SUOMI- NPP VIIRS ICE SURFACE TEMPERATURE STATUS

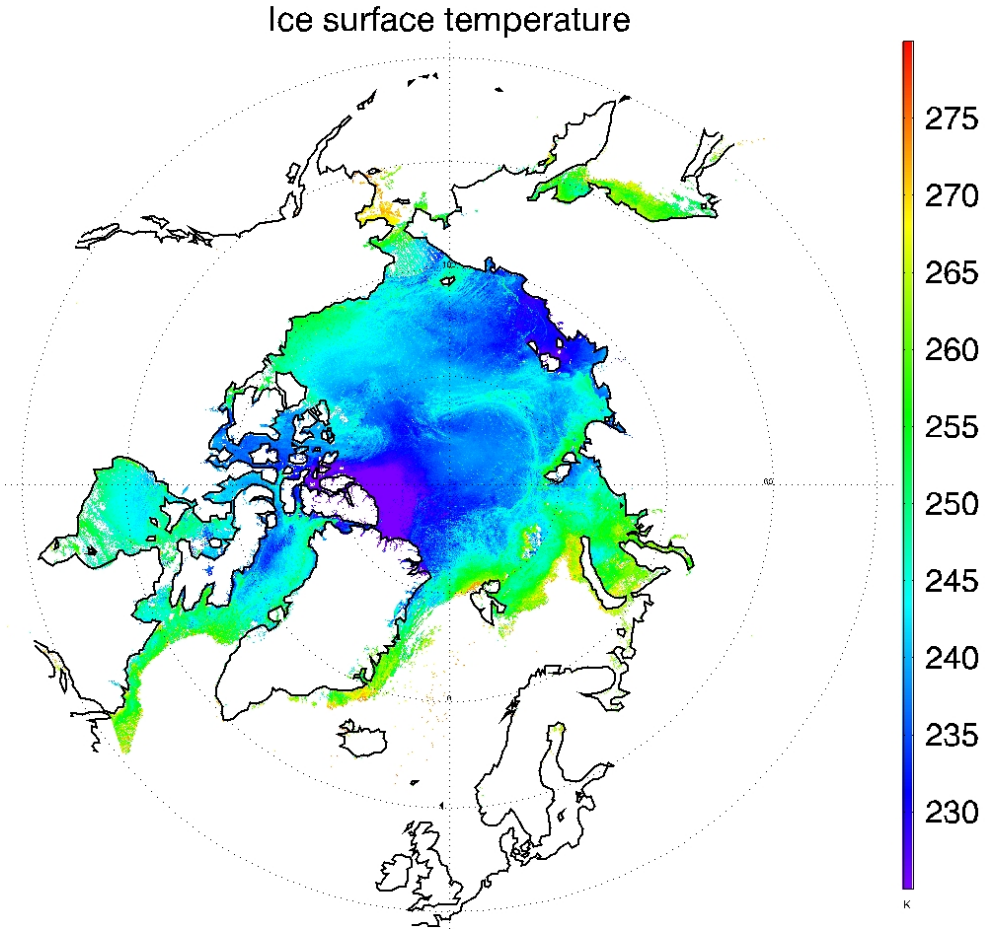
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Cryosphere: with J. Key, Y. Liu, R. Dvorak, X. Wang, A. Letterly

Cal/Val Team Members

PI	Organization	Team Members	Roles and Responsibilities
J. Key	NOAA NESDIS	M. Tschudi Y. Liu R. Dworak X. Wang A. Letterly	Ice conc & thickness cal/val IST development, cal/val IST cal/val Ice thickness development, cal/val NDE cryo products assessment

VIIRS Ice Surface Temperature

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.



Ice surface temperature (IST) composite from all overpasses over the Arctic on March 1, 2015. From *Liu et al*., 2015.

Summary of the VIIRS IST EDR

- The VIIRS Ice Surface Temperature (IST) EDR provides surface temperatures retrieved at VIIRS moderate resolution (750m), for Arctic and Antarctic sea ice for both day and night.
- The baseline split window algorithm statistical regression method is based on the IST algorithm of *Key and Haefliger.,* 1992:

$$IST = a + bT_{11} + c(T_{11}-T_{12}) + d(T_{11}-T_{12})(\sec(z)-1)$$

T_{11} and T_{12} : TOA TB's for ~11 and 12 μm bands
z: satellite zenith angle
a, b, c, d: regression coefficients.

