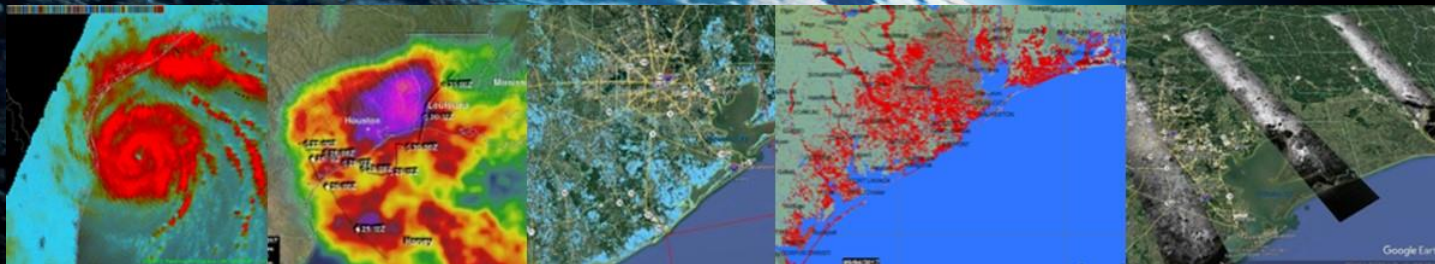




Hurricane Season 2017: A NASA Disasters Program Response Perspective



***Jordan Bell
Disaster Response Coordinator
Marshall Space Flight Center
Huntsville, Alabama, USA***



*Answering key
questions and filling
information gaps*



*Supporting actions
with data,
information and
tools*

*Establishing national
and international
partners*

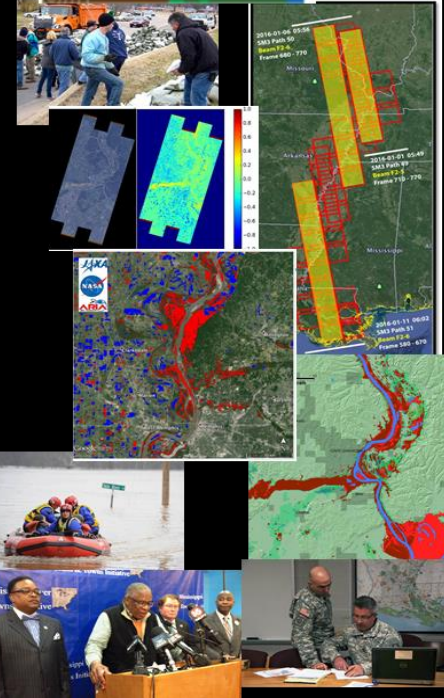
*Coordinating with
preparedness and
response agencies*

Responding to the Time and Scale of Decisions

*Global to Local Reach
on Extreme Events*

*Harvesting and
Exploiting Data*

*Decision
Making Support*

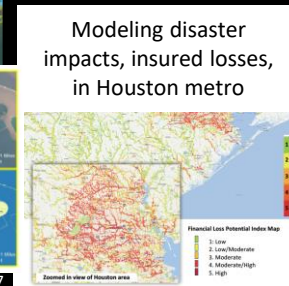
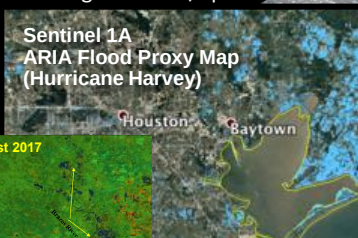


NASA Response and Engagement Timeline Hurricane Harvey (Aug-Sept 2017)

