ESRI FEDERAL GIS CONFERENCE 2019
NASA DISASTERS PROGRAM

Geospatial Solutions Towards Weather & Climate Risk Reduction

David E. Borges, GISP, PMP

NASA Applied Sciences Disasters Program

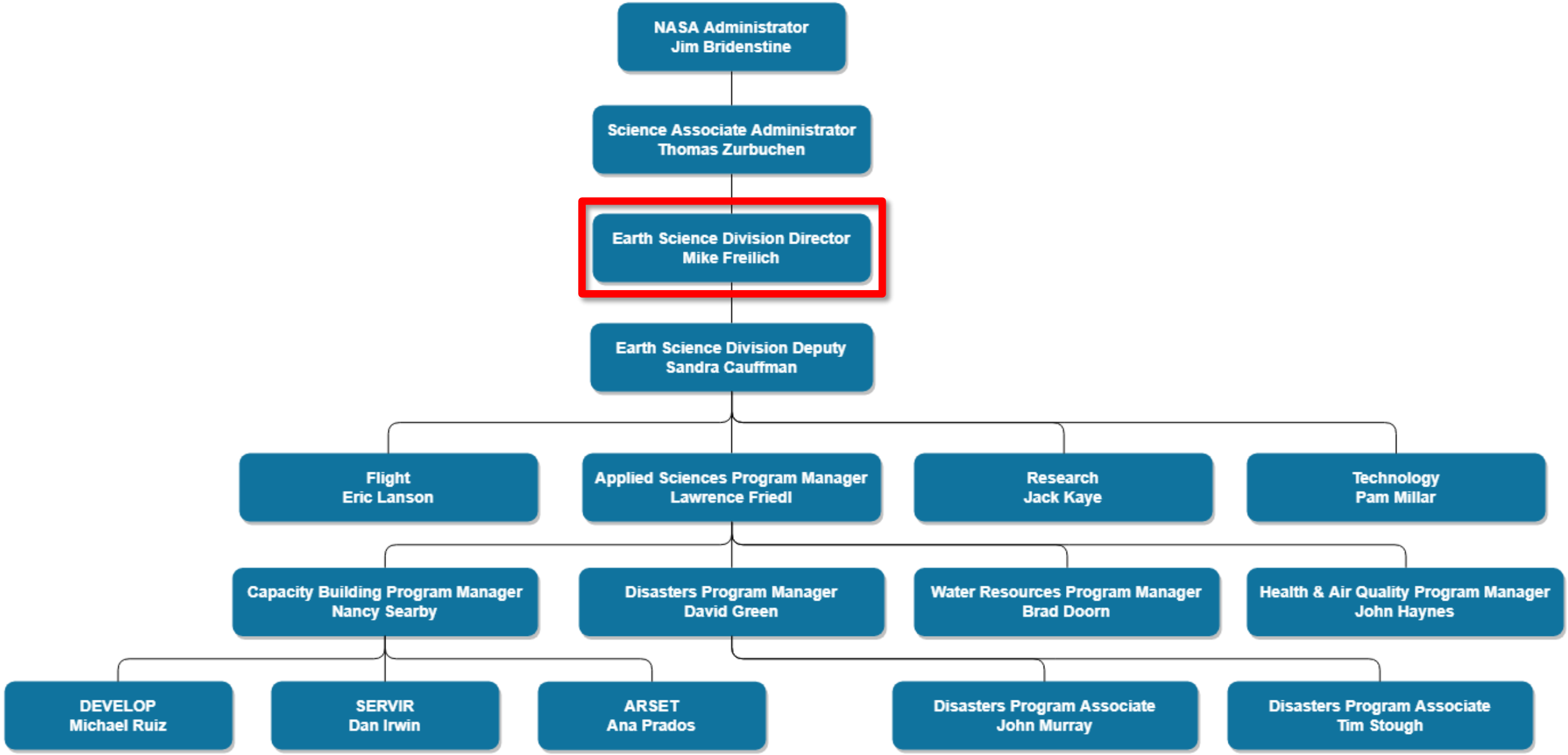
david.borges@nasa.gov

January 2019

NASA MISSION

Drive advances in science, technology, aeronautics, and space exploration to enhance knowledge, education, innovation, economic vitality and **stewardship of Earth.**

NASA Applied Sciences DISASTERS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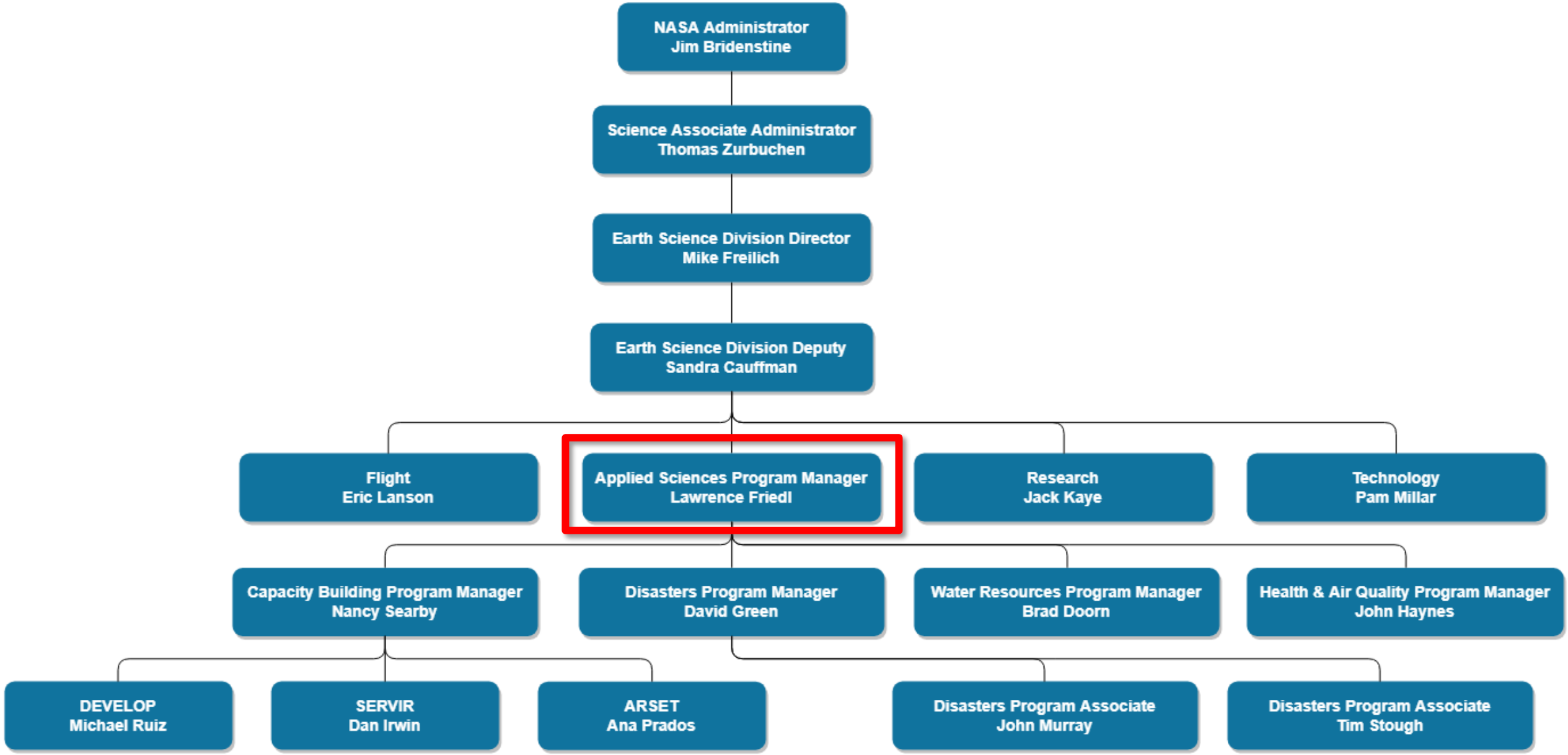
Thomas Zurbuchen
Earth Science Division Director
Mike Freilich
Earth Science Division Deputy
Sandra Cauffman
Flight
Eric Lanson
Applied Sciences Program Manager
Lawrence Friedl
Research
Jack Kaye
Technology
Pam Millar
Capacity Building Program Manager
Nancy Searby
Disasters Program Manager
David Green
Water Resources Program Manager
Brad Doorn
Health & Air Quality Program Manager
John Haynes
DEVELOP
Michael Ruiz
SERVIR
Dan Irwin
ARSET
Ana Prados
Disasters Program Associate
John Murray
Disasters Program Associate
Tim Stough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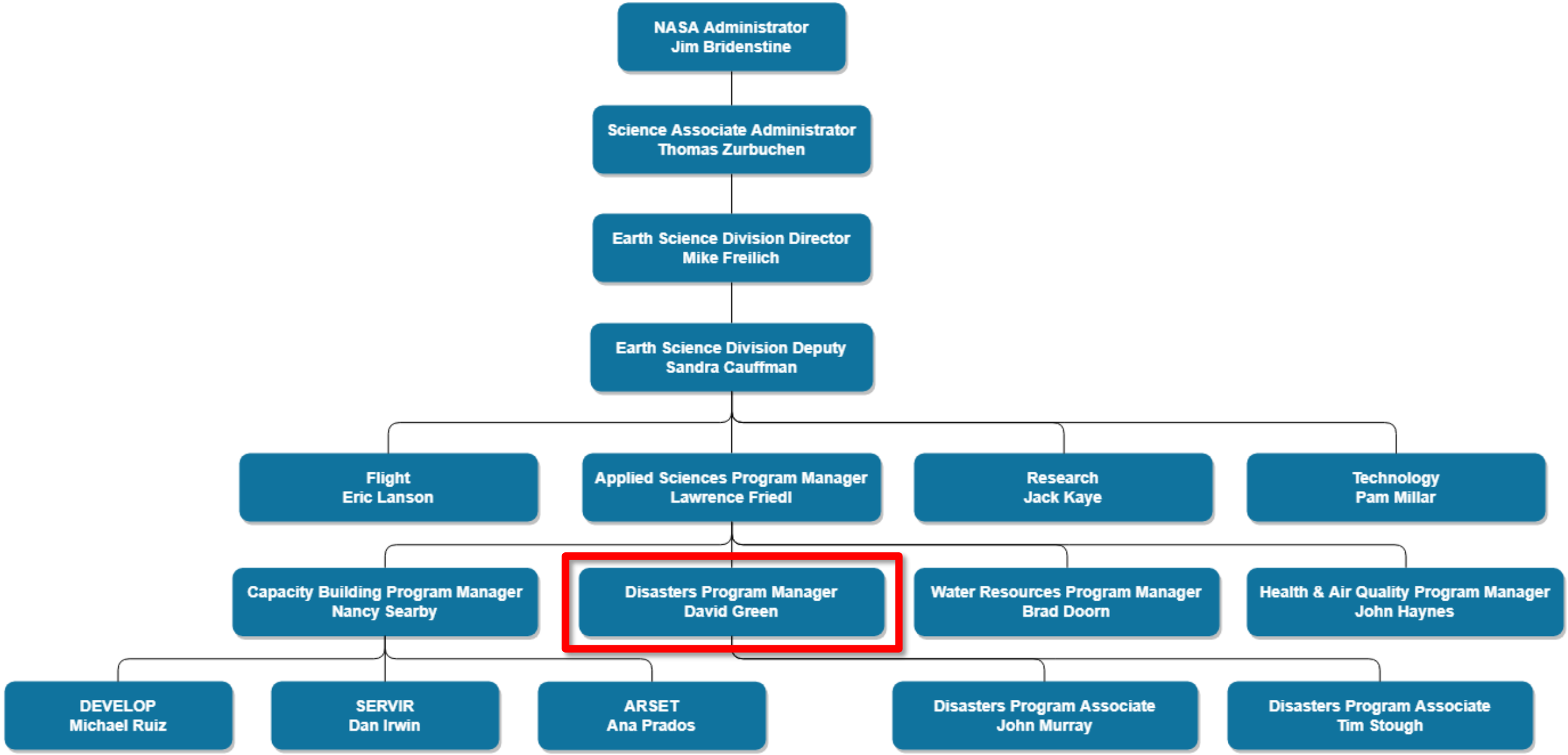
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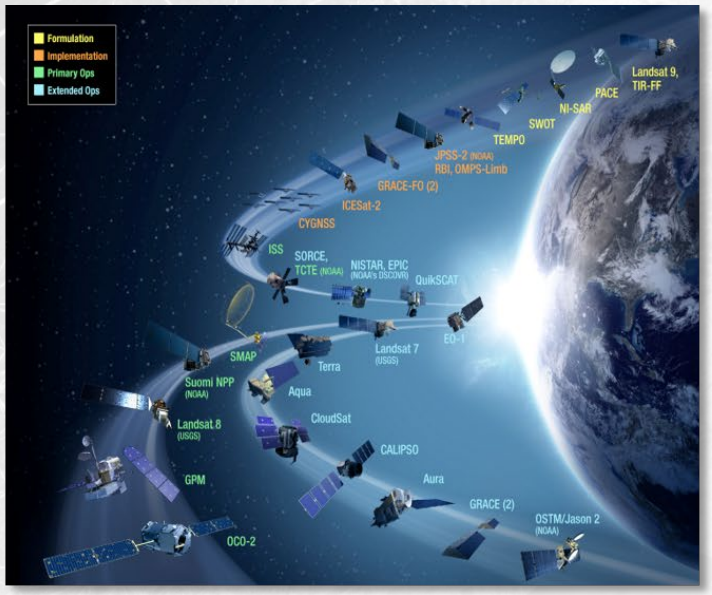
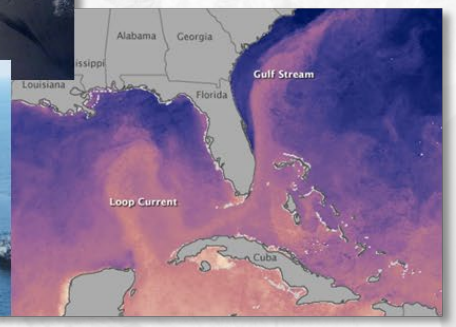
DISASTERS PROGRAM

Disasters Applications promotes the use of Earth observations to improve prediction of, preparation for, response to, and recovery from disaster situations.