- Threshold Measurement Uncertainty = **1K** over a measurement range of 213–275 K.

Key, J., and M. Haefliger (1992), Arctic ice surface temperature retrieval from AVHRR thermal channels, J. Geophys. Res., 97(D5), 5885–5893.

VIIRS IST Validation Approach

Validation Dataset	Parameter	Spatial Resolution	Spatial Coverage
NASA IceBridge KT-19 IR Surface Temperature	Snow/ice temperature	15 x 15 m	Arctic and Antarctic
MODIS Ice Surface Temperature	Snow/ice temperature	1 km	Arctic and Antarctic
MODIS simultaneous nadir overpass	Snow/ice temperature	0.05 degree longitude by 0.05 degree latitude	Arctic
Arctic drifting buoy	2 m air temperature	Point observations	Arctic
NCEP/NCAR reanalysis	Air temperature at 0.995 sigma level	2.5 x 2.5 degree latitude/longitude	Arctic and Antarctic

VIIRS IST EDR Validation with IceBridge IST

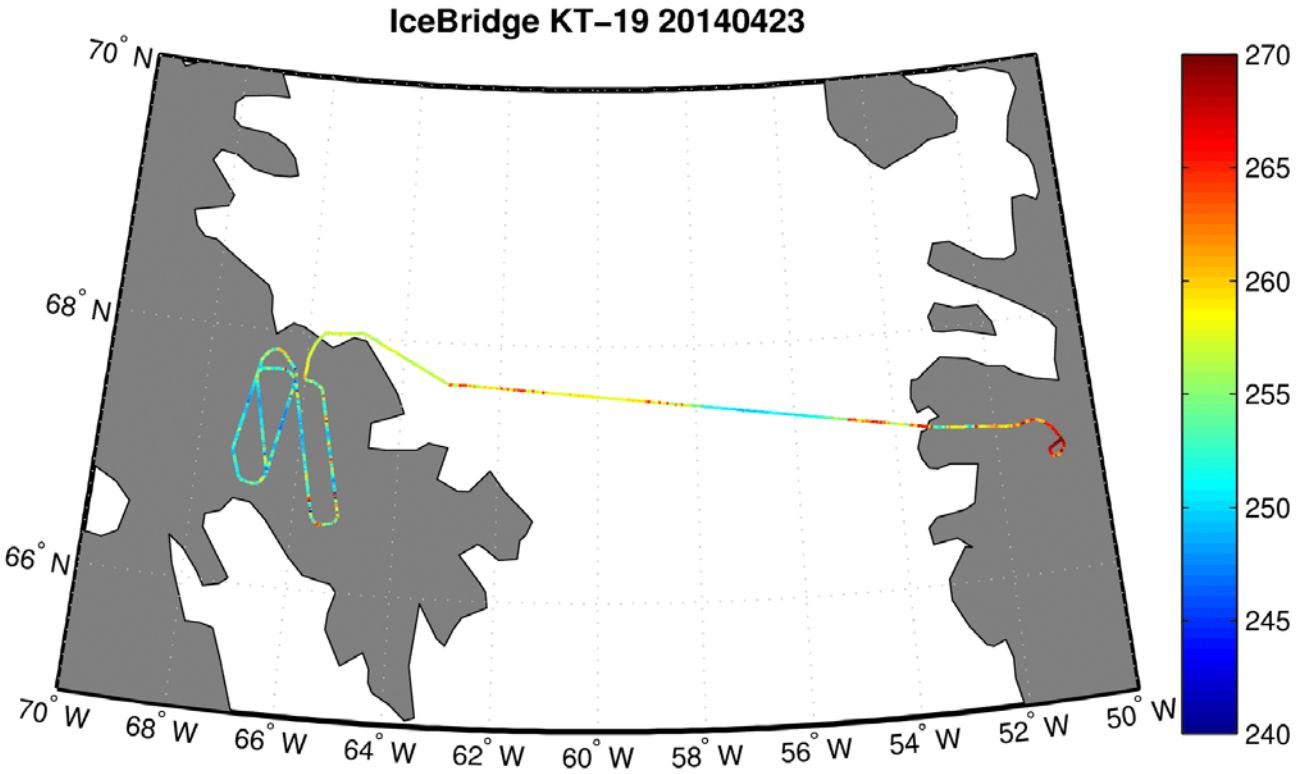
- IceBridge NASA P-3 aircraft carries a KT-19: a downward-pointing, IR pyrometer that measures IST
- No atmospheric corrections applied
- Spot size = 15m
- Resolution = 0.1° C
- Sampling = 10Hz





Krabill, W. B. and E. Buzay. 2012, updated 2014. IceBridge KT19 IR Surface Temperature. Boulder, Colorado USA: NASA DAAC at the National Snow and Ice Data Center.

