

LANCCE @ 10

NASA'S Land, Atmosphere Near Real-time Capability for EOS
"LANCCE" is 10 years old

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LANCE's Roots

Following the large wildfires in Montana in 2000, the MODIS Land Discipline group created handcrafted images that demonstrated the significant contribution that MODIS Terra data could make to wildfire suppression and rehabilitation.

To be of value, the data and imagery needed to be available within 3 hours of satellite observation.

This led to the development of the Moderate Resolution Imaging Spectroradiometer (MODIS) Land **Rapid Response System**.



*Photo by John McColgan, Bureau of Land Management, Alaska Fire Service.
Source https://commons.wikimedia.org/wiki/File:Deerfire_high_res.jpg*

LANCE's Roots: MODIS Rapid Response

In 2001 the MODIS Land Rapid Response provided swath-based, non-geo-referenced imagery from MODIS Terra for North America. By 2007, Rapid Response was producing global data and had incorporated data and imagery from the Aqua.

Example of Active Fire / Corrected Reflectance Product
Siberia (05/22/01)



Example of 250m Corrected Reflectance Product
Hurricane Erin (09/11/01)

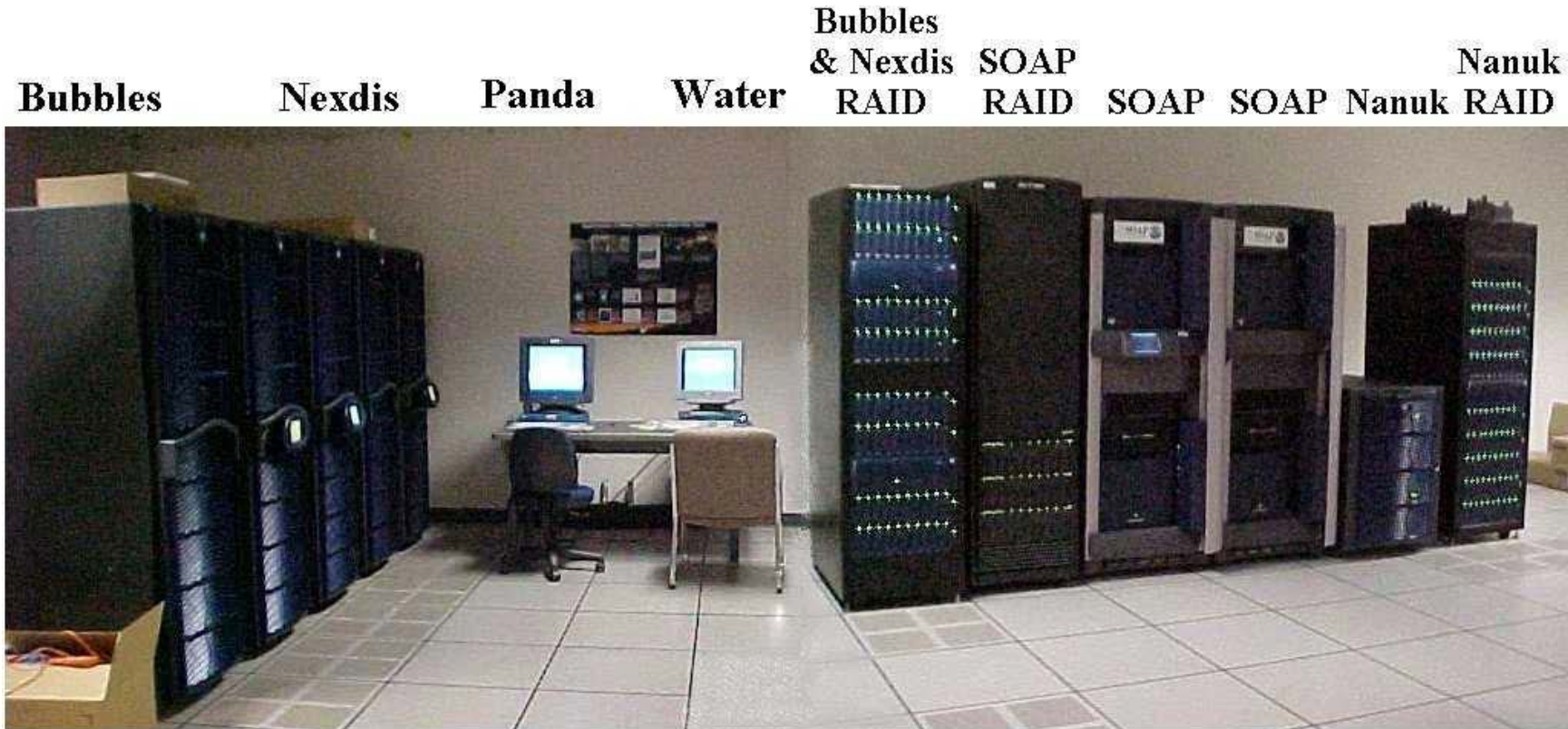


Example of Corrected Reflectance Product
Dust Storm in Western Africa (05/08/01)



Early images from MODIS Rapid Response: Initially the MODIS Rapid Response Project was used for wildfire management but it soon became clear that there were many other applications such as monitoring hurricanes, dust storms as well as crops, floods, ash plumes and oil spills.

LANCE's Roots: Near Real-Time Processing Effort (NRTPE)



NOAA MODIS &
AIRS NRT
Processing System

In 2002 the National Polar-Orbiting Operational Environmental Satellite System (NPOES - NASA/NOAA/Department of Defense) established the Near Real-Time Processing Effort (NRTPE) to provide military, weather agencies and first responders with timely data from NASA's Earth Observing Satellites. It was a risk reduction effort to aid and familiarize future applications users through observations of dust storms, fires, and severe weather.

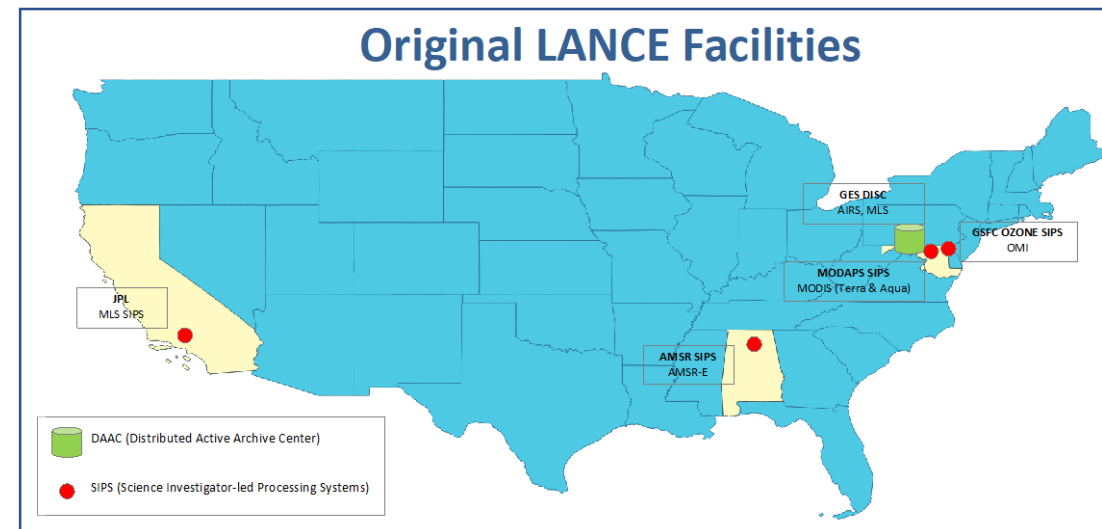


Establishment of LANCE

LANCE was formally established in September 2009.

