National Oceanography Centre

INTERNAL REPORT

The UK Storm Surges of 2024

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Abstract

This report contains summary plots for the 2024 storm surges from the NTSLF surgeQC data and NEMO surge model. Observational data is from the UK "Class A" Tide Gauge network, operated by the Environment Agency. The data is at 15 min intervals.

It also includes highest total water levels of 2024 at each site in the context of the 2018 Coastal Flood Boundary report.

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Data and Processing

Tide gauge sites

There are 43 named sites (the list includes Jersey, and Islay which is retained for backwards compatibility.) In the timeseries plots they are offset by 1 metre (10 metres for the total water lever plot) and ordered anti-clockwise around the UK starting from Sheerness using the single-nearest-coastline method to include other islands.

Data and Quality Control

UK tide gauge data is quality controlled on a monthly basis at BODC, to GLOSS standards, intended for climate research. A great many gauges do not currently meet these criteria, either because there is no levelling of the gauge to fixed benchmarks or because of unexplained discrepancies between multiple data channels at the gauges. Of the 43 sites, only about 14 are substantially complete for 2024. I have included one plot of this data, for comparison of completeness.

Therefore as part of the monthly data summary, used by the Met Office to assess performance of the model, the tide gauge data undergoes a second quality control step at NOC, which we refer to as the surgeQC. Each month the most complete channel is used at each site, and this may change from the previous month, leading to datum jumps. Data should not drift or jump within the month by more than about 10 cm, but tidal-cycle oscillations between the full-tide and mid-tide sensors are accepted. Radar channels are used where they are substantially more complete than pressure channels. The data to this standard is much more complete, and most surge events are captured at most sites, allowing comparison of spatial patterns of the surge, although the absolute levels may not be correct. It is plots of this data that forms the bulk of this report. The data is not currently publicly distributed, but is archived internally at NOC Liverpool. Completion to this standard is much better. Barmouth was repaired in August. Avonmouth, Immingham are poor. Islay has no data and only remains in the list for consistency with older records.

Note that for statistics of extremes, which may be sensitive to distribution tails, it is recommended to use the climate quality data. No extreme statistics are reported here.

Model

The model data here is the deterministic operational UK surge-and-tide NEMO model, as run every 6 hours at the Met Office and provided to NOC. Each model run starts from 6 hours in the past, for a total of 2.5 days. The first 6 hours forward of every run are used here, to provide a single timeseries at every gauge and at every grid point. Model surge residuals are the difference between the tide-and-surge model run and a tide-only run.

Tidal analysis

Observation-derived tide predictions are taken from the Marine Information Products and Services (MIPS) team at NOC Liverpool, and are based on POLTIPS predictions. These are harmonic tides predictions including up to 115 constituents, and nodal corrections.

Choice of storms

The storms are the named ones as listed on the Met office (as part of the European weather centre Western group, UK, Ireland and the Netherlands), and also events not covered by the named storms with a skew surge of more than 0.5m at no fewer than 8 sites. Where these events were named by other European weather centres the names are given here.

Spring-Neap tides

At most sites in the UK by far the dominant effect on total water level is the tide. During spring tides, the range between high and low water can be metres more than during neap tides, so flooding is far more likely to occur on spring tides. In the following figures the spring-neap cycle is indicated by yellow-pink bars, with a colour scale corresponding to the daily range of the predicted tide at Sheerness. Phases of the moon are indicated on the bars as space allows.

Acknowledgements

Many people contribute directly or indirectly to the routine analysis of the tide gauge data and surge forecasting. In particular, thanks are due to:

Elizabeth Bradshaw, Polly Hadziabdic, Clare Bellingham at BODC, for regular data processing and quality control at BODC;

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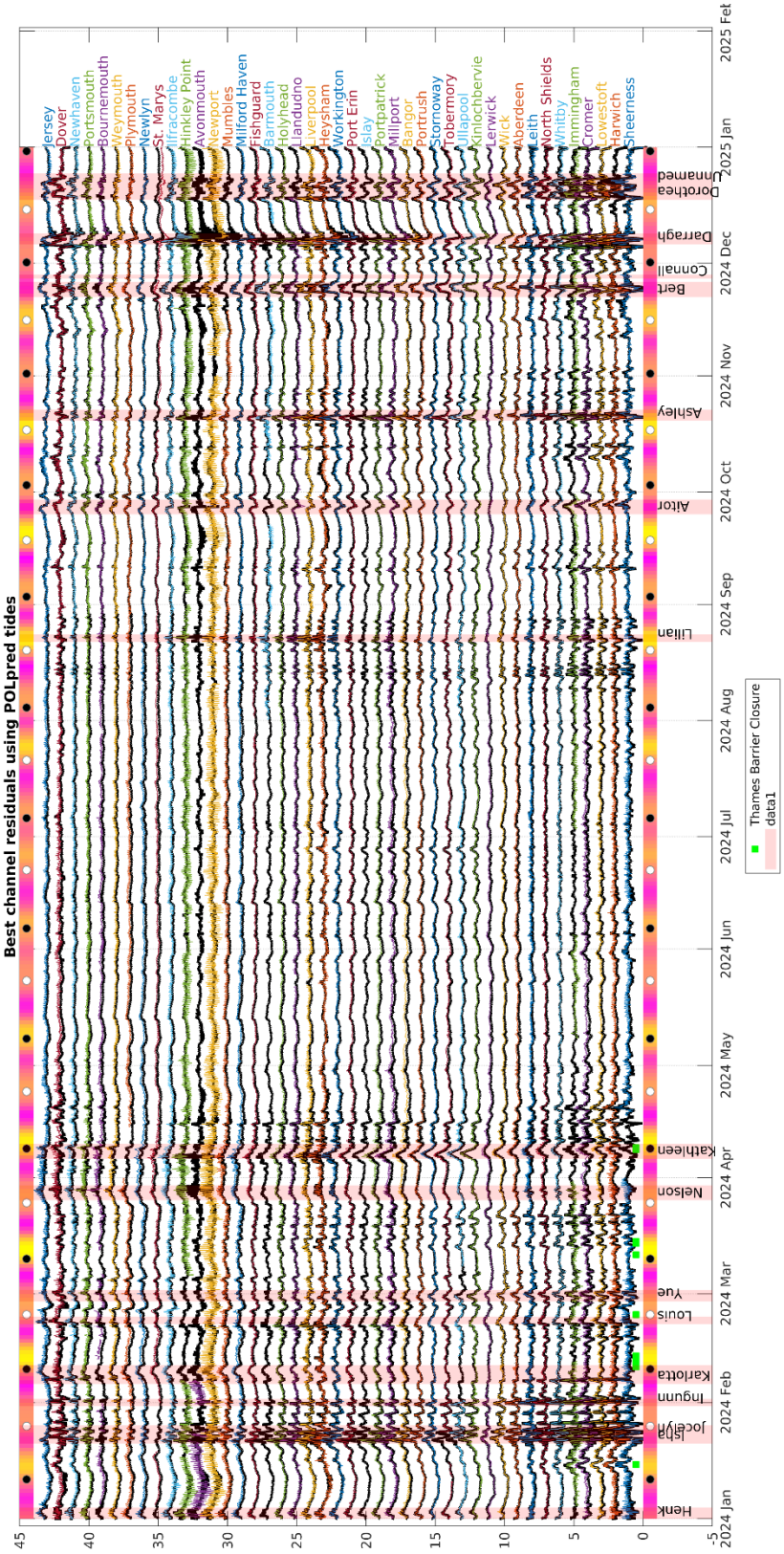
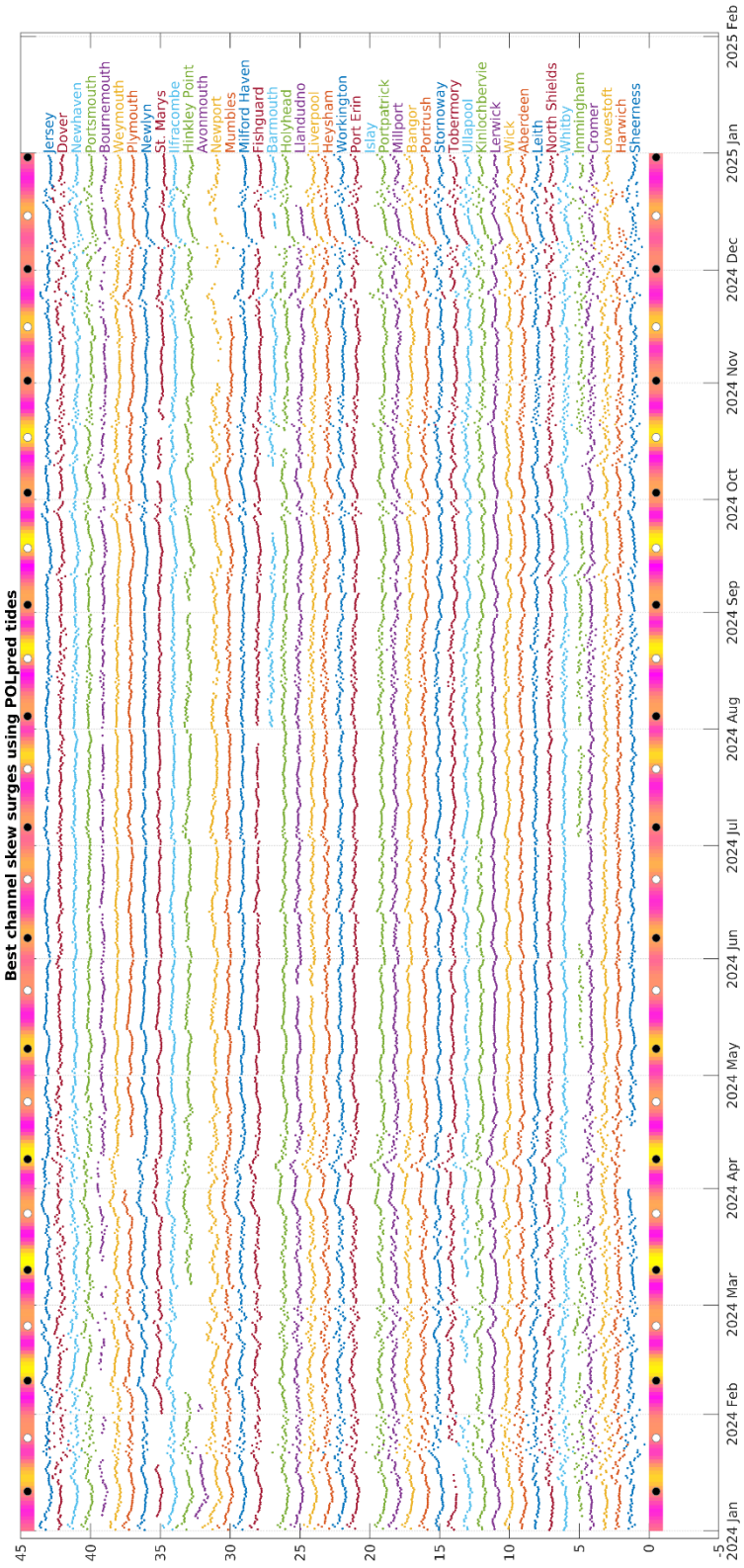
Jenny Sansom, Philip Staley, Roger Quinn and others at the Environment Agency for funding and support of this and related work, and many helpful discussions.

Annual summary plots.

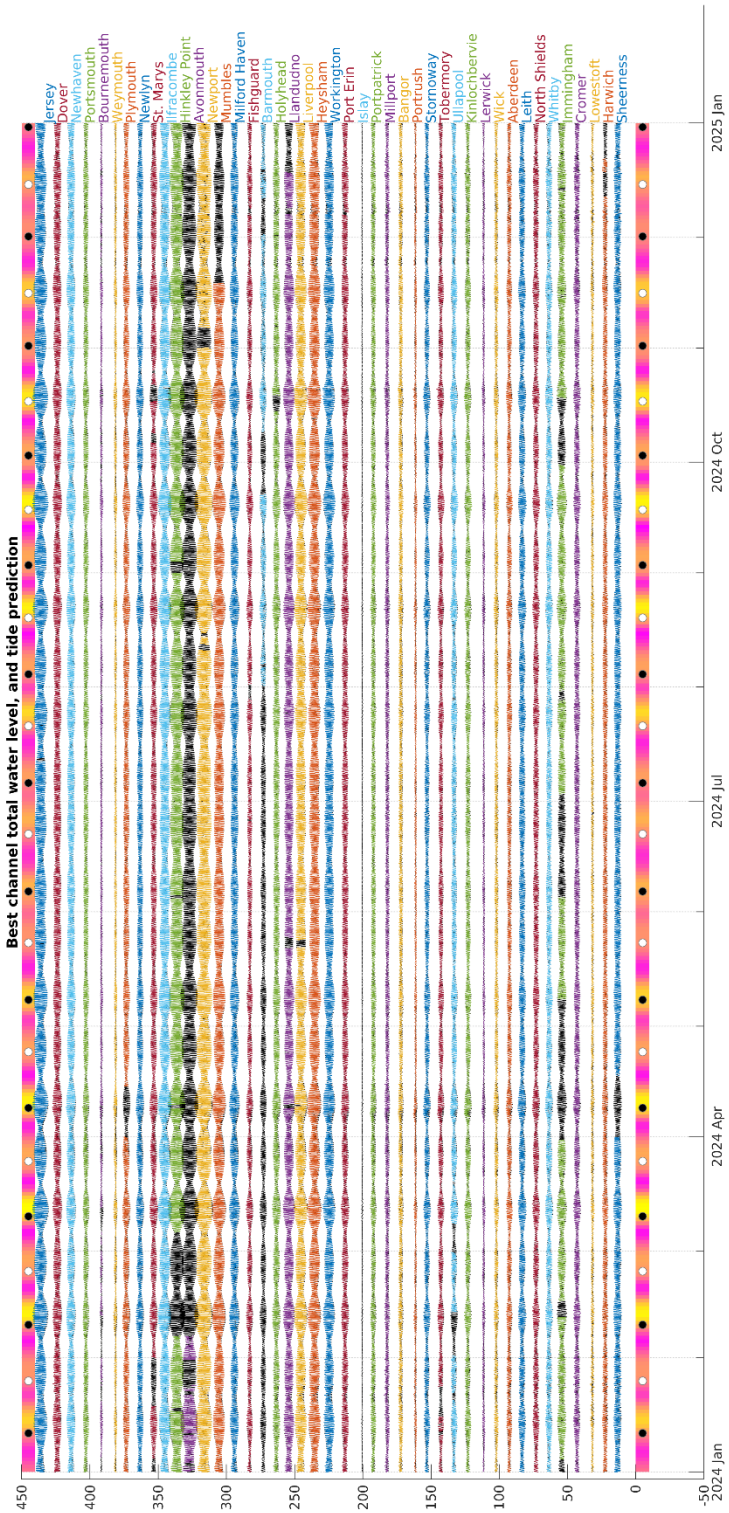
Data from 2024: Surge residual, observations and model



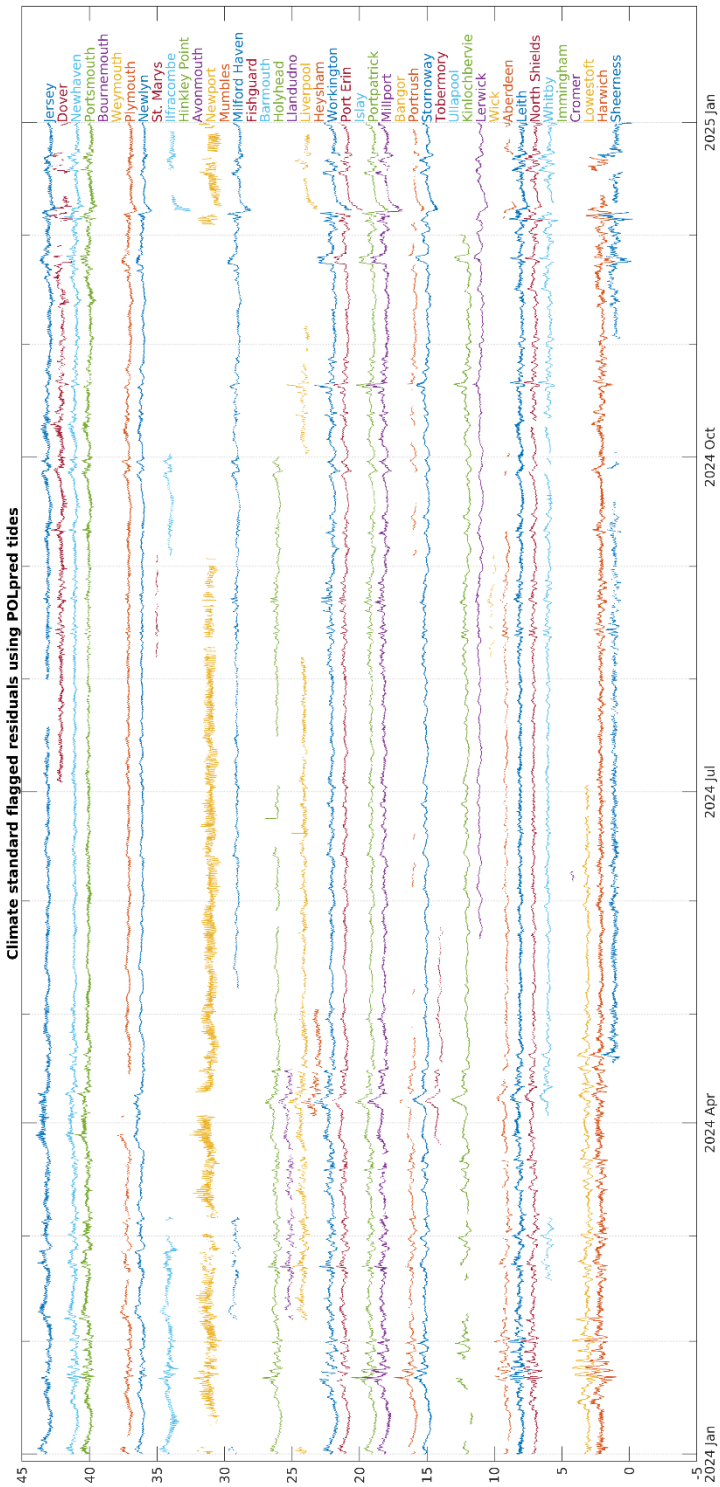
Data from 2024: Skew Surge observations.



Data from 2024: Total water levels



Data from 2024: Data meeting GLOSS climate-quality QC standards



Highlighted events

Named Storms

These events are the storms with names adopted by the Met Office, and also events not covered by the named storms with a skew surge of more than 0.5m at at least 8 sites. Where these events were named by neighbouring countries the names are given here.

Storm Name	Dates	Storm surge
Henk	2024-01-01 to 2024-01-03	Skew surge up to 1m (Newport) and 0.6-0.7m widespread on the south and west coast as far as Millport. Occurred on neap tides.
Unnamed, Jan15	2024-01-15 to 2024-01-16	Unnamed event that happened to fall on a (small) spring tide. Thames Barrier closed, highest total recorded at Sheerness (although Sheerness flagged during Kathleen). Skew surge 0.7-0.8m south east and East Anglia.
Isha	2024-01-21 to 2024-01-23	**Storm surges 1.3m in the north Irish sea, at Heysham, Workington, Portpatrick and Millport.** Neap tide
Jocelyn	2024-01-23 to 2024-01-25	Second in series of storms, following immediately from Isha. Skew surge up to 1m (Millport). Notable negative surges on east coast, down to -0.7m
Ingunn* (Norway)	2024-01-31 to 2024-02-02	Localised surge in southern North Sea, 1.2m at Sheerness, and widespread negative surges. Moderate tides.
Karlotta* (Spain)	2024-02-06 to 2024-02-10	Surge is mostly further south, but observed up to 0.8m on south coast.
Louis* (France)	2024-02-21 to 2024-02-23	Widespread skew surge up to 0.7m, lasting 2-3 days
Yue* (Free U. Berlin)	2024-02-28 to 2024-03-02	Event mostly further south, but skew surges up to 0.5m on east coast.
Nelson* (Spain)	2024-03-27 to 2024-03-30	Long period (6days) of skew surge, up to 0.7m, on south and west coasts up to Millport. Moderate tides
Kathleen (immediately followed by Pierrick)	2024-04-05 to 2024-04-10	**On high tides, 2 days before spring tides, leading to the highest totals of the year for: Weymouth, Portsmouth, Newhaven, Dover, Harwich, Cromer, Whitby, North Shields, Leith, Aberdeen and Wick. No data at Sheerness or Immingham during this event. Could have been another 15cm at Cromer if 1 day later. Highest skew surge 1.1m in Tobermory.** Coastal flooding and waves in Fife, parked car washed away in Lower Largo.
Lilian	2024-08-22 to 2024-08-23	Small skew surge, only ~30cm, but fell on a spring tide, close to equinox. **Highest total of the year at Workington.**
Aitor* (Spain)	2024-09-25 to 2024-09-28	Small skew surge, up to 0.6m in south east and south. Small tides.
Ashley	2024-10-20 to 2024-10-22	Fortunately 2 days after the spring tide, otherwise totals during the storm would have been 50cm more at Stornoway, which already had the highest spring tide of the year. **Highest totals of the year at Kinlochbervie, Tobermory, Portrush, Heysham, Bangor, Millport, Portpatrick and Lerwick. Highest skew surge 1.3m at Tobermory**

		Also highest totals of the year at Barmouth (5 months only). Notable negative surge in Wash and south east.
Bert	2024-11-23 to 2024-11-25	Large skew surges (1.0m) for 2 days on west coast, from Cornwall to northwest Scotland. Negative surges (-0.9m) in Sheerness to Immingham. Neap tides.
Conall	2024-11-26 to 2024-11-27	Storm named for the rainfall event, no significant storm surge.
Darragh	2024-12-04 to 2024-12-09	**Positive surge (up to 0.9m) followed rapidly by unusually low negative surge (-1.0m).**
Dorothea* (Spain)	2024-12-17 to 2024-12-20	**Highest totals of the year at Lowestoft** (small tides, so misses the highest associated with Kathleen). Widespread skew surge across North Sea, especially to south. Up to 0.9m.
Unnamed, Dec22	2024-12-21 to 2024-12-24	Similar pattern to Dorothea with widespread surge across the0 North Sea, up to 1.0m at Cromer and Lowestoft. Negative surge on west coast, -0.5m.

