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Supplement of

Storm Franz: Societal and energy impacts in northwest Europe on 11–12 January 2007

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SUMMARY OF SECTIONS IN THE SUPPLEMENT

SECTION S1. STORM TRAJECTORY FROM PRIMAVERA DATASET

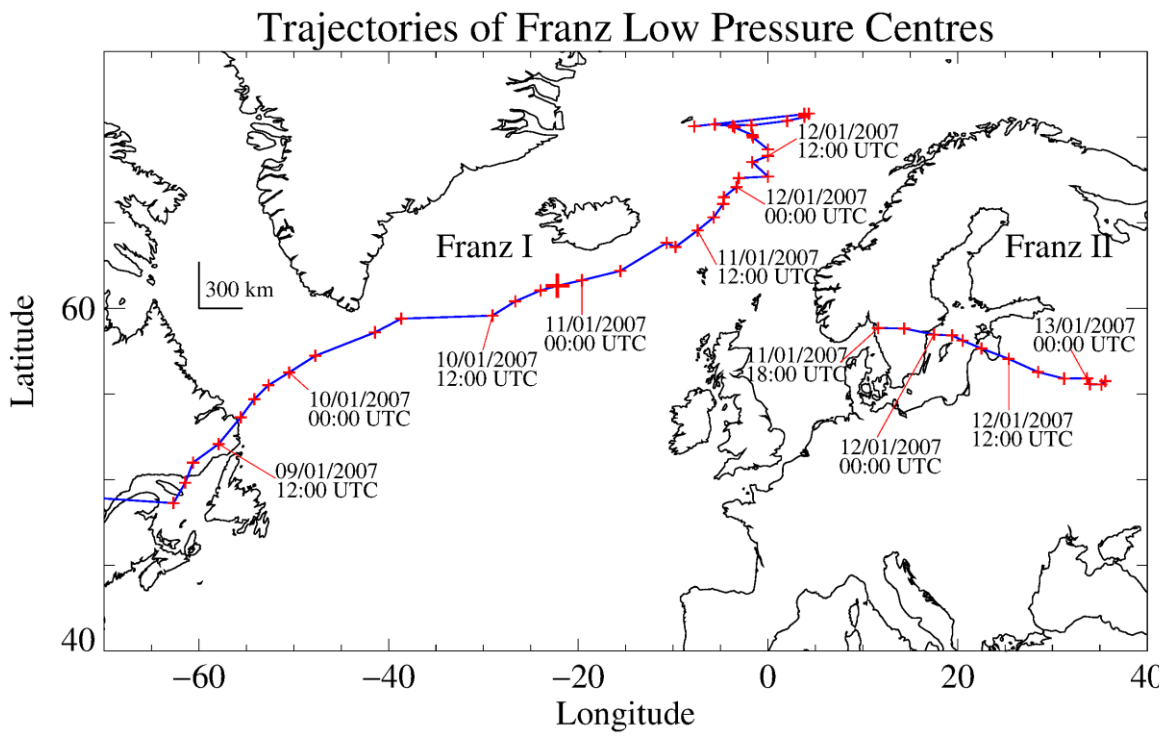


Figure S1.1. Map of trajectories of Franz I and Franz II. The lowest pressure of Franz I is shown with a large cross south of Iceland.

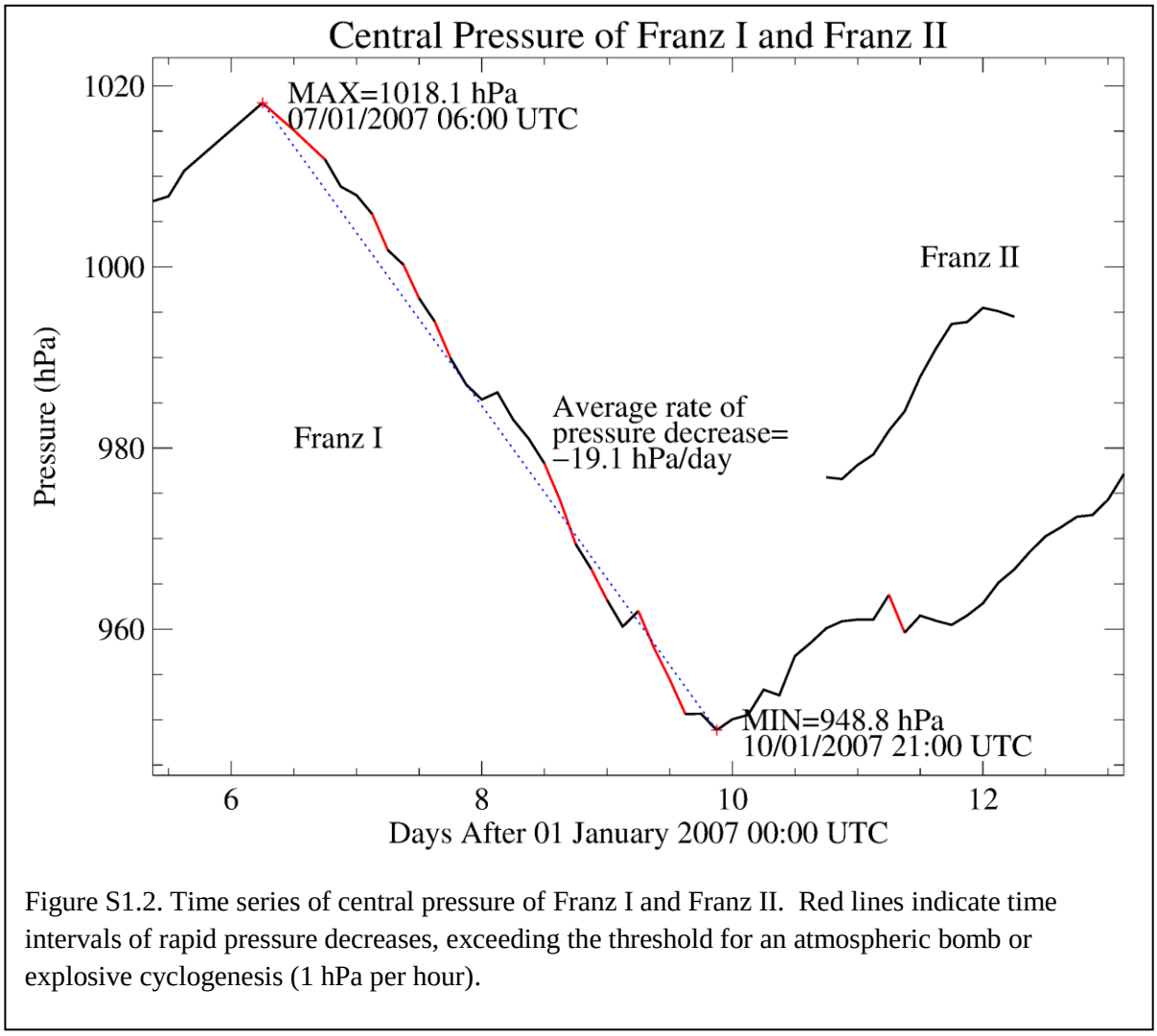


Figure S1.2. Time series of central pressure of Franz I and Franz II. Red lines indicate time intervals of rapid pressure decreases, exceeding the threshold for an atmospheric bomb or explosive cyclogenesis (1 hPa per hour).

SECTION S2. WIND MEASUREMENTS ACROSS THE PERIOD OF THE STORM

The following text is reproduced from the Supplement of Kettle (2023) as background information to understand the maps produced from the USAF and Quikscat satellite data.

The USAF data set is described in the website 'U.S.A.F. DATSAV3 Surface observations, 1901–continuing' at https://rda.ucar.edu/datasets/ds463.2/. Data from the WMO, ICAO, and AFWA networks within the larger dataset forms an element of the Copernicus Climate Data Store product 'Global land surface atmospheric variables from 1755 to 2020 from comprehensive in-situ observations' at https://cds.climate.copernicus.eu/cdsapp#!/dataset/insitu-observations-surface-land?tab=overview'. The wind data from the WMO, ICAO, and AFWA networks have been used to compose the diagrams in this section. According to WMO reporting requirements, the wind speed report is a 10 minute average value and corrected for a 10 m standard height (CIMO guide, Chapter 5. Measurement of surface wind https://library.wmo.int/doc_num.php?explnum_id=3177/CIMO_Guide_2014_en_I_5.pdf).

Problems have been noted with some of the wind speed data passing into the international weather networks, which is most likely associated with a unit conversion error between knots and m/s (Gatey and Miller, 2007). The problem makes it difficult to trust the infrequent occurrence of high wind speed values in the raw data set. For this reason, a basic data buddy check was implemented for rejecting potentially bad data when drawing up the maps of this section. For a given reporting time, a wind speed value was compared with the nearest other reporting station and rejected if it was more than four times greater.

Reference:

Gatey, D.A. and Miller, C.A.: An investigation into 50-year return period wind speed differences for Europe, J Wind Engineering and Industrial Aerodynamics, 95, 1040–1052, 2007.

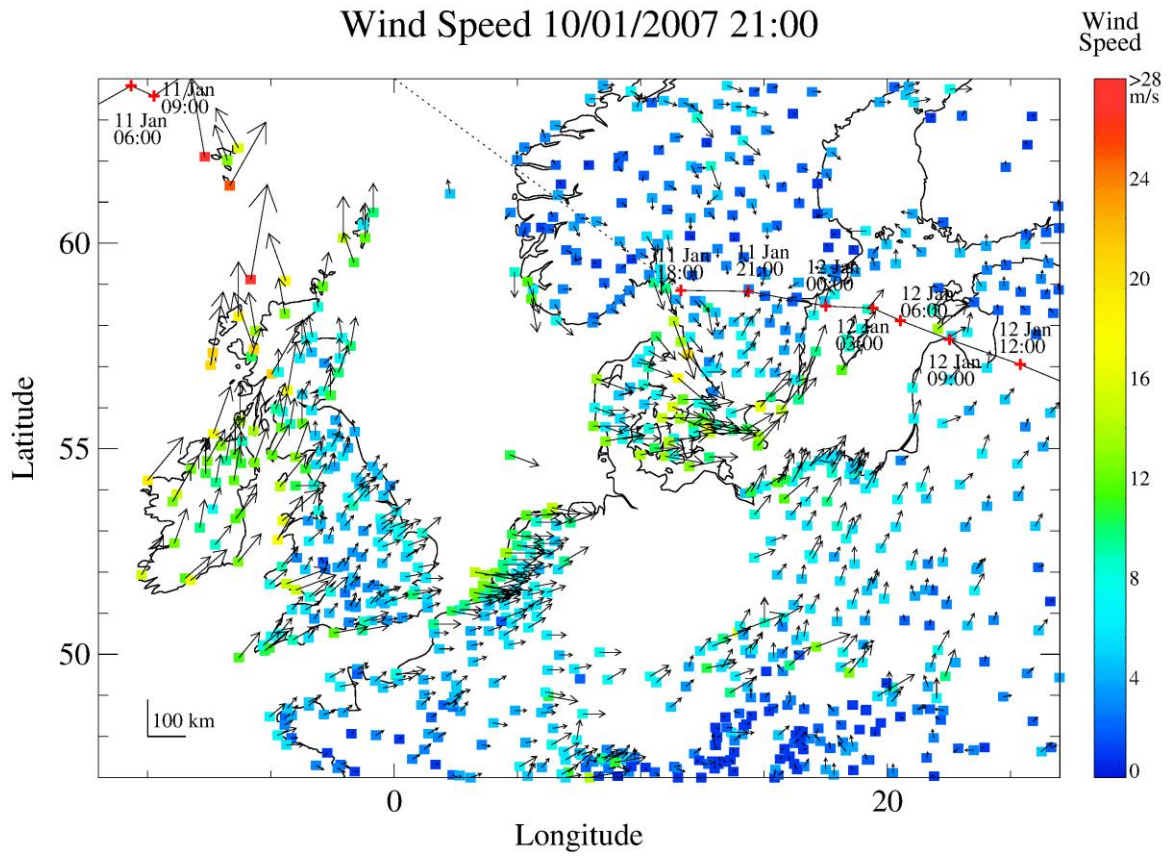


Figure S2.1. Wind speed and direction within 5 minutes of 21:00 UTC 10 January 2007 from selected stations of the USAF data set. The trajectory of low pressure centre is indicated by the black line with red crosses at 3 hour intervals (Lockwood et al., 2022). The location of the pressure centre at the time of wind field is shown by a larger cross.

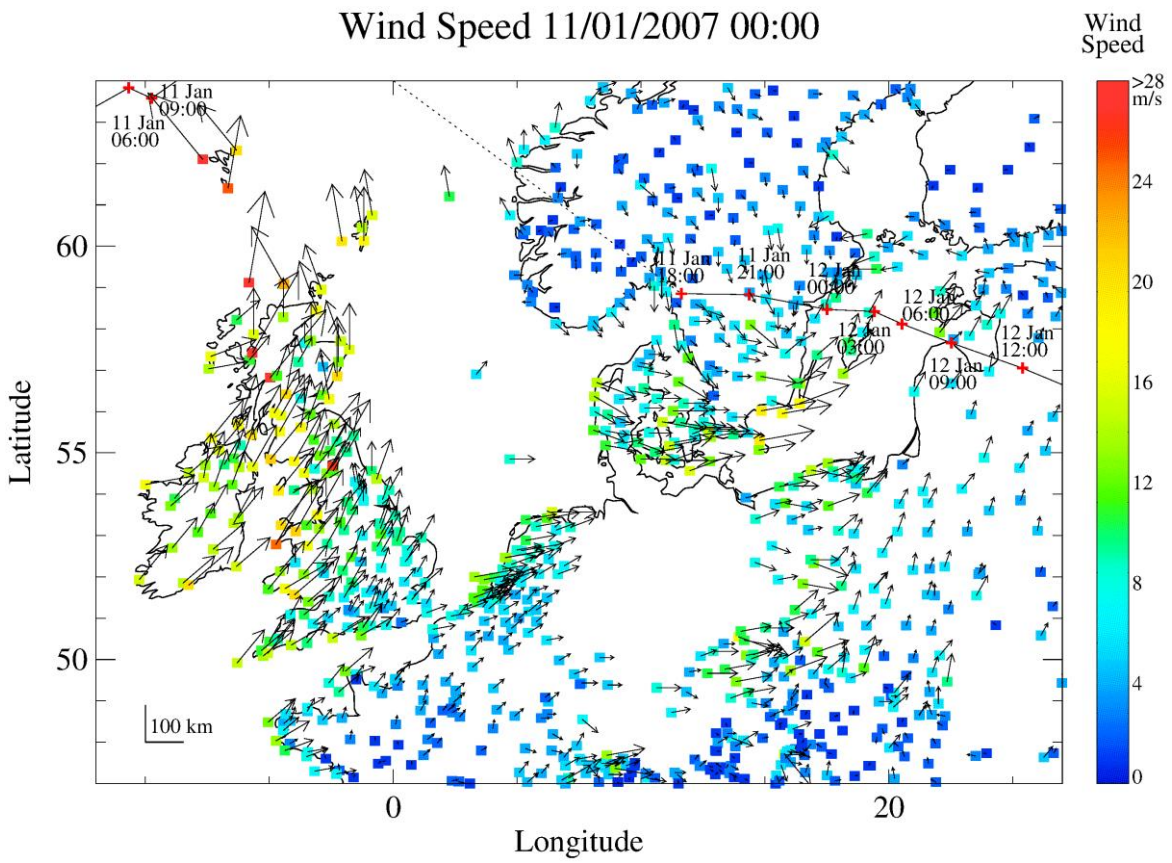


Figure S2.2. Wind speed and direction within 5 minutes of 00:00 UTC 11 January 2007 from selected stations of the USAF data set. The trajectory of low pressure centre is indicated by the black line with red crosses at 3 hour intervals (Lockwood et al., 2022). The location of the pressure centre at the time of wind field is shown by a larger cross.

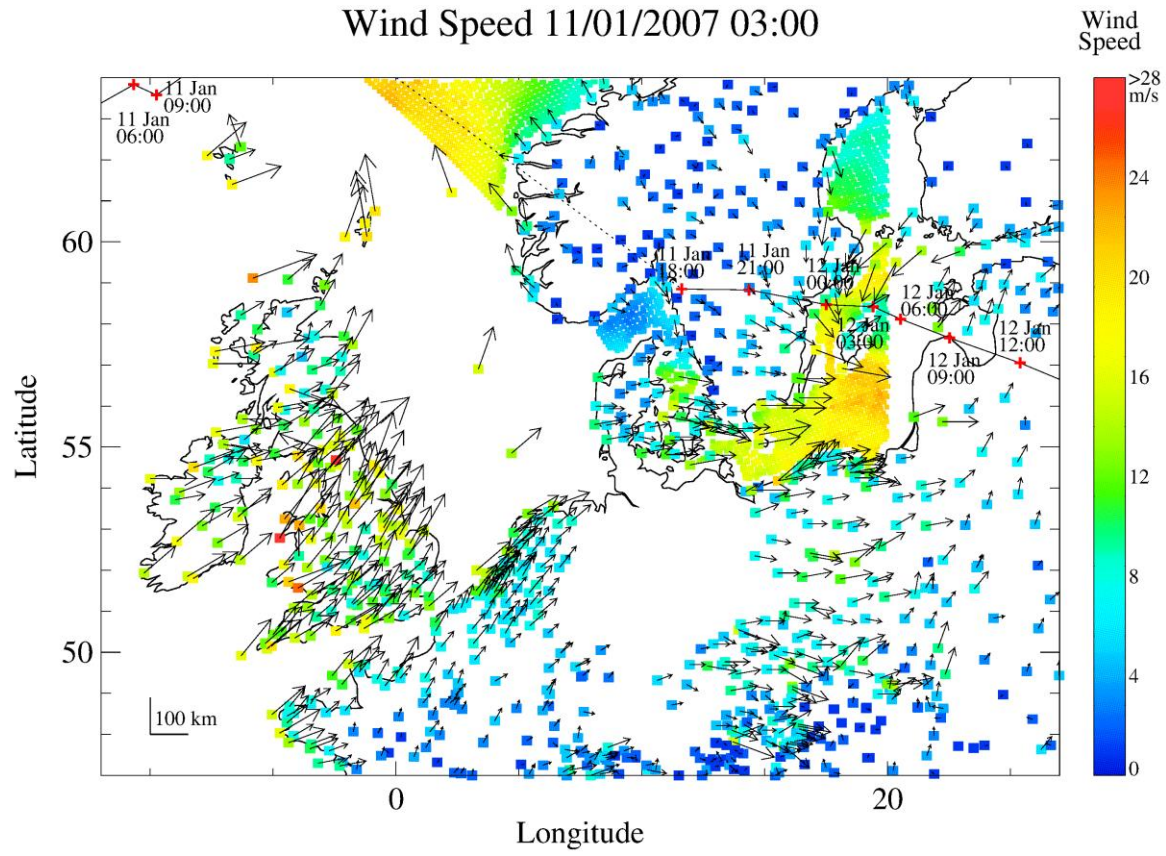


Figure S2.3. Wind speed and direction within 5 minutes of 03:00 UTC 11 January 2007 from selected stations of the USAF data set. The trajectory of low pressure centre is indicated by the black line with red crosses at 3 hour intervals (Lockwood et al., 2022). The location of the pressure centre at the time of wind field is shown by a larger cross. QuikSCAT sea surface wind speeds are shown for a satellite overpass at ~03:25 UTC or ~25 minutes after the synoptic station reports.

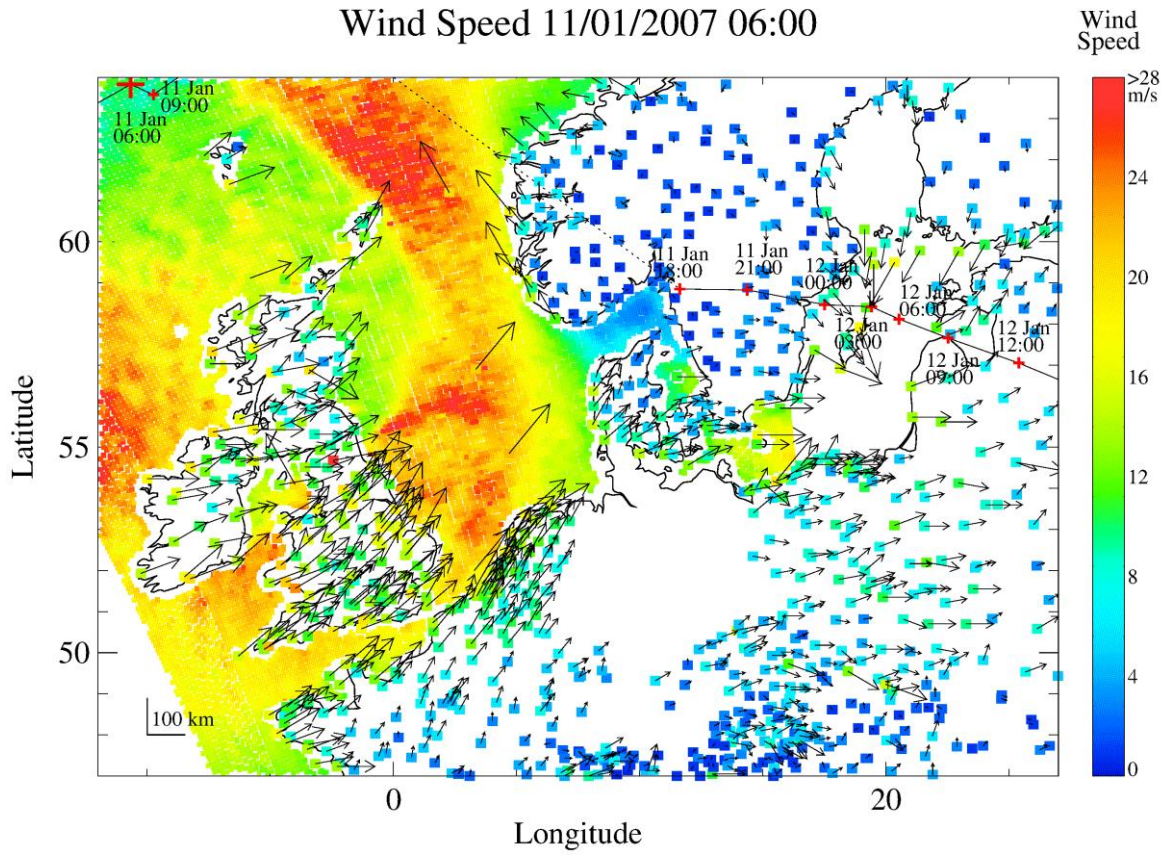


Figure S2.4. Wind speed and direction within 5 minutes of 06:00 UTC 11 January 2007 from selected stations of the USAF data set. The trajectory of low pressure centre is indicated by the black line with red crosses at 3 hour intervals (Lockwood et al., 2022). The location of the pressure centre at the time of wind field is shown by a larger cross. QuikSCAT sea surface wind speeds are shown for a satellite overpass at ~05:05 UTC or ~55 minutes before the synoptic station reports.

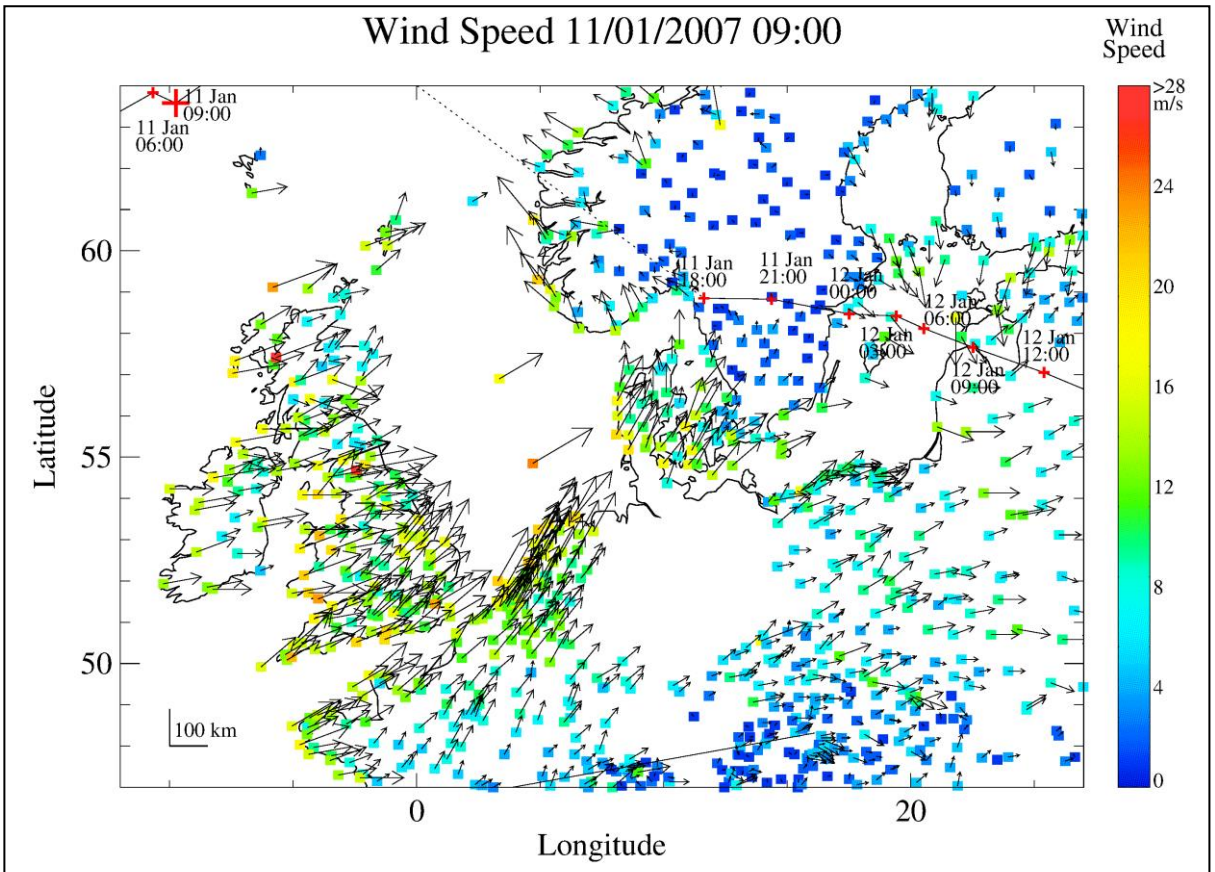


Figure S2.5. Wind speed and direction within 5 minutes of 09:00 UTC 11 January 2007 from selected stations of the USAF data set. The trajectory of low pressure centre is indicated by the black line with red crosses at 3 hour intervals (Lockwood et al., 2022). The location of the pressure centre at the time of wind field is shown by a larger cross.

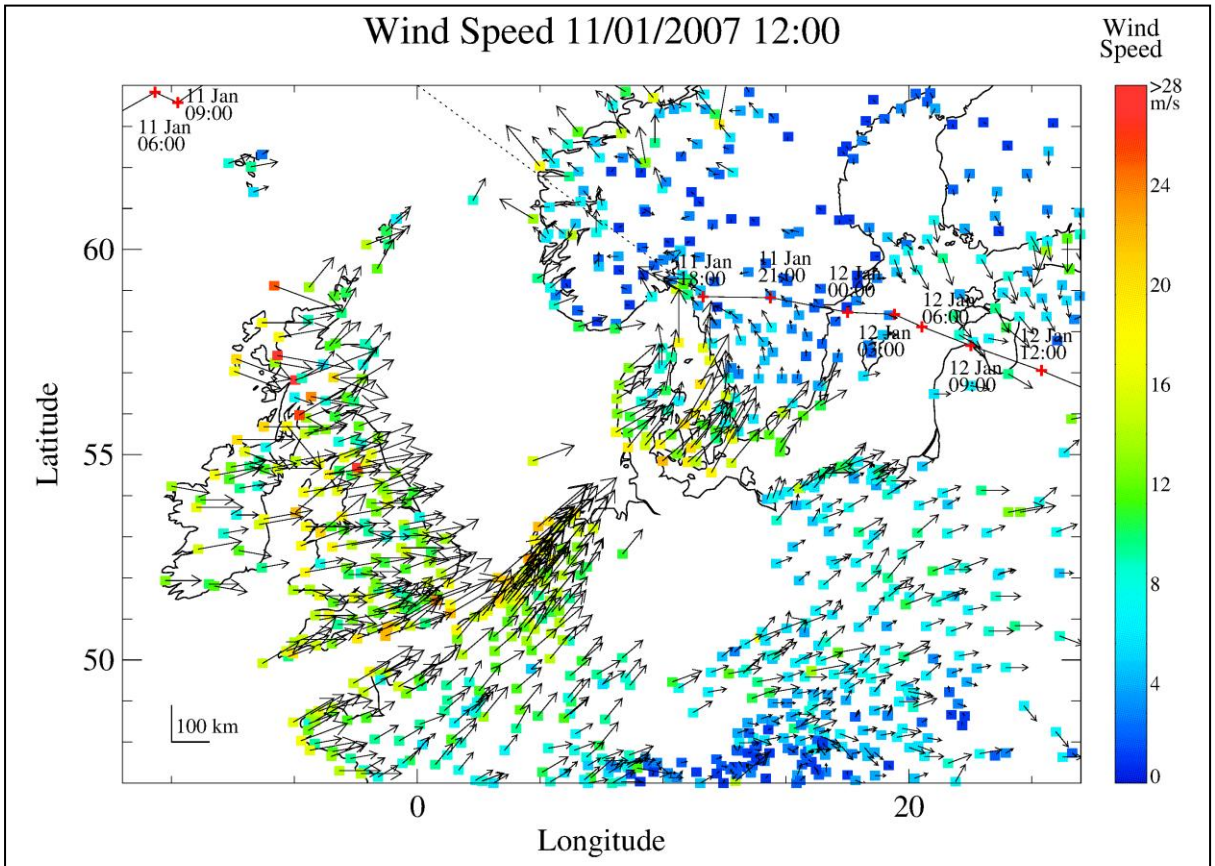


Figure S2.6. Wind speed and direction within 5 minutes of 12:00 UTC 11 January 2007 from selected stations of the USAF data set. The trajectory of low pressure centre is indicated by the black line with red crosses at 3 hour intervals (Lockwood et al., 2022). The location of the pressure centre at the time of wind field is shown by a larger cross.

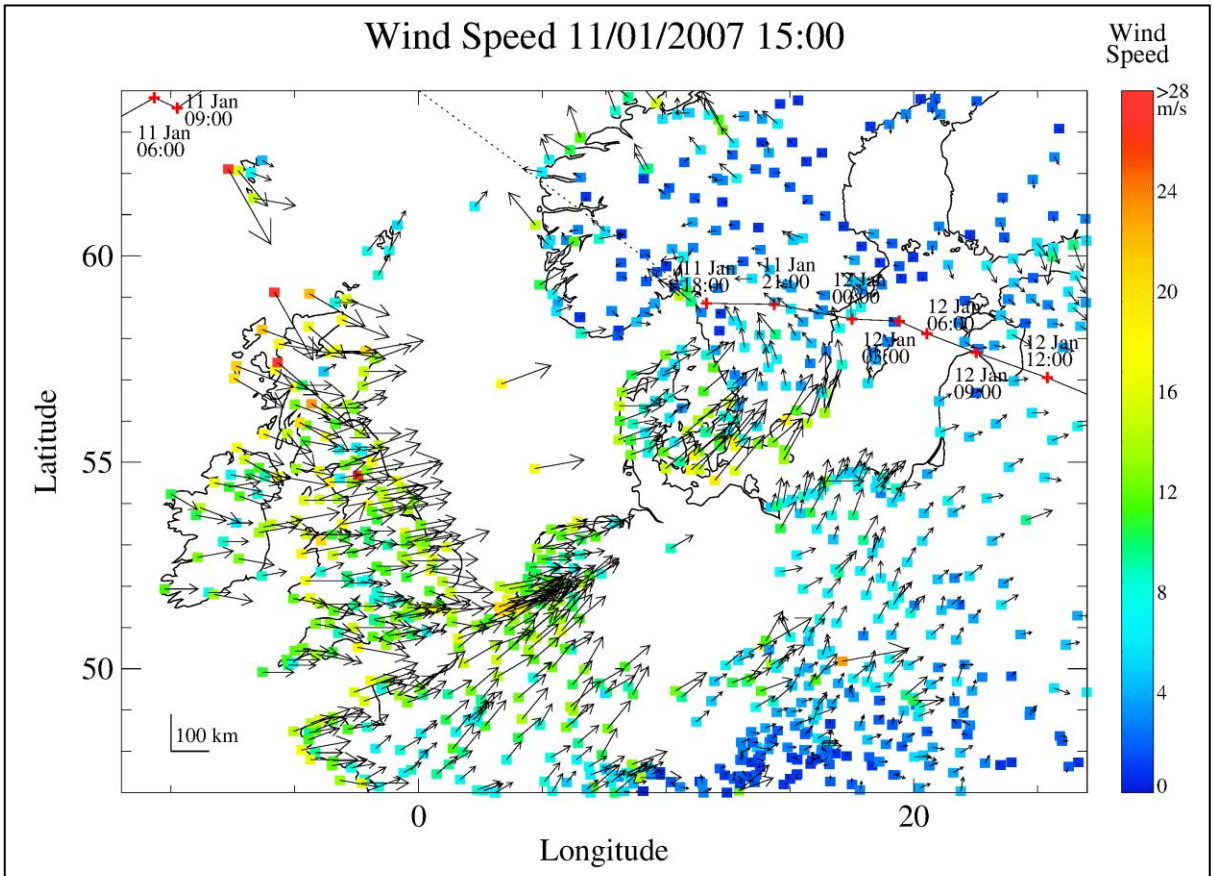
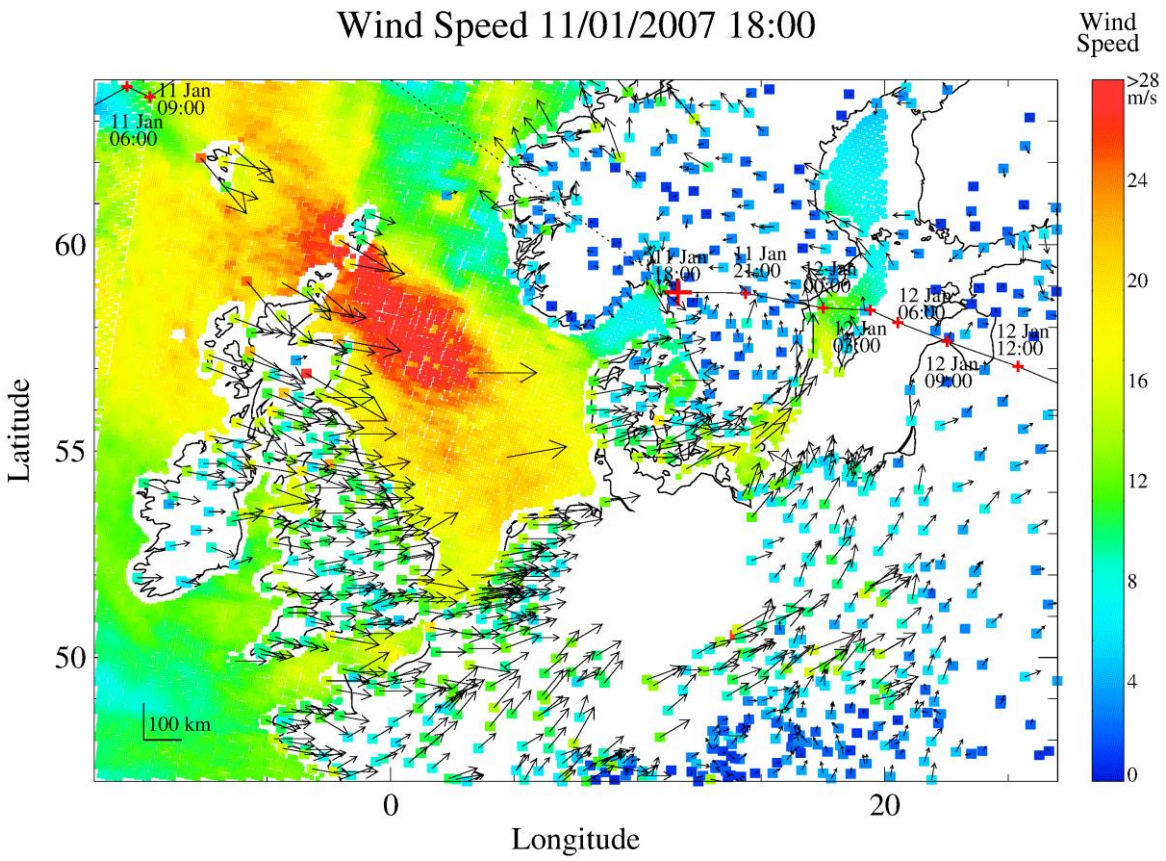


Figure S2.7. Wind speed and direction within 5 minutes of 15:00 UTC 11 January 2007 from selected stations of the USAF data set. The trajectory of low pressure centre is indicated by the black line with red crosses at 3 hour intervals (Lockwood et al., 2022). The location of the pressure centre at the time of wind field is shown by a larger cross.



S2.8. Wind speed and direction within 5 minutes of 18:00 UTC 11 January 2007 from selected stations of the USAF data set. The trajectory of low pressure centre is indicated by the black line with red crosses at 3 hour intervals (Lockwood et al., 2022). The location of the pressure centre at the time of wind field is shown by a larger cross. QuikSCAT sea surface wind speeds are shown for a satellite overpass at ~18:50 UTC or ~50 minutes after the synoptic station reports.

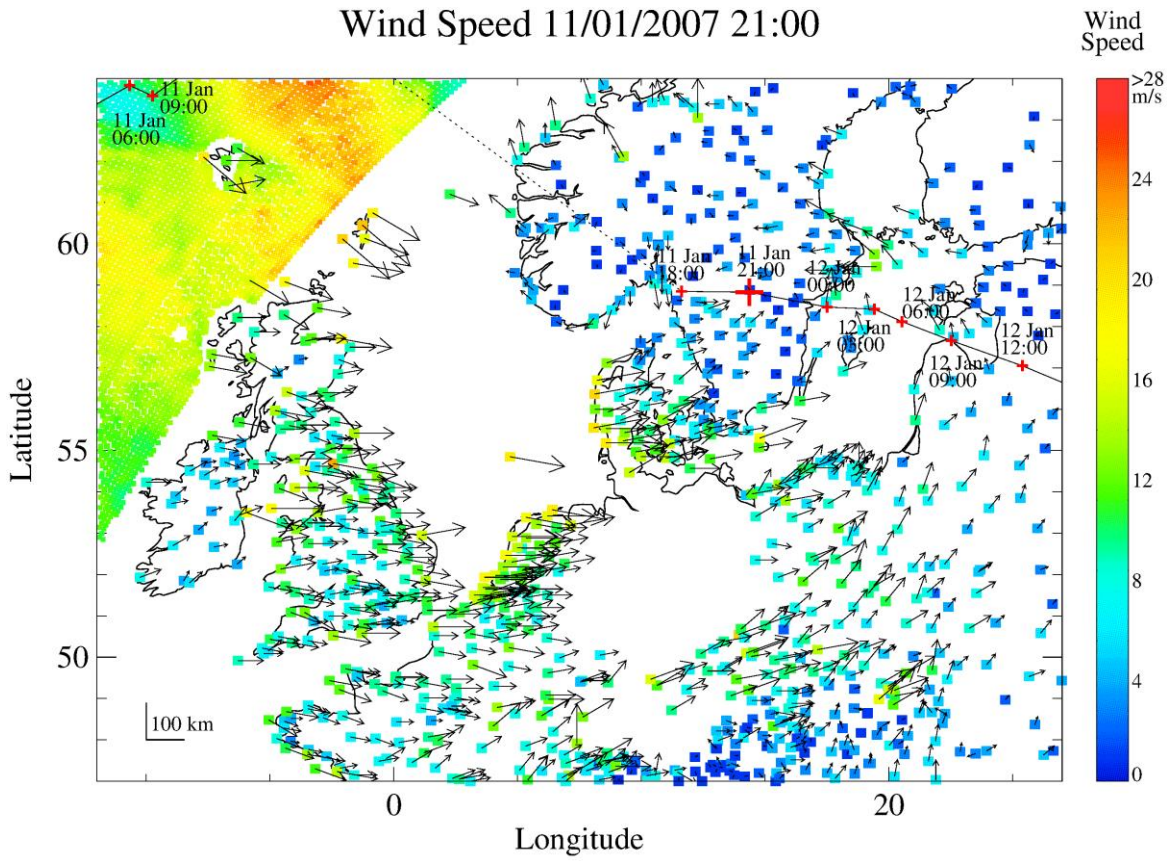


Figure S2.9. Wind speed and direction within 5 minutes of 21:00 UTC 11 January 2007 from selected stations of the USAF data set. The trajectory of low pressure centre is indicated by the black line with red crosses at 3 hour intervals (Lockwood et al., 2022). The location of the pressure centre at the time of wind field is shown by a larger cross. QuikSCAT sea surface wind speeds are shown for a satellite overpass at ~20:30 UTC or ~30 minutes before the synoptic station reports.

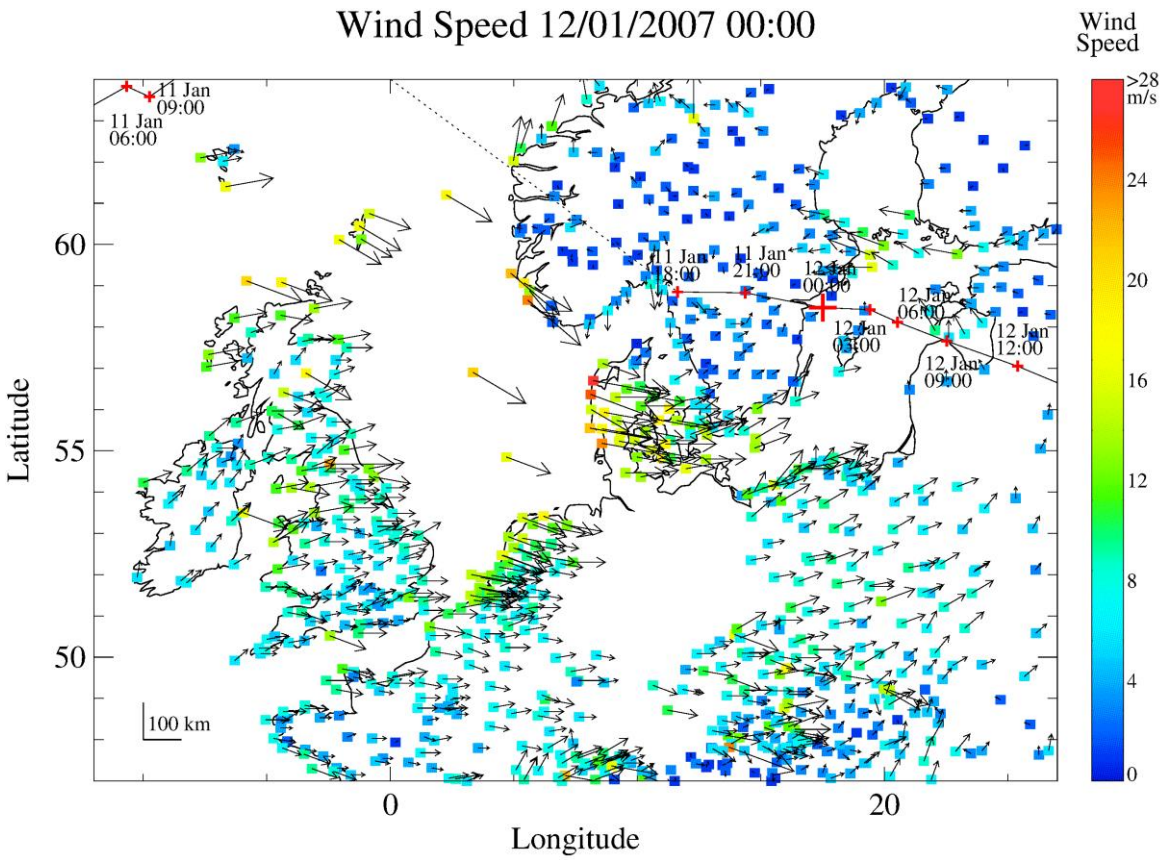


Figure S2.10. Wind speed and direction within 5 minutes of 00:00 UTC 12 January 2007 from selected stations of the USAF data set. The trajectory of low pressure centre is indicated by the black line with red crosses at 3 hour intervals (Lockwood et al., 2022). The location of the pressure centre at the time of wind field is shown by a larger cross.

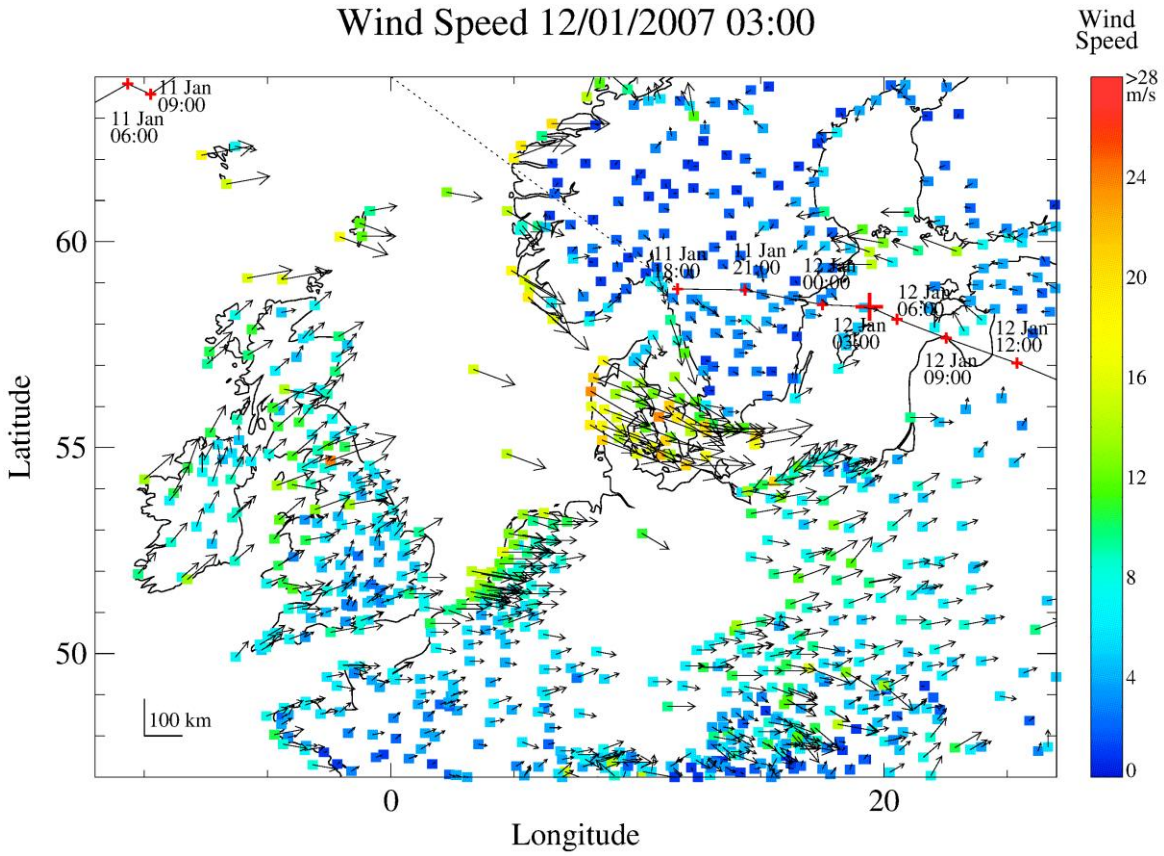


Figure S2.11. Wind speed and direction within 5 minutes of 03:00 UTC 12 January 2007 from selected stations of the USAF data set. The trajectory of low pressure centre is indicated by the black line with red crosses at 3 hour intervals (Lockwood et al., 2022). The location of the pressure centre at the time of wind field is shown by a larger cross.

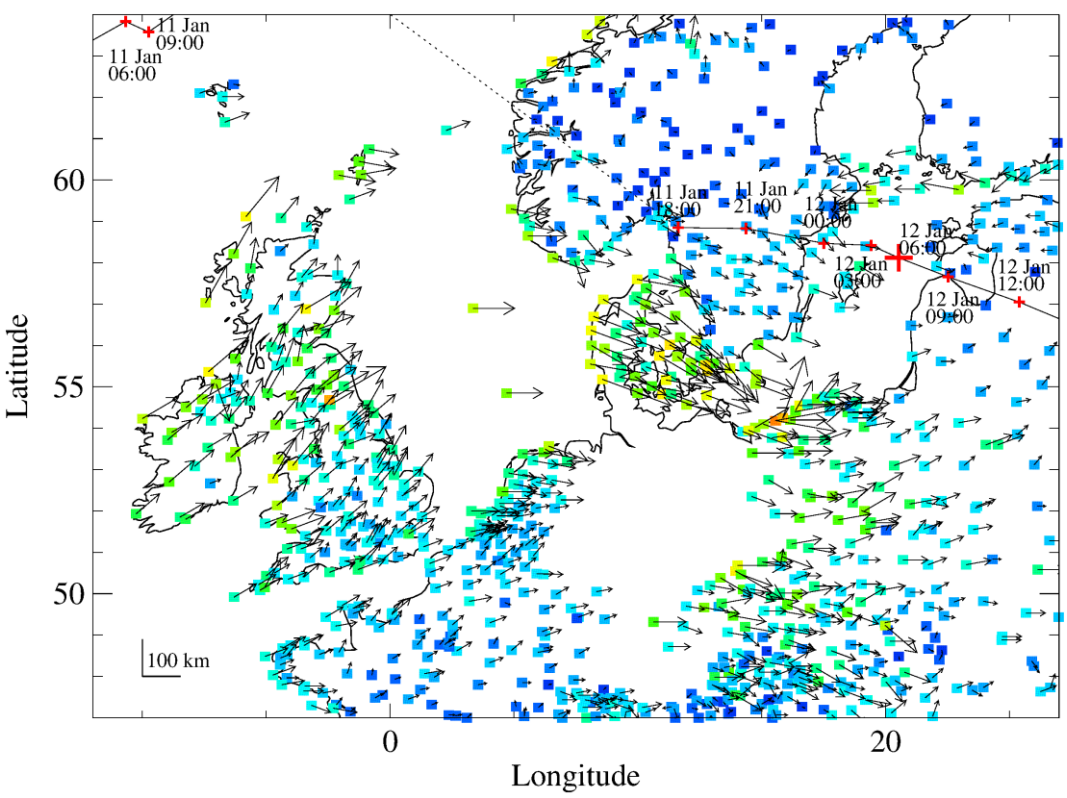


Figure S2.12. Wind speed and direction within 5 minutes of 06:00 UTC 12 January 2007 from selected stations of the USAF data set. The trajectory of low pressure centre is indicated by the black line with red crosses at 3 hour intervals (Lockwood et al., 2022). The location of the pressure centre at the time of wind field is shown by a larger cross.

SECTION S3. QUIKSCAT IMAGES OF OFFSHORE WIND DURING THE STORM

The following text is reproduced from the Supplement of Kettle (2023) with modification as background information in this section.

The reprocessed and improved Quikscat wind speed data in this report is described in Fore et al (2013). Hoffmann and Leidner (2005) present more information on the QuikSCAT instrument and processing chain during the period when it was in operation from 1999–2009. The major challenges with wind vector retrieval from Quikscat scatterometer data focus on:

- dealing with the problem that the backscatter signal recorded by the satellite is consistent with one to four possible valid wind vector solutions.
- difficulties obtaining information at low wind speeds
- low scatterometer bias for wind speeds greater than 20m/s
- difficulties in retrieving the wind vector during rain events.

Quikscat netcdf data files for 11 January 2007 were downloaded from the Internet site https://podaac.jpl.nasa.gov/dataset/QSCAT_LEVEL_2B_PWV_COMP_12 (QuikSCAT Level 2B Ocean Wind Vectors in 12.5km Slice Composites Version 3). Each netcdf file is a package of data for an orbital swath around the Earth with 14 files in each day for the 14 orbits. The data in each netcdf file includes latitude, longitude, time, retrieved wind speed and direction, with extra administrative files for quality control and ancillary parameters. The QuikSCAT satellite was sun synchronous with an ascending pass over the same point each day. For the North Sea area, for example, there was one overpass in one direction in early evening. However, there was also a second overpass in the early morning in the opposite direction, giving two views of the same region each day. Storm Franz was moving on an eastward trajectory, and the timing of the QuikSCAT overpasses gives two looks at the storm in North Sea on the morning and evening of 11 January 2007.

References:

Fore AG, BW Stiles, AH Chau, BA Williams, RS Dunbar, E Rodriguez, Point-wise wind retrieval and ambiguity removal improvements for the QuikSCAT climatological data set, IEEE Transactions on Geoscience and Remote Sensing, 52, 51-59, 2013.

Hoffman R.N. and S.M. Leidner, An introduction to the near real-time Quikscat data, Weather and Forecasting, 20, 476-493, 2005

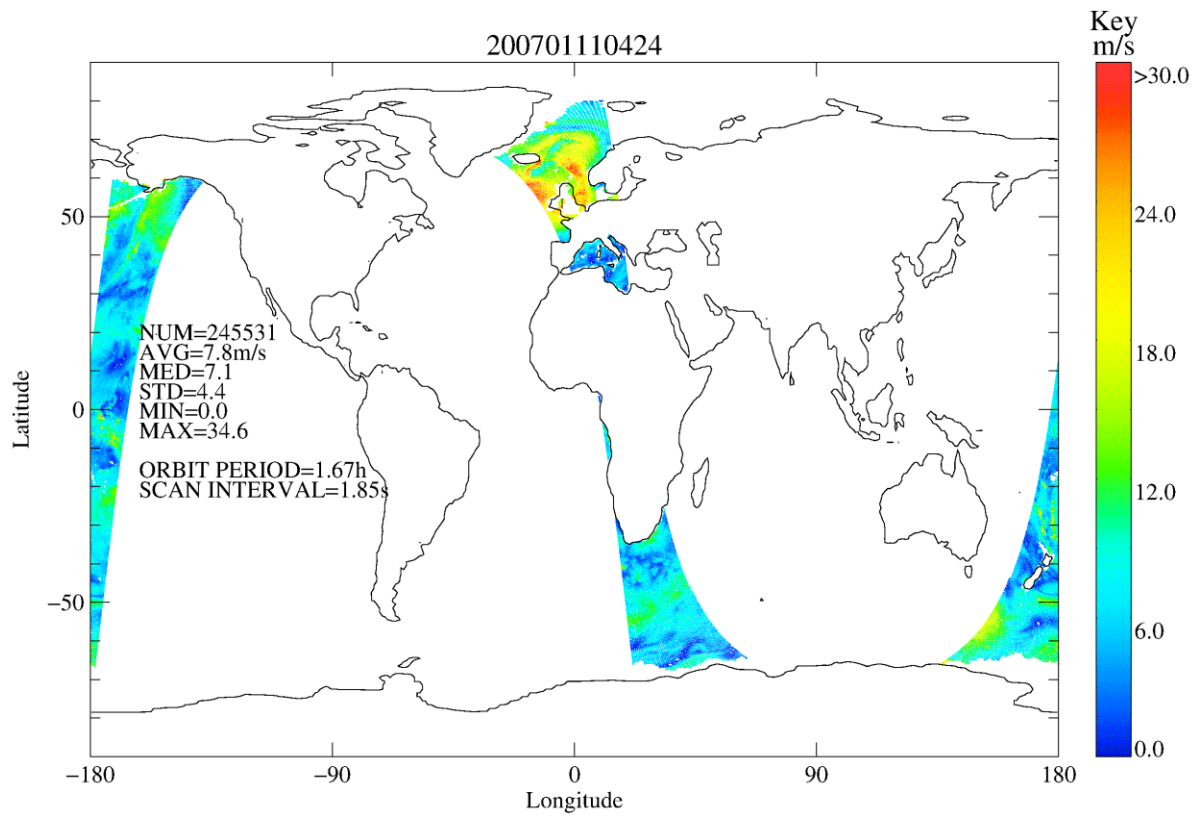


Figure S3.1. QuikSCAT satellite image of sea surface wind speed for one orbital swath starting at 04:24 UTC 11 January 2007 and lasting 1.67 h. The low pressure centre of Storm Franz was between Iceland and the Faroe Islands at the time of the overpass and storm damage was being registered in Ireland and the UK starting from about 20:00 UTC on 10 January 2007 or ~9 hours before the overpass.

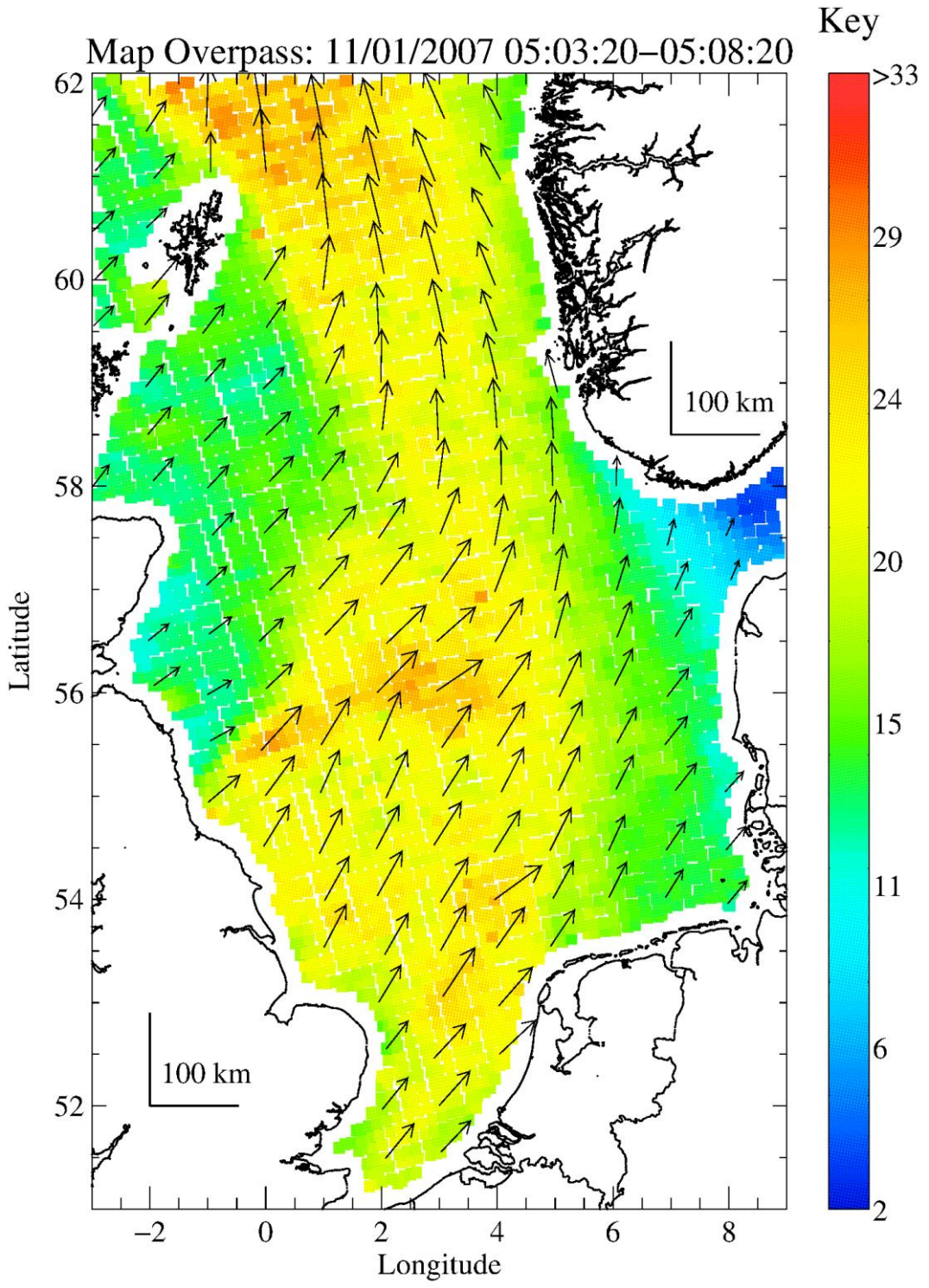


Figure S3.2. QuikSCAT satellite image of sea surface wind speed and direction in the North Sea at about 11 January 2007 05:05 UTC. At the time of the image, the low pressure centre was between Iceland and the Faroe Islands.

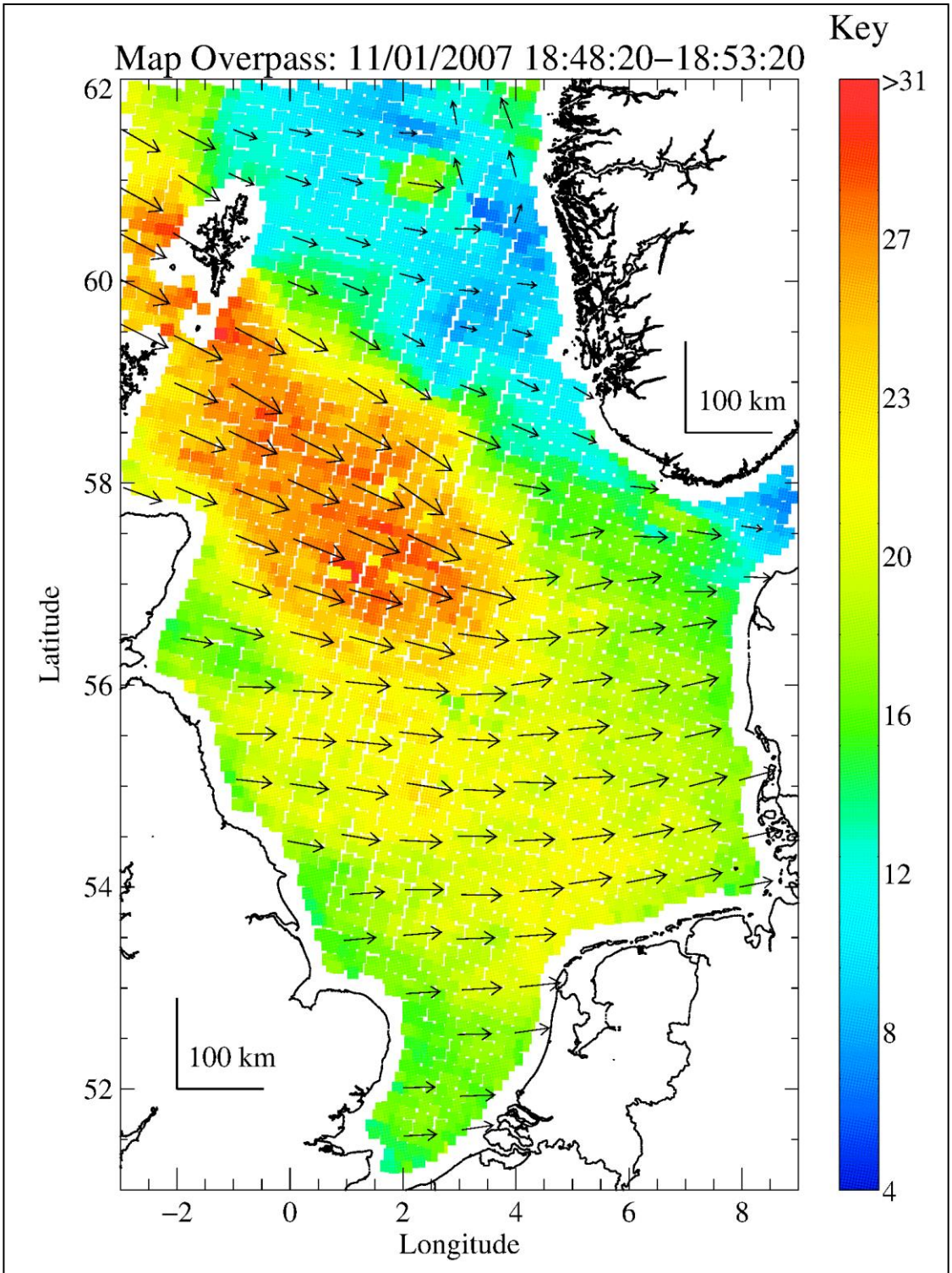


Figure S3.3. QuikSCAT satellite image of sea surface wind speed and direction in the North Sea at about 11 January 2007 18:50 UTC. At the time of the image, the low pressure centre of Franz II was just to the south of Oslo, Norway.

SECTION S4. RADIOSONDE ANALYSIS ACROSS THE PERIOD OF THE STORM

Radiosonde data for Europe were downloaded from the University of Wyoming archival website at http://weather.uwyo.edu/upperair/sounding.html. The locations of the 52 stations chosen for the analysis are shown in Fig. S4.1. The data for the time period 1–25 January 2007 were selected for analysis. Most of the stations had radiosonde ascents at 12 h intervals, although some had data at 6 h intervals. The original data sets included primary profile measurements (pressure, height, temperature, dew point temperature, wind speed, and wind direction), derived profile measurements (relative humidity, mixing ratio, and potential temperature) and a number of diagnostic values including convective available potential energy (CAPE) and lifted condensation level. Although the archival website does not present metadata or instrument specifications, information about the radiosonde instruments that have used by the different national meteorological services is given in Gaffen (1993).

A subset of information for height and wind speed is presented in this section. Time series of vertical profiles of wind speed are shown in Fig. S4.2, S4.3, S4.4 for three stations. These show high upper tropospheric wind speeds at the time of Storm Kyrill on 18–19 January 2007 (Valentia in Ireland, Nottingham in England, and de Bilt in the Netherlands). These stations were in the region of high surface wind speeds that stretched across Europe from Ireland to the Russia, south of the low pressure trajectory. The upper tropospheric wind speeds of > 80 m/s for all three stations would have marked this storm as a category 5 hurricane if the wind speeds had been registered as a 10 minute sustained average at 10 m height above the ground surface. The three selected stations also register high upper tropospheric winds for an earlier storm on 12 January 2007 (Storm Franz).

Latitude-height profiles of wind speed are shown for stations in Europe at 11 January 2007 at 11:00 UTC (Fig. S4.5) and 11 January 2007 at 12:00 UTC (Fig. S4.6). The figures emphasize that the highest tropospheric winds occurred at latitudes between Nottingham and Vienna, south of the trajectory of the low pressure centre. The high winds penetrated down into the troposphere below 5 km.

References:

Gaffen, Dian J.: Historical changes in radiosonde instruments and practices, World Meteorological Organization, Instruments and Observing Methods, Report No. 50. WMO/TD-No.541, 1993

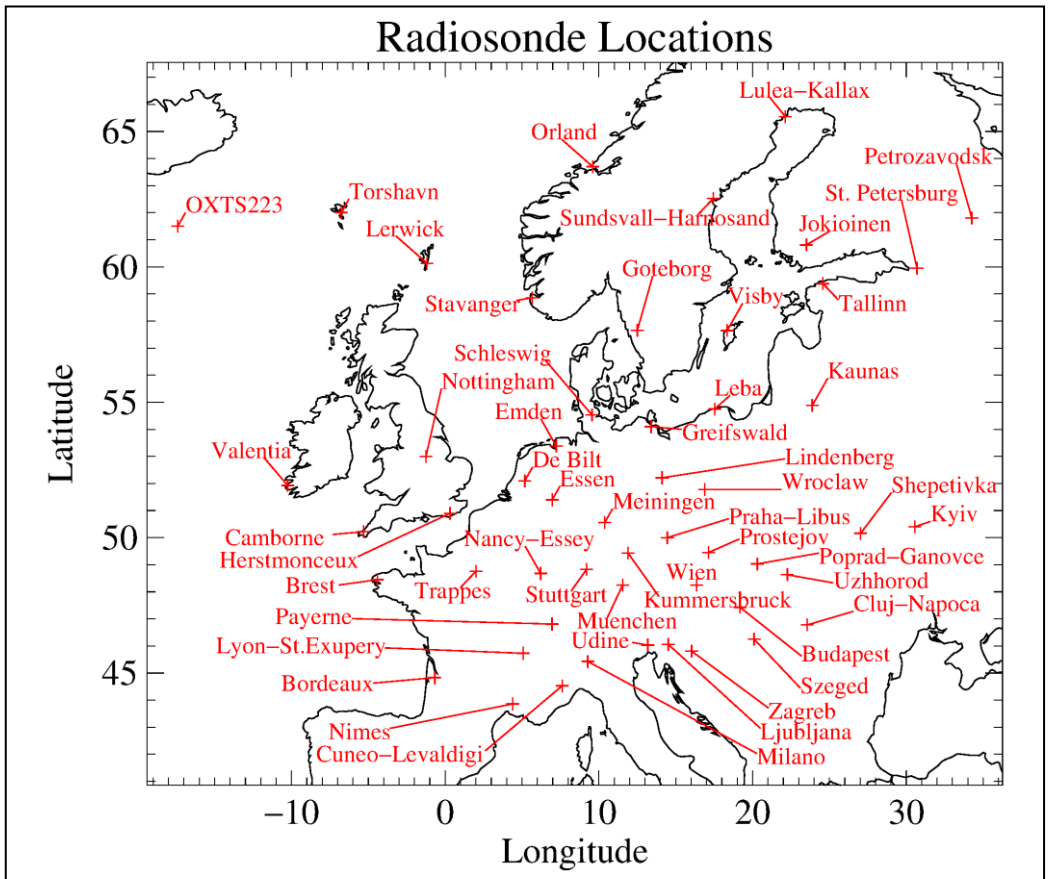


Figure S4.1. Map of radiosonde stations with data during the time period 1–25 January 2007.

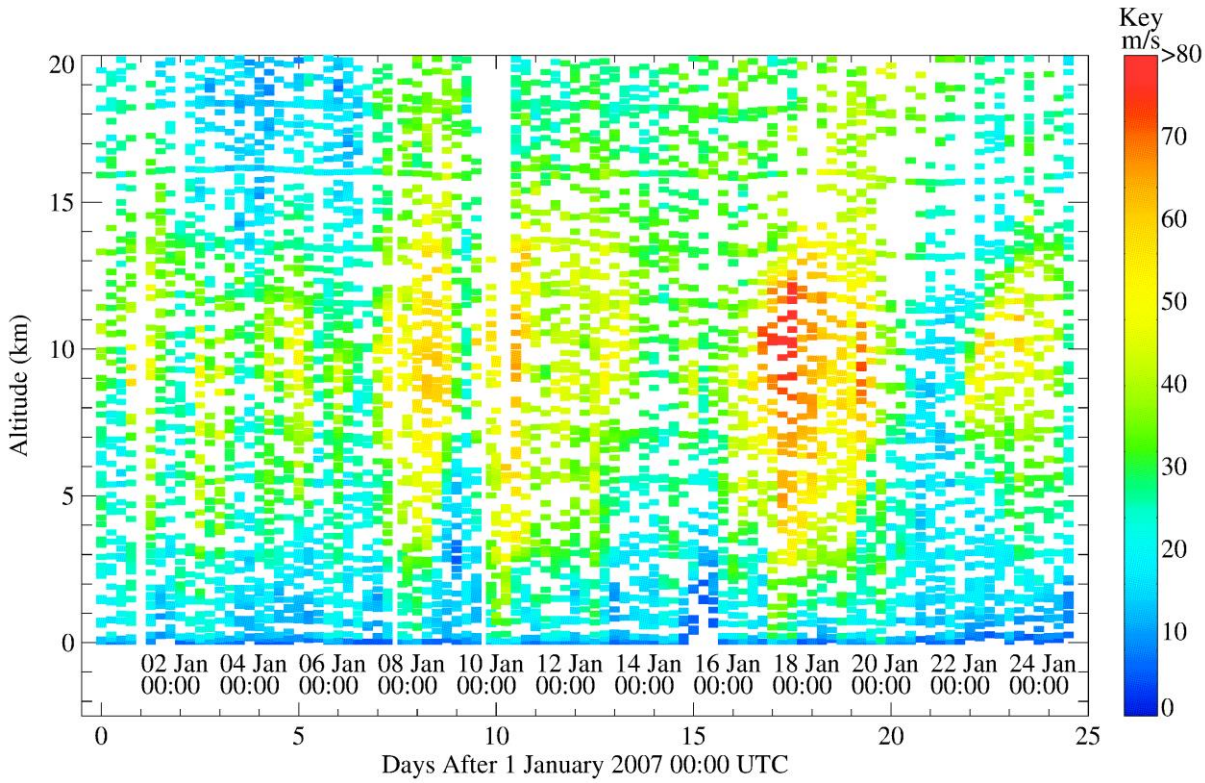


Figure S4.2. Time series of vertical profiles of wind speed for the radiosonde station at Valentia in Ireland for the period 1–25 January 2007.

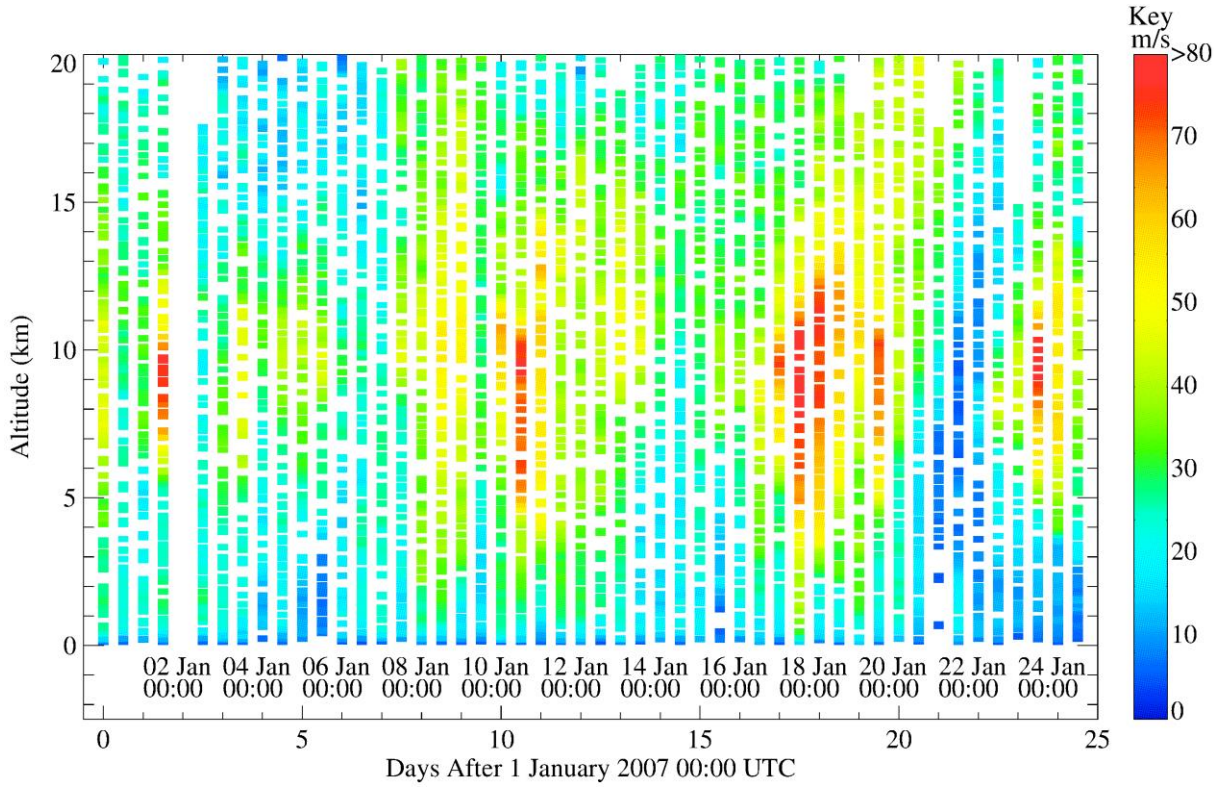


Figure S4.3. Time series of vertical profiles of wind speed for the radiosonde station at Nottingham in England for the period 1–25 January 2007.

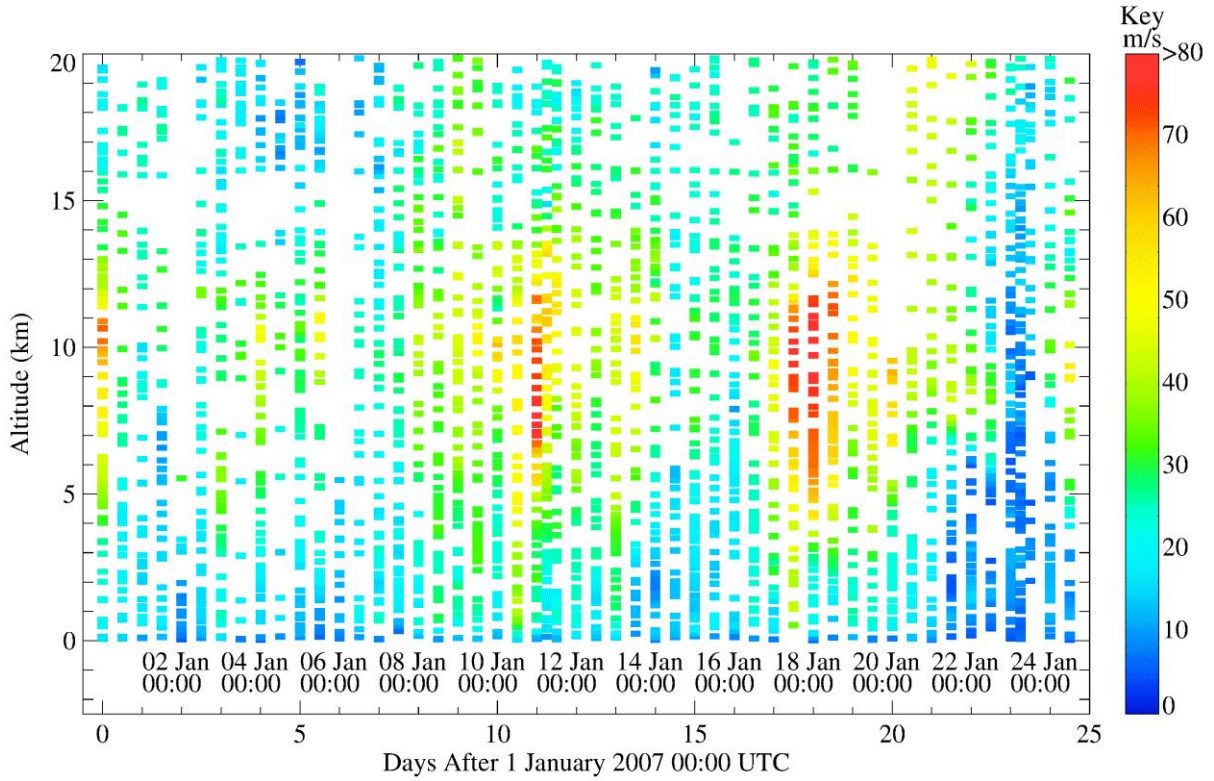


Figure S4.4. Time series of vertical profiles of wind speed for the radiosonde station at De Bilt in the Netherlands for the period 1–25 January 2007.

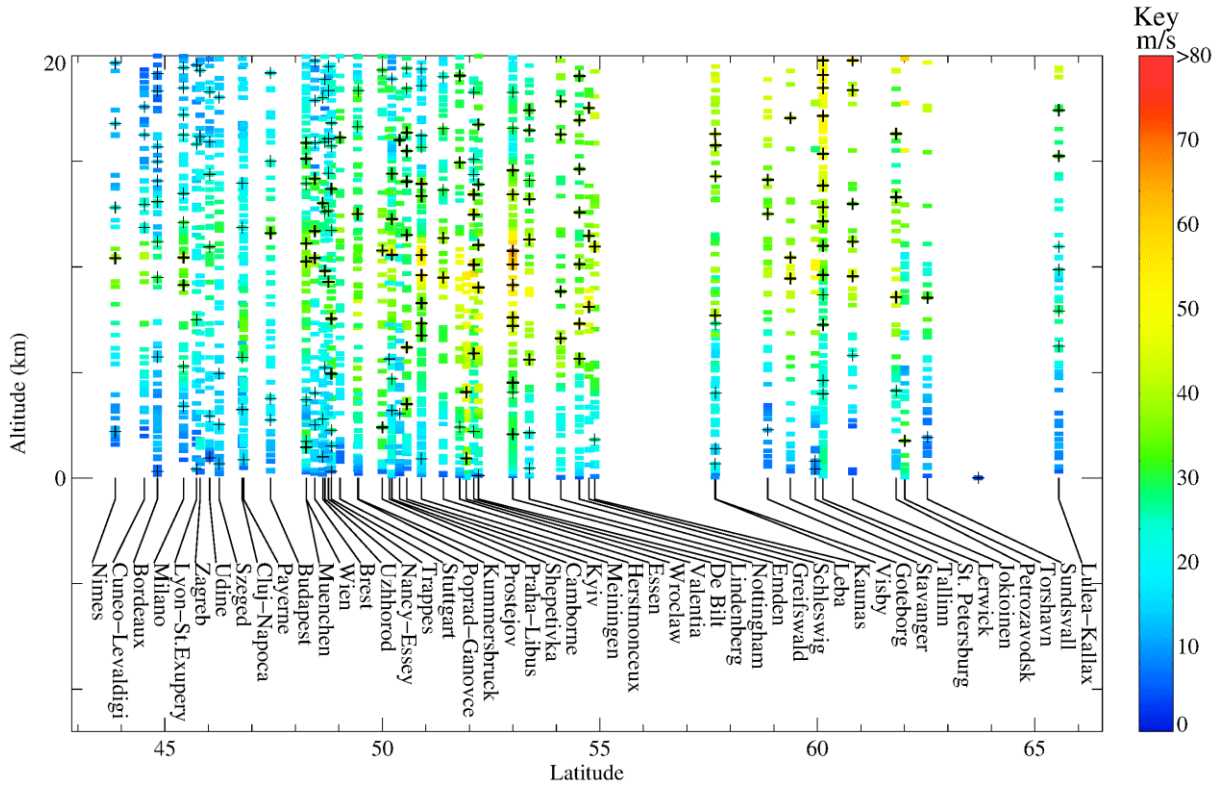


Figure S4.5. Latitude-height section of radiosonde wind speeds for stations in Europe on 11 January 2007 at 00:00 UTC. Crosses mark local maxima in the wind speed profiles, and bold crosses indicate local maximum wind speeds exceeding 32 m/s.

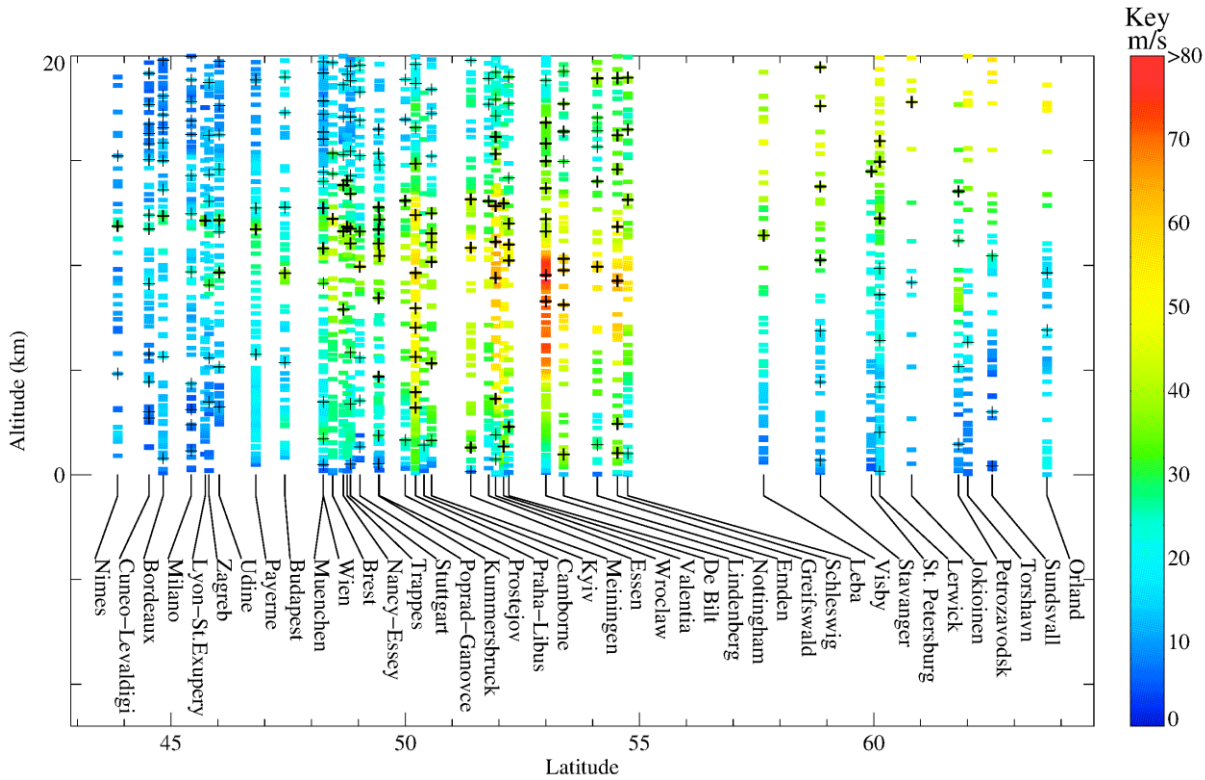


Figure S4.6. Latitude-height section of radiosonde wind speeds for stations in Europe on 11 January 2007 at 12:00 UTC. Crosses mark local maxima in the wind speed profiles, and bold crosses indicate local maximum wind speeds exceeding 32 m/s.

