



# U.S. National Ice Center



USN



USCG



NOAA



## National Ice Center Applications

STAR JPSS 2016 Annual Science Team Meeting  
NCWCP, College Park, MD  
8-12 August, 2016

Presenter: Dr. Pablo Clemente-Colón, NIC Chief Scientist

CDR Ruth Lane  
Director / Commanding Officer

Mr. Kevin Berberich  
Deputy Director

LCDR Robert Atkinson  
Naval Ice Center Executive Officer



# The U.S. National Ice Center (NIC)

## Mission

The U.S. National Ice Center (NIC) is a tri-agency partnership of the United States Navy (USN), the National Oceanic and Atmospheric Administration (NOAA), and the United States Coast Guard (USCG) providing global ice and snow analysis and short term forecasting services for the maximum benefit of the United States government.

## Vision

To be the U.S. government's authority on global sea ice and snow analysis and forecasting.

## Goals

Goal 1. Develop Capabilities

Goal 2. Transition Science and Technology

Goal 3. Strengthen Partnerships

Goal 4. Professional Excellence

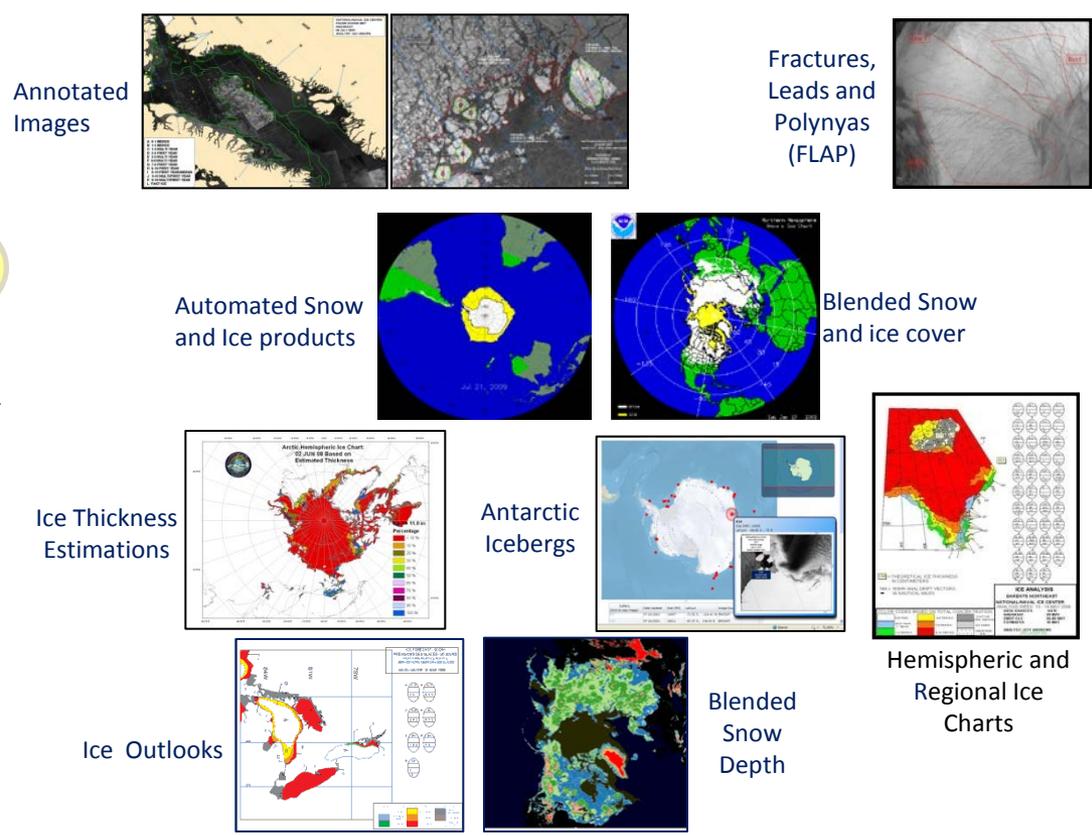
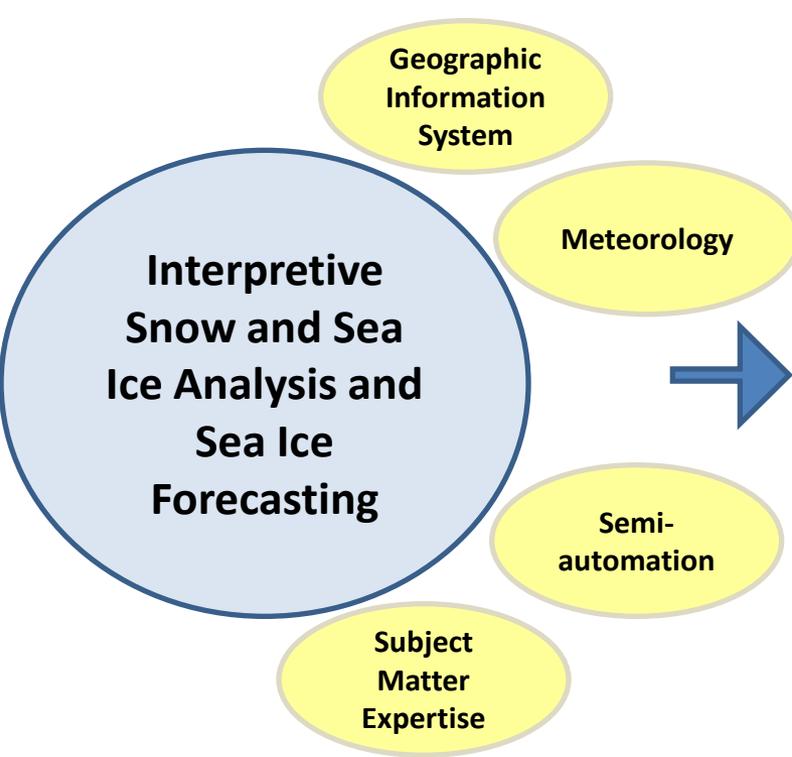




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# NIC Product Generation

## Arctic Maritime Domain Awareness



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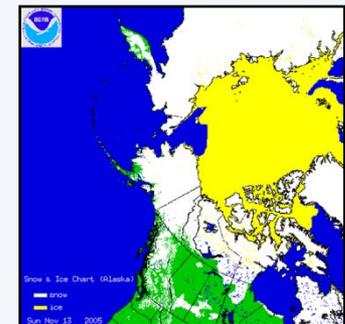
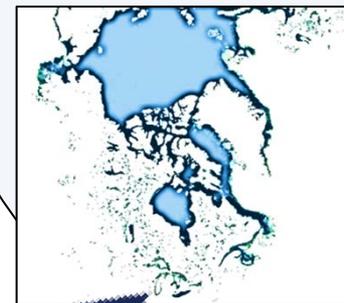
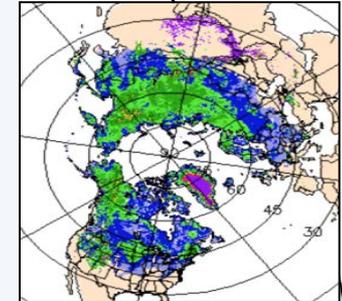
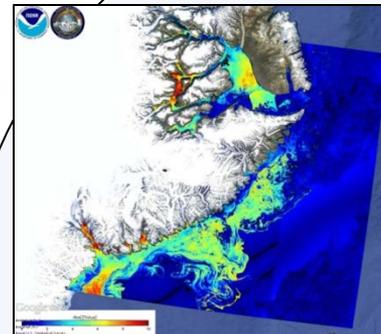
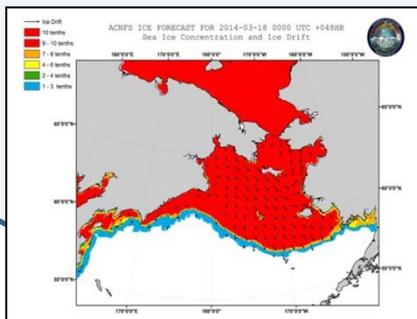
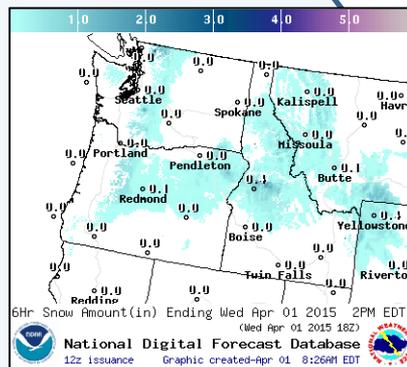
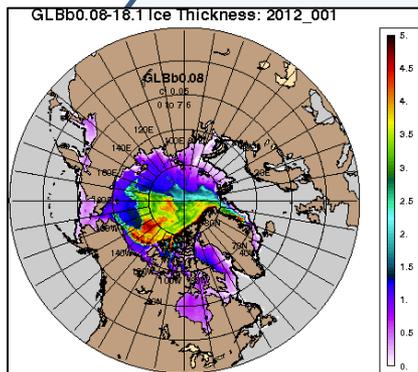
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# Sea Ice and Snow Analysis Integration with Models

