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Global assimilation of multi-sensor snow observations for improved characterization of snow processes

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Snow conditions on the land surface are recognized to be key components of the global hydrological cycle as they play a critical role in the determination of local and regional climate. In many mid-latitude and high-latitude regions, the seasonal water storage and associated spring snowmelt dominate the local hydrology. The contribution to the runoff and moisture conditions from snow is vital in supporting agriculture and in determining water resources management practices. Consequently, accurate characterization of snow properties becomes important for both end-use applications and weather and climate research. Recently a joint effort between the U.S. Air Force and NASA has enabled a blended, multi-sensor snow product known as the AFWA NASA Snow Algorithm (ANSA). This global snow dataset has been generated by utilizing the Earth Observation System (EOS) Moderate Resolution Imaging Spectroradiometer (MODIS) and Advanced Microwave Scanning Radiometer for EOS (AMSR-E) datasets. ANSA product includes estimates of snow cover extent, snow water equivalent (SWE) and SWE-derived snow depth fields. The MODIS-based products enable snow cover mappings under cloud-free conditions whereas the passive microwave data from AMSR-E provides measurements under cloudy conditions. These remotely-sensed snow observations are further augmented with the information from ground-based snow measurements through data fusion techniques. The resulting ANSA products are employed in the NASA Land Information System (LIS) data assimilation framework, which provides a comprehensive environment for integrating community land surface models, ground and satellite-based observations, and ensemble-based data assimilation tools. LIS incorporates the multi-sensor ANSA snow retrievals with the land surface model estimates to generate spatially and temporally continuous estimates of snow states, through data assimilation. A suite of experiments to assimilate ANSA snow cover, SWE and snow depth estimates with different land surface models in LIS are conducted and the resulting estimates of snow conditions are evaluated against a number of in-situ observational datasets, over several regions of the world. These evaluations are used to compare and contrast the advantages and disadvantages of these multi-sensor snow observations.