Remote sensing of snow in China

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Abstract

For climatological, hydrological, and snow hazard investigations, the areas covered by snow and snow water equivalence are important parameters. MODIS sub-pixel snow cover algorithm applies the traditional methods based on the binary concept – a pixel is either classified as snow or non-snow. Large error is expected when using moderate to coarse resolution imagery to map snow covered areas at a regional scale. One of the objectives of this study is to develop an automatic snow mapping algorithm at sub-pixel resolution for MODIS. We improved the inversion of sub-pixel snow cover based on MESMA (Multiple Endmember Spectral Analysis) by selecting optimal endmembers. Although the original MESMA has a clear physical meaning and high precision, it is difficult to calculate efficiently at large area .Therefore, in order to calculate automatically snow fraction from MODIS, it is necessary to improve the method of unsupervised endmember selection to enhance the computational efficiency of MESMA. The new improved estimation of MODIS subpixel snow cover based on MESMA improved the accuracy, in contrast to MODIS/NASA standard snow cover product.

Secondly, a new semi-empirical snow depth algorithm has been developed under AMSR-E and FY3/MWRI by incorporating land cover fraction, based on 7-year (2002–2009) observations of brightness temperature by AMSR-E and snow depth from Chinese meteorological stations. When its land cover fraction is larger than 85%, we regard a pixel as pure at the satellite passive microwave remote-sensing scale. A 1-km resolution land use/land cover (LULC) map from the Data Center for Resources and Environmental Sciences, Chinese Academy of Sciences, is used to determine fractions of four main land cover types (grass, farmland, bare soil, and forest). Land cover sensitivity snow depth retrieval algorithms are initially developed using AMSR-E brightness temperature data. Each grid-cell snow depth was estimated as the sum of snow depths from each land cover algorithm weighted by percentages of land cover types within each grid cell. Through evaluation of this algorithm using station measurements from 2006, the root mean square error (RMSE) of snow depth retrieval is about 5.6 cm. In forest regions, snow depth is underestimated relative to ground observation, because stem volume and canopy closure are ignored in current algorithms. In addition, comparison between snow cover derived from AMSR-E and FY3B-MWRI with Moderate-resolution Imaging Spectroradiometer (MODIS) snow cover products (MYD10C1) in January 2010 showed that algorithm accuracy in snow cover monitoring can reach 84%.

Additionally, a physically-based inversion technique is developed to estimate snow water equivalence (SWE) under AMSR-E in this work. The ground surface emission signals at 18.7 GHz and 36.5 GHz were highly correlated regardless of the ground surface properties (dielectric and roughness properties) through numerical simulations by AIEM. This provides a new technique that separates snowpack and ground surface emission signals. With the parameterized snow emission model from a simulated database that was derived using a multi-scattering microwave emission model (DMRT-AIEM-MD) over dry snow covers, we developed an algorithm to estimate SWE using the microwave radiometer measurements. Evaluations on this technique using both the model simulated data and the field experimental data with the airborne Polarimetric Scanning Radiometer (PSR) data from NASA Cold Land Processes Experiment 2003 (CLPX03) showed the promising results, with the root mean square error of 32.8mm and 31.85mm, respectively. This newly developed inversion method has the advantages over the AMSR-E SWE baseline algorithm when applied to high

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resolution airborne observations.