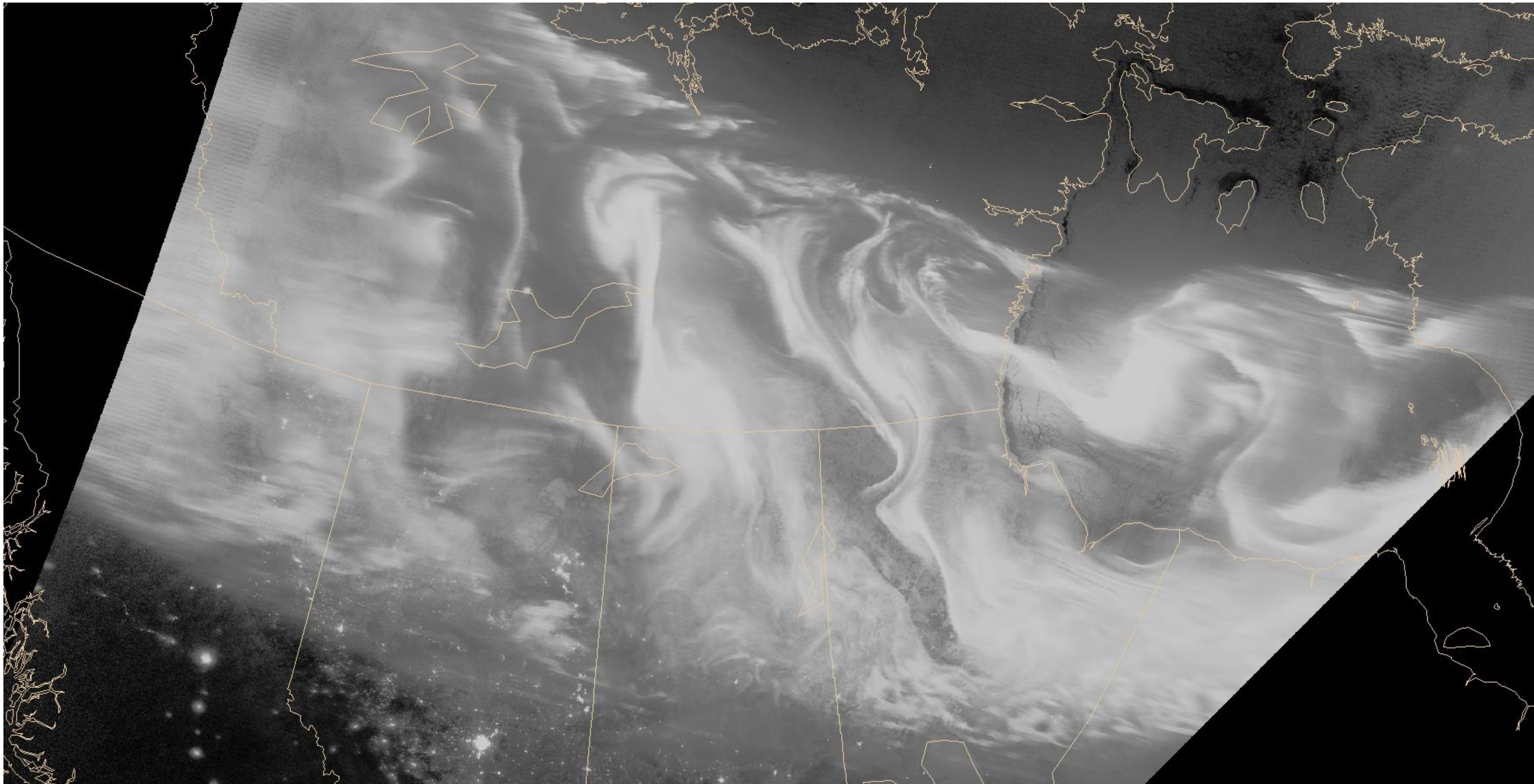


New Generation Weather Satellite Readiness: Marine and Arctic Applications

Jordan Gerth, Cooperative Institute for Meteorological Satellite Studies

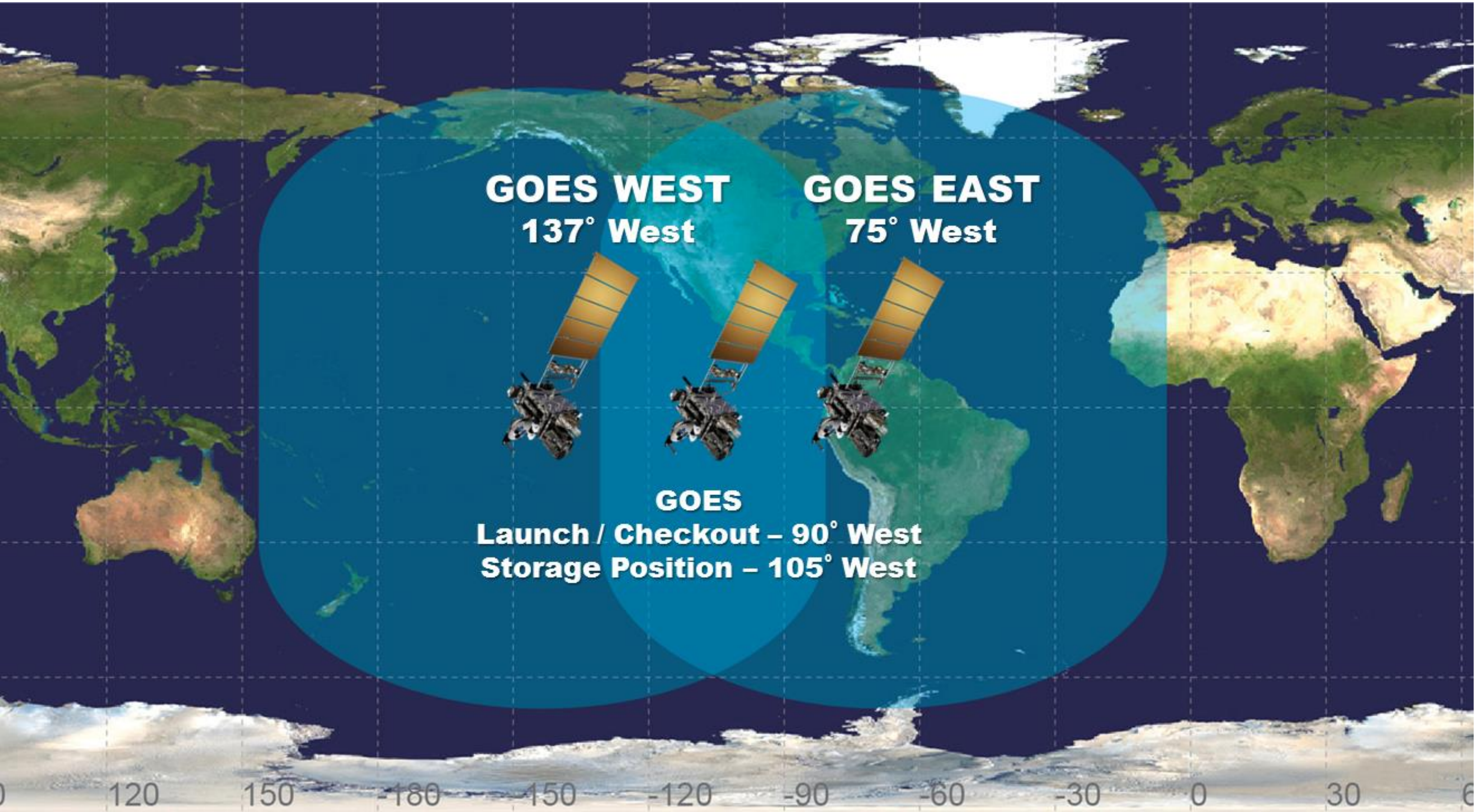
Contributors

- CIMSS Satellite Blog
  - Scott Bachmeier
  - Scott Lindstrom
  - http://cimss.ssec.wisc.edu/goes/blog/
- Tim Schmit (NOAA)
- Jeffrey Key (NOAA)

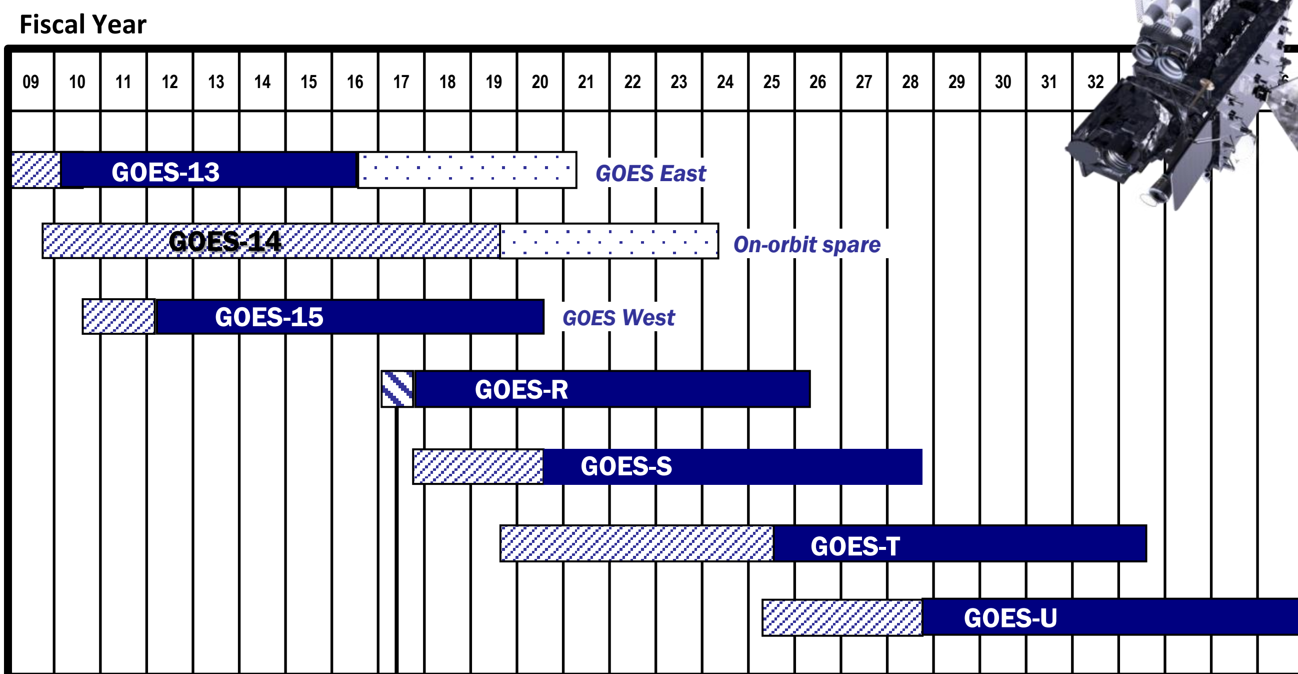
Upcoming GOES-R/S Launch

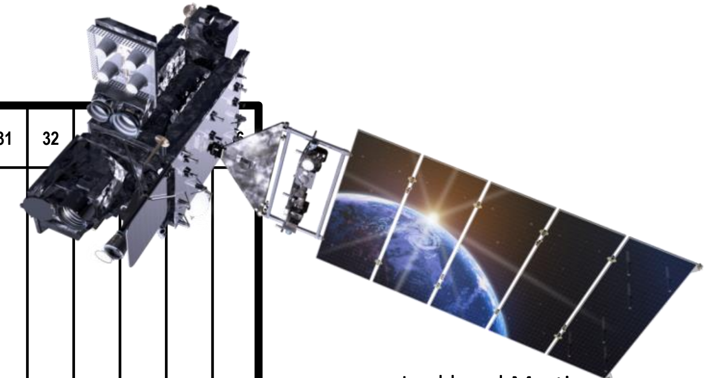
- GOES-R is tentatively scheduled to launch on October 13, 2016, in Cape Canaveral, Florida
- GOES-S will launch approximately one year after GOES-R
- GOES-R post-launch testing will occur with the satellite at 89.5 degrees West
  - GOES-R will be there for approximately one year
- Operational location of GOES-R will depend on NWS priorities and the health of the existing GOES satellites

