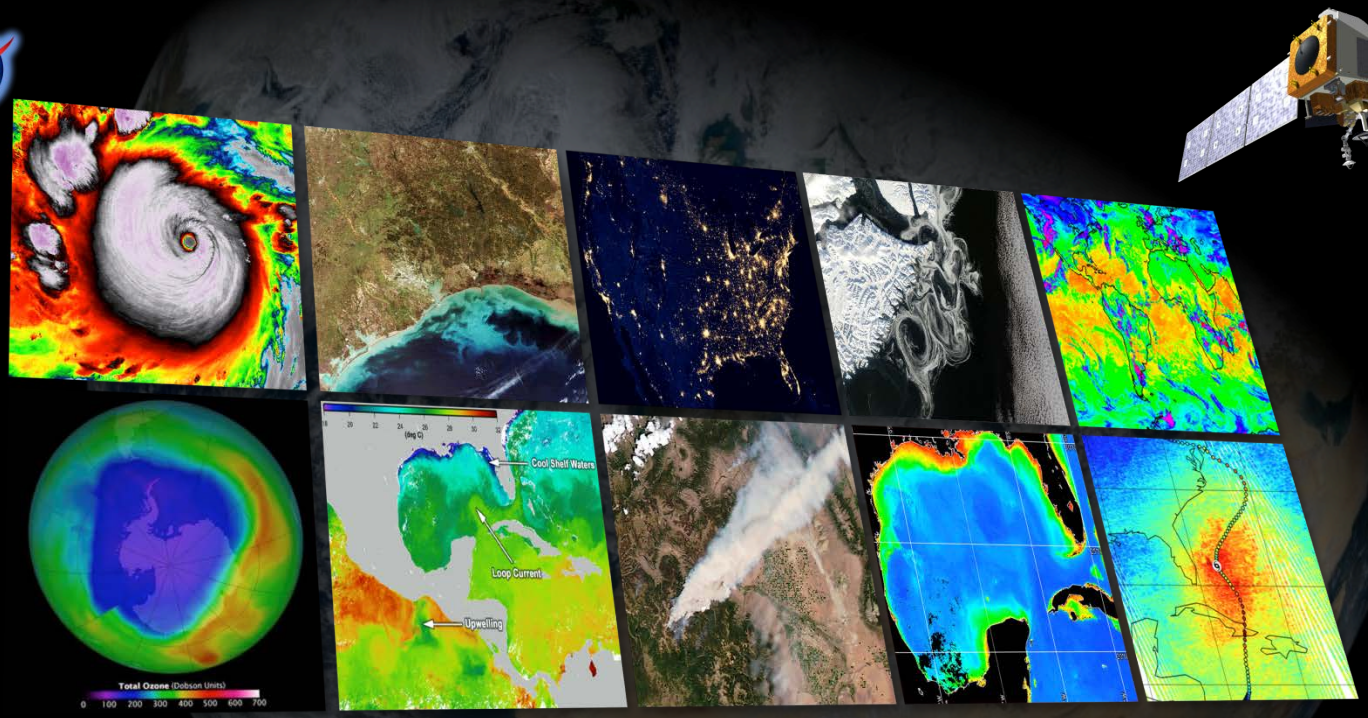
VIIRS Applications

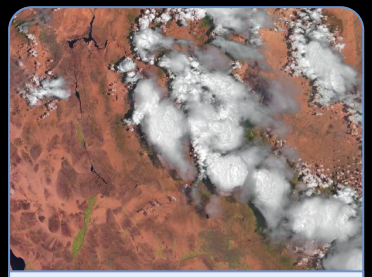


Carven A Scott
Chief, Environmental and Scientific Services Division
NWS Alaska Region
NWS Operational Advisory Team (NOAT), Chair

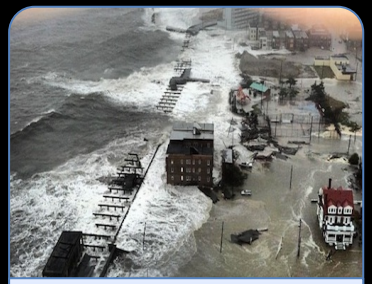
Why JPSS?

- Critical for the accuracy of forecasts three to seven days in advance of a severe weather event.
- Significant technological and scientific advances enabling better weather forecasting and monitoring.
- Continuity of key global observations of the Earth's atmosphere, oceans, land, and cryosphere—follow-on for the NOAA Polar-orbiting satellites (POES) and NASA Earth-observing satellites (EOS).
- NOAA's environmental satellites are the backbone of life-saving weather forecasts and advance hazardous outlooks. There is no substitute for the role they play in the U.S. and around the world.

EF-5 tornado in Moore, Okla. (2013)



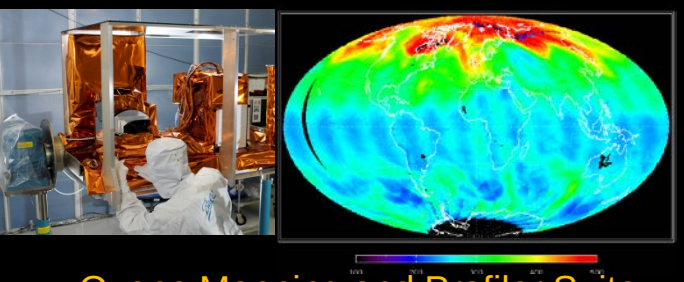
Yarnell Hill fire in Prescott, Ariz. (2013)



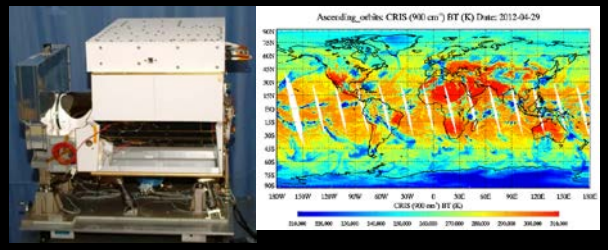
Hurricane Sandy in Atlantic City, N.J. (2012)

Without JPSS, the Nation will experience an immediate degradation in weather forecasting capability

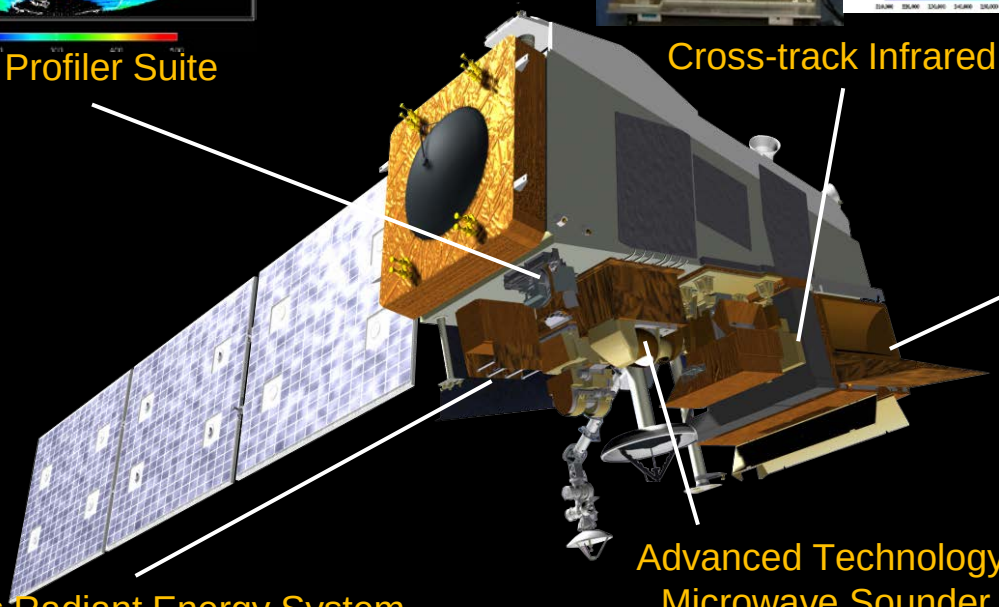
JPSS-1 Spacecraft

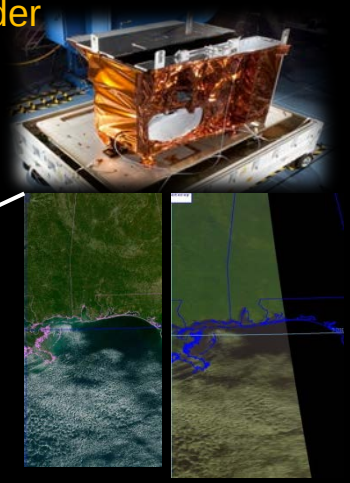


Ozone Mapping and Profiler Suite



Cross-track Infrared Sounder

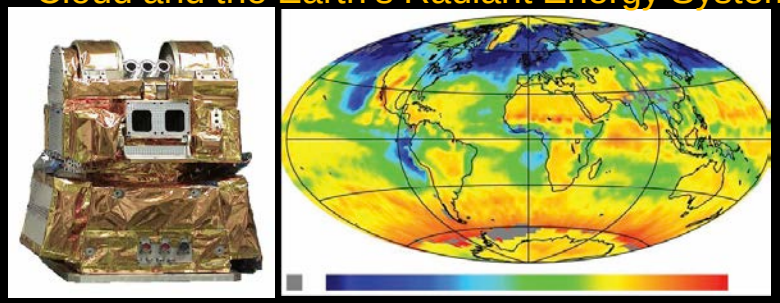




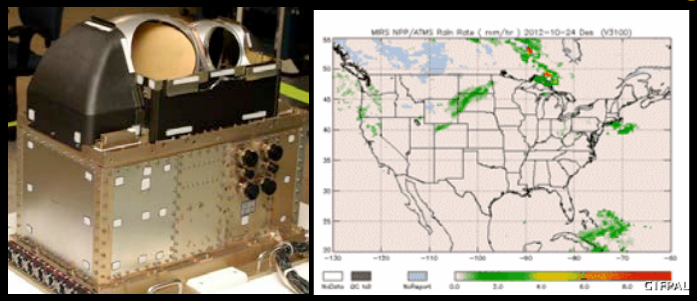
S-NPP VIIRS NOAA-19 AVHRR

Visible Infrared Imaging Radiometer Suite

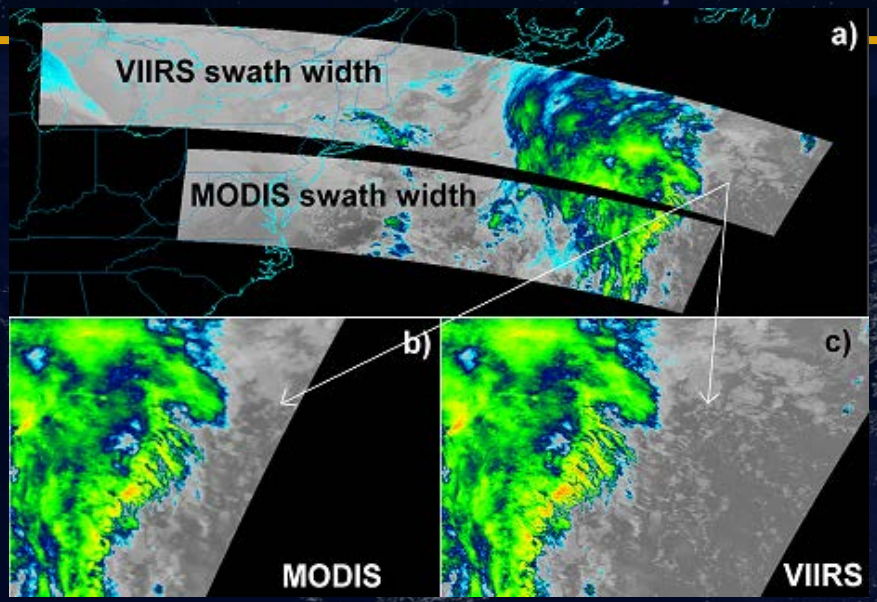
Cloud and the Earth's Radiant Energy System