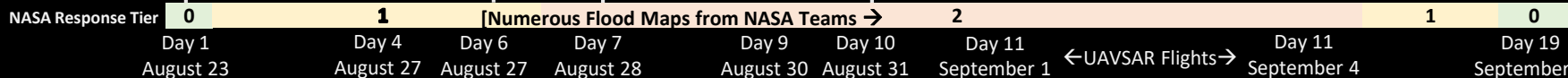
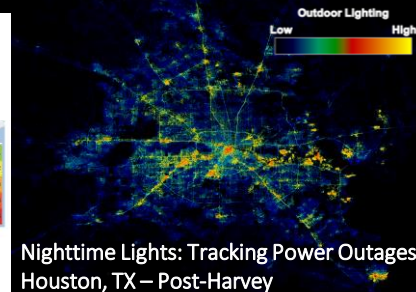
Forecasts for Harvey identify impacts to U.S. mainland, NASA team activates for coordination calls, product generation, and end-user engagement



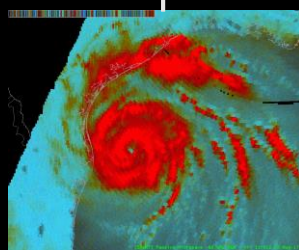
NASA, NOAA, ESA, International Space Station, and Charter data used collaboratively to map flooding from SAR/optical



Use of NASA Black Marble HD product to explore power outages during post-Harvey flooding



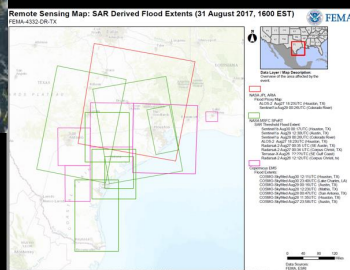
Daily calls begin to coordinate NASA team in generation of products, engagement of funded PIs, and coordination with federal end user partners including FEMA, USGS, National Guard, and others.



NASA's GPM helps track Harvey with data provided to NOAA/NWS and NHC



NASA team collaborations provide *over a dozen* detailed flood maps from SAR used by FEMA's geospatial team



NASA provides daily flights of UAVSAR from September 1-4 to rapidly map evolving flood impacts

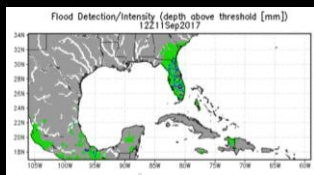
NASA Response and Engagement Timeline Hurricane Irma (Sept 2017)

SAR damage proxy maps generated from ESA Sentinel 1 to identify changes resulting from Irma's winds and flooding

NASA team initiates response in collaboration with end user partners focused on preparedness and recovery from Hurricane Irma



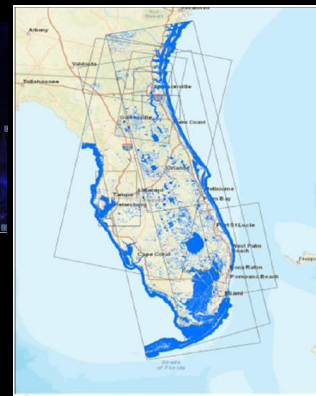
Partners model likely flood and inundation impacts from Irma's predicted rainfall



Preliminary mapping of flooding in Key West via ESA Sentinel-1



Daily maps of nighttime lights to help understand power loss and recovery



NASA team contributed numerous SAR/optical flood and damage maps to FEMA along with other ESA and commercial partners

NASA Response Tier 0 1 0

Day 1
Sept 5

Day 2
Sept 6

Day 4
Sept 8

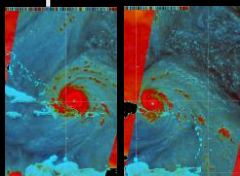
Day 6
Sept 10

Day 8
Sept 12

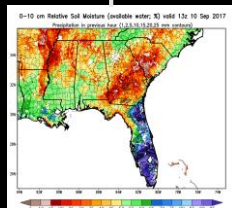
Day 9
Sept 13

Day 15
September 19

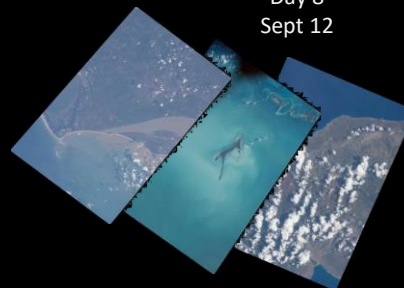
Continuing from Harvey, daily coordination calls and user engagement with partners including FEMA, National Guard, USGS and others



