Development of Geostationary-JPSS Flood Product for Flood Monitoring and Mitigation

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Outline

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Flood Blended Product Team

Algorithm Team Members

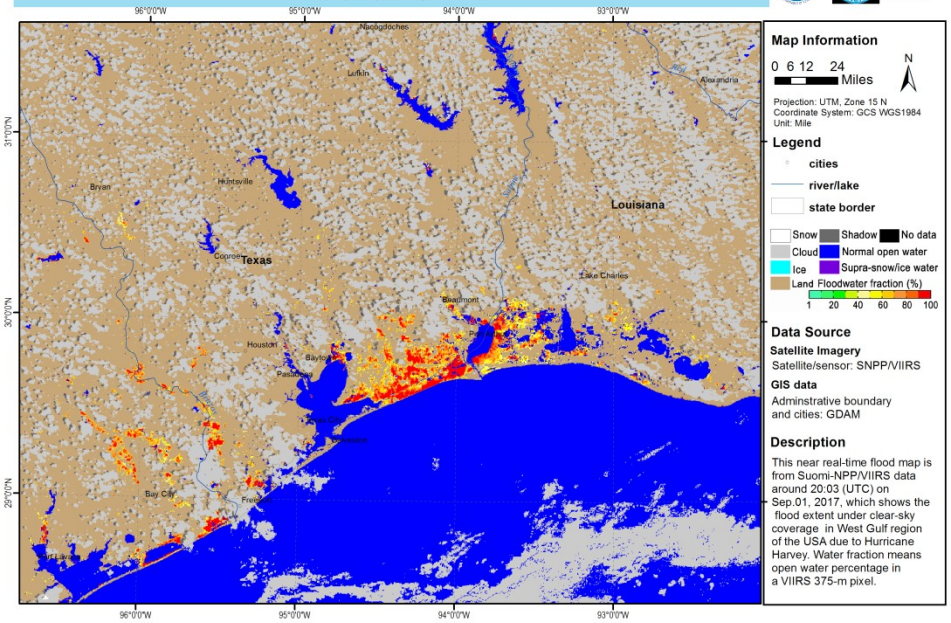
Name	Organization	Major Task
Sanmei Li	George Mason University	Algorithm development
Donglian Sun	George Mason University	Project management
Jay Hoffman	SSEC/UW	Routine process and maintenance
Lisa Wirth	GINA/UAF	Routine process and maintenance
Mike DeWeese	NCRFC	Validation

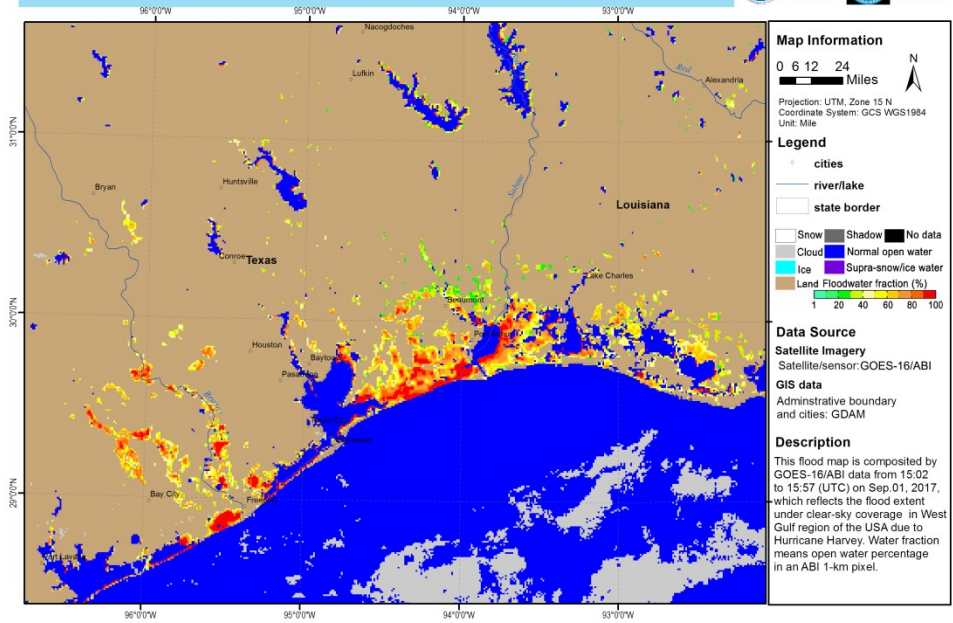
Input Needs for the Blended Product Algorithm

