



National Oceanography Centre Southampton
University of Southampton and
Natural Environmental Research Council

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Southampton

Lessons learnt from examining 100 years of coastal flood events around the UK

Ivan Haigh
Associate Professor in coastal
Oceanography

Ocean and Earth Science,
National Oceanography Centre,
University of Southampton

I.D.Haigh@soton.ac.uk
[@ivanhaigh](https://twitter.com/ivanhaigh)
www.surgewatch.org



1. Introduction

Florida, Hurricane Irma

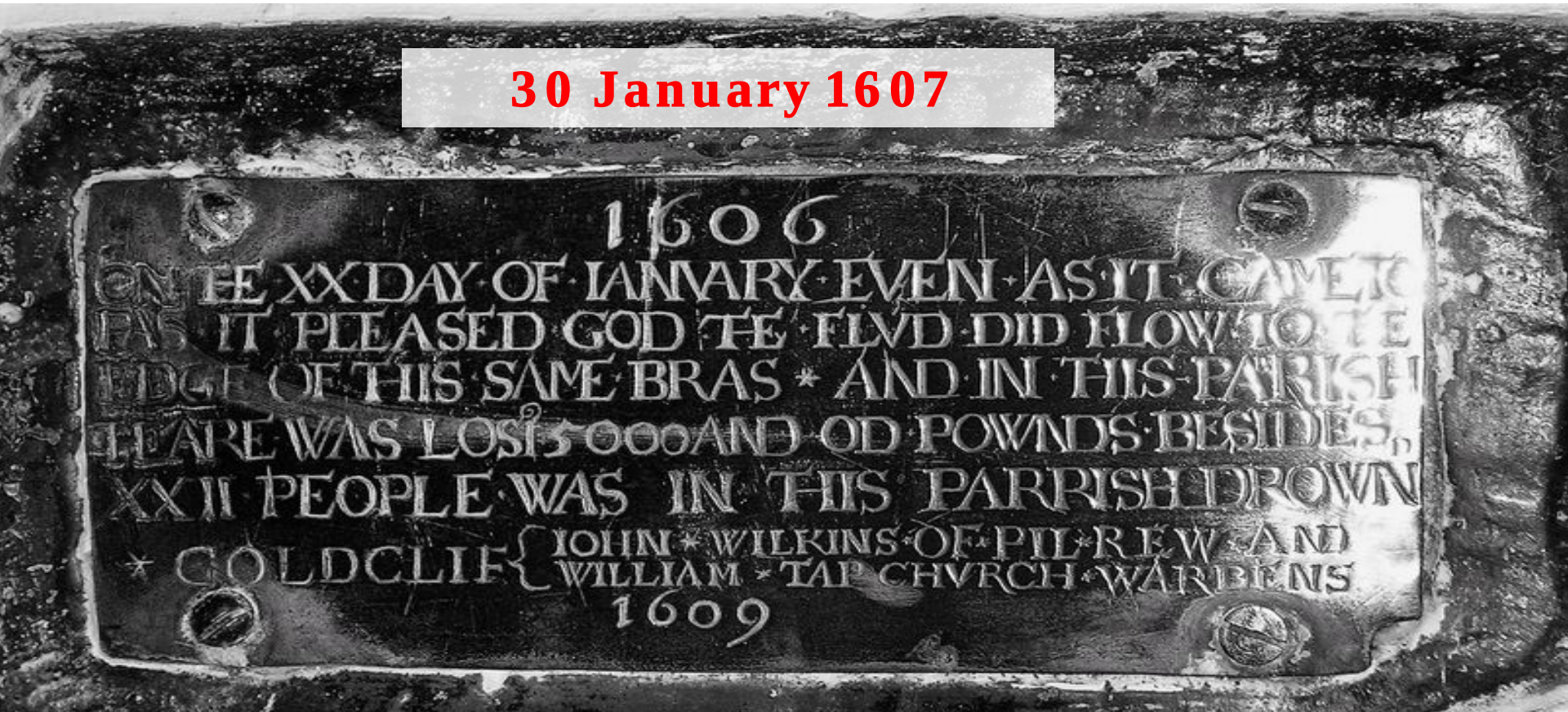


Source: <http://newsmediainsider.blogspot.com/2010/08/katrina-survivor-talks-about-escaping.html>

1. Introduction

Coastal floods have always happened. They are not a new phenomena. The UK has a long history of coastal flooding!

30 January 1607



The greatest loss of life from a natural catastrophe in the UK during the last 500 years

1. Introduction

7-8 December 1703



Washed away the lowermost street of houses at the village of Brighthelmstone (today's Brighton) described by Defoe as 'the very picture of desolation, that it looked as if an enemy had sacked it'.

1. Introduction

**31st Jan – 1st Feb 1953
'Big Flood'**



Completed 1982 (30 years later)

1. Introduction

13 – 17 December 1989

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Whitby 5 December 2013



Chesil Beach 1 January 2014





**Somerset levels
2 February 2014**

<http://www.metoffice.gov.uk/climate/uk/interesting/2014-janwind>

Cornish coast Porthleven 5 February 2014



Dawlish 5 February 2014



<http://www.metoffice.gov.uk/climate/uk/interesting/2014-janwind>

Dawlish 7 June 2013



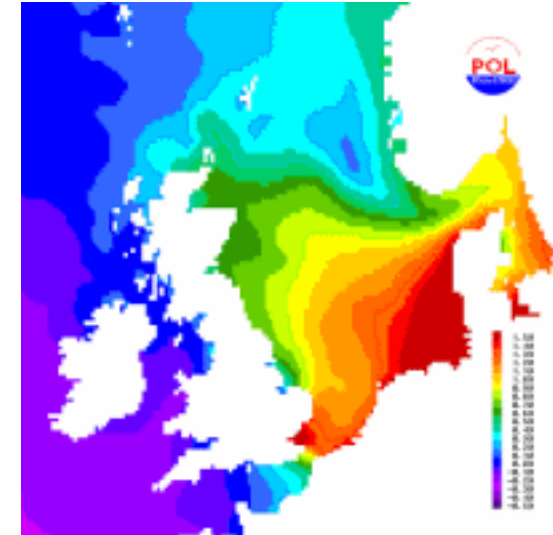
1. Introduction

We have:

- UK Flood Forecasting Centre (FCC) (Met. Office, EA - NOC);
- UK National Tide Gauge Network (NOCL);
- Database of extreme exceedance probabilities (EA).

We don't have:

1. Record of whether high waters progress to coastal flooding;
2. Systematic document information on the extent of coastal floods and associated consequences.