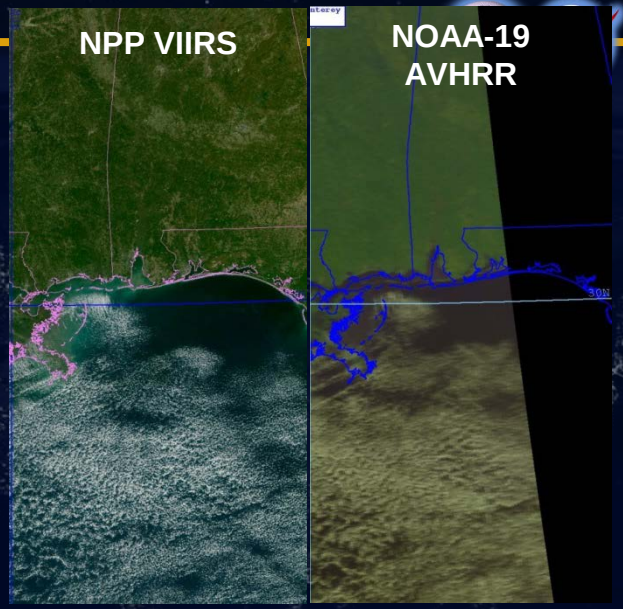
Advanced Technology Microwave Sounder

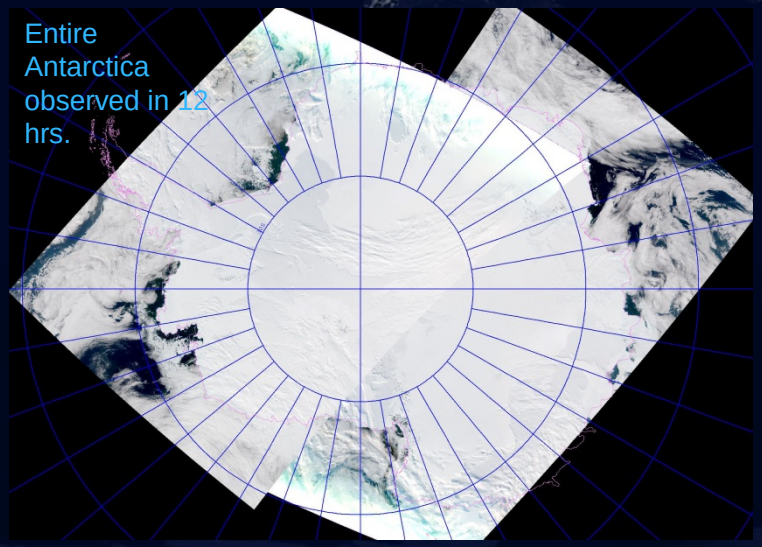


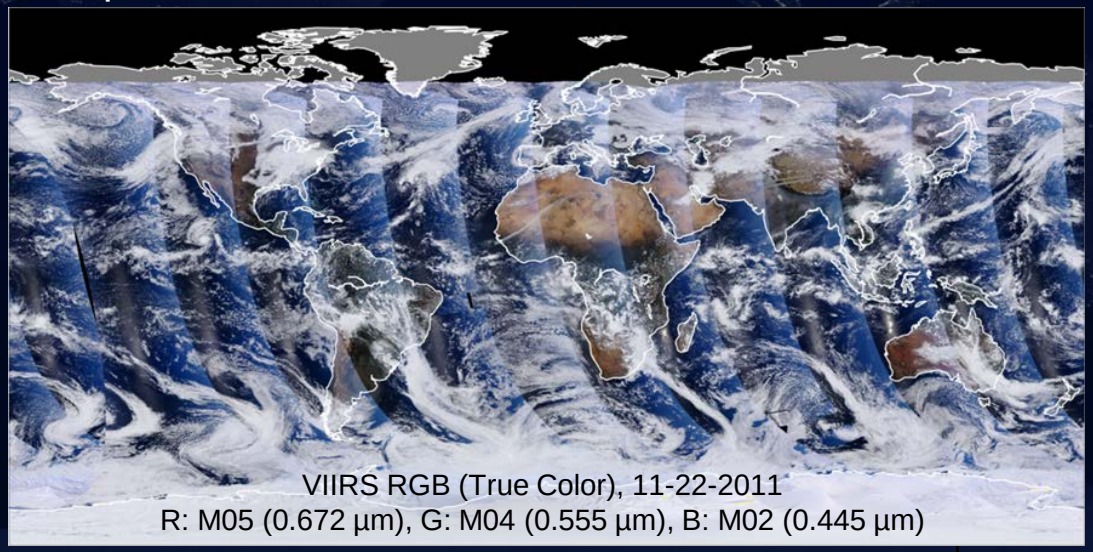
JPSS Next Generation Instruments



The Visible Infrared Imaging Radiometer Suite offers more spectral bands, higher resolution, wider swath and greater accuracy, resulting in a large number of products.





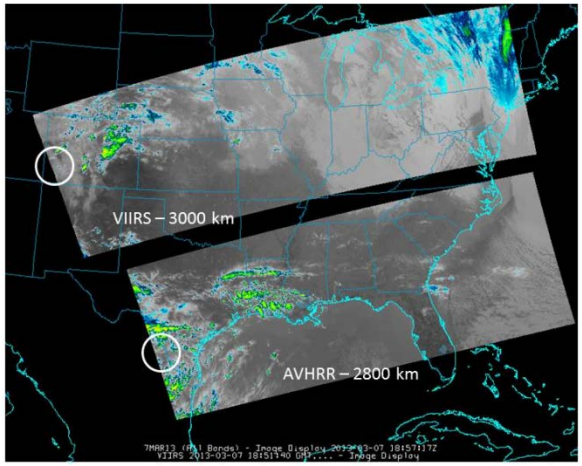


VIIRS Overview

- **VIIRS is NOAA's new operational polar orbiting imager.**

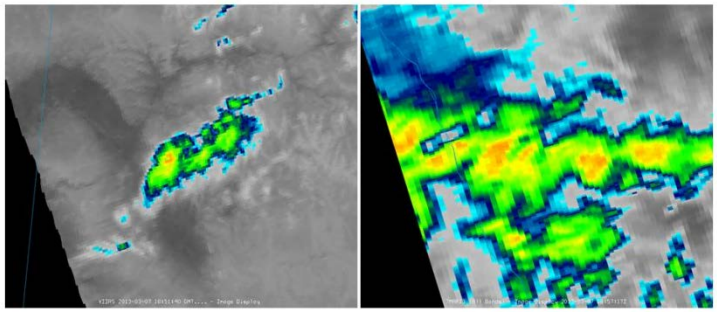
- **VIIRS is a major improvement over AVHRR**
  - 4X spectral and 2X – 15X spatial resolution improvement over AVHRR
  - AVHRR has no ocean color capabilities
  - AVHRR has no night-time visible detection
  - AVHRR is prone to large errors in:
    - discriminating clouds from snow, and low clouds from fog
    - poor navigation and sensitivity for adequate fire location and intensity
    - poor spatial resolution at edge of scan resulting in distorted images rendering environmental assessments impractical.

VIIRS vs. AVHRR swath width



See next slide for comparison of spatial resolution at swath edge (within white circles)

VIIRS vs. AVHRR spatial resolution at swath edge
(blowup of images within white circles in previous slide)



VIIRS – 1.5 km @ swath edge (M-band 750 m @ nadir)

AVHRR – 5.5 km @ swath edge (LAC 1.1 km @ nadir)

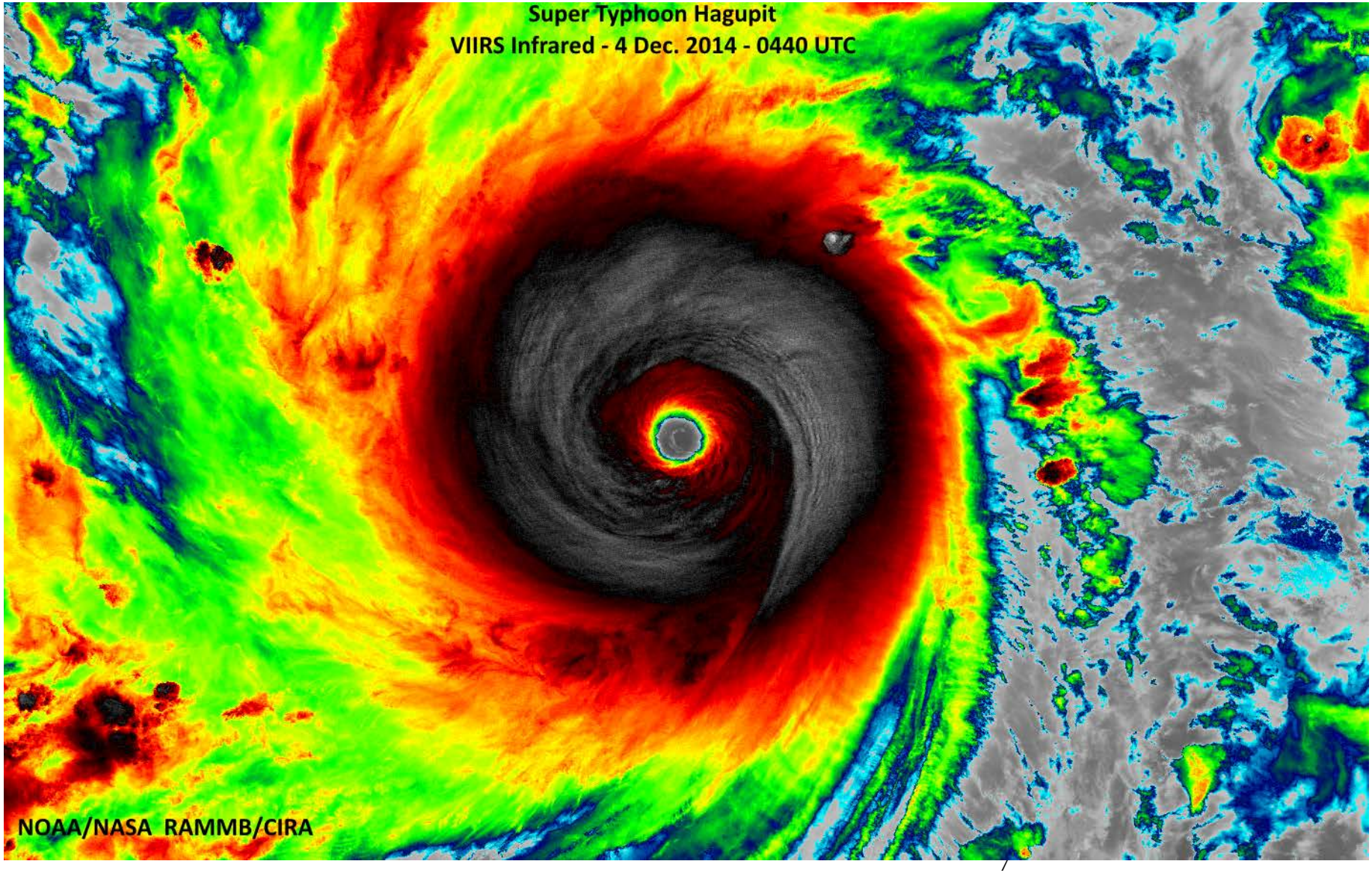
Note that these images are not of the same clouds, but are from similar scan angles.

VIIRS: Next Gen Operational Polar Orbiting Imaging Radiometer

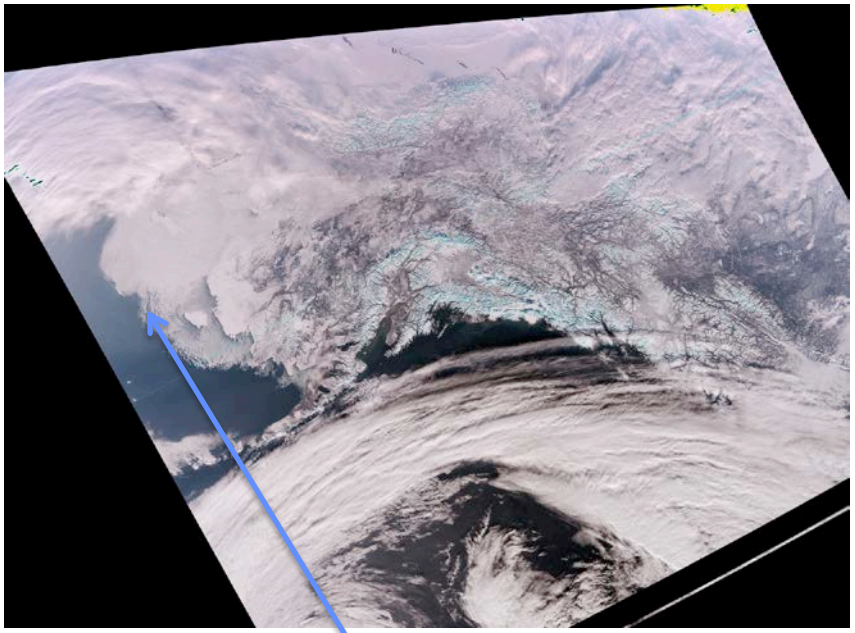
- **22 spectral bands**
  - Visible to LWIR
  - Spatially registered
- **Better spatial resolution**
  - Reduced variation over scan
  - Higher resolution imaging bands
- **High radiometric accuracy**
  - NIST-traceable
  - Supported by on-board calibrators
- **Day Night Band**

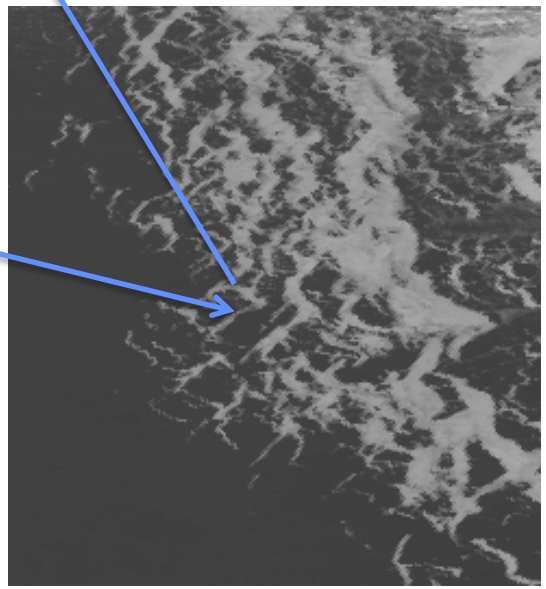
		Band No.	Wave-length (μm)	Horiz Sample Interval (km Downtrack x Crosstrack)		Driving EDRs
				Nadir	End of Scan	
VIS/NIR FPA	Silicon PIN Diodes	M1	0.412	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols
		M2	0.445	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols
		M3	0.488	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols
		M4	0.555	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols
		I1	0.640	0.371 x 0.387	0.80 x 0.789	Imagery
		M5	0.672	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols
		M6	0.746	0.742 x 0.776	1.60 x 1.58	Atmospheric Corr'n
		I2	0.865	0.371 x 0.387	0.80 x 0.789	NDVI
		M7	0.865	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols
CCD		DNB	0.7	0.742 x 0.742	0.742 x 0.742	Imagery
S/MWIR	PV HgCdTe (HCT)	M8	1.24	0.742 x 0.776	1.60 x 1.58	Cloud Particle Size
		M9	1.378	0.742 x 0.776	1.60 x 1.58	Cirrus/Cloud Cover
		I3	1.61	0.371 x 0.387	0.80 x 0.789	Binary Snow Map
		M10	1.61	0.742 x 0.776	1.60 x 1.58	Snow Fraction
		M11	2.25	0.742 x 0.776	1.60 x 1.58	Clouds
		I4	3.74	0.371 x 0.387	0.80 x 0.789	Imagery Clouds
		M12	3.70	0.742 x 0.776	1.60 x 1.58	SST
		M13	4.05	0.742 x 0.259	1.60 x 1.58	SST Fires
LWIR	PV HCT	M14	8.55	0.742 x 0.776	1.60 x 1.58	Cloud Top Properties
		M15	10.763	0.742 x 0.776	1.60 x 1.58	SST
		I5	11.450	0.371 x 0.387	0.80 x 0.789	Cloud Imagery
		M16	12.013	0.742 x 0.776	1.60 x 1.58	SST

