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OPTIMIZATION OF FRACTIONAL SNOW COVER ALGORITHMS FOR OPTICAL REMOTE SENSING

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The future snow applications of satellite data to a great degree depend on using the Visible Infrared Radiometer Suite (VIIRS) onboard the Suomi National Polar-orbiting Partnership (SNPP) platform. Because of an original scanning and aggregation scheme, VIIRS observations providing the spectral coverage from 412 nm to 12 μm are characterized by a pixel growth factor of only two both along a track and along a scan giving the opportunity of getting snow distribution globally at 800 m resolution and 375 m at nadir.

The sub-grid variability of snow calls for knowing the fractional snow cover. The hypothesis that snow fraction can be determined by assuming that observed reflectance spectra are linear combinations of the spectra of a small set of scene components (spectral endmembers) has been supported by numerous studies. However, the variability in spectral signatures of the endmembers often is not taken into account and observed changes in pixel reflectances are completely ascribed to variable fractions of endmembers. As a result, the performance of various algorithms is influenced to a very great degree by the choice of endmembers for the scenes included in consideration.

Significant sub-scene heterogeneity can contaminate snow fraction derivation. To increase the accuracy of the algorithm, we assume variation of the endmembers on a pixel-by-pixel basis, which accounts for variation in surface types both for snow and non-snow endmembers.

Our study includes analysis of the following approaches under completely comparable conditions using the same pure snow and non-snow endmembers predetermined for each individual scene:

Tie-point algorithm for a visible band calculating snow fraction by linear Interpolation between band endmember reflectances.

The Normalized Difference Snow Index (NDSI) method based on the concept that the index expresses the range in the spectral differences between the non-snow covered background and complete snow cover.

Spectral Unmixing estimating snow cover fraction by the linear mixture model with least mixing mean-square-root error.

The quality of snow fraction product is evaluated through a quantitative comparison of the VIIRS snow retrieval with high resolution Landsat data in the vicinity of a snow line separating snow covered areas from snow free regions. The validation results demonstrate that on the whole the performance of the algorithms using NDSI has advantages.

The optimal approach to improve moderate resolution remote sensing information on fractional snow cover includes (a) nonlinear dependence of snow fraction on NDSI explained by the nonlinear dependence of NDSI on reflectances; (b) the means of geometric optics describing bidirectional reflectance distribution function (BRDF) by a simple asymptotic analytical model; (c) allowing for the variability of snow and non-snow reflective properties within a scene-specific snow algorithm.