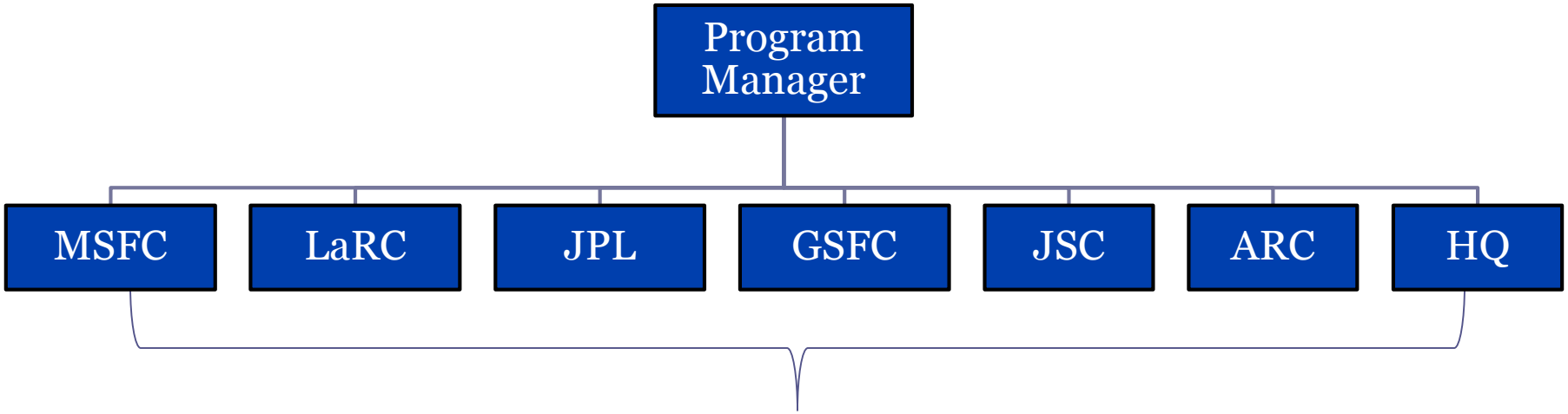
NASA Disaster Response Program

Jordan Bell
Research Associate
Marshall Space Flight Center/UAH
Disaster Response Program

NASA's Earth Science
DISASTERS

Disaster Response Program



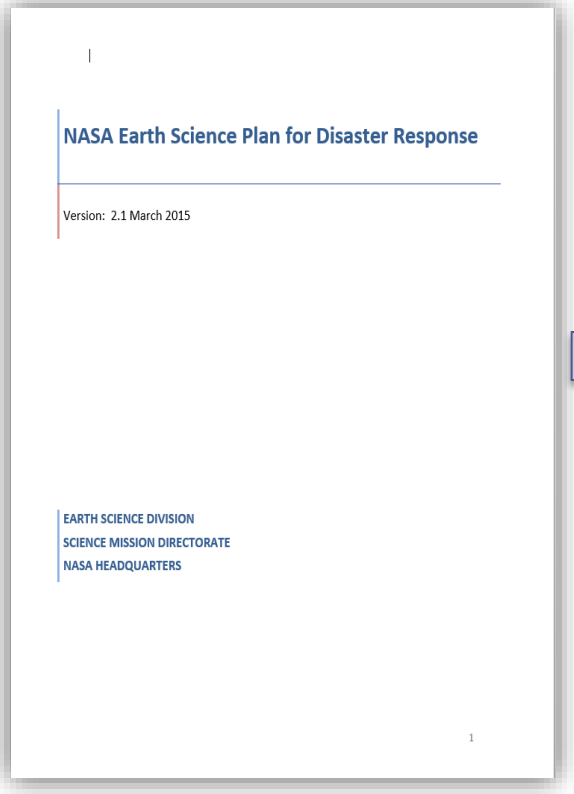
- Coordination of response efforts between the NASA Centers
- Utilizes each center's expertise to provide imagery and derived products to additional government partners and end users

Capabilities

Flood
Earthquake
Severe Weather/Tropical Cyclone
Earthquake
Oil Spills
**Flight Assets

NASA's Earth Science DISASTERS

NASA's Tiered Response


NASA Earth Science Plan for Disaster Response

Version: 2.1 March 2015

EARTH SCIENCE DIVISION
SCIENCE MISSION DIRECTORATE
NASA HEADQUARTERS

1

Tier 1

response and recovery is on an "as available" basis

- ESD expects Centers and programs to make only minor impacts to existing, on-going activities

Tier 2

considerable given the extent of the disaster and are worth some impact to on-going activities.

- Personnel relevant to the disaster type would be expected, tasked, and assigned to support data collection and analysis

Tier 3

directly affects national safety, security, or interests

- All relevant personnel would be expected to review their activities for possible support to the disaster and/or be on-call to be tasked.

- Assets and personnel may be specifically assigned and tasked for lengthy time periods.

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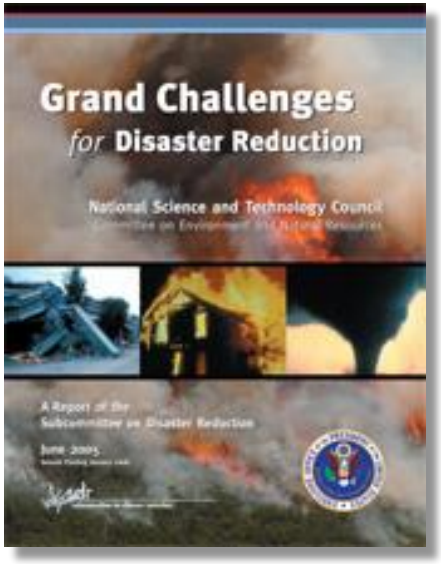
US Disaster Coordination

NASA supports the White House Office of Science and Technology Policy (OSTP) Committee on Environment, Natural Resources and Sustainability (CENRS)

Subcommittee on Disaster Reduction (SDR)
Six Grand Challenges:



① Provide hazard and disaster information where and when it is needed
② Understand the natural processes that produce hazards
③ Develop hazard mitigation strategies and technologies
④ Recognize and reduce vulnerability of interdependent critical infrastructure
⑤ Assess disaster resilience using standard methods
⑥ Promote risk-wise behavior

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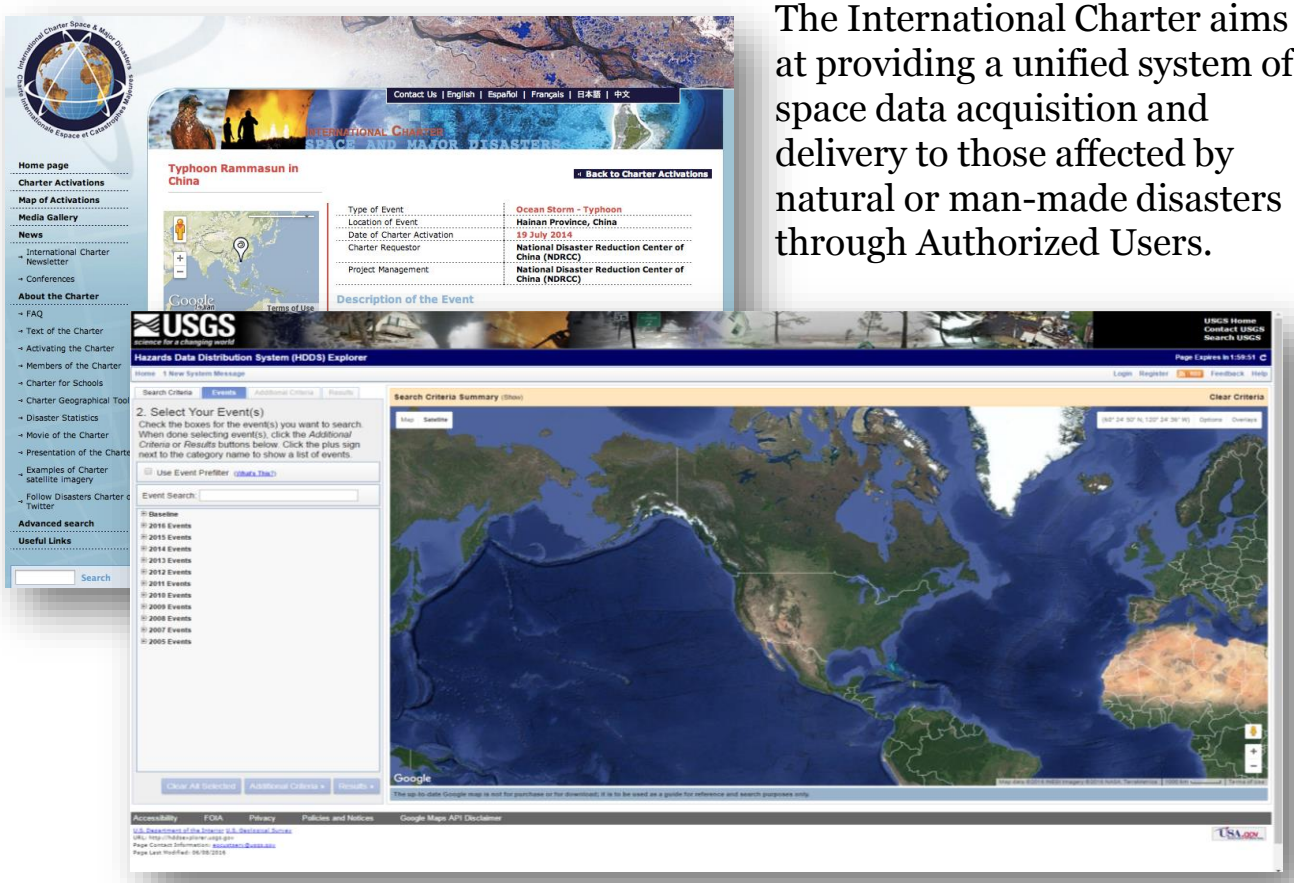
International Charter - Space & Major Disasters



The International Charter aims at providing a unified system of space data acquisition and delivery to those affected by natural or man-made disasters through Authorized Users.

