

**NOAA**

**Satellite and  
Information  
Service**

**29 September  
2020**

**@NOAASatellites**

# NESDIS Science Overview

**Dr. Mitch Goldberg, NESDIS Senior Scientist**

Community Meeting on NOAA Satellites





# NOAA's Role in Improving the Use of Satellite Information

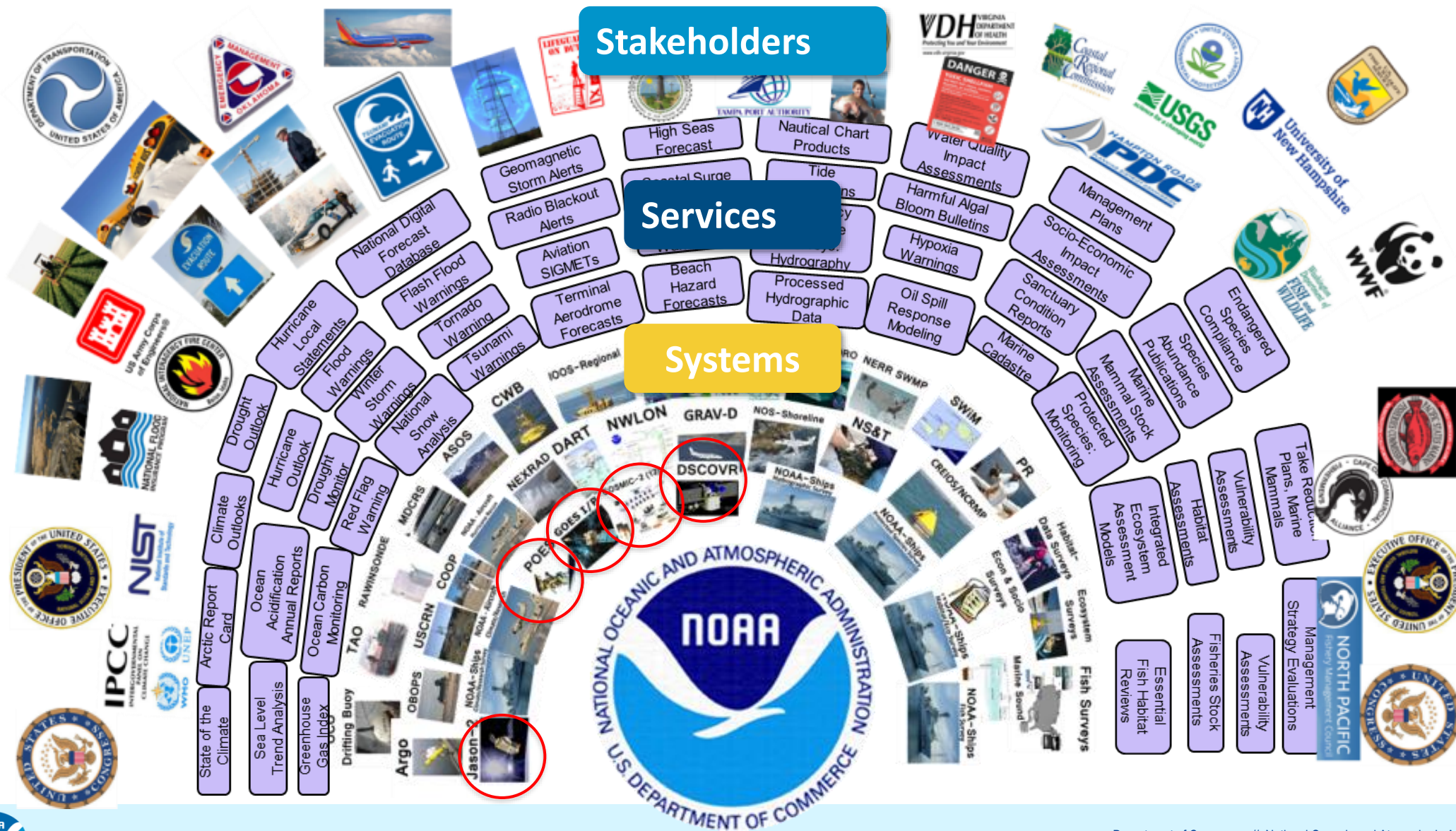


- User Engagement - listening, learning and understanding user needs
- Satellite missions – providing long-term continuity of key observables.
- Free, Open and Easy Access to the NOAA suite of products and services
- Use Inspired Science
  - Use-inspired science consists of scientific investigation whose rationale, conceptualization, and research directions are driven by the potential use to which the knowledge will be put (Stokes, 1997).
- Satellite Proving Grounds - engaging the user community to promote and improve the use of satellite observations and products for user applications and services.
- Training - providing educational and training material to the user community
- Stewardship – establish authoritative quality, uncertainties and provenance

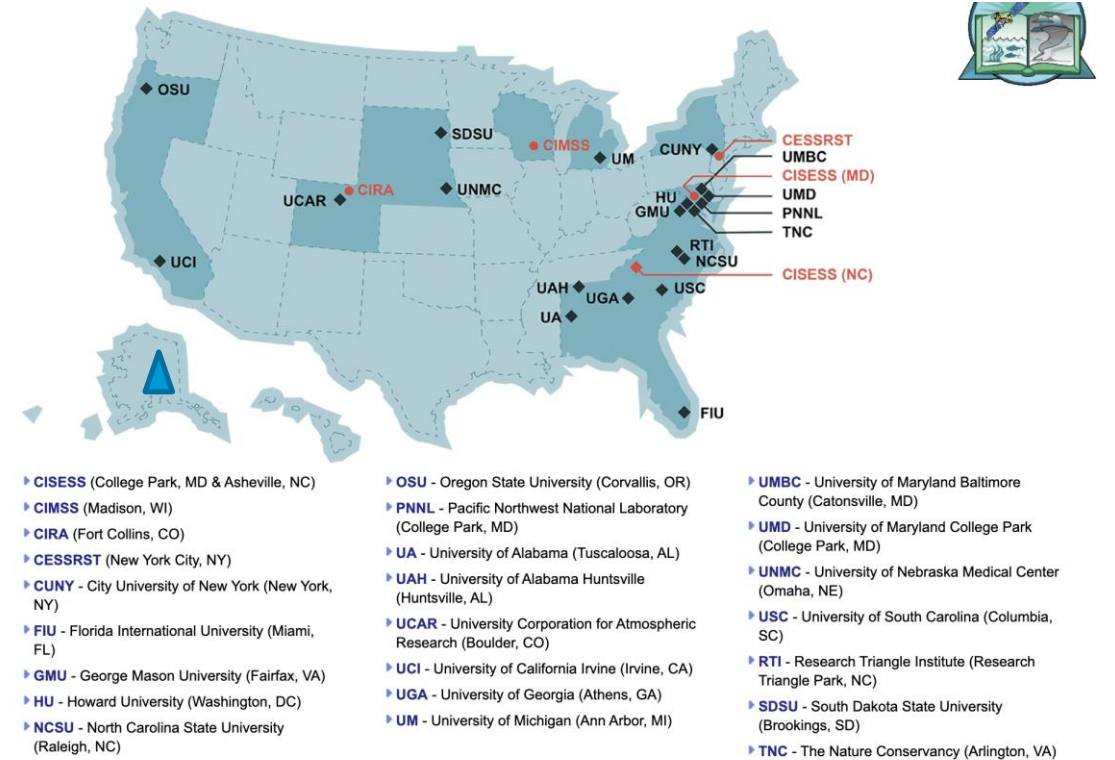
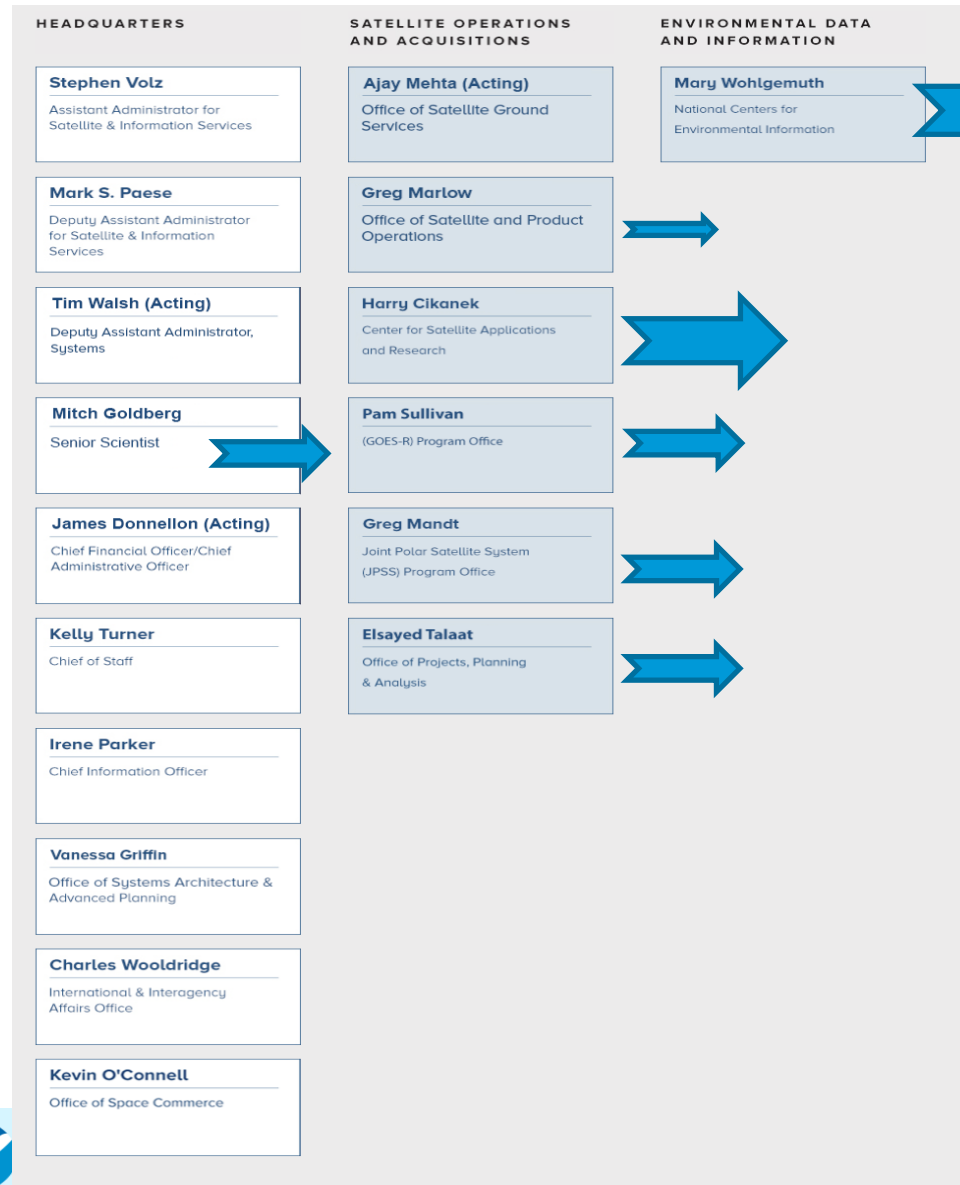




# NOAA Satellites serves NOAA and partner services and stakeholders



# Science cuts across the NESDIS organization



Cooperative Institute and Academic Partners





## Science across the NESDIS Enterprise and Lifecycle

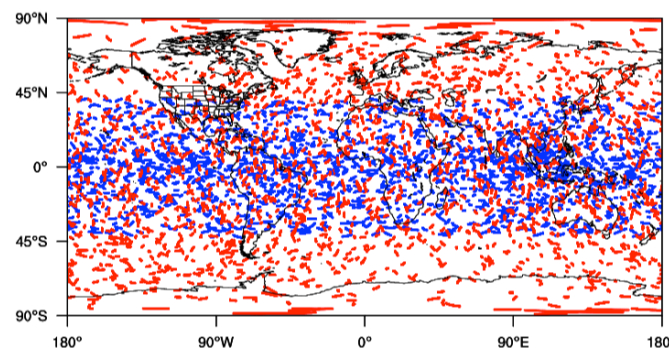
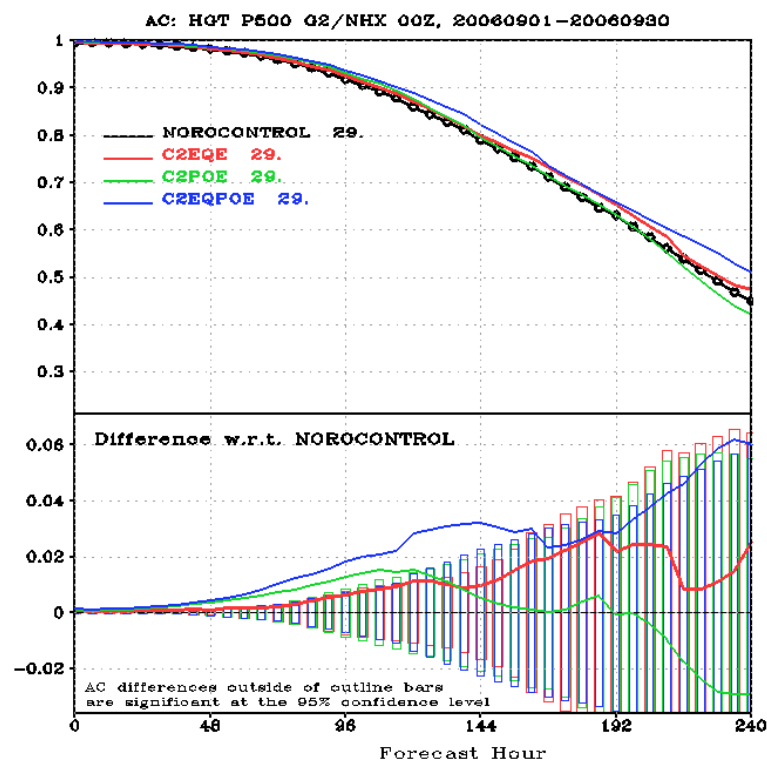


