



NOAA-20 VIIRS Snow Cover Products Beta Maturity

May 30, 2018

VIIRS Snow Cover Team

Peter Romanov (CREST) – Snow Products Lead



Outline



- Snow Cover Team Members
- Product and Algorithm Description
- Product Requirements
- Beta Maturity Product Assessment
- Documentation
- Conclusions
- Path Forward



STAR Snow Products Cal/Val Team



Name	Organization	Major Task
Jeff Key	NESDIS/STAR	Cryosphere Team Lead
Peter Romanov	CREST/CUNY	Snow Products Lead
Walter Wolf	NESDIS/STAR	STAR ASSIST integration
Zhaohui Cheng	OSPO	Product Area Lead



VIIRS Snow Products

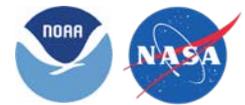


- Binary Snow Cover
 - Presence or absence of snow within FOV
- Fractional Snow Cover
 - Area fraction of snow within FOV as seen from the above (viewable snow fraction)

Retrievals require daylight and clear sky conditions



VIIRS Snow Algorithms



- Binary Snow Cover
 - Threshold-based decision tree technique (modified MODIS SnowMap)
 - Consistency testing with auxiliary climatic datasets
- Fractional Snow Cover
 - Single-band linear unmixture technique (used with GOES and AVHRR)
 - Observations in one (visible) spectral band
 - Two endmembers (snow, snow-free land)
 - Applied to pixels identified as “snow covered”

VIIRS		
Band	Range (um)	HSR (m)
DNB	0.500 - 0.900	
M1	0.402 - 0.422	750
M2	0.436 - 0.454	750
M3	0.478 - 0.498	750
M4	0.545 - 0.565	750
I1	0.600 - 0.680	375
M5	0.662 - 0.682	750
M6	0.739 - 0.754	750
I2	0.846 - 0.885	375
M7	0.846 - 0.885	750
M8	1.230 - 1.250	750
M9	1.371 - 1.386	750
I3	1.580 - 1.640	375
M10	1.580 - 1.640	750
M11	2.225 - 2.275	750
I4	3.550 - 3.930	375
M12	3.660 - 3.840	750
M13	3.973 - 4.128	750
M14	8.400 - 8.700	750
M15	10.263 - 11.263	750
I5	10.500 - 12.400	375
M16	11.538 - 12.488	750

Snow Cover		
ATTRIBUTE	THRESHOLD	OBJECTIVE
a. Horizontal Cell Size	1.6 km	1.6 km
b. Horizontal Reporting Interval	HCS	HCS
c. Horizontal Coverage	Global	Global
d. Mapping Uncertainty, 3 sigma	3 km	3 km
e. Measurement Range		
1. Binary Snow Cover	0/1 Binary mask	0/1 Binary mask
2. Fractional Snow Cover	0.0 – 1.0	0.0 – 1.0
f. Measurement Uncertainty		
1. Binary Snow Cover	90% Probability of correct typing	90% Probability of correct typing
2. Fractional Snow Cover	20% snow fraction	20% snow fraction
g. Refresh	At least 90% coverage of the globe every 12 hours (monthly average)	At least 90% coverage of the globe every 12 hours (monthly average)

* As per JPSS/NESDIS ESPC Requirements Document (JERD), v.2, March 31, 2016



NDE/STAR Snow Product Status



Suomi NPP: NDE Operational since 2016

NOAA-20: NDE Systematic production since May 2018



JPSS/GOES-R Data Product Validation Maturity Stages – COMMON DEFINITIONS (Nominal Mission)

1. Beta

- Product is minimally validated, and may still contain significant identified and unidentified errors.
- Information/data from validation efforts can be used to make initial qualitative or very limited quantitative assessments regarding product fitness-for-purpose.
- Documentation of product performance and identified product performance anomalies, including recommended remediation strategies, exists.

2. Provisional

- Product performance has been demonstrated through analysis of a large, but still limited (i.e., not necessarily globally or seasonally representative) number of independent measurements obtained from selected locations, time periods, or field campaign efforts.
- Product analyses are sufficient for qualitative, and limited quantitative, determination of product fitness-for-purpose.
- Documentation of product performance, testing involving product fixes, identified product performance anomalies, including recommended remediation strategies, exists.
- Product is recommended for potential operational use (user decision) and in scientific publications after consulting product status documents.

