



Request for VIIRS Ice Surface Temperature EDR Beta Maturity

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Outline



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- Beta EDR Maturity Definition
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- Future Plans Toward Provisional Status
- Conclusions



VIIRS IST EDR Product Users



- U.S. Users

- NSIDC, National Snow Ice Data Center
- NIC, National/Naval Ice Center
- OSPO, Office of Satellite and Product Operations
- STAR, Center for Satellite Applications and Research
- GSFC, NASA/Goddard Space Flight Center Hydrological Sciences Branch
- NWS, National Weather Service, including the Alaska Ice Desk
- CLASS, Comprehensive Large Array-data Stewardship System

- User Community

- Navigation
- Emergency Management
- Operational Weather Prediction
- Climate Research
- DOD



Beta EDR Maturity Definition



- Early release product.
- Minimally validated.
- May still contain significant errors.
- Versioning not established until a baseline is determined.
- Available to allow users to gain familiarity with data formats and parameters.
- Product is not appropriate as the basis for quantitative scientific publication studies and applications.



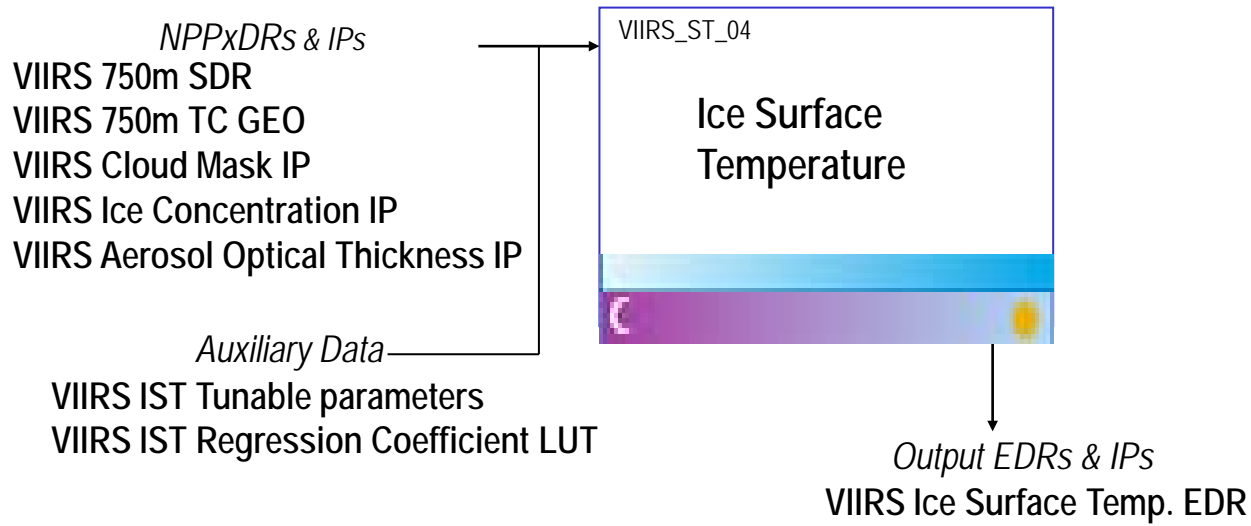
Summary of the VIIRS IST EDR



- The VIIRS Ice Surface Temperature (IST) EDR provides surface temperatures retrieved at VIIRS moderate resolution, for snow/ice covered oceans for both day and night.
- The baseline split window algorithm statistical regression method uses two VIIRS Infrared bands, 10.76 μm (M15) and 12.01 μm (M16) for both day and night and is based on the Advanced Very High Resolution Radiometer (AVHRR) heritage IST algorithm (Yu *et al.*, 1995).
- IST EDR performance is dependent upon on the quality of the input SDR brightness temperatures, VIIRS Cloud Mask IP cloud confidence, Ice Concentration IP, Aerosol Optical Thickness IP and regression coefficients derived from matchups between the VIIRS M15 and M16 top of atmosphere (TOA) brightness temperatures and truth surface temperature sources for snow/ice covered ocean surfaces