CUSTOMERS & PUBLIC

NIC Analysis

Navy and NOAA Models



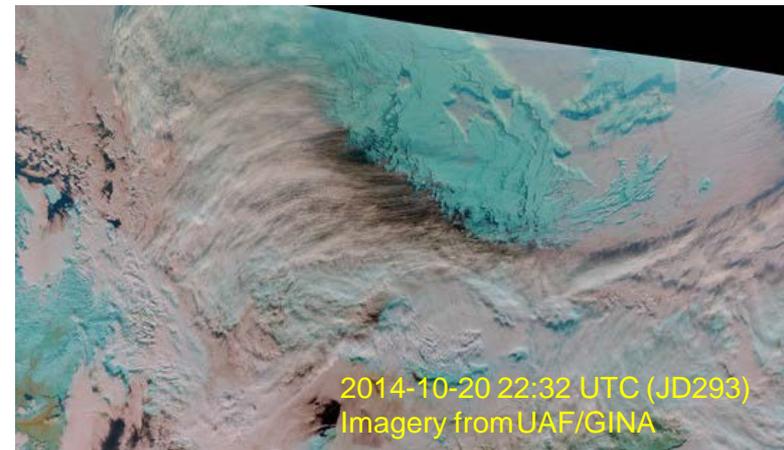
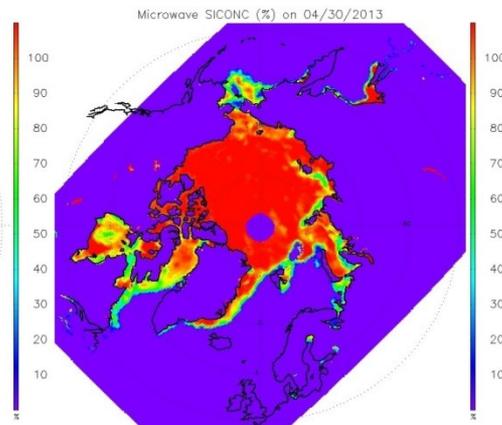
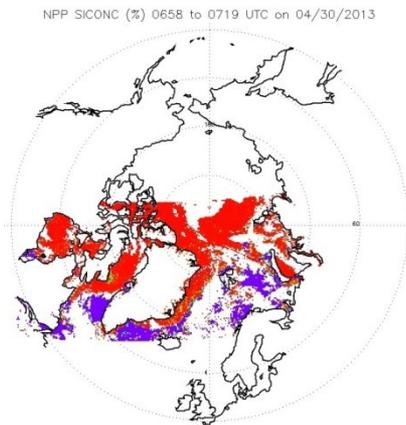
Models provide forecast guidance and NIC analysts incorporate real time data to produce interpretive analysis.

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# Continued SNPP Utility in NIC Products

1. Imagery (I1, I2, I3, I5, DNB) (All)
2. VIIRS Sea ice characterization (IMS)  
Only used for Ice/No Ice (inaccurate ice typing), Cloud Mask issues
3. VIIRS Sea Ice concentration IP (Working on IMS, Hemi Ice Charts, & MIZ)  
Data format (HDF5 to Geotiff conversion being built)  
Will be helpful in IMS Blended Ice Con.
4. VIIRS Snow cover (IMS)  
OK, but conservative cloud mask





# Continued SNPP Utility in NIC Products

## 5. AMSR2 Ice Concentration (MIZ, Hemispheric Ice Charts)

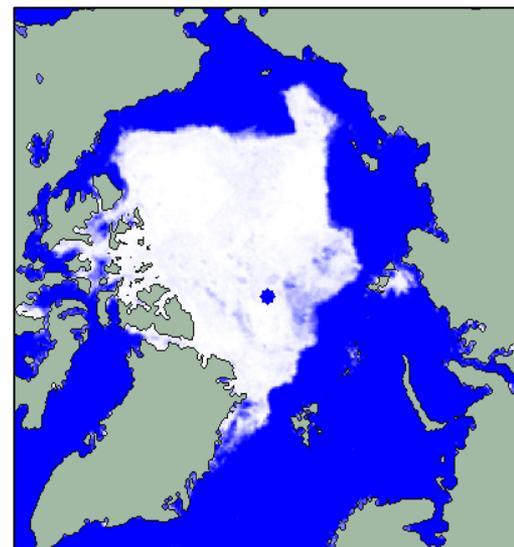
Applied in IMS Blended Ice Concentration

Using ASI (Univ Bremen), last resort data source,

## 6. ATMS Snow Water Equivalent (IMS)

Used to make IMS Snow Depth

Release of Version 11.1 – better agreement with AMSR 2 except in boreal forest areas



0 Concentration 100



# Continued Potential JPSS Utility in NIC Products

## 7. ATMS Snow Grain Size (IMS)

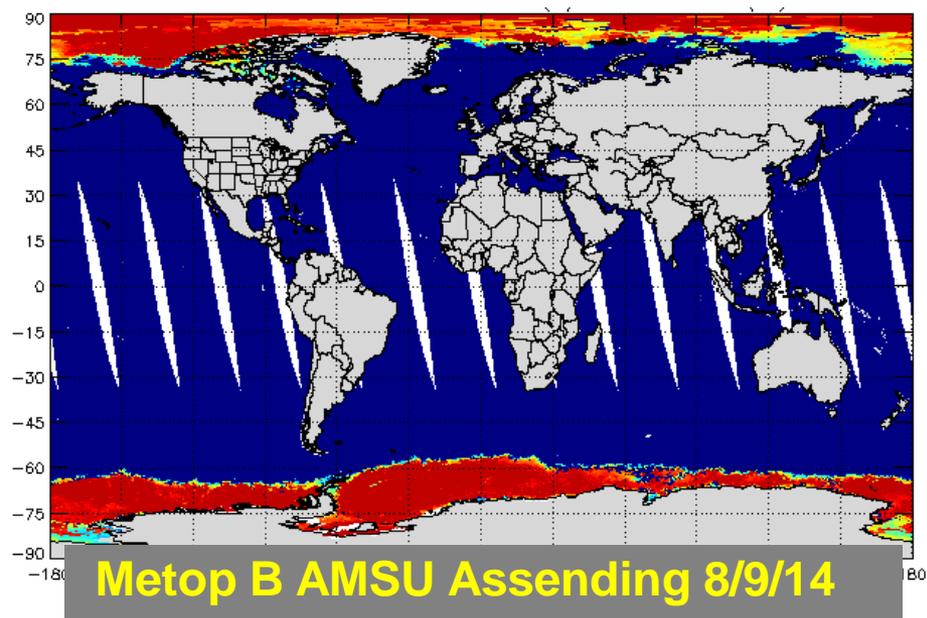
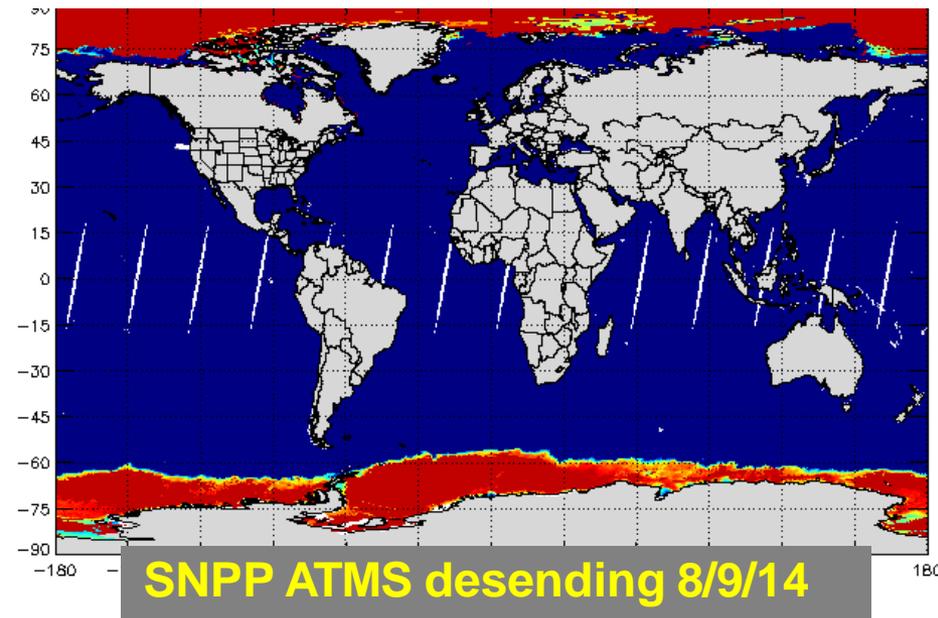
Desired to adjust IMS Snow Depth

