JPSS DPA Program Planning Meeting
Cryosphere EDR Team

Peter Romanov and/or Mark Tschudi

Jeff Key

Cryosphere EDR Lead

September 17-18, 2012

Overview of Data Products

- Sea ice characterization
  - Currently this is ice type: no ice, new/young ice, other ice
  - This EDR includes a sea ice concentration IP
- Ice surface temperature (IST)
- Snow cover
  - Binary snow cover
  - Fractional snow cover (2x2 averages of binary mask)

Notes:

1) Information on ice concentration and snow fraction is important to almost all other EDRs.
2) AMSR2 on GCOM-W1 will be used to generate other snow and ice products: Ice Characterization, Snow Cover, Snow Depth, and Snow Water Equivalent (SWE).
3) Ice motion is not on either list.

Team Members' Roles & Responsibilities

EDR	Name	Organization	Funding Agency	Task
Lead	Jeff Key	NOAA/NESDIS/STAR	NJO	Lead Cryosphere EDR Team
Co-Lead	Pablo Clemente-Colón	NOAA/NESDIS/STAR and NIC	NJO	Team co-lead; operational applications
Wisconsin:				
Ice	Yinghui Liu	CIMSS/U. Wisc	NJO	Ice concentration and IST val & alg
Ice	Xuanji Wang	CIMSS/U. Wisc	NJO	Ice char val & alg
Ice	Tony Schreiner	CIMSS/U. Wisc	NJO	Validation
Maryland/NY:				
Snow	Peter Romanov	CREST/CCNY	NJO	Snow val & alg
Snow	Igor Appel	IMSG	NJO	Snow val & alg

(Continued on next slide)

Team Members' Roles & Responsibilities

EDR	Name	Organization	Funding Agency	Task
Colorado:				
Ice	Jim Maslanik	CIRES/U. Colo	NJO	Ice EDR val & alg
Ice	Mark Tschudi	CIRES/U. Colo	NJO	Ice EDR val & alg
Ice	Dan Baldwin	CIRES/U. Colo	NJO	Ice EDR val; ADL
Other:				
All	Paul Meade	DPE	JPO	DRs
All	Robert Mahoney	NGAS		Snow and ice alg & val

FY-12 Accomplishments

- Performed numerous **validation case studies** to identify issues with
  - All snow and ice EDRs and IPs
  - VIIRS cloud mask
  - Surface albedo
  - Snow/ice rolling tile (not originally part of our plan)
- Some **results** from above:
  - Overview analyses identified discontinuities in VIIRS cloud mask (VCM) over polar regions. Discussion with VCM team led to changes in processing (removal of latitude dependency).
  - Validation of Sea Ice Characterization EDR yields different results depending on season.
  - Sea ice concentration is biased high when compared to passive microwave concentration.
  - Ice Surface Temperature assessments vs. MODIS and NASA IceBridge aircraft data suggest VIIRS IST underestimates temperature by 1 to 2 deg. C.
  - VIIRS misses more snow than MODIS. There are errors of commision (tropics) and omission (forests).
  - VIIRS snow misses are more likely for observations made in the backscatter geometry.
  - An albedo banding problem was identified (no solution yet).

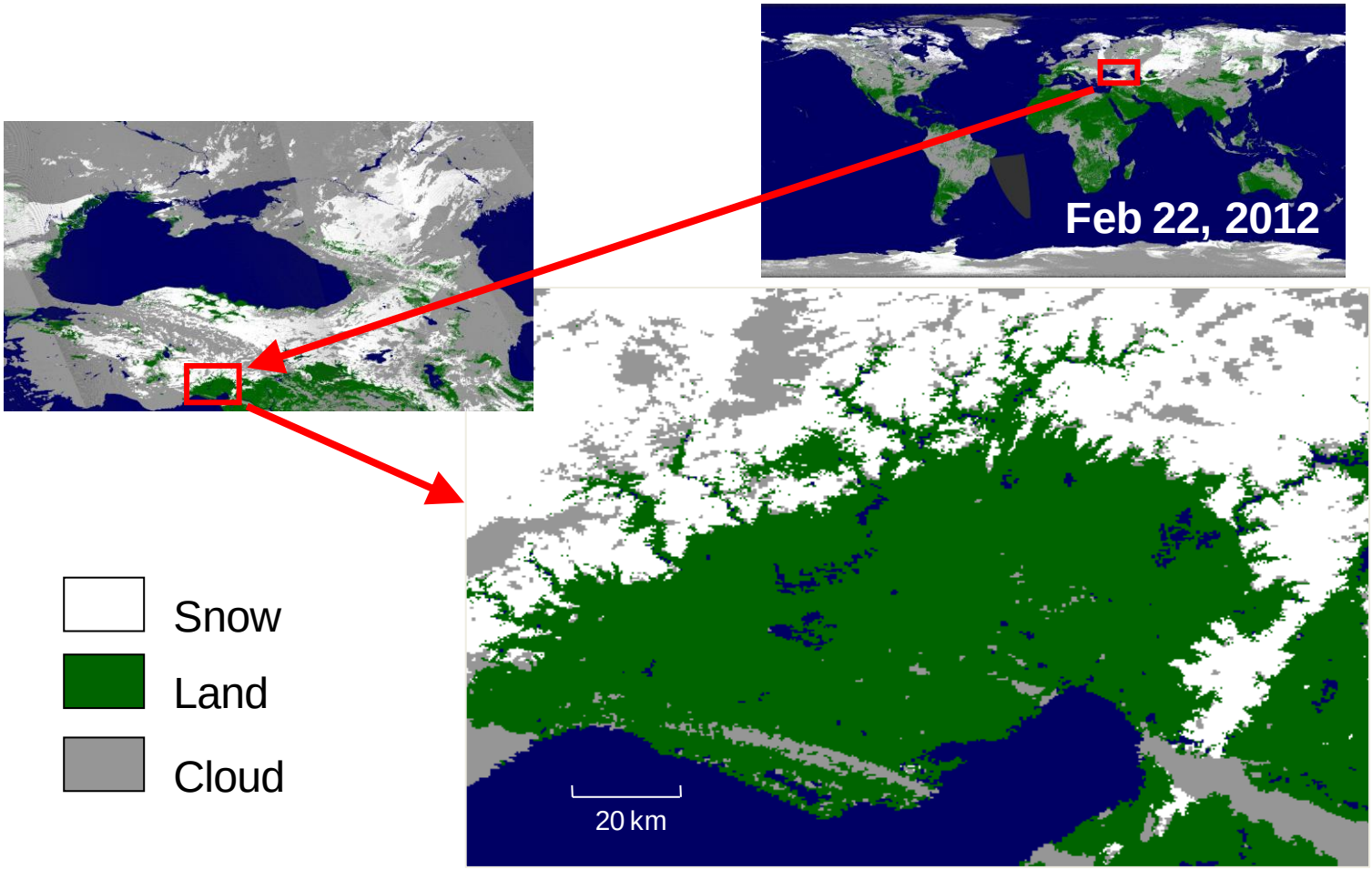
FY-12 Accomplishments, cont.