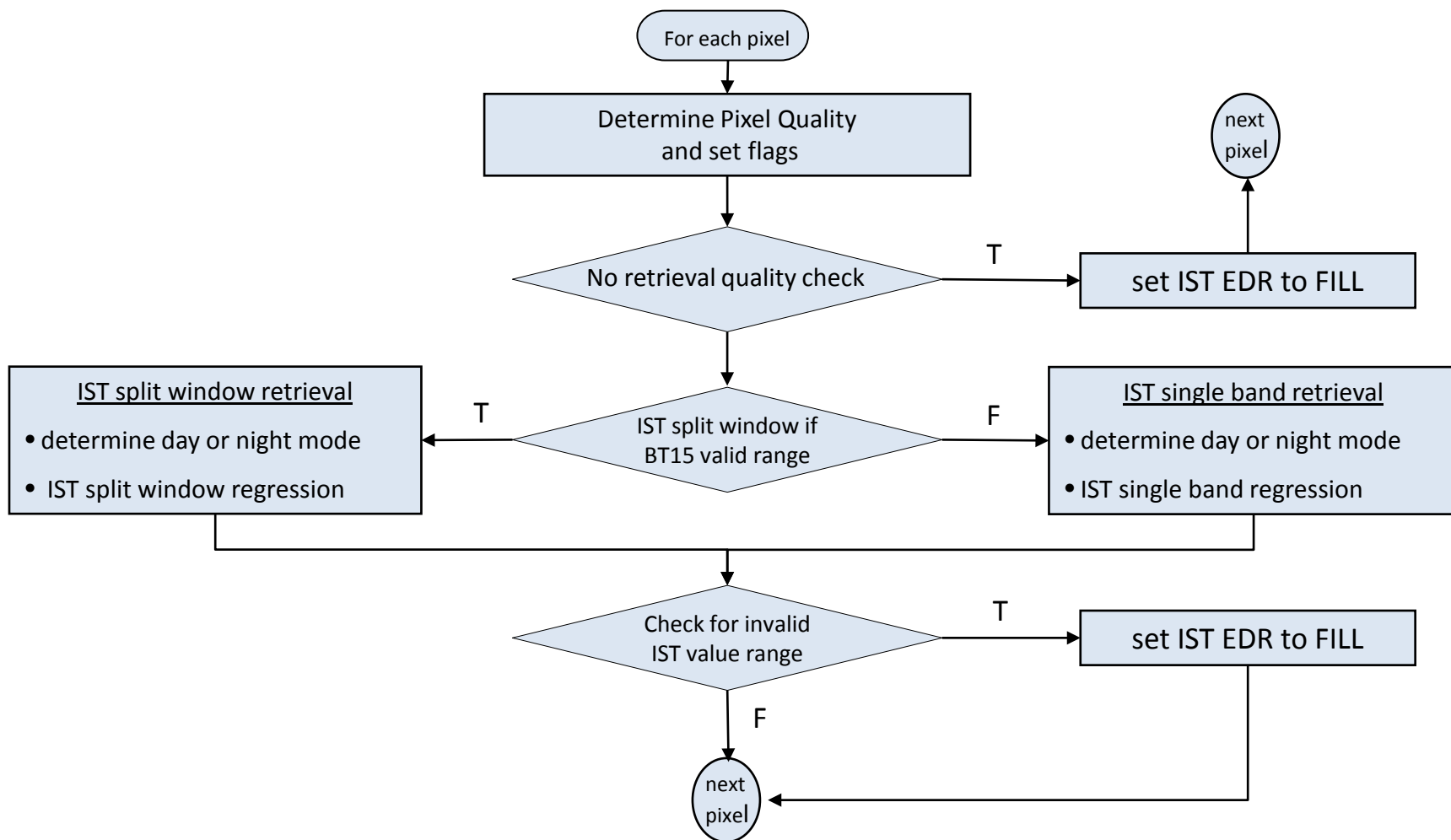


Summary of the VIIRS IST EDR Algorithm Inputs





Summary of VIIRS IST EDR Processing Flow





VIIRS IST EDR L1RD Requirements



Ice Surface Temperature (IST)

“IST is the radiating, or "skin", temperature at the ice surface. It includes the aggregate temperature of objects comprising the ice surface, including snow and melt water on the ice. Inland water bodies and coastal ice temperatures will be obtained from the LST EDR.

- As an objective, the Ice Surface Temperature EDR shall measure the atmospheric temperature 2 m above the surface of the ice.



VIIRS IST EDR L1RD Requirements (Continued)



Ice Surface Temperature (IST) Requirements from L1RD Supplement. v2.4

EDR Attribute	Threshold	Objective
IST Applicable Conditions 1. Clear, only		
a. Sensing Depth	Ice Surface	Ice Surface
b. Horizontal Cell Size 1. Nadir 2. Worst Case	1 km 1.6 km	0.1 km 0.1 km
c. Mapping Uncertainty, 3 sigma 1. Nadir 2. Worst Case	1 km 1.6 km	0.1 km 0.1 km
d. Measure Range	213-275 K	213-293 K (2 m above ice)
e. Measurement Uncertainty	1 K	
f. Refresh	At least 90% coverage of the global every 24 hours (monthly average)	12 hrs
g. Geographic Coverage	Ice-covered oceans	All ice-covered waters



History of Algorithm changes/updates



Date	Update/DR#	Reason	Status
04-17-2013	7138	IST EDR OAD Corrections	open
04-17-2013	7137	IST EDR ATBD Section 2.3 Wording Error Correction	open
11-18-2011	4457	EDR PR to define mid quality criteria	open
11-18-2011	4456	EDR PR update to Define the exclusion criteria for quality summations	open
11-18-2011	4455	Update EDR PR to define high quality retrievals	open
12-22-2010	4136	ECR A-337 Dec 10 Look Up Table drop	request closure
07-17-2009	2936	Ice Surface Temp and IST use different emissivities for ice	Deferred for future re-evaluation



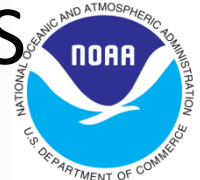
Beta Maturity Evaluation



- Beta Maturity Evaluation Approaches
 - Visualizations and quantitative comparisons of daily global gridded VIIRS IST, comparison with MODIS IST and NCEP surface air temperature, Ice Bridge flight IST
 - Time series analysis and bias analysis
 - NH analysis dates: 1/29/2012, 2/1/2012, 3/14/2012
 - SH analysis dates: 4/10/2012
 - Beaufort Sea analysis dates: 3/14/2012 (IceBridge), 2/12/2012, 2/25/2012, 2/26/2012, 3/30/2012
 - Terra Nova Bay analysis dates: 2/12/2012, 2/25/2012, 2/26/2012, 3/30/2012



