

UEF 2017 - Storms

Using Weather Pattern Analysis to Identify Periods of Heightened Coastal Flood Risk in the Medium to Long Range

David Price (FFC) and Robert Neal (Met Office)

Thursday 15 June



The Flood Forecasting Centre

- Set up in response to inland flooding during summer 2007.
- Record breaking rainfall amounts leading to severe flooding impacts.
- A Pitt Review recommendation:



“The Environment Agency and the Met Office should work together, through a joint centre, to improve their technical capability to forecast, model and warn against all sources of flooding.”

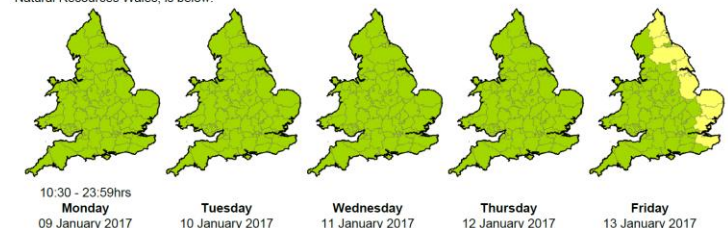
- Located in the Met Office HQ, a joint Environment Agency - Met Office centre.
- Nationally consistent overview of flood risk for **all natural sources of flooding** for all Category 1 and 2 responders over an extended lead time.
- Flood Guidance Statement, briefings and consultancy.

FLOODFORECASTINGCENTRE

a working partnership between  Environment Agency |  Met Office

Flood Guidance Statement 10:30hrs Monday 09 January 2017

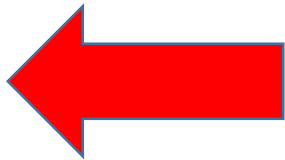
Our assessment of daily flood risk for England and Wales, working with flood forecasting teams in the Environment Agency and Natural Resources Wales, is below.



There is a **LOW** coastal flood risk along the east coast of England on Friday with a very low likelihood of significant coastal flooding.

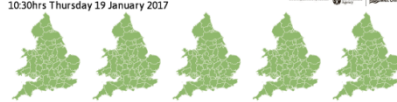
Flood forecasting/warning timeline

Guidance extended to 6 to 10 days to highlight possible heightened flood risk.



Days 5 & 4 Day 3 Day 2 Day 1 Post Flood Recovery

Flood Guidance Statement
10:30hrs Thursday 19 January 2017



Thursday 19 Jan 2017 18:30:23:59
Trend since last ISS: Steady → Steady → Steady → Steady → Steady →

The flood risk is VERY LOW for the next five days.

Assessment of flood risk

- Rivers**
The river flood risk is VERY LOW for the next five days.
- Coastal/Tidal**
The coastal/tidal flood risk is VERY LOW for the next five days.
- Surface water**
The surface water flood risk is VERY LOW for the next five days.
- Groundwater**
The groundwater flood risk is VERY LOW for the next five days.

Flood risk matrix

LIKELIHOOD	HIGH	VERY LOW	LOW	MEDIUM	HIGH
	MEDIUM	MINOR	LOW	MEDIUM	HIGH
	LOW	MINOR	LOW	MEDIUM	HIGH
	VERY LOW	MINOR	LOW	MEDIUM	HIGH
	MINOR	LOW	MEDIUM	HIGH	SEVERE
	IMPACT				
	VERY LOW	LOW	MEDIUM	HIGH	SEVERE
	OVERALL FLOOD RISK				

MINOR
Isolated and minor flooding of low-lying land and roads but no disruption to travel, but wet road surfaces.

LOW
Localised flooding of land and roads. Flooding affecting individual properties. Disruption to travel and key sites in flood plans.

MEDIUM
Localised flooding of land and roads. Flooding affecting individual properties. Disruption to travel and key sites in flood plans.

HIGH
Danger to life, severe disruption to travel. Widespread flooding affecting whole communities. Widespread disruption to travel and infrastructure. Large scale evacuation of properties possible.

Next statement due: 10:30 Friday 20 January 2017 (all times are local)
Contact details: Flood Forecasting Centre Duty Hydro-meteorologist - 0300 32345 81
More information: <http://www.flood-forecasting-centre.gov.uk>
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GOV.UK Flood Information service

This is a new service - your feedback will help us to improve it.

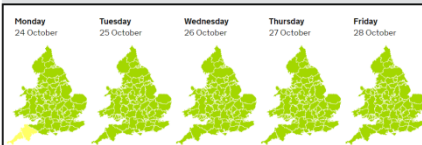
5-day flood risk for England and Wales

Last updated at 10:30am on Monday 24 October 2016

Forecast for Monday 24 October 2016 to Friday 28 October 2016

Heavy showers today (Monday) may occur locally across south west England. The surface water flood risk is low. It is possible that there will be disruption to travel and flooding of roads and properties. From Tuesday onwards the flood risk then becomes very low for England and Wales.

Are you at risk? Select your county to view its 5-day flood risk.



Risk of flooding

Very low Low Medium High

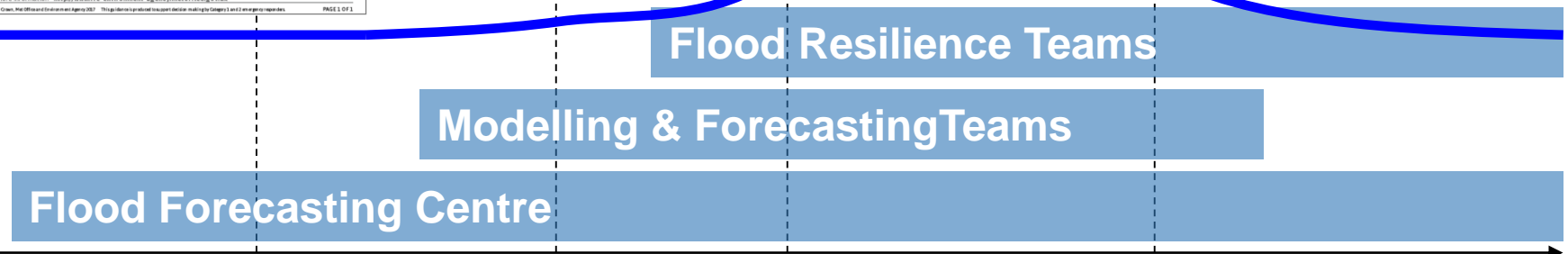
What these risk types mean



FLOOD ALERT
FLOODING IS POSSIBLE. BE PREPARED.

