

# **Integrating and Combining Ice Sheet Mass Balance Estimates through GRACE and ICESat datasets**

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A wide range of estimates has been made of current Antarctic and Greenland ice sheet mass balance using different methods. Large discrepancies in these estimates arise in part as a result of the various instruments and approaches used, each of which has its strengths and limitations.

The overarching objective of our project is to understand and quantify key differences among various ice sheet mass balance estimates, and use that information to improve ice sheet mass balance assessments now and in the future. Our primary focus will be on improving the analyses and interpretation of observations from the Gravity Recovery and Climate Experiment (GRACE) and the Ice Cloud and Land Elevation Satellite (ICESat) missions, which unlike most other approaches, together observe the total integrated effects of different mass balance components.

The first method of combining these datasets will reanalyze and combine ICESat  $dH/dt$  data with improved GRACE  $dM/dt$  solutions and Surface Mass Balance models into an integrated dataset, providing volume, mass and density changes into a single raster grid at greater spatial resolution than GRACE has traditionally provided, with better interpretation and spatial mapping of mass balance components than ICESat, GRACE, or other methods could ascertain alone.

The second method, Monte Carlo optimization, will eventually difference mass changes due to (i) surface mass balance and (ii) ice dynamics (inferred by correcting ICESat  $dH/dt$  observations for surface processes) at each downscaling node within from total mass change at the larger GRACE mass-con node. This approach acknowledges that a number of parameterizations are invoked in this process (i.e. retention fraction, firn density, etc.). Monte Carlo simulations are executed to vary parameters within their respective uncertainty ranges and explore the infinite combination of surface mass balance and ice dynamic changes at the downscaling nodes within a given GRACE mass-con node that can sum to the observed GRACE mass-con value. An optimal solution is selected by minimizing spatial gradients in all parameters. As a demonstration of the utility of Monte Carlo simulations in providing a robust treatment of numerous uncertain parameters, we execute the downscaling using only surface mass balance output. The methods will be compared for the observed accuracies and robustness of results, as well as cross-validated against each other as independent attempts at the combination of ICESat and GRACE datasets.

When properly exploited these assessments can provide a more robust estimate of ice sheet contributions to sea level rise than has been provided before, along with important new information on their likely (or unlikely) future behavior. They will also provide a baseline set of algorithms for combining datasets upon the launch of NASA's upcoming ICESat-2 (2016) and GRACE-II (20??) missions, invoking a keen opportunity for future data integration.