IceBridge IST flickers with NDE IST, April 23, 2014

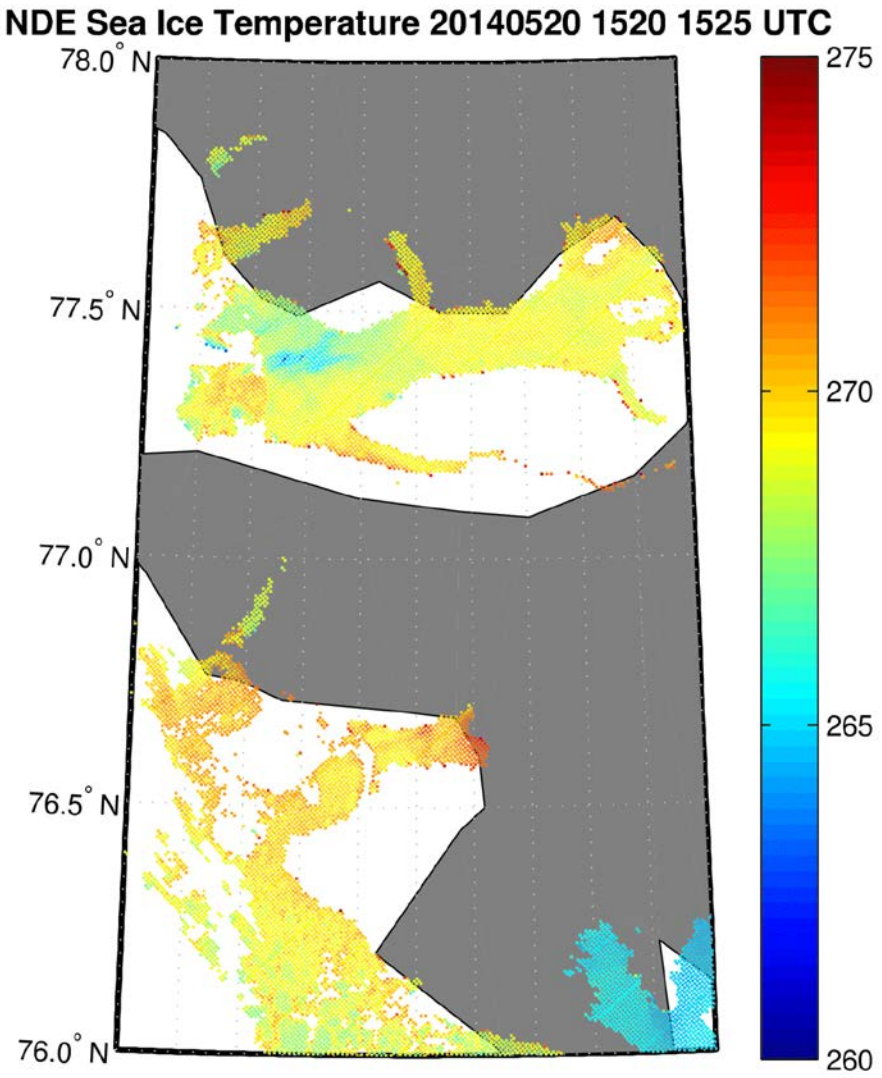


Ice Bridge flight over Western Greenland, Baffin Bay and Baffin Island

