Disaster Risk Reduction, Impact and Recovery Mapping – Perspectives from Space

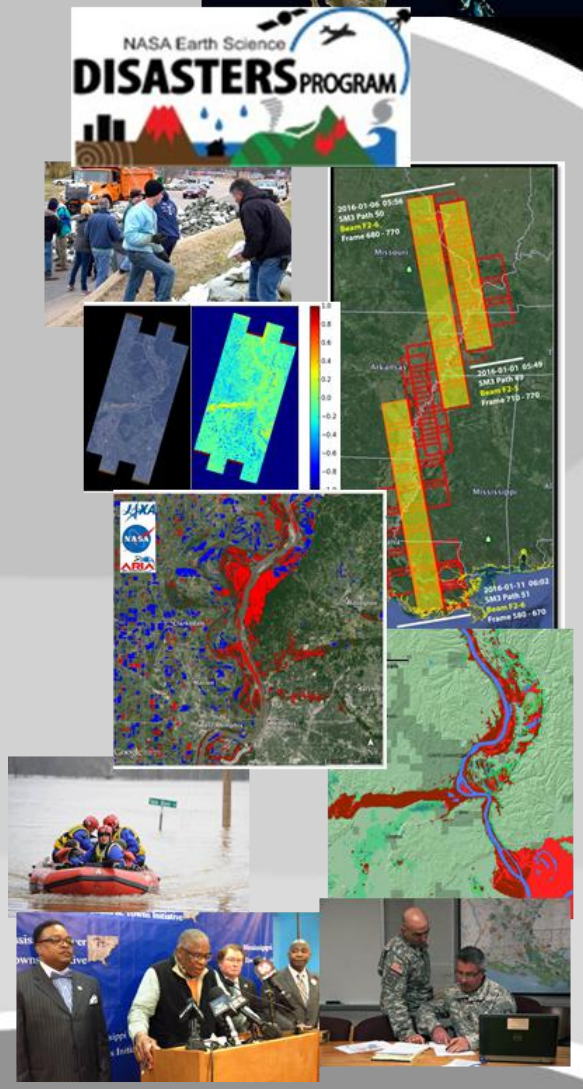
Dr. David Green
Disaster Program Manager
Science Mission Directorate
Earth Science Division

ICC 2017 67/2/2017

Overview

https://disasters.nasa.gov/floods

- *Risk Reduction and Response*
  - Global Framework and Partnerships
  - Workflows: Monitoring, Outlooks, Extent, Duration, Impacts
  - Engagement



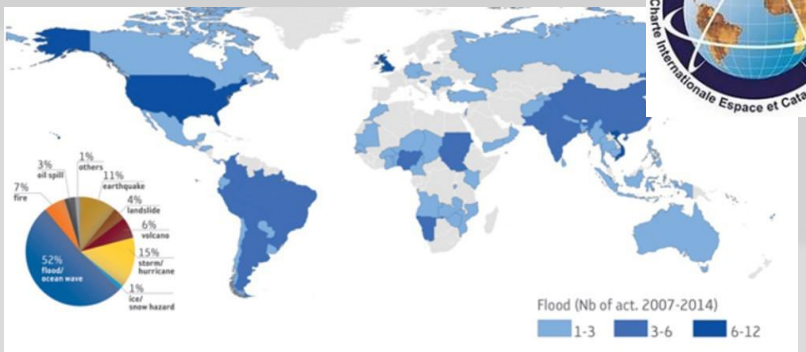
https://disasters.nasa.gov/

International Coordination and Data Sharing

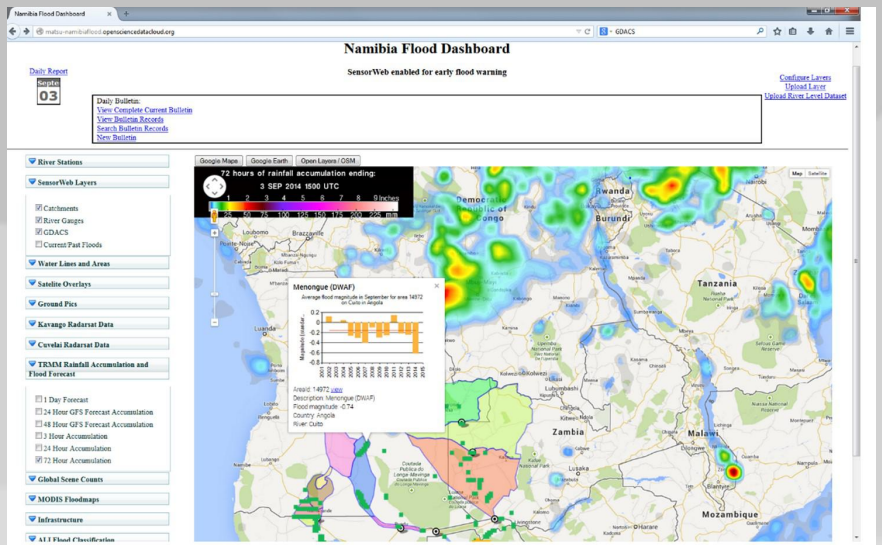
Group on Earth Observations - Flood Task:

Supporting access to a unified system of space data acquisition and delivery, models and mapping to support those affected by natural or man-made disasters

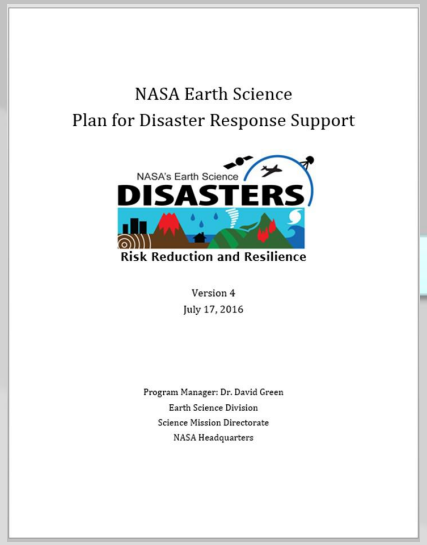
GFP: better link to users
From hazards to impacts



Left: Diagram showing disaster types (%) covered by the Charter since its inception in 2000. Over 50% of activations concern flooding. Top: Map illustrating the number of flooding events by country covered by the Charter between 2007 and August 2014 (in total 172 flooding events worldwide).



NASA's Tiered Response


NASA Earth Science
Plan for Disaster Response Support

NASA's Earth Science DISASTERS
Risk Reduction and Resilience

Version 4
July 17, 2016

Program Manager: Dr. David Green
Earth Science Division
Science Mission Directorate
NASA Headquarters

Assessment

Rapid Hazard Assessment Expected

- Centers and program experts to contribute within scope of daily activity
- Guidance to elevate to Tier response, direct to research or no action
- Days

E.g.: media report

Tier 1

Response and Recovery Short Term and Best Effort

- Centers and programs respond as available with only minor impact to existing/on-going activities
- Detailed assessment and products scaled to modest response
- Weeks to Month(s)

E.g..: Napa Earthquake (2014), Chile Earthquake (2015), Oklahoma tornadoes, yearly floods

Tier 2

Significant Contributions Over Extended Period

- Contributions are considerable given continual assessment of size and scale of impact
- Personnel relevant to disaster type (s) expected, tasked, and assigned to support
- Data and products adapted into recovery
- Weeks to Month(s)

E.g.: Nepal Earthquake (2015), Deep Horizon (2010), Eyjafjallajökull Eruption (2015)

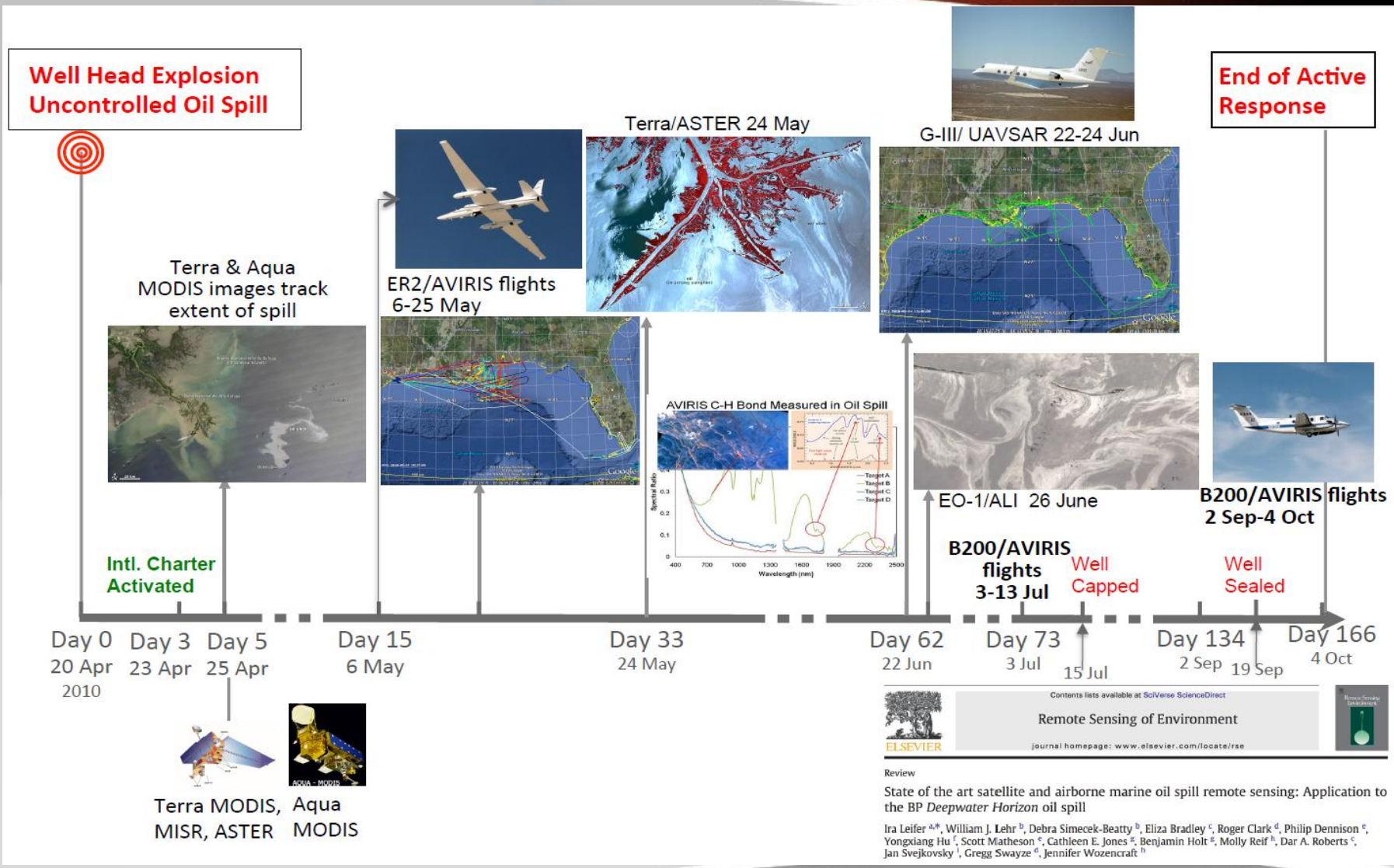
Tier 3

Disaster is of major national importance

- All relevant personnel expected to review activities for level of support to the disaster and/or be on-call
- Assets and personnel may specifically assigned and tasked for lengthy time period (Months into recovery).

E.g.: Hurricane Katrina (2005), September 11, 2001 attacks

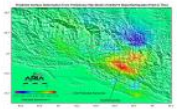
Deepwater Horizon Oil Spill



Disaster Response for Nepal

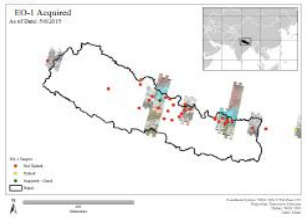
Products include: Surface deformation maps (interferograms), Optical imagery
Damage Proxy Maps
Damage & Vulnerability Maps
Surface Deformation Models
Induced Hazards (i.e. Landslide/Flood susceptibility maps)

M7.8 Earthquake & 1st coordination call



Initial quake models
Interferograms
tilt maps

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



GPS Surface Deformation
- Delivered to USGS
- Publicly released

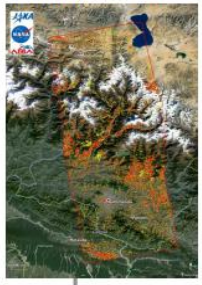
First Radar Surface Deformation – S1A
- Publicly released

Sub-Groups formed
& First optical images

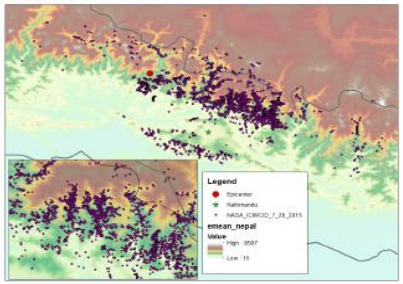
Optical Imagery: Landsat, ASTER, EO-1 Tasking

Landslide Identifications

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

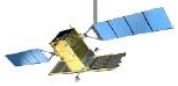


Landslide mapping + Susceptibility Maps
SERVIR/ICIMOD

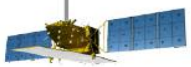


Last telecon

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

AmeriGEOSS – The Americas Group on Earth Observing System of Systems

Strengthening Disaster Risk Reduction across the Americas: A Regional Summit on the Contribution of Earth Observations

September 3rd - 8th, 2017

Buenos Aires, Argentina *

Version en español

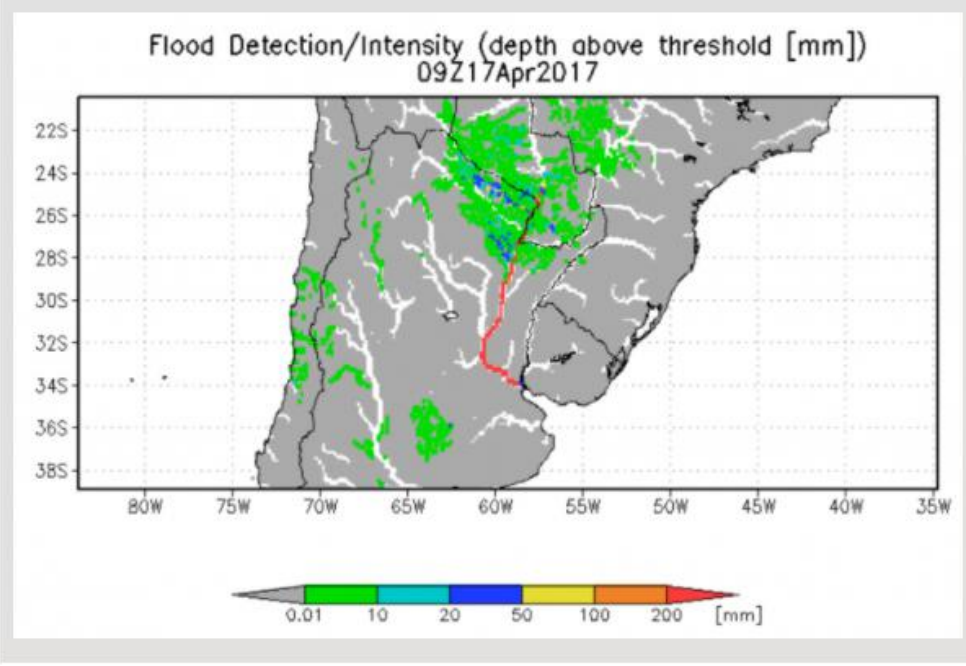
The Disaster Risk Reduction (DRR) Across the Americas Summit will provide the unique opportunity for needed joint dialogue and work planning between representatives of the scientific earth observation (EO) and DRR community, including stakeholders in regional preparedness and planning, disaster mitigation, emergency response, and recovery. Using the UNISDR Sendai Framework as an impetus, which calls for an increased role for science

Click here to sign up for more information about the summit.

CEOS

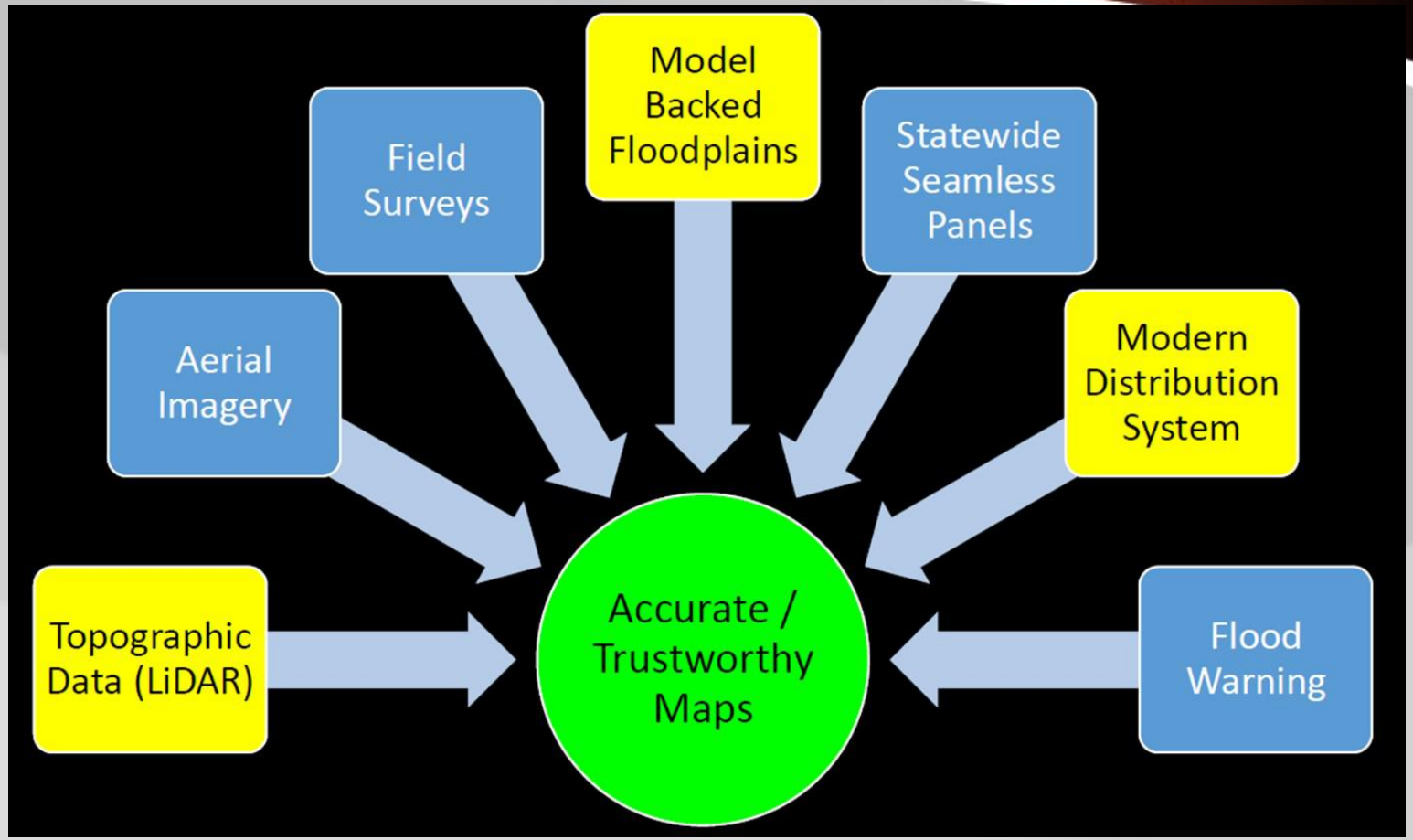
GEO GROUP ON EARTH OBSERVATIONS

Overview of northern Argentina floods on April 17th 2017



https://disasters.nasa.gov/argentina-summit-2017

Risk Reduction – Moving Global to Local Exposure, Vulnerability and Impacts



** J. Dorman, North Carolina Public Safety*

Is there Timely and Relevant Remote Sensing Data and Information?

Limitations for using remote sensing (satellite and airborne) due to

- Routine monitoring vs event characterization
- Discovery and access to data
- Latency and frequency of measurements
- Spatial Resolution
- Variety of data and information products

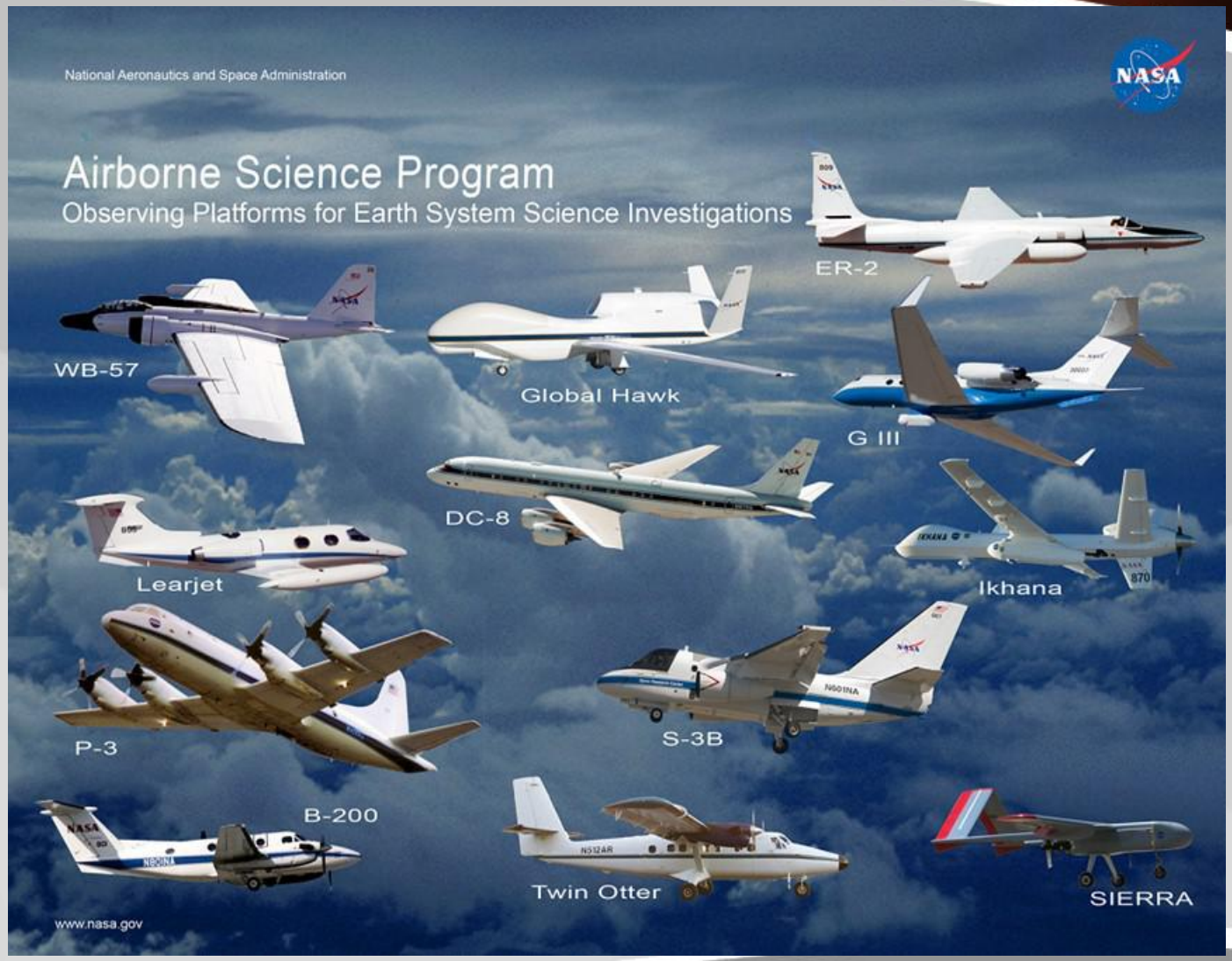
Need to consider if there is a timely flyover, rapid processing and **mapping** - if yes, data could prove useful.

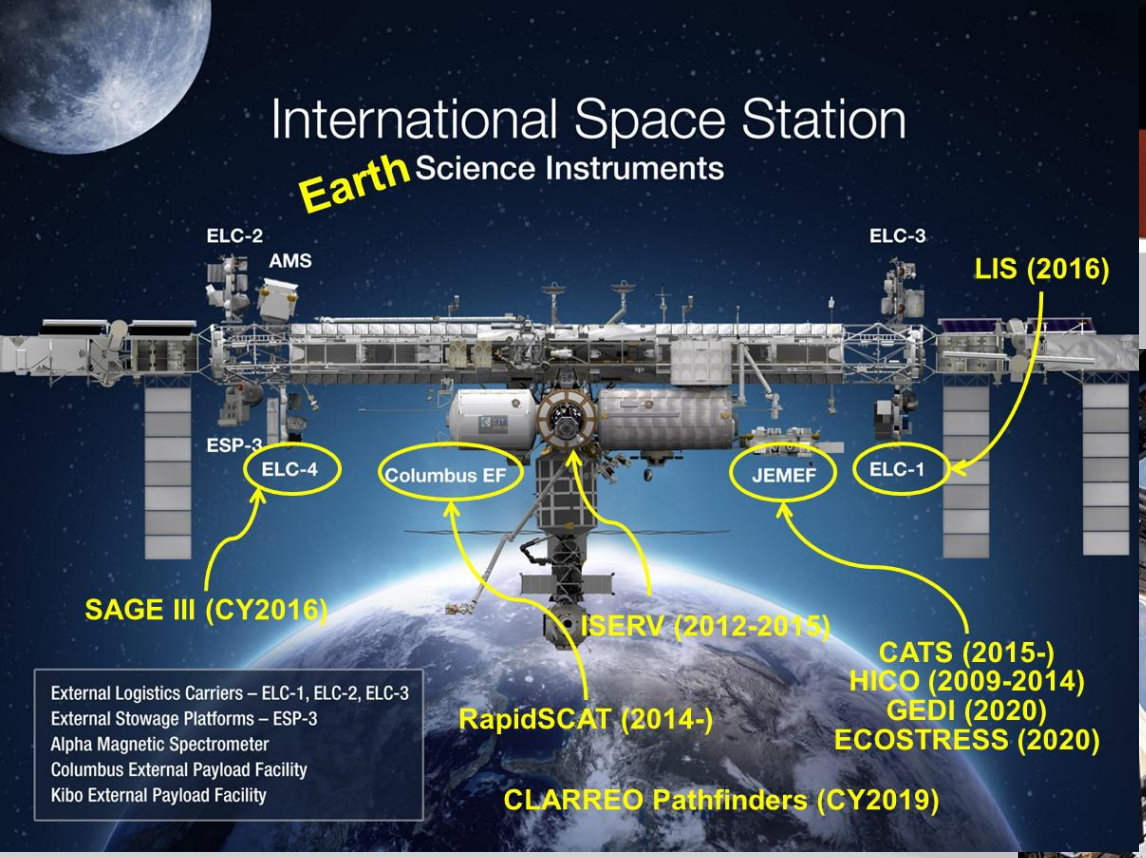
It all comes down to the questions being asked, knowing what is needed or available, and can it be applied against the time information is needed for action or decisions

Missions


Formulation
Implementation
Primary Ops
Extended Ops
MAIA (~2021)
TROPICS (~2021)
GeoCarb (~2022)
Landsat 9 (202
PACE (2022)
NISAR (2022)
SWOT (2021)
TEMPO (2018)
JPSS-2 (NOAA)
RBI, OMPS-Limb (2018
GRACE-FO (2) (2018)
ICESat-2 (2018)
CYGNSS (2016)
SORCE, (2017)
NISTAR, EPIC (2019)
TCTE (NOAA)
(NOAA'S DSCOVR)
QuikSCAT (2017)
EO-1 (2017)
Landsat 7 (USGS) (~2022)
Terra (>2021
Aqua (>2022)
CloudSat (~2018)
CALIPSO (>2022)
Aura (>2022)
GRACE (2) (2018)
OSTM/Jason 2 (>2022) (NOAA)
OCO-2 (>2022)
GPM (>2022)
Landsat 8 (USGS) (>2022)
Suomi NPP (NOAA) (>2022)
SMAP (>2022)
ISS
Sentinel-6A/B (2020, 2025)
Earth Science Instruments on ISS:
CATS, (2020)
LIS, (2017)
SAGE III, (2017)
TSIS-1, (2018)
ECOSTRESS, (2018)
GEDI, (2019)
OCO-3, (2018)
CLARREO-PF, (2021)
TSIS-2 (2020)
InVEST/Cubesats
MiRaTA (2017)
RAVAN (2016)
IceCube (2017)
HARP (2017)
TEMPEST-D (2018)
RainCube (2018*)
CubeRRT (2018*)
CIRiS (2018*)
CIRAS (2018*)
LMPC (----)
*Target date, not yet manifested