- Preformulation Science Studies. -- Weather Research and Innovation Forecasting Act of 2017: OSSEs must be conducted before: (1) acquisition of major government-owned or government-leased operational observing systems with a lifecycle cost of more than \$500 million, and (2) purchase of any major new commercially provided data with a lifecycle cost of more than \$500 million.
- Instrument science related to prelaunch and post launch activities
- Scientific algorithms to derive products from satellite observations
- Application of satellite observations and products to support understanding and decisions
- Services, Assessments, and Stewardship

# COSMIC2 Radio Occultation OSSEs

Anomaly correlation 500-hPa geopotential heights  
Northern Hemisphere extratropics

Anomaly correlation 500-hPa geopotential heights  
Southern Hemisphere extratropics

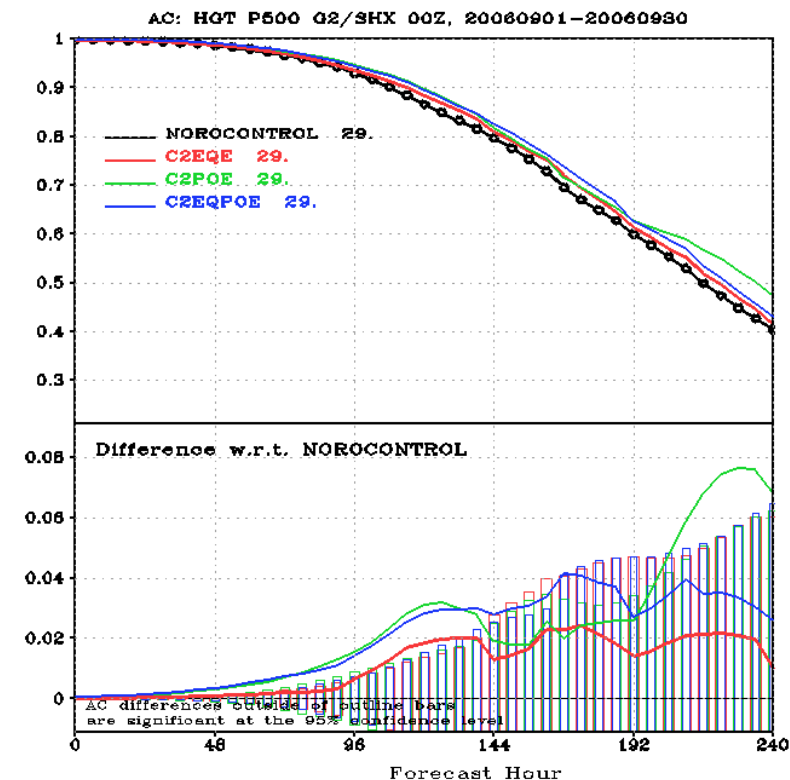


**NOROCONTROL:** operations

**C2EQE:** NOROCONTROL + C2 Equatorial

**C2POE:** NOROCONTROL + C2 Polar

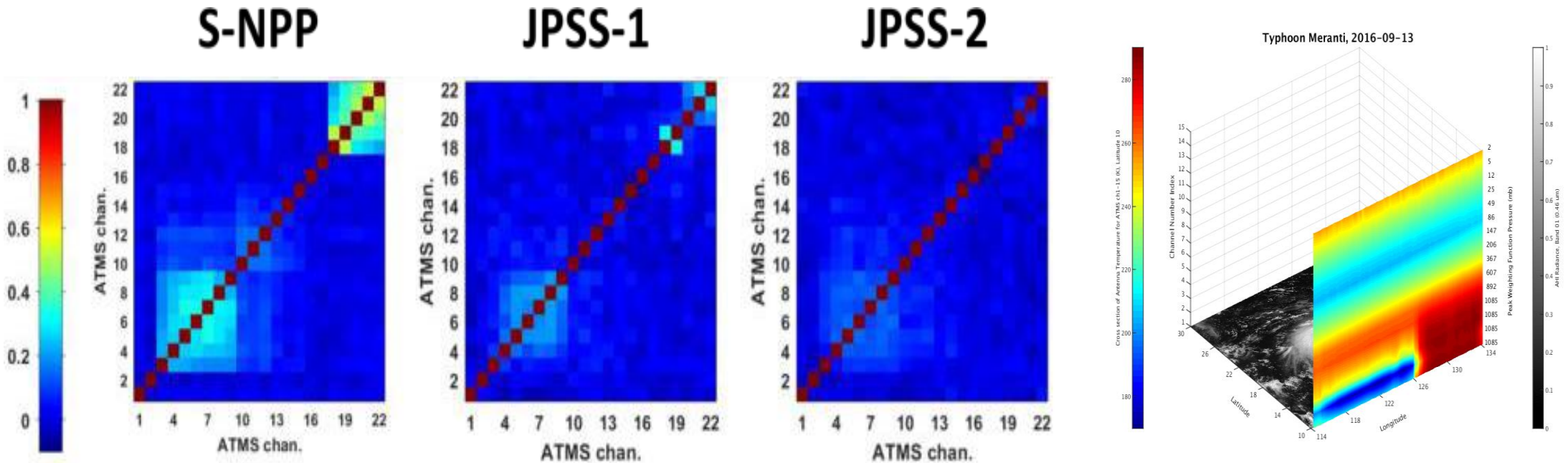
**C2EQPOE:** NOROCONTROL + C2



(OAR, Dr. Lidia Cucurull)

# Instrument Science (ATMS)

- Science activities include intensive instrument prelaunch characterization and post launch assessments.



SNPP ATMS analysis revealed that the receiver front-ends had noise issues which resulted in striping and correlated noise. This problem was fixed in JPSS-1 (NOAA-20) and prelaunch testing of ATMS for JPSS-2 shows further refinement significantly reduced correlated error.



# Algorithm Science for operational products

STAR JPSS

STAR Joint Polar Satellite System Website

Maintaining the continuity of climate observations and critical environmental data from the polar orbit — Increasing the timeliness and accuracy of severe weather forecasts

STAR JPSS Home

- JPSS Data Products
- [Algorithm Cal/Val Maturity >>](#)
- Product Operational Matrix
- Documentation

Product Monitoring

- ICVS
- EDR LTM Site
- NPROVS
- N-20/SNPP Equator Crossing

JPSS Instruments/SDRs

- ATMS
- CrIS
- VIIRS
- OMPS

Environmental Data Records

- Ocean Products**
  - Sea Surface Temperature
  - Ocean Color
- Land Products**
  - Active Fires
  - Land Surface Temperature
  - Surface Albedo
  - Surface Type
  - Surface Reflectance
  - Vegetation Index
  - Green Vegetation Fraction
  - Vegetation Health
- Cryosphere Products**
  - Snow Cover
  - Sea Ice
  - Ice Surface Temperature
- Atmosphere**
  - Imagery
  - Clouds
  - Aerosols
  - VIIRS Polar Winds
  - NUCAPS IR+MW Products
  - MIRS MW Products
  - OMPS Ozone
  - GCOM-W AMSR2 Products

JPSS/SNPP Algorithm Maturity Matrix

Algorithm Maturity Definitions

S-NPPNOAA-20GCOM

Updated: September 18, 2020

Sensor	Algorithm	Beta	Provisional	Validated
ATMS	ATMS TDR	08-Dec-17	23-Jan-18	05-Jul-18
ATMS	ATMS SDR	08-Dec-17	23-Jan-18	05-Jul-18
CrIS	CrIS SDR	17-Jan-18	16-Feb-18	14-Aug-18
VIIRS	VIIRS SDR	01-Feb-18	19-Feb-18	30-Apr-18
OMPS	OMPS Nadir Mapper SDR	05-Jan-18	18-Feb-18	06-Nov-19
OMPS	OMPS Nadir Profiler SDR	05-Jan-18	02-Jul-18	23-Apr-20
VIIRS	VIIRS Imagery	01-Feb-18	19-Feb-18	22-Aug-18
VIIRS	VIIRS Cloud Mask	18-Apr-18	02-Oct-18	16-May-19
VIIRS	Cloud Phase/Type	02-Oct-18	02-Oct-18	16-May-19
VIIRS	Cloud Height (CTH/CTP/CTT/CCL)	23-Jul-18	02-Oct-18	16-May-19
VIIRS	Cloud Base Height (CBH)	23-Jul-18	02-Oct-18	16-May-19
VIIRS	Daytime Cloud Properties (DCOMP)	23-Jul-18	27-Nov-18	16-May-19
VIIRS	Nighttime Cloud Properties (NCOMP)	07-Mar-19	07-Mar-19	16-May-19
VIIRS	Aerosol Optical Depth and Particle Size Parameter	20-Mar-18 <sup>1</sup>	20-Mar-18 <sup>1</sup>	16-May-19
VIIRS	Aerosol Detection	18-Apr-18 <sup>1</sup>	18-Apr-18 <sup>1</sup>	16-May-19
VIIRS	Volcanic Ash	27-Nov-18	27-Nov-18	16-May-19
VIIRS	Ice Surface Temperature	15-Jun-18	16-May-19	16-May-19

[JPSS Home](#) > [Product teams](#) > [Active Fires](#)

## Active Fires

Team Lead: [Ivan Csizsar](#)

### Product Description

The Active Fires product is based on the detection of the radiative signature of natural or anthropogenic fires as received by the sensor. The product includes geolocation and Fire Radiative Power (FRP) if fires are detected, and a full mask consisting of a 2-dimensional array of values representing the relevant thematic classes (e.g., cloud) of each data granule.



NOAA

Satellite Products and Services Review Board  
Algorithm Theoretical Basis Document Template  
Page 13 of 26

The detection of unambiguous fire pixels is accomplished with the following fixed threshold tests:

**Test 1:** Daytime:  $T_{13} > 360$  K; Nighttime:  $T_{13} > 320$  K

Where  $T_{13}$  is the brightness temperature on channel M13.

Before other candidate fire pixels can be selected, an internal cloud masking procedure is applied to all image pixels using the following set of conditions:

$(\rho_5 + \rho_7) > 1.2$  (daytime only)  
or  
 $(\rho_5 + \rho_7) > 0.7$  and  $T_{16} < 285$  K (daytime only)  
or  
 $T_{16} < 265$  K  
or  
water pixel AND  $\rho_7 > 0.25$  AND  $T_{16} < 300$  K

Where  $\rho_i$  is the reflectance on VIIRS M channel  $i$ , and  $T_{16}$  is the brightness temperature on channel M16. Following the screening of cloud pixels, candidate fire pixels are selected based on the following criteria:

Daytime:  $T_{13} > T_{13}^*$  and  $\Delta T_{13-15} > \Delta T_{13-15}^*$  AND  $\rho_7 < 0.35$   
Nighttime:  $T_{13} > T_{13}^*$  and  $\Delta T_{13-15} > \Delta T_{13-15}^*$

Here  $\Delta T_{13-15}$  represents the brightness temperature difference between channel M13 and M15. The  $T_{13}^*$  and  $\Delta T_{13-15}^*$  thresholds are the mean background values calculated using a large sampling window centered in the candidate pixel after exclusion of clouds, water and other candidate fire pixels. Next, the following sequence of commands is performed:

- Conduct search in geometric neighborhood of potential fire pixel, ranging from 3x3 pixel box (centered at the candidate fire pixel) to 21x21 pixels.
- For each valid clear land pixel in the geometric neighborhood:
  - Calculate the difference between the candidate fire pixel and the background fire pixel.

