GSFC Disaster Working Group

October 28th , 2016

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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 – Dongliu Sun, GMU – Flood Mapping
- 11:40-12:00 – Discussion and next steps

Updates

- **Response Activities**
  - Hurricane Matthew
  - Italy Earthquake
- **Meetings**
  - 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)
  - **ARSET:** Application of Satellite Remote Sensing for Fire and Smoke Monitoring, Nov. 14th, Long beach, CA
  - ARSET: **Remote Sensing Training: Methods & Best Practices, Oct. 13-27th , 3 part webinar**
- **Website**
  - NEW: Internal GSFC Applied Sciences Page, with area for Disasters WG: http://science.gsfc.nasa.gov/610/applied-sciences/index.html
  - NASA Disasters Response Program website to go live in early December
- **Playbooks**
  - Floods (GSFC) – Carver Struve is at HQ working with David Green and is tasked to lead to completion of the emergency response and flood playbooks

Earth Science Division

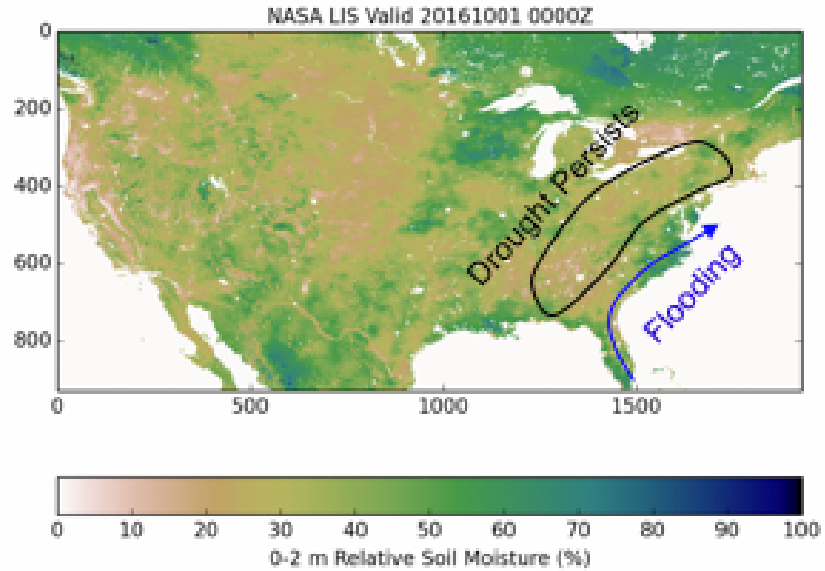
Hurricane Matthew

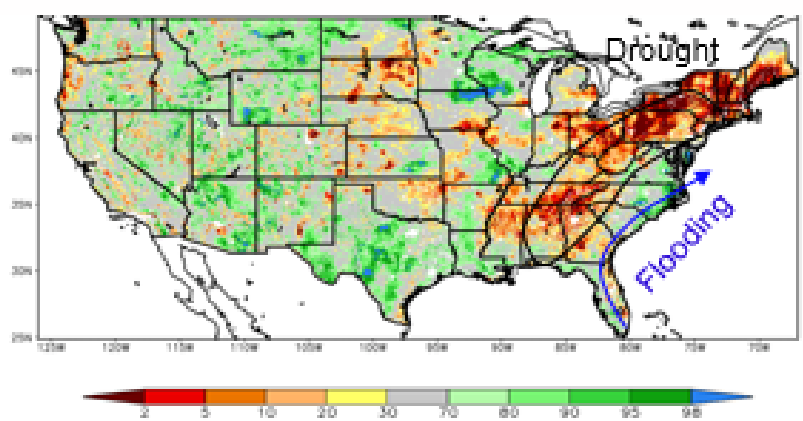
Note: These slides represent support to Matthew from across NASA Earth Science

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.

NASA SPoRT/GSFC LIS: October 1-12, 2016



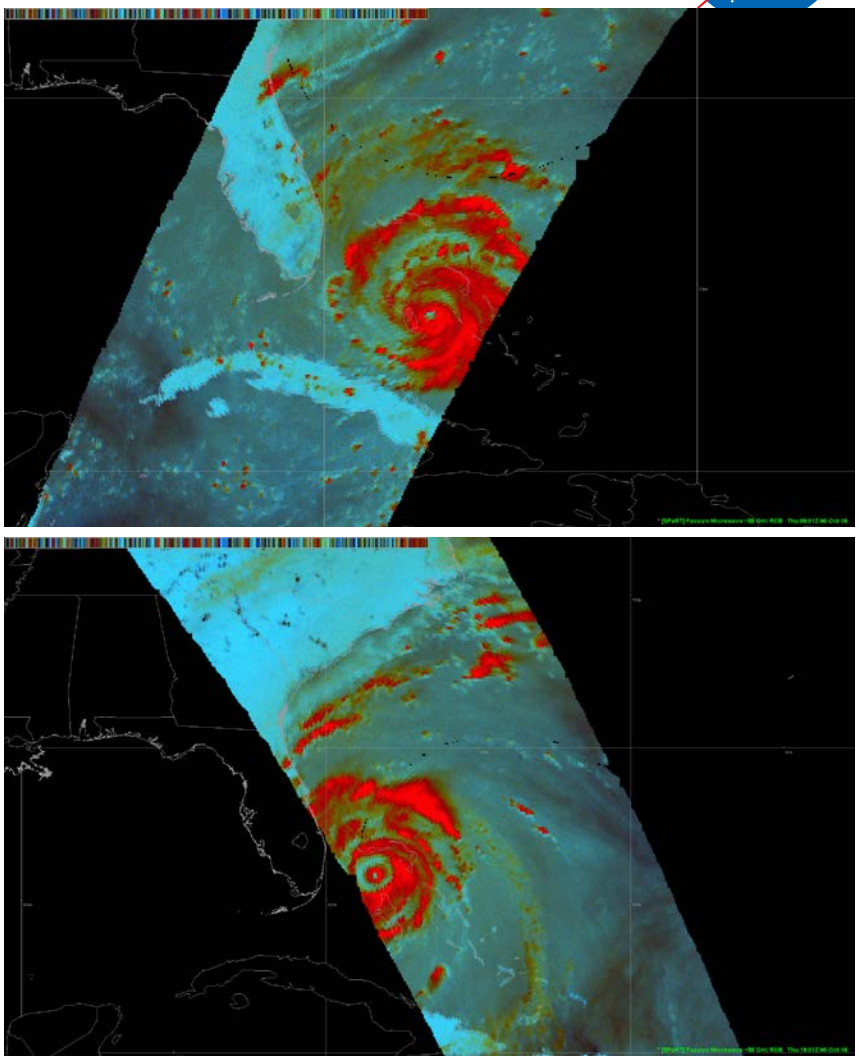


0-2 m Soil Moisture Percentile (30-year Climatology)

(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.

Imaging Matthew's Circulation with GPM

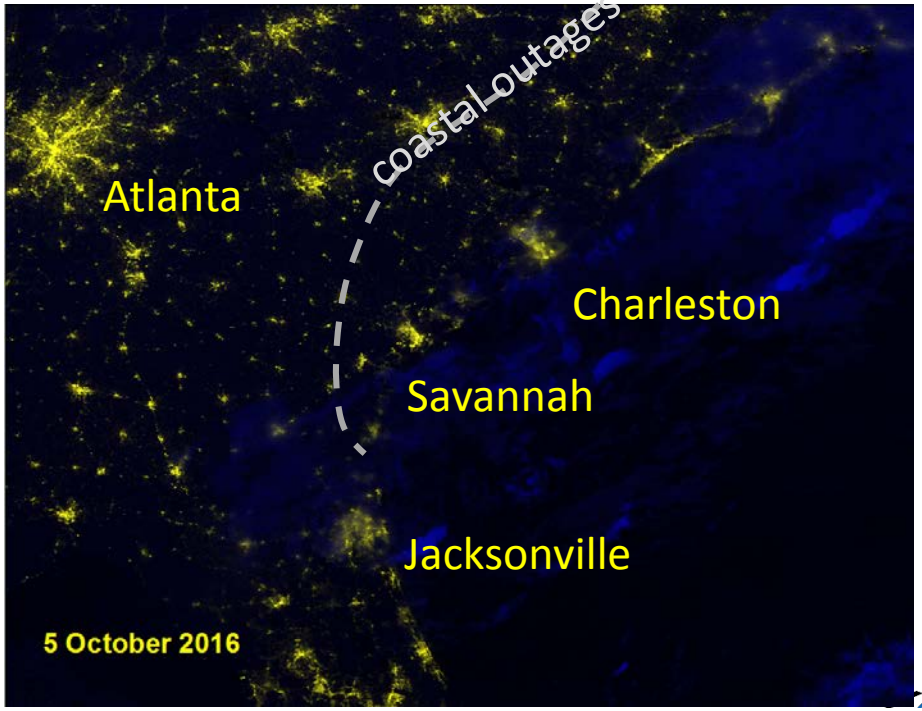
- Collaborative effort between the GPM science team and NASA SPoRT provided brightness temperature and IMERG products to NOAA's National Weather Service and the National Hurricane Center.
- Images on the right capture snapshots of Matthew using NASA's Global Precipitation Measurement mission Microwave 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.