Other high levels

Vernal spring tide	2024-02-12	Thames Barrier closed 4 times in 4 consecutive days. **Highest totals recorded at St Mary's, Newlyn, Plymouth.**
Vernal spring tide	2024-03-12	Thames Barrier closed 3 times in 3 consecutive days, 11, 12, 13 March. **Highest totals for the year recorded at Port Erin, Liverpool, Llandudno, Holyhead, Fishguard, Milford Haven, Mumbles, Newport, Hinkley Point, Ilfracombe, and Jersey**.
Autumn spring tide	2024-10-18 to 2024-10-19	October spring tide. **Highest totals of the year at Ullapool, Stornoway.** Also highest of the year at Immingham and Bournemouth (which happened to be missing data during other high events.)

Maximums at Avonmouth and Barmouth were not recorded this year. Avonmouth has frequent gauge problems, is reliant on a radar gauge and does not always record the top of the tidal cycle. Barmouth only has data from August onwards due to bridge repair work.

Thames Barrier Closures

The Thames Barrier had Flood Defence closures on the following dates:

FD Closure Number	Date of Closure	Event
211	15-Jan-24	Unnamed storm
212	10-Feb-24	Spring tides
213	11-Feb-24	Spring tides
214	12-Feb-24	Spring tides
215	13-Feb-24	Spring tides
216	24-Feb-24	Storm Louis
217	11-Mar-24	Spring tides
218	14-Mar-24	Spring tides
219	14-Mar-24	Spring tides
220	08-Apr-24	Spring tides, Kathleen
221	08-Apr-24	Spring tides, Kathleen

Most closures are associated with fluvial flooding in combination with extreme sea levels. When the river is high, the barrier is closed around high tide to prevent the sea pushing the river back upstream, so allowing the river to drain more quickly over the course of the tidal cycle.

There were no closures in the autumn of 2024.

Total water levels

Highest totals at each site

These are the highest levels at each site with climate standard data (i.e. Quality Controlled to GLOSS standards). Heights are given in Ordnance Datum Newlyn, or local datums for island sites. This allows comparison with return periods as used in the Coastal Flood Boundary Conditions 2018 report,[1] and is meaningful to local land management. Return periods are reproduced below in Table 3 for convenience.

To summarize, highest confirmed levels were seen during the following storms. Kathleen/Pierrick brought levels with around 5-10 year return period in Whitby, North Shields & Leith; and 25-75 year return period in Portsmouth and Newhaven. Storm Ashley brought the highest totals in northwest Scotland, with return periods from 2 to 20 years. Storm Lilian, unusually in falling in August was the highest total in Workington, but only a 2 year return period. Storm Karlotta brought the highest totals in Newlyn and Plymouth, at 2-10 year return period.

At several sites the highest totals fell on the vernal spring tide, with 2-10 year return period, and a 25-50 year return period at Newport, although confidence in return period fit is low at Newport (CFBC2018).

Most sites in 2024 saw events of at heights previously estimated to have return periods of around 5 years. The year 2024 was a maximum for predicted tides at some sites, those locations with large tidal range could expect around 10cm more from astronomical factors in another year (Table 4).

[1] See https://assets.publishing.service.gov.uk/media/5d667084e5274a170c435326/Coastal_flood_boundary_conditions_for_the_UK_2018_update_-_technical_report.pdf , Table 4.2.

Table 1: Highest totals in 2024, where data available to climate standard. Return periods are based on median levels.

Tide gauge (Climate standard data)	Height, metres ODN	Date	RP in CFBC 2018	Storm or other event	
Whitby	**3.59**	**2024-Apr-08 15:30**	**5-10**	Kathleen/Pierrick	
North Shields	**3.43**	**2024-Apr-08 14:45**	**5-10**	Kathleen/Pierrick	
Leith	**3.63**	**2024-Apr-08 14:00**	**10**	Kathleen/Pierrick	
Lerwick*	**1.62**	**2024-Oct-21 01:30**	**5-10**	Ashley	
Kinlochbervie	**3.48**	**2024-Oct-20 21:30**	**5-10**	Ashley	
Stornoway*	**3.20**	**2024-Oct-18 19:15**	**10-20**	Ashley	
Millport	**2.89**	**2024-Oct-21 02:15**	**2-5**	Ashley	
Portpatrick	**3.05**	**2024-Oct-21 01:30**	**2-5**	Ashley	
Port Erin*	**3.43**	**2024-Mar-13 13:15**	**2-5**	Vernal Spring tide	
Workington	**5.21**	**2024-Aug-22 00:45**	**2**	Lilian	
Holyhead	3.51	2024-Mar-13 12:15	2-5	Vernal Spring tide	Incomplete
Newport	8.05	2024-Mar-12 08:30	25-50	Vernal Spring tide	Incomplete
Newlyn	**3.28**	**2024-Feb-12 06:15**	**5-10**	Karlotta	
Plymouth	**3.05**	**2024-Feb-12 07:30**	**2-5**	Karlotta	
Portsmouth	**3.01**	**2024-Apr-08 23:30**	**50-75**	Kathleen/Pierrick	
Newhaven	**4.24**	**2024-Apr-08 23:15**	**25-50**	Kathleen/Pierrick	
Jersey	**6.42**	**2024-Mar-12 07:45**	**5-10**	Vernal Spring tide	

Table 2: Highest totals in 2024, all sites including those where the highest total was flagged as not meeting GLOSS QC standards

Tide gauge	Height, metres ODN	Date	RP in CFBC 2018	Flagged, possible datum shift or gauge drift
Sheerness	3.61	2024-Jan-15 15:30	<1	FLAGGED
Harwich	2.80	2024-Apr-08 11:15	1-2	(Felixstowe in CFBC)
Lowestoft	1.97	2024-Dec-19 23:45	<1	FLAGGED & incomplete
Cromer	3.29	2024-Apr-08 18:00	2-5	FLAGGED
Immingham	3.96	2024-Oct-19 06:30	<1	FLAGGED
Whitby	**3.59**	**2024-Apr-08 15:30**	**5-10**	
North Shields	**3.43**	**2024-Apr-08 14:45**	**5-10**	
Leith	**3.63**	**2024-Apr-08 14:00**	**10**	
Aberdeen	2.92	2024-Apr-08 12:45	5-10	FLAGGED
Wick	2.65	2024-Apr-08 10:45	10-20	FLAGGED
Lerwick	**1.62**	**2024-Oct-21 01:30**	**5-10**	
Kinlochbervie	**3.48**	**2024-Oct-20 21:30**	**5-10**	
Ullapool	3.49	2024-Oct-18 19:15	5-10	FLAGGED
Tobermory	3.6	2024-Oct-20 19:30	50-75	FLAGGED
Stornoway	**3.2**	**2024-Oct-18 19:15**	**10-20**	
Portrush	2.09	2024-Oct-20 20:00	25-50	FLAGGED
Bangor	2.44	2024-Oct-21 01:00	5-10	FLAGGED

Millport	**2.89**	**2024-Oct-21 02:15**	**2-5**	
Portpatrick	**3.05**	**2024-Oct-21 01:30**	**2-5**	
Islay	NaN	No data		
Port Erin	**3.43**	**2024-Mar-13 13:15**	**2-5**	
Workington	**5.21**	**2024-Aug-22 00:45**	**2**	
Heysham	6.26	2024-Oct-21 00:45	5-10	FLAGGED
Liverpool	5.7	2024-Mar-12 12:15	2-5	FLAGGED
Llandudno	4.87	2024-Mar-12 12:00	2-5	Data very incomplete
Holyhead	**3.51**	**2024-Mar-13 12:15**	**2-5**	**Several months missing**
Barmouth	3.6	2024-Oct-20 22:00	2-5	FLAGGED
Fishguard	3.24	2024-Mar-12 08:30	2-5	FLAGGED
Milford Haven	4.46	2024-Mar-12 07:30	5-10	FLAGGED
Mumbles	5.74	2024-Mar-12 07:30	2-5	FLAGGED
Newport	**8.05**	**2024-Mar-12 08:30**	**25-50**	**Several months missing**
Avonmouth	6.72	2024-Jan-14 09:15	25-50	FLAGGED
Hinkley Point	7.25	2024-Mar-12 08:15	5	FLAGGED
Ilfracombe	5.68	2024-Mar-12 07:15	10	FLAGGED
St. Marys	3.49	2024-Feb-12 06:15	2-5	FLAGGED
Newlyn	**3.28**	**2024-Feb-12 06:15**	**5-10**	
Plymouth	**3.05**	**2024-Feb-12 07:30**	**2-5**	
Weymouth	1.94	2024-Apr-08 18:45	2-5	FLAGGED
Bournemouth	1.7	2024-Oct-19 01:45	20-25	FLAGGED
Portsmouth	**3.01**	**2024-Apr-08 23:30**	**50-75**	
Newhaven	**4.24**	**2024-Apr-08 23:15**	**25-50**	
Dover	4.07	2024-Apr-08 22:45	5-10	FLAGGED
Jersey	**6.42**	**2024-Mar-12 07:45**	**5-10**	**(Local Datum)**

Coastal Flood Boundary Conditions 2018

These are the median heights (in ODN) for each return period in the Coastal Flood Boundary Conditions 2018. Sites marked * are relative to a local datum that may differ from ODN.

Reproduced from the Coastal Flood Boundary Report for convenience.

Table 3: Median heights for return periods

Return period (years)	1	2	5	10	20	25	50	75	100	150	200	250	300	500	1000	10000
St Helier*	6.21	6.29	6.38	6.45	6.52	6.54	6.61	6.65	6.68	6.72	6.75	6.78	6.8	6.85	6.93	7.2
Newlyn	3.11	3.18	3.26	3.33	3.39	3.41	3.47	3.5	3.52	3.56	3.58	3.6	3.61	3.65	3.7	3.88
St Mary's*	3.41	3.48	3.56	3.61	3.67	3.69	3.74	3.77	3.79	3.82	3.84	3.86	3.87	3.9	3.96	4.11
Padstow	4.56	4.63	4.73	4.79	4.85	4.87	4.93	4.96	4.99	5.02	5.05	5.07	5.08	5.13	5.19	5.42
Ilfracombe	5.43	5.51	5.61	5.68	5.75	5.77	5.85	5.89	5.92	5.96	5.99	6.01	6.03	6.09	6.17	6.45
Hinkley Point	7.05	7.14	7.25	7.34	7.44	7.47	7.57	7.63	7.67	7.73	7.78	7.82	7.85	7.93	8.06	8.54
Avonmouth	8.11	8.22	8.37	8.49	8.61	8.65	8.79	8.86	8.92	9.01	9.07	9.12	9.16	9.27	9.43	10.05
Newport	7.45	7.56	7.7	7.81	7.92	7.96	8.07	8.14	8.2	8.27	8.33	8.37	8.41	8.52	8.67	9.25
Mumbles	5.51	5.62	5.77	5.88	5.98	6.02	6.13	6.19	6.23	6.3	6.34	6.38	6.4	6.48	6.59	6.99
Milford Haven	4.2	4.29	4.4	4.49	4.57	4.6	4.68	4.73	4.76	4.81	4.84	4.87	4.89	4.95	5.04	5.33
Fishguard	3.1	3.17	3.26	3.33	3.4	3.42	3.49	3.52	3.55	3.59	3.62	3.64	3.65	3.7	3.77	3.99
Barmouth	3.46	3.59	3.75	3.87	3.99	4.03	4.14	4.21	4.26	4.33	4.38	4.42	4.45	4.54	4.67	5.09
Holyhead	3.37	3.44	3.55	3.62	3.7	3.72	3.79	3.84	3.87	3.91	3.94	3.96	3.98	4.03	4.1	4.35
Llandudno	4.7	4.78	4.9	4.98	5.06	5.09	5.17	5.22	5.25	5.3	5.33	5.36	5.38	5.44	5.53	5.81
Hilbre	5.24	5.34	5.47	5.57	5.66	5.69	5.78	5.84	5.87	5.92	5.96	5.99	6.01	6.08	6.17	6.5
Liverpool	5.44	5.56	5.73	5.86	5.98	6.03	6.16	6.24	6.29	6.37	6.42	6.46	6.5	6.6	6.73	7.19
Port Erin*	3.27	3.36	3.48	3.57	3.66	3.69	3.78	3.83	3.87	3.92	3.95	3.98	4	4.07	4.15	4.44
Heysham	5.86	5.99	6.16	6.29	6.42	6.46	6.59	6.67	6.72	6.8	6.86	6.9	6.93	7.03	7.17	7.63
Workington	5.09	5.21	5.35	5.47	5.58	5.61	5.73	5.79	5.84	5.91	5.95	5.99	6.02	6.11	6.22	6.62
Portpatrick	2.82	2.92	3.06	3.15	3.25	3.28	3.37	3.43	3.47	3.52	3.56	3.59	3.61	3.68	3.78	4.09
Millport	2.67	2.79	2.96	3.09	3.22	3.26	3.39	3.47	3.52	3.6	3.65	3.69	3.73	3.83	3.97	4.44
Port Ellen	1.45	1.56	1.7	1.81	1.91	1.94	2.04	2.1	2.14	2.2	2.24	2.27	2.3	2.37	2.47	2.81
Tobermory	2.98	3.09	3.23	3.34	3.45	3.48	3.59	3.65	3.69	3.76	3.8	3.84	3.87	3.95	4.06	4.43
Ullapool	3.22	3.32	3.44	3.53	3.62	3.65	3.74	3.78	3.82	3.87	3.9	3.92	3.94	4	4.08	4.34
Stornoway*	2.89	2.97	3.07	3.14	3.22	3.24	3.31	3.35	3.37	3.41	3.44	3.46	3.47	3.52	3.58	3.78
Kinlochbervie	3.17	3.28	3.42	3.52	3.62	3.65	3.74	3.8	3.84	3.9	3.94	3.97	3.99	4.06	4.16	4.46
Lerwick*	1.5	1.54	1.6	1.65	1.69	1.71	1.75	1.77	1.79	1.81	1.83	1.84	1.85	1.88	1.91	2.02
Wick	2.4	2.48	2.57	2.64	2.71	2.73	2.79	2.83	2.85	2.88	2.91	2.93	2.94	2.98	3.04	3.21
Moray Firth	2.85	2.92	3.01	3.08	3.14	3.16	3.22	3.26	3.29	3.32	3.35	3.37	3.39	3.43	3.5	3.71
Clachnaharry	3.15	3.23	3.34	3.43	3.52	3.55	3.64	3.69	3.73	3.79	3.83	3.86	3.88	3.95	4.05	4.38
Aberdeen	2.69	2.77	2.86	2.93	3	3.02	3.09	3.13	3.15	3.19	3.22	3.24	3.25	3.3	3.36	3.58
Grangemouth	3.92	4.01	4.13	4.22	4.32	4.35	4.45	4.51	4.56	4.62	4.66	4.7	4.73	4.81	4.93	5.37
Leith	3.37	3.45	3.56	3.63	3.71	3.73	3.81	3.85	3.88	3.93	3.96	3.98	4	4.06	4.14	4.41
North Shields	3.21	3.29	3.4	3.48	3.56	3.59	3.68	3.73	3.77	3.82	3.85	3.89	3.91	3.99	4.08	4.42
Whitby	3.36	3.45	3.57	3.67	3.77	3.8	3.9	3.96	4	4.07	4.11	4.15	4.18	4.26	4.37	4.81
Immingham	4.17	4.27	4.42	4.53	4.65	4.68	4.8	4.88	4.93	5	5.06	5.1	5.14	5.24	5.38	5.92
Cromer	3.07	3.19	3.35	3.48	3.61	3.65	3.79	3.88	3.93	4.02	4.08	4.13	4.17	4.29	4.45	5.03
Lowestoft	2.02	2.17	2.38	2.55	2.72	2.77	2.93	3.03	3.1	3.2	3.27	3.32	3.37	3.5	3.69	4.31

Felixstowe	2.68	2.81	2.97	3.11	3.24	3.29	3.43	3.52	3.58	3.68	3.74	3.79	3.82	3.95	4.12	4.77
Sheerness	3.7	3.81	3.96	4.08	4.21	4.25	4.37	4.45	4.51	4.59	4.65	4.7	4.74	4.85	5.01	5.59
Dover	3.8	3.91	4.06	4.17	4.29	4.33	4.44	4.51	4.56	4.63	4.68	4.72	4.75	4.84	4.97	5.39
Newhaven	3.87	3.94	4.04	4.12	4.2	4.22	4.3	4.35	4.38	4.43	4.46	4.49	4.51	4.57	4.66	4.96
Portsmouth	2.55	2.63	2.73	2.8	2.87	2.89	2.96	3	3.03	3.07	3.1	3.12	3.14	3.19	3.25	3.49
Bournemouth	1.4	1.47	1.56	1.63	1.69	1.71	1.78	1.81	1.84	1.88	1.9	1.93	1.94	1.99	2.06	2.28
Weymouth	1.82	1.89	1.99	2.05	2.12	2.15	2.22	2.26	2.28	2.32	2.35	2.37	2.39	2.44	2.51	2.76
Exmouth	2.76	2.84	2.95	3.03	3.1	3.13	3.2	3.24	3.27	3.31	3.34	3.36	3.37	3.42	3.48	3.66
Devonport	2.95	3.02	3.11	3.18	3.25	3.27	3.34	3.38	3.4	3.44	3.47	3.49	3.51	3.55	3.62	3.84
Belfast	2.16	2.26	2.39	2.49	2.6	2.64	2.74	2.8	2.85	2.91	2.96	2.99	3.02	3.11	3.23	3.69
Portrush	1.61	1.71	1.83	1.92	2	2.03	2.12	2.17	2.21	2.26	2.29	2.32	2.35	2.41	2.5	2.78

Highest predicted tide compared to 19yr period

Long term nodal (18.6 year) and perigean (4.5 year) cycles affect the maximum tide that occurs in any given year, with up to 75cm variation in the Severn. At most sites in 2024 the tide was predicted to reach within 5cm of the highest possible due to astronomical factors alone (various coincidences in the timing of cycles of the position of moon and sun). But at some sites tides more than 10cm higher could be reached in another year. This table puts 2024 in context of the surrounding 19yr period for the predicted tide for each site. No allowance for sea-level rise or local datum is included in this table.

Table 4: Estimated height (metres, relative to mean tidal level) for astronomical tide predictions in 2024 compared to maximums for each year in the surrounding 19yr period. This table was calculated by comparing maximums of a 19-yr prediction of astronomical tide to the same prediction during 2024 alone. Eg at Sheerness the predicted maxtide in 2026 is 2.96m, in 2015 it was 3.24m above the mean tide.

