Comparison of hindcasted extreme waves with Doppler radar measurements in the North Sea.

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I r e l a n d

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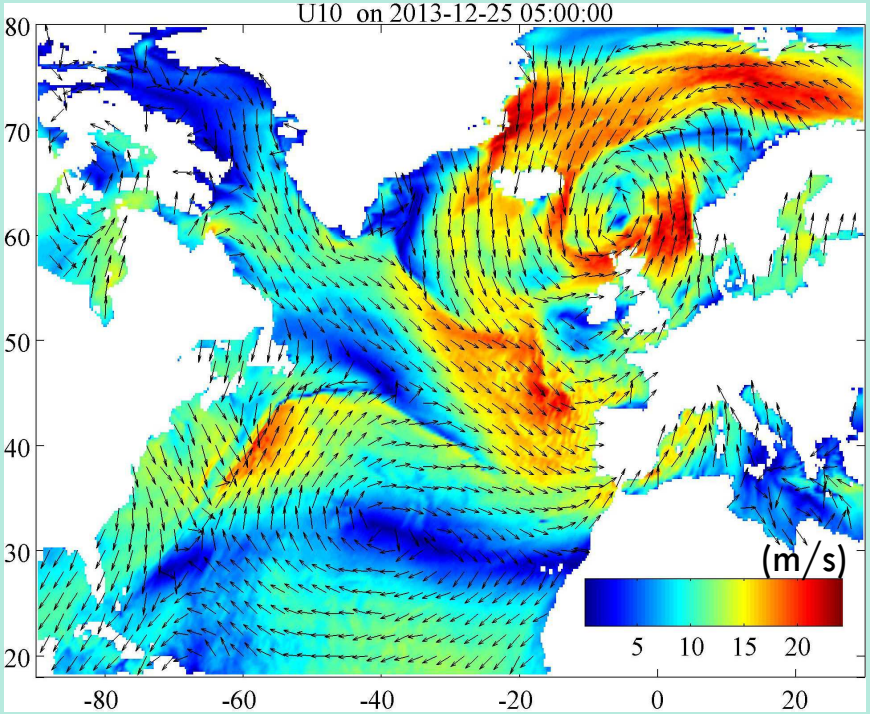
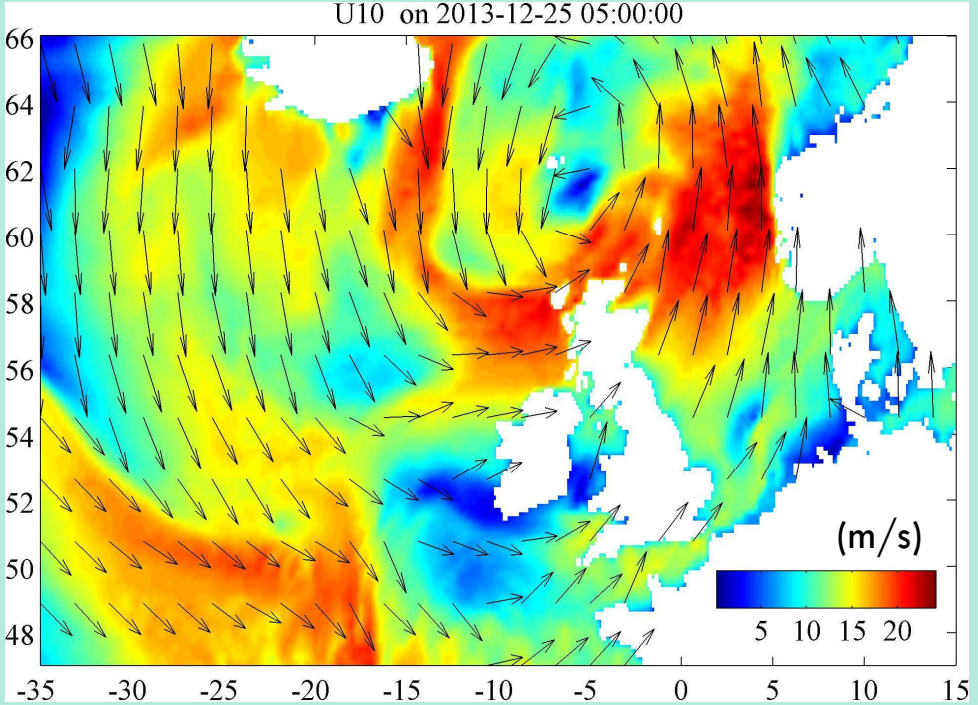
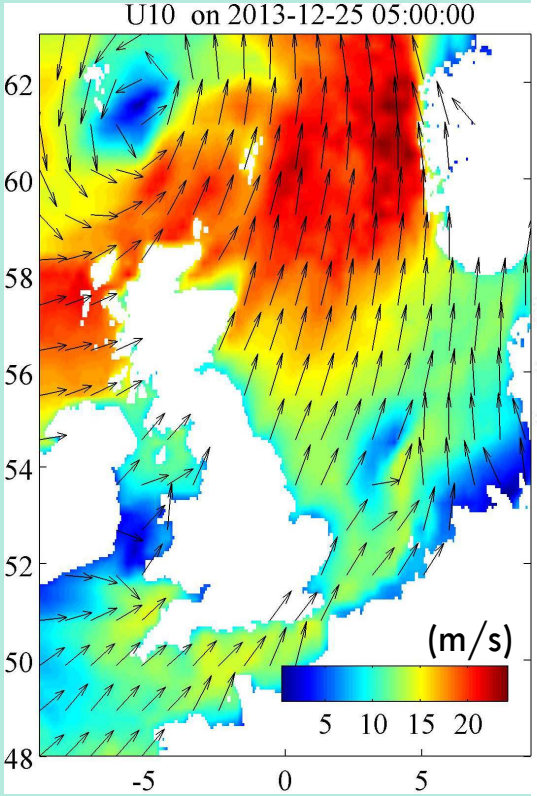
Coarse grid and nested intermediate grids and the wind field on the 25th December 2013 at 05 UTC

Hourly wind product from the European Centre for Medium-Range Weather Forecasts (ECMWF) operational forecast high resolution model





High resolution nested grid wind and wave maps and configuration of the WW3 hindcast