GPM and constellation satellites provide mapping of Irma's track through the Caribbean, data to NOAA/NHC, NRL



Daily NASA LIS captures saturated soils and flooding in FL/SE



ISS astronaut photography provides imagery of impacts in Caribbean/Florida



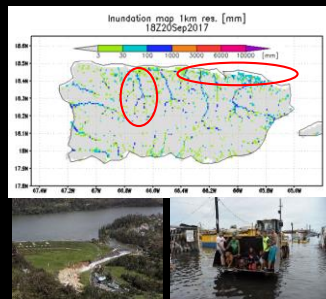
GPM/IMERG rainfall product measures rainfall across the impacted area

NASA Response and Engagement Timeline Hurricane Maria (Sept-Oct 2017)

NASA team initiates response in collaboration with end user partners focused on preparedness and recovery from Hurricane Maria



Flood modeling by partners for impacts in Puerto Rico



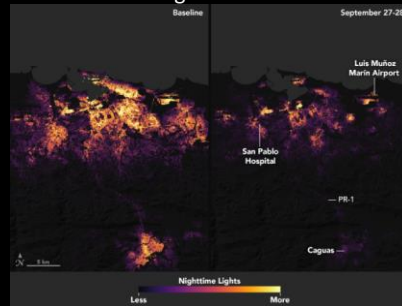
Guajataca Dam Breach

Cataño, PR

ESA Sentinel SAR imaging used to produce damage proxy maps for affected regions in Puerto Rico



NASA Black Marble HD captures Puerto Rico outages, used by partners and major media to keep public informed of local power conditions on neighborhood scales.



Damage proxy maps extended to Dominica using ESA S1 data



NASA Response Tier **0** **1** **Daily Power and Light Analysis w/Black Marble → 0**

Day 1
Sept 18

Day 3
Sept 20

Day 4
Sept 21

Day 5
Sept 22

Day 7
Sept 24

Day 10
Sept 27

Day 13
Sept 30

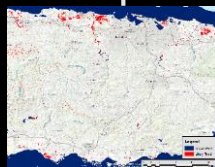
Day 14
Oct 2

Day 15
Oct 3

Continuing from Irma, daily coordination calls and user engagement with partners including FEMA, National Guard, USGS and others



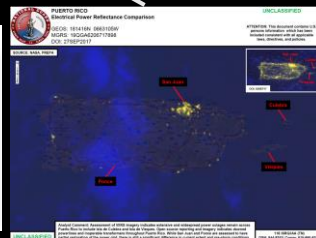
GPM and constellation satellites map Maria, data for NOAA/NHC and NRL



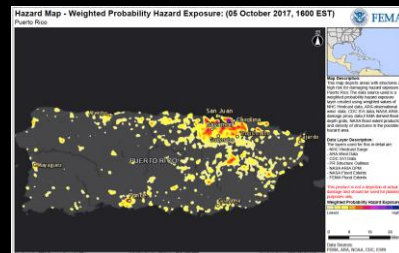
Flood mapping by the NASA team using ESA and Charter SAR and optical assets



Multiple flood-mapped scenes from NASA and commercial partners combined by FEMA to assess flood extent

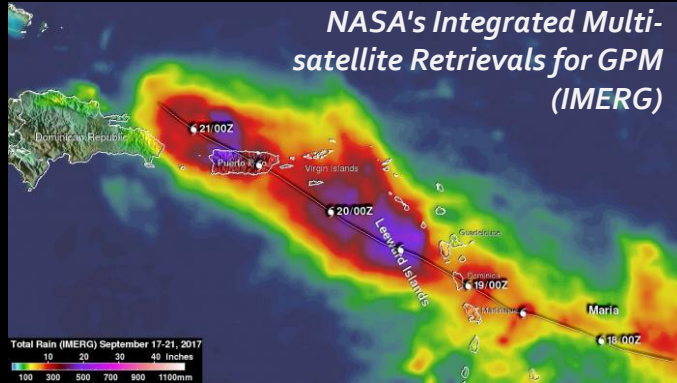


NASA Black Marble by National Guard teams for daily situational awareness.