UK Tide Gauge Network



2. SurgeWatch

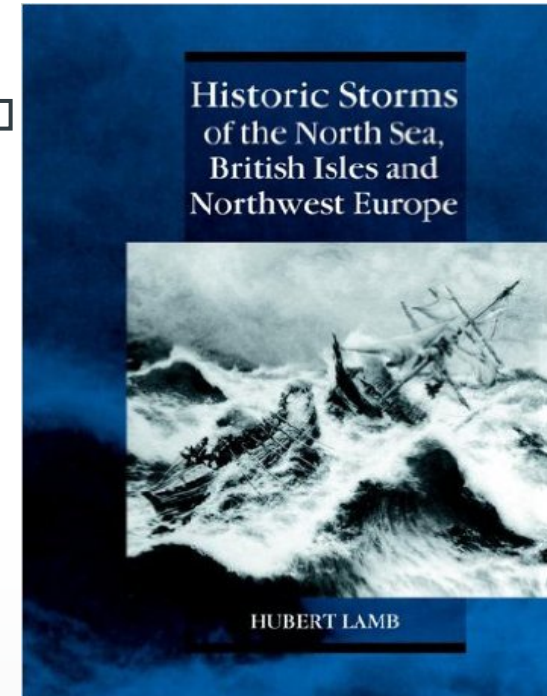
Ver1: Hard Data



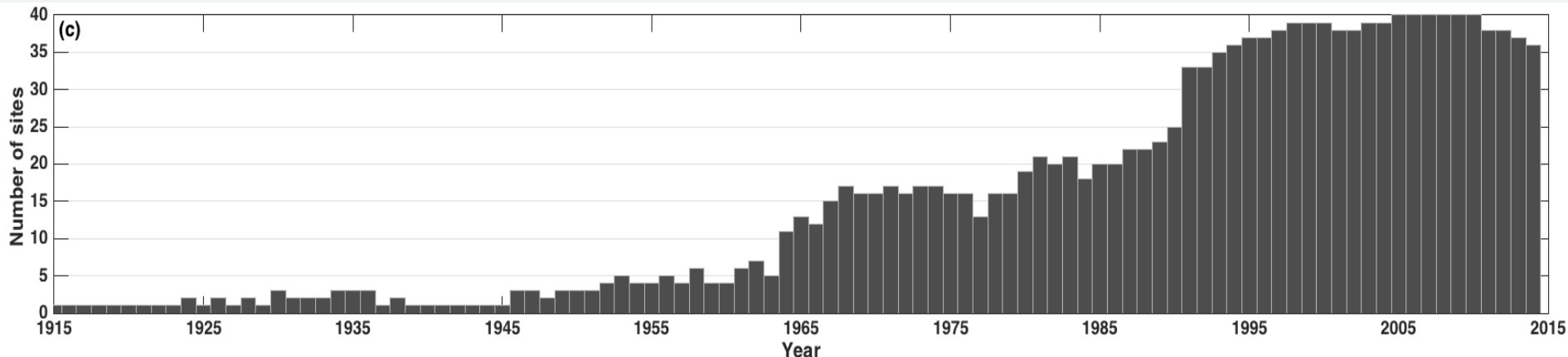
A interactive and user friendly database of UK coastal flood events for the last 100 years (1915-2017).

SurgeWatch

Ver2: Soft Data



☐ >1 in 5 year return level - 96 events (45 of which led to flooding)



2. SurgeWatch

1. Zong & Tooley (2003);
2. Stevens et al. (2014)
3. Hickey (1997)
4. Eden (2008)
5. Lamb (1991)
6. Davison et al (1993)
7. Kundewicz et al (2012)
8. Ruocco et al (2011)

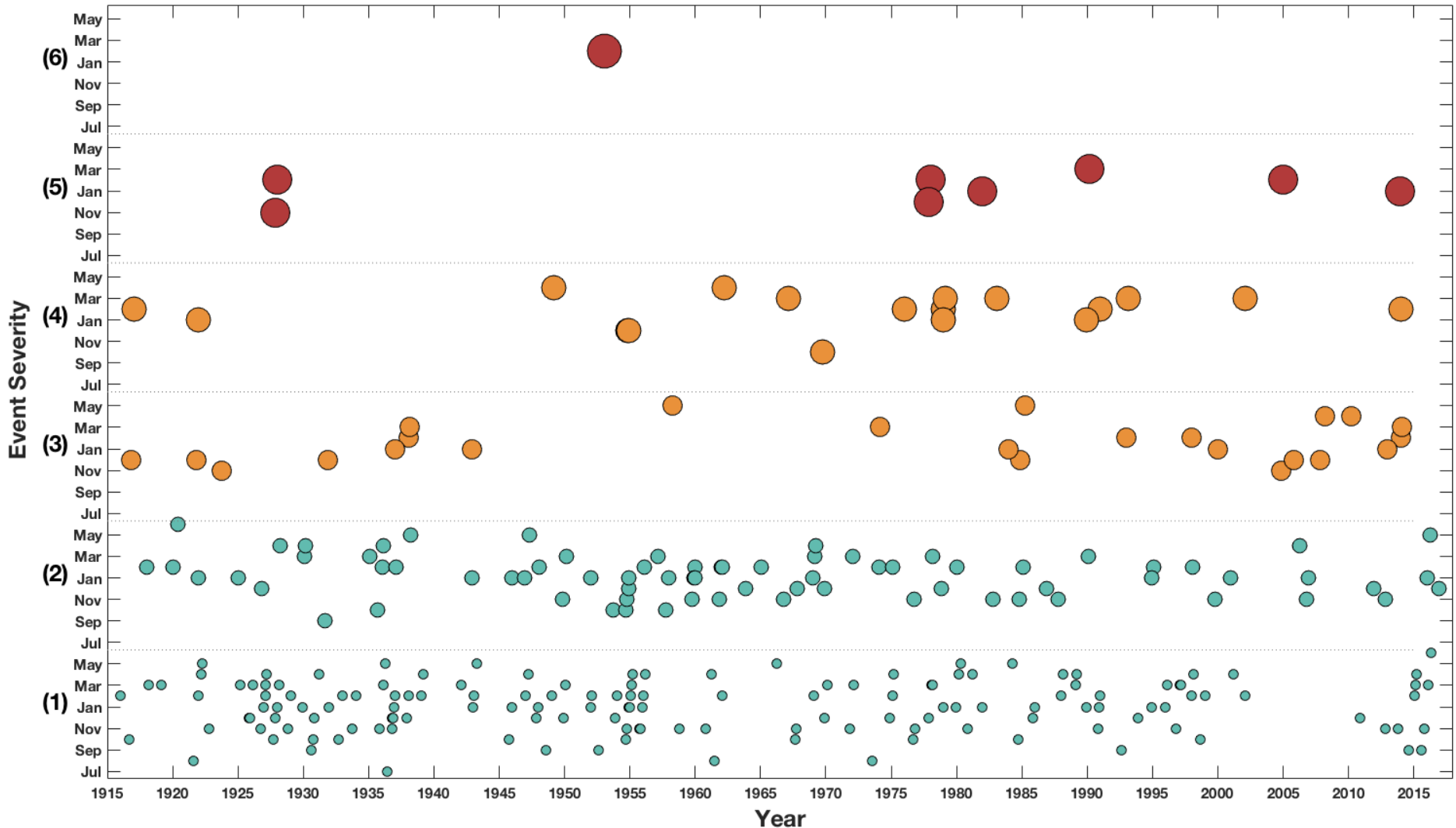
45 → 330 coastal
Flooding events

**Simple ranking
system:**

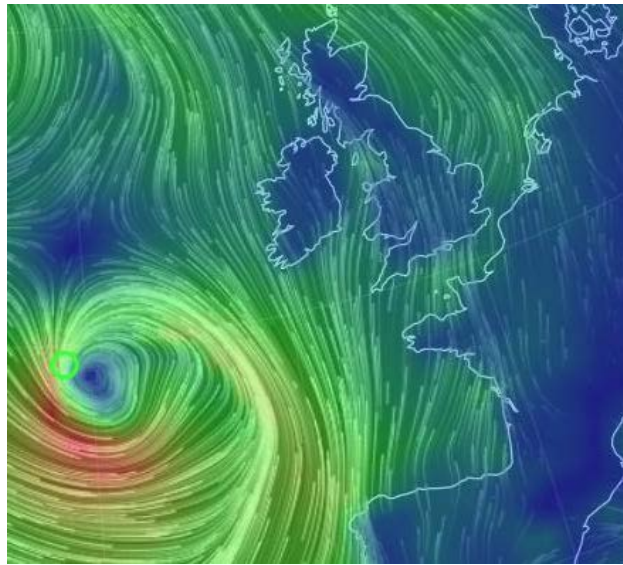
1. Nuisance floods
2. Minor floods
3. Moderate floods
4. Major floods
5. Severe flood
6. Disaster

2. SurgeWatch

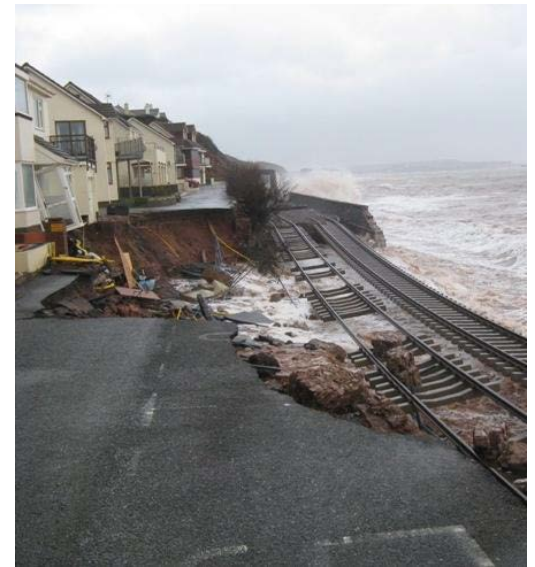
Simple ranking system:



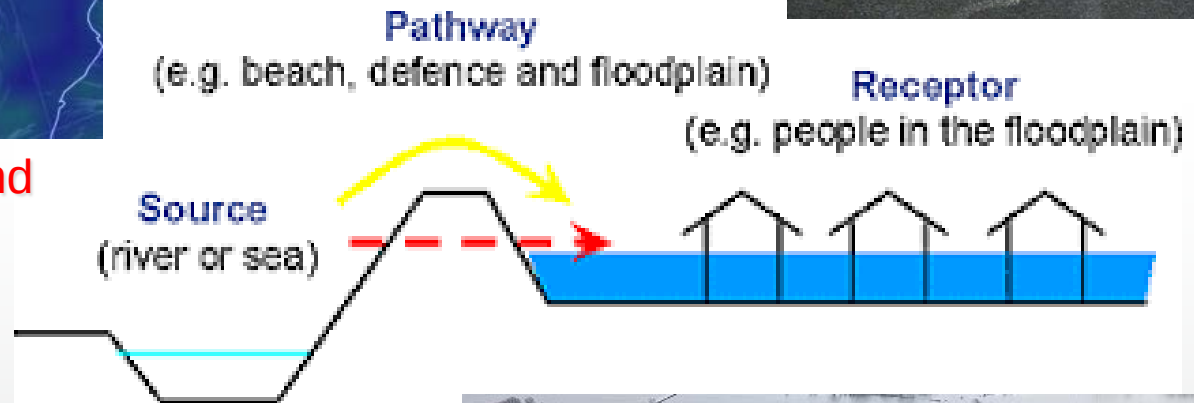
2. SurgeWatch



Overtopping or
Breach



track, pressure & wind



Social, economic
& environmental
Consequence



Total = waves + surge
+ tides + MSL

SurgeWatch

STORM EVENT

3rd January 2014

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

Severity Ranking

4

Social

Loss of life	*
Residential property	Over 250 properties flooded in various locations
Evacuation & rescue	Around 100 persons in Scotland evacuated

Economic

Cost	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
Ports	*
Transport	Railway track and the Coastal Path in Wales were damaged; flood of many coastal roads
Energy	*
Public services	One police station on the Isle of Man closed
Water & wastewater	*
Livestock	*
Agricultural land	3.5 km ² of agricultural land in Wales either inundated or impacted

Environmental

Coastal erosion	"Large" parts of the coastline in Hastings eroded
Natural environment	37 SSSI's and 10 SAC's in Wales impacted (during this event and over preceding/forthcoming days)
Cultural heritage	*
Coastal defences	*

*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

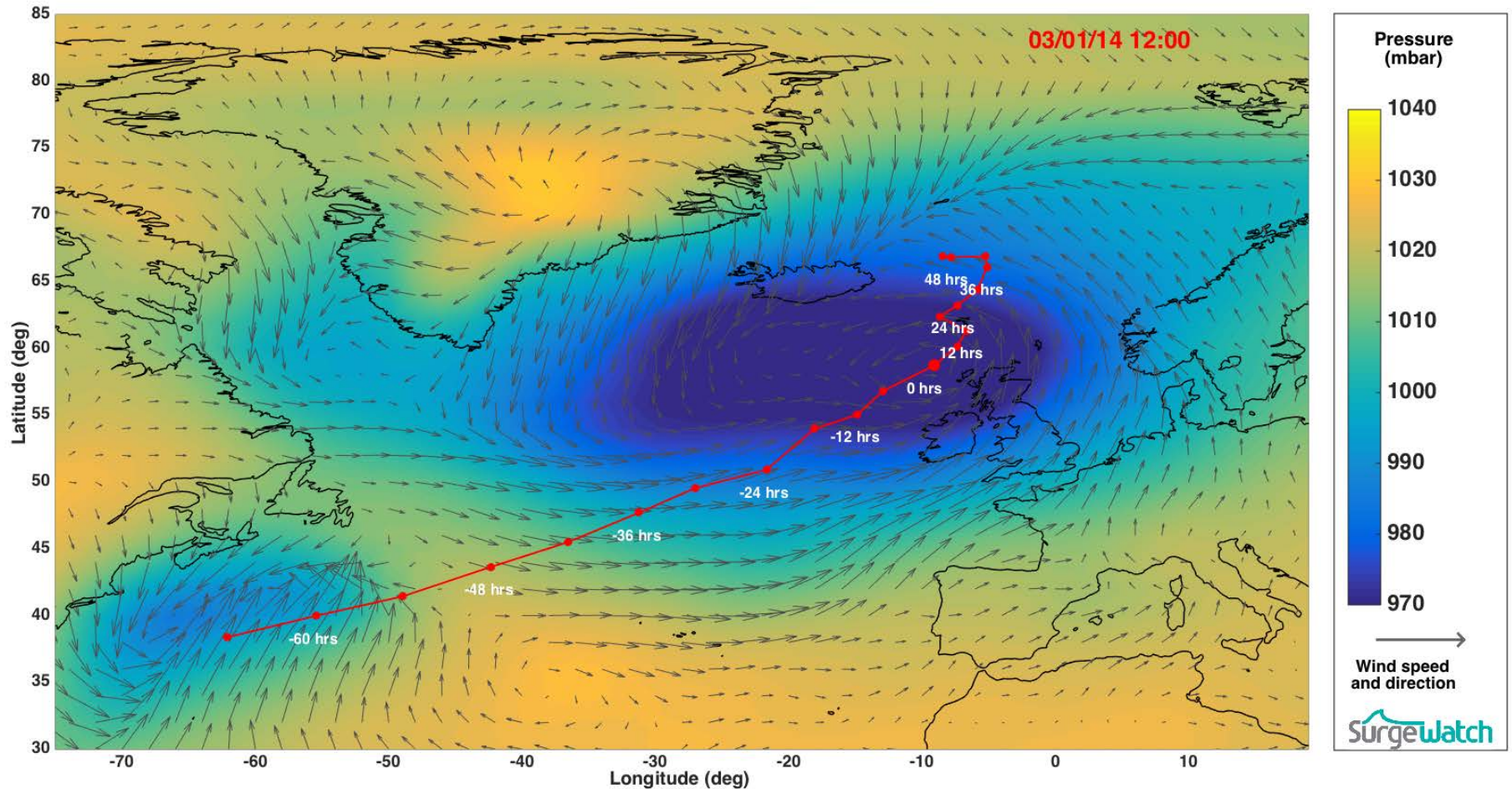
The flood pathways during this event were primarily overtopping observed in many locations across the southwest and west coasts.

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.