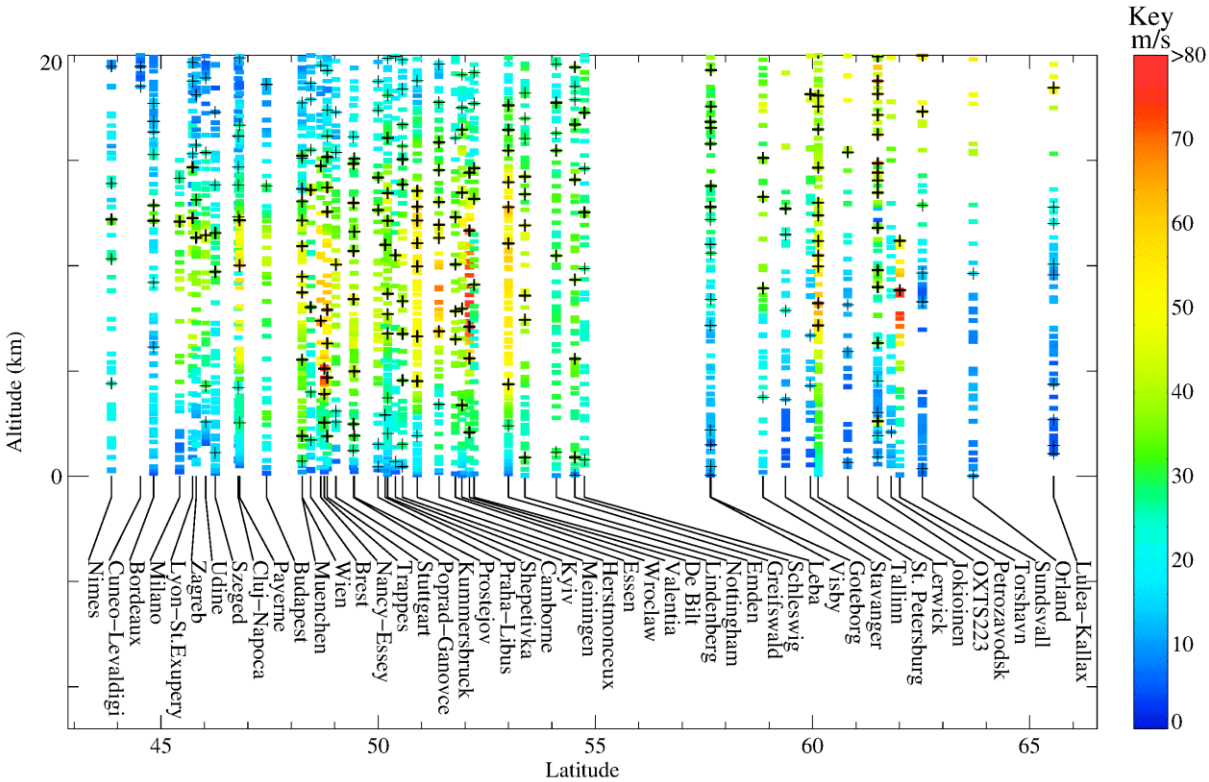


Figure S4.7. Latitude-height section of radiosonde wind speeds for stations in Europe on 12 January 2007 at 00:00 UTC. Crosses mark local maxima in the wind speed profiles, and bold crosses indicate local maximum wind speeds exceeding 32 m/s.

SECTION S5. WAVE MEASUREMENTS IN THE NORTH SEA AND NORWEGIAN SEA

Measurements of significant wave height are presented for stations in the Norwegian Sea and North Sea. The data originate from different sources, which are given in Tables S5.1 and S5.2. The data providers are mostly governmental authorities, except CMEMS, which is a European Commission organization and has provided data from different sources. The quality control and data cleaning procedures for the different providers is not known. Magnusson (2009) indicated that the data cleaning may be too vigorous in some instances and may remove valid wave data in extreme sea states.

Reference:

Magnusson, A.K.: What is true sea state? Proceedings of the 11th International Workshop on Wave Hindcasting and Forecasting and Coastal Hazard Symposium, JCOMM Halifax, Canada, Oct 18–23, 2009, Technical Report No 52, WMO/TD-No. 1533, IOC Workshop Report No. 232, 2009b.

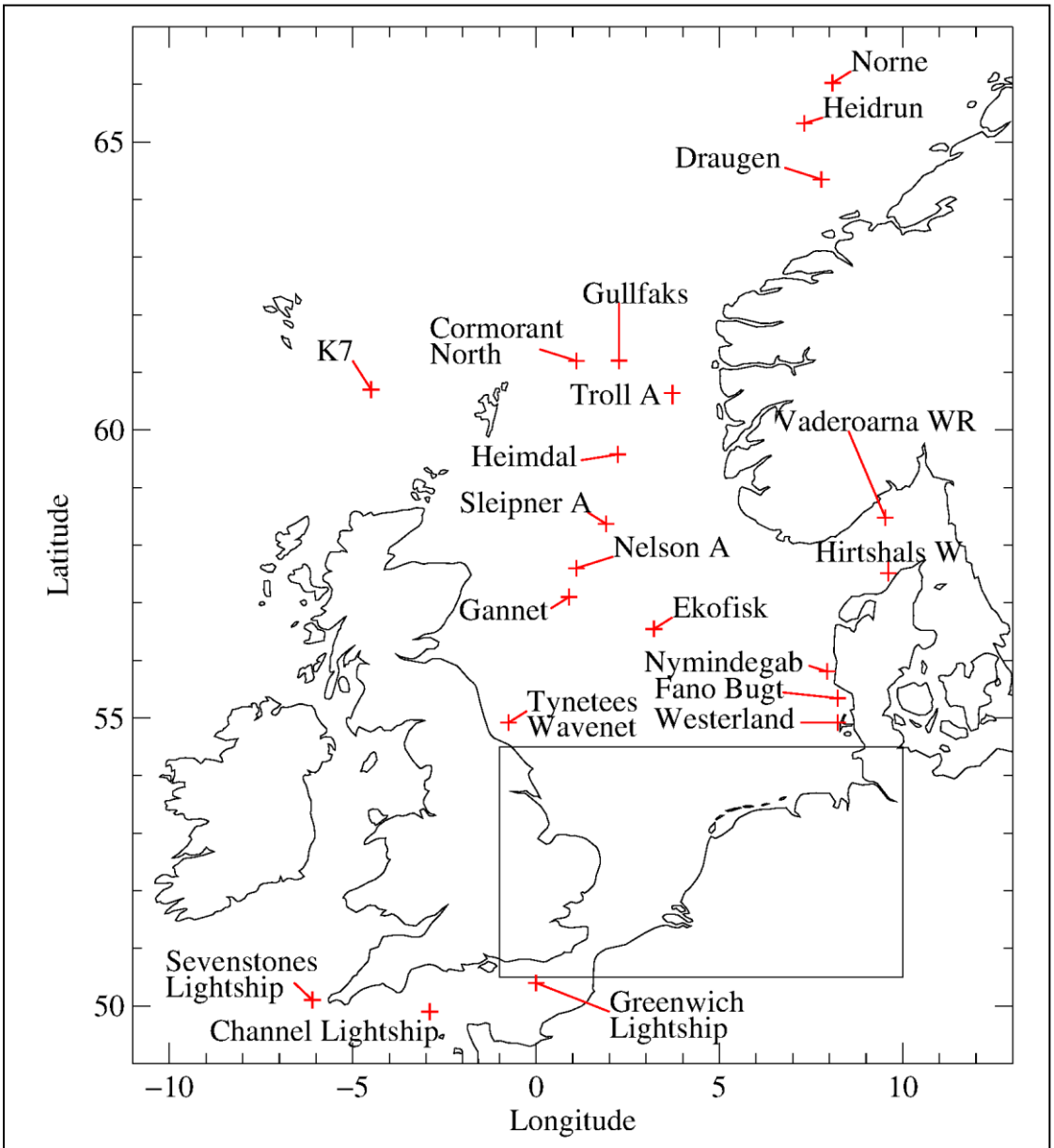


Figure S5.1. Location of wave measurement stations. Wave recorders in the box in the southern North Sea are shown in Figure S5.2 for clarity.

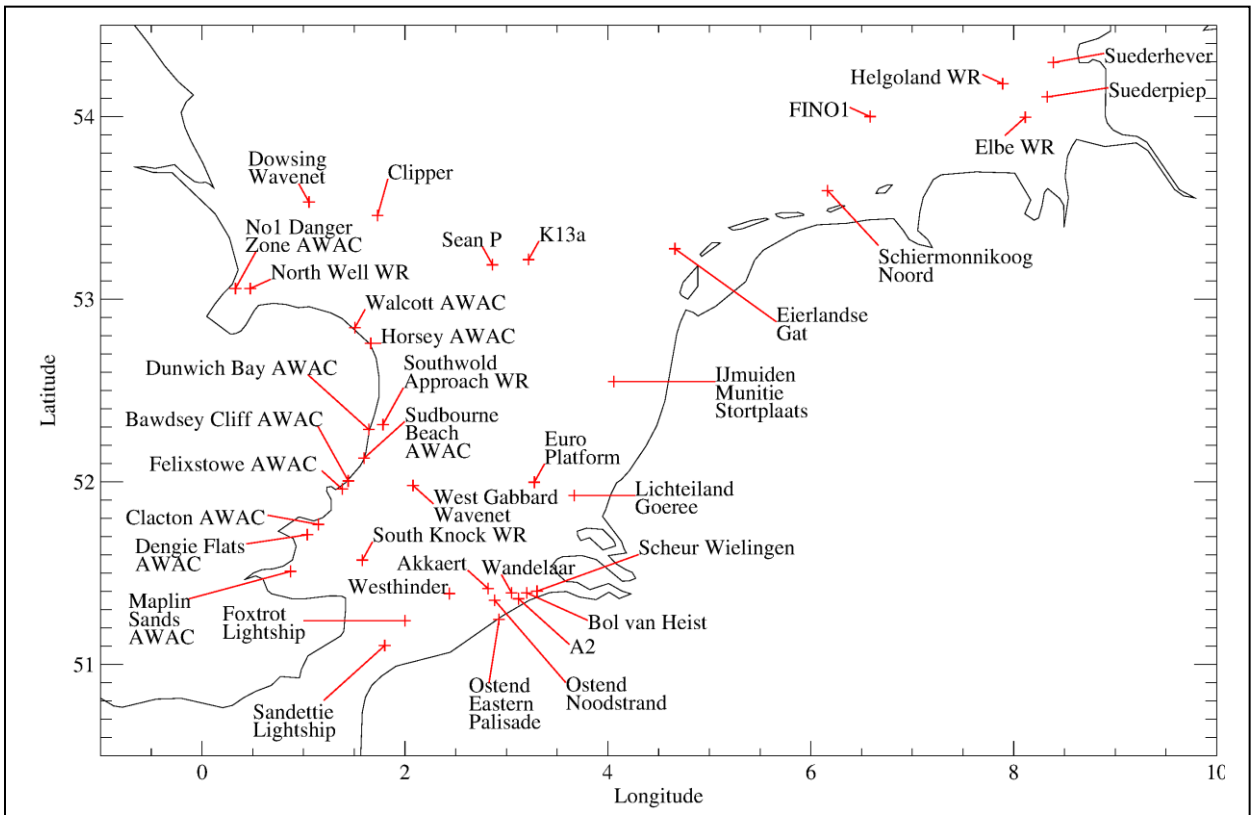


Figure S5.2. Location of wave measurement stations in the southern North Sea.

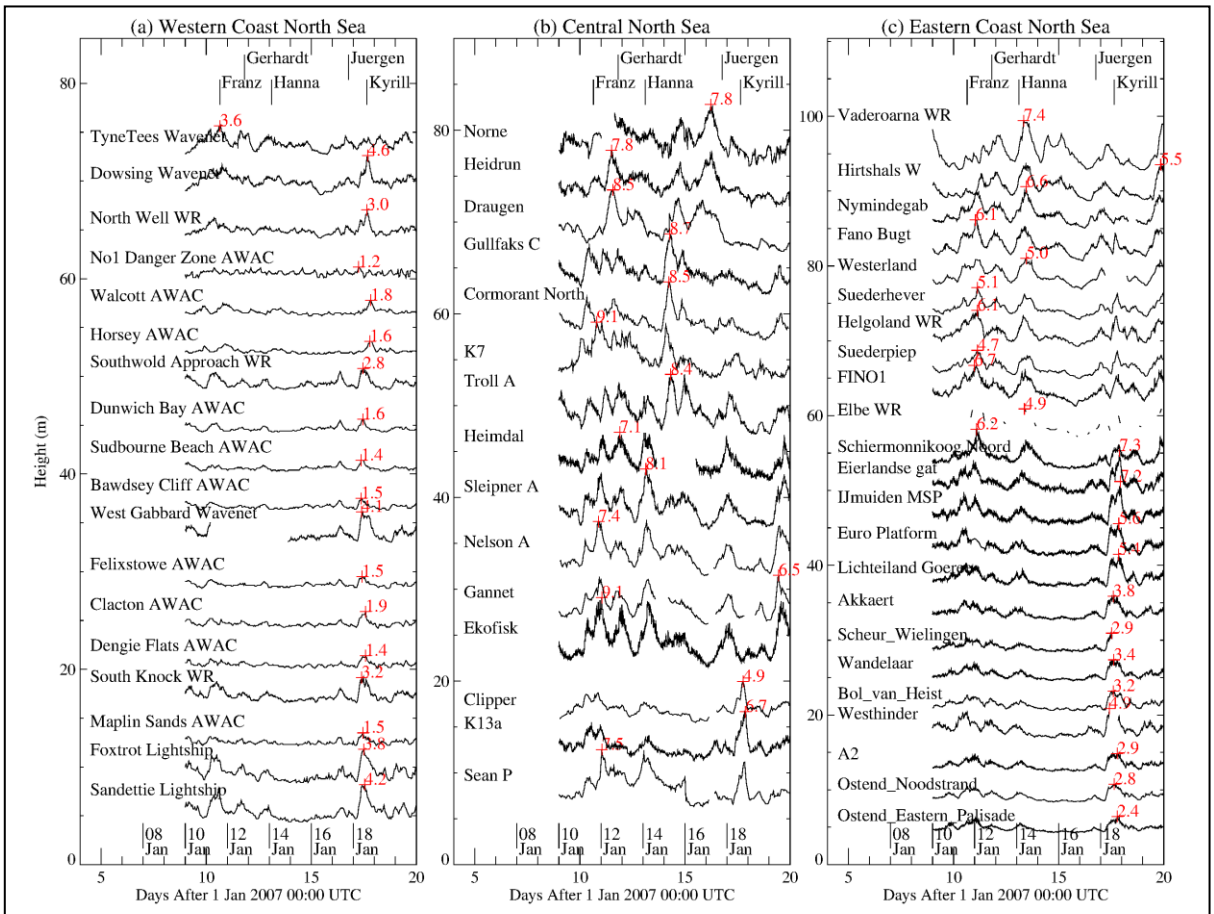


Figure S5.3. Time series of significant wave height for selected stations in the Norwegian Sea and North Sea for the period 10–20 January 2007: (a) western coast of North Sea (UK stations), (b) central North Sea and Norwegian Sea (stations of UK, the Netherlands, and Norway), and (c) eastern coasts of North Sea (stations of Belgium, the Netherlands, Germany, Denmark, Sweden). The time series have been vertical offset for clarity, and the stations in each panel have been arranged according to latitude. The highest value of each series is indicated by a red cross and marked in red font. The storm label times at the top of the panels are digitized from Deutsche Rück (2007) and based on peak wind speeds from the meteorological station at Sylt on the coast of the German Bight.

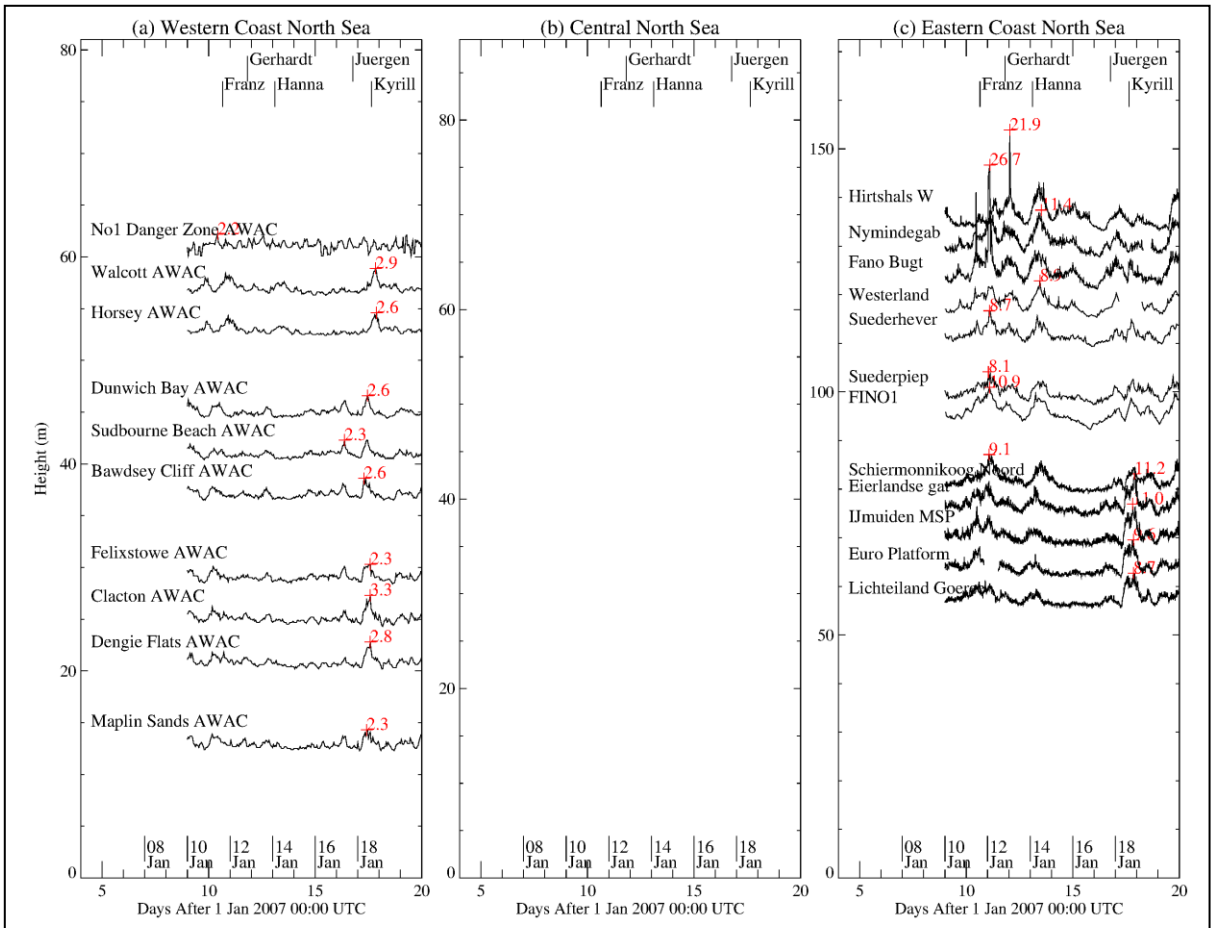


Figure S5.4. Time series of maximum wave height for selected stations in the Norwegian Sea and North Sea for the period 10–20 January 2007: (a) western coast of North Sea (UK stations), (b) central North Sea and Norwegian Sea (no available stations), and (c) eastern coasts of North Sea (stations of Belgium, the Netherlands, Germany, Denmark, Sweden). The time series have been vertical offset for clarity, and the stations in each panel have been arranged according to latitude. The highest value of each series is indicated by a red cross and marked in red font. Note that some Danish stations show very large, though still physically possible, maximum wave heights. The storm label times at the top of the panels are digitized from Deutsche Rück (2007) and based on peak wind speeds from the meteorological station at Sylt on the coast of the German Bight.

Table S5.1. Significant wave height information from the North Sea and Norwegian Sea area for the period January 2007. Information is presented for the highest significant wave height over the full period and for the two day period of the storm 11–12 January 2007.

Station name [1]	Land [2]	NNN [3]	Date & time series start [4]	Date & time series end [5]	Median Δt (min) [6]	Date/time peak full series [7]	Peak (m) [8]	Date/time peak 2–day storm [9]	Peak (m) [10]
K1	CM	744	01/01/2007 00:00	01/02/2007 00:00	60.5	18/01/2007 06:59	8.8	11/01/2007 22:59	7.5
Channel Lightship	CM	745	01/01/2007 00:00	01/02/2007 00:00	60.5	11/01/2007 15:00	6.2	11/01/2007 15:00	6.2
Sevenstones Lightship	CM	744	01/01/2007 00:00	01/02/2007 00:00	60.5	21/01/2007 03:59	7.9	11/01/2007 12:00	6.7
Greenwich Lightship	CM	739	01/01/2007 00:00	01/02/2007 00:00	60.5	18/01/2007 09:59	5.3	11/01/2007 13:59	5.2
K2	CM	676	01/01/2007 00:00	01/02/2007 00:00	60.5	20/01/2007 15:59	10.6	11/01/2007 15:00	10.2
Sandettie Lightship	CM	745	01/01/2007 00:00	01/02/2007 00:00	60.5	18/01/2007 12:59	4.2	11/01/2007 13:59	3.8
Foxtrot Lightship	CM	721	01/01/2007 00:00	01/02/2007 00:00	60.5	18/01/2007 12:00	3.8	11/01/2007 06:00	3.2
Ostend_Eastern_Palisade	BE	2766	01/01/2007 00:00	31/01/2007 23:45	15.0	18/01/2007 19:00	2.4	12/01/2007 01:00	2.2
Ostend_Noodstrand	BE	1474	01/01/2007 00:00	31/01/2007 23:30	30.0	18/01/2007 15:30	2.8	11/01/2007 15:30	2.5
A2	BE	2960	01/01/2007 00:00	31/01/2007 23:45	15.0	18/01/2007 18:45	2.9	12/01/2007 00:45	2.5
Westhinder	BE	1139	01/01/2007 00:00	30/01/2007 07:30	30.0	18/01/2007 10:00	4.9	11/01/2007 15:30	4.3
Bol_van_Heist	BE	1346	01/01/2007 00:00	31/01/2007 23:30	30.0	18/01/2007 14:30	3.2	11/01/2007 15:30	2.7
Wandelaar	BE	2973	01/01/2007 00:00	31/01/2007 23:45	15.0	18/01/2007 15:00	3.4	11/01/2007 23:15	2.9
Scheur_Wielingen	BE	2489	01/01/2007 00:00	31/01/2007 23:45	15.0	18/01/2007 12:30	2.9	11/01/2007 15:00	2.3
Akkaert	BE	2878	01/01/2007 00:00	31/01/2007 23:45	15.0	18/01/2007 14:30	3.8	11/01/2007 12:00	3.4
Maplin Sands AWAC	UK(d)	739	01/01/2007 00:00	01/02/2007 00:00	60.0	18/01/2007 11:00	1.5	11/01/2007 04:00	1.1
South Knock WR	UK(d)	1462	01/01/2007 00:00	01/02/2007 00:00	30.0	18/01/2007 09:30	3.2	11/01/2007 12:00	2.7
Dengie Flats AWAC	UK(d)	738	01/01/2007 00:00	01/02/2007 00:00	60.0	18/01/2007 14:00	1.4	11/01/2007 05:00	1.1
Clacton AWAC	UK(d)	745	01/01/2007 00:00	01/02/2007 00:00	60.0	18/01/2007 14:00	1.9	11/01/2007 04:00	1.2
Lichteiland Goeree	RWS	4459	01/01/2007 01:00	01/02/2007 00:00	9.9	18/01/2007 20:30	5.4	11/01/2007 13:50	4.3
Felixstowe AWAC	UK(d)	745	01/01/2007 00:00	01/02/2007 00:00	60.0	22/01/2007 14:00	1.6	11/01/2007 05:00	1.2
West Gabbard Wavenet	UK(d)	1313	01/01/2007 00:00	01/02/2007 00:00	30.0	18/01/2007 09:30	4.1	11/01/2007 04:30	3.0
Euro Platform	RWS	4375	01/01/2007 01:00	01/02/2007 00:00	9.9	18/01/2007 20:40	5.6	11/01/2007 10:10	5.0
Bawdsey Cliff AWAC	UK(d)	745	01/01/2007 00:00	01/02/2007 00:00	60.0	08/01/2007 00:00	1.6	11/01/2007 04:00	1.1
Sudbourne Beach AWAC	UK(d)	745	01/01/2007 00:00	01/02/2007 00:00	60.0	22/01/2007 17:00	2.1	11/01/2007 06:00	0.9
Dunwich Bay AWAC	UK(d)	745	01/01/2007 00:00	01/02/2007 00:00	60.0	22/01/2007 16:00	1.9	11/01/2007 11:00	1.2
Southwold Approach WR	UK(d)	1474	01/01/2007 00:00	01/02/2007 00:00	30.0	18/01/2007 11:00	2.8	11/01/2007 10:30	2.4
IJmuiden MSP	RWS	4343	01/01/2007 01:00	01/02/2007 00:00	9.9	18/01/2007 22:20	7.2	11/01/2007 11:50	5.5
Horsey AWAC	UK(d)	745	01/01/2007 00:00	01/02/2007 00:00	60.0	22/01/2007 13:00	2.3	11/01/2007 21:00	1.3
Walcott AWAC	UK(d)	745	01/01/2007 00:00	01/02/2007 00:00	60.0	22/01/2007 13:00	2.3	11/01/2007 19:00	1.5
No1 Danger Zone AWAC	UK(d)	731	01/01/2007 00:00	31/01/2007 22:00	60.0	22/01/2007 08:00	2.1	11/01/2007 09:00	1.1
North Well WR	UK(d)	1473	01/01/2007 00:00	01/02/2007 00:00	30.0	18/01/2007 15:30	3.0	11/01/2007 09:00	2.2

Table S5.1 (continued).

Station name [1]	Land [2]	NNN [3]	Date & time series start [4]	Date & time series end [5]	Median Δt (min) [6]	Date/time peak full series [7]	Peak (m) [8]	Date/time peak 2–day storm [9]	Peak (m) [10]
Sean P	UK(f)	317	07/01/2007 23:53	24/01/2007 00:04	58.6	12/01/2007 00:57	7.5	12/01/2007 00:57	7.5
K13a	RWS	2307	01/01/2007 01:00	01/02/2007 00:00	19.9	18/01/2007 21:00	6.7	11/01/2007 13:10	5.3
Eierlandse gat	RWS	4435	01/01/2007 01:00	01/02/2007 00:00	9.9	18/01/2007 21:20	7.3	12/01/2007 01:00	5.8
Clipper	UK(f)	298	07/01/2007 23:49	24/01/2007 00:08	59.6	18/01/2007 18:15	4.9	11/01/2007 20:10	3.7
Dowsing Wavenet	UK(d)	1489	01/01/2007 00:00	01/02/2007 00:00	30.0	18/01/2007 16:30	4.6	11/01/2007 18:00	3.6
Schiermonnikoog Noord	RWS	4456	01/01/2007 01:00	01/02/2007 00:00	9.9	12/01/2007 02:00	6.2	12/01/2007 02:00	6.2
Elbe WR	CM	521	01/01/2007 00:22	23/01/2007 15:52	30.2	01/01/2007 14:22	4.9	11/01/2007 21:27	4.7
FINO1	CM	1400	01/01/2007 00:08	31/01/2007 23:37	30.2	11/01/2007 23:37	6.7	11/01/2007 23:37	6.7
Suederpiep	LSH	705	01/01/2007 01:00	31/01/2007 23:00	60.0	12/01/2007 03:00	4.7	12/01/2007 03:00	4.7
Helgoland WR	CM	1083	01/01/2007 00:01	31/01/2007 23:38	27.4	12/01/2007 03:00	6.1	12/01/2007 03:00	6.1
Suederhever	LSH	740	01/01/2007 01:00	31/01/2007 23:00	60.0	12/01/2007 03:00	5.1	12/01/2007 03:00	5.1
K4	CM	745	01/01/2007 00:00	01/02/2007 00:00	60.5	11/01/2007 10:59	12.3	11/01/2007 10:59	12.3
Westerland	LSH	644	01/01/2007 01:00	31/01/2007 23:00	60.0	14/01/2007 11:00	5.0	12/01/2007 01:00	4.9
TyneTees Wavenet	UK(d)	952	01/01/2007 00:00	20/01/2007 19:30	30.0	11/01/2007 15:30	3.6	11/01/2007 15:30	3.6
Fano Bugt	DK	666	08/01/2007 23:00	22/01/2007 22:30	30.0	12/01/2007 01:00	6.1	12/01/2007 01:00	6.1
Nymindegab	DK	653	08/01/2007 23:00	22/01/2007 22:30	30.0	14/01/2007 11:00	6.6	12/01/2007 04:30	5.8
Ekofisk	NO	2230	01/01/2007 00:00	31/01/2007 23:40	20.2	01/01/2007 06:40	10.4	12/01/2007 01:00	9.1
Gannet	UK(f)	285	08/01/2007 00:04	23/01/2007 23:55	58.8	20/01/2007 10:57	6.5	11/01/2007 22:05	6.2
Hirtshals W	DK	671	08/01/2007 23:00	22/01/2007 22:30	30.0	20/01/2007 20:30	5.5	12/01/2007 23:30	4.4
Nelson A	UK(f)	325	07/01/2007 23:55	23/01/2007 23:57	58.8	11/01/2007 21:20	7.4	11/01/2007 21:20	7.4
Sleipner A	NO	2232	01/01/2007 00:00	31/01/2007 23:40	20.2	14/01/2007 03:20	8.1	12/01/2007 00:20	7.6
Vaderoarna WR	CM	745	01/01/2007 00:00	01/02/2007 00:00	60.5	14/01/2007 08:00	7.4	12/01/2007 21:00	4.7
K5	CM	739	01/01/2007 00:00	01/02/2007 00:00	60.5	11/01/2007 10:59	12.6	11/01/2007 10:59	12.6
Heimdal	NO	2036	01/01/2007 00:00	31/01/2007 22:40	20.2	09/01/2007 18:00	7.6	12/01/2007 21:40	7.1
Troll A	NO	2231	01/01/2007 00:00	31/01/2007 23:40	20.2	15/01/2007 07:40	8.4	12/01/2007 20:40	7.4
K7	CM	729	01/01/2007 00:00	01/02/2007 00:00	60.5	11/01/2007 18:59	9.1	11/01/2007 18:59	9.1
Cormorant North	UK(f)	329	07/01/2007 23:58	24/01/2007 00:08	61.2	15/01/2007 05:20	8.5	11/01/2007 07:55	6.8
Gullfaks C	NO	2223	01/01/2007 00:00	31/01/2007 23:40	20.2	15/01/2007 06:40	8.7	11/01/2007 10:40	7.4
Draugen	NO	2173	01/01/2007 00:00	31/01/2007 23:40	20.2	12/01/2007 13:40	8.5	12/01/2007 13:40	8.5
Heidrun	NO	2228	01/01/2007 00:00	31/01/2007 23:40	20.2	26/01/2007 22:40	8.3	12/01/2007 12:00	7.8
Norne	NO	2025	01/01/2007 00:00	30/01/2007 23:20	20.2	26/01/2007 20:20	9.0	12/01/2007 15:40	6.9

Notes:
[1] Wave measuring station name
[2] Sources of wave data:
BE: digital data of downloaded from Belgian stations https://meetnetvlaamsebanken.de,
CM: CMEMS,
DK: digital files for Denmark from https://kyst.dk/soeterritoriet/maalinger-og-data/vandstandsmaalinger/
LSH: digital data files emailed by Maria Bluemel
NO: digital data from Norwegian offshore platforms downloaded from https://seklima.met.no,
UK(d): digital data file downloaded from the CEFAS Wavenet website https://wavenet.cefas.co.uk/,
UK(f): hand-digitized data from figure from the CEFAS Wavenet website https://wavenet.cefas.co.uk/,
RWS: digital data file downloaded from Waterinfo website https://waterinfo.rws.nl/#!/nav/expert/alle-groepen/,
[3] Number of data points in time series
[4] Start date and time of time series (GMT)
[5] End date and time of time series (GMT)
[6] Median time interval
[7] Date and time of peak of full time series (GMT)
[8] Peak significant wave height of full time series.
[9] Date and time of peak of 2 d time series during Storm Franz 11–12 January 2007.
[10] Peak significant wave height of 2 d time series during Storm Franz 11–12 January 2007.

Table S5.2. Maximum wave height information from the North Sea area for the period January 2007. Information is presented for the highest significant wave height over the full period and for the two day period of the storm 11–12 January 2007.

Station name [1]	Land [2]	NNN [3]	Date & time series start [4]	Date & time series end [5]	Median Δt (min) [6]	Date/time peak full series [7]	Peak (m) [8]	Date/time peak 2–day storm [9]	Peak (m) [10]
Maplin Sands AWAC	UK(d)	745	01/01/2007 00:00	01/02/2007 00:00	60.0	18/01/2007 10:00	2.3	11/01/2007 04:00	1.9
Dengie Flats AWAC	UK(d)	745	01/01/2007 00:00	01/02/2007 00:00	60.0	18/01/2007 14:00	2.8	11/01/2007 04:00	1.8
Clacton AWAC	UK(d)	745	01/01/2007 00:00	01/02/2007 00:00	60.0	18/01/2007 14:00	3.3	11/01/2007 04:00	2.2
Lichteiland Goeree	RWS	4458	01/01/2007 01:00	01/02/2007 00:00	9.9	18/01/2007 20:30	8.7	11/01/2007 21:20	7.2
Felixstowe AWAC	UK(d)	745	01/01/2007 00:00	01/02/2007 00:00	60.0	22/01/2007 15:00	2.7	11/01/2007 05:00	2.1
Euro Platform	RWS	4364	01/01/2007 01:00	01/02/2007 00:00	9.9	18/01/2007 20:10	9.6	11/01/2007 15:10	8.2
Bawdsey Cliff AWAC	UK(d)	745	01/01/2007 00:00	01/02/2007 00:00	60.0	08/01/2007 00:00	3.0	11/01/2007 04:00	1.8
Sudbourne Beach AWAC	UK(d)	745	01/01/2007 00:00	01/02/2007 00:00	60.0	22/01/2007 17:00	4.3	11/01/2007 06:00	1.5
Dunwich Bay AWAC	UK(d)	745	01/01/2007 00:00	01/02/2007 00:00	60.0	22/01/2007 16:00	2.8	11/01/2007 12:00	1.9
IJmuiden MSP	RWS	4346	01/01/2007 01:00	01/02/2007 00:00	9.9	18/01/2007 19:30	11.0	11/01/2007 12:00	10.5
Horsey AWAC	UK(d)	745	01/01/2007 00:00	01/02/2007 00:00	60.0	22/01/2007 13:00	4.6	11/01/2007 22:00	2.3

Table S5.2 (continued).

Station name [1]	Land [2]	NNN [3]	Date & time series start [4]	Date & time series end [5]	Median Δt (min) [6]	Date/time peak full series [7]	Peak (m) [8]	Date/time peak 2–day storm [9]	Peak (m) [10]
Walcott AWAC	UK(d)	745	01/01/2007 00:00	01/02/2007 00:00	60.0	22/01/2007 13:00	3.6	11/01/2007 19:00	2.4
No1 Danger Zone AWAC	UK(d)	742	01/01/2007 00:00	01/02/2007 00:00	60.0	22/01/2007 08:00	3.5	11/01/2007 10:00	2.2
Eierlandse gat	RWS	4431	01/01/2007 01:00	01/02/2007 00:00	9.9	18/01/2007 21:30	11.2	12/01/2007 01:30	9.6
Schiermonnikoog Noord	RWS	4454	01/01/2007 01:00	01/02/2007 00:00	9.9	12/01/2007 01:50	9.1	12/01/2007 01:50	9.1
FINO1	CM	701	01/01/2007 00:08	31/01/2007 23:06	60.5	12/01/2007 02:06	10.9	12/01/2007 02:06	10.9
Suederpiep	LSH	690	01/01/2007 01:00	31/01/2007 23:00	60.0	12/01/2007 01:00	8.1	12/01/2007 01:00	8.1
Suederhever	LSH	736	01/01/2007 01:00	31/01/2007 23:00	60.0	12/01/2007 02:00	8.7	12/01/2007 02:00	8.7
Westerland	LSH	586	01/01/2007 01:00	31/01/2007 22:00	60.0	14/01/2007 11:00	8.9	12/01/2007 05:00	7.7
Fano Bugt	DK	666	08/01/2007 23:00	22/01/2007 22:30	30.0	21/01/2007 02:30	28.9	12/01/2007 02:30	26.7
Nymindegab	DK	653	08/01/2007 23:00	22/01/2007 22:30	30.0	14/01/2007 12:30	11.4	12/01/2007 02:30	11.4
Hirtshals W	DK	671	08/01/2007 23:00	22/01/2007 22:30	30.0	13/01/2007 01:00	21.9	12/01/2007 22:00	8.1

SECTION S6. THEMATIC MAPS OF STORM IMPACTS

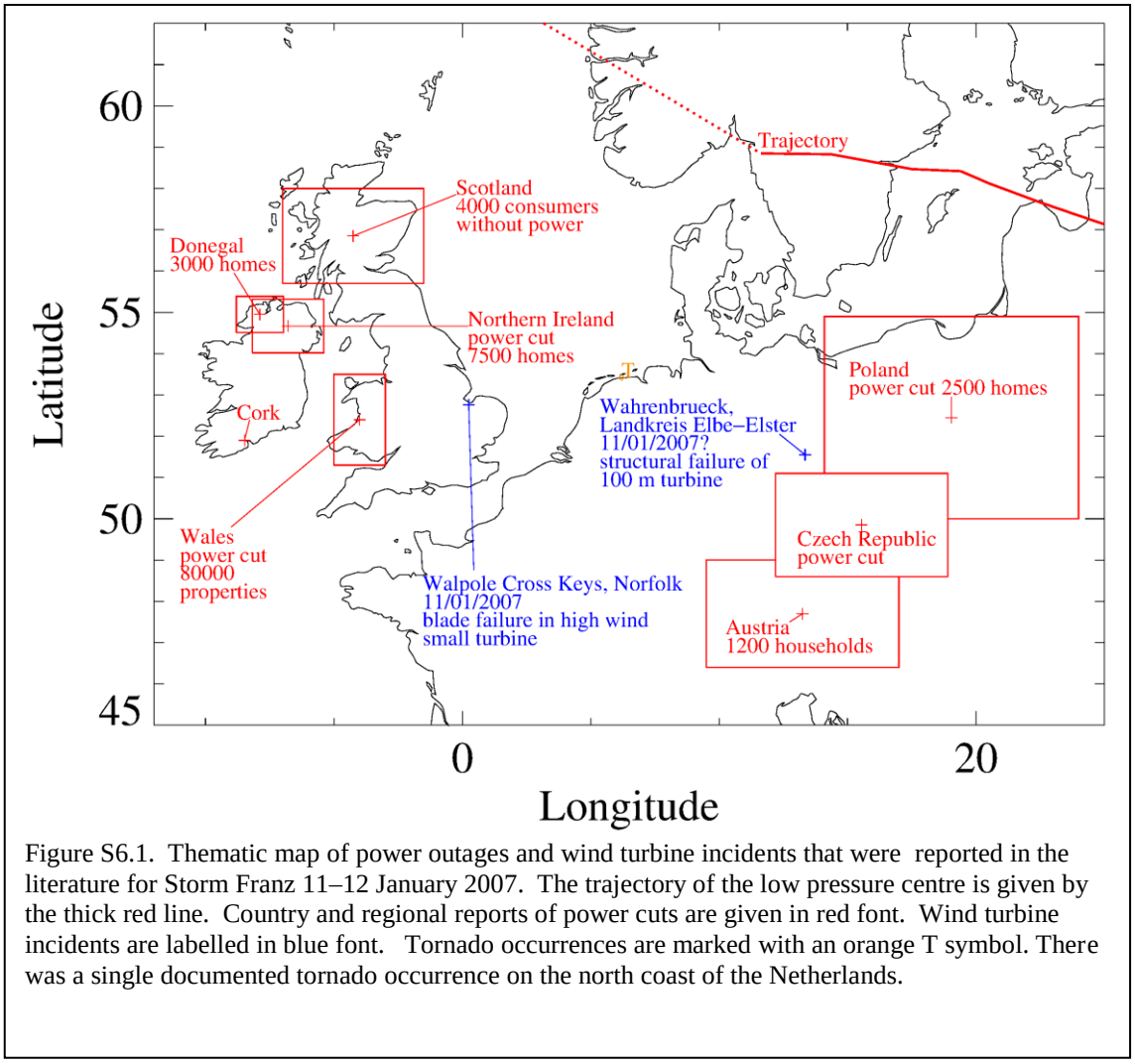


Figure S6.1. Thematic map of power outages and wind turbine incidents that were reported in the literature for Storm Franz 11–12 January 2007. The trajectory of the low pressure centre is given by the thick red line. Country and regional reports of power cuts are given in red font. Wind turbine incidents are labelled in blue font. Tornado occurrences are marked with an orange T symbol. There was a single documented tornado occurrence on the north coast of the Netherlands.

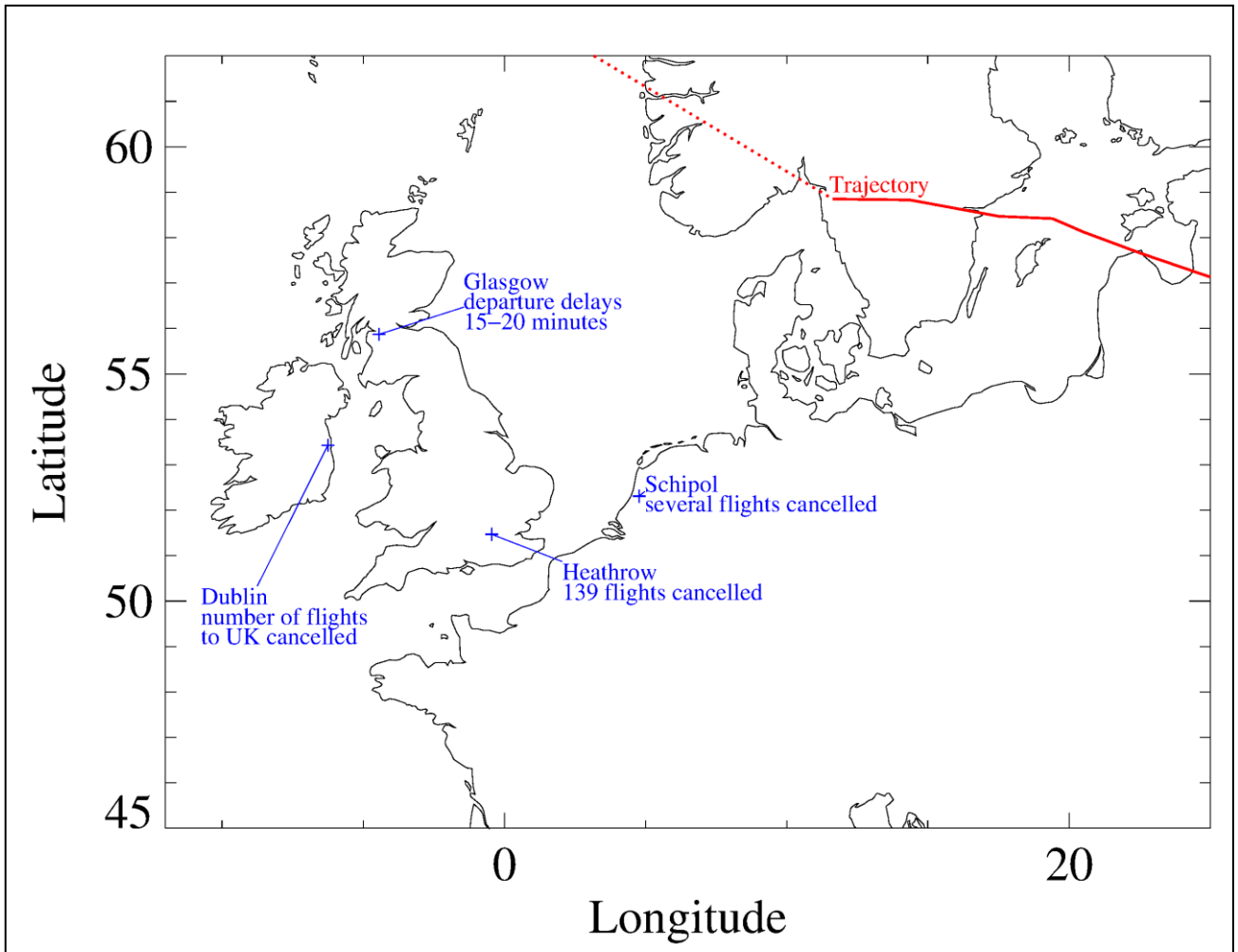


Figure S6.2. Thematic map of flight cancellations and air transport incidents that were reported in the literature for Storm Franz 11–12 January 2007. The trajectory of the low pressure centre is given by the thick red line.

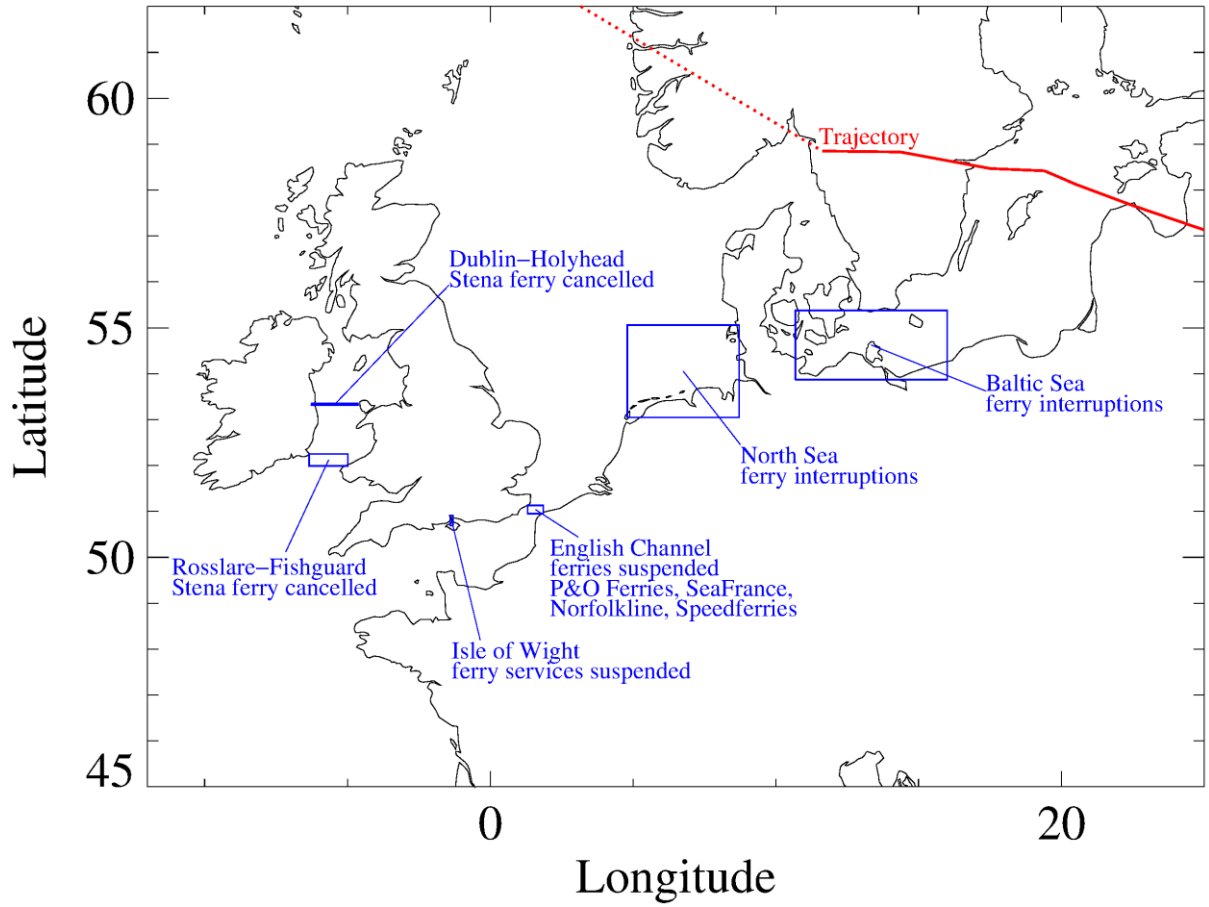


Figure S6.3. Thematic map of ferry and port interruptions that were reported in the literature for Storm Franz 11–12 January 2007. The trajectory of the low pressure centre is given by the thick red line.

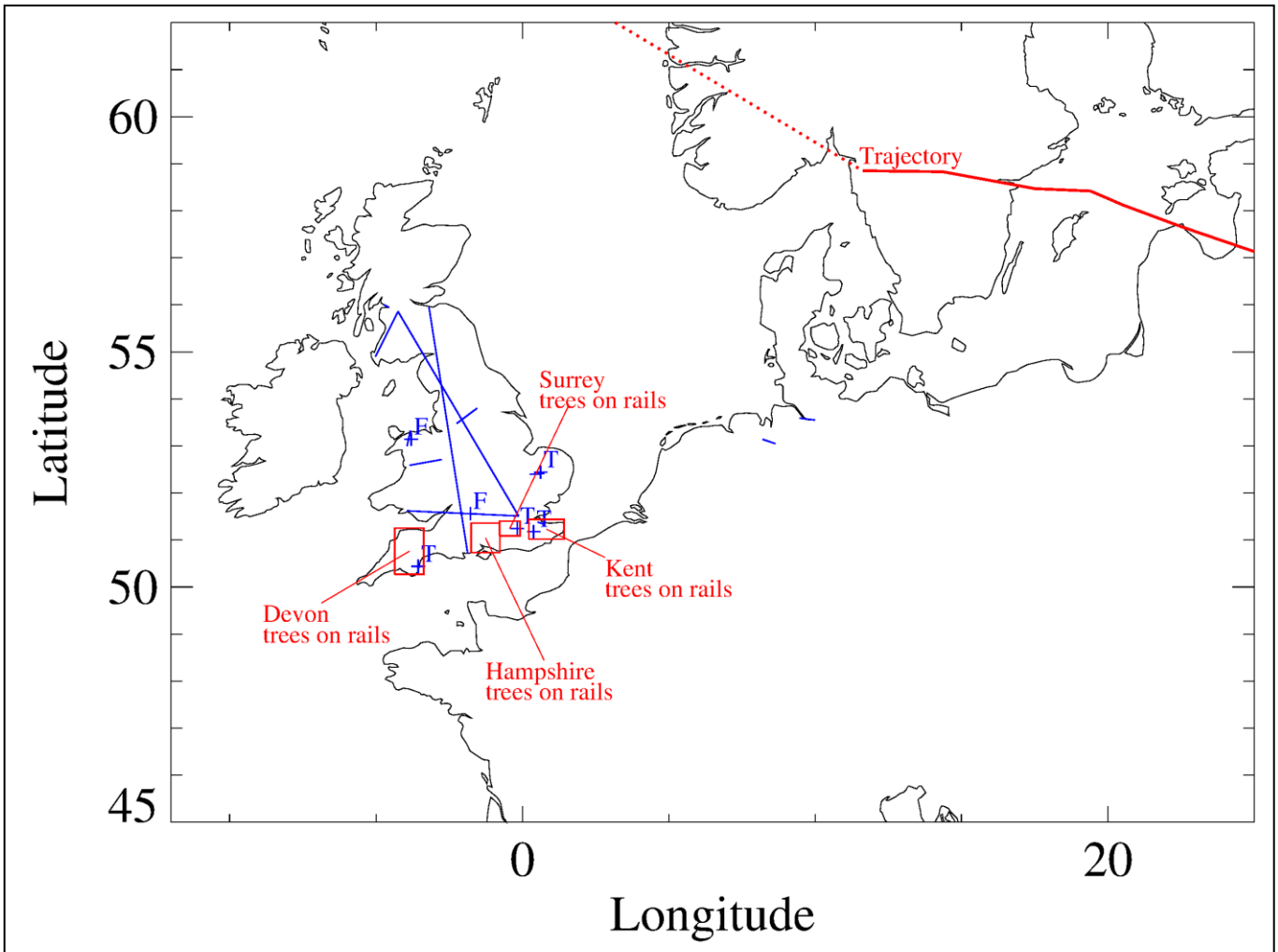


Figure S6.4. Thematic map of rail transport interruptions that were reported in the literature for Storm Franz 11–12 January 2007. Blue lines indicate routes between two points that were interrupted by flooding ('F') or trees on the track ('T'). Only reports from the UK and Germany were located in the literature.

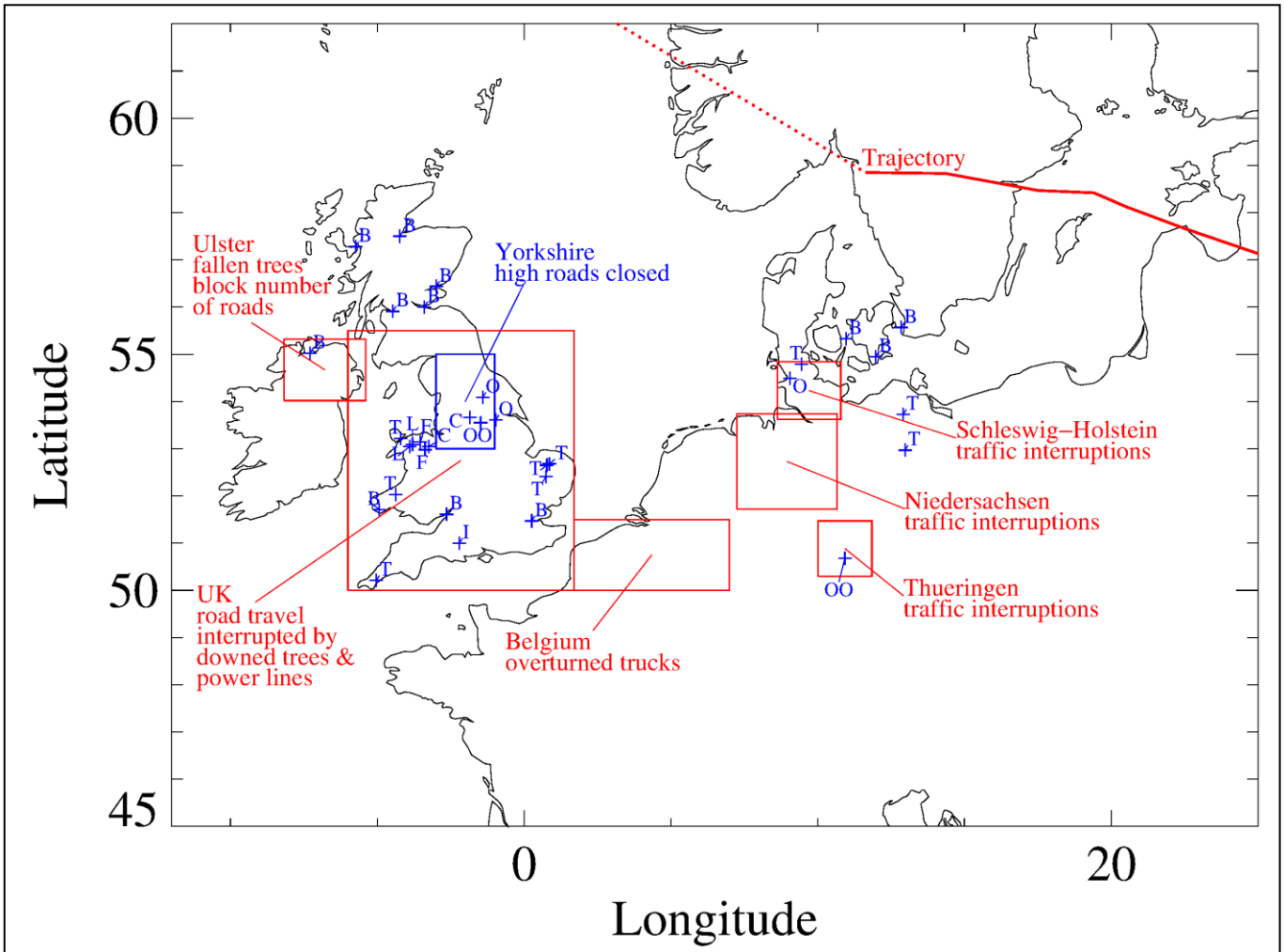


Figure S6.5. Thematic map of road transport interruptions that were reported in the literature for Storm Franz 11–12 January 2007. Letters denote bridge closure 'B', trees across the road 'T', flooded roads 'F', landslide 'L', road closure 'C', overturned truck 'O', and multiple overturned trucks 'OO'. The trajectory of the low pressure centre is given by the thick red line.

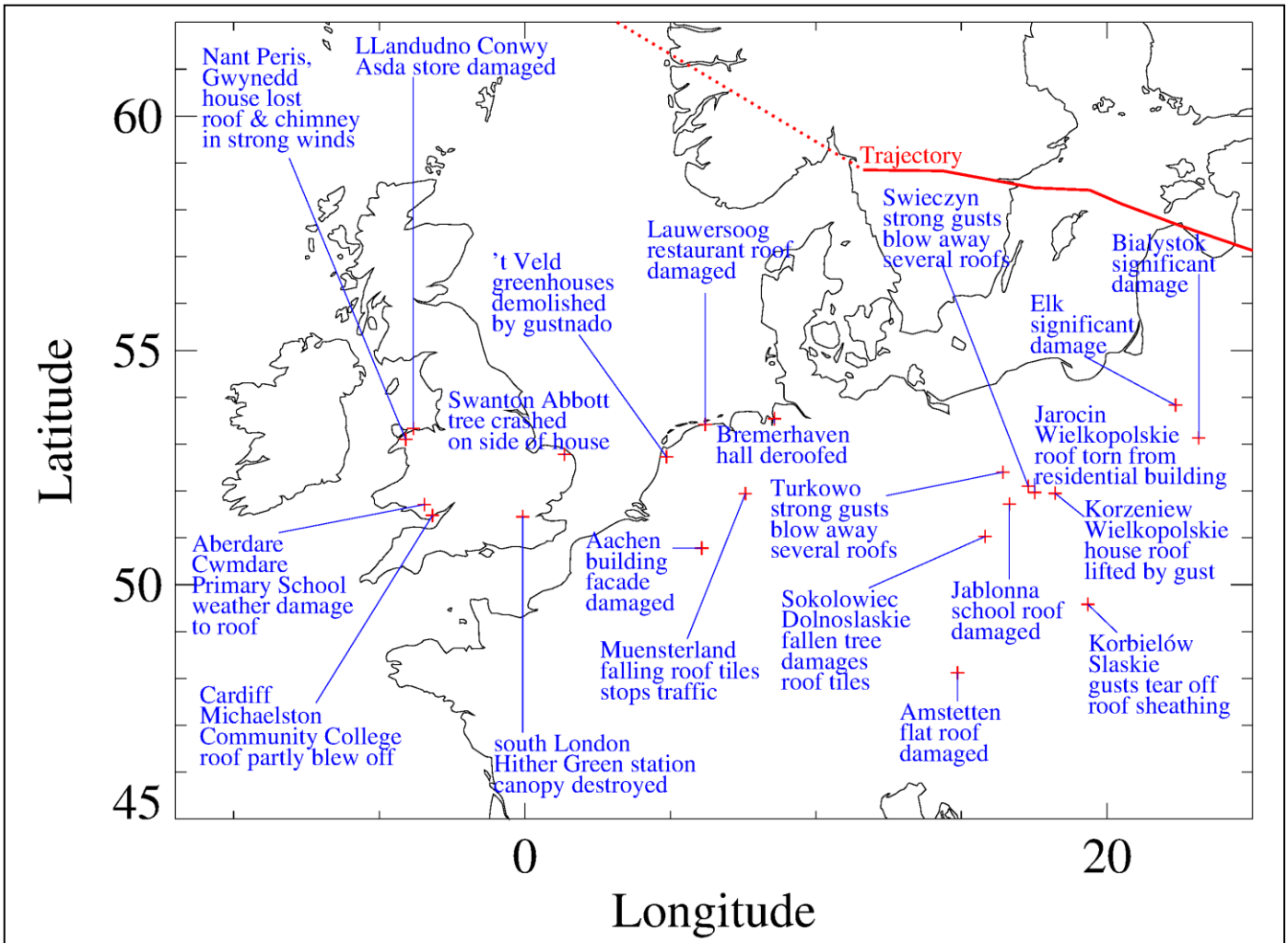


Figure S6.6. Thematic map of damage to buildings and monuments that were reported in the literature for Storm Franz 11–12 January 2007. The trajectory of the low pressure centre is given by the thick red line.

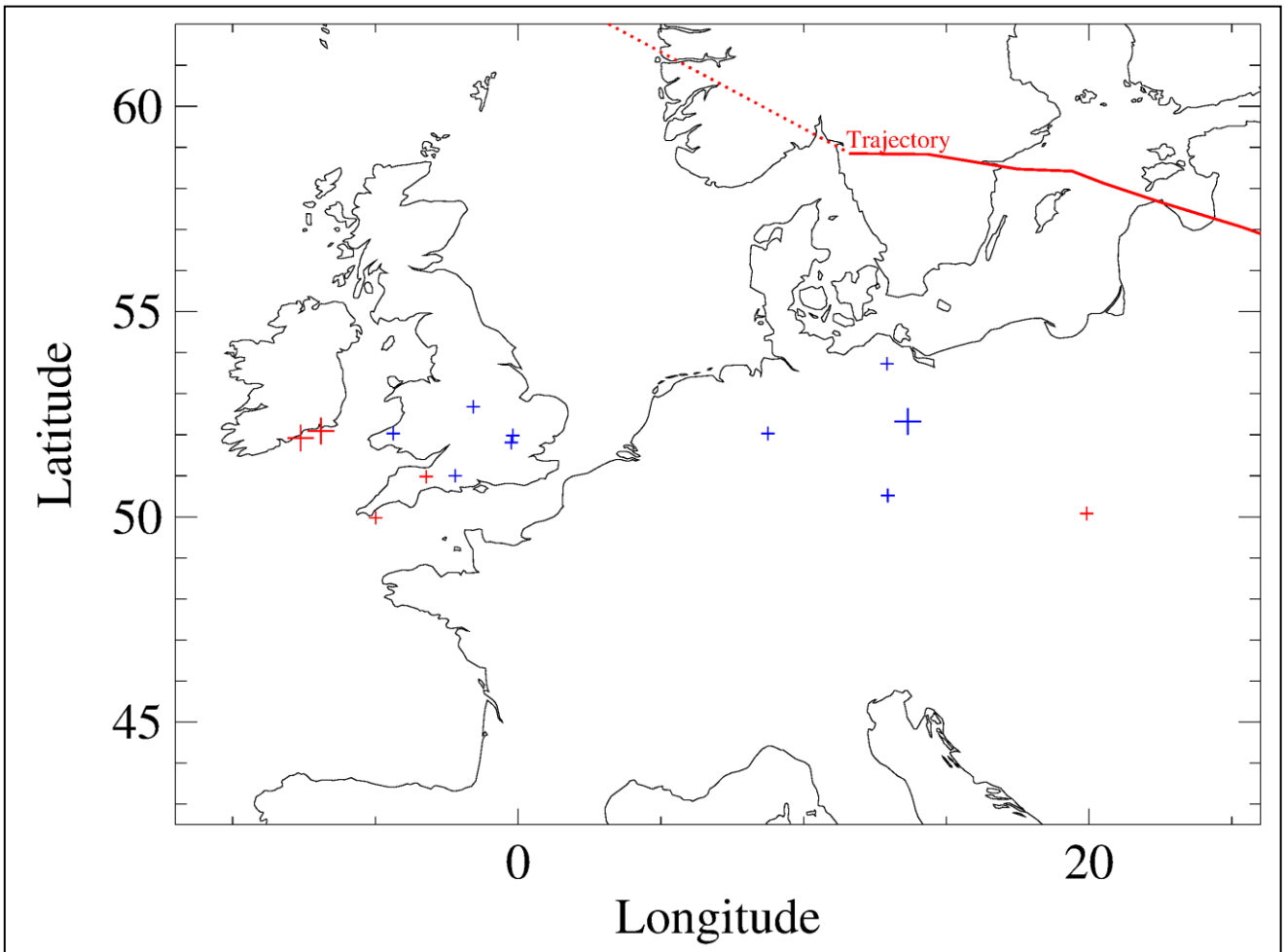


Figure S6.7. Thematic map of fatalities(red crosses) and injuries (blue crosses) that were reported in the literature for Storm Franz 11–12 January 2007. The smaller symbol size denotes a single fatality or injury; the larger symbol denotes multiple casualties. Most of the fatalities of this storm were in offshore events off southeast Ireland. The storm trajectory is plotted as a red line.

SECTION S7. COASTAL CUTBACK REPORTS FROM LOWER SAXONY (NIEDERSACHSEN)

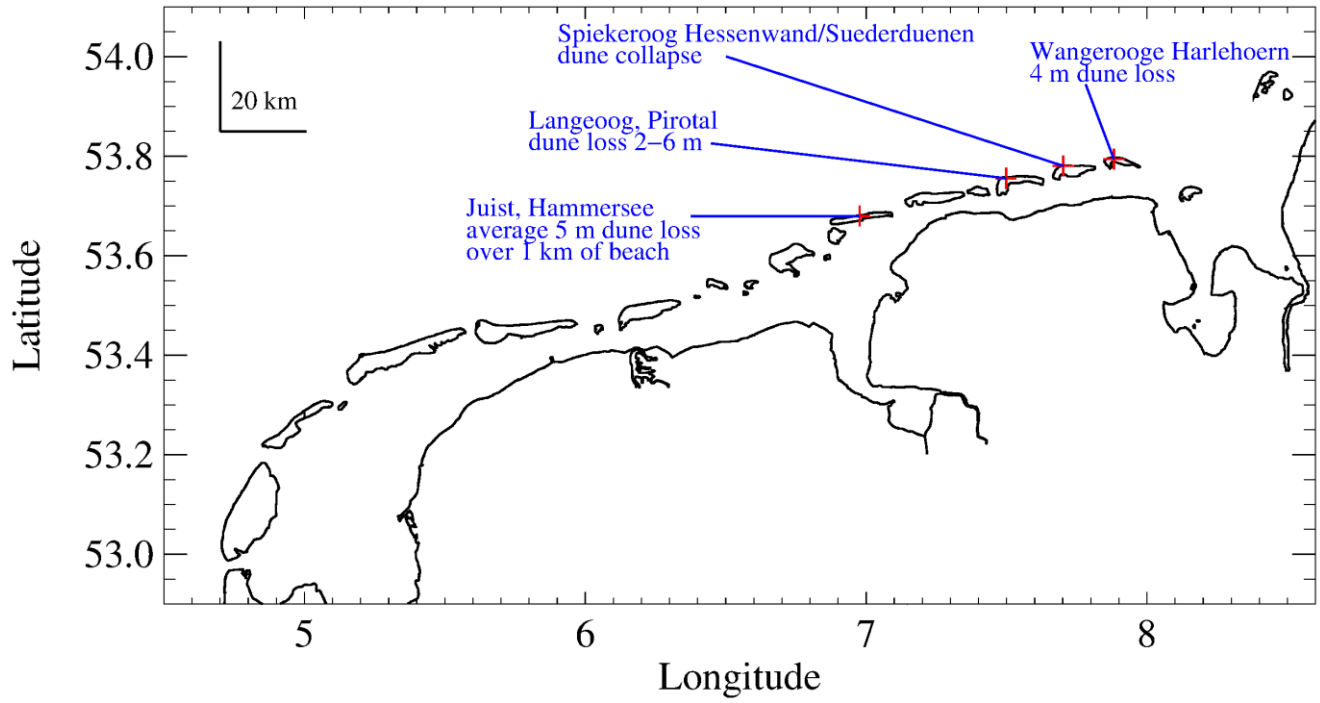


Figure S7.1. Map of dune collapse reports for Storm Franz on 11–12 January 2007 on the Germany East Friesland islands from NLWKN (2007).

References:

NLWKN: Sturmflut am 12. Januar 2007: Nordseeküste kam glimpflich davon 12. Januar 2007 (aktualisiert am 15. Januar 2007): Duenenabbrueche auf den ostfriesischen inseln https://www.nlwkn.niedersachsen.de/startseite/aktuelles/presse_und_offentlichkeitsarbeit/pressemitteilungen/-41838.html, 15 January 2007.

SECTION S8. TABLE OF TIDE GAUGE STATIONS USED IN THE INVESTIGATION

The following text is reproduced from the Supplement of Kettle (2023)

Table S8.1. Information on tide gauge data used in this study with source.

N [1]	Station Name [2]	Abb [3]	Country [4]	Latitude (degree) [5]	Longitude (degree) [6]	Δt orig (min) [7]	Δt use (min) [8]	Source [9]
1	Wick	WK	UK	58.44	−3.09	15	15	BODC
2	Aberdeen	AB	UK	57.14	−2.07	15	15	BODC
3	Leith	LE	UK	55.99	−3.18	15	15	BODC
4	North Shields	NS	UK	55.01	−1.44	15	15	BODC
5	Whitby	WH	UK	54.49	−0.61	15	15	BODC
6	Immingham	IM	UK	53.63	−0.19	15	15	BODC
7	Cromer	CR	UK	52.93	1.30	15	15	BODC
8	Lowestoft	LT	UK	52.47	1.75	15	15	BODC
9	Felixstowe	FE	UK	51.96	1.35	15	15	BODC
10	Harwich	HW	UK	51.95	1.28	15	15	BODC
11	Sheerness	SH	UK	51.44	0.74	15	15	BODC
12	Lerwick	LW	UK	60.15	−1.14	15	15	BODC2
13	Southend	SU	UK	51.52	0.72	15	15	EA
14	Nieuwpoort	NI	BE	51.15	2.73	5	5	VLIZ
15	Ostend harbor	OE	BE	51.23	2.92	5	5	VLIZ
16	Zeebrugge Leopold II dam	ZB	BE	51.35	3.20	5	5	VLIZ
17	Cadzand	CZ	NE	51.38	3.38	10	10	RWS
18	Westkapelle	WL	NE	51.52	3.44	10	10	RWS
19	Vlissingen	VL	NE	51.44	3.60	10	10	RWS
20	Terneuzen	TE	NE	51.34	3.82	10	10	RWS
21	Roompot buiten	RM	NE	51.62	3.68	10	10	RWS
22	Euro platform	EU	NE	52.00	3.28	10	10	RWS
23	Brouwershavensche Gat 08	BH	NE	51.75	3.83	10	10	RWS
24	Lichteiland Goeree	LG	NE	51.92	3.67	10	10	RWS
25	Hoek van Holland	HH	NE	51.98	4.12	10	10	RWS
26	Dordrecht	DD	NE	51.82	4.67	10	10	RWS
27	Scheveningen	SC	NE	52.10	4.26	10	10	RWS
28	IJmuiden buitenhaven	IJ	NE	52.46	4.55	10	10	RWS
29	Petten	PE	NE	52.79	4.67	10	10	RWS
30	Den Helder	DH	NE	52.96	4.74	10	10	RWS
31	Oudeschild	OS	NE	53.04	4.85	10	10	RWS
32	Kornwerderzand buiten	KW	NE	53.07	5.34	10	10	RWS
33	Vlieland haven	VH	NE	53.30	5.09	10	10	RWS
34	Harlingen	HL	NE	53.18	5.41	10	10	RWS
35	West−Terschelling	TL	NE	53.36	5.22	10	10	RWS
36	Terschelling Noordzee	TN	NE	53.44	5.33	10	10	RWS
37	Nes	NE	NE	53.43	5.76	10	10	RWS
38	Wierumergronden	WG	NE	53.52	5.96	10	10	RWS
39	Lauwersoog	LR	NE	53.41	6.20	10	10	RWS
40	Schiermonnikoog	SM	NE	53.47	6.20	10	10	RWS

Table S8.1 (continued).

N [1]	Station Name [2]	Abb [3]	Country [4]	Latitude (degree) [5]	Longitude (degree) [6]	Δt orig (min) [7]	Δt use (min) [8]	Source [9]
41	Huibertgat	HG	NE	53.57	6.40	10	10	RWS
42	Eemshaven	EE	NE	53.45	6.83	10	10	RWS
43	Delfzijl	DF	NE	53.33	6.93	10	10	RWS
44	Nieuwe Statenzijl	NZ	NE	53.23	7.21	10	10	RWS
45	Bremen−Grosse−Weserbruecke	BW	DE	53.07	8.80	1	10	BAFG
46	Knock	KN	DE	53.33	7.04	1	10	BAFG
47	Emden−Neue−Seeschleuse	EM	DE	53.34	7.20	1	10	BAFG
48	Emshoern	EH	DE	53.49	6.84	1	10	BAFG
49	Borkum−Fischerbalje	BF	DE	53.56	6.75	1	10	BAFG
50	WHV−Alter−Vorhafen	WV	DE	53.51	8.14	1	10	BAFG
51	Zollenspieker	ZO	DE	53.40	10.19	1	10	BAFG
52	Norderney−Riffgat	ND	DE	53.70	7.16	1	10	BAFG
53	Hamburg−St−Pauli	HB	DE	53.55	9.97	1	10	BAFG
54	Langeoog	LA	DE	53.73	7.51	1	10	BAFG
55	Hetlingen	HE	DE	53.61	9.54	1	10	BAFG
56	Stadersand	SD	DE	53.63	9.53	1	10	BAFG
57	Spiekeroog	SP	DE	53.75	7.68	1	10	BAFG
58	Wangerooge−West	WW	DE	53.78	7.86	1	10	BAFG
59	Pinnau−Sperrwerk	PI	DE	53.67	9.56	1	10	BAFG
60	Mellumplate	MP	DE	53.77	8.09	1	10	BAFG
61	Wangerooge−Nord	WN	DE	53.81	7.93	1	10	BAFG
62	Kollmar	KO	DE	53.73	9.46	1	10	BAFG
63	Glueckstadt	GL	DE	53.78	9.41	1	10	BAFG
64	LT−Alte−Weser	AW	DE	53.86	8.13	1	10	BAFG
65	Cuxhaven−Steubenhoeft	CU	DE	53.87	8.72	1	10	BAFG
66	Brunsbuettel−Mole4	BR	DE	53.89	9.14	1	10	BAFG
67	Mittelgrund	MG	DE	53.94	8.63	1	10	BAFG
68	Zehnerloch	ZE	DE	53.95	8.66	1	10	BAFG
69	Scharhoern	SN	DE	53.97	8.46	1	10	BAFG
70	Bake−Z	BZ	DE	54.01	8.32	1	10	BAFG
71	Buesum	BU	DE	54.12	8.86	1	10	BAFG
72	Helgoland−Suedhafen	HF	DE	54.18	7.90	1	10	BAFG
73	Helgoland−Binnenhafen	HD	DE	54.18	7.90	1	10	BAFG
74	Eider−Sperrwerk	EI	DE	54.26	8.84	1	10	BAFG
75	Husum	HU	DE	54.47	9.02	1	10	BAFG
76	Pellworm	PW	DE	54.50	8.70	1	10	BAFG
77	Wittduen	WI	DE	54.63	8.39	1	10	BAFG
78	Dagebuell	DA	DE	54.73	8.69	1	10	BAFG
79	Hoernum	HR	DE	54.76	8.31	1	10	BAFG
80	List	LS	DE	55.02	8.45	1	10	BAFG

Table S8.1 (continued).

N	Station Name	Abb	Country	Lati–tude (degree)	Longi–tude (degree)	Δt orig (min)	Δt use (min)	Source
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
81	Hojer	HO	DK	54.96	8.66	10	10	KDI
82	Havneby	HY	DK	55.09	8.57	10	10	KDI
83	Ballum	BM	DK	55.13	8.69	10	10	KDI
84	Ribe	RI	DK	55.34	8.68	10	10	KDI
85	Esbjerg	EJ	DK	55.47	8.42	10	10	KDI
86	Thorsminde (Havn)	TS	DK	56.37	8.12	10	10	KDI
87	Ferring	FR	DK	56.52	8.12	10	10	KDI
88	Thyboron (Havet hofde 58)	TY	DK	56.71	8.21	10	10	KDI
89	Hanstholm	HA	DK	57.12	8.60	10	10	KDI2
90	Hirtshals	HI	DK	57.60	9.96	10	10	KDI2
91	Skagen	SK	DK	57.72	10.60	10	10	KDI2
92	Tregde	TG	NO	58.00	7.56	10	10	Kartv
93	Stavanger	SV	NO	58.97	5.73	10	10	Kartv

Notes:
[1] Station running index
[2] Station name
[3] Station abbreviation used in figures of the main manuscript
[4] Country
[5] Latitude
[6] Longitude
[7] Data reporting interval in minutes
[8] Data time interval used in analysis; data for the Germany stations was averaged onto a 10 minute grid.
[9] Source:
BODC: (British Oceanographic Data Centre; water level data from the primary tide gauge packed with the residual water level after subtraction of the BODC model tide): https://bodc.ac.uk/data/hosted_data_systems/sea_level/uk_tide_gauge_network/
BODC2: (British Oceanographic Data Centre; raw water level data from the secondary tide gauge in the case where the primary tide gauge data had errors): https://bodc.ac.uk/data/hosted_data_systems/sea_level/uk_tide_gauge_network/
EA: email communication with Victoria Grobler at Victoria.Grobler@environment-agency.gov.uk
VLIZ: (Vlaams Instituut voor de Zee) https://meetnetvlaamsebanken.de
RWS: (Rijkswatersaat Waterinfo) https://waterinfo.rws.nl/#!/nav/expert/alle-groepen/
BAFG: (Bundesanstalt fuer Gewaesserkunde) email communication with Wilfried Wiechmann at Datenstelle-M1@bafg.de
KDI: (Kystdirektoratet) https://kystatlas.kyst.dk/public2/data/vandstand/vandstand.html
KDI2: (Kystdirektoratet; data from gauges operated by Danish harbour authorities) email communication with Bjørn Frederiksen bfr@kyst.dk
Kartv: (Kartverket) api.sehavniva.no/tideapi_en.html

Table S8.2. Summary of Rejected Stations

Station	Country	Reason
Lerwick (primary guage)	UK	Trend in data
Dover	UK	Long data gap
Bath	Netherlands	Long data gap
Haringvliet 10	Netherlands	Long data gap
Petten	Netherlands	Long data gap
Texel Noordzee	Netherlands	Long data gap
Tönning	Germany	Bad data
Hvide Sande	Denmark	Data gaps >2 h
Thorsminde	Denmark	Data gaps >2 h
Bergen	Norway	Data gaps >2 h
Maløy	Norway	Data gaps >2 h

SECTION S9. SAMPLE POWER SPECTRUM OF TIDE GAUGE WATER LEVEL DATA

The following graph is reproduced from the Supplement of Kettle (2023)

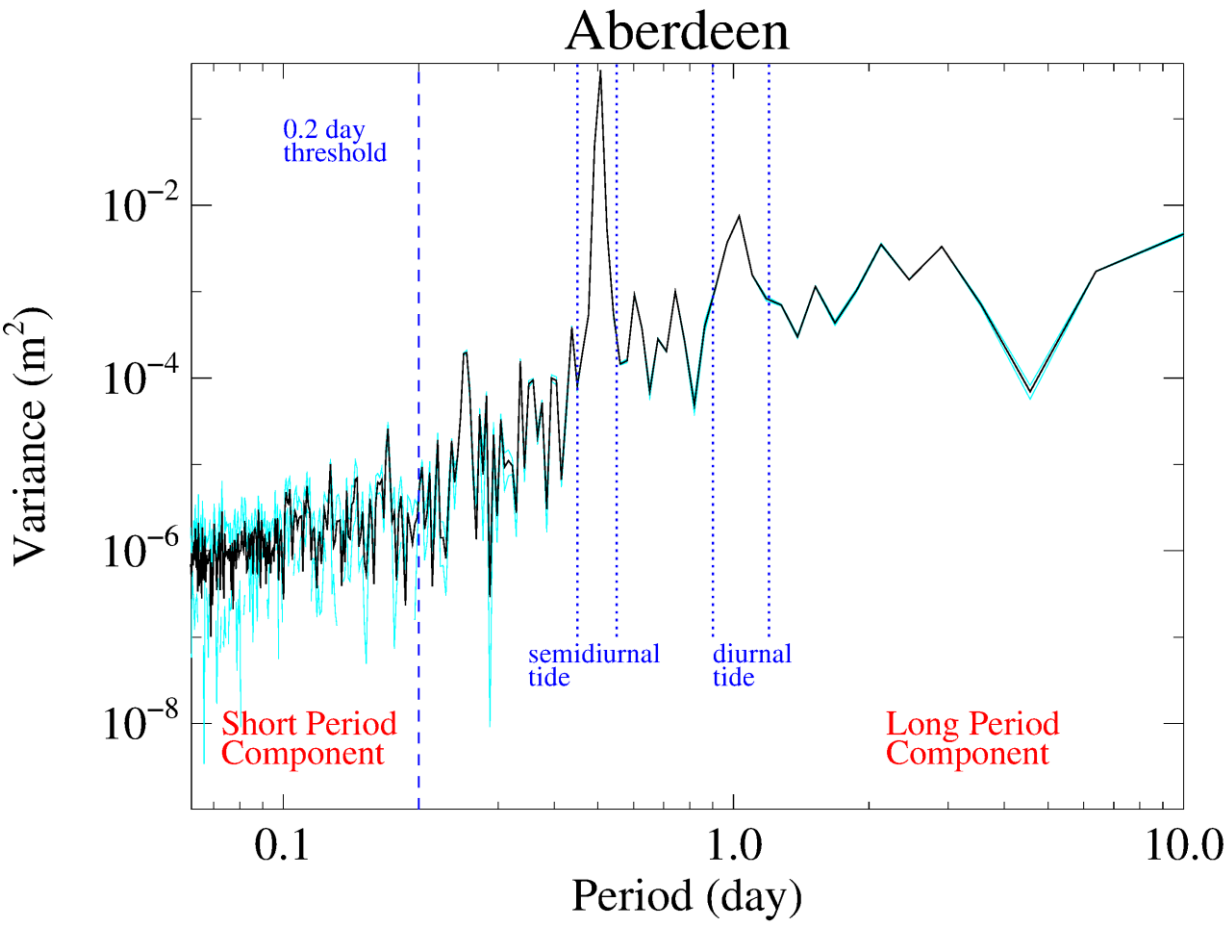


Figure S9.1. Sample spectrum of water level for Aberdeen across the 16 day period 8–23 January 2007. The 0.2 day threshold separating the short period and long period components of the time series reconstructions is shown, as well as the thresholds defining the diurnal and semidiurnal components that were used to de-tide the time series. The uncertainty in the spectrum (light blue line) calculated as the standard deviation of three spectra derived from re-sampling the time series at every third point.

