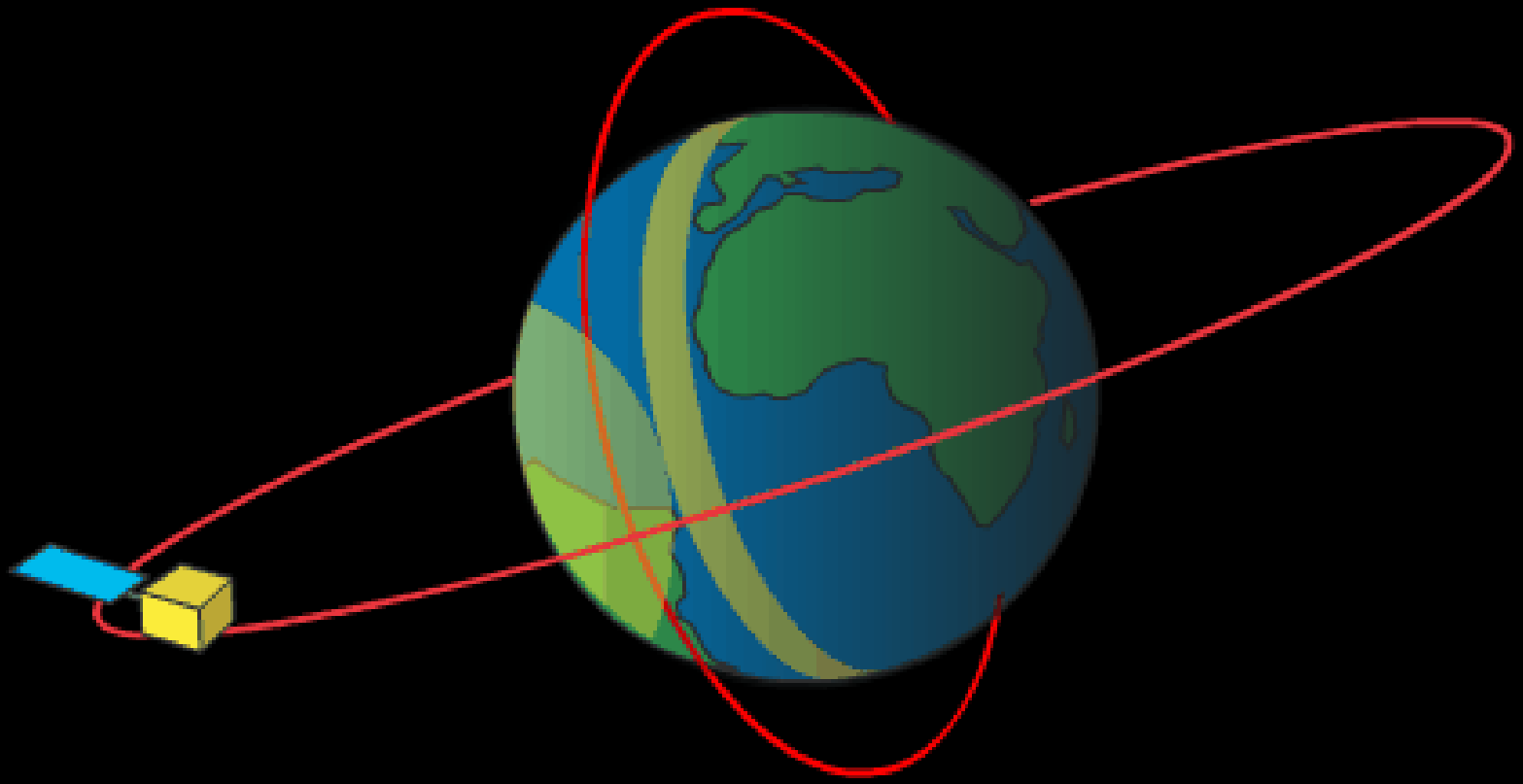
Earth Observing Satellites and their Impact on Weather Forecasting

NASA / NOAA Joint Polar Satellite System
Common Ground System
Mission Services

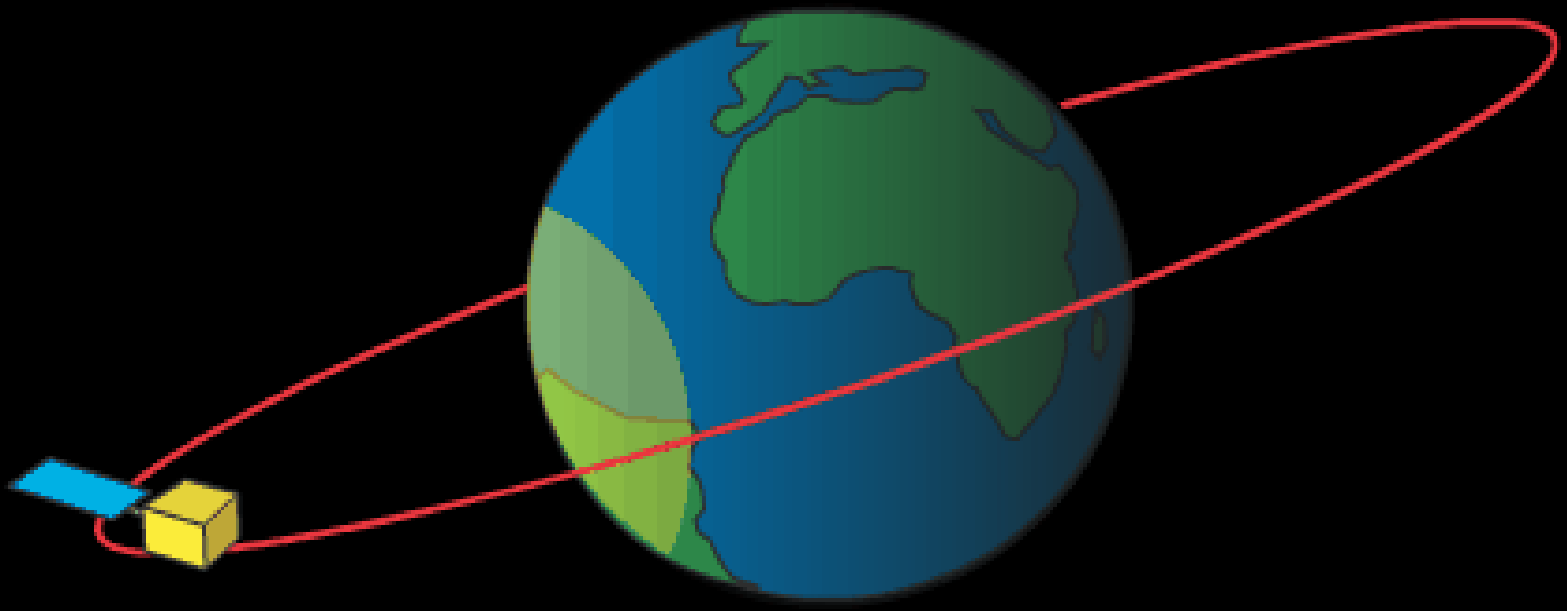
Shawn Cochran

7 April 2018

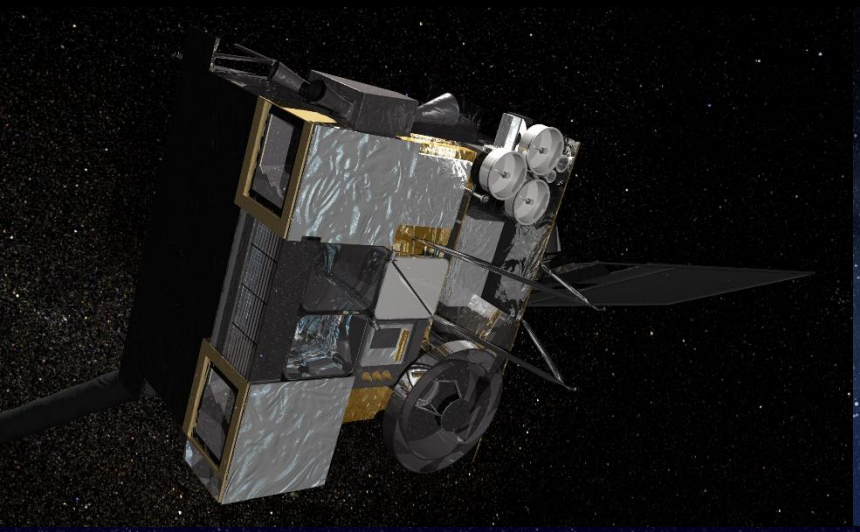
How do we observe the Earth?

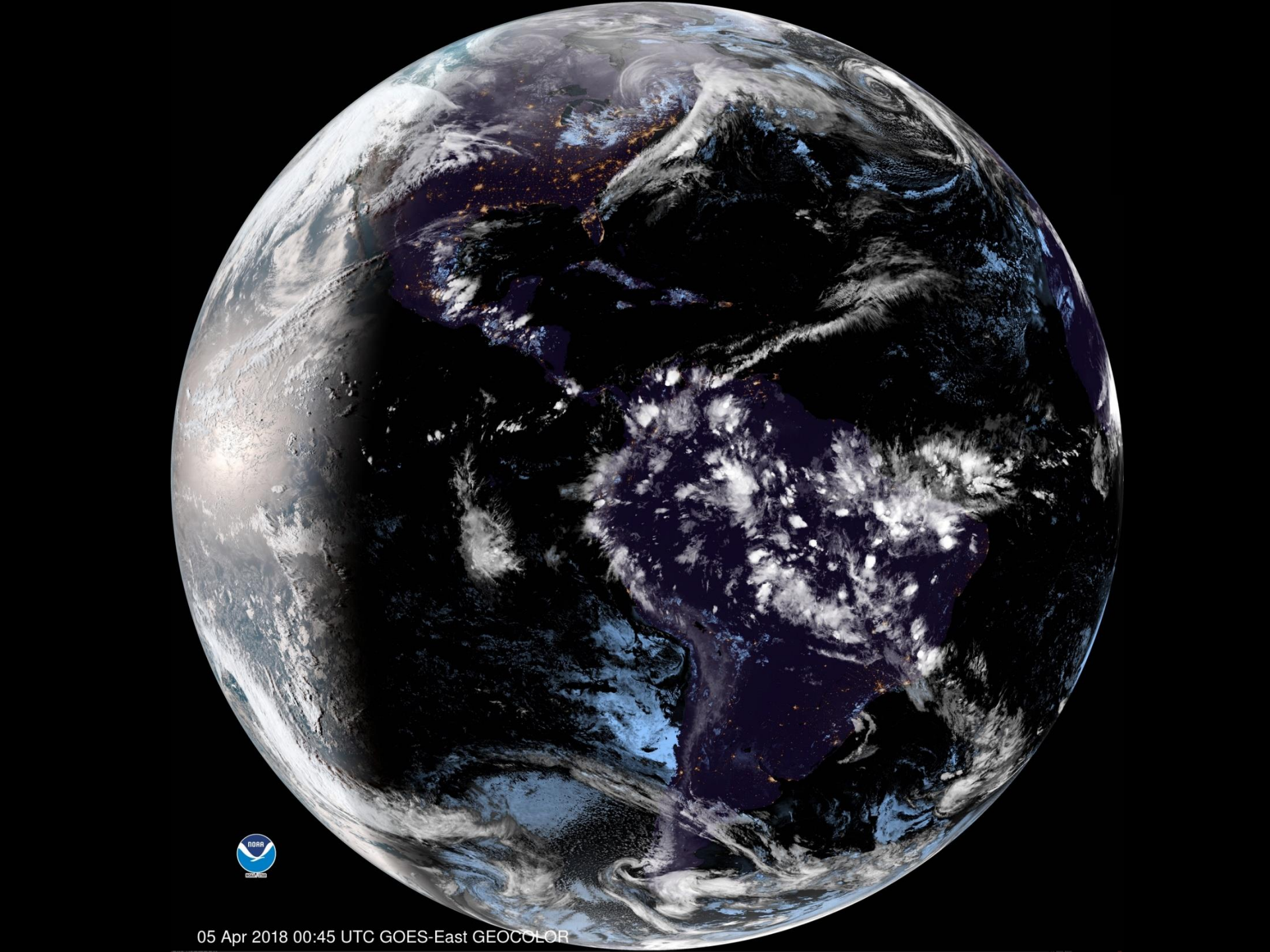


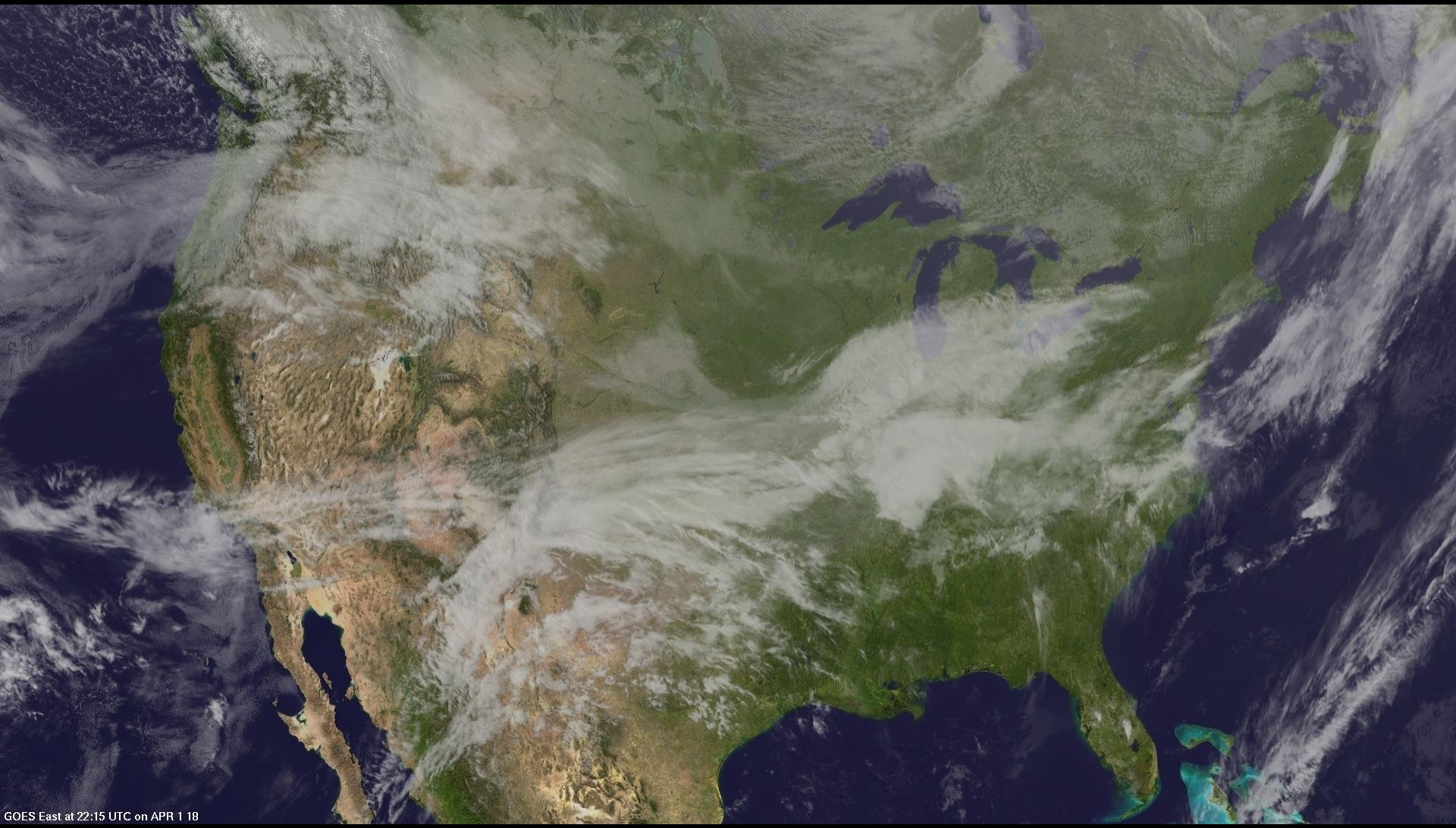
Geostationary satellite (GEO)

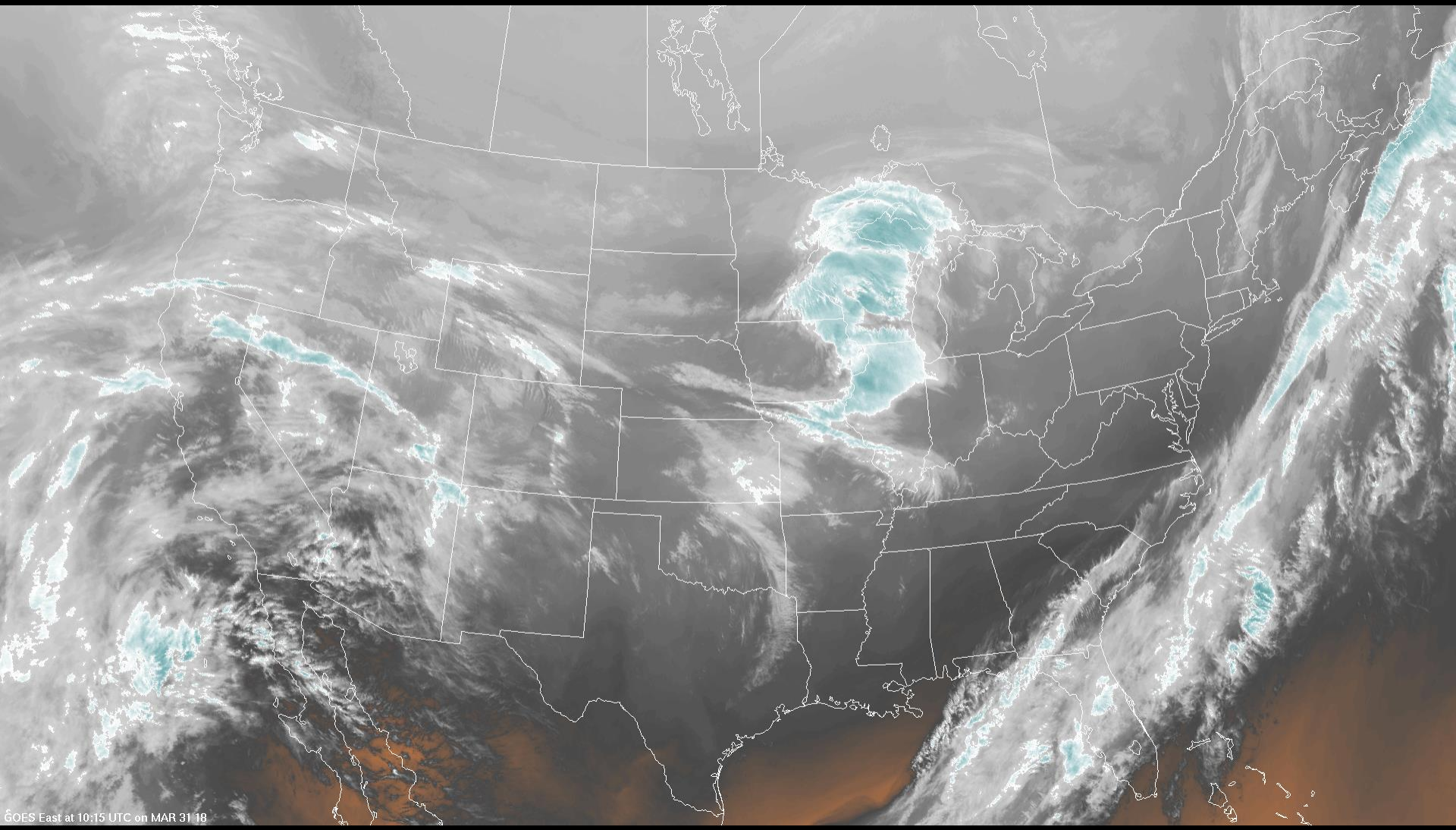


GOES Weather Satellites… (GOES 15/16)