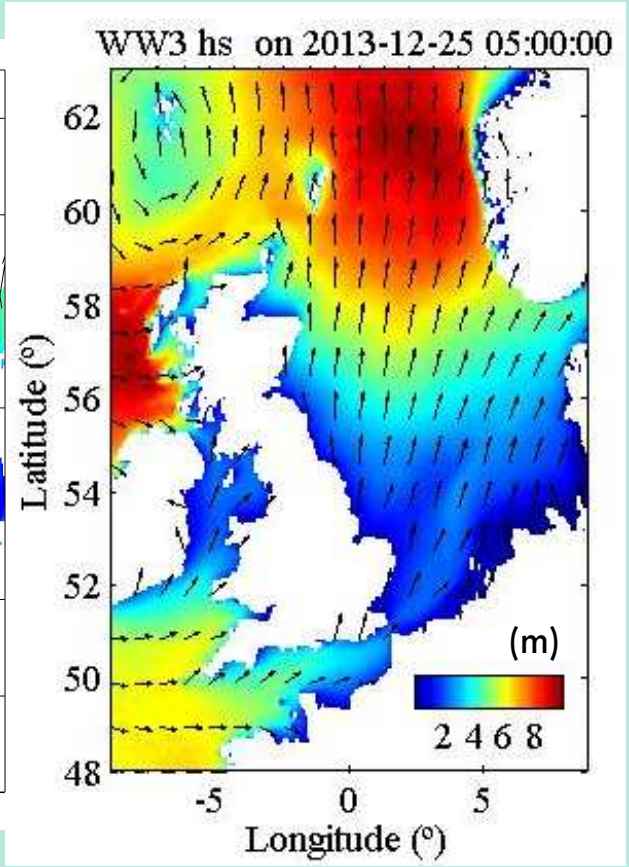
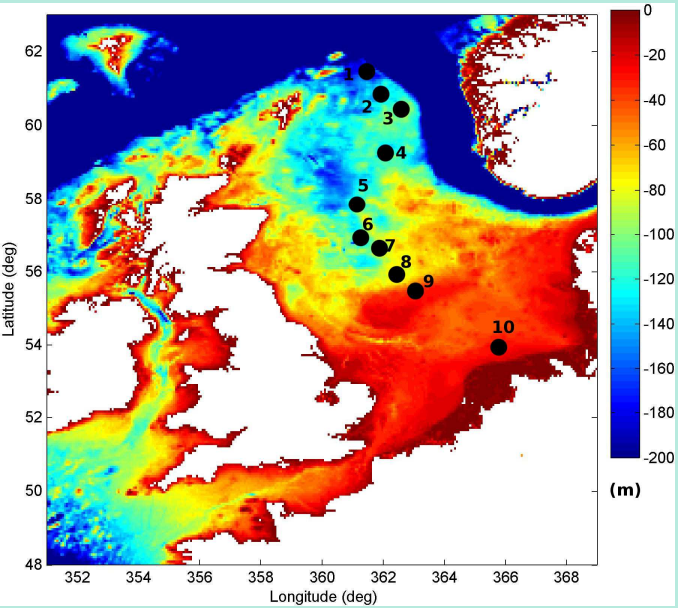


Table 1. Definition of the WW3 configuration.

Parameters	Coarse grid North Atlantic	Intermedium nested grid	High resolution nested
Geographical limits	80ºN, 18ºN, 90ºW, 30ºE	66.0ºN,47ºN,35ºW,12.875ºE	63ºN,48ºN,9ºW,7.375ºE
Spatial resolution	0.25º	0.125º	0.0625º
Number of points	(481,249)119769	(401,153)61353	(289,241) 69649
Type of spectral model	deep water	deep water	shallow water
Propagation	Spherical	Spherical	Spherical
Wind input (S_{in})	Janssen (1989, 1991)	Janssen (1989, 1991)	Janssen (1989, 1991)
White capping dissipation	Komen et al. (1984)	Komen et al. (1984)	Komen et al. (1984)
Nonlinear Interactions (S_{nl})	Four wave-wave nonlinear interactions	Four wave-wave nonlinear interactions	Triad interactions Eldeberky (1996)
Bottom friction dissipation (S_{bofr})	JONSWAP	JONSWAP	JONSWAP
Wind input time step (hour)	1	1	1
Wave model output time step (hour)	1	1	1
Integration time step (seconds)	120	60	30

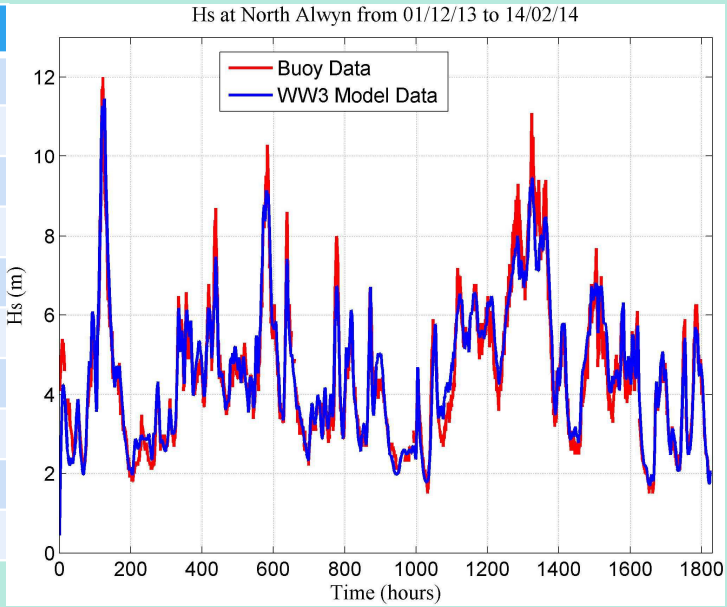
Nested grid bathymetry and the wave recording sites:
10 wave buoy data distributed by the JCOMM project (Bidlot 2015)



The bathymetry data comes from the GEODAS NOAA's National Geophysical Data Centre (NGDC). Original resolution:
1 minute of degree.

Table 1. Statistical parameters for the Hs at the locations: 1-Gullafks, 2-North Alwyn, 3-Troll, 4-Heimdal, 5-Sleipner, 6-Mungo, 7-Ullabnor, 8-Ekofisk, 9-Valhall, 10-Fino1 (See Fig. 1). Cc-correlation coefficient.

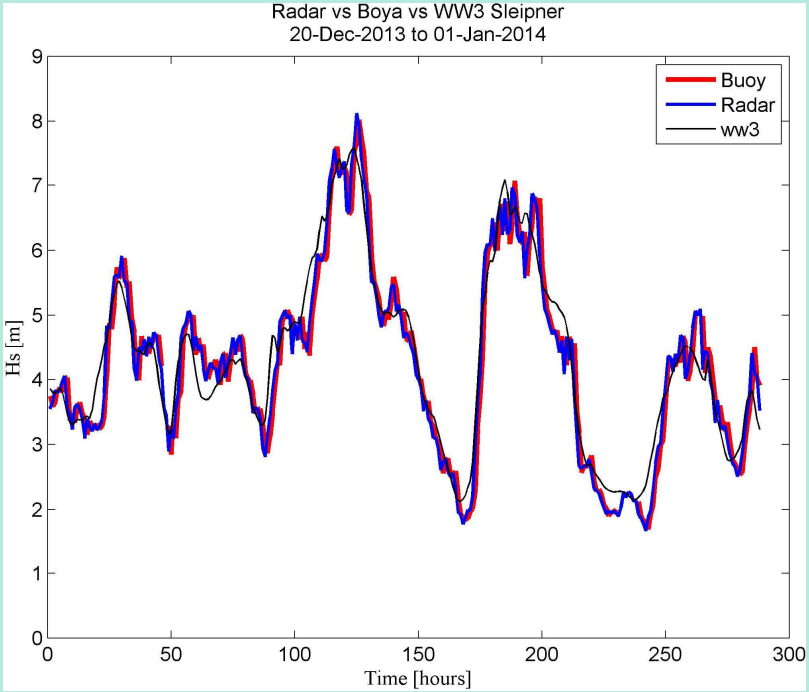
Location	Bias	Scatter index	Cc
1	0.289	0.137	0.938
2	0.056	0.111	0.961
3	-0.096	0.179	0.892
4	-0.296	0.146	0.910
5	0.277	0.137	0.949
6	-0.212	0.129	0.922
7	-0.167	0.130	0.948
8	0.094	0.136	0.951
9	-0.135	0.131	0.960
10	0.064	0.292	0.850



