The impact of the assimilation of altimeters and ASAR wave data in the wave model MFWAM

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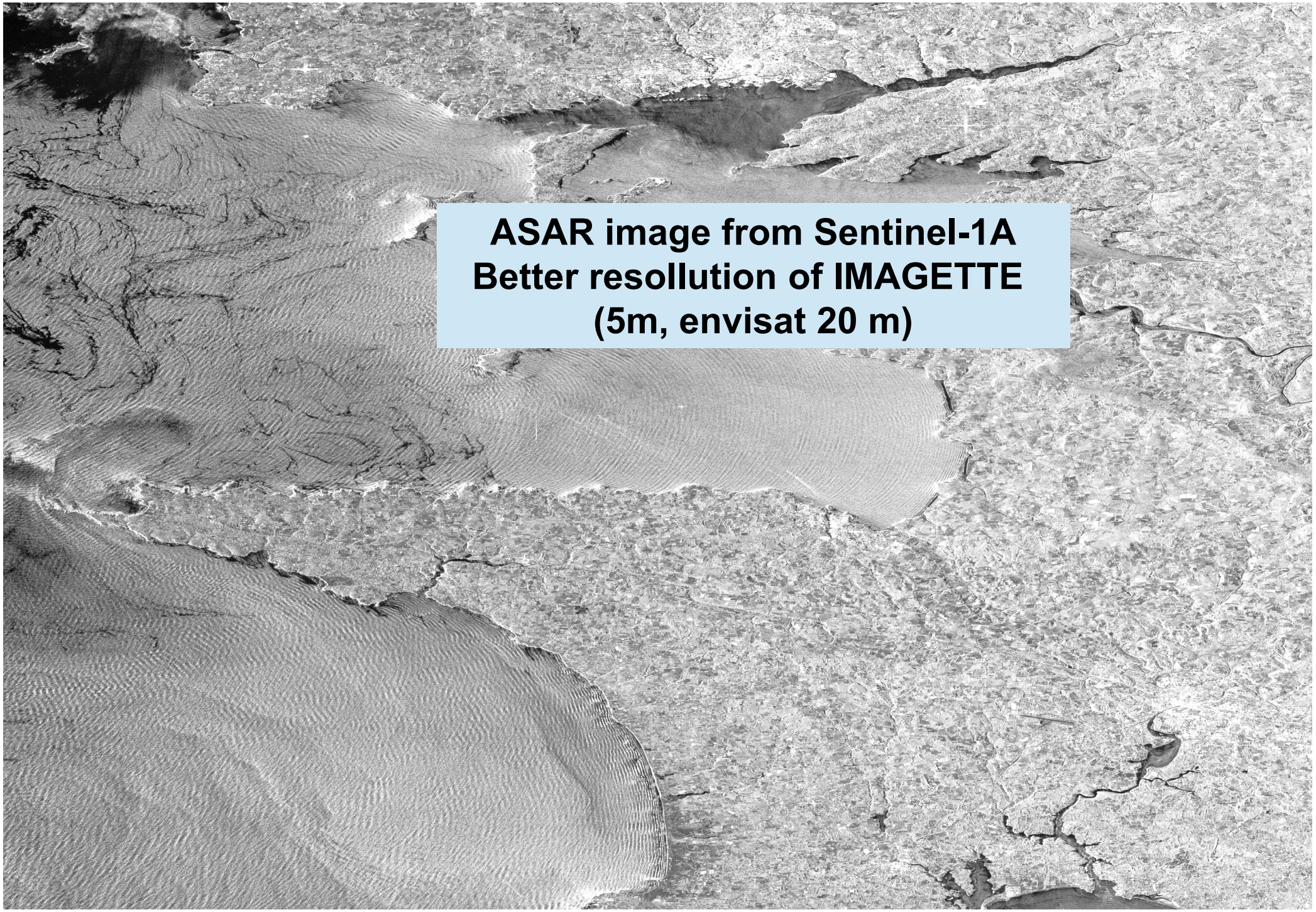
Outline

1- Motivation
2- the assimilation system and partitionning
3- features from Sentinel-1
4- Results
5- Conclusions

Motivation

- Improving the operational wave forecast
- Assimilation of SAR and altimeters in the upgraded MFWAM (Jason-1, Envisat Ra2 and ASAR)
- Preparation to use of Sentinel-1A level 2 wave Spectra (L2 products are not available yet...)

