Coastal sea level time series and trends from reprocessed Jason altimetry

The Climate Change Initiative Coastal Sea Level Team

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Objectives of the project:

➢ Produce, validate and deliver consistent sea level time series in several coastal regions worldwide

➢ Compute sea level trends as close as possible to the coast in order to answer the question: “Is sea level at the coast rising at the same rate as in the open ocean?”

➢ Does the answer depend on regions? Does it depend on the Bathymetry (presence or not of coastal shelves)?

➢ Does small-scale ocean dynamics impact sea level variations at the coast? If yes, how? What is its relation with the large-scale ocean circulation?

➢ What is the influence on natural modes of climate variability (e.g. ENSO/PDO, NAO, AMO, etc.) on interannual coastal sea level?

➢ Can we explain (in terms of climate & non-climate-related contributions) coastal sea level trends?

6 regions considered:

Western Europe, Mediterranean Sea, Western Africa, Southeast Asia, Australia, North Indian
1. Approach

➢ Use of ALES (Adaptative Leading Edge Subwaveform) retracking
  • developed by Passaro et al. 2014 (TUM)
  • + associated Sea State Bias (SSB) (Passaro et al., 2018)

➢ Use of X-TRACK processing system developed at LEGOS (CTOH; Birol et al., 2017)

➢ Missions reprocessed: Jason 1, Jason 2, Jason 3

➢ Resolution: 20 Hz along track (350 m)

➢ Period covered: June 2002 to May 2018: 16 years

➢ Selection of valid data between 0 and 20 km from the coast at numerous coastal sites

➢ Severe editing was performed in order to remove outliers (based on error, % of missing data, trend continuity between successive 20 Hz points, ...)

1. Approach
2. Content of the product

- The coastal sea level product will contain 429 portions of 20km-long tracks, crossing land at different locations across all regions in netCDF files.

Content of a file:

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>lat</td>
<td>Latitude of each 20 Hz point</td>
</tr>
<tr>
<td>lon</td>
<td>Longitude of each 20 Hz point</td>
</tr>
<tr>
<td>distance_to_coast</td>
<td>Distance to a reference point at the coast of each 20 Hz point</td>
</tr>
<tr>
<td>time</td>
<td>Time of measurements</td>
</tr>
<tr>
<td>sla</td>
<td>Monthly Sea Level Anomalies from X-TRACK/ALES 20 Hz</td>
</tr>
<tr>
<td>local_msl_trend</td>
<td>Sea level trends computed from the monthly SLA</td>
</tr>
<tr>
<td>local_msl_trend_error</td>
<td>Sea level trend errors</td>
</tr>
</tbody>
</table>
3. A few examples of the product (1/3)

**Mediterranean Sea**

*MEDSEA Track 146 - Site #02 - oriented northward*

- **Sea Level trends**
- **Trend (mm/year)**
- **Distance to coast (km)**
- **Point #1: 30.38°N 8.01°E**
  - Distance to coast: 0.91 km - 60%
  - Sea level trend: 0.5 mm / year
- **Point #2: 30.37°N 8.07°E**
  - Distance to coast: 0.91 km - 60%
  - Sea level trend: 0.5 mm / year

**West Africa**

*WAFFRICA Track 237 - Site #01 - oriented southward*

- **Sea Level trends**
- **Trend (mm/year)**
- **Distance to coast (km)**
- **Point #1: 5.06°N 1.64°W**
  - Distance to coast: 2.58 km - 96%
  - Sea level trend: 0.7 mm / year
- **Point #2: 5.06°N 1.64°W**
  - Distance to coast: 2.87 km - 97%
  - Sea level trend: 0.7 mm / year
3. A few examples (2/3)
3. A few examples (3/3)
4. Statistics of the product (1/3)

• Altimetry-based coastal sea level trends (mm/yr) 2002/2018

• Mean trend for all regions: 2.6 mm/yr (no GIA correction)
4. Statistics of the product (2/3)

• Distance to the coast of the first valid sea level trend data (km)

• Mean distance for all regions: 3.5 km
4. Statistics of the product (3/3)

- Trend differences between the first valid point near the coast (average over 2 km) and open ocean (14-16 km from coast)

- Mean difference for all regions: -0.40 mm/yr
Mean coastal trend (averaged over all regions) is 2.6 +/- 1.1 mm/yr
Lowest trends are seen in the Mediterranean Sea
Largest trends are observed in the north Indian Ocean and around Australia
On average, there is no difference between ascending and descending tracks
We note more valid data when track come from sea in the Mediterranean Sea and Northeast Atlantic

There are no significant trend differences between open ocean and the coast (closest valid point to coast) at most sites. *This is a totally unexpected result!*

The average distance to coast of the first valid point is ~3.5 km (all regions)
In the Mediterranean Sea and around Australia, we note a significant number of sites with distance of the first valid point within 2 km
Conclusion

• This monthly product will correspond to a validated and reliable sea level dataset at a large number of coastal sites

• It will allow to study long-term trends in sea level rise very close to the coast

• Reference article in preparation for publication in Nature Scientific Data

• This new coastal sea level dataset will be made freely available to users with the Nature Scientific Data publication
