

Staines
Surrey

FLOODFORECASTINGCENTRE

a working partnership between



Environment
Agency

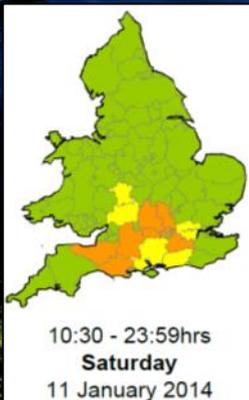


Met Office

Flood Risk Forecasts for England and Wales: Production and Communication

Jon Millard

UEF 2015 : Quantifying and Communicating Uncertainty



What is the FFC?

- ➔ Successful partnership between the Met Office and Environment Agency.
- ➔ Remit to forecast for all natural sources of flooding.
- ➔ Operational since April 2009 delivering 24/7 services.
- ➔ Combine staff expertise in hydrometeorology to provide improved and new services.
- ➔ Works across organisations to act as a trusted advisor for responders.
- ➔ Seeks to introduce new science and continually improve services for customers.

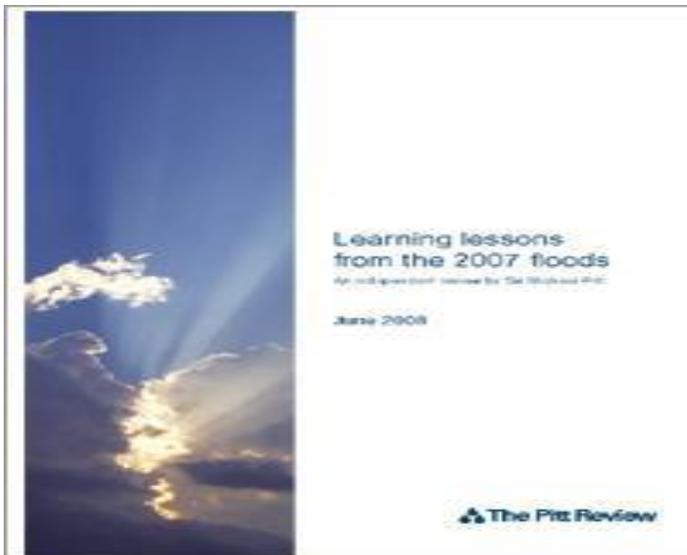
What is the FFC?

Pitt Review Recommendations:

- (6) 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



- (34) The Met Office and the Environment Agency should issue warnings against a **lower threshold of probability** to increase preparation lead times for emergency responders.



Uncertainties in Flood Forecasts

4 main areas of uncertainty;

Precipitation and hydrological response

Impacts

Communication & Understanding

Use of ensembles to attempt to model the spread in possible solutions.

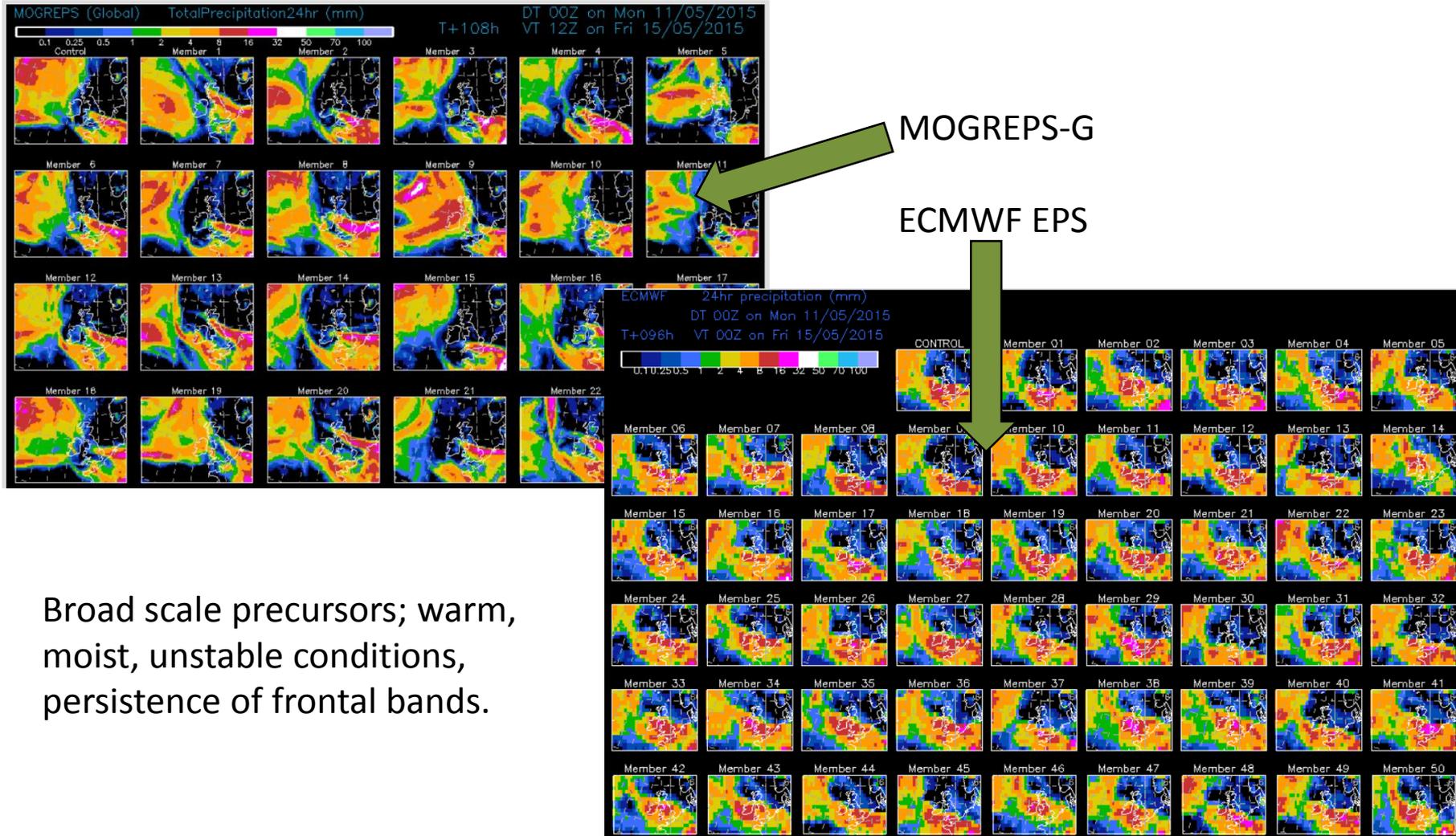
Use of flood risk matrix to try and clearly communicate the uncertainties.



Production

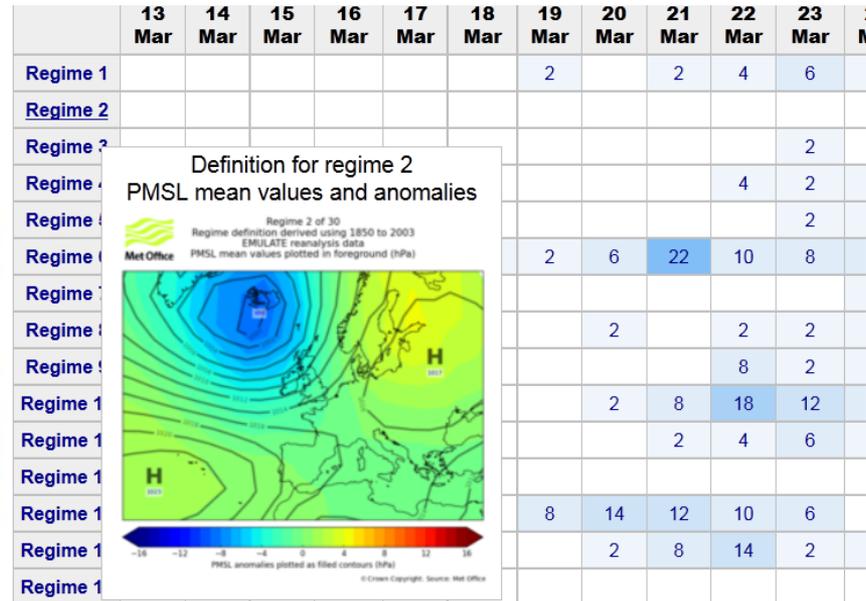
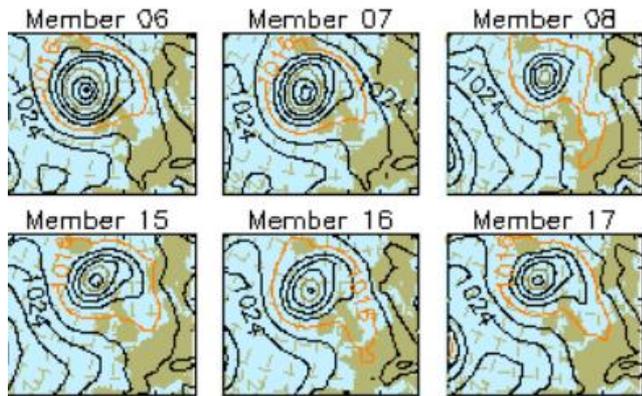
Medium Range Forecasting

Coarse precipitation ensembles



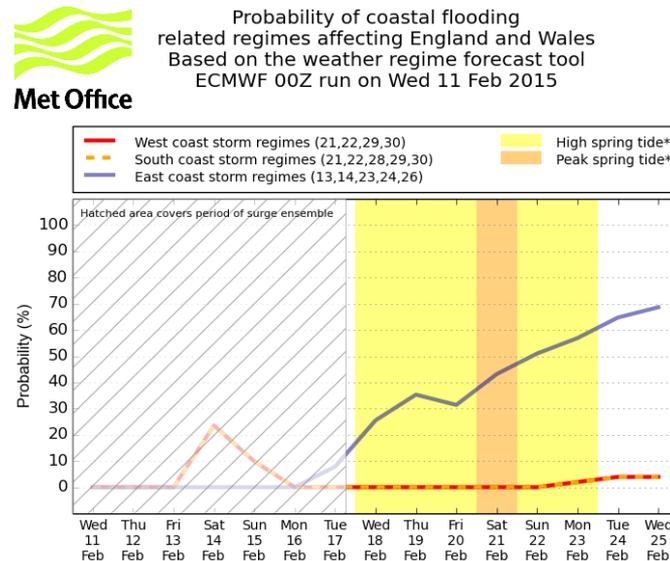
Coastal - Strategic requirement for an early trigger to increase awareness (especially East Coast).

