

# 331652: Collaborative, Rapid Mapping of Water Extents During Hurricane Harvey Using Optical and Radar Satellite Sensors



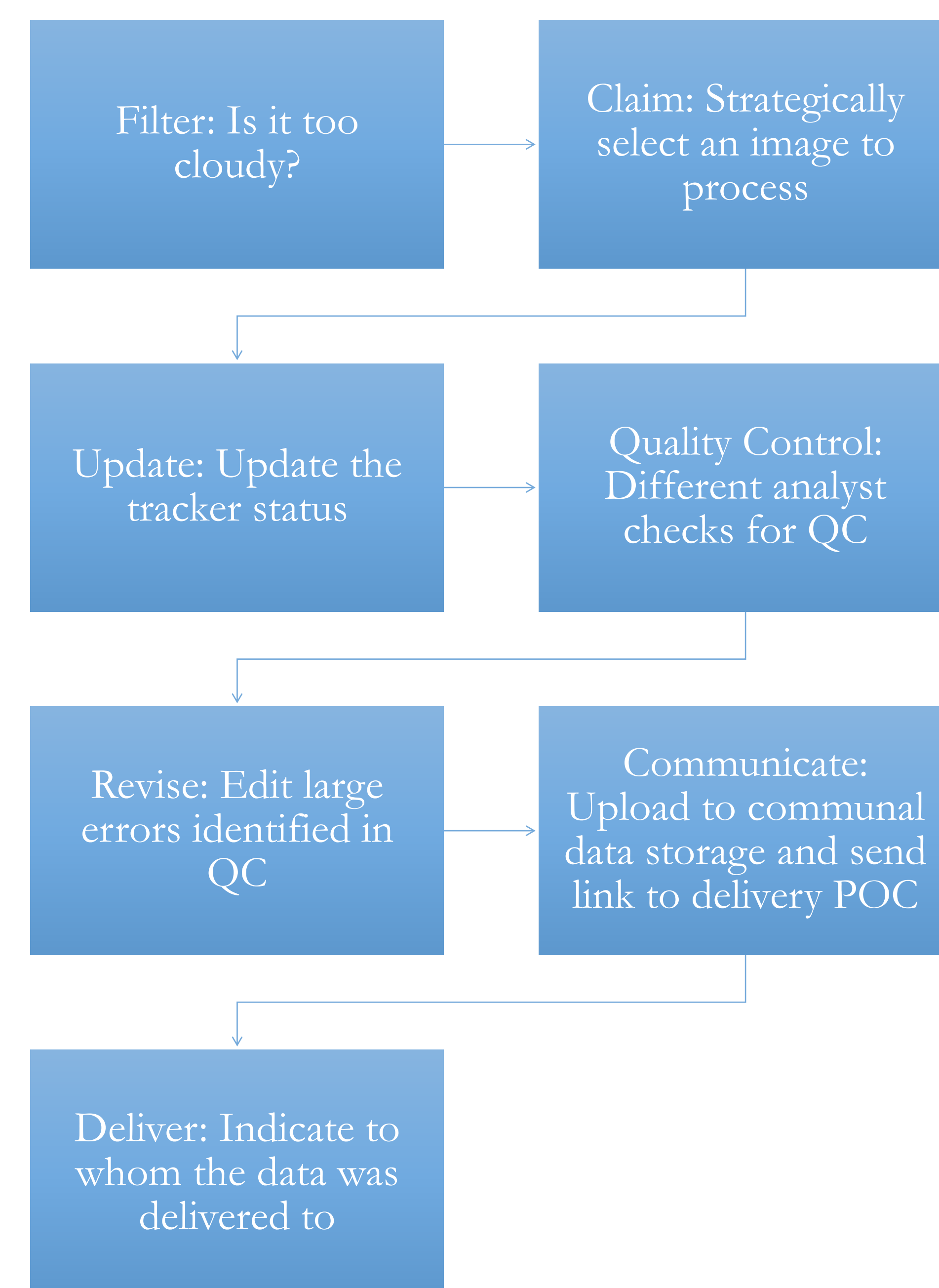
Rebekke Muench, Madeline Jones, Kelsey Herndon, Lori Shultz, Jordan Bell, Eric Anderson, Kel Markert, Andrew Molthan, Emily Adams, Emil Cherrington, Africa Flores, Garrett Layne, Ronan Lucey, Thailynn Munroe, Sarva Pulla, Githika Tondapu, Amanda Weigel  
University of Alabama in Huntsville, NASA Marshall Space Flight Center, New Light Technologies Inc,