The growing demand for near real-time products and an aging NRTPE system spurred NASA Headquarters to fund a new, more robust system leveraging existing EOSDIS processing facilities and serving NRT data from:

- MODIS (Aqua and Terra)
- AIRS (Aqua)
- MLS (Aura)
- OMI (Aura)
- AMSR-E (Aqua)

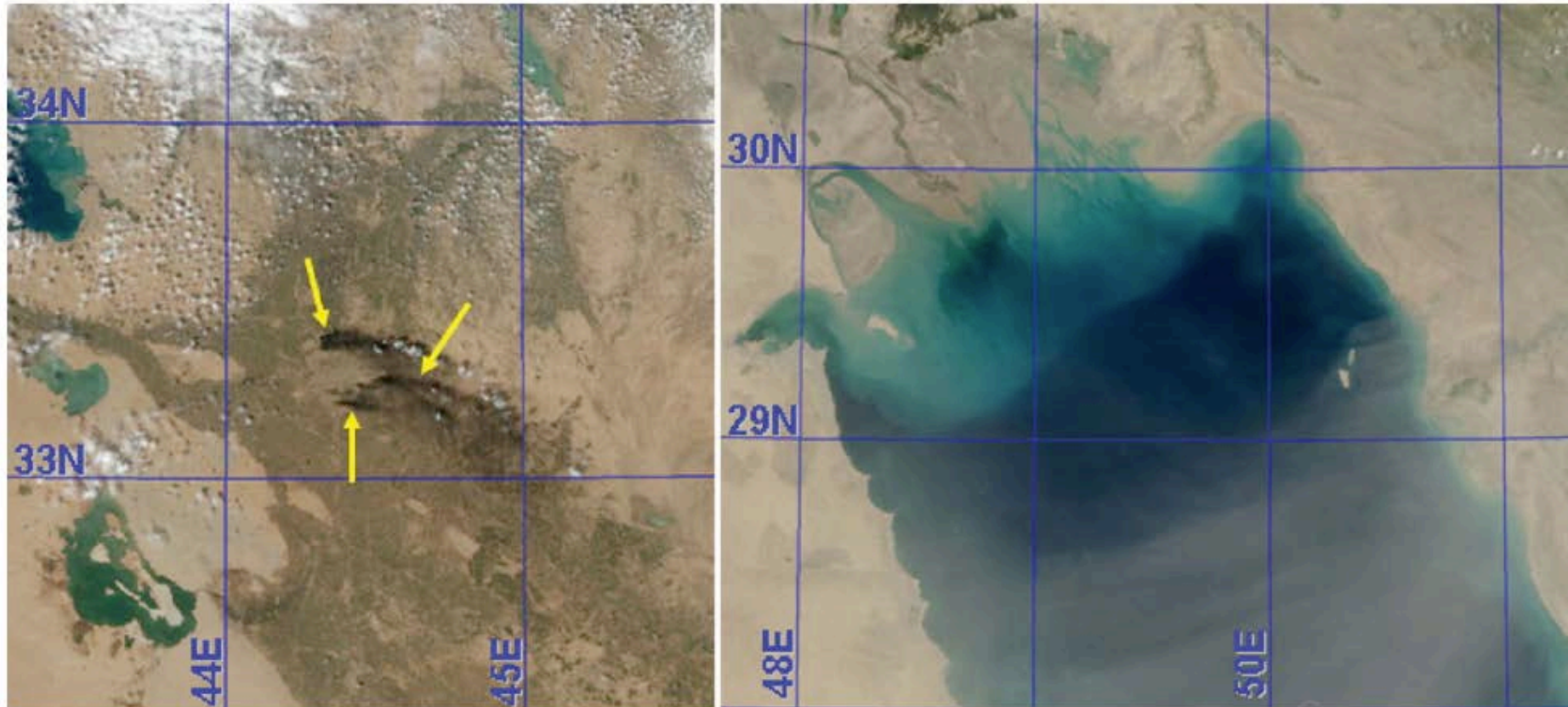




LANCE Approach:

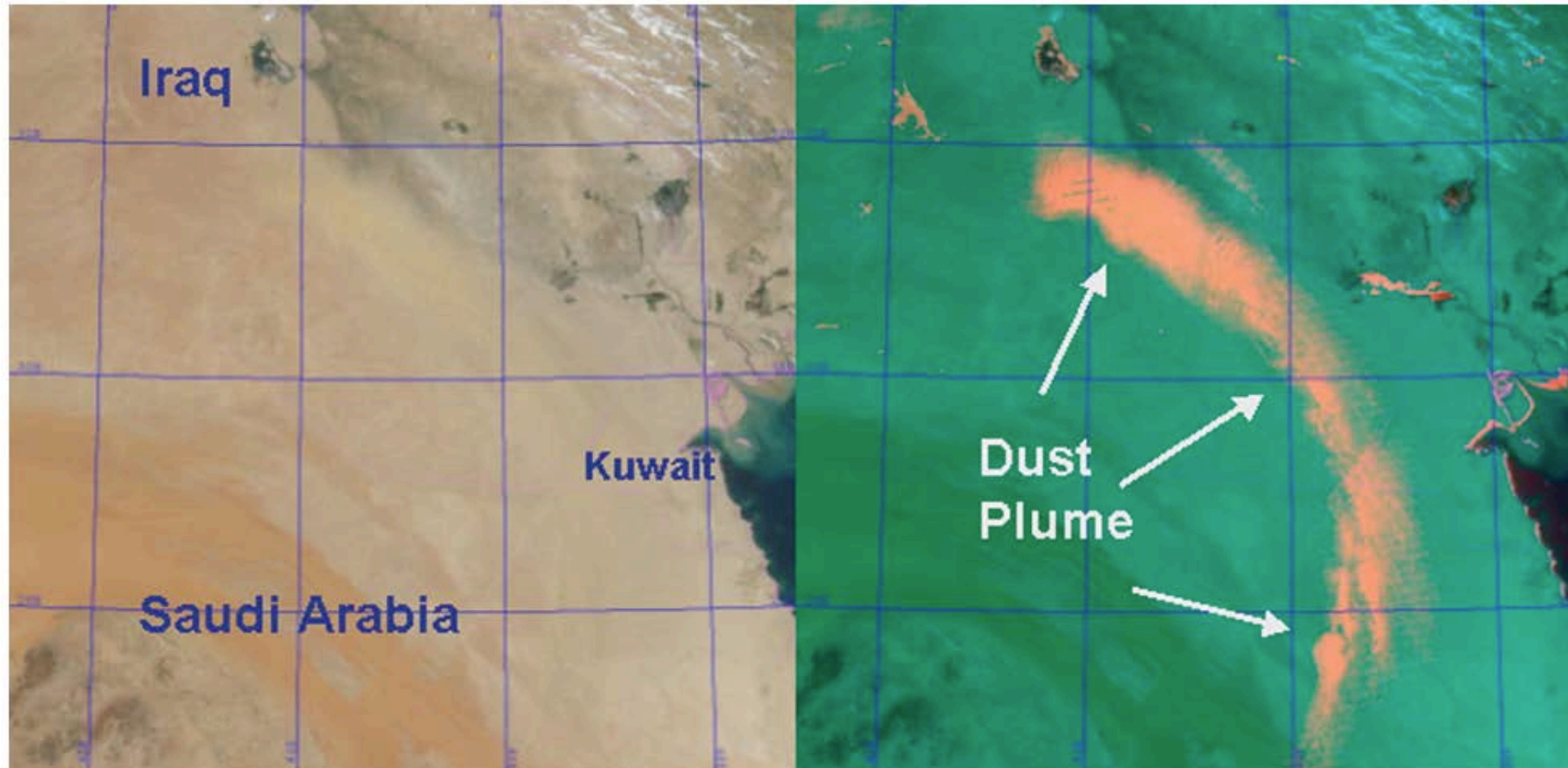
- Leverage existing science processing expertise to create high quality NRT products
- Provide data and imagery within 3-hours of satellite observation:
 - To achieve the 3-hour latency requirement, all aspects of data processing, from geo-location (attitude and ephemeris) data to ground systems and inputs to science algorithms, had to be modified.
- Establish an “umbrella environment” with uniform high level requirements to ensure consistency and foster coordination and cooperation between the individual elements
- Provide data products with high reliability using redundant systems
- New requirements and enhancements are reviewed and recommended by the LANCE User Working Group

