GSFC Disaster Working Group

September 13th, 2016

Dalia Kirschbaum & Miguel Román

GSFC Disaster Coordinators

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NASA Applied Sciences

DISASTERS

Agenda

- 11:00-11:20– Updates on NASA Disaster Response Activities, updates from group
- 11:20-11:40 – Tim Hall/GISS
- 11:40-12:00 – Discussion and next steps

Updates

- **Response Activities**
  - Louisiana Flooding
  - Tropical Storm Hermine
  - Italy Earthquake
- **Meetings**
  - CEOS Disaster Working Group Meeting, Vancouver WA
  - National Academies Workshop on Improving Understanding of Volcanic Eruptions, Washington, DC, on August 17-19, 2016 (Closed Session: http://www8.nationalacademies.org/cp/meetingview.aspx?MeetingId=8691)
  - **Upcoming**: Workshop to Develop a Portfolio of **Low Latency Datasets** for Time-Sensitive Applications, September 27-29th, 2016. Langley Research Center, Hampton VA
- **Trainings/Webinars**
  - **GPM Data:** https://pmm.nasa.gov/training (4th training on 9/13))
- **Website**
  - NEW: Internal GSFC Applied Sciences Page, with area for Disasters WG: http://science.gsfc.nasa.gov/610/applied-sciences/index.html
  - Continuing to work on the conceptual framework for a "back end" system for data management
- **Playbooks**
  - Floods (GSFC), Severe Storms (MSFC), Earthquakes (JPL), Airborne is starting

New GSFC Applied Sciences Website: http://science.gsfc.nasa.gov/610/applied-sciences/index.html

National Aeronautics and Space Administration
Goddard Space Flight Center

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Flight Projects | Sciences and Exploration

Expand sub-menus | Directorate & Offices (600) | Earth Sciences (610) | Astrophysics (660) | Heliophysics (670) | Solar System (690)

Sciences and Exploration Directorate
Earth Sciences Division Code 610

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Recent Highlights

A Tale of Fire and Water: A NASA Scientist's Quest to Understand the Rain in Africa
NASA's Earth Observatory profiles Dr. Charles Ichoku's research and career.

Bolten SERVIR Proposal Selected
Bolten SERVIR Proposal Selected
Dr. John Bolten will lead a project to improve hydrologic decision support for the Lower Mekong River basin through integrated remote sensing and modeling.

Duncan H-AQAST Proposal Selected
Duncan H-AQAST Proposal Selected
Dr. Bryan Duncan's team will develop a satellite-based global health air quality index.

Getirana SERVIR Proposal Selected
Getirana SERVIR Proposal Selected
Dr. Augusto Getirana will lead a project to develop an improved land data assimilation system (LDAS) for forecasting extreme hydrological events in West Africa.

Mites from Space: Tracking a Microscopic Pest in Puerto Rico
DEVELOP project led by Dr. Sarah Lubkin at NASA Goddard.

Bad Bromes in the Badlands: Monitoring Invasives in the Great Plains
DEVELOP project completed at NASA Goddard.

Upcoming Events

Disasters working group meeting	Sept. 14th, 11am	B33, E108
NASA-Rio Education Webinar #1: Climate Change Basics	Sept. 21st, 6:30pm	N/A

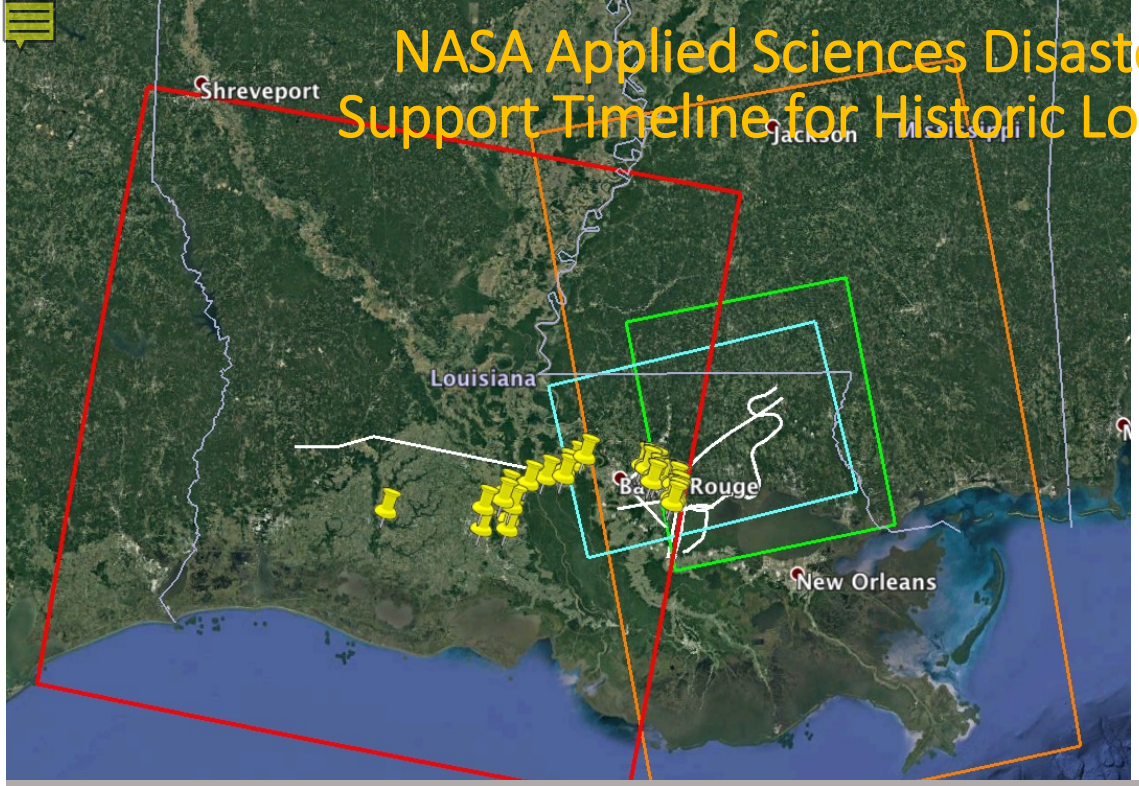
Overview
Goddard Applied Sciences brings together Goddard's vast Earth Science resources for societal benefit. Goddard Applied Sciences coordinates projects funded by a variety of NASA programs and missions, connects NASA researchers with end users, supports interagency activities, and develops external partnerships. Activities span the range of the Earth Sciences; current working groups include air quality, climate, water and natural disaster-related applications.

Working Groups
- Air Quality & Health
- Climate Applications
- Disasters
- Mission Applications
- Water Applications

Partnerships
- NASA-Rio de Janeiro

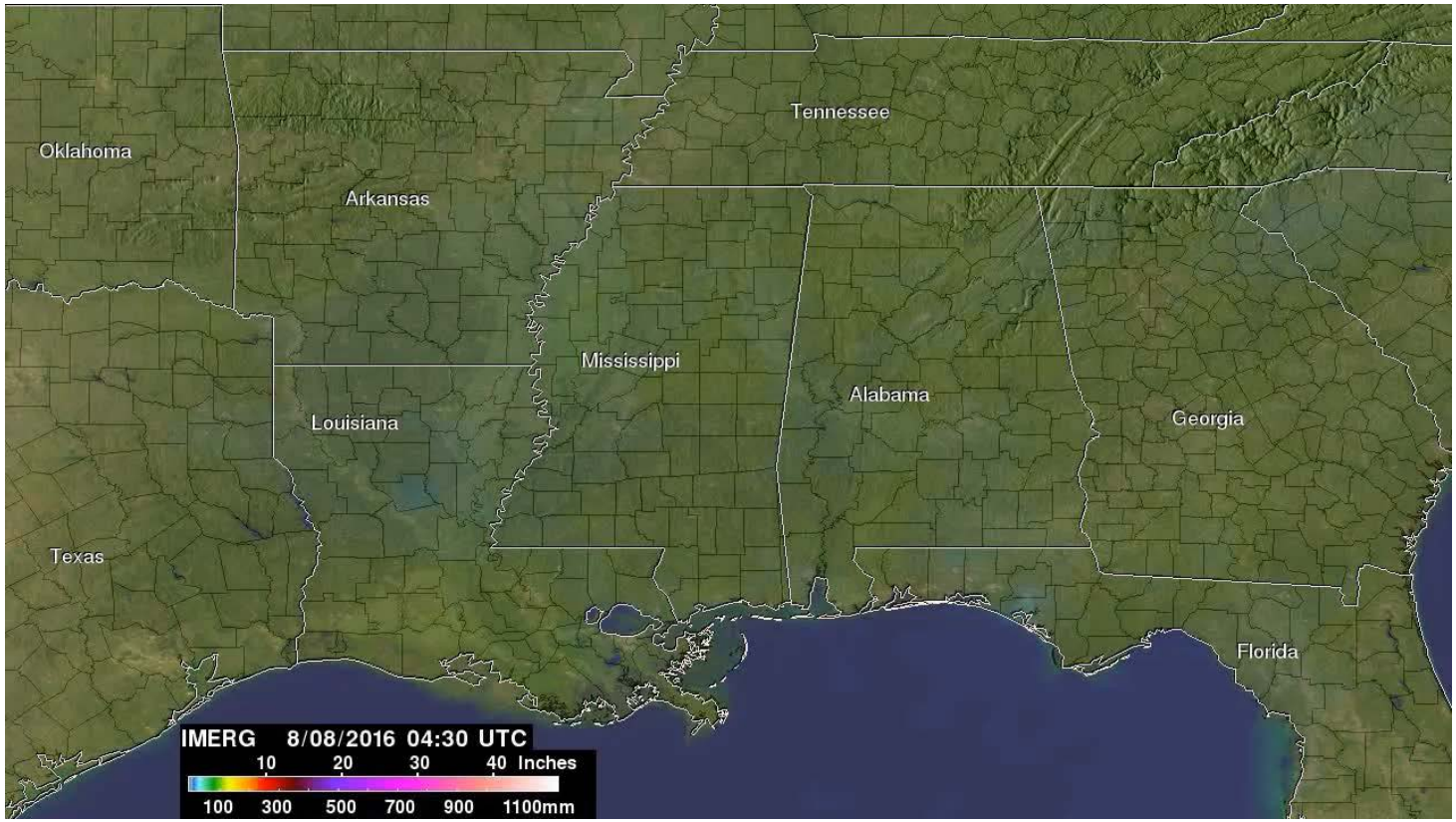
Related Programs
- ARSET
- DEVELOP
- SERVIR

NASA Applied Sciences Disasters Program
Support Timeline for Historic Louisiana Floods



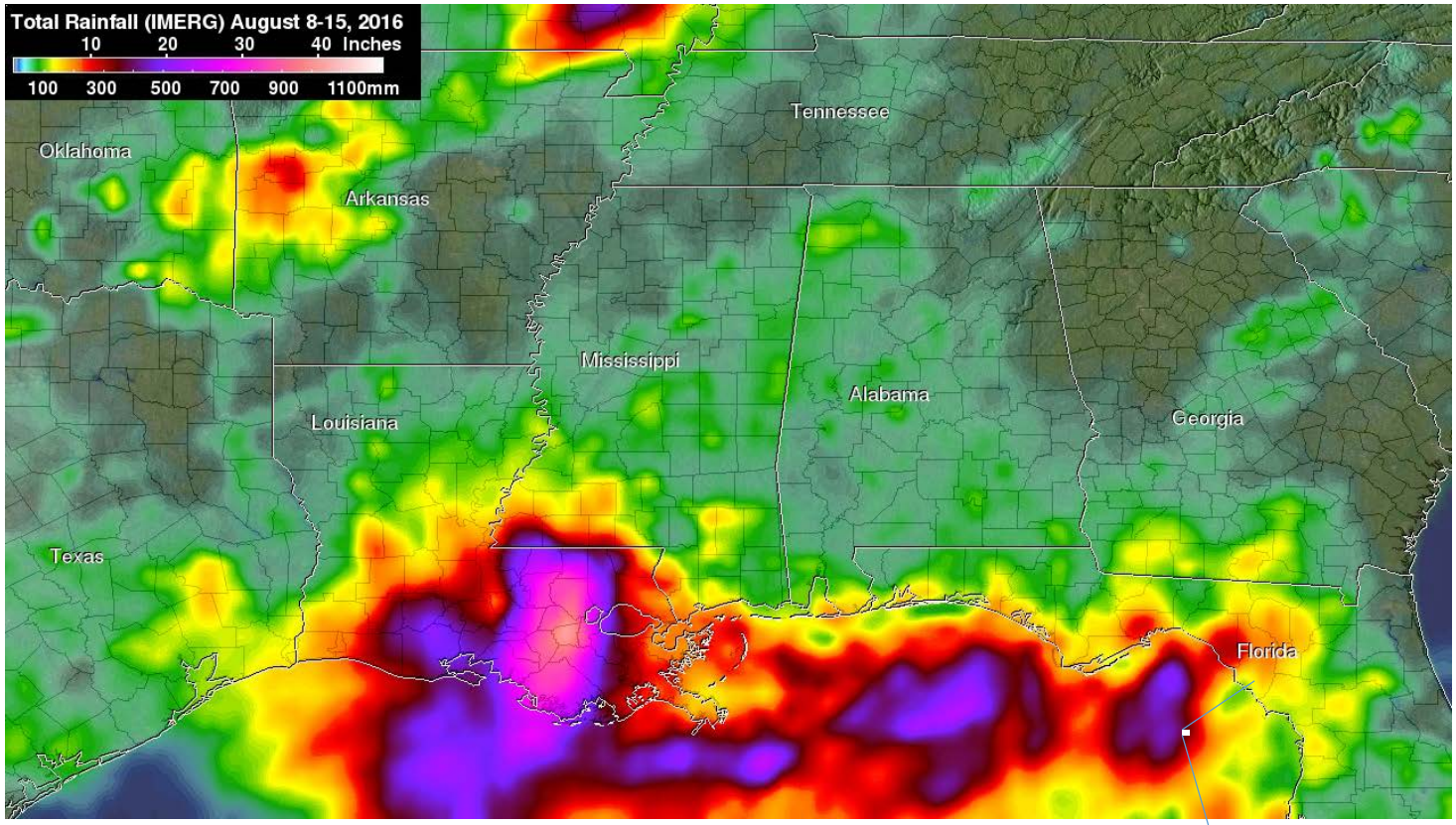
- August 8 -15 South central LA receives > 20 inches of rain.
- Friday 8/12 FEMA requests assistance from NASA and joins initial rapid assessment call with NASA Disaster Coordinators and NASA SME's. Daily coordination Telcons between NASA and FEMA's Geospatial Office begin
- Saturday 8/13 International Disaster Charter activated, providing unprecedented access to SAR data and satellite imagery
- Monday 8/15 through Tuesday 8/23 activities also coordinated through USGS lead Remote Sensing Working Group (RSWG) Telcons with broad local, state, federal and international participation

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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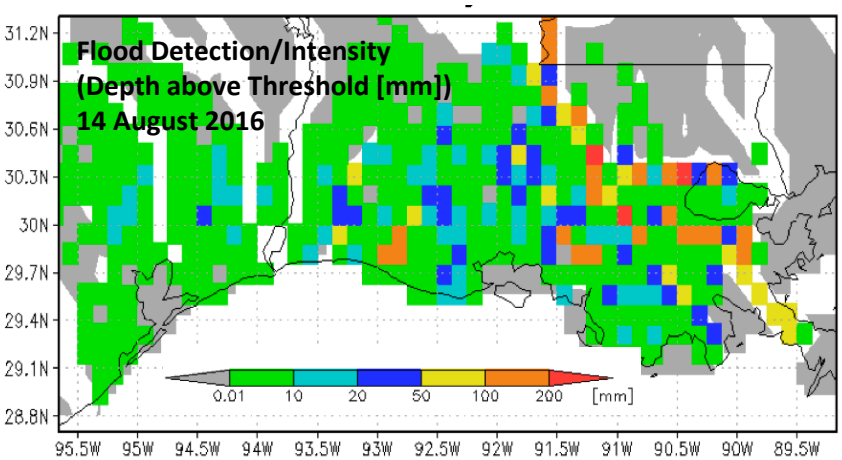
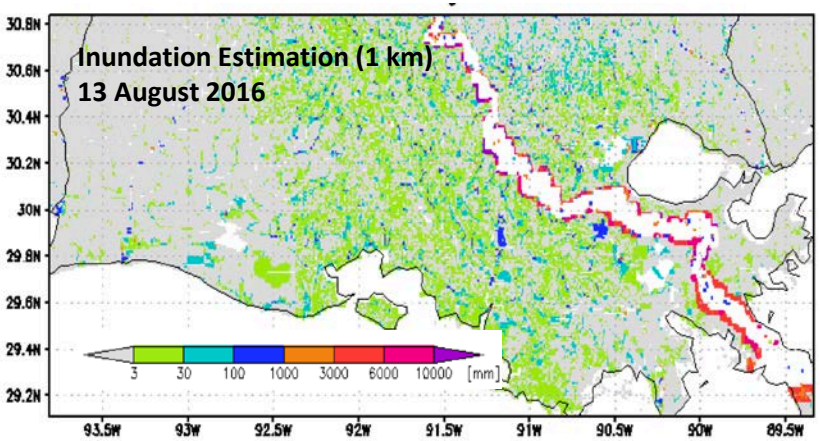
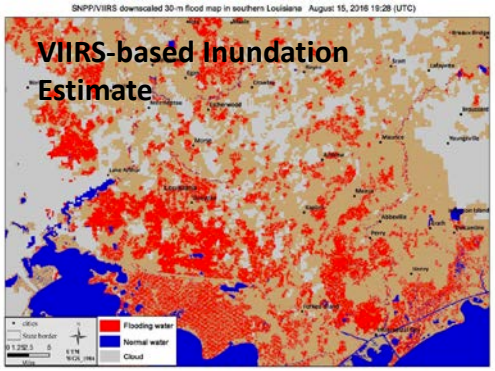
Global Flood Mapping System – GFMS

