Enterprise Resiliency at OSPO

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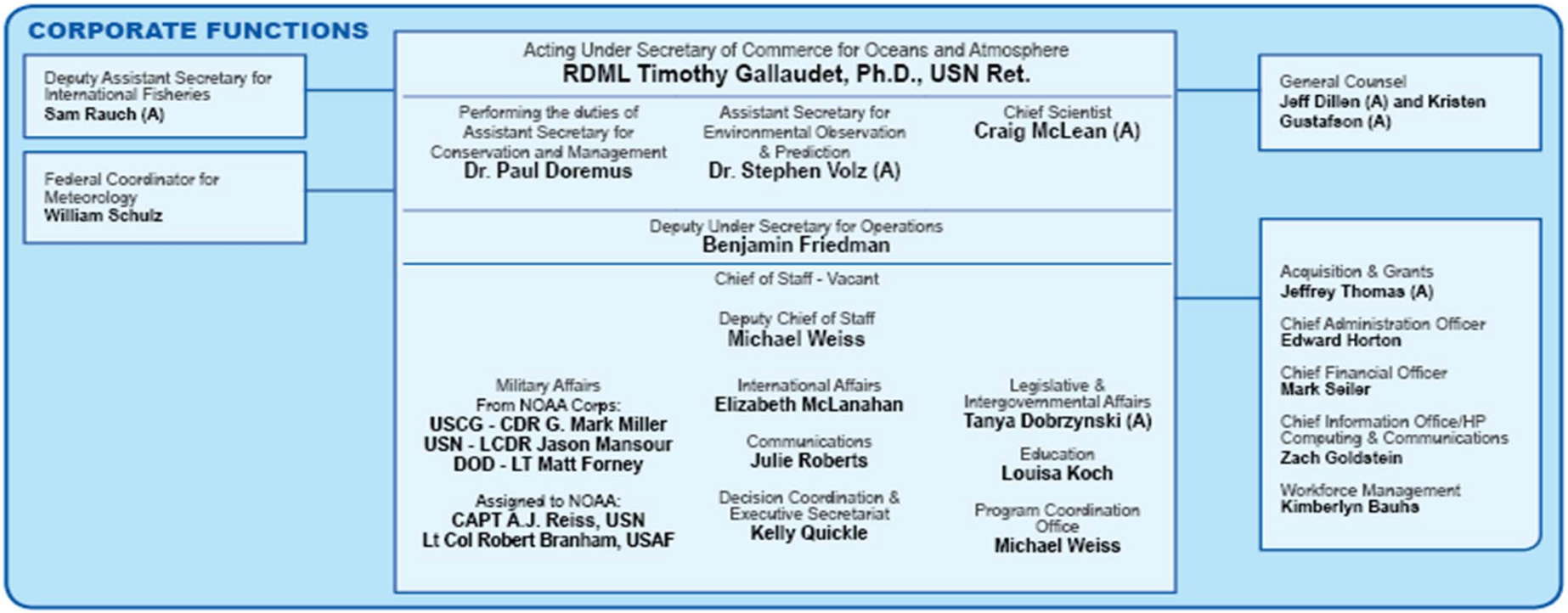
Resiliency is more than Systems

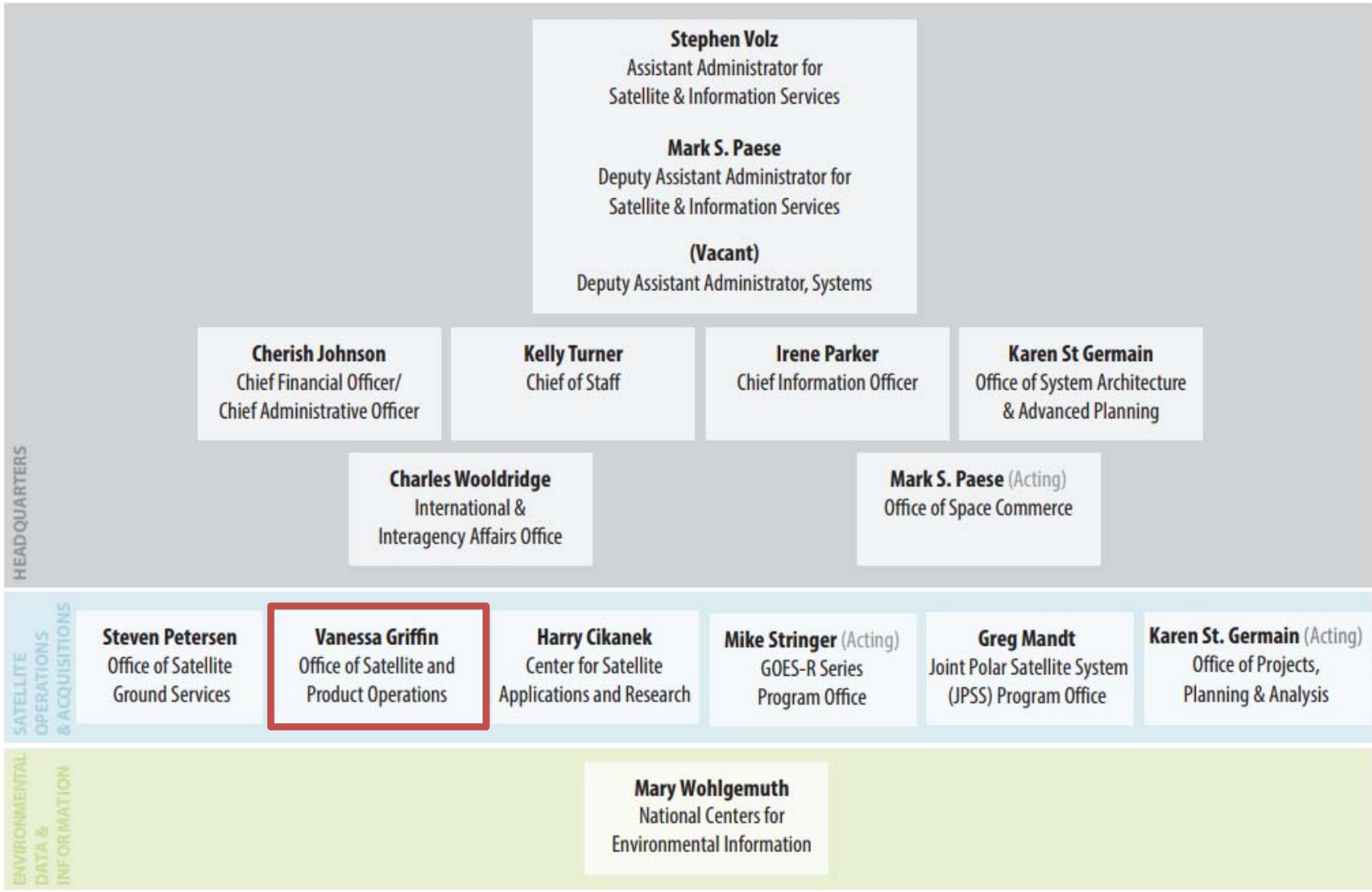
- Resilience of systems is necessary but not sufficient
- True resiliency is resilience of your entire enterprise
  - –Systems
  - –Networks
  - –People
  - –Partners
- I'm going to use the OSPO enterprise as an example

NOAA HEADQUARTERS ORGANIZATION



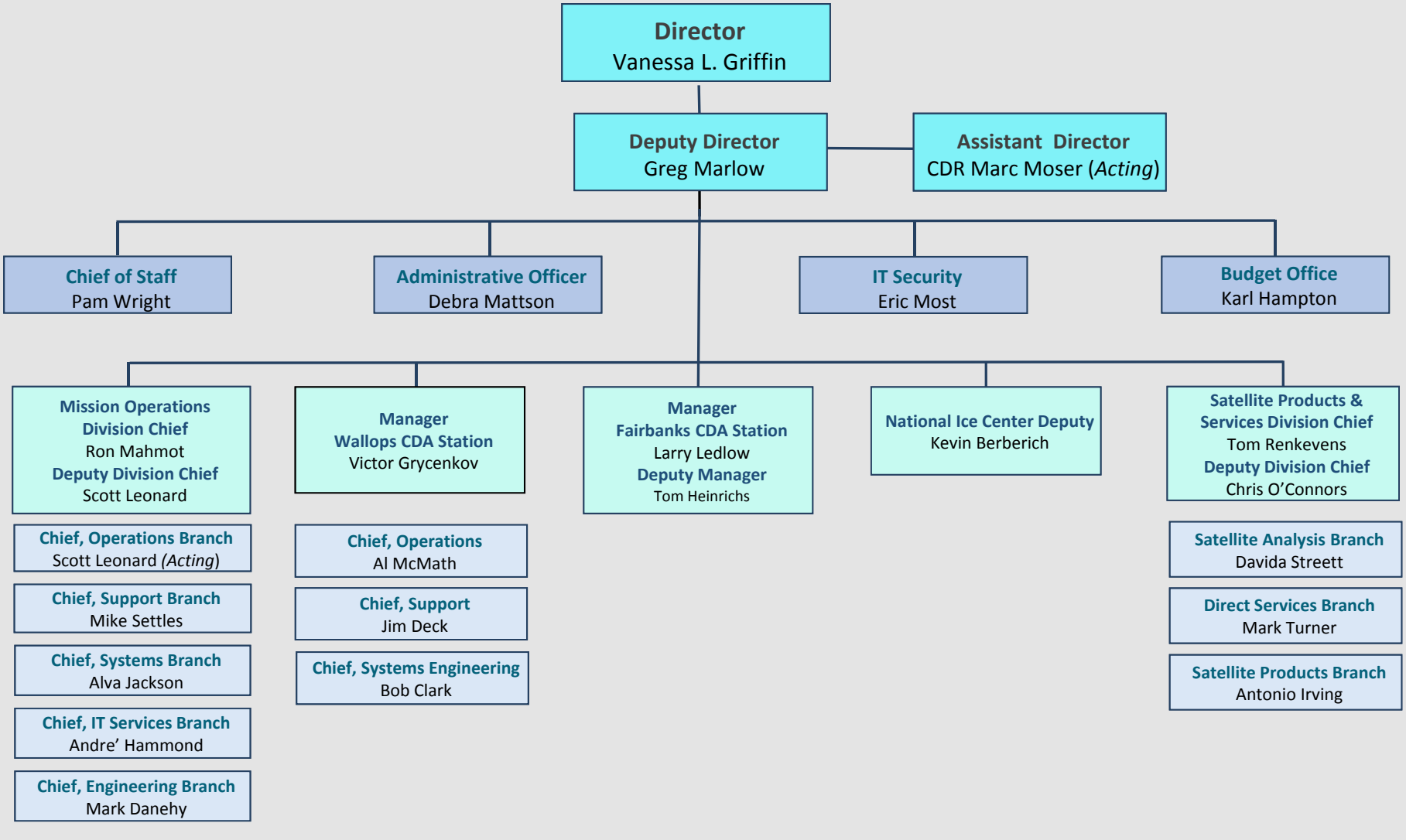
Key: (A) = Acting Last updated: 11/01/17