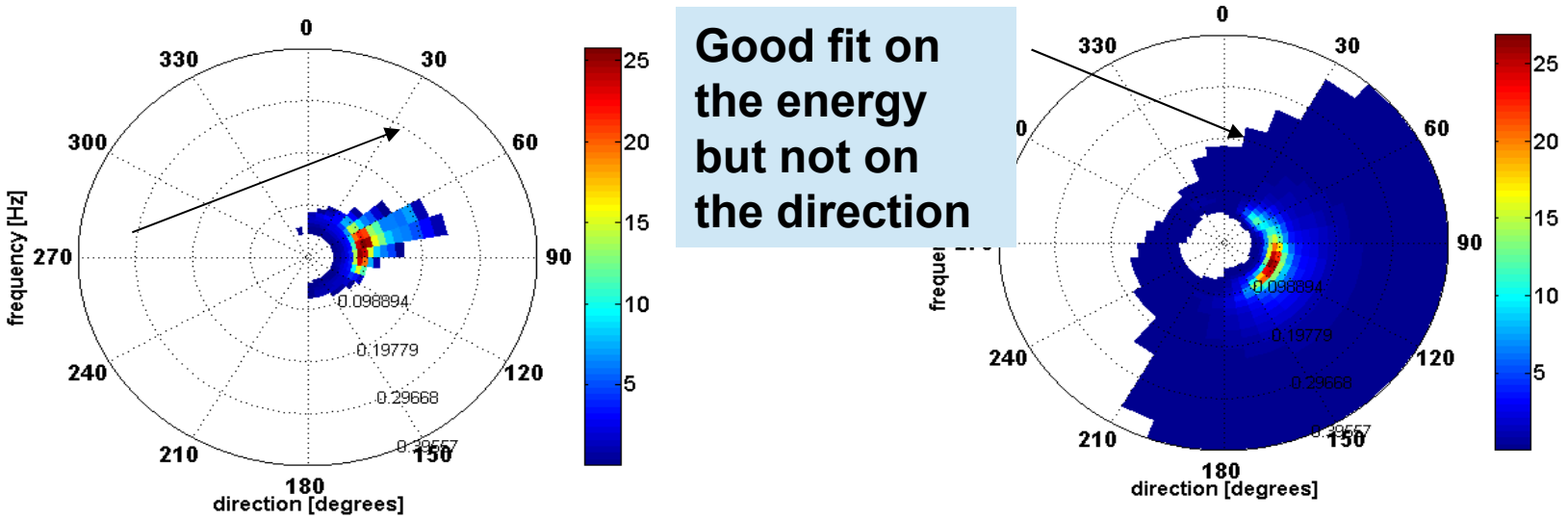

ASAR image from Sentinel-1A
Better resollution of IMAGETTE
(5m, envisat 20 m)

Assimilation of satellite data (Altimeters, SAR) to improve Off shore Sea-state analyses and predictions

→ Provide more accurate boundary conditions to coastal wave models

ENVISAT ASAR (only long waves are detected if travelling in the azytmutal direction)

MFWAM (3G global Model)



Good fit on the energy but not on the direction

→Differences between wave directions from model and observation (ENVISAT/ASAR)

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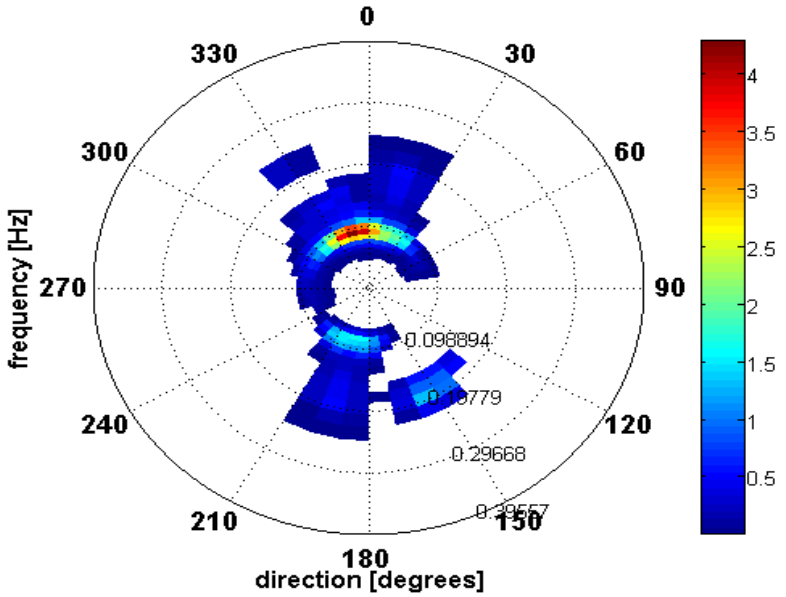
The assimilation of ASAR L2 wave spectra

- Available on the GTS of meteorological services since August 2010
- Robust Quality control procedure for ASAR wave spectra (Aouf et al. 2008)

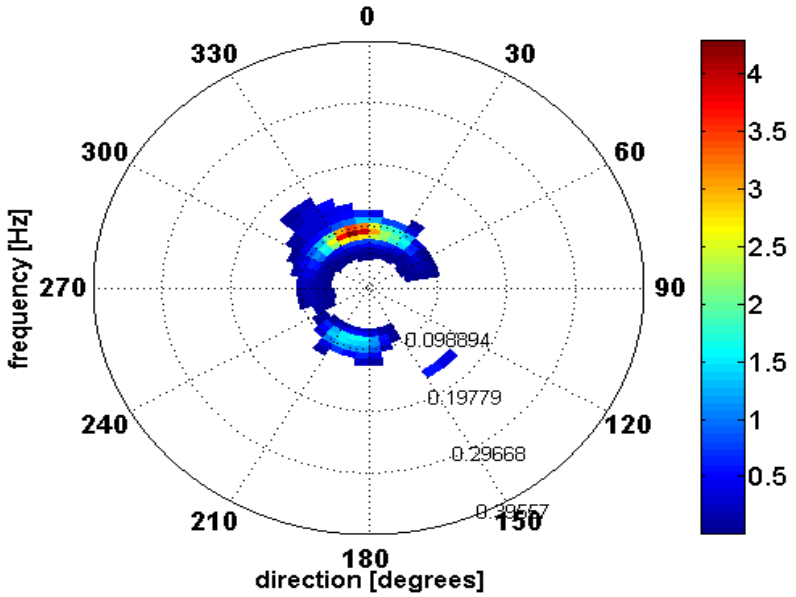
Threshold intervals for signal parameters (3<snr <30, NVI ASAR imagettes 1-1.6 and wind speed)

- Use of a variable cut-off for SAR wave spectra depending on the azimuthal cut-off, the orbit track angle and the wave direction from the model