Each member agency has committed resources to support the provisions of the Charter and thus is helping to mitigate the effects of disasters on human life and property.

USGS and NOAA are the two United States signatories with NASA being a contributing organization for data and disaster related products.

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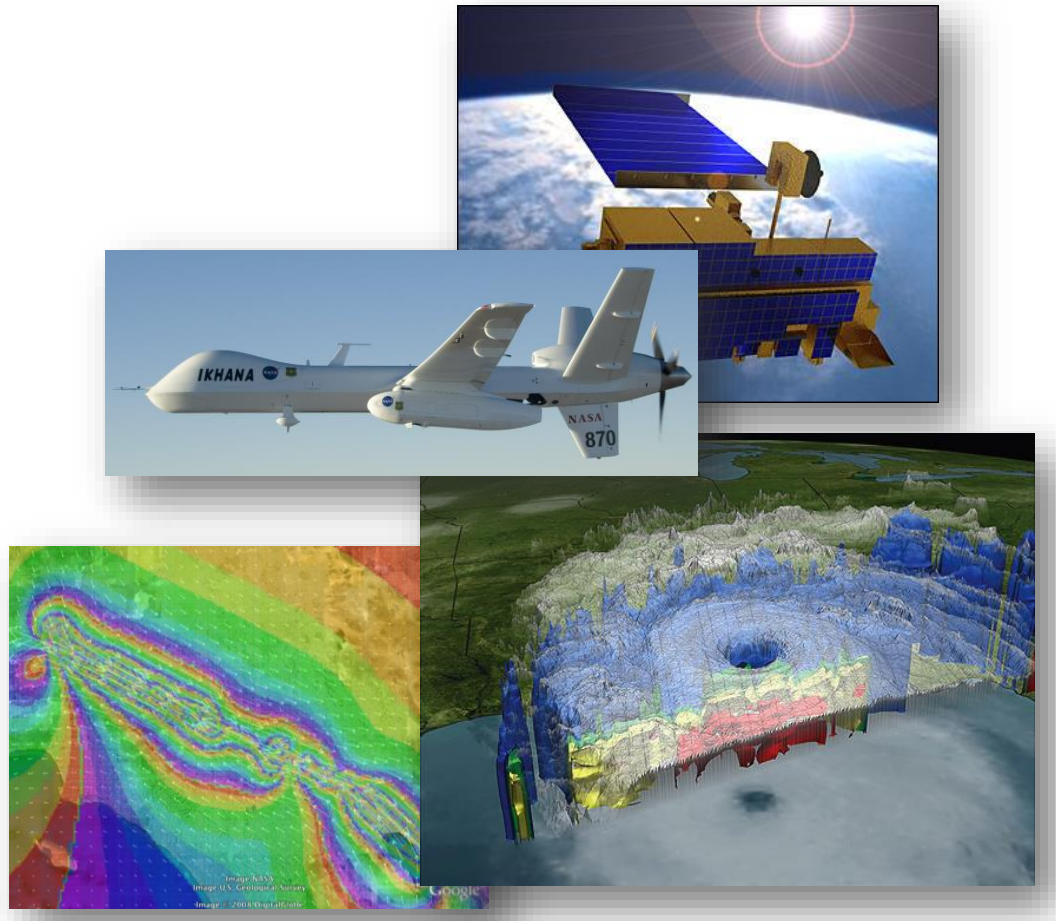
NASA ESD Capabilities for Disaster Response

- ***Spaceborne Assets***
  - Existing and Formulation missions: MODIS, NPP, Landsat, TRMM, EO-1, ASTER, GPM…
  - Decadal Survey Missions: SMAP, HyspIRI, …
  - ISS
- ***Airborne Instruments***
  - UAVSAR – Radar
  - LVIS – Lidar
  - AMS, MASTER – Thermal Infrared
  - HIWRAP, APR2, HAMSR, HIRAD, PALS MAPIR – Active and passive microwave
- ***Data processing, analysis systems, Data Centers***
  - EOSDIS-ESDIS
  - LANCE/NRT/DB
- ***Modeling and Analysis***



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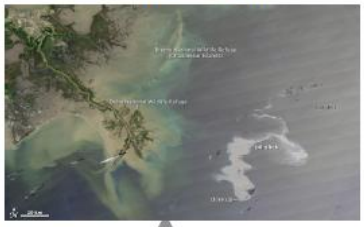
Deepwater Horizon Oil Spill

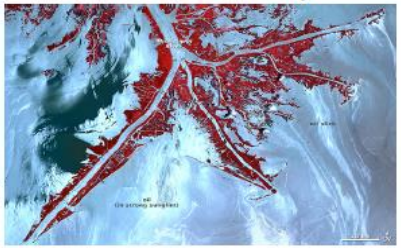
Well Head Explosion
Uncontrolled Oil Spill

Terra & Aqua
MODIS images track
extent of spill

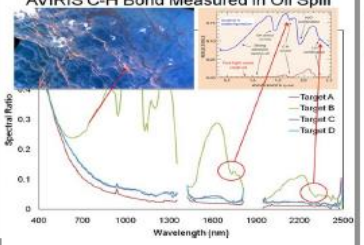


ER2/AVIRIS flights
6-25 May

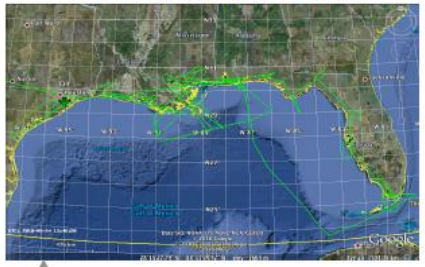
Terra/ASTER 24 May



AVIRIS C-H Bond Measured in Oil Spill



G-III/ UAVSAR 22-24 Jun



EO-1/ALI 26 June

End of Active Response

B200/AVIRIS flights
2 Sep-4 Oct

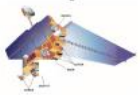
Intl. Charter Activated

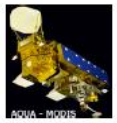
B200/AVIRIS flights 3-13 Jul

Well Capped

Well Sealed

Day 0	Day 3	Day 5	Day 15	Day 33	Day 62	Day 73		Day 134		Day 166
20 Apr 2010	23 Apr	25 Apr	6 May	24 May	22 Jun	3 Jul	15 Jul	2 Sep	19 Sep	4 Oct





Terra MODIS, MISR, ASTER

Aqua MODIS

Contents lists available at SciVerse ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

Review

State of the art satellite and airborne marine oil spill remote sensing: Application to the BP *Deepwater Horizon* oil spill

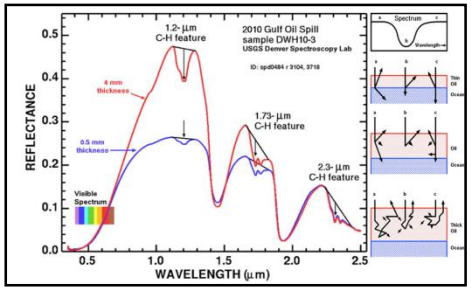
Ira Leifer [a,*], William J. Lehr [b], Debra Simecek-Beatty [b], Eliza Bradley [c], Roger Clark [d], Philip Dennison [e], Yongxiang Hu [f], Scott Matheson [e], Cathleen E. Jones [g], Benjamin Holt [g], Molly Reif [h], Dar A. Roberts [c], Jan Svejkovsky [i], Gregg Swayze [d], Jennifer Wozencraft [h]

NASA Oil Spill Response

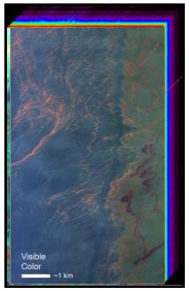
NASA AVIRIS used by USGS, NOAA and NASA science team to estimate the thickness and volume of the surface oil. Example result: High values at 131 liters/pixel*.