SECTION S10. TIDE GAUGE LEVELLING DIFFERENCES AND SURGE CORRECTIONS

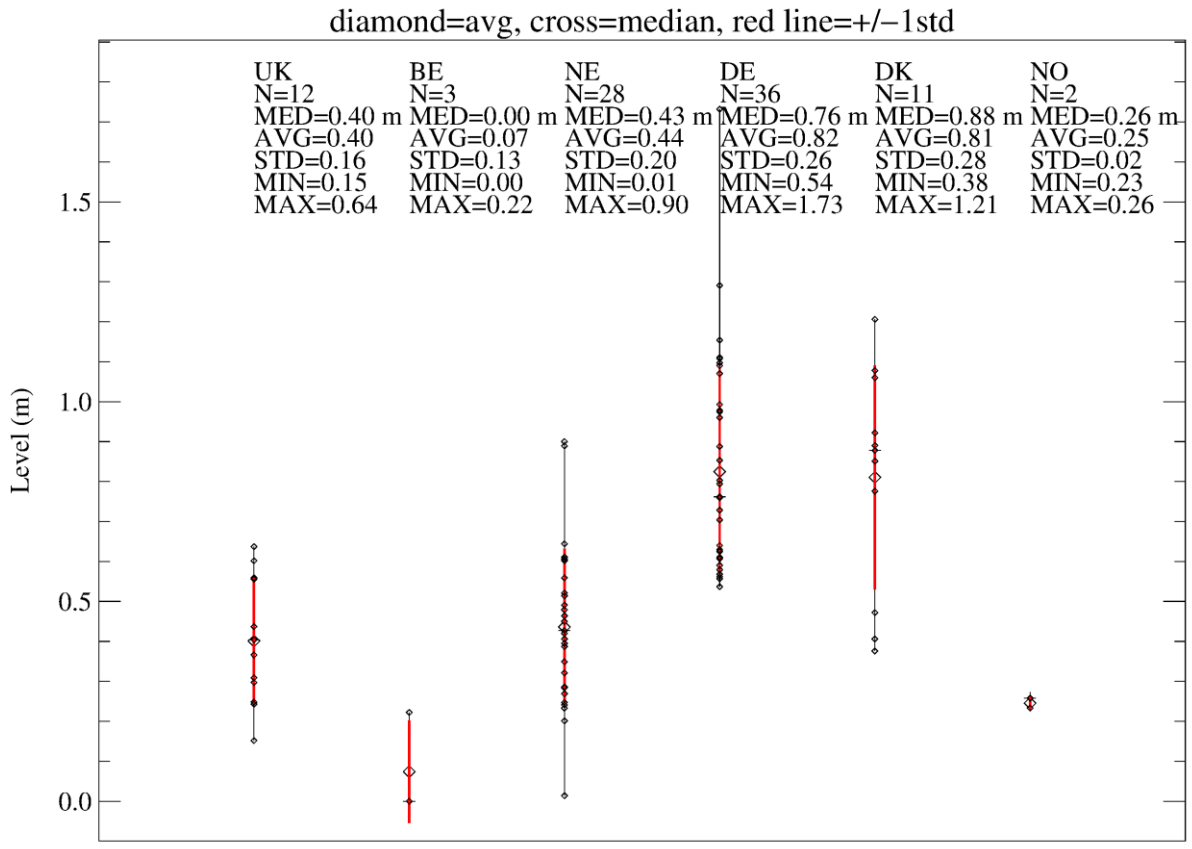


Figure S10.1. Difference of the reported mean sea level and the 16 day median level calculated from the tide gauge data for the period 8–23 January 2023. The station differences have been separated by country, and statistics from the country collections have been calculated. The reason for the apparent bias is not clear. This graph has been reproduced from the Supplement of Kettle (2023).

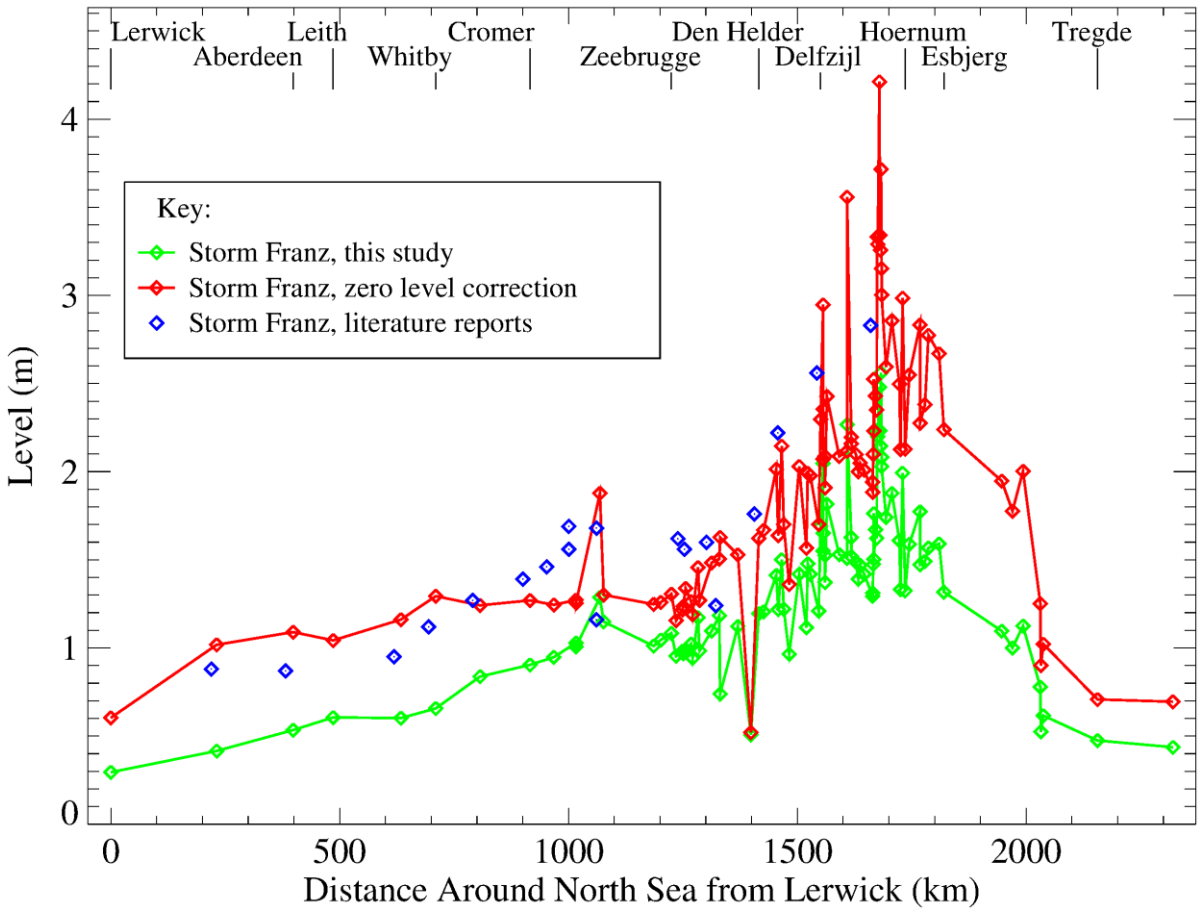


Figure S10.2. Maximum surge height for stations around the North Sea during Storm Franz on 11–12 January 2007 tide (green line). This is calculated as the detrended maximum water level minus the diurnal and semidiurnal. The red line shows the results when a zero level correction is applied between the reported mean sea level of the tide gauge and median of the trend line fitted to the 16 day time series. Blue diamonds show literature reports of surge levels. Better agreement between the surge levels in the present survey with literature values is obtained when the zero-level correction is applied.

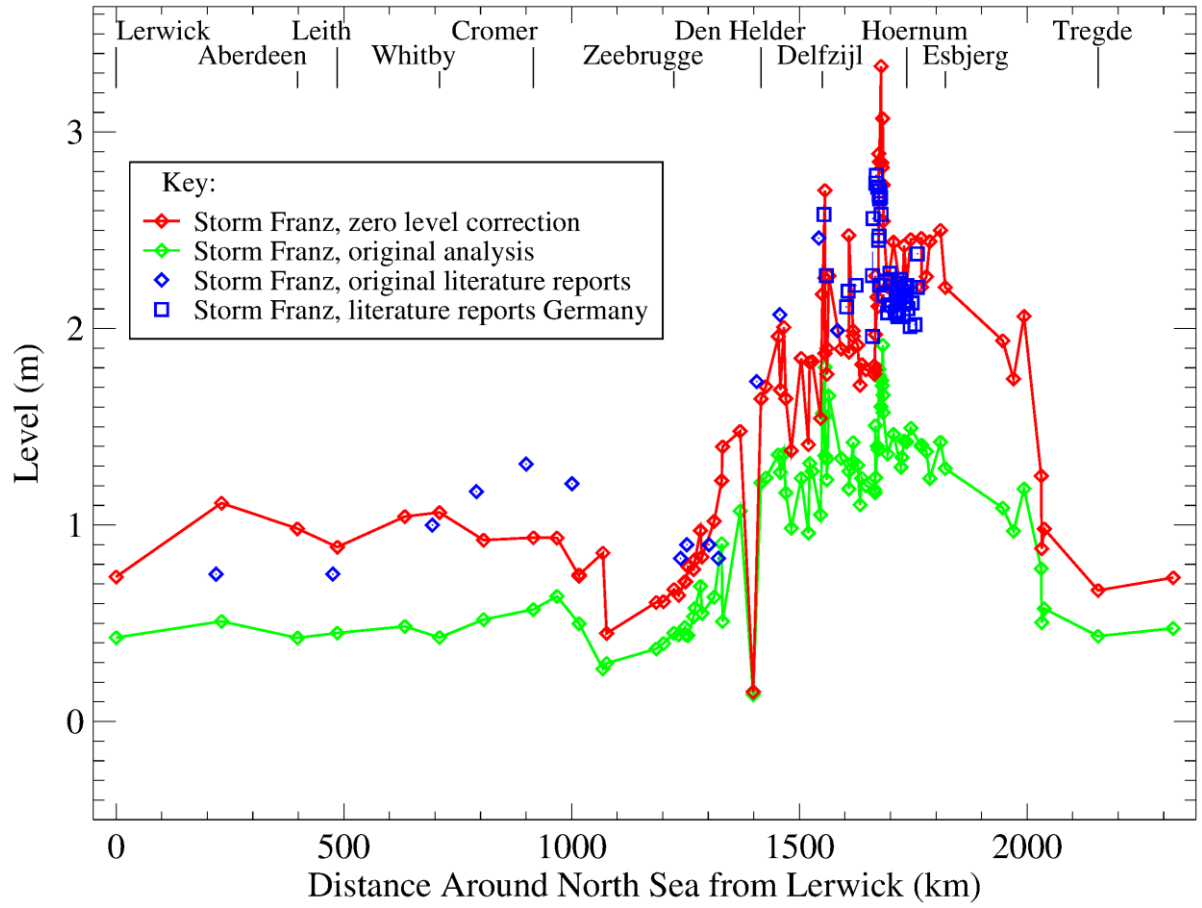


Figure S10.3. Maximum skew surge height for stations around the North Sea during Storm Franz on 11–12 January 2007 (green line). This has been calculated as the detrended maximum water level minus the nearest modelled high tide level. The red line shows the results when a zero level correction is applied between the reported mean sea level of the tide gauge and median of the trend line fitted to the 16 day time series. Blue diamonds show literature reports of surge levels. The black crosses are the downward corrections of the literature reports for Germany to take account of the difference between the long term mean high water level and the high water level during Storm Franz. Better agreement between the skew surge results in the present survey with literature values is obtained when the zero-level correction is applied.

SECTION S11. TABLE OF MARITIME ACCIDENTS AND INCIDENTS 11–12 JANUARY 2007

Table S11.1. Information for the maritime accidents and offshore events for 11–12 January 2007.

N [1]	Ship/Platform Name or Incident [2]	Abb [3]	Lati–tude (deg) [4]	Longi–tude (deg) [5]	Date (UTC) dd/mm/yyyy [6]	Time UTC hh:mm [7]	Source [8]
1	Arctic Sea	ARC	57.69	10.62	11/01/2007	13:16	LCW_MA20070119
2	Almar	ALM	53.02	4.41	11/01/2007	18:56	LCW_MA20070126
3	CSO Orelia	CSO	58.13	1.23	12/01/2007	01:45	LCW_MA20070126
4	Eiltank 4	EIL	51.92	4.48	11/01/2007	12:00	LCW_MA20070126
5	Grande Portogallo	POR	51.46	3.58	11/01/2007	09:00	LCW_MA20070126
6	Independent	IND	53.61	5.92	11/01/2007	13:00	LCW_MA20070126
7	Maersk Wave	MAE	53.54	8.58	11/01/2007	14:20	LCW_MA20070126
8	Server	SER	60.75	4.71	12/01/2007	18:26	LCW_MA20070126
9	Sierra Lara	SIE	57.72	10.58	12/01/2007	12:00	LCW_MA20070126
10	Vans Queen	VAN	54.98	−1.62	12/01/2007	15:00	LCW_MA20070126
11	Vindo	VIN	54.28	2.16	11/01/2007	16:09	LCW_MA20070126
12	JRS Canis	JRS	53.96	8.09	12/01/2007	01:40	BSU_20081001
13	Fano Bugt wave 2	FA2	55.34	8.23	12/01/2007	02:30	KDI
14	Fano Bugt wave 3	FA3	55.34	8.23	11/01/2007	11:00	KDI
15	Fano Bugt wave 4	FA4	55.34	8.23	12/01/2007	04:00	KDI

Notes:
[1] Running index of event
[2] Ship/platform name or wave measuring instrument with incident number
[3] Abbreviation used in figures of main manuscript
[4] Latitude
[5] Longitude
[6] Date of incident
[7] Time of incident
[8] Source

BSU_20081001: BSU, Loss overboard of 10 containers from JRS Canis at estuary of Elbe River on 12 January 2007 at 02:40, Investigation Report 45/07, Less Serious Marine Casualty, Bundestelle für Seeunfalluntersuchung, 1 October 2008.
KDI: These are observations of unusual maximum waves in the time series records of Kystdirektoratet.
LCW_MA20070119: Lloyd's Casualty Week: Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ, 19 January 2007
LCW_MA20070126: Lloyd's Casualty Week: Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ, 26 January 2007

SECTION S12. MAXIMUM SURGE RESIDUAL

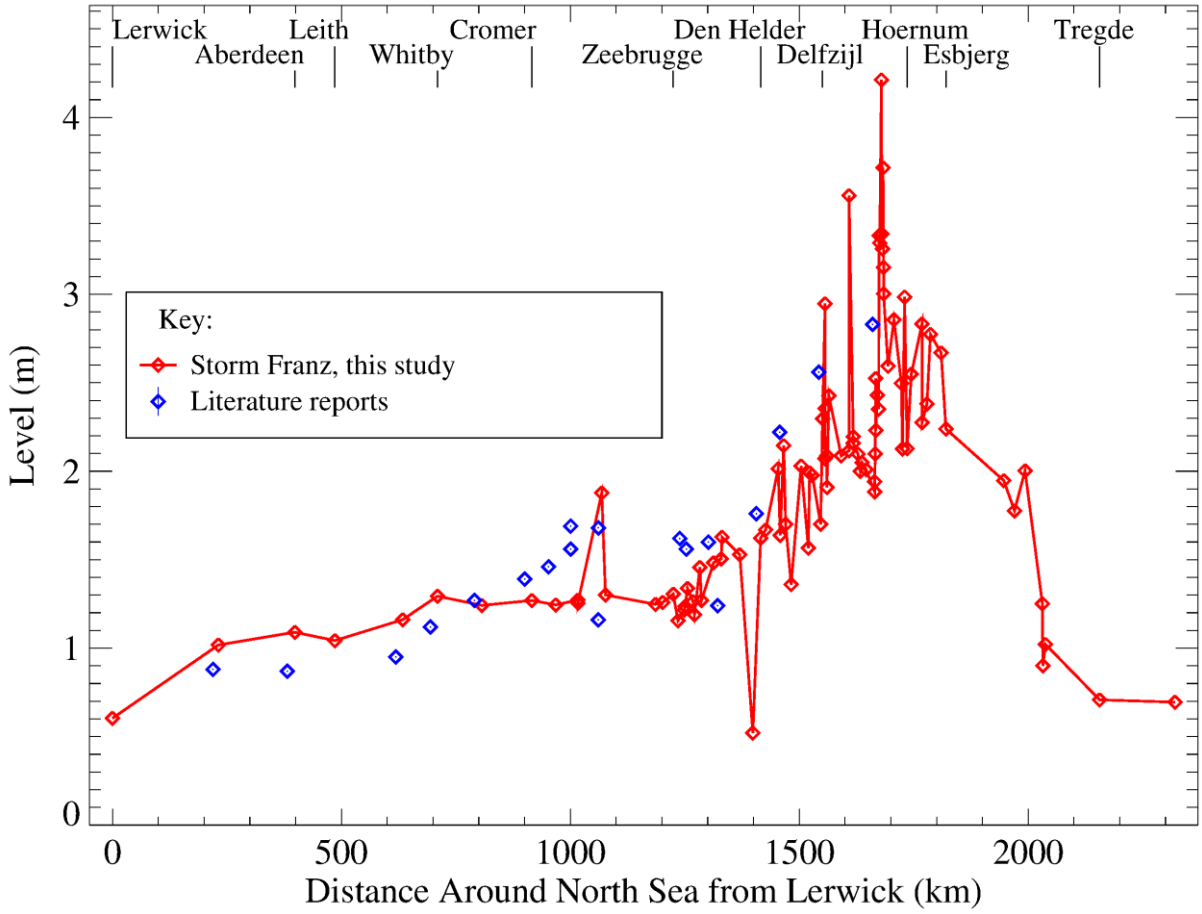


Figure S12.1. Maximum surge residual during Storm Franz on 11–12 January 2007 versus coastal distance around the North Sea starting from Lerwick in Scotland. The values of this study have been adjusted to compare with literature values (blue) by adding the difference in the calculated average sea level of the ~2 week data segment and official sea level presented with the data.

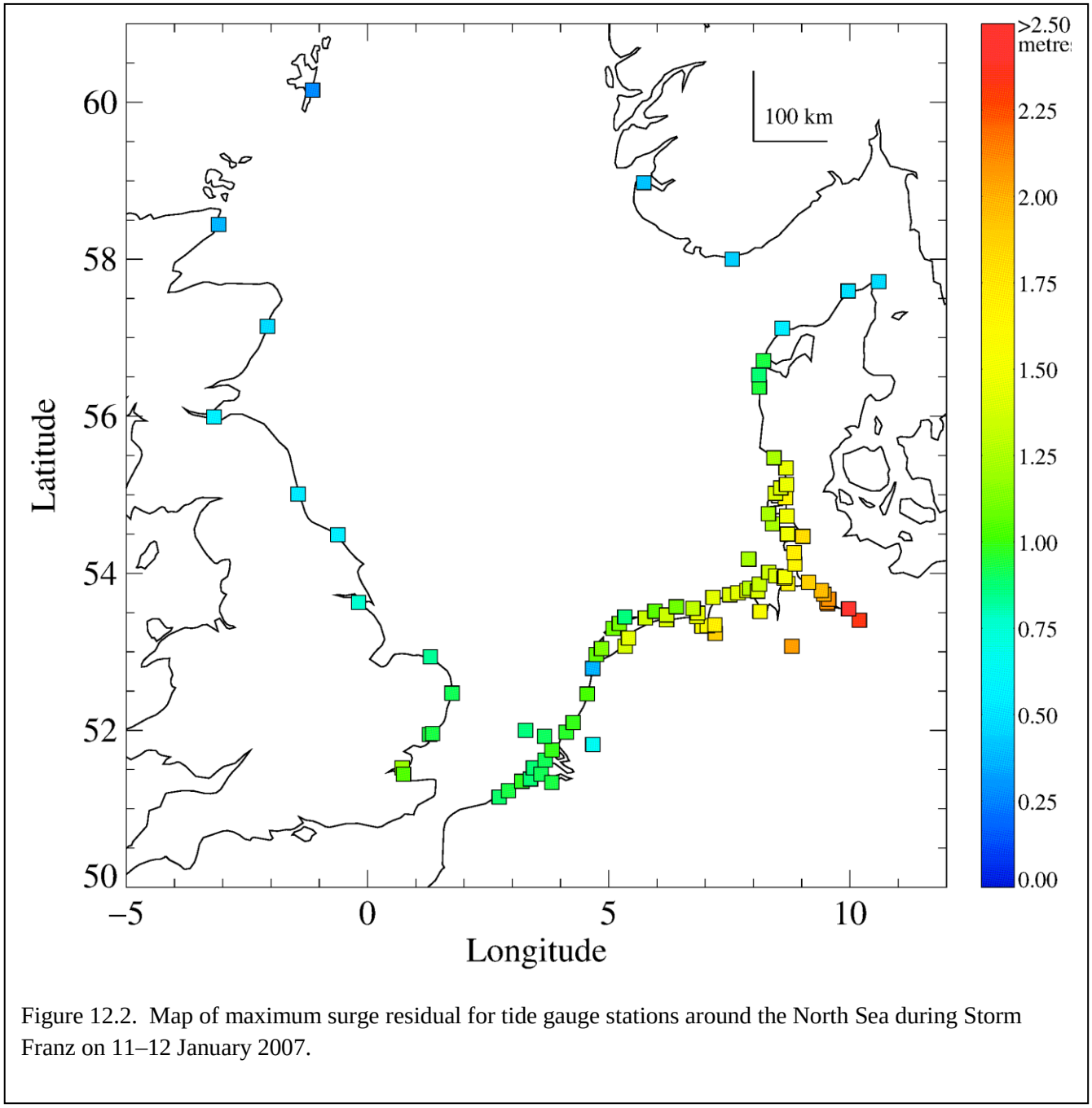


Figure 12.2. Map of maximum surge residual for tide gauge stations around the North Sea during Storm Franz on 11–12 January 2007.

SECTION S13. RETURN PERIOD OF WATER LEVELS FROM THE LITERATURE

Table S13.1. Sorted list of return periods of highest water levels during Storm Franz on 11–12 January 2007.

N	Location	Country	Latitude (degree)	Longitude (degree)	Return Period (year)	Case
[1]	[2]	[3]	[4]	[5]	[6]	[7]
1	Kloster	DK	56.30	8.30	32	5:kdi18
2	Thyboren Havn	DK	56.70	8.20	30	5:kdi18
3	Kinlochbervie	UK	58.46	–5.05	18	7:NTSLF13
4	Thyboren Hav	DK	56.70	8.20	15	5:kdi18
5	Skagen	DK	57.70	10.60	14	5:kdi18
6	Ullapool	UK	57.90	–5.16	12	7:NTSLF13
7	Hirtshals	DK	57.60	10.00	9.1	5:kdi18
8	Cromer	UK	52.93	1.30	8.4	7:NTSLF13
9	Harwich	UK	51.95	1.29	7.5	7:NTSLF13
10	Wick	UK	58.44	–3.09	6.2	7:NTSLF13
11	Immingham	UK	53.63	–0.19	5.5	7:NTSLF13
12	Whitby	UK	54.49	–0.61	4.9	7:NTSLF13
13	Koebenhavn	DK	55.70	12.60	4.6	5:kdi18
14	Heysham	UK	54.03	–2.92	4.4	7:NTSLF13
15	Port Erin	UK	54.09	–4.77	4.3	7:NTSLF13
16	Delfzijl	NE	53.33	6.93	4.2	2:FREQ
17	Leith	UK	55.99	–3.18	3.6	7:NTSLF13
18	Ferring	DK	56.50	8.10	3.5	5:kdi18
19	Stornaway	UK	58.21	–6.39	3.2	7:NTSLF13
20	Den Helder	NE	52.97	4.75	3.1	2:FREQ
21	Port Ellen	UK	55.63	–6.19	2.9	7:NTSLF13
22	Lowestoft	UK	52.47	1.75	2.9	6:DT94
23	Thorsminde	DK	56.40	8.10	2.9	5:kdi18
24	Portrush	UK	55.21	–6.66	2.8	7:NTSLF13
25	Cuxhaven	DE	53.87	8.72	2.7	1:RP
26	Felixstowe	UK	51.96	1.35	2.7	7:NTSLF13
27	Havneby	DK	55.10	8.60	2.5	5:kdi18
28	Gabet	DK	55.50	10.60	2.5	5:kdi18
29	Workington	UK	54.65	–3.57	2.5	7:NTSLF13
30	Liverpool	UK	53.45	–3.02	2.4	7:NTSLF13
31	Ballum	DK	55.10	8.70	2.3	5:kdi18
32	Harlingen	NE	53.17	5.42	2.3	2:FREQ
33	Norderney	NE	53.70	7.15	2.0	1:RP
34	Hvide Sand Hav	DK	56.00	8.10	1.3	5:kdi18
35	Dordrecht	NE	51.82	4.67	0.29	2:FREQ

Table S13.1. Continued

N [1]	Location [2]	Country [3]	Latitude (degree) [4]	Longitude (degree) [5]	Return Period (year) [6]	Case [7]
36	Hoek van Holland	NE	51.98	4.12	0.06	2:FREQ
37	Roompot buiten	NE	51.62	3.67	0.03	2:FREQ
38	Vlissingen	NE	51.45	3.60	0.01	2:FREQ
39	Felixstowe	UK	51.96	1.35	0.00	6:DT94

Notes:
[1] Running index of data
[2] Station name
[3] Country
[4] Latitude
[5] Longitude
[6] Calculated return period in years
[7] Water level, if presented in the source; the return period for the NTLSF13 source is based on a ranked series of skew surge values.
[8] Description of calculation:
RP: return period presented in source
FREQ: source presents number of exceedances within a time interval; return period is taken as reciprocal
RANK: source presents rank of water level across a date range; return period is calculated as the number of years represented divided by the rank.
DT94: Dixon and Tawn (1994) present algorithms for calculating return periods from true surge heights for selected stations. True surge heights are presented in the NTLSF07 annual report [Dixon MJ and JA Tawn, Extreme sea-levels at UK A-class site: site-by-site analysis, Proudman Oceanographic Laboratory, Internal document No.65, March 1994, 234 pp; NTSLF07: Bradshaw, Elizabeth (ed), Annual Report for 2007 for the UK National Tide Gauge Network and Related Sea Level Science, National Tide and Sea Level Facility, NERC 100017897 2007, p.2]
kdi18: Ditlevsen et al (2018) present the maximum water levels during Storm Anatol and tabulated values of standardized return periods versus water level that were interpolated to derive the return periods for the Storm Anatol case [Ditlevsen C, MM Ramos, C Sørensen, UR Ciocan, T Pionkowitz, Højvandsstatistikker 2017, Miljo- og Fødevareministeriet, Kystdirektoratet Lemvig, Februar, 2018]
NTLSF13: The National Tide and Sea Level Facility NTSLF presents web pages with ranked lists of the top 10 skew surge levels for selected tide gauges around the UK across specified date ranges up to 2013. The return period was calculated as the number of years of data divided by the rank of Storm Kyrill, if it was present [https://ntslf.org/storm-surges/skew-surges/scotland, https://ntslf.org/storm-surges/skew-surges/england-east, https://ntslf.org/storm-surges/skew-surges/england-south, https://ntslf.org/storm-surges/skew-surges/england-wales, https://ntslf.org/storm-surges/skew-surges/england_west, https://ntslf.org/storm-surges/skew-surges/isle-of-man, https://ntslf.org/storm-surges/skew-surges/northern-ireland, https://ntslf.org/storm-surges/skew-surges/channel-islands (accessed 10Nov2021)]

SECTION S14. MAXIMUM RANGE AND AMPLITUDE OF SHORT PERIOD OSCILLATIONS

Table S14.1. List of maximum range (in descending order) of down-crossing oscillations derived from the short period time series reconstructions for each North Sea tide gauge station.

N	Station Name	Range (cm)	Midpoint of Oscillation (h after 11 Jan 2007 00:00 UTC)	Duration of Oscillation (h)
1	Bremen−Grosse−Weserbruecke	87.6	2.50	3.17
2	Southend	71.4	6.88	1.25
3	IJmuiden buitenhaven	62.4	12.92	2.83
4	Scheveningen	61.4	13.08	3.50
5	Pinnau−Sperrwerk	55.0	2.75	3.33
6	Hamburg−St−Pauli	55.0	4.08	3.33
7	Stadersand	52.2	2.75	3.33
8	Hetlingen	50.5	2.83	3.17
9	Harwich	50.2	16.62	3.25
10	Brouwershavensche Gat 08	45.6	17.25	4.17
11	Hoek van Holland	42.8	13.25	3.83
12	Zollenspieker	42.7	5.17	3.17
13	Kollmar	42.5	2.33	3.50
14	Nieuwpoort	41.4	18.58	2.50
15	Glueckstadt	40.5	2.25	3.67
16	Thyboron (Havet hofde 58)	39.6	34.58	2.50
17	Felixstowe	39.5	16.50	3.00
18	Ostend harbor	38.5	18.50	2.67
19	Eider−Sperrwerk	36.2	16.50	2.83
20	Petten	33.6	17.75	3.50
21	Zeebrugge Leopold II dam	33.1	18.21	2.58
22	Thorsminde (Havn)	32.9	8.17	2.33
23	Roompot buiten	32.8	13.58	3.50
24	Terneuzen	32.8	14.58	3.50
25	Husum	31.2	29.83	3.50
26	Ballum	30.8	11.33	3.00
27	Cadzand	30.4	18.50	3.33
28	Lichteiland Goeree	29.8	17.33	3.67
29	Lowestoft	28.3	15.50	3.50
30	Schiermonnikoog	28.1	13.58	2.50
31	Nieuwe Statenzijl	27.8	26.42	3.50
32	Hanstholm	27.8	32.08	1.17
33	Delfzijl	27.6	10.50	3.33
34	Hojer	27.4	12.08	2.17
35	Terschelling Noordzee	27.4	12.58	1.50
36	Ferring	26.7	25.75	1.83
37	Dordrecht	25.9	19.08	4.17
38	Wierumergronden	25.3	12.42	2.50
39	Vlissingen	25.0	14.08	3.50
40	Emden−Neue−Seeschleuse	23.3	7.25	4.33
41	Immingham	23.0	31.00	3.50
42	Westkapelle	22.3	3.67	3.67
43	Pellworm	21.7	12.92	4.00
44	Kornwerderzand buiten	21.6	12.42	2.83
45	Den Helder	21.2	15.00	2.67
46	Langeoog	21.1	28.58	3.33
47	Hirtshals	21.0	38.92	0.50

Table 14.1 (continued).

N	Station Name	Range (cm)	Midpoint of Oscillation (h after 11 Jan 2007 00:00 UTC)	Duration of Oscillation (h)
48	Wangerooge–Nord	20.9	7.50	3.83
49	Leith	20.5	40.13	3.75
50	Nes	20.5	13.50	3.00
51	Euro platform	20.2	17.33	3.33
52	Dagebuell	20.0	16.42	3.33
53	Spiekeroog	20.0	28.75	3.33
54	Cuxhaven–Steubenhoeft	19.7	14.50	2.17
55	Havneby	19.6	11.83	3.33
56	Norderney–Riffgat	19.4	6.58	3.33
57	Huibertgat	19.2	24.50	1.00
58	Lerwick	19.2	42.88	0.75
59	Knock	18.5	10.75	3.67
60	Bake–Z	18.4	13.42	1.67
61	Ribe	18.3	20.42	2.17
62	Mellumplate	17.9	7.75	3.67
63	Mittelgrund	17.9	14.25	2.67
64	Brunsbuettel–Mole4	17.7	12.83	2.50
65	Harlingen	17.5	21.33	4.00
66	Scharhoern	17.3	13.83	2.17
67	Vlieland haven	17.1	7.58	3.83
68	LT–Alte–Weser	16.7	7.75	3.67
69	Buesum	16.6	13.75	3.67
70	Hoernum	16.5	12.83	1.83
71	Lauwersoog	16.2	5.25	4.17
72	Sheerness	16.1	17.88	3.75
73	Eemshaven	15.7	14.00	0.67
74	Whitby	15.5	15.25	3.00
75	Wangerooge–West	15.5	10.92	2.67
76	West–Terschelling	14.8	7.67	3.00
77	Cromer	14.8	18.75	2.00
78	Aberdeen	14.4	12.75	1.50
79	Wittduen	14.4	13.08	2.00
80	WHV–Alter–Vorhafen	14.3	3.50	3.83
81	Zehnerloch	14.1	14.25	2.33
82	Esbjerg	13.7	29.58	1.50
83	Oudeschild	12.2	13.17	1.67
84	North Shields	11.9	4.13	1.75
85	Stavanger	11.6	8.50	3.00
86	Borkum–Fischerbalje	11.6	6.33	2.83
87	List	11.5	8.75	3.00
88	Emshoern	11.2	13.75	3.00
89	Helgoland–Suedhafen	10.1	23.33	2.50
90	Helgoland–Binnenhafen	9.4	19.42	3.33
91	Skagen	8.7	3.08	3.17
92	Wick	8.7	36.50	3.50
93	Tregde	8.5	3.00	0.33

Table S14.2. List of maximum amplitude (in descending order) of down-crossing oscillations derived from the short period time series reconstructions for each North Sea tide gauge station.

N	Station Name	Max (cm)	Midpoint of Oscillation (h after 11 Jan 2007 00:00 UTC)	Duration of Oscillation (h)
1	Southend	50.7	6.88	1.25
2	IJmuiden buitenhaven	46.5	12.92	2.83
3	Scheveningen	45.0	13.08	3.50
4	Bremen−Grosse−Weserbruecke	41.2	2.50	3.17
5	Harwich	31.0	16.62	3.25
6	Brouwershavensche Gat 08	30.9	13.08	4.17
7	Hoek van Holland	30.6	13.25	3.83
8	Thyboron (Havet hofde 58)	28.0	34.58	2.50
9	Hamburg−St−Pauli	24.7	4.08	3.33
10	Felixstowe	24.3	16.50	3.00
11	Roompot buiten	23.9	13.58	3.50
12	Pinnau−Sperrwerk	22.7	2.75	3.33
13	Hetlingen	22.7	2.83	3.17
14	Stadersand	22.4	2.75	3.33
15	Ballum	21.9	11.33	3.00
16	Terneuzen	21.2	14.58	3.50
17	Hanstholm	21.0	32.08	1.17
18	Nieuwpoort	20.4	18.58	2.50
19	Terschelling Noordzee	19.9	12.58	1.50
20	Kollmar	18.1	2.33	3.50
21	Lowestoft	18.0	15.50	3.50
22	Eider−Sperrwerk	17.8	16.50	2.83
23	Ostend harbor	17.7	18.50	2.67
24	Petten	16.5	17.75	3.50
25	Glueckstadt	16.0	2.25	3.67
26	Zeebrugge Leopold II dam	16.0	18.21	2.58
27	Vlissingen	15.9	14.08	3.50
28	Ferring	15.9	25.75	1.83
29	Nieuwe Statenzijl	15.9	26.42	3.50
30	Thorsminde (Havn)	15.9	17.33	1.00
31	Kornwerderzand buiten	15.7	12.42	2.83
32	Cadzand	15.5	14.17	2.67
33	Wierumergronden	14.9	12.42	2.50
34	Bake−Z	14.8	13.42	1.67
35	Emden−Neue−Seeschleuse	14.8	7.25	4.33
36	Delfzijl	14.7	25.92	2.50
37	Husum	14.6	29.83	3.50
38	Lichteiland Goeree	13.8	13.25	4.50
39	Dordrecht	13.8	15.00	4.00
40	Havneby	13.8	11.83	3.33
41	Zollenspieker	13.7	5.17	3.17
42	Scharhoern	13.0	13.83	2.17
43	Hojer	13.0	12.08	2.17
44	Westkapelle	12.9	13.75	3.50
45	Eemshaven	12.9	14.00	0.67
46	Schiermonnikoog	12.8	5.33	4.33
47	Hoernum	12.7	12.83	1.83

Table 14.2 (continued).

N	Station Name	Max (cm)	Midpoint of Oscillation (h after 11 Jan 2007 00:00 UTC)	Duration of Oscillation (h)
48	Pellworm	12.2	12.92	4.00
49	Langeoog	11.9	28.58	3.33
50	Cuxhaven−Steubenhoeft	11.7	14.50	2.17
51	Lauwersoog	11.5	14.00	1.33
52	Norderney−Riffgat	11.5	6.58	3.33
53	Huibertgat	11.5	24.50	1.00
54	Leith	11.4	40.13	3.75
55	Buesum	11.4	13.75	3.67
56	Vlieland haven	11.2	12.83	1.33
57	Immingham	11.1	31.00	3.50
58	Knock	11.0	6.92	4.00
59	Wangerooge−Nord	10.9	7.50	3.83
60	Spiekeroog	10.8	28.75	3.33
61	Mittelgrund	10.8	14.25	2.67
62	Den Helder	10.4	15.00	2.67
63	Sheerness	10.1	14.38	3.25
64	Mellumplate	10.0	7.75	3.67
65	Euro platform	9.9	14.83	1.67
66	Hirtshals	9.6	29.08	1.50
67	Cromer	9.5	11.00	2.00
68	Harlingen	9.4	12.17	2.67
69	Dagebuell	9.1	24.92	3.67
70	Ribe	8.9	30.25	2.17
71	Nes	8.8	4.67	5.00
72	Lerwick	8.7	42.88	0.75
73	Aberdeen	8.5	12.75	1.50
74	LT−Alte−Weser	8.4	7.75	3.67
75	Brunsbuettel−Mole4	8.4	15.42	2.67
76	Zehnerloch	8.3	14.25	2.33
77	Wittduen	8.3	13.08	2.00
78	Wangerooge−West	8.3	29.67	1.50
79	Esbjerg	7.7	26.67	1.33
80	Whitby	7.5	15.25	3.00
81	Emshoern	7.4	13.75	3.00
82	Borkum−Fischerbalje	7.3	6.33	2.83
83	West−Terschelling	7.2	4.00	4.33
84	Oudeschild	6.7	36.00	4.33
85	WHV−Alter−Vorhafen	6.5	11.67	3.83
86	Tregde	6.4	35.17	0.33
87	Helgoland−Suedhafen	6.4	13.08	1.00
88	Wick	6.2	24.88	1.25
89	Helgoland−Binnenhafen	5.8	8.50	1.17
90	Stavanger	5.5	5.00	4.00
91	Skagen	5.4	18.67	2.00
92	List	5.2	11.83	3.17
93	North Shields	5.1	4.13	1.75

SECTION S15. WATER LEVEL RANGE ACROSS 10-MINUTE INTERVALS: GERMANY

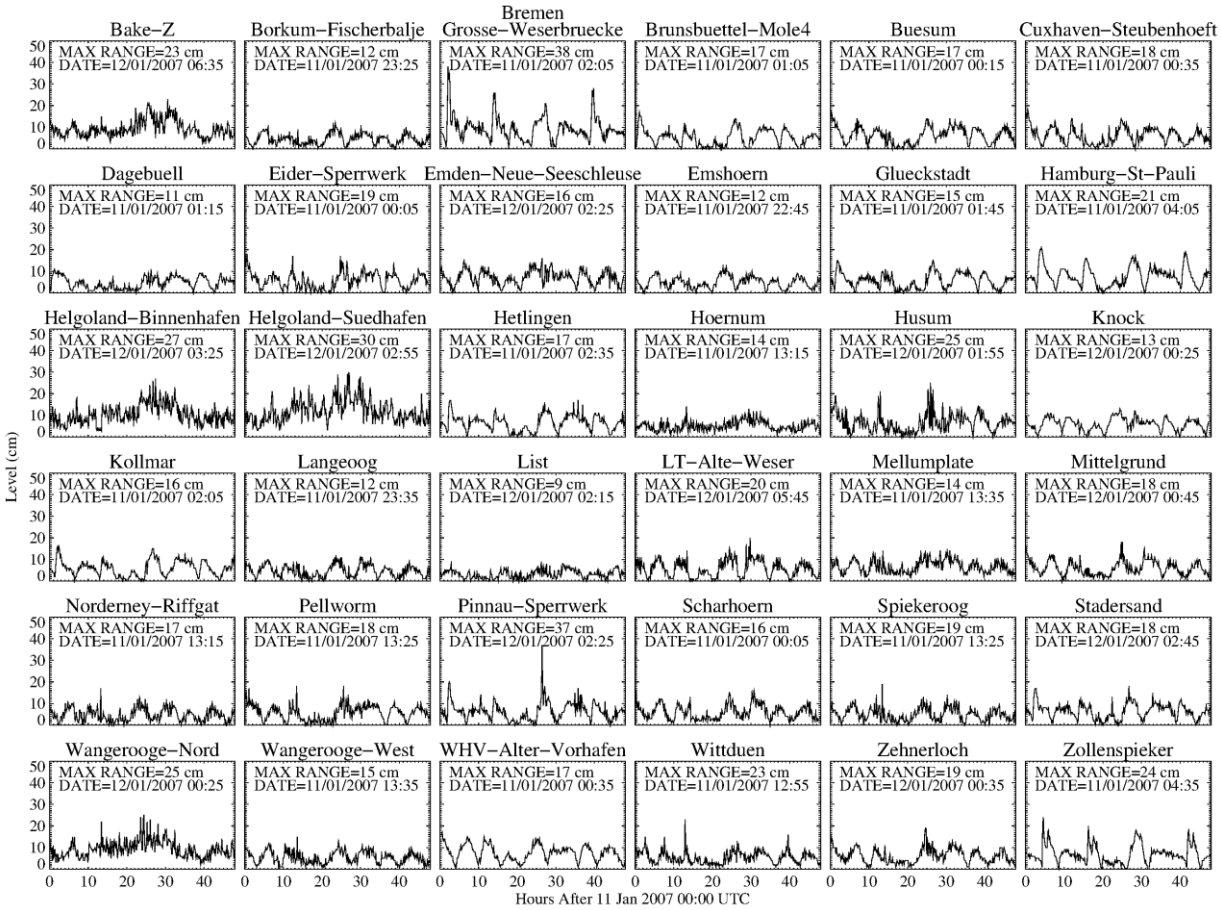


Figure S15.1. Range of water levels across 10-minute intervals, calculated from the original 1-minute time series data for Germany. The data for this graph was sent by Wilfried Wiechmann (Bundesanstalt für Gewasserkunde).

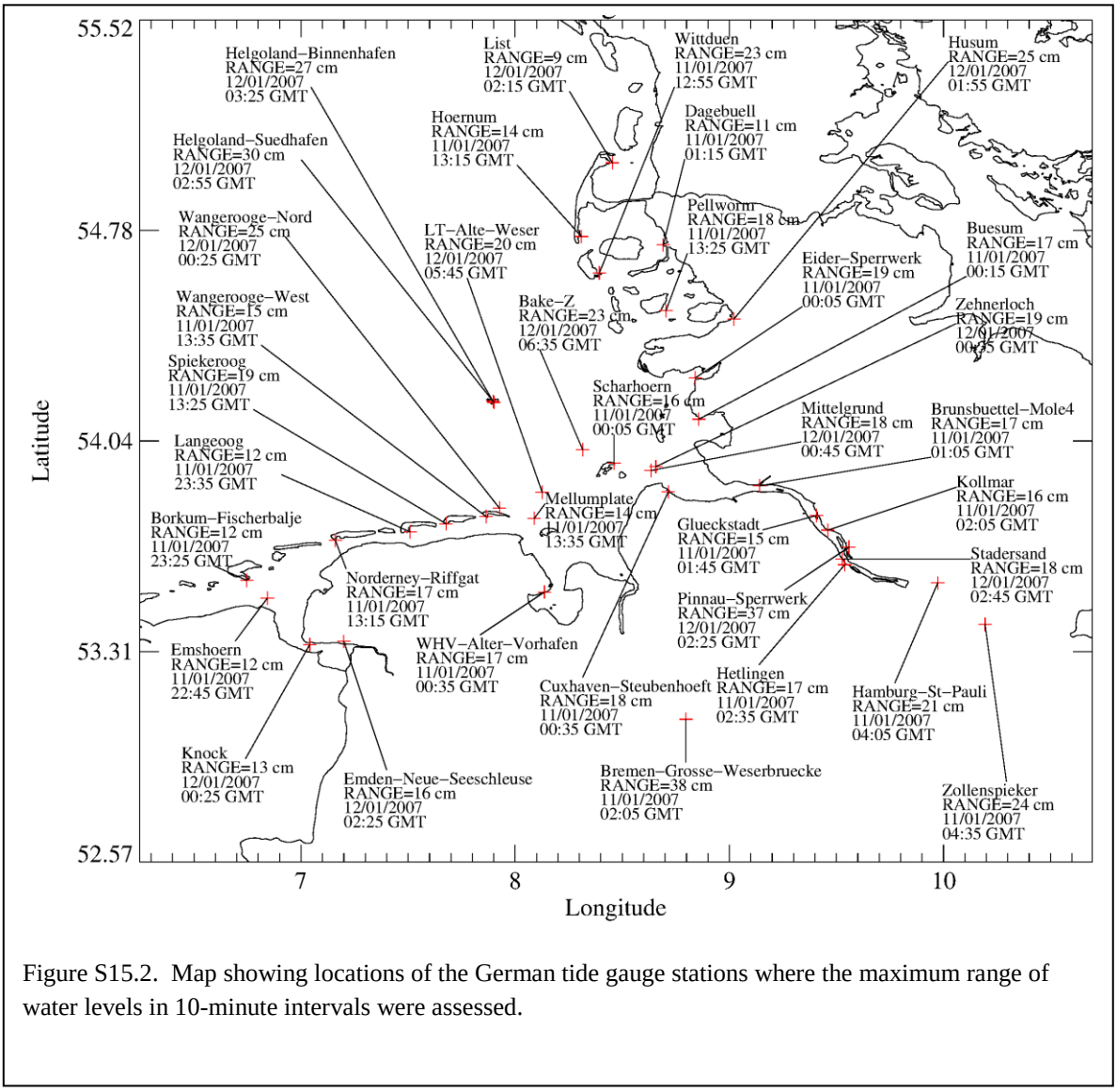


Figure S15.2. Map showing locations of the German tide gauge stations where the maximum range of water levels in 10-minute intervals were assessed.

SECTION S16. TIMING OF TIDE, SURGE, AND INCIDENTS AROUND NORTH SEA COAST

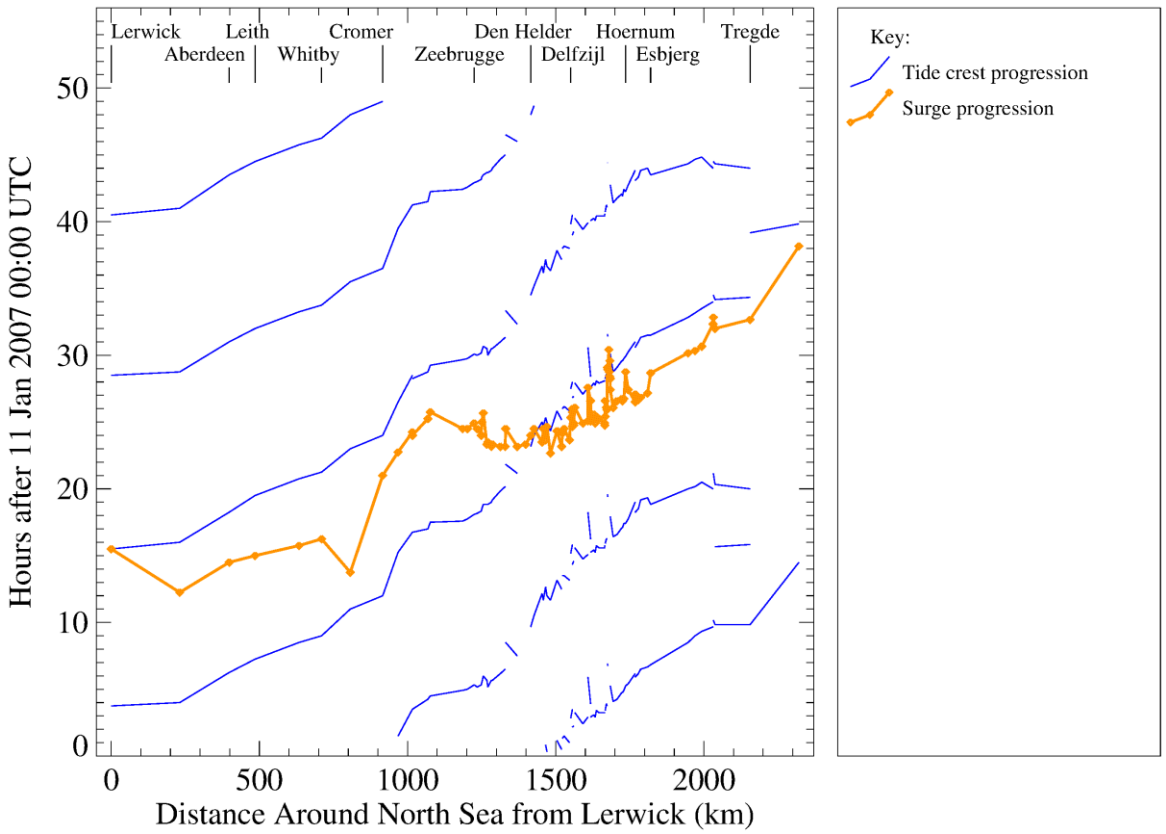


Figure S16.1. Summary of the progression of the tidal crests and storm surge peak around the North Sea on 11–12 January 2007. The data are plotted on axes of time versus counter-clockwise distance around the North Sea starting from Lerwick in Scotland.

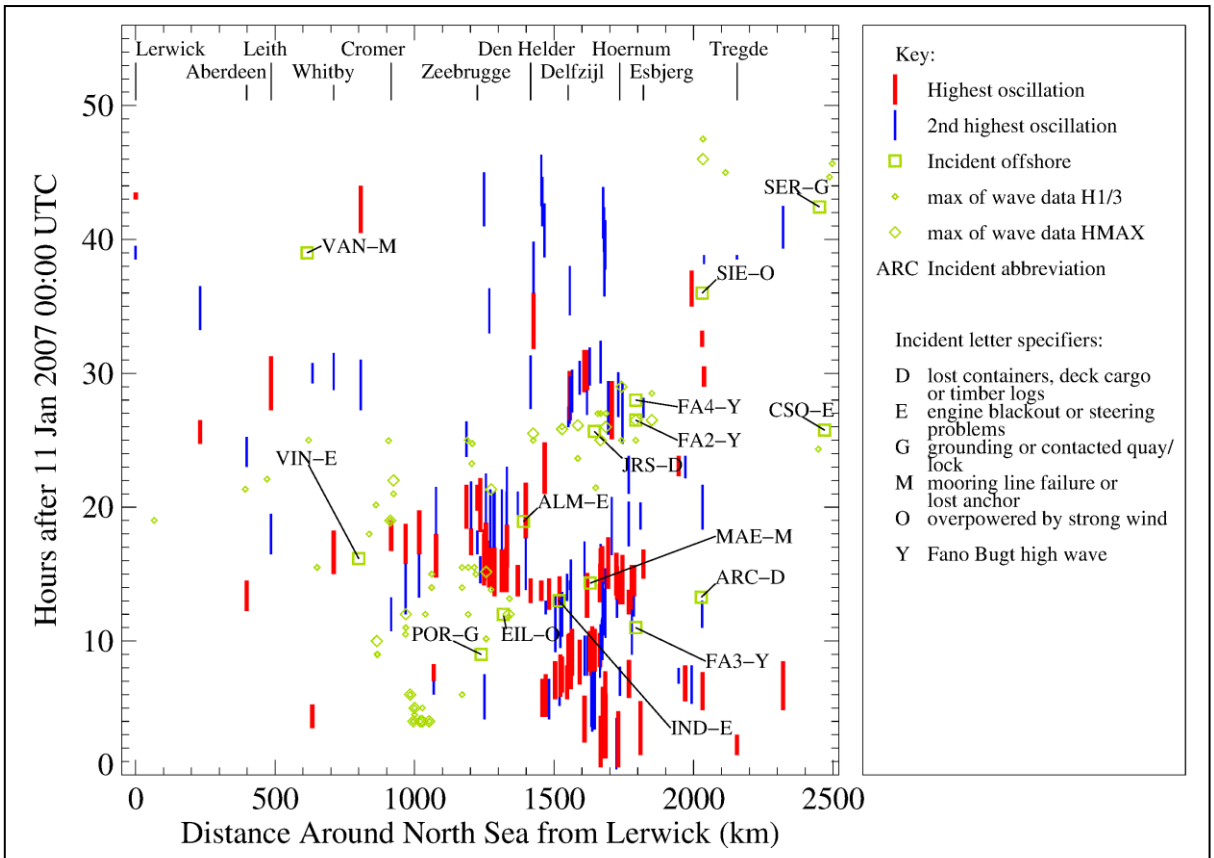


Figure S16.2. Summary of the spatial-temporal relationship of peak-to-trough range of the highest up-crossing short period oscillations in the tide gauge record, maritime incidents/accidents, and significant/maximum wave height across the two day storm period. The data are plotted on axes of time versus counter-clockwise distance around the North Sea starting from Lerwick in Scotland.

S17. THEMATIC TABLES OF STORM DESCRIPTION AND IMPACTS

This section has been updated and augmented Kettle (2023)

Table SL0. Master list of tables in working notes

Table SL1. List of sources reviewed for project (arranged by year and then alphabetically)

Source	Type[1]	Full Reference and Notes
Rossiter (1958)	4	Rossiter JR, Storm surges in the North Sea, 11 to 30 December 1954, Philosophical Transactions of the Royal Society of London, Series A, 251, No. 991, 139-160, 1958.
Prandle (1975)	4	Prandle D, Storm surges in the southern North Sea and River Thames, Proc. R. Soc. Lond. A, 344, 509-539, 1975
Ashcroft (1985)	4	Ashcroft, John, Potential ice and snow accretion on North Sea rigs and platforms (volume 1), Marine Technical Note No 1, Marine Advisory, Consultancy and Data Services, Meteorological Office, Eastern Road, Bracknell, Berkshire RG12 2UR, July 1985
Dannevig (1990)	4	Dannevig, Petter, Ceausescu ga ordre om a forfalske vaermeldinger, Vaeret, Aargang 14, Nr.1, p.19, 1990.
McCallum (1990)	4	McCallum E, The Burn's Day storm, 25 January 1990, Weather, 45, 166-173, 1990.
Gaffen (1993)	4	Gaffen, Dian J., Historical changes in radiosonde instruments and practices, World Meteorological Organization, Instruments and Observing Methods, Report No. 50. WMO/TD-No.541, 1993
Dixon and Tawn (1994)	4	Dixon MJ and JA Tawn, Extreme sea-levels at UK A-class site: site-by-site analysis, Proudman Oceanographic Laboratory, Internal document No.65, March 1994, 234 pp
Sorensen et al (2001)	4	Sorensen, T., F.V. Jensen, N. Raben, J. Lykkegaard, J. Saxov, Lightning protection for offshore wind turbines, CIRED2001, 18-21 June 2001, Conference Publication No. 482, IEE 2001
Hoffman and Leidner (2005)	4	Hoffman R.N. and S.M. Leidner, An introduction to the near real-time Quikscat data, Weather and Forecasting, 20, 476-493, 2005
IEA (2006)	4	IEA, Wind Energy Annual Report 2006, International Energy Agency, July 2006
RWS (2006)	4	RWS, Verslag van de stormvloed van 31 oktober en 1 november 2006 (SR84), Ministerie van Veerkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, november 2006
Air Worldwide (20070112)	1	Air Worldwide, European Winter Storm Franz, first posting 12Jan2007, https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-franz/first-posting/ [FRANZ]
Air Worldwide (20070116)	1	Air Worldwide, European winter storm Per, 16Jan2007 10:30AM https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-per/first-posting/ [PER/HANNO]
BBC (20070111a)	1	BBC, England battered by wind and rain, 11Jan2007 16:43GMT news.bbc.co.uk/2/hi/uk_news/england/6251415.stm [FRANZ]
BBC (20070111b)	1	BBC, Search for Russian ship steward, 11Jan2007b, 1430GMT, news.bbc.co.uk/1/hi/uk_news/england/cornwall/6252609.stm [FRANZ]
BBC (20070111c)	1	BBC, Thousands hit by storm power cuts, 11Jan2007c (Thursday) http://news.bbc.co.uk/2/hi/uk_news/wales/6250925.stm [FRANZ]
BBC (20070112)	1	BBC News, Power restored as winds subside, Friday, 12 Jan 2007, 08:59GMT news.bbc.co.uk/2/hi/uk_news/wales/6254617.stm [FRANZ]
BBC (20070118a)	1	BBC News, Nine dead as UK struck by storms, 18Jan2007, http://news.bbc.co.uk/2/hi/uk_news/6272193.stm [KYRILL]
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Belfast Telegraph (20070111a)	1	Belfast Telegraph, Severe gales continue (contributor Colm Lenaghan and Victoria O'Hara), 11Jan2007a [FRANZ]
Belfast Telegraph (20070112a)	1	Belfast Telegraph, Ulster on alert as more high winds are forecast (contributor Matthew McCreary), 12Jan2007a. [FRANZ]
Belfast Telegraph (20070112b)	1	Belfast Telegraph, Navy continues its search for fishermen lost off Irish coast, 12Jan2007b, p2. [FRANZ]

Belfast Telegraph (20070112c)	1	Belfast Telegraph, Heavy rain set to continue as Portstewart harbour feels the force of stormy weather (contributor Mark Jamieson), 12Jan2007c, p2. [FRANZ]
Belfast Telegraph (20070119)	1	Belfast Telegraph, Killer storms claim 13 lives (PA Reporters and Deborah McAleese), p.4, 19Jan2007. [KYRILL]
Bottema (2007)	1	Bottema M, Zwaarste storm sinds 1990. Bijzondere golf- en waterhoogten IJsselmeer. Trendsinwater.nl. Monitoring van Nederlandse wateren: resultaten en ontwikkelingen. nummer 21, april 2007 [KYRILL]
Bradshaw (2007)	3	Bradshaw, Elizabeth (ed), Annual Report for 2007 for the UK National Tide Gauge Network and Related Sea Level Science, National Tide and Sea Level Facility, NERC 100017897 2007, p.2
Brugge (200701)	3	Brugge R, British Isles weather diary, Jan 2007, www.met.reading.ac.uk/~brugge/diary2007.html#200701
Dailey (2007)	3	Dailey, Peter, The 2006-2007 European winter storm season: winding down, March 7, 2007. http://www.air-worldwide.com/Publications/AIR-currents/The-2006-2007-European
Deutsche Rueck (2007)	3	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015]
DR (20070112)	1	DR, Storebaelts broen lukket paa grund af blaesten, 12Jan2007 https://www.dr.dk/nyheder/indland/storebaeltsbroen-lukket-paa-grund-af-blaesten [FRANZ]
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DW (20070119)	1	DW, Killer winds in Europe expected to cause heavy financial loss, 19Jan2007 (18Jan2007?) https://www.dw.com/en/killer-winds-in-europe-expected-to-cause-heavy-financial-loss/a-2317752 [KYRILL]
DW (20070120)	1	DW, Power cuts in Europe as continent begins to clean up, 20/01/2007, https://www.dw.com/en/power-cuts-in-europe-as-continent-begins-clean-up/a-2319624 [KYRILL]
DW (20070123)	1	DW, Hurricane causes massive damage to German forests, 23Jan2007, https://www.dw.com/en/hurricane-causes-massive-damage-to-german-forests/a-2323760
Eden (200703)	3	Eden, Philip, Weather Log January 2007, Weather, 62, pp.1-4, March 2007
EDP (20070111)	1	EDP, Motorists faced with flood shock, Eastern Daily Press, p16, 11Jan2007 [FRANZ]
EDP (20070112a)	1	EDP, County is battered by 61mph winds, Eastern Daily Press (contributor Katie Cooper), p.8, 12Jan2007a [FRANZ]
EDP (20070112b)	1	EDP, We want to see an end to our flooding misery, Eastern Daily Press, pp8-9, 12Jan2007b [FRANZ]
EDP (20070112c)	1	EDP, Sinking: family hit by third tragedy, Eastern Daily Press, p.6, 12Jan2007c. [FRANZ]
EDP (20070112d	1	EDP, Stricken ship could put lives at risk, Eastern Daily Press, p.6, 12Jan2007d. [FRANZ]
EDP (20070113a)	4	EDP, GBP 5m cut from flood budget, Eastern Daily Press, p1-2, 13Jan2007a
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EDP (20070118)	1	EDP, 70 mph winds expected to lash region, Eastern Daily Press (Contributor Chris Bishop), p1, 18Jan2007
EDP (20070119a)	1	EDP, Nine fatalities as savage storms disrupt Britain, Eastern Daily Press, p.5, 19Jan2007a
EDP (20070119b)	1	EDP, Beachcombers urged to watch out for turtles, Eastern Daily Press, p5, 19Jan2007b
EDP (20070119c)	1	EDP, Ship crew recoveringafter lifeboat airlift, Eastern Daily Press, p5, 19Jan2007c
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EDP (20070119j)	1	EDP, Weather damage like to cost millions, Eastern Daily Press, p5, 19Jan2007j
EDP (20070120)	1	EDP, The big clean-up after the storm, Eastern Daily Press, p11, 20Jan2007
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Evening Herald (20070111)	1	Evening Herald, Lost. Tragic end: last picture of doomed trawler with five crew (contributor Aoife Finneran), p.1, p.4, 11Jan2007. [FRANZ]
Evening Herald (20070112a)	1	Evening Herald, Family Torn Apart. Skipper of second trawler perishes leaving behind wife, 3 children (contributor Fionuala O'Leary and Jane Last), p.1,p.2 12Jan2007a [FRANZ]
Evening Herald (20070112b)	1	Evening Herald, Our 17 hours clinging to life in raft (contributor Jane Last), p.4, 12Jan2007b
Evening Herald (20070113)	1	Evening Herald, Tears as families hold lonely vigil (contributor Jane Last), 13Jan2007 [FRANZ]
FAZ (20070112)	1	Frankfurter Allgemeine Zeitung, Orkantief Franz wuetet ueber Europa, 12Jan2007
Financial Times (20070119)	1	Financial Times, Fourteen die as storms lash north Europe (reporter: William MacNamara), 19Jan2007 [KYRILL]
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FU-Berlin (20070312)	1	FU-Berlin, Lebensgeschichte. Tiefdruckgebiet Franz (getauft am 09.01.2007) (written on 12/03/2007 by R. Loewenherz), https://www.met.fu-berlin.de/wetterpate/lebensgeschichten/Tief_FRANZ_09_01_07.htm
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Irish Independent (20070111a	1	Irish Independent, A lonely waterside wait for crew's families, Irish Independent (contributor: Furlong, B and F Khan), p3, 11Jan2007a [FRANZ]
Irish Independent (20070111b)	1	Irish Independent, Five fishermen feared dead as trawler sinks, Irish Independent (contributor: Khan, F. and B. Farrelly), p1-2, 11Jan2007b [FRANZ]
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Recharge (20220201)	4	Recharge: Video. Rescue dash as rudderless cargo ship hits foundation at giant North Sea wind farm (contributor Andrew Lee), https://www.rechargenews.com/wind/video-rescue-dash-as-rudderless-cargo-ship-hits-foundation-at-giant-north-sea-wind-farm/2-1-1160591, 1 February 2022.
UKMO (2022)	3	UKMO, personal communication with Catherine Ross, UKMO, 2 Mar 2021. UKMO daily weather summaries at Digital Library and archive: https://digital.nmla.metoffice.gov.uk/collection_86058de1-8d55-4bc5-8305-5698d0bd7e13/
Wikipedia (20220322)	1	Wikipedia, Cyclone Kyrill, https://en.wikipedia.org/wiki/Cyclone_Kyrill, accessed 22Mar2022
Wikipedia (20220323)	1	Wikipedia, Cyclone Per, https://en.wikipedia.org/wiki/Cyclone_Per, accessed 23Mar2022
BBC (20230509)	4	BBC, Can a wind turbine handle hurricane speed winds? (contributor Chris Baraniuk) 09May2023 https://www.bbc.com/news/business-65261147
Danish Energy Agency (20230719)	4	Danish Energy Agency, Overview of the Energy Sector, last access 19Jul2023 https://ens.dk/en/our-services/statistics-data-key-figures-and-energy-maps/overview-energy-sector

Electrek (20230427)	4	Electrek, In a first, a cargo ship strikes an offshore wind turbine (contributor Michelle Lewis), 27Apr2023 https://electrek.co/2023/04/27/cargo-ship-offshore-wind-turbine/
IEA (20230605)	4	IEA, Electricity production, https://www.iea.org/reports/electricity-information-overview/electricity-production, last access 05 June 2023
Kystdirektoratet (20230309)	3	Kystdirektoratet, De 10 hojest maalte vandstande langs Vestkysten, https://kyst.dk/kyster-og-klima/stormflod-og-beredskab/historiske-stormfloder-paa-vestkysten/, last access 09Mar2023.

Notes:
[1] Type: 1=storm is main focus (or used as key example in general discussion); 2=1-4 case studies including the storm; 3=the storm is one of many case studies or mentioned only; 4=storm not mentioned; reference is included for background information

Table SL2. List of sources that could not be obtained (arranged by year and then alphabetically)

Source	Full Reference	Request results
DHI (1993)	DHI, Greater Ekofisk environmental design criteria study, Copenhagen, 1993.	Email from Vibeke Ewald Salmon on 27/01/2023 that the report is marked as confidential matieral Email from Vibeke Ewald Salmon on 27/01/2023 that the DHI libary had moved to new offices 3-4 years previously and that alot of old reportsremoved from archives
Haver (1993)	Haver, S, Extreme wave conditions for the Ekofisk area, Statoil, Stavanger, 1993	Email to Einar Nygaard of Equinor identifies internal Statoil report that is normally not released.
Magnusson (1993)	Magnusson, AK, Ekofisk Extreme Wave analysis, Preliminary Report, Technical Report Nr. 103, DNMI, Feb. 1993.	Email request sent to Per Helmer Skaali of met.no; he was was unable to find it in his library
Kvitrud (1994)	Kvitrud, Arne, Bolgeforholdene pa Ekofisk, note, 27/01/1994	Email from Arne Kvitrud on 29/12/2022 indicating that he does not have a copy of the report and to contact Gerhard Ersdal Email to Gerhard Ersdal on 27/01//2023 unanswered
Haver and Vestbostad (2001)	Haver, S. and T.M. Vestbostad, Uvaershelga utenfor Midt-Norge 10-11 november 2001, Statoil report PTT-KU-MA-024, 2001-11-23, 2001 (cited in Olagnon and Magnusson, 2004)	Email to Tone Vestbostad at Equinor unanswered.
Reistad and Magnusson (2002)	Reistad, M. and A.K. Magnusson, Extreme waves in the northern North Sea, Research Report No. 139, Norwegian Meteorological Institute, 2002	
Reistad et al (2003)	Reistad, M., A.K. Magnusson, D. Kvamme, Extreme waves at Haltenbanken, Research Report No. 156, Norwegian Meteorological Institute, 2003, statoil contract no. 4500572454, ISSN 0332-9879	

Table SL3. List of normal photos of event (arranged by year and then alphabetically)

Source	Full Reference and Notes
BBC (20070111a)	BBC, England battered by wind and rain, 11Jan2007a 16:43GMT news.bbc.co.uk/2/hi/uk_news/england/6251415.stm -FRANZ -FIG. [PHOTO] park in Huntingdon flooded when River Ouse burst banks -FIG. [PHOTO] Road users in Scarborough had to watch out for high waves -FIG. [PHOTO] man suffered head injuries when plank smashed his windscreen -FIG. [PHOTO] cars where crushed by falling trees in Kidderminster -FIG. [PHOTO] cars crushed by falling trees in Kidderminster
BBC (20070111c)	BBC, Thousands hit by storm power cuts, 11Jan2007c (Thursday) http://news.bbc.co.uk/2/hi/uk_news/wales/6250925.stm FIG. [PHOTO] Rail services were disrupted at Llanrwst where the track flooded FIG. [PHOTO] Wind tore the roof off this house at Nant Peris, Gwynedd
BBC (20070112)	BBC News, Power restored as winds subside, Friday, 12 Jan 2007, 08:59GMT news.bbc.co.uk/2/hi/uk_news/wales/6254617.stm -FRANZ FIG. [PHOTO] wind tore the roof off this house at Nant Peris, Gwynedd on Thursday
BBC (20070118a)	BBC News, Nine dead as UK struck by storms, 18Jan2007, http://news.bbc.co.uk/2/hi/uk_news/6272193.stm FIG. [PHOTO] Falling trees in high winds posed a hazard (photo: David Fergus) FIG. [PHOTO] Heavy rain and gusts have swept across much of UK FIG. [PHOTO] Scotland has seen first major snowfalls of the year
BBC (20070118b)	BBC, Huge storms sweep northern Europe, 18Jan2007, 2234GMT, http://news.bbc.co.uk/2/hi/europe/6274377.stm FIG1. [PHOTO] Huge waves pound port o Wimereaux, northern France FIG2. [PHOTO] Tree toppled on car with deaths listing: Britain 9, Germany 7, Netherlands 4, Czech 3, France 2
Belfast Telegraph (20070111a)	The Belfast Telegraph, Severe gales continue (contributor Colm Lenaghan and Victoria O'Hara), 11Jan2007a FIG. [PHOTO] Fallen tree in Ulster; Thousands of homes lose power in overnight storm; a falling tree causes traffic disruption on the Newry Road in Armagh this morning after heavy winds last night
Belfast Telegraph (20070119)	Belfast Telegraph, Killer storms claim 13 lives (PA Reporters and Deborah McAleese), p.4, 19Jan2007. FIG. [PHOTO] A lorry lies in a canal near Skipton after it left the road and overturned in high winds. Driver certified dead at the scene (John Giles/PA Wire) FIG. [PHOTO] A lorry lies on its side near Loughbrickland, Co. Armagh, as savage storms continue to sweep across the province
Bottema (2007)	Bottema M, Zwaarste storm sinds 1990. Bijzondere golf- en waterhoogten IJsselmeer. Trendsinwater.nl. Monitoring van Nederlandse wateren: resultaten en ontwikkelingen. nummer 21, april 2007 FIG2. [PHOTO] Onderlopen kade Lelystad-Parkhaven, 21/01/2007, waterstand ca. +50cm NAP

	(foto Marcel Bottema, RWS)
Deutsche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] -FIG_p5b.[PHOTO] (a) Fallen steel beam of window pain (b) deroofed house. Hurricane Kyrill caused immense damage across country on 18Jan2007 [source Lutherstadt Wittenberg] -FIG_p7. [PHOTO] Kyrill caused forest damage in Germany never previously seen
DW (20070118)	DW, Weather expert predicts more storms in coming winters, 18/01/2007, https://www.dw.com/en/weather-expert-predicts-more-storms-in-coming-winters/a-2317448 -FIG. [PHOTO] storm already flipped trailer truck in northern parts of Germany -FIG. [PHOTO] effects of storm already seen in Blackpool England; waves on breakwater -FIG. [SATELLITE] satellites have tracked Kyrill for days
DW (20070119)	DW, Killer winds in Europe expected to cause heavy financial loss, 19Jan2007 (18Jan2007?) https://www.dw.com/en/killer-winds-in-europe-expected-to-cause-heavy-financial-loss/a-2317752 -FIG. [PHOTO] Wind-damaged house -FIG. [PHOTO] Passengers stranded at stations slept where they could -FIG. [PHOTO] Berlin's new station took a battering from the storm -FIG. [PHOTO] Germany's autobahns became particularly treacherous; toppled transport truck -FIG. [PHOTO] Storm brought chaos to airports across country
DW (20070120)	DW, Power cuts in Europe as continent begins to clean up, 20/01/2007, https://www.dw.com/en/power-cuts-in-europe-as-continent-begins-clean-up/a-2319624 FIG1. [PHOTO] Fallen power mast during Kyrill [AP] FIG2. [PHOTO] storm damaged main train station in Berlin FIG3. [PHOTO] uprooted trees caused widespread damage
EDP (20070111)	EDP, Motorists faced with flood shock, Eastern Daily Press, p16, 11Jan2007 FIG. [PHOTO] Disruption: Traffic makes its way round a white car stuck in the floods on B1077/B1113 crossroads at New Buckenham yesterday (10Jan2007)
EDP (20070112a)	EDP, County is battered by 61mph winds, Eastern Daily Press (contributor Katie Cooper), p.8, 12Jan2007a FIG: [PHOTO] Road block: A fallen tree blocks the B1077 between Winfarthing and Old Buckenham FIG: [PHOTO] Felled tree: Lesley and Bob O'Hanlon at their home in Swanton Abbott FIG: [PHOTO] Windy walk: Barbara Pritchard struggles against wind at Snettisham beach
EDP (20070118)	EDP, 70 mph winds expected to lash region, Eastern Daily Press (Contributor Chris Bishop), p1, 18Jan2007 -FIG: Wind-blown: A couple braving the gusts on an already windy beach at Hunstanton yesterday 17Jan2007
EDP (20070119a)	EDP, Nine fatalities as savage storms disrupt Britain, Eastern Daily Press, p.5, 19Jan2007a FIG. [PHOTO] Battered. Spectacular waves crash over the promenade in Dover Kent, during height of yesterday's storms FIG. [PHOTO] A young Highland cow feels the chill in Scotland yesterday
EDP (20070119h)	EDP, Mayhem in wake of storms, pp.2-3, Eastern Daily Press, 19Jan2007h -FIG: [PHOTO] Yarmouth: Tesco store evacuated and closed while crews dealt with damaged sign at gates -FIG: [PHOTO] Tree fell on 3 parked vehicles behind Nationwide Auto Centre, Garden Street, Norwich -FIG: [PHOTO] Samantha von Daniken in rubble of her new antiques shop at Kettlestone -FIG: [PHOTO] firefighter prepares to dig a trench to drain flood water at Roughton garage
EDP (20070119i)	EDP, Storm chaos on the roads and railways, Eastern Daily Press (contributor: Lorna Marsh), p.4, 19Jan2007i. -FIG. [PHOTO] A truck overturned on the A140 just north of Swainsthorpe near Norwich -FIG. [PHOTO] Engineers work on overhead lines near Tivetshall St Margaret
EDP (20070120)	EDP, The big clean-up after the storm, Eastern Daily Press, p11, 20Jan2007 FIG. [PHOTO] Shattered remains: The debris of 2 beach huts at Heacham which were blown down by Thursday's strong winds
Evening Herald (20070111)	Evening Herald, Lost. Tragic end: last picture of doomed trawler with five crew (contributor Aoife Finneran), p.1, p.4, 11Jan2007. FIG. [PHOTO] night photo of Pere Charles before sinking FIG. [PHOTO] Waiting for news. Locals Tommy Power (left) and Pa O'Grady (right) wait on the pier for news of the trawlermen who are missing off the treacharous Wexford coast FIG. [MAP] Map of sinking sites off Hook Head since 2002: Maggie B Mar2005, Pisces Jul2002, Rising Sun Nov2005
Evening Herald (20070112a)	Evening Herald, Family Torn Apart. Skipper of second trawler perishes leaving behind wife, 3 children (contributor Fionuala O'Leary and Jane Last), p.1,p.2 12Jan2007a [FRANZ] FIG. [PHOTO] skipper of Honeydew II standing proudly with his family beside doomed vessel FIG. [PHOTO] relatives comfort each other after the worst ever Irish sea tragedy FIG. [PHOTO] Lost dad Ger Bohan
Evening Herald (20070112b)	Evening Herald, Our 17 hours clinging to life in raft (contributor Jane Last), p.4, 12Jan2007b FIG: [PHOTO] Cold and weary: Viktor Losev and Vladimir Kostyr warm bodies in Waterford rescue centre after dramatic ordeal
Evening Herald (20070113)	Evening Herald, Tears as families hold lonely vigil (contributor Jane Last), 13Jan2007 [FRANZ] FIG: [PHOTO] Family loss: a happier picture of Ger Bohan with his wife Mary and son Joseph in front of Honeydew II FIG: [PHOTO] Harrowing grief
FAZ (20070112)	Frankfurter Allgemeine Zeitung, Orkantief Franz wuetet ueber Europa, 12Jan2007 FIG. [PHOTO] car under fallen wall. Die umwerfende Wirkung des Orkantiefs Franz
Irish Independent (20070111b)	Irish Independent, Five fishermen feared dead as trawler sinks, Irish Independent (contributor: Khan, F. and B. Farrelly), p1-2, 11Jan2007b FIG1. [MAP] Map of Co Wexford showing Fethard & Hook Head; Pere Charles last known position

	FIG2. [PHOTO] People at Dunmore East harbour in Wexford wait for news of the fishing trawler Pere Charles which sent a distress signall yesterday. In the background is the Suzanna G which is believed to have been fishing with the missing trawler
KNMI (20070118)	KNMI, Nieuwsbericht, De zware storm Kyrill van 18 januari 2007, 17 januari 2007, https://www.knmi.nl/over-het-knmi/nieuws/de-zware-storm-kyrill-van-18-januari-2007 FIG2. [PHOTO] House at Westeinder hit by waves 18Jan2007
Met Eireann (200701)	Met Eireann, Monthly Weather Bulletin, No 249, Jan 2007 -FIG_p2d. [PHOTO] damaged British container ship Napoli
New York Times (20070119)	New York Times, Deadly wind and rain storm sweeps Europe, (Mark Landler) 19Jan2007, https://www.nytimes.com/2007/01/19/world/europe/19europe.html FIG. Waves at flooded port of Wimereux in France on Thursday [Philippe Huguen, Agence France-Presse] FIG. Truck overturned Gotha by fierce winds that also disrupted air and rail travel [Sasha Fromm, Thueringer Allgemeine] FIG. The Netherlands. Pedestrian clung to pillar for support against storm in Rotterdam [Robert Vos/Agence France-Presse] FIG. Scotland. A young Highland cow up to neck in icy snow [Andrew Millian, Press Association]
NLWKN (20070115)	NLWKN, Sturmflut am 12. Januar 2007: Nordseekueste kam glimpflich davon 12. Januar 2007 (aktualiert am 15. Januar 2007): Duenenabbrueche auf den ostfriesischen inseln https://www.nlwkn.niedersachsen.de/startseite/aktuelles/presse_und_offentlichkeitsarbeit/pressemitteilungen/-41838.html FRANZ FIG. [PHOTO] Der kleine Seehund auf Norderney am 12. Januar 2007 wieder tief durch FIG. [PHOTO] after storm surge on 12Jan2007, dunes on Norderney came trhough easily FIG. [PHOTO] still a problem: the Teekabfuhr after storm flooding. photo from Norderney
NLWKN (20070122)	NLWKN, Sturmflut von 19.Januar: Es kam nicht so schlimm wie befurchtet. 19.Januar2007: keine Duenenabbruche auf den Inseln/Fuer das Wochenende wird erhoehtes tidewasser erwartet, 22/01/2007 https://www.nlwkn.niedersachsen.de/startseite/aktuelles/presse_und_offentlichkeitsarbeit/pressemitteilungen/-41867.html FIG1. [PHOTO] After the storm surge on 18Jan2007; hardly any dune collapse on Juist FIG2. [PHOTO] After the storm surge on 18Jan2007; Juist easily withstood everything
Nyheder (20070121b	nyheder.tv2.dk, 540 skader efter lordagens storm, 21 Jan 2007, https://nyheder.tv2.dk/krimi/2007-01-21-540-skader-efter-loerdagens-storm FIG. [PHOTO] Regnskyl og storm skaber oversvommelse mellom Brorup og Vejen
MAIB (200804)	MAIB, Report on the investigation of the structural failure of MSC Napoli English Channel on 18 January 2007, Marine Accident Investigation Branch, Carlton House, Carlton Place, Southampton, UK, SO15 2DZ, Report No 9/2008, April 2008 -FIG3_p7. [PHOTO] MSC Napoli following structural failure -FIG5_p10. [PHOTO] MSC Napoli under tow -FIG6_p10. [PHOTO] MSC Napoli beached at Branscombe Bay
SMHI (20090806)	SMHI, Per - Januaristormen 2007, 6Aug2009, https://www.smhi.se/kunskapsbanken/meteorologi/per-januaristormen-2007-1.5287 -FIG3. [PHOTO] waves on shore at Langedrag at Goteborgs coast -FIG5. [PHOTO] Rodvalta? after storm Per, south Halland 26Jan2007 [photo: Hans Alexandersson]
Wetteronline (20070118)	Wetteronline, Orkan Kyrill tobt in Europa, 18Jan2007 22:00, https://www.wetteronline.de/wetterticker/orkan-kyrill-tobt-in-europa--UZiFNRdrmvxoC3RHqLLyU FIG. [PHOTO] Whole mountainsides blown down by violence of gusts (Wolfgang Schwarz) FIG. [PHOTO] Trees fell on the roads and blocked highways (Sasscha Engst) FIG. [PHOTO] Small river Emmer by Emmerthal im LK-Hameln-Pyrmont is running far outside banks
Wetteronline (20070118b)	Wetteronline, Schwere Schaeden nach Kyrill, https://www.wetteronline.de/wetterticker/schwere-schaeden-nach-kyrill--643tBpXGzIivrA8sEYH1EU (accessed 03Sep2022) FIG. [PHOTO] Trees whose trunks were not broken were simply uprooted [Wolfgang Schwarz] FIG. [PHOTO] Severe devastation occurred also in the high areas of Thueringer Waldes [Wolfgang Schwarz] FIG. [PHOTO] There were many cases of flooding following the hurricane [Alexander Wratolis] FIG. [PHOTO] Kyrill's gusts flattened complete forest areas in wide parts of the country like here near Ilmenau in Thueringen [Wolfgang Schwarz] FIG. [PHOTO] approx 25 ha forest was destroyed around Ilmenau alone [Wolfgang Schwarz] FIG. [PHOTO] Complete hillsides were mown down by violence of the gusts [Wolfgang Schwarz] FIG. [PHOTO] Trees thrown down like a huge game of jackstraws [Wolfgang Schwarz] FIG. [PHOTO] One continues to meet broad paths of devastation FIG. [PHOTO] Also in the Hohen Westerwald the hurricane left behind violent damage [Manuel Schuetz] FIG. [PHOTO] Pictures of destruction from the Wildpark at Bad Marienberg [Manuel Schuetz] FIG. [PHOTO] Also there trees were uprooted or broken off as far as the eye could see [Manuel Schuetz] FIG. [PHOTO] Broken off or uprooted trees characterize the picture also in Weserbergland [Alexander Wratolis] FIG. [PHOTO] The small river Emmer at Emmerthal in Kandkreis Hameln-Pyrmont stepped far over its banks [Alexander Wratolis] FIG. [PHOTO] Remains of a storm-destroyed Treibhaus (greenhouse?) FIG. [PHOTO] Brick wall damage in Rieder, Landkreis Quedlinburg, Harz [Harald Froitzheim]
Wikipedia (20220322)	Wikipedia, Cyclone Kyrill, https://en.wikipedia.org/wiki/Cyclone_Kyrill, accessed 22Mar2022 FIG. [PHOTO] Storm damage in Delft, Netherlands (snapped tree)

	FIG. [PHOTO] Felled power pylons caused widespread electricity damage -FIG. [PHOTO] Stranded travellers sleeping in an ICE train stopped at Wuerzburg station FIG. [PHOTO] fallen girder at Berlin Hbf FIG. [PHOTO] uprooted trees in forest in Balve FIG. [PHOTO] twisted traffic light in Danube area of upper Austria FIG. [PHOTO] windthrown tree in Wythenshawe Park, Manchester, England FIG. [PHOTO] windthrown tree after first stage of clearing up, Hale, Greater Manchester, England FIG. [PHOTO] forest on Lindenberg mountain above Ilmenau Germany was heavily damaged FIG. [PHOTO] Abiesconcolor subsp. lowianaroots in Botanic Garden in Wroclaw. Tree was overthrown by hurricane Kyrill night 18Jan2007. Age 65-70y FIG. [PHOTO] Young spruce group marginal windthrow area 12y after Kyrill Vogelsberg, Germany

Table SL4. Ranking of storm among events; assessing importance of storm (arranged by year and then alphabetically)

Source	Full Reference and Notes
Air Worldwide (20070112)	Air Worldwide, European Winter Storm Franz, first posting 12Jan2007, https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-franz/first-posting/ -AIR NWP-based Extratropical Cyclone Model for Europe -expect wind-associated losses to onshore properties not to be significant
Air Worldwide (20070116)	Air Worldwide, European winter storm Per, 16Jan2007 10:30AM https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-per/first-posting/ -SMHI: Per worst storm to hit country since Erwin 2005 -Erwin had previously caused substantial loss in UK and Denmark & big forest losses in Scandinavian countries other than Sweden -AIR NWP-based Extratropical Cyclone Model; AIR does not expect significant wind-loss to onshore properties
BBC (20070118b)	BBC, Huge storms sweep northern Europe, 18Jan2007, 2234GMT, http://news.bbc.co.uk/2/hi/europe/6274377.stm -highest winds UK since Jan 1990 -head of German railways said situation was unprecedented -German meteorologists said storm shaping up to be worst in 5y
Belfast Telegraph (20070119)	Belfast Telegraph, Killer storms claim 13 lives (PA Reporters and Deborah McAleese), p.4, 19Jan2007. -at least 13 people died in Britain's worst storm in 17y as another death reported today
Bottema (2007)	Bottema M, Zwaarste storm sinds 1990. Bijzondere golf- en waterhoogten IJsselmeer. Trendsinwater.nl. Monitoring van Nederlandse wateren: resultaten en ontwikkelingen. nummer 21, april 2007 -Lemmer on IJsselmeer: highest water level since measurement start in 1976 -Lelystad on IJsselmeer: water level during storm Kyrill was 15cm over previous record in 1976
Bradshaw (2007)	Bradshaw, Elizabeth (ed), Annual Report for 2007 for the UK National Tide Gauge Network and Related Sea Level Science, National Tide and Sea Level Facility, NERC 100017897 2007, p.2 -Franz rank1 max storm event for year in terms of true surge and absolute water level (rank 1 at Port Ellen only) -Franz rank1 min storm event for year in terms of true surge and absolute water level -Kyrill rank1 max storm event for year in terms of true surge and absolute water level (rank 1 at Harwich and Portpatrick) -Kyrill did no return any ranked min water levels -Lancelot rank1 max storm event for year in terms of true surge (Hinkley Point only) and rank2 event for absolute water level (Portrush) -Lancelot rank1 min storm event for year in terms of true surge and absolute water level (Millport and Portrush)
Brugge (200701)	Brugge R, British Isles weather diary, Jan 2007, www.met.reading.ac.uk/~brugge/diary2007.html#200701 -The 18th saw England & Wales experiencing the worst Atlantic storm since Jan 1990 [STORM KYRILL]
Dailey (2007)	Dailey, Peter, The 2006-2007 European winter storm season: winding down, March 7, 2007. http://www.air-worldwide.com/Publications/AIR-currents/The-2006-2007-European -SMHI: Per was worst storm since Erwin in 2005
Deutsche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] -for Germany Kyrill was strongest storm event of past 30y (probably ref to Capella 1976) -wind speed & extent of strong wind field make Kyrill strongest storm of last 30y
DW (20070118)	DW, Weather expert predicts more storms in coming winters, 18/01/2007, https://www.dw.com/en/weather-expert-predicts-more-storms-in-coming-winters/a-2317448 -Is the Kyrill low pressure system nothing but hot air when compared to the hurricanes and typhoons that occur in other regions of the world? -tropical cyclones naturally have stronger winds than this kind of non-tropical, low-pressure system. Hurricane winds can reach up to 300kph. -what we are experiencing now is an unusual development that only occurs in central Europe every few years.
DW (20070119)	DW, Killer winds in Europe expected to cause heavy financial loss, 19Jan2007 (18Jan2007?) https://www.dw.com/en/killer-winds-in-europe-expected-to-cause-heavy-financial-loss/a-2317752 -Kyrill had most powerful winds for about 30 year (reference to Capella?) -rail services halted; first time in history for Deutsche Bahn; trees on tracks
EDP (20070119h)	EDP, Mayhem in wake of storms, pp.2-3, Eastern Daily Press, 19Jan2007h -winds of nearly 80mph widespread and on par with 1987 storm
EDP (20070119i)	EDP, Storm chaos on the roads and railways, Eastern Daily Press (contributor: Lorna Marsh), p.4, 19Jan2007i. -Weatherquest, John Law: winds reached 78mph in Marham & Norwich International Airport 66mph -comparable or stronger than Oct1987 gale; storms were more widely spread
EDP (20070120)	EDP, The big clean-up after the storm, Eastern Daily Press, p11, 20Jan2007 -East Anglia 19Jan2007 recovering from worst storm in 17years