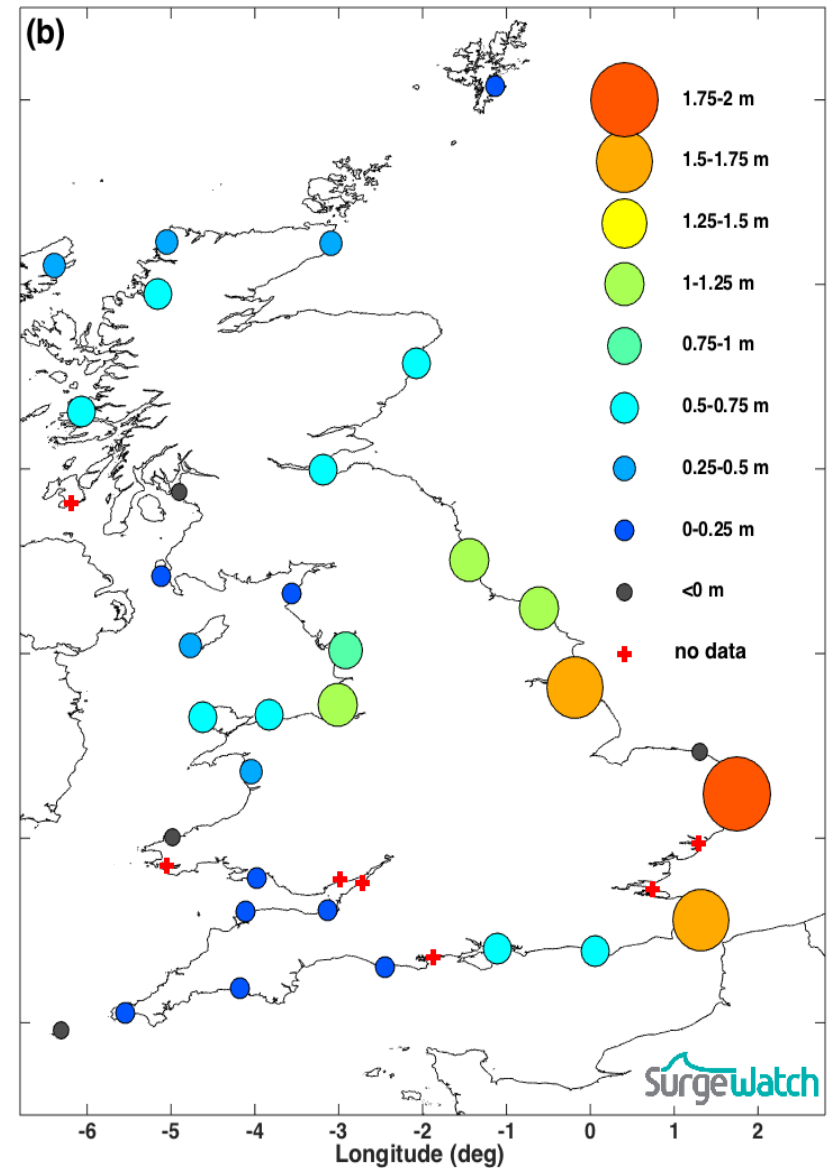
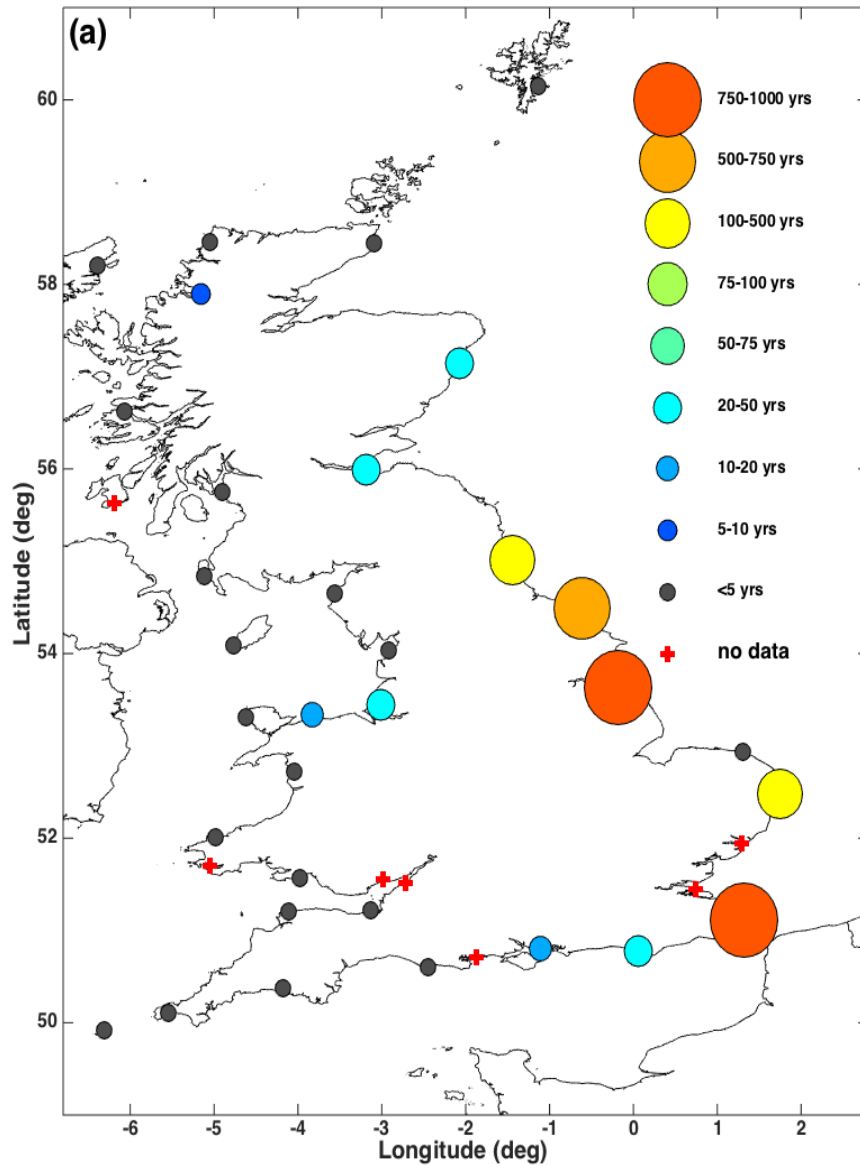
2. SurgeWatch

Example Storm track – 3rd January 2014



NOAA 20th Century meteorological Reanalysis
http://www.esrl.noaa.gov/psd/data/20thC_Rean/

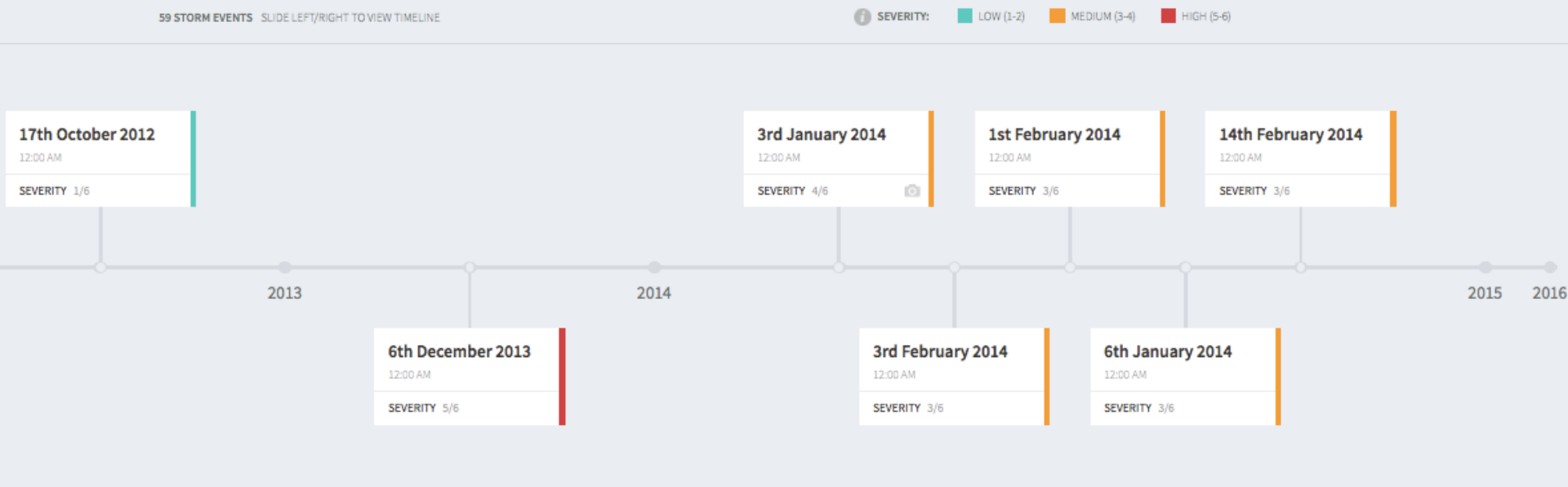
2. SurgeWatch



2. SurgeWatch

www.surgewatch.org

Please, please help us promote the site: Follow us on facebook and twitter: @surgewatch



Do you have any photos of coastal flooding for the UK? We would be grateful if you could upload these to improve our understanding of coastal floods – your contribution will be fully acknowledged.