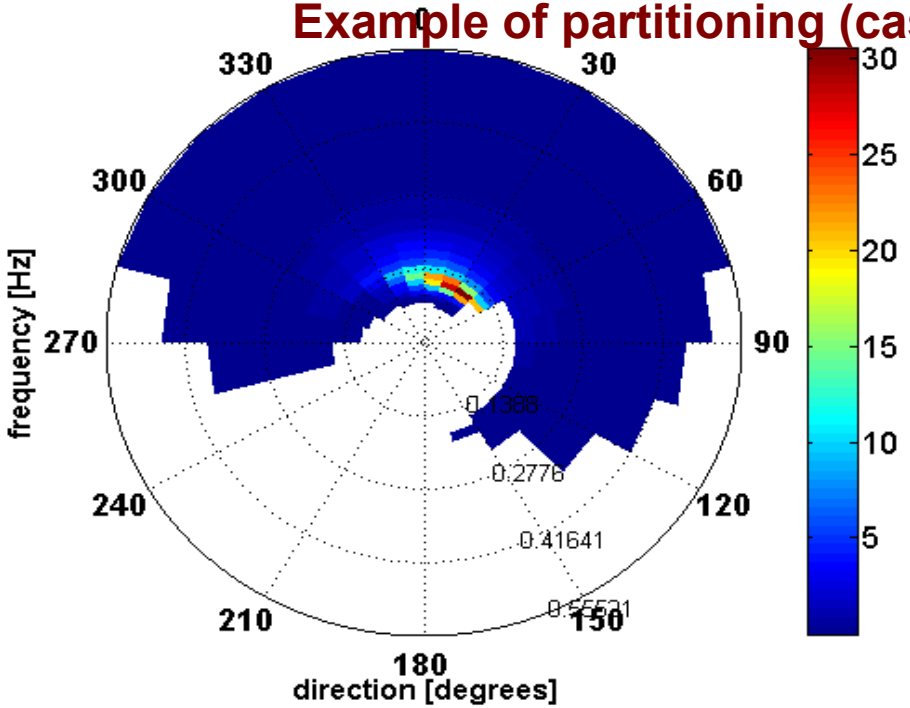
ASAR wave spectrum (before cut-off)

