Forecasting sea state with a spectral wave model

Rogue Waves 2004, Brest

Martin Holt 22 October 2004
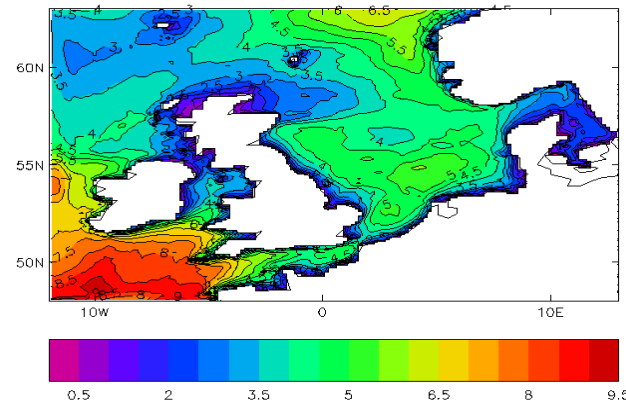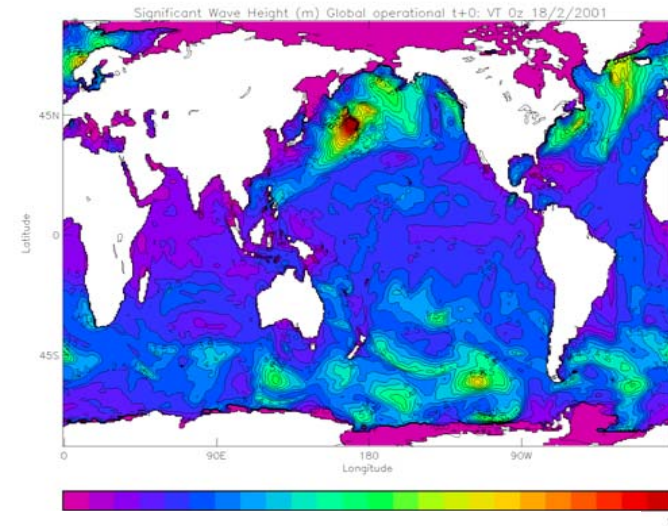
www.metoffice.gov.uk

Wave Modelling at the Met Office

Operational wave models predict the offshore wave energy spectrum

Hourly 10m wind forcing from a weather prediction model

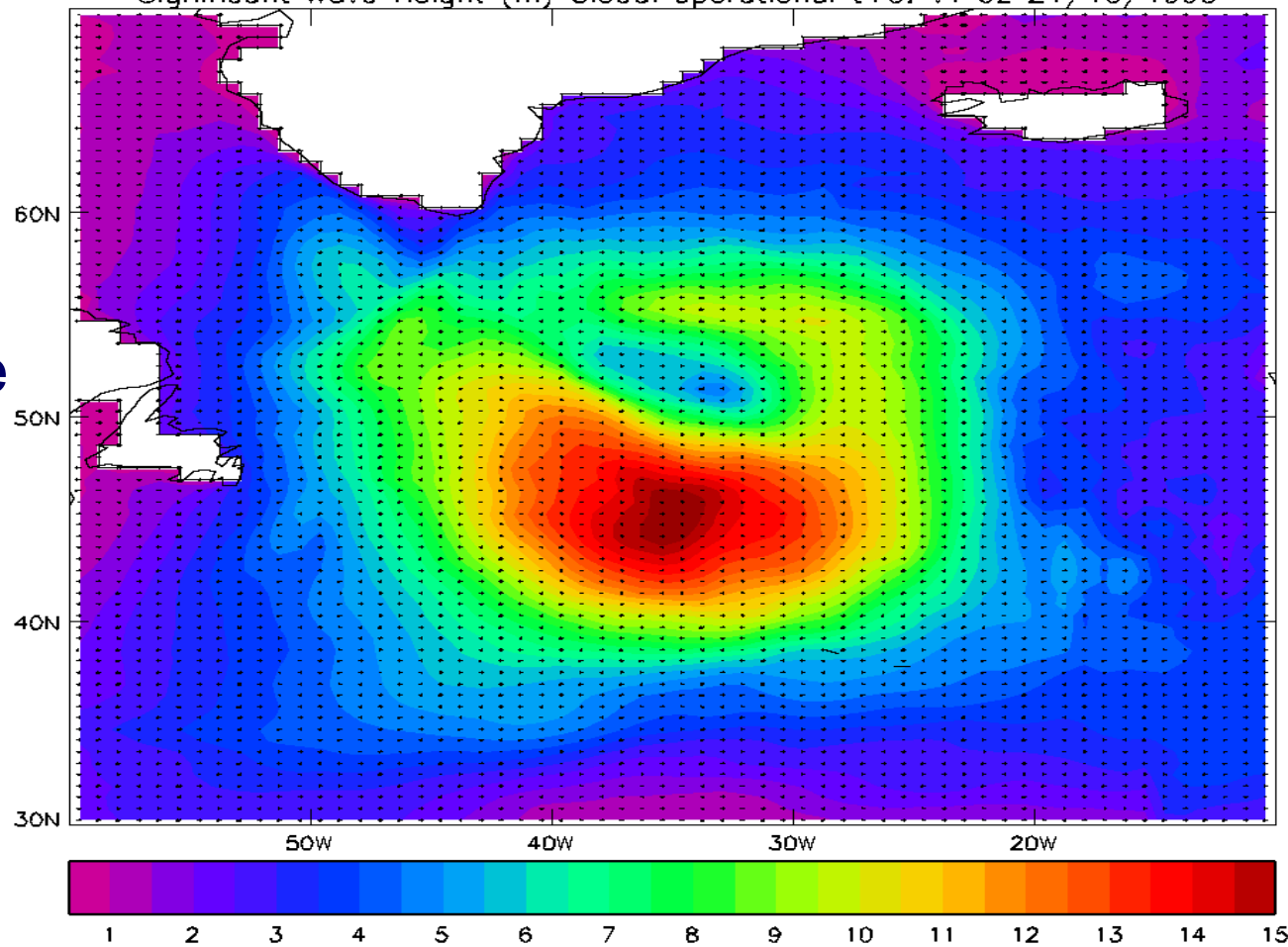**Global wave model grid spacing ~ 60km. Five day forecast updated twice daily**