- Developed **an automated system** to download VIIRS ice products from GRAVITE, obtain similar products from other satellite sensors (MODIS, SSM/I), in situ data (buoys), and NCEP model fields, regrid and generate plots of all products, and perform basic statistical comparisons. *This system will be expanded to include other products, more robust statistics, and a web interface.*
- Created a **Cryosphere Wiki** (password protected) as a place to put highlights of our validation work.
- Worked with the **Land PEATE**, helping to identify and fix problems
- **Algorithms**:
  - Worked with NGAS on various algorithm issues
  - Performed comparisons between NGAS and STAR/cooperative institute algorithms
  - Evaluated potential improvements
  - Explored potential problems in LUTs

Now a few examples…

Validation of Snow Properties

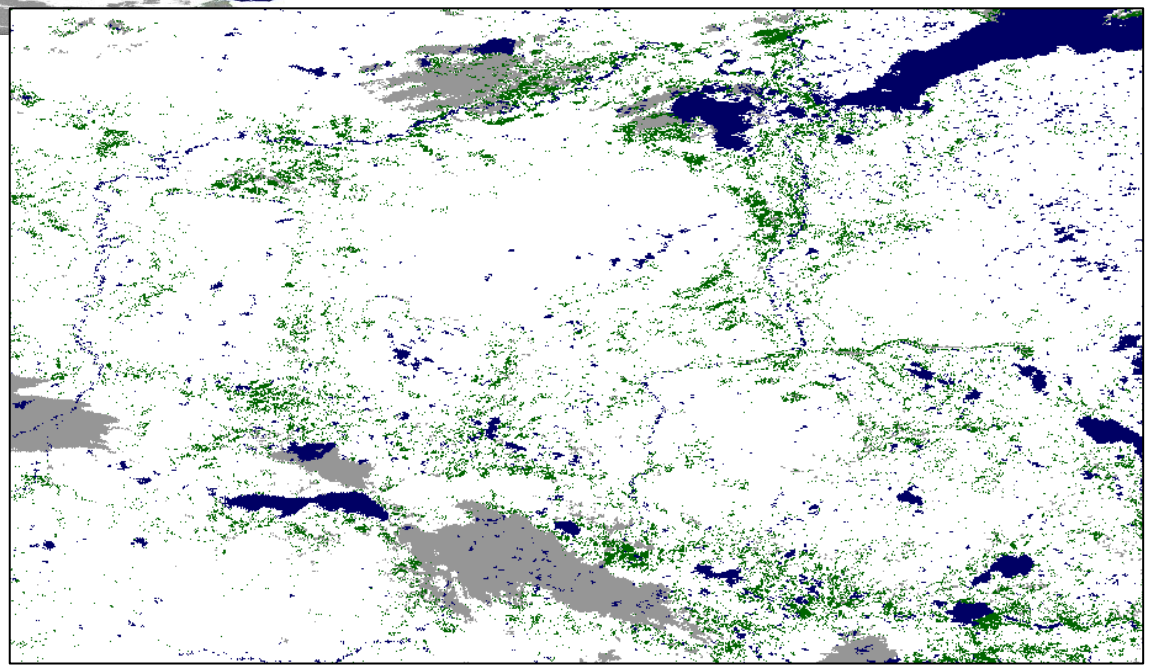
Global gridded VIIRS snow map: **Realistic, detailed** characterization of regional snow cover at high spatial resolution



0.5 km spatial resolution

However closer analysis reveals frequent snow misses (omission errors) in densely forested areas

Example of snow misses in the boreal forest zone in Canada.