NDE was 2.3 K warmer than KT-19

IDPS was 1.9 K warmer

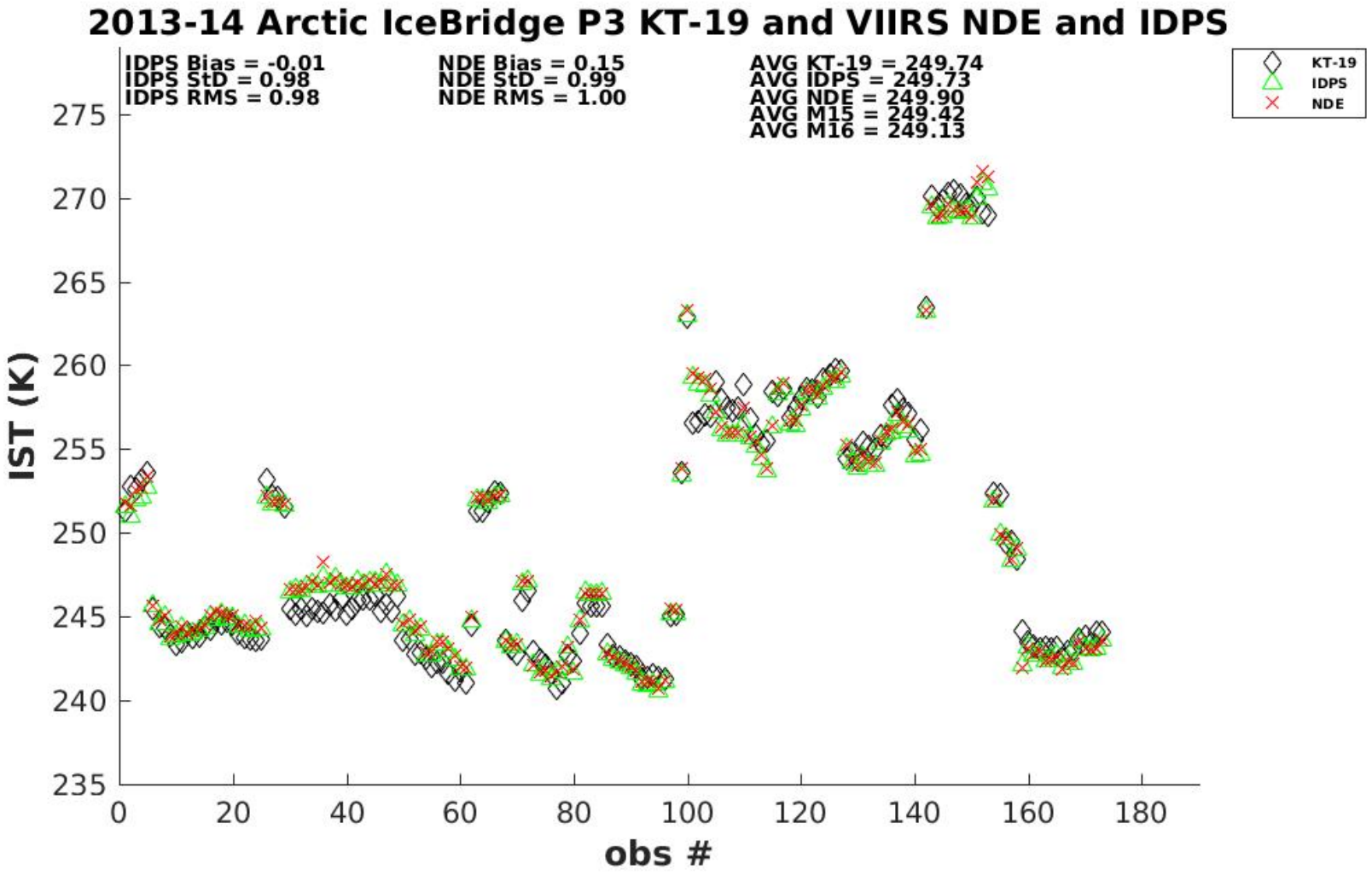
Another NDE / IceBridge IST flicker



