



S-NPP ICE CONCENTRATION STATUS

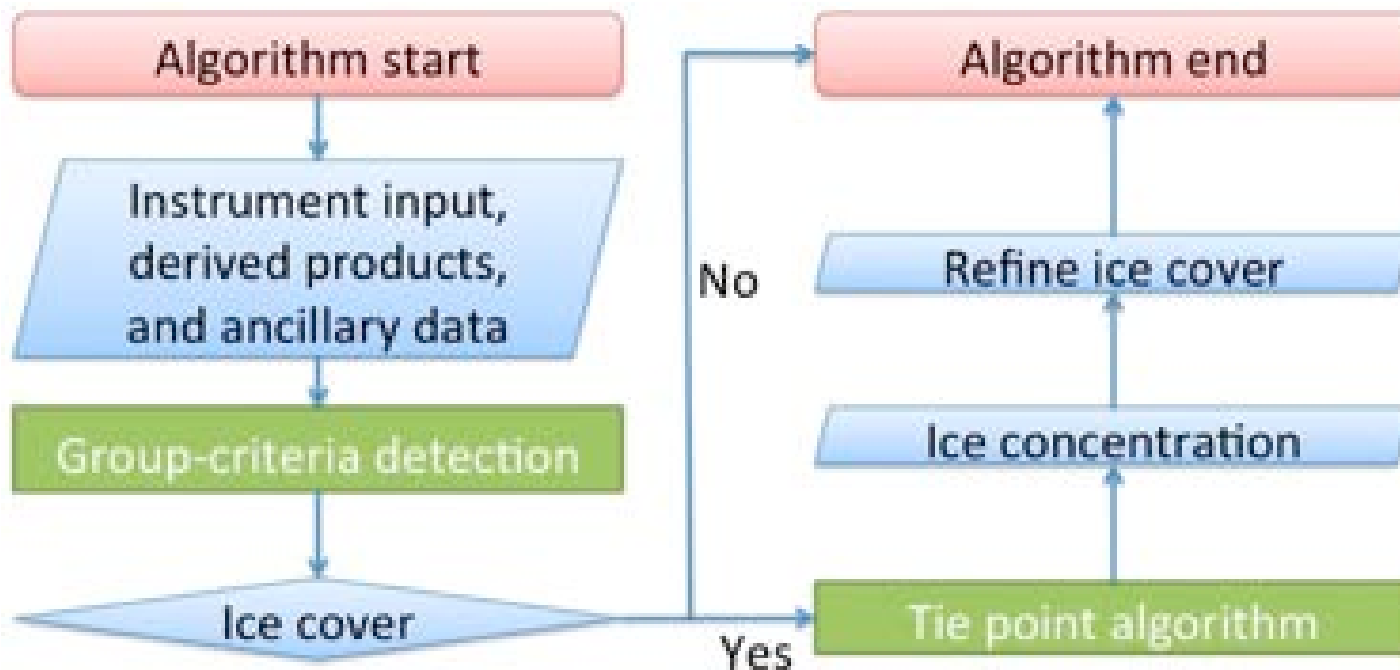
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Collaborators: Jeff Key, Rich Dworak, Mark Tschudi, Dan Baldwin

Ice Concentration Team

PI	Organization	Team Members	Roles and Responsibilities
J. Key	NESDIS	Y. Liu (UW/CIMSS) M. Tschudi (CU/CCAR) D. Baldwin (CCAR) R. Dworak (CIMSS) X. Wang (CIMSS)	Ice conc. Development and cal/val Ice concentration cal/val Ice concentration cal/val Ice concentration data cal/val Ice concentration application

Enterprise Algorithm Overview



Difference with IDPS algorithm:

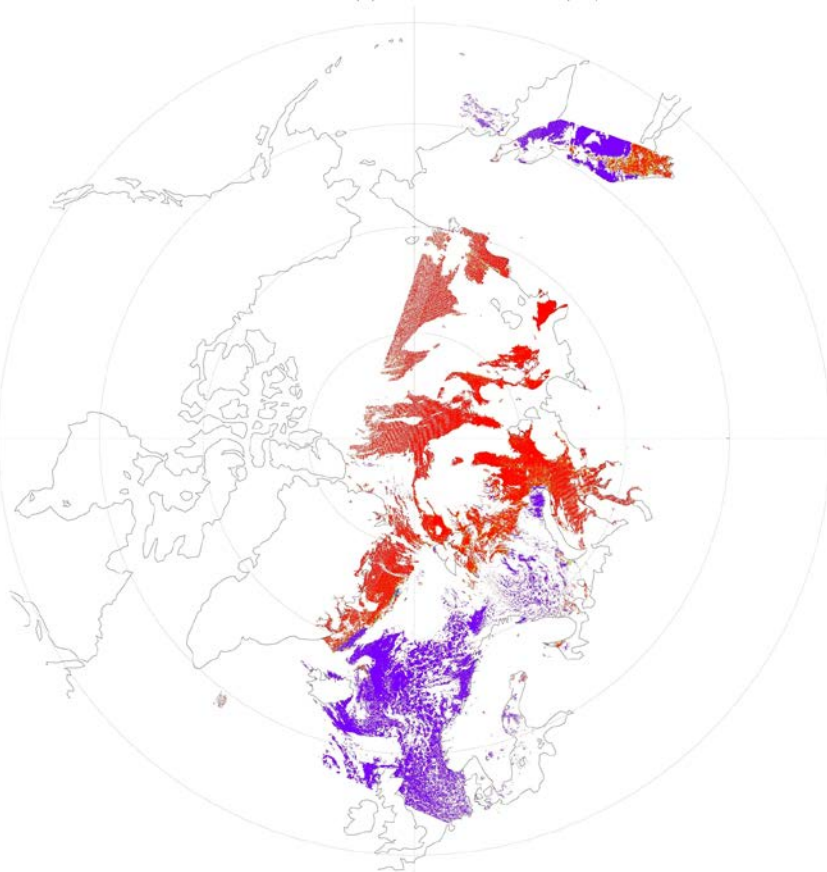
- ◆ Enterprise algorithm applies threshold method to identify ice covered pixels first with Normalized Difference Snow Index (NDSI) explicitly used;
- ◆ Retrieves Ice Concentration (IC) using tie-point algorithm on single band information of 0.64 μm reflectance at daytime and surface temperature at nighttime,
- ◆ Final ice identification is refined by the retrieved SIC;
- ◆ IDPS SIC algorithm applies band weighted ICs from tie point algorithm on multiple bands, with identification of ice covered pixels implicitly included.
- ◆ Enterprise IC is in M-band resolution, and IDPS product is in I-band resolution