Future GOES-R/S Constellation

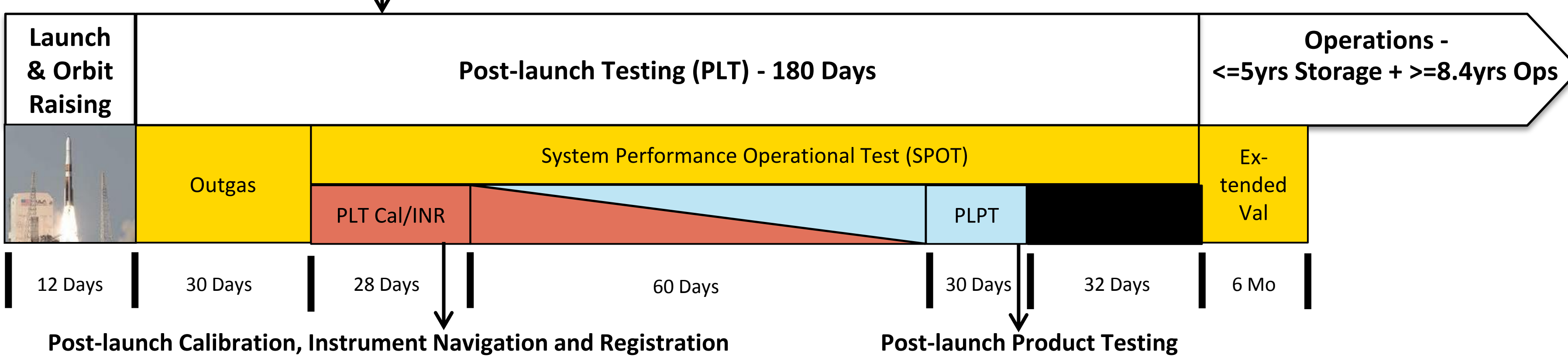


Continuity of GOES through 2036

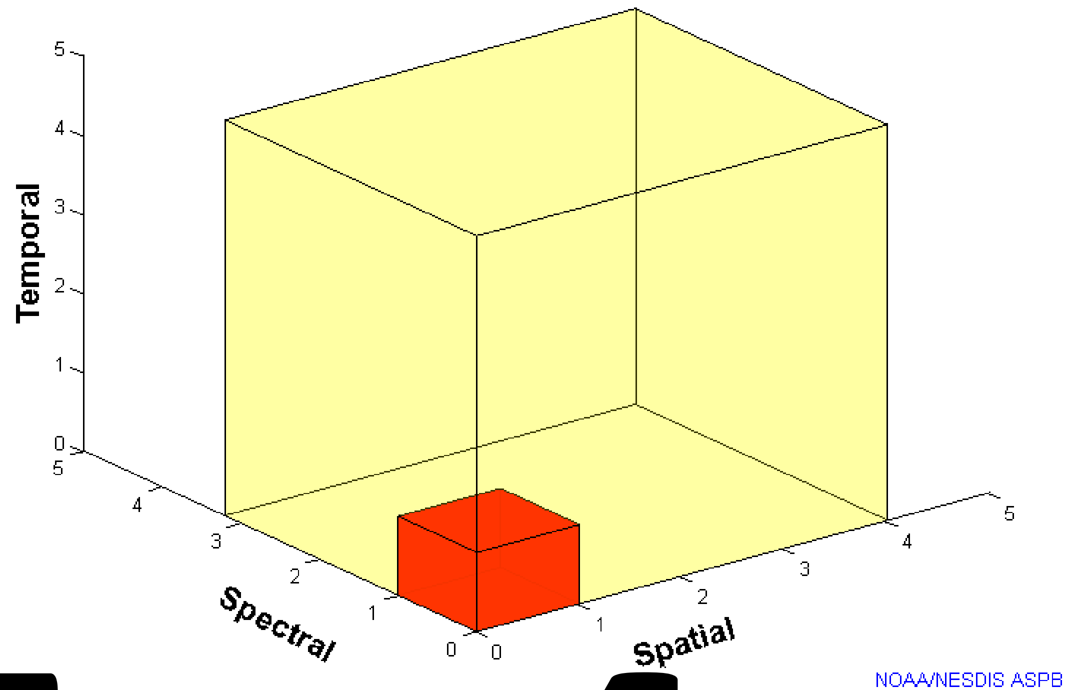




Lockheed Martin



Advanced Baseline Imager (ABI)

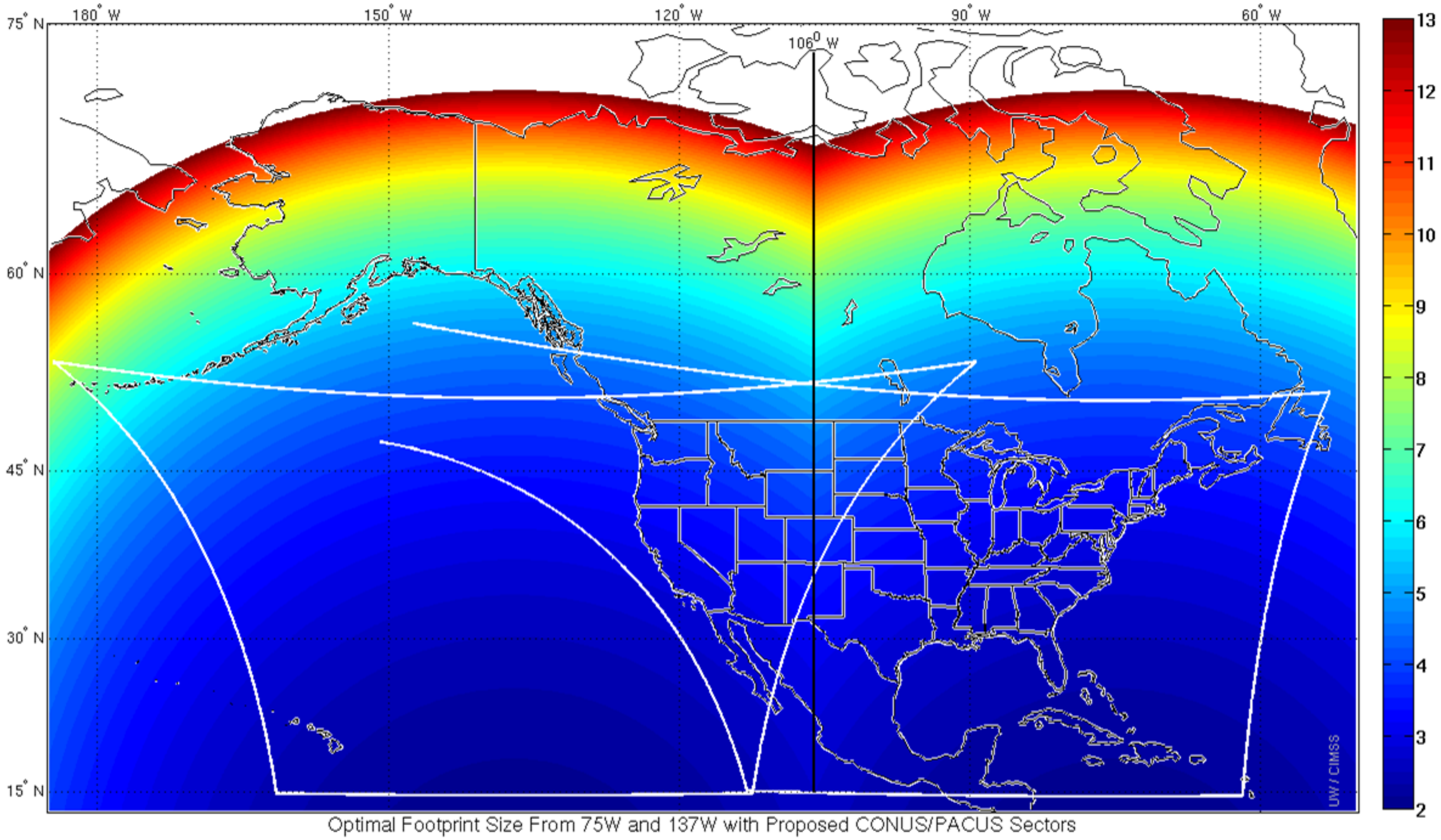


5 X
Faster scanning (5-minute full disk vs. 25-minute)

4 X
Improved spatial resolution (2 km IR vs. 4 km)

3 X
More spectral bands (16 on ABI vs. 5)

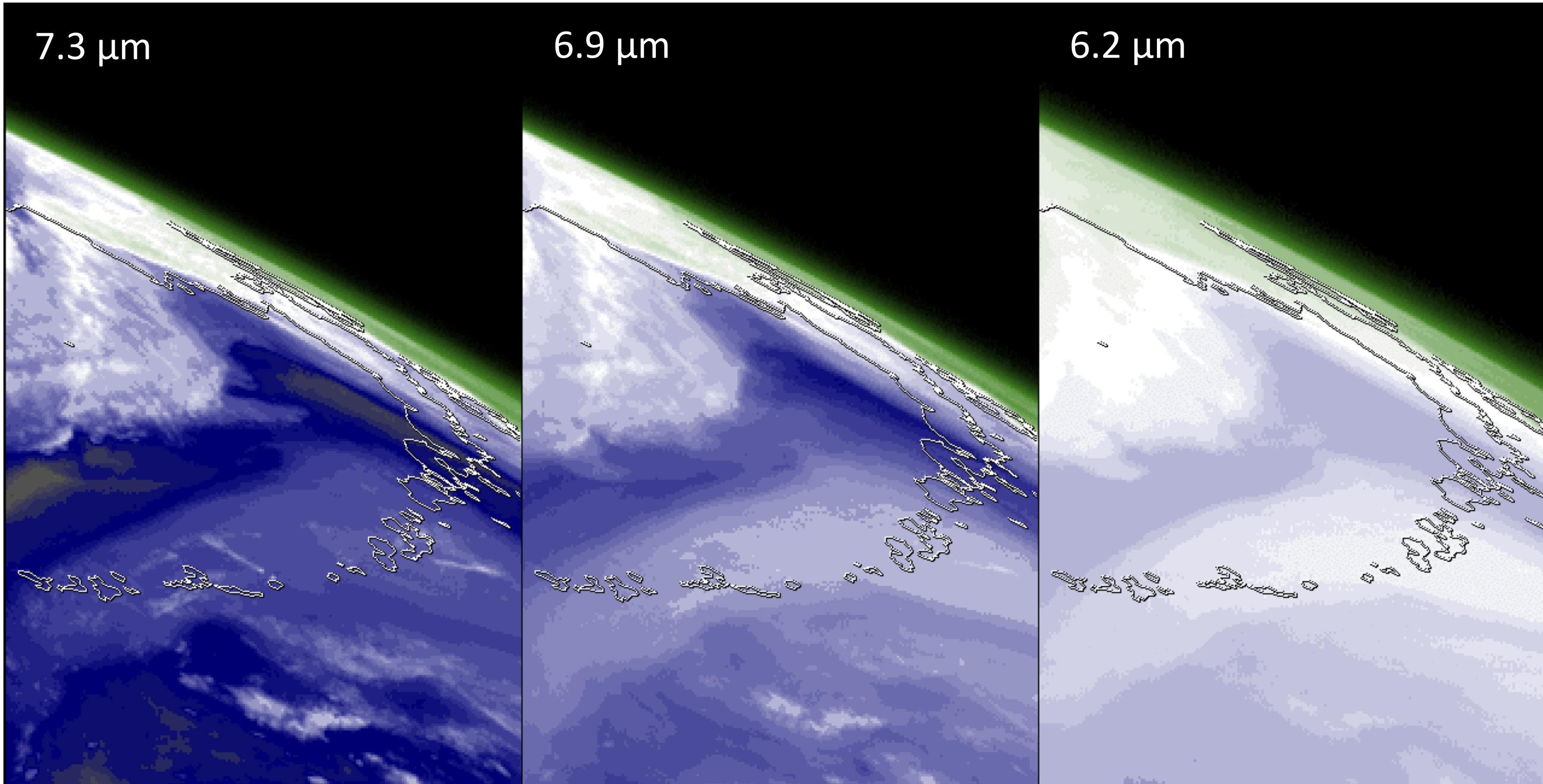
Improved Spatial Resolution



Highest infrared window spatial resolution from two GOES-R series satellite constellation

List of ABI Spectral Bands

ABI Band	Wavelength (µm)	Wavelength range (µm)	Sub-point pixel spacing (km)	Descriptive Name
1	0.47	0.45 - 0.49	1	"Blue"
2	0.64	0.60 - 0.68	0.5	"Red"
3	0.864	0.847 - 0.882	1	"Veggie"
4	1.373	1.366 - 1.380	2	"Cirrus"
5	1.61	1.59 - 1.63	1	"Snow/Ice"
6	2.24	2.22 -2.27	2	"Cloud Particle Size"
7	3.90	3.80 - 3.99	2	"Shortwave window"
8	6.19	5.79 - 6.59	2	"Upper-level Water Vapor"
9	6.93	6.72 - 7.14	2	"Mid-Level Water Vapor"
10	7.34	7.24 - 7.43	2	"Lower/Mid-level Water Vapor"
11	8.44	8.23 - 8.66	2	"Cloud-top Phase"
12	9.61	9.42 - 9.80	2	"Ozone"
13	10.33	10.18 - 10.48	2	"Clean longwave window"
14	11.21	10.82 - 11.60	2	"Longwave window"
15	12.29	11.83 - 12.75	2	"Dirty longwave window"
16	13.28	12.99 - 13.56	2	"CO_2"