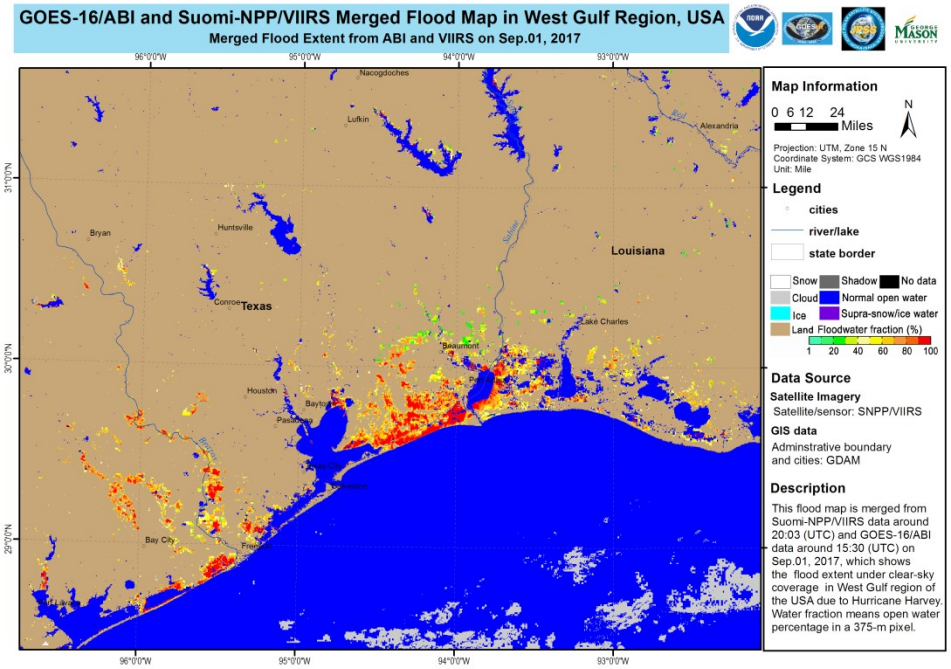
- Blended Product Name: **Geostationary-JPSS flood product**

Required Satellite and Ancillary Input Data Products

	Data Product Name (Inputs)	Input Data Type (Satellite/Model Forecasts/*In-situ*)	Temporal/ Spatial Resolution, Format	Source(s)
1	Flood product	S-NPP/NOAA-20 VIIRS 375-m flood product	375m, hdf4, twice/day	JPSS-VIIRS
2	Flood product	GOES-16 ABI 1-km flood product	1-km, 5-m in the CONUS and 15-m at full disk	GOES16-ABI
3	Flood product	Himawari-8/AHI 1-km flood product	1-km	Himawari8-AHI
4	90-m SRTM/DEM	Raw data	30-m/90m	USGS
5	Water reference map	hdf	375-m	MODIS and USGS