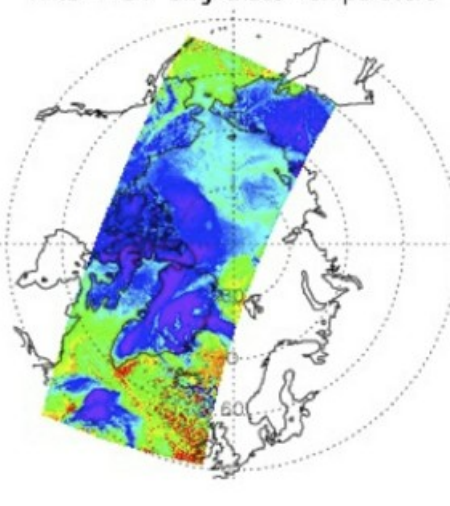
Beta Maturity Evaluation – Comparison VIIRS IST with MODIS and NCEP



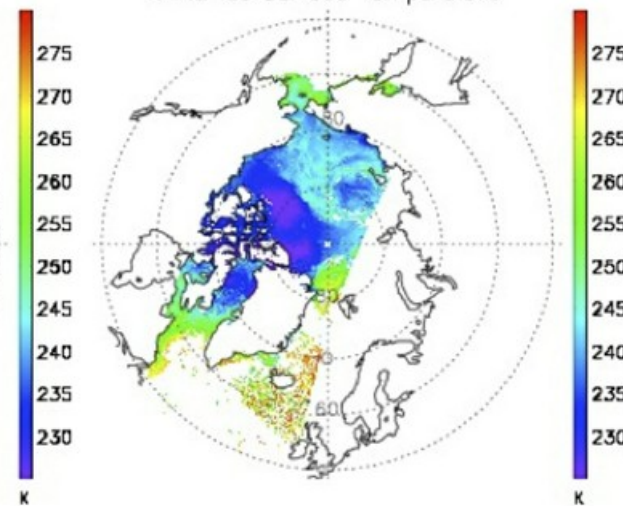
Ice Surface Temperature (IST) EDR validation activities have shown that VIIRS IST has a 1-2 K cold bias relative to the MODIS Ice Surface Temperature product. The bias for VIIRS Land Surface Temperature over the ice sheet (not shown) is less than for IST.

Comparisons to NCEP and International Arctic Buoy Program (IABP) air temperatures show a similar spatial pattern but yield a VIIRS cold bias of approximately 4 K, which is the opposite of the MODIS comparison. The comparison confirms the validity of the MODIS IST. **Note that this bias appears to be less with recently re-processed data.**