FLOOD WARNING
FLOODING IS EXPECTED. IMMEDIATE ACTION REQUIRED.

SEVERE FLOOD WARNING
SEVERE FLOODING. DANGER TO LIFE.



Why a need for extended forecast lead times?

- Coastal flooding in the UK considered to have the highest risk to life and infrastructure of all natural disasters in the UK (as defined in the National Risk register).
- Preparing a properly coordinated response takes many days, particularly for the east coast of England.
- Longer lead time forecasts of possible severe coastal flooding are essential to UK government and other Cat 1 and Cat 2 responders.
- Because of this there is an increasing requirement to extend forecasts into the medium- and long-range to provide early awareness of the possibility of a heightened flood risk.
- The FGS extends to 10 days ahead, current Met Office surge (and wave) ensemble products extend to 7 days, while **the demand for information extends to weeks ahead ...**
- The FFC has worked with the Met Office to develop **Coastal Decider** - an operational forecasting tool that provides an objective assessment of the likelihood of coastal flooding for the UK coastline in the **medium- to long-range**.

Figure 2: Other risks



Based on coastal risk equivalent in consequence to that of the 1953 east coast surge.

Coastal Decider

- Coastal Decider is a medium- to long-range (7 to 51 days ahead) forecast product.
- It gives the **first guess** probability of 'coastal risk' weather patterns affecting different stretches of the UK coastline
- Coastal risk weather patterns have been objectively related to an increased likelihood of coastal flooding (resulting from large waves and storm surges).
- It is most useful beyond the forecast range of the Met Office seven day storm surge and wave ensembles ...

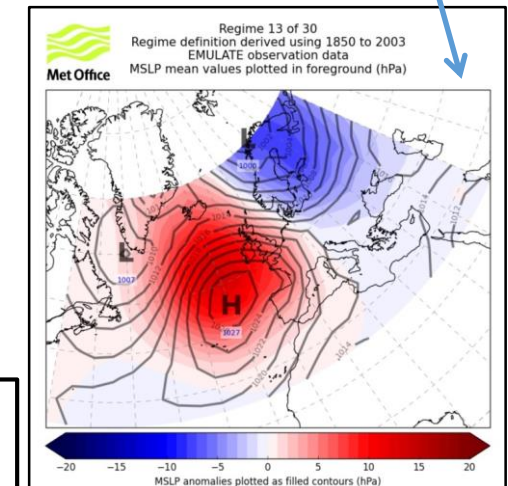
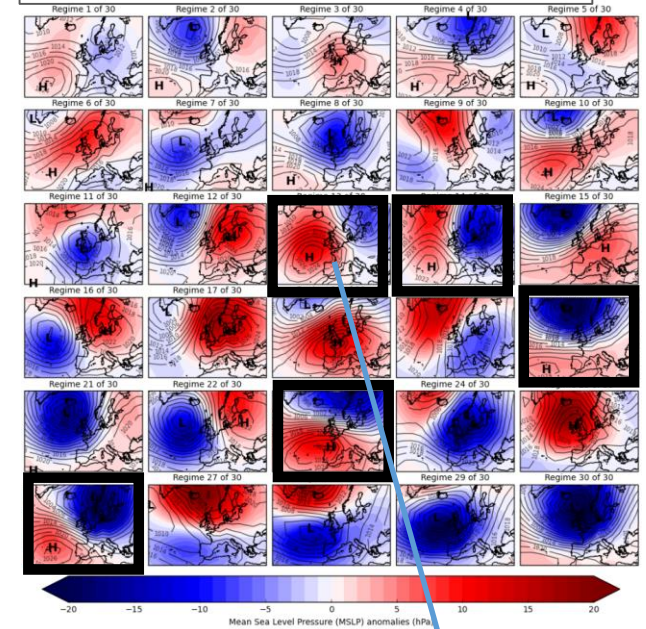
.... and provides the extended lead time required for the UK Government and response agencies to plan for a coastal flood event (particularly an east coast event).

- The premise behind Coastal Decider is relatively simple:

Ensemble members associated with elevated coastal risk weather patterns are identified and grouped to provide objective percentage probabilities of elevated coastal risk for specific coastal stretches or specific coastal locations (ports).

Eg, Weather patterns 13, 14, 20, 23 & 26 – identified as coastal risk weather patterns for the east coast of England.

30 weather pattern types

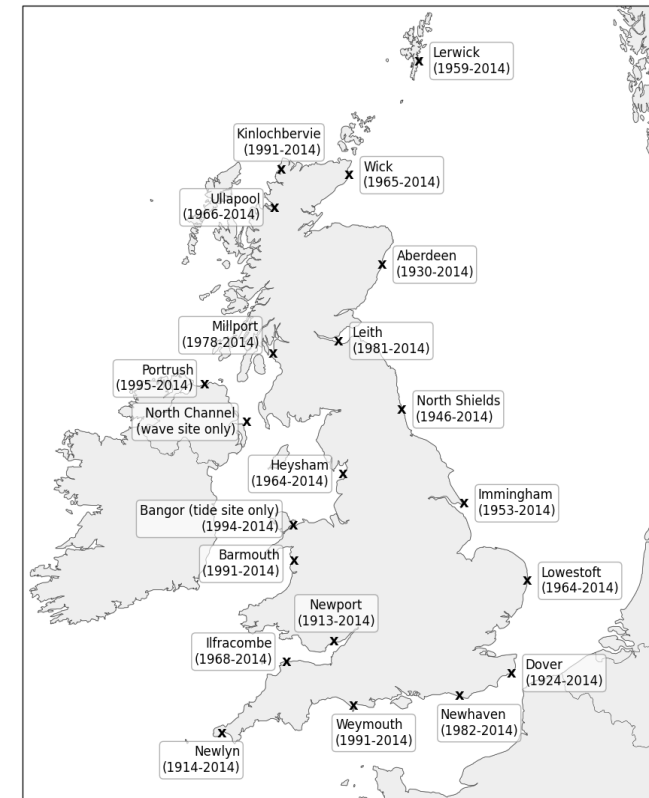


Coastal Decider

- Probabilities are displayed for coastal flooding related weather patterns which affect three coastal stretches (Regional Summary plots), along with more specific information for 21 coastal locations (Specific Summary plots).
- Updated several times daily using output from a number of different ensemble forecasting systems, of most use to the FFC is the **ECMWF medium-range forecast** to 15 days ahead (2x/day).

