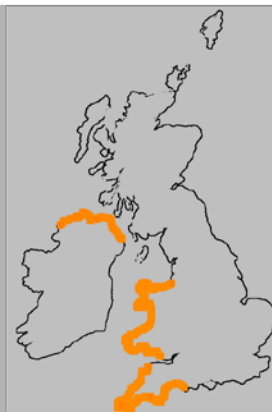


STORM EVENT

——— 3rd January 2014 ———

High water levels and strong winds bring flooding to Wales, Scotland and western England



Severity Ranking



Social	<u>Loss of life</u>	*
	<u>Residential property</u>	Over 250 properties flooded in various locations
	<u>Evacuation & rescue</u>	Around 100 persons in Scotland evacuated
Economic	<u>Cost</u>	Total economic losses were estimated at £55 million, although this includes losses beyond flood impacts (i.e. wind-generated) and possibly over a time frame extending beyond this event only
	<u>Ports</u>	*
	<u>Transport</u>	Railway track and the Coastal Path in Wales were damaged; flooding of many coastal roads
	<u>Energy</u>	*
	<u>Public services</u>	One police station on the Isle of Man closed
	<u>Water & wastewater</u>	*
	<u>Livestock</u>	*
Environmental	<u>Agricultural land</u>	3.5 km ² of agricultural land in Wales either inundated or impacted
	<u>Coastal erosion</u>	"Large" parts of the coastline in Hastings eroded
	<u>Natural environment</u>	37 SSSI's and 10 SAC's in Wales impacted (during this event and over preceding/forthcoming days)
	<u>Cultural heritage</u>	*
	<u>Coastal defences</u>	*

**No known sources of information available*

Source

The storm developed south of Nova Scotia, Canada on 31st December 2013 and moved northeastwards towards the UK. On 2nd January 2014, the storm approached Ireland and combined with, and was enhanced by, another low-pressure system located south of Iceland. On 3rd January, it then travelled north of Scotland and progressed northwards more slowly, where the central pressure dropped to below 960 mbar. Gusts of between 60 and 70 knots [31 to 36 m/s] were measured along the exposed parts of the west and south coasts of the UK. The highest recorded wind speed was 92 knots [47 m/s] at the Needles Old Battery on the Isle of Wight (Met Office, 2014).

The storm generated a skew surge of between 0.5 and 1 m at many sites on the west and south coasts of the UK. Water levels exceeded the 1 in 5 year return level at 20 sites in these regions; the highest number for any one event within this database. At 7 of these sites, the water level was the highest on record (for respective sites). The highest return period water level was at Portpatrick and was 1 in 244 years. The next largest return period of 1 in 68 years was at Port Erin, Isle of Man. The highest skew surge was at Millport and was 1.07 m.

Wave heights of 4.5 m were forecast in the Irish Sea (Isle of Man Today, 2014). Off the west coast of the UK, wave heights of up to 9 m were recorded for several days before and after January 3rd (AON Benfield, 2014). Along parts of the Scottish coastline, [inshore] wave heights reached up to 1.8 m (BBC, 2014a).

Pathway

The flood pathways during this event were primarily overtopping observed in many locations across the southwest and west coasts.

Receptor & Consequence

This event was associated with widespread flooding in southwest England, Wales, and Northern Ireland (Haigh *et al.*, 2015). On the Isle of Man, a police station was closed and flooding occurred in many coastal roads and promenades. A minimum of 250 properties were flooded during this event (Watkins, 2014; Natural Resources Wales, 2014). The harbour walls were overtopped by water levels of about 0.8 m over the crest level. In Scotland, about 100 people evacuated their homes (BBC, 2014a). In Lahinch, Ireland, there was extensive structural damage to coastal defences and surrounding businesses were flooded (RTE, 2014). In the southwest of the England there was flooding of streets in Looe, Kingsbridge and Salcombe. In Newquay, part of a coastal road collapsed due to the large waves overtopping the sea wall (Cornish Guardian, 2014). At the River Severn, the banks were overtopped when a large tidal bore arrived and caused 'several inches' of flooding of roads and houses in Minsterworth, Maisemore, Elmore and Newnham (BBC, 2014b). On the south coast at Hastings, large parts of the cliffed coastline eroded from the storm wave impacts (Metro, 2014). In north Wales, about 30 properties were flooded causing some people to be trapped at home by water up to waist deep (BBC, 2014c). In Jersey, flooding led to the closure of several roads (Jersey Evening Post, 2014). In combination with a successive Atlantic depression in the following days, approximately 110 coastal defences were damaged in Wales, with an estimated financial impact of £2.8 million (Natural Resources Wales, 2014). The total economic losses were estimated in excess of €75 million.