Oil Spill

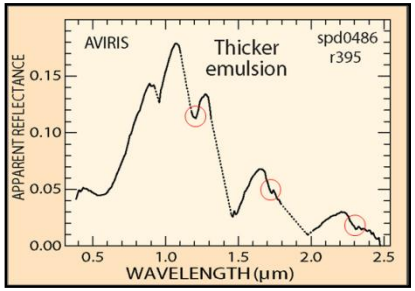
Spectroscopic Basis
C-H Bond Absorptions



AVIRIS



AVIRIS Spectra



Fraction

Thickness

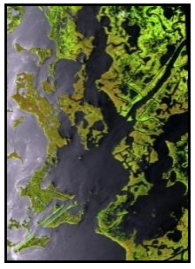
Quantitative Volume Estimates

NASA AVIRIS used by a broad government and university science team to map vegetation species and physiological condition (health) before and after oil impact.

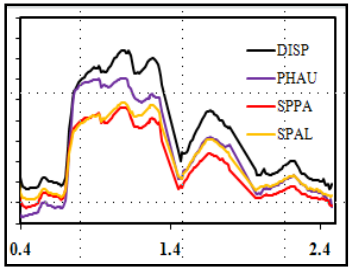
Pre Oil

AVIRIS ER-2

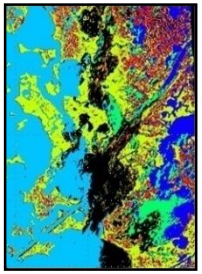
Coastal Data



AVIRIS Vegetation Spectra

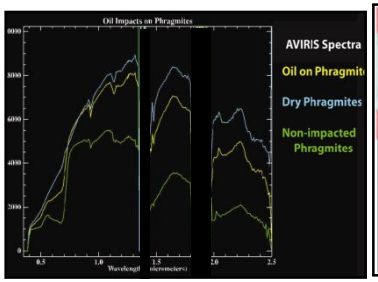


AVIRIS Species Map

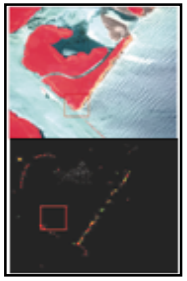


Post Oil

AVIRIS Oil Impacted Vegetation Spectra



Oil Impact Product



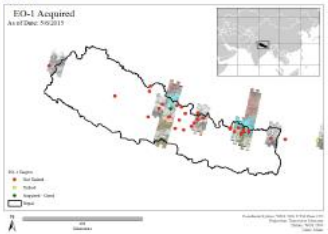
NASA's Earth Science DISASTERS

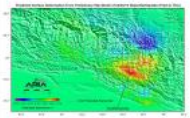
Disaster Response for Nepal

Products include: Surface deformation maps (interferograms), Optical imagery
Damage Proxy Maps
Damage & Vulnerability Maps
Surface Deformation Models
Induced Hazards (i.e. Landslide/Flood susceptibility maps)

M7.8 Earthquake & 1st coordination call

CSK Damage Proxy Map (DPM)
- Delivered to NGA, OFDA/USAID
- Publicly released



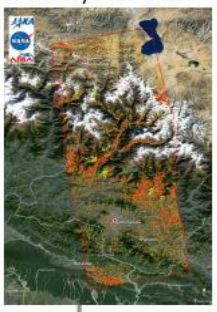


Initial quake models
Interferograms
tilt maps

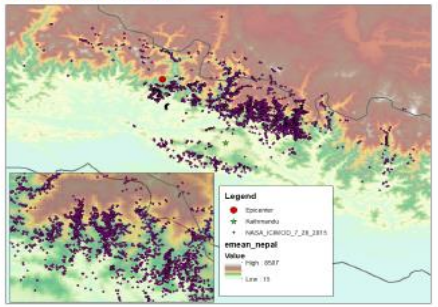
GPS Surface Deformation
- Delivered to USGS
- Publicly released

First Radar Surface Deformation – S1A
- Publicly released

ALOS-2 DPM
- Delivered to NGA, OFDA, DigitalGlobe, Esri
- Publicly released



Landslide mapping + Susceptibility Maps
SERVIR/ICIMOD



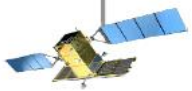
Sub-Groups formed
& First optical images

Optical Imagery: Landsat, ASTER, EO-1 Tasking

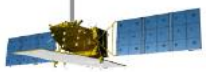
Landslide Identifications

Last telecon

Day 0 April 25 | Day 1 April 26 | Day 3 April 28 | Day 4 April 29 | Day 7 May 1 | Day 9 May 4 | Day 10 May 5 | July