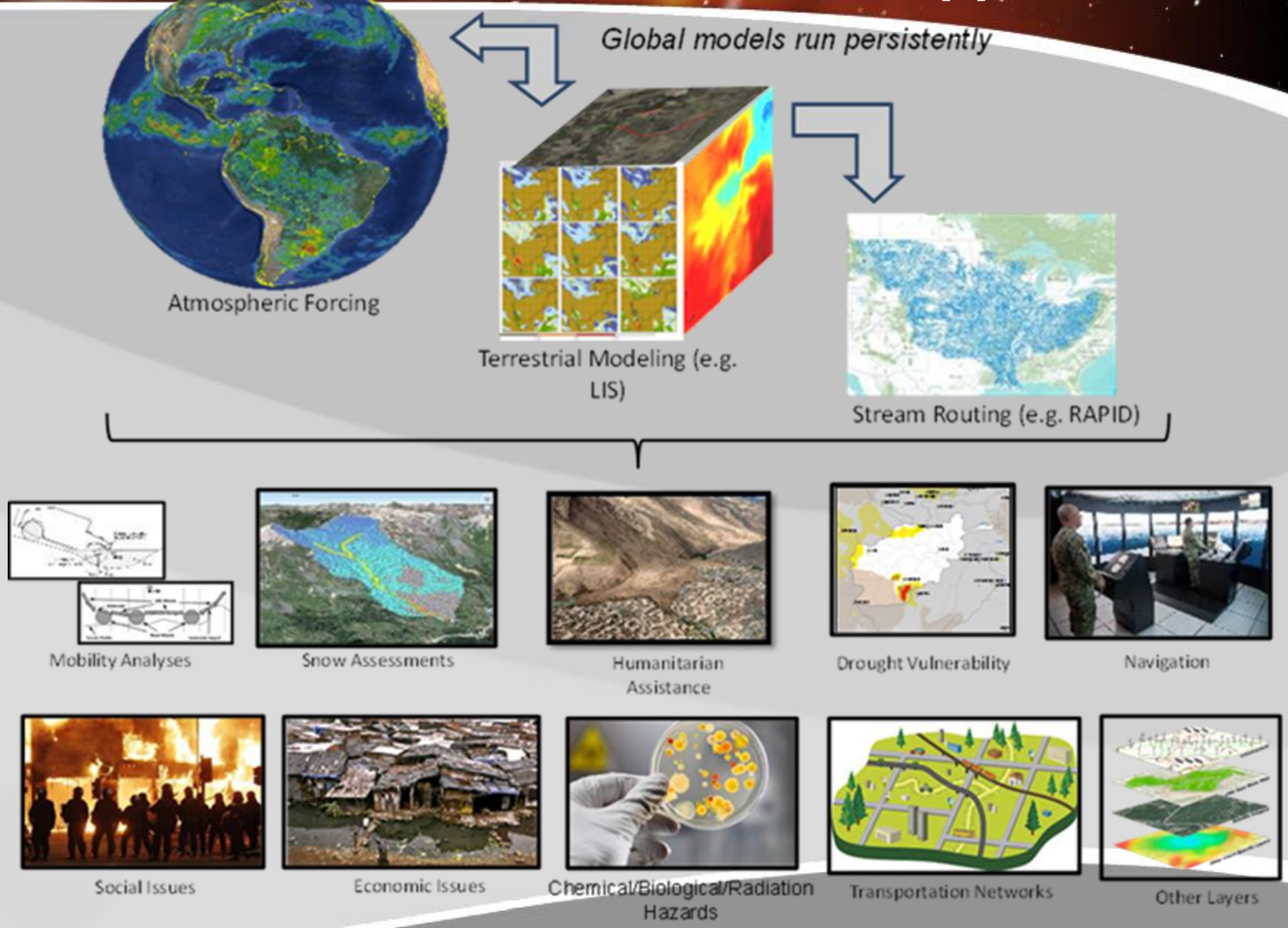
Airborne


National Aeronautics and Space Administration
NASA
Airborne Science Program
Observing Platforms for Earth System Science Investigations
ER-2
WB-57
Global Hawk
G III
DC-8
Learjet
Ikhana
P-3
S-3B
B-200
Twin Otter
SIERRA
www.nasa.gov

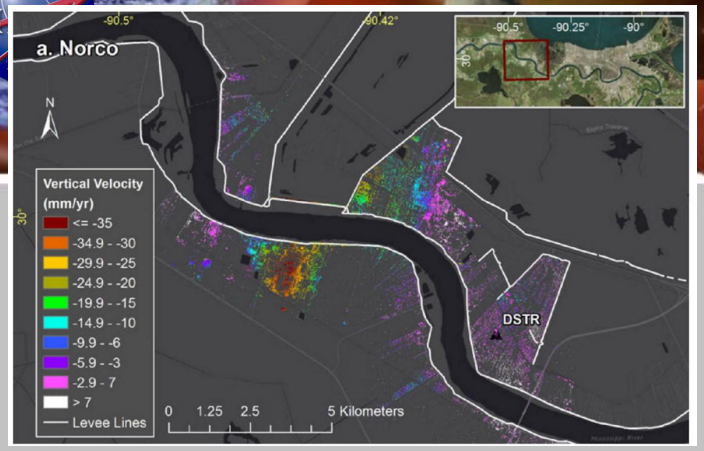


Space provides a unique perspective

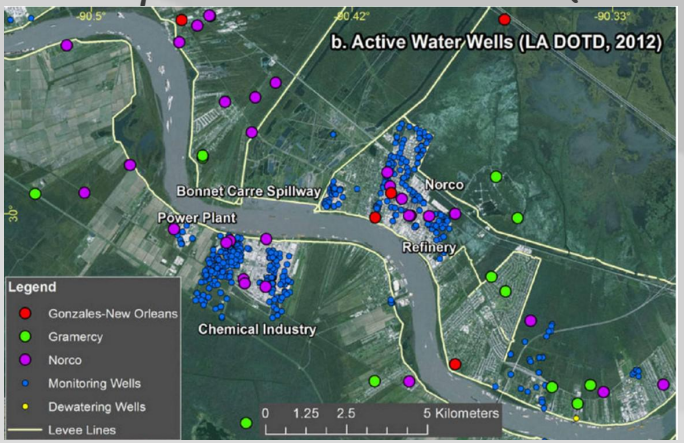
Challenge: Moving Data to Modeling to Mapping To Tools for Decision Support



Mapping Where the Ground is Sinking.. Subsidence



Subsidence rates in the area of Norco, Louisiana, as well as the flood protection levees (the

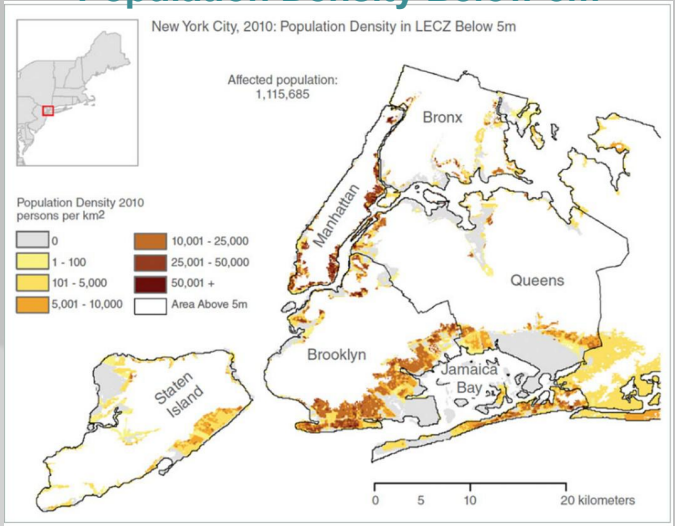


Location of water wells and local industry. The highest subsidence forms a bowl within the industrial site to the south of the river.

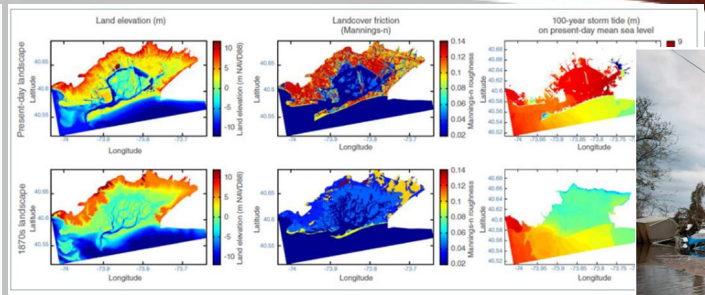
Jefferson Parish, Louisiana, and how much subsidence has occurred in some areas. The measurements combine movement of the ground and structures.

Mapping People and Place

Population Density Below 5m



This map of the New York City boroughs and the western edge of Nassau County (right edge of the map) shows the population density in contiguous low-elevation coastal zones below 5 meters above mean sea level. The population density data are based on 100-meter resolution 2010 population data. Lidar elevation data at 1-meter resolution are used to filter for elevation; the map only shows population density data where more than 50 percent of a cell area is below 5 meters in elevation. (Courtesy K. MacManus)



These maps of Jamaica Bay show how long-term changes to the landscape have affected storm tides. The left colu shows the land elevation for the present day and for the 1870s, before the bay was altered for human purposes. center column shows the relative friction of the land cover for the present landscape and for the 1870s, measure the variable "Mannings-n roughness." The third column shows modeled storm tide levels on the present-day and landscapes, based on present-day mean sea level. (Courtesy P. Orton)

A man slogs through flooded streets as residents clean out their homes in Midland Beach, Staten Island, New York after Hurricane Sandy. (Courtesy N. Dvir, Polaris)

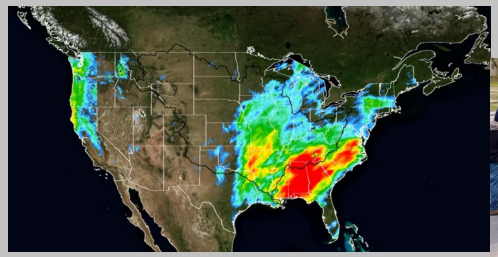
Landscape Change and Storm Surge

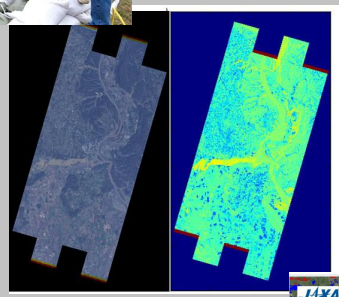
http://sedac.ciesin.columbia.edu/

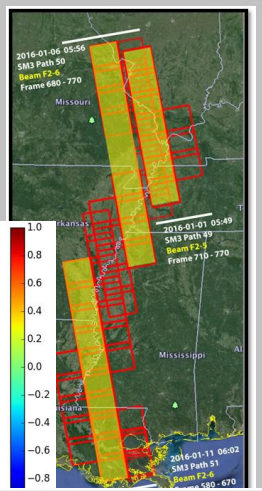
"**The sheer number of people in that situation is challenging to manage**," said Kytt MacManus localized maps from a NASA Socioeconomic Data and Applications Center (SEDAC) data set.

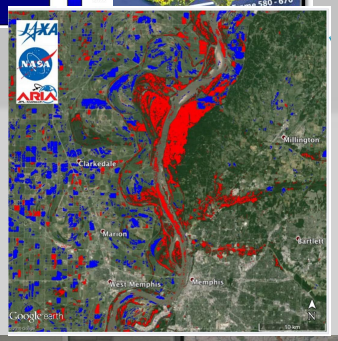
Evacuation would push millions of people over gridlocked roads and through choked bridges and tunnels. "**And many people are unwilling to evacuate**," MacManus said, alluding to research showing about half of people ordered to evacuate refuse to or are reluctant to leave, or face barriers to leaving such as age, illness, or poverty. "**Without making policymakers aware of elevation issues, and making the connection to the number of people impacted, it is hard to get their attention. The data broaden the community that registers on their radar**," MacManus said.

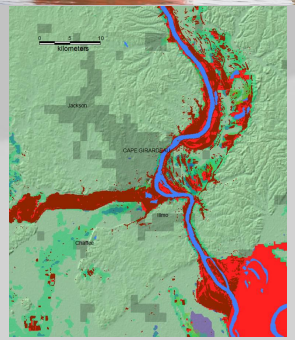
Mapping Response to Record Flooding Mapping a Disaster from Illinois to Mississippi December 29, 2015 – January 15, 2016











- Consolidated flood and water-index maps
- GIS-capable web-mapping, visualization and decision tools
- Inundation and Damage proxy maps/assessments
- Imagery and interpretive support
- Prioritized, shared, ingested and processed SAR and optical data over areas of interest and disseminated products to stakeholders

Sendai Framework for DRR 2015-2030

UNISDR
United Nations Office for Disaster Risk Reduction

http://www.unisdr.org/we/inform/publications/43291

Disaster risk reduction requires a multi-hazard approach and inclusive risk-informed decision-making based on the open exchange and dissemination of disaggregated data

Priority 1: Understanding disaster risk

To promote and improve dialogue and cooperation among scientific and technological communities, other relevant stakeholders and policymakers in order to facilitate a science-policy interface for effective decision-making in disaster risk management

Global and regional level

To enhance the development and dissemination of science-based methodologies and tools to record and share disaster losses and relevant disaggregated data and statistics, as well as to strengthen disaster risk modelling, assessment, mapping, monitoring and multi-hazard early warning systems;

Targets

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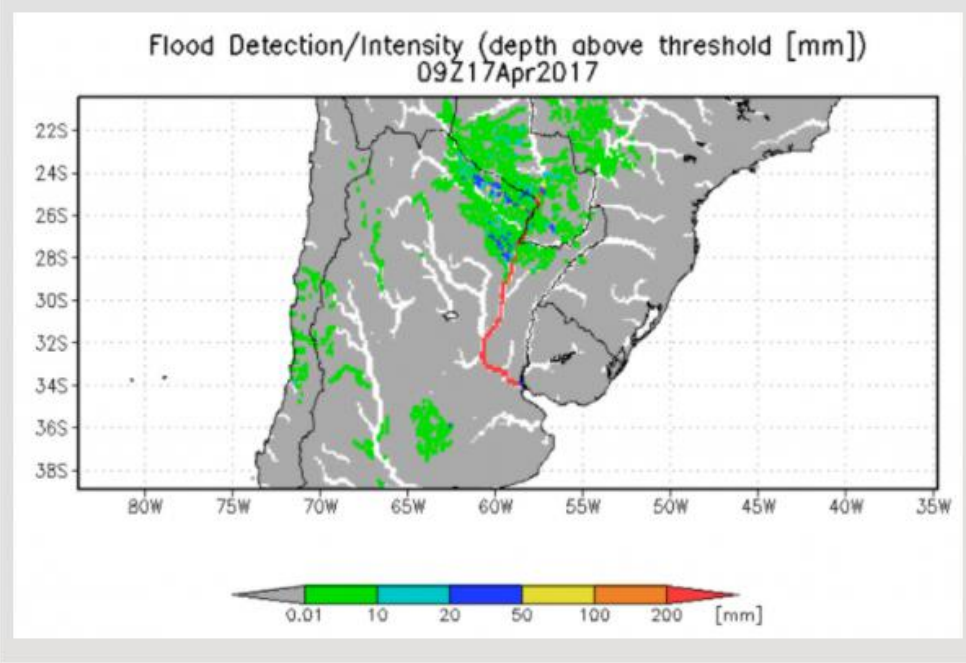

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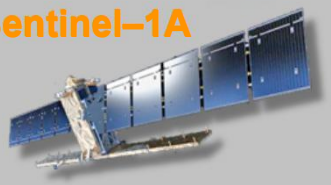
Flood Response

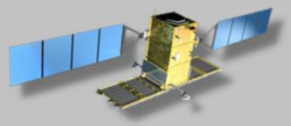
NASA Coordinates Synchronized Space-Air-Ground Observations for Louisiana Floods

ALOS–2

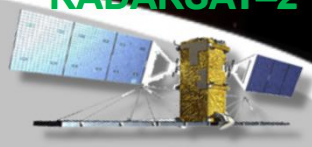
Sentinel–1A

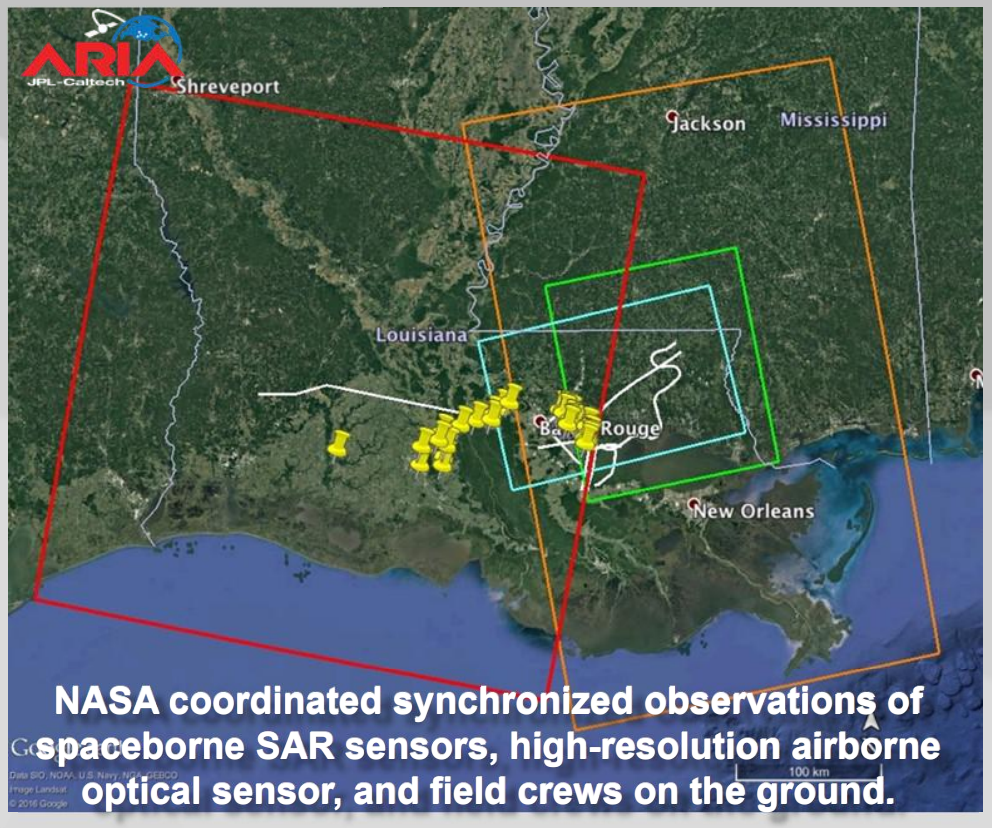


COSMO-SkyMed



RADARSAT–2



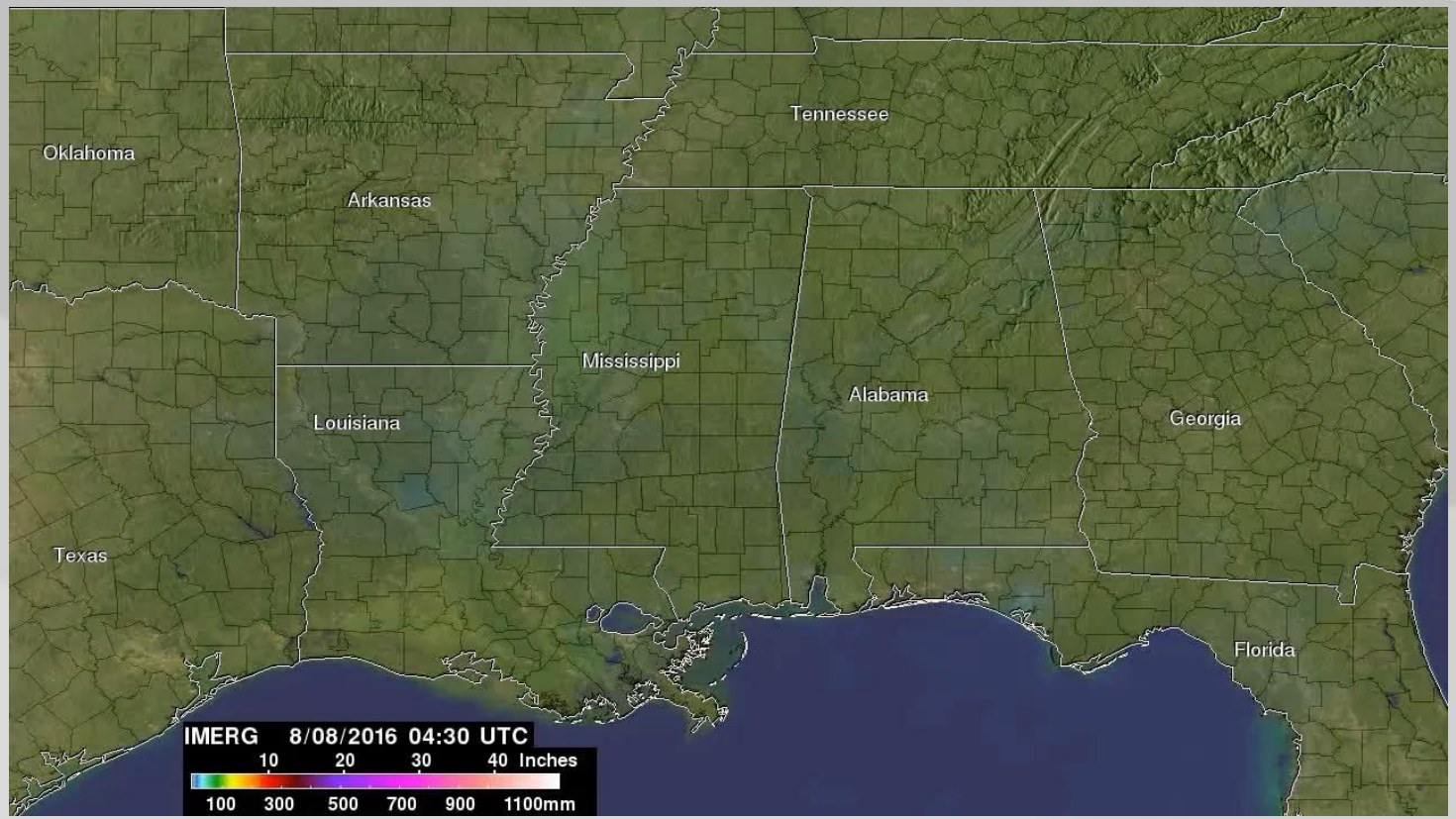


NASA coordinated synchronized observations of spaceborne SAR sensors, high-resolution airborne optical sensor, and field crews on the ground.

NOAA

FEMA

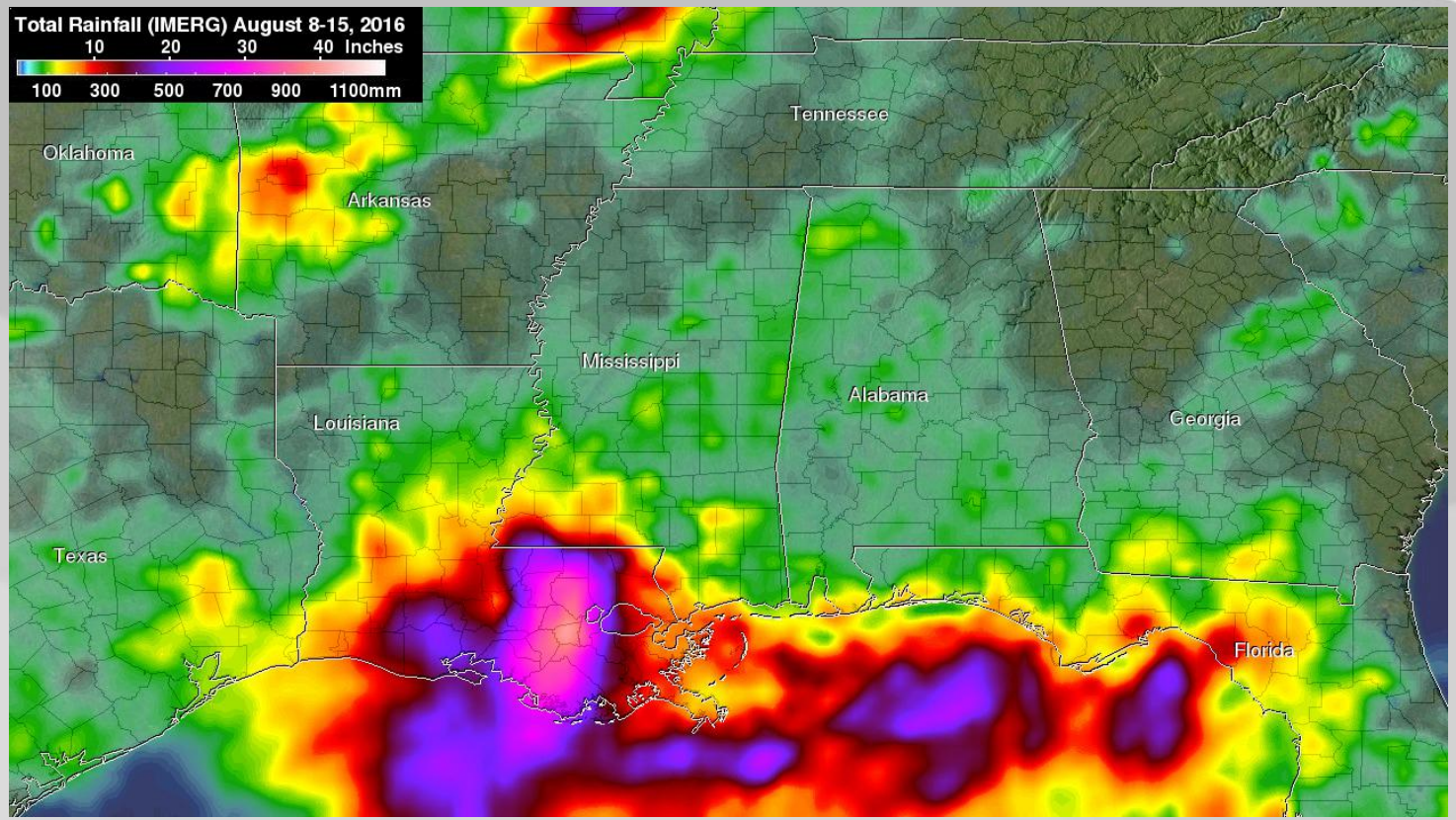
NASA Observes Historic Rainfall in Louisiana



NASA's IMERG data from Aug. 8 to Aug. 15, 2016 showed over 20 inches (508 mm) of rainfall was estimated in large areas of southeastern Louisiana and extreme southern Mississippi. Even greater rainfall totals of 30 inches (762 mm) were indicated in a small area of Louisiana west of Lake Pontchartrain.

Credits: NASA/JAXA, Hal Pierce

NASA Global Precipitation Mission – GPM IMERG



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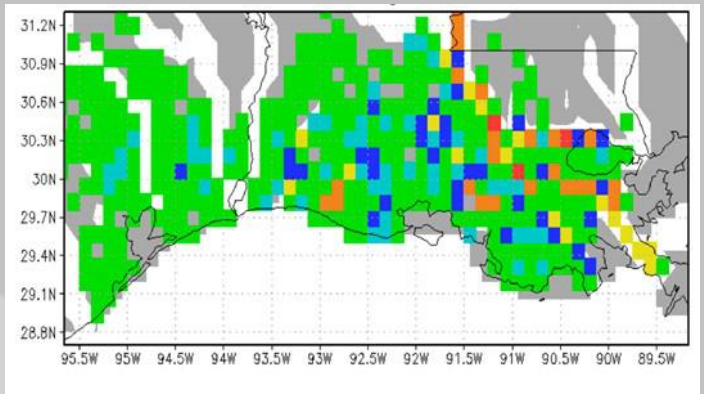
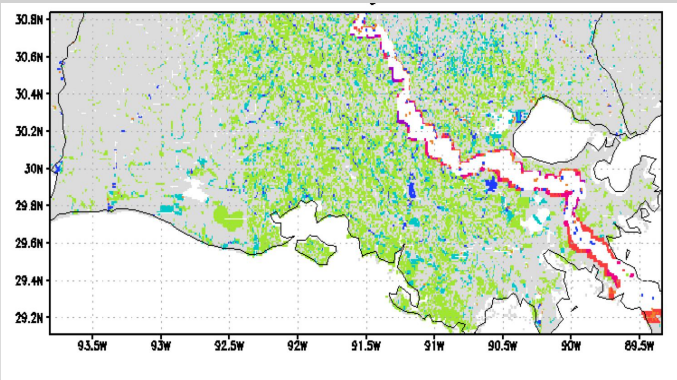
Global Flood Mapping System – GFMS

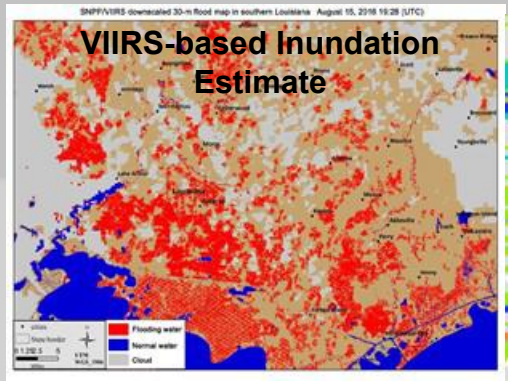


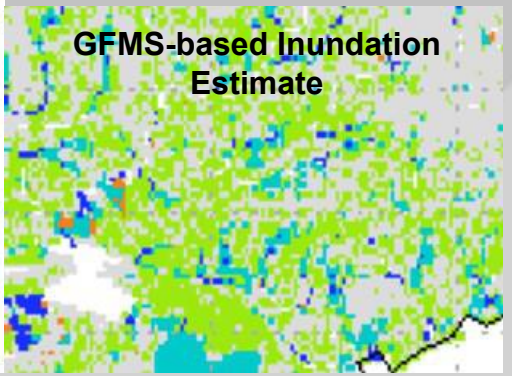
Global Flood Monitoring System (GFMS)
Adler/Wu University of Maryland



Credit: Bob Adler and Huan WU, UMD

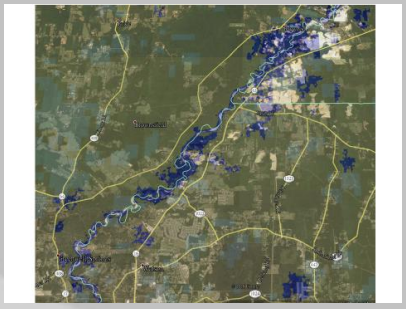
Satellite precipitation estimates merged via the GPM product are utilized as a key Input into the Global Flood Monitoring System (GFMS) utilizing land surface and routing models at 12 and 1 km resolution to estimate the occurrence and intensity of floods. The hydrological calculations are extended into the future (out to five days) using GEOS-5 rainfall predictions.