Himawari-8 view of Mount Pavlof eruption

Alaska Peninsula, 28 March 2016, Starting 0:00 UTC

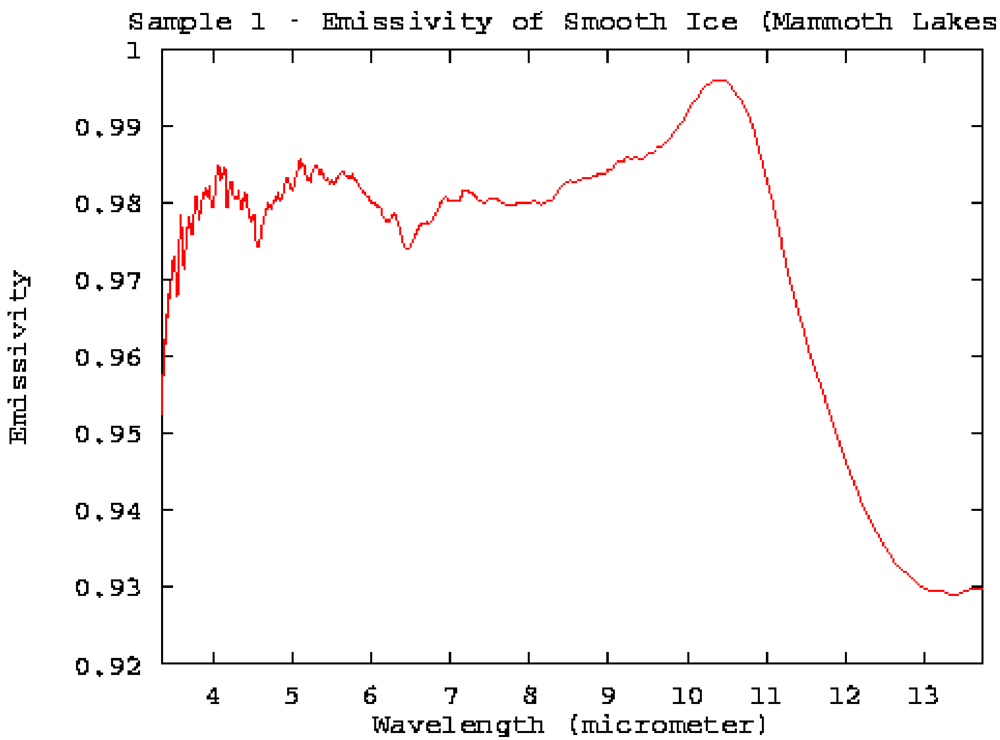
Source: CIMSS Satellite Blog (http://cimss.ssec.wisc.edu/goes/blog/)

ABI Bands of Interest

to Marine and Arctic Weather Community

- Reflectance: ABI Bands 2, 3, and 5
- Brightness Temperature: ABI Bands 14 and 15

New ABI bands collectively enable better discrimination between land, sea, ice, water cloud, and ice cloud.



Source: http://www.icess.ucsb.edu/modis/EMIS/html/em.html

ABI and AHI Band Fact Sheets

http://www.goes-r.gov/

State of NWS Training Efforts

- Foundational course
  - Introduction to enhanced spatial, spectral, and temporal resolution of ABI (and GLM) with general applications to common weather analysis/forecast scenarios
  - Approximately eight hours of self-paced, pre-recorded teletraining content
  - Interactive elements
  - Available in October 2016
- Specific applications
  - Many marine and arctic applications are not part of the foundational course; may be available later

Training Paradigm

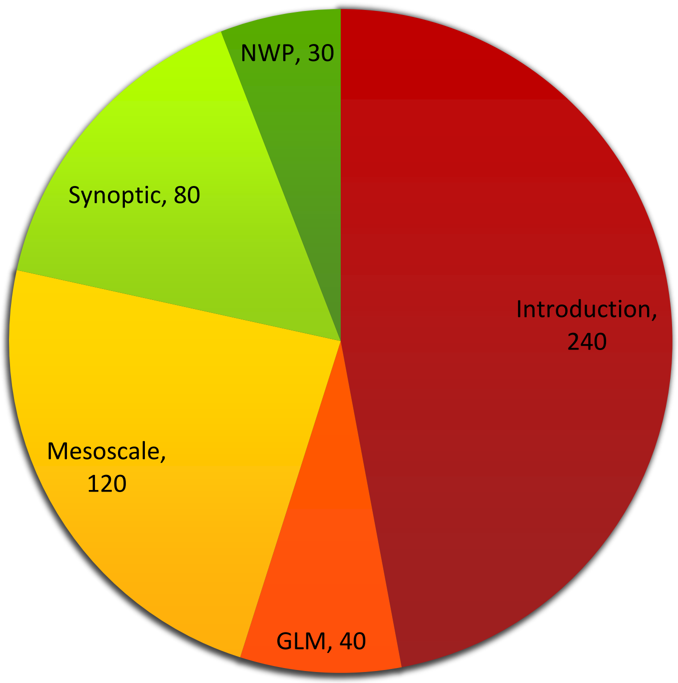
Foundation

General

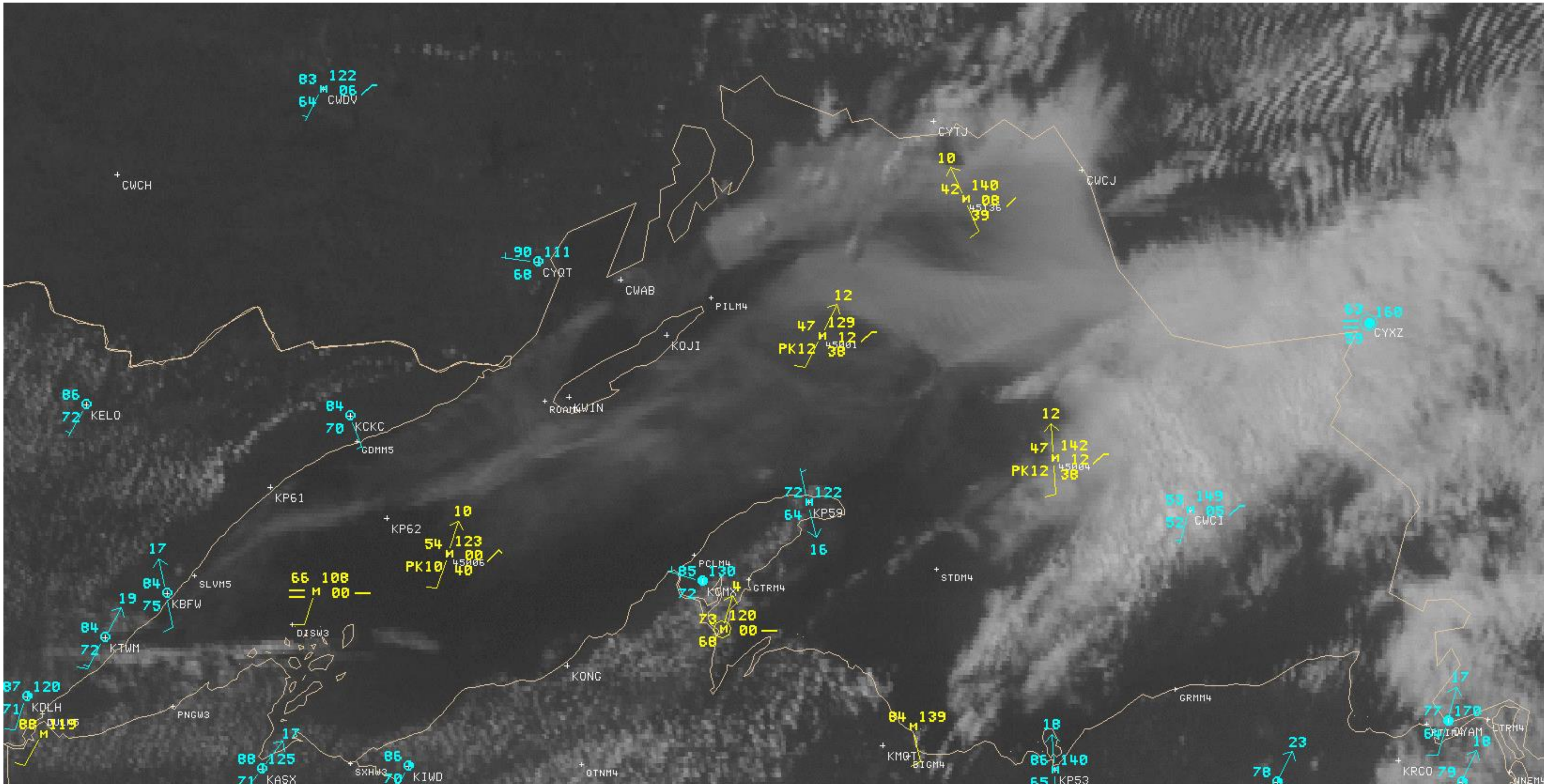
Specialized

Foundational Training Distribution

for all NWS (US NMHS) meteorologists



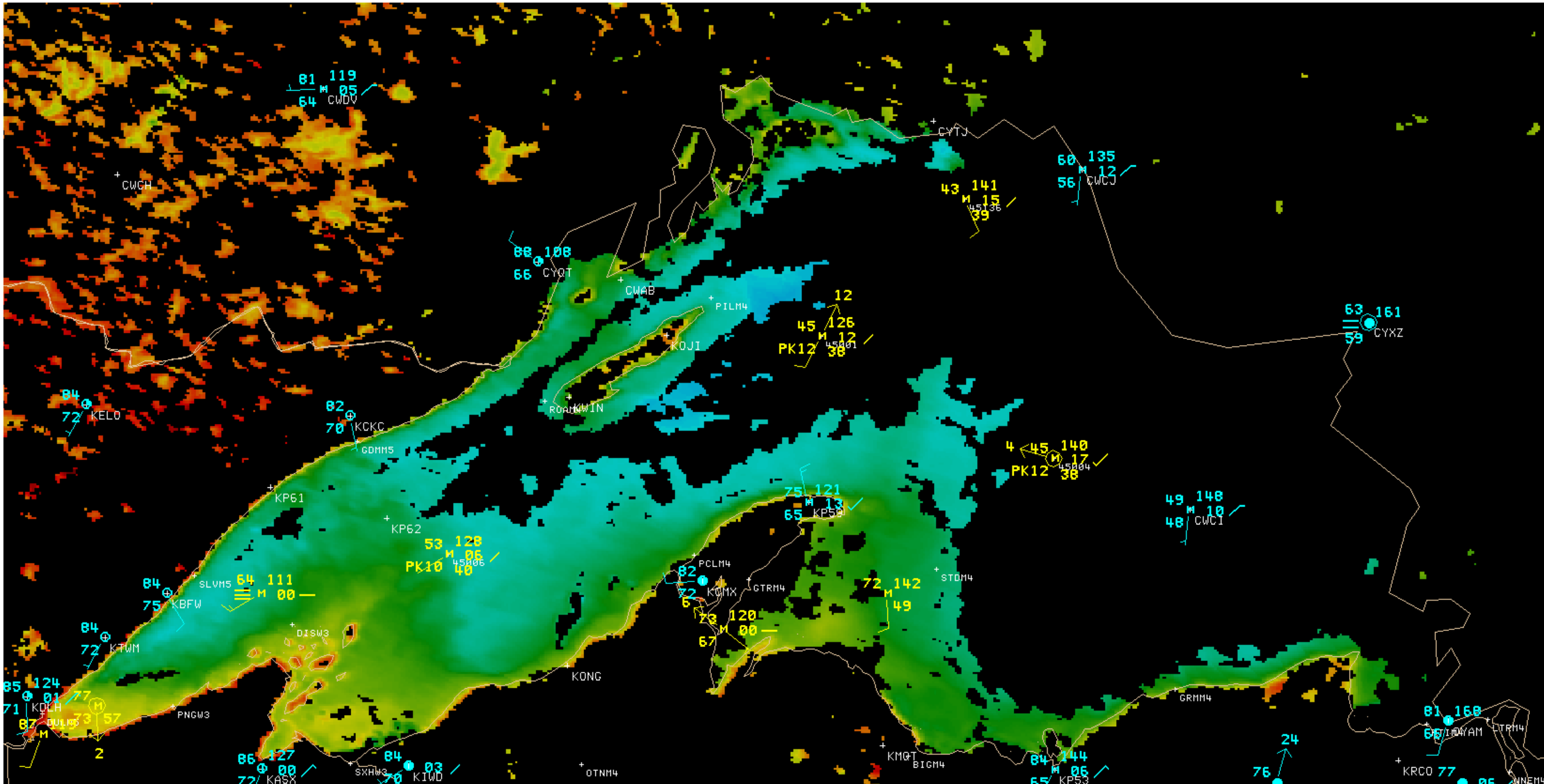
- GOES-R Introduction and SatMet Background Track (240 minutes)
- Geostationary Lightning Mapper Track (40 minutes)
- Mesoscale/Convection Track (120 minutes)
- Synoptic Scale Track (80 minutes)
- Numerical Weather Prediction and Data Assimilation Track (30 minutes)



Characterizing marine advection fog with GOES

Lake Superior, 21 July 2014, 19:00 UTC (to 1:00 UTC)

