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The assimilation of CFOSAT synthetic wave data in the wave model MFWAM

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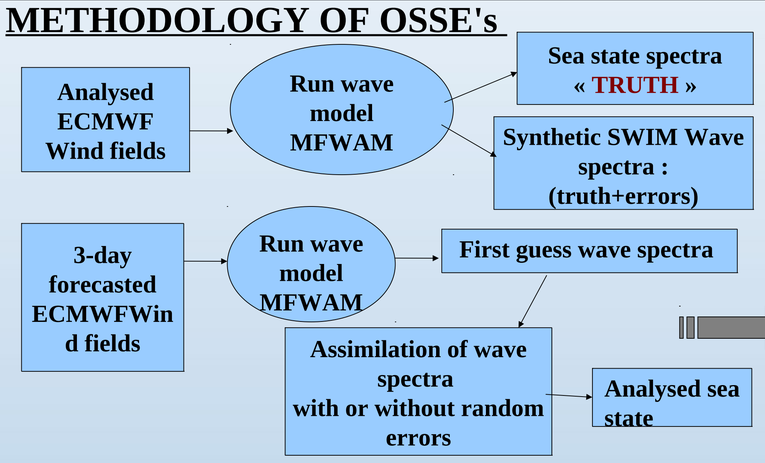
MOTIVATION:

- **Assessment of the assimilation system in the new wave model MFWAM (improving the wave forecast)**

Evaluate the impact of using multi sources of wave observations. Investigating the contribution of each instrument RaR, SAR, altimeters,)

- **Perform OSSE's (synthetic data from SWIM instrument : in preparation to the CFOSAT mission). As the wavelength cut-off is much better than the ASAR one, therefore it is needed to evaluate the impact on sea state forecast.**

METHODOLOGY OF OSSE's



→ **The rms errors of significant wave height of the first guess are about 18.2% in reference with altimeters**

The operational wave model MFWAM improvement and validation partly thanks to Altimetry

Based on ECWAM code with new physics for dissipati on: (Ardhuin et al. 2010, JPO)

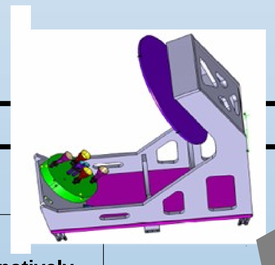
- **Non isotropic dissipation:**

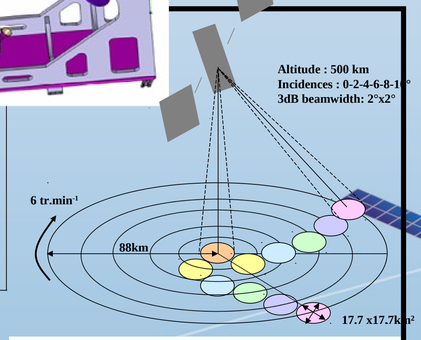
-> Better adjustment of the mean direction and angular spreading

- **Breaking Threshold mechanism from the saturation spectrum , instead of mean wave steepness dependency breaking term:**

- **New term for swell damping due to air friction**

Description of SWIM on CFOSAT

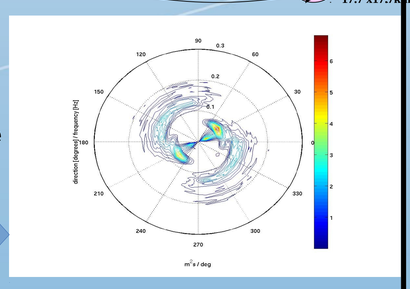




Ku-Band radar (13.2-13.6 GHz)
Multibeam (6 incidences 0-2-4-6-8-10°) alternatively illuminated within 218 ms. Scanning in azimuth (5.7 rpm)
Horizontal final resolution within footprint, after processing): 35 m in the look direction (18 km cross)
Maximum scanning radius: 88 km (10° incidence)

CFOSAT mission provides the wave and Wind data at the same locations :

SWIM provides Significant wave heights at the Nadir direction and directional wave spectra.
Scat provides the wind fields



Synthetic wave spectrum from FAWASSI (CNES)

ASSIMILATION EXPERIMENTS

The assimilation is performed during 1 cycle of CFOSAT (13 days) every 6 hours starting from 12 September 2011 at 12:00 (UTC)
The wave model resolution is of 0.5° and the wave spectrum in 24 directions and 30 frequencies. 6-hourly analysed ECWMF wind fields are used for the experiments.