## Abstract

On August 25, 2017, Hurricane Harvey made landfall between Port Aransas and Port O'Connor, Texas, bringing with it unprecedented amounts of rainfall and record flooding. In times of natural disasters of this nature, emergency responders require timely and accurate information about the hazard in order to assess and plan for disaster response. Due to the extreme flooding impacts associated with Hurricane Harvey, delineations of water extent were crucial to inform resource deployment. Through the USGS's Hazards Data Distribution System, government and commercial vendors were able to acquire and distribute various satellite imagery to analysts to create value-added products that can be used by these emergency responders. Rapid-response water extent maps were created through a collaborative multi-organization and multi-sensor approach. One team of researchers created Synthetic Aperture Radar (SAR) water extent maps using modified Copernicus Sentinel data (2017), processed by ESA. This group used backscatter images, pre-processed by the Alaska Satellite Facility's Hybrid Pluggable Processing Pipeline (HyP3), to identify and apply a threshold to identify water in the image. Quality control was conducted by manually examining the image and correcting for potential errors. Another group of researchers and graduate student volunteers derived water masks from high resolution DigitalGlobe and SPOT images. Through a system of standardized image processing, quality control measures, and communication channels the team provided timely and fairly accurate water extent maps to support a larger NASA Disasters Program response. The optical imagery was processed through a combination of various band thresholds and by using Normalized Difference Water Index (NDWI), Modified Normalized Water Index (MNDWI), Normalized Difference Vegetation Index (NDVI), and cloud masking. Several aspects of the pre-processing and image access were run on internal servers to expedite the provision of images to analysts who could focus on manipulating thresholds and quality control checks for maximum accuracy within the time constraints. The combined results of the radar- and optical-derived value-added products through the coordination of multiple organizations provided timely information for emergency response and recovery efforts .

## Methodology

### Optical Protocol

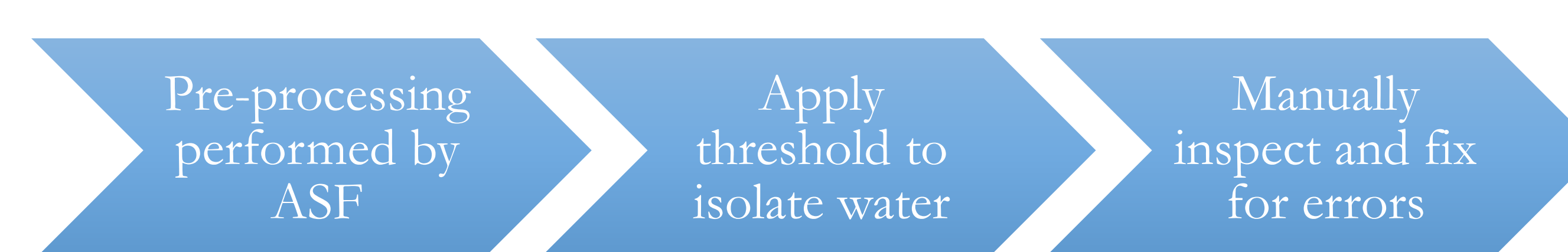


The rapid response to Hurricane Harvey required the collaboration of multiple groups and analysts. Data types were assigned depending on knowledge of the analysts and data availability. The analysts worked on Sentinel 1 SAR imagery, SPOT optical imagery, and DigitalGlobe WorldView imagery. As optical data became available through the Data Distribution System, the optical imagery protocol was followed by each analyst for efficient imagery selection and processing. As Synthetic Aperture Radar (SAR) images were acquired, they were pre-processed by the Alaska Satellite Facility and delivered through their Hybrid Pluggable Processing Pipeline (HyP3) to then be further analyzed.