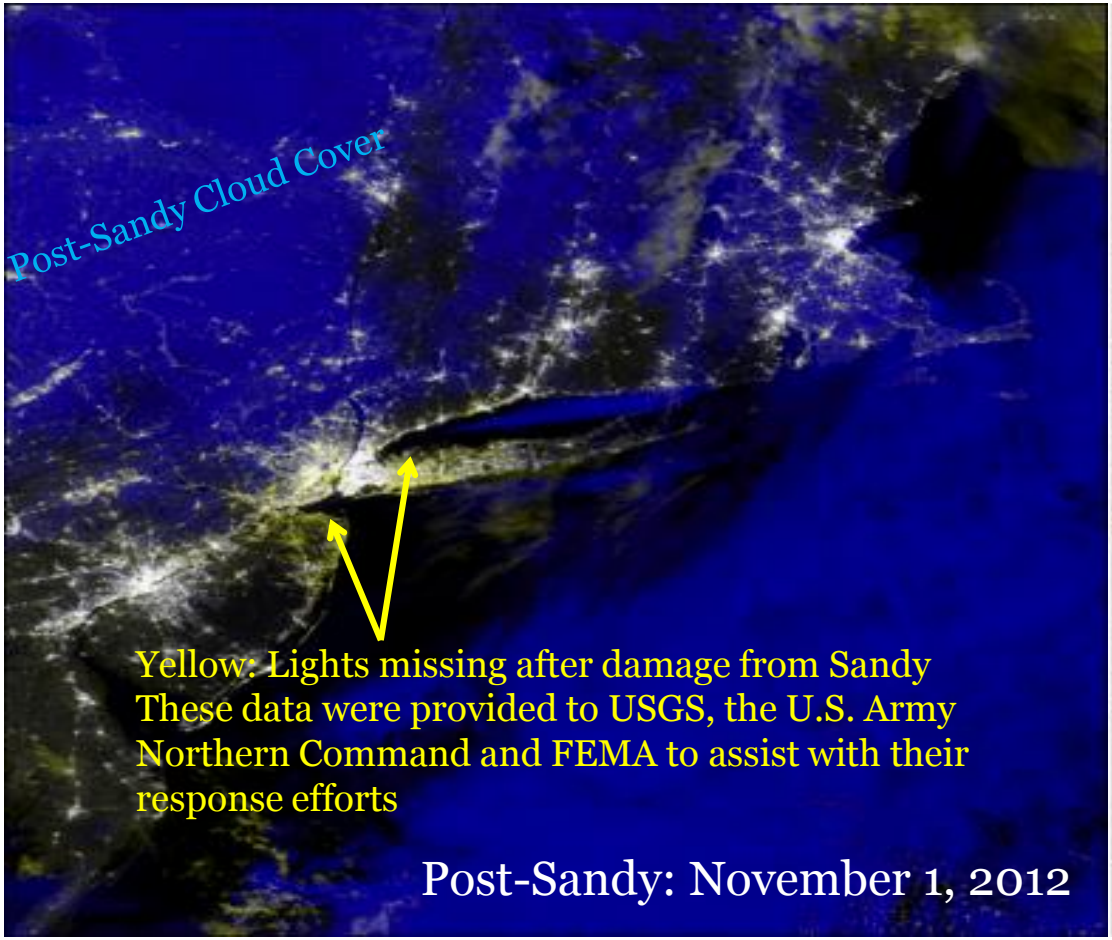


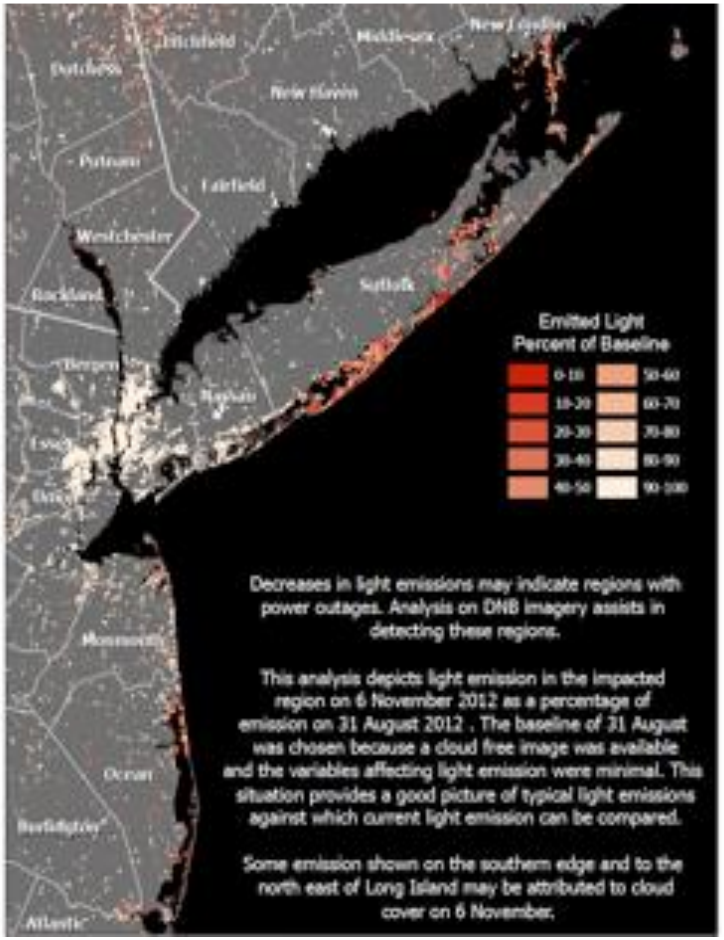
COSMO-SkyMed images Nepal



ALOS-2 images Nepal

Disaster Response for "Superstorm Sandy"





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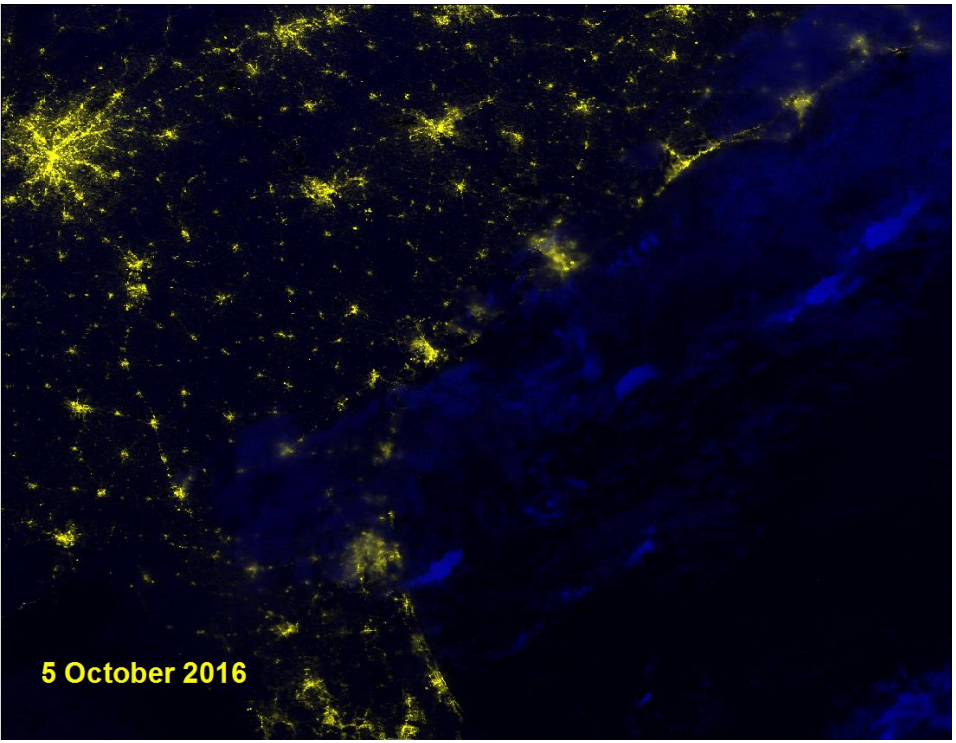
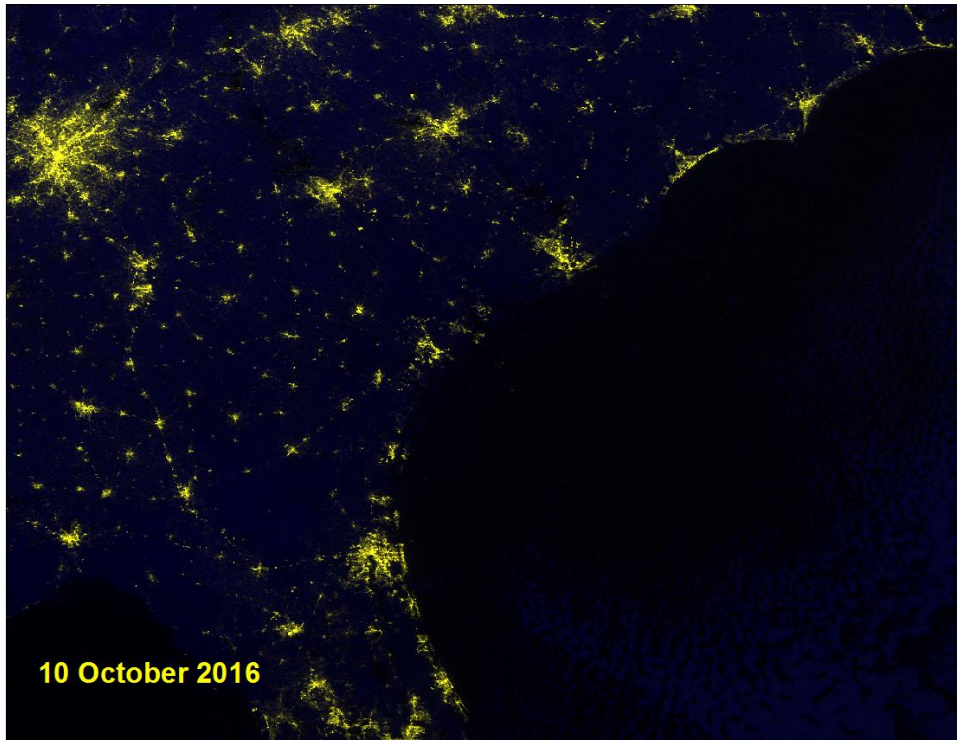
Disaster Response for “Superstorm Sandy”





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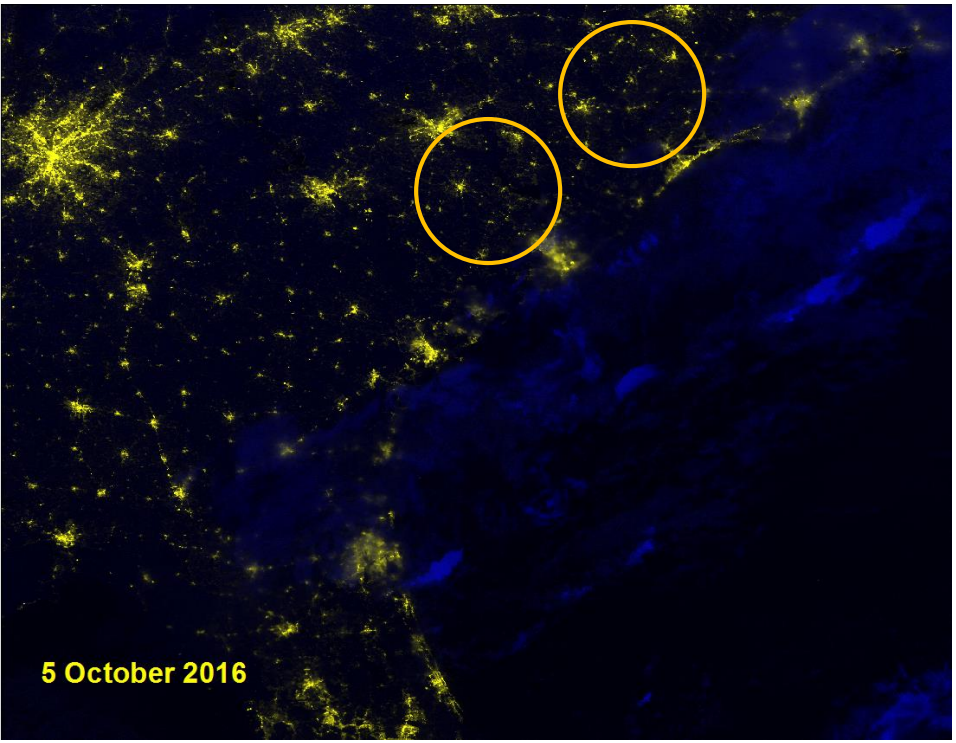
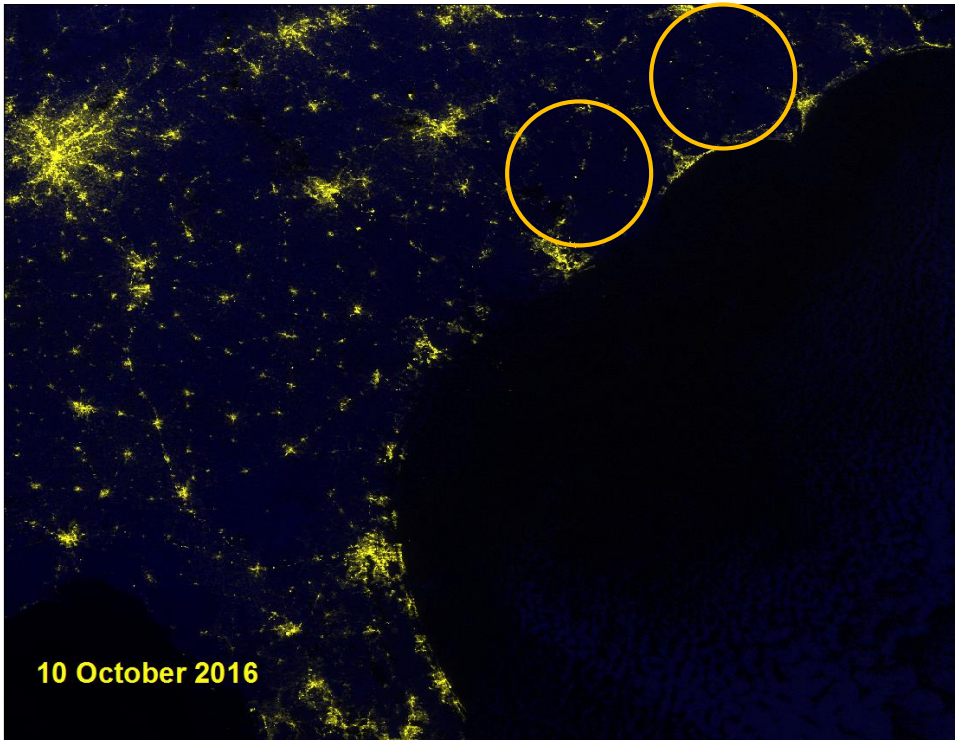
Disaster Response for Hurricane Matthew





