Understanding the relative contributions of sediment delivery and plants production to resilience of the Mississippi River Delta to sea level rise

PI Marc Simard

https://Deltax.jpl.nasa.gov

Jet Propulsion Laboratory
California Institute of Technology

Marc.simard@jpl.nasa.gov

Solving pressing Earth system Science issues: NASA's Earth Venture Suborbital – 3

(NASA's Science Mission Directorate/Earth Science Division)

- ACTIVATE:

Aerosol Cloud Meteorology Interactions over the Western Atlantic Experiment

- DCOTSS:

Dynamics and Chemistry of the Summer Stratosphere

- Delta-X:

Resilience of River Deltas

- IMPACTS:

Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms

- S-MODE:

Submesoscale Ocean Dynamics and Vertical Transport

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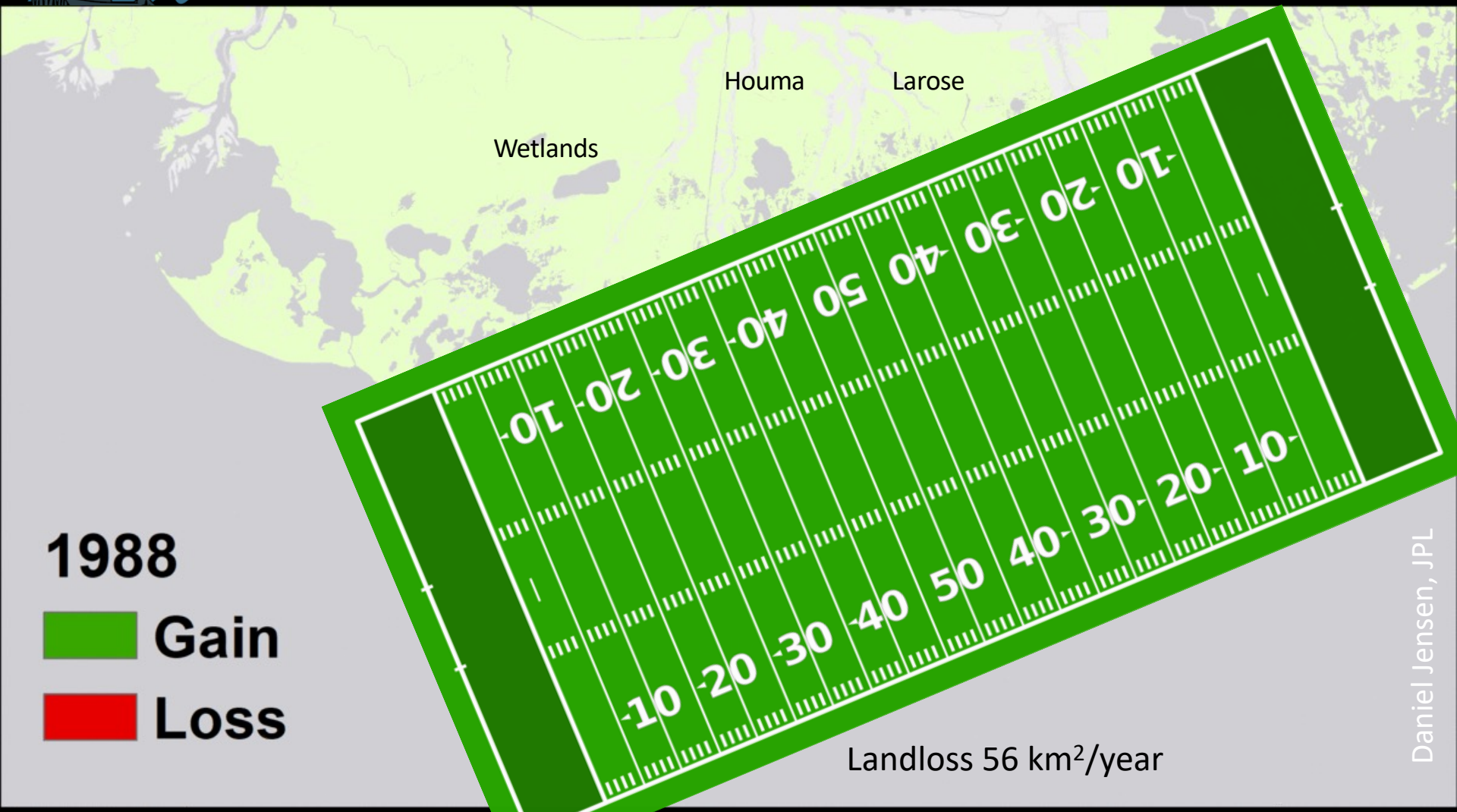