Outstanding imagery



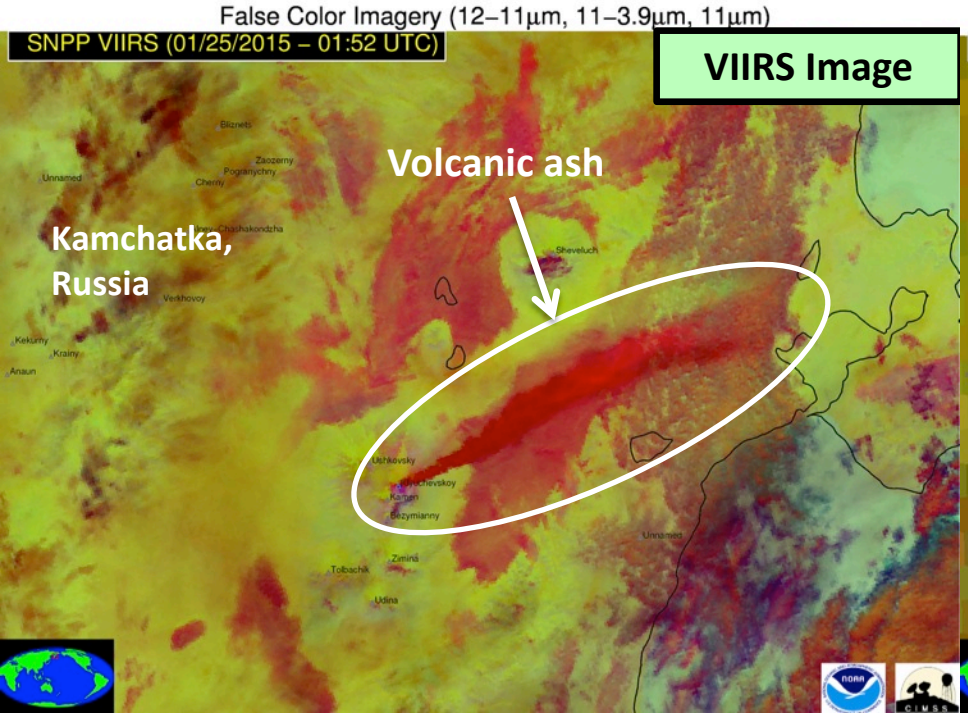
VIIRS has outstanding spatial resolution as shown by this comparison of a picture from an commercial jetliner and VIIRS visible imagery near the edge of scan

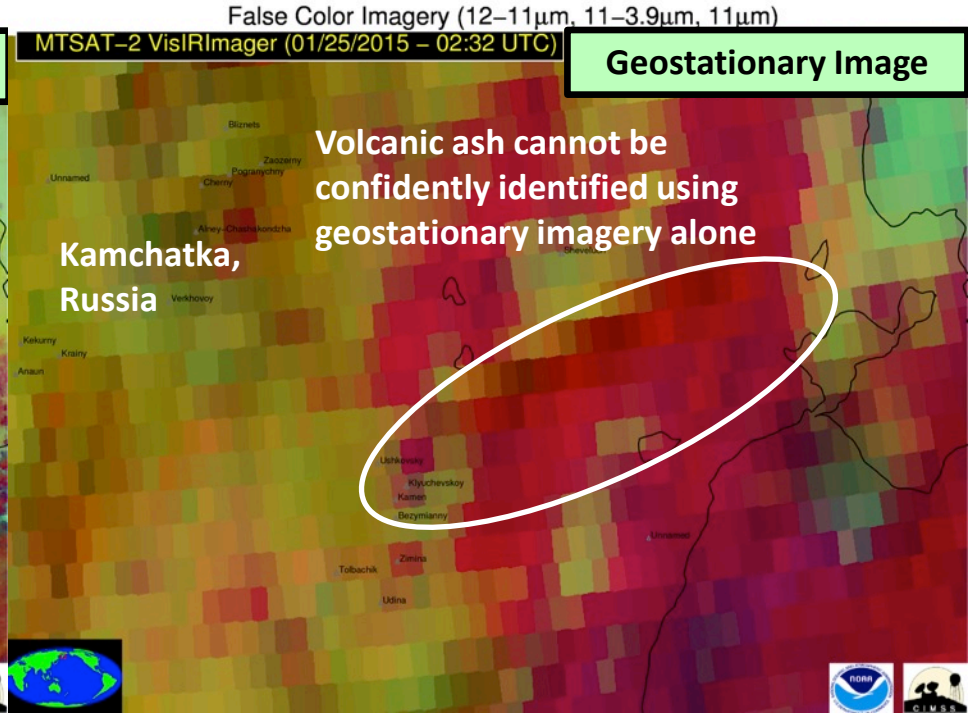




Picture from aircraft
Courtesy Mitch Goldberg

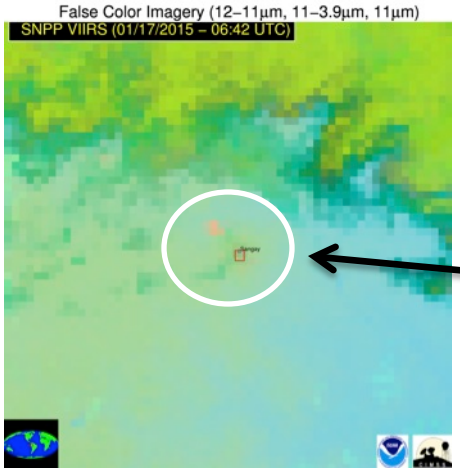
VIIRS is Critical for Mitigating Volcanic Related Aviation Hazards: Direct and indirect benefits





Direct Benefit: Nearly everyday VIIRS identifies volcanic activity that is not unambiguously identifiable using any other meteorological satellite sensor.

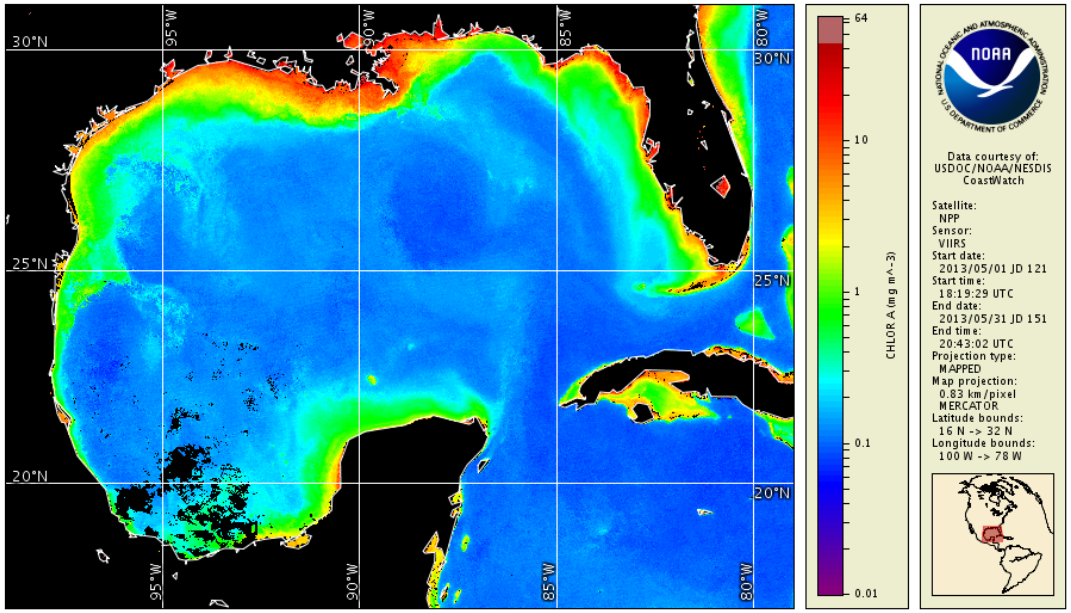
Indirect Benefit: The VIIRS images are used to identify subtle volcanic ash cloud features from geostationary imagery, thereby allowing the clouds to be tracked in time.



Recently, VIIRS was the first space sensor to detect renewed activity at Sangay Volcano in Ecuador (lava and ash emissions)

PI: Mike Pavolonis, NESDIS Center for SaTellite Applications and Research (STAR)

VIIRS Ocean Color is used by NOAA to monitor health of ocean, coastal and large lake ecosystems



Credit: NOAA Coastwatch

The New York Times **Environment** April 6, 2013

Florida Algae Bloom Leads to Record Manatee Deaths

Julio Cortez/Associated Press

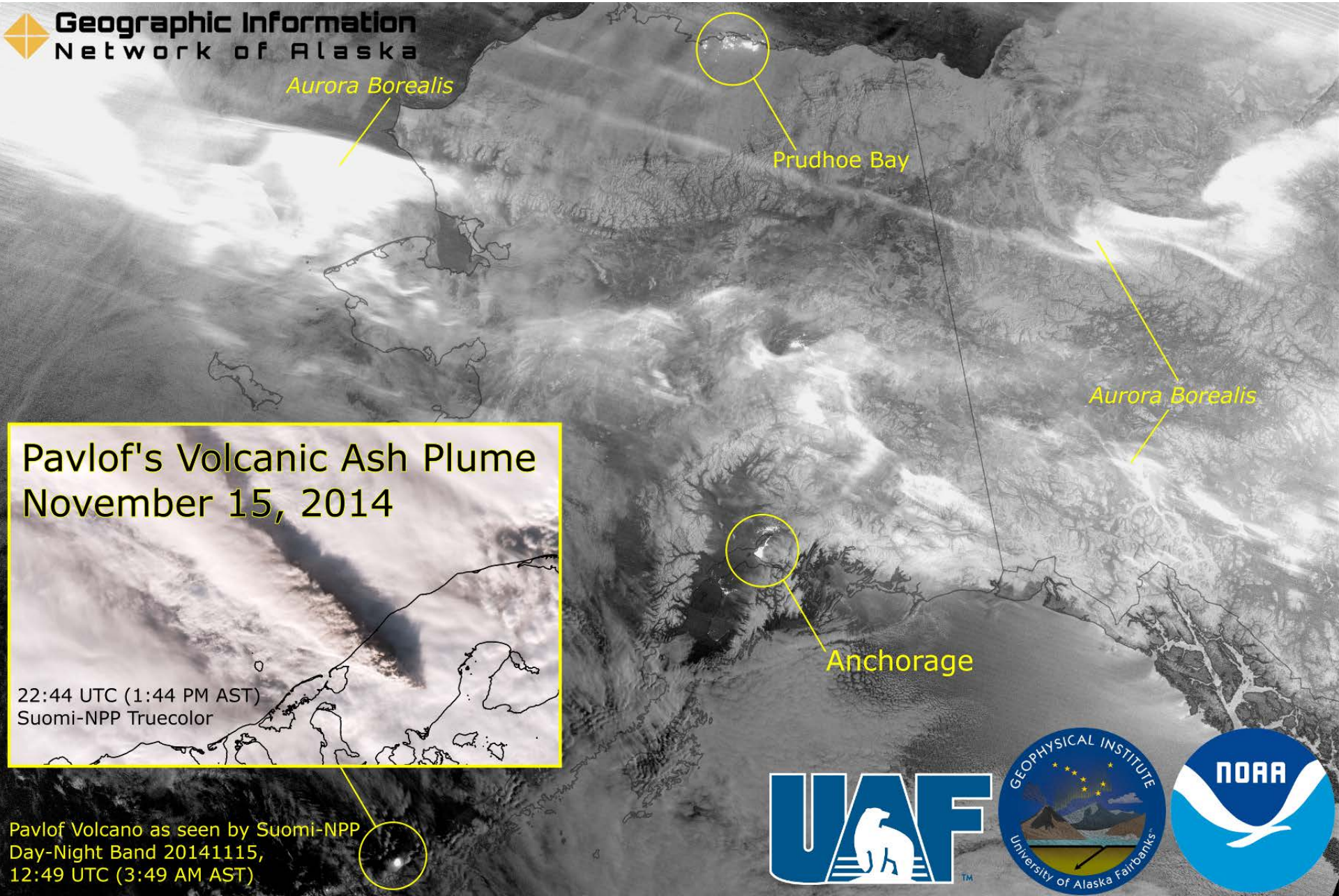
A manatee off Peanut Island, Fla.

The state's annual red tide affects a wide range of aquatic animals and can cause problems in people. The algae contain a nerve poison known as brevetoxin that is not only found underwater but that is also blown through the air when waves break open the algae's outer casing.

