Are the SAR wave spectra of S1-A ready for use in the operational wave model MFWAM ?

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Reston, Virginia, 21 October 2015

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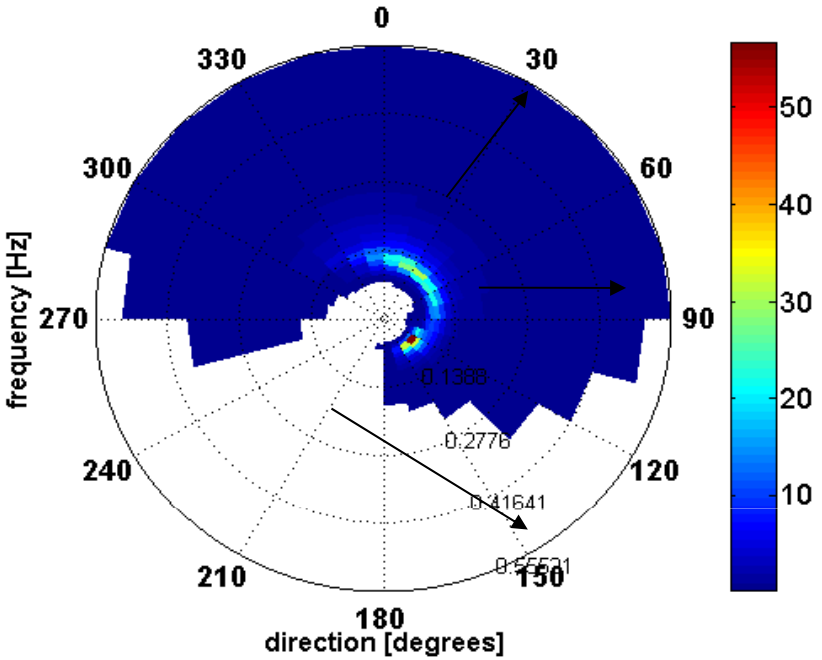
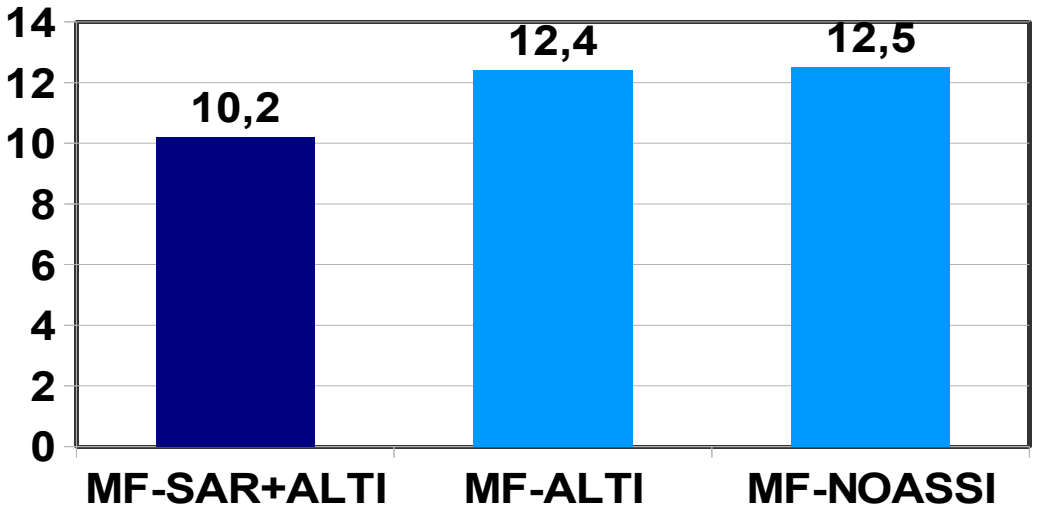
Lessons from ENVISAT : the contribution of SAR spectra



Exemple 3 wave systems seen by SAR

The use of SAR wave spectra improved the peak period by ~20 % for swell over 12 seconds (~225 m).