Requirements

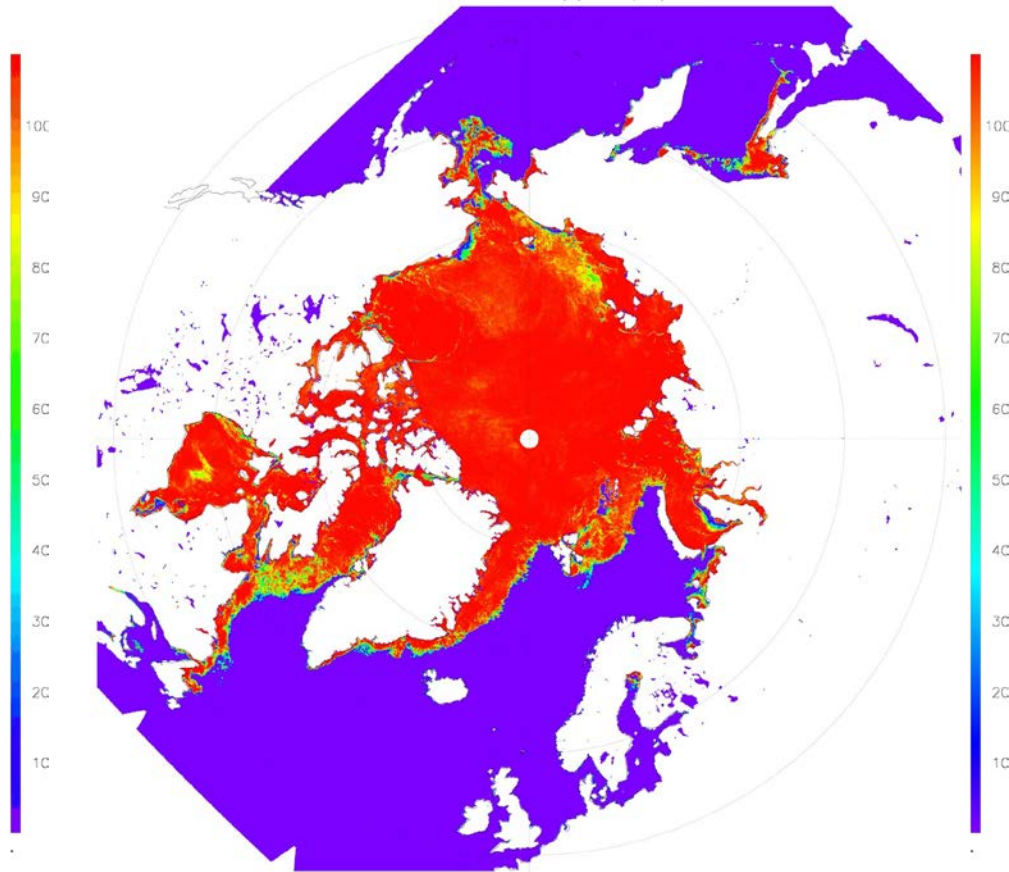
Attribute	Threshold	Performance
a. Vertical Coverage	Ice Surface	Ice Surface
b. Horizontal Cell Size		
1. Clear	1.0 km	1.0 km
2. All Weather	No capability	No capability
c. Mapping Uncertainty, 3 Sigma		
1. Clear	1 km at Nadir	1.0 km
2. Cloudy	No capability	No capability
d. Measurement Range		
2. Ice Concentration	0.0 – 1.0	0.0 – 1.0
e. Measurement Uncertainty		
2. Ice Concentration	10%	10%
f. Refresh	At least 90% coverage of the globe every 24 hours (monthly average)	At least 90% coverage of the globe every 24 hours (monthly average)
g. Geographic coverage	All ice-covered regions of the global ocean	All ice-covered regions of the global ocean

NDE CM appears to identify more cloud than IDPS, with some possible cloud leakage