## 8. ATMS First Year Ice Concentration (IMS, Hemispheric Ice Charts)

Could be used in IMS Blended Ice Con

## 9. ATMS Multi-Year Ice Concentration (IMS, Hemi Ice Charts)

Will be helpful in IMS Blended Ice Con





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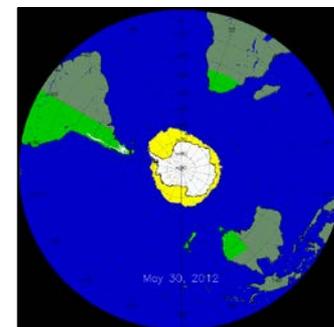
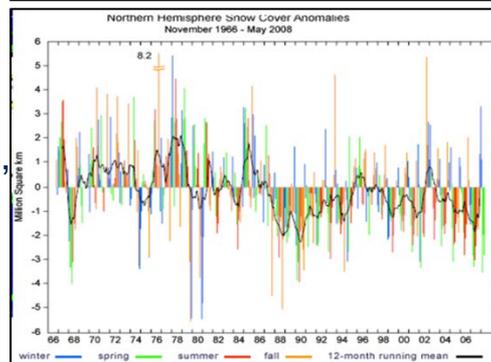
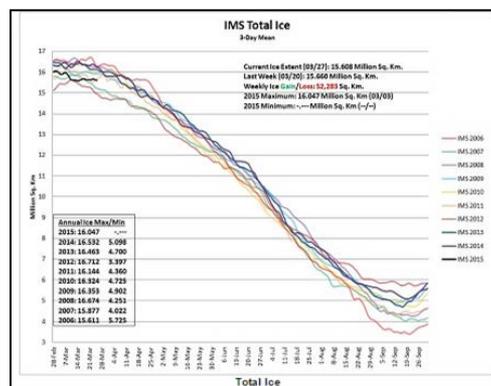
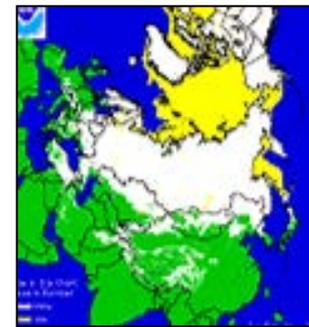
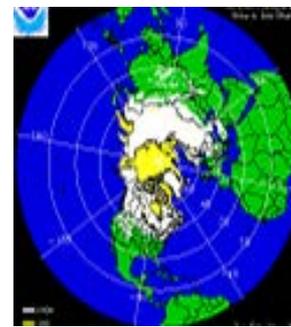
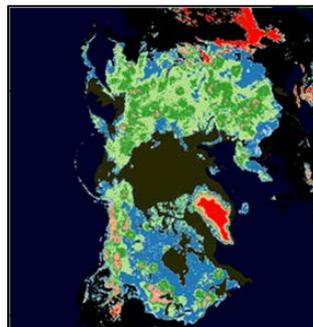
# NIC Interactive Multisensor Snow and Ice Mapping System (IMS) Products

## Primary Customers

- NOAA NWS NCEP Environmental Modeling Center (EMC)
- Climate Prediction Center (CPC)

## Secondary Customers

- US Army
- US Air Force
- US Department of Agriculture
- Great Lakes Engineering Research Lab
- NOAA SSD
- US Department of Transportation
- Environment Canada
- ECMWF
- UK Met
- Fleet Numerical Meteorology and Oceanography Center
- Naval Oceanographic Office
- Numerous Universities
- Media Outlets such as: Weather Channel, AccuWeather
- Private Companies
- General Public



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# MASIE and MASAM2: NSIDC Exploitation of the NIC Ice Edge Analysis

NSIDC National Snow and Ice Data Center

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Education Center Photo Gallery

Data Programs & Projects Science Publications News & Events About

## MASIE

Multisensor Analyzed Sea Ice Extent - Northern Hemisphere (MASIE-NH)

**MASIE Home**  
 Browse Regions  
 MASIE FAQs  
 About MASIE

**Where is Arctic sea ice NOW?**  
 The MASIE (gray-red) project is produced in cooperation with the U.S. National Ice Center to give the best available Arctic-wide answer to that question. MASIE lets you view and download:  
 • Northern hemisphere-wide sea ice coverage, for yesterday and the last four weeks  
 • Sea ice coverage by region  
 • A file of ice extent in sq km for the entire northern hemisphere and by region, updated daily

MASIE uses the most recent full day of data from the National Ice Center, obtained nightly. As is the rule with operational centers, gaps in production can occur without warning.

To obtain the last four weeks of data, see the product archive on the EITF site. For details about this data set, see the full document (MSIS-05-01)

Download Daily Northern Hemisphere Sea Ice Extent:  
 GeoTIF (All Surface Types) GeoTIF (Sea/Ice) PNG Shapefile  
 Download Sea Ice Extent Values: CSV

MASIE - Multisensor Analyzed Sea Ice Extent - Northern Hemisphere (MASIE-NH)

http://www.colorado.edu/~nsidc/.../masie/browse\_regions.html

NSIDC National Snow and Ice Data Center

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## MASIE

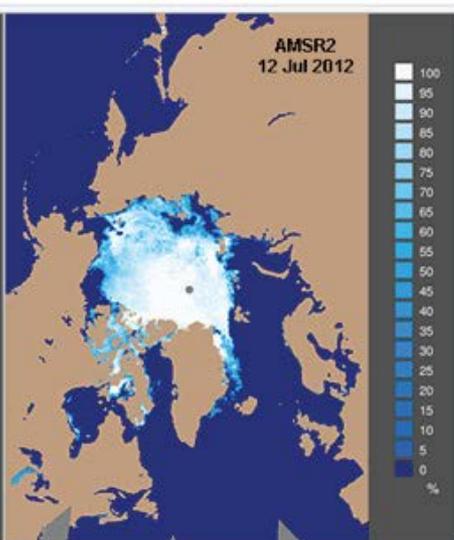
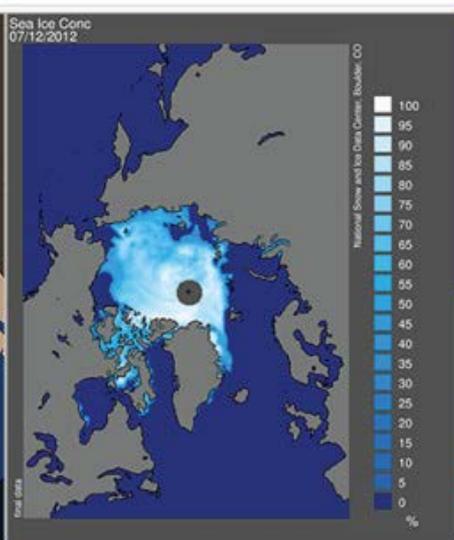
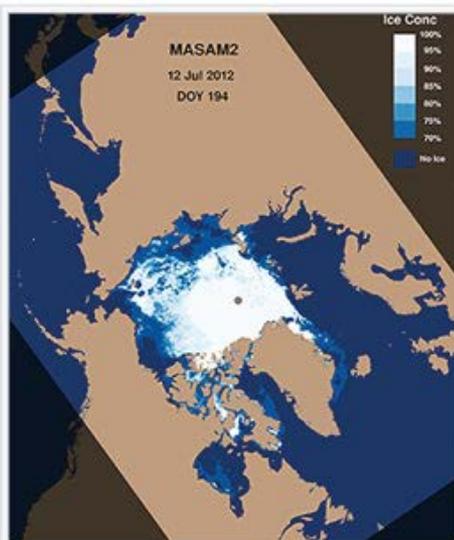
Multisensor Analyzed Sea Ice Extent - Northern Hemisphere (MASIE-NH)

**MASIE Home**  
 Browse Regions  
 MASIE FAQs  
 About MASIE

Use the MASIE Regions map to select your region of interest and view a PNG. To download GeoTIFs and data values see the table below.

