Committee on Earth Observation Satellites

# GEO/LEO/SAR Flood Pilot Proposal

David Green (NASA), Andrew Molthan (NASA) and

Mitch Goldberg (NOAA)

2020 WGDisasters Meeting

Virtual Discussion

9 – 13, March 2020

# Co-Leads and Introductions

- Dr. Mitch Goldberg, NOAA/NESDIS
  - NOAA's Chief Scientist for Low Earth Orbiting Satellites and formerly the Chief of the NESDIS Satellite Meteorology and Climatology Division
  - Leads the NESDIS Satellite Proving Ground program to improve NOAA services through facilitated collaboration for product developers and end users

- Dr. Andrew Molthan, Marshall Space Flight Center
  - Research Meteorologist at NASA Marshall, collaborates with NASA's Disasters Program to help the disasters community use NASA data and tools
  - Past experience in the use of numerical weather prediction, GEO/LEO remote sensing, and SAR

# GEO / LEO Progress and Pilot Concepts

- 2019 CEOS Plenary – WGDisasters proposed expanding CGMS flood pilot to include SAR, focus on urban and coastal flooding and bring in more CEOS participation.
- GEO/LEO and WGDisasters see opportunities for collaboration:
  - Work with community of partners to document needs and requirements for effective water extent and flood mapping
  - Share information about techniques, methodologies, methods of product dissemination and best practices
  - Identify a small number of impactful flood events with known, rich volumes of GEO/LEO and complementary SAR data
  - Identify additional past cases and new, unfolding cases emphasizing availability of multi-frequency and new SAR missions

# GEO / LEO Progress and Pilot Concepts


Synthetic aperture radar is beneficial for its ability to penetrate through most clouds and precipitation

- wavelength dependent

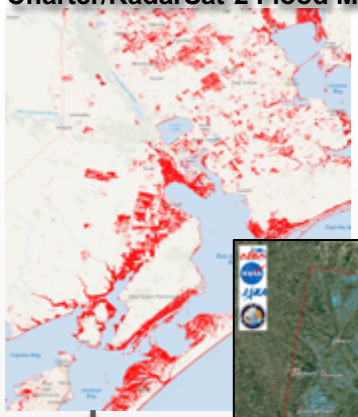
Here, a movie captures Hurricane Dorian in the Bahamas, where clouds prevented a view of the surface – at the same time, ESA Sentinel-1 observations were acquired that helped to produce a change detection-based flood map.

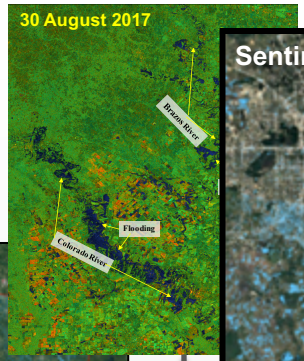
SAR also provides phase measurements complimentary to backscatter, and combined these offer approaches to mapping water and damage extent complimentary to optical approaches.

Multi-frequency SAR (X, C, S, L) are increasingly available to exploit for these purposes.