Ensemble forecasting system	Centre	Lead time	Number of members	Decider update times	
	MOGREPS-G Time-lagged	Met Office	7 days	24 members ¹	00Z run ⇒ 0615 GMT 06Z run ⇒ 1215 GMT 12Z run ⇒ 1815 GMT 18Z run ⇒ 0015 GMT
	MOGREPS-G Latest run only			12 members	
	ECMWF Medium-range	ECMWF	15 days	51 members	00Z run ⇒ 0930 GMT 12Z run ⇒ 2130 GMT
	ECMWF Monthly		32 days		00Z run ⇒ 2230 GMT ²
	GEFS	NCEP	16 days	21 members	00Z run ⇒ 0630 GMT 06Z run ⇒ 1230 GMT 12Z run ⇒ 1830 GMT 18Z run ⇒ 0030 GMT
	GloSea5	Met Office	51 days	4 members ³	00Z run ⇒ 0840 GMT ⁴

ECMWF medium-range forecast to 15 days ahead, twice/day.



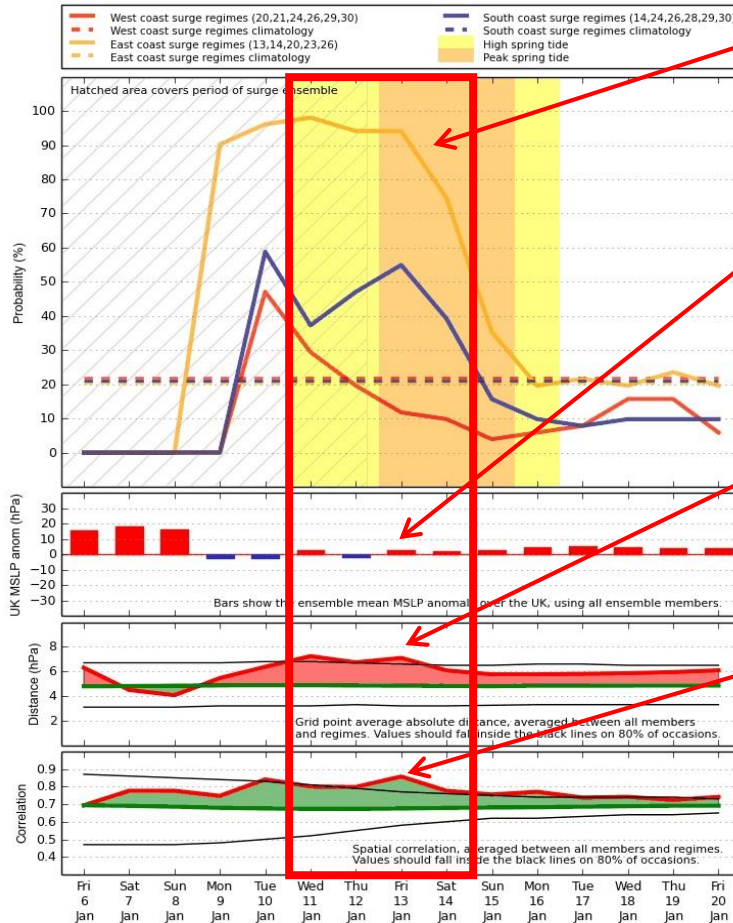
21 sites for which specific summary plots are generated.

Coastal Decider – Regional Summary Plots



Coastal Decider for England and Wales
Probability of coastal risk weather regimes

ECMWF
12Z run on Thu 05 Jan 2017



Example – East coast surge, 13 Jan 2017

- High probability of east coast coastal risk weather pattern coinciding with spring tide period - probability > climatology (dashed lines) = trigger to **investigate further**

MSLP anomaly is weak – not signalling a (possible) trend to more/less settled conditions.

Distance = poor, indicating that the lows (or highs) are on average either much lower (or higher) than their assigned regimes. As MSLP anomaly is weak this doesn't provide insight here.

Correlation = good (>90%), indicating good spatial agreement between ensembles and their assigned regimes.

Therefore:

At this broad level an elevated risk for the east coast is identified, further investigation required.

Coastal Decider – Site Specific Summary Plots

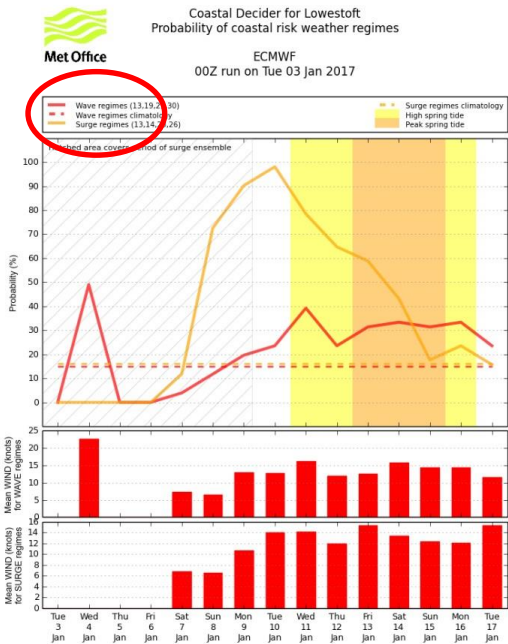
More detailed analysis, port specific.

Site Specific summary plots give the probability of **surge and wave** coastal risk weather patterns coinciding with a spring tide period for specific coastal sites.