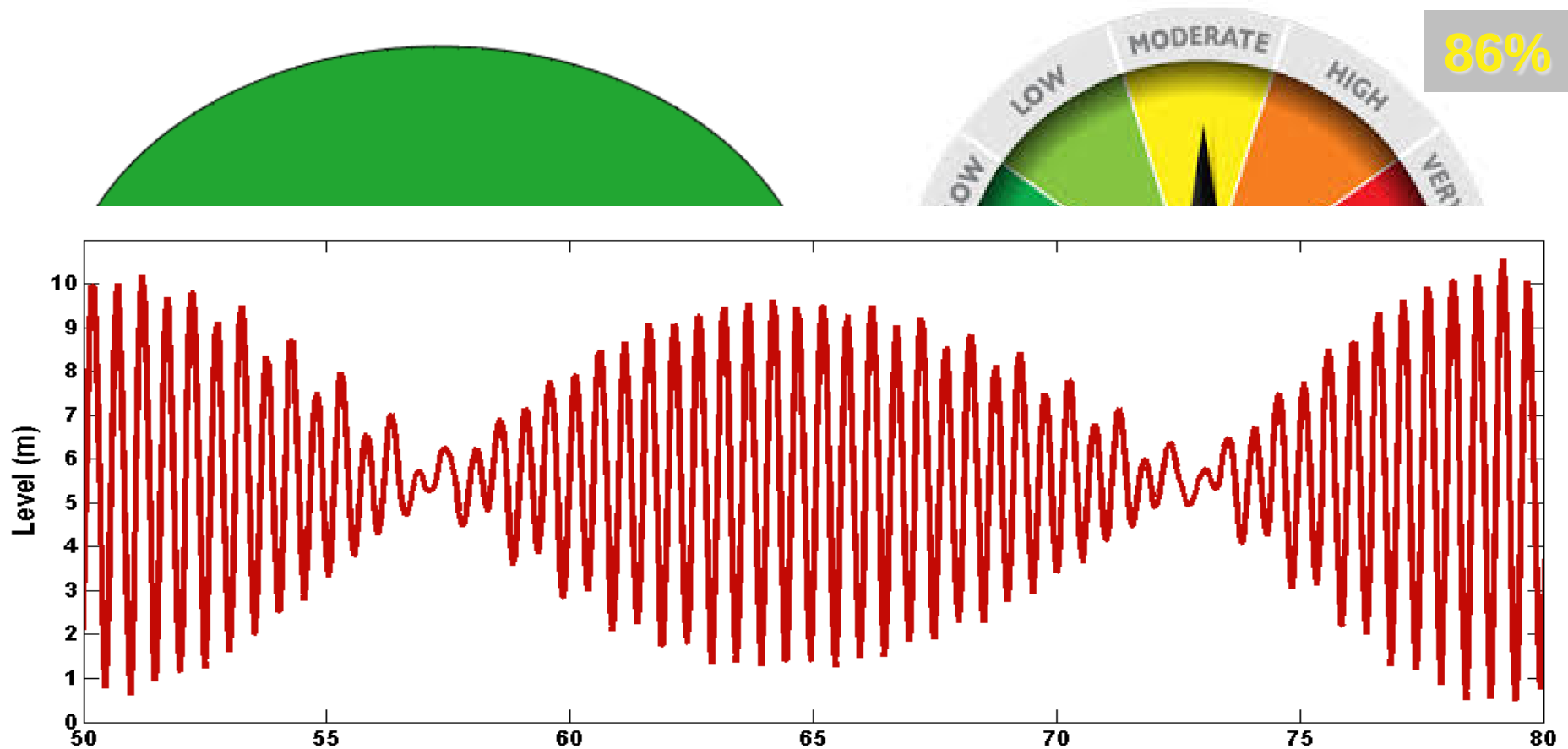
Contribute Photos





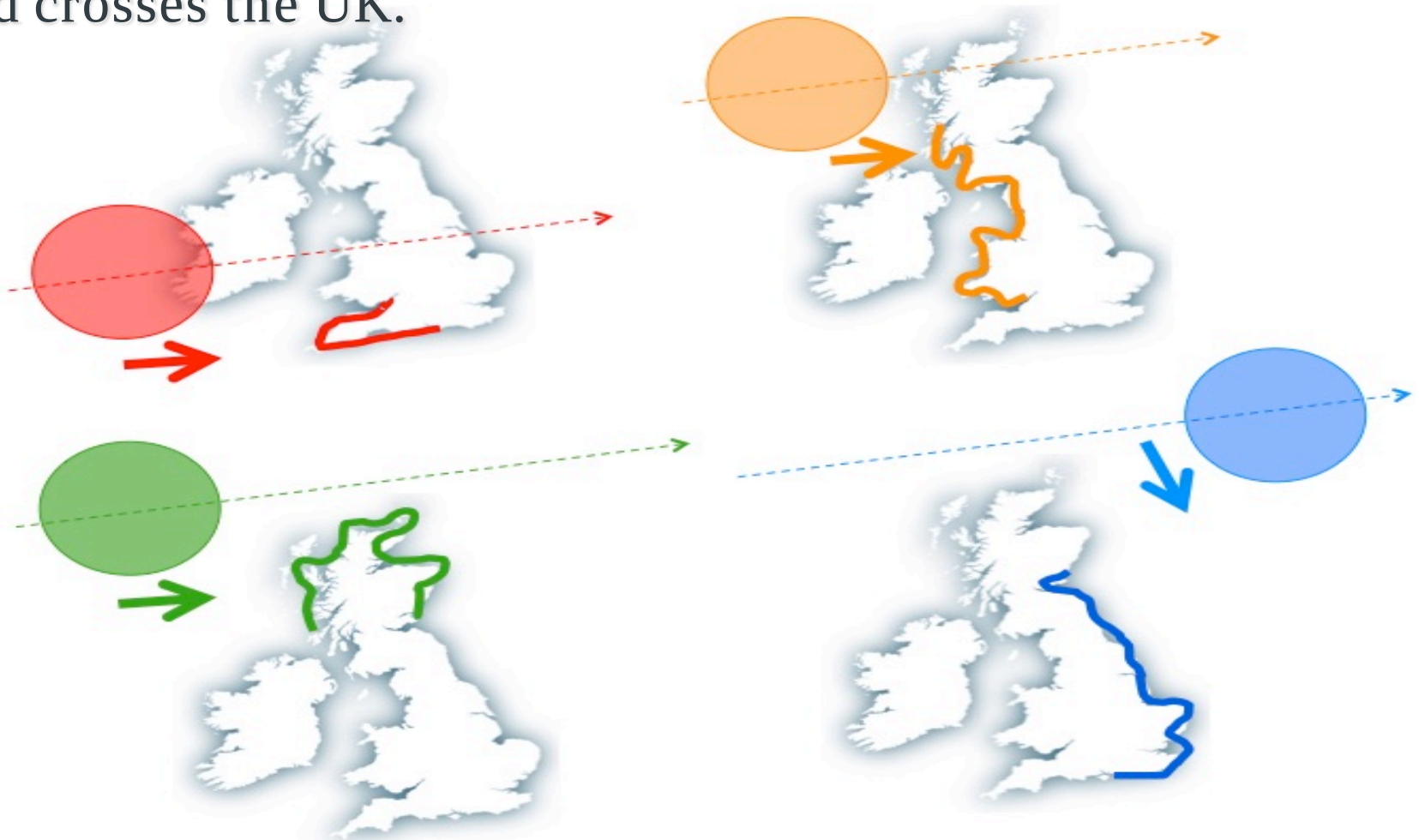
3. Results (1)

The vast majority of extreme sea level events over the last 100 years have been generated by moderate, rather than extreme skew surges, combined with spring astronomical high tides.



