



sea level budget closure cci

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



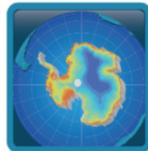
sea level
cci



sst
cci



ice sheets
greenland
cci



antarctic
ice sheet
cci

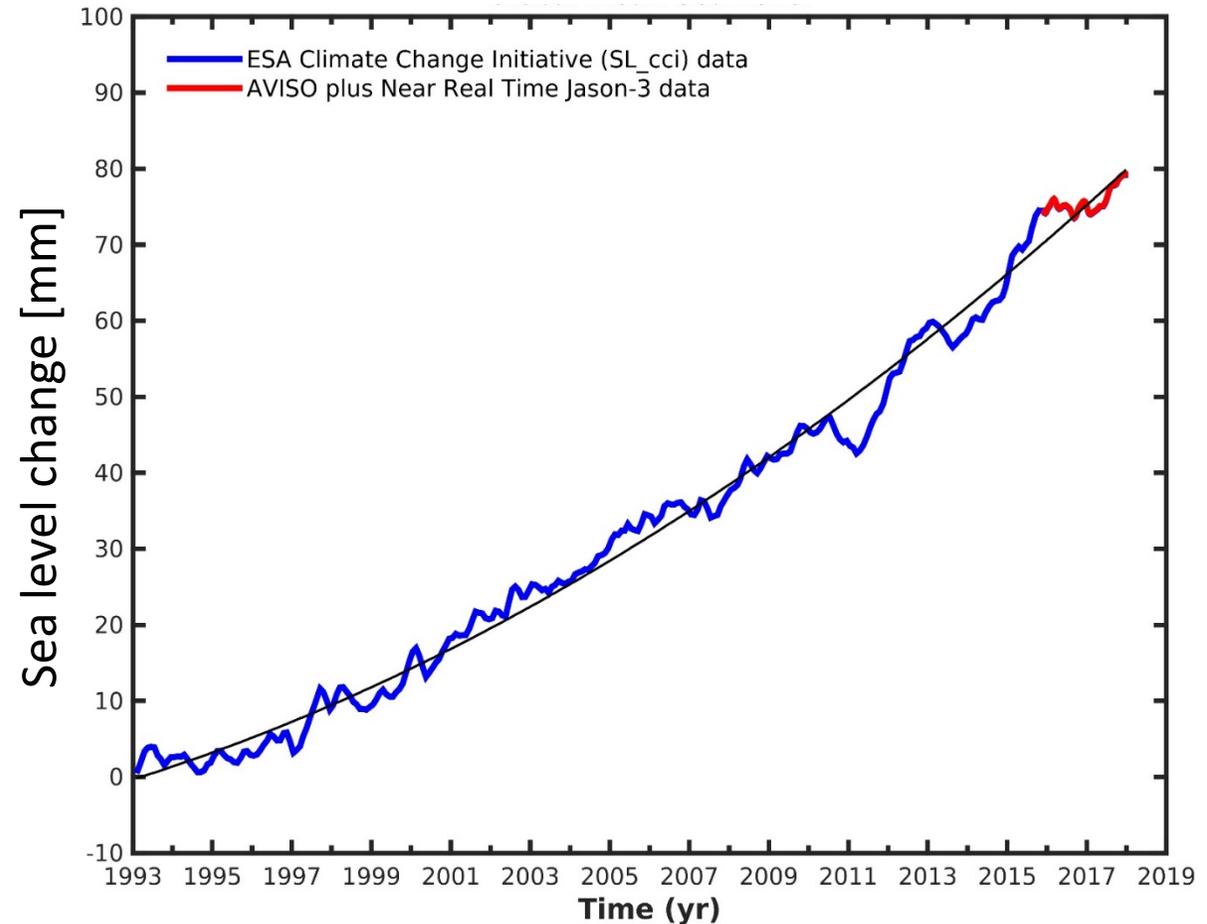


glaciers
cci

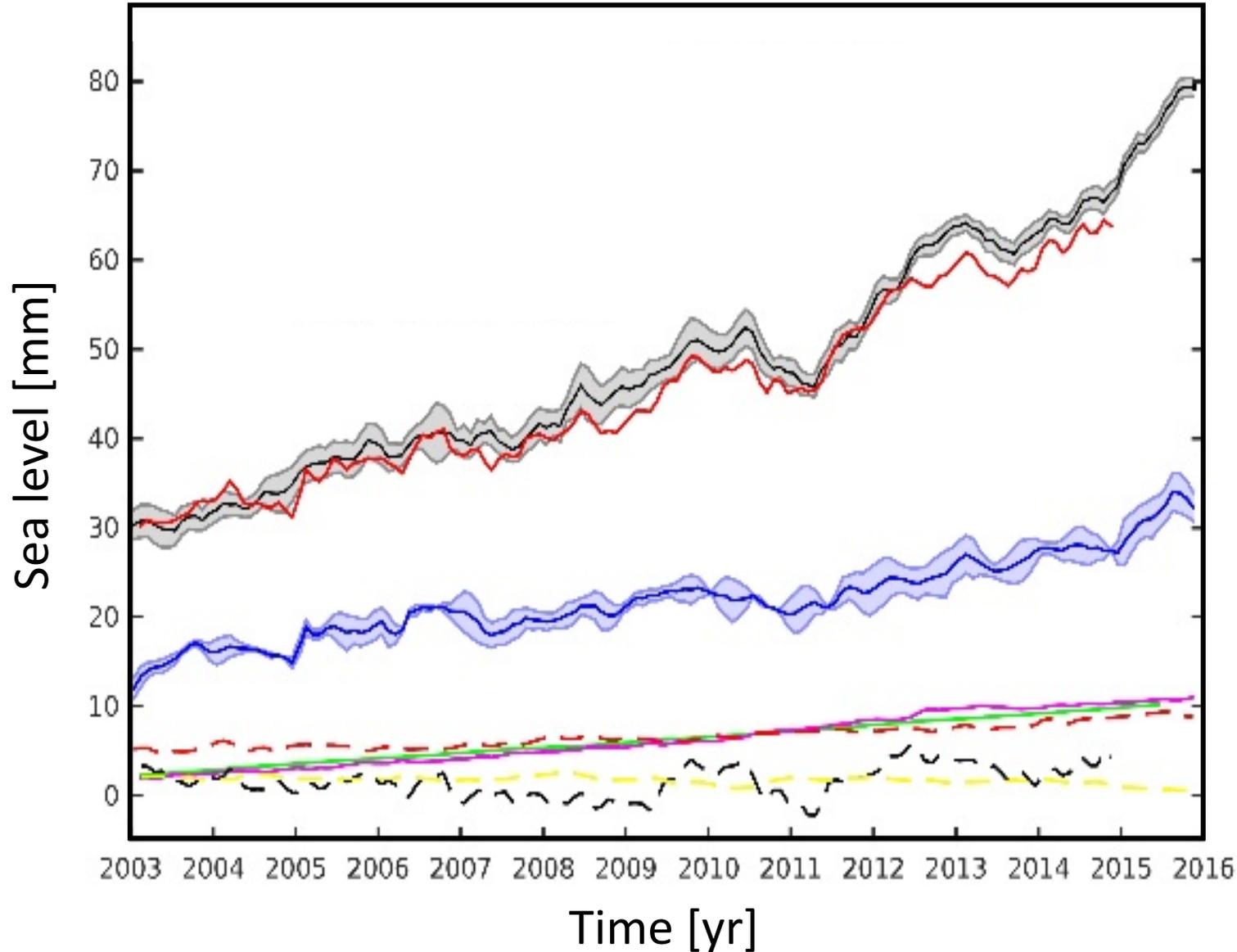
“CCI questions”

How useful are CCI products to answer the above science question?