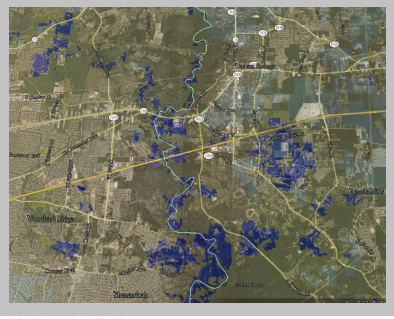


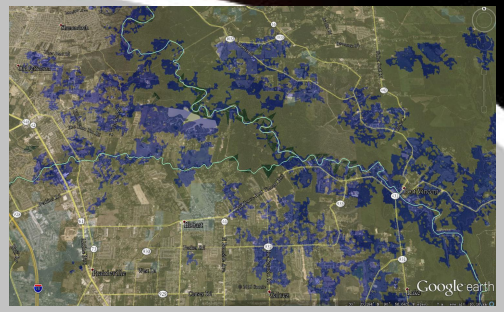


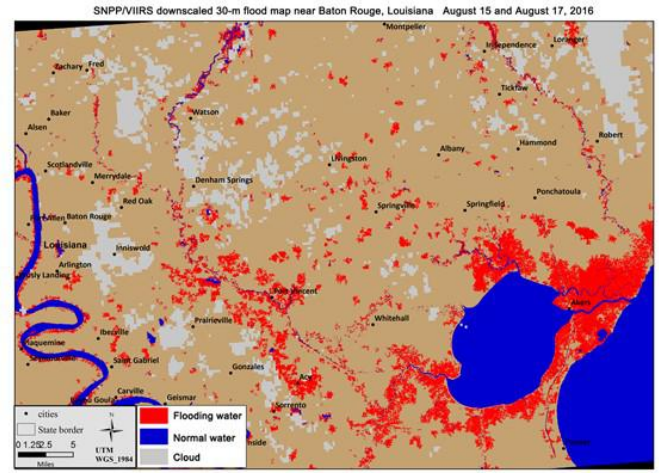
GFMS showing current conditions and forecasts (3-hr resolution) provided to help plan their response to estimate number of structures and homes impacted.

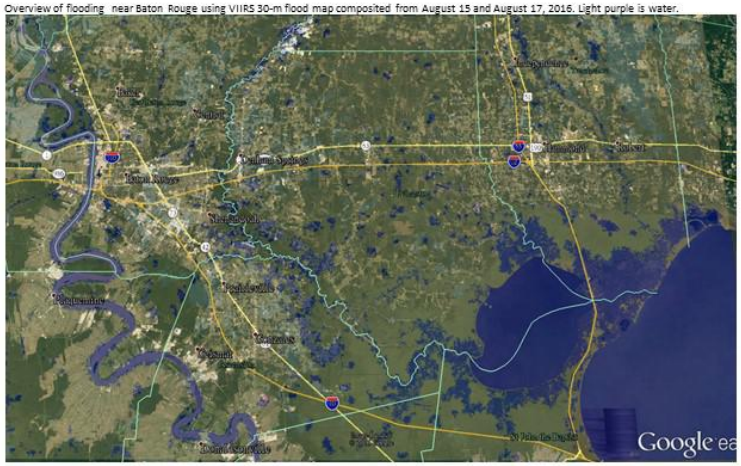
NPP Suomi VIIRS Flood Maps

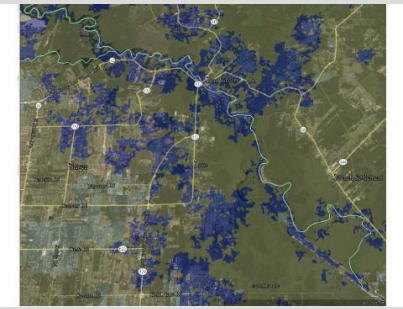


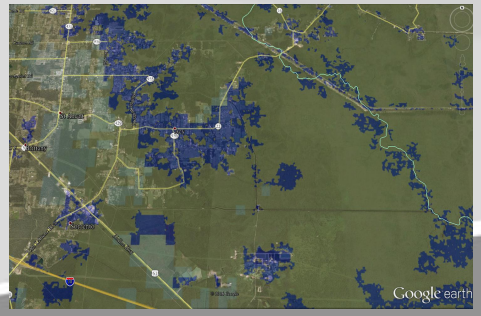






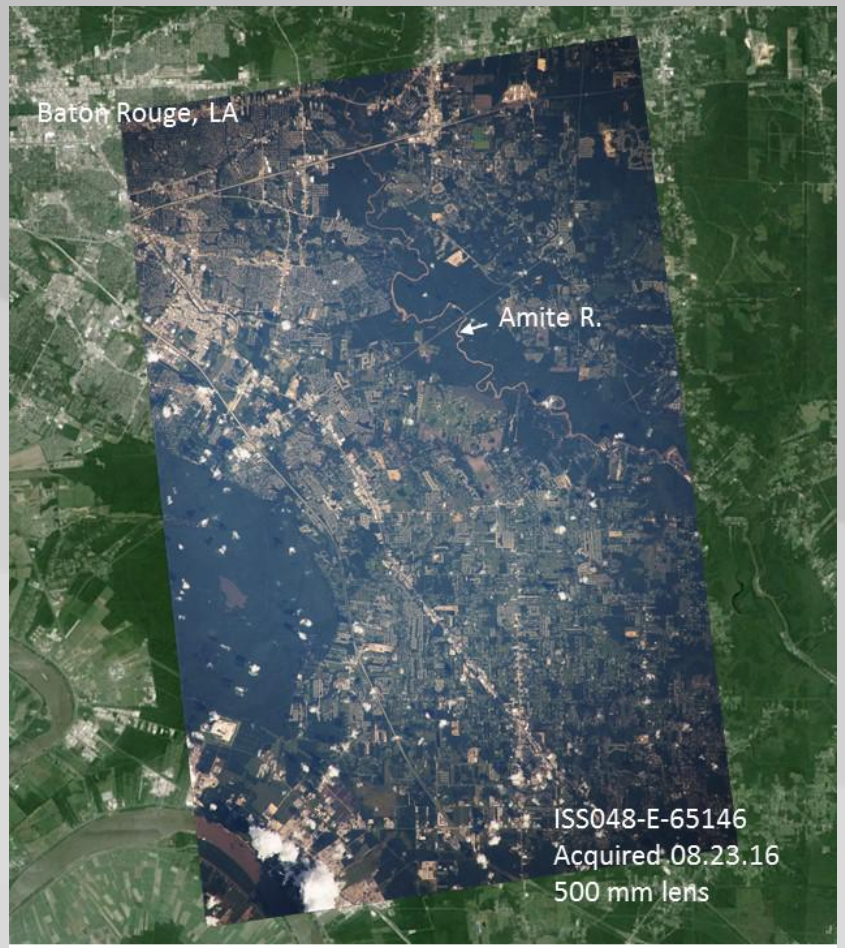






August 15-17, 2016 VIRRS Flood maps courtesy of Sanmei Li, GMU.

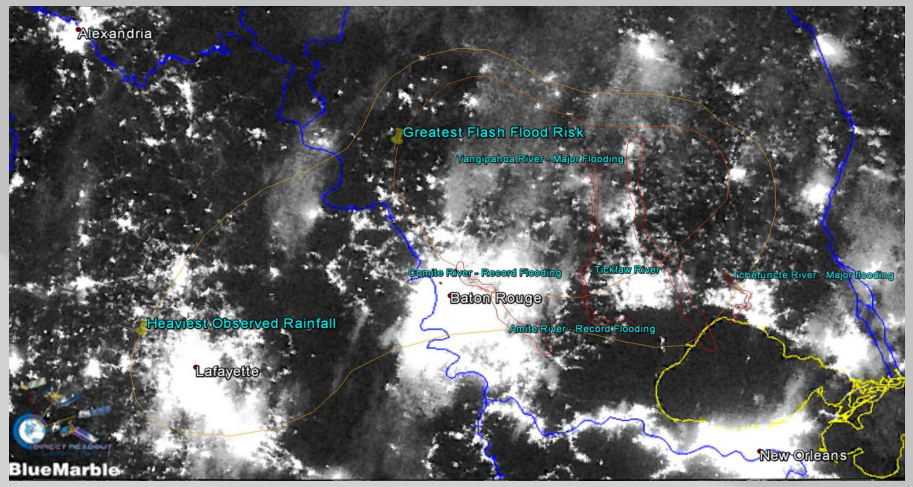
International Space Stations (ISS) Handheld Digital Camera Photography

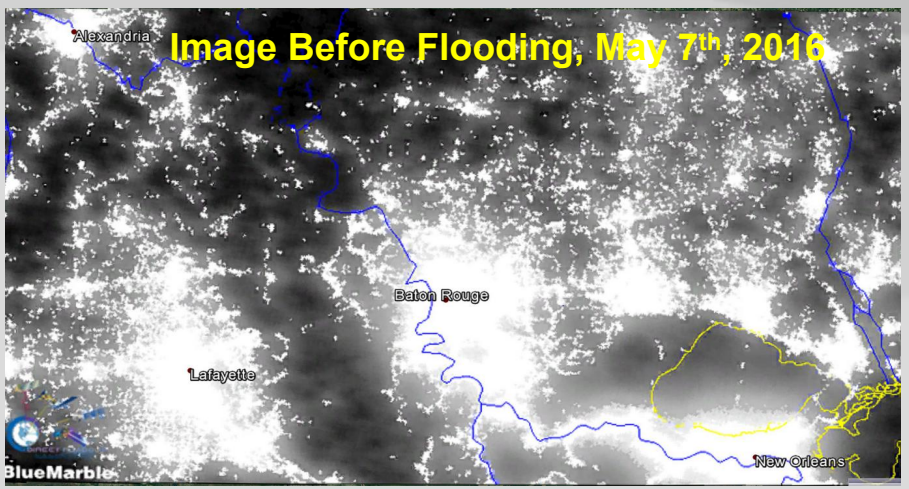


- ISS USOS crew acquired imagery of flooding area on Aug 16, 17, 23 in response to target requests from JSC Crew Earth Observations ops team
- Downlinked imagery reviewed and manually georeferenced prior to delivery to USGS HDDS team
- Data potentially useful for validation of SAR and flood extent model products

Suomi NPP VIIRS Day-Night Band Detects Power Outages

VIIRS DNB Image During Flood Event, August 15th, 2016





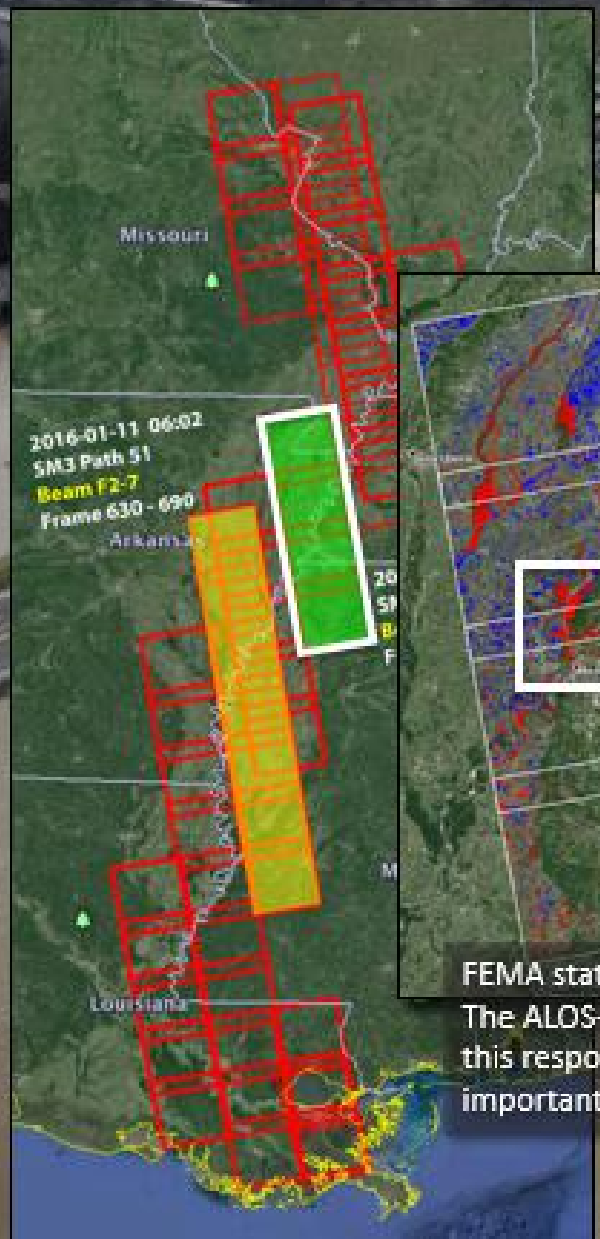
Credit: Dalia Kirschbaum and Miguel Roman, NASA GSFC

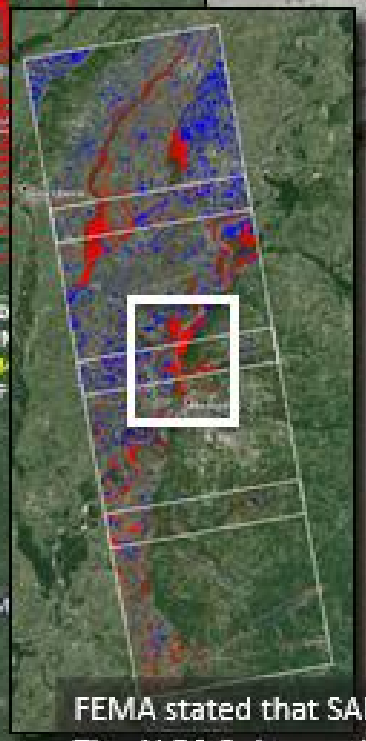
NASA Night time optical data for assessing impact of the Louisiana floods at the request of FEMA.

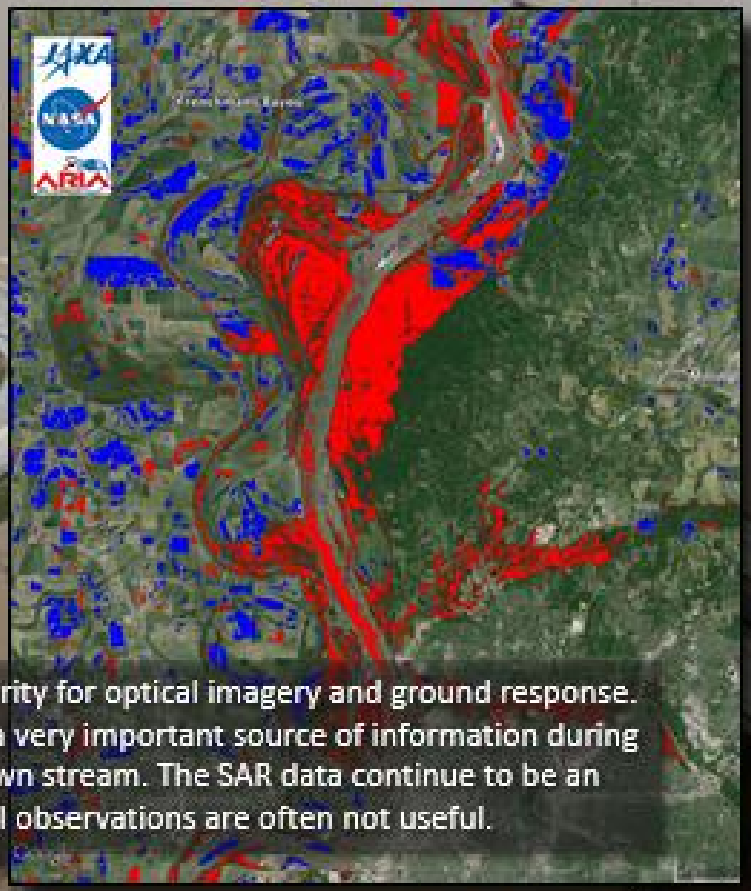
Data was used for determining power outages as a means of mapping impact zones. (NASA Direct Readout Lab) and by DHS/FEMA in helping to restore power after Hurricane Sandy.

2016 Midwest Floods

Sensor: ALOS-2 SAR (JAXA)
Coverage: 70km x (240km + 420km)
Resolution: ~12m
Blue pixels: Open Land Floods
Red pixels: Vegetation Floods
Available online at
http://aria-share.jpl.nasa.gov/events/



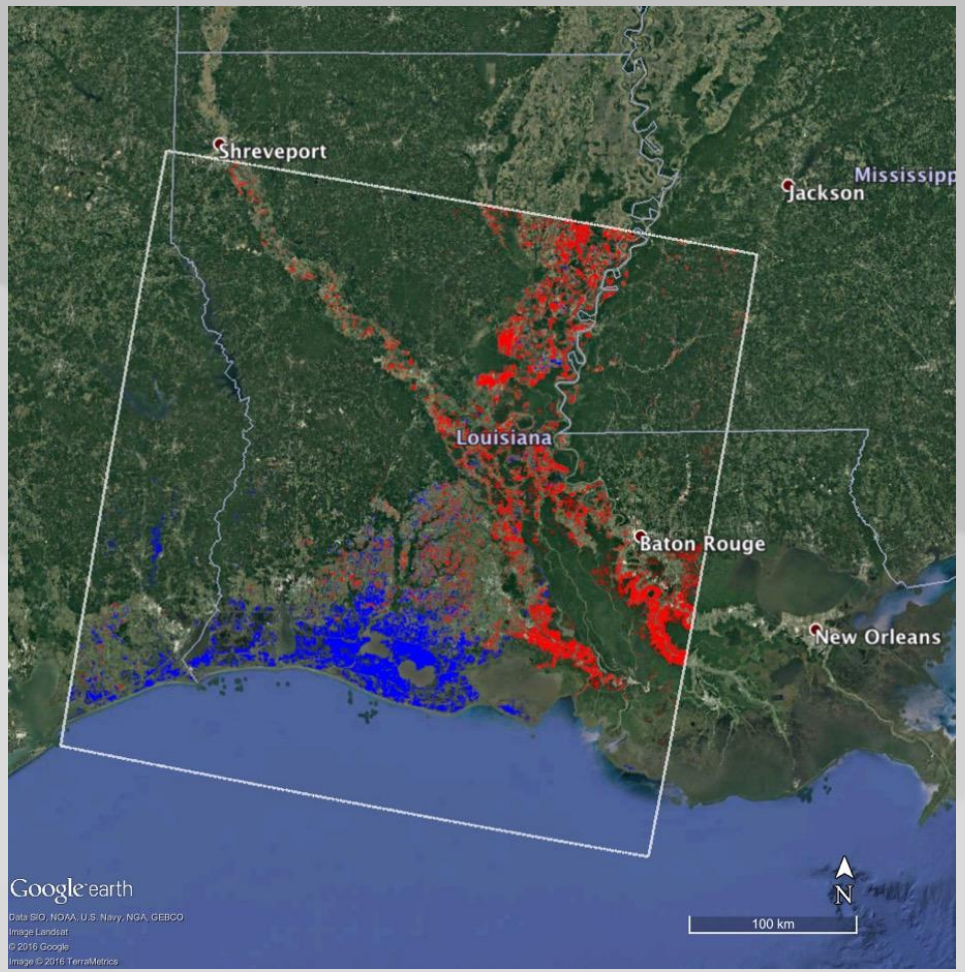


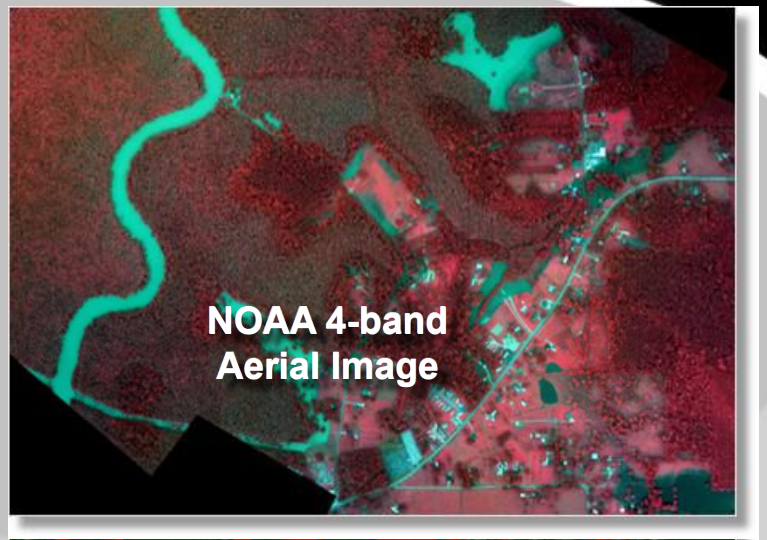


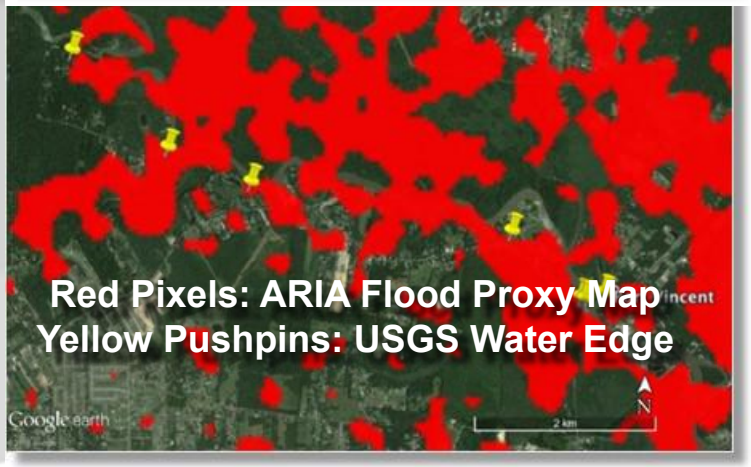
FEMA stated that SAR provides inspection priority for optical imagery and ground response. The ALOS-2 data and the products have been a very important source of information during this response as the flood crest has moved down stream. The SAR data continue to be an important resources during times when optical observations are often not useful.

Jeff Roberson/AP Photo

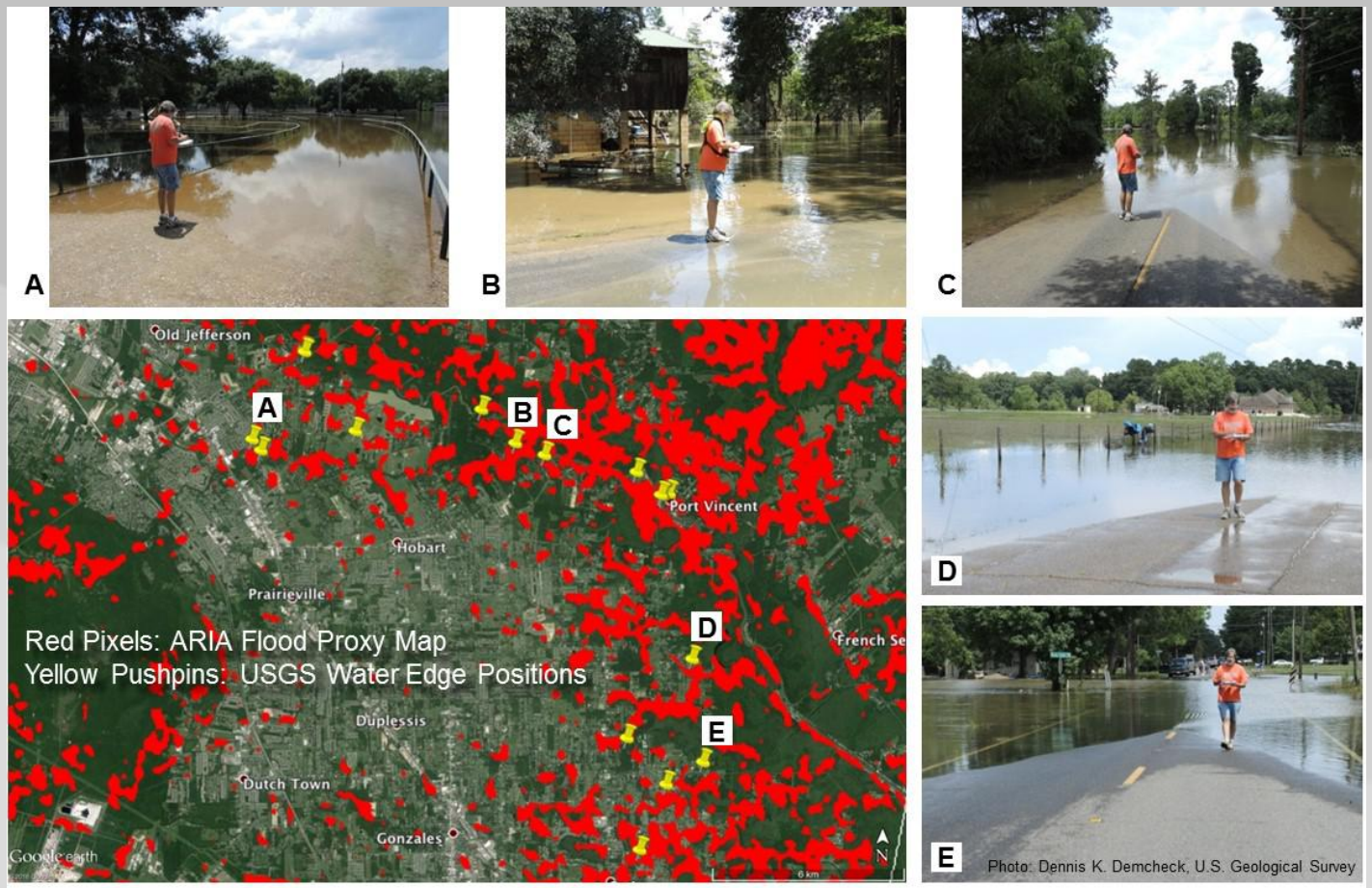
Flood Proxy Map Derived from ALOS-2 SAR Data and Calibrated with Independent Observations







Flood Proxy Map Derived from ALOS-2 SAR Data and USGS Ground Observations (Water Edge Survey)



GPM Observes Pineapple Express rainfall, causing flooding in California January 2017

An atmospheric river ("Pineapple Express") delivered over 5 inches of rainfall in parts of California in early January, 2017 (bottom) as viewed by GPM's IMERG data. The 30-day rainfall anomalies ending Jan. 10th show TRMM Multi-satellite Precipitation Analysis from 2017 (top right) and 2016 (bottom, right).