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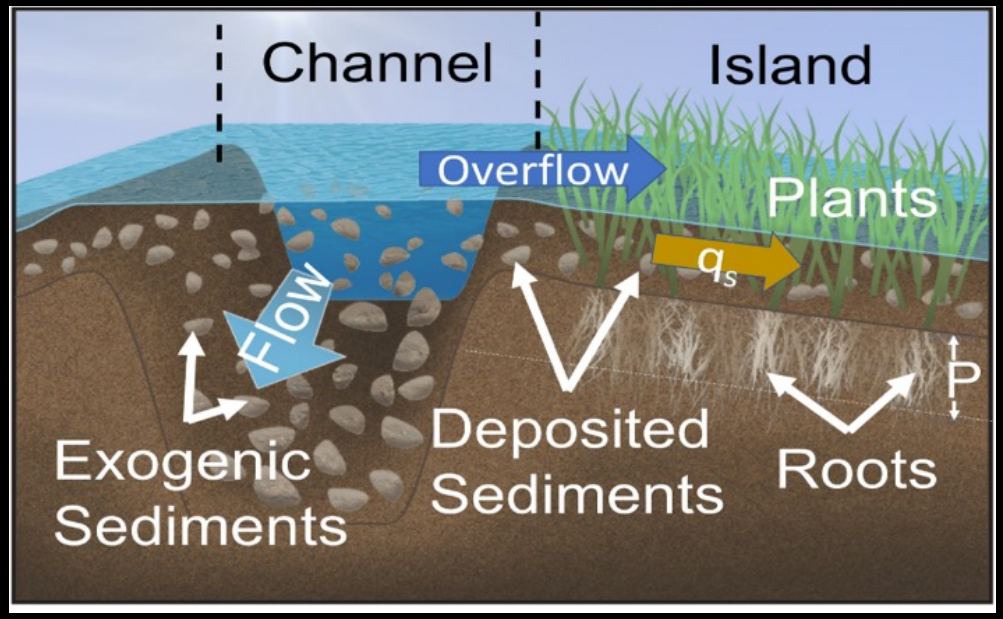
Delta-X goal:

To predict which parts of the Mississippi River Delta will keep up with sea level rise and which part will drown.

To achieve that goal, Delta-X develops a model that simulates the two processes that contribute to soil elevation:

1. **Sediment delivery to wetlands and;**
2. **Organic matter produced by vegetation.**