3. Validated

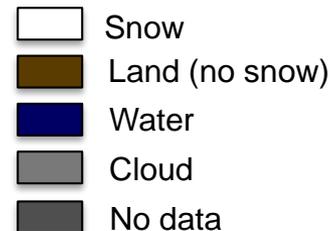
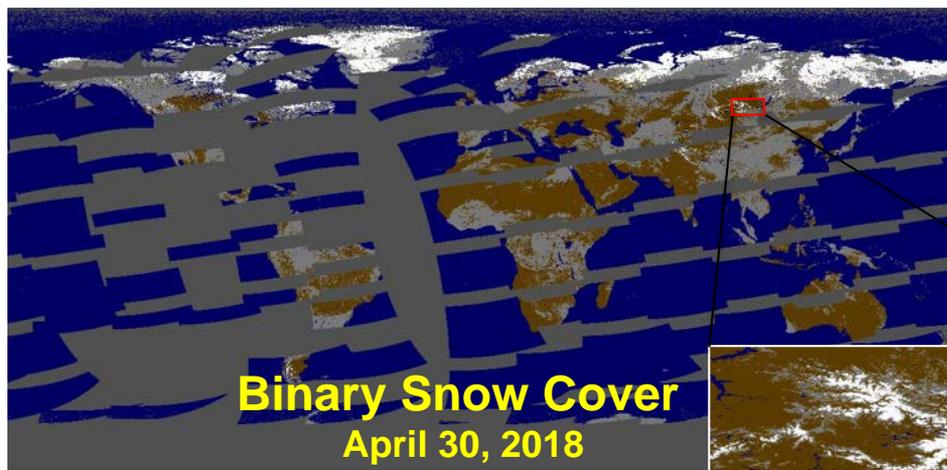
- Product performance has been demonstrated over a large and wide range of representative conditions (i.e., global, seasonal).
- Comprehensive documentation of product performance exists that includes all known product anomalies and their recommended remediation strategies for a full range of retrieval conditions and severity level.
- Product analyses are sufficient for full qualitative and quantitative determination of product fitness-for-purpose.
- Product is ready for operational use based on documented validation findings and user feedback.
- Product validation, quality assurance, and algorithm stewardship continue through the lifetime of the instrument.



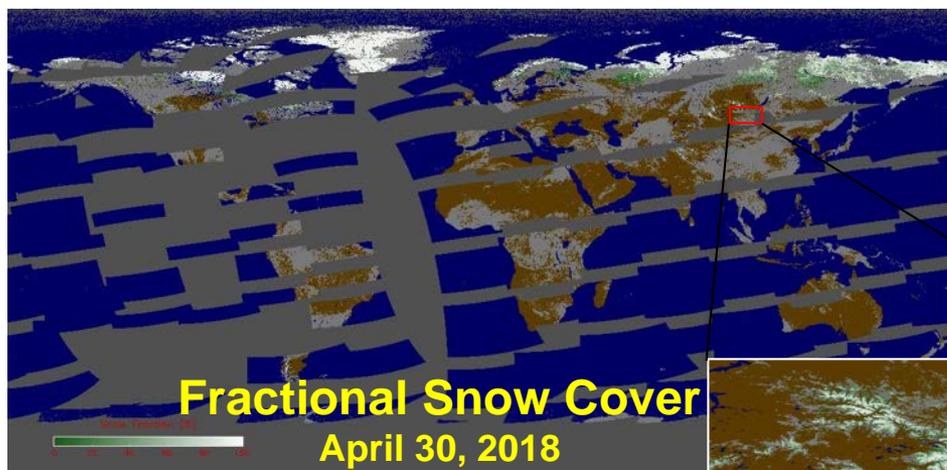
Evaluation methodology



- Visual assessment of NOAA-20 VIIRS global gridded products
 - Presence of bad/missing scanlines/granules
 - Presence of unusual/unphysical spatial patterns in products
- Visual comparison between Suomi NPP and NOAA-20 snow products
- Consistency of seasonal changes in the snow extent/fraction
- Comparison of NOAA-20 products with IMS maps
- Snow products used for validation: April 30 to June 10, 2018