NOAA Satellite and Information Service Organizational Chart



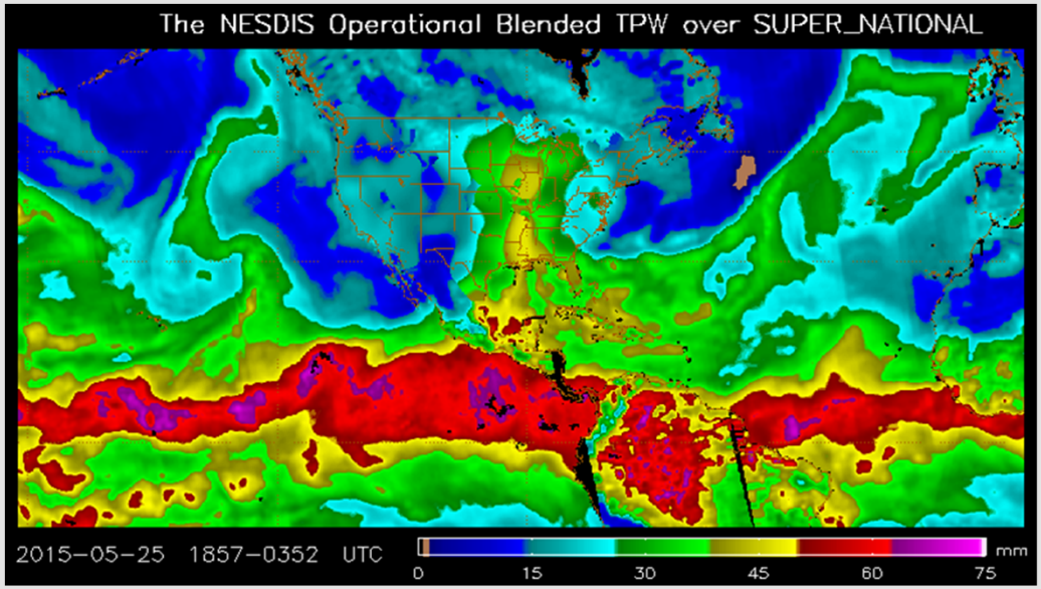
Revised: 06/15/2017

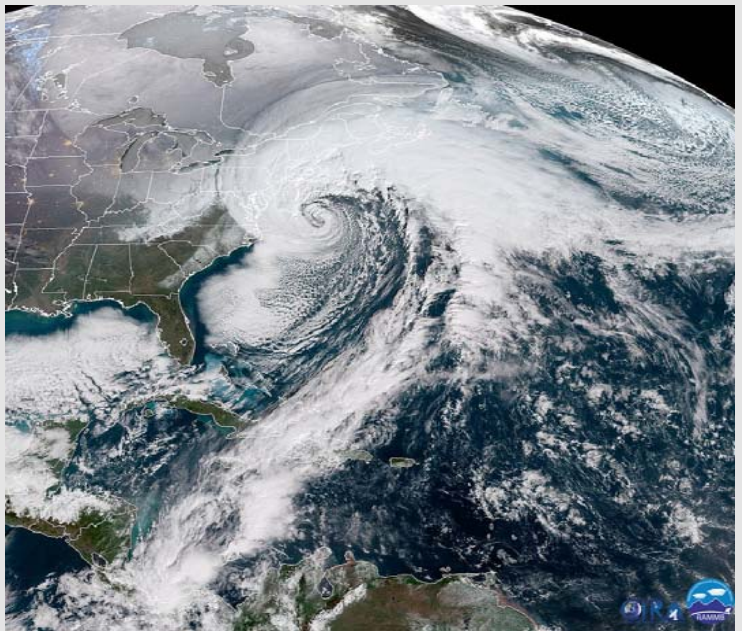
OSPO Organizational Chart



What – OSPO Mission

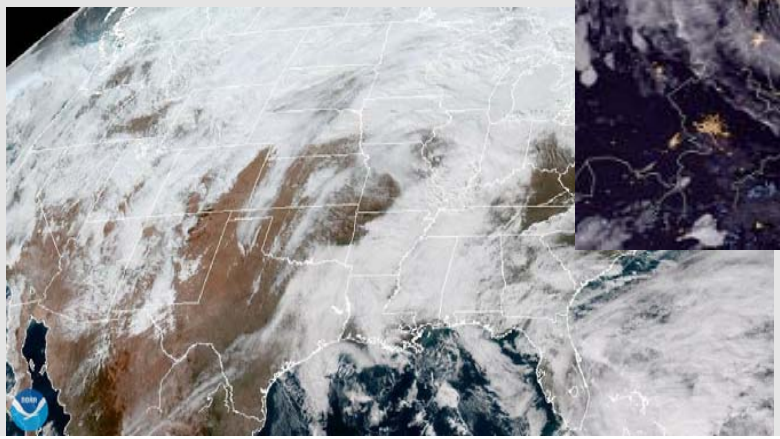
Mission: To acquire and deliver accurate, timely, and reliable satellite observations and integrated products

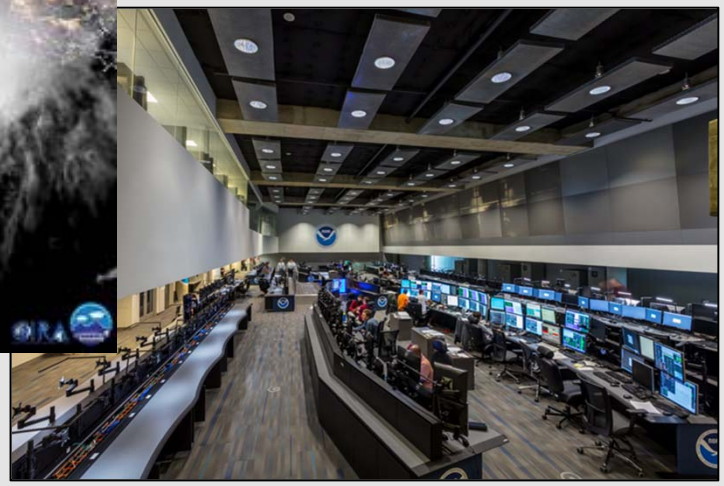




What – OSPO Functions

- Perform command and control of the Nation's operational weather satellites (for 9 NOAA satellites and 8 non-NOAA satellites)
- Operate ground based receptor sites for command & control, and for data acquisition and retransmission
- Produce derived products from satellite observations and distribute those to our stakeholders in near real-time and to the archive

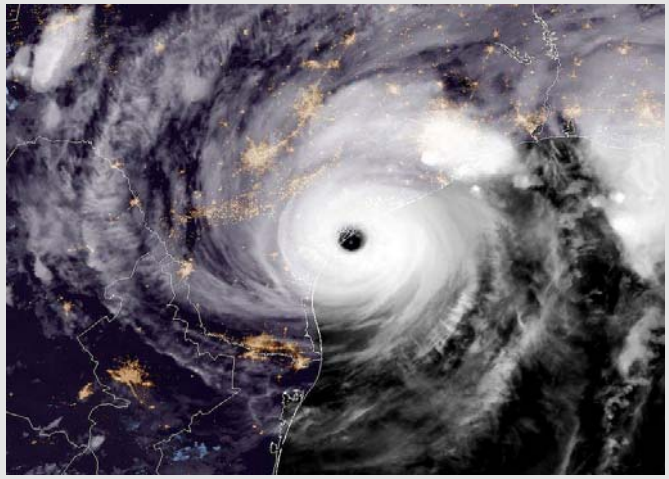




Why - Helping Protect the Nation

S-NPP Imagery of California and Oregon wild fires

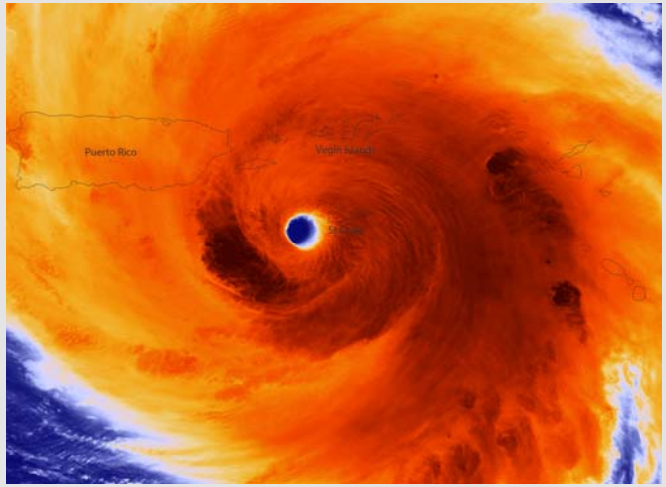
Weather satellites provide data critical to the accuracy and timeliness of the nation's weather forecasts and warnings.