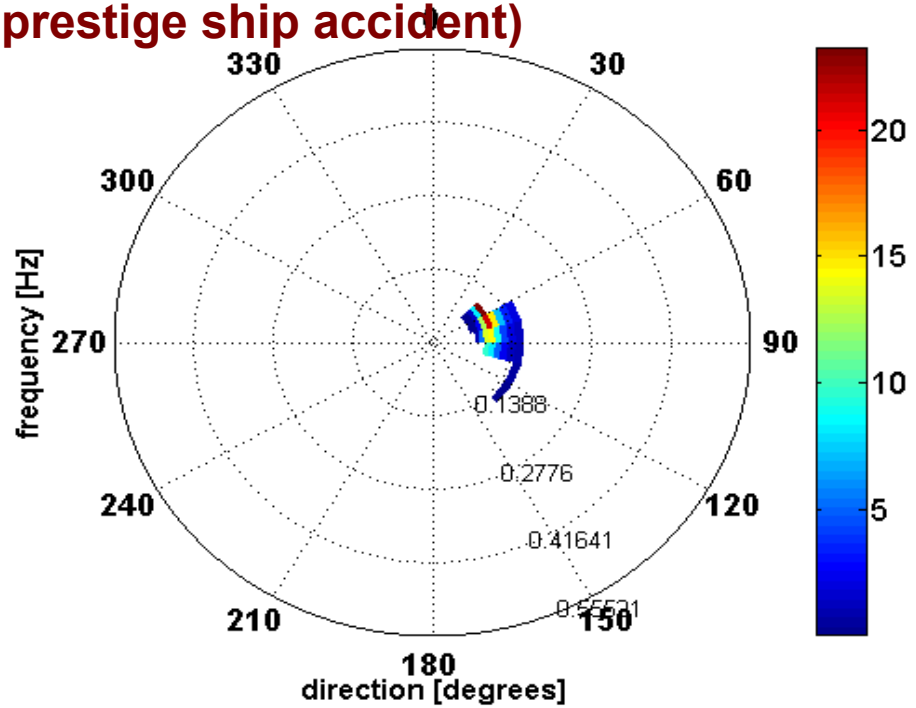


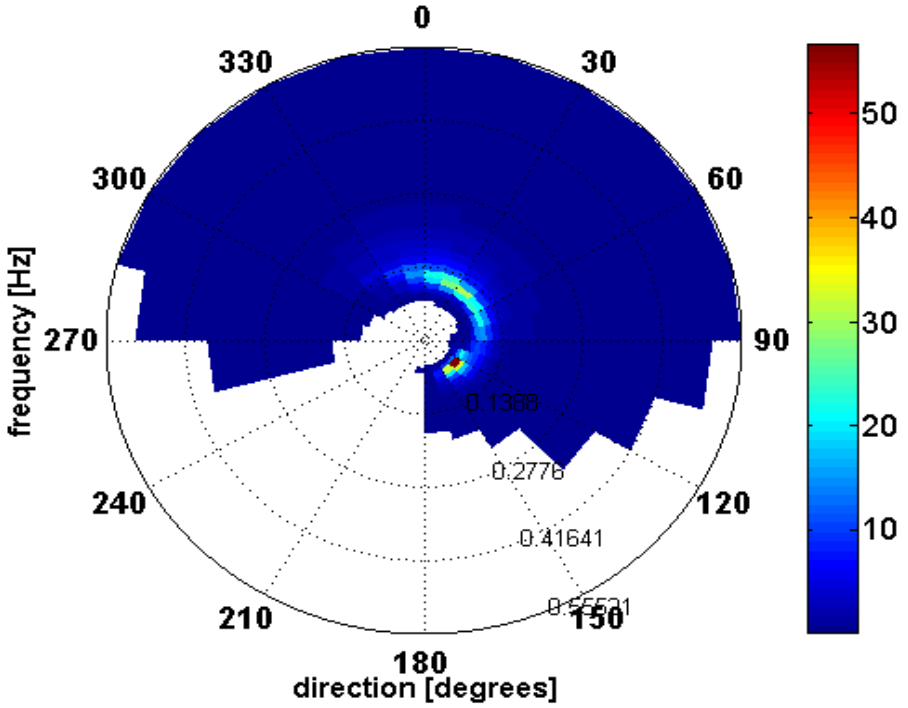
After using variable cut-off

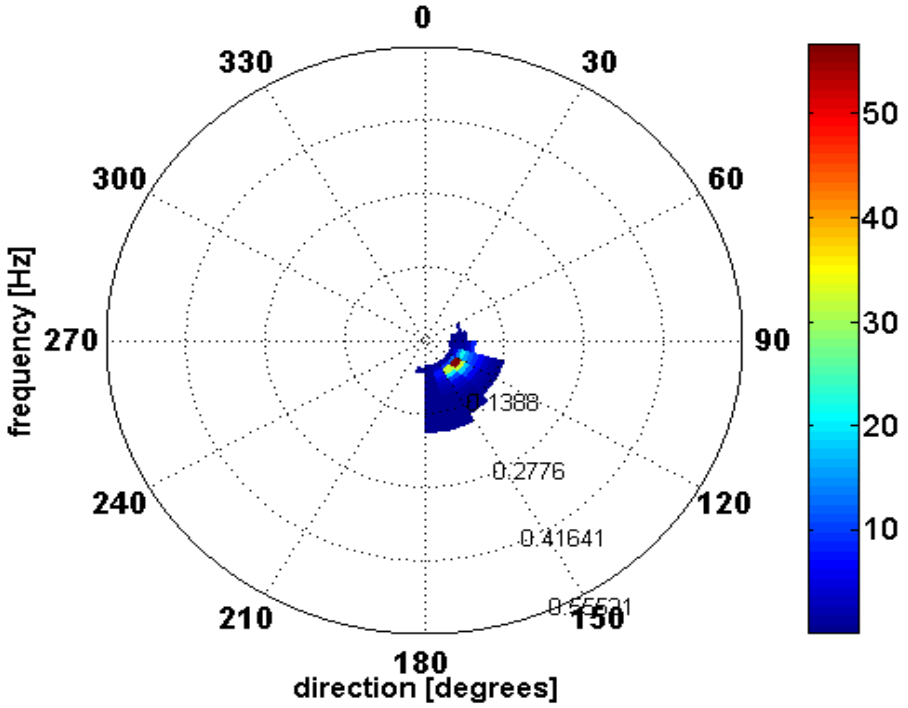


Example of partitioning (case of prestige ship accident)