### Product and Data Access

#### M-Band Active Fires:

- Tailored version of the M-band UMD / NA
- Operational within NDE system since May 2018
- Includes fire mask and additional output: 1) Fire mask, 2) Fire Radiative Power (FRP), 3) Fire Radiative Flux (FRF)
- Provides a 2D array of values representing the fire mask of each pixel. This is a new attribute to the data granule.
- Provides global coverage (include water)

#### Users

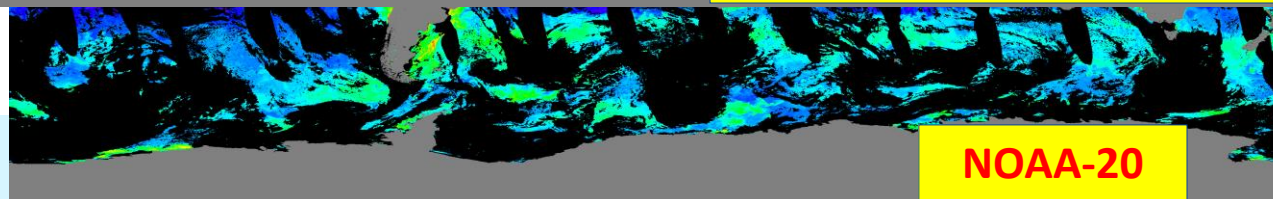
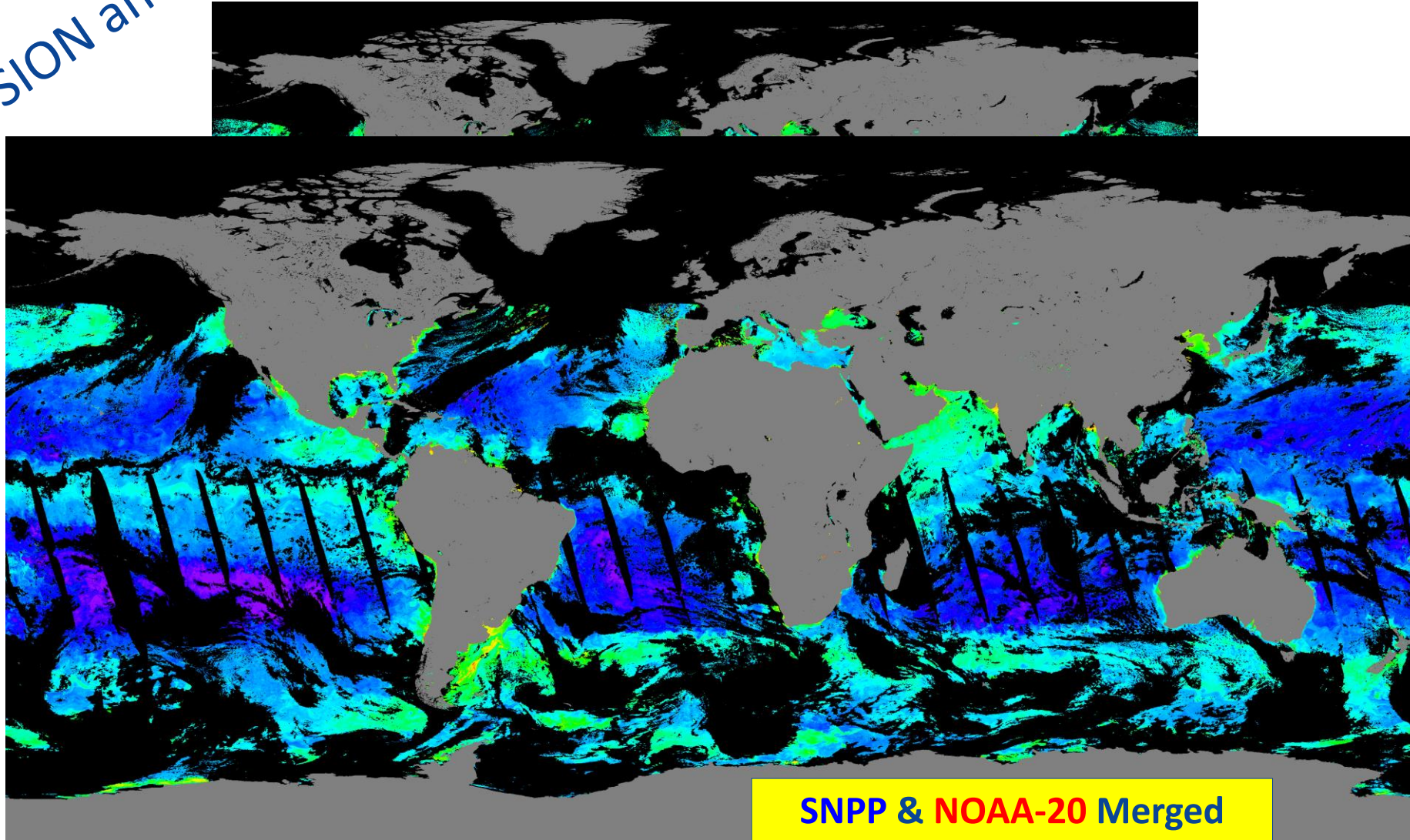
NESDIS Hazard Mapping System, NOAA Aerological Weather Program, USDA Forest Service and Interagency Fire Center, NOAA High Resolution community of international users



# VIIRS-SNPP and NOAA-20 Chl-a Images

(January 6, 2018)

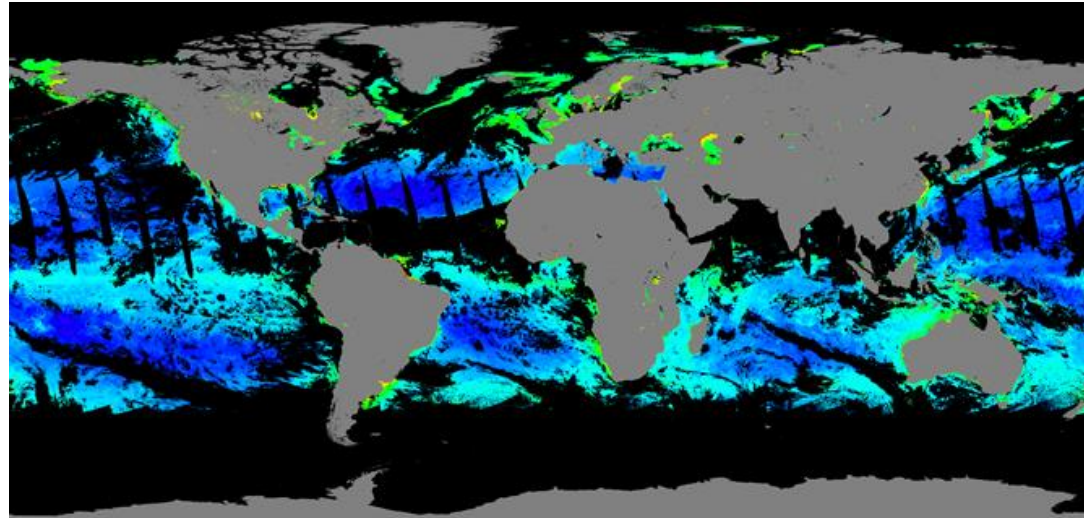
DATA FUSION and AI



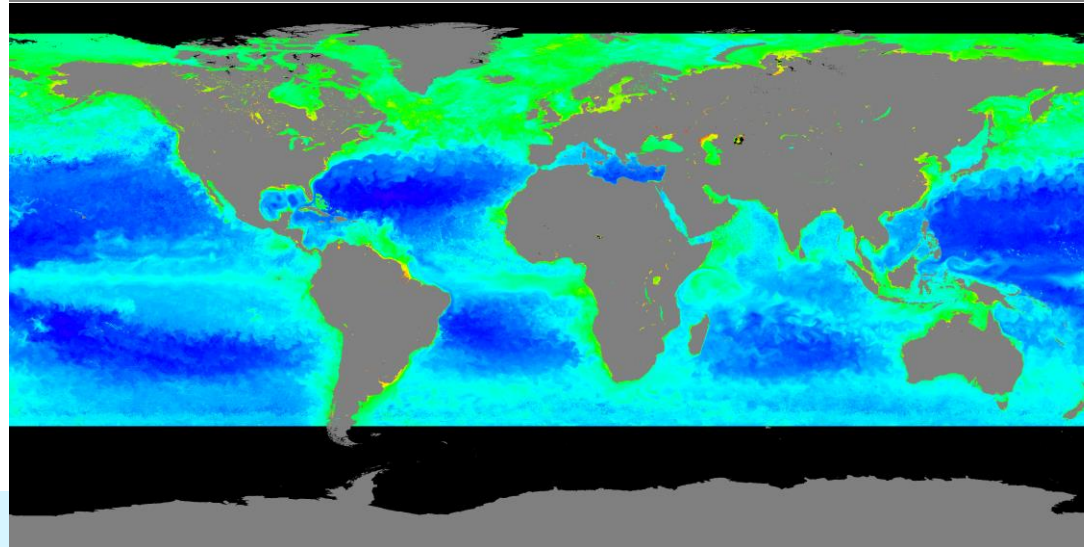
# Example of Gap-filled Products

Global 9-km Chl-a Level-3 images (June 21, 2018)

Merged product



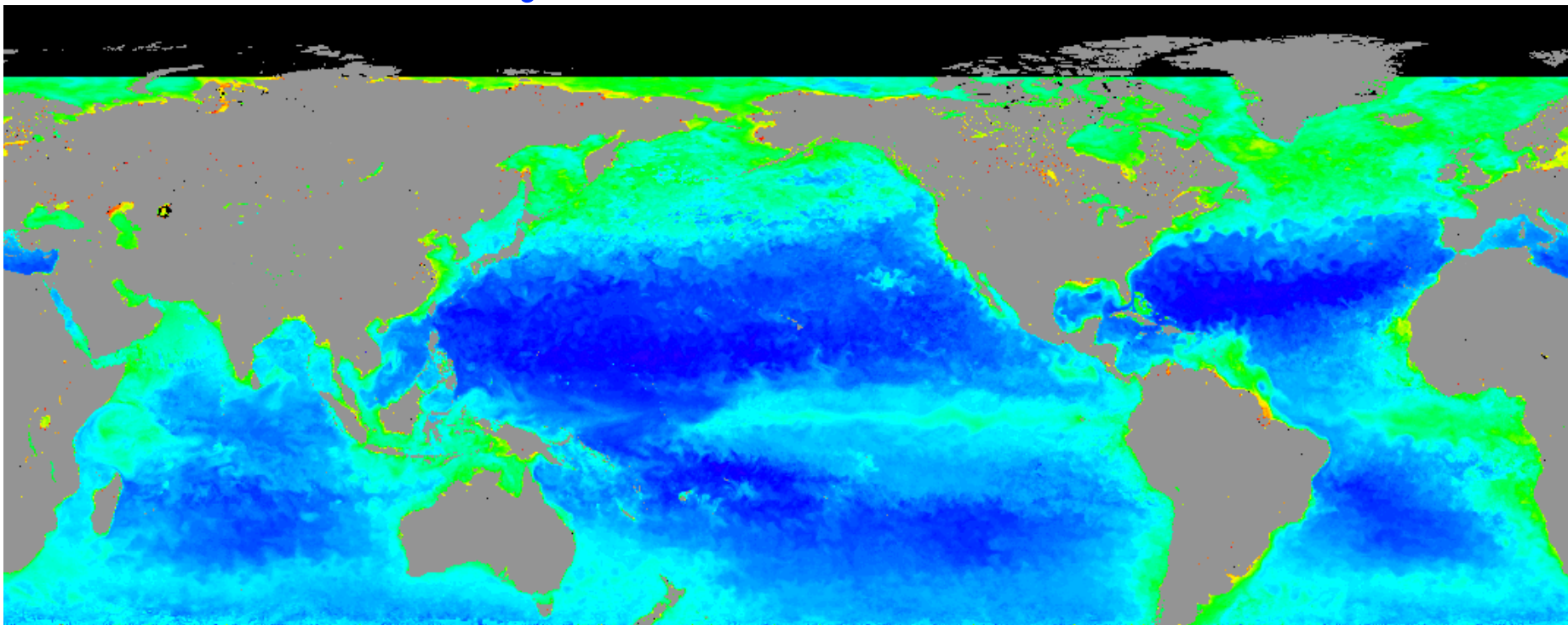
Gap-filled Product







# Gap-free Global Daily Chl-a Movie



Liu, X. and M. Wang, "Filling the gaps of missing data in the merged VIIRS SNPP/NOAA-20 ocean color product using the DINEOF method," *Remote Sens.*, **11**, 178, 2019.