1- MFWAM with the assimilation of synthetic wave spectra and SWH from SWIM (No instrument errors)
2- MFWAM with the assimilation of synthetic wave spectra and SWH from SWIM (from FAWASSI CNES simulator)
3- MFWAM with assimilation with synthetic wave spectra and SWH from SWIM and ASAR L2 wave spectra
4- MFWAM with assimilation of only synthetic significant wave heights from from SWIM (No instrument errors)
5-Baseline run without assimilation

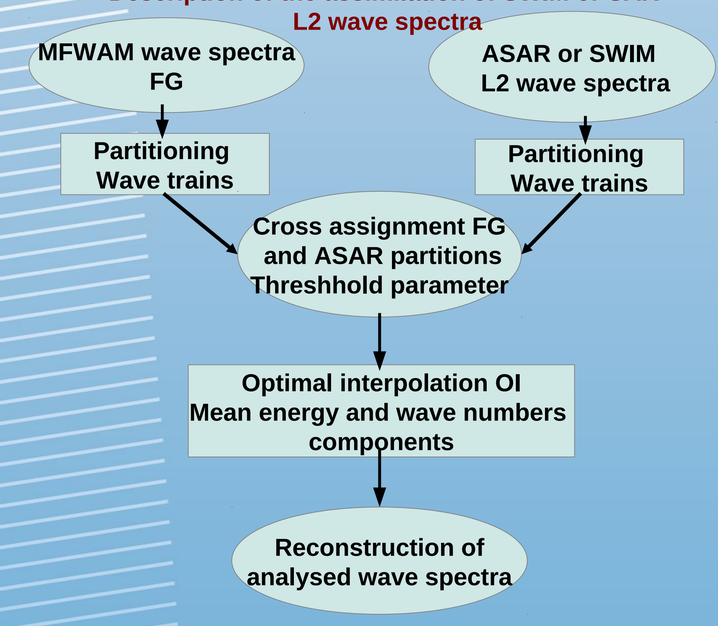
ASSIMILATION SCHEME

- **PARTITIONING CONCEPT**

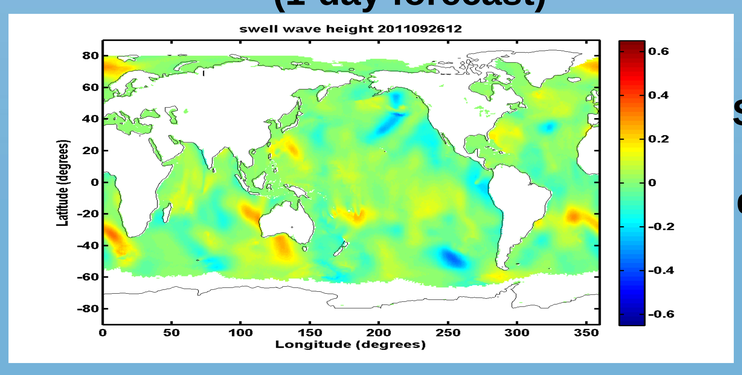
This principle consists in decomposing the wave spectrum in several partitions, each one represents a particular wave system such as: swell, wind-sea, …etc.

Cross-assignment between first-guess and observed partitions which are from the same wave system (threshold condition). Then, mean parameters of partitions are ready to optimal interpolation

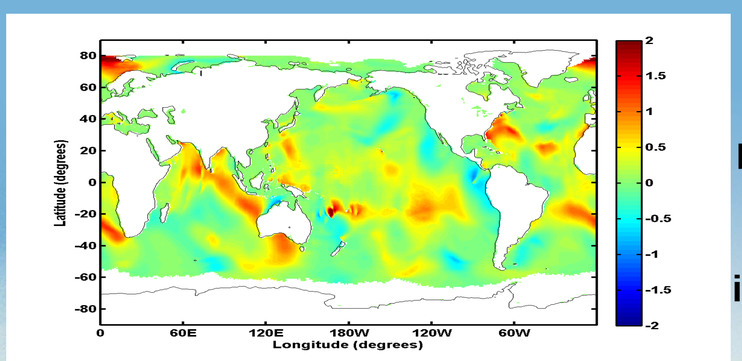
Description of the assimilation of SWIM or SAR L2 wave spectra



Impact of the assimilation of SWIM (SWH and wave spectra) and ASAR in the forecast period (1-day forecast)



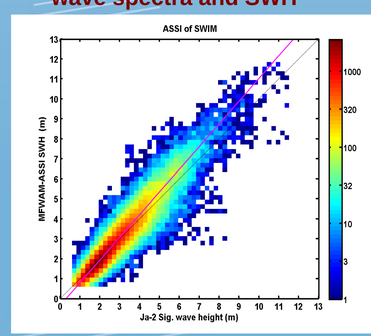
Swell wave Height difference in meters



Mean wave period difference in seconds

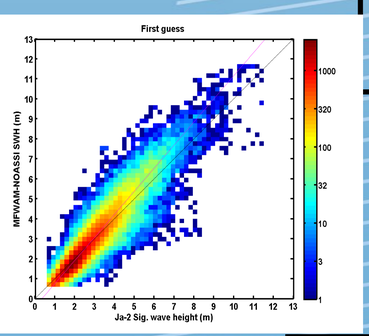
Validation with Jason-2 Sig. Wave height