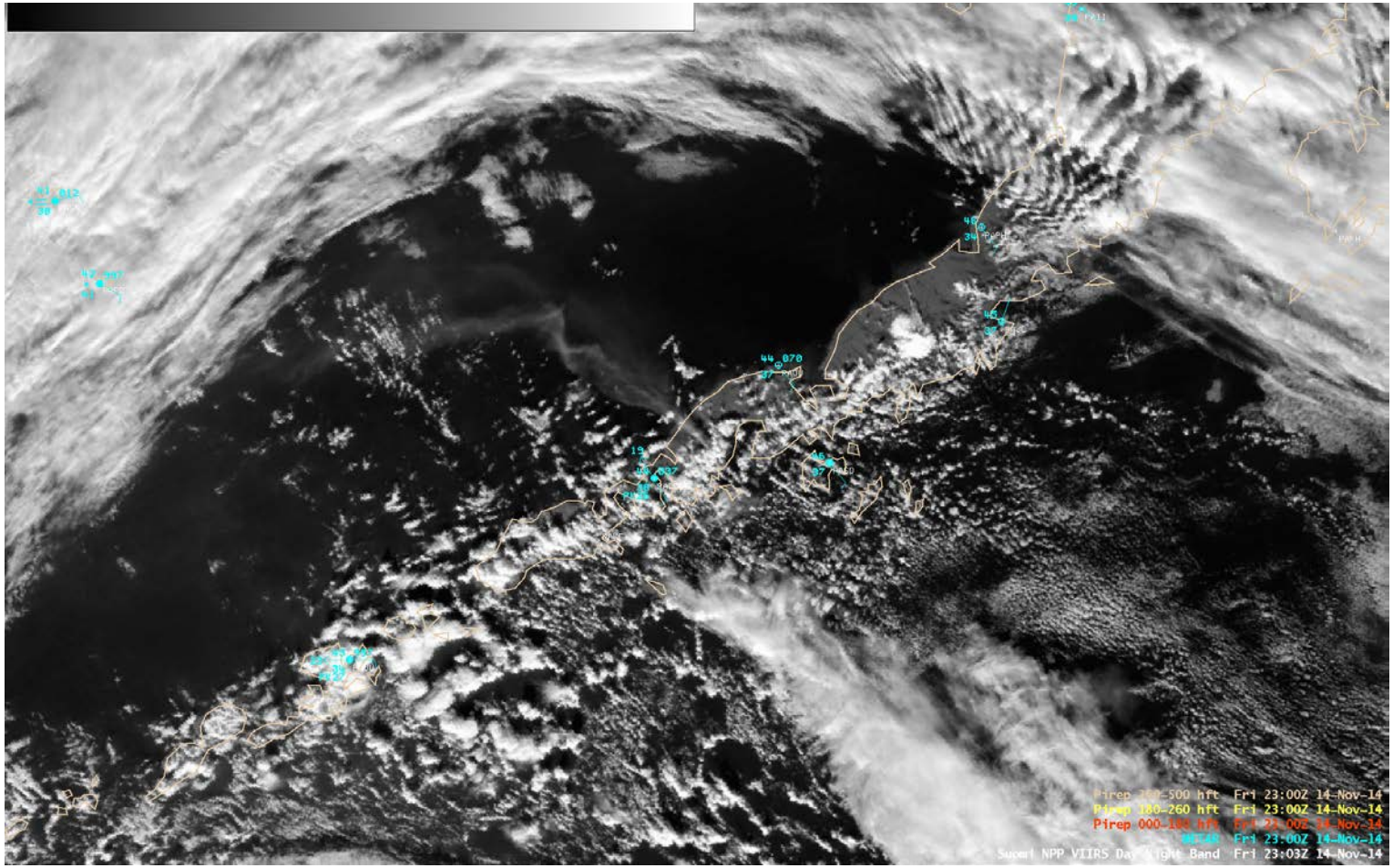
Manatees, birds, dolphins and other animals can be killed by consuming the poison, either by accidentally eating the algae or by ingesting small organisms clinging to sea grass that have soaked up the poison while filtering seawater.

Residents and tourists regularly have respiratory problems after inhaling brevetoxins while strolling on beaches near red tides. People can also become ill after eating oysters and clams that have absorbed the toxin.

Day-Night Band



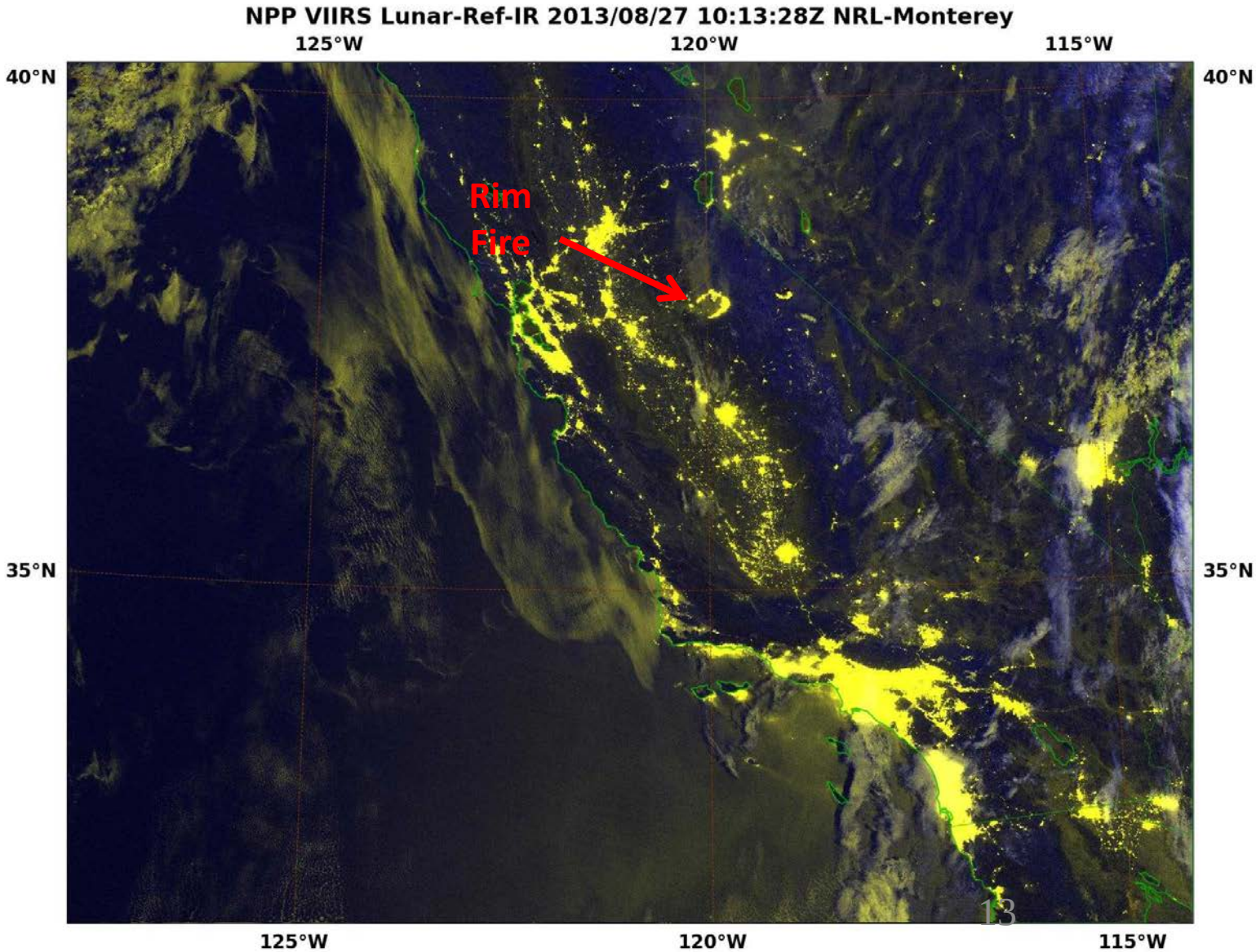
Volcanic Ash (Pavlov) DNB
November 13, 2013



Tracking the Rim Fire at Night

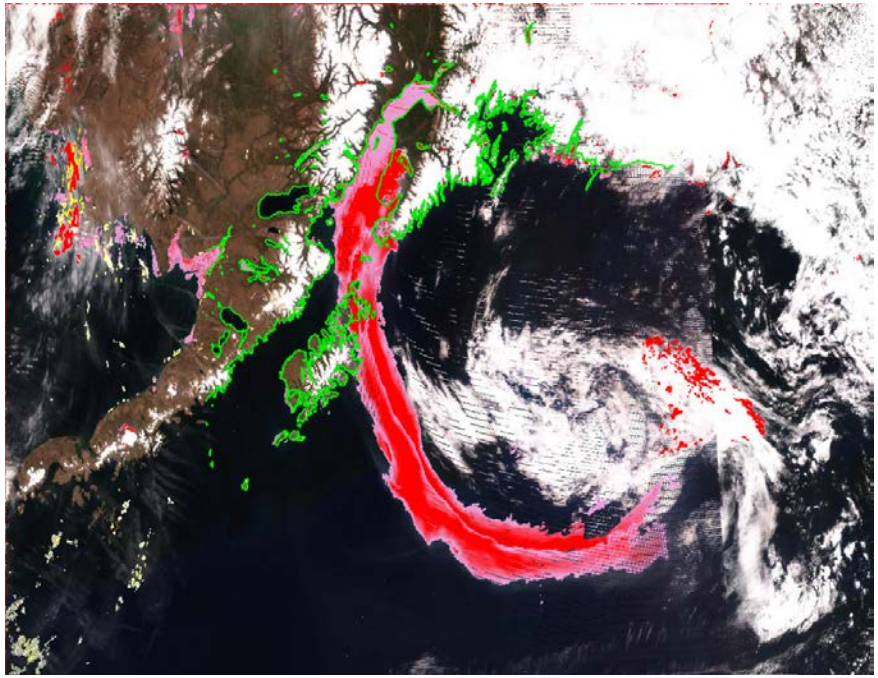
VIIRS DNB + IR enhanced with Lunar Irradiance Model