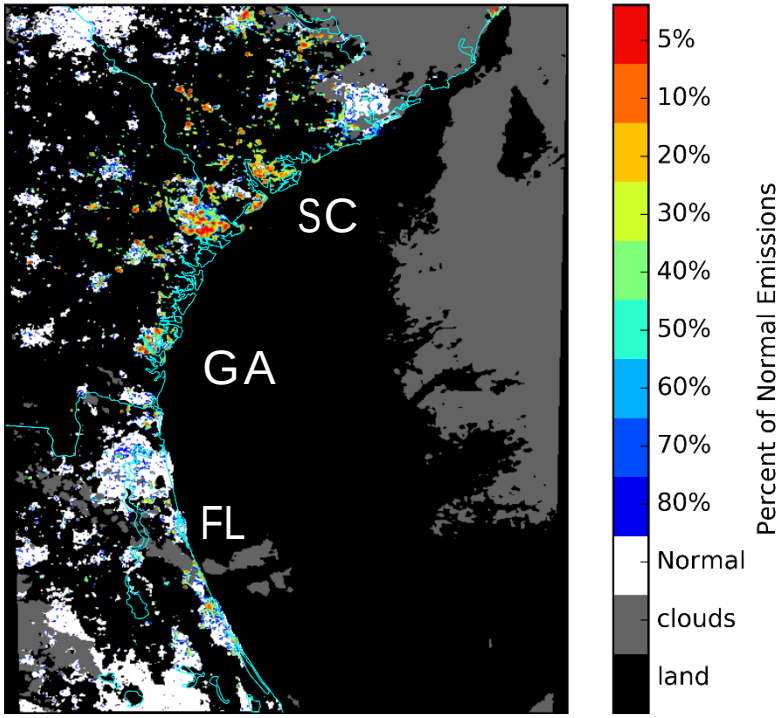
Hurricane Matthew approaches Florida on at (top) 9 and (bottom) 19 UTC on October 6, with passive microwave brightness temperatures observed from the GPM GMI; data provided to NOAA/NWS/National Hurricane Center.

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.



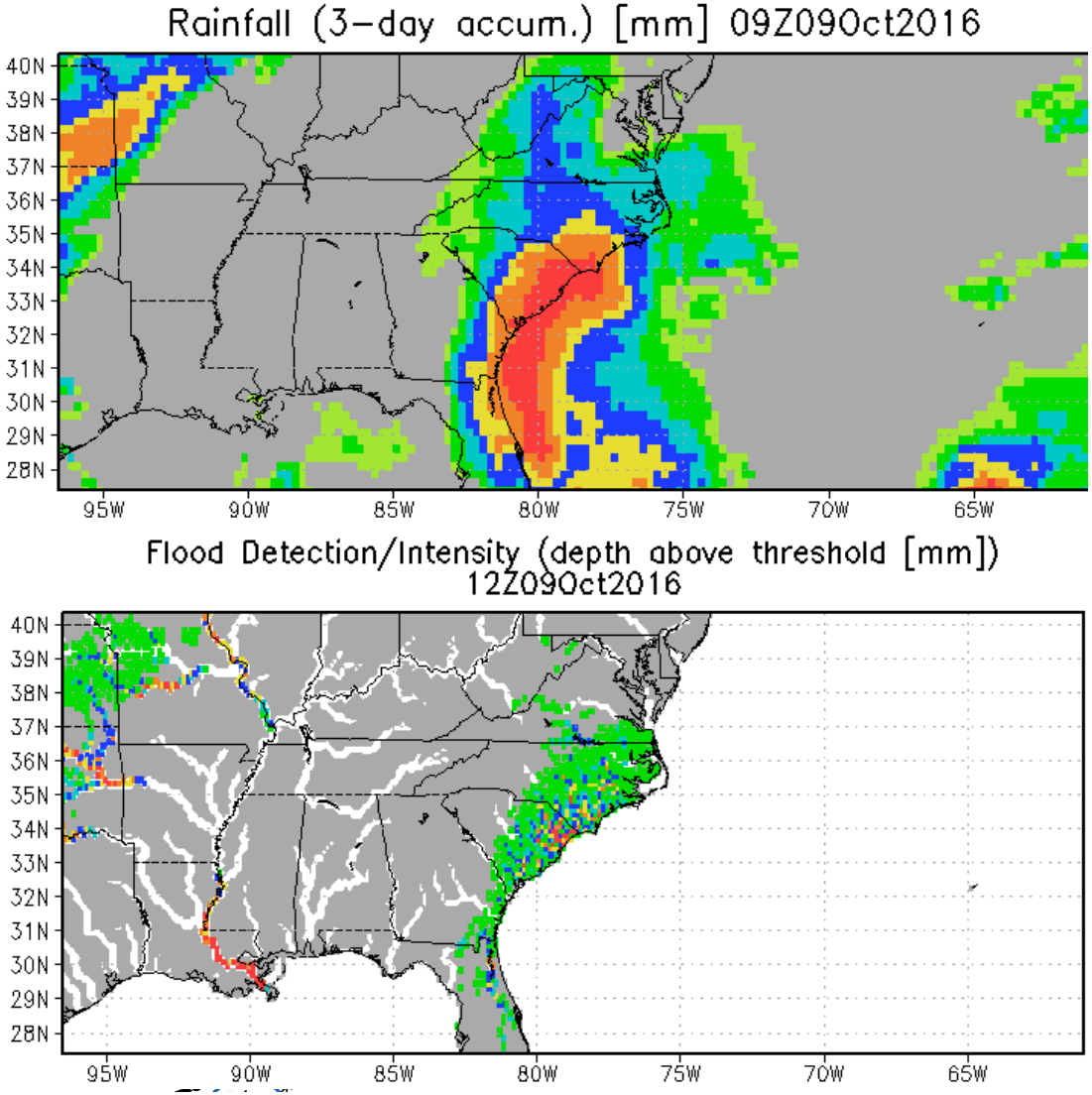
Animation of change in lights pre- and post-event; lights here are shown in yellow, and pre- or post-event cloud cover in blue.



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

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.

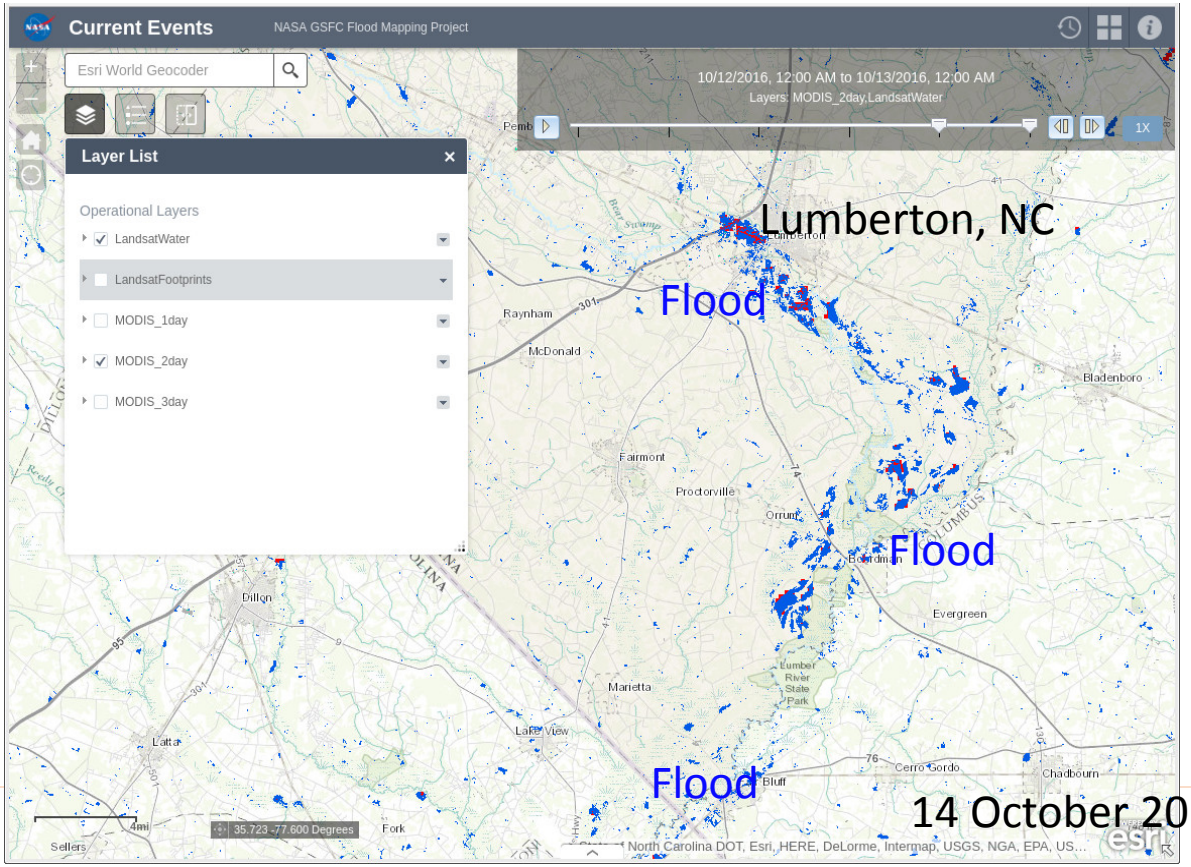


NASA GEOS-5 48-hour rainfall prediction (top) and associated prediction of streamflow and resulting flooding associated with Matthew's coastal impacts on the Carolinas and coastal Georgia.

GSFC Flood Mapping Project

- The Flood Mapping Project provided automated detection of flood extent from Terra and Aqua MODIS as skies cleared following the passage of Matthew.