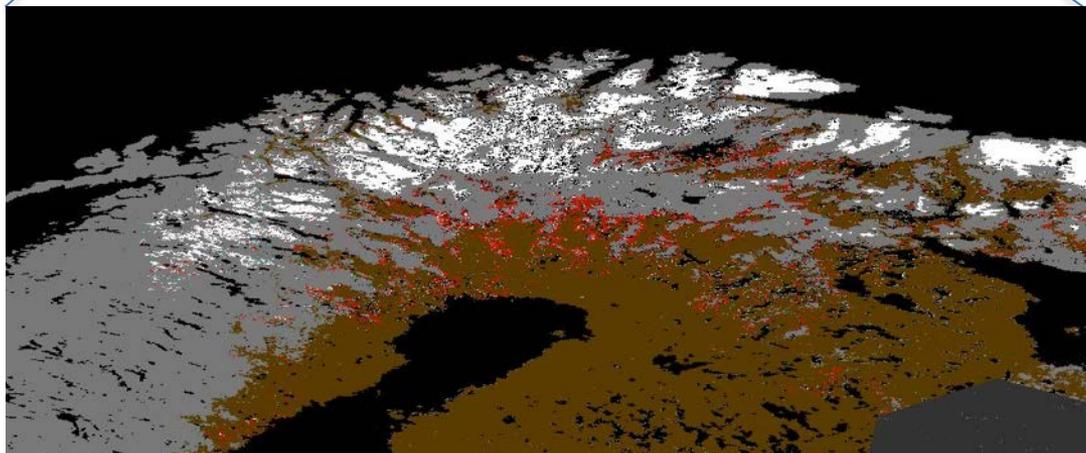
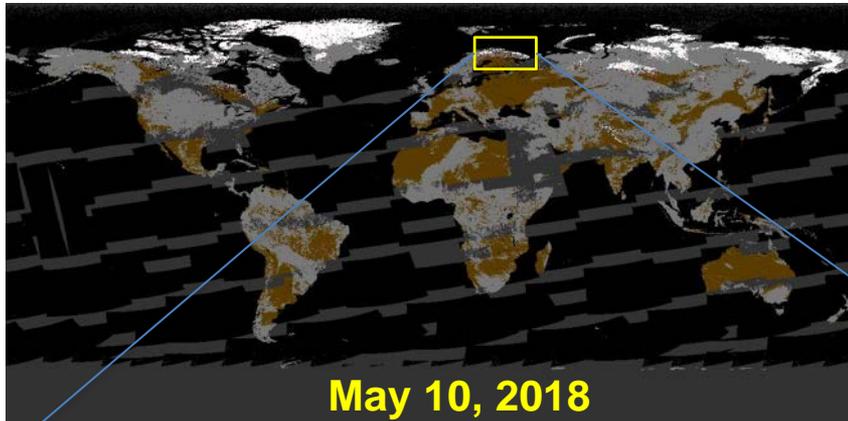
About 15-20% of all daytime snow product granules are not available. As per W. Wolf, there is a bug in the current operational NDE product generation system causing missing granules. The bug should be fixed in the next implementation of the system.



Qualitative analysis has shown

- No obvious issues at the scan-line or granule level
- No unusual/unphysical spatial patterns/features in the mapped snow
- Generally realistic characterization of the global snow cover distribution