Nested wave models grid spacing ~12km 48 hour forecast updated four times daily

Wave height forecasts for GMDSS, for shipping forecast

Hurricane Irene

21 Oct 1999

Contours of Hs over global wave model grid

Significant Wave Height (m) Global operational t+0: VT 0z 21/10/1999

+

Integrated parameters Hs Tz Tp

Multimodal spectra; remote (and local) swell

Wind forcing history

"running fetch" situations automatically handled

–

Linear theory, Gaussian statistics (not describing individual waves)

Rather coarse resolution in frequency and direction

Resolution of modelled winds, turbulence not accounted for

Resolution of coastlines

Integrated parameters used: Hs Tz Tp

Forecasting sea state

Can we do more than just Hs, Tz, Tp and swell?
(the 1998 wave model forecasts for "Schiehallion" were pretty good for Hs, Tz / Tp)

Combinations of integrated spectral parameters, of forcing winds history ?

(Olagnon & Magnusson)
Choose parameters related to integrated spectral properties

?? Not the same as estimating a spectrum or spectral parameters from a timeseries ??

Diagnosis of likelihood of an extreme or damaging wave from a given sea state

Case studies of ship casualties
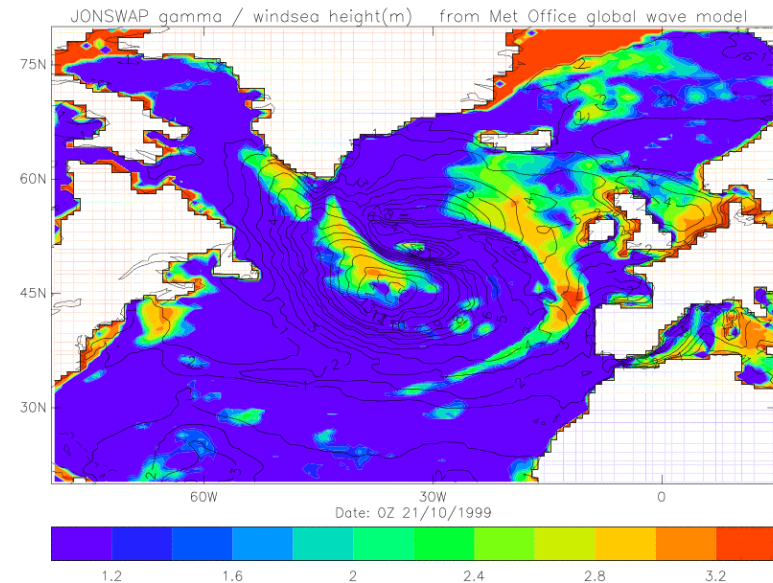
Spectral diagnostics

- Jonswap "gamma"
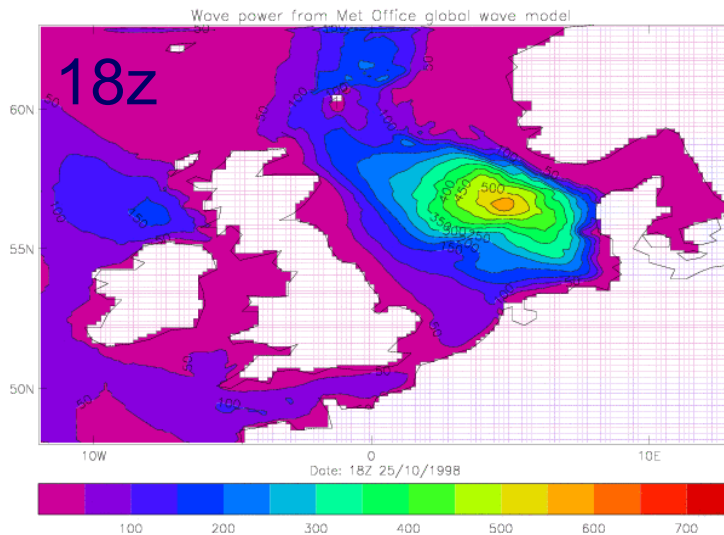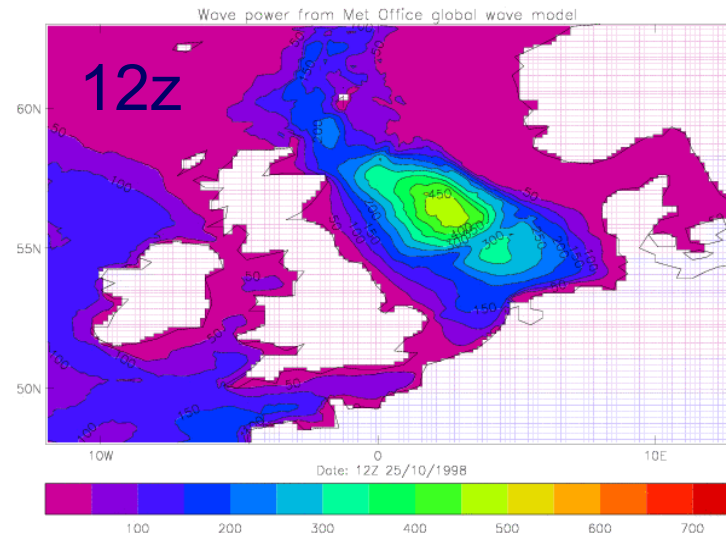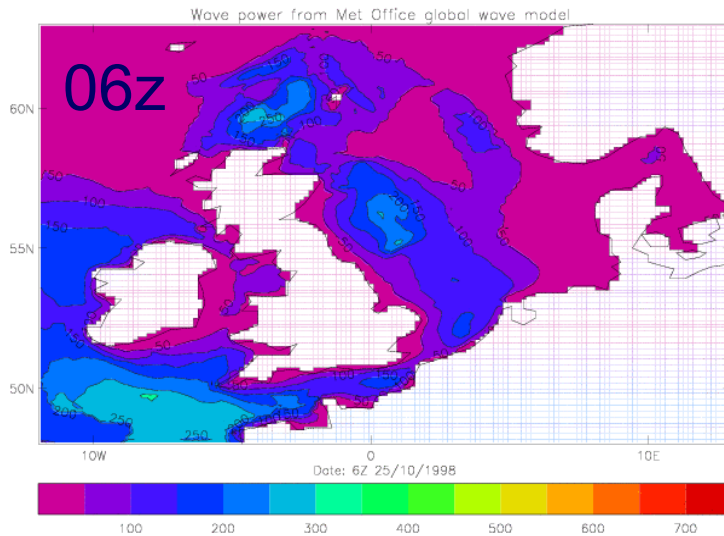Shows where waves are actively growing