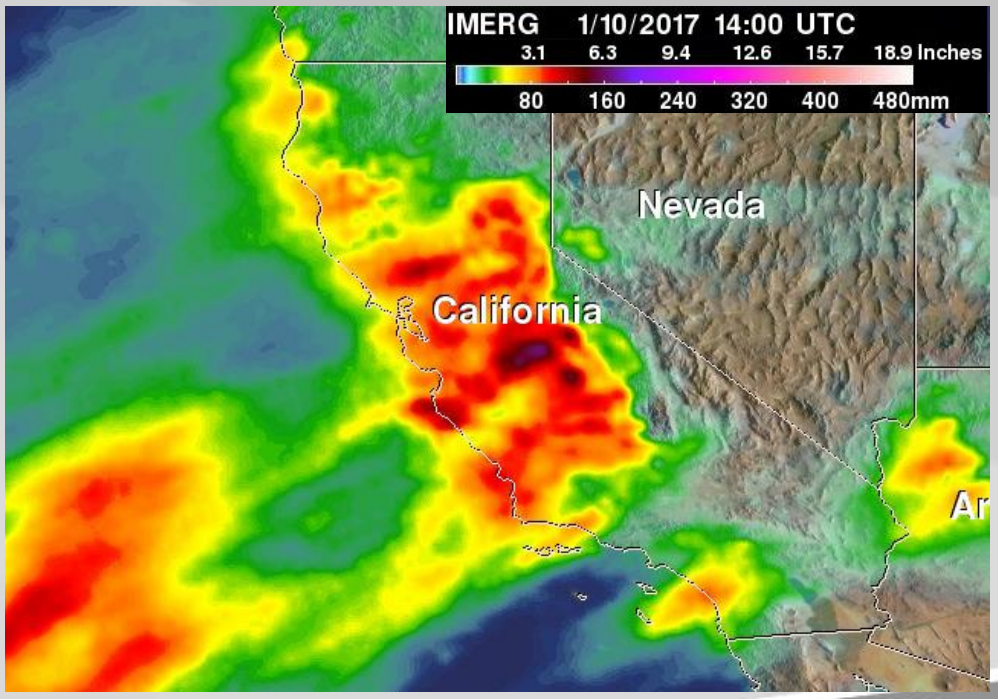
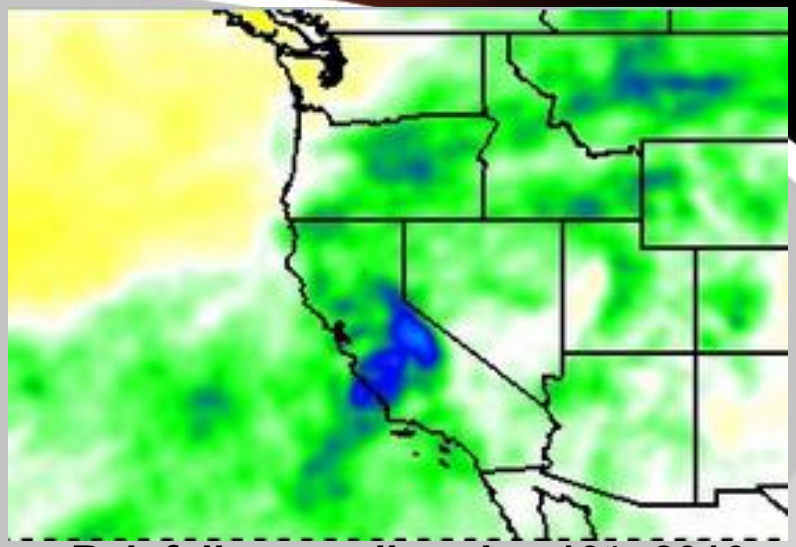
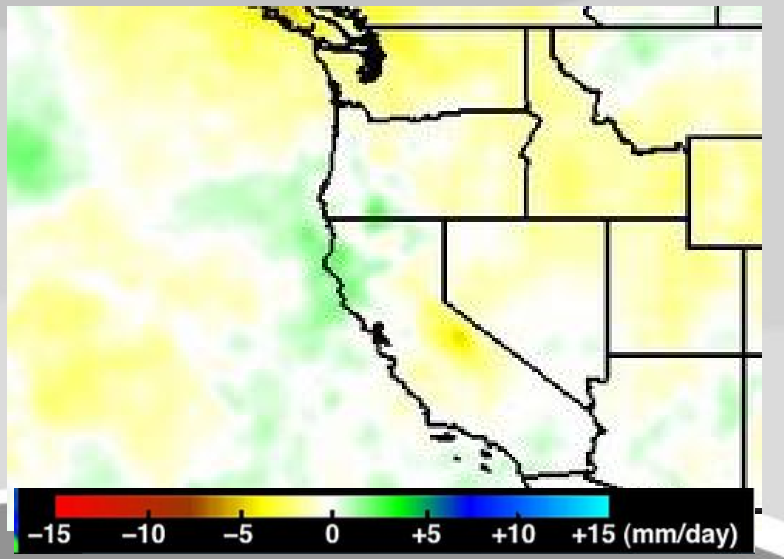


Image credit: Hal Pierce, SSAI/GSFC

Rainfall anomalies, Jan 10th, 2017

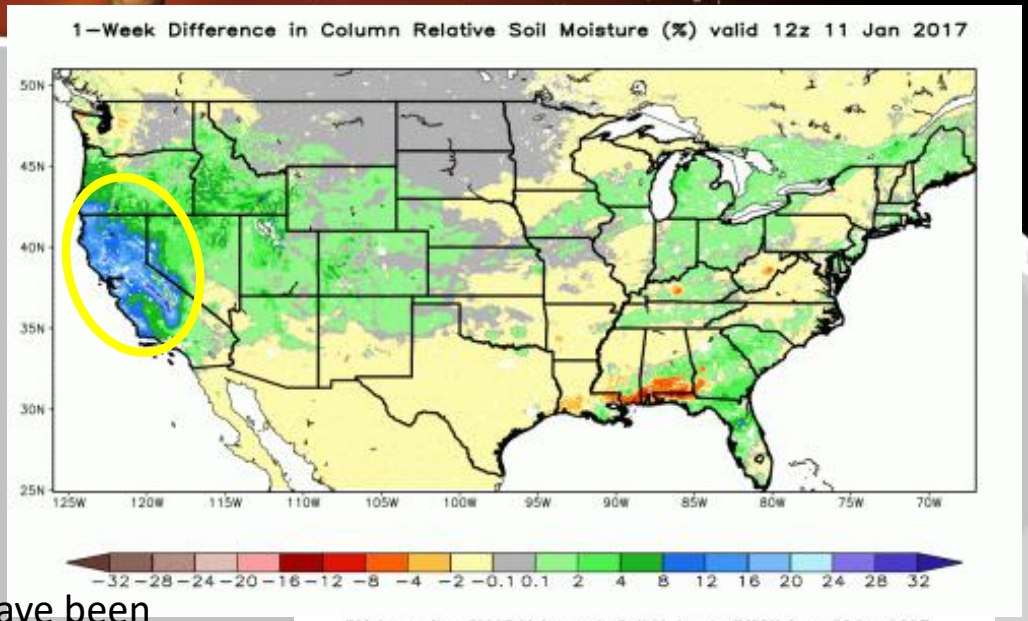


Rainfall anomalies, Jan 10th, 2016

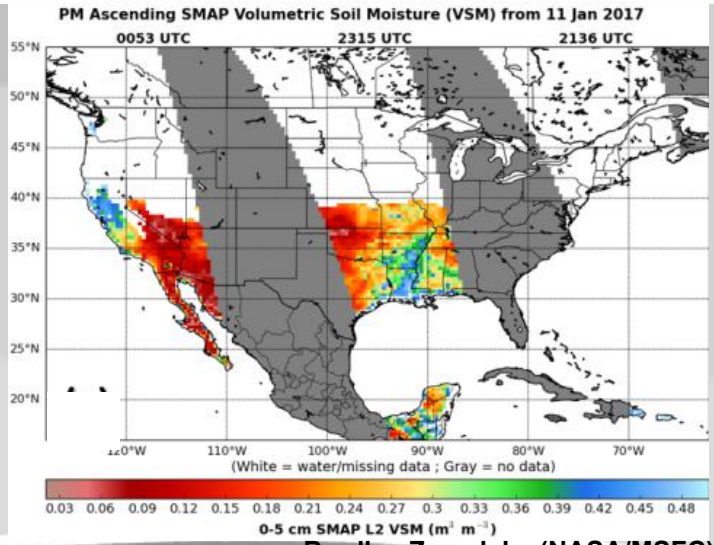


SPoRT Soil Moisture Products Highlight California Flood Potential January 2017

- MSFC/SPoRT runs a real-time version of the NASA Land Information System (LIS) to output soil moisture products used in identifying areal flood potential during CA floods in January
- Surface soil moisture one-week change product from LIS (upper right) shows >35% change in some areas meaning higher runoff/flood potential, consistent with other high-profile flood events



- Select NOAA/National Weather Service offices have been using these products for identifying flood potential since early 2014
- Level 2 SMAP soil moisture products (lower right) from the same day show very high soil moisture values in CA
- SPoRT has completed assimilation of the L2 SMAP soil moisture into the real-time LIS and is currently validating this offline run
- Working with to bring SMAP data 1) into the National Water Model and 2) to evaluate impacts on regional numerical weather prediction forecasts

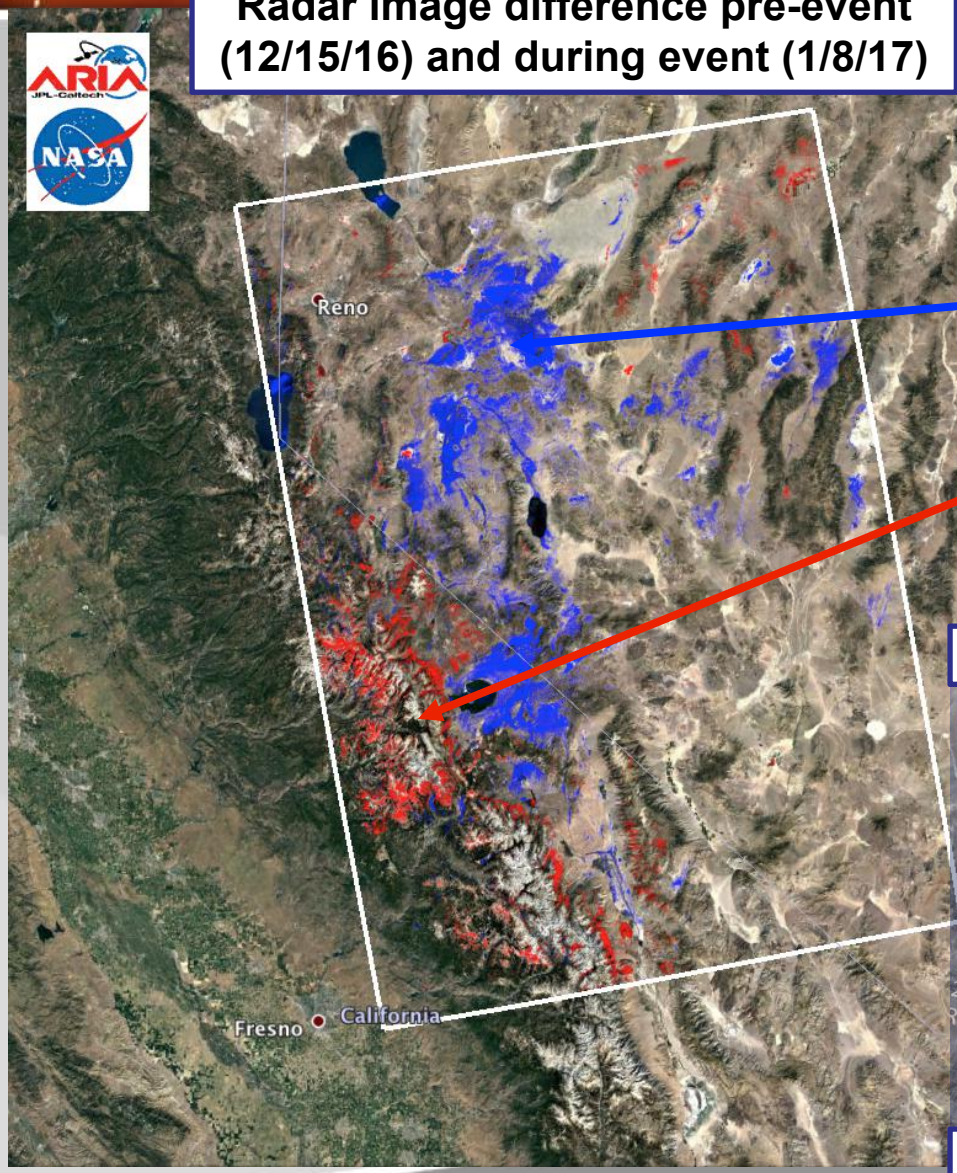


Bradley Zavodsky (NASA/MSFC), Jonathan Case (ENSCO, Inc.), Clay Blankenship (USRA)

Synthetic Aperture Radar Uncovers Flooding in NV

Flood Proxy Map (FPM) covering an area of 155-by-224 miles (250-by-360 km), derived from Sentinel-1's pre- (2016-12-15 6 PM PST) and during-the-event (2017-01-08 6 PM PST) Synthetic Aperture Radar (SAR) amplitude images. The colored pixels represent areas of potential flood (Red: flooded vegetation, Blue: open water flood). Different irrigation conditions on the two data acquisition dates can produce errors on agricultural lands. This FPM should be used as guidance to identify potential areas of flooding, and may be less reliable over urban areas or snow cover.

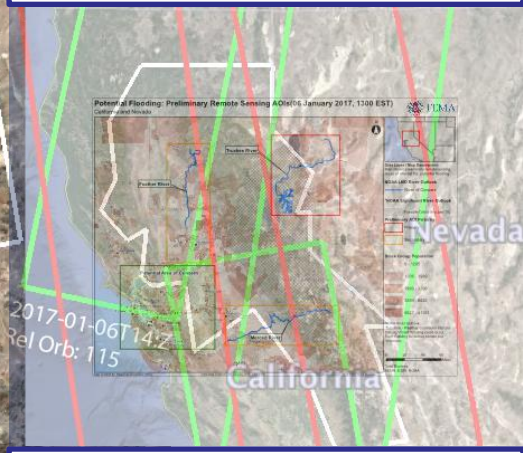
Radar image difference pre-event (12/15/16) and during event (1/8/17)



Blue: open water flood

Red: flooded vegetation

Map covers FEMA Primary AOI



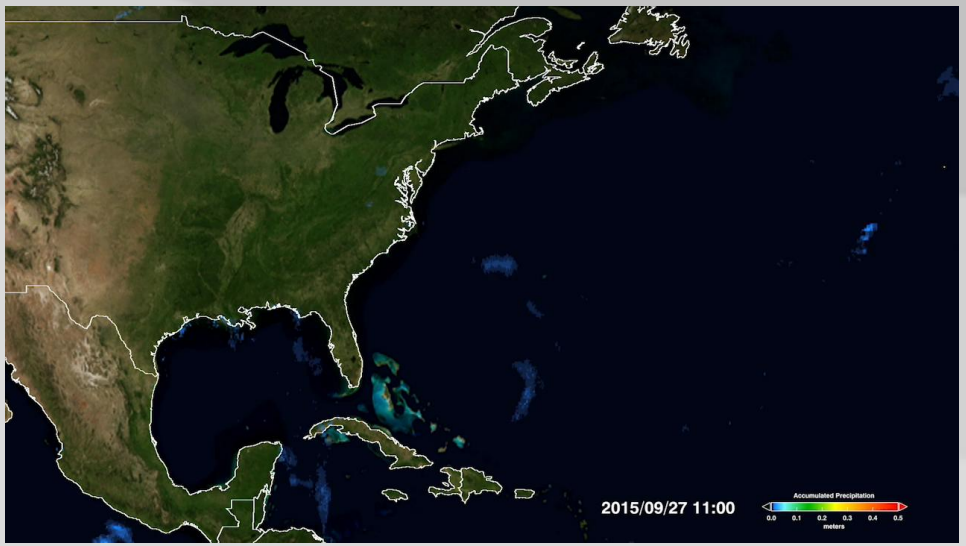
Overlap of Sentinel ground tracks and FEMA AOIs

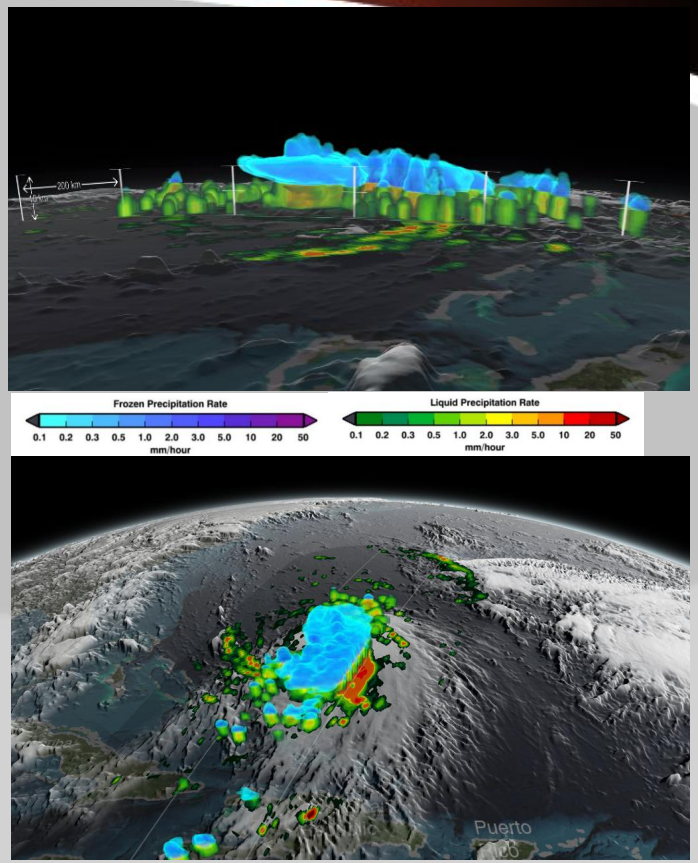
Science POC: Sang-Ho Yun Coordinator POC: Rashied Amin Date: 1/17/17

Hurricane Response

Global Precipitation Measurement (GPM) Sees inside Hurricane Joaquin

Joaquin became a tropical storm on the evening (EDT) of Monday, September 28th midway between the Bahamas and Bermuda. GPM captured Joaquin Tuesday, September 29th, 2015 at 21:39 UTC

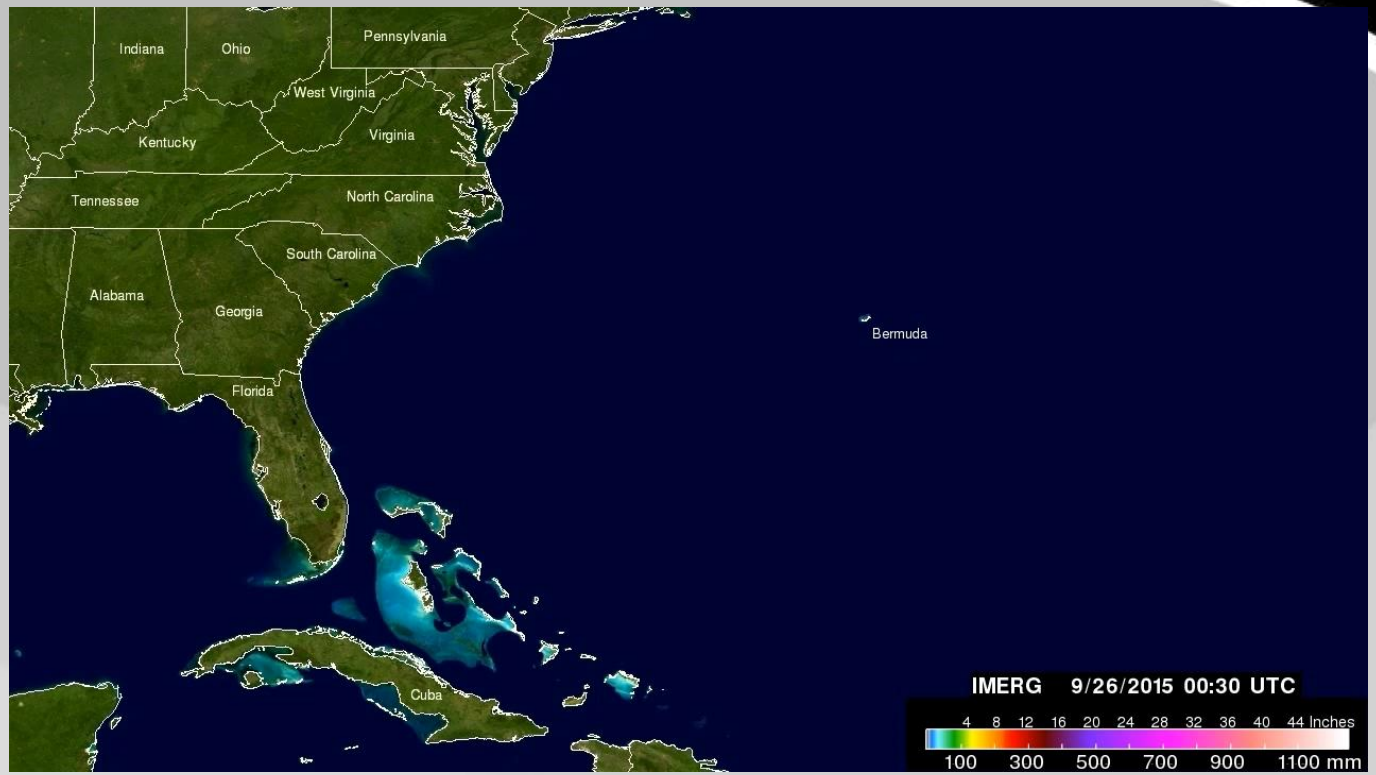




Visualization available at:
https://svs.gsfc.nasa.gov/vis/a000000/a004300/a004367/joaquin_w360_1080p30.mp4

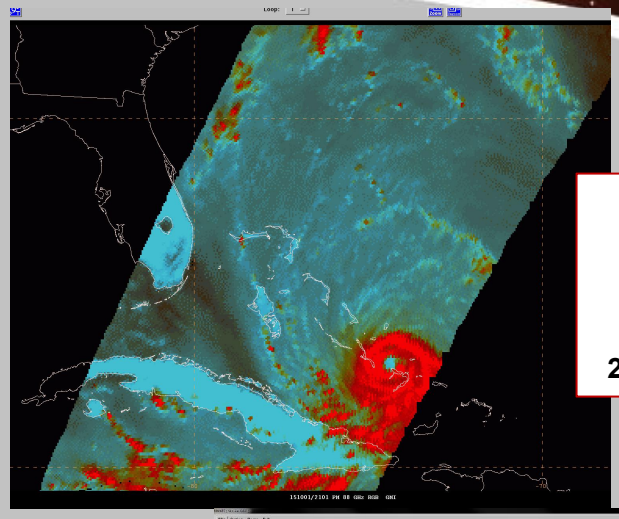
GPM Observes Historic Rainfall Totals for Nor'easter and Hurricane Joaquin

NASA's Integrated Multi-satellitE Retrievals for GPM (IMERG) data were used to estimate the historic amount of rain that fell during the past week in the Carolinas.

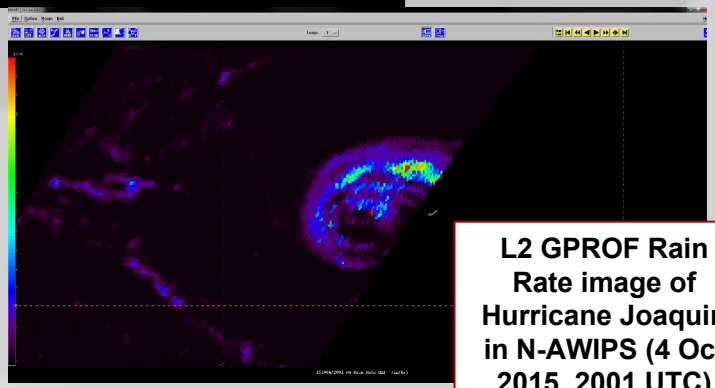


GPM data used in Operational Decision Support at the National Hurricane Center

NASA's Short-term Prediction Research and Transition (SPoRT) Center has been working with the National Weather Service to transition GPM observations into their decision support systems.



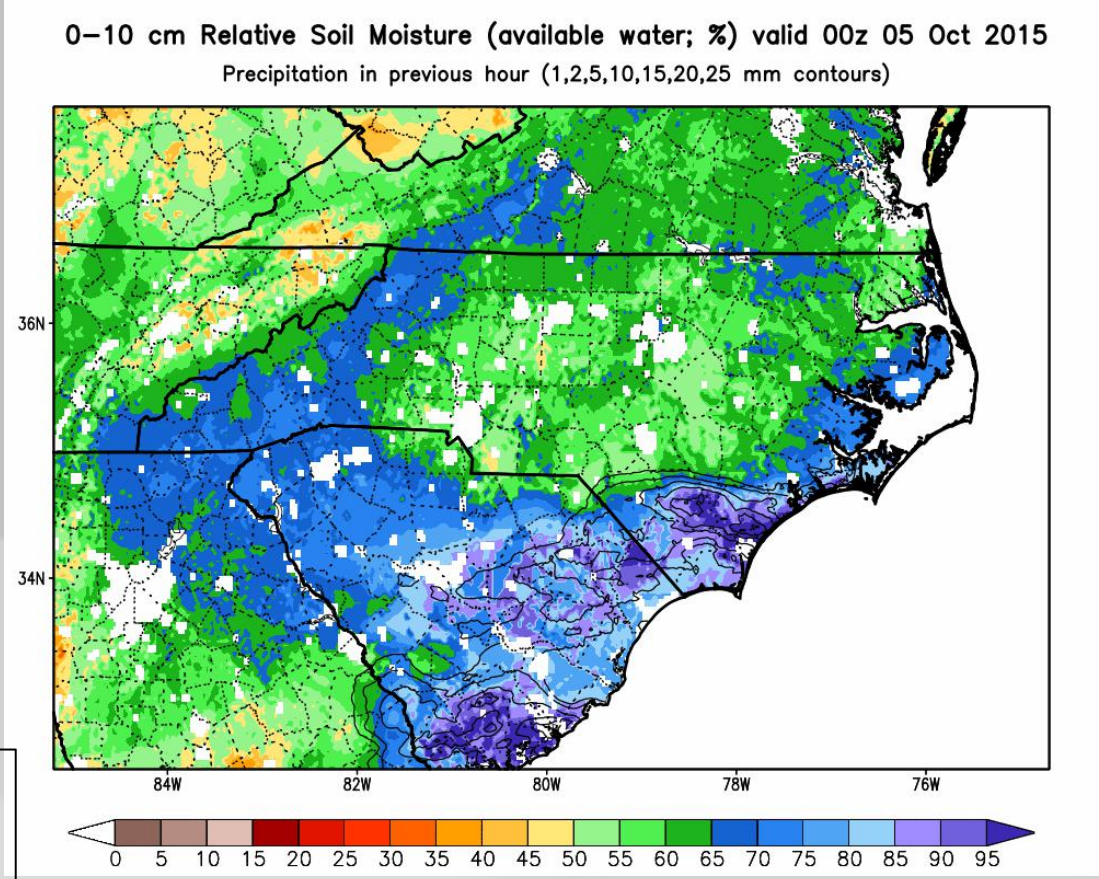
89 GHz RGB image of Hurricane Joaquin in N-AWIPS (1 Oct 2015 2101 UTC)



L2 GPROF Rain Rate image of Hurricane Joaquin in N-AWIPS (4 Oct 2015 2001 UTC)

Soil Moisture modeled from NASA's Land Information System

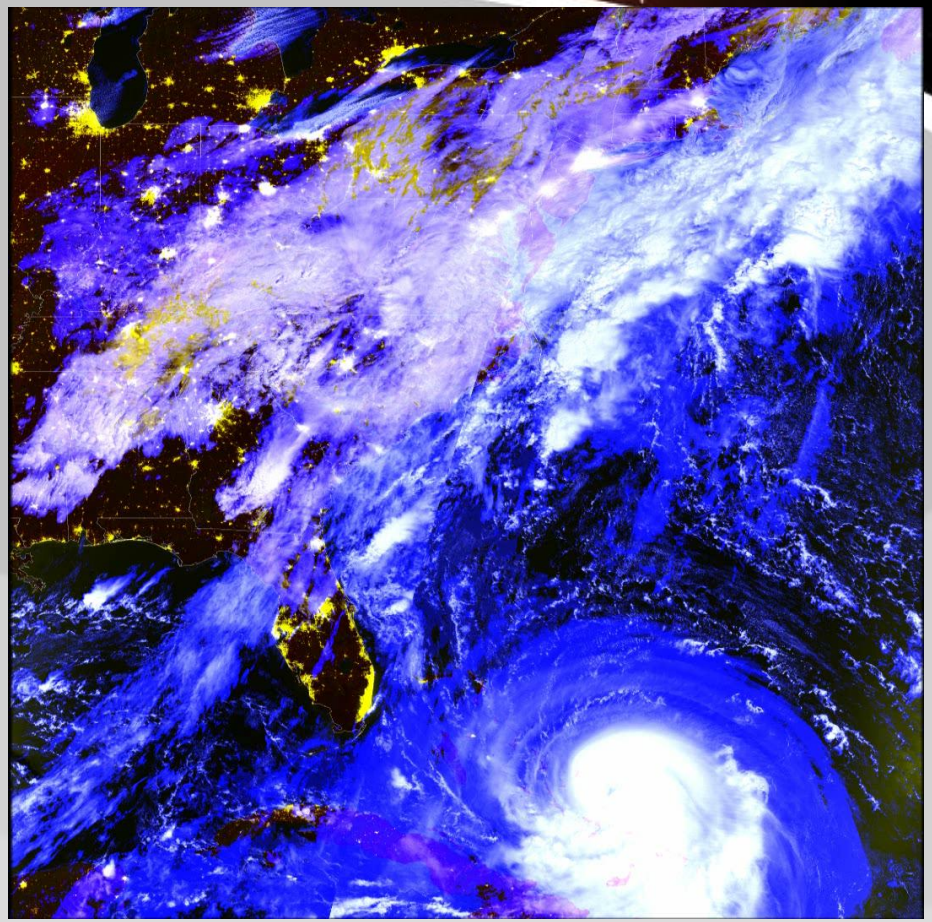
NASA's Land Information System runs operationally at MSFC using NOAA Stage IV precipitation and other forcing inputs to produce analyses and short term forecasts of soil moisture and other parameters. GPM and SMAP data are being integrated into this system. .



In the graphic (right), dark blues and purples suggest that these soils are holding 70-95+% of their water capacity, hence significant and immediate runoff that contributes to flash flooding.

Applications of Suomi-NPP VIIRS Day/Night Band for Disaster Response

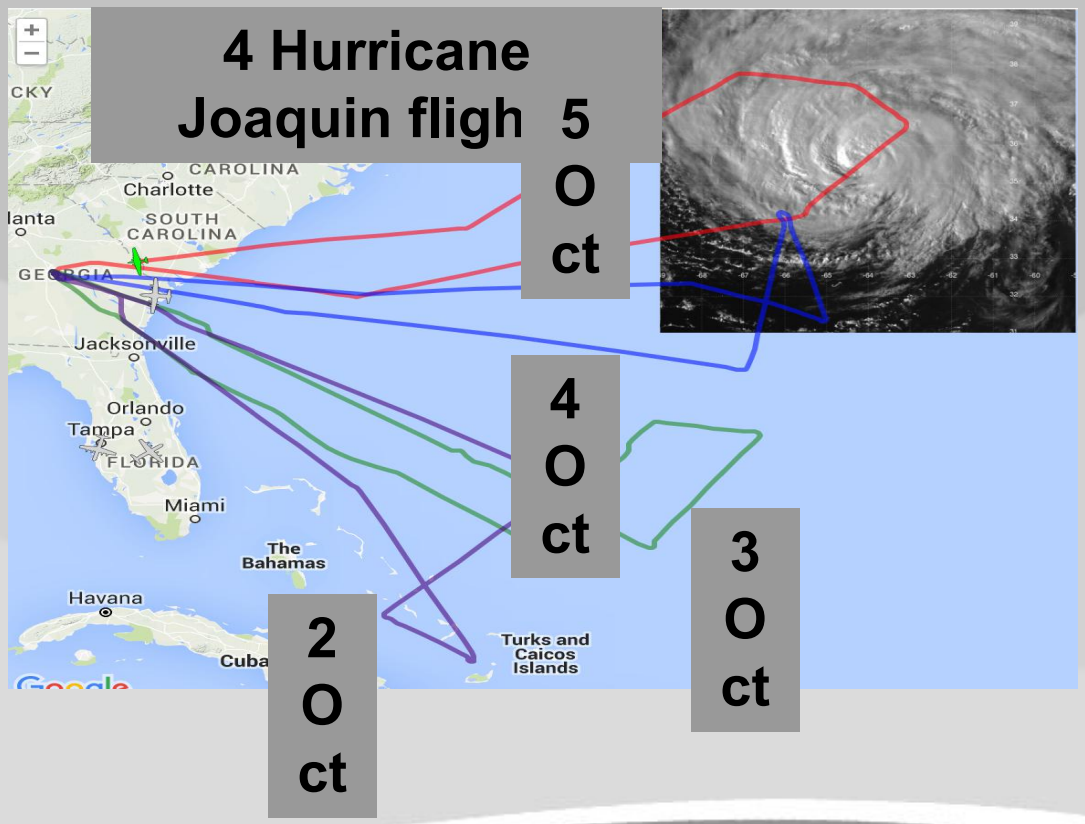
Images on right shows VIIRS Day/Night Band highlighting Hurricane Joaquin and the East Coast Nor'easter during October 1-5th, 2015 when Hurricane Joaquin was a Category 1 storm.