18 – 27 August, 2013

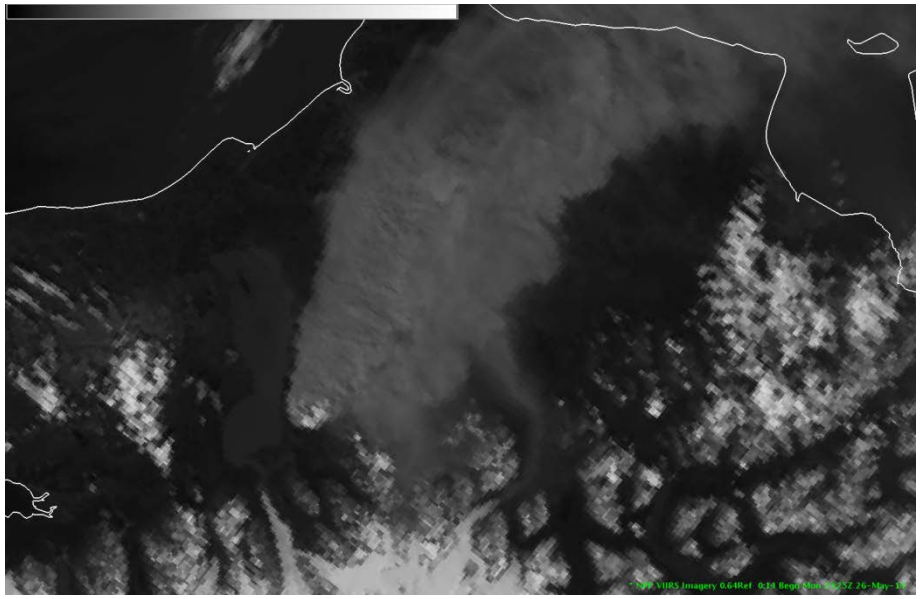


VIIRS Smoke Detection-“Funny River” Fire

20 and 21, May 2014



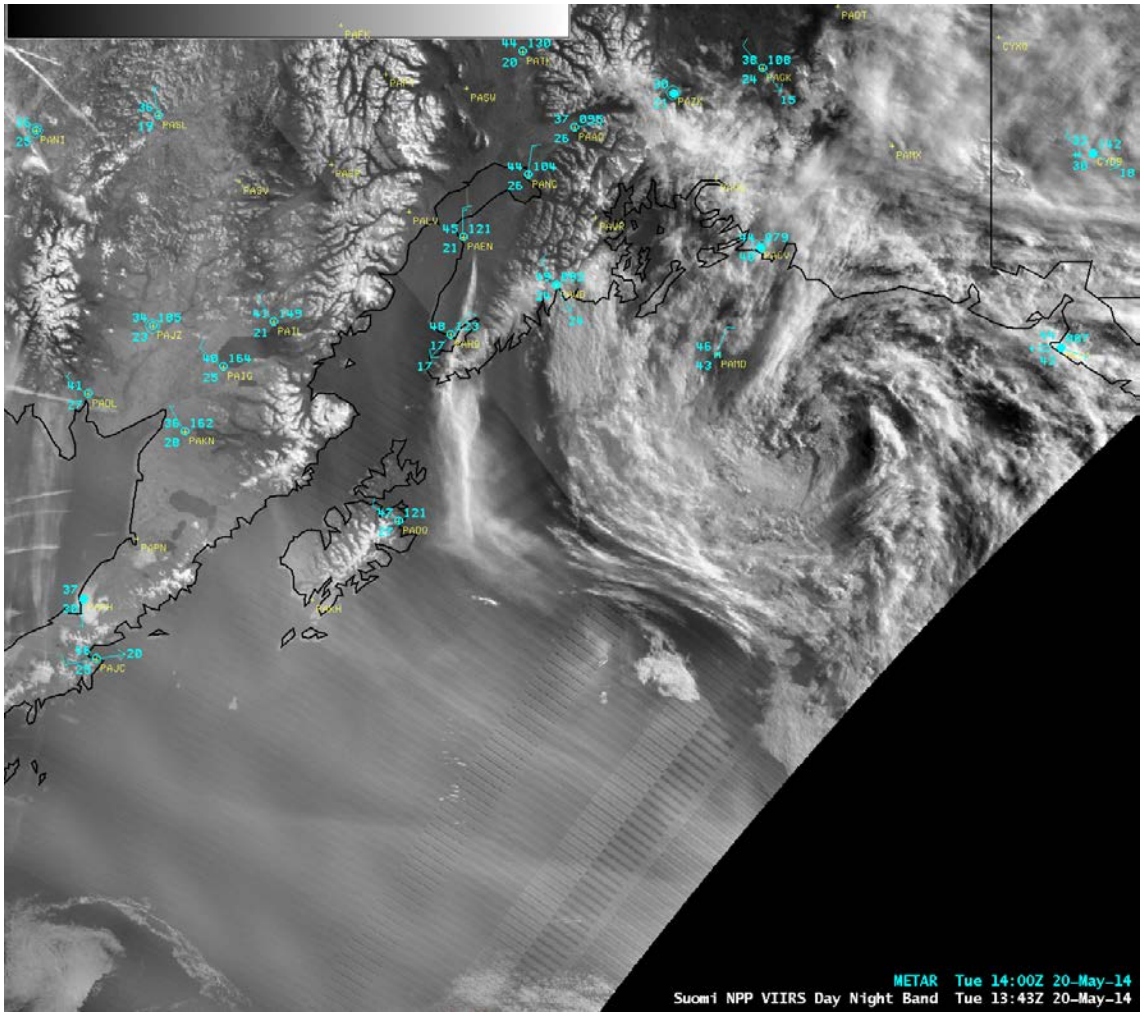
JPSS Smoke Algorithm



.64 micron Channel

VIIRS Smoke Detection-“Funny River” Fire

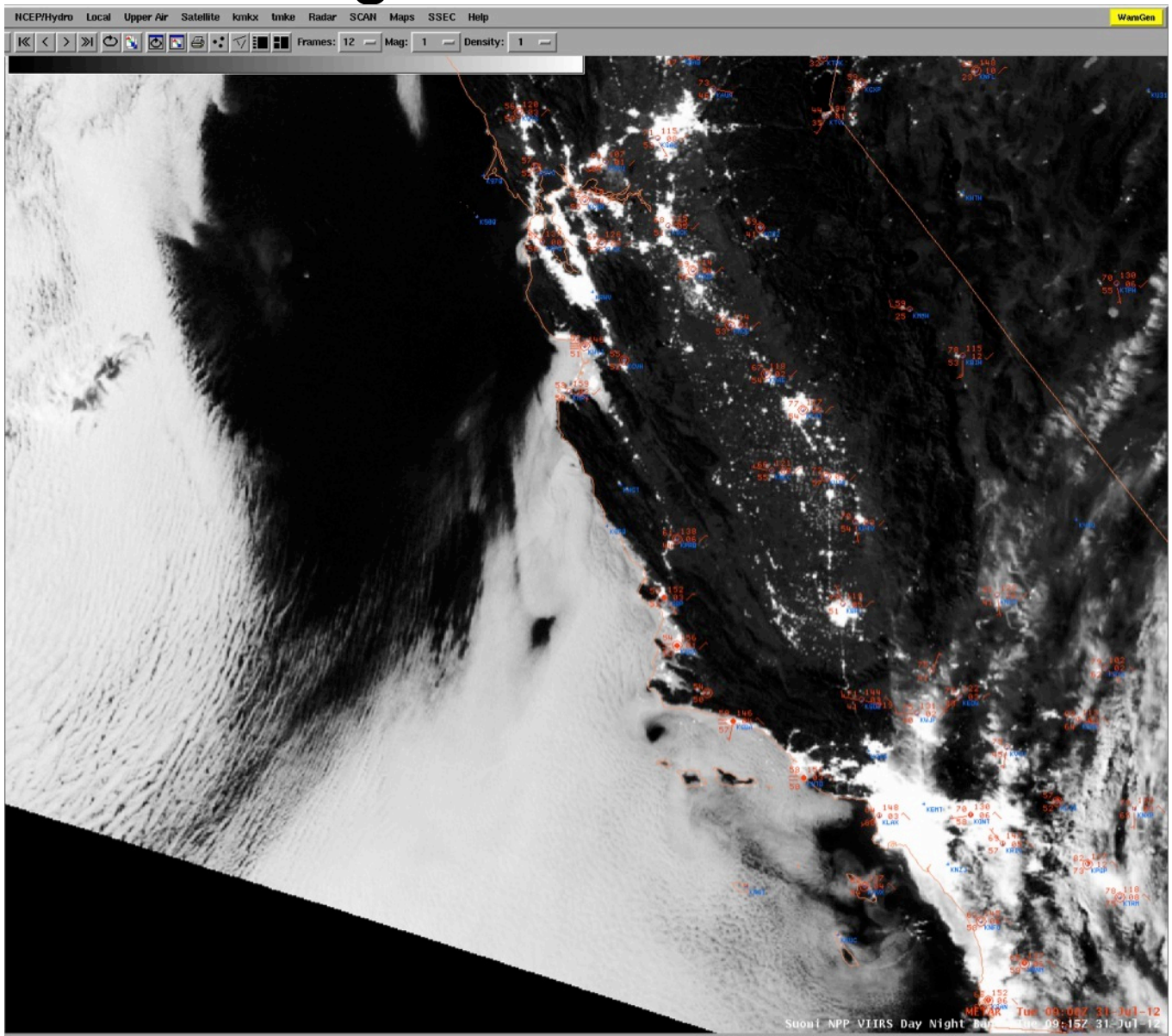
20 and 21, May 2014



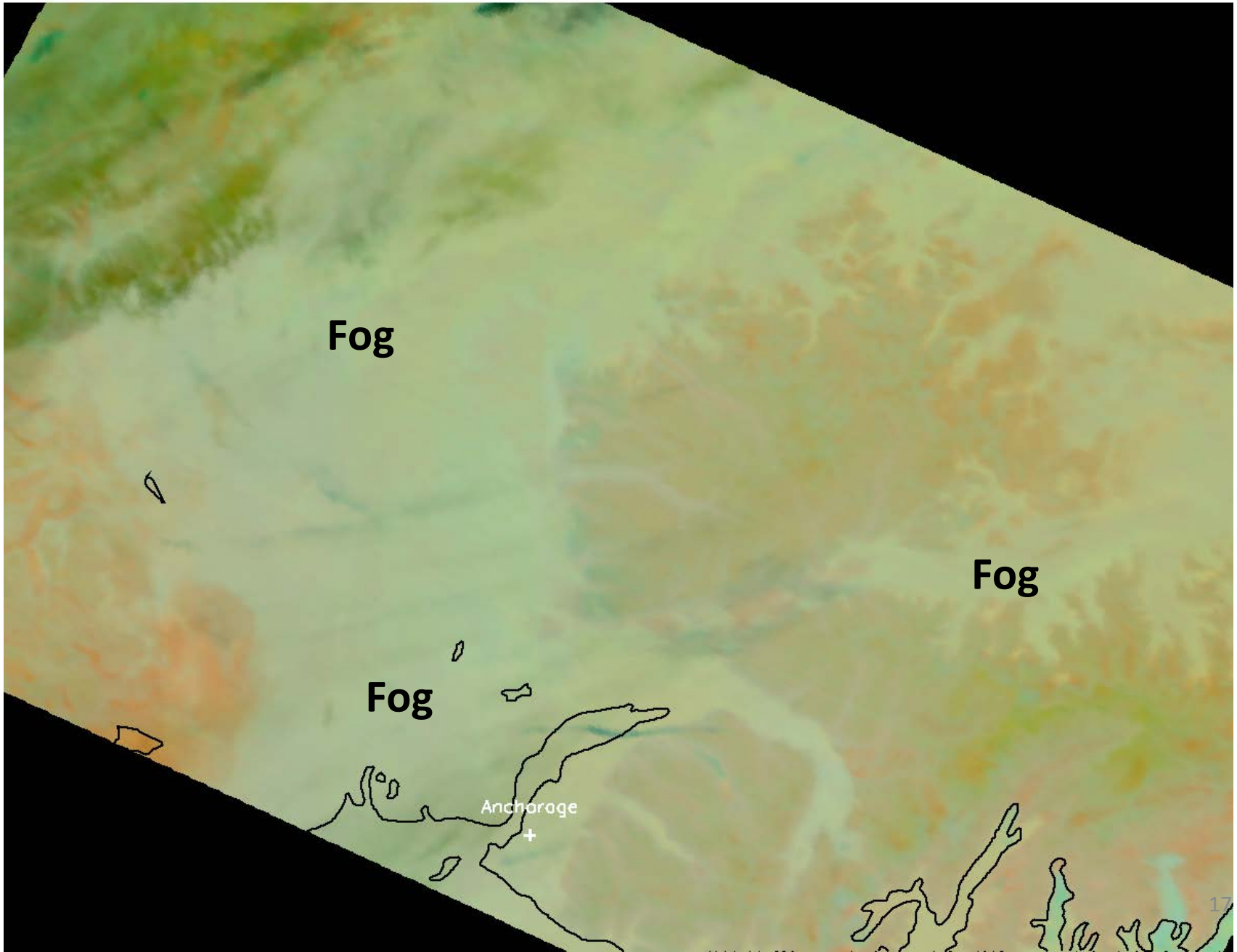
“Funny River” Fire
May 2014

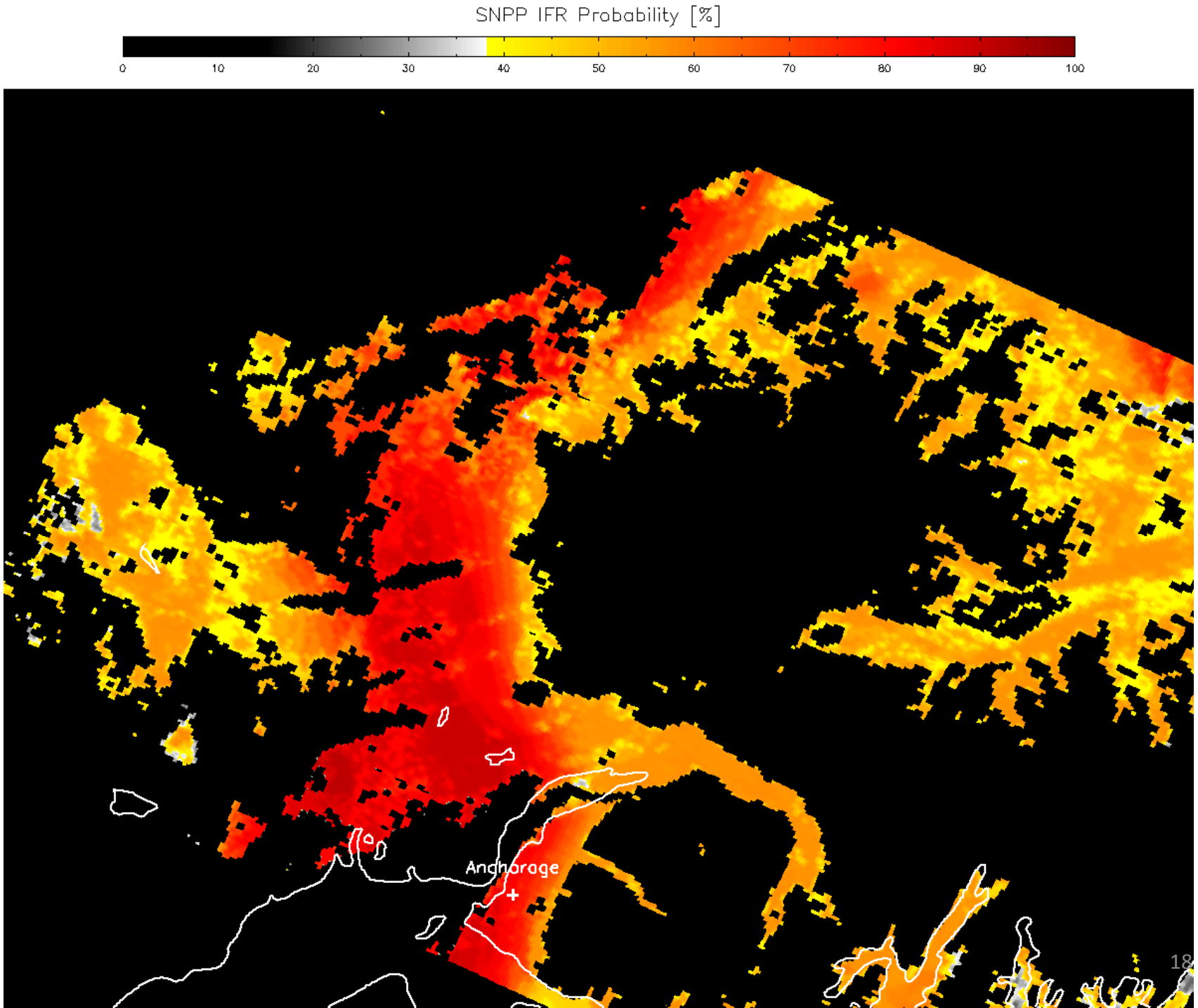
VIIRS Night-time visible routinely used for dense fog advisories

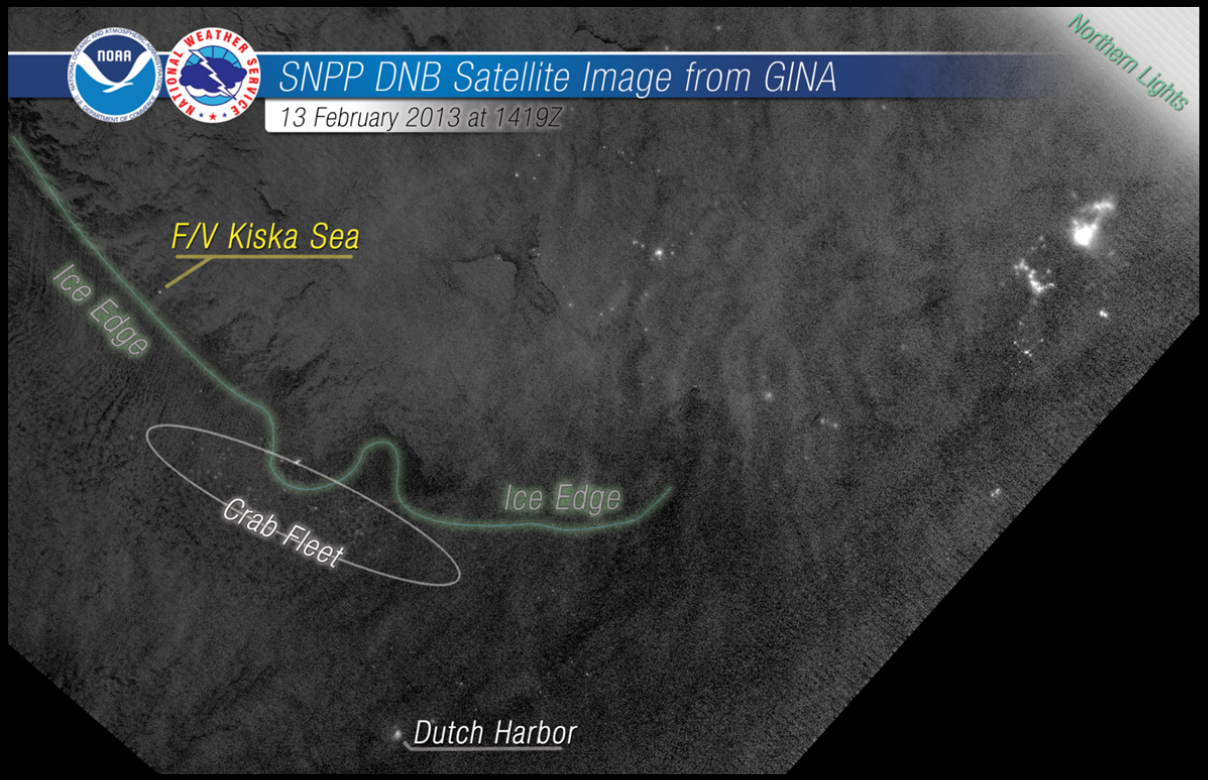
The National Weather Service Forecast Office in Monterey, California Currently employs the VIIRS DNB to provide higher confidence for issuing marine dense fog advisories



SNPP VIIRS December 8, 2013 – 12:59 UTC




SNPP IFR Probability [%]
0
10
20
30
40
50
60
70
80
90
100
Anchorage



F/V Kiska Sea assist February 2013

DNB images from the previous night clearly showed the lights from F/V Kiska Sea and the ice pack around the vessel.