Supplemental description of impacts

South-west England

Cornwall suffered particularly badly during this event, and much detail is provided by Andrew (2014) reporting the cumulative damages experienced across the county over the 2013/2014 season. Damages were widespread and localised flooding occurred in many places from 3rd to 6th January, including Looe, Mevagissey, Bude, Flushing, Hayle, Polperro, Fowey, Perranporth, Wadebridge, Seaton, Portreath and St. Ives. High tides and storm surge acting in combination with rainfall led to road closures when rivers burst their banks at Lerryn, Newquay and Tresillian. The railway line between Liskeard and Looe which, in part, runs very close to the coast along the East Looe River, was also closed due to flooding. A considerable number of properties were flooded. High tides combined with swell waves flooded 60 properties in Looe (at least 5 of which internally), and some shopkeepers on Fore Street reported flood water of up to 0.1 m deep throughout their premises (Cornwall Council, 2014a). Overtopping of harbour defences at Porthleven flooded a further 5 properties (Cornwall Council, 2014b), while in Fowey 8 properties were flooded during 31st December and 9th January (Cornwall Council, 2014c), and also in Penzance (Andrew, 2014).

Widespread impacts resulting from strong wave action (with wave heights of around 6 m reported from the Bristol Channel buoy) were caused to sea defences, including damage to the harbour wall at Portreath and collapse of a large section of the sea wall at Seaton, with total repair costs at both sites amounting to over £1 million (Watkins, 2014). At Portreath, there was a partial collapse of the Eastern Breakwater, while waves also caused damage to the sea wall at Newquay (Andrew, 2014). Other impacts included damage to the Ancient pier at Lamorna Quay near Penzance (Watkins, 2014), a grade two listed structure built in 1850 with notable heritage value, and also the Finger Pier at Portreath (Andrew, 2014). A considerable amount of erosion occurred at Fistral Beach in Newquay, exposing the front of the RNLI station and Fistral Surf Centre (Andrew, 2014). Significant morphological impacts were also felt at Seaton, including changes to the beach profile and flow of the river. Further key impacts include the indirect economic consequences of significant damage to the South West Coast Path (collectively, over the entire season) which is a key touristic attraction with an estimated value of over £180 million per annum for the regional economy (Andrew, 2014).

In Devon, the most significant impacts were felt in the northern locations, including Westward Ho!, Ilfracombe, Lynmouth and Bideford, with Salcombe and Kingsbridge along the south also being badly affected (Devon County Council, 2014). Other impacted locations include Bishops Tawnton, Instow, Stoke Gabriel, Totnes and Lee. In Topsham, some areas including The Quay and Strand saw flood waters up to 0.5 m deep. Coastal flooding caused flooding to at least 9 properties in Lynmouth, 5 (commercial) properties in Salcombe, and 3 in Dartmouth with further reports of flooded properties in several other locations (Devon County Council, 2014). Waves caused the loss of a 5 m section of the sea wall at Instow, resulting in flooding of the highway and threatening some seafront properties. Similar damage was also reported for Ilfracombe, where significant volumes of overtopping affected several seafront properties (Devon County Council, 2014; The Telegraph, 2014).

Along the River Severn, already swollen due to rainfall, a tidal bore travelling up the river burst the river banks at several locations, resulting in

many homes being flooded (BBC, 2014b). Affected areas included Minsterworth, Maisemore, Elmore and Newnham, although the Environment Agency noted that defences in other locations were also close to failing.