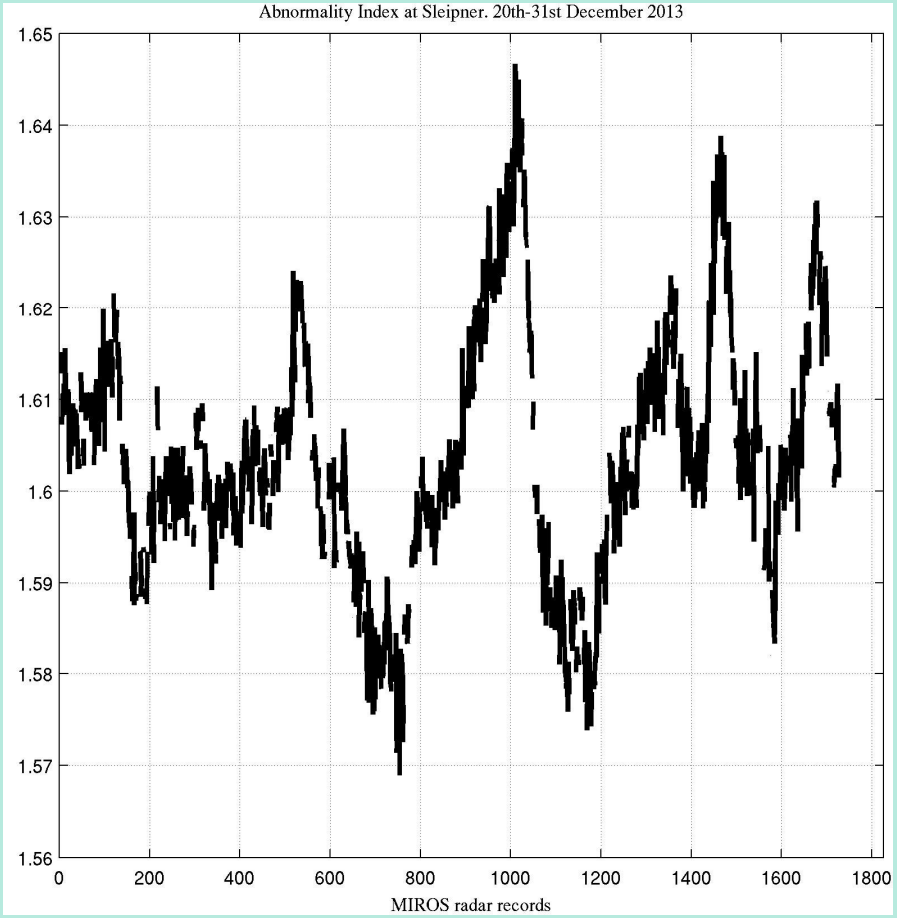
RADAR MIROS at Sleipner platform (location 5)

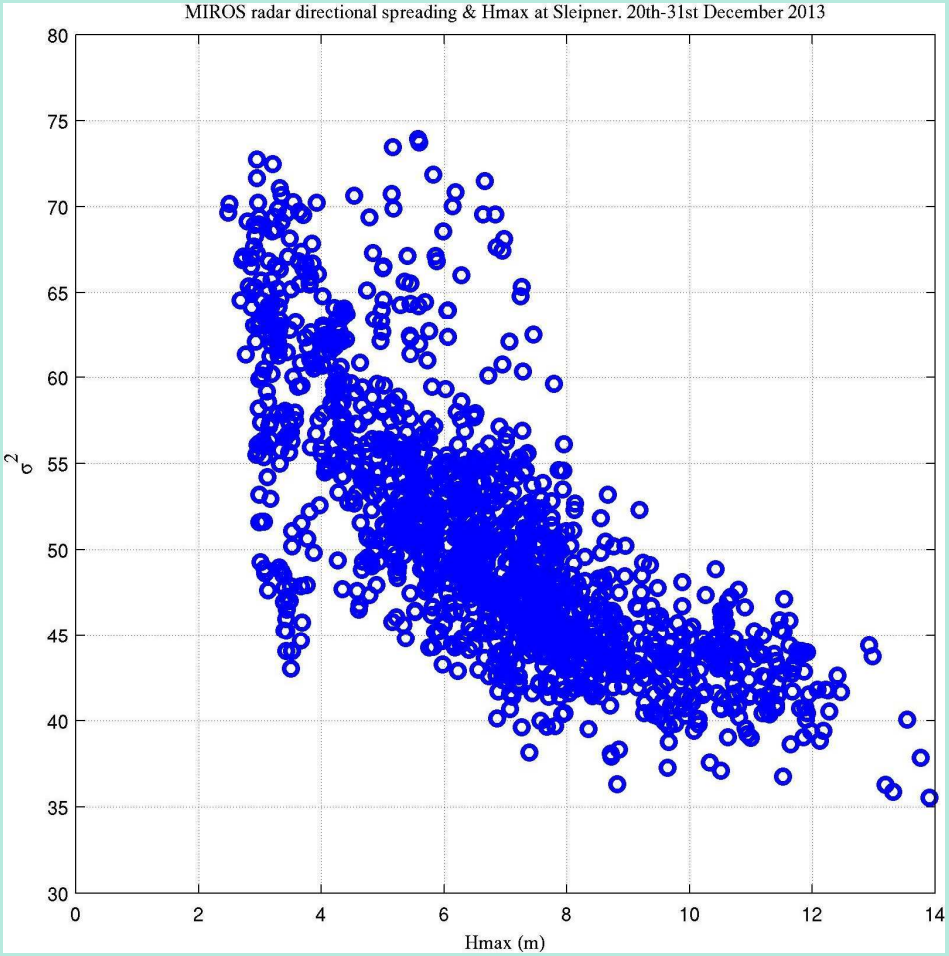
Radar data were available at every 10 minutes during 10 days from the 20th – 31st December 2013. The radar data (time series and the 1d and 2d wave spectra) were compared to a wave buoy and to the WW3 outputs.