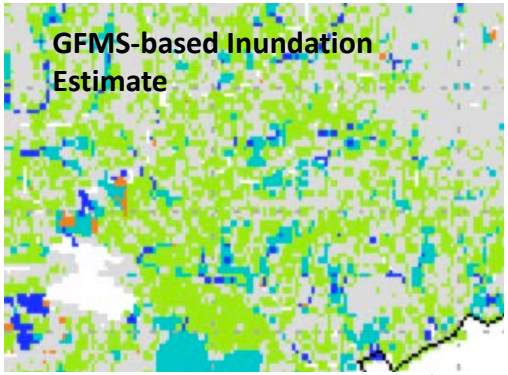


Satellite precipitation estimates merged via the GPM product are utilized as a key Input into the Global Flood Monitoring System (GFMS) utilizing land surface and routing models at 12 and 1 km resolution to estimate the occurrence and intensity of floods. The hydrological calculations are extended into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

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



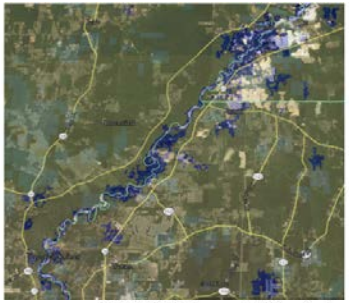


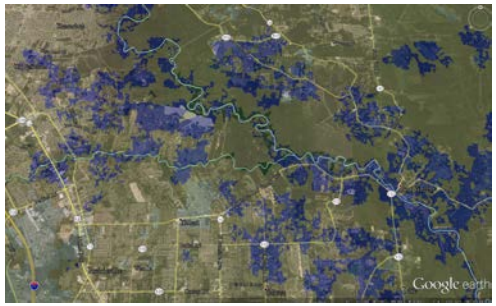


During the Louisiana floods in August GFMS images and data were provided showing large-scale current conditions and forecasts as in upper left image (3-hr resolution). The forecasts were used by FEMA to help plan their response. The 1-km resolution inundation estimates from GFMS (example in lower left) were downloaded by FEMA and used to estimate number of structures and homes impacted. The GFMS inundation [illegible] were also used to compare with those from optical and SAR data, when available (see above).

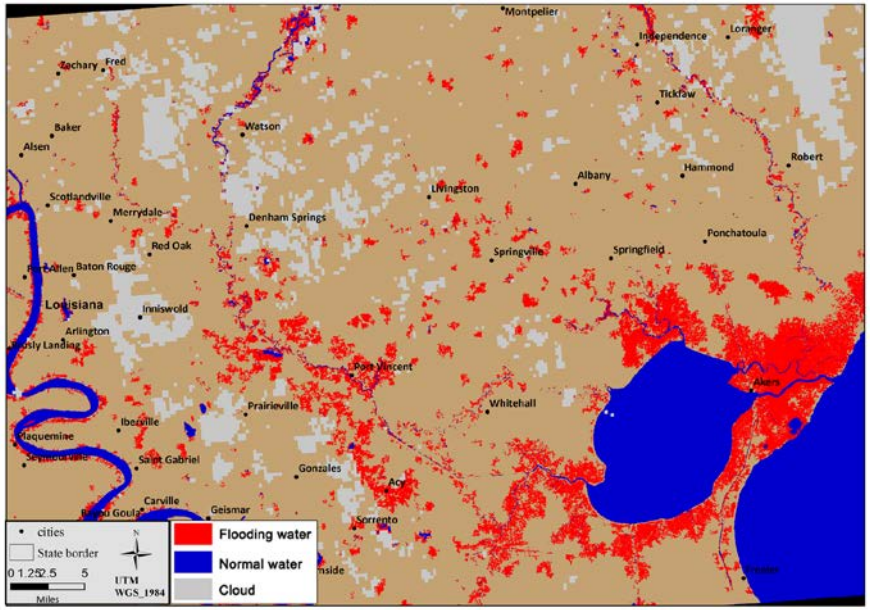
Credit: Bob Adler and Huan WU, UMD

NPP Suomi VIIRS Flood Maps

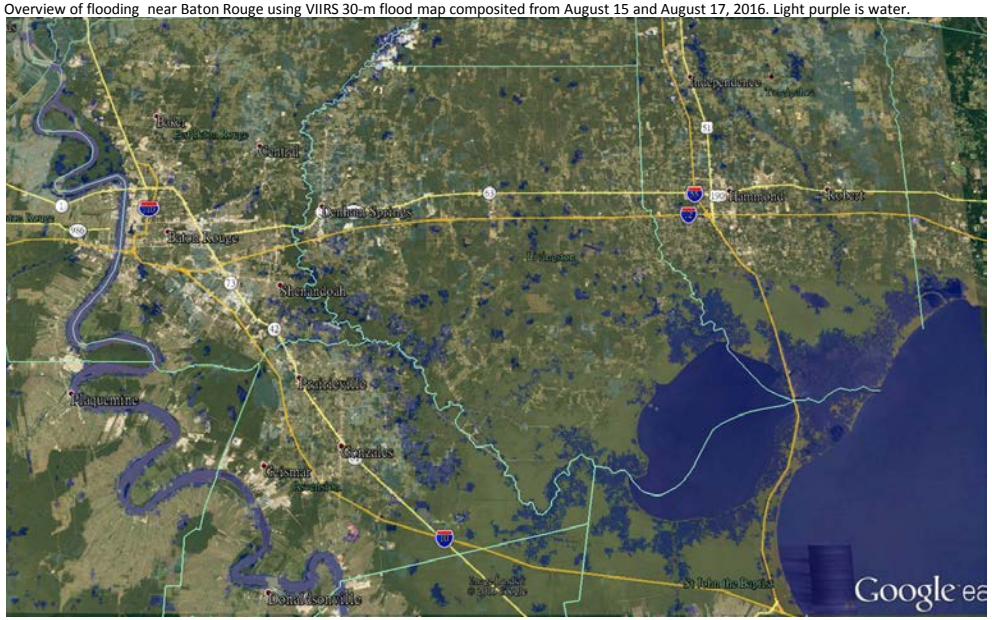




SNPP/VIIRS downscaled 30-m flood map near Baton Rouge, Louisiana August 15 and August 17, 2016



Overview of flooding near Baton Rouge using VIIRS 30-m flood map composited from August 15 and August 17, 2016. Light purple is water.

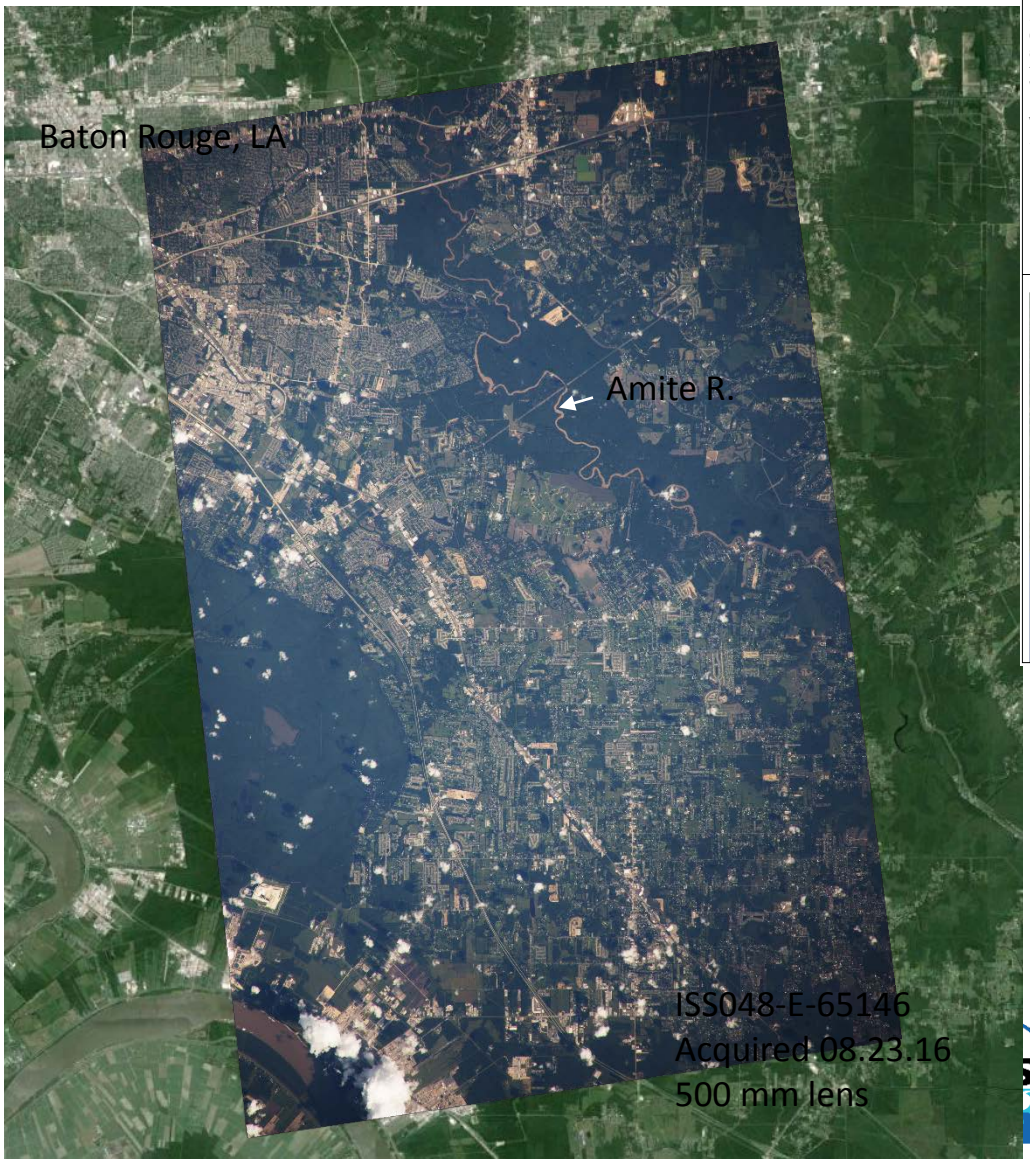


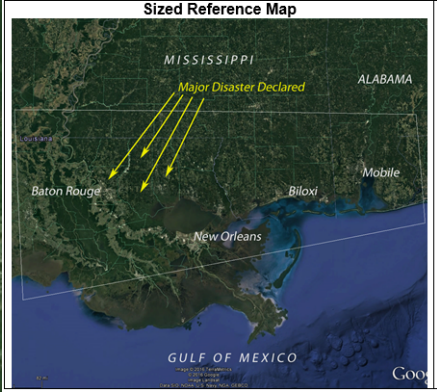
August 15-17, 2016 VIRRS Flood maps courtesy of Sanmei Li, GMU.

NASA EO-1 Imagery

August 16, 2016 15m EO-1 imagery courtesy of Stu Frye, NASA GSFC

ISS Handheld Digital Camera Photography

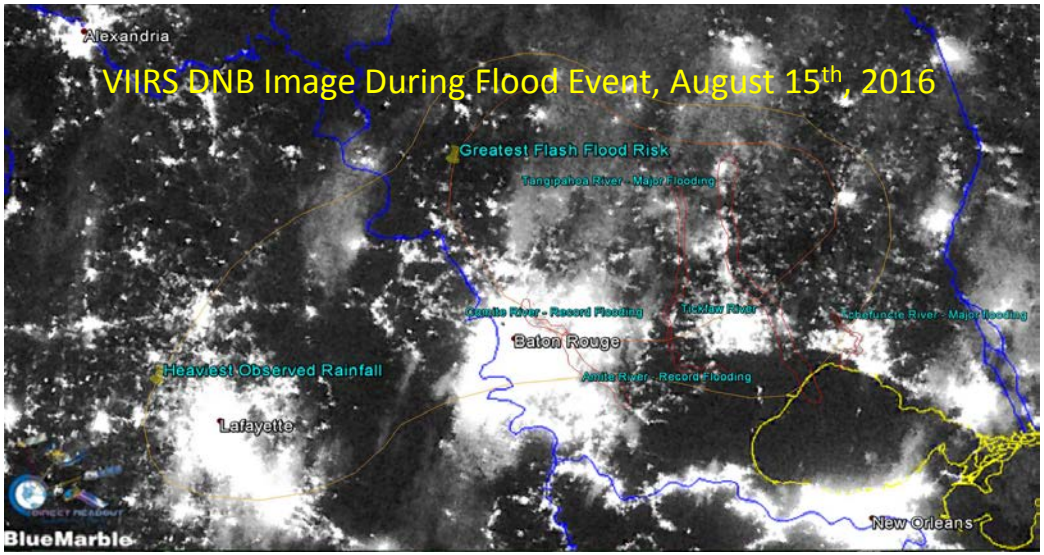


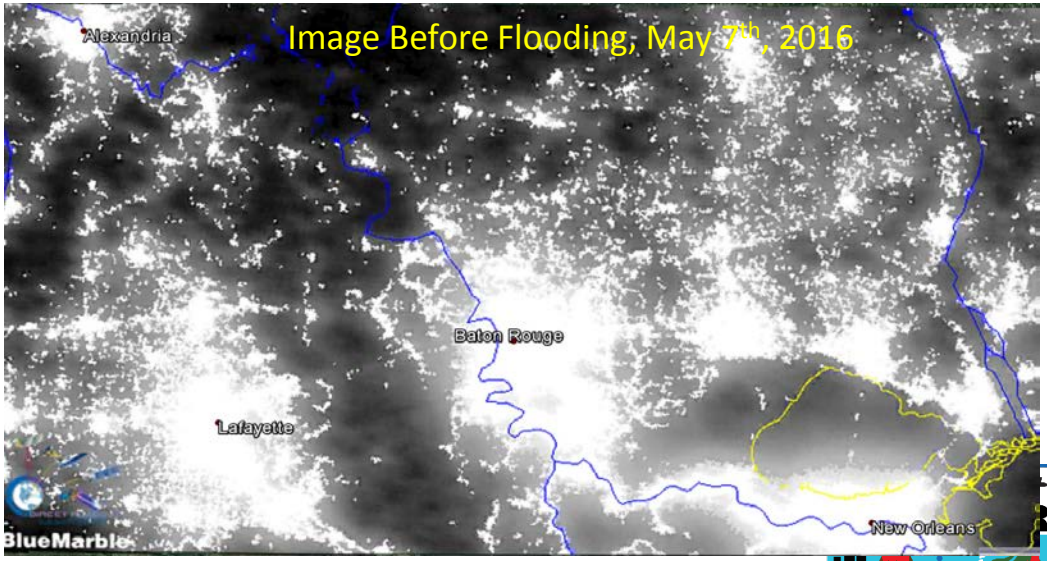
Site Plan Information	Nugget
Site objective: Document any visible evidence of the extent of flooding in eastern Louisiana and southern Mississippi and Alabama, especially the area of the four parishes where the Major Disaster has been declared. Window: Any available Lens: 50-180mm oblique, 400-1200mm near nadir Viewing angle: Near Vertical, Oblique Season: 13AUG16 through 23AUG16 Maximum clouds: 50% Frequency: As visible	More than 20,000 people have needed rescue following massive floods that swept across the state of Louisiana. Residents are being warned it's going to get worse before the flood waters recede. President Barack Obama declared a major disaster in the hard-hit parishes of East Baton Rouge, Livingston, St. Helena and Tangipahoa, freeing up federal funding for flood-related assistance. The heavy rainfall started on Friday, where some areas received more than 17 inches (43cm) of rain. The neighboring states of Alabama and Mississippi are also experiencing severe weather. More than 1,700 rescue personnel had been mobilized and nearly 170 high-water vehicles had been tasked or staged. The Coast Guard was also assisting in the rescue efforts, using helicopters to help residents from their rooftops, cars and trailers.
Sized Reference Map	**Recommended Site Coordinates:**
	Type: Box Coordinates: 29.3N 92.1W 30.1N 87.3W 31.2N 87.4W 31.3N 92.2W

- 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 (example of targeting information above)
- 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

Credit: Will Stefanov, NASA JSC

Suomi NPP VIIRS Day-Night Band Detects Power Outages



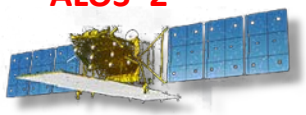


NASA GSFC Disaster Team utilized a new algorithm for producing night time optical data, which was used as one of the assets for assessing impact of the Louisiana floods at the request of FEMA. In this case, the data was used for determining power outages as a means of mapping impact zones. (NASA Direct Readout Lab). **Top-L:** During flood event, Aug 15th, 2016; **Bottom-L**: Before event, May 7th, 2016. A similar product developed by NASA MSFC to difference images such as these was first provided by NASA Disasters to DHS/FEMA to support efforts to restore power after Hurricane Sandy.