<https://dx.doi.org/10.3390/rs11020178>

Liu, X. and M. Wang, "Gap filling of missing data for the VIIRS global ocean color products using the DINEOF method," *IEEE Trans. Geosci. Remote Sens.*, **56**, 4464–4476, 2018.

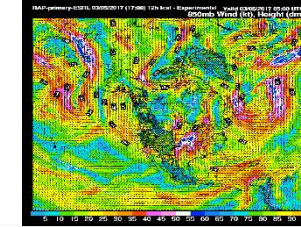
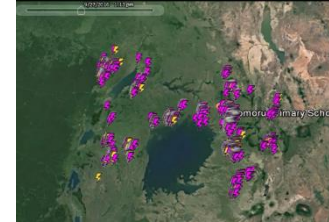
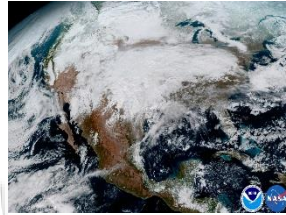
<https://dx.doi.org/10.1109/tgrs.2018.2820423>

SNPP and NOAA-20 measurements

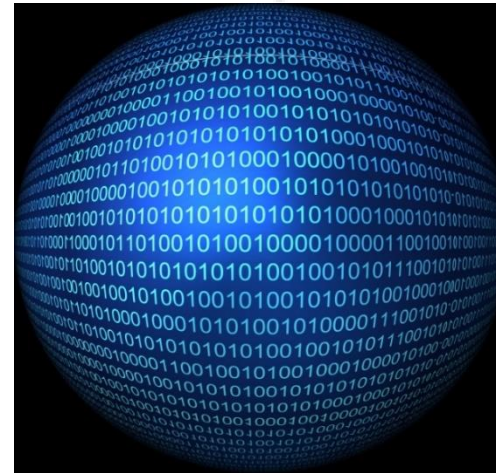
Chlorophyll-a ( $\text{mg m}^{-3}$ )

Gap-free **daily** global Chl-a data are now routinely produced and available through **CoastWatch!**

# Transformation Example: Higher Information Content

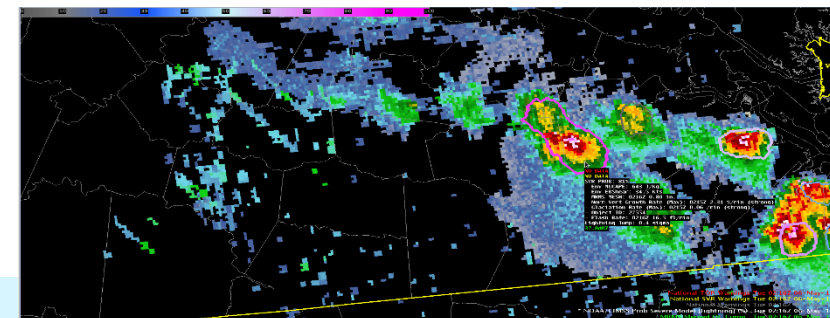
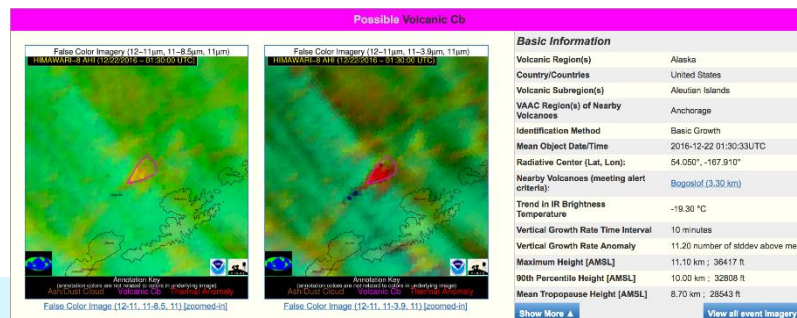


Operational applications  
require “Big Data” to be  
automatically transformed  
into information and insight  
for decision making

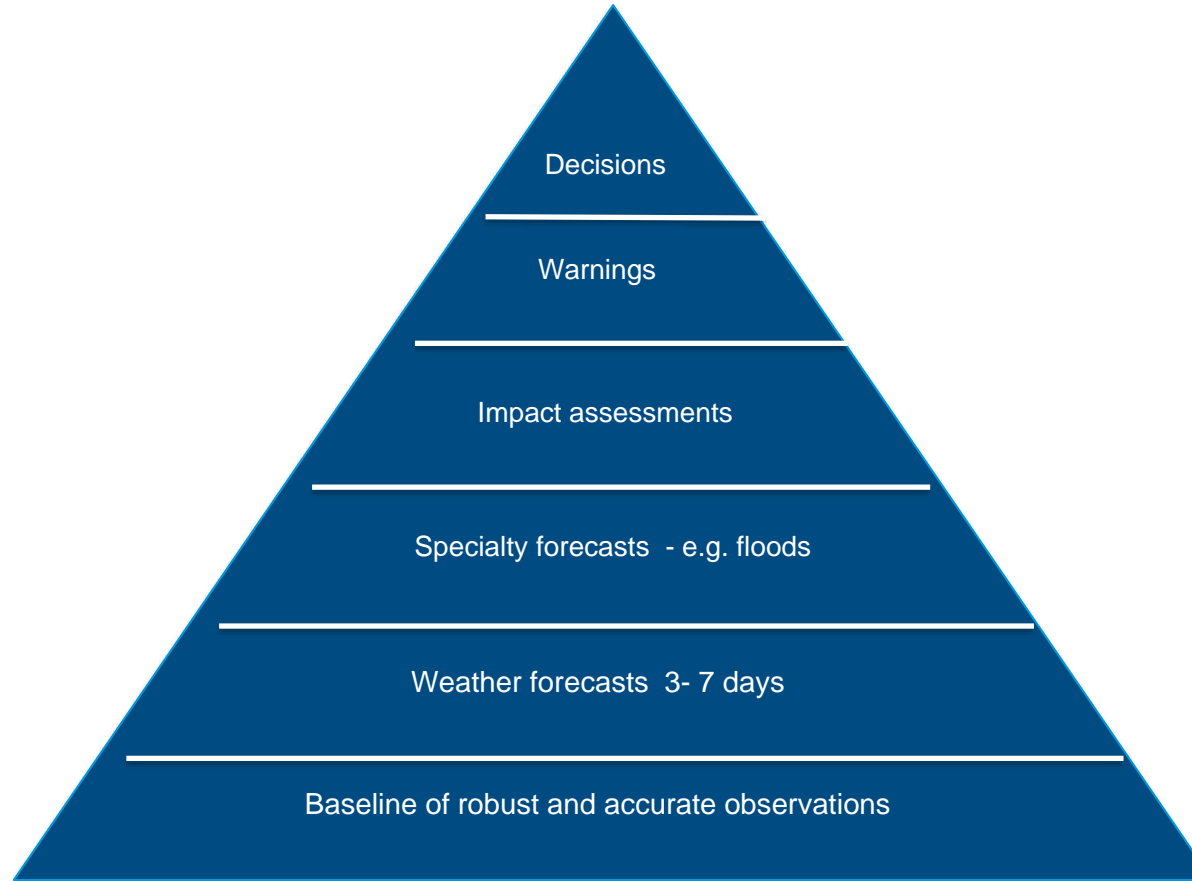


***VOLCAT***  
Volcanic Eruption Detected!

***ProbSevere***  
Severe Weather Likely



# Ultimately the value of our products is how its being applied for knowledge



*NESDIS Strategic Metric " The utilization of NESDIS developed science by internal and external partners and stakeholders through enhanced coordination with partners and the user community"*

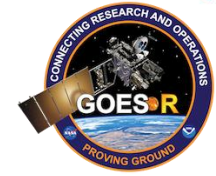
## Climb the pyramid through

- **Listening /understanding user needs and feedback**
- **Communicating our capabilities**
- **Identifying user advocates/leaders**
- **Clearly stated objectives/deliverables**
- **Managed projects**

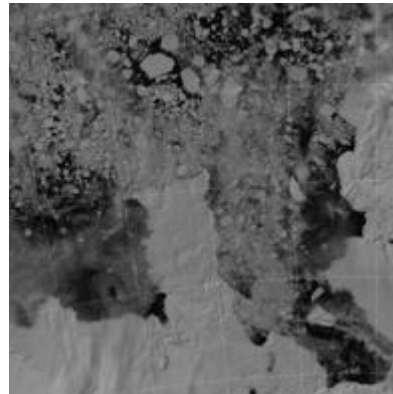


# Satellite Proving Grounds

- Supports demonstration and utilization of new capabilities by the end users
- Facilitates the transition of GOES-R and JPSS research to applications
- Incorporating user feedback for product improvements

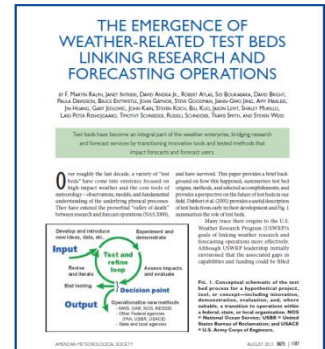
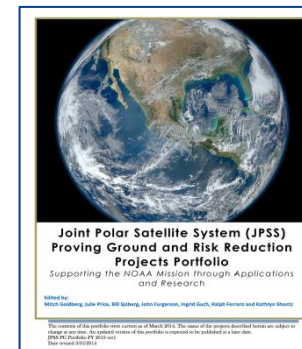
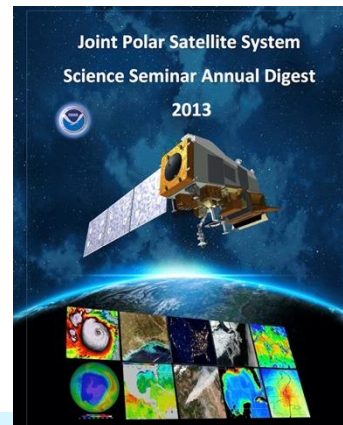
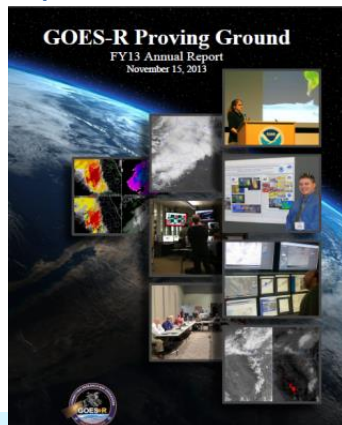


Hurricane Sandy- GOES High Density Atmospheric Motion Vectors



S-NPP Day/Night Band Ice Detection

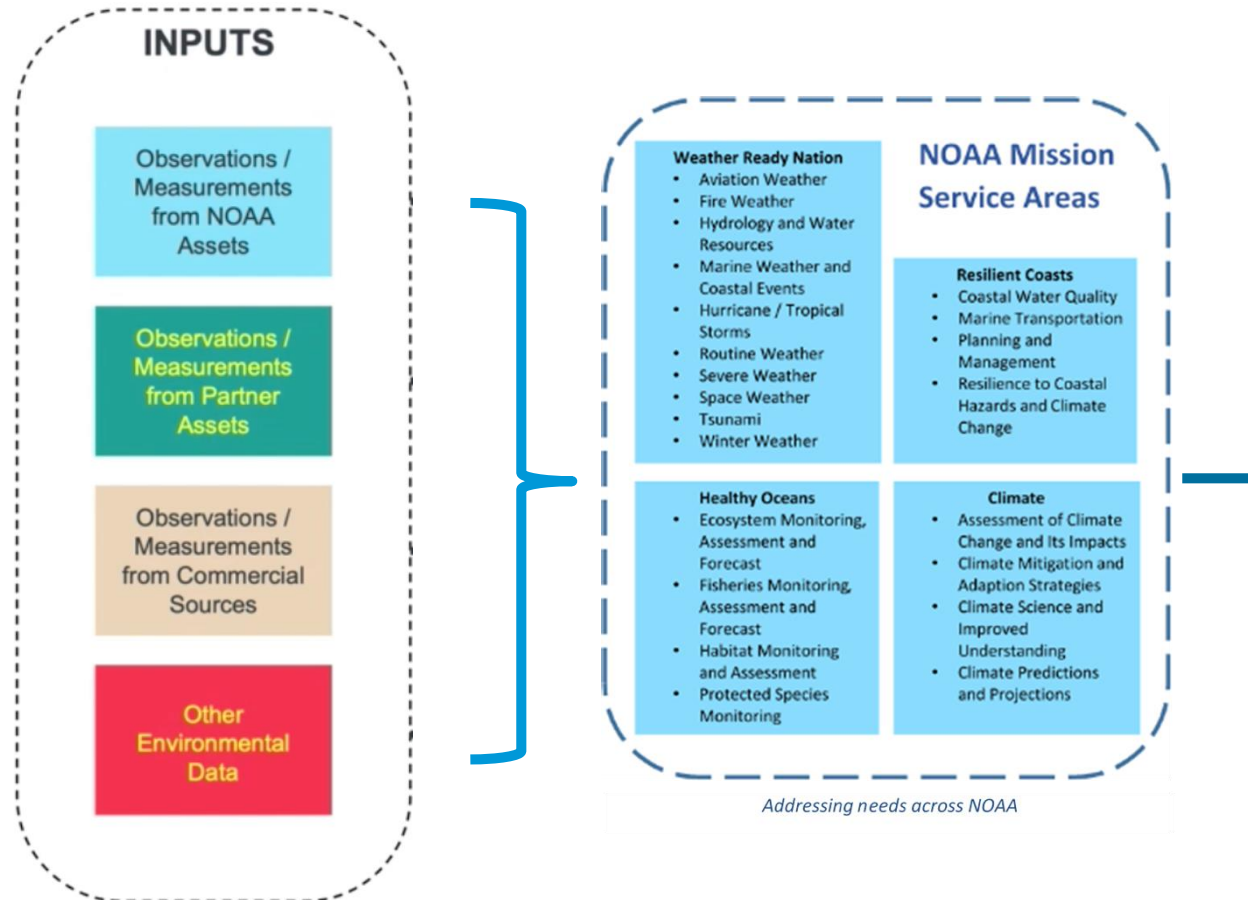
## NOAA Hazardous Weather Testbed (HWT)