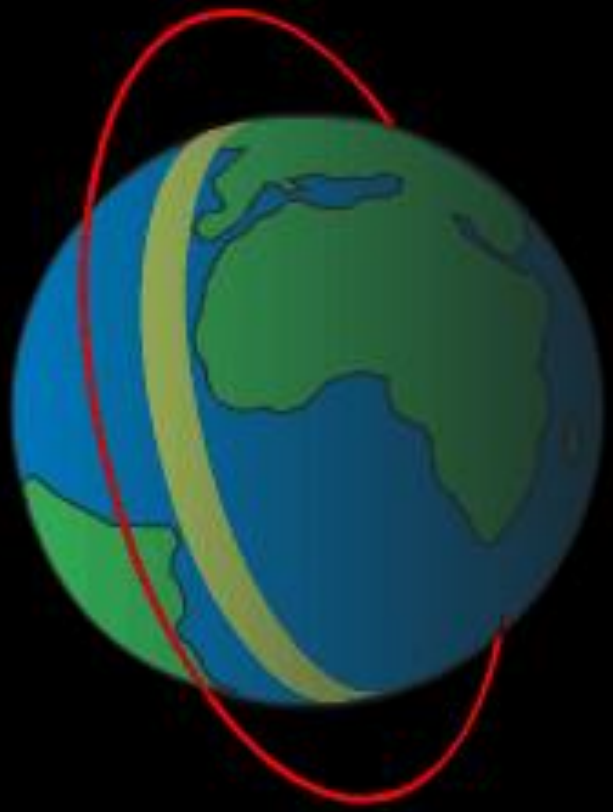


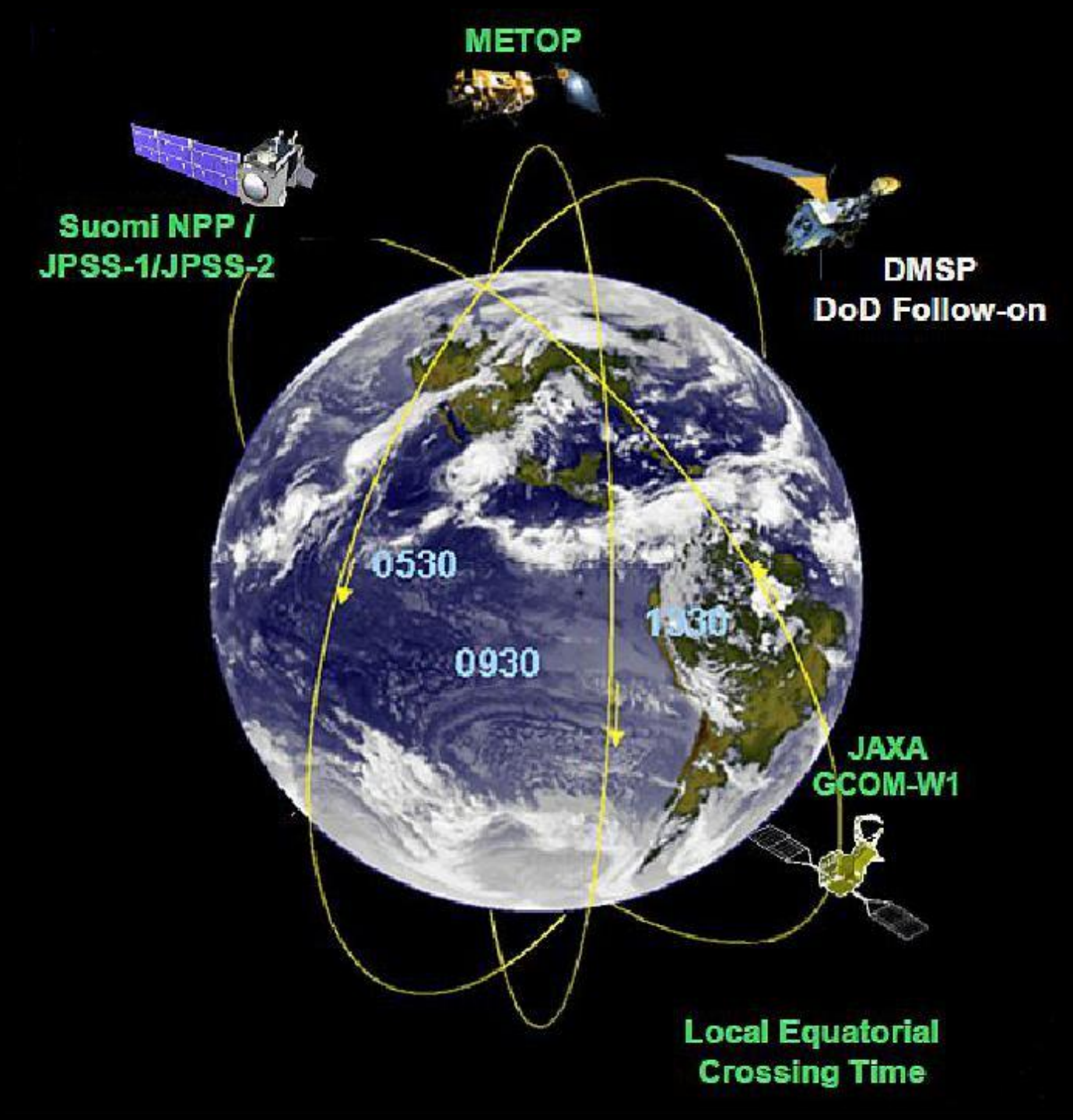

05 Apr 2018 00:45 UTC GOES-East GEOCOLOR


GOES East at 22:15 UTC on APR 1 18


GOES East at 10:15 UTC on MAR 31 18

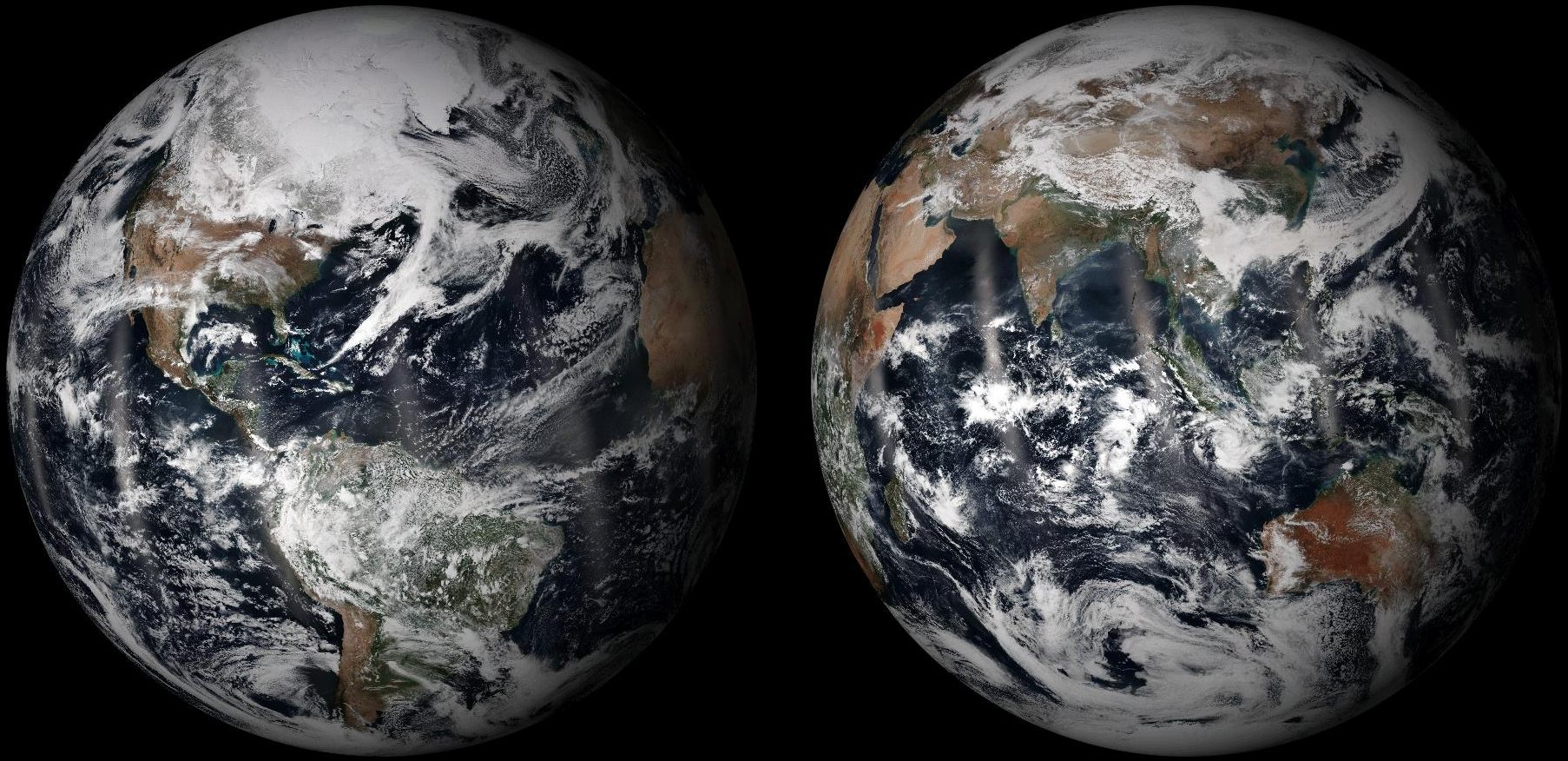
Polar Orbiting satellite (LEO)





LTAN = local time ascending node

This is when the LEO satellite is going to “fly” over the equator going north or “ascending”



Why the Joint Polar Satellite System (JPSS)?

Information about our planet is vital for the ability to plan, predict, respond and *protect our Nation's lives and property.* JPSS Science is critical to accomplishing this primary goal.

The Joint Polar Satellite System (JPSS) Science Goals include:

- Producing and delivering new satellite data, imagery and products to *increase the accuracy and reliability of weather forecasting* capabilities for severe weather events and phenomena—such as *tropical cyclones— i.e., Hurricanes*;
- Improving our Earth's *ocean and coastal applications*' use of polar-orbiting satellite data;
- Continuing the enhancement of our long-term *environmental data* sets to facilitate long-term climate monitoring and prediction; and
- Developing our *land applications*

85% of numerical weather prediction model inputs come from the low earth orbiting (LEO) observations

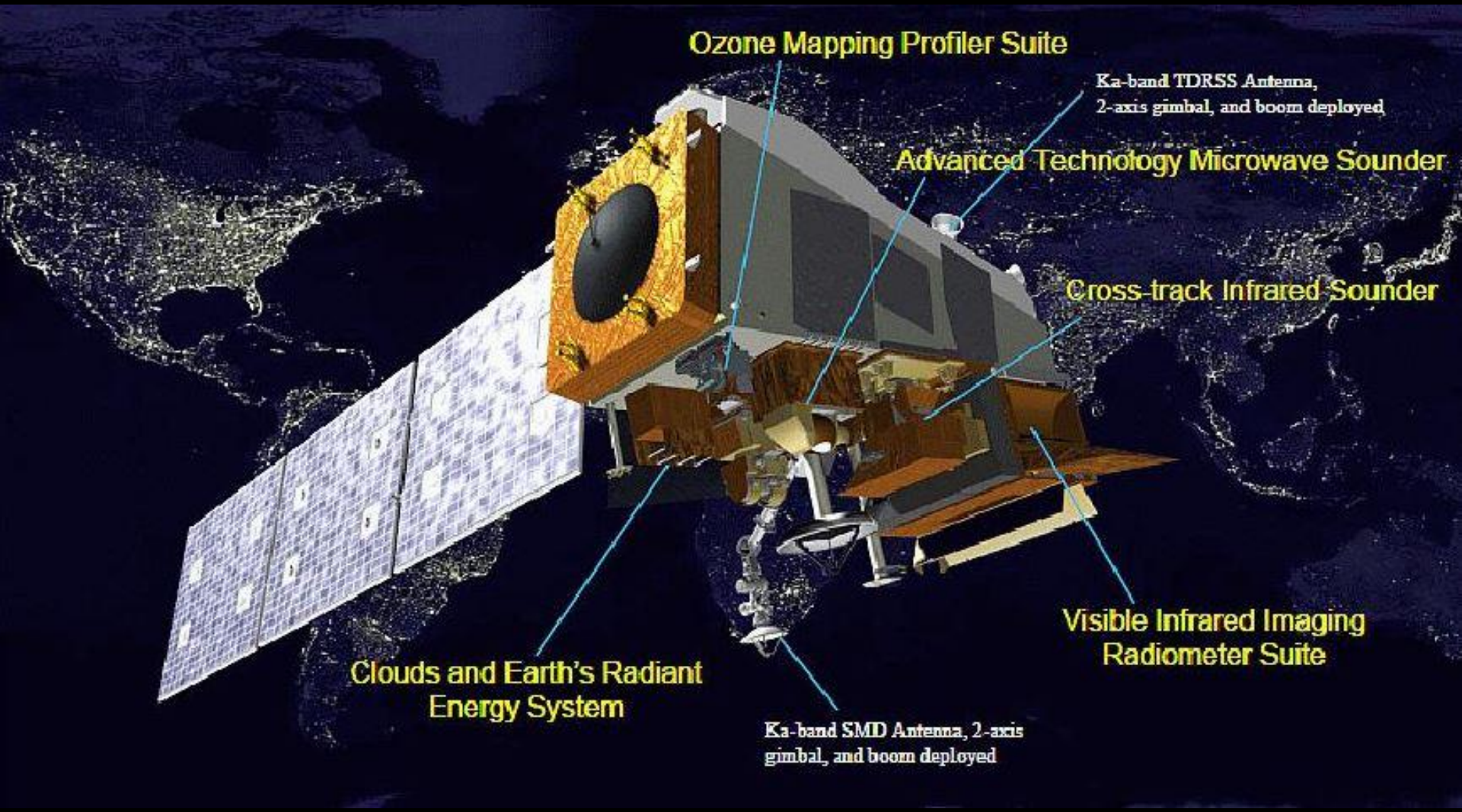
Polar Orbiting Weather Satellites

DEPARTMENT OF DEFENSE · UNITED STATES OF AMERICA · NASA · NOAA · NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION · U.S. DEPARTMENT OF COMMERCE · 空へ挑み、宇宙を拓く · JAXA · 宇宙航空研究開発機構 · EUMETSAT

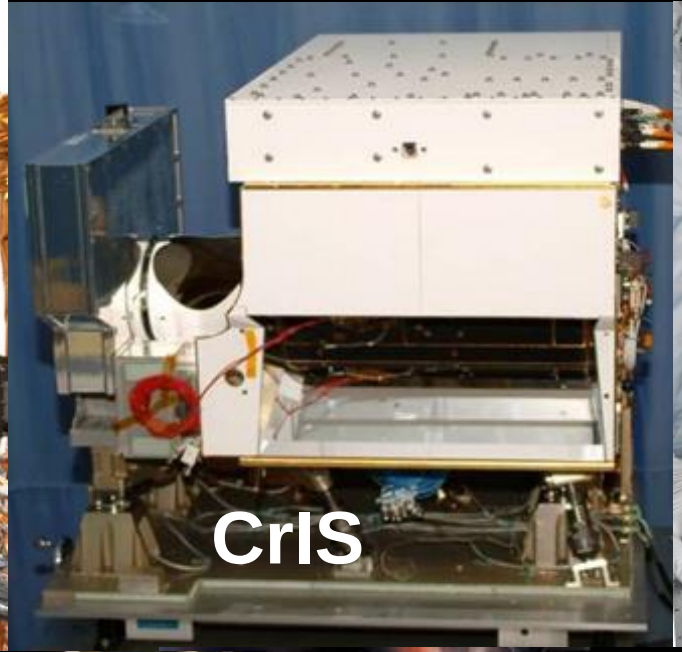
Polar orbiting constellation

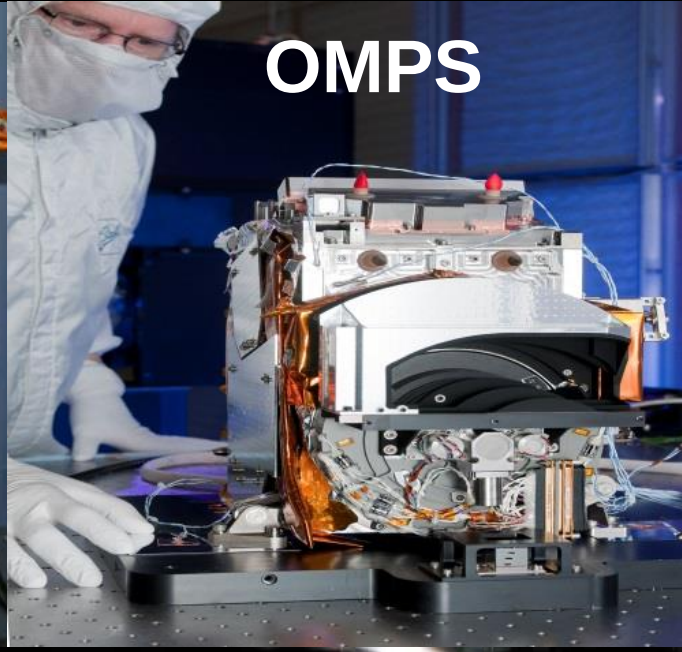

McMurdo, Antarctica

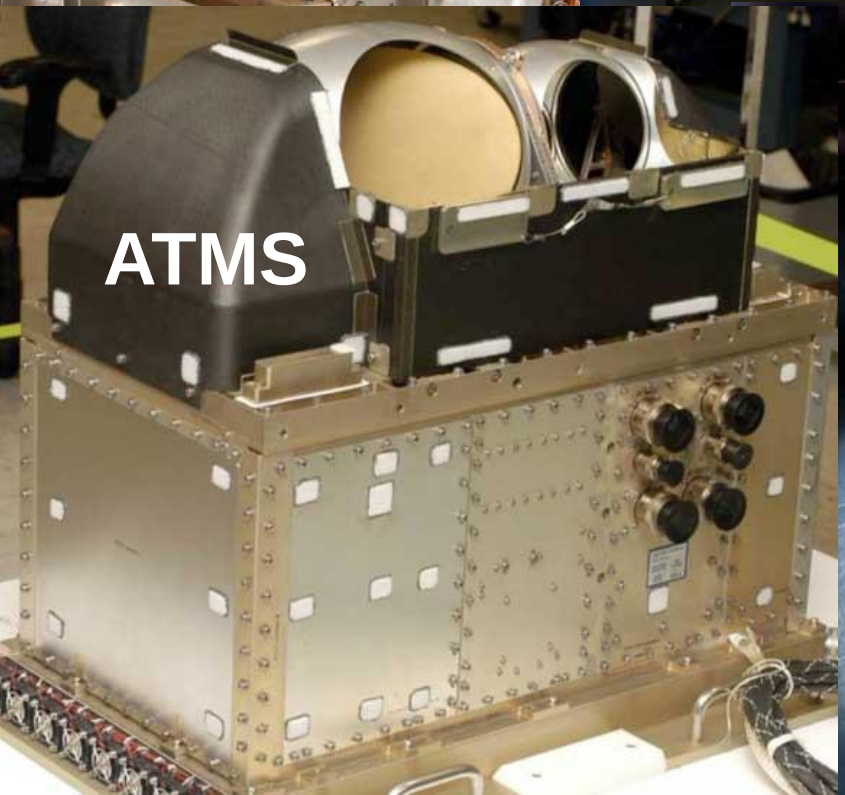

Svalbard, Norway


Ozone Mapping Profiler Suite
Ka-band TDRSS Antenna, 2-axis gimbal, and boom deployed
Advanced Technology Microwave Sounder
Cross-track Infrared Sounder
Visible Infrared Imaging Radiometer Suite
Clouds and Earth's Radiant Energy System
Ka-band SMD Antenna, 2-axis gimbal, and boom deployed