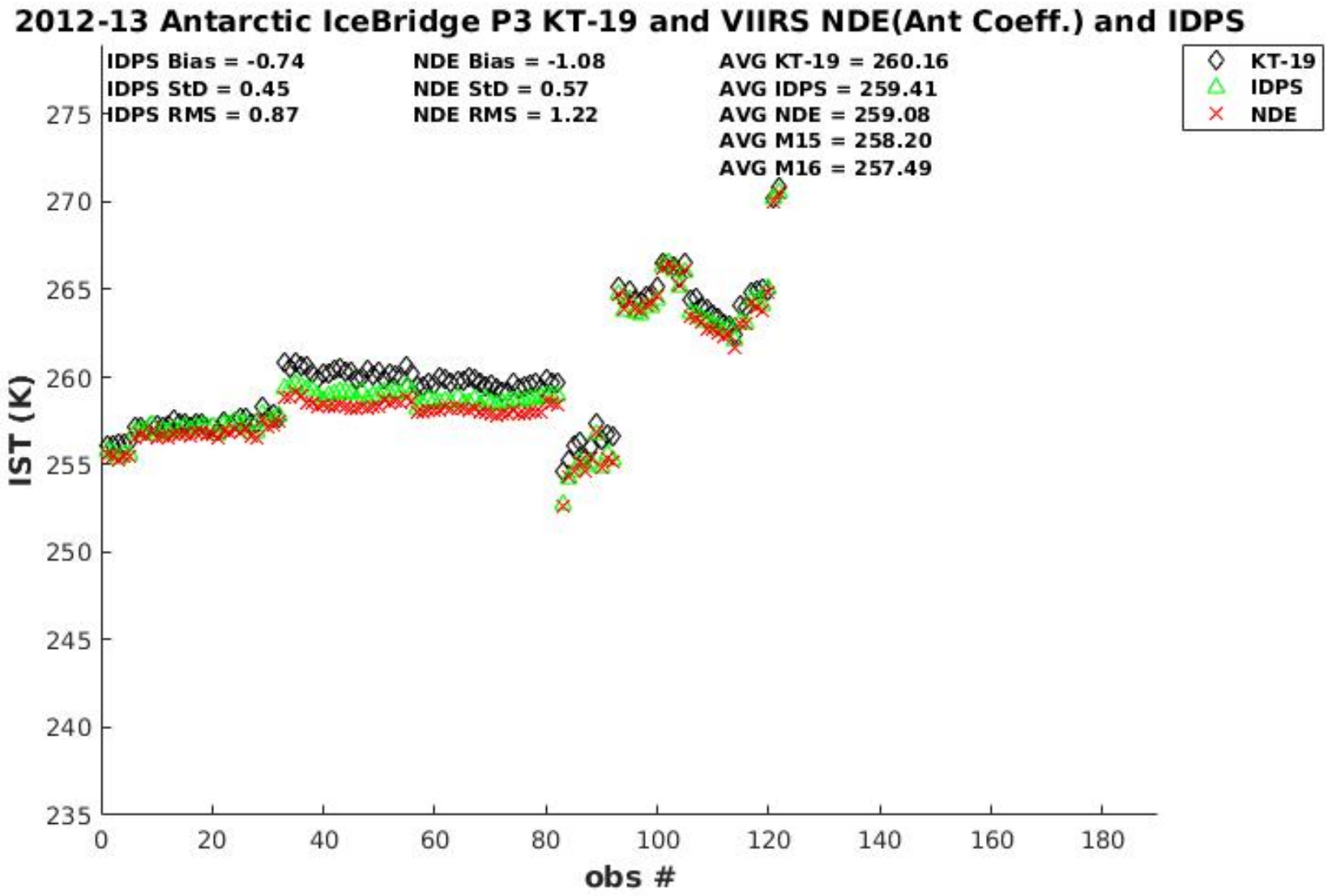
Over this scene along NW Greenland coastline NDE was on average 0.7 K colder than KT-19 Ice Surface Temp.