NASA's Earth Science
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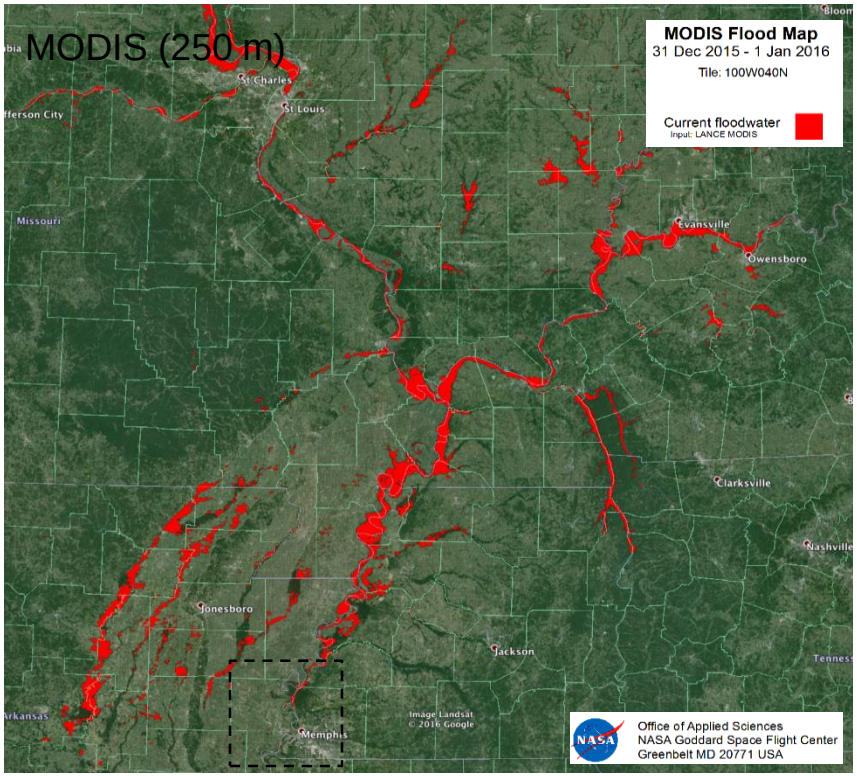
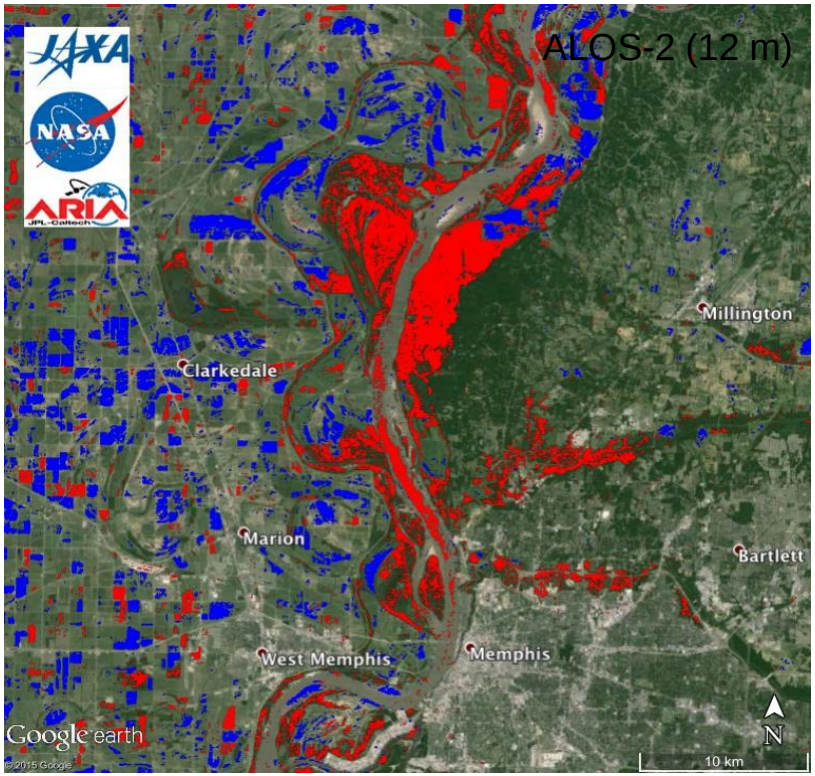
Remote Sensing of Flood Waters

NASA MODIS Detections and JAXA ALOS-2 Synthetic Aperture Radar



Flood detections (red) from NASA Near Real-Time Global Flood Mapping with flood extent on January 1, 2016, courtesy of Goddard Space Flight Center.

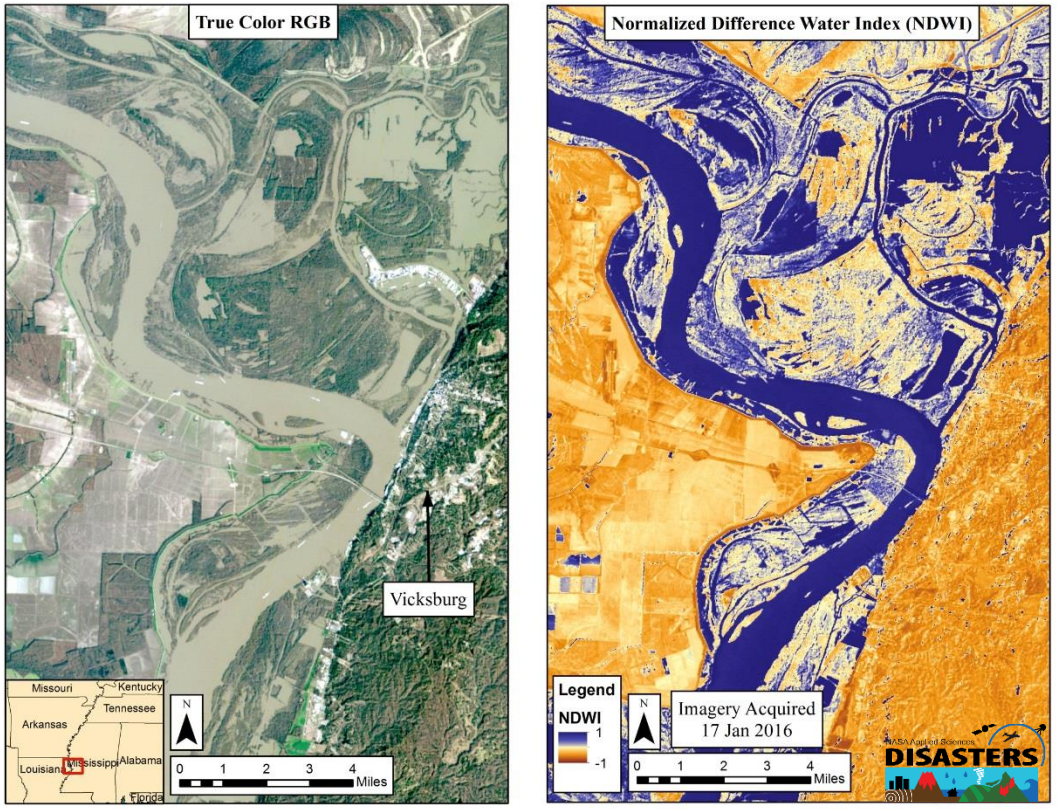


Standing water (blue) and water-inundated vegetation (red) detected by ALOS-2 and the Synthetic Aperture Radar (SAR) at the Jet Propulsion Laboratory, January 6. Coverage area shown as dashed inset of MODIS image.