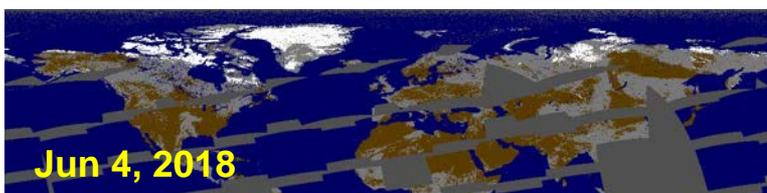
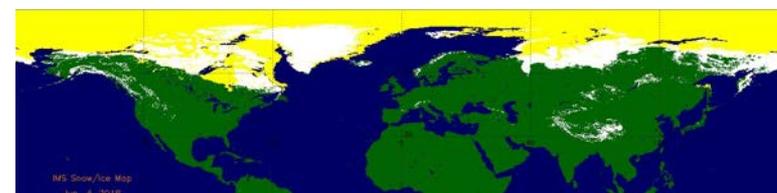
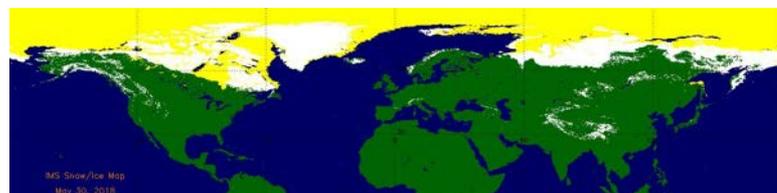
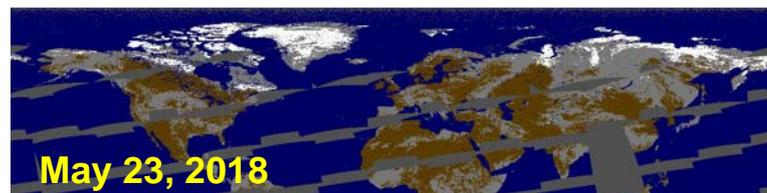
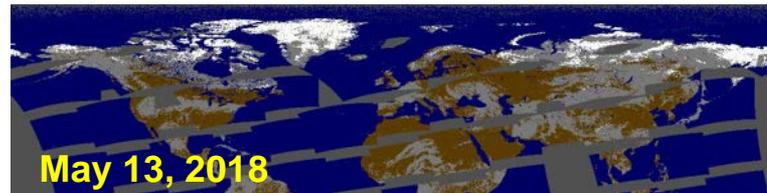
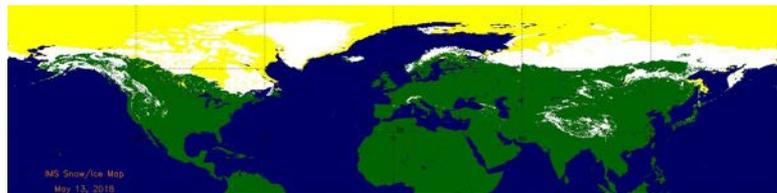
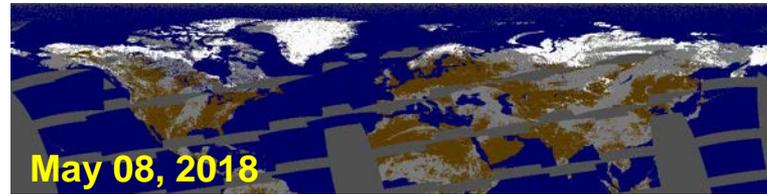