not shown: IDPS was 0.8 K colder

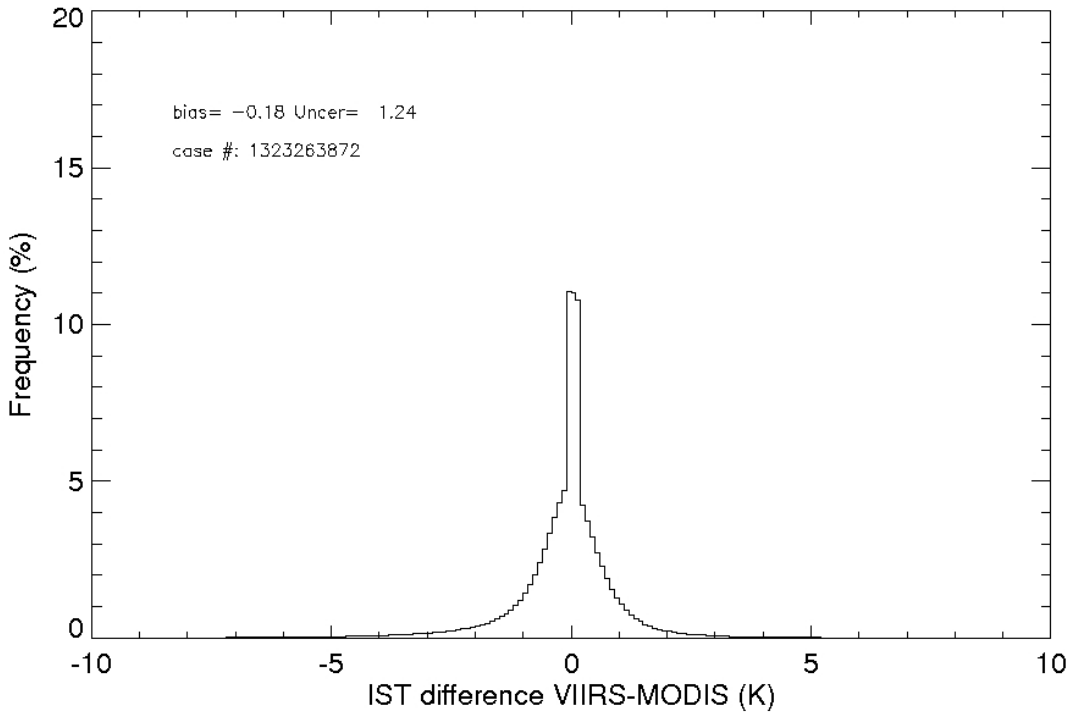
VIIRS IST IceBridge Validation



Antarctic KT-19, VIIRS NDE & IDPS IST



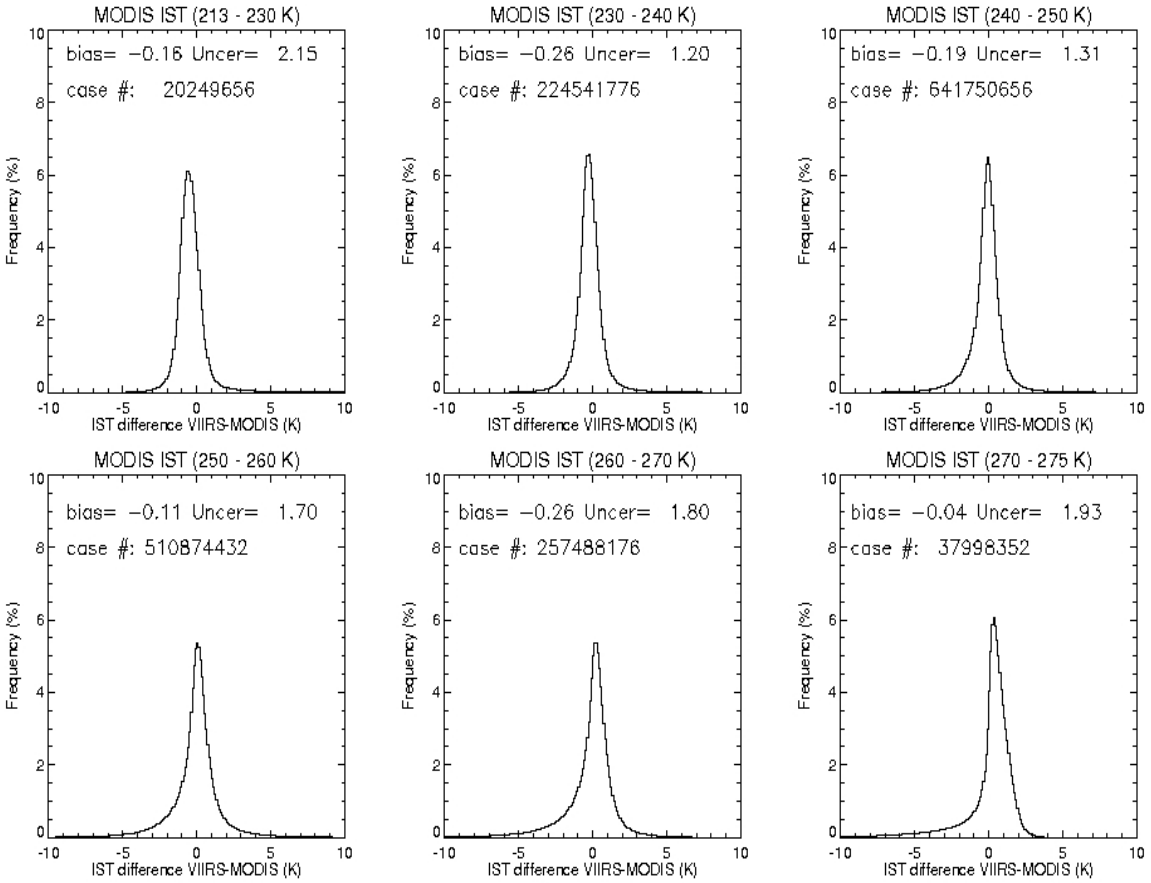
VIIRS / MODIS IST Inter-comparison



Differences between NPP VIIRS and MODIS (Aqua and Terra) IST in the Arctic from August 2012 to July 2015.