Scatter index of Tp



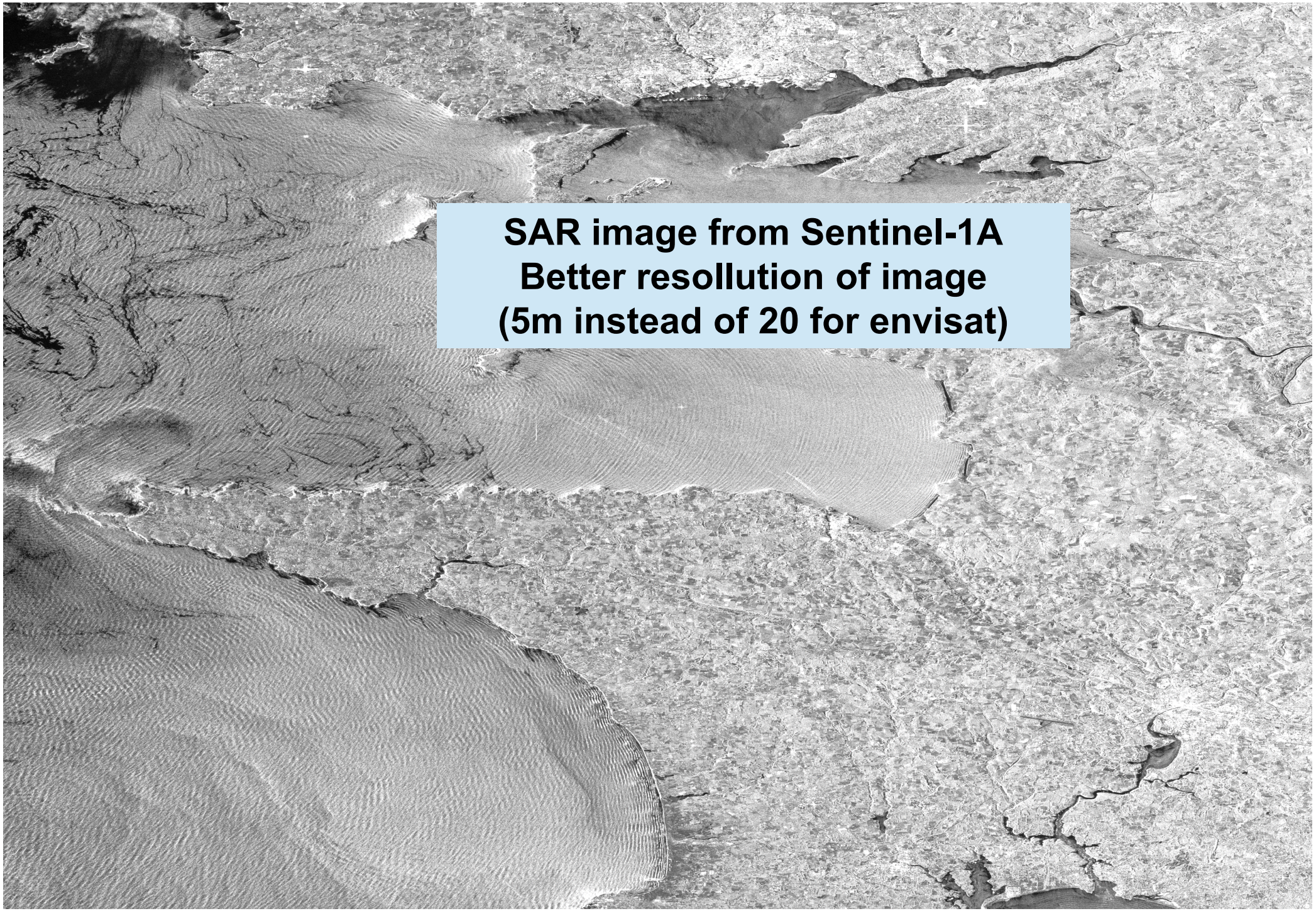
Comparison with buoys

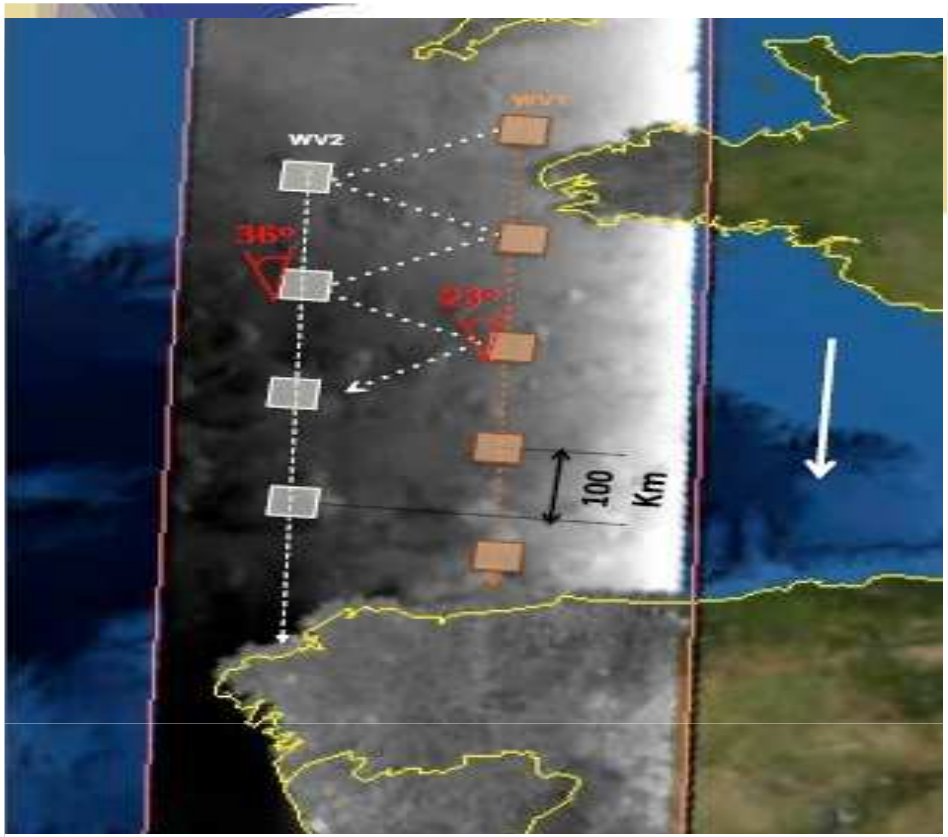
MOTIVATION

- Improving the swell forecast and in particular directional properties in the wave model MFWAM

- Implementing a quality control procedure for the L2 SAR wave spectra of Sentinel-1A : Threshhold for signal and parameters

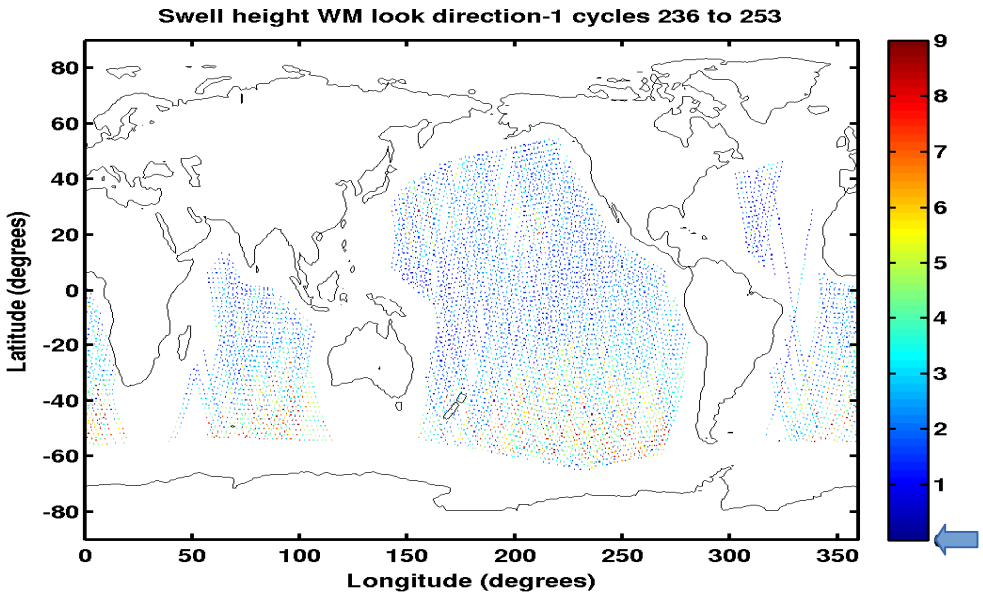
- Evaluating the impact of the assimilation of SAR-L2 of S-1A (both WV- 1&2) in MFWAM. Performing also combined assimilation with altimeters.

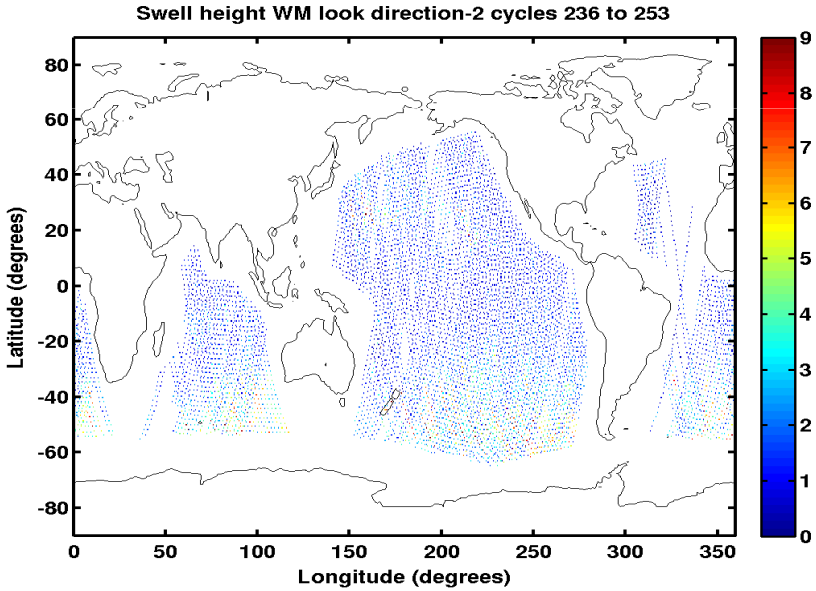

SAR image from Sentinel-1A
Better resollution of image
(5m instead of 20 for envisat)



In WV, a single stripmap image is acquired with an alternating elevation beam at a fixed on/off duty cycle, resulting in the generation of vignettes 20 by 20 km in size at regular intervals of 100 km.

