

A HMRF-based spatio-temporal modeling technique for improving MODIS snow products

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In many mountainous or high-latitude regions in the world, seasonal snow cover and its melt play an important role in regional hydrological circulation and climate variability. MODIS snow cover products at 500 m spatial resolution have been widely used for regional hydrological modelling. However, the snow product accuracy is significantly lower for forested areas and topographically complex regions and for the time periods when snow cover is thin and ephemeral. In addition, data gaps in snow products due to frequent clouds remain a serious problem, particularly for daily products. This research presents a spatio-temporal modeling technique for improving daily MODIS snow products, based on time series of Terra/Aqua MODIS images. The spatio-temporal modeling technique integrates MODIS spectral information, spatial and temporal contextual information, and environmental association in an optimal manner within a Hidden Markov Random Field (HMRF) framework. The performance of our new technique is quantitatively evaluated in comparison with ground in situ observations at 33 SNOTEL stations as well as to original MODIS snow cover products over the Upper Rio Grande Basin during 2006-2008 snow seasons. Since our new technique takes the spatio-temporal continuity and environmental association into accounts, we are able to reduced cloud-cover related data gaps to < 1%. Our evaluation shows that our HMRF approach is capable of improving snow cover for both Version 5 and Version 6 MODIS snow products. The snow mapping accuracies were significantly improved over whole snow transition periods and over evergreen forests and mixed forests.