→ quality → consistency → uncertainty
characterisation



Sea level budget closure: an Example



— Global mean sea level change from altimetry (SL_cci)

— Sum of contributions

— Steric contribution

Mass contributions

— Glaciers

— Greenland

— Land water

— Antarctica

— 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

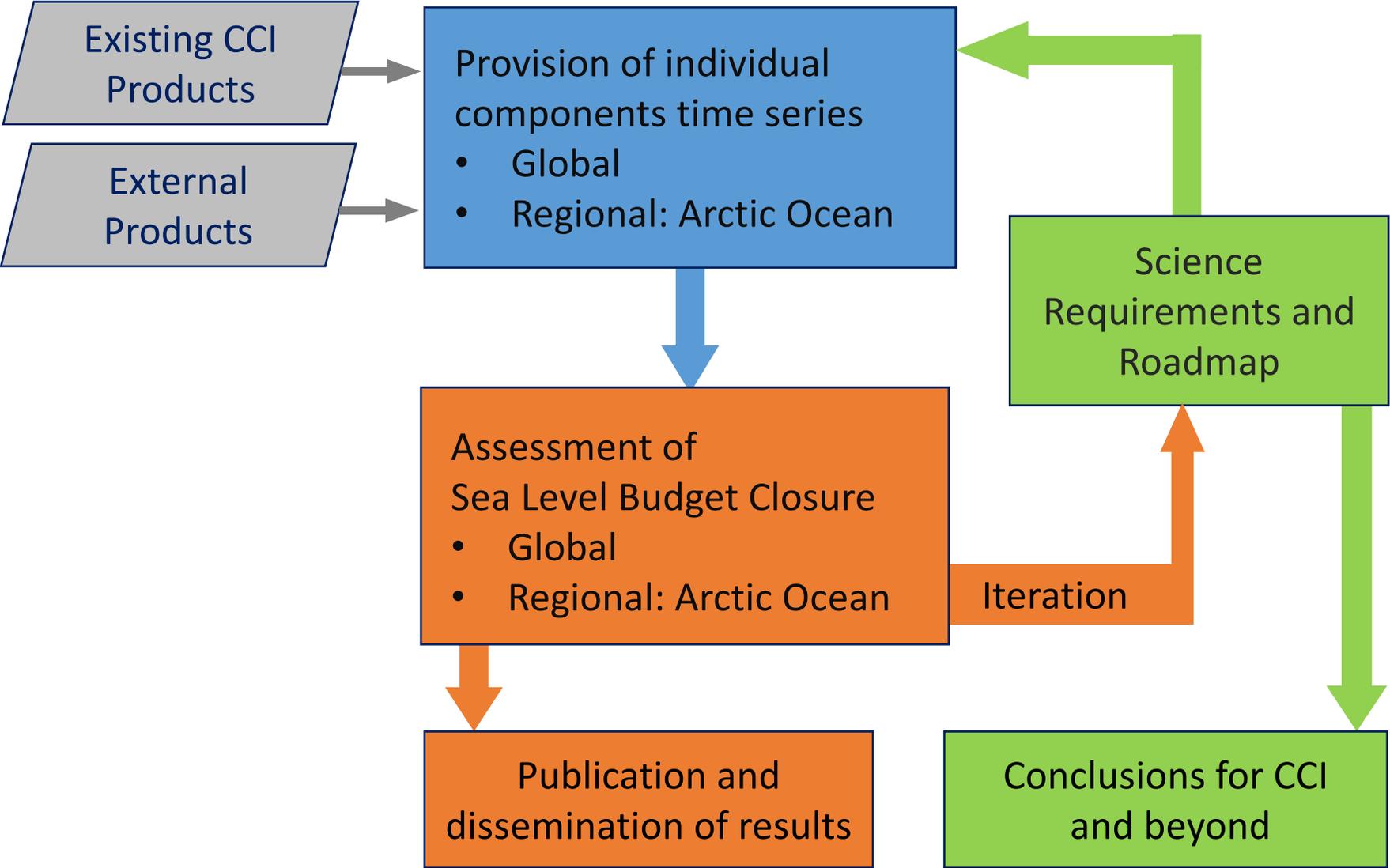
2-year project 04/2017 – 03/2019

10 partners

ESA technical officer: Jérôme Benveniste



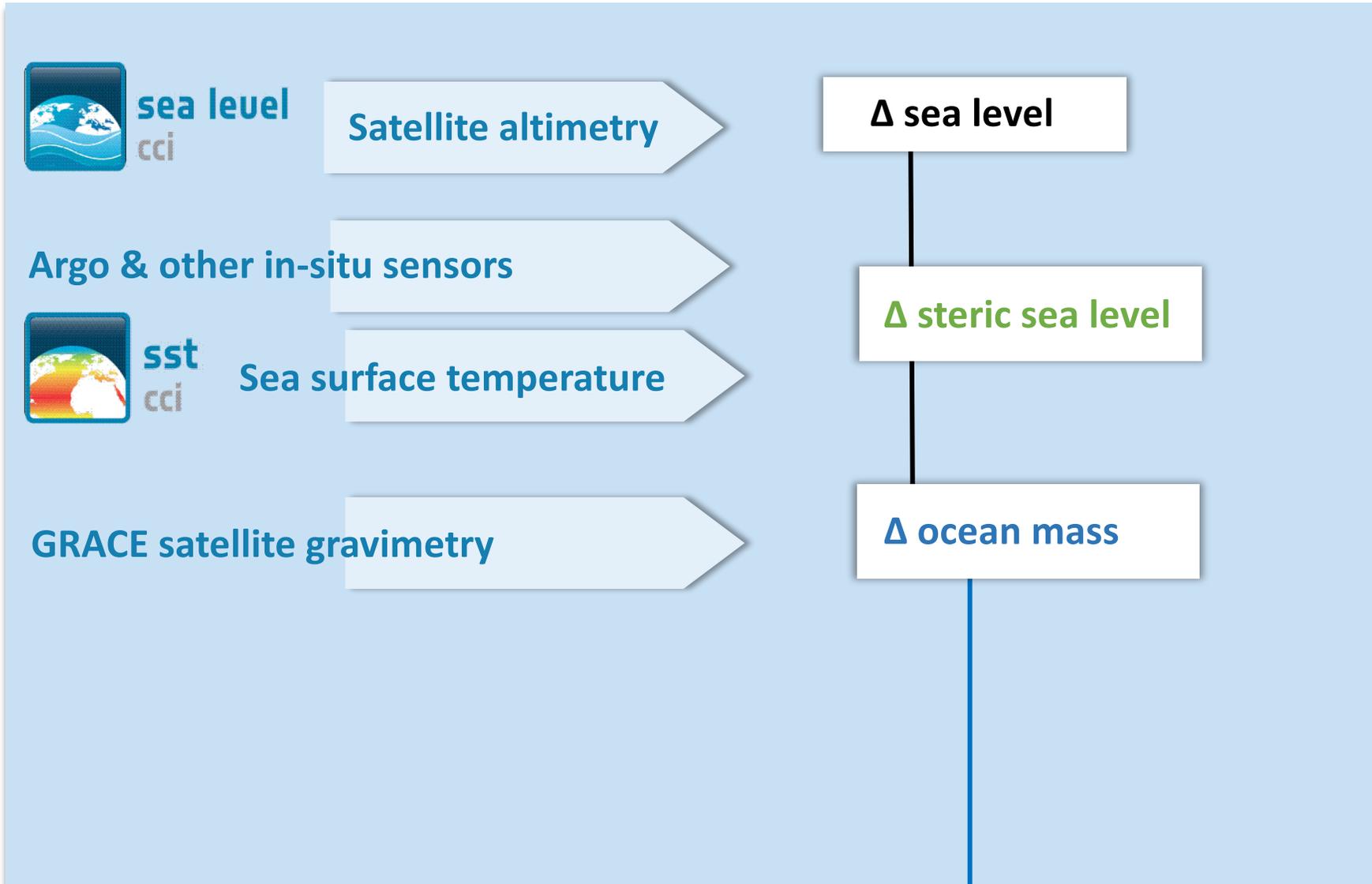
Project logic



Provision of individual components with uncertainties



sea level
budget closure
cci



Anny Cazenave



Chris Merchant



Karina
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Martin Horwath

Provision of individual components with uncertainties



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Open Global Glacier Model OGCM



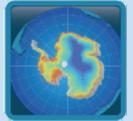
glaciers
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Glacier outlines,
mass balance obs.



ice sheets
greenland
cci

Mass balance (GRACE)



antarctic
ice sheet
cci

Mass balance (altimetry)