Snow Land Cloud

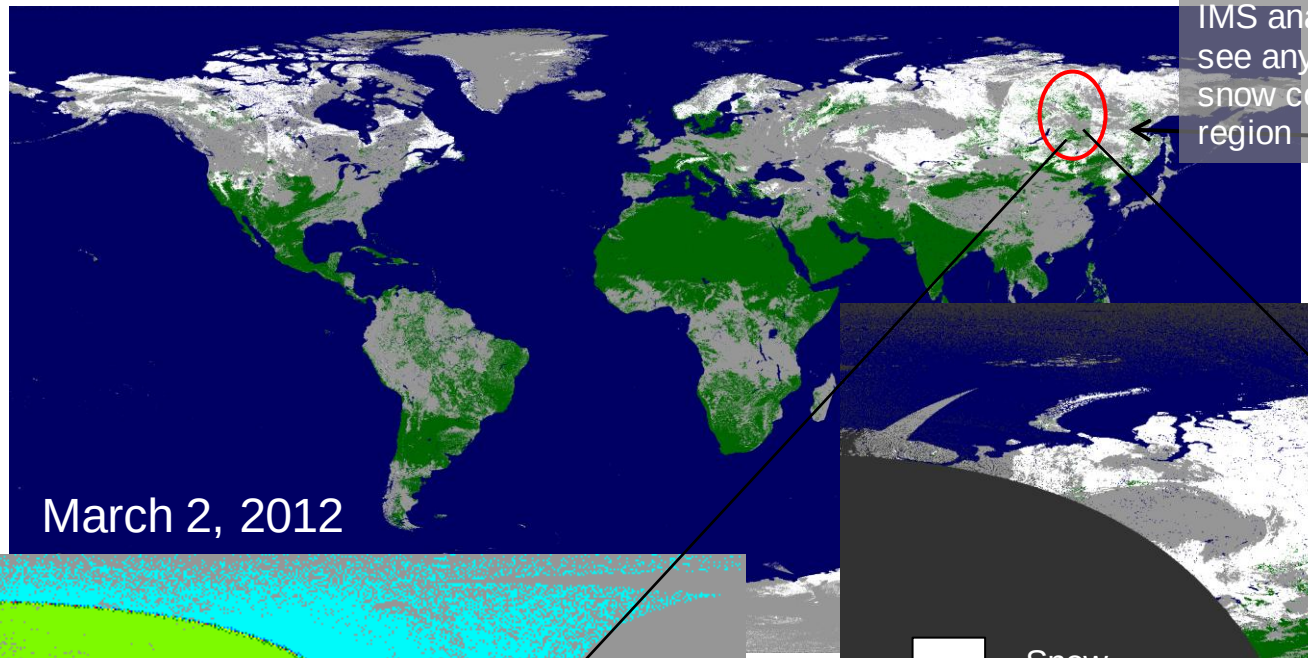
Area size:~ 400 x 700 km

Classification results:
Water: 5.2%
Cloud: 5.4%
Land: 6.4% (errors)
Snow: 83.0%

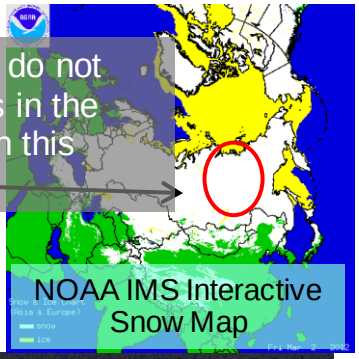
However, the area is completely snow-covered.

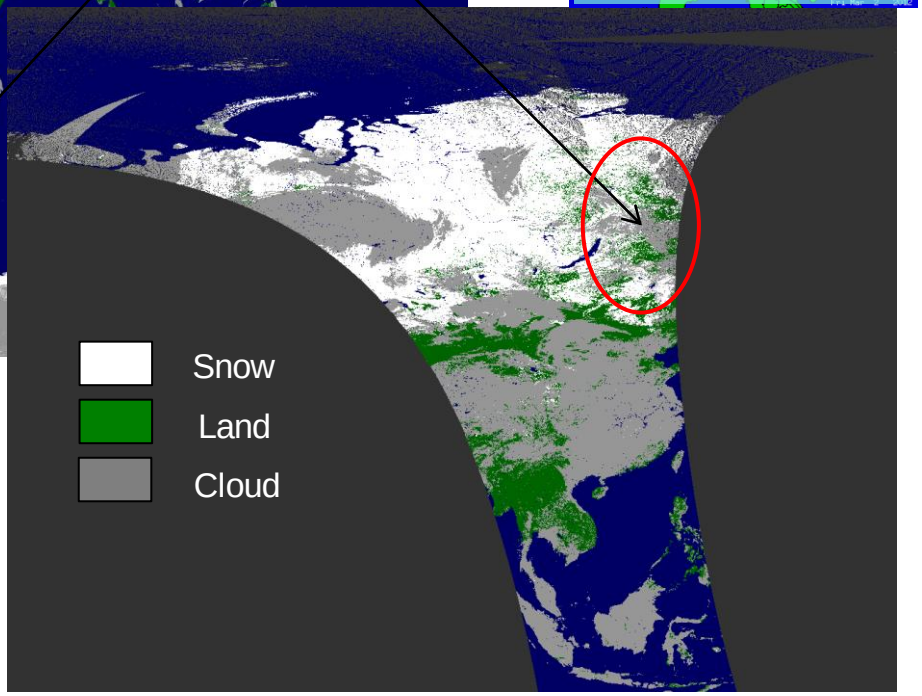
The rate of snow omission errors in clear sky land pixels is 7.1%.

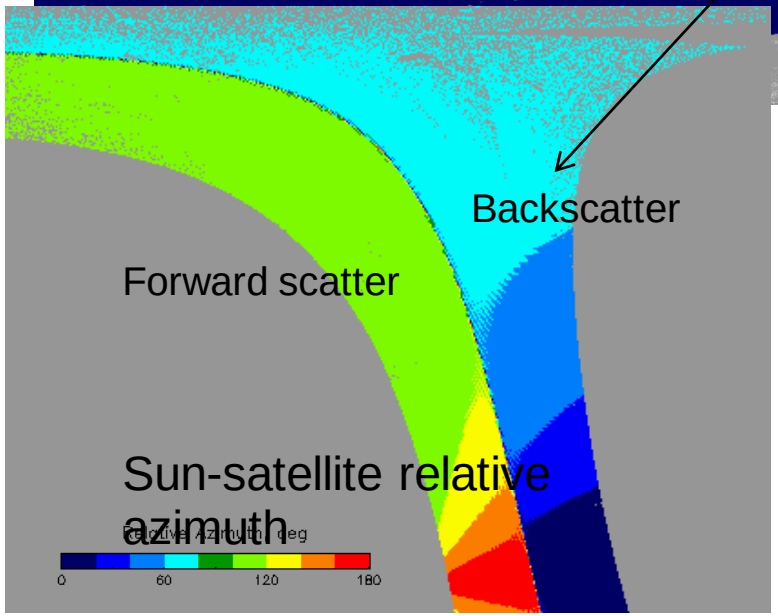
VIIRS snow misses are more likely for observations made in the backscatter geometry