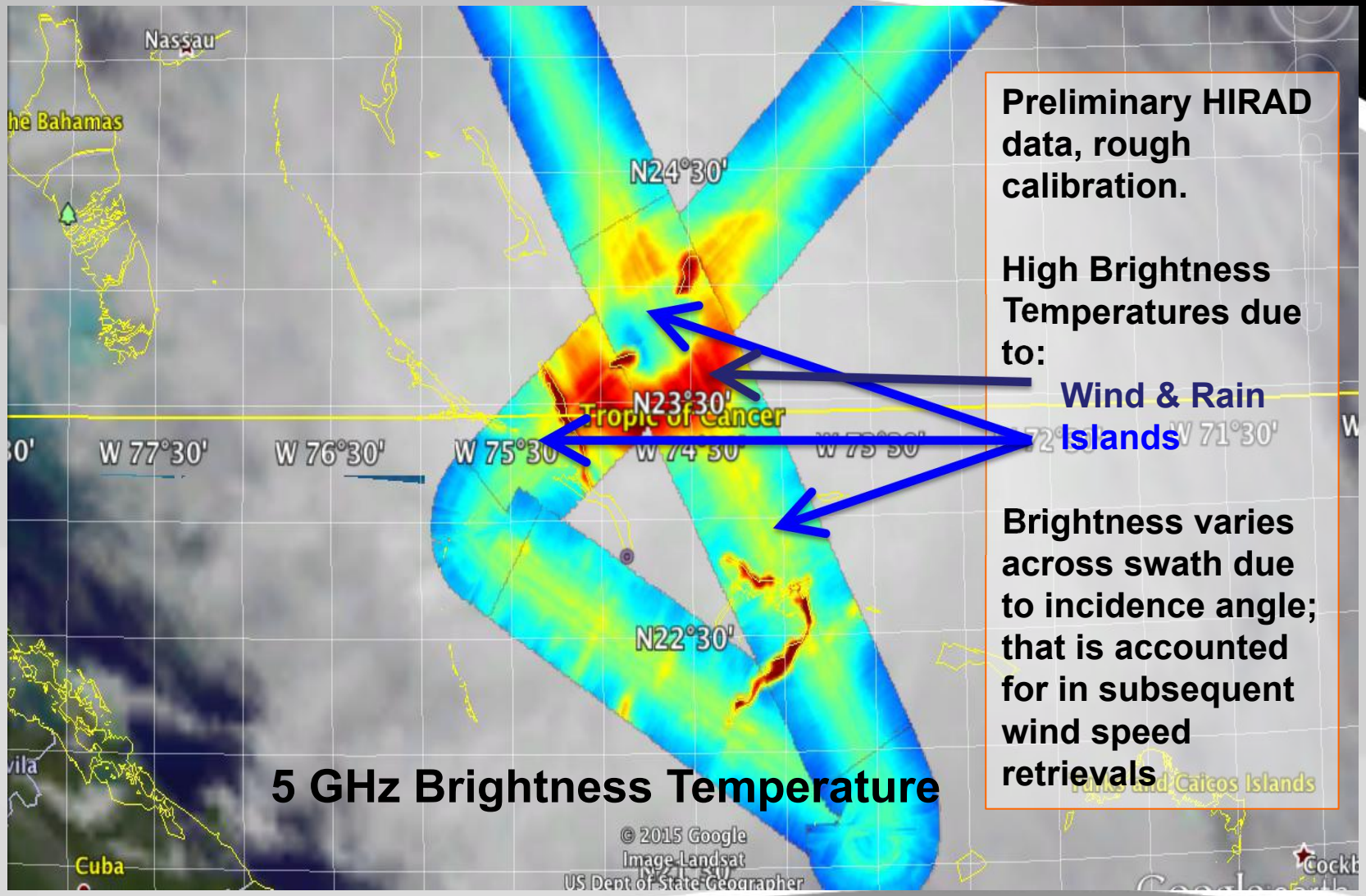
Hurricane Joaquin Over Flights
Tropical Cyclone Intensity Experiment (TCI 2015)
supported *by Office of Naval Research*

NASA WB-57 (JSC) carrying:

- **High Definition Sounding System (HDSS) dropsondes by Yankee Environmental Systems Measure vertical profiles of Temperature, Pressure, Relative Humidity, Wind**
- **Hurricane Imaging Radiometer HIRAD (MSFC) measures ocean surface wind speed**



Hurricane Joaquin
Friday 02 October 2015 Pass 2: 18:35 Z



Preliminary HIRAD data, rough calibration.

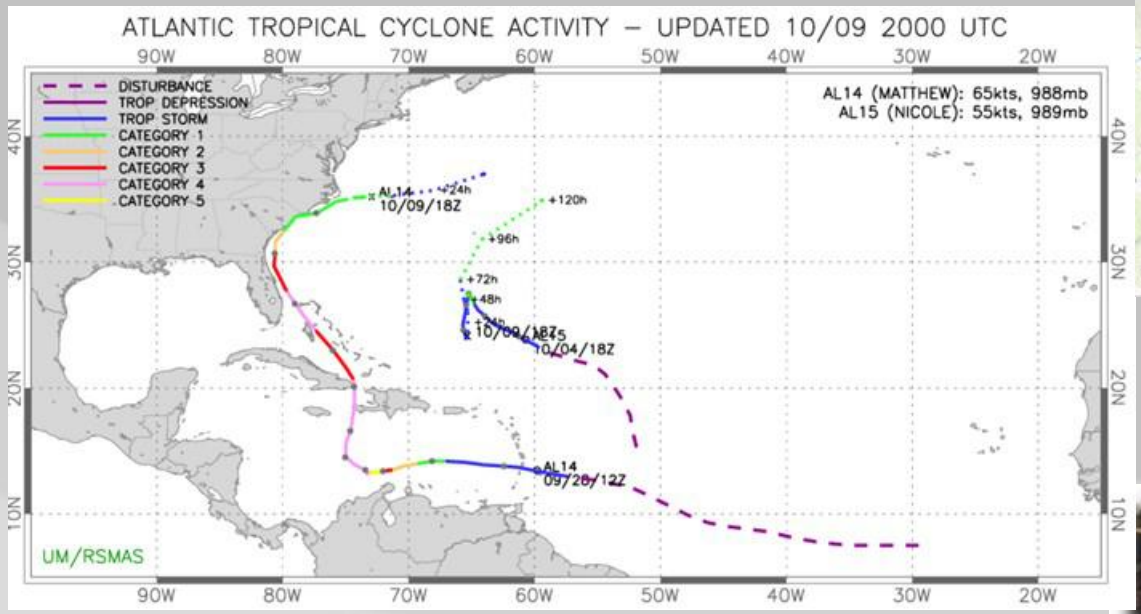
High Brightness Temperatures due to:

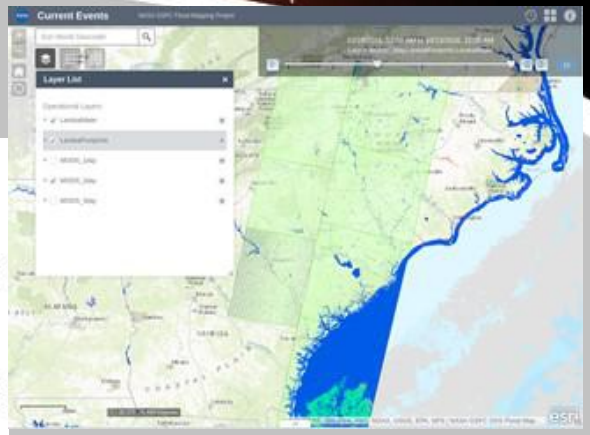
Wind & Rain

Islands

Brightness varies across swath due to incidence angle; that is accounted for in subsequent wind speed retrievals

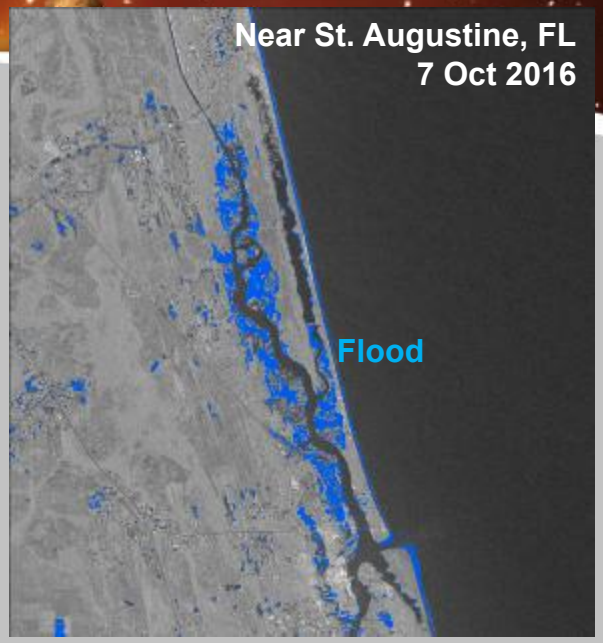
Hurricane Matthew October 2016



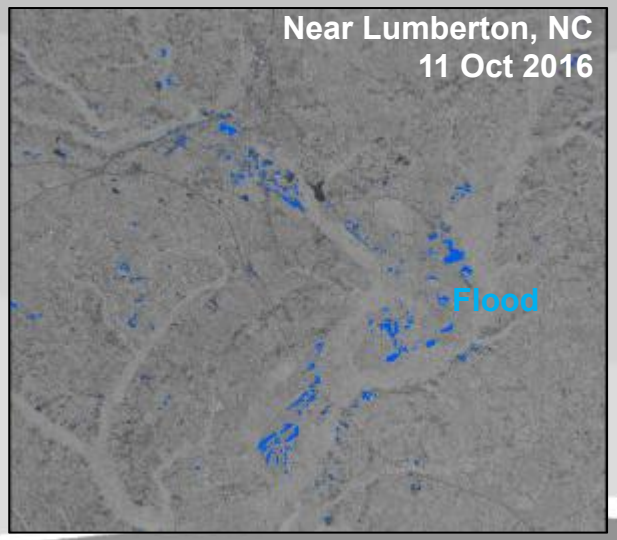


Flood Mapping SAR Applications

- In preparation for NISAR's launch, Disasters Team collaborators are working with a variety of platforms to develop products in support of disaster response efforts.
- Through the International Charter activation assets, the team obtained data through the CEOS Flood Pilot, and through Sentinel 1A/1B acquisitions from ESA. Team members contributed flood maps to USGS/HDDS and FEMA partners, including:
  - SAR Imaging of Haiti, the Dominican Republic and eastern Cuba
  - Products for the U.S. coastline including the eastern coast of Florida (via Charter/Radarsat-2) and the Carolinas (via Sentinel)
- Collaborations among team members are ongoing to share and explore best practices, improve products, their validation, and automation to provide service to FEMA and international partner disaster response efforts, and to build a user community in preparation for the launch of NISAR.



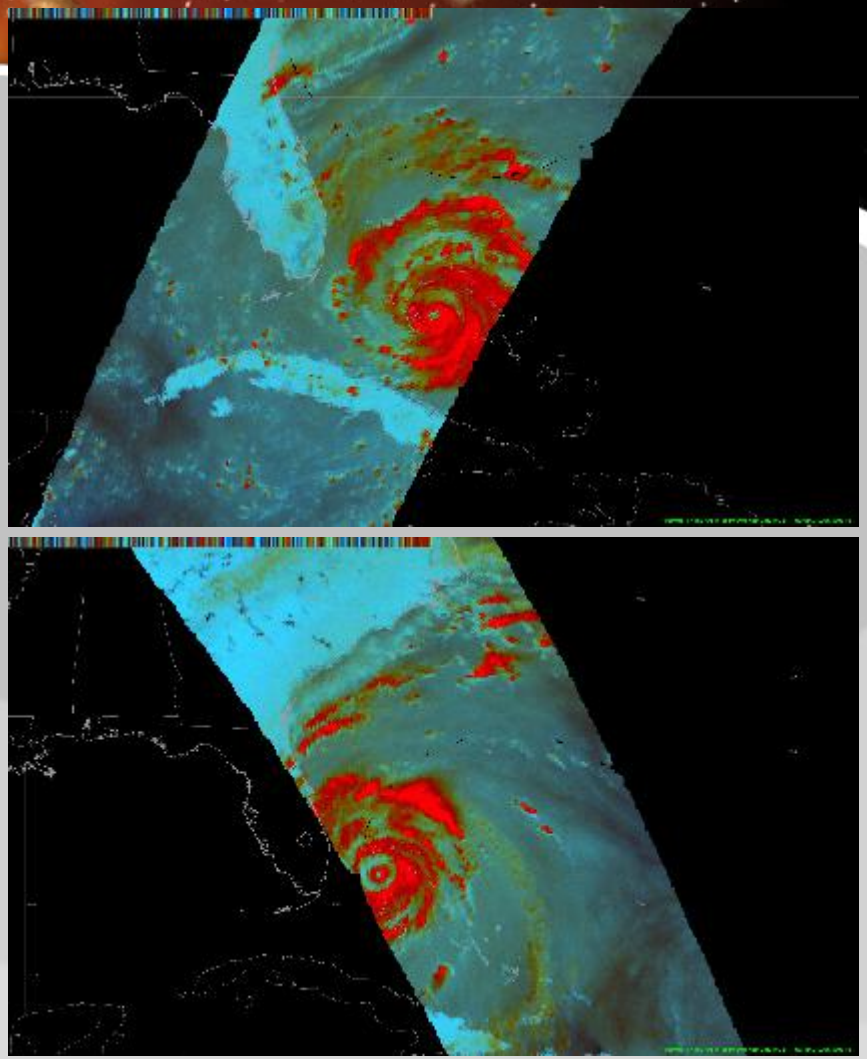
Imagery was acquired by RADARSAT-2 on 7 October 2016 RADARSAT-2



Sentinel 1A/1B imagery collected in partnership with ESA and delivered through the Alaska Satellite Facility / UAF.

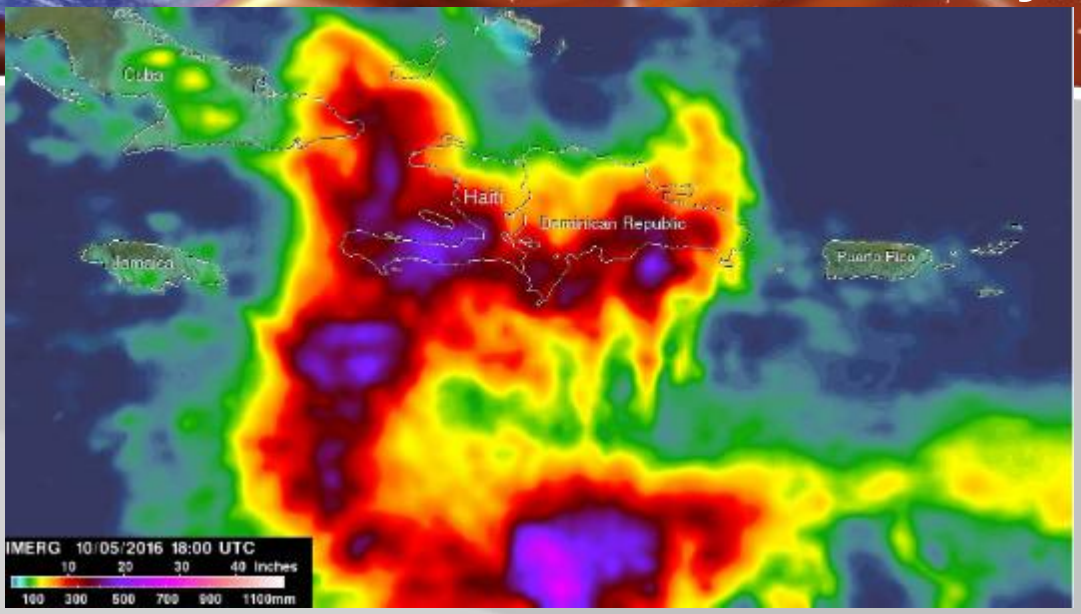
Imaging Matthew's Circulation with GPM

- Collaborative effort between the GPM science team and NASA SPoRT provided brightness temperature and IMERG products to NOAA's National Weather Service and the National Hurricane Center.
- Images on the right capture snapshots of Matthew using NASA's Global Precipitation Measurement mission Microwave Imager (GPM GMI) data, as displayed within the AWIPS decision support system used by NOAA/National Weather Service partners.
- NASA's GPM GMI provides passive microwave brightness temperatures useful for displaying cyclone structure, particularly when able to see through overlying cirrus to the center of circulation and spiraling rain bands.
- In addition, cross-calibration of other passive microwave brightness temperatures are made available from the Precipitation Processing System, along with estimates of rainfall from the Integrated Multi-satellitE Retrievals for GPM (IMERG) product.

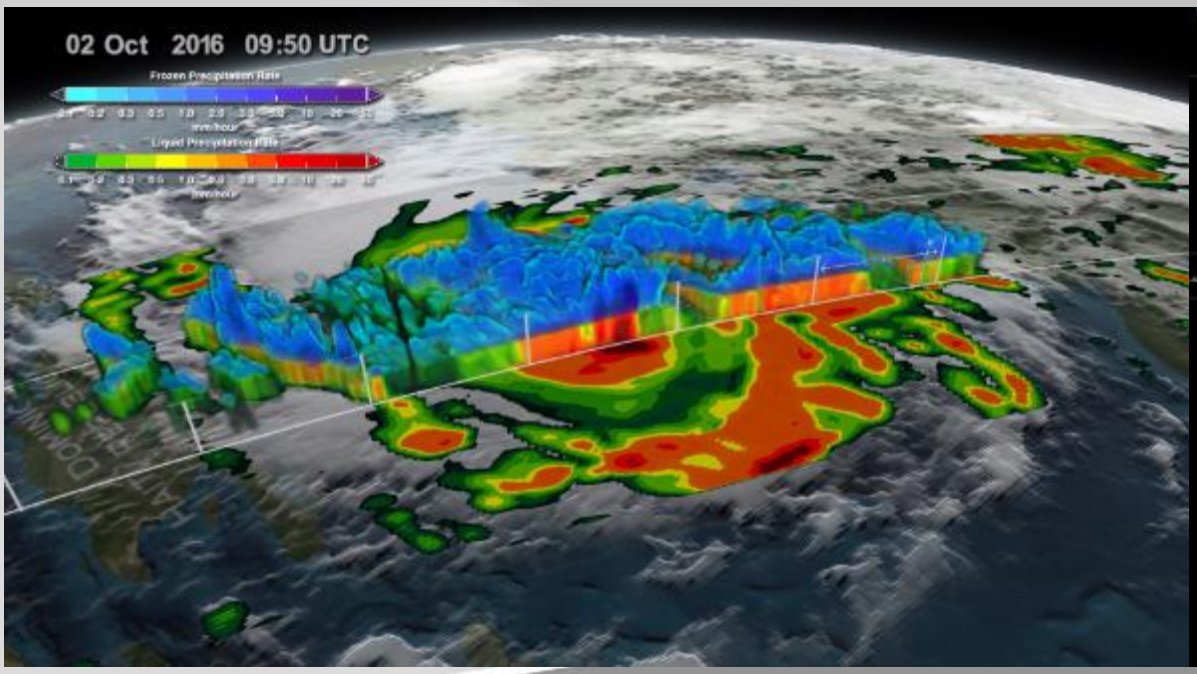


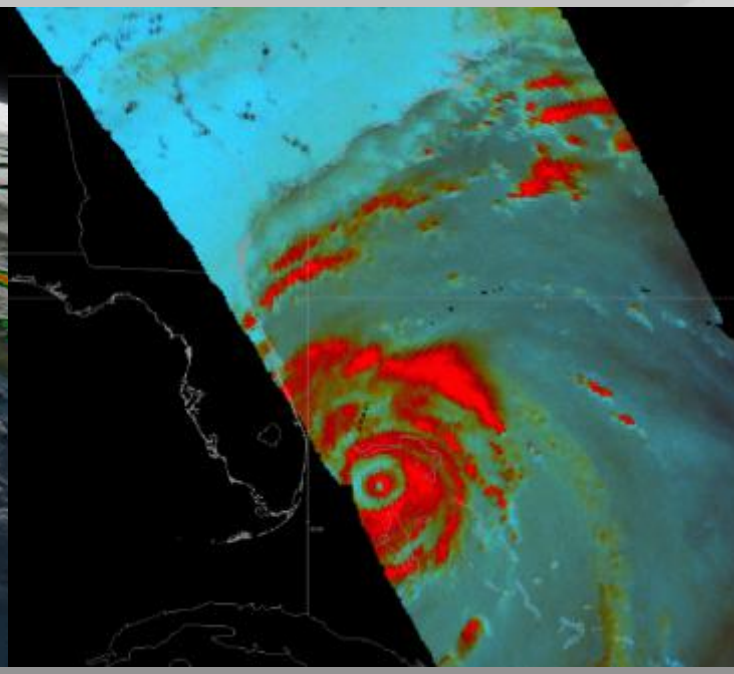
Hurricane Matthew approaches Florida on at (top) 9 and (bottom) 19 UTC on October 6, with passive microwave brightness temperatures observed from the GPM GMI; data provided to NOAA/NWS/National Hurricane Center

GPM observes Hurricane Matthew's rapid intensification and eyewall replacement



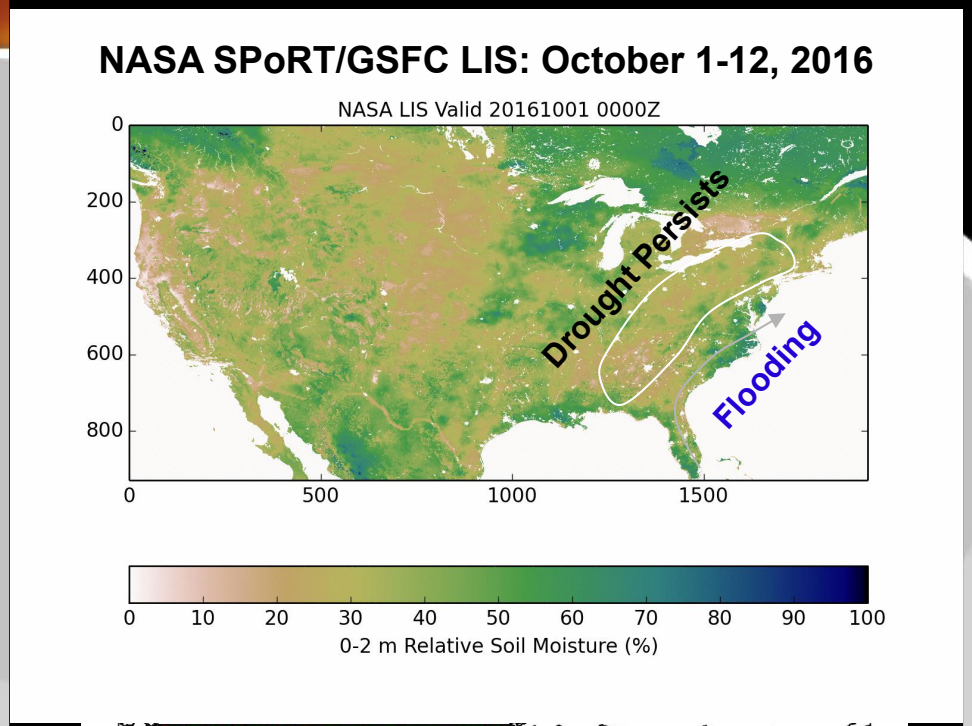
- GPM observed intense rainfall (left) as Matthew battered Hispaniola and Cuba
- On Oct. 2 (bottom left) GPM Core Observatory viewed a newly intensified Cat 4 storm south of Haiti, showing strong convection and heavy rainfall in the eye wall and rain bands
- GPM's Microwave Imager (bottom right) observed the storm going through eye wall replacement before impacting Florida as a Cat. 3. This data was provided to FEMA and NWS Offices for situational awareness

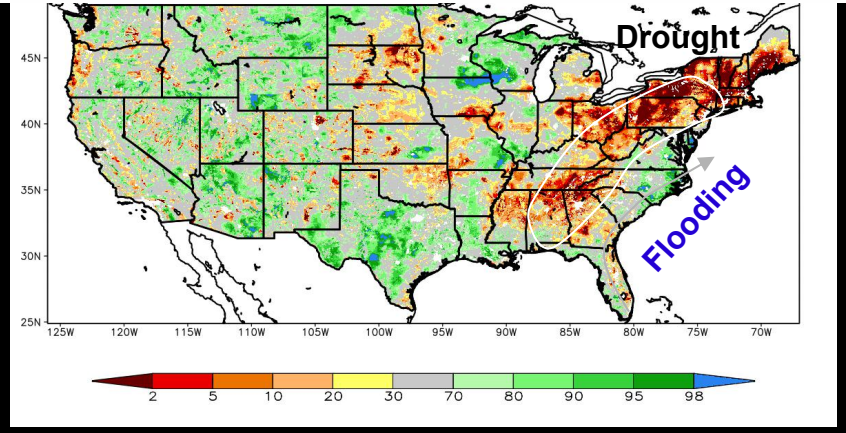




Soil Moisture Mapping of Matthew

- NASA's Land Information System (LIS) assisted NOAA/NWS partners with:
  - Mapping high soil moisture content prior to Matthew and heavy rainfall events where flooding is likely
  - Mapping dry soils to understand the extent of and change in drought, used by NWS partners to inform updates to the U.S. Drought Monitor
  - Understanding how current conditions relate to 30-year climatology
- LIS outputs were shared with NOAA/NWS and USGS/HDDS during their Hurricane Matthew response.
- New application partners identified (U.S. Forest Service); other spinoffs to follow, including power-outage prediction when combined with predicted wind speeds, duration, and extent.

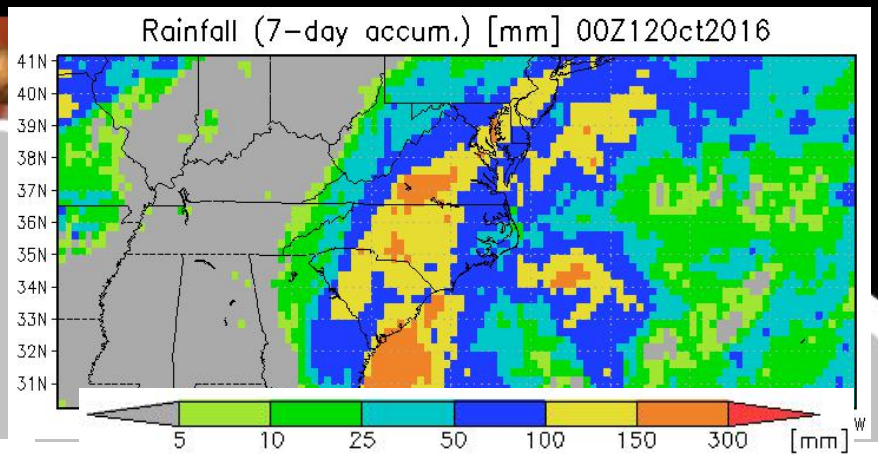




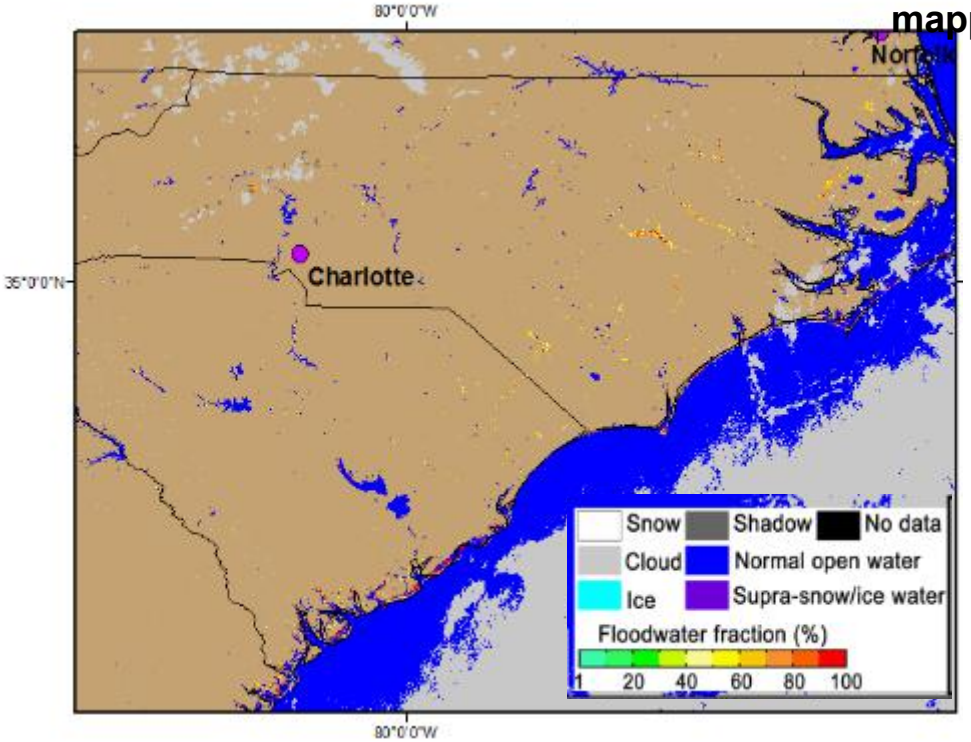
(Top) (0-2 m) soil moisture (0-100%) pre- and post-Matthew. (Bottom) Soil moisture compared to 30-year climatology (percentiles). Pre-Matthew soils were saturated in the eastern Carolinas and drier in eastern Florida; high soil moisture remains.