### Optical Methodology



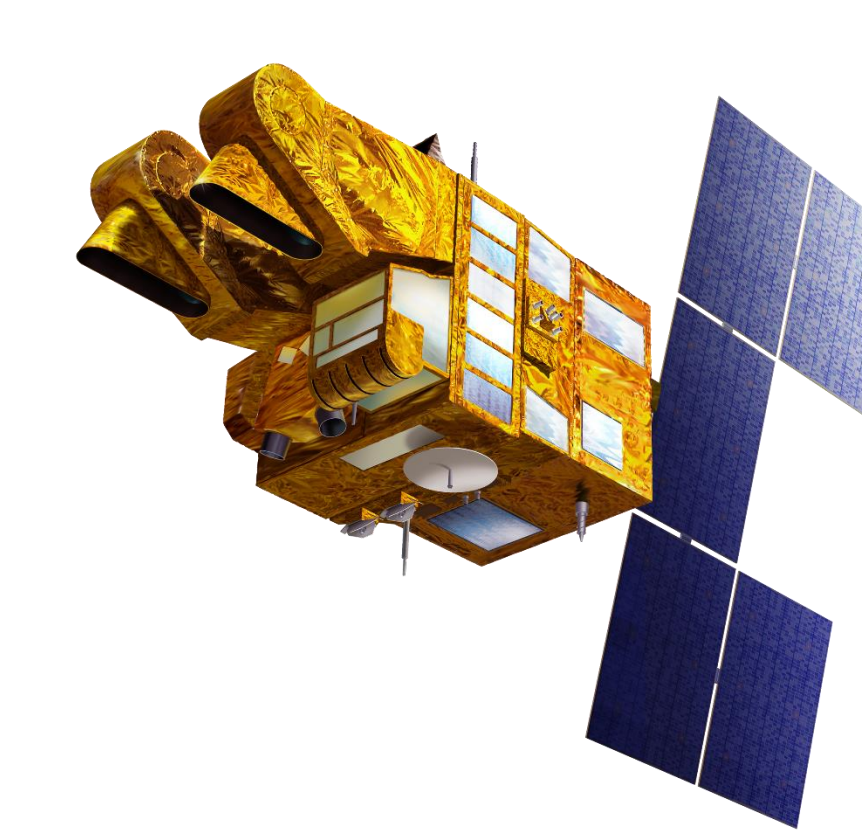
### SAR Methodology



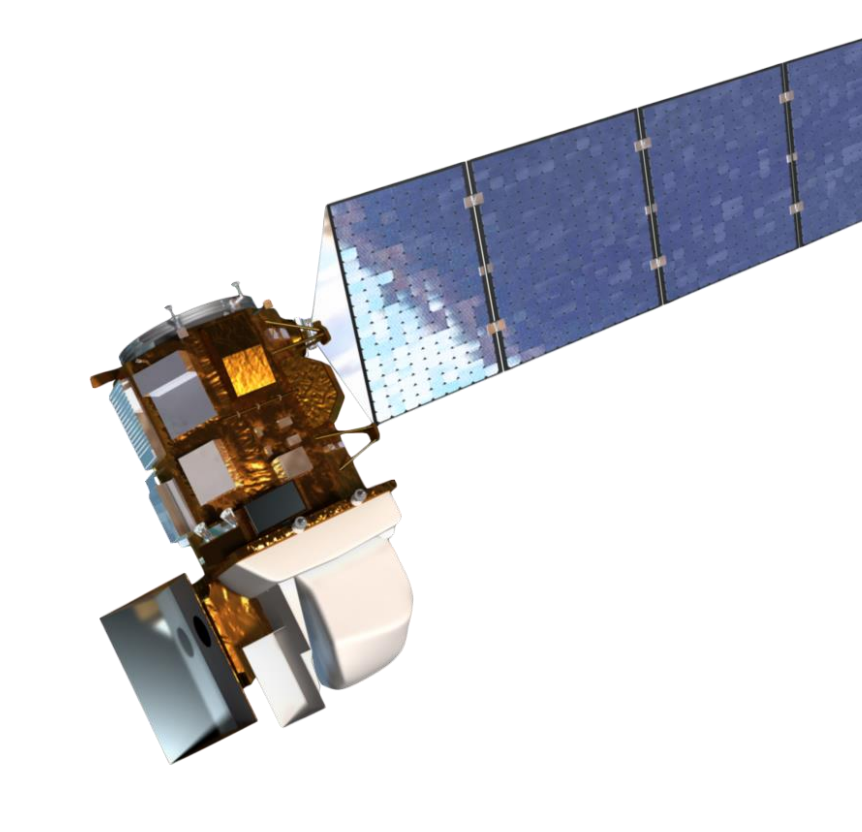
## Acknowledgements

The authors would like to acknowledge the Earth System Science Center at the University of Alabama in Huntsville, the SERVIR Science Coordination Office, the NASA Applied Science's Program, NASA Disasters Program, and the NASA Capacity Building Program. Additionally data were provided by the Alaska Satellite Facility by pre-processing the Sentinel 1 data, contains modified Copernicus Sentinel data (2017), processed by ESA, the USGS's Hazards Data Distribution System for the DigitalGlobe and SPOT imagery.