Wales

Over 100 flood warnings were issued during early January across Wales, an unprecedented number in recent years (Natural Resources Wales, 2014). Reports suggest Barmouth, northwest Wales, was the first place to encounter flooding at around high tide on Friday morning (Daily Post, 2014a). With waves crashing over sea defences, 15 properties were evacuated. Around 100 people were evacuated to a school in Aberystwyth and a community centre in Borth (BBC, 2014d). About 30 properties were flooded in Cardigan, and some people were trapped in their homes (BBC, 2014c). Emergency services undertook evacuations at several other locations across northwest Wales, including 4 persons at Llanbedr where there were reports of waist-deep water in some places, and the owner of a seafront café in Barmouth had to be rescued from a rooftop. A further 9 people had to be rescued close by at Pwllheli. In Trearddur Bay, Anglesey, flood waters forced motorists to abandon their vehicles on the road, with subsequent cancellations to bus services (Daily Post, 2014a). Many other road closures were experienced across the region, and several train services were also affected (Daily Post, 2014b).

Wave heights of over 6m were reported at Aberporth Buoy, close to the western coast near New Quay, Wales (Sibley *et al.*, 2015). In Aberystwyth, severe overtopping resulted in significant damages to the sea wall and the nearby road, and a car was also washed away when a driver mistakenly took a wrong turn (whom was subsequently rescued having luckily been washed on to the shore) (BBC, 2014a). Overtopping of sea defences between Prestatyn and Rhyl was observed (Newsflare, 2014).

The overall consequences of the January storms for Wales were very significant, with impacts observed around the entire coastline. According to Natural Resources Wales (2014), between 2nd and 6th January around 150 properties were flooded in Wales, and a further 415 indirectly affected. During the month, there were evacuations at Aberystwyth, Cardigan, and in areas of Wales, and coastal defences suffered storm damage at 110 locations. The environmental impacts included local erosion and loss of beach, damages to 37 SSSI's and 10 SAC's, and the Wales Coastal Path was damaged at over 70 locations. Around 360 ha [3.6 km²] of agricultural land was reported to have been flooded or impacted, roughly 200 ha [2 km²] of which was at Llanbedr.

Isle of Man

Much of the Isle of Man suffered from flooding also, including Ramsey, Castletown, Douglas, Peel, Port St Mary, Gansey and Laxey (Flood Support UK, 2015), although media reports seem to have largely overlooked the impacts felt here. Many roads and promenades were closed due to the rough conditions, and low-lying areas around all of the islands' ports were affected by flooding (Isle of Man Today, 2014). Reports suggest flood water levels exceeded those during the 1st February 2002, the last major event to have impacted the Isle of Man, during which an estimated £8m in damages was caused. Amateur footage available online shows large parts of Ramsay central shopping district inundated with water around high tide, with flood waters seen to have reached many businesses with apparently some residential property too, and in some cases internally. Other amateur video, although unconfirmed as far as we are

aware, appears to shown parts of Castletown flooded to a significant depth, and vehicles parked close to the seafront being floated around.

Western Scotland

In Scotland, the west coast appeared to suffer the worst impacts and localised flooding occurred in many places, with around 40 flood warnings issued by Environment Sepa in place, although conditions were not as severe as anticipated. Conditions in Helensburg were said to have been the worst in several years, with the esplanade closed having been flooded in several places (BBC, 2014e). At Port William, flood water impacted one (commercial) property, damaged coastal defences and caused flooding to the A716 north of Drummole (SEPA, 2014). There were also reports of flooding on the A747 between Glenluce and Port William, and at Carsethorn, Powfoot and Newbie (Herald Scotland, 2014). A road was also closed in Aberdeen when the River Dee burst its banks (Daily Record, 2014). Numerous other properties were affected by flooding in Portpatrick, Isle of Whithorn, Garlieston, Kirkcudbright, Annan, Carsethorn, Powfoot (BBC, 2014e). Three families from Queensberry Bay Caravan Park were evacuated to a farmhouse in Powfoot, while one other person was evacuated in Creetown and some families had to leave their homes in Port William (STV News, 2014).