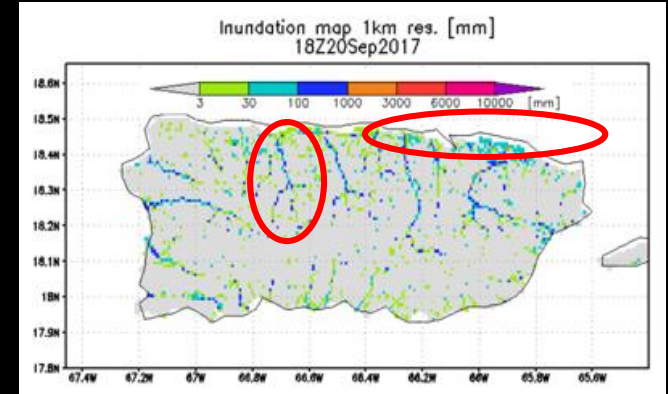
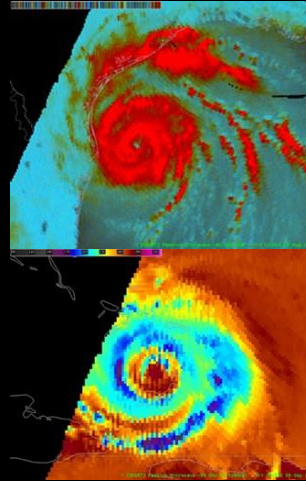


NASA team damage proxy and flood information synthesized with other FEMA data to map impacts

How much rain dropped?



Total Rainfall (IMERG) Sept 17-21, 2017



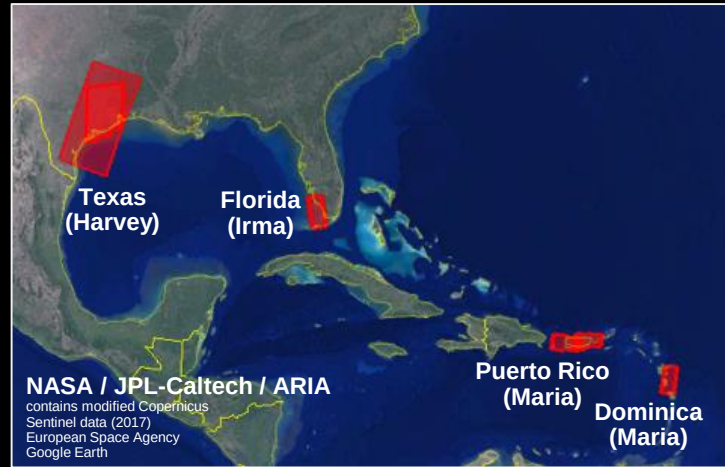
(GFMS) Hurricane Maria Impacts
Sept 20, 2017; 200-400 mm water depth

Estimated > 20 in (512 mm) of rain dropped from September 17 to 21, 2017 across the Leeward Islands, Virgin Islands and Puerto Rico (PR).

Imagery cited and used by the National Hurricane Center during forecasts

International Red Cross and other partners data from the UMD Global Flood Mapping System (GFMS)

So much cloud cover, how to overcome it?