# Combined Value of LEO/GEO and SAR

Charter/RadarSat-2 Flood Map



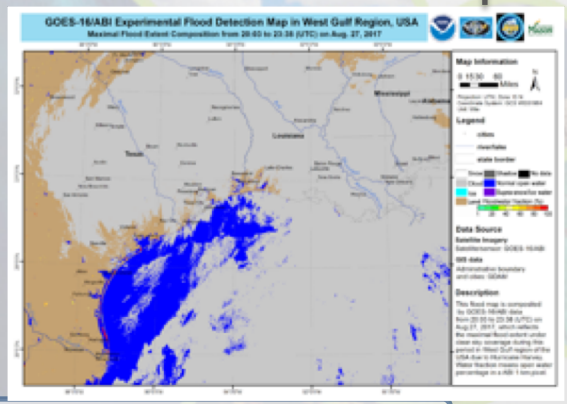


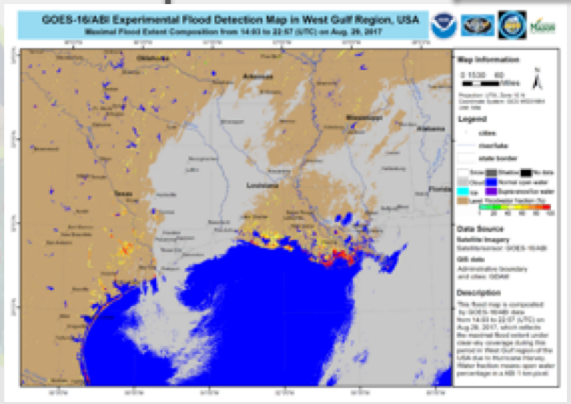


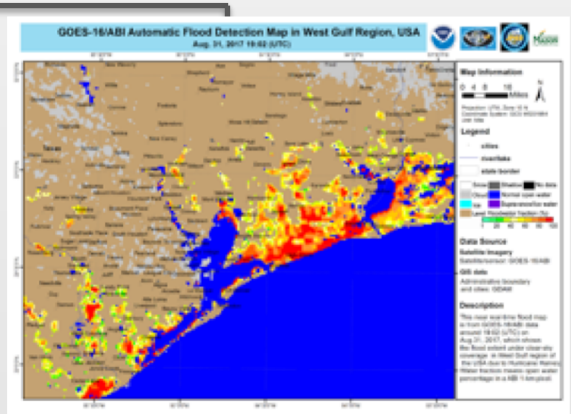

increased flooding from 9/1-2


Multi-agency collaborations around remote sensing response to Harvey

August 23 | 8/26 | 8/27 | 8/28 | 8/29 | 8/30 | 8/31 | September 1 | ←UAVSAR Flights→ | 9/4



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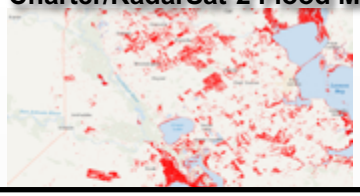


*SAR provides cloud and under-vegetation views of water, but often with additional data latency and infrequent repeat passes: constellation approaches are highly valuable!*

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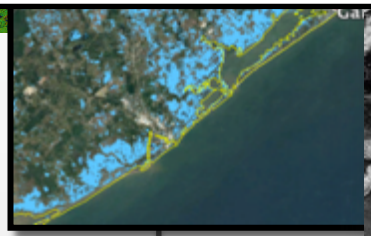


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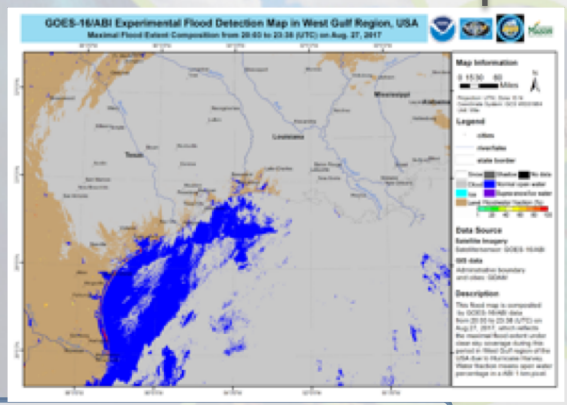


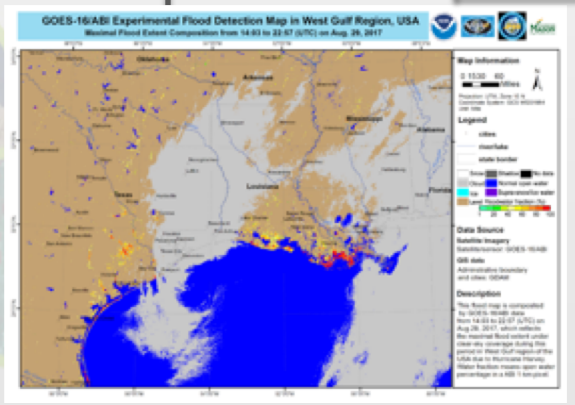


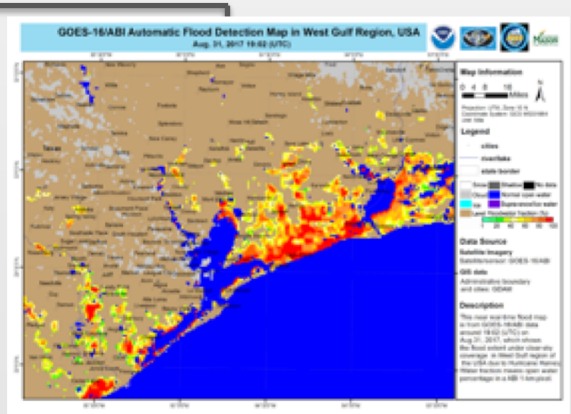

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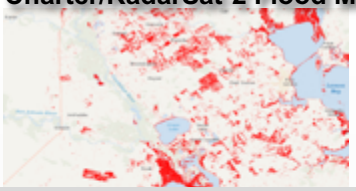