Early Applications of MODIS imagery for Operation Iraqi Freedom



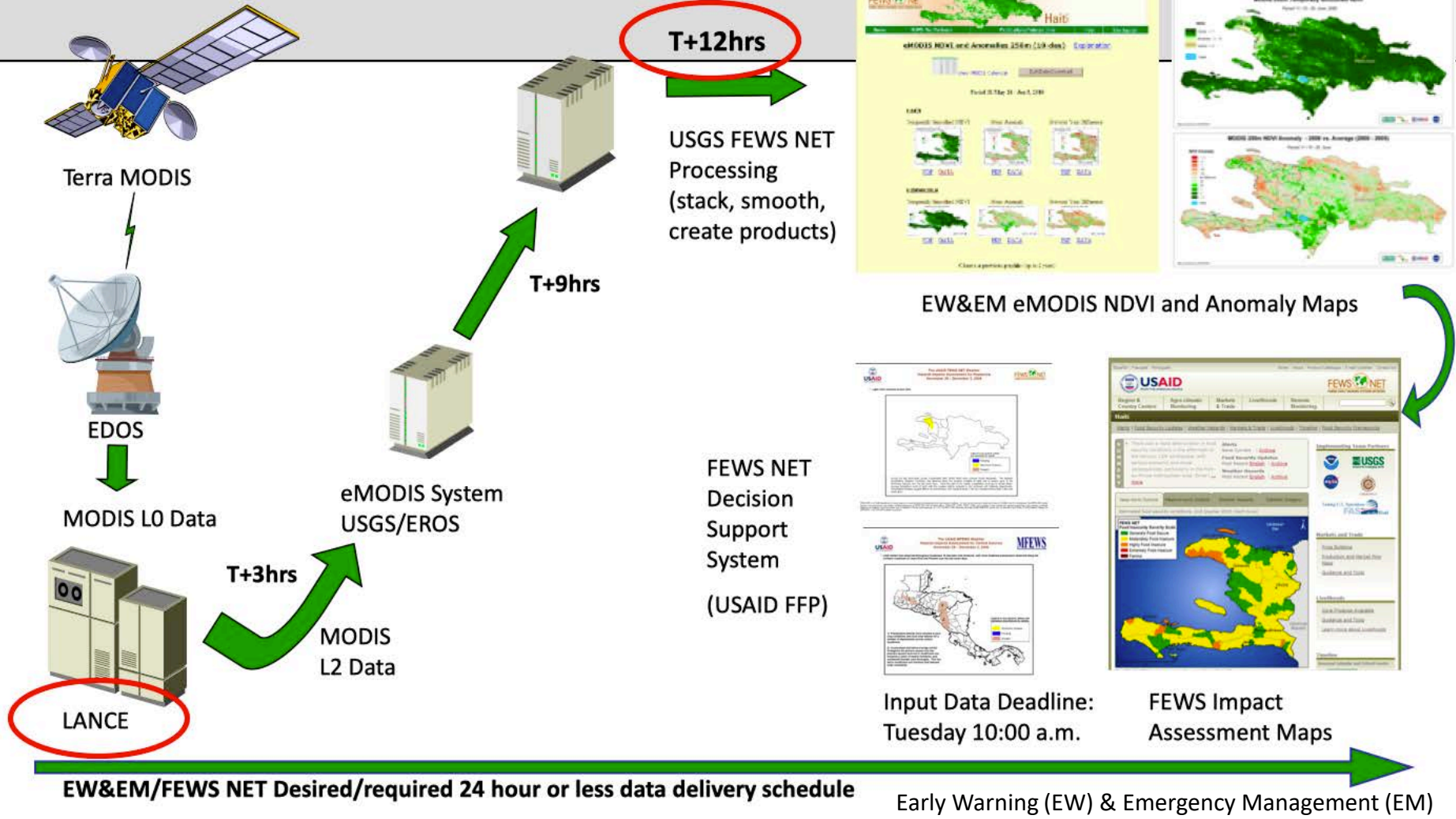
MODIS 250 m true color examples revealing black smoke plumes (yellow arrows) over Baghdad (left, 27 March 2003, 1000 UTC) and tan dust plume over the northern Arabian Gulf (right, 17 April 2003, 1015 UTC)

Early Applications of MODIS imagery for Operation Iraqi Freedom cont'd







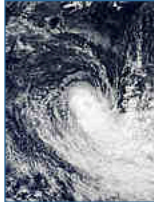
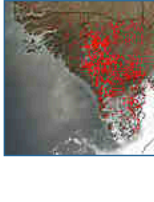
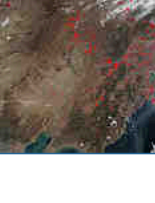