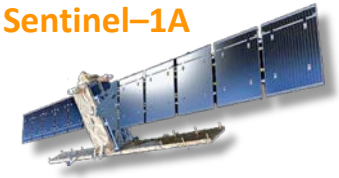
Credit: Dalia Kirschbaum and Miguel Roman, NASA GSFC

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

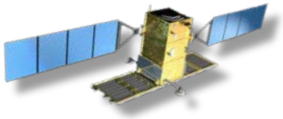
ALOS–2



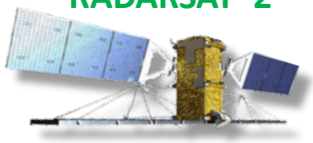
Sentinel–1A

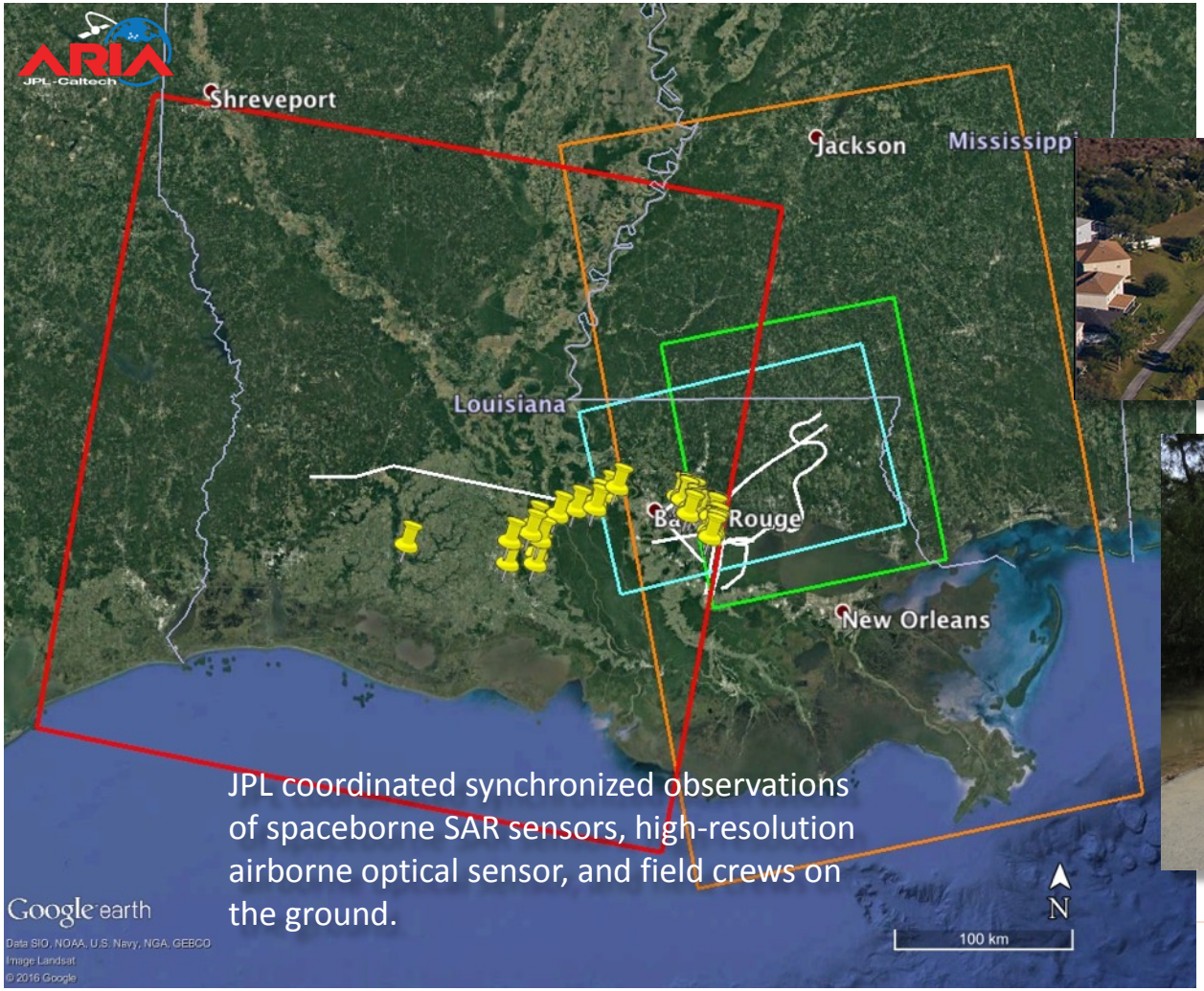


COSMO-SkyMed



RADARSAT–2



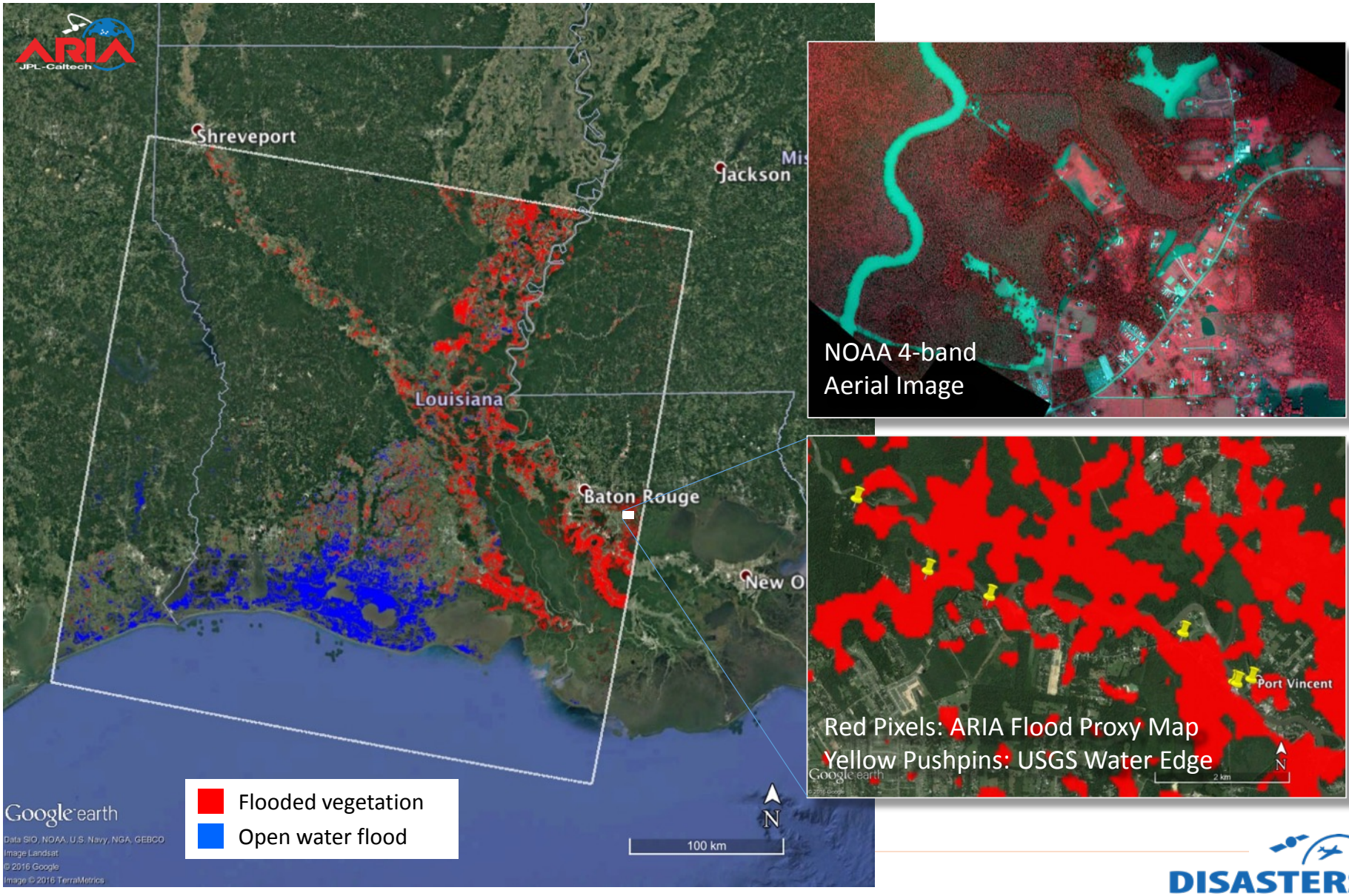


JPL coordinated synchronized observations of spaceborne SAR sensors, high-resolution airborne optical sensor, and field crews on the ground.

FEMA

Photo: Dennis K. Demcheck, U.S. Geological Survey

DISASTERS
NASA's Earth Science



DISASTERS
NASA's Earth Science

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

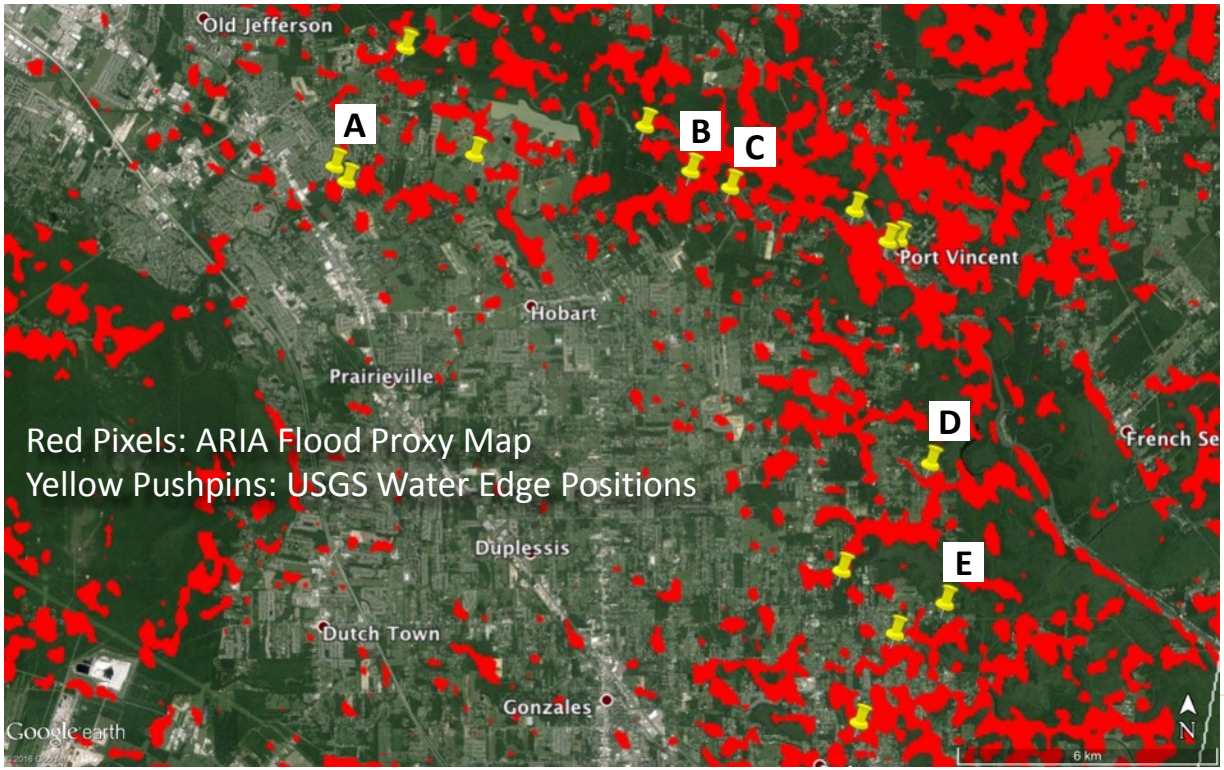
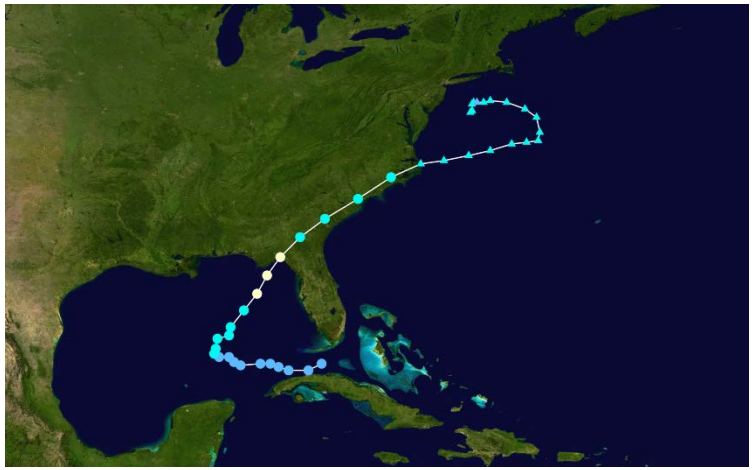
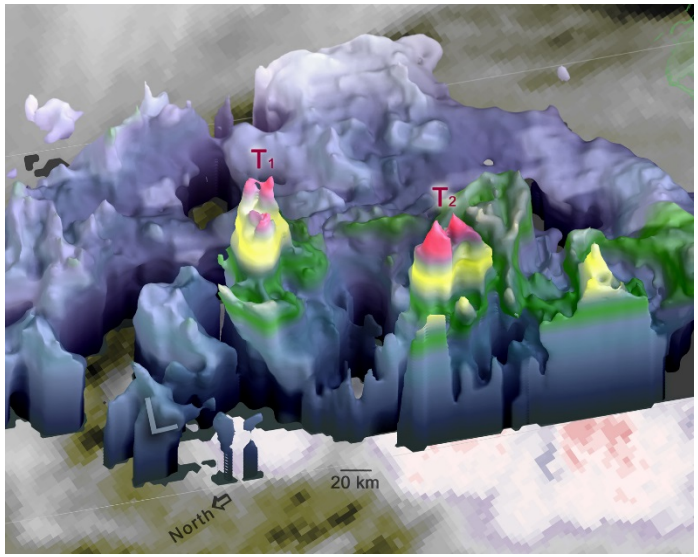


Photo: Dennis K. Demcheck, U.S. Geological Survey

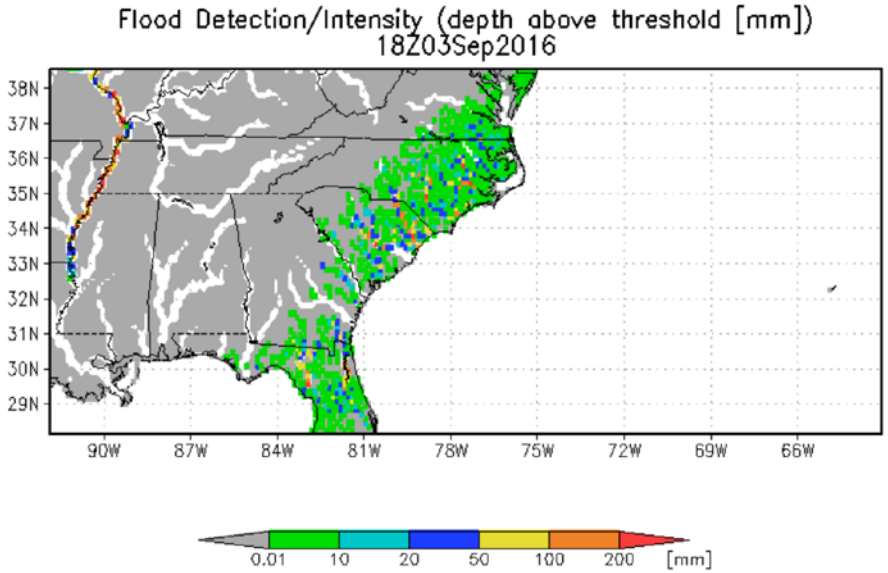
Response to Tropical Storm Hermine (Aug-Sept. 2016)