CERES

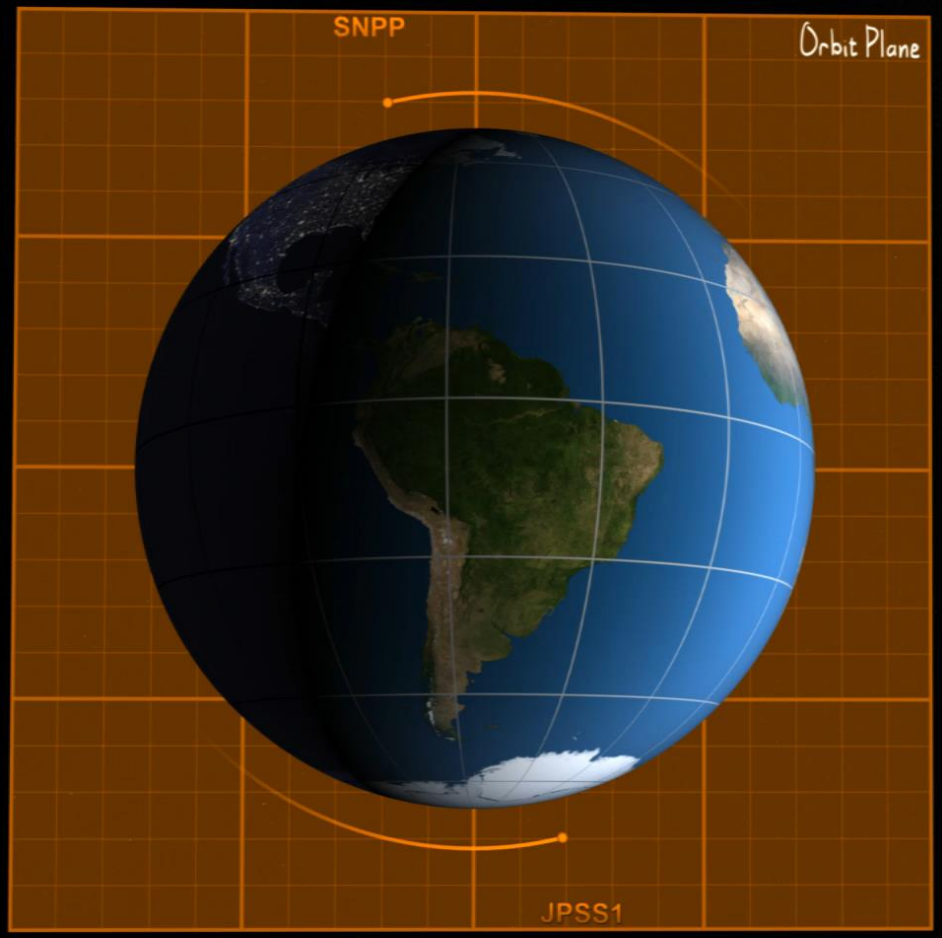

CrIS


OMPS


ATMS


VIIRS

S-NPP and JPSS-1 (NOAA-20)



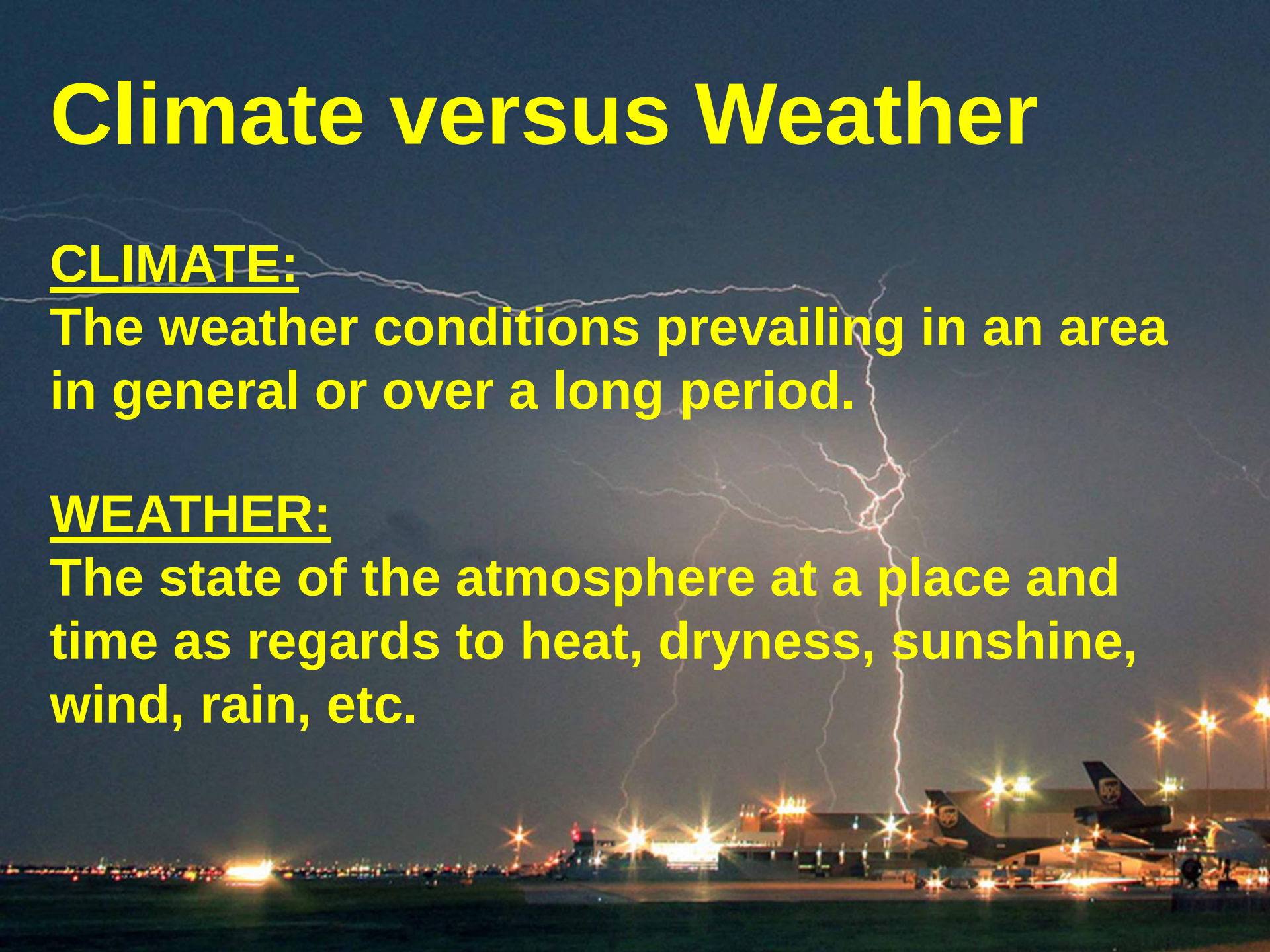
Climate versus Weather

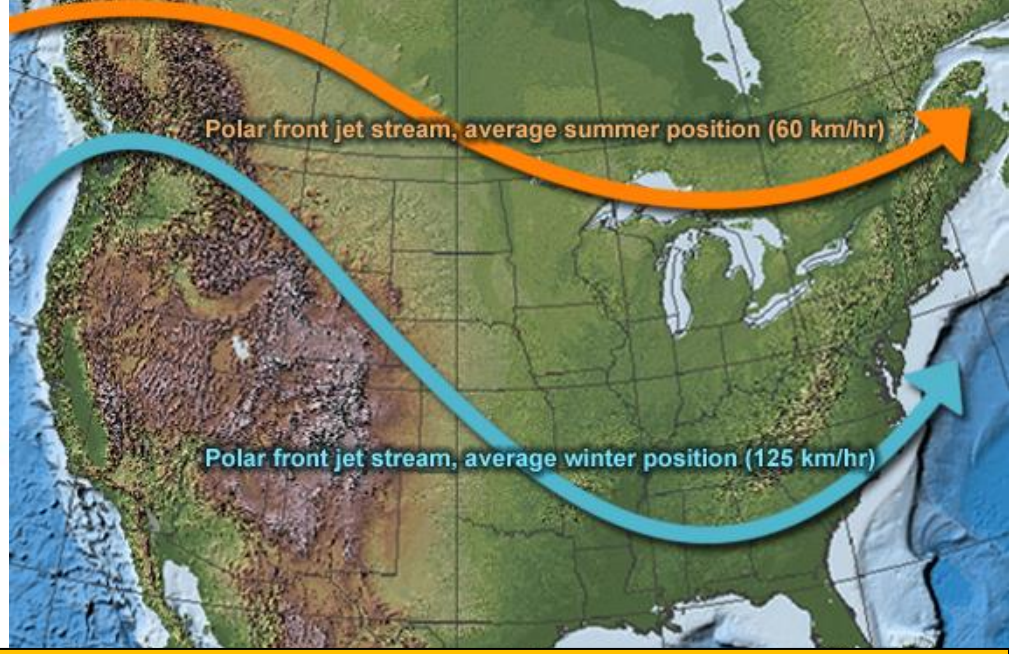
CLIMATE:

The weather conditions prevailing in an area in general or over a long period.

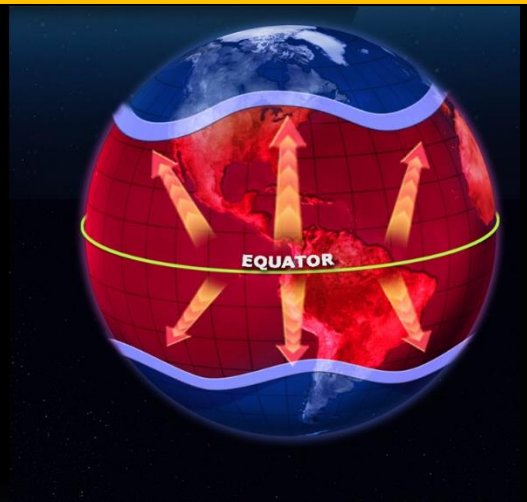
WEATHER:

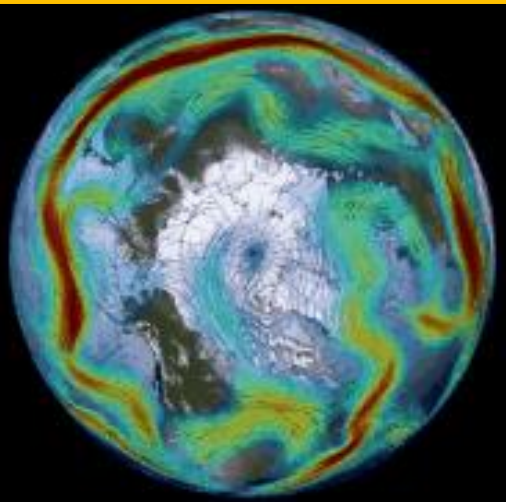
The state of the atmosphere at a place and time as regards to heat, dryness, sunshine, wind, rain, etc.

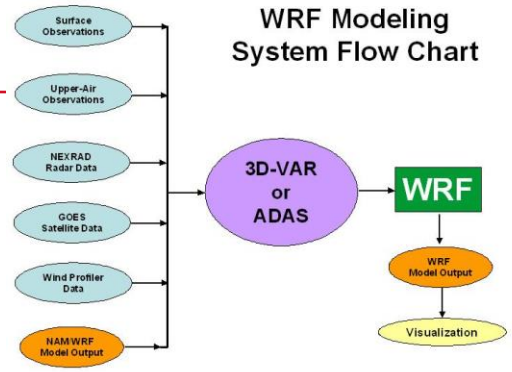




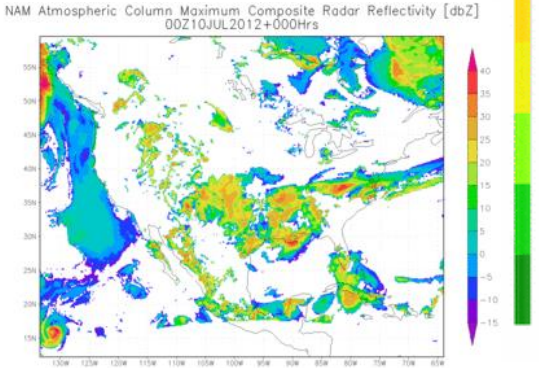
The jet stream is creeping northward and weakening. That potentially means less rain in the already dry South and Southwest and more storms in the North. And it could also translate into more and stronger hurricanes since the jet stream suppresses their formation. Two other jet streams in the Southern Hemisphere are also shifting poleward. The northern jet stream is the dominant thing that creates weather systems for the United States.







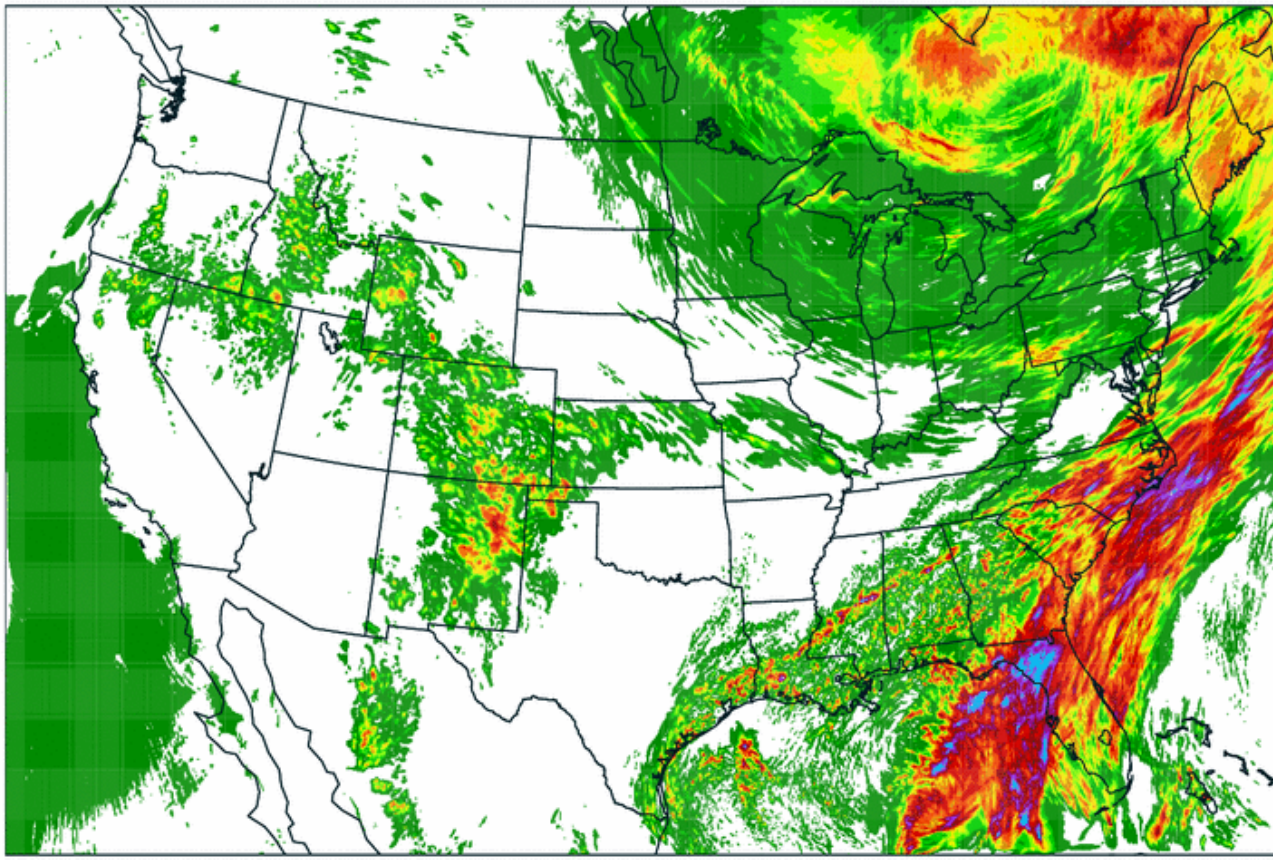
The Weather Research and Forecasting (WRF) Model is a next-generation mesoscale numerical weather prediction system designed to serve both atmospheric research and operational forecasting needs



PRECIP(mm)
36h accum
VALID 12Z 07 JUN 16

NSSL Realtime WRF
36-H FCST
4.0 KM LMB CON GRD

http://wrf.nssl.noaa.gov/refl_loop.html



What is the Science Behind JPSS?

Raytheon

The JPSS Science goals directly support NOAA's mission to secure a more 'Weather Ready Nation.'

As a result, JPSS Science aligns with the overall focus of the JPSS Program, which is to utilize polar-orbiting satellite data products to feed NOAA's National Weather Service's (NWS) Numerical Weather Prediction (NWP) models.

These NWP models help National Weather Service (NWS) forecasters more accurately *predict severe weather phenomena* in longer periods of time, thus providing advanced notice and warnings to the public-at-large, emergency makers and political leaders.

> "The goal of weather prediction is to provide information people and organizations can use to reduce weather-related losses and enhance societal benefits, including protection of life and property, public health and safety, and support of economic prosperity and quality of life."
>
> *- Board on Atmospheric Sciences and Climate Committee on Progress and Priorities of U.S. Weather Research and Research-to-Operations Activities - 2010*

Global Data Assimilation System (GDAS)

GDAS is the set of assimilation data, both input and output, in various formats for the Global Forecast System model, which has been archived since 2004.

Global Ensemble Forecast System (GEFS)

GEFS is a global-coverage weather forecast model made up of 21 separate forecasts, or ensemble members, used to quantify the amount of uncertainty in a forecast. GEFS is produced four times a day with weather forecasts going out to 16 days.