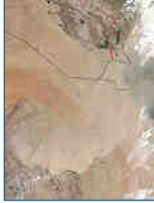
MODIS dust enhancement(right) reveals dust plumes over land difficult-to-detect using true color or conventional imagery (left). Data collected on 10 June 2003 at 1010 UTC, and latitude/longitude grid spacing is 2°

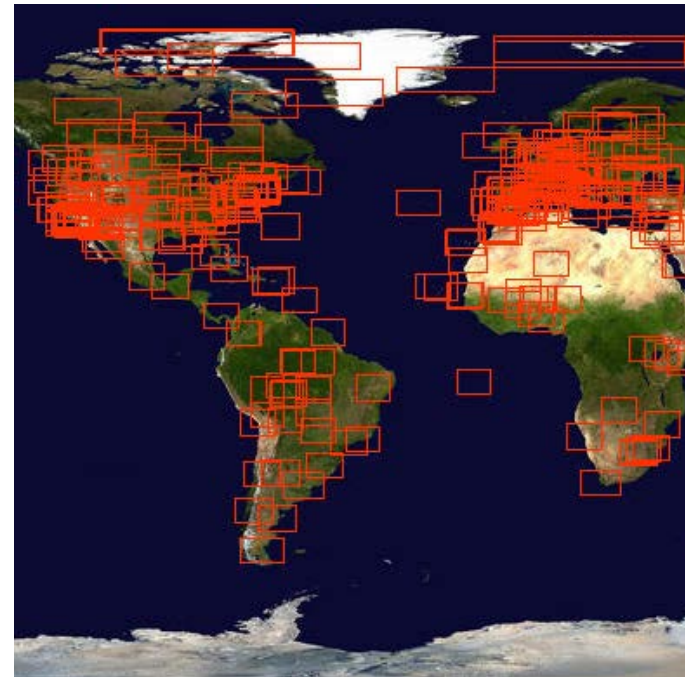
eMODIS FEWS NET Expedited Product Flow



MODIS Rapid Response merges with LANCE

In 2009 MODIS Rapid Response (MRR) started using the LANCE NRT Level 0 data feed and in 2011 MRR became part of LANCE




Most Recent Images		
Date: 2018/180 - 06/29 Pixel size: 3km 1500m 750m 375m  21:00 UTC Tropical Storm Emilia (06E) off Mexico Satellite: SNPP	Date: 2018/175 - 06/24 Pixel size: 1km 500m 250m  18:30 UTC Tropical Storm Daniel (05E) off Mexico Satellite: Terra	Date: 2018/143 - 05/23 Pixel size: 2km 1km 500m 250m  07:00 UTC Tropical Cyclone Mekunu (02A) off the Horn of Africa Satellite: Terra
Date: 2018/139 - 05/19 Pixel size: 2km 1km 500m 250m  10:25 UTC Tropical Cyclone Sagar (01A) over the Horn of Africa Satellite: Aqua	Date: 2018/120 - 04/30 Pixel size: 2km 1km 500m 250m  08:05 UTC Tropical Cyclone Flamboyant (21S) in the South Indian Ocean Satellite: Aqua	Date: 2018/116 - 04/26 Pixel size: 1500m 750m 375m  14:12 UTC Fires in West Africa Satellite: SNPP
Date: 2018/115 - 04/25 Pixel size: 1500m 750m 375m  04:30 UTC Fires and smoke in eastern Asia Satellite: SNPP	Date: 2018/114 - 04/24 Pixel size: 3km 1500m 750m 375m  09:36 UTC Tropical Cyclone Fakir (20S) in the South Indian Ocean Satellite: SNPP	Date: 2018/113 - 04/23 Pixel size: 1500m 750m 375m  10:06 UTC Dust storm in Saudia Arabia Satellite: SNPP



MRR outputs (left to right): Gallery images, MODIS Subsets and Level 2 Global Browse Images.

























Date: 2008/359 - 12/24/08

[prev](#) [next](#)

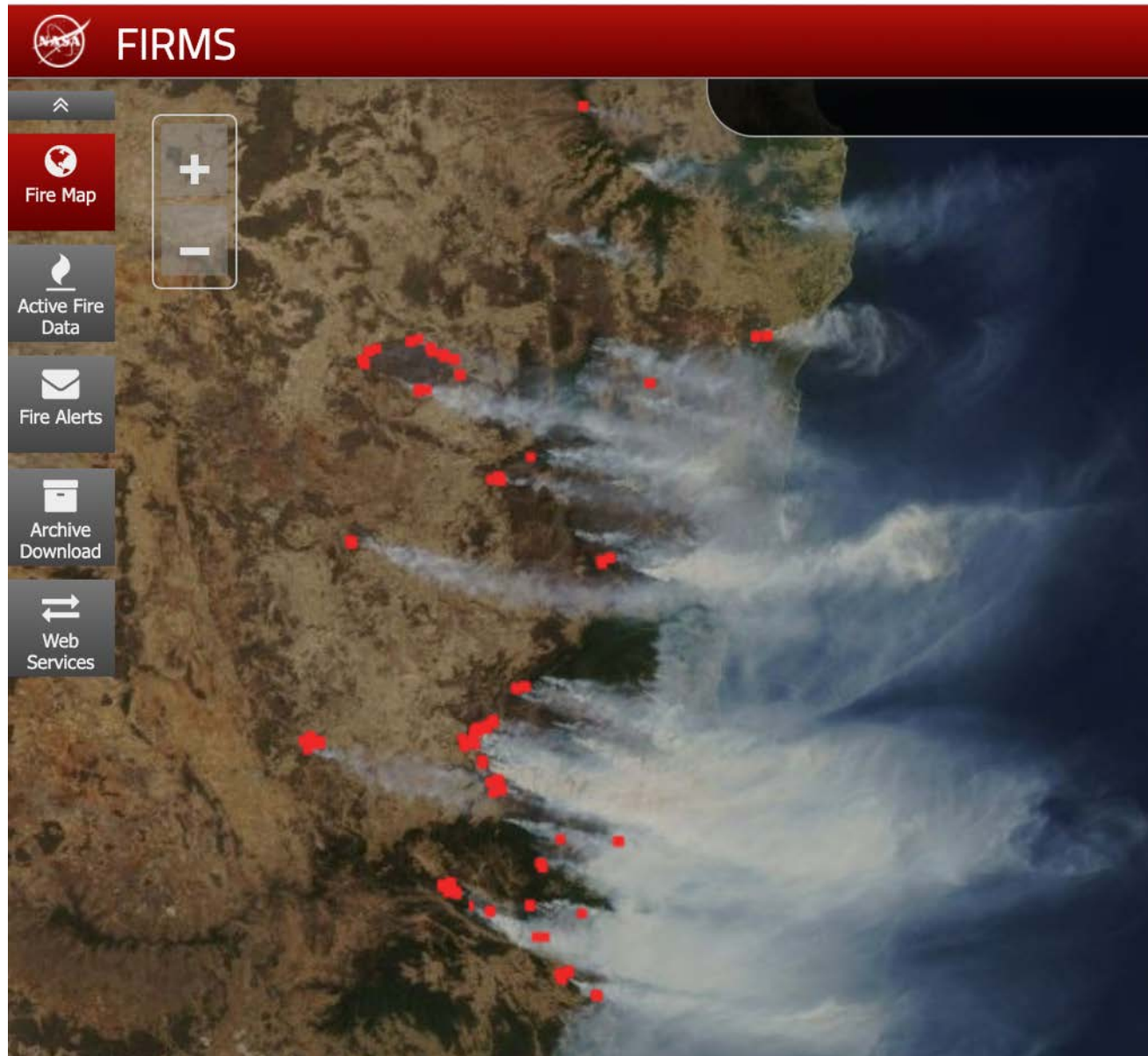
  

[Terra Orbit Tracks](#) [Aqua Orbit Tracks](#) [Display true-color and false-color](#)