IMS analysts do not see any gaps in the snow cover in this region



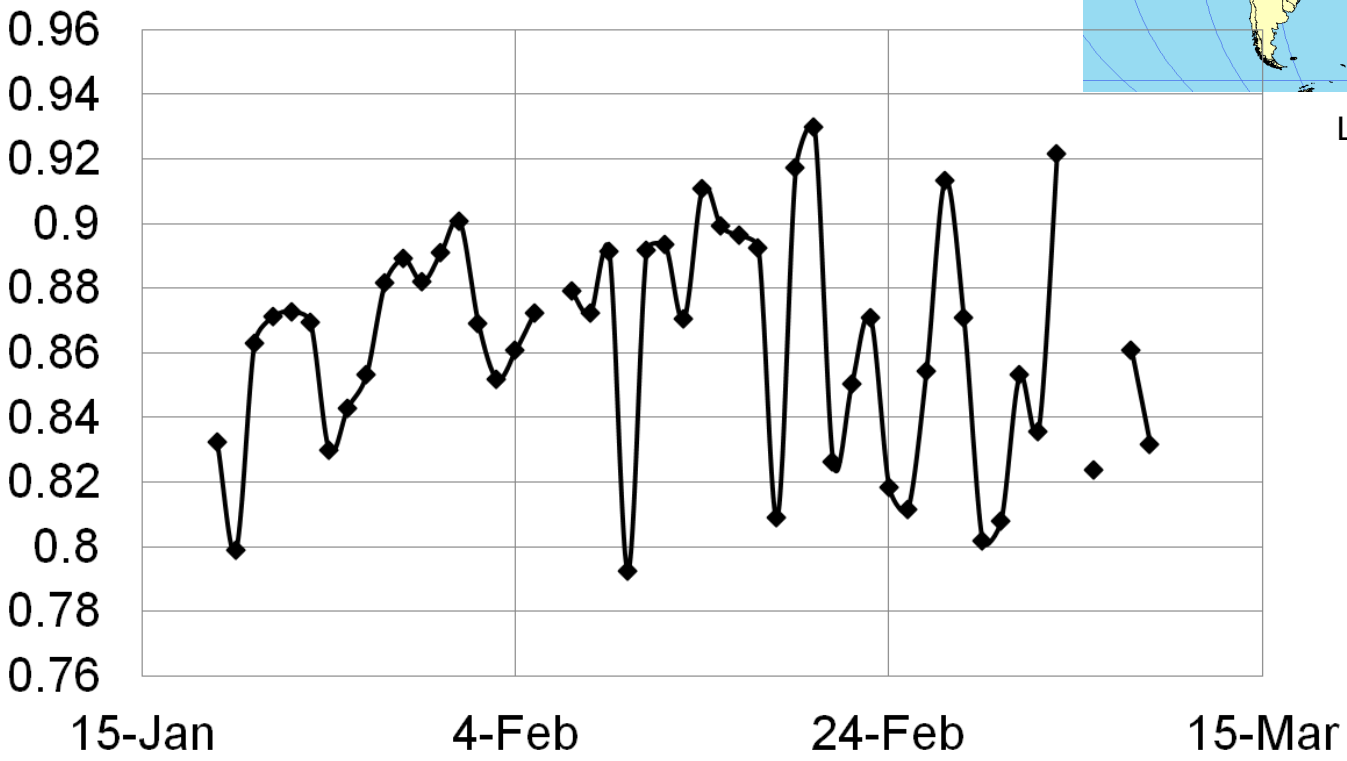


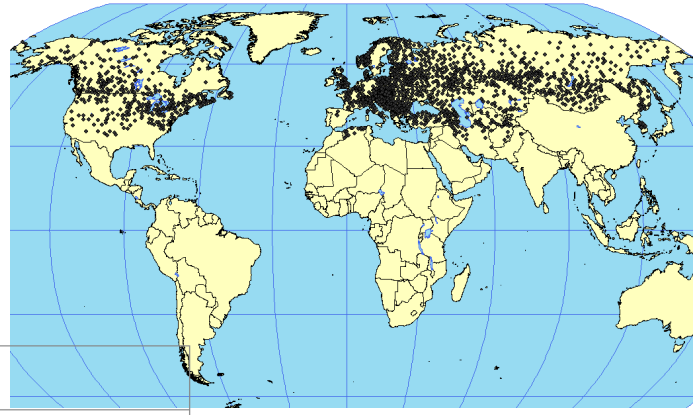


Snow is more often missed at the edge of the scan in the backscatter portion of the swath. **These misses typically occur over densely forested areas.**

VIIRS snow vs in situ snow at WMO stations

Probability of correct snow identification (PCSI) in the VIIRS snow product (Nsnow_hits/(Nsnow_hits+Nsnow_misses)



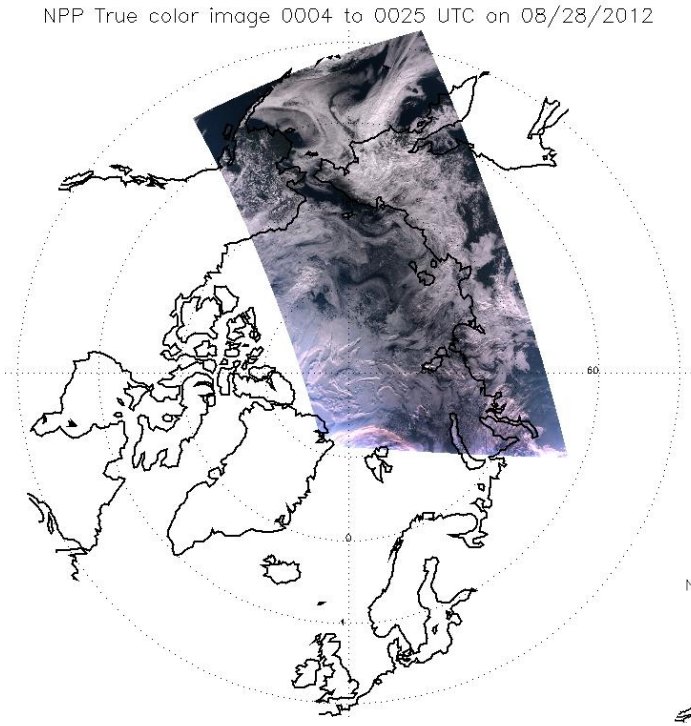


Location of WMO stations used in the validation

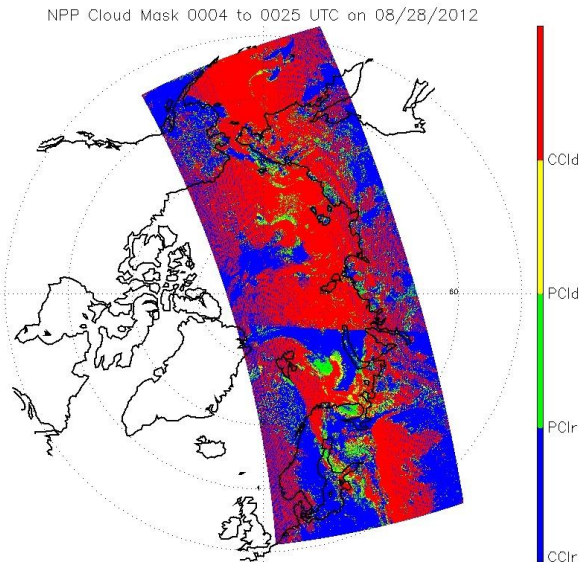
Reports from over 2000 stations around the globe have been processed daily