The radar has the following characteristics to record the directional wave spectra: directions: 36, directional resolution: 10º, frequencies: 37, frequency resolution: 0.01 Hz, frequency range: 0.0312 - 0.3125 Hz, update interval: 2.5 minutes and an averaging time: 21 minutes. http://www.miros.no

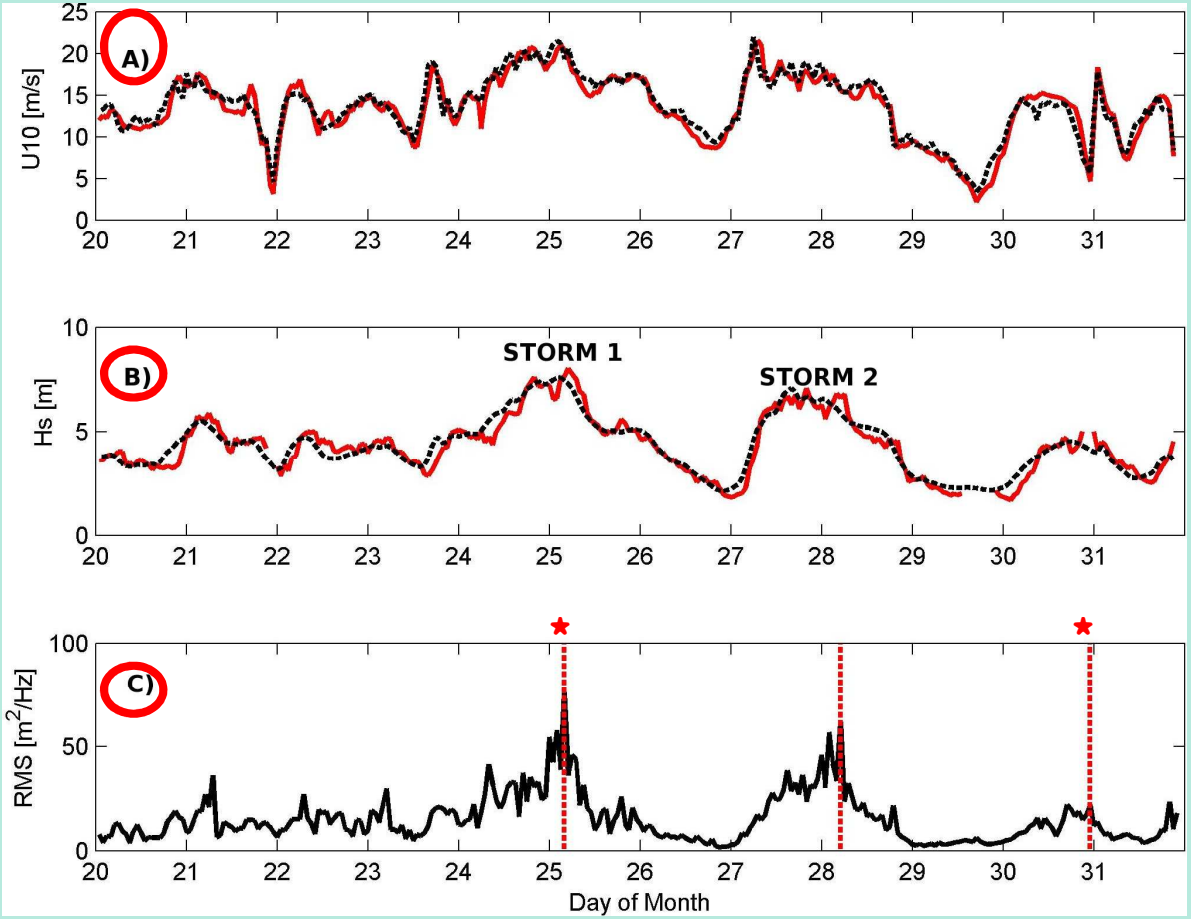


Abnormality index (Hmax/Hs) and the relation between the wave spreading and the Hmax (MIROS radar data)





Time series of A) U10; B) Hs, C) Root mean square (RMS) error of WW3 frequency spectra for the period: 20/12/2013 up to 31/12/2013.



recorded by radar ( ); WW3 (dashed black line)

RMS error computed by interpolating radar spectra to WW3 frequency grid (in the common frequency range).

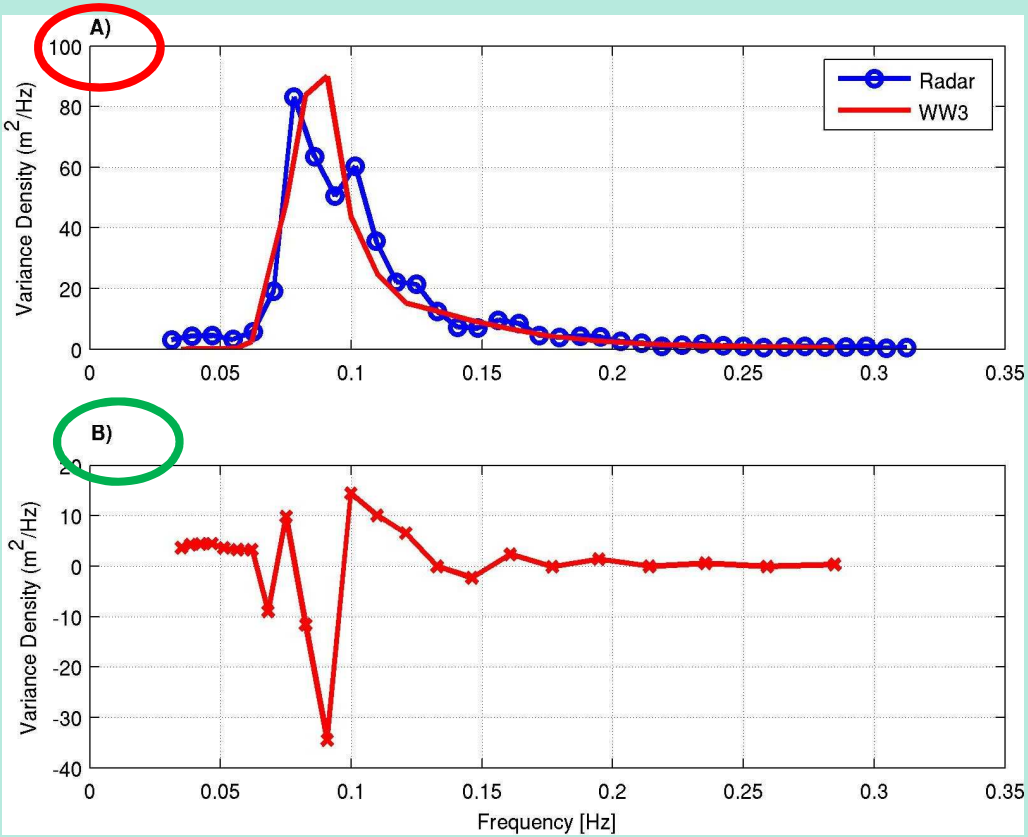
Dashed vertical red lines at ***25/12/2013 04 UTC**, 28/12/2013 05 UTC and ***30/12/2013 23 UTC**.