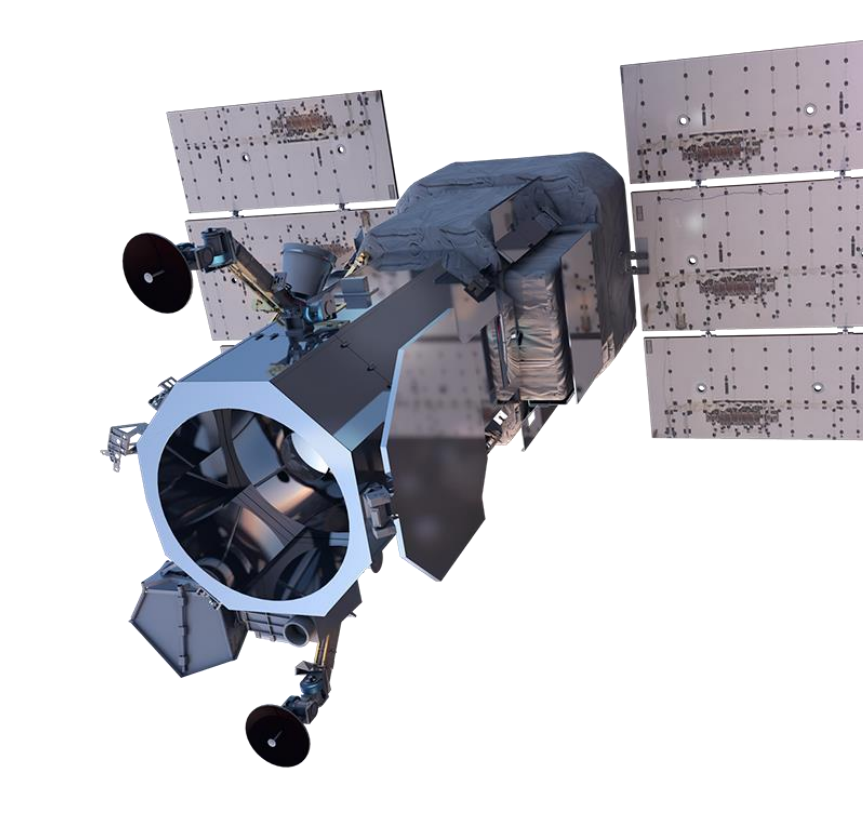
## Earth Observations



Sentinel 1



SPOT