Global hydrol. model WGHM

GRACE sat. gravimetry

Reanalysis data

Same sources as for global ocean

Ocean modelin

Δ glacier mass

Δ ice sheet mass

Δ land water & snow

Δ atmosph. water mass

Arctic Ocean regional
budget components



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Frank Paul



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UNIVERSITY OF LEEDS

Anna Hogg,
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Petra Döll



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DTU

Ole Andersen

individual components with uncertainties

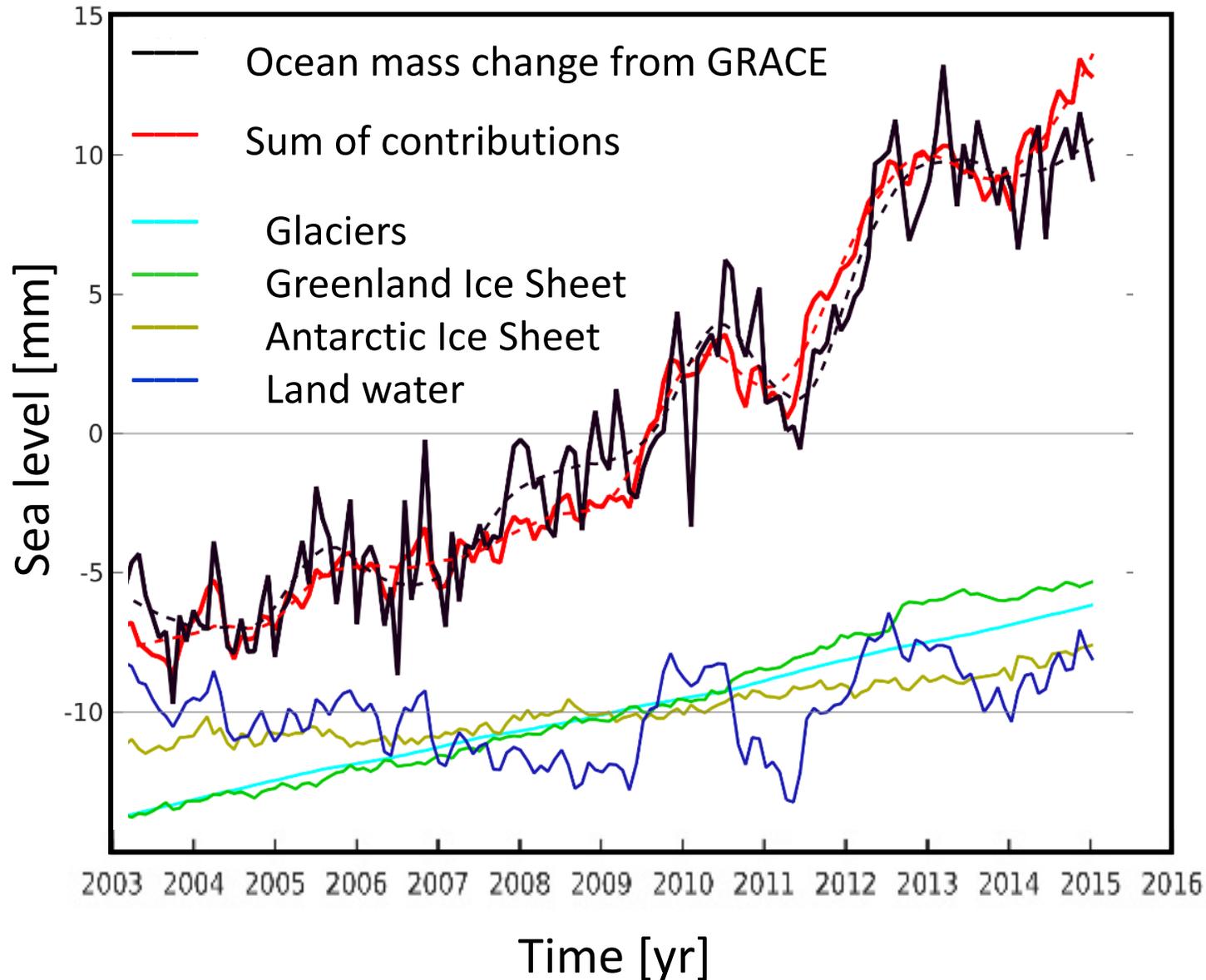
Iteration

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)