Site	Max annual Tide Predictions				Site	Max annual Tide Predictions			
	Smallest 2014-2033	2024	Largest 2014-2033	Shortfall, 2024 to max		Smallest 2014-2033	2024	Largest 2014-2033	Shortfall, 2024 to max
Sheerness	2.96	3.13	3.24	0.12	Heysham	4.92	5.42	5.53	0.11
Harwich	2.06	2.20	2.29	0.09	Liverpool	4.50	4.97	5.04	0.07
Lowestoft	1.13	1.27	1.27	0.00	Llandudno	3.98	4.42	4.48	0.05
Cromer	2.42	2.71	2.71	0.00	Holyhead	2.71	3.01	3.04	0.03
Immingham	3.39	3.75	3.76	0.01	Barmouth	2.64	2.95	2.98	0.04
Whitby	2.56	2.84	2.86	0.02	Fishguard	2.45	2.75	2.77	0.02
North Shields	2.46	2.75	2.76	0.01	Milford Haven	3.53	3.94	4.00	0.06
Leith	2.69	2.99	3.05	0.06	Mumbles	4.72	5.17	5.25	0.08
Aberdeen	2.02	2.27	2.29	0.02	Newport	6.48	7.04	7.22	0.17
Wick	1.70	1.89	1.91	0.02	Portbury	6.86	7.45	7.60	0.14
Lerwick	1.08	1.18	1.19	0.02	Avonmouth	6.86	7.45	7.63	0.18
Kinlochbervie	2.34	2.63	2.63	0.00	Hinkley Point	6.09	6.64	6.75	0.11
Ullapool	2.42	2.77	2.77	0.00	Ilfracombe	4.68	5.16	5.25	0.09
Islay	0.51	0.62	0.62	0.00	St. Marys	2.75	3.06	3.10	0.05

Tobermory	2.15	2.52	2.52	0.00
Stornoway	2.30	2.65	2.65	0.00
Portrush	1.13	1.36	1.36	0.00
Bangor	1.72	1.72	1.82	0.10
Millport	1.69	1.73	1.83	0.10
Portpatrick	2.02	2.08	2.13	0.05
Port Erin	2.73	2.94	2.98	0.04
Workington	4.19	4.62	4.71	0.09

Newlyn	2.60	2.89	2.92	0.03
Plymouth	2.39	2.63	2.64	0.01
Weymouth	1.34	1.53	1.53	0.00
Bournemouth	0.87	1.05	1.05	0.00
Portsmouth	2.03	2.17	2.23	0.06
Newhaven	3.30	3.55	3.63	0.09
Dover	3.19	3.41	3.47	0.06
Jersey	5.52	6.08	6.14	0.06

A selection of events, for the State of the UK Climate report

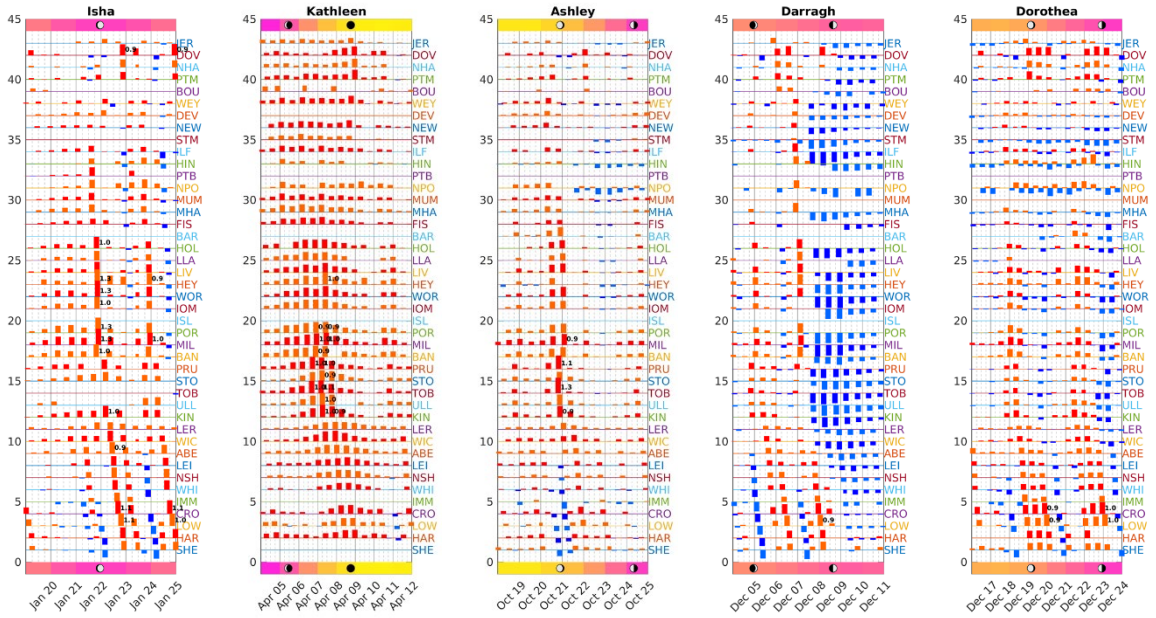


Figure1 Observed skew surges (m) at tide gauges during selected Isha, Kathleen, Ashley, Darragh, and Dorothea. Spring (yellow) and neap (pink) tides are also indicated.

The final selection of highlights for the State of the UK Climate report may change as that is still in preparation.

As ever timing of surge events is critical. Storm Isha had the highest skew surges (1.3m) but Kathleen/Pierrick and Ashley occurred close to spring tides so brought the highest totals in many places. In the context of the levels in the Coastal Flood Boundary Report 2018, the highest total was from Storm Pierrick with a median return period of 25-50 years at Newhaven and 50-75 years at Portsmouth. Monthly-mean sea-level at Portsmouth was unusually high in April, around 22cm higher than the average for that month in (1961-2023). Without this contribution, the total water level from storm Pierrick would have been only around a 5yr return period event.

Storm Darragh was notable for an unusual surge profile, with a brief positive surge followed by a prolonged negative. Fortunately Darragh came during neap tides.

Equinoctial spring tides in February, March and October also brought high levels, regardless of storms. In 2024 the Thames Barrier had 11 operational flood defence closures, 7 of which were on spring high tides and unrelated to named storm events.

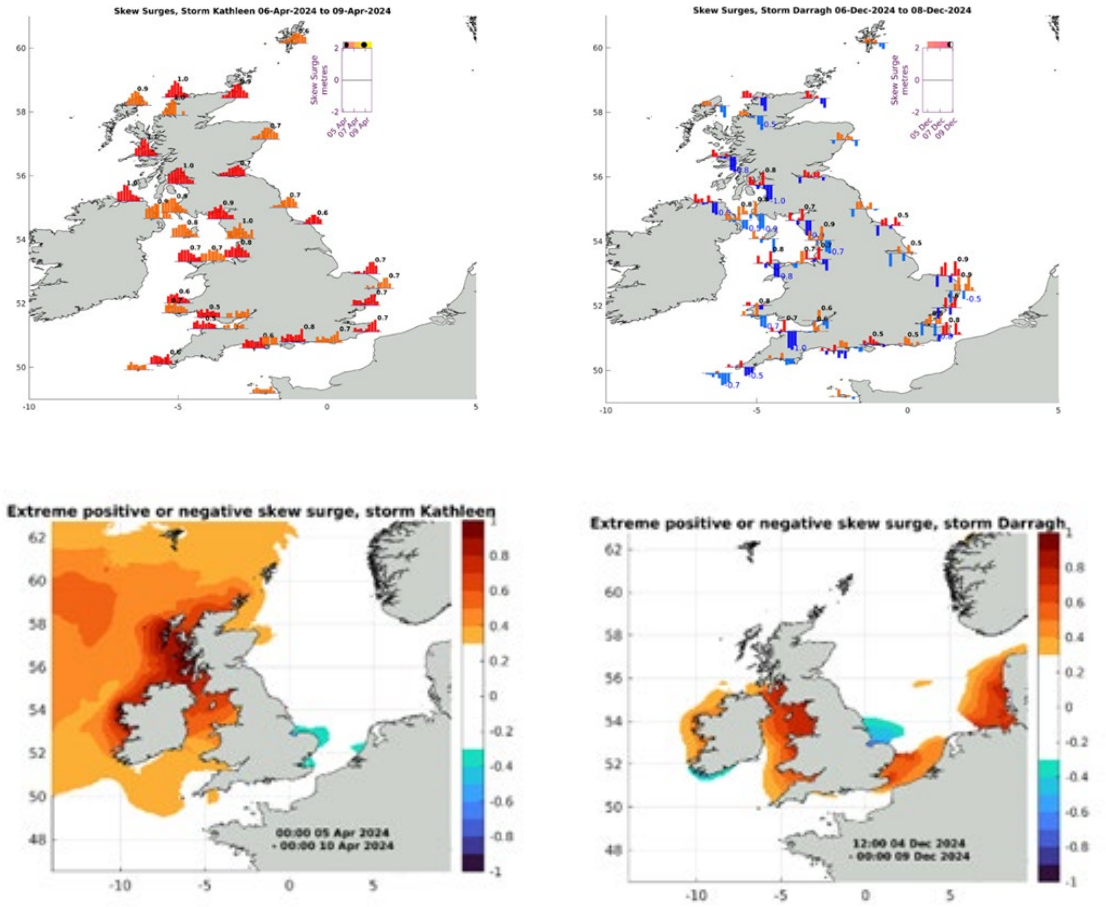
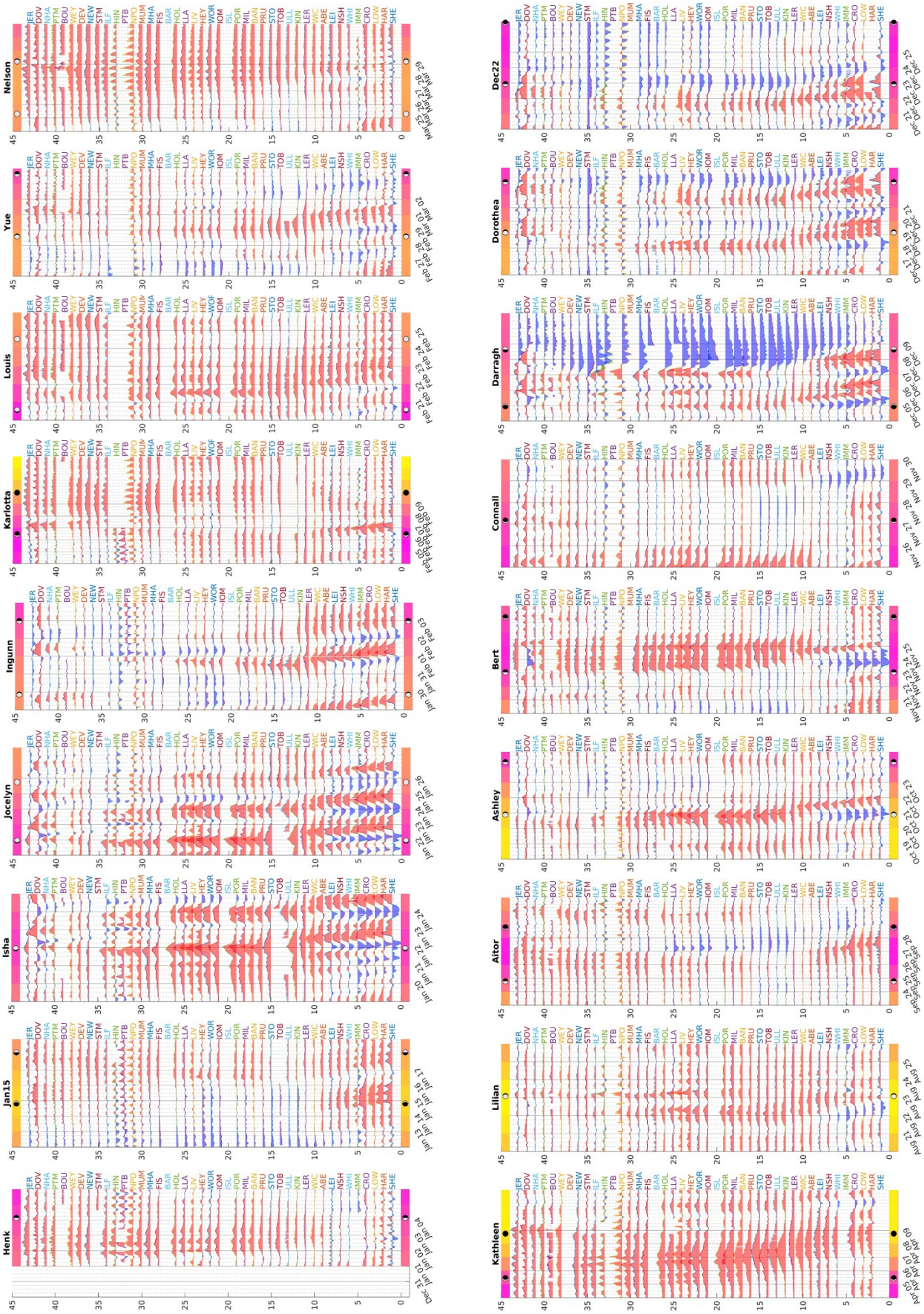
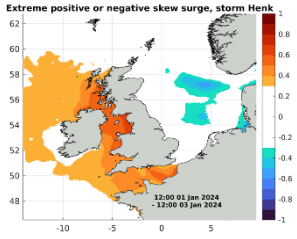


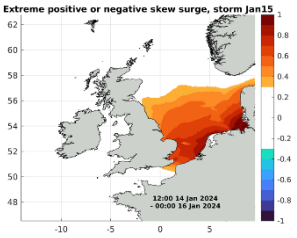
Figure 1: Observations (top) and storm surge model (bottom) of storms, Kathleen and Darragh. Kathleen caused high skew surges everywhere, but especially on the west coast of Scotland, Northern Ireland and Irish Sea. It also fell only a day or two before the April spring tide, leading to highest total water levels in many places. Darragh was notable for the extreme positive and negative surges in quick succession. The model here is the NEMO surge and tide operational model, and show patterns of extreme skew surges in open water that correspond well with observed extremes. Model maps show the most extreme positive skew or negative skew during each event (if there are both then positive only is plotted).

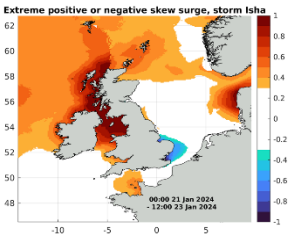
All storms, surge residuals.

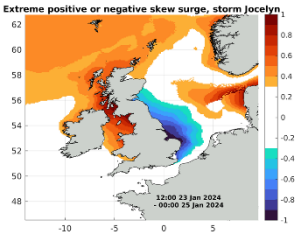


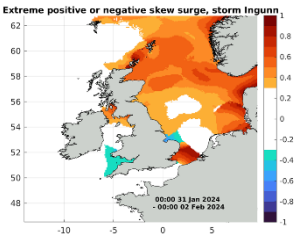
All storms: model skew surge

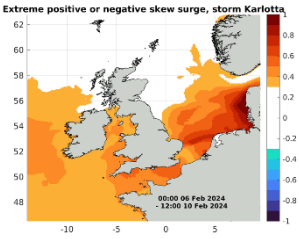


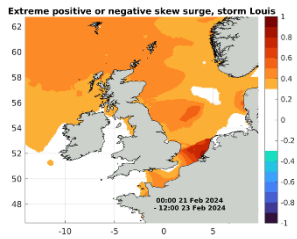


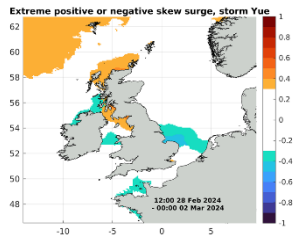


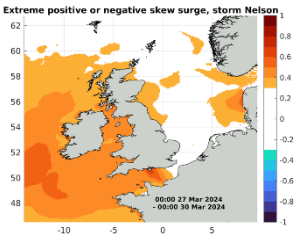


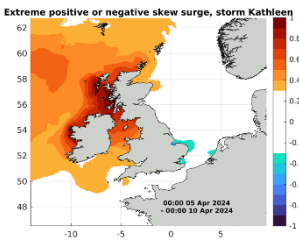


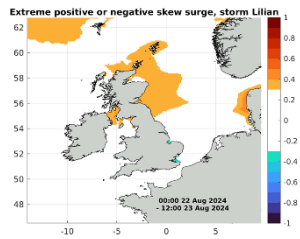


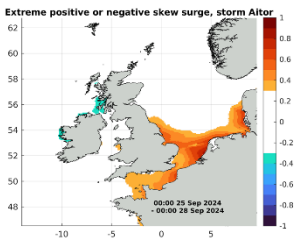


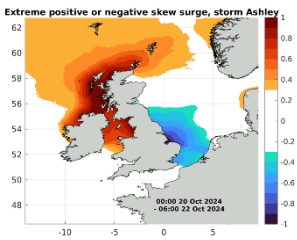


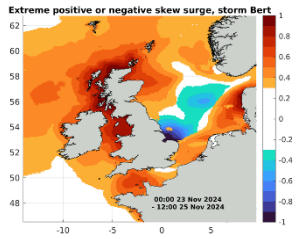


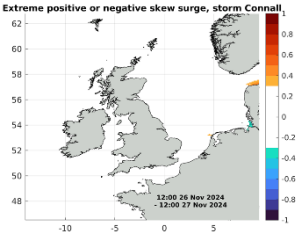


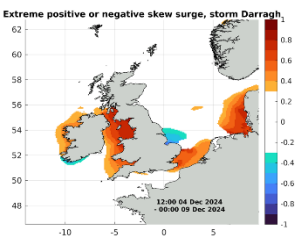


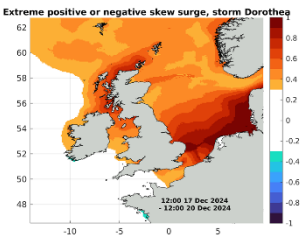


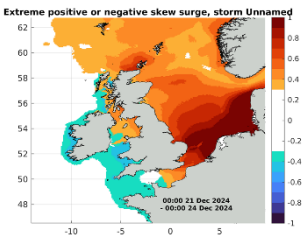






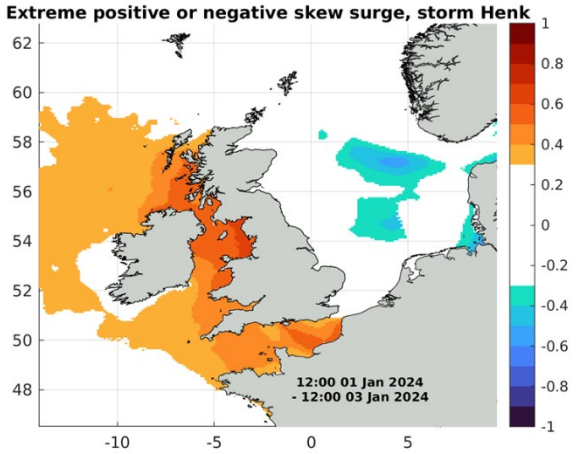


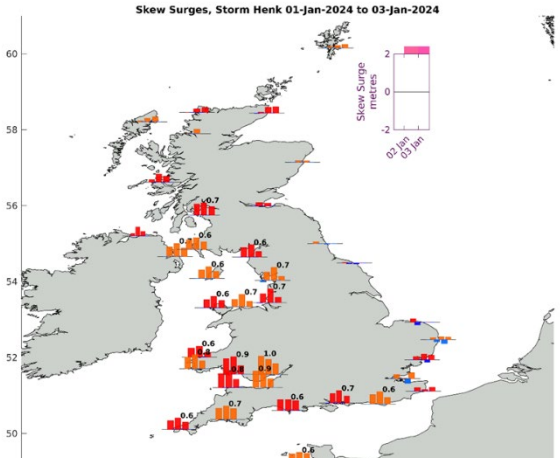


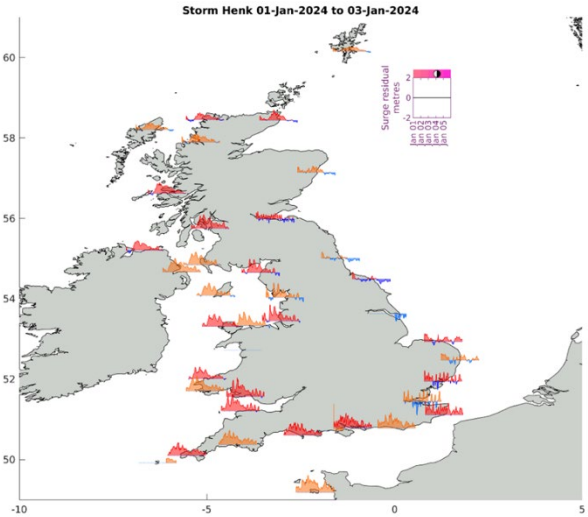


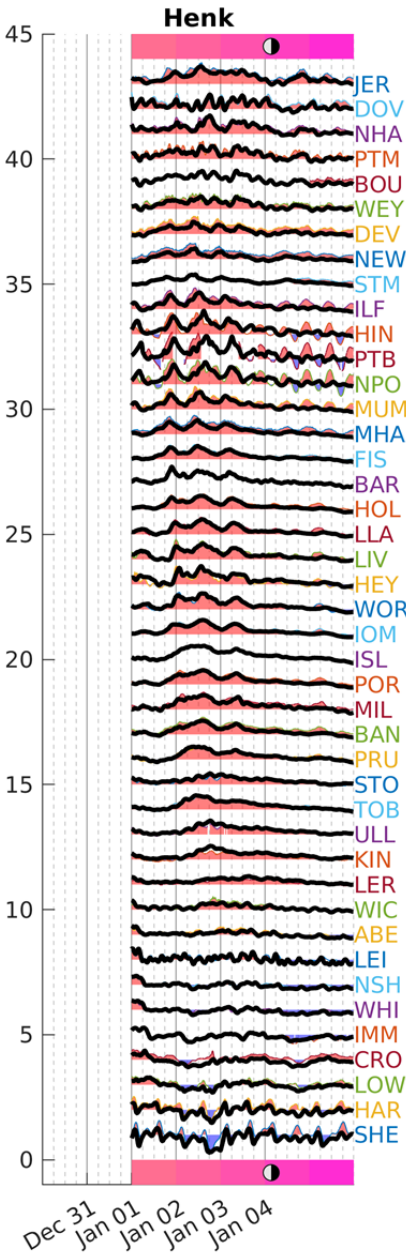
Individual Storms.

