



NOAA

**Satellite and
Information
Service**

**29 September
2020**

@NOAASatellites

NESDIS Science Overview

Dr. Mitch Goldberg, NESDIS Senior Scientist

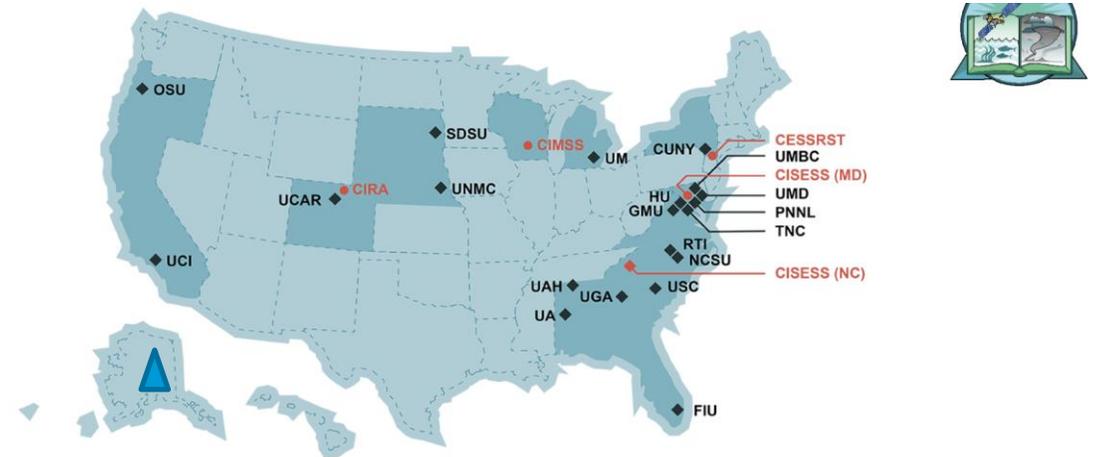
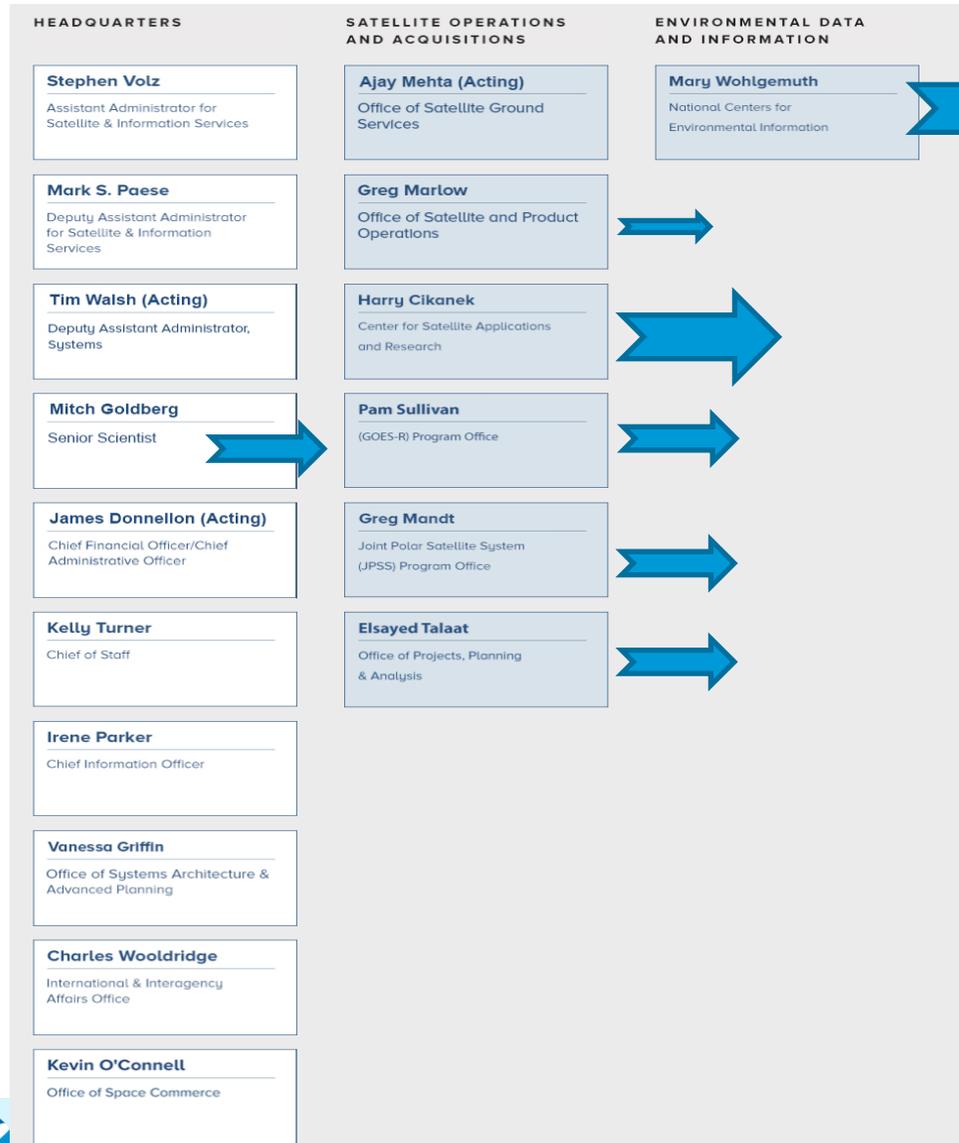
Community Meeting on NOAA Satellites



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

Science cuts across the NESDIS organization



- ▶ CISESS (College Park, MD & Asheville, NC)
- ▶ CIMSS (Madison, WI)
- ▶ CIRA (Fort Collins, CO)
- ▶ CESSRST (New York City, NY)
- ▶ CUNY - City University of New York (New York, NY)
- ▶ FIU - Florida International University (Miami, FL)
- ▶ GMU - George Mason University (Fairfax, VA)
- ▶ HU - Howard University (Washington, DC)
- ▶ NCSU - North Carolina State University (Raleigh, NC)
- ▶ OSU - Oregon State University (Corvallis, OR)
- ▶ PNNL - Pacific Northwest National Laboratory (College Park, MD)
- ▶ UA - University of Alabama (Tuscaloosa, AL)
- ▶ UAH - University of Alabama Huntsville (Huntsville, AL)
- ▶ UCAR - University Corporation for Atmospheric Research (Boulder, CO)
- ▶ UCI - University of California Irvine (Irvine, CA)
- ▶ UGA - University of Georgia (Athens, GA)
- ▶ UM - University of Michigan (Ann Arbor, MI)
- ▶ UMBC - University of Maryland Baltimore County (Catonsville, MD)
- ▶ UMD - University of Maryland College Park (College Park, MD)
- ▶ UNMC - University of Nebraska Medical Center (Omaha, NE)
- ▶ USC - University of South Carolina (Columbia, SC)
- ▶ RTI - Research Triangle Institute (Research Triangle Park, NC)
- ▶ SDSU - South Dakota State University (Brookings, SD)
- ▶ TNC - The Nature Conservancy (Arlington, VA)

Cooperative Institute and Academic Partners

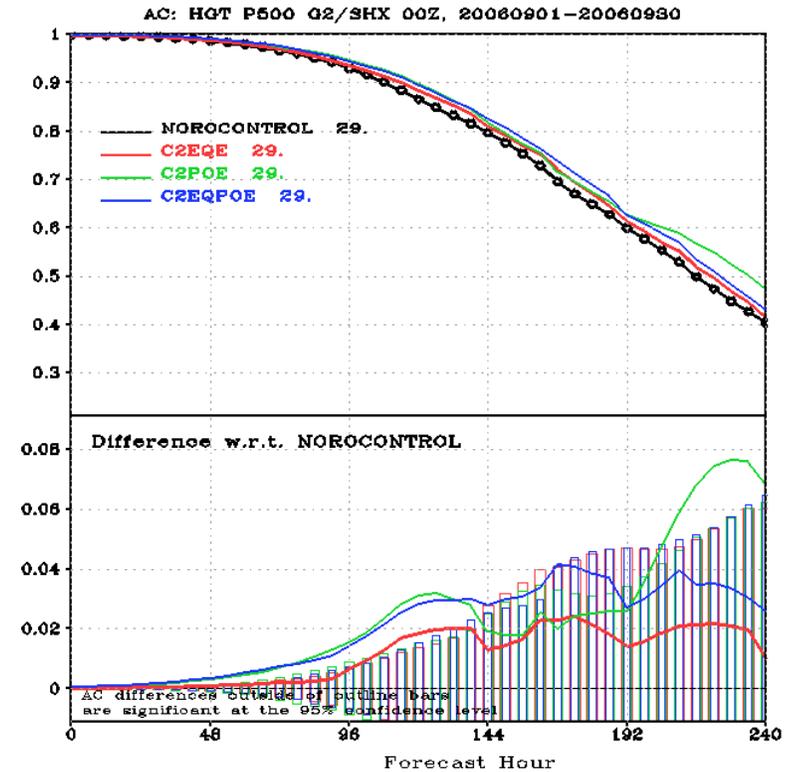
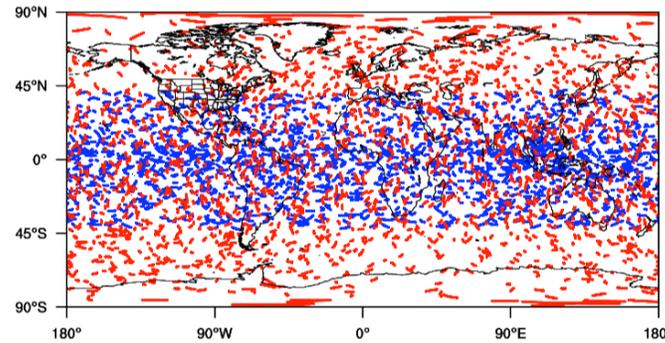
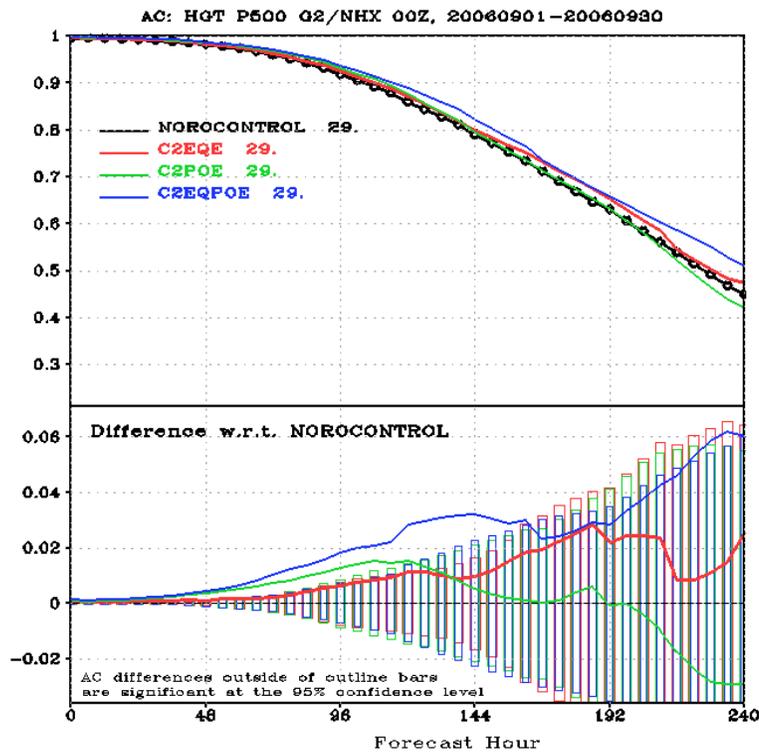
Science across the NESDIS Enterprise and Lifecycle