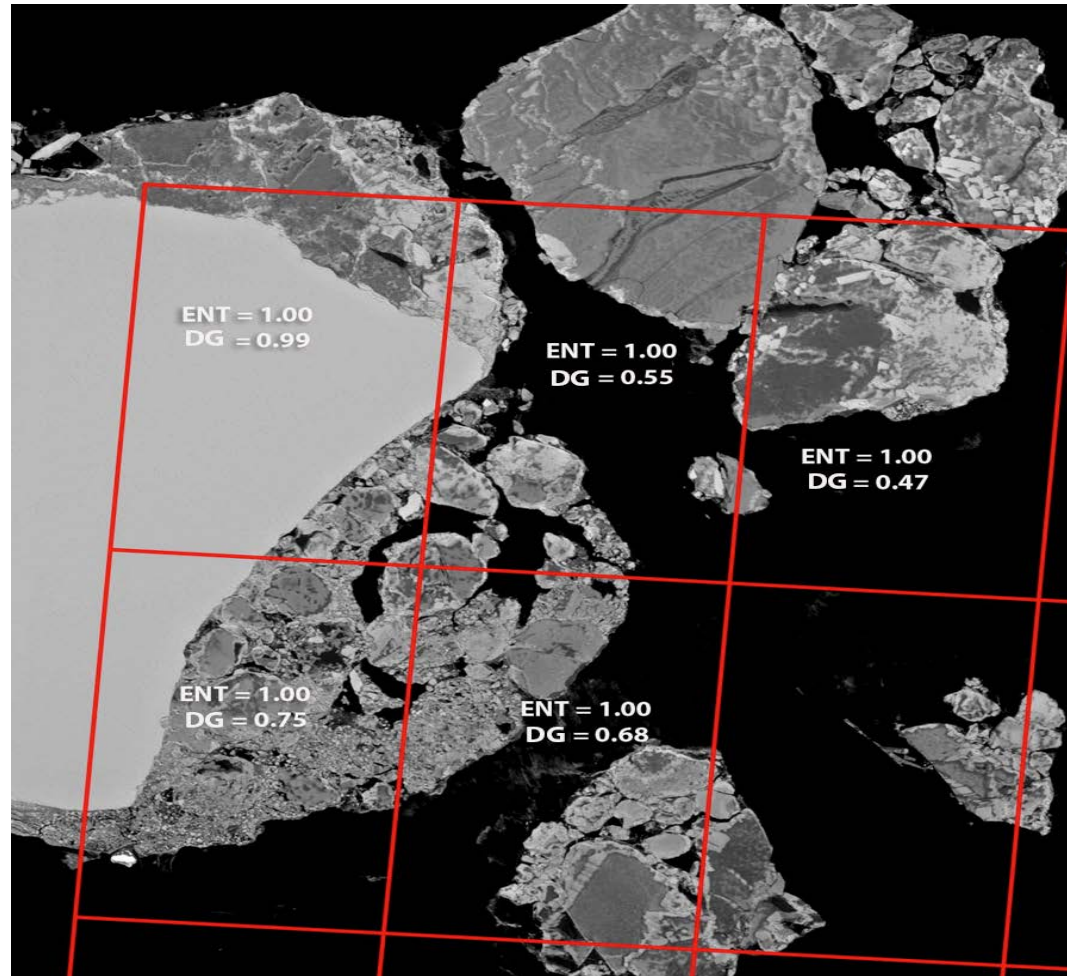
NPP Ice Concentration (%) 0245 to 0304 UTC on 04/17/2017 CIMSS



Microwave Ice Concentration (%) on 04/17/2017



Operational NDE VIIRS ice concentration from PDA, and from local run (left), and SSMIS ice concentration (right) on April 17, 2017.



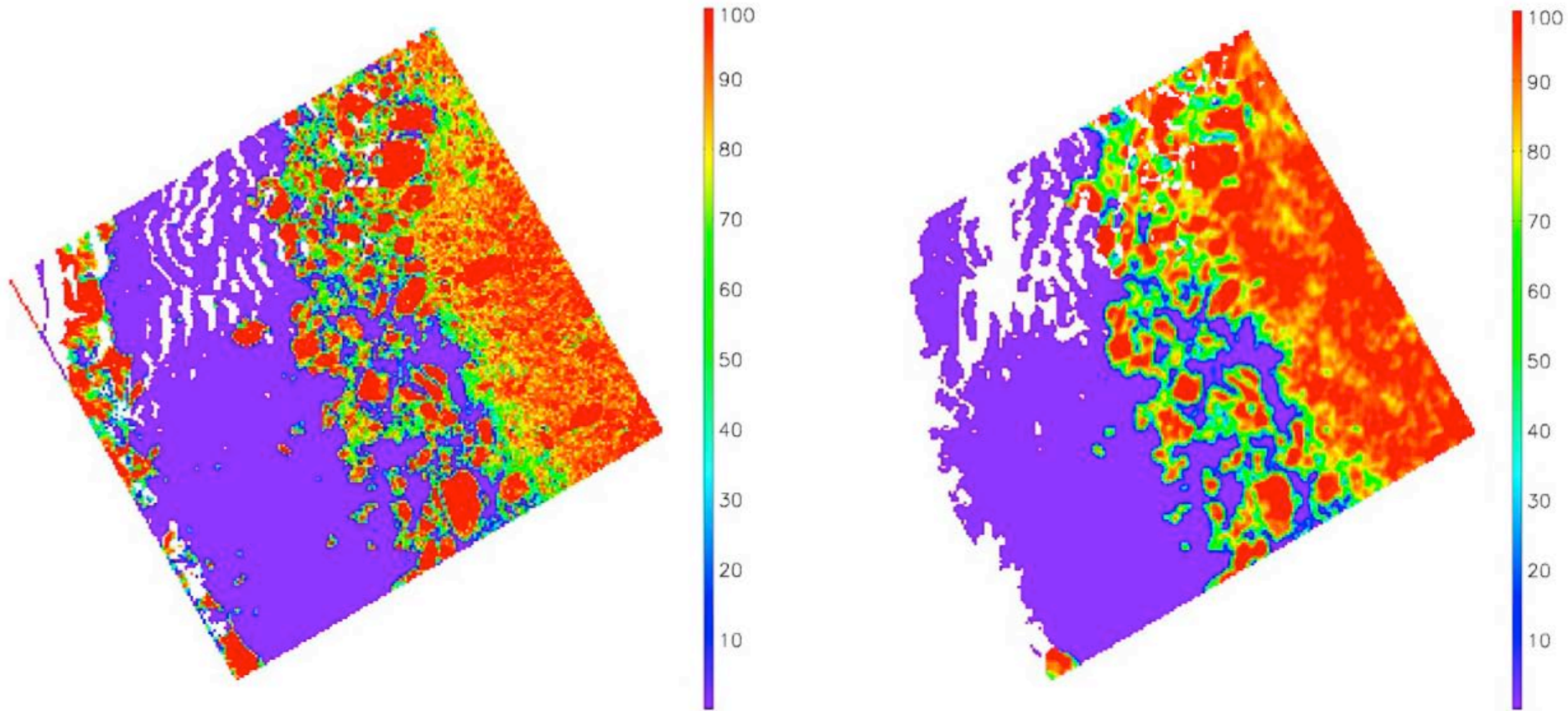
VIIRS M-Band FOVs from the Enterprise SIC during May 10, 2014, overlaid upon corresponding DigitalGlobe data. Numbers in boxes are Enterprise SIC and SIC estimate computed from DG image.