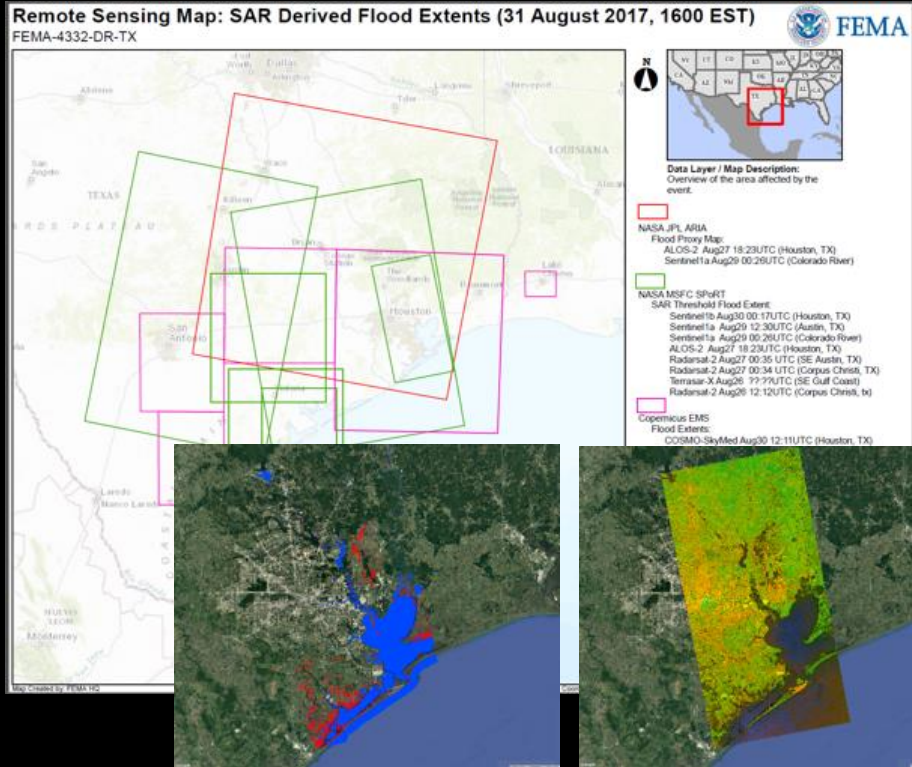


ARIA flood and damage maps for Hurricane Harvey, Irma, and Maria

***Synthetic Aperture Radar** – derived flood and damage proxy maps using JAXA ALOS-2 satellite and Copernicus Sentinel-1 (operated by the European Space Agency) and delivered to FEMA, USGS and NGB.*

FEMA created a damage density map and multiple, other data sources to estimate damage and guide response and recovery activities

What is the flood extent, exposure and potential risk?