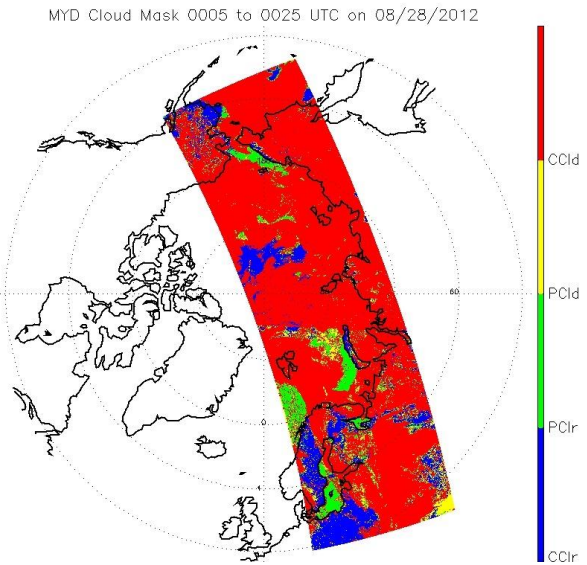
PCSI ranges mostly within 0.8 to 0.9

Automated Validation System Example (1/3)

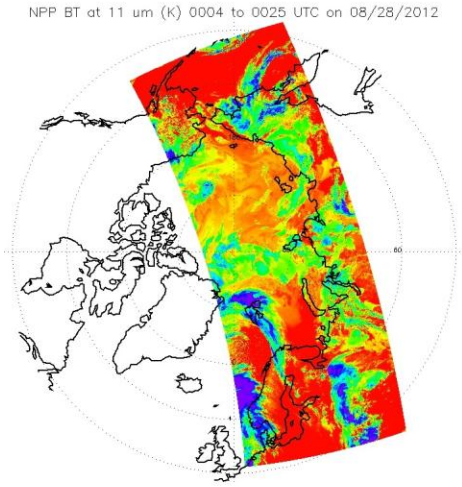


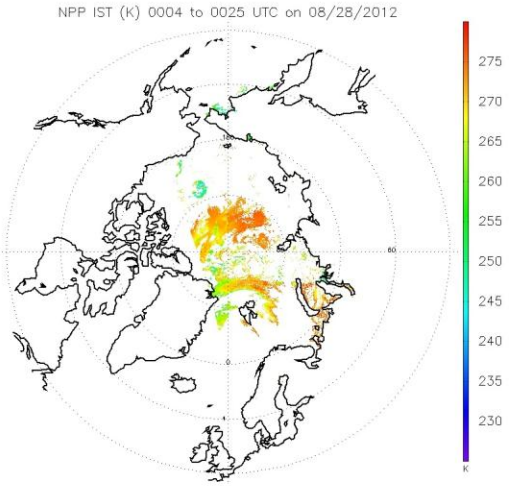
Comparison of cloud mask from NPP VIIRS and MODIS

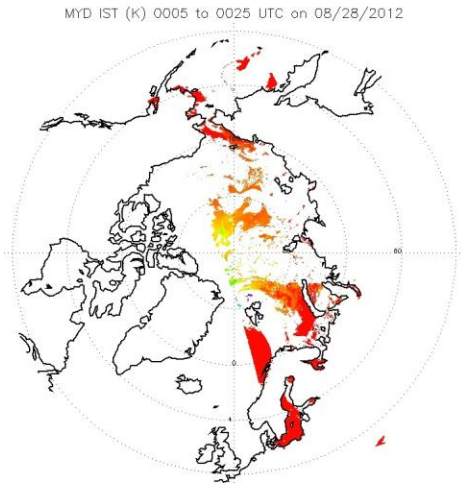


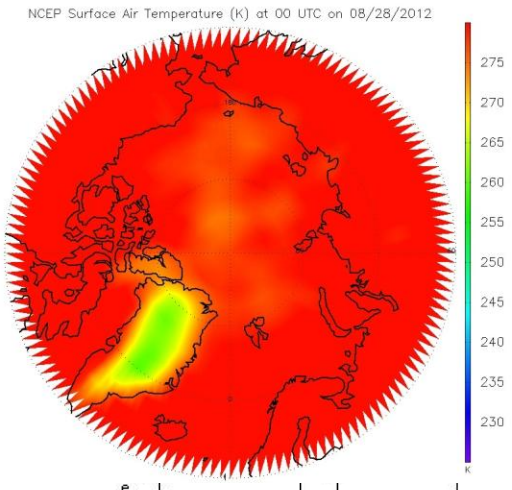


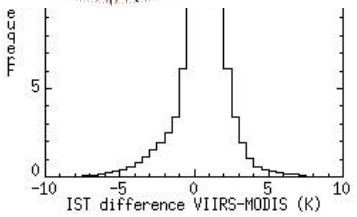
Automated Validation System Example (2/3)