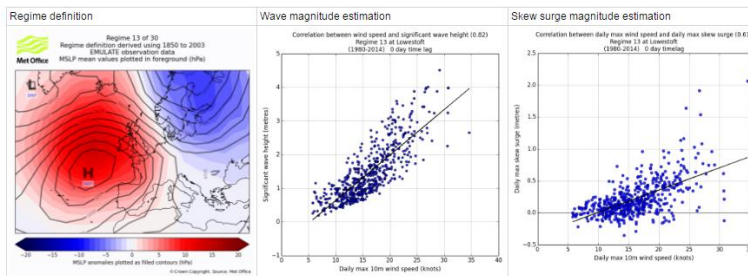
Forecast probabilities greater than climatology suggest risk of the listed weather pattern(s) occurring is greater than normal for the time of year (climatology).

As a general rule, the MSLP anomaly needs to be more -ve than it's assigned weather pattern MSLP anomaly for flooding to occur.

Additional outputs are used to estimate the potential for coastal flood impacts and the magnitude of the surge and wave event:



The pressure anomaly difference between ensemble members and their assigned weather pattern (UK-PAD and MIN-PAD) and the daily maximum 10m wind speed (WIND).



- A forecast with a more intense low pressure compared to its assigned weather pattern may lead to a greater likelihood of large skew surges or waves.

- UK-PAD, MIN-PAD and WIND can be used to estimate the potential magnitude of a skew surge or wave event.

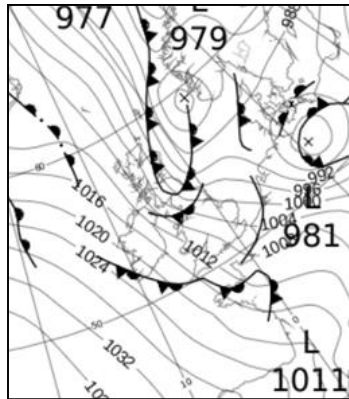
January 2017 Case Study

A large storm surge affected parts of the east coast of England on 13 January 2017.

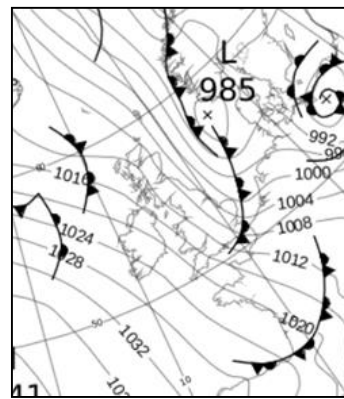
A deepening low pressure near Denmark.

Force 8 to 9 NWly winds over the North Sea generated a large surge and large waves which affected the east coast of England.

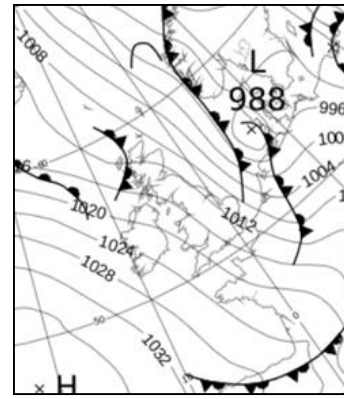
These coincided with a period of spring tides.



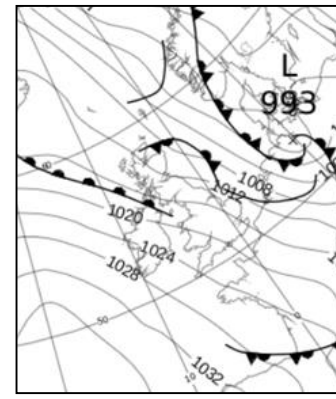
06:00 GMT/13/01/17



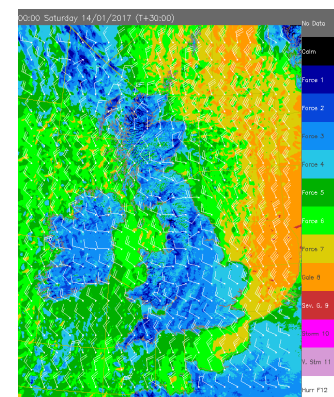
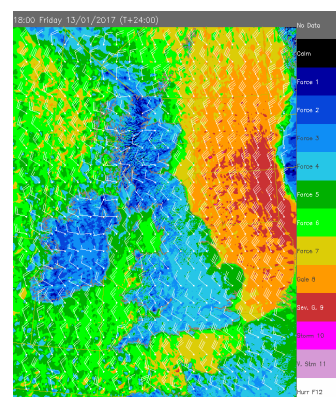
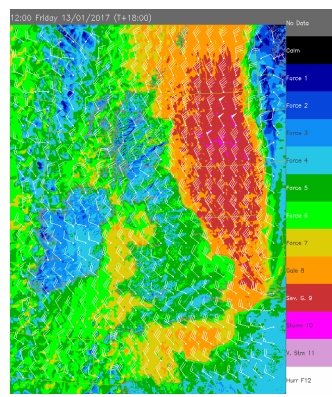
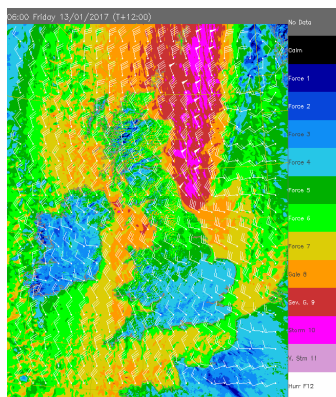
12:00 GMT/13/01/17