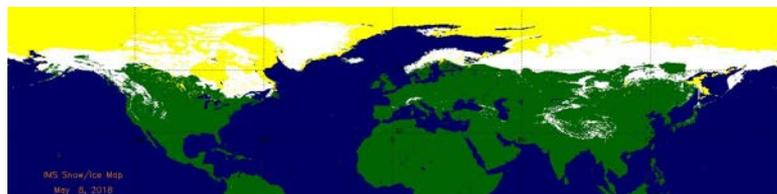
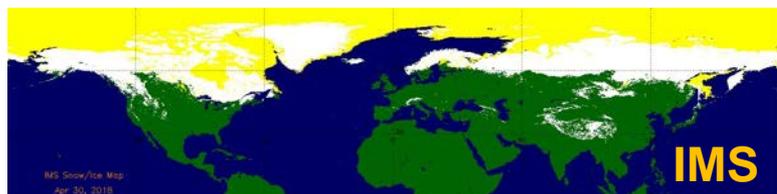
Overlay of VIIRS NOAA-20 and SNPP daily snow masks



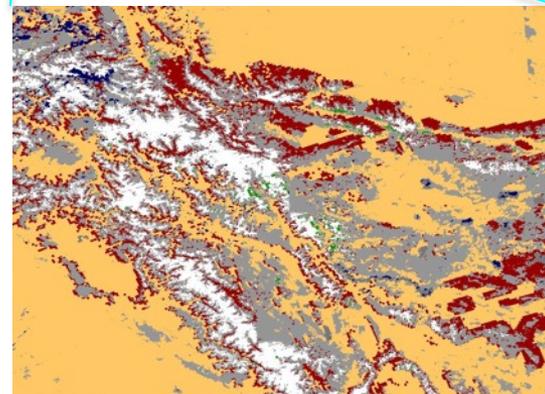
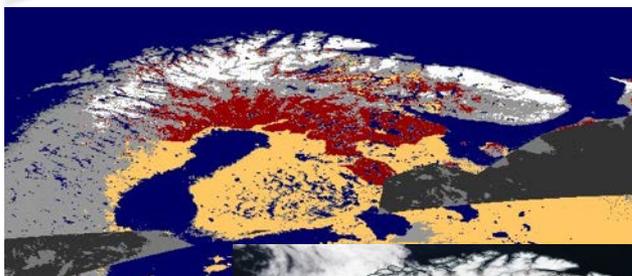
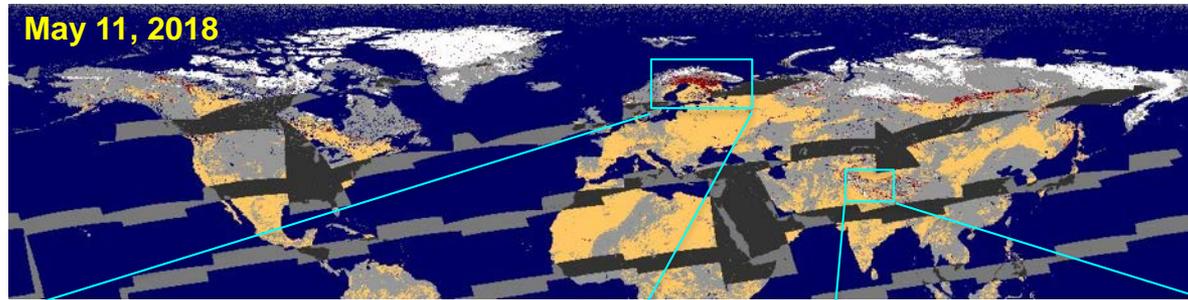
NOAA-20 vs SNPP NDE Binary Snow Mask:

- Over 98% agreement on snow/no snow in the N. Hemisphere
- Differences are mostly in the transition zone

NOAA-20 Binary Snow vs IMS



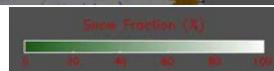
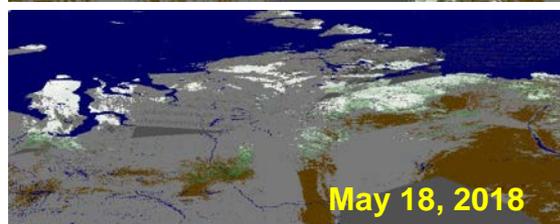
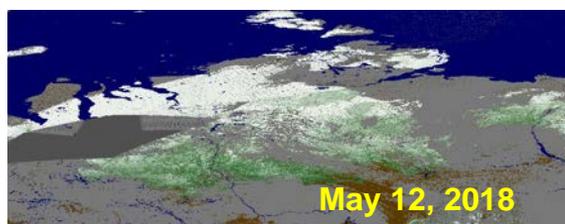
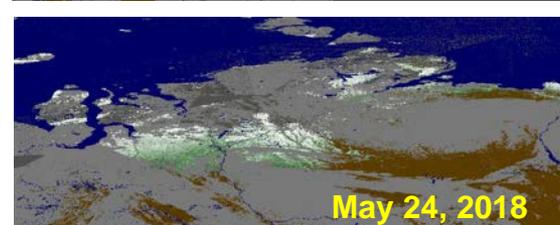
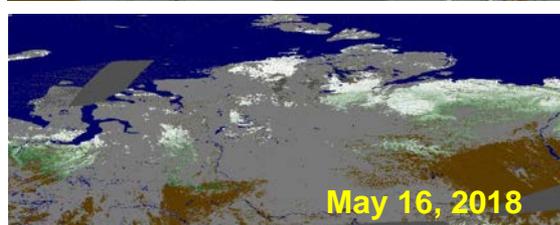
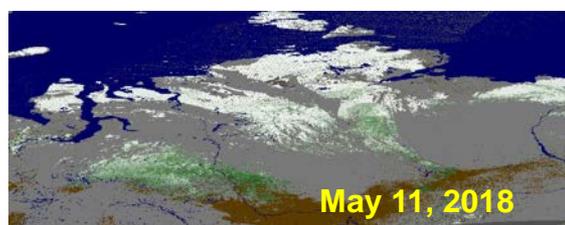
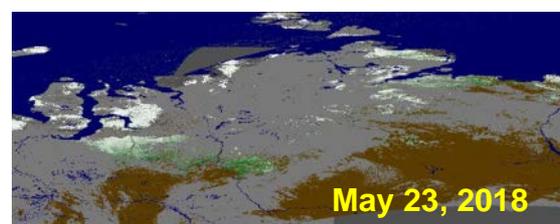
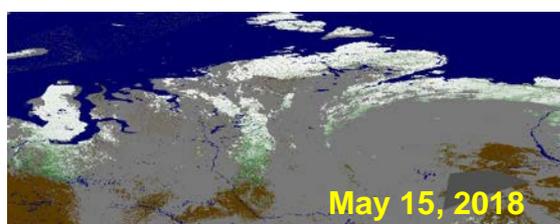
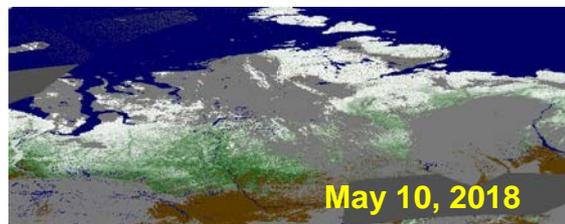
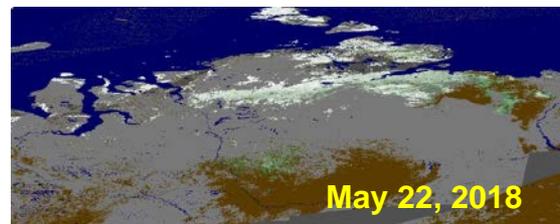
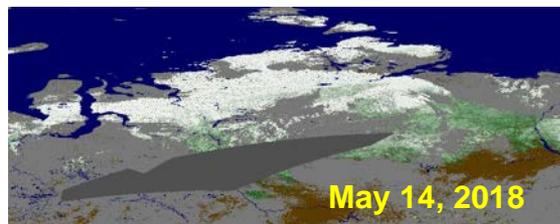
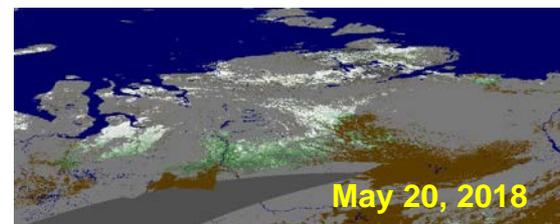
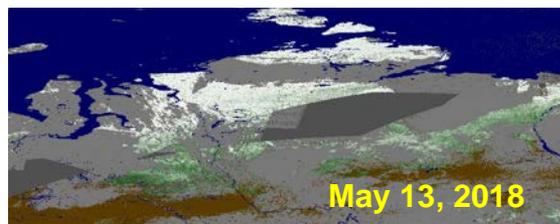
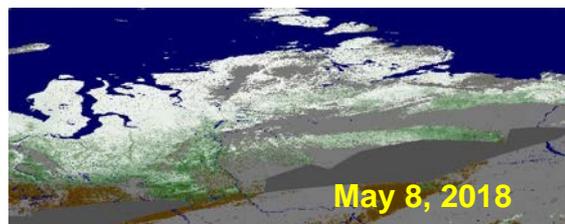
Overlay of NDE VIIRS NOAA-20 and IMS daily snow masks