GOES-16 Imagery of hurricane Harvey

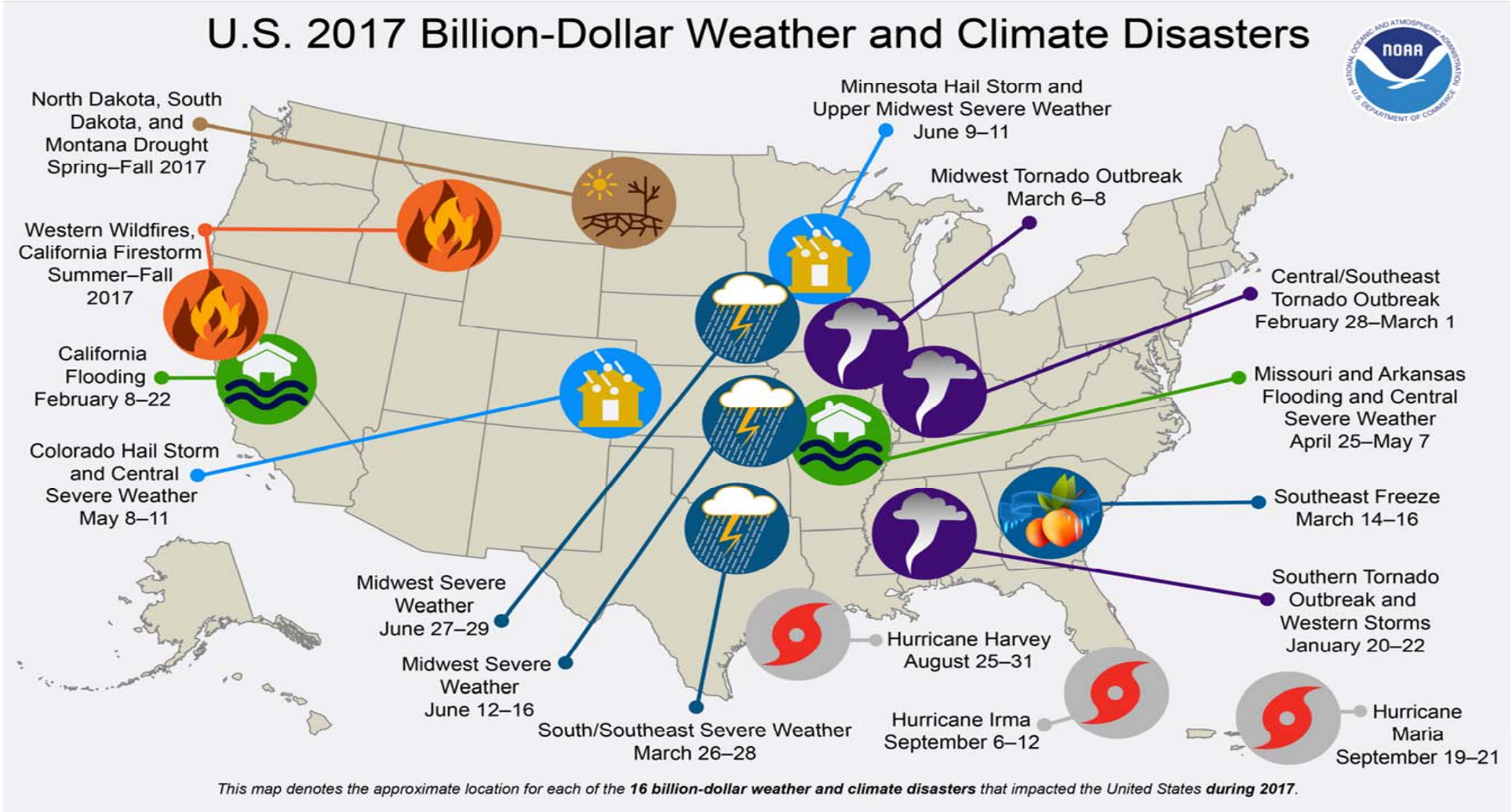
S-NPP Imagery of lake Erie Algal Bloom

NOAA's weather satellites are essential to public safety, and they underpin the entire public and private weather enterprise.



GOES-16 Imagery of hurricane Maria

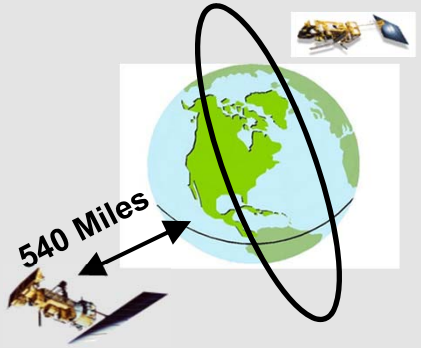
Impact: Data for Forecasting, for Early Warning



In 2017, there were 16 weather and climate disaster events with losses exceeding $1 billion each across the US; total losses in 2017 exceeded $300 billion.

How: Three Observation Points

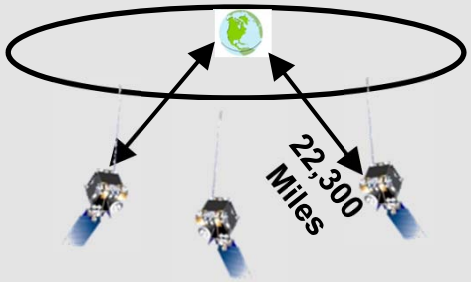
Polar-orbiting Operational Environmental Satellites



Each satellite covers the Earth twice daily

- Pole-to-pole orbit is 102 minutes and views each location at the same time of day
- Global coverage every 12 hours with one satellite
- Information is used for mid-range, 3-7 day advanced warnings of severe weather, environmental imaging and monitoring for short term polar weather, and global ocean and atmosphere forecasting/monitoring
- EUMETSAT in the mid-morning orbit; NOAA in the early afternoon orbit

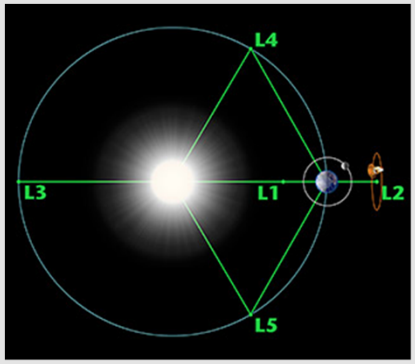
Geostationary Operational Environmental Satellites



Continuous monitoring of the Americas

- Same geographic image over time
- Full image every 10 minutes, Northern Hemisphere images every 5 minutes, and Mesoscale (regional) areas of interest every 1 minute
- Usable images between 60°N and 60°S
- Information is used for short-term weather forecasting and severe storm warning/tracking

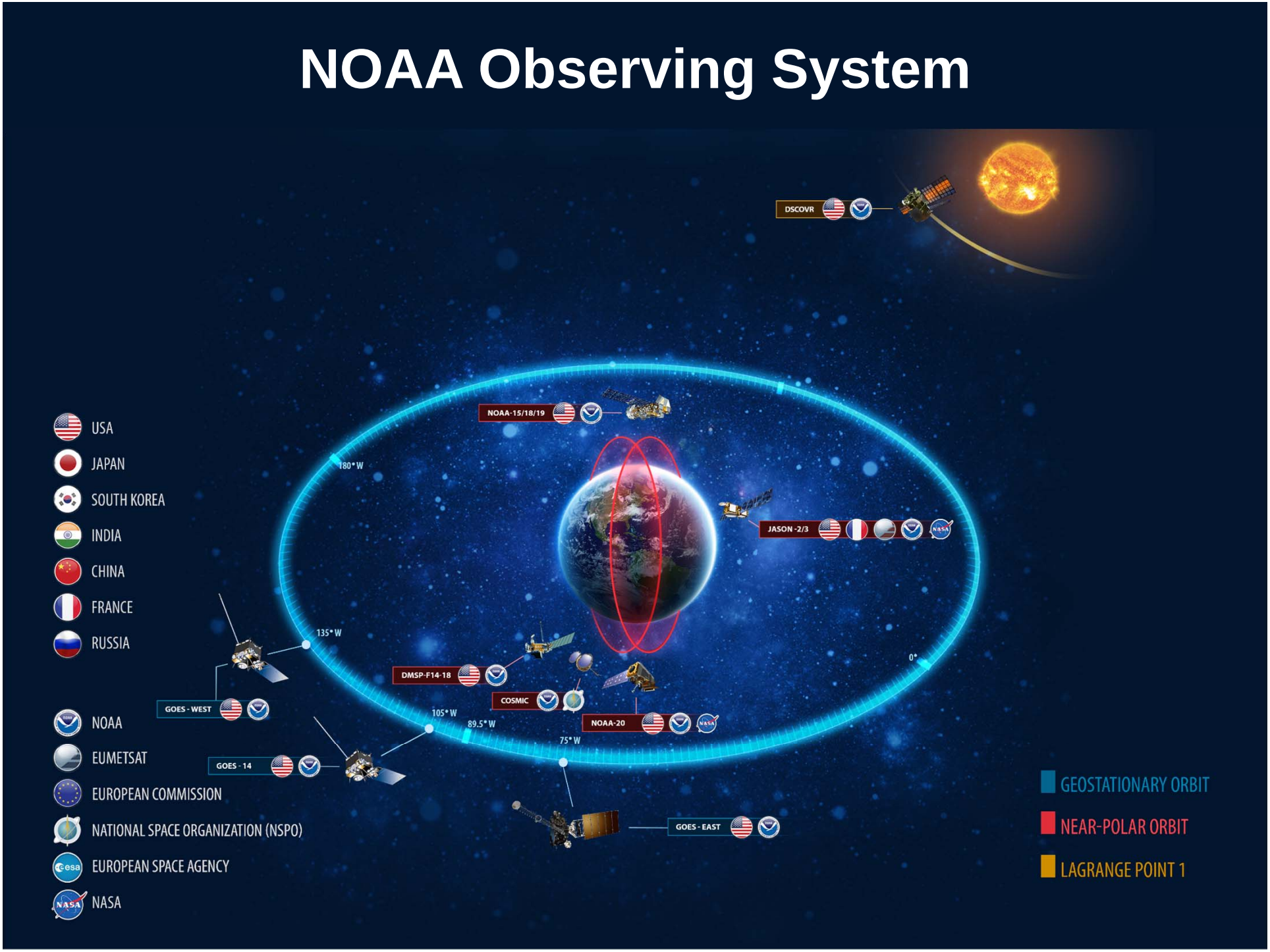
Deep Space at Lagrange Point 1



Continuous monitoring of the surface of the Sun

- Uninterrupted view of the sun
- Located ~1 million miles from Earth, at the Lagrange Point 1 position of the Sun-Earth system
- Information is used for solar winds monitoring for Space Weather warnings

NOAA Observing System



Global Observing System


DSCOVR
JASON-3
OPERATIONAL JULY 27, 2016
COSMIC-2
OPERATIONAL JULY 1, 2016
COSMIC-2A - 2018
GOES-R SERIES
GOES-16 - OPERATIONAL DEC 18, 2017
GOES-S - 2018
GOES-T - 2020
GOES-U - 2025
JPSS SERIES
NOAA-20 - LAUNCHED NOV 18, 2017
JPSS-2 - 2021
JPSS-3 - 2026
JPSS-4 - 2031

The OSPO Enterprise

Satellites

POES
METOP
S-NPP, JPSS
GOES, GOES-R
JASON-2 & 3
DSCOVR
COSMIC
DMSP

TDRSS

Wallops, VA
Ground Station

Fairbanks, AK
Ground Station

Svalbard, Norway
Ground Station

McMurdo, Antarctica
Ground Station

White Sands, NM
Ground Station

Continuity of Operations
(COOP) Site
Fairmont, WV

NOAA Satellite Operations Facility
Suitland, MD

Meteosat
MTSAT
NASA EOS

Environmental Satellite
Processing Center

Satellite Applications

Direct Services

Data & Products

Archive

Government
Military
Universities
Private Industry
Public

Comprehensive Large Array-data
Stewardship System (CLASS), Asheville,
MD/Boulder, CO

