GlobalMass: a Bayesian modelling approach for closing the sea-level budget

Attributing global sea level rise to its component parts

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1. Introduction

- The GlobalMass project will – for the first time at a global scale – rigorously combine satellite and *in-situ* data related to different aspects of the sea level budget.
- It uses a Bayesian Hierarchical Model (BHM) framework to combine prior knowledge with observations to solve for sea level change on a global scale, and to attribute this change to its component parts.
- The overall aim of the project is to produce simultaneous, consistent and statistically-rigorous estimates of Glacial Isostatic Adjustment (GIA), land ice mass, land hydrology and sea level trends with global spatial coverage for a common epoch.
- This poster summarises progress to date and signposts where to go to find out more.

3a. BHM FRAMEWORK

- We are developing a Bayesian model-data synthesis method for global geophysical processes (the BHM framework)

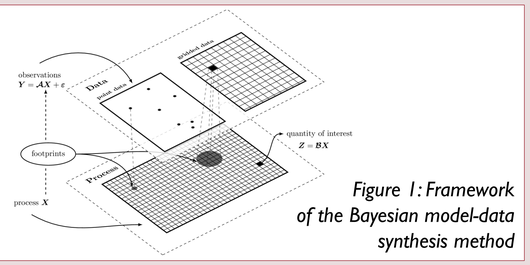

Figure 1: Framework of the Bayesian model-data synthesis method

- It reduces computational cost of massive scale Gaussian updates on a sphere through sparse approximation
- We have extended it to cover non-stationary processes
- Find out more: **www.globalmass.eu/statistical-framework**

Latest output

- Sha, Z. *et al.* (2018) Bayesian model-data synthesis with an application to global Glacio-Isostatic Adjustment, *accepted in Environmetrics*.

www.globalmass.eu/bayes-comp-2018-bayesian-model-data-synthesis-poster

3b. LAND ICE

- Common sources of uncertainty and bias exist between mass balance estimates from different approaches.
- We use a BHM framework to produce statistically-rigorous estimates of ice sheet mass balance and the contribution of component parts at the drainage basin scale.
- Annual mass trends for Antarctica have been updated from [1], and are now available for 2003-2015.
- Annual mass trends for Greenland for 2003-2015 are currently in development, though some preliminary results have been produced.
- Find out more: **www.globalmass.eu/land-ice**

Latest output

Chuter, S. *et al.* (2018) Annual Greenland mass trends from 2003-2015 from a Bayesian hierarchical modelling approach. Presentation at EGU General Assembly 2018, Vienna, 8-13 Apr 2018.

www.globalmass.eu/egu18-greenland-bhm-presentation

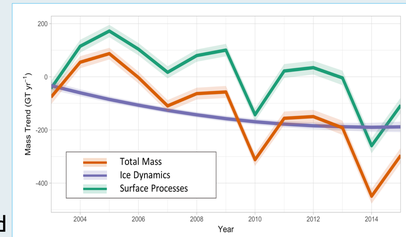

Figure 2: Annual Antarctic mass trends for 2003-2015, including component parts

Reference [1] Martin-Espanol, A. *et al.* (2016), Spatial and temporal Antarctic ice sheet mass trends, glacio-isostatic adjustment and surface processes from a joint inversion of satellite altimeter, gravity and GPS data, J. Geophys. Res., 121(2), 182-200. DOI: 10.1002/2015JF003550

2. Overview of BHM framework

Observation layer (direct observations from satellites and *in situ* data)

Process layer (latent geophysical processes that define the sea level budget)

CHANGE IN SEA LEVEL	=	Change in water temperature + Change in water salinity (OCEANS)	+	Change in land ice mass (LAND ICE)	+	Change in freshwater hydrology (HYDROLOGY)	+	Change in ocean floor (SOLID-EARTH)

Parameter layer (prior information/assumptions about geophysical processes)

3c. SOLID-EARTH

- Glacial isostatic adjustment (GIA) is a fundamental geophysical process that has important implications for the sea level budget.
- We have developed a fully-automatic approach to remove non-GIA artefacts from GPS data.
- Using this, we have created a dataset of 4,000 GPS stations to provide an observational estimate of GIA.

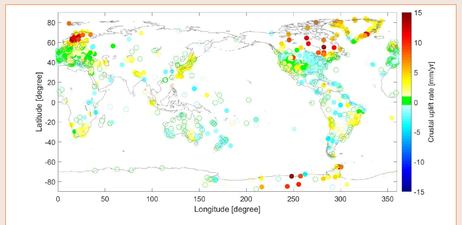

Figure 3: The 'clean' global GPS dataset for GIA

- We will next use this dataset to update global GIA forward model solutions within the BHM framework.
- Find out more: **www.globalmass.eu/solid-earth**

Latest output

- Schumacher, M. *et al.* (2018) A new global GPS dataset for testing and improving modelled GIA uplift rates, 214(3), 2164-2176, doi: 10.1093/gji/ggy235

https://academic.oup.com/gji/article/214/3/2164/5048688

3d. OCEANS

- As part of BHM framework development, we estimate steric sea level trends (due to temperature and salinity) for 2005-2015 on a global scale.
- Based on observations and prior knowledge about trends in sea surface height (SSH; from altimetry), GIA (from the ICE-6G forward model) and ocean mass (from GRACE), the residual SSH signal (i.e. altimetry minus mass) should reflect steric changes.
- We compare our solution with four established observational datasets to assess their performance, focusing on basin-scale trends and under-sampled ocean areas such as polar regions.
- Find out more: **www.globalmass.eu/oceans**

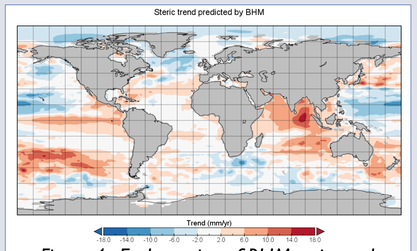

Figure 4: Early version of BHM-estimated steric sea level trend for 2005-2015

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Keep in touch

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