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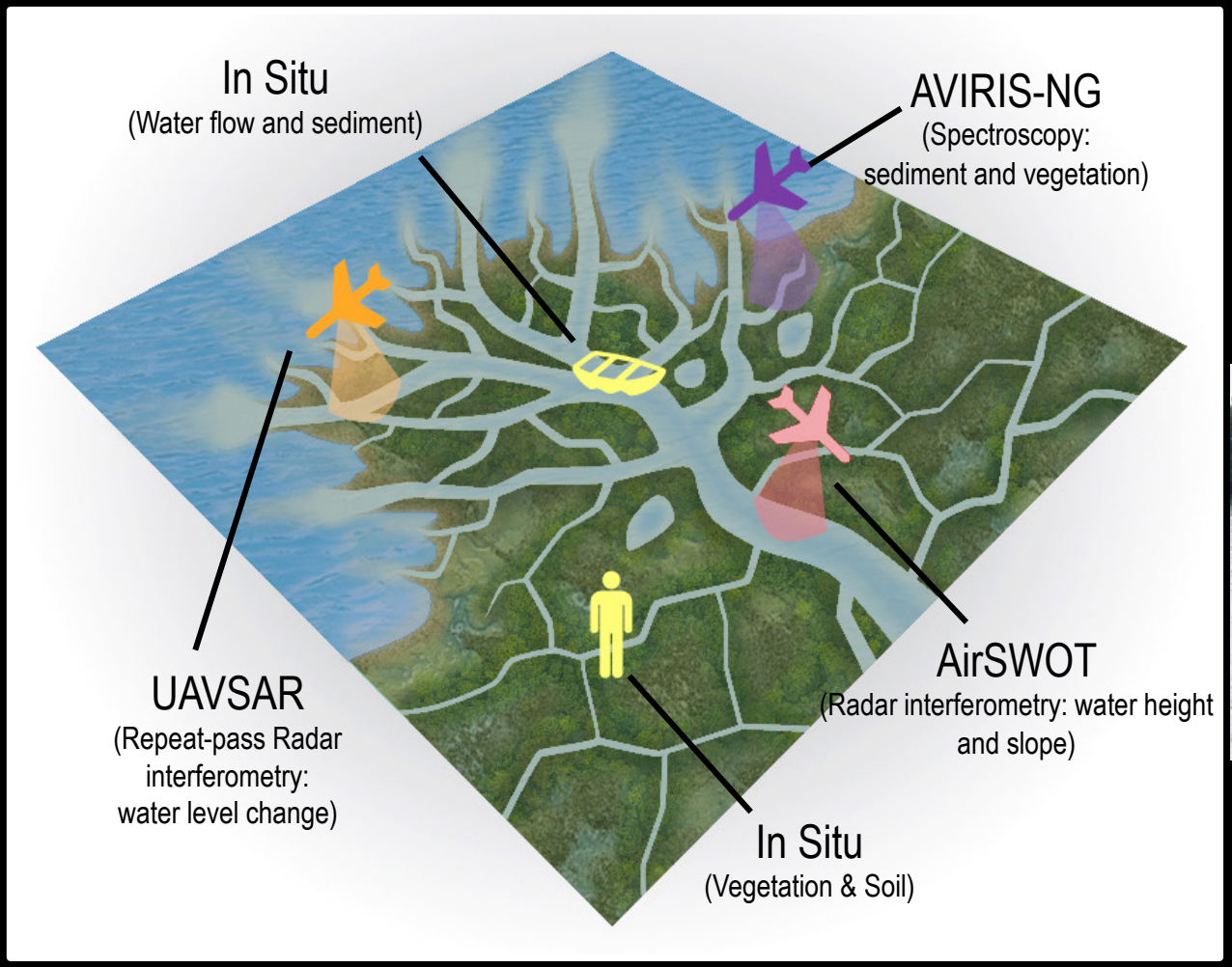
12 Co-Investigators from 8 different institutions from 6 coastal states

- **California**:
  - Jet Propulsion Laboratory, California Institute of Technology (M. Simard, C. Jones, E. Rodriguez, D. Thompson)
  - Caltech (M. Lamb)
- **Louisiana**: Louisiana State University, Baton Rouge (R. Twilley)
- **Texas**: University of Texas, Austin (P. Passalacqua)
- **Florida**: Florida International University (E. Castañeda)
- **North Carolina**: University of North Carolina (T. Pavelsky)
- **Massachusets**:
  - Boston University (C. Fichot & S. Fagherazzi)
  - Woodshole Oceanographic institution (L. Giosan)