Financial Times (20070119)	Financial Times, Fourteen die as storms lash north Europe (reporter: William MacNamara), 19Jan2007 -Met Office: 'most notable event in recent memory' -Met Office: wind strength did not match 1987 hurricane but larger geographic area -wind speeds highest recorded in UK for 17y
Financial Times (20070120)	Financial Times, Insurers play down scale of storm damage claims, (reporter: William MacNamara), 20Jan2007 -Royal and Sun Alliance: not as bad as 1987 or 1990 (2bill GBP at time) -Royal and Sum Alliance: closest equivalent Carlisle storm of 2005; 250 mill GBP
KNMI (20070118)	KNMI, Nieuwsbericht, De zware storm Kyrill van 18 januari 2007, 17 januari 2007, https://www.knmi.nl/over-het-knmi/nieuws/de-zware-storm-kyrill-van-18-januari-2007 -KYRILL 3. Most severe storm in 5 years -Jeanett: previous most severe storm 27Oct2002 with avg wspd Bf 10 -Jeanett: avg wspd 101km/h & gust 148km/h stronger than Kyrill -worst storm of recent decades was 25Jan1990 (Daria) -Daria: 70? fatalities; avg wspd Bf 11
Kvamme (20070214)	Kvamme, Dag, Ekstremvaer nr.1/2007 - 'Per', Intern Rapport, met.no, 15pp, Meteorogisk Institutt met.no, Bergen, 14/02/2007 -PER/HANNO -captain said strongest wind he had been out in for 13y -boat lay out in the weather W of Kvitsoy, 4h of strong winds up to 40m/s; wave height 12-17m
Kystdirektoratet (2007)	Kystdirektoratet, Hojvandsstatistikker 2007, Extreme sea level statistics for Denmark, 2007, Kystdirektoratet, Dec, 2007. -KARLA: storm rank for any Danish tide gauge station rank 20 (Skagen): -FRANZ: storm rank for any Danish tide gauge station rank 2 (Kloster) -HANNO: storm rank for any Danish tide gauge station rank 3 (Skovlunde): -KYRILL: highest storm rank for any Danish tide gauge station rank 4 (Kobenhavn): 31Dec1921>26Dec1902>18Dec1921>19Jan2017
LCW (20070112)	Lloyds Casualty Week, 12Jan2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ -01Jan2007 storm -Danish police evacuated 2 apartment blocks outskirts Kiev 01Jan for fear they would collapse in high winds -faults in concrete construction of 12- and 14-storey structures built in mid-1950s -SMHI issued highest weather warning for country's southern tip, east of Skagen
LCW (20070202)	Lloyds Casualty Week, 02Feb2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ -Kyrill: UK storm was worst in 17y (since storm Daria 1990) -Kyrill: German rail system closed for first time in history -hurricane force winds left 14 dead Britain, 12 Germany, 6 Netherlands, 6 Poland, 4 Czech Republic, 3 France, 2 Belgium; highest storm death toll since 1999 when gales downed trees & driving snow brought avalanches that killed 120 in 3 days
Met Eireann (200701)	Met Eireann, Monthly Weather Bulletin, No 249, Jan 2007 -many Ireland met stations registered the highest windspeed/gust of the month during the storm -Dublin airport meas gust 80kt morning 18Jan2007; highest since station opening 1941; mean wspd53kt Bf11 -UKMO reported strongest winds since Jan1990
Mariners Weather Log (200708)	Mariners Weather Log, vol. 51, No. 2, Aug 2007, Marine Weather Review - North Atlantic Area, January through April 2007, Bancroft, GP, https://www.vos.noaa.gov/MWL/aug_07/northatlantic.shtml -' The period of January to April 2007 included an exceedingly stormy period of January and February, with February having the most hurricane-force events seen in any month by this author. After a peak of 15 such events in February, the frequency dropped during March and April, with the latter having one hurricane-force low.' -storm Hanno: during initial 24h central pressure dropped 28mb making this a meteorological bomb -storm Hanno: central pressure 950hPa S of Iceland made hurricane force low one of deepest of period
Mueller-Westermeier (2007)	Mueller-Westermeier, Gerhard, Beschreibung un klimatologische Bewertung des Orkantiefs "Kyrill", pdf properties: Title: Deutscher Wetterdients - Nationale Klimauberwachung, Author: Gerhard Mueller-Westermeier, Subjet: Orkan Kyrill, datestamp: 26Jan2007 -rank 2 for wind gust of 25 focus storms in Germany 1990-2007 (56.3m/s at Wendelstein) -rank 4 for daily ppt of 25 focus storms in Germany 1990-2007 (89.7mm at Brocken)
New York Times (20070119)	New York Times, Deadly wind and rain storm sweeps Europe, (Mark Landler) 19Jan2007, https://www.nytimes.com/2007/01/19/world/europe/19europe.html -Burkhard Kirsch, meteorologist at DWD: worst storm since 2002
NLWKN (20070115)	NLWKN, Sturmflut am 12. Januar 2007: Nordseekueste kam glimpflich davon 12. Januar 2007 (aktualiert am 15. Januar 2007): Duenenabbrueche auf den ostfriesischen inseln https://www.nlwkn.niedersachsen.de/startseite/aktuelles/presse_und_offentlichkeitsarbeit/pressemitteilungen/-41838.html -FRANZ storm surge water levels most serious since Storm Britta 1Nov2006
Nyheder (20070121b)	nyheder.tv2.dk, 540 skader efter lordagens storm, 21 Jan 2007, https://nyheder.tv2.dk/krimi/2007-01-21-540-skader-efter-loerdagens-storm -LANCELOT: 600 Falck damage reports compared with 100 for Storm Hanno
RWS (200701a)	RWS, Verslag van de stormvloed van 11 en 12 januari 2007 (SR85), Ministerie van Veerkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007a -classified as a low storm surge -not necessary to close storm surge barriers -storm surge not exceptional; recurrence frequency 43 to 24 times per 100y -Appendix 11.Highest wave periods 1979-2002: Scheur west wandelaar (rank>50), Euro platform (no data), IJmuiden munitiestortplaats (rank>50),

	Eierlandse gat (rank>50), Schiermonnikoog noord (rank 26) Appendix 12.Highest significant wave heights 1979-2002 - Scheur west wandelaar (rank>50), Euro platform (no data), IJmuiden munitiestortplaats (rank=23), Eierlandse gat (rank=36), Schiermonnikoog noord (rank=12)
RWS (200701b)	RWS, Verslag van de stormvloed van 18 en 19 januari 2007 (SR86), Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007 -water levels not extraordinary; 36 to 20 times per 100 year (surge event localized to Den Helder & Harlingen) -APPENDIX10. High water levels after 1900 (Den Helder & Harlingen aafter 1932) (NOTE: info up to 2002 only): Den Helder rank 14; Harlingen rank11; other basis stations below rank 50 -APPENDIX11. Globally corrected wave periods after 1976 (NOTE: info up to 2002 only): IJmuiden munitiestortplaats 10.1s at rank17; Eierlandse gat 10.0s at rank 14; other stations below rank 50 -APPENDIX12. Globally corrected significant wave height: IJmuiden munitiestortplaats 5.82m at rank14; Eierlandse gat 7.03m at rank 3; other stations below rank 50
Swiss Re (2007)	Swiss Re, Sigma, Natural catastrophes and man-made disasters in 2007: high losses in Europe, No1., 2007. authors: Rudolf Enz, Kurt Karl, Jens Mehlhorn, Susanna Schwarz -Kyrill rank 3 European storm after Daria and Lothar -Kyrill rank1 insurance loss 2007
Tetzlaff (2007)	Tetzlaff, G, Der Orkan Kyrill, INFO, DKKV Deutsches Komitee Katastrophenvosorge e.V., pp.1-2, Februar/Maerz 2007, No. 1+2/2007 -wind speeds at the level of a 50y event -5y return period events will cause building damage
UKMO Daily Weather Summary (200701)	UKMO Daily Weather Summary 01-31Jan2007, UK MetOffice [pdf document properties: author=jan.freeman; datestamp=23/04/2015] -wind was headline maker -severe W to SW gale across England, Wales, N Ireland; widespread gusts 70-80mph -significant disruption and some loss of life -Heathrow gust 77mph; 2mph higher than 1987 storm
Unwetterzentrale_Kyrill (200701a)	Unwetterzentrale, Orkantief KYRILL - 18., 19.01.2007 (Tief Nr. 33) - Der schwerste Orkan seit Jahrzehnten, analysis by Manfred Spatzierer, Thomas Sävert, Stefan Laps, www.unwetterzentrale.de/uwz/348.html -Kyrill: worst large scale event in 20y -Kyrill: forest loss comparable with Storm Lothar Dec1999
Unwetterzentrale_Kyrill (200701b)	Unwetterzentrale, Orkantief KYRILL: Ausführliche Analyse der Wetterlage,www.unwetterzentrale.de/uwz/355.html, page accessed 21Aug2022. -pressure difference between St Peter Ordning 973hPa and Oberrhein Stuehlingen 1015hPa was 42hPa -such a large pressure difference had not been observed in central Europe for many years -Pressure difference Vivian Feb1990 at 37hPa; Anatol Dec1999 at 44hPa; Jeanett Oct2002 at 41hPa -DB shuts down operations 1700 because of storm first time in countrywide history -Also in Poland, Tschechien, Austria, Switzerland hurricane noteworthy at night -at one point wind gust record at Wolfsegg in Austria 148km/h -lowland stn near Wien at 146km/h; previous record from winter 1946
Unwetterzentrale_Kyrill (200701c)	Unwetterzentrale, Orkantief KYRILL: Vorhersagbarkeit des Ereignisses und Warnmanagement der Unwetterzentrale, www.unwetterzentrale.de/uwz/356.html (downloaded 20220916) -UWZ had not previously experienced such conditions of strong rain -for UWZ Germany, it was highest warning level since founding in Jan2003 -on evening 18Jan2007 there was max of 1084 Landkreis warnings of storm, heavy rain, thunderstorms -previous record 30-31Dec2005 had 1050 warnings for storm/heavy rain/heavy snowfall, freezing rain
Wetteronline (20070118)	Wetteronline, Orkan Kyrill tobt in Europa, 18Jan2007 22:00, https://www.wetteronline.de/wetterticker/orkan-kyrill-tobt-in-europa--UZiFNRdrmvxoC3RHqLLyU -Kyrill counts under hurricane series in winter 1990 & Lothar Dec 1999 as most serious storm occurrence in Germany of last 20 year
Wetteronline (20070118b)	Wetteronline, Schwere Schaeden nach Kyrill, https://www.wetteronline.de/wetterticker/schwere-schaeden-nach-kyrill--643tBpXGzIivrA8sEYH1EU (accessed 03Sep2022) -Kyrill counts under hurricane series in winter 1990 & Lothar Dec 1999 as most serious storm occurrence in Germany of last 20 year
Jensen and Mueller-Navarra (2008)	Jensen J, SH Mueller-Navarra, Storm surges on the German coast, Die Kueste, 74 ICCE (2008), 92-124. -Storm Kyrill was forecast as a worst case scenario with a wind setup of 4-5m; actual surge much lower
Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -Kyrill rank 1/10 for number NCEP1 grid points > 98th percentile threshold -Kyrill rank 1/10 for damage parameter (wind speed over threshold cubed) -Kyrill rank 5/10 for miimum central pressure -Kyrill rank 4/10 for maximum pressure gradient.
SMHI (20090806)	SMHI, Per - Januaristormen 2007, 6Aug2009, https://www.smhi.se/kunskapsbanken/meteorologi/per-januaristormen-2007-1.5287 -PER/HANNO: Sweden wind gust return period 20-50 year; Eggegrund wind gust return period >50y -new record significant wave height at Vaderoarna -rank 4 forst loss storm since 1930s
Tetzlaff (2009)	Tetzlaff, G., Extreme rain and wind storms in the mid-latitudes I, Singapore, 21-22.04.2009. https://imsarchives.nus/edu.sg/oldwww/Programs/09fluidss/files/Gerd Tetzlaff.pdf (Spring School on Fluid

	Mechanics and Geophysics of Environmental Hazards, Singapore, April 19-May 2, 2009) [pdf datestamp: 14/05/2009] -remarkable gust measured at Duesseldorf airport; 100y return period event
Gardiner (2010)	Gardiner, Barry, Appendix 3: Background information on 11 storms selected for detailed analysis, European Forest Institute, Atlantic European Regional Office - EFIAtlantic, 161 pp. [PDF properties: datestamp 23Jul2010] -storm 17-18Jan2007 brought much destruction to to N Europeans -Storm Kyrill not exceptional storm for the Netherlands -record temperature high of 14C in Prague -one of most violent and destructive storms in more than century with 53 killed -storm warnings in many countries in western, central & northern Europe -Kyrill knocked over more trees than Lothar Christmas 1999 -temperature in warm sector increased to 13-16C, establishing new record *-big ppt: Berlin had 25L/m2; Berlin-Dahlem registed 40.6 L/m2 avg over 24h January record precipitation amount; also highest of any single winter month
Donat et al (2011)	Donat MG, T Pardowitz, GC Leckebusch, U Ulbrich, O Burghoff, High resolution refinement of storm loss model and estimation of return periods of loss-intensive storms over Germany, Nat Hazards Earth Syst Sci, 11, 2821-2833, 2011 -Kyrill ranked 1 of 34 storm events in insurance database from 1997-2008 -Kyrill ranked 2 of 30 in VGV_sim insurance records from 1984-2008 -Kyrill ranked 7 of 30 for insurance losses in Germany in NCEP storm database from 1948-2009
Magnusson (2011)	Magnusson, Ann Karin, True sea state ...? Comparing different sensors and analyzing techniques, 12th Wave Workshop, Hawaii's Big Island, Oct.30-Nov4, 2011 (32 slides) -FRANZ & PER/HANNO & LANCELOT exceeded 9m threshold for EXWW storm -KYRILL did not have important wave field -all storms of the Jan2007 less than 2 top-ranked storms of 2007-2008: 18Mar2007 & 08Nov2007 (TILO)
Munich Re (2013)	Munich RE, Natural catastrophes in Germany 1970-2012, Muenchener Rueckversicherung-Gesellschaft, Geo Risks Research, NatCatSERVICE - as of January 2013 -Kyrill was rank1 event for storms in period 1970-2013 for overall loss and insured loss -rank10/14 event for fatalities
DWD (20120116)	DWD, 18.Januar 2007: Windfeld von Kyrill ueber Deutschland. Rueckblick auf einen der bisher schwersten Orkane, Pressemitteilung, Deutscher Wetterdienst, Offenbach, 16. Januar 2012. -described as 20y storm event -comparable to Jeanette Oct2002 -storm area larger than Lothar Dec1999 but Lothar had stronger winds in southern Germany -rail services stoped across Germany for the first time since WWII
Esurge (20121111)	Esurge_2007_kyrill(2012), Triple storm even (2007), Philip Harwood, Sun, 2012/11/11 15:04 -highest wind gust 81kt (150km/h) at Belmullet Co Mayo, highest gust since 1999
AON Benfield (2013)	AON Benfield, Historie von 1703 bis 2012: Winterstuerme in Europea, Stand: Januar 2013 -Kyrill similar to hurricane series winter 1990 and Hurricane Lothar Dec1999 as one of worst storm occurrences in Germany over 20y -damage assessed as 20-30y event -insured damage in Germany assessed at 2.8billion EUR (indexed to year 2012) -rank 1/21 storm for insured losses Germany in list from 1972-2013
NTLSF (2013)	NTSLF, Skew surge history, https://ntslf.org/storm-surges/skew-surges/scotland, https://ntslf.org/storm-surges/skew-surges/england-east, https://ntslf.org/storm-surges/skew-surges/england-south, https://ntslf.org/storm-surges/skew-surges/england-wales, https://ntslf.org/storm-surges/skew-surges/england_west, https://ntslf.org/storm-surges/skew-surges/isle-of-man, https://ntslf.org/storm-surges/skew-surges/northern-ireland, https://ntslf.org/storm-surges/skew-surges/channel-islands (accessed 10Nov2021) -NOTE 22 stations with ranked surges -rank 7 surge Wick (Franz) -rank 6 surge Leith (Franz) -rank 6 surge Whitby (Franz) -rank 9 surge Immingham (Franz) -rank 3 surge Cromer (Franz) -rank 9 surge Felixstowe (Franz) -rank 3 surge Harwich (Franz) -rank 7 surge Hinkley Point (Kyrill) -rank 8 surge Avonmouth (Kyrill) -rank 4 surge Barmouth (Kyrill) -rank 5 surge Holyhead (Hanno) -rank 1 surge Llandudno (Hanno) -rank 2 surge Liverpool (Hanno) -rank 8 surge Liverpool (Franz) -rank 9 surge Heysham (Franz) -rank 8 surge Workington (Franz) -rank 4 surge Port Erin (Franz) -rank 7 surge Port Erin (Kyrill) -rank 2 surge Millport (Kyrill) -rank 6 surge Port Rush (Franz) -rank 8 surge Port Ellen (Franz) -rank 9 surge Tobermory (Franz) -rank 3 surge Ullapool (Franz) -rank 1 surge Kinlochbervie (Franz)
Kristandt et al (2014)	Kristandt, J., B. Brecht, H. Frank, H. Knack, Optimization of empirical storm surge forecast-modeling of high resolution wind fields, Die Kuste, 81, 301-348, 2014

	-Storm Franz rank24 with return period 2.04y -Storm Kyrill rank38 with return period 1.29y
Petroliagis and Pinson (2014)	Petroliagis TI and P Pinson, Early warnings of extreme winds using the ECMWF Extreme Forecast Index, Meteorological Applications, 21, 171-185, 2014. *FIG7. Time series of daily max wind speed values for Hannover over the period 2374 days (1Dec2003 to 31May2010) in Reanalysis mod. Peak values corresponding to Kyrill, Emma, Herbert and Xynthia storms are highlighted. -Kyrill was the worst storm of the data segment
Roberts et al. (2014)	Roberts JF, AJ Champion, LC Dawkins, KI Hodges, LC Shaffrey, DB Stephenson, MA Stringer, HE Thornton, DB Youngman, The XWS open access catalogue of extreme European windstorms from 1979 to 2012, Nat. Hazards Earth Syst. Sci, 14, 2487-2501, 2014 -rank 3 insurance losses after Daria and Lothar
Statistica (20151208)	Statistica, The costliest winter storms ever to hit Europe. Fatalities and financial losses of Europe's 10 costliest winter storms (source Munich Re), 08Dec2015 -rank 2 of 10 worst European winter storms ever in terms of insurance losses
Vlaamse Hydrografie (2016)	Vlaamse Hydrografie, Overzicht van de tijwaarnemingen langs de Belgische kust. Periode 2001-2010 voor Nieuwpoort, Oostende en Zeebrugge. Ministerie van de Vlaamse Gemeenschap, Agentschap Maritieme Dienstverlening en Kust, Afdeling Kust, Vlaamse Hydrografie, Oostende [pdf properties: author=beirenro; datestamp 24Feb2016] -no Jan2007 storms were ranked; Tilo was worst storm of 2007
Pantillon et al (2017)	Pantillon, F., P. Knippertz, U. Corsmeier, Revisiting the synoptic-scale probability of severe European winter storms using ECMWF ensemble reforecasts, Nat. Hazards Earth Syst. Sci., 17, 1795-1810, 2017. -Kyrill rank 1 for area affected by gusts and rank 4 for SSI
Tatge (2017)	Tatge, Yorn, Kyrill the winter storm that walloped most of Europe, https://www.air-worldwide.com/blog/posts/2017/1/kyrill-the-winter-storm-that-walloped-most-of-europe/, Verrisk, 19Jan2017 -insured loss for Kyrill >7bill USD in present day 2017 dollars -among 40 greatest insurance losses of al time -except for Daria 1990 no event caused as much damage in 30y -Kyrill met 2 of 3 criteria for extreme European loss event - intensity, size, location (it did not have extreme intensity) -economic losses Kyrill USD 12 bill (2016 values); > half borne by insurance industry
Environment Agency (2018)	Environment Agency, Thames Barrier Project Pack 2018, January, 2018. Environment Agency. Thames Barrier View Cafe and Information Centre, 1 Unity Way, Woolwich, London, SE18 5NJ. email: thamesbarrierenquiries@environment-agency.gov.uk. -22Jan2007 Thames barrier Southend water level 4.04m, rank2 event (after Storm Xaver 2013), return period 17.46y -18Jan2007 Thames barrier Southend water level 3.76m, rank21 event, return period 1.66y -27Jan2007 Thames barrier Southend water level 3.72m, rank27 event, return period 1.29y -highest water levels since opening of Barrier in 1983 for 22Jan2007 event
Wikipedia (20070322)	Wikipedia, Cyclone Kyrill, https://en.wikipedia.org/wiki/Cyclone_Kyrill, accessed 22Mar2022 -described as once in decade event
Kystdirektoratet (20230309)	Kystdirektoratet, De 10 hojest maalte vandstande langs Vestkysten, https://kyst.dk/kyster-og-klima/stormflod-og-beredskab/historiske-stormfloder-paa-vestkysten/, last access 09Mar2023. -Thyboron rank5 water level (FRANZ)

Table SL5. Severe forecast (arranged by year and then alphabetically)

Source	Full Reference and Notes
BBC (20070111c)	BBC, Thousands hit by storm power cuts, 11Jan2007c (Thursday) http://news.bbc.co.uk/2/hi/uk_news/wales/6250925.stm -BBC meteorologist: warned of more wind and rain on Friday but not as severe
Deutsche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] -DWD had precise forecast of storm >1 week in advance -alot of advance warning, unique circumstance -DWD broadcast storm warning for entire country
DW (20070118)	DW, Weather expert predicts more storms in coming winters, 18/01/2007, https://www.dw.com/en/weather-expert-predicts-more-storms-in-coming-winters/a-2317448 -DWD criticized for incorrect weather predictions since 1999 storm Lothar with 6.4 bill EUR across Europe. Has DWD become more careful about issuing warnings? -DWD has not changed tactics or threshold levels -for Kyrill, we could give very early warning -result clearly forecast by weather models few days in advance -other situations, particularly in summer when this is impossible
EDP (20070111)	EDP, Motorists faced with flood shock, Eastern Daily Press, p16, 11Jan2007 -Chris Bell, Weather quest: 15-20mm rain over day; in winter not much evaporation; not much rain needed for flooding -Chris Bell: new weather from 11Jan2007 bringing gale force winds 50mph on coast
EDP (20070112a)	EDP, County is battered by 61mph winds, Eastern Daily Press (contributor Katie Cooper), p.8, 12Jan2007a -another 10days of wind & rain predicted last night 11Jan2007 after Norfolk faced day of power cuts & road closures -windy weather expected to continue until 22Jan2007
EDP (20070118)	EDP, 70 mph winds expected to lash region, Eastern Daily Press (Contributor Chris Bishop), p1, 18Jan2007 -winds gusting up to 70 mph could lash East Anglia today; warning snow to follow -Norfolk coast expected to be worst hit; mild weather to be followed by cold snap; first snow of winter

	-John Law, Weatherquest: similar to storm last Thursday, strong winds, gusts 50-60mph, 70mph on coast -winds should ease through Thursday night; Friday will be a settled day -damage to property likely; drivers of high-sided vehicles & motorcycles advised to take care -next week widespread frosts and risk of snow over northern & eastern parts of country may cause problems on roads -Steve Grundell, West Norfolk council district emergency planning manager: strongest winds 9-12 -gust to 68mph during Storm Franz -temperatures expected to fall sharply over weekend -John Law: 1 or 2 snow showers in the week, perhaps Sunday night into Monday -Met Office: first potentially disruptive snowfall of winter; eastern & northern parts of UK early next week -temperatures will plummet with widespread frosts -Met Office: potential blizzards in north and northwest Norfolk; inland areas with severe frosts & icy roads -Steven Davenport, Meteogroup: January has been very warm so far -no flood warning on the coast or any of East Anglia's rivers last night -predominantly SW winds expected to push tide away from vulnerable areas of coastline
EUMETSAT (20070117)	EUMETSAT, Winter storm Kyrill leaves a trail of destruction, 17 Jan2007 1500UTC, https://www.eumetsat.int/winter-storm-kyrill-leaves-trail-destruction (authors: Jochem Kerkmann & Hans Peter Roesli (EUMETSAT); Maria Putsay (Hungarian Meteorological Service); Martin Setvak & Petr Novak (CHMI)) -KYRILL -storm had been very well predicted by NWP models & severe wind warning issued in time -4-panel image gallery; Meteosat-8 played crucial role in early detection of rapidly dev storm -Rapid cyclogenesis conceptual model: cloud pattern E of Newfoundland that became Kyrill
Kvamme (20070214)	Kvamme, Dag, Ekstremvaer nr.1/2007 - 'Per', Intern Rapport, met.no, 15pp, Meteorogisk Institutt met.no, Bergen, 14/02/2007 -comparison of forecasts by 3 models at 60h, 36h, 12h in advance of storm -location of low P centre too far south in Skagerrak in 60h forecasts of two models with highest resolution -severe weather warning broadcast in advance of the event
NLWKN (20070122)	NLWKN, Sturmflut von 19.Januar: Es kam nicht so schlimm wie befurchtet. 19.Januar2007: keine Duenenabbruche auf den Inseln/Fuer das Wochenende wird erhoehtes tidewasser erwartet, 22/01/2007 https://www.nlwkn.niedersachsen.de/startseite/aktuelles/presse_und_offentlichkeitsarbeit/pressemitteilungen/-41867.html -forecast windspeed Norderney 120km/h; actual measurement 80km/h
RWS (200701b)	RWS, Verslag van de stormvloed van 18 en 19 januari 2007 (SR86), Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007 -SVSD 6h advance surge forecast higher than measurements for all stations except Den Helder & Harlingen
Stern (20070111)	Stern, Orkantief "Franz" Schwerer Sturm über Deutschland, 11Jan2007, 21:30 https://www.stern.de/panorama/orkantief--franz--schwerer-sturm-ueber-deutschland-3359640.html -DWD: Thursday bad weather warning for almost all states
Tetzlaff (2007)	Tetzlaff, G, Der Orkan Kyrill, INFO, DKKV Deutsches Komitee Katastrophenvosorge e.V., pp.1-2, Februar/Maerz 2007, No. 1+2/2007 1.4. Development of Kyrill was textbook case -theoretical foundation for weather development well understood -precise forecast for weather in Germany already from 15Jan -16Jan Tuesday storm warnings on media; time and strength of storm and strong rain -17Jan evening: announced school closures for several states
Unwetterzentrale Franz (200701)	Unwetterzentrale, Orkantief FRANZ - 11.,12.01.2007 (Tief Nr. 29), prepared by Manfred Spatzierer and Stefan Laps http://www.unwetterzentrale.de/uwz/347.html -the sudden development and location of the hurricane low in 24h correctly predicted by all national and international prognosis models at early time -pre and acute warnings of storm field were already issued by UWZ for preceding Dieter storm on night 10Jan -hurricane gusts of 110km/h predicted for passage of hurricane Franz on Jan 11 -orange and red warnings issued on evening of 10Jan and 11Jan -lability parameter Lifted Index and KLA at 500 & 850 hPa well characterized -predicted wind speeds over 56km/s from surface to 2km height; shower and thunderstorm potential behind the trough; significant tornado potential -UWZ meteorologists several days before event warned of danger of danger of extensive storms
Unwetterzentrale Kyrill (200701)	Unwetterzentrale, Orkantief KYRILL - 18., 19.01.2007 (Tief Nr. 33) - Der schwerste Orkan seit Jahrzehnten, analysis by Manfred Spatzierer, Thomas Sävert, Stefan Laps, www.unwetterzentrale.de/uwz/348.html -early storm forecast available
Unwetterzentrale_Kyrill (200701c)	Unwetterzentrale, Orkantief KYRILL: Vorhersagbarkeit des Ereignisses und Warnmanagement der Unwetterzentrale, www.unwetterzentrale.de/uwz/356.html (downloaded 20220916) -Hurricane Kyrill forecast 132h by the forecast model of UKMO before actual appearance -meteorologists of Unwetterzentrale UWZ gave storm warning 3-4 day before hand on basis of consistent model outputs -30-36h beforehand UWZ-Mets warned of danger of inland hurricane -at this time models were not totally sure of exact intensity
Jensen and Mueller-Navarra (2008)	Jensen J, SH Mueller-Navarra, Storm surges on the German coast, Die Kueste, 74 ICCE (2008), 92-124. -Storm Kyrill was forecast as a worst case scenario with a wind setup of 4-5m; actual surge much lower
Behrens and Guenther (2009)	Behrens, A. and H. Guenther, Operational wave prediction of extreme storms in Northern Europe, Nat. Hazards, 49, 387-399, 2009 -good advance forecast: '...the main feature has been predicted by the LSM already 42 h in advance and shows therefore again the capability of the wave forecast system...' -negative feature of advance forecast: 42h advance forecast west winds were too high and wave model predicted SWH too high at 8m

Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -'contrary to Lothar, Kyrill was well-predicted days in advance' -'Kyrill appeared on a weathr map over the Southern Mississippi valley about 4 days before it hit Europe'
Petroliagis and Pinson (2014)	Petroliagis TI and P Pinson, Early warnings of extreme winds using the ECMWF Extreme Forecast Index, Meteorological Applications, 21, 171-185, 2014. -extreme wind conditions could be forecast 5.5 days in advance; other storms Herbert and Xynthia could not be forecast well so far in advance
DWD (20120116)	DWD, 18.Januar 2007: Windfeld von Kyrill ueber Deutschland. Rueckblick auf einen der bisher schwersten Orkane, Pressemitteilung, Deutscher Wetterdienst, Offenbach, 16. Januar 2012. -storm predicted far in advance from the point of explosive deepening near Newfoundland
Lange (2017)	Lange, Ingo, Der Sturm "Kyrill" von 18. Januar 2007, 28Mar2017 https://wettermast.uni-hamburg.de/frame.php?doc=Sturm20070118.htm -atmospheric pressure down to 972.9hPa; lowest since measurement start 1995 -5min avg wind speed 20m/s & 30m/s at 250m height; values only occasionally seen previous years
Lockwood et al (2022)	Lockwood, J.F, Guentchev, G.S., Alabaster, A., Brown, S.B., Palin, E.J., Roberts, M.J., and Thornton, H.E.: Using high-resolution global climate models from the Primavera project to create a European winter windstorm event set, Nat. Hazards Earth Syst. Sci., 22, 3585-3606, https://doi.org/10.5194/nhess-22-3585-2022, 2022 -Kyrill rank 3 European winter storm insurance loss in storm list 1970-2018 -full ranked list is Daria 1990 > Lothar 1999 > Kyrill 2007 > 87J 1987 > Vivian 1990

Table SL6. Storm not as bad as expected; not as bad as it could have been (arranged by year and then alphabetically)

Source	Full Reference and Notes
Air Worldwide (20070112)	Air Worldwide, European Winter Storm Franz, first posting 12Jan2007, https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-franz/first-posting/ -AIR NWP-based Extratropical Cyclone Model for Europe -expect wind-associated losses to onshore properties not to be significant
Air Worldwide (20070116)	Air Worldwide, European winter storm Per, 16Jan2007 10:30AM https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-per/first-posting/ -AIR NWP-based Extratropical Cyclone Model; AIR does not expect significant wind-loss to onshore properties
Belfast Telegraph (20070112a)	The Belfast Telegraph, Ulster on alert as more high winds are forecast (contributor Matthew McCreary), 12Jan2007a. -FRANZ -night 11-12Jan2007 relatively calm; all power from 11Jan restored & no new outages overnight -no reports this morning of blocked roads; websites indicated ferries and planes on schedule
Dailey (2007)	Dailey, Peter, The 2006-2007 European winter storm season: winding down, March 7, 2007. http://www.air-worldwide.com/Publications/AIR-currents/The-2006-2007-European -Kyrill met 2/3 crit for extreme Europ loss event: (intensity), size, location -low intensity storm: London wspd 126kph instead of 160kph for Daria for 1999 Lothar -if Kyrill had Daria wind, insured losses >10 billion -if Kyrill had Lothar wind, insured losses >40 billion -BRITTA: storm did not reach parts of Europe with signif conc of insured properties (S UK, N France, Benelux, Germany)
Deutsche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] -BSH gave warnings of a heavy storm surge on North Sea coast -highest wind was at low water, so no dangerous surge developed
DR (20070112)	DR, Storebaelts broen lukket paa grund af blaesten, 12Jan2007 https://www.dr.dk/nyheder/indland/storebaeltsbroen-lukket-paa-grund-af-blaesten -FRANZ -generally one would say that the night's storm was not so dramatic as most had feared -there were toppled trees that councils will attempt to remove in the morning
DW (20070118)	DW, Weather expert predicts more storms in coming winters, 18/01/2007, https://www.dw.com/en/weather-expert-predicts-more-storms-in-coming-winters/a-2317448 -Is the Kyrill low pressure system nothing but hot air when compared to the hurricanes and typhoons that occur in other regions of the world? -tropical cyclones naturally have stronger winds than this kind of non-tropical, low-pressure system. Hurricane winds can reach up to 300kph. -what we are experiencing now is an unusual development that only occurs in central Europe every few years.
Financial Times (20070120)	Financial Times, Insurers play down scale of storm damage claims, (reporter: William MacNamara), 20Jan2007 -Royal and Sun Alliance: not as bad as 1987 or 1990 (2bill GBP at time) -Royal and Sum Alliance: closest equivalent Carlisle storm of 2005; 250 mill GBP -ABI: claim from 18Jan2007 storm typically run into low 100s millions -small claims for roof-tile damage, broken chimneys, car can be settled promptly -country had restored almost all vital services by yesterday evening 19Jan ->1000 obstructions on British rails -79% of Friday morning trains ran on time
FAZ (20070112)	Frankfurter Allgemeine Zeitung, Orkantief Franz wuetet ueber Europa, 12Jan2007 -light damage by storm surge in Hamburg -Police assessed light weather damage

Herald (20070112)	The Herald, Disaster averted as drifting ship misses North Sea platforms, 12Jan2007 https://www.heraldscotland.com/default_content/12754075.disaster-averted-drifting-ship-misses-north-sea-platforms/ -ship Vindo lost power and almost collided with 2 rigs in North Sea
KNMI (20070118)	KNMI, Nieuwsbericht, De zware storm Kyrill van 18 januari 2007, 17 januari 2007, https://www.knmi.nl/over-het-knmi/nieuws/de-zware-storm-kyrill-van-18-januari-2007 -KYRILL -Jeanett: previous most severe storm 27Oct2002 with avg wspd Bf 10 -Jeanett: avg wspd 101km/h & gust 148km/h stronger than Kyrill -worst storm of recent decades was 25Jan1990 (Daria) -Daria: 70? fatalities; avg wspd Bf 11
Kvamme (20070214)	Kvamme, Dag, Ekstremvaer nr.1/2007 - 'Per', Intern Rapport, met.no, 15pp, Meteorogisk Institutt met.no, Bergen, 14/02/2007 -[HANNO/PER] no great damage that we know of; small damage to buildings & trees blown down -tide gauge water levels at Bergen and Stavanger were below storm surge threshold warning levels.
Mueller-Westermeier (2007)	Mueller-Westermeier, Gerhard, Beschreibung un klimatologische Bewertung des Orkantiefs "Kyrill", pdf properties: Title: Deutscher Wetterdients - Nationale Klimauberwachung, Author: Gerhard Mueller-Westermeier, Subjet: Orkan Kyrill, datestamp: 26Jan2007 -on North Sea coast, storm surge was feared but did not come -storm passed quickly; wind decreased quickly after passage of cold front -at time of high tide, no longer strong wind -passage of Kyrill in north, especially Harz & Nord/Mittelhessen was coupled with strong ppt -rapid increase water levels in small rivers; eg. Lahn & -large scale flooding did not occur because of the low preceding rainfall and no snow cover
NLWKN (20070115)	NLWKN, Sturmflut am 12. Januar 2007: Nordseekueste kam glimpflich davon 12. Januar 2007 (aktualiert am 15. Januar 2007): Duenenabbrueche auf den ostfriesischen inseln https://www.nlwkn.niedersachsen.de/startseite/aktuelles/presse_und_offentlichkeitsarbeit/pressemitteilungen/-41838.html -FRANZ -Niedersachsen coast easily came through; storm surge 12Jan2007 did not compare with Britta surge -during Britta historical losses on Ostfriesen coast in addition to Ems and Jade regions -some dune collapse on offshore islands; worst hit: Juist, Langeoog, Spiekeroog, Wangeroog
NLWKN (20070122)	NLWKN, Sturmflut von 19.Januar: Es kam nicht so schlimm wie befurchtet. 19.Januar2007: keine Duenenabbruche auf den Inseln/Fuer das Wochenende wird erhoehtes tidewasser erwartet, 22/01/2007 https://www.nlwkn.niedersachsen.de/startseite/aktuelles/presse_und_offentlichkeitsarbeit/pressemitteilungen/-41867.html -storm abated earlier than feared; low pressure center wandered to SE -otherwise hurricane Kyrill raged in the NW not as strong as expected -forecast windspeed Norderney 120km/h; actual measurement 80km/h -Cuxhaven max surge significantly before max tide -Borkum: water levels only little above expected -hurricane Kyrill & storm surge caused hardly any damage to Ostfriesland islands -if forecast winds had been realized then large dune collapse Juist, Langeoog, Spiekeroog, Wangeroog -FIG2. [PHOTO] After the storm surge on 18Jan2007; Juist easily withstood everything
RWS (200701b)	RWS, Verslag van de stormvloed van 18 en 19 januari 2007 (SR86), Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007 -STORM KYRILL -water level measurements mostly lower than 6h forecast except for Den Helder and Harlingen -water levels not extraordinary; 36 to 20 times per 100 year
Unwetterzentrale_Kyrill (200701b)	Unwetterzentrale, Orkantief KYRILL: Ausführliche Analyse der Wetterlage, www.unwetterzentrale.de/uwz/355.html, page accessed 21Aug2022. -initially storm surge feared -actual storm path further S than predicted by computer model -short period of main storm field over North Sea -storm covered area of low water and following high water night to 19Jan -water levels reached 1-1.5m over average high water -only on a few coastal sections was 1.5m exceeded (threshold for light storm surge)
Jensen and Mueller-Navarra (2008)	Jensen J, SH Mueller-Navarra, Storm surges on the German coast, Die Kueste, 74 ICCE (2008), 92-124. -Storm Kyrill was forecast as a worst case scenario with a wind setup of 4-5m; actual surge much lower -low pressure centre passed Jutland 3h earlier than expected; did not have maximum impact on water levels -14h advance forecast for water level was 1.75m too high
Behrens and Guenther (2009)	Behrens, A. and H. Guenther, Operational wave prediction of extreme storms in Northern Europe, Nat. Hazards, 49, 387-399, 2009 -42h advance forecast of SWH in southern North Sea too high at 8m because advance forecast of ind speed too high -wave heights in southern North Sea quite low because wind blowing in transverse direction with fetch of 500km
Tetzlaff (2009)	Tetzlaff, G., Extreme rain and wind storms in the mid-latitudes I, Singapore, 21-22.04.2009. https://imsarchives.nus/edu.sg/oldwww/Programs/09fluidss/files/Gerd Tetzlaff.pdf (Spring School on Fluid Mechanics and Geophysics of Environmental Hazards, Singapore, April 19-May 2, 2009) [pdf datestamp: 14/05/2009] -remarkable gust measured at Duesseldorf airport exceeded by higher gusts at Karlsruhe during storm Lothar and at List during Storm Anatol. -stronger gusts in Europe-northeast Atlantic region during Great storm Oct 1987 in France, at Brocken German

	Nov1984, at Zugspitze in 12Jan1985 -highest gusts during Pacific typhoons, Atlantic hurricanes, and in Antarctic katabatic winds
Lange (2017)	Lange, Ingo, Der Sturm "Kyrill" von 18. Januar 2007, 28Mar2017 https://wettermast.uni-hamburg.de/frame.php?doc=Sturm20070118.htm -Hamburg relatively unscathed during storm; only fallen trees -forecast storm surge for the following morning did not appear
Tatge (2017)	Tatge, Yorn, Kyrill the winter storm that walloped most of Europe, https://www.air-worldwide.com/blog/posts/2017/1/kyrill-the-winter-storm-that-walloped-most-of-europe/, Verrisk, 19Jan2017 -Kyrill met 2 of 3 criteria for extreme European loss event - intensity, size, location (it did not have extreme intensity)
Wikipedia (20220322)	Wikipedia, Cyclone Kyrill, https://en.wikipedia.org/wiki/Cyclone_Kyrill, accessed 22Mar2022 -predicted surge levels 3.5m above mean high tide for Niedersachsen & Schleswig-Holstein -actual water levels lower because storm passed before high tide set in

Table SL7. Storm worse than expected; unusual damage or emergency services actions (arranged by year and then alphabetically)

Source	Full Reference and Notes
Bottema (2007)	Bottema M, Zwaarste storm sinds 1990. Bijzondere golf- en waterhoogten IJsselmeer. Trendsinwater.nl. Monitoring van Nederlandse wateren: resultaten en ontwikkelingen. nummer 21, april 2007 -Waterschap Groot Salland set high water brigade in action with movable water protection barriers in the city because of rising water levels at Kampen NAP+1.56m -light damage to western Noordoostpolderdijk through long wavelength
Dailey (2007)	Dailey, Peter, The 2006-2007 European winter storm season: winding down, March 7, 2007. http://www.air-worldwide.com/Publications/AIR-currents/The-2006-2007-European -Kyrill: large: wind footprint over 10 countries (Ireland to Germany, Scotland to Austria) -Daria 1990: also wide footprint but Kyrill larger
Mueller-Westermeier (2007)	Mueller-Westermeier, Gerhard, Beschreibung un klimatologische Bewertung des Orkantiefs "Kyrill", pdf properties: Title: Deutscher Wetterdients - Nationale Klimauberwachung, Author: Gerhard Mueller-Westermeier, Subjet: Orkan Kyrill, datestamp: 26Jan2007 -train services completely stopped for a period
RWS (200701a)	RWS, Verslag van de stormvloed van 11 en 12 januari 2007 (SR85), Ministerie van Veerkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007a -STORM FRANZ -water levels for Den Helder 10cm higher than forecast -water levels for Delfzijl 18cm higher then forecast
RWS (200701b)	RWS, Verslag van de stormvloed van 18 en 19 januari 2007 (SR86), Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007 -STORM KYRILL -water levels for Den Helder 32 cm higher then forecast -water levels for Harlingen 41cm higher than forecast
Unwetterzentrale_Franz (200701)	Unwetterzentrale, Orkantief FRANZ - 11.,12.01.2007 (Tief Nr. 29), prepared by Manfred Spatzierer and Stefan Laps http://www.unwetterzentrale.de/uwz/347.html -spurs of hurricane low caused rain in full north half of Germany; mountainous area of Nordrhein-Westfalen had 6 L/m2 in an hour -special characteristic of this low pressure is that it covered Germany with wind gust warnings -between 14:00-15:00 MEZ cold front of low pressure crossed Ostfriesen islands -diverse models forecast massive wind changes along a narrow line of showers; thunderstorm downpours and large danger of hurricane gusts -Borkum reached peak wind speed 178km/h -UWZ meteorologists thought possible the passage of a waterspout; viewing the local storm damage indicated that the development of a waterspout could not be ruled out;... -weather situation meant signficant tornado potential not ruled out; radial wind speed in area of squall line gave suspicious signature -UWZ meteorologists gave warning of strong rain showers and thunderstorms of highest arning level with hints of tornadoes -on late afternoon and evening the cold front passed the western & middle part of Germany & shifted further to the south -storm gusts 90-100km/h spread out -observed damage indicated hurricane gusts of 110km/h or more: many uprooted trees, damaged roofs, damage by flying objects -cold front associated with downbursts in Alps on night to 12Jan; observed hurricane gusts at 400m height
Unwetterzentrale_Kyrill (200701a)	Unwetterzentrale, Orkantief KYRILL - 18., 19.01.2007 (Tief Nr. 33) - Der schwerste Orkan seit Jahrzehnten, analysis by Manfred Spatzierer, Thomas Sävert, Stefan Laps, www.unwetterzentrale.de/uwz/348.html -Kyrill: people slept in trains overnight or on cots in rainway shelters -Kyrill: unexpected structural damage to renovated Berlin Hbf
Unwetterzentrale_Kyrill (200701b)	Unwetterzentrale, Orkantief KYRILL: Ausführliche Analyse der Wetterlage,www.unwetterzentrale.de/uwz/355.html, page accessed 21Aug2022. -DB shuts down operations 1700 because of storm first time in countrywide history
Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -storm gusts higher than expected from horizontal pressure gradient; convective mixing or downward transport momentum

Ludwig et al (2015)	Ludwig P, JG Pinto, SA Hoepp, AH Fink, SL Gray, Secondary cyclogenesis along an occluded front leading to damaging wind gusts: Windstorm Kyrill, January 2007, Monthly Weather Review, 143, 1417-1437, 2015 -over Germany, Czech republic and Poland there were 8 tornado reports including 3 F3 tornadoes
Tatge (2017)	Tatge, Yorn, Kyrill the winter storm that walloped most of Europe, https://www.air-worldwide.com/blog/posts/2017/1/kyrill-the-winter-storm-that-walloped-most-of-europe/, Verrisk, 19Jan2017 -Netherlands: construction crane toppled onto university building causing heavy damage
Wikipedia (20220322)	Wikipedia, Cyclone Kyrill, https://en.wikipedia.org/wiki/Cyclone_Kyrill, accessed 22Mar2022 -unexpected damage to newly constructed main train station Berlin

Table SL8. Storm duration; extended period bad weather (arranged by year and then alphabetically)

Source	Full Reference and Notes
Deutsche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] -from afternoon 18Jan to early morning following day front wind band of hurricane Kyrill crossed Germany quickly from W to E; large damage across country
DW (20070119)	DW, Killer winds in Europe expected to cause heavy financial loss, 19Jan2007 (18Jan2007?) https://www.dw.com/en/killer-winds-in-europe-expected-to-cause-heavy-financial-loss/a-2317752 -rail services gradually returning to normal Fri 19Jan2007
EUMETSAT (20070117)	EUMETSAT, Winter storm Kyrill leaves a trail of destruction, 17 Jan2007 1500UTC, https://www.eumetsat.int/winter-storm-kyrill-leaves-trail-destruction (authors: Jochem Kerkmann & Hans Peter Roesli (EUMETSAT); Maria Putsay (Hungarian Meteorological Service); Martin Setvak & Petr Novak (CHMI)) -Atlantic transit similar to the Dec1999 (Lothar and Martin) -when it reached Europe it started to slow down & spin up converting kinetic to rotational energy -on 19Jan as it moved into Russia, satell showed spiral struct of cyclone 17Jan 1430Z-19Jan2330
Evening Herald (20070113)	Evening Herald, Tears as families hold lonely vigil (contributor Jane Last), 13Jan2007 [FRANZ] -search efforts for Pere Charles and Honydew II hampered by extended period of bad weather 10-13Jan2007
Mueller-Westermeier (2007)	Mueller-Westermeier, Gerhard, Beschreibung un klimatologische Bewertung des Orkantiefs "Kyrill", pdf properties: Title: Deutscher Wetterdients - Nationale Klimauberwachung, Author: Gerhard Mueller-Westermeier, Subjet: Orkan Kyrill, datestamp: 26Jan2007 -no major storm surge because storm passed quickly
Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -storm lasted 17-19Jan2009
Gatzen et al (2011)	Gatzen C., T. Pucik, D. Ryva, Two cold-season derechoes in Europe, Atmospheric Research, 100, 740-748, 2011 -'wind reports indicate a concentrated, 200km wide swath of severe wind gusts from the Netherlands to south-eastern Poland over a distance of 1200km' -'wind gust measurements of the sparse WMO network in the Ukraine support a total length up to 1500km and a duration of 14h.'
Magnusson (2011)	Magnusson, Ann Karin, True sea state ...? Comparing different sensors and analyzing techniques, 12th Wave Workshop, Hawaii's Big Island, Oct.30-Nov4, 2011 (32 slides) -Ekofisk storms from 11Jan2007-20Jan2007
Environment Agency (2018)	Environment Agency, Thames Barrier Project Pack 2018, January, 2018. Environment Agency. Thames Barrier View Cafe and Information Centre, 1 Unity Way, Woolwich, London, SE18 5NJ. email: thamesbarrierenquiries@environment-agency.gov.uk. -spring tide period 18-22Jan coinc /w very high W winds over Nsea & prolonged rainfall in Thames catchment -period of high flows (250cumecs) in Thames; highest over prolonged period since Jan2003 -depression N of Scotland at mightnight Jan moved rapidly east -considerable surge activity S Nsea with Southend forecast oscillating -1.0 to +1.0m -forecasts indicated 3 tides would be particularly high; Thames Barrier closed on these tides

Table SL9. Names of the storm1 - Franz (arranged by year and then alphabetically)

Name	Full Reference and Notes
Franz	Air Worldwide, European Winter Storm Franz, first posting 12Jan2007, https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-franz/first-posting/ DW, Heavy storms batter northern Europe, 12Jan2007 https://www.dw.com/en/heavy-storms-batter-northern-europe/a-2308237 Frankfurter Allgemeine Zeitung, Orkantief Franz wuetet ueber Europa, 12Jan2007 FU-Berlin, Lebensgeschichte. Tiefdruckgebiet Franz (getauft am 09.01.2007) (written on 12/03/2007 by R. Loewenherz), https://www.met.fu-berlin.de/wetterpate/lebensgeschichten/Tief_FRANZ_09_01_07.htm KIT-CEDIM, Orkantiefs 'Franz' und 'Hanno'. Mitteleuropa, Suedskandinavien 11-14.1.2007, (contributors CE and BM) Wettergefahren-Fruehwarnung, Dientag, 16.Januar 2007, !4:00 MEZ http://www.wettergefahren-fruehwarnung.de/Ereignis/20070116_e.html Rheinische Post, Orkan Franz fegt ueber Deutschland hinweg, 11Jan2007 https://rp-online.de/panorama/deutschland/orkan-franz-fegt-ueber-deutschland-hinweg_aid-11404937 Stern, Orkantief "Franz" Schwerer Sturm über Deutschland, 11Jan2007, 21:30 https://www.stern.de/panorama/orkantief--franz--schwerer-sturm-ueber-deutschland-3359640.html Unwetterzentrale, Orkantief FRANZ - 11.,12.01.2007 (Tief Nr. 29), prepared by Manfred Spatzierer and Stefan Laps http://www.unwetterzentrale.de/uwz/347.html

Table SL10. Names of the storm2 - Hanno/Per (arranged by year and then alphabetically)

Name	Full Reference and Notes

Hanno	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] KIT-CEDIM, Orkantiefs 'Franz' und 'Hanno'. Mitteleuropa, Suedskandinavien 11-14.1.2007, (contributors CE and BM) Wettergefahren-Fruehwarnung, Dientag, 16.Januar 2007, !4:00 MEZ http://www.wettergefahren-fruehwarnung.de/Ereignis/20070116_e.html Pinto JG, I Gomara, G Masato, HF Dacre, T Woolings, R Caballero, Large-scale dynamics associated with clustering of extratropical cyclones affecting Western Europe, J Geophys Res Atmos, 119, 13704-13719, 2014.
Per	Dailey, Peter, The 2006-2007 European winter storm season: winding down, March 7, 2007. http://www.air-worldwide.com/Publications/AIR-currents/The-2006-2007-European Kvamme, Dag, Ekstremvaer nr.1/2007 - 'Per', Intern Rapport, met.no, 15pp, Meteorogisk Institutt met.no, Bergen, 14/02/2007 SMHI, Per - Januaristormen 2007, 6Aug2009, https://www.smhi.se/kunskapsbanken/meteorologi/per-januaristormen-2007-1.5287 Meteorologisk institutt, Tidligere ekstremvaer hendelser, (compiled by D. Kristoffersen), filename Ekstremvaer-arkiv 20170112.odt, 12Jan2017

Table SL11. Names of the storm3 - Kyrill (arranged by year and then alphabetically)

Name	Full Reference and Notes
Kyrill	Dailey, Peter, The 2006-2007 European winter storm season: winding down, March 7, 2007. http://www.air-worldwide.com/Publications/AIR-currents/The-2006-2007-European Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] KNMI, Nieuwsbericht, De zware storm Kyrill van 18 januari 2007, 17 januari 2007, https://www.knmi.nl/over-het-knmi/nieuws/de-zware-storm-kyrill-van-18-januari-2007 Mueller-Westermeier, Gerhard, Beschreibung un klimatologische Bewertung des Orkantiefs "Kyrill", pdf properties: Title: Deutscher Wetterdients - Nationale Klimauberwachung, Author: Gerhard Mueller-Westermeier, Subjet: Orkan Kyrill, datestamp: 26Jan2007 New York Times, Deadly wind and rain storm sweeps Europe, (Mark Landler) 19Jan2007, https://www.nytimes.com/2007/01/19/world/europe/19europe.html Tetzlaff, G, Der Orkan Kyrill, INFO, DKKV Deutsches Komitee Katastrophenvosorge e.V., pp.1-2, Februar/Maerz 2007, No. 1+2/2007 Unwetterzentrale, Orkantief KYRILL: Ausführliche Analyse der Wetterlage, www.unwetterzentrale.de/uwz/355.html, page accessed 21Aug2022. Jensen J, SH Mueller-Navarra, Storm surges on the German coast, Die Kueste, 74 ICCE (2008), 92-124. Behrens, A. and H. Guenther, Operational wave prediction of extreme storms in Northern Europe, Nat. Hazards, 49, 387-399, 2009 Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. Tetzlaff, G., Extreme rain and wind storms in the mid-latitudes I, Singapore, 21-22.04.2009. https://imsarchives.nus/edu.sg/oldwww/Programs/09fluidss/files/Gerd Tetzlaff.pdf (Spring School on Fluid Mechanics and Geophysics of Environmental Hazards, Singapore, April 19-May 2, 2009) [pdf datestamp: 14/05/2009] Donat MG, T Pardowitz, GC Leckebusch, U Ulbrich, O Burghoff, High resolution refinement of storm loss model and estimation of return periods of loss-intensive storms over Germany, Nat Hazards Earth Syst Sci, 11, 2821-2833, 2011 Gatzen C., T. Pucik, D. Ryva, Two cold-season derechoes in Europe, Atmospheric Research, 100, 740-748, 2011 AON Benfield, Historie von 1703 bis 2012: Winterstuerme in Europea, Stand: Januar 2013 Kristandt, J., B. Brecht, H. Frank, H. Knack, Optimization of empirical storm surge forecast-modeling of high resolution wind fields, Die Kuste, 81, 301-348, 2014 Petroliagis TI and P Pinson, Early warnings of extreme winds using the ECMWF Extreme Forecast Index, Meteorological Applications, 21, 171-185, 2014. Pinto JG, I Gomara, G Masato, HF Dacre, T Woolings, R Caballero, Large-scale dynamics associated with clustering of extratropical cyclones affecting Western Europe, J Geophys Res Atmos, 119, 13704-13719, 2014. Tatge, Yorn, Kyrill the winter storm that walloped most of Europe, https://www.air-worldwide.com/blog/posts/2017/1/kyrill-the-winter-storm-that-walloped-most-of-europe/, Verrisk, 19Jan2017 Wikipedia, Cyclone Kyrill, https://en.wikipedia.org/wiki/Cyclone_Kyrill, accessed 22Mar2022

Table SL12. Satellite pictures (arranged by year and then alphabetically)

Source	Full Reference and Notes
Dailey (2007)	Dailey, Peter, The 2006-2007 European winter storm season: winding down, March 7, 2007. http://www.air-worldwide.com/Publications/AIR-currents/The-2006-2007-European -FIG. [SATELLITE] winter storms Britta, Franz, Per -FIG. [SATELLITE] Kyrill's passage over Europe [EUMETSAT]
EUMETSAT (20070117)	EUMETSAT, Winter storm Kyrill leaves a trail of destruction, 17 Jan2007 1500UTC, https://www.eumetsat.int/winter-storm-kyrill-leaves-trail-destruction (authors: Jochem Kerkmann & Hans Peter Roesli (EUMETSAT); Maria Putsay (Hungarian Meteorological Service); Martin Setvak & Petr Novak (CHMI))

	FIG. [SATIMAGE] SatRep 17Jan2007 0000UTC by HK at KNMI Met-8, 17Jan2007 0000UTC, Channel09 (IR10.8)+SatRep (Source: KNMI) FIG. [SATIMAGE] Met-8 18Jan2007 0900UTC Channel 05 (WV6.2) + height of 1.5PVU (WV6.2=wind vector 6.2km?) (source: Meteo France) [satellite wind vectors 170kt over Ireland * midlands] [NOTE: high wind vector over N Germany, Denmark, S Sweden] FIG. [SATIMAGE] Met-8 18Jan2007 0900UTC RGB Composite (Airmass) + height of 2.0PVU WV6.2-WV7.3, IR9.7-IR10.8, WV6.2 (source:Hungarian Meteorological Service) [NOTE: PV2.0 surface dips to 4000m in wind jet over Ireland and UK] FIG. [RADAR] Czech radar composite 18Jan2007 2030UTC (18Jan 1700-19Jan 0200UTC, source: CHMI) FIG. [SATIMAGE] Meteosat-8 RGB Composite (Airmass RGB) Met-8, 18Jan2007 2000UTC RGB Composite WV6.2-WV7.3, IR9.7-IR10.8, WV6.2
KIT-CEDIM (2007)	KIT-CEDIM, Orkantiefs 'Franz' und 'Hanno'. Mitteleuropa, Suedskandinavien 11-14.1.2007, (contributors CE and BM) Wettergefahren-Fruehwarnung, Dientag, 16.Januar 2007, 04:00 MEZ http://www.wettergefahren-fruehwarnung.de/Ereignis/20070116_e.html FIG. [photo] Satellitenbild 14.1.2007 2:56UTC NOAA 18 IR. Source B.J. Burton FIG4. (a) 13Jan2007 2040UTC N17 IR [GEO Inst, Uni Bern] (b) 14Jan2007 0553UTC N15 IR [GEO Inst, Uni Bern] (c) 14Jan2007 2017UTC N17 IR [GEO Inst, Uni Bern (d) 14Jan2007 1033UTC N17 IR [GEO Inst, Uni Bern] (e) 10Jan2007 1326UTC N18 IR [GEO Inst, Uni Bern] (f) 11Jan2007 1137UTC N18 IR [GEO Inst, Uni Bern] (g) 11Jan2007 1316UTC N18 IR [GEO Inst, Uni Bern]
Lehner (2007)	Lehner, S., Institut fuer Methodik der Fernerkundung SAR Oceanography, 52nd IEA Topical Expert Meeting, Wind and wave measurements at offshore locations, Berlin, Germany, 18-19 February 2007, organized by TU Berlin and Germanischer Lloyd, International Energy Agency, Implementing Agreement for Co-operation in the Research, Development and Deployment of Wind Turbine Systems, Task 11. -FIG5. [SATELLITE] ENVISAT ASAR image 400X400km of Denmark, eastern North Sea and western Baltic Sea during Storm Kyrill 20070118 2059 with sigma0 (dB) and CMOD4 wind field showing max wspd to 18m/s
Mariners Weather Log (200708)	Mariners Weather Log, vol. 51, No. 2, Aug 2007, Marine Weather Review - North Atlantic Area, January through April 2007, Bancroft, GP, https://www.vos.noaa.gov/MWL/aug_07/northatlantic.shtml -FIG2. [MAP] High resolution Quikscat scatterometer image of satellite-sensed winds around the storm shown in FIG1. Resolution is 12.5km. valid time of pass is 0713 UTC 10Jan2007 or about 17h prior to valid time of second part of FIG1. Storm center at 59N 39W. STORM FRANZ [credit: NOAA/NESDIS] -FIG4. High resolution Quikscat scatterometer image of satellite-sensed winds around the storm system passing east and southeast of Greenland shown in FIG3. The resolution is 12.5km. The valid time of the pass is 0758 UTC 16Jan2007 or about 4h prior to valid time for first part FIG3. center of storm near 59N 40W [credit: NOAA/NESDIS]
Met Eireann (200711)	Met Eireann, Monthly Weather Bulletin, No 249, Jan 2007 -FIG_p1. [SATELLITE] THis false-colour infrared satellite image shows and Atlantic storm system approaching Ireland on the 17th. It continued to deepen on the 18th as it moved eastwards into Britain and continental Europe, where there was significant storm damage and over 40 fatalities [picture courtesy EUMETSAT] -FIG_p2c. [SATELLITE] Infrared satellite image at 0214UTC on 18Jan2007
RWS (200701a)	RWS, Verslag van de stormvloed van 11 en 12 januari 2007 (SR85), Ministerie van Veerkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007a -FIG_p0. Satellite image of the storm from 19Jan2007 0200l? [SOURCE KNMI]
RWS (200701b)	RWS, Verslag van de stormvloed van 18 en 19 januari 2007 (SR86), Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007b -FIG_p0. Satellite image of the storm from 19Jan2007 0200l? [SOURCE KNMI]
Unwetterzentrale Franz (200701)	Unwetterzentrale, Orkantief FRANZ - 11.,12.01.2007 (Tief Nr. 29), prepared by Manfred Spatzierer and Stefan Laps http://www.unwetterzentrale.de/uwz/347.html FIG6. [MAP] IR satellite image of 11Jan2007 15UTC. Hurricane Franz with centre near Faroe Islands; its outrunners influenced the weather from Scandinavia over Baltic to Mediterranean and western Europe.
Unwetterzentrale Kyrill (200701)	Unwetterzentrale, Orkantief KYRILL - 18., 19.01.2007 (Tief Nr. 33) - Der schwerste Orkan seit Jahrzehnten, analysis by Manfred Spatzierer, Thomas Sävert, Stefan Laps, www.unwetterzentrale.de/uwz/348.html -FIG12.[MAP] IR satellite image from 18Jan2007 0600UTC. Storm Juergen has vortex over Scandinavia reaching into central Europe. Storm Kyrill vortex north of Ireland. Kyrill warm air advection shown by clouds in northern Spain -FIG13.[MAP] IR satellite image from 18Jan2007 1200UTC.

	Storm Kyrill center over North Sea. Cold front has just reached Ostfriesen islands -FIG14.[MAP] Satellite visible image 18Jan2007 1500UTC. Storm center over southern North Sea. Middle and southern Germany high-reaching cloud with high ppt noticeable -FIG15.[MAP] IR satellite image from 18Jan2007 1730UTC. Centre of low over Denmark. The cold front has crossed middle of Germany with band of heavy showery rain and some thunderstorms
Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -METEOSAT 8 image of brightness temperatures at 6.2um
Gatzen et al (2011)	Gatzen C., T. Pucik, D. Ryva, Two cold-season derechoes in Europe, Atmospheric Research, 100, 740-748, 2011 FIG8. [MAP] Satellite derived cloud top temperatures for (a) 18Jan 18 UTC and (b) 01Mar 10UTC. Temperatures are given in gray shading and labelled by the bar to the right of the figure.
Wikipedia (20220322)	Wikipedia, Cyclone Kyrill, https://en.wikipedia.org/wiki/Cyclone_Kyrill, accessed 22Mar2022 FIG. [SATELLITE] RGB composite view of Kyrill 18 January 2007 from EUMETSAT
Wikipedia (20220323)	Wikipedia, Cyclone Per, https://en.wikipedia.org/wiki/Cyclone_Per, accessed 23Mar2022 FIG: [SATELLITE IMAGE] Per located just onshore Norway on Jan14, 2007

Table SL13. Weather radar, radar reflectivity (arranged by year and then alphabetically)

Source	Full Reference and Notes
EUMETSAT (20070117)	EUMETSAT, Winter storm Kyrill leaves a trail of destruction, 17 Jan2007 1500UTC, https://www.eumetsat.int/winter-storm-kyrill-leaves-trail-destruction (authors: Jochem Kerkmann & Hans Peter Roesli (EUMETSAT); Maria Putsay (Hungarian Meteorological Service); Martin Setvak & Petr Novak (CHMI)) FIG. [RADAR] Czech radar composite 18Jan2007 2030UTC (18Jan 1700-19Jan 0200UTC, source: CHMI)
KIT-CEDIM (20070116)	KIT-CEDIM, Orkantiefs 'Franz' und 'Hanno'. Mitteleuropa, Suedskandinavien 11-14.1.2007, (contributors CE and BM) Wettergefahren-Fruehwarnung, Dientag, 16.Januar 2007, 04:00 MEZ http://www.wettergefahren-fruehwarnung.de/Ereignis/20070116_e.html -FIG3. Radar images from Netherlands/Belgium/Germany on 11Jan2007 09,12,15... UTC [SOURCE DWD]
Unwetterzentrale (200701)	Unwetterzentrale, Orkantief KYRILL - 18., 19.01.2007 (Tief Nr. 33) - Der schwerste Orkan seit Jahrzehnten, analysis by Manfred Spatzierer, Thomas Sävert, Stefan Laps, www.unwetterzentrale.de/uwz/348.html -FIG10.[MAP] precipitation animation 17Jan2007 2200UTC
Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -FIG5. [MAP] Composite radar reflectivity in dBZ for Germany on 18:30UTC 18Jan2007 with the top twenty 24h precipitation amounts
Gatzen et al (2011)	Gatzen C., T. Pucik, D. Ryva, Two cold-season derechoes in Europe, Atmospheric Research, 100, 740-748, 2011 FIG2. [MAP] Radar composite image and detected lightning for (a) 18Jan2007 18UTC and (b) 01Mar2009 09UTC. The data of a lightning detection network (black dots) is given for the whole time frame. The radar reflectivity of a greater than 40dBZ is plotted in hourly intervals and labelled by UTC times next to each line.

Table SL14. Meteorological data maps or surface analysis (arranged by year and then alphabetically)

Source	Full Reference and Notes
Deutsche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] FIG_p26. [MAP] lightning distribution in Germany from 13-24MET 18Jan2007
Eden (200703)	Eden, Philip, Weather Log January 2007, Weather, 62, pp.1-4, March 2007 -daily maps for Jan 2007 of mean sea level pressure with fronts marked; based on NCEP reanalysis data
KIT-CEDIM (20070116)	KIT-CEDIM, Orkantiefs 'Franz' und 'Hanno'. Mitteleuropa, Suedskandinavien 11-14.1.2007, (contributors CE and BM) Wettergefahren-Fruehwarnung, Dientag, 16.Januar 2007, 04:00 MEZ http://www.wettergefahren-fruehwarnung.de/Ereignis/20070116_e.html -FIG1. [MAP] Analyzed surface pressure from 10-15Jan2007 at 00UTC [source: FU Berlin, DWD, Wetterzentrale]
Kvamme (20070214)	Kvamme, Dag, Ekstremvaer nr.1/2007 - 'Per', Intern Rapport, met.no, 15pp, Meteorogisk Institutt met.no, Bergen, 14/02/2007 -FIG5.1. Analysis Friday 12Jan2007 12UTC; low P developed SW of Ireland -FIG5.2. Analysis Saturday 13Jan2007 00UTC -FIG5.3. Analysis Saturday 13Jan2007 12UTC -FIG5.4. Analysis Sunday 14Jan2007 00UTC -FIG5.5. Analysis Sunday 14Jan2007 03UTC -FIG5.6. Analysis Sunday 14Jan2007 06UTC
Mariners Weather Log (200708)	Mariners Weather Log, vol. 51, No. 2, Aug 2007, Marine Weather Review - North Atlantic Area, January through April 2007, Bancroft, GP, https://www.vos.noaa.gov/MWL/aug_07/northatlantic.shtml -FIG1. [MAP] OPC North Atlantic Surface Analysis charts valid 1200UTC 9Jan2007 (Part 2-west) and 0000UTC 11Jan2007 (Part 1-east) STORM FRANZ -FIG3. OPC North Atlantic Surface Analysis charts valid 1200UTC 16Jan2007 (Part 2) and 1200 UTC 18Jan2007 (Part 1).

Met Eireann (200701)	Met Eireann, Monthly Weather Bulletin, No 249, Jan 2007 -FIG_p2a. [MAP] Synoptic chart at 1200UTC on 18Jan2007
Mueller-Westermeier (2007)	Mueller-Westermeier, Gerhard, Beschreibung un klimatologische Bewertung des Orkantiefs "Kyrill", pdf properties: Title: Deutscher Wetterdients - Nationale Klimauberwachung, Author: Gerhard Mueller-Westermeier, Subjet: Orkan Kyrill, datestamp: 26Jan2007 -FIG1. [MAP] synoptic weather map from 18Jan2007 18:00UTC [NOTE: storm center in S Sweden; cold front over Germany; occluded front Nsea]
Unwetterzentrale (200701)	Unwetterzentrale, Orkantief KYRILL - 18., 19.01.2007 (Tief Nr. 33) - Der schwerste Orkan seit Jahrzehnten, analysis by Manfred Spatzierer, Thomas Sävert, Stefan Laps, www.unwetterzentrale.de/uwz/348.html FIG1. [MAP] ECMWF surface pressure, 500hPa geopotential height, 500hPa temperature 17Jan2007 1800GMT. NOTE: Kyrill, Juergen, Ikarus labelled FIG2. [MAP] ECMWF surface pressure, 500hPa geopotential height, 500hPa temperature 18Jan2007 0000GMT. NOTE: Kyrill, Juergen, Ikarus labelled FIG3. [MAP] ECMWF surface pressure, 500hPa geopotential height, 500hPa temperature 18Jan2007 0600GMT. NOTE: Kyrill, Juergen, Ikarus labelled FIG4. [MAP] ECMWF surface pressure, 500hPa geopotential height, 500hPa temperature 18Jan2007 1200GMT. NOTE: Kyrill, Juergen labelled FIG5. [MAP] ECMWF surface pressure, 500hPa geopotential height, 500hPa temperature 18Jan2007 1800GMT. NOTE: Kyrill, Juergen labelled FIG6. [MAP] ECMWF surface pressure, 500hPa geopotential height, 500hPa temperature 19Jan2007 1000GMT. NOTE: Kyrill, Juergen labelled -FIG7. [MAP] UKMO NA surface pressure & 10m wind 18Jan2007 0000GMT -FIG8. [MAP] UKMO NA surface height of 925hPa surface & wind field kn at 925hPa Gaps in W & S are orography 18Jan2007 0000GMT -FIG9. [MAP] UKMO NA surface height of 850hPa surface & wind field kn at 850hPa Gaps in W & S are orography 18Jan2007 0000GMT -FIG11.[MAP] Integrated precipitation map showing 24h amount between 0700MEZ 18Jan to 0700MEZ 19Jan. Area-covering high ppt in NW & N; orographic brake effect in Mittelgebirgen -TAB1. Measured values: ppt amount across 39h from 17Jan 2100 to 19Jan 1200 (MEZ) Source of data: Messnetze MeteoGroup, DWD, Auswahl NOTE: highest ppt Hochenschand Schwarzwald, all N German plain in 30-40mm band
Unwetterzentrale_Kyrill (200701d)	Unwetterzentrale, Orkantief KYRILL: gemessene Spitzenwindböen, http://www.unwetterzentrale.de/uwz/357.html (downloaded 20220916) FIG1. [MAP] Peak gusts in 6h period 18Jan2007 0600-1200UTC FIG2. [MAP] Peak gusts in 6h period 18Jan2007 1200-1800UTC FIG3. [MAP] Peak gusts in 6h period 18Jan2007 1800UTC - 19Jan2007 0000UTC FIG4. [MAP] Peak gusts in 6h period 19Jan2007 0000-0600UTC
MAIB (200804)	MAIB, Report on the investigation of the structural failure of MSC Napoli English Channel on 18 January 2007, Marine Accident Investigation Branch, Carlton House, Carlton Place, Southampton, UK, SO15 2DZ, Report No 9/2008, April 2008 -FIG10_p13. [MAP] Surface analysis for 1100UTC 18Jan2007; map of North Sea area with Great Britain, northern France, suthern Norway, Denmark with suraface isobars and wind flags for regional stations; >50kt winds in English Channel
Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -FIG3. [MAP] surface analysis of MSLP & fronts (DWD) 18Jan2007 0000UTC, 1200UTC, 1800 UTC; -FIG6. [MAP] Maximum wind gusts in km/h at different synoptic stations reports during the period 17Jan2007 0000UTC to 19Jan2007 1800UTC. Dots delineate lowland stations (<800masl); crosses mountain stations. White symbols denote stations where no wind gusts observed or reported.
SMHI (20090806)	SMHI, Per - Januaristormen 2007, 6Aug2009, https://www.smhi.se/kunskapsbanken/meteorologi/per-januaristormen-2007-1.5287 -FIG2. [MAP] Highest measured wind gusts duing Gudrun 8-9Jan2005 & Per 14Jan2007
Tetzlaff (2009)	Tetzlaff, G., Extreme rain and wind storms in the mid-latitudes I, Singapore, 21-22.04.2009. https://imsarchives.nus/edu.sg/oldwww/Programs/09fluidss/files/Gerd Tetzlaff.pdf (Spring School on Fluid Mechanics and Geophysics of Environmental Hazards, Singapore, April 19-May 2, 2009) [pdf datestamp: 14/05/2009] S22. [MAP] DWD surface weather map 18Jan2007 06UTC showing split low pressure system approaching UK; strong pressure gradient across southern England S26. [MAP] map of Germany with max gusts 18/01/2007 over 24h; wetteronline; Dusseldorf gust 1/100y event; damage 5-10 billion EUR
Gardiner et al (2010)	Gardiner, Barry, Appendix 3: Background information on 11 storms selected for detailed analysis, European Forest Institute, Atlantic European Regional Office - EFIAtlantic, 161 pp. [PDF properties: datestamp 23Jul2010] -FIG10.1. [MAP] Maximum hourly wind speed and maximum gust speed on Thu 18Jan2007 in Netherlands (source: KNMI) -FIG10.2. [MAP] Precipitation on Thu 18Jan2007 in the Netherlands (source: KNMI) -FIG10.3. [MAP] Lightning strikes by Kyrill, coniciding very well with the most storm damaged parts Netherland and Germany 18Jan2007 00-22UTC; 19Jan2007 00-22UTC
Gatzen et al (2011)	Gatzen C., T. Pucik, D. Ryva, Two cold-season derechoes in Europe, Atmospheric Research, 100, 740-748, 2011 FIG3. [MAP] Subjective surface analysis for (a) 18Jan2007 18UTC and (b) 01Mar2008 09UTC. Isobars are drawn at 4hPa intervals and the position of the intense narrow precipitating line

	is indicated by a thick solid line. Additionally, temperature/dewpoint pairs are given in deg C along the cold front. FIG4. [MAP] Analysis of the difference of hourly temperature measurements before and after the passage of the front for (a) 18Jan2007 and (b) 01Mar2008. Reports of graupel and snow are display by triangles and stars
Pinto et al (2014)	Pinto JG, I Gomara, G Masato, HF Dacre, T Woolings, R Caballero, Large-scale dynamics associated with clustering of extratropical cyclones affecting Western Europe, J Geophys Res Atmos, 119, 13704-13719, 2014. -FIG7. (a,c,e) RWB occurrence (B>0; hatched), wind intensity at 250hPa (m/s; dashed contours 40m/s), cyclone surface centers and fronts (UK Met Office charts) for 00UTC on example dates 11, 13, 19Jan2007. (b,d) Weather charts (00UTC) on 11 and 13 Jan2007. (f) Schematic summary showing relative positions of clustering cyclones with respect

Table SL15. Model fields (arranged by year and then alphabetically)

Source	Full Reference and Notes
Dailey (2007)	Dailey, Peter, The 2006-2007 European winter storm season: winding down, March 7, 2007. http://www.air-worldwide.com/Publications/AIR-currents/The-2006-2007-European - FIG. [MAP] Damaging wind footprints of Daria, Lothar, Kyrill [AIR]
Deutsche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] -FIG_p6. [MAP] Maximum gust field of the 4 strongest storms in Jan2007 -FIG_p25a. [MAP] sea level pressure map hurricane Kyrill 18Jan2007 0100MET -FIG_p25b. [MAP] sea level pressure map hurricane Kyrill 19Jan2007 0100MET -FIG_p27. [MAP] maximum gust field hurricane Kyrill 18Jan2007
KIT-CEDIM (20070116)	KIT-CEDIM, Orkantiefs 'Franz' und 'Hanno'. Mitteleuropa, Suedskandinavien 11-14.1.2007, (contributors CE and BM) Wettergefahren-Fruehwarnung, Dientag, 16.Januar 2007, 04:00 MEZ http://www.wettergefahren-fruehwarnung.de/Ereignis/20070116_e.html -FIG2. [MAP] 500 hPa geopotential height in gpdm and temperature, and surface pressure (hPa) from 10-15Jan2007 at 00UTC
KNMI (20070118)	KNMI, Nieuwsbericht, De zware storm Kyrill van 18 januari 2007, 17 januari 2007, https://www.knmi.nl/over-het-knmi/nieuws/de-zware-storm-kyrill-van-18-januari-2007 FIG1. [MAP] Maximum wind gusts Netherlands 18Jan2007
Kvamme (20070214)	Kvamme, Dag, Ekstremvaer nr.1/2007 - 'Per', Intern Rapport, met.no, 15pp, Meteorogisk Institutt met.no, Bergen, 14/02/2007 FIG2.1. +60h, HIRLAM 20km prognosis for Sunday 14Jan 00UTC, calculated Thursday 11Jan 12UTC. Isobars & 10m wind arrows model forecast in blue Analyzed field in red. NOTE: forecast trajectory through Denmark; actual trajectory Bergen FIG2.2. +60h, HIRLAM 10km prognosis for Sunday 14Jan 00UTC, calculated Thursday 11Jan 12UTC. Isobars & 10m wind arrows model forecast in blue Analyzed field in red. NOTE: forecast trajectory through Skagerrak; actual trajectory Bergen FIG2.3. +60h, EC prognosis for Sunday 14Jan 00UTC, calculated Thursday 11Jan 12UTC. Isobars & 10m wind arrows model forecast in blue Analyzed field in red. NOTE: good agreement between model and analysis; course resolution grid FIG2.4. +36h, HIRLAM 20km prognosis for Sunday 14Jan 00UTC, calculated Friday 12Jan 12UTC. Isobars & 10m wind arrows model forecast in blue Analyzed field in red. NOTE: close agreement model and analysis FIG2.5. +36h, HIRLAM 10km prognosis for Sunday 14Jan 00UTC, calculated Friday 12Jan 12UTC. Isobars & 10m wind arrows model forecast in blue Analyzed field in red. NOTE: close agreement model and analysis FIG2.6. +36h, EC prognosis for Sunday 14Jan 00UTC, calculated Friday 12Jan 12UTC. Isobars & 10m wind arrows model forecast in blue Analyzed field in red. NOTE: close agreement model and analysis FIG2.7. +12h, HIRLAM 20km prognosis for Sunday 14Jan 00UTC, calculated Saturday 13Jan 12UTC. Isobars & 10m wind arrows model forecast in blue Analyzed field in red. NOTE: model and analysis overlapping FIG2.8. +12h, HIRLAM 10km prognosis for Sunday 14Jan 00UTC, calculated Saturday 13Jan 12UTC. Isobars & 10m wind arrows model forecast in blue

	Analyzed field in red. NOTE: model and analysis overlapping FIG2.9. +12h, EC prognosis for Sunday 14Jan 00UTC, calculated Saturday 13Jan 12UTC. Isobars & 10m wind arrows model forecast in blue Analyzed field in red. NOTE: model and analysis overlapping
RWS (200701a)	RWS, Verslag van de stormvloed van 11 en 12 januari 2007 (SR85), Ministerie van Veerkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007a -FIG2. [MAP] Surface air pressure map 10Jan 0700M -FIG3. [MAP] Surface air pressure 11Jan 0100M -FIG4. [MAP] Surface air pressure 11Jan 1100M -FIG5. [MAP] Surface air pressure 12Jan 0100M -FIG.A3a. [MAP] Map of model wind speed, direction, and sea level pressure 11Jan2007 12:00GMT -FIG.A3b. [MAP] Map of model wind speed, direction, and sea level pressure 11Jan2007 15:00GMT -FIG.A3c. [MAP] Map of model wind speed, direction, and sea level pressure 11Jan2007 18:00GMT -FIG.A3d. [MAP] Map of model wind speed, direction, and sea level pressure 11Jan2007 21:00GMT -FIG.A3e. [MAP] Map of model wind speed, direction, and sea level pressure 12Jan2007 00:00GMT -FIG.A3f. [MAP] Map of model wind speed, direction, and sea level pressure 12Jan2007 03:00GMT
RWS (200701b)	RWS, Verslag van de stormvloed van 18 en 19 januari 2007 (SR86), Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007b -FIG2. [MAP] Surface air pressure from 17Jan2007 1300L or 1200UTC -FIG3. [MAP] Surface air pressure from 18Jan2007 0100L or 0000UTC -FIG4. [MAP] Surface air pressure from 18Jan2007 1300L or 1200UTC -FIG5. [MAP] Surface air pressure from 18Jan2007 1900L or 1800UTC FIG_A3a. [MAP] model wind & pressure at 18Jan 0600GMT FIG_A3b. [MAP] model wind & pressure at 18Jan 0900GMT FIG_A3c. [MAP] model wind & pressure at 18Jan 1200GMT FIG_A3d. [MAP] model wind & pressure at 18Jan 1500GMT FIG_A3e. [MAP] model wind & pressure at 18Jan 1800GMT FIG_A3f. [MAP] model wind & pressure at 18Jan 2100GMT NOTE: high winds only on right hand side of travelling low pressure center
Tetzlaff (2007)	Tetzlaff, G, Der Orkan Kyrill, INFO, DKKV Deutsches Komitee Katastrophenvosorge e.V., pp.1-2, Februar/Maerz 2007, No. 1+2/2007 -FIG1. [MAP] Wind speed forecast issued on 16Jan 00? for 18Jan2007 from forecast model GSF (after Wetteronline 2007). With empirical gust factor of 1.7 Leipzig area had max gust of 110km/h; actual observed value was 112km/h
Tonis (2007)	Tonis, Rico, Handig online systeem waterstandvoorspellingen, Trendsinwater.nl. Monitoring van Nederlandse wateren: resultaten en ontwikkelingen. nummer 21, april 2007, p10. -FIG2. [MAP] Voorspelde waterstand (tov NAP) in de westelijke Waddenzee voor 18Jan2007 at 22:00 uur met het Nederlandse waterstandmodel SIMONA/WAQUA
Unwetterzentrale_Franz (200701)	Unwetterzentrale, Orkantief FRANZ - 11.,12.01.2007 (Tief Nr. 29), prepared by Manfred Spatzierer and Stefan Laps http://www.unwetterzentrale.de/uwz/347.html FIG1. [MAP] Europe map with surface pressure, H500, T500 on 10/01/2007 0600Z; Franz, Dieter labelled FIG2. [MAP] Europe map with surface pressure, H500, T500 on 11/01/2007 0000Z; Franz, Dieter labelled FIG3. [MAP] Europe map with surface pressure, H500, T500 on 11/01/2007 1200Z; Franz labelled FIG4. [MAP] Europe map with surface pressure, H500, T500 on 11/01/2007 1800Z; Franz I and Franz II labelled FIG5. [MAP] Europe map with surface pressure, H500, T500 on 12/01/2007 0000Z; Franz I, Franz II, Gerhard labelled
Unwetterzentrale_Kyrill (200701b)	Unwetterzentrale, Orkantief KYRILL: Ausführliche Analyse der Wetterlage, www.unwetterzentrale.de/uwz/355.html, page accessed 21Aug2022. FIG: [MAP] Kyrill trajectory and central pressure 18Jan2007 0100MEZ to 19Jan2007 1800MEZ. Map shows area of hurricane and storm gusts stretching into mid-France, N Italy, Austria, Hungary, Ukraine, Beloruss. Storm trajectory across N coast of Poland & across S Baltic states
Unwetterzentrale_Kyrill (200701c)	Unwetterzentrale, Orkantief KYRILL: Vorhersagbarkeit des Ereignisses und Warnmanagement der Unwetterzentrale, www.unwetterzentrale.de/uwz/356.html (downloaded 20220916) FIG. [MAP] Warning animation of Unwetterzentral on 17Jan2007 FIG. [MAP] Warning animation from 18Jan2007. Since formation of Unwetterzentrale 1Jan2003 this is the first time Germany was covered with red warnings, with a few higher violet warnings FIG. [MAP] Colleagues of Unwetterzentral in Austria warned of violet areas. Alpenhauptkamm in Bergland was hit; in Niederosterreich there was a strong pressure gradient and orographic effect.
BSU (20081001)	BSU, Loss overboard of 10 containers from JRS Canis at estuary of Elbe River on 12 January 2007 at 02:40, Investigation Report 45/07, Less Serious Marine Casualty, Bundestelle fuer Seeunfalluntersuchung, 1 October 2008. -FIG7. [MAP] wave forecast in German Bight at 01:00M 12/01/2007 -FIG8. [MAP] wave forecast in German Bight at 04:00M 12/01/2007
Behrens and Guenther (2009)	Behrens, A. and H. Guenther, Operational wave prediction of extreme storms in Northern Europe, Nat. Hazards, 49, 387-399, 2009 -FIG8: [MAP] 42h & 6h advance wave forecast by LSM Hs=8m, waves toward east, wspd=26-28m/s

Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -FIG2. [MAP] Top panel shows jet stream on 250hPa level (source: ECMWF) with surface track of Kyrill (source: NCEP-1). Jet stream shown in 6h moving window centred on position of Kyrill. Color scale in knots. Window has latitudinal extension 30deg; longitudinal size adapted to tranlation speed of storm. Split jet structure denoted by numerals 1,2,3 -FIG3. [MAP] geopotential height gpdm, wspd, in kn, and divergence in 10-5 s-1 at the 300hPa pressure level (ECMWF) -FIG8. [MAP] Pre-existing MSLP gradient, cyclone path, and associated surface winds for 3 storms over Europe (a-b) Daria, (c-d) Anatol, (e-f) Kyrill. Left panels show pre-existing average MSLP gradient (hPa/100km) for 9 days before crossing 10W longitude. Right panels show cyclone tracks and associated wind fields based on NCEP-1 reanalysis data. Black dots indicate 6h storm position. Green dots give position with lowest core pressures Remaining dots show fractional exceedance off the 98th wind speed percentile for Dec-Feb 1958-2005 maximum surface winds observed during storm passage. The two boxes in (a) are used for the calculation of the MSLP gradients.
SMHI (20090806)	SMHI, Per - Januaristormen 2007, 6Aug2009, https://www.smhi.se/kunskapsbanken/meteorologi/per-januaristormen-2007-1.5287 -FIG4. [MAP] Calculated return period for wind gusts during storm Per
Tetzlaff (2009)	Tetzlaff, G., Extreme rain and wind storms in the mid-latitudes I, Singapore, 21-22.04.2009. https://imsarchives.nus/edu.sg/oldwww/Programs/09fluidss/files/Gerd Tetzlaff.pdf (Spring School on Fluid Mechanics and Geophysics of Environmental Hazards, Singapore, April 19-May 2, 2009) [pdf datestamp: 14/05/2009] S24. [MAP] wind at 300hPa at 100m/s 19/01/2007 00GMT; polar jetstream; band across southern Scotland, Netherlands, into Germany S25. [MAP] Surface pressure 18/01/2007 at 1800GMT and equivalent potential temperature for central Europe S27. [MAP] map UK east coast to Baltic: surface pressure (hPa), isotach 10m wind speed (km/h) NOTE: high wind speeds over English Channel & North Sea with 18m/s as the average wind speed, there is a band of gusts plausible: standard gust factor (building codes) 1.6: 29.m/s thunderstorm theort gust with u=3.9delT: 39m/s observed gust factor (widely spread) 1.8: 32m/s city gust factor (high roughness) 2.3: 41m/s airport Dusseldorf observed 2.4: 40m/s
Gatzen et al (2011)	Gatzen C., T. Pucik, D. Ryva, Two cold-season derechoes in Europe, Atmospheric Research, 100, 740-748, 2011 FIG1. [MAP] Objective surface analysis of GFS model for (a) 18Jan2007, 18UTC and (b) 01Mar2008 09UTC. Isobars at 4hPa intervals. Rectangles show severe wind gusts >25m/s. Positions of low pressure centre 6h before and after analysis indicated by crosses. FIG5. [MAP] 500 hPa heights (m) and winds (m/s) of the GFS model analysis, chronological from top to bottom for the Kyrill (5a,12 UTC followed by 5b,00 UTC) and the Emma event (5c, 00 UTC followed by 5d, 12UTC. The geopotential is drawn in 100m intervals (solid lines) and the temperature (C, dashed) is drawn in 4K intervals. Regions with winds that exceeded 40 and 60m/s are given by shading and labelled by numbers in the figure. FIG6. [MAP] 850hPa heights (m) of the GFS model analysis for (a) 18Jan 18UTC and (b) 01Mar 06UTC. The geopotential is drawn in 100m intervals (solid) and the temperature (C) in 4K intervals. Regions with winds that exceeded 30,35,40m/s are given by shading and labeled by numbers in figure.
AON Benfield (2013)	AON Benfield, Historie von 1703 bis 2012: Winterstuerme in Europea, Stand: Januar 2013 -FIG_p19. map maximum gust wind speed for Kyrill 18/19Jan2007
Petroliagis and Pinson (2014)	Petroliagis TI and P Pinson, Early warnings of extreme winds using the ECMWF Extreme Forecast Index, Meteorological Applications, 21, 171-185, 2014. FIG8. [MAP] Samples of different EFI (10FGI) maps valid for the Kyrill storm hitting Hannover airport 18Jan2007. Various forecast horizons (a) T+132, (b) T+96, (c) T+48. A set of such maps is used in operational mode for the production of specialized EFI-GRAM products as the one contained in panel (d)
Pinto et al (2014)	Pinto JG, I Gomara, G Masato, HF Dacre, T Woolings, R Caballero, Large-scale dynamics associated with clustering of extratropical cyclones affecting Western Europe, J Geophys Res Atmos, 119, 13704-13719, 2014. -FIG3. 6-20Jan2007. Red/blue shadings: theta on 2PVU surface in K (00UTC). Hatched fields: daily RWB occurrent. Dashed contours: wind intensity at 250hPa (m/s,00UTC), contours drawn from 40m/s with 10m/s contour intervals. Solid contour lines: Full p95 cyclone trajectories until 18UTC of each day. Large filled black dots: cyclone positions at 00UTC. Small circles: threee forthcoming cyclone postion on the same date.

