On the impact of Saral/Altika wave data on the wave forecasting system of Météo-France

Lotfi Aouf, and Jean-Michel Lefèvre

Division Marine et Océanographie, Météo-France

Ocean Surface Topography Science Team (OSTST), Boulder 8-11 October 2013
Improving the sea state forecast in high wind conditions

Snapshot on SWH from MFWAM-Global

Typhoons FITOW and DANAS generating high sea state on Sunday 6 October 2013 at 12:00 (UTC)
Evaluate the impact of the assimilation of Saral/Altika wave data on the wave forecasting System

Test of small changes on QC procedure (consequence of PATCH-V1): new thresholds values for $\sigma_0$ and wave height

Impact of using Saral/Altika wave data in regional wave model (high resolution MFWAM-EURAT01)
Saral NRT products are downloaded in NETCDF format from [ftp.saral.oceanobs.com](ftp.saral.oceanobs.com): period 31 March to 1 September 2013

Quality control procedure is implemented to prepare the data for the assimilation in the wave model:

<table>
<thead>
<tr>
<th>Land flag</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMS_SWH/4.15</td>
<td>(\leq 0.3 \text{ m} )</td>
</tr>
<tr>
<td>SWH Min</td>
<td>0.5 m</td>
</tr>
<tr>
<td>SWH Max</td>
<td>13 m</td>
</tr>
<tr>
<td>Ice flag</td>
<td>0</td>
</tr>
<tr>
<td>(\sigma_0) Min</td>
<td>5 db</td>
</tr>
<tr>
<td>(\sigma_0) Max</td>
<td>30 db</td>
</tr>
<tr>
<td>Number of valid points</td>
<td>(\geq 35)</td>
</tr>
</tbody>
</table>

Threshold values in table as for Jason-2

- RMS_SWH/4.15: \(0.3 \text{ m}\)
- \(\sigma_0\) Min: 5 db
- \(\sigma_0\) Max: 30 db
- Number of valid points: \(\geq 35\)

QC2 tested for August

METEO FRANCE

[Toujours un temps d’avance](meteofrance)
Example of QC check for August 2013

Data rejected in %

Histograms of Saral sig. wave heights
Example of QC1 check (June and July 2013)

Before QC1
Nb of data : 3272808

After QC1
Nb of data : 2516442

~23% Saral Sig. Wave heights are rejected before the assimilation

Histograms of Saral sig. wave heights
Distribution of Saral data on wave model grid

- Assimilation of altimeters
  - Optimal interpolation on SWH (Significant wave height)
  - Correction of wave spectra using empirical laws and assumptions

Example of 1-day global coverage of SARAL Sig. wave height (~5800)
Description of runs:
from 31 March 2013 to 1 August 2013

- Wave model set-up
  - Wave model MFWAM (global coverage 0.5x0.5° irregular grid),
    wave spectrum in 30 frequencies (starting 0.035 Hz) and 24 directions
  - ECMWF analyzed winds every 6 hours
  - Assimilation time step 6 hours

→ Assimilation of Saral/Altika Sig. wave heights
→ Assimilation of Saral and Jason-2 sig. wave heights
→ Outputs from the operational forecasting system (**MFWAM with assimilation of Jason 1 & 2**)
→ Baseline run of MFWAM without assimilation
Assimilation of Saral/Altika Sig. Wave heights
Validation with Jason 1 & 2

Assimilation of Saral

Without assimilation

Bias = 0.04
SI = 11%
RMSE = 11.2%
Slope = 1.04
Intercept = -0.07

Data collected : 1661664
April to Aug 2013

Bias = 0.14
SI = 13.8%
RMSE = 14.7%
Slope = 1.11
Intercept = -0.17
Assimilation of SARAL/Altika in MFWAM in different ocean basins: April to August 2013

Scatter Index of SWH (%)

Collected data: 549685 683667 428312

High Lat $|\phi| > 50^\circ$
Intermediate lat $20^\circ < |\phi| < 50^\circ$
Tropics $|\phi| < 20^\circ$

Validation with Jason 1 & 2
Assimilation of Saral and Jason-2 in MFWAM in different ocean basins

Scatter Index of SWH (%)

Validation with Jason-1: April, May and June (until 21)

Great performance!
VALIDATION OF SWH WITH BUOYS DATA

Data are collected from the JCOMM model intercomparison archive produced by J. Bidlot (ECMWF).
Validation with buoys Sig. Wave heights

Use of Saral is very promising!

- **NOASSI**: without assimilation
- **ASSI-SRL**: assimilation of SARAL/Altika
- **ASSI-SRL-JA2**: assimilation of SARAL and Jason-2
- **OPER**: Operational MFWAM with assimilation of Jason-1 & 2

April-May-June 2013 (29005 collected data)
Performance of the assimilation of Saral/Altika at the peaks

**Scatter Index (%)**

- **Blue** for assimilation with saral
- **Red** is reference run

- Scatter index is well reduced in wind sea and swell wave systems

**Comparison with NDBC buoys located on North America: Jun-Jul-Aug 2013**
Impact of the QC2 on the assimilation system
Experiment for August 2013

Bias = 0.06
SI = 11.1%
RMSE = 11.3%
Slope = 1.04
Intercept = -0.07

Same performance for both QC1 and QC2

The use of QC2 is affecting mainly
the shallow water areas (close to coastline)

Difference between SWH of the assimilation with QC1 and QC2 (example of 1-day 20130812)
The assimilation of Altika in regional and high resolution MFWAM- EURAT01

Domain: 32°W-42°E and 20°N-72°N
Grid resolution of 10km (irregular grid)
Wind forcing from the atmospheric model ARPEGE-0.1° (every 3 hours)
Boundary conditions from MFWAM-Global

The assimilation is performed from 7 to 15 July 2013, with a step of 3 hours

1-day (by a step of 3 hours) difference of SWH from the Assimilation run and the operational MFWAM- EURAT01 (without assimilation)
Validation of the assimilation of Saral/Altika in MFWAM-EURAT01: preliminary results

<table>
<thead>
<tr>
<th>Statistical analysis</th>
<th>ASSI</th>
<th>OPER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bias</td>
<td>0.</td>
<td>0.07</td>
</tr>
<tr>
<td>Scatter Index(%)</td>
<td>14.5</td>
<td>15.9</td>
</tr>
<tr>
<td>RMSE</td>
<td>14.5</td>
<td>16.5</td>
</tr>
<tr>
<td>Collected</td>
<td>2343</td>
<td></td>
</tr>
</tbody>
</table>

Orbit tracks of Jason-2 for the day 20130712

Comparison with Jason-2 Sig. Wave Heights 7-13 July 2013
Conclusions

- The sea state forecast is well improved after using Saral/Altika Si significant wave height: thanks to the good quality of Saral wave data.

- Positive impact on the wave analysis and forecast: ready to be used operationnally in MFWAM (Altika in BUFR format on the GTS today).

- The use of Saral with Jason-2 showed very promising results (the SWH errors are greatly reduced SI<9% in the tropics).

- The use of QC2 is successful, more data are included in the system without degrading the performance.

- Positive impact showed by the assimilation of Saral/Altika in regional model MFWAM-EURAT01. We look forward to implement the assimilation for cyclone season at the Indian ocean MFWAM-La réunion.