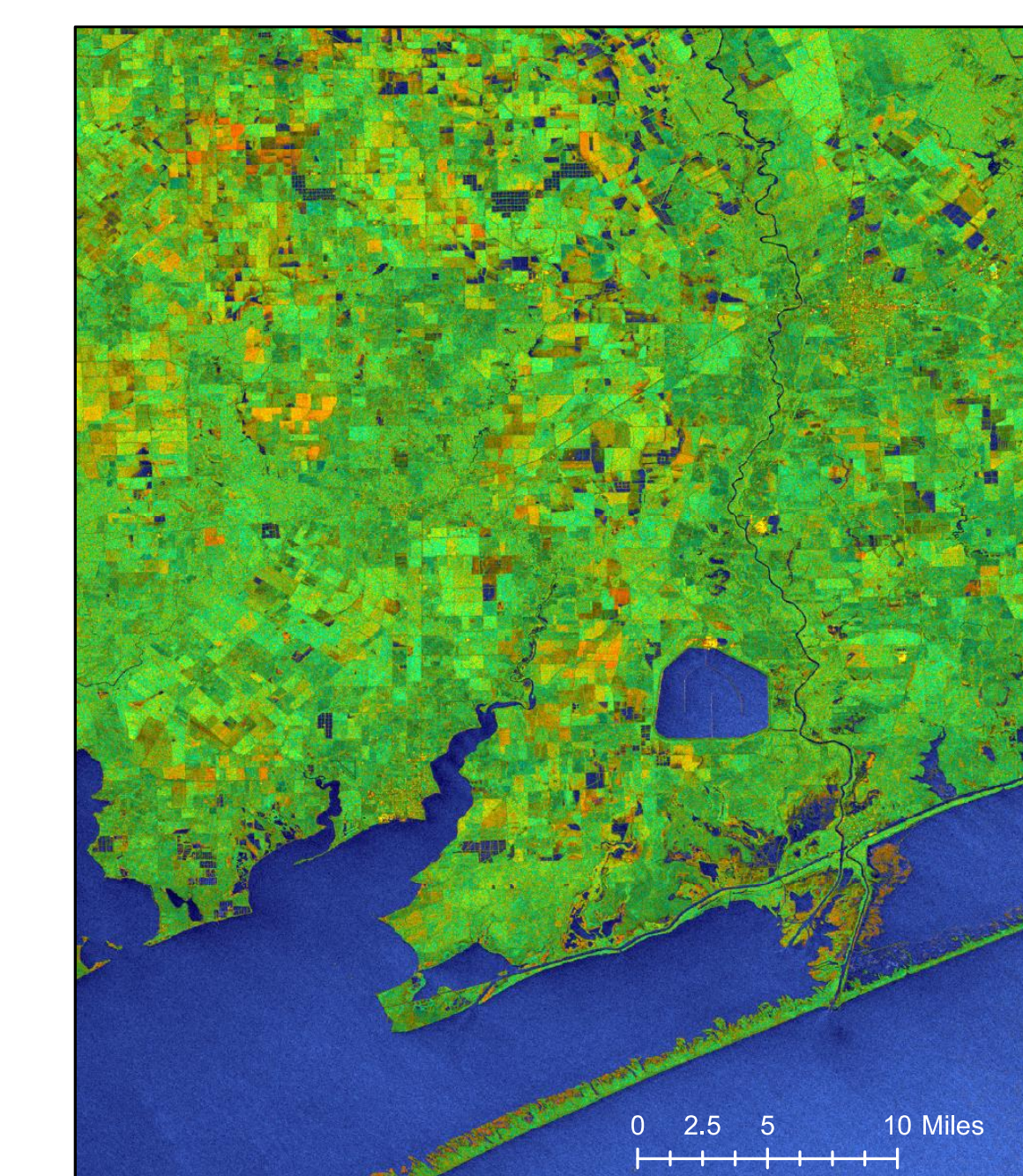
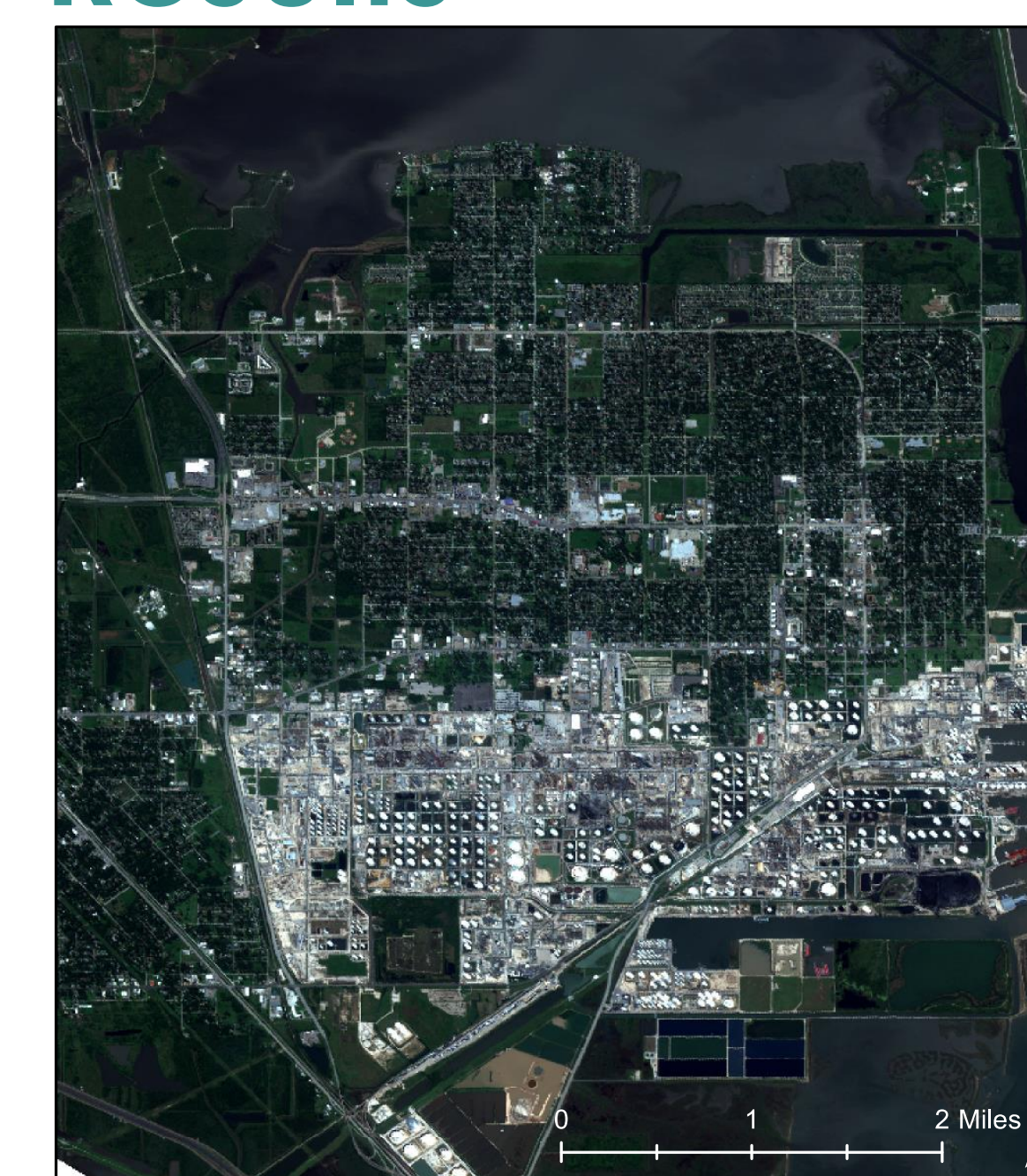