Vignettes on the same incidence angle are separated by 200 km. Swaths alternate incidence angles between near range and far range (23° and 36.5° respectively).





WV-1

WV-2

Swell wave height retrieved from the L2

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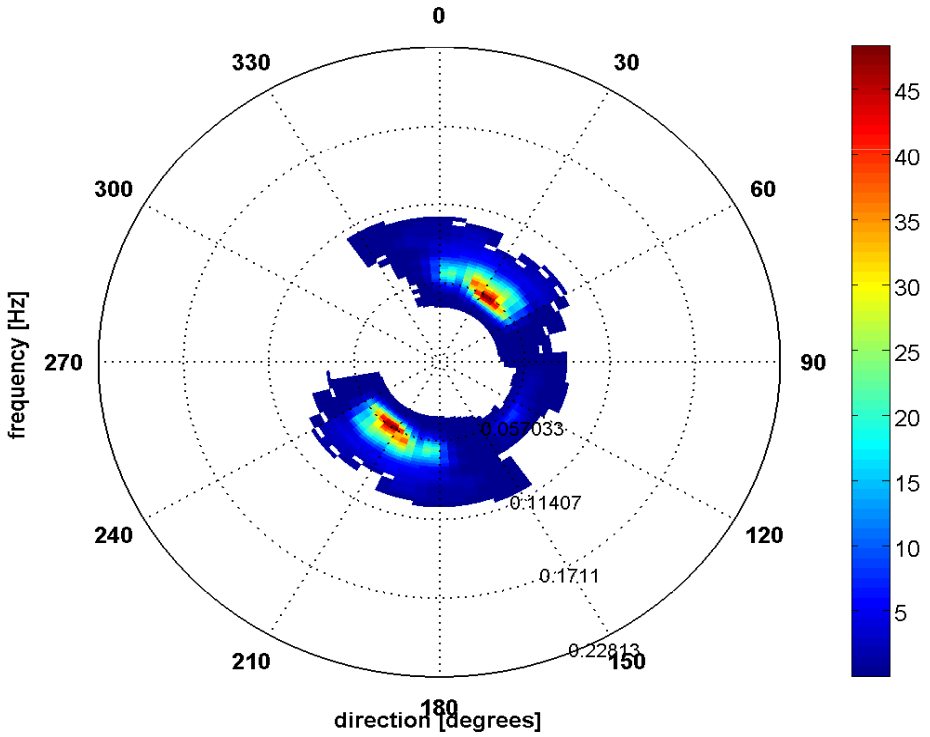
The SAR (L2) wave spectra of Sentinel-1A
Cycles 236-253

- Since 30 June 2015 the level 2 wave products are provided globally at ifremer (produced by ESA-MPC of S-1A). In this study the data cycles from 236 to 253 have been carried out. The resolution of SAR wave spectrum is 60 frequencies from 0.04 to 0,23 Hz and 72 directions (by step of 5°)

The L2 wave products cover the period from 24 August to 11 September 2015.



Sample of Sentinel-1 Level 2 wave products provided by ESA/IFREMER :
- goo resolution of the wave spectrum (30 fréquence-Max-0.22hz et 72 directions)

Exemple of wave spectrum from S-1A WM-1

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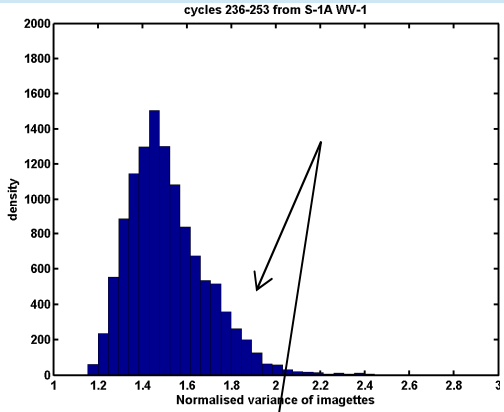
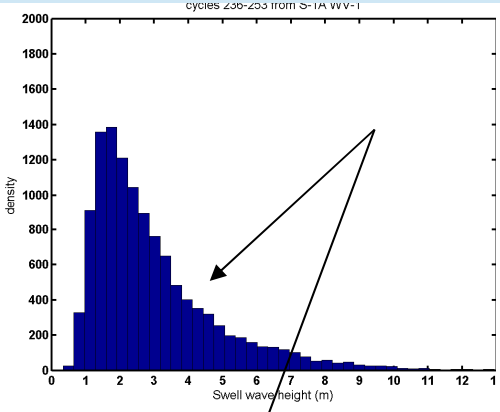
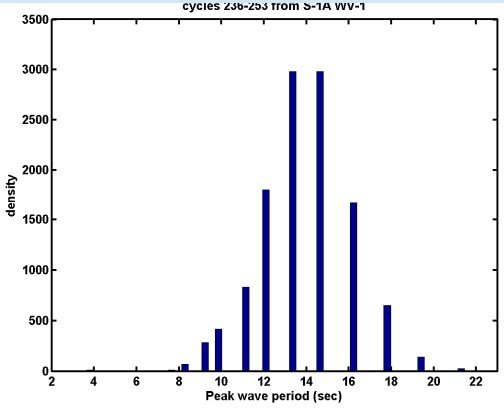
Quality control on signal and wave parameters

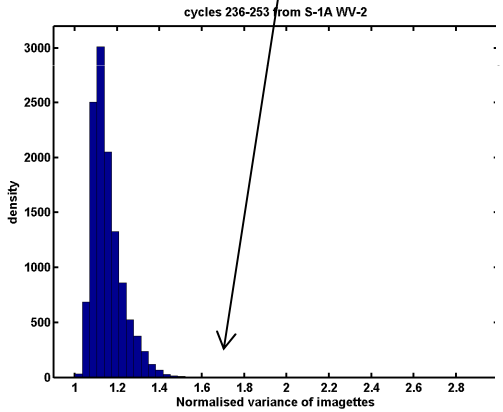
NV of imagette **Swell height** **Peak period** **.....SNR**