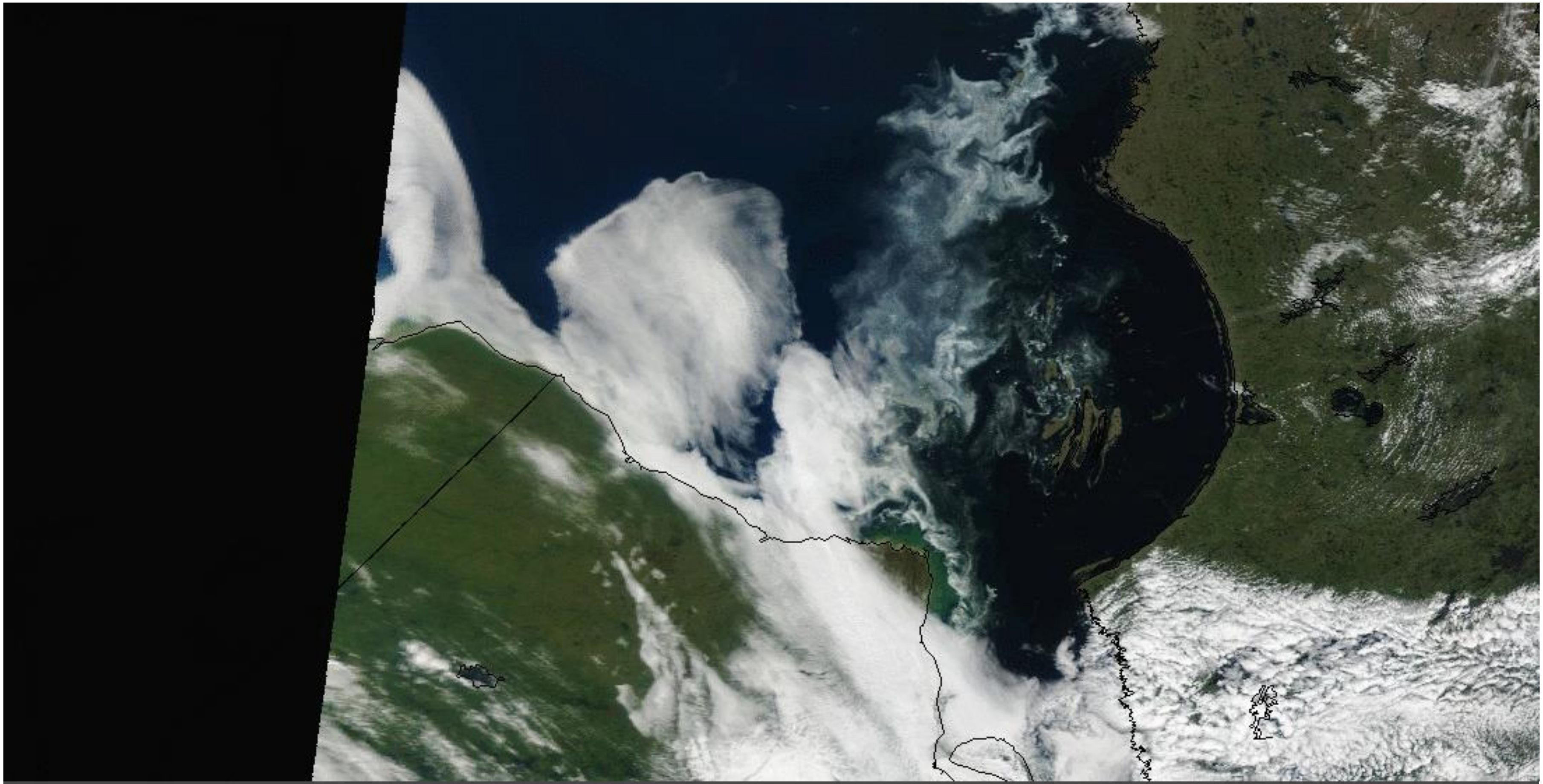
Source: CIMSS Satellite Blog (http://cimss.ssec.wisc.edu/goes/blog/)



Assessing fog potential with skin temperatures

MODIS, Lake Superior, 21 July 2014, 17:37 UTC

Source: CIMSS Satellite Blog (http://cimss.ssec.wisc.edu/goes/blog/)

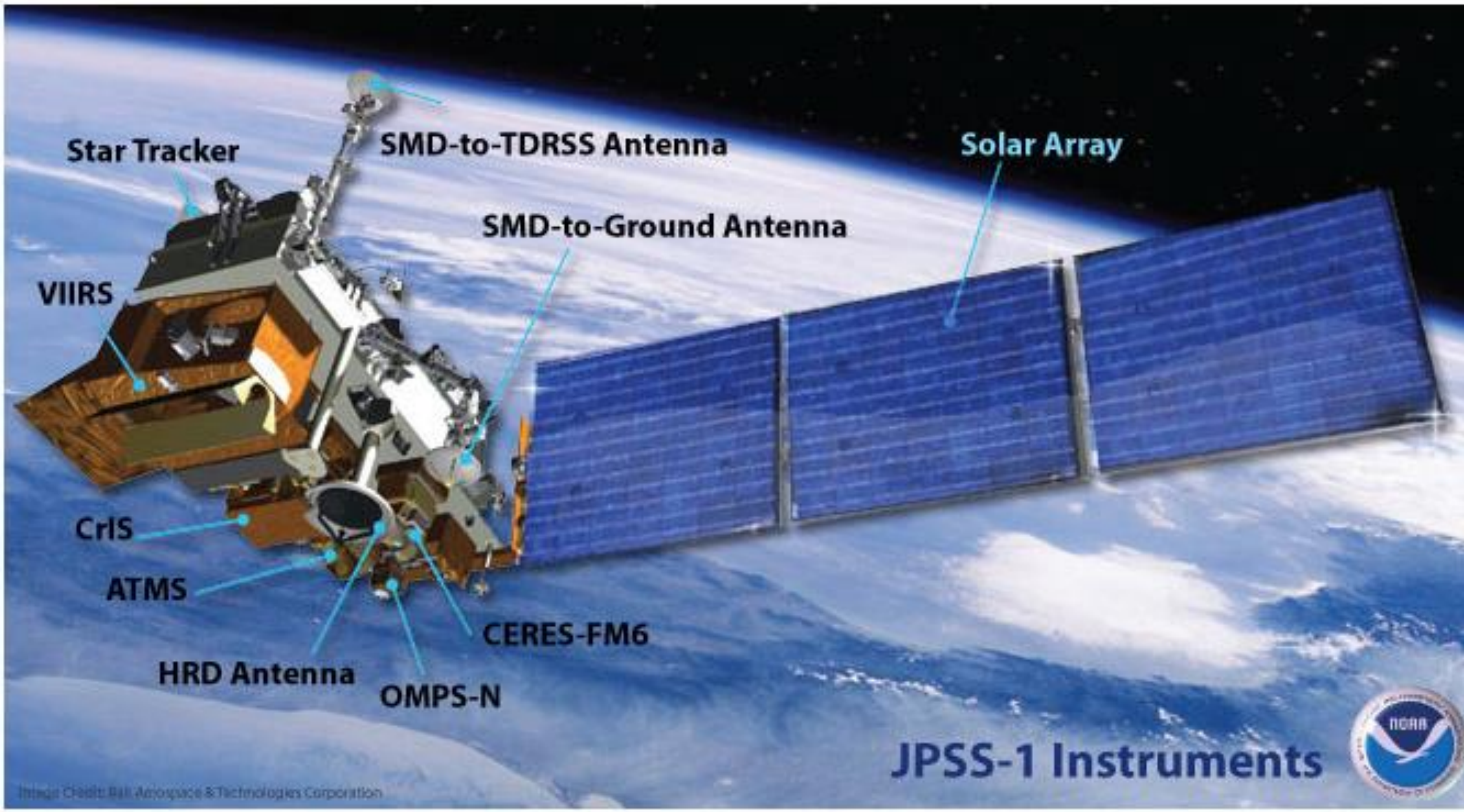


Discriminating ice from supercooled water cloud

MODIS, Hudson Bay, 7 August 2015, 16:11 UTC

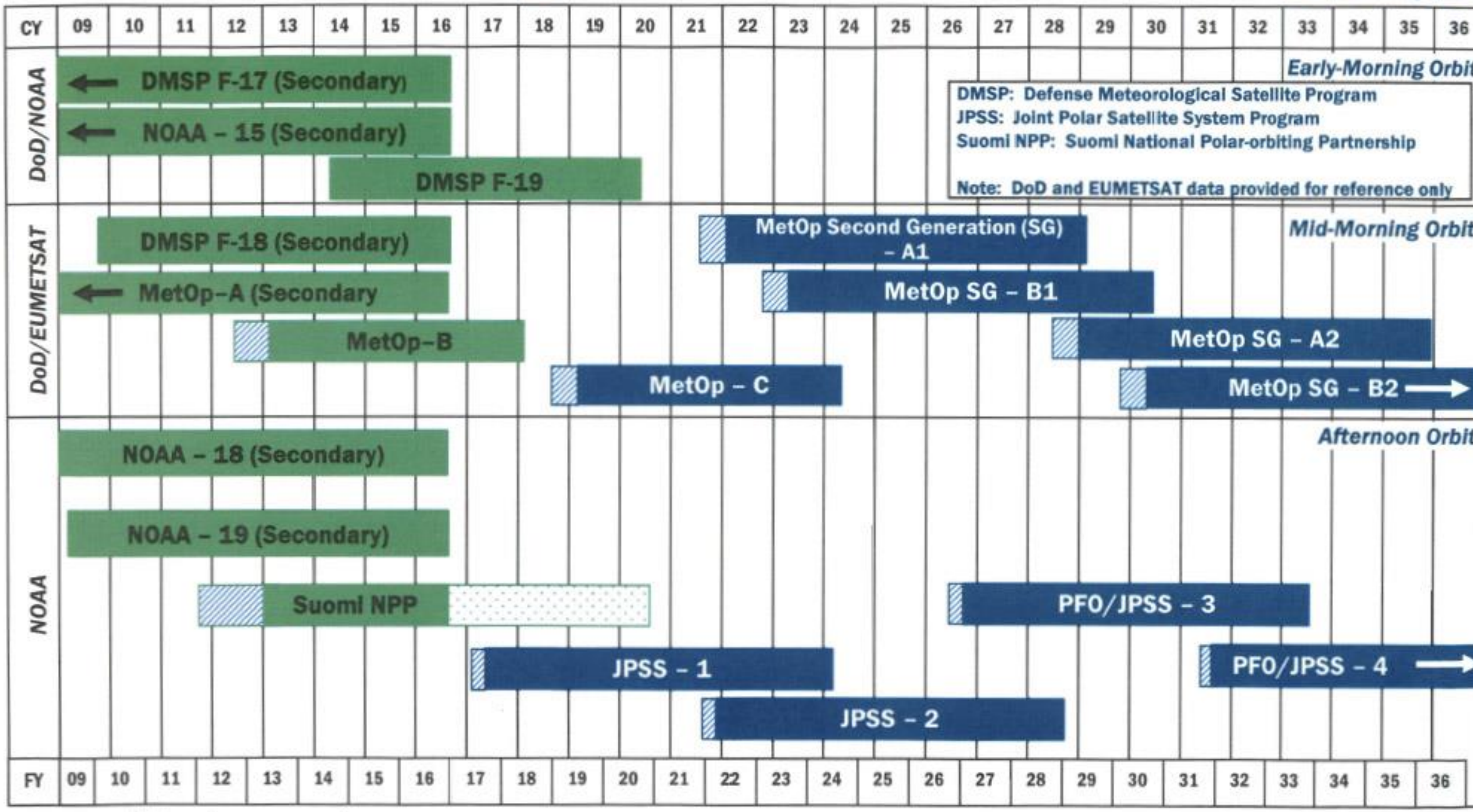
Source: CIMSS Satellite Blog (http://cimss.ssec.wisc.edu/goes/blog/)

Joint Polar Satellite System (JPSS)



