



VIIRS Binary Snow Cover and an Alternative Algorithm for Snow Fraction

Peter Romanov, CREST/CUNY @ NOAA/STAR
Igor Appel, IMSG @ NOAA/STAR

14 May 2014





Outline



- Overview of VIIRS Snow Cover products
- Binary Snow Map
 - Examples, Accuracy, Existing problems
- Fractional Snow Cover
 - Current algorithm
 - Planned improvements & modifications



VIIRS Snow Cover Product



- Binary snow map:
 - Snow/no snow discrimination
 - Imagery (375m) resolution (better than MODIS @ 0.5 km)
- Snow fraction:
 - Fraction of snow cover in a horizontal cell
- Both snow products are critically dependent on the accuracy of the VIIRS cloud mask which is an upstream product.

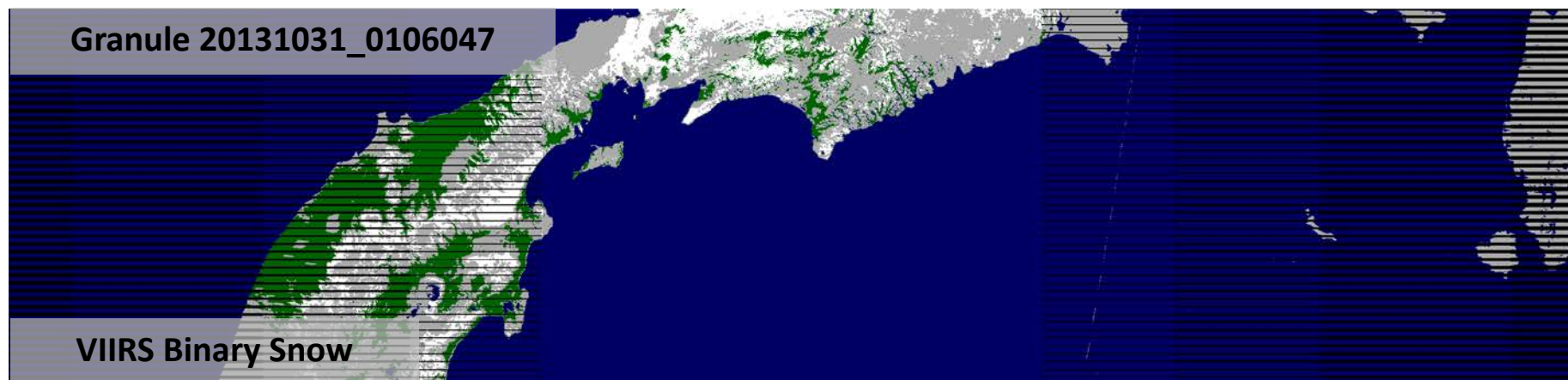
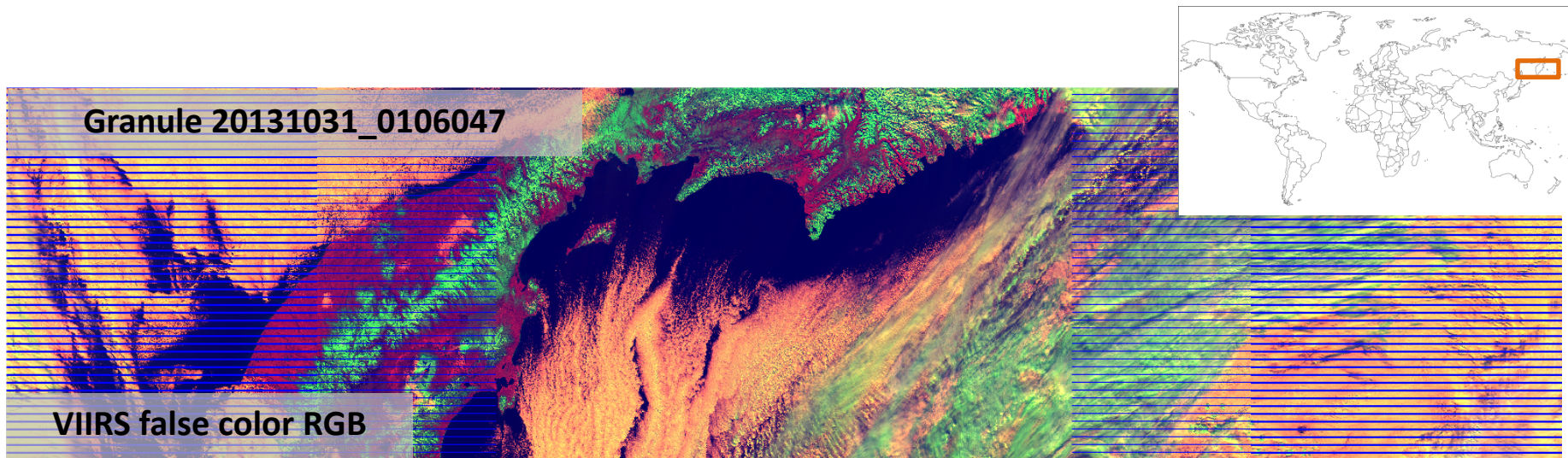