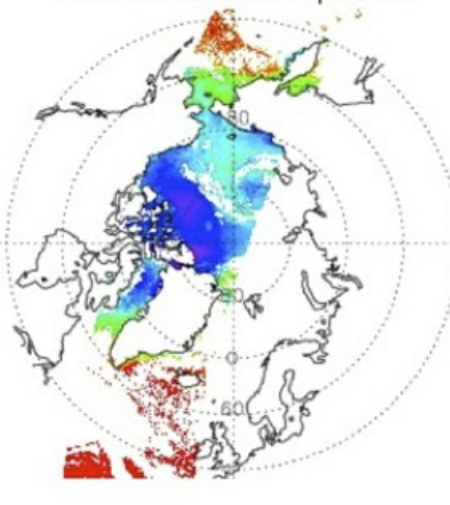
VIIRS 11um Brightness Temperature



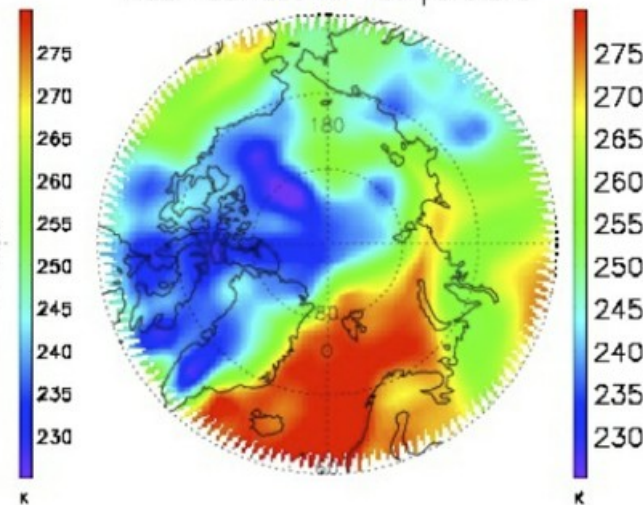
VIIRS Ice Surface Temperature



MODIS Ice Surface Temperature



NCEP Surface Air Temperature

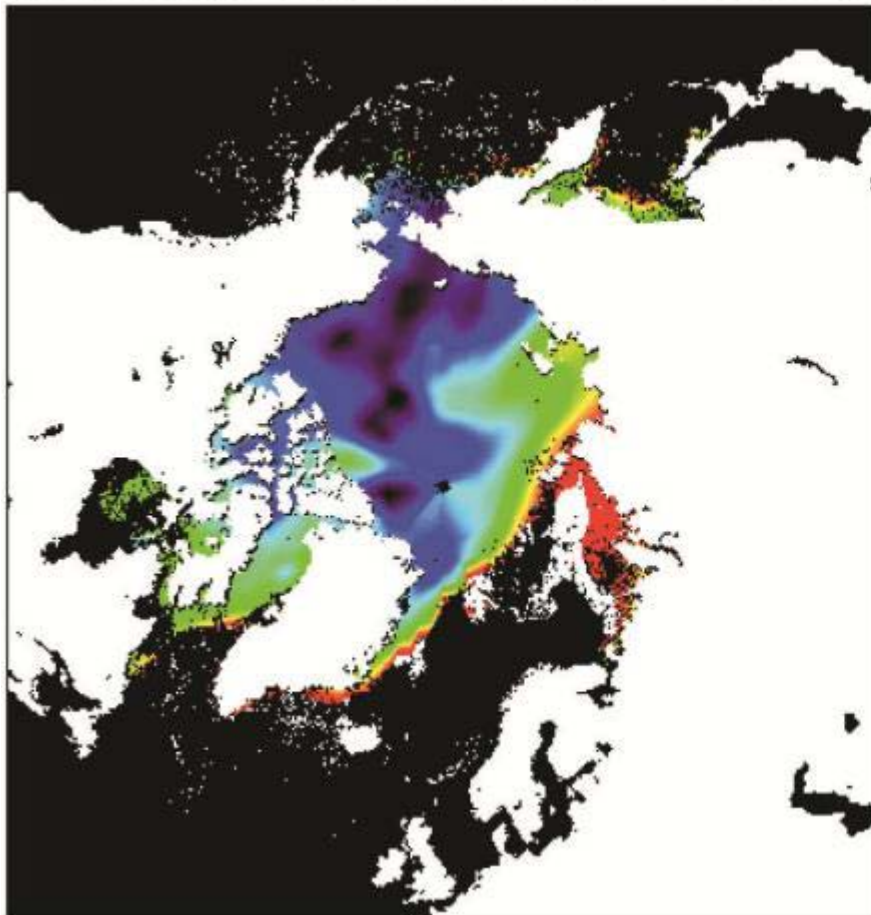




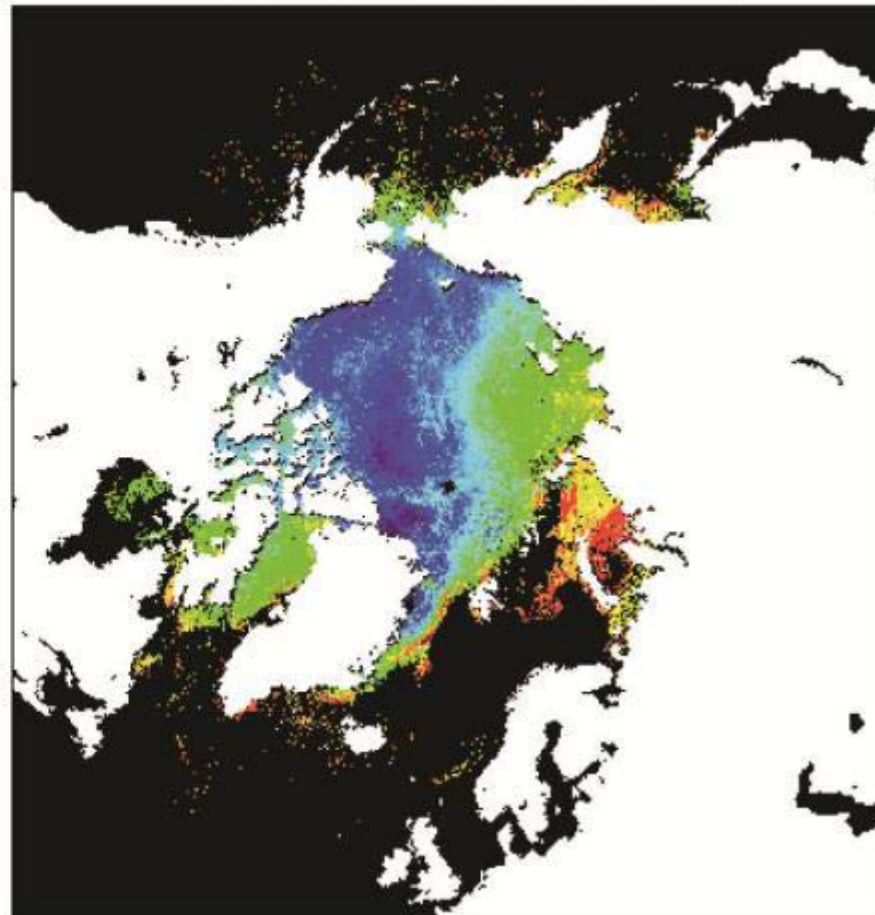
Beta Maturity Evaluation – NH comparison