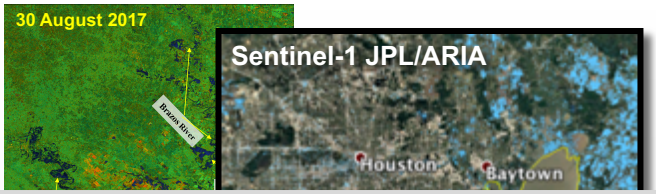


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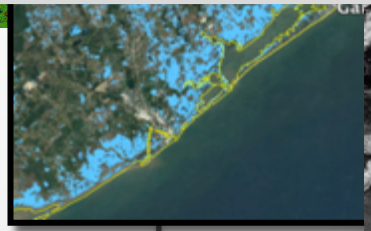


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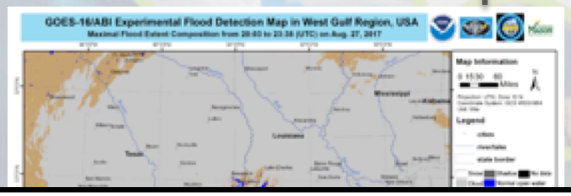
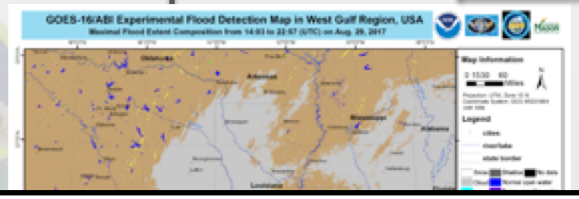
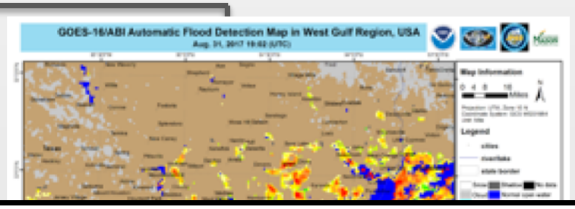