NOAA & Partner Polar Satellite Programs
Continuity of Weather Observations

As of January 2016

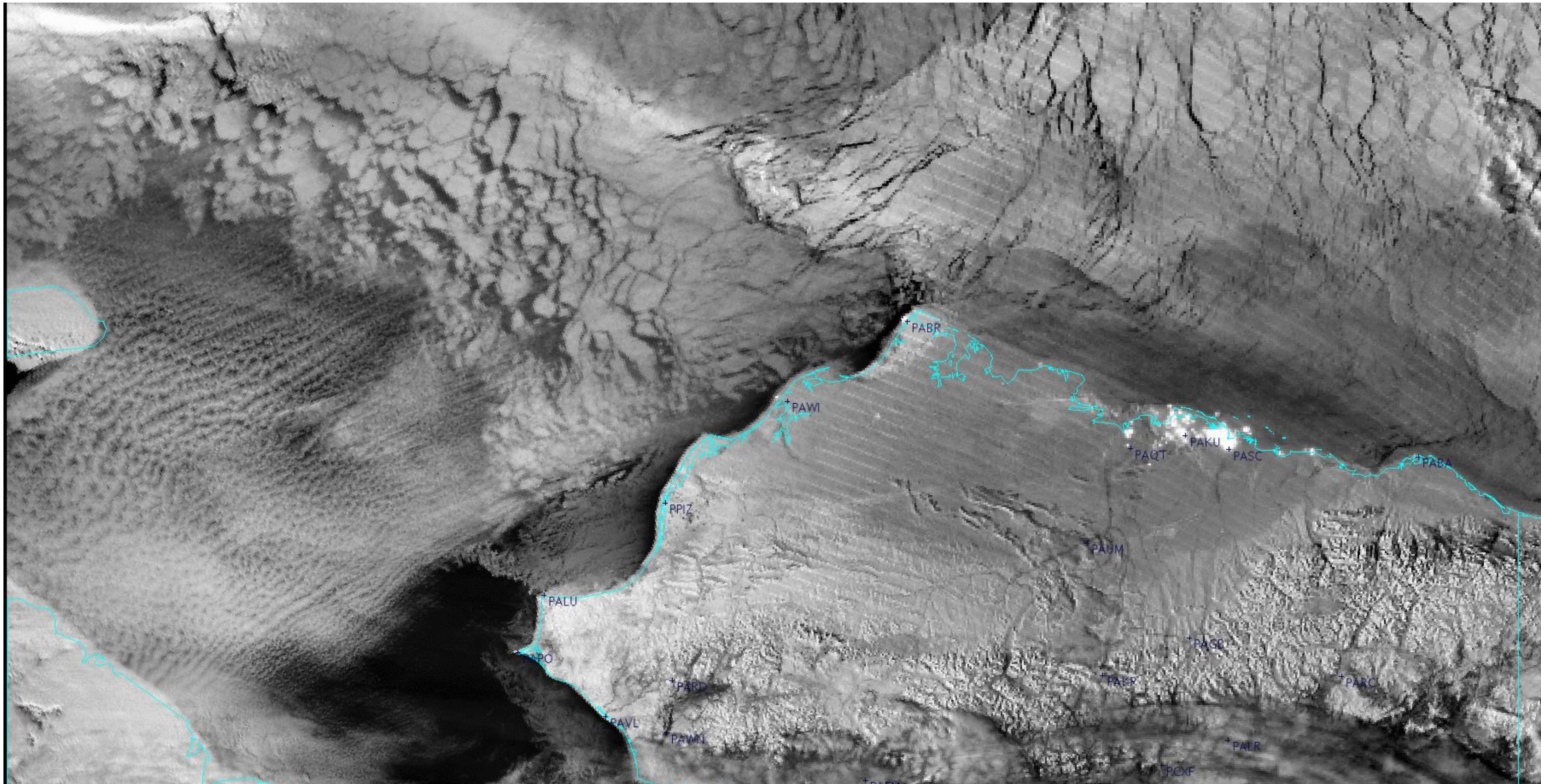


Approved: [signature]

Assistant Administrator for Satellite and Information Services

Note: Extended operations are reflected through the current FY, based on current operating health.

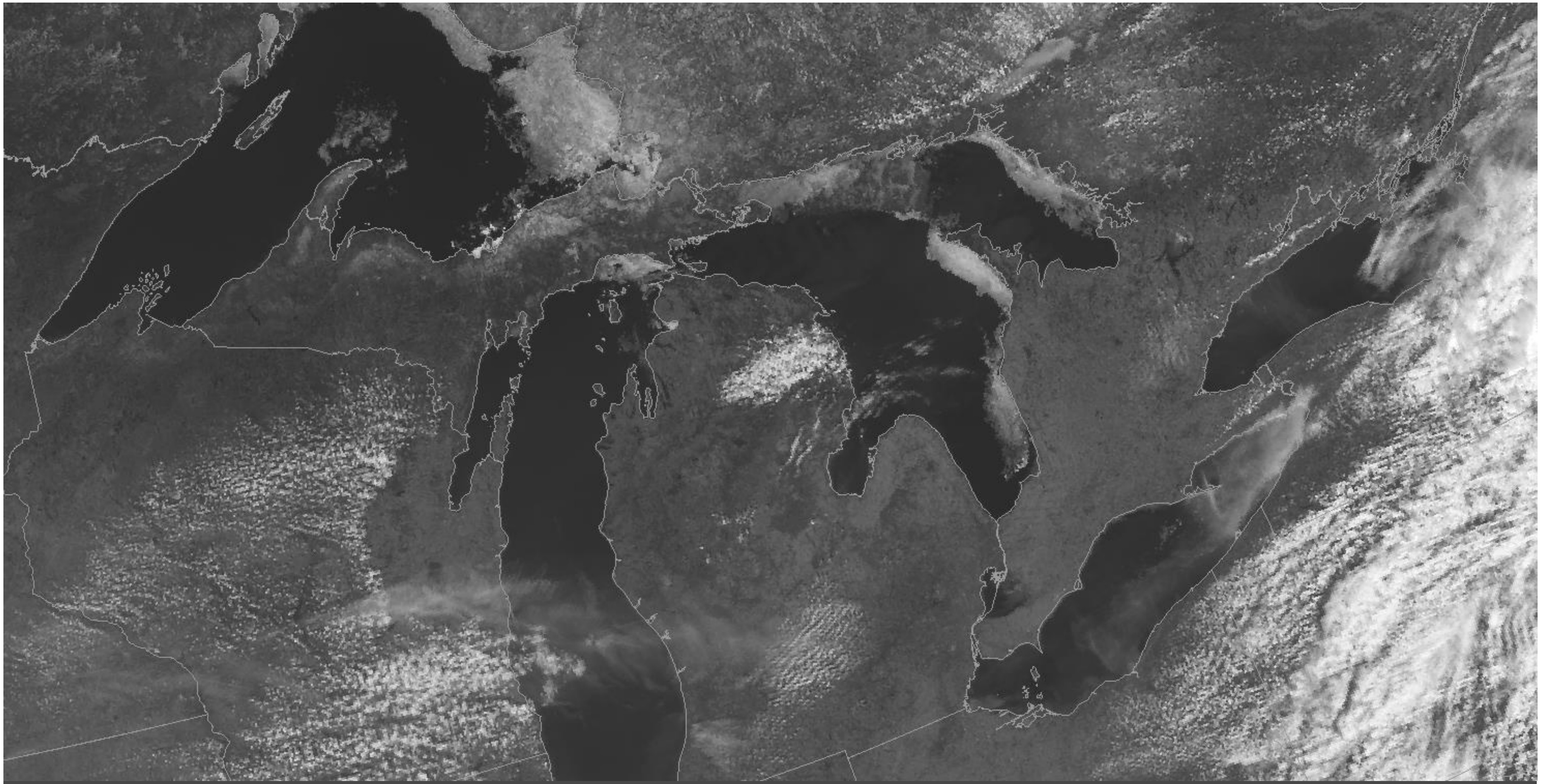
- In orbit
- Post Launch Test
- Fuel-Limited Lifetime Estimate
- Planned Mission Life, from Launch Readiness Date
- Launched before Oct 2008
- Operational beyond Dec 2036



Suomi NPP VIIRS Day-Night Band (DNB)

Northern Alaska, 5-9 December 2014

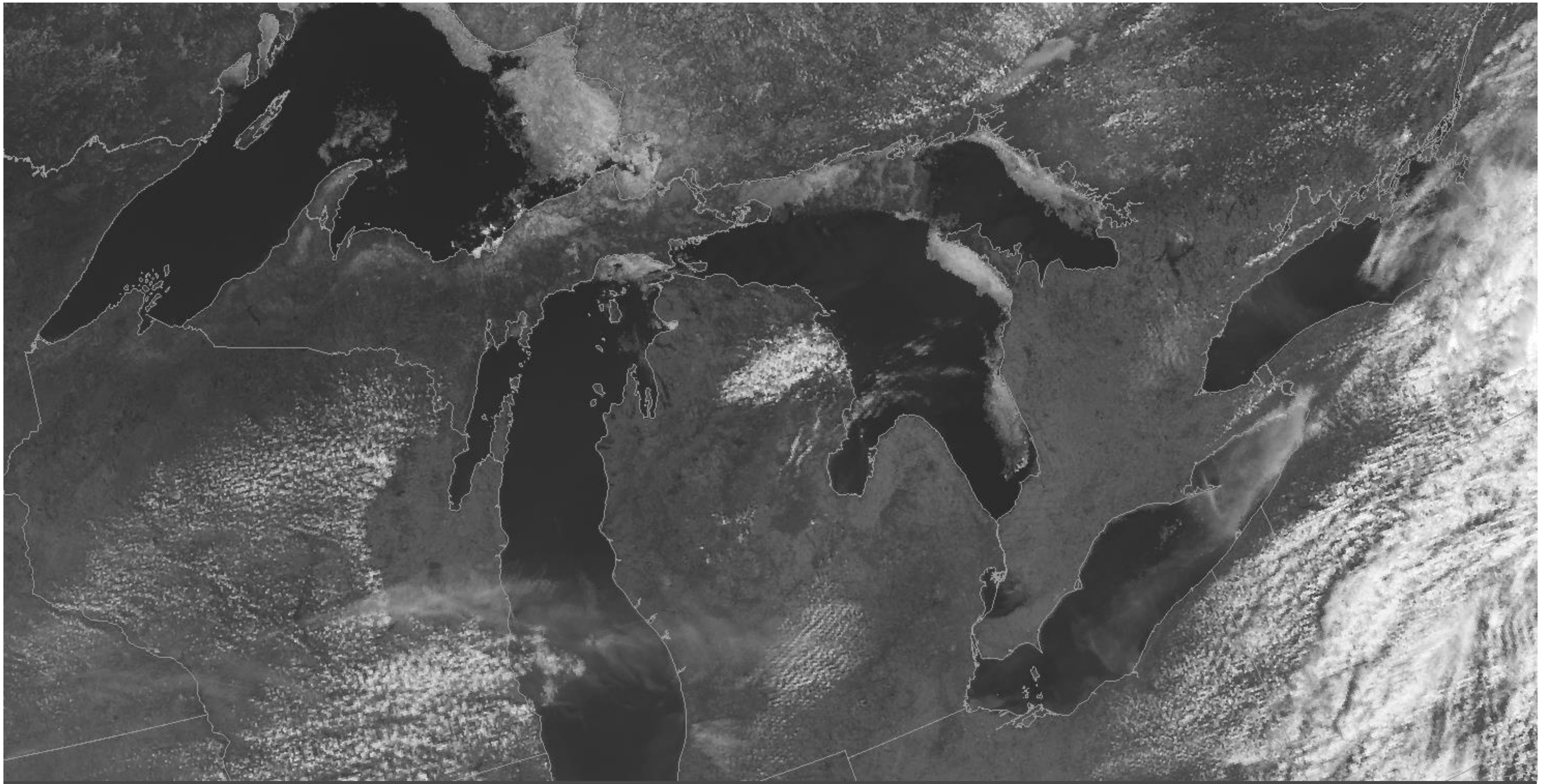
Source: CIMSS Satellite Blog (http://cimss.ssec.wisc.edu/goes/blog/)



Suomi NPP VIIRS (0.86 µm, 0.64 µm, DNB)

Great Lakes, 17 April 2015, 18:02 UTC

Source: CIMSS Satellite Blog (http://cimss.ssec.wisc.edu/goes/blog/)



Suomi NPP VIIRS (1.61 μm, 0.64 μm)