-BFI
-Goda
-wave power
-mean wave steepness

Jonswap Gamma (colour) /

windsea Hs (contours)

MAXWAVE Stenfjell: Windsea Height squared times windsea Tz (proportional to **Wave Power**) from Met Office wave model
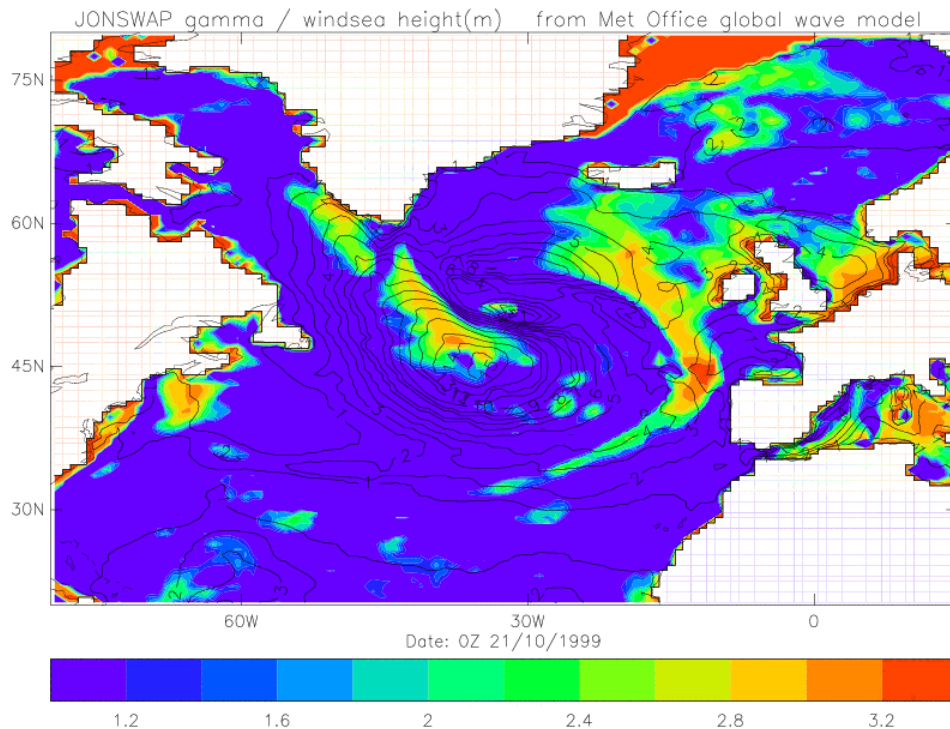

Plots of "wave power" for the Stenfjell storm at 06z,12z and 18z on 25th October 1998.

Ship was damaged near to peak of storm

Parametrisation of "gamma" parameter

Jonswap Gamma (colour) /

windsea Hs (contours)