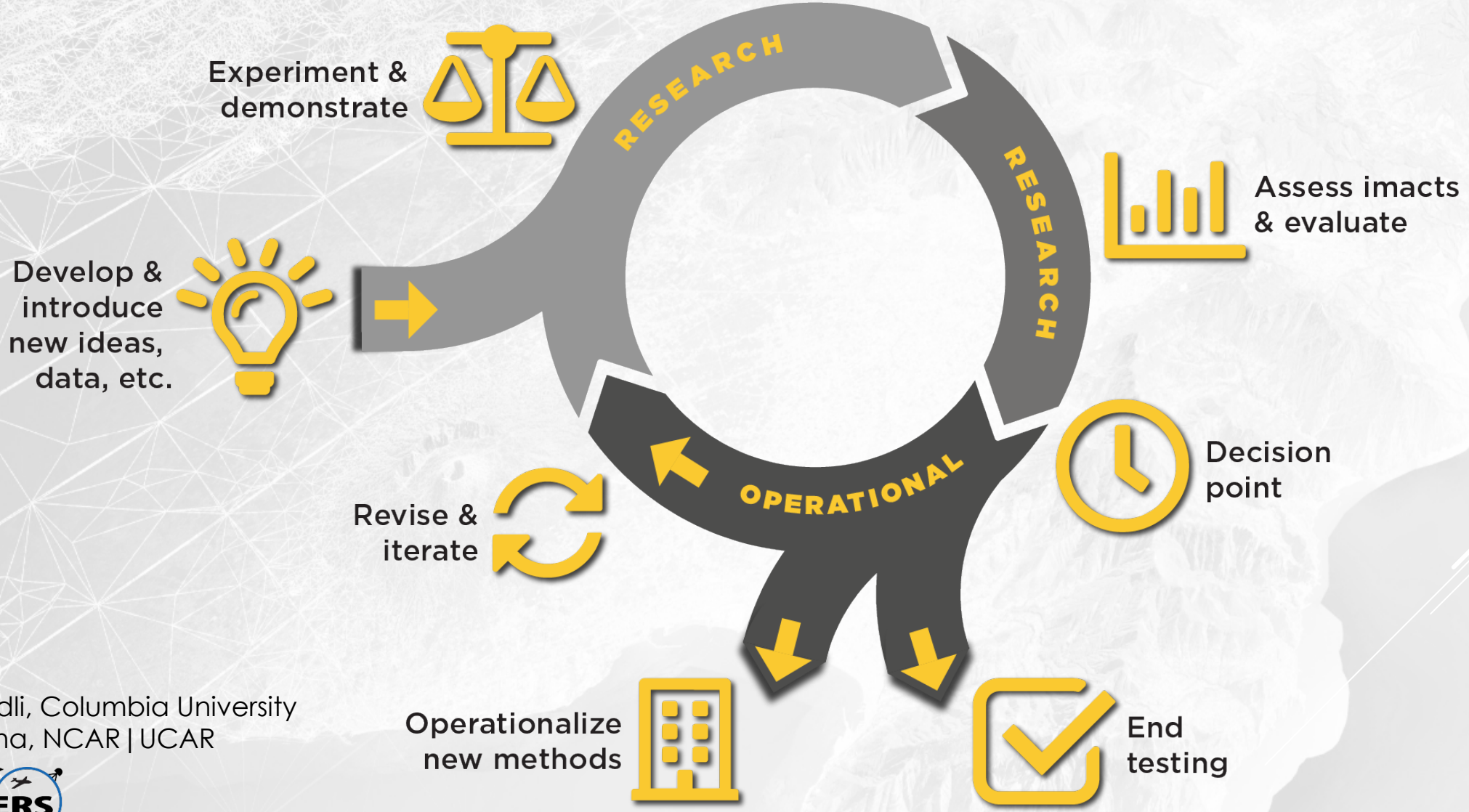
Deepwater Horizon Oil Spill , 2010

Earthquakes ***Volcanoes*** ***Landslides*** ***Floods*** ***Fires*** ***Land Subsidence***

Multi-hazard and Global

NASA Applied Sciences DISASTERS

RESEARCH / OPERATIONAL RELATIONSHIP



Kyle Mandli, Columbia University
Simmi Sinha, NCAR | UCAR

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DISASTERS ARE NOT NATURAL

There is no such thing as a natural disaster only natural hazards.

Disasters often follow natural hazards.

A disaster's severity and cascading impacts depends on how much impact a hazard has on society and the environment.

The scale of the impact in turn depends on the choices we make for our lives and for our environment.

Each decision and action makes us more vulnerable to disasters or more resilient to them.

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NASA

DISASTERS PROGRAM SCOPE

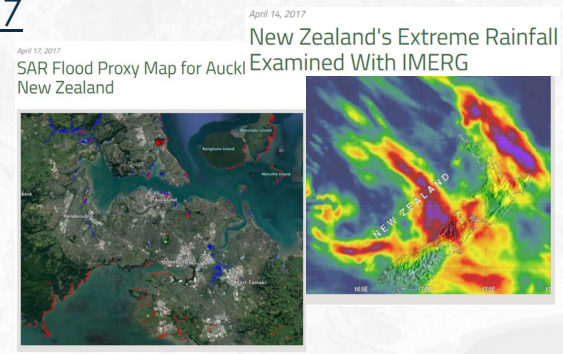
Monitoring and Observing Local, Regional and Global

Transforming data to information to tools

Disaster Risk Reduction and Resilience through strategic information sharing with critical decision-making end users

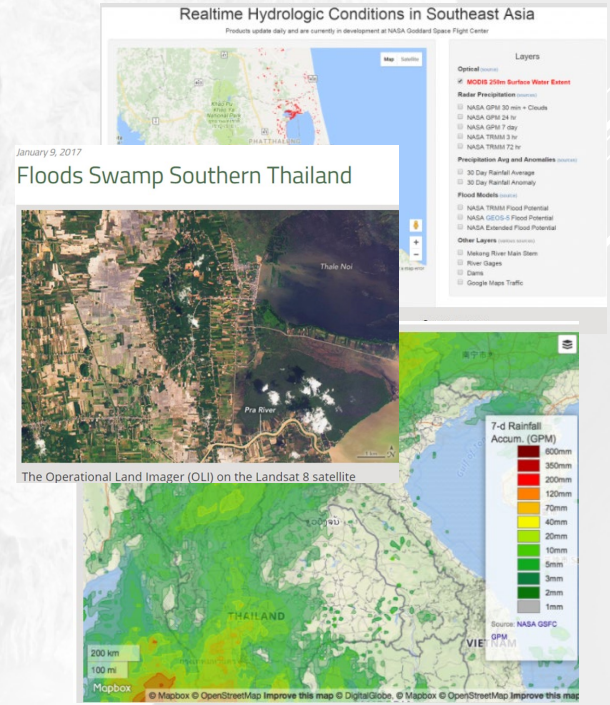
New Zealand Flooding 2017

https://disasters.nasa.gov/new-zealand-flooding-2017



Thailand Flooding 2017

https://disasters.nasa.gov/thailand-flooding-2017



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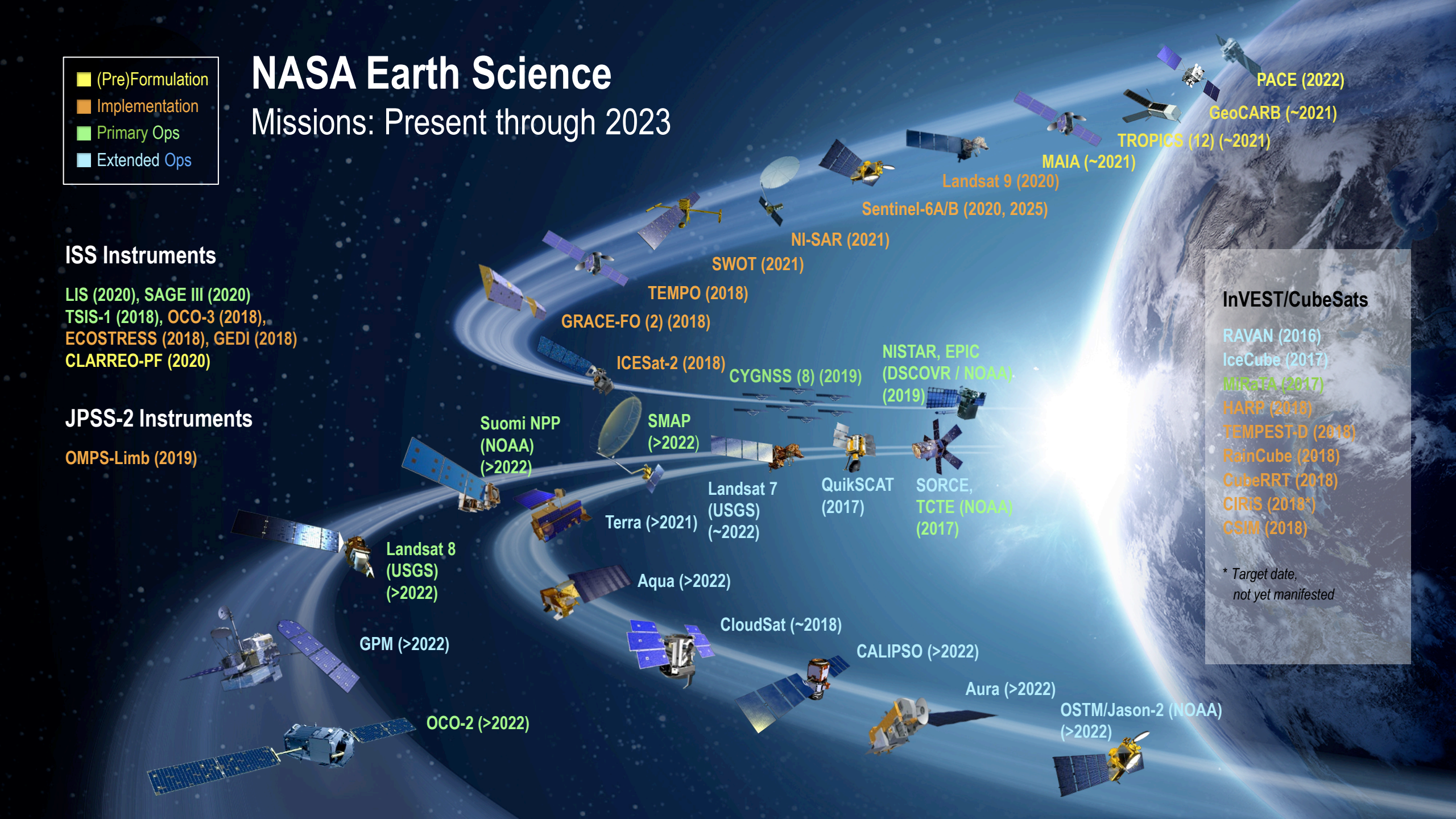
(Pre)Formulation
Implementation
Primary Ops
Extended Ops
NASA Earth Science
Missions: Present through 2023
ISS Instruments
LIS (2020), SAGE III (2020)
TSIS-1 (2018), OCO-3 (2018),
ECOSTRESS (2018), GEDI (2018)
CLARREO-PF (2020)
JPSS-2 Instruments
OMPS-Limb (2019)
PACE (2022)
GeoCARB (~2021)
TROPICS (12) (~2021)
MAIA (~2021)
Landsat 9 (2020)
Sentinel-6A/B (2020, 2025)
NI-SAR (2021)
SWOT (2021)
TEMPO (2018)
GRACE-FO (2) (2018)
ICESat-2 (2018)
CYGNSS (8) (2019)
NISTAR, EPIC
(DSCOVR / NOAA)
(2019)
Suomi NPP
(NOAA)
(>2022)
SMAP
(>2022)
Landsat 7
(USGS)
(~2022)
QuikSCAT
(2017)
SORCE,
TCTE (NOAA)
(2017)
Terra (>2021)
Landsat 8
(USGS)
(>2022)
Aqua (>2022)
CloudSat (~2018)
CALIPSO (>2022)
Aura (>2022)
OSTM/Jason-2 (NOAA)
(>2022)
GPM (>2022)
OCO-2 (>2022)
InVEST/CubeSats
RAVAN (2016)
IceCube (2017)
MiRaTA (2017)
HARP (2018)
TEMPEST-D (2018)
RainCube (2018)
CubeRRT (2018)
CIRiS (2018*)
CSIM (2018)
* Target date,
not yet manifested

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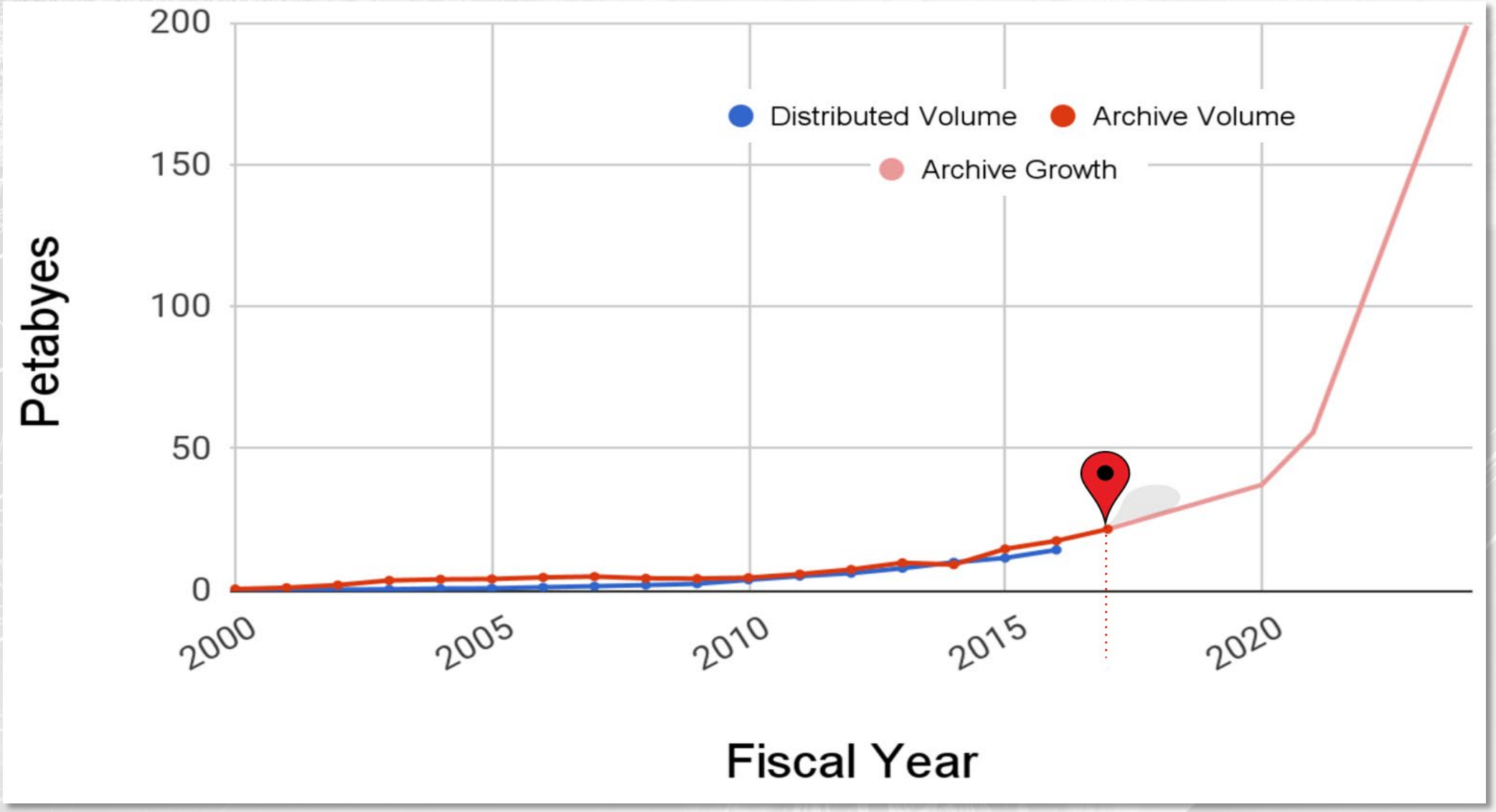
disasters.nasa.gov

NASA

IS THERE A PROBLEM?



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Kevin Murphy, ESDS, NASA

NASA

GEOSPATIAL ENABLEMENT

Turning [big] data into targeted, impactful, decision-making quality information.

Providing this information to the right people, in the right format.

In a temporally relevant manner.