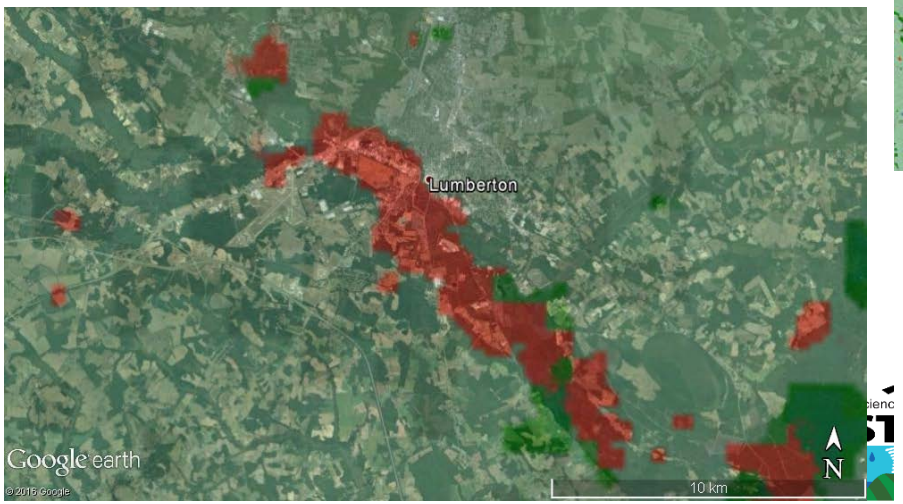
- The Flood Mapping Project identified flooded areas, as illustrated in blue shades. On the ground reports from Lumberton, NC confirmed the flooding.
- The Flood Mapping Project generated products in geospatial formats, shared them with FEMA partners, and made them available through the GSFC Current Events online portal.

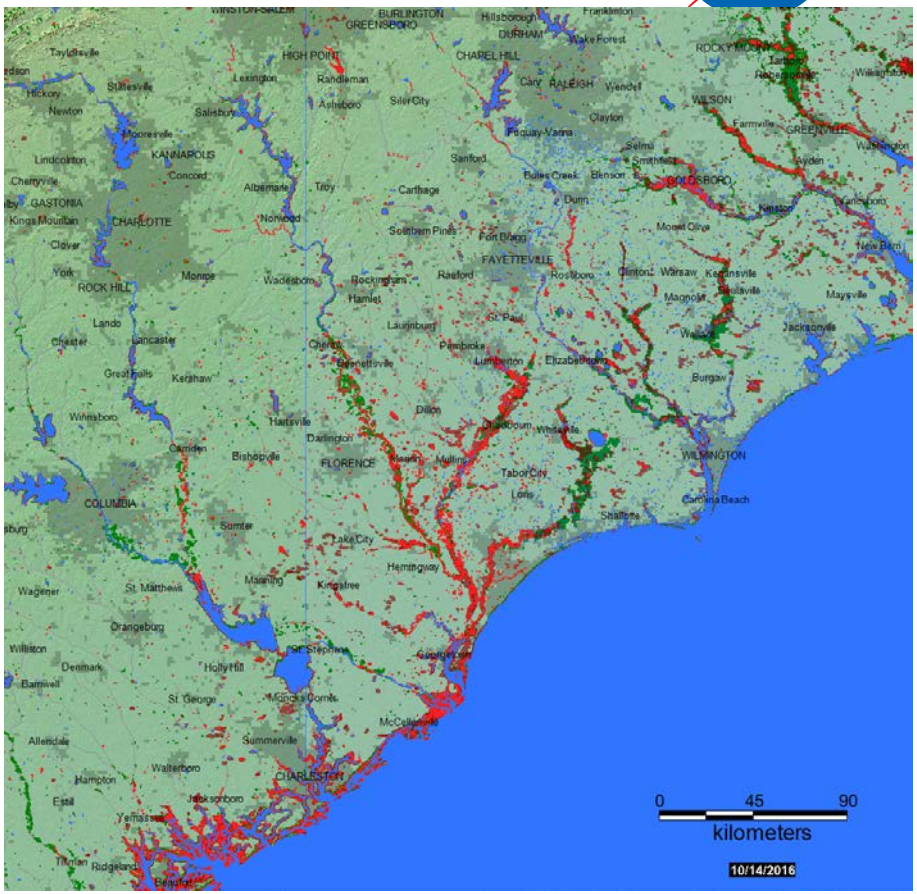


14 October 2016

Dartmouth Flood Observatory

- Flooding in the Carolinas was also well-documented by partners at the Dartmouth Flood Observatory, using VIS/NIR remote sensing from MODIS, Landsat, and EO-1.
- As skies cleared, Dartmouth Flood Observatory produced broad coverage flood mapping (right, bottom) and distributed it to FEMA and other partners to help estimate the broader extent of flooding that had occurred as a result of Matthew.
- Red pixels highlight flood detections from MODIS 250 m products over the two weeks following Hurricane Matthew, while green pixels highlight past flooding events.

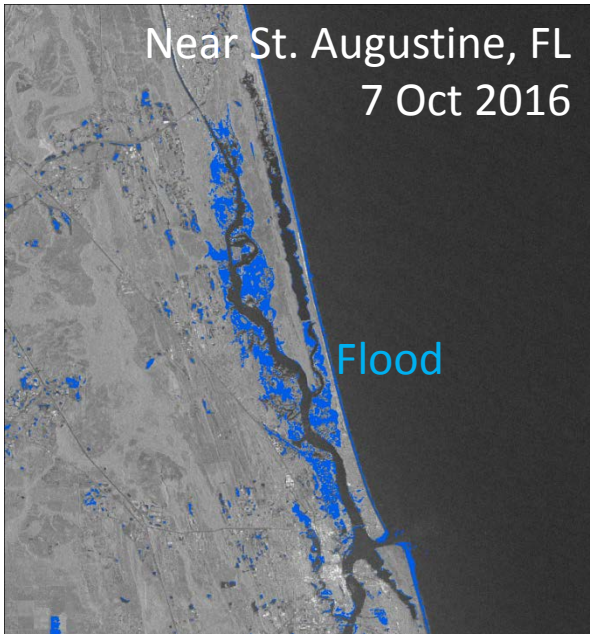




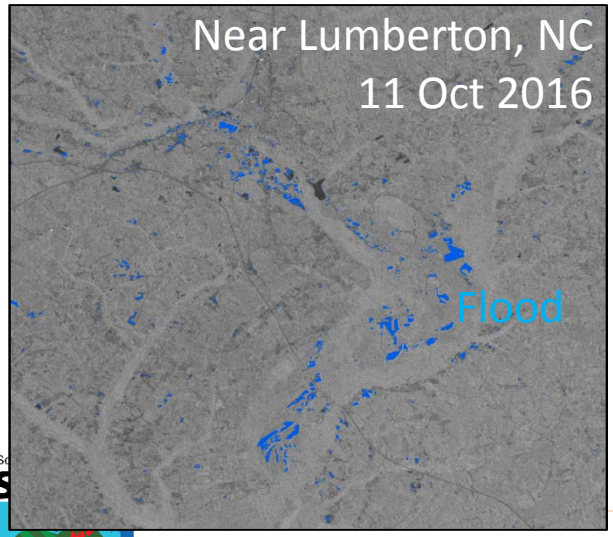
Dartmouth Flood Observatory mapping of flood extent from Matthew with flooded portions of the Carolinas highlighted above in red, and an inset (left) showing extensive flooding near Lumberton, NC. Reports on the ground confirmed flood damage in that area.

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.