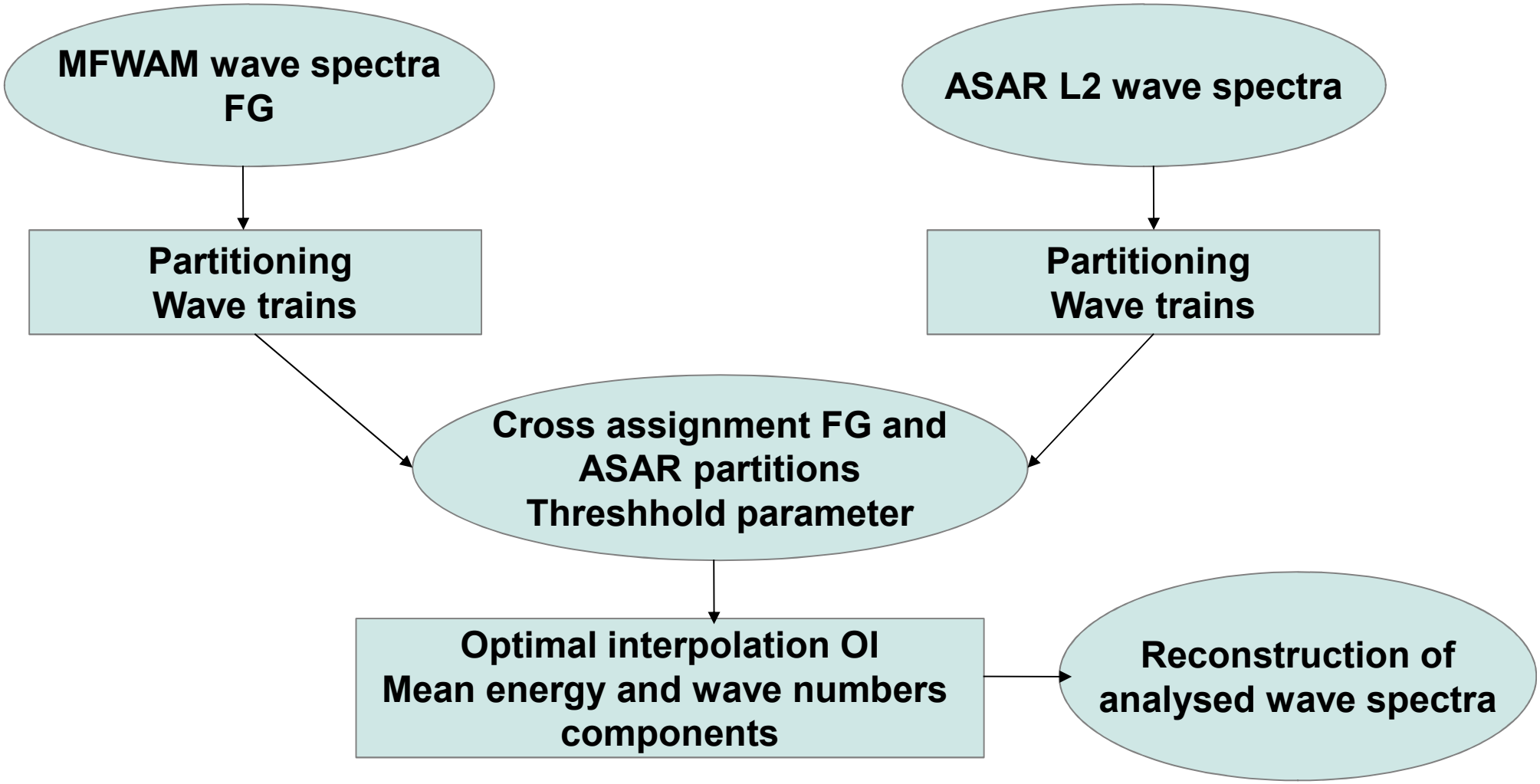




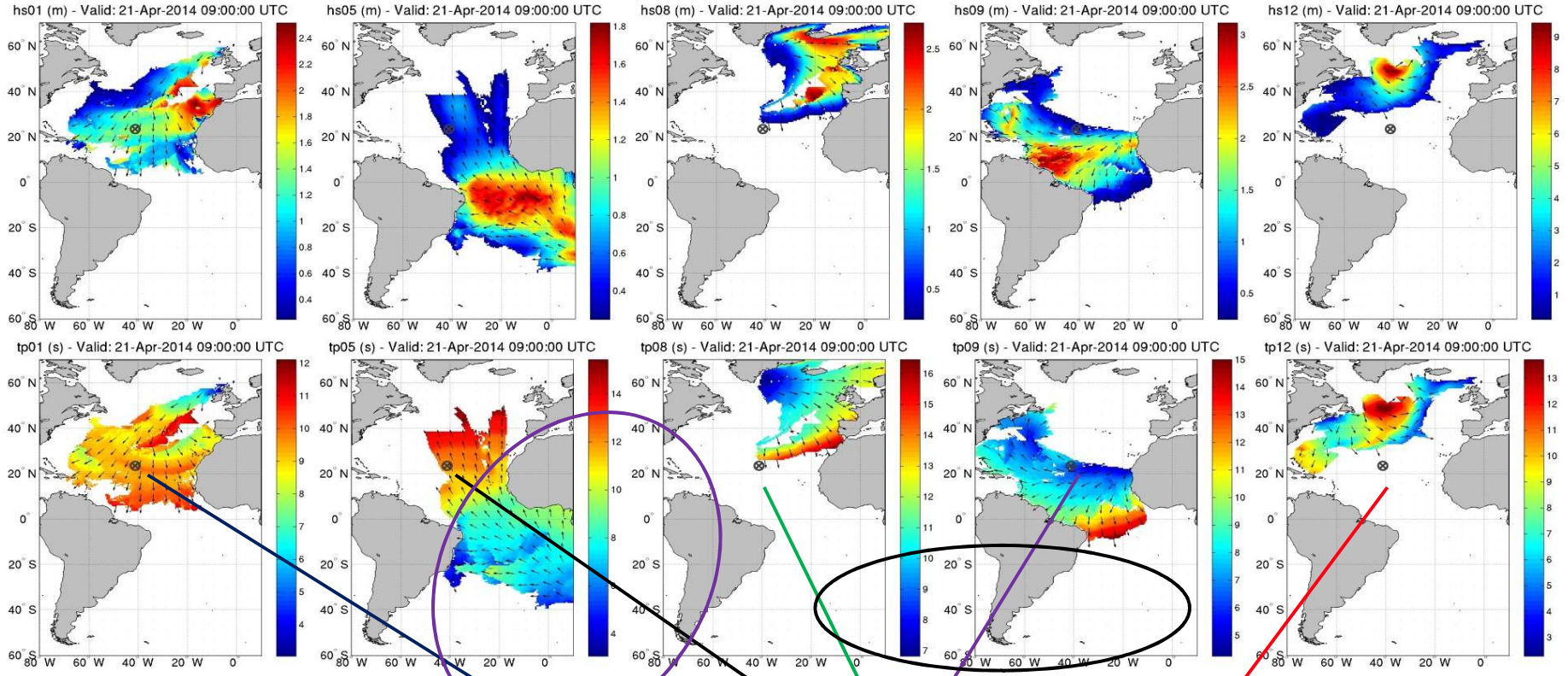


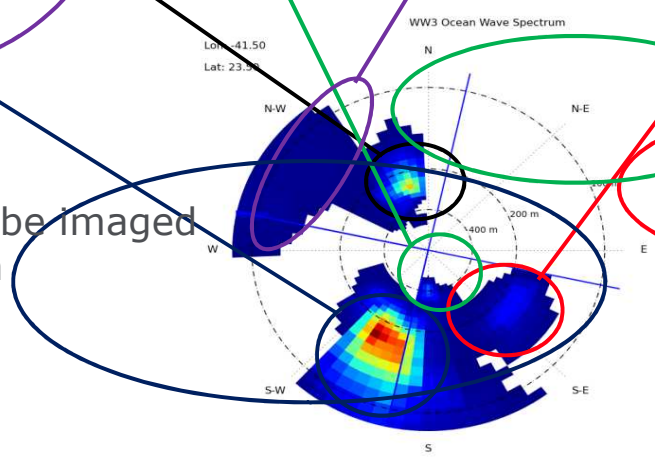


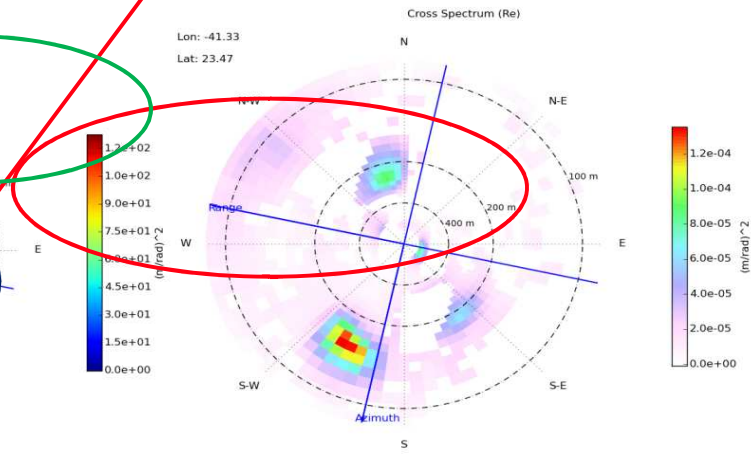
Description of the assimilation of ASAR L2 wave spectra