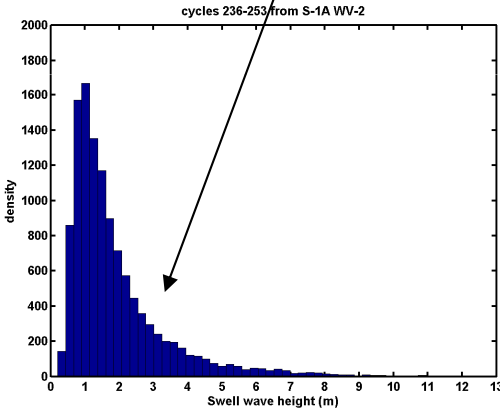


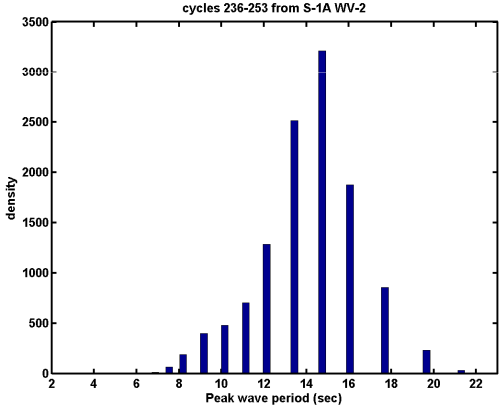




Wave Mode 1







Wave Mode 2

Only normalized variance of imagette between 0.9 and 1.8 are left : WV-2 (<1%), WV-1 (~9%)

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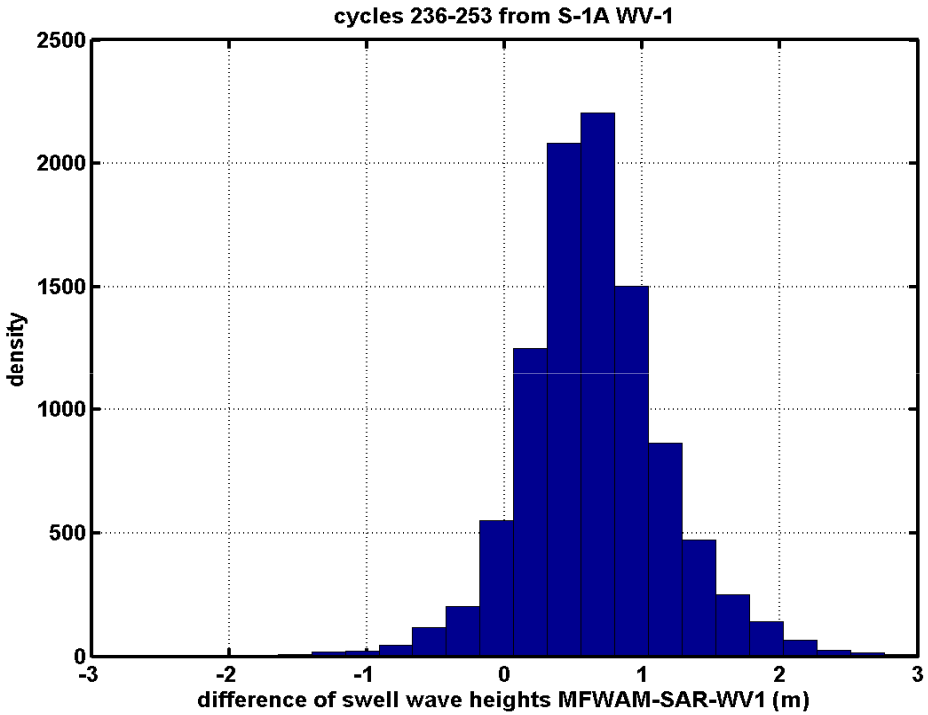
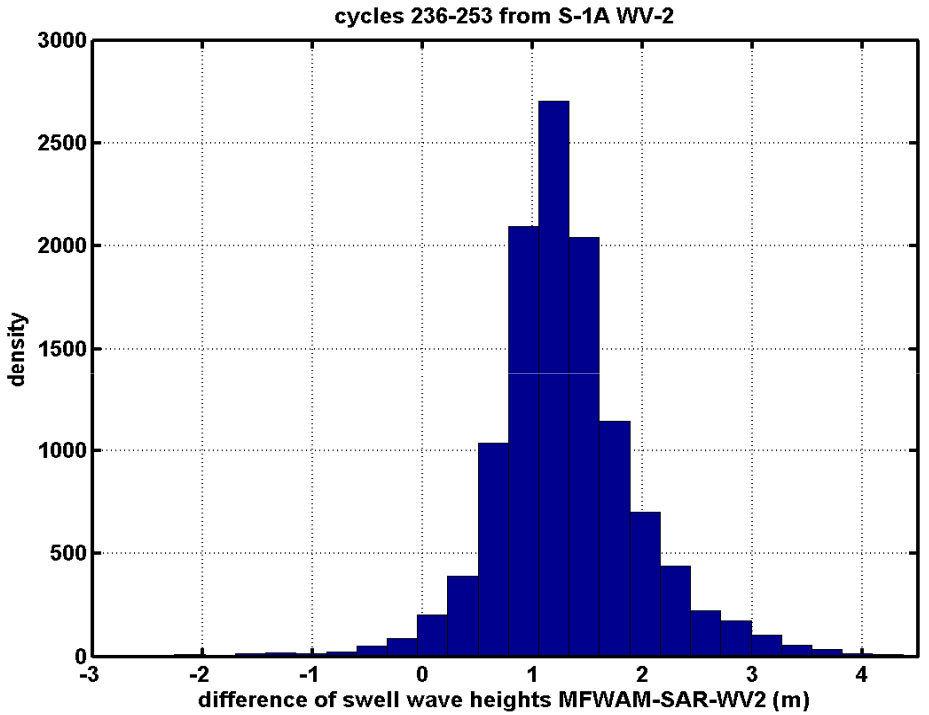
Difference of swell wave height S-1A and MFWAM

MFWAM-WV1



MFWAM-WV2



Mean difference of swell wave height are 0.66 m and 1.30 m for WV-1 and WV-2, respectively.