Global Forecast System (GFS)

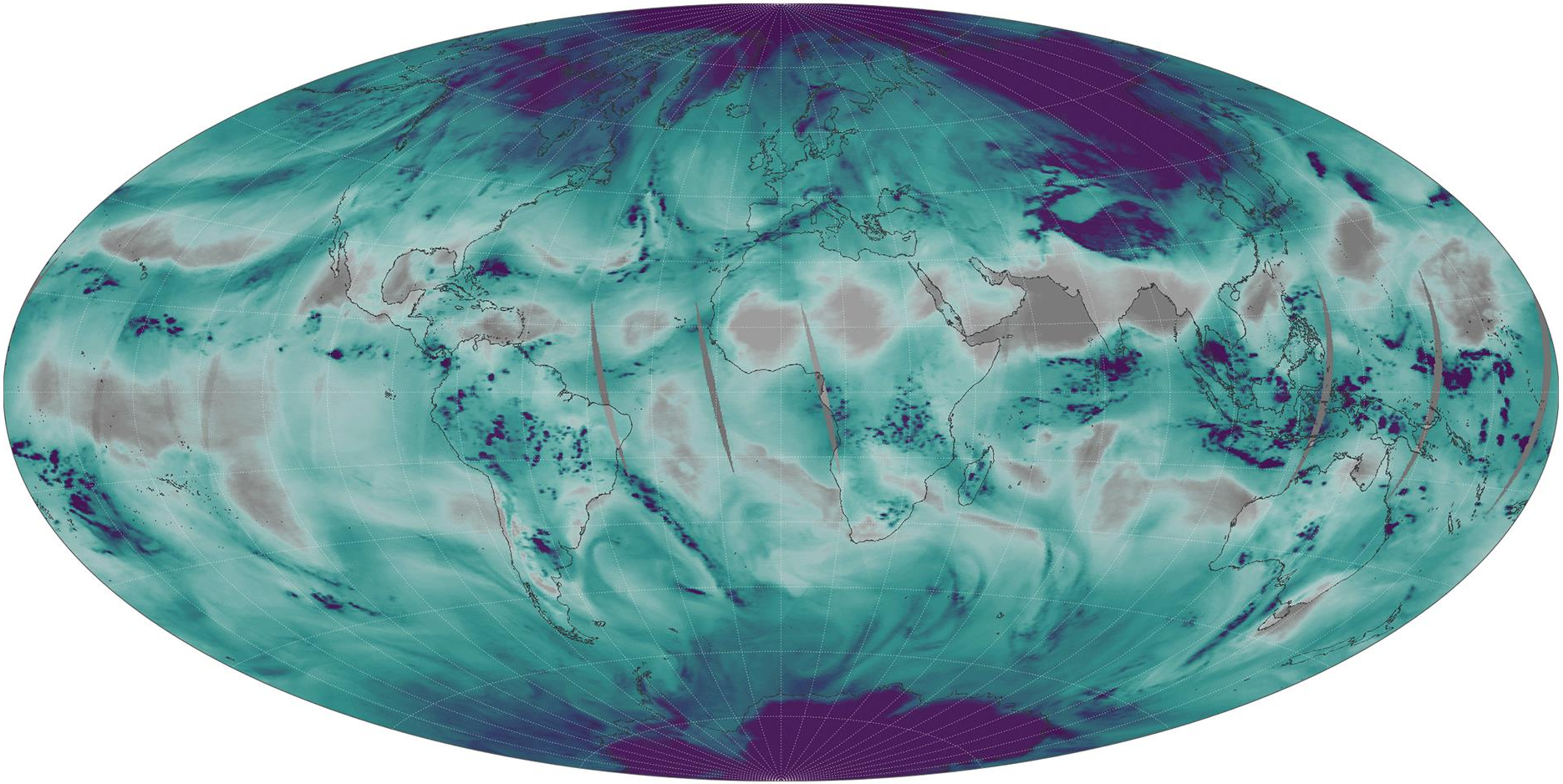
The GFS model is a coupled weather forecast model, composed of four separate models that work together to provide an accurate picture of weather conditions. The entire globe is covered by the GFS down to a horizontal resolution of 28 km.

North American Mesoscale (NAM)

NAM is a regional weather forecast model covering North America down to a horizontal resolution of 12 km. Dozens of weather parameters are available from the NAM grids, from temperature and precipitation to lightning and turbulent kinetic energy.

Rapid Refresh (RAP)

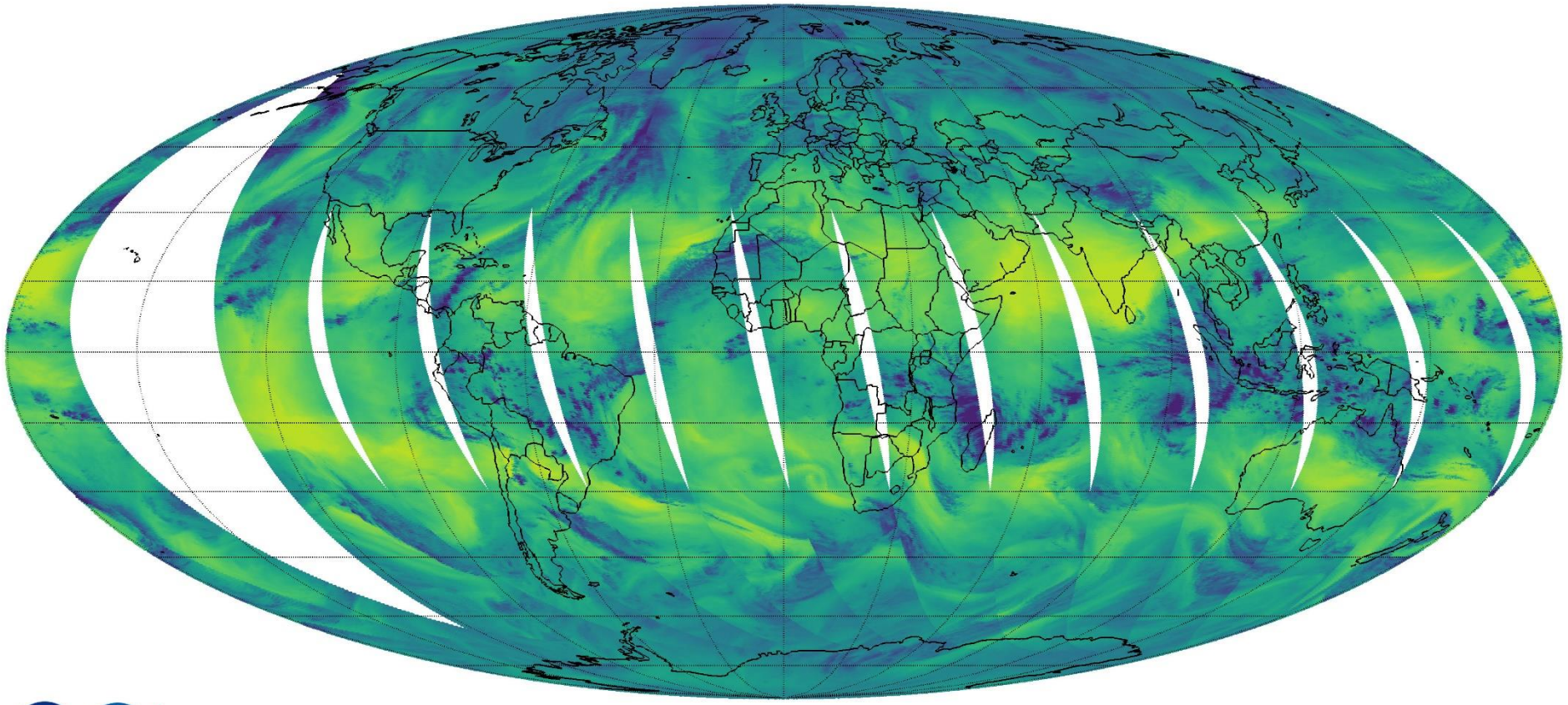
RAP is a regional weather forecast model of North America with separate sub-grids (with different horizontal resolutions) within the overall North America domain. RAP forecasts are generated every hour with forecast lengths going out 18 hours.



NOAA-20 ATMS Channel 18 Antenna Temperature (°K)

235 247 260 272 285

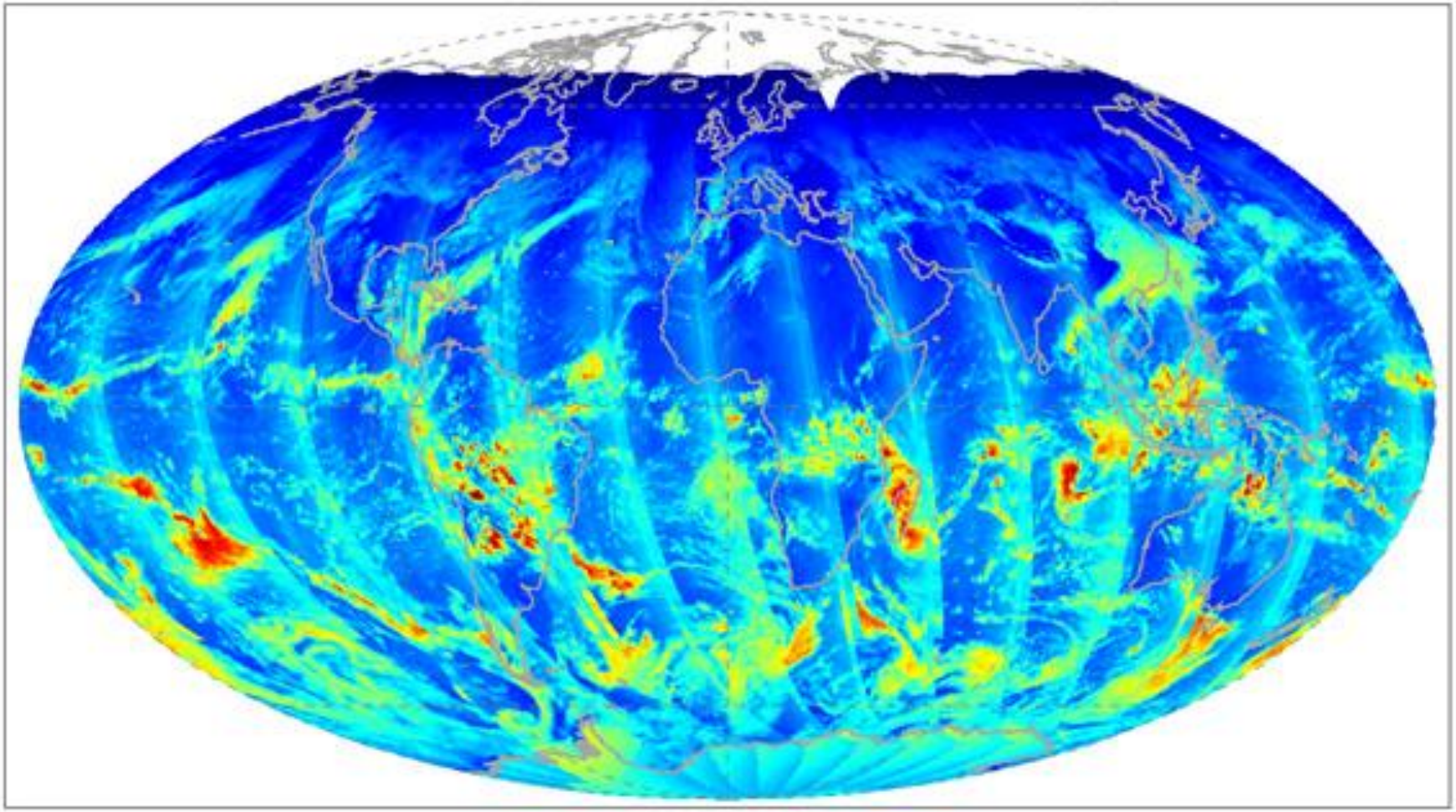
date acquired
November 29, 2017



NOAA-20 CrIS Channel 1025: 1598.75cm^{-1} (^{o}K)