Wave mode products: multiple swell systems





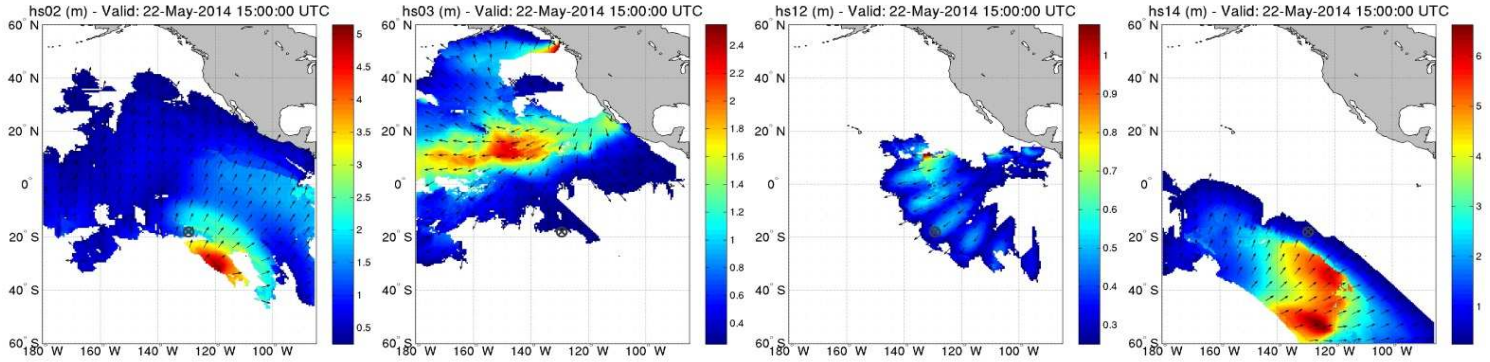


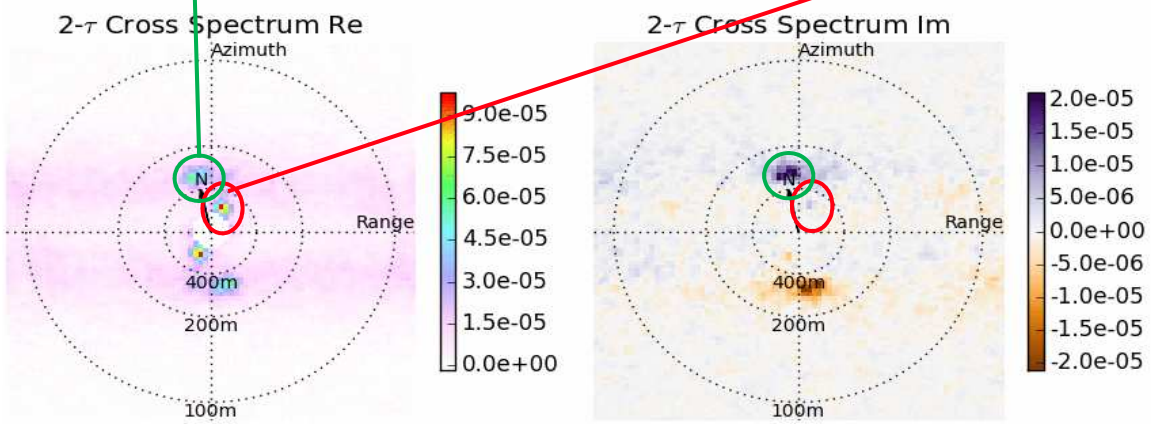
Association between WW3 swell systems and S-1 WM spectrum shows good agreement
→ Up to 5 swell systems and can be imaged with correct propagation direction

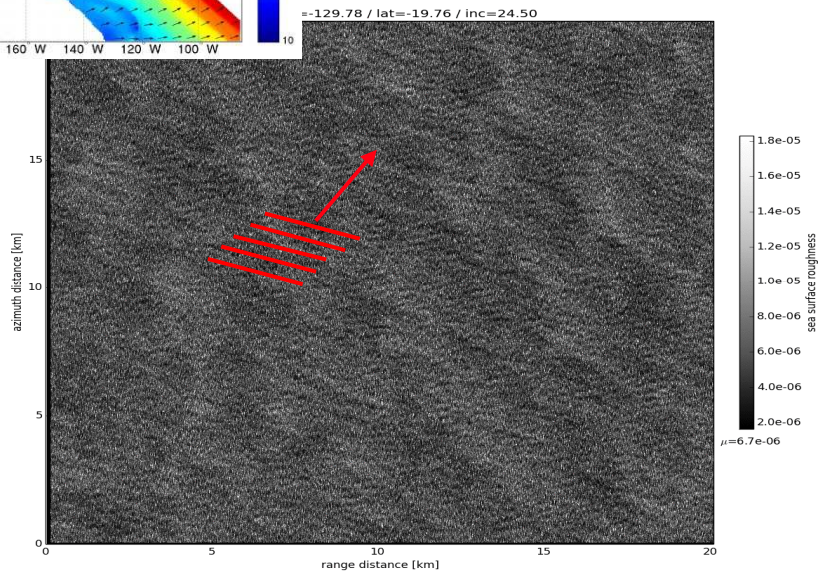
Only 2 were kept on ENVISAT

Courtesy of R. Husson (CLS)

Wave mode products: Forerunners







Larger spatial coverage

→ Extremely long swell travelling ahead of the energy front

Here:
Tp > 22s, Wl > 800m have been observed in the cross-spectrum

Courtesy of R. Husson (CLS)

Toward an upgraded MFWAM (issued from MYWAVE project)

- Update of the code (IFS-38R2) : improved propagation scheme
- Improved bathymetry (better subrid for islands)
- Smoothing function Rayleigh type for the source term of swell
- damping induced by air friction at the sea surface
- Adjustement of whithcapping dissipation term :
  better variation of the drag coefficient with the sea state
  (future coupling between wave model MFWAM and AROME)
- Adjustement of the coefficients in the non-linear interaction source term

Validation of MFWAM-UPGRADE global over 1-year run (Dec 2012 to Nov 2013) forced by ECMWF winds.