Coastal Decider – identifying when spring tides and specific weather regimes which are associated with large surges and/or large waves coincide (using ECMWF mslp ensemble forecasts).



Current project

- Developing surge and wave climatology by regime
- Linking weather regimes to past surge and wave events
- Quantifying surges and waves according to regime and anomaly (difference in mslp from idealised regime)



* High tides defined as 'spring' tide when water levels reach 2.4m OD(N) or more at North Shields.

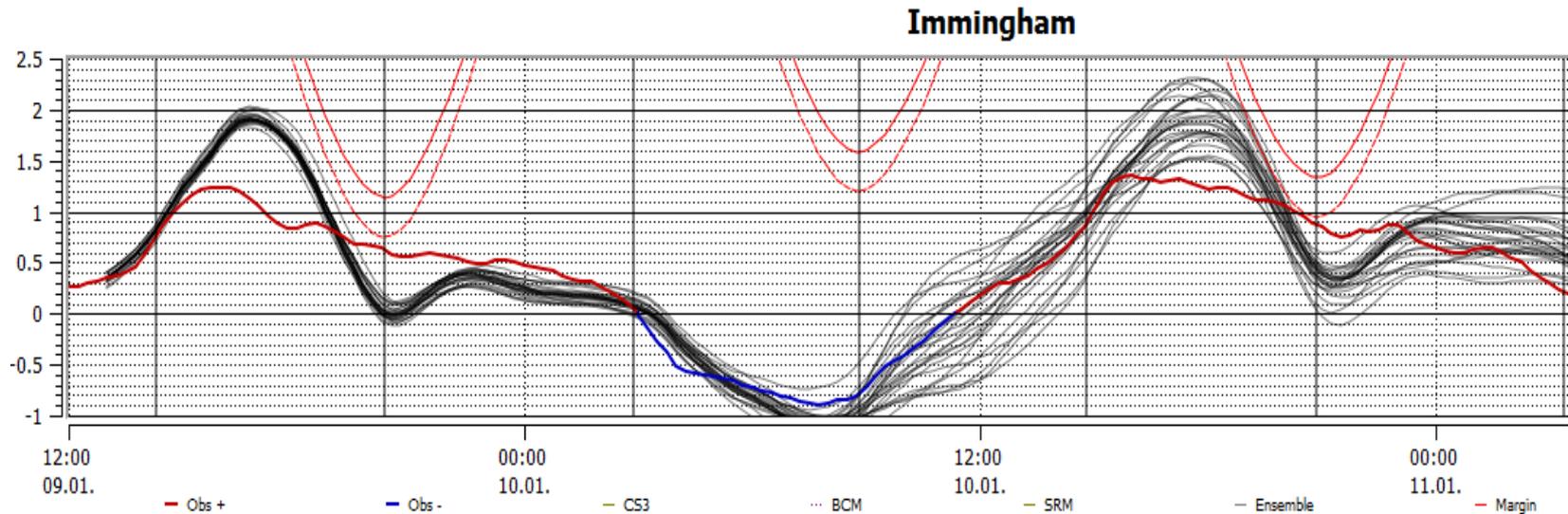
© Crown Copyright. Source: Met Office

See Rob Neal's presentation on Wednesday.

Medium Range Forecasting

Coastal forecasting

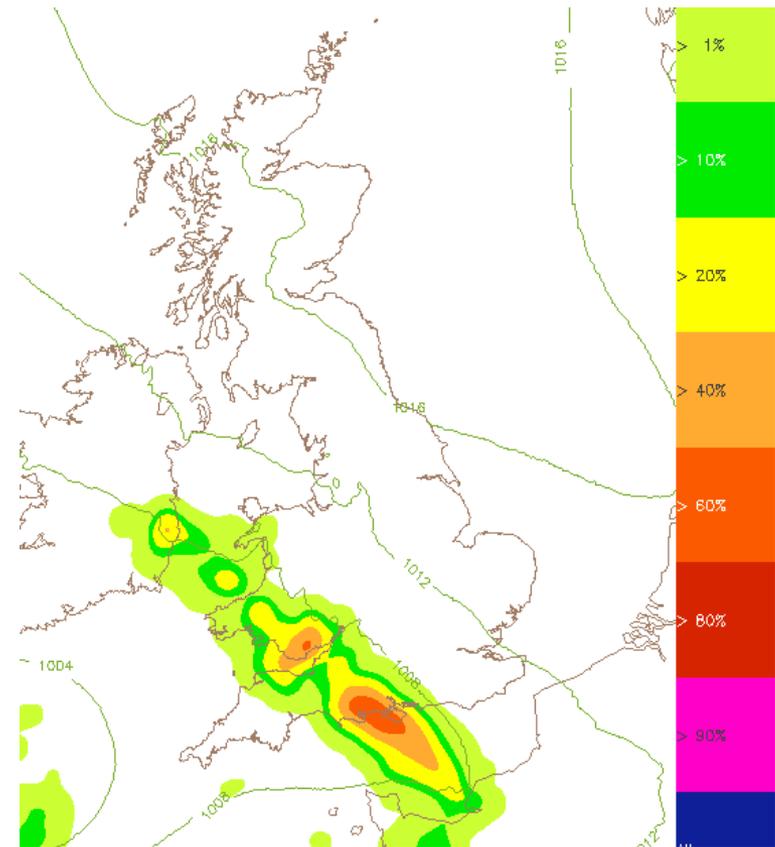
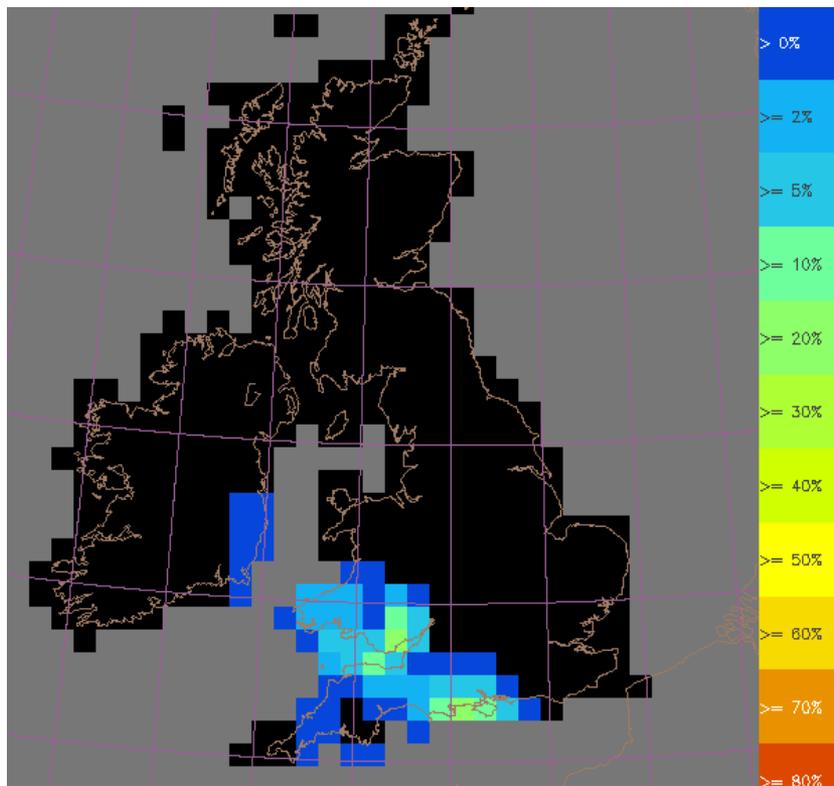
CS3x MOGREPS-G driven surge ensemble forecasts to day 6



Short Range Forecasting

High resolution precipitation models

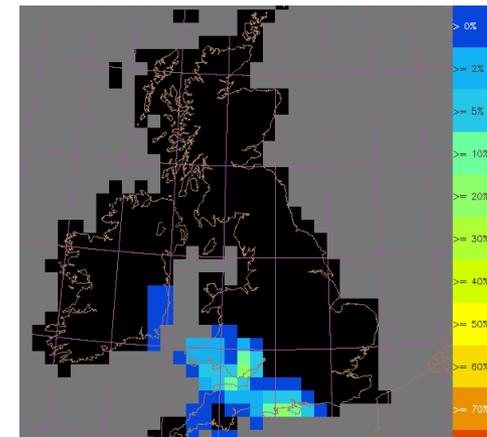
Post processed MOGREPS-UK (2.2km, convection permitting, 12 members / 24 members if time lagged)



Short Range Forecasting

Surface Water flood forecasting using MOGREPS-UK probabilities of exceeding standard 10 and 30 year return period thresholds combined with SMD (antecedent conditions) and urbanisation value to produce FGS aligned output.

