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# Greenland Monthly Mass Trends Determined Using a Bayesian Hierarchical Modelling Approach

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The Greenland Ice Sheet has been an increasingly large contributor to global mean sea level rise over the last two decades. Therefore, in order to provide closure to the global sea level budget, accurate quantification of this mass loss and its uncertainty is imperative. Robust and contemporaneous mass balance measurements are also important as initial conditions for future model projections.

The altimetry, gravimetry and mass budget techniques for determining ice sheet mass balance use disparate observations of varying spatio-temporal resolutions. Additionally, each of these techniques requires geophysical model output to resolve for unobserved processes, which may introduce hard to quantify uncertainty and biases into the results. These issues also make it challenging to combine multiple results from differing techniques in a statistically rigorous manner.

To address these challenges, we have developed a Bayesian Hierarchical Model (BHM) approach to determine the Greenland Ice Sheet mass trend at a monthly timestep between 2003-2015, including the contribution of each constituent driving process. The framework combines altimetry (ENVISAT, and CryoSat-2), GRACE and in-situ observations (GPS uplift rates) using statistical source separation to attribute the observations to their driving latent process. The solution is predominantly data-driven, as geophysical models are only used to aid source separation within the framework. This ability to combine disparate and discontinuous spatio-temporal observations is a key advantage over other existing techniques. This work provides complementary results to the Resolving Antarctic ice mass TrEndS (RATES) project, which used a similar approach to estimate mass trends for Antarctica.

This study is part of the wider GlobalMass (www.globalmass.eu) European Research Council five-year project, based at the University of Bristol.