JONSWAP gamma / windsea height(m)   from Met Office global wave model
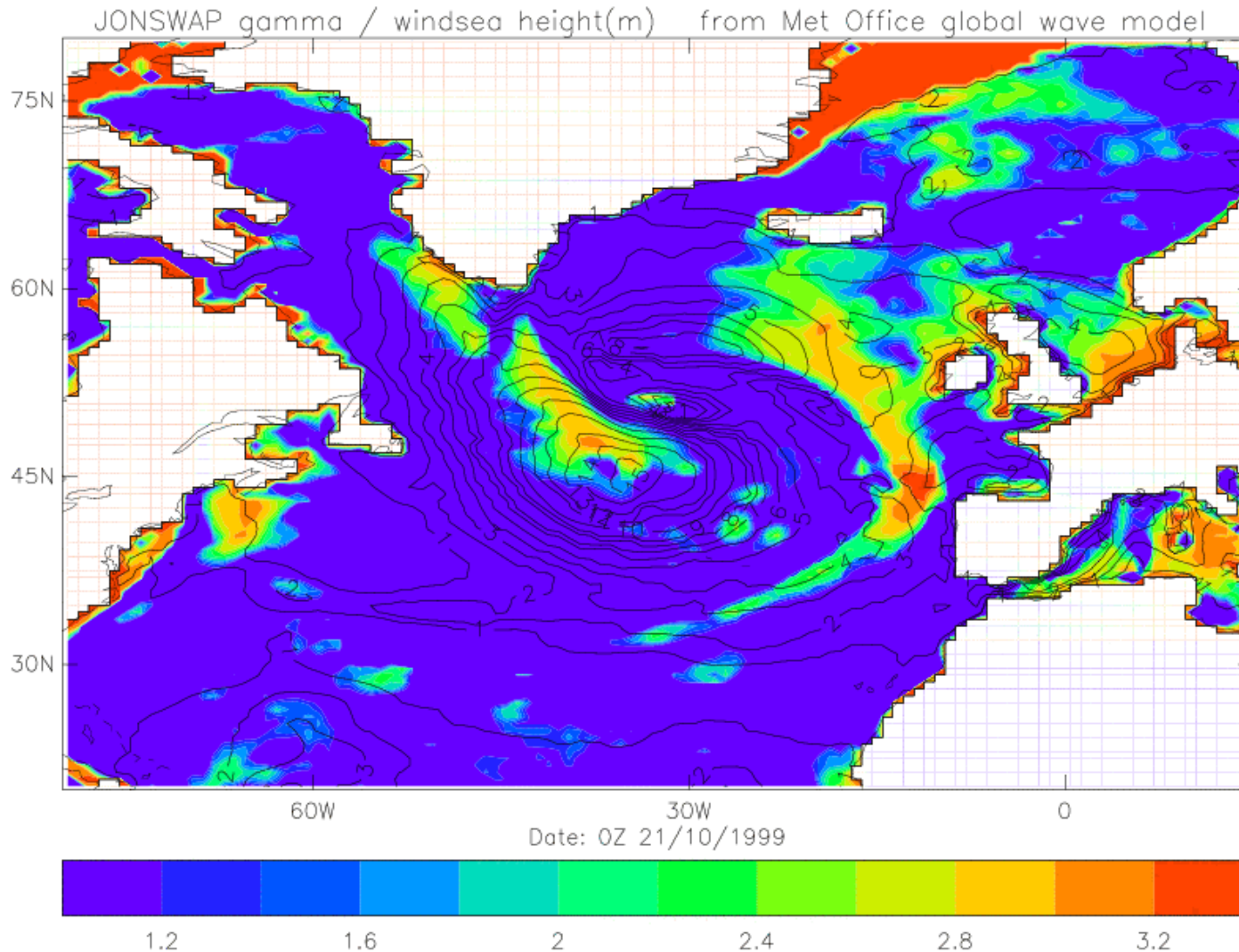
Date: 0Z 21/10/1999

Model estimates this from the amount of windsea energy present, compared to the total PM energy for the local windspeed

Growing windsea is fitted to a JONSWAP spectrum

For this calculation a value of 1 means *either* a PM spectrum *or* that the local wind speed has reduced over time

Ex-Hurricane Irene October 1999

Jonswap Gamma (colour) / windsea Hs (contours)