10 year return periods	30 year return periods
20 mm / hour	30 mm / hour
30 mm / 3 hours	40 mm / 3 hours
40mm / 6 hours	50mm / 6 hours

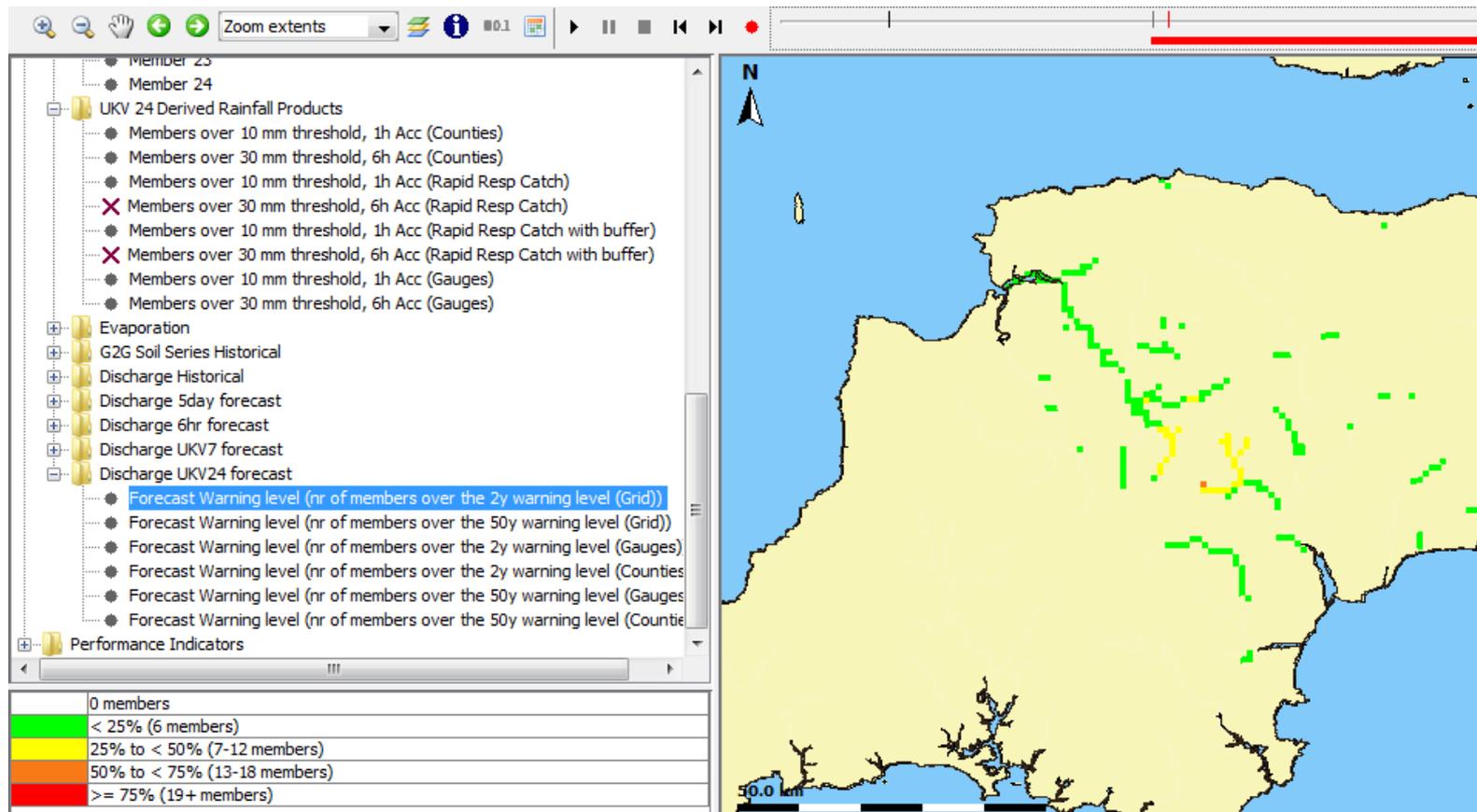


Surface Water Flooding Decision Support Tool

ID	County / Unitary Authority	Blue Square (%)	Blue Sq. Category	Met Hazard Description		Prob. Excd. 10Yr Max		Prob. Excd. 30Yr Max		SMD		Total weighted score	Risk Category
				Weight	Score	Weight	Score	Weight	Score	Weight	Score		
0	Merseyside	17.64	3	Organised/BBuild/Slow	2	5	0.05	1	0.01	10.00	0.60	1.01	Low
1	S Yorkshire	10.63	2	Organised/BBuild/Slow	2	4	0.04	1	0.01	20.00	0.30	0.00	Very Low
2	Tyne and Wear	19.60	3	Organised/BBuild/Slow	2	3	0.03	1	0.01	20.00	0.30	0.00	Very Low
3	W Midlands	44.47	3	MCS/FrontalEmbeddedPI	3	5	0.05	1	0.01	20.00	0.30	1.20	Low
4	W Yorkshire	18.09	3	Organised/BBuild/Slow	2	4	0.04	1	0.01	20.00	0.30	0.00	Very Low
5	Gtr London	62.27	3	MCS/FrontalEmbeddedPI	3	7	0.07	3	0.03	10.00	0.60	1.38	Low
6	Gtr Manchester	28.84	3	Organised/BBuild/Slow	2	5	0.05	1	0.01	10.00	0.60	1.01	Low
7	Bedfordshire	5.96	2	MCS/FrontalEmbeddedPI	3	7	0.07	5	0.05	30.00	0.20	1.19	Low
8	Buckinghamshire	7.22	2	MCS/FrontalEmbeddedPI	3	11	0.11	5	0.05	10.00	0.60	1.42	Low

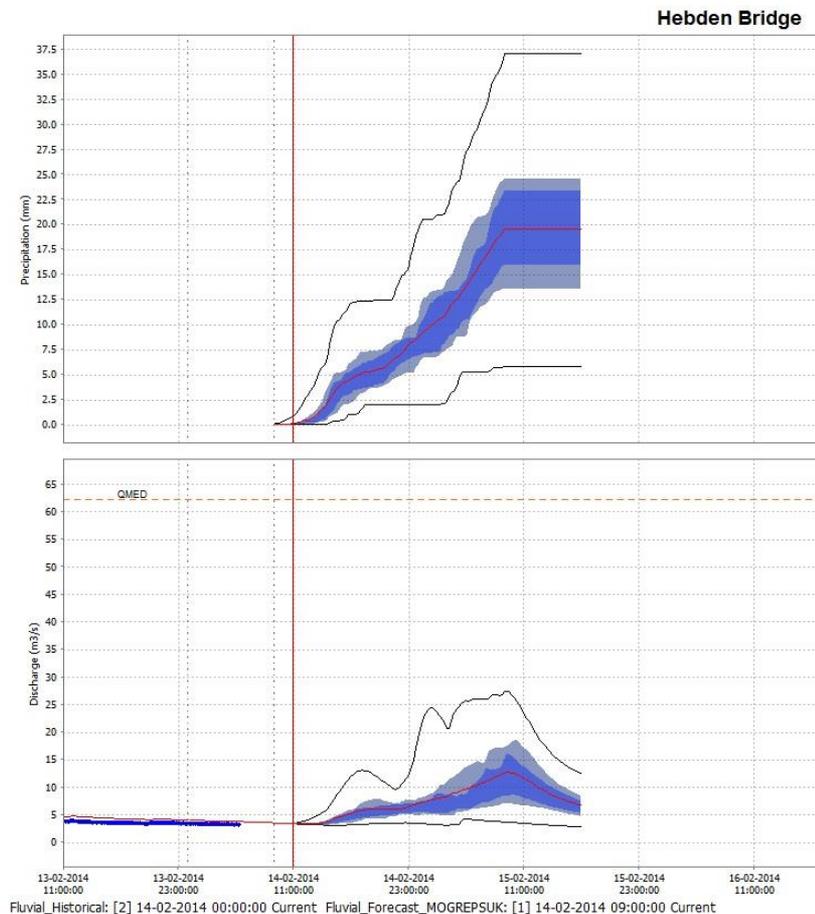
Short Range Forecasting

Fluvial modelling using CEH Grid to Grid Hydrological Model.
 Forecasting percentage of ensemble members exceeding return period thresholds.