Earth Venture Suborbital 3 Delta-X



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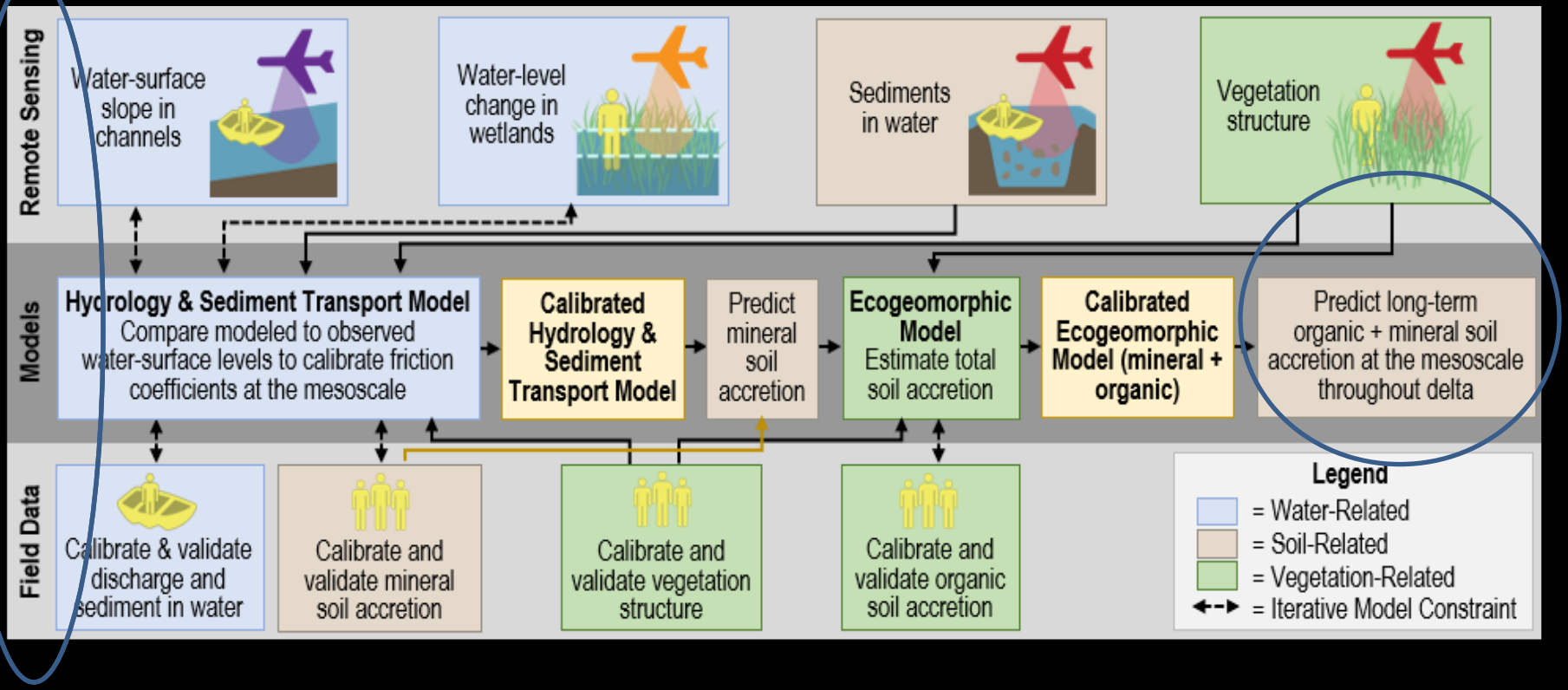
The Delta-X Framework Implementation



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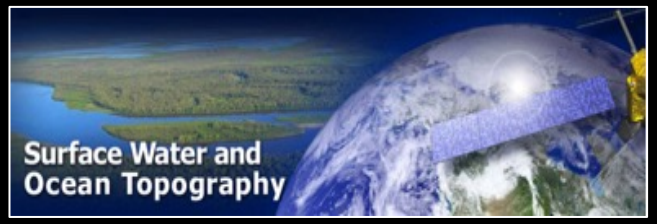
Airborne Remote Sensing Instruments

UAVSAR (for NISAR)

- L- band Radar, full-pol, 6m
- Shallow bathymetry,
- Above Ground Biomass AGB
- Water level changes within marshes
- Water surface velocity

AirSWOT (for SWOT)

- Ka-band radar interferometer
- Centimeter-level open water surface elevation and surface slope



AVIRIS-NG (for SBG and more)

- Imaging spectroscopy (425 bands)
  - 380-2510nm, 5nm
- High spatial resolution (~4m)
- Vegetation species and structure Water quality

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Delta-X Airborne Campaign

- Spring campaign 2021: March 21st - April 22nd (including in situ)
  - 3/27/21 - 4/6/21 AVIRIS-NG flights
  - 3/26 - 4/18 AirSWOT flights
  - 3/27 – 4/18 UAVSAR flights.
- Fall campaign 2021: August 16th - September 26th (including in situ)
  - 8/21/21-9/12/21 AirSWOT flights
  - 9/1/21-9/12/21 UAVSAR flights
  - 8/18/21-8/25/2021 AVIRISNG flights
- Pre-Delta-X campaigns
  - May 2015 (Spring)
  - October 2016 (Fall)