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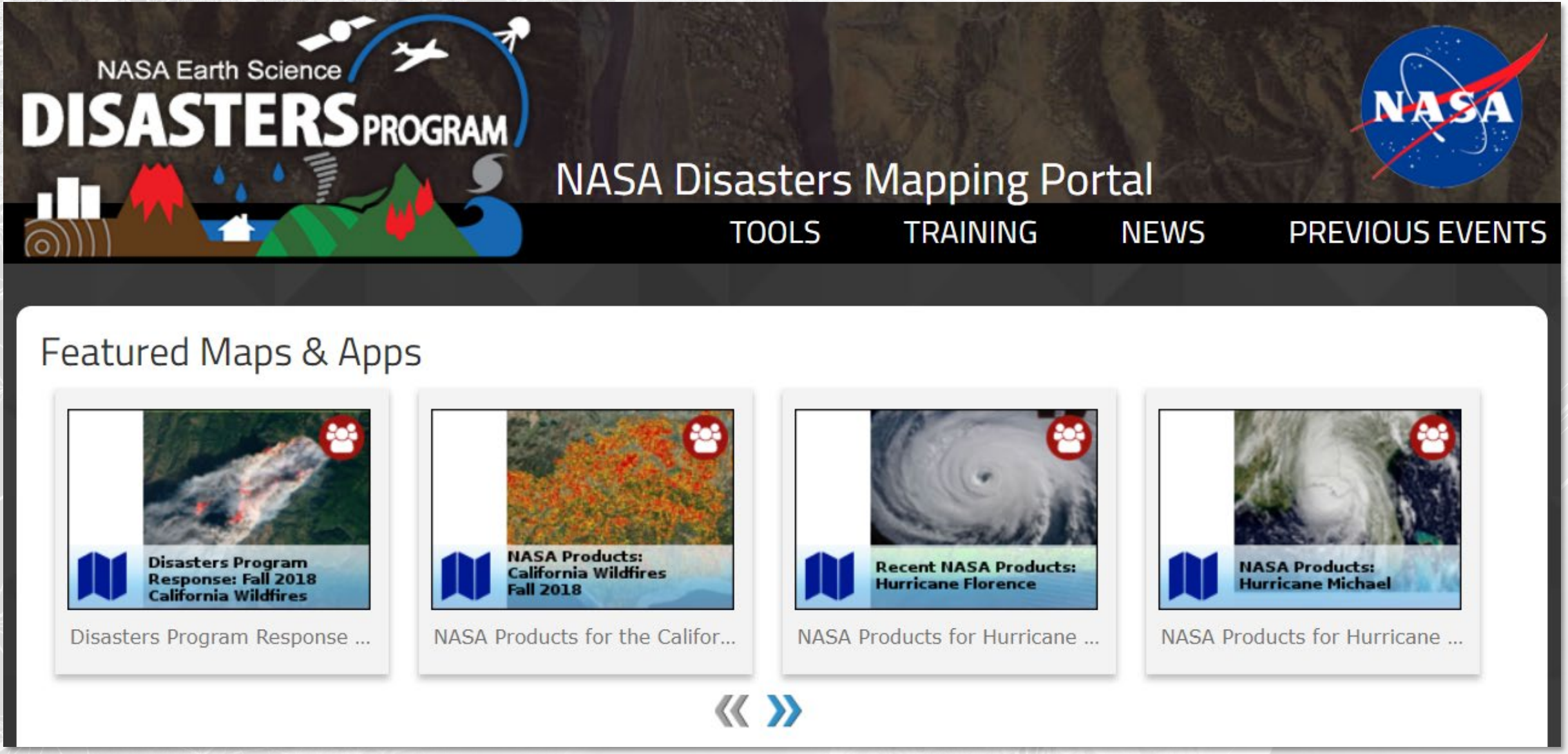
NASA



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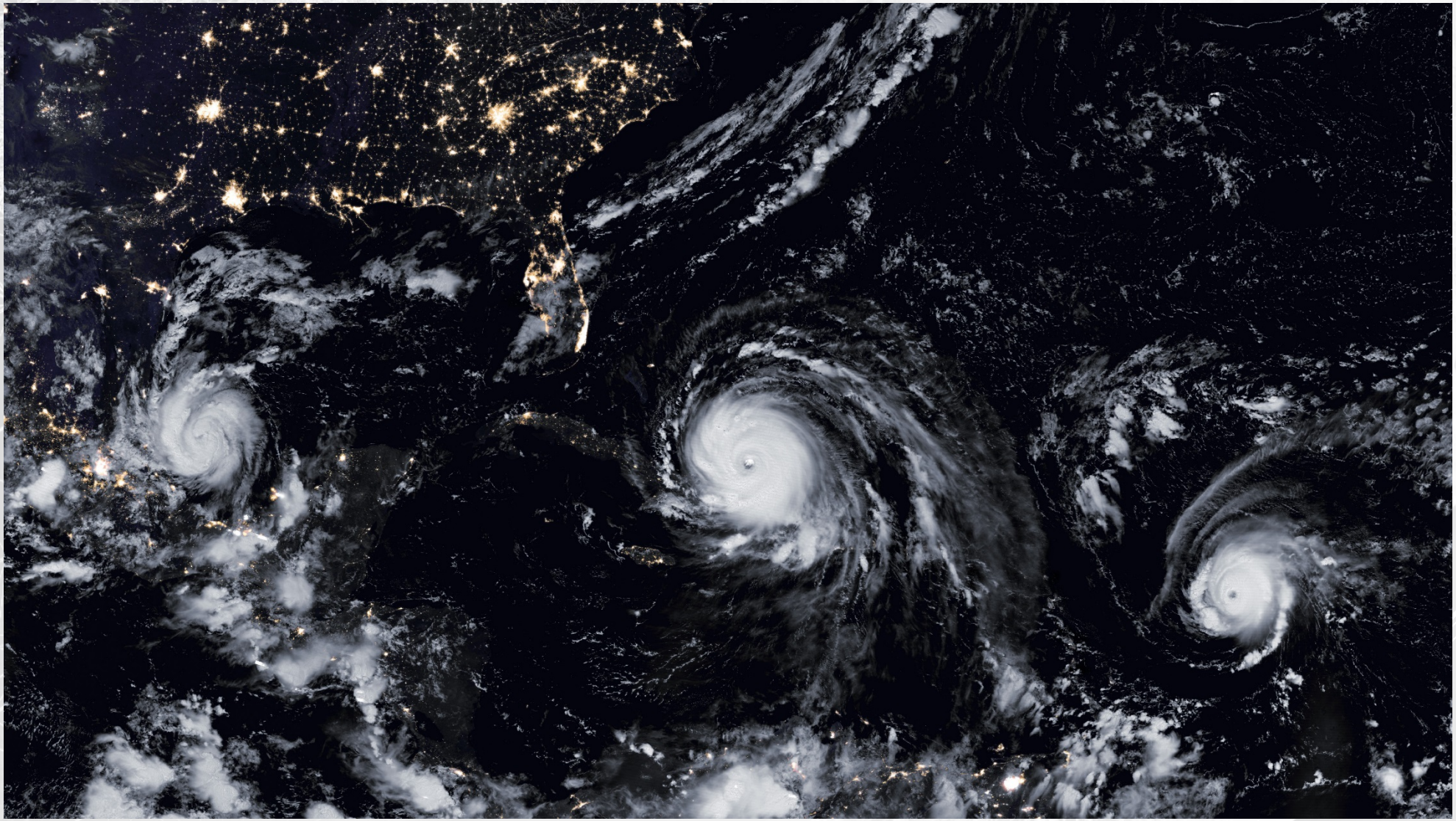
maps.disasters.nasa.gov

NASA

ENSURING AWARENESS & IDENTIFYING IMPACT



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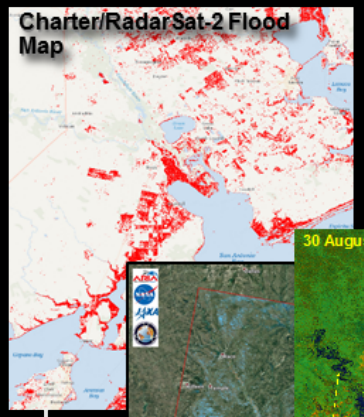
Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi NPP satellite captured the data for a mosaic of Katia, Irma, and Jose as they appeared in the early hours of September 8, 2017.

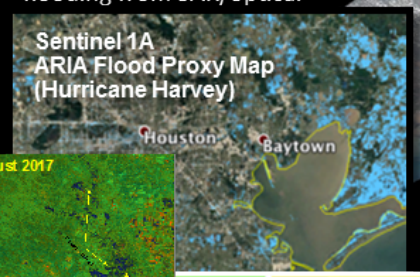
NASA

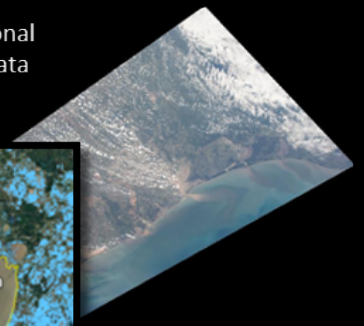
HURRICANE HARVEY – EVENT RESPONSE TIMELINE (AUG-SEPT 2017)

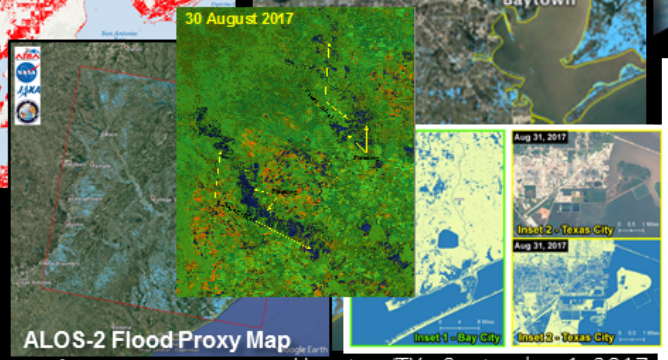
Forecasts for Harvey identify impacts to U.S. mainland, NASA team activates for coordination calls, product generation, and end-user engagement



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

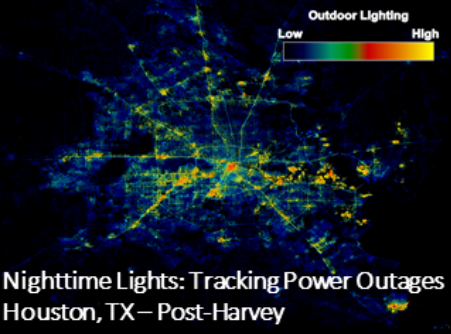






Modeling disaster impacts, insured losses, in Houston metro

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

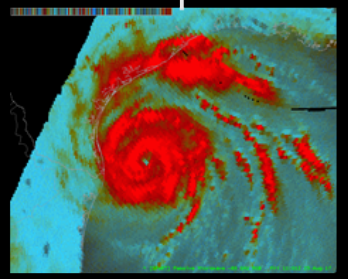


Nighttime Lights: Tracking Power Outages Houston, TX – Post-Harvey

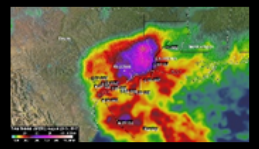
NASA Response Tier 0 | 1 | [Numerous Flood Maps from NASA Teams → | 2 | 1 | 0

Day 1 August 23 | Day 4 August 27 | Day 6 August 27 | Day 7 August 28 | Day 9 August 30 | Day 10 August 31 | Day 11 September 1 | ←UAVSAR Flights→ | Day 11 September 4 | Day 19 September 9

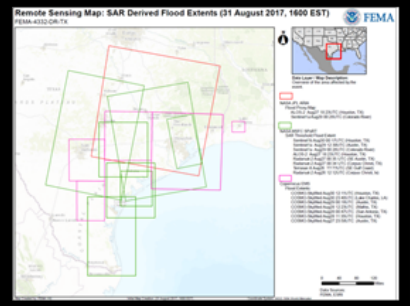
Daily calls begin to coordinate NASA team in generation of products, engagement of funded PIs, and coordination with federal end user partners including FEMA, USGS, National Guard, and others.



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



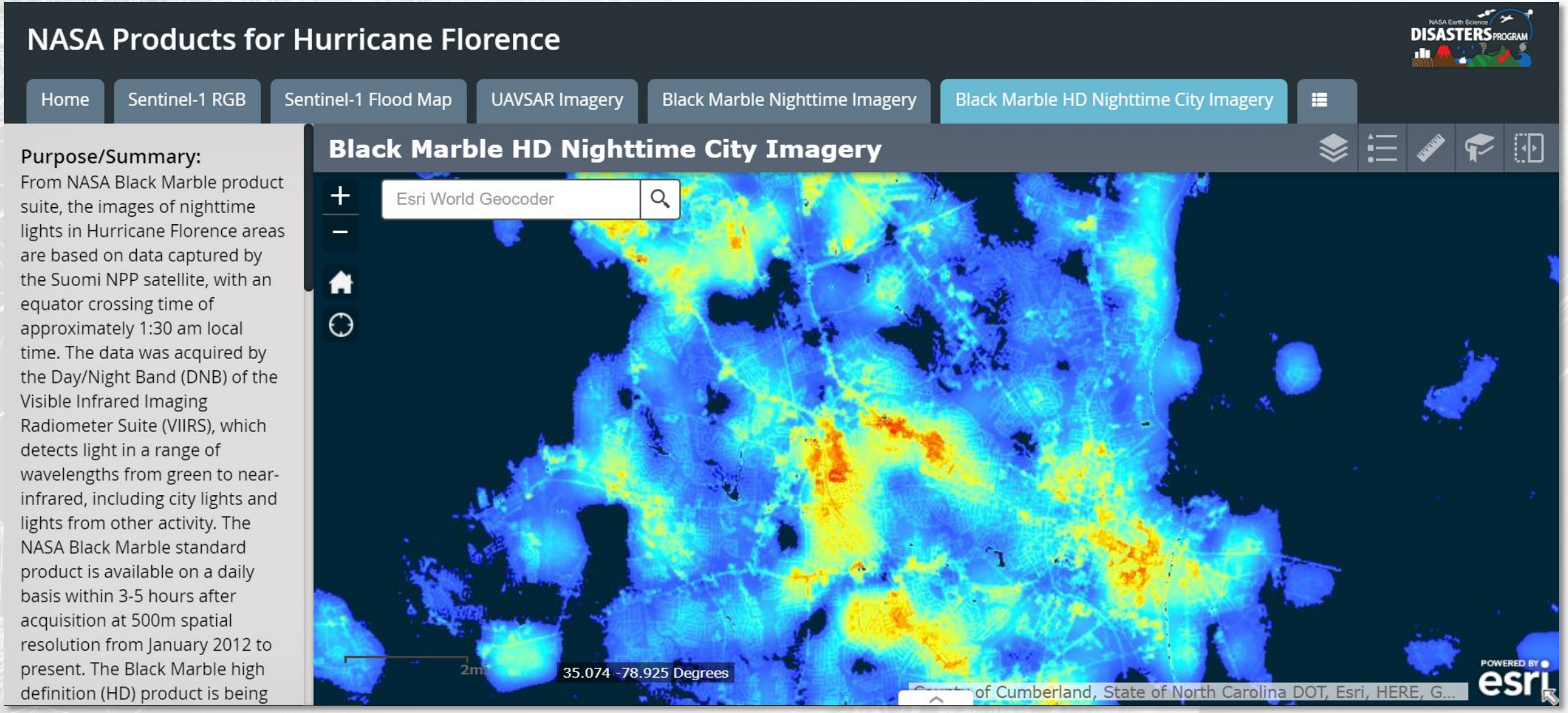
GPM maps the record-setting rainfall in SE Texas from Harvey