	Large open white dots: Position (00UTC) of names historical storms crossing detection area on that day -FIG7. (a,c,e) RWB occurrence (B>0; hatched), wind intensity at 250hPa (m/s; dashed contours 40m/s), cyclone surface centers and fronts (UK Met Office charts) for 00UTC on example dates 11, 13, 19Jan2007. (b,d) Weather charts (00UTC) on 11 and 13 Jan2007. (f) Schematic summary showing relative positions of clustering cyclones with respect to jet streak location and location of RWB
Roberts et al (2014)	Roberts JF, AJ Champion, LC Dawkins, KI Hodges, LC Shaffrey, DB Stephenson, MA Stringer, HE Thornton, DB Youngman, The XWS open access catalogue of extreme European windstorms from 1979 to 2012, Nat. Hazards Earth Syst. Sci, 14, 2487-2501, 2014 -FIG2. [MAP] Footprints of storms 4769, 4773 (Dieter), 4872 (Kyrill), 4774 (Lancelot) made by taking the maximum gusts over the whole domain (contaminated) NOTE: KYRILL STORM COMPLEX -FIG8. (a) and (d) Observational footprints for the storms Jeanette (Oct2002) and Kyrill (Jan2007) (b) and (e) corresponding model footprints for the same storms (c) and (f) plot of model gust vs oobservational gust for each of the stations plotted in the observational footprint. Gusts from stations with altitudes greater than 500m are plotted in rid, and those with altitude LE500m are plotted in blue, line is 1:1 (g) shows the low-altitude data from plots (c) and (f) overlain, with contours representing the density of points for easy comparison
Rohman (2014)	Rohman, J., European Extratropical Cyclones. Implications for local insurers, TransRe, May 2014 FIG7. [MAP] This shows the windstorm footprints of Xynthia (Feb 2010) on the left and Kyrill (Jan2007) on the right. Although each storm had a slightly different storm track, one can see how the storms did not lose energy over land and were able to maintain strength deep into the European continent
Ludwig et al (2015)	Ludwig P, JG Pinto, SA Hoepp, AH Fink, SL Gray, Secondary cyclogenesis along an occluded front leading to damaging wind gusts: Windstorm Kyrill, January 2007, Monthly Weather Review, 143, 1417-1437, 2015 -FIG3. Synoptic-scale overview for 25km grid spacing simulation of Kyrill I and II at (a),(d),(g) 12UTC 17Jan; (b),(e),(h) 00UTC 18Jan; (c),(f),(i) 12UTC 18Jan (a)-(c) Jet stream (m/s) shaded and geopotential height (black isolines of 16dam) at 300hPa (d)-(f) Specific humidity g/kg and potential vorticity at 500hPa (g)-(i) equivalent potential temperature theta_e at 850hPa and mean sea level pressure hPa -FIG4. Frontal structure and forcing during secondary cyclogenesis for 7km grid spacing simulation at 00UTC 18Jan and 06UTC 18Jan (a),(b) Horizontal wind speed m/s and divergence 10-5/s at 300hPa (c),(d) alongfront stretching deformation of the wind field 10-5/s at 900hPa, potential vorticity, and mean sea level pressure (e),(f) potential vorticity and equivalent potential temperature K at 850hPa, ageostrophic wind component vectors at 900hPa and mean sea level pressure (g),(h) precipitation amount (mm/h) for the preceding hour, wind barbs for wind speed at 975hPa, and mean sea level pressure. Dotted lines in (g),(h) denote location of cross sections -FIG5. West-east and south-north oriented vertical cross sections at (a)(c)(e)(g) 0000UTC 18Jan and (b)(d)(f)(h) 0600 UTC 18Jan for 7km grid spacing. Positions of cross sections marked in Fig4 (a)(b) west-east cross sections for equivalanet potential temperature theta_e (K), dynamical tropopause marked with 2PVU line, and regions of diabatic heating. (c)(d) as for (a)(b) but for north-south cross sections (e)(f) as in (c)(d) but for diabatic heating rate from cumulus parameterization excluded Number '2' along the abscissa marks the corresponding cyclone positions of Kyrill II (g)(h) total DPVR and the z-component of absolute vorticity. -FIG6. (a) Synopsis of locations when Kyrill I and II co-occur for the first time for CCLM 25km grid spacing CNTRL and sensitivity experiments with suppressed latent heat release in convection scheme. (b) Pressure progression for Kyrill I (c) Pressure progression for Kyrill II -FIG7. Frontal forcing, structure, and wind gusts for the 7km grid spacing simulation of Kyrill II over central Europe at 1500, 1800 and 2100UTC 18Jan -FIG8. Convection-permitting CCLM simulation (2.8km grid resolution) of the olld front over Germany between 1700 and 1900UTC 18Jan (a)-(c) Simulated radar reflectivity shaded dBZ, upward vertical velocity at 850hPa, and relatve humidity at 500hPa (d)-(f) Maximum vDWD wind gust and upper level jet stream Inverted triangles in (e) and (f) mark the positions of thee verified tornado reports (g)-(i) Hourly averaged precipitation rate (preceding hour) and mean sea level pressure -FIG9. Vertical profiles at 51.28N, 6.76E and at 1645UTC 18Jan. (a) Gradient Richardson number [Ri, dimensionless, shaded gray marks the transition between stable Ri>1 and turbulent flow (Ri<0.25)] and turbulent kinetic energy TKE m2/s2 (b) Vertical velocity and diabatic heating rate [delTLH (K/h)], (c) Magnitude of horizontal wind speed (m/s), (d) potential and equivalent poential temperature of saturated air (e) areas over central Germany with instantaneous gust wind speed at 1645UTC exceeding 32.7m/s. Equivalent potential temperature along the front region at 950hPa marked with blue contours.

	Black/white circles mark the location of vertical profiles -FIG10. As in FIG9 but for 51.28N 10.50E at 1800UTC 18Jan and the front normal cross section depicted in FIG11b is marked by a bold black line. -FIG11. Front normal cross sections for (a) 1645UTC 18Jan and (b) 1800UTC 18Jan. Locations of cross sections are marked by the bold black lines in FIG9e and 10e. Depicted equivalent potential temperature theta_e, wind vectors of front normal and vertical wind component and magnitude of horizontal wind speed. Gradient Richardson numbrs Ri below 0.25 (turbulent flow) are shaded in gray. Regions with 0.25<Ri<1 (transition between stable and turbulent flow)are shaded in light gray. Bold vertical lines up to 700hPa at 51.28N mark the locations of corresponding vertical profiles in FIG9 and 10 -FIG12. [MAP] Comparison of simulated (2.8km grid spacing simulation, shaded areas) and observed (colored points) 10m wind gusts (both averaged between 1200UTC 18Jan and 0600UTC 19Jan) for (a) v_DWD and (b) v_TKE
Tatge (2017)	Tatge, Yorn, Kyrill the winter storm that walloped most of Europe, https://www.air-worldwide.com/blog/posts/2017/1/kyrill-the-winter-storm-that-walloped-most-of-europe/, Verrisk, 19Jan2017 -FIG1. [MAP] Maximum wind speed footprint and track (trajectory) of Kyrill (AIR)

Table SL16. Satellite altimeter strip maps (arranged by year and then alphabetically)

Source	Full Reference and Notes

Table SL17. List meteorological data (arranged by year and then alphabetically)

Data type	Location	Time Interval	Full Reference and Notes
[TEXT] maximum wind speeds?/gusts? reached	The Needles on the Isle of Wight, Crosby near Liverpool, Rhyl in Wales, Heathrow	18Jan2007	BBC News, Nine dead as UK struck by storms, 18Jan2007, http://news.bbc.co.uk/2/hi/uk_news/6272193.stm
[TEXT] highest gust	The Needles, Heathrow	18Jan2007	Brugge R, British Isles weather diary, Jan 2007, www.met.reading.ac.uk/~brugge/diary2007.html#200701
[TABLE] Max gust measurements from selected DWD stations with altitude <500m	Duesseldorf airport, Kiel leuchtturm, Muhldorf am Inn, Chemnitz, List/Sylt, Braunschweig airport, Koeln-Bonn airport, Berlin-Dahlem, Dresden airport, Rostock-Warnemuende, Helgoland/Duene, Dortmund, Aachen, Munchen airport, Erfurt, Regensburg, Hannover airport, Leipzig airport, Muenster/Osnabrueck flg, Karlsruhe	18Jan2007	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015]
[TABLE] Maximum gust of day	Wendelstein, Brocken, Zugspitze, Feldberg/Schw., Weinbeit, Fichtelberg, Hohenpeissenberg, Wasserkuppe, Wernigerode, Helgoland, List, Grosser Arber, Alte Weser Leuchtturm, Greifswalder Oie, Kap Arkona, WarnemuendeBarth	11, 12, 13, 14 Jan2007	KIT-CEDIM, Orkantiefs 'Franz' und 'Hanno'. Mitteleuropa, Suedskandinavien 11-14.1.2007, (contributors CE and BM) Wettergefahren-Fruehwarnung, Dientag, 16.Januar 2007, 04:00 MEZ http://www.wettergefahren-fruehwarnung.de/Ereignis/20070116_e.html
[TABLE] wind speed (10 min avg?), maximum wind speed (over 3 h?), maximum gust (over 3h)	Fedje, Flesland, Bergen, Kvamsoy, Slatteroy fyr, Stord flyplass, Haugesund flyplass, Utsira fyr, Kvitsoy, Sola, Obrestad fyr, Lista, Lindesnes, Oksoy fyr, Kjevik	14Jan2007 03, 06, 09, 12 UTC	Kvamme, Dag, Ekstremvaer nr.1/2007 - 'Per', Intern Rapport, met.no, 15pp, Meteorogisk Institutt met.no, Bergen, 14/02/2007
[TABLE] maximum avg wind, wind gust	Flesland flyplass, Bergen, Kvamsoy, Slatteroy fyr, Stord flyplass, Utsira fyr, Kvitsoy, Sola flyplass, Obrestad fyr	14Jan2007	Kvamme, Dag, Ekstremvaer nr.1/2007 - 'Per', Intern Rapport, met.no, 15pp, Meteorogisk Institutt met.no, Bergen, 14/02/2007
[FIGURE] 10 minute average wind, 3s max gust, air temperature, dew point, relative humidity, air pressure; multiple sensors	Heidrun platform	1-31Jan2007	Loginfo A/S, Heidrun EMS-Data, Monthly Report January 2007, Project No. 442, Completion date 25/02/2007, project manager JK fLoeken, executed by P-O Kjensli, approved by K Johansen
[TABLE, TEXT] wind speed	Various platforms, buoys, ships	Jan2007	Mariners Weather Log, vol. 51, No. 2, Aug 2007, Marine Weather Review - North Atlantic Area, January through April 2007, Bancroft, GP, https://www.vos.noaa.gov/MWL/aug_07/northatlantic.shtml
[TABLE] maximum wind	Shannon Airport, Cork	18Jan2007	Met Eireann, Monthly Weather Bulletin, No 249, Jan 2007

speed and gust for selected stations in Ireland	Airport, Malin Head, Casement Aerodrome, Dublin Airport, Valentia Observatory, Kilkenny, Belmullet, Knock Airport, Clones, Birr, Mulingar II, Rosslare		
[TIMESERIES] Wind speed for Jan2007	Offshore buoy M1	Jan2007	Met Eireann, Monthly Weather Bulletin, No 249, Jan 2007
[TIMESERIES] wind speed, wind gust, wind direction, air pressure, humidity, loud height	Ekofisk platform	Jan2007	MIROS, Ekofisk Monthly Report, January 2007, Doc. No. ND/1024/07/01, MIROS, 27pp, 11 Apr 2007
[TIMESERIES] wind speed, wind gust, wind direction, air temperature, relative humidity, air pressure, sea temperature, water level, height lowest cloud	Draugen platform	Jan2007	MIROS, Monthly Report, January 2007, Doc. No. ND/1022/07/01, Project Draugen - Met-Ocean Data Recording, 01/02/2007.
[TIMESERIES] 10min average wind speed, wind gust, wind direction, air temperature, relative humidity, barometric pressure, visibility	Gullfaks C platform	Jan2007	MIROS, Maanedsrapport, januar 2007, Dok. nr. ND/1013/07/01, Prosjekt Gullfaks C - Naturdatainnsamling, 02/02/2007.
[TIMESERIES] 10min average wind speed, wind gust, wind direction, air temperature, sea temperature, relative humidity, barometric pressure, visibility, synoptic code	Heimdal platform	Jan2007	MIROS, Maanedsrapport, januar 2007, Dok. nr. ND/1047/07/01, Prosjekt: Heimdal - Naturdatainnsamling, 21/03/2007
[TEXT] maximum wind gusts during storm for selected stations above hurricane threshold	Wendelstein, Brocken, Artern, Schleitz, Muhlldorf/Bayern, Stotten./Alb, Koeln	18Jan2007	Mueller-Westermeier, Gerhard, Beschreibung un klimatologische Bewertung des Orkantiefs "Kyrill", pdf properties: Title: Deutscher Wetterdients - Nationale Klimauberwachung, Author: Gerhard Mueller-Westermeier, Subjet: Orkan Kyrill, datestamp: 26Jan2007
[TIMESERIES] hourly wind gusts	Koeln, Brocken, Muehldorf/Inn, Wendelstein	17-19Jan2007	Mueller-Westermeier, Gerhard, Beschreibung un klimatologische Bewertung des Orkantiefs "Kyrill", pdf properties: Title: Deutscher Wetterdients - Nationale Klimauberwachung, Author: Gerhard Mueller-Westermeier, Subjet: Orkan Kyrill, datestamp: 26Jan2007
[TIMESERIES] wind speed, wind direction, air and sea temperaure	FINO1	18Jan2007 06:00UTC - 19Jan2007 06:00UTC	Neumann, T., FINO and the mast shadow effect, 52nd IEA Topical Expert Meeting, Wind and wave measurements at offshore locations, Berlin, Germany, February 2007, organized by TU Berlin and Germanischer Lloyd, International Energy Agency, Implementing Agreement for Co-operation in the Research, Development and Deployment of Wind Turbine Systems, Task 11.
[TIMESERIES] wind speed and direction	Lichteiland Goeree, Europlatform, Hoek van Holland, IJmuiden semafor, Platform K13a, Platform F3	11-12Jan2007	RWS, Verslag van de stormvloed van 11 en 12 januari 2007 (SR85), Ministerie van Veerkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007a
[TIMESERIES] wind speed and direction	Lichteiland Goeree, Europlatform, Hoek van Holland, IJmuiden semafor, Platform K13a, Platform F3	18-19Jan2007	RWS, Verslag van de stormvloed van 18 en 19 januari 2007 (SR86), Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007b
[TEXT] maximum gust	Heathrow	18Jan2007	UKMO Daily Weather Summary 01-31Jan2007, UK MetOffice [pdf document properties: author=jan.freeman; datestamp=23/04/2015]
[TABLE] peak gust	Stations in Germany, Switzerland, Austria	11-12Jan2007	Unwetterzentrale, Orkantief FRANZ - 11.,12.01.2007 (Tief Nr. 29), prepared by Manfred Spatzierer and Stefan Laps http://www.unwetterzentrale.de/uwz/347.html
[TABLE] peak gust	Stations in Germany, Switzerland, Austria	18-19Jan2007	Unwetterzentrale, Orkantief KYRILL: gemessene Spitzenwindböen, http://www.unwetterzentrale.de/uwz/357.html (downloaded 20220916)
[TEXT and TABLE] maximum gust	Brocken, Feldberg, Weinbiet, Duesseldorf, Artern, Schleiz, Muehldorf am Inn, Wendelstein in	18Jan2007	Wetteronline, Orkan Kyrill tobt in Europa, 18Jan2007 22:00, https://www.wetteronline.de/wetterticker/orkan-kyrill-tobt-in-europa--UZiFNRdrmvxoC3RHqLLyU

	Bayerischen Alpen		
[TIMESERIES] wind speed and direction	Station Elbe	10-15Jan2007	BSU, Loss overboard of 10 containers from JRS Canis at estuary of Elbe River on 12 January 2007 at 02:40, Investigation Report 45/07, Less Serious Marine Casualty, Bundestelle fuer Seeunfalluntersuchung, 1 October 2008.
[TIMESERIES] wind speed and pressure	Buoy M5, Roches Point station	10-11Jan2007	MCIB, Report of investigation into the loss of the FV "Honeydew II" off Ram Head Co. Waterford on 11th January 2007, Marine Casualty Investigation Board, Report No. MCIB/135, 31Aug2009.
[TABLE] wind speed, gust and wind direction	Buoy M5 (51.7N, 6.7W)	9-11Jan2007	MCIB, Report of investigation into the loss of the FV "Honeydew II" off Ram Head Co. Waterford on 11th January 2007, Marine Casualty Investigation Board, Report No. MCIB/135, 31Aug2009.
[MAP] maximum wind gust color coded on map	Europe	17Jan2007 0000UTC to 19Jan2007 1800UTC	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009.
[TIMESERIES] Temperature, dewpoint, precipitation, present weather, maximum gust, sea level pressure	Lindenburg, Duesseldorf	18Jan2007 0600UTC to 19Jan2007 0600UTC	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009.
[MAP WITH TEXT] highest wind gusts	Swedish stations in Gotaland	14Jan2007	SMHI, Per - Januaristormen 2007, 6Aug2009, https://www.smhi.se/kunskapsbanken/meteorologi/per-januaristormen-2007-1.5287
[MAP WITH TEXT] highest wind gusts	Many stations in Germany	18Jan2007	Tetzlaff, G., Extreme rain and wind storms in the mid-latitudes I, Singapore, 21-22.04.2009. https://imsarchives.nus/edu.sg/oldwww/Programs/09fluidss/files/Gerd Tetzlaff.pdf (Spring School on Fluid Mechanics and Geophysics of Environmental Hazards, Singapore, April 19-May 2, 2009) [pdf datestamp: 14/05/2009]
[TEXT] strongest wind gust	Wendelstein, Brocken, Muehldorf/Bayern, Koeln	18Jan2007	DWD, 18.Januar 2007: Windfeld von Kyrill ueber Deutschland. Rueckblick auf einen der bisher schwersten Orkane, Pressemitteilung, Deutscher Wetterdienst, Offenbach, 16. Januar 2012.
[TEXT] maximum wind gust	Belmullet	18Jan2007	Esurge_2007_kyrill(2012), Triple storm even (2007), Philip Harwood, Sun, 2012/11/11 15:04
[TEXT] Maximum wind gust	Berlin Adlershof	18Jan2007	AON Benfield, Historie von 1703 bis 2012: Winterstuerme in Europea, Stand: Januar 2013
[TIMESERIES] wind gust and 5 minute average wind speed at selected heights from 10m to 250	Wettermast Hamburg	17-19Jan2007	Lange, Ingo, Der Sturm "Kyrill" von 18. Januar 2007, 28Mar2017 https://wettermast.uni-hamburg.de/frame.php?doc=Sturm20070118.htm

Table SL18. Significant wave height and sea state (arranged by year and then alphabetically)

Data type	Location	Time Interval	Full Reference and Notes
[TEXT] significant wave height	Rotterdamse Hoek	18Jan2007	Bottema M, Zwaarste storm sinds 1990. Bijzondere golf- en waterhoogten IJsselmeer. Trendsinwater.nl. Monitoring van Nederlandse wateren: resultaten en ontwikkelingen. nummer 21, april 2007
[TABLE,TEXT] significant wave height	Platforms, buoys, ships across North Atlantic	Jan2007	Mariners Weather Log, vol. 51, No. 2, Aug 2007, Marine Weather Review - North Atlantic Area, January through April 2007, Bancroft, GP, https://www.vos.noaa.gov/MWL/aug_07/northatlantic.shtml
[TIMESERIES] Significant wave height at 1 hour intervals	Offshore buoy M1	Jan2007	Met Eireann, Monthly Weather Bulletin, No 249, Jan 2007
[TIMESERIES] significant wave height, maximum wave height	Heidrun platform	Jan2007	Loginfo A/S, Heidrun EMS-Data, Monthly Report January 2007, Project No. 442, Completion date 25/02/2007, project manager JK fLoeken, executed by P-O Kjensli, approved by K Johansen
[TIMESERIES] significant wave height, maximum wave height	Ekofisk platform	Jan2007	MIROS, Ekofisk Monthly Report, January 2007, Doc. No. ND/1024/07/01, MIROS, 27pp, 11 Apr 2007
[TIMESERIES] significant wave height, (expected maximum wave height)	Draugen platform	Jan2007	MIROS, Monthly Report, January 2007, Doc. No. ND/1022/07/01, Project Draugen - Met-Ocean Data Recording, 01/02/2007.
[TIMESERIES] significant wave height, (expected maximum wave height)	Gullfaks C platform	Jan2007	MIROS, Maanedsrapport, januar 2007, Dok. nr. ND/1013/07/01, Prosjekt Gullfaks C - Naturdatainnsamling, 02/02/2007.
[TIMESERIES]	Heimdal platform	Jan2007	MIROS, Maanedsrapport, januar 2007, Dok. nr.

significant wave height, (expected maximum wave height)			ND/1047/07/01, Prosjekt: Heimdal - Naturdatainnsamling, 21/03/2007
[TIMESERIES] Significant wave height and direction; hourly derived from 20 min records	Scheur West Wandelaar, IJmuiden, Eierlandse gat, Schiermonnikoog noord	11-12Jan2007	RWS, Verslag van de stormvloed van 11 en 12 januari 2007 (SR85), Ministerie van Veerkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007a
[TIMESERIES] Signficant wave height and direction; hourly derived from 20 min records	Scheur West Wandelaar, IJmuiden, Eierlandse gat, Schiermonnikoog noord	18-19Jan2007	RWS, Verslag van de stormvloed van 18 en 19 januari 2007 (SR86), Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007b
[TIMESERIES] Significant wave height	Southern North Sea Buoy 62145	16-23Jan2007	Behrens, A. and H. Guenther, Operational wave prediction of extreme storms in Northern Europe, Nat. Hazards, 49, 387-399, 2009
[TEXT] Highest significant wave height	Vaderoarna	14Jan2007	SMHI, Per - Januaristormen 2007, 6Aug2009, https://www.smhi.se/kunskapsbanken/meteorologi/per-januaristormen-2007-1.5287
[TIMESERIES] Significant wave height	Ekofisk	11Jan2007, 13Jan2007, 14Jan2007, 20Jan2007	Magnusson, Ann Karin, True sea state ...? Comparing different sensors and analyzing techniques, 12th Wave Workshop, Hawaii's Big Island, Oct.30-Nov4, 2011 (32 slides)
[TIMESERIES] Significant wave height	Elbe, Helgoland, FINO1	10-15Jan2007	BSU, Loss overboard of 10 containers from JRS Canis at estuary of Elbe River on 12 January 2007 at 02:40, Investigation Report 45/07, Less Serious Marine Casualty, Bundestelle fuer Seeunfalluntersuchung, 1 October 2008.
[TIMESERIES] Significant wave height	Ekofisk	11Jan2007, 13Jan2007, 14Jan2007, 20Jan2007	Magnusson, Anne Karin, Variability of sea state measurements and sensor dependence, Workshop: Statistical models of the Metocean environment for engineering uses, IFREMER 30.09-01.10.2013. [pdf timestamp: 10/10/2013]

Table SL19. Wave period and other wave data (arranged by year and then alphabetically)

Data type	Location	Time Interval	Full Reference and Notes
[TIMESERIES] zero upcrossing wave period	Heidrun platform	Jan2007	Loginfo A/S, Heidrun EMS-Data, Monthly Report January 2007, Project No. 442, Completion date 25/02/2007, project manager JK fLoeken, executed by P-O Kjensli, approved by K Johansen
[TIMESERIES] zero crossing wave period	Ekofisk platform	Jan2007	MIROS, Ekofisk Monthly Report, January 2007, Doc. No. ND/1024/07/01, MIROS, 27pp, 11 Apr 2007
[TIMESERIES] peak period, zero crossing wave period, wave direction	Draugen platform	Jan2007	MIROS, Monthly Report, January 2007, Doc. No. ND/1022/07/01, Project Draugen - Met-Ocean Data Recording, 01/02/2007.
[TIMESERIES] peak period, zero crossing wave period, wave direction	Gullfaks C platform	Jan2007	MIROS, Maanedsrapport, januar 2007, Dok. nr. ND/1013/07/01, Prosjekt Gullfaks C - Naturdatainnsamling, 02/02/2007.
[TIMESERIES] peak period, zero crossing wave period, wave direction	Heimdal platform	Jan2007	MIROS, Maanedsrapport, januar 2007, Dok. nr. ND/1047/07/01, Prosjekt: Heimdal - Naturdatainnsamling, 21/03/2007
[TIMESERIES] wave direction	FINO1	18Jan2007 0600UTC - 19Jan2007 0600UTC	Neumann, T., FINO and the mast shadow effect, 52nd IEA Topical Expert Meeting, Wind and wave measurements at offshore locations, Berlin, Germany, February 2007, organized by TU Berlin and Germanischer Lloyd, International Energy Agency, Implementing Agreement for Co-operation in the Research, Development and Deployment of Wind Turbine Systems, Task 11.
[TIMESERIES] Wave period derived from 20 minute records	IJmuiden, Scheur West Wandelaar, Schiermonnikoog Noord, Eierlandse Gat	11-12Jan2007	RWS, Verslag van de stormvloed van 11 en 12 januari 2007 (SR85), Ministerie van Veerkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007a
[TIMESERIES] Wave period derived from 20 minute records	IJmuiden, Scheur West Wandelaar, Schiermonnikoog Noord, Eierlandse Gat	18-19Jan2007	RWS, Verslag van de stormvloed van 18 en 19 januari 2007 (SR86), Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007b
[SPECTRAL POLAR DIAGRAM] WAMOS II spectral wave energy	FINO1	18Jan2007 1800 UTC	Behrens, A. and H. Guenther, Operational wave prediction of extreme storms in Northern Europe, Nat. Hazards, 49, 387-399, 2009
[TIMESERIES] peak period and wave direction	Elbe, Helgoland, FINO1	10-15Jan2007	BSU, Loss overboard of 10 containers from JRS Canis at estuary of Elbe River on 12 January 2007 at 02:40, Investigation Report 45/07, Less Serious Marine Casualty, Bundestelle fuer Seeunfalluntersuchung, 1 October 2008.

Table SL20. Surge reports and quantitative water levels (arranged by year and then alphabetically)

Data type	Location	Time Interval	Full Reference and Notes
[TEXT] highest water level	IJsselmeer locations: Lemmer, Ketelhaven, Lelystad	18Jan2007	Bottema M, Zwaarste storm sinds 1990. Bijzondere golf- en waterhoogten IJsselmeer. Trendsinwater.nl. Monitoring van Nederlandse wateren: resultaten en ontwikkelingen. nummer 21, april 2007
[TABLE] True surge and water level for stations with the highest values of month and year	NTLSF stations in UK	Jan2007	Bradshaw, Elizabeth (ed), Annual Report for 2007 for the UK National Tide Gauge Network and Related Sea Level Science, National Tide and Sea Level Facility, NERC 100017897 2007, p.2
[TEXT] Skew surge	Hamburg	12Jan2007	KIT-CEDIM, Orkantiefs 'Franz' und 'Hanno'. Mitteleuropa, Suedskandinavien 11-14.1.2007, (contributors CE and BM) Wettergefahren-Fruehwarnung, Dientag, 16.Januar 2007, 04:00 MEZ http://www.wettergefahren-fruehwarnung.de/Ereignis/20070116_e.html
[TEXT] Skew surge	Bergen, Stavanger	14Jan2007	Kvamme, Dag, Ekstremvaer nr.1/2007 - 'Per', Intern Rapport, met.no, 15pp, Meteorogisk Institutt met.no, Bergen, 14/02/2007
[TABLE] highest water level	Ferring, Thyboren Havn, Thyboren Hav, Hirtshals, Skagen, Gabet	31Dec2006-02Jan2007	Kystdirektoratet, Hojvandsstatistikker 2007, Extreme sea level statistics for Denmark, 2007, Kystdirektoratet, Dec, 2007.
[TABLE] highest water level	Havneby, Ballum, Hvide Sand Hav, Thorsminde, Ferring, Thyboren Havn, Thyboren Hav, Hirtshals, Skagen, Kloster, Gabet, Koebenhavn	12Jan2007	Kystdirektoratet, Hojvandsstatistikker 2007, Extreme sea level statistics for Denmark, 2007, Kystdirektoratet, Dec, 2007.
[TABLE] highest water level	Ferring, Thyboren Hav Skagen, Bork, Skovlunde, Hesnaes, Ronne	14-15Jan2007	Kystdirektoratet, Hojvandsstatistikker 2007, Extreme sea level statistics for Denmark, 2007, Kystdirektoratet, Dec, 2007.
[TABLE] highest water level	Ferring, Hirtshals, Skagen, Ringkobing, Koebenhavn, Hesnaes, Ronne	18-20Jan2007	Kystdirektoratet, Hojvandsstatistikker 2007, Extreme sea level statistics for Denmark, 2007, Kystdirektoratet, Dec, 2007.
[TABLE] Maximum water level, average high tide 1986-1995, water level above average high tide	Stations along Germany North Sea coast, focussing on Schleswig-Holstein	12Jan2007	Land Schleswig-Holstein, Sturmflutereignis am 12.01.2007 (vorlaufige Wasserstande am Pegelmessstellen) Amt fuer laendliche Raume, Husum, Az: 5514, Stand: 12.01.2007 (emailed report from Maria Bluemel 13Jan2007)
[TEXT] Water level and skew surge	Den Helder	12Jan2007	Lloyds Casualty Week, 26Jan2007
[TIMESERIES] measured water level	Ekofisk platform	Jan2007	MIROS, Ekofisk Monthly Report, January 2007, Doc. No. ND/1024/07/01, MIROS, 27pp, 11 Apr 2007
[TIMESERIES] measured water level	Draugen platform	Jan2007	MIROS, Monthly Report, January 2007, Doc. No. ND/1022/07/01, Project Draugen - Met-Ocean Data Recording, 01/02/2007.
[TIMESERIES] measured water level	Heimdal platform	Jan2007	MIROS, Maanedsrapport, januar 2007, Dok. nr. ND/1047/07/01, Prosjekt: Heimdal - Naturdatainnsamling, 21/03/2007
[TIMESERIES] water level (scale make it difficult ot read at better than 10cm accuracy)	FINO1	18Jan2007 0600UTC-19Jan2007 0600UTC	Neumann, T., FINO and the mast shadow effect, 52nd IEA Topical Expert Meeting, Wind and wave measurements at offshore locations, Berlin, Germany, February 2007, organized by TU Berlin and Germanischer Lloyd, International Energy Agency, Implementing Agreement for Co-operation in the Research, Development and Deployment of Wind Turbine Systems, Task 11.
[TEXT] Highest water levels during storm expressed as metres above average high tide	Emden,Cuxhaven, Stadersand, Otterndorf, Vareler Schleuse, Fedderwardersiel, Brake, Ems-sperrwerk Gandersum	12Jan2007	NLWKN, Sturmflut am 12. Januar 2007: Nordseekueste kam glimpflich davon 12. Januar 2007 (aktualiert am 15. Januar 2007): Duenenabbrueche auf den ostfriesischen inseln https://www.nlwkn.niedersachsen.de/startseite/aktuelles/presse_und_offentlichkeitsarbeit/pressemitteilungen/-41838.html
[TEXT] Highest water levels during storm expressed as metres above average high tide	Norderney, Borkum, Emden, Cuxhaven, Bensersiel, Knock, Leyhoern, Wilhelmshaven, Bremerhaven, Stadersand, Huntesperrwerk, Ochtum-sperrwerk, Fedderwardersiel, Leuchtturm Alte Weser	18Jan2007	NLWKN, Sturmflut von 19.Januar: Es kam nicht so schlimm wie befurchtet. 19.Januar2007: keine Duenenabbruche auf den Inseln/Fuer das Wochenende wird erhoehtes tidewasser erwartet, 22/01/2007 https://www.nlwkn.niedersachsen.de/startseite/aktuelles/presse_und_offentlichkeitsarbeit/pressemitteilungen/-41867.html
[TIMESERIES] measured water level, astrnomical tide, surge	Vlissingen, Hoek van Holland, IJmuiden buiten haven, Den Helder, Harlingen, Delfzijl	11-12Jan2007	RWS, Verslag van de stormvloed van 11 en 12 januari 2007 (SR85), Ministerie van Veerkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007a
[TIMESERIES] measured	Vlissingen, Hoek van	18-19Jan2007	RWS, Verslag van de stormvloed van 18 en 19 januari 2007

water level, astrnomical tide, surge	Holland, IJmuiden buiten haven, Den Helder, Harlingen, Delfzijl		(SR86), Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007b
[TIMESERIES] measured water level	Harlingen	17-20Jan2007	Tonis, Rico, Handig online systeem waterstandvoorspellingen, Trendsinwater.nl. Monitoring van Nederlandse wateren: resultaten en ontwikkelingen. nummer 21, april 2007, p10.
[FIGURE WITH TEXT] water level, astronomical tide, surge residual	Cuxhaven	12Jan2007	Goennert, Gabriele & Thomas Buss, Sturmfluten zur Bemessung von Hochwasserschutzanlagen, Berichte des Landesbetriebes Strassen, Bruecken und Gewaesser Nr.2/2009, Freie und Hansestadt Hamburg, Landesbetrieb Strassen, Bruecken und Gewaesser, Hamburg, ISSN 1867-7959.
[FIGURE WITH TEXT] water level with Storm Franz peak labelled	Hamburg St Pauli, Harburg	23/12/2006-16/02/2007	Ge J, D Much, J Kappenberg, O Nino, P Ding, Z Chen, Simulating storm flooding maps over Hafencity under present and sea level rise scenarios, Journal of Flood Risk Management, 7, 319-331, 2014.
[TABLE] water level above mean high water	Norderney	12Jan2007	Kristandt, J., B. Brecht, H. Frank, H. Knack, Optimization of empirical storm surge forecast-modeling of high resolution wind fields, Die Kuste, 81, 301-348, 2014
[TABLE] water level above mean high water	Norderney	18Jan2007	Kristandt, J., B. Brecht, H. Frank, H. Knack, Optimization of empirical storm surge forecast-modeling of high resolution wind fields, Die Kuste, 81, 301-348, 2014
[TABLE] High water level and skew surge	Southend	18Jan2007 00:00	Environment Agency, Thames Barrier Project Pack 2018, January, 2018. Environment Agency. Thames Barrier View Cafe and Information Centre, 1 Unity Way, Woolwich, London, SE18 5NJ. email: thamesbarrierenquiries@environment-agency.gov.uk.
[TABLE] Skew surge	Wick, Leith, Whitby, Immingham, Cromer, Felixstowe, Harwich, Liverpool, Heysham, Workington, Port Erin, Portrush, Port Ellen, Franz, Ullapool	11-12Jan2007	NTSLF, Skew surge history, https://ntslf.org/storm-surges/skew-surges/scotland, https://ntslf.org/storm-surges/skew-surges/england-east, https://ntslf.org/storm-surges/skew-surges/england-south, https://ntslf.org/storm-surges/skew-surges/england-wales, https://ntslf.org/storm-surges/skew-surges/england_west, https://ntslf.org/storm-surges/skew-surges/isle-of-man, https://ntslf.org/storm-surges/skew-surges/northern-ireland, https://ntslf.org/storm-surges/skew-surges/channel-islands (accessed 10Nov2021)
[TABLE] skew surge	Hinkley Point, Avonmouth, Barmouth, Port Erin	18Jan2007	NTSLF, Skew surge history, https://ntslf.org/storm-surges/skew-surges/scotland, https://ntslf.org/storm-surges/skew-surges/england-east, https://ntslf.org/storm-surges/skew-surges/england-south, https://ntslf.org/storm-surges/skew-surges/england-wales, https://ntslf.org/storm-surges/skew-surges/england_west, https://ntslf.org/storm-surges/skew-surges/isle-of-man, https://ntslf.org/storm-surges/skew-surges/northern-ireland, https://ntslf.org/storm-surges/skew-surges/channel-islands (accessed 10Nov2021)
[TABLE] skew surge	Holyhead, Llandudno, Liverpool	13Jan2007	NTSLF, Skew surge history, https://ntslf.org/storm-surges/skew-surges/scotland, https://ntslf.org/storm-surges/skew-surges/england-east, https://ntslf.org/storm-surges/skew-surges/england-south, https://ntslf.org/storm-surges/skew-surges/england-wales, https://ntslf.org/storm-surges/skew-surges/england_west, https://ntslf.org/storm-surges/skew-surges/isle-of-man, https://ntslf.org/storm-surges/skew-surges/northern-ireland, https://ntslf.org/storm-surges/skew-surges/channel-islands (accessed 10Nov2021)
[TABLE] skew surge	Bangor, Millport	31Dec2006	NTSLF, Skew surge history, https://ntslf.org/storm-surges/skew-surges/scotland, https://ntslf.org/storm-surges/skew-surges/england-east, https://ntslf.org/storm-surges/skew-surges/england-south, https://ntslf.org/storm-surges/skew-surges/england-wales, https://ntslf.org/storm-surges/skew-surges/england_west, https://ntslf.org/storm-surges/skew-surges/isle-of-man, https://ntslf.org/storm-surges/skew-surges/northern-ireland, https://ntslf.org/storm-surges/skew-surges/channel-islands (accessed 10Nov2021)
[TABLE] water level	Thyboron	12Jan2007	Kystdirektoratet, De 10 hojest maalte vandstande langs Vestkysten, https://kyst.dk/kyster-og-klima/stormflod-og-beredskab/historiske-stormfloder-paa-vestkysten/, last access 09Mar2023.

Table SL21. Water current information (arranged by year and then alphabetically)

Data type	Location	Time Interval	Full Reference and Notes

Table SL22. Return period of water level; ranking of water level

Source	Full Reference and Notes
Dixon and Tawn (1994)	Dixon MJ and JA Tawn, Extreme sea-levels at UK A-class site: site-by-site analysis, Proudman Oceanographic Laboratory, Internal document No.65, March 1994, 234 pp -background information to calculate return period from measure water level -list of highest water levels for tide gauge stations around the UK but no dates or events information given
RWS (200701a)	RWS, Verslag van de stormvloed van 11 en 12 januari 2007 (SR85), Ministerie van Veerkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007a -TAB4. Exceedance frequency and classification Date Station Level Exceedance NAPcm frequency --- 11Jan 2HW Vlissingen 237 17000/100y 11Jan 2HW Roompot buiten 200 6300/100y 11Jan 2HW Hoek van Holland 185 1400/100y 11Jan 2HW Dordrecht 170 540/100y 11Jan 2HW IJmuiden buitenh 220 150/100y * 12Jan 1HW Den Helder 240 32/100y * 12Jan 1HW Harlingen 309 43/100y * 12Jan 1HW Delfzijl 378 24/100y * 12Jan 1HW Vlissingen 240 15000/100y * 12Jan 1HW Roompot buiten 210 3600/100y * 12Jan 1HW Hoek van Holland 180 1800/100y * 12Jan 1HW Dordrecht 179 350/100y *
RWS (200701b)	RWS, Verslag van de stormvloed van 18 en 19 januari 2007 (SR86), Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007 -TAB4. Exceedance frequency and classification Date Station Level Return NAPcm Period --- 18Jan 2HW Vlissingen 276 2200/100y 18Jan 2HW Roompot buiten 219 2100/100y 18Jan 2HW Hoek van Holland 178 1900/100y 18Jan 2HW Dordrecht 175 420/100y 18Jan 2HW IJmuiden buitenhav 224 140/100y 18Jan 2HW Den Helder 242 30/100y 18Jan 2HW Harlingen 331 19/100y 18Jan 2HW Delfzijl 322 110/100y 19Jan 2HW Vlissingen 277 2100/100y 19Jan 2HW Roompot buiten 223 1800/100y 19Jan 2HW Hoek van Holland 172 2100/100y 19Jan 2HW Dordrecht 183 290/100y
Kristandt et al (2014)	Kristandt, J., B. Brecht, H. Frank, H. Knack, Optimization of empirical storm surge forecast-modeling of high resolution wind fields, Die Kuste, 81, 301-348, 2014 -water level return period calculated from tabulated information -Storm Franz rank24 with return period 2.04y -Storm Kyrill rank38 with return period 1.29y
Environment Agency (2018)	Environment Agency, Thames Barrier Project Pack 2018, January, 2018. Environment Agency. Thames Barrier View Cafe and Information Centre, 1 Unity Way, Woolwich, London, SE18 5NJ. email: thamesbarrierenquiries@environment-agency.gov.uk. -water level return periods at Southend calculated from tabulated information -22Jan2007 Thames barrier Southend water level 4.04m, rank2 event (after Storm Xaver 2013), return period 17.46y -18Jan2007 Thames barrier Southend water level 3.76m, rank21 event, return period 1.66y -27Jan2007 Thames barrier Southend water level 3.72m, rank27 event, return period 1.29y

Table SL23. Return period of wind speed; ranking of wind speed

Source	Full Reference and Notes
BBC (20070118b)	BBC, Huge storms sweep northern Europe, 18Jan2007, 2234GMT, http://news.bbc.co.uk/2/hi/europe/6274377.stm -[KYRILL] UKMO winds reached severe gale force as they crossed Britain; highest since Jan1990
Belfast Telegraph (20070119)	Belfast Telegraph, Killer storms claim 13 lives (PA Reporters and Deborah McAleese), p.4, 19Jan2007. -at least 13 people died in Britain's worst storm in 17y as another death reported today
Deutsche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] -for Germany Kyrill was strongest storm event of past 30y (probably ref to Capella 1976)
DW (20070119)	DW, Killer winds in Europe expected to cause heavy financial loss, 18Jan2007 https://www.dw.com/en/killer-winds-in-europe-expected-to-cause-heavy-financial-loss/a-2317752 -Kyrill had most powerful winds for about 30 year (reference to Capella?)

Financial Times (20070119)	Financial Times, Fourteen die as storms lash north Europe (reporter: William MacNamara), 19Jan2007 -Met Office: wind strength did not match 1987 hurricane but larger geographic area -wind speeds highest recorded in UK for 17y
KNMI (20070118)	KNMI, Nieuwsbericht, De zware storm Kyrill van 18 januari 2007, 17 januari 2007, https://www.knmi.nl/over-het-knmi/nieuws/de-zware-storm-kyrill-van-18-januari-2007 -Germany estimated Kyrill had a return period of 10-20y -3. Most severe storm in 5 years -Jeanett: previous most severe storm 27Oct2002 with avg wspd Bf 10 -Jeanett: avg wspd 101km/h & gust 148km/h stronger than Kyrill -worst storm of recent decades was 25Jan1990 (Daria) -Daria: 70? fatalities; avg wspd Bf 11
Kvamme (20070214)	Kvamme, Dag, Ekstremvaer nr.1/2007 - 'Per', Intern Rapport, met.no, 15pp, Meteorogisk Institutt met.no, Bergen, 14/02/2007 -[HANNO/PER] captain of Color Lines ferry Prinsesse Ragnhild from Hirtshals to Stavanger declares it is the strongest wind he has seen in 13 y
Tetzlaff (2007)	Tetzlaff, G, Der Orkan Kyrill, INFO, DKKV Deutsches Komitee Katastrophenvosorge e.V., pp.1-2, Februar/Maerz 2007, No. 1+2/2007 -Storm Kyrill in Germany was 50y event
SMHI (20090806)	SMHI, Per - Januaristormen 2007, 6Aug2009, https://www.smhi.se/kunskapsbanken/meteorologi/per-januaristormen-2007-1.5287 -[HANNO/PER] FIG4. [MAP] Calculated return period for wind gusts during storm Per
Tetzlaff (2009)	Tetzlaff, G., Extreme rain and wind storms in the mid-latitudes I, Singapore, 21-22.04.2009. https://imsarchives.nus/edu.sg/oldwww/Programs/09fluidss/files/Gerd Tetzlaff.pdf (Spring School on Fluid Mechanics and Geophysics of Environmental Hazards, Singapore, April 19-May 2, 2009) [pdf datestamp: 14/05/2009] -very high wind gust at Duesseldorf airport assessed at 100 year return period
Esurge (20121111)	Esurge_2007_kyrill(2012), Triple storm even (2007), Philip Harwood, Sun, 2012/11/11 15:04 -[KYRILL] maximum wind gust Belmullet 81kt; highest gust since 1999
Petroliagis and Pinson (2014)	Petroliagis TI and P Pinson, Early warnings of extreme winds using the ECMWF Extreme Forecast Index, Meteorological Applications, 21, 171-185, 2014. *FIG7. Time series of daily max wind speed values for Hannover over the period 2374 days (1Dec2003 to 31May2010) in Reanalysis mod. Peak values corresponding to Kyrill, Emma, Herbert and Xynthia storms are highlighted. -Kyrill had the highest wind speed of the period

Table SL24. Return period of insurance loss; ranking of insurance loss

Source	Full Reference and Notes
Swiss Re (2007)	Swiss Re, Sigma, Natural catastrophes and man-made disasters in 2007: high losses in Europe, No1., 2007. authors: Rudolf Enz, Kurt Karl, Jens Mehlhorn, Susanna Schwarz -Kyrill rank1 insurance loss 2007, -Kyrill rank 3 European storm after Daria and Lothar
Wetteronline (20070118)	Wetteronline, Orkan Kyrill tobt in Europa, 18Jan2007 22:00, https://www.wetteronline.de/wetterticker/orkan-kyrill-tobt-in-europa--UZiFNRdrmvxoC3RHqLLyU -Kyrill counts under hurricane series in winter 1990 & Lothar Dec 1999 as most serious storm occurrence in Germany of last 20 year -caused damage of approx 8 billion EUR of which 4.5 billion EUR in Germany
Dotzek et al (2010)	Dotzek N, S Emeis, C Lefevre, J Gerpott, Waterspouts over the North and Baltic Seas: Observations and climatology, prediction and reporting, Meteorologische Zeitschrift, 19, 115-129, 2010. -waterspouts expected to occur at an offshore wind farm in Germany every second year by 2020
Donat et al (2011)	Donat MG, T Pardowitz, GC Leckebusch, U Ulbrich, O Burghoff, High resolution refinement of storm loss model and estimation of return periods of loss-intensive storms over Germany, Nat Hazards Earth Syst Sci, 11, 2821-2833, 2011 -return period of storm Kyrill (most severe event VGV data 1997-2007) 15, 17-18, 21y -uncertainty 9-43y -Kyrill ranked 1 of 34 storm events in insurance database from 1997-2008 -Kyrill ranked 2 of 30 in VGV_sim insurance records from 1984-2008 -Kyrill ranked 7 of 30 for insurance losses in Germany in NCEP storm database from 1948-2009 -statistical model of return period: Generalized Pareto Distribution GPD -peaks over threshold approach (POT)
Roberts et al (2014)	Roberts JF, AJ Champion, LC Dawkins, KI Hodges, LC Shaffrey, DB Stephenson, MA Stringer, HE Thornton, DB Youngman, The XWS open access catalogue of extreme European windstorms from 1979 to 2012, Nat. Hazards Earth Syst. Sci, 14, 2487-2501, 2014 -rank 3 insurange loss after Daria and Lothar
Statistica (20151208)	Statistica, The costliest winter storms ever to hit Europe. Fatalities and financial losses of Europe's 10 costliest winter storms (source Munich Re), 08Dec2015 -rank 2 of 10 worst European winter storms ever in terms of insurance losses
Pantillon et al (2017)	Pantillon, F., P. Knippertz, U. Corsmeier, Revisiting the synoptic-scale probability of severe European winter storms using ECMWF ensemble reforecasts, Nat. Hazards Earth Syst. Sci., 17, 1795-1810, 2017. -Kyrill was one 4 highest insurance loss storms, along with Lothar, Klaus, Martin
Tatge (2017)	Tatge, Yorn, Kyrill the winter storm that walloped most of Europe, https://www.air-worldwide.com/blog/posts/2017/1/kyrill-the-winter-storm-that-walloped-most-of-europe/, Verrisk, 19Jan2017 -among 40 greatest insurance losses of al time -except for Daria 1990 no event caused as much damage in 30y

Table SL25. Storm trajectory map (arranged by year and then alphabetically)

Source	Full Reference and Notes
FU-Berlin (20070312)	FU-Berlin, Lebensgeschichte. Tiefdruckgebiet Franz (getauft am 09.01.2007) (written on 12/03/2007 by R. Loewenherz), https://www.met.fu-berlin.de/wetterpate/lebensgeschichten/Tief_FRANZ_09_01_07.htm -description of life cycle including how low pressure centre split into two FRANZ I and FRANZ II
RWS (200701a)	RWS, Verslag van de stormvloed van 11 en 12 januari 2007 (SR85), Ministerie van Veerkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007a -FIG.A2a. [MAP] Map of sea level air pressure 11Jan2007 1300M 1200UTC with trajectory
RWS (200701b)	RWS, Verslag van de stormvloed van 18 en 19 januari 2007 (SR86), Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007b FIG_A2a. [MAP] map surface air pressure 18Jan2007 1900MET (1800UTC) NOTE: TRAJECTORY NOTE: central air pressure development does not indicate explosive cyclogenesis
Unwetterzentrale_Kyrill (200701b)	Unwetterzentrale, Orkantief KYRILL: Ausführliche Analyse der Wetterlage, www.unwetterzentrale.de/uwz/355.html, page accessed 21Aug2022. FIG: [MAP] Kyrill trajectory and central pressure 18Jan2007 0100MEZ to 19Jan2007 1800MEZ. Map shows area of hurricane and storm gusts stretching into mid-France, N Italy, Austria, Hungary, Ukraine, Beloruss. Storm trajectory across N coast of Poland & across S Baltic states
Behrens and Guenther (2009)	Behrens, A. and H. Guenther, Operational wave prediction of extreme storms in Northern Europe, Nat. Hazards, 49, 387-399, 2009 -FIG1: [MAP] Britta & Kyrill trajectory selected for cross North Sea tracks
SMHI (20090806)	SMHI, Per - Januaristormen 2007, 6Aug2009, https://www.smhi.se/kunskapsbanken/meteorologi/per-januaristormen-2007-1.5287 -FIG1. [MAP] Low pressure trajectory every 3h from 01:00 13Jan to 04:00 15Jan
Tetzlaff (2009)	Tetzlaff, G., Extreme rain and wind storms in the mid-latitudes I, Singapore, 21-22.04.2009. https://imsarchives.nus/edu.sg/oldwww/Programs/09fluidss/files/Gerd Tetzlaff.pdf (Spring School on Fluid Mechanics and Geophysics of Environmental Hazards, Singapore, April 19-May 2, 2009) [pdf datestamp: 14/05/2009] S23. [MAP] Storm trajectory map from Meteomedia with low P positions and values at 6h intervals 18Jan2007 0100MEZ to 19Dan2007 1900MEZ; color areas for hurricane gusts on rightside of trajectory (Ireland to Belarus & Denmark to northern Italy) & storm gusts Note on fast propagation speed of low P 18Jan2007 0100MEZ to 19Jan2007 0100MEZ of 100km/h with constant core pressure
Pinto et al (2014)	Pinto JG, I Gomara, G Masato, HF Dacre, T Woolings, R Caballero, Large-scale dynamics associated with clustering of extratropical cyclones affecting Western Europe, J Geophys Res Atmos, 119, 13704-13719, 2014. -trajectories for many cyclones in Jan 2007, including: -Storm Lothar 25/12/1999 -Storm Martin 28/12/1999 -Storm Franz 11/01/2007 -Storm Gerhard 12/01/2007 -Storm Hanno/Per 13/01/2007 -Storm Ikarus 15/01/2007 -Storm Kyrill 18/01/2007 -Storm Lancelot 20/01/2007
Roberts et al (2014)	Roberts JF, AJ Champion, LC Dawkins, KI Hodges, LC Shaffrey, DB Stephenson, MA Stringer, HE Thornton, DB Youngman, The XWS open access catalogue of extreme European windstorms from 1979 to 2012, Nat. Hazards Earth Syst. Sci, 14, 2487-2501, 2014 -FIG2. [MAP] Footprints of storms 4769, 4773 (Dieter), 4872 (Kyrill), 4774 (Lancelot) made by taking the maximum gusts over the whole domain (contaminated) NOTE: KYRILL STORM COMPLEX -FIG3. [MAP] As FIG2 but footprints were decontaminated using the method described in Section 2.2.3. The track of each storm is overplotted to show the relationship between storm track and footprint.
Rohman (2014)	Rohman, J., European Extratropical Cyclones. Implications for local insurers, TransRe, May 2014 FIG8. Various storm tracks of those listed in TAB1. Normal path of most storms is from WSW to ENE. The remaining storms with the aforementioned path take unusual routes through the North Atlantic and Europe.
Ludwig et al (2015)	Ludwig P, JG Pinto, SA Hoepp, AH Fink, SL Gray, Secondary cyclogenesis along an occluded front leading to damaging wind gusts: Windstorm Kyrill, January 2007, Monthly Weather Review, 143, 1417-1437, 2015 -FIG2. Comparison of (a) cyclone tracks and (b) core pressure evolution of the CCLM simulations for Kyrill I and II: the 6h ERA-Interim data for Kyrill I/Kyrill II, hourly CCLM 25km grid spacing data for Kyrill I/Kyrill II, and hourly CCLM 7km grid spacing data for Kyrill I/Kyrill II. All Kyrill I (Kyrill II) tracks in (a) end (start) at 0000 UTC 18Jan
Tatge (2017)	Tatge, Yorn, Kyrill the winter storm that walloped most of Europe, https://www.air-worldwide.com/blog/posts/2017/1/kyrill-the-winter-storm-that-walloped-most-of-europe/, Verrisk, 19Jan2017 -FIG1. [MAP] Maximum wind speed footprint and track (trajectory) of Kyrill (AIR)

Table SL26. Unusual pressure drop; time series central pressure; explosive characteristics; bomb; unusually low central pressure (arranged by year and then alphabetically)

Source	Full Reference and Notes
Air Worldwide (20070116)	Air Worldwide, European winter storm Per, 16Jan2007 10:30AM https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-per/first-posting/ -minimum central pressure 970mb
EUMETSAT (20070101)	EUMETSAT, Winter storm Kyrill leaves a trail of destruction, 17 Jan2007 1500UTC, https://www.eumetsat.int/winter-storm-kyrill-leaves-trail-destruction (authors: Jochem Kerkmann & Hans Peter Roesli (EUMETSAT); Maria Putsay (Hungarian Meteorological Service); Martin Setvak & Petr Novak (CHMI)) -Kyrill travelled across Atlantic at v high speed 17Jan 0600UTC-18Jan1700UTC without deepening
Kvamme (20070214)	Kvamme, Dag, Ekstremvaer nr.1/2007 - 'Per', Intern Rapport, met.no, 15pp, Meteorogisk Institutt met.no, Bergen, 14/02/2007 -[HANNO/PER] low pressure center deepened at rate of 1hPa/h for 24h from 12Jan2007 12:00UTC -low P deepened at 2hPa/h from Saturday afternoon as it crossed northern part of North Sea
Loginfo A/S (20070225)	Loginfo A/S, Heidrun EMS-Data, Monthly Report January 2007, Project No. 442, Completion date 25/02/2007, project manager JK fLoeken, executed by P-O Kjensli, approved by K Johansen -3 intervals showing cyclonic bomb in Jan2007 at Heidrun platform
Mariners Weather Log (200708)	Mariners Weather Log, vol. 51, No. 2, Aug 2007, Marine Weather Review - North Atlantic Area, January through April 2007, Bancroft, GP, https://www.vos.noaa.gov/MWL/aug_07/northatlantic.shtml -storm Franz: during initial 24h central pressure dropped 28mb making this a meteorological bomb \ -storm Franz: central pressure 950hPa S of Iceland made hurricane force low one of deepest of period
RWS (200701)	RWS, Verslag van de stormvloed van 18 en 19 januari 2007 (SR86), Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007 FIG_A2a. [MAP] map surface air pressure 18Jan2007 1900MET (1800UTC) NOTE: TRAJECTORY NOTE: central air pressure development does not indicate explosive cyclogenesis
Unwetterzentrale_Franz (200701)	Unwetterzentrale, Orkantief FRANZ - 11.,12.01.2007 (Tief Nr. 29), prepared by Manfred Spatzierer and Stefan Laps http://www.unwetterzentrale.de/uwz/347.html -peak wind gusts Shetland Islands & mainland 133-165km/h; lighter gusts at North Rona -sudden development of low P also visible in pressure decrease -in GB, Scotland & North Sea, air pressure decreased up to 14.0hPa in 3 h; -average wind speed 13:00-13:10 MEZ of 108 km/h; air pressure increased 3.2 hPa in 10min behind front [PRESSURE INCREASE IMMEDIATELY AFTER PASSAGE OF COLD FRONT]
Unwetterzentrale_Kyrill (200701b)	Unwetterzentrale, Orkantief KYRILL: Ausführliche Analyse der Wetterlage, www.unwetterzentrale.de/uwz/355.html, page accessed 21Aug2022. -rapid development of storm showed in rapid P fall in Ireland & England 14.2hPa in 3h -behind cold font, air pressure Ireland and UK jumped up to 13.6hPa in 3h -ship report 1300 over North Sea reported pressure drop 14.2hPa in 3h -in N Ireland pressure increase 15.1 hPa in same time frame -largest pressure increase in west and central Europe from Denmark at 18.6hPa over 3h
Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -'Upper level flow steered the surface depression north-eastward out on the Western North Atlantic Ocean to the southeast of Nova Scotia where it started to undergoe an explosive cylogenesis, i.e., the core pressure of Kyrill I deepened by more than 24 hPa for example between 12:00UTC 16Jan (998hPa) and 12:00UTC 17Jan2007 (968hPa). This rapid intensification was asociated with the poleward crossing of the strong polar jet steram with winds in excess of 200 kn corresponding to 103 m/s'
Gardiner (2010)	Gardiner, Barry, Appendix 3: Background information on 11 storms selected for detailed analysis, European Forest Institute, Atlantic European Regional Office - EFIAtlantic, 161 pp. [PDF properties: datestamp 23Jul2010] -North Atlantic 1.8C warmer than average -circumstances advantageous for explosive development of low pressure centre
Ludwig et al (2015)	Ludwig P, JG Pinto, SA Hoepp, AH Fink, SL Gray, Secondary cyclogenesis along an occluded front leading to damaging wind gusts: Windstorm Kyrill, January 2007, Monthly Weather Review, 143, 1417-1437, 2015 -'Kyrill underwent explosive cyclogenesis [pressure drop of more than 24hPa in 24 h at 60N] over the northeastern Atlantic between 1200UTC 16Jan (998hPa) and 1200UtC 17Jan (968hPa)'
Tatge (2017)	Tatge, Yorn, Kyrill the winter storm that walloped most of Europe, https://www.air-worldwide.com/blog/posts/2017/1/kyrill-the-winter-storm-that-walloped-most-of-europe/, Verrisk, 19Jan2017 -Kyrill strong with min central pressure 965mb as it approached UK

Table SL27. Horizontal pressure gradient

Source	Full Reference and Notes
Unwetterzentrale_Franz (200701)	Unwetterzentrale, Orkantief FRANZ - 11.,12.01.2007 (Tief Nr. 29), prepared by Manfred Spatzierer and Stefan Laps http://www.unwetterzentrale.de/uwz/347.html -in GB, Scotland & North Sea, air pressure decreased up to 14.0hPa in 3 h; increase in pressure up to 6.9hPa in central Europe behind Dieter -significant pressure gradient set up
Unwetterzentrale_Kyrill (200701b)	Unwetterzentrale, Orkantief KYRILL: Ausführliche Analyse der Wetterlage, www.unwetterzentrale.de/uwz/355.html, page accessed 21Aug2022. -pressure difference between St Peter Ordning 973hPa and Oberrhein Stuehlingen 1015hPa was 42hPa -such a large pressure difference had not been observed in central Europe for many years

	-Pressure difference Vivian Feb1990 at 37hPa; Anatol Dec1999 at 44hPa; Jeanett Oct2002 at 41hPa

Table SL28. Low level jet

Source	Full Reference and Notes

Table SL29. Sting Jet

Source	Full Reference and Notes
Fink et al (2007)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -'... the existence of a sting jet cannot be verified in the case of Kyrill II'
Tatge (2017)	Tatge, Yorn, Kyrill the winter storm that walloped most of Europe, https://www.air-worldwide.com/blog/posts/2017/1/kyrill-the-winter-storm-that-walloped-most-of-europe/, Verrisk, 19Jan2017 -AIR meteorologists: Kyrill may have included 1 or more sting jets causing extreme localized damage -broad brush events are elongated and north-south oriented cold front; frontal orientation allows for very broad wind footprint

Table SL30. Radiosonde analysis

Source	Full Reference and Notes
Fink et al (2007)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -FIG4. Skew T-log p diagram of (a) Lindenberg and (b) Larkhill on 18Jan2007 1200UTC & 1800UTC. Solid lines represent temperature. Dashed thick lines represent dew point. Height of tropopause given by T. Wind barbs only for Lindenburg 1800UTC. At Larkhill surface values taken several minutes in advance of ascent; not representative of launch at 1126UTC
Tetzlaff (2007)	Tetzlaff, G, Der Orkan Kyrill, INFO, DKKV Deutsches Komitee Katastrophenvosorge e.V., pp.1-2, Februar/Maerz 2007, No. 1+2/2007 -reference to wind speed at 9km altitude of 300km./h
Gatzen et al (2011)	Gatzen C., T. Pucik, D. Ryva, Two cold-season derechoes in Europe, Atmospheric Research, 100, 740-748, 2011 -FIG7. Soundings at Lindenberg for (a) 18Jan 18 UTC and (b) 01Mar 06 UTC. Location in FIG3.
Ludwig et al (2015)	Ludwig P, JG Pinto, SA Hoepp, AH Fink, SL Gray, Secondary cyclogenesis along an occluded front leading to damaging wind gusts: Windstorm Kyrill, January 2007, Monthly Weather Review, 143, 1417-1437, 2015 -reference to analysis of Lindenburg radiosonde (not shown) for vertical convective structure and gradient Richardson number
Gatzen et al (2020)	Gatzen CP, AH Fink, DM Schultz, JG Pinto, An 18-year climatology of derechos in Germany, Nat Hazards Earth Syst. Sci., 20, 1335-1351, 2020 -'to study thermodynamic environments in which derechos in Germany form, we used proximity soundings... soundings had to be taken within 150km and 2h of the derecho path' -'parameters such as mixed layer CAPE were taken from the University of Wyoming sounding data archive (http://weather.uwyo.edu/upperair/sounding.html)'

Table SL31. Stable/unstable atmospheric boundary layer

Source	Full Reference and Notes
Neumann (200702)	Neumann, T., FINO and the mast shadow effect, 52nd IEA Topical Expert Meeting, Wind and wave measurements at offshore locations, Berlin, Germany, February 2007, organized by TU Berlin and Germanischer Lloyd, International Energy Agency, Implementing Agreement for Co-operation in the Research, Development and Deployment of Wind Turbine Systems, Task 11. -stable boundary conditions during 6h period of highest winds during Storm Kyrill 18Jan2007 1700-2400
Ludwig et al (2015)	Ludwig P, JG Pinto, SA Hoepp, AH Fink, SL Gray, Secondary cyclogenesis along an occluded front leading to damaging wind gusts: Windstorm Kyrill, January 2007, Monthly Weather Review, 143, 1417-1437, 2015 -gradient Richardson number analsysis of model fields to understand turbulence in boundary layer and upper atmosphere

Table SL32. Problems with drag coefficient & forecasting wind setup at high wind speeds > 25m/s

Source	Full Reference and Notes
Jensen and Mueller-Navarra (2008)	Jensen J, SH Mueller-Navarra, Storm surges on the German coast, Die Kueste, 74 ICCE (2008), 92-124. -'the third point 'Stratification and wind profile ' is a problem often overlooked. Although it has been a reseearch topic in meteorology for many years, gaps of knowledge concerning the atmosphere/ocean impulse transfer at very high wind speeds still exist...In a situation of unstable stratification, wind gustines can increase wind streass and water set-up on the coasts; such conditions probably prevailed during the storm surge caused by the Hamburg hurricane. An inflow of cold airon November 12/13, 1872, probably contributed to the extreme peak levels reached during the storm surge of November 13, 1872'

Table SL33. Strong jet stream & Rossby wave breaking

Source	Full Reference and Notes
Deutsche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] -Kyrill intensified under influence of polar jet over N Ireland at 962hPa &

	reached hurricane strength
EUMETSAT (20070117)	EUMETSAT, Winter storm Kyrill leaves a trail of destruction, 17 Jan2007 1500UTC, https://www.eumetsat.int/winter-storm-kyrill-leaves-trail-destruction (authors: Jochem Kerkmann & Hans Peter Roesli (EUMETSAT); Maria Putsay (Hungarian Meteorological Service); Martin Setvak & Petr Novak (CHMI)) FIG. [SATIMAGE] Met-8 18Jan2007 0900UTC Channel 05 (WV6.2) + height of 1.5PVU (WV6.2=wind vector 6.2km?) (source: Meteo France) [satellite wind vectors 170kt over Ireland * midlands] [NOTE: high wind vector over N Germany, Denmark, S Sweden] FIG. [SATIMAGE] Met-8 18Jan2007 0900UTC RGB Composite (Airmass) + height of 2.0PVU WV6.2-WV7.3, IR9.7-IR10.8, WV6.2 (source:Hungarian Meteorological Service) [NOTE: PV2.0 surface dips to 4000m in wind jet over Ireland and UK]
KNMI (20070118)	KNMI, Nieuwsbericht, De zware storm Kyrill van 18 januari 2007, 17 januari 2007, https://www.knmi.nl/over-het-knmi/nieuws/de-zware-storm-kyrill-van-18-januari-2007 -storms followed one after the other -strong jet stream at 10km
Unwetterzentrale_Franz (200701)	Unwetterzentrale, Orkantief FRANZ - 11.,12.01.2007 (Tief Nr. 29), prepared by Manfred Spatzierer and Stefan Laps http://www.unwetterzentrale.de/uwz/347.html -during night to 11Jan, lowP moved with massive strengthening past south of Iceland -because of significant temperature difference between cold air behind & warm air in front Franz had formed an extensive North Atlantic storm complex -storm transported rapidly to east on Jet Stream -LowP transported eastwards over Atlantic by very strong Jet Stream at 140-150kt (259-278 km/h) -on front side of low warm subtropical air tapped; directed north into central Europe -on backside polar air from Greenland and Denmark Strait tapped
Unwetterzentrale_Kyrill (200701b)	Unwetterzentrale, Orkantief KYRILL: Ausführliche Analyse der Wetterlage, www.unwetterzentrale.de/uwz/355.html, page accessed 21Aug2022. -Kyrill: strong Jet stream transported low in night to 18Jan rapidly eastwards across Atlantic
Tetzlaff (2009)	Tetzlaff, G., Extreme rain and wind storms in the mid-latitudes I, Singapore, 21-22.04.2009. https://imsarchives.nus/edu.sg/oldwww/Programs/09fluidss/files/Gerd Tetzlaff.pdf (Spring School on Fluid Mechanics and Geophysics of Environmental Hazards, Singapore, April 19-May 2, 2009) [pdf datestamp: 14/05/2009] -S24. [MAP] wind at 300hPa at 100m/s 19/01/2007 00GMT; polar jetstream; band across southern Scotland, Netherlands, into Germany
Gardiner (2010)	Gardiner, Barry, Appendix 3: Background information on 11 storms selected for detailed analysis, European Forest Institute, Atlantic European Regional Office - EFIAtlantic, 161 pp. [PDF properties: datestamp 23Jul2010] -further advantageous factor: large temperature extremes across small horiz scale 200-300km & largely undisturbed stream at 500-200hPa level at 5-13km in Jet Stream -centre of cyclone directly under Jet Stream; strengthening effect on low pressure dev
Pinto et al (2014)	Pinto JG, I Gomara, G Masato, HF Dacre, T Woolings, R Caballero, Large-scale dynamics associated with clustering of extratropical cyclones affecting Western Europe, J Geophys Res Atmos, 119, 13704-13719, 2014. -analysis of persistent jet stream through most of January 2007 with Rossby wave breaking on each side

Table SL34. Storm clustering; upstream/downstream cyclogenesis

Source	Full Reference and Notes
KNMI (20070118)	KNMI, Nieuwsbericht, De zware storm Kyrill van 18 januari 2007, 17 januari 2007, https://www.knmi.nl/over-het-knmi/nieuws/de-zware-storm-kyrill-van-18-januari-2007 -storms followed one after the other -strong jet stream at 10km -Feb2002 also period of consecutive storms; storm on 26Feb2002 -Jan-Feb1990 was period of consec storms with serious storms 25Jan1990 & 26Feb1990
Unwetterzentrale Franz (200701)	Unwetterzentrale, Orkantief FRANZ - 11.,12.01.2007 (Tief Nr. 29), prepared by Manfred Spatzierer and Stefan Laps http://www.unwetterzentrale.de/uwz/347.html -west component of jet stream had been sending storm lows to central Europe over previous week
Air Worldwide (20100920)	Air Worldwide (Zuba, Gerhard and Milan Simic), European Windstorms: Implications of storm clustering on definitions of occurrence losses, Air Currents, 20Sep2010. https://www.air-worldwide.com/publications/air-currents/2010/European-Windstorms--Implications-of-Storm-Clustering-on-Definitions-of-Occurrence-Losses/ -Kyrill part of storm cluster with Hanno in 2007 -other noted storm clusters: -winter 1989-1990: 8 consecutive storms in quick succession -Daria: strongest, highest wind speeds ever recorded in Europe -almost 100 killed; >4 bill EUR(1990) insured damage -1999 -Lothar & Martin: insured loss >6 bill EUR(1999); separated by 36h -2007 -Hanno-Kyrill -2008 -Johanna-Kirsten-Emma

	-2010 -Wera-Xynthia -Norwegian meteorologists 1920s: cyclone families; parent cyclone spawn one or more others
Pinto et al (2014)	Pinto JG, I Gomara, G Masato, HF Dacre, T Woolings, R Caballero, Large-scale dynamics associated with clustering of extratropical cyclones affecting Western Europe, J Geophys Res Atmos, 119, 13704-13719, 2014. -storm clustering in Jan-Feb1990, Dec1999, 1993, Jan2007 -secondary cyclogenesis upstream & downstream -model of clustering mechanism in jet stream inflow & outflow regions.
Tatge (2017)	Tatge, Yorn, Kyrill the winter storm that walloped most of Europe, https://www.air-worldwide.com/blog/posts/2017/1/kyrill-the-winter-storm-that-walloped-most-of-europe/, Verrisk, 19Jan2017 -propensity of storms to arrive in clusters

Table SL35. Squall line, convective thunderstorms, tornadoes (arranged by year and then alphabetically)

Source	Full Reference and Notes
Deutsche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] -cold front developed in north & east Germany; pushed into tropical, moist air mass -formed thunderstorm convection line -at least 2 tornadoes in convection line: Wittenburg & Lauchhammer -passage of cold front ppt to 20L/m2; some places > 30L/m2 -strongest wind gusts linked to cold front passage; Germany was worst impacted country -numerous thunderstorms developed along the cold front; esp Westfalen, Sachsen-Anhalt, Brandenburg, Berlin, Sachsen -Wittenburg: F2-F3 tornado 181-332km/h winds caused damage mill EUR -2 other tornadoes in Brandenburg: F3 in Lauchhammer & Brachwitz-Kemnitz (254-332km/h)
KIT-CEDIM (20070116)	KIT-CEDIM, Orkantiefs 'Franz' und 'Hanno'. Mitteleuropa, Suedskandinavien 11-14.1.2007, (contributors CE and BM) Wettergefahren-Fruehwarnung, Dientag, 16.Januar 2007, 04:00 MEZ http://www.wettergefahren-fruehwarnung.de/Ereignis/20070116_e.html -FRANZ: with approach of frontal system wind strengthened -FRANZ: after front passage late evening, winds in these regions gradually abated -HANNO: warm front crossed northern Germany 13Jan to east -HANNO: Cold front from northwest on 14Jan; reached Alps on afternoon; storm gusts moved eastward (Angermuende 104km/h, Berlin-Tempelhof 94km/h)
EUMETSAT (20070117)	EUMETSAT, Winter storm Kyrill leaves a trail of destruction, 17 Jan2007 1500UTC, https://www.eumetsat.int/winter-storm-kyrill-leaves-trail-destruction (authors: Jochem Kerkmann & Hans Peter Roesli (EUMETSAT); Maria Putsay (Hungarian Meteorological Service); Martin Setvak & Petr Novak (CHMI)) FIG. [RADAR] Czech radar composite 18Jan2007 2030UTC (18Jan 1700-19Jan 0200UTC, source: CHMI) [NOTE: Squall line stretching E-W scross N Bohemia] FIG. [SATIMAGE] Meteosat-8 RGB Composite (Airmass RGB) Met-8, 18Jan2007 2000UTC RGB Composite WV6.2-WV7.3, IR9.7-IR10.8, WV6.2 [NOTE: derecho cloud band across NW Poland, Czech Republic, Bavaria]
KNMI (20070118)	KNMI, Nieuwsbericht, De zware storm Kyrill van 18 januari 2007, 17 januari 2007, https://www.knmi.nl/over-het-knmi/nieuws/de-zware-storm-kyrill-van-18-januari-2007 -KYRILL 2. Very severe wind gusts deep inland -Kyrill had wind gusts 120-130km/h -highest wind gust Wilhelminadorp 133km/h -also severe wind gusts inland at 110-120km/h -highest wind gust inland 124 km/h -LANCELOT -storm following weekend 20-21Jan2007; Bf 9 with wind gusts -Hoek van Holland gust 115km/h -new damage at Velserbroek -possible tornado (windhoos?) -windhozen occur primarily in summer -Dec2006 tornado in London caused enormous damage
Met Eireann (200711)	Met Eireann, Monthly Weather Bulletin, No 249, Jan 2007 -time of gusts at different Ireland stations on 18Jan2007 indicates passage of two squall systems
Mueller-Westermeier (2007)	Mueller-Westermeier, Gerhard, Beschreibung un klimatologische Bewertung des Orkantiefs "Kyrill", pdf properties: Title: Deutscher Wetterdients - Nationale Klimauberwachung, Author: Gerhard Mueller-Westermeier, Subjet: Orkan Kyrill, datestamp: 26Jan2007 -tornado at Wittenburg causes damage
Tetzlaff (2007)	Tetzlaff, G, Der Orkan Kyrill, INFO, DKKV Deutsches Komitee Katastrophenvosorge e.V., pp.1-2, Februar/Maerz 2007, No. 1+2/2007 -confirmed occurrence of F2 tornado at Wittenburg
Unwetterzentrale_Franz (200701)	Unwetterzentrale, Orkantief FRANZ - 11.,12.01.2007 (Tief Nr. 29), prepared by Manfred Spatzierer and Stefan Laps http://www.unwetterzentrale.de/uwz/347.html -between 14:00-15:00 MEZ cold front of low pressure crossed Ostfriesen islands

	-diverse models forecast massive wind changes along a narrow line of showers; thunderstorm downpours and large danger of hurricane gusts -Borkum reached peak wind speed 178km/h -UWZ meteorologists thought possible the passage of a waterspout; viewing the local storm damage indicated that the development of a waterspout could not be ruled out;... -analysis of 10min data of the station showed a normal front passage with significant convective activity -average wind speed 13:00-13:10 MEZ of 108 km/h; air pressure increased 3.2 hPa in 10min behind front -weather situation meant signficant tornado potential not ruled out; radial wind speed in area of squall line gave suspicious signature -UWZ meteorologists gave warning of strong rain showers and thunderstorms of highest arning level with hints of tornadoes -on late afternoon and evening the cold front passed the western & middle part of Germany & shifted further to the south -storm gusts 90-100km/h spread out -observed damage indicated hurricane gusts of 110km/h or more: many uprooted trees, damaged roofs, damage by flying objects -on evening of 11Jan in southern Germany, classic channelizing effect on front side of cold front between Schwarzwald and Alps: strong west wind between cold front and orographic barrier. -leads to hurricane gusts of 144km/h on Feldberg and 152km/h on Zugspitze -Wendelstein gusts to 187km/h on night 12Jan -also hurricane gusts in Alpenhauptkamm: 161km/h on Feuerkogel in Austria -hurricane gusts to 107km/h in Alpenvorland from convective structure at front -long periods of rainfall in Mittelgebirgen with 6h totals 10-13 L/m2 -on Brocken in Harz significant snowstorm
Unwetterzentrale_Kyrill (200701a)	Unwetterzentrale, Orkantief KYRILL - 18., 19.01.2007 (Tief Nr. 33) - Der schwerste Orkan seit Jahrzehnten, analysis by Manfred Spatzierer, Thomas Sävert, Stefan Laps, www.unwetterzentrale.de/uwz/348.html -afternoon & evening 18Jan2007, cold front crossed Germany from NW to SE; organized convection cells & thunderstorms -Luthurstadt Wittenburg confirmed suspected F2 or F3 tornadoes -significant damage in Brandenburg by two F3 tornadoes -3 tornados caused several 10's mill EUR damage
Unwetterzentrale_Kyrill (200701b)	Unwetterzentrale, Orkantief KYRILL: Ausführliche Analyse der Wetterlage, www.unwetterzentrale.de/uwz/355.html, page accessed 21Aug2022. -turbulence and convection with linear organized structure behind cold front (Squall line) -strong rain with thunder; accumulations up to 14.8mm eg Ostrhauderfehn -behind cold front occlusion with convergence line in NW and N with renewed hurricane gusts at Nsea coast
Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -FIG5. [MAP] Composite radar reflectivity in dBZ for Germany on 18:30UTC 18Jan2007 with the top twenty 24h precipitation amounts [map shows passage of cold front] -FIG7. Hourly surface observations from the synoptic station Lindenburg 18Jan2007 0600UTC to 19Jan2007 0600UTC. Observations of present weather & max wind gusts for Dusseldorf Germany. Temperature, dew point, precipitation amounts. Present weather ww and wind barbs. MSLP and maximum wind gusts during the preceding hour in knots. Arrows at the bottom part indicate estimated arrival time of Kyrill II's cold front [time series shows gusts & thunderstorms during passage of cold front] -'there were also reports of at least two tornadic storms (Friedrich and Kratzsch, 2007) around the time of the radar picture shown' (19Jan2007 0600UTC)
Gardiner (2010)	Gardiner, Barry, Appendix 3: Background information on 11 storms selected for detailed analysis, European Forest Institute, Atlantic European Regional Office - EFIAtlantic, 161 pp. [PDF properties: datestamp 23Jul2010] -WIKI-BOX: -cold front spawned several tornados in Germany -FIG10.3. [MAP] Lightning strikes by Kyrill, coinciding very well with the most storm damaged parts Netherland and Germany 18Jan2007 00-22UTC; 19Jan2007 00-22UTC -in afternoon cold front crossed North Sea to Germany -thunderstorms along squall line; characteristics of summer thunderstorm -several stations reported thunder with strong hurricane gusts, hail, high lightning activity
Gatzen et al (2011)	Gatzen C., T. Pucik, D. Ryva, Two cold-season derechoes in Europe, Atmospheric Research, 100, 740-748, 2011 -in Europe severe squall line used in place of derecho -convection and hail associated with Kyrill travelling squall line
Roberts et al (2014)	Roberts JF, AJ Champion, LC Dawkins, KI Hodges, LC Shaffrey, DB Stephenson, MA Stringer, HE Thornton, DB Youngman, The XWS open access catalogue of extreme European windstorms from 1979 to 2012, Nat. Hazards Earth Syst. Sci, 14, 2487-2501, 2014 -mention of tornadoes for Kyrill
Ludwig et al (2015)	Ludwig P, JG Pinto, SA Hoepp, AH Fink, SL Gray, Secondary cyclogenesis along an occluded front leading to damaging wind gusts: Windstorm Kyrill, January 2007, Monthly Weather Review, 143, 1417-1437, 2015 -passage of cold front across eastern Gemrany, Czech republic, Poland with 8 tornado reports including 3 F3 tornados -FIG12 shows averaged wind gusts from model between 18Jan 1200UTC and 19Jan 0600 UTC showing wind gusts associated with passage of coherent, long-lasting convection cell structures across the region