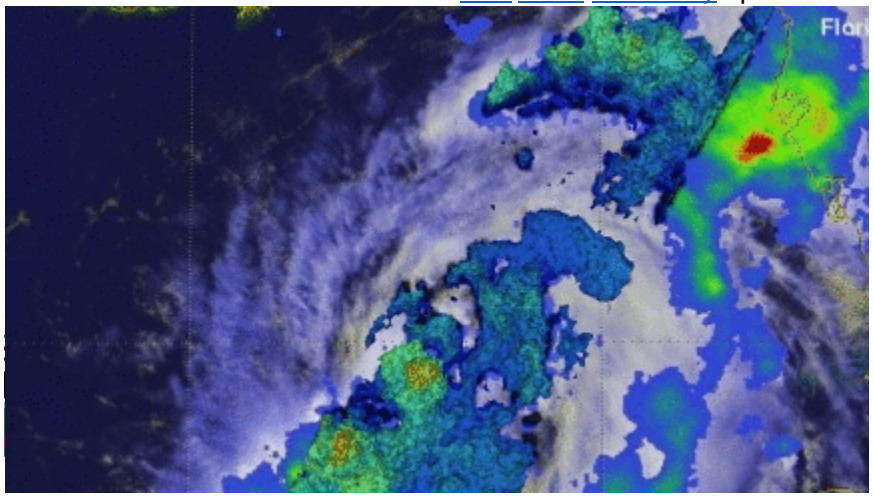




GPM's DPR instrument saw strong storms near the center of Tropical Depression Hermine on the evening of Aug. 31. Two "hot towers" are seen to the right of the low pressure center (south and east of the center), which are labeled "T1" and "T2." The "L" indicates center of Hermine and red color shows a 20-dBZ radar reflectivity up to 14 km

GFMS Flood Detection on Sept 3rd, 2016





Response to Tropical Storm Hermine

- MSFC Took the lead in organizing an “Assessment” call
- Concerns were regarding flooding and storm surge
- FEMA sent preliminary impact estimates in terms of damage points, and depth grid
- Another example of good coordination between NASA and FEMA in terms of damage assessment and points of interest
- Need to continue determining how NASA Products can be more rapidly used within the preliminary damage assessment process

ARIA Damage Proxy Maps of M6.2 Aug 24, 2016 Central Italy Earthquake

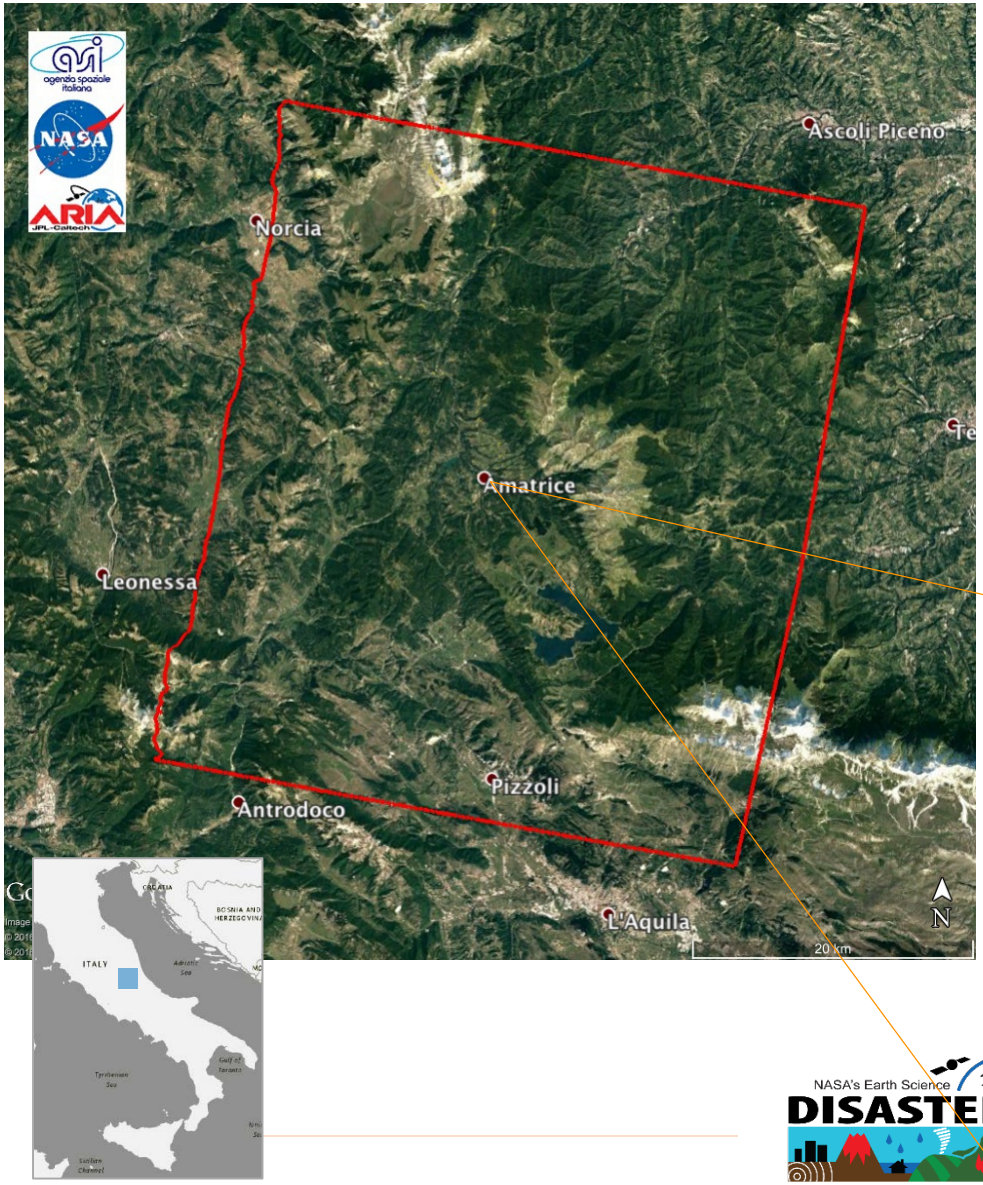
Sang-Ho Yun, Cunren Liang, Frank Webb, Eric Gurrola,
Gerald Manipon, Eric Fielding, Piyush Agram, Hook Hua, Susan Owen

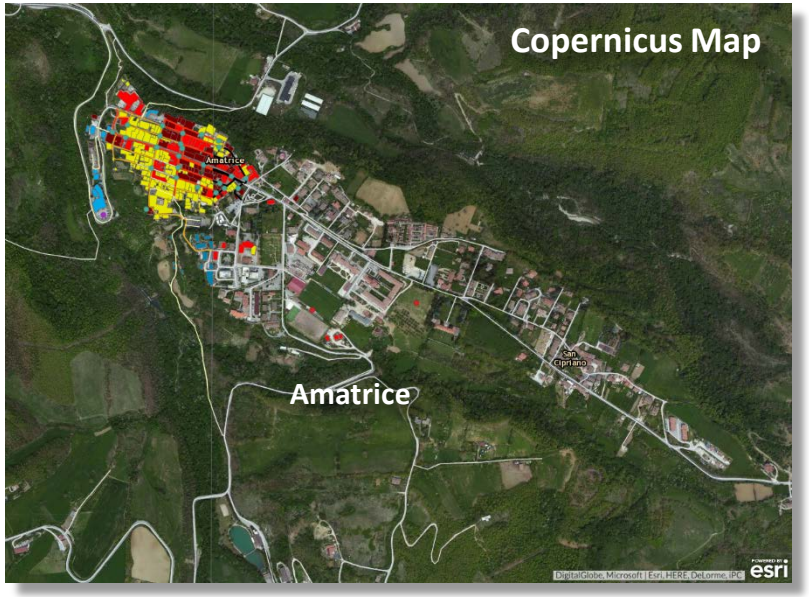
ARIA Team

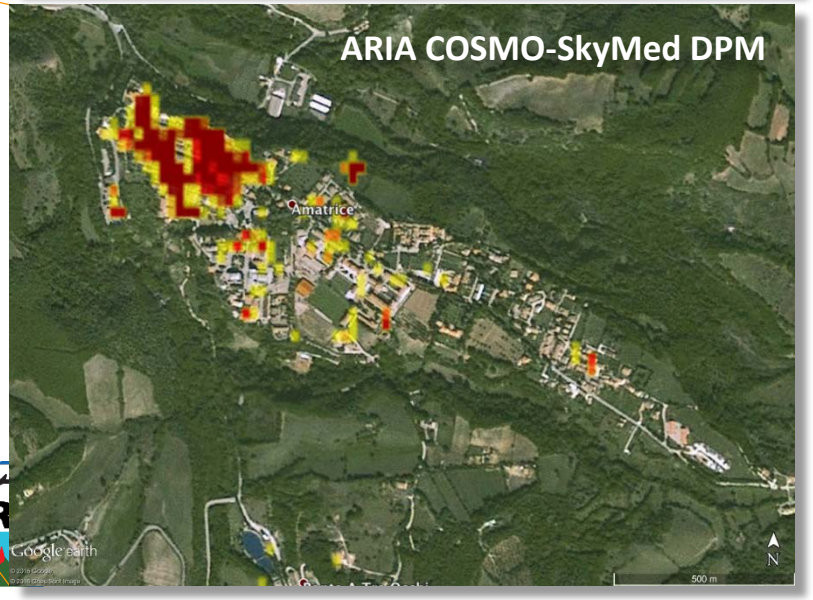
Jet Propulsion Laboratory / California Institute of Technology

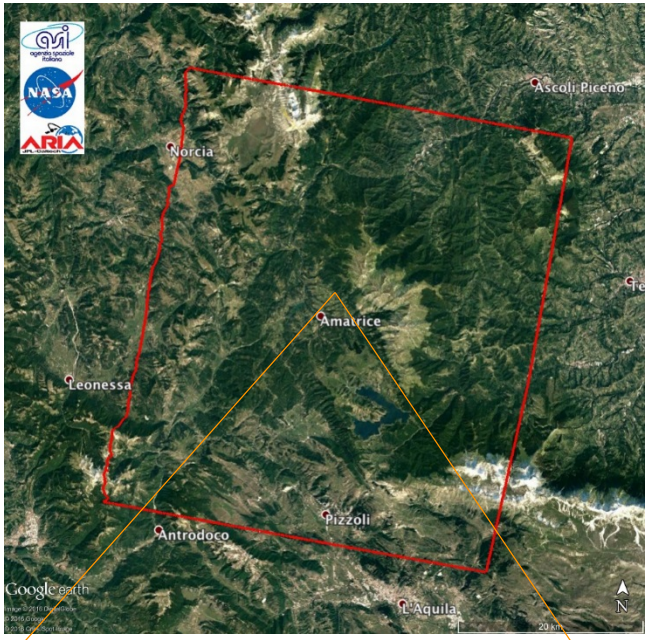
ARIA Damage Proxy Map from COSMO-SkyMed SAR Data

Showing Change Between Aug 20 – Aug 28, 2016



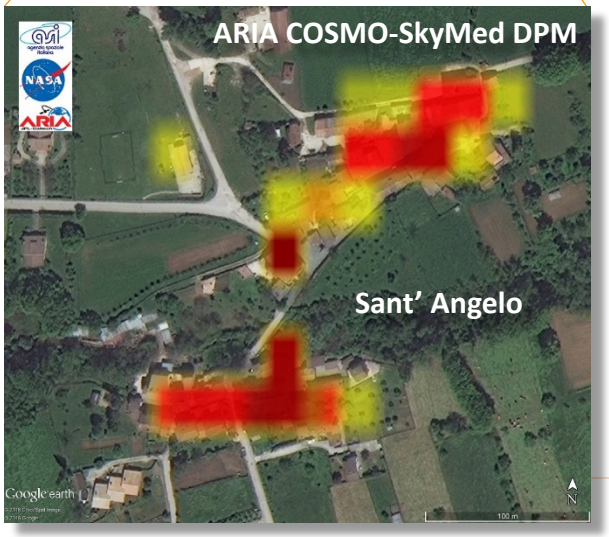


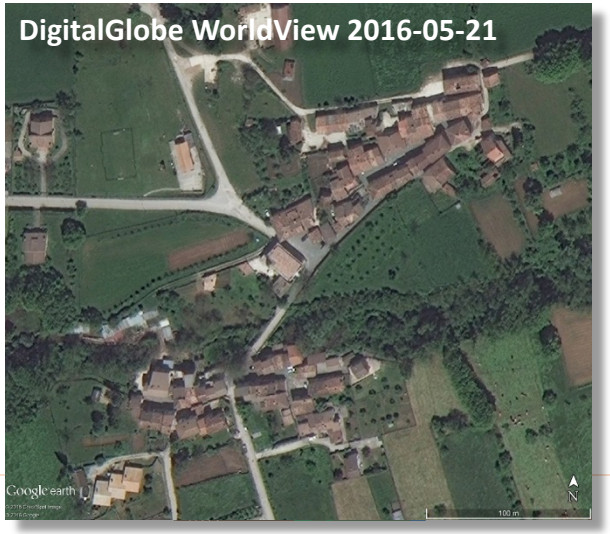




- Derived from COSMO-SkyMed SAR Data (Aug 28)
- Coverage: 40 km x 50 km
- Resolution: 30 m
- Calibrated with Copernicus map
- Product formats: KMZ, GeoTiff
- Product URL

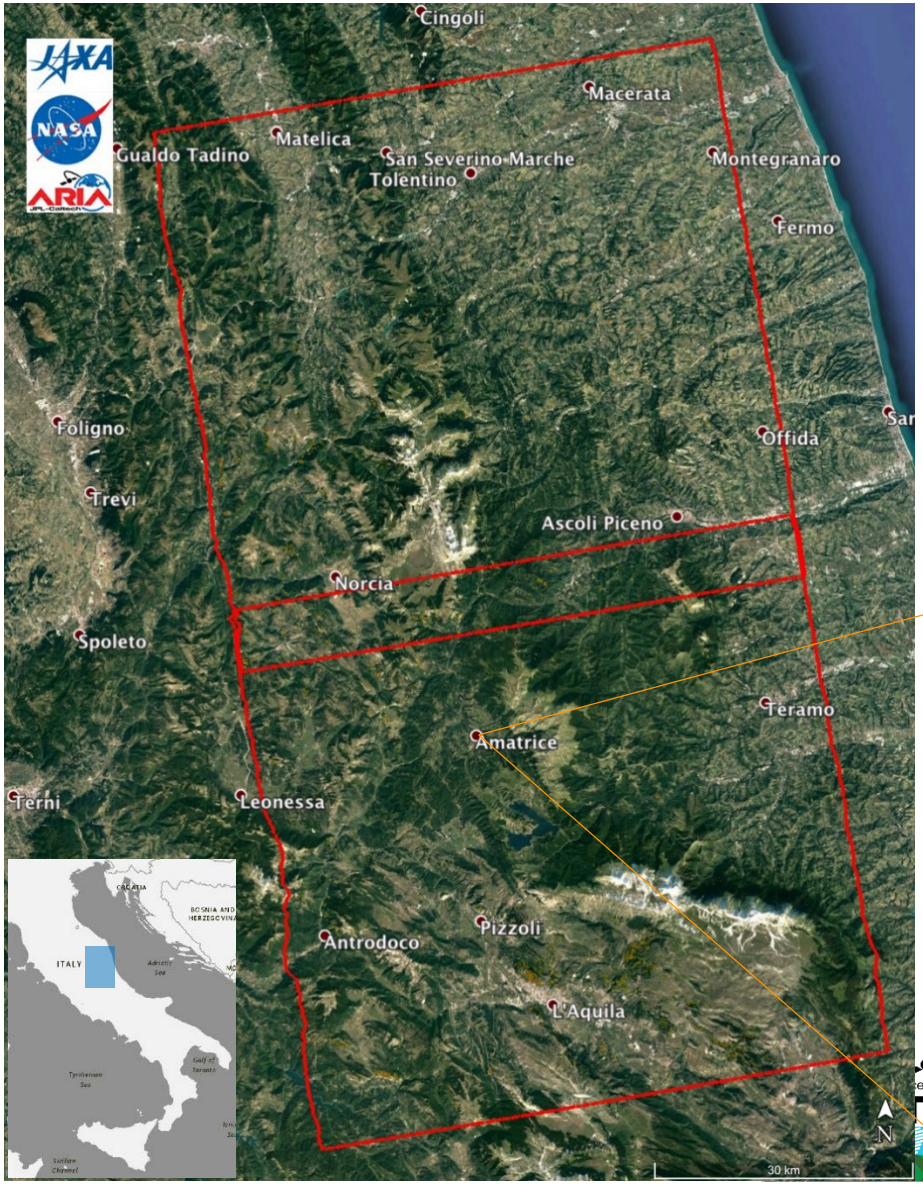
  http://aria-share.jpl.nasa.gov//events/20160824-Italy_EQ/DPM/