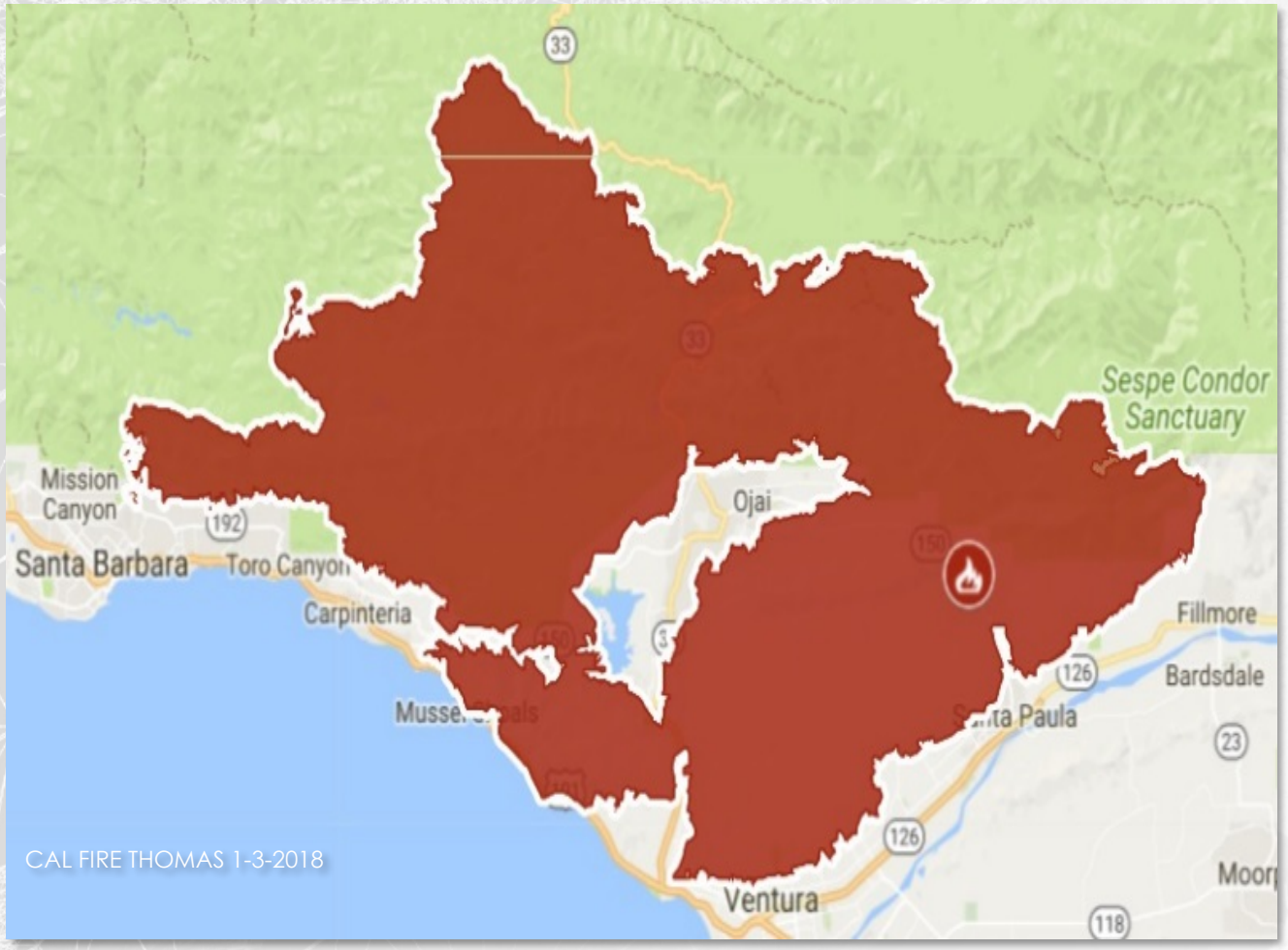
NASA team collaborations provide ***over a dozen*** detailed flood maps from SAR used by FEMA's geospatial team

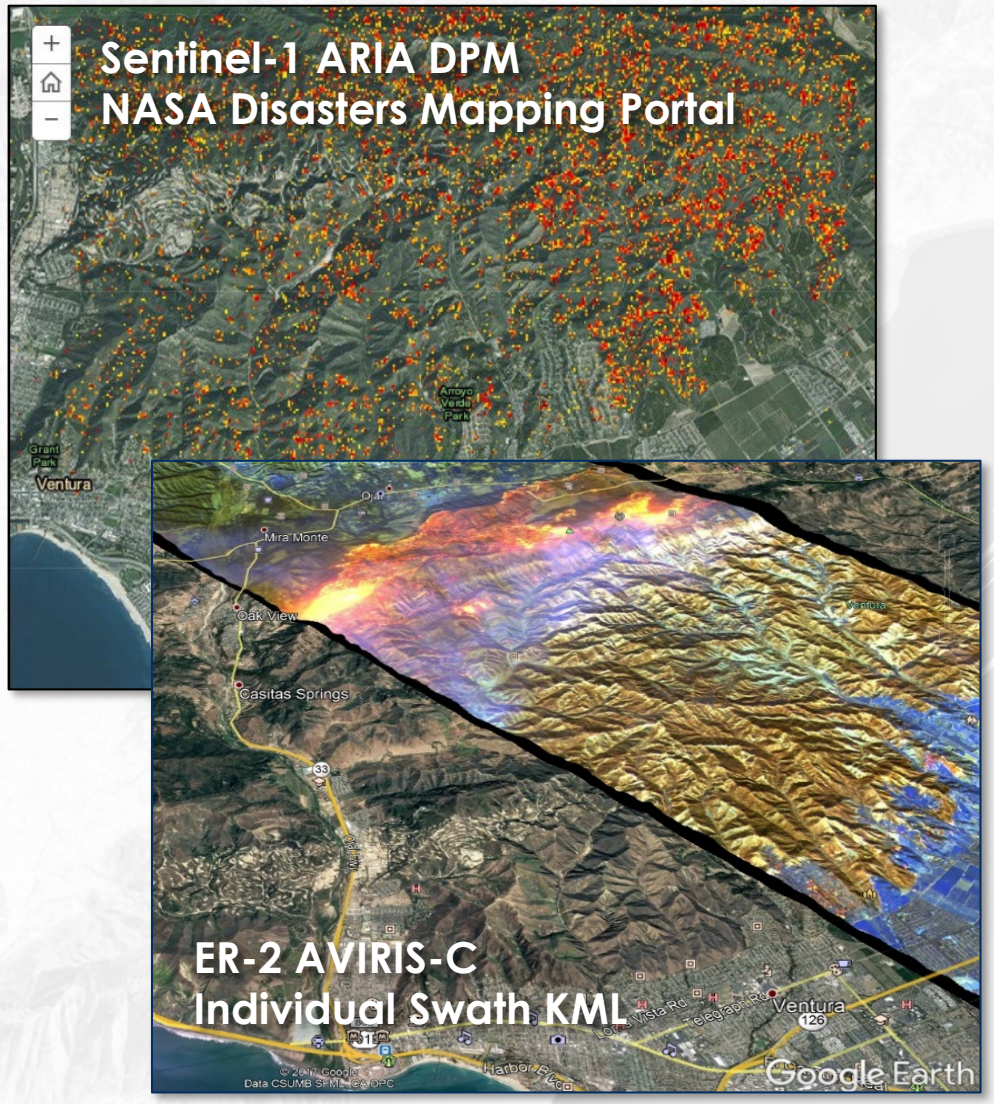
NASA provides daily flights of UAVSAR from September 1-4 to rapidly map evolving flood impacts

HURRICANE FLORENCE RESPONSE



CALIFORNIA WILDFIRES 2017





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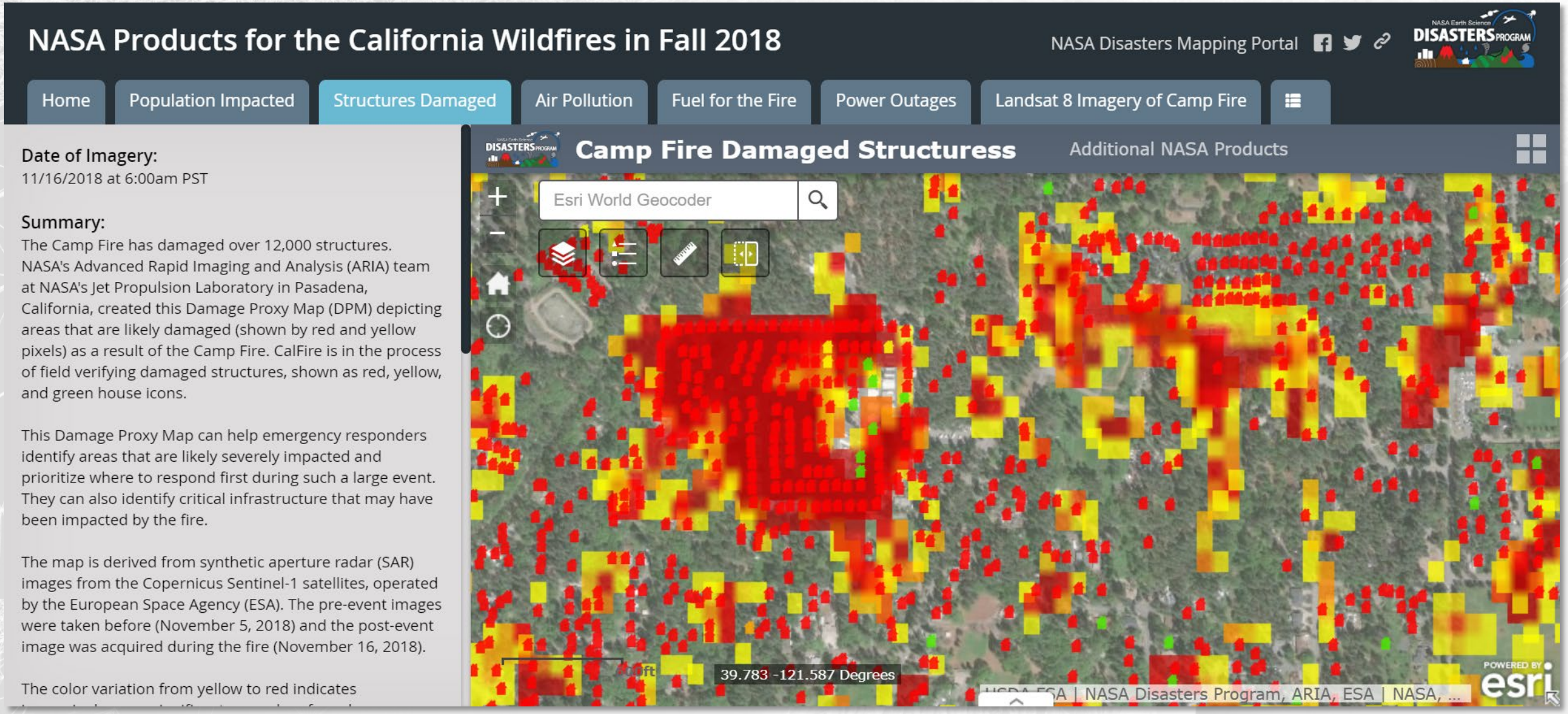
CALIFORNIA WILDFIRES 2018



Montecito Debris Flows Observed with UAVSAR

Image Pair

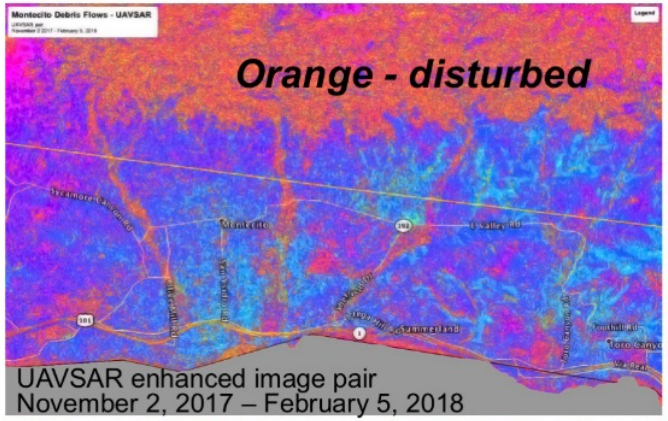
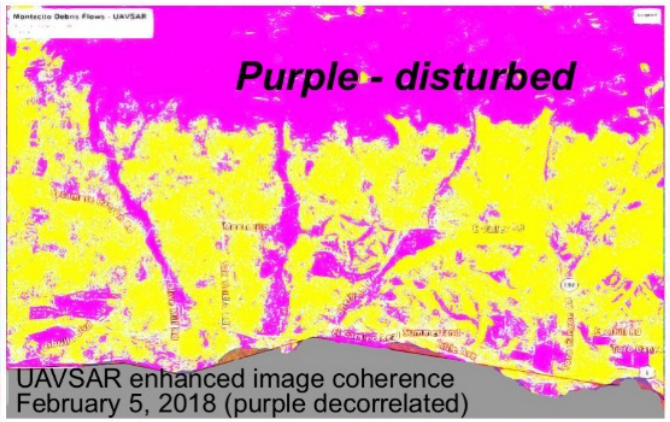
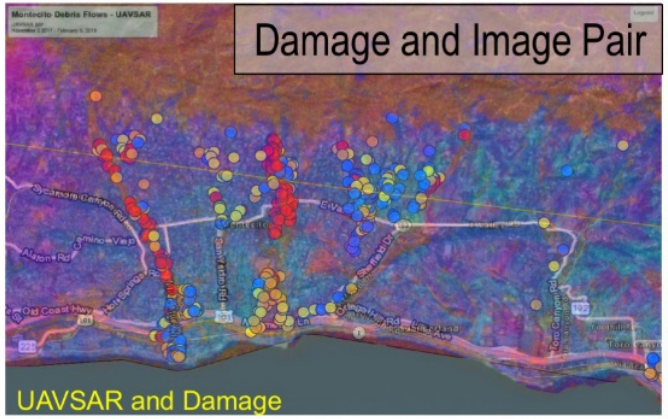
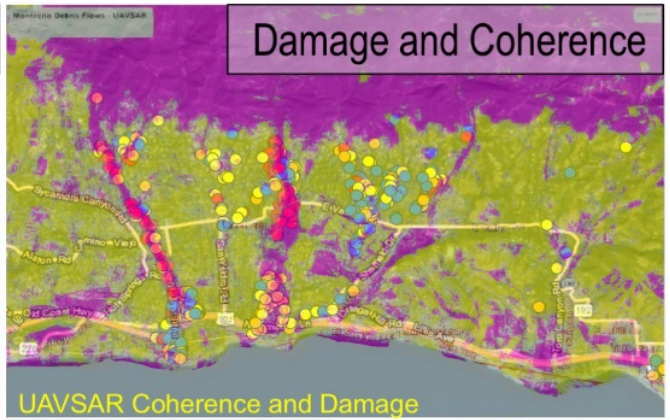
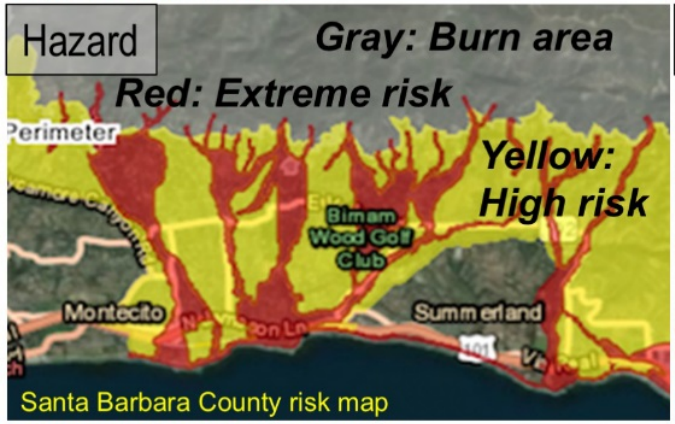