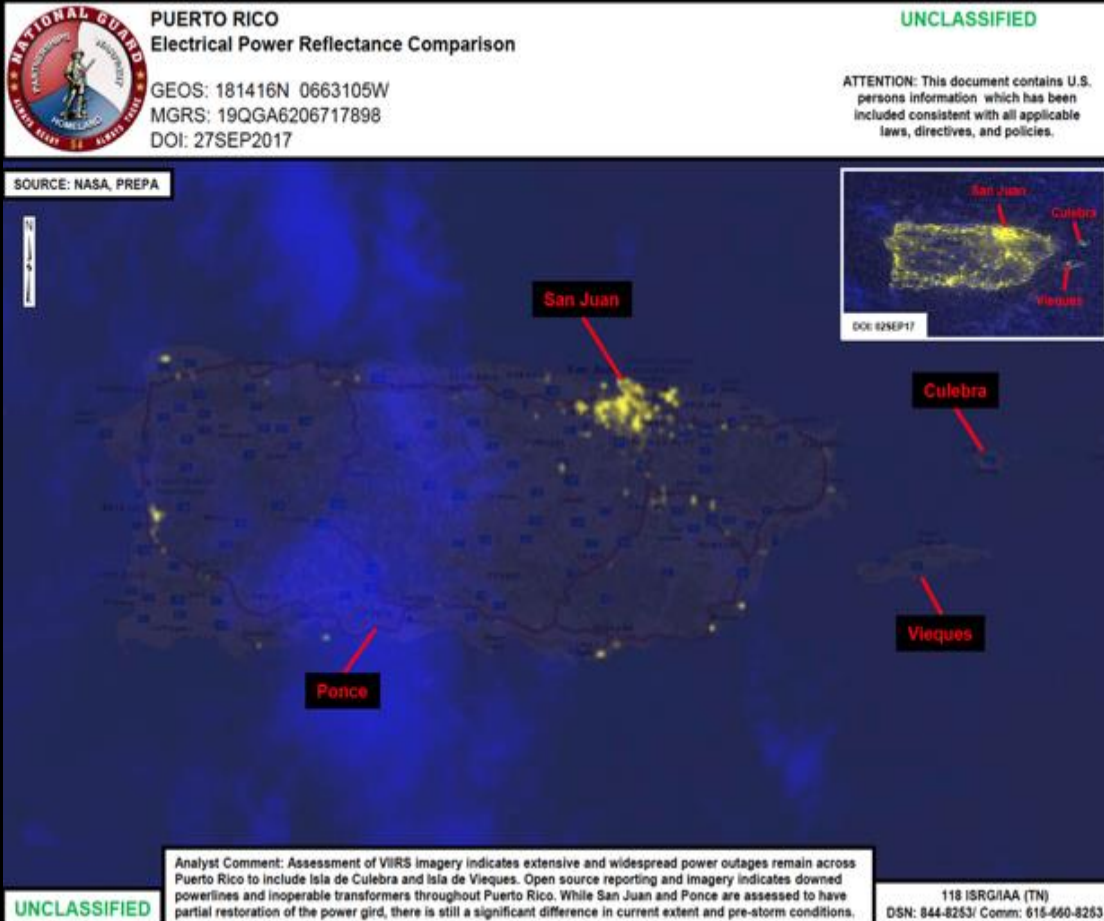


Examples of Copernicus Sentinel 1 (processed by ASF) products used during Hurricane Harvey by end users

NASA and partners utilized data from the *International Charter on Space and Major Disasters* and the *Copernicus/European Space Agency*, while FEMA and private sector partners combined maps with their risk models

Data was shared with affected states and other partners, extending the reach of analysis and decision support

Where is the Electrical Power out in Puerto Rico?



NASA's Black Marble "night vision" imagery with thermal infrared data

*Pre-event (upper right) and post-event (center) nighttime scenes to the US National Guard Bureau team members **assisted in their detailed analysis of power conditions and response activities.***

Partnerships with End Users

FEMA highlights NASA efforts on daily multi-agency conference calls

Partners at FEMA used SAR-based flood analysis to help verify and validate modeling simulations:

- *"We used the Damage Proxy Maps to refine initial impacts of damage and help with targeting of response efforts, and FEMA will work on ground-truth to validate and focus on including this into future production workflows."*

Partners in the National Guard appreciated access to Black Marble products for analyzing nighttime lights:

- *"...The accuracy and quality of the product was upgraded significantly by a updated product recently [received] from NASA."*

Remote Sensing

A separate Remote Sensing Coordination Call is held daily at 3:00 PM ET
Telecon: 800-320-4330, Pin 132118

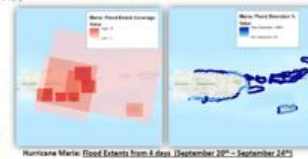
Contact FEMA-Remote-Sensing@fema.dhs.gov for additional information

NASA Support Team

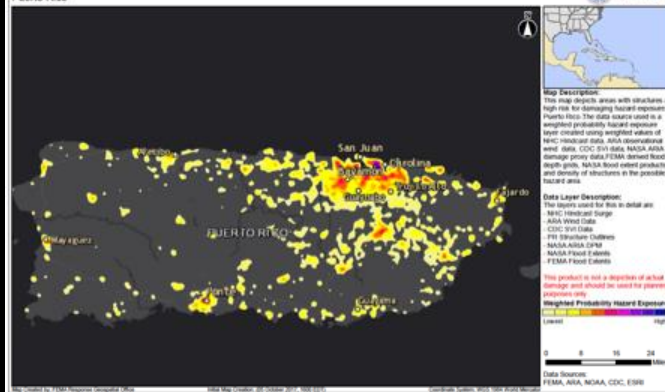
- NASA Short-term Prediction Research and Transition Center (SPoRT)
 - Created water threshold products based on SAR data, VIIRS DNB RGB products, and flood extents
 - Working to process cloud-free scenes of optical data (Data from 9/26 had some breaks in the clouds over western PR)
- NASA Jet Propulsion Lab (JPL) and CalTech: Advanced Rapid Imaging and Analysis Center (ARIA)
 - Provided a damage proxy map to FEMA based on SAR data
 - Hoping to produce an updated damage proxy map (dependent on the availability of additional SAR data)
- NASA Goddard: Creating a downsized 30m DNB product (pre-event for situational awareness) then based on 9/26 data
- Products available at: <https://data.fema.gov/national-disasters/hurricane-maria/data/remote-sensing/>
- NASA RECOVER and FEMA EHP GIS are working to create a webapp for disaster specific decision support and recovery planning
 - Currently working with NASA JPL to see if data can be publicly releasable