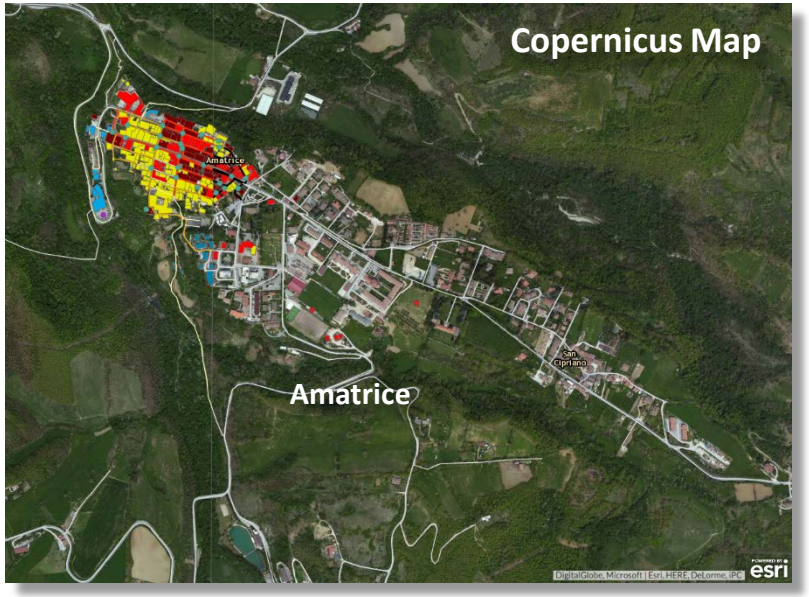


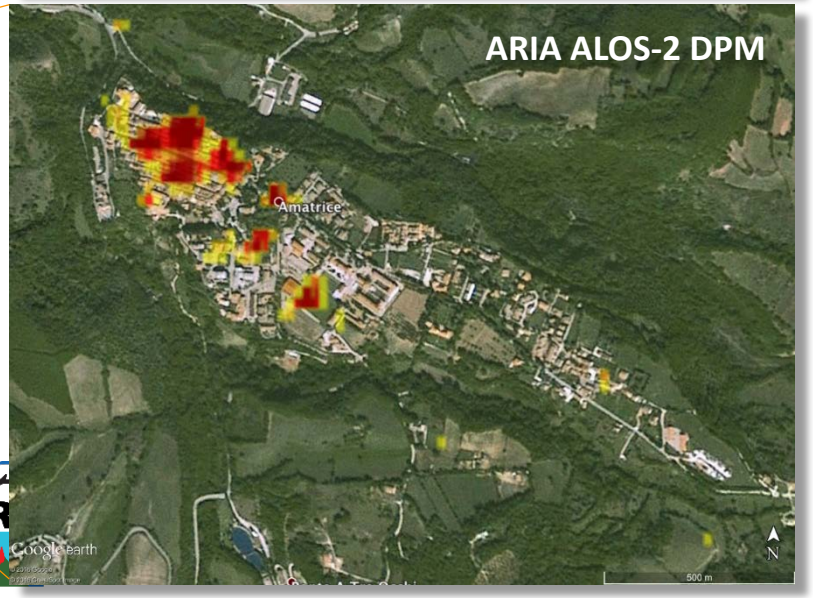


ARIA Damage Proxy Map derived from ALOS-2 SAR Data

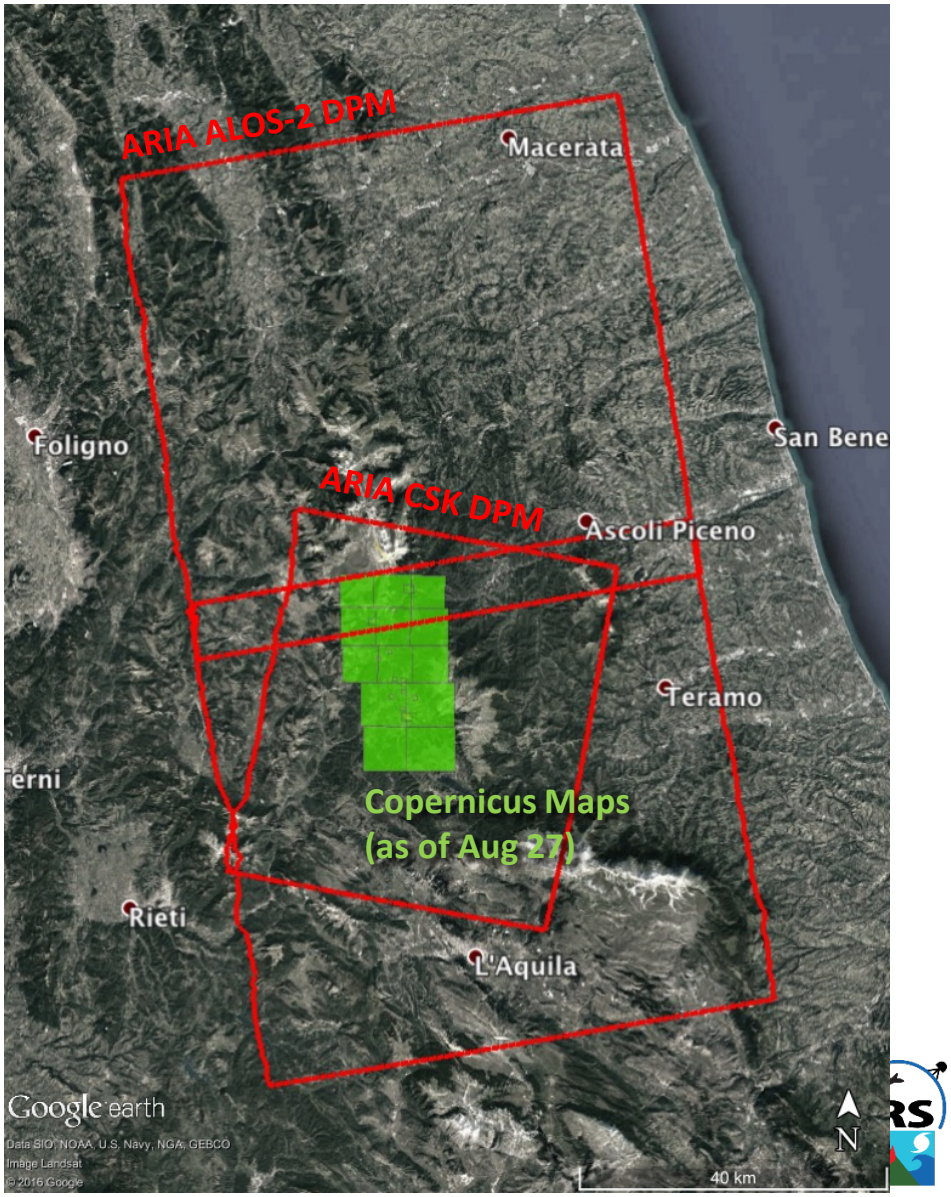
Showing Change Between Jan 27 – Aug 24, 2016







ARIA Damage Proxy Maps Cover Wide Area



Damage Proxy Maps can improve situational awareness at early stage of response, providing synoptic view of large area. The maps may be less reliable over vegetated areas. The Damage Proxy Maps were created by Advanced Rapid Imaging and Analysis (ARIA) team at JPL/Caltech. The COSMO-SkyMed data were provided by the Italian Space Agency (ASI), and the ALOS-2 data were provided by Japan Aerospace Exploration Agency (JAXA).

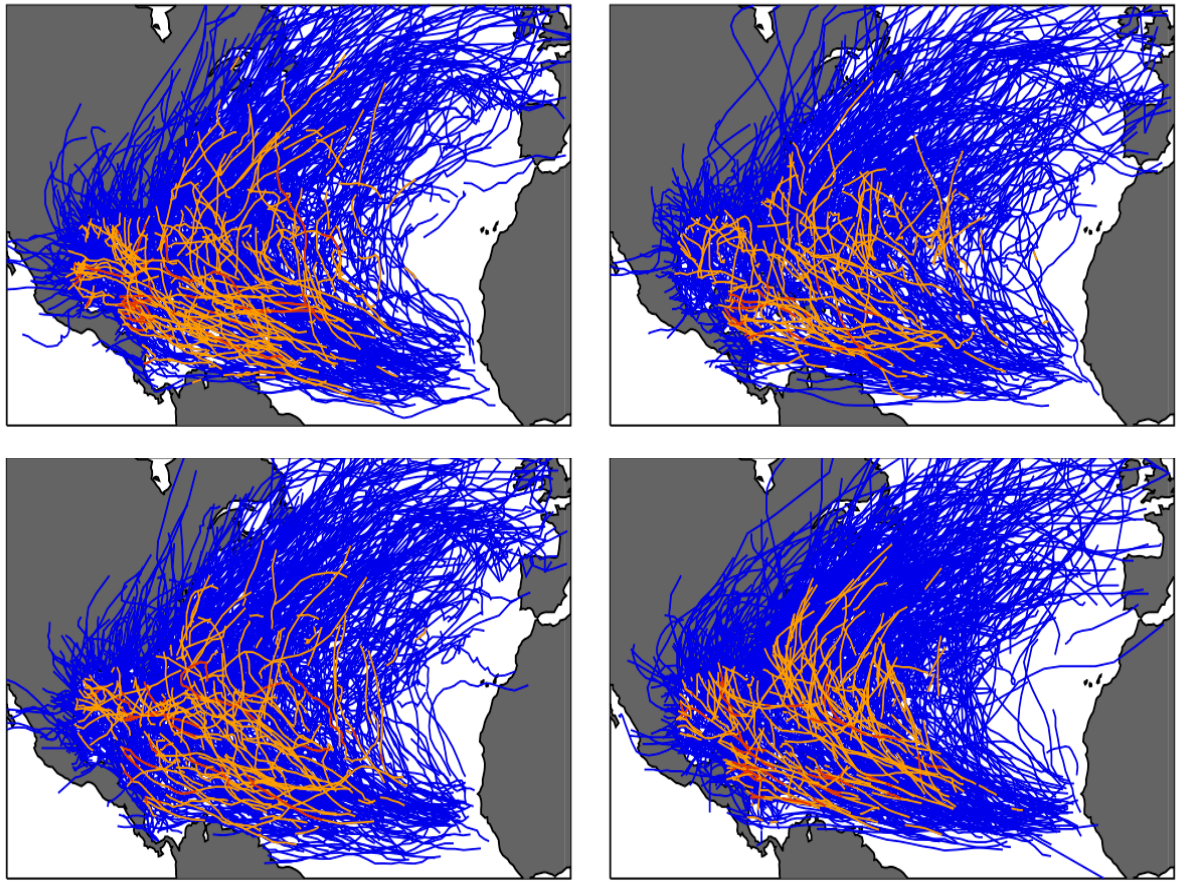
Updates from Group?

- Proposal news?
- Workshop news?
- Relevant events?
- **If you have any new publications, visualizations, keynote presentations, etc. on the topic of disasters that you would like highlighted…PLEASE let us know (Dalia, Miguel and/or Maggie)**

Presentation by Tim Hall

- Senior Scientist, NASA Goddard Institute for Space Studies, and Adjunct Professor, Department of Applied Physics and Applied Mathematics, Columbia University

Hurricane Hazard Modeling



Tim Hall

National Aeronautics and Space Administration
Goddard Institute for Space Studies

Outline

Basic Methods

- Statistical model of TC life cycle of using basin-wide HURDAT/IBTrACS 1950+.
- A few large-scale climate covariates (seasonal SST, ENSO).
- Generate large sets of synthetic TCs for rate estimations.

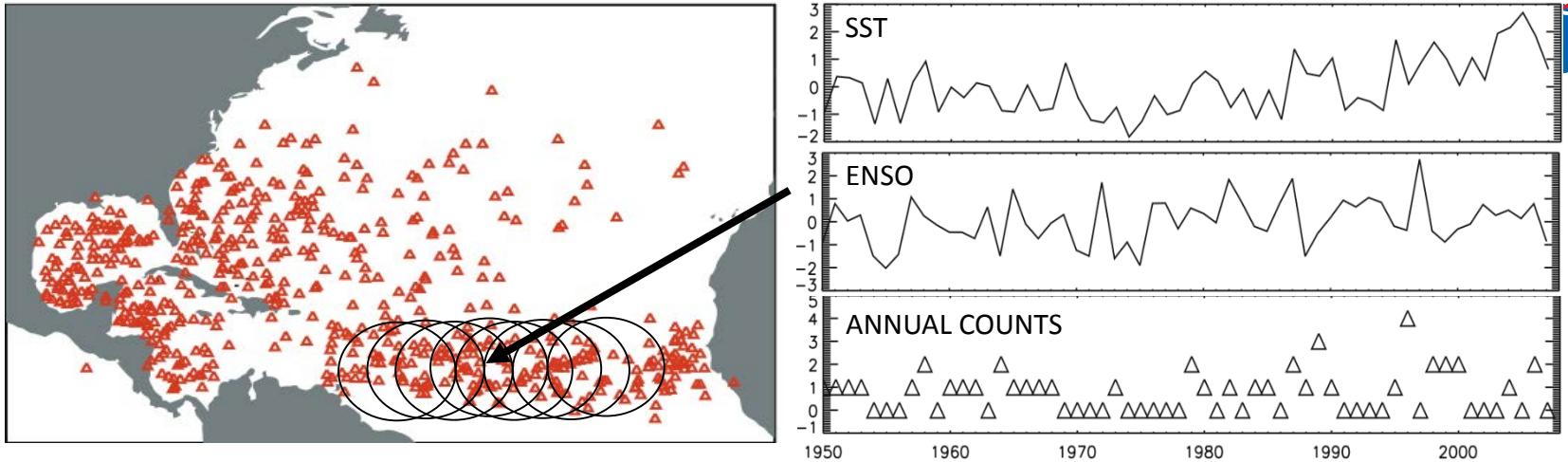
Model Components

- Formation
- Track
- Intensity

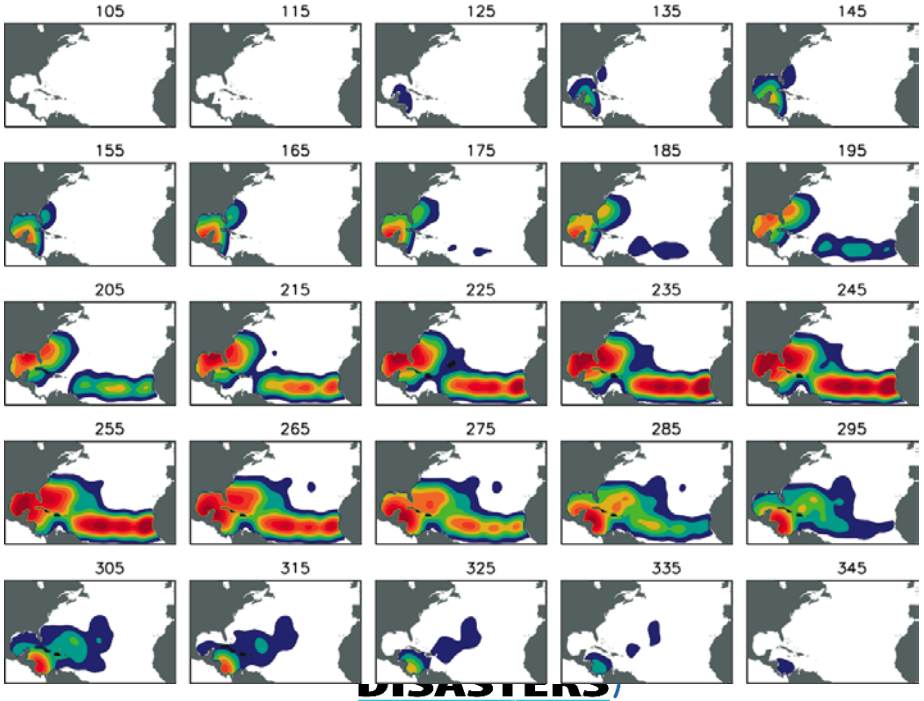
Applications

- Regionally-resolved rates of landfall hazard, means and spread.
- Landfall rates as functions of climate state.
- Return periods of particular events; e.g., Sandy track, landfall drought.
- Drive hydrodynamic models of storm surge.
- Seasonal probabilistic forecasts.
- Catastrophe-bond analysis.