NASA's Earth Science DISASTERS

Remote Sensing of Flood Waters

Multispectral Views from NASA's Earth Observing-1 Mission



True color (left) and Normalized Difference Water Index (right) imagery derived from NASA's Earth Observing-1 mission, observed near Vicksburg, Mississippi on 17 January 2016.

NASA staff at Goddard Space Flight Center and Marshall Space Flight Center targeted collections of imagery by NASA's Earth Observing-1 (EO-1) mission.

Multispectral imaging by EO-1 provides true color imagery (left) and capabilities for derived products (right), and can also be applied to Landsat-7 and Landsat-8 missions, Aqua and Terra MODIS, Suomi-NPP VIIRS, and other imagery provided by federal agency partners, International Charter, and commercial vendors.

Here, true color imagery near Vicksburg, Mississippi highlights flood water (left) along the Mississippi in a visual sense, while the Normalized Difference Water Index helps to draw attention to standing water (right) in shades of blue.

NASA's Earth Science
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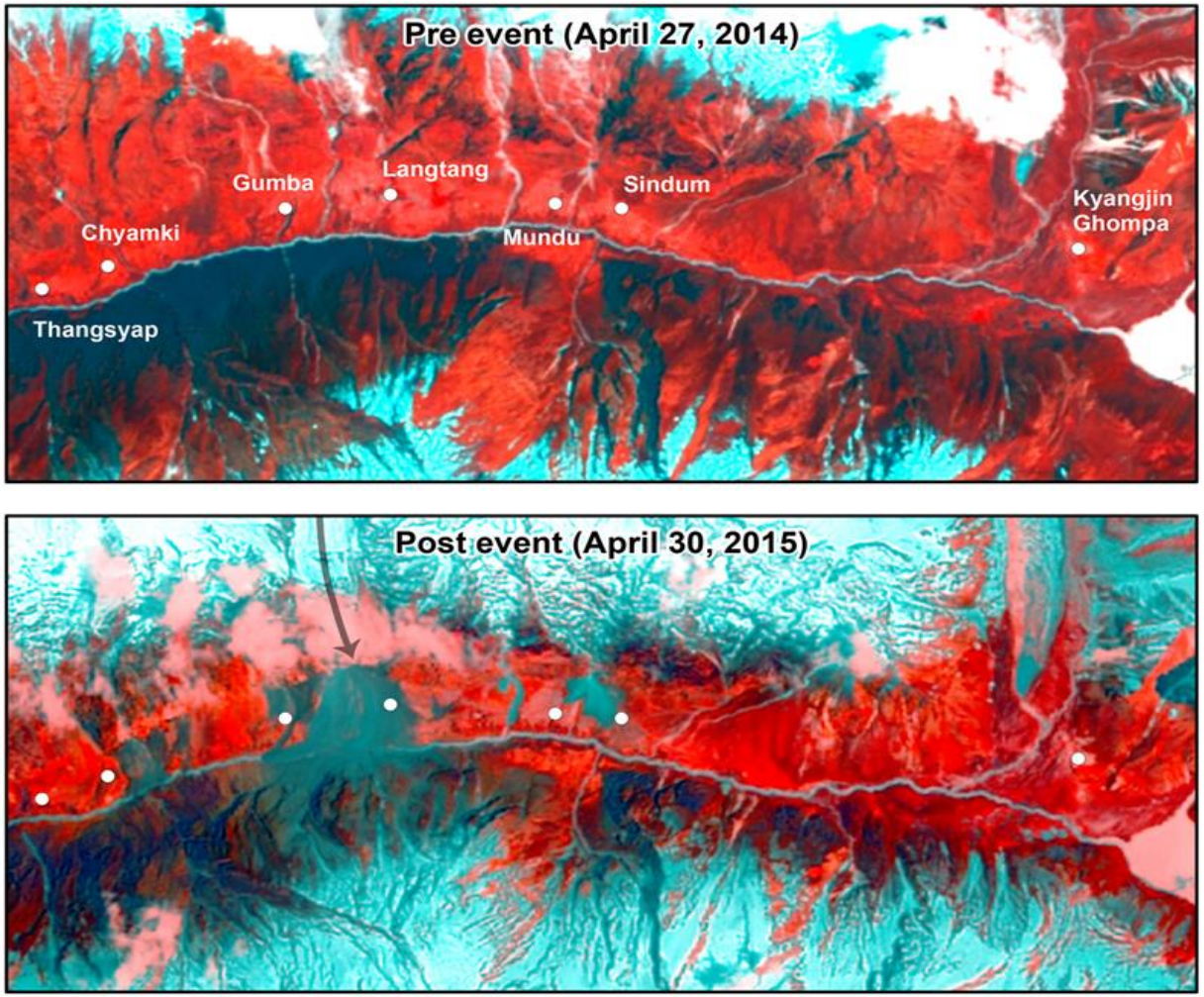
Disaster Response for 2015 Nepal Earthquake



NASA Collaborations with USCG

- NASA Applied Sciences attended the Houston Sector HURREX in February 2016
  - As a first time attendee to an exercise like this, it was very informative and eye opening
- USCG expressed interest in accessing NASA datasets in their operational command center
  - Additionally, observed that EPA (Response Manager) and NOAA (ERMA) could benefit of NASA datasets as well
- Briefed Disasters Program on observations and interactions with players involved in the exercise.
  - Developed strategy to build web-viewer for USCG that focuses on NASA datasets and derived product that could help USCG achieve their mission
- Attended second HURREX in April 2016 at USCG Port Arthur MSU to showcase what had been developed to date