Terra/MODIS

23:40 UTC 	22:00 UTC 	20:20 UTC 	18:40 UTC 	17:05 UTC 	15:25 UTC 
23:45 UTC 	22:05 UTC 	20:25 UTC 	18:45 UTC 	17:10 UTC 	15:30 UTC 
23:50 UTC 	22:10 UTC 	20:30 UTC 	18:50 UTC 	17:15 UTC 	15:35 UTC 
23:55 UTC 	22:15 UTC 	20:35 UTC 	18:55 UTC 	17:20 UTC 	15:40 UTC 

Fire Information for Resource Management System (FIRMS)



FIRMS provides global NRT active fire/thermal anomaly data from MODIS and VIIRS.

Originally developed at the University of Maryland in partnership with the United Nations (UN) Food and Agriculture Organization (FAO), in 2012 FIRMS became part of LANCE

Users can:

- view data and imagery in FIRMS Fire Map
- receive email Fire Alerts
- download data in easy to use formats

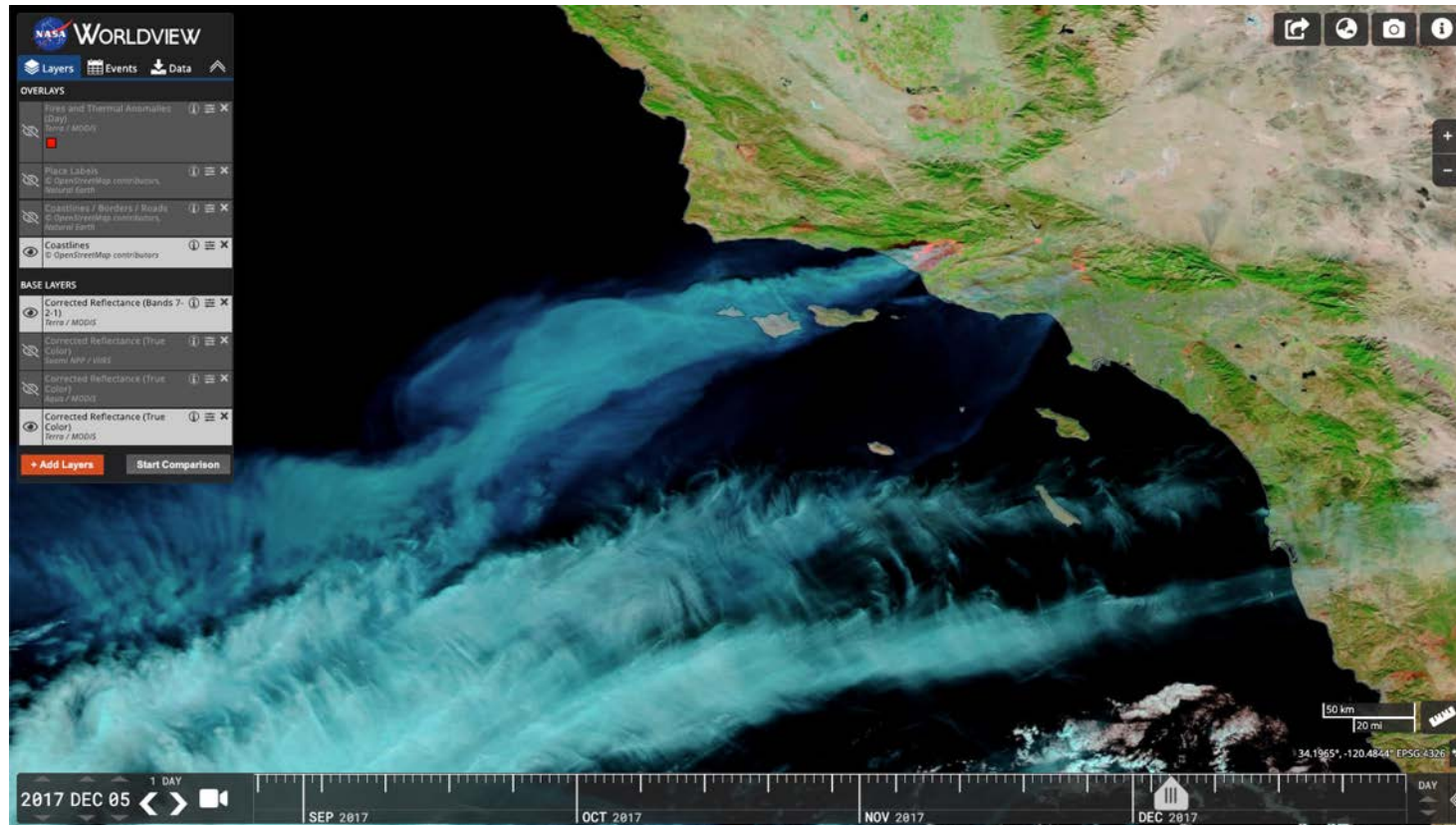
Approximately 240,000 FIRMS alerts (including daily, rapid and weekly alerts) are sent to users in more than 160 countries.

Left: FIRMS Fire Map showing active fires in New South Wales, Australia. The fires, overlaid in red, are on a corrected reflectance true color image from VIIRS SNPP from 11/13/ 19

GIBS and NASA Worldview

NASA EOSDIS developed the LANCE-powered Global Imagery Browse Services (GIBS) in 2011 and the NASA Worldview in 2012.

As a result, users can easily download NRT imagery, interactively explore this imagery, and download the underlying data behind this imagery.



Left: Screenshot of Worldview showing Corrected Reflectance Imagery (Bands 7,2,1) from MODIS Terra. The image shows thick smoke streaming from several fires in southern California

NASA WORLDVIEW

Layers Events Data

OVERLAYS

- Place Labels
© OpenStreetMap contributors, Natural Earth
- Coastlines / Borders / Roads
© OpenStreetMap contributors, Natural Earth
- Coastlines
© OpenStreetMap contributors






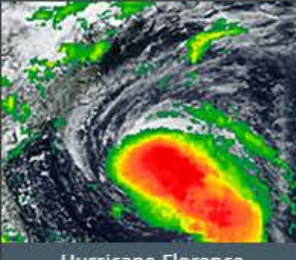



BASE LAYERS

- Corrected Reflectance (True Color)
AVHRR / VIIRS
- Corrected Reflectance (True Color)
Aqua / MODIS
- Corrected Reflectance (True Color)
Terra / MODIS

+ Add Layers Start Comparison

Welcome to Worldview!