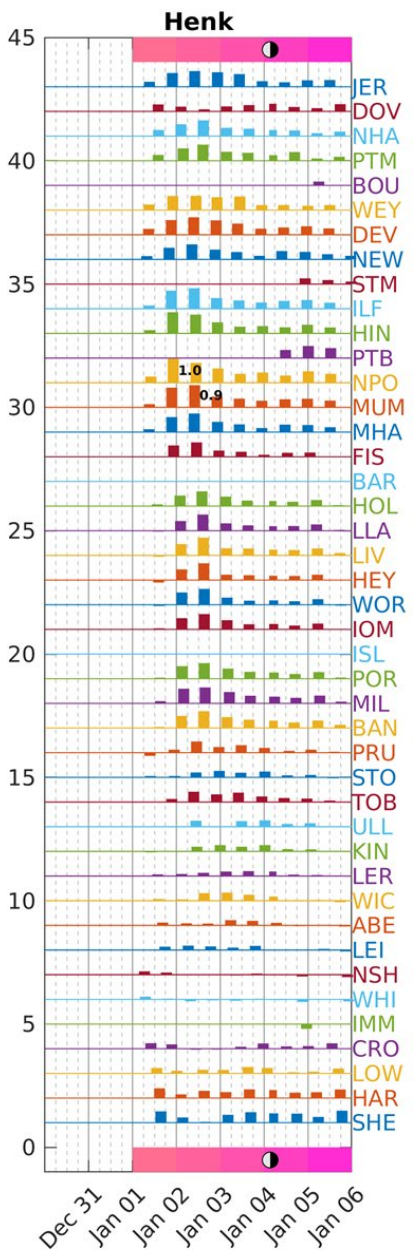
Storm Henk, 1st-3rd January



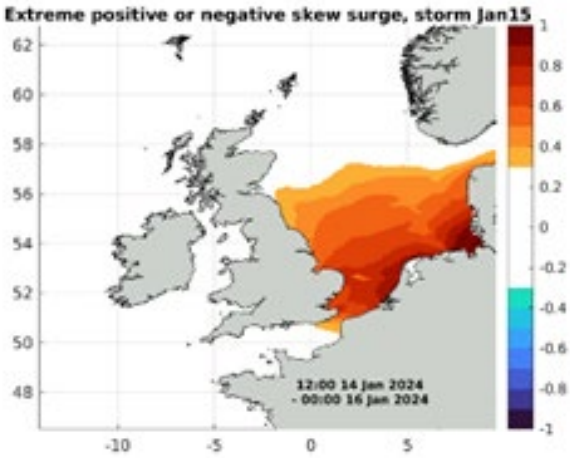


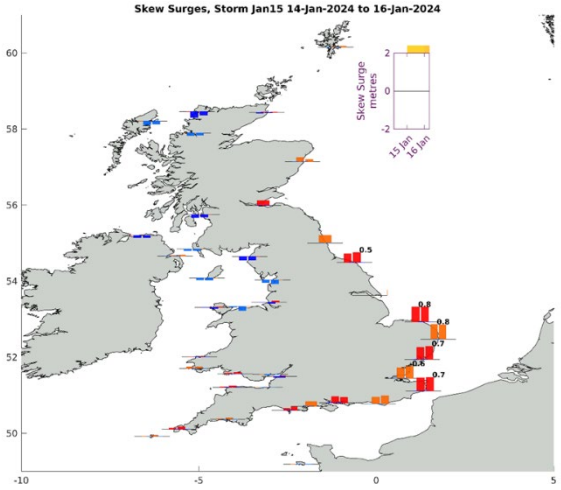


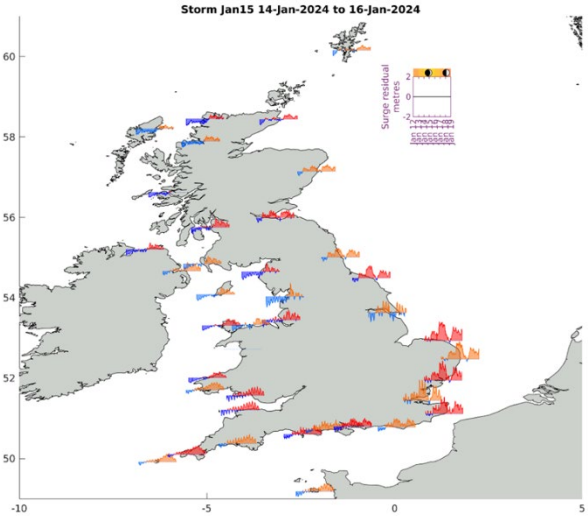


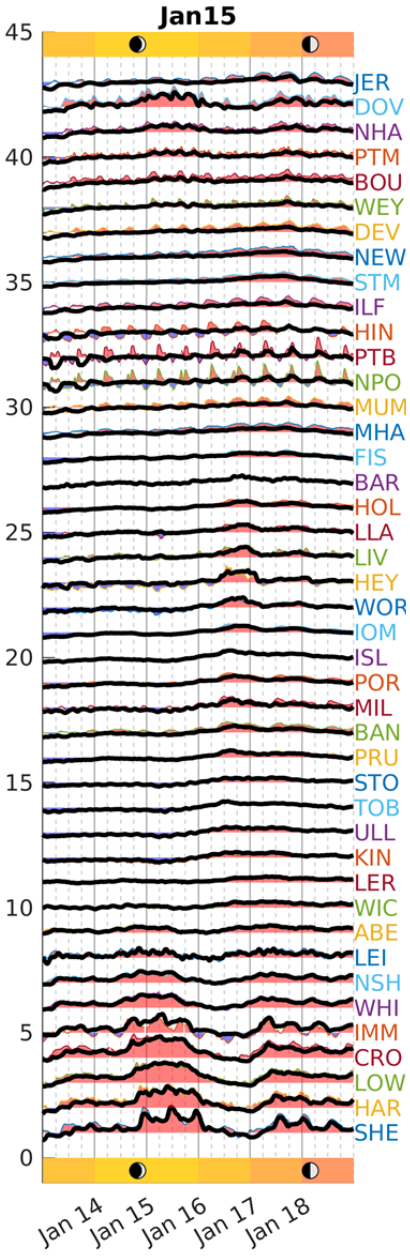


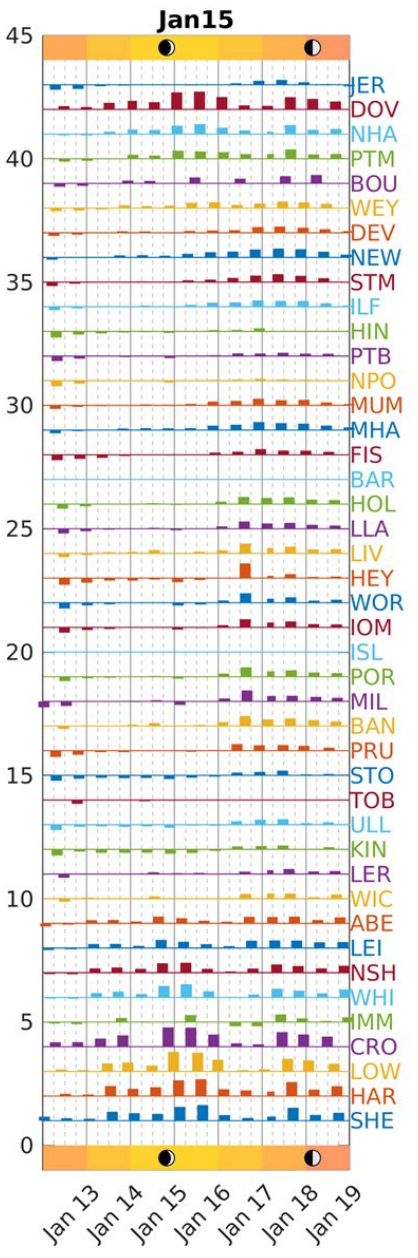
Storm Jan15, 15th – 16th January



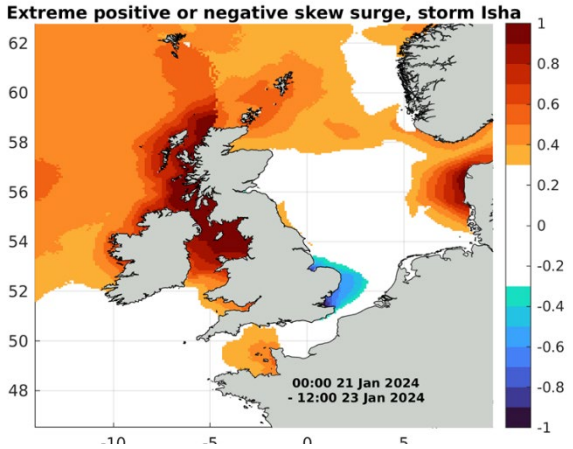


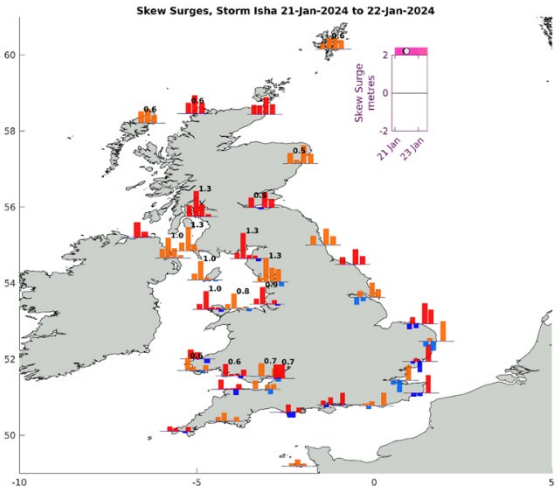


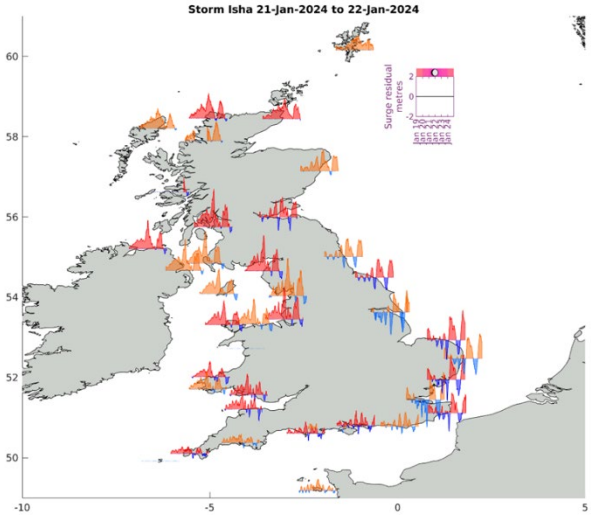


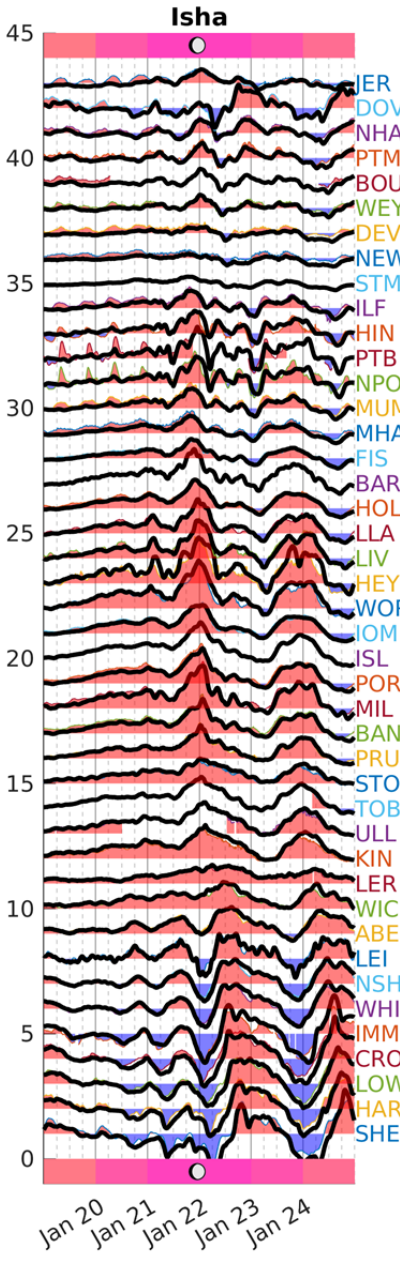


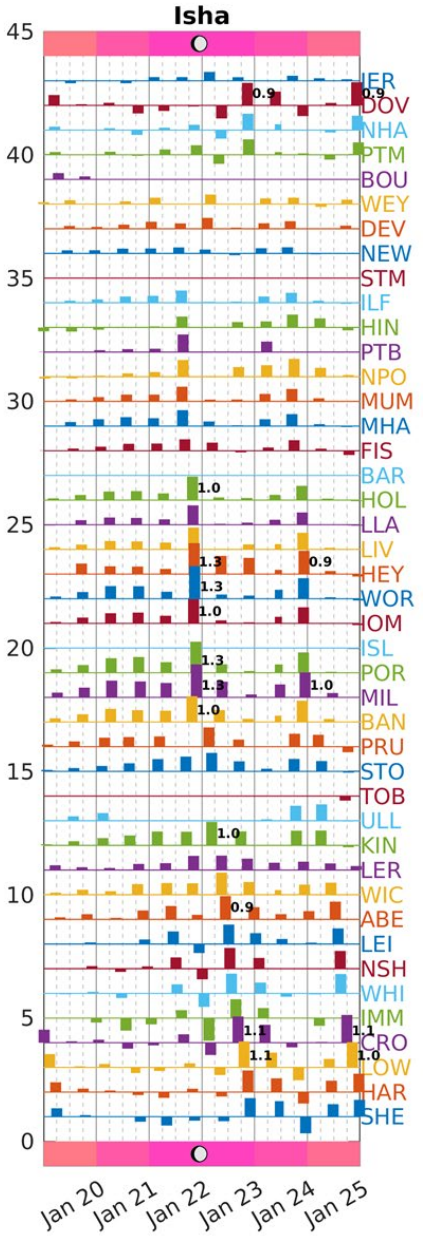
Storm Isha, 21st -23rd January



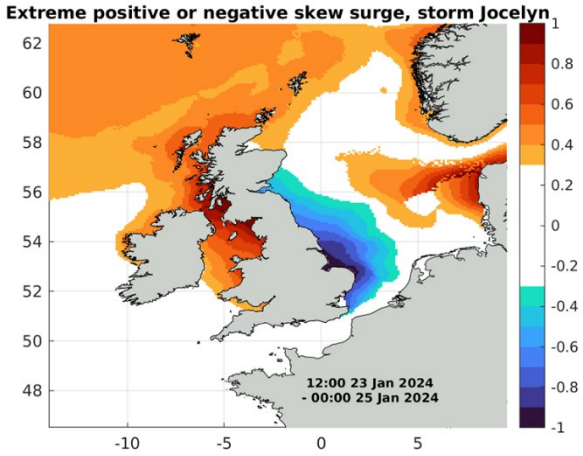


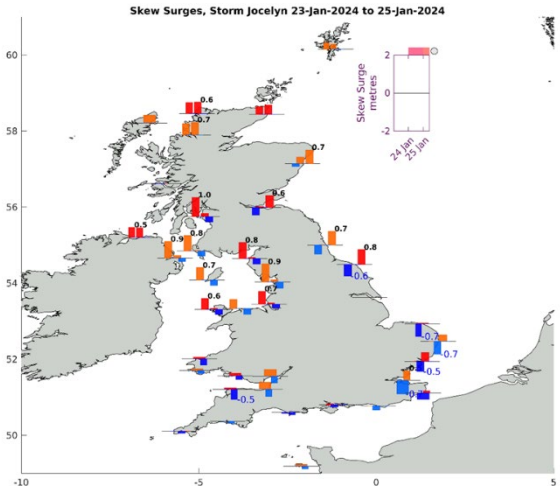


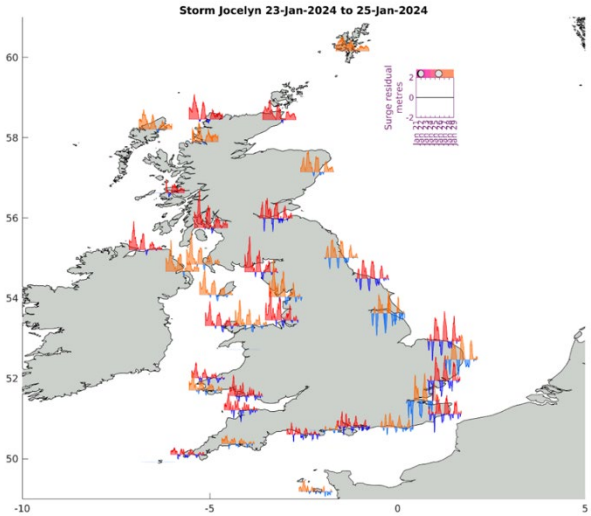


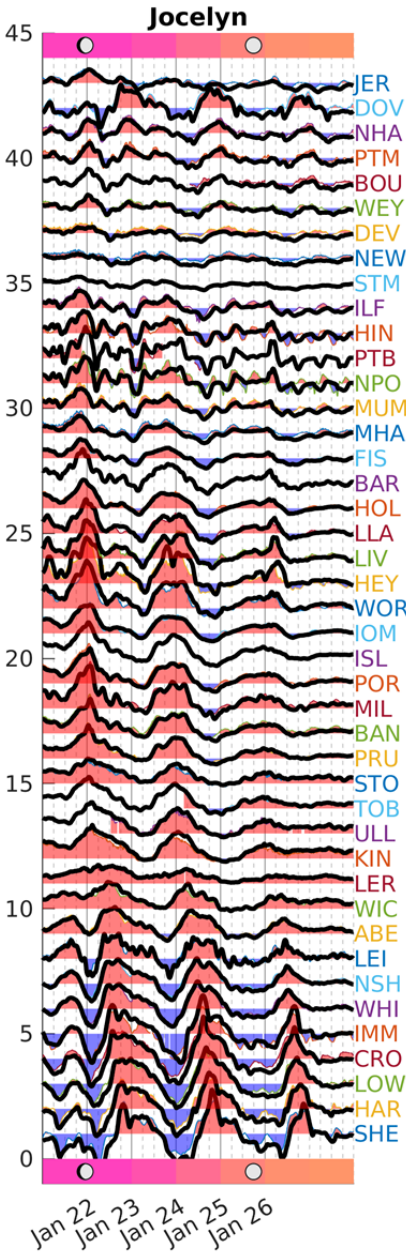


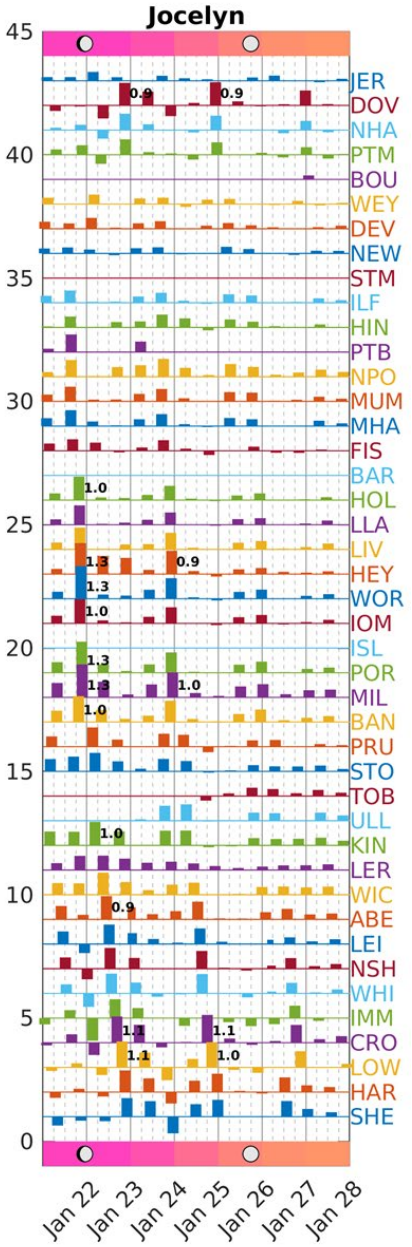
Storm Jocelyn, 23rd – 25th January



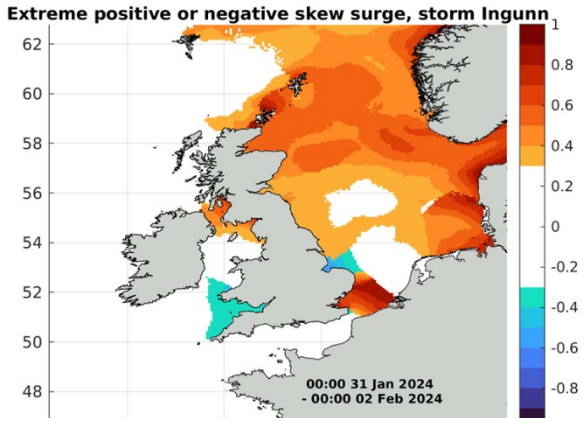


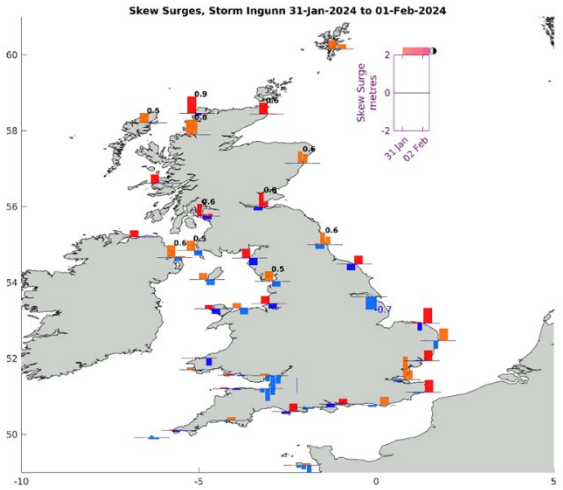


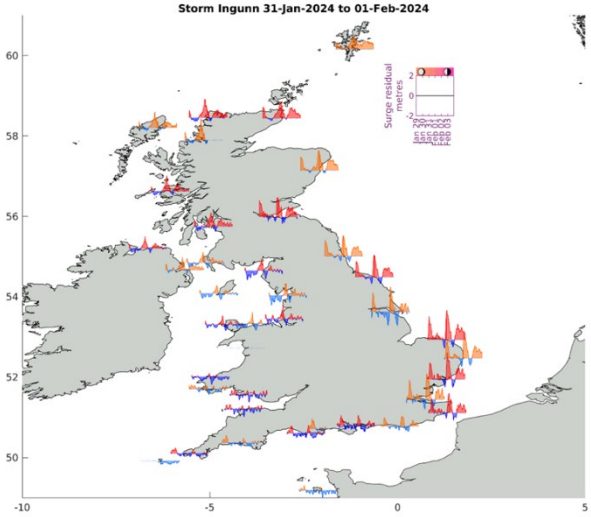


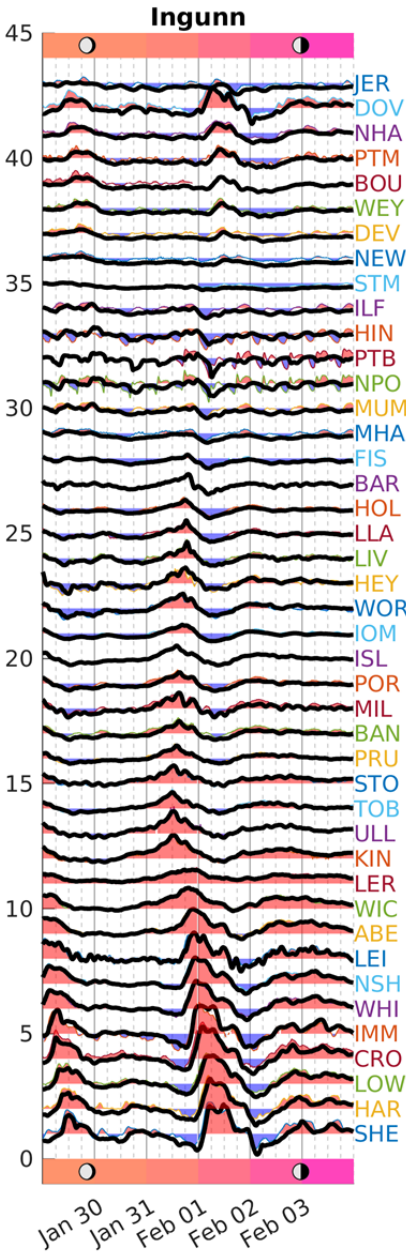


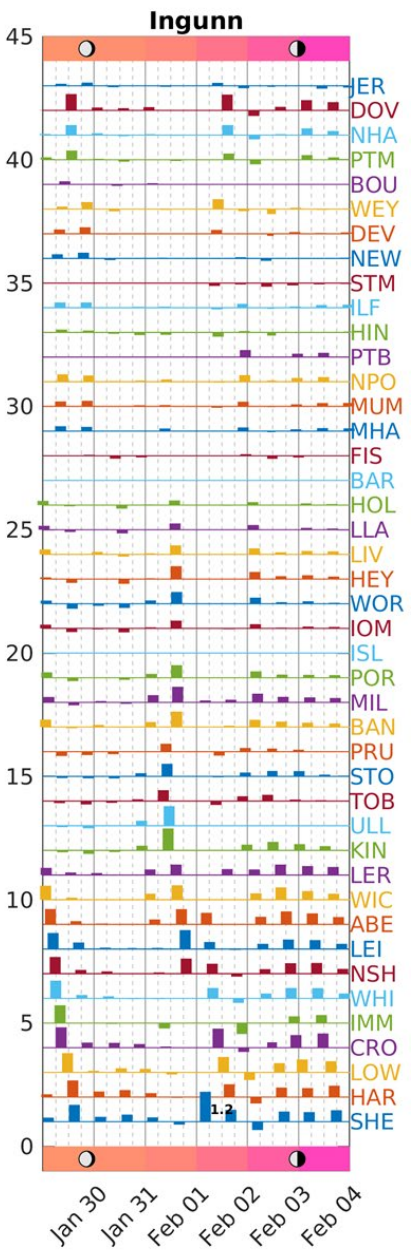
Storm Ingunn, 31st January – 2nd February