Validation

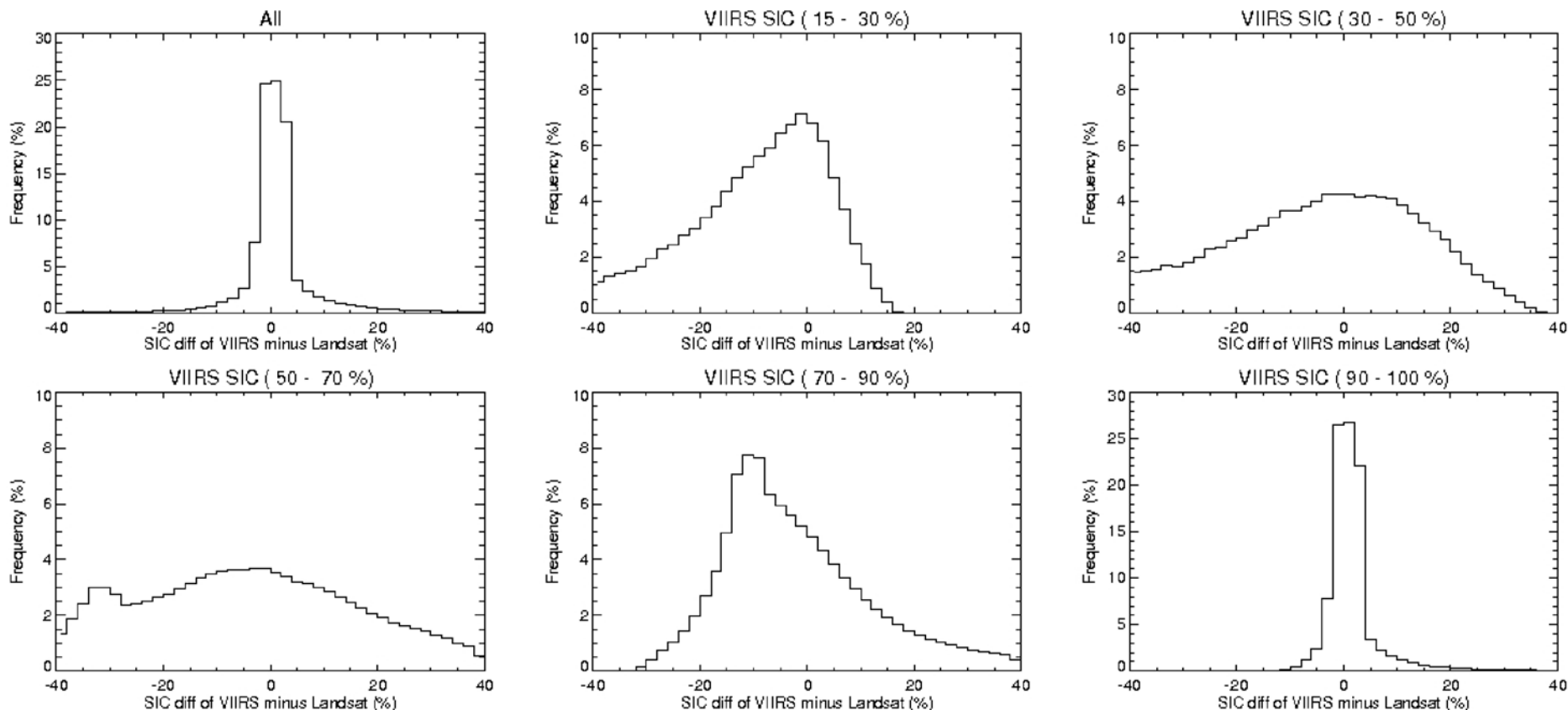
IDPS and Enterprise SIC values vs. DG SIC estimate for March 21, 2014, for three normalized difference threshold values. * Aggregate bins over a broader range; ** All IDPS and Enterprise SIC values of 0.0 were eliminated from the statistics for this bin.

Ice Concentration Range (based on DG SIC Estimate)	Normalized Difference Threshold Value	Number FOVs IDPS/Enterprise	Bias (DG-IDPS) /(DG.-Ent)	RMS IDPS/Enterprise
0.0 – 1.0	0.3	1386/196	-0.06/-0.11	0.24/0.22
	0.5	1386/196	0.04/-0.05	0.24/0.14
	0.7	1386/196	0.13/-0.01	0.30/0.10
0.0– 0.4 *	0.3	1130/152	-0.06/-0.08	0.23/0.23
	0.5	946/140	0.01/-0.02	0.16/0.12
	0.7	812/133	0.03/0.02	0.09/0.10
0.4 – 1.0 *	0.3	256/44	-0.08/-0.18	0.29/0.22
	0.5	440/56	0.12/-0.12	0.36/0.19
	0.7	574/63	0.27/-0.07	0.47/0.12
0.4 – 1.0 (0.0 eliminated) **	0.3	234/44	-0.15/-0.18	0.21/0.22
	0.5	327/56	-0.05/-0.12	0.21/0.19
	0.7	375/63	0.02/-0.07	0.19/0.12

Validation



(**left**) Ice concentration (IC) derived from the Landsat image (30 m resolution); and (**right**) the calculated IC using the Suomi NPP VIIRS. White areas denote pixels flagged out as either land or cloud.