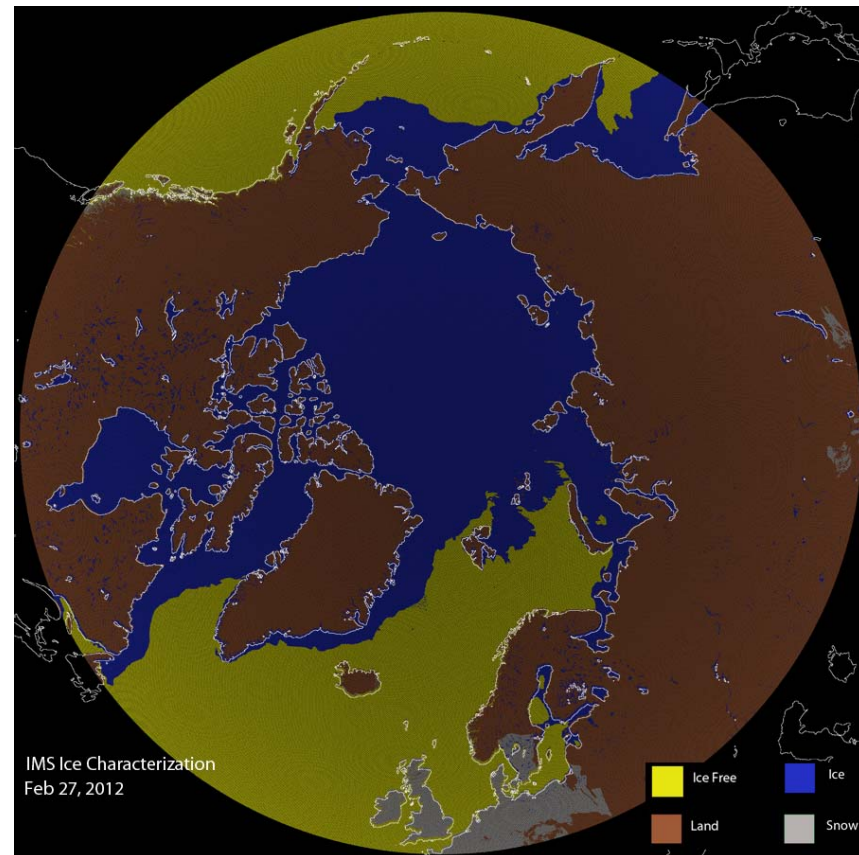
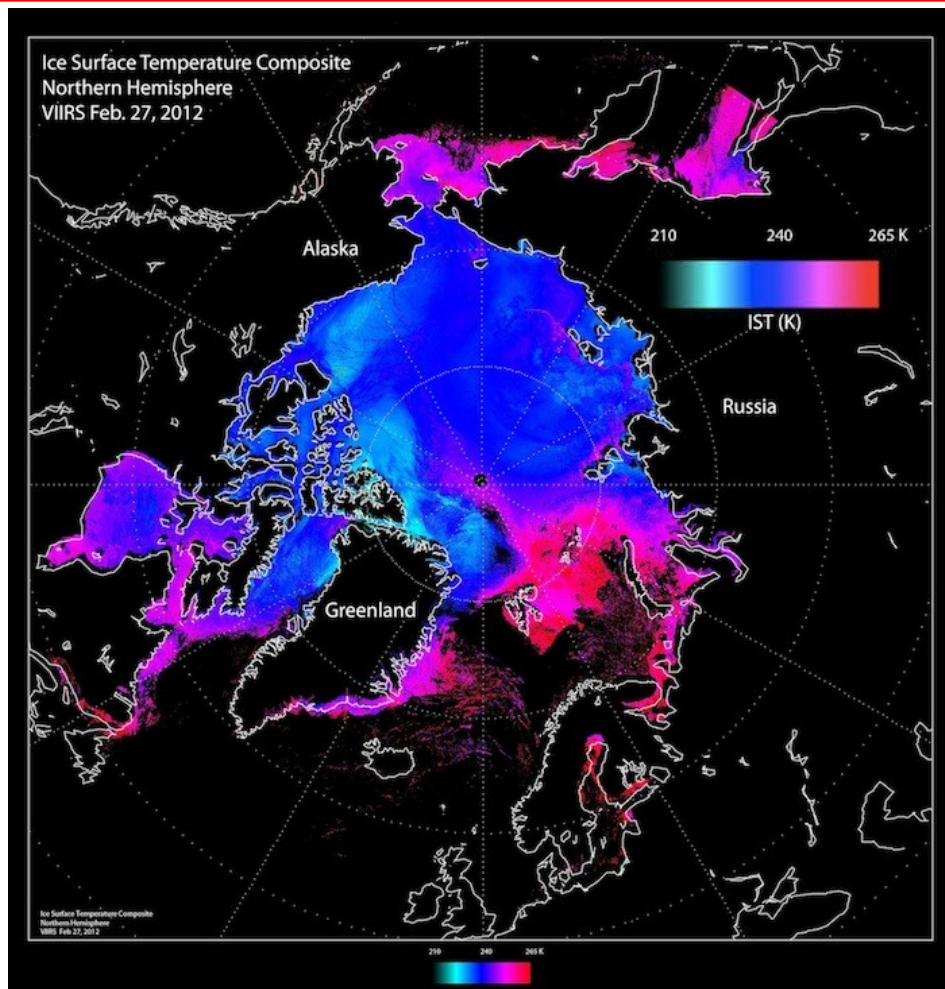
NCEP surface temperature (range = 220K to 270K)



VIIRS IST (range = 220K to 270K)