JONSWAP gamma / windsea height(m)   from Met Office global wave model

Date: 0Z 21/10/1999

Identifies regions with high sea state **AND** actively growing waves

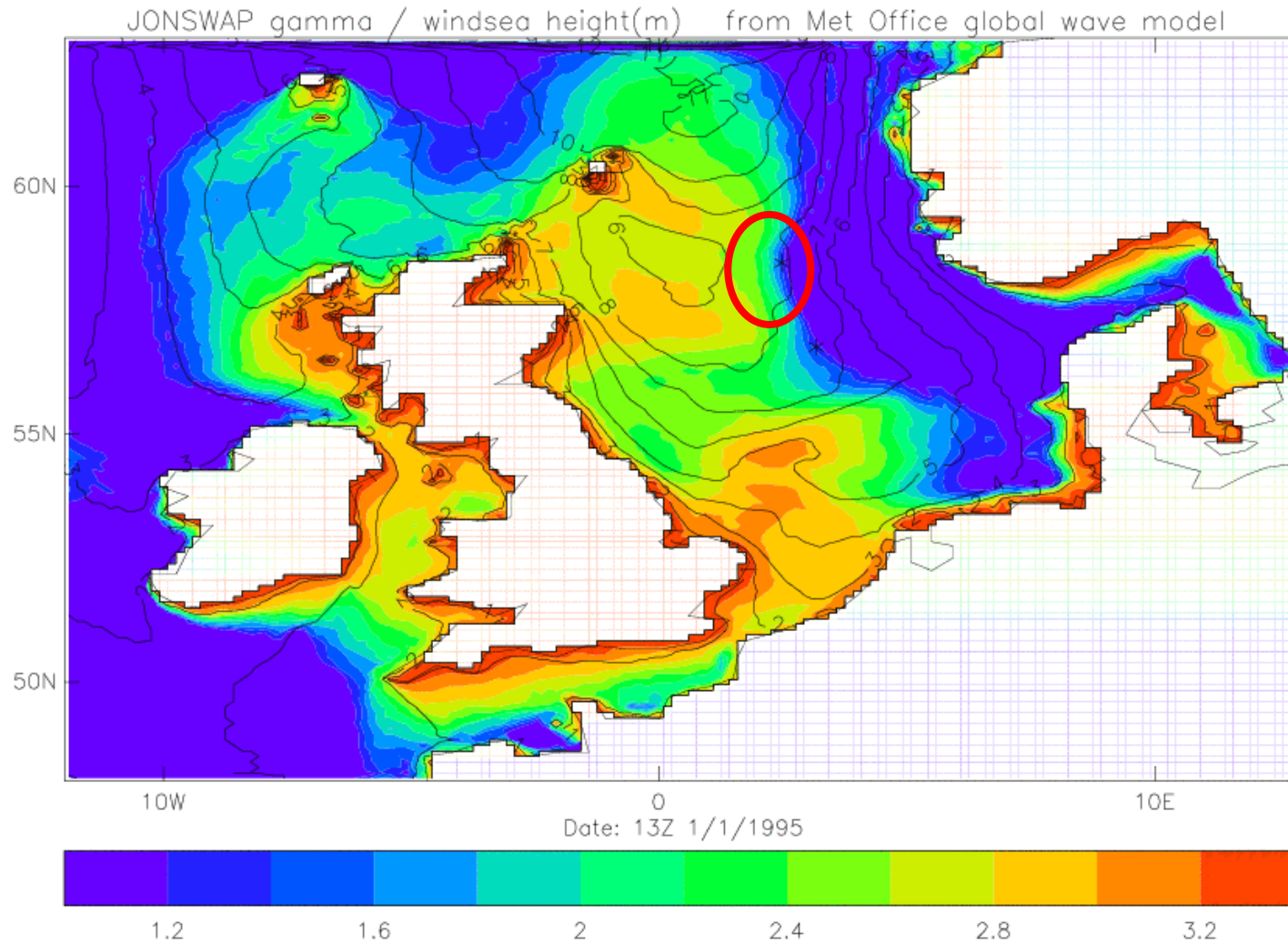# Can we say why the Draupner wave occurred when and where it did ?

JONSWAP gamma / windsea height(m)   from Met Office global wave model

Date: 12Z 1/1/1995

12z

JONSWAP gamma / windsea height(m)   from Met Office global wave model

Date: 13Z 1/1/1995

13z

Can we say why the Draupner wave occurred when and where it did ?

JONSWAP gamma / windsea height(m)   from Met Office global wave model

Date: 14Z 1/1/1995

14z

Can we say why the Draupner wave occurred when and where it did ?
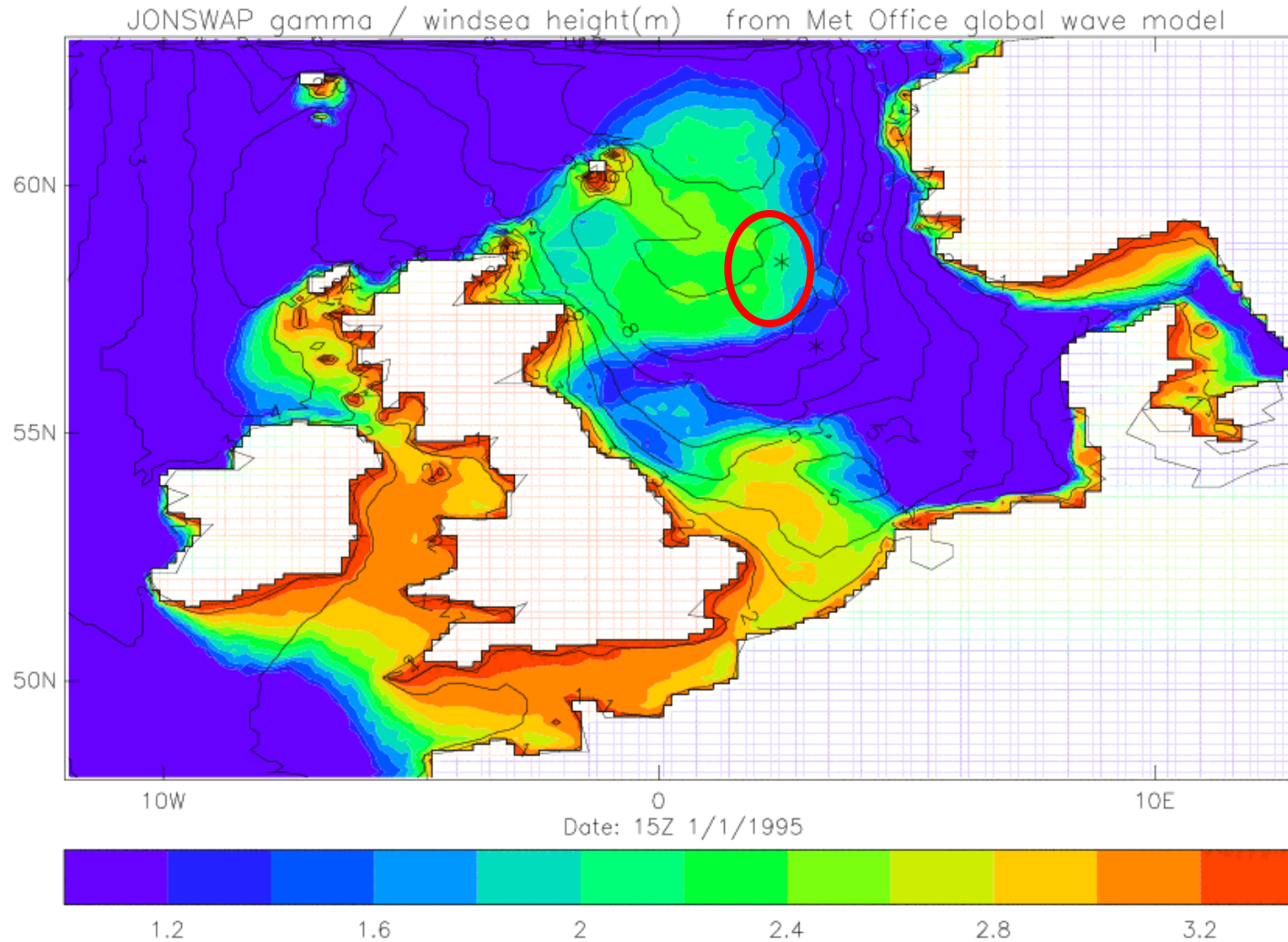
Met Office