**Download Daily Sea Ice Extent for MASIE Arctic Regions**

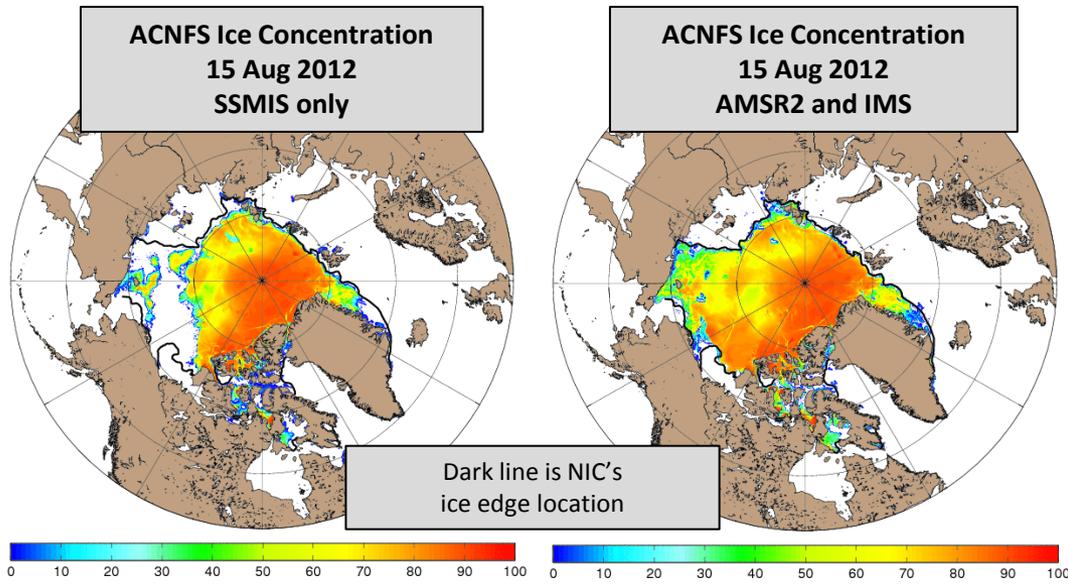
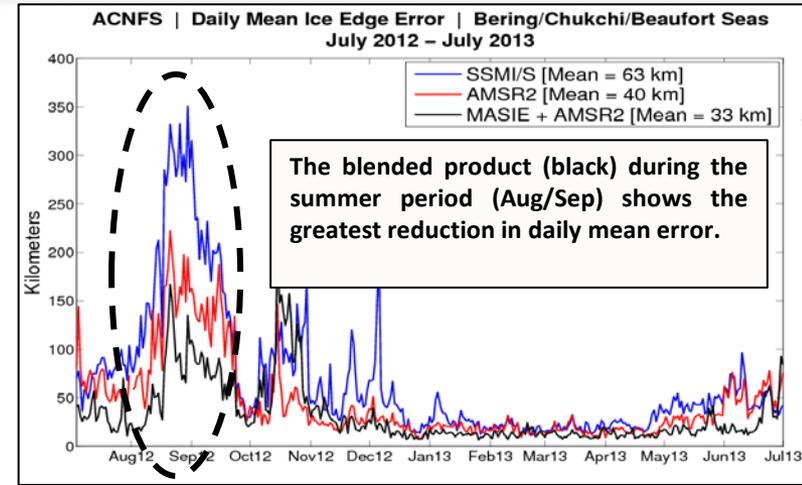
Region	Download Options
Region 1 - Beaufort Sea	GeoTIF (All Surface Types) PNG GeoTIF (Sea/Ice) CSV (Extent Values)
Region 2 - Chukchi Sea	GeoTIF (All Surface Types) PNG GeoTIF (Sea/Ice) CSV (Extent Values)
Region 3 - East Siberian Sea	GeoTIF (All Surface Types) PNG GeoTIF (Sea/Ice) CSV (Extent Values)
Region 4 - Laptev Sea	GeoTIF (All Surface Types) PNG GeoTIF (Sea/Ice) CSV (Extent Values)





# Improved Sea Ice Edge Forecasting Through Assimilation of NIC IMS Analysis

Since the late 1990's, DMSP SSMI and then SSMIS ice concentration (25km) has been assimilated in the Navy's ice forecast systems. Passive microwave sensors have a known problem identifying melt ponds as open water which leads to underestimating sea ice especially during the summer. Developed technique with National Snow and Ice Data Center (NSIDC) to assimilate: AMSR2 (10km) and NIC's Interactive Multisensor Snow and Ice Mapping System (IMS) ice mask (4km).



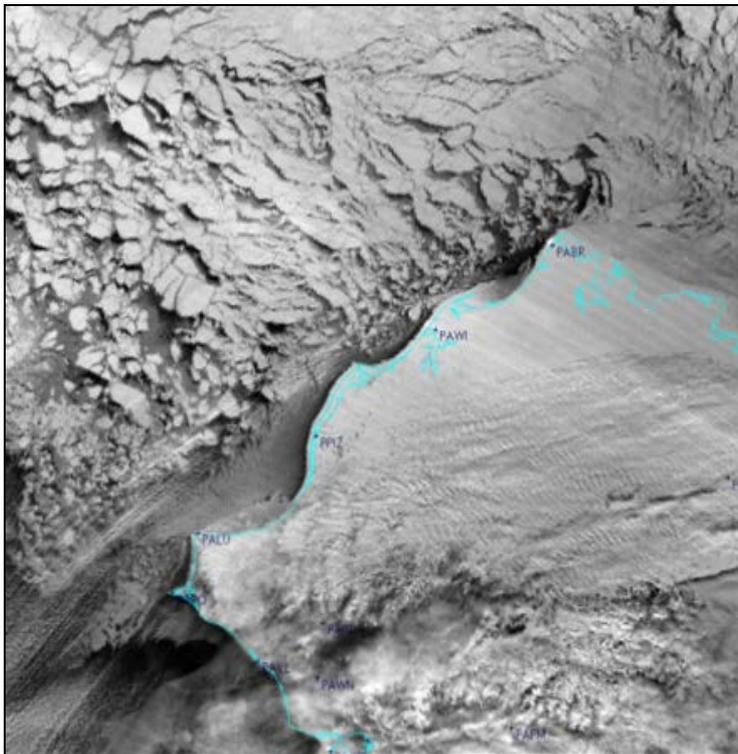
- Sensitivity studies assimilating SSMIS, AMSR2 and IMS data sources were completed.
- Adding in new data sources (AMSR2 and IMS), overall ice edge errors in the Arctic were reduced by **36%** and **56%** (year and summer, respectively).
- Submitted paper to "The Cryosphere" – Posey et al., 2015

**New data sources implemented into ACNFS and GOFS 3.1 on 2 Feb 2015.**

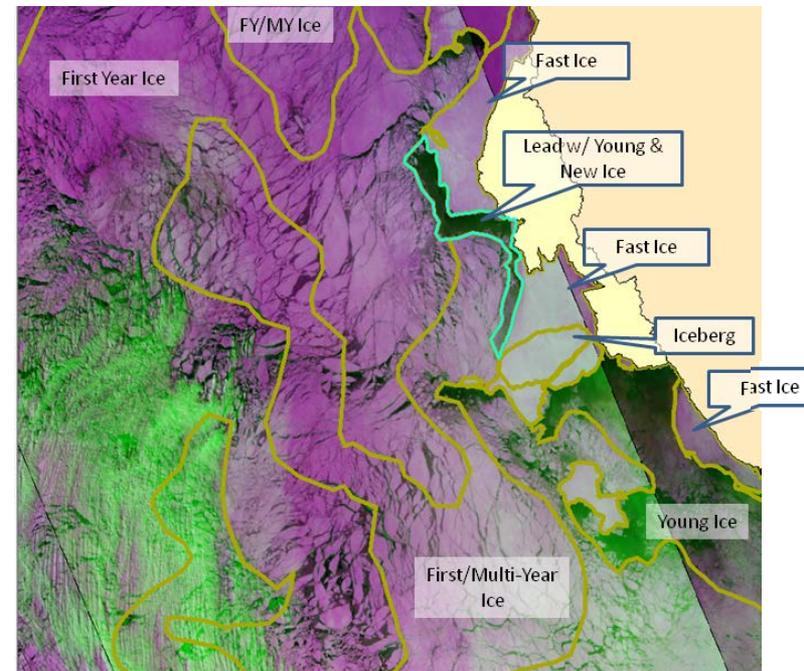


# SNPP Imagery Operational Use at NIC

- **NIC applies imagery and derived data from NASA/NOAA Suomi NPP**
  - High resolution visible channels
  - High resolution infrared channels
  - Visible imagery at night, needed for the polar winters
  - Sea ice concentrations
  - Snow cover detection
  - Microwave snow depth and sea ice concentrations



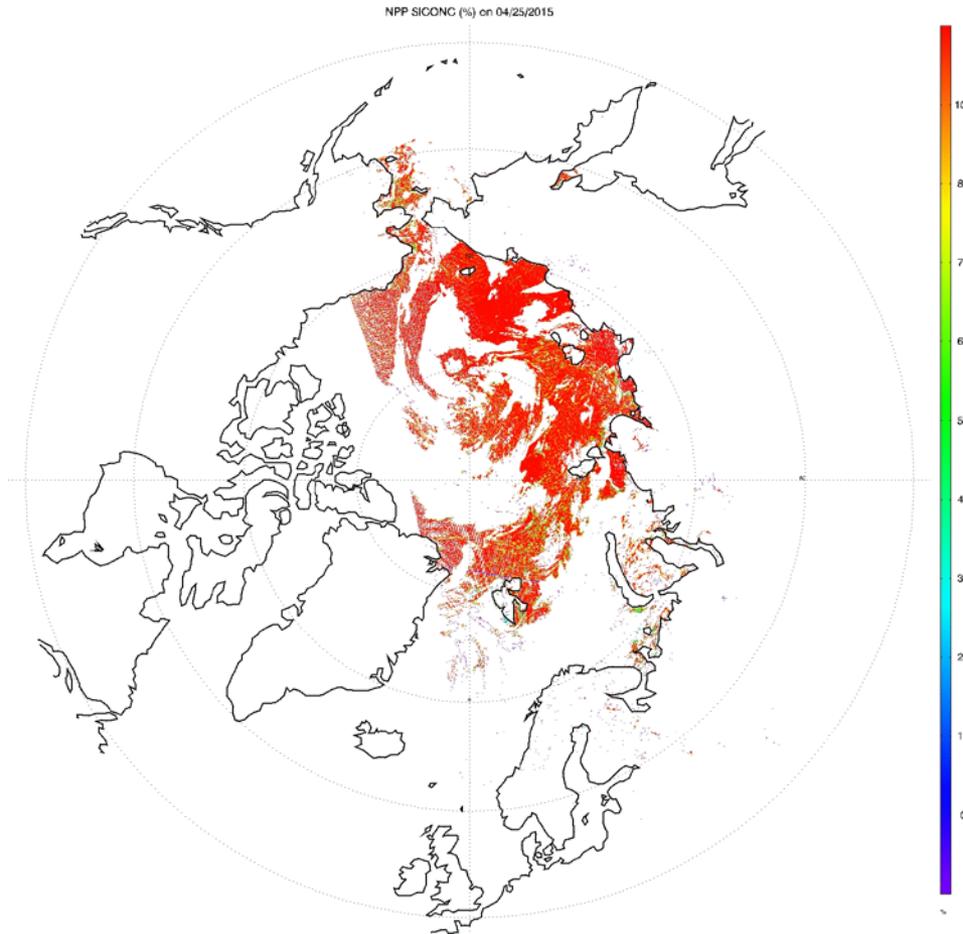
SNPP Visible imagery at night over Alaska