Visually explore the past and the present of this dynamic planet from a satellite's perspective. Select from an array of stories below to learn more about Worldview, the satellite imagery we provide and events occurring around the world. [Start using Worldview →](#)

 <p>Sunlight</p>	 <p>Tropical Cyclone Idai (March 2019)</p>	 <p>Earth at Night</p>
 <p>Pine Island Glacier/Iceberg B-46, Nov 2018</p>	 <p>Camp Fire (November 2018)</p>	 <p>Hurricane Florence (September 2018)</p>
 <p>California & British Columbia Wildfires (Summer 2018)</p>	 <p>Snow in Lesotho, Africa (August 2018)</p>	 <p>Swath Gaps</p>

2019 JUL 03

DAYS

◀ ▶



Map navigation controls: Share, Home, Camera, Info, Zoom (+/-), Scale (1000 km, 1000 mi), Timeline (JUL)

Do not show until a new story has been added.

Over the past 6 years, EOSDIS Worldview capabilities have been significantly expanded and enhanced, e.g.:











- Full-resolution imagery download capability
- Data granule selection and download
- Greater time range of imagery available
- Service standardization to Open Geospatial Consortium WMTS*
- Polar stereographic projections
- Color bars / legends
- Dynamic data range thresholding
- Integration with EONet Events Tracker
- Interrogate exact value under mouse cursor
- Ability to create and export animations
- Visualization of multi-day events, including Comparison mode
- Merged Rapid Response with Worldview: Worldview Snapshots

 **WORLDVIEW**

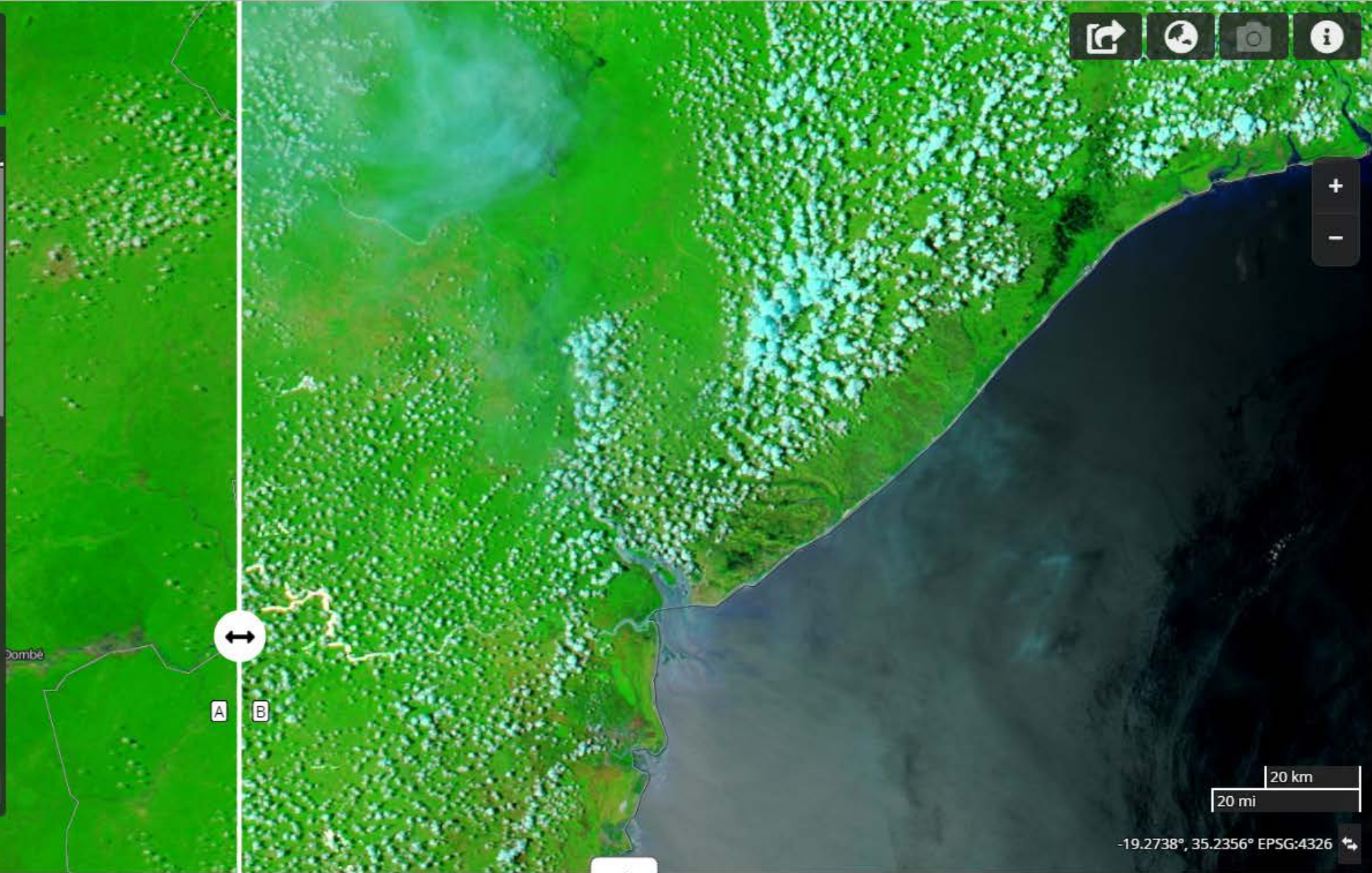
 Layers  Events  Data 

 A: 2019-03-25  B: 2019-01-11

- OVERLAYS
-  Fires and Thermal Anomalies (Day and Night) Terra / MODIS   
 -  Fires and Thermal Anomalies (Night, 375m) Suomi NPP / VIIRS   
 -  Fires and Thermal Anomalies (Day, 375m) Suomi NPP / VIIRS   
 -  Fires and Thermal Anomalies (Day and Night) Terra and Aqua / MODIS   
 -  Fires and Thermal Anomalies (Day and Night) Aqua / MODIS   
 -  Place Labels   