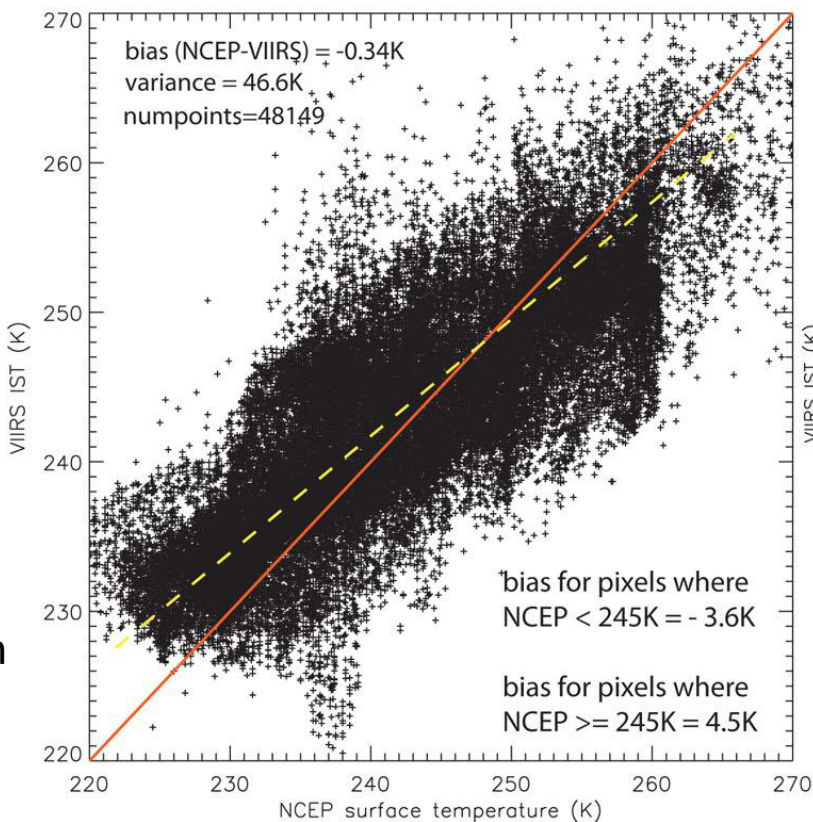
NCEP vs. VIIRS IST, Feb 27, 2012. Spatial patterns appear consistent.



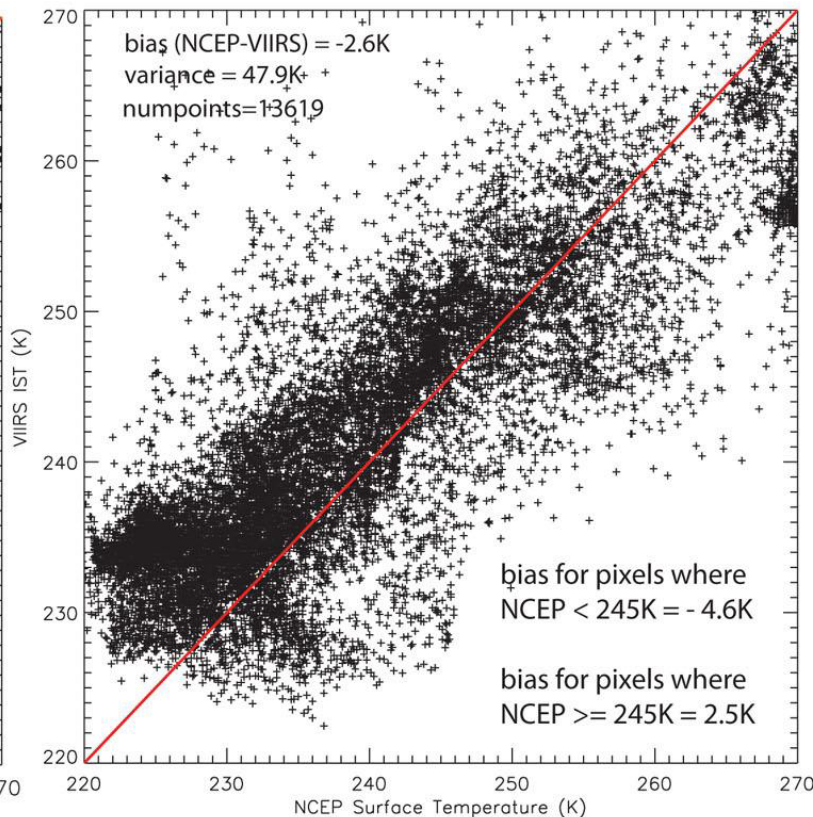
Left: IST EDR for Feb 27, 2012. Right: Corresponding IMS ice data, showing reasonable correspondence of sea ice location.

VIIRS is biased high (too warm) compared to NCEP reanalysis (opposite of the MODIS & IceBridge results). Bias increases with decreasing temperature.

Comparison of VIIRS IST with NCEP surface temperature for 29 Jan. 2012 Arctic composite