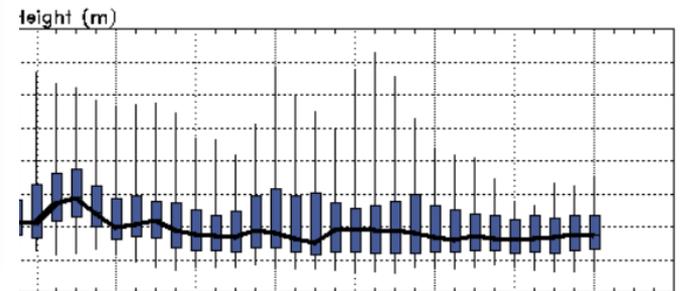
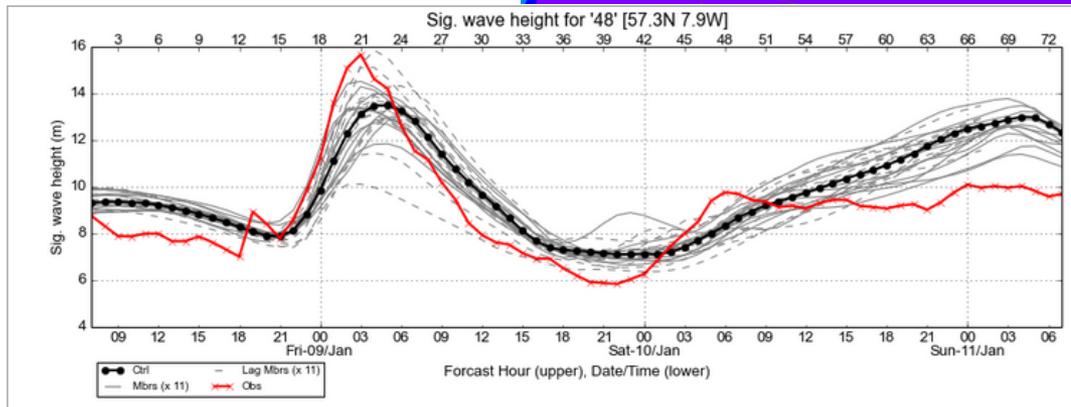
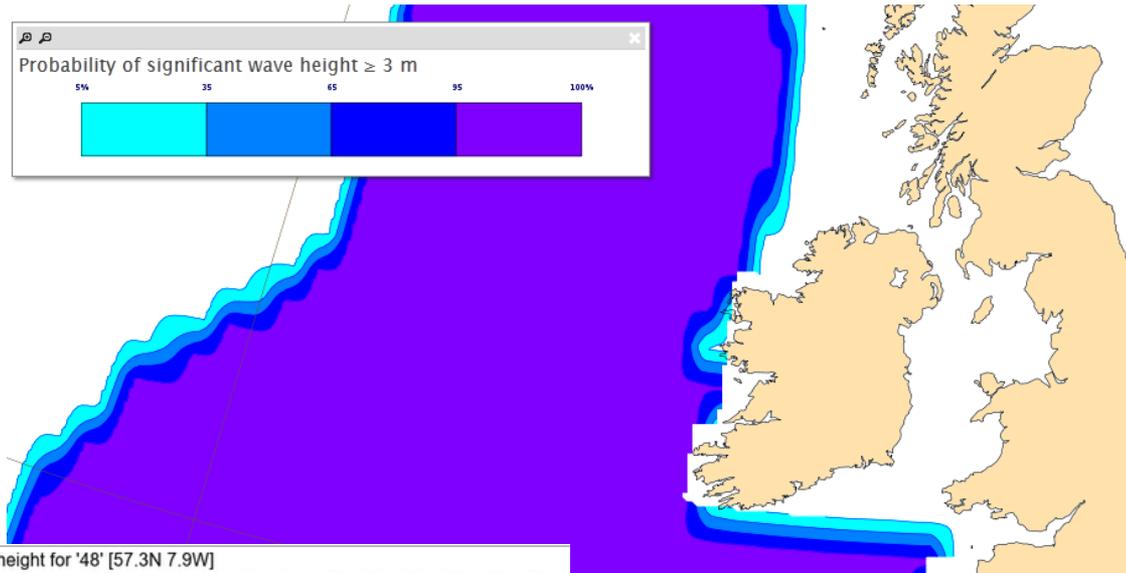


Short Range Forecasting

Fluvial modelling using CEH Grid to Grid Hydrological Model. Forecast point hydrograph outputs – short range ensembles (MOGREPS-UK 36 hour rainfall input)



Coastal forecasting ECMWF Wave ensemble forecasts

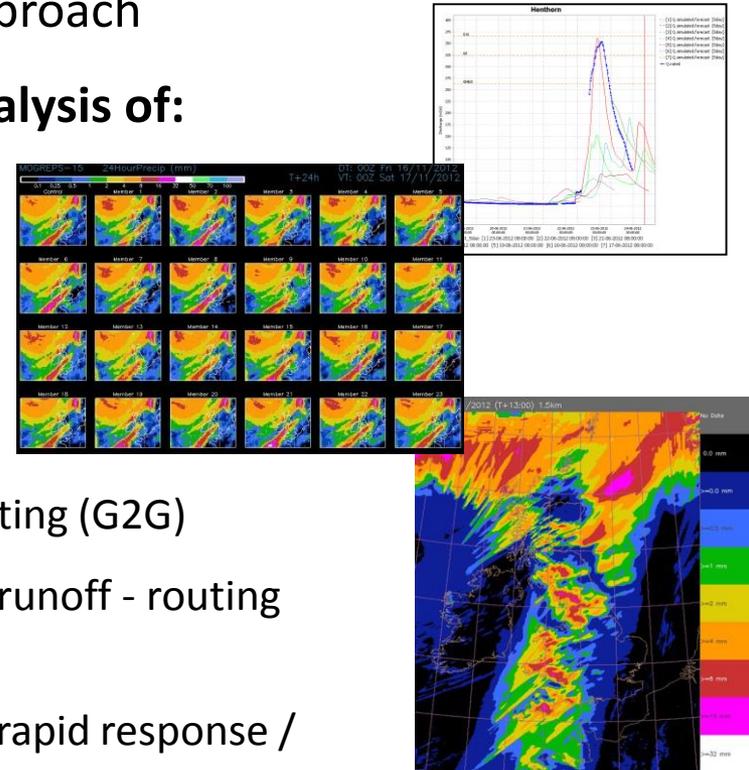


MO Wave ensemble forecast (trial) and CS3x surge ensemble

Production

Assigning Flood Risk

- ➔ Flood risk determined using a probabilistic approach
- ➔ **Hydrometeorologist employs a subjective analysis of:**
 - ➔ NWP models (deterministic and ensemble)
 - ➔ Guidance from the Met Office chief and deputy chief forecaster
 - ➔ Raingauge & radar data
 - ➔ Hydrological modelling - grid based rainfall/runoff – routing (G2G)
 - ➔ EA regional flood forecasting team's catchment rainfall/runoff - routing models
 - ➔ Pre-determined rainfall depth-duration thresholds (esp rapid response / surface water impacts)
 - ➔ Conference with EA flood forecasting teams (catchment sensitivity, defence condition and deployment, etc)





Communication



Communication

Medium Range Forecasting

Strategic briefing documents – uncertainty in words

The purpose of this short briefing note is to explain the coastal flood risk over the period 20-23 February 2015.

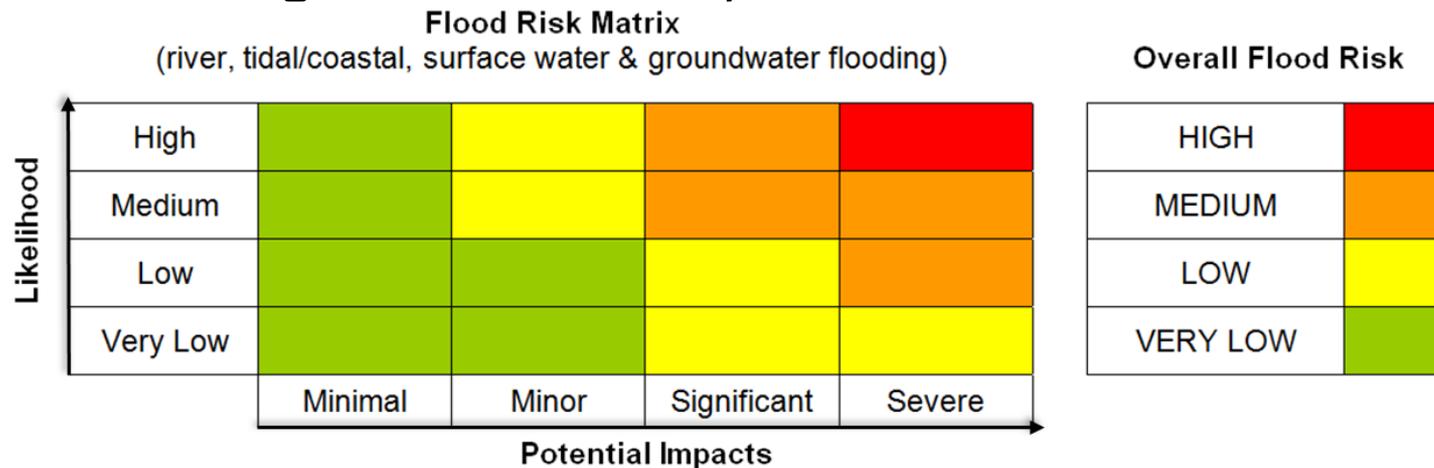
- A period of high spring tides begins on Wednesday 18 February and will reach their highest levels during the weekend of 21 – 22 February. An area of low pressure is expected to develop to the west and track across England and Wales on Friday (20 Feb) and remain over the North Sea on Saturday (21 Feb). It has the potential to cause strong to near gale force winds on coasts in the south and southwest of England on Friday, slackening slightly through Saturday
- On Friday 20 February the combination of high astronomic tides and waves brings a medium likelihood of MINOR flooding impacts to parts of the north-west and north-east coasts, parts of the South Wales coast, parts of the Severn and Wye estuaries and the coast of Cornwall.

Communication

Flood Risk Matrix

Forecasting the likelihood of different levels of impact to give an overall flood risk.

Identical to the NSWWS matrix (so they should be the same for pluvial flooding event forecasts).



NOTE: The risk colours are not a progressive ready-steady-go system indicating the likelihood of flooding. They take account of the impact and the likelihood of flooding to highlight an overall flood risk.