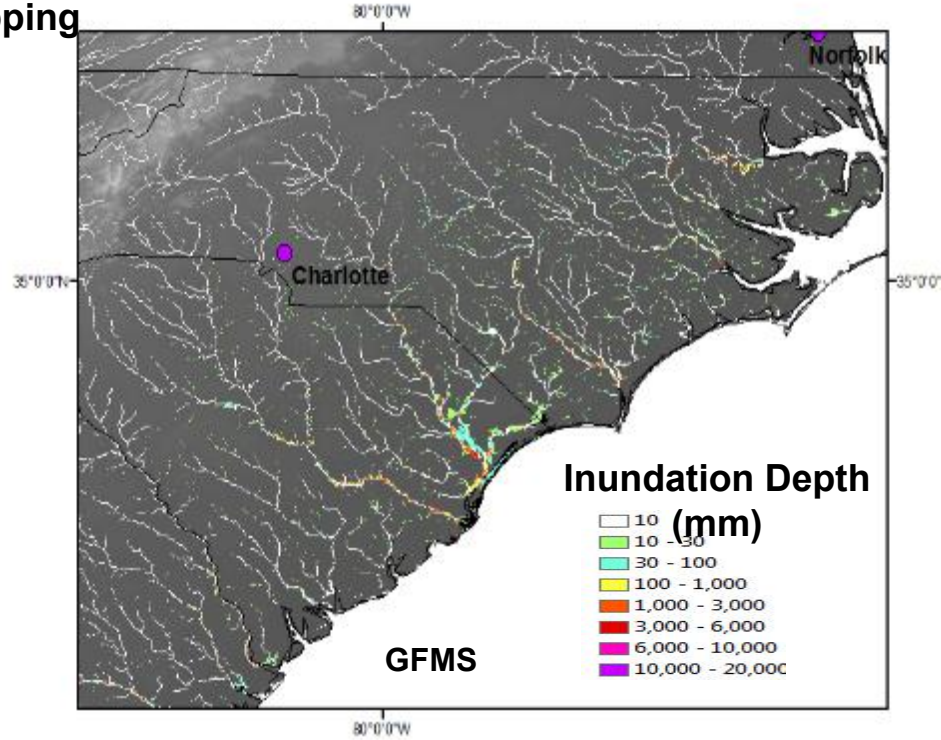
Flood products provided for Hurricane Matthew Response

- The Global Flood Monitoring System provided inundation estimates, flood intensity/detection, and forecasts for Matthew (bottom right)
- GMU used VIIRS to map estimated inundation area follow Matthew's passage (bottom left)



Inundation on same time: Oct. UTC 18:00: Global Flood Modeling System vs. GMU's VIIRS mapping



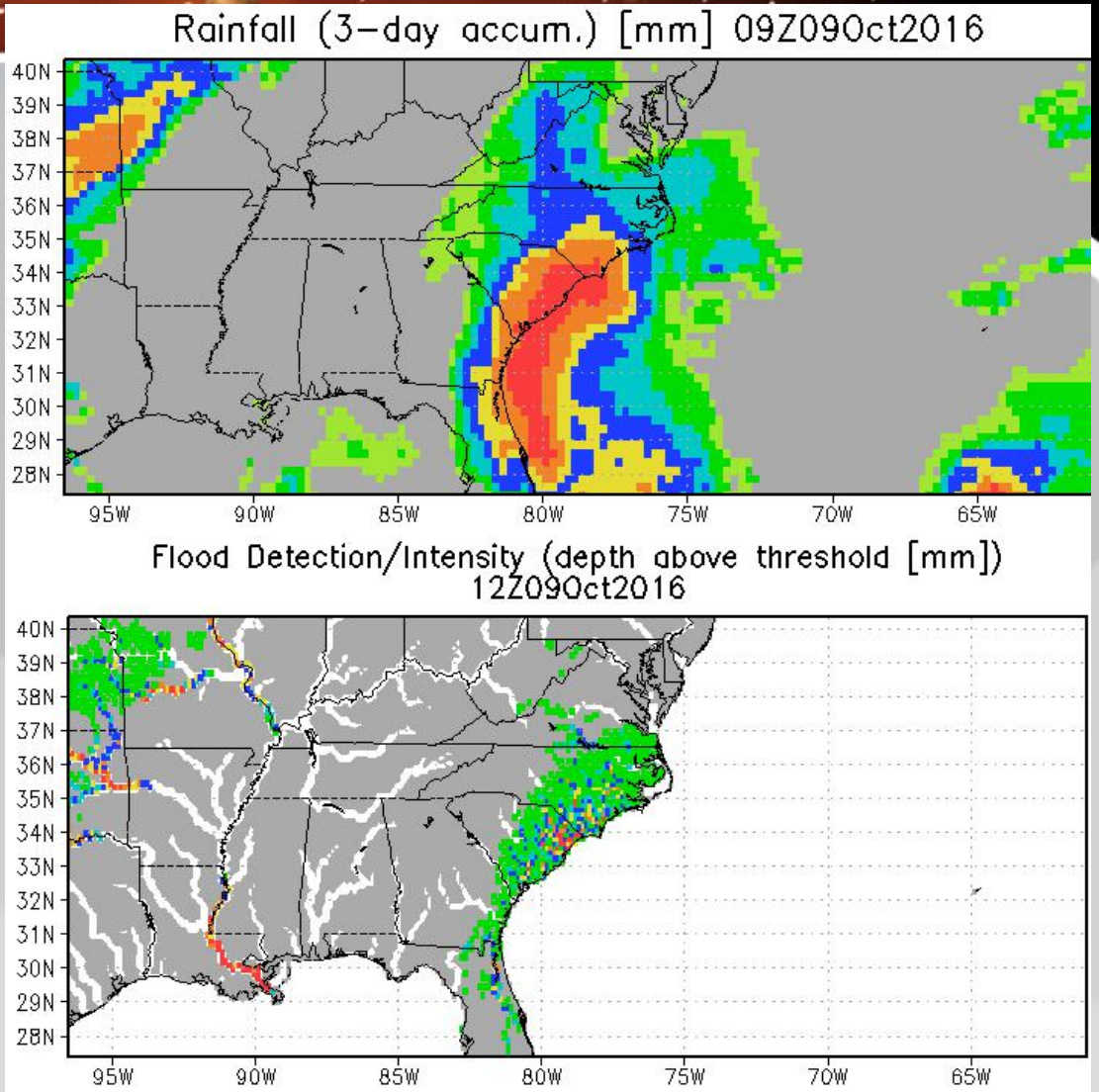


Samei Li, Donglian Sun/GMU

Huan Wu, Bob Adler/UMD

Heavy Rainfall and Flood Prediction

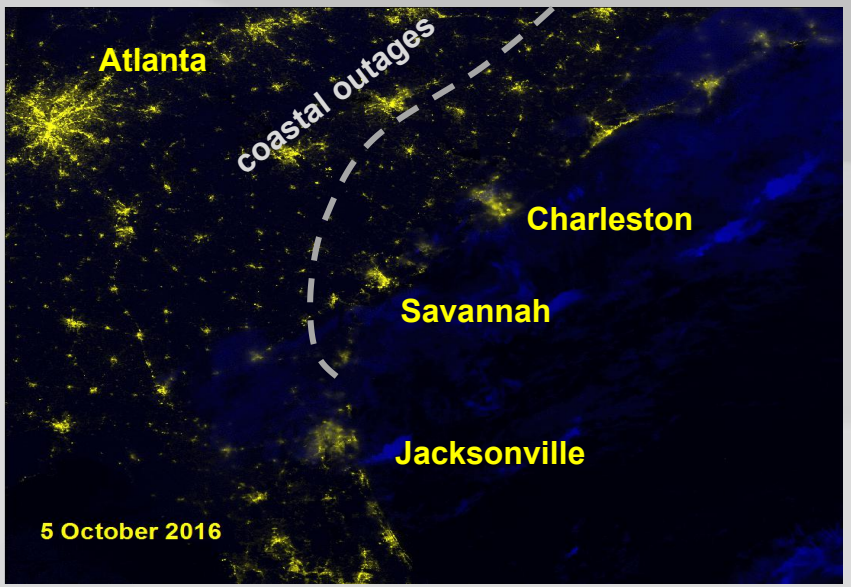
- Extensive inland flooding was widely predicted as a result of extremely heavy rains inland of Matthew's trajectory up the eastern seaboard.
- The Global Flood Monitoring project used NASA GEOS-5 model simulations of precipitation, combined with streamflow and flood predictions to map areas of likely flooding in eastern North Carolina, South Carolina, coastal Georgia, and northeastern Florida.
- These areas experienced record rainfall with Matthew, resulting in several days of near or record flooding in the areas highlighted by the Global Flood Monitoring project's flood predictions.



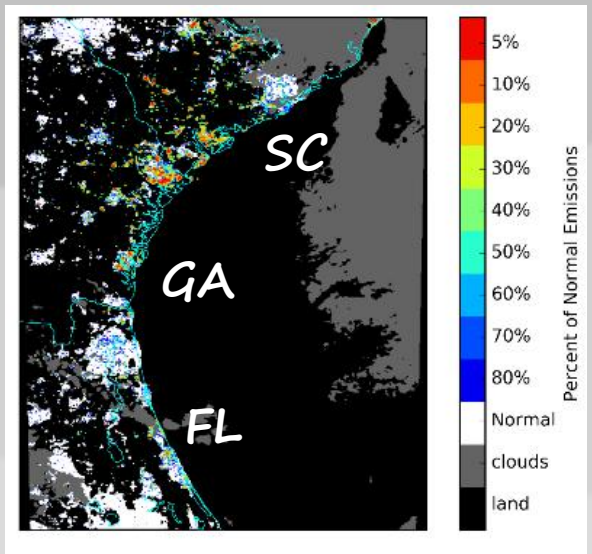
NASA GEOS-5 48-hour rainfall prediction (top) and associated prediction of streamflow and resulting flooding associated with Matthew's coastal impacts on the Carolinas and coastal Georgia.

Power Outages with S-NPP VIIRS

- Collaborations between NASA Goddard, their Direct Readout Laboratory, and MSFC/SPoRT have contributed pre- and post-event light comparisons using VIIRS Day-Night Band emissions and gridded products that incorporate corrections for moonlight.
- This approach allows for analyzing changes between pre- and post-event scenes and identifying missing or reduced lights due to power outages and other impacts from Hurricane Matthew.
- Products provided to FEMA, with future goals of reduced latency and automation.



Animation of change **in lights pre- and post-event; lights here are shown in yellow, and pre- or post-event cloud cover in blue.**



Comparison of pre- ("normal") and post-event light emission along the southeastern coast following Hurricane Matthew, on October 9.

Mission and Fight Assets for Flood Response

Earthquake Response

NASA's Response to the magnitude 7.8 Gorkha Earthquake in Nepal – April 25, 2015

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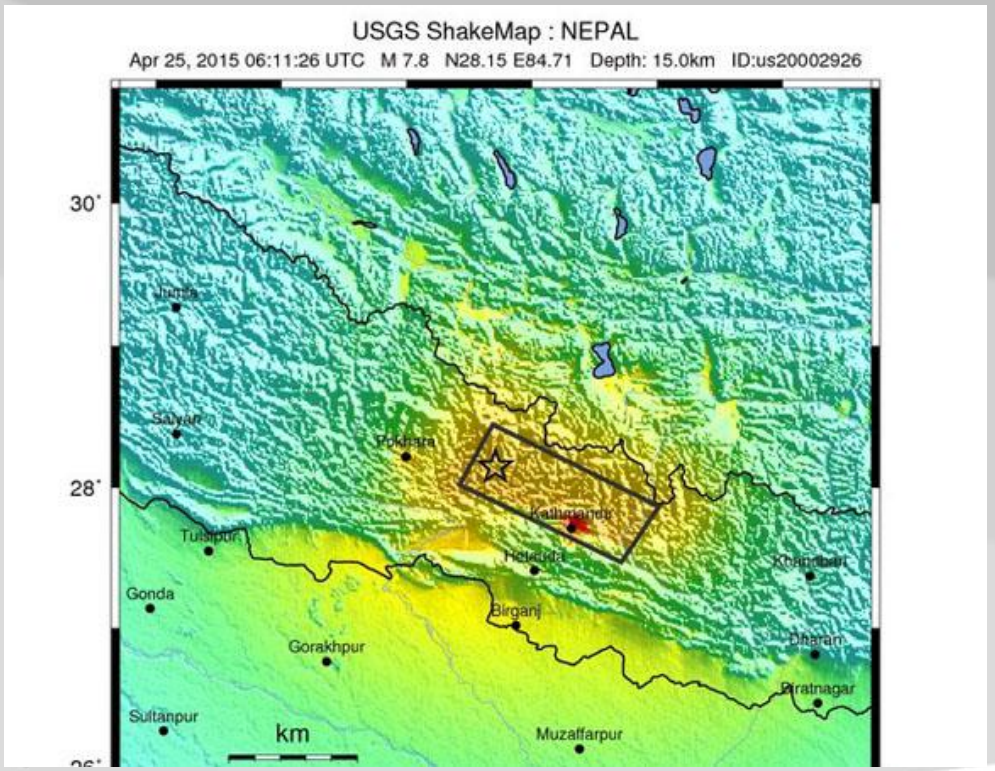
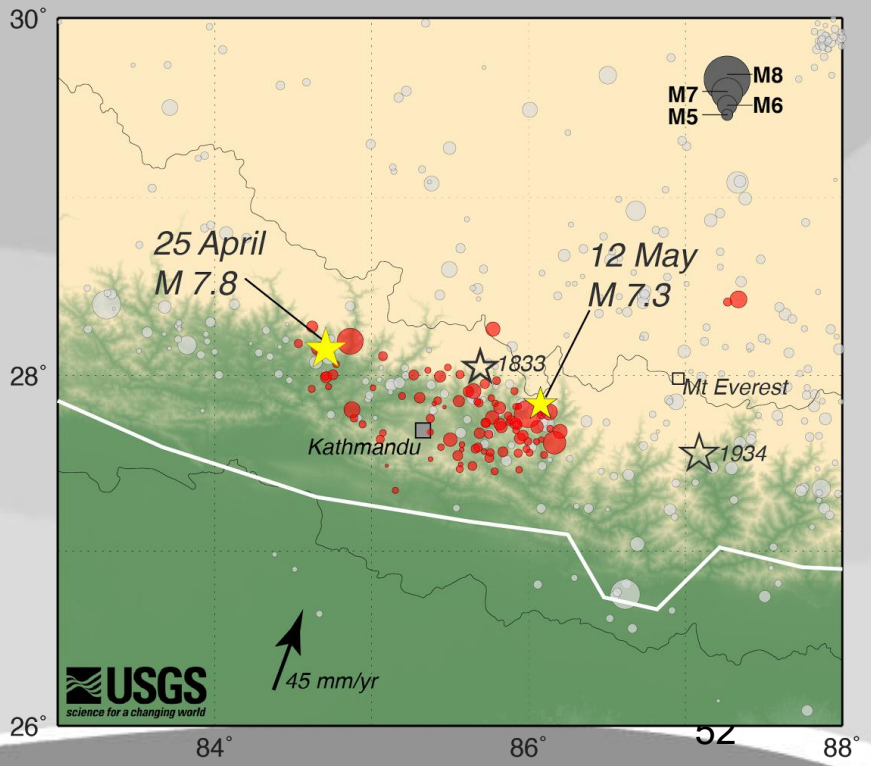
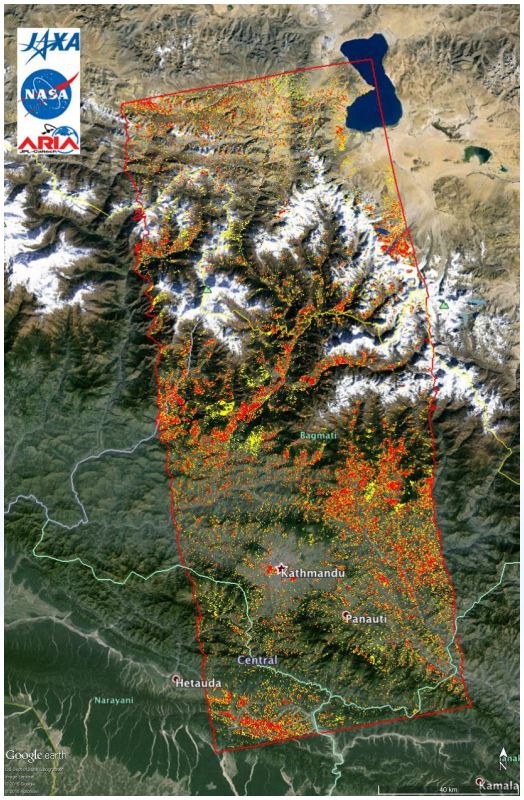




Damage Proxy Map from ALOS-2



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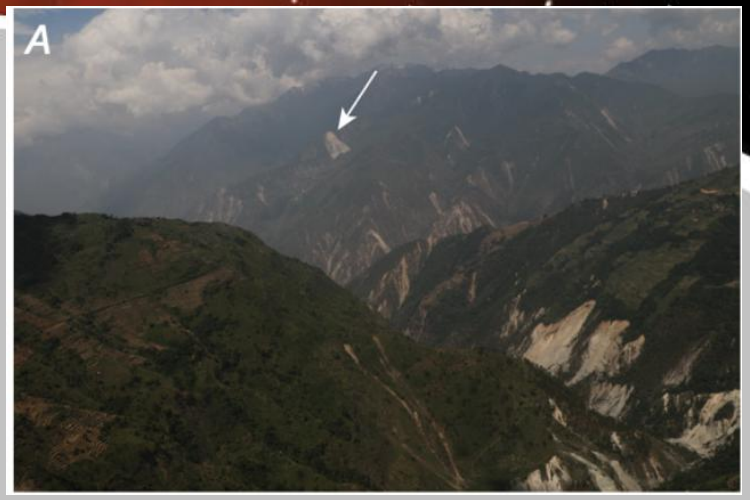

Partially breached Gogane landslide dam in Rasuwa District. Top of scarp below village is 400m above river level

Above: Widespread ridgetop landsliding in Gorkha district
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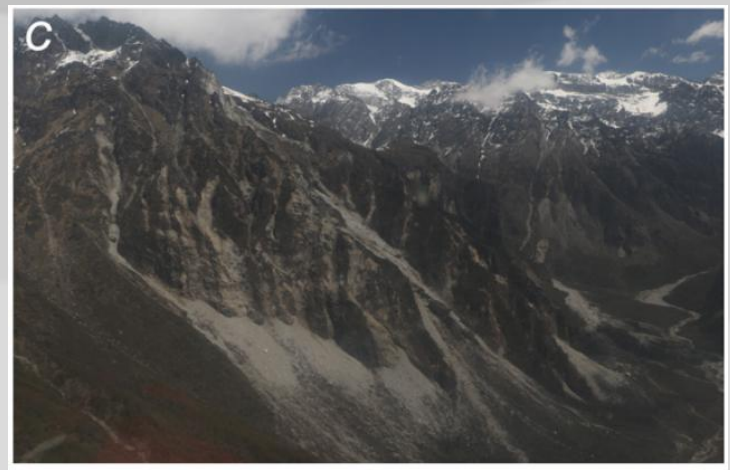

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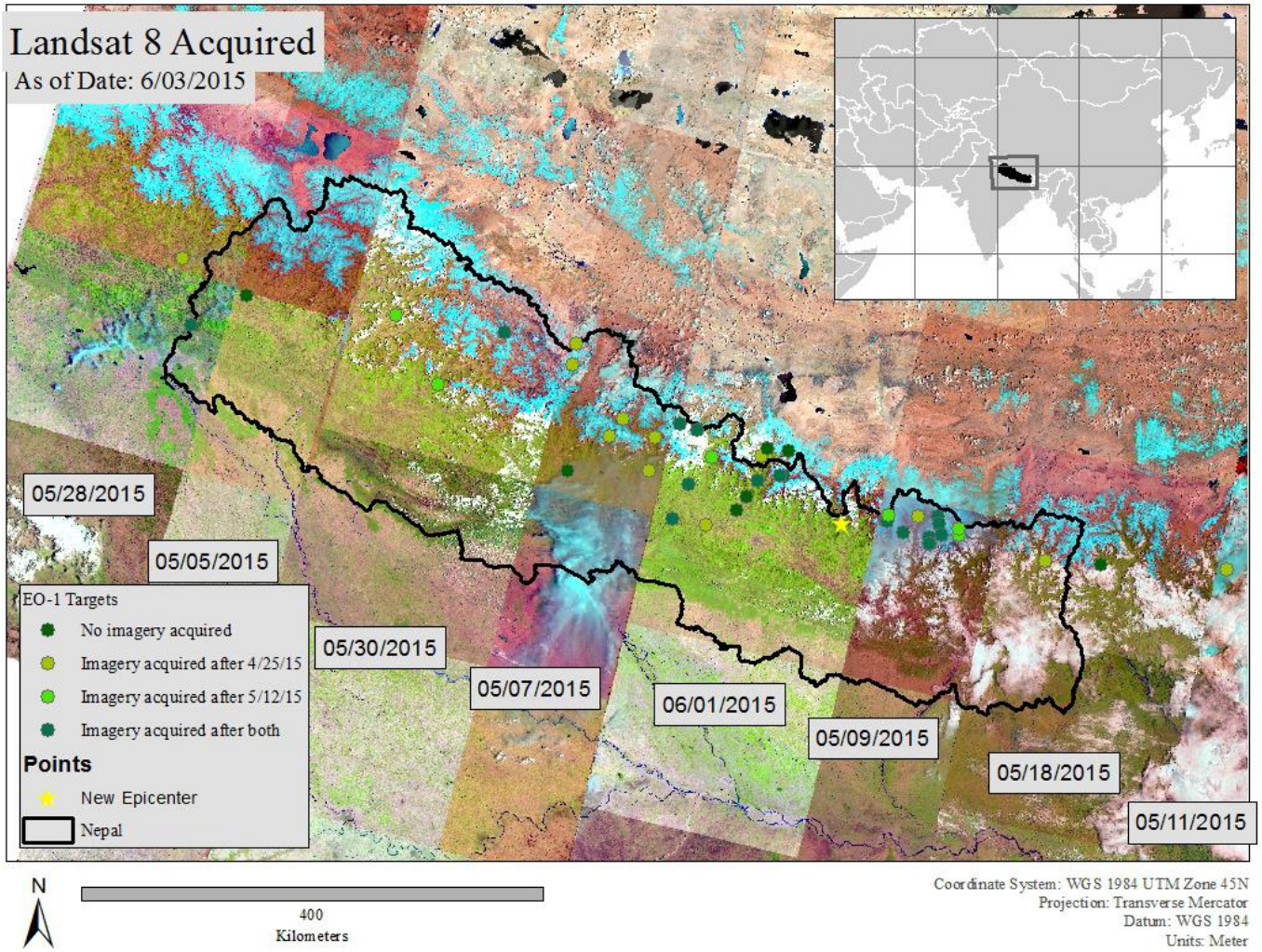
Optical Imagery: Landsat 8



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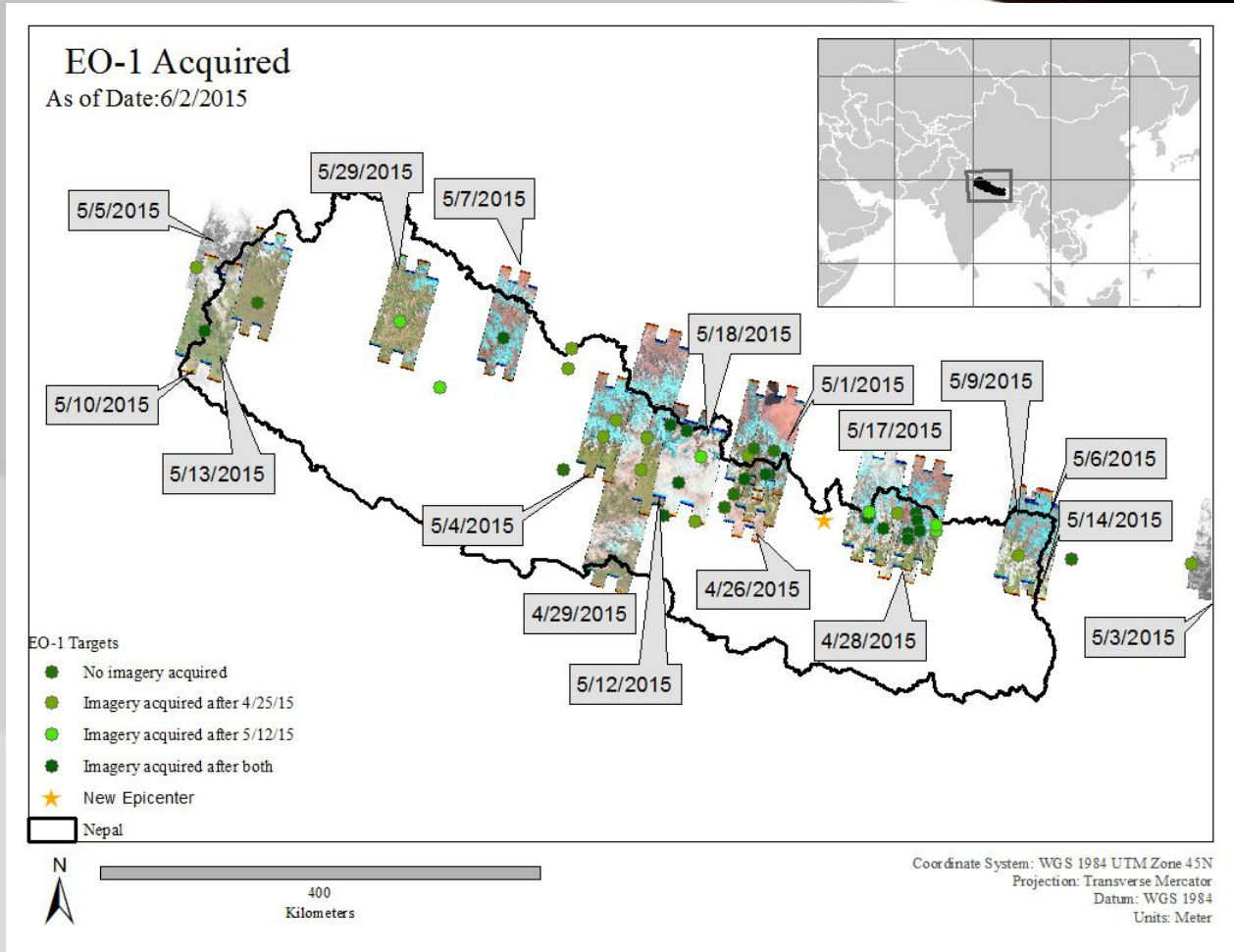
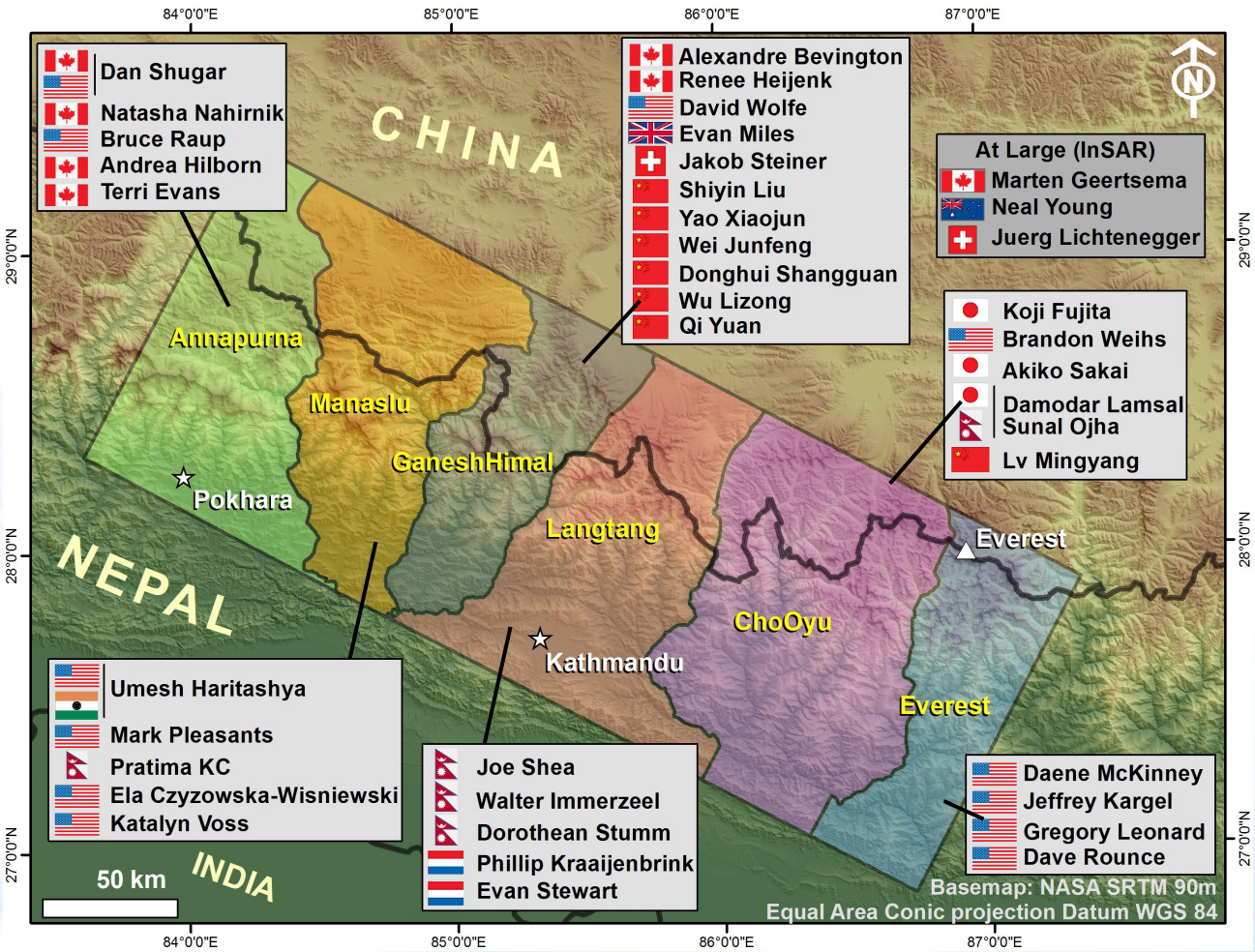