Comparison of VIIRS and Landsat ice concentrations for different concentration ranges/bins when a tie point adjustment scheme is employed.

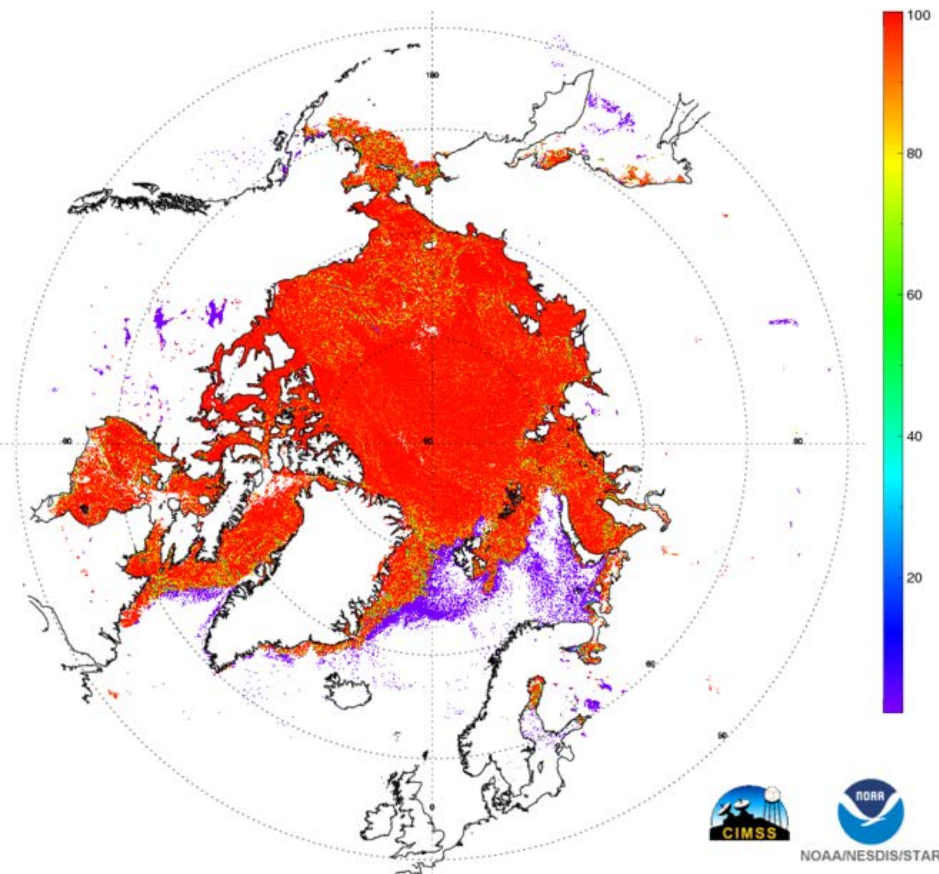
Table 8. Bias and RMSE with bias removed (precision) for comparisons of VIIRS minus Landsat ice concentrations for different concentration ranges/bins after tie point adjustment.

	Overall	VIIRS SIC 15%–30%	VIIRS SIC 30%–50%	VIIRS SIC 50%–70%	VIIRS SIC 70%–90%	VIIRS SIC 90%–100%
Case number	2,480,093	6055	16,559	34,428	168,009	2,255,042
Bias (%)	1.4	–12.6	–9.1	–4.5	0.3	1.6
RMSE (%)	8.9	17.4	22.4	21.7	17.2	7.2