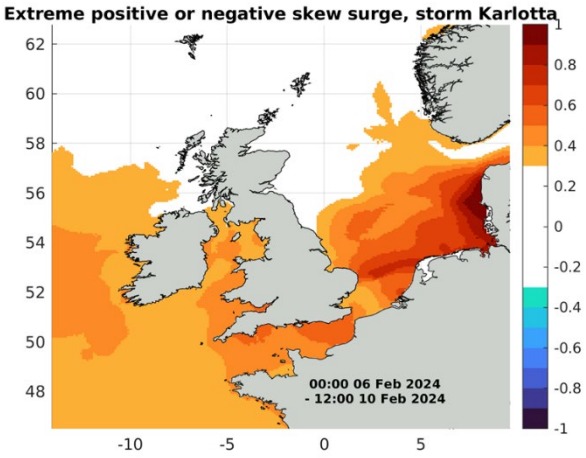


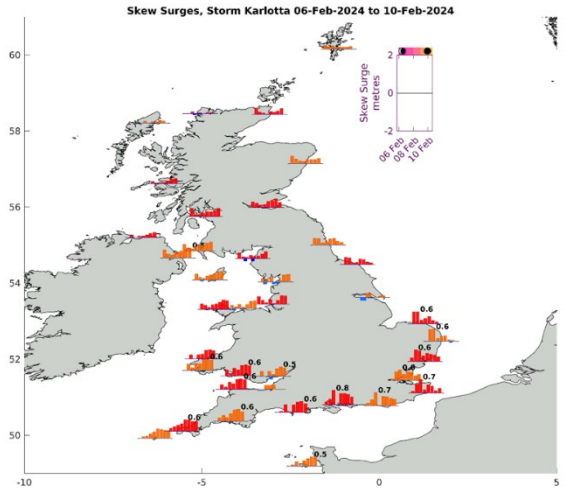


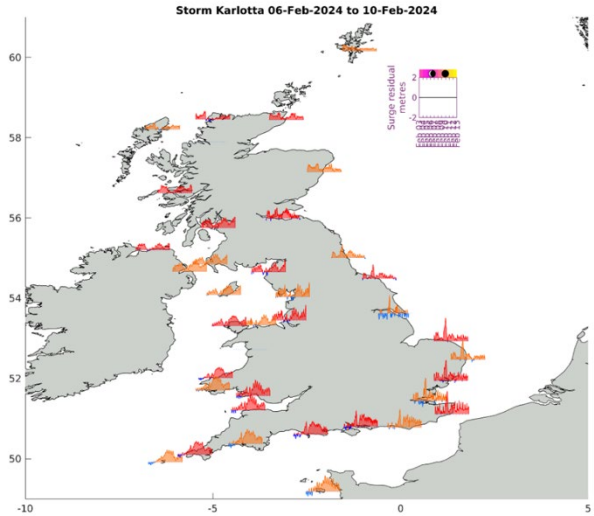


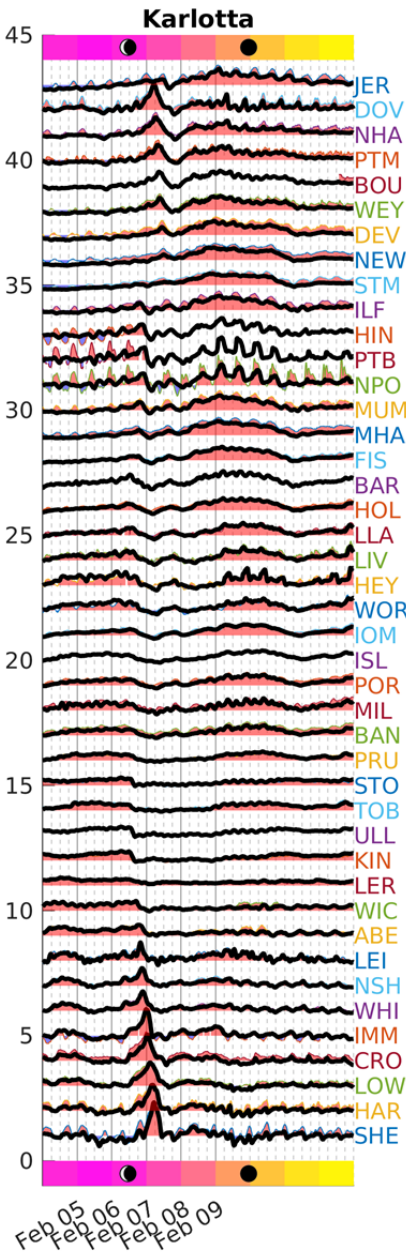


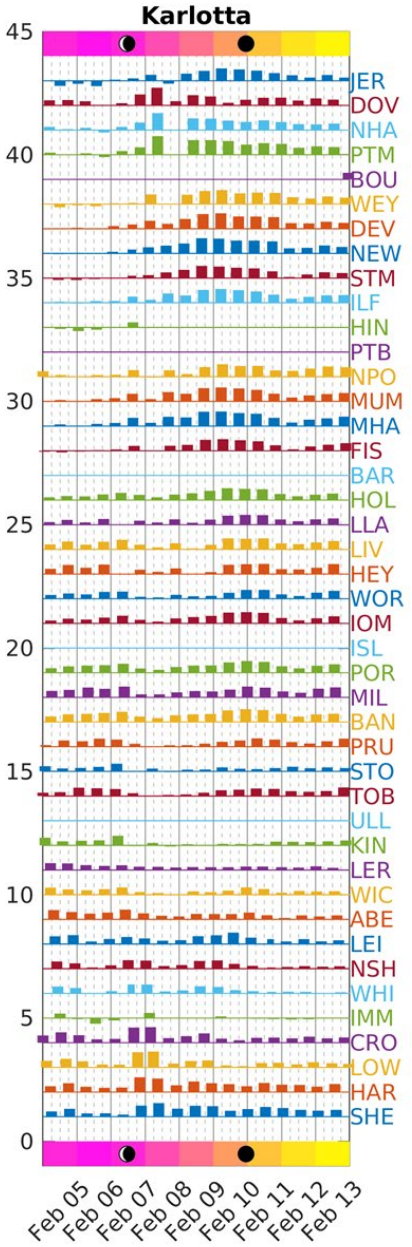
Storm Karlotta, 6-10th February



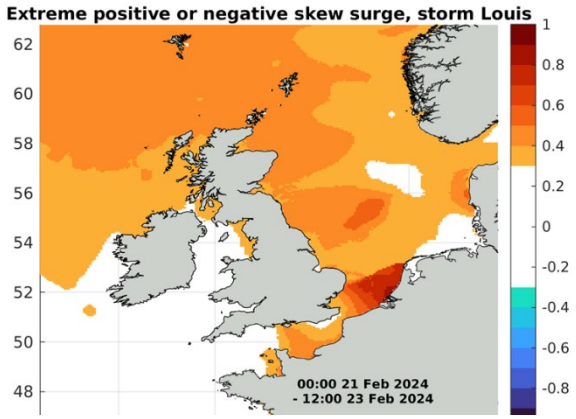


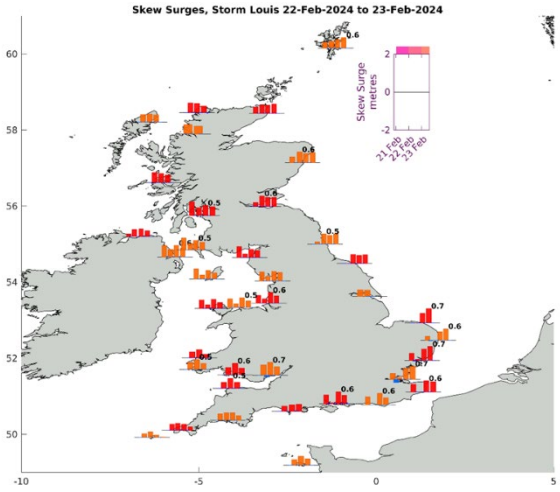


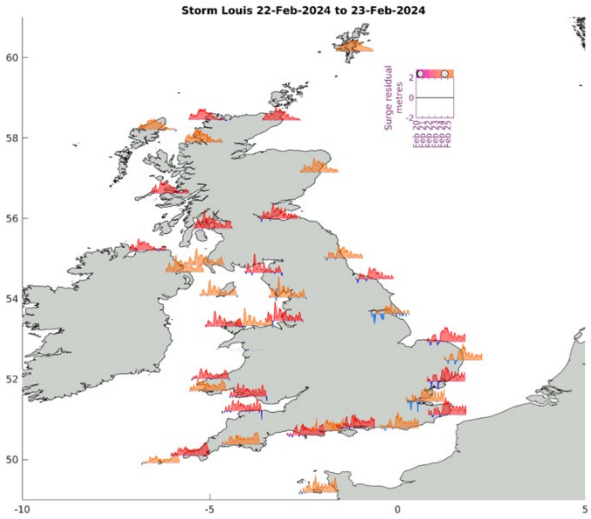


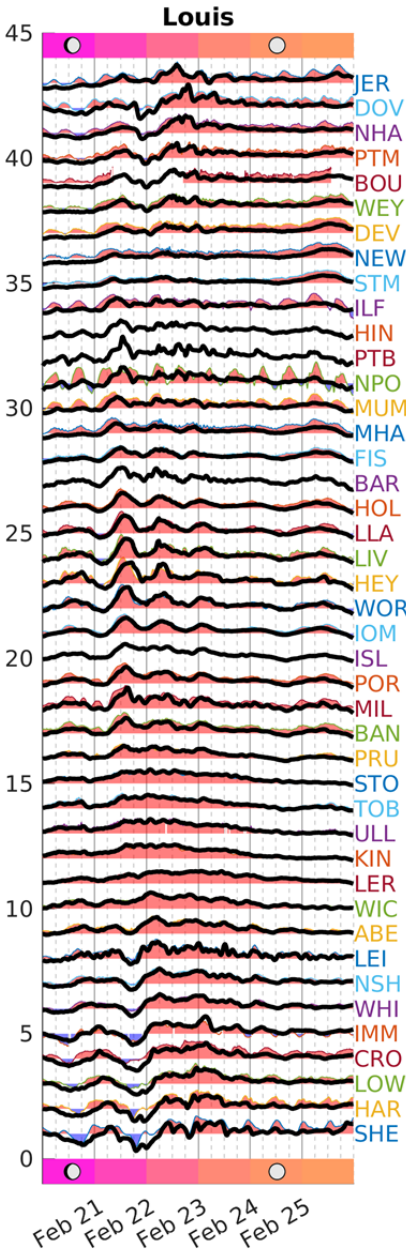


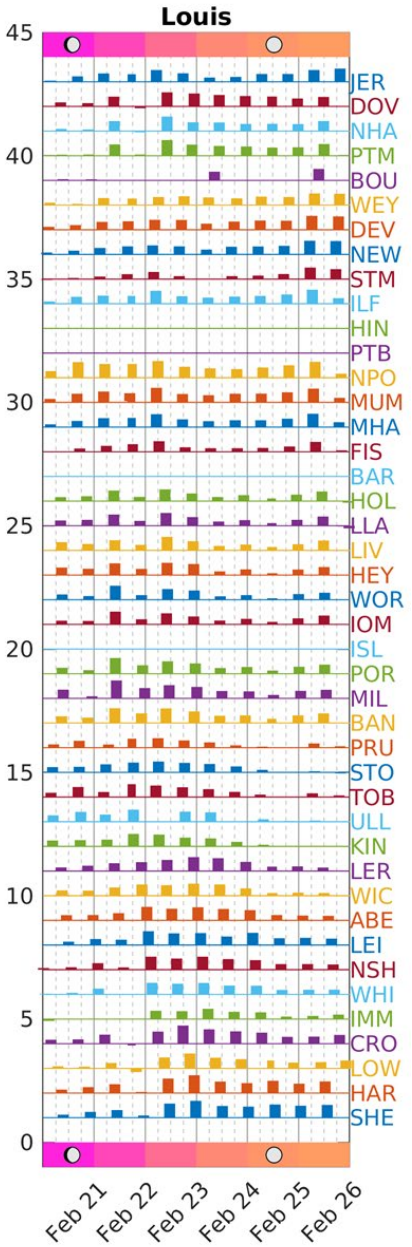
Storm Louis, 21st – 23rd February



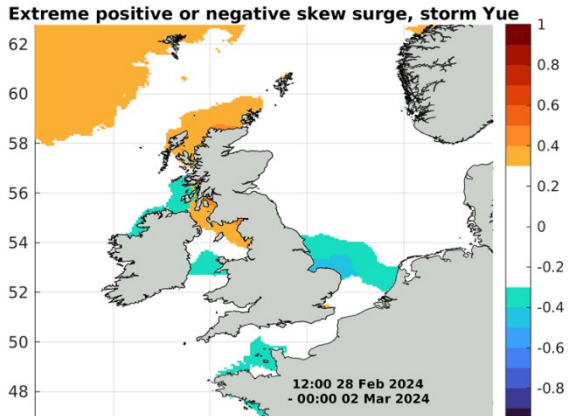


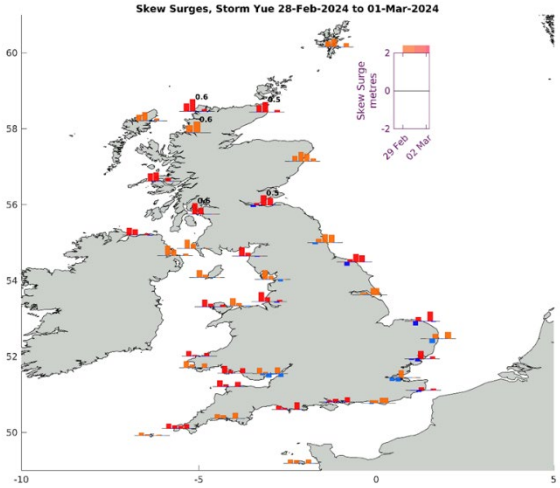


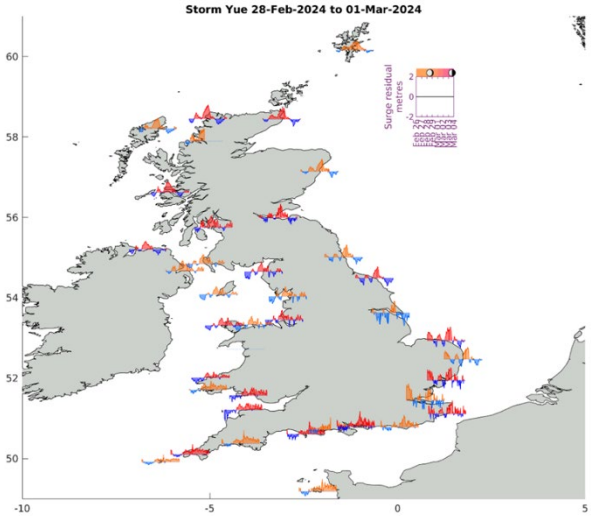