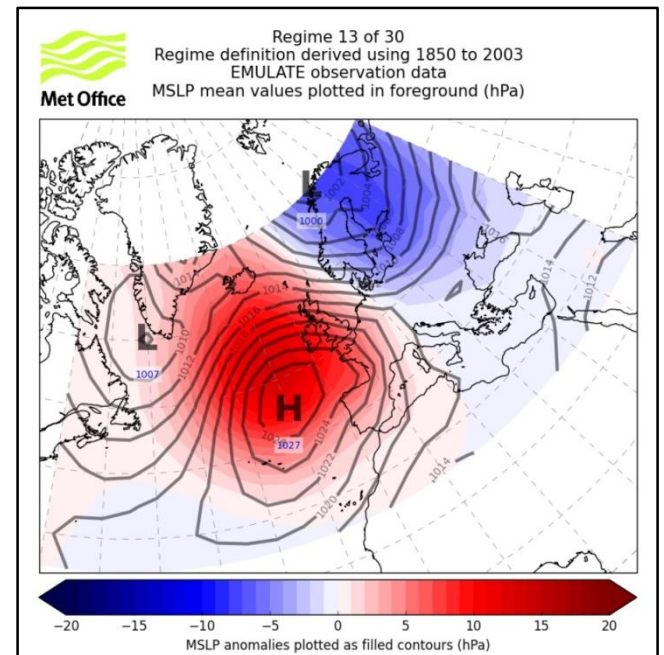
18:00 GMT/13/01/17



00:00 GMT/14/01/17



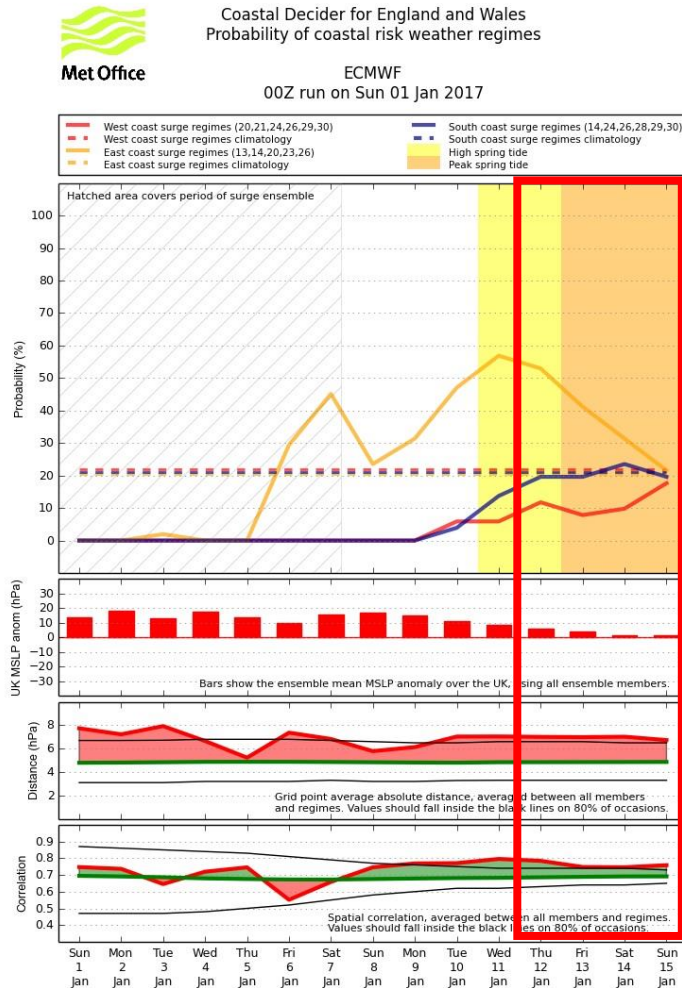
Synoptic set-up analysed as weather pattern 13



January 2017 Case Study

00:00GMT run on 1 January 2017

Regional summary plot



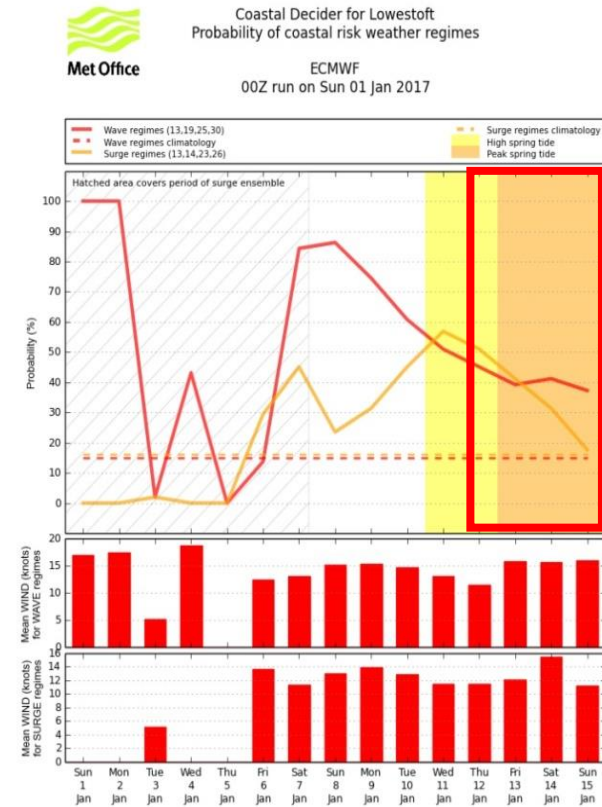
- Elevated probability of east coast coastal risk weather pattern coinciding with spring tide period.

- **MSLP anomaly** is weak.

- **Distance** = poor, indicating that the lows (or highs) are on average either much lower (or higher) than their assigned weather patterns. As MSLP anomaly is weak this doesn't provide insight here.

- **Correlation** = good (>90%), indicating good spatial agreement between ensembles and their assigned regimes.