- 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

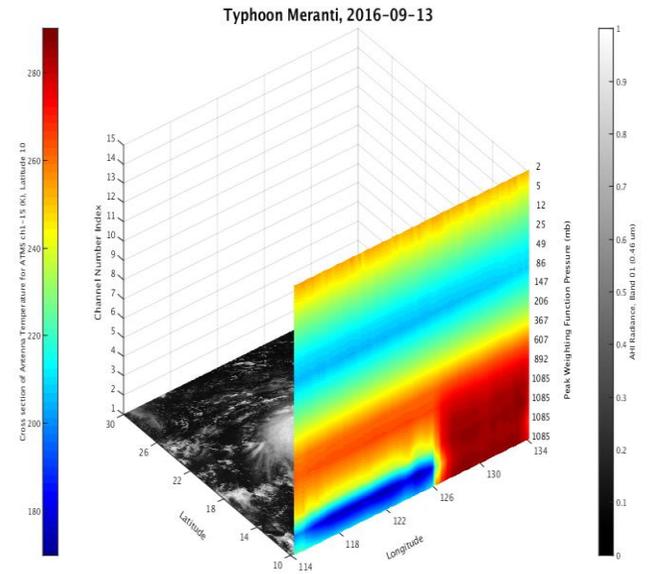
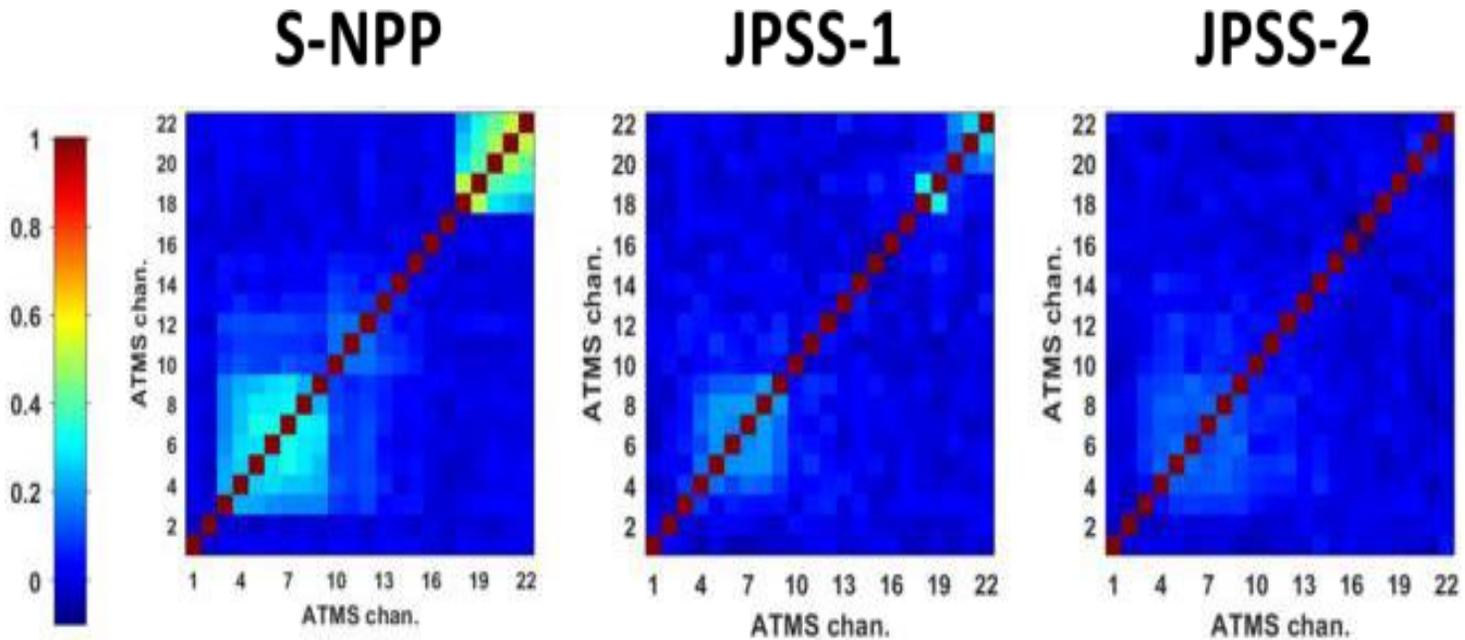
C2POE: NOROCONTROL + C2 Polar

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 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-NPP NOAA-20 GCOM

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 ¹	20-Mar-18 ¹	16-May-19
VIIRS	Aerosol Detection	18-Apr-18 ¹	18-Apr-18 ¹	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 Csiszar](#)

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) of fires as detected, and a full mask consisting of a 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:

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

Where ρ_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:

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

Here ΔT_{13-15} represents the brightness temperature difference between channel M13 and M15. The T_{13}^* and ΔT_{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:

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

Product and Data Access

M-Band Active Fires:

- Tailored version of the M-band UMD / NA
- Operational within NDE system since Mar 2018
- Includes fire mask and additional output: $\rho_5 + \rho_7$
- Provides a 2D array of values representing $\rho_5 + \rho_7$ of each pixel. This is a new attribute to derive fire mask
- Provides global coverage (include water)

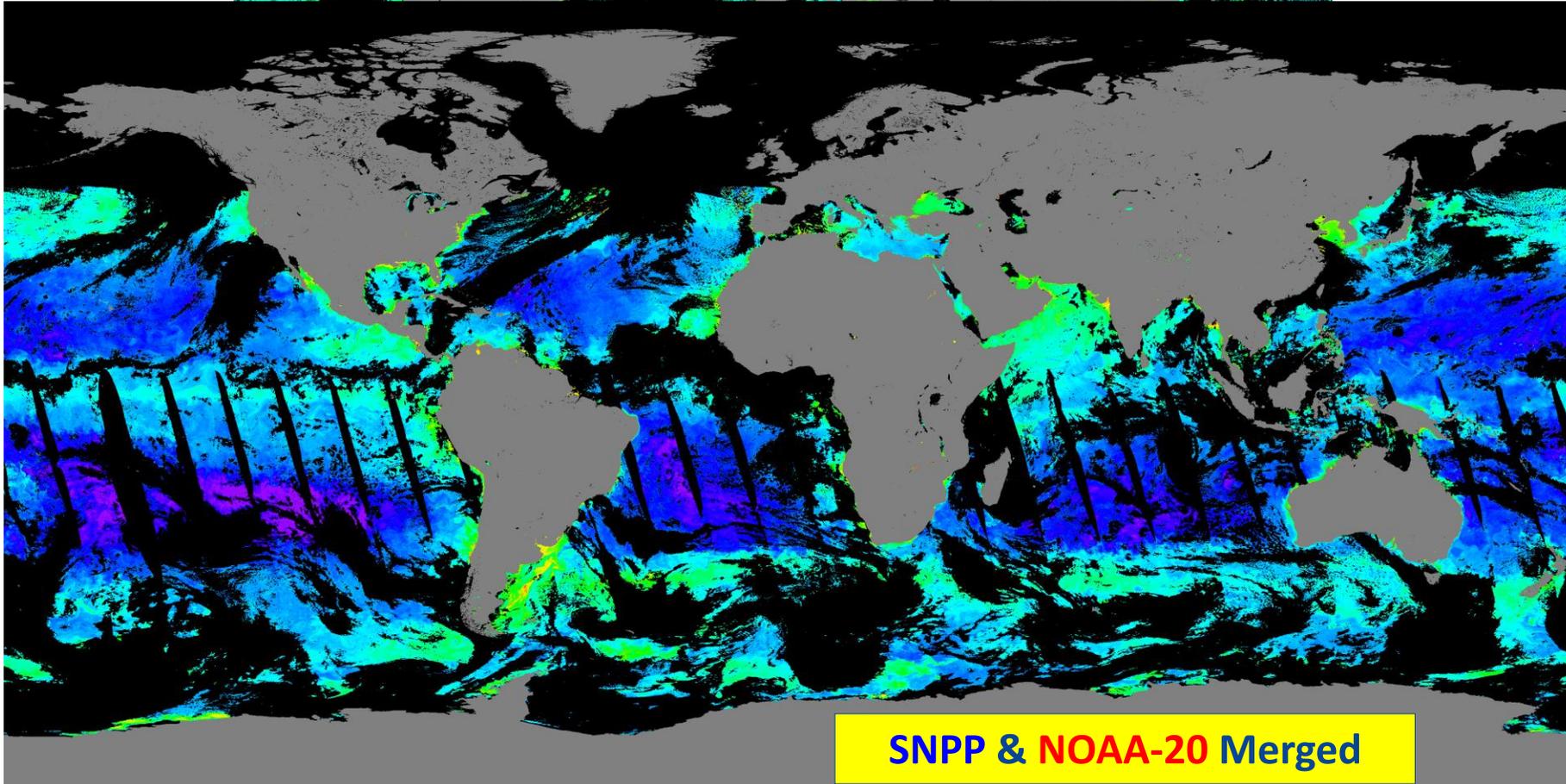
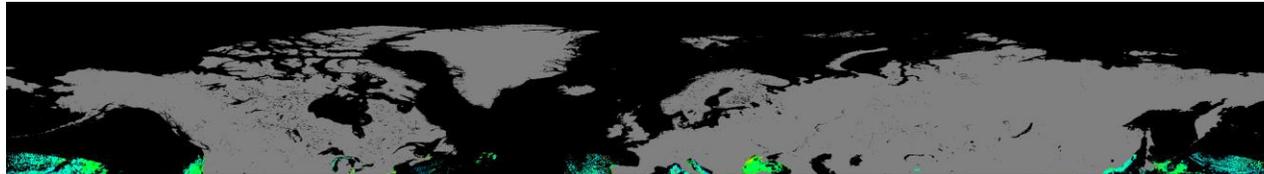
Users