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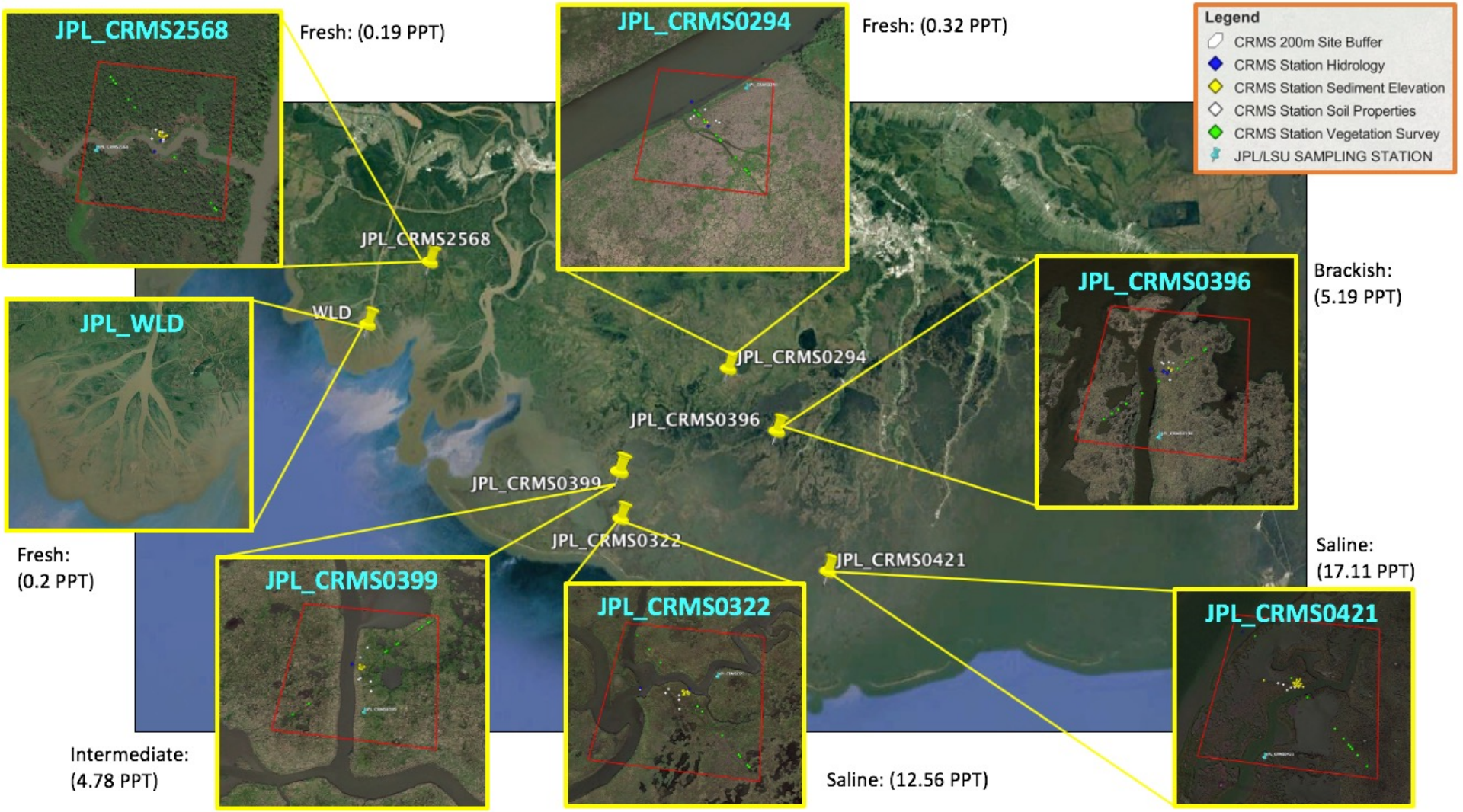
Location of the 7 Delta-X Intensive Study Sites



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Diversity of Vegetation Types

Hydrogeomorphic zones are defined from ground elevation with respect to mean water level. These zones control hydrology and vegetation type.