Northern Ireland

Some locations in Northern Ireland experienced coastal flooding including Warrenpoint, Hollywood, Portaferry, Donaghadee and Belfast (Belfast Telegraph, 2014). Several coastal paths and many roads were closed due to flood water or in anticipation of flooding. Although the worst was avoided, many areas including Belfast were reportedly close to seeing far more severe consequences, with “walls of sandbags” built in parts of central and east Belfast (BBC, 2014f) and many properties were within inches of being flooded elsewhere. In Carnlough, the main road was closed once it had been covered in material thrown up from the beach, bringing the village to a “standstill”, and so too was the coastal road between Carnlough and Waterfoot which in part was blocked by boulders (Belfast Telegraph, 2014). The sea wall was damaged at Cushendall. Total repair costs resulting from storm and flood damages across Ireland amounted to over €60 m, around a third of which was for coastal protection works (NDFEM, 2014).

Table 1: High water levels (m CD) recorded at the UK National Tide Gauge sites that reached or exceeded a 1 in 5 year return level during the event.

Tide gauge Site	Date and time (GMT)	Return period (years)	Water level (m CD)	Astronomical tide (m CD)	Skew surge (m)
Newhaven	03/01/14 12:15	<1	7.34	7.19	0.15
Portsmouth	03/01/14 12:30	7	5.49	4.91	0.58
Weymouth	03/01/14 08:00	13	2.94	2.53	0.41
Devonport	03/01/14 06:45	5	6.33	5.95	0.38
Newlyn	03/01/14 06:00	9	6.32	6	0.32
Ilfracombe	03/01/14 07:00	20	10.5	10.02	0.48
Hinkley Point	03/01/14 08:00	13	13.35	12.7	0.65
Newport	02/01/14 19:15	<1	12.68	12.74	-0.05
Mumbles	03/01/14 07:15	9	10.73	10.23	0.5
Milford Haven	02/01/14 19:00	<1	7.82	7.45	0.36
Fishguard	03/01/14 08:00	17	5.8	5.31	0.49
Barmouth	03/01/14 09:15	18	6.36	5.62	0.74
Holyhead	03/01/14 11:00	20	6.74	6.2	0.54
Llandudno	03/01/14 12:00	17	8.93	8.41	0.52
Liverpool	03/01/14 12:00	8	10.79	10.22	0.57
Heysham	03/01/14 12:15	9	11.18	10.47	0.71
Workington	03/01/14 12:30	46	9.9	9.06	0.84
Port Erin	03/01/14 12:30	68	6.62	5.83	0.79
Portpatrick	03/01/14 12:30	244	5.28	4.39	0.89
Millport	03/01/14 13:15	18	4.8	3.73	1.07
Tobermory	03/01/14 07:15	8	5.73	5.07	0.65
Stornoway	03/01/14 08:15	14	5.89	5.45	0.44
Ullapool	03/01/14 08:00	9	6.25	5.77	0.48
Kinlochbervie	03/01/14 08:30	5	5.92	5.45	0.47
Lerwick	03/01/14 12:15	<1	2.68	2.45	0.23
Wick	02/01/14 22:45	<1	3.57	3.6	-0.03
Aberdeen	03/01/14 02:15	<1	4.91	4.47	0.44
Leith	03/01/14 03:15	2	6.36	5.89	0.47
North Shields	01/01/14 15:00	<1	5.61	5.34	0.27
Whitby	02/01/14 16:30	<1	6.13	6.07	0.06
Immingham	02/01/14 18:30	<1	7.6	7.56	0.04
Cromer	02/01/14 19:00	<1	5.37	5.31	0.05
Lowestoft	02/01/14 22:00	<1	2.79	2.77	0.02
Harwich	03/01/14 00:15	<1	4.42	4.19	0.23
Dover	02/01/14 23:45	<1	7.1	6.92	0.18