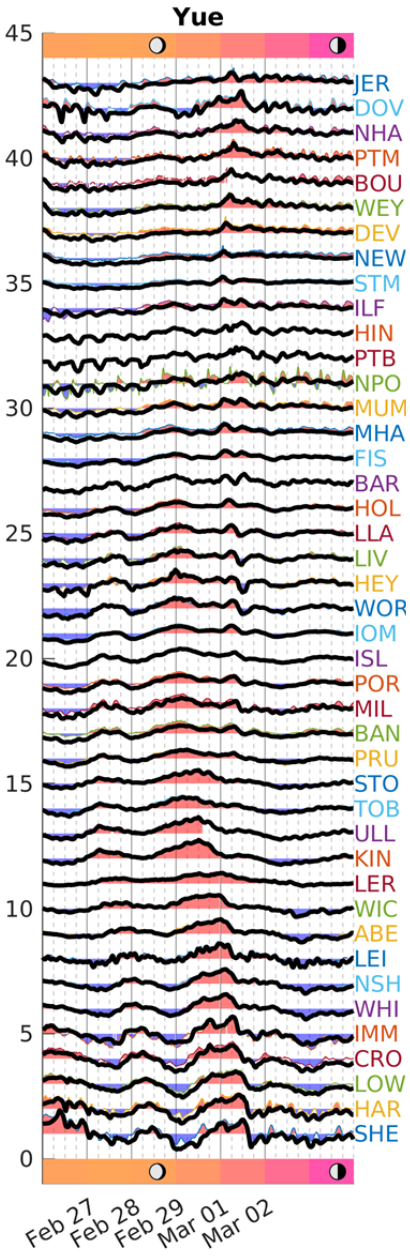


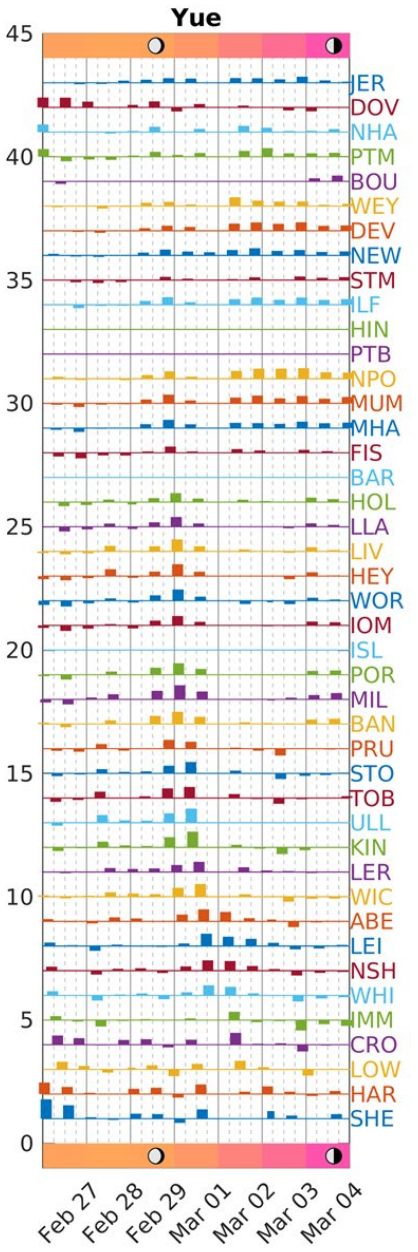
Storm Yue, 28th February – 2nd March



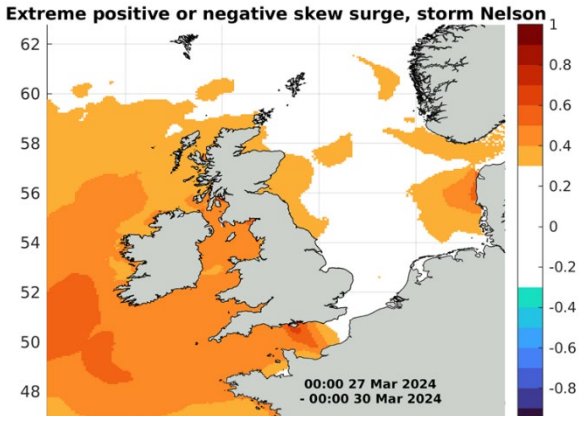


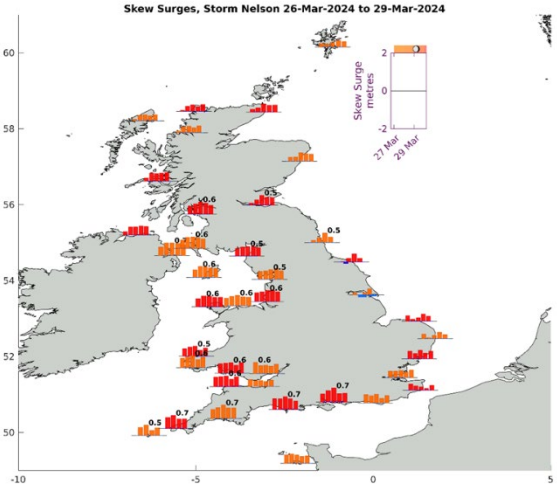


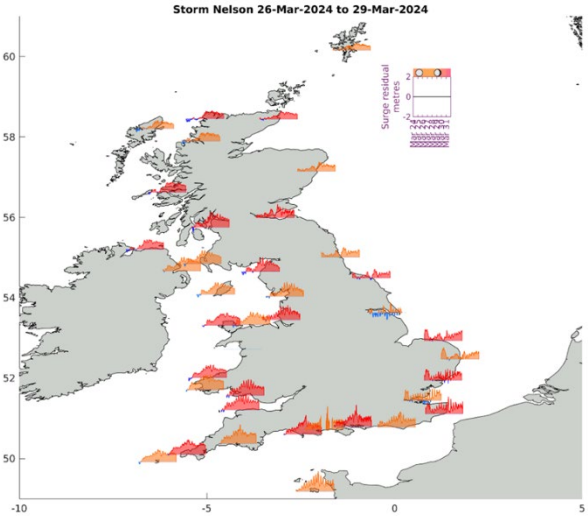


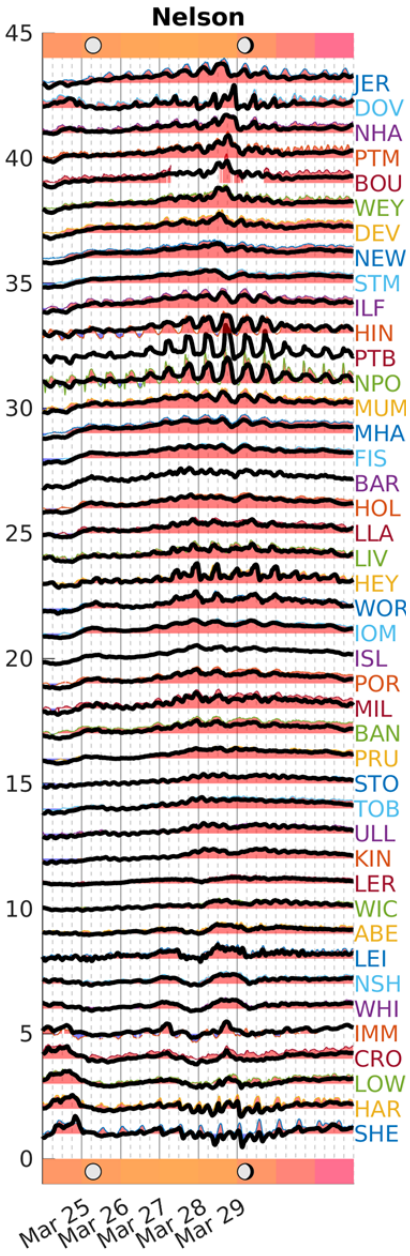


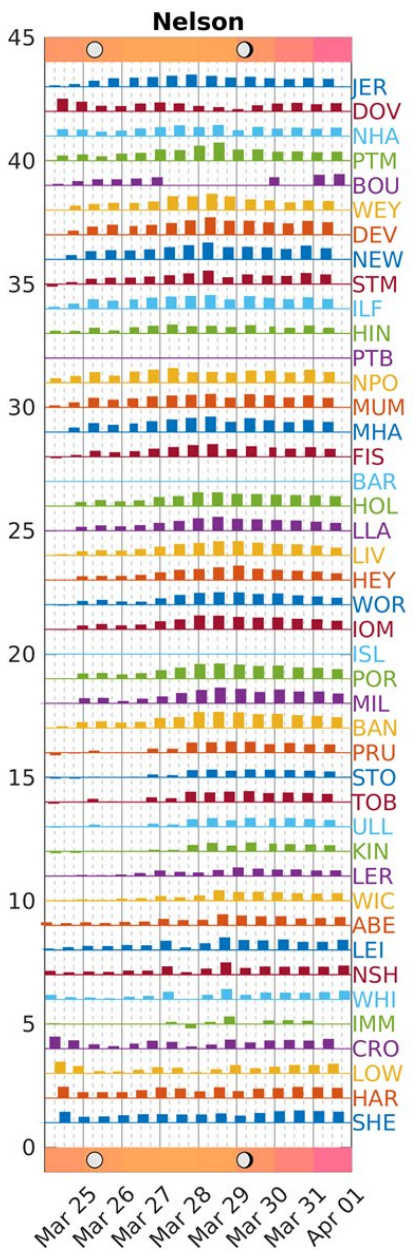
Storm Nelson, 27th – 30th March



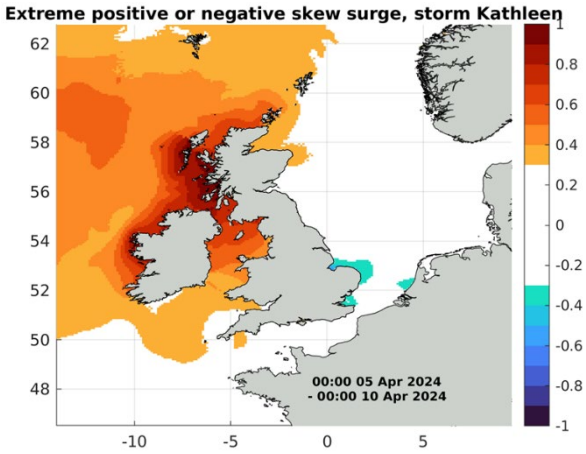


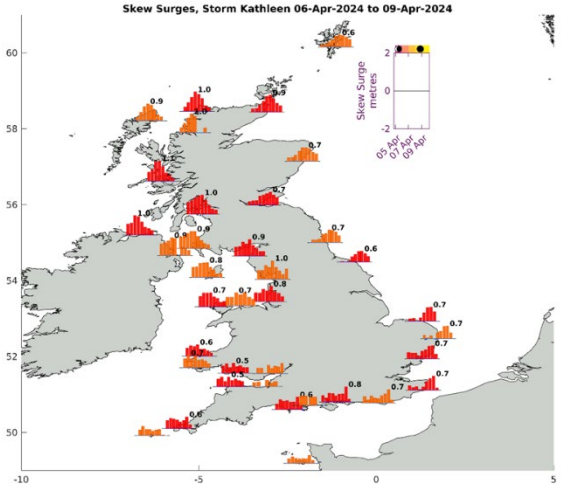


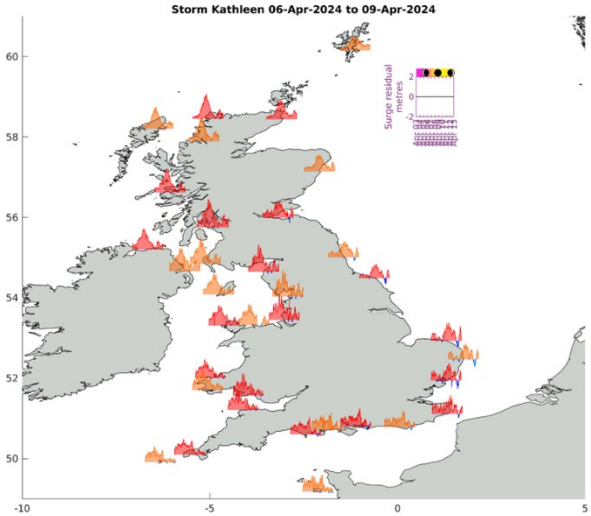


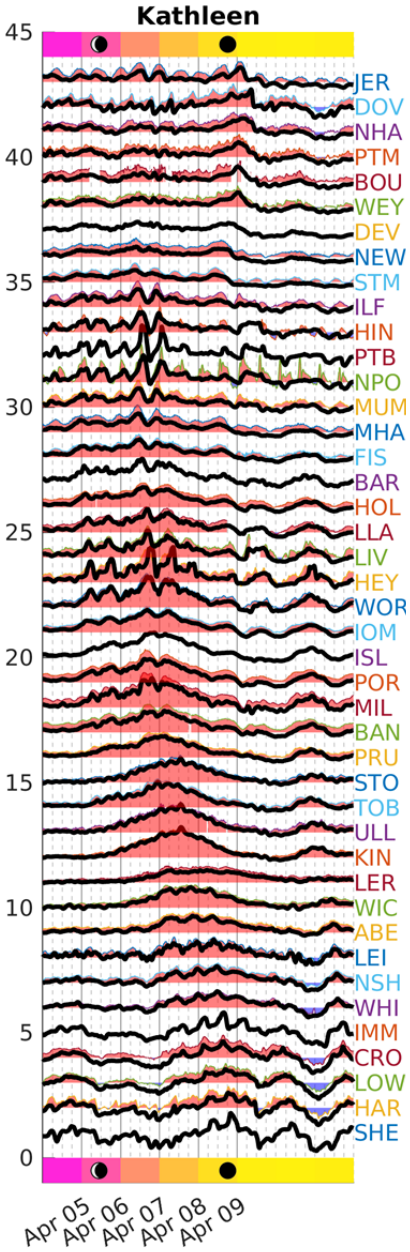


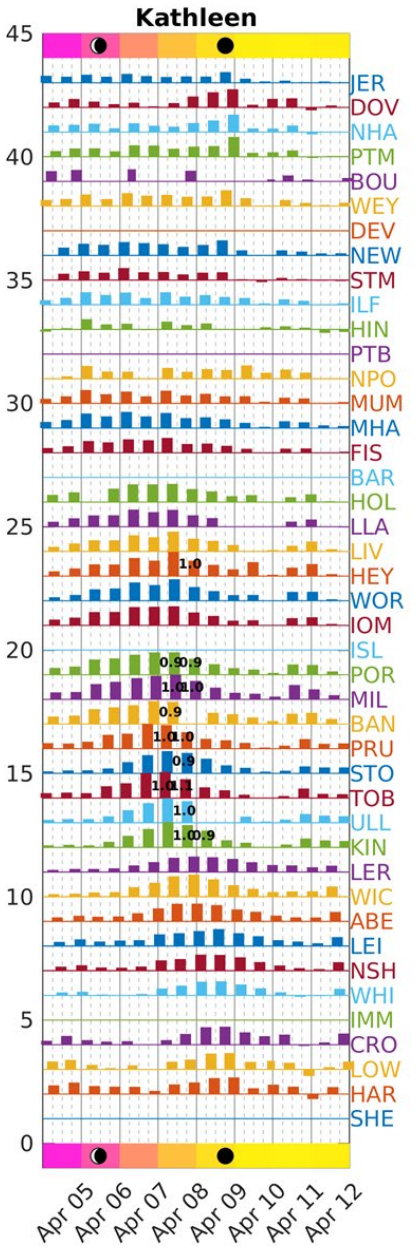
Storm Kathleen/Pierrick, 6th – 8th April