WorldView 3

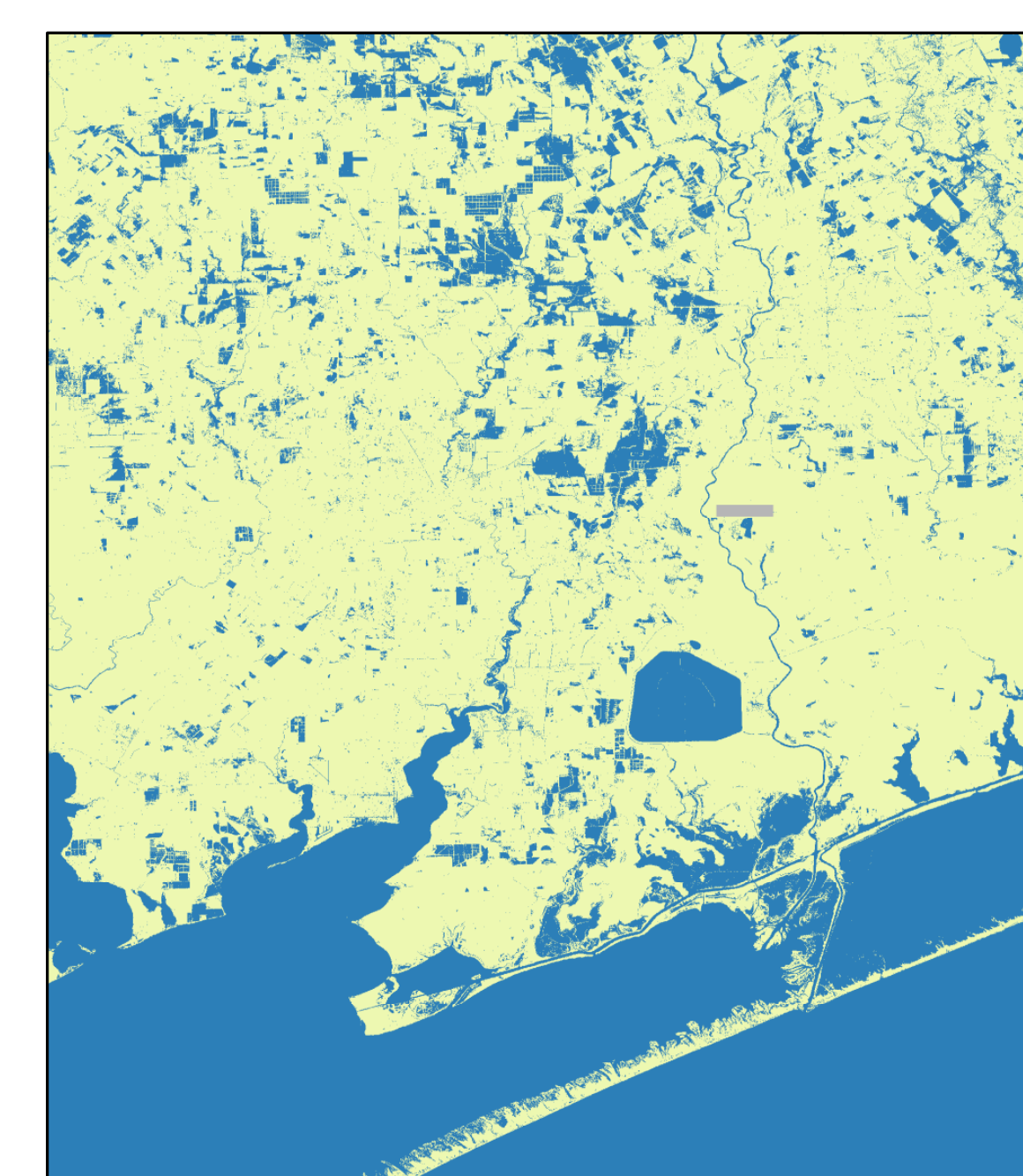


WorldView 2