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

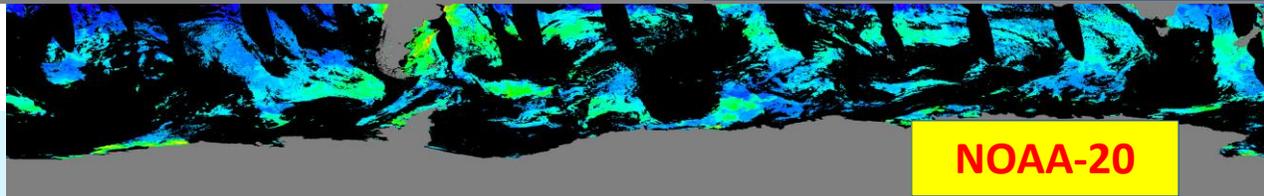
VIIRS-SNPP and NOAA-20 Chl-a Images

(January 6, 2018)

DATA FUSION and AI



SNPP & NOAA-20 Merged



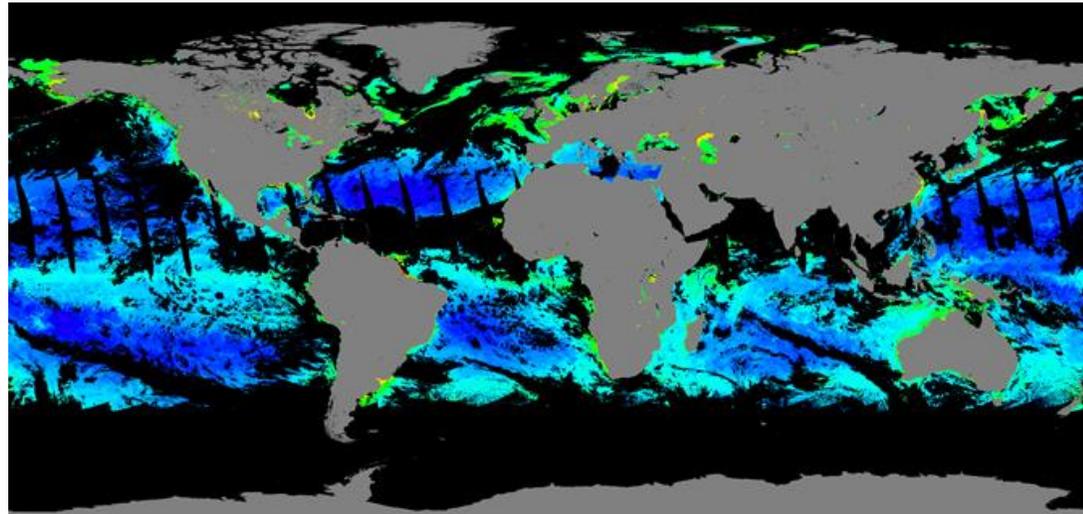
NOAA-20



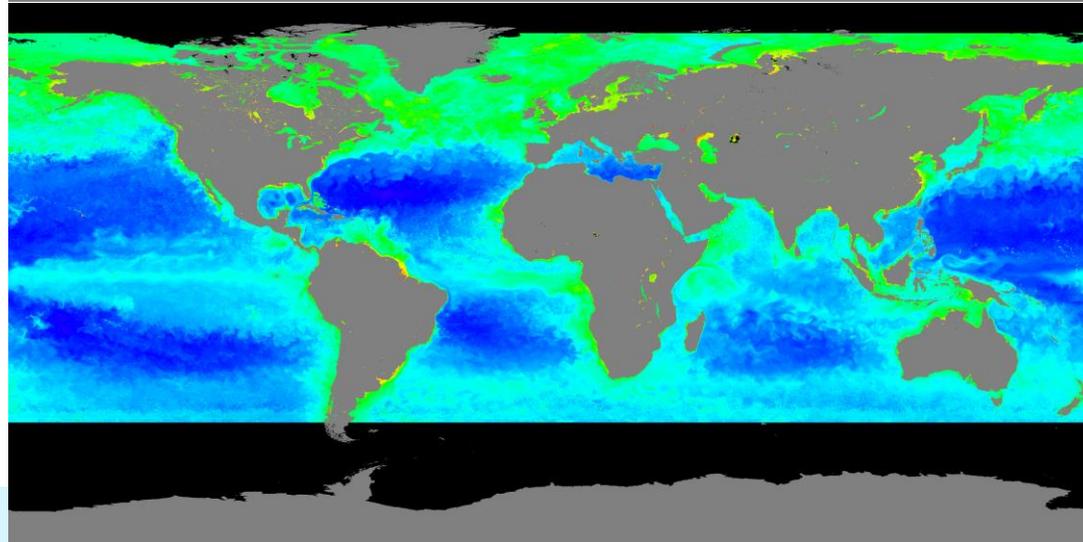
Example of Gap-filled Products

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

Merged product

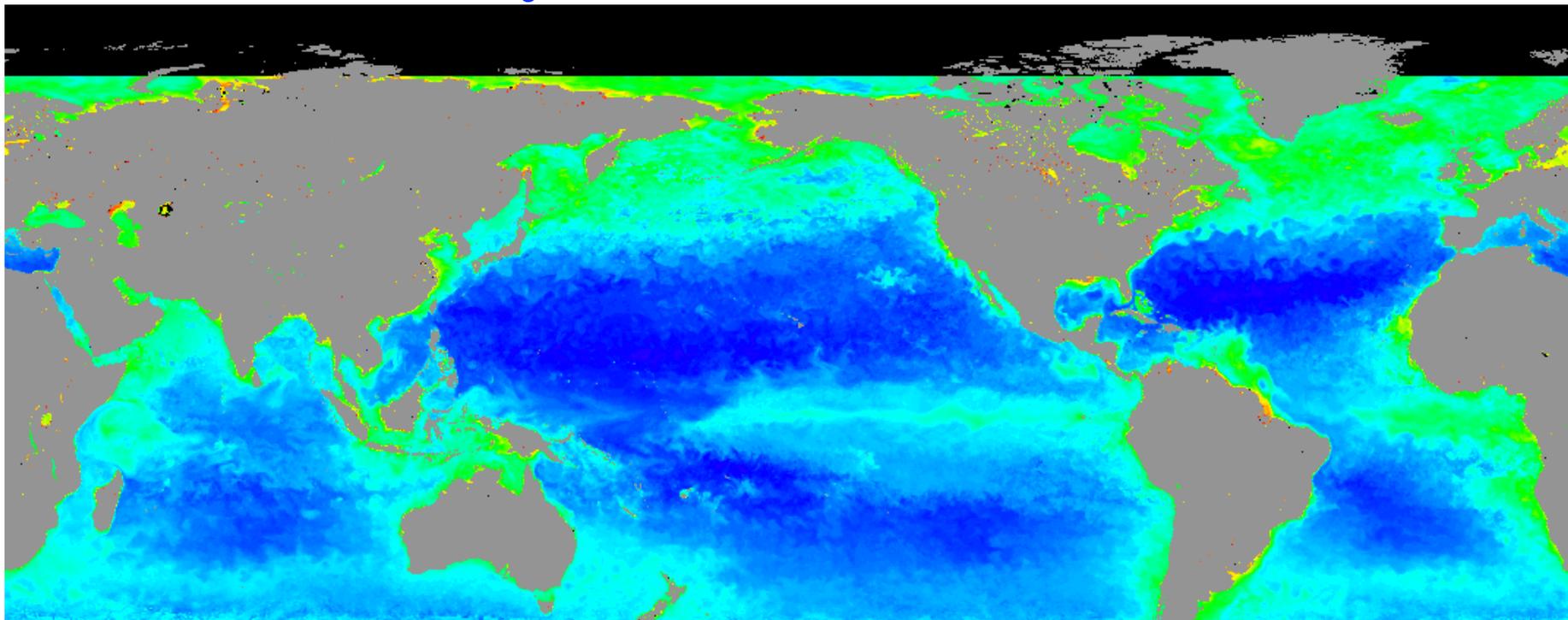


Gap-filled Product





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>

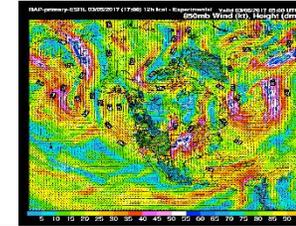
SNPP and NOAA-20 measurements

Chlorophyll-a (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

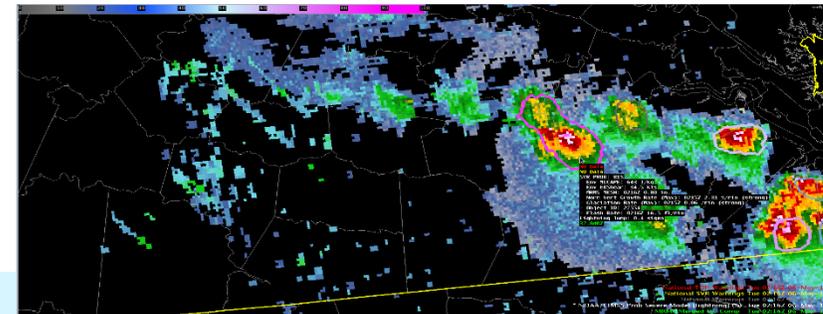
Possible Volcanic Cb

False Color Imagery (12-11µm, 11-8.6µm, 11µm)
HIMAWARI-8 AH 130226014 - 01:30:10 UTC