COMPARE MODE: **Swipe** Opacity Spy

+ Add Layers **Exit Comparison**



2019 MAR 25   

MAR 2019 APR 2019 MAY 2019



NASA WORLDVIEW

Layers Events Data

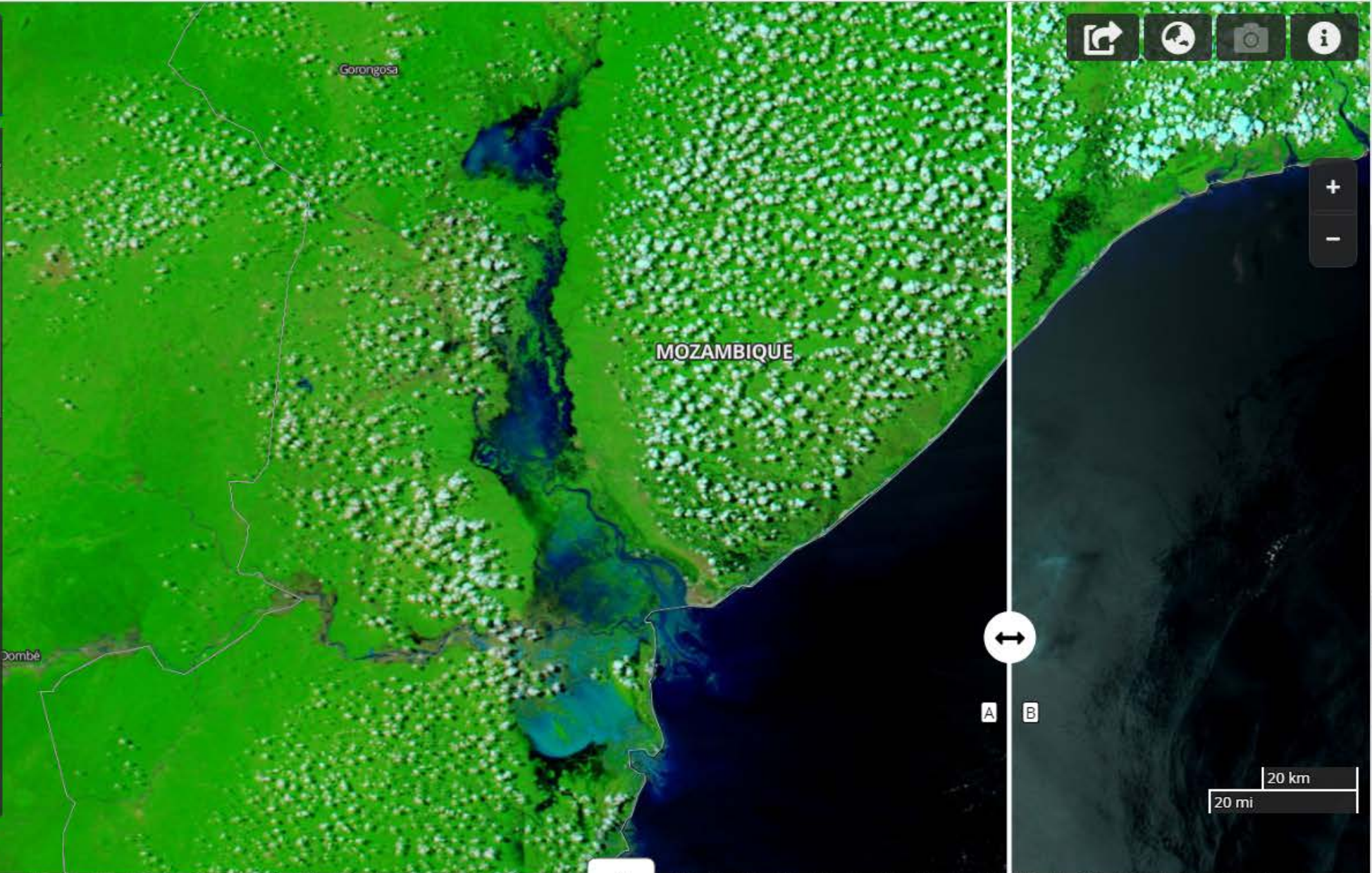
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OVERLAYS

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- Fires and Thermal Anomalies (Day and Night) Aqua / MODIS
- Place Labels © OpenStreetMap contributors

COMPARE MODE: Swipe Opacity Spy

+ Add Layers Exit Comparison



2019 MAR 25 DAYS < > [Timeline: MAR 2019, APR 2019, MAY 2019]

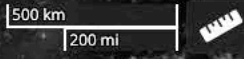
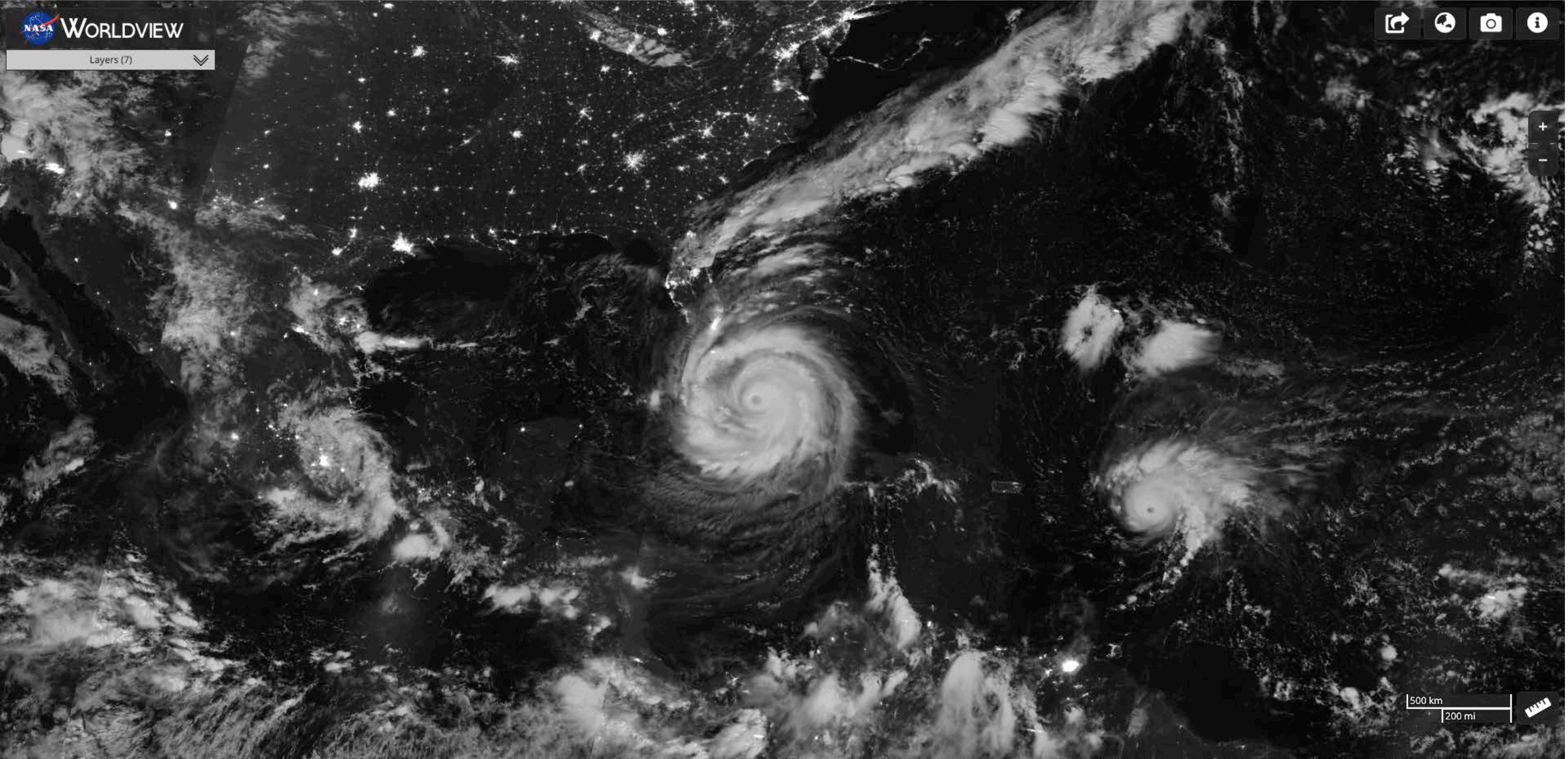
Expansion of LANCE

