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Assessment of modeled surface mass balance estimates over the Greenland ice sheet using in-situ observations and remote sensing data

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Accurately representing the Surface Mass Balance (SMB) of the Greenland Ice Sheet (GrIS) is essential for gaining a better understanding about how the ice sheet will respond and is responding to recent and future temperature changes. Ground-based in-situ measurements are sparse, particularly away from the edges of the ice sheet. Regional Climate models, such as the Modele Atmospherique Regionale (MAR), can help improve estimates of the SMB limited by sparse observational data, but are subject to biases, limiting their accuracy. In order to advance our ability to map, quantify, and understand the GrIS SMB, we are engaged in developing a data assimilation framework, which integrates the results of climate modeling experiments, observational measurements, and remotely sensed data. This integrated approach allows for the development of optimal SMB estimates by incorporating multiple data sources, thereby reducing uncertainty.

In order to this aim, several intermediate steps are required. Our preliminary work utilizes remotely sensed measurements of albedo, grain size, and surface melt estimated by the Moderate Resolution Imaging Spectroradiometer (MODIS) and by spaceborne microwave radiometers (such as SSM/I or AMSR-E), in conjunction with in-situ measurements to validate estimates of these quantities provided by the MAR model. At a local scale, MAR estimates were compared to in-situ measurements from two snow pits that were dug at Summit, Greenland, during the summer of 2010. The local scale comparison reveals that MAR underestimates densities close to the snowpack surface. A further examination of parameterizations used in MAR, including an analysis of the evolution of snow/ice layers with time, will help characterizing model biases for the purpose of improving density and grain size estimates. Future work will also involve assimilating MODIS albedo estimates into the MAR model to improve MAR estimates. New estimates will then be compared with observed density and grain size profiles to validate the efficacy of the data assimilation scheme.