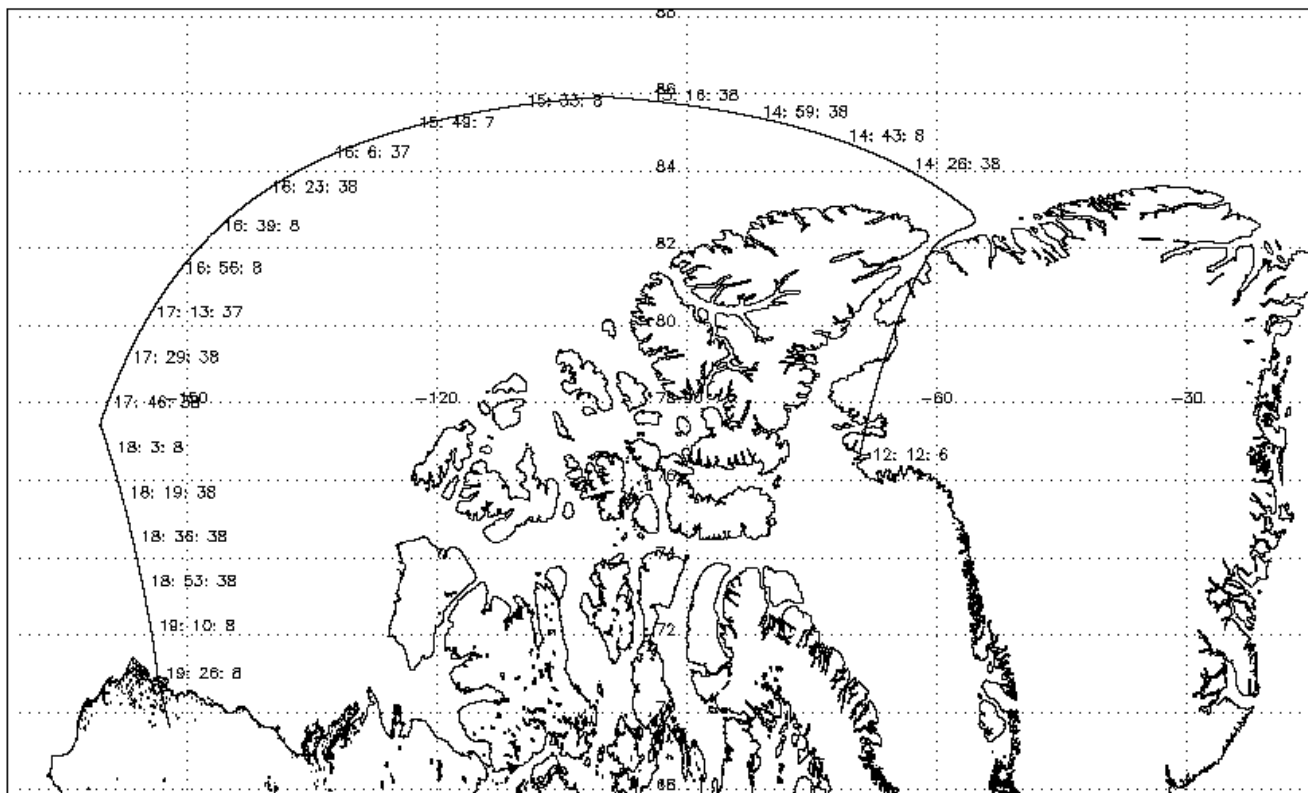
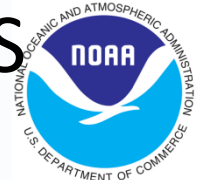


Comparison of VIIRS IST with NCEP surface temperature for 1 Feb. 2012 Arctic composite





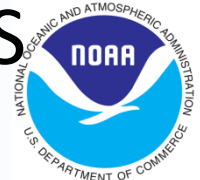
Beta Maturity Evaluation – Comparison VIIRS IST EDR with IceBridge Flight IST



Track of the NASA P-3 aircraft for the March 14, 2012 IceBridge flight. UTC times are shown along the track. The P-3 flew at an altitude of 1000 ft over the sea ice. Among several instruments, it carried a KT-19: a downward-pointing, IR pyrometer that measures the surface temperature (in this case, the IST). The KT-19 measurements are considered Beta as of this writing.



Beta Maturity Evaluation – Comparison VIIRS IST EDR with IceBridge Flight IST

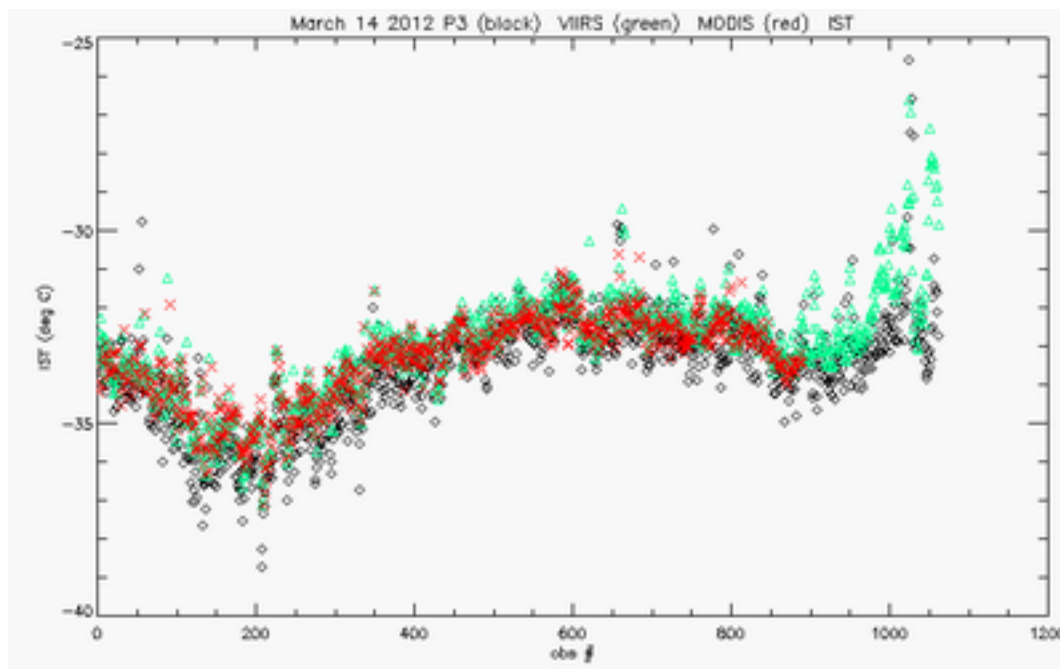


NASA's Land PEATE re-processed portions of the VIIRS IST EDR that are co-incident with IceBridge flights over sea ice during March and April 2012. The resulting VIIRS IST EDR shows much better agreement with the ice surface temperature observed by the IceBridge P-3 aircraft 's KT-19 instrument than the previous IST EDR data produced in March 2012.