Goal is to improve NOAA and partner services through optimizing the use of satellite data along with other sources of data & information



## Observations/Products to Services to Stakeholders







# The Initiatives



The initiatives comprise of a team of developers and users working together to improve an application in a testbed environment providing assessments of utility from the users and feedback to the developers.

- Arctic
- Aviation
- Fire and Smoke
- Hurricanes and Tropical Storms
- Hydrology
- NWP
- Oceans and Coasts
- River Ice and Flooding
- Sounding
- Training
- Volcanic Hazards



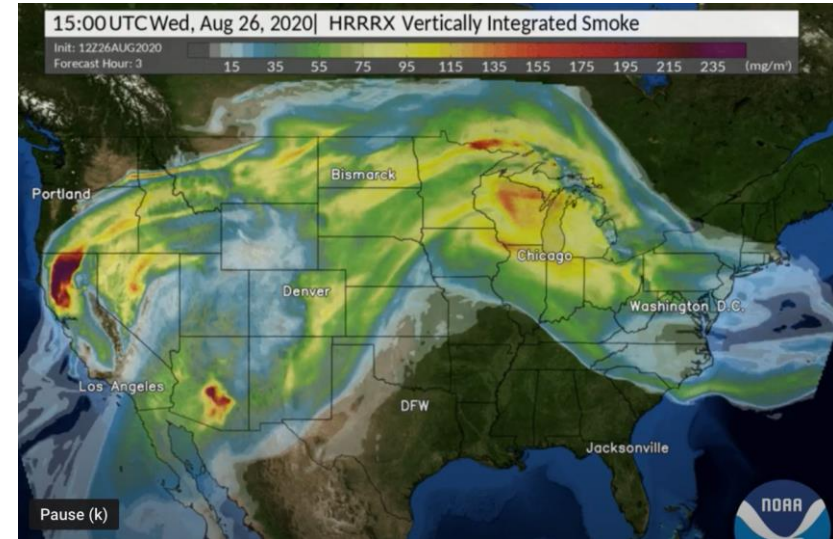
[https://www.star.nesdis.noaa.gov/star/meeting\\_2020JPSSGOES.php](https://www.star.nesdis.noaa.gov/star/meeting_2020JPSSGOES.php)



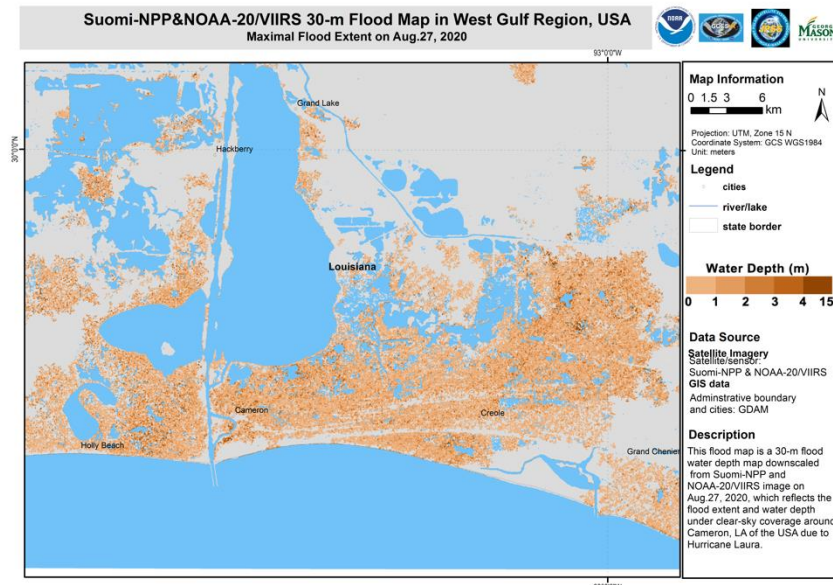
# Enterprise Proving Ground has 3 main objectives



- **Assessing “Fit for Purpose.”** Fine tuning products for new project applications
  - *Are the products “Fit for Purpose”; are they meeting expected utilization?*
  - *Are there opportunities for unrealized “Fit for Purpose”?*
- **Product Innovation. RL 2- 5**
  - *Can NOAA services be improved by new products and/or enhancing current ones?*
- **Product Innovation Demonstrations. RL 6**
  - *Full demonstrations of promising product innovations to get complete feedback from users before commitment to operational development and deployment.*



VIIRS Fire Radiative Power (FRP) ingested in HRRR Smoke Forecast Model





## NOAA Satellite Proving Ground Global Flood Website

NRT NOAA global flood map products and information

[HOME](#)[REAL EARTH FLOOD  
PRODUCTS](#)[SPONSOR, QUICK GUIDES AND  
REFERENCES](#)[BLOGS AND USEFUL  
LINKS](#)[TOOLS, ARCHIVE AND  
TRAINING LINKS](#)

This site is for users access the NOAA LEO/GEO Flood Mapping Product. Products found here are demonstration products and are run on a best effort basis.

A brief quick guide of and overview of the NOAA LEO/GEO products is shown below Click here to [download guide in PDF Form](#)

# NOAA Global Flood Product Quick Guide



Updated June 22, 2020



Click here for Quick links to regional products: [US](#), [Asia](#), [Global](#)

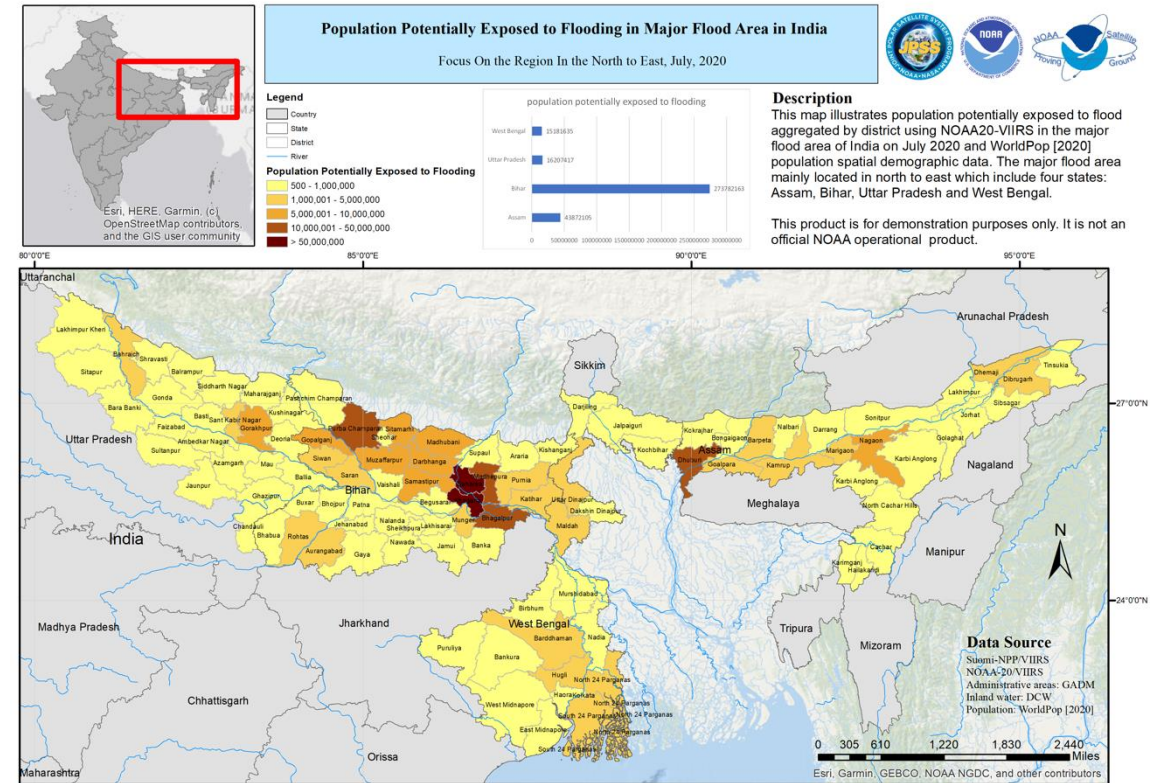
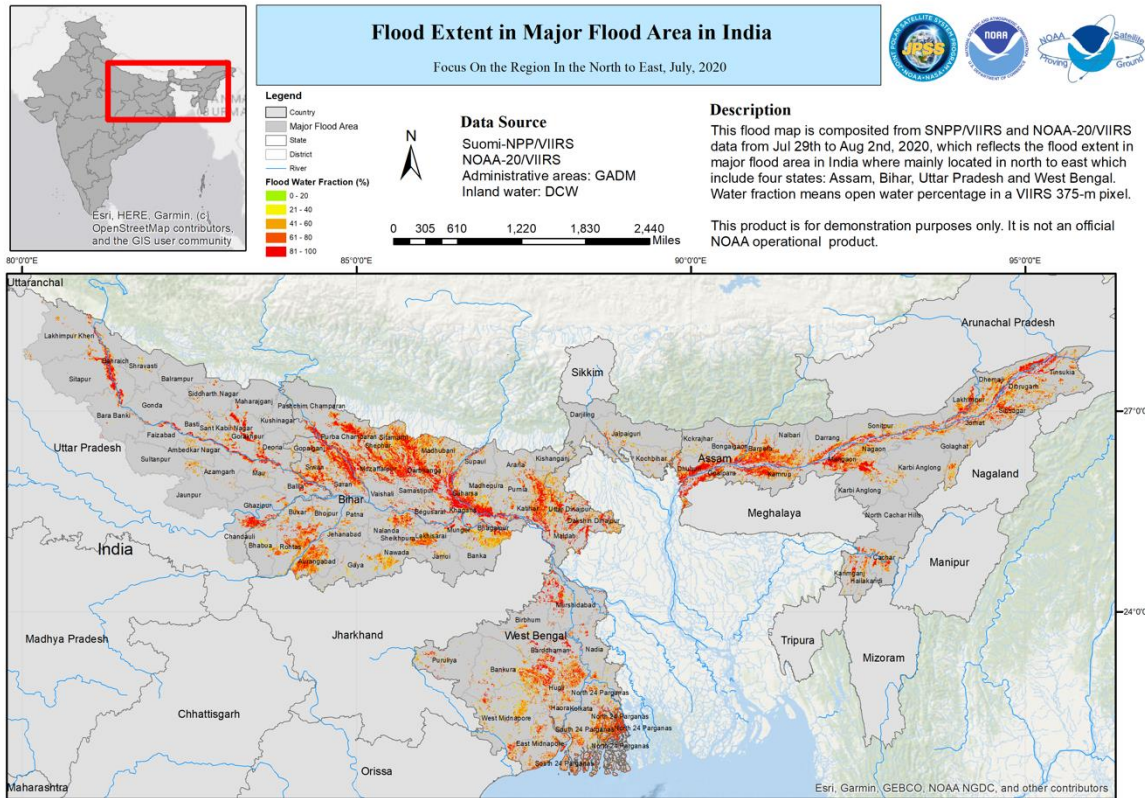
Click [here](#) for an embedded SSEC RealEarth map with some basic flood products.