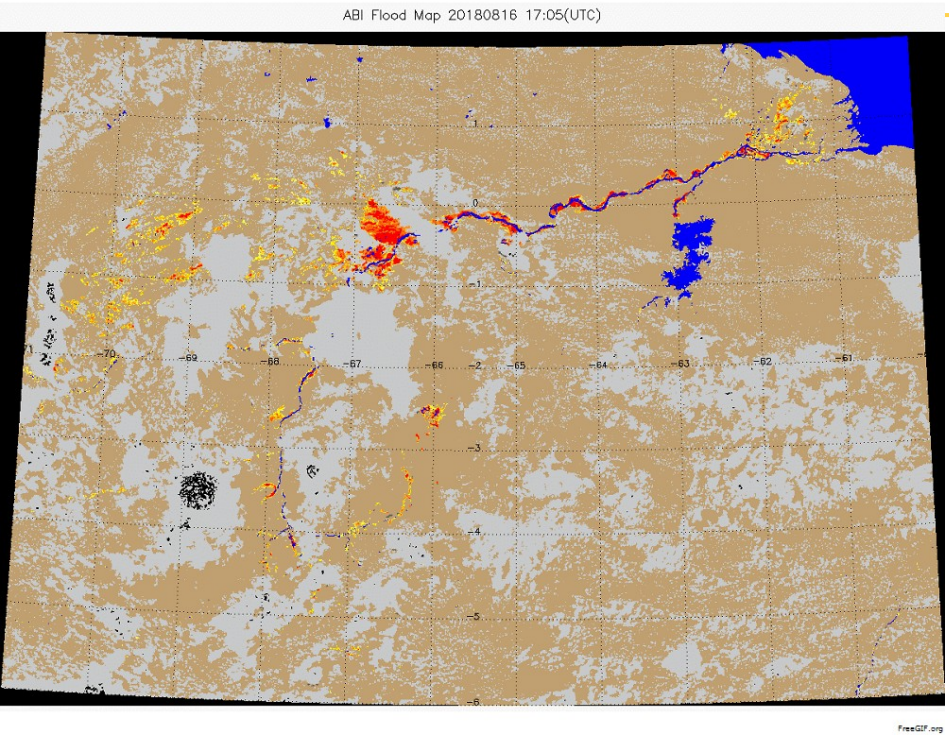




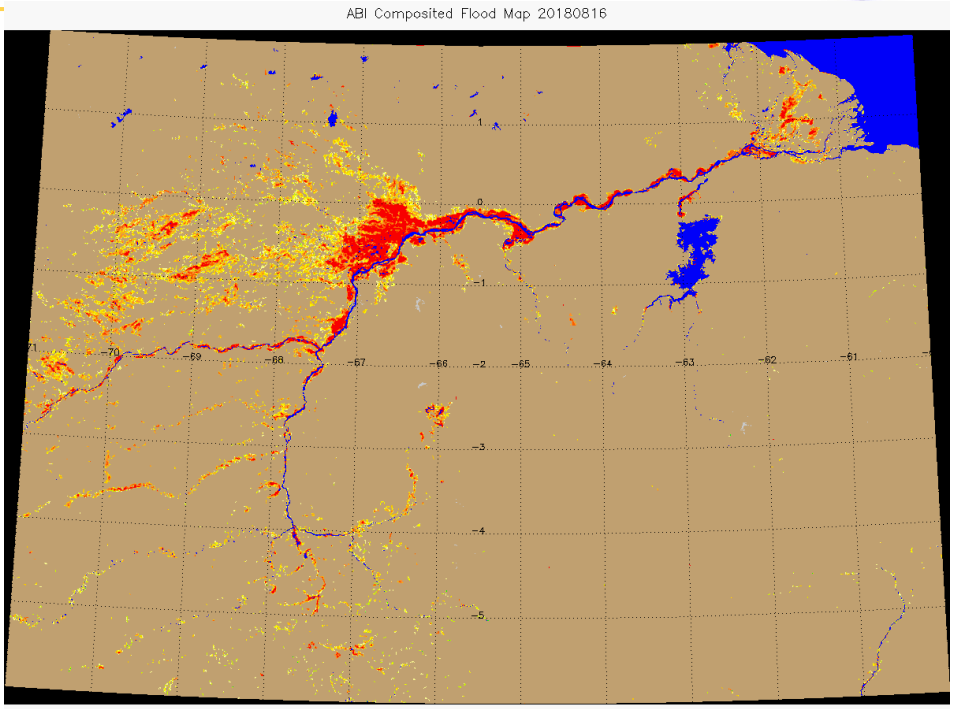
- VIIRS flood product shows good detail because of 375-m spatial resolution, but is easily affected by cloud/cloud shadows due to observation once a day.
- ABI flood product can be available every 5 minutes in the CONUS, but is with 1-km spatial resolution.
- The combination of the two products can produce a blended product which is with the high spatial resolution of VIIRS imagery and the high temporal resolution of ABI imagery.

Technical Approach

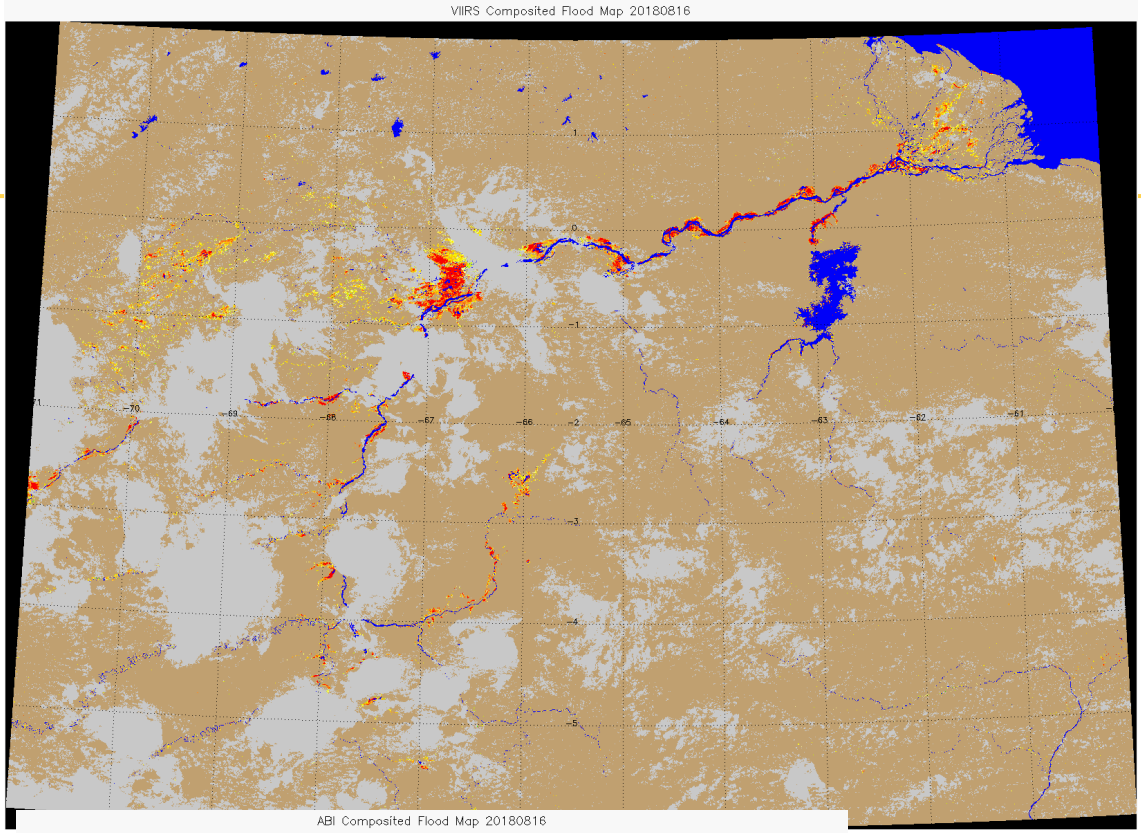
- The simple method to get a blended flood product from VIIRS, ABI and AHI is nearest interpolation:
  - Spatially match the ABI/AHI flood map with the VIIRS flood map by nearest interpolation.
  - Take the VIIRS flood map as a base map, and any flooding water in the VIIRS flood map is used as it is in the blended flood map.
  - For cloud/cloud shadow pixels in the VIIRS flood map, if they are with flooding water or clear-sky dry land in the ABI flood map, then these pixels are assigned with ABI/AHI flooding water fractions or clear-sky dry land in the blended flood map.

