APPROACH

The GlobalMass project uses a novel statistical framework that allows us to combine prior knowledge on physical processes with observations, mostly from satellites.

The approach has previously been developed for Antarctica in the NERC-funded RATES project[1]. GlobalMass extends and expands this work to include more observations and prior information, to solve for sea level change on a global scale.

AIM AND OBJECTIVES

The overall aim of the project is to produce global, consistent and statistically-rigorous estimates of (i) glacial isostatic adjustment (GIA), (ii) land ice mass trends, (iii) land hydrology trends and (iv) sea level budget for a common epoch.

These estimates will be data-driven (not modelled) and consistent with each other and physical constraints (e.g. conservation of mass and salt). To this end, the key research objectives are to:

(1) Solve for GIA without the use of forward models that rely on assumptions about ice history;

(2) Solve for the mass trends of land ice;

(3) Solve for the global exchange of mass between land and ocean;

(4) Solve for the different components that contribute to changes in ocean density; and

(5) Develop and showcase a new approach to tackling signal processing in geostatistics.

THE PROJECT

GlobalMass is a 5-year ERC-funded project which aims to – for the first time at a global scale – rigorously combine satellite and *in-situ* data related to different aspects of the sea level budget, so that observed sea level rise can be attributed to its component parts.

Get in touch

Website: www.globalmass.eu

Email: globalmass-project@bristol.ac.uk

Follow us on Twitter: @GlobalMassTeam

GLOBAL MASS

University of BRISTOL

GlobalMass

Attributing global sea level rise to its component parts

European Research Council
Established by the European Commission
Supporting top researchers from anywhere in the world

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SOLID-EARTH

Glacial isostatic adjustment (GIA) is the long-term response of the solid-Earth to past ice loading, primarily since the last glacial period approximately 20,000 years ago. It has an important effect on contemporary sea level changes at a regional scale and is therefore crucial for predicting future sea level trends.

GlobalMass will provide a data-driven estimate of GIA that synthesises forward model solutions with global positioning system (GPS) station data and satellite gravity data from the Gravity Recovery And Climate Experiment (GRACE) satellite mission.

A major benefit of this solution is that it is independent of any assumptions about ice loading history or Earth structure; an inevitable, but highly uncertain, feature of numerical model simulations for GIA.

OCEANS

Once GIA has been estimated, it is used as an input to our statistical framework, meaning we will have observations for every term in the sea level budget:

Change in mean sea level	=	Change in water density	+	Change in water mass	+	Change in ocean floor

Our approach enables the partitioning of the 'ocean density' (steric) and 'ocean mass' (barystatic) components of sea level both in space and time. This will be most reliable from 2005 onwards, when direct observations are available from Argo buoys and GRACE data, respectively, as well as global mean sea level estimates from satellite altimetry and tide gauges.

It will also allow the identification of the processes underlying the sea level patterns, and separation of seasonal and inter-annual variability from longer-term trends.

LAND ICE

Conventionally the mass balance of glaciers, ice caps and ice sheets have been treated as separate problems, using different approaches and assumptions.

Since the early 1990s, three approaches have been adopted: (i) the Input-Output Method (IOM), (ii) volume change estimates (geodetic approach) and (iii) changes in the gravity field from GRACE data. All of these methods rely on numerical models to constrain unmeasured or unknown processes. Combining estimates in a statistically rigorous way is challenging because each has markedly different spatial and temporal resolutions and errors.

Our statistical framework simultaneously accounts for the differing spatio-temporal properties of the various datasets and physical processes, and thus provides a far more powerful and informative way of deriving ice mass trends[1].

HYDROLOGY

Although its contribution to global mean sea level may be small at the global scale, land hydrology can have a significant effect on sea level at a regional scale[2], though its exact magnitude remains uncertain.

A large-scale land hydrology signal has previously been estimated from GRACE alone[2], but our approach will provide increased resolution in space and time, and a better constraint on its magnitude.

References

[1] Martín-Español 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. Earth Surface* 121(2): 182-200.

[2] Riva et al. (2010), Sea-level fingerprint of continental water and ice mass change from GRACE. *Geophys. Res. Lett.* 37(19).