OSPO Infrastructure

Suitland, MD

College Park, MD

Asheville, NC

Boulder, CO

Fairmont, WV

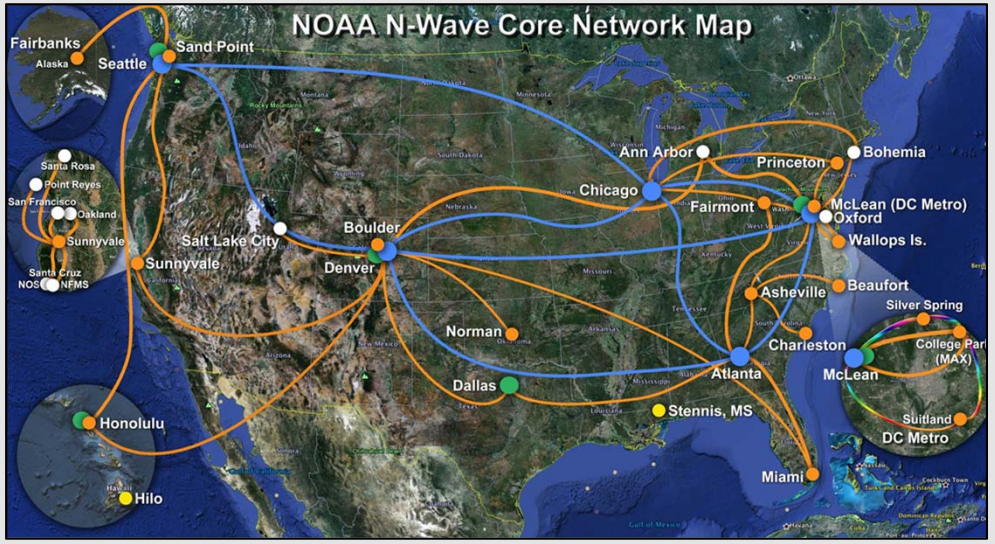
Wallops, VA

Fairbanks, AK

In addition to the OSPO infrastructure, OSPO contracts for operational services; e.g., satellite acquisition services from Svalbard, and communication services

Data Processing and Distribution

- Satellite-based Services
  - GOES Re-Broadcast (GRB) - GOES-R series
  - High Rate Data (HRD) - JPSS
- Terrestrial-based Systems
  - Direct Interface to NWS (GOES to Advanced Weather Interactive Processing System (AWIPS) Satellite Broadcast Network (SBN)
  - Near Real-time Interface for authorized users (Product Distribution and Access (PDA)
  - Long Term Archive and community access (CLASS)
  - Cloud Services (Big Data Project)



Storm Prediction Center
GRB Receivers

National Hurricane Center
GRB Receivers

Recent Achievements

- NOAA in conjunction with our partners launched two new weather satellites in the past 18 months (GOES-16 and NOAA-20/JPSS-1) and GOES-S is set to launch in the comings days
- Provides greater environmental monitoring capabilities for users

GOES-16 (GOES-R)

Launched on Nov 19, 2016

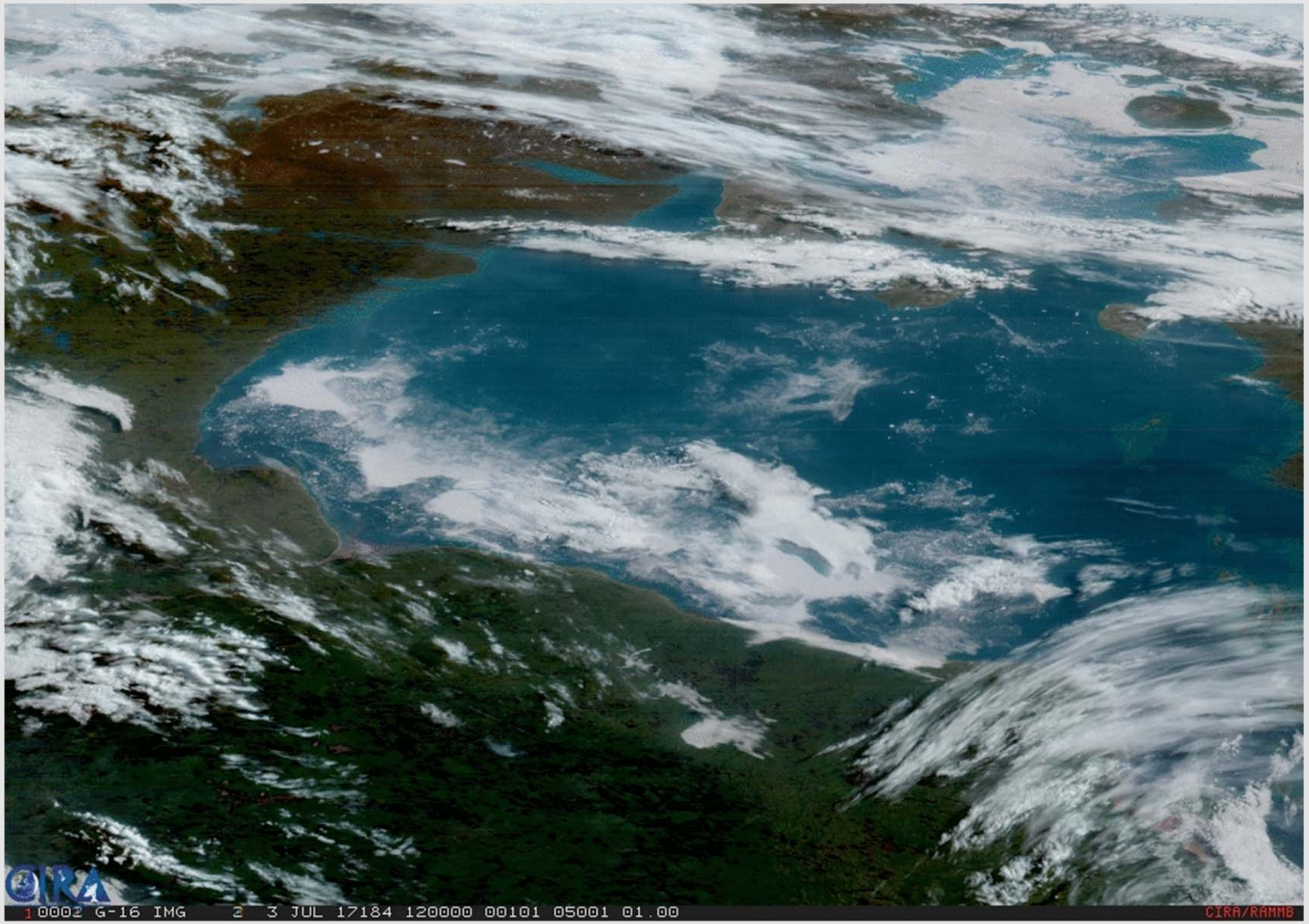
NOAA-20 (JPSS-1)

Launched on Nov 18, 2017

Major Hurricanes in the Atlantic

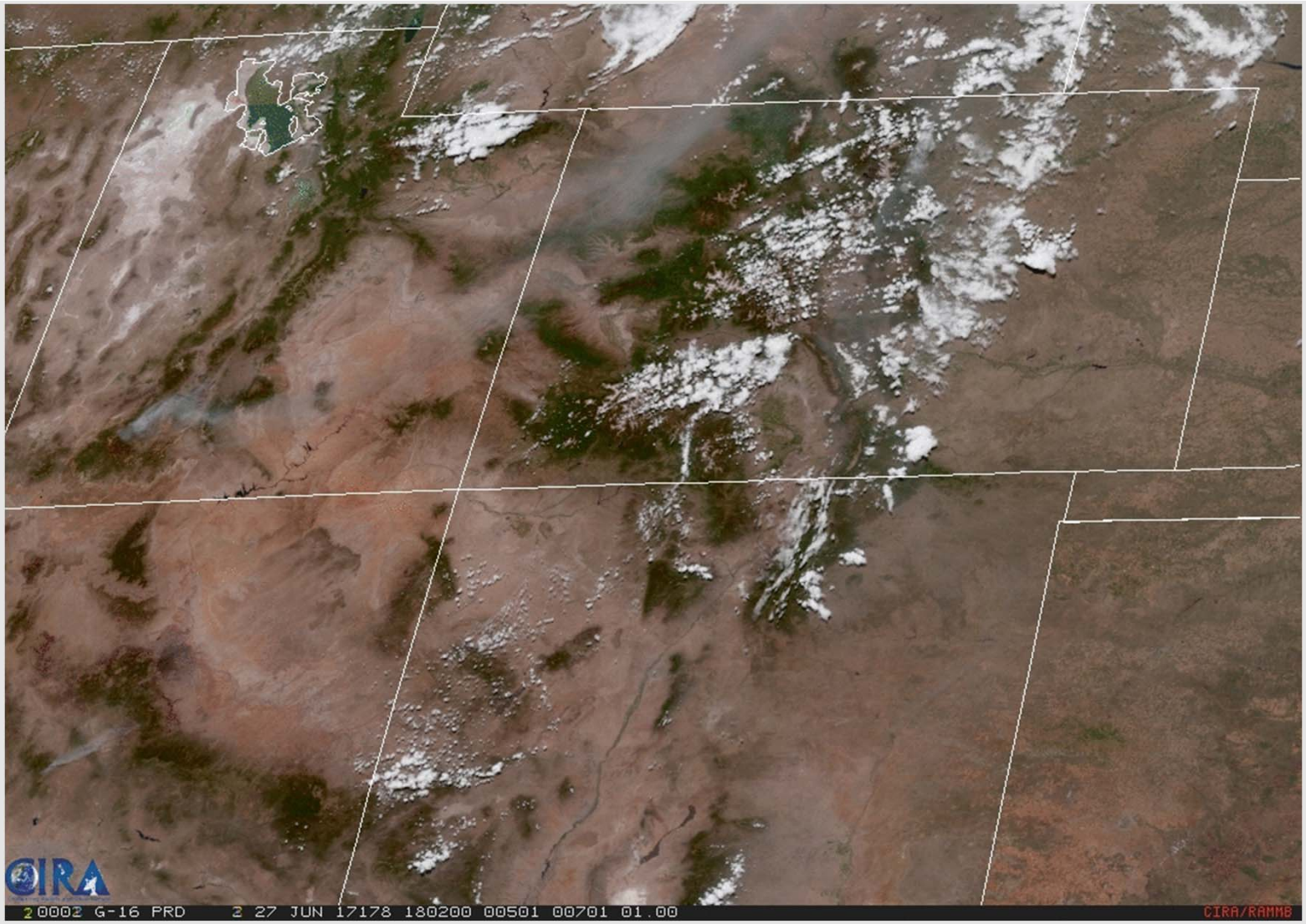
GOES-16 sees Hurricanes Katia, Irma and Jose on September 8, 2017