25th December 2013 at 04 UTC

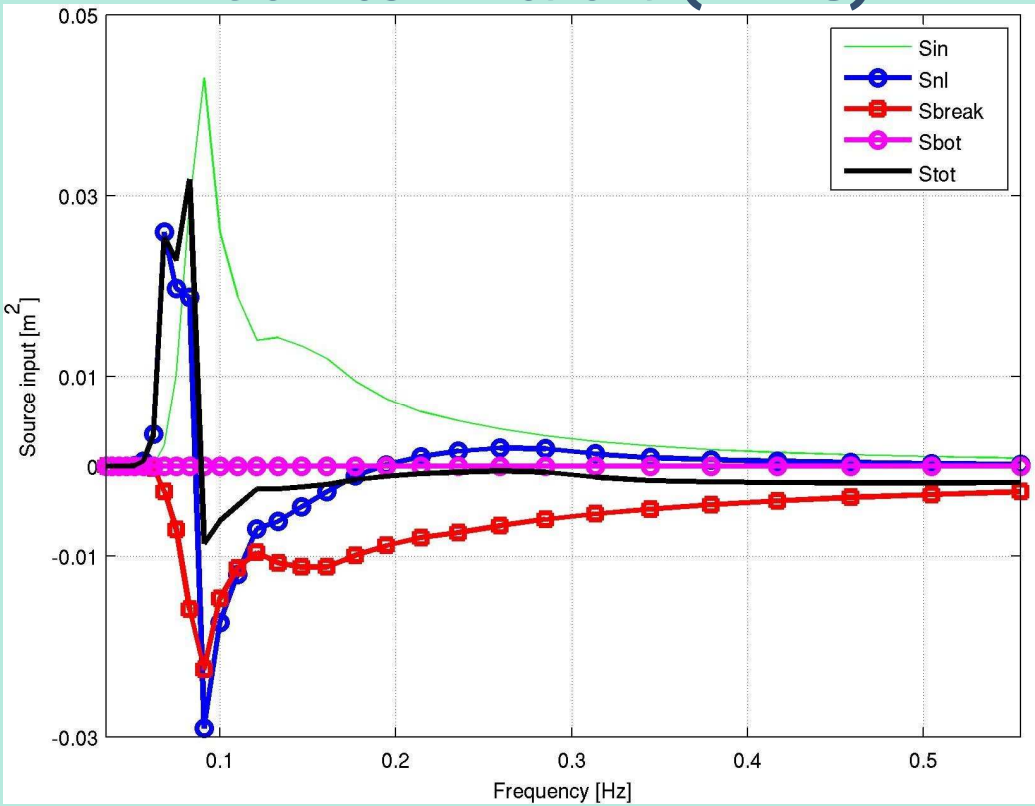
Frequency spectra at Sleipner (LEFT)

A) Radar and WW3 spectra.

B) Difference between radar and WW3 spectra.



Source functions (WW3)

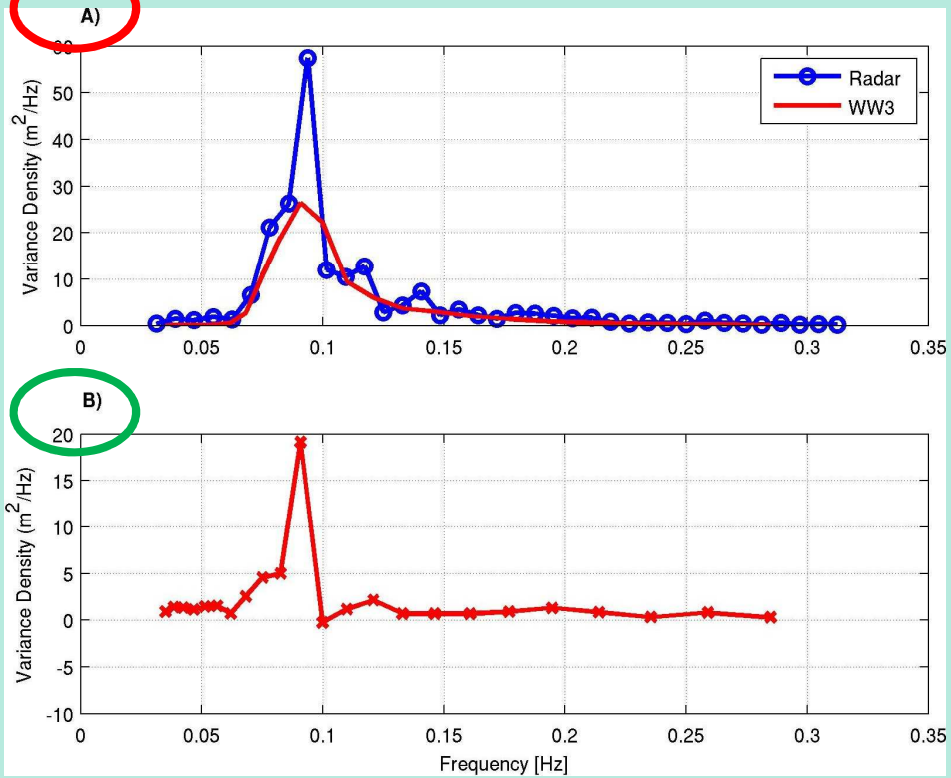


30th December 2013 at 23 UTC

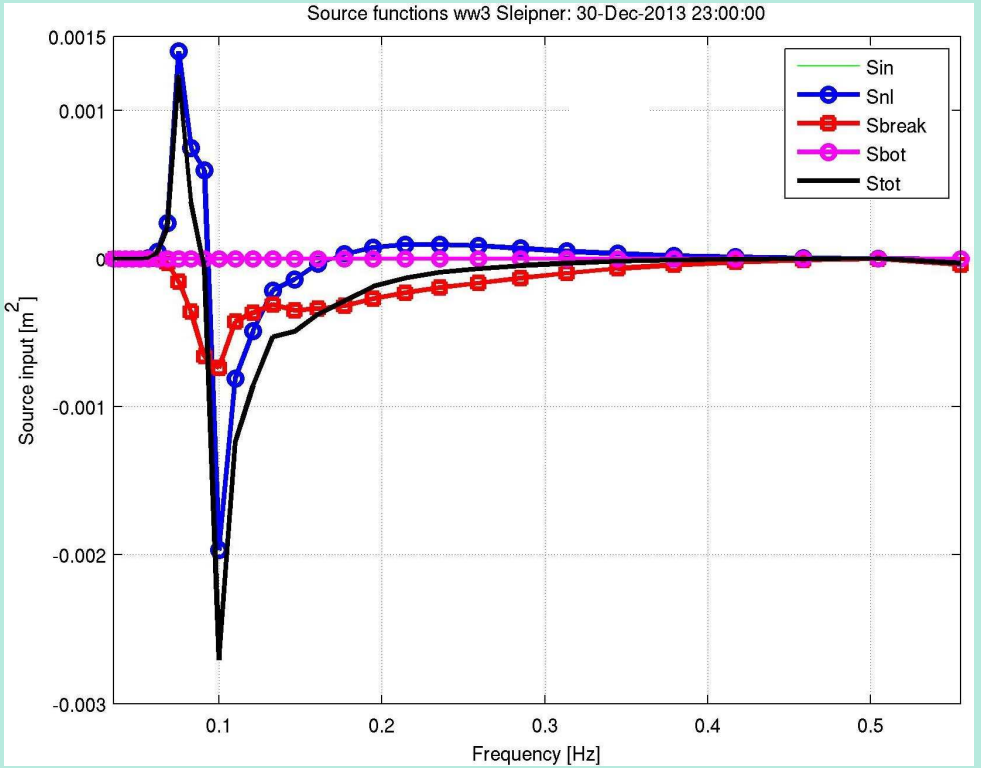
Frequency spectra at Sleipner (LEFT)

A) Radar and WW3 spectra.