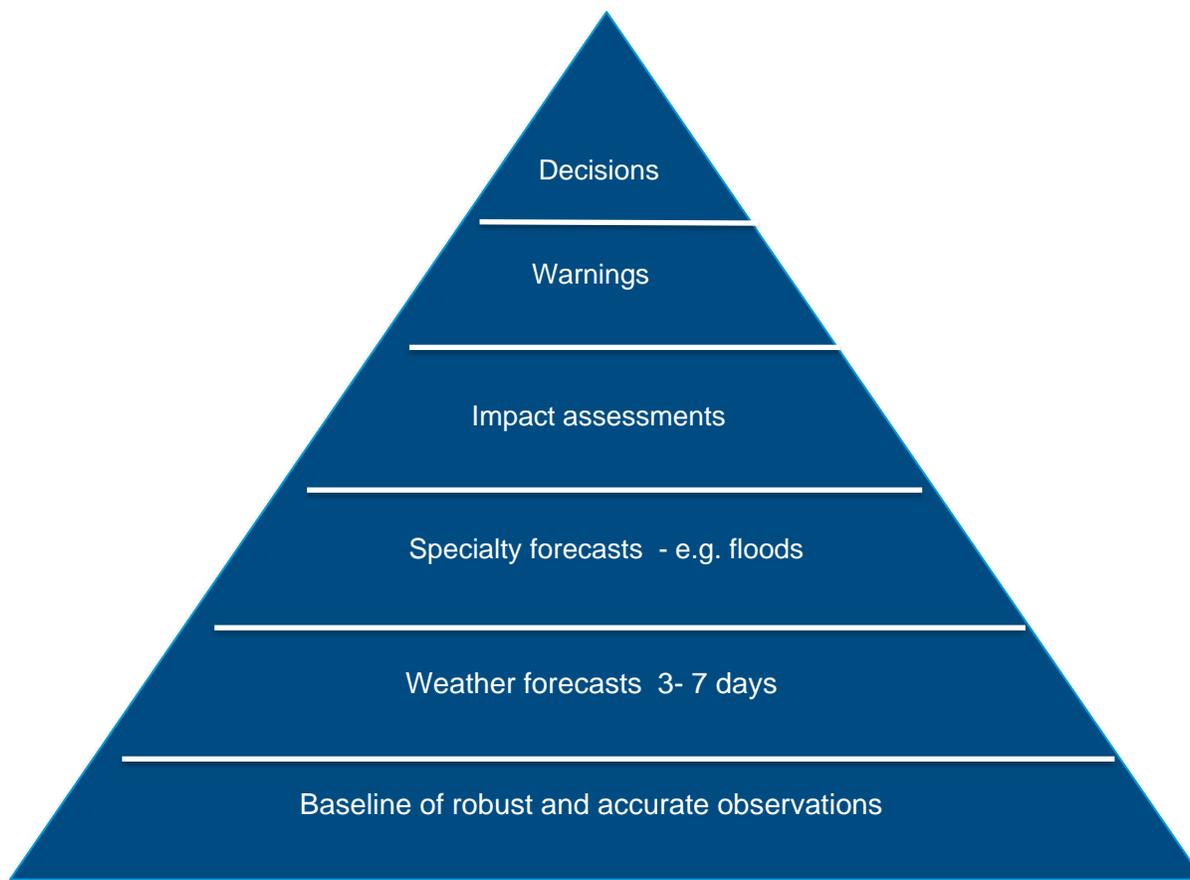
False Color Imagery (12-11µm, 11-3.9µm, 11µm)
HIMAWARI-8 AH 130226014 - 01:30:10 UTC

Basic Information	
Volcanic Region(s)	Alaska
Country/Countries	United States
Volcanic Subregion(s)	Aleutian Islands
VAAC Region(s) of Nearby Volcanoes	Anchorage
Identification Method	Basic Growth
Mean Object Date/Time	2016-12-22 01:30:33UTC
Radiative Center (Lat, Lon)	54.050°, -167.910°
Nearby Volcanoes (meeting alert criteria):	Bogoslof (3.30 km)
Trend in IR Brightness	-19.30 °C
Temperature	
Vertical Growth Rate Time Interval	10 minutes
Vertical Growth Rate Anomaly	11.20 number of stddev above mean
Maximum Height [AMSL]	11.10 km ; 36417 ft
90th Percentile Height [AMSL]	10.00 km ; 32808 ft
Mean Tropopause Height [AMSL]	8.70 km ; 28643 ft

[Show More](#) [View all event imagery](#)



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



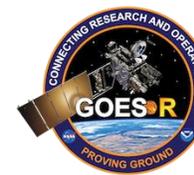
Climb the pyramid through

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

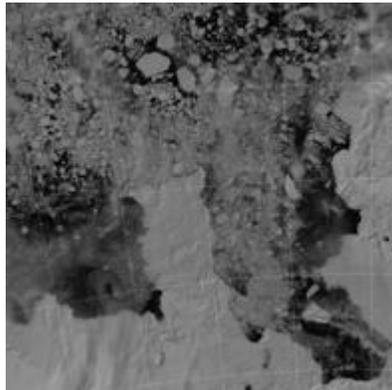
NESDIS Strategic Metric " The utilization of NESDIS developed science by internal and external partners and stakeholders through enhanced coordination with partners and the user community"

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

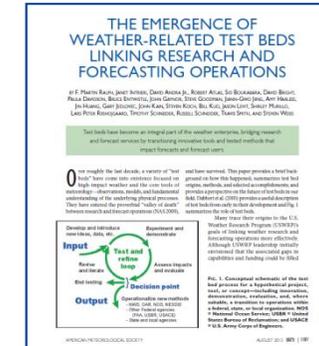
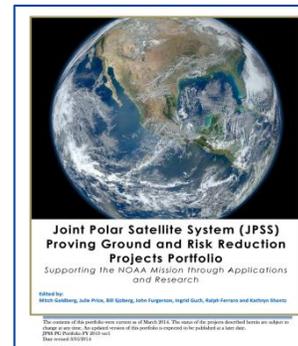
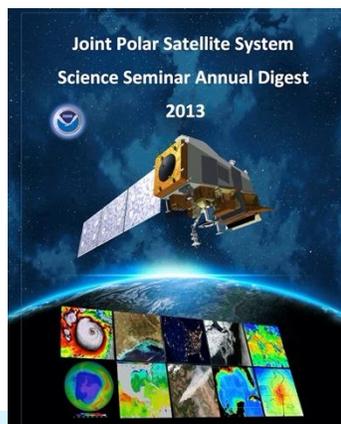
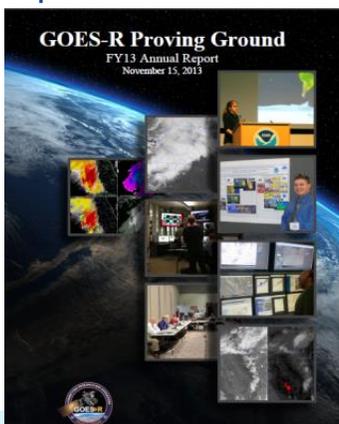


Hurricane Sandy- GOES High Density Atmospheric Motion Vectors



S-NPP Day/Night Band Ice Detection

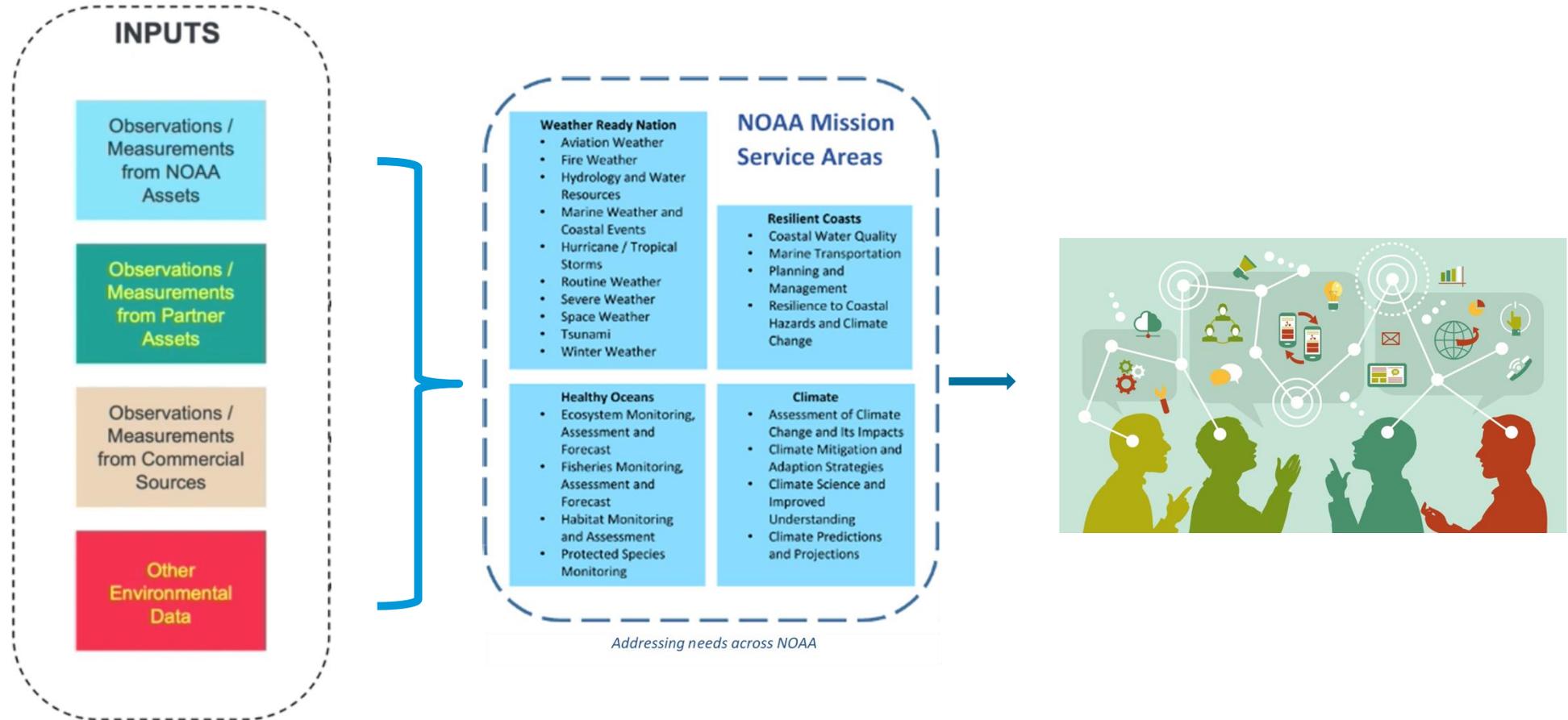
NOAA Hazardous Weather Testbed (HWT)