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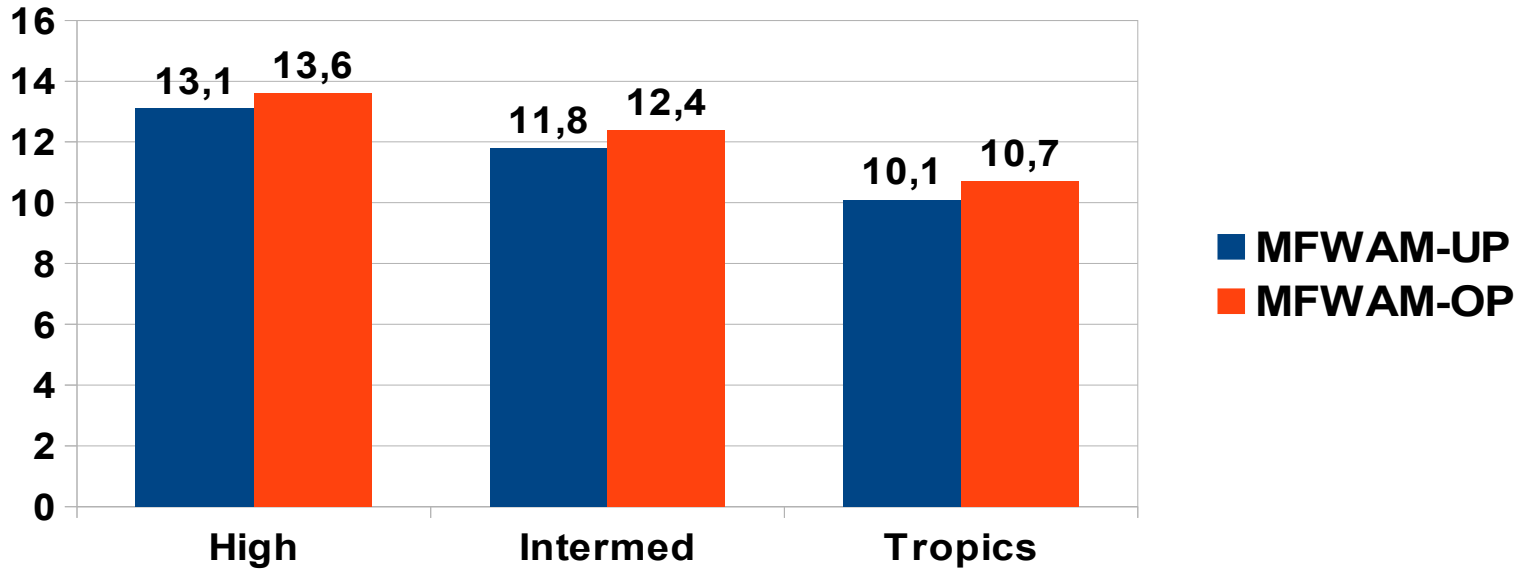
Global validation with altimeters Ja-2 and Saral

Scatter index for SWH (%)



➡ Improvement ~6 % on SWH comparing To the operational MFWAM

High Lat |☞|> 50°
Intermediate lat 20°<|☞|<50°
Tropics |☞|<20°

1-year run Dec 2012-Nov 2013

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Description of runs : September 2011

- **Test runs set-up**
  - upgraded MFWAM (global coverage 0.5x0.5° irregular grid), wave spectrum in 30 frequencies (starting 0.035 Hz) et 24 directions
  - ECMWF analysed winds every 6 hours
  - Assimilation timestep 6 hours

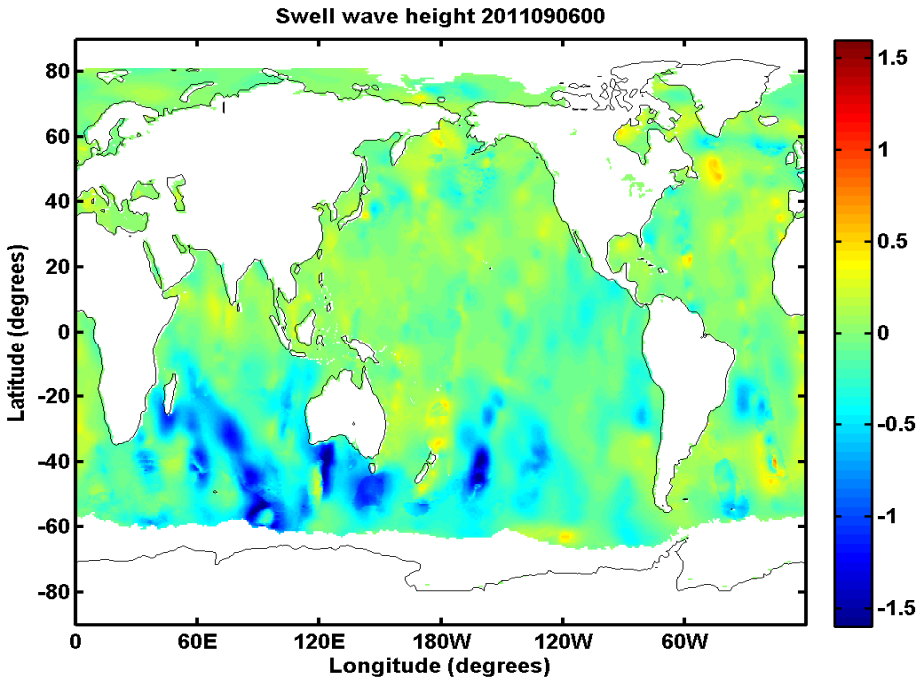
→ EXP1 : **Assimilation** of **ASAR** wave spectra and altimeters Ra-2 and Jason-1