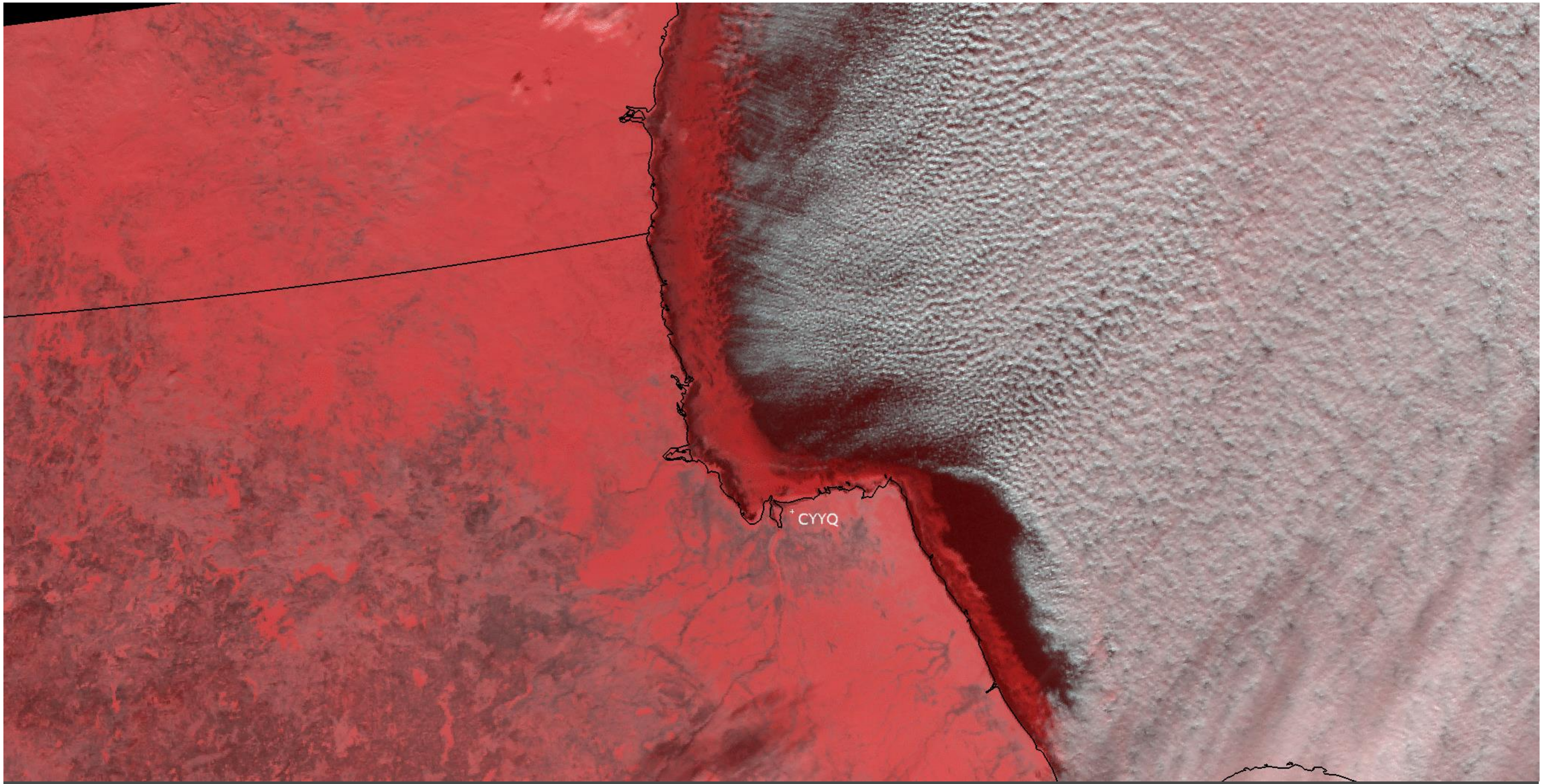
Great Lakes, 17 April 2015, 18:02 UTC

Source: CIMSS Satellite Blog (http://cimss.ssec.wisc.edu/goes/blog/)

Suomi NPP VIIRS (3.74 µm)

Great Lakes, 17 April 2015, 18:02 UTC

Source: CIMSS Satellite Blog (http://cimss.ssec.wisc.edu/goes/blog/)

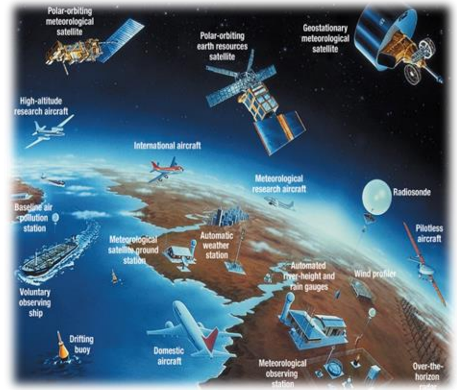


Discriminating ice from supercooled water cloud

VIIRS, Churchill Airport, 17-18-19 November 2013, 19 UTC

Source: CIMSS Satellite Blog (http://cimss.ssec.wisc.edu/goes/blog/)

Snow and Ice Products



NPP/JPSS VIIRS

- Snow cover (binary)
- Snow fraction
- Ice thickness and age
- Ice concentration
- Ice surface temperature

GOES-R ABI, Himawari-8 AHI

- Ice thickness/age[1]
- Ice cover[2]
- Ice concentration[2]
- Ice motion[2]
- Fractional snow cover (baseline)
- Snow depth – prairie only[2]

AMSR-2 on GCOM-W1

- Snow cover
- Snow depth
- Snow water equivalent (SWE)
- Ice characterization
  - Ice age class (first-, multi-year)
  - Ice concentration

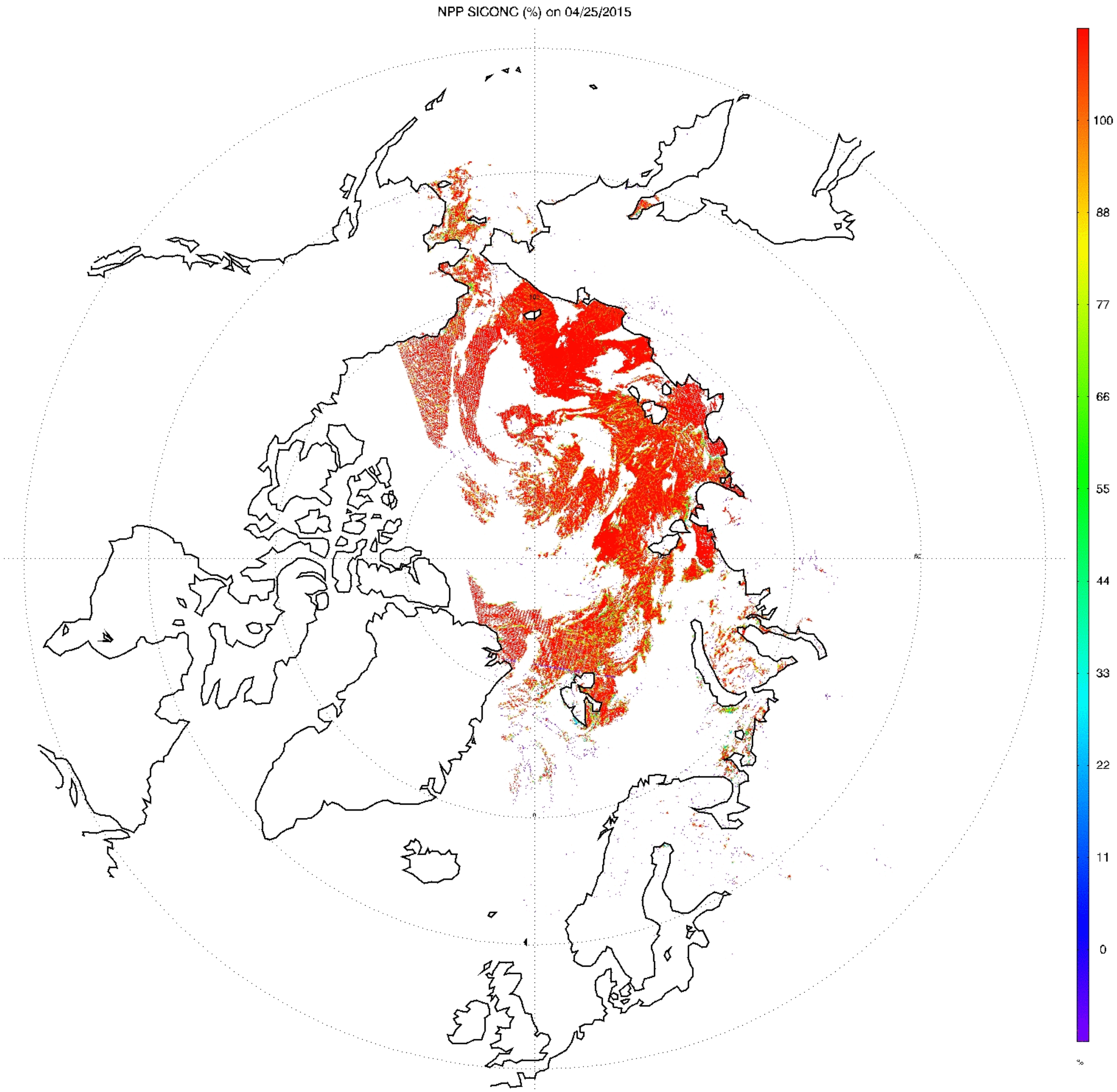
Other

- Sea ice leads (VIIRS)

[1]Future capabilities
[2]Future capabilities, NOAT Top 5

Source: Jeff Key, NOAA

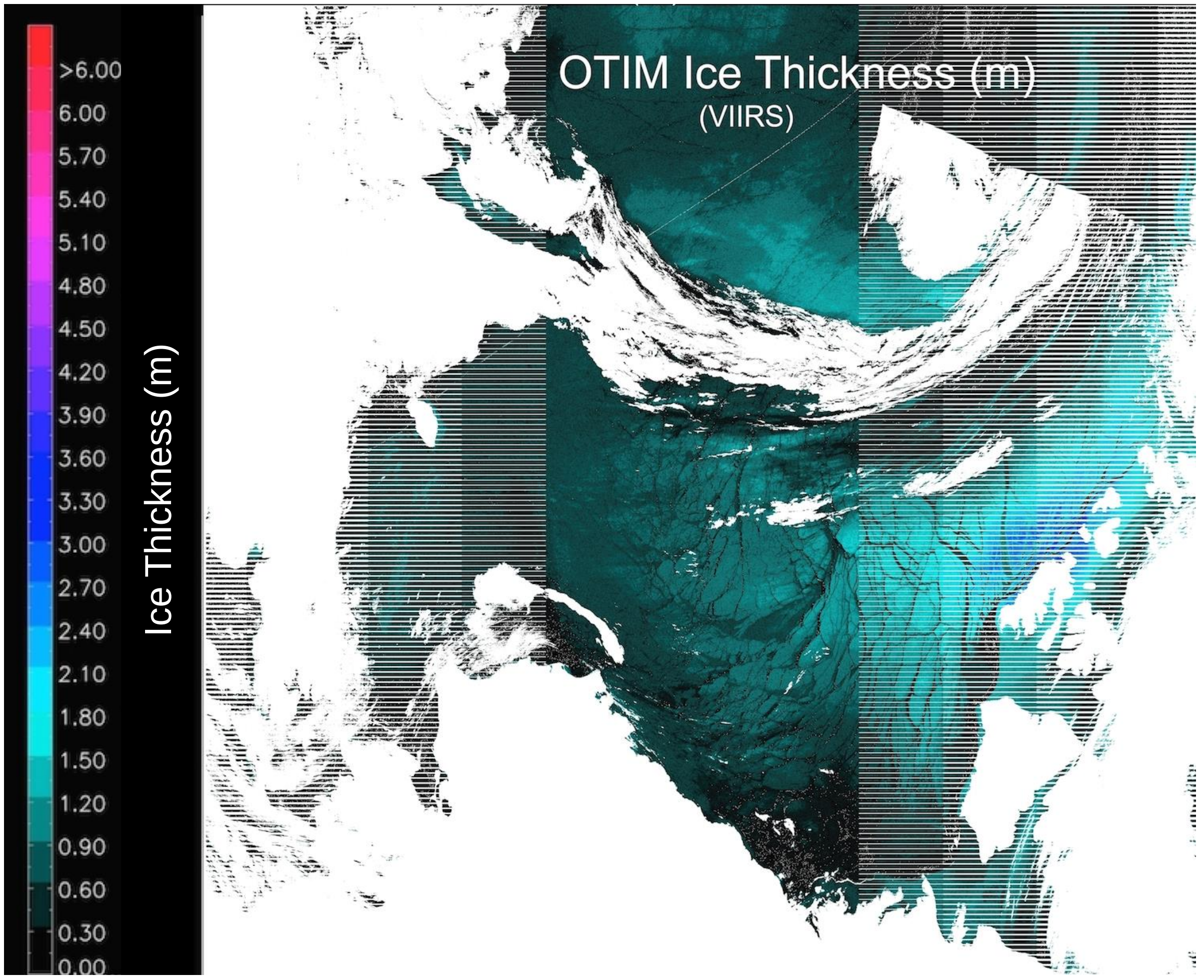
VIIRS Ice Concentration

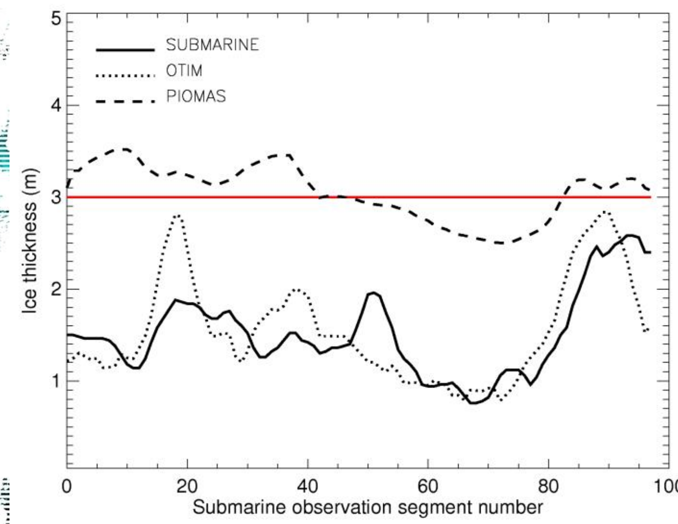


(animation)