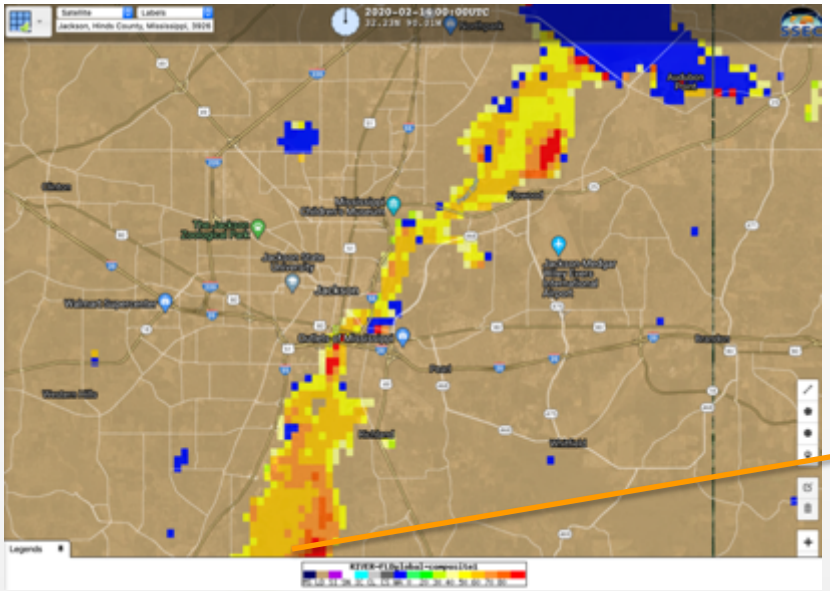



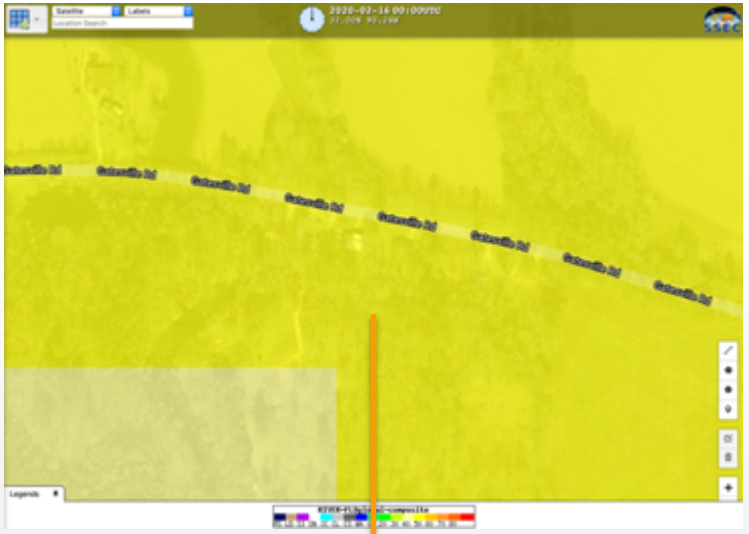

LEO/GEO provide routine coverage, limited by cloud cover – their combination provides multiple opportunities to revisit and reassess!

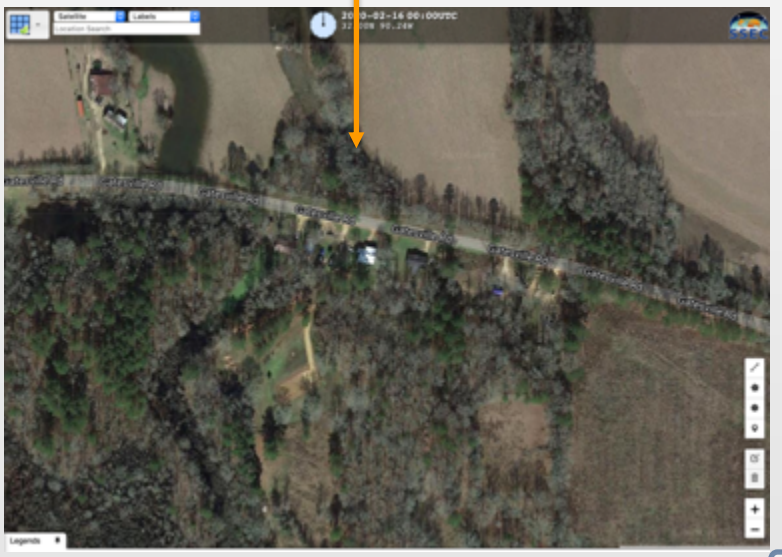
# Combined Value of LEO/GEO and SAR

- We know that GEO optical sensors provide tremendous value in mapping flood extent – new, geostationary sensors are providing additional coverage in space and time…
- LEO sensors provide higher spatial resolution and near-nadir views of flood extent, and benefit from application of methods to a growing number of remote sensing platforms:
  - NOAA, NASA, ESA/Sentinel, commercial, defense, …
- Multi-frequency and multi-partner constellations of SAR measurements help address key limitations of optical methods:
  - Persistent cloud cover in weather-affected regions
  - Limitations to observe during daylight hours only
  - Some limits on ”seeing” water through vegetation canopies

# Additional Need: Ground Truth Validation



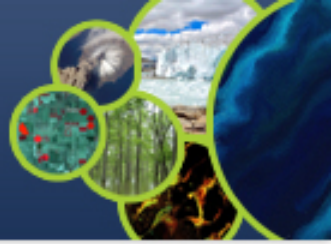




Feb 16, 2020

An Example Of Ground Truth

# Combined Value of LEO/GEO and SAR



- *Questions:*
  - What are the water extent and flood mapping activities currently being tackled by the CEOS partner community?
    - Capture efforts in optical, SAR, other platforms
  - What are the requirements (and potential desirements) for sustaining and improving these capabilities?
  - What observations or modeling resources are available to assist with calibration/validation of LEO/GEO, SAR, and their combination?
  - How can we best combine these diverse measurements to improve the value of LEO/GEO and SAR to the community?
  - How are resulting data and products currently being shared and used by the disaster risk, resilience, and response community?