FEMA HQ

- Composite products available from 63 different remote sensing-derived flood extents from NASA MSFC SPoRT, Copernicus EMS, MDA Systems and ARIA NASA, JPL/Caltech
- Available as a Map Service (1) and for download (2) at:
 1. <https://data.fema.gov/national-disasters/hurricane-maria/data/remote-sensing/>
 2. <https://data.fema.gov/national-disasters/hurricane-maria/data/remote-sensing/>



Hazard Map - Weighted Probability Hazard Exposure: (05 October 2017, 1600 EST)



Example of NASA JPL/ARIA DPM and NASA flood mapping combined with other FEMA geospatial data to produce internal value-added product used to guide response and recovery efforts including targeting of CAP flights.

For More Information



NASA Earth Science
DISASTERS PROGRAM

NASA Applied Sciences Program | www.nasa.gov

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ORGANIZATION DISASTERS PRODUCTS RESOURCES

Recent Disasters

- Mount Agung Volcano Monitoring 2017
- Typhoon Damrey 2017
- California Wildfires 2017
- Hurricane Maria 2017
- Mexico City Earthquake 2017
- Southern Mexico Earthquake 2017
- Hurricane Irma 2017
- Hurricane Harvey 2017
- Montenegro Wildfires 2017
- Mexico City Earthquake 2017

Agung volcano began displaying heightened volcanic activity on the August 16, 2017. On November 20, 2017, MIRS observed a plume reaching 19 km. Particles were transported to low pressure (low) & high pressure (high) altitudes (both high and low) and the potential for regional impacts is high. Read More

Figure 1 Figure 2

Read More

About the NASA Disasters Program

The Disasters Applications area promotes the use of Earth observations to improve prediction of, preparation for, response to, and recovery from natural and technological disasters. Disaster applications and applied research on natural hazards support emergency preparedness leaders in developing mitigation approaches, such as early warning systems, and providing information and maps to disaster response and recovery teams.

Learn More

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- PACIFIC DISASTER CENTER
- USAID FROM THE AMERICAN PEOPLE

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ORGANIZATION DISASTERS PRODUCTS RESOURCES

California Wildfires 2017

Start Date

October 8, 2017

Overview

Wildfires began burning in numerous counties across the entire state of California on October 8th. These fires have prompted mass evacuations, over 190,000 acres and 1,500 structures have been burned. Key infrastructure is threatened as strong winds continue to fuel the fast moving fires. As many as 18 fires have burned in nine counties, and an estimated 20,000 people have been evacuated.

Disaster Types

Fires

Datasets

MODIS Thermal Anomalies / Hotspots (MODIS) distributed via FIRMS
VIIRS Thermal Anomalies / Hotspots (VIIRS) distributed via FIRMS

US Wildfire Activity Publ...

Find address or place

RECOVER Fire Maps:

- Clear Lake: https://recover2.giscenter.isu.edu/ClearLakeFire_CA/
- Grass Valley: https://recover2.giscenter.isu.edu/GrassValleyFire_CA/
- Mendocino Complex: https://recover2.giscenter.isu.edu/MendocinoComplexFire_CA/
- Adobe: https://recover.giscenter.isu.edu/adobeFire_CA/

Jordan Bell
Response Coordinator

Jordan.r.bell@nasa.gov

Response: <https://disasters.nasa.gov>

Mapping Portal: <https://maps.disasters.nasa.gov>

Program: <https://appliedsciences.nasa.gov/programs/disasters-program>