Martin Horwath
and the SLBC_cci consortium
Introduction

Science questions
How well do we know and understand sea level change and its causes?

CCI projects related to sea level

“CCI questions”
How useful are CCI products to answer the above science question?
→ quality  → consistency  → uncertainty characterisation
Sea level budget closure: an Example

<table>
<thead>
<tr>
<th>Time [yr]</th>
<th>Mass contributions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Glaciers</td>
</tr>
<tr>
<td></td>
<td>Greenland</td>
</tr>
<tr>
<td></td>
<td>Antarctica</td>
</tr>
<tr>
<td></td>
<td>Land water</td>
</tr>
<tr>
<td></td>
<td>Water vapour</td>
</tr>
</tbody>
</table>

- **Global mean sea level change from altimetry (SL_cci)**
- **Sum of contributions**
- **Steric contribution**

**Mass contributions**
- Glaciers
- Greenland
- Antarctica
- Land water
- Water vapour

[SLBC_cci version 0 assessment]
Project objectives

- Investigate in a coherent way the closure of the sea level budget
- Thereby assess the quality of CCI products
- Study and analyze the regional variability of sea level and its steric and mass components. The Arctic Ocean is chosen as study region.
- Prepare the way to more comprehensive and more operational assessments of the global and regional sea level budget

2-year project  04/2017 – 03/2019

10 partners
ESA technical officer: Jérôme Benveniste
Project logic

- **Provision of individual components time series**
  - Global
  - Regional: Arctic Ocean

- **Assessment of Sea Level Budget Closure**
  - Global
  - Regional: Arctic Ocean

- **Existing CCI Products**
  - External Products

- **Science Requirements and Roadmap**

- **Publication and dissemination of results**

- **Conclusions for CCI and beyond**

- **Iteration**
Provision of individual components with uncertainties

- Satellite altimetry
- Argo & other in-situ sensors
- Sea surface temperature
- GRACE satellite gravimetry

\[ \Delta \text{sea level} \]

\[ \Delta \text{steric sea level} \]

\[ \Delta \text{ocean mass} \]

Anny Cazenave
Chris Merchant
Karina von Schuckmann
Martin Horwath
Provision of individual components with uncertainties

Open Global Glacier Model OGCM
- Glacier outlines, mass balance obs.

Mass balance (GRACE)

Δ glacier mass

Mass balance (altimetry)

Δ ice sheet mass

Global hydrol. model WGHM

Δ land water & snow

GRACE sat. gravimetry

Δ atmosph. water mass

Reanalysis data

Arctic Ocean regional budget components

Same sources as for global ocean

Ocean modeling

Ben Marzeion
- Frank Paul
- Rene Forsberg
- Anna Hogg, Andrew Shepherd
- Petra Döll
- Johnny Johannessen
- Ole Andersen
Budget closure assessment

Assessment of budget closure/mis-closure

• 1993 – 2015 (altimetry period)
• 2003 – 2015 ("golden period", with ARGO and GRACE)
• based on monthly datasets:
  long-term, inter-annual, and seasonal scales

• Total sea level budget
• Total ocean mass budget
• Regional budgets: North of 66°N

• Analyze mis-closure and its causes
• Consider missing contributions
• Re-assess uncertainties
Version 0 mass budget assessment

Based on v0 datasets (available at start of project, prior to improvements foreseen within the project)

**Trends 2003 – 2014 [mm / yr mean sea level]**

- Ocean mass from GRACE: \(1.4 \pm 0.35\)\(^{+}\)?
- Sum of assessed components: \(1.8 \pm 0.18\)

→ Budget closure for ocean mass trend (2003-2014) within uncertainties
Based on v0 datasets
(available at start of project, prior to improvements foreseen within the project)

**Trends 2003 – 2015 [mm / year mean sea level]**

- Sea level (altimetry) \( 3.36 \pm 0.15 \)
- Steric component \( 1.14 \pm 0.09 \)
- Ocean mass (GRACE) \( 1.5 \ldots 2.10 \pm 0.35\) +?
  *depending on GRACE time series used*

→ Budget closure for global mean sea level trend (2003-2015) within uncertainties *for some choices of GRACE Ocean mass change*
More work to do

Improve datasets on individual budget components and their uncertainty characterization

Improve consistency between datasets, e.g. use glacier model output as input to hydrological model

Methodology of budget closure assessment

• Consistent treatment of “trends”, “interannual”, “seasonal” components
• Consistence of uncertainty characterization
• Including error correlations

→ Great benefit from having the authors of the data products involved in the consortium

Example: Errors in Antarctic GIA (Glacial Isostatic Adjustment) correction affect
(a) GRACE-based ocean mass change,
(b) GRACE-based Antarctic ice mass contribution
(c) altimetry-based global mean sea level trend

Note: We may come up with higher uncertainties than previously published, even though our products are improved
Conclusions

Sea Level Budget Closure project: a cross-ECV scientific exploitation project with high impact on
  • Science
  • Assessment and improvement (consistence!) of CCI products

Promising results after one year of the 2-year project

Perspectives (beyond current project)
  • Inclusion of new ECVs (snow, water vapour, others?)
  • Extend regional assessments
  • More comprehensive and operational assessments

Input and feedback welcome