From: *Yinghui Liu, Jeffrey Key, Mark Tschudi, Richard Dworak, Robert Mahoney, and Daniel Baldwin*, 2015: Validation of the Suomi NPP VIIRS Ice Surface Temperature Environmental Data Record, *Remote Sens.* **2015**, *7*, 13507-13527; doi:10.3390/rs71013507

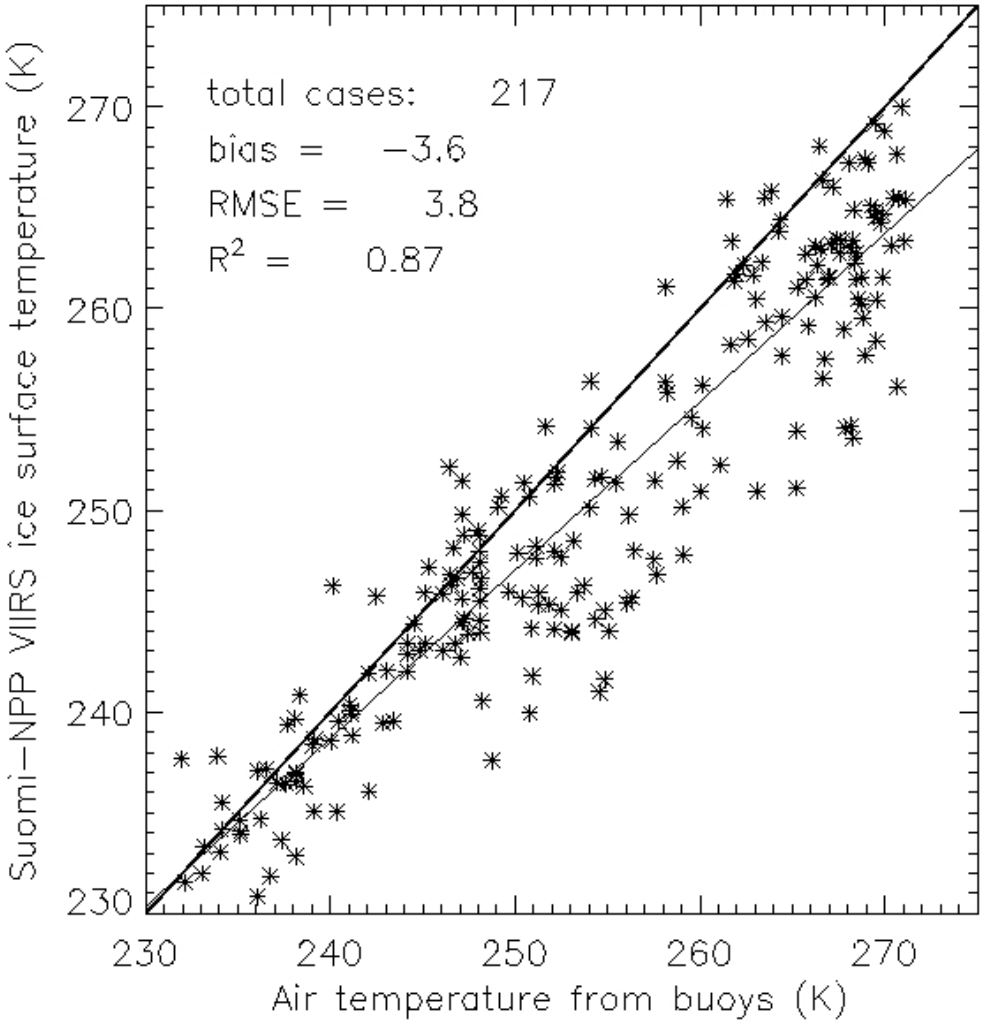
VIIRS IST vs. MODIS IST



NPP VIIRS and MODIS (Aqua and Terra) IST differences in the Arctic and Antarctica from August 2012 to July 2015. VIIRS-MODIS bias and uncertainty (RMS) are indicated for each bin.