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

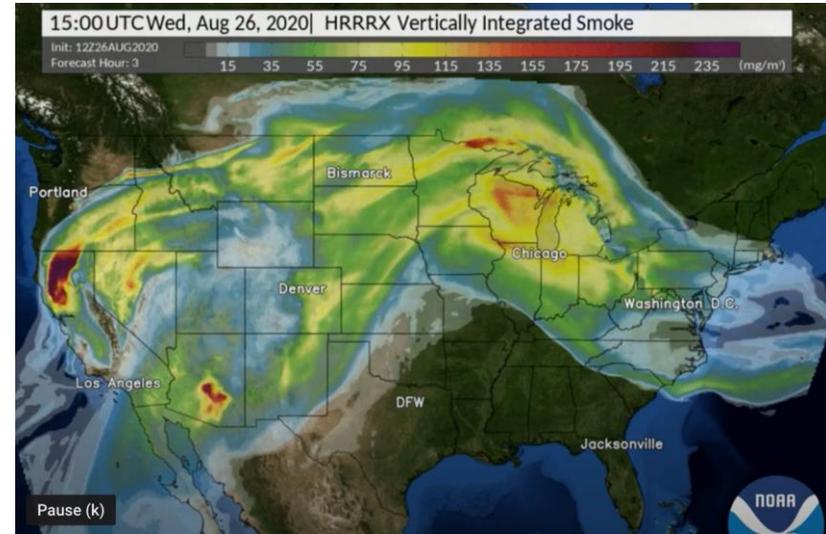


https://www.star.nesdis.noaa.gov/star/meeting_2020JPSSGOES.php

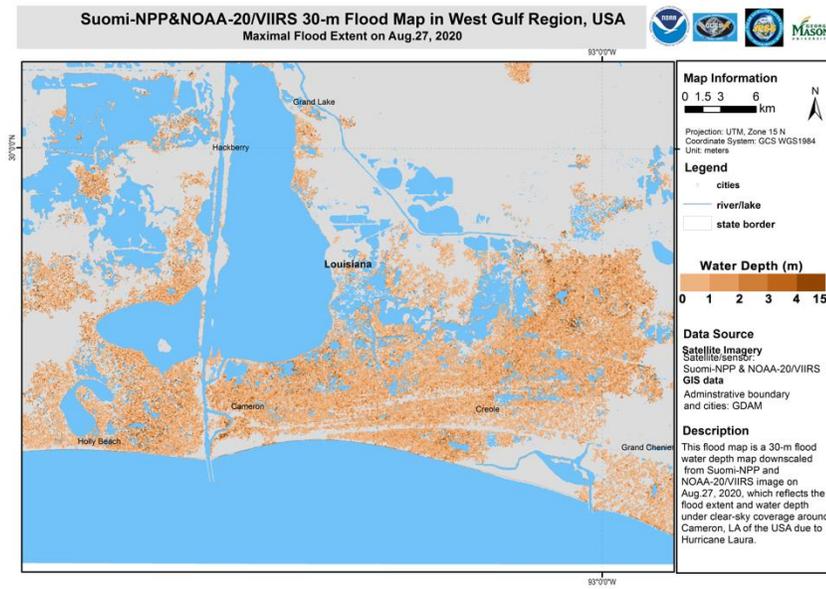
Enterprise Proving Ground has 3 main objectives



- **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](#)



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

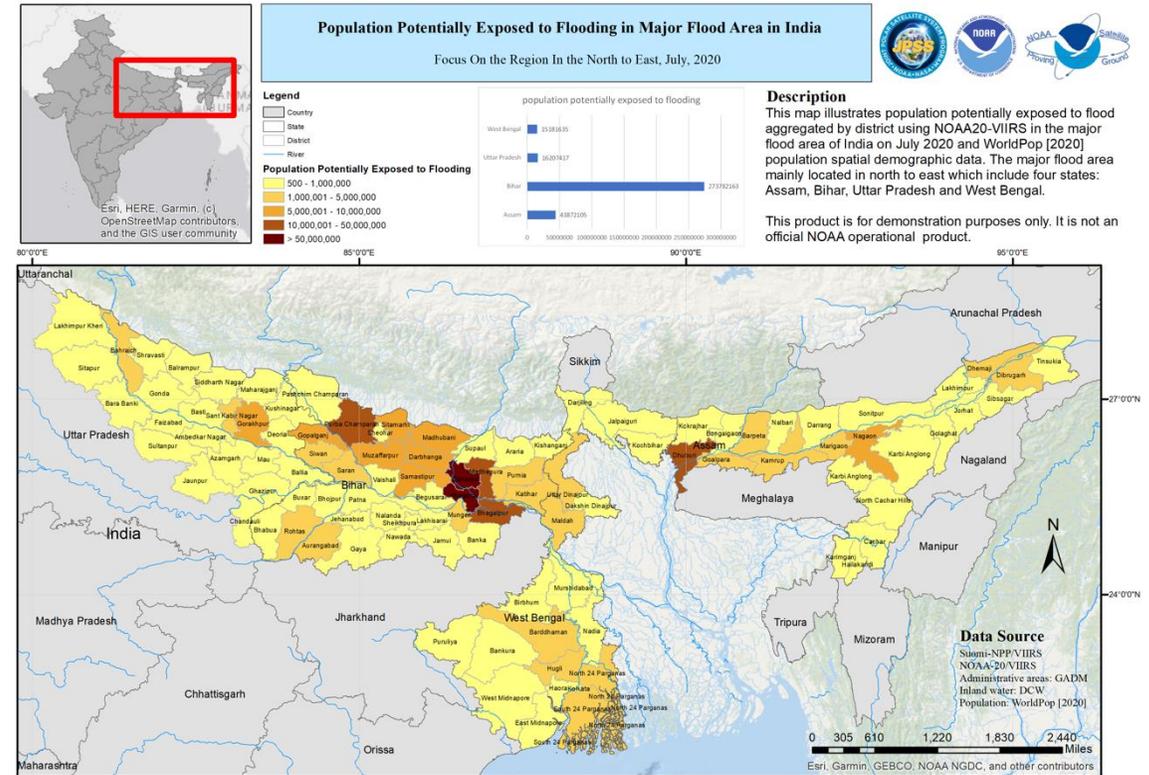
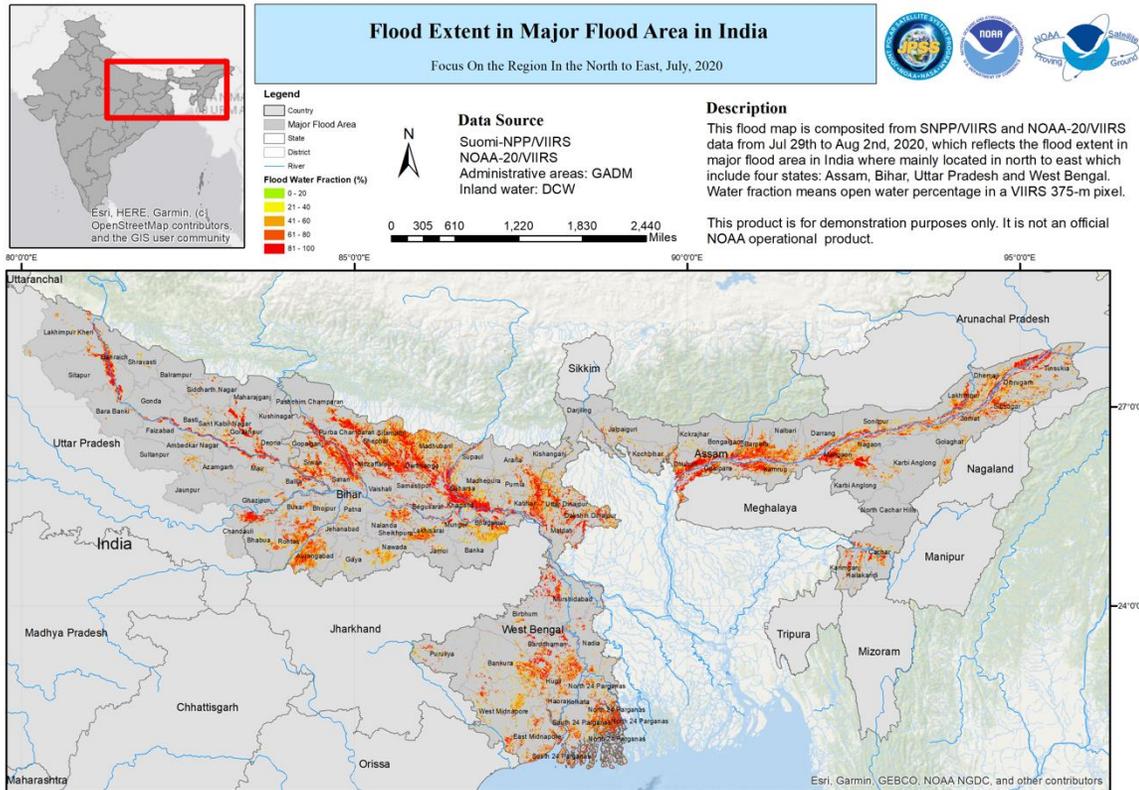
Click [here](#) for an embedded SSEC RealEarth map with some basic flood products.