3. Results (2)

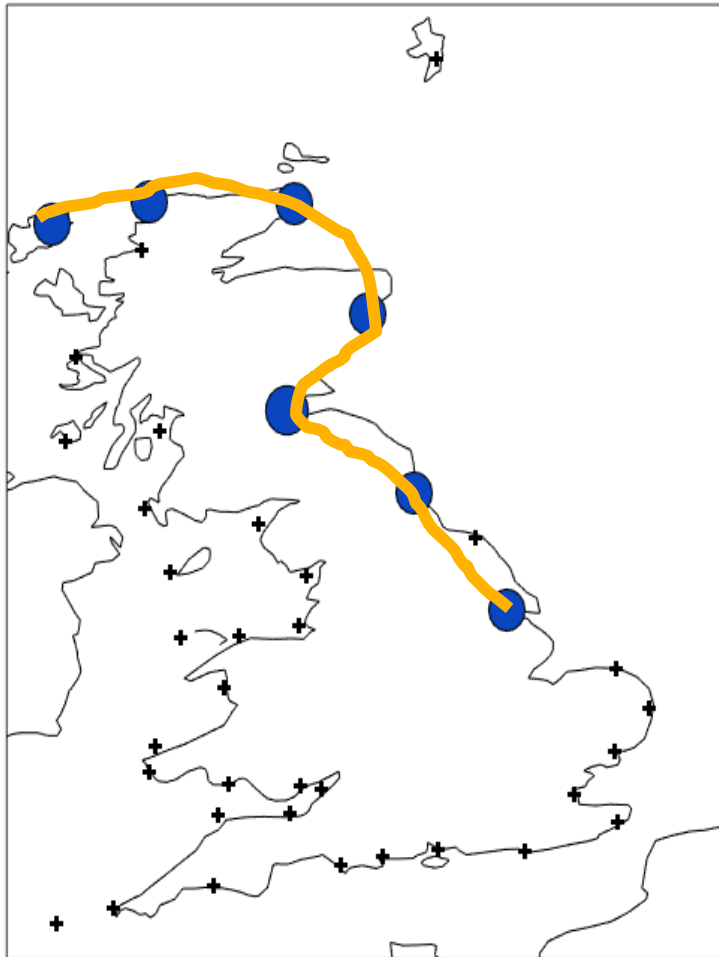
Spatial footprint: Extreme sea level events have 1 of 4 broad spatial footprints (i.e. stretches of coastline affected) and these relate to the track and location of the storm as it approaches and crosses the UK.



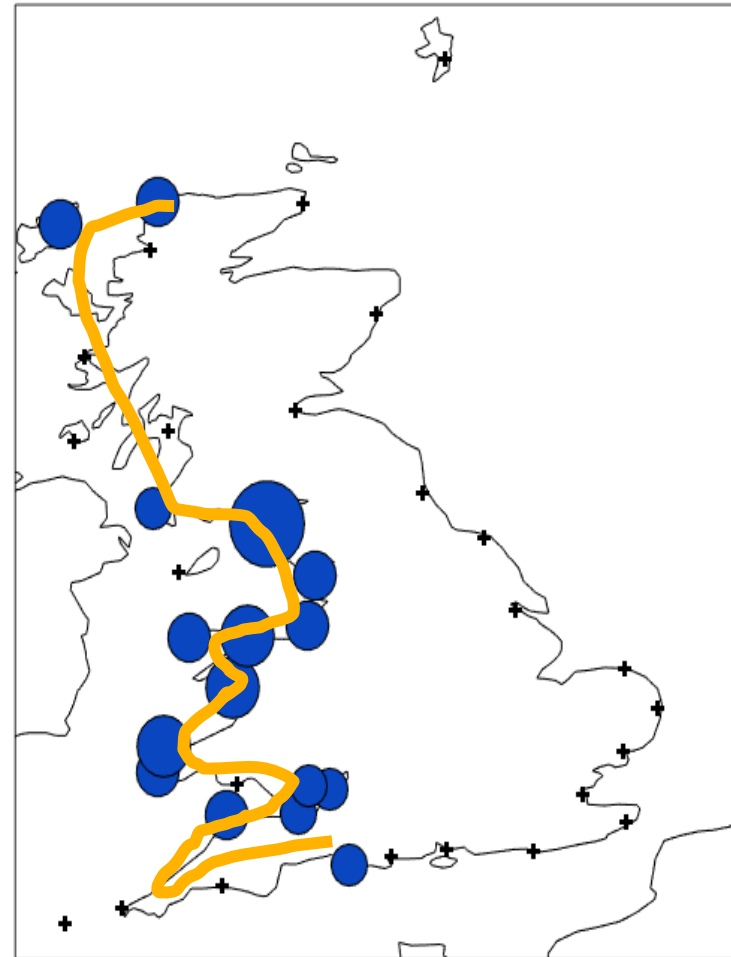
3. Results (3)

Temporal clustering: The events that occur in closest succession (<4 days) typically impact different stretches of coastline.