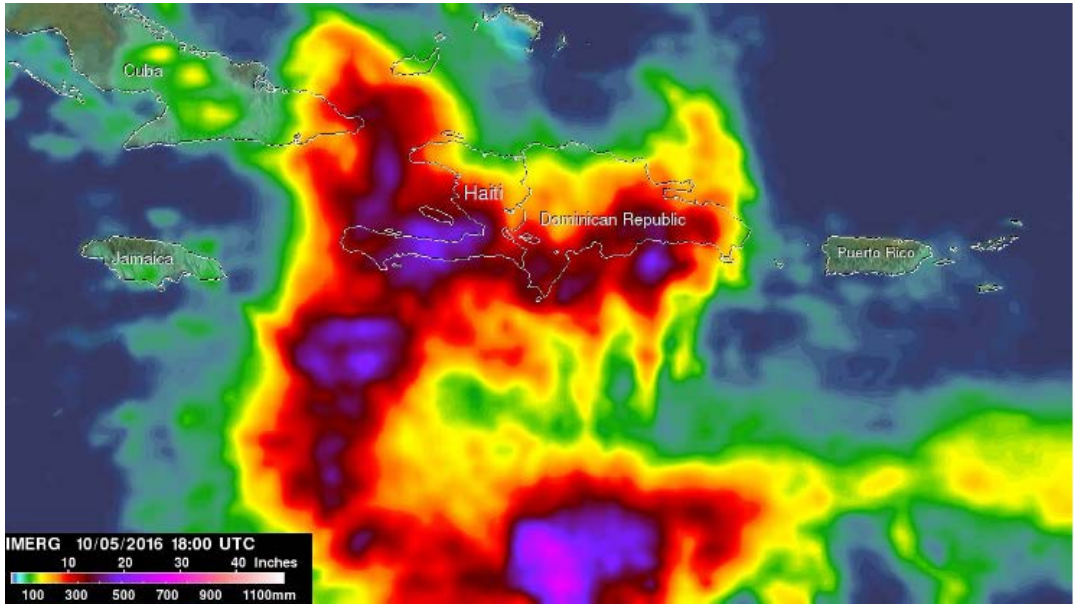


Imagery was acquired by RADARSAT-2 on 7 October 2016 RADARSAT-2

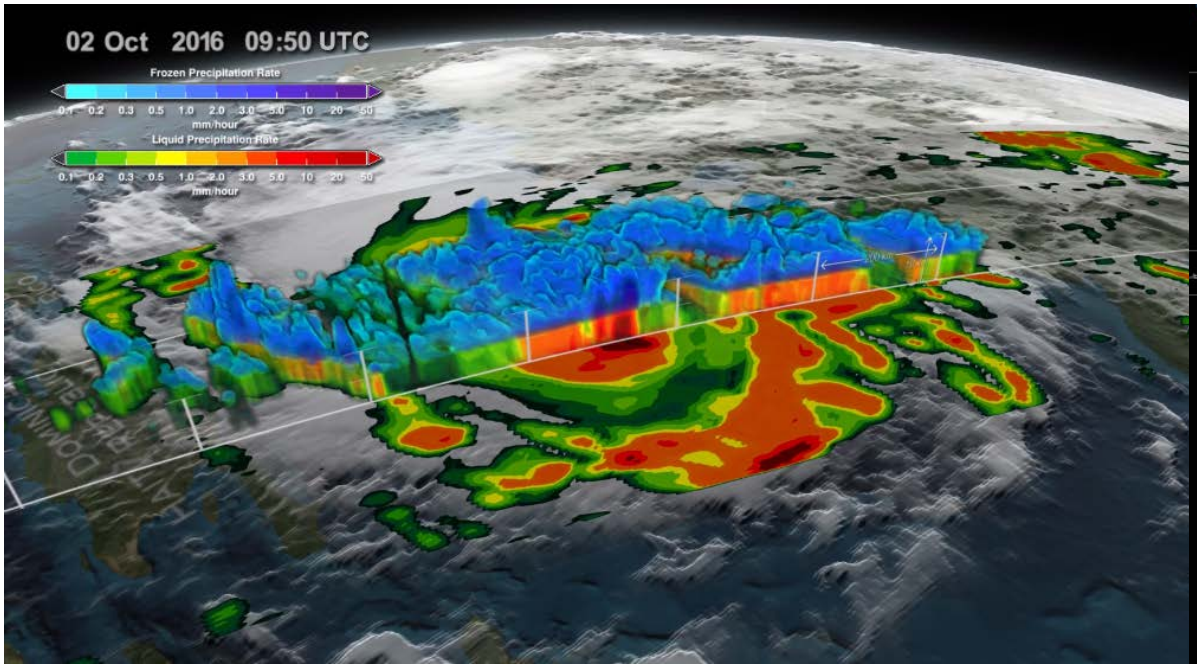


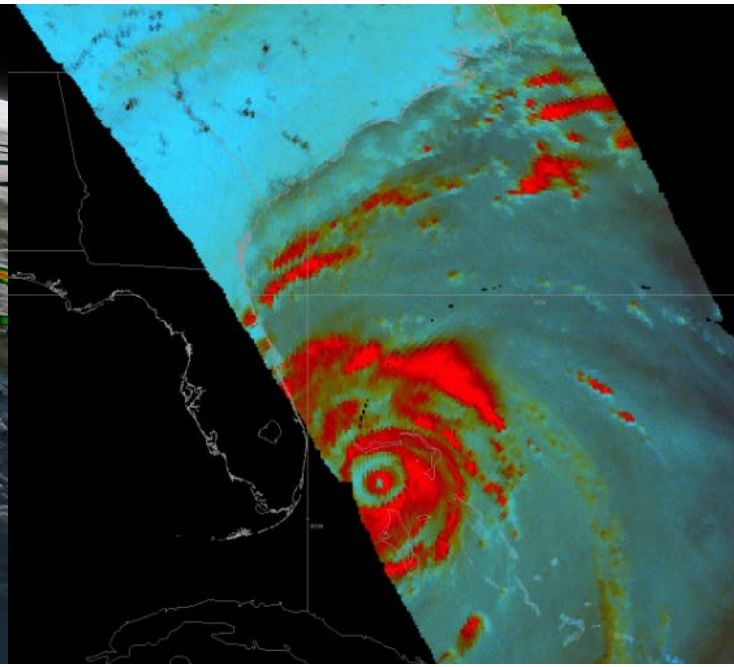
Sentinel 1A/1B imagery collected in partnership with ESA and delivered through the Alaska Satellite Facility / UAF.

GPM observes Hurricane Matthew's rapid intensification and eyewall replacement



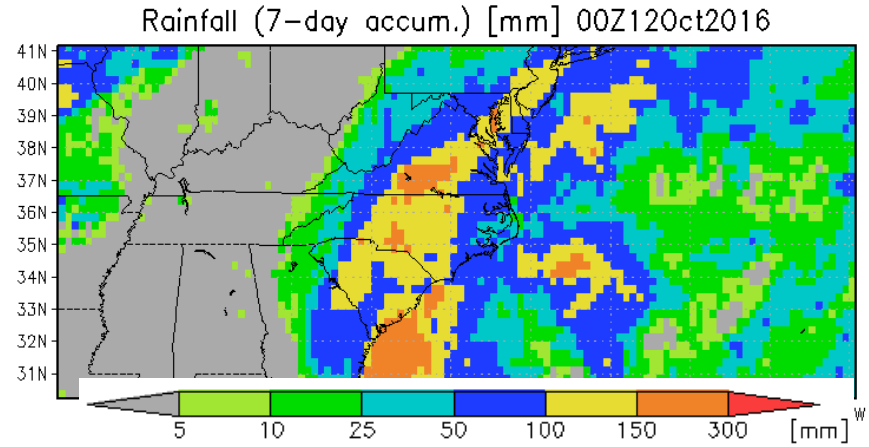
- GPM observed intense rainfall (left) as Matthew battered Hispaniola and Cuba
- On Oct. 2 (bottom left) GPM Core Observatory viewed a newly intensified Cat 4 storm south of Haiti, showing strong convection and heavy rainfall in the eye wall and rain bands
- GPM's Microwave Imager (bottom right) observed 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



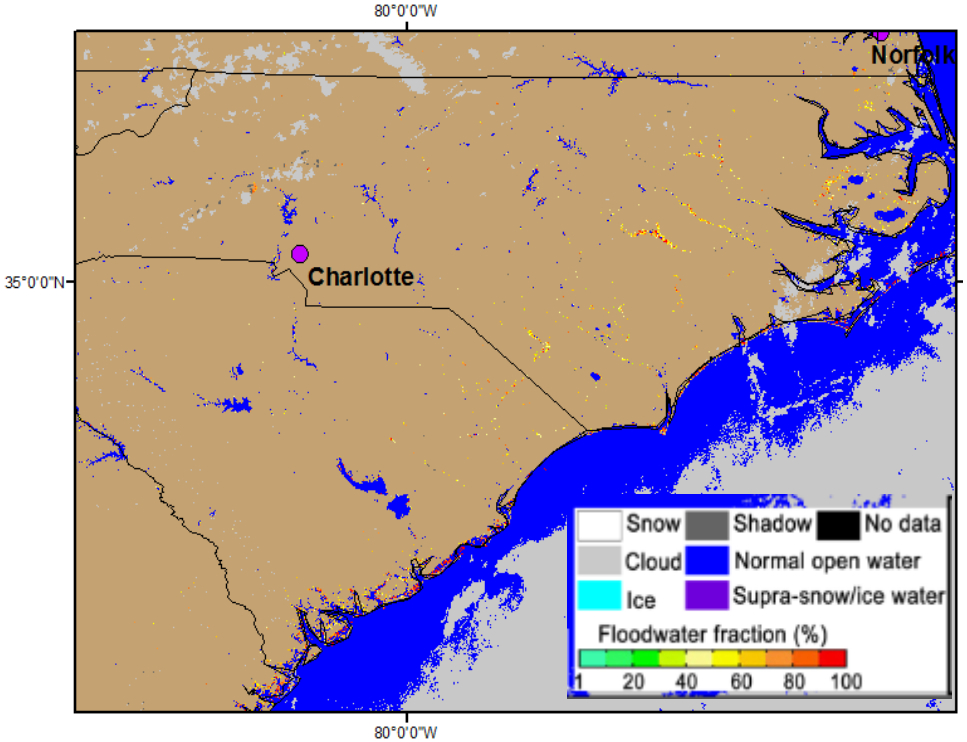


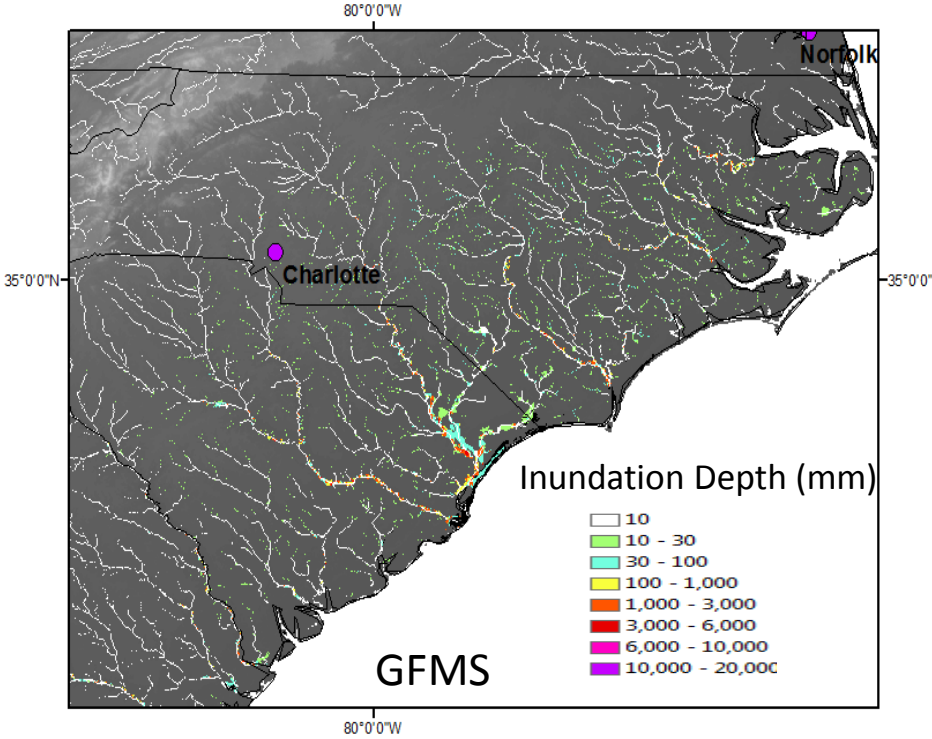
Flood products provided for Hurricane Matthew Response