Source: Jeff Key, NOAA

VIIRS Sea Ice Thickness



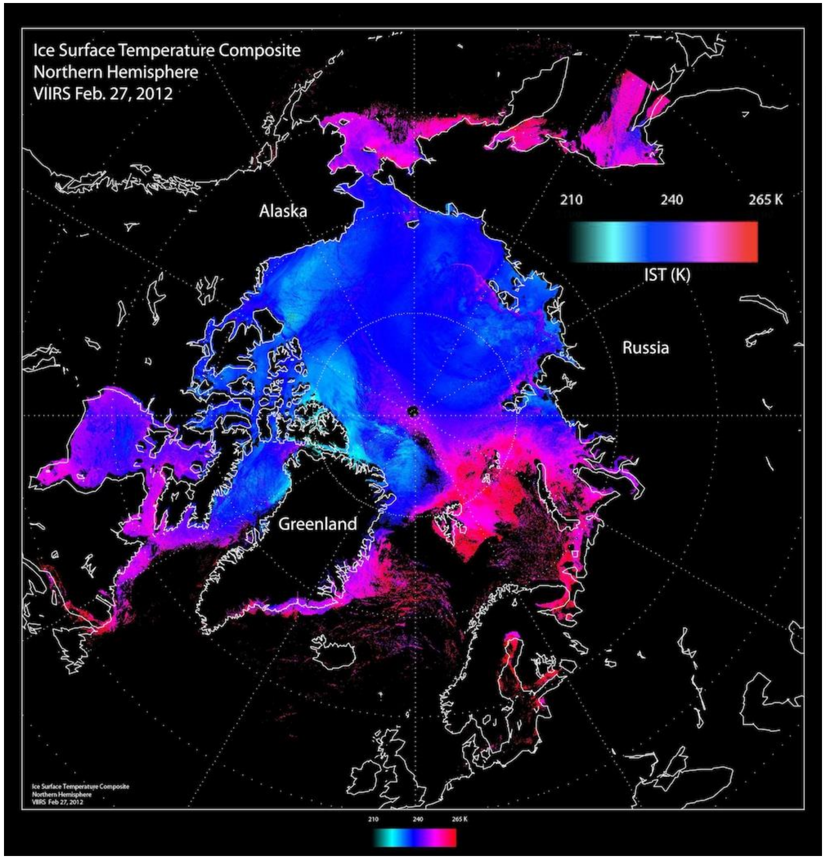


Validation with submarine sonar and modeled ice thicknesses.

Source: Jeff Key, NOAA

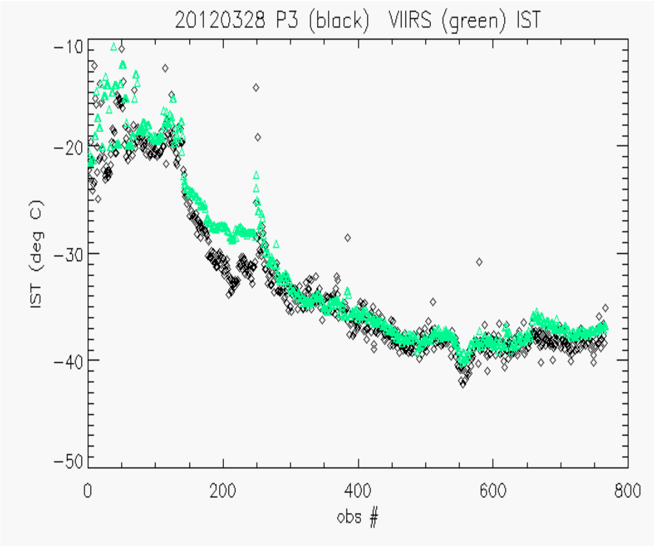
VIIRS Ice Surface Temperature

The Ice Surface Temperature (IST) is the surface skin, or radiating, temperature of sea ice.



Composite of VIIRS Ice Surface Temperature, 27 Feb 2012

IceBridge KT19 vs. VIIRS IST, 2012



DATE	BIAS	RMS
3/14	0.56	0.08
3/15	-0.84	0.63
3/16	1.01	0.71
3/21	-0.55	0.41
3/22	-0.21	0.14
3/27	0.12	0.21
3/28	1.12	0.53
3/29	0.46	0.10
4/02	0.66	0.19

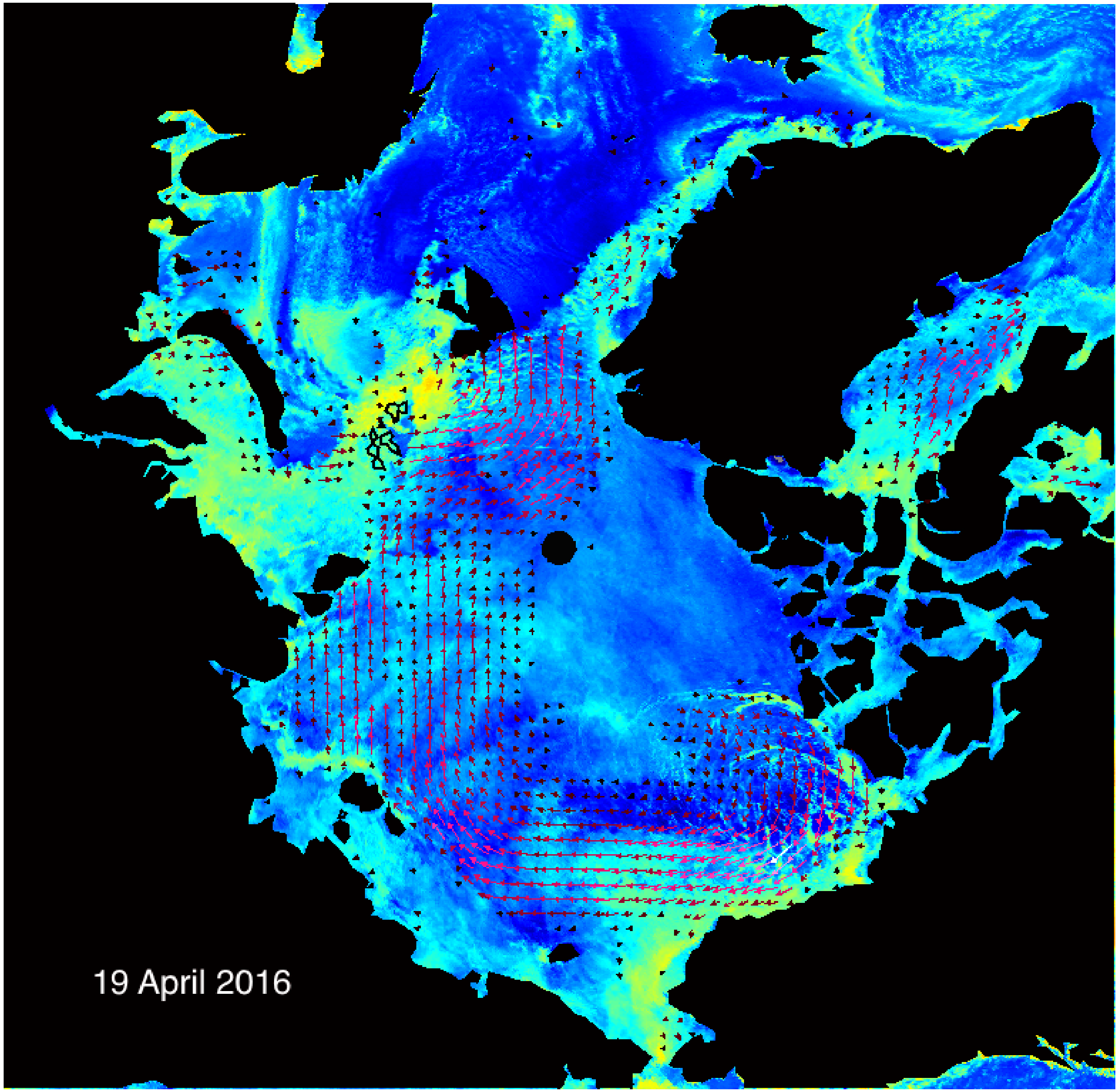
BIAS = VIIRS - KT19

Source: Jeff Key, NOAA

Ice motion from Advanced Microwave Scanning Radiometer 2 (AMSR2) over the Arctic on 19 April 2016

Source: Jeff Key

AMSR2 Ice Motion



Source: Jeff Key, NOAA

Uses and Users

- Numerical Weather Prediction (NWP centers)
  - Snow and ice cover are commonly used.
  - Ice thickness is not yet utilized; should be used universally!
- Navigation and Transportation (National Ice Center, NWS Anchorage Ice Desk, Navy, USCG, local services)
  - Shipping, national security
  - Highway, railroad, municipal, and commercial snow removal services
- Hydrologic Modeling (NOHRSC, local services)
  - River flood forecasters – the protection of life, property, and commerce
  - Emergency managers and responders
  - Water supply forecasters
  - Soil moisture forecasters and agriculture, forestry, and wildfire managers
  - Recreation industry
- Climate Modeling, Monitoring, and Analysis

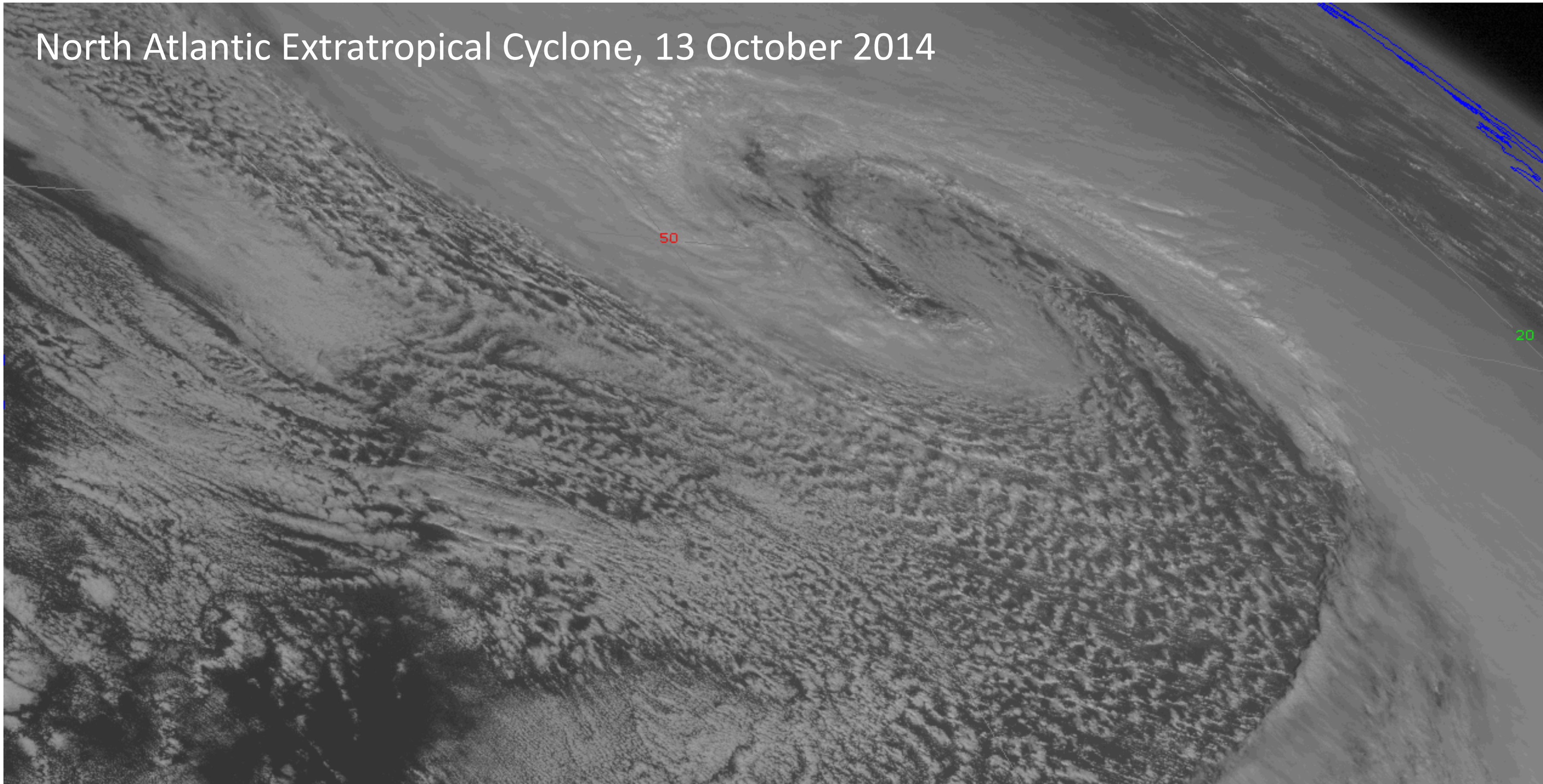
Source: Jeff Key, NOAA

Potential Areas of Collaborations

- Applications-based training and workflows for applying new generation satellite imagery and products to operational decisions related to arctic and marine forecasts
- Assuring availability and awareness of GOES-R mesoscale sectors to Canadian counterparts when cross-border coverage exists
- Standardization of derived satellite products available to customers and stakeholders