Binary Snow Cover Algorithm



- Similar to MODIS SnowMap algorithm (Hall et.al 2001)
- Decision-tree threshold-based classification approach
- Uses Normalized Difference Snow Index (NDSI), reflectance, thermal and NDVI thresholds
- Applied to clear sky pixels, requires daylight

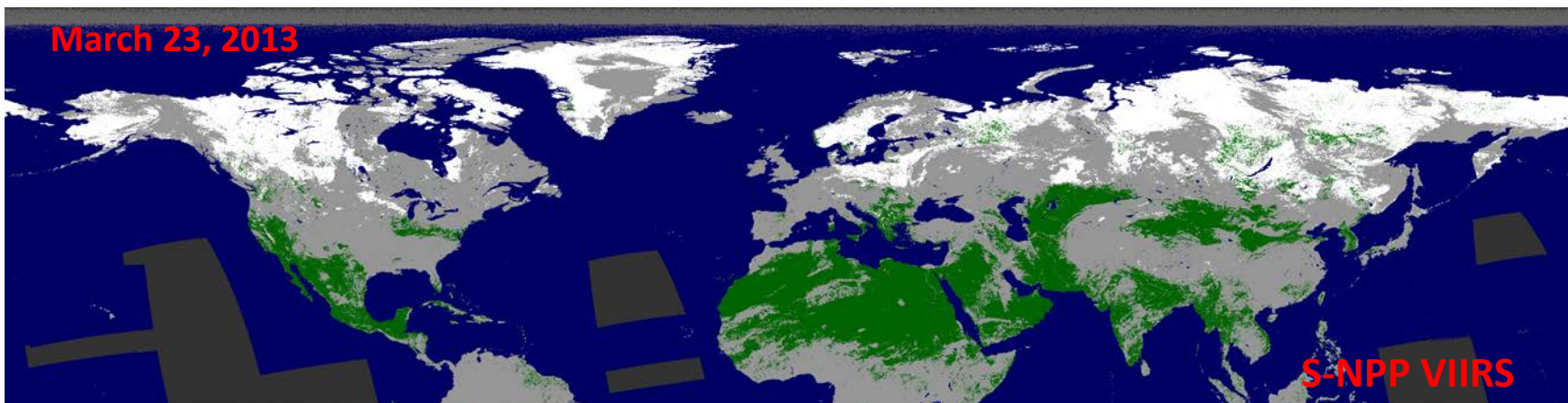
VIIRS Binary Snow Map at Granule Level



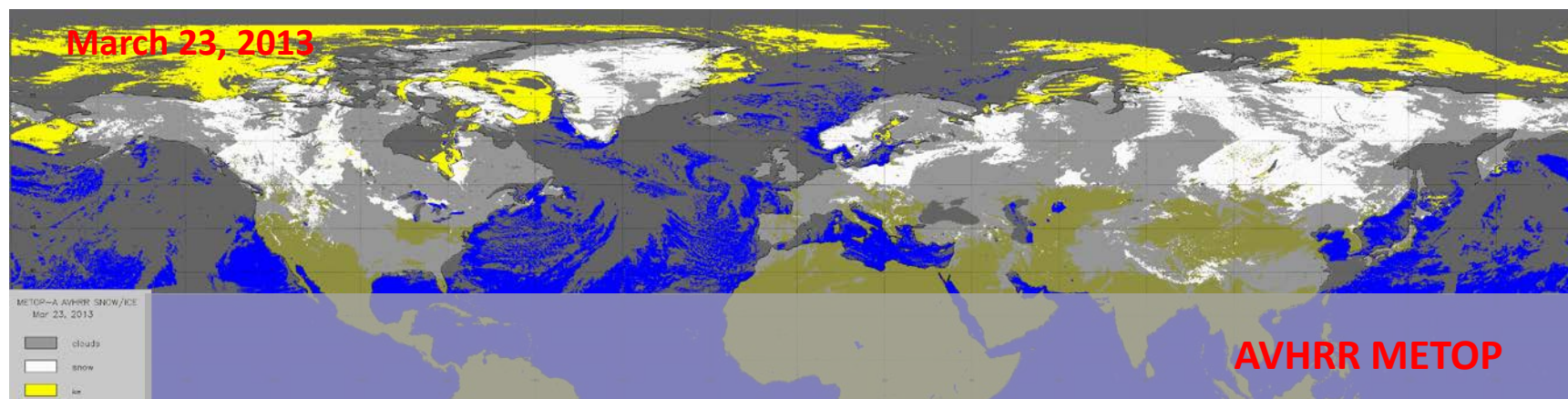
□ snow ■ land ■ cloud ■ No data

Good qualitative agreement between the snow cover seen in VIIRS false color images and mapped in the VIIRS binary snow cover product