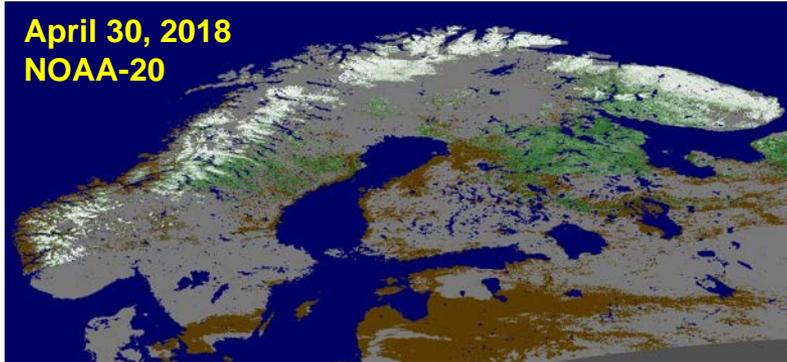


- N20: Snow, IMS: No-snow
- N20: No-snow, IMS: Snow
- Both: Snow
- Both: No-snow
- Water
- Cloud
- No data

NOAA-20 NDE Snow Mask vs IMS (May 1– May 31, 2018):

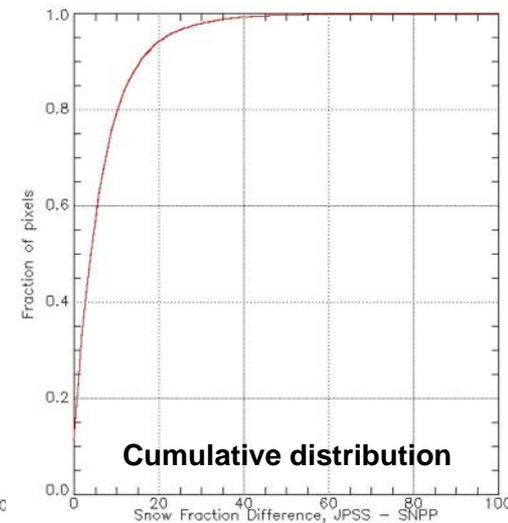
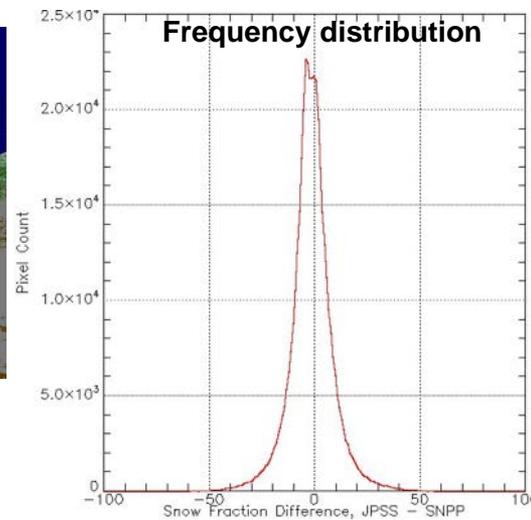
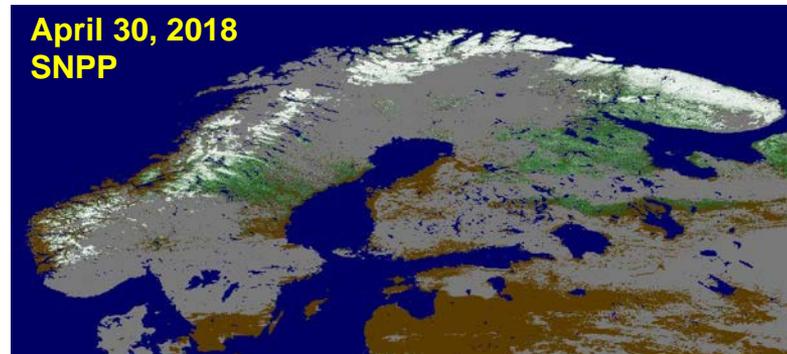
- Over 96% agreement on snow/no snow in N. Hemisphere
- IMS analysts generally map more snow, particularly in the transition zone





N20 vs SNPP snow fraction
FSC comparison statistics
for $0.02 < \text{FSC} < 0.98$