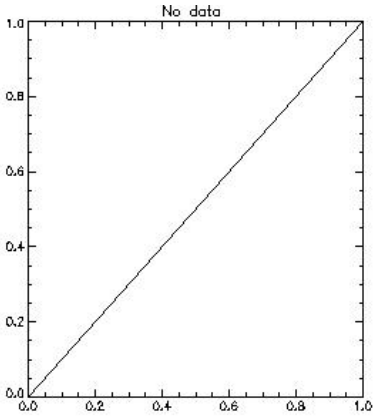


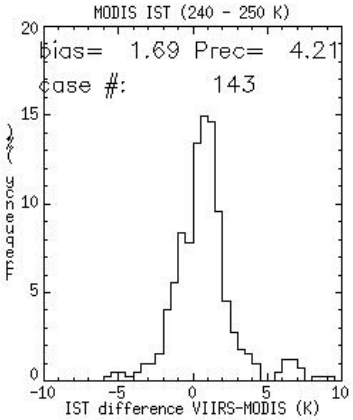


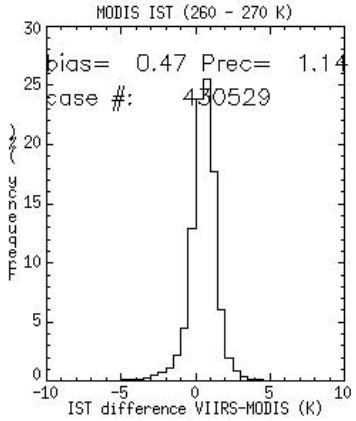


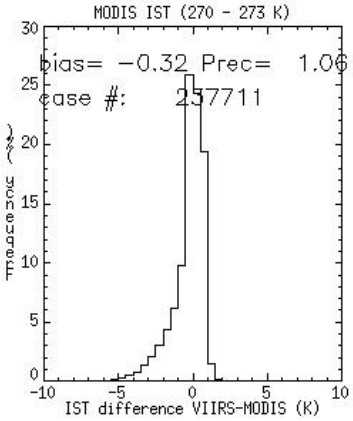
Comparison of IST from VIIRS and MODIS

Below: Statistical analysis of IST from NPP VIIRS and MODIS

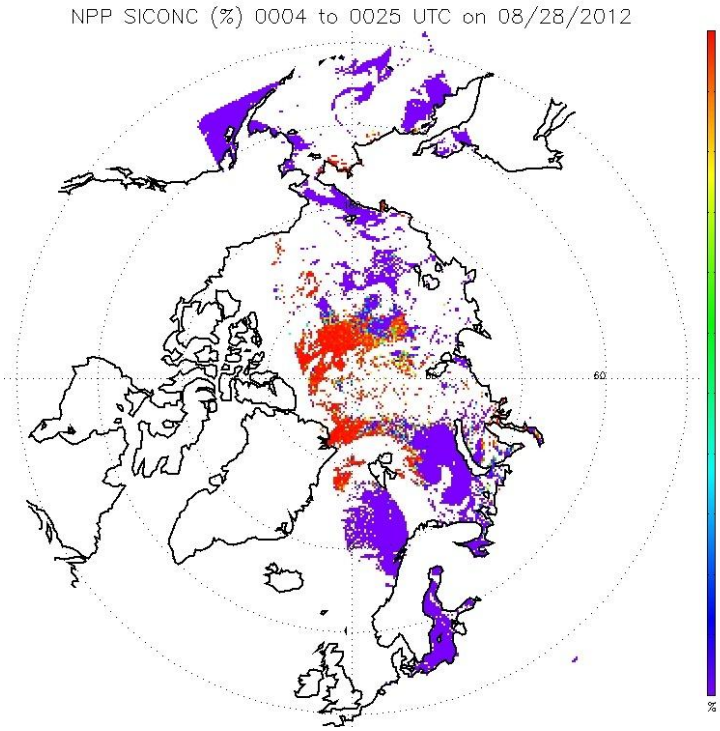


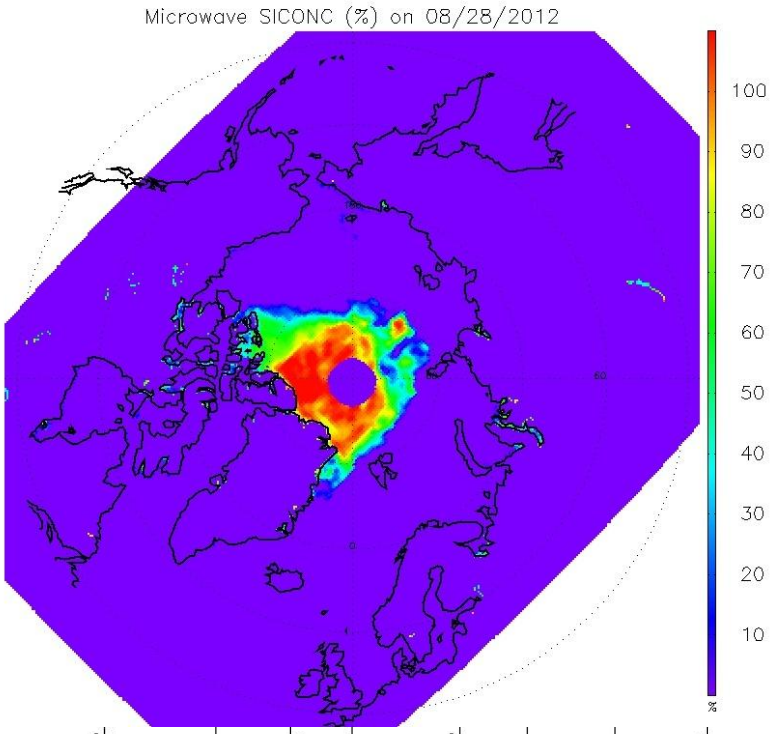


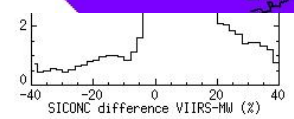


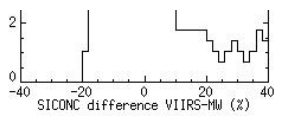


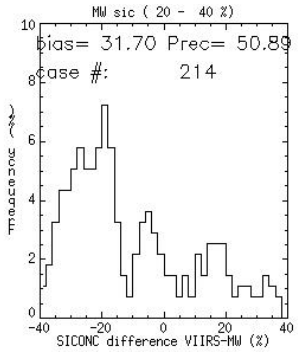
Automated Validation System Example (3/3)