From *Liu et al*., 2015

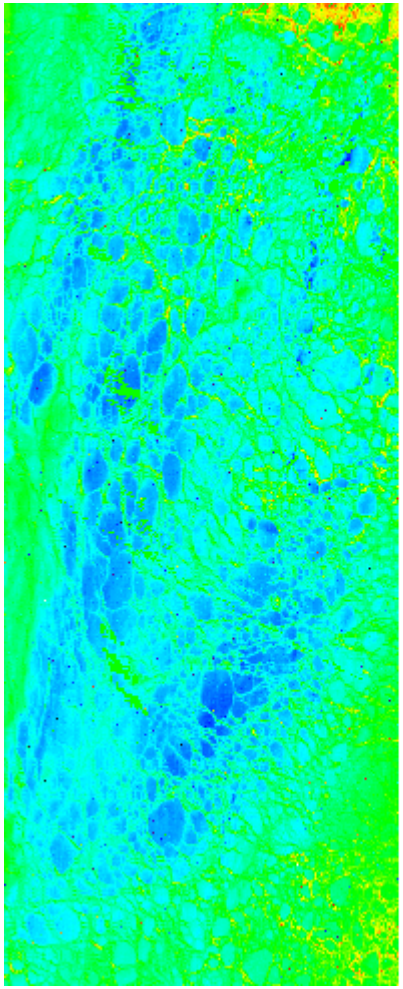
VIIRS IST vs. buoys

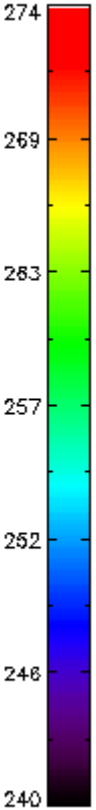


Scatter plot of surface air temperature from Arctic buoys and NPP VIIRS IST from August 2012 to June 2014, with the thick line as the 1 to 1 ratio line, and thin line as the linear regression.

From *Liu et al*., 2015

NASA's Suomi-NPP VIIRS IST





- Utilizes similar split window to NOAA product:

$$IST = a_o + a_1 T_{M15} + a_2(T_{M15} - T_{M16}) + a_3(T_{M15} - T_{M16})(\sec(z) - 1)$$

- Has been delivered to NASA's NSIDC DAAC
- Upgrades have been proposed in response to NASA AO

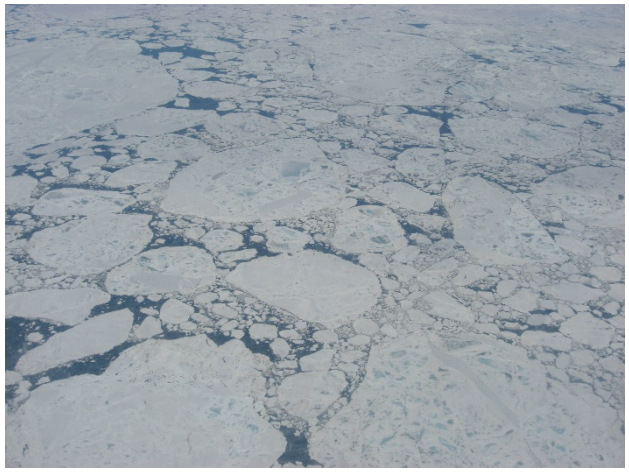
Left: VIIRS IST (K) from the NASA VIIRS IST product
Sept 12, 2014, 21:10 UTC
Beaufort Sea, AK

Product Status Summary

- The NOAA Enterprise IST product is stable and is accurate to within 1K
- No VIIRS IST code changes currently planned, except for an update to regression coefficients based on our cal/val work
- More cal/val planned after determination and update of new coefficients
- NASA VIIRS IST has been delivered to NASA's NSIDC DAAC
  - IST ATBD delivered to NASA GSFC
  - User Guide delivered to NSIDC

Conclusions

- NDE VIIRS IST in most cases meets the requirement of 1K measurement uncertainty
- *Liu et al*., 2015 describes the IST product and cal/val work in detail
- NDE VIIRS IST calibration coefficients will be adjusted and cal/val'd, based on previous cal/val results
- Improvements in the VIIRS IST performance have been realized as the VIIRS Cloud Mask matures
- NASA's IST product has been developed & delivered to provide continuity with the NASA MODIS product
- THANK YOU!



Overflow slides

Flow for the VIIRS Operational (IDPS) IST

