Validation of a global dataset based on subwaveform retracking: improving the precision of pulse-limited satellite altimetry

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Ocean Surface Topography Science Team, 2017
Miami, USA, 23-27.10.2017
Summary

- Introduction: Background, Motivation, Data Sources
- High-rate Noise and new Sea State Bias
- Crossover Analysis
- Conclusions
Background

ALES (Adaptive Leading Edge Subwaveform) is a retracker: it fits the signals from satellite altimetry

Originally planned to improve the data near the coast; improvements validated through tide gauges in several publications

A version of ALES data at 20-Hz within 50 km of the coast is available from PODAAC for Jason-2 and Envisat (currently no Sea State Bias correction):
ftp://podaac.jpl.nasa.gov/allData/coastal_alt/L2/ALES/

Regional post-processed sea level time series in North Sea and Med at 20-Hz and 1-Hz are available from COSTA: https://doi.pangaea.de/10.1594/PANGAEA.871920 (SEE POSTER IN SESSION „ADVANCES IN COASTAL ALTIMETRY!“)
New global data availability: ALES in OpenADB

In the framework of OSTST Project RECAP24 (REprocessed Coastal Altimetry Products)

- From https://openadb.dgfi.tum.de/, in netCDF
- No hassle, made for users: Sea Surface Height already computed
  (corrections and 20Hz data available on request)

### Data Format

The product "Adaptive Leading Edge Subwaveform (ALES) Retracker" includes the following parameters.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>lon</td>
<td>Longitude of Satellite Footprint</td>
</tr>
<tr>
<td>lat</td>
<td>Latitude of Satellite Footprint</td>
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<tr>
<td>day</td>
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<tr>
<td>ssh</td>
<td>Sea Surface Heights</td>
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<td>Standard Deviation</td>
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<td>swt</td>
<td>Significant Wave Height</td>
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<tr>
<td>mss</td>
<td>Mean Sea Surface</td>
</tr>
<tr>
<td>tide</td>
<td>Ocean Tide Correction</td>
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<td>tidec</td>
<td>Ocean Lead Tide Correction</td>
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<td>Distance to Coast</td>
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<tr>
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</tr>
<tr>
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<td>Orbit Status and Quality Flags</td>
</tr>
<tr>
<td>flags</td>
<td>Instrument Status and Quality Flags</td>
</tr>
</tbody>
</table>

The data will be provided in NetCDF. More details on the data is available here.
Scope and Data Sources

Today's menu: internal global single-mission validation, i.e. noise and crossovers statistics.

Scientific question: can ALES be used with confidence as a global ocean retracker?

Data sources:
- High frequency: ranges and sea state bias from SGDR data (default mle4 retracker for Jason) and from ALES.

- 1-Hz averages: original ranges at 1-Hz from SGDR, computed averages from ALES

- To derive sea level data, same corrections applied to all dataset
Spectral Analysis – Jason 2 example

From Smith et al., 2017 (This conference!)

Known tolerance on high-rate noise, „hidden“ by new SSB correction

ALES improves the description of 100-10 Km scales of variability
High-rate noise as consecutive differences

Example cycle 50 of Jason-2: 6% noise improvement at SWH=2.5, over 20% for extreme waves
Crossover Analysis - Methods

- Crossover: intersection of two tracks, assumes the same sea level for 'small' space-time differences

- Statistics: standard deviation of the crossover differences in space and time

- Max 5 km distance in space, Max 10 days difference, one measurement for each crossover location per cycle (median value if more than one point)

- Outliers are: Missing points & Crossover differences over 50 cm
Crossover analysis – in space

Jason-1

Standard Deviation of the Crossovers
RED: \text{std}(ALES) < \text{std}(SGDR)

Jason-2

ALES IMPROVEMENT IS NOT RESTRICTED TO THE COAST
Crossover analysis – in time

J1 Median improvement= 0.08 cm
4.5% Variance Reduction

J2 Median improvement= 0.13 cm
7.5% Variance Reduction

NOTE: 0.5 cm/sqrt(20)=0.11 cm!
Verified!
Outliers analysis – in space

Number of outliers SGDR-ALES

Jason-1

ALES-> + 3337 valid crossover points

Outliers are:
- Missing measurements at crossovers
- Crossover height differences >0.5 m

Jason-2

ALES-> + 1934 valid crossover points
Except for some data gaps, ALES 1Hz crossovers have systematically less outliers than SGDR.
Conclusions

Scientific question: can ALES be used with confidence as a global ocean retracker?

YES, it SHOULD, because it even IMPROVES the current standards.
Conclusions

- A global 1-Hz ALES multi-mission dataset is now available in [http://openadb.dgfi.tum.de/](http://openadb.dgfi.tum.de/)

- Compared to the current GDR products, ALES dataset has:
  1) A better representation of the spatial scales up to 10 km
  2) An improved precision
  3) 7% (4.5%) Variance reduction in Jason-2 (Jason-1)
  4) Less outliers

Next Steps towards higher precision

- Release of more missions and of high rate data with improved flagging
- New Sea State Bias MODEL for ALES
- Correction for correlated SWH/Epoch errors