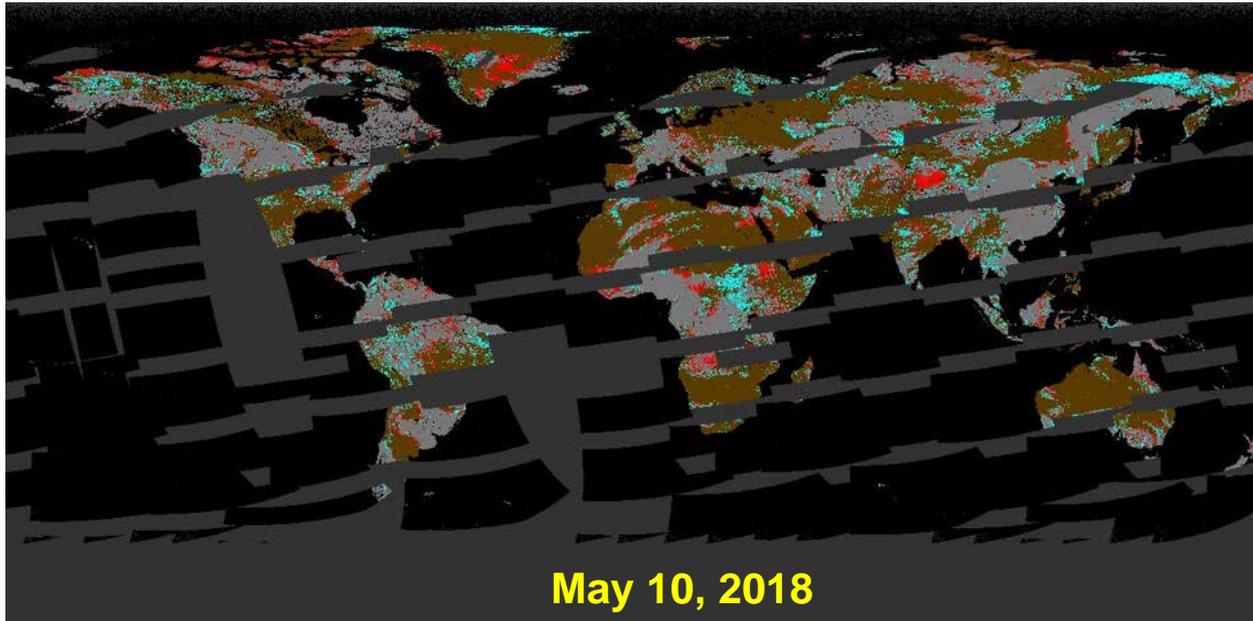
Correlation: 0.94
RMSD: 0.07
Bias: 0.01



NOAA-20 vs SNPP FSC:

- Strong spatial correlation between FSC estimates
- Small RMSD (< 0.1) with negligible bias

Overlay of VIIRS NOAA-20 and SNPP daily daytime cloud masks



Global clear-sky fraction:

NOAA-20: 52.5%

SNPP: 52.7%

Agreement rate: ~80%

NOAA-20 vs SNPP NDE cloud mask:

- Agree well on the overall fraction of cloudy/clear scenes
- Spatial differences (~20%) appear too large to be explained only by the overpass time difference.



Documents (Check List)



Science Maturity Check List	Yes ?
ReadMe for Data Product Users	Yes (NOAA-20)
Algorithm Theoretical Basis Document (ATBD)	Yes
Algorithm Calibration/Validation Plan	Yes
(External/Internal) Users Manual	
System Maintenance Manual (for ESPC products)	
Peer Reviewed Publications	Yes
Validation Reports	JPSS Annual Meeting



Check List - Beta Maturity



Beta Maturity End State	Assessment
Product is minimally validated, and may still contain significant identified and unidentified errors	“Yes” to “minimally validated”, small chance of significant errors
Information/data from validation efforts can only be used to make initial qualitative or very limited quantitative assessments regarding product fitness-for-purpose	Yes
Documentation of product performance and identified product performance anomalies, including recommended remediation strategies, exists	Yes



Check List - Provisional Maturity



Provisional Maturity End State	Assessment
<p>Product performance has been demonstrated through analysis of a large, but still limited (i.e., not necessarily globally or seasonally representative) number of independent measurements obtained from select locations, periods, and associated ground truth or field campaign efforts.</p>	<p>?</p> <p>Short time period, no ground truth data, but performance is generally similar to SNPP</p>
<p>Product analysis is sufficient to communicate product performance to users relative to expectations (Performance Baseline).</p>	<p>?</p> <p>Insufficient analysis due to insufficient data.</p>
<p>Documentation of product performance exists that includes recommended remediation strategies for all anomalies and weaknesses. Any algorithm changes associated with severe anomalies have been documented, implemented, tested, and shared with the user community.</p>	<p>Yes</p>
<p>Product is ready for operational use and for use in comprehensive cal/val activities and product optimization.</p>	<p>No</p> <p>Mostly due to gaps in the area coverage because of missing granules</p>

- NOAA-20 VIIRS Snow Products have been minimally validated
 - No issues at the scan-line or granule level
 - Good (above 96%) agreement of NOAA-20 binary snow to SNPP
 - Good (above 95%) agreement to NOAA-20 binary snow to IMS
 - NOAA-20 FSC agree well with SNPP FSC (RMSD < 0.07, R > 0.9)
- Information is sufficient to make qualitative assessment of the product
 - NOAA-20 VIIRS snow products realistically reproduce global snow cover
 - Products are close to satisfying accuracy requirements
- Required documentation exists
- NOAA-20 Snow product has reached Beta maturity

- Limited duration of the dataset (end of winter season in N. Hemisphere)
 - Limited geographical coverage (high latitudes, tundra)
 - End of spring season, mostly melting snow conditions, patchy snow
 - No in situ data used: most stations are in mid-latitudes
- Incomplete daily coverage (missing granules)
 - Causes uncertainty in the large-scale accuracy estimates
 - Affects 90% daily coverage/refresh requirement
- Cloud mask is beta maturity (not yet Provisional)
 - Future possible changes in the cloud mask may affect the snow product accuracy

Provisional maturity may be declared once these issues are resolved



Path Forward



- Comprehensive evaluation of the product
 - Other seasons
 - Different land cover types, topography
 - Consistency with other datasets (e.g., in situ data)
 - Verification with high resolution imagery
- Check EDR quality flags