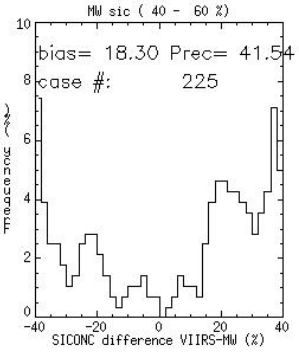


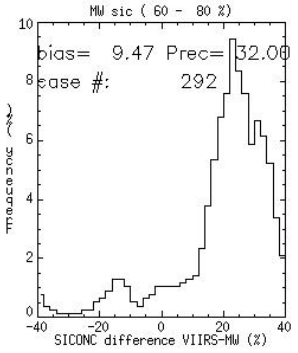


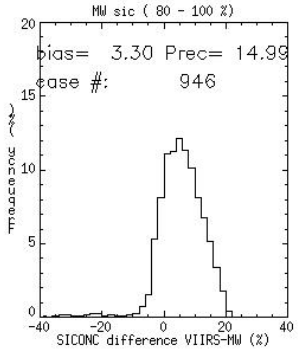












Comparison of SICO from VIIRS and microwave

Right: Statistical analysis of SICO from NPP VIIRS and Microwave

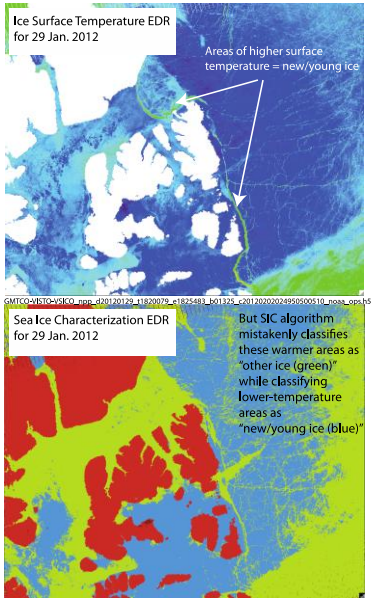
A Few Validation Results: Ice

Approach: (1) Use initial "quick-look" overview analyses and comparisons with other data sets to identify general performance , performance relative to meeting spec, and to detect possible algorithm problems. (2) Based on these analyses, assemble full suite of related data (quality flags, algorithm inputs, etc.) and near-coincident MODIS products for select granules to "drill down" through the data to identify possible causes for algorithm inaccuracies.

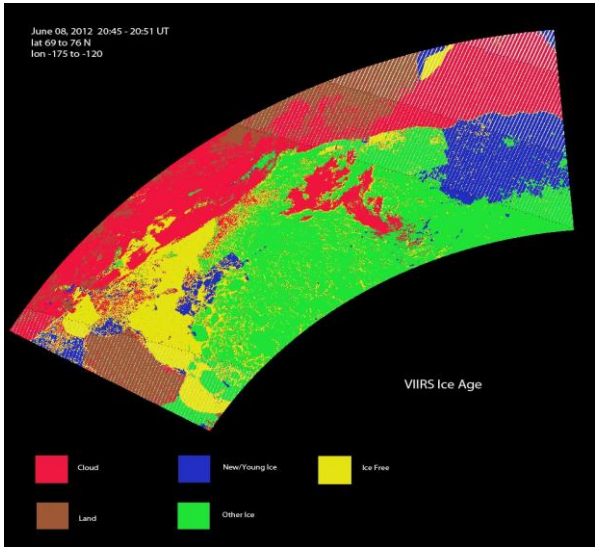
Selected Results to Date:

- Overview analyses identified discontinuities in the VIIRS cloud mask (VCM) over the polar regions. Discussion with VCM team led to changes in processing (removal of latitude dependency in an algorithm step).
- Validation of Sea Ice Characterization EDR yields different results depending on season:

In winter, areas with thin (warm) ice are missclassified as "other ice."



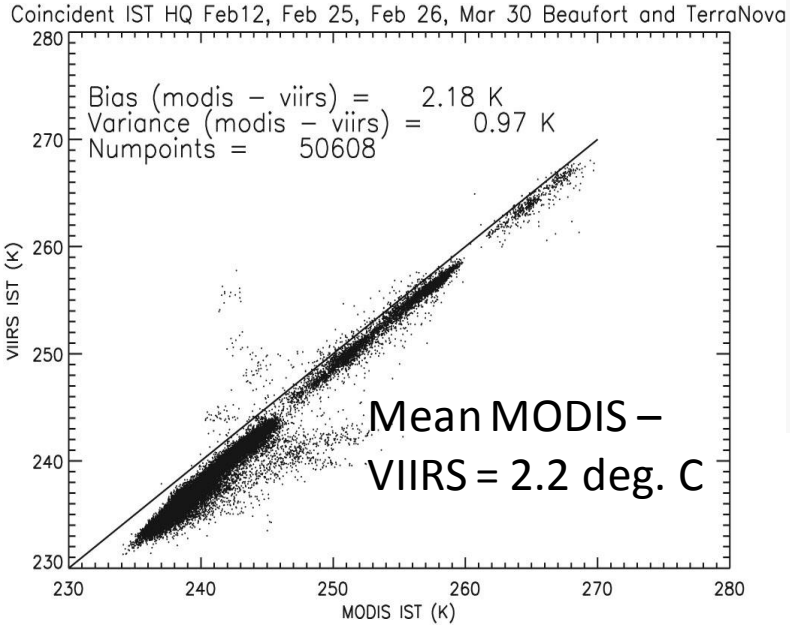
During melt season, some melting ice is classified as "new/young" ice.



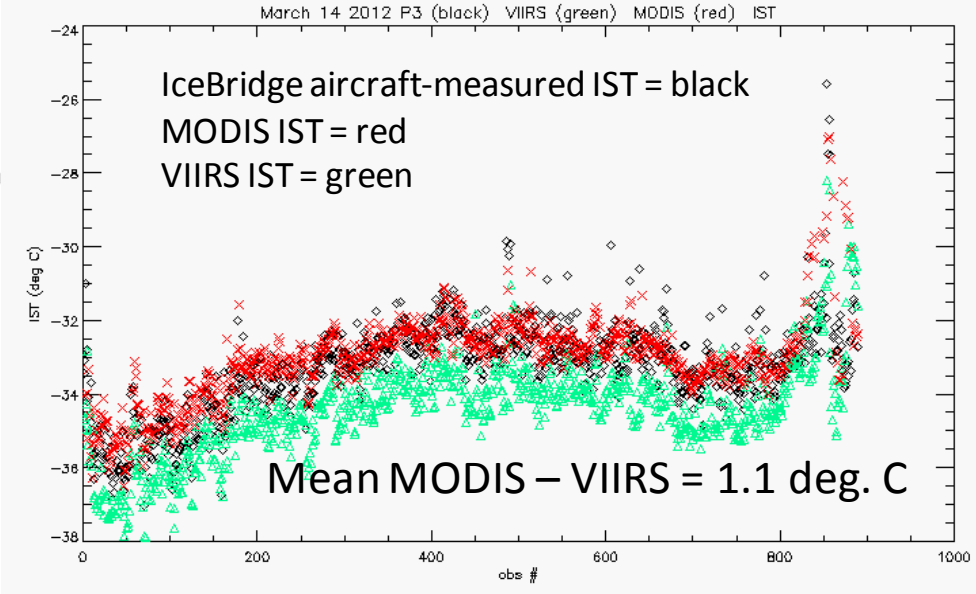
To find possible causes of misclassification, LUTs for prescribed snow depth and prescribed reflectances are being examined.