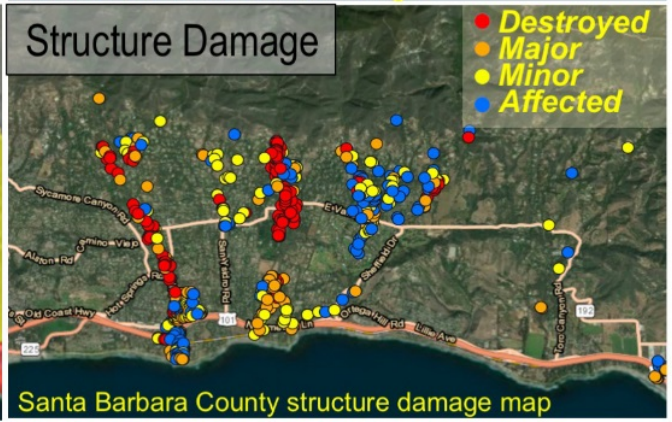
Image Coherence











Produced February 9, 2018

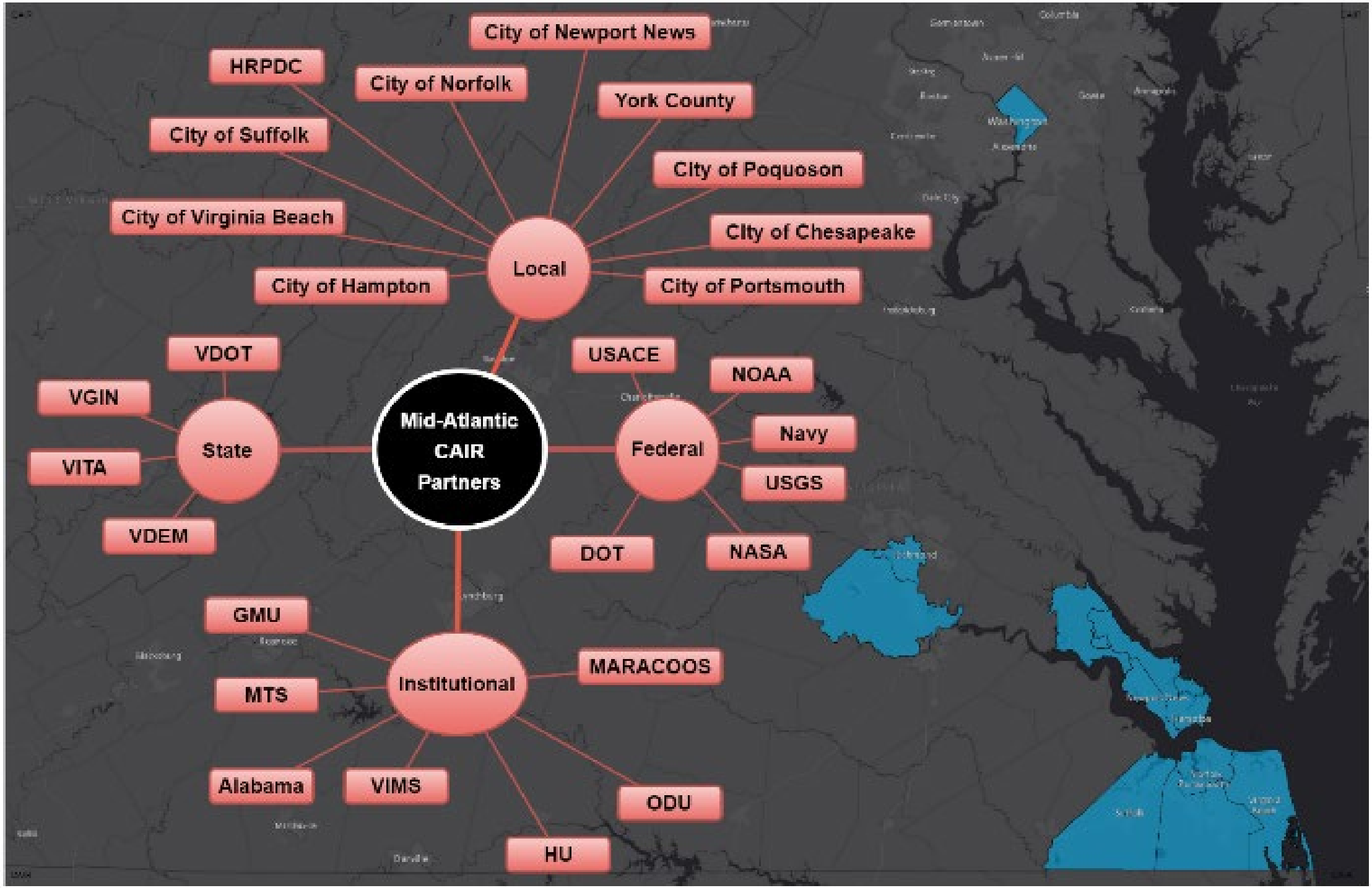
Andrea Donnellan, Principal Investigator, NASA/JPL/Caltech

CALIFORNIA DEBRIS FLOWS JAN 2018

MID-ATLANTIC COMMUNITIES AND AREAS AT INTENSIVE RISK DEMONSTRATION (CAIR)

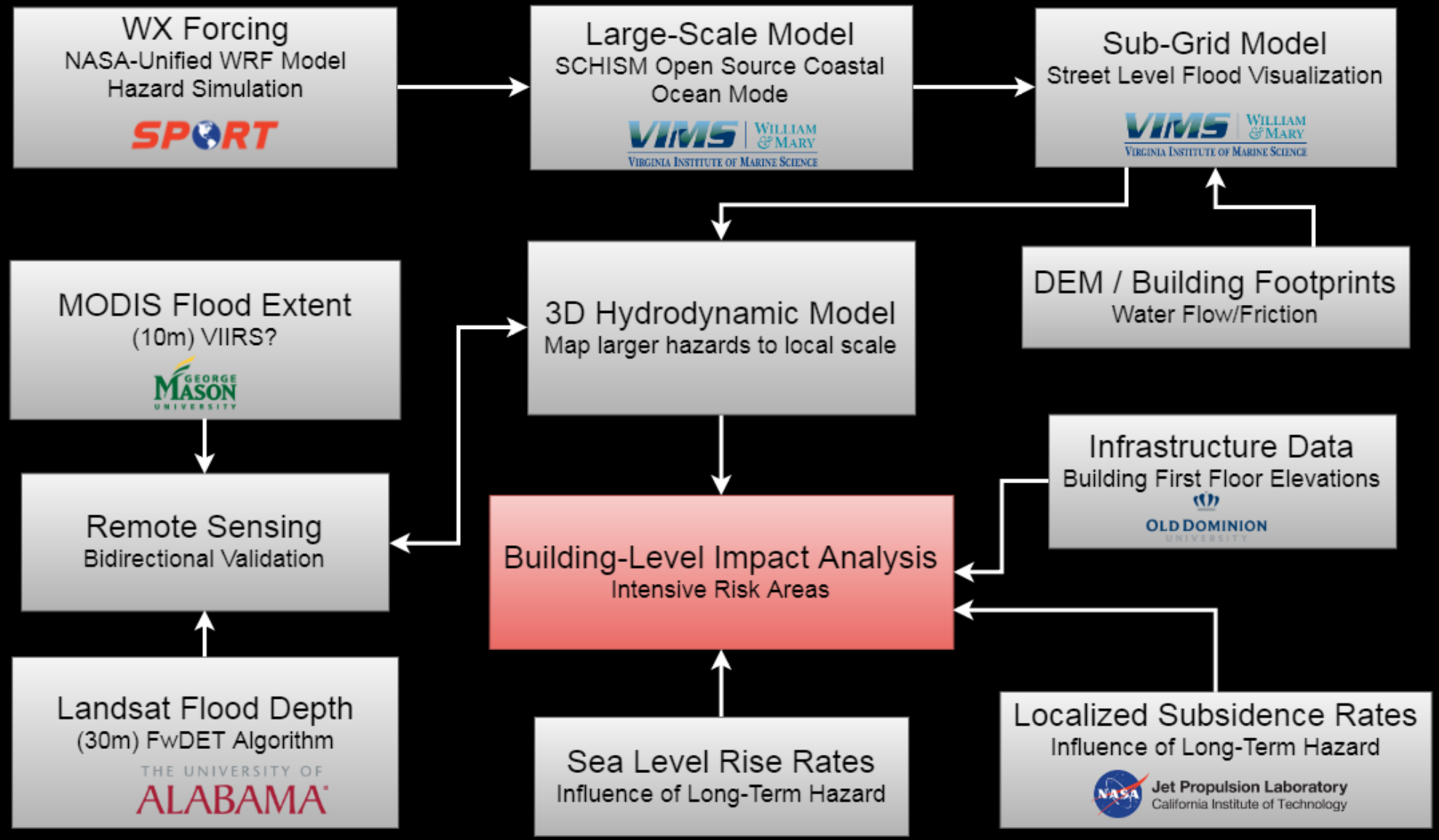
Virginian Pilot

- The mid-Atlantic CAIR project demonstrates the ability to integrate satellite derived earth observations and physical models into actionable, trusted knowledge.


Mid-Atlantic CAIR Partners
Local
City of Newport News
HRPDC
City of Norfolk
York County
City of Suffolk
City of Poquoson
City of Virginia Beach
City of Chesapeake
City of Hampton
City of Portsmouth
State
VDOT
VGIN
VITA
VDEM
Federal
USACE
NOAA
Navy
USGS
DOT
NASA
Institutional
GMU
MARACOOS
MTS
Alabama
VIMS
ODU
HU

NASA Disasters Program
Communities and Areas at Intensive Risk (CAIR)

Mid-Atlantic Demonstration Schematic



COMMUNITIES & AREAS AT INTENSIVE RISK (CAIR)

Mid-Atlantic Project

Sea Level Rise Projections

Virginia Institute of Marine Science

2018 SLR Report Cards – VA / NC

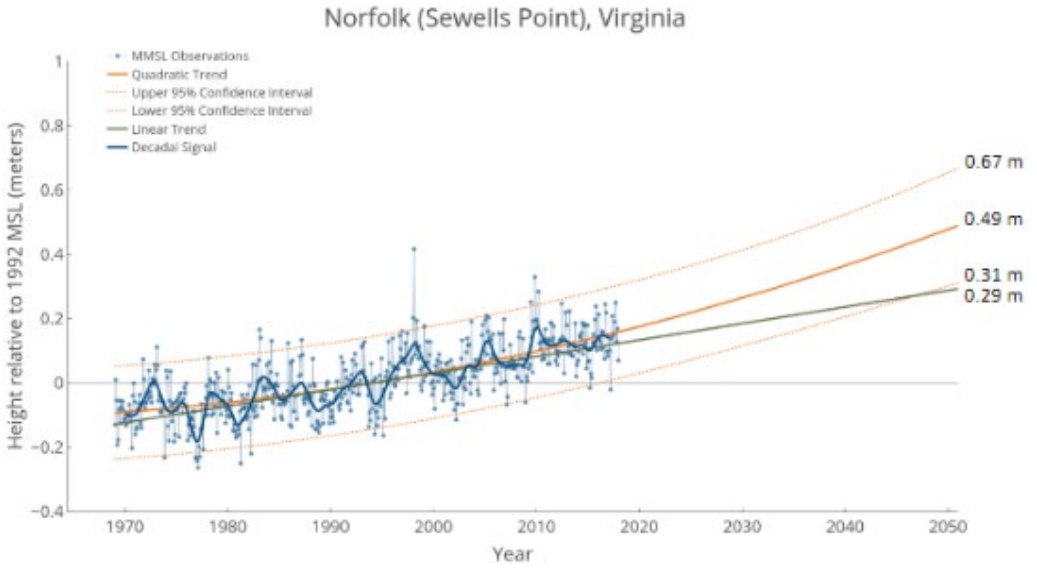


Figure IV-3. Plot of 1969-2017 MMSL, decadal signal, linear and quadratic trends, Norfolk, Virginia.

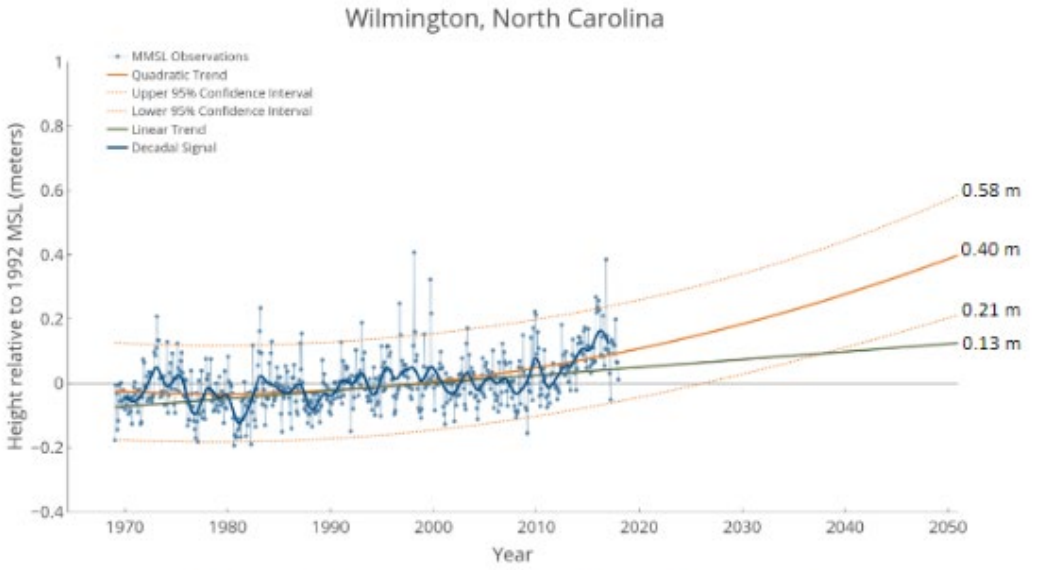


Figure IV-4. Plot of 1969-2017 MMSL, decadal signal, linear and quadratic trends, Wilmington, North Carolina.