# Flood Composites and Impacted Populations estimated from NOAA VIIRS.

CEOS Flood Pilot will integrate more satellite source, including SAR, to improve representativeness and accuracy.

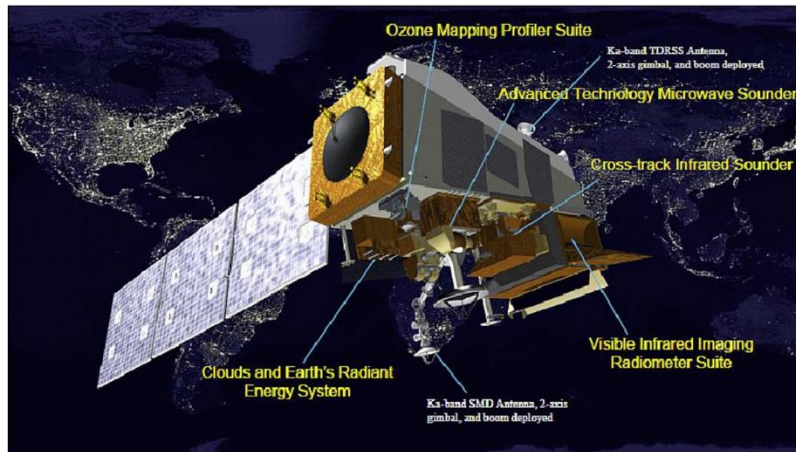




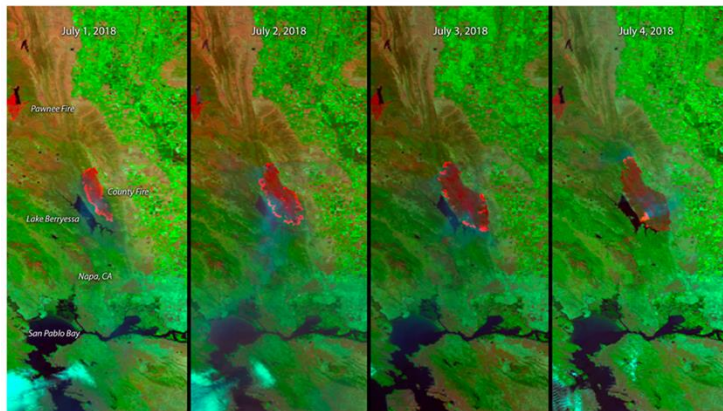


# Fire and Smoke Initiative

## JPSS Program – Polar orbiting

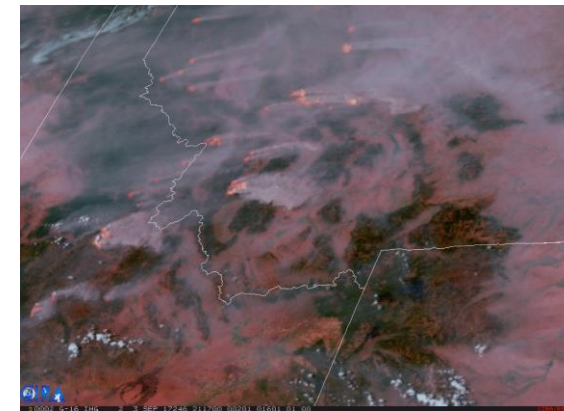
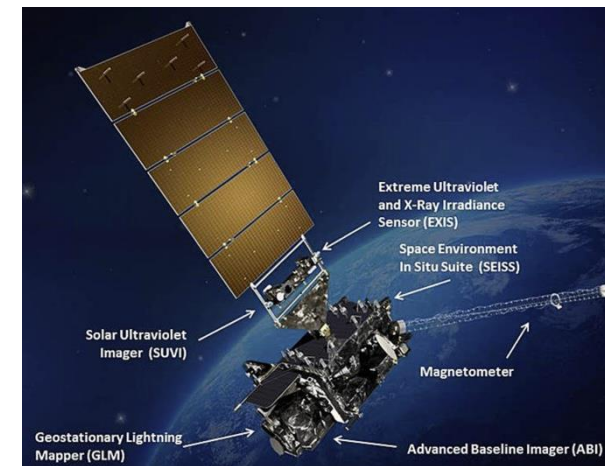


### The Expanding County Fire in Northern California



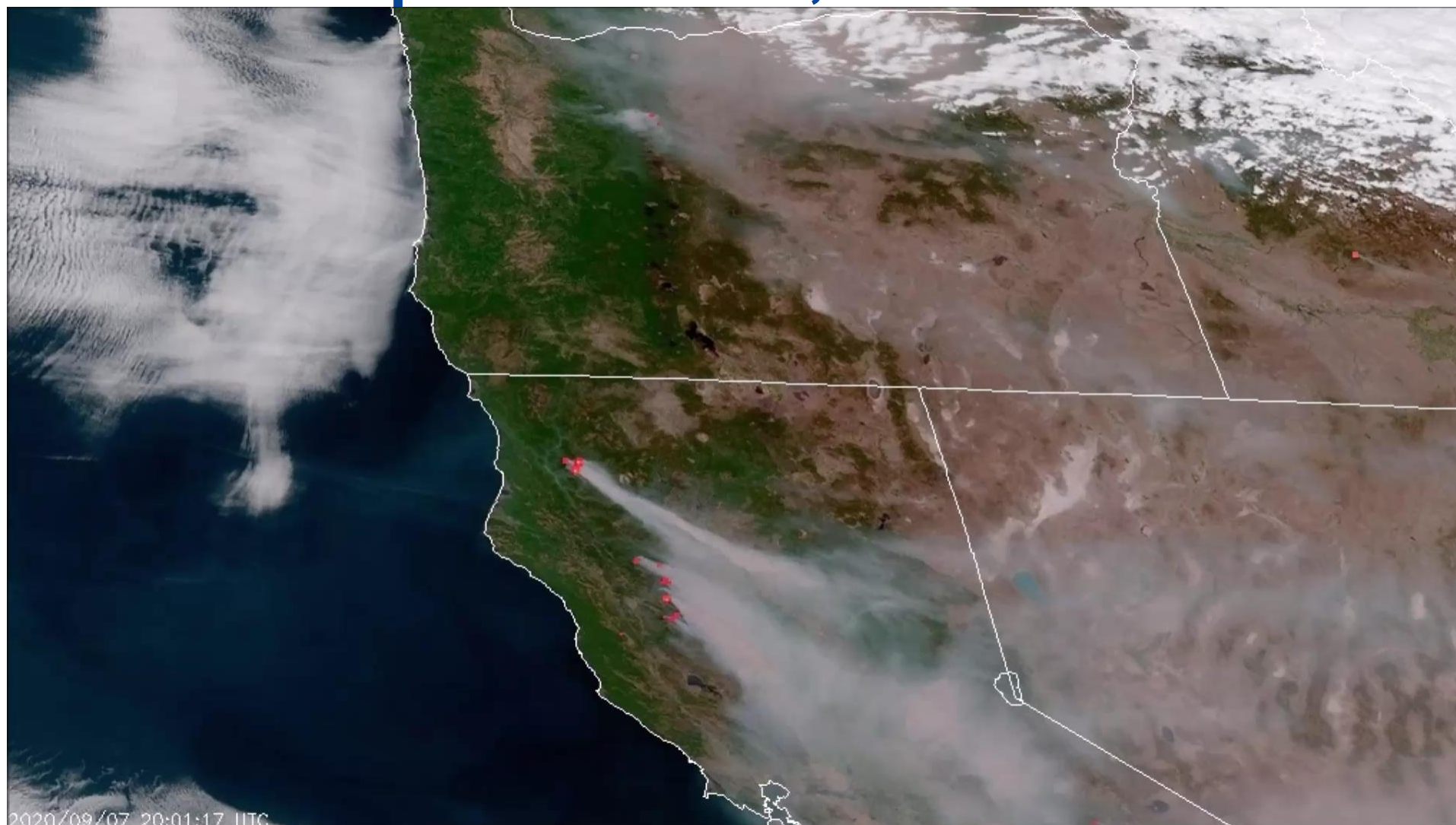
JPSS provides high spatial resolution ~ 375 m used for identifying fire perimeters and for input to smoke forecast models

## GOES-R Series - Geostationary



GOES East and West provides nearly continuous observations of fires at a 2 to 3 km resolution (function of latitude ~ 6 km in central Alaska)