Wikipedia (20220322)	Wikipedia, Cyclone Kyrill, https://en.wikipedia.org/wiki/Cyclone_Kyrill, accessed 22Mar2022 -wspd Needles 160km/h, Dublin 149km/h, Aberdaron 130km/h, Mumbles 101km/h, St Athan 101km/h -DWD advised people to stay at home 18Jan -wspd up to Bf12 Netherlands & Germany -storm spread across Germany evening 18Jan -gust Wendelstein 202km/h, Brocken 198km/h -storm centre crossed Niedersachsen 18-19CET moving toward Baltic Sea * -3 confirmed tornadoes Germany -highest gust Poland Snezka in Krkonose mountains 212km/h -Czech Rep wspd as high as 200km/h disrupted rail & air traffic

Table SL36. Derecho (arranged by year and then alphabetically)

Source	Full Reference and Notes
Gatzen et al (2011)	Gatzen C., T. Pucik, D. Ryva, Two cold-season derechoes in Europe, Atmospheric Research, 100, 740-748, 2011 -case studies of Kyrill (2007) and Emma (2008) derechos
Pantillon et al (2017)	Pantillon, F., P. Knippertz, U. Corsmeier, Revisiting the synoptic-scale probability of severe European winter storms using ECMWF ensemble reforecasts, Nat. Hazards Earth Syst. Sci., 17, 1795-1810, 2017. -'The severe wind gusts observed during the passage of storm Kyrill in January 2007 over central Europe finally emphasized the role of convection embedded in the cold front including the formation of cold-season derechos'
Gatzen et al (2020)	Gatzen CP, AH Fink, DM Schultz, JG Pinto, An 18-year climatology of derechos in Germany, Nat Hazards Earth Syst. Sci., 20, 1335-1351, 2020 -database of 40 warm and cold and cold season derechos in period 1997-2014 -Kyrill was a moderate intensity cold season derecho in Germany

Table SL37. Cold air outbreak (arranged by year and then alphabetically)

Source	Full Reference and Notes
Brugge (200701)	Brugge R, British Isles weather diary, Jan 2007, www.met.reading.ac.uk/~brugge/diary2007.html#200701 -KYRILL: 18Jan2007 Cold air drawn across Scotland led to some snow in places by early afternoon.
Eden (200703)	Eden, Philip, Weather Log January 2007, Weather, 62, pp.1-4, March 2007 -Storm Kyrill: parts of central Scotland had 5-10cm snow
LCW (20070126)	Lloyds Casualty Week, 26Jan2007 -UK: Storm Kyrill: Scotland first major snowfall 2007
Tetzlaff (2007)	Tetzlaff, G, Der Orkan Kyrill, INFO, DKKV Deutsches Komitee Katastrophenvosorge e.V., pp.1-2, Februar/Maerz 2007, No. 1+2/2007 -10C drop in temperature in 1/4h and intense ppt of 10mm in the same period
Unwetterzentrale Franz (200701)	Unwetterzentrale, Orkantief FRANZ - 11.,12.01.2007 (Tief Nr. 29), prepared by Manfred Spatzierer and Stefan Laps http://www.unwetterzentrale.de/uwz/347.html -in the evening behind the trough of the hurricane low there were showers in N Germany and strengthening of winds -with the inflow of cold air temperature -32C on 50hPa surface; mild air in central Europe to be replaced by cold air -morning weather more quiet with rapid departure of hurricane center from west -warm front of storm Gerhard appeared in running of day
Gardiner (2010)	Gardiner, Barry, Appendix 3: Background information on 11 storms selected for detailed analysis, European Forest Institute, Atlantic European Regional Office - EFIAtlantic, 161 pp. [PDF properties: datestamp 23Jul2010] -in afternoon cold front crossed North Sea to Germany -thunderstorms along squall line; characteristics of summer thunderstorm -several stations reported thunder with strong hurricane gusts, hail, high lightning activity -cold front reached Berlin evening

Table SL38. Unusual warm air temperature (arranged by year and then alphabetically)

Source	Full Reference and Notes
EUMETSAT (20070117)	EUMETSAT, Winter storm Kyrill leaves a trail of destruction, 17 Jan2007 1500UTC, https://www.eumetsat.int/winter-storm-kyrill-leaves-trail-destruction (authors: Jochem Kerkmann & Hans Peter Roesli (EUMETSAT); Maria Putsay (Hungarian Meteorological Service); Martin Setvak & Petr Novak (CHMI)) -curious side effect Kyrill in Switzerland; sfc temp Locarno reached 24C (Foehn)
KNMI (20070118)	KNMI, Nieuwsbericht, De zware storm Kyrill van 18 januari 2007, 17 januari 2007, https://www.knmi.nl/over-het-knmi/nieuws/de-zware-storm-kyrill-van-18-januari-2007 8. High temperature records Austria during storm -summer temperatures to 20C Austria with warm Foehn wind -Eisenstadt registered 19.7C, Salzburg 19.3C, Vienna 19.3C -temperature records
Unwetterzentrale (200701b)	Unwetterzentrale, Orkantief KYRILL: Ausführliche Analyse der Wetterlage, www.unwetterzentrale.de/uwz/355.html, page accessed 21Aug2022. -at 2200MEZ temperature in front of cold front at Salzburg at 18C through Foehn effect -station Wiener Hohewarte and Mariabrunn registered still 17.6C -midnight 18-19Jan Salzburg temperature at 19.9C
Wikipedia (20220322)	Wikipedia, Cyclone Kyrill, https://en.wikipedia.org/wiki/Cyclone_Kyrill, accessed 22Mar2022 -record high temperature Prague -foehn wind high temperature Italy 25C Turin

Table SL39. Lightning (arranged by year and then alphabetically)

Source	Full Reference and Notes

Brugge (200701)	Brugge R, British Isles weather diary, Jan 2007, www.met.reading.ac.uk/~brugge/diary2007.html#200701 -STORM LANCELOT: Bands of showers spread across much of British Isles from the W; heavier rain in places. These were accompanied by sferics in the afternoon over Ireland.
Deusche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] -numerous thunderstorms developed along the cold front; esp Westfalen, Sachsen-Anhalt, Brandenburg, Berlin, Sachsen -FIG_p26. [MAP] lightning distribution in Germany from 13-24MET 18Jan2007
LCW (20070202)	Lloyds Casualty Week, 02Feb2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ -lighting fires on ships at Novorussiysk: Yannis P 19Jan 1940L; Eagle Phoenix evening 20Jan
Unwetterzentrale (200701)	Unwetterzentrale, Orkantief KYRILL - 18., 19.01.2007 (Tief Nr. 33) - Der schwerste Orkan seit Jahrzehnten, analysis by Manfred Spatzierer, Thomas Sävert, Stefan Laps, www.unwetterzentrale.de/uwz/348.html -afternoon & evening 18Jan2007, cold front crossed Germany from NW to SE; organized convection cells & Thunderstorms
Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -lightning during passage of cold front
Gardiner (2010)	Gardiner, Barry, Appendix 3: Background information on 11 storms selected for detailed analysis, European Forest Institute, Atlantic European Regional Office - EFIAtlantic, 161 pp. [PDF properties: datestamp 23Jul2010] -FIG10.3. [MAP] Lightning strikes by Kyrill, coinciding very well with the most storm damaged parts Netherland and Germany 18Jan2007 00-22UTC; 19Jan2007 00-22UTC -thunderstorms along squall line; characteristics of summer thunderstorm -several stations reported thunder with strong hurricane gusts, hail, high lightning activity
Gatsen et al (2011)	Gatzen C., T. Pucik, D. Ryva, Two cold-season derechoes in Europe, Atmospheric Research, 100, 740-748, 2011 FIG2. [MAP] Radar composite image and detected lightning for (a) 18Jan2007 18UTC and (b) 01Mar2009 09UTC. The data of a lightning detection network (black dots) is given for the whole time frame. The radar reflectivity of a greater than 40dBZ is plotted in hourly intervals and labelled by UTC times next to each line.
AON Benfield (2013)	AON Benfield, Historie von 1703 bis 2012: Winterstuerme in Europea, Stand: Januar 2013 -intense thunderstorms north and east Germany
Caithness Windfarm (20180730)	CaithnessWindfarm, craigdr, Detailed accidents to 19 June 2018. Document time stamp 30/07/2018, 177pp Wind turbine accident compilation (start 30Nov1980) [reports for Storms Hanno-Kyrill-Lancelot]' -wind turbine lightning strike Germany 01Jan2007
Gatzen et al (2020)	Gatzen CP, AH Fink, DM Schultz, JG Pinto, An 18-year climatology of derechos in Germany, Nat Hazards Earth Syst. Sci., 20, 1335-1351, 2020 -lightning used to identify and track European derechos 1997-2014 -'We used data from the Arrival Time Difference (ATD) system operated by the Met Office (Lee, 1986) available at wetterzentrale.de (2016) until the year 2000 and from the Siemens Blids lightning network (Siemens, 2019) for events after the year 2000'

Table SL40. Meso-vortex (arranged by year and then alphabetically)

Source	Full Reference and Notes

Table SL41. Meteotsunami and unusual surges (arranged by year and then alphabetically)

Source	Full Reference and Notes

Table SL42. Hurricane gusts only on south (right) side of pressure center (arranged by year and then alphabetically)

Source	Full Reference and Notes
Mueller-Westermeier (2007)	Mueller-Westermeier, Gerhard, Beschreibung un klimatologische Bewertung des Orkantiefs "Kyrill", pdf properties: Title: Deutscher Wetterdients - Nationale Klimauberwachung, Author: Gerhard Mueller-Westermeier, Subjet: Orkan Kyrill, datestamp: 26Jan2007 -south side of low across large area across Germany, very high wind speeds -due large pressure gradient between low & high pressure center Spain
RWS (200701)	RWS, Verslag van de stormvloed van 18 en 19 januari 2007 (SR86), Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007 -model wind speed fields show high winds only on right hand side of storm track
Behrens and Guenther (2009)	Behrens, A. and H. Guenther, Operational wave prediction of extreme storms in Northern Europe, Nat. Hazards, 49, 387-399, 2009 -wave map of North Sea during Storm Kyrill shows high wave field only on south side of trajectory
Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -wind speeds exceed 98th percentile on right hand side of storm track for Daria, Lothar, Kyrill
Tetzlaff (2009)	Tetzlaff, G., Extreme rain and wind storms in the mid-latitudes I, Singapore, 21-22.04.2009. https://imsarchives.nus/edu.sg/oldwww/Programs/09fluidss/files/Gerd Tetzlaff.pdf (Spring School on Fluid Mechanics and Geophysics of Environmental Hazards, Singapore, April 19-May 2, 2009) [pdf datestamp: 14/05/2009] -Meteomedia trajectory map shows hurricane gusts only on right hand side of trajectory track
Gardiner (2010)	Gardiner, Barry, Appendix 3: Background information on 11 storms selected for detailed analysis, European

	Forest Institute, Atlantic European Regional Office - EFIAtlantic, 161 pp. [PDF properties: datestamp 23Jul2010] -FIG10.5. [MAP] Countries affected by Kyrill and the areas of greatest wind throw Note: Ireland, Sweden, Norway, Estonia, Belarus, Ukraine affected but no reported wind throw; lines indicate main storm track
AON Benfield (2013)	AON Benfield, Historie von 1703 bis 2012: Winterstuerme in Europea, Stand: Januar 2013 -map of maximum wind gusts shows high values only on right side of storm track
Roberts et al (2014)	Roberts JF, AJ Champion, LC Dawkins, KI Hodges, LC Shaffrey, DB Stephenson, MA Stringer, HE Thornton, DB Youngman, The XWS open access catalogue of extreme European windstorms from 1979 to 2012, Nat. Hazards Earth Syst. Sci, 14, 2487-2501, 2014 -map of storm gust gust footprint to right of trajectory
Rohman (2014)	Rohman, J., European Extratropical Cyclones. Implications for local insurers, TransRe, May 2014 * -'with an average forward motion of 35 mph, an ETC's assymetrical windfield created the greatest swath of damage along its southeast quadrant near the frontal wave'
Ludwig et al (2015)	Ludwig P, JG Pinto, SA Hoepp, AH Fink, SL Gray, Secondary cyclogenesis along an occluded front leading to damaging wind gusts: Windstorm Kyrill, January 2007, Monthly Weather Review, 143, 1417-1437, 2015 -model gust field for Germany on south side of storm track
Tatge (2017)	Tatge, Yorn, Kyrill the winter storm that walloped most of Europe, https://www.air-worldwide.com/blog/posts/2017/1/kyrill-the-winter-storm-that-walloped-most-of-europe/, Verrisk, 19Jan2017 -map of trajectory show gust footprint almost entirely on right (south) side

Table SL43. Wind direction, fetch and wave size in German Bight (arranged by year and then alphabetically)

Source	Full Reference and Notes
Behrens and Guenther (2009)	Behrens, A. and H. Guenther, Operational wave prediction of extreme storms in Northern Europe, Nat. Hazards, 49, 387-399, 2009 -westerly wind direction determined short fetch and low wave field at FINO1 in German Bight
Pleskachevsky et al (2012)	Pleskachevsky, A.L., S. Lehner, W. Rosenthal, Storm observations by remote sensing and influences of gustiness on ocean waves andon generation of rogue waves, Ocean Dynamics, 62, 1335-1351, 2012. -Dogger Bank protects German Bight from high wave field except for north winds

Table SL44. Culmination time and location determines damage properties of storm (arranged by year and then alphabetically)

Source	Full Reference and Notes
Air Worldwide (2007)	Air Worldwide, European Winter Storm Franz, first posting 12Jan2007, https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-franz/first-posting/ -minimum central pressure 950mn as it struck UK; weakened to around 980mb over mainland Europe
KIT-CEDIM (20070116)	KIT-CEDIM, Orkantiefs 'Franz' und 'Hanno'. Mitteleuropa, Suedskandinavien 11-14.1.2007, (contributors CE and BM) Wettergefahren-Fruehwarnung, Dientag, 16.Januar 2007, 04:00 MEZ http://www.wettergefahren-fruehwarnung.de/Ereignis/20070116_e.html -Gerhard already reached high point of development when it reached Norwegian coast -Hanno lowest pressure under 970 hPa on 14Jan 00:00 UTC in front of Norwegian coast
Jensen and Mueller-Navarra (2008)	Jensen J, SH Mueller-Navarra, Storm surges on the German coast, Die Kueste, 74 ICCE (2008), 92-124. -'Will the cyclone increase in intensity? ... Particularly over the sea, there is no sufficientnumber of observation stations which would allow an estimate of thether the hurricane has already lost its force or is still increasing in intensity'
Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -Kyrill culminates eastern Baltic north coast Poland with 962hPa at 19Jan2007 0000UTC (easternmost of Daria-Anatol-Kyrill)

Table SL45. Blocking high pressure system (arranged by year and then alphabetically)

Source	Full Reference and Notes
Deutsche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] -'Westlage' replaced 23Jan with weather situation 'Trog Mitteleuropa' (23-26Jan) and 'Nordwestlage Zyklonal' (27-31Jan)
Mariners Weather Log (200708)	Mariners Weather Log, vol. 51, No. 2, Aug 2007, Marine Weather Review - North Atlantic Area, January through April 2007, Bancroft, GP, https://www.vos.noaa.gov/MWL/aug_07/northatlantic.shtml -' The pattern during the first three weeks of January was progressive, with lows developing off the northeast U.S. or Canadian coast and moving east or northeast before passing near or north of the British Isles. The pattern changed late in January and became more blocked, forcing cyclones north toward the Davis Strait or northeast over the North Atlantic with the lows stalling, turning west toward Labrador or looping near or south of Greenland. ' -Northwest Atlantic storm 21-23Jan2007: "moved northeast but was forced northwest over the Labrador Sea on January 22 due to increased blocking over the North Atlantic."

Table SL46. Infragravity wave, rogue wave, green water incidents (arranged by year and then alphabetically)

Source	Full Reference and Notes
Pleskachevsky et al (2012)	Pleskachevsky, A.L., S. Lehner, W. Rosenthal, Storm observations by remote sensing and influences of gustiness on ocean waves andon generation of rogue waves, Ocean Dynamics, 62, 1335-1351, 2012. -documented rogue waves at German Bight site 1Jan1995, 1Nov2006, 9Nov2007; 4y return period -rogue waves with 25s period & 400 m wavelength.

Table SL47. Wave dynamics and dike breaches; wave runup studies (arranged by year and then alphabetically)

Source	Full Reference and Notes

Table SL48. Precipitation, river level, inland flooding, river dike breaches , landslide (arranged by year and then alphabetically)

Source	Full Reference and Notes
Air Worldwide (2007)	Air Worldwide, European Winter Storm Franz, first posting 12Jan2007, https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-franz/first-posting/ -STORM FRANZ -winter storm Franz buffetted British Isles & continental Europe with heavy winds & rain 11-12Jan2007 -flooding, -heavy rains England added water to already saturated soils; flooding & tree damage -over 170 flood warnings & watches posted across England, Scotland, Wales -heavy rainfall sparked flooding on numerous rivers England
BBC (20070111a)	BBC, England battered by wind and rain, 11Jan2007a 16:43GMT news.bbc.co.uk/2/hi/uk_news/england/6251415.stm -STORM FRANZ -flood warning put in place through eastern England; rivers burst banks in Norfolk, Suffolk, Cambridgeshire, Northamptonshire, Essex -further west heavy rain also meant flood barriers up along River Severn -North Yorkshire Fire Service said it received calls for flash flooding incidents -flooding near Halifax, North Yorkshire caused delays on rail network between Leeds & Manchester but EA said no river flooding incidents in the area
BBC (20070111c)	BBC, Thousands hit by storm power cuts, 11Jan2007c (Thursday) http://news.bbc.co.uk/2/hi/uk_news/wales/6250925.stm -eight flood warnings still in force -part of A470 at Pontypair in Conwy blocked by debris after landslide -firefighters used boat to rescue Land Rover driver in floodwater between Garth Mill & Forder in Powys -Environment Agency: one severe flood warning on River Vymwy from Llansantffraid to Shrawardine -Green Lane in Corwen, Denbighshire: closed due to flooding -First Great Western: trains between S Wales and London disrupted by flooding Swindon-Bristol Parkway -cancellations and extended journey times
BBC (20070112)	BBC News, Power restored as winds subside, Friday, 12 Jan 2007, 08:59GMT news.bbc.co.uk/2/hi/uk_news/wales/6254617.stm -STORM FRANZ: WALES: 1 severe flood warning & 8 flood warnings remain in place
Brugge (200701)	Brugge R, British Isles weather diary, Jan 2007, www.met.reading.ac.uk/~brugge/diary2007.html#200701 -STORM FRANZ: Severe flooding rivers Vyrnwy and Severn on England-Wales border.
Deutsche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] -passage of low pressure led to big ppt over large area -flooding of small streams -Mittelgebirgen reported significant ppt; Harz registered >80L/m2 in 24h
DW (20070112)	DW, Heavy storms batter northern Europe, 12Jan2007 https://www.dw.com/en/heavy-storms-batter-northern-europe/a-2308237 -FRANZ, England: severe storm & driving rain caused transport chaos & flood alerts Britain -FRANZ, England: rivers swelled -FRANZ, England: flooding mid-Wales as EA issued more than 60 flood warnings in England, Scotland, Wales -FRANZ, England: motorists SE England stranded & river burst banks Norfolk, Suffolk, Cambridgeshire, Essex -FRANZ, England: heavy rain & storms set ot continue risk of flooding large parts of Britain
EDP (20070111)	EDP, Motorists faced with flood shock, Eastern Daily Press, p16, 11Jan2007 -river burst banks morning 10Jan2007 in central & west Norfolk -only 20mm rain; flooded properties & roads between 0300-1000AM 10Jan2007 -Environment Agency warnings -River Tiffey from Wymondham to Barford -River Yare from Barnham Broom to Cringleford -River Bure and Spixworth Beck -River Tud -River Wensum from Great Ryburgh to Lenwade -River Tas upstream of Marlingford -Great Ellingham near Attleborough: Deeply Rooted garden centre unable to open after tributary of Thet burst banks -Welney near Wisbech: 3 people rescued from car in flooded road -Nordelph: truck left flooded road; ended up in ditch -Snettisham: 14 inches of water on Bircham Road -New Buckenham: 14 inches of water on B1077/B1113 -Wymondham: aquaplaning on A11 -affected villages: Rockland St Peter, Tivetshall St Margaret, Flordon, Thorpe End -Chris Bell, Weather quest: 15-20mm rain over day; in winter not much evaporation; not much rain needed for flooding -Chris Bell: new weather from 11Jan2007 bringing gale force winds 50mph on coast -north Suffolk: large volumes standing water but no accidents -Derek Eaton of Great Ellingham garden center: road outside under 18 inches water
EDP (20070112b)	EDP, We want to see an end to our flooding misery, Eastern Daily Press, pp8-9, 12Jan2007b -Welney cut off by flooding for weeks on end

	-water from flood plain risen to cover main A1101 road -parents with 40mile round trip diversion -parish councillors meeting SW Norfolk MP Christopher Fraser
EDP (20070119h)	EDP, Mayhem in wake of storms, pp.2-3, Eastern Daily Press, 19Jan2007h -Environment Agency: flood alerts for Rivers Yare, Bure, Waveney
Guardian (20070112)	Guardian, Nine killed as gales lash UK, Fri 12Jan2007 16:57GMT https://www.theguardian.com/world/2007/jan/12/weather.uk -FRANZ: 170 areas on flood alert from heavy rain -FRANZ: heavy rainfall sparked flood alerts on river Ouse in York & Severn in Shropshire -FRANZ: EA said 59 flood warnings & 118 flood watches throughout country -FRANZ: Met Office officials said 10d of rain fallen on Yorkshire Pennines overnight on Wed 11-12Jun -FRANZ: Shap Cumbria had 50mm rain in 12h
Herald (20070112)	The Herald, Disaster averted as drifting ship misses North Sea platforms, 12Jan2007 https://www.heraldscotland.com/default_content/12754075.disaster-averted-drifting-ship-misses-north-sea-platforms/ -Scottish Environment Protection Agency: 14 flood watches & 4 flood warnings in west Perthshire area -Met Office in Aberdeen warned 2inches rain expected in some areas 12Jan2007
Irish Independent (20070112)	Irish Independent, Gales cut power to thousands and spark widespread travel chaos, Irish Independent (contributor E. Kennedy), p7, 12Jan2007 -Killarney: localised flooding; phone box blown over
KIT-CEDIM (20070116)	KIT-CEDIM, Orkantiefs 'Franz' und 'Hanno'. Mitteleuropa, Suedskandinavien 11-14.1.2007, (contributors CE and BM) Wettergefahren-Fruehwarnung, Dientag, 16.Januar 2007, 04:00 MEZ http://www.wettergefahren-fruehwarnung.de/Ereignis/20070116_e.html -FRANZ -at 7AM 12Jan 24h rain accum > 10 L/m2 in north and central Germany -late afternoon more lowland stations registered storm & severe storm gusts; eg at 15MEZ, Karlsruhe reported 90km/h, Wurzberg 76km/h -peak rainfall accumulations in Braunlage and Brocken-in-Harz with 29-32 L/m2
KNMI (20070118)	KNMI, Nieuwsbericht, De zware storm Kyrill van 18 januari 2007, 17 januari 2007, https://www.knmi.nl/over-het-knmi/nieuws/de-zware-storm-kyrill-van-18-januari-2007 -storm 18Jan2007 most severe in 5 y -Bft 10 along entire coast -much ppt 50-60mm in 36h -avg month ppt 69mm
LCW (20070126)	Lloyds Casualty Week, 26Jan2007 -Latvia: Storm Hanno: biggest damage Riga 0.86mill USD; gusts broke trees & tore off telegraph wire; some streets inundated by water -Latvia: Storm Hanno: dam in Vidzem district broken. -UK: Storm Kyrill: gales & heavy downpours affected travel across UK -UK: Storm Kyrill: thousands homes Wales lost power after heavy rain & winds to 80mph brought down power lines -UK: Storm Kyrill: widespread disruption on roads & rail lines from fallen trees & flooding -UK: Storm Kyrill: EA Wales: 13 flood warnings & 35 flood watches -UK: Storm Franz: more than 400 passengers guided to safety along tracks after landslip onto line in Surrey caused train derailment at 1230UTC
New York Times (20070119)	New York Times, Deadly wind and rain storm sweeps Europe, (Mark Landler) 19Jan2007, https://www.nytimes.com/2007/01/19/world/europe/19europe.html -rain Britain, Ireland, France, Belgium, Netherlands
Nyheder (20070121b)	nyheder.tv2.dk, 540 skader efter lordagens storm, 21 Jan 2007, https://nyheder.tv2.dk/krimi/2007-01-21-540-skader-efter-loerdagens-storm -LANCELOT -inland flooding in mid & south Jutland
Stern (20070111)	Stern, Orkantief "Franz" Schwerer Sturm über Deutschland, 11Jan2007, 21:30 https://www.stern.de/panorama/orkantief--franz--schwerer-sturm-ueber-deutschland-3359640.html -Great Britain: significant damage by wind and rain
Tetzlaff (2007)	Tetzlaff, G, Der Orkan Kyrill, INFO, DKKV Deutsches Komitee Katastrophenvosorge e.V., pp.1-2, Februar/Maerz 2007, No. 1+2/2007 -cold front passage associate with 100mm precipitation
Unwetterzentrale_Franz (200701)	Unwetterzentrale, Orkantief FRANZ - 11.,12.01.2007 (Tief Nr. 29), prepared by Manfred Spatzierer and Stefan Laps http://www.unwetterzentrale.de/uwz/347.html -morning hours of 11Jan warm front of Franz reached northern Germany in compact area with much rain -spurs of hurricane low caused rain in full north half of Germany; mountainous area of Nordrhein-Westfalen had 6 L/m2 in an hour -diverse models forecast massive wind changes along a narrow line of showers; thunderstorm downpours and large danger of hurricane gusts -UWZ meteorologists gave warning of strong rain showers and thunderstorms of highest arning level with hints of tornadoes -rainfall amounts 5-7 L/m2 in hour when the line moved suddenly from north to south -long periods of rainfall in Mittelgebirgen with 6h totals 10-13 L/m2 -on Brocken in Harz significant snowstorm -high areas of Alps with strong precip above 1000-1300m -Brocken (1142m) snow depth on morning 12Jan 20cm; Rudolfshuette Osterreich (2304m) 23cm; Sonnblick (3105m) 15cm
Unwetterzentrale_Kyrill (200701b)	Unwetterzentrale, Orkantief KYRILL: Ausführliche Analyse der Wetterlage, www.unwetterzentrale.de/uwz/355.html, page accessed 21Aug2022.

	-heavy continuous precipitation associated with storm
Unwetterzentrale_Kyrill (200701c)	Unwetterzentrale, Orkantief KYRILL: Vorhersagbarkeit des Ereignisses und Warnmanagement der Unwetterzentrale, www.unwetterzentrale.de/uwz/356.html (downloaded 20220916) -models predicted 36-42h of strong rain: GFS0.5, UKMO NA, UKMO NX, LM, EZ-, MM-MOS -red warnings Schwarzwald with amounts of 100mm -Bergischen Landes, Siegerlandes, Westerwaldes, Harz red warnings with 70-100mmm -Flachland N & W Germany wide areas to receive 20-30mm; orange warning -UWZ high water expert Andreas Wagner warned of flooding of smaller streams & rivers -ground saturated -UWZ had not previously experienced such conditions of strong rain
Wetteronline (20070118)	Wetteronline, Orkan Kyrill tobt in Europa, 18Jan2007 22:00, https://www.wetteronline.de/wetterticker/orkan-kyrill-tobt-in-europa--UZiFNRdrmvxoC3RHqLLyU -FIG. [PHOTO] Small river Emmer by Emmerthal im LK-Hameln-Pyrmont is running far outside banks -country-wide road closures by wind-toppled trees and flooded roads
Wetterlonline (20070118b)	Wetteronline, Schwere Schaeden nach Kyrill, https://www.wetteronline.de/wetterticker/schwere-schaeden-nach-kyrill--643tBpXGzIivrA8sEYH1EU (accessed 03Sep2022) FIG. [PHOTO] There were many cases of flooding following the hurricane [Alexander Wratolis] FIG. [PHOTO] The small river Emmer at Emmerthal in Kandkreis Hameln-Pyrmont stepped far over its banks [Alexander Wratolis] -road closures across country by toppled trees and heavy rain/flooding
Ludwig et al (2015)	Ludwig P, JG Pinto, SA Hoepp, AH Fink, SL Gray, Secondary cyclogenesis along an occluded front leading to damaging wind gusts: Windstorm Kyrill, January 2007, Monthly Weather Review, 143, 1417-1437, 2015 -'Intensive convection with severe wind gusts and exceptional precipitation amounts (some of them exceeding the mean January accumulations) were observed as the cold front passed over central Europe'
Tatge (2017)	Tatge, Yorn, Kyrill the winter storm that walloped most of Europe, https://www.air-worldwide.com/blog/posts/2017/1/kyrill-the-winter-storm-that-walloped-most-of-europe/, Verrisk, 19Jan2017 -heavy rain through Europe especially Germany & Netherlands

Table SL49. Unusual peak of significant wave height in northern North Sea (arranged by year and then alphabetically)

Source	Full Reference and Notes

Table SL50. Very low coastal water levels (arranged by year and then alphabetically)

Source	Full Reference and Notes
Bottema (2007)	Bottema M, Zwaarste storm sinds 1990. Bijzondere golf- en waterhoogten IJsselmeer. Trendsinwater.nl. Monitoring van Nederlandse wateren: resultaten en ontwikkelingen. nummer 21, april 2007 -low water levels registered on western side of IJsselmeer

Table SL51. Modelled turbulence kinetic energy in ocean wave model (arranged by year and then alphabetically)

Source	Full Reference and Notes
Behrens and Guenther (2009)	Behrens, A. and H. Guenther, Operational wave prediction of extreme storms in Northern Europe, Nat. Hazards, 49, 387-399, 2009 -'the wave model itself sometimes has problems during storm events to predict reasonable wave heights in shallow water near to the coasts due to insufficient dissipation'

Table SL52. Classification of storm surges (arranged by year and then alphabetically)

Source	Full Reference and Notes
RWS (200701)	RWS, Verslag van de stormvloed van 18 en 19 januari 2007 (SR86), Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007 -Jutland type from trajectory map
Jensen and Mueller-Navarra (2008)	Jensen J, SH Mueller-Navarra, Storm surges on the German coast, Die Kueste, 74 ICCE (2008), 92-124. * -2 types of storm surge a) wind setup type: winds blowing from NW for long period of time b) circulation type: small intense low pressure tracks across UK at high speed
Kristandt et al (2014)	Kristandt, J., B. Brecht, H. Frank, H. Knack, Optimization of empirical storm surge forecast-modeling of high resolution wind fields, Die Kuste, 81, 301-348, 2014 -explanation of Jutland/Skagerrak/Scandinavian types with exceptions.

Table SL53. Fatalities & injuries (arranged by year and then alphabetically)

Source	Full Reference and Notes
Air Worldwide (20070112)	Air Worldwide, European Winter Storm Franz, first posting 12Jan2007, https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-franz/first-posting/ -FRANZ -10 fatalities reported -storm claimed 8 lives at sea -2 trawlers sunk off Ireland -knocked overboard stewart on Russian cargo ship -two auto fatalities in England and Belgium blamed on storm
Air Worldwide (20070116)	Air Worldwide, European winter storm Per, 16Jan2007 10:30AM https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-per/first-posting/ -3 fatalities; all due to falling trees Sweden
BBC (20070111a)	BBC, England battered by wind and rain, 11Jan2007a 16:43GMT news.bbc.co.uk/2/hi/uk_news/england/6251415.stm -FRANZ

	-man killed in Somerset when his vehicle collided with fallen tree near Britty Common near Wellington at about 1100GMT -17y old girl trapped for 45min under tree blown onto her car in No Mans Heath Warwickshire -another woman escaped with minor injuries when tree fell on her in Hertfordshire
BBC (20070111c)	BBC, Thousands hit by storm power cuts, 11Jan2007c (Thursday) http://news.bbc.co.uk/2/hi/uk_news/wales/6250925.stm -Llangeler, Carmarthenshire: man treated in hospital after car crashed into tree on A484
BBC (20070118a)	BBC News, Nine dead as UK struck by storms, 18Jan2007, http://news.bbc.co.uk/2/hi/uk_news/6272193.stm -KYRILL -2y old boy when wall fell on him in Kentish Town, London -2 people died Cheshire, 2 Greater Manchester, 1 North Yorkshire, 1 in Berkshire, 1 Shropshire, 1 Humberside -Deaths -managing director Birmingham airport, Richard Heard 49, died after branch fell on car between Bridgenorth & Broseley, Shropshire -male passenger in Ford Fiesta killed when tree fell on car in Streatley, Berkshire -lorry driver killed when vehicle left road & overturned in high winds on A629 Skipton, N Yorkshire -lorry driver from Germany killed when vehicle overturned on A55 on outskirts of Chester -Stockport, Greater Manchester: woman in 60s killed when wall toppled on her -man died after being blown into metal shutter at industrial estate in Strangeways, Manchester -Chester Constab said 60y old man pronounced dead at hospital after being struck by tree Byley, Middlewich -elderly man died when shed collapsed on him Humberside
BBC (20070118b)	BBC, Huge storms sweep northern Europe, 18Jan2007, 2234GMT, http://news.bbc.co.uk/2/hi/europe/6274377.stm -KYRILL FIG2. [PHOTO] Tree toppled on car with deaths listing: Britain 9, Germany 7, Netherlands 4, Czech 3, France 2 -at least 25 people have been killed by violent storms in northern Europe; travel chaos -Britain worst hit with 9 killed as rain & gusts of up to 159km/h swept the country -hurricane force winds in Germany claimed 7 lives -other deaths in France, Czech, Netherlands -18month child crushed by door in Munich -many of fatalities in Europe caused by traffic accidents & falling debris -in London 2y old boy crushed by falling wall
Belfast Telegraph (20070111a)	Belfast Telegraph, Severe gales continue (contributor Colm Lenaghan and Victoria O'Hara), 11Jan2007a -in Republic 5 fisherman feared drowned after trawler sank -10 fishing boats, 2 lifeboats & CG helicopterfrom Waterford searching off Hook Head in Wexford
Belfast Telegraph (20070119)	Belfast Telegraph, Killer storms claim 13 lives (PA Reporters and Deborah McAleese), p.4, 19Jan2007. -at least 13 people died in Britain's worst storm in 17y as another death reported today -Bamber Bridge , Preston, man killed while refueling car by falling garage canopy -2y old boy killed -1 man killed and another injured by fire engine responding to emergency involving diverted flight Belfast to Stansted diverted to Liverpool; 3 firefighters taken ot hospital -fire engine collided with car on way to airport for emergency landing -2 people received minor injuries when 2 lorries overturned in province; several roads blocked by fallen trees
Brugge (200701)	Brugge R, British Isles weather diary, Jan 2007, www.met.reading.ac.uk/~brugge/diary2007.html#200701 11Jan: One man died after a tree fell on his car in Somerset while a woman was swept off a cargo ship in Cornwall. Two trawlers (Pere Charles and Honey Dew II) sunk off the southeast Irish coast. 17 year old girl in Warwickshire airlifted to hospital with spinal injuries after her car was struck by a tree. Man died after tree fell on car near Wellington, Somerset. ... Man treated in hospital after car hit by fallen tree in west Wales. 18Jan: 10 people killed by wind; 26 crew rescued from sinking ship off Lizard Point.
Deutsche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] -Kyrill led to significant damage within total country -traffic accidents & fallen trees; numerous injured & 12 dead -significant damage in large parts of Europe -press reports of 43 people killed
DW (20070112)	DW, Heavy storms batter northern Europe, 12Jan2007 https://www.dw.com/en/heavy-storms-batter-northern-europe/a-2308237 -FRANZ, Ireland: sinking 2 Irish trawlers with 7 dead -FRANZ, Germany: several people injured, mostly by falling trees or in car accidents
DW (20070119)	DW, Killer winds in Europe expected to cause heavy financial loss, 18Jan2007 https://www.dw.com/en/killer-winds-in-europe-expected-to-cause-heavy-financial-loss/a-2317752 -KYRILL -Thurs storm 18Jan estimated to have cause 1 bill EUR damage Germany; killed 44 across Europe -11 fatalities Germany -death toll to 11 after motorist killed in NW state Nordrhein Westfalia; crashed into uprooted tree -4 people died after being hit by falling trees, including 2 firemen -18 month old baby crushed by door ripped from hinges in Munich -73 year old man in Augsburg killed by falling barn door -Saxon-Anhalt man died trapped under fallen wall of restaurant -3 drivers crushed by tree in Baden-Wuerttemberg, in Hildesheim, & in Strausberg near Berlin
DW (20070120)	DW, Power cuts in Europe as continent begins to clean up, 20/01/2007, https://www.dw.com/en/power-cuts-in-

	europe-as-continent-begins-clean-up/a-2319624 -KYRILL -Germany: 11 killed; -Poland: storms killed 6 & injured 30, including 9 emergency service workers -Netherlands: 7 killed -Ukraine: 1 woman filled by falling tree
Eden (200703)	Eden, Philip, Weather Log January 2007, Weather, 62, pp.1-4, March 2007 -KYRILL: 19 people died
EDP (20070119a)	EDP, Nine fatalities as savage storms disrupt Britain, Eastern Daily Press, p.5, 19Jan2007a -2y old boy among 9 people killed yesday in savage storms that battered Britain -Scotland Yard said brick wall collapsed on boy in Southampton Road, Belsize Road, N London -Richard Heard (49) killed on way to work as managing director Birmingham airport; tree branch on windshield on B4373 near Bridgnorth, Shropshire -male driver killed Streatley, W Berkshire -middle aged woman died when lorry blew off A629 Skipton western bypass North Yorkshire -man killed when lorry blew into another vehicle on A55 near Forte Penthouse in Chester -man died after being blown into metal shutter at industrial estate at HMP Manchester in Strangeways area -woman pensioner crushed by falling wall Stockport, Chester -man in 80s died of heart attach securing fencing in Merseyside -man died when struck by fire engine on way to emergency call in Liverpool
EDP (20070119f)	EDP, Pupils in hospital after school roof is blown down, Eastern Daily Press, p.5, 19Jan2007f. -3 school children taken to hospital after art of roof of school blown onto them by high winds -teenagers standing outside dining hall at Blake Valley Technical College, Hednesford, Staffordshire when hit by tiles
EDP (20070119g)	EDP, Castle closed after tree falls on woman, Eastern Daily Press, p.5, 19Jan2007g -woman 63 visiting Stafford Castle in Staffordshire 19Jan2007 when tree hit her 1130AM -trapped for 20min until ambulance crews and paramedic able to free her -woman airlifted to Selly Oak Hospital in Birmingham with leg & internal injuries
EDP (20070119h)	EDP, Mayhem in wake of storms, pp.2-3, Eastern Daily Press, 19Jan2007h -at least 9 deaths in Britain; none in Norfolk & north Suffolk -A10 at Kings Lynn: tree fell on car with minor injuries to all 3 passengers -Carlton Colville: man hit by tree & taken to hospital -Bluebell Road, Norwich: tree fell on cyclist -A10 at Stretham near Ely: bus blown off road with minor injury -Sibton near Saxmundham: 81 year old man trapped under tree; needed hospital treatment -Happisburgh C of E Fisrt School: gales smashed hall window -near UEA Norwich: ambulance badly damaged by falling tree -Northgate Street, Yarmouth: part of Lord Roberts pub collapsed on neighouring shop -Halesworth, Hemsby, Caister: trees damaged houses
EDP (20070120)	EDP, The big clean-up after the storm, Eastern Daily Press, p11, 20Jan2007 -no fatalities in Norfolk and north Suffolk; 13 fatalities in UK; double decker bus in ditch Cambridge
Evening Herald (20070111)	Evening Herald, Lost. Tragic end: last picture of doomed trawler with five crew (contributor Aoife Finneran), p.1, p.4, 11Jan2007. -FRANZ: fatalities with sinking of Pere Charles southeast Ireland 10Jan2007
Evening Herald (20070112)	Evening Herald, Family Torn Apart. Skipper of second trawler perishes leaving behind wife, 3 children (contributor Fionuala O'Leary and Jane Last), p.1,p.2 12Jan2007 -FRANZ: fatalities with sinking of Honeydew II near Mine Head, southest Ireland at 22:00 10Jan2007
Evening Herald (20070113)	Evening Herald, Tears as families hold lonely vigil (contributor Jane Last), 13Jan2007 [FRANZ] -FRANZ: 7 men missing from Pere Charles (5) and Honeydew II (2)
Financial Times (20070119)	Financial Times, Fourteen die as storms lash north Europe (reporter: William MacNamara), 19Jan2007 -14 deaths N Europe -weather deaths in UK mainly on roads -managing director Birmingham International airport (Richard Heard) killed by tree on car -collapsing walls killed elderly woman in Skipton, North Yorkshire & 2y old in Belsize Park, N London
Guardian (20070112)	Guardian, Nine killed as gales lash UK, Fri 12Jan2007 16:57GMT https://www.theguardian.com/world/2007/jan/12/weather.uk -FRANZ -gales up to 90mph caused chaos across Britain 11Jan; 9 people died, 1000s without electricity -7 victims were fishing boats that sank off Ireland in heavy seas -coastguard called off search for female stewart fallen from Russian cargo ship Vera Maretskaya 7nm S of Falmouth Cornwall -Ireland: 2 more fishermen drowned after 2nd trawler sank night 11-12Jan -1st trawler (Pere Charles) nearby had 5 drownings; search called off nightfall Jan11 -another boat sank morning 11Jan with 2 saved from raft -man killed in village of Britty Common near Taunton Somerset when tree crashed on car -tree fall injuries in north Warwickshire & Baldock Hertfordshire
Herald (20070112)	The Herald, Disaster averted as drifting ship misses North Sea platforms, 12Jan2007 https://www.heraldscotland.com/default_content/12754075.disaster-averted-drifting-ship-misses-north-sea-platforms/ -FRANZ -7 fishermen missing 11Jan2007 night after 2 trawlers sank off Irish coast -Pere Charles sank off Hooke Head early evening 10Jan2007 -Honeydew II: 2 survivors picked up by CG shortly after 7PM; ship sank sometime before mighnight -motorist dead in Somerset after tree fell on car -stewardess swept from deck of Russian freighter off Cornwall

KNMI (20070118)	KNMI, Nieuwsbericht, De zware storm Kyrill van 18 januari 2007, 17 januari 2007, https://www.knmi.nl/over-het-knmi/nieuws/de-zware-storm-kyrill-van-18-januari-2007 -Kyrill went from S North Sea into Baltic ->60 fatalities; 11 in Netherlands
Kvamme (20070214)	Kvamme, Dag, Ekstremvaer nr.1/2007 - 'Per', Intern Rapport, met.no, 15pp, Meteorogisk Institutt met.no, Bergen, 14/02/2007 -[HANNO/PER] no fatalities for Norway; 3 people died Sweden
LCW (20070119)	Lloyds Casualty Week, 19Jan2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ -Pere Charles lost with all crew near Wexford
LCW (20070126)	Lloyds Casualty Week, 26Jan2007 -Belarus: Storm Hanno: 3 people injured -UK: Storm Kyrill: managing director Birmingham airport died when tree fell on car in Shropshire
LCW (20070202)	Lloyds Casualty Week, 02Feb2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ p.23: London, 20Jan -press report 19Jan -Poland & Czech Republic latest countries hard hit by storm that swept N Europe with 43 people dead -6 people killed Poland in winds >200km/h -Germany 11 dead, Britain 11 dead, Netherlands at least 1 dead p.24: London, 19Jan -Europeans worked today to restore services across continent after hurricane force winds toppled trees, brought down power lines, damaged buildings, killing 47 people, disrupted travel for 10s thousands -hurricane force winds left 14 dead Britain, 12 Germany, 6 Netherlands, 6 Poland, 4 Czech Republic, 3 France, 2 Belgium -highest storm death toll since 1999 when gales downed trees & driving snow brought avalanches that killed 120 in 3 days p.25, London, 19Jan -11 died 18Jan; gusts up to 99mph
Met Eireann (200701)	Met Eireann, Monthly Weather Bulletin, No 249, Jan 2007 -at least 47 deaths Europe;
Mueller-Westermeier (2007)	Mueller-Westermeier, Gerhard, Beschreibung un klimatologische Bewertung des Orkantiefs "Kyrill", pdf properties: Title: Deutscher Wetterdients - Nationale Klimauberwachung, Author: Gerhard Mueller-Westermeier, Subjet: Orkan Kyrill, datestamp: 26Jan2007 -8 killed across Germany; larger number fatalities
New York Times (20070119)	New York Times, Deadly wind and rain storm sweeps Europe, (Mark Landler) 19Jan2007, https://www.nytimes.com/2007/01/19/world/europe/19europe.html -Britain: 3 motorists killed in storm-related accidents, woman died wall collapse -Netherlands: 2 killed when uprooted tree crushed car -Germany: 2 killed by flying debris, motorist killed while swerving to avoid tree
Stern (20070111)	Stern, Orkantief "Franz" Schwerer Sturm über Deutschland, 11Jan2007, 21:30 https://www.stern.de/panorama/orkantief--franz--schwerer-sturm-ueber-deutschland-3359640.html -Great Britain motorist hit by tree -Belga news agency: autobahn Brussels-Luettich fatal motorist accident because of storm gusts
Tetzlaff (2007)	Tetzlaff, G, Der Orkan Kyrill, INFO, DKKV Deutsches Komitee Katastrophenvosorge e.V., pp.1-2, Februar/Maerz 2007, No. 1+2/2007 -11 fatalities in Germany for Storm Kyrill
Unwetterzentrale (200701)	Unwetterzentrale, Orkantief KYRILL - 18., 19.01.2007 (Tief Nr. 33) - Der schwerste Orkan seit Jahrzehnten, analysis by Manfred Spatzierer, Thomas Sävert, Stefan Laps, www.unwetterzentrale.de/uwz/348.html -Kyrill: 11 killed in Germany; 5 in NRW, 2 in Bayern; atleast 43 across Europe
Wetteronline (20070118)	Wetteronline, Orkan Kyrill tobt in Europa, 18Jan2007 22:00, https://www.wetteronline.de/wetterticker/orkan-kyrill-tobt-in-europa--UZiFNRdrmvxoC3RHqLLyU -in Germany at least 13 fatalities -6 drivers in traffic accidents, 2 deaths by hinge failure of doors/gates, 1 by roof collapse -2 firefighters died in rescue operation -several hundred injured
Wetteronline (20070118b)	Wetteronline, Schwere Schaeden nach Kyrill, https://www.wetteronline.de/wetterticker/schwere-schaeden-nach-kyrill--643tBpXGzIivrA8sEYH1EU (accessed 03Sep2022) -11 fatalities in Germany -6 drivers killed in auto accidents; 2 people killed by door/gate unhinged; 1 under toppled roof -2 firemen died in rescue -several hundred people injured
Behrens and Guenther (2009)	Behrens, A. and H. Guenther, Operational wave prediction of extreme storms in Northern Europe, Nat. Hazards, 49, 387-399, 2009 -44 people killed in Europe
Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -46 deaths across Europe
Gardiner (2010)	Gardiner, Barry, Appendix 3: Background information on 11 storms selected for detailed analysis, European Forest Institute, Atlantic European Regional Office - EFIAtlantic, 161 pp. [PDF properties: datestamp 23Jul2010] 10.6. Direct casualties -UK 13 Germany 13 Ireland 7 (lost at sea) Netherlands 7

	Poland 6 Czech 4 Belgium 2 France 2 Austria 1 -in Nordrhein-Westfalen: 8 deadly accidents & 795 non-deadly accidents from clear up (relatively low)
DWD (20120116)	DWD, 18.Januar 2007: Windfeld von Kyrill ueber Deutschland. Rueckblick auf einen der bisher schwersten Orkane, Pressemitteilung, Deutscher Wetterdienst, Offenbach, 16. Januar 2012. -at least 13 fatalities in Germany
Esurge (20121111)	Esurge_2007_kyrill(2012), Triple storm even (2007), Philip Harwood, Sun, 2012/11/11 15:04 -47 fatalities -BBC: at least 43 killed by evening of 19Jan
AON Benfield (2013)	AON Benfield, Historie von 1703 bis 2012: Winterstuerme in Europa, Stand: Januar 2013 -40 people died across Europe; 13 in Germany -6 drivers died in road accidents -2 firefighters died in rescues -several hundred injuries
Munich Re (2013)	Munich RE, Natural catastrophes in Germany 1970-2012, Muenchener Rueckversicherung-Gesellschaft, Geo Risks Research, NatCatSERVICE - as of January 2013 -13 people killed
Ludwig et al (2015)	Ludwig P, JG Pinto, SA Hoepp, AH Fink, SL Gray, Secondary cyclogenesis along an occluded front leading to damaging wind gusts: Windstorm Kyrill, January 2007, Monthly Weather Review, 143, 1417-1437, 2015 -54 fatalities in Europe
Tatge (2017)	Tatge, Yorn, Kyrill the winter storm that walloped most of Europe, https://www.air-worldwide.com/blog/posts/2017/1/kyrill-the-winter-storm-that-walloped-most-of-europe/, Verrisk, 19Jan2017 -47 fatalities
ESWD (20220609)	European Severe Weather Database, 11-12Jan2007 FRANZ, accessed 09Jun2022 Location LA Latitud Longitu Date Day Time Uncertainty ND --- Basepohl DE 53.73 N 12.92 E 12-01-2007 fri 00:00 UTC (+/- 3 hrs.) a tree collapsed damaging a driving car; one injury Crottendorf DE 50.52 N 12.95 E 12-01-2007 fri 00:00 UTC (+/- 3 hrs.) a car was hit by severe wind gust and pushed on a tree; one injury Niederlehme A 10 (Highway) DE 52.32 N 13.65 E 11-01-2007 thu 17:00 UTC (+/- 15 min) a car driving A10 was hit by severe wind gusts; 4 injured Jüchen DE 52.03 N 8.75 E 11-01-2007 thu 15:00 UTC (+/- 6 hrs.) A construction testle was blown aside; one man was injured; Shaftesbury UK 51.01 N 2.19 W 11-01-2007 thu 10:00 UTC (+/- 12 hrs) a plank crashed through the windscreen of a vehicle in Dorset, southern England; 1 injury Kraków Malopolskie PL 50.08 N 19.92 E 12-01-2007 Fri 09:30 UTC (+/- 30 min) A large tree branch fell on a woman who died from sustained injuries.
Wikipedia (20220322)	Wikipedia, Cyclone Kyrill, https://en.wikipedia.org/wiki/Cyclone_Kyrill, accessed 22Mar2022 -CASUALTES AND FATALITIES 13 Germany 11 UK 7 Ireland 7 Netherlands 6 Poland 4 Czech Republic 3 France 3 Belgium 1 Austria -Netherlands -6 people injured when crane fell through roof Utrecht University -France -significant damage to the cathedral at Saint-Omer -Poland -crane operator killed Katowice when 25m crane broke in half -by 19Jan 6 fatalities & 19 injuries reported; 800 000 households without electricity; 500 damaged houses -tabulated fatalities & injuries LA Ki In Location Description --- UK 1 Shropshire car collided with uprooted tree UK 1 Kentish Town, London crushed under fallen wall UK 1 A629 in Yorkshire overturned lorry UK 1 A55 near Chester overturned lorry UK 1 A329 near Streatley Berkshire branch hit car

	UK 1 Manchester man blown into metal shutters UK 1 Byley Cheshire man hit by tree at construction site UK 1 North Lincolnshire man crushed under collapsing shed UK 1 Stockport woman crushed under fallen wall UK 1 Lancashire man hit by fallig canopy at petrol station UK 1 Wooferton Shropshire lorry driver collided with another vehicle DE 1 Milbertshofen Munich crushed in patio door DE 1 near Kirrlach,Baden-Wuerttemburg motorist swerved to avoid tree; hit oncoming vehicle DE 1 Gersthofen Augsburg man crushed by barn door DE 1 Tonisvorst in north Rhine-Westfalen fireman during cleaning up DE 1 Hildesheim motorist killed by fallen tree DE 1 Essen motorcyclist slid under tree DE 1 Lippstadt car driver killed by falling birch tree DE 1 GrossRodensleben, Sachsen-Anhalt crushed under falling gable DE 1 Strausberg, Brandenburg motorist crashed into fallen tree DE 1 Finnentrop motorist crashed into fallen tree DE 1 Muelheim an der Ruhr man killed by falling tree NE 2 between Arnhem & Ede tree hit car NE 1 Oosterhout collision with truck NE 1 near Leersum motorcycle collision with tree NE 1 SintOedenrode moped collision with tree NE 1 Riel blow blown in front of moving car NE 1 Staphorst man blown off roof of barn NE 0 6 Utrecht university crane fell through roof FR 1 1 Roubaix electricity pole fell on top of car FR 1 near Abbeville swerving truck crashed into car FR 1 Lille roof of store collapsed BE 1 Halle crushed under falling wall BE 1 Liege tree fell on top of car BE 1 Antwerp hit by falling beam PL 1 Katowice crane broke in half PL 5 6 across Poland CZ 1 Slunecna Liberec Region tree fall during road clearance CZ 2 Vestec near Prague tree on car
Wikipedia (20220323)	Wikipedia, Cyclone Per, https://en.wikipedia.org/wiki/Cyclone_Per, accessed 23Mar2022 -Storm Hanno 14Jan2007 Deaths: -man in car hit by falling tree Jonkoping County 14Jan -9y old boy in Motala killed by falling tree midday 14Jan -24y old truck driver killed Ullared when truck hit by tree 14Jan -61y old man died Malmo harbor in storm accident 14 Jan -2 men died in woods in aftermath of storm on 15Jan: Oland and Smaaland

Table SL54. Coastal flooding, dike breaks, and evacuations (arranged by year and then alphabetically)

Source	Full Reference and Notes
Air Worldwide (20070112)	Air Worldwide, European Winter Storm Franz, first posting 12Jan2007, https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-franz/first-posting/ -FRANZ: low-lying areas of Hamburg expected to be flooded by storm surge
Air Worldwide (20070116)	Air Worldwide, European winter storm Per, 16Jan2007 10:30AM https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-per/first-posting/ -Finland: flooding around Turku harbour
Bottema (2007)	Bottema M, Zwaarste storm sinds 1990. Bijzondere golf- en waterhoogten IJsselmeer. Trendsinwater.nl. Monitoring van Nederlandse wateren: resultaten en ontwikkelingen. nummer 21, april 2007 -KYRILL 2. Waterschappen in actie (regional water authorities in action) -at Enkhuizen-Zuid closure of sluices prevented damage to the Hoogheemraadschap -in the evening RWS issued 10 new water warnings for the Ketelmeer -Waterschap Groot Salland set high water brigade in action with movable water protection barriers in the city because of rising water levels at Kampen NAP+1.56m -midday Balgstuw at Ramspolclosed because of rapidly rising water in the Ketelmeer -around the same time Waterschap Zuiderzeeland started intensive dyke watch on Flevolandse dykes -light damage to western Noordoostpolderdijk through long wavelength
FAZ (20070112)	Frankfurter Allgemeine Zeitung, Orkantief Franz wuetet ueber Europa, 12Jan2007 -light damage by storm surge in Hamburg -Hamburg Fishmarket flooded -Halligen along Schleswig-Holstein coast reported 'Land unter'
KIT-CEDIM (20070116)	KIT-CEDIM, Orkantiefs 'Franz' und 'Hanno'. Mitteleuropa, Suedskandinavien 11-14.1.2007, (contributors CE and BM) Wettergefahren-Fruehwarnung, Dientag, 16.Januar 2007, 04:00 MEZ http://www.wettergefahren-fruehwarnung.de/Ereignis/20070116_e.html -Storm Franz caused 2.70m surge Hamburg -Fischmarkt & Speicherstadt flooded
NLWKN (20070122)	NLWKN, Sturmflut von 19.Januar: Es kam nicht so schlimm wie befurchtet. 19.Januar2007: keine Duenenabbruche auf den Inseln/Fuer das Wochenende wird erhoehtes tidewasser erwartet, 22/01/2007 https://www.nlwkn.niedersachsen.de/startseite/aktuelles/presse_und_offentlichkeitsarbeit/pressemitteilungen/-

	41867.html -no dune collapse on German North Friesland islands; actual wind much less than expected -NKWKN staff mobilized with local emergency workers during storm
Stern (20070111)	Stern, Orkantief "Franz" Schwerer Sturm über Deutschland, 11Jan2007, 21:30 https://www.stern.de/panorama/orkantief--franz--schwerer-sturm-ueber-deutschland-3359640.html -high water expected for Hamburg; storm surge on Niedersachsen coast
Ge et al (2014)	Ge J, D Much, J Kappenberg, O Nino, P Ding, Z Chen, Simulating storm flooding maps over Hafencity under present and sea level rise scenarios, Journal of Flood Risk Management, 7, 319-331, 2014. -FRANZ: minor flooding Hamburg Hafencity during storm Franz; not as bad as Storm Anatol
ESWD (20220609)	European Severe Weather Database, 11-12Jan2007 FRANZ, accessed 09Jun2022 Location LA Latitud Longitu Date Day Time Uncertainty ND --- Riga LV 56.95 N 24.10 E 11-01-2007 thu 16:00 UTC (+/- 3 hrs.) Most of all it caused a sea flood (+ 1,5 m above normal)

Table SL55. Coastal dike heights and protection levels (arranged by year and then alphabetically)

Source	Full Reference and Notes
EDP (20070113a)	EDP, GBP 5m cut from flood budget, Eastern Daily Press, p1-2, 13Jan2007a -Norfolk MP yesterday branded decision to cut 5m GBP from East Anglia flood defence budget scandalous and as bad for the government as New Orleans is for US -Norman Lamb, LibDem: work recharging beach Eccles-Winterton would not go ahead -EA describes DEFRA decision as disappointing -EA Anglian (eastern) Regional Flood Defence Committee received budget 12Jan2007: 33m GBP or 5.2m GBP < last year -private/public partnership Broadland Flood Alleviation Project; small-scale development Great Yarmouth -1m GBP to improve flood defences along RIver Wensum in Norwich -no 2m GBP scheme to protect broads from being breached at most vulnerable point between Winterton & Eccles -Norman Lamb: comparison with New Orleans flood defences -Malcom Kirby, Coastal Concern Action Group: decision puts at risk Hickling, Waxham, Sea Palling, & 6000 ha of Broads -Anthony Coe, chariman of flood defence committee: East of England has one of largest flood defence budgets -money reallocated for flood defence programs in Carlisle and Weston-super-Mare
Get et al (2014)	Ge J, D Much, J Kappenberg, O Nino, P Ding, Z Chen, Simulating storm flooding maps over Hafencity under present and sea level rise scenarios, Journal of Flood Risk Management, 7, 319-331, 2014. -Tidal Elbe River: 4 million people in Hamburg 19km2 -only vulnerable area HafenCIty District of Hamburg -HafenCity in old harbour area; elevation 4.4m to 7.2m -dyke height standard Elbe at Hamburb +7.5m; HafenCity one of few areas vulnerable to storm surge
Environment Agency (2018)	Environment Agency, Thames Barrier Project Pack 2018, January, 2018. Environment Agency. Thames Barrier View Cafe and Information Centre, 1 Unity Way, Woolwich, London, SE18 5NJ. email: thamesbarrierenquiries@environment-agency.gov.uk. -Thames Barrier gives protection from 1000y surge water level

Table SL56. Surge barrier closures (arranged by year and then alphabetically)

Source	Full Reference and Notes
Bottema (2007)	Bottema M, Zwaarste storm sinds 1990. Bijzondere golf- en waterhoogten IJsselmeer. Trendsinwater.nl. Monitoring van Nederlandse wateren: resultaten en ontwikkelingen. nummer 21, april 2007 -at Enkhuizen-Zuid closure of sluices prevented damage to the Hoogheemraadschap -in the evening RWS issued 10 new water warnings for the Ketelmeer -Waterschap Groot Salland set high water brigade in action with movable water protection barriers in the city because of rising water levels at Kampen NAP+1.56m -midday Balgstuw at Ramspolclosed because of rapidly rising water in the Ketelmeer -around the same time Waterschap Zuiderzeeland started intensive dyke watch on Flevolandse dykes
NLWKN (20070115)	NLWKN, Sturmflut am 12. Januar 2007: Nordseekueste kam glimpflich davon 12. Januar 2007 (aktualiert am 15. Januar 2007): Duenenabbrueche auf den ostfriesischen inseln https://www.nlwkn.niedersachsen.de/startseite/aktuelles/presse_und_offentlichkeitsarbeit/pressemitteilungen/-41838.html -FRANZ -surge barriers closed: lower Elbe barriers closed like the Ochtum-Sperrwerk, Leesumsperrwerk, Hunte-sperrwerk -Ems-Sperrwerk in Gandersum in Landkreis Leer closed 0300 to protect upstream at Papenburg
NLWKN (20070122)	NLWKN, Sturmflut von 19.Januar: Es kam nicht so schlimm wie befurchtet. 19.Januar2007: keine Duenenabbruche auf den Inseln/Fuer das Wochenende wird erhoehtes tidewasser erwartet, 22/01/2007 https://www.nlwkn.niedersachsen.de/startseite/aktuelles/presse_und_offentlichkeitsarbeit/pressemitteilungen/-41867.html -KYRILL: Ems-Sperrwerk in Gandersum closed because water level 2.20 muMTHW; closed for 40min
RWS (200701a)	RWS, Verslag van de stormvloed van 11 en 12 januari 2007 (SR85), Ministerie van Veerkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007a -FRANZ: storm surge barriers not closed in the Oosterschelde and Europoort: includes Maeslandkering, Hartelkering and storm surge barriers in Hollandsche IJssel
RWS (200701b)	RWS, Verslag van de stormvloed van 18 en 19 januari 2007 (SR86), Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007b

	-KYRILL: storm barriers not closed: Oostercheldekering, Maeslantkering, Hartelkering -KYRILL: Hollandsche IJssel storm barrier was closed
Environment Agency (2018)	Environment Agency, Thames Barrier Project Pack 2018, January, 2018. Environment Agency. Thames Barrier View Cafe and Information Centre, 1 Unity Way, Woolwich, London, SE18 5NJ. email: thamesbarrierenquiries@environment-agency.gov.uk. -Thames Barrier closed 18Jan2007, 21Jan2007, 22Jan2007

Table SL57. Beach damage and coastal issues; salt water contamination of groundwater; sewer systems (arranged by year and then alphabetically)

Source	Full Reference and Notes
Air Worldwide (20070116)	Air Worldwide, European winter storm Per, 16Jan2007 10:30AM https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-per/first-posting/ -HANNO/PER -high seas & storm winds caused significant erosion of Danish island Anholt
NLWKN (20070115)	NLWKN, Sturmflut am 12. Januar 2007: Nordseekueste kam glimpflich davon 12. Januar 2007 (aktualiert am 15. Januar 2007): Duenenabbrueche auf den ostfriesischen inseln https://www.nlwkn.niedersachsen.de/startseite/aktuelles/presse_und_offentlichkeitsarbeit/pressemitteilungen/-41838.html -FRANZ -Dune collapse on the islands -Juist-West: west of Hammersee overe a km; avg 5m loss but greater in some places; NKWKN plans for strengthening -Langeoog Pirotal/Bereich Kinderkur; duneloss ca 2-6m at Pirolatal; some collapse other places; NLWKN focus area -Spiekeroog Hessenwand/Suederduenen: collapse; NKWKN began protection 2006 dune foot with rock armour -Wangerooge Harlehoern: further damage on already narrow dune; 4m dune loss on Harlehorn
NLWKN (20070122)	NLWKN, Sturmflut von 19.Januar: Es kam nicht so schlimm wie befurchtet. 19.Januar2007: keine Duenenabbruche auf den Inseln/Fuer das Wochenende wird erhoehtes tidewasser erwartet, 22/01/2007 https://www.nlwkn.niedersachsen.de/startseite/aktuelles/presse_und_offentlichkeitsarbeit/pressemitteilungen/-41867.html -KYRILL: no dune collapse on German Ostfriesen Islands

Table SL58. Power interruptions; oil pipeline flow stopped due to electricity loss (arranged by year and then alphabetically)

Source	Full Reference and Notes
Air Worldwide (20070112)	Air Worldwide, European Winter Storm Franz, first posting 12Jan2007, https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-franz/first-posting/ -FRANZ -winds uprooted trees, knocked down power lines, damaged houses -Wales: 80000 people lost power -Austria: 1200 households -Poland: 2500 households -Czech Republic: unknown number
Air Worldwide (20070116)	Air Worldwide, European winter storm Per, 16Jan2007 10:30AM https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-per/first-posting/ -PER/HANNO -cut power to 280000 Swedish households; 50000 lost landline telephone service -Monday afternoon 15Jan 180000 houses still without power -additional 3000 Norwegian households lost power overnight on Monday with continued high winds
BBC (20070111c)	BBC, Thousands hit by storm power cuts, 11Jan2007c (Thursday) http://news.bbc.co.uk/2/hi/uk_news/wales/6250925.stm -FRANZ -80000 homes & businesses without electricity earlier in day; Powys & south Wales worst hit -Western Power Distribution: said tree hit cable in Crickhowell, knocking out power to many homes Powys -extra staff brought into Wales to restore power by midnight -1900GMT 2500 homes still cut off -Scottish Power: said 250 customers across north of Wales still remained affected -Scottish Power: continuing high winds meant unable to send engineers to deal with problem areas -work will continue until midnight & resume early Friday -numerous faults after power lines came down or trees fell across them -Gwynedd and parts of Dee Valley worst affected; but no estimate when customers reconnected -Western Power Distribution: mid-Wales customers experienced power cuts from 0800GMT but cables hit by strong winds
BBC (20070112)	BBC News, Power restored as winds subside, Friday, 12 Jan 2007, 08:59GMT news.bbc.co.uk/2/hi/uk_news/wales/6254617.stm -FRANZ -80000 properties across N Wales & Powys left without power as cables brought down -on Thurs around 2750 properties at Brecon in Powys & Merthyr Tydfil still without power after fallen tree hit cable at Crickhowell -supplier Wester Power Distribution drafted extra staff from England; electricity now restored
BBC (20070118a)	BBC News, Nine dead as UK struck by storms, 18Jan2007, http://news.bbc.co.uk/2/hi/uk_news/6272193.stm -KYRILL -thousands of homes across UK left without power when storms at peak -earlier on 18Jan, approx 100000 people affected by power cuts Godalming, Surrey -10000's left without electricity NE England, Yorkshire, N Lincolnshire

	-people in parts of Lancashire & S Lake District lost power -1000s people lost power Hertfordshire, Bedfordshire, Buckinghamshire, Cheshire, Wales
BBC (20070118b)	BBC, Huge storms sweep northern Europe, 18Jan2007, 2234GMT, http://news.bbc.co.uk/2/hi/europe/6274377.stm -KYRILL: tens of thousands of homes without power
Belfast Telegraph (20070111a)	Belfast Telegraph, Severe gales continue (contributor Colm Lenaghan and Victoria O'Hara), 11Jan2007a -FRANZ -severe gales that left 1000s of homes without power overnight continue to batter the province -houses without power in early morning as 70mph winds brought down power lines -hurricane force winds hit at 10pm 10Jan2007 -worst affected towns: Coleraine, Enniskillen, Omagh -NIE spokeswoman: there are now about 1100 homes still without power; to be restored through day
Belfast Telegraph (20070112a)	Belfast Telegraph, Ulster on alert as more high winds are forecast (contributor Matthew McCreary), 12Jan2007a. -7500 homes (many in west) left without power 11Jan2007 Thu after heavy winds Wednesday night -hundreds of Bank of Ireland bank machines nonfunction by weather -homes in Crawfordsburn in Co Down without power as telegraph pole brought down -night 11-12Jan2007 relatively calm; all power from 11Jan restored & no new outages overnight
Belfast Telegraph (20070112c)	Belfast Telegraph, Heavy rain set to continue as Portstewart harbour feels the force of stormy weather (contributor Mark Jamieson), 12Jan2007c, p2. -However, the severe gales which knocked out powerlines and brought down a bank's computer systems during the week expected to ease
Belfast Telegraph (20070119)	Belfast Telegraph, Killer storms claim 13 lives (PA Reporters and Deborah McAleese), p.4, 19Jan2007. -severe gales reached 82 mph in south Down; also disruption to power supply -14000 customers without power; 5000 still without power 18-19Jan in areas Dungannon to Newry
Brugge (200701)	Brugge R, British Isles weather diary, Jan 2007, www.met.reading.ac.uk/~brugge/diary2007.html#200701 -11Jan: thousands of UK homes were left without power including 80000 in Wales caused by damaged power lines. -18Jan: Trees and pylons brought down in many parts of England Wales... Thousands of homes without power.
Deutsche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] -KYRILL, Germany: Magdeburg: several power masts collapsed; 85000 households impacted -KYRILL, Germany: in other areas destroyed lines resulted in numerous power outages in other cities of country -KYRILL, Britain: toppled trees caused numerous power cable cuts; hundreds of thousands without power
DW (20070112)	DW, Heavy storms batter northern Europe, 12Jan2007 https://www.dw.com/en/heavy-storms-batter-northern-europe/a-2308237 -FRANZ, Poland: around 2500 households in Poland left without electricity Thurs night 11Jan -FRANZ, Poland: winds of more than 100kph felled trees on power lines -FRANZ, England: thousands homes without power; fallen trees disrupting train travel
DW (20070120)	DW, Power cuts in Europe as continent begins to clean up, 20/01/2007, https://www.dw.com/en/power-cuts-in-europe-as-continent-begins-clean-up/a-2319624 -KYRILL -10s thousands homes England, Germany, Poland still without power -19000 households in eastern England had no electricity -Germany: 11 killed; 12000 of 60000 homes with cut power still in dark, 10000 in Thuringia -Olaf Werner (E.ON spokesman): objective to connect all 55 areas between now & this evening -Poland: no information on number of homes without electricity this morning (Saturday); -Poland: on Friday afternoon, 800000 were without power -Dariusz Malinowski -Poland: new terminal of Warsaw Okecia airport damaged & partially closed -Ukraine: power lines damaged -Ukraine: telephone connections severed -Ukraine: Russian oil deliveries to EU interruped Friday after high winds knocked out electricity at pumping station on section of pipeline that transits Ukraine
EDP (20070112a)	EDP, County is battered by 61mph winds, Eastern Daily Press (contributor Katie Cooper), p.8, 12Jan2007a -another 10days of wind & rain predicted last night 11Jan2007 after Norfolk faced day of power cuts & road closures -county battered by winds up to 61mph, downing power lines; leaving 100s without power -Norfolk police inundated with calls of fallen trees & power cables throughout county -Dereham: Power cut in downtown, affecting 600 homes, shopping center, police station -Cromer: power cut to 400 homes
EDP (20070119i)	EDP, Storm chaos on the roads and railways, Eastern Daily Press (contributor: Lorna Marsh), p.4, 19Jan2007i. -EDF Energy Networks estimated 20000 homes & businesses affected across East Anglia
EDP (20070120)	EDP, The big clean-up after the storm, Eastern Daily Press, p11, 20Jan2007 -East Anglia: 1000s people still without power -15000 homes & businesses in Norfolk, Suffolk, Cambridgeshire still without electricity from fallen cables -North Walsham: scores of homes lost power night 19Jan2007 -EDF: 100s of extra staff getting people back on power
EDP (20070122a)	EDP, All brrr-aced for cold snap, Eastern Daily Press (contributor Laura Devlin), p.13, 22Jan2007a -1100 homes still left without power 21Jan2007; should have power 22Jan2007 -Emma Coombs Weatherquest: could be snowfall in county; unlikely to cause major disruption -as of 21Jan2007: EDF Energy restored power to 98.5% homes affected by storms East Anglia -clusters of homes without power: Beccles, Bunwell, Bury St. Edmunds, Denver, Dereham, Diss, Downham Market, Yarmouth, Hevingham, Hunstanton, Kings Lynn, North Walsham, Norwich, Sheringham,

	Swaffham, Thetford, Wisbech
Guardian (20070112)	Guardian, Nine killed as gales lash UK, Fri 12Jan2007 16:57GMT https://www.theguardian.com/world/2007/jan/12/weather.uk -FRANZ: gales up to 90mph caused chaos across Britain 11Jan; 9 people died, 1000s without electricity -FRANZ: mid- and south Wales 80000 homes without electricity from damaged line in extreme conditions
Herald (20070112)	The Herald, Disaster averted as drifting ship misses North Sea platforms, 12Jan2007 https://www.heraldscotland.com/default_content/12754075.disaster-averted-drifting-ship-misses-north-sea-platforms/ -FRANZ -Scottish Power: reckoned they have 2500 homes cut off -at one point Scottish Hydro had 4000 consumer affected -80000 homes in Wales without power
Irish Independent (20070112)	Irish Independent, Gales cut power to thousands and spark widespread travel chaos, Irish Independent (contributor E. Kennedy), p7, 12Jan2007 -falling trees caused electricity cuts in pockets across country; Donegal & Northern Ireland hit worse -number of schools in Donegal closed for day due to power losses; Inishowen peninsula worst affected -ESB staff worked to restore service to est 3000 homes/businesses; efforts hampered by high winds & lightning throughout afternoon 11Jan2007 -surgeries at Cork Univ Hospital postponed by weather conditions & power problems -Tony Long, hospital manager, said 1h surgery cancelled
KIT-CEDIM (20070116)	KIT-CEDIM, Orkantiefs 'Franz' und 'Hanno'. Mitteleuropa, Suedskandinavien 11-14.1.2007, (contributors CE and BM) Wettergefahren-Fruehwarnung, Dientag, 16.Januar 2007, 04:00 MEZ http://www.wettergefahren-fruehwarnung.de/Ereignis/20070116_e.html -FRANZ: power loss in localized areas eg, Kreis Ortenau -Hanno caused collapse of southern Sweden power masts and caused alot of damage
Kvamme (20070214)	Kvamme, Dag, Ekstremvaer nr.1/2007 - 'Per', Intern Rapport, met.no, 15pp, Meteorogisk Institutt met.no, Bergen, 14/02/2007 -[HANNO/PER] Some lost power, among others on Haugeland (Sveio, Tysvaer, Vindafjord) with 100-200 subscribers without power
LCW (20070112)	Lloyds Casualty Week, 12Jan2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ -01Jan2007 storm: Swedish power companies reported storms caused power outages for 15000 households throughout southern part of country
LCW (20070126)	Lloyds Casualty Week, 26Jan2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ -Belarus: Storm Hanno: 1200 populated localities, especial Grodno & Minsk regions, hit by storm since beginning of day -Belarus: Storm Hanno: storm left 1077 towns & villages without electricity supplies; 500 still without power -Belarus: Storm Hanno: special teams to restore power & repair roofs -Latvia: Storm Hanno: gusts broke trees & tore off telegraph wire -Latvia: Storm Hanno: irregular power supplies -Sweden: Storm Hanno: hurricane winds whipped across SW Sweden leaving >100000 households without power -Sweden: Storm Hanno: central train station Gothenburg without power -Sweden: Storm Hanno: power companies called in extra people to restore electricity but strong winds made it nearly impossible to repair damaged power lines -UK: Storm Kyrill: thousands homes Wales lost power after heavy rain & winds to 80mph brought down power lines -UK: Storm Kyrill: Scottish Power: 25000 homes north & mid Wales & Merseyside hit -UK: Storm Kyrill: Scottish Power dealing with 100 separate incidents in mid & north Wales, many isolated households -UK: Storm Kyrill: power cuts stretch from mid-Wales to northeast
LCW (20070202)	Lloyds Casualty Week, 02Feb2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ -late 19Jan high winds reached Russia & Ukraine; pipeline carrying Russian oil to EU via Ukraine shut down with power loss -roads, rail lines, electricity pylons taken out of action across N Europe by falling trees, collaping walls, flying wreckage -Czech Republic million people with power cuts -million households Germany had blackouts -power cuts at 10s thousands homes Poland, Austria, northern France, UK -Czech Republic: >1 million homes without electricity with winds up to 112 mph -power outages Germany -10s thousands in Poland & Austria hit with outages -flow of Russian oil through Ukrainian pipeline restored Friday after temporary shutdown from power cut to pumping station -UK: thousands of homes remain without power; flood warnings in place
Met Eireann (200701)	Met Eireann, Monthly Weather Bulletin, No 249, Jan 2007 -KYRILL -power outages across continent -millions households between Ireland & Russia with blackouts; Germany & Czech worst affected
Stern (20070111)	Stern, Orkantief "Franz" Schwerer Sturm über Deutschland, 11Jan2007, 21:30 https://www.stern.de/panorama/orkantief--franz--schwerer-sturm-ueber-deutschland-3359640.html -NE Poland: 2500 homes without power -toppled trees brought down many power lines -Wales: power cuts for 80000 people
UKMO Daily Weather Summary (200701)	UKMO Daily Weather Summary 01-31Jan2007, UK MetOffice [pdf document properties: author=jan.freeman; datestamp=23/04/2015] -FRANZ: wind speeds in excess of the 60kt at times; coupled with wet ground, this caused disruption; large parts

	of Wales losing power
Unwetterzentrale (200701)	Unwetterzentrale, Orkantief KYRILL - 18., 19.01.2007 (Tief Nr. 33) - Der schwerste Orkan seit Jahrzehnten, analysis by Manfred Spatzierer, Thomas Sävert, Stefan Laps, www.unwetterzentrale.de/uwz/348.html -Kyrill: numerous households without power due to damaged transmission lines
Upstream (20070119)	Upstream, Ukraine restarts oil flow after storms, Upstream (contributor James MacKenzie), 19Jan2007 https://www.upstreamonline.com/live-fsu/ukraine-restarts-oil-flow-after-storms/1-1-1043988 -KYRILL keywords: Ukraine, oil pipeline stoppage, Storm Kyrill, high winds, Druzhba pipeline, UkrTransNafta
Wetteronline (20070118)	Wetteronline, Orkan Kyrill tobt in Europa, 18Jan2007 22:00, https://www.wetteronline.de/wetterticker/orkan-kyrill-tobt-in-europa--UZiFNRdrmvxoC3RHqLLyU -KYRILL -Hurricane left behind path of devastation in parts of Europe 18-19Jan2007 -dozens of people died; over million households lost power, traffic came zum Erliegen -10s of thousands with power cuts; telephone lines also partly overloaded
Wetteronline (20070118b)	Wetteronline, Schwere Schaeden nach Kyrill, https://www.wetteronline.de/wetterticker/schwere-schaeden-nach-kyrill--643tBpXGzIivrA8sEYH1EU (accessed 03Sep2022) -KYRILL -damaged power lines led to power outages -telephone system overloaded
Behrens and Guenther (2009)	Behrens, A. and H. Guenther, Operational wave prediction of extreme storms in Northern Europe, Nat. Hazards, 49, 387-399, 2009 -loss of power and telephone communication during storm Kyrill
Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -'in Germany, Austria, the Czech Republic, and Poland a total of million homes were left without electricity'
Gardiner (2010)	Gardiner, Barry, Appendix 3: Background information on 11 storms selected for detailed analysis, European Forest Institute, Atlantic European Regional Office - EFIAtlantic, 161 pp. [PDF properties: datestamp 23Jul2010] -Sweden: Storm Per: 14Jan2007; thousands of households losing electricity
Esurge (20121111)	Esurge_2007_kyrill(2012), Triple storm even (2007), Philip Harwood, Sun, 2012/11/11 15:04 -power outage for 100,000 people
AON Benfield (2013)	AON Benfield, Historie von 1703 bis 2012: Winterstuerme in Europa, Stand: Januar 2013 -extended power outages in many regions -damaged power cables caused power cuts
ESWD (20220609)	European Severe Weather Database, 11-12Jan2007 FRANZ, accessed 09Jun2022 Location LA Latitud Longitu Date Day Time Uncertainty ND ---------- Ostrowite Wielkopolskie PL 52.53 N 17.87 E 11-01-2007 thu 22:00 UTC (+/- 3 hrs.) more than 170 transformator stations / power lines damaged Strzalkowo Wielkopolskie PL 52.32 N 17.82 E 11-01-2007 thu 22:00 UTC (+/- 3 hrs.) more than 170 transformator stations / power lines damaged n. Dzierzoniów Dolnoslaskie PL 50.72 N 16.65 E 11-01-2007 thu 22:00 UTC (+/- 6 hrs.) damage to property: power lines damaged Bielawa Dolnoslaskie PL 50.68 N 16.62 E 11-01-2007 thu 22:00 UTC (+/- 6 hrs.) damage to property: power lines damaged Wrzesnia Wielkopolskie PL 52.32 N 17.58 E 11-01-2007 thu 20:00 UTC (+/- 3 hrs.) Damaged power lines reported Koscian Wielkopolskie PL 52.10 N 16.63 E 11-01-2007 thu 20:00 UTC (+/- 3 hrs.) Damaged power lines reported Olecko Warminsko-Mazurskie PL 54.03 N 22.49 E 11-01-2007 thu 09:00 UTC (+/- 6 hrs.) Power outages were reported in the city (several hundred houses) Zelenogradsk RU 54.96 N 20.49 E 11-01-2007 thu 09:00 UTC (+/- 3 hrs.) wide spread damages of power lines reported Gur'yevsk RU 54.77 N 20.60 E 11-01-2007 thu 09:00 UTC (+/- 3 hrs.) wide spread damages to power lines reported Gvardejsk RU 54.65 N 21.07 E 11-01-2007 thu 09:00 UTC (+/- 3 hrs.) wide spread damages to power lines reported Volotovo RU 58.53 N 31.35 E 11-01-2007 thu 03:00 UTC (+/- 1 hrs.) 10 km of power lines were destroyed/damaged by severe wind gusts Lakhdenpokh'ya RU 61.52 N 30.18 E 11-01-2007 thu 00:00 UTC (+/- 6 hrs.) wide spread damages to power lines reported; Sortavala RU 61.70 N 30.68 E 11-01-2007 thu 00:00 UTC (+/- 6 hrs.) wide spread damages to power lines reported; Suojärvi RU 62.08 N 32.35 E 11-01-2007 thu 00:00 UTC (+/- 6 hrs.) wide spread damages to power lines reported; Wlen Dolnoslaskie PL 51.02 N 15.67 E 11-01-2007 thu 22:00 UTC (+/- 6 hrs.) Damaged power poles were reported in this area. Sulecin Lubuskie PL 52.43 N 15.10 E 11-01-2007 thu 20:00 UTC (+/- 3 hrs.) several power lines damaged Choszczno Zachodniopomorskie PL 53.17 N 15.42 E 11-01-2007 thu 20:00 UTC (+/- 3 hrs.) several power lines damaged Sankt Thomas DE 50.07 N 6.60 E 11-01-2007 thu 15:00 UTC (+/- 6 hrs.) trees uprooted and power lines destroyed;

