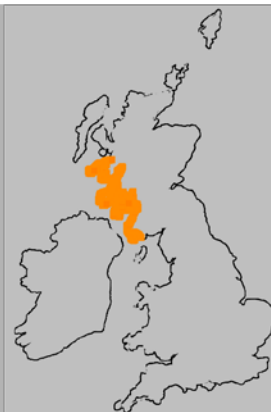


# STORM EVENT

— 5<sup>th</sup> January 1991 —

*Storm 'Undine' hits the UK, flooding streets, damaging coastal defences, and causing the death of 30 persons*



## Severity Ranking



Social	<u>Loss of life</u>	*
	<u>Residential property</u>	*
	<u>Evacuation &amp; rescue</u>	*
Economic	<u>Cost</u>	Damages in the Firth of Clyde totaled £7 million. £4.6 million in damages was incurred in other Scottish districts.
	<u>Ports</u>	*
	<u>Transport</u>	Flooding of streets in Helensburgh and Millport
	<u>Energy</u>	*
	<u>Public services</u>	*
	<u>Water &amp; wastewater</u>	*
	<u>Livestock</u>	*
	<u>Agricultural land</u>	*
Environmental	<u>Coastal erosion</u>	Sand dunes were eroded at Ardrossan
	<u>Natural environment</u>	*
	<u>Cultural heritage</u>	*
	<u>Coastal defences</u>	Defences at Ardrossan, Helensburgh and Millport experienced much damage

*\*No known sources of information available*

**Source**

The storm developed off the US northeast coast on 2<sup>nd</sup> January 1991 and moved northeastwards towards the UK crossing Scotland. The central pressure dropped to a minimum of approximately 946 mbar as the storm approached the UK on 5<sup>th</sup> January (Irish Meteorological Service, 1991). By midnight, the storm was over the northeast of Scotland and the central pressure was 959 mbar. The storm then moved off over the North Sea, crossing Norway (Harwood, 2012). A strong southerly gale developed ahead of the storm and affected Ireland, southern Scotland, England, and Wales. Maximum 10-minute average wind speeds at 14 weather stations around the UK ranged from 37 to 54 knots [19–28 m/s] with gusts of 63 to 83 knots [32–43 m/s]. In Ireland (near Connemara), average 10-minute wind speeds of 60 knots [31 m/s] with gusts of up to 90 knots [46 m/s] were recorded.

The storm generated skew surges of over 1 m in the Irish sea and between 0.5 m and 1 m in the southern North Sea. Water levels exceeded the 1 in 5 year return level at two sites, both in the Irish Sea; the high water levels there were thus fairly localized. The highest return period water level was at Portpatrick and was 1 in 134 years. At Millport the water level had a return period of 1 in 81 years. The highest skew surge was at Millport and was 1.31 m (Hickey, 1997).

Waves of 30 m in height were recorded off the UK west coast and computer models suggested significant wave heights of up to 15 m on 5<sup>th</sup> January.

**Pathway**

The stormy conditions during this event caused overtopping of defences in many locations around the UK, most notably in the Firth of Clyde.

**Receptor & Consequence**

This event is noted for causing extensive and costly damage to parts of the western and southern coasts, from Starthclyde to Sussex as sea defences were overwhelmed (Met Office, 1991). In Scotland, the Helensburgh waterfront was completely submerged and some streets flooded to a level of up to 1 m. In Millport, the sea front and promenade were flooded, and 50 m of the promenade was washed away, and many streets were covered by up to 0.35 m of water. There was extensive damage to coastal defences at Ardrossan, Helensburgh and Millport and sand dune erosion at Ardrossan (Hickey, 1997). There was severe coastal flooding in the Firth of Clyde totaling £7 million in damages (Kaya *et al.*, 2005); with Rothesay, Dumbarton Central, and Dumbarton East suffering a total of £4.6 million in damages (Mcnair, 1998). This storm resulted in the commissioning of the Clyde Estuary Flood Warning system, operated by the Scottish Environment Protection Agency (SEPA) since 2001 (Kaya *et al.*, 2005).