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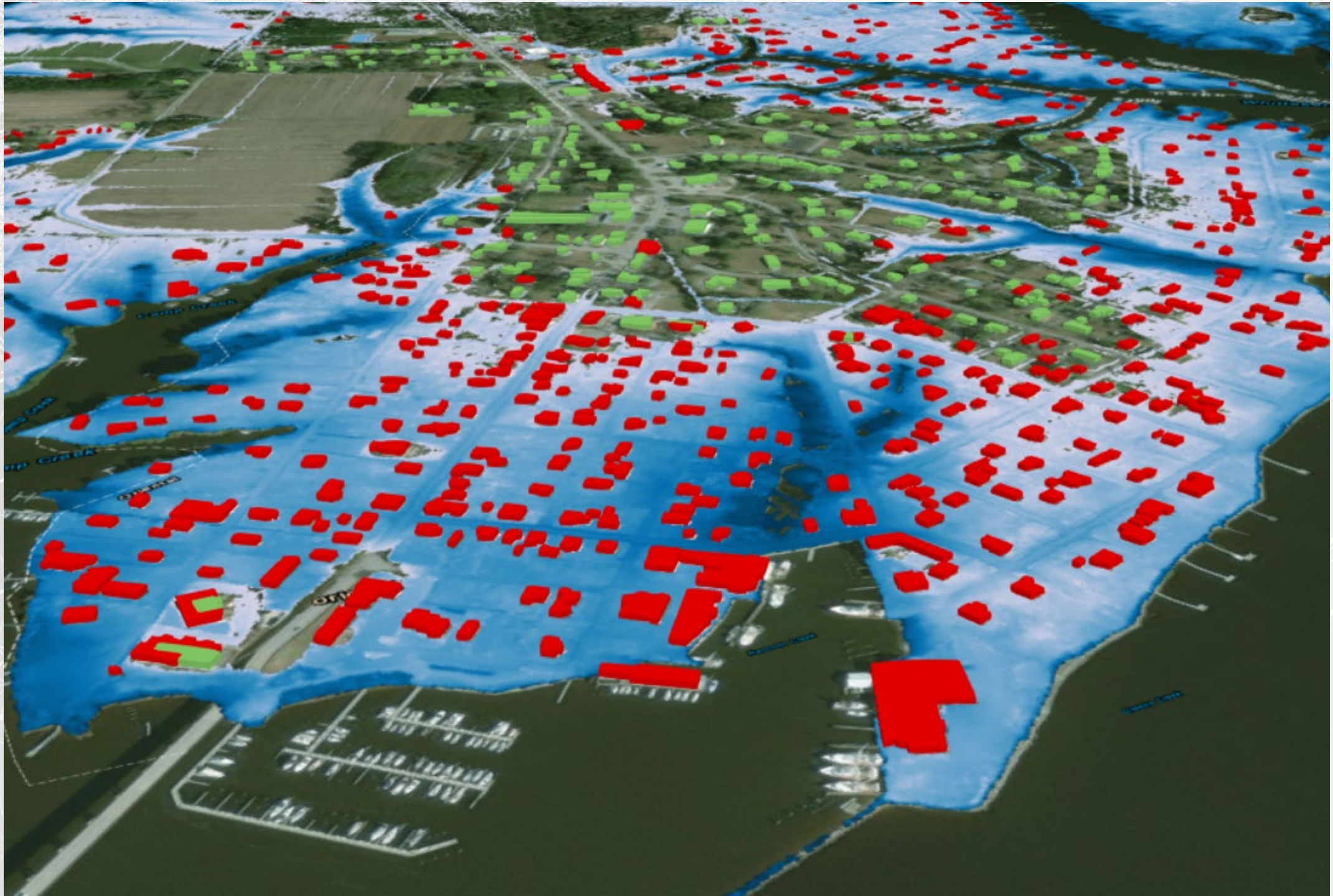
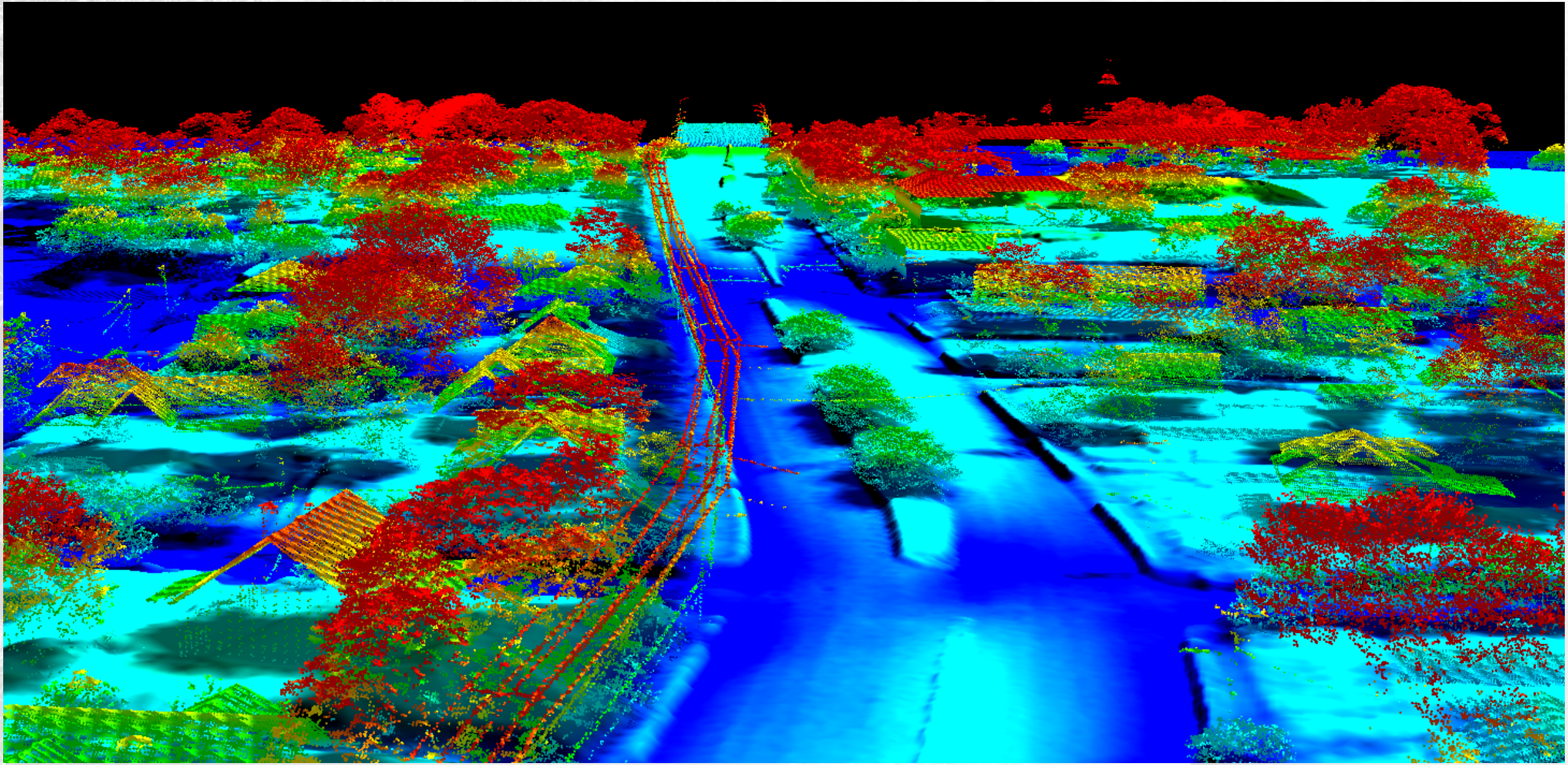
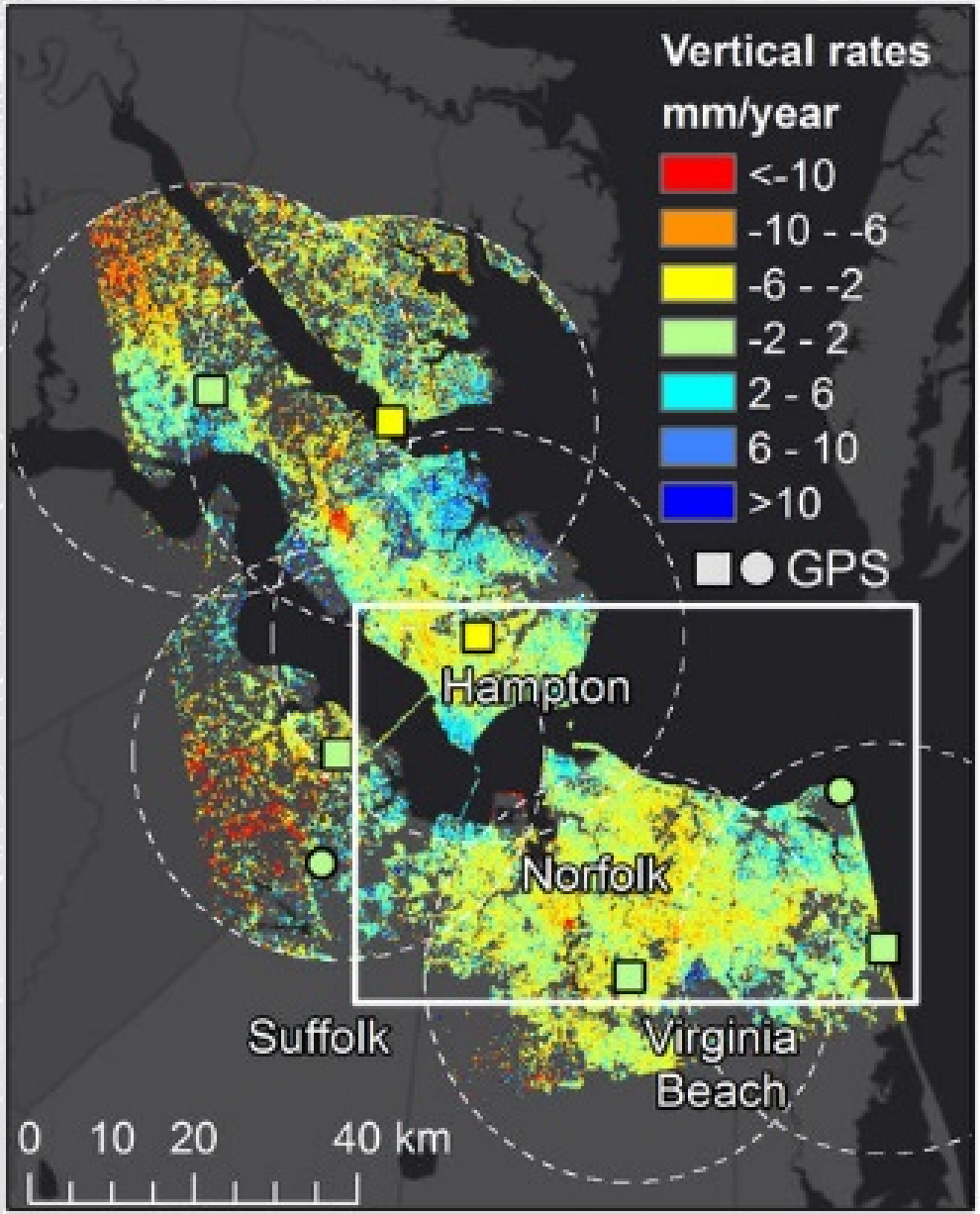
Virginia Institute of Marine Science (VIMS)

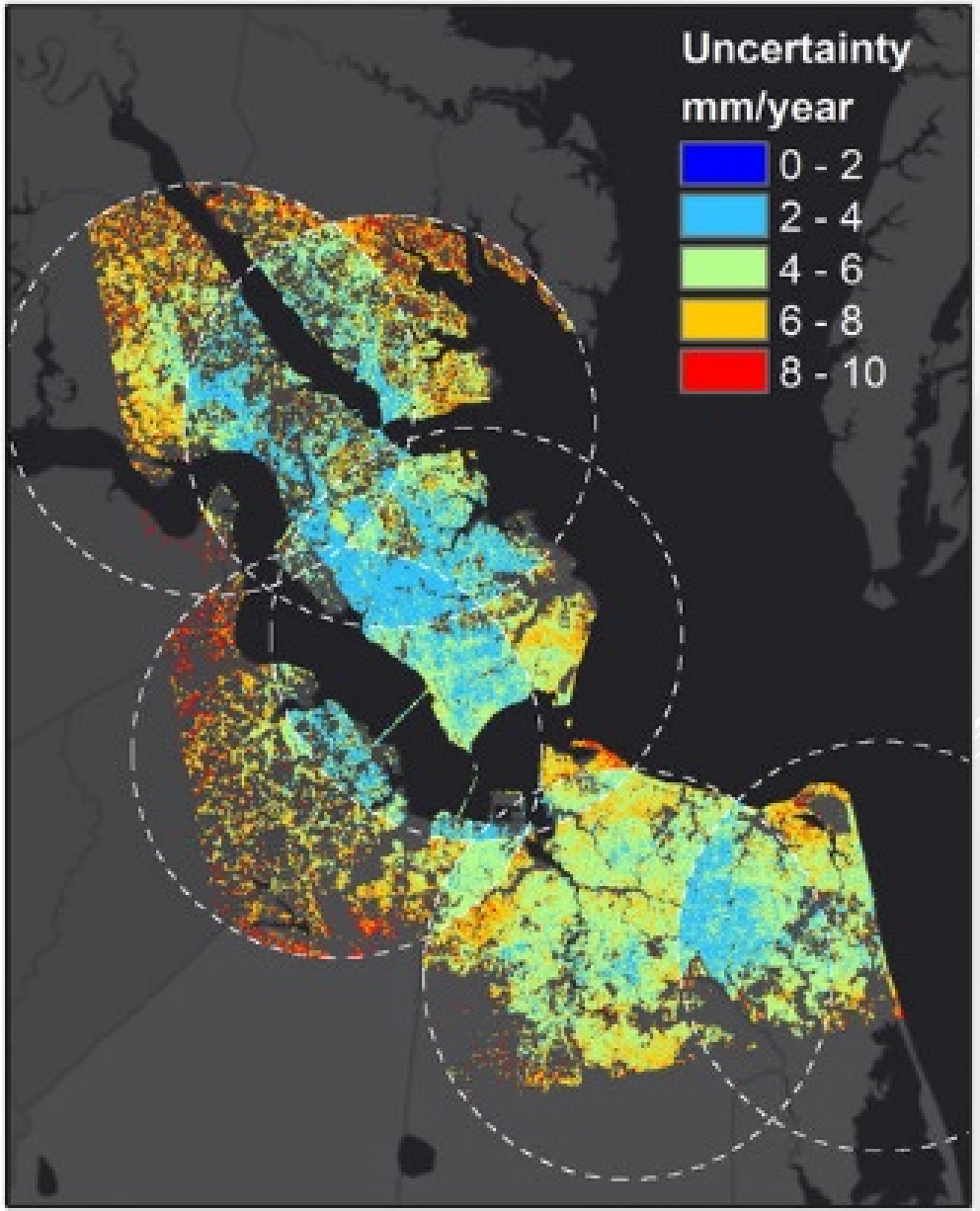


AIRBORNE LIDAR – NORFOLK, VA



DISPLACEMENT/SUBSIDENCE DATA





David Bekaert, Ben Hamlington, NASA JPL

IMPACTFUL DECISION INFORMATION

Blue

2011

Hurricane Irene

Reanalysis

Red

2045

Storm Surge +

+ SLR + Subsidence

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VIMS

LOOKING FORWARD

OGC Disasters Interoperability Study

- Lack of integrated policy and operational framework
- Inability with existing metadata approaches to quickly discover and understand information sources
- Inability to properly fuse and synthesize multiple data sources
- Need for a persistent platform to organize and manage disaster related geospatial information and tools

Open Geospatial Consortium

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Geospatial Solutions Towards Weather & Climate Risk Reduction

David E. Borges, GISP, PMP

NASA Applied Sciences Disasters Program

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January 2019

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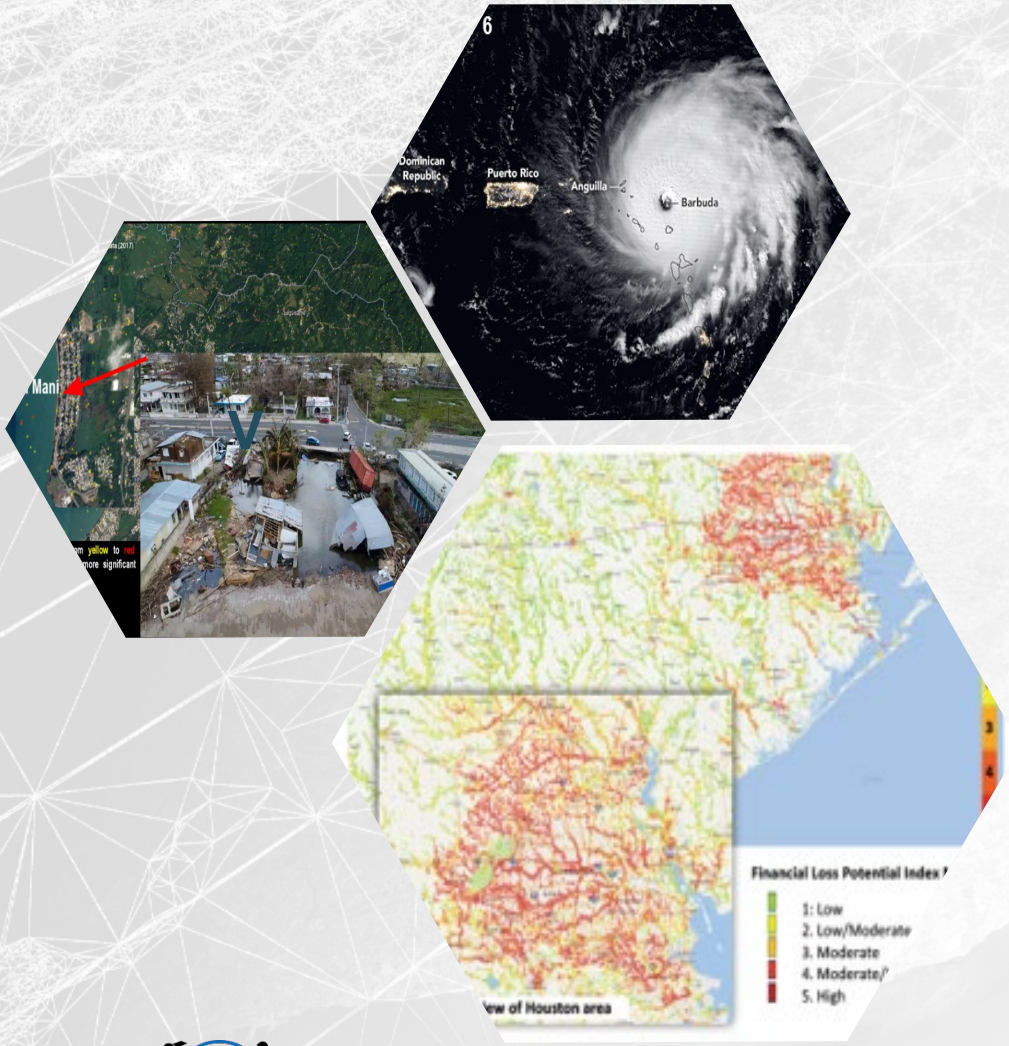

Visual, Scalable, Flexible

Making Cascading Hazards and Risks VISUAL

Driving Decisions with Data that is SCALABLE

Providing Tools and Building Capability to be FLEXIBLE

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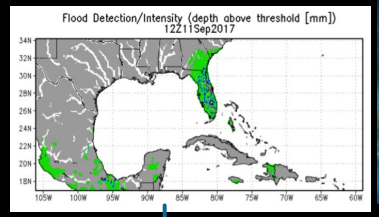
HURRICANE IRMA – EVENT RESPONSE TIMELINE (SEPT 2017)