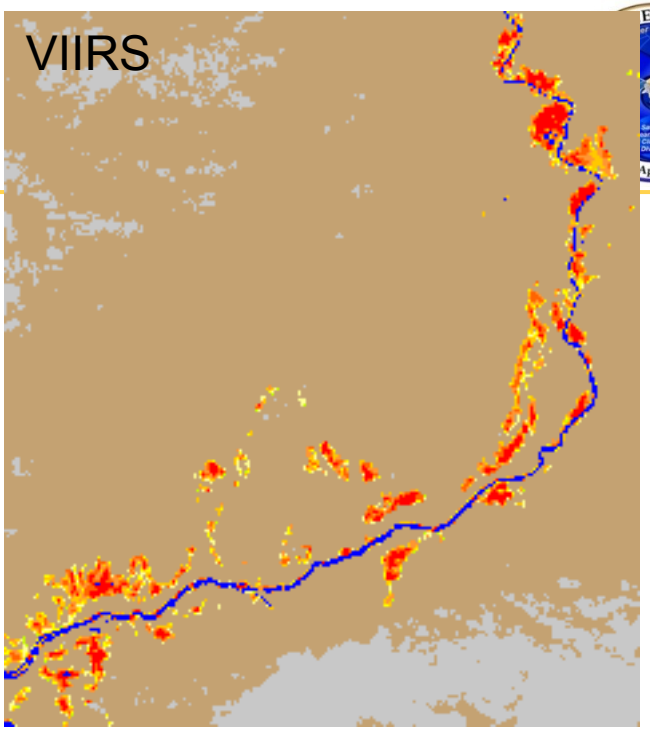


GOES-16/ABI flood animation in Venezuela on Aug. 16, 2018

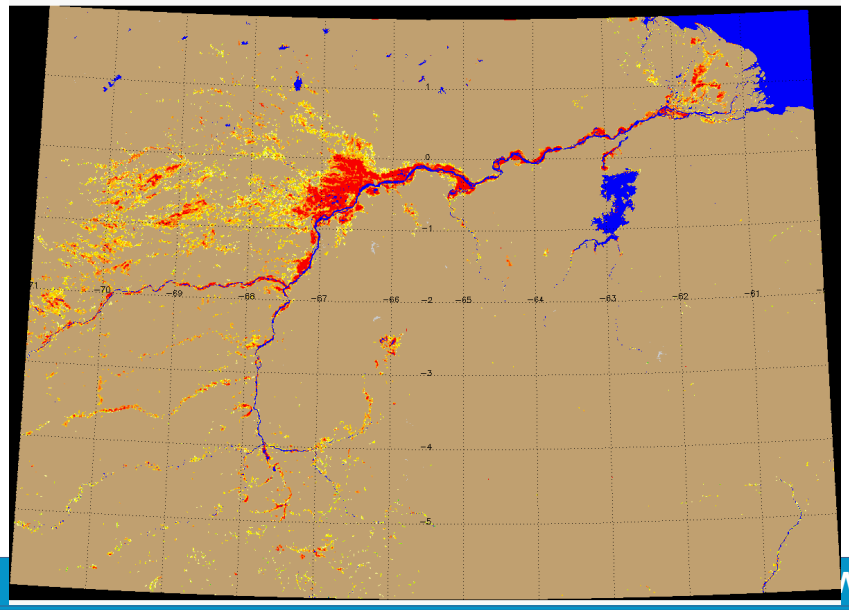


GOES-16/ABI daily composition produces a completely clear-sky flood map in Venezuela on Aug. 16, 2018