Formation

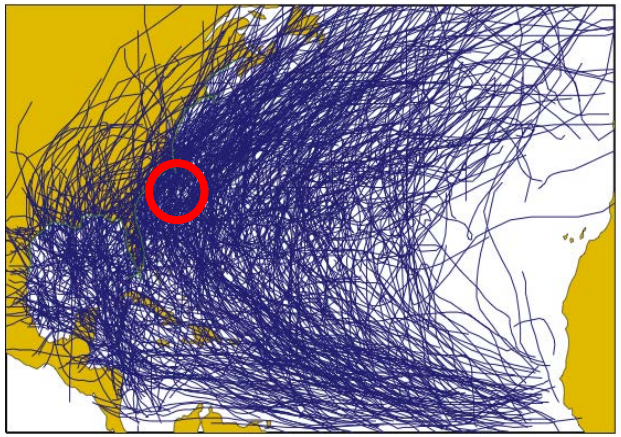


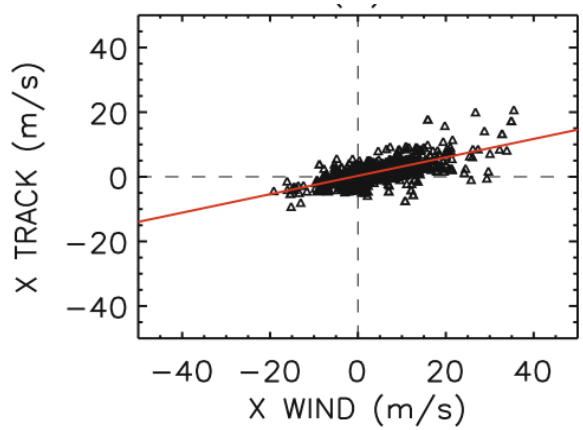
Local Poisson regression annual formation counts on large-scale covariates



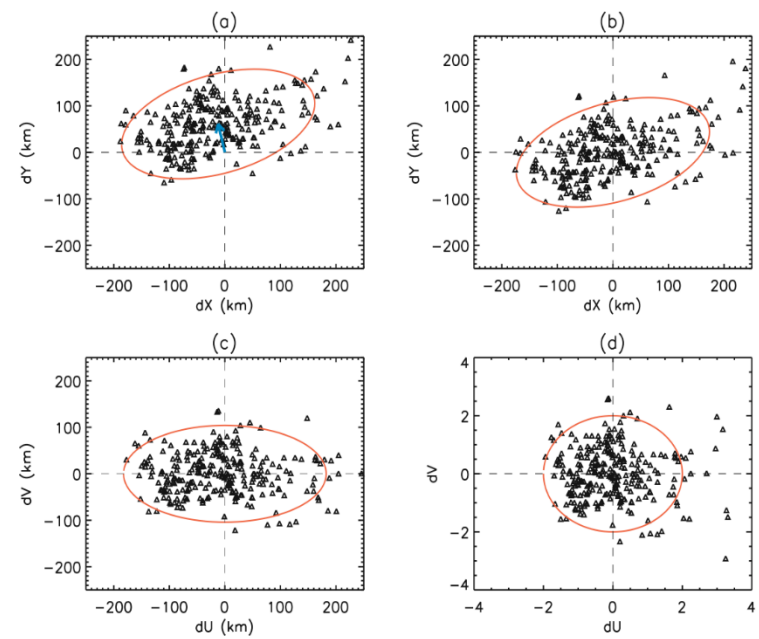
Space-time kernel density for date of year

Tracks: 6-hour increments *Hall and Jewson, 2007; 2008*





Means from local regression on upper-level NCEP annual-cycle composite



dx, dy modeled with bivariate correlated normal distribution.

$$u_i = c\,u_{i-1} + (1-c^2)^{1/2}\,\varepsilon$$

Standardized du, dv errors independent. Each has high Autocorrelation at lag one.

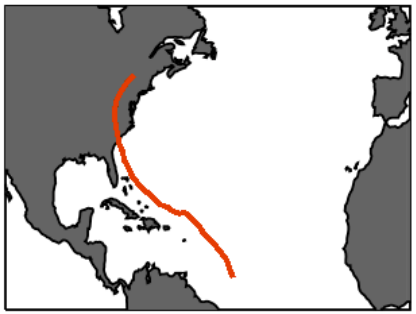
Model errors as AR(1)

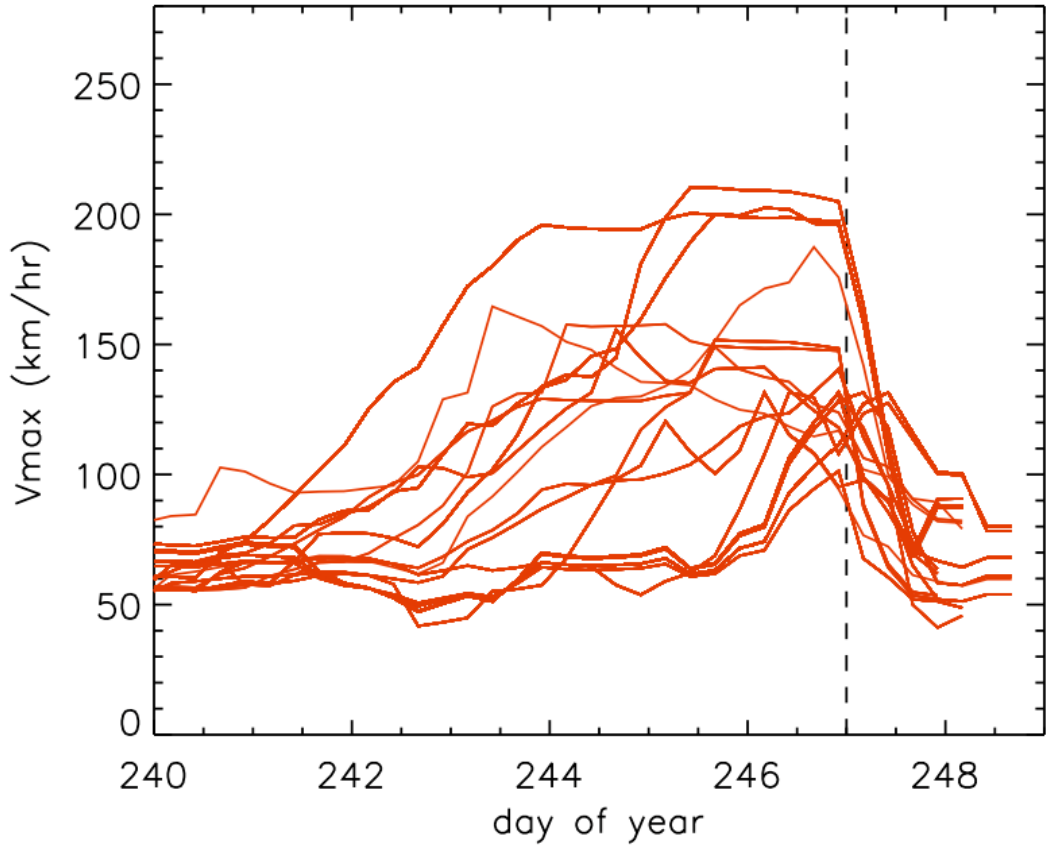
- Rescale u, v by rms variance
- Rotate to x, y coordinates
- Add x, y means

Convert back to dimensional x, y.

Intensity: V_{max} time series sampling

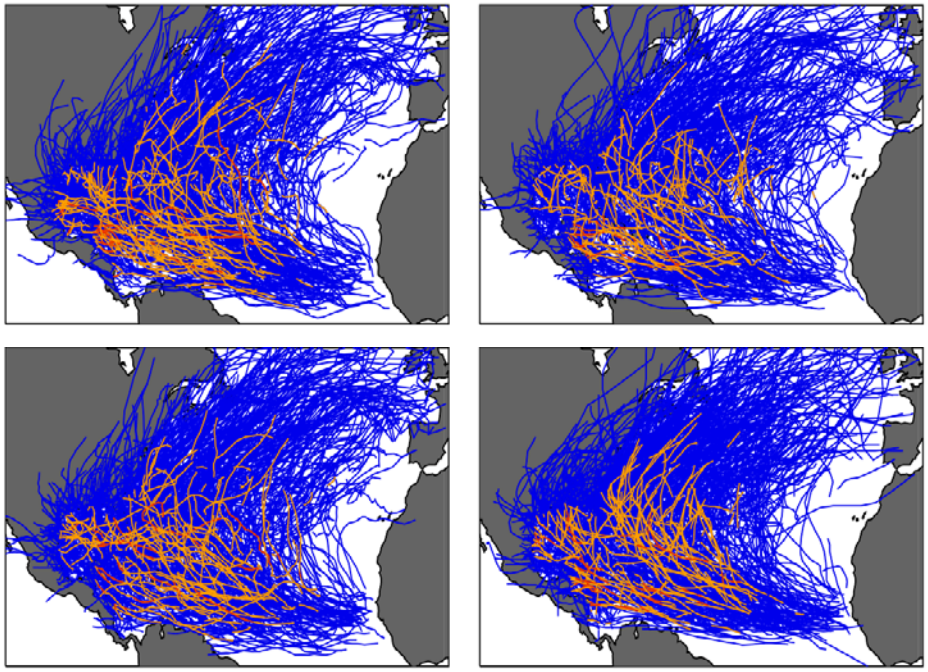
Preference to series whose tracks are similar to simulated track. Separate ocean land segments. Add perturbation to selected series.



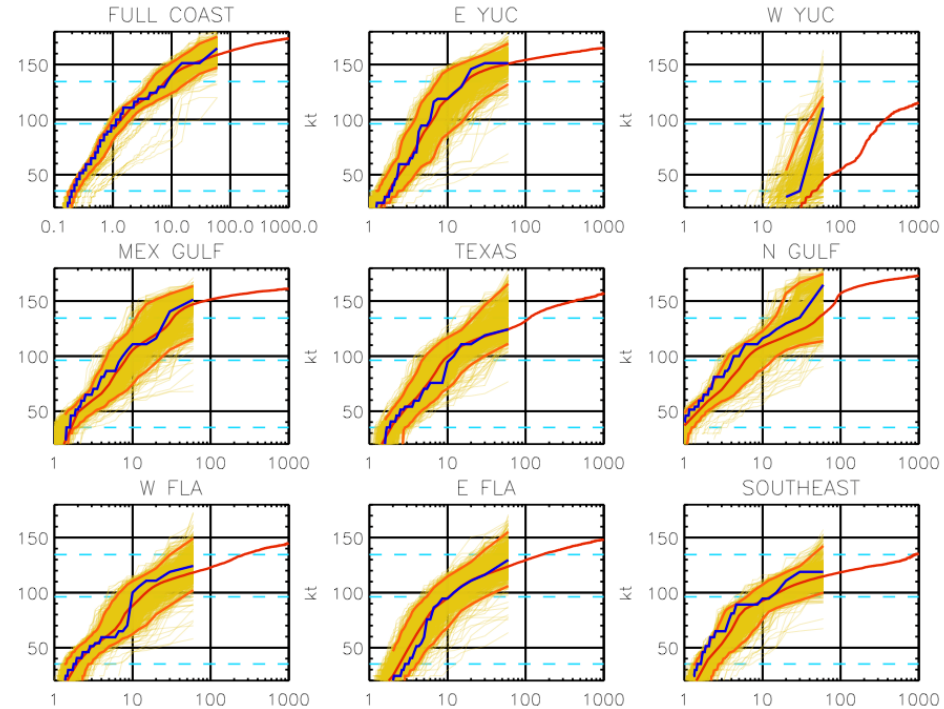


Example of multiple V_{max} simulations on single track.

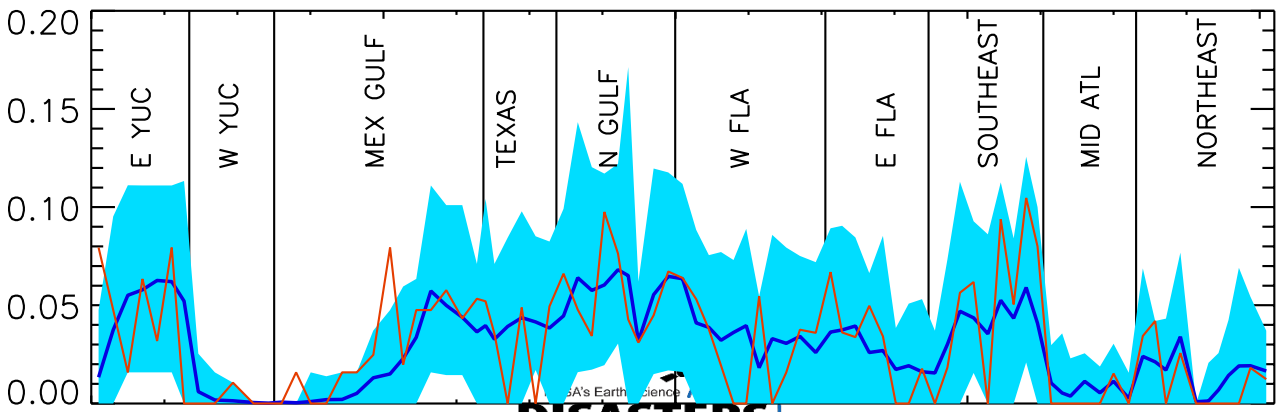
Simulation and landfall evaluation (*Hall and Yonekura, J Clim, 2013*)



Multiple simulations of historical period (e.g., 1950-2012)

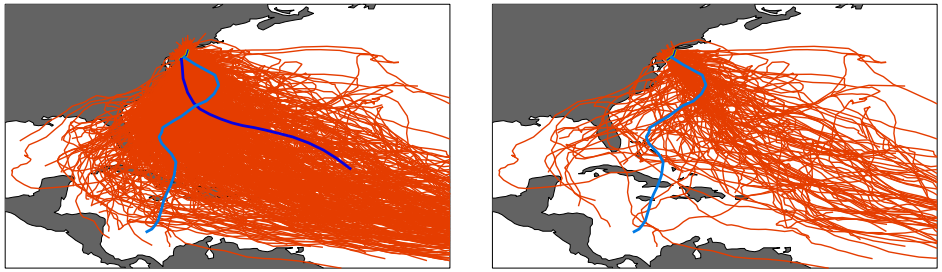


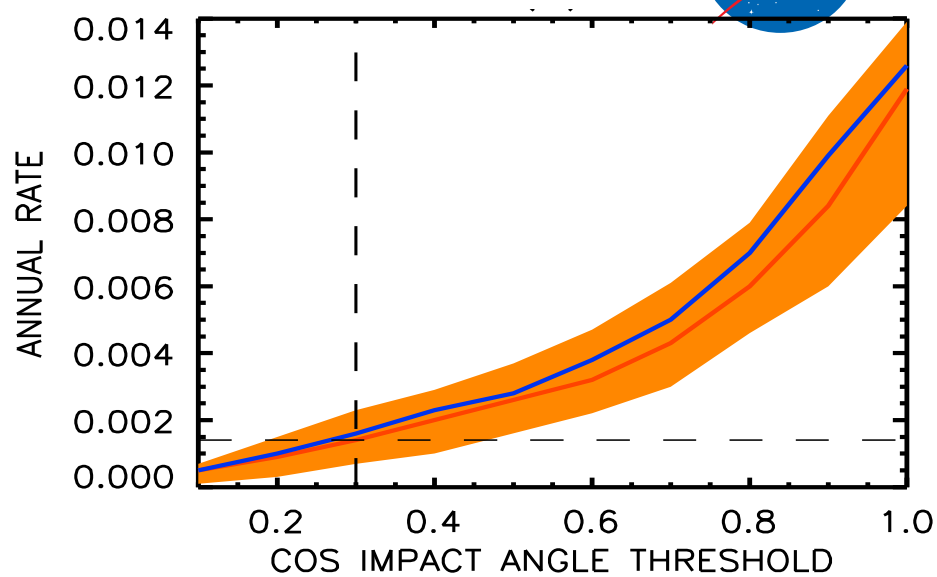
Regional return periods model mean (red), model spread (yellow), HURDAT (blue).



Annual rate per 100km of Cat1+ landfall along the coast. HURDAT (red), model mean (dark blue), model spread inner 90% (light blue).