VIIRS vs AVHRR Snow Map

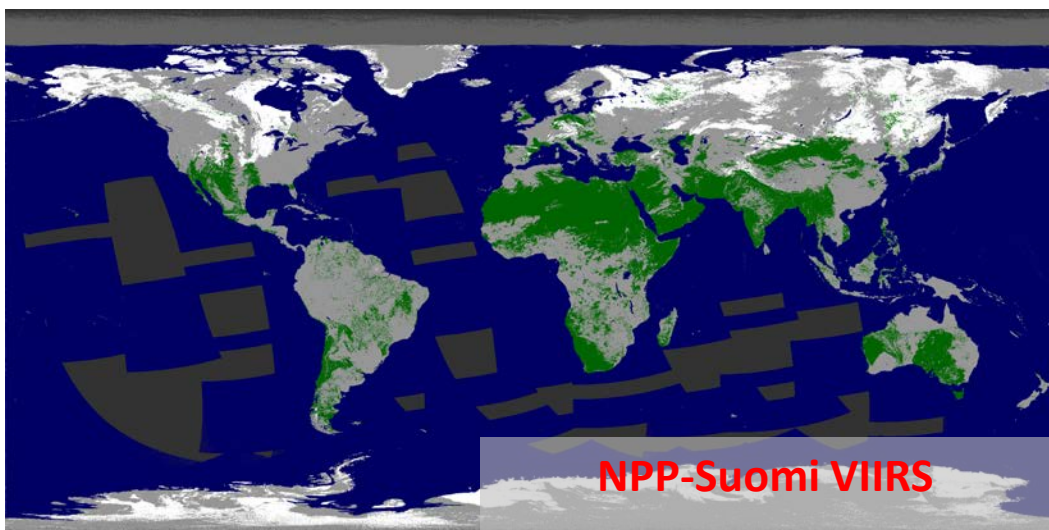


 Snow  Land  Cloud  No data



VIIRS Binary Snow Map agrees well to other similar satellite products (AVHRR, MODIS)

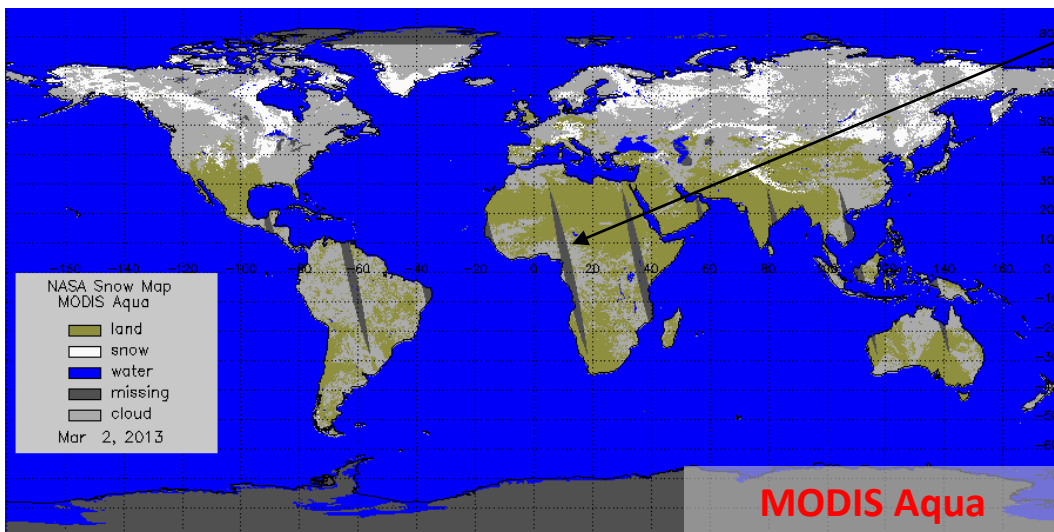
VIIRS vs MODIS Snow Map



NPP-Suomi VIIRS



VIIRS daily global snow map has no gaps between adjacent swaths inherent to the MODIS global daily snow product.