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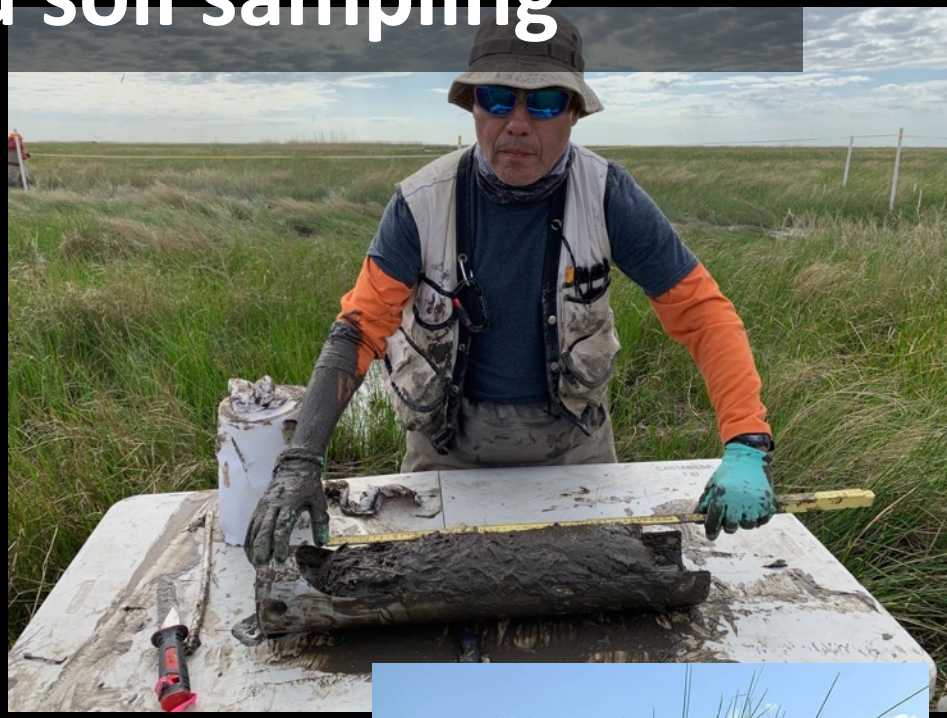
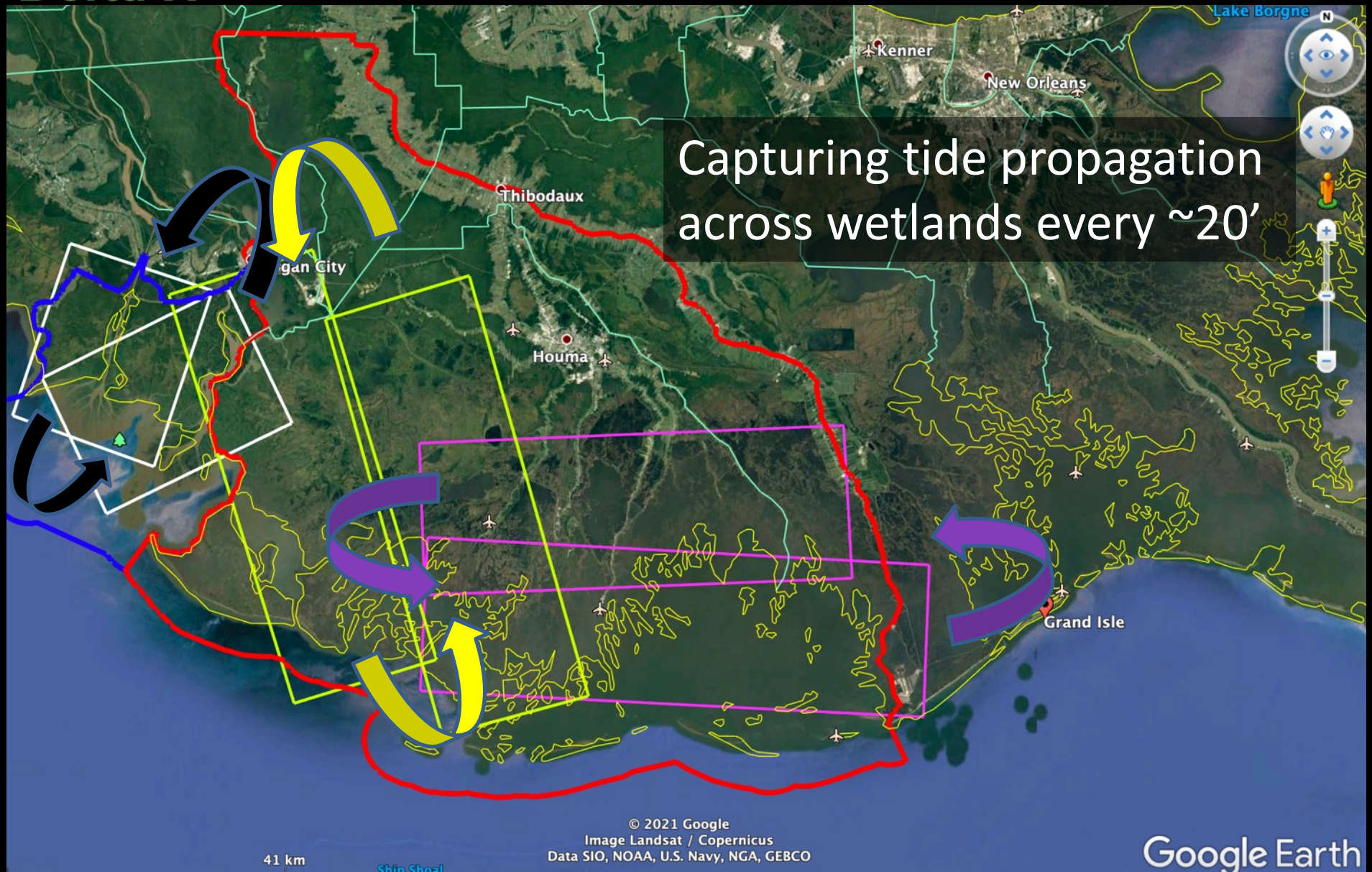
Vegetation and soil sampling



