Quantify the MODIS Fractional Snow Cover Retrieval Errors over CONUS and Assimilation Experiments

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As both model predictions and remotely-sensed estimates are characterized by different uncertainties at different times and locations, the most accurate snow pack status estimate results from the assimilation of remotely-sensed estimates into a land surface model, with correct observation and model error specifications. Understanding and quantifying satellite-based remotely sensed snow cover uncertainty are critical for its successful utilization. The Moderate Resolution Imaging Spectroradiometer (MODIS) snow cover errors have been previously recognized to be associated with factors such as cloud contamination, snowpack grain sizes, vegetation cover, and topography, however, the quantitative relationship between the retrieval errors and these factors remains elusive. Joint analysis of the MODIS fractional snow cover (FSC) from Collection-6 (C6) and in-situ air temperature and snow water equivalent (SWE) measurements provides a unique look at the error structure of the MODIS C6 FSC products. Analysis of the MODIS FSC data set over the period from 2000 to 2005 was undertaken over the Continental US (CONUS) with an extensive observational network. When compared to MODIS Collection-5 (C5) snow cover area (SCA), the MODIS C6 product demonstrates a large improvement in detecting the presence of snow cover, especially in the early and late snow seasons. However, significant spatial and temporal variations in accuracy still exist, and a proxy is required to adequately predict the expected errors in MODIS C6 FSC retrievals. We demonstrate a relationship between the MODIS FSC retrieval errors and temperature over the CONUS domain, captured by a cumulative double exponential distribution function. The quantitative nonlinear relationship between MODIS FSC and model air temperature will enable users to more efficiently assimilate MODIS snow cover information into various hydrological applications, and the performance of the error quantitative prediction will be evaluated through assimilation experiments.