	Gödenroth DE 50.08 N 7.48 E 11-01-2007 thu 15:00 UTC (+/- 6 hrs.) trees uprooted and power lines destroyed; Crickhowell UK 51.85 N 3.13 W 11-01-2007 thu 10:00 UTC (+/- 6 hrs.) power lines demaged / power cuts affected regions: Cardiff, Neath, Swansea; Tula RU 54.20 N 37.61 E 11-01-2007 thu 15:00 UTC (+/- 3 hrs.) wide spread damages of power lines reported; Kirzhach RU 55.90 N 39.07 E 12-01-2007 fri 10:00 UTC (+/- 3 hrs.) F0 wide spread damages of power lines reported; Yur'yev-Pol'skiy RU 56.50 N 39.68 E 12-01-2007 fri 10:00 UTC (+/- 3 hrs.) F0 wide spread damages of power lines reported; Gus'-Khrustal'nyy RU 55.62 N 40.67 E 12-01-2007 fri 07:00 UTC (+/- 6 hrs.) F0 wide spread damages of power lines; Silnowo PL 53.62 N 16.50 E 12-01-2007 fri 06:00 UTC (+/- 6 hrs.) A high-voltage power line was damaged between Silnowo and Zlocieniec. n. Drawsko Pomorskie Zachodn... PL 53.53 N 15.80 E 12-01-2007 fri 06:00 UTC (+/- 6 hrs.) Several places were cut off from a electric power supply in this area. Nieszawa Kujawsko-Pomorskie PL 52.83 N 18.90 E 12-01-2007 fri 06:00 UTC (+/- 6 hrs.) Damaged power lines reported (widespread event?) Wiecbork Kujawsko-Pomorskie PL 53.35 N 17.50 E 12-01-2007 fri 06:00 UTC (+/- 6 hrs.) Damaged power lines reported (widespread event?) n. Zywiec Slaskie PL 49.68 N 19.22 E 12-01-2007 fri 01:00 UTC (+/- 3 hrs.) About 500 houses were without power in this area.
Wikipedia (20220322)	Wikipedia, Cyclone Kyrill, https://en.wikipedia.org/wiki/Cyclone_Kyrill, accessed 22Mar2022 -on day of landfall ~25000 homes S England without electricity after electricity pylons damaged by storm (INCORRECT: actually downed power lines) -same day 18Jan massive power cut Brandenburg, Saxony, Saxony-Anhalt hit by massive power cut 52000 homes without power -German district Siegen-Wittgenstein issued state of emergency; schools closed -2nd day of storm -1 million homes without power Czech Rep (19Jan?) -1 million homes without electricity Germany -10's thousands homes without power Austria & Poland -Ukraine: oil supply through Druzhba pipeline came to halt because of storm -Ireland: 1000s homes without power; heavy downpours caused flash flooding -Poland: 800 000 households without electricity;
Wikipedia (20220323)	Wikipedia, Cyclone Per, https://en.wikipedia.org/wiki/Cyclone_Per, accessed 23Mar2022 -Storm Hanno/Per: Sweden: 6 fatalities & 300,000 households without electricity

Table SL59. List bridge closures, cancelled ferry crossings, port closures, airport cancel, rail interruptions, traffic accidents (arranged by year and then alphabetically)

Source	Full Reference and Notes
Air Worldwide (20070112)	Air Worldwide, European Winter Storm Franz, first posting 12Jan2007, https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-franz/first-posting/ -FRANZ -rail and road travel severely interrupted UK due to downed trees & electrical lines -wind overturned trucks & cars in UK, Germany, Belgium -ferry services interrupted across English Channel & German Baltic & North Sea coasts -several flights cancelled Heathrow & Schipol
Air Worldwide (20070116)	Air Worldwide, European winter storm Per, 16Jan2007 10:30AM https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-per/first-posting/ -significant interruptions of rail/road/sea/air travel -rail service Sweden yet to be fully restored -all major bridges Denmark closed -Oresund bridge connecting Denmark and Sweden closed -ferry travel around Baltic interrupted
BBC (20070111a)	BBC, England battered by wind and rain, 11Jan2007a 16:43GMT news.bbc.co.uk/2/hi/uk_news/england/6251415.stm -FRANZ -man killed in Somerset when his vehicle collided with fallen tree near Britty Common near Wellington at about 1100GMT -17y old girl trapped for 45min under tree blown onto her car in No Mans Heath Warwickshire -another woman escaped with minor injuries when tree fell on her in Hertfordshire -trains affected by trees on rails in Kent, Surrey, Hampshire, Devon -9 trains delayed by at least an hour after large tree fell line between Chatham & Sittingbourne Kent after 0500GMT -train services between Shrewsbury & Wales affected by flooding across Welsh border -part of canopy at Hither Green station in south London destroyed by high wind -P&O Ferries, SeaFrance, Norfolkline, Speedferries suspended all cross-Channel services to and from Dover when winds reach Bf10 -services from Kent to Calais/Dunkirk/Boulogne affected -ferry services to/from Isle of Wight suspended by high winds Solent -Red Funnel suspended all services -Wightlink unable to the operate catamaran Portsmouth to Ryde -Road closures -road to King Harry Ferry across River Dart at Kingswear, Devon blocked by fallen tree

	-Dartford river crossing bridge on M25 linking Essex to Kent closed by strong winds; traffice diverted into tunnel -new Sheppey crossing in Kent closed, but Kingsferry bridge to island remained open -high roads in Yorkshire including trans-Pennine M62 motorway closed to high-sided vehicles -M18 closed after lorry blown over near Thorne -A1 shut after truck overturned near Boroughbridge -A628 near Barneley 2 trucks blown over -Dorset truck driver with head injuries when plank through wind screen near Shaftesbury
BBC (20070111c)	BBC, Thousands hit by storm power cuts, 11Jan2007c (Thursday) http://news.bbc.co.uk/2/hi/uk_news/wales/6250925.stm -landslide on A470 at Dolwyddelan in Conwy -part of A470 at Pontypair in Conwy blocked by debris after landslide -firefighters used boat to rescue Land Rover driver in floodwater between Garth Mill & Forder in Powys -Environment Agency: one severe flood warning on River Vymwy from Llansantffraid to Shrawardine -Llanfairpwll on Anglesey: large tree fell across A4080 -Green Lane in Corwen, Denbighshire: closed due to flooding -Ruthin to Llanrhaeadris: only passable with care -Nant-y-Garth Pass in Denbighshire closed near Llysfasi College -Llangeler, Carmarthenshire: man treated in hospital after car crashed into tree on A484 -A477 Cleddau Bridge Pembrokshire closed -M48 Severn Bridge closed to traffic -First Great Western: trains between S Wales and London disrupted by flooding Swindon-Bristol Parkway -cancellations and extended journey times -north Wales: Arriva Trains has replacement bus service between Llandudno & Blaenau Ffestiniog; track flooded at LLanwrst
BBC (20070118a)	BBC News, Nine dead as UK struck by storms, 18Jan2007, http://news.bbc.co.uk/2/hi/uk_news/6272193.stm -KYRILL -Scotland saw first major snowfalls 2007; disruption road & rail -Dover port in Kent closed for a period -192 flights cancelled at Heathrow, 39 cancellations Scotland, 5 Southampton, 2 Stansted, some Cardiff, 80 Manchester. Flights from Liverpool John Lennon airport suspended for time -Road closures -M48 Severn Bridge closed, Dartford crossing closed -Motorways: M25 jn 29-30; M1 jn 30-31; M11 jn 6-10; M18 jn 4-7 -London Bridge closed for day after glass panels fell on concourse -Network Rail said speed restrictions to 50mph in place England & Wales to reduce damage overhead cables -Virgin Trains cancelled all West Coast services London-Scotland -First Great Western forced to run shuttle service Paddington to Reading
BBC (20070118b)	BBC, Huge storms sweep northern Europe, 18Jan2007, 2234GMT, http://news.bbc.co.uk/2/hi/europe/6274377.stm -KYRILL -Germany: national rail service suspended all services, leaving passengers stranded -head of German railways said situation was unprecedented -air traffic badly affected with many cancelled flights-London Heathrow cancels 130 flights; Frankfurt/Munich/Amsterdam/Vienna report delays/cancelled -Eurostar train service Paris-Brussels-London briefly suspended -ferries cancelled/delayed in Britain/Ireland/France/Belgium/Netherlands/Finland
Belfast Telegraph (20070111a)	Belfast Telegraph, Severe gales continue (contributor Colm Lenaghan and Victoria O'Hara), 11Jan2007a -FRANZ -police warned motorists: fallen trees blocked a number of roads across the province -storm also forced Foyle Bridge in Derry to close to all traffic last night for a time
Belfast Telegraph (20070112a)	Belfast Telegraph, Ulster on alert as more high winds are forecast (contributor Matthew McCreary), 12Jan2007a. -FRANZ -no reports this morning of blocked roads; websites indicated ferries and planes on schedule
Belfast Telegraph (20070119)	Belfast Telegraph, Killer storms claim 13 lives (PA Reporters and Deborah McAleese), p.4, 19Jan2007. -KYRILL -morning commuters had continuing problems during clear-up operation -1 man killed and another injured by fire engine responding to emergency involing diverted flight Belfast to Stansted diverted to Liverpool; 3 firefighters taken ot hospital -fire engine collided with car on way to airport for emergency landing -passengers from Liverpool diversion bussed to Stansted -number of flights from Belfast to Bristol/Edinburgh/Glasgow delayed because of weather -Stena line forced to cancel sailings from Larne and Belfast -2 people received minor injuries when 2 lorries overturned in province; several roads blocked by fallen trees -Foyle bridge in Londonderry closed to high-sided vehicles
Brugge (200701)	Brugge R, British Isles weather diary, Jan 2007, www.met.reading.ac.uk/~brugge/diary2007.html#200701 -09Jan: Strong winds forced Wightlink to suspend its catamaran between Portsmouth and Ryde as gusts to 40kn spread to S England with the cold front -11Jan: Rough conditions English Channel led to suspension of P&O Ferries & Seafrance services to Calais, Norfolkline to Dunkirk & Speedferries to Boulogne. Floods & fallen trees affected train services Shrewsbury-Machynlleth on Wales coast. Train delays Leeds-Manchester. Trees fell on line at Paddock Wood near Tonbridge Kent, Redhill in Surrey, Paignton in Devon disrupting First Western trains to London

	-18Jan: Snowfall at Glasgow airport led to flights being cancelled as visibility fell. Gales developed inland with Heathrow reporting 77mph gusts 1300GMT; many flights cancelled S UK. Tall-sided vehicles toppled. Rail companies operated reduced services due to debris. Several motorways closed because of accidents or fears
Deutsche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] -KYRILL -toppled trees led to significant traffic blockages on roads & rail -in Mittelgebirgen many roads closed -clearing blockages hindered by danger of further falling trees -transport trucks toppled by gusts -many road bridges closed; autobahn traffic cut -DB stopped long-distance trains afternoon 18Jan; large part of local trains stopped shortly after -normal train operations only in course of weekend -ferry traffic North Sea, Baltic Sea, Lake Constance stopped part of the time -significant delays in flights; several hundred flights cancelled -Britain: traffic chaos in south -rail traffic Netherlands completely stopped
DR (20070112)	DR, Storebaelts broen lukket paa grund af blaesten, 12Jan2007 https://www.dr.dk/nyheder/indland/storebaeltsbroen-lukket-paa-grund-af-blaesten -FRANZ -Storabaeltbroen closed to traffic in both directions; bridge expected to re-open at 08:00 -Oresund bridge is however open, also for light and wind-sensitive vehicles -there is risk that Oresund Bridge will be closed between 06:00-09:00 because of wind gusts -Faro bridge is also open, but police advise all wind-sensitive vehicles to use old Storstroomsbro instead -Ferry traffic between Ronne and Ystad are suspended; ferry from Bornholm will not arrive before 15:30
DW (20070112)	DW, Heavy storms batter northern Europe, 12Jan2007 https://www.dw.com/en/heavy-storms-batter-northern-europe/a-2308237 -FRANZ -Germany: ferry service on Germany's Baltic and North Sea coastline partly interrupted -Germany: Hamburg, major port & Germany 2nd city, closed in preparation of storm tide Friday morning 12Jan -England: severe storm & driving rain caused transport chaos & flood alerts Britain -England: thousands homes without power; fallen trees disrupting train travel -England: roads closed -England: rough conditions English Channel; suspension ferry services to Calais, Dunkerque, Boulogne -England: motorists SE England stranded & river burst banks Norfolk, Suffolk, Cambridgeshire, Essex
DW (20070119)	DW, Killer winds in Europe expected to cause heavy financial loss, 18Jan2007 https://www.dw.com/en/killer-winds-in-europe-expected-to-cause-heavy-financial-loss/a-2317752 -KYRILL -rail services halted; first time in history for Deutsche Bahn; trees on tracks -closure of Berlin central train station after girder collapsed -1000s travellers forced to spend night in rail stations or emergency accommodation -rail services gradually returning to normal Fri 19Jan2007 -many schools & businesses closed early Thur before full force of storm -100's flights cancelled on Thursday; German air traffic returning to normal Friday -Lufthansa forced to cancel 331 flights around Europe; 19000 passengers affected -Frankfurt grounded 207 of 1300 daily flights Thurs
DW (20070120)	DW, Power cuts in Europe as continent begins to clean up, 20/01/2007, https://www.dw.com/en/power-cuts-in-europe-as-continent-begins-clean-up/a-2319624 -KYRILL -German rail services largely back to normal after appalling weather forced DB to suspend all services for first time in history
DW (20070123)	DW, Hurricane causes massive damage to German forests, 23Jan2007, https://www.dw.com/en/hurricane-causes-massive-damage-to-german-forests/a-2323760 -KYRILL -rail passengers still experiencing delays & many trains yet to return to tracks 4 days after storm -DB said it expected train travel to return to normal by Wednesday
EDP (20070112a)	EDP, County is battered by 61mph winds, Eastern Daily Press (contributor Katie Cooper), p.8, 12Jan2007a -FRANZ -another 10days of wind & rain predicted last night 11Jan2007 after Norfolk faced day of power cuts & road closures -Central train services suspended between Thetford & Ely by fallen tree at Brandon -fallen trees cause blocked roads: A47 near Wendling, A47 at Nrecton, B1107 Thetford-Brandon -Norwich: 20X10foot billboard sign blew onto Yarmouth Road; one lane blocked at rush hour -car left A47 at Narborough
EDP (20070113b)	EDP, Motorist hurt as high winds fell tree, Eastern Daily Press, p18, 13Jan2007b -FRANZ -Thorpe End -motorist suffered shoulder injuries after strong windsblew tree into road; Plumstead Road 17:00 12Jan2007 -Ford Focus drove into it -diversions in place while highways engineers removed the tree

EDP (20070119e)	EDP, Roof closes motorway, Eastern Daily Press, p.5, 19Jan2007e -KYRILL -M69 at Enderby in Leicestershire near junction of M1 closed 12:30 when barn roof blew off
EDP (20070119h)	EDP, Mayhem in wake of storms, pp.2-3, Eastern Daily Press, 19Jan2007h -KYRILL -A10 at Kings Lynn: tree fell on car with minor injuries to all 3 passengers -Tivetshall St Margaret, between Norwich & Diss: conservatory blew onto rail line -A140 at Dunston: lorry blown over -A47 near Postwick: roof blew off car dealership -A149 at Smallburgh: motorcyclist blown off road -A11 at Elveden: fallen trees held up traffic -A140 at Hainford: fallen trees held up traffic
EDP (20070119i)	EDP, Storm chaos on the roads and railways, Eastern Daily Press (contributor: Lorna Marsh), p.4, 19Jan2007i. -KYRILL -severe weather: East Anglia rail services & road interrrupted; 1000's homes & businesses without power -ONE train services replaced by bus Norwich to Diss; conservatory on line at Tivetshall St Margaret; line re-opened 21:00 -delays on all train lines after Network Rail imposed 50mph speed restriction -Central trains to Liverpool through the Midlands were also badly affected -Norwich International Airport: flights delayed or cancelled to Paris, Amsterdam, Manchester -bus services affected due to diversions around closed roads: -Kings Lynn A149, A47; Dunston A140, Elvedon A11, Trowse/Postwick A47, Guist A1067, Garboldisham A1066
EDP (20070120)	EDP, The big clean-up after the storm, Eastern Daily Press, p11, 20Jan2007 -KYRILL -train & plane services back to normal; some minor roads closed from fallen trees & battered buildings - double decker bus in ditch Cambridge
Financial Times (20070119)	Financial Times, Fourteen die as storms lash north Europe (reporter: William MacNamara), 19Jan2007 -KYRILL -traffic in port of Rotterdam severely affected when contrainer ship collided with oil jetty; spill -Emma Maersk trapped -Britain: speed restrictions snarled rail lines; problems with fallen trees -London Bridge station closed -Kings Cross station shut after train suspensions on CNER and First Capital Connect lines -many mainline train services suspended; all those operating had delays -Eurostar service to and from Paris cancelled -Heathrow winds of 77mph; thousands stranded as BA cancelled 146 of 400 flights -inbound flights to Manchester suspended for 2h
Financial Times (20070120)	Financial Times, Insurers play down scale of storm damage claims, (reporter: William MacNamara), 20Jan2007 -KYRILL -country had restored almost all vital services by yesterday evening 19Jan ->1000 obstructions on British rails -79% of Friday morning trains ran on time
FAZ (20070112)	Frankfurter Allgemeine Zeitung, Orkantief Franz wuetet ueber Europa, 12Jan2007 -FRANZ -on North Sea and Baltic Sea ferry traffic partially suspended
Guardian (20070112)	Guardian, Nine killed as gales lash UK, Fri 12Jan2007 16:57GMT https://www.theguardian.com/world/2007/jan/12/weather.uk -FRANZ -severe weather disrupted rail services across country -services between Bournemouth & Edinburgh & west coast mainline routes delayed with trees on tracks -Heathrow 139 flights cancelled -fierce winds caused trees to fall on roads & made exposed stretched treacherous
Herald (20070112)	The Herald, Disaster averted as drifting ship misses North Sea platforms, 12Jan2007 https://www.heraldscotland.com/default_content/12754075.disaster-averted-drifting-ship-misses-north-sea-platforms/ -FRANZ -throughout 11Jan2007 80mph winds caused havoc across much of Scotland -Erskine Bridge across River Clyde closed to all traffic before morning rush hour; shut all day -Tay (Bridge) crossing closed to double decker buses -Forth Road Bridge closed to high-sided vehicles -Kessock Bridge at Inverness: strong wind warnings in place -Skye Bridge: strong wind warnings in place -Scottish Power: reckoned they have 2500 homes cut off -at one point Scottish Hydro had 4000 consumer affected -rail services interrupted -fallen tree brought down power lines on Dumbarton-Helensburgh line -Stranraer-Glasgow line: closed after a tree fell on it -Glasgow airport: 15-20 min delays in takeoff because of gusts
Irish Independent (20070112)	Irish Independent, Gales cut power to thousands and spark widespread travel chaos, Irish Independent (contributor E. Kennedy), p7, 12Jan2007 -motorists warned to drive carefully because of fallen trees; heavy rain caused flooding -cyclists warned to be careful; blown off in wind -air & sea travel badly affected; many cancelled flights & ferry sailings -early flight cancellations had knock-on effect

	-number of flights to UK cancelled -all Stena line sailings Dublin-Holyhead & Rosslare-Fishguard cancelled
KIT-CEDIM (20070116)	KIT-CEDIM, Orkantiefs 'Franz' und 'Hanno'. Mitteleuropa, Suedskandinavien 11-14.1.2007, (contributors CE and BM) Wettergefahren-Fruehwarnung, Dientag, 16.Januar 2007, 04:00 MEZ http://www.wettergefahren-fruehwarnung.de/Ereignis/20070116_e.html -FRANZ: North Sea ferry traffic suspended -FRANZ: North Sea container ship lost part of its load -FRANZ: roads blocked area Freudenstadt for short period -FRANZ: in high Sauerland, several trees fell on train tracks; several roads closed -FRANZ: Thuringen autobahnen several trucks toppled
Kvamme (20070214)	Kvamme, Dag, Ekstremvaer nr.1/2007 - 'Per', Intern Rapport, met.no, 15pp, Meteorogisk Institutt met.no, Bergen, 14/02/2007 -[HANNO/PER] Color Lines boat Prinsesse Ragnhild from Hirtshals was 10h delayed to Stavanger from 0600 Sunday to 1600. Tilhenger? tipped on board and 10 cars were damaged. Captain felt it was the strongest wind he had been out in for 13y. The boat rode out the weather west of Kvitsoy; the was strongest at 04:00 at 40m/s and waves heights of 12-17m
LCW (20070112)	Lloyds Casualty Week, 12Jan2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ -01Jan2007 storm -Oresund bridge linking Denmark to Sweden closed to road traffic for 1h with the high winds -airline traffic at Copenhagen & Malmo Sweden unaffected by high winds
LCW (20070119)	Lloyds Casualty Week, 19Jan2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ -Storm FRANZ -storm force winds led to disruption on rail & ferry services across SE -trees across lines near Newington & Chatham Kent -ferry crossings in Kent & Sussex suspended because of very rough sea conditions in English Channel -UKMO: severe weather conditions in many areas of UK -in SE gusts of more than 60mph forecast -Rail -large tree fell on southbound line near Newington Kent between Chatham & Sittingbourne just after 0500UTC -9 trains delayed by at least an hour -Roads -Dartford bridge over Thames partially closed because of high winds -Ferries: storm force winds led to Channel ferry crossings being disrupted at Port of Dover -disruption affected all sailing to Calais by P&O Ferries & SeaFrance, to Dunkerque by Norfolkline, to Boulogne by Speedferries -ferries cancelled at Newhaven port in Sussex
LCW (20070126)	Lloyds Casualty Week, 26Jan2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ -Sweden: Storm Hanno: major disruptions in train & ship traffic across Scandinavia -Sweden: Storm Hanno: Sweden Denmark bridge shut to all traffic -Sweden: Storm Hanno: nearly all train departures S Sweden & Norway cancelled; winds knocks trees across tracks in several places -Sweden: Storm Hanno: central train station Gothenburg without power -Sweden: Storm Hanno: several ferry lines between Denmark, Norway Sweden cancelled -UK: Storm Kyrill: gales & heavy downpours affected travel across UK -UK: Storm Kyrill: blown over lorries cause M1 closure between junctions 29 & 30 South Yorkshire -UK: Storm Kyrill: Network Rail speed restrictions on some lines -UK: Storm Kyrill: M18 partially closed -UK: Storm Kyrill: ferry services to Isle of Wight cancelled -UK: Storm Kyrill: Southampton container terminal closed -UK: Storm Kyrill: Chester Shrewsbury train closed by fallen tree -UK: Storm Kyrill: P&O ferries reported delays on Dover crossings -UK: Storm Kyrill: widespread disruption on roads & rail lines from fallen trees & flooding -UK: Storm Kyrill: flights from Cardiff International airport hit; most flights out cancelled; only one flight leaving; high winds caused flight diversion -UK: Storm Kyrill: rail services affected in/out of Wales -UK: Storm Kyrill: train services London to Cardiff cancelled -UK: Storm Kyrill: Stena Line 1430 ferry service Fishguard-Rosslare cancelled -UK: Storm Franz: more than 400 passengers guided to safety along tracks after landslip onto line in Surrey caused train derailment at 1230UTC -UK: Storm Kyrill: Easyjet aircraft, Belfast to Stansted, made emergency landing Liverpool airport; pilot said low on fuel; Easyjet said diversion due to high winds en route to London; no shortage of fuel; no other diversions from Stansted; aircraft landed safely Liverpool at 1140UTC; coaches for onward travel to Stansted
LCW (20070202)	Lloyds Casualty Week, 02Feb2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ Misc info: p.6: Kiel Canal closed for 6h 18Jan for any traffic by storm winds (grounding of ship Happy Falcon in canal); 20 ships waited for passage in Kiel; 50 waited in Brunsbuettel [KYRILL] Canal re-opened 2145L? as wind pressure decreased p.23: London, 20Jan [KYRILL] -press report 19Jan -increasingly severe hurricane force winds over N & NE Europe caused delays & cancellation of airline services across continent -78 Swiss flights cancelled

	-BA cancelled 130 flights from Heathrow to Manchester & Liverpool -Frankfurt airport 188 flights cancelled -19 flights cancelled Paris Charles de Gaulle -100 flights cancelled in 3 major airports Switzerland -Eurostar cancelled all itineraries London-Paris & London-Brussels -Germany forced to cancel many itineraries for first time in country history; DB said many lines remain closed from fallen trees -problems with rail connections to Holland, Poland, Czech Republic p.23: London, 20Jan -press report 19Jan -some travellers still stranded -roads, rail lines, electricity pylons taken out of action across N Europe by falling trees, collapsing walls, flying wreckage -normal rain operations resuming in Germany after entire network closed down for first time in its history p.24: London, 19Jan -Europeans worked today to restore services across continent after hurricane force winds toppled trees, brought down power lines, damaged buildings, killing 47 people, disrupted travel for 10s thousands -virtually entire German national railway system shut down during storm with trees over many tracks -Frankfurt airport flights regular Friday; 200 cancellations Thursday; -Lufthansa cancelled 331 flights across Germany Thursday, affecting 19000 passengers -BA cancelled 34 incoming flights to Heathrow & Gatwick -reduced rail services to two London Scotland lines -Eurostar running full service again after 1 early London-Paris train cancelled -London Bridge station reopened after part of roof collapsed; delays through day from repairs -1000s Dutch commuters stranded overnight when service was halted on all trains from track obstruction & downed power cables -early Friday most Dutch trains running again -German subways, trams, buses largely back in service but only few long distance trains running p.25: London, 19Jan -pilotage for large vessels Rotterdam resumed 0945 19Jan after being suspended by bad weather Thu 18Jan p.25: London, 19Jan -ports around Britain recovering from 18Jan storm -Aberdeen/Peterhead: no delays or weather damage -Bristol Channel: -general weather delays, storm force winds until 18Jan 1530; -Swansea pipe offloading stopped, ok today -Newport steel coils offloading stopped all day yesterday; ok today -Cardiff tanker operations unaffected -no damages or casualties -Felixstowe: no delays or weather damage -Grangemouth/Hound Point/Braefoot Bay: no delays or weather damage -Immingham: no delays or weather damage -Lerwick/Scalloway: no delays or weather damage -Mersey/MSC: general weather delays; port of Liverpool & Manchester Ship Canal suspended all arrivals/sailings 1400 18Jan to 0600 19Jan -Pembroke/Milford Haven: -general weather delays; -no cargo operations 2200 17Jan to 1600 18Jan due to gale force winds & no pilotage movements -no damage or casualties -Southampton -general weather delays -Southampton port closed 0500-2000 on 19Jan -damage/casualties: MSC Napoli in danger -Sullom Voe: no delays or weather damage -Tees: no delays or weather damage -Thames/Medway: general weather delays -Sunk (inner light vessel) went off stn from 0830 18Jan for about 12h -NE Spit still operationsl -no damage or casualties
Met Eireann (200701)	Met Eireann, Monthly Weather Bulletin, No 249, Jan 2007 -KYRILL -Dublin port forced to close during morning -Scotland saw first major snowfalls of 2007; road & rail disruption -winds gusting to 168km/h recorded late 18Jan in Germany; suspension all rail services; 1000s stranded -air traffic badly affected with many flights cancelled
Mueller-Westermeier (2007)	Mueller-Westermeier, Gerhard, Beschreibung un klimatologische Bewertung des Orkantiefs "Kyrill", pdf properties: Title: Deutscher Wetterdients - Nationale Klimauberwachung, Author: Gerhard Mueller-Westermeier, Subjet: Orkan Kyrill, datestamp: 26Jan2007 -traffic problems -train services completely stopped for a period

New York Times (20070119)	New York Times, Deadly wind and rain storm sweeps Europe, (Mark Landler) 19Jan2007, https://www.nytimes.com/2007/01/19/world/europe/19europe.html -KYRILL -German DB suspended all long-distance service -Heathrow: 123 flights cancelled; Frankfurt 122 flights cancelled -Secretary of State Condoleeza Rice cuts short visit to Berlin
Rheinische Post (20070111)	Rheinische Post, Orkan Franz fegt ueber Deutschland hinweg, 11Jan2007 https://rp-online.de/panorama/deutschland/orkan-franz-fegt-ueber-deutschland-hinweg_aid-11404937 -FRANZ -storm brought traffic interruptions for Niedersachsen, Schleswig-Holstein, Thueringen -rail services cancelled afternoon by uprooted trees -in other places, transport trucks blown over -numerous North Sea ferries storpped services; Ostfriesischen islands cut of from mainland -Thursday maintenance train hit toppled tree on line Oldenburg-Delmenhorst -no one injured; both tracks closed until late afternoon -between Hamburg and Stade 25m high tree toppled onto overhead power supply; 100kEUR damage -Near Husum in Schleswig-Holstein transport truck blow over -in Flensburg, toppled trees blocked several roads -on bridge of Autobahn 71 near Ilmenau several transport trucks toppled; no one injured
Stern (20070111)	Stern, Orkantief "Franz" Schwerer Sturm über Deutschland, 11Jan2007, 21:30 https://www.stern.de/panorama/orkantief--franz--schwerer-sturm-ueber-deutschland-3359640.html -Belga news agency: autobahn Brussels-Luettich fatal motorist accident because of storm gusts -Meteomedia weather service: peak wind speed Borkum 178km/h; many ferries to island cancelled -in Thueringen, A71 between Ilmenau-West and Zella-Mehlist closed because of several toppled transport trucks -ship traffic on the coast Niedersachsen and Schleswig-Holstein reduced -Bundesstrasse near Wernigerode, Sachsen-Anhalt, truck trailer toppled -valley bridge on Thuringer Wald Autobahn A71: hurricane gusts toppled 2 trucks; recovery only achieved on Friday morning -on A4 between Gotha and Wandersleben, 3 transport trucks toppled; long queues resulted -Oldenburg Niedersachsen: tree damaged overhead power cable of railway -Muensterland: rush hour traffic came to standstill because of falling tiles -Channel coast in France: ship traffic stopped -Dover port closed
Unwetterzentrale_Kyrill (200701a)	Unwetterzentrale, Orkantief KYRILL - 18., 19.01.2007 (Tief Nr. 33) - Der schwerste Orkan seit Jahrzehnten, analysis by Manfred Spatzierer, Thomas Sävert, Stefan Laps, www.unwetterzentrale.de/uwz/348.html -KYRILL -DB closed; many people spent night 19Jan2007 in trains or field beds in emergency locations -numerous train delays the day after -331 German airline flights across Europe cancelled on 18Jan
Unwetterzentrale_Kyrill (200701b)	Unwetterzentrale, Orkantief KYRILL: Ausführliche Analyse der Wetterlage, www.unwetterzentrale.de/uwz/355.html, page accessed 21Aug2022. -DB shuts down operations 1700 because of storm first time in countrywide history
Wetteronline (20070118)	Wetteronline, Orkan Kyrill tobt in Europa, 18Jan2007 22:00, https://www.wetteronline.de/wetterticker/orkan-kyrill-tobt-in-europa--UZiFNRdrmvxoC3RHqLLyU -KYRILL -hurricane brought traffic to standstill -numerous trees fell; roads & rails blocked by consequence -train traffic almost in chaos -on safety grounds, long-distance trains stopped; local trains stopped by area -numerous people spent night in train stations -country-wide road closures by wind-toppled trees and flooded roads -whole autobahns were closed until following day -storm toppled transport trucks damaged power lines
Wetteronline (20070118b)	Wetteronline, Schwere Schaeden nach Kyrill, https://www.wetteronline.de/wetterticker/schwere-schaeden-nach-kyrill--643tBpXGzIivrA8sEYH1EU (accessed 03Sep2022) -KYRILL -hurricane left behind strong damage and had significant impact on traffic -ferry connections to North Sea islands stopped -air traffic decreased; many flights cancelled or directed to alternate airports -rail traffic in chaos -long-distance train system stopped; regional trains stopped by region -many people spent night in train stations -road closures across country by toppled trees and heavy rain/flooding -in places Autobahns were cut until Friday afternoon -transport trucks were tipped in the wind
Behrens and Guenther (2009)	Behrens, A. and H. Guenther, Operational wave prediction of extreme storms in Northern Europe, Nat. Hazards, 49, 387-399, 2009 -ferry and train stops during Storm Kyrill
Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -'It provoked a significant disruption of road, railway, aircraft, and ship transportation services across Europe'
Gardiner (2010)	Gardiner, Barry, Appendix 3: Background information on 11 storms selected for detailed analysis, European Forest Institute, Atlantic European Regional Office - EFIAtlantic, 161 pp. [PDF properties: datestamp

	23Jul2010] -KYRILL -travel chaos across region -Germany and Netherlands national railways closed -Frankurt airport 200 flights cancelled
AON Benfield (2013)	AON Benfield, Historie von 1703 bis 2012: Winterstuerme in Europa, Stand: Januar 2013 -KYRILL -first time in history that train traffic in all Germany stopped -extensive bad damage and significant impact on traffic -ferry connections to North Sea islands mainly stopped -air traffic reduced; many flights cancelled or directed to other airports -chaotic situation with train traffic -long distance trains completely stopped; regional trains stopped in places -trees toppled by wind -strong rain caused flooding & road closures -parts of autobahn closed to Friday morning -transport trucks blown over by strong winds -damaged power cables caused power cuts -telephone network overloaded -Brockenhotel evacuated in the Brocken in Harz
ESWD (20220609)	European Severe Weather Database, 11-12Jan2007 FRANZ, accessed 09Jun2022 Location LA Latitud Longitu Date Day Time Uncertainty ND --- Lindow in der Mark road L17 DE 52.97 N 12.98 E 12-01-2007 fri 00:00 UTC (+/- 3 hrs.) several uprooted trees blocking L17 Basepohl DE 53.73 N 12.92 E 12-01-2007 fri 00:00 UTC (+/- 3 hrs.) a tree collapsed damaging a driving car Lakinsk Russian Interstate Hwy M7 RU 56.02 N 39.95 E 11-01-2007 thu 18:25 UTC (+/- 5 min.) severe wind gust uprooting tree, which blocked M7;
Wikipedia (20220322))	Wikipedia, Cyclone Kyrill, https://en.wikipedia.org/wiki/Cyclone_Kyrill, accessed 22Mar2022 -HARBORS AND SHIPPING -ferry services cancelled: Fishguard-Rosslare, Heligoland, west Frisian Islands, East & North Frisian Islands -Dublin Port forced to close for first time in history -ROAD TRANSPORT -many countries had road & motorway closures -UK: major motorways M1,M6,M18 closed in several places; M25 London ringroad -UK: bridges closed: M6 Thelwall Viaduct Warrington, M25 Dartford Crossing London, M1 Tinsley Viaduct Sheffield -UK: all Pennine Passes closed -UK: closures due to toppling of high-sided vehicles -Germany: number of motoroways closed especially with bridges over Rhine or valleys -Netherlands: police advised drivers of empty lorries not to enter Netherlands -Ireland: many roads closed due to fallen trees & overturned lorries -AIR TRANSPORT -UK: Heathrow 280 flights canc, Doncaster Sheffield 80 flights canc, Manchester 80 flights canc -Ireland: many flights delayed morning 19Jan from high winds; afternoon high winds other places -Germany: several flights Frankfurt cancelled -18-19Jan Swiss Internatinal Airlines announced cancellation at least 88 flights -BA cancelled at least 180 flights -Lufthansa cancelled 329 flights -RAILWAYS -FIG. [PHOTO] Stranded travellers sleeping in an ICE train stopped at Wuerzburg station -UK -storm seriously affected 18Jan rush hour across GB -heavy snowfall Scotland -speed limit 80km/h put in place by Network Rail -First Great Western services London Paddington to Cardiff cancelled; Reading line cancelled -East Coast Main Line operating on reduced time table -Virgin trains West Coast services cancelled London to Scotland -London Bridge station closed after glass panels came loose from roof -Netherlands -all train services stopped evening 18Jan -stations at Delft & central station Amsterdam evacuated due to roof damage -train driver had minor injuries when train hit fall tree on railway near Venlo

	-Germany -DB limited max speed trains to 200km/h initially -then all services on IC/ICE network & local services N & W Germany stopped from 17:15 18Jan -major main lines Bremen-Hannover, Hamburg-Hannover, Bremen-Osnabrueck & many branch lines affected by storm -virtually all train services in Germany discontinued 19:30CET -10's thousands passengers stranded across Germany -Muenster & Hanover stations opened air raid shelters; Red Cross issued blankets -train services resumed 19Jan -cancellations & delays during weekend; 34000km of track needed to be checked & cleared -major challenge to get network running after full stop during night; first time ever in peactime -IC train ran into tree on tracks between Elmshorn & Westerland; one loc damaged -IC train with 450 passengers stuck near Diepholz & evacuated -Duisburg Hbf had power outage due to grid failure

Table SL60. Structural damage to wind farms and wind energy impacts (arranged by year and then alphabetically)

Source	Full Reference and Notes
Feng et al (2010)	Feng Y, Tavner PJ, H Long, Early experiences with UK round 1 offshore wind farms, Proceedings of the Institution of Civil Engineers, Energy, 163, 167-181, 2010. -Jan2007 was high wind speed month for period Jul2004-Dec2007 -North Hoyle & Scroby Sands had highmonthly capacity factor for Jan2007 -availability of Barrow low for Jan2007 -trend for decreased availability for increasing wind speeds in range 6-12 m/s -availability much lower than onshore wind
Chou and Tu (2011)	Chou, J-S, W-T Tu, Failure analysis and risk management of a collapsed large wind turbine tower, Engineering Failure Analysis, 18, 295-313, 2011. 38 2007/01/08 Japan Structural Vestas strong winds 39 2007/01/09 Germany Fire N/A fire 40 2007/01/13 Germany Structural HSW 100 storm
Caithness Windfarm (20180730)	CaithnessWindfarm, craigdr, Detailed accidents to 19 June 2018. Document time stamp 30/07/2018, 177pp Wind turbine accident compilation (start 30Nov1980) [reports for Storms Hanno-Kyrill-Lancelot]' -9 wind turbine accidents of large and small wind turbines from mid January 2007 -Cases: -01/01/2007: Melle-Riemsloh, Landkreis Osnabruck; lightning strike causes fire -09/01/2007: Ketin beiFalkenrehde, Landkreis Markisch Havelland; fire at Ketin I wind park -11/01/2007: Walpole Cross Keys, Norfolk; broken blake -13/01/2007: Windpark Raden in Besdorf, Kreis Steinburg; 70m turbine collapsed, may be noctural wind storm -19/01/2007: Sutton Elms, South Leicestershire; all 3 blades ripped from test turbine during storm -20/01/2007: Scheid bei Kronenburg, Kreis Daun, Rheinland-Pfalz; rotor blade broke off surign storm
Ma et al (2018)	Ma Y, P Martinez-Vazquez, C Baniotopoulos, Wind turbine collapse cases: a historical overview, Institution of Civil Engineers. Proceedings. Structures and Buildings. https://doi.org/10.1680/jstbu.17.00167. document properties: date stamp 15/05/2018 Cases from Caithness wind farm -09/01/2007 Germany N/A fire -13/01/2007 Germany HSW100 storm STORM HANNO?

Table SL61. Hydropower impacts (arranged by year and then alphabetically)

Source	Full Reference and Notes

Table SL62. Structural damage to buildings, piers, and cultural monuments (arranged by year and then alphabetically)

Source	Full Reference and Notes
Air Worldwide (20070116)	Air Worldwide, European winter storm Per, 16Jan2007 10:30AM https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-per/first-posting/ -Per's winds demolished house under construction outside Bergen -AIR NWP-based Extratropical Cyclone Model; AIR does not expect significant wind-loss to onshore properties
BBC (20070111a)	BBC, England battered by wind and rain, 11Jan2007a 16:43GMT news.bbc.co.uk/2/hi/uk_news/england/6251415.stm -FRANZ part of canopy at Hither Green station in south London destroyed by high wind
BBC (20070111c)	BBC, Thousands hit by storm power cuts, 11Jan2007c (Thursday) http://news.bbc.co.uk/2/hi/uk_news/wales/6250925.stm -FRANZ -Cardiff: roof partly blew off Michaelston Community College -Aberdare: Cwmdare Primary School weather damage to roof -LLandudno Conwy: Asda store damaged when 4X4foot metal housing for air conditioner blew off -Nant Peris, Gwynedd: house lost roof and Chimney in strong winds
BBC (20070118)	BBC News, Nine dead as UK struck by storms, 18Jan2007, http://news.bbc.co.uk/2/hi/uk_news/6272193.stm -KYRILL: London Bridge closed for day after glass panels fell on concourse
Brugge (200701)	Brugge R, British Isles weather diary, Jan 2007, www.met.reading.ac.uk/~brugge/diary2007.html#200701 -FRANZ: 11Jan: Asda supermarket Llandudno, Conwy had part of roof blown off.
Deutsche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015]

	-in all Germany damage to buildings & vehicles from falling trees, roof tiles, roofs, fassade bits -in Barsinghausen (Landkreis Hannover) storm gusts tore off large part of roof of wood house & threw it into neighboring house -Wittenburg: F2-F3 tornado 181-332km/h winds caused damage mill EUR -2 other tornadoes in Brandenburg: F3 in Lauchhammer & Brachwitz-Kemnitz (254-332km/h) -damage to UNESCO site Schlosskirche -damage to facade of Berlin HBf; building evacuated -Bacholt: roof of elementary school torn off -Osnabruck: storm destroyed tent of Russian state circus -Orienburg-Sachsenhausen: roof of conc camp memorial torn off -Romisch-Germanischen Museum Koln: Holzbohlen crashed on world famous Dionysis mosaic -Bohmte/Bad Essen airport: roof torn from hangar; debris damaged nearby buildings -near Apolda (area Weimar) part of a Tiefkuhl-Hochregallagers crashed
DW (20070112)	DW, Heavy storms batter northern Europe, 12Jan2007 https://www.dw.com/en/heavy-storms-batter-northern-europe/a-2308237 -FRANZ, Poland: most signif damage in E Polish city Bialystok & nearby Masurian town Elk
DW (20070119)	DW, Killer winds in Europe expected to cause heavy financial loss, 18Jan2007 https://www.dw.com/en/killer-winds-in-europe-expected-to-cause-heavy-financial-loss/a-2317752 -KYRILL -closure of Berlin central train station after girder collapsed -Berlin new train stn (biggest in Europe) closed Thurs 18Jan when high winds tore girder from facade -2t girder fell 40m onto stairway -stn re-opened to passengers lunchtime Fri 19Jan -structural engineers seeking to establish why steel/glass building failed to withstand first storm -opened 8 months previously; cost 1 billion EUR -Kyrill had most powerful winds for about 30 year (reference to Capella?) -several cultural buildings damaged in storm -church in Wittemberg where Martin Luthur nailed 95 theses -Cologne museum with Roman mosaic -archive building with Nazi Sachsenhausen documents
DW (20070120)	DW, Power cuts in Europe as continent begins to clean up, 20/01/2007, https://www.dw.com/en/power-cuts-in-europe-as-continent-begins-clean-up/a-2319624 -KYRILL -Poland: new terminal of Warsaw Okecia airport damaged & partially closed -Netherlands: damage to Amsterdam Schipol airport
DW (20070123)	DW, Hurricane causes massive damage to German forests, 23Jan2007, https://www.dw.com/en/hurricane-causes-massive-damage-to-german-forests/a-2323760 -KYRILL -PR still DB's largest problem after part of roof of new Hbf collapsed -Hbf temporarily closed Sunday for second time in week; to re-open Sunday night (Lancelot 21Jan2007) -preliminary repairs allowing train station to withstand similar storm scheduled to be finished by end of week -Cologne Romano-Germanic Museum: storm damaged Dionysos mosaic in 50 spots; wine god himself unharmed.
EDP (20070112a)	EDP, County is battered by 61mph winds, Eastern Daily Press (contributor Katie Cooper), p.8, 12Jan2007a -Swanton Abbott near North Walsham: tree crashed on side of house at 0730AM 11Jan2007; roof damaged
EDP (20070119d)	EDP, Lord's Cricket ground damaged by winds, Eastern Daily Press, p.5, 19Jan2007d. -strong winds damaged roof of historic Lords Cricket Ground -fire brigade called after debris fell from roof of grounds Tavern Stand -incident took place around 1pm at the ground in St John's Wood, north London
EDP (20070119h)	EDP, Mayhem in wake of storms, pp.2-3, Eastern Daily Press, 19Jan2007h -Happisburgh C of E Fisrt School: gales smashed hall window -Northgate Street, Yarmouth: part of Lord Roberts pub collapsed on neighouring shop -Halesworth, Hemsby, Caister: trees damaged houses -Kettlestone near Fakenham: tree crashed through roof of shop -Halesworth: tree fell on house: 50 ft acacia tree fell through new extension
EDP (20070120)	EDP, The big clean-up after the storm, Eastern Daily Press, p11, 20Jan2007 -areas still closed in cleanup: -car park at West Suffolk Hospital in Bury St Edmunds, parts of Yarmouth town hall, North Norfolk District Council woodland
EDP (20070122a)	EDP, All brrr-aced for cold snap, Eastern Daily Press (contributor Laura Devlin), p.13, 22Jan2007a -Samantha van Daniken: antiques centre destroyed by 200y old tree through roof at Kettlestone near Fakenham -Dereham: entrance to Tesco stor cordoned off after tiles blew off roof in storm -Bury St Edmunds, West Suffolk Hospital: row of 30 trees damaged by winds in storm; 250 place parking lot closed
Financial Times (20070119)	Financial Times, Fourteen die as storms lash north Europe (reporter: William MacNamara), 19Jan2007 -roofs collapse at London Bridge stn & Lord's Cricket Ground
Kvamme (20070214)	Kvamme, Dag, Ekstremvaer nr.1/2007 - 'Per', Intern Rapport, met.no, 15pp, Meteorogisk Institutt met.no, Bergen, 14/02/2007 -[HANNO/PER] minor damage to buildings. From the newspapers the day after, house under construction on Sotra was crushed by the wind 0400-0500. On Fitjar (Stord) a laave? was smadret? On Jorpeland a roof was blown off a Fretex building and carried 30m. Several boats sank at the quayside
LCW (20070126)	Lloyds Casualty Week, 26Jan2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ -Belarus: Storm Hanno: special teams to restore power & repair roofs -Latvia: Storm Hanno: water towers struck down in Lispai district & in Ventava

	-UK: Storm Kyrill: roof collapse Bournemouth with winds up to 80mph
LCW (20070202)	Lloyds Casualty Week, 02Feb2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ -crane operator in Katowice Poland killed when machinery collapsed; another died Zaborow near Warsaw when roof fell in -wind damage to new Berlin Hbf -London Bridge station reopened after part of roof collapsed; delays through day from repairs
Met Eireann (200701)	Met Eireann, Monthly Weather Bulletin, No 249, Jan 2007 - damaged buildings across continent
Nyheder (20070121b)	nyheder.tv2.dk, 540 skader efter lordagens storm, 21 Jan 2007, https://nyheder.tv2.dk/krimi/2007-01-21-540-skader-efter-loerdagens-storm -LANCELOT -some storm roof damage Denmark
Stern (20070111)	Stern, Orkantief "Franz" Schwerer Sturm über Deutschland, 11Jan2007, 21:30 https://www.stern.de/panorama/orkantief--franz--schwerer-sturm-ueber-deutschland-3359640.html -Bremerhaven: hall deroofed -Kreis Aachen: pieces of fassade fell onto taxi -Muensterland: rush hour traffic came to standstill because of falling tiles
Mueller-Westermeier (2007)	Mueller-Westermeier, Gerhard, Beschreibung un klimatologische Bewertung des Orkantiefs "Kyrill", pdf properties: Title: Deutscher Wetterdients - Nationale Klimauberwachung, Author: Gerhard Mueller-Westermeier, Subjet: Orkan Kyrill, datestamp: 26Jan2007 -extensive storm damage on buildings -tornado in Wittenberg, causing large damage & unlivable buildings
Unwetterzentrale (200701)	Unwetterzentrale, Orkantief KYRILL - 18., 19.01.2007 (Tief Nr. 33) - Der schwerste Orkan seit Jahrzehnten, analysis by Manfred Spatzierer, Thomas Sävert, Stefan Laps, www.unwetterzentrale.de/uwz/348.html -Berlin Hbf: 40 ton steel beam fell -Hbf had just had renovation work 8 months previously for 1 bill EUR
Tatge (2017)	Tatge, Yorn, Kyrill the winter storm that walloped most of Europe, https://www.air-worldwide.com/blog/posts/2017/1/kyrill-the-winter-storm-that-walloped-most-of-europe/, Verrisk, 19Jan2017 -Netherlands: construction crane toppled onto university building causing heavy damage
ESWD (20220609)	European Severe Weather Database, 11-12Jan2007 FRANZ, accessed 09Jun2022 Location LA Latitud Longitu Date Day Time Uncertainty ND --- Korzeniew Wielkopolskie PL 51.95 N 18.22 E 11-01-2007 thu 22:00 UTC (+/- 3 hrs.) roof of a one-family house was lifted completely lifted by severe wind gusts Turkowo PL 52.40 N 16.43 E 11-01-2007 thu 20:00 UTC (+/- 3 hrs.) Strong wind gales has blown away several roofs; Swieczyn PL 52.10 N 17.30 E 11-01-2007 thu 20:00 UTC (+/- 3 hrs.) Strong wind gales has blown away several roofs Jablonna PL 51.72 N 16.65 E 11-01-2007 thu 20:00 UTC (+/- 3 hrs.) roof of the local school building demaged / lifted; Jarocin Wielkopolskie PL 51.97 N 17.52 E 11-01-2007 thu 03:00 UTC (+/- 6 hrs.) A roof was torn off from a residential building and fell on an outubuilding causing further damage Amstetten Niederösterreich AT 48.12 N 14.87 E 12-01-2007 fri 00:00 UTC (+/- 3 hrs.) many trees were broken, a flat roof was damaged Sokolowiec Dolnoslaskie PL 51.03 N 15.82 E 11-01-2007 thu 22:00 UTC (+/- 6 hrs.) A fallen tree damaged a few tiles of a residential building roof and downed an utility pole. 't Veld NE 52.73 N 4.87 E 11-01-2007 thu 13:00 UTC possible gustnado; trees uprooted, greenhouses demolished, roof damage; 50 m X 1 km damage path Lauwersoog NE 53.42 N 6.20 E 11-01-2007 thu 11:50 UTC Damage to trees. roof of a restaurant Llandudno UK 53.33 N 3.83 W 11-01-2007 thu 10:00 UTC (+/- 6 hrs.) parts of the roof of a supermarket were blown off Korbielów Slaskie PL 49.58 N 19.35 E 12-01-2007 fri 01:00 UTC (+/- 3 hrs.) 60 m2 of a roof sheathing was torn off by strong wind gusts.
Wikipedia (20220322)	Wikipedia, Cyclone Kyrill, https://en.wikipedia.org/wiki/Cyclone_Kyrill, accessed 22Mar2022 -several windows broken Roemisch-Germanisches Museum in Cologne; damage to Roman mosaic -chapel of Wittenberg Castle (World Heritage Site) lost several sandstorn merlons -London Bridge station closed after glass panels came loose from roof -stations at Delft & central station Amsterdam evacuated due to roof damage -late 18Jan Berlin Hbf had major structural damage -2 ton girder fell from 40m height damage outside stairwell -station evacuated as glass plates from facade falling on pavement -station re-opened early afternoon 19Jan -DB to close station at winds > Bf8 or 75km/h until problem resolved -station closed again afternoon 21Jan2007 due to high winds; closed until 20:00CET -Netherlands: 6 people injured when crane fell through roof Utrecht University -France: significant damage to the cathedral at Saint-Omer -Poland: 500 damaged houses

Table SL63. Forest damage and tree falls (arranged by year and then alphabetically)

Source	Full Reference and Notes
Air Worldwide (20070116)	Air Worldwide, European winter storm Per, 16Jan2007 10:30AM https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-per/first-posting/

	-Swedish Forest Agency: 12 million cubic metres forest blown over in storm -Erwin had previously caused substantial loss in UK and Denmark & big forest losses in Scandinavian countries other than Sweden
BBC (20070111a)	BBC, England battered by wind and rain, 11Jan2007a 16:43GMT news.bbc.co.uk/2/hi/uk_news/england/6251415.stm -trains affected by trees on rails in Kent, Surrey, Hampshire, Devon
BBC (20070111c)	BBC, Thousands hit by storm power cuts, 11Jan2007c (Thursday) http://news.bbc.co.uk/2/hi/uk_news/wales/6250925.stm -Western Power Distribution: said tree hit cable in Crickhowell, knocking out power to many homes Powys -numerous faults after power lines came down or trees fell across them -Llanfairpwll on Anglesey: large tree fell across A4080
Belfast Telegraph (20070111a)	Belfast Telegraph, Severe gales continue (contributor Colm Lenaghan and Victoria O'Hara), 11Jan2007a -police warned motorists: fallen trees blocked a number of roads across the province
Belfast Telegraph (20070119)	Belfast Telegraph, Killer storms claim 13 lives (PA Reporters and Deborah McAleese), p.4, 19Jan2007. -2 people received minor injuries when 2 lorries overturned in province; several roads blocked by fallen trees
Brugge (200701)	Brugge R, British Isles weather diary, Jan 2007, www.met.reading.ac.uk/~brugge/diary2007.html#200701 -11Jan: Gusts of 50-55kt occurred over Ireland overnight and spread across much of England and Wales during the morning, bringing down fences and trees... Floods & fallen trees affected train services Shrewsbury-Machynlleth on Wales coast. Trees fell on line at Paddock Wood near Tonbridge Kent -18Jan: Trees and pylons brought down in many parts of England Wales.
Deutsche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] -strong precipitation so that trees weakened by following storms -approx 75 mill trees or 37mill m3 timber, mostly spruce*, fell during hurricane (BMELV2007; BDF2008) -equal to 1/2 of harvest in Germany -most damage in Nordrhein-Westfalen with 15 mill m3 windthrow mostly in Sauer- & Siegerland -no previous storm caused such damage -Deutsche Forstwirtschaft assessed damage at 1 billion EUR, only small part insured
DW (20070112)	DW, Heavy storms batter northern Europe, 12Jan2007 https://www.dw.com/en/heavy-storms-batter-northern-europe/a-2308237 -FRANZ, Germany: several people injured, mostly by falling trees or in car accidents -FRANZ, Poland: around 2500 households in Poland left without electricity Thurs night 11Jan -FRANZ, Poland: winds of more than 100kph felled trees on power lines -FRANZ, Britain: thousands homes without power; fallen trees disrupting train travel
DW (20070119)	DW, Killer winds in Europe expected to cause heavy financial loss, 18Jan2007 https://www.dw.com/en/killer-winds-in-europe-expected-to-cause-heavy-financial-loss/a-2317752 -rail services halted; first time in history for Deutsche Bahn; trees on tracks
DW (20070123)	DW, Hurricane causes massive damage to German forests, 23Jan2007, https://www.dw.com/en/hurricane-causes-massive-damage-to-german-forests/a-2323760 -KYRILL -forestry officials said Kyrill hurricane, which killed 11 people last week, also knocked down 40 million trees. High industry costs expected -German Forestry Council estimated storm toppled 20 mill m3 of wood -cost to forest industry 1 billion EUR in lost revenue and damages -Monday: drastic fall in price of wood not expected as demand higher than available supplies -62 million trees toppled across Europe -effects of hurricane that struck Germany Thursday night, not as serious on national scale as previous storms; major consequences for some regions -western state North Rhine-Westphalia suffered worst damage; 25 million trees lost; older spruces worst hit -spruce trees in low mountain ranges and forests of central and eastern Germany also fell -state officials in Saxony and Thuringia expected to find at a least 1 million m3 fallen trees; they have been unable to assess damage completely -spokesman for Harz National Park said 1142m Brocken Mountain acted as a brake for the storm -park representative not made evaluation of storm's total damages
EDP (20070112a)	EDP, County is battered by 61mph winds, Eastern Daily Press (contributor Katie Cooper), p.8, 12Jan2007a -Norfolk police inundated with calls of fallen trees & power cables throughout county -Central train services suspended between Thetford & Ely by fallen tree at Brandon
EDP (20070122b)	EDP, Habitat boost from gales, Eastern Daily Press, p13, 22Jan2007b. -severe weather may reap a conservation dividend -many 100s trees blown down; majority fallen in woodland where they present no hazard -fallen trees provide greater range of habitat for plants, invertebrates, mammals, birds -Bob Goodliffe, North Norfolk District Council; clearance projects Holt Country Park, Bacton Wood, Pretty Corner near Sheringham, Sadler's Wood near North Walsham -lesson from 1987 tree fall
Financial Times (20070119)	Financial Times, Fourteen die as storms lash north Europe (reporter: William MacNamara), 19Jan2007 -winds 70-80mph across Britain -trees blown across rail lines
Guardian (20070112)	Guardian, Nine killed as gales lash UK, Fri 12Jan2007 16:57GMT https://www.theguardian.com/world/2007/jan/12/weather.uk -travel across country severely disrupted by trees on roads & rail -man killed in village of Britty Common near Taunton Somerset when tree crashed on car

	-tree fall injuries in north Warwickshire & Baldock Hertfordshire -services between Bournemouth & Edinburgh & west coast mainline routes delayed with trees on tracks -fierce winds caused trees to fall on roads & made exposed stretched treacherous
KIT-CEDIM (20070116)	KIT-CEDIM, Orkantiefs 'Franz' und 'Hanno'. Mitteleuropa, Suedskandinavien 11-14.1.2007, (contributors CE and BM) Wettergefahren-Fruehwarnung, Dientag, 16.Januar 2007, 04:00 MEZ http://www.wettergefahren-fruehwarnung.de/Ereignis/20070116_e.html -Storm Franz caused much damage Germany -mountain areas numerous trees uprooted; buildings deroofed;
Kvamme (20070214)	Kvamme, Dag, Ekstremvaer nr.1/2007 - 'Per', Intern Rapport, met.no, 15pp, Meteorogisk Institutt met.no, Bergen, 14/02/2007 -[HANNO/PER] some problems with trees blown down
LCW (20070126)	Lloyds Casualty Week, 26Jan2007 -Latvia: Storm Hanno: gusts broke trees -Sweden: Storm Hanno: winds knock trees across tracks in several places -UK: Storm Kyrill: Chester Shrewsbury train closed by fallen tree -UK: Storm Kyrill: widespread disruption on roads & rail lines from fallen trees & flooding
LCW (20070202)	Lloyds Casualty Week, 02Feb2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ -roads, rail lines, electricity pylons taken out of action across N Europe by falling trees, collaping walls, flying wreckage -virtually entire German national railway system shut down during storm with trees over many tracks
Met Eireann (200701)	Met Eireann, Monthly Weather Bulletin, No 249, Jan 2007 -uprooted trees across continent
Mueller-Westermeier (2007)	Mueller-Westermeier, Gerhard, Beschreibung un klimatologische Bewertung des Orkantiefs "Kyrill", pdf properties: Title: Deutscher Wetterdients - Nationale Klimauberwachung, Author: Gerhard Mueller-Westermeier, Subjet: Orkan Kyrill, datestamp: 26Jan2007 -extensive storm damage on buildings & forests -NW Germany large areas of toppled trees
Stern (20070111)	Stern, Orkantief "Franz" Schwerer Sturm über Deutschland, 11Jan2007, 21:30 https://www.stern.de/panorama/orkantief--franz--schwerer-sturm-ueber-deutschland-3359640.html -Great Britain motorist hit by tree -Brocken im Harz 178km/h wind speed measured -Oberharz: hurricane knocked down many trees -Oldenburg Niedersachsen: tree damaged overhead power cable of railway -Nordrhein-Westfalen: numerous trees uprooted by gusts
Unwetterzentrale Franz (200701)	Unwetterzentrale, Orkantief FRANZ - 11.,12.01.2007 (Tief Nr. 29), prepared by Manfred Spatzierer and Stefan Laps http://www.unwetterzentrale.de/uwz/347.html -observed damage indicated hurricane gusts of 110km/h or more: many uprooted trees, damaged roofs, damage by flying objects
Unwetterzentrale Kyrill (200701)	Unwetterzentrale, Orkantief KYRILL - 18., 19.01.2007 (Tief Nr. 33) - Der schwerste Orkan seit Jahrzehnten, analysis by Manfred Spatzierer, Thomas Sävert, Stefan Laps, www.unwetterzentrale.de/uwz/348.html -numerous trees uproots; forests and districts devastated
Wetteronline (20070118)	Wetteronline, Orkan Kyrill tobt in Europa, 18Jan2007 22:00, https://www.wetteronline.de/wetterticker/orkan-kyrill-tobt-in-europa--UZiFNRdrmvxoC3RHqLLyU FIG. [PHOTO] Whole mountainsides blown down by violence of gusts (Wolfgang Schwarz) -numerous trees fell; roads & rails blocked by consequence -country-wide road closures by wind-toppled trees and flooded roads
Wetteronline (20070118b)	Wetteronline, Schwere Schaeden nach Kyrill, https://www.wetteronline.de/wetterticker/schwere-schaeden-nach-kyrill--643tBpXGzIivrA8sEYH1EU (accessed 03Sep2022) FIG. [PHOTO] Trees whose trunks were not broken were simply uprooted [Wolfgang Schwarz] FIG. [PHOTO] Severe devastation occurred also in the high areas of Thueringer Waldes [Wolfgang Schwarz] FIG. [PHOTO] Kyrill's gusts flattened complete forest areas in wide parts of the country like here near Ilmenau in Thueringen [Wolfgang Schwarz] FIG. [PHOTO] approx 25 ha forest was destroyed around Ilmenau alone [Wolfgang Schwarz] FIG. [PHOTO] Complete hillsides were mown down by violence of the gusts [Wolfgang Schwarz] FIG. [PHOTO] Trees thrown down like a huge game of jackstraws [Wolfgang Schwarz] FIG. [PHOTO] One continues to meet broad paths of devastation FIG. [PHOTO] Also in the Hohen Westerwald the hurricane left behind violent damage [Manuel Schuetz] FIG. [PHOTO] Pictures of destruction from the Wildpark at Bad Marienberg [Manuel Schuetz] FIG. [PHOTO] Also there trees were uprooted or broken off as far as the eye could see [Manuel Schuetz] FIG. [PHOTO] Broken off or uprooted trees characterize the picture also in Weserbergland [Alexander Wratolis] -road closures across country by toppled trees and heavy rain/flooding
Behrens and Guenther (2009)	Behrens, A. and H. Guenther, Operational wave prediction of extreme storms in Northern Europe, Nat. Hazards, 49, 387-399, 2009 -thousands of hectares of forest damaged
Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -'Of note is the uprooting of 62 million trees in central Europe, particularly spruce trees in the low mountain ranges of the Sauer- and Siegerland in Central Germany'
SMHI (20090806)	SMHI, Per - Januaristormen 2007, 6Aug2009, https://www.smhi.se/kunskapsbanken/meteorologi/per-

	januaristormen-2007-1.5287 -wind direction when Per caused tree fall was W or WNW -for Gudrun, wind direction was SW or WSW -list of storms in Sweden with many fallen trees; inventory by Skogsstyrelsen 1. 75 mill m3 8-9Jan2005; SW Gotaland; Gudrun 2. 25 mill m3 22Sep1969; NW Gotaland 3. 18 mill m3 03Jan1954; E Svealand 4. 12 mill m3 14Jan2007; middle & north Gotaland; Per
Gardiner (2010)	Gardiner, Barry, Appendix 3: Background information on 11 storms selected for detailed analysis, European Forest Institute, Atlantic European Regional Office - EFIAtlantic, 161 pp. [PDF properties: datestamp 23Jul2010] -Dedrick et al (2007) lost 45mill m3 standing timber -Germany lost 45 mill m3 or 20% of annual allowable cut -Czech Republic lost 10mill m3 or 65% of annual allowable cut -Netherlands 0.25 mill m3 (Neefjies 2007) -Wallony Belgium 0.3 mill m3 or 0.5% of standing stock of conifers -further estimate that Kyrill felled 53 850 000 m3 of wood in Europe -Sweden 12 mill m3 -Czech 12 mill m3 -Austria 2.5 mill m3 -Poland 1.5 mill m3 -Latvia 0.5 mill m3 -Lithuania 0.3 mill m3 -Slovakia 0.15 mill m3 -France 0.12 mill m3 -Romania 0.13 mill m3 -England 0.05 mill m3 -Germany North Rhine-Westphalia 12 mill m3 -Germany Bavaria 4 mill m3 -Germany Lower Saxony 2 mill m3 -Germany Hesse 2 mill m3 -Germany Saxony-Anhalt 1 mill m3 -Germany Thuringia 1 mill m3 -Germany Saxony 1 mill m3 -Germany Rhineland-Palatinate 0.5-0.6 mill m3 -Germany Baden-Wuerttemberg 0.5-0.6 mill m3 -Germany Brandenburg 0.5-0.6 mill m3 -current annual removals Europe 450 mill m3; windfall represented 12% annual harvest -damage in Nordrhein-Westfalen 15.7Mm3 with 50 000 ha of damaged forest -early estimates 9Mm3 or 3 times annual harvest & 6.5-8.3% of standing volume -around 90% is Norway spruce; 15% of standing volume Norway spruce damaged -TAB10.1. Summary of the key quantities of windthrow timber in Europe resulting from Kyrill [Source: CONFOREST expert network; Ofice National des Forets] Country Loss Dominant species Percent Mm3 Ann cut --- Austria 2.25 15 Belgium 0.22 Czech 10.0 Norway spruce 65 Denmark 0.005 Norway spruce <1 France 0.2 <1 Germany 25.0 Norway spruce 20 Latvia 0.5 Lithuania 0.3 Netherlands 0.18 Pinus sylvestris 20 Poland 2.5 Pinus Romania 0.13 Slovakia 0.33 Norway spruce 5 UK 0.05 ---
DWD (20120116)	DWD, 18.Januar 2007: Windfeld von Kyrill ueber Deutschland. Rueckblick auf einen der bisher schwersten Orkane, Pressemitteilung, Deutscher Wetterdienst, Offenbach, 16. Januar 2012. -approx 50 million trees toppled; 25 million m3 wood destroyed (in Germany)
Esurge (20121111)	Esurge_2007_kyrill(2012), Triple storm even (2007), Philip Harwood, Sun, 2012/11/11 15:04 -major forest damage through wind throw
AON Benfield (2013)	AON Benfield, Historie von 1703 bis 2012: Winterstuerme in Europa, Stand: Januar 2013 -trees toppled by wind
Tatge (2017)	Tatge, Yorn, Kyrill the winter storm that walloped most of Europe, https://www.air-worldwide.com/blog/posts/2017/1/kyrill-the-winter-storm-that-walloped-most-of-europe/, Verrisk, 19Jan2017 -damaged up to 75 mill trees across Europe
ESWD (20220609)	European Severe Weather Database, 11-12Jan2007 FRANZ, accessed 09Jun2022 Location LA Latitud Longitu Date Day Time Uncertainty ND --- Polkowice Dolnoslaskie PL 51.50 N 16.07 E 11-01-2007 thu 22:00 UTC (+/- 6 hrs.) At least seven downed

	trees reported Poznan PL 52.42 N 16.97 E 11-01-2007 thu 20:00 UTC (+/- 3 hrs.) Damaged trees reported Amstetten Niederösterreich AT 48.12 N 14.87 E 12-01-2007 fri 00:00 UTC (+/- 3 hrs.) many trees were broken, a flat roof was damaged Sokolowiec Dolnoslaskie PL 51.03 N 15.82 E 11-01-2007 thu 22:00 UTC (+/- 6 hrs.) A fallen tree damaged a few tiles of a residential building roof and downed an utility pole. Saalfeld DE 50.65 N 11.37 E 11-01-2007 thu 18:00 UTC (+/- 3 hrs.) several trees were uprooted demaging several cars Sankt Thomas DE 50.07 N 6.60 E 11-01-2007 thu 15:00 UTC (+/- 6 hrs.) trees uprooted and power lines destroyed; Gödenroth DE 50.08 N 7.48 E 11-01-2007 thu 15:00 UTC (+/- 6 hrs.) trees uprooted and power lines destroyed; 't Veld NE 52.73 N 4.87 E 11-01-2007 thu 13:00 UTC possible gustnado; trees uprooted, greenhouses demolished, roof damage; 50 X 1 km m damage path Lauwersoog NE 53.42 N 6.20 E 11-01-2007 thu 11:50 UTC Damage to trees. roof of a restaurant Lakinsk Russian Interstate Hwy M7 RU 56.02 N 39.95 E 11-01-2007 thu 18:25 UTC (+/- 5 min.) severe wind gust uprooting tree, which blocked M7;
Wikipedia (20220322)	Wikipedia, Cyclone Kyrill, https://en.wikipedia.org/wiki/Cyclone_Kyrill, accessed 22Mar2022 FIG. [PHOTO] uprooted trees in forest in Balve FIG. [PHOTO] twisted traffic light in Danube area of upper Austria FIG. [PHOTO] windthrown tree in Wythenshawe Park, Manchester, England FIG. [PHOTO] windthrown tree after first stage of clearing up, Hale, Greater Manchester, England FIG. [PHOTO] forest on Lindenberg mountain above Ilmenau Germany was heavily damaged FIG. [PHOTO] Abiesconcolor subsp. lowianaroots in Botanic Garden in Wroclaw. Tree was overthrown by hurricane Kyrill night 18Jan2007. Age 65-70y FIG. [PHOTO] Young spruce group marginal windthrow area 12y after Kyrill Vogelsberg, Germany

Table SL64. Ecological impacts (arranged by year and then alphabetically)

Source	Full Reference and Notes
EDP (20070119b)	EDP, Beachcombers urged to watch out for turtles, Eastern Daily Press, p5, 19Jan2007b -visitors to Britain's beaches urged to look out for marine turtles blown in by strong SW gales -Marine Conservation Society
EDP (20070122b)	EDP, Habitat boost from gales, Eastern Daily Press, p13, 22Jan2007b. -severe weather may reap a conservation dividend -many 100s trees blown down; majority fallen in woodland where they present no hazard -fallen trees provide greater range of habitat for plants, invertebrates, mammals, birds -Bob Goodliffe, North Norfolk District Council; clearance projects Holt Country Park, Bacton Wood, Pretty Corner near Sheringham, Sadler's Wood near North Walsham -lesson from 1987 tree fall

Table SL65. General ship/rig emergency reports/offshore incidents/platform evacuations (arranged by year and then alphabetically)

Source	Full Reference and Notes
Air Worldwide (20070112)	Air Worldwide, European Winter Storm Franz, first posting 12Jan2007, https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-franz/first-posting/ -[FRANZ] -storm claimed 8 lives at sea -2 trawlers sunk off Ireland -knocked overboard stewart on Russian cargo ship
Air Worldwide (20070116)	Air Worldwide, European winter storm Per, 16Jan2007 10:30AM https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-per/first-posting/ -[HANNO/PER] -cargo ship broke up off Norwegian coast with oil spill
BBC (20070111a)	BBC, England battered by wind and rain, 11Jan2007a 16:43GMT news.bbc.co.uk/2/hi/uk_news/england/6251415.stm -[FRANZ] major air and sea search for a woman who fell overboard from ship off Cornwall -woman fallen from 24000 ton Russian bulk carrier Vera Maretskaya near Falmouth 1050GMT
BBC (20070111b)	BBC, Search for Russian ship steward, 11Jan2007b, 1430GMT, news.bbc.co.uk/1/hi/uk_news/england/cornwall/6252609.stm -[FRANZ] search for Russian steward fallen off Vera Maretskaya off Falmouth in Cornwall
BBC (20070118a)	BBC News, Nine dead as UK struck by storms, 18Jan2007, http://news.bbc.co.uk/2/hi/uk_news/6272193.stm -26 mariners rescued from damaged British container ship in English Channel 80km off the Lizard
BBC (20070118b)	BBC, Huge storms sweep northern Europe, 18Jan2007, 2234GMT, http://news.bbc.co.uk/2/hi/europe/6274377.stm -[KYRILL] British container ship MSC Napoli listing in English Channel 80km off Cornwall; 26 crew abandon ship
Belfast Telegraph (20070111a)	The Belfast Telegraph, Severe gales continue (contributor Colm Lenaghan and Victoria O'Hara), 11Jan2007a -in Republic 5 fisherman feared drowned after trawler sank -10 fishing boats, 2 lifeboats & CG helicopter from Waterford searching off Hook Head in Wexford
Belfast Telegraph (20070112a)	The Belfast Telegraph, Ulster on alert as more high winds are forecast (contributor Matthew McCreary), 12Jan2007a. -dive teams on standby as search continues for 7 missing fishermen of SE Irish coast -using side scan sonar, hope to locate trawler Pere Charles on seabed several miles from Hook Head, Co. Waterford
Belfast Telegraph (20070112b)	The Belfast Telegraph, Navy continues its search for fishermen lost off Irish coast, 12Jan2007, p2. -Navy dive teams on standby today as search continues for 7 missing fishermen off SE Irish coast

	-hope to locate trawler Pere Charles on seabed using side scan sonar -lifeboat crews, CG, local fishing vessels expecting to join search at first light, Navy to join if weather eases -separate search for 2 missing men from sunken trawler Honeydew II further down coast off Mine Head -2 of 4 crew winched to safety last night at 15.5 h clining to life raft
Brugge (200701)	Brugge R, British Isles weather diary, Jan 2007, www.met.reading.ac.uk/~brugge/diary2007.html#200701 -11Jan: Two trawlers (Pere Charles and Honey Dew II) sunk off the southeast Irish coast. -18Jan: 26 crew rescued from sinking ship off Lizard Point.
Deutsche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] -sunken container ship in English Channel -Rotterdam: ship pushed into oil pipe, wich broke causing oil spill
DW (20070112)	DW, Heavy storms batter northern Europe, 12Jan2007 https://www.dw.com/en/heavy-storms-batter-northern-europe/a-2308237 -FRANZ, Ireland: storm responsible for sinking 2 Irish trawlers -FRANZ, Ireland: Irish coastguard helicopter rescued 2 from one trawler Honeydew II after 20h on raft -FRANZ, Ireland: winds 130km/h hampered search for missing of 2 others from same boat & crew 5 on Pere Charles
DW (20070120)	DW, Power cuts in Europe as continent begins to clean up, 20/01/2007, https://www.dw.com/en/power-cuts-in-europe-as-continent-begins-clean-up/a-2319624 -KYRILL -Britain: MSC Napoli deliberately run aground to stop it breaking apart English Channel -62000 t cargo ship transporting 2394containers; including 1700t hazardous industrial & ag chem -French officials said long oil slick in English Channel -275m container ship developed long gashes on both sides just above water line during storm weather on Thursday -TV footage shows ship with low stern close to shoreline in Lyme Bay -Napoli being hauled by 2 French tug boats; hampered by rough seas & jammed rudder -engine room flooded, vessel listed badly, 26 crew abandoned ship; rescued by 3 Sea King helicopters; 9m waves
EDP (20070112c)	EDP, Sinking: family hit by third tragedy, Eastern Daily Press, p.6, 12Jan2007c. -2 liferafts recovered; coast guard gives up search for survivors from Pere Charles -20m boat sank in seconds in treacherous seas and gales on Wednesday night 10Jan2007, 2 miles off Hook Head
EDP (20070112d)	EDP, Stricken ship could put lives at risk, Eastern Daily Press, p.6, 12Jan2007d. [FRANZ] -North Sea: 4500 ton ship adrift in North Sea & heading for gas platform, coast guard said -Vindo broke down afternoon 11Jan2007 in very poor weather 9 miles from Murdoch gas platform -9 crew and 4200 tons fertilizer; ship drifting toward rig -rescuers said race against time to save lives
EDP (20070119c)	EDP, Ship crew recoveringafter lifeboat airlift, Eastern Daily Press, p5, 19Jan2007c -crew of British cargo ship recovering last night after airlift -MSC Napoli called for help 10:30AM 19Jan2007 after losing power when hole in side flooded engine room -ship had been traveling from Antwerp to Portugal; stranded in gale force 9 wind & 8-9m swell 50 miles off Lizard Cornwall
EDP (20070122c)	EDP, Eco-fear for oils on stricken cargo ship, Eastern Daily Press, p.5, 22Jan2007c. -major anti-polution operation underway after stricken cargo ship started leaking oil off coast Devon -MASC Napoli deliberately srun aground near Sidmouth east Devon after damager durign storm 19Jan2007 -62000 ton ship carrying 2400 containers -Coast Guard reports 200 containers have come off ship, which contains 3500 tons fuel oil -Navy helicopters rescued Napoli's 26 crew members 19Jan2007 40 miles off Lizard Point Cornwall -Napoli being towed to Portland when severe structural failure forced salvage teams to beach it yesterday -English coast chosen to French to avoid deeper water -sinking in deeper water would have posed greater threat to environment -thousands flocked to east Devon cliffs & crowds gathered at Sidmouth sea front to see vessel -Branscomb Beach closed by police as 20 containers broken up on sand
Evening Herald (20070111)	Evening Herald, Lost. Tragic end: last picture of doomed trawler with five crew (contributor Aoife Finneran), p.1, p.4, 11Jan2007. -FRANZ: sinking of Pere Charles southeast Ireland 18:00 10Jan2007
Evening Herald (20070112b)	Evening Herald, Our 17 hours clinging to life in raft (contributor Jane Last), p.4, 12Jan2007b -FRANZ: Honeydew II sinking off Mine Head
Evening Herald (20070113)	Evening Herald, Tears as families hold lonely vigil (contributor Jane Last), 13Jan2007 [FRANZ] -FRANZ: search efforts for Pere Charles and Honeydew II hampered by extended period of bad weather 10-13Jan2007
Financial Times (20070119)	Financial Times, Fourteen die as storms lash north Europe (reporter: William MacNamara), 19Jan2007 -KYRILL -British & French CG rescued crew of MSC Napoli off Cornwall in 27 foot waves -traffic in port of Rotterdam severely affected when contrainer ship collided with oil jetty; spill -Emma Maersk trapped
Guardian (20070112)	Guardian, Nine killed as gales lash UK, Fri 12Jan2007 16:57GMT https://www.theguardian.com/world/2007/jan/12/weather.uk -FRANZ -coastguard evacuated 30 gas workers from North Sea platform in path of drifting cargo ship -4500 ton Vindo narrowly missed rig -ship then drifted towards another rig off Lincolnshire coast, missing it by 700yards -salvage tug to tow it to port 12Jan -second vessel lost power off Aberdeen coast last night, drifting within 3nm of oil & gas plat

	-huge wave smashed window on dive support vessel, flooding electrical system, 94 on board -coastguard called off search for female stewart fallen from Russian cargo ship Vera Maretskaya 7nm S of Falmouth Cornwall -Ireland: 2 more fishermen drowned after 2nd trawler sank night 11-12Jan -1st trawler (Pere Charles) nearby had 5 drownings; search called off nightfall Jan11 -another boat sank morning 11Jan with 2 saved from raft
Herald (20070112)	The Herald, Disaster averted as drifting ship misses North Sea platforms, 12Jan2007 https://www.heraldscotland.com/default_content/12754075.disaster-averted-drifting-ship-misses-north-sea-platforms/ -FRANZ -maritime disaster averted last night (11Jan2007 PM) when 4500 ton ship adrift in storm missed 2 platforms -engines of Vindo, cargo boat carrying fertilizer, failed earlier in day -30 men evacuated from Murdoch gas rig 80 nm E of Flamborough head as precaution -Vindo crew managed to restart engines 1nm from Murdoch platform -CG confirmed engines failed again; Vindo released anchor; no damage to gas pipelines -drifting toward unmanned Caistor platform -ship with 9 crew missed platform by 700 yards -early 12Jan2007 Vindo drifting in open sea; likely to be rescused by tug; towed to British port -last year Vindo crashed into another large vessel, Dealer, after failing to respond to radio messages -incident took place 17nm off coast of North Foreland, Kent; headng for Seville in Spain -7 fishermen missing 11Jan2007 night after 2 trawlers sank off Irish coast -Pere Charles sank off Hooke Head early evening 10Jan2007 -Honeydew II: 2 survivors picked up by CG shortly after 7PM; ship sank sometime before mighnight -stewardess swept from deck of Russian freighter off Cornwall
Irish Independent (20070111a)	Irish Independent, A lonely waterside wait for crew's families, Irish Independent (contributor: Furlong, B and F Khan), p3, 11Jan2007a -FRANZ: sinking of Pere Charles from Dunmore East
Irish Independent (20070111b)	Irish Independent, Five fishermen feared dead as trawler sinks, Irish Independent (contributor: Khan, F. and B. Farrelly), p1-2, 11Jan2007b -FRANZ: sinking of Pere Charles off Co Wexford
Kvamme (20070214)	Kvamme, Dag, Ekstremvaer nr.1/2007 - 'Per', Intern Rapport, met.no, 15pp, Meteorogisk Institutt met.no, Bergen, 14/02/2007 -[HANNO/PER] Color Lines boat Prinsesse Ragnhild from Hirtshals was 10h delayed to Stavanger from 0600 Sunday to 1600. Tilhenger? tipped on board and 10 cars were damaged. Captain felt it was the strongest wind he had been out in for 13y. The boat rode out the weather west of Kvitsoy; the was strongest at 04:00 at 40m/s and waves heights of 12-17m -Server shipwrecked at Fedje
LCW (20070112)	Lloyds Casualty Week, 12Jan2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ -Adler Clipper 0600 01Jan2007 Hoernbridge inner harbor Kiel ropes thrown loose and stormy winds -Borelly 03Jan2007 0720Z N53d42m W00d41m main engine failure on River Ouse -Bow Sirius 02Jan2007 morning southern lock of Kiel Canal hit gate of southern lock of Kiel Canal -Emsland 29Dec2006 1610Z Montrose Harbour grounded on Annat sandbank outside Montrose Harbour -Fehn Mistral 29Dec2006 1603Z N59d09.2m W02d16.9m lost 19 empty containers during storm -Finnoy 29Dec2006 2205M Hanasand grounded near quay in dense fog -Lemo 28Dec2006 1800M Kiel Canal grounding caused by rudder failure -Luz do Sameiro 29Dec2006 near Nazare Portugal capsized in rough water -Melderskin 30Dec2006 1215M Sunde engine blackout and grounded near quay at Sunde -Ocean Viscount 30Dec2006 0846Z N57d19.4m E00d50.8m engine failure and drifting in bad weather -Orenburg 03Jan2007 Kiel Canal Brunsbuttel collided with gate of North Northern lock of Kiel Canal Brunsbuttel -Stevns Arctic 03Jan2007 Ymuiden in collision with fishing TX 53 -Sunna 02Jan2007 0457Z N58d44.8m W03d03.8m ran aground -Tananger 02Jan2007 0200M N59d43.5m E05d35.75m grounded -Xynthia 30Dec2006 1532Z N53d00.5m E01d03.3m anchored near Cley with engine problems
LCW (20070119)	Lloyds Casualty Week, 19Jan2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ -Arctic Sea: 11Jan2007 1316UTC: N57d41m42s E10d37m22s: dumped large amount of timber near west coast Jutland -Astrid Cornelis: 08Jan2007 morning: : ran aground close to Den Oever lock -CEC Hunter: 29Dec2006: N43d40m, W09d15.9m PM: steering gear trouble -Chemtrans Moon: 09Jan2006: Amsterdam: broke all aft wires while moored at buoy, ran aground -Fridborg: 03Jan2007 2017UTC: N52d29m W43d05m: wheelhouse windows blown out in bad weather -Grace: 04Jan2007: N45d47.5m W07d25.3m: main engine crankshaft damage -Jomi: 11Jan2007 0920UTC: N51d26.05m W04d21.91m: drifting; propeller separated from engines -Marina Ace: 05Jan2007 afternoon: near Zeebrugge: blackout -Pere Charles: 11Jan2007 1800UTC: N52d07.4m W06d55.8m: sank in heavy seas, wind SW force 7 -Scot Trader: 04Jan2007 0335UTC: N57d47m E10d32.5m: drifting with engine trouble near Skagen -Superfast VIII: 31Dec2006-01Jan2007 night: Rostock harbour: tore moorings in harbour due to stormy weather -Ulysses: 10Jan2007 0630UTC: 7nm off mouth of Loch Eriboll: taking on water & losing power; Bf 6 & moderate wind
LCW (20070126)	Lloyds Casualty Week, 26Jan2007 Almar 11/01/2007 1856Z N53d01m E04d24.3m Y E NE NS LCW_MA20070126 1 edible oil tanker Almar (Netherlands Antilles,1756gt,1980), Erith for Hamburg with rapeseed oil, reported engine trouble N53d01m E04d24.3m at 1856UTC 11Jan; vessel dropped anchor but high winds caused drag Amathea 14/01/2007 X=Brunsbuettel lock Y O DE NS LCW_MA20070126 1 container carrier

