Assimilation of GRACE/GRACE-FO Terrestrial Water Storage Retrievals to Improve Snow Mass Estimates across North America

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ABSTRACT

Accurate estimation of snow mass, and its change in space and time, is necessary for the optimal management of freshwater resources, especially in regions of complex terrain. Assimilation of remotely-sensed observations into a land surface model (LSM) can help better characterize snow mass. Gravimetric observations collected by the Gravity Recovery and Climate Experiment (GRACE / GRACE-FO) are a useful complement to more traditional means of snow remote sensing (i.e., passive microwave radiometry) because, unlike radiometers, gravimetry does not suffer from signal saturation in the presence of deep and/or wet snow. However, gravimetry has its own limitations, primarily in the form of coarse spatial and temporal resolutions.

The Noah-MP land surface model without the benefit of assimilated observations (a.k.a., Open Loop; OL) is first investigated within the NASA Land Information System (LIS) to estimate hydrologic states and fluxes (including snow) across North America. GRACE-based retrievals of terrestrial water storage (TWS) are then assimilated into the Noah-MP model using an ensemble Kalman filter in order to dynamically update model-derived estimates of snow water equivalent (SWE) based on the TWS retrievals. To evaluate changes in modeled snow with and without assimilation, model results are validated against ground-based measurements of snow mass across North America obtained from the Canadian Snow Water Equivalent dataset (CanSWE), the United States SNOTEL network, and the European GlobSnow product. Preliminary results suggest improvement in terms of both snow amount and timing of snow accumulation and ablation in regions where snow is a significant contributor to the hydrologic cycle. Findings from this study will help water resources managers by providing useful information that ultimately leads to better characterization of snow in regions with limited ground-based stations and in places where snow is variable across time and space.

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