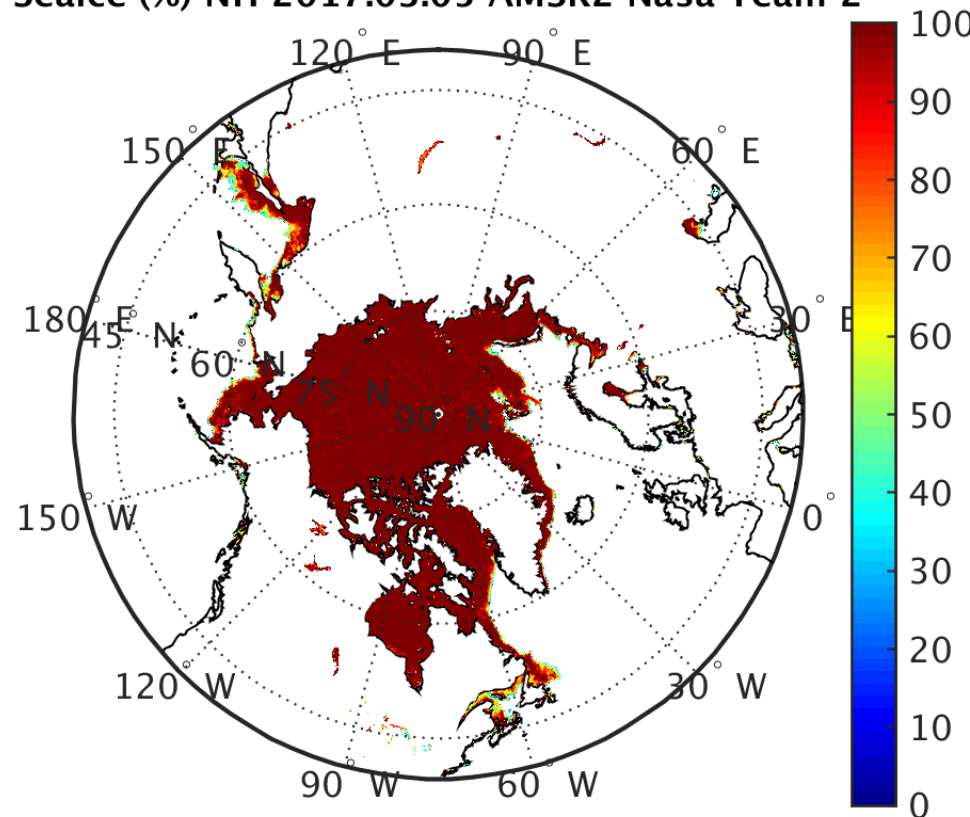
Validation and Monitoring

Suomi NPP Sea Ice Concentration - Arctic - Enterprise

05 Mar 2017



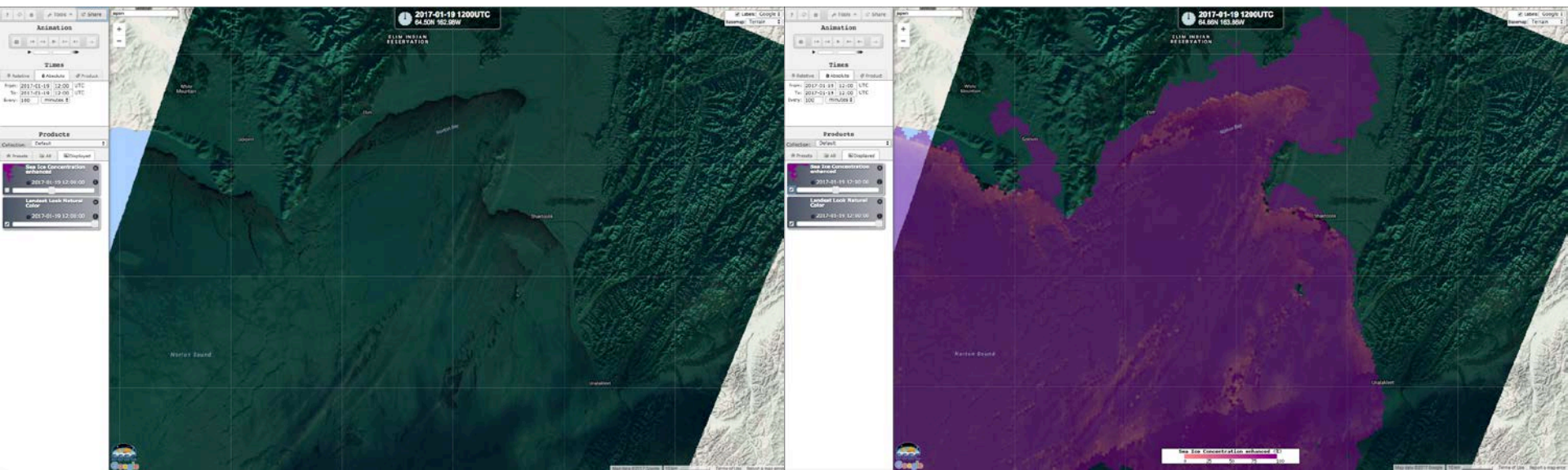
Seaice (%) NH 2017.03.05 AMSR2 Nasa Team 2



Daily Ice concentration (IC) composite from VIIRS (**left**); and IC AMSR2 (**right**) over the Arctic on March 5th 2017. White areas in the AMSR2 image denote pixels flagged as either land or the area with IC less than 15%. White areas in the VIIRS data denote pixels flagged as land, ice-free ocean, or cloud.