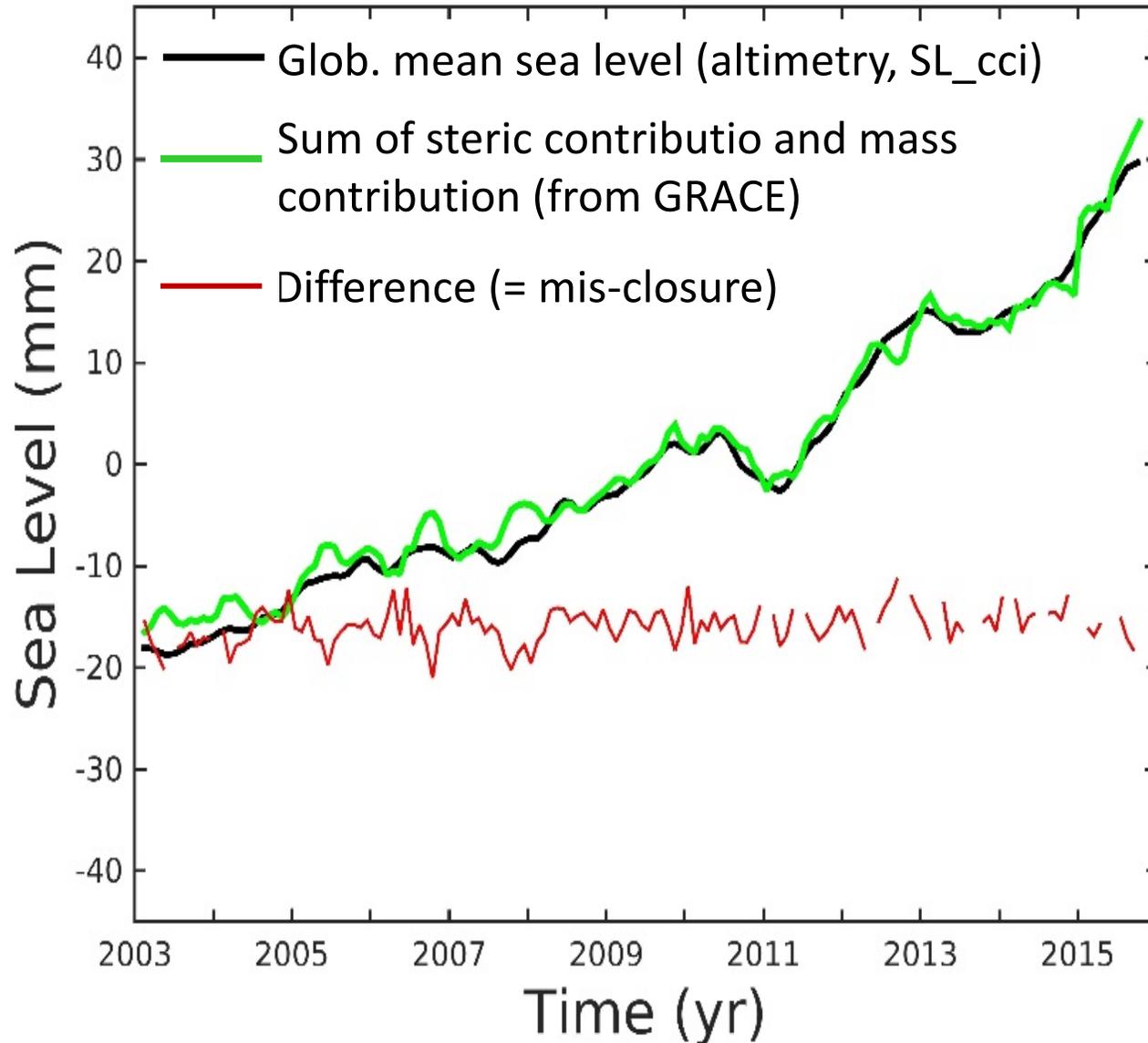
Trends 2003 – 2014 [mm / yr mean sea level]

ocean mass from GRACE $1.4...1.9 \pm 0.35+?$
depending on GRACE time series used

Sum of assessed components 1.8 ± 0.18

→ Budget closure for ocean mass trend
(2003-2014) within uncertainties

Version 0 global sea level budget assessment



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 ± 0.15**

Steric component **1.14 ± 0.09**

Ocean mass (GRACE) **$1.5 \dots 2.10 \pm 0.35+?$**
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*)

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



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