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Uncertainty Estimates of Forward Modeling over Ice-Covered Regions from GRACE

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Forward modeling can be used to localize GRACE's estimates of mass change and to decrease the leakage of local signals into neighboring territory. GRACE's large spatial smoothing and north-south stripe errors make the satellite data unable to properly localize such mass changes using ordinary techniques like basin averaging. This results in large smears of land/ice signal being leaked out into the ocean and onto unaffected land areas, as well as a poor understanding of the ice melt/gain patterns themselves. Forward modeling can reduce this affect by using a least squares estimate to project GRACE information onto a pre-determined collection of local basins, each with uniform density. This technique is especially valuable over Greenland, Antarctica, and continental glacier regions, where models of current-day mass change are poor.

This forward modeling technique has been used previously with GRACE data, but its uncertainty is not well understood. We demonstrate that the accuracy of the forward-modeled results is dependent on the choice of basins, both in the ice-covered region of interest and over the water and land regions surrounding it. We also compute the uncertainty that parameters such as the choice of GRACE solution series and smoothing radius add to the forward modeling procedure. We use in situ ice measurements in Greenland, as well as simple basin averages from non-forward-modeled GRACE, to verify the accuracy and estimate the uncertainty of forward modeling over ice-covered regions.