Gorkha Earthquake Volunteers Image Analysis Group



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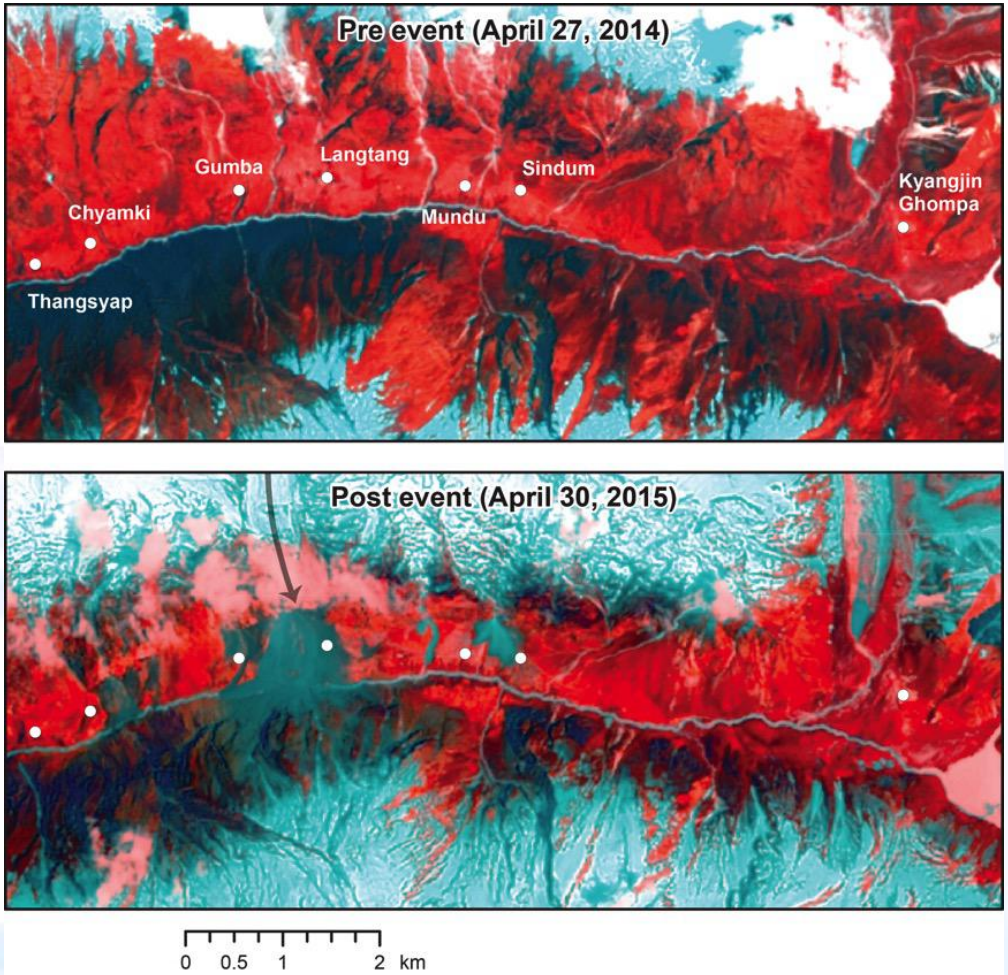
Gorkha Earthquake: Langtang Valley landslides, Nepal



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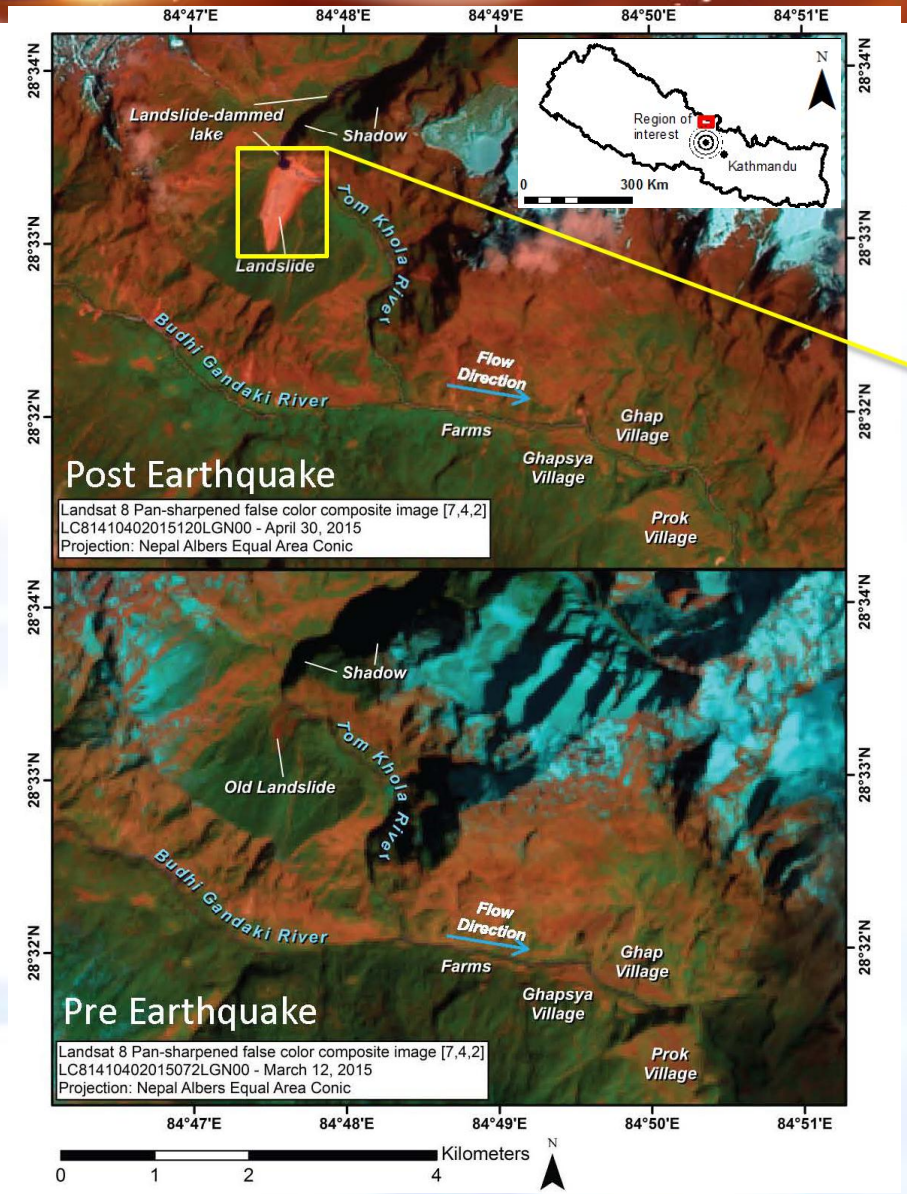

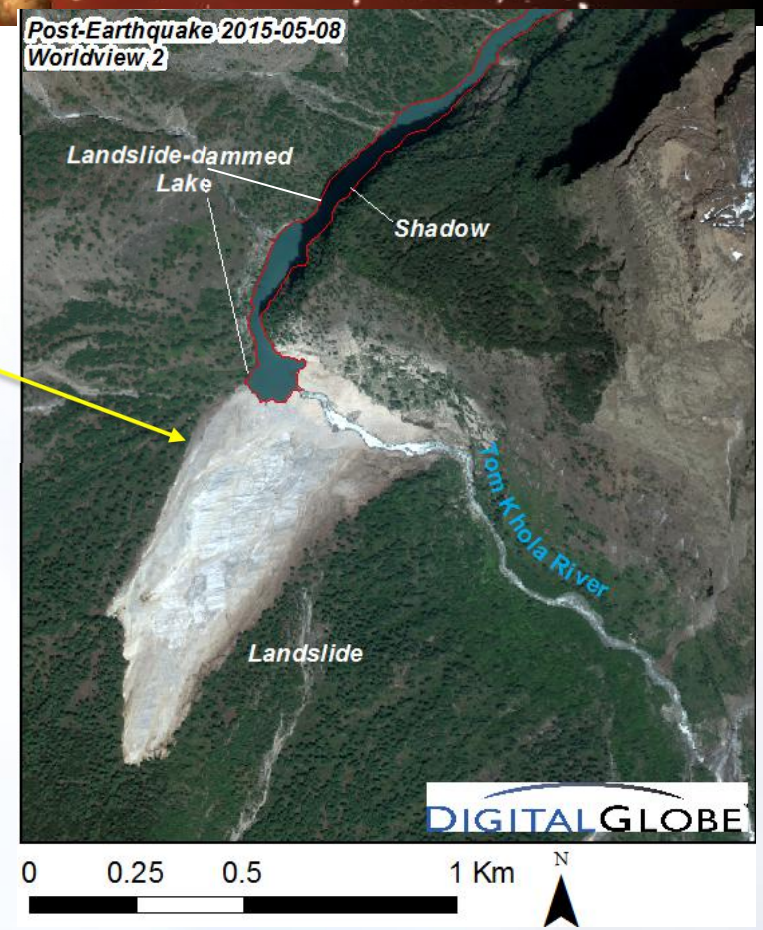

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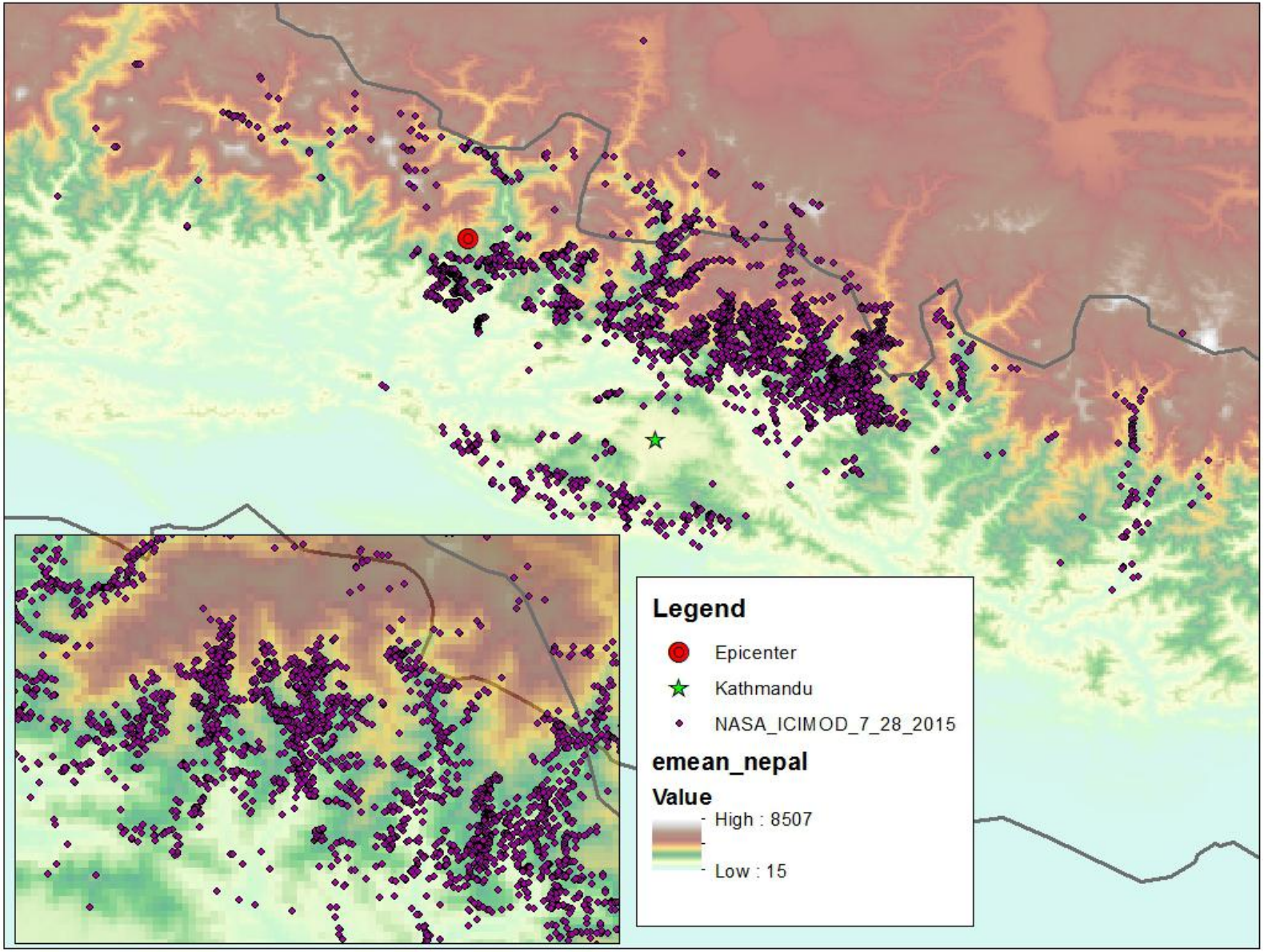

Volcano Response

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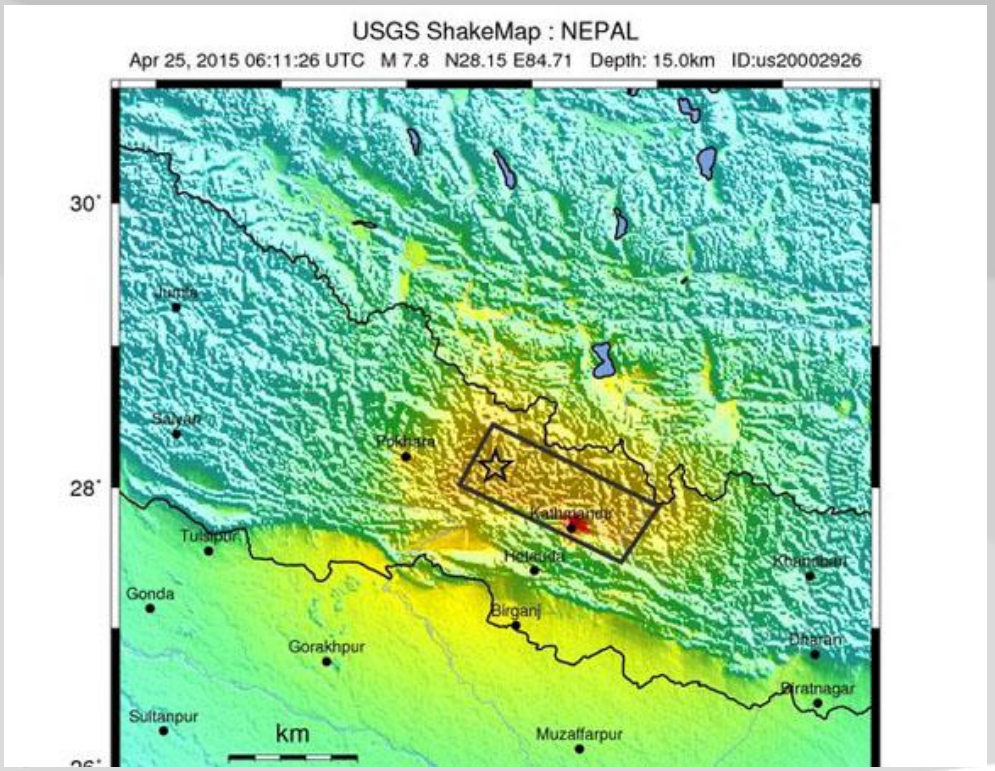

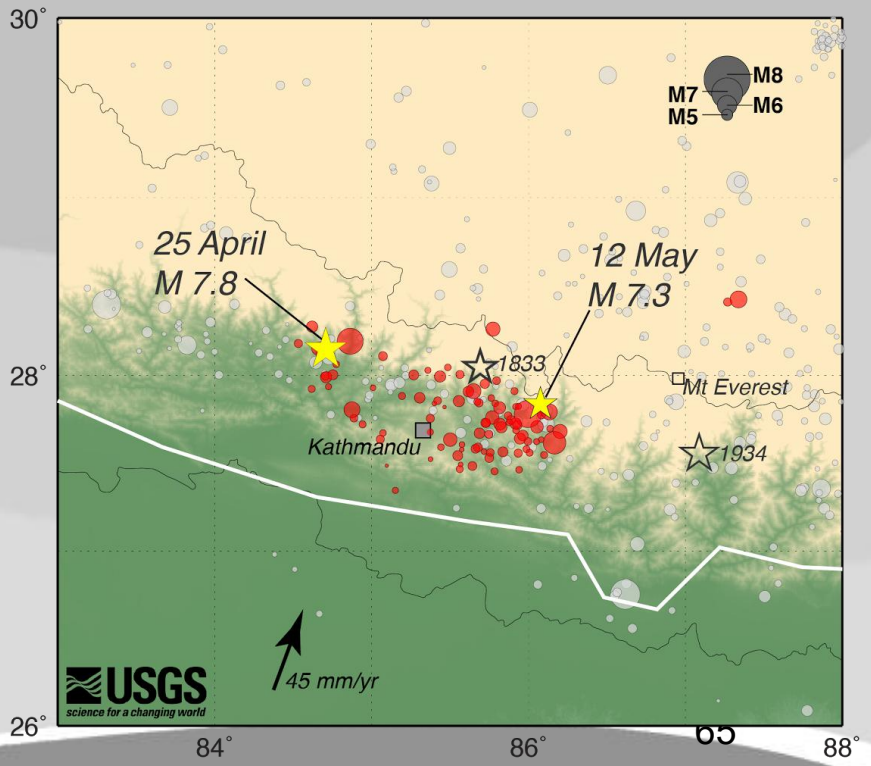

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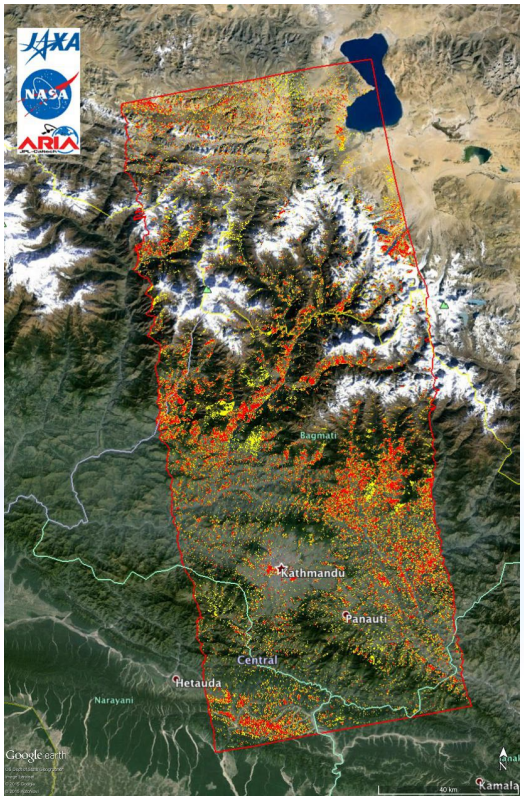

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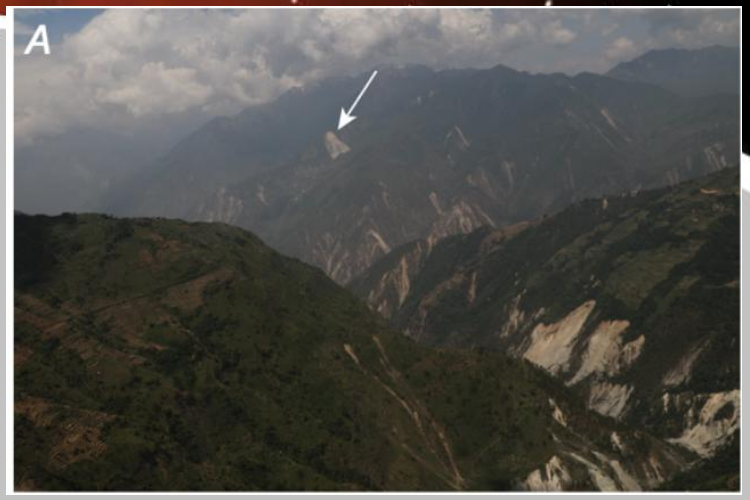

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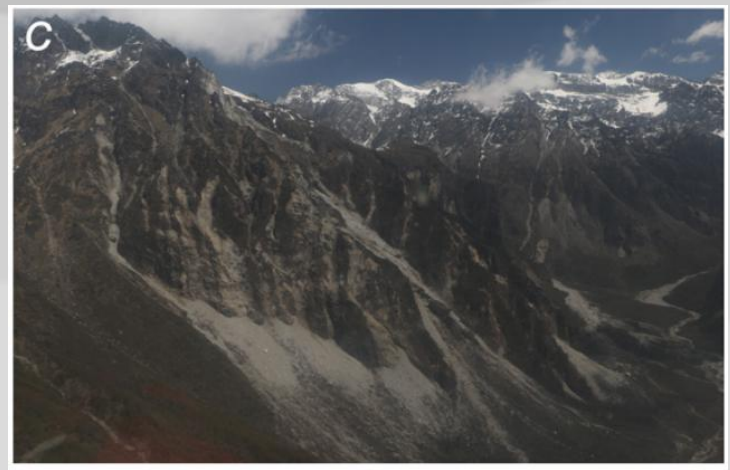

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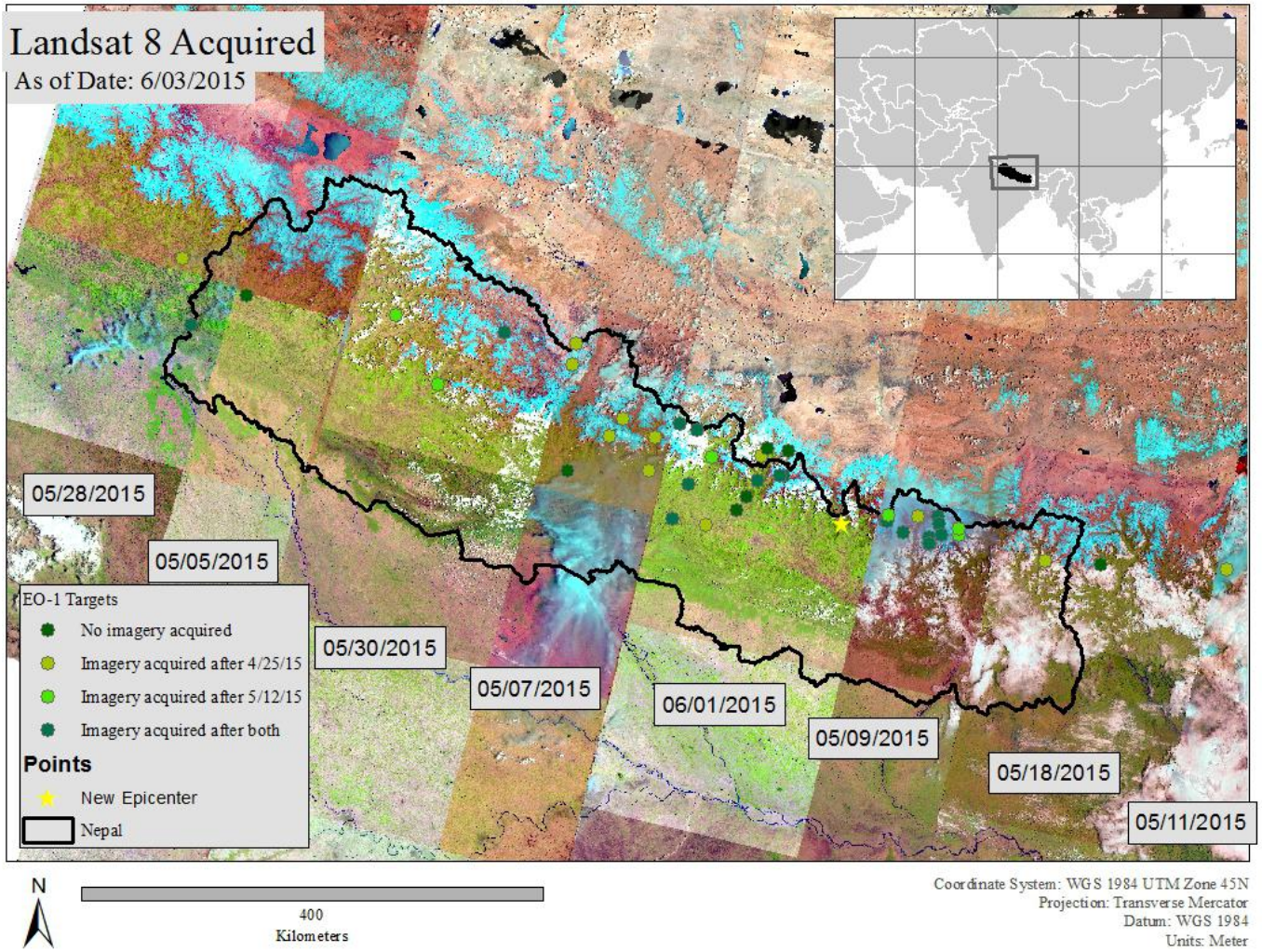

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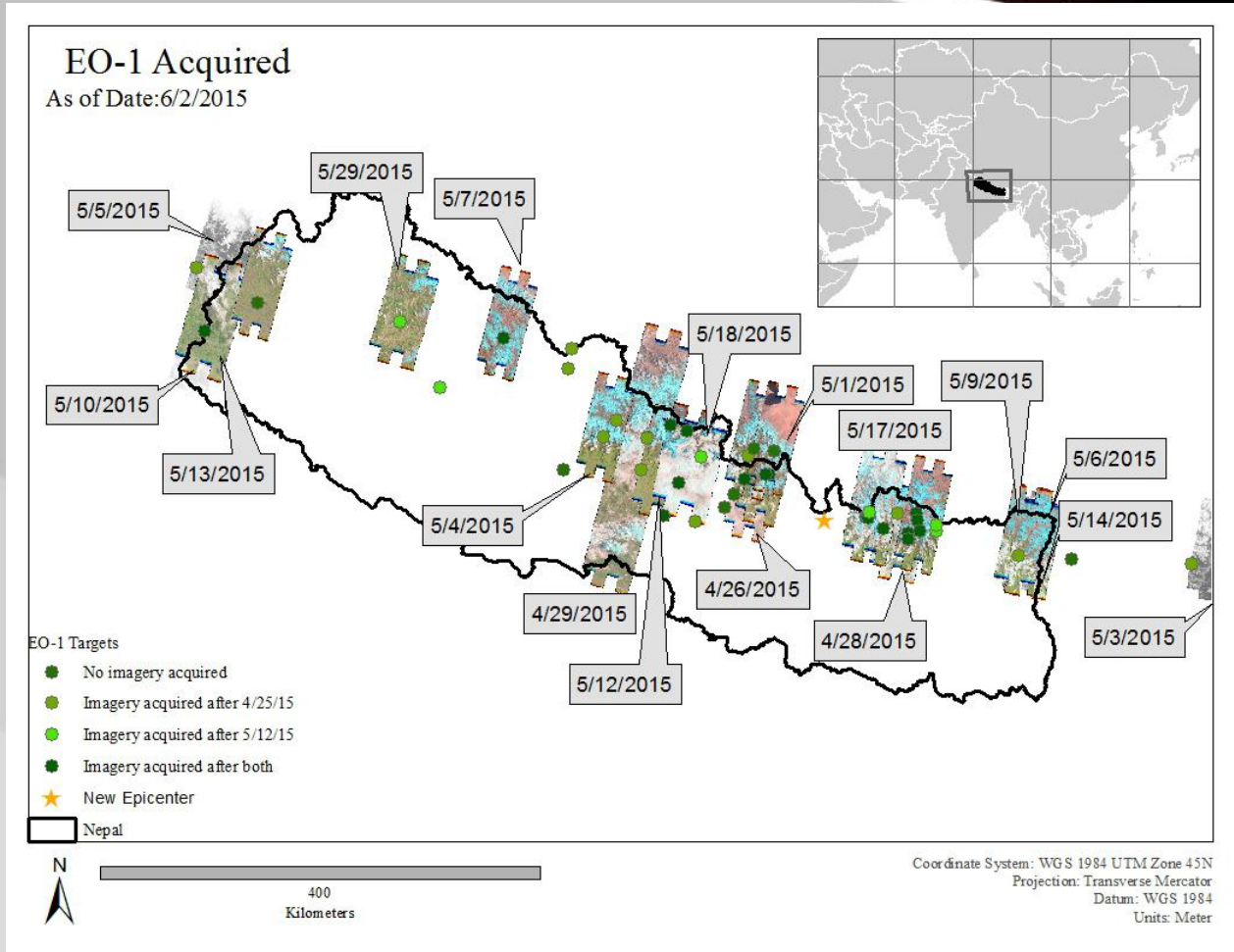

