Enterprise Snow Cover Algorithm Migration

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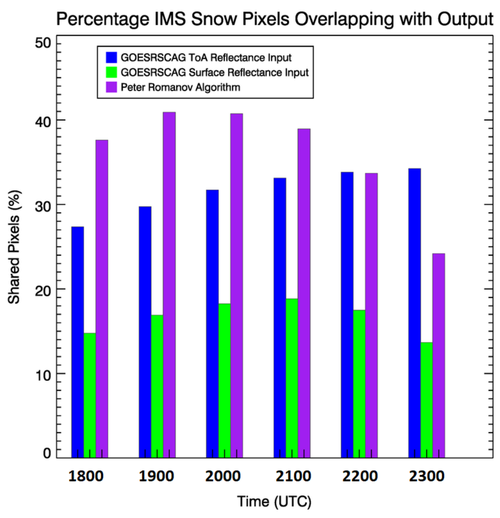
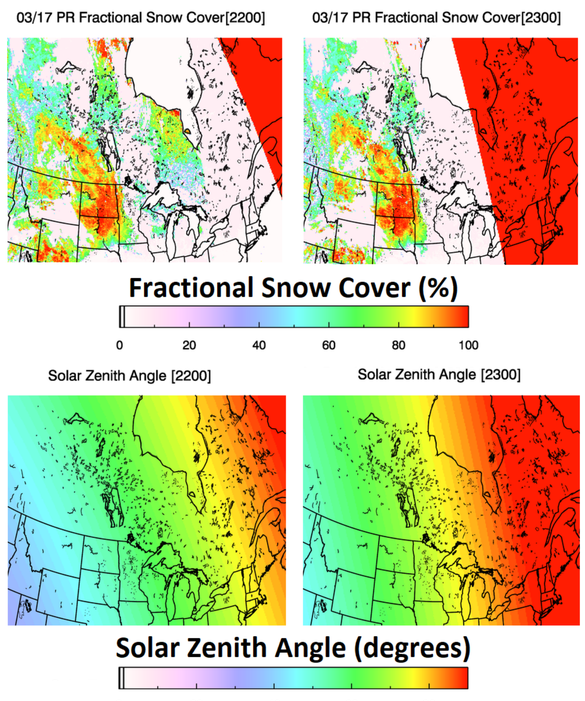
Here we test, implement, and document the best **fractional snow cover (FSC) algorithm** for the **Advanced Baseline Imager (ABI)**. The current algorithm is called "GOES-R Snow Cover and Grain Size (GOESRSCAG)", which employs an optimized spectral unmixing analysis using 3 visible and 2 near-infrared bands. The operational snow fraction algorithm for the **Visible Infrared Imaging Radiometer Suite (VIIRS)**, which uses multiple bands for snow identification and a single reflectance band for snow fraction, is also being tested. Here we present some validation case studies with GOES-16 using the National Ice Center **Interactive Multisensor Snow and Ice Mapping System (IMS)** and **Landsat Normalized Difference Snow Index (NDSI)** as references.

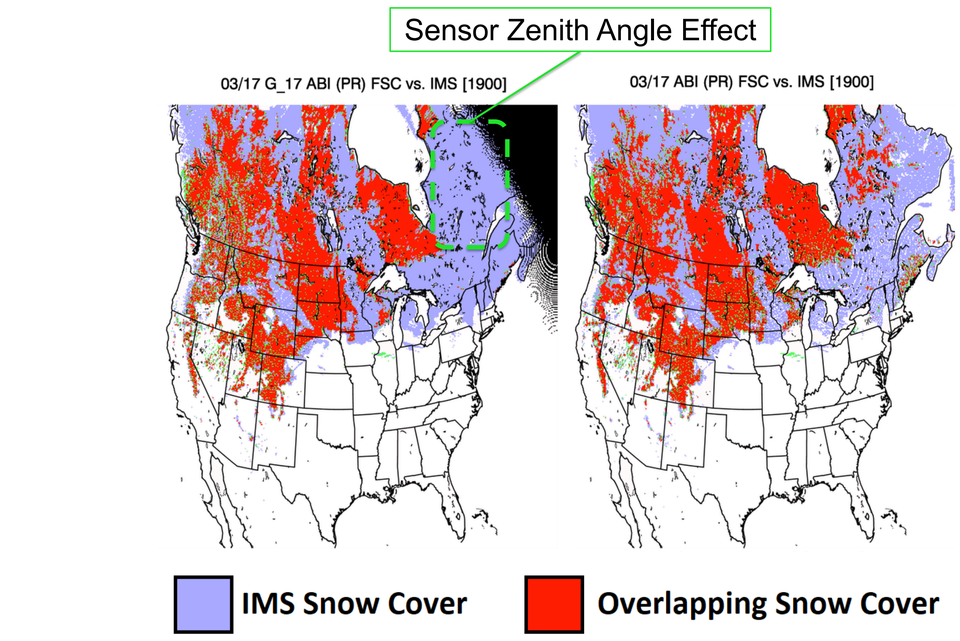
Solar & Sensor Zenith Angle Dependencies