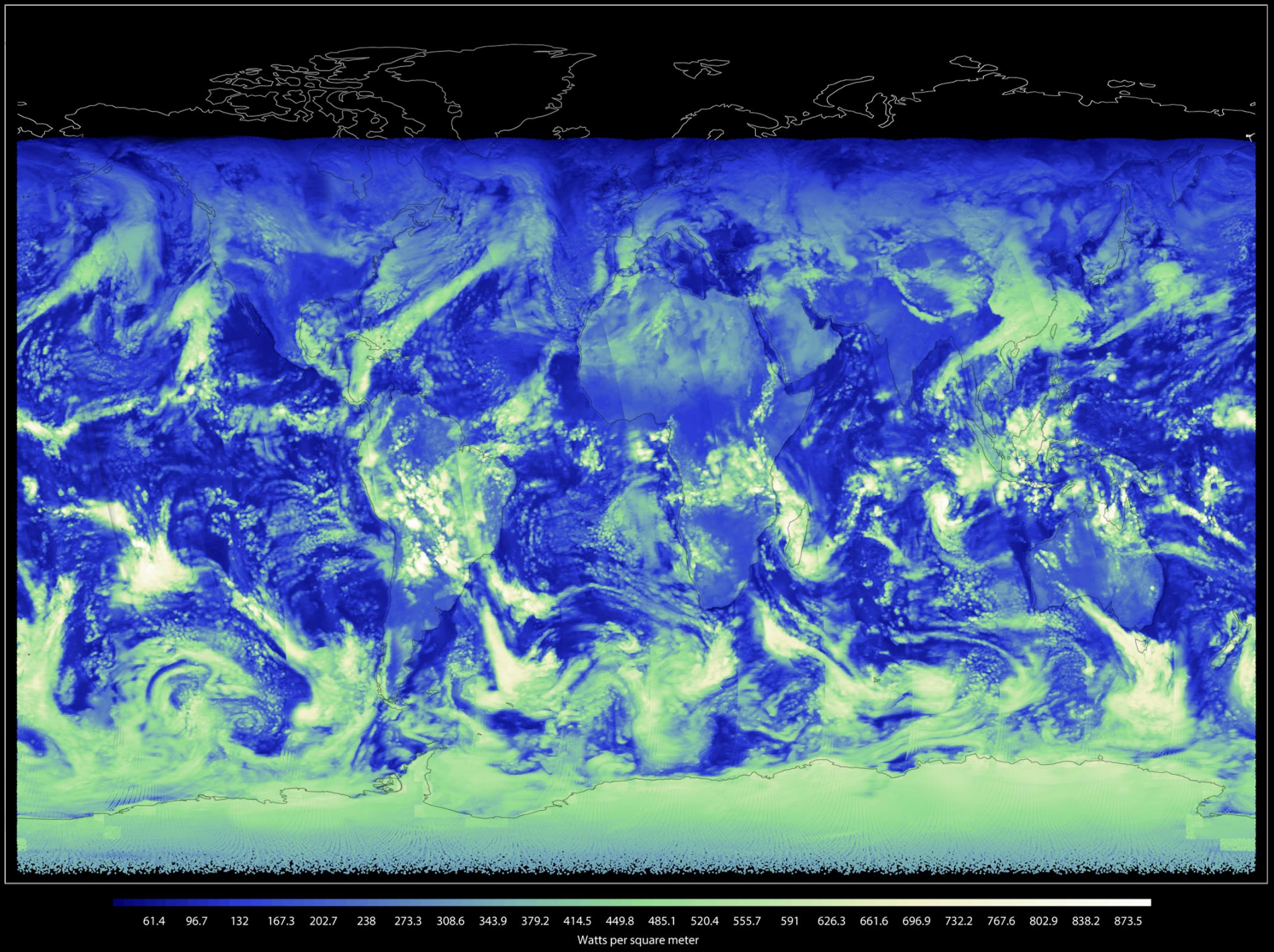
215 230 245 260 275

2018/01/05 First Light NOAA-20 OMPS Nadir Mapper, 360.8nm

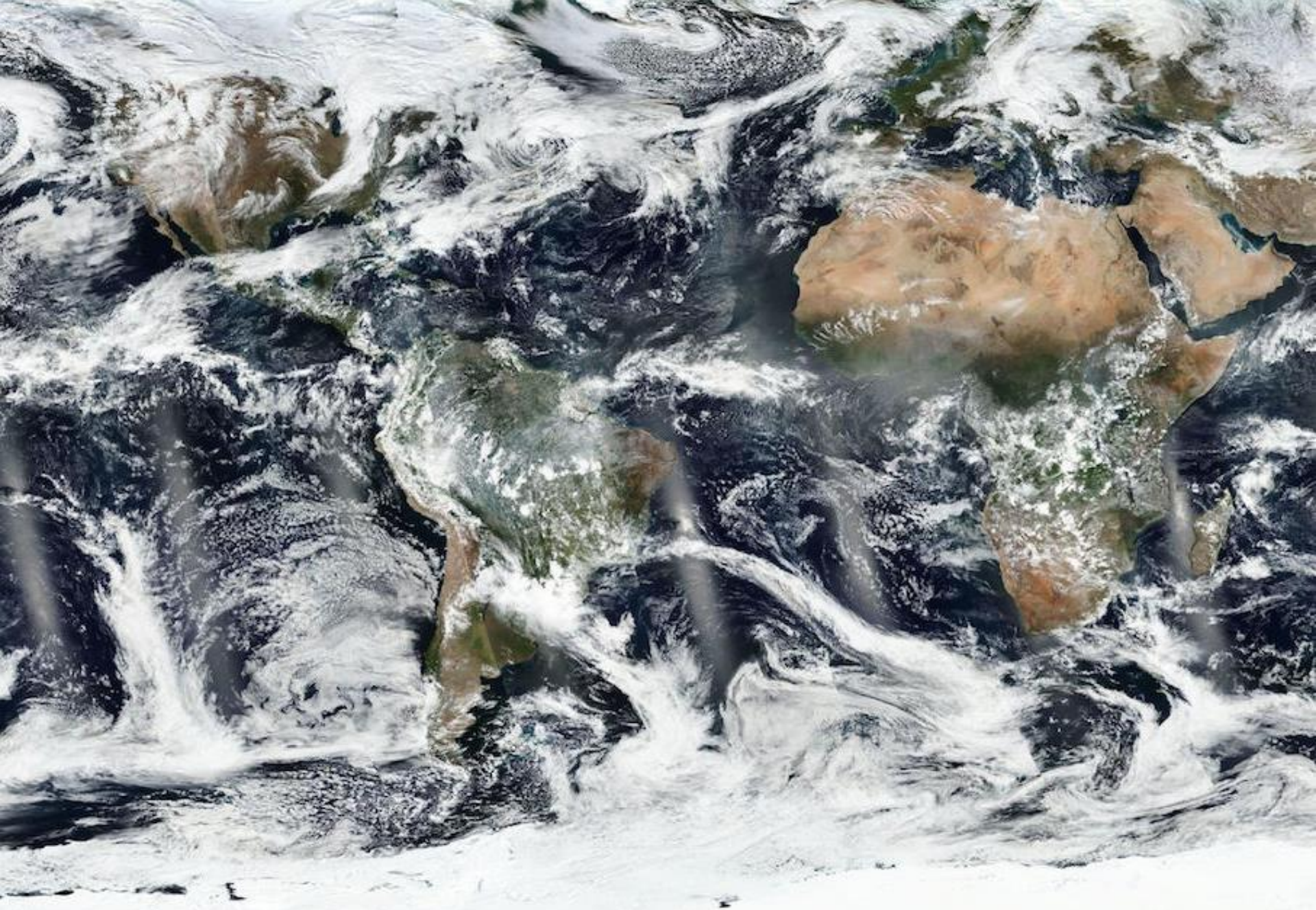


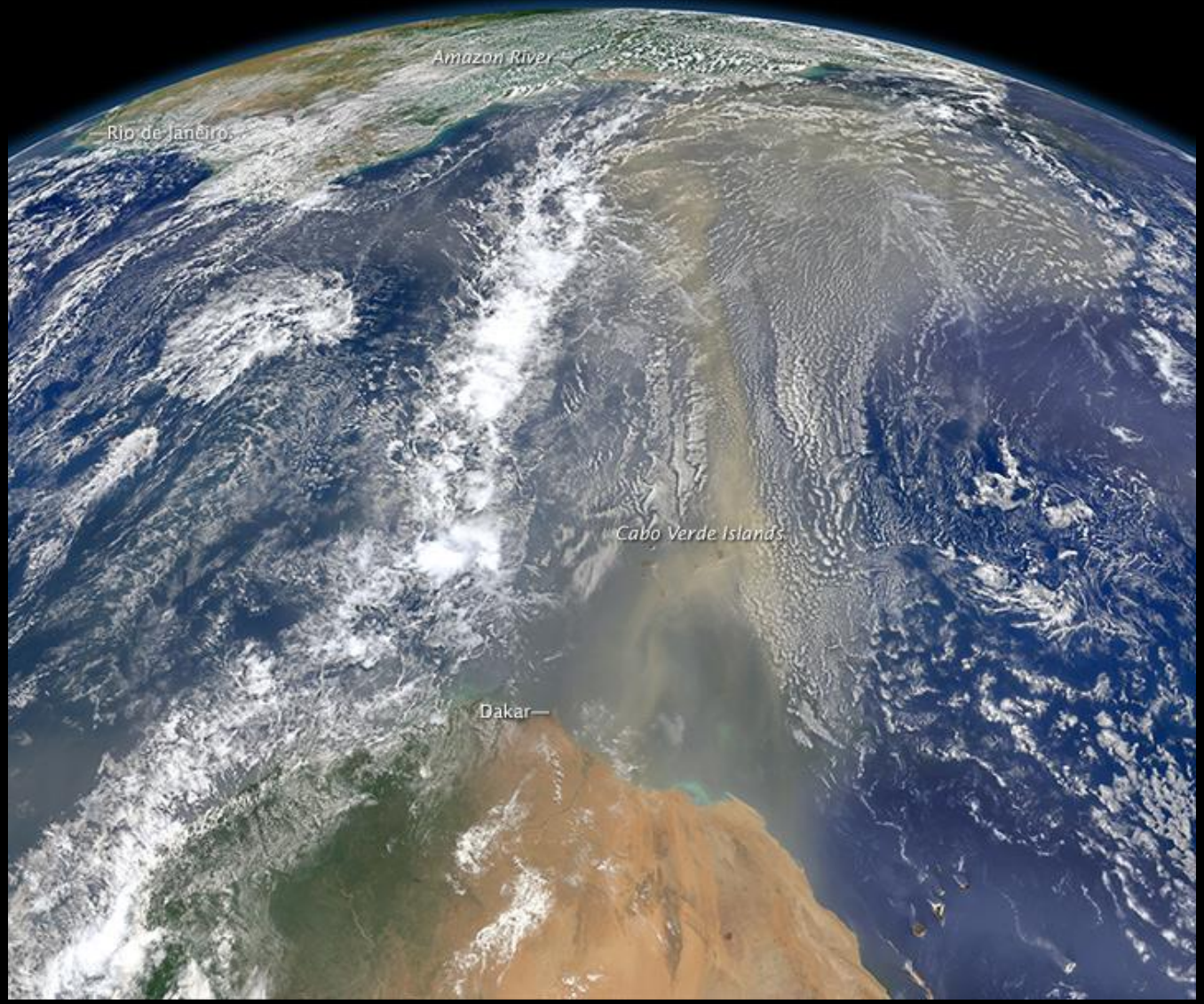
Radiance at 360.8nm, Watts/cm^2/nm/sr

0 49 98 147 197 246 295


61.4 96.7 132 167.3 202.7 238 273.3 308.6 343.9 379.2 414.5 449.8 485.1 520.4 555.7 591 626.3 661.6 696.9 732.2 767.6 802.9 838.2 873.5
Watts per square meter

Raytheon

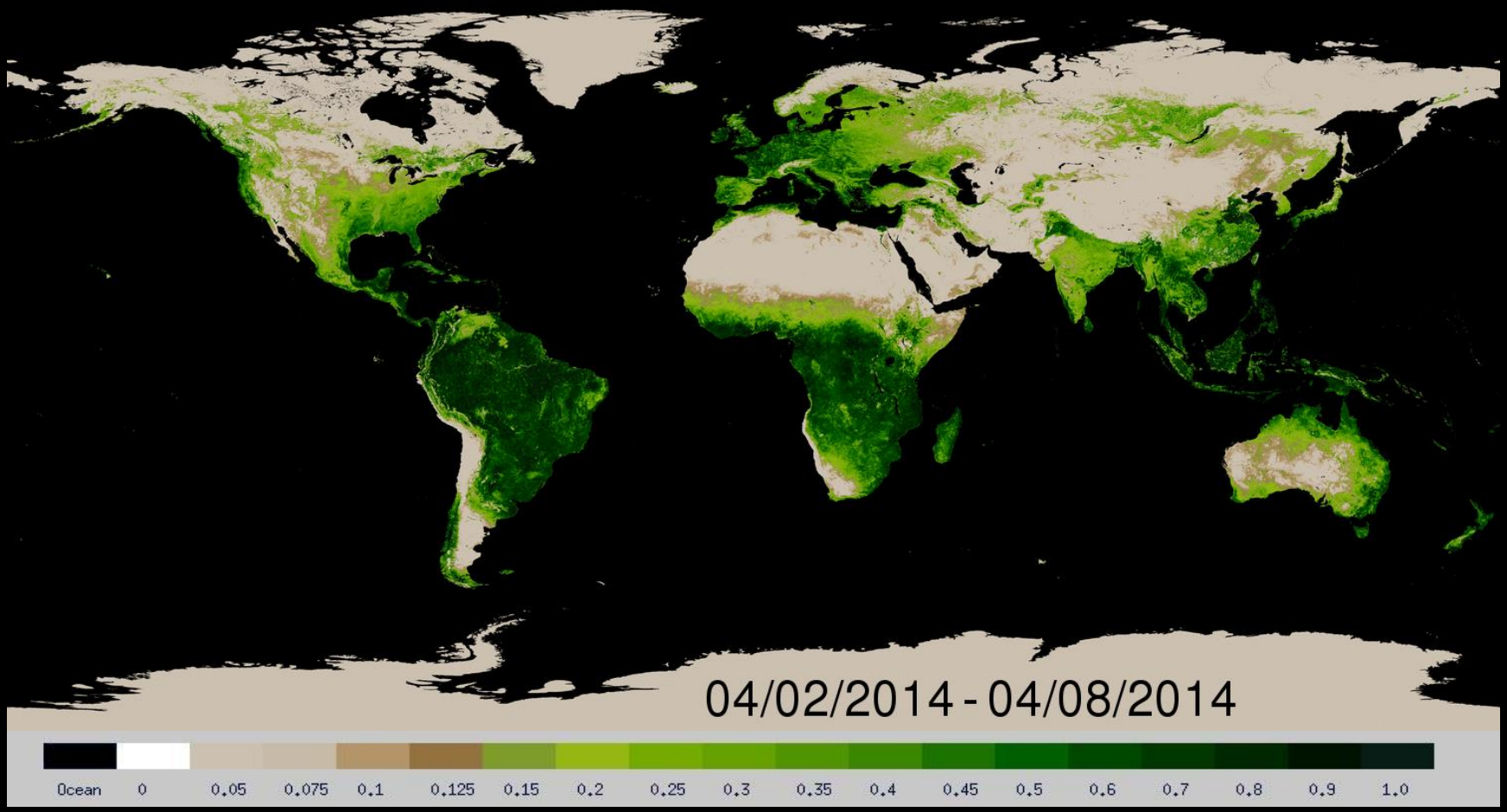




On June 23 2014, a lengthy river of dust from western Africa began to push across the Atlantic Ocean on easterly winds. A week later, the influx of dust was affecting air quality as far away as the southeastern United States. This composite image, made with data from the Visible Infrared Imaging Radiometer Suite (VIIRS) on Suomi NPP, shows dust heading west toward South America and the Gulf of Mexico on June 25, 2014

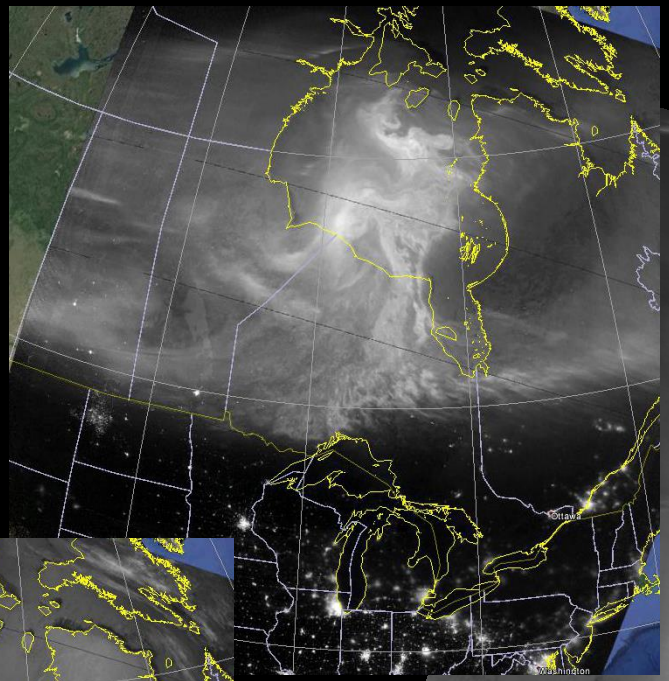
Green Vegetation Fraction

Weekly GVF from Apr 8 2014 to Oct 28 2014

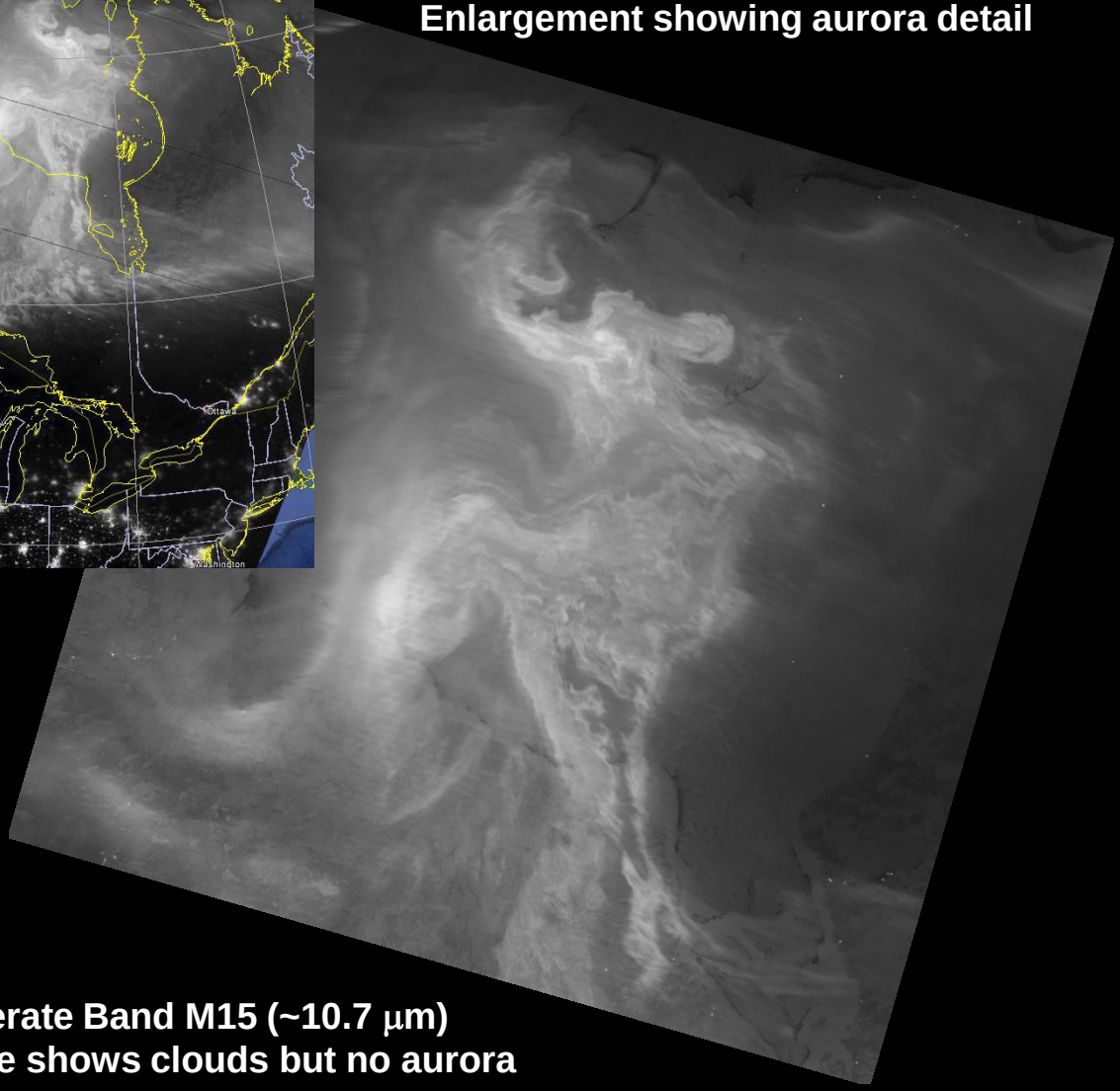


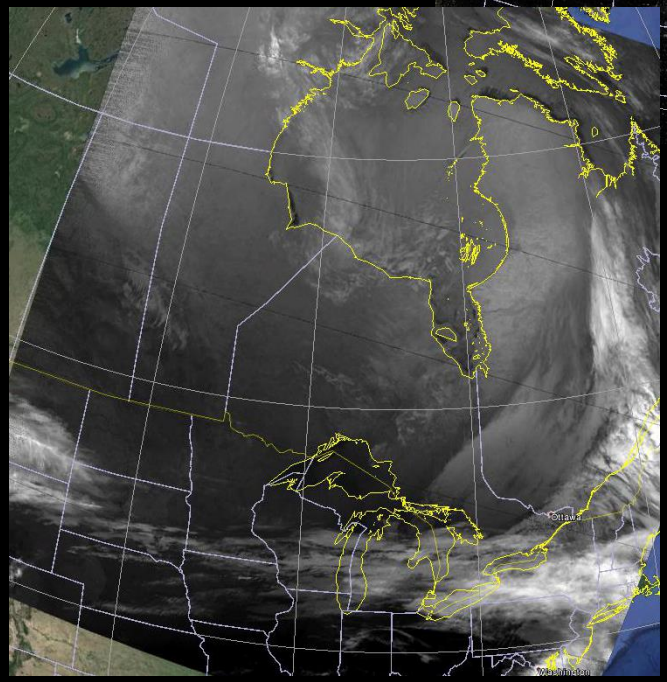
Aurora imaged by S-NPP during Geomagnetic Storm 17 March 2015 ~0800 GMT

Day-Night Band M15 (0.5 – 0.9 μm) Image shows portion of auroral oval



Day-Night Band M15 (0.5 – 0.9 μm) Image Enlargement showing aurora detail

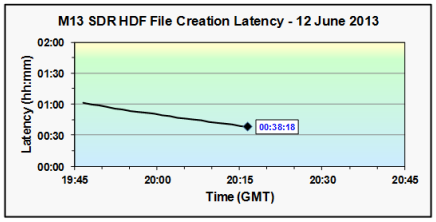




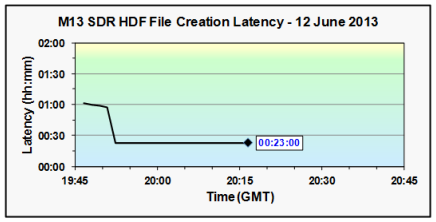
Moderate Band M15 (~10.7 μm) Image shows clouds but no aurora

Granule ID: NPP000517401942
Observation Beginning: 20:16:33.254Z
Observation Ending: 20:17:57.429Z