Gusts brought down trees and power lines, and thousands of homes were without power in Ireland and southwest England (*The Canberra Times*, 1991). Thirty fatalities were attributed to the storm, in the UK, Ireland and Germany (Munich RE, 2012). This included a couple walking on the beach in Brighton who were swept away. Undine was one of the costliest winter storms of the 1990's, with estimated damages of £545 million (*The Telegraph*, 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	04/01/91 01:00	<1	6.91	6.78	0.13
Newlyn	04/01/91 07:00	<1	5.73	5.61	0.12
Ilfracombe	04/01/91 08:00	<1	9.42	9.42	0
Hinkley Point	04/01/91 09:00	<1	11.99	11.88	0.11
Avonmouth	04/01/91 10:00	<1	13.38	13.13	0.25
Mumbles	04/01/91 09:00	<1	9.71	9.65	0.06
Fishguard	05/01/91 10:00	<1	5.17	4.76	0.42
Holyhead	05/01/91 13:00	<1	6.12	5.7	0.42
Heysham	05/01/91 15:00	<1	10.29	9.42	0.87
Portpatrick	05/01/91 15:00	134	5.16	4.07	1.1
Millport	05/01/91 15:00	81	5.07	3.76	1.31
Tobermory	04/01/91 08:00	<1	5.37	4.77	0.6
Stornoway	04/01/91 09:00	<1	5.49	5.11	0.38
Ullapool	04/01/91 09:00	<1	5.87	5.45	0.41
Lerwick	04/01/91 13:00	<1	2.71	2.36	0.35
Wick	04/01/91 14:00	<1	4.06	3.71	0.35
Aberdeen	04/01/91 16:00	<1	4.61	4.42	0.19
North Shields	04/01/91 18:00	<1	5.2	5.18	0.03
Whitby	04/01/91 19:00	<1	5.54	5.52	0.03
Immingham	04/01/91 20:00	<1	7.19	7.09	0.11
Cromer	06/01/91 22:00	<1	5.02	4.46	0.56
Lowestoft	06/01/91 14:00	<1	2.86	2.15	0.7
Sheerness	06/01/91 16:00	<1	6.08	5.24	0.84
Dover	04/01/91 01:00	<1	6.96	6.69	0.27