Site specific summary plot



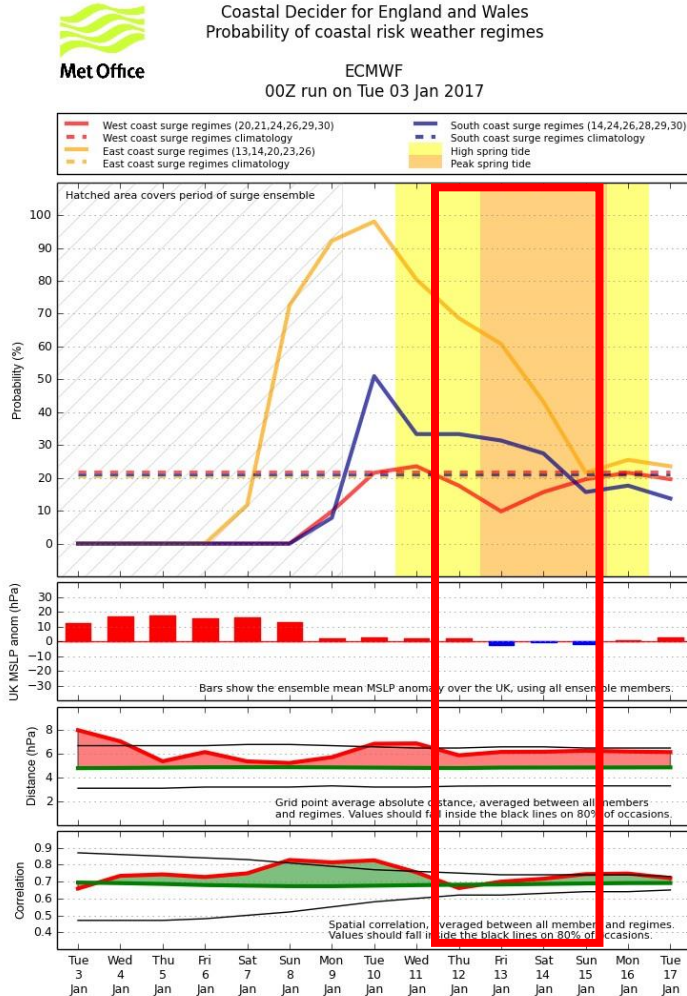
- Strong signal for coastal risk regimes occurring during the spring tide period at Lowestoft, for surge and waves.

- WIND metric data can be used to estimate **RWC** surge and wave heights.

January 2017 Case Study

00:00GMT run on 3 January 2017

Regional summary plot



- Continuing elevated probability of east coast coastal risk weather pattern coinciding with spring tide period.

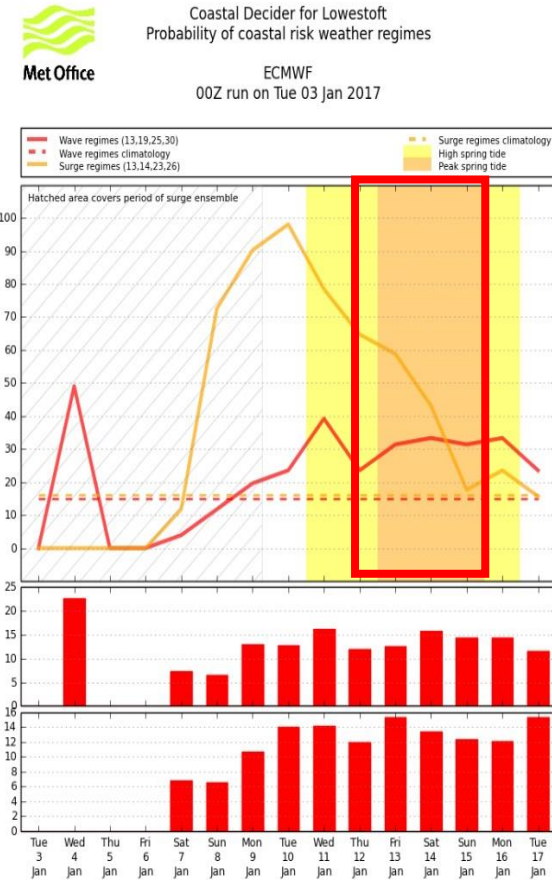
- MSLP anomaly remains weak.

- Distance remains poor.

- Correlation = good (>90%).

- Data shows improving picture for later in the spring tide period (useful information for post event activity)