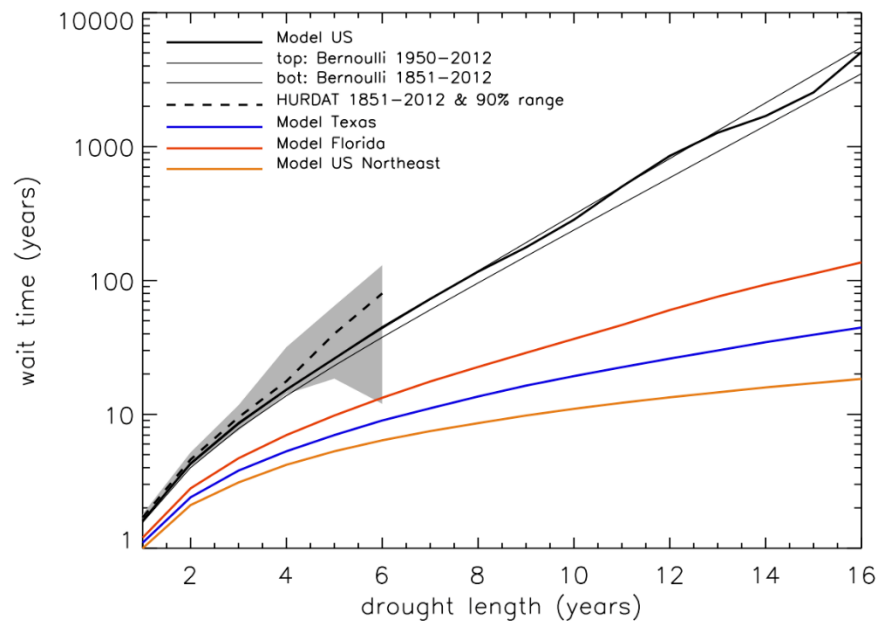
TC Model Applications





On the Impact Angle of Hurricane Sandy's New Jersey Landfall

Hall and Sobel, GRL, 2013



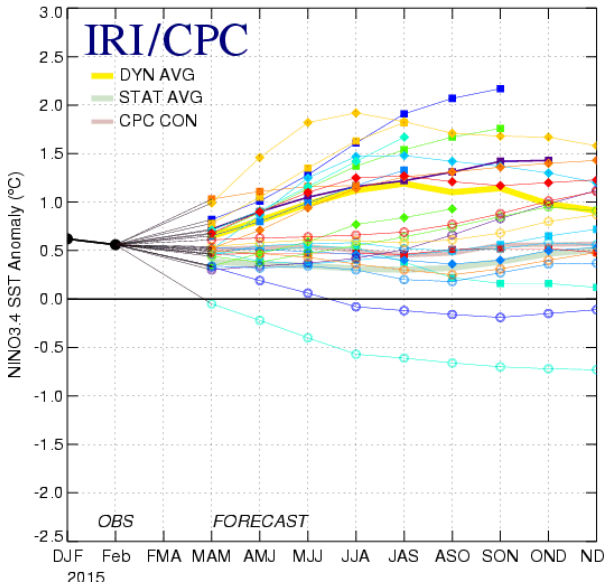
The Frequency and Duration of US Hurricane Droughts

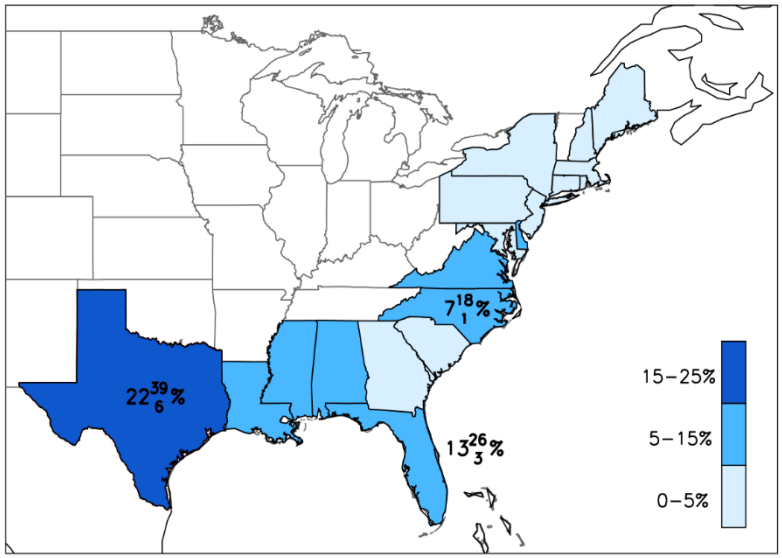
Hall and Hereid, GRL, 2015

Seasonal Outlooks:

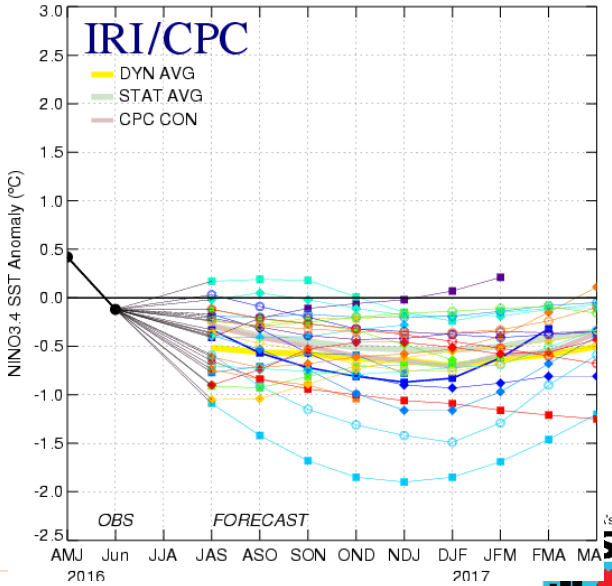
2015/2016 Cat1+ landfall forecasts below/above average, driven by ENSO and N. Atl. SST.

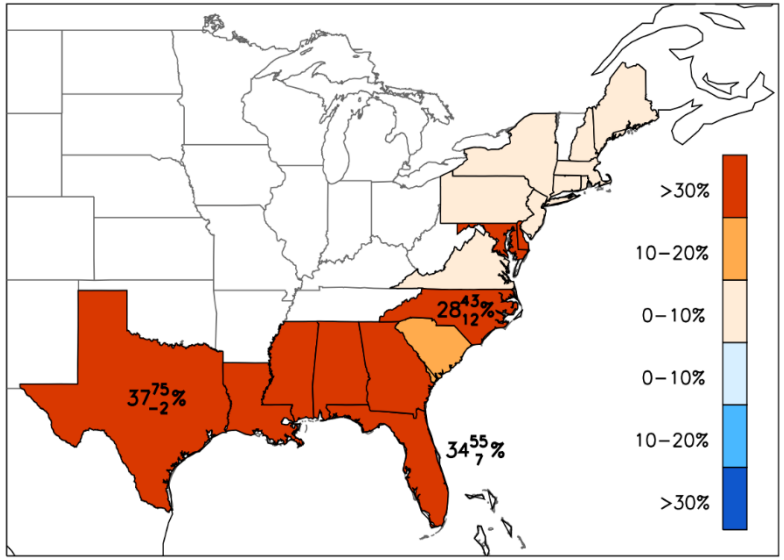
2015





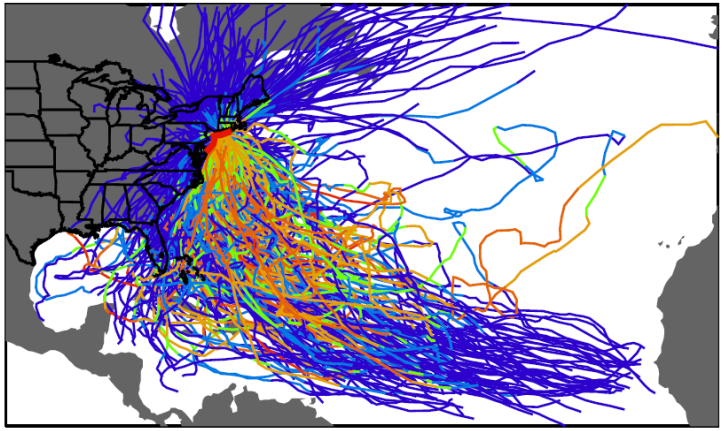
2016





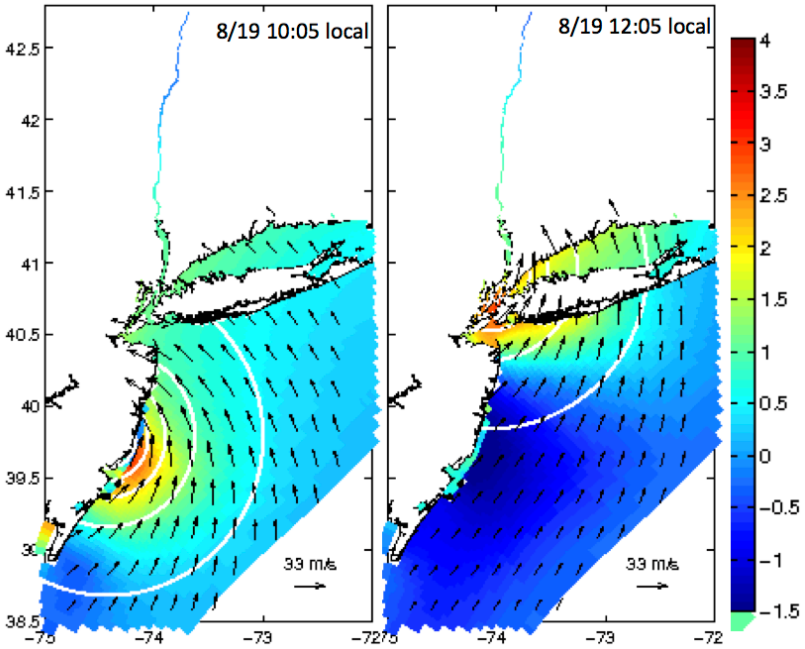
Hall, InsuranceLinked.com, 2015, 2016

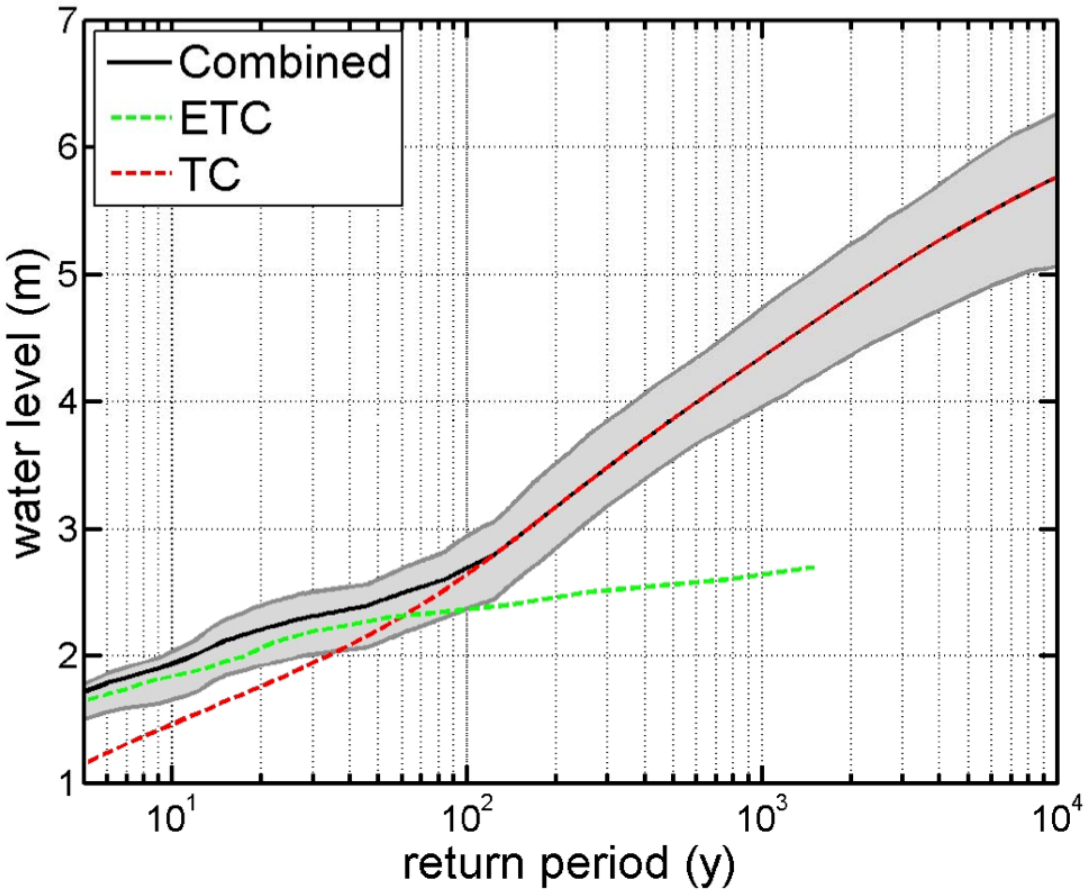
Surge hazard: Drive the sECOM NYHOPS hydrodynamic model



A Validated Tropical Extra-tropical Flood Hazard Assessment for New York Harbor

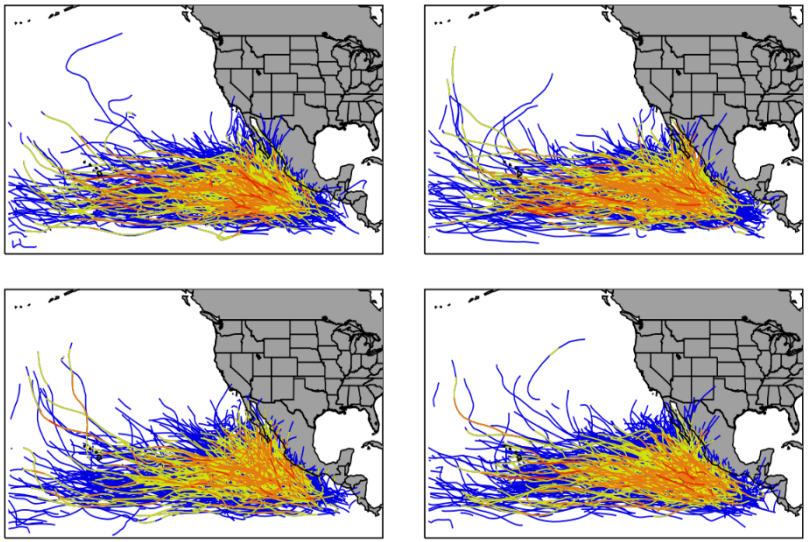
Orton et al., JGR, in press, 2016.