**Antarctica – Amery East**  
Imagery: VIIRS 1/3/2 Composite  
10 Aug 2016 0845Z  
Analyst: M. Welshans (NIC/NAVICE)



# SNPP VIIRS Ice Concentration



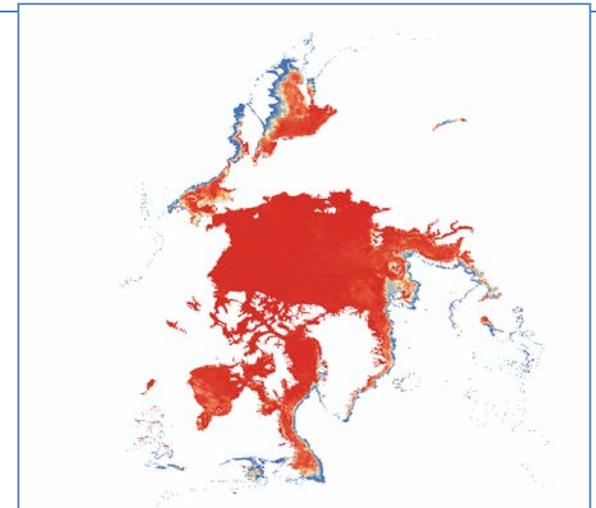
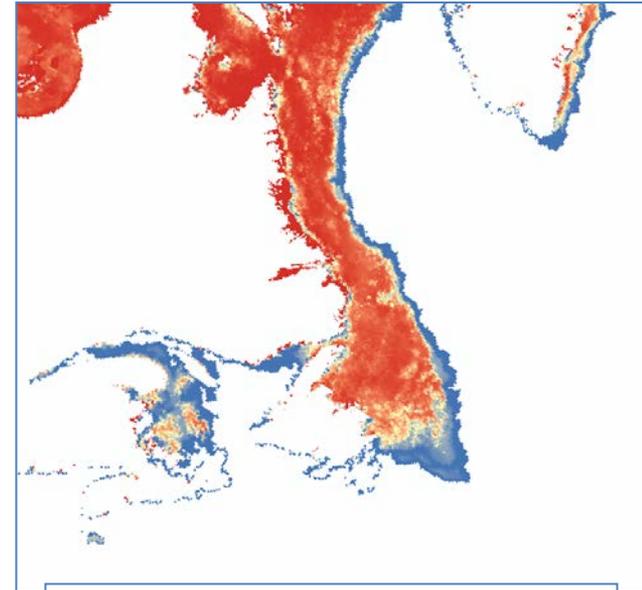
*(animation)*



# Preliminary Blended Sea Ice Concentrations

**BLENDED ICE CONCENTRATIONS:** STAR and NIC are developing a Blended Ice Concentration primarily for modeling

- Using Differential Weighting and Interpolation to blend ice concentrations
- Ice Concentrations determined from:
  - *IMS Ice Cover*
  - **AMSR 2**
  - **ATMS MIRS**
  - **VIIRS Ice Con**
  - *Ice Charts (NIC, CIS, DMI, MetNo, NWS Alaska, etc)*
  - *NWP model SST*
- **Jan 2017 Release**

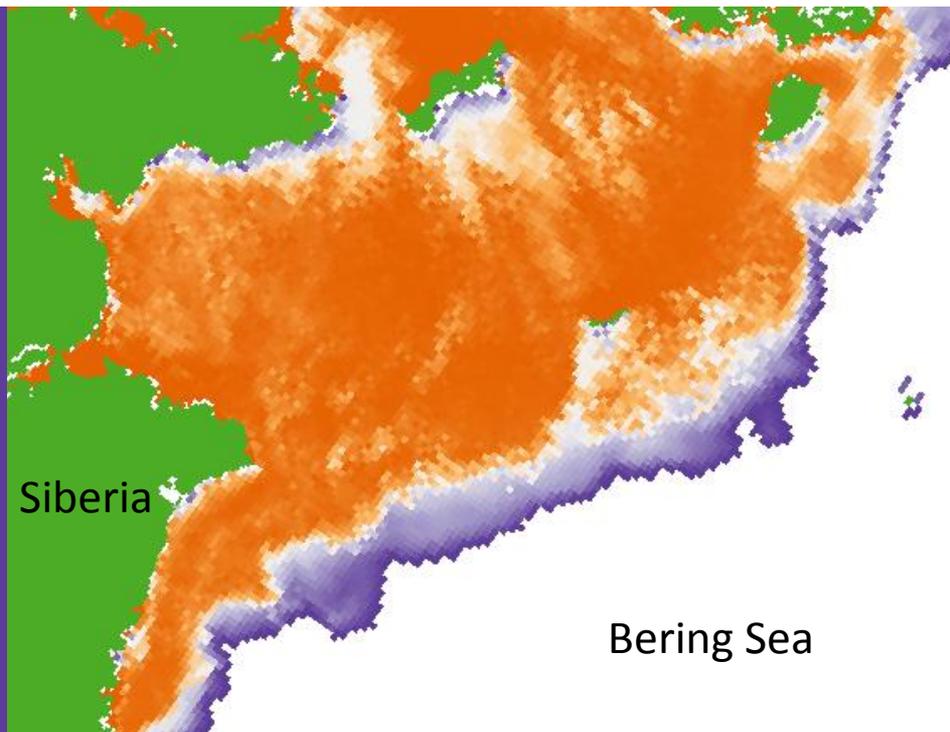
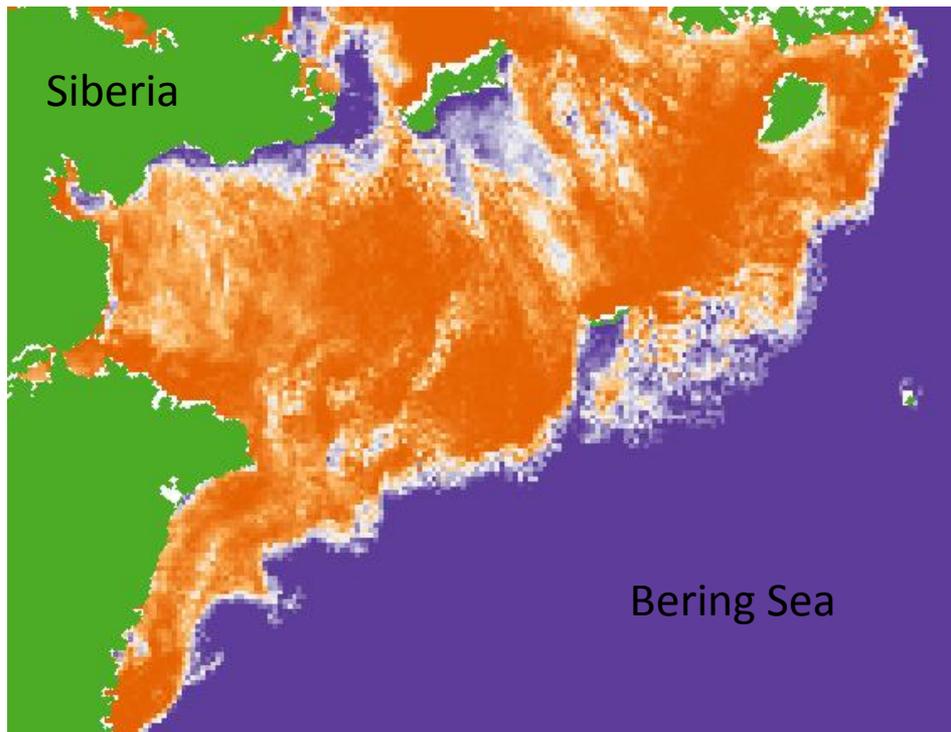