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Description of test runs

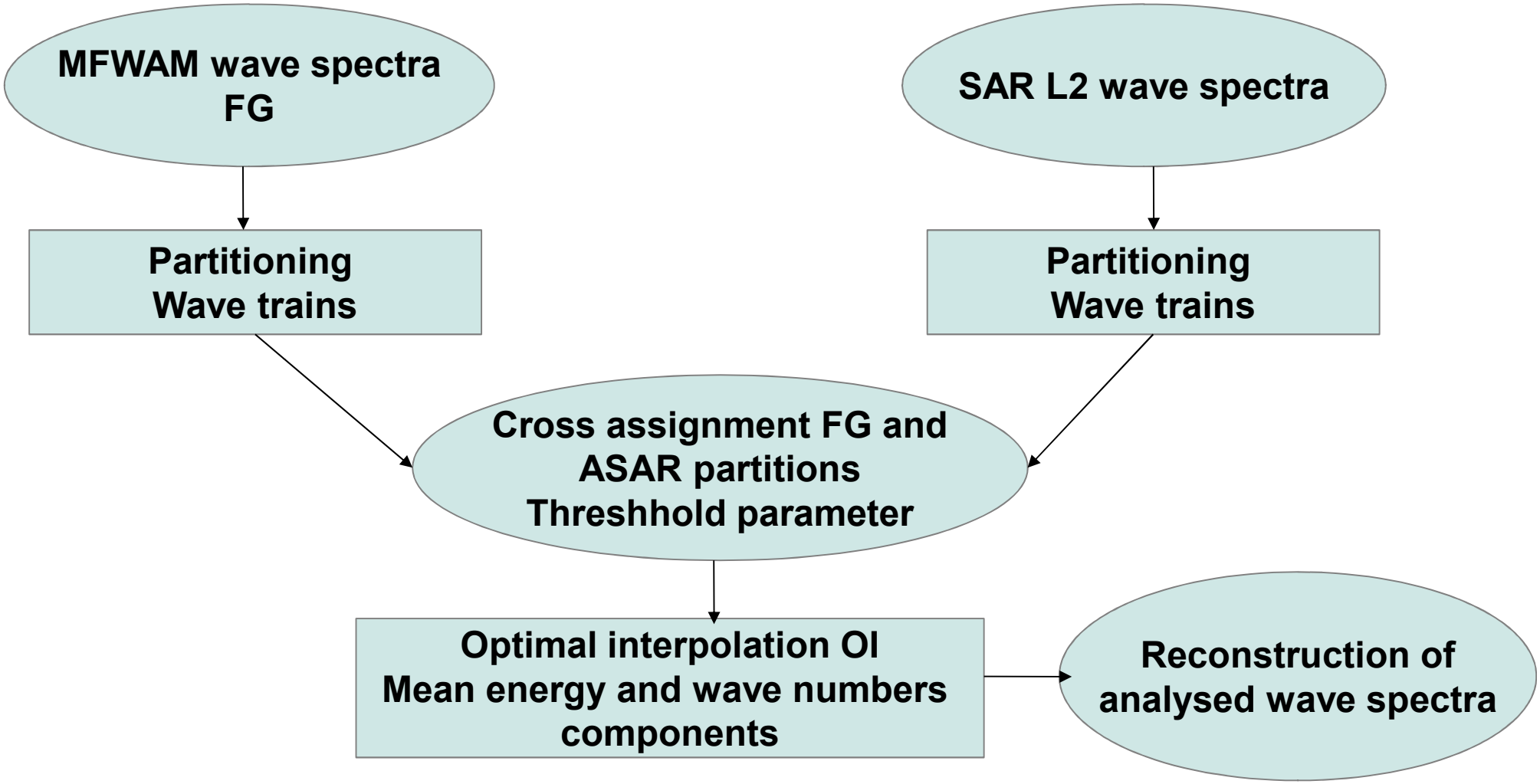
- Assimilation runs are performed from cycle 236 until 253 (24 August 2015 until 11 september 2015)

- The model MFWAM with grid size of 0.5° and the wave spectrum in 24 directions and 30 frequencies (starting 0.035Hz). The model MFWAM is driven by 6-hourly ECMWF analysed winds)

- Assimilation runs (from cycles 236 to 253 : 24 Aug to 11 Sep. 2015) :

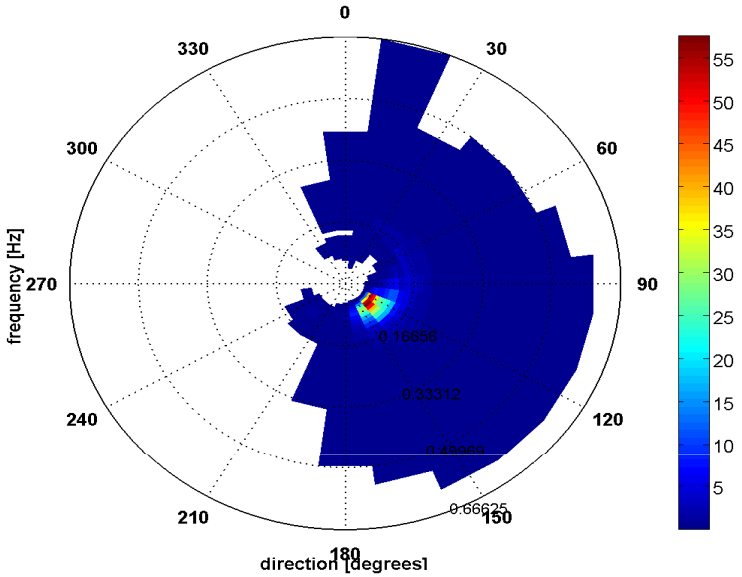
- Run of MFWAM with assimilation of S-1A (WV-1)
- Run of MFWAM with assimilation of S-1A (WV-2)
- Run of MFWAM with assimilation of S-1A (WV-1 & 2)
- Run of MFWAM with assimilation of Saral, CR-2 and S-1A (WV-1 & 2)
- Run of MFWAM with assimilation with only altimeters Saral, CR-2)
- Baseline run without assimilation of MFWAM

Description of the assimilation of SAR wave spectra

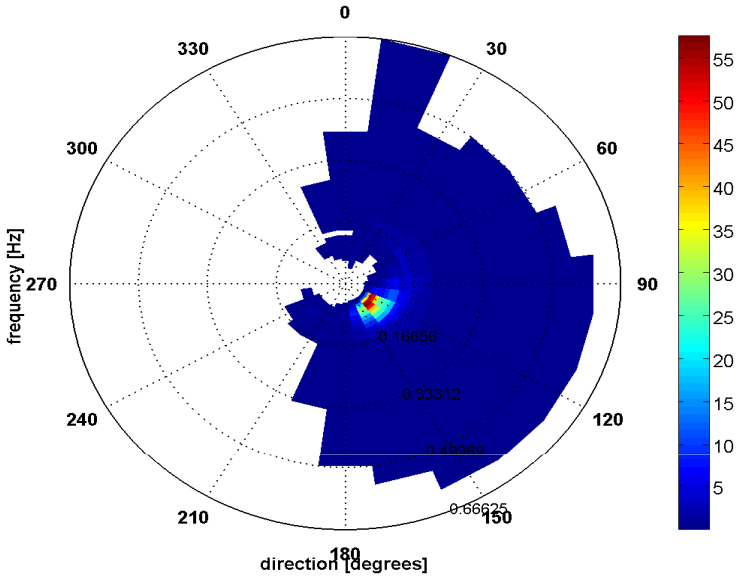


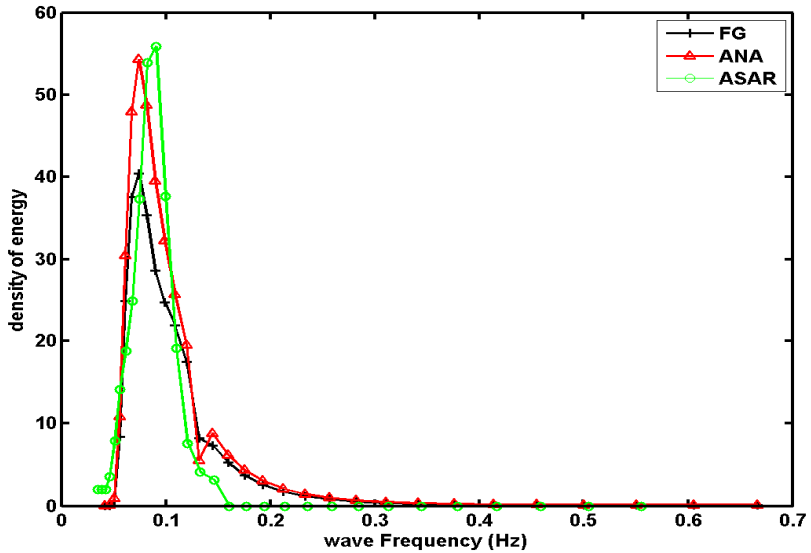
Exemple before and after the assimilation in MFWAM