The following instruments were added to LANCE between 2015 - 2019

Instrument	Product Categories	Data added to LANCE
LIS	Lightning, Atmospheric Electricity, Weather Events	Mar 2018
MISR	Cloud motion vectors (Winds), Radiances	Jun 2016
MOPITT	Total column carbon monoxide (CO) retrieved from thermal infrared radiances	Oct 2017
OMPS	Total Column Ozone and Aerosol Index, SO ₂ , Ozone Profile	S-NPP: Dec 2017 NOAA 20: Dec 2019
VIIRS	375 m Active Fire, Corrected Reflectance Imagery, Land Surface Reflectance, Land Surface Temperature, Snow Cover, Sea Ice, Ice Surface Temperature	S-NPP: Oct 2017 NOAA 20: Aug 2019

The following products were recently added to LANCE

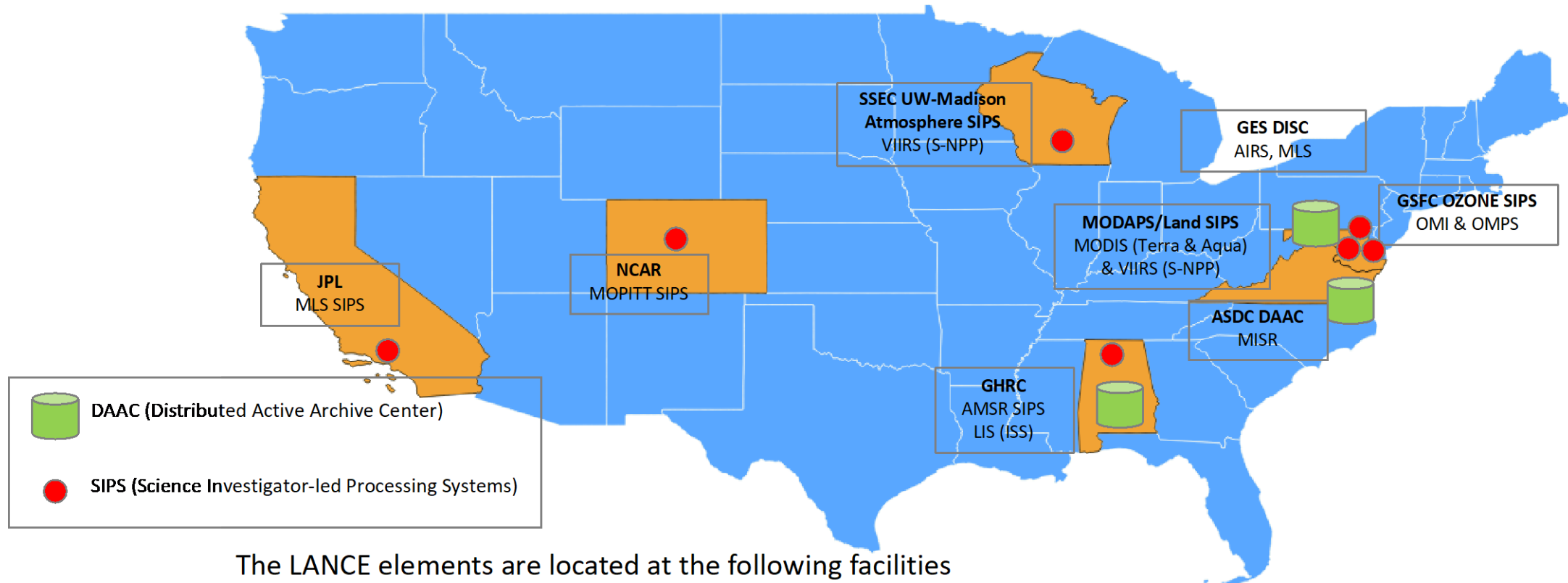
- VIIRS Nighttime Imagery product; January 2017
- OMPS Pyrocumulonimbus product (PyroCb); October 2018
- MODIS Thermal Alert System (MODVOLC); produced in 2018 by LANCE from MODIS data to serve the volcano monitoring community and distributed primarily through the University of Hawaii
- MODIS Multi-Angle Implementation of Atmospheric Correction (MAIAC); produced in 2019 by LANCE to support the air quality and climate/atmospheric modeling communities
- MODIS Global Near Real-Time Flood Product (in progress)



NASA Worldview screenshot of Nighttime imagery from 9 September 2017 produced VIIRS data and showing Hurricane Irma .



LANCE Facilities in 2019



The LANCE elements are located at the following facilities

- **GSFC Earth Sciences Data and Information Services Center (GES DISC)** is providing AIRS data with support from the AIRS Science Computing Facility (SCF) at JPL, and MLS data via the MLS SIPS at JPL
- **Atmospheric Science Data Center (ASDC) DAAC** is providing MISR data with support from the MISR SCF at JPL
- **AMSR Science Investigator-led Processing System (SIPS)** is providing AMSR2 and **Global Hydrology Resource Center (GHRC) DAAC** is providing LIS data
- **MODIS Adaptive Processing System (MODAPS) and Land SIPS** are providing MODIS and VIIRS Land data
- **OZONE Science Investigator-led Processing System (SIPS)** is providing OMI and OMPS data
- **MOPITT SIPS (National Center for Atmospheric Research (NCAR))** is providing MOPITT data
- **Atmosphere SIPS (Space Science and Engineering Center (SSEC) University of Wisconsin)** is providing VIIRS Atmosphere data



LANCE ... Where are we now?

- November 2019 was the 10th Anniversary of LANCE
- LANCE provides over 203 image and derived data products
- On an average day, over 16.2 TB of NRT products (data and imagery) are downloaded (excluding imagery from GIBS and Worldview)
- After 10 years Chris Justice (UMD) stepped down as chair
 - New UWG Chair: Miguel Román (USRA)
- Recently approved to add NRT SMAP products
- The UWG is considering a LANCE-Lite component where experimental products and products from non-NASA instruments (such as fire data from GOES and SAR data from Sentinel-1) might be added to serve the expanding user community



Thanks to my co-authors!

Diane Davies

Karen Michael

Chris Justice

Miguel Roman