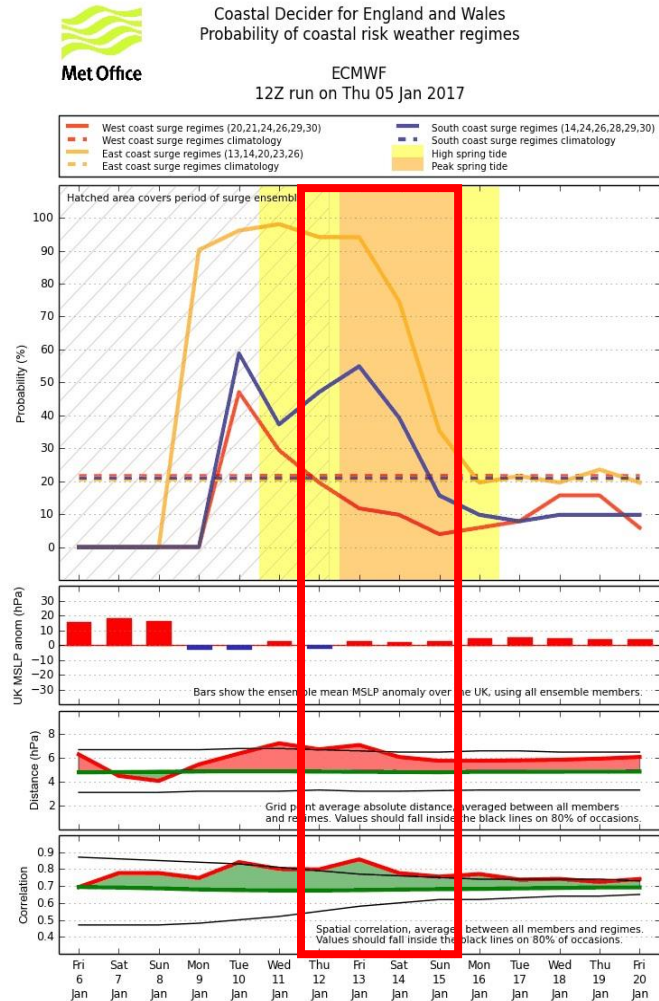
Site specific summary plot



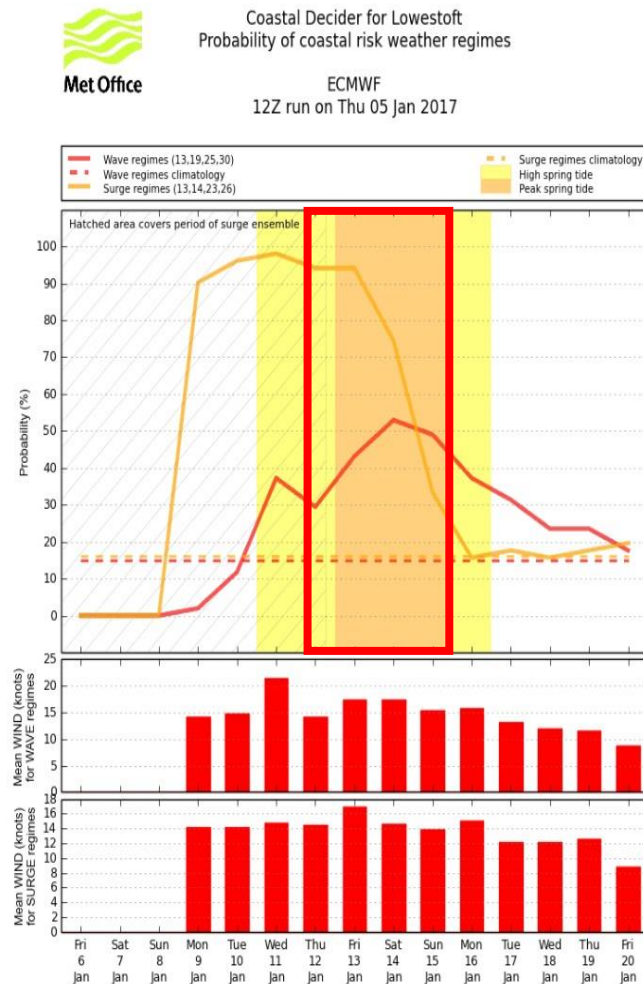
- Strong signal for coastal risk regimes continues for the spring tide period at Lowestoft, for surge and waves.