B) Difference between radar and WW3 spectra.



Source functions (WW3)

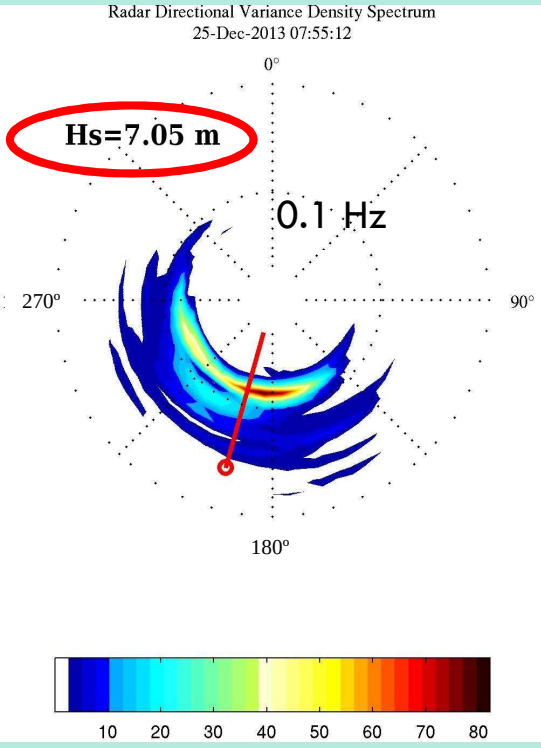


Comparison of the 2D spectra

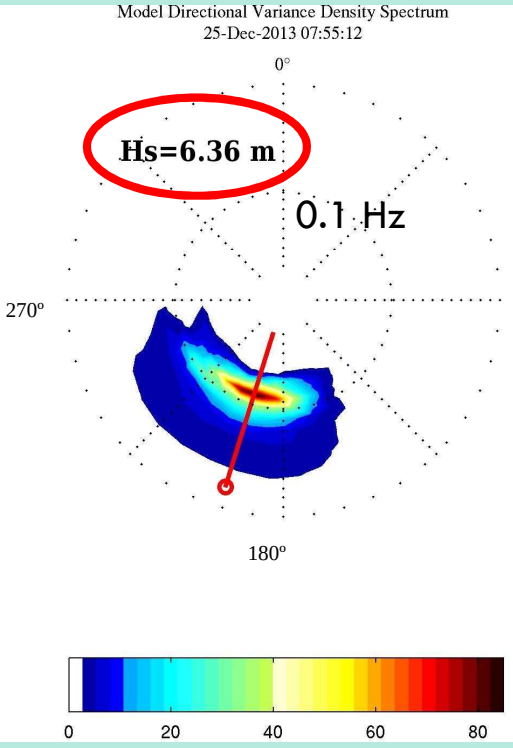
25th December2013 at 08 UTC

26th December 2013 at 06 UTC

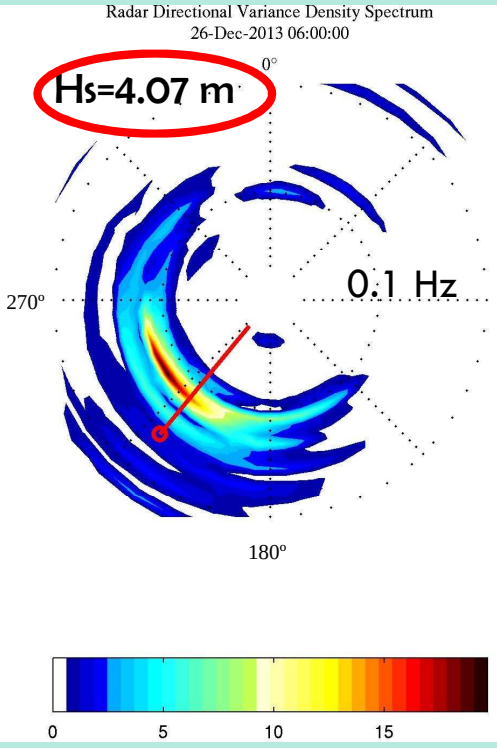
RADAR



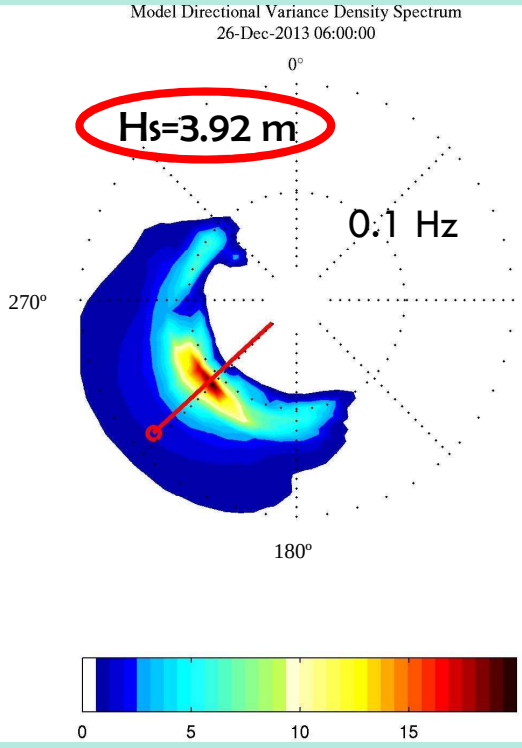
WW3