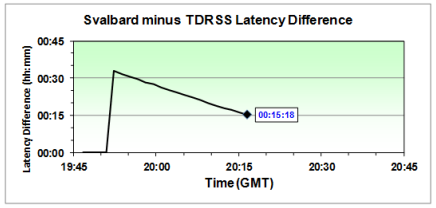
Svalbard Latency: 00:38:18

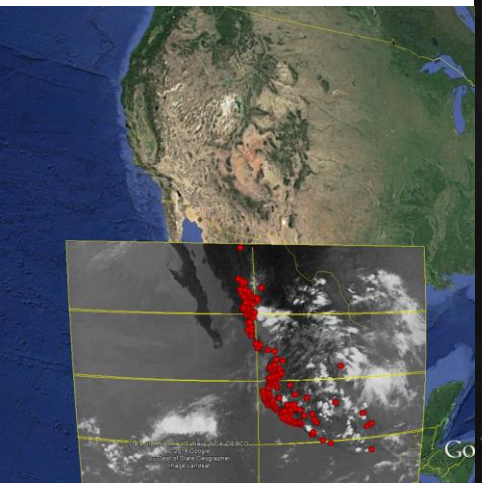


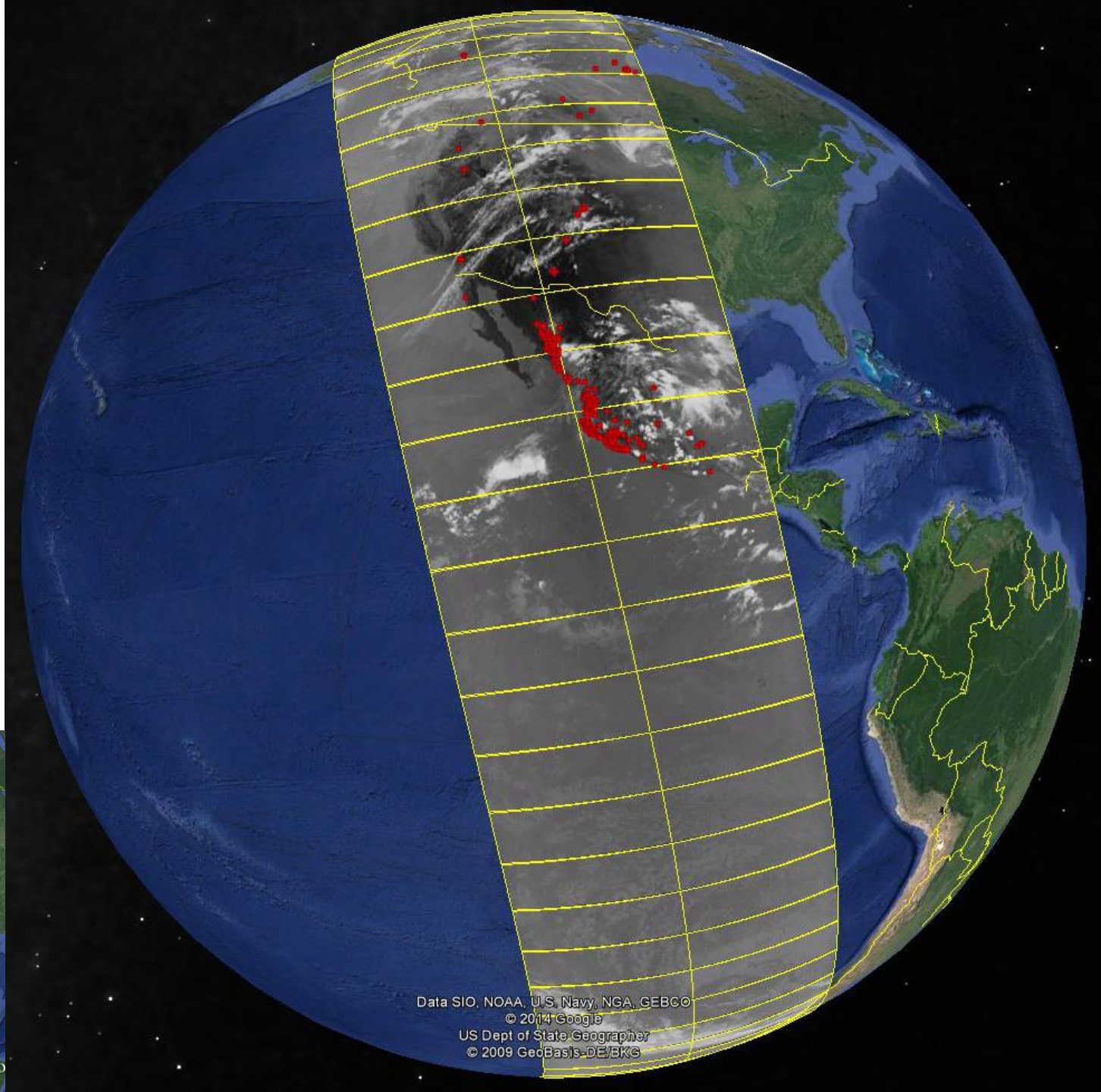
TDRSS Latency: 00:23:00

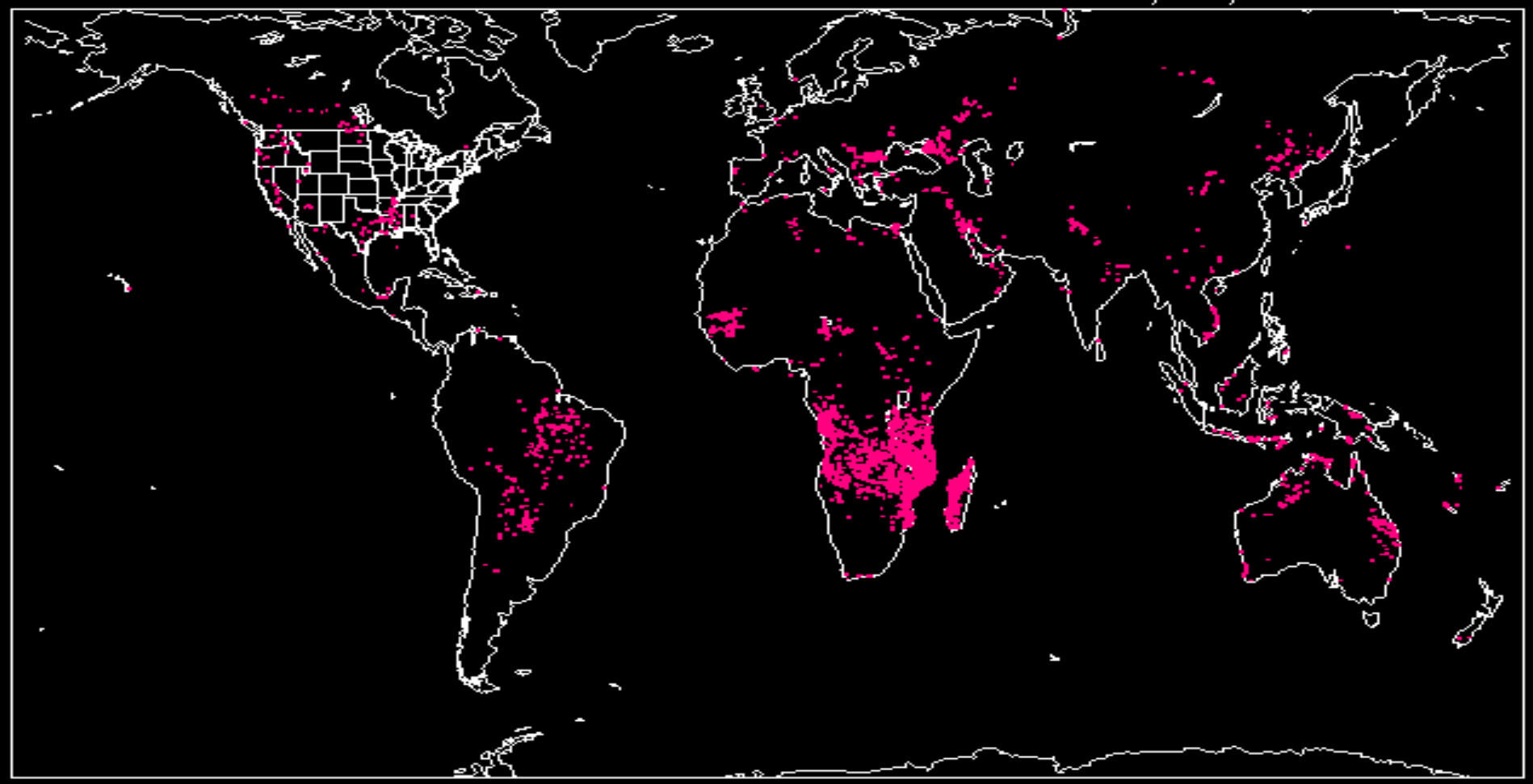


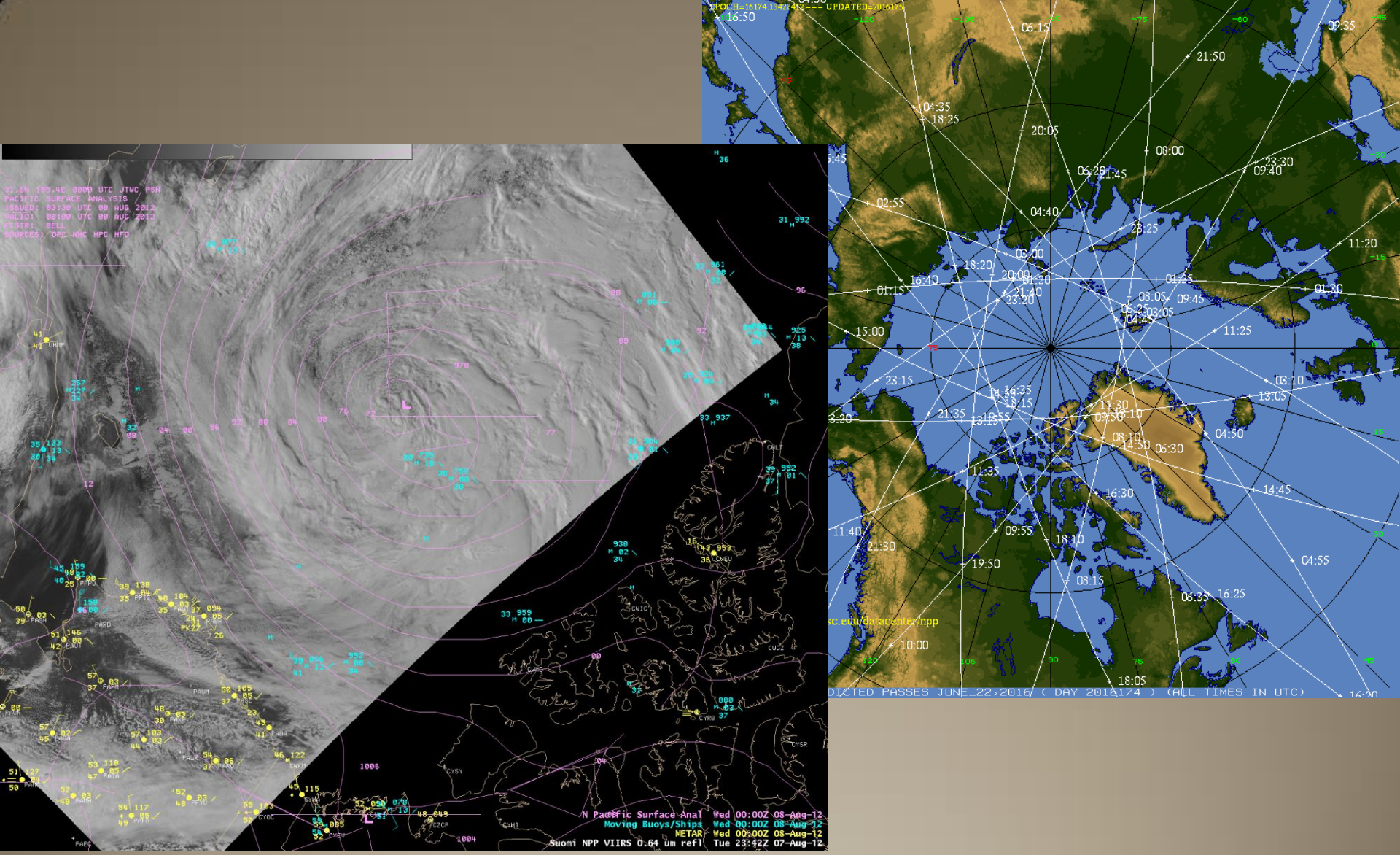
Svalbard – TDRSS Latency Difference: 00:15:18