NASA's Earth Science
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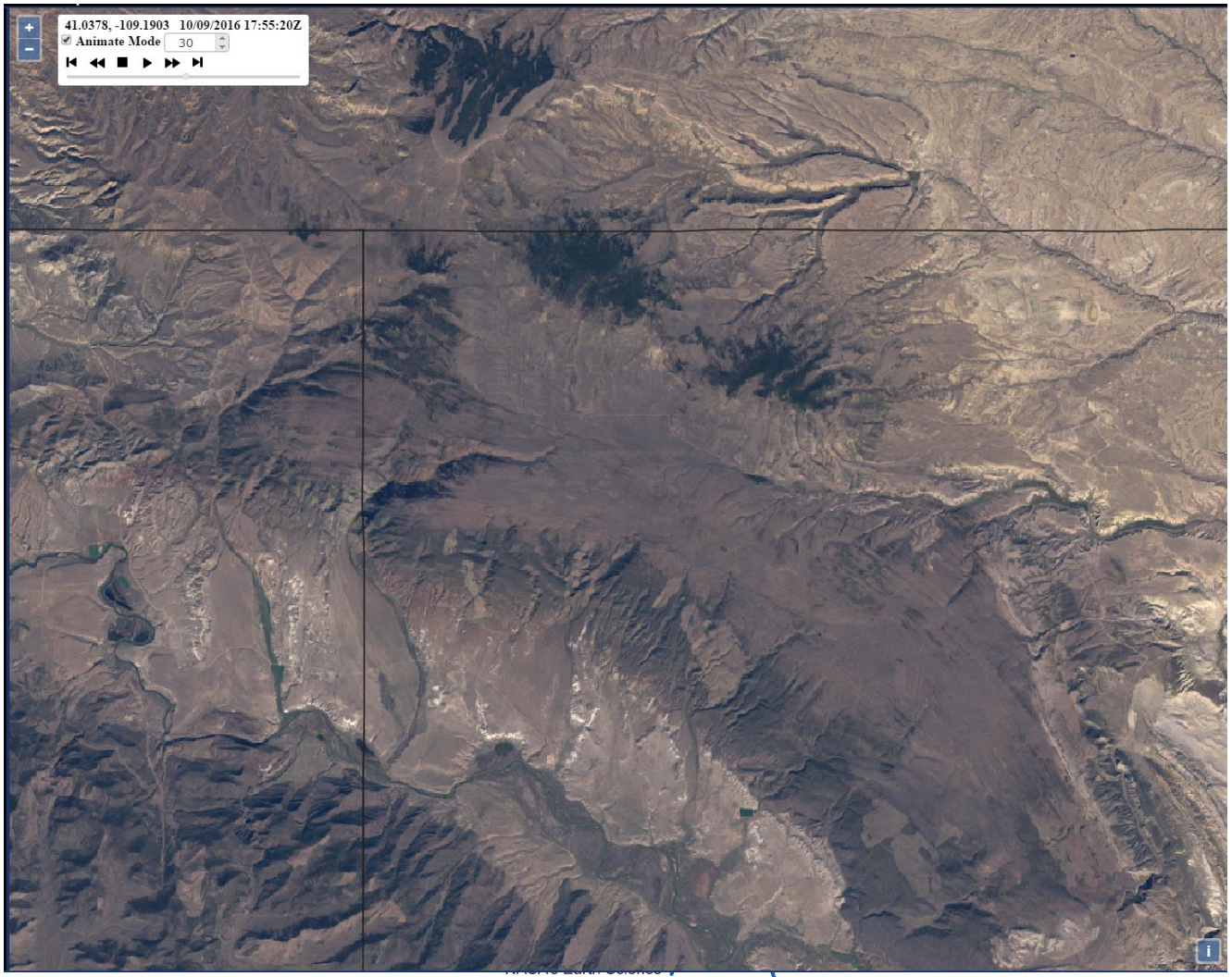
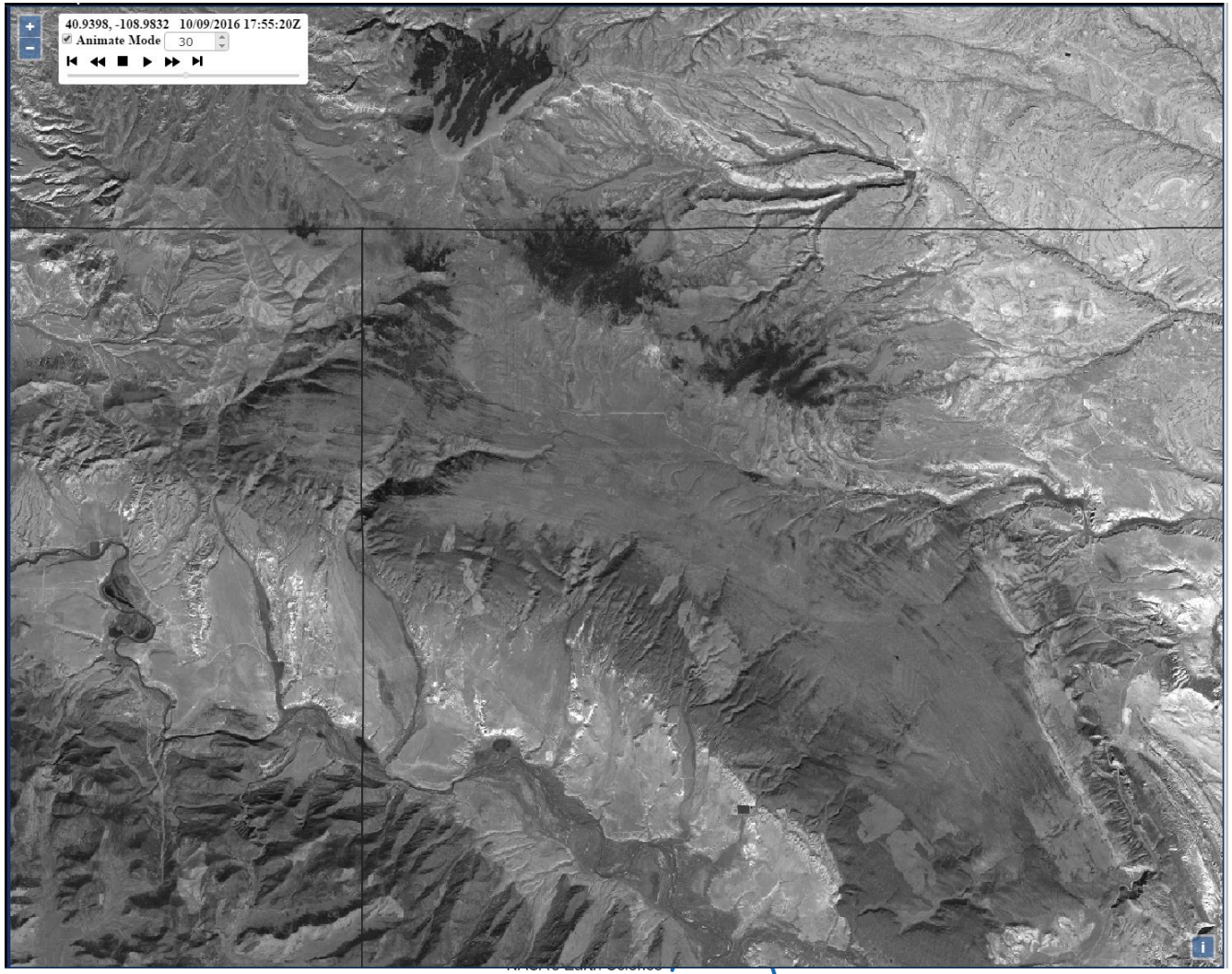
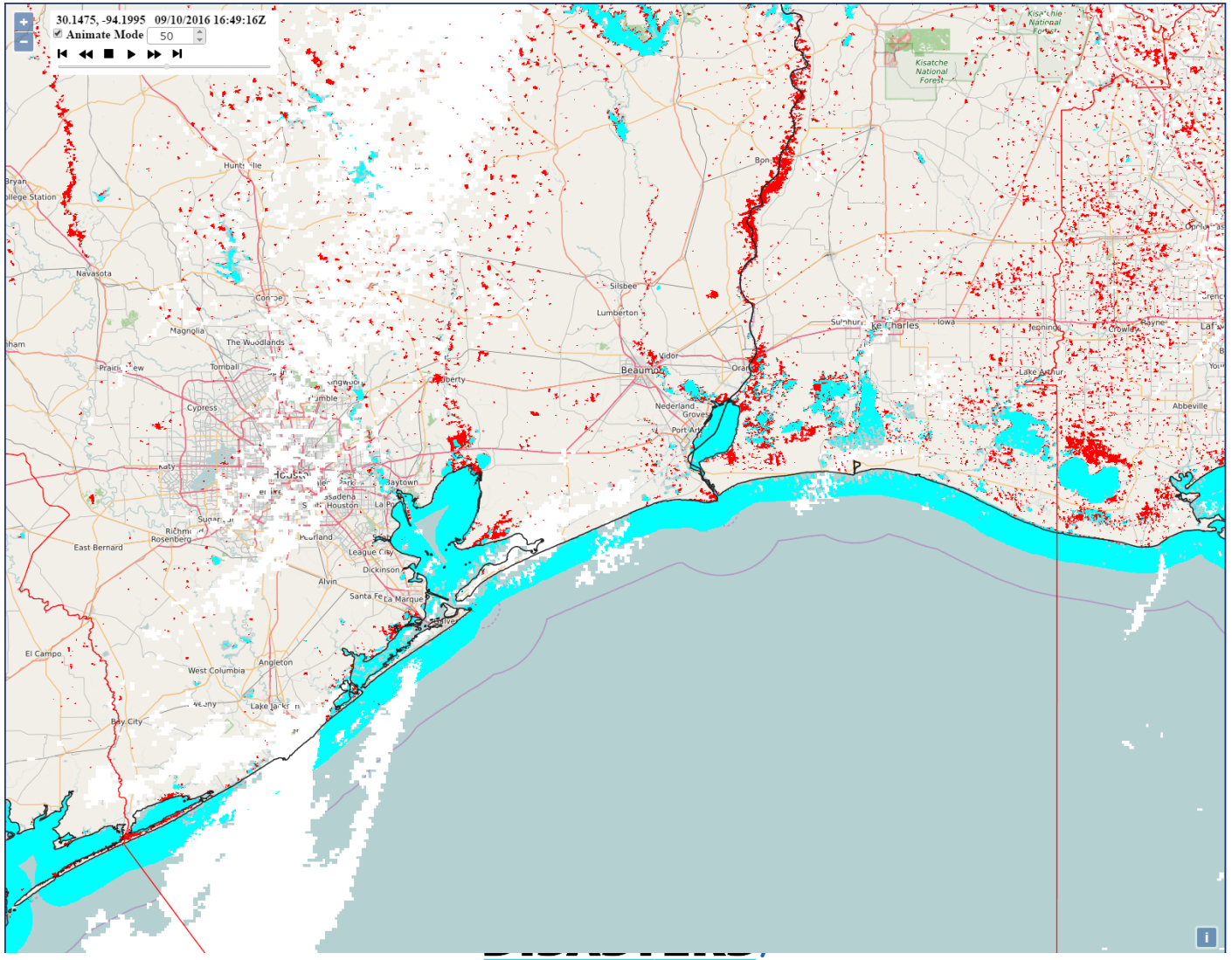
Landsat-8 True Color