High sensor/solar zenith angles present can make accurate snow detection more difficult for both the VIIRS and GOESRSCAG algorithms. Below (left) is a bar plot showing the percentage of IMS pixels labelled as "snow" that were collocated with snow cover pixels from output using the VIIRS or the GOESRSCAG algorithms for six hours during March 17, 2019. The 4-panel figure (right) shows the observable snow cover south of Hudson Bay change abruptly as the solar zenith angle increases from 70º to 80º between 22:00 and 23:00 UTC.

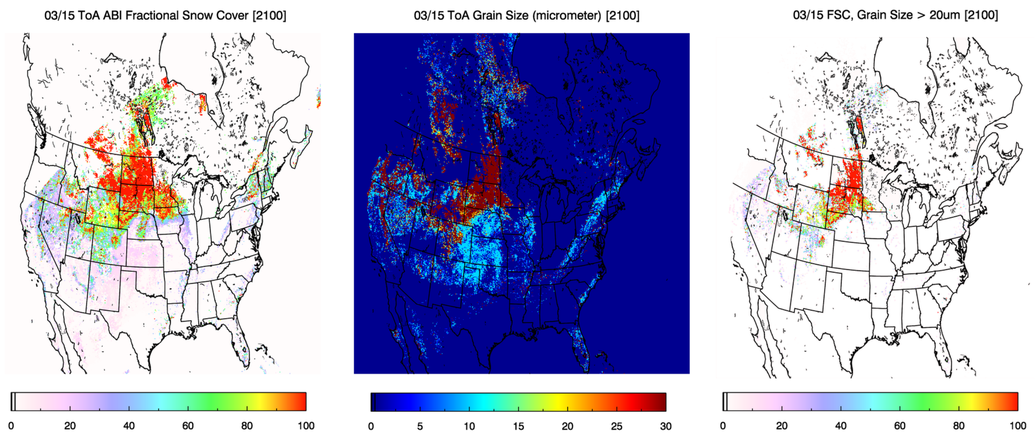




Shown below is a comparison of snow coverage from IMS and the VIIRS algorithm (labeled "PR" for its author) using GOES-17 (left) and GOES-16 (right) data for March 17 at 19:00 UTC. "Overlapping" means that both IMS and the VIIRS algorithm agree on the presence of snow. Snow pixels east of Hudson Bay from GOES-West are not detected due to the high sensor zenith angle near the edge of the disk, but are detected from GOES-East due to the lower sensor zenith angle.