First guess



Analysis





The 1D wave spectrum :
Green line : SAR
Red line : Analyzed MFWAM
Black line : First guess

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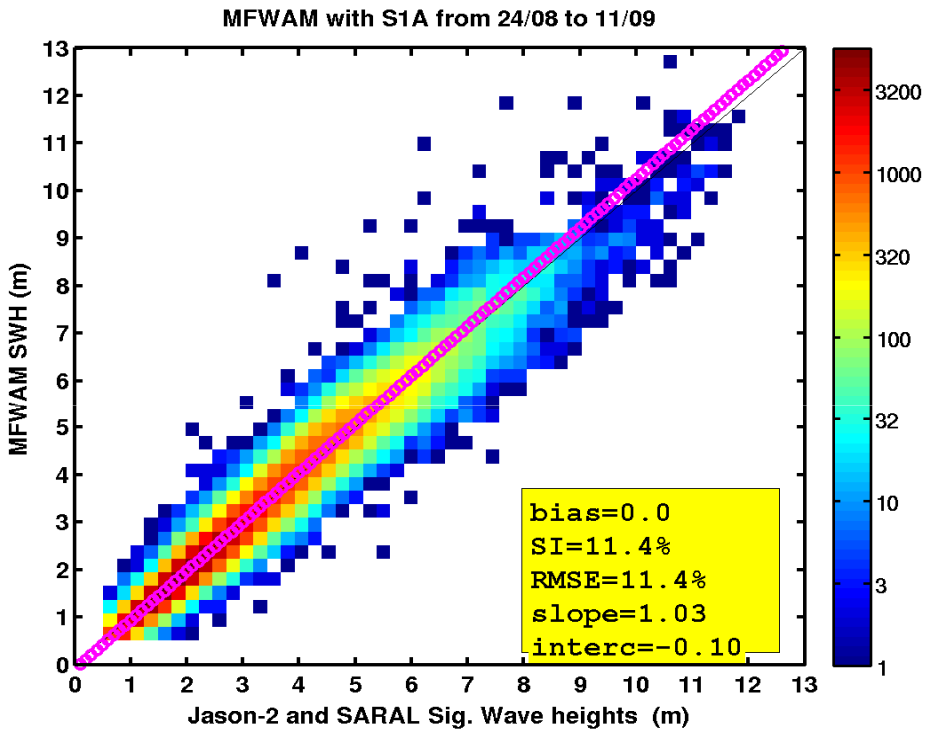
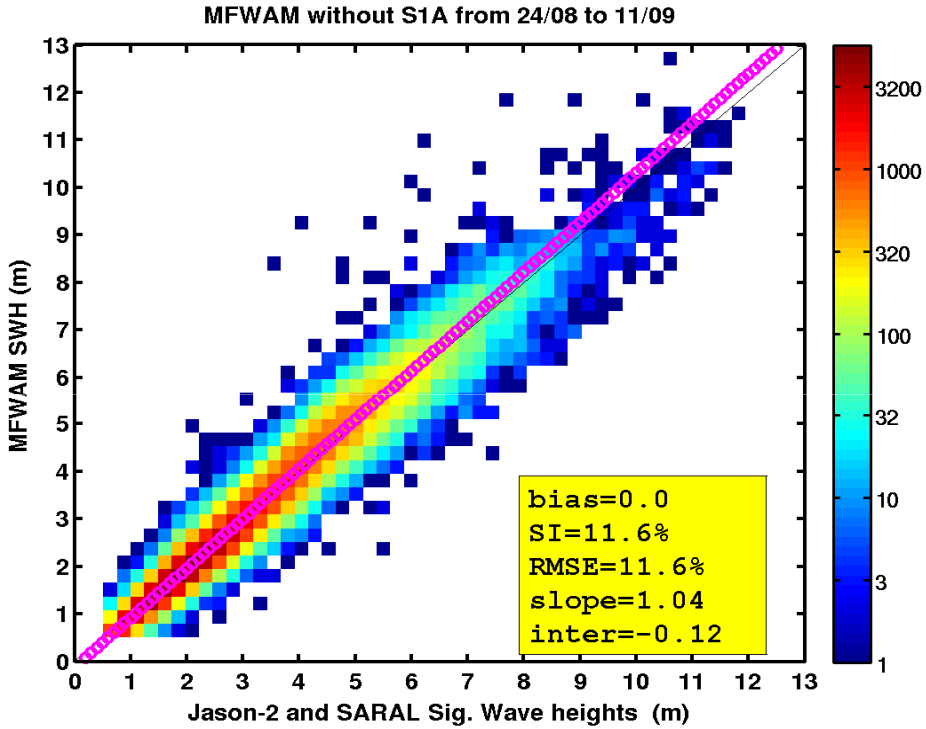
Validation of the assimilation of S1-A wave spectra
Significant wave heights

MFWAM-ASSI-S1A

Better slope

MFWAM-NOASSI





Bias = 0.0
SI = 11.4%
RMSE = 11.4%
Slope = 1 .03
Intercept = -0.10

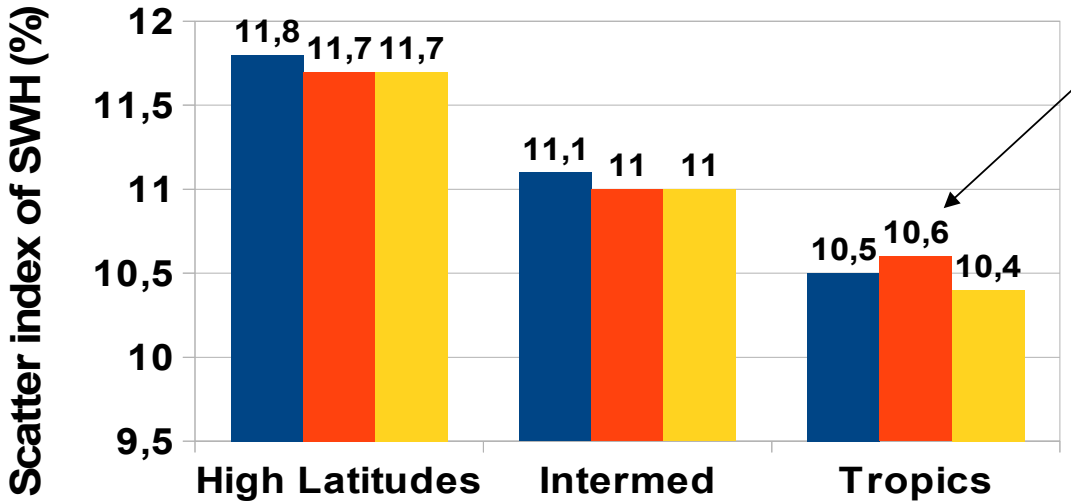
Scatter index is slightly improved by 1.5 %