NWS Sea Ice personnel were able to assist the captain plot a track out of the ice pack, avoiding areas of thicker and higher concentration sea ice.

The timeliness of the DNB images provided an essential tool for this vessel assist.

7 Feb 2013 — 10 Feb 2013 — 11 Feb 2013 — 12 Feb 2013 — 13 Feb 2013 — 15 Feb 2013

Strong Northerly winds cause rapid advance of ice pack

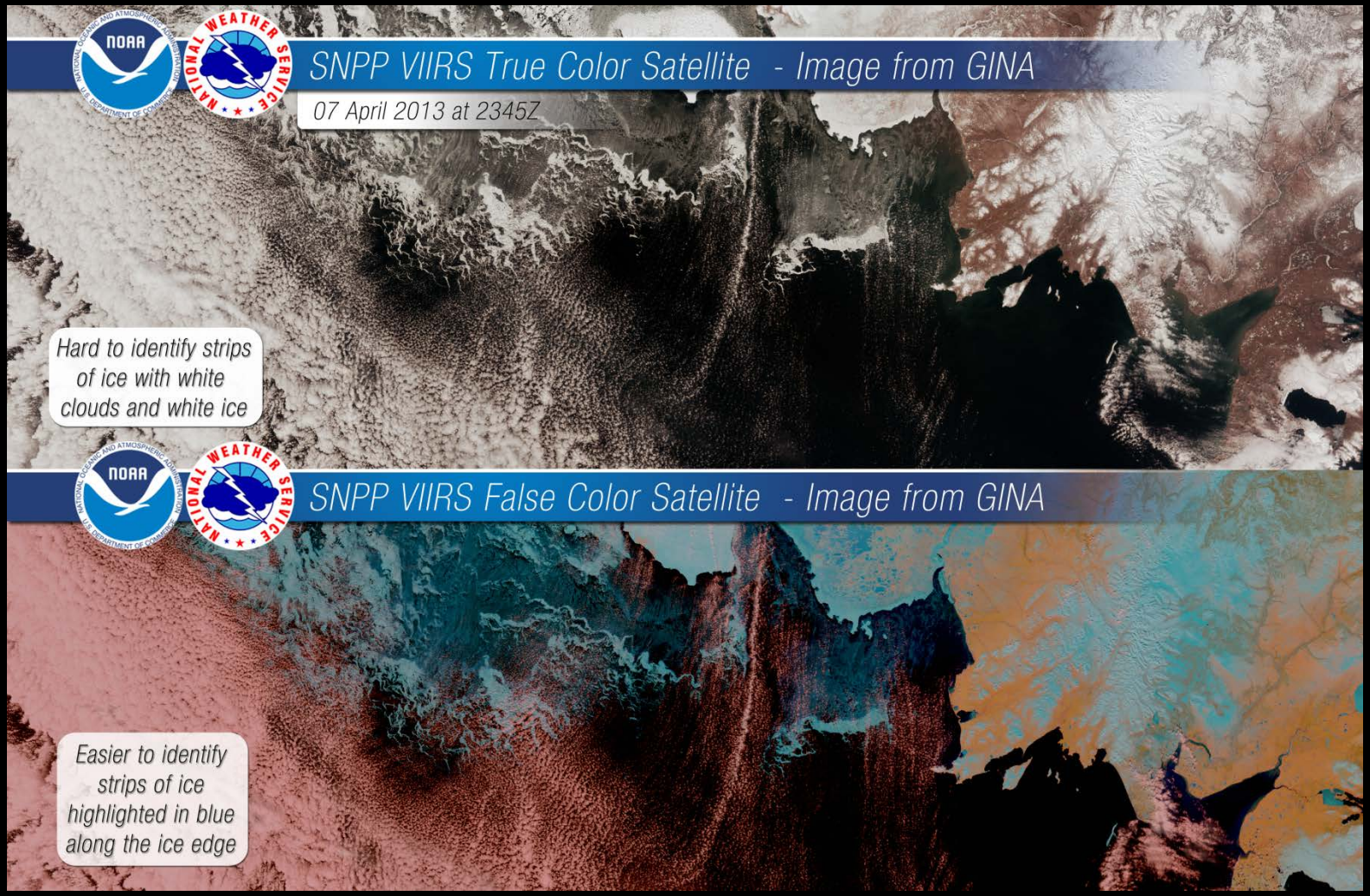
150+ F/V Kiska Sea crab pots were deemed in danger of being overrun by sea ice

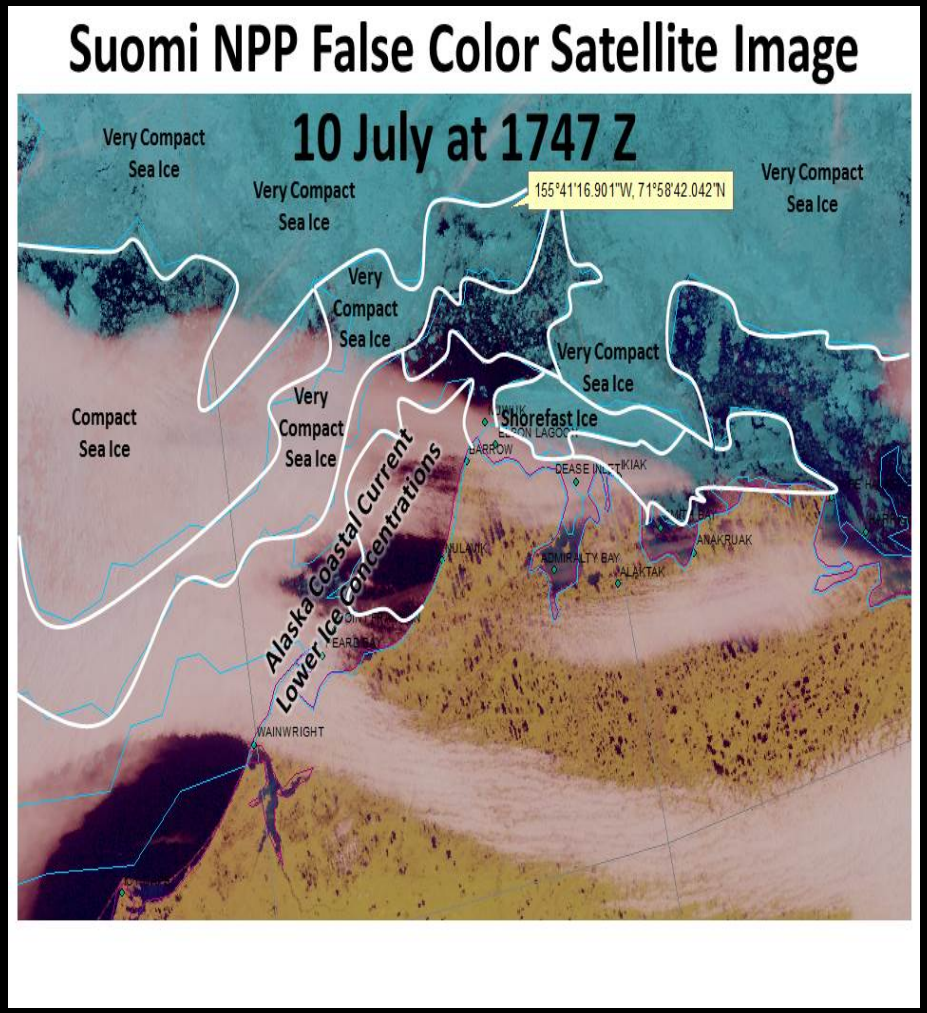
F/V Kiska Sea captain and NWS Sea Ice Desk worked together to get pots back and return to ice free waters

F/V Kiska Sea surrounded by sea ice, some >3 ft thick

VIIRS in Alaska Sea Ice

True/False Color





Good Afternoon USCG Juneau,

Here is the latest update on the sea ice conditions near the vessel's latest position of 71.978345N 155.688028W.

The vessel is currently surrounded by sea ice in an area of 70-90% ice cover. An area of 80-100% ice cover is less than 2 nm to the north of the vessel's latest position. A region of 60-90% sea ice cover lies 12.5 nm to the south of the vessel's position and 8.5 nm to the southeast of the vessel's current position.

The situation is becoming increasingly concerning at this point in time. Easterly winds are expected to persist through today... becoming Northerly winds tonight through Saturday at 10-15 knots. With this northerly wind flow the overall pack ice north of the vessel is expected to compact and shift to the south... closing off lower concentration ice pathways and options for the vessel to escape the sea ice.

Winds are expected to become westerly Saturday night and then southwesterly Sunday into Monday. This wind will shift the compact ice to the west of the vessel over to the east... also packing in the sea ice surrounding the vessel. It is likely by Monday that this area will be in roughly 80%-100% ice cover north of 71.55N

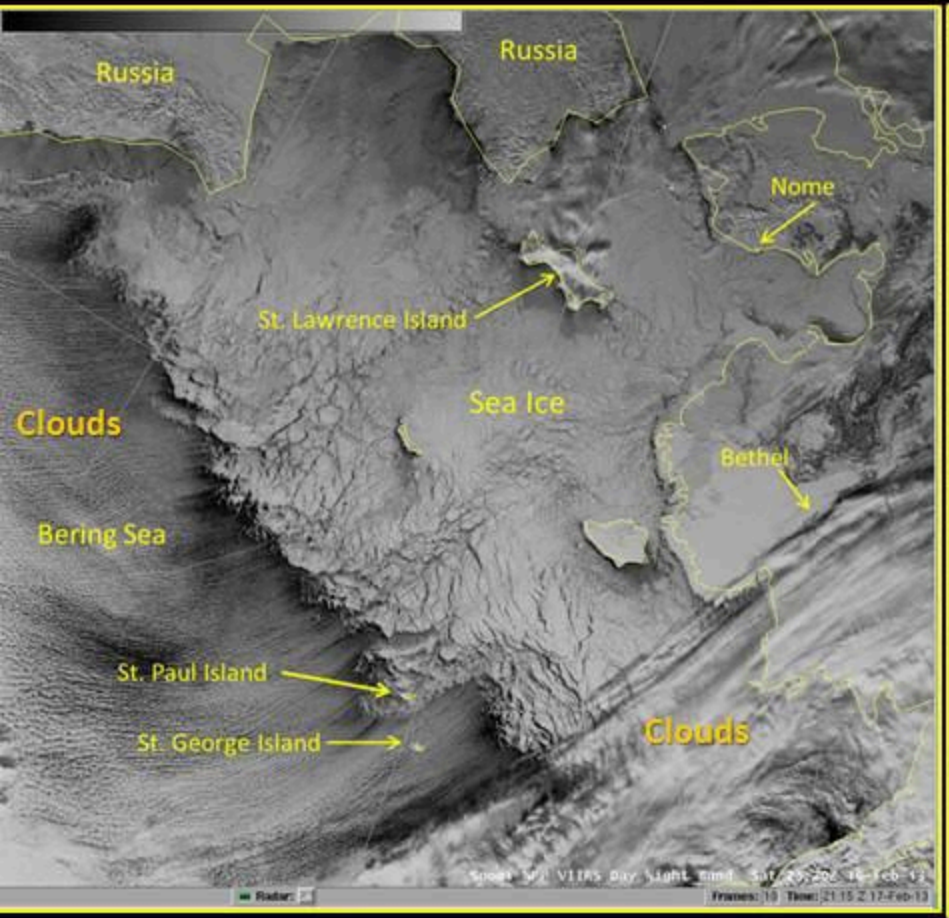
Early next week we are also having increasing confidence of a strong storm moving over the Chukchi Sea. Another item of concern for this vessel.

The best option for avoiding the high concentrations of ice compacting to a very serious situation for this vessel is to advise the vessel to head toward the west facing coast of Barrow.