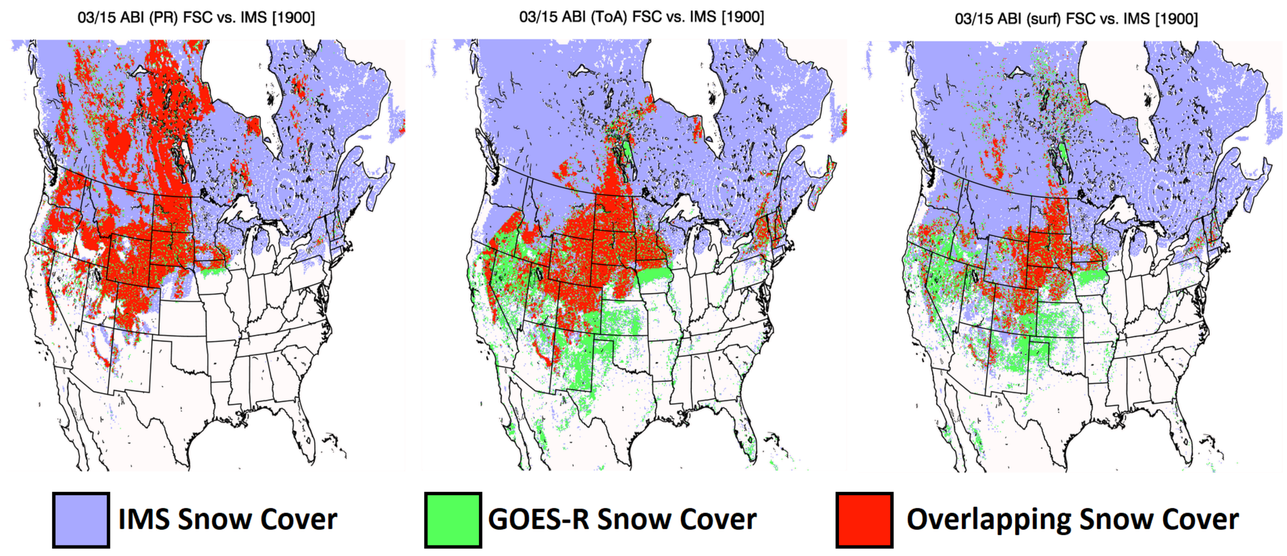


GOESRSCAG Screened by Snow Grain Size



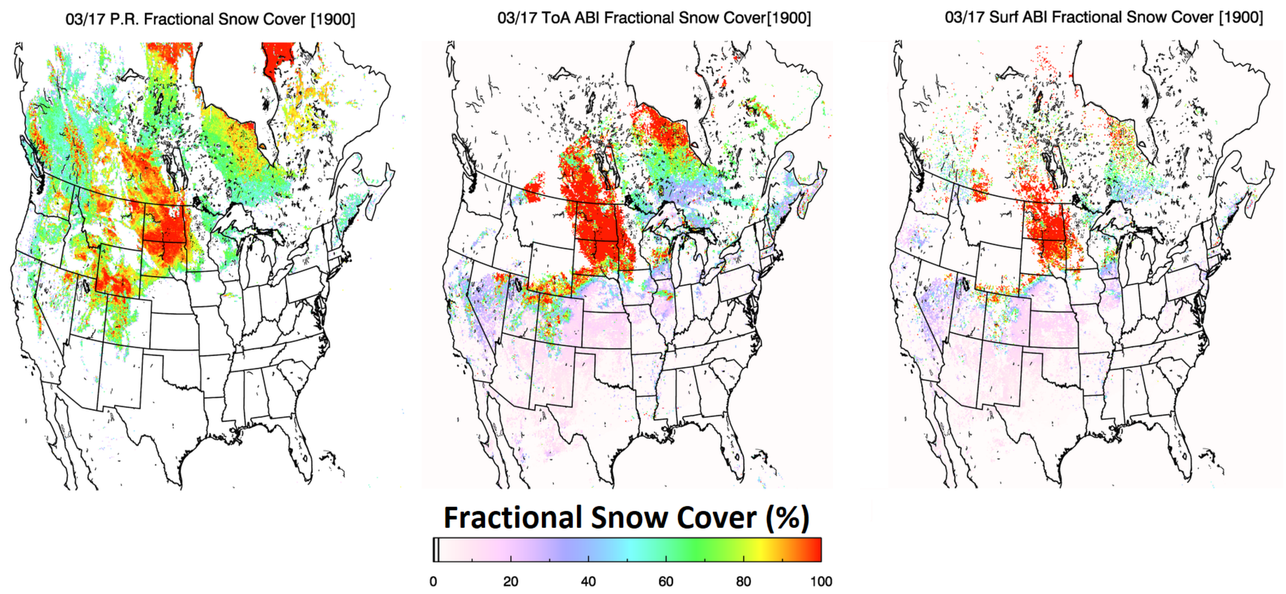
Filtering the operational product to ignore snow fraction where snow grain size is < 20μm removes much of the falsely-assigned snow in the southern United States. Above is the unfiltered FSC (left), snow grain size (center) and filtered FSC (right) on March 17, 2019.