Flood Composites and Impacted Populations estimated from NOAA VIIRS.



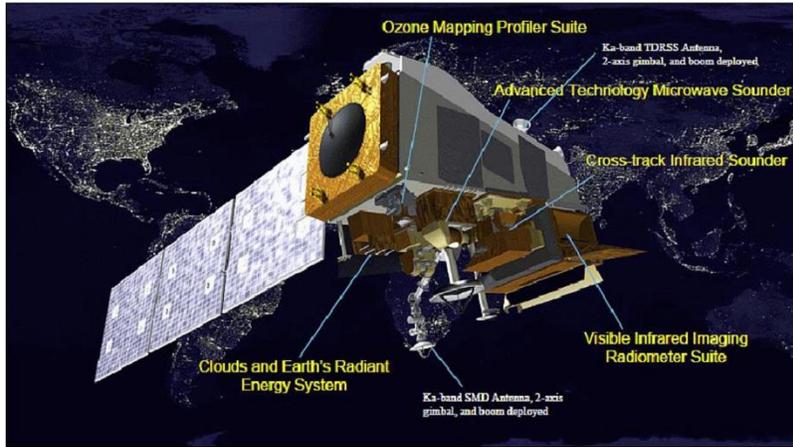
CEOS Flood Pilot will integrate more satellite source, including SAR, to improve representativeness and accuracy.



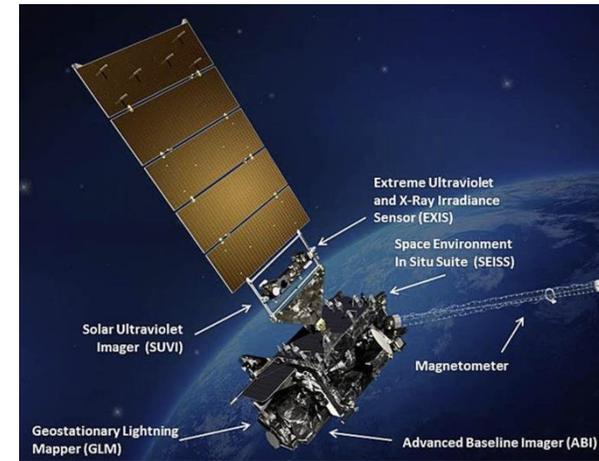


Fire and Smoke Initiative

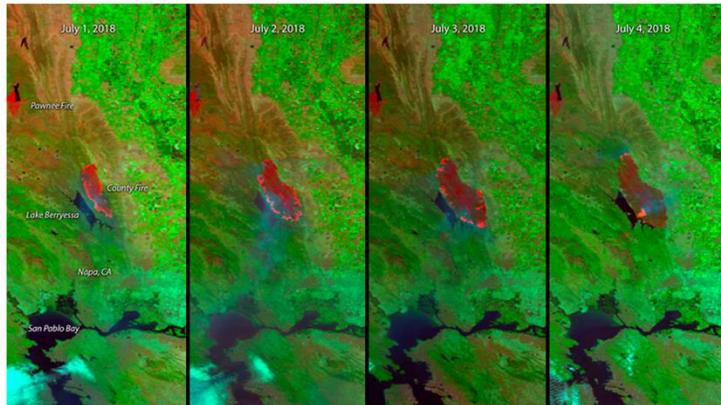
JPSS Program – Polar orbiting



GOES-R Series - Geostationary



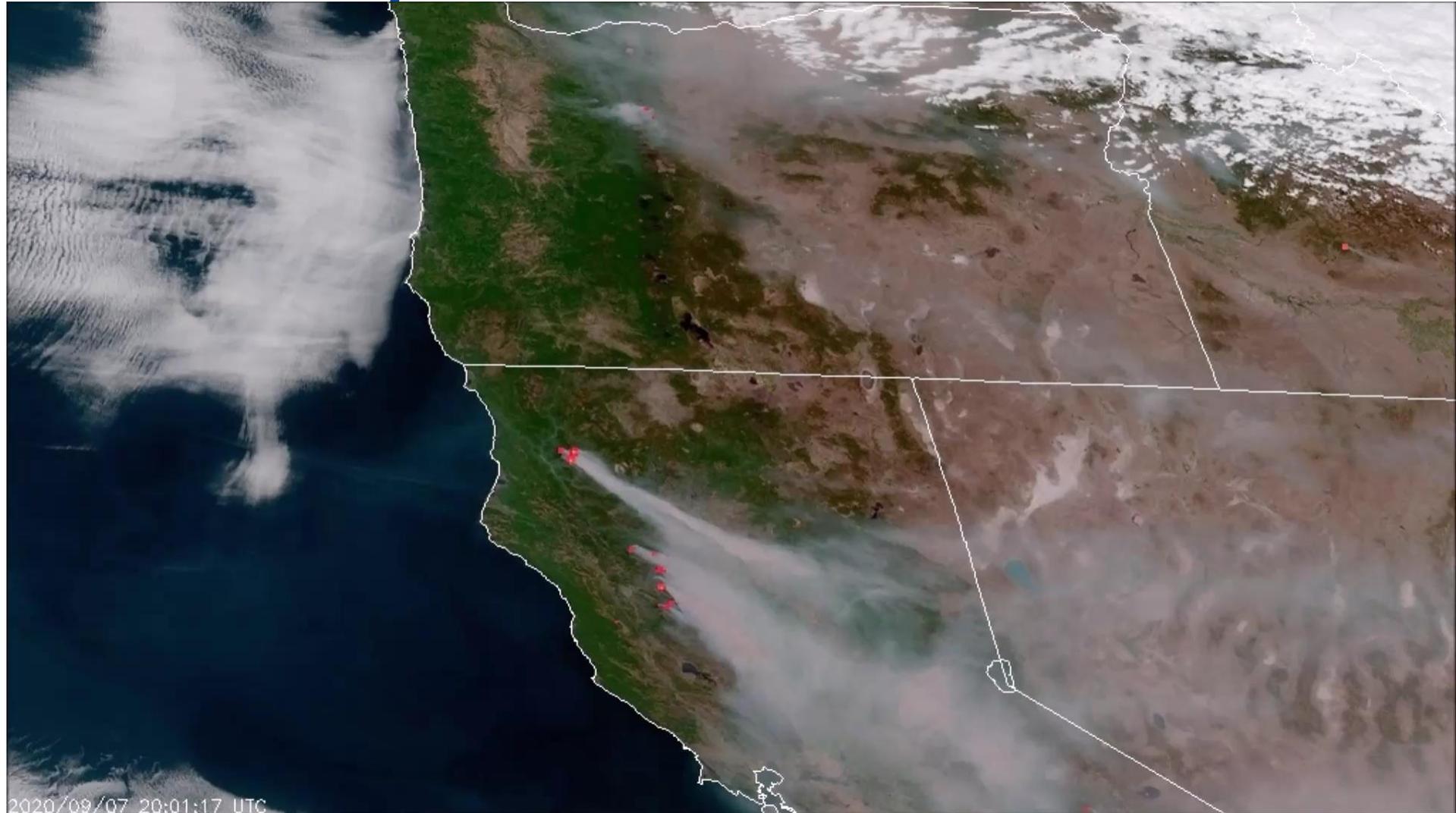
The Expanding County Fire in Northern California



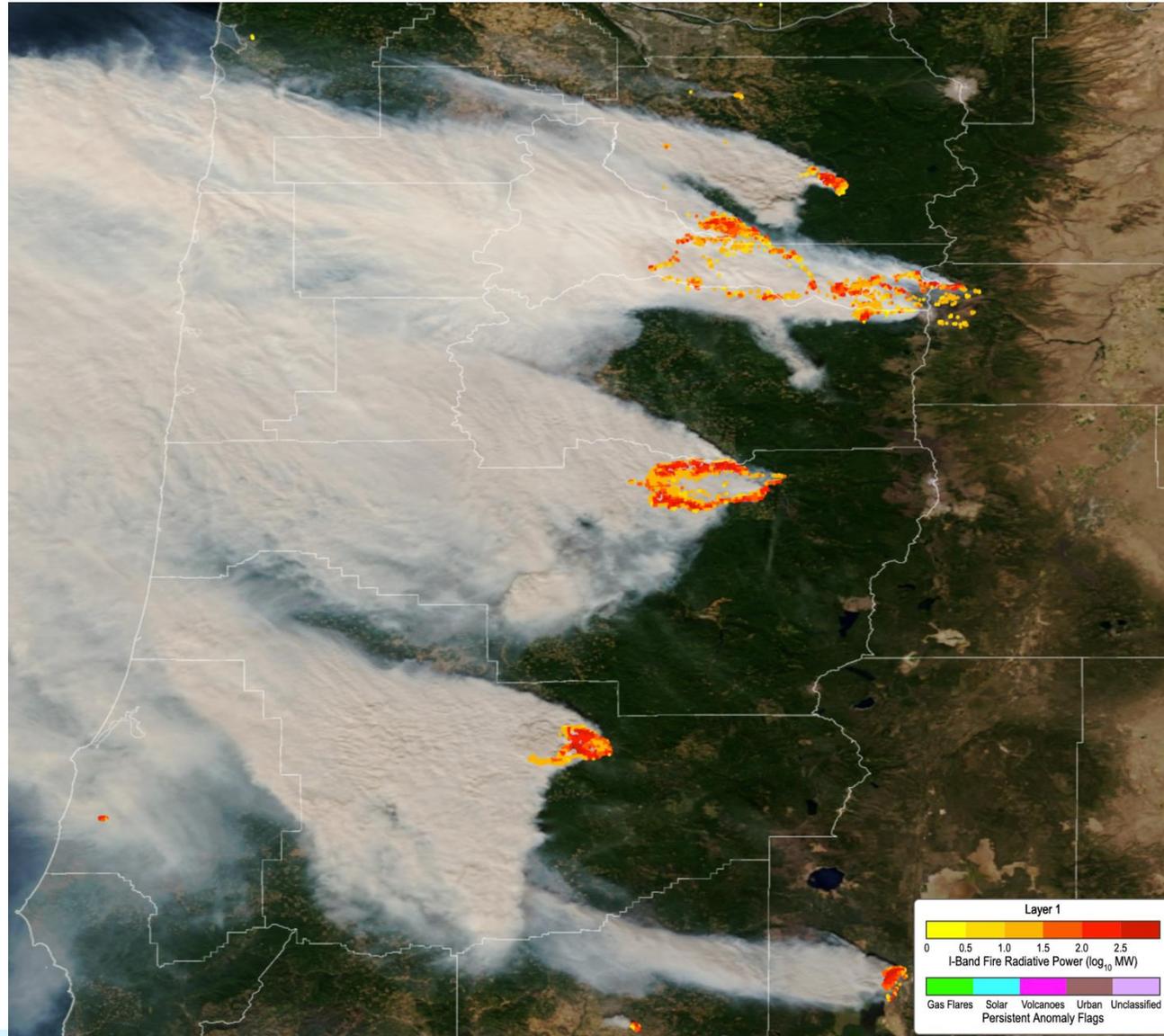
JPSS provides high spatial resolution ~ 375 m used for identifying fire perimeters and for input to smoke forecast models