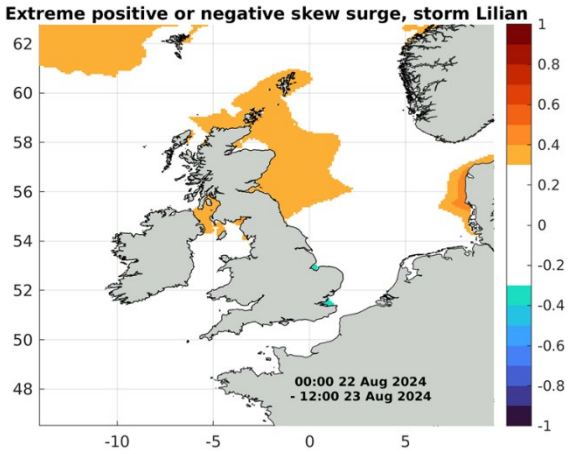


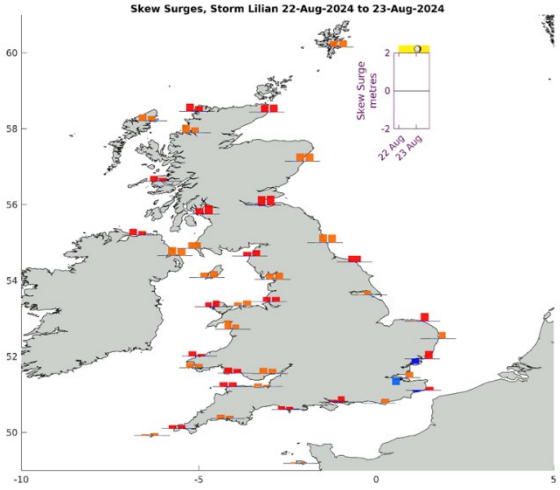


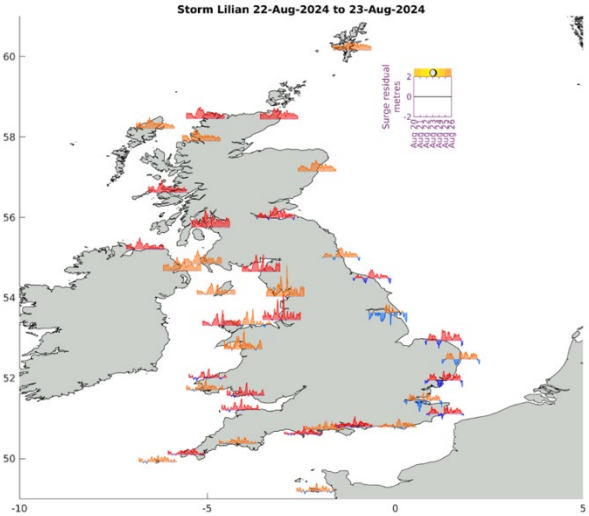


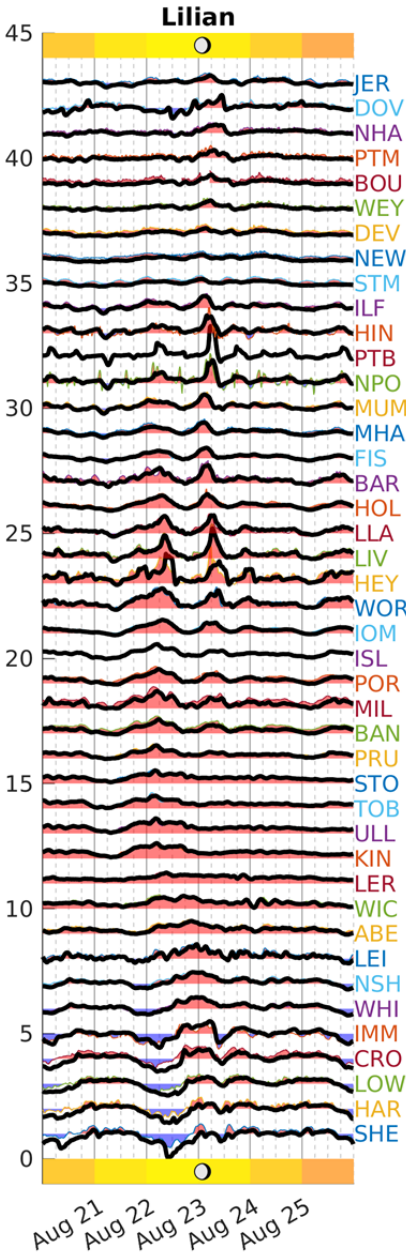


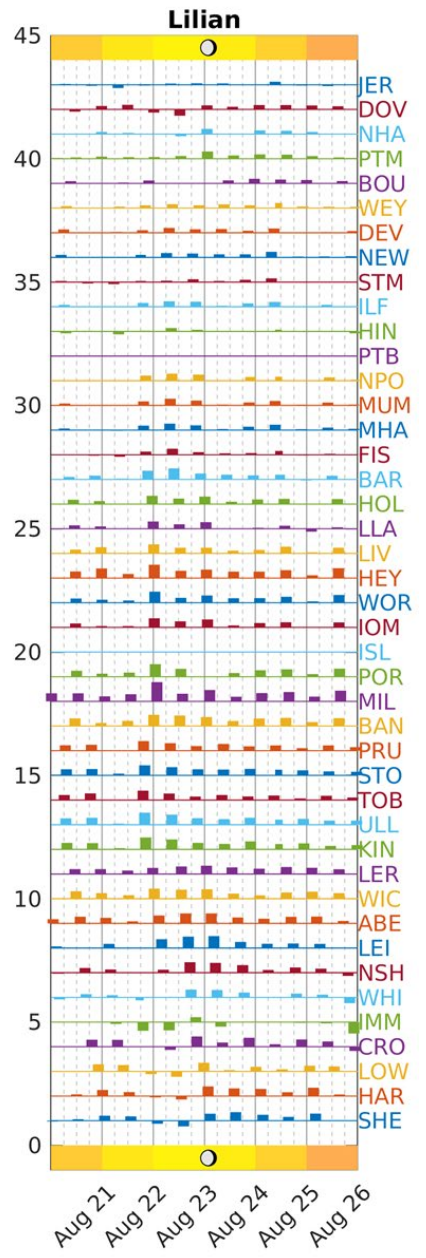
Storm Lilian, 22-23rd August



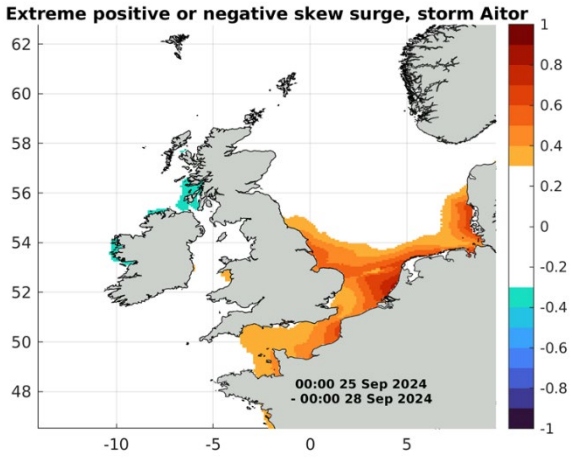


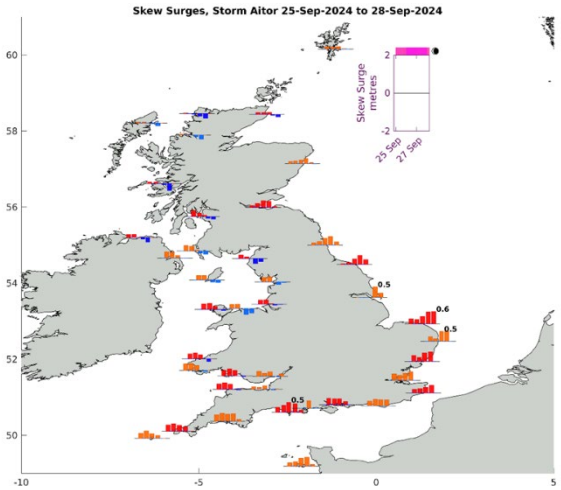


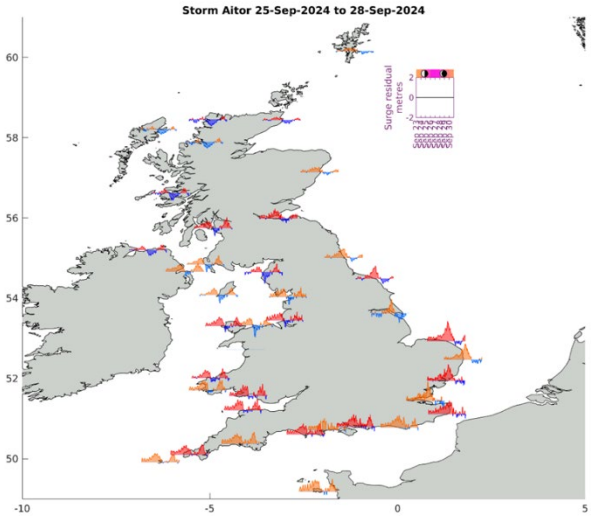


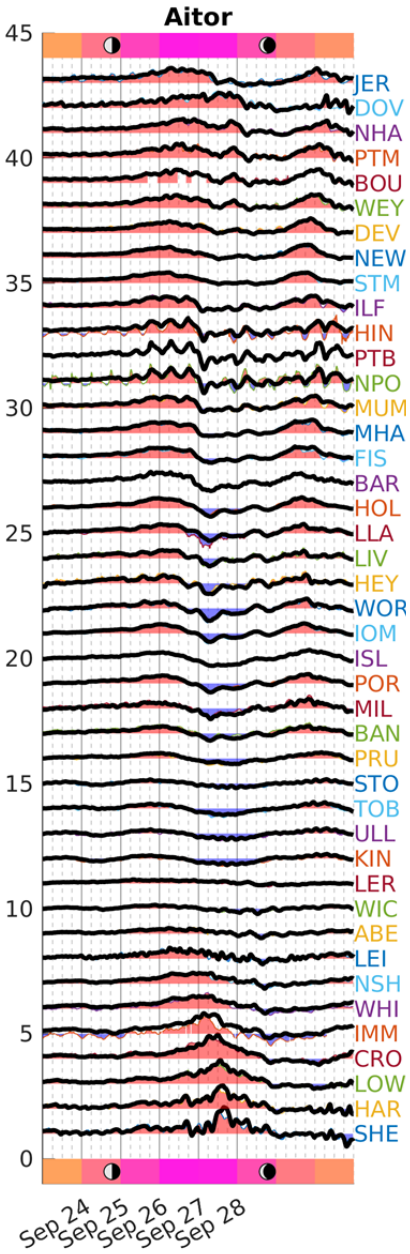


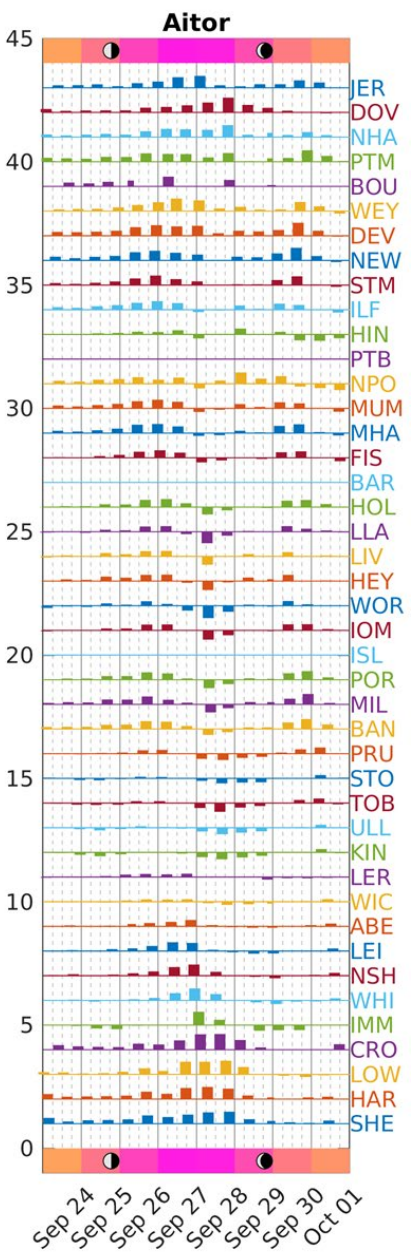
Storm Aitor, 25-28th September



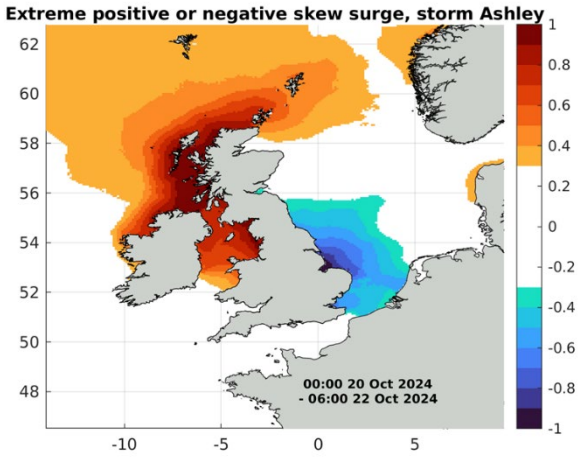


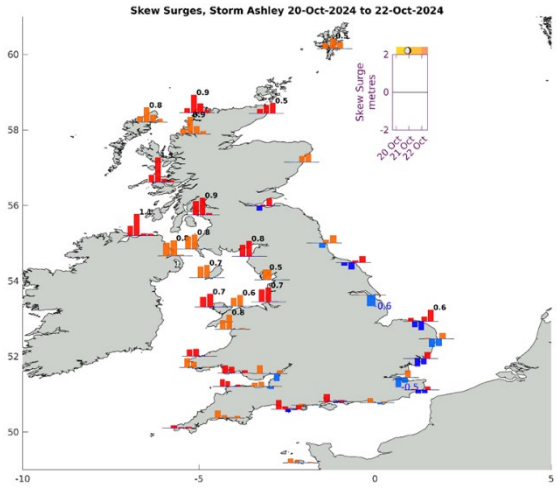


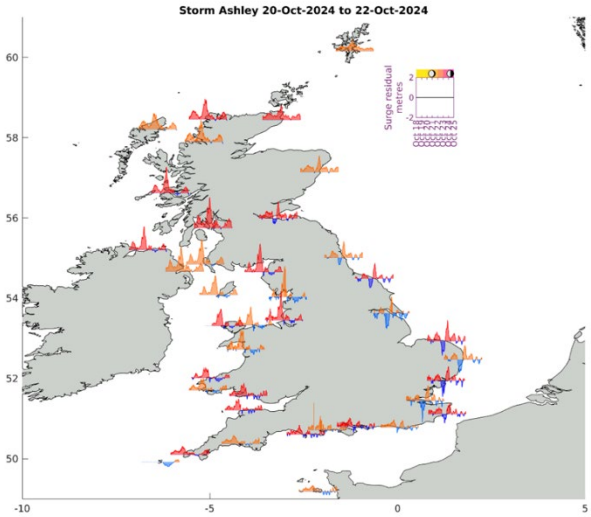


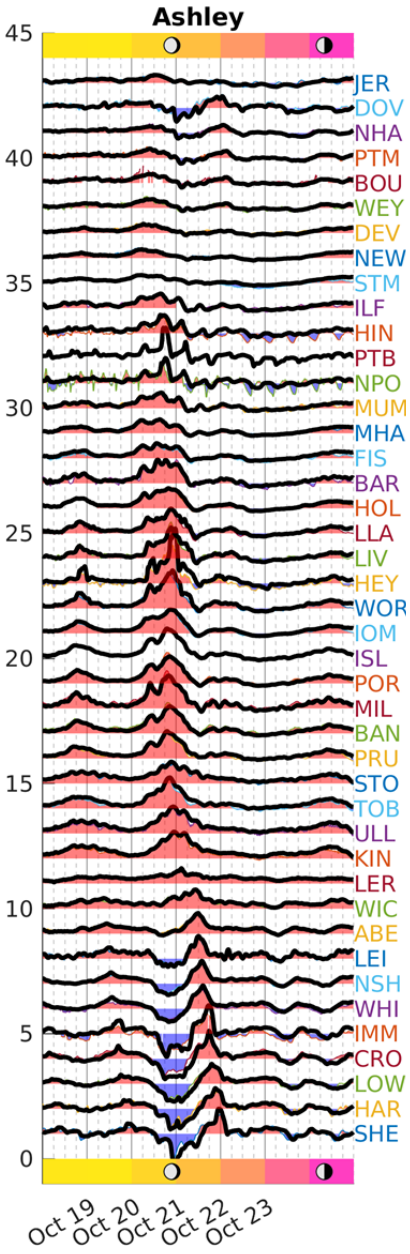


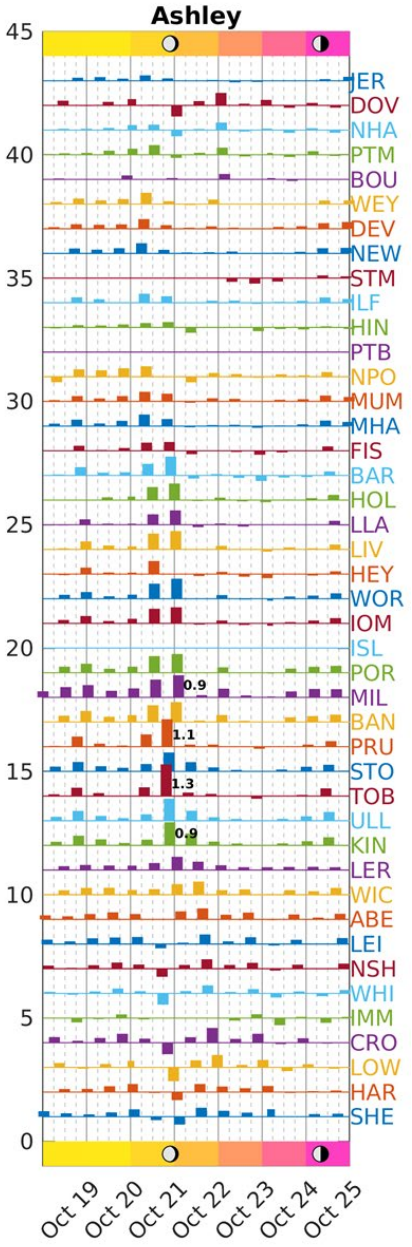
Storm Ashley, 20th – 22nd October



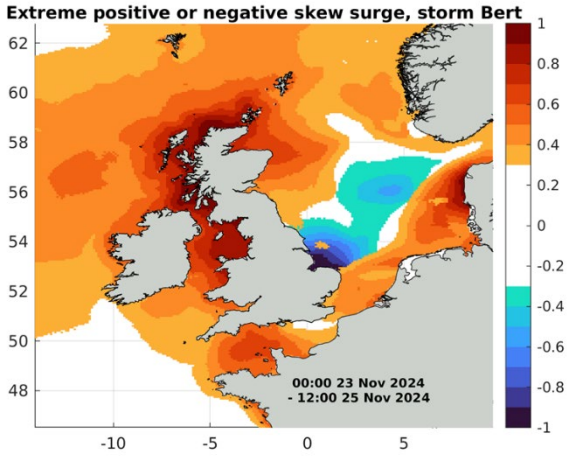


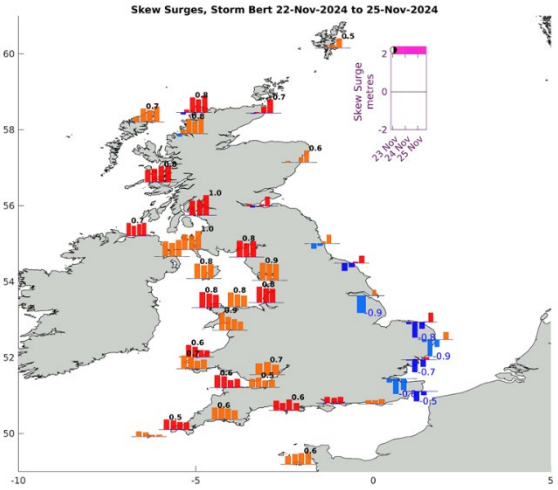


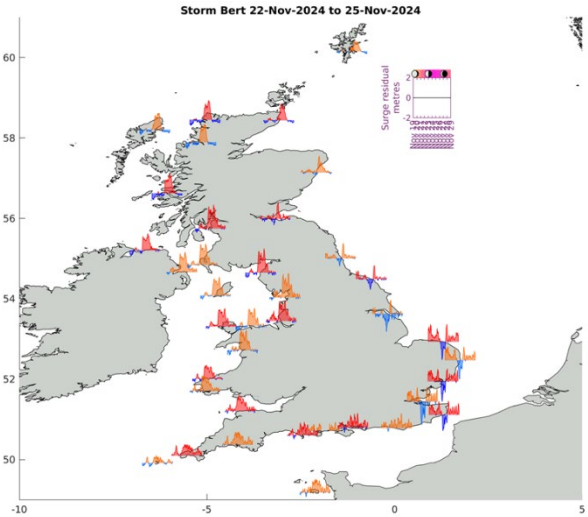


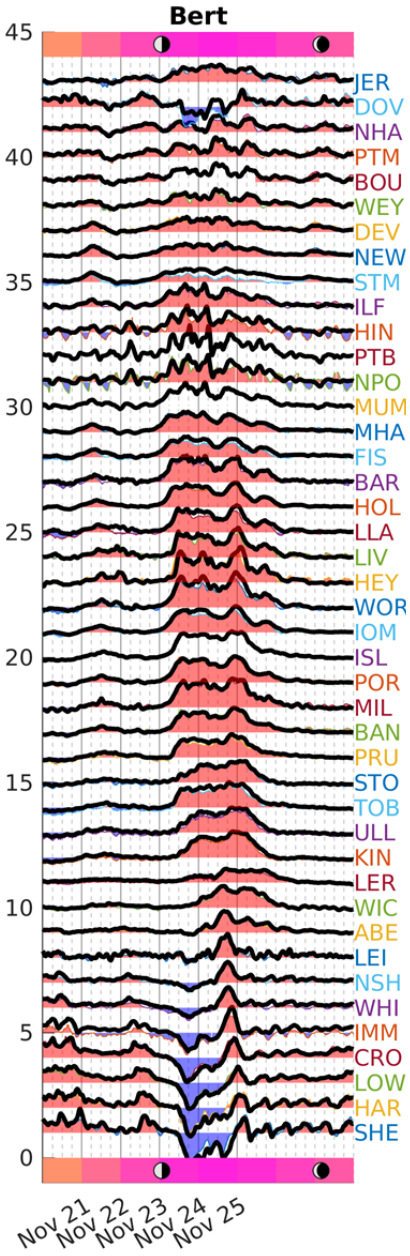


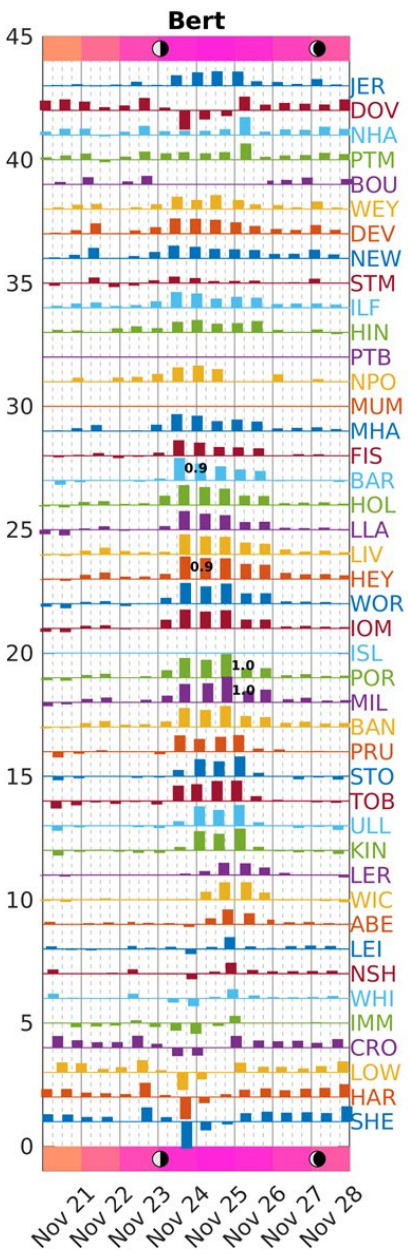
Storm Bert, 23rd- 25th November



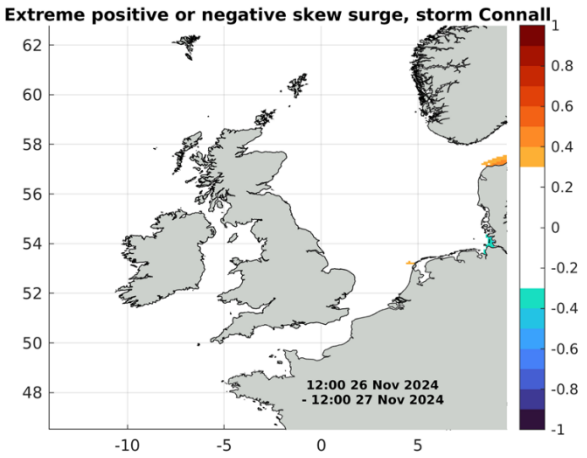