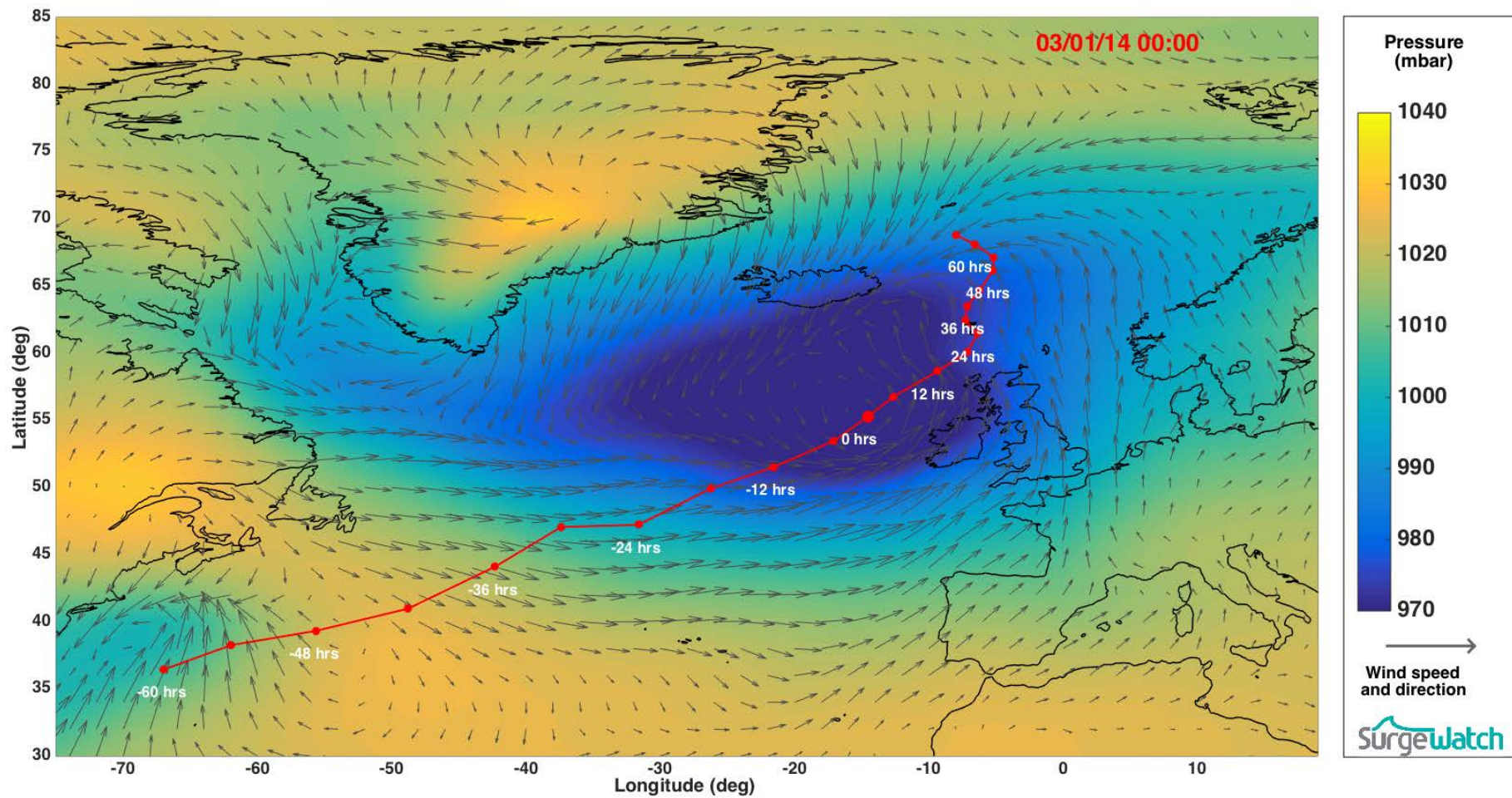


Figure 1: Meteorological conditions at time of maximum water level overlaid by the storm track