Water Quality And Dynamics


Delta-X
Capturing tide propagation across wetlands every ~20’
Lake Borgne
Kenner
New Orleans
Thibodaux
Houma
Grand Isle
© 2021 Google
Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
41 km
Google Earth

Repeat Radar Measurements as tides come in-and-out of the wetlands


Capturing tide propagation through channels every ~hour
Lake Borgne
Kenner
New Orleans
Thibodaux
Morgan City
Houma
Grand Isle
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Google Earth


Delta-X
Lake Borgne
Kenner
New Orleans
Thibodaux
Morgan City
Houma
Grand Isle
Captured tide propagation around high, low and receding stages simultaneously in channels & wetlands
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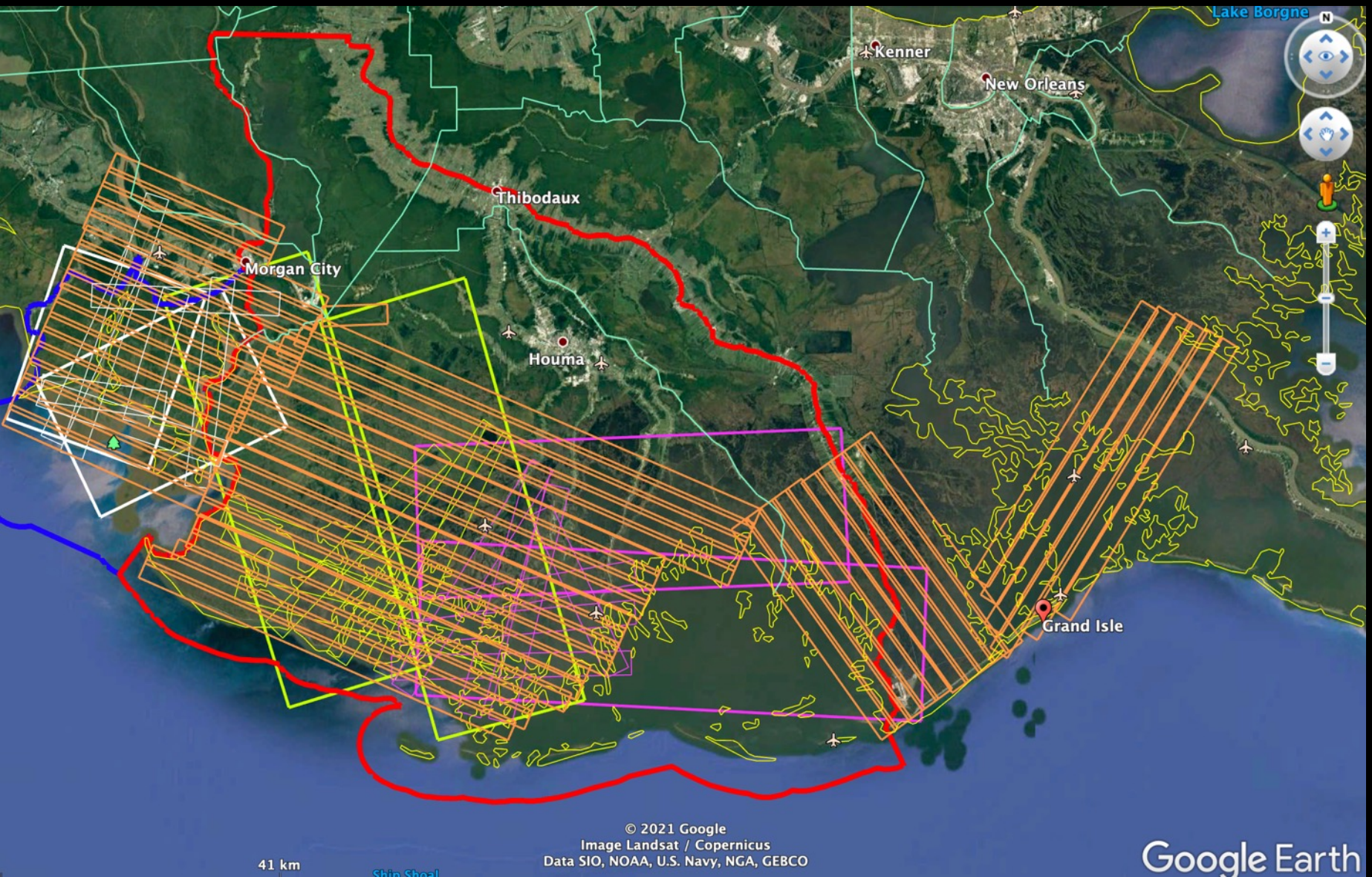
Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
41 km
Google Earth