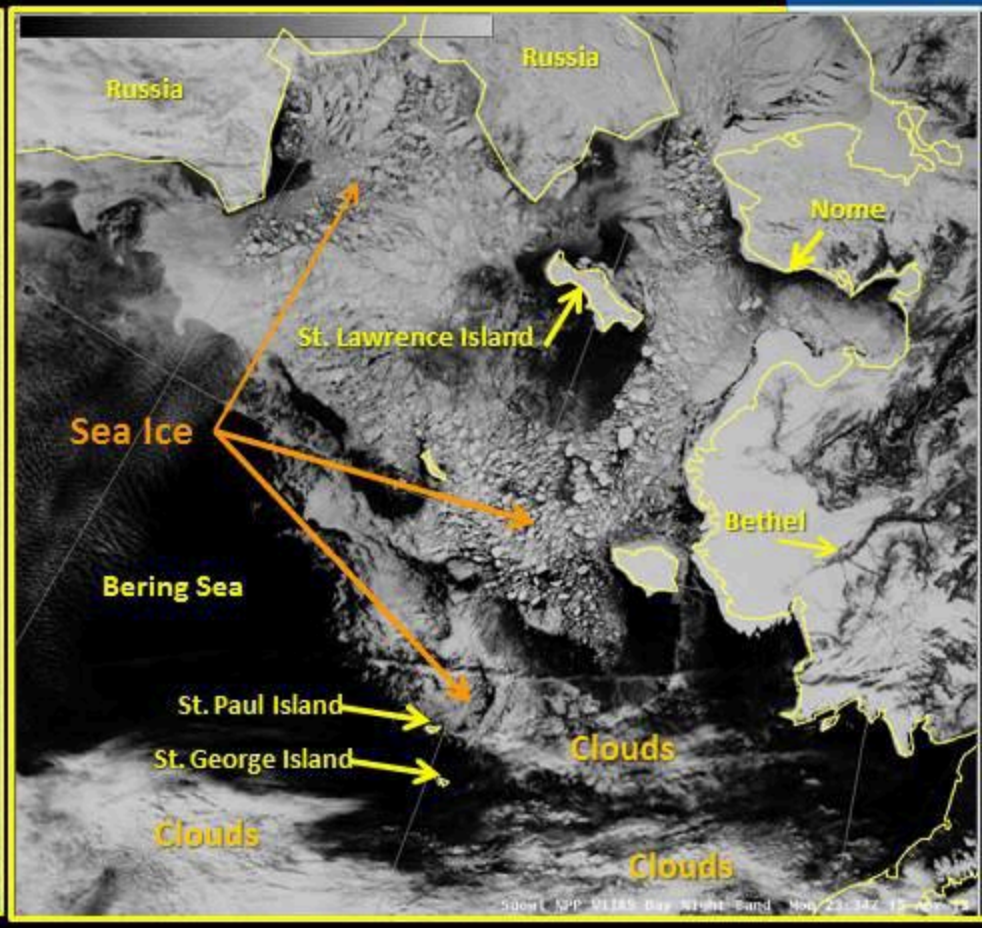
USCG Rescues Mariner in Sailboat Trapped in Ice North of Barrow

WFO Anchorage sea ice forecasters provided "phenomenal weather products" that proved key to USCG decision makers, said Rear Adm. Dan Abel, commander, 17th Coast Guard District.

I Spy With My Satellite Eye…
Bering Sea Ice Melting!

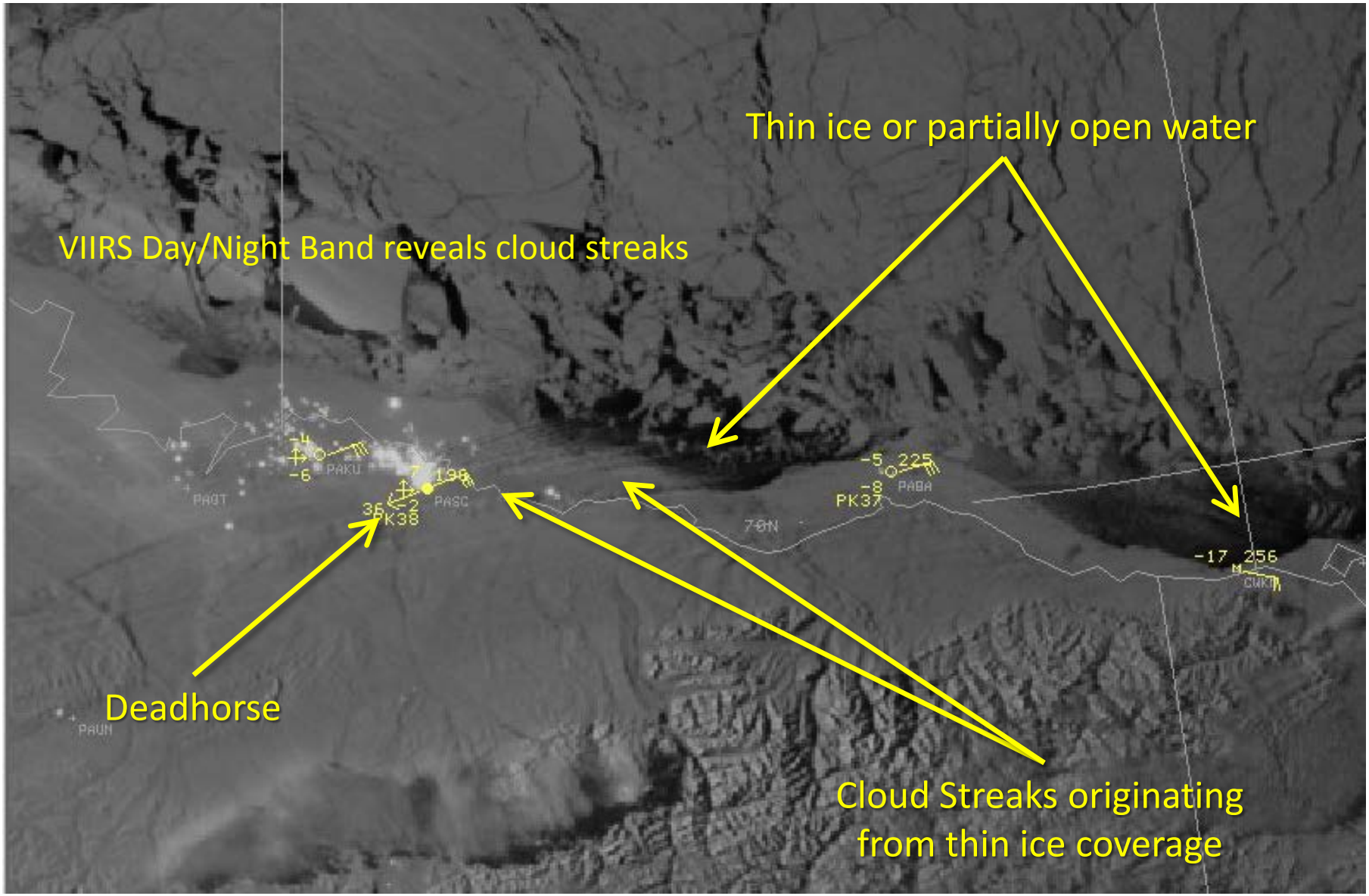


Feb 16, 2013

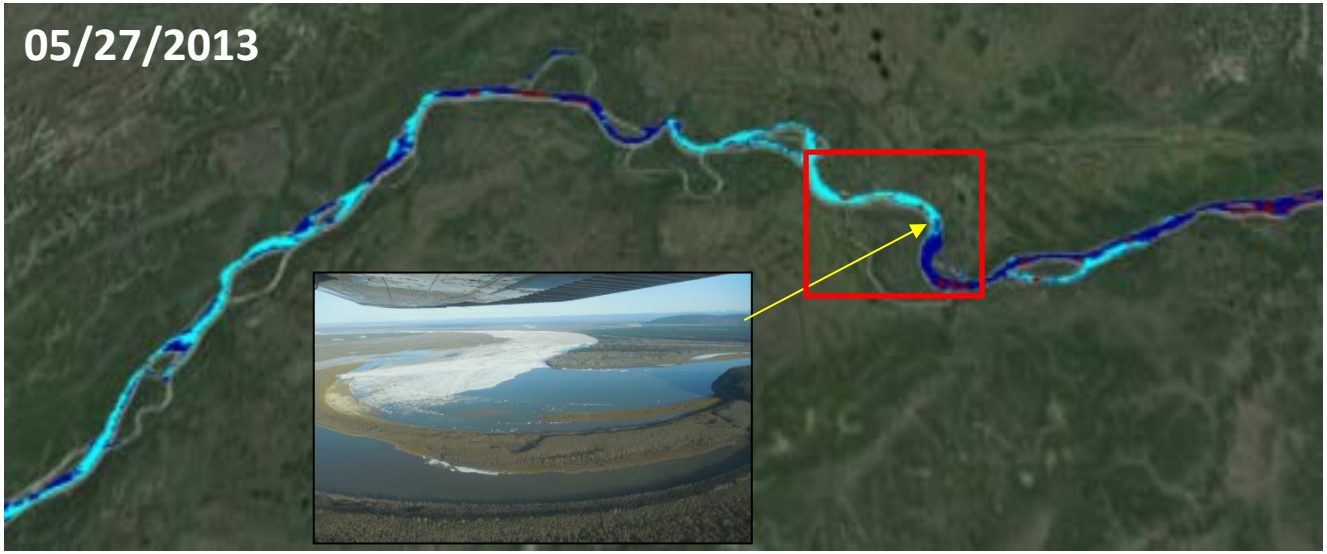


Apr 15, 2013

VIIRS DNB
December 24, 2013



VIIRS River Ice and Flood Products



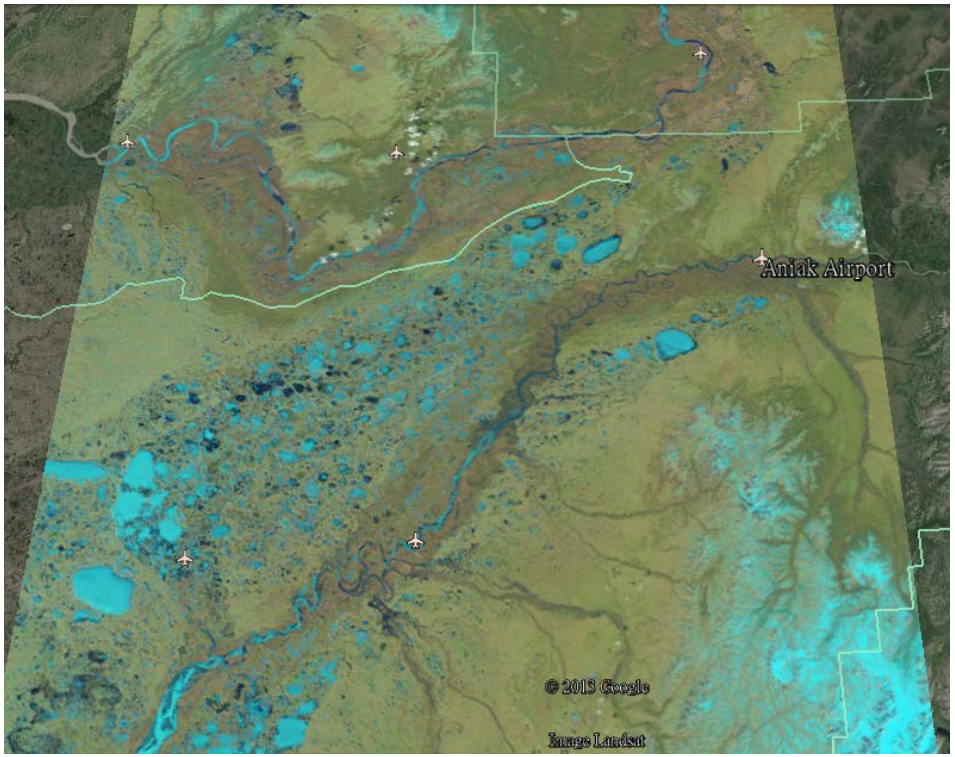
VIIRS can identify
river ice jams
which can lead
to large flood events

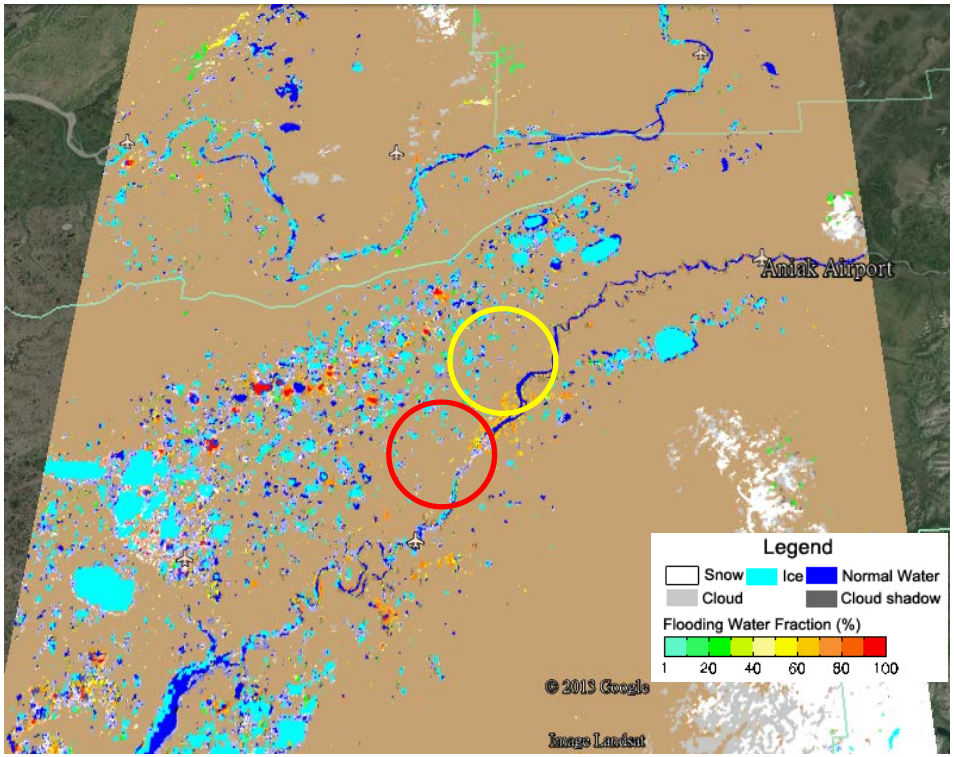
- Cyan is mixed ice/water
- Blue is water
- Red is cloud
- Yellow is solid ice