- Ice Surface Temperature assessments vs. MODIS and NASA IceBridge aircraft data suggest that VIIRS IST underestimates temperature by 1 to 2 deg. C.

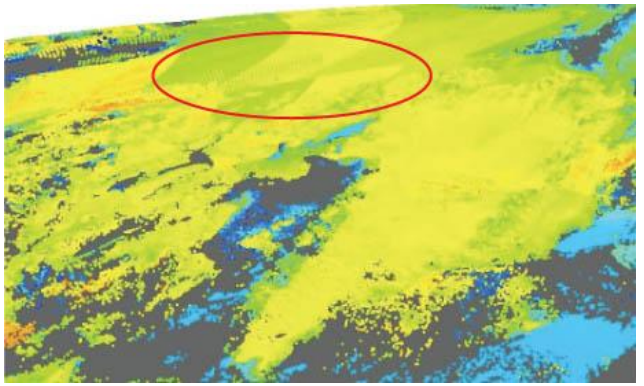
Combined results for near-coincident granules on Feb. 12, Feb. 25, Feb. 26 and March 30 for Arctic and Antarctic locations:



IST comparison along NASA P-3 flight track (March 2012):



- Banding in Albedo EDR over sea ice. Looks like a possible Bright Pixel Surface Albedo algorithm issue but Ice Albedo algorithm should be active:



FY12 Accomplishments: DRs

DR number	Short Description
2724 CLOSED	Resolve Energy Balance Disconnect between Ice Surface Temperature and Sea Ice Age Algorithms •DR closed because it was determined that a solution required the ability to distinguished between bare ice and snow covered ice, and that no such algorithm currently existed
4699 CLOSED	Replace Static September 2002 Snow-Ice Cover Rolling Tiles Seed Data •Closed, but spawned DRs 4769, 4770, and 4787
4700 Under Development	Implement Ingested Ancillary Snow-Ice Cover Data Source •Long-term solution to ingest "back up" microwave data (NOAA Global Automated Snow/Ice Cover Map) for snow-ice cover for regions where VIIRS Snow Cover EDR will provide no information (e.g., polar night)
4769 CCR AERB Approved	June 2012 Static Snow-Ice Cover Rolling Tiles Seed Data •Replace Static September 2002 Seed Data •Raytheon IDPS Incorporation In-Progress
4770 CCR AERB Deferred	Fast Track Status for Future Snow-Ice Cover Rolling Tiles Seed Data Updates •Deferred pending Raytheon/JPSS IDPS evaluation of process and level of effort involved in DR 4769
4787 CCR AERB Approved	Increase VIIRS-SNOW-COVER-QUAL LUT SZA Cutoff Thresholds from 60° to 85° •Avoid excluding potentially-valid data during Cal/Val •Cal/Val effort will determine appropriate values for cutoff thresholds

Scientific Advancements

- An evaluation of the likelihood that NG snow and ice EDRs will meet spec has shown that some will and some may not.
- Comparisons between algorithms have led to improvements in the characterization of physical processes, e.g., the daytime retrieval of ice thickness.
- Developed and evaluated potential modifications to the sea ice characterization and snow cover EDRs.
- Synergy with algorithm development for GOES-R ABI and, less directly, GCOM AMSR2.

Issues, Challenges, Setbacks

- DRs:
  - DR 4769/4770: Snow-Ice Cover Rolling Tiles Seeds
    - Fast Track Status for Seed Data (DR 4770) Depends on "trial run" with June Update (DR 4769), which has been slow
    - Impact on downstream users (VIIRS Cloud Mask EDR)
    - The proposal is to use a multi-sensor (microwave) NOAA snow/ice product as a backup.
  - DR 4700: Snow Cover EDR Gridding
    - Significant work to develop new ancillary data ingest prior to mid-November MxNext code cutoff
  - DR 4246: Snow Cover EDR Algorithm
    - 2x2 binning of imagery resolution data needs to be re-evaluated against current accuracy requirements
  - DR 4197: Sea Ice Characterization EDR Misclassifies New/Young Ice
    - Algorithm improvements under consideration, particularly the dependence on modeled snow depth
- Preparation for JPSS (post-NPP) satellites: Major algorithm changes may be necessary, so we are interested in the process for new algorithms.

Changes in Strategy (due to funding constraints)

- Minimal funding the first two years dictated that we focus on product validation and comparison rather than NG code. This is slowly changing.

FY-13 Schedule and Milestones

Major Activities:

- Validation
- Product comparison
- Tool development
- Algorithm change process

Major Milestones:

- Validation case study results for in situ and other satellite product comparisons with VIIRS data: January 1 – December 31, 2013 (new case studies always being added)
- Declare beta maturity of EDRs: October (?, it was Feb 2013 until recently)
- Analysis of NGAS cryosphere products with comparisons to NESDIS/CI algorithms and in situ data for all seasons: May 31, 2012
- Updated snow and ice validation and visualization tools: August 31, 2013
- Recommendations on major algorithm changes: December 31, 2013

Path Forward (FY-13 thru FY-17)

(assume "FYxx" runs from April 1, 20xx to March 31, 20xx+1)

	Suomi NPP	JPSS J1
FY13	Continue validation under a broader range of conditions; code changes for minor fixes; evaluate product improvements	Begin evaluation of potential algorithm changes; implement potential major algorithm changes in-house using NPP VIIRS data
FY14	Continue validation but over all conditions; code changes for more substantial fixes; evaluate product improvements	Gradually increase support to apply lessons learned from NPP; revisit requirements
FY15		
FY16		
FY17		

Summary

We continue to examine VIIRS snow and ice EDRs, identify problems, and explore solutions. Validation has been done through comparisons to in situ data and similar products - including our own - from other satellite sensors.

We have worked with NGAS and with other cal/val teams, notably the cloud and albedo teams, to identify interrelated problems and how to address them.

Bottom line: The Cryosphere Team's validation activities have identified a number of issues with the VIIRS snow and ice EDRs and IPs which have been, are being, and will be addressed. The result is improved product quality for NPP and the future JPSS satellites.