RADAR

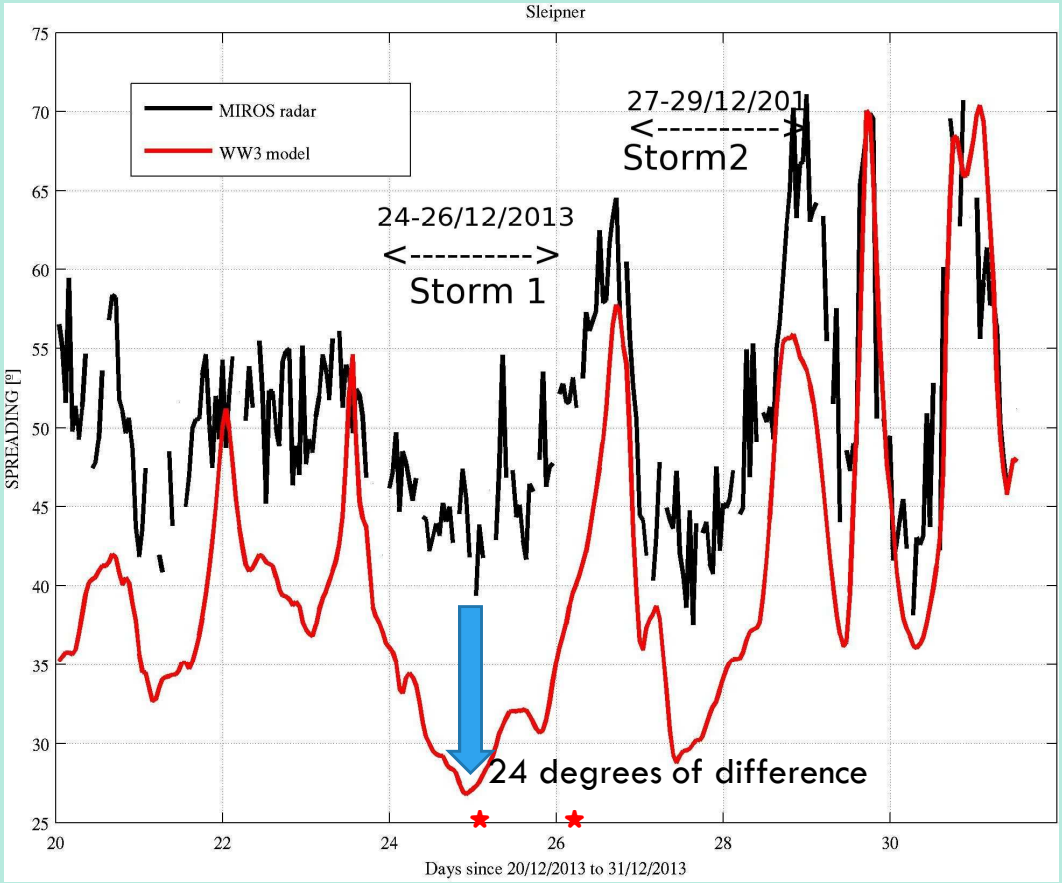


WW3



Directional spreading (º) time series from WW3 (red line) and from the MIROS radar (black line).

20th-31st December 2013

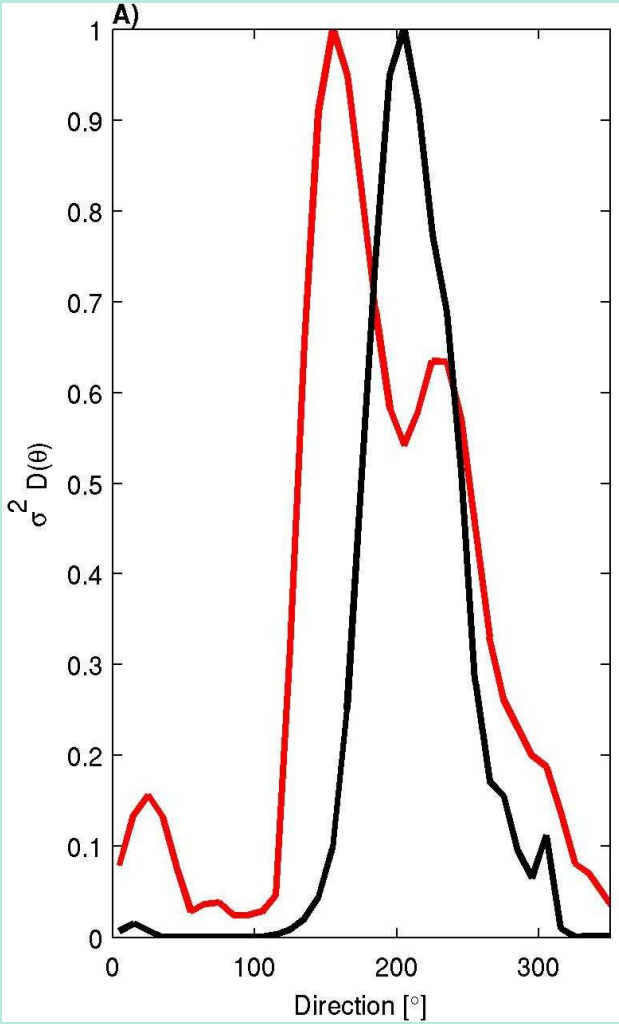


Normalized directional distribution of wave spectral energy.

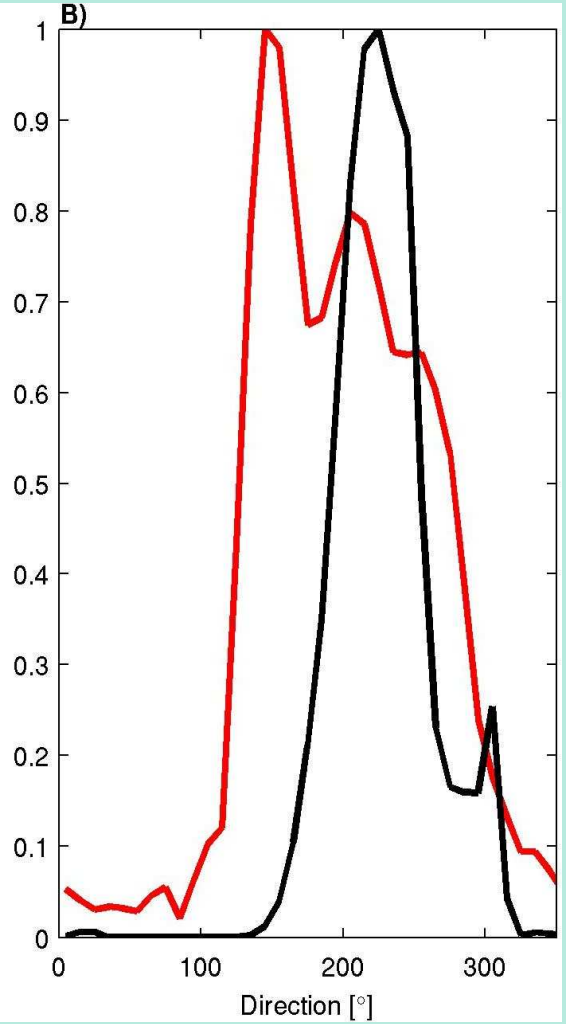
Radar ( )

WW3 ( )