Ice in Hudson Bay

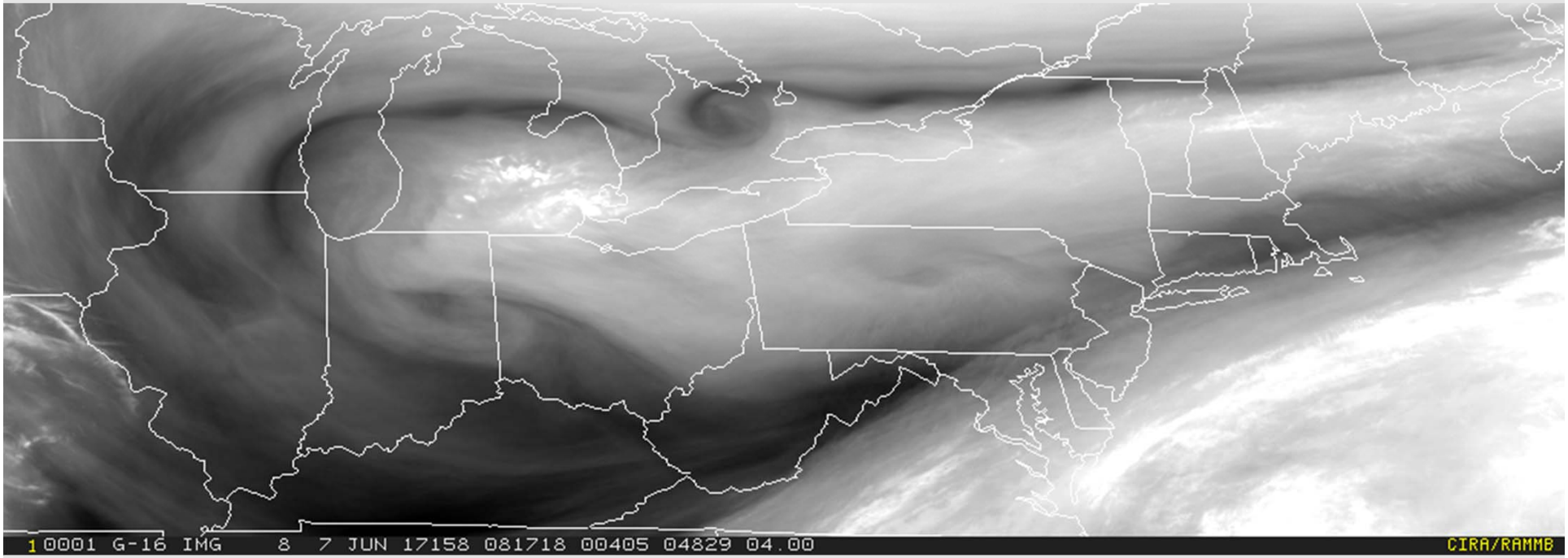


Maritime benefit: Identification of ice provides critical information with economic impact on maritime traffic.

GOES-16 sees Wildfires in Utah and New Mexico



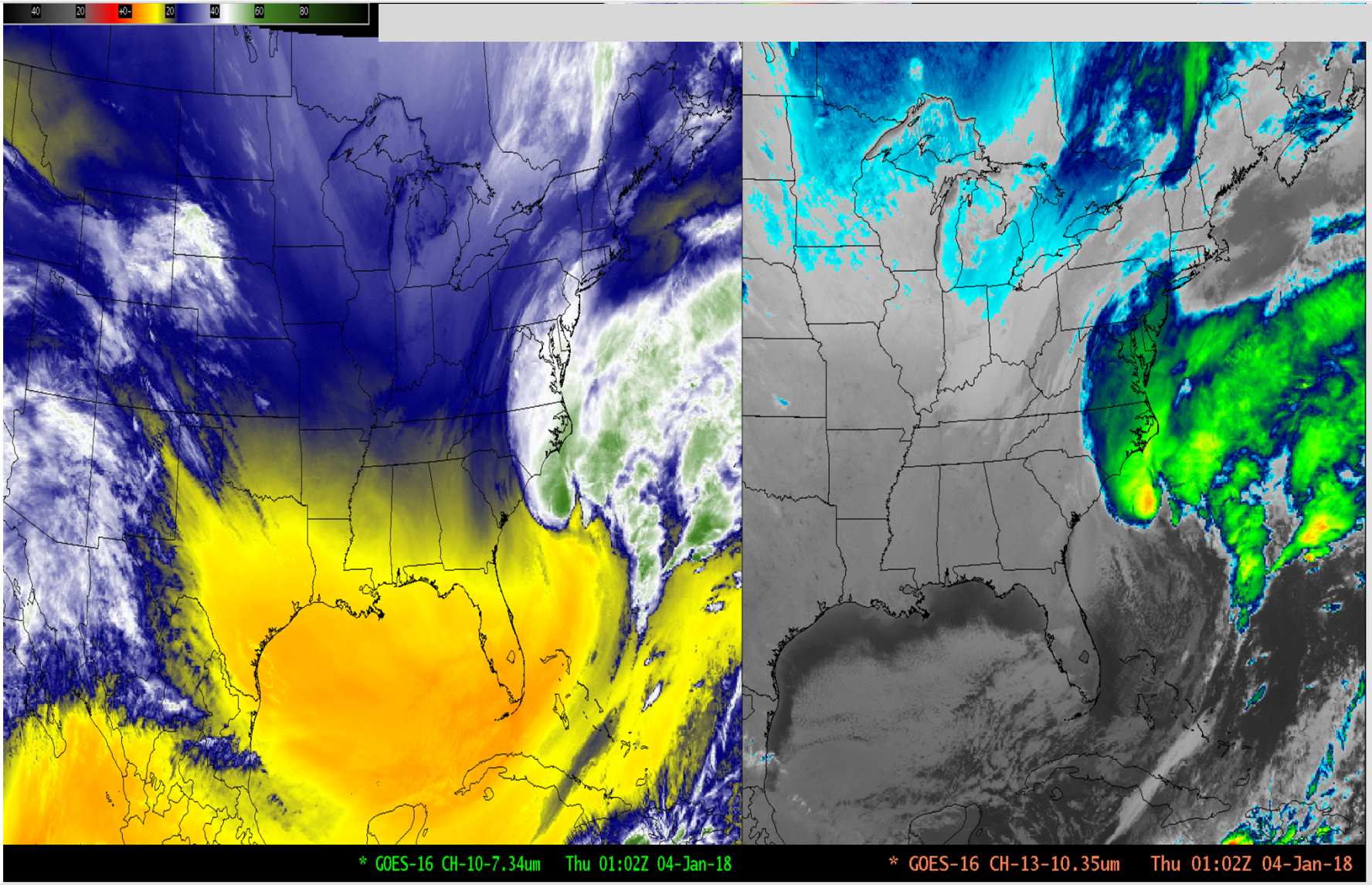
Upper-level Vortices seen by GOES-16 over NE U.S.



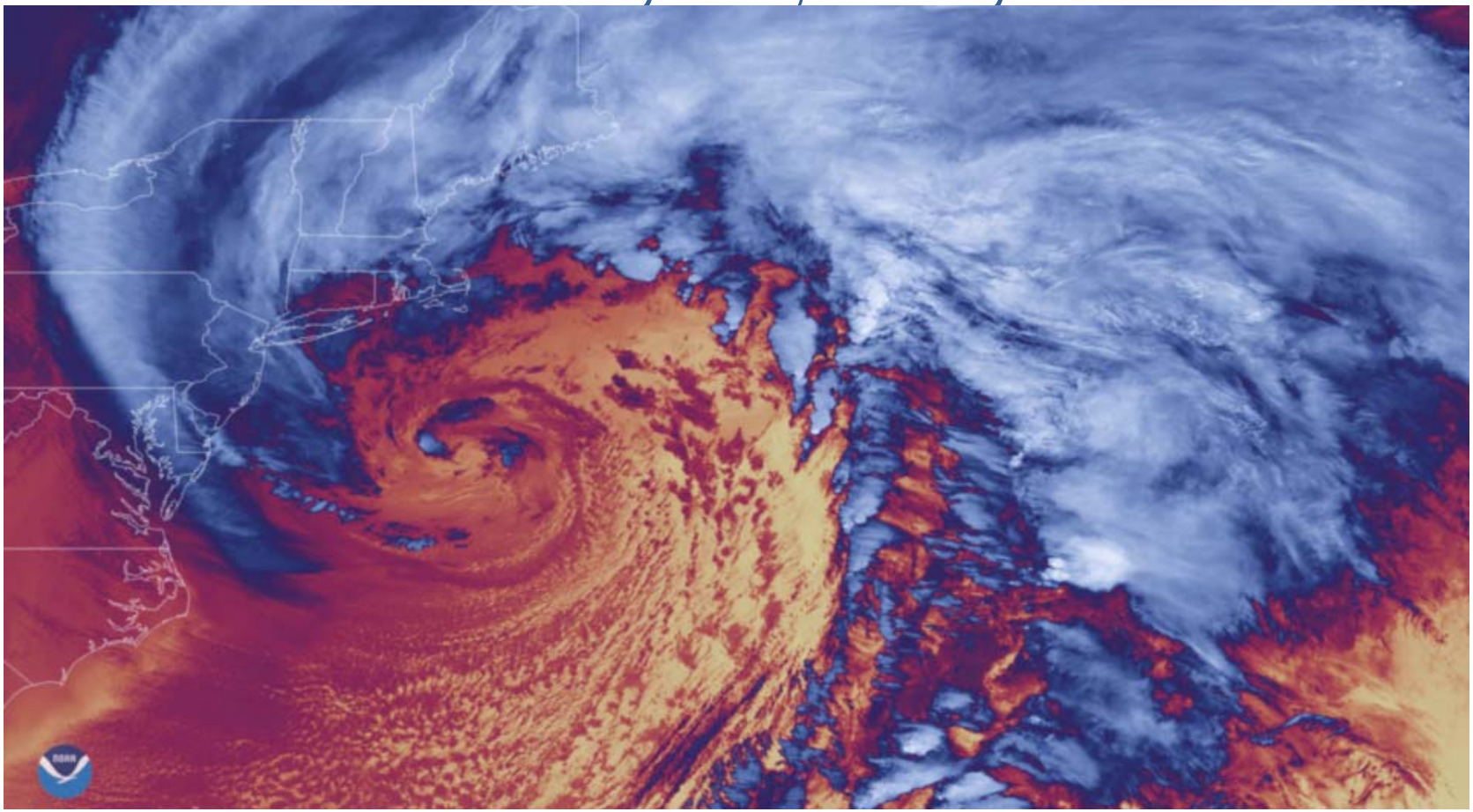
GOES-16 Captured a Powerful Nor'easter Battering the U.S. East Coast on January 4, 2018

NOAA's GOES-16 satellite captured this geocolor enhanced image of a powerful nor'easter moving up the U.S. Eastern Seaboard. The winter storm, which rapidly intensified off of the mid-Atlantic coast, battered coastal areas from Florida to Maine with a combination of heavy snow, ice, and gusty winds. In this image, clearing skies over the Southeast reveal a swath of snow left behind in the storm's wake. The National Weather Service reported accumulating snow as far south as Tallahassee, Florida for the first time in 28 years. As the storm intensified near the mid-Atlantic, blizzard conditions have been reported from coastal Virginia into southern New England.