August 24 au September 11, 2015
Comparison with SARAL and JA2

Bias=0.0
SI=11.6%
RMSE=11.6%
Slope=1.04
Intercept=-0.12

Impact of the assimilation of S1-A depending on the incidence angle of Sentinel-1A WM

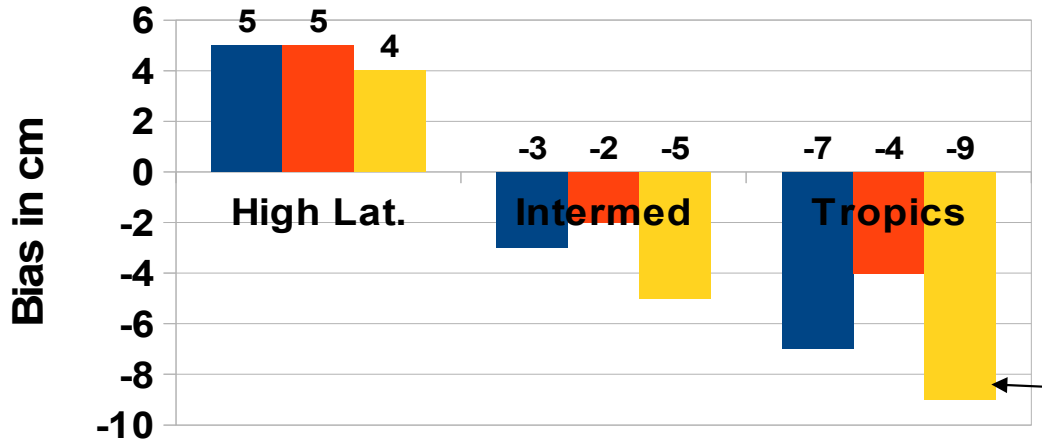
Statistical analysis



WV-1 slightly degrades in the tropics

NOASSI
MFWAM-WV1
MFWAM-WV2

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



NOASSI
MFWAM-WV1
MFWAM-WV2

WV-2 slightly Increases the bias

Validation with Jason-2 and SARAL

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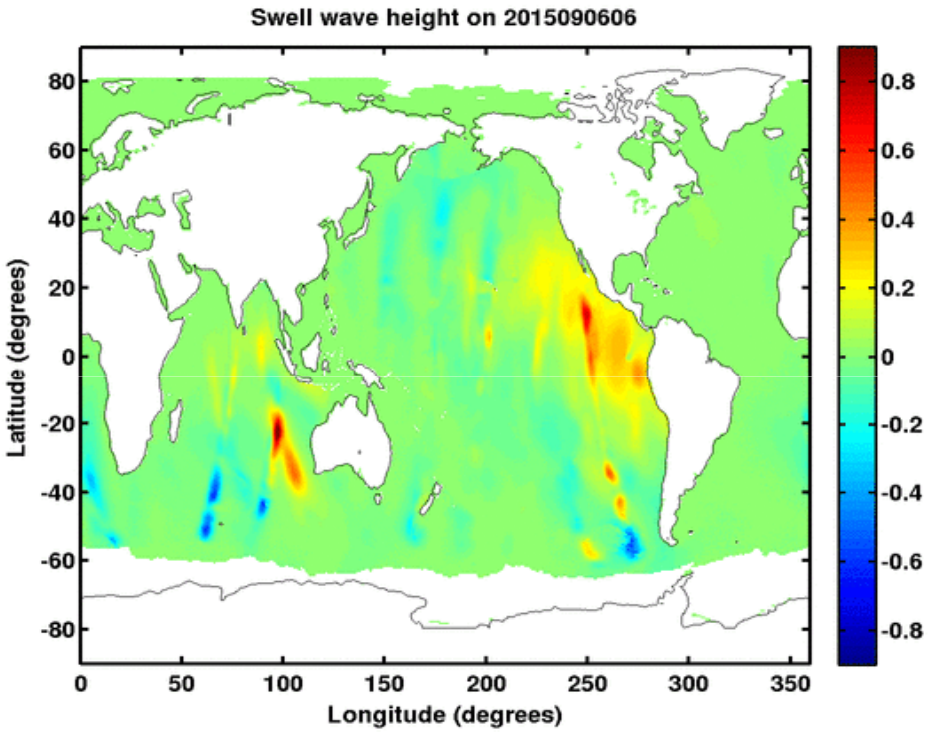
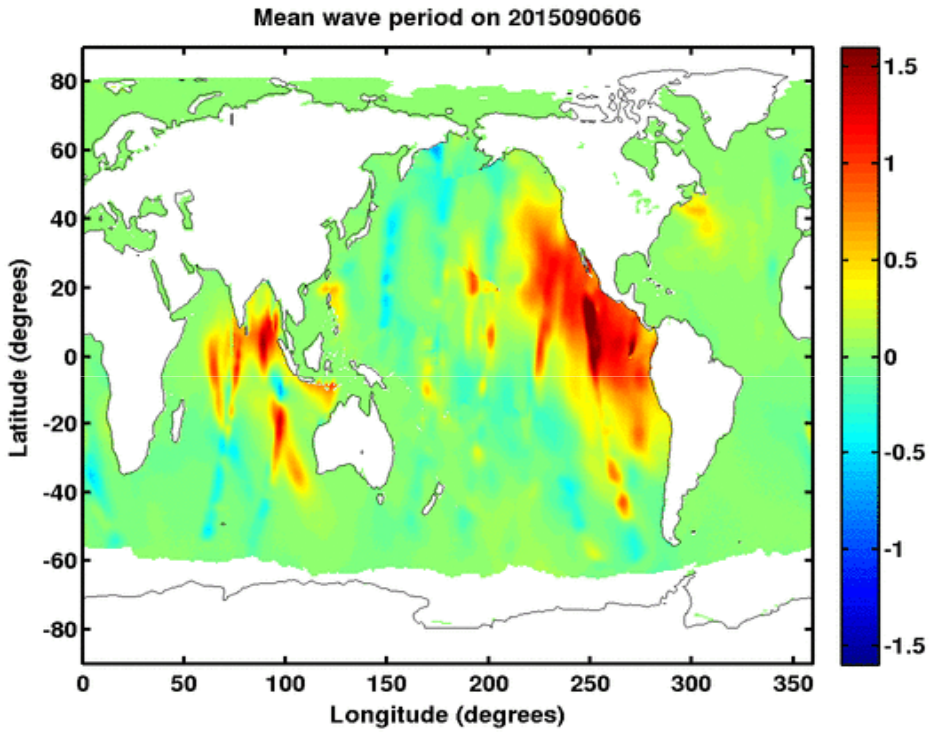
Impact of the assimilation of sentinel-1A (WM 1 & 2) in the forecast period