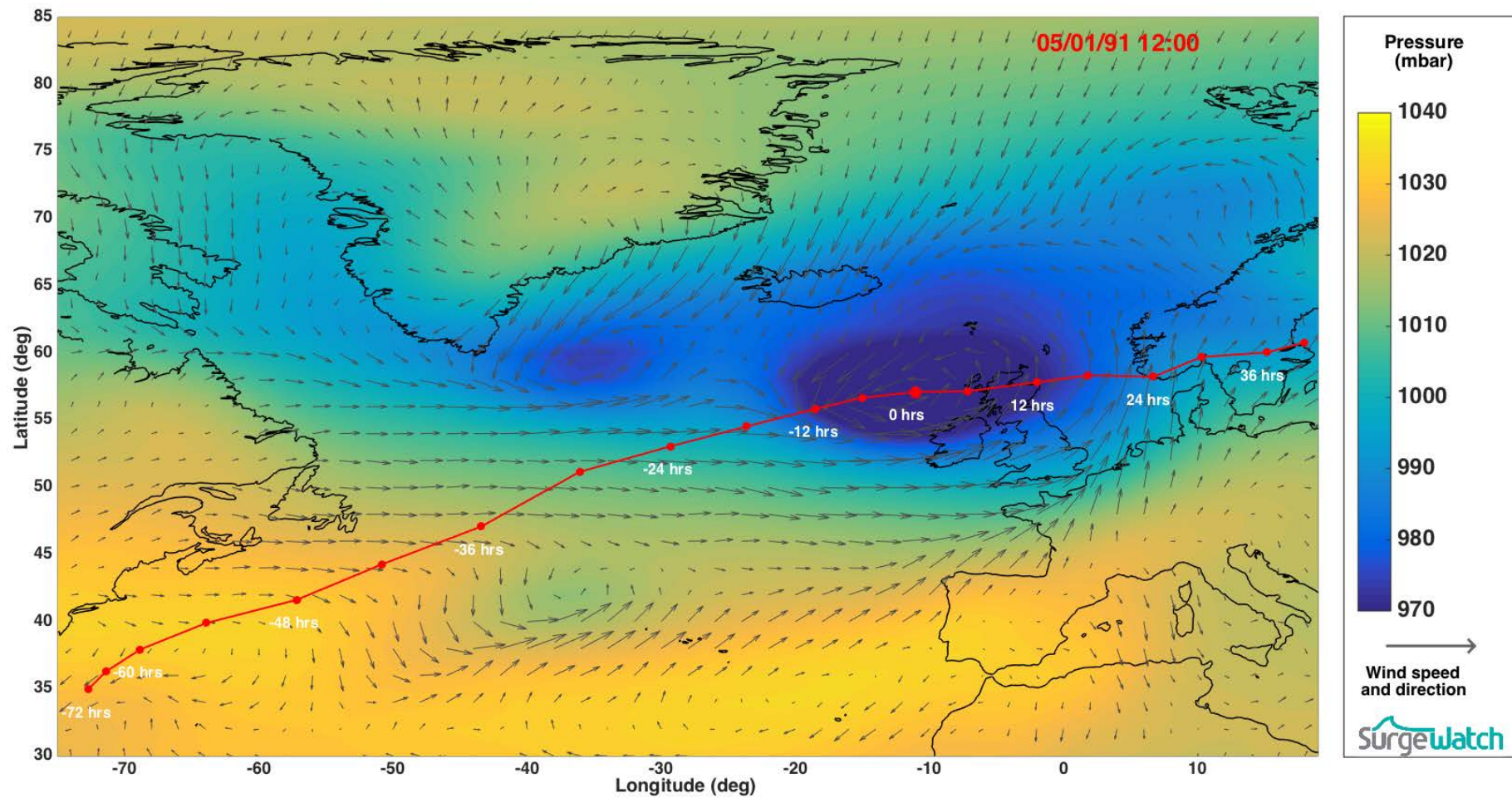


Figure 1: Meteorological conditions at time of maximum water level overlaid by the storm track