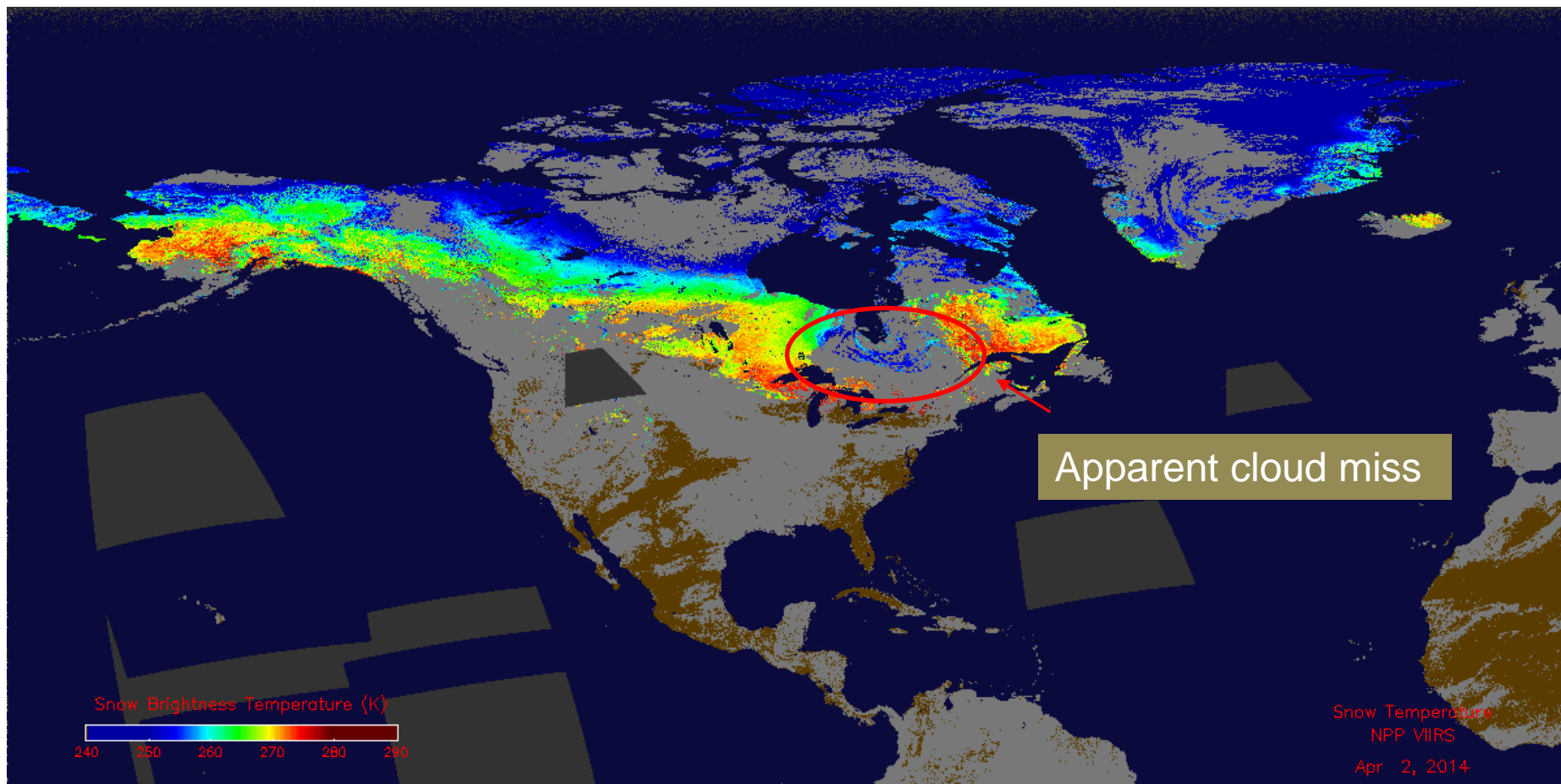


MODIS Aqua

**March 2, 2013
(day 2013061)**



VIIRS Temperature of Snow-Covered Land



Maps of snow-covered land temperature reveal areas of snow melt and may also be used to identify cloud masking problems.