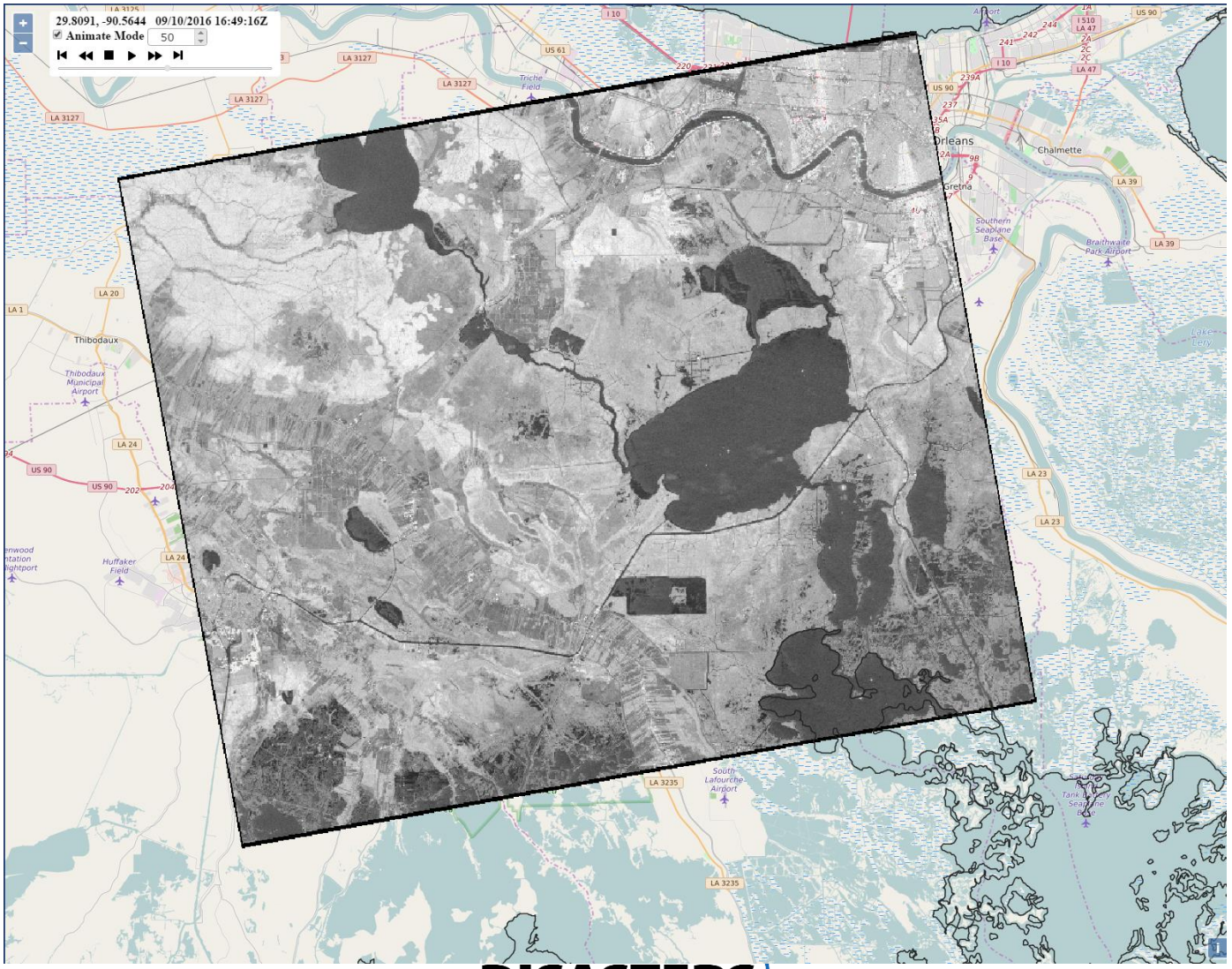
Landsat-8 Panchromatic



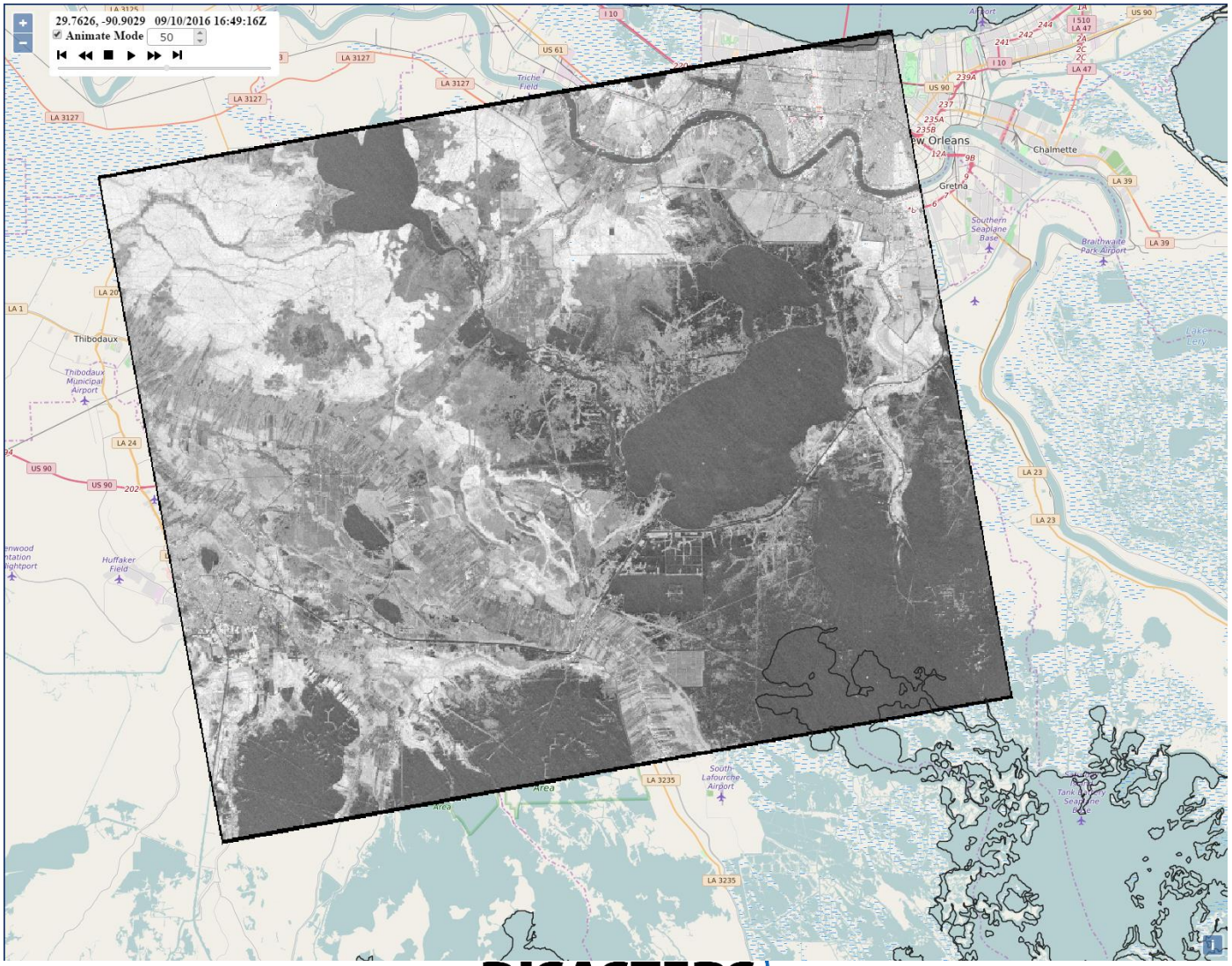
MODIS Flood Products



SAR-Before: Hurricane Isaac



SAR-After: Hurricane Isaac



DISASTERS

High Resolution Imagery: Hurricane Ike

Benefits of WMS Delivery

- WMS is accessible from any internet connection and does not require any desktop software.
- Currently, USCG, and other end users do not have to host any data as MSFC is hosting it.
  - Developing a new WMS strategy to handle requests from growing list of end users and partners.
- Viewer platform is flexible, customizable and easily created to meet the individual USCG Sector needs.
  - In addition to a new WMS strategy, additional options for displaying data are being investigated as well.

Summary

- The NASA Disaster Program is:
  - Growing and enhancing its capabilities to respond within the interagency
  - Responding to requests for support from domestic and international partners
  - Looking for interagency and international partners
  - Identifying relevant opportunities to participate and/or observe applicable exercises and trainings.

- NASA would like to not only continue to support the USCG & Partners with WMS development but also provide in-person support during relevant emergency events

NASA's Earth Science
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