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

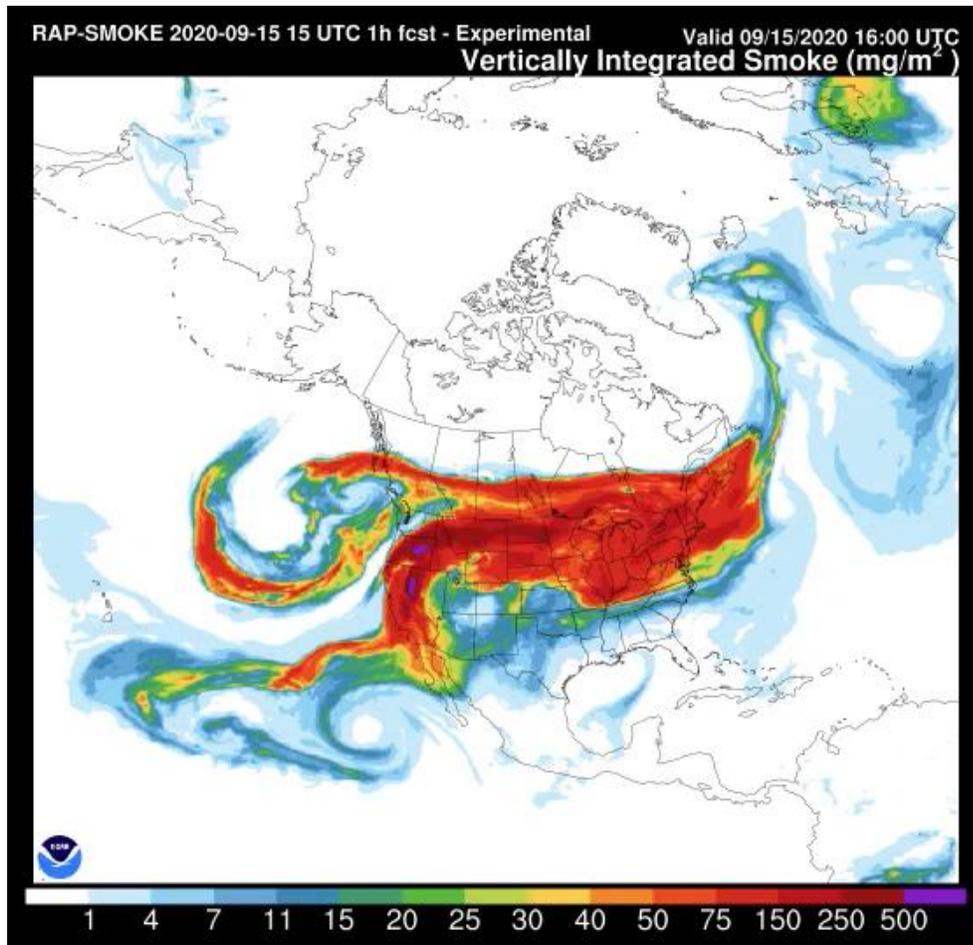
Oregon and California Fires, September 7 – 9, 2020



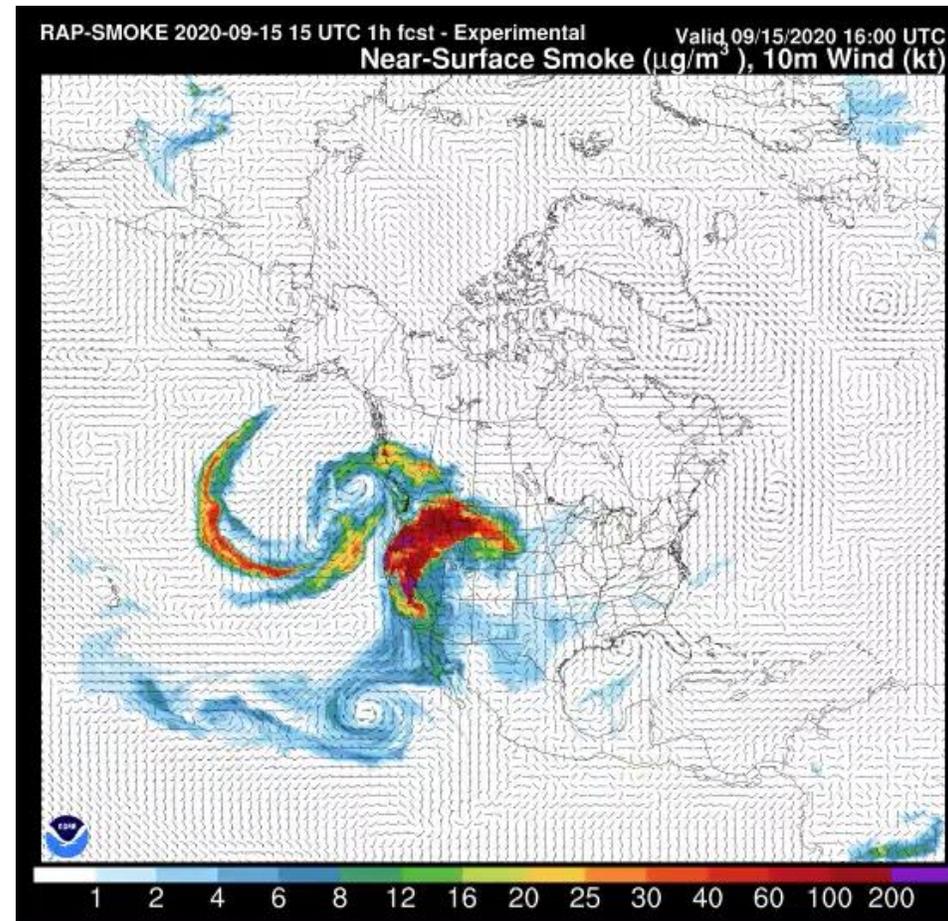
JPSS provides higher spatial resolution



VIIRS Fire Radiative Power is used in the HRRR Smoke Model

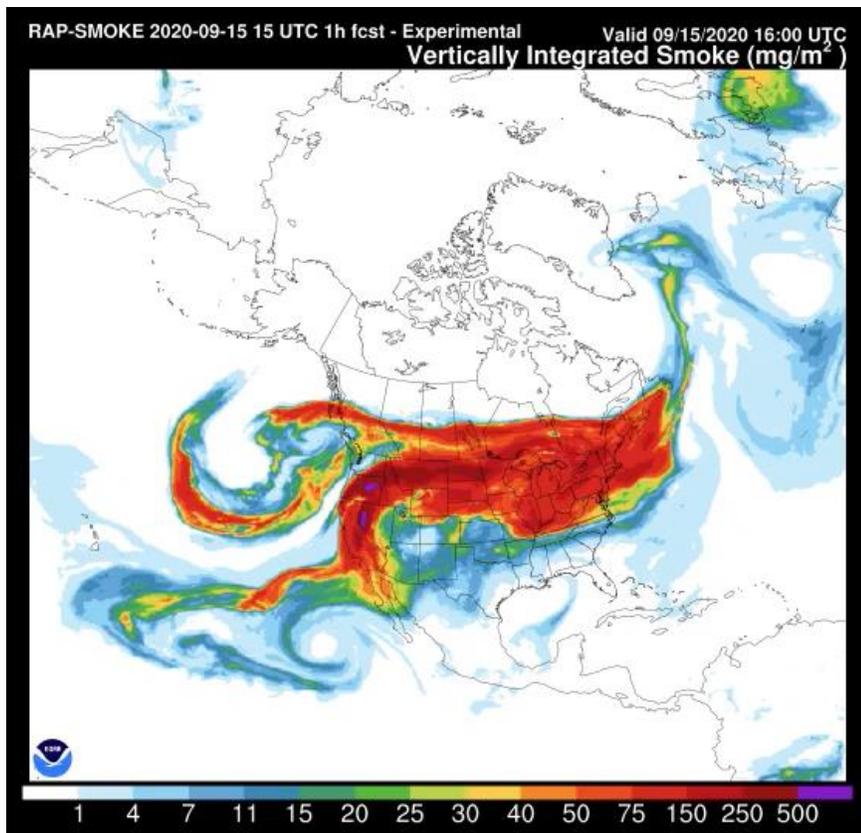


Total vertically integrated smoke



Near surface smoke

VIIRS Fire Radiative Power is used in the HRRR Smoke Model



Total vertically integrated smoke

2020-09-15
18:50:17 UTC

Stop (space) < >

(L)oop (R)ock Re(v)

Speed

Zoom (+) Zoom (-) Max (Z)oom

(M)aps Lat/Lo(n) Slid(e)r

(S)atellite GOES-16 (East;...)