Accuracy Assessment Approach

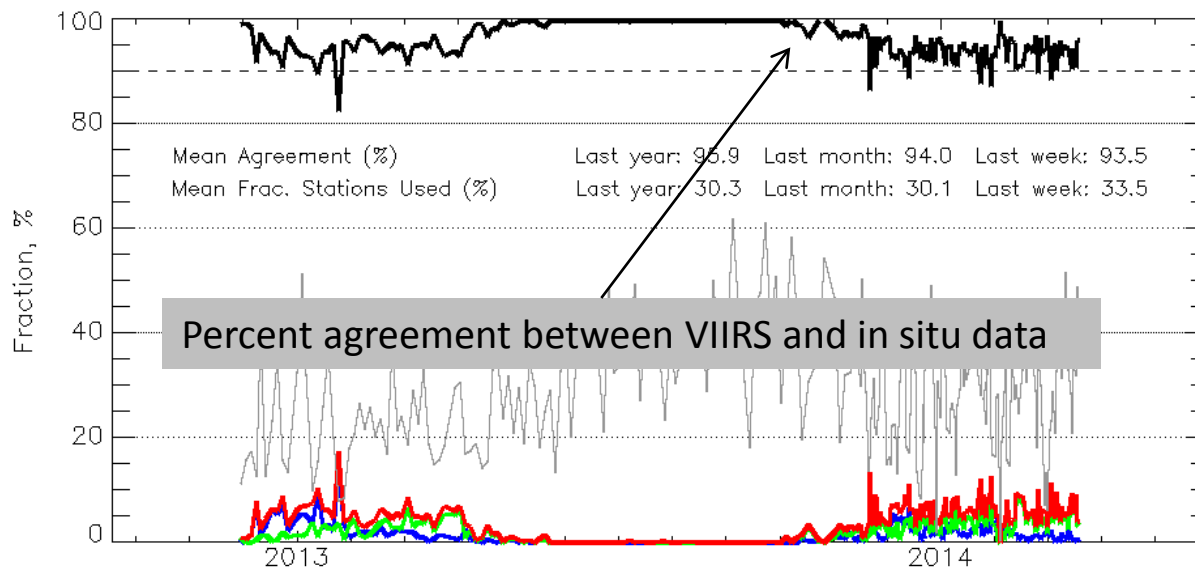
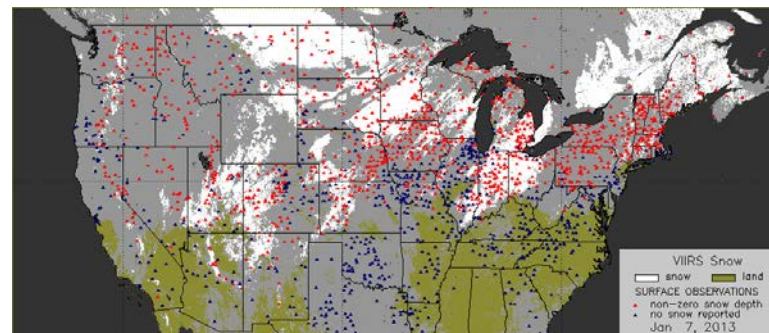


Quantitative accuracy assessment of VIIRS snow maps via

- Comparison with in situ snow cover observations
- Comparison with NOAA Interactive Snow/Ice product (IMS)

VIIRS Snow: Agreement to Station Data

Daily statistics of correspondence between VIIRS snow and in situ data



Northern Hemisphere

VIIRS Snow vs Station Data

- Total Hits
- Total Errors
- Snow Misses
- False Snow
- Fraction of Stations Used

- Several hundred station snow depth reports are used daily
- Agreement to station data is above 90% for most of the days
- Mean agreement in winter months is close to 94%.



VIIRS, AVHRR, MODIS Snow vs IMS



Mean agreement to IMS and cloud-clear fraction
of daily automated snow products in 2013
Northern Hemisphere

	<i>Agreement to IMS (%)</i>	<i>Cloud-clear(%)*</i>
VIIRS	98.0	38.6
MODIS (T)	97.3	49.1
MODIS(A)	97.1	48.3
AVHRR	97.9	55.0

*Cloud-clear fraction is estimated in 25-60°N latitude band

Somewhat better accuracy of VIIRS snow maps is attained at the expense of substantially reduced effective clear-sky coverage