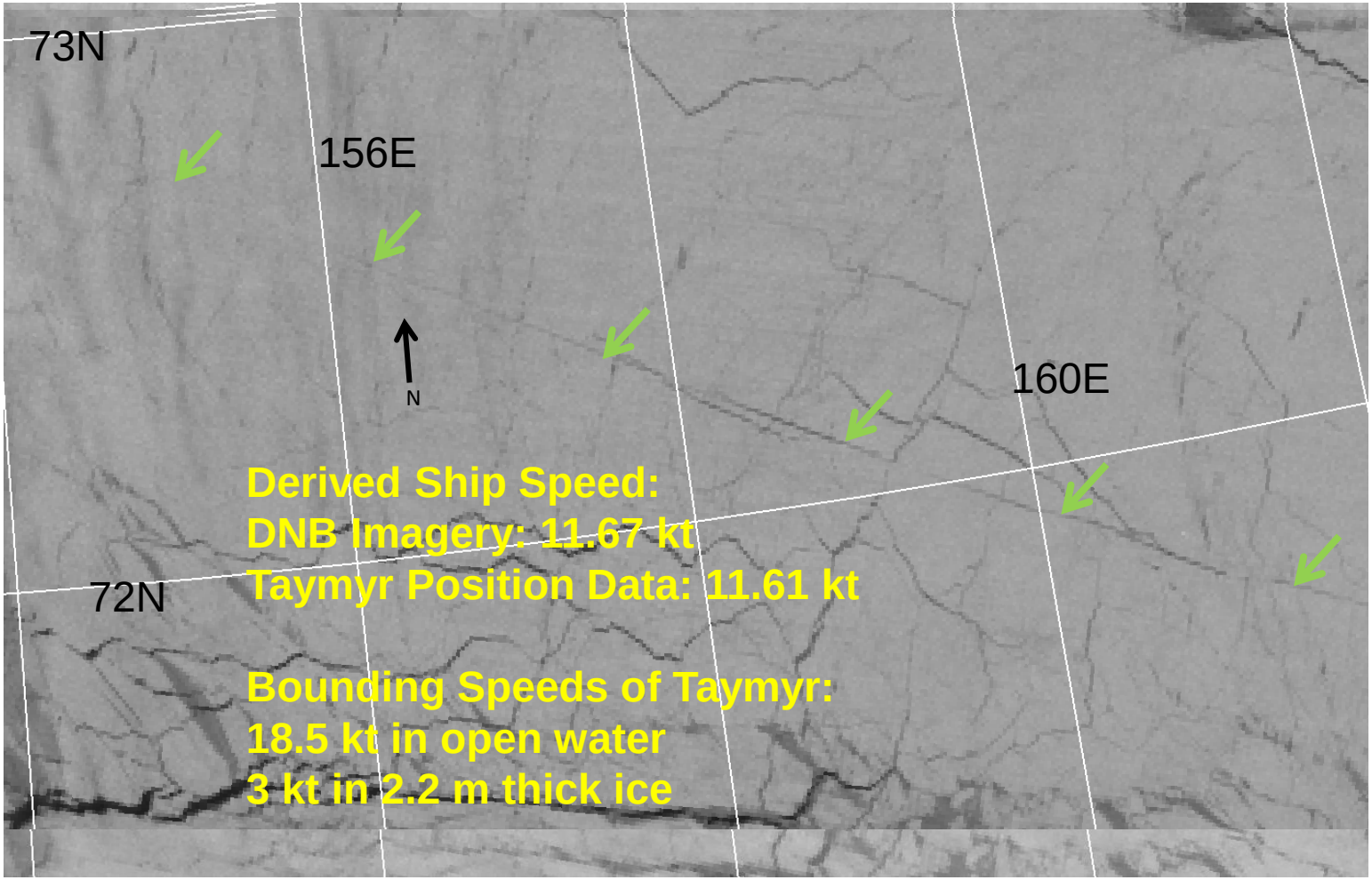

VIIRS M-Band Fire Positions Received 24 Hrs Before 10/05/2017 1621 Z

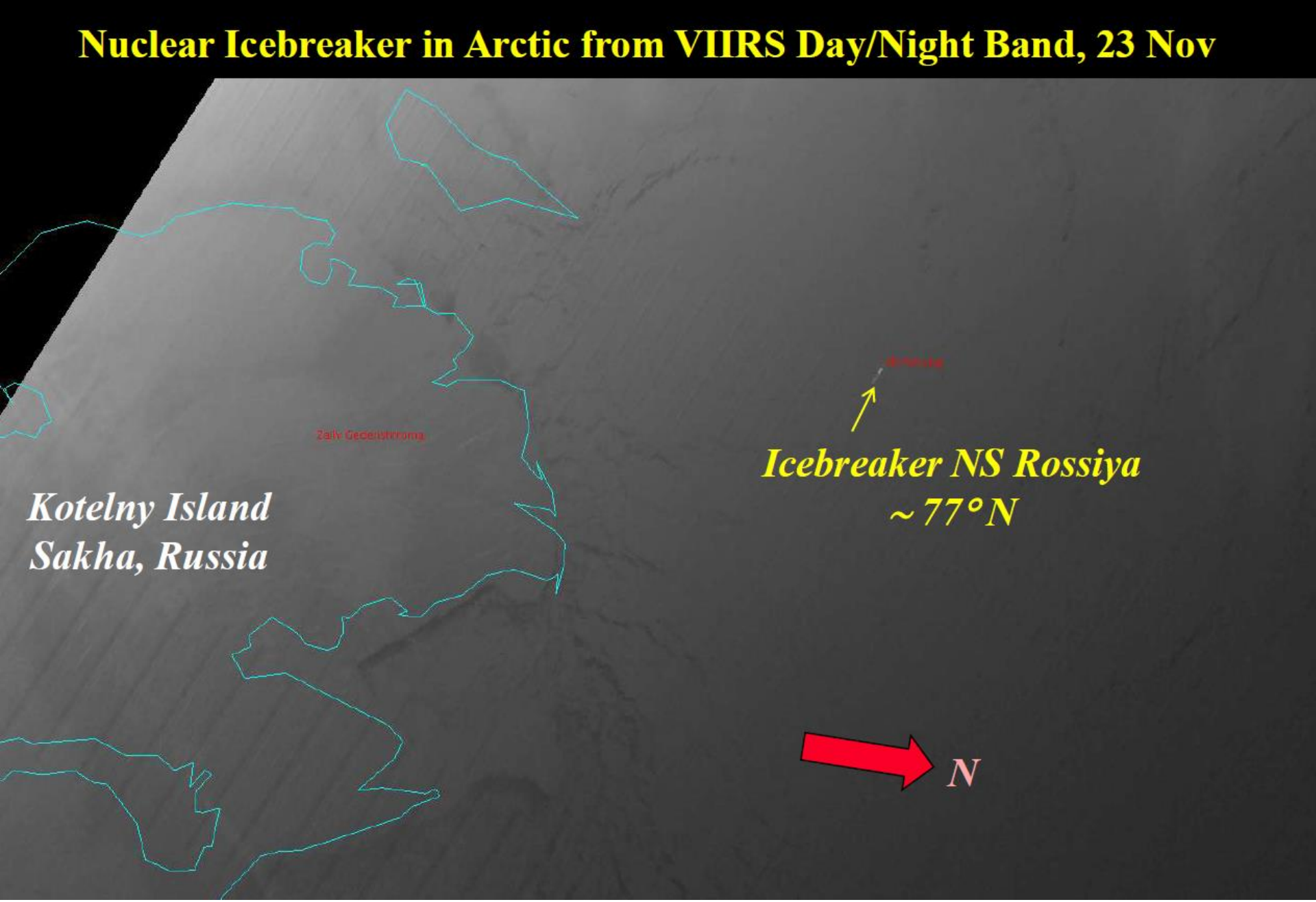


Entire Arctic Observed – including environmental data

Movement of Individual Ships

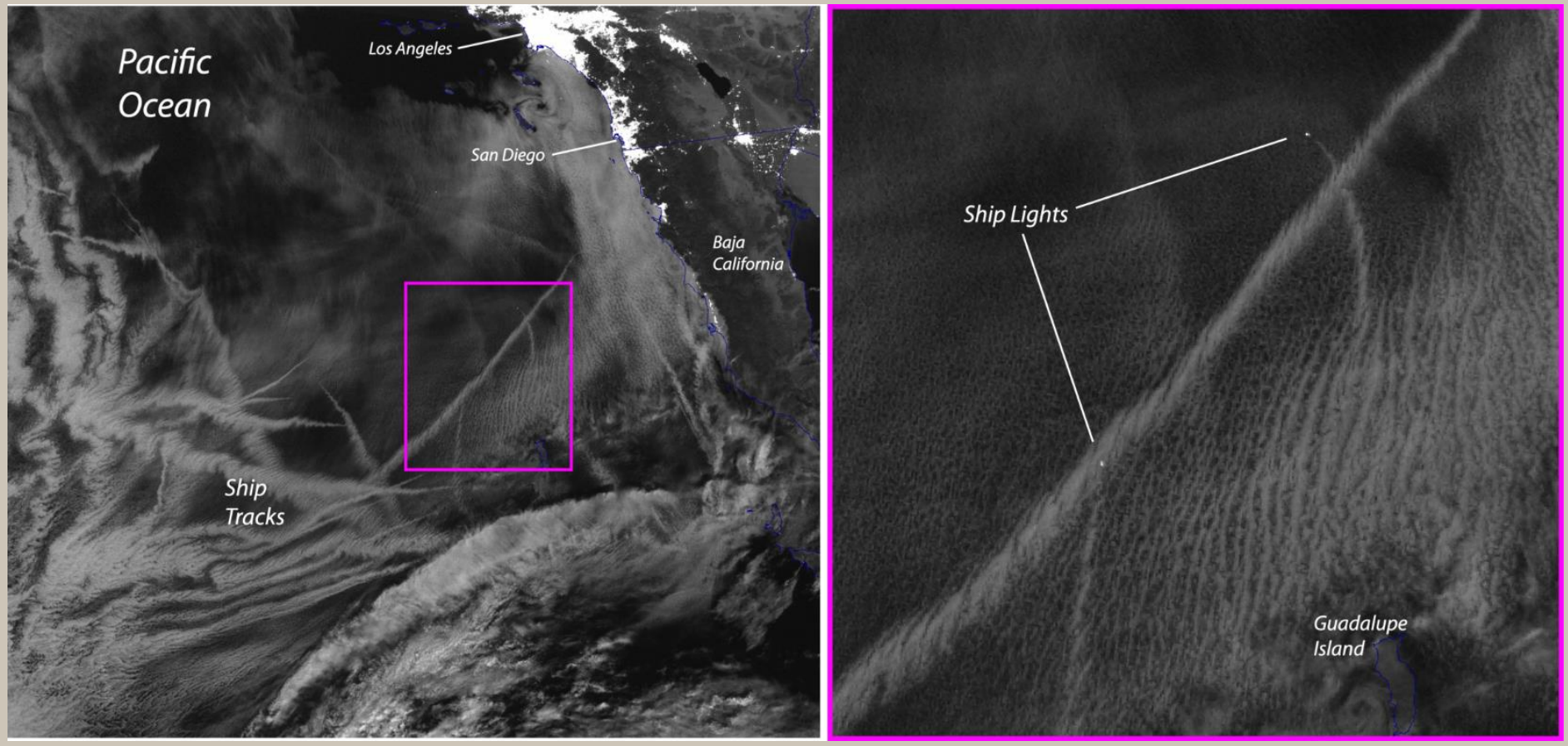
Taymyr Russian Icebreaker



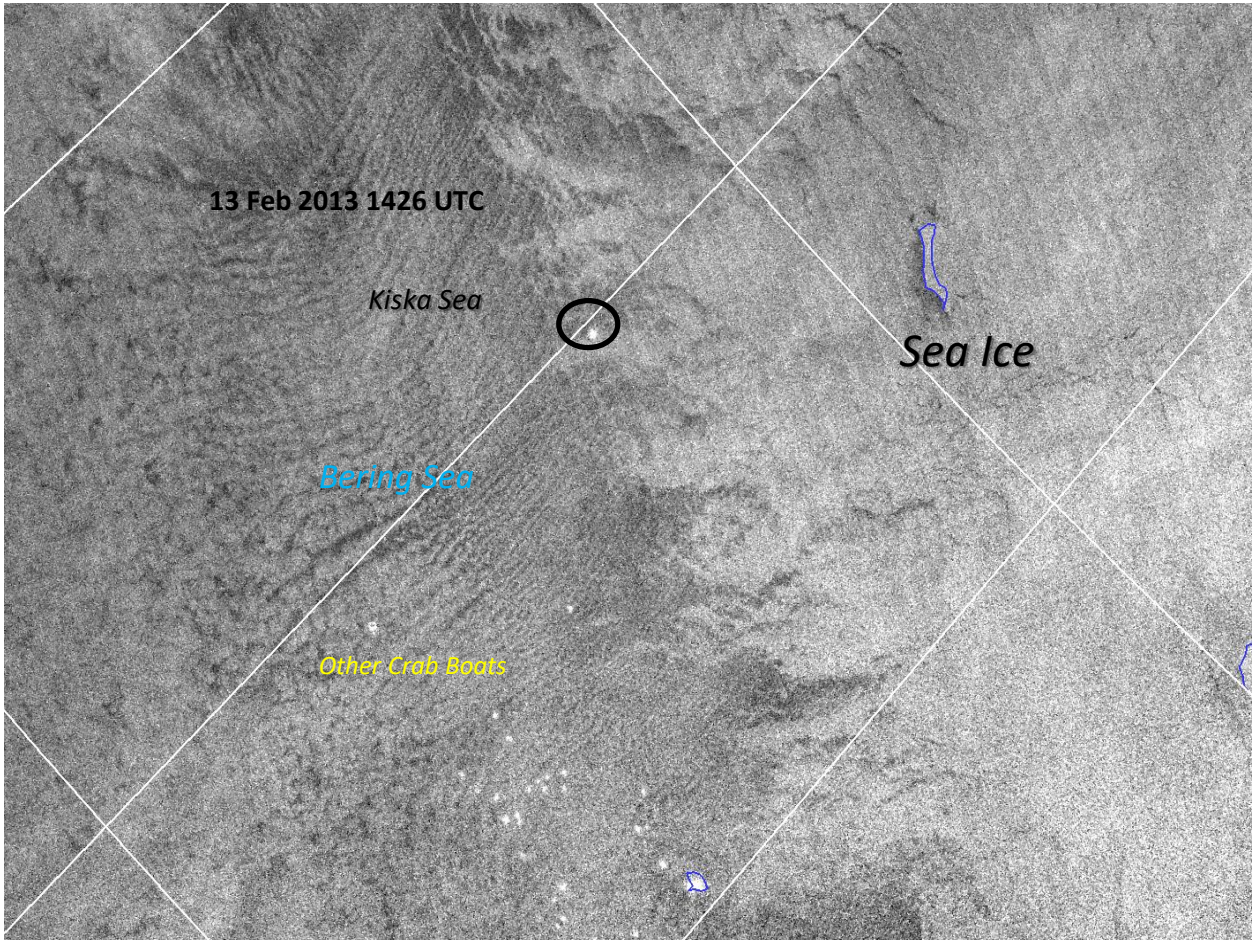


Another Russian Icebreaker (Rossiya)

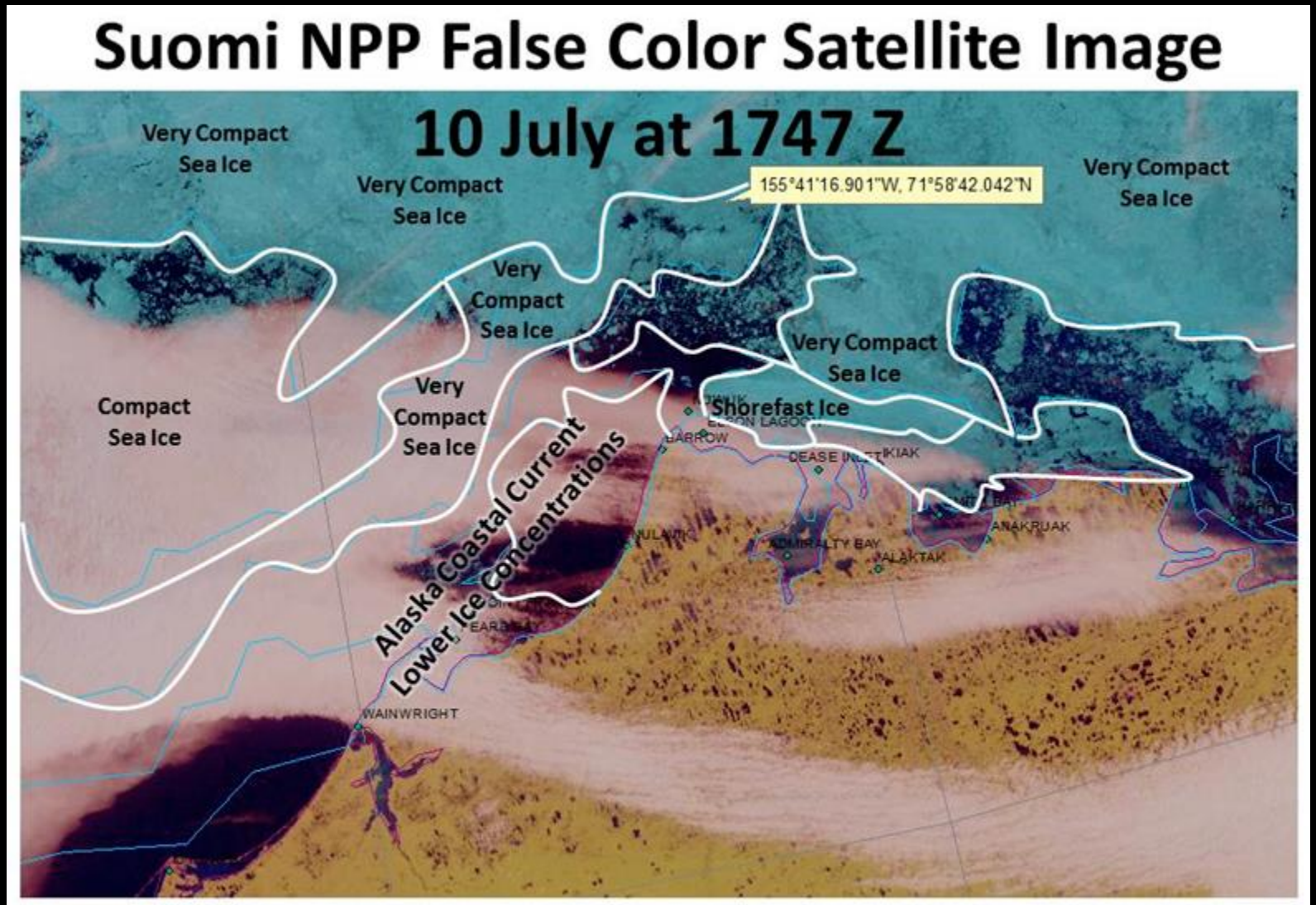
Tracking Ships at Night



Day/Night Band (DNB) to the Rescue!



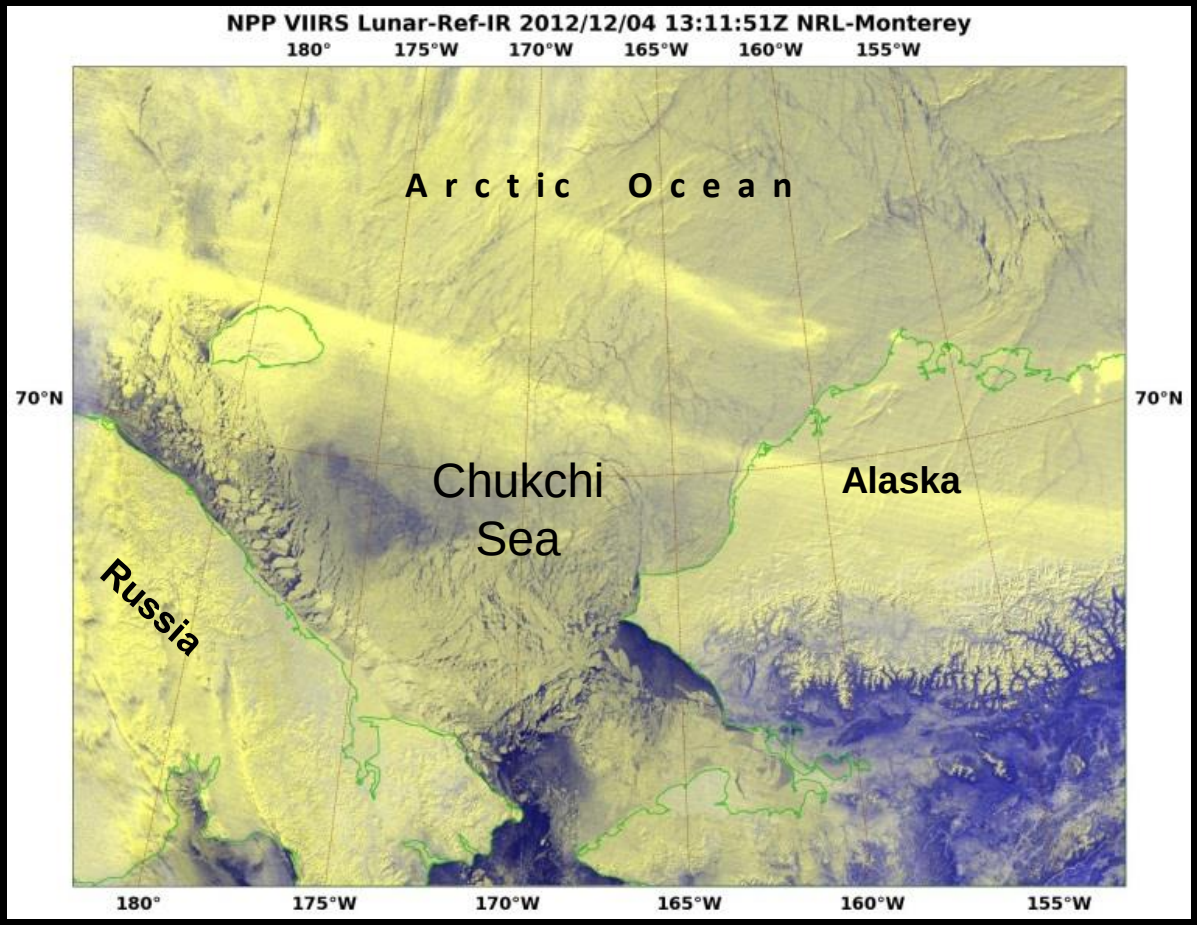
Rescue of Sailboat in Bering Sea



Used by AK Ice Desk to help Coast Guard respond to mayday call received

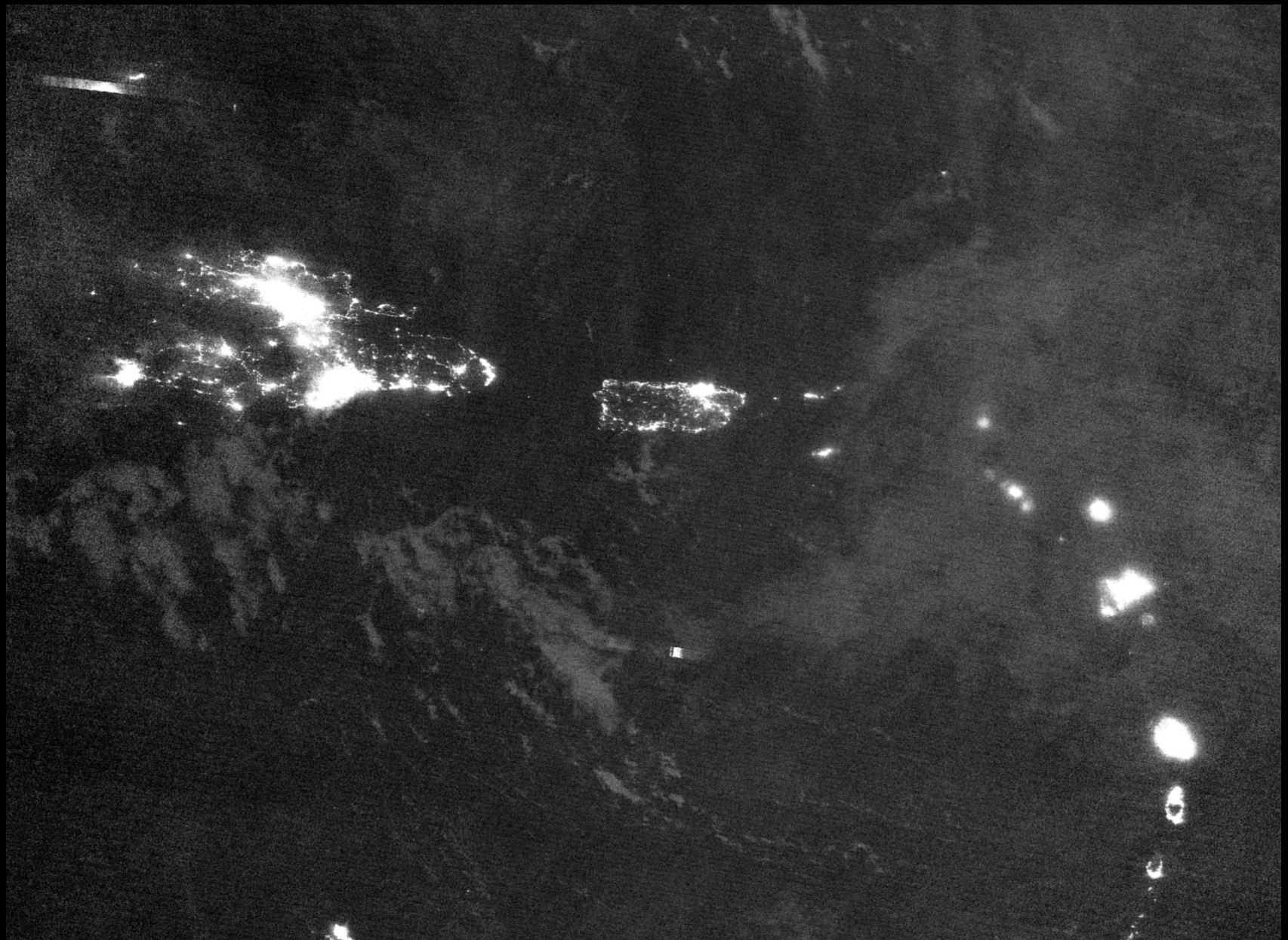
Nighttime Sea Ice Monitoring

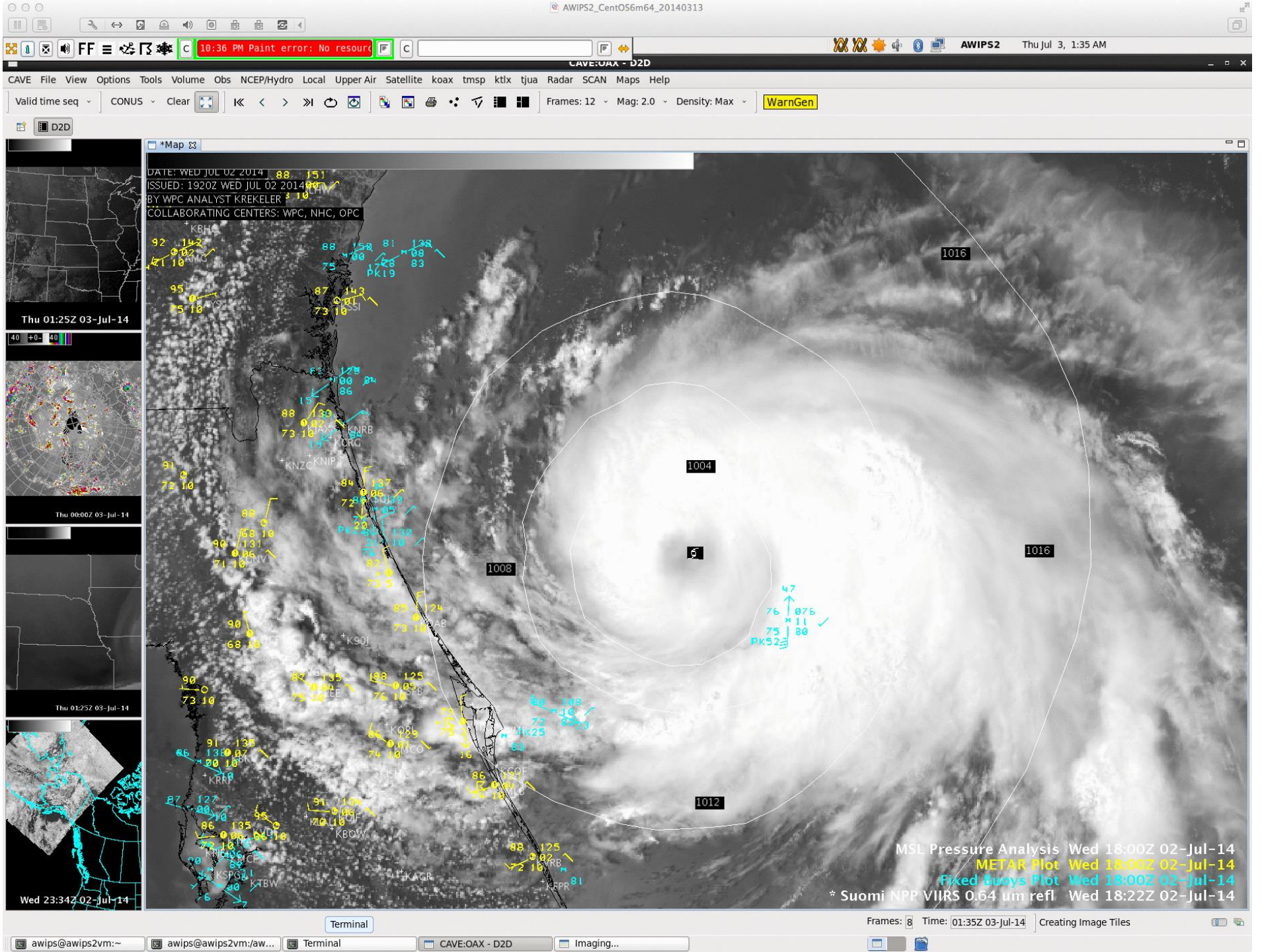
11/27 – 12/04, Lunar cycle > 3/4



DNB (low light visible) - Nighttime during Full Moon

Hurricane Maria
Impact (via light) in Puerto Rico [VIIRS DNB]