→ EXP2 : **Assimilation ASAR** wave spectra

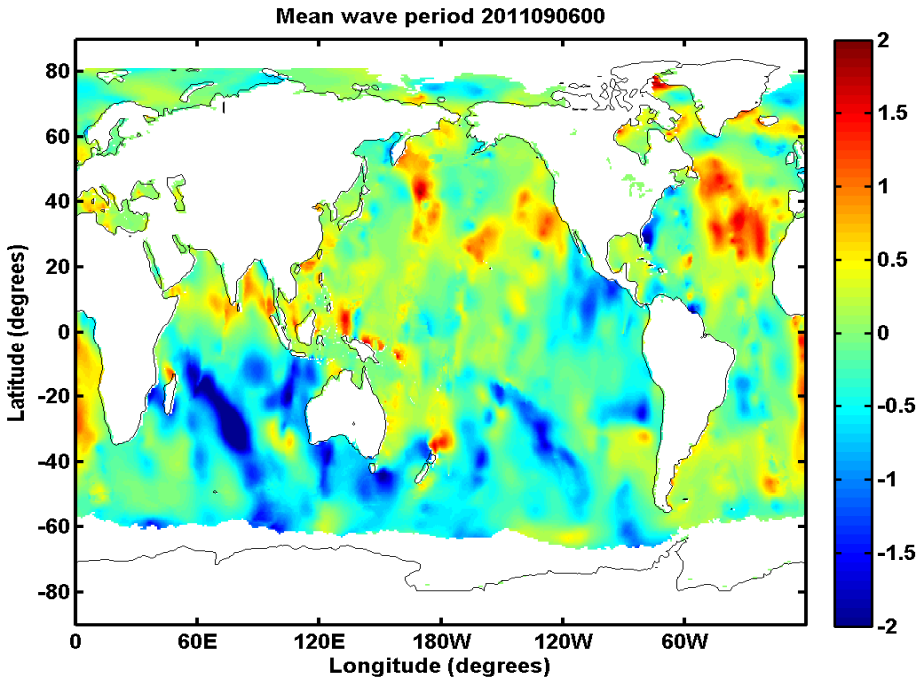
→ **Baseline** run without assimilation

Impact of the assimilation of Altimeters and ASAR on upgraded MFWAM

Swell wave height



Mean Wave Period



Difference between MFWAM-UP with and without assimilation

Snaphots on 6 September 2011 at 0:00 (UTC)

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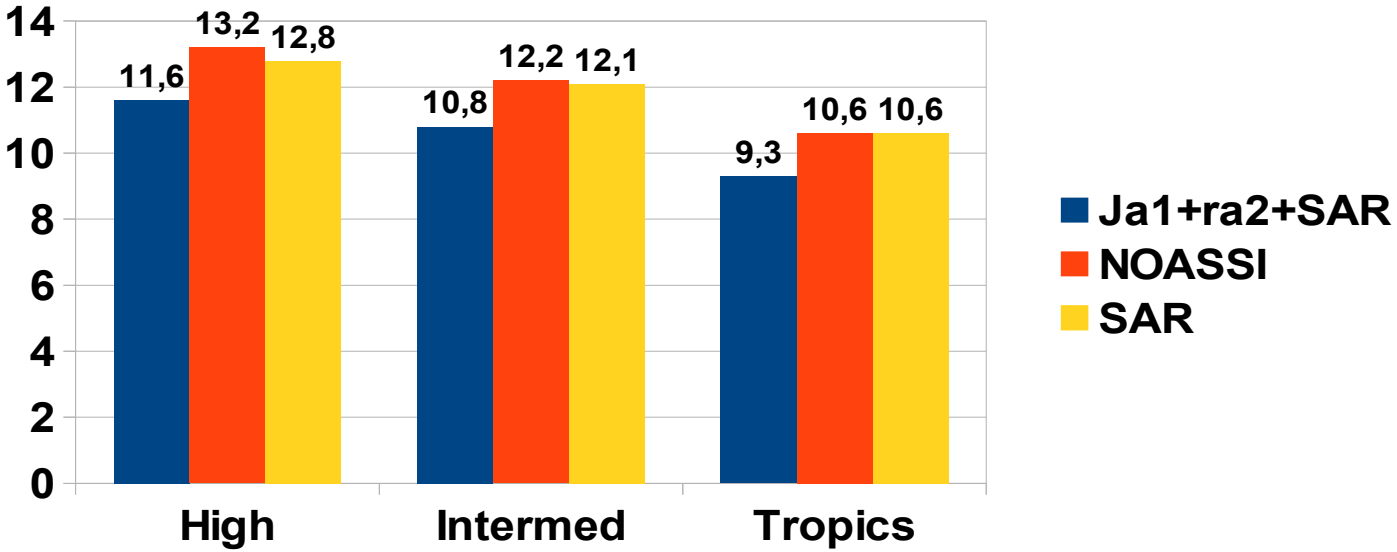
MFWAM-upgrade with the assimilation of Jason-1,Ra2 and SAR Validation of with Jason-2 Sig. Wave height)

Since starting the assimilation of ASAR directional wave spectra and both Jason-1 and Ra2 atlimeters wave heights

Statistics for different ocean basins

Sacatter index of SWH (%)



	High	Intermed	Tropics
Collected data :	**54101**	**77485**	**48529**

Control data from Jason-2

High Lat |☞|> 50°
Intermediate lat 20°<|☞|<50°
Tropics |☞|<20°

September 2011

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Conclusions

→ The assimilation of Enviat-ASAR in the upgraded MFWAM has less impact : thanks to the new dissipation term

→ The impact of ASAR wave data on the wave period is significant for the swell part of the wave spectrum

→Longer assimilation of altimeters and ASAR are needed

→ The Sentinel-1A L2 will be probably provided soon...