The Influence of Observation Geometry on the Quality of VIIRS Snow Products

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Introduction

The first Visible/Infrared Imager Radiometer Suite (VIIRS) onboard S-NPP platform was launched in October 2011. Along with a large number of other land surface, ocean, atmosphere and cryosphere products, VIIRS observations are used to routinely map and monitor the global distribution of snow cover.

Routine generation of the snow cover product with NPP VIIRS data started in January 2012. Daily snow cover maps are produced operationally at the finest spatial resolution of 375 m. In this poster, the results of the analysis of the VIIRS snow cover product are presented and the performance of the algorithm is estimated. The algorithm performance is evaluated through a qualitative visual comparison of the derived maps with false color imagery data as well as through quantitative comparison at a pixel resolution.

VIIRS Instrument, Snow Algorithm and Product

VIIRS is a 22-channel scanning radiometer which provides observations in the wavelength range from the visible to infrared. The nominal spatial resolution is 375 m for imagery resolution spectral bands and 750 m for moderate resolution spectral bands (see Table on the right).

Snow algorithm:
- Very similar to the one of MODIS
  - Bands used: I1, I2, I3 and I5
  - Threshold-based, decision tree technique
  - Spectral features used: NDVI, NDSI, I2, I5
  - External cloud mask is applied

Snow Product accuracy requirement:
90% probability of correct typing

VIIRS binary snow map product is provided and validated as 5-min granules in the natural swath projection (along track / scan) at VIIRS binary snow map product is provided and validated as 5-min (see Table on the right). About 500 daytime granules per day are generated.

Qualitative estimate of VIIRS Snow Map Binary Product

Near snow line

Within snow-covered areas

Fractional Snow Diminishes Omission Errors and Enhances Information

Analytical Asymptotic Description of Radiative Transfer in Snow

Approach to Quantitative Estimate of VIIRS Snow Product

Proper validation is a critically important means to improve snow cover retrieval. The careful detailed validation of VIIRS snow data on the basis of comparison with the ground truth for a variety of conditions provides valuable information on the reasons of retrieval errors and helps identify the directions to improve the snow products.

The geometry of VIIRS observations is included in the stratified analysis of the VIIRS snow algorithm performance. As a first approximation, the illumination and viewing geometry of observation are parameterized by latitude and a scan angle.

Influence of Solar Zenith Angle and Surface Type

The probability of omission errors as a function of the solar zenith angle. In many cases, increased percentage of missing snow is observed in the regions of the boreal forest. Missing snow (red and yellow) is not necessarily related to clouds.

Influence of Scan Angles on Omission Errors

The probability of omission errors as a function of a scan angle for probably cloudy (thick), probably clear (medium) and confidently clear (thin) conditions. The influence of the scan angle on omission errors is better revealed for confidently clear areas having weaker dependence on cloudiness and surface type. In typical cases, the probability of omission errors rises significantly toward the ends of scans.

Fractional Snow Diminishes Omission Errors and Enhances Information

Analytical Asymptotic Description of Radiative Transfer in Snow

It has been demonstrated that the means of geometric optics could describe angular dependencies related to bidirectional snow reflectance, and a simple asymptotic analytical model could be used to calculate theoretically bidirectional reflectance.

Summary

Current VIIRS snow maps provide generally realistic characterization of the global snow extent on a daily basis. Problems are mostly associated with snow mixes in dense forests and near edges of scans. False snow identifications are suppressed to a large degree after recent modifications of the VIIRS cloud mask. A number of enhancements to the algorithm is foreseen to improve the accuracy of snow retrievals. Enhancements concern additional filtration of clouds that look similar to snow, implementation of observations geometry-dependent threshold values for use in snow identification tests.

The optimal approach to improve moderate resolution remote sensing information on snow cover will combine allowing for the variability of snow and non-snow properties with snow fraction retrieval within a scene-specific snow algorithm to create unbiased and consistent information on snow cover distribution required for global studies, regional and local scale hydrological applications.