12:00GMT run on 5 January 2017

Regional summary plot

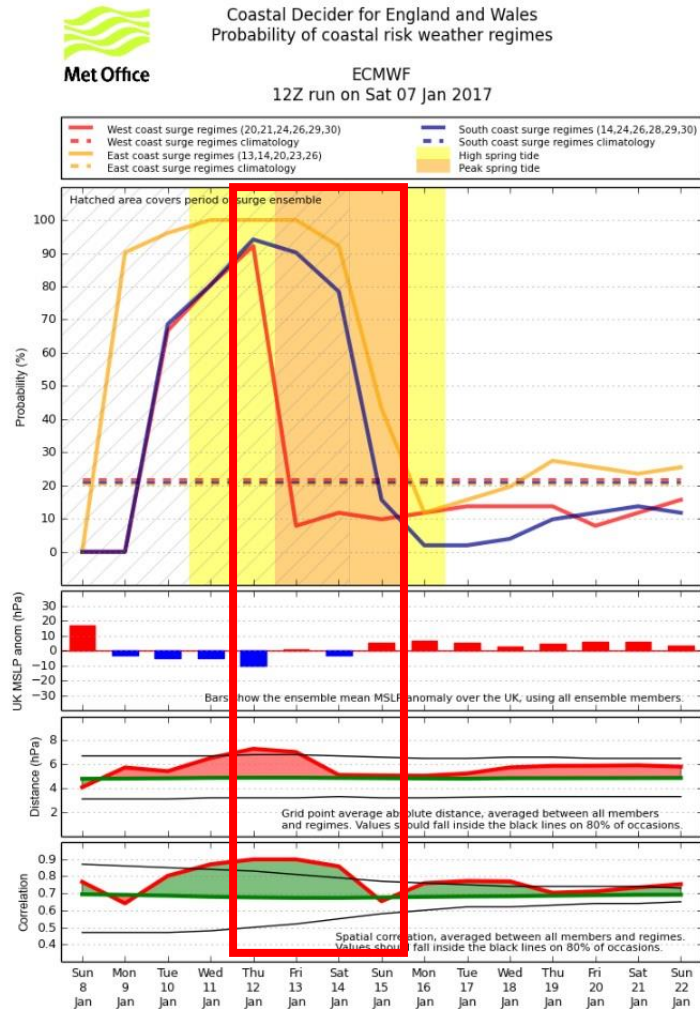


Site specific summary plot

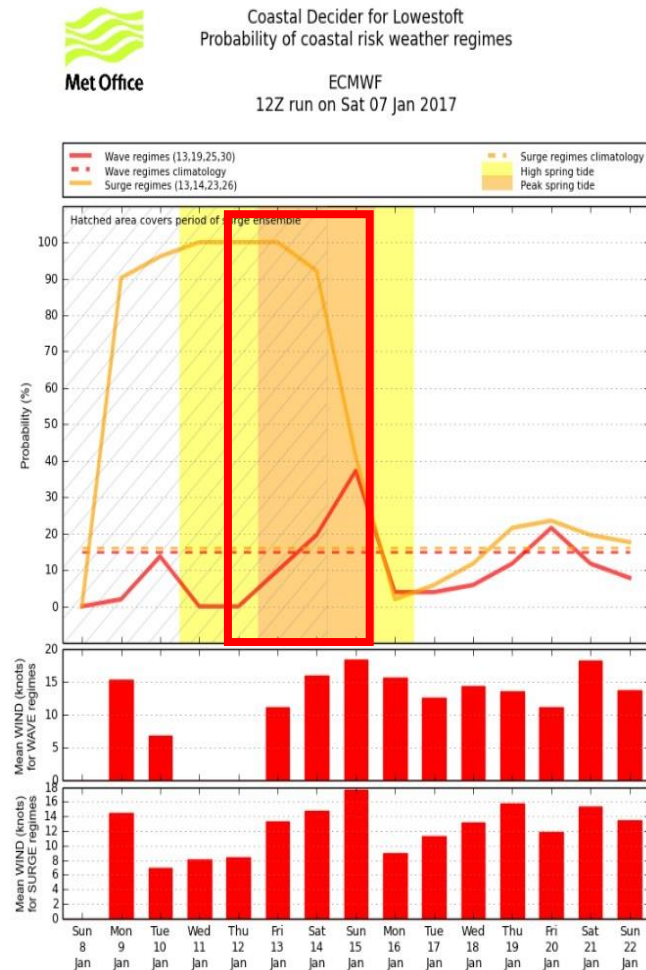


12:00GMT run on 7 January 2017

Regional summary plot



Site specific summary plot



January 2017 Case Study

12:00GMT run on 7 January 2017

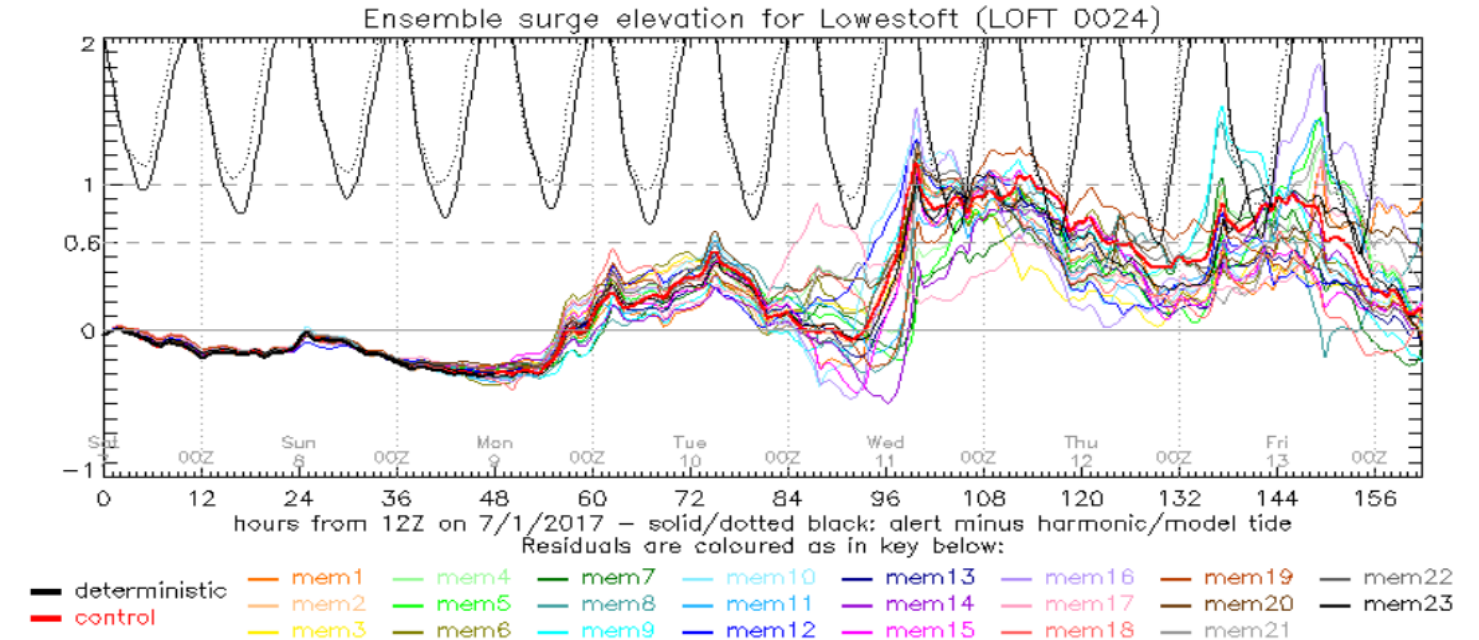
Met Office surge and wave ensemble data available from 7th January.

MOGREPS driven gridded surge (CS3x) and wave (WaveWatchIII) models.

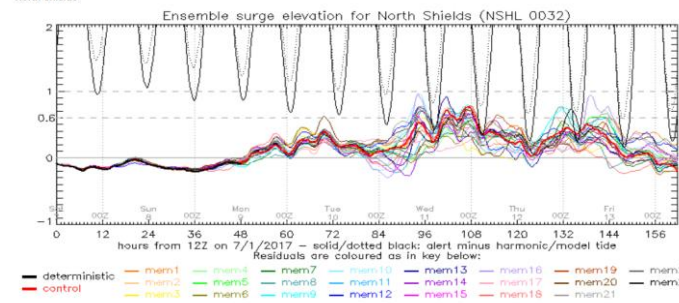
First data showing actual forecasts of surge for this spring tide period.

These data used to refine forecast as the event approaches.

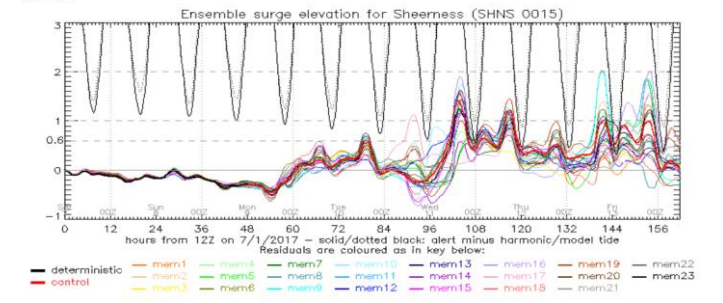
Lowestoft



North Shields



Sheerness



January 2017 Case Study

Multiple flood warnings were issued, 1000s of properties were evacuated and almost 9000m of temporary flood defences were employed at critical locations.

Coastal Decider provided valuable additional lead which allowed early communication and planning.

Impacts were limited on this occasion, mostly minor and locally significant, with 23 properties flooded.

Coastal Decider is part of an integrated set of tools which has extended the lead time within which the risk of coastal flooding can be identified and communicated.



East Yorkshire - Hornsea



Temporary barriers - Lowestoft



North Yorkshire - Scarborough



the guardian

Weather

Storms and floods force evacuation of thousands on east coast

Emergency services out in force and many spend night in shelters, but storm surge causes less damage than was feared

Kevin Rawlinson and agencies

Saturday 14 January 2017 01:13 GMT

The Telegraph News

UK severe weather: Relief for east coast as tidal wave fails to wreak chaos

Streets were closed in Whitby after a tidal surge caused flooding on Friday evening

- Coastal decider allows the forecaster to make objective assessments of future trends and possible consequences in the medium- to long-range.
- Summarises large amounts of ensemble data in an easily accessible way and at a time scale appropriate to operational forecasting.
- Used alongside other tools and has a proven track record.
- For further information see:

Neal R, Fereday D, Crocker R, Cromer, R. 2016. A flexible approach to defining weather patterns and their application in weather forecasting over Europe. Meteorological Applications. 23: 389 – 400.

Thank You