31. 09/02/1997 15:45

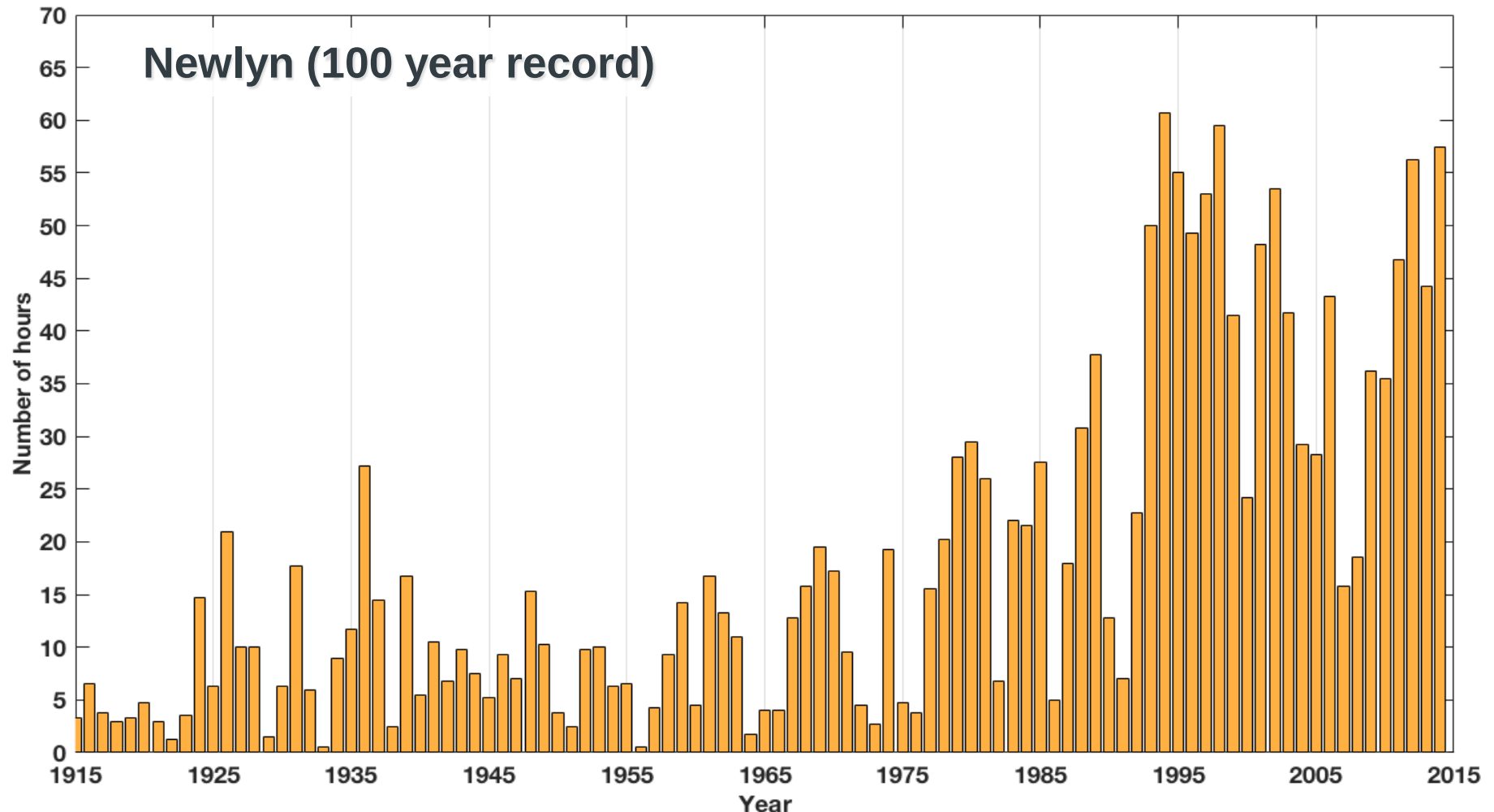


8. 10/02/1997 13:15



3. Results (4)

Extreme sea levels have increased over the last 100 years mainly because mean sea level has risen, rather than changes in storminess.





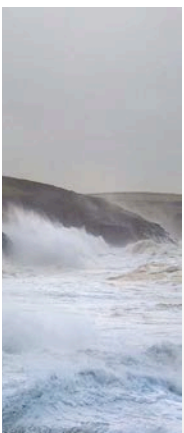
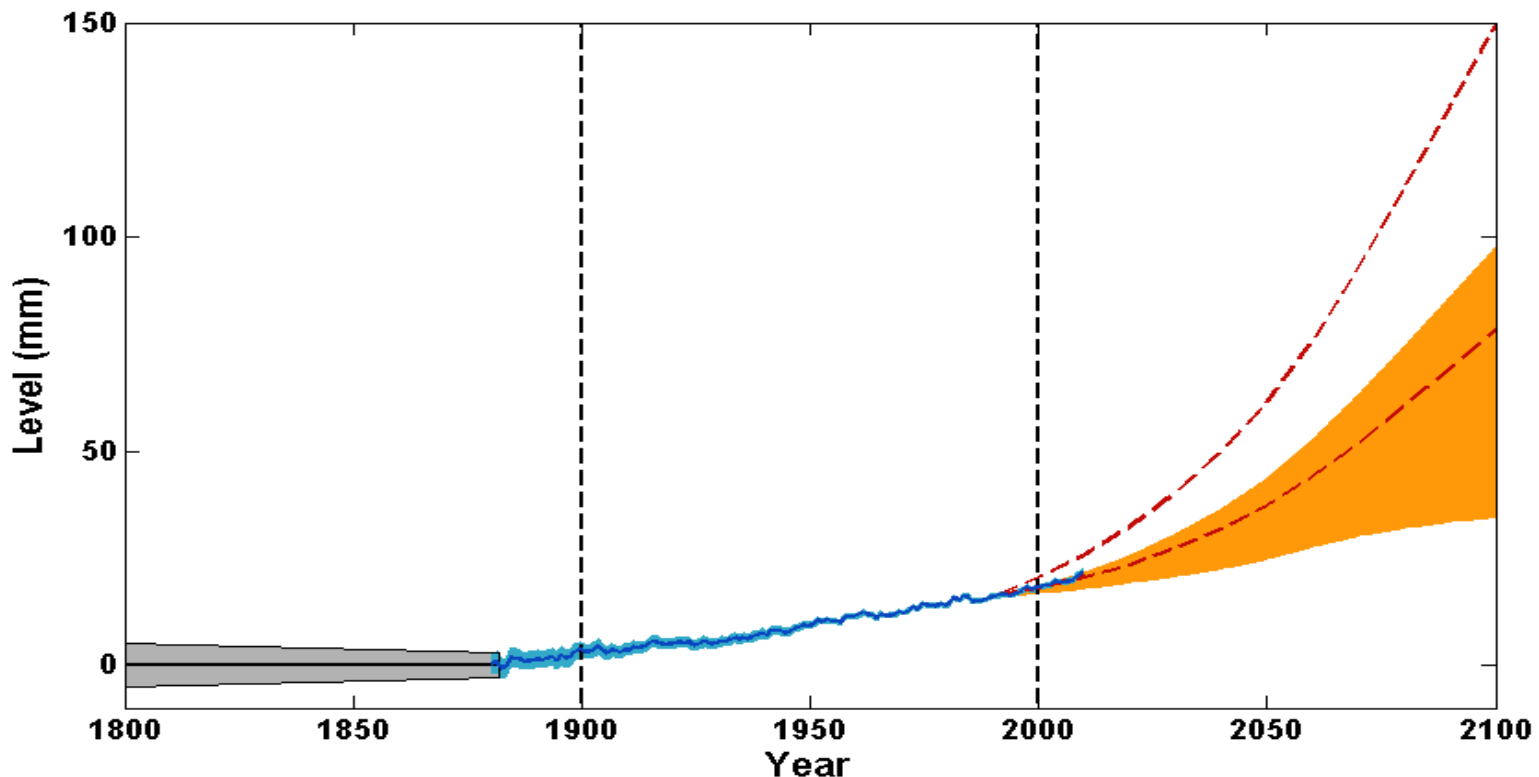
3. Results (5)

Although, extreme sea levels have increased over the last 100 there is little evidence that instances of coastal flood have increased --- because of investments of flood defences and improvements in forecasting and warnings;



3. Results (6)

Now is not the time to be complacent. With sea-level rise accelerating, and possible changes in storminess, high sea levels will occur more frequently in the future. Without upgrades to flood protection this will significantly increase coastal flooding and impact growing populations and cities.



4. Conclusions

- SurgeWatch is one of, if not the most detailed databases on coastal flooding ever developed worldwide;
- Looking to partner with people to expand this to other countries;
- Given us valuable insights into coastal flooding;
- We continue to enhance the database;
 - Identified >400 flood events post 1915 (going back as far as 250 AD)
 - Recording when major flood defence schemes were implemented, to capture how the flood system may have changed in different areas, in the period intervening past events;
- Looking for ways to integrate the database into the UK's Flood Forecasting Service;
 - State-of-the-art weather typing routines (see Section 9), to match specific forecast storm-tide/wave events, with similar historic events.

5. Papers

1. Haigh, I.D., Wadey, M.P., Gallop, S.L., Loehr, H., Nicholls, R.J., Horsburgh, K., Brown, J.M, and Bradshaw, E., **2015. A user-friendly database of coastal flooding in the United Kingdom 1915-2014.** Scientific Data, 2, Article number: 150021.
2. Haigh, I.D., Nicholls, R.J., Horsburgh, K., Brown, J.M, and Bradshaw, E., **2016. A spatial and temporal assessment of extreme sea level events around the coastline of the UK.** Scientific Data, 3, Article number: 160107
3. Haigh, I.D., Ozsoy, O., Wadey, M.P., Nicholls, R.J., Gallop, S.L., Wahl, T., Brown, J.M., **2017. An improved database of coastal flooding in the United Kingdom from 1915 to 2016.** In press Scientific Data.