# Proposed Pilot Objectives

- Objective A
  - Solicit input from CEOS partnering agencies and participants on current and upcoming efforts to map water and flood extent from diversity of LEO/GEO and SAR contributions
- Objective B
  - Capture underlying requirements and future needs to sustain and improve upon these capabilities.
- Objective C
  - Explore ideal combination of LEO/GEO/SAR flood mapping outputs, using representative regional events of interest to partners.
  - Develop and document best practices for combining and sharing flood information from multiple platforms with diversity in sensor, spatial/temporal resolution, etc.

# Proposed Pilot Deliverables

- Objective A
  - Document requirements, current and future needs for remote sensing in LEO/GEO and SAR to sustain and advance water and flood extent mapping capabilities.
- Objective B
  - Develop and share information online to aggregate sources of water extent and flood mapping information
- Objective C
  - Demonstrate and document best practices for combining LEO/GEO and SAR flood extent mapping

# Questions / Group Discussion

- What are your thoughts about these objectives?
- How can CEOS best bring together partnering agencies to capture needs and improve combined use of LEO/GEO/SAR?
- How would your team contribute to these efforts?

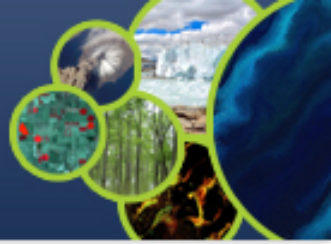
# Proposed CEOS Objectives

- Assist CEOS partners with developing documented requirements or future needs for the mapping of water and flood extent from Earth observations
- Aggregate information about CEOS community flood mapping efforts and share through an online portal for background and access to resources during flood events
- Develop and demonstrate best practices for combining multiple platforms and sources of information to assist in response to major flood events mapped with LEO/GEO and SAR assets

# Proposed CEOS Contributions

- Serve as coordinating body to facilitate participation by member agencies, through WGDisasters
  - Share information on the current state of flood mapping and promising new techniques leveraging LEO/GEO and SAR
  - Coordinate and support sharing of imagery to support analysis of past regional events of interest and those that may arise during the time of the pilot collaboration
  - When possible, provide feedback to other CEOS efforts (e.g. CARD4L, etc.) supporting routine and improved access to LEO/GEO and SAR data sets
  - Partnering agencies provide appropriate project support to oversee implementation and execution of pilot activities

# Proposed Next Steps



- Discuss concept of WGDisasters Flood Pilot among potential partners, suggest revisions and refined direction
- Create portfolio of the flood community – document remote sensing requirements, data formats, and ancillary data across optical and SAR platforms
- Identify water extent and flood mapping capabilities and techniques throughout CEOS agency efforts
- Create a CEOS Flood Portal to share documentation on requirements and capture capabilities for flood detection along with related forecasting and analysis websites.
- Use case studies to explore best practices for combining LEO/GEO and SAR information from multiple spatial/temporal resolutions
- Share lessons learned on mapping capabilities and combined LEO/GEO and SAR in partnership with WGCapD

# Expressions of Interest

| Potential Participants | Organizations |
|---|---|
| Theodora (Dorella) Papadopoulou | ARGANS |
| Philippe Bally | European Space Agency |
| Roberto Ruadi | CIMA Research Foundation |
| Patrick Matgen | Luxembourg Institute of Science and Technology (LIST) |
| Haris Kontoes | National Observatory of Athens |
| Issaak Parcharidis | University of Athens |
| Weiyuan Yao | Academy of Opto-Electronics / Chinese Academy of Sciences |
| Shantanu Bhatawdekar | Indian Space Research Organization |
| Praveen Thakur | |
| Prakash Chauhan | |
| S. P. Aggarwal | |
| Álvaro Soldano | Comisión Nacional de Actividades Espaciales (CONAE) |
| Sandro Martinis | German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) |
| Yves Crevier | Canadian Space Agency |
| Vern Singhroy | Natural Resources Canada |
| Vince Decker | |

# Expressions of Interest

| Potential Participants | Organizations |
|---|---|
| Franz Meyer | University of Alaska Fairbanks |
| Kristy Tiampo | University of Colorado |
| Sang-Ho Yun<br>Savannah Cooley | NASA / Jet Propulsion Laboratory |
| Guy Schumann | Remote Sensing Systems |

# Questions / Group Discussion

- Are expected CEOS Contributions reasonable?
- Are there new partners looking to engage and contribute?
- What capabilities or areas of expertise can your agency contribute?

# Questions / Group Discussion