Flooding from ice jams can occur in a very short time

Galena, Alaska on May 28, 2013

VIIRS River Ice and Flood Products





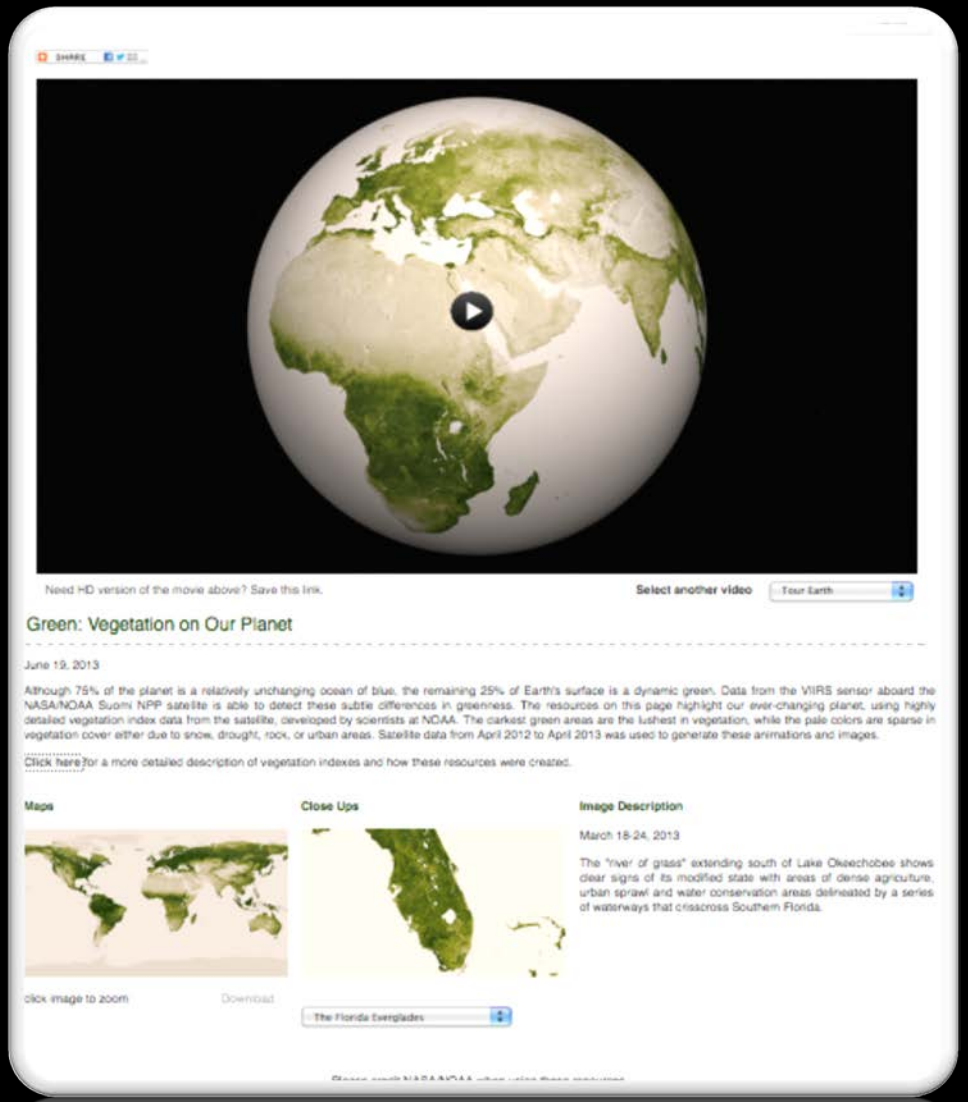
VIIRS false-color image
May 28, 2013 21:49 (UTC)

VIIRS flood detection map
May 28, 2013 21:49 (UTC)

Ice jam is found in the river section within the red circle, and flooding water is found in the river section within the yellow circle.

#NOAAGreen using VIIRS NDVI

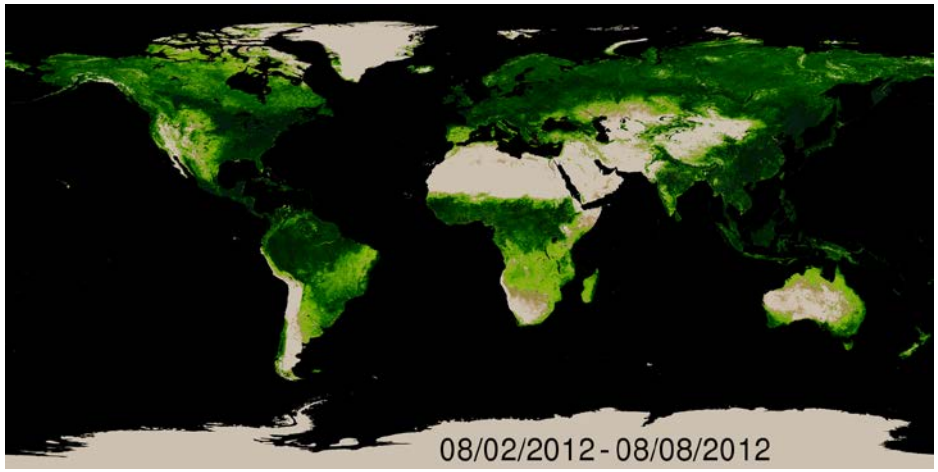
www.nnvl.noaa.gov/green.php

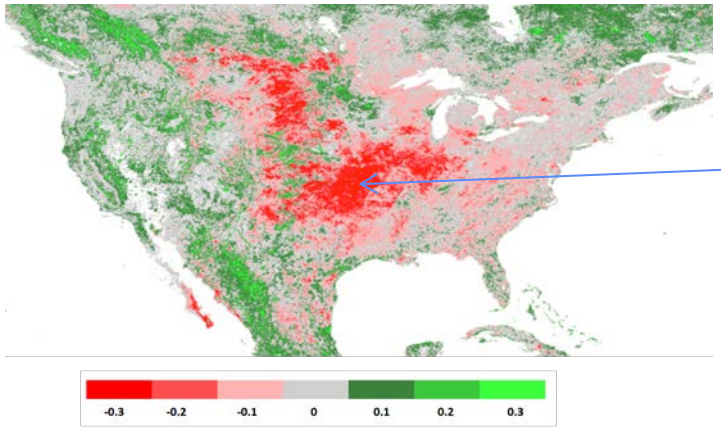


Interactive map at http://www.nnvl.noaa.gov/Green.html

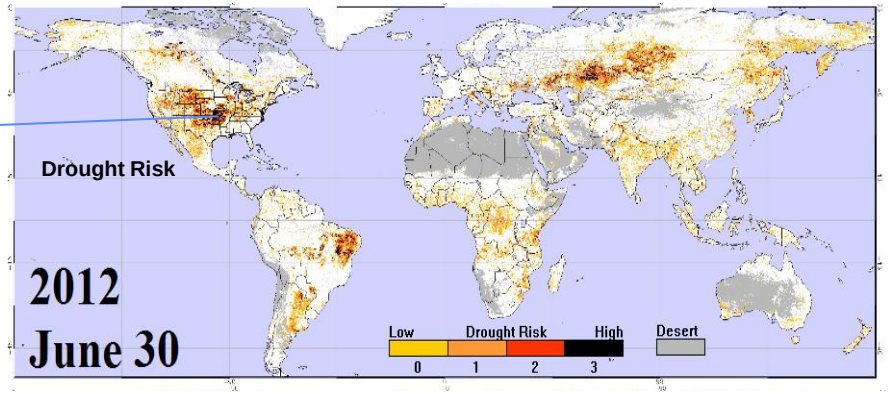
VIIRS provides global vegetation monitoring and enables drought assessments

Green vegetation fraction



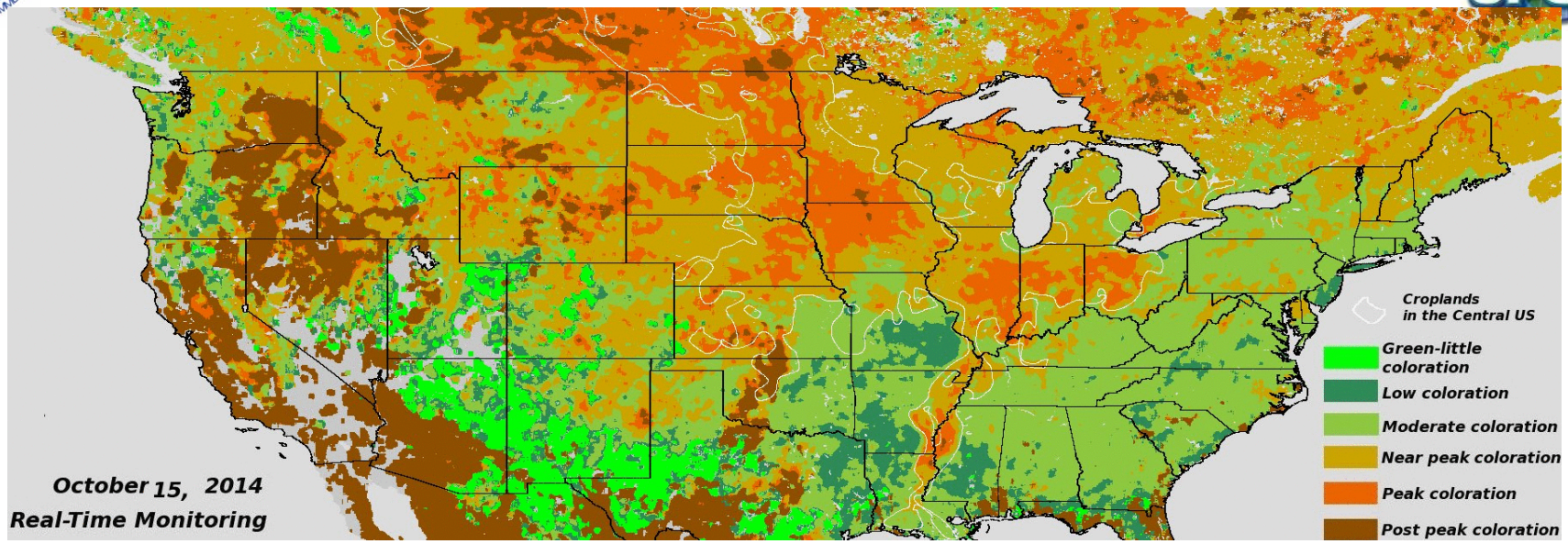


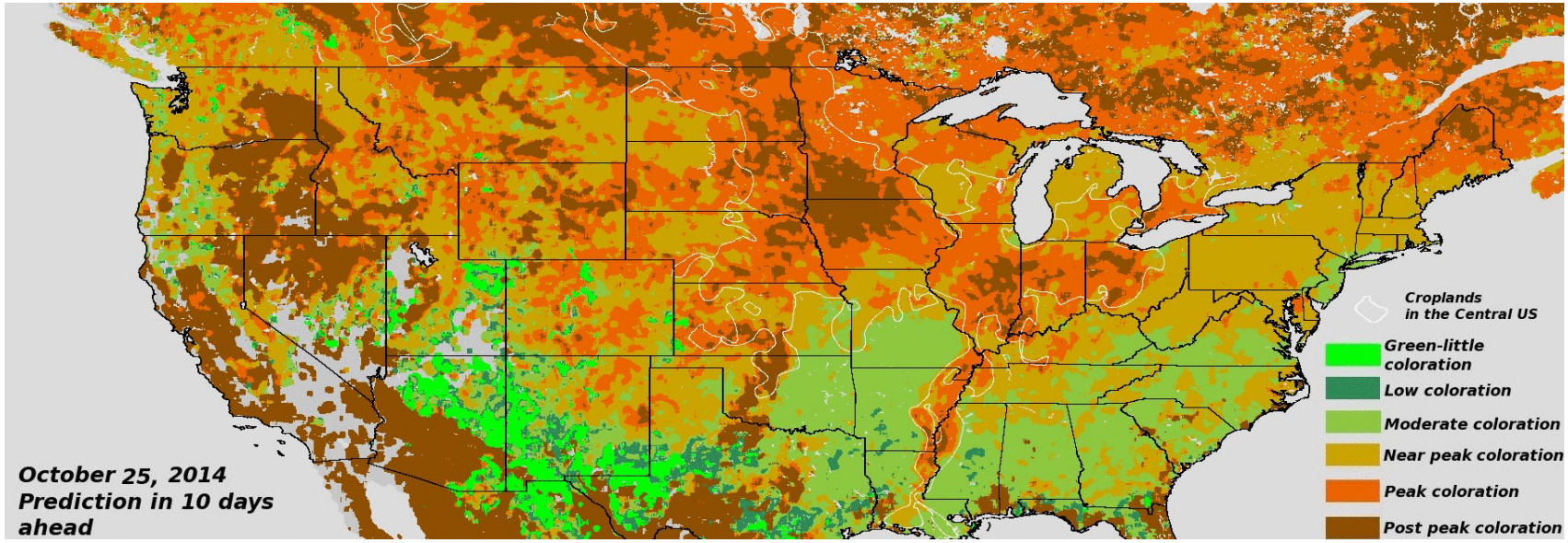
VIIRS GVF difference (15 Aug 2012 minus 15 Aug 2014)



(note: US has record corn yield in 2014)

Real-time Monitoring and Short-term Forecasting of Fall Foliage from VIIRS





Animation of Vegetation Fraction September 2012-February 2015

Thank you!

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