Delta-X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Flight Plans: AVIRIS-NG, AirSWOT, UAVSAR

UAVSAR (white,yellow,green boxes) and AirSWOT (orange boxes) flight plans. Each UAVSAR box represents the area this is imaged 5-8 times during each flight. AirSWOT and UAVSAR fly at the same time in 9 (6) flights during the Fall campaign. Yellow and red markers are Delta-X water level gauges for hydrodynamic modeling and AirSWOT and UAVSAR cal/val. Small lozenges are CRMS stations (water level, weather, plant data) Not all field instrumentation / sites are shown.

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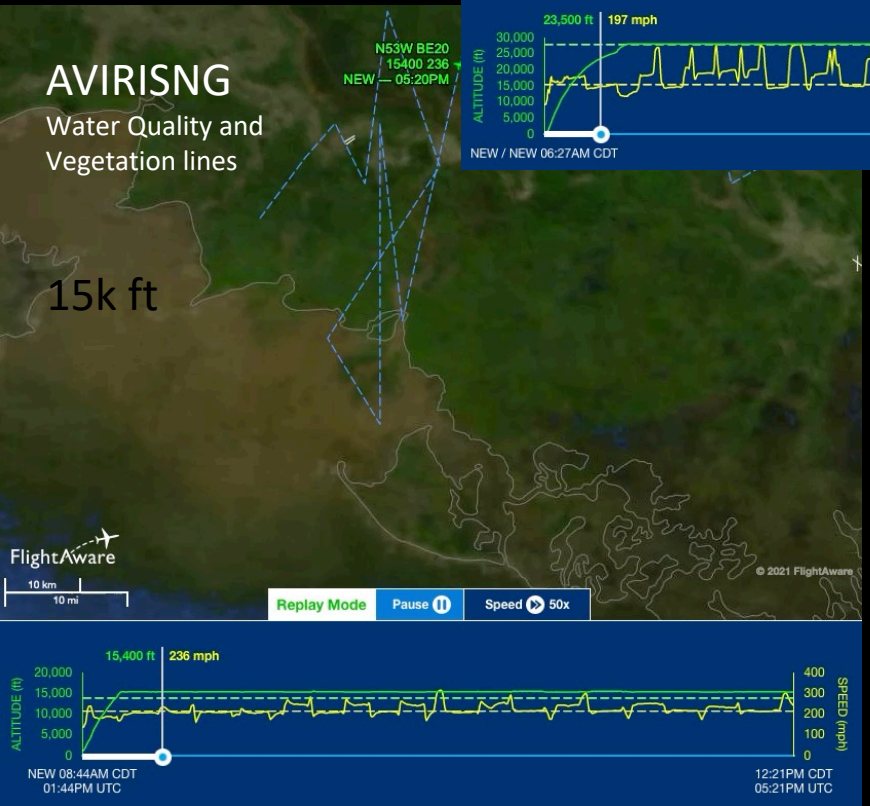