# Blended Ice Conc. Enhancements

AMSR 2 Only

Blended Ice Con





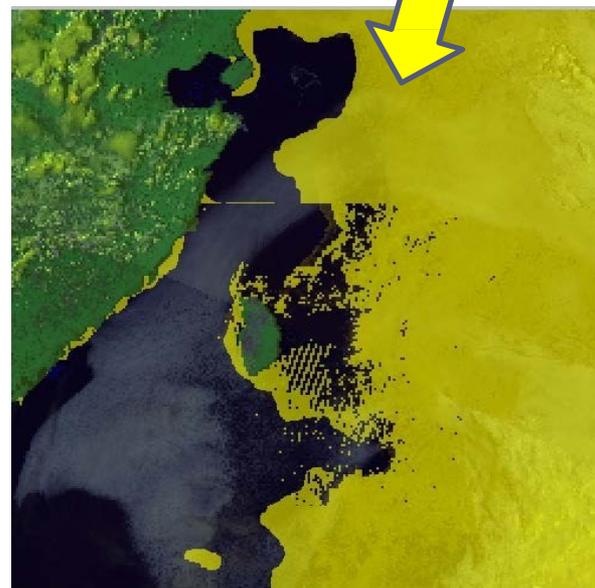
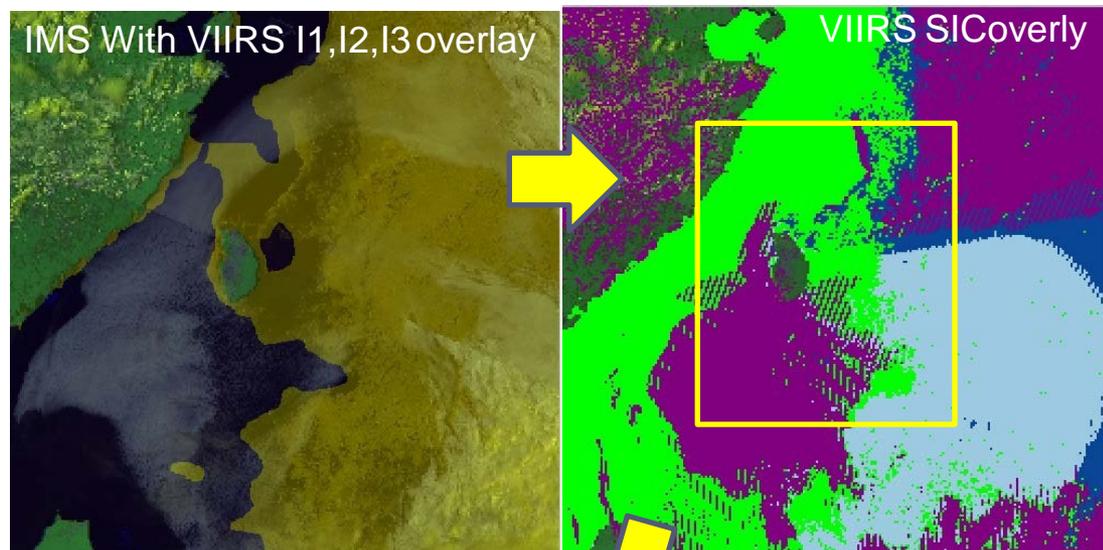
# Adding Elements to IMS Direct Import of Automated Snow & Ice Cover

Analysts will be able to selectively import the data from satellite derived products directly into the Blended Analysis

Analysis will have selection box to select snow cover and ice cover from the VIIRS, **NOHRSC**, **Blended Ice Concentrations**, **SAR Ice Mask** and NH AutoSnowIcE.

Human data selection to optimize product use based on expert knowledge and imagery interpretation

Combines the speed and reliability of automated products with the QC and flexibility of Human Analysts





# NOAA CREST Sea Ice Product Monitor for the Ross Sea



CS:dir\$

Computational Science of Data Intensive Remote Sensing

## Sea Ice Product Monitor

Ross Sea



### INSTRUMENTS

- MODIS A
- VIIRS
- MODIS T
- AMSR2

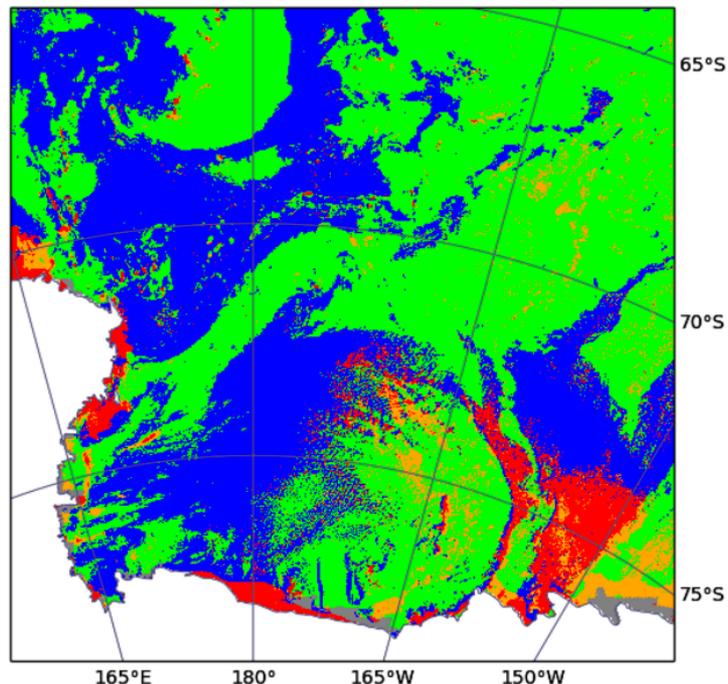
### VIEW

- Ice Extent
- False Color
- RGB
- Sea Ice Concentration

### DAILY PRODUCTS

- MISIC
- IMS
- NIC
- OSISAF
- CMC
- Sea Ice Concentration
- IMS
- NCEP
- MASAM2

2016 02 25



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This work has been supported by ONR grant #W911NF1310116 and NIC

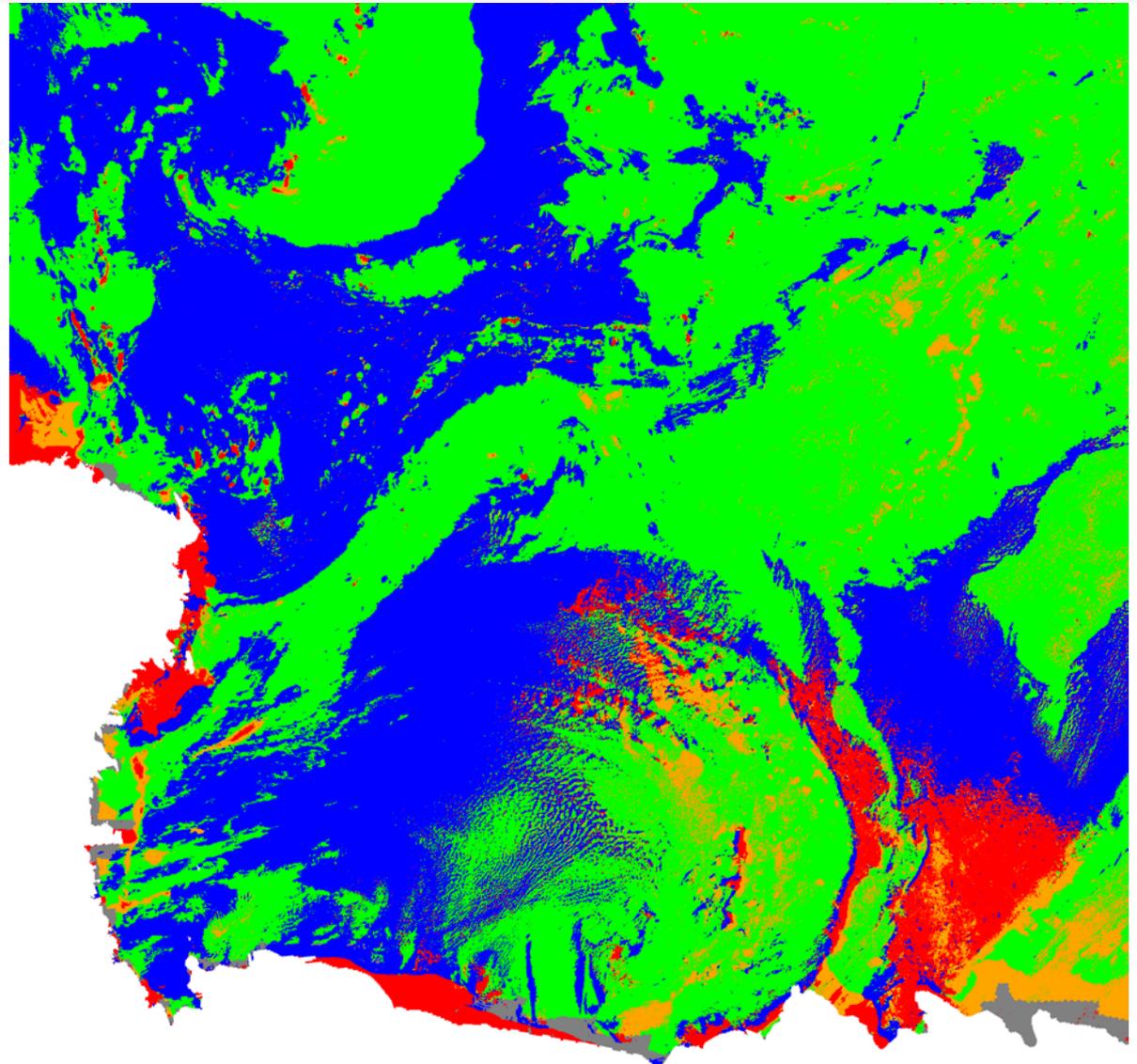


Courtesy of Dr. Irina Gladkova

Sea ice classification based on NOAA/CREST Microwave/Imager Sea Ice Classifier (MISIC)