GOES-16 Snow Cover Vs. IMS



Shown above are the results of comparing the snow-covered pixels from IMS with output from (left) the VIIRS algorithm ("PR"), (center) GOESRSCAG algorithm using TOA reflectances as input, and (right) GOESRSCAG algorithm using surface reflectances as input for March 15 at 19:00 UTC. "Overlapping" means that both IMS and the VIIRS algorithm agree on the presence of snow.

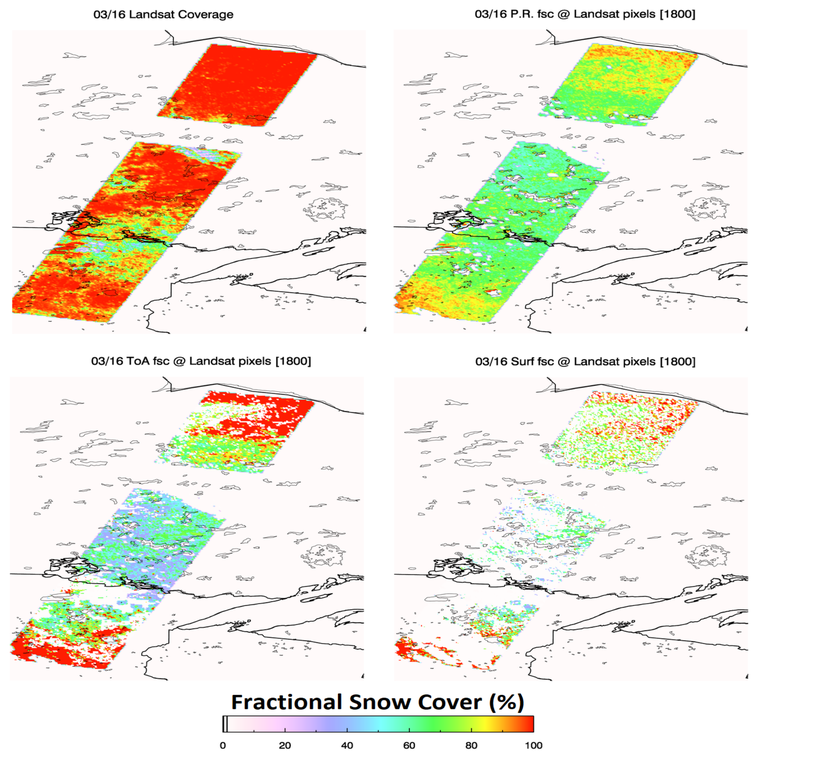
GOES-16 Snow Cover Fraction Differences



Fractional snow cover results from (left) the VIIRS algorithm ("P.R."), (center) GOESRSCAG algorithm using TOA reflectances as input, and (right) GOESRSCAG algorithm using surface reflectances as input for March 17 at 19:00 UTC.

Landsat Comparison and Validation

In many cases, snow cover from the VIIRS algorithm is more continuous than from the operational algorithm**.** Fractional snow cover shown here from Landsat NDSI (top left), the VIIRS algorithm (top right), GOESRSCAG algorithm using TOA reflectances as input (bottom left), and GOESRSCAG algorithm using surface reflectances as input (bottom right) for March 17 at 18:00 UTC. Landsat snow fraction data may have a positive bias due to the NDSI threshold used (0.55).



Conclusions and Future Work

GOES-16 snow cover from the VIIRS algorithm shows excellent agreement (where not cloudy) with IMS and Landsat.

GOESRSCAG snow cover is spatially inconsistent and occurs too far south unless snow grain size is used to filter the fractional snow cover.

Snow cover fraction output from the VIIRS algorithm is more continuous than GOESRSCAG snow cover output and has less intra-day variance.

Sun/sensor viewing geometry has some effect on snow cover identification in cases where solar/sensor zenith angle > 75º.

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