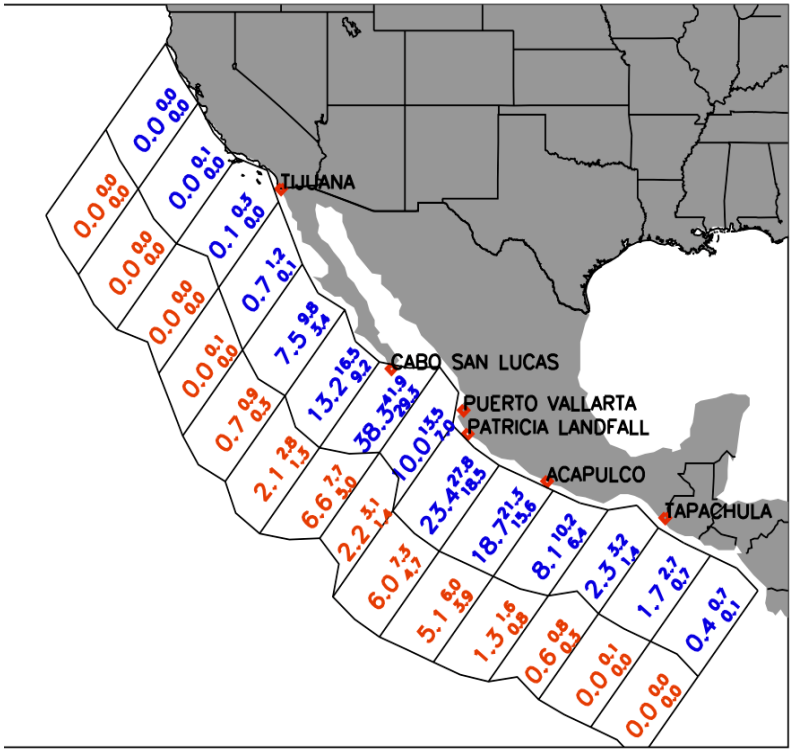


Pacific Hurricane Landfalls on Mexico and SST

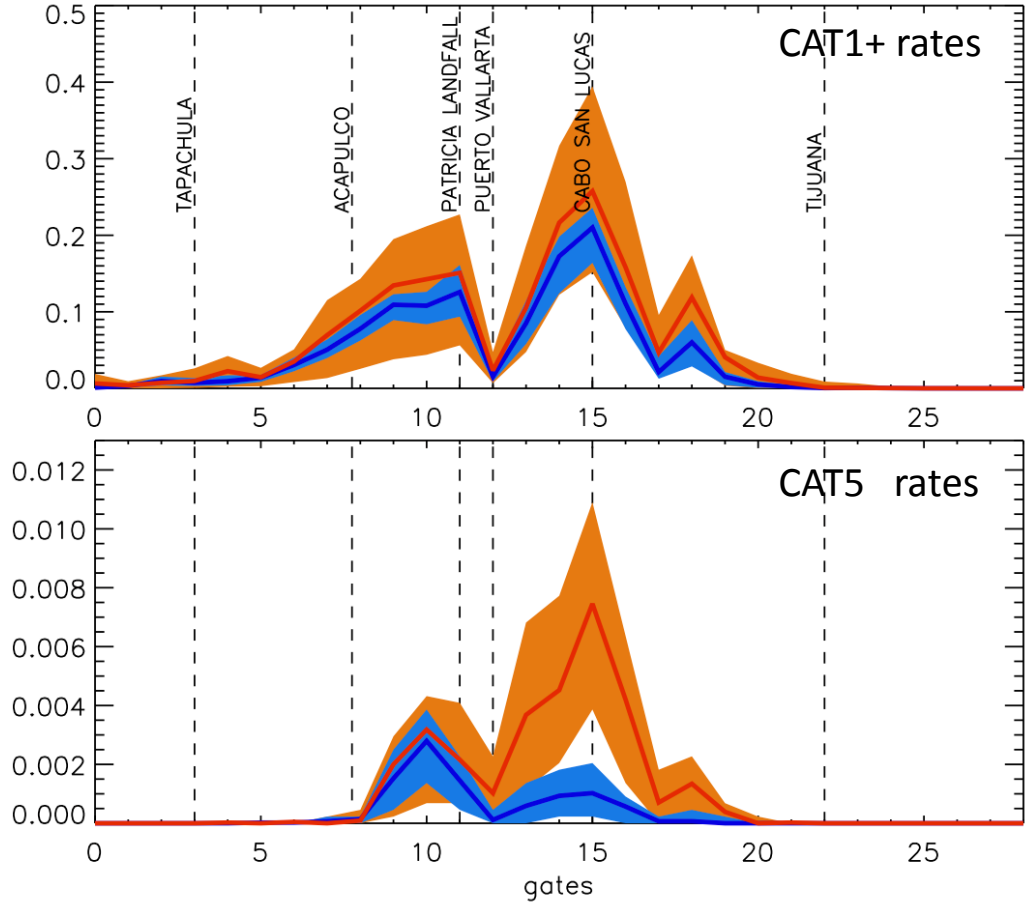
Hall and Tippett, JAMC, in prep, 2016



Multiple simulations 1971-2014 period



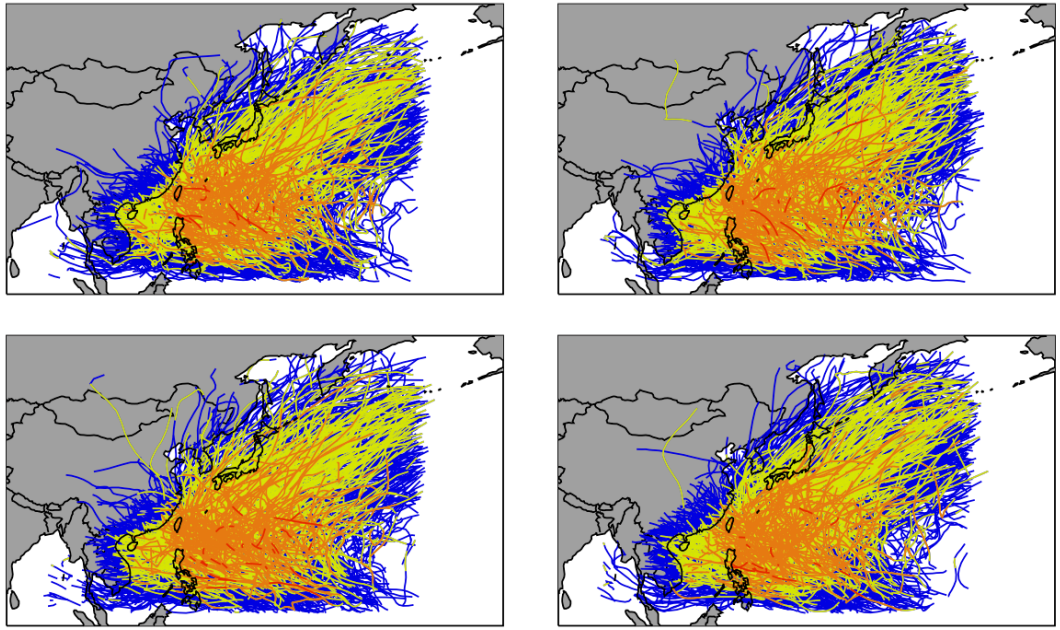
Landfalls per 100 yrs per 400km Cat1+ and Cat3+.



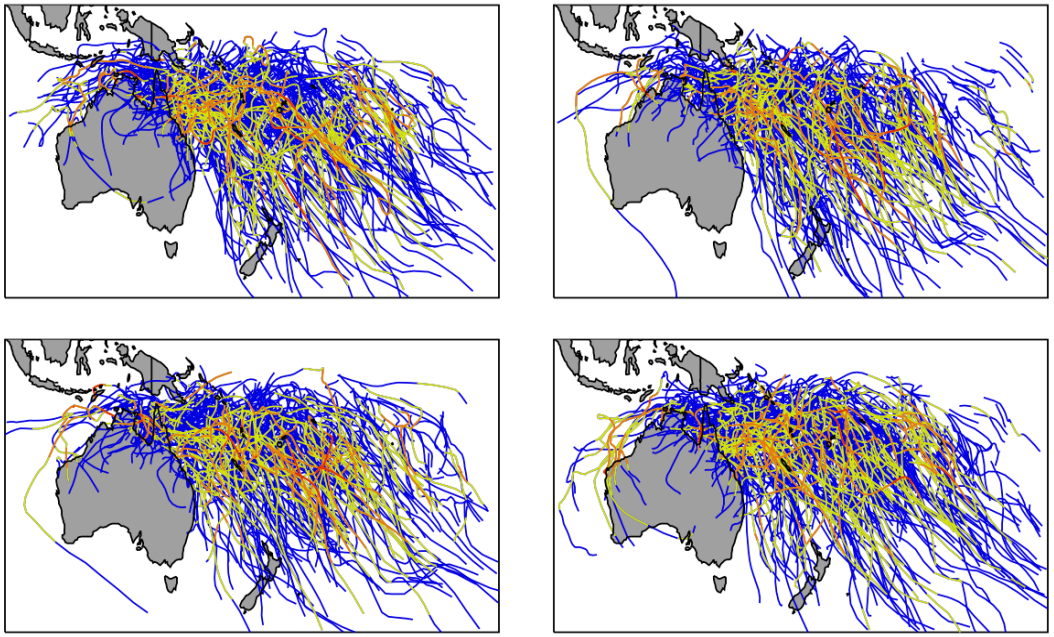
Annual landfall rates per gate along coast for 2015 and 1971-2014 SST conditions with uncertainty.

Same Methods, Other Basins

Multiple ENSO-dependent simulations 1971-2014



Northwest Pacific



South Pacific

Compass Re II cat bond:

Issued by AIG $300M for 2015 North Atlantic hurricane season. Trigger: Loss commences when a specified index surpasses a lower threshold ("attachment"). Full loss occurs above an upper threshold ("exhaustion"). Index depends on hurricane landfall location, intensity, and size. Use TC model to estimate these probabilities.

P_{att}	P_{ex}	L
0.0227	0.0108	0.0157

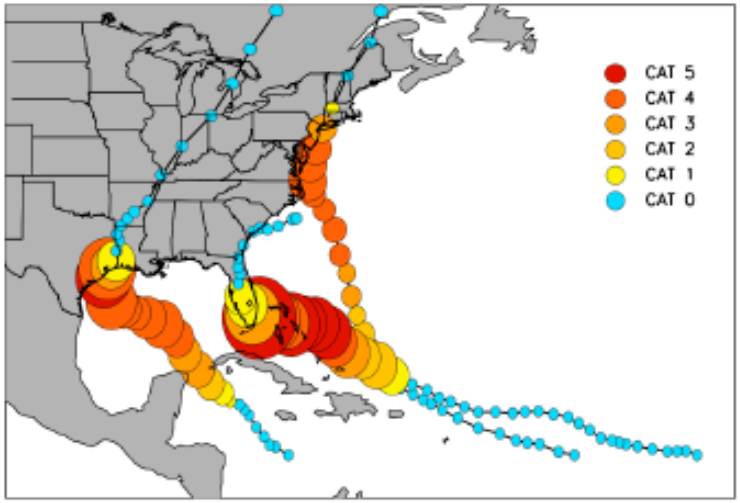


Fig 1: Three simulated hurricanes that exhaust Compass Re II. Color at each 6-hourly track step is the V_{max} category, defined in the key. Circle radius R_{HF} (except for Cat 0).

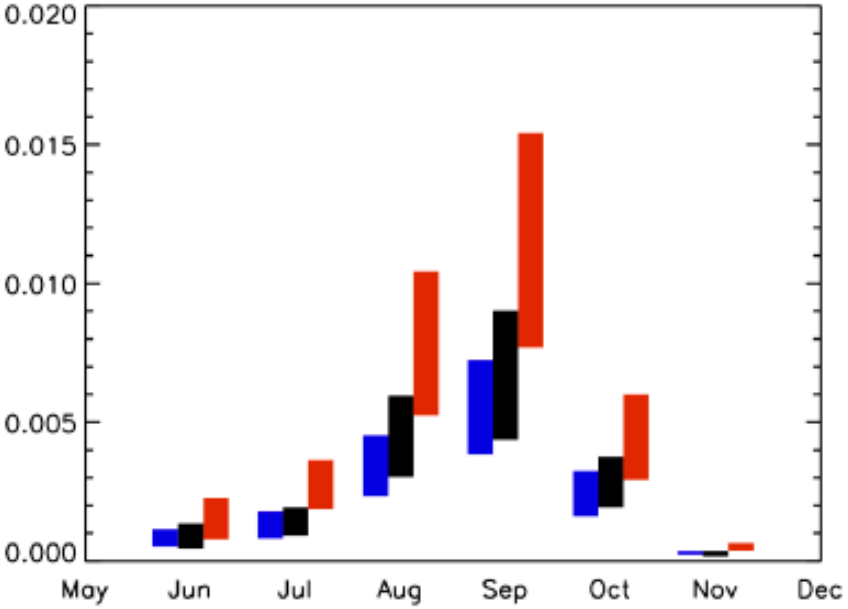
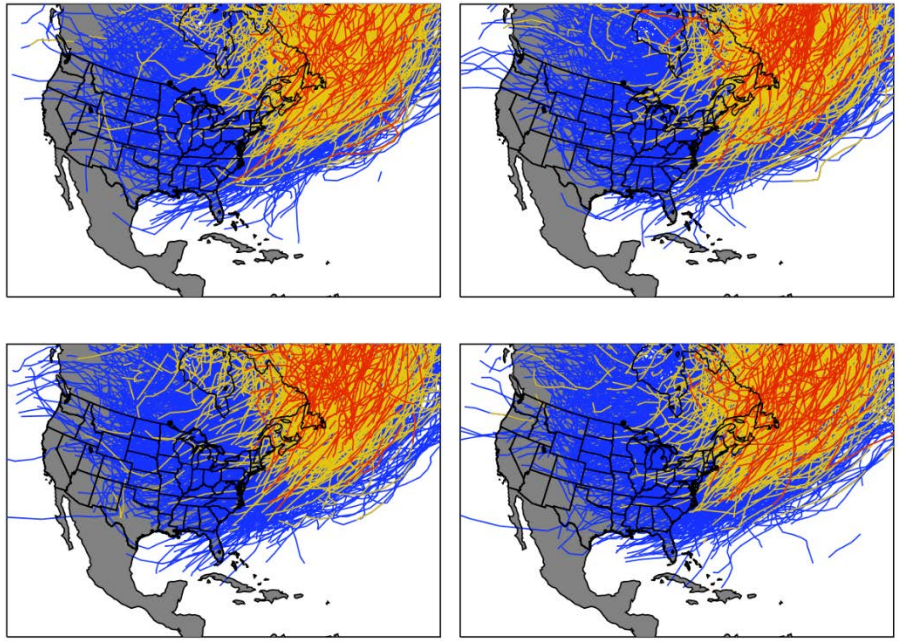


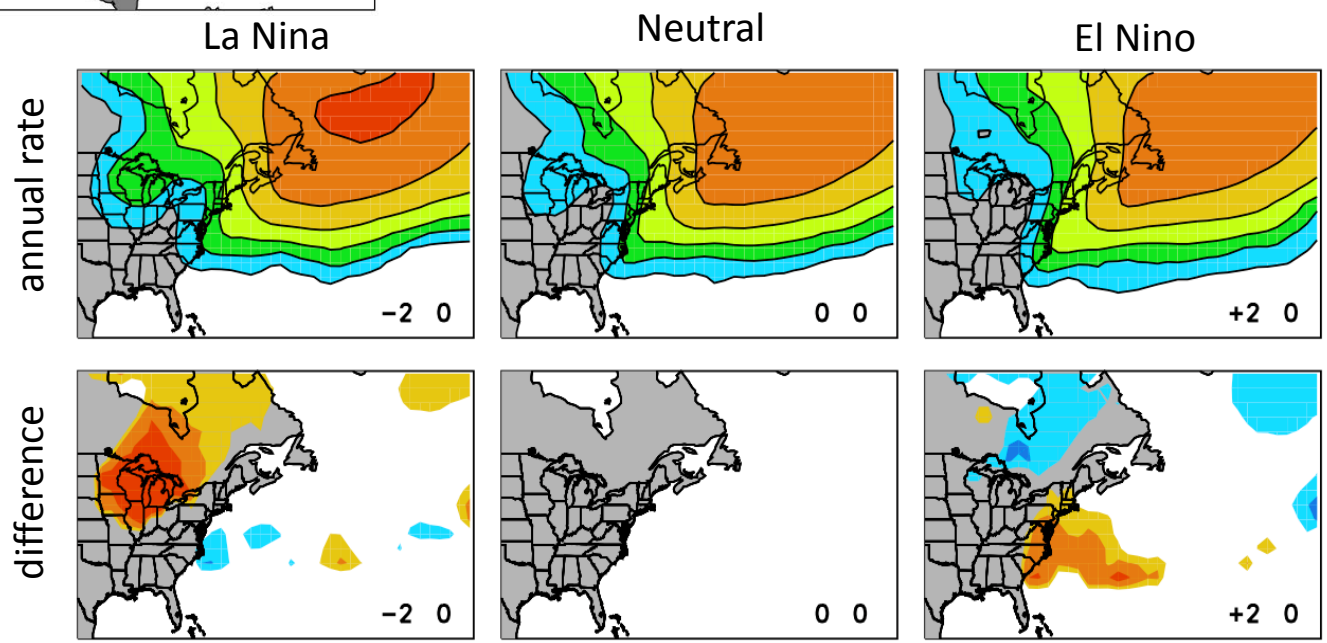
Fig 2: Compass Re II attachment and exhaustion probabilities, P_{at} and P_{ex}, month by month. Black is the long-term best estimate, blue uses the forecast climate state for 2015 (ENSO and SST), and red uses the climate state of 2010. P_{ex} is the bottom end of each band, and P_{at} is the top end. Over the full period P_{at} = 0.023 and P_{ex} = 0.011 for the long-term estimate, P_{at} = 0.018 and P_{ex} = 0.009 for 2015, and P_{at} = 0.039 and P_{ex} = 0.019 for 2010.

Mid-latitude Winter Storms:

- Trained on MCMS-tracked ERA-Interim met reanalysis 1979-2012.
- Dependent on ENSO & NAO.



Annual rate of passage within 200km of ETC with CP<970mb. Contours 0.003, 0.001, 0.03, 0.01, 0.3, and 1 /yr.



Hall and Booth, J Clim, submitted, 2016.

Discussion and Wrap-up

- Get updates on current activities of the NASA Disasters Program (disasters, solicitations, other)
- Disaster response – what is “expected” what can *be* expected
- Summary of Disasters through GSFC White Paper and Data Matrix
- Discuss current GSFC disaster activities (research, operational activities, etc.)
- Two-way feedback on current needs, issues, etc.
- **What else would be helpful?**