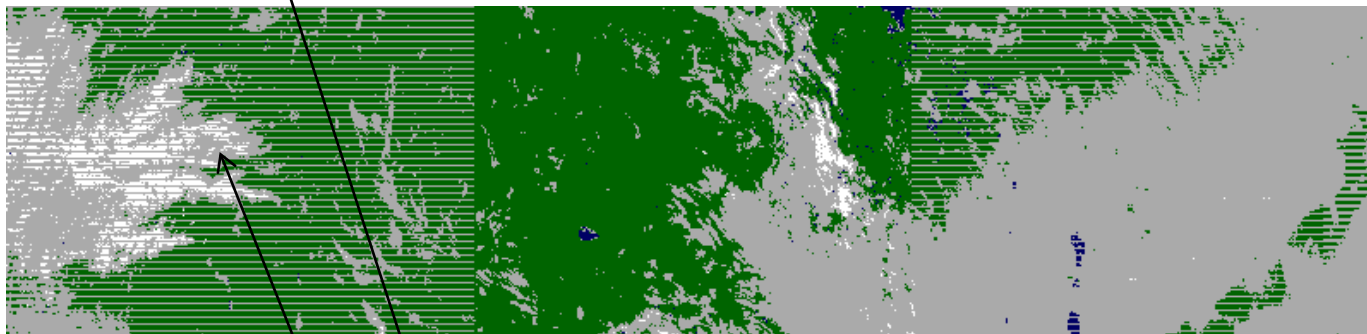
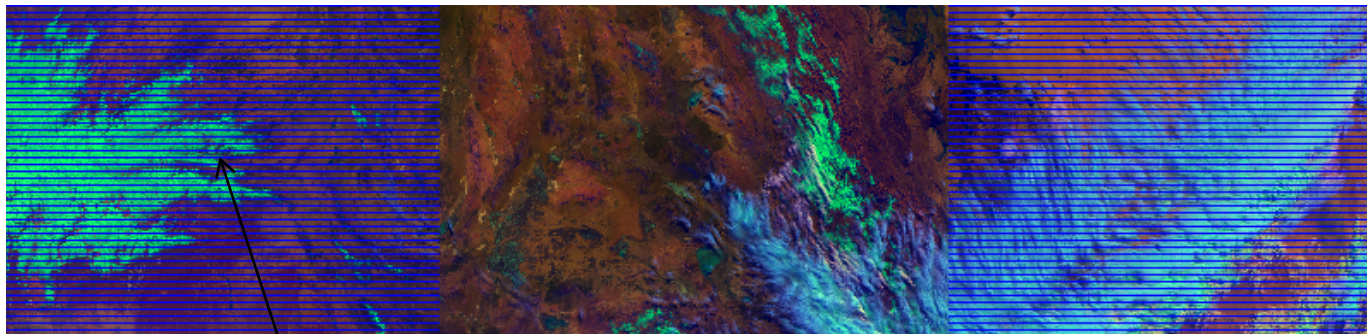
Current Problems in the **VIIRS Binary Snow Cover Map Product**

- Caused by cloud mask issues
- Caused by snow algorithm limitations

Overestimated cloud extent

Partially snow-covered pixels are often interpreted as cloudy.

This hampers accurate delineation of the snow cover boundary



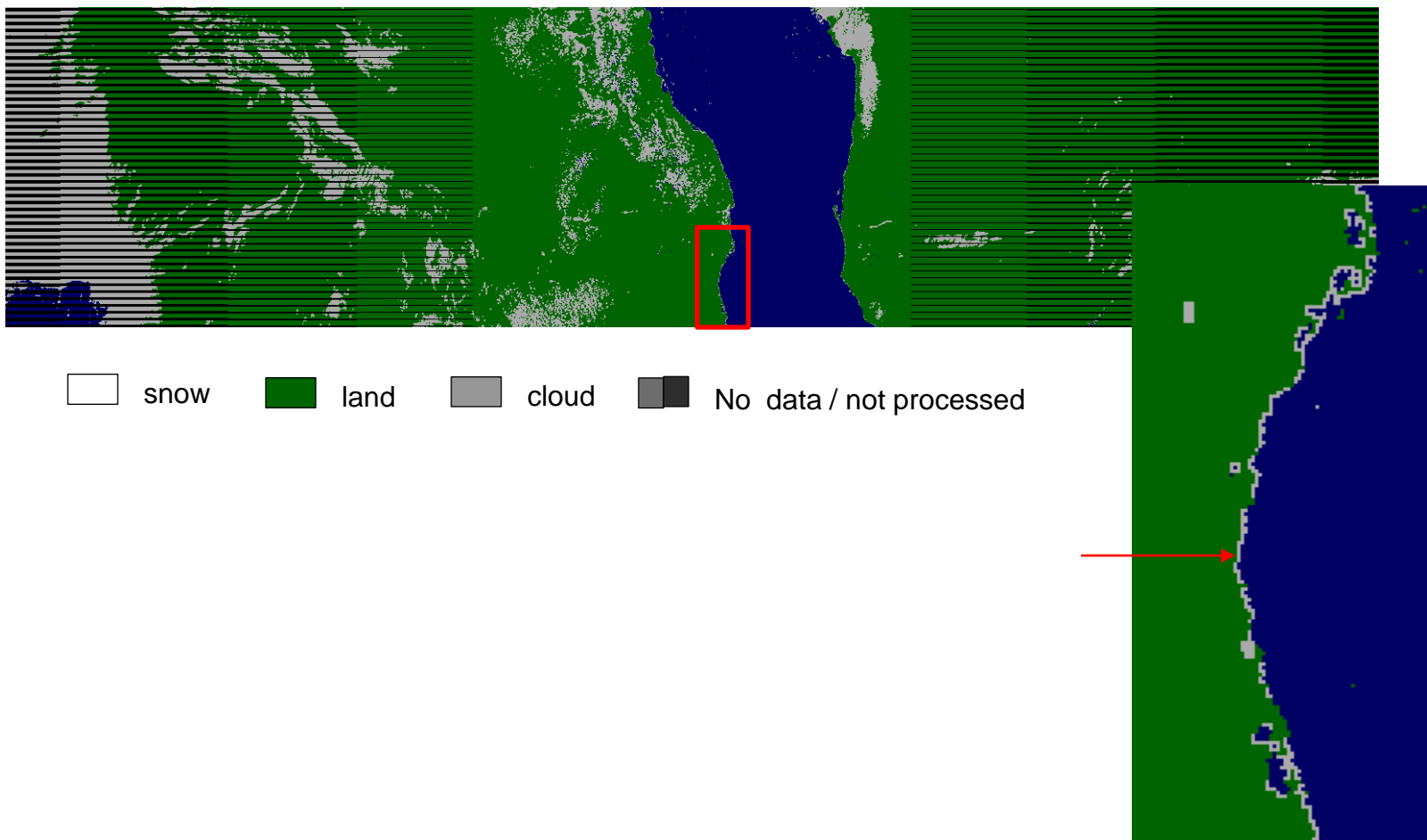
□ snow ■ land ■ cloud ■ No data / not processed