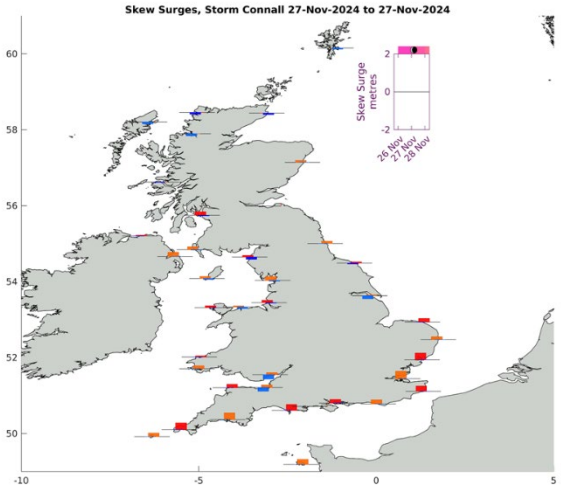


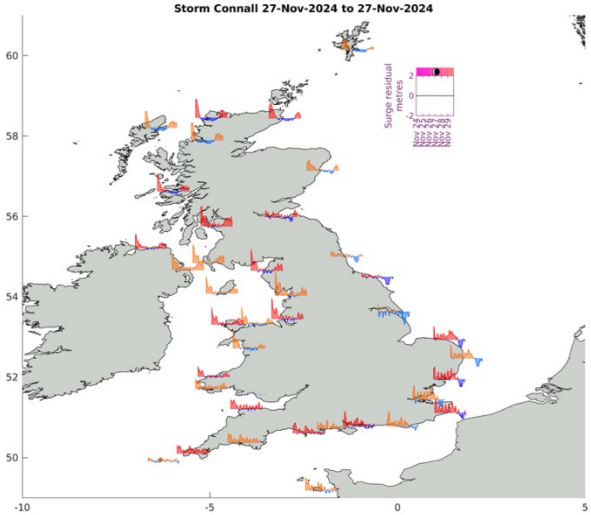


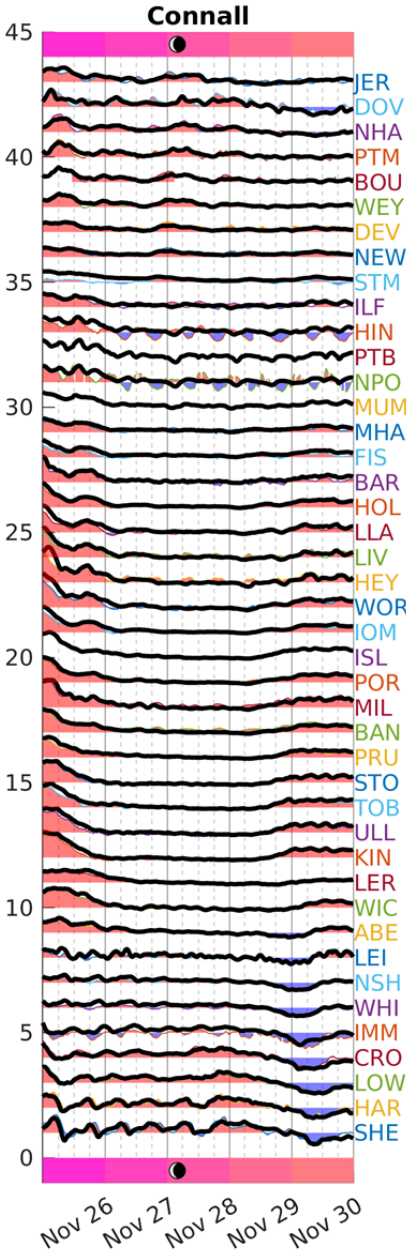


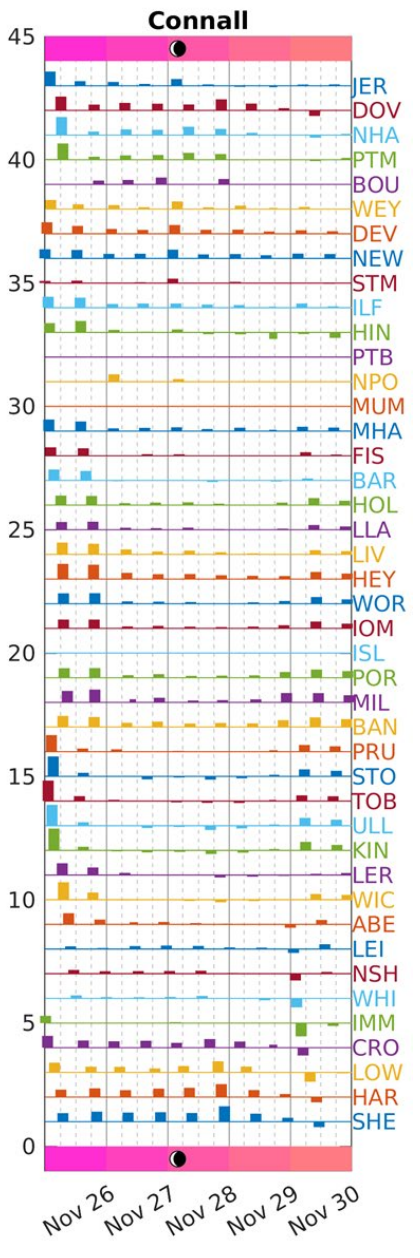
Storm Conall, 26th – 27th November



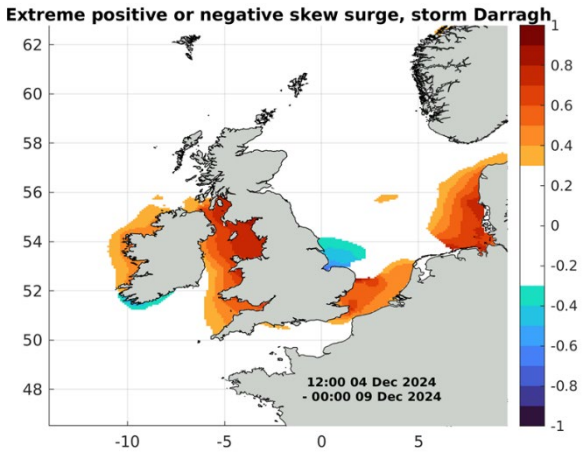


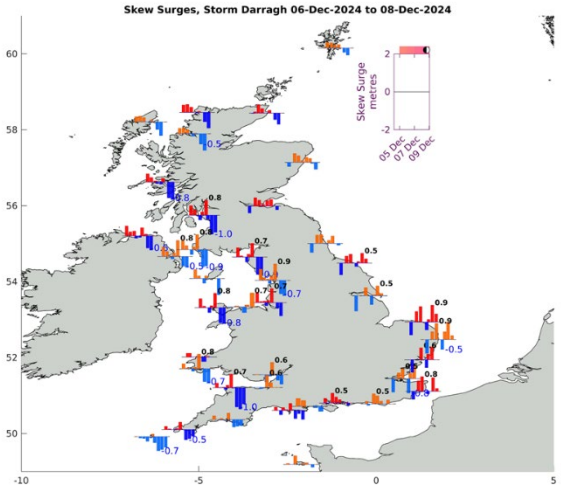


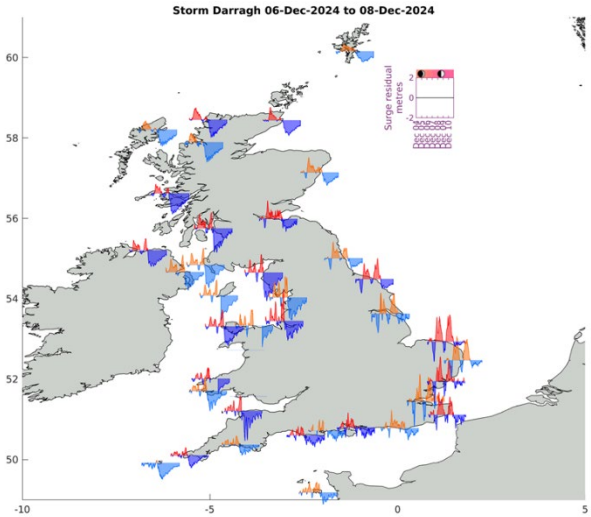


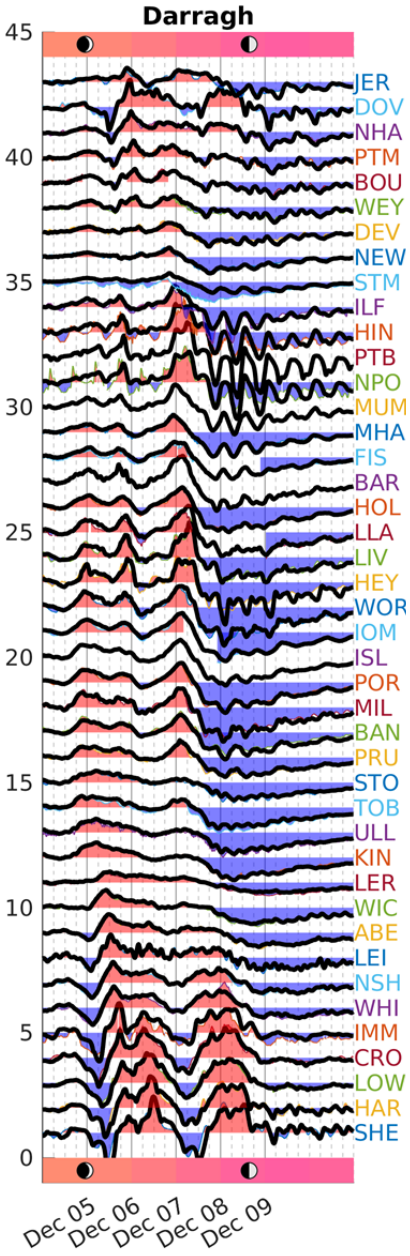


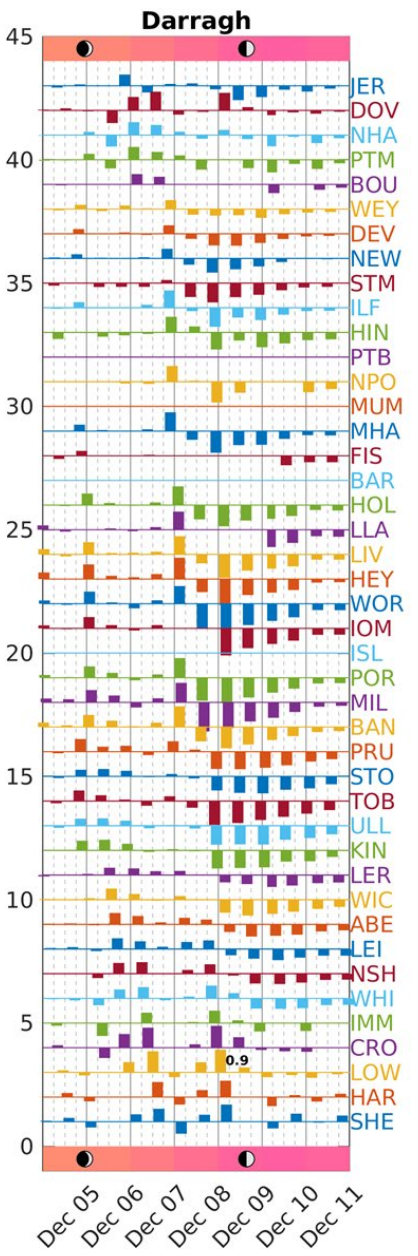
Storm Darragh, 4th – 9th December



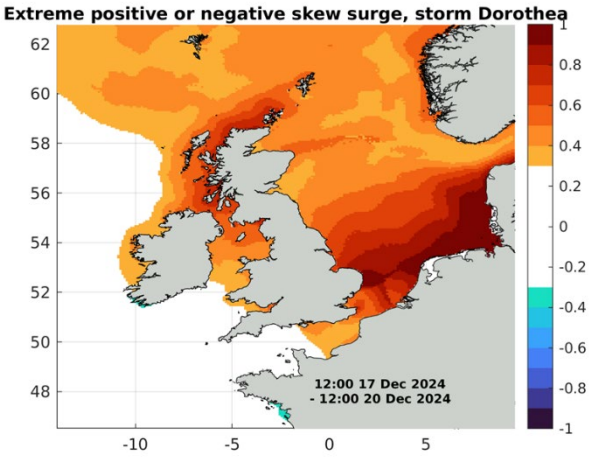


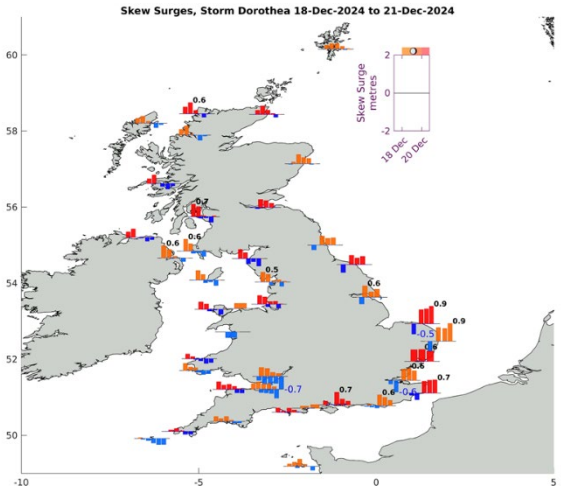


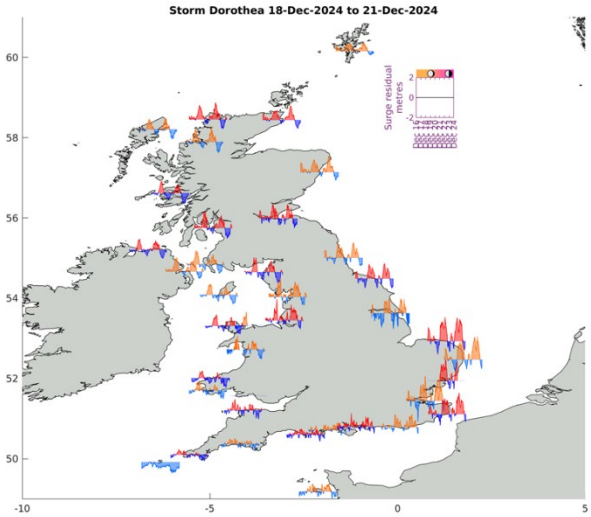


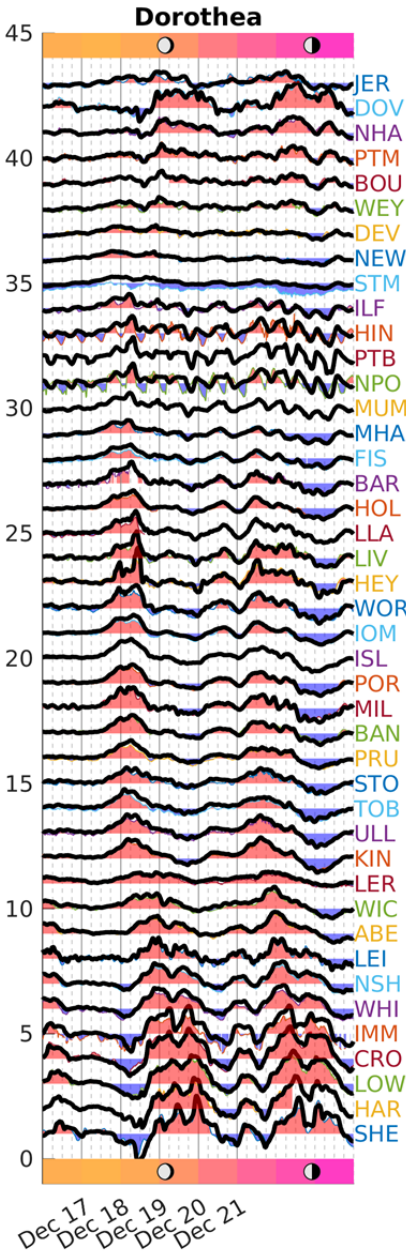


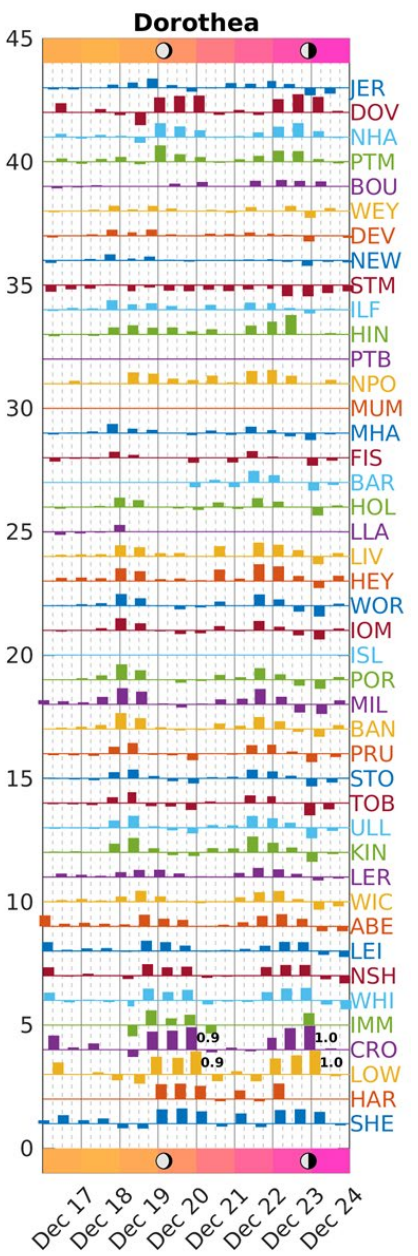
Storm Dorothea, 17th – 20th December



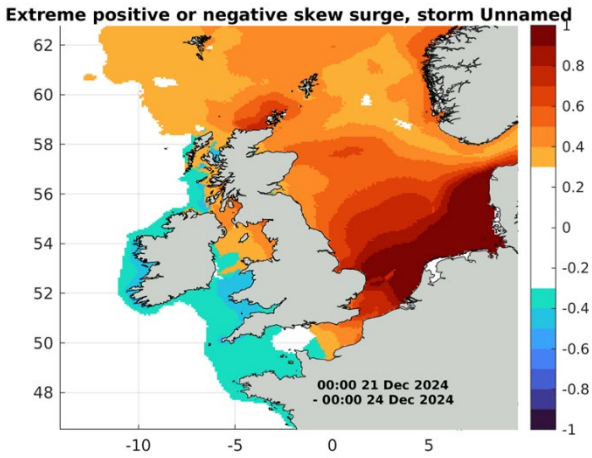


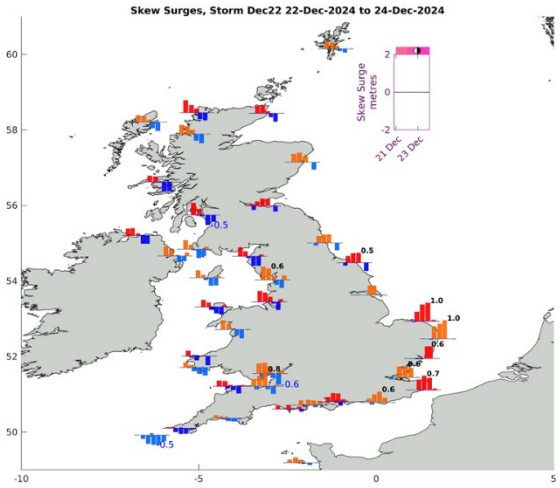


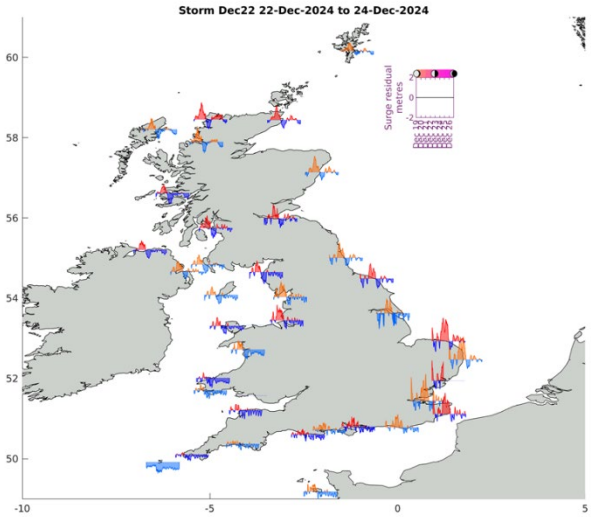


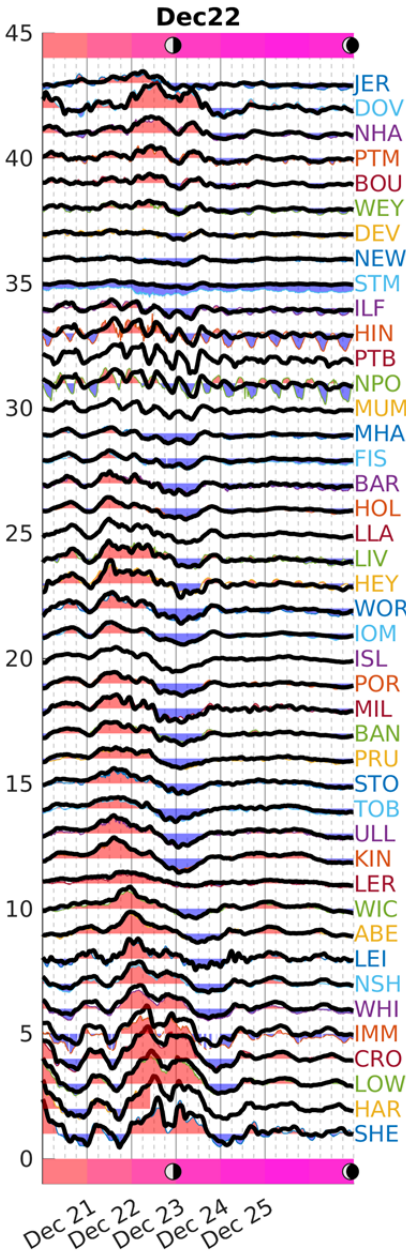


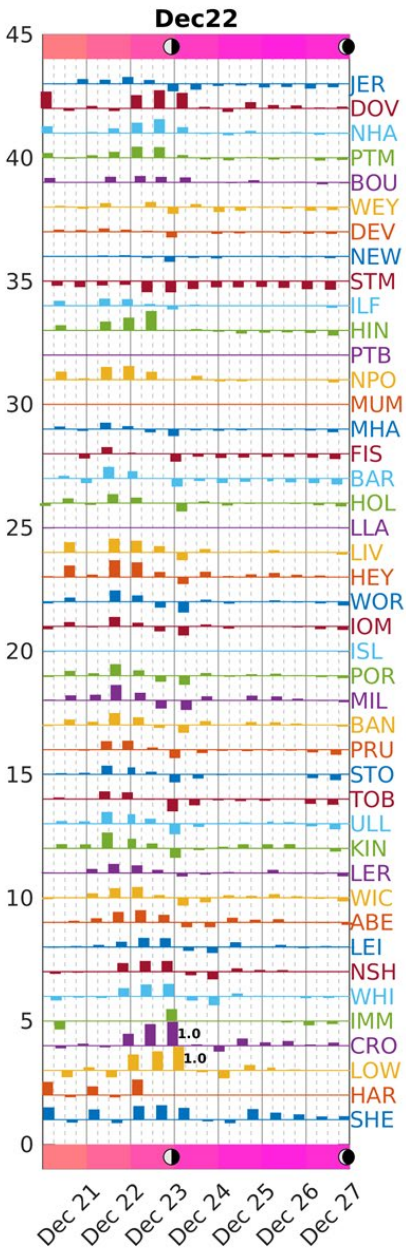
Storm Dec22, 21st – 24th December











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