A comparison of IST measured by the NASA P-3 aircraft's KT-19 instrument (J. Yungel, PI) and the VIIRS IST EDR

mean VIIRS = -33.2358 °C
mean KT-19 = -33.7450 °C
mean MODIS = -33.3882 °C

VIIRS - KT-19 = +0.5092 °C
MODIS- KT-19 = +0.3568 °C
VIIRS – MODIS = +0.1524 °C



Comparison between the IST (in deg C) measured by the KT-19 (in black, smoothed over 100 points), the nearest VIIRS IST measurement (in green) and MODIS observation (red). The comparison is for the leg from 16:03:37 -19:10:08 (west of -120 lon). The VIIRS overpass occurred from 16:01 - 16:06 UTC . VIIRS, MODIS, and the KT-19 IST's show consistent good agreement along the flight track, with VIIRS close to meeting the 0.5 °C (or K) spec.



Beta Justification Summary



- **Criteria: Early release product**
 - IST EDR performance is dependent on VIIRS SDR, VIIRS Cloud Mask IP, Ice Concentration IP, Aerosol Optical Thickness IP and IST Regression Coefficients
 - VIIRS SDR Cal and Geo products reached provisional maturity in March, 2013.
 - VIIRS Cloud Mask IP reached provisional maturity in February, 2013
 - VIIRS Aerosol Optical Thickness reached beta maturity in September 2013
 - VIIRS Ice Concentration IP beta maturity pending approval
- **Criteria: Minimally validated**
 - Evaluation is based on a limited number of focus days (global comparisons for retrieval products)
 - Some detailed analysis has been done on other days with a limited set of granules focused on a region



Beta Justification Summary



- Criteria: Available to allow users to gain familiarity with data formats and parameters
 - Cryosphere IST EDR team has evaluated IDPS EDR products available from CLASS
 - Users can access and read the products and the product compares reasonably with the heritage satellite snow map products
 - Beta release will allow other users within the community to gain experience with the data formats and parameters.
 - This is important to allow users to complement the validation activity.



Beta Justification Summary



- Criteria: Product is not appropriate as the basis for quantitative scientific publication studies and applications
 - The product has known flaws (see caveats slides later in this presentation), but these products are of sufficient quality to justify use by a broader community
 - Most of the issues
 - IST EDR contains retrievals over false ice retrieved by the VIIRS Sea Ice Concentration IP. Some of the false ice retrieved by the VIIRS Sea Ice Concentration IP has been linked to cloud leakage from a VIIRS Cloud Mask (VCM) which is still maturing and out of date Grid-VIIRS-Snow-Ice-Cover-Rolling Tiles (not update daily) that affects the VCM performance
 - IST EDR surface temperature performance bias exists but is expected to improve with updated regression coefficients but the bias has been observed to be reduced by examining re-processed data with more recent IDPS code, primarily due to improvements in the VIIRS Cloud Mask.



Caveats for Operational VIIRS IST EDR (additional issues)



- List known problems and proposed technical solutions if there are any
 - Examination of the VIIRS IST EDR shows temperature over false ice retrieved by the Sea Ice Concentration IP. Such errors will be reduced with MX 8.0 VIIRS Cloud Mask update and implementation additional quality checks in the Sea Ice Concentration IP for future builds beyond MX 8.0
 - Current IST bias should be reduced with updated IST regression coefficients based on matchup of VIIRS M15, M16 TOA brightness temperatures with surface temperature truth. Evidence of lower bias has been shown with IceBridge IST comparisons.



Additional Supporting Documentation



- TIM Meetings and Presentations
 - Cal/Val Team Meeting, April 2012
- Monthly/weekly reports
<https://groups.ssec.wisc.edu/groups/jpss/cryosphere/reports>



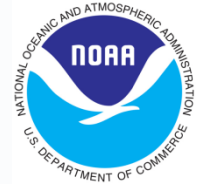
Future Plans and Issues



- No code changes currently planned
- Detailed performance characterization requires:
 - Update of IST regression coefficients based on matchup with VIIRS and truth IST sources
- Major actions for the provisional maturity justification and schedule
 - Ability to check for reduced quality VIIRS Ice Concentration IP input based on quality flags to with additional quality checks to be added to the Ice Concentration IP



Conclusion



- VIIRS IST EDR has met the beta maturity stage based on the definitions and the evidence shown
 - It exceeds the definition of beta in most cases
 - Off-line EDR product performance overall is close to meeting requirements at this time and meets requirements in some cases. It continue to improve.
- Some issues have been uncovered during validation and solutions are being evaluated.
 - Improvements in IST EDR performance may be realized as the VIIRS Cloud Mask IP matures and additional quality flags become available in the VIIRS Ice Concentration IP to avoid IST retrievals near clouds