25th December at 13 UTC

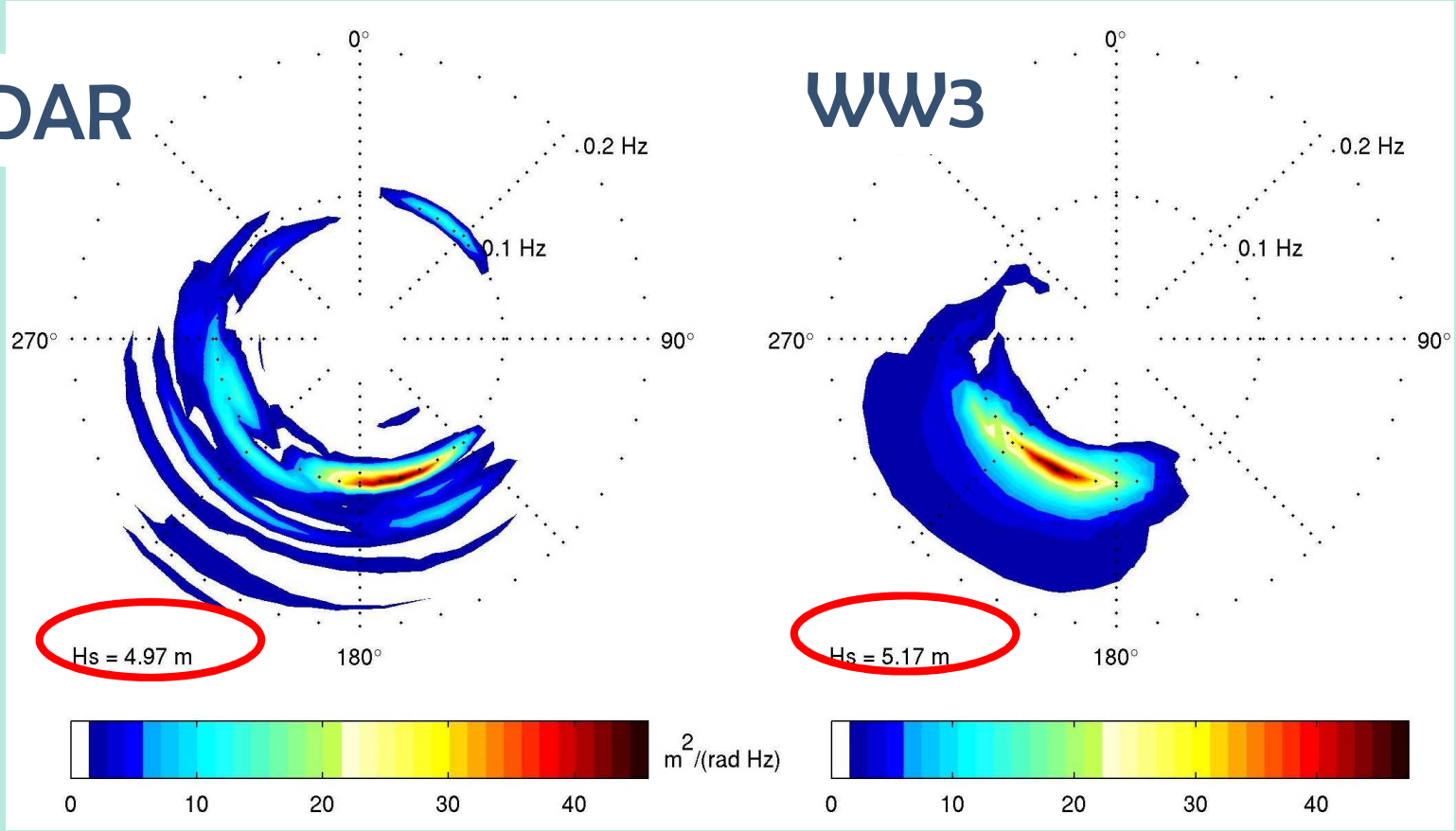


26th December at 01 UTC



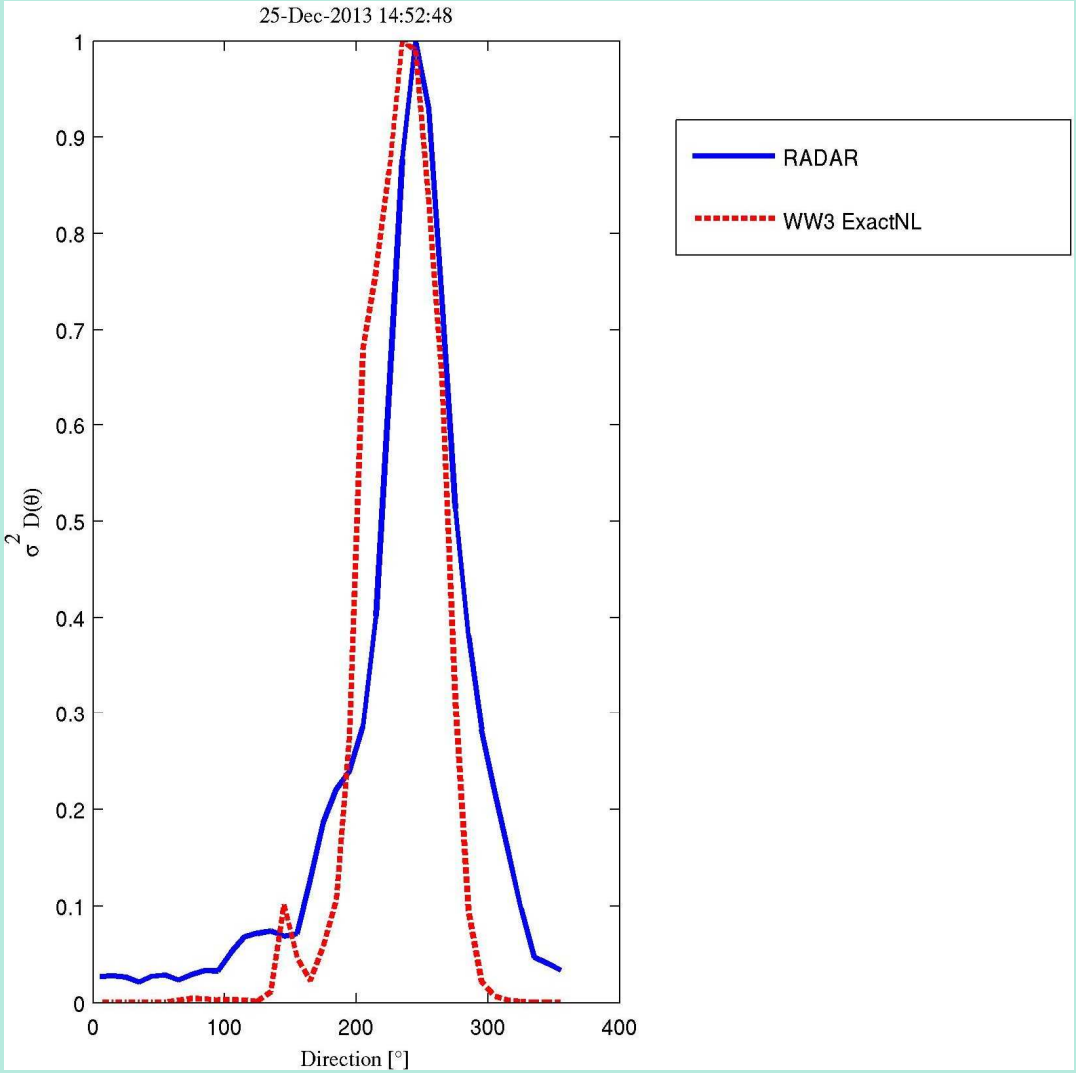
Directional wave spectra

25/12/2013 at 13 UTC



Normalized directional distribution of wave spectral energy.

25th December 2013 at 15 UTC



Concluding remarks

The skill of a 3rd generation wave model in hindcasting extreme sea states was assessed for a 10 day winter period in the North Sea using buoys and Doppler radar records.

It was found that the model consistently underestimated the directional spreading when compared to the value of the radar.

Ongoing work is devoted to reveal the source of these discrepancies in the directional spreading estimated by the model and also on the more general source term balance in the wave spectrum.

Acknowledgements

The authors are very grateful to STATOIL and Dr. Anne Karin Magnusson and Dr. Magnar Reistad from the Norwegian Meteorological Institute who kindly supplied the MIROS radar records.

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WW3 simulations were conducted on the Fionn cluster at the Irish supercomputing centre ICHEC.

http://www.ercmultiwave.eu/