Communication

Impact Table

FLOOD IMPACTS TABLE				
to be used by FFC (FGS), EA and Met Office (weather alerts / warnings of heavy rain) as an optional link on websites				
	Minimal Impacts	Minor Impacts	Significant Impacts	Severe Impacts
Typical impacts	<p>Minimal disruption</p> <ul style="list-style-type: none"> • Generally no impact, however there may still be • Isolated and minor flooding of low-lying land and roads • Isolated instances of spray/wave overtopping on coastal promenades • Little or no disruption to travel although wet road surfaces could lead to difficult driving conditions 	<p>Minor disruption</p> <ul style="list-style-type: none"> • Localised flooding of land and roads – risk of aquaplaning • Localised flooding could affect individual properties • Individual properties in coastal locations affected by spray and/or wave overtopping • Localised disruption to key sites identified in flood plans (e.g. railways, utilities) • Local disruption to travel – longer journey times 	<p>Significant disruption</p> <ul style="list-style-type: none"> • Flooding affecting properties and parts of communities • Damage to buildings/structures is possible • Possible danger to life due to fast flowing/deep water/ wave overtopping/ wave inundation • Disruption to key sites identified in flood plans (e.g. railways, utilities, hospitals) • Disruption to travel is expected. A number of roads are likely to be closed 	<p>Severe disruption</p> <ul style="list-style-type: none"> • Widespread flooding affecting significant numbers of properties and whole communities • Collapse of buildings/structures is possible • Danger to life due to fast flowing/ deep water/ wave overtopping/ wave inundation • Widespread disruption or loss of infrastructure identified in flood plans (e.g. railways, utilities, hospitals) • Large scale evacuation of properties may be required • Severe disruption to travel. Risk of motorists becoming stranded

Likelihood: Very Low < 20% Low 20% < 40%
 Medium 40% < 60% High > 60%

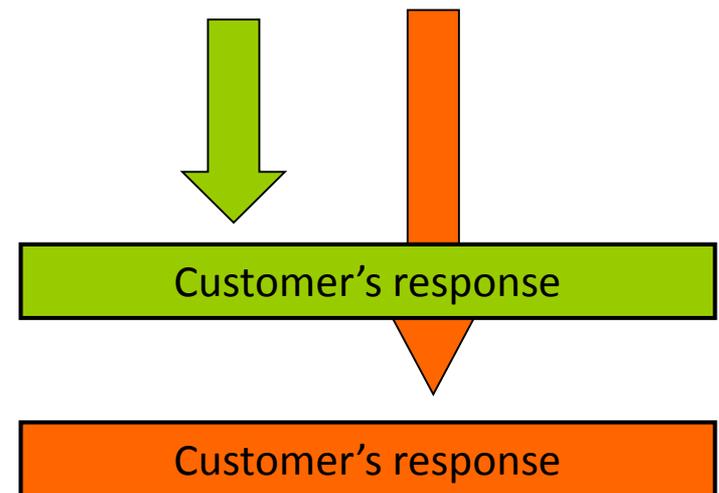
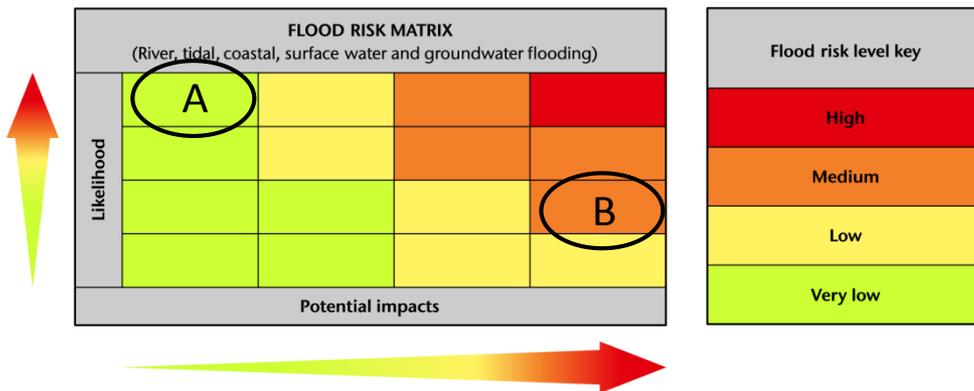
Communication

Assigning Flood Risk

➔ Level of FLOOD RISK is assigned on a county by county basis:

A High Likelihood x Very Low Impact = **VERY LOW OVERALL FLOOD RISK**

B Low Likelihood x High Impact = **MEDIUM OVERALL FLOOD RISK**



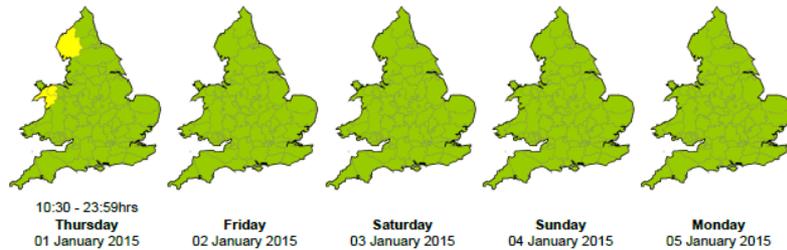
Flood Guidance Statement

FLOODFORECASTINGCENTRE

a working partnership between  Environment Agency |  Met Office

Flood Guidance Statement 10:30hrs Thursday 01 January 2015

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.



The highest overall flood risk for England and Wales over the next five days is **LOW**. There is a medium likelihood of minor river flooding impacts in Cumbria and north-west Wales today (Thursday).

General overview of flood risk

Rain will become persistent and heavy today over high ground in the north of England and across west Wales. This leads to a **LOW** risk of river flooding in Cumbria and parts of north-west Wales, as rivers are expected to respond here. In other parts of the north and west of England and Wales today, despite the rainfall, the overall flood risk remains **VERY LOW**.

Assessment of flood risk

Rivers

Rain will become persistent and heavy over the high ground of both the north of England and the west of Wales during today with river levels expected to rise. This gives a medium likelihood of minor river flooding impacts for Cumbria and parts of north-west Wales, leading to a **LOW** river flood risk overall here (See Area of Concern map for details on locations). In other parts of north and west England and Wales there is a low likelihood of minor river flooding impacts today. Typical flooding impacts may include localised flooding of land and roads, some travel disruption, and possible flooding affecting isolated properties.

Elsewhere and at other times, the river flood risk is **VERY LOW** for the next five days, despite further rainfall over the weekend.

Surface water

Persistent, heavy rain over the high ground of both the north of England and the west of Wales today gives a low likelihood of minor impacts from surface water flooding. Consequently, the surface water flood risk here, and elsewhere, remains **VERY LOW** for the next five days, despite further rainfall over the weekend.

Coastal / tidal

The coastal flood risk remains **VERY LOW** for the next five days. Strong winds today and into Friday will develop large waves for the coasts of Wales and the west and south of England at times, but any impacts are expected to be minimal.

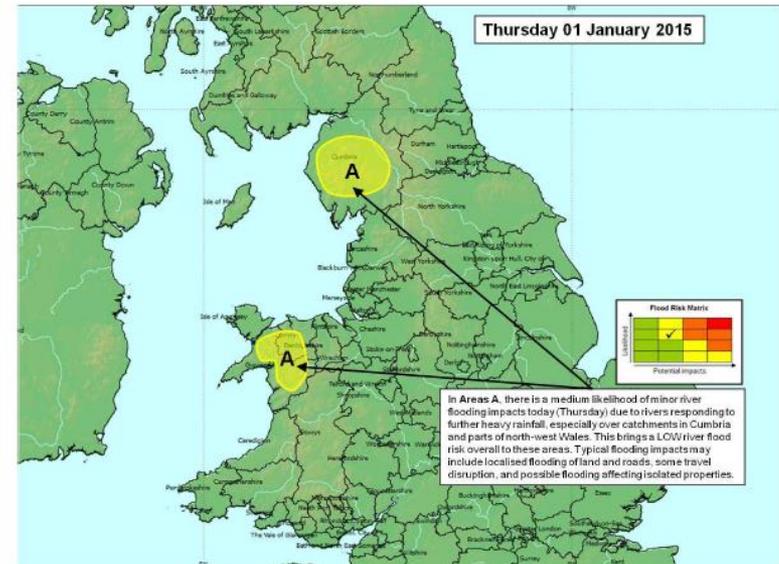
Groundwater

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

Warnings and Alerts in force in England and Wales at 10:30hrs

Flood (click here)		Severe Weather (click here)	
Severe Flood Warnings	0	Warnings	No
Flood Warnings	0	Alerts	No
Flood Alerts	2		

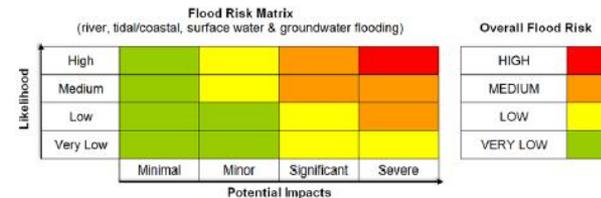
Specific areas of concern



Next statement due: 10:30hrs Friday 02 January 2015

Contact details: Flood Forecasting Centre Duty Hydrometeorologist: 0300 12345 01

All times are local.

