A New ECV Release (v2.0) to Accurately Measure the Sea Level Change from the ESA Climate Change Initiative

I – The Sea Level Climate Change Initiative (SL_cci) project overview

Sea Level is a very sensitive index of climate change and variability. It has been selected as an Essential Climate Variables (ECV) by the European Space Agency (ESA) which has initiated the Climate Change Initiative (CCI) programme, launching 13 ECV projects. It aims at providing accurate long-term satellite-based products for climate applications. It provides a unique opportunity to dialogue and cooperate between Earth Observation and Climate Research communities. The first version of the Sea Level ECV has been produced in 2012 and a full reprocessing of the ECV is now available (Dec, 2016). This new version is described here as well as the differences with the previous release. The project has also focused on the improvement of the regional sea level estimation and the better characterisation of uncertainties.

II - The Sea Level ECV products

The SL_cci ECV v2.0 maps of the sea level are generated from 1993 to 2015. They are now available upon request at info-sealevel@esa-sealevel-cci.org. The Product User Guide and Specification Document can be found on the website project: www.sealevel-cci.org

Associated Climate Sea Level indicators are also available for users. They concern:
- The global Mean Sea Level (MSL) evolution and its trend (left figure)
- The map of regional MSL trends (right figure)
- The amplitude and phase of the annual cycle of the sea level (not shown)

III – Comparison of v2.0 versus v1.1

For the v2.0 ECV (1993-2015), many algorithms have been developed and tested for the numerous altimeters corrections. A formal validation protocol has been developed to select the standards that contribute to increase the ECV homogeneity and reduce the errors. The major evolutions compared with the previous release are described in the table below at the different climate scales and illustrations are provided.

### Climate Applications

<table>
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<tr>
<th>Climate Applications</th>
<th>Temporal Scales</th>
<th>Mean Squared Error</th>
<th>User Requirements</th>
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<tbody>
<tr>
<td>Global Mean Sea Level</td>
<td>Long-term evolution (10 years)</td>
<td>-0.3 mm/yr</td>
<td>0.03 mm/yr</td>
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<td></td>
<td>Inter annual signals (1-5 years)</td>
<td>2 mm over 1 year</td>
<td>0.5 mm over 1 year</td>
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<td></td>
<td>Periodic Signals (Annual: 60-day)</td>
<td>Annual: +1 mm</td>
<td>Not defined</td>
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<td></td>
<td></td>
<td>60-day: +5 mm</td>
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<tr>
<td></td>
<td>Long-term evolution (30-day averages)</td>
<td>3 mm/yr</td>
<td>1 mm/yr</td>
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<tr>
<td>Regional Mean Sea Level</td>
<td>Inter annual signals (1-5 years)</td>
<td>Not evaluated</td>
<td>Not defined</td>
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The use of the new GPD+ wet troposphere correction (Fernandes et al., 2015) significantly impacts the global MSL decadal signals (left figure) and the sea level mesoscale signals in coastal areas (right figure).

At inter annual scale, the 2008 global MSL jump (1 mm) previously observed in the v1.1 has been reduced (left figure).

The new POE-E, GFZ and GSF std15 orbit solutions (all using the same gravity field) used for the different missions improve the sea level estimation. It affects the regional v2.0 MSL trends compared to v1.1 (see figure).

The FES 2014 ocean tide model leads to a reduced variance of the sea level, in many coastal areas and at high latitudes (see figure).

IV – Quality assessment, Arctic and coastal sea level

Error Characterization of Sea Level ECV ECV

The sea level ECV products error budget has been determined at climate scales (see table) through the analysis of each source of error. The comparison with the user requirements (defined in the CCI project and the last GCOS report) allows us to define the level of altimetry errors at climate scale: null, low or strong.

The confidence interval of the regional MSL trends has been characterized (see figure).

The validation and user assessment of the SL_cci products have been performed through:
- Internal consistency checks and comparison with in-situ data.
- Comparison with ocean model assimilation experiments, by quantifying changes of the model performances.
- Sea level closure budget approach by comparison with the steric (Argo) and mass (GRACE) contributions (see figure) but also from the glaciers, ice sheets and inland water.

V – Contacts

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