- 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



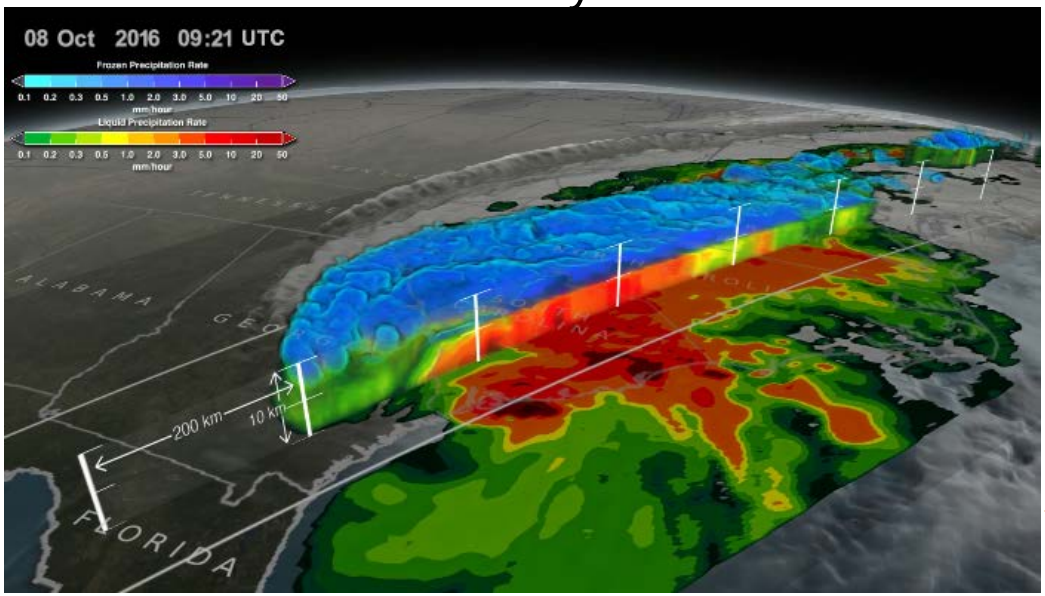


Samei Li, Donglian Sun/GMU

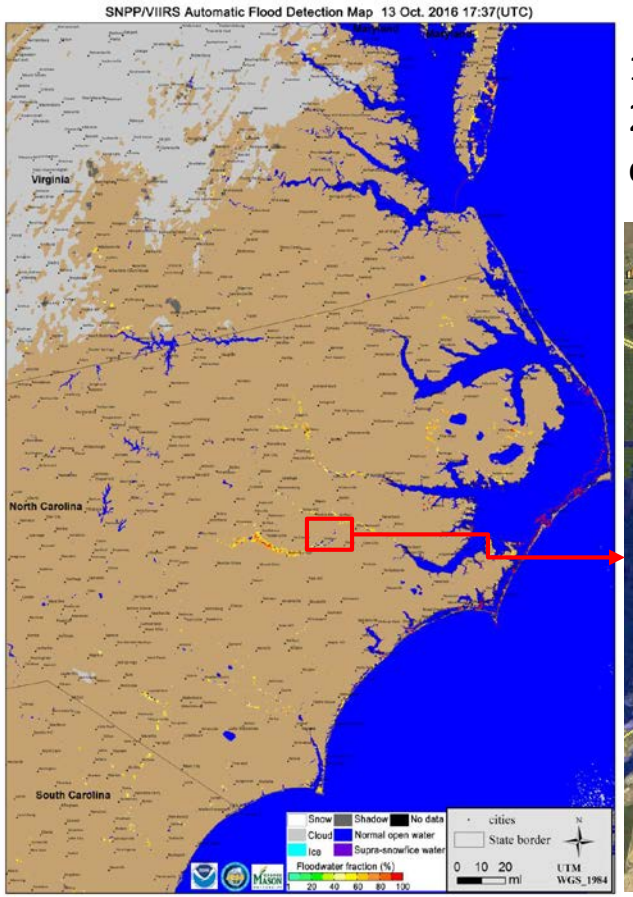
Huan Wu, Bob Adler/UMD

GSFC Outreach Activities for Hurricane Matthew

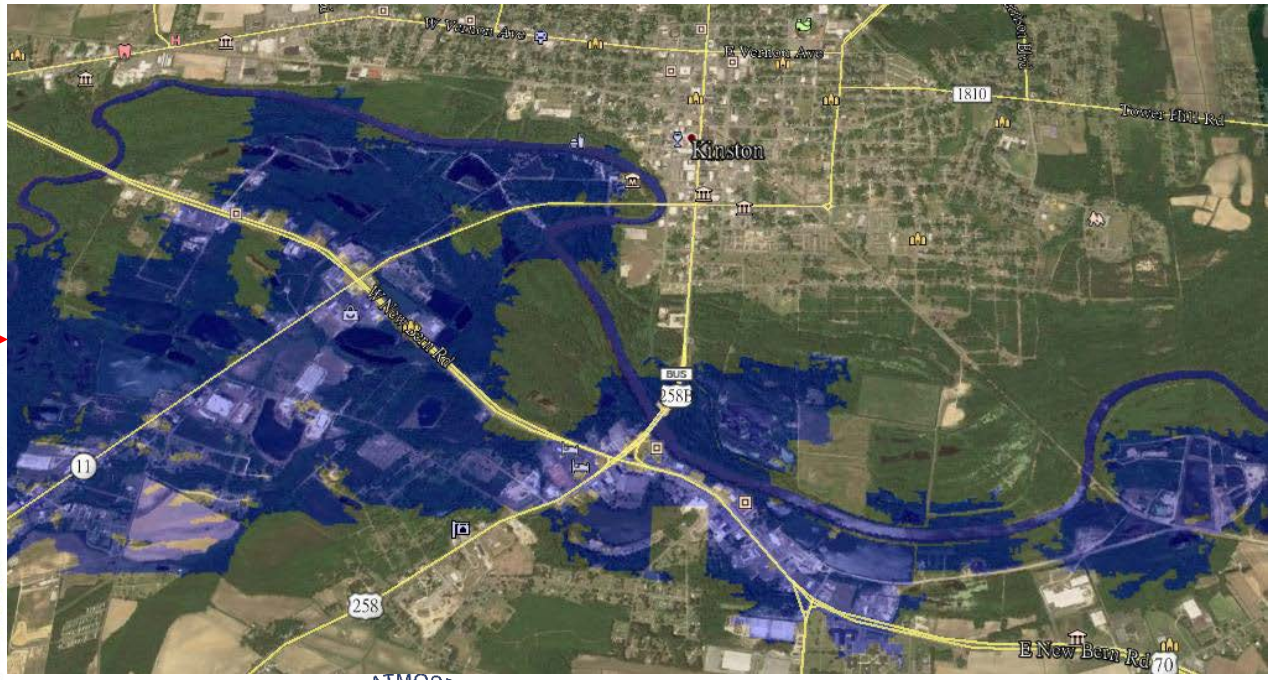
- GSFC conducted 48 Media Interviews, including live shots, in person interviews, print, radio and Skype calls on Oct. 6th and 7th on how GPM and other missions observed Hurricane Matthew
- A 30 minute Facebook Live event Oct. 7th had over 8.6k concurrent views during the event and over 280k views, 2.2k shares
- Visualizations showing GPM observations of Hurricane Matthew were shared with media outlets across the country



SNPP/VIIRS flood detection in North Carolina

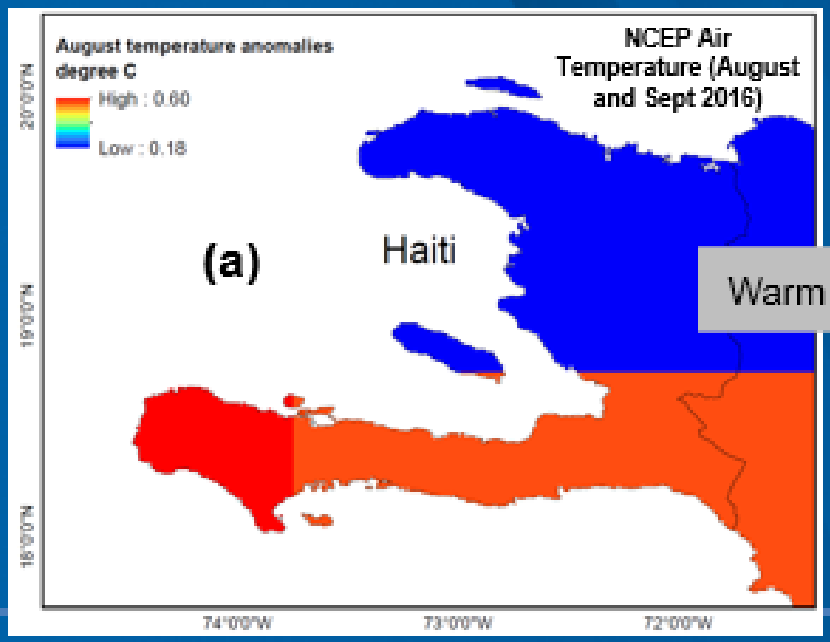


1. Matthew caused 26 deaths in North Carolina
2. George Mason inundation downscaling model used 9 m digital elevation data to generate VIIRS flood maps for severely flooded areas.

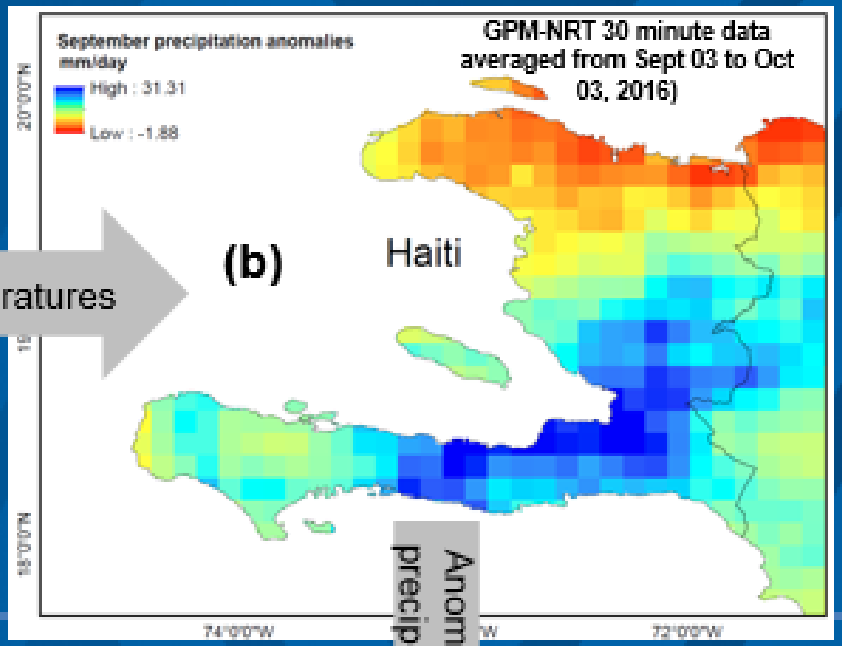


Prediction of risk of epidemic cholera in Haiti after Hurricane Matthew

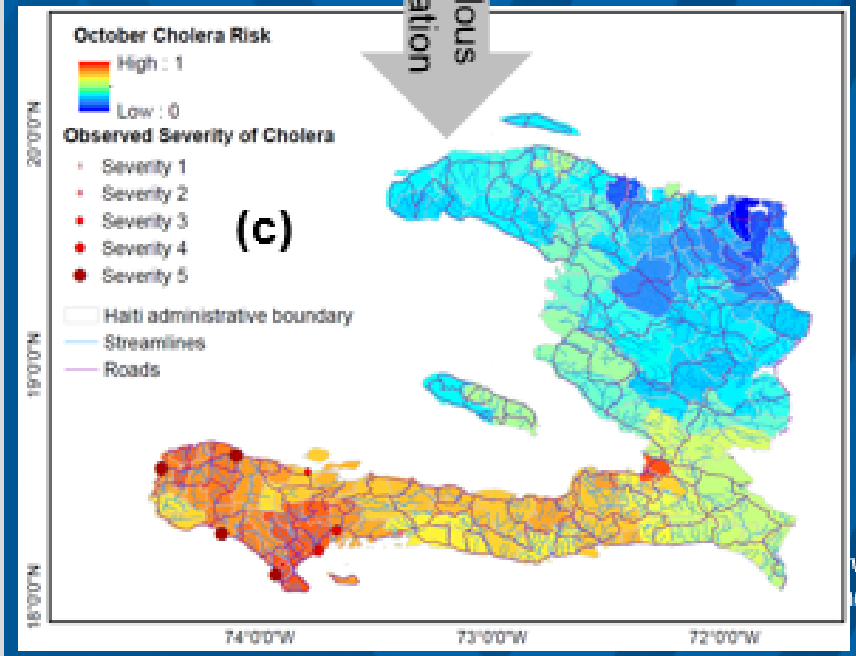
Antar Jutla, West Virginia University & Rita Colwell, University of Maryland, College Park, MD



Warm temperatures



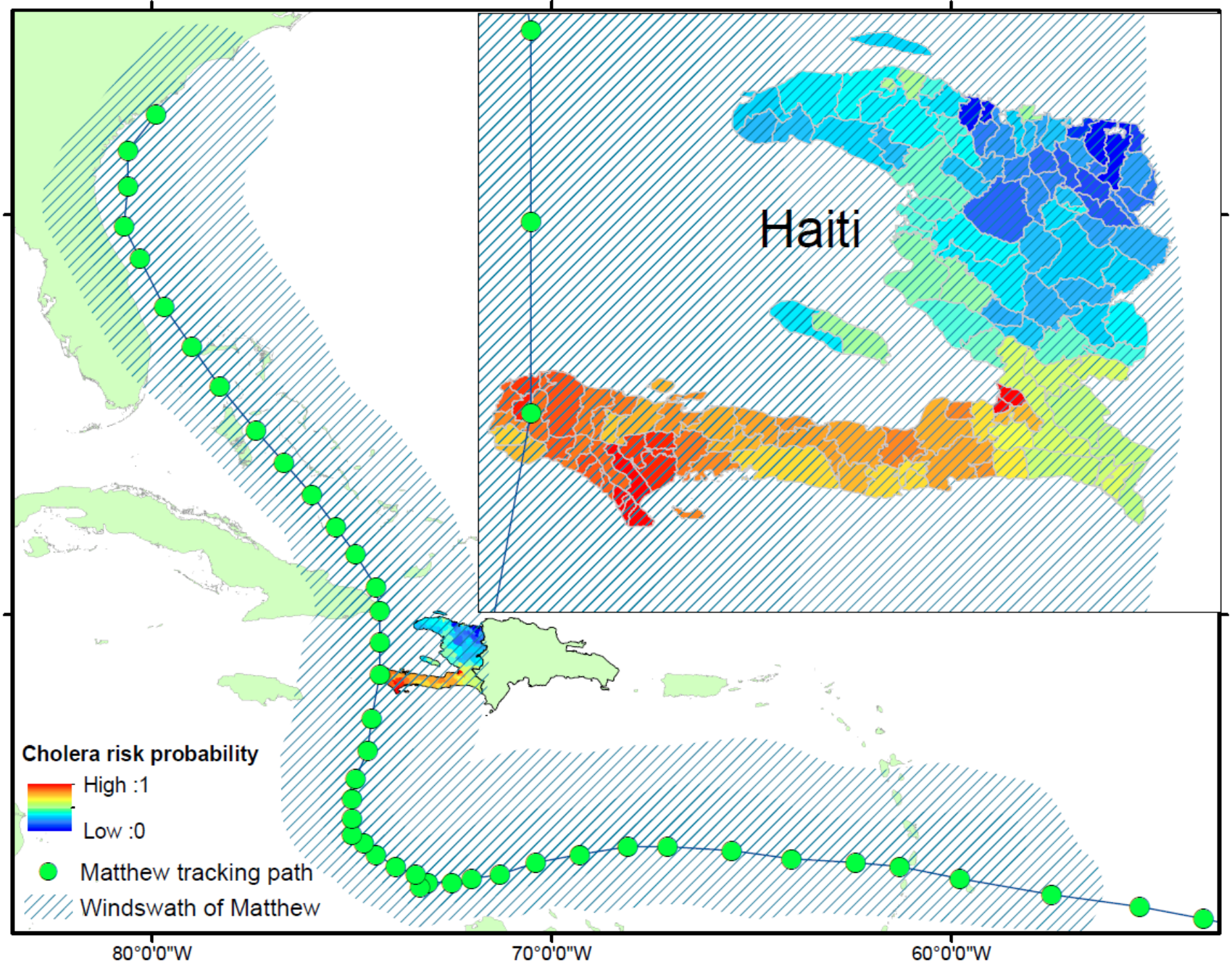
Anomalous precipitation



Risk of epidemic cholera is high if heavy precipitation follows persistent warm temperatures in regions with poor or damaged water and sanitation infrastructure.

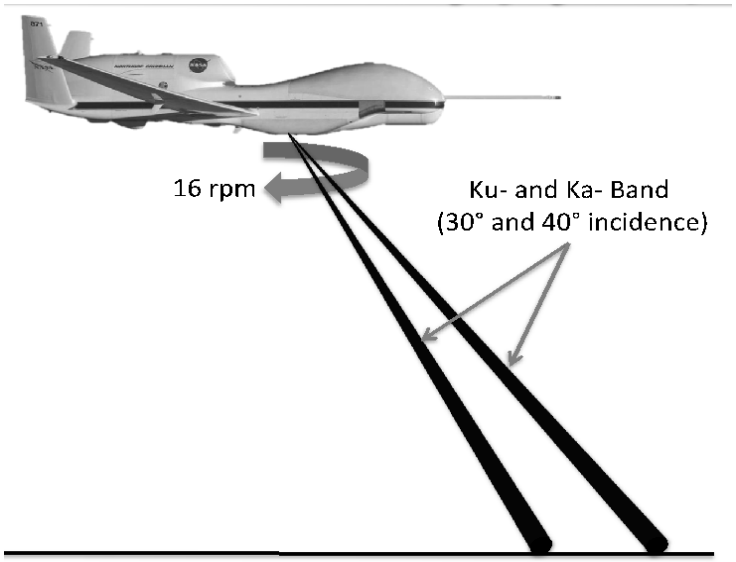
- (a) Prior to Hurricane Matthew, very warm temperatures were observed.
- (b) Matthew's heavy precipitation destroyed water and sanitation infrastructure leading to high risk of cholera in the region
- (c) For the first time, used GPM near real time data to track heavy precipitation in Haiti and produce near real time outlook for cholera risk.

Most of the cholera cases started after Matthew's arrival, coincident with predicted risk. The team continues to monitor Haiti for secondary infection risk.


Haiti
Cholera risk probability
High :1
Low :0
Matthew tracking path
Windswath of Matthew
30°0'0"N
20°0'0"N
80°0'0"W
70°0'0"W
60°0'0"W

High-Altitude Imaging Wind & Rain Airborne Profiler (HIWRAP) on the Global Hawk Aircraft

Steve Guimond and the Airborne Radar Group (GSFC/612)



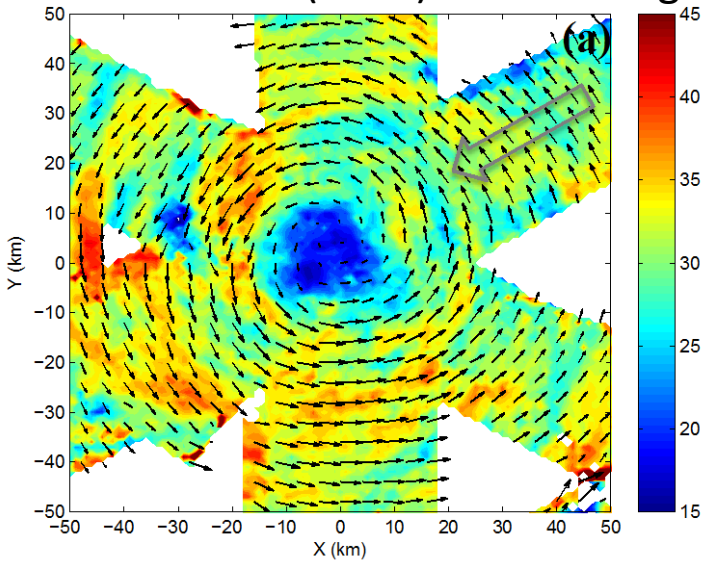
1 km retrieval products:

- **Ku/Ka band reflectivity**
- **3D winds in precipitation**
- **Ocean surface winds**

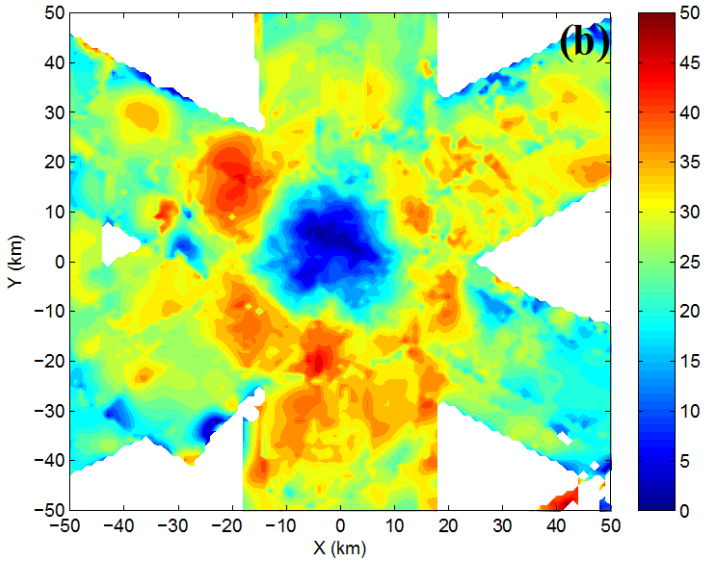
Applications for Disaster Group:

- Understand small-scale processes
  - Rainfall/flooding - reflectivity
  - Storm surge – ocean winds
  - Wind damage – 3D winds
  - Intensity change – 3D winds/refl.

Hurricane Karl (2010) at 2 km height

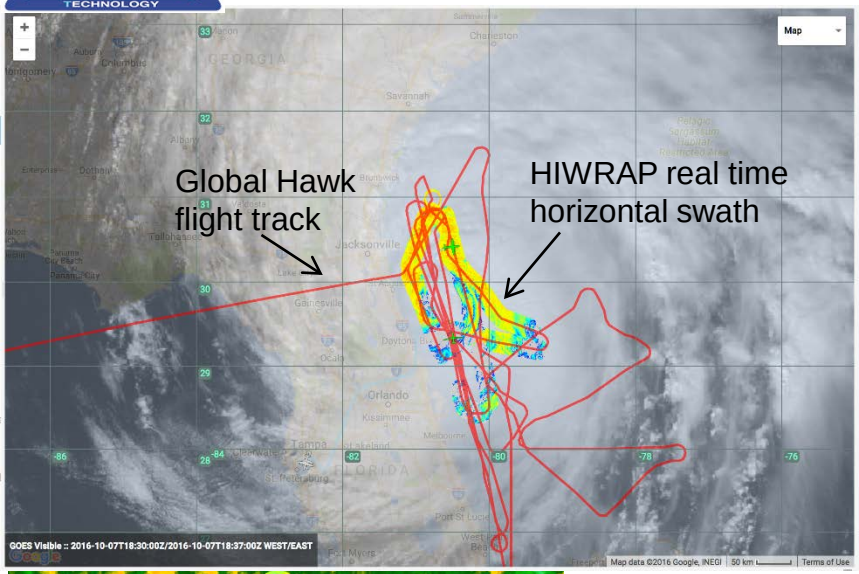


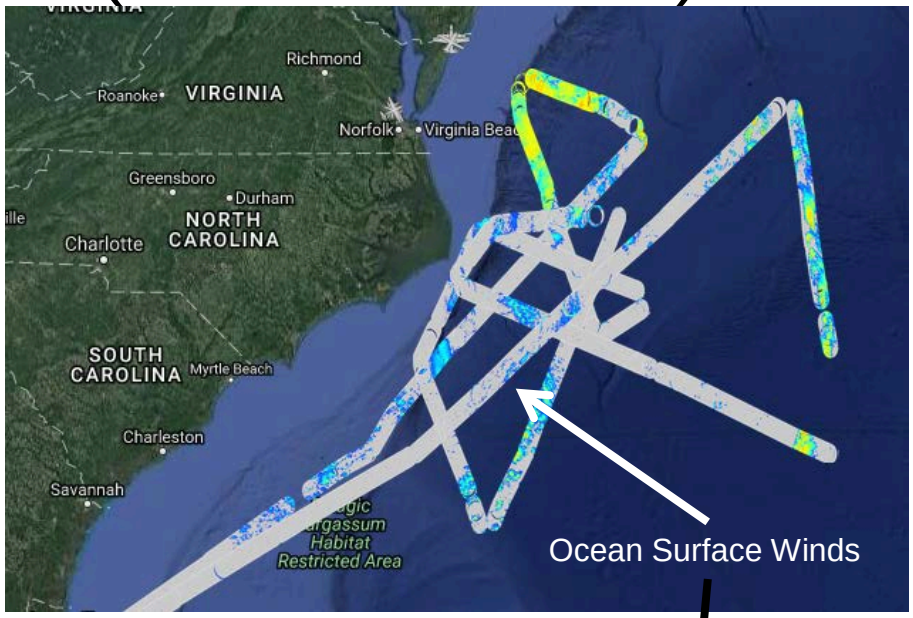
Ku Band Reflectivity (dBZ) & Wind Vectors

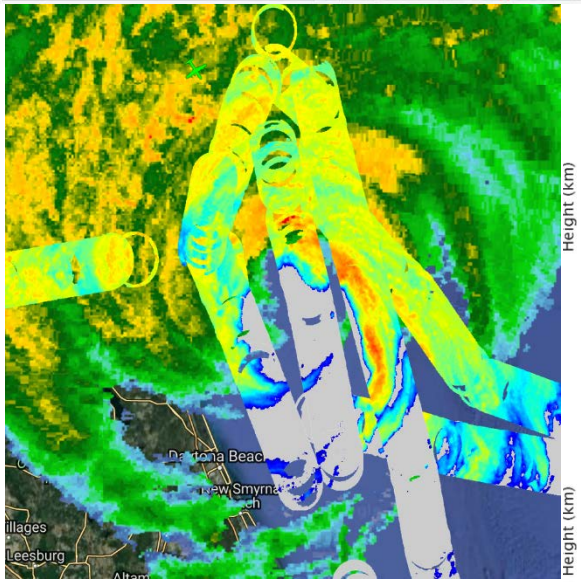


Wind Speed (m/s)

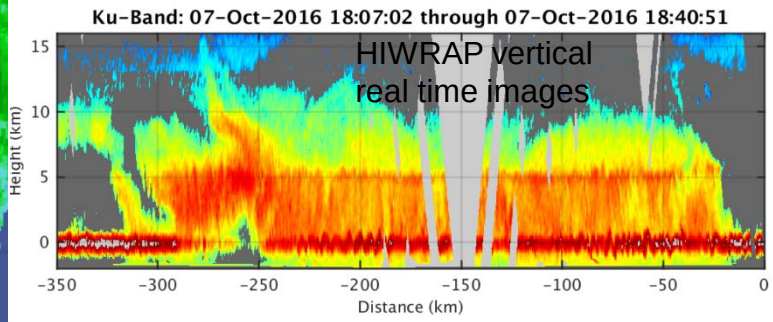
NOAA SHOUT Field Experiment 2016
Hurricane Matthew (10/6-10/7 & 10/9)

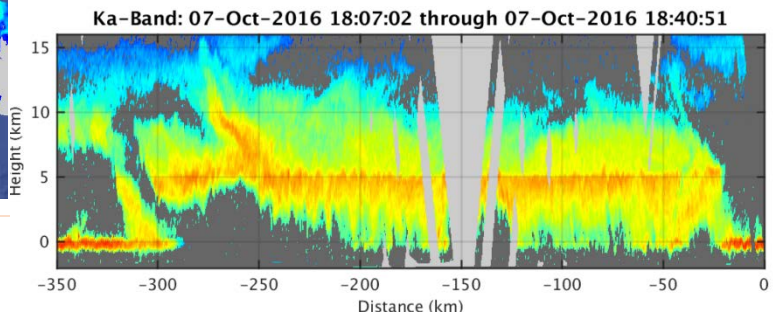


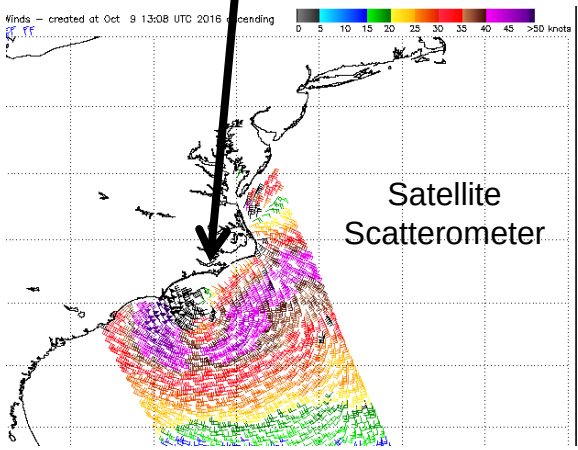




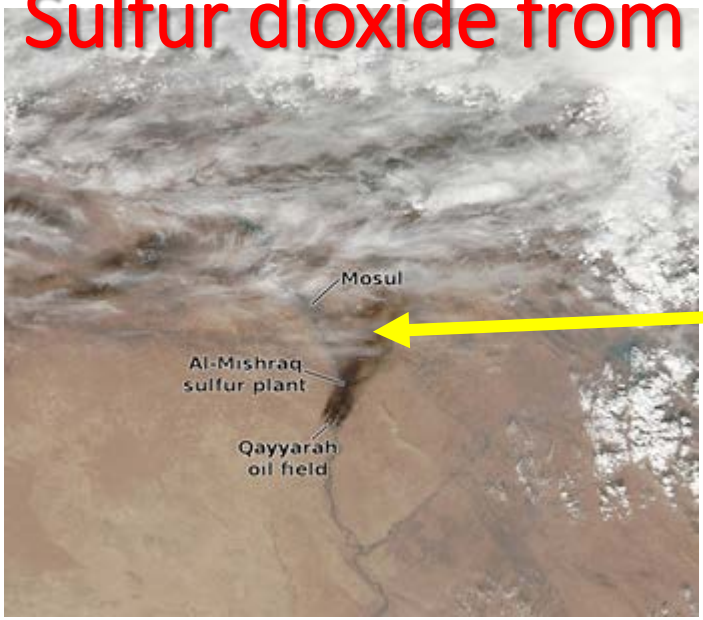
HIWRAP real time horizontal swath over radar image

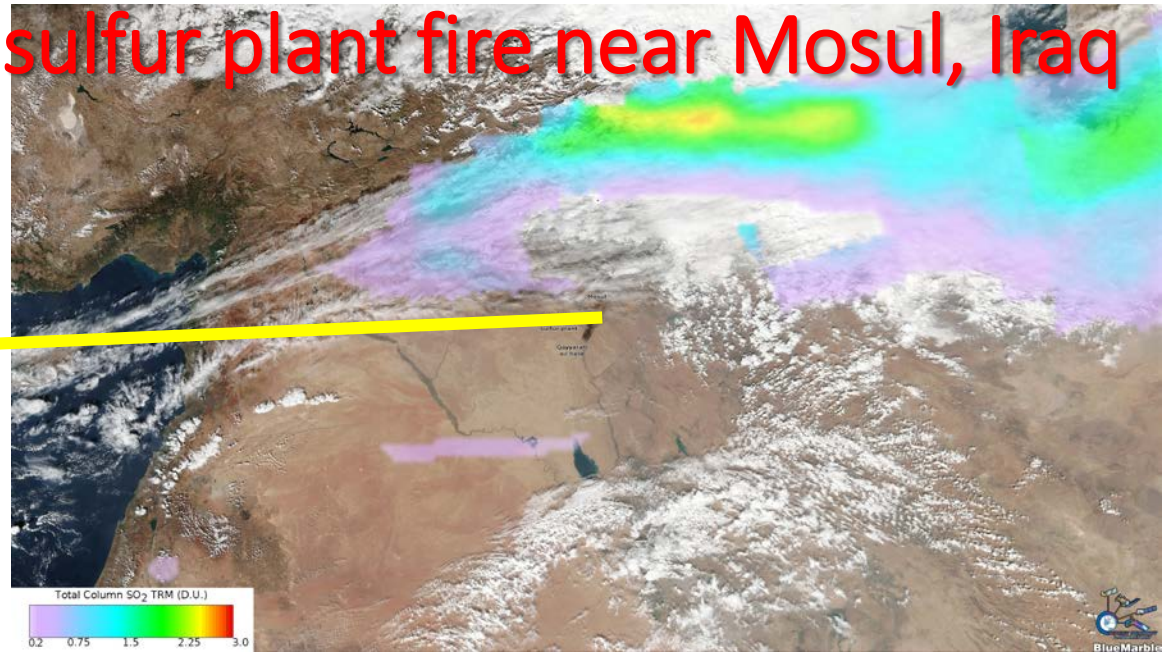


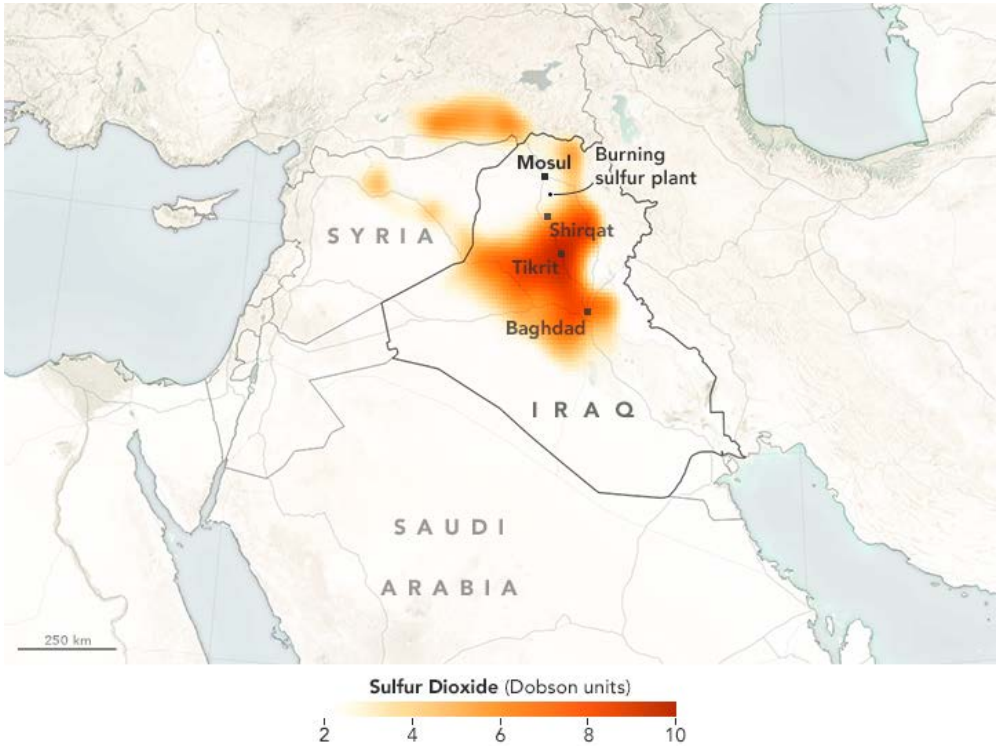




Sulfur dioxide from sulfur plant fire near Mosul, Iraq







Fires set by ISIS in and around Mosul, in particular a sulfur plant that was set ablaze to produce noxious SO2. The image (above) illustrates DRL's real-time algorithm and image enhancement software to produce bi-product concentrations. In the true color background image, the black smoke is from oil field and the gray smoke is from the sulfur plant. Then note the SO2 concentration in the atmosphere.

"Sulfur dioxide emissions from the fire have been significant. If the sulfur dioxide were coming from a volcano rather than a fire, it would already be among the largest eruptions of 2016" – Simon Carn, Michigan Tech

Credits: NASA's Direct Readout Lab, Kelvin Brentzel

NASA Earth Observatory: http://earthobservatory.nasa.gov/IOTD/view.php?id=88994

Dongliu Sun, George Mason University

- Associate Professor at George Mason University
- Geography and Geographical Sciences
- Ph.D., University of Maryland

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)**

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?**