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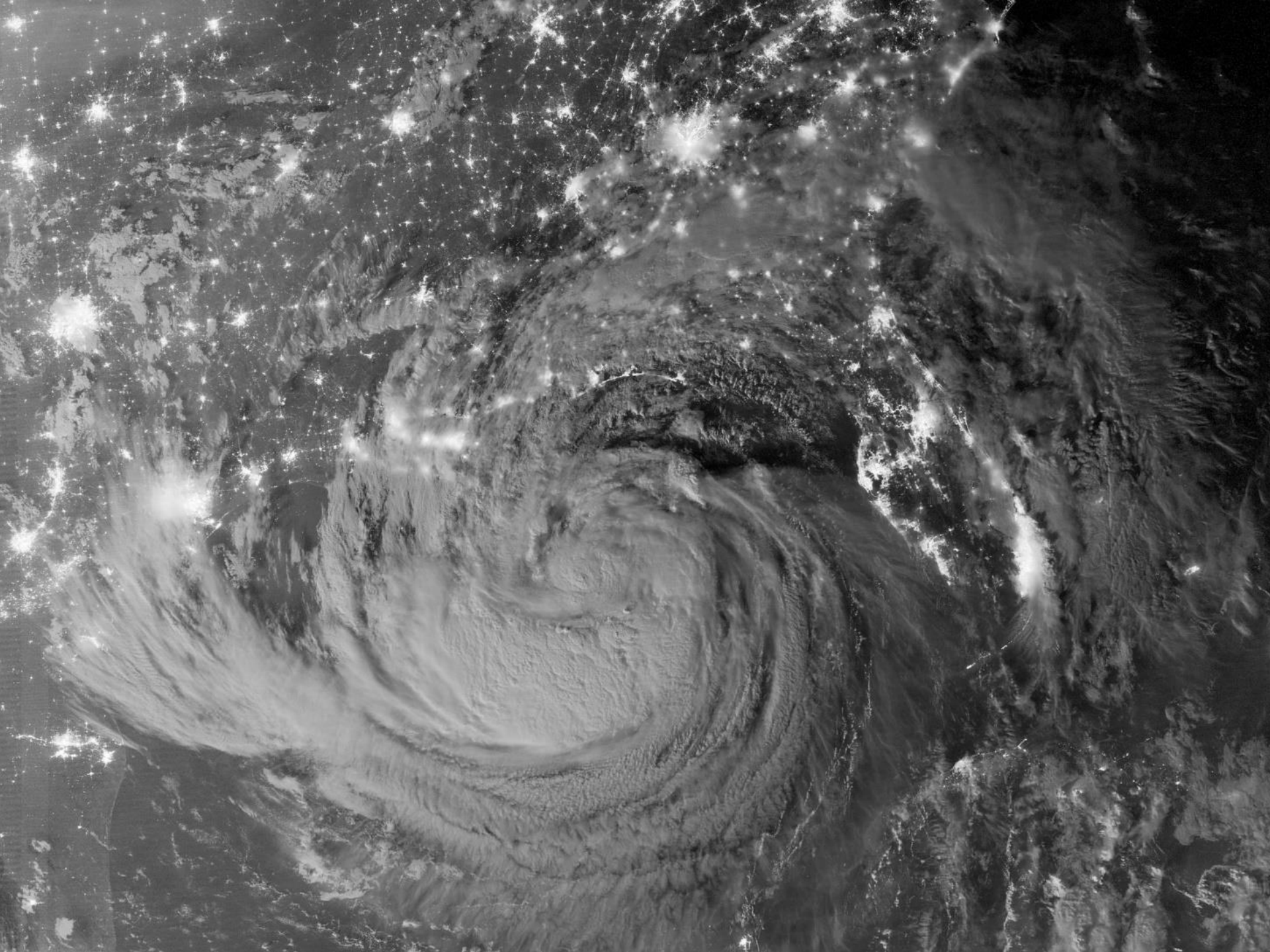
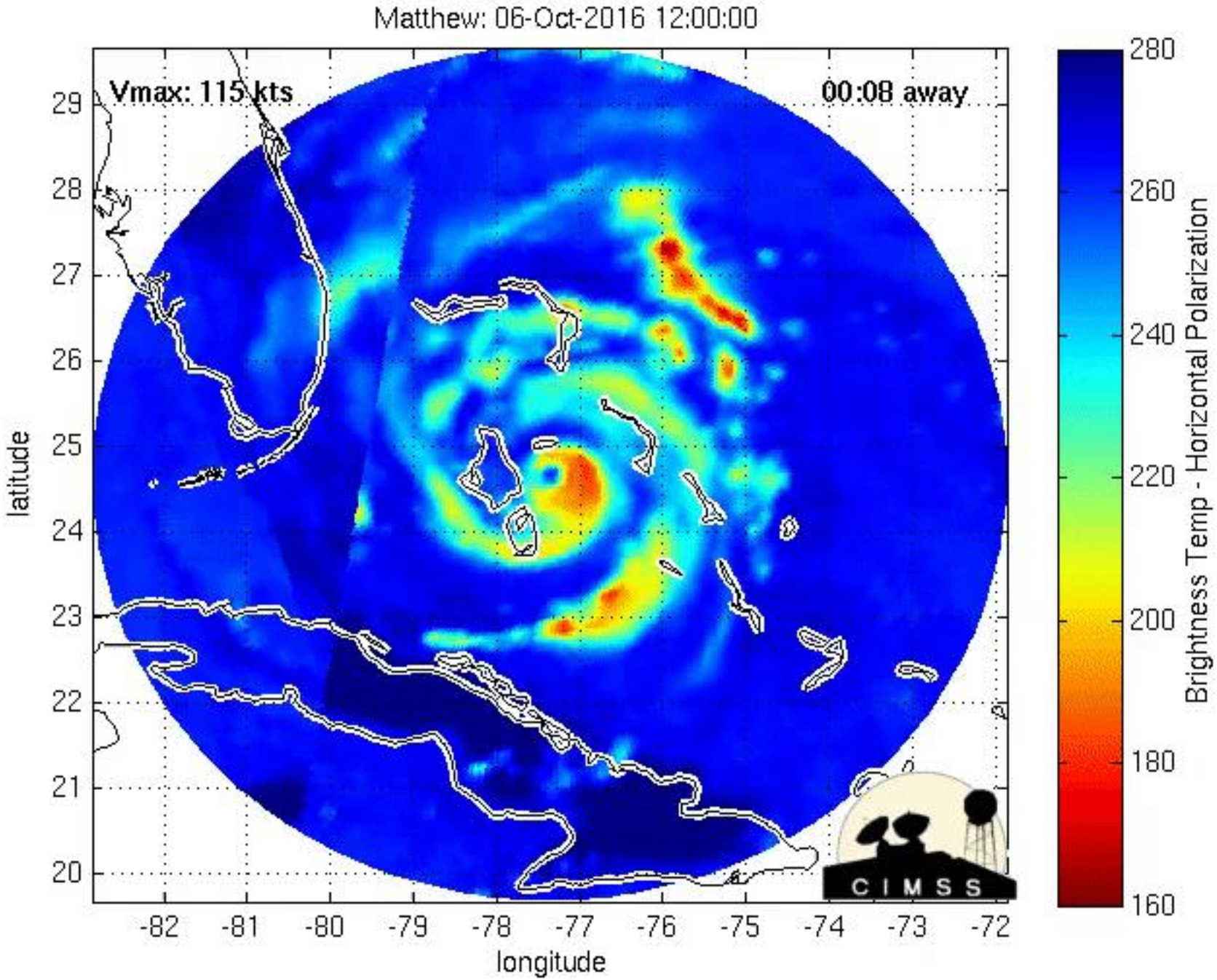
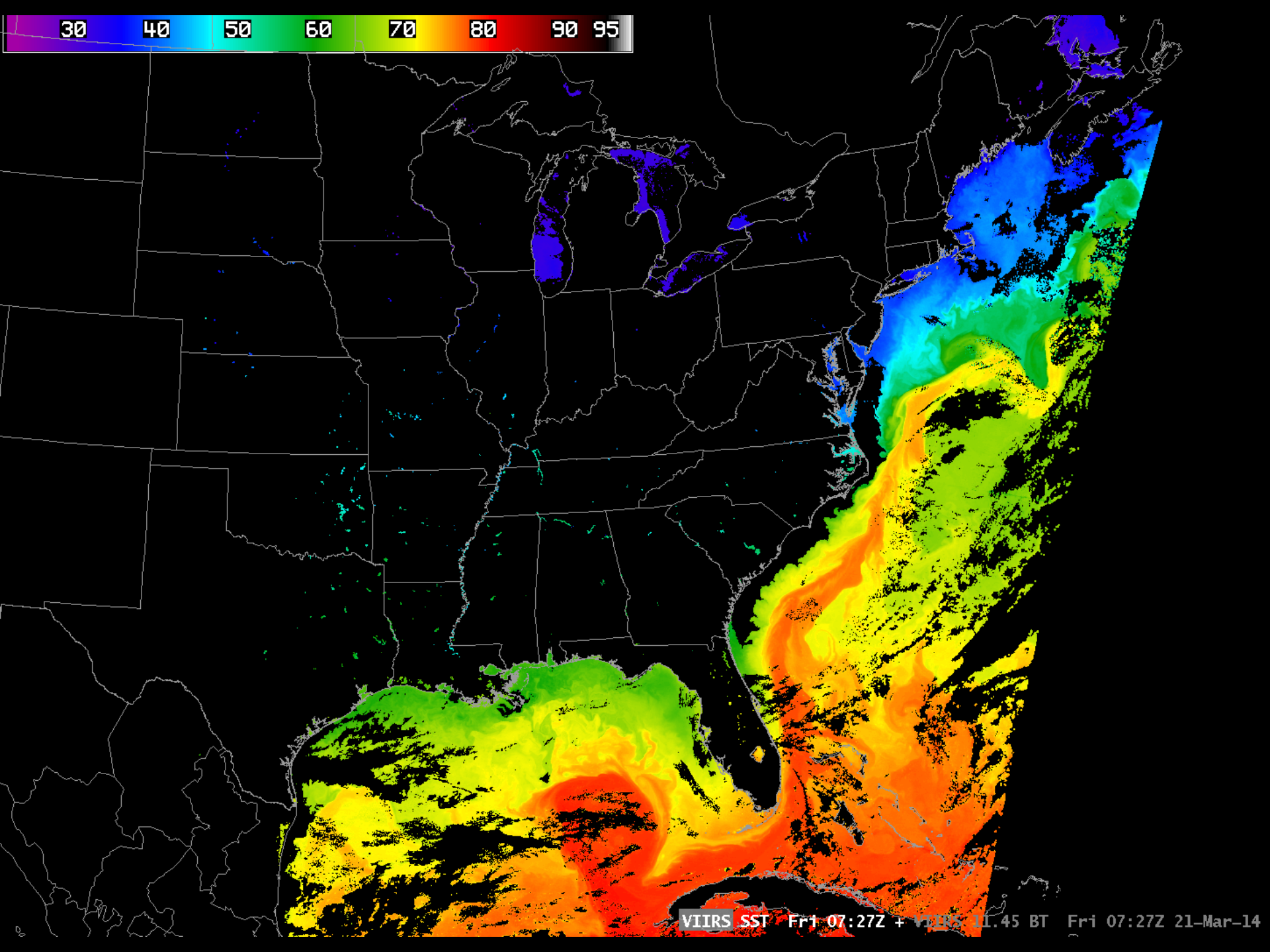
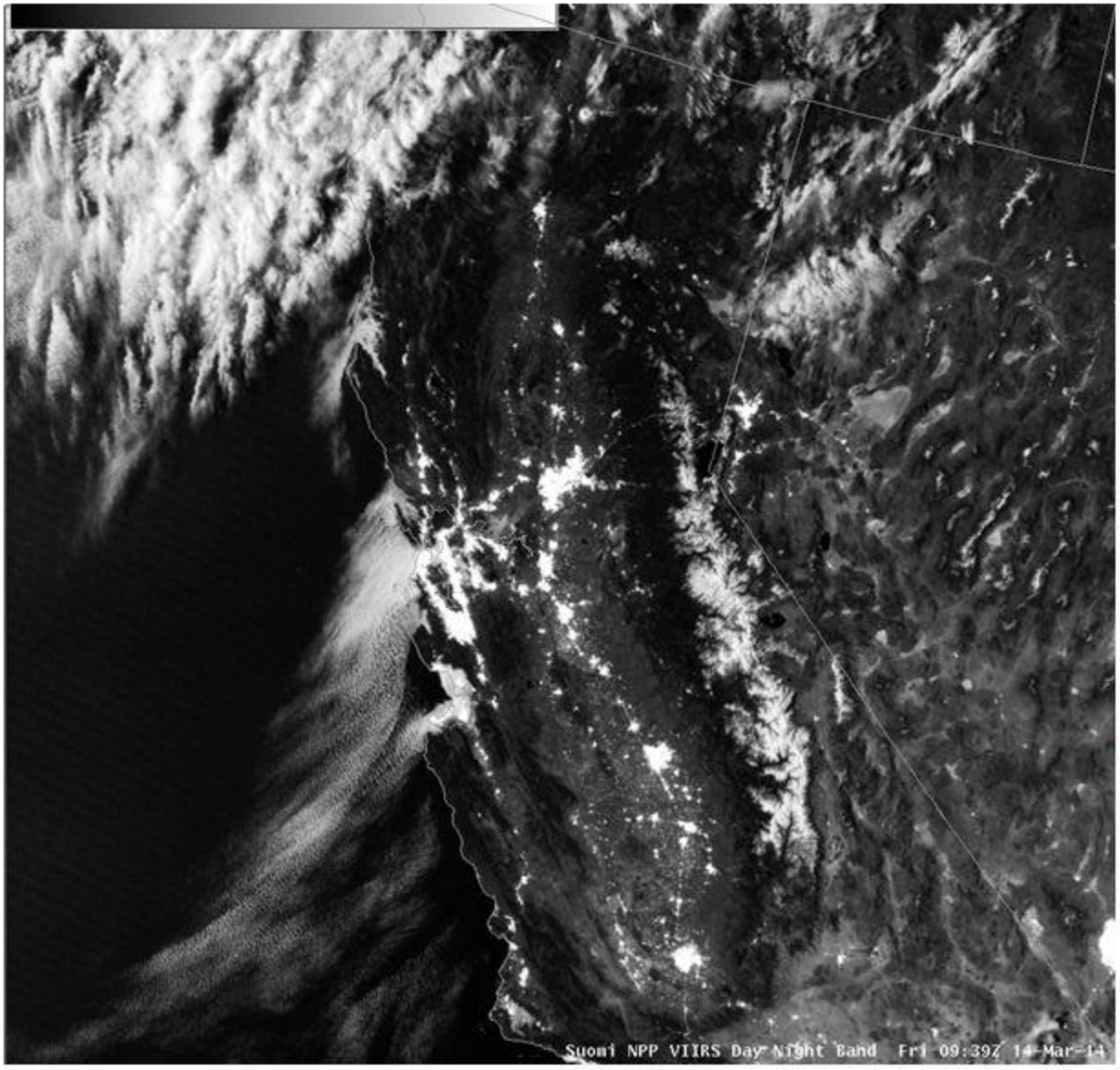
10:36 PM Paint error: No resourc
AWIPS2
Thu Jul 3, 1:35 AM
CAVE:OAX - D2D
CAVE File View Options Tools Volume Obs NCEP/Hydro Local Upper Air Satellite koax tmsp ktlx tjua Radar SCAN Maps Help
Valid time seq
CONUS
Clear
Frames: 12
Mag: 2.0
Density: Max
WarnGen
D2D
*Map
DATE: WED JUL 02 2014
ISSUED: 1920Z WED JUL 02 2014
BY WPC ANALYST KREKELER
COLLABORATING CENTERS: WPC, NHC, OPC
1016
1004
1008
1016
1012
Thu 01:25Z 03-Jul-14
Thu 00:00Z 03-Jul-14
Thu 01:25Z 03-Jul-14
Wed 23:34Z 02-Jul-14
MSL Pressure Analysis Wed 18:00Z 02-Jul-14
METAR Plot Wed 18:00Z 02-Jul-14
Fixed Buoys Plot Wed 18:00Z 02-Jul-14
* Suomi NPP VIIRS 0.64 um refl Wed 18:22Z 02-Jul-14
Terminal
Frames: 8
Time: 01:35Z 03-Jul-14
Creating Image Tiles
awips@awips2vm:~
awips@awips2vm:/aw...
Terminal
CAVE:OAX - D2D
Imaging...




Matthew: 06-Oct-2016 12:00:00
Vmax: 115 kts
00:08 away
latitude
longitude
29
28
27
26
25
24
23
22
21
20
-82
-81
-80
-79
-78
-77
-76
-75
-74
-73
-72
CIMSS
Brightness Temp - Horizontal Polarization
280
260
240
220
200
180
160


30 40 50 60 70 80 90 95
VIIRS SST Fri 07:27Z + VIIRS 11.45 BT Fri 07:27Z 21-Mar-14

Low Cloud/ Fog Seen by VIIRS DNB at Night



AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE SAN FRANCISCO BAY AREA
443 AM PDT FRI MAR 14 2014

.DISCUSSION...AS OF 4:10 AM PDT FRIDAY...THE DRY TAIL END OF A WEATHER SYSTEM MOVING IN TO THE PACIFIC NORTHWEST IS APPROACHING OUR DISTRICT...AND RESULTING IN ENHANCEMENT OF THE MARINE LAYER AND ***A RETURN OF THE MARINE STRATUS. LATEST GOES FOG PRODUCT IMAGERY...AND IN RATHER SPECTACULAR DETAIL JUST REC'D SUOMI VIIRS NIGHTTIME HIGH RES VISUAL IMAGE...SHOW COVERAGE ALONG MUCH OF THE COAST FROM PT REYES SOUTH TO THE VICINITY OF THE MONTEREY PENINSULA...AND A BROAD SWATH EXTENDING INLAND ACROSS SAN FRANCISCO AND THROUGH THE GOLDEN GATE TO THE EAST BAY.*** LATEST BODEGA BAY AND FT ORD PROFILER DATA INDICATE A MARINE LAYER DEPTH OF ABOUT 1300 FT. SOME THIN HIGH CLOUDS ARE ALSO PASSING THROUGH ABOVE.

QUESTIONS?