# NOAA CREST Sea Ice Classification



Sea Ice	Water	Land
Cloud	Cloud	Undefined

Sea ice classification based on NOAA/CREST Microwave/Imager Sea Ice Classifier (MISIC)



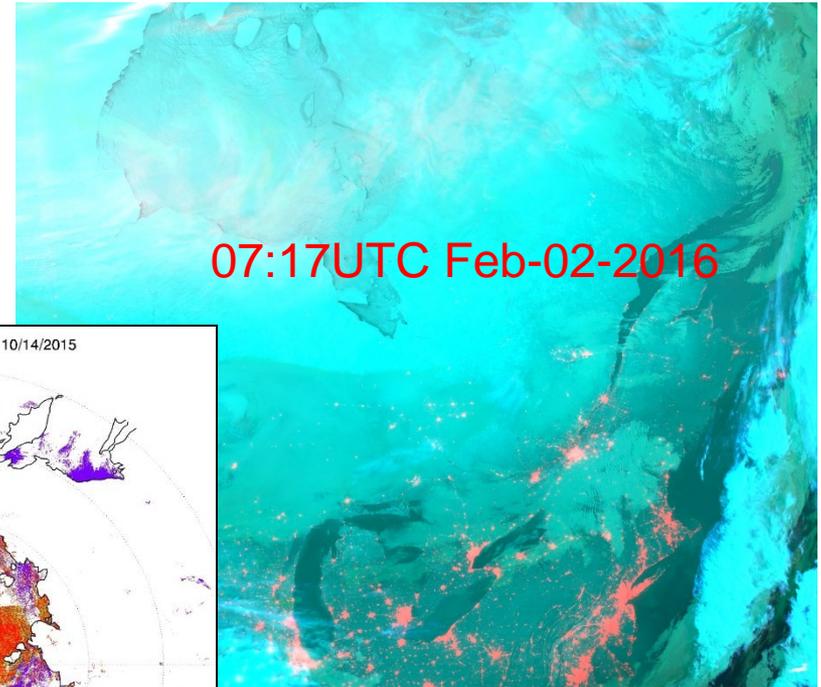
# NAIS Remote Sensing - VIIRS



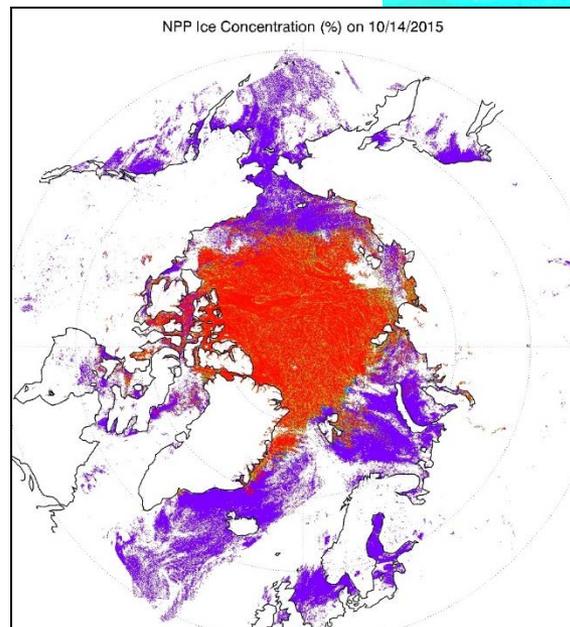
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CIS and NIC is processing day and night imagery in near real time images from VIIRS

CIS worked on improved visualization of VIIRS data

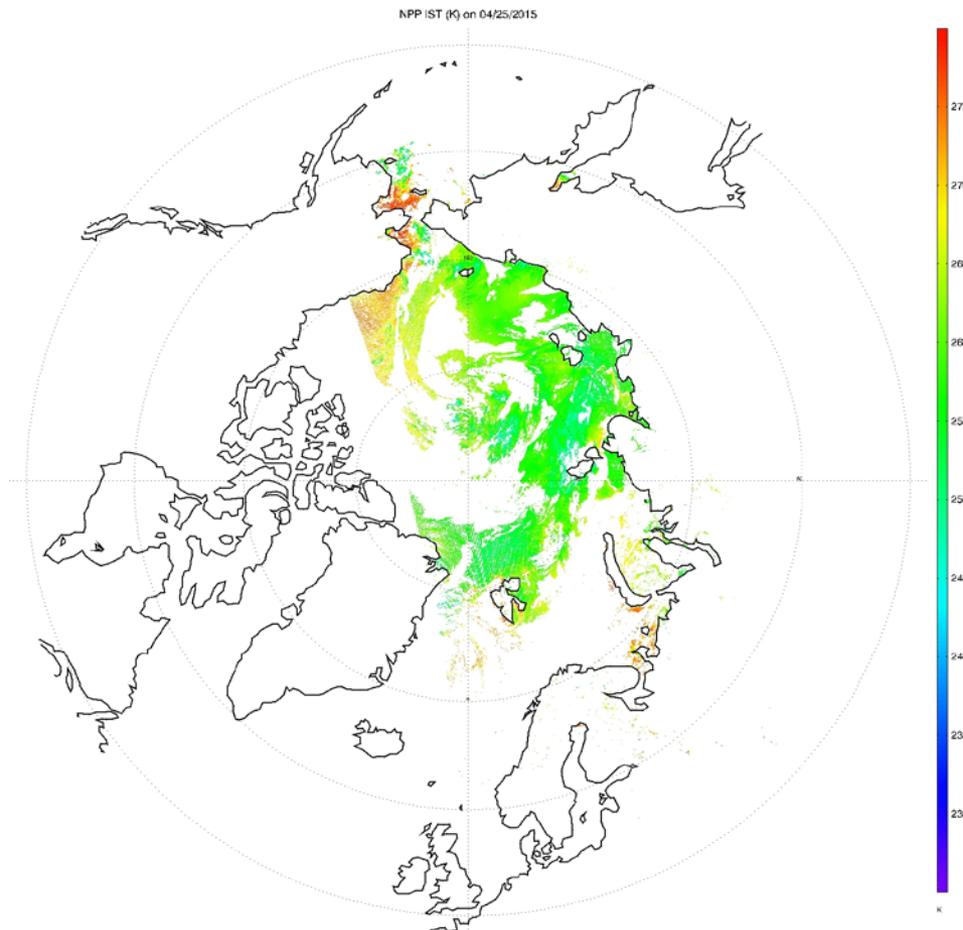


NIC is working with CIMSS and NRL on the integration of VIIRS ice concentrations into ArcGIS, GOFS and potentially other models such as GIOPS.





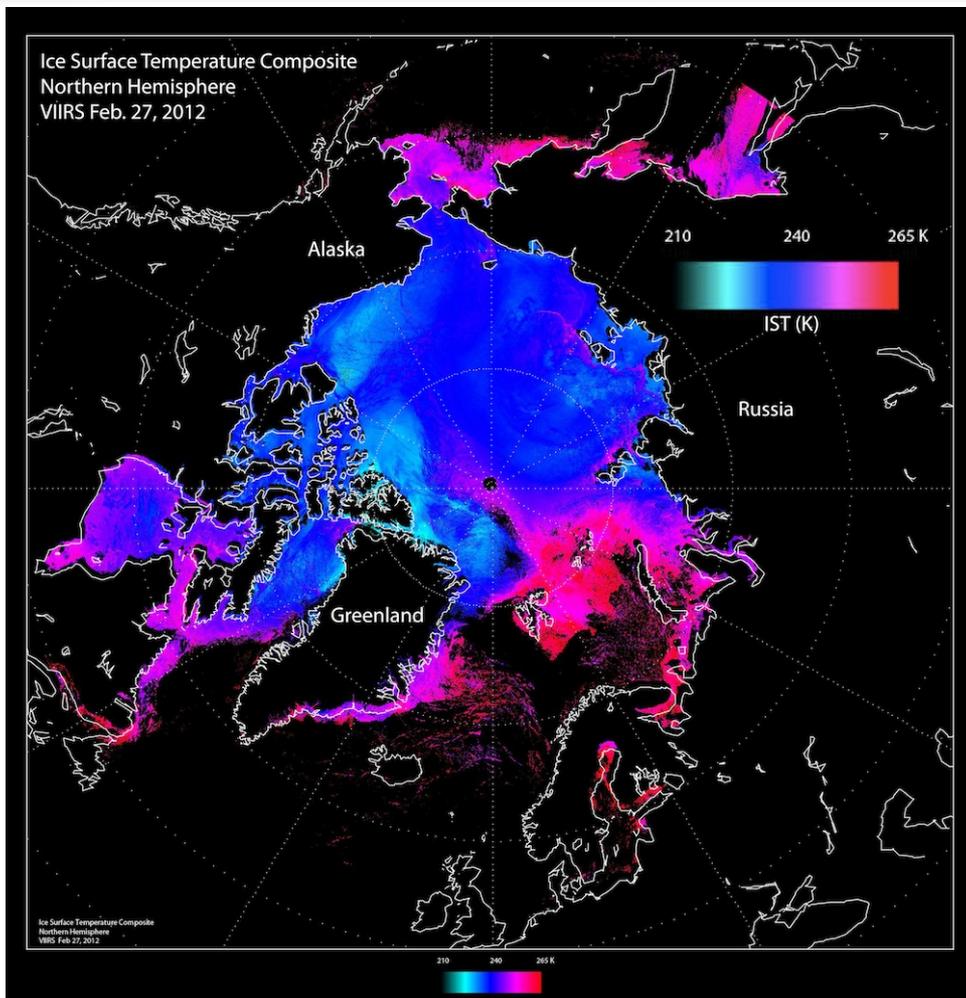
# SNPP VIIRS Ice Surface Temperature (IST)



