

Statistical evaluation of remotely sensed snow-cover products with constraints from streamflow and SNOTEL measurements

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Abstract

Using streamflow and Snowpack Telemetry (SNOTEL) measurements as constraints, the evaluation of the Moderate Resolution Imaging Spectroradiometer (MODIS) daily and 8-day snow-cover products is carried out using the Upper Rio Grande River Basin as a test site. A time series of the snow areal extent (SAE) of the Upper Rio Grande Basin is retrieved from the MODIS tile h09v05 covering the time period from February 2000 to June 2004 using an automatic Geographic Information System (GIS)-based algorithm developed for this study. Statistical analysis between the streamflow at Otowi (NM) station and the SAE retrieved from the two MODIS snow-cover products shows that there is a statistically significant correlation between the streamflow and SAE for both products. This relationship can be disturbed by heavy rainstorms in the later springtime, especially in May. Correlation analyses show that the MODIS 8-day product has a better correlation ($r=0.404$) with streamflow and has less percentage of spurious snowmelt events in wintertime than the MODIS daily product ($r=0.300$). Intercomparison of these two products, with the SNOTEL data sets as the ground truth, shows that (1) the MODIS 8-day product has higher classification accuracy for both snow and land; (2) the omission error of misclassifying snow as land is similar for both products, both are low; (3) the MODIS 8-day product has a slightly higher commission error of misclassifying land as snow than the MODIS daily product; and (4) the MODIS daily product has higher omission errors of misclassifying both snow and land as clouds. Clouds are the major cause for reduction of the overall accuracy of the MODIS daily product. Improvement in suppressing clouds in the 8-day product is obvious from this comparison study. The sacrifice is the temporal resolution that is reduced from 1 to 8 days. The significance of the results is that the 8-day product will be more useful in evaluating the streamflow response to the snow-cover extent changes, especially from the long-term point of view considering its lower temporal resolution than the daily product. For clear days, the MODIS daily algorithm works quite well or even better than the MODIS 8-day algorithm.

Keywords: Streamflow; SNOTEL; Moderate Resolution Imaging Spectroradiometer; Remote sensing; Snow cover; Geographic Information System

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