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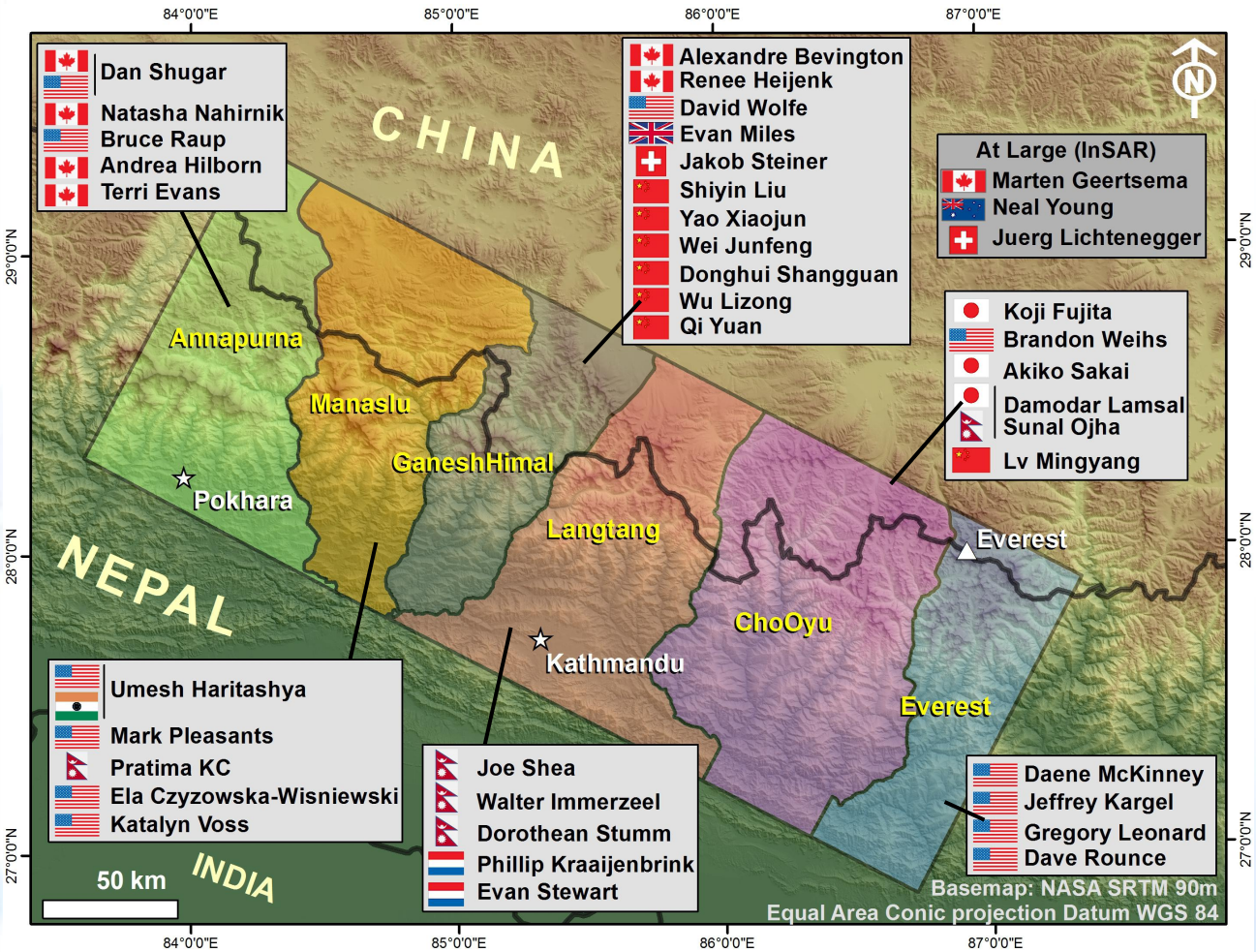

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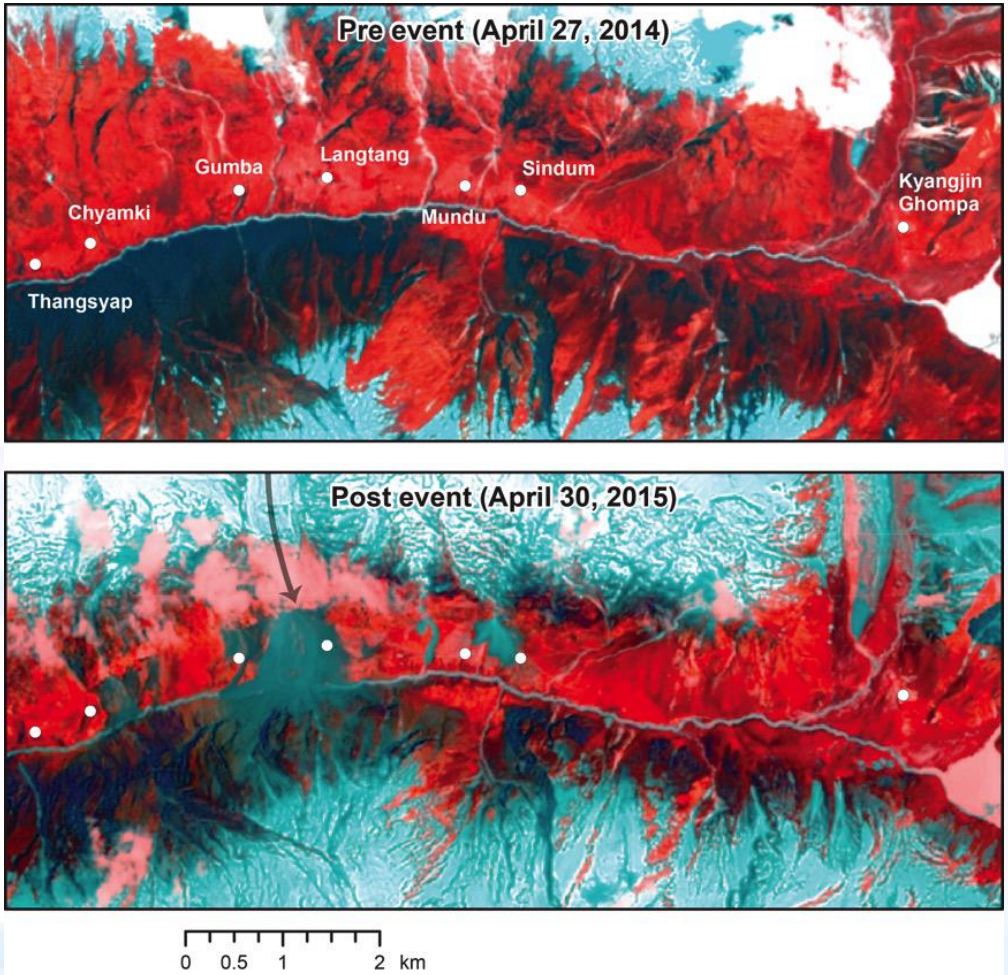

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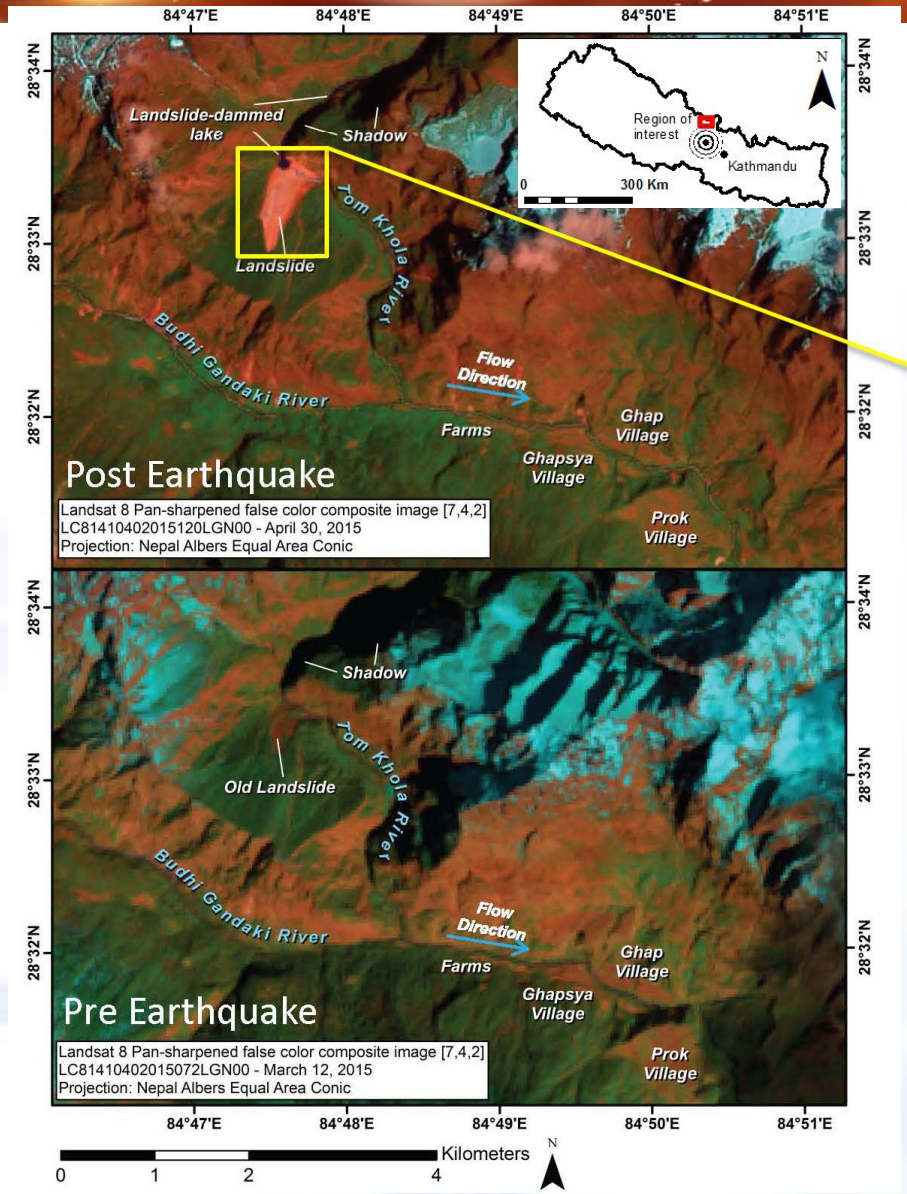

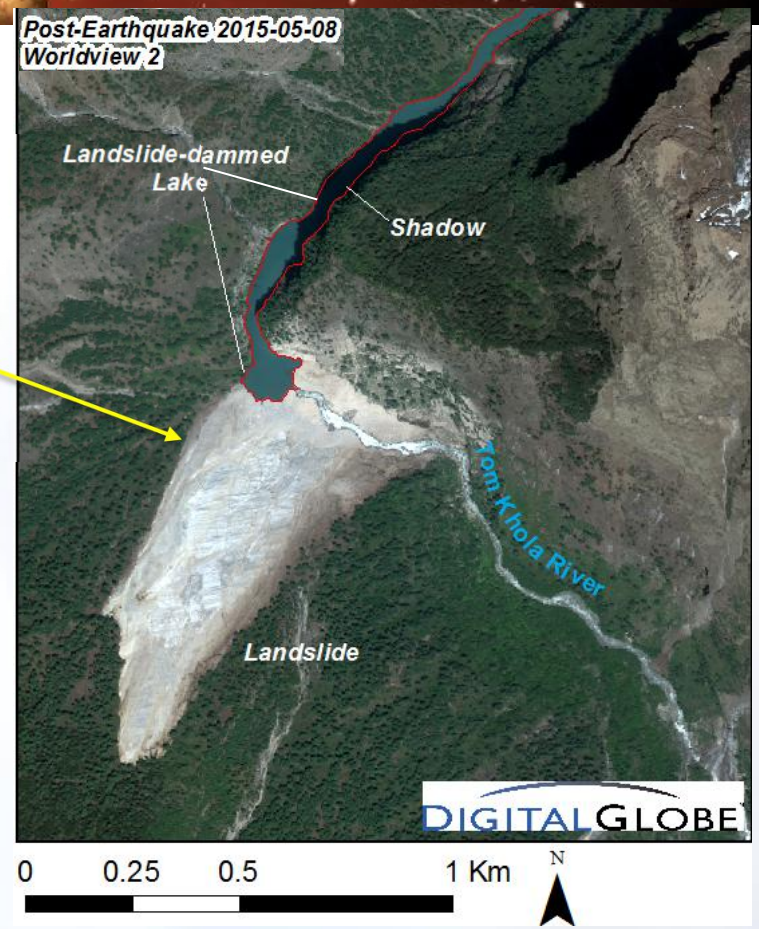

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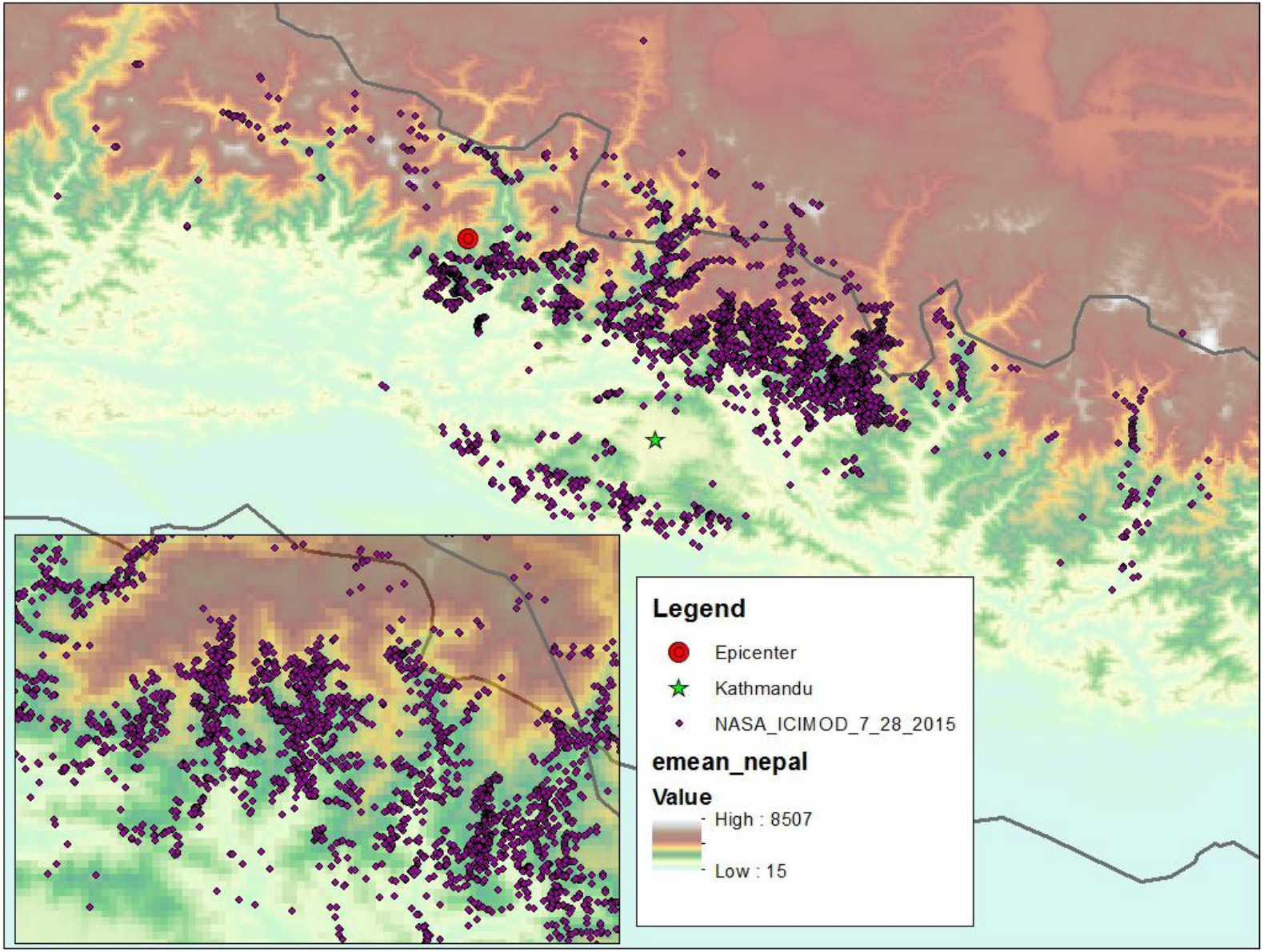
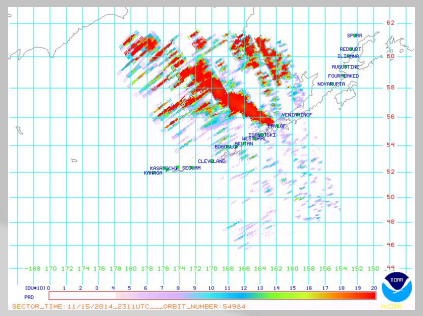


Volcano Response

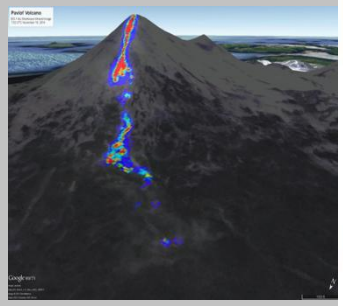
NASA Volcano Response

Volcanic Ash Disrupts – NASA Guides Response to November 15, 2014 Pavlof Eruption

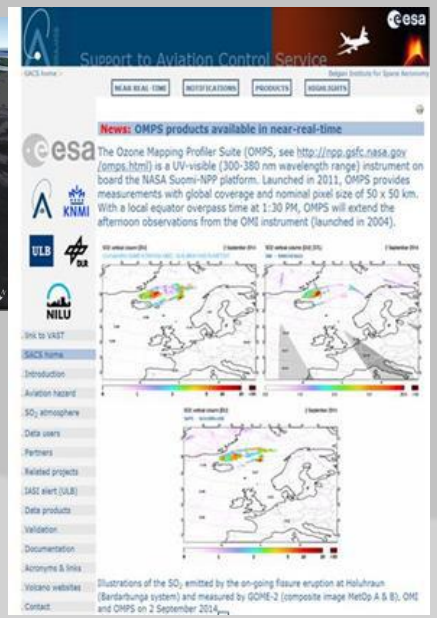
NASA data and models provide comprehensive data, information and mod to guide decision makers, communities, media, airlines and warning service

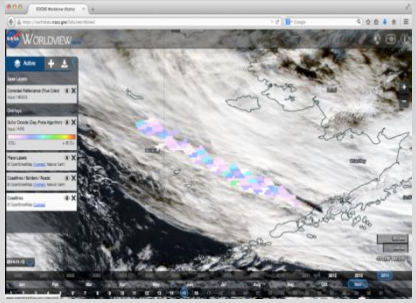


Early indication of trouble - automated NOAA OMI image shows SO_2 plume November 15 http://satepsanone.nesdis.noaa.gov/pub/OMI/OMISO2/alaska.html



Active lava and pyroclastic flow confirmed from EO-1 Hyperion Nov 16.

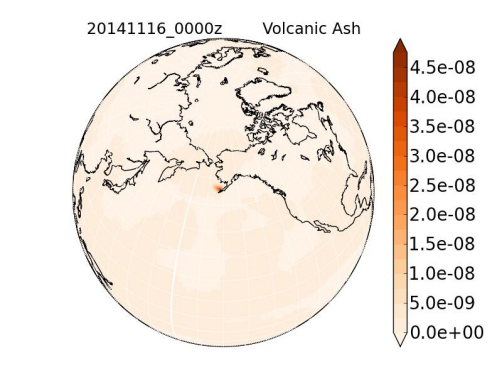




Extended areas of impact revelaed - automated NASA MODIS True-color image shows plume over clouds at NASA *Worldview*. Overlayed Aqua/AIRS IR SO_2 image November 16.

NASA information guides response: European Support to Aviation Control Service (SACS) uses SO2 column and Absorbing Aerosol Index products of OMPS at NASA EOSDIS User Registration System.

OMPS data complements the information already available from the other instruments (GOME-2A, GOME-2B, OMI, IASI-A,IASI-B, AIRS)



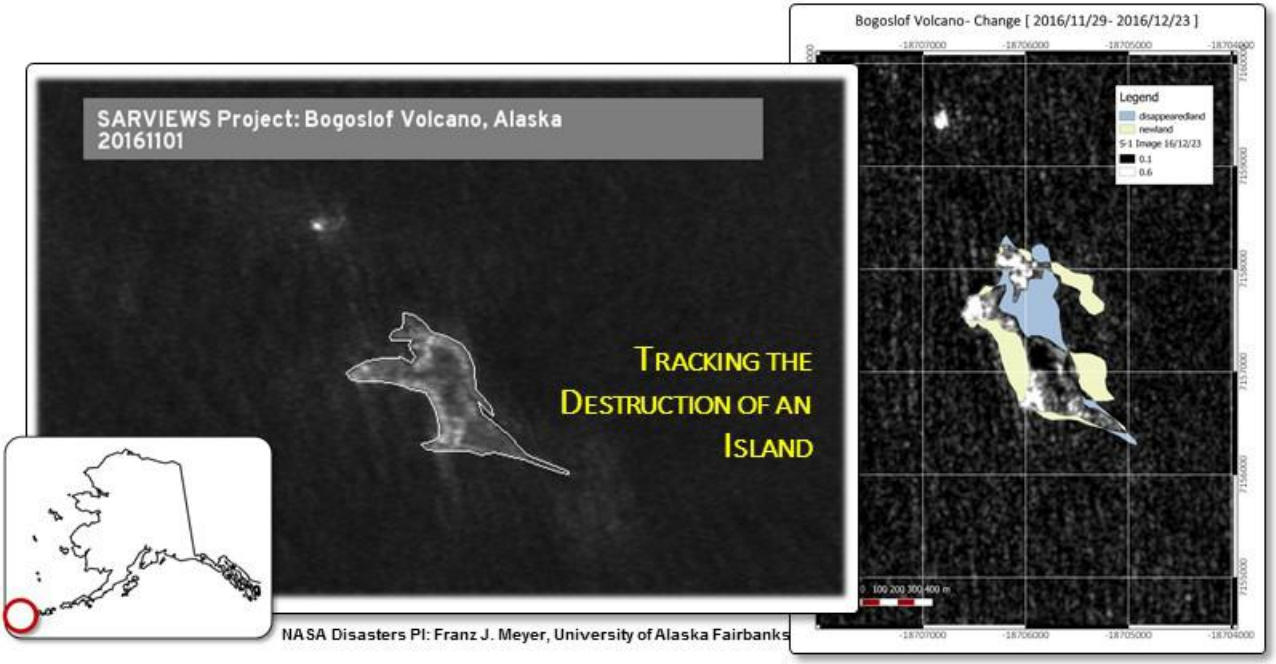
Warnings are activated and first demonstration of the free-running 1 day GEOS-5 Ash concentration forecast from Nov 15 contributes to decision making.

NASA SAR-Views: Boogoslof – Tracking the Destruction of an Island January 2017

As of: *1/13/17*

- *SAR-VIEWS: SAR Volcano Integrated Early Warning System*
- Bogoslof event started on Dec 16, 2016 and is ongoing
- SARVIEWS assisting USGS Alaska Volcano Observatory with image time series and change detection information

NASA ASP Disasters Most Recent Volcano Hazard Support
Bogoslof Eruption Dec'16 – Jan'17

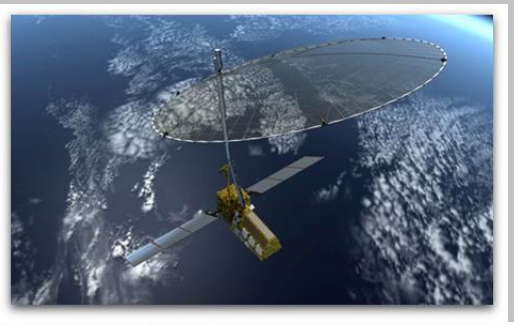


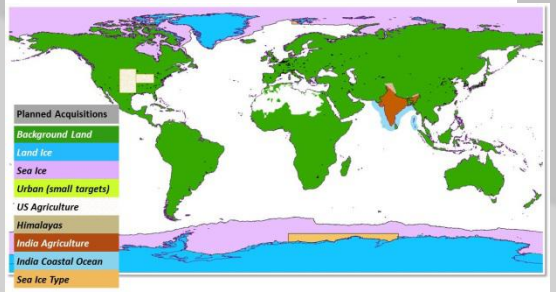
End-User Testimony

D. Schneider (AVO) via email on 1/12/17:

"This has been a fascinating eruption for many of us and it is remarkable how much information you have provided for such a remote volcano. I appreciate your help and the support of NASA"

NASA and Mission Partnerships NISAR* and Resilience





Among the many existing, new and planned missions NISAR is one of many examples where NASA partnerships opportunities would improved resilience and response

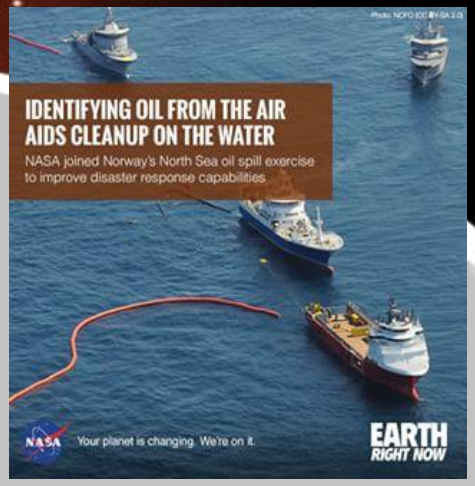
NISAR will change the way the world shares data and provide advanced radar imaging that it will capture uniquely the Earth in motion

* NASA and ISRO (the Indian Space Research Organisation) Synthetic Aperture Radar *Mission Concept to Launch in 2020*

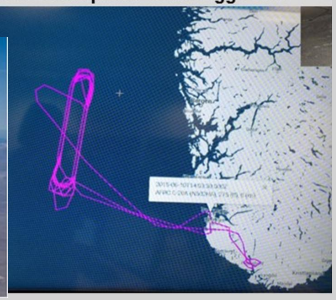
Oil Spill Response

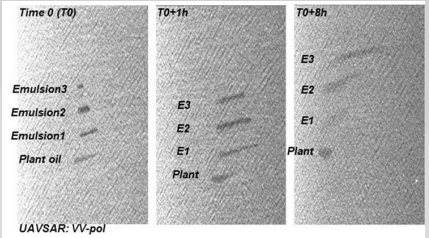
NASA Application Science and Technology Deployed in Norway's Annual Oil Spill Cleanup Exercise

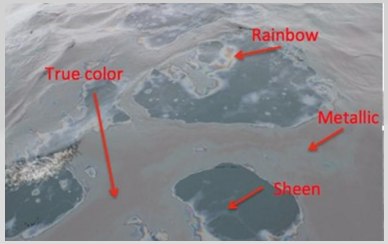
- NASA/UAVSAR deployed for the first time in the annual Norwegian "Oil on Water" spill exercise June 8-11, 2015 in simulation of a large spill (10s of kl) in the North Sea
- Objective to advance application science, calibrate and validate technology and test oil characterization models, demonstrate L-band SAR-based capacity, and inform NISAR Mission applications science
    - Concurrent sea truth and optical, IR, and satellite SAR imagery all obtained at no cost to NASA.
- Norwegian collaboration expected to lead to oil-in-ice spill response capability – important for Arctic oil exploration

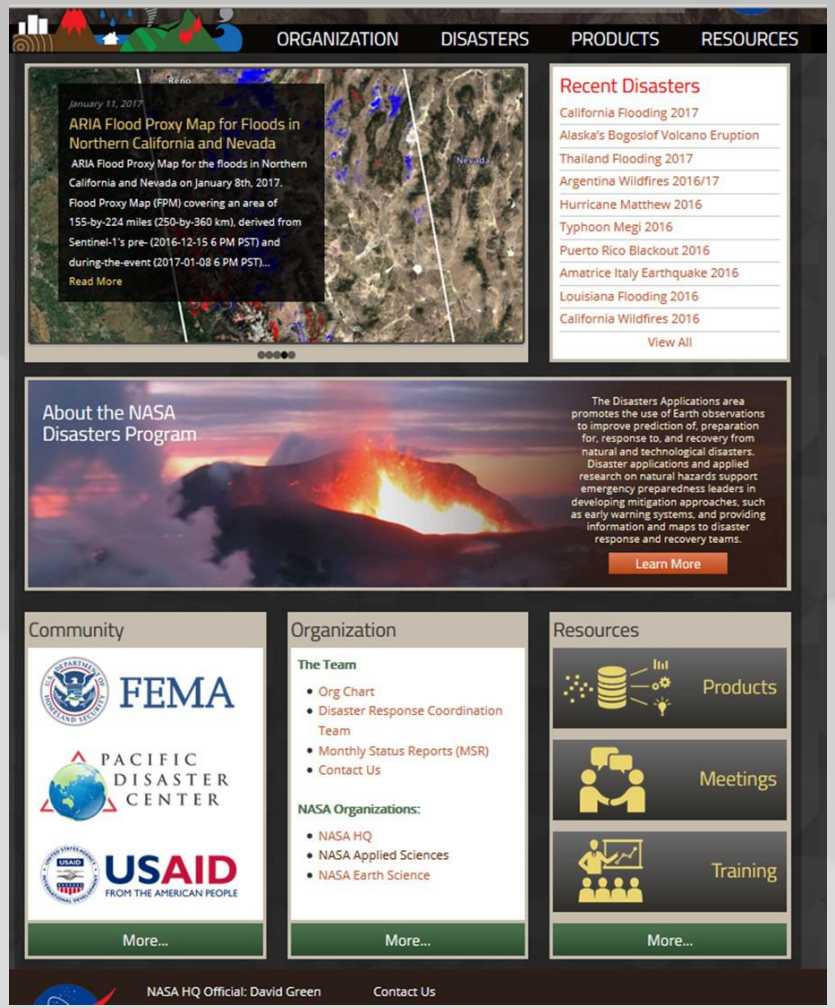


UAVSAR
2 days, 3 flights,
33 flight lines acquired over Frigg Field









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