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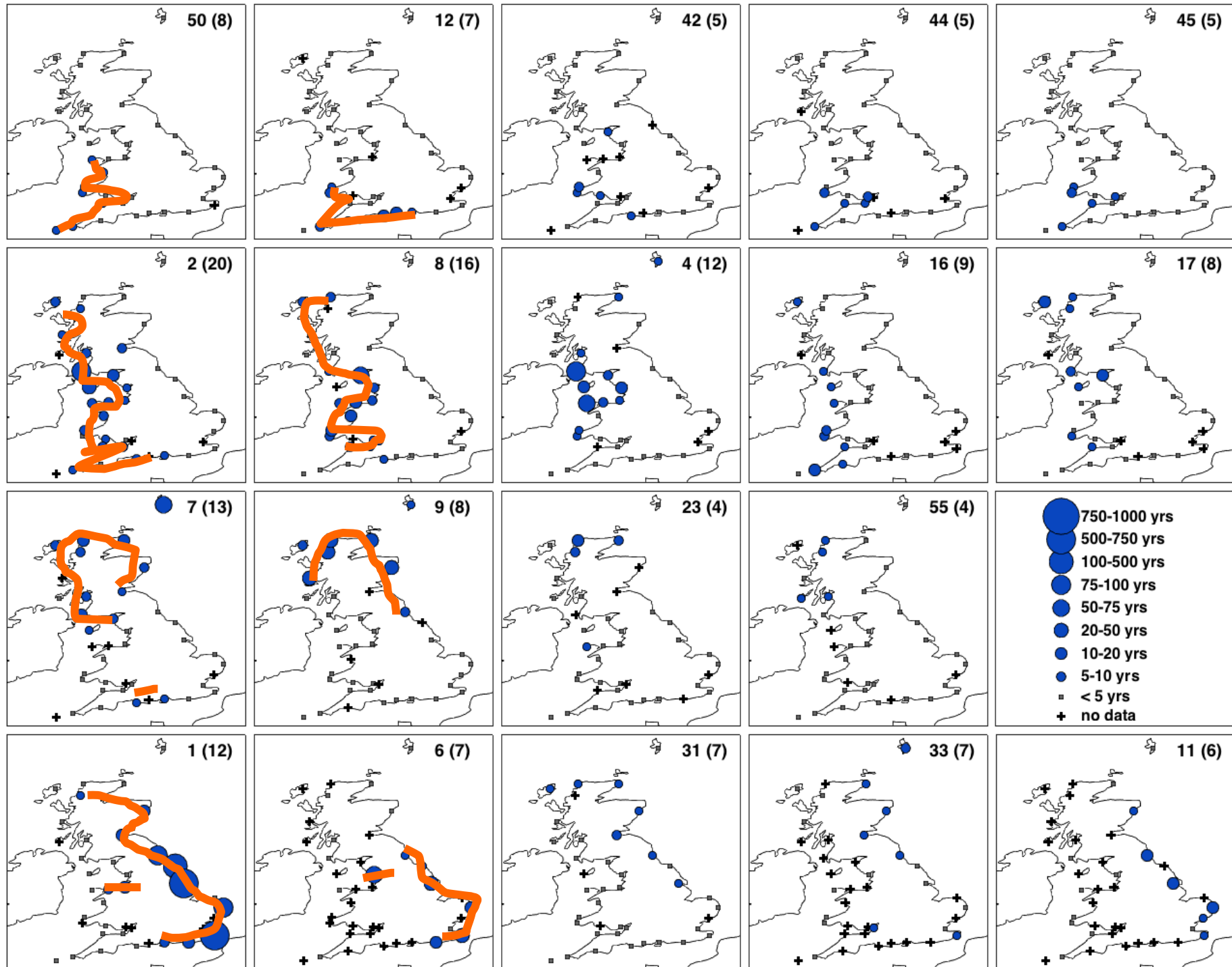
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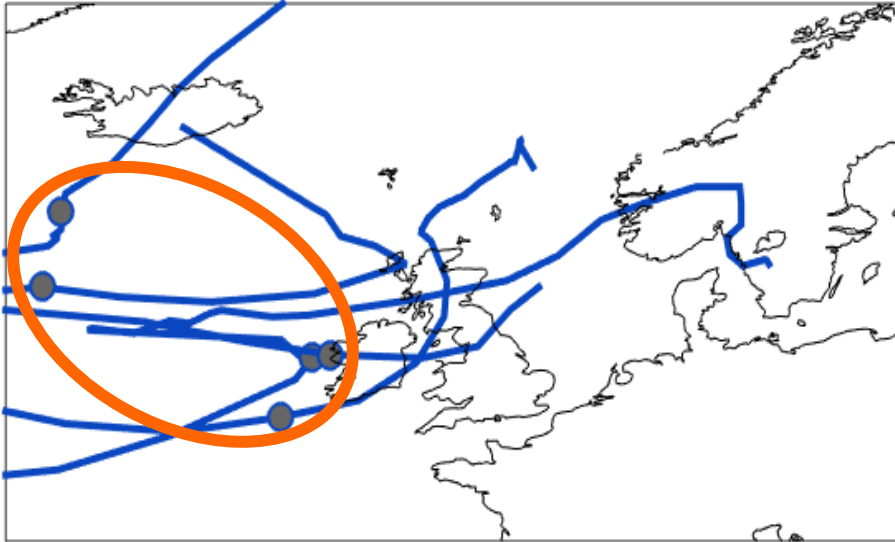
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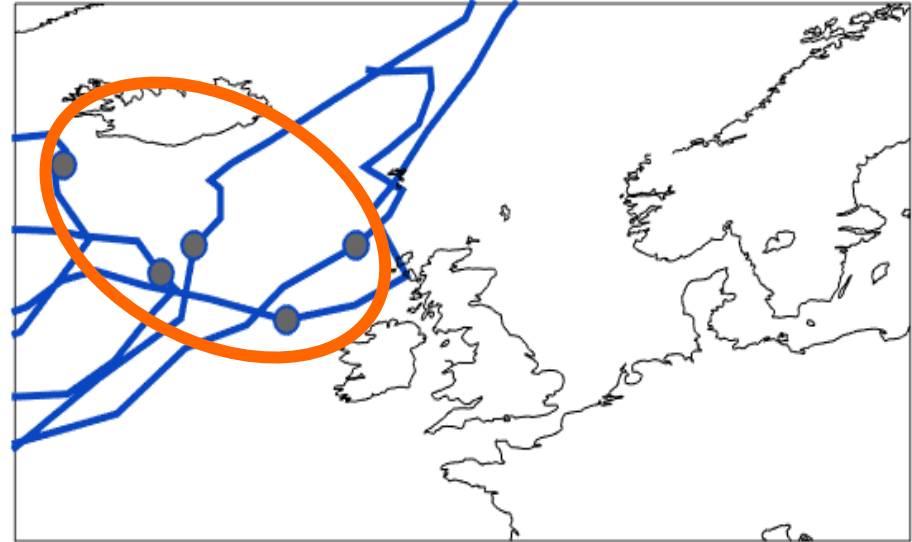


3. Spatial Analysis

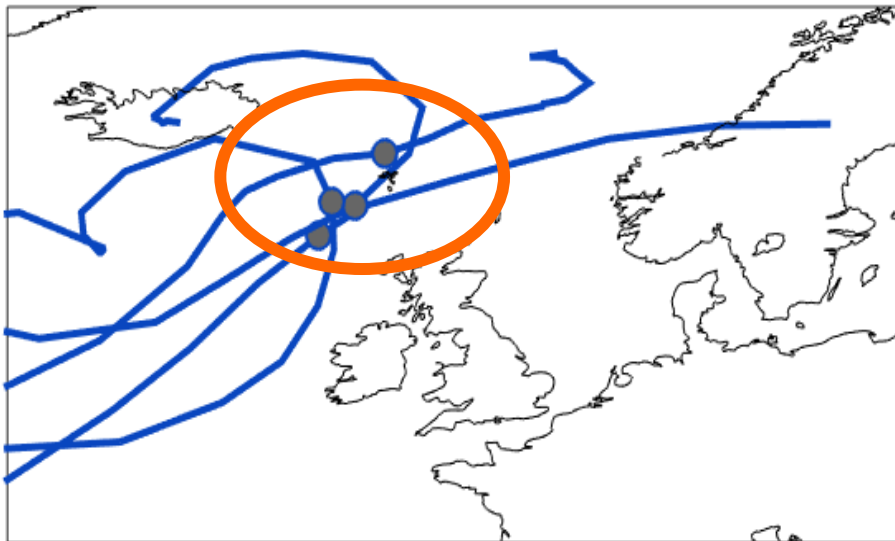
(a) South/West Events



(b) West Events



(c) North Events



(d) East Events