# Oregon and California Fires, September 7 – 9, 2020

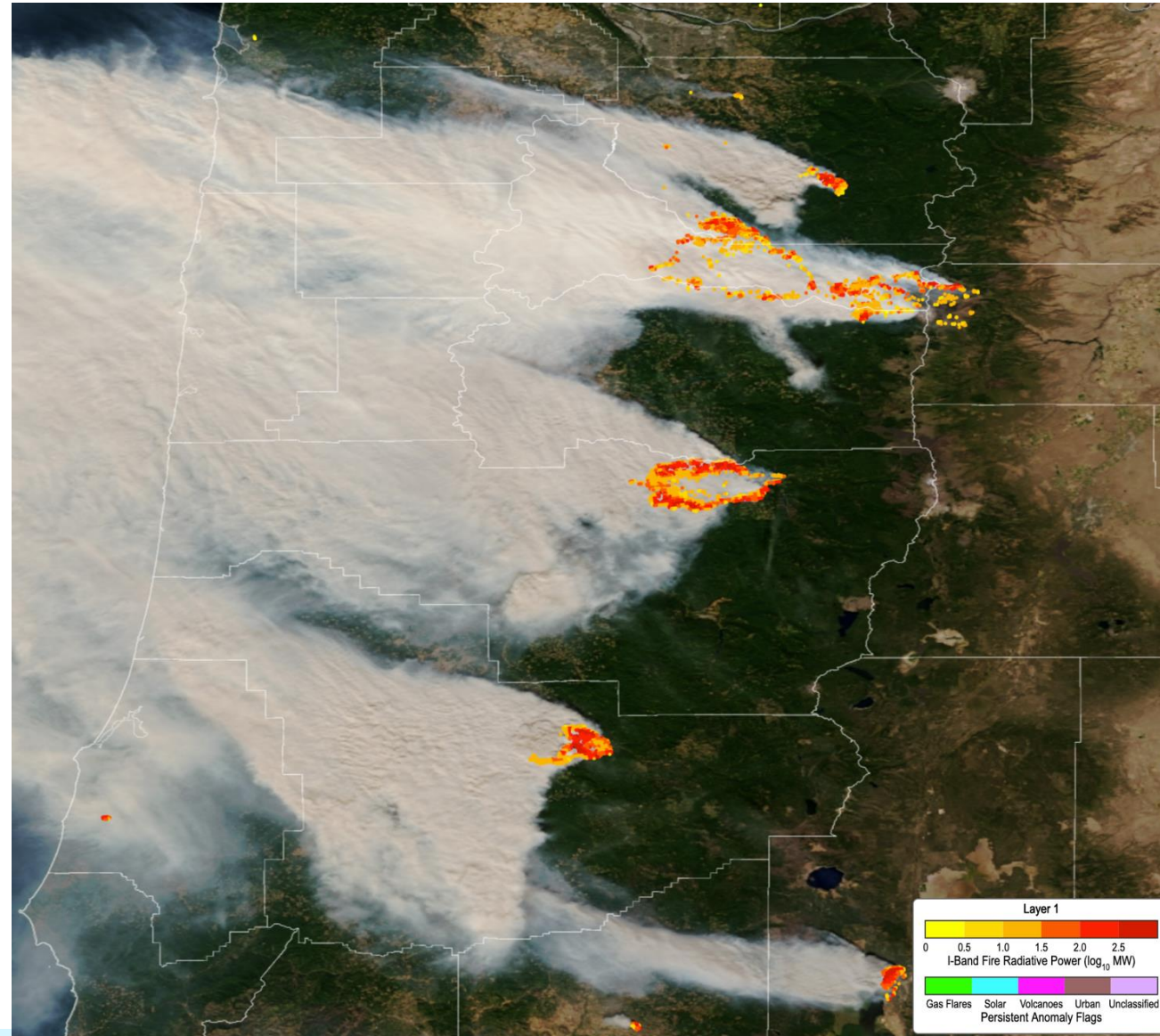


2020/09/07 20:01:17 UTC



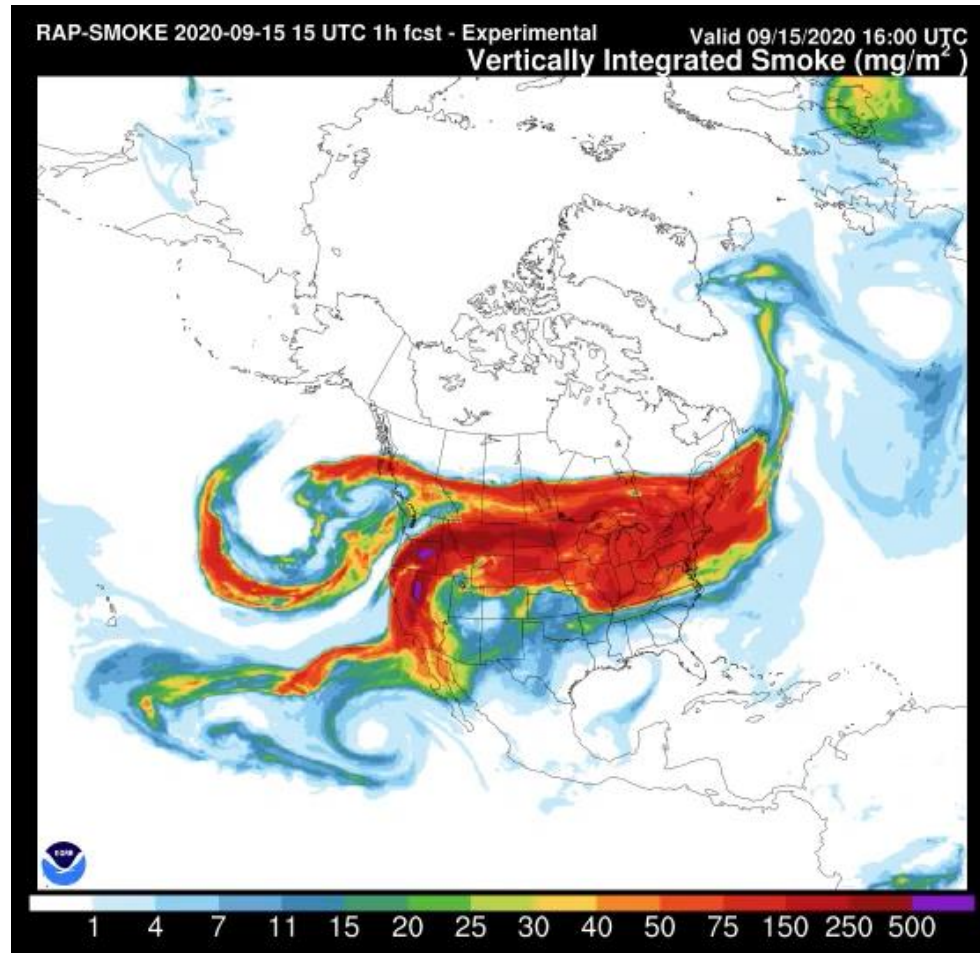


# JPSS provides higher spatial resolution

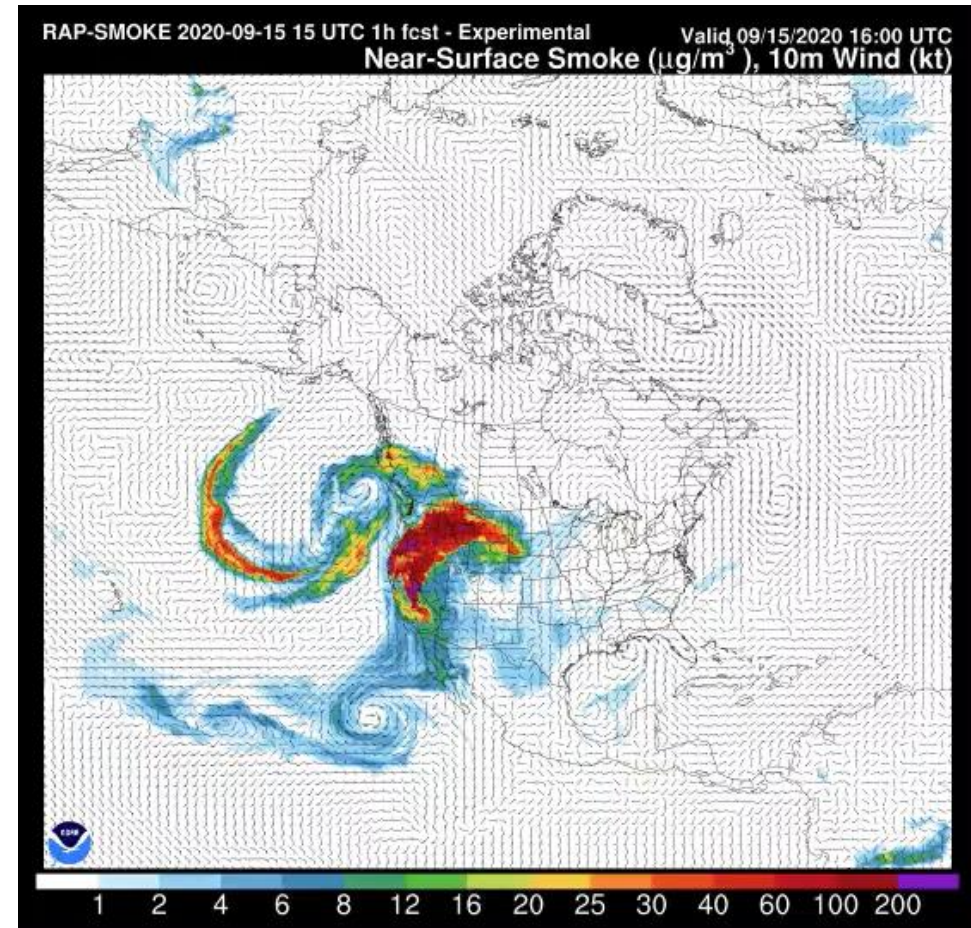




# VIIRS Fire Radiative Power is used in the HRRR Smoke Model



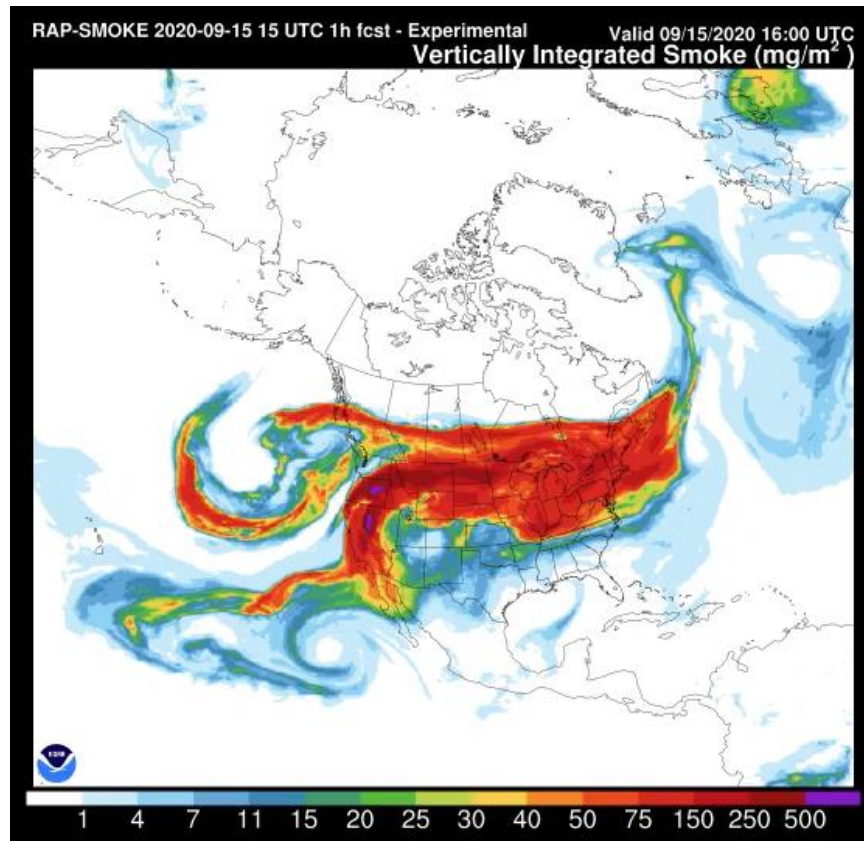
Total vertically integrated smoke



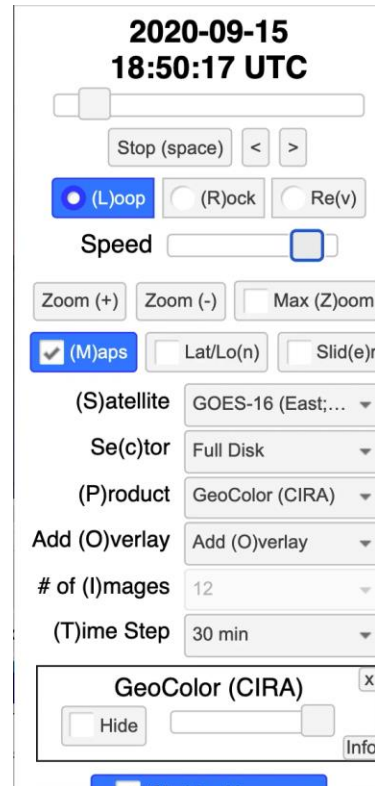
Near surface smoke



# VIIRS Fire Radiative Power is used in the HRRR Smoke Model

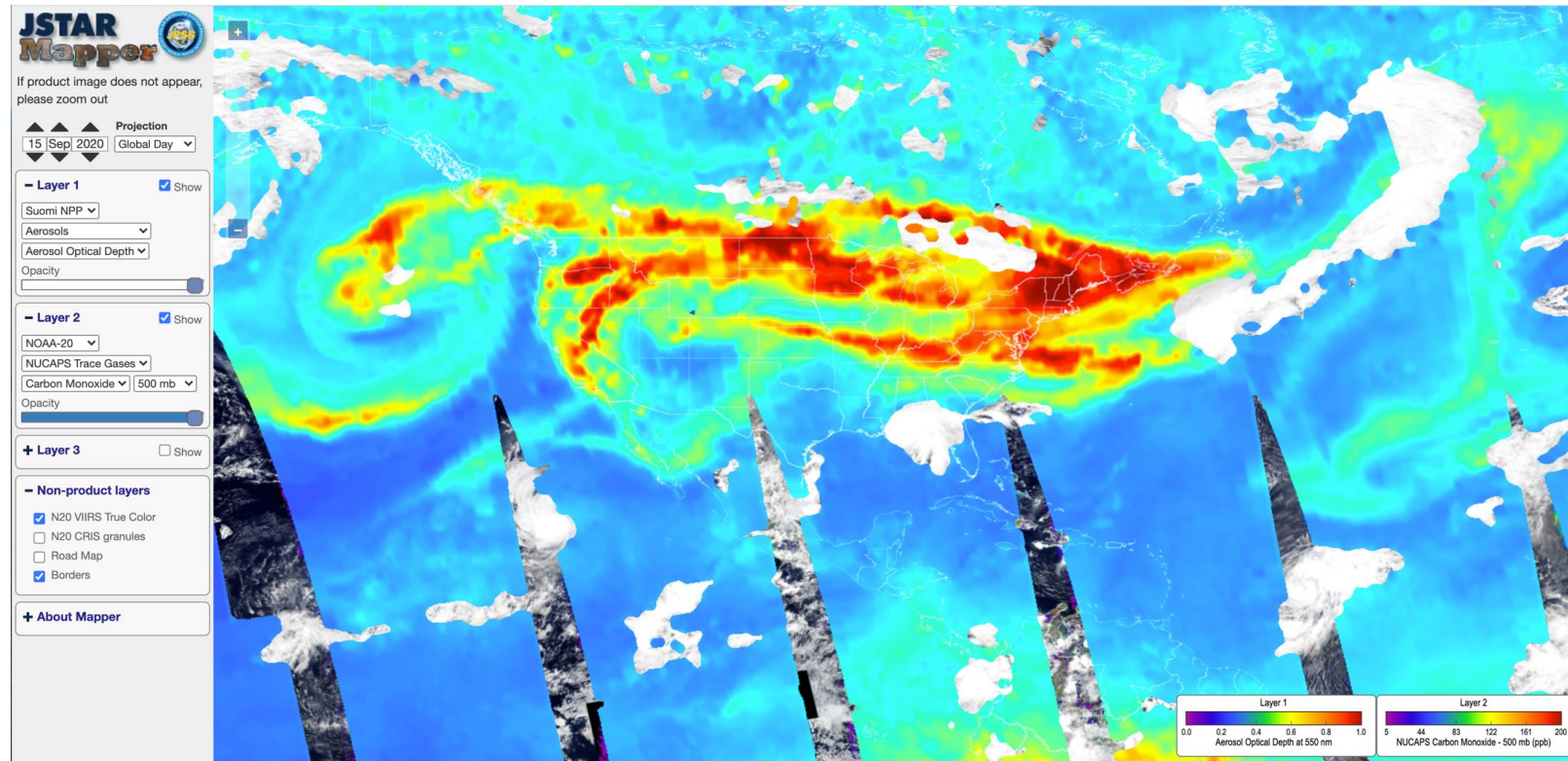


Total vertically integrated smoke



GOES-16 GeoColor imagery

# JPSS derived Aerosols and Carbon Monoxide



Developing plans with NWS/NCEP to enable the assimilation of satellite aerosols and trace gas products in their models to meet their Mission needs.