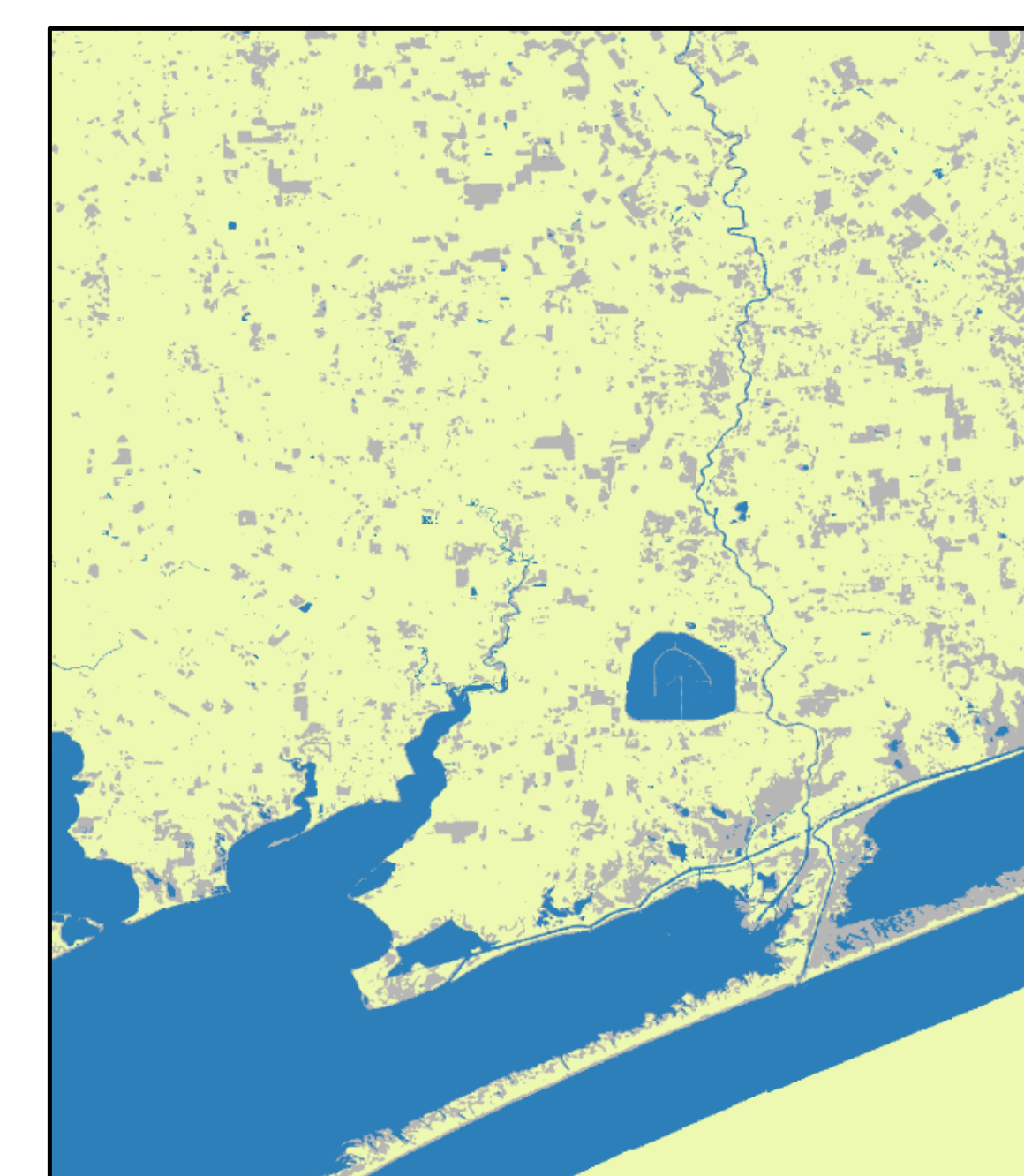
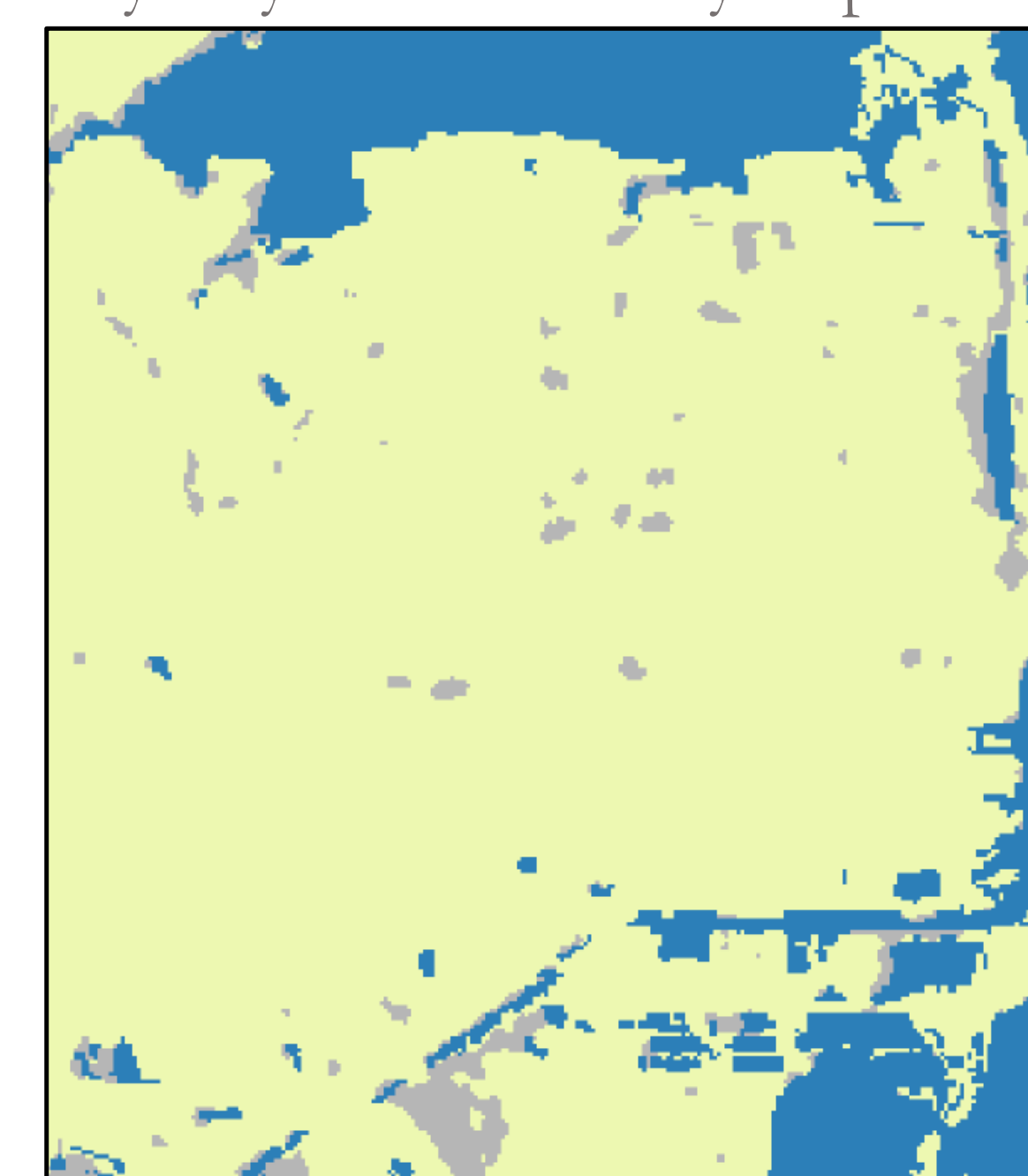
## Results