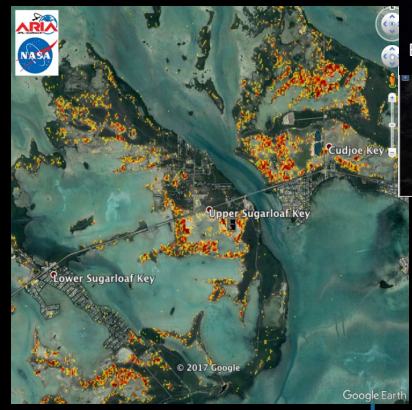
NASA team initiates response in collaboration with end user partners focused on preparedness and recovery from Hurricane Irma

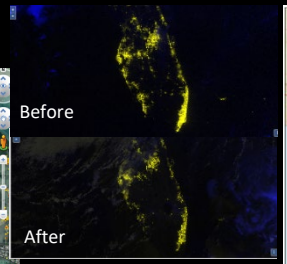
Partners model likely flood and inundation impacts from Irma's predicted rainfall



Preliminary mapping of flooding in Key West via ESA Sentinel 1

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





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

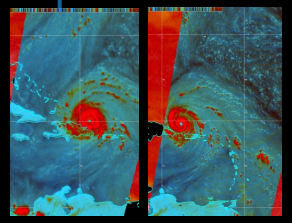
Day 6 Sept 10

Day 8 Sept 12

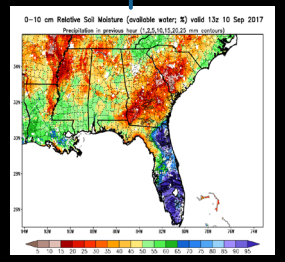
Day 9 Sept 13

Day 15 September 19

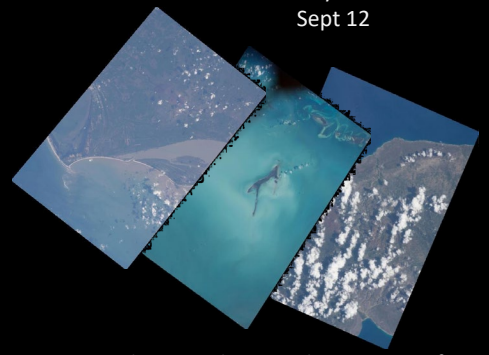
Continuing from Harvey, daily coordination calls and user engagement with partners including FEMA, National Guard, USGS and others



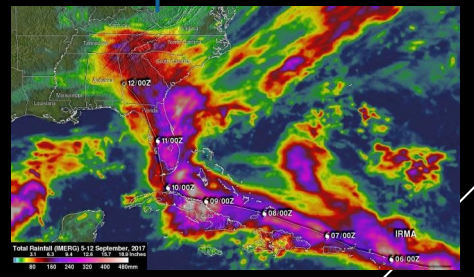
GPM and constellation satellites provide mapping of Irma's track through the Caribbean, data to NOAA/NHC, NRL



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



ISS astronaut photography provides imagery of impacts in Caribbean/Florida



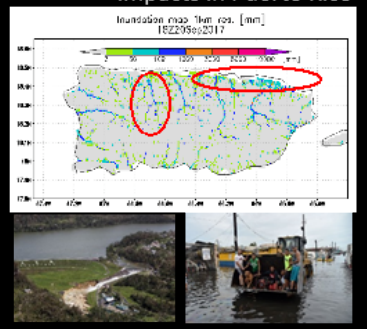
GPM/IMERG rainfall product measures rainfall across the impacted area

HURRICANE MARIA – EVENT RESPONSE TIMELINE (SEPT-OCT 2017)

Daily: FEMA Remote Sensing and Geospatial Teams incorporate NASA information into daily briefings and use analysis to understand recovery needs.

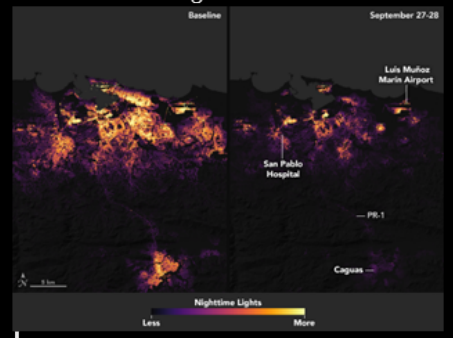
NASA team initiates response in collaboration with end user partners focused on preparedness and recovery from Hurricane Maria

Flood modeling by partners for impacts in Puerto Rico

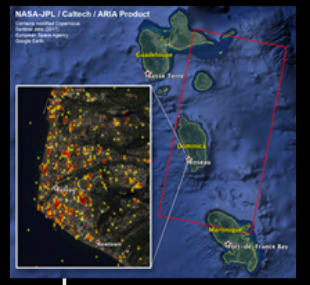


ESA Sentinel SAR imaging used to produce damage proxy maps for affected regions in Puerto Rico

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.



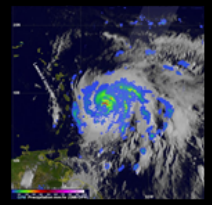
Damage proxy maps extended to Dominica using ESA S1 data



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

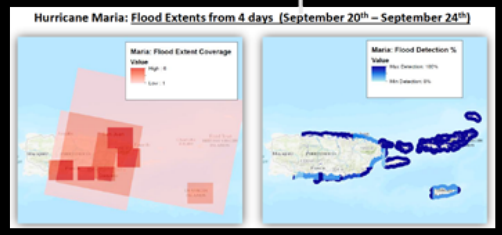
Day 1 Sept 18 | Day 3 Sept 20 | Day 4 Sept 21 | Day 5 Sept 22 | Day 7 Sept 24 | Day 10 Sept 27 | Day 13 Sept 30 | Day 14 Oct 2 | Day 15 Oct 3

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

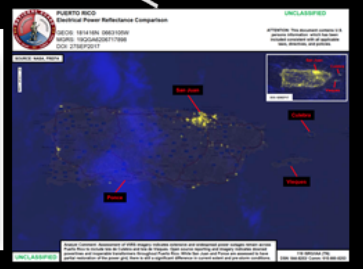


GPM and constellation satellites map Maria, data for NOAA/NHC and NRL

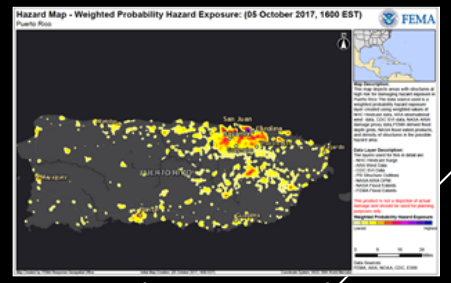
Flood mapping by the NASA team using ESA and Charter SAR and optical assets



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

NASA DISASTERS ROSES PROPOSALS

Research Opportunities in Space and Earth Science (ROSES)

A.37 Earth Science Applications

Disaster Risk Reduction and Response

Due Date delayed to 29 June 2018

https://nspires.nasaprs.com/external/solicitations/summary!init.do?solId=%7B9CEF8BAC-CBF7-809C-51BD-8334579799C8%7D

EARTHQUAKE CHARACTERIZATION - GNSS

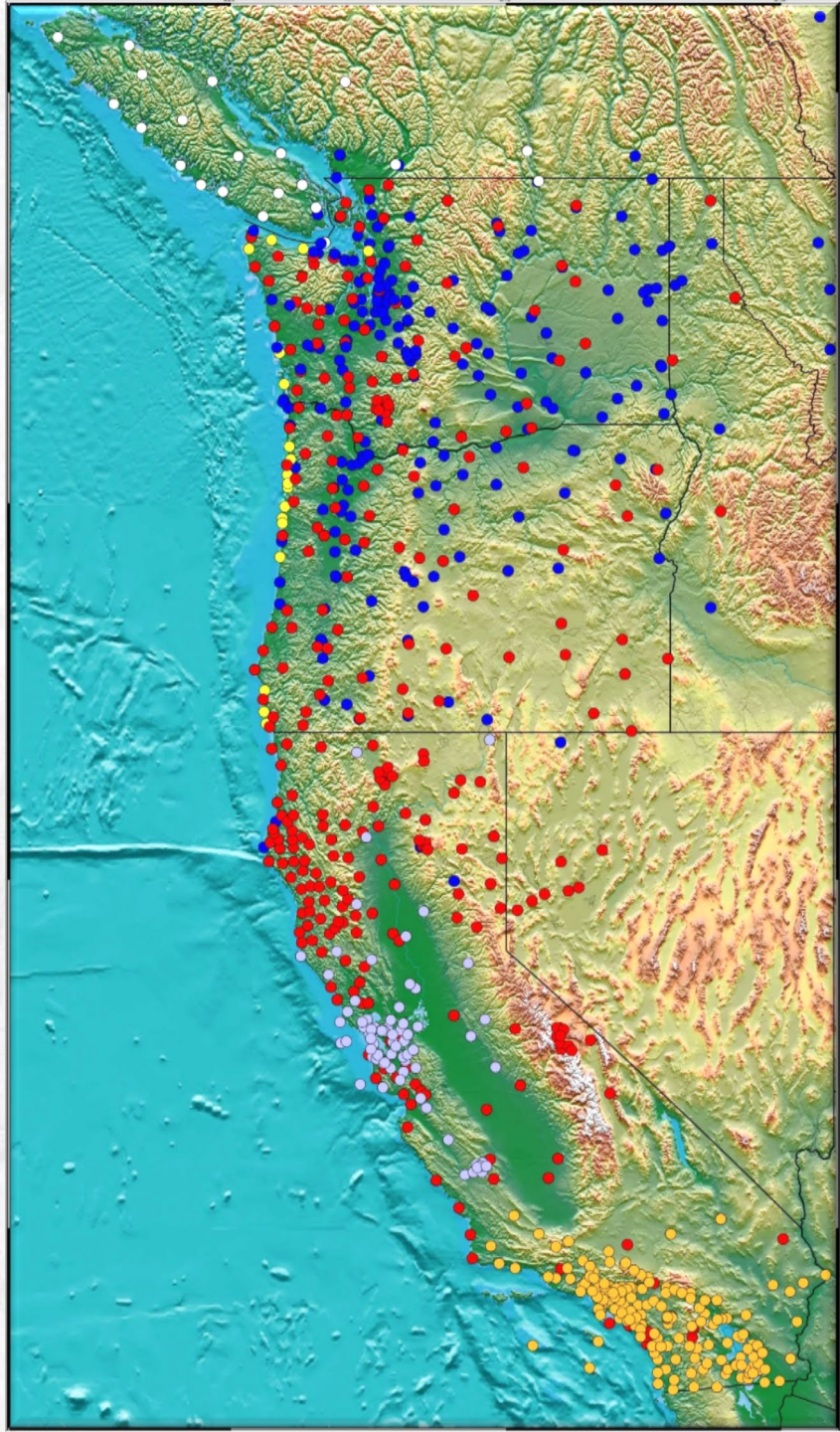
Magnitude, Location, Faulting Mechanism, Spatial Extent

Real-Time GNSS Point Positioning

Earthquake Early Warning

Advancing research toward applications

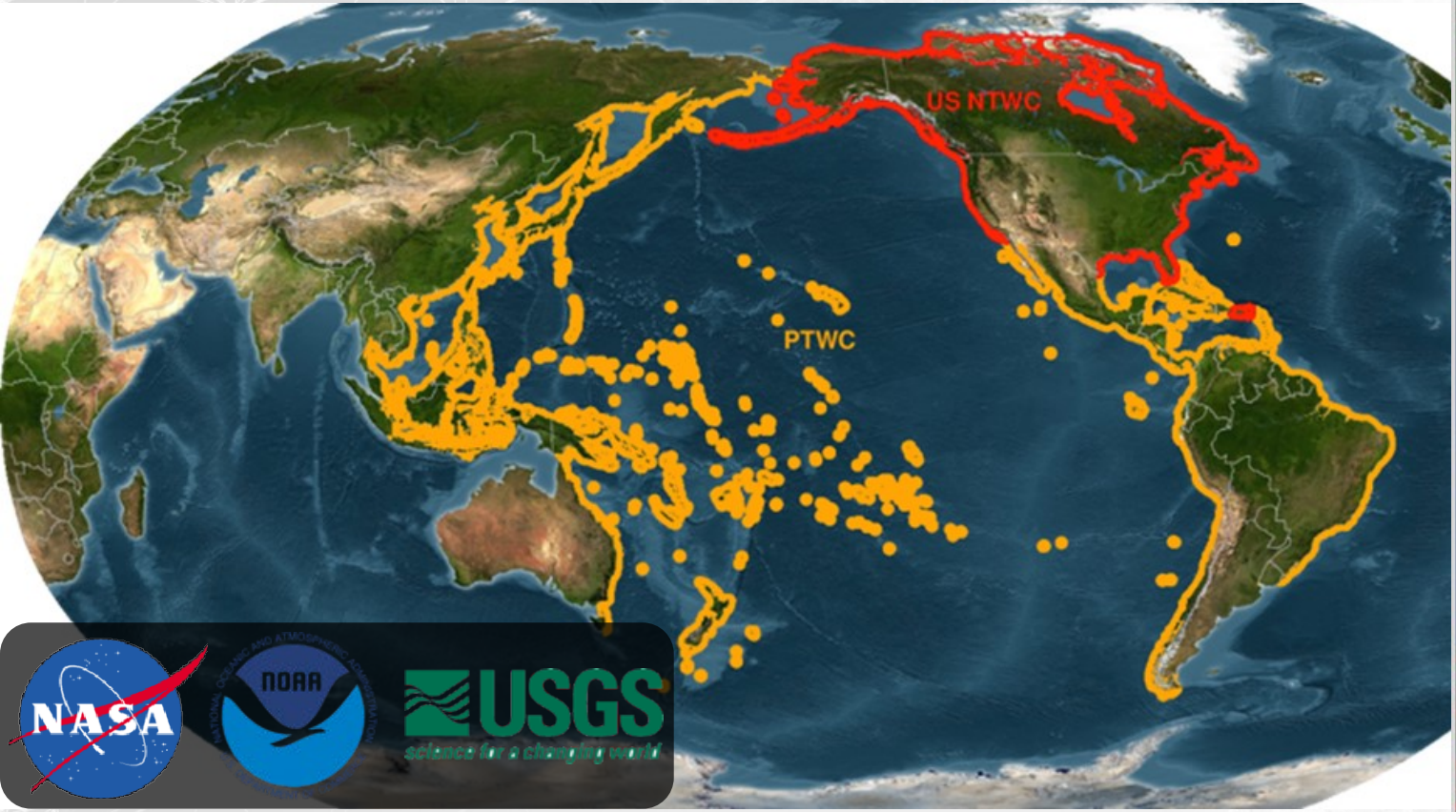
Application of research improves readiness