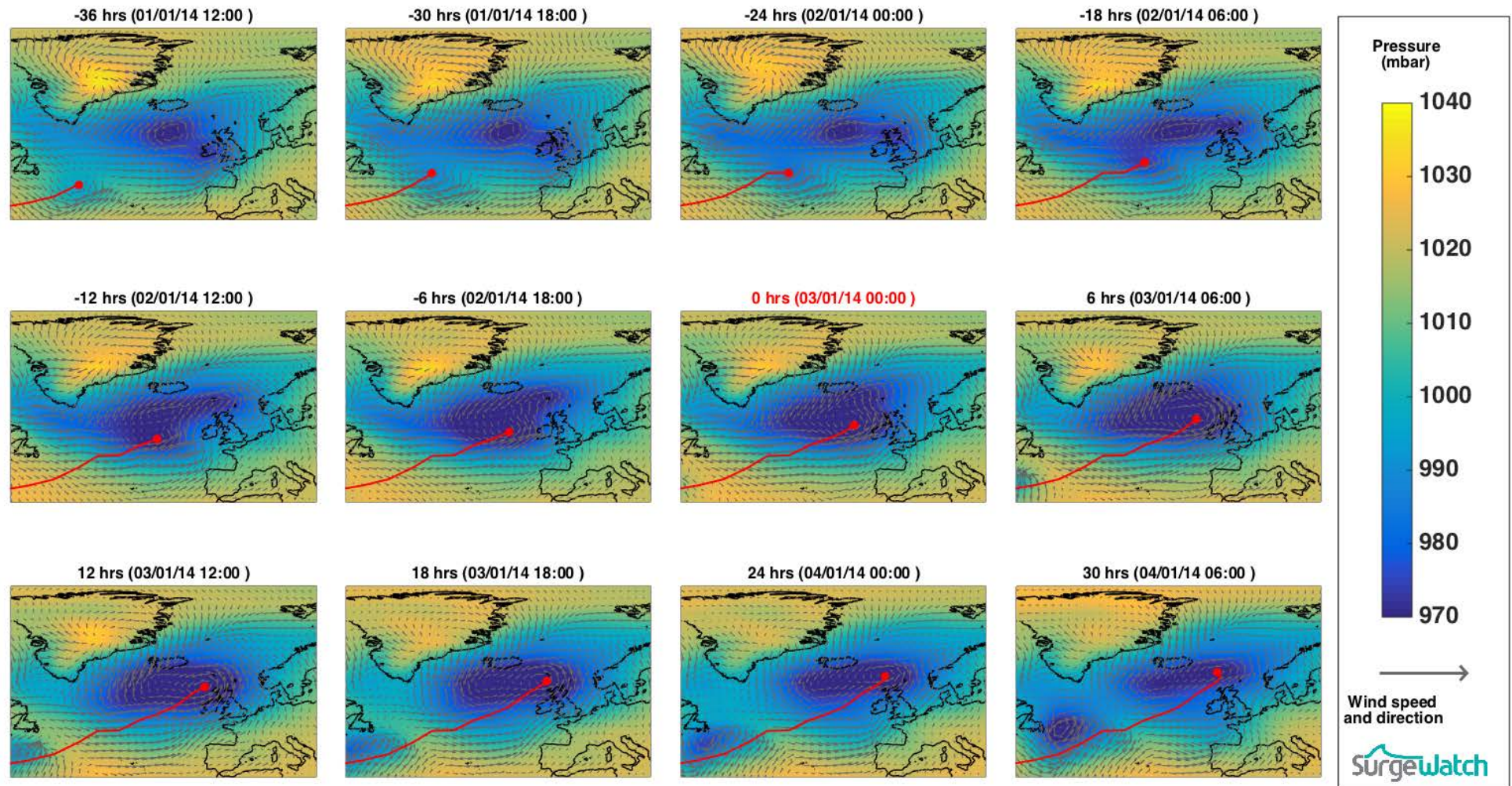


Figure 2: Meteorological conditions during event

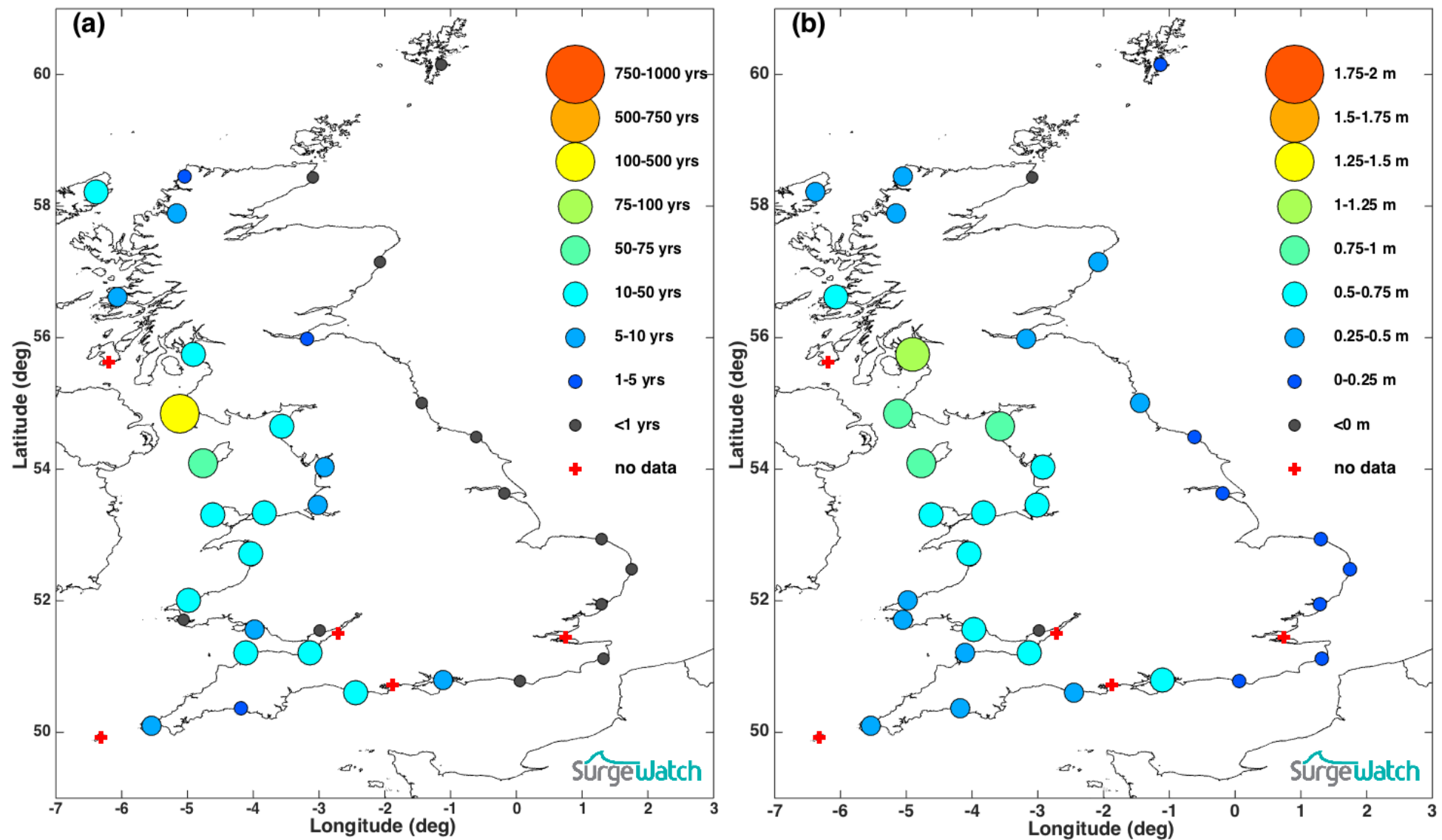


Figure 3: (a) Water level return period; (b) Skew surge levels

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