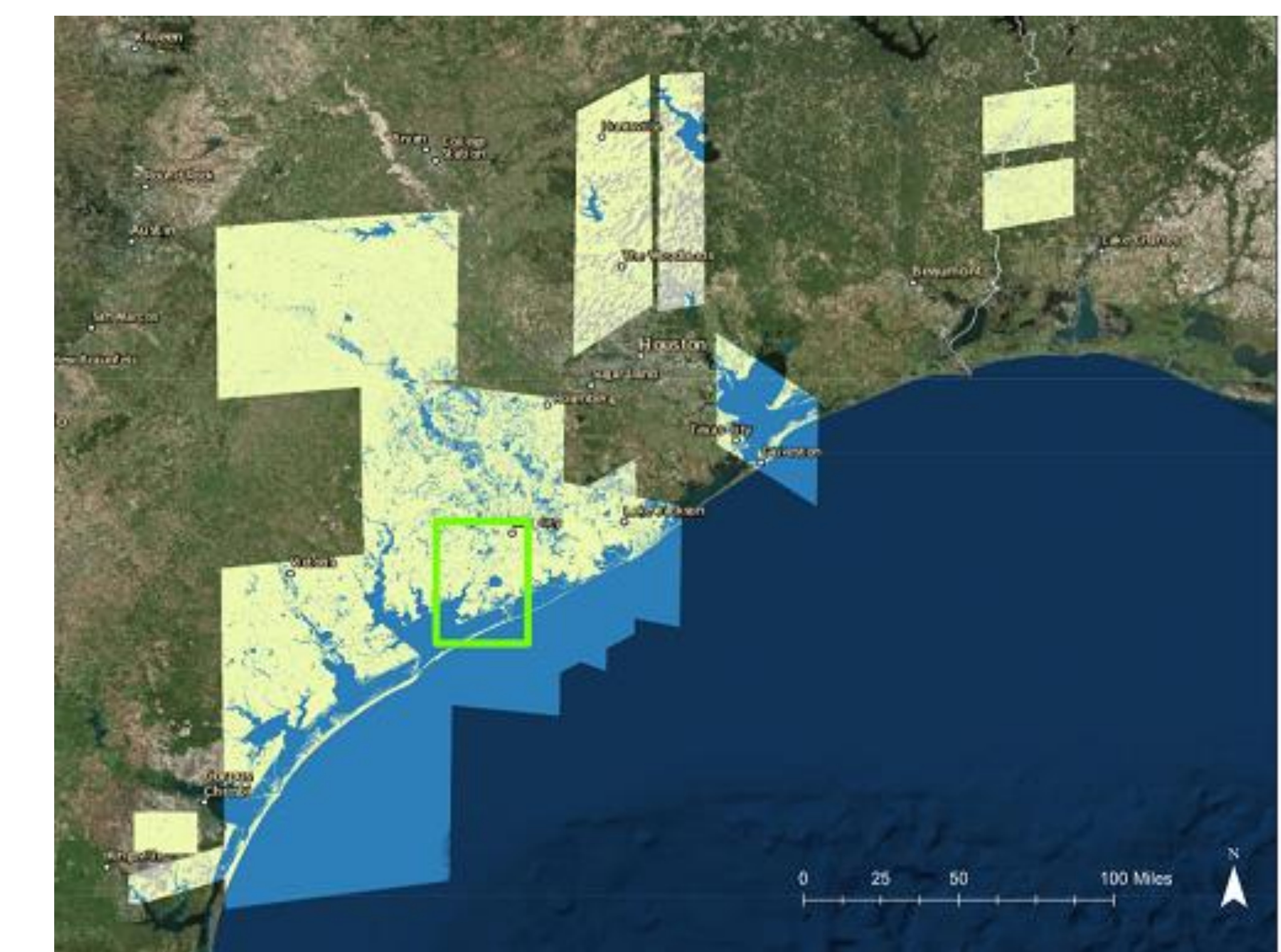
Figures A and B show the true color optical image of Texas City and an RGB SAR image respectively



Figures C and D show the high-resolution optical derived water masks for Bay City and Texas City respectively



Figures E and F show the SAR derived water masks for Bay City and Texas City respectively



## Conclusions

- ▶ High resolution commercial imagery has uses beyond the visible true color image
- ▶ Rapid response to disasters requires a strategy and plan for optimal impact
- ▶ Combined approach of radar and optical imagery can provide additional insight rather than one sole data source
- ▶ In emergency situations, the more data the better; however, it is important to prioritize the data that is most useful to decision makers