GOES-16 sees Bomb Cyclone (Explosive cyclogenesis) off the East Coast of the United States

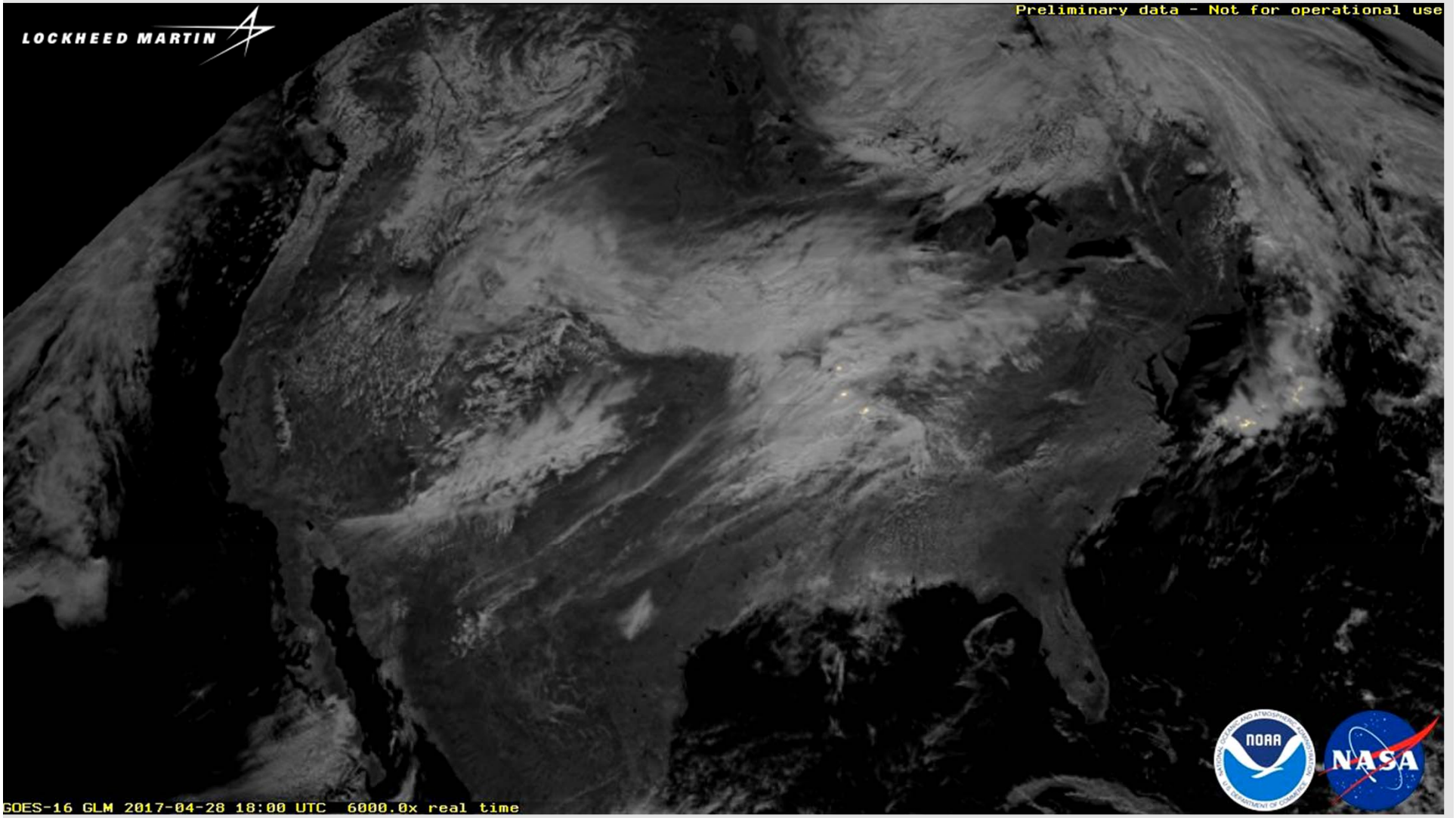


NOAA-20 Captured Detailed Thermal Imagery of Bomb Cyclone, January 4

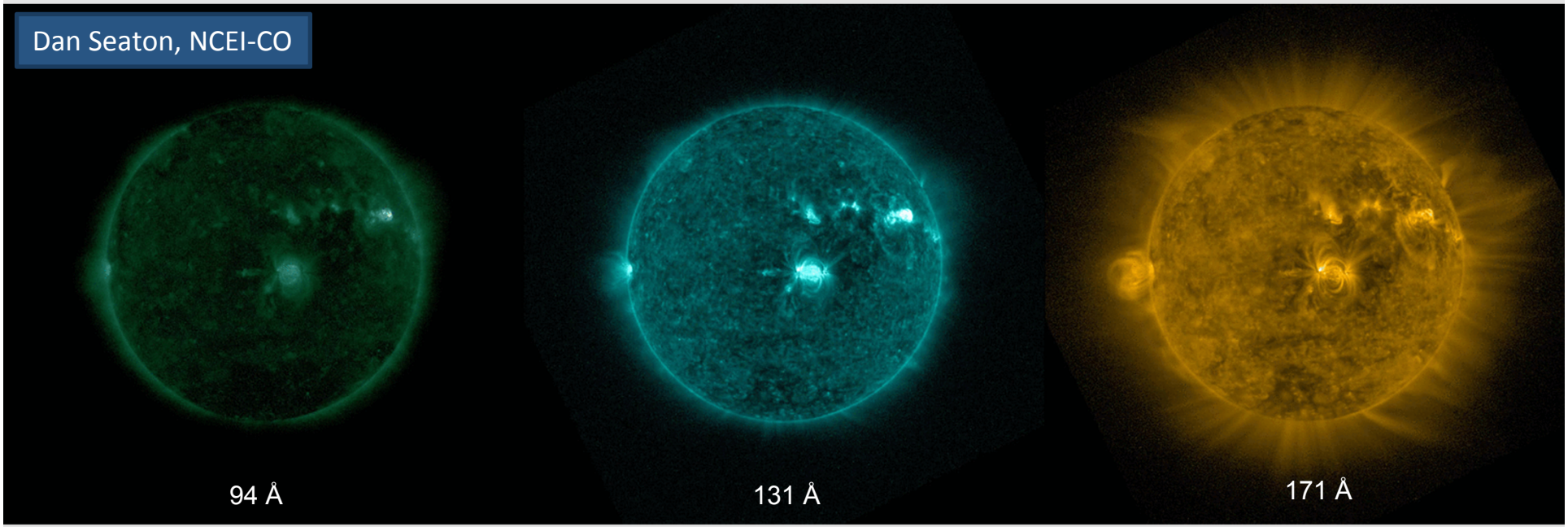


Forty-seven days after it was first launched, the NOAA-20 polar-orbiting satellite sent back its first thermal infrared images on January 4. This VIIRS thermal infrared image shows stunning detail of the powerful 'bomb cyclone' that struck the East Coast of North America on Jan. 2-3, 2018. The powerful winter nor'easter delivered snow and ice, 50 to 80 mph wind gusts, and strong surf from northern Florida to Nova Scotia, Canada. Due to its rapid intensification, the storm ranks among strongest ever observed along East Coast.