False clouds over partially snow covered areas

Overestimated cloud extent

Coastal line pixels are always interpreted as “cloudy”.

This prevents from mapping snow cover in coastal areas

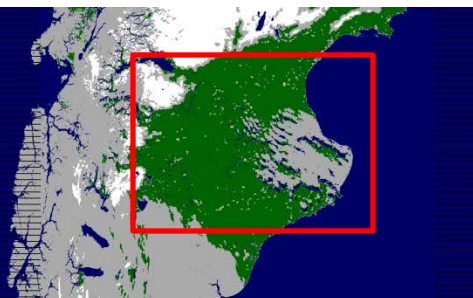


Corrupted Land/Water Mask

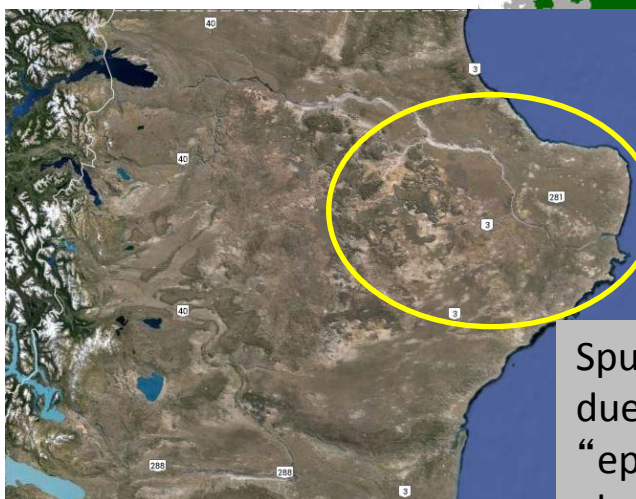
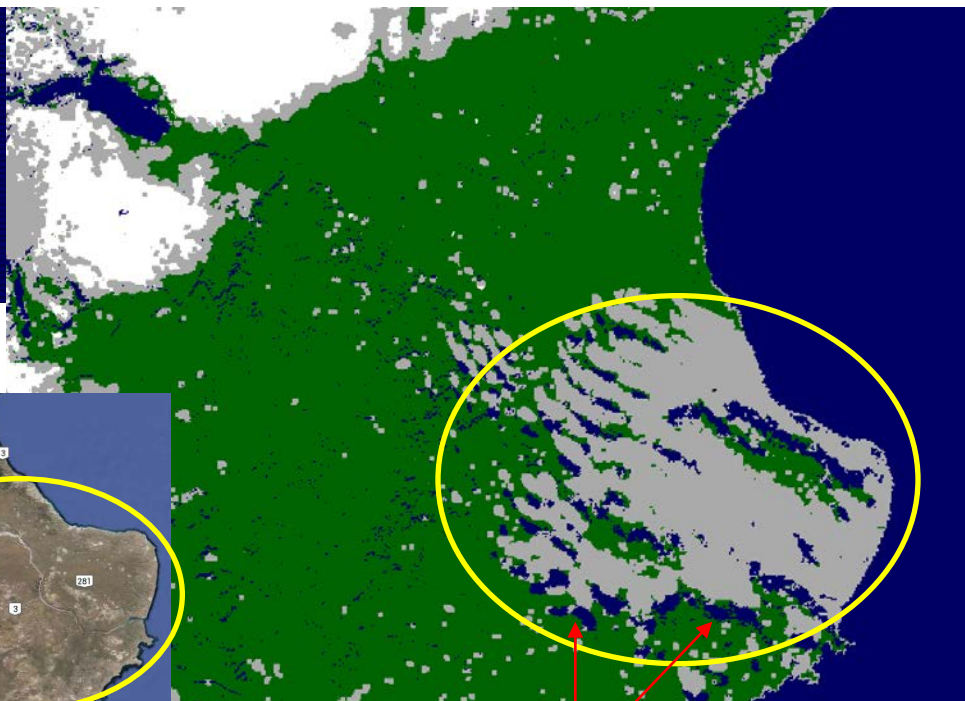
Land/water mask provided with the VIIRS snow product has inaccuracies