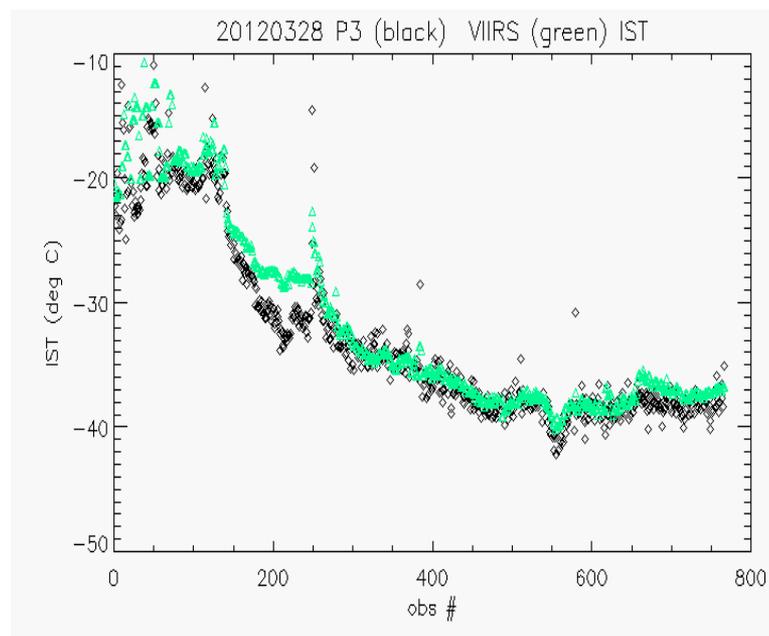
*(animation)*



# SNPP VIIRS Ice Surface Temperature (IST)



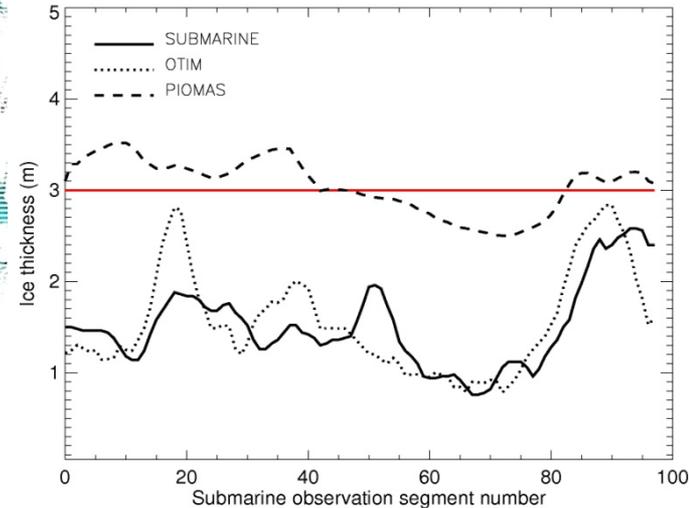
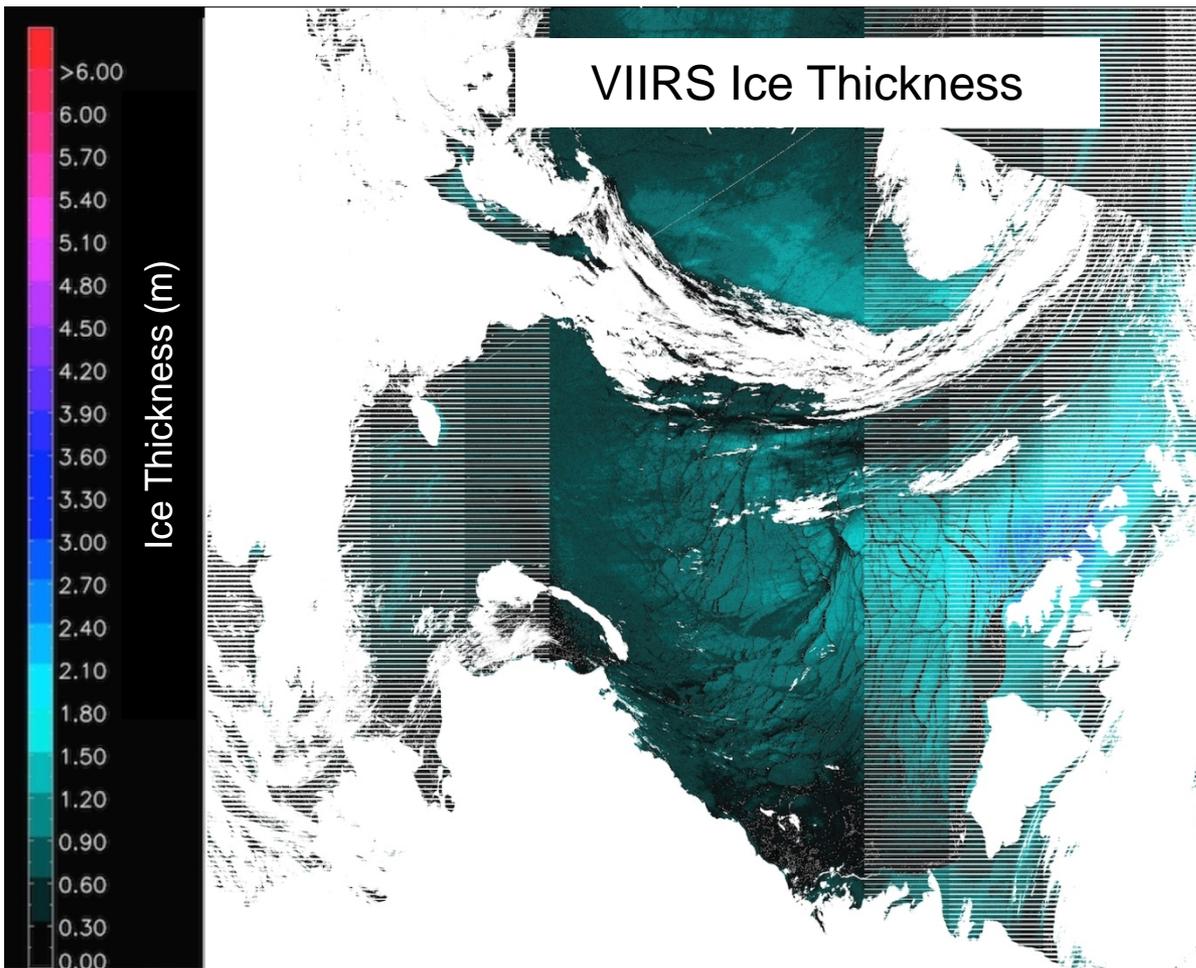
## IceBridge KT19 vs VIIRS IST, 2012



Composite of VIIRS Ice Surface Temperature on 27 Feb 2012.



# The Holy Grail: Sea Ice Thickness



Validation with submarine sonar and modeled ice thicknesses.



# NIC SNPP/JPSS Wish list for Future Work Still Holds

## (1) Geotiff formats (All)

NIC spends much of its infrastructure, bandwidth and processing on file conversion from HDF formats from VIIRS and MODIS

## (2) Include Lake ice in the Ice products (IMS, Great Lakes Analysis)

## (3) Product Composites at 1km (IMS, Hemispheric Ice Charts)

Difficulty stitching multiple swath and resampling to lower resolution

## (4) Ice Edge (Marginal Ice Zone)

## (5) Ice Drift (Ice Forecasting, IMS, annotated imagery)

## (6) Ice Lead Detection (FLAP, Annotated Imagery)

## (7) Snow Fraction (IMS, ASI)

## (8) Blended products (All)

## (9) Optional Cloud masks (All)



# Present and Upcoming Operational VIS/IR Missions

## **JPSS/VIIRS**

- JPSS-2 – launch scheduled for 2021
- JPSS-1 Launch delayed to March 2017
- Design life 7 years

## **Sentinel-3/OLCI & SLSTR**

- Sentinel-3c launch before 2020
- Sentinel-3b launch scheduled for 2017
- Sentinel-3a launched 16 February 2016
- Design life 7 years (consumables 12 years)

## **NPP/VIIRS**

- Launched on 28 October 2011
- Design life 6 years (consumables 7 years)

## **Aqua and Terra/MODIS**

- Aqua launched 4 May 2002 (over 14 years in operation)
- Terra launched 18 December 1999 (over 16 years in operation)
- Design life 6 years
- Life expectancy into 2020's

## **DMSP/OLS**

- DMSP F-20 (S-20) launch date projected for 2020
- DMSP F18- launched 18 October 2009 (over 6 years in operation)
- DMSP F-17 launched 4 November 2006 – Primary (over 9 years in operation)
- Design life 5 years



Thank You!