JONSWAP gamma / windsea height(m)   from Met Office global wave model

Date: 15Z 1/1/1995

15z

1.2   1.6   2   2.4   2.8   3.2

Can we say why the Draupner wave occurred when and where it did ?

JONSWAP gamma / windsea height(m)   from Met Office global wave model

Date: 16Z 1/1/1995

16z

1.2   1.6   2   2.4   2.8   3.2

Can we say why the Draupner wave occurred when and where it did ?

Met Office
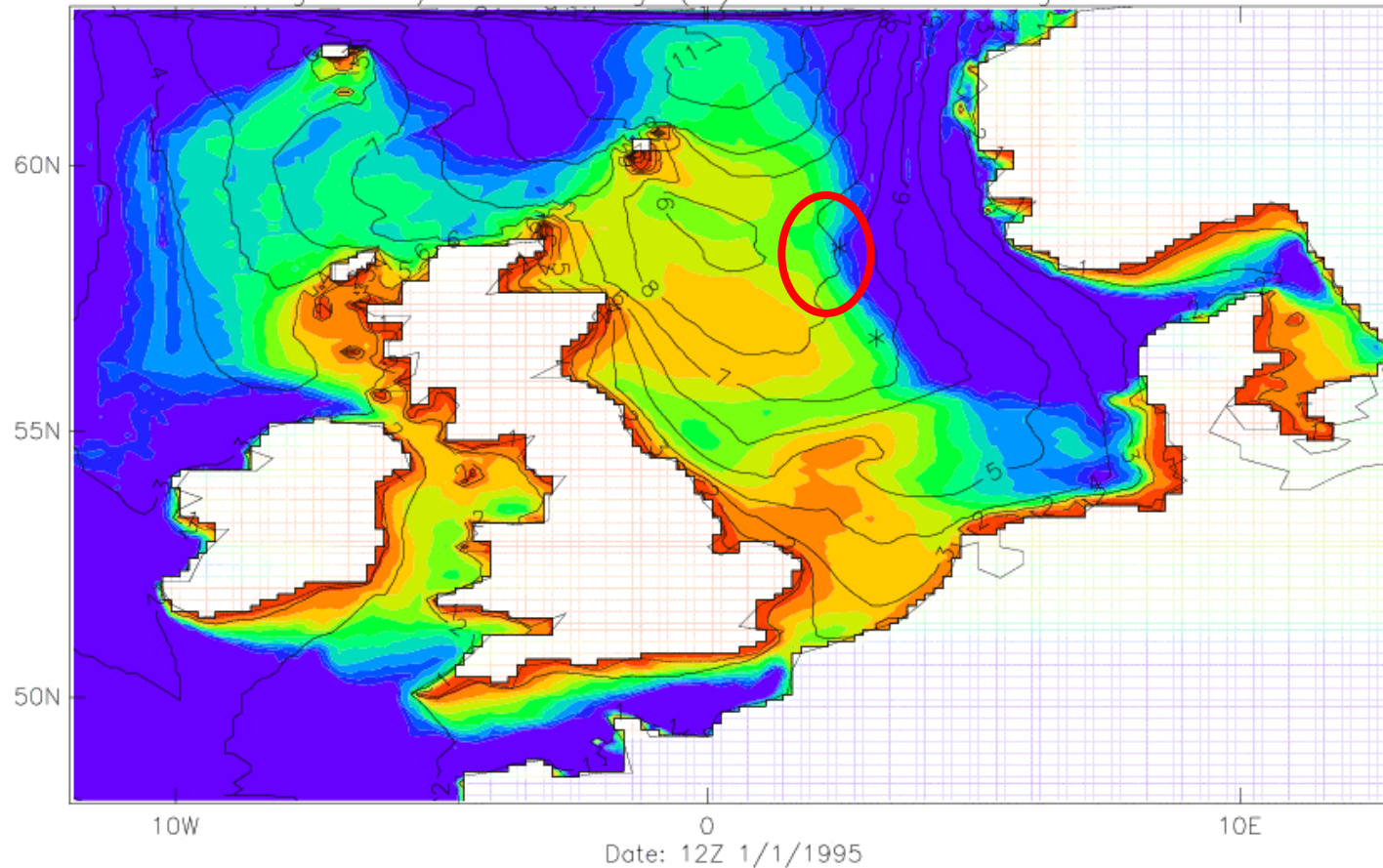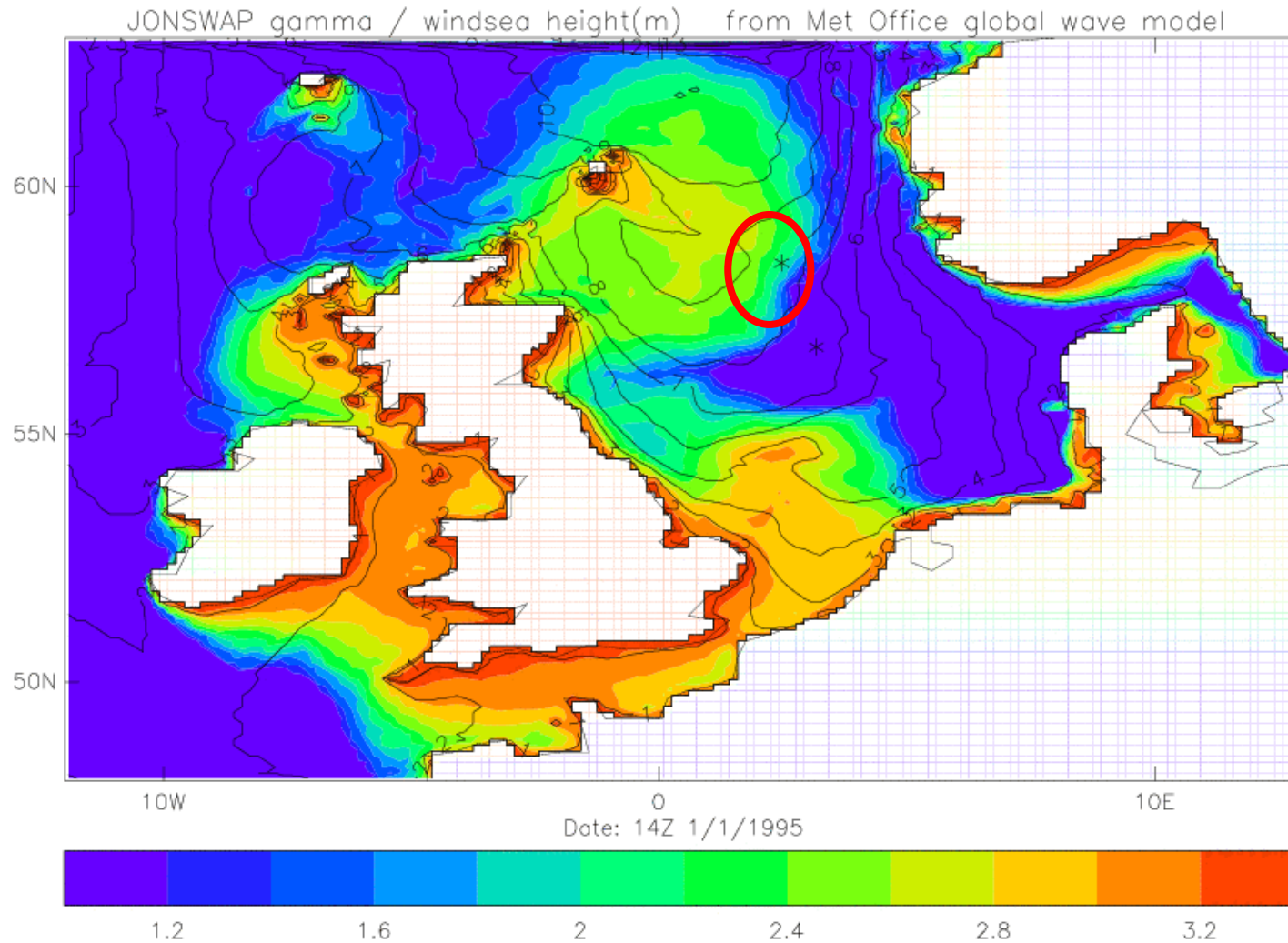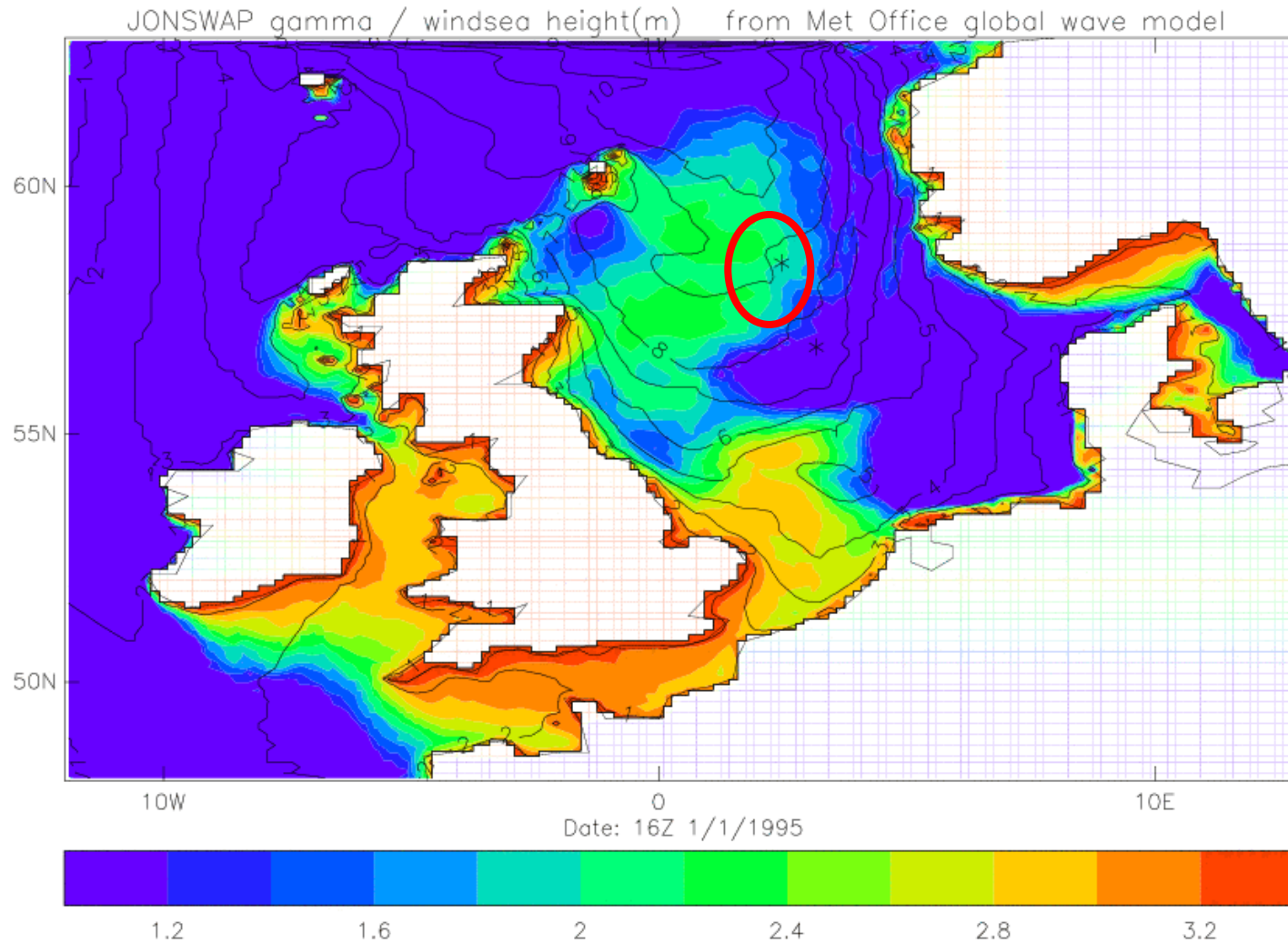
Not yet with this particular parameter combination