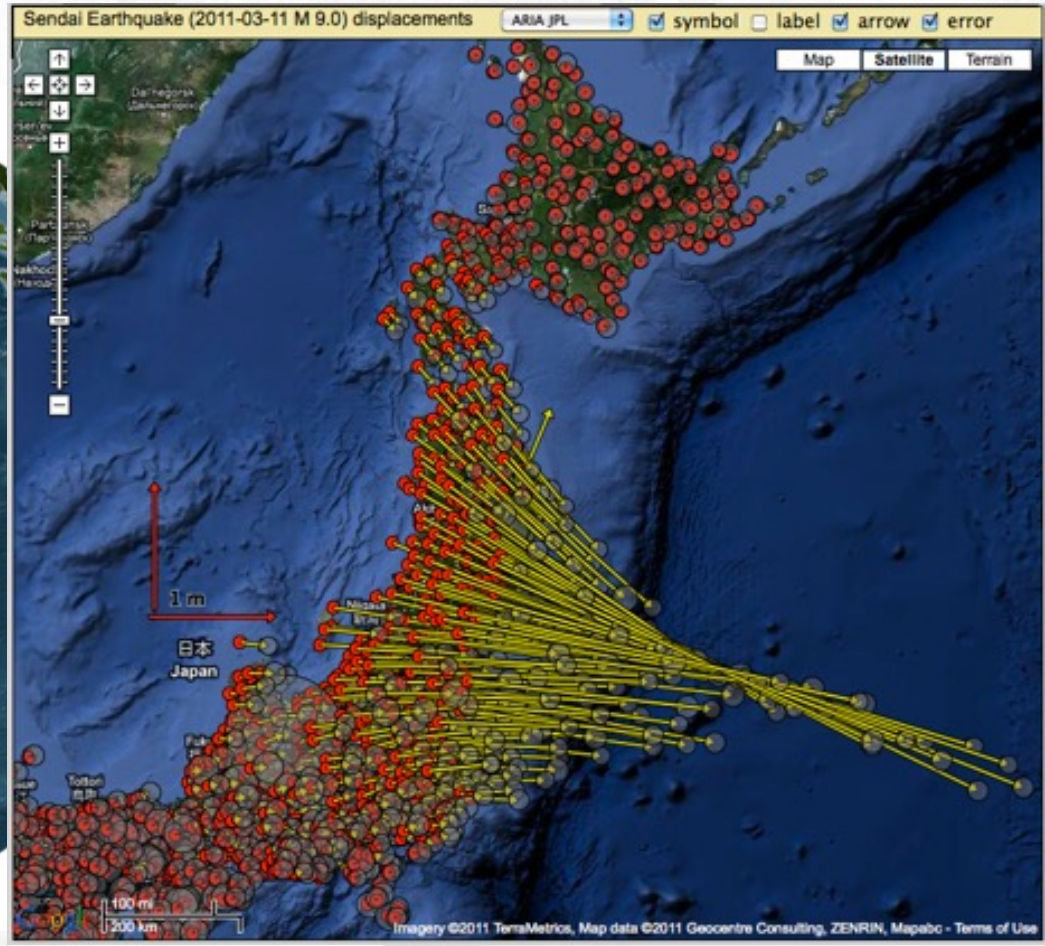


NASA Applied Sciences
DISASTERS

GNSS-AUGMENTED TSUNAMI EARLY WARNING

Tsunami early warning to augment the speed and accuracy of the NOAA NTWC/PTWC response process





PACIFIC COMMUNITIES AND AREAS AT INTENSIVE RISK (CAIR) INITIATIVE

Leveraging GNSS-Augmentation Success

Determine specific focus region

Engagement at local and regional level

Increase network of partners and stakeholders

NASA Applied Sciences DISASTERS

NASA

SUBSEA – NASA AMES

Systematic Underwater Biogeochemical Science and Exploration Analog (SUBSEA)

"SUBSEA science is focused on fluid venting isolated seamounts in the deep ocean as analog environments to hydrothermal systems on other Ocean Worlds"

Loihi Seamount Cruise, Hawaii

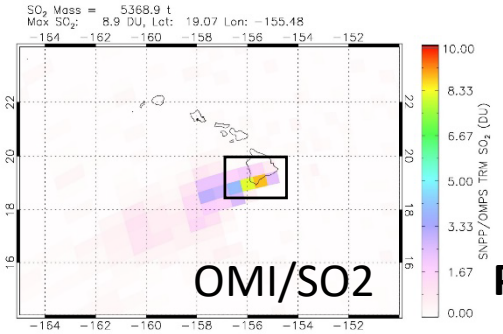
Planned diversion to Kilauea volcano ocean entry points

Providing data to USGS HVO

SUBSEA

VolKilau: **Vol**cano Rapid Response Campaign after the **Kilau**ea eruptions

J.-P. Vernier(1), J. Diaz (2) and L. Kalnajs (3) ; (1) NIA/NASA Langley, (2) Univ. of Costa Rica, (3) Univ. of Colorado



SO2 concentration

Concentration (ppm) averaged between 0 m and 100 m
Integrated from 1100 04 Jun to 1200 04 Jun 18 (HST)
SO2 Release started at 0200 03 Jun 18 (HST)

Univ. of Hawaii
http://weather.hawaii.edu/vmap/

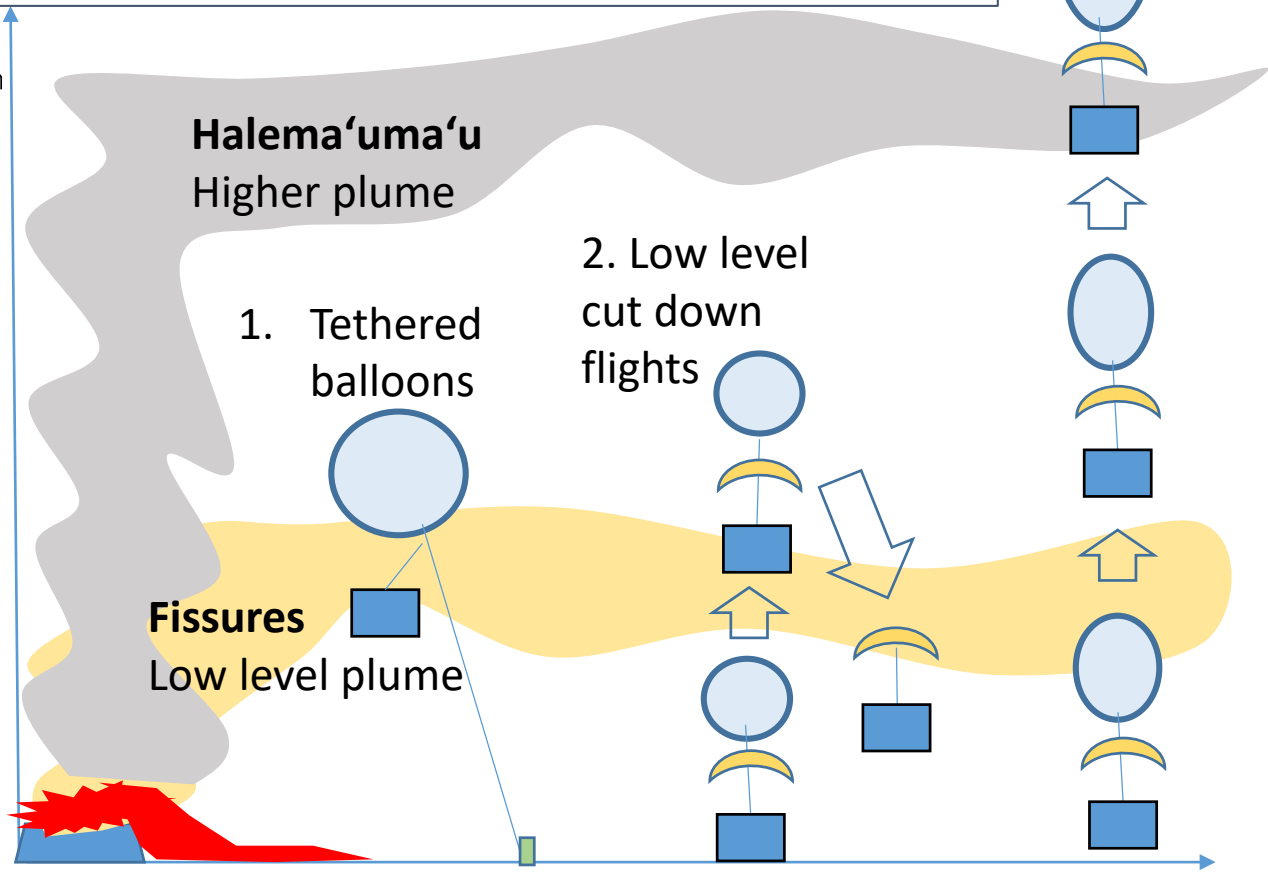
Science Objectives

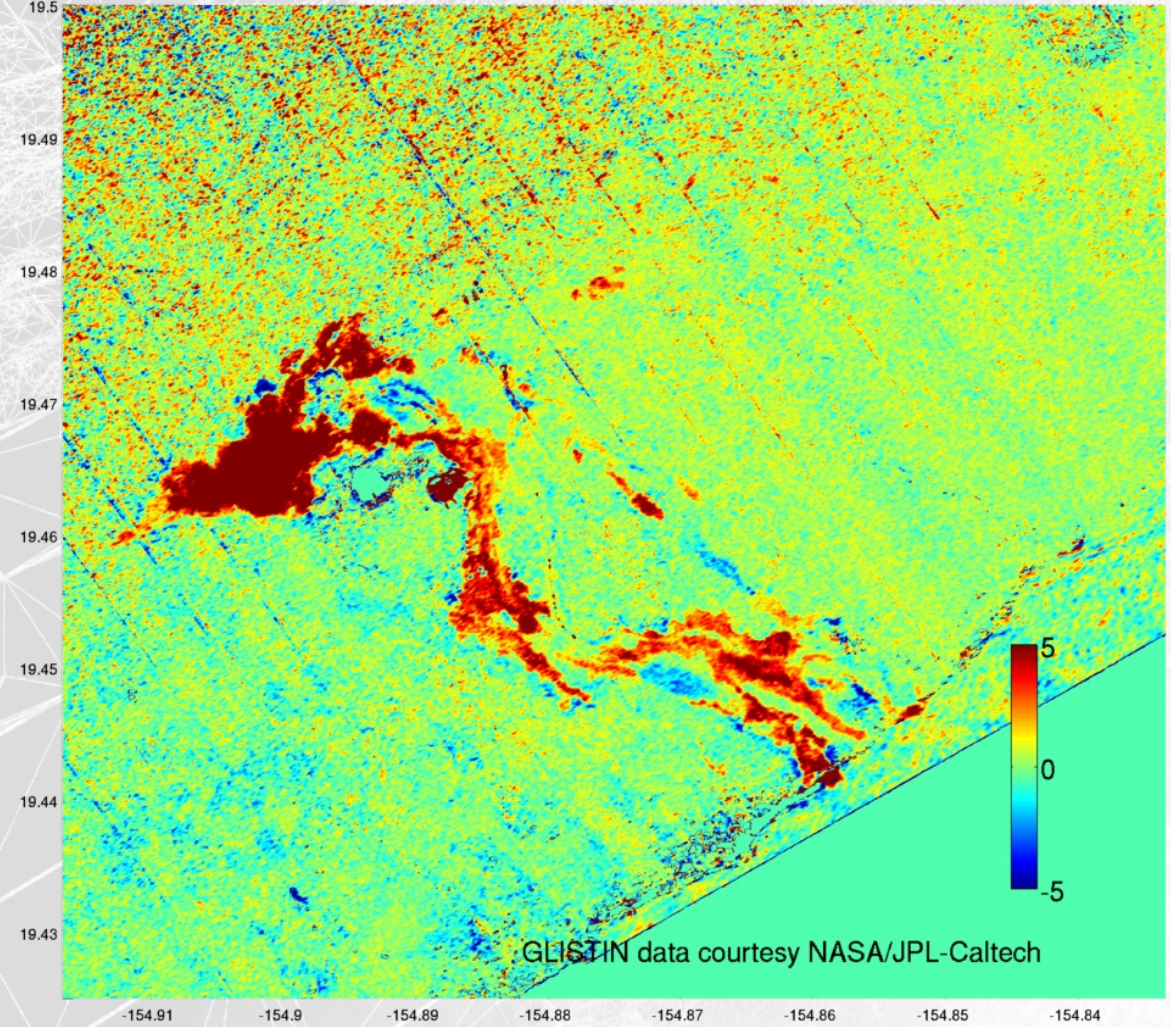
- ❑ Profile SO2, aerosol physical, optical and chemical properties for air quality and model validation
- ❑ Validate satellite observations of SO2 and aerosols
- ❑ Be better prepared for the next large volcanic eruption

Deployment

- ✓ Where: Downwind from fissures and Halemaumau crater
- ✓ When: June 11th to June 17th 2018

Payloads	Measurement
MiniGas sensor	SO2, H2S concentration
Optical Particle Counter	Aerosol size distribution, concentration
COBALD sonde	Aerosol Backscatter at 470 and 940 nm
Aerosol Impactor	Aerosol composition





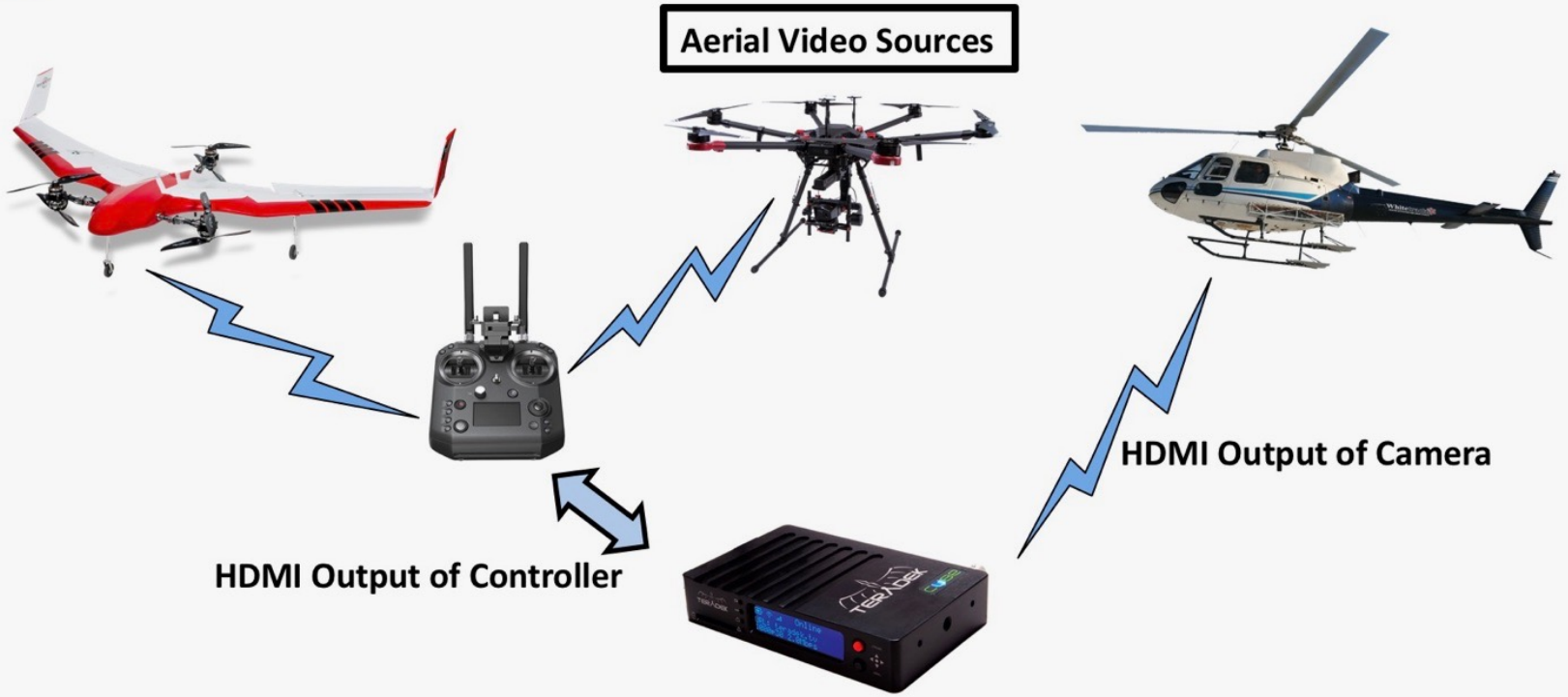
- Glacier and Ice Surface Topography Interferometer (GLISTIN)
- Topography Difference Maps

NASA Applied Sciences DISASTERS

Paul Lundgren, JPL, Airborne Science Program

NASA

NASA/DOI Live Video Streaming Configuration
Hawaii Kilauea Eruption Support



Verizon USB HotSpot 4G

NASA Teradek CORE Server

Password Protected Video Feed

Hilo Emergency Operations Center

Darlene Lim
Michael Downs

National Aeronautics and Space Administration

KILAUEA – SPACE BASED OBSERVATIONS