Swell wave height



Mean wave period



Difference of wave parameters with and without assimilation of S1A
Snapshots with a step of 6 hours in the period of forecast starting on 6 september 2015 at 0:00 UTC until 8 september at 0:00

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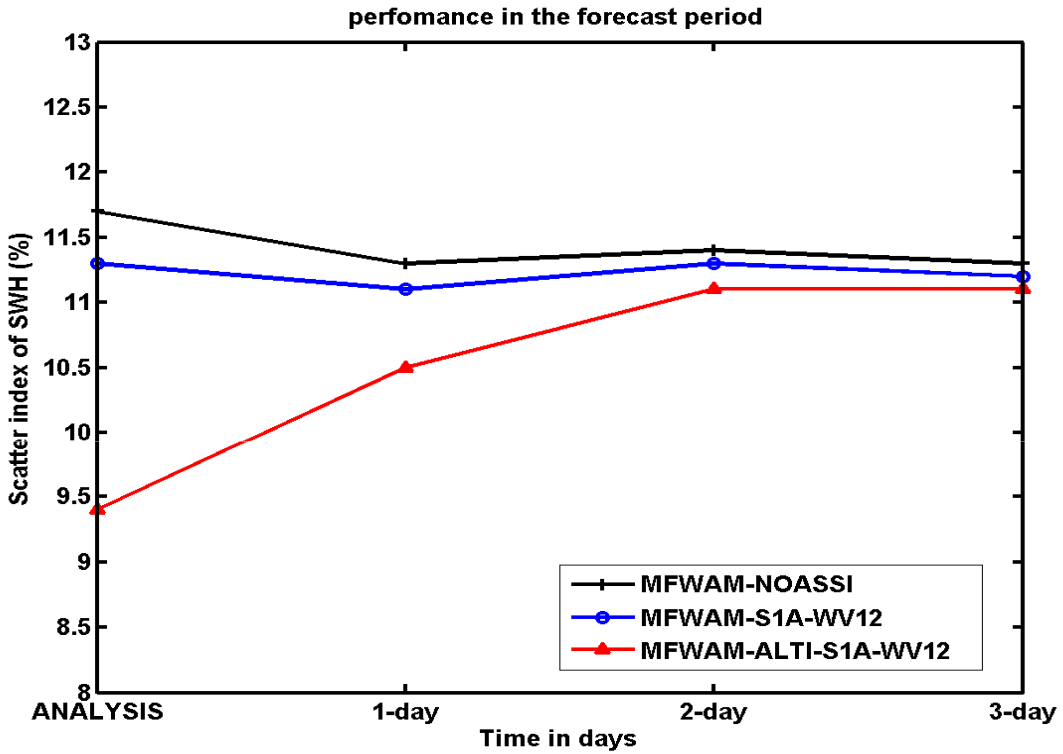
The impact of the assimilation in the forecast period

Normalized Scatter index of SWH (%)



Black line : MFWAM without assimilation

Blue line : MFWAM with S1A

Red line : MFWAM with altimeters (CR2+SRL) and S1A

Validation with Jason-2 and Saral

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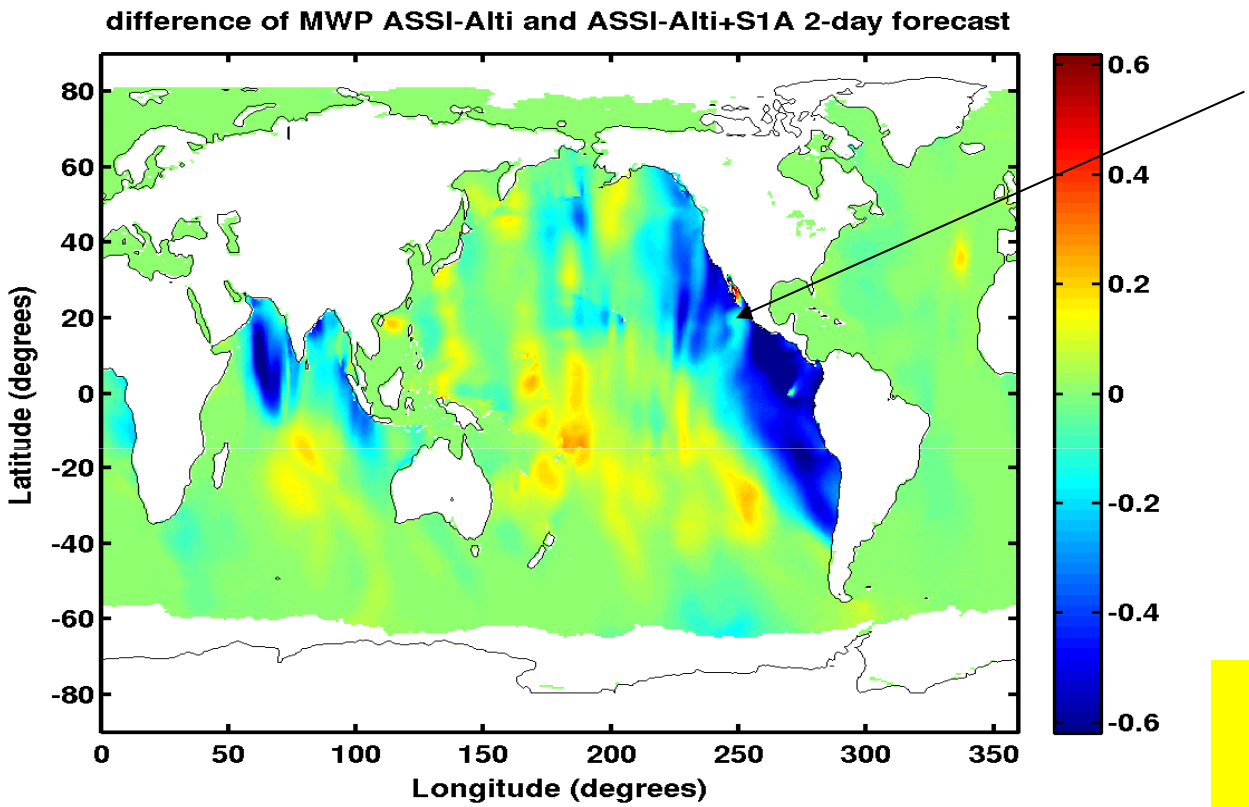
The contribution of S-1A SAR in the forecast period



Strong cyclone Activity (hurricane LINDA in Baja California)

2-day forecast after the end of the assimilation

Difference between mean wave period (in sec) of runs with assimilation of altimeters only and the one with assimilation altimeters and S1A wave spectra

8 September 2015 at 0:00 UTC

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Conclusions

→ The impact of the assimilation of both wave mode incidence (1&2) indicates a positive and small improvement in the analysis (in reference to altimeters saral and Jason-2)

→ The wave spectra from the WM-1 slightly degrade the analysis in the tropics. The MTF for the retrieval needs to be improved.

→ The impact of the assimilation is enhanced in the forecast period for hurricanes and storms events.

→ Works are ongoing for more testing and adapting the assimilation scheme. The validation with buoys data will be also performed.