The problem occurs due to incorrect interpretation of cloud and topographical shadows as “water” by the VIIRS cloud mask algorithm. As a result, the land/water mask in the snow product gets corrupted.

VIIRS Binary Snow
Map Granule



Date&time :20130718_t1838355



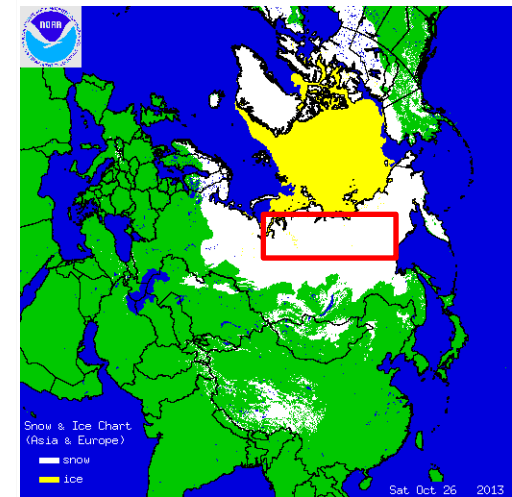
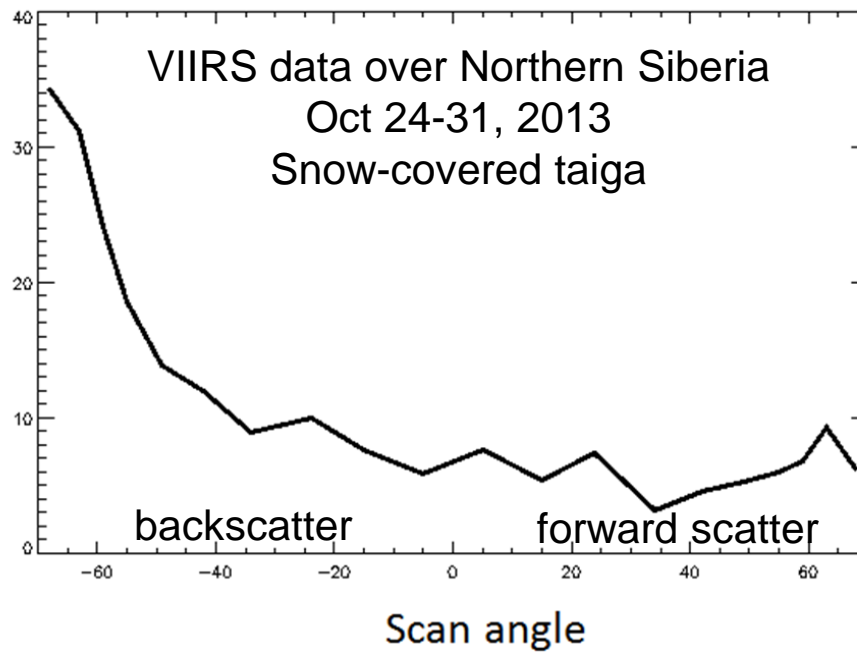
Spurious water bodies in the VIIRS snow product due to misinterpretation of cloud shadows as “ephemeral water” by the VIIRS cloud mask algorithm

Observation Geometry Effect

More missed snow at the edge of the scan, particularly in the backscatter

Observations in the backscatter portion of the scan are made at larger solar zenith angles. Problem may be alleviated by introducing geometry-dependent thresholds in the algorithm.

Probability of snow omission





Binary Snow Map: Summary



- VIIRS Binary Snow Product is consistent with existing satellite-based snow maps and with in situ data
- Over 90% agreement with other snow datasets
- Most issues are related to cloud masking
 - Somewhat overestimated cloud extent
 - Corrupted land/water mask needs immediate attention
- Some potential exist to improve the algorithm and the product
 - Geometry-dependent threshold values
- Introducing modifications to the algorithm makes more sense once VIIRS cloud mask is finalized.