	Amalthea (Marshall Islands,14290gt,2001) in trouble in Kiel Canal from strong wind 14Jan; old locks Brunsbuettel; assisted by Bugsier 11 Awakenings 17/01/2007 Q1 X=Oestrich-Winkel N G DE IN LCW_MA20070126 1 general cargo Awakenings (2945dwt,1984), Mainz to the Netherlands, grounding in River Rhine off Oestrich-Winkel at km518 on night 16-17Jan Badrinath 12/01/2007 1530Z X=Bermuda N E BM AS LCW_MA20070126 1 refrig general cargo Badrinath (Liberia,7286gt,1987) drifting & disabled 160nm E of Bermuda at 1530UTC 12Jan BCL Iwona 14/01/2007 1730Z N53d54m36s E09d10m25s N E DE NS LCW_MA20070126 1 container carrier BCL Iwona (Antigua & Barbuda,6701gt,2006) ran aground at km44 in Kiel Canal embankment after machine failure 1730 14Jan N53d54m36s E09d10m25s at 0648UTC 15Jan Catherine R 17/01/2007 1037Z N55d12m W08d57m N P EI AN LCW_MA20070126 1 Malin Head MRSC informed at 1037UTC that Catherine R had rope in propeller N55d12m W08d57m Claudia 14/01/2007 pm18h X=Harwich Y L UK NS LCW_MA20070126 1 general cargo Claudia (Netherlands,4235gt,1999) reached Harwich 15Jan morning after cargo of steel coils shifted dangerously in HEAVY WEATHER causing list to port; passed Brunsbuettel 13Jan CSO Orelia 12/01/2007 0145Z N58d08.1m E01d13.8m Y E UK NS LCW_MA20070126 1 diving support CSO Orelia (Marshall Islands,6368gt,1984) lost main propulsion in North Sea 115nm ENE of Aberdeen; weather on scene is still poor; 94 people Eiltank 4 11/01/2007 X=Rotterdam Y O NE NS LCW_MA20070126 1 non-specific tanker Eiltank 4 (Germany,1550dwt,1971) pushed against breakwater Geulenhavendam, Rotterdam harbour by strong winds today Enforcer 17/01/2007 1845Z N50d33.69m W05d50.34m N D UK CE LCW_MA20070126 1 general cargo Enforcer (Netherlands,7642gt,2003), bound Belfast, lost 5 20 foot containers N50d33.69m W05d50.34m at 1845UTC Fugro Meridian 13/01/2007 0143Z N57d33.4m W01d47.3m Y G UK NS LCW_MA20070126 1 seismographic research ship Fugro Meridian (Bahamas,2255gt,1982), 29 persons, reported 0143UTC grounded & refloated 3nm N of Peterhead N57d33.4m W01d47.3m; vessel sheltering from weather Golden Sky 15/01/2007 Q1 N57d28m08s E21d35m56s Y G LA BS LCW_MA20070126 1 bulker Golden Sky (Cyprus,15786gt,1985) grounded in winds 25m/s during night 5nm off Ventspils; vessel holed, water in engine room; 18/26 crewtaken off vessel Grande Portogallo 11/01/2007 1000M X=Sloe Hr Flushing E Y G NE NS LCW_MA20070126 1 Ro-ro Grande Portogallo (Italy,37726gt,2002) hit dolphin while mooring during heavy gale in Sloe Harbor of Flushing East about 1000L; hole below water line Independent 11/01/2007 1300Z N53d36.4m E05d55.4m N E NE NS LCW_MA20070126 1 general cargo Independent (Barbados,2113gt,1982), Brement for Shoreham with cement reported not under command 11Jan 1300UTC N53d36.4m E05d55.4m Johannes 11/01/2007 0200Z X=Aholfing N C DE IN LCW_MA20070126 1 general cargo Johannes and Giurgiu 29 were in collision on the River Dunav close to Aholfing in the Straubing-Bogen region at 0200UTC 11Jan JRS Canis 12/01/2007 X=Bremerhaven W D DE NS LCW_MA20070126 2 container carrier JRS Canis (Cyprus,7430gt,2006), Bremerhaven to St Petersburg, lost 10 containers after being hit by series of waves 7-8m in Elbe estuary Le Castellet 11/01/2007 X=Friedrichsort Y M DE BS LCW_MA20070126 1 Ro-Ro Le Castellet (French Southern Territories,7930gt,1982) started drifting off Holtenau 11Jan while waiting to pass through Kiel Canal, in spite of 2 anchors; drifted to Friedrichsort & struck pilings Maersk Wave 11/01/2007 1520M X=Bremerhaven Y M DE NS LCW_MA20070126 1 vehicle carrier Maersk Wave (Singapore,51770gt,2000) tore loose at stern Bremerhaven 1520? 11Jan when all mooring lines broke; stern drifted across harbor basin & damaged quay wall over 50m MSC Napoli 18/01/2007 1030Z N49d20.41m W04d34.50m Y W UK EC LCW_MA20070126 2 container carrier MSC Napoli (UK,53409gt,1992) with 26 persons taking water in engine room N49d20.41m W04d34.50m; crew abandoned to life raft; wind Bft=7-8 near gale-gale Norrona 12/01/2007 X=Torshavn N E FA AN LCW_MA20070126 1 departure of passenger ro-ro Norrona (Faroe,35966gt,2003) from Torshavn to Kiel delayed yesterday after vessel experienced problems with bow thrusters on both sides; divers found damage to both bow thrusters Omega 17/01/2007 0615M X=Rhine River N G DE IN LCW_MA20070126 1 chemical tanker Omega (Netherlands,1980dwt,2004) ran aground Rhine River at 0615, 17Jan; Omega loaded too deep Paradise Ace 16/01/2007 X=Wandelaar Y M BE NS LCW_MA20070126 1 evening 16Jan tug Multrasalvor at Wandelaar anchor area where vehicle carrier lost anchor; strong sea current; rough seas Passaden 16/01/2007 1330Z X=Immingham N E UK NS LCW_MA20070126 1 general cargo Passaden (Finland,3828gt,1991), Klaipeda for Immingham, had engine failure off Immingham 1330UTC 16Jan Renegade 16/01/2007 1709Z N52d10m W06d01m Y S EI CE LCW_MA20070126 1 fishing vessel Renegade (Ireland,93gt,1968) sank night 16Jan E of Tuskar Rock lighthouse; winds NE Bf 3-4 with moderate swell; at 1709UTC 16Jan mayday from Renegade N52d10m W06d01m, 13nm E Carnsmore Point Rosemount 13/01/2007 1828Z N57d35.44m W01d49.49m N G UK NS LCW_MA20070126 1 fishing vessel Rosemount (UK,176gt,1983) aground at N57d35.44m W01d49.49m at 1828UTC 13Jan, 500m N of St Fergus gas terminal Server 12/01/2007 1826Z N60d45m E04d42.6m Y G NO NS LCW_MA20070126 1 at 1826UTC message that bulker Server (Cyprus,19864gt,1985), Aardalstangen for Murmansk, run aground N60d45m E04d42.6m; at approx 1815UTC today bulker Server grounded Hellisoy Island near Fedje N60d45.1m E0407m, near Mongstad Harbour; weather very rough Sierra Lara 12/01/2007 X=Skagen Y O DK NS LCW_MA20070126 1 refrigerated general cargo Sierra Lara (Panama,5110gt,1996) in trouble Skagen 12Jan; sailed into Skagen port during windy weather; touched quay & breakwater Trans Frej 15/01/2007 1725M X=Ronnskarsgrund Y G SV BS LCW_MA20070126 1 general cargo Trans Frej (Antigua & Barbuda,2997gt,1994) ran aground at Ronnskarsgrund at 1725?; hard wind and conditions at sea

	Vans Queen 12/01/2007 1500Z X=Tyne Y M UK NS LCW_MA20070126 1 ro-ro container carrier Vans Queen (Liberia,11861gt,1978) broke free from moorings & drifted down Tyne in strong winds; blown into river about 1500 UTC Vera 13/01/2007 AM X=Elbe Y D DE NS LCW_MA20070126 1 general cargo Vera (Russia,2457gt,1976) caught by stormy winds morning 13Jan; 3 empty containers blown into River Elbe Vindo 11/01/2007 1609Z N54d16.67m E02d09.4m Y E UK NS LCW_MA20070126 1 general argo Vindo (Antigua & Barbuda,3183gt,2004) with 9 persons & 4200 tons fertilizer broken down & drifting towards platform in Murdoch gas field N54d16.67 E02d09.4m at 1609UTC; 6m swell wind W Bft9 (strong gale) Wilson Tana 10/01/2007 X=Nantes-Rouen Y E FR BB LCW_MA20070126 1 bulker Wilson Tana (Malta) on ballast passage between Nantes & Rouen when it experienced main engine trouble; drifting in heavy seas & strong windsl 10Jan?
LCW (20070202)	Lloyds Casualty Week, 02Feb2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ keywords ship: -bulker Arisbe brok moorings Rotterdam; STRONG WIND on 18Jan -container carrier Cape Martin collided with quay in Wisma(?) during STORM KYRILL 18Jan -general cargo Celtic Endeavour towed to IJmuiden 22Jan2007 05:04 with engine problems -container carrier CMA CGM Claudel broke 12 lines during FORCE 9 GUSTS 18Jan2007 1238L -pusher tug Dennis P problems with HIGH WIND AND WAVES 18Jan 1300 on route Terneuzen to Antwerp -crude oil tanker Eagle Phoenix struck by LIGHTNING Nonorussiysk & caught fire evening 20Jan2007 -bulker Efi Theo ran into embankment of Kiel Canal 14:22 21Jan2007; STRONG WINDS -general cargo Fast Jef broken down near the Humber Bridge near buoy 28; 18Jan 1900UTC (weather conditions not mentioned) -general cargo Gerhein G grounded outside Thyboron 1852UTC 21Jan; -bulker Golden Sky grounded 5km off Ventspils on Latvian coast -vehicle carrier Grande Argentina from Antwerp to (Terneuzen) until STRONG GALE FORCE WINDS decrease 18Jan -LPG carrier Happy Falcon (Isle of Man,3366GT,2002) pushed to embankment Kiel Canal by STORM WINDS 18Jan -fishing Heroey grounded off Kristiansund N63d02.8m E07d17.2m at 05:00L 25Jan -ferry HSC Gotlandia mooring lines broke 14-15Jan -oil tanker Iran Hengam (Iran,160930GT2003) reported adrift with engine problems 20nm Kristiansand 21Jan 1430L -general cargo Jonrix (UK,1987GT,1977) drifting not under command at N55d26.5m W01d17.5m [19Jan 0402UTC] -general cargo Kyros (Cook Islands,771GT,1966) grounded 19Jan 0130L N63d32m E09d49m near Trondheim -general cargo Love Music (Malta,6500GT,1987) damage to crane, victim of HEAVY WEATHER; ship diverted to Brest [22Jan?] -container carrier Maersk Denton (Germany,45803GT,2002) grounded near Le Havre; free again 0930 [23Jan?] -general cargo Nijord (Malta,2696GT,1980) ran aground on night Sunday 21Jan in Irbe Strait; LIGHT WINDS & GOOD WEATHER -inland general cargo Orlando (Netherlands,1043DWT,1956) engine trouble IJsselmeer; HIGH WAVES might smash hatches [21Jan?] -fishing vessel Our Heritage (54GT,1976) taking on water 1nm SE Soay; RELATIVELY CALM CONDITIONS [21Jan 1045UTC] -general cargo Passaden had main engine turbo-charger failure while passing Immingham Oil Terminal 16Jan 1030 -passenger ro/ro Prinsesse Ragnhild (35438GT,1981) met with HEAVY WEATHER 20Jan evening when HUGE WAVE smashed some of front windows (bridge) -general cargo Sava Lake (Latvia,2030GT,1990) grounded 23Jan 1200L at N56d36.3m E10d21.7m -container carrier SCI Tej (Marshall Islands,32630gt,1989) berthed at Steubenhoeft Cuxhaven 17Jan 0900L? due to machine problems -general cargo Sodade (St Vincent & Grenadines, 2472GT,1985) in Humber River; dragging anchor and being BLOWN OUT TO SEA -fire-fighting tug Wizard (Panama,347GT,1969) Margate Roads for Piraeus lost starboard anchor & hove to N51d 24.79m E01d23.62m, WIND W BF 9-10 SEVERE GALE-STORM, SEA ROUGH -during Yannis P loading operations at Pier No 1 Novorossiysk at 1940L 19Jan mast riser fire caused by ELECTRICAL STORM
New York Times (20070119)	New York Times, Deadly wind and rain storm sweeps Europe, (Mark Landler) 19Jan2007, https://www.nytimes.com/2007/01/19/world/europe/19europe.html -26 sailors rescued fronm ship in English Channel
Nyheder (20070121)	nyheder.tv2.dk, Norge-faerge tog vand ind i nat, 21 Jan 2007. https://nyheder.tv2.dk/krimi/2007-01-21-norgefaerge-tog-vand-ind-i-nat -LANCELOT -wave strike on Prinsesse Ragnhild causing broken windows in Conference room decks.
BSU (20081001)	BSU, Loss overboard of 10 containers from JRS Canis at estuary of Elbe River on 12 January 2007 at 02:40, Investigation Report 45/07, Less Serious Marine Casualty, Bundestelle fuer Seeunfalluntersuchung, 1 October 2008. -accident report for lost containers from JRS Canis during Stom Franz -accident particulars 12Jan2007 0240M, N53d57.5m E08d05.5m
EMSA (2008)	EMSA, Maritime Accident Review 2007, European Maritime Safety Agency, 2008. -French Trawler La Ptite Julie, sinking & fatalities, off Brittany 07Jan2007 -MSC Napoli, sinking, English Channel, 18Jan2007 -Server, grounding Fedje S coast Norway 12Jan2007 -Golden Sky, grounding & pollution, Ventspils Latvia, 15Jan2007, hurricane -Pere Charles, fatalities, SE coast Ireland 11Jan2007, 130km/h winds -Honeydew, fatalities, SE coast Ireland 11Jan2007
MAIB (200804)	MAIB, Report on the investigation of the structural failure of MSC Napoli English Channel on 18 January 2007, Marine Accident Investigation Branch, Carlton House, Carlton Place, Southampton, UK, SO15 2DZ, Report No 9/2008, April 2008 -KYRILL: MSC Napoli; crack in hull preceeded by unusual wave sequence

	-wind was SW storm force 10-11 -swell running from SW; wave hght 5-9m; wavelength 150m; period 9-10s; water depth 80m -tidal stream to WSW in direction opposite to storm winds
MCIB (20081015)	MCIB, Report of the Investigation into the sinking of the Irish fishing vessel 'Pere Charles' off the south Wexford coast on 10th January 2007, Marine Casualty Investigation Board, Report No. MCIB/134, 15Oct2008. [FRANZ] -accident report for trawler Pere Charles in Irish Sea during storm Franz 10Jan2007 -eye witness account give not bad weather at time: '...there was a light breeze with good visibility and no swell' -Appendix 10.2. Weather report for sea area N52d05.1m W06d54.3m 10Jan2007 1400-2000UTC -wind W Bf5-6 backing to SW increasing to Bf7, gusting to gale 8 by end of period -a few light showers initially; rain and drizzle set in later -visibility good becoming moderate to poor later -sea state: rough throughout period
MCIB (20090831)	MCIB, Report of investigation into the loss of the FV "Honeydew II" off Ram Head Co. Waterford on 11th January 2007, Marine Casualty Investigation Board, Report No. MCIB/135, 31Aug2009. [FRANZ] -rogue wave incident sinks Honeydew II in Irish Sea 11Jan2007 2.10. Environmental conditions -sea state rough to high, rough swh=4-6m, high swh 6-9m, max wave height 8-18m -Appendix 9.9b: predicted tidal flow relative to course of FV Honeydew II at 0200-0300 11Jan2007 (NOTE: tidal current and wind speed to east) -Weather report for a 3 mile radius of position N51d54.998m W07d37.175m between 2300 10Jan2007 to 0400 11Jan2007 -winds SW strong gale Bf9 with gusts to 60kt -weather: rain & squally showers -visibility: moderate, poor in rain and showers -sea state: very rough to high
Wikipedia (20220322)	Wikipedia, Cyclone Kyrill, https://en.wikipedia.org/wiki/Cyclone_Kyrill, accessed 22Mar2022 -MSC Napoli abandoned in English Channel on 18Jan; crew of 26 picked up by rescue services -Cypriot-flagged freighter Golden Sky with fertiliser & fuel oil ran aground near Ventspils, off coast of Latvia; crew rescued in joint Latvian-Swedeish operation

Table SL66. Instrument failures during storm (arranged by year and then alphabetically)

Source	Full Reference and Notes
Bradshaw (2007)	Bradshaw, Elizabeth (ed), Annual Report for 2007 for the UK National Tide Gauge Network and Related Sea Level Science, National Tide and Sea Level Facility, NERC 100017897 2007, p.2 Missing/suspect data list Missing Suspect Bangor 002,014-015,017-019,022-023 Dover 017-023 Ilfacrombe 018,020-023 Port Erin 001-005,031 Port Ellen 005 Lerwick 001-122 Mumbles 016-073 Newport 001-025 025-045 Portpatrick 022 St Mary's 001-004 Tobermory 011-015
Kvamme (20070214)	Kvamme, Dag, Ekstremvaer nr.1/2007 - 'Per', Intern Rapport, met.no, 15pp, Meteorogisk Institutt met.no, Bergen, 14/02/2007 -instrument failures: Fedje, Slatteroy, Lindesnes
Land SH (20070112)	Land Schleswig-Holstein, Sturmflutereignis am 12.01.2007 (vorlaufige Wasserstande am Pegelmessstellen) Amt fuer laendliche Raume, Husum, Az: 5514, Stand: 12.01.2007 (emailed report from Maria Bluemel 13Jan2007) -tide gauge failure Nordgroven AP
RWS (200701a)	RWS, Verslag van de stormvloed van 11 en 12 januari 2007 (SR85), Ministerie van Veerkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007a -communication with Huibertgat anemometer lost -measurement buoy at Euro Platform not operational at time of storm
RWS (200701b)	RWS, Verslag van de stormvloed van 18 en 19 januari 2007 (SR86), Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007 -Huibertgat anemometer fails at 1940L 18Jan2007b -no wave data for Europlatform
Unwetterzentrale_Kyrill (2007d)	Unwetterzentrale, Orkantief KYRILL: gemessene Spitzenwindböen, http://www.unwetterzentrale.de/uwz/357.html (downloaded 20220916) -instrument malfunction Wolfsegg Austria
Hueppop et al (2009)	Hueppop O, R Hill, K Hueppop, F Jachmann, Auswirkung auf den Vogelzug. Begleitforschung im Offshore-Bereich auf Forschungsplattformen in der Nordsee. FINOBIRD. Abschlussbericht September 2009. Institut fuer Vogelforschung 'Vogelwarte Helgoland', Inselstation, An der Sapskuhle 511, 27498 Helgoland -vertical radar on FINO1 functioned from 15Oct2003 to 11Jan2007 when damaged by unusually strong hurricane 'Kyrill' (actually Franz) and made inoperational.
Lange (2017)	Lange, Ingo, Der Sturm "Kyrill" von 18. Januar 2007, 28Mar2017 https://wettermast.uni-hamburg.de/frame.php?doc=Sturm20070118.htm

	-10m anemometer on Wettermast Hamburg had electronic failure

Table SL67. Nonhomogeneous data sets (arranged by year and then alphabetically)

Source	Full Reference and Notes

Table SL68. Climatological background of storm; unusual preceding weather events (arranged by year and then alphabetically)

Source	Full Reference and Notes
BBC (20070118)	BBC News, Nine dead as UK struck by storms, 18Jan2007, http://news.bbc.co.uk/2/hi/uk_news/6272193.stm -unusually mild start to January
Deutsche Rück (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] -Kyrill was high point of exceptionally rainy winter season 2006-2007 -January was warmest in Germany since 1901 -DJF season was the mildest in middle Europe for past 250y -in many parts of country also too wet -winter ppt Germany was 151% of climate reference period 1961-1990 -ann avg temperature Germany 2007 9.8C; 2nd highest value since record start -only 2000 with 9.9C was higher -20% more ppt in Germany across year -NH annual temp 2007 at rank 5-7 -Canadian NW passage was ice free for 5 months for first time in history -Jan2007 was month of extremes -avg Jan temp Germany 4.7C; 5.2C higher than clim avg 1961-1990 -no warmer Jan since start 20C -much ppt; 60% more than clim avg
DW (20070112)	DW, Heavy storms batter northern Europe, 12Jan2007 https://www.dw.com/en/heavy-storms-batter-northern-europe/a-2308237 -FRANZ: Warm Weather Across Europe -warmest autumn since Columbus discovered New World, -extraordinary warm start of winter - Juerg Luterbacher at U Berne Geographical Institute -Jan temperatures several deg C wamer than avg -2006 in weather annals as one of hottest years globally -much of NH on course for one of mildest winters on record -temperature Muenster 12C versus 7C in some Med resorts -Sweden: brown bears finally went into hibernation 2 months behind schedule -March/April flowers blooming Dec/Jan -across alpine Europe ski resorts laying off working with snowless slopes & empty chalets
Eden (200703)	Eden, Philip, Weather Log January 2007, Weather, 62, pp.1-4, March 2007 -very disturbed SW airflow for almost 3 weeks followed by anticyclonic/northwesterly type -mean monthly pressure chart shows steep westerly gradient over British Isles -sea level pressure ranged from 8mb below norma Lerwick to 4mb above at Scilly -January ranked fifth warmest in entire CET record after 1796, 1834, 1916, 1921 -in parts of Scotland & N Ireland Jan2005 was fractionally warmer -not a single instance of subzero max below 300amsl in the UK TAB_p3. UK monthly data Central England Temperature Dec2006 at 7.0C or +3.2C versus long-term average UK mean temperature anomaly +3.0C
LCW (20070202)	Lloyds Casualty Week, 02Feb2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ *-climate researchers had been predicting stormy weather with Natl temperatures 1-2C higher than normal
Met Eireann (200701)	Met Eireann, Monthly Weather Bulletin, No 249, Jan 2007 p3. Another month of record breaking global temperatures -following warmest December on record globally, combined air+sea sfc temperatures highest for any Jan -source NOAA National Climatic Data Centre -most unusually warm conditions in mid- and high-latitude areas of NH -monthly mean temp >5C above avg east of Europe & much of Russia -temperatures >3C over much of Canada -moderate El Nino episode that began Sept2006 continued into Jan but weakened during month -presence of El Nino along with continuing global warming trend contributed to global warm Jan -unusual warm conditions brought second lowest Jan snow cover extent on record for Eurasian continents -more info on webside lwf.ncdc.noaa.gov/oa/climate/research FIG_p15b. [MAP] January mean temperature (difference from 1961-1990 normal) NOTE: Britain 1-3C above climate norm; eastern German 5C above climate norm FIG_p15c. [MAP] While most of Europe has been experiencing a mild winter so far, it has been particularly mild in Moscow. Here temperatures are averaging above 0C, around 9 degrees higher than normal. On the 11th, a maximum temperature of 8.6C was recorded, 4 deg higher than the previous January record set in 1957.
Mueller-Westermeier (2007)	Mueller-Westermeier, Gerhard, Beschreibung un klimatologische Bewertung des Orkantiefs "Kyrill", pdf properties: Title: Deutscher Wetterdients - Nationale Klimauberwachung, Author: Gerhard Mueller-Westermeier, Subjet: Orkan Kyrill, datestamp: 26Jan2007 -autumn/winter 2006/2007 many systems from west -in heightened west winds many low pressure centers formed; heightened probability storm centers -development of low pressure centers helped by relatively warm water of North Atlantic
Rosenorn (2007)	Rosenorn, Af Stig, Vintervejret 2006-2007, Vejret, 111, 28-31, May, 2007.

	-Winter 2006/2007 record warmth and record ppt -avg temp 4.7C was 0.1C warmer than previous record 1988-9 -ppt 318mm was 45mm more than previous record 1994-5 -temp 4C warmer than normal; ppt twice normal -Dec weather was really unusually warm -Jan weather had record warmth with winds from W -0.1C warmer than Jan1989; 10mm more ppt than record Jan1988 -Feb weather was warm and ppt-rich
Tetzlaff (2007)	Tetzlaff, G, Der Orkan Kyrill, INFO, DKKV Deutsches Komitee Katastrophenvosorge e.V., pp.1-2, Februar/Maerz 2007, No. 1+2/2007 -frontal zone over Atlantic known several days before 18Jan -Atlantic frontal zone separated cold air in north from warmer air in south -band of temperature contrast stretched from Nfld to Ireland -2d before low P crossed Germany, 20C temperature difference across 400km -half of temperature difference between equator & North Pole -large wind difference contributed to strong wind band at 9km height -wind speed well over 300km/h observed at 9km over Germany on 18Jan
Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -high pressure gradient over a large area of Europe in the 9 day preceding the storm were favorable conditions for a severe storm event; also for Daria and Anatol
Gardiner (2010)	Gardiner, Barry, Appendix 3: Background information on 11 storms selected for detailed analysis, European Forest Institute, Atlantic European Regional Office - EFIAtlantic, 161 pp. [PDF properties: datestamp 23Jul2010] -North Atlantic 1.8C warmer than average -circumstances advantageous for explosive development of low pressure centre -air with higher moisture content and energy content for atmospheric development -energy and motion coupled through physical processes -more energy means higher wind speed -further advantageous factor: large temperature extremes across small horiz scale 200-300km & largely undisturbed stream at 500-200hPa level at 5-13km in Jet Stream -centre of cyclone directly under Jet Stream; strengthening effect on low pressure dev
DWD (20120116)	DWD, 18.Januar 2007: Windfeld von Kyrill ueber Deutschland. Rueckblick auf einen der bisher schwersten Orkane, Pressemitteilung, Deutscher Wetterdienst, Offenbach, 16. Januar 2012. -clustering of the storms in Jan2007: Karla-Franz-Hanno-Kyrill
Rohman (2014)	Rohman, J., European Extratropical Cyclones. Implications for local insurers, TransRe, May 2014 -link between severe extratropical storms in Europe and Arctic Oscillation, North Atlantic Oscillation, Quasi-Bienniel Oscillation
Ludwig et al (2015)	Ludwig P, JG Pinto, SA Hoepp, AH Fink, SL Gray, Secondary cyclogenesis along an occluded front leading to damaging wind gusts: Windstorm Kyrill, January 2007, Monthly Weather Review, 143, 1417-1437, 2015 -'In Jan 2007 the NAO index was strongly positive (+1.77) resulting in a series of extratropical cyclones (Anton, 3Jan; Franz 11Jan; Gerhard 13Jan; Hanno 14Jan; Lancelot 20Jan) over the North Atlantic with Kyrill being the most intensein terms of maximumwind gusts and precipitation amounts over central Europe. This successive occurrence of cyclones (building a cyclone family) is also known as serial clustering. Additionally, the NAO dipole was shifted toward Europe forming an enhanced background pressure gradient (associated with amplified wind speeds at the surface) between western Europe and the Baltic states, in which the cyclones were embedded'

Table SL69. Storm timing compared with spring tide; phase of surge and tide (arranged by year and then alphabetically)

Source	Full Reference and Notes
Mueller-Westermeier (2007)	Mueller-Westermeier, Gerhard, Beschreibung un klimatologische Bewertung des Orkantiefs "Kyrill", pdf properties: Title: Deutscher Wetterdients - Nationale Klimauberwachung, Author: Gerhard Mueller-Westermeier, Subjet: Orkan Kyrill, datestamp: 26Jan2007 -no storm surge because of fast storm passage & wind falling at high water
Neumann (200702)	Neumann, T., FINO and the mast shadow effect, 52nd IEA Topical Expert Meeting, Wind and wave measurements at offshore locations, Berlin, Germany, February 2007, organized by TU Berlin and Germanischer Lloyd, International Energy Agency, Implementing Agreement for Co-operation in the Research, Development and Deployment of Wind Turbine Systems, Task 11. -Kyrill high winds started at low water 18Jan2007 1700 and ended at high water 18Jan2007 2300 at FINO1
NLWKN (20070122)	NLWKN, Sturmflut von 19.Januar: Es kam nicht so schlimm wie befurchtet. 19.Januar2007: keine Duenenabbruche auf den Inseln/Fuer das Wochenende wird erhoehtes tidewasser erwartet, 22/01/2007 https://www.nlwkn.niedersachsen.de/startseite/aktuelles/presse_und_offentlichkeitsarbeit/pressemitteilungen/-41867.html -Cuxhaven max surge significantly before max tide
RWS (200701a)	RWS, Verslag van de stormvloed van 11 en 12 januari 2007 (SR85), Ministerie van Veerkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007a APPENDIX5: Table of expected & actual HW levels; times astronomical tide and maximum water level given; values within 1/2 hour of each other
RWS (200701b)	RWS, Verslag van de stormvloed van 18 en 19 januari 2007 (SR86), Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007b APPENDIX5: Table of expected & actual HW levels; times astronomical tide and maximum water level given; values within an hour of each other
Jensen and Mueller-	Jensen J, SH Mueller-Navarra, Storm surges on the German coast, Die Kueste, 74 ICCE (2008), 92-124.

Navarra (2008)	-Storm Kyrill: -18h wind forecasts predicted wind setups of 4-5m but with 3h uncertainty -low pressure crossed Jutland about 3h earlier than forecast; no max impact water levels -forecast very severe storm surge did not occur (Mueller-Navarra, 2008) * -14h forecast water level 1.75m too high
Environment Agency (2018)	Environment Agency, Thames Barrier Project Pack 2018, January, 2018. Environment Agency. Thames Barrier View Cafe and Information Centre, 1 Unity Way, Woolwich, London, SE18 5NJ. email: thamesbarrierenquiries@environment-agency.gov.uk. -spring tide period 18-22Jan coinc /w very high W winds over Nsea & prolonged rainfall in Thames catchment
Wikipedia (20220322)	Wikipedia, Cyclone Kyrill, https://en.wikipedia.org/wiki/Cyclone_Kyrill, accessed 22Mar2022 -predicted surge levels 3.5m above mean high tide for Niedersachsen & Schleswig-Holstein -actual water levels lower because storm passed before high tide set in

Table SL70. Tide analysis (arranged by year and then alphabetically)

Source	Full Reference and Notes
Bradshaw (2007)	Bradshaw, Elizabeth (ed), Annual Report for 2007 for the UK National Tide Gauge Network and Related Sea Level Science, National Tide and Sea Level Facility, NERC 100017897 2007, p.2 -'Tidal residuals are defined to be the measured water level minus the predicted tide. The predictions are defined to the measured water level minus the predicted tide. The predictions derive from the database of tidal constants maintained by POL's Applications Group for the ports of the UK and elsewhere' -gap definition: 4.1h -Doodson X0 filter
LandSH (20070112)	Land Schleswig-Holstein, Sturmflutereignis am 12.01.2007 (vorlaufige Wasserstande am Pegelmessstellen), Amt fuer laendliche Raume, Husum, Az: 5514, Stand: 12.01.2007 -average high tide calculated over 1986-1995
MAIB (200804)	MAIB, Report on the investigation of the structural failure of MSC Napoli English Channel on 18 January 2007, Marine Accident Investigation Branch, Carlton House, Carlton Place, Southampton, UK, SO15 2DZ, Report No 9/2008, April 2008 -FIG9_p12. Tidal stream atlas for 1020UTC; NOTE tenths of a knot

Table SL71. Data filtering and discretization issues (arranged by year and then alphabetically)

Source	Full Reference and Notes
Bradshaw (2007)	Bradshaw, Elizabeth (ed), Annual Report for 2007 for the UK National Tide Gauge Network and Related Sea Level Science, National Tide and Sea Level Facility, NERC 100017897 2007, p.2 -UK tide data at 15min intervals; gap defined as 4.1h
RWS (200701b)	RWS, Verslag van de stormvloed van 18 en 19 januari 2007 (SR86), Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007 -wave height and period based on 20 minute records but smoothed with 3 point moving average filter
Magnusson (2007)	Magnusson, Anne Karin, Variability of sea state measurements and sensor dependence, Workshop: Statistical models of the Metocean environment for engineering uses, IFREMER 30.09-01.10.2013. [pdf timestamp: 10/10/2013] -wave qc filters too strict & cut out good data; focus on wave limiting steepness -tests of different time intervals for calculating HsL 17.5, 20, 30, 60 min.

Table SL72. Difficulties in meteorological model of storm (arranged by year and then alphabetically)

Source	Full Reference and Notes
Kvamme (20070214)	Kvamme, Dag, Ekstremvaer nr.1/2007 - 'Per', Intern Rapport, met.no, 15pp, Meteorogisk Institutt met.no, Bergen, 14/02/2007 -[HANNO/PER] met.no used 3 numerical models to predict storm up to 60h in advance; all models converged on true sturge at 36h and 12h advanced forecast; for 60h advance forecast only coarse resolution model correctly predicted location of low pressure centre but wind strength was too weak.
NLWKN (20070122)	NLWKN, Sturmflut von 19.Januar: Es kam nicht so schlimm wie befurchtet. 19.Januar2007: keine Duenenabbruche auf den Inseln/Fuer das Wochenende wird erhoehtes tidewasser erwartet, 22/01/2007 https://www.nlwkn.niedersachsen.de/startseite/aktuelles/presse_und_offentlichkeitsarbeit/pressemitteilungen/-41867.html -DWD model incorrectly forecast 120km/h winds for Norderney; 80km/h wind speed measured
Jensen and Mueller-Navarra (2008)	Jensen J, SH Mueller-Navarra, Storm surges on the German coast, Die Kueste, 74 ICCE (2008), 92-124. -storm low pressure centre crossed Jutland 3h earlier than expected -key factors for surges a) how fast does cyclone move & on what track b) will cyclone increase in intensity c) how will near-bottom wind profile develop
Mueller-Navarra (2008)	Mueller-Navarra, Sylvin, Zur Vorhersagbarkeit schwere Sturmfluten an deutschen Kuesten, DMG Deutsche Meteorologische Gesellschaft, Mitteilungen 02/2008, pp9-10. -for Kyrill movement of windspeed from west to east was not well forecast FIG. [TIMESERIES] Comparison of 3 LME-Laeufe (17/01/2007 12:00UTC to 18/01/2007 00:00UTC at position Feuerschiff 'Deutsche Bucht' N54d10m E07d27m.
Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -Kyrill was well predicted days in advance
DWD (20070116)	DWD, 18.Januar 2007: Windfeld von Kyrill ueber Deutschland. Rueckblick auf einen der bisher schwersten

	Orkane, Pressemitteilung, Deutscher Wetterdienst, Offenbach, 16. Januar 2012. -accurate advance forecast of storm from when it started off Newfoundland
Behrens and Guenther (2009)	Behrens, A. and H. Guenther, Operational wave prediction of extreme storms in Northern Europe, Nat. Hazards, 49, 387-399, 2009 -DWD 42h advance forecast of wind field too high
Roberts et al (2014)	Roberts JF, AJ Champion, LC Dawkins, KI Hodges, LC Shaffrey, DB Stephenson, MA Stringer, HE Thornton, DB Youngman, The XWS open access catalogue of extreme European windstorms from 1979 to 2012, Nat. Hazards Earth Syst. Sci, 14, 2487-2501, 2014 -model gust underestimated especially for Kyrill because of importance of convection; Kyrill known for intense convection and even tornadoes
Pantillon et al (2017)	Pantillon, F., P. Knippertz, U. Corsmeier, Revisiting the synoptic-scale probability of severe European winter storms using ECMWF ensemble reforecasts, Nat. Hazards Earth Syst. Sci., 17, 1795-1810, 2017. -ECMWF reforecast analysis for 25 storms 1995-2015 -'The storm are well predicted by the whole ensemble up to 2-4 days ahead. At longer lead times, the number of members predicting the observed storms decreases and the ensemble average is not clearly defined for the track and intensity.'

Table SL73. Difficulties in modelling water levels and surge (arranged by year and then alphabetically)

Source	Full Reference and Notes
Unwetterzentrale_Kyrill (200701b)	Unwetterzentrale, Orkantief KYRILL: Ausführliche Analyse der Wetterlage, www.unwetterzentrale.de/uwz/355.html, page accessed 21Aug2022. -initially storm surge feared -actual storm path further S than predicted by computer model -short period of main storm field over North Sea -storm covered area of low water and following high water night to 19Jan -water levels reached 1-1.5m over average high water -only on a few coastal sections was 1.5m exceeded (threshold for light storm surge)
Jensen and Mueller-Navarra (2008)	Jensen J, SH Mueller-Navarra, Storm surges on the German coast, Die Kueste, 74 ICCE (2008), 92-124. -Storm Kyrill: -18h wind forecasts predicted wind setups of 4-5m but with 3h uncertainty -low pressure crossed Jutland about 3h earlier than forecast; no max impact water levels -forecast very severe storm surge did not occur (Mueller-Navarra, 2008) * -14h forecast water level 1.75m too high

Table SL74. Future sea level rise and flooding effects; future climate and storm return period (arranged by year and then alphabetically)

Source	Full Reference and Notes
Jensen and Mueller-Navarra (2008)	Jensen J, SH Mueller-Navarra, Storm surges on the German coast, Die Kueste, 74 ICCE (2008), 92-124. 4.2. Storm surges and climate change * -climate change: winter month temperatures have increased by 1C in 150y but no major change in storm surge climate -model studies show 10% increase wind speed by 2100 -20-30cm increase in surge levels at the 10m bathymetric contour * -IPCC prediction of 40cm sea level rise by 2100 * -storm surges at 2100 may exceed historic max by 2.0-2.1m
Ge et al (2014)	Ge J, D Much, J Kappenberg, O Nino, P Ding, Z Chen, Simulating storm flooding maps over Hafencity under present and sea level rise scenarios, Journal of Flood Risk Management, 7, 319-331, 2014. -analysis of flooding scenarios in HafenCity Hamburg with 90cmsea lvel rise at 2080.
Environment Agency (2018)	Environment Agency, Thames Barrier Project Pack 2018, January, 2018. Environment Agency. Thames Barrier View Cafe and Information Centre, 1 Unity Way, Woolwich, London, SE18 5NJ. email: thamesbarrierenquiries@environment-agency.gov.uk. -discussion accelerating sea level rise and level of protection of Thames Barrier -high water levels have increased

Table SL75. Isostatic rebound and tide gauge record corrections (arranged by year and then alphabetically)

Source	Full Reference and Notes
Bradshaw (2007)	Bradshaw, Elizabeth (ed), Annual Report for 2007 for the UK National Tide Gauge Network and Related Sea Level Science, National Tide and Sea Level Facility, NERC 100017897 2007, p.2 -global sea level increased 10-20cm during 20C -around Britain: Aberdeen +7cm, Sheerness +21cm -glacial isostatic adjustment GOA -land movements British Isles 1-2mm/y -2 techniques: Global Positioning System GPS & absolute gravity AG -geodetic techniques at Univ Nottingham since 1990 -continuous GPS stations at Aberdeen, Liverpool, Lowestoft, Newlyn, North Shields, Portsmouth, Sheerness -network AG stations Aberdeenl Lerwick, Newlyn since 1996 -during 2005 three new CGPS stations Dover, Lerwick, Stornaway -Data from 10 CGPS stations at British Isles GPS archive Facility BIGF -data from 4 CGPS stations (Aberdeen,Newlyn,North Shields,Sheerness) contrib to ESEAS, IGS-TIGA, EPN -log files for 10 CGPS stations with data availablity & quality -data from AG stations processed by POL -2007 R&D Technical Report -Scotland rising 1-2mm/y; south of England subsiding by 1.2mm/y -best current estimate for changes in sea level 0.9-1.2mm/y

	-FIG_p45. [MAP] CGPS stations in the British Isles GPS archive Facility (BIGF)
Kystdirektoratet (2007)	Kystdirektoratet, Hojvandsstatistikker 2007, Extreme sea level statistics for Denmark, 2007, Kystdirektoratet, Dec, 2007. -land height changes for all tide gauges station in Denmark for 1891-1990
Environment Agency (2018)	Environment Agency, Thames Barrier Project Pack 2018, January, 2018. Environment Agency. Thames Barrier View Cafe and Information Centre, 1 Unity Way, Woolwich, London, SE18 5NJ. email: thamesbarrierenquiries@environment-agency.gov.uk. -reference to isostatic rebound in SE England

Table SL76. Storm event as manifestation of climate change (arranged by year and then alphabetically)

Source	Full Reference and Notes
DW (20070118)	DW, Weather expert predicts more storms in coming winters, 18/01/2007, https://www.dw.com/en/weather-expert-predicts-more-storms-in-coming-winters/a-2317448 -Are weather phenomona like Lothar & other 'storms of the century' a sign of climate change -individual event cannot be connected to climate change -climate change assessed from observations that span decades -climate models predict that if trends are confirmed & temperature increase continues, winters will have heavier precipitation -ppt connected to intense low pressure situations -one can expect that these weather conditions will appear for often in winter
EDP (20070119j)	EDP, Weather damage like to cost millions, Eastern Daily Press, p5, 19Jan2007j -high winds & rain to cause millions GBPs damage; insurers warned UK to see future increase violent weather -ABI Association of British Insurers: not yet possible to predict how much current stormy weather would cost -over past 5 years, insurers paid 0.45-1.2 biollion GBP in damage from floods, storms & high winds each year -ABI said climate change looks set to increase bad weather & associated costs
Financial Times (20070120)	Financial Times, Insurers play down scale of storm damage claims, (reporter: William MacNamara), 20Jan2007 -ABI: global warming increasing threat to insurance industry ability to offer flood & weather insur -'high winds and heavy rain currently hitting much of UK looks set to occur more frequently and cause more expensive damage in the future unless action is taken now.'
Mueller-Westermeier (2007)	Mueller-Westermeier, Gerhard, Beschreibung un klimatologische Bewertung des Orkantiefs "Kyrill", pdf properties: Title: Deutscher Wetterdients - Nationale Klimauberwachung, Author: Gerhard Mueller-Westermeier, Subjet: Orkan Kyrill, datestamp: 26Jan2007 -analysis of geostrophic winds in German Bight, noting 50y variation
Jensen and Mueller-Navarra (2008)	Jensen J, SH Mueller-Navarra, Storm surges on the German coast, Die Kueste, 74 ICCE (2008), 92-124. *-CLIMATE CHANGE: surges in recent past with Netherlands flood 1953 raised question on change of pattern -Nsea water levels since last glacial period char by trangression & regression -detailed data on water level devel Nsea & Baltic available from 1850 -4000y ago water level SW Baltic about 1m below current mean level -water level 0AD 50cm higher than in Middle Ages (Jensen and Toppe 1990) 4.2. Storm surges and climate change * -climate change: winter month temperatures have increased by 1C in 150y but no major change in storm surge climate
Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -Kyrill as a model for altered storm patterns in future climate

Table SL77. Baltic Sea events (arranged by year and then alphabetically)

Source	Full Reference and Notes
Deutsche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] -thunderstorms in East Germany; damage in Poland
DW (20070112)	DW, Heavy storms batter northern Europe, 12Jan2007 https://www.dw.com/en/heavy-storms-batter-northern-europe/a-2308237 -FRANZ: diisrupted ferry services German Baltic Sea coast; power outages Poland; largest damage Bialystok & Elk
LCW (20070126)	Lloyds Casualty Week, 26Jan2007 -Belarus: Storm Hanno -Latvia: Storm Hanno -Sweden: Storm Hanno
Jensen and Mueller-Navarra (2008)	Jensen J, SH Mueller-Navarra, Storm surges on the German coast, Die Kueste, 74 ICCE (2008), 92-124. -review of Baltic storm surges and forecasting
Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -Kyrill culminated over Baltic states 19Jan2007 0000UTC with 962hPa minimum MSLP -peak winds in excess of 120kn in Baltic states
Gardiner (2010)	Gardiner, Barry, Appendix 3: Background information on 11 storms selected for detailed analysis, European Forest Institute, Atlantic European Regional Office - EFIAtlantic, 161 pp. [PDF properties: datestamp 23Jul2010] -Kyrill forest damage in Poland & Germany -Per forest damage in Sweden; flooding damage in Lithuania

Wikipedia (20220322)	Wikipedia, Cyclone Kyrill, https://en.wikipedia.org/wiki/Cyclone_Kyrill, accessed 22Mar2022 -Cypriot-flagged freighter Golden Sky with fertiliser & fuel oil ran aground near Ventspils, off coast of Latvia; crew rescued in joint Latvian-Swedeish operation -Poland -crane operator killed Katowice when 25m crane broke in half -by 19Jan 6 fatalities & 19 injuries reported; 800 000 households without electricity; 500 damaged houses

Table SL78. Irish Sea events (arranged by year and then alphabetically)

Source	Full Reference and Notes
Belfast Telegraph (20070111a)	The Belfast Telegraph, Severe gales continue (contributor Colm Lenaghan and Victoria O'Hara), 11Jan2007a -FRANZ -in Republic 5 fisherman feared drowned after trawler sank -10 fishing boats, 2 lifeboats & CG helicopter from Waterford searching off Hook Head in Wexford
DW (20070112)	DW, Heavy storms batter northern Europe, 12Jan2007 https://www.dw.com/en/heavy-storms-batter-northern-europe/a-2308237 -FRANZ: 2 trawlers sink off SW coast Ireland, flooding in mid-Wales
Guardian (20070112)	Guardian, Nine killed as gales lash UK, Fri 12Jan2007 16:57GMT https://www.theguardian.com/world/2007/jan/12/weather.uk -FRANZ: trawler sinkings near coast of Ireland; power outages Wales; west coast line rail disruptions
LCW (20070119)	Lloyds Casualty Week, 19Jan2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ -FRANZ: loss of Pere Charles near Ireland coast
LCW (20070126)	Lloyds Casualty Week, 26Jan2007 -UK: Storm Kyrill: Easyjet aircraft, Belfast to Stansted, made emergency landing Liverpool airport; pilot said low on fuel -UK: Storm Kyrill: Stena Line 1430 ferry service Fishguard-Rosslare cancelled
Esurge (20121111)	Esurge_2007_kyrill(2012), Triple storm even (2007), Philip Harwood, Sun, 2012/11/11 15:04 -storm surge up to 2m that impacted NW English coastline of Irish Sea -5m waves in eastern Irish Sea
NTLSF (2013)	NTSLF, Skew surge history, https://ntslf.org/storm-surges/skew-surges/scotland, https://ntslf.org/storm-surges/skew-surges/england-east, https://ntslf.org/storm-surges/skew-surges/england-south, https://ntslf.org/storm-surges/skew-surges/england-wales, https://ntslf.org/storm-surges/skew-surges/england_west, https://ntslf.org/storm-surges/skew-surges/isle-of-man, https://ntslf.org/storm-surges/skew-surges/northern-ireland, https://ntslf.org/storm-surges/skew-surges/channel-islands (accessed 10Nov2021) -Hanno high surge only on northern part of Wales & Liverpool Bay

Table SL79. Bristol Channel/English Channel/Celtic Sea events (arranged by year and then alphabetically)

Source	Full Reference and Notes
Air Worldwide (2007)	Air Worldwide, European Winter Storm Franz, first posting 12Jan2007, https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-franz/first-posting/ -2 trawlers sunk off Ireland -knocked overboard stewart on Russian cargo ship
BBC (2000111a)	BBC, England battered by wind and rain, 11Jan2007a 16:43GMT news.bbc.co.uk/2/hi/uk_news/england/6251415.stm -major air and sea search for a woman who fell overboard from ship off Cornwall -woman fallen from 24000 ton Russian bulk carrier Vera Maretskaya near Falmouth 1050GMT -P&O Ferries, SeaFrance, Norfolkline, Speedferries suspended all cross-Channel services to and from Dover when winds reach Bf10 -services from Kent to Calais/Dunkirk/Boulogne affected -ferry services to/from Isle of Wight suspended by high winds Solent -Red Funnel suspended all services -Wightlink unable to the operate catamaran Portsmouth to Ryde
Financial Times (20070119)	Financial Times, Fourteen die as storms lash north Europe (reporter: William MacNamara), 19Jan2007 -British & French CG rescued crew of MSC Napoli off Cornwall in 27 foot waves
MAIB (200804)	MAIB, Report on the investigation of the structural failure of MSC Napoli English Channel on 18 January 2007, Marine Accident Investigation Branch, Carlton House, Carlton Place, Southampton, UK, SO15 2DZ, Report No 9/2008, April 2008 -KYRILL: wave strike and wreck o MSC Napoli 18Jan2007 in English Channel
NTLSF (2013)	NTSLF, Skew surge history, https://ntslf.org/storm-surges/skew-surges/scotland, https://ntslf.org/storm-surges/skew-surges/england-east, https://ntslf.org/storm-surges/skew-surges/england-south, https://ntslf.org/storm-surges/skew-surges/england-wales, https://ntslf.org/storm-surges/skew-surges/england_west, https://ntslf.org/storm-surges/skew-surges/isle-of-man, https://ntslf.org/storm-surges/skew-surges/northern-ireland, https://ntslf.org/storm-surges/skew-surges/channel-islands (accessed 10Nov2021) -Kyrill high surge only in Bristol Channel

Table SL80. Aftermath: new defenses; new design criteria; assessment of climate change; model problems (arranged by year and then alphabetically)

Source	Full Reference and Notes
Kvamme (20070214)	Kvamme, Dag, Ekstremvaer nr.1/2007 - 'Per', Intern Rapport, met.no, 15pp, Meteorogisk Institutt met.no, Bergen, 14/02/2007 -[HANNO/PER] some procedural and communications problems in broadcasting storm warnings
NLWKN (20070115)	NLWKN, Sturmflut am 12. Januar 2007: Nordseekueste kam glimpflich davon 12. Januar 2007 (aktualiert am

	15. Januar 2007): Duenenabbrueche auf den ostfriesischen inseln https://www.nlwkn.niedersachsen.de/startseite/aktuelles/presse_und_offentlichkeitsarbeit/pressemitteilungen/-41838.html -Juist-West: west of Hammersee overe a km; avg 5m loss but greater in some places; NKWKN plans for strengthening -Langeoog Pirotal/Bereich Kinderkur; duneloss ca 2-6m at Pirolatal; some collapse other places; NLWKN focus area -Spiekeroog Hessenwand/Suederduenen: collapse; NKWKN began protection 2006 dune foot with rock armour
NLWKN (20070122)	NLWKN, Sturmflut von 19.Januar: Es kam nicht so schlimm wie befurchtet. 19.Januar2007: keine Duenenabbruche auf den Inseln/Fuer das Wochenende wird erhoehtes tidewasser erwartet, 22/01/2007 https://www.nlwkn.niedersachsen.de/startseite/aktuelles/presse_und_offentlichkeitsarbeit/pressemitteilungen/-41867.html -NLWKN performing surveys at Westknopf Norderney to assess amount of beach washed away
MAIB (200804)	MAIB, Report on the investigation of the structural failure of MSC Napoli English Channel on 18 January 2007, Marine Accident Investigation Branch, Carlton House, Carlton Place, Southampton, UK, SO15 2DZ, Report No 9/2008, April 2008 -MAIB contacted major classification societies for urgent checks on the buckling strength of a number of ship designs. 1500 ships screened; 12 required remedial action; 10 as borderline
Behrens and Guenther (2009)	Behrens, A. and H. Guenther, Operational wave prediction of extreme storms in Northern Europe, Nat. Hazards, 49, 387-399, 2009 -DWD wave model does not have enough dissipation in shallow water near coast
Gardiner (2010)	Gardiner, Barry, Appendix 3: Background information on 11 storms selected for detailed analysis, European Forest Institute, Atlantic European Regional Office - EFIAtlantic, 161 pp. [PDF properties: datestamp 23Jul2010] -declaration of state of emergency in Czech Republic -small fluctuation timber prices -EU change of law to allow fallen timber to be transported out of impact area -reforestation with Norway spruce even though this is susceptible to wind damage
DWD (20120116)	DWD, 18.Januar 2007: Windfeld von Kyrill ueber Deutschland. Rueckblick auf einen der bisher schwersten Orkane, Pressemitteilung, Deutscher Wetterdienst, Offenbach, 16. Januar 2012. -technical developments in weather forecasting after Kyrill improvd forecasts for Hurricane Ulli & Andrea Jan2012
Petroliagis and Pinson (2014)	Petroliagis TI and P Pinson, Early warnings of extreme winds using the ECMWF Extreme Forecast Index, Meteorological Applications, 21, 171-185, 2014. -extreme forecast index EFI to give advance warning of extreme events -case studies focus on Kyrill, Emma, Herbert, Xynthia
Wikipedia (20220322)	Wikipedia, Cyclone Kyrill, https://en.wikipedia.org/wiki/Cyclone_Kyrill, accessed 22Mar2022 -UKMO: Kyrill would have generated red warning on scale introduced in 2008

Table SL81. Worst case storm surge/storm situation (arranged by year and then alphabetically)

Source	Full Reference and Notes
Prandle (1975)	Prandle D, Storm surges in the southern North Sea and River Thames, Proc. R. Soc. Lond. A, 344, 509-539, 1975 -strategy for assessing maximum North Sea surge
Dailey (2007)	Dailey, Peter, The 2006-2007 European winter storm season: winding down, March 7, 2007. http://www.air-worldwide.com/Publications/AIR-currents/The-2006-2007-European -Kyrill met 2/3 crit for extreme Europ loss event: (intensity), size, location -low intensity storm: London wspd 126kph instead of 160kph for Daria for 1999 Lothar -if Kyrill had Daria wind, insured losses >10 billion -if Kyrill had Lothar wind, insured losses >40 billion -truly large loss events can happen in Europe -not question if, but rather when
Neumann (200702)	Neumann, T., FINO and the mast shadow effect, 52nd IEA Topical Expert Meeting, Wind and wave measurements at offshore locations, Berlin, Germany, February 2007, organized by TU Berlin and Germanischer Lloyd, International Energy Agency, Implementing Agreement for Co-operation in the Research, Development and Deployment of Wind Turbine Systems, Task 11. -highest winds at FINO1: Karla 31Dec2006, Britta 01Nov2006, Erwin 08Jan2005, Kyrill 18Jan2007
RWS (200701a)	RWS, Verslag van de stormvloed van 11 en 12 januari 2007 (SR85), Ministerie van Veerkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007a -tables of ranked highest water levels, significant wave heights, wave periods
RWS (200701b)	RWS, Verslag van de stormvloed van 18 en 19 januari 2007 (SR86), Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007b -tables of ranked highest water levels, significant wave heights, wave periods -for water level, Kyrill was in the rank 10-15 range or Harlingen and Hoek van Holland only
Jensen and Mueller-Navarra (2008)	Jensen J, SH Mueller-Navarra, Storm surges on the German coast, Die Kueste, 74 ICCE (2008), 92-124. -reference to MUSE project of Jensen et al (2006)
Ge et al (2014)	Ge J, D Much, J Kappenberg, O Nino, P Ding, Z Chen, Simulating storm flooding maps over Hafencity under present and sea level rise scenarios, Journal of Flood Risk Management, 7, 319-331, 2014. -analysis of worst case flooding in HafenCity with 90cm sea level rise at 2080

Table SL82. Damage costs; insurance losses (arranged by year and then alphabetically)

Source	Full Reference and Notes
Air Worldwide (2007)	Air Worldwide, European Winter Storm Franz, first posting 12Jan2007,

	https://alert.air-worldwide.com/extratropical-cyclone/2007/european-winter-storm-franz/first-posting/ -AIR NWP-based Extratropical Cyclone Model for Europe -expect wind-associated losses to onshore properties not to be significant
Dailey (2007)	Dailey, Peter, The 2006-2007 European winter storm season: winding down, March 7, 2007. http://www.air-worldwide.com/Publications/AIR-currents/The-2006-2007-European -Kyrill -Jan 2007 storm with signficant insured loss -large: wind footprint over 10 countries (Ireland to Germany, Scotland to Austria) -Daria 1990: also wide footprint but Kyrill larger -insurance losses still being evaluated; readjustment from 1 to 2 bill in Germany -Kyrill met 2/3 crit for extreme Europ loss event: (intensity), size, location -low intensity storm: London wspd 126kph instead of 160kph for Daria for 1999 Lothar -if Kyrill had Daria wind, insured losses >10 billion -if Kyrill had Lothar wind, insured losses >40 billion
Deutsche Rueck (2007)	Deutsche Rueck, Sturmdokumentation 2007 Deutschland, Deutsche Rueckversicherung Aktiengesellschaft, Duesseldorf und Berlin, Hansaallee 177, 40549 Duesseldorf, Postfach 290110, 40528 Duesseldorf, www.deutscherueck.de, 38pp, 2007, ed by Thomas Axer, Thomas Bistry, Meike Mueller, Andreas Reiner, Michael Suesser, [Document properties, created 08Sep2015] -hurricane Kyrill crossed Germany quickly from W to E; large damage across country -insured damage at 2.4 bill EUR (GDV2007)
DW (20070119)	DW, Killer winds in Europe expected to cause heavy financial loss, 18Jan2007 https://www.dw.com/en/killer-winds-in-europe-expected-to-cause-heavy-financial-loss/a-2317752 -European insurers expect costs to be massive -GDV German insurance association said insured damage could total 1 bill EUR -Allianz (biggest insurer Germany) set up 24h hotlines for customers
DW (20070120)	DW, Power cuts in Europe as continent begins to clean up, 20/01/2007, https://www.dw.com/en/power-cuts-in-europe-as-continent-begins-clean-up/a-2319624 -KYRILL -Netherlands: -insurers say insurance losses could be at least 160 million EUR -damage to Amsterdam Schipol airport & railways add another 40 million EUR
EDP (20070119j)	EDP, Weather damage like to cost millions, Eastern Daily Press, p5, 19Jan2007j -high winds & rain to cause millions GBPs damage; insurers warned UK to see future increase violent weather -ABI Association of British Insurers: not yet possible to predict how much current stormy weather would cost -over past 5 years, insurers paid 0.45-1.2 biollion GBP in damage from floods, storms & high winds each year -ABI said climate change looks set to increase bad weather & associated costs
KNMI (20070118)	KNMI, Nieuwsbericht, De zware storm Kyrill van 18 januari 2007, 17 januari 2007, https://www.knmi.nl/over-het-knmi/nieuws/de-zware-storm-kyrill-van-18-januari-2007 6. Storm cost Achmea 125mill EUR -storm cost Achmea (insurance company?) 125 mill EUR for Kyrill -total damage cost in country min 330mill EUR -Swiss Re re-insurance company estimated cost in Europe at 3.5bill EUR
LCW (20070126)	Lloyds Casualty Week, 26Jan2007 -Latvia: Storm Hanno: damage from hurricane over Latvia 16Jan estimated at >2mill USD -Latvia: Storm Hanno: biggest damage Riga 0.86mill USD -Netherlands: Storm Franz: Netherlands storm of 11Jan caused 15mil EUR damage
LCW (20070202)	Lloyds Casualty Week, 02Feb2007, Lloyd's MIU, Telephone House, 69-77 Paul Street, London, EC2A 4LQ p.25, London, 19Jan -Kyrill Britain's strongest storm in 17y (ref to 1990 events) -cost hundreds of millions of pounds p.25, London 23Jan -clients of insurance companies in Czech Republic made 28000 claims worth CZK 485 mill
Swiss Re (2007)	Swiss Re, Sigma, Natural catastrophes and man-made disasters in 2007: high losses in Europe, No1., 2007. authors: Rudolf Enz, Kurt Karl, Jens Mehlhorn, Susanna Schwarz -Storm Kyrill -flood cover underpredicted -Kyrill rank1 insurance loss 2007 -Kyrill rank 3 European storm after Daria and Lothar
Unwetterzentrale (200701)	Unwetterzentrale, Orkantief KYRILL - 18., 19.01.2007 (Tief Nr. 33) - Der schwerste Orkan seit Jahrzehnten, analysis by Manfred Spatzierer, Thomas Sävert, Stefan Laps, www.unwetterzentrale.de/uwz/348.html -KYRILL: damage assessed at 4.7bill EUR by insurance agencies
Fink et al (2009)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -'according to the German Insurance Association (GDV) storm Kyrill caused circa 2.4 billion Euro of insured losses in Germany alone (GDV, 2007). The correspondent value for Europe is currently estimated betweenfour and seven billion Euro (Swiss Re, 2008; Munich Re, 2008)'.
Tetzlaff (2009)	Tetzlaff, G., Extreme rain and wind storms in the mid-latitudes I, Singapore, 21-22.04.2009. https://imsarchives.nus/edu.sg/oldwww/Programs/09fluidss/files/Gerd Tetzlaff.pdf (Spring School on Fluid Mechanics and Geophysics of Environmental Hazards, Singapore, April 19-May 2, 2009) [pdf datestamp: 14/05/2009] - damage 5-10 billion EUR
DWD (20120116)	DWD, 18.Januar 2007: Windfeld von Kyrill ueber Deutschland. Rueckblick auf einen der bisher schwersten Orkane, Pressemitteilung, Deutscher Wetterdienst, Offenbach, 16. Januar 2012. -insurance companies reckoned billions EUR damage

	-damage would have been higher but several days forecast for the storm
Esurge (20121111)	Esurge_2007_kyrill(2012), Triple storm even (2007), Philip Harwood, Sun, 2012/11/11 15:04 -insurance cost of storm est up to 3.5 billion Euro by Swiss Re
AON Benfield (2013)	AON Benfield, Historie von 1703 bis 2012: Winterstuerme in Europa, Stand: Januar 2013 -Kyrill similar to hurricane series winter 1990 and Hurricane Lothar Dec1999 as one of worst storm occurrences in Germany over 20y -damage assessed as 20-30y event -insured damage in Germany assessed at 2.8billion EUR (indexed to year 2012) -rank 1/21 insurance loss storm for Germany in period 1972-2013
MunichRe (2013)	Munich RE, Natural catastrophes in Germany 1970-2012, Muenchener Rueckversicherung-Gesellschaft, Geo Risks Research, NatCatSERVICE - as of January 2013 -Kyrill rank1 in Germany for overall loss and insured loss
Petroliagis and Pinson (2014)	Petroliagis TI and P Pinson, Early warnings of extreme winds using the ECMWF Extreme Forecast Index, Meteorological Applications, 21, 171-185, 2014. -estimated insurance market loss was about 3.5 bill EUR
Ludwig et al (2015)	Ludwig P, JG Pinto, SA Hoepp, AH Fink, SL Gray, Secondary cyclogenesis along an occluded front leading to damaging wind gusts: Windstorm Kyrill, January 2007, Monthly Weather Review, 143, 1417-1437, 2015 -'overal insured lossed of 4.6 billion Euro in Germany, the UK, Belgium, and the Netherlands (economic losses even reached 7.6 billion EUR)'
Statistica (20151208)	Statistica, The costliest winter storms ever to hit Europe. Fatalities and financial losses of Europe's 10 costliest winter storms (source Munich Re), 08Dec2015 -rank 2/10 worst European winter storms ever in terms of insurance losses; rank 5 for fatalities
Pantillon et al (2017)	Pantillon, F., P. Knippertz, U. Corsmeier, Revisiting the synoptic-scale probability of severe European winter storms using ECMWF ensemble reforecasts, Nat. Hazards Earth Syst. Sci., 17, 1795-1810, 2017. -'insured losses have been shown to scale with the third power of the stronget wind gusts ... The scaling with v98 accounts for the local adaptation to wind gusts , whose impact on infrastructure is weaker in exposed areas such as coasts and mountains thatn in the continental flatlands for the same absolutewind speed.'
Tatge (2017)	Tatge, Yorn, Kyrill the winter storm that walloped most of Europe, https://www.air-worldwide.com/blog/posts/2017/1/kyrill-the-winter-storm-that-walloped-most-of-europe/, Verrisk, 19Jan2017 3. High Insured Losses -Kyrill met 2 of 3 criteria for extreme European loss event - intensity, size, location (it did not have extreme intensity) -economic losses Kyrill USD 12 bill (2016 values); > half borne by insurance industry -average claim small at around USD1500 -large footprint size meant many claims to total into billions -deductibles were low to nonexistant; event a few blown shingles warrant a claim -good insurance penetration in Europe contributed to high insurance losses -except for a few countries like Poland, Czech Republic, Lithuania; wind insurance takeup Europe 100%
Lockwood et al (2022)	Lockwood, J.F, Guentchev, G.S., Alabaster, A., Brown, S.B., Palin, E.J., Roberts, M.J., and Thornton, H.E.: Using high-resolution global climate models from the Primavera project to create a European winter windstorm event set, Nat. Hazards Earth Syst. Sci., 22, 3585-3606, https://doi.org/10.5194/nhess-22-3585-2022, 2022 -insurance loss for Storm Kyrill and ranking among top 5 loss European winter storms 1970-2018
Wikipedia (20220322)	Wikipedia, Cyclone Kyrill, https://en.wikipedia.org/wiki/Cyclone_Kyrill, accessed 22Mar2022 -Swiss Re est 3.5 bill EUR insurance loss Europe; UK insurance loss 520 mill EUR -extratropical storms rank as second highest cause of global natural catastrophe loss after US hurricanes

Table SL83. Online data sets (alphabetically)

Source	Full Reference and Notes
Belgium VLIZ	Belgium tide gauge and wave information with some associated meteorology: https://meetnetvlaamsebanken.de
Caithness Wind Farm	Caithness wind farm list of wind energy accidents: https://scotlandagainstspin.org/turbine-accident-statistics/ https://scotlandagainstspin.org/wp-content/uploads/2023/04/Detailed-incidents-to-31-Mar2023.pdf https://sctlandagainstspin.org/turbine-accident-statistics/
CMEMS	European Copernicus wave information http://www.marineinsitu.eu/dashboard/
Danish Energy Agency (20230719)	Danish Energy Agency, Overview of the Energy Sector, last access 19Jul2023 https://ens.dk/en/our-services/statistics-data-key-figures-and-energy-maps/overview-energy-sector -excel files of operating and decommissioned turbines in Denmark -monthly wind energy production in Denmark from 2002
Denmark tide gauge data	https://kyst.dk/soeterritoriet/maalinger-og-data/vandstandsmaalinger/
DWD (2022)	DWD archive of weather maps: www2.wetter3.de/Archiv/archiv_dwd.html
ESWD (20220501)	European Severe Weather Database, https://eswd.eu (last access 01May2022)
Extreme Wind Storms Catalog	http://www.europeanwindstorms.org
Fink et al (2007)	Fink AH, T Brucher, V Ermert, A Kruger, JG Pinto, The European storm Kyrill in Jan 2007: synoptic evolution, meteorological impacts and some considerations with repect to climate change, Natural Hazards and Earth System Sciences, 9, 405-423, 2009. -'weather charts over North America were obtained from the California Regional Weather Server and Unisys Weather Information Services'
Gatzen et al (2020)	Gatzen CP, AH Fink, DM Schultz, JG Pinto, An 18-year climatology of derechos in Germany, Nat Hazards Earth Syst. Sci., 20, 1335-1351, 2020 -lightning used to identify and track European derechos 1997-2014 -'We used data from the Arrival Time Difference (ATD) system operated by the Met Office (Lee, 1986) available at wetterzentrale.de (2016) until the year 2000 and from the Siemens Blids lightning network (Siemens, 2019) for events after the year 2000'

Karlsruhe Institute of Technology KIT	KIT extreme weather descriptions: http://www.wettergefahren-fruehwarnung.de/Ereignis/archiv_sturm.html
Karlsruhe Institute of Tecnology KIT	KIT FDA reports: https://www.cedim.kit.edu/english/2850.php
Land-SH	http://www.umweltdaten.landsh.de/public/hsi/pegelsuche.html -information on the Land-SH tide gauges
Norway Kartverket (20220301)	Kartverket website https://api.sehavniva.no/tideapi_en.html (last access 1Mar2022)
Norway SEklima	Norway wave information https://seklima.met.no
Netherlands RWS Waterinfo	RWS: (Rijkswatersaat Waterinfo) https://waterinfo.rws.nl/#!/nav/expert/alle-groepen/
Primavera	PRIMAVERA European winter windstorm event https://zenodo.org/record/6492182#.YzRjCqTMJPY
Quikscat	qscat data product information site https://podaac.jpl.nasa.gov/dataset/QSCAT_LEVEL_2B_OWV_COMP_12 qscact ftp download site https://podaac-tools.jpl.nasa.gov/drive/files/allData/quikscat/L2B12/v3/2007/011
UK BODC tide gauge	https://www.bodc.ac.uk/data/hosted_data_systems/sea_level/uk_tide_gauge_network/processed/
UK CEFAS Wavenet	https://wavenet.cefas.co.uk/
UKMO (2021) Daily Weather Summary	UKMO, personal communication with Catherine Ross, UKMO, 2 Mar 2021. UKMO daily weather summaries at Digital Library and archive: https://digital.nmla.metoffice.gov.uk/collection_86058de1-8d55-4bc5-8305-5698d0bd7e13/
UKMO (2022) Marine Observer	Back issues of Marine Observer, https://digitial.nmla.metoffice.gov.uk/SO_Oafb8f96-434b-42c3-8082-056623702322/
UKMO Meteorological Magazine	Back issues fo Meteorological Magazine https://digital.nmla.metoffice.gov.uk/SO_31c4215d-460a-4ce3-bdac-12c775f5c92d/
University of Wyoming radiosonde archie	https://weather.uwyo.edu/upperair/sounding.html

Table SL84. Storm animations (alphabetically)

Source	Full Reference and Notes
European Wind Storms Catalog (2022)	www.europeanwindstorms.org/cgi-bin/storms/storms.cgi?storm1=Kyrill -animation maps of most severe European winter storms

Table SL85. Onshore/offshore wind energy policy and historical development

Source	Full Reference and Notes
IEA (2006)	IEA, Wind Energy Annual Report 2006, International Energy Agency, July 2006 -annual report of the IEA Wind Energy member countries -graphs of growth of wind energy to 2007; iincreasing turbine size -IEA Wind Energy start 1977
Chou and Tu (2008)	Chou, J-S, W-T Tu, Failure analysis and risk management of a collapsed large wind turbine tower, Engineering Failure Analysis, 18, 295-313, 2011. -case of turbine collapse in Japan during typhoon 28Sep2008 but at wind speed much less than design survival wind speed; faulty bolts and tensioning suspected cause -wind turbine should have 20y life cycle with investment recovered in 15y

Table SL86. Context and background information where storm not mentioned (arranged by year and then alphabetically)

Source	Full Reference and Notes
Rossiter et al (1958)	Rossiter JR, Storm surges in the North Sea, 11 to 30 December 1954, Philosophical Transactions of the Royal Society of London, Series A, 251, No. 991, 139-160, 1958. -longitudinal seiche period 30-40h; transverse seiche period 12h -positive surges develop oscillatory manner which is heavily damped -solitary Kelvin waves -negative surges exhibit strong tendency towards oscillations -'Corkan ultimately considered the damping factor to be such as to allow neglect of all oscillations after the first peakof a positive surge' -'The question at issue, then , is not whether seiching does take place but the amount of damping associated with it' -Aberdeen, Lowestoft, Southend: '...for northerly winds any oscillations which may exist are so heavily damped as to be indiscernible among other second order effects such as interaction between tide and surge. Analysis of residual at all three ports revealed no lack of transient oscillations in the period band of 24 to 40 h, but no consistent results could be obtained'
Prandle (1975)	Prandle D, Storm surges in the southern North Sea and River Thames, Proc. R. Soc. Lond. A, 344, 509-539, 1975 -strategy to estimate maximum North Sea surge
Ashcroft (1985)	Ashcroft, John, Potential ice and snow accretion on North Sea rigs and platforms (volume 1), Marine Technical Note No 1, Marine Advisory, Consultancy and Data Services, Meteorological Office, Eastern Road, Bracknell, Berkshire RG12 2UR, July 1985 -'The 'air gap' or height between HSL and deck on a platform is based on the maximum 1 in 50y wave plus additions for surge and 2m air clearancefrom crest of the estimated maximum wave to deck level (Dr. L. Draper, personal communication)' -around 54N (1 in 50y wave=17m) the height of the deck of a unit is estimated to be 2/3 Hmax+2m surge+2m gap; i.e. 17m -farther north, est 1 in 50y wave increases so the platforms are designed with

	larger clearance from deck to MSL
Dannevig (1990)	Dannevig, Petter, Ceausescu ga ordre om a forfalske vaermeldinger, Vaeret, Aargang 14, Nr.1, p.19, 1990. -false temperature reports from Romania during Ceaucescu regime -possible indication of bad wind speed data being fed into USAF data base
McCallum (1990)	McCallum E, The Burn's Day storm, 25 January 1990, Weather, 45, 166-173, 1990. -strongest winds on right hand side of storm track for Storm Daria Jan 1990
Gaffen (1993)	Gaffen, Dian J., Historical changes in radiosonde instruments and practices, World Meteorological Organization, Instruments and Observing Methods, Report No. 50. WMO/TD-No.541, 1993 -WMO report decribing radiosonde instruments used by different meteorological services with instrument uncertainty
Dixon and Tawn (1994)	Dixon MJ and JA Tawn, Extreme sea-levels at UK A-class site: site-by-site analysis, Proudman Oceanographic Laboratory, Internal document No.65, March 1994, 234 pp -background information to calculate return period from measure water level -list of highest water levels for tide gauge stations around the UK but no dates or events information given -reference to long term land level changes in the UK -calculation and presentation of long term trends in maximum water levels -calculation of return period of UK tide gauge stations based on long-term data sets -reference to importance of wave field for overtopping events, but too little wave information to carry analysis far -extreme value theory and Fisher Tippet distributions; importance of shape parameter -UK tide gauge station classification on basid if tide or surge dominated -problem stations at Cromer and Lowestoft for assessing return period.
Sorensen et al (2001)	Sorensen, T., F.V. Jensen, N. Raben, J. Lykkegaard, J. Saxov, Lightning protection for offshore wind turbines, CIRED2001, 18-21 June 2001, Conference Publication No. 482, IEE 2001 -review lightning strike data base for Denmark, Germany, Sweden -at least 5% of turbines per year expect a lightning strike -turbines affected by near misses -lightning strike probability increases as square of turbine height -turbines in 1990 were 45m high so lightning was negligible probability once in 75y
Hoffman and Leidner (2005)	Hoffman R.N. and S.M. Leidner, An introduction to the near real-time Quikscat data, Weather and Forecasting, 20, 476-493, 2005 -background information on Quikscat scatterometer
IEA (2006)	IEA, Wind Energy Annual Report 2006, International Energy Agency, July 2006 -annual report of the IEA Wind Energy member countries -graphs of growth of wind energy to 2007; iincreasing turbine size -IEA Wind Energy start 1977
RWS (2006)	RWS, Verslag van de stormvloed van 31 oktober en 1 november 2006 (SR84), Ministerie van Veerkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, november 2006 -unprecedented wave heights along Dutch coast during Storm Britta
Gatey and Miller (2007)	Gatey DA and CA Miller: An investigation into 50-year return period wind speed differencesfor Europe, J Wind Engineering and Industrial Aerodynamics, 95, 1040-1052, 2007. -wind speed unit conversion ambiguity in the NCEIdata sets
MAIB (200709)	MAIB, Report on the investigation of the loss of the fishing vessel Meridian KY147 with the loss of four crew 160nm due east of Aberdeen on 26 October 2006, Marine Accident Investigation Branch, Carlton House, Southampton, Report No 20/2007, September 2007 -disappearance of Meridian on guard duty in North Sea 26Oct2006
Neumann and Nolopp (2007)	Neumann, T. and K. Nolopp, Three years of operation of far offshore measurements at FINO1, DEWI Magazine, 30, 42-46, 2007. -photographs of FINO1 damage during Storm Britta on 31Oct-1Nov 2006.
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	*platform demobilization start 2005-2006 (2-3years before 2008)
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	-ODN is average sea level at Newlyn in period 1916-2921 at time of Second Geodetic Leveling of UK -ODN agreed with sea level at Felixstowe but Dunbar MSL was 20cm higher -initially throught to represent ocean current effect; geoid measurements show sea level around the UK should be about the same; 20cm offset due to systematic land survey errorss
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Becerra et al (2018)	Becerra M, M Long, W Schulz, R Thottappillil, On the estimation of lightning incidence to offshore wind farms, Electric Power Systems Research, 157, 211-226, 2018. -field observations shown that freq of dangerous lightning events to wind turbines... is grossly underestimated -field obs shown that actual number of strikes on wind farms several times higher than std -lightning location systems LLS have shown that lightning incidence in close vicinity to wind turbines and communications towers much higher than surrounding region -lightning hot spot: most attributed to upward lightning from elevated objects -frequent occurrence of upward lightning triggered from wind turbines obs in field studies
Ma et al (2018)	Ma Y, P Martinez-Vazquez, C Baniotopoulos, Wind turbine collapse cases: a historical overview, Institution of Civil Engineers. Proceedings. Structures and Buildings. https://doi.org/10.1680/jstbu.17.00167. document properties: date stamp 15/05/2018 -paper presents historical wind turbine collapse cases to identify most common failure mechanisms -unexpected extreme wind load levels combined with human errors (poor QC, faulty construction, erroneous ops) -extreme wind events conc about 56% of total number of failures -most collapsed structures designed according to guidelines -cyclic effects: rotor revolve 10**9 cycles spanning over 20+y -wind turbines designed for 20-30y energy harvesting -fatigue effects major cause of collapse -cyclic loading more dangerous when oscillatory freq approx natural freq of tower
Environment Agency (2019)	Environment Agency, Coastal flood boundary conditions for the UK: update 2018. Technical summary report, SC060064/TR6, published by: Environment Agency, Horizon House, Deanery Road, Bristol BS1 5AH, May 2019 -explanation of skew surge
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Kurth et al (2022)	Kurth, R., P. Taiarol, J. Crowther, M. Stobart, 4 challenges to overcome when transmitting offshore wind power, Stantec, 07Jun2022, https://www.stantec.com/en/ideas/4-challenges-to-overcome-when-transmitting-offshore-wind-power -approx 3/4 of all offshore insurance claims related to cables, ->3 months to get system back online after cable failure
Recahrge (20220201)	Recharge: Video. Rescue dash as rudderless cargo ship hits foundation at giant North Sea wind farm (contributor Andrew Lee), https://www.rechargenews.com/wind/video-rescue-dash-as-rudderless-cargo-ship-hits-foundation-at-giant-north-sea-wind-farm/2-1-1160591, 1 February 2022. -collision cargo ship Julietta D and substation foundation of Hollandse Kust South wind farm Dutch North Sea
BBC (20230509)	BBC, Can a wind turbine handle hurricane speed winds? (contributor Chris Baraniuk) 09May2023 https://www.bbc.com/news/business-65261147 -new turbine designs that can resist hurricane winds -insurance losses for offshore wind turbines 2012-2012 -new turbines with largest power generation ratings develop problems in 2 years
Electrek (20230427)	Electrek, In a first, a cargo ship strikes an offshore wind turbine (contributor Michelle Lewis), 27Apr2023 https://electrek.co/2023/04/27/cargo-ship-offshore-wind-turbine/

	-first collision between ship (Petra L) and offshore wind farm (Gode Wind 1) in North Sea
IEA (20230605)	IEA, Electricity production, https://www.iea.org/reports/electricity-information-overview/electricity-production, last access 05 June 2023 -gross electricity production trends between 1974-2019 -global electricity producton has grown each year continuously since 1974, except for between 2008 and 2009 when the global financial crisis sharply cut demand -in 2019, non-OECD countries share of production reached 58.6% of world electricity generation, more than double share in 1974 -increasing energy efficiency limited annual production growth between 2010 and 2019 to just 0.1% in OECD countries compared with 4.% in non-OECD countries -in 2019 generation from combustable fuels accounted for 65.3% of global gross electricity production

Table SL87. List of accidents to offshore wind turbines (arranged by year)

Event	Date	Full Reference and Notes
Nacelle came off turbine at Danish Samso turbine in the Kattegat	28Nov2015	4coffshore: Samsø turbine collapsed due to welding crack, http://www.4coffshore.com/windfarms/sams%C3%B8-turbine-collapsed-due-to-welding-crack-nid3005.html, 15 December 2015.
Turbine at Alpha Ventus wind farm in German Bight lost most of nacelle	6Apr2018	offshoreWIND.biz, Adwen turbine missing hardware on Alpha Ventus, 9Apr2018, https://www.offshorewind.biz/2018/04/09/adwen-turbine-missing-hardware-on-alpha-ventus/ Wind Action: Massive damage in the wind farm - cause unclear (contributer: Christina Gerlach, NDR.de), http://www.windaction.org/posts/48258-massive-damage-in-the-wind-farm-cause-unclear#.XsD_dDl7nIU, 25 April 2018.
Cargo ship Julietta D collides with substation foundation of Hollandse Kust South wind farm in Dutch North Sea	1Feb2022	Recharge: Video. Rescue dash as rudderless cargo ship hits foundation at giant North Sea wind farm (contributor Andrew Lee), https://www.rechargenews.com/wind/video-rescue-dash-as-rudderless-cargo-ship-hits-foundation-at-giant-north-sea-wind-farm/2-1-1160591, 1 February 2022.
Rotor separated from nacelle of turbine at Danish Anhold offshore wind farm	6Apr2022	Ørsted: Incident at Anholt offshore wind farm, https://orsted.com/en/media/newsroom/news/2022/04/incident-at-anholt-offshore-wind-farm, 6 April 2022.
Lightning induced nacelle fire at turbine at Arklow Bank windfarm in Ireland	19Oct2022	The Journal: 'No impact on the grid' after wind turbine catches fire during lightning storm off Wicklow coast, 20 October 2022.
Cargo ship collides with turbine at Orsted's Gode Wind 1 offshore wind farm in German Bight	24Apr2023	Electrek, In a first, a cargo ship strikes an offshore wind turbine (contributor Michelle Lewis), 27Apr2023 https://electrek.co/2023/04/27/cargo-ship-offshore-wind-turbine/

Table SL88. Errors/typos in source reports for storm (arranged by year and then alphabetically)

Source	Full Reference and Notes
Mueller-Westermeier (2007)	Mueller-Westermeier, Gerhard, Beschreibung un klimatologische Bewertung des Orkantiefs "Kyrill", pdf properties: Title: Deutscher Wetterdients - Nationale Klimauberwachung, Author: Gerhard Mueller-Westermeier, Subjet: Orkan Kyrill, datestamp: 26Jan2007 -Wednesday 16Jan2007 (TYPO) Kyrill developed east Atlantic; strengthened Thurs over Scotland, Nsea, Denmark
RWS (200701a)	RWS, Verslag van de stormvloed van 11 en 12 januari 2007 (SR85), Ministerie van Veerkeer en Waterstaat, Rijkswaterstaat, Stormvloedwaarschuwingsdienst/SVSD, Postbus 20907, 2500 EX 's-Gravenhage, www.svsd.nl, 's-Gravenhage, januari 2007a -ranked table of water levels in Appendix 10 not updated after storm Britta 01Nov2006
Hueppop et al (2009)	Hueppop O, R Hill, K Hueppop, F Jachmann, Auswirkung auf den Vogelzug. Begleitforschung im Offshore-Bereich auf Forschungsplattformen in der Nordsee. FINOBIRD. Abschlussbericht September 2009. Institut fuer Vogelforschung 'Vogelwarte Helgoland', Inselstation, An der Sapskuhle 511, 27498 Helgoland -FINO1 radar damage ascribed to storm Kyrill but it was actually Storm Franz 11Jan2023
DWD (20120116)	DWD, 18.Januar 2007: Windfeld von Kyrill ueber Deutschland. Rueckblick auf einen der bisher schwersten Orkane, Pressemitteilung, Deutscher Wetterdienst, Offenbach, 16. Januar 2012. -reference to Storm Hanna instead of Storm Hanno for Jan2007
Ge et al (2013)	Ge J, D Much, J Kappenberg, O Nino, P Ding, Z Chen, Simulating storm flooding maps over Hafencity under present and sea level rise scenarios, Journal of Flood Risk Management, 7, 319-331, 2014. -Hamburg storm surge event of 11Jan2007 erroneously ascribed to Kyrill instead of Franz
Wikipedia (20220322)	Wikipedia, Cyclone Kyrill, https://en.wikipedia.org/wiki/Cyclone_Kyrill, accessed 22Mar2022 -water peaked early 19Jan almost 4.5m above astronomical prediction level [INCORRECT; does not agree with RWS storm report; height may be number from Storm Britta 2006] -2 fishing vessels lost at sea; 3rd vessel doing rescue sank but crew saved [INCORRECT: these events occurred during Storm Franz the previous week]

Table SL89. Abbreviations used in manuscript (alphabetical)

Abbreviation	Full name
BAFG	Bundesanstalt für Gewässerkunde
BODC	British Oceanographic Data Centre
BSH	Bundesamt für Seeschifffahrt und Hydrographie
DW	Deutsche Welle
DWD	Deutscher Wetterdienst

ESWD	European Severe Weather Database
FINO1	Forschungsplattform in Nord- und Ostsee Nr. 1
IEA	International Energy Agency
KNMI	Koninklijk Nederlands Meteorologisch Instituut
KNRM	Koninklijke Nederlandse Redding Maatschappij
MAIB	Marine Accident Investigation Branch
MISELA	Minute Sea-Level Analysis
NLWKN	Niedersächsischer Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz
NTSLF	National Tidal and Sea Level Facility
ODN	Ordnance Datum Newlyn
PRIMAVERA	Process-based climate simulation: advances in high-resolution modelling and European climate risk assessments
QuikSCAT	Quick Scatterometer
RWS	Rijkswaterstaat
SMHI	Sveriges meteorologiska och hydroliska institut
UK	United Kingdom
USAF	United States Air Force
UTC	Coordinated universal time
XWS	Extreme Wind Storms

Table SL90. People contacted for information about storm (alphabetical)

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