GOES-16 Geostationary Lightning Mapper (GLM) Observation of Severe Weather

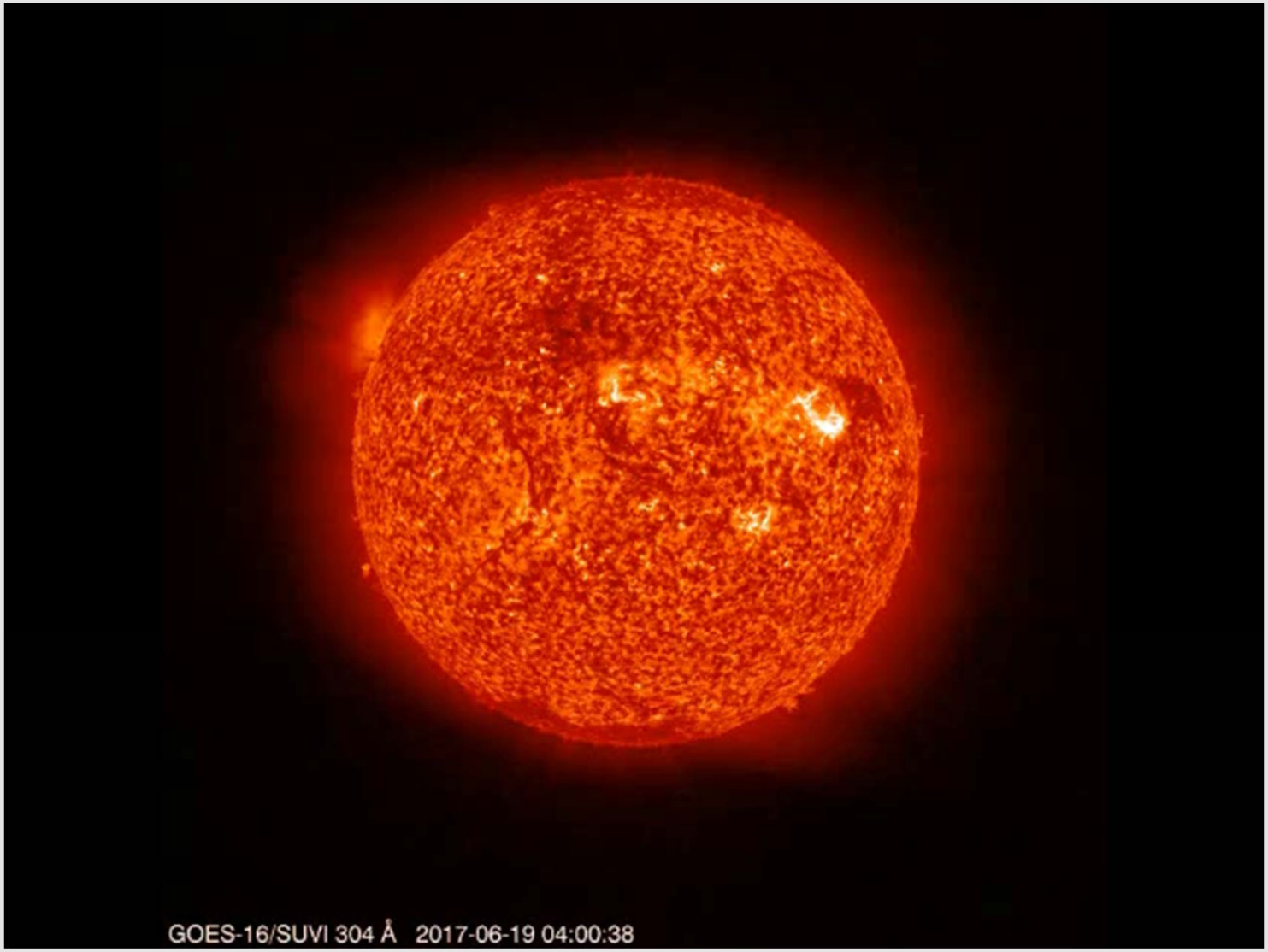


SUVI on GOES-16 Observes a Solar Eruption

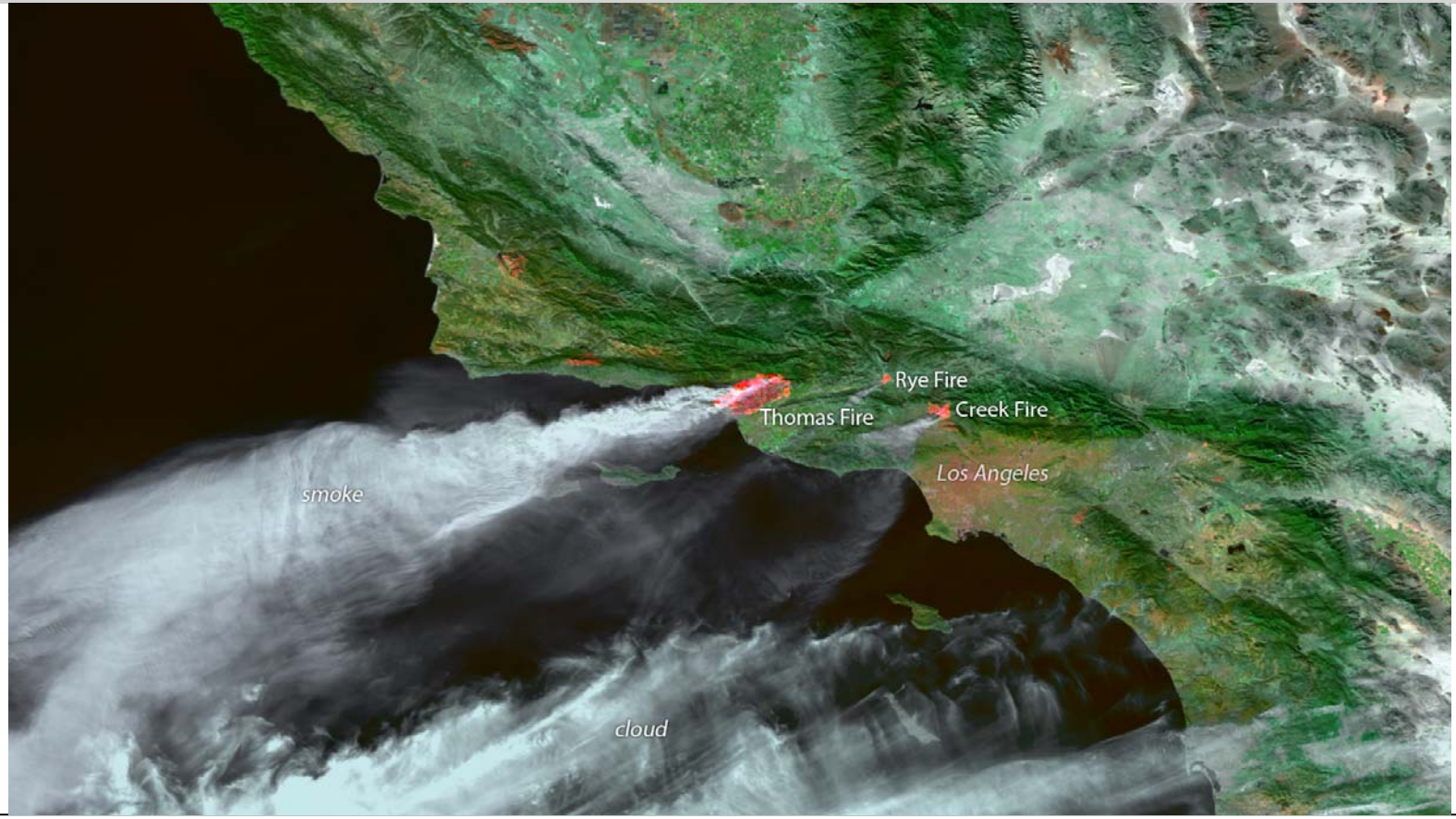


- Concentrated bundles of magnetic field that emerge from inside sun appear as dark blotches on the surface called sunspots
- In the corona, which SUVI observes, they appear as twisted tubes of magnetic field filled with million-degree plasma
- Flares (rapid intense brightening) and eruptions (coronal mass ejection) result - April 1 at about 21:45 UTC (upper right quadrant)
- These are valuable to NCEI-CO as they analyze SUVI performance

GOES-16 SUVI Captures Solar Eruption on June 19, 2017



Santa Ana Winds Fuel Southern California Wildfires



Fast-moving fires ignited in parts of Ventura, Oxnard, Santa Barbara and Los Angeles, California. Heavy brush and strong dry Santa Ana Winds have fueled the active blazes, with wind speeds reaching 80 mph. The largest Thomas Fire, Creek Fire and Rye Fire have so far burned a combined total of over 83,000 acres in two days (Dec.5-6). This image was created by combining three of the **Suomi NPP** satellite's high resolution thermal and visible channels from the VIIRS sensor (SVI 4,2,1). These different channels allow us to distinguish areas of land that are hotter in temperature (red) due to an active fire or a burn scar.

Why the Need for Resiliency

- OSPO's enterprise has been designated as a **National-Critical** under Presidential Decision Directive/NSC-63 (PDD-63), May 1998
  - –Satellite observations provide important contributions to U.S. national security by providing military personnel with forecasts and imagery for their aircraft, ships, ground forces and facilities worldwide
  - –The Department of Homeland Security and state and local emergency managers depend on vital up-to-the-minute information for disaster preparedness, response and recovery, and the protection of the nation's critical infrastructure and natural resources

Note: **Congress must be notified when there is permanent loss of critical mission data.**

Why the Need for Resiliency

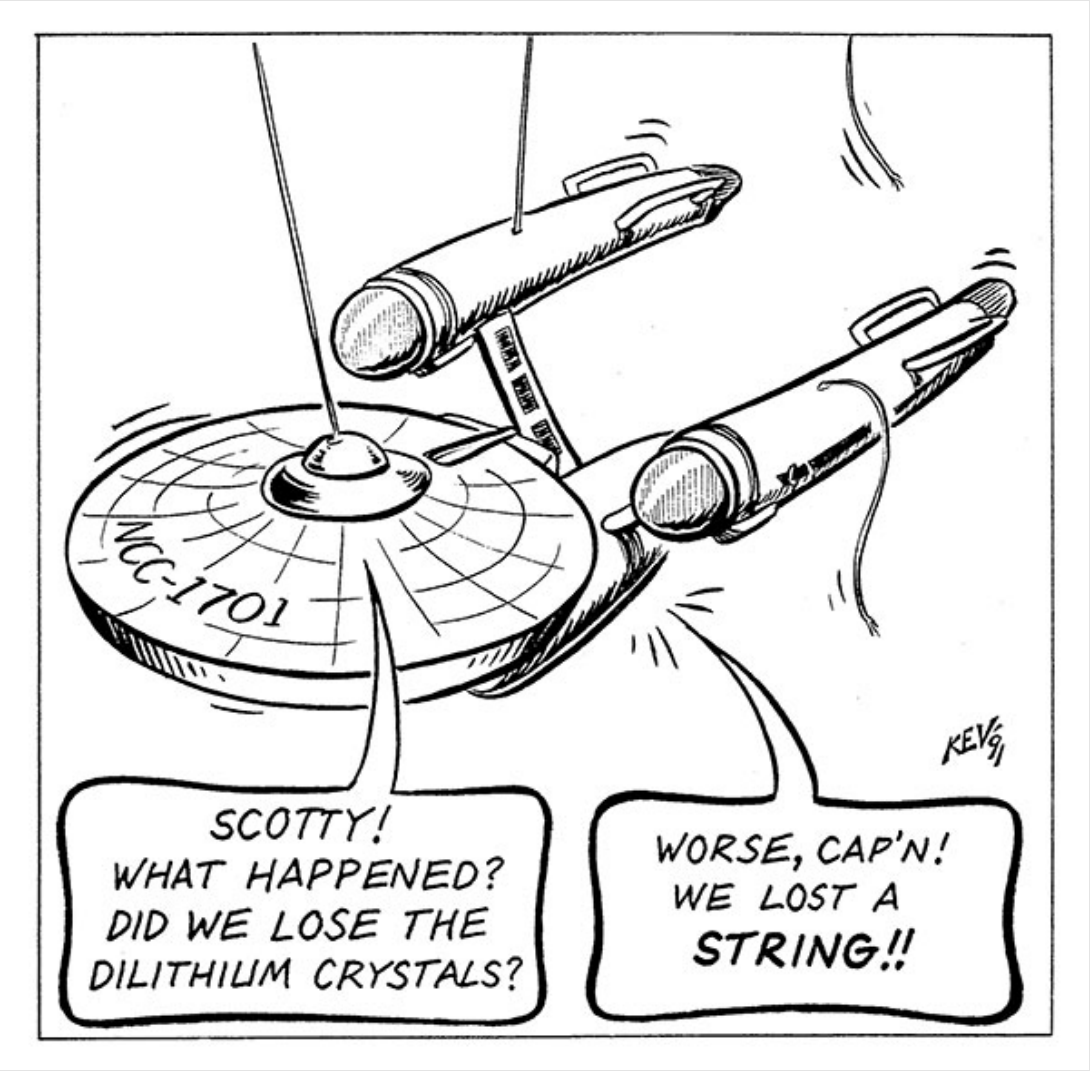
- Presidential Policy Directive (PPD-21) - Critical Infrastructure Security and Resilience, issued February 12, 2013
  - –The Presidential Policy Directive (PPD) on Critical Infrastructure Security and Resilience advances a national unity of effort to strengthen and maintain secure, functioning, and resilient critical infrastructure
  - –Defines resilience as **the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions.** Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents

NOAA's Weather-Ready Nation Initiative

- Help our nation become more resilient to increasing extreme weather, water and climate events.
- Keep these threats from becoming disasters with greater accuracy in forecasts and warnings, evolving services to community decision makers, and better ways to communicate risk to stakeholders and the public.
- Partner with emergency management officials, businesses, and the media to motivate individuals and communities to prepare for a potential weather disaster.
- These actions can save lives – at home, in schools, and in the workplace.