Summary

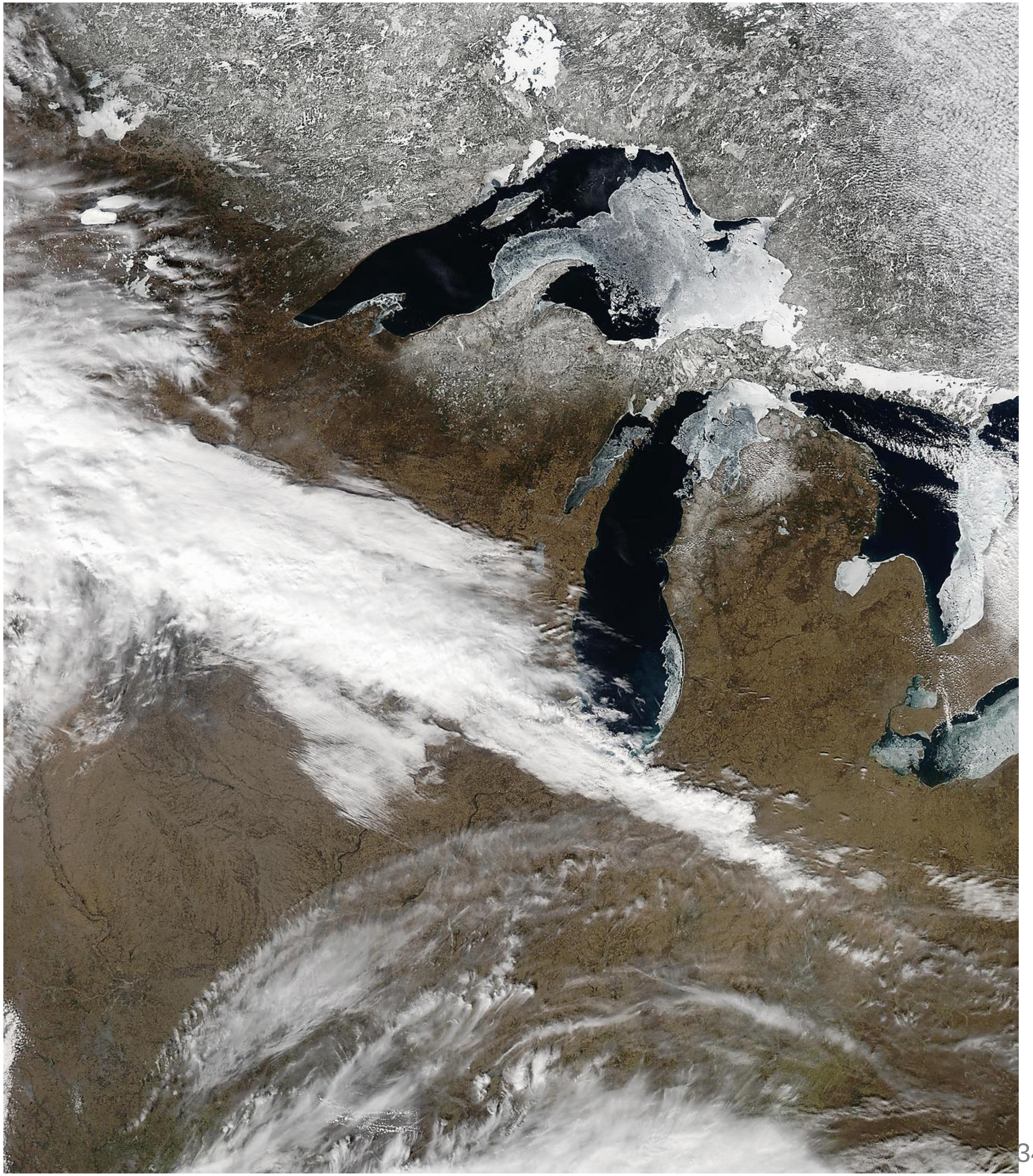
- This is an exciting time for the United States operational environmental satellites with new geostationary and polar-orbiting satellites launching in the upcoming year.
- These new satellites will positively impact marine and arctic operational weather analysis/forecast capabilities as a result of improved specifications for spectral, spatial, and temporal resolution.
- We can and should work together!



Questions? Comments?

Jordan Gerth, Cooperative Institute for Meteorological Satellite Studies
E-mail: Jordan.Gerth@noaa.gov

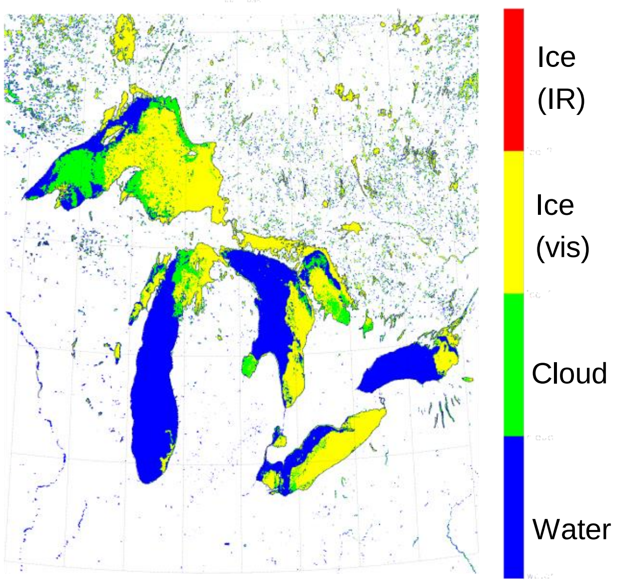
Great Lakes Examples



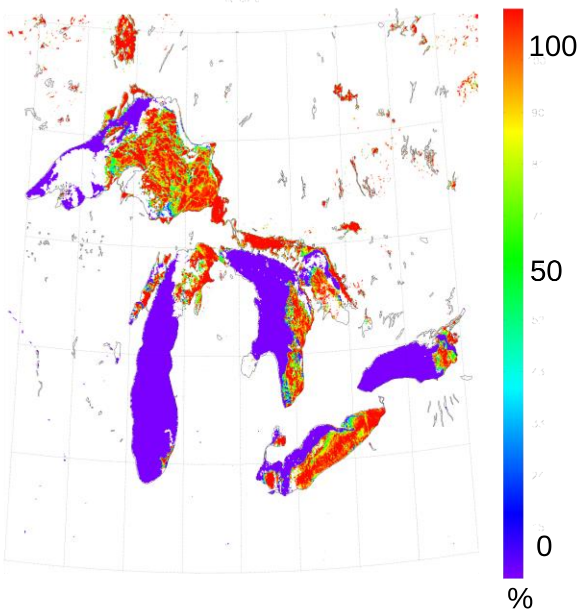
MODIS, March 23-28, 2015
(with 2-day gap)

Great Lakes Ice

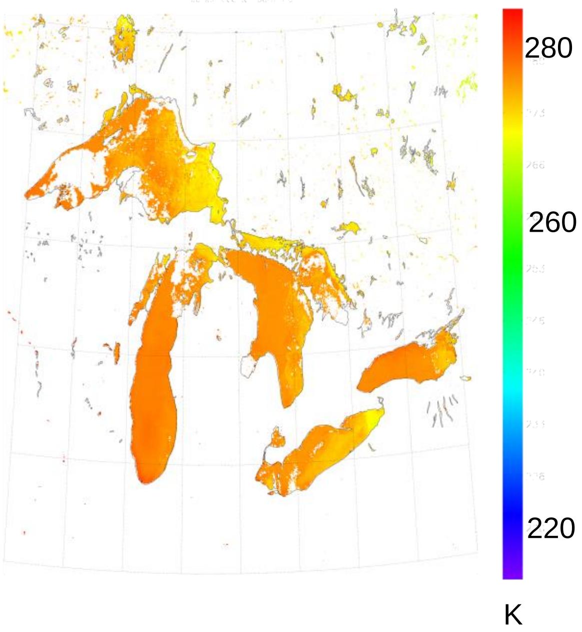
Ice Cover



Ice Concentration



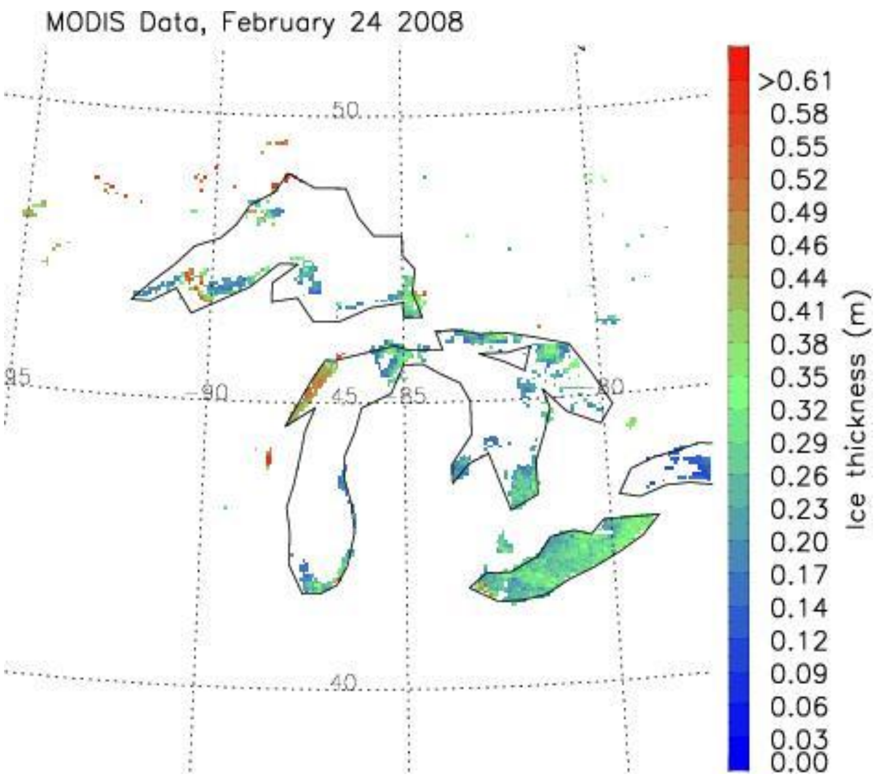
Ice Surface Temperature



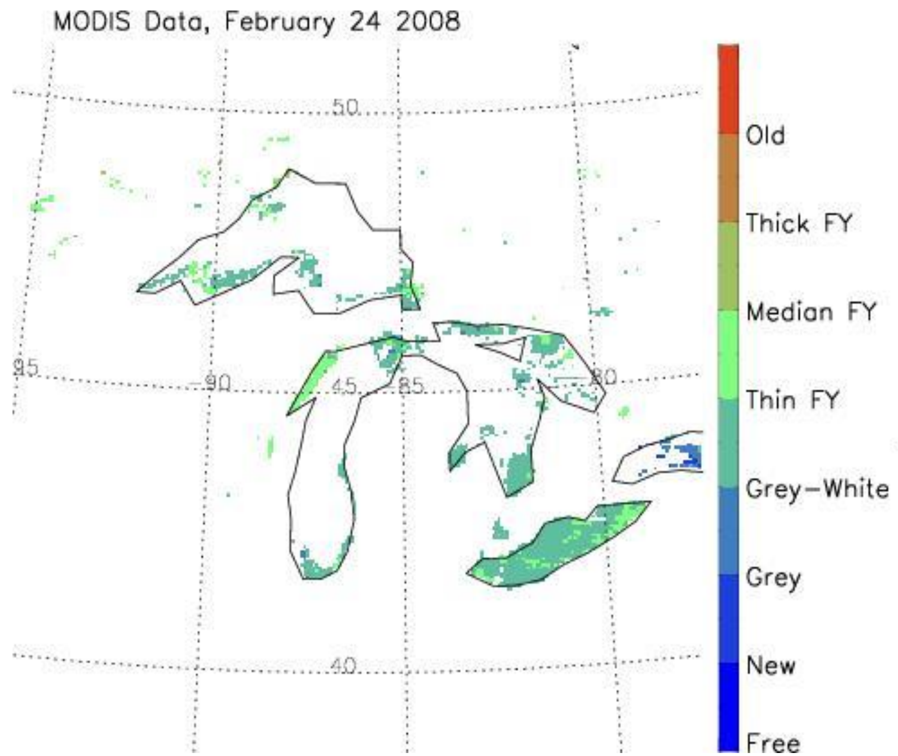
Based on MODIS data, March 28, 2015

Ice Thickness and Age

Ice Thickness



Ice Age



Estimated ice thickness (left) and ice age categories (right) based on MODIS data on February 24, 2008.