September 15, 2020  
Smoke extent from Western Fires



# Training via UCAR COMET

[https://www.meted.ucar.edu/satmet/western\\_wildfires\\_2019/navmenu.php?tab=1&page=1-0-0&type=flash](https://www.meted.ucar.edu/satmet/western_wildfires_2019/navmenu.php?tab=1&page=1-0-0&type=flash)



[meted.ucar.edu/satmet/western\\_wildfires\\_2019/navmenu.php?tab=1&page=1-0-0&type=flash](#)🔍 ⭐ 🌐

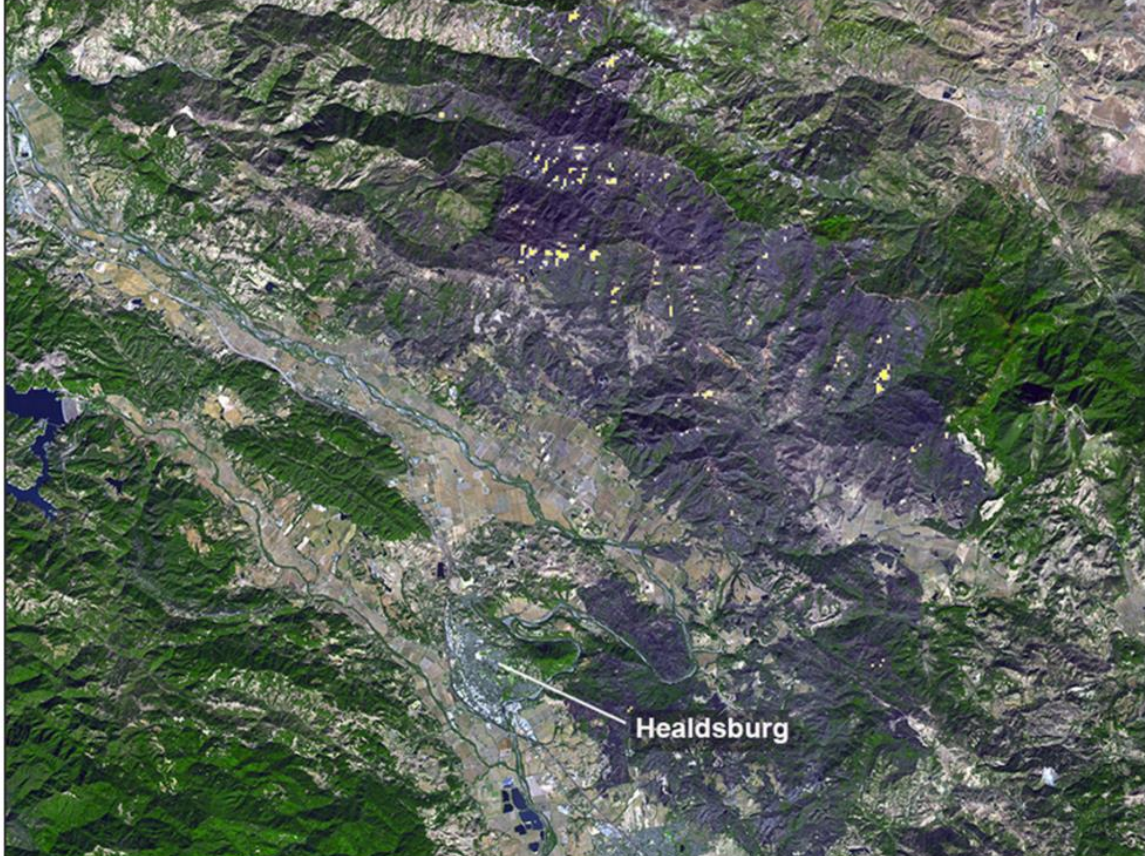
HomeLessonDownloadGalleryQuizSurveyBooster

## GOES-R/JPSS Case Exercise: Detecting and Monitoring Western US Wildfires

- 1.0 Introduction**
- 2.0 Key Dates: The Kincade Fire
- 3.0 Detecting a Fire Start
- 4.0 Monitoring Fire Spread
- 5.0 Event Summary and Testimonials
- 6.0 Resources
- Contributors

### 1.0 Introduction

In the fall of 2019 a number of high profile and rapidly spreading fires ignited throughout California. The largest, the Kincade fire, was active from 23 October to 6 November in Sonoma County. The fire burned nearly 78,000 acres and damaged or destroyed over 400 structures.



Healdsburg

[Print](#)



# NESDIS Services, Stewardship and Assessments



# SATELLITE ANALYSIS BRANCH FIRE DETECTION PRODUCT:

## HAZARD MAPPING SYSTEM (HMS)



**Davida Streett, John Simko, Wilfrid Schroeder**

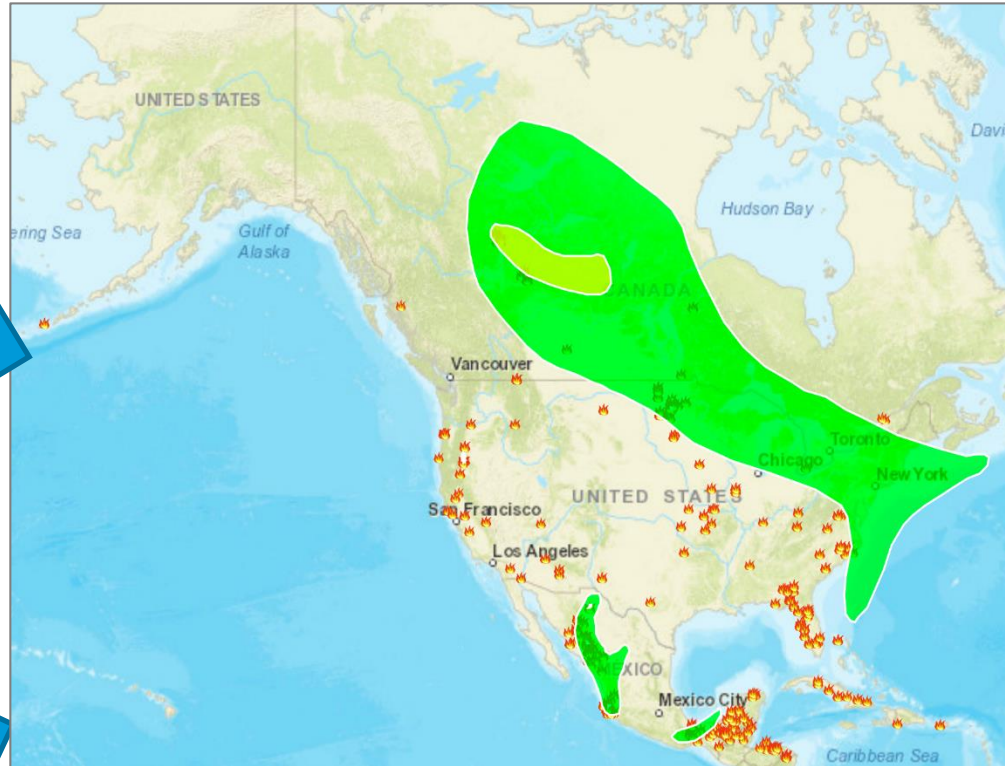
### Satellites & Sensors

- S-NPP & NOAA-20 VIIRS
- GOES-16 & 17 ABI
- Terra MODIS
- Landsat-7/ETM+ & Landsat-8/OLI
- Sentinel-2/MSI

**Coming soon:  
Sentinel-3/SLSTR**

### Fire Algorithms

- VIIRS AF (NOAA)
- ABI FDC (NOAA)
- MODIS MOD14 (NASA)



### USERS include:

- NWS
- Forestry Service
- ARL
- EPA
- USGS
- BLM
- State/local land mngt
- State/local air quality
- FEMA
- DOD
- Fire responders
- Researchers
- Public





Connecting  
ocean and coastal  
users  
with satellite data  
for decision-making



INCREASING  
ASSISTANCE TO USER

Provide access to curated datasets with data servers, including the interactive viewing, layering, aggregating, subsetting and downloading with **the CoastWatch Data Portal**

Develop tools and tutorials to help users access and use data

Provide training and hands-on assistance – Satellite Data Courses

Find or create products in response to users needs

Work directly with users on developmental projects

CoastWatch HelpDesk, User forum

[CoastWatch.NOAA.gov](https://CoastWatch.NOAA.gov)





# NCEI Tiers of Stewardship



## 6: National Services and International Leadership

- Establish highly specialized levels of data services and product assessments



## 5: Authoritative Records

- Establish authoritative quality, uncertainties, and provenance



## 4: Derived Products

- Distill, combine, or analyze products and data to create new or blended scientific data products

## 3: Scientific Improvements

- Improve data quality or accuracy with scientific quality assessments, controls, warning flags, & corrections



## 2: Enhanced Access and Basic Quality Assurance

- Create complete metadata, automate QA and provide enhanced data access through specialized software services



## 1: Long Term preservation and Basic Access

- Preserve original data with metadata for discovery and access
- Serve as expert advisors on standards for data providers and coordinate support agreements for sustainable data archiving

Traceable  
Transparent  
Consistent  
Documented





# Monitoring & Assessment

## *Draw meaning and strategic value across NCEI's climate data holdings*

- **Climate Monitoring**

- Aggregate and blend climate scale data for weekly/monthly/seasonal “play-by-play” of the climate system

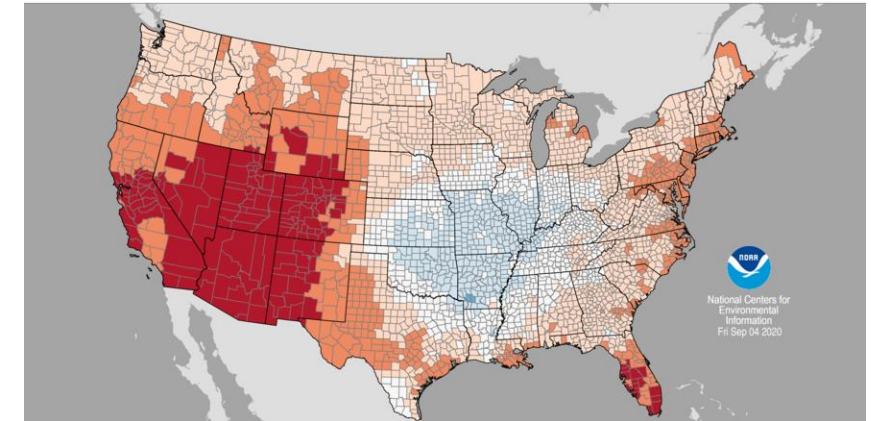
- **BAMS State of the Climate**

- ~200 analyses from ~500 authors for 40+ ECVs and many other phenomena
- “Annual physical of the climate system”

- **Technical Support: Nat'l Climate Assessment.**

- Interagency report is assembled in CSSD
- Ensures data quality and provenance, creates indices, synthesizes model output
- Provides necessary corrections and treatment for data sets

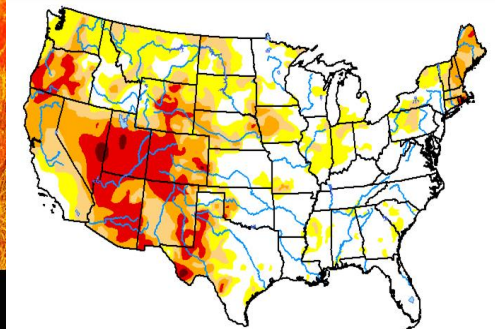
County Average Temperature Ranks  
August 2020  
Period: 1895–2020



STATE OF THE CLIMATE  
IN 2019



U.S. Drought Monitor  
Continental U.S. (CONUS)





# Summary

- **NESDIS Science is across the enterprise**
- **Our use-inspired science is an integral part of NOAA-wide services.**
- **Coordination between Research, Applications, and Stewardship Improves End-to-end Science Productivity**