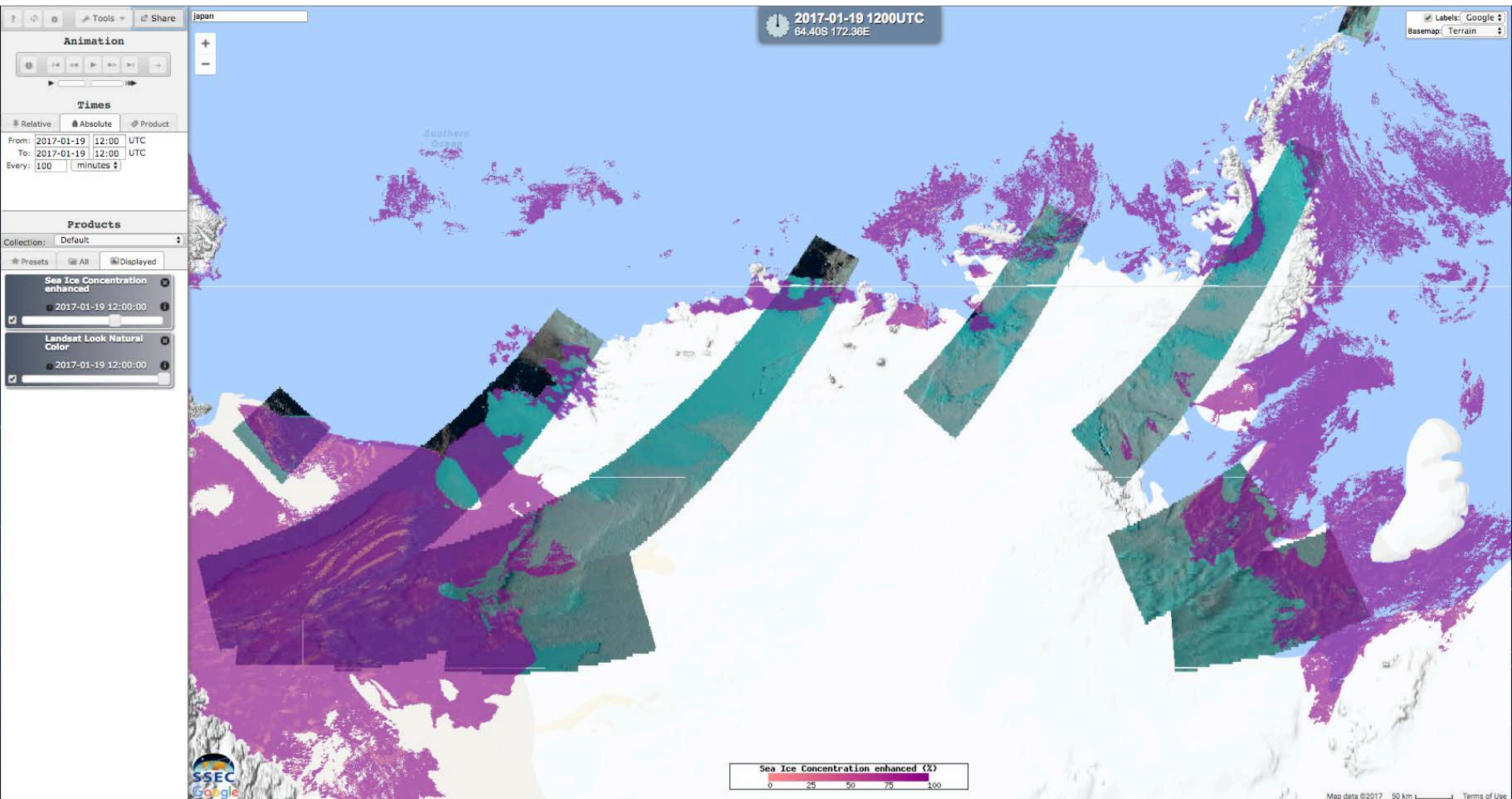
Validation and Monitoring

VIIRS ice concentration daily composite has been installed in the RealEarth Info sections. This provides a tool to monitor and validate VIIRS IC with Landsat data.



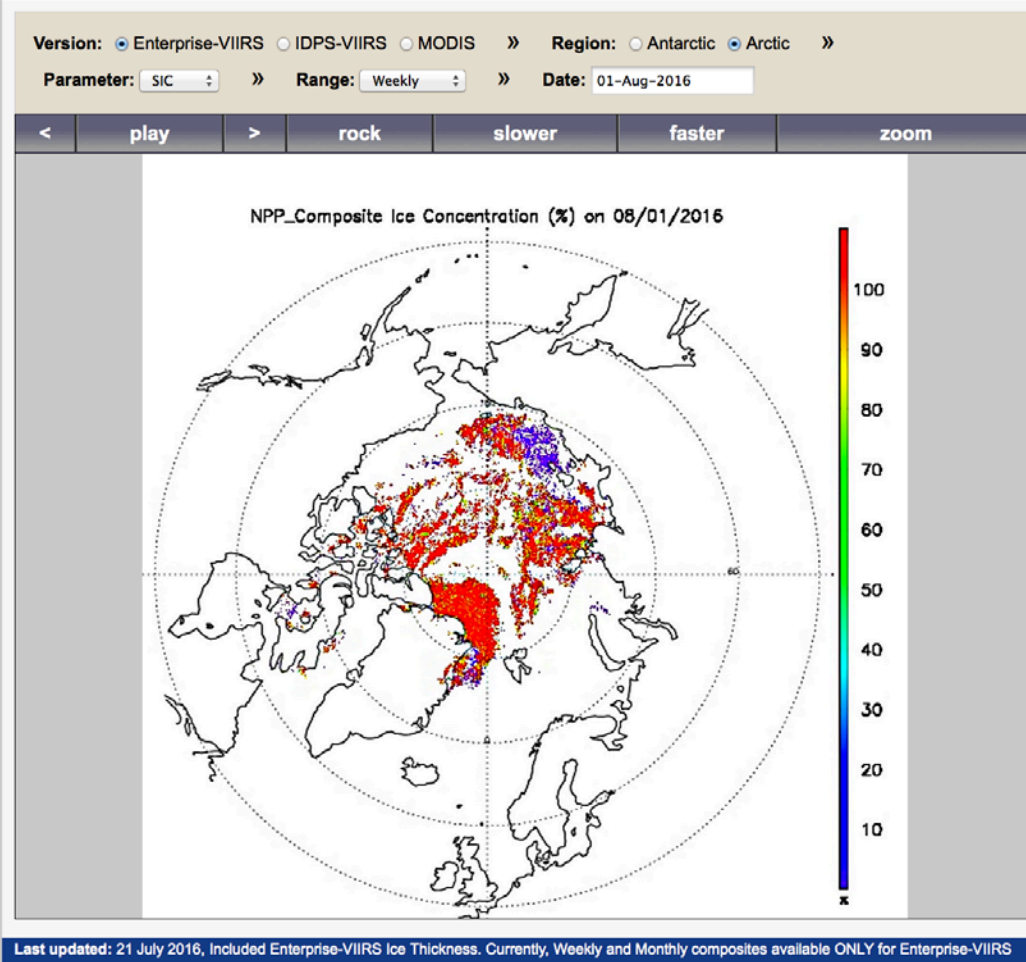
Landsat NatureColor (left), and VIIRS ice concentration (right) centered over the west coast of Alaska on January 9th 2017.

Validation and Monitoring



Landsat NatureColor (left), and VIIRS ice concentration (right) over Antarctica on January 9th 2017.