Se(c)tor Full Disk

(P)roduct GeoColor (CIRA)

Add (O)verlay Add (O)verlay

of (I)mages 12

(T)ime Step 30 min

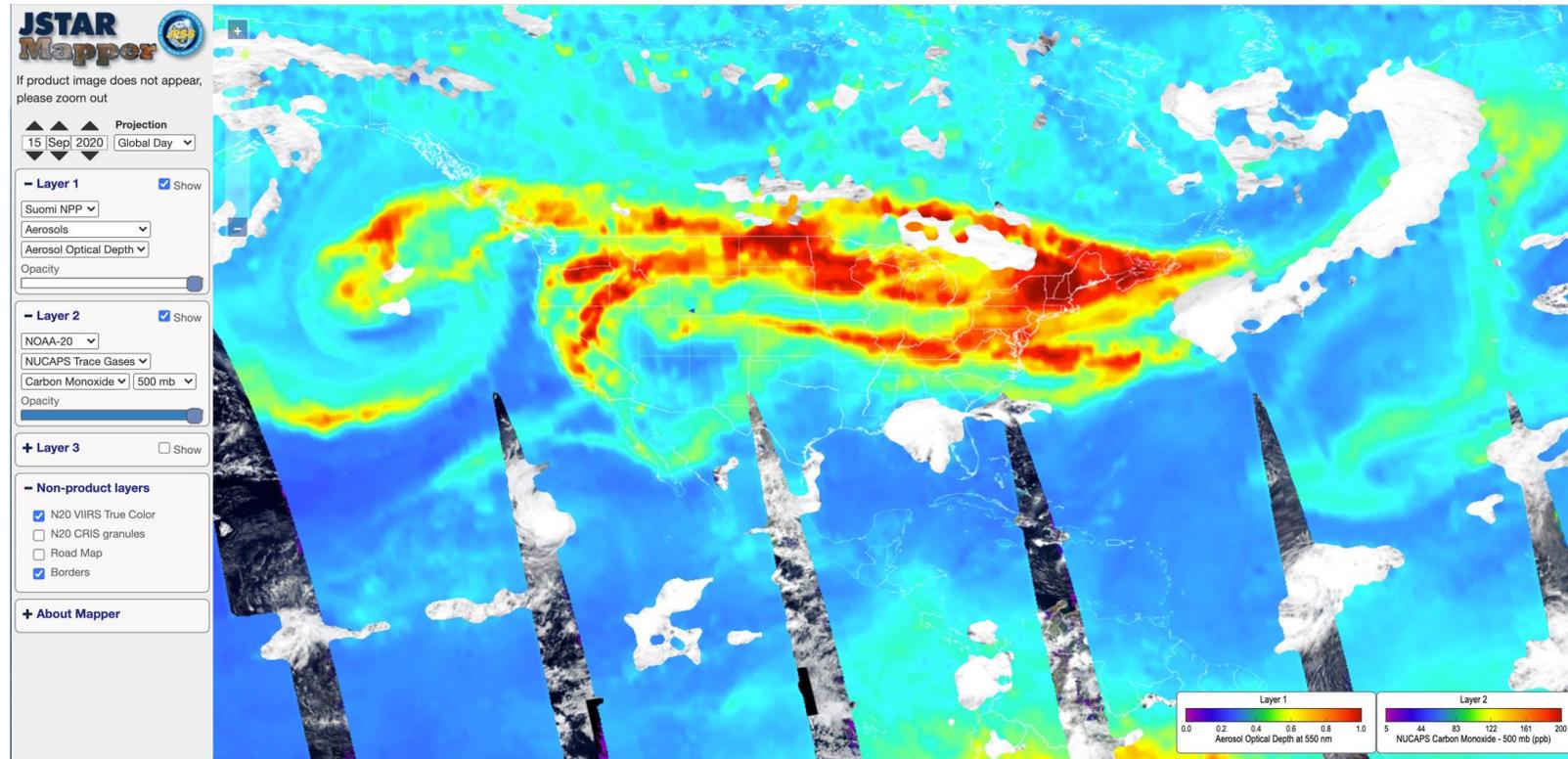
GeoColor (CIRA)

Hide Info



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



meted.ucar.edu/satmet/western_wildfires_2019/navmenu.php?tab=1&page=1-0-0&type=flash

Home Lesson Download Gallery Quiz Survey Booster

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 Print

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



NESDIS Services, Stewardship and Assessments



SATELLITE ANALYSIS BRANCH FIRE DETECTION PRODUCT:



HAZARD MAPPING SYSTEM (HMS)

Davida Streett, John Simko, Wilfrid Schroeder

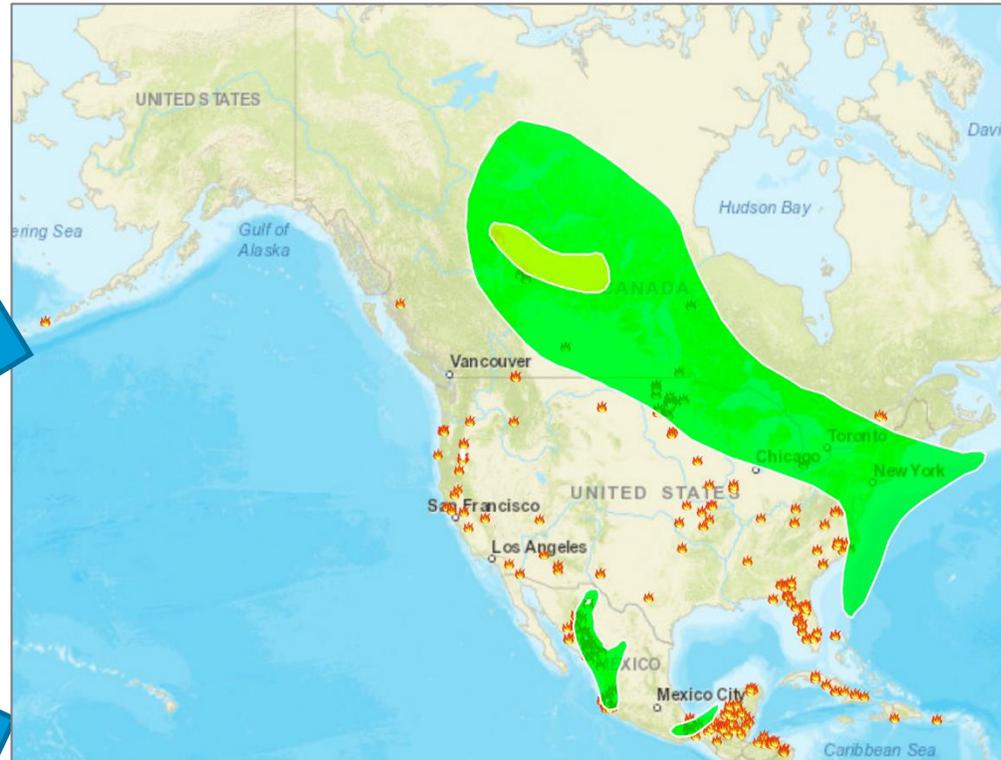
Satellites & Sensors

- 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

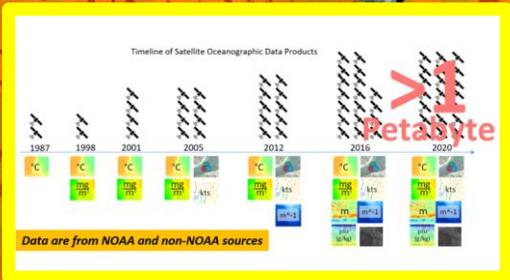
Provide training and hands-on assistance – Satellite Data Courses

Find or create products in response to users needs

Work directly with users on developmental projects

CoastWatch HelpDesk, User forum

CoastWatch.NOAA.gov





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

Traceable
Transparent
Consistent
Documented



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





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**

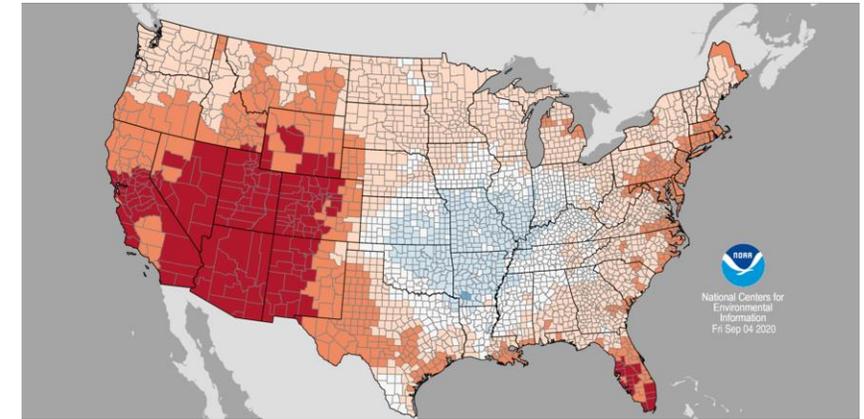
- ~200 analyses from ~500 authors for 40+ ECVs and many other phenomena
- “Annual physical of the climate system”

• **Technical Support: Nat’l Climate Assessment.**

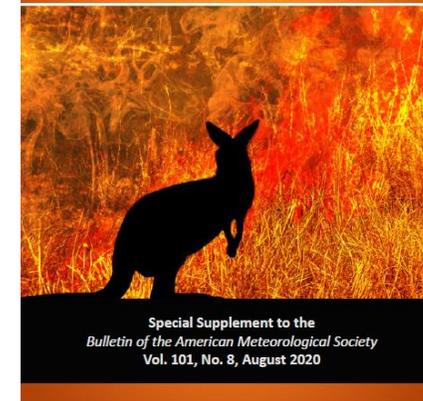
- Interagency report is assembled in CSSD
- Ensures data quality and provenance, creates indices, synthesizes model output
- Provides necessary corrections and treatment for data sets

County Average Temperature Ranks

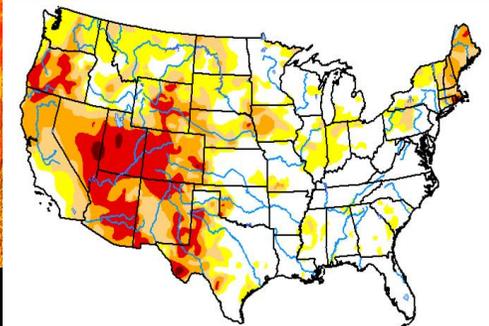
August 2020
Period: 1895–2020



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**