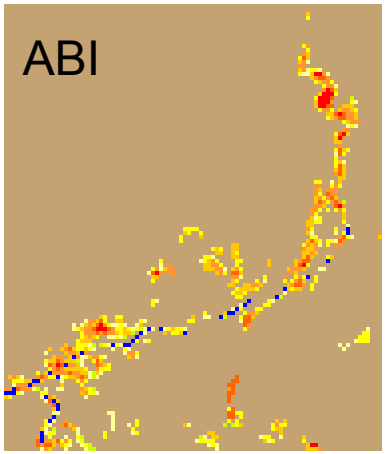




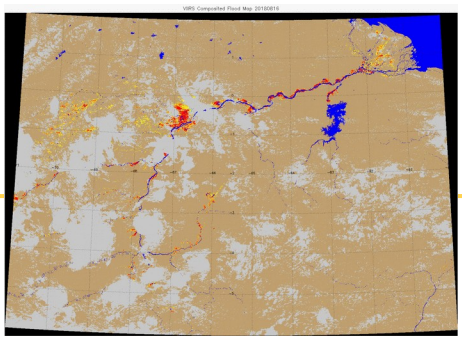
VIIRS 375-m flood map shows more detail

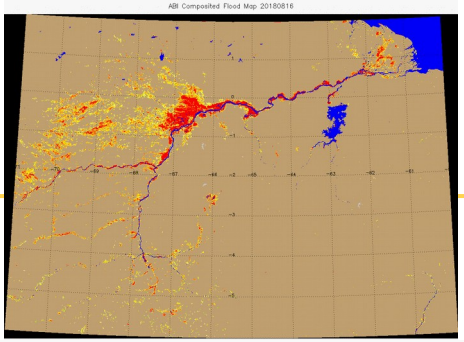


ABI flood map is completely clear-sky



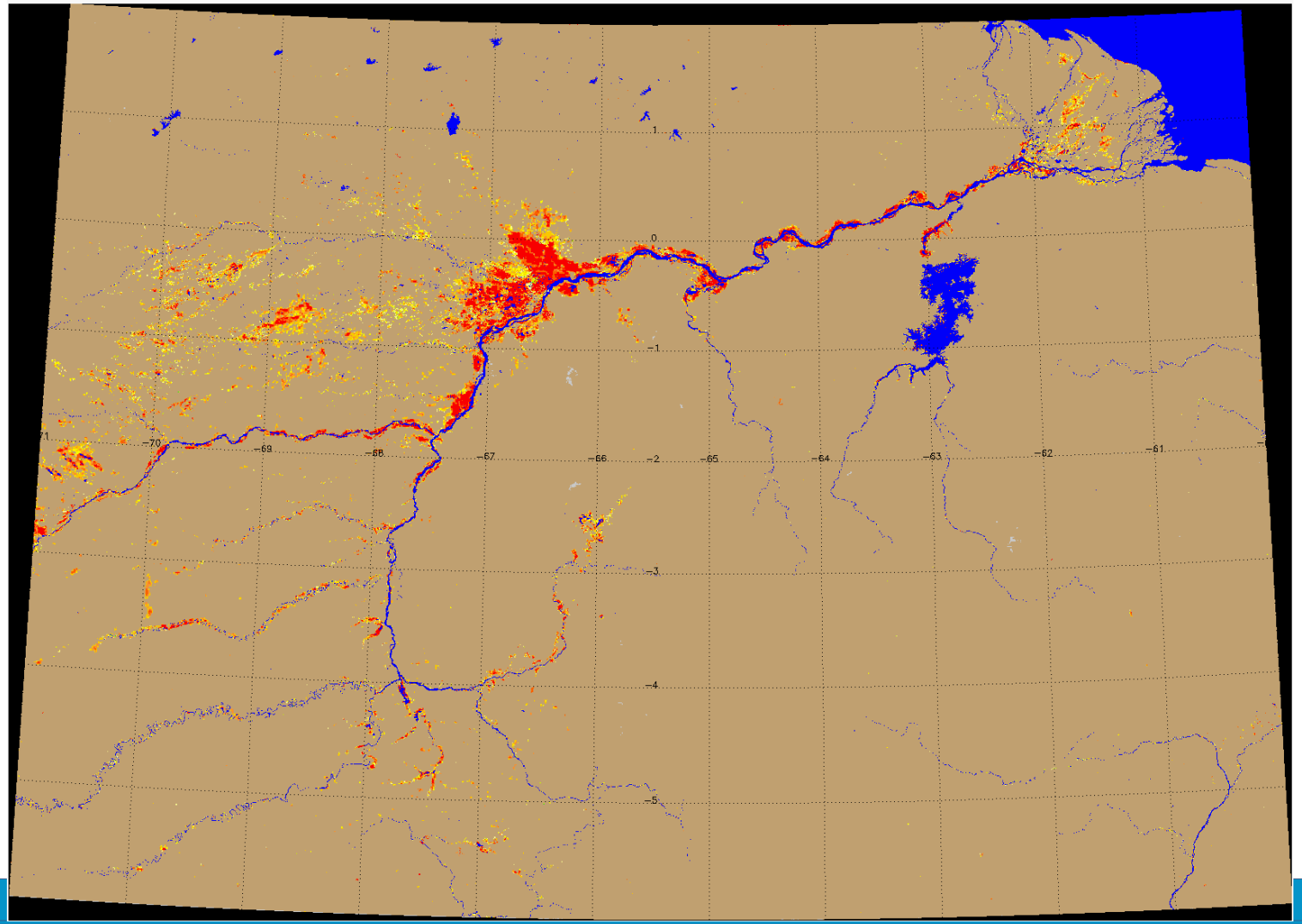
VIIRS