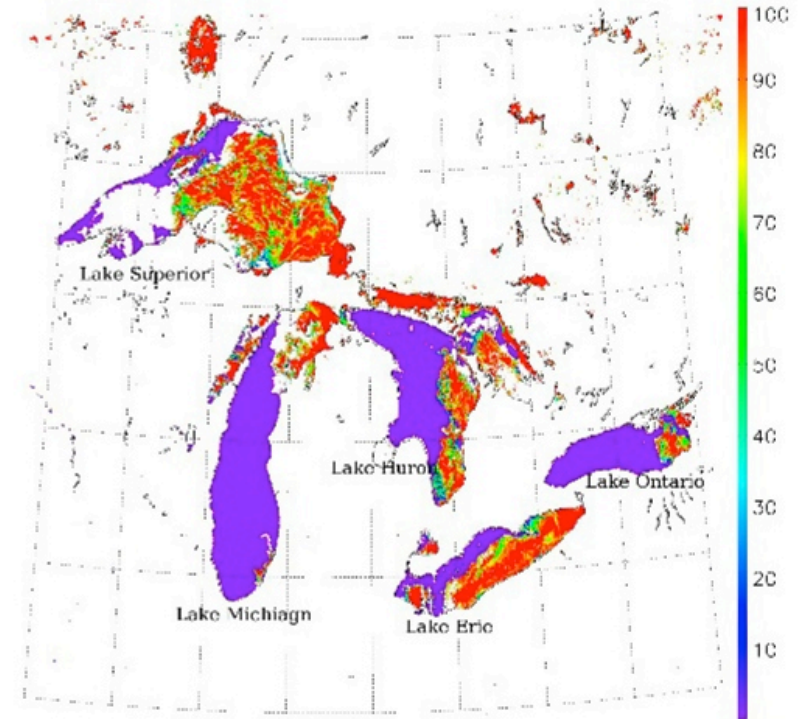
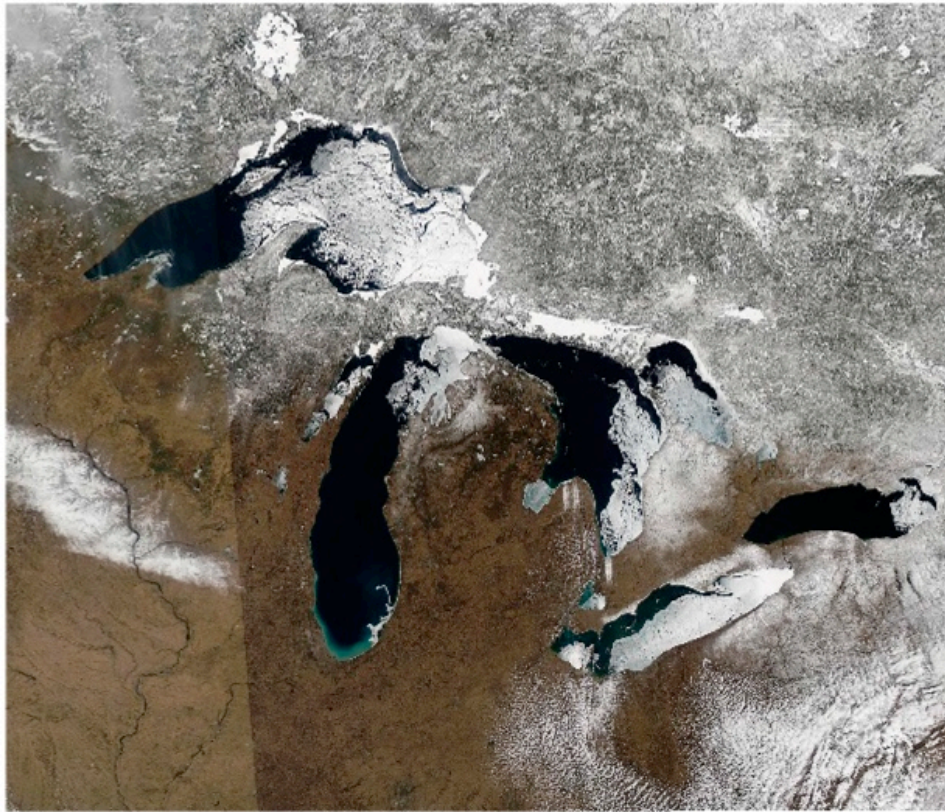
Suomi NPP VIIRS and MODIS Ice Products



Ice concentration near real-time Enterprise product has been generated and monitored routinely, and figures have been archived and shown on CIMSS website at <http://stratus.ssec.wisc.edu/ice-products/anibrowser/index.php>, and at JPSS EDRs LTM site, http://www.star.nesdis.noaa.gov/jpss/EDRs/products_cryosphere.php

- ◆ Ice concentration is being archived by Naval Research Laboratory for applications in model simulation
- ◆ Ice concentration is used by National Ice Center
- ◆ Ice concentration has been archived for Walt Meier of GSFC for comparison with microwave products
- ◆ Have been in contact with researchers on the possibility in using JPSS ice concentration product in the operational weather forecasting model

Product Example



Aqua MODIS true-color image at 6:20 p.m. UTC on 28 March 2015 (**left**); and the corresponding ice concentration (**right**).

Future plan:

- ◆ Algorithm can be improved with further evaluation to include the tie point adjustment approach;
- ◆ Algorithm can be improved to produce higher spatial resolution products of I-band spatial resolution, with ice surface temperature with I-band spatial resolution available;
- ◆ VIIRS ice concentration due to cloud leakage can be reduced with historical maximum ice coverage using ice coverage data from NOAA's Interactive Multisensor Snow and Ice Mapping System (IMS);
- ◆ Validation will be expanded with more Landsat data, historical SAR data, C-band SAR onboard Sentinel-1, and high optical imagery onboard Sentinel-2.

Summary and Path Forward

- The Suomi NPP and JPSS VIIRS Enterprise Ice Concentration product has high potential to become an extremely useful JPSS product.
- Performance evaluation based on comparisons with microwave and Landsat indicate that the VIIRS Ice Concentration meets the performance requirements; evaluation with DigitalGlobe indicates further improvement might be needed. Both evaluations show VIIRS ice concentration is an useful product for identifying ice extent for both day and night for clear sky conditions.
- Further improvement and evaluation is needed with new ice concentration products from sensors with very high spatial resolution onboard the newly launched European satellites.