Speaking of the Enterprise …

The Resilient OSPO Enterprise



Credits: Kev Brockschmidt, Illustrator

OSPO Resiliency Tripod

NESDIS Strategic Plan 2016

Maintaining System Capabilities

- Considering, analyzing and planning observing systems as an integrated system
- Regularly evaluate our systems, requirements and plans as new conditions and capabilities emerge
- Deliver ever-increasing value, including new and better information products and services in close coordination with our user community in an open and transparent way

Paraphrased from NESDIS Strategic Plan 2016

Maintaining Workforce Community and Partners

- Retaining, creating and developing an agile, expert workforce built around the value of full engagement and a continuous learning environment
- Maximize NOAA's value to the Nation through observations and scientific capabilities, share these capabilities with our partners and users and draw significant value from our partner's investments and expertise

Paraphrased from NESDIS Strategic Plan 2016

Living Up to Our Commitments

- Continuity of products and services delivered by NOAA
  - –Challenge as requirements, technologies, and Earth's climate continue to evolve
- Ensuring quality, accuracy, and preservation of Nation's historical environmental data archives
  - –Constantly improving and augmenting this vast environmental repository with new data sets, merged products and integrated observations from NOAA, other U.S. and global observing systems

Paraphrased from NESDIS Strategic Plan 2016

Redundancy and Flexibility

- Redundancy requires investment
  - Design/Development considerations
  - 3 strings (at least)
  - Continues through Lifecycle
  - Infrastructure redundancy is costly
  - Government budgets risk redundancy
- Flexibility options must consider the entire enterprise
  - System capabilities
  - Workforce/partnerships
  - Commitments

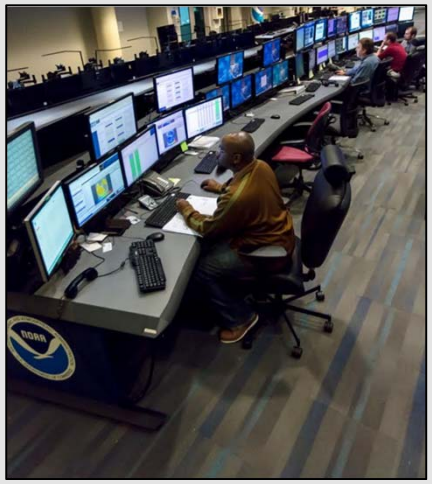
Resiliency: Staffing and Partners

- Systems vs. Staffing
  - –Don’t over-engineer the solution – simpler is better
    - Operational complexity leads to operator error
    - Complex solutions often require re-work and workarounds
  - –Fewer systems are better
    - Multiple systems more prone to operator error
    - Requires extensive training/re-training
    - Requires more staff
- Partnerships
  - –Take time to develop but give value to both parties
  - –NOAA partnerships include DoD, EUMETSAT, CNES, and JAXA

Infrastructure Investments

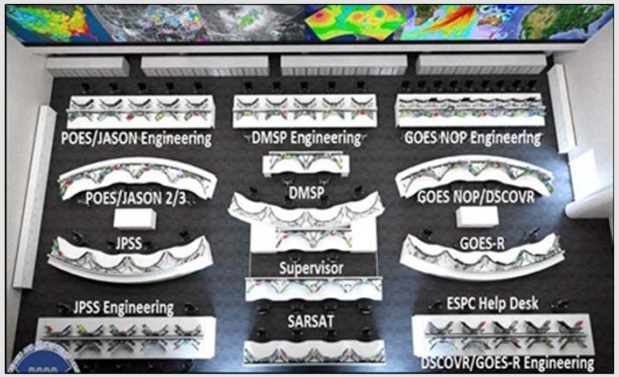
- Cooling and power
- Control Room Renovation
- Backup Facility (CBU)

UPS and backup generators installed at Suitland, MD



Renovated Satellite Operations Control Center (new)

NOAA Satellite Operations Facility in Suitland, MD



Renovated Satellite Operations Control Center in Suitland, MD

Consolidated Backup Facility in Fairmont, WV

Support to Partners: Japan

- GOES-9 was launched in 1995
- In 2002-2003, GOES-9 was used by NOAA to provide a temporary on-orbit replacement for Japan's failing GMS-5 satellite
  - –Its intended replacement, MTSAT-1, had failed to reach orbit
  - –GOES-9 was operated at 155 degrees east from Fairbanks, Alaska until November 2005, when MTSAT-1R became operational

Support from Partners: EUMETSAT

- The NOAA polar-orbiting constellation is required to have two satellites in two orbits
  - This two-orbit constellation* provides the data needed to provide accurate predictions to meet NOAA's weather forecasting, climate monitoring, and ocean and coastal observing requirements.
- Since 2006, the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) has supplied the mid-morning orbit
  - Initial Joint Polar System (IJPS) Agreement – Agreement Between the U.S. National Oceanic and Atmospheric Administration (NOAA) and the EUMETSAT on Joint Transition Activities Regarding Polar-orbiting Environmental Satellite Systems (signed 24 June 2003)

* NOAA's polar satellites operate as part of a three satellite system constellation consisting of a Defense Meteorological Satellite Program (DMSP) satellite, a EUMETSAT satellite, and a NOAA satellite flying in complementary orbits.

Satellite Resiliency Requirements

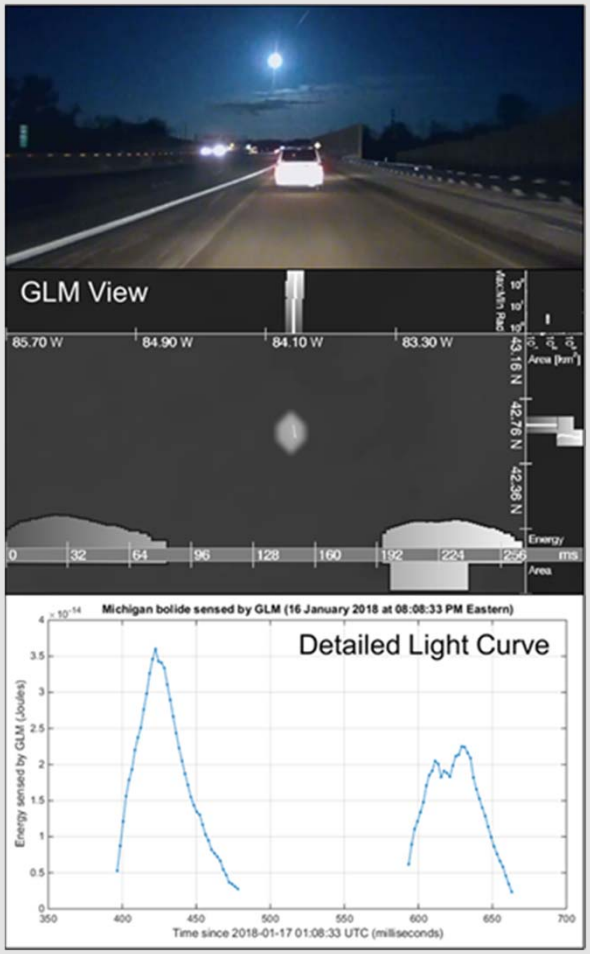
- GOES-R
  - –Satellite Maximum Time to Restore Service (MaxTTRS) ≤ 3 weeks
  - –Outages of sensor data < 6 hours per year
  - –Failover time to a backup site ≤ 5 minutes
- JPSS
  - –Operational Availability of ≥ 98% over any 30 day period for mission lifetime (excluding on-orbit failures)
  - –Alternate command and control and data processing site (CBU)
  - –90% probability of data availability

Resiliency in GOES-R, JPSS Enterprise

- GOES-R - Controllers have been cross-trained to support both GOES and GOES-R satellites
- JPSS - Under NOAA-EUMETSAT Joint Polar Agreement, NOAA and EUMETSAT agreed to cooperative capabilities to utilize each other's ground segment assets
  - In Svalbard, EUMETSAT provides JPSS access to its Ka and X/S antennae for NOAA satellite routine utilization
  - In McMurdo, JPSS is responsible for providing global mission Data Reception for EUMETSAT satellites

Take advantage of the unexpected

- A fireball was widely observed slightly south of Howell, Michigan (near Detroit) on January 16
  - This bolide was observed by the Geostationary Lightning Mapper (GLM) instrument on the GOES-East weather satellite.
  - Along with lightning, the GLM observes fireballs with equal sensitivity everywhere within its coverage area
- The largest fireball observed by GLM so far occurred over Atlantic Ocean on March 11, 2017 and was reported by other U.S. Government sensors to be equivalent to an explosion of 2.9 kilotons of TNT



GLM fireball light curve observations help study meteor threats to the Earth

Resiliency in Government Systems

- Requirements driven by need to protect Life and Property
- Risk averse
- More redundancy in infrastructure and people
  - More costly
  - Less agile
- Longer procurement / planning cycles
- More partnerships

Resiliency in Commercial Systems

- Example: Intelsat
- Cost driven
  - –Willing to accept more risk
- More agile – Ready for new satellite in 1-3 years
- Longevity of core Intelsat system - continuous improvement
- Multiple buses, one core system (now two)
- Single user interfaces for multiple systems
- Two satellite operations centers – hot back-ups
  - –Why? PanAmSat merger

So what is Resiliency?

- Adaptability and continuity of mission in the face of disruption and threat
- Secure
- Operable
  - Simpler when feasible
- Maintainable
- Sustainable
- Includes the entire enterprise
  - Partners
  - Customers
  - Systems

And Finally…

- Consider your entire enterprise
- Think outside of your organization/systems for resilience options
  - Look for redundant service/capabilities in addition to redundant internal system
- Understanding your requirements is essential in evaluating resilience option
- Be flexible and open to new solutions
- Redundancy plans for simultaneous failures.
- Rule of 3: big problems come from three simultaneous failures. Your system may not handle that, but your enterprise can and must.

Because sometimes 3 things happen

GOES-16 sees Hurricanes Katia, Irma and Jose on September 8, 2017