assimilation of Synthetic SWIM wave spectra and SWH



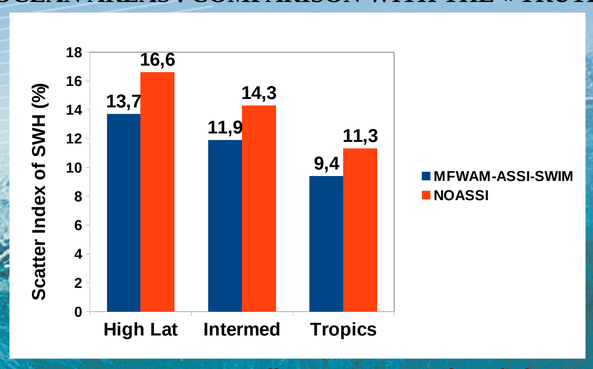
Bias = 0.02
SI = 16.1%
NRMS = 16.1%
Slope = 1 .14
Intercept = -0.33

Run without assimilation



Bias=0.01
SI=18.2%
NRMS=18.2%
Slope=1.16
Intercept=-0.41

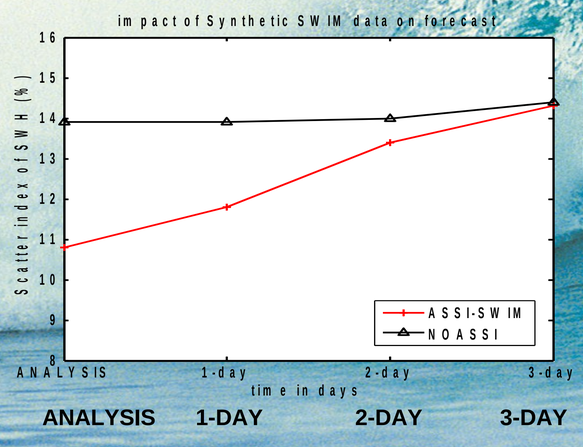
STATISTICAL ANALYSIS FOR DIFFERENT OCEAN AREAS : COMPARISON WITH THE « TRUTH »



High Lat : |Φ| > 50° Intermediate ocean : 20° < |Φ|< 50° Tropics : |Φ| < 20°

THE IMPACT OF THE ASSIMILATION OF SYNTHETIC WAVE SPECTRA AND SWH FROM CFOSAT

Comparison with TRUTH significant wave height at Jason 1 & 2 orbit tracks

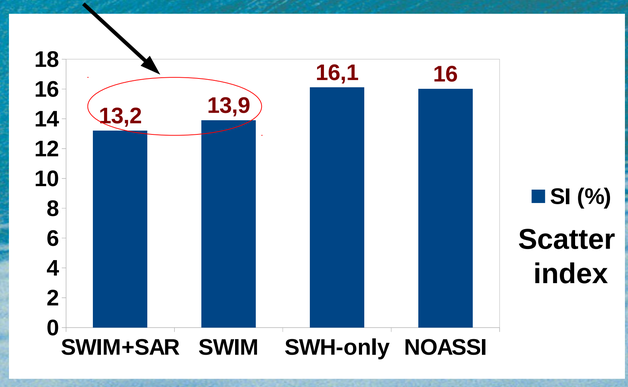


Red : Assimilation of SWIM
Black : reference run

ANALYSIS 1-DAY 2-DAY 3-DAY

VALIDATION WITH BUOY PEAK PERIOD Tp

impact of using directional wave spectra



CONCLUDING REMARKS AND FUTURE WORKS

- **The assimilation system improves significantly the wave analyses : Normalized scatter index of Significant wave heights is less ~10% refering to altimeters**

- **The contribution of directional wave spectra in the assimilation is clearly showed for longer waves such swell when the peak period Tp is greater than 12 sec. The improvement of the scatter index for Tp when we use ASAR or SWIM directional wave spectra is slightly ~20 %. This results is very promising for the use of Sentinelle-1 and CFOSAT jointly in the near future.**

- **The assimilation of directional wave spectra from the FAWASSI simulator show the same tendency than the use of synthetic wave spectra without random errors (weak degradation of the impact less than 1%).**

- **The impact of the assimilation of SWIM wave data stays efficient until 3 days which is quite relevant for the operational forecasting system of Météo-France.**

- **The simulator FAWASSI for SWIM developed by the CNES is recently improved. Consequently further assimilation runs will be performed and investigated.**

- **Also assimilation runs are needed in order to analyse the sensitivity with the wavelengths cut-off**