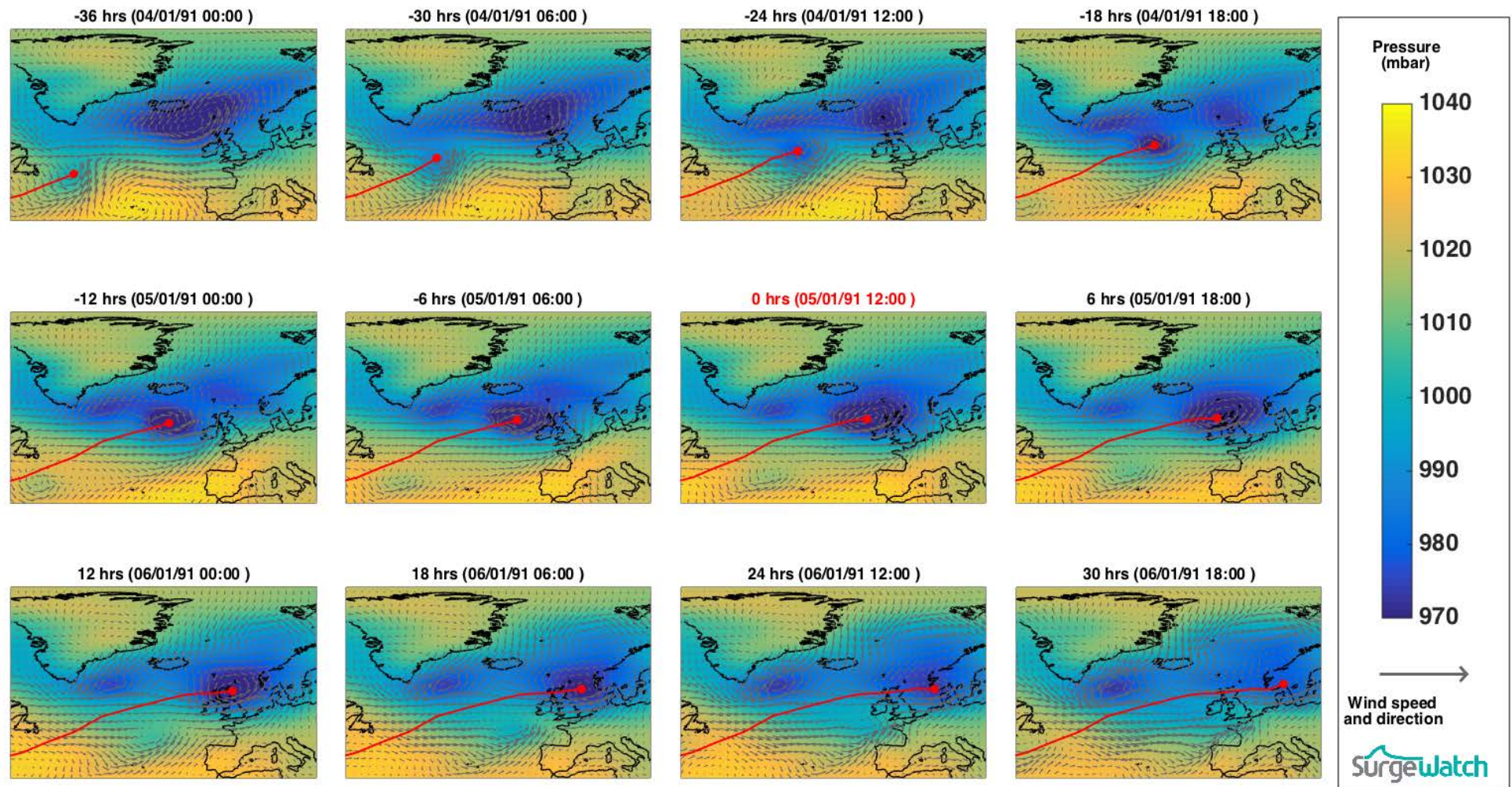


Figure 2: Meteorological conditions during event

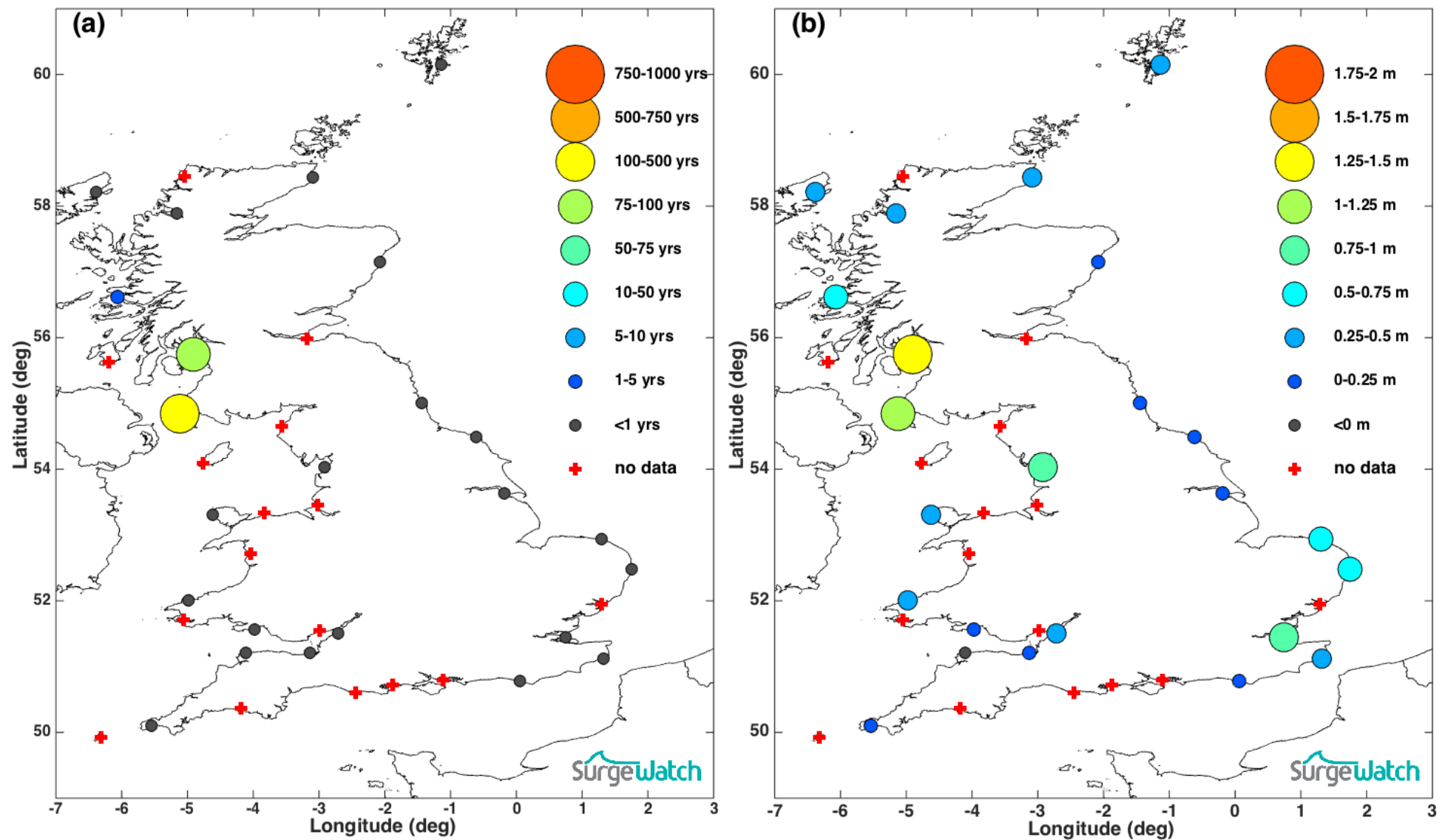


Figure 3: (a) Water level return period; (b) Skew surge levels

## References

- The Telegraph, 2014. The top 10 worst UK storms. Available at: <http://www.telegraph.co.uk/sponsored/motoring/weather-watch/10587590/most-expensive-storms.html> [Accessed September 11, 2015].
- The Canberra Times, 1991. Killer gales leave British Isles in chaos. *The Canberra Times*. Available at: <http://trove.nla.gov.au/ndp/del/article/122335734>.
- Munich RE, 2012. *Significant natural catastrophes in Europe 1980 – 2011 10 costliest winter storms with storm surges ordered by overall losses*, Munich. Available at: [https://www.munichre.com/site/corporate/get/documents\\_E1385616822/mr/assetpool.shared/Documents/0\\_Corporate Website/6\\_Media Relations/Press Dossiers/50th anniversary storm surge hamburg/euope-costliest-storm-surges-en.pdf](https://www.munichre.com/site/corporate/get/documents_E1385616822/mr/assetpool.shared/Documents/0_Corporate Website/6_Media Relations/Press Dossiers/50th anniversary storm surge hamburg/euope-costliest-storm-surges-en.pdf).
- Met Office, 1991. Monthly Weather Report of the Meteorological Office. *Monthly Weather Report*, 108(1). Available at: <http://www.metoffice.gov.uk/learning/library/archive-hidden-treasures/monthly-weather-report-1990s>.