….without a lot more understanding

(if you believe the modelled winds and waves !!)

Other processes?

So far this has been deep water only.

Not investigated Janssens BFI index – need to learn how to use this.

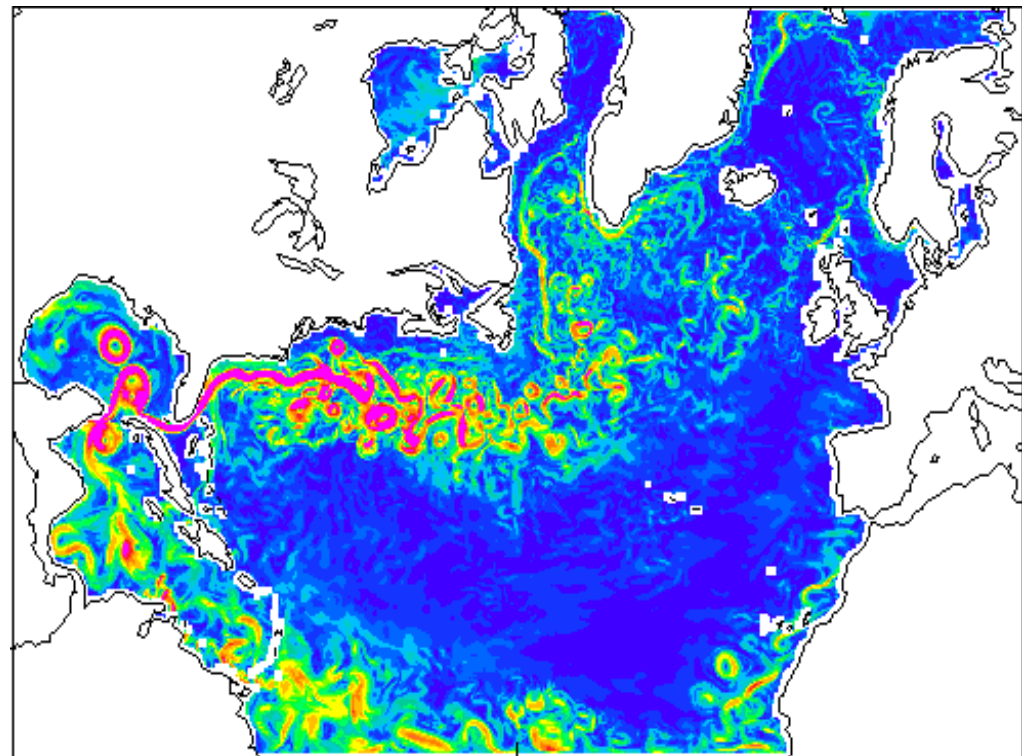?wave-current interactions influence the spectrum

?? Shallow water ??

MERSEA project 2004-2006

North Atlantic wave model at resolution of MERSEA ocean model currents

Demonstrate impact of MERSEA ocean model currents on the wave energy spectrum.

For both high sea state and long-period swell

High resolution global ocean currents later

North Atlantic FOAM
1/9° pre-operational April 2002
Surface currents 0-100cm/sec

Conclusions

Brief overview of wave forecast modelling.

Examples of additional spectral or environmental parameters.

Can identify regions of high sea-state that are still actively growing.

But cannot yet say whether this increases or decreases likelihood of an extreme wave.

Other processes: (swell / cross seas / Janssen's BFI /open ocean wave currents)

Forecast models can provide more than just Hs / Tz

Thank you