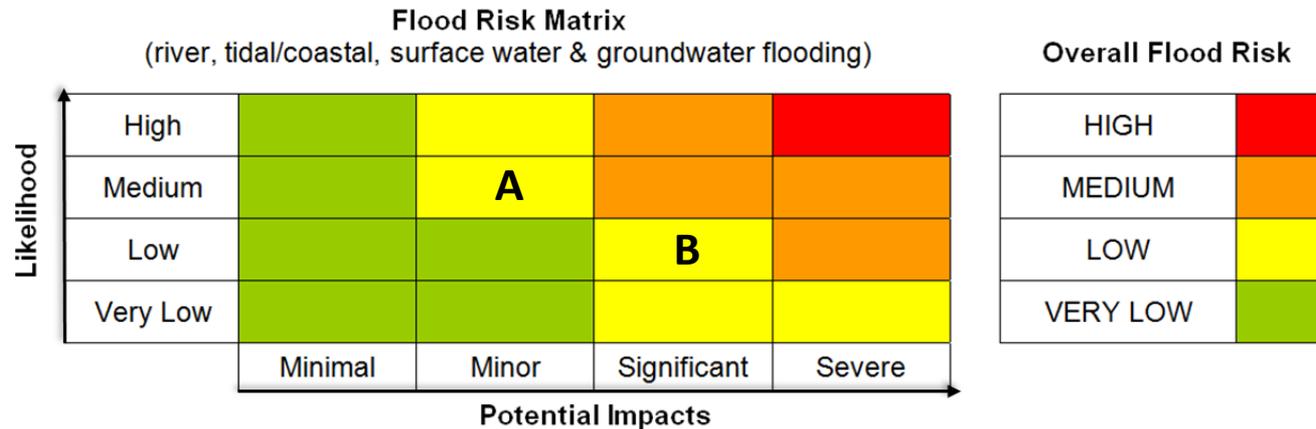


[Click here](#) for the Flood Guidance Statement User Guide.

Communication

Flood Risk Matrix

92 per cent of 2013/14 Yellow FGS at day 3 showed significant impacts (low or very low likelihood).



A and **B** are not the same ... waiting for Amber (medium flood risk) means important lead time is lost.

Communication of **potential impacts** is important rather than just overall flood risk.

Communication

Responder Training

Category 1 and 2 responders can find supporting documents and training tools on-line to help them understand the risk matrix, the FGS and what is meant by uncertainty.

“The FGS risk assessment comes with uncertainty, particularly at longer lead times. Discussing and understanding this uncertainty is a key part of decision making for strategic managers. Some key areas to explore in discussion are: uncertainty in the weather forecast driving the flooding, certainty on locations and timings, and certainty on impacts” (Joint Responder Training for Strategic Managers).

Depending on your role in flood response the potential impact level and likelihood of flooding may be just as relevant as the overall risk. So you need to take account of all three elements in your decision making.

Communication

Supporting Information and Actions

An FGS product is supported by supplementary actions and information, including;

National Flood Advisory Service telecons (NFAS) – *‘helps to ensure that emergency responders and government contacts receive consistent and timely information from the Met Office, FFC, Environment Agency and Natural Resources Wales and that key communication links are in place - especially when the flood requires a multi-agency response’ (Joint Responder Training).*

For EA - National Operations Incident Management telecons (NOIMT)

For all - MO Civil Contingency Advisors

For all - FFC telephone consultancy service



Response

Communication

Use of the Flood Risk Matrix

2015 survey of responders using the FGS (1342 responses).

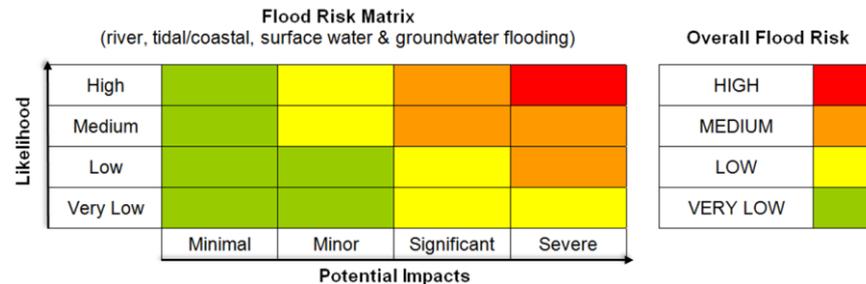
Responders were asked which element they focused on when using the matrix;

39% use all elements equally

22% focus on colour (Overall Flood Risk)

20% on impact

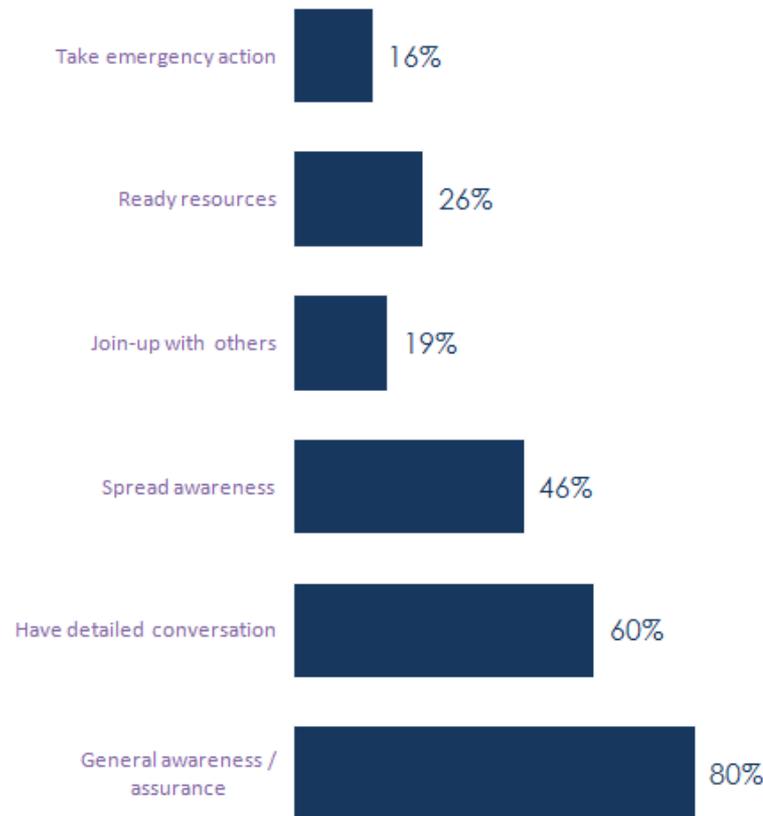
16% on likelihood



Communication

Use of the Flood Risk Matrix

What actions do you typically take when the Flood Guidance Statement forecasts very low or low likelihood of significant (yellow) or very low likelihood of severe (yellow) flooding at Days 3, 4 or 5?



Communication

Use of the Flood Risk Matrix

“The statements are of too low a level of certainty over a wide spatial area. This means that if we responded to every warning which included our administrative boundaries we would have spent huge sums on false alarms. As emergency responders we cannot commit resources on the basis of this accuracy however we will be condemned for not deploying when one of the warnings actually results in flooding.”

Local Authority, neither satisfied or dissatisfied with FGS,
sometimes uses matrix

Perceptions of impacts differ;

from person to person

between organisations

across different roles

across different scales



Communication

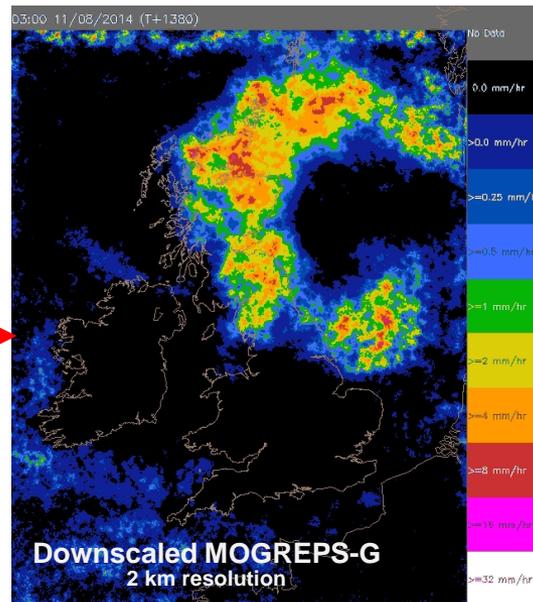
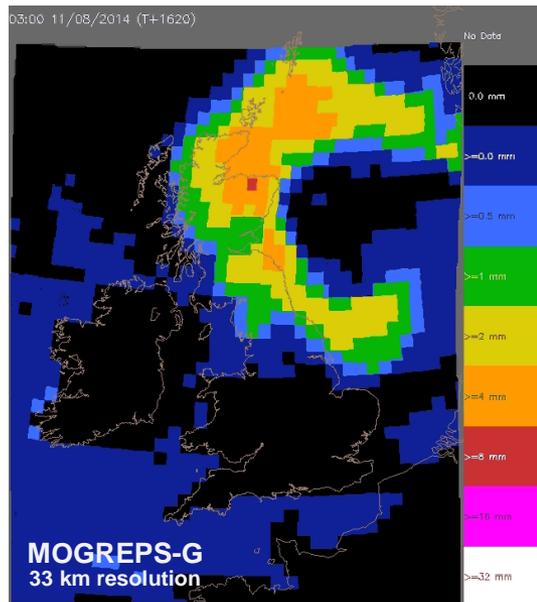
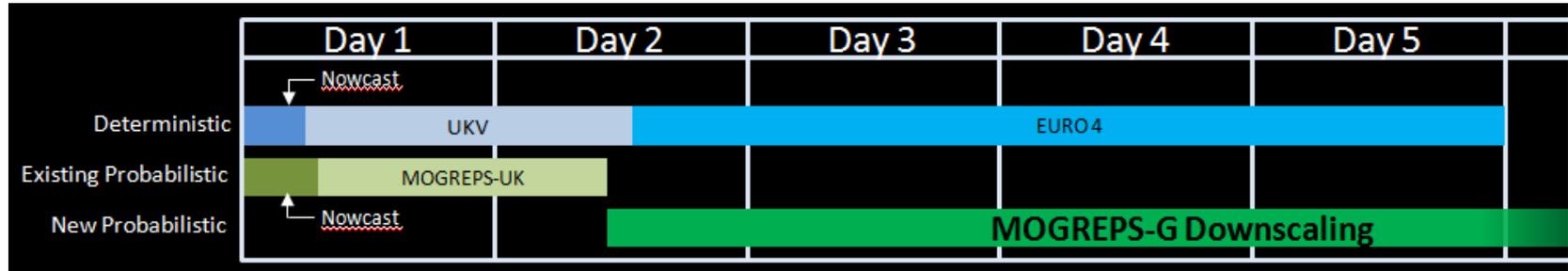
Challenges

- Improve forecast accuracy
- Increase understanding of uncertainty
- Improve responder training
- Improve responder action plans



Future Developments

Grid to Grid Hydrological Model



Provides G2G model with medium range rainfall ensembles, allowing probabilistic forecasting.

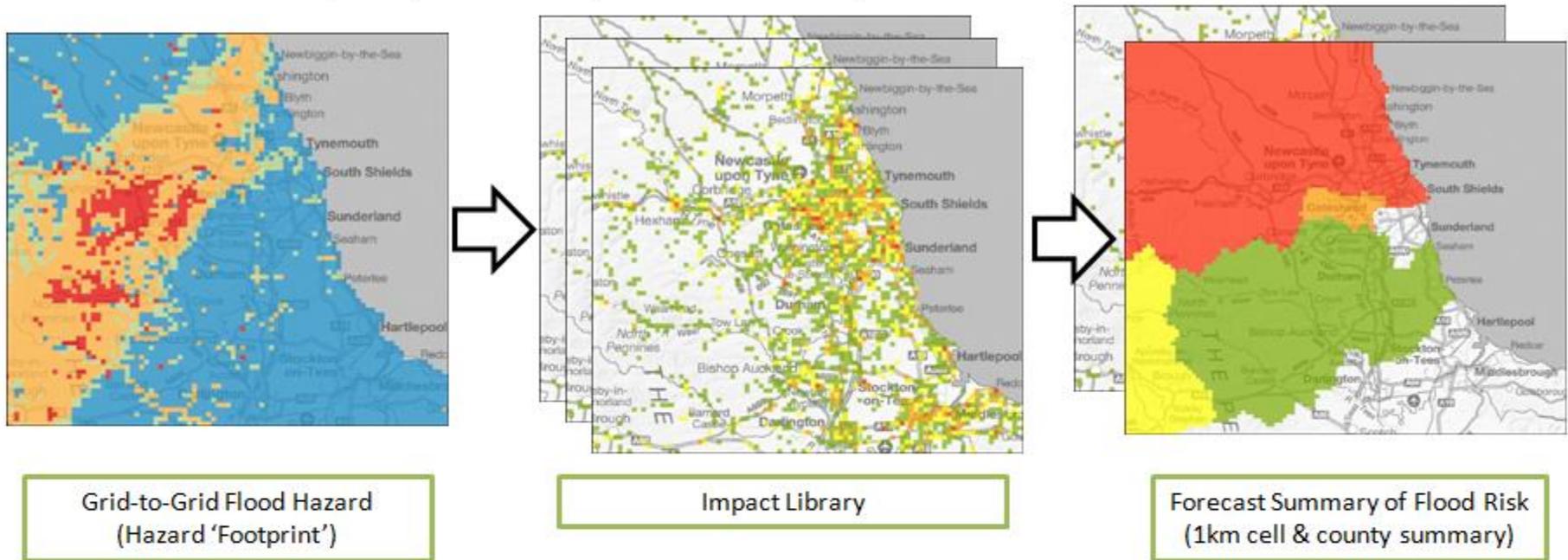
Allows objective estimates of flow probability for all five days of the Flood Guidance Statement. Informing not only the impact level but also likelihood.

A statistical method is used to increase the resolution of the MOGREPS-G rainfall ensemble model

Surface Water Flooding - Hazard Impact Model

Project in conjunction with NHP, CEH, HSL and MO.

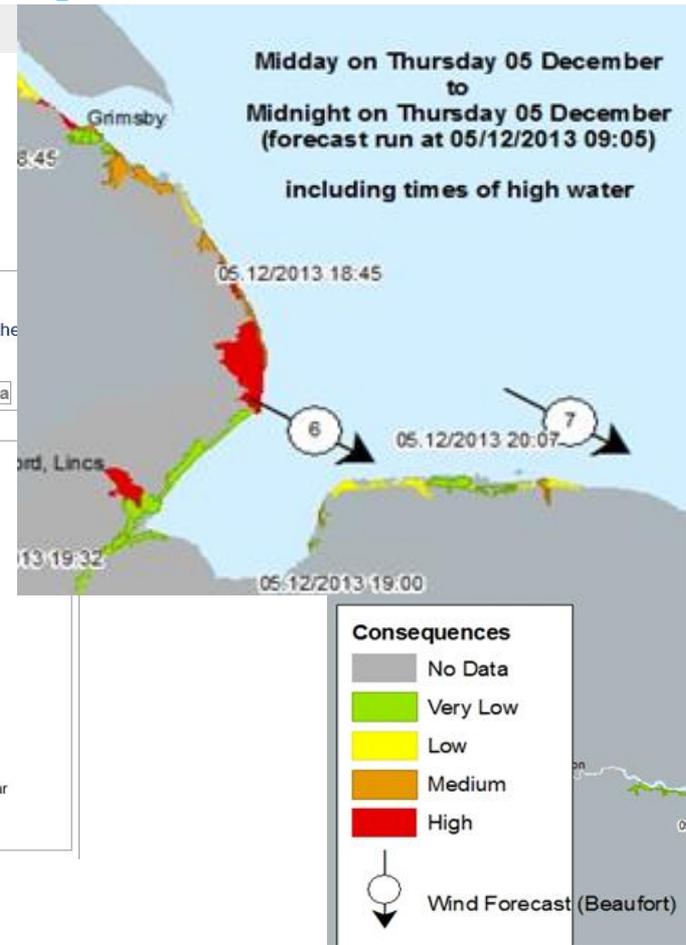
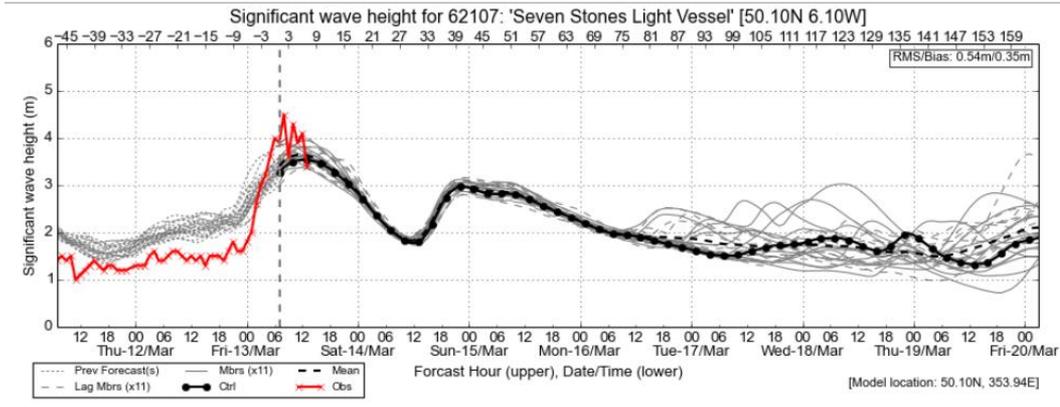
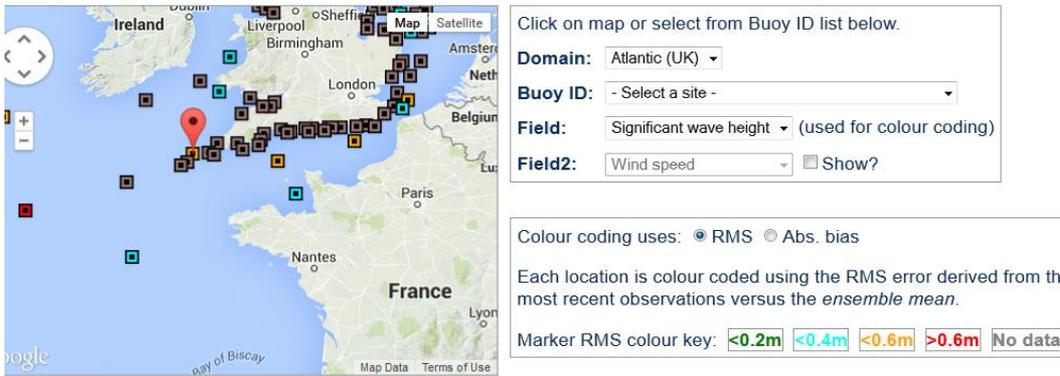
Structure of proposed operational system:



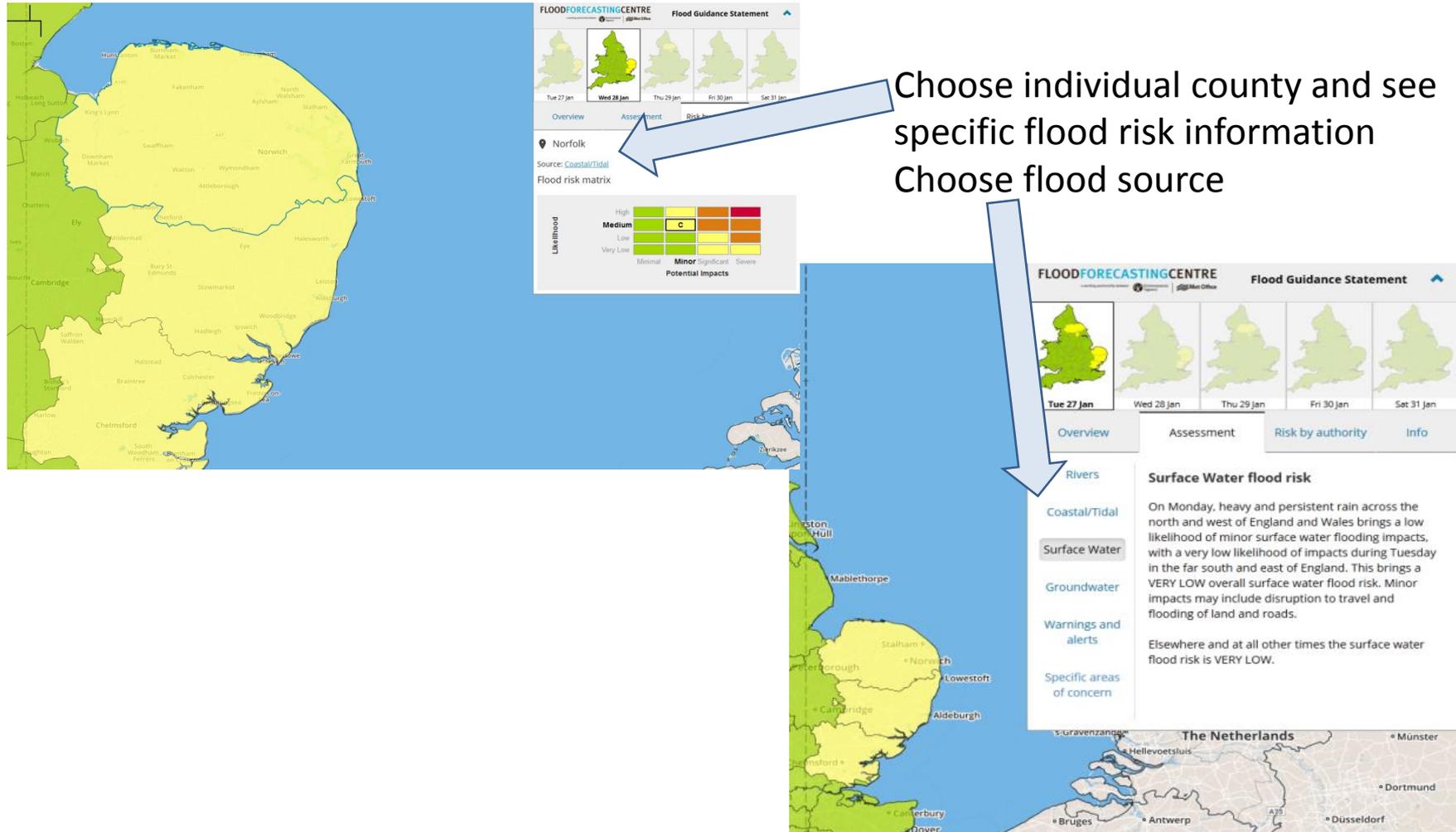
- *Impact Library* set up as database of pre-calculated impact information
- Presentation of impact data to inform flood advice
- Summarise for time, space & uncertainty
- Reporting by County/Authority – further information at 1km cell level

Coastal – Wave Ensemble & Input into CDST

MyWave Ensemble - Buoy Verification



Dynamic Customizable Web Page



The screenshot displays the Flood Forecasting Centre (FFC) web interface. On the left is a large map of Norfolk, England, with various towns and regions labeled. In the top right, there's a 'Flood Guidance Statement' section with a navigation menu (Overview, Assessment, Risk by authority, Info) and a series of five maps showing the flood risk for different dates: Tue 27 Jan, Wed 28 Jan, Thu 29 Jan, Fri 30 Jan, and Sat 31 Jan. Below this is a 'Flood risk matrix' table with columns for Likelihood (High, Medium, Low, Very Low) and Potential Impacts (Minimal, Minor, Significant, Severe). A blue arrow points from the text 'Choose individual county and see specific flood risk information' to the Norfolk map. Another blue arrow points from the text 'Choose flood source' to the 'Surface Water' option in the 'Rivers' section of the detailed assessment. The detailed assessment on the right shows 'Surface Water' as the selected flood source, with a description of the risk: 'On Monday, heavy and persistent rain across the north and west of England and Wales brings a low likelihood of minor surface water flooding impacts, with a very low likelihood of impacts during Tuesday in the far south and east of England. This brings a VERY LOW overall surface water flood risk. Minor impacts may include disruption to travel and flooding of land and roads. Elsewhere and at all other times the surface water flood risk is VERY LOW.'

Choose individual county and see specific flood risk information

Choose flood source



Questions...

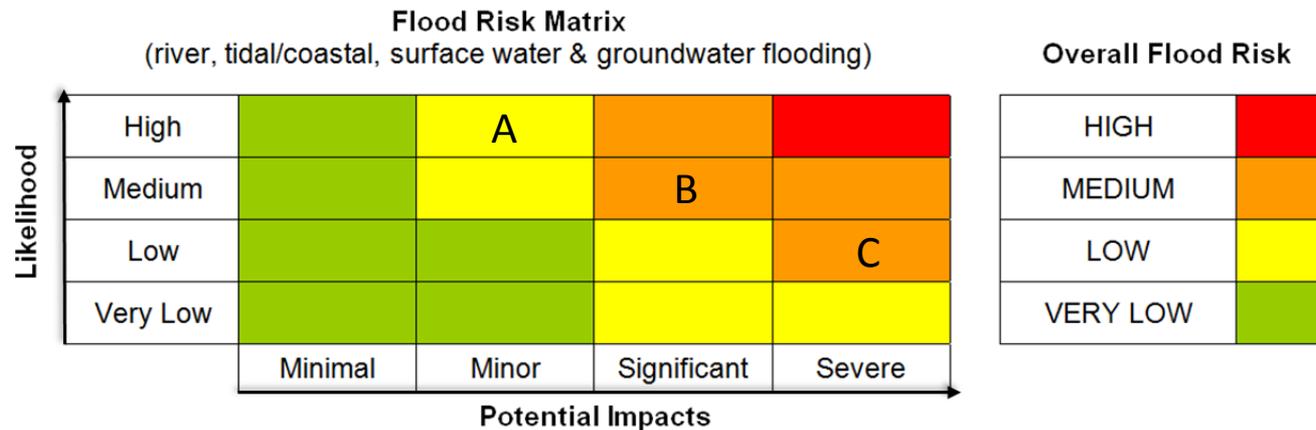
Uncertainty

Flood Risk Matrix

most likely scenario? A

scenario with highest impact level? C

range of scenarios and likelihoods? ABC



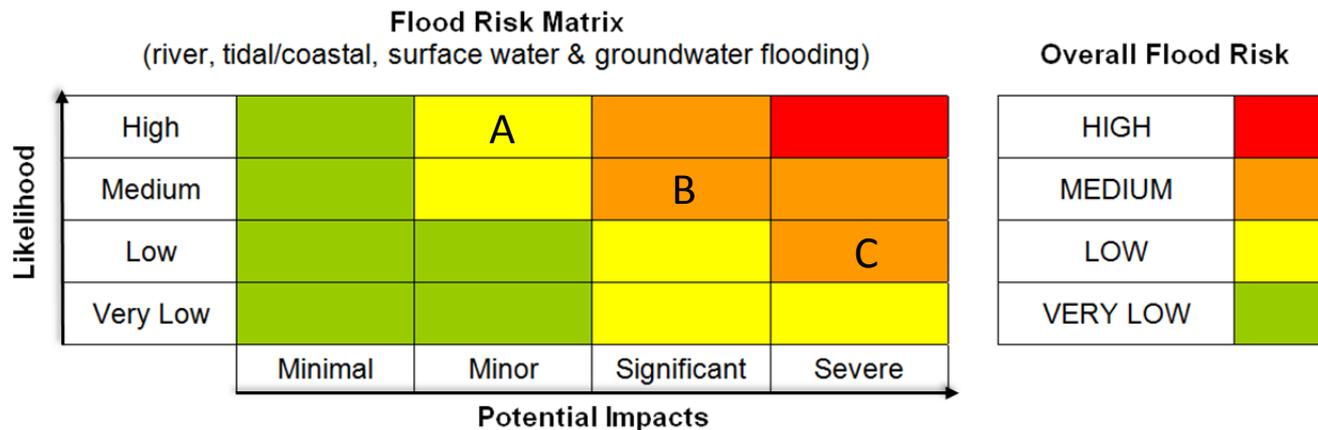
Uncertainty

Customizable Thresholds

most likely scenario? A - cost averse responders / slowly developing events

scenario with highest impact level? C – risk averse responders / rapidly occurring events

range of scenarios and likelihoods? ABC – responders with multiple, varied actions





Answers?