- McNair, A., 1998. Facing barrage in the front line. *The Herald Scotland*.
- Kaya, Y., Stewart, M. & Becker, M., 2005. Flood Forecasting and Flood Warning in the Firth of Clyde, UK. *Natural Hazards*, 36, pp.257–271.
- Irish Meteorological Service, 1991. Storm causes death and destruction. *Monthly Weather Bulletin published by the Meteorological Service*. Available at: <http://www.met.ie/climate/MonthlyWeather/clim-1991-Jan.pdf> [Accessed August 9, 2015].
- Hickey, K.R., 1997. *Documentary records of coastal storms in Scotland, 1500-1991 A.D.* Coventry University. Available at: <https://curve.coventry.ac.uk/open/items/aa6dfd04-d53f-4741-1bb7-bdf99fb153be/1/>.
- Harwood, P., 2012. Winter Storm Undine (1991). *eSurge*. Available at: <http://www.storm-surge.info/winter-storm-undine-1991> [Accessed September 23, 2015].

## Additional sources of information

- Weather-history, 2006. Winter 1990-1991 The great December snowstorm/February freeze. Available at: <http://forum.netweather.tv/topic/34026-winter-1990-91-the-great-december-snowstormfebruary-freeze/> [Accessed September 10, 2015].
- University of East Anglia, 2005. *Western/Central/Eastern Europe and Southern Alps winter storms and river flooding - causes and damages*, Available at: [https://crudata.uea.ac.uk/projects/stardex/deliverables/D9/D9\\_FTS\\_tables.pdf](https://crudata.uea.ac.uk/projects/stardex/deliverables/D9/D9_FTS_tables.pdf).