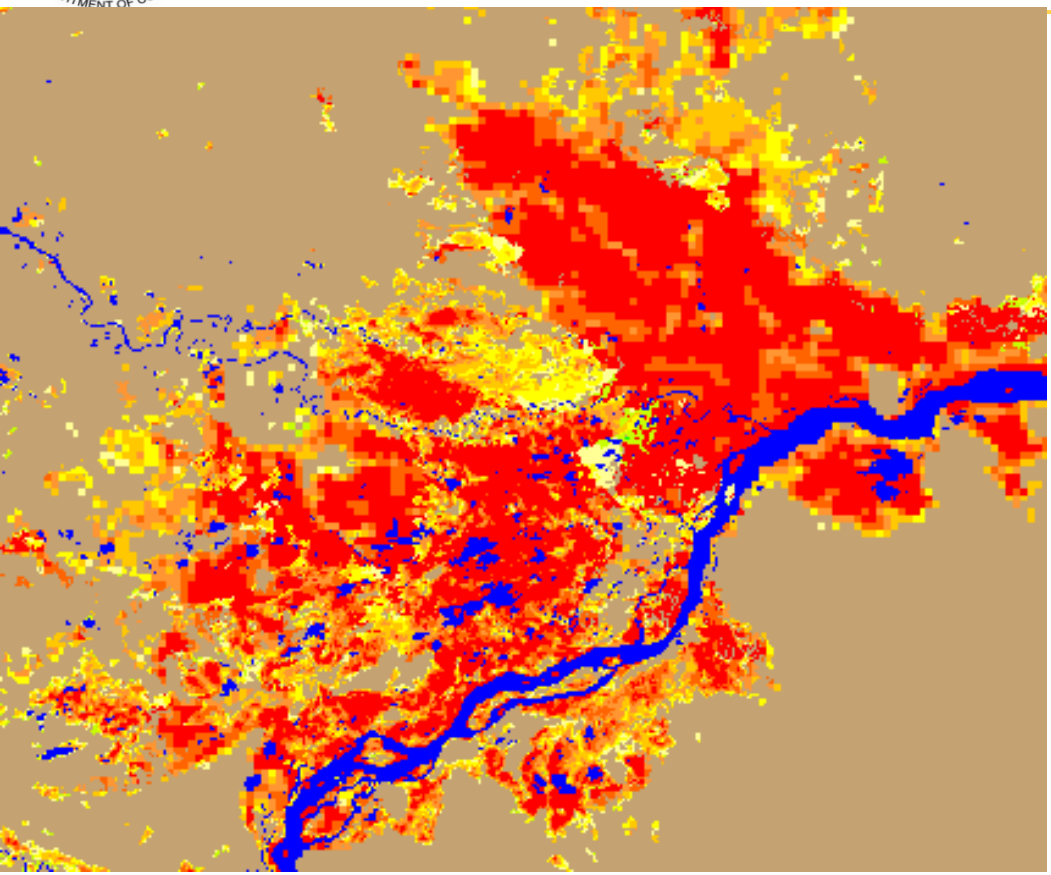


ABI

Blended Flood Map from VIIRS and ABI 20180816



Blended



- Issues of the nearest interpolation:
  - Nearest interpolation does not produce smooth floodwater boundaries.
  - Floodwater fractions may not be exaggerated or under estimated.

Technical Approach

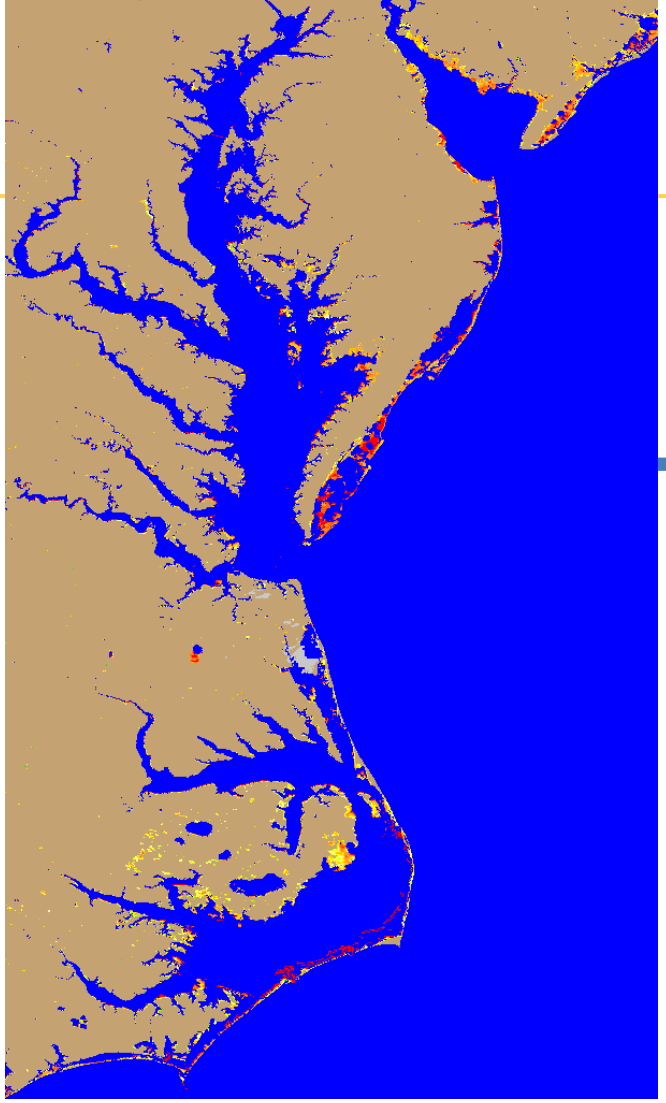
- **A better method is to downscaling and upscaling process:**
  - **Downscale ABI/AHI 1-km flood map into a fine spatial resolution using high resolution DEM such as SRTM/DEM:**

$$A = \int_{\min\_h}^{\max\_h} f(h)dh$$

Where, A the total water area or water fraction retrieved from ABI/AHI, $f(h)$ is the increment of water area between the minimal surface elevation $\min\_h$ derived from DEM and maximal inundated surface elevation $\max\_h$.

  - Calculate floodwater fractions in 375-m spatial resolution from the downscaled ABI/AHI flood extent.

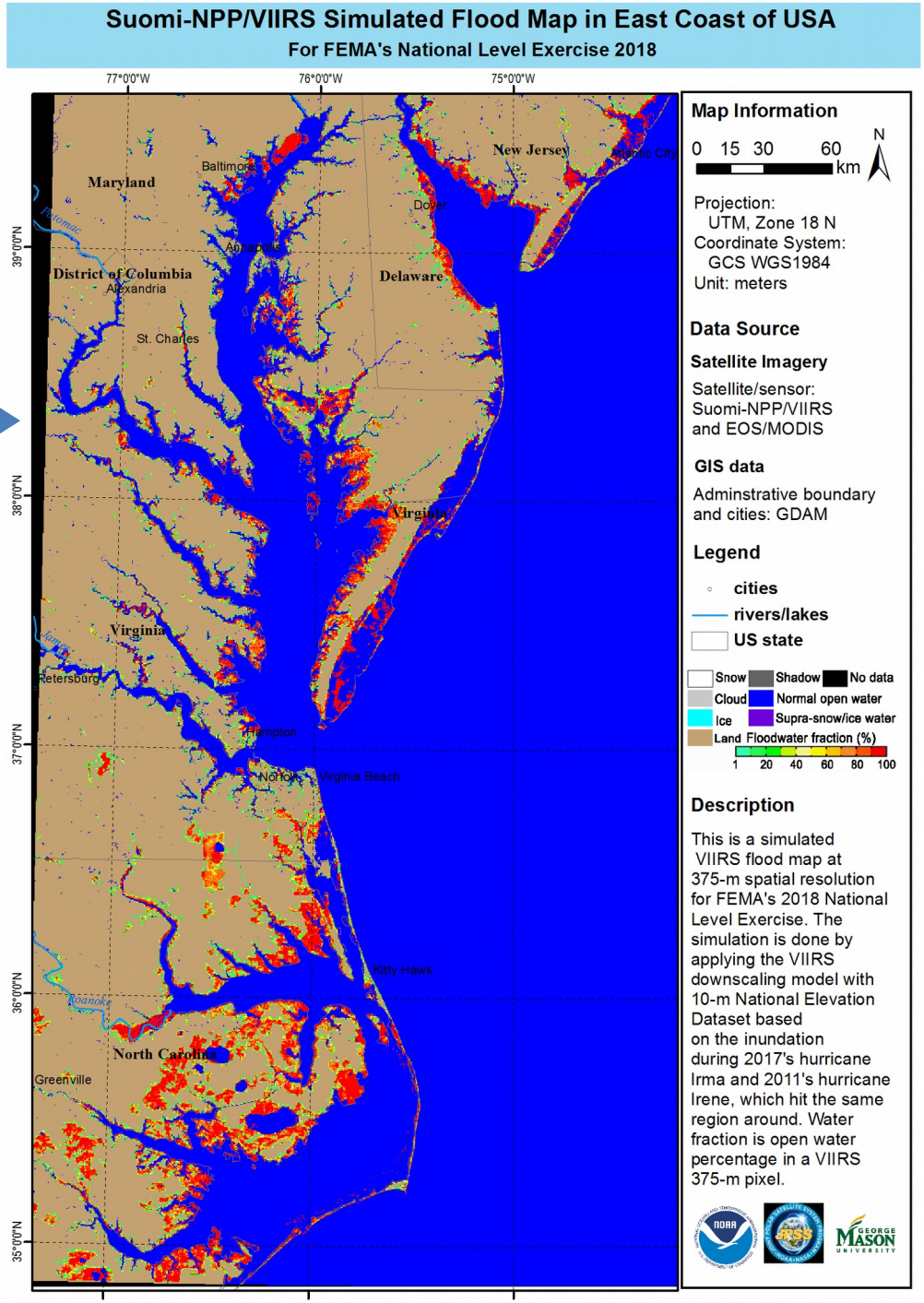
Where, the total water area or water fraction retrieved from ABI/AHI, is the increment of water area between the minimal surface elevation derived from DEM and maximal inundated surface elevation.
Calculate floodwater fractions in 375-m spatial resolution from the downscaled ABI/AHI flood extent.



Downscale with 10-m NED data

Upscale to derive 375-m water fractions

MODIS 500-m flood map from Aug. 28 to 30, 2011



Product(s) Examples/Outputs

- The output product will be the blended floodwater fractions from S-NPP/VIIRS, NOAA-20/VIIRS, GOES-16/ABI and Himawari-8/AHI at 375-m spatial resolution.
- The formats of the product will be the same with the current S-NPP/VIIRS flood product, which include geotiff, png, kmz and hdf.

Product Evaluation/Validation/Tools

- Product Evaluation/Validation
  - Qualitative comparison with aerial photos and other images collected from RFCs
  - Quantitative comparison between the blended flood water fractions and results derived from Landsat-8 OLI images and SAR images

Identified Issues/Risks/Mitigations

- Geolocation accuracy of satellite imagery:
  - The geolocation accuracy of satellite imagery especially from ABI and AHI can be a risk of the blended flood product, as the results of ABI/AHI are composited from 5-minute or 15-minute flood maps.
- The accuracy of the floodwater fractions:
  - Cloud shadows: The accuracy of the flood detection is still affected by cloud shadows due to the uncertainty of cloud mask and cloud heights.
  - Sun glint: The accuracy of the floodwater fractions can be affected by sun glint in low-latitudes
- Quality of the DEM:
  - The downscaled flood extent may be affected by the quality of the DEM. (90-m SRTM/DEM or 30-m SRTM/DEM)

Future Algorithm Improvements

- Improve the accuracy of the VIIRS/ABI/AHI flood products:
  - Identify sun-glint-contaminated water surface
  - Further improve the quality of cloud shadow removal
- Use the simplified downscaling /upscaling method instead of nearest interpolation to derive smoother floodwater boundaries from ABI/AHI in the blended products.
  - Investigate the downscaled results from 90-m SRTM/DEM data. If necessary, 30-m SRTM/DEM will be used instead for the quality of the blended products
- Future Validation Plans
  - Work with RFCs to validate the blended flood products

Importance/Benefits/Users

Name	Organization	Application	User Feedback - User readiness dates for ingest of data and bringing data to operations
NWS's RFCs	River Forecast Centers	Use the product for river forecast, monitoring and post-flooding analysis	
FEMA	Federal Emergency Management Agency	Use the product for disaster investigation and mitigation	
USACE	US Army Corps of Engineers	Use the product for disaster investigation and mitigation	
WMO's International Charter	World Meteorological Organization	Respond international flood activations	

Summary and Path Forward

- The blended flood product is with the advantages of VIIRS, ABI and AHI: 375-m spatial resolution, maximal clear-sky coverage
- A simple nearest interpolation can blend the VIIRS, ABI and AHI flood products together, but does not produce smooth floodwater boundaries.
- The downscaling and upscaling process helps merge the floodwater fractions at different spatial resolution together and produce blended flood products with smooth floodwater boundaries.
- The final blended flood product is called geostationary-JPSS flood product: It is based on the VIIRS global flood product, and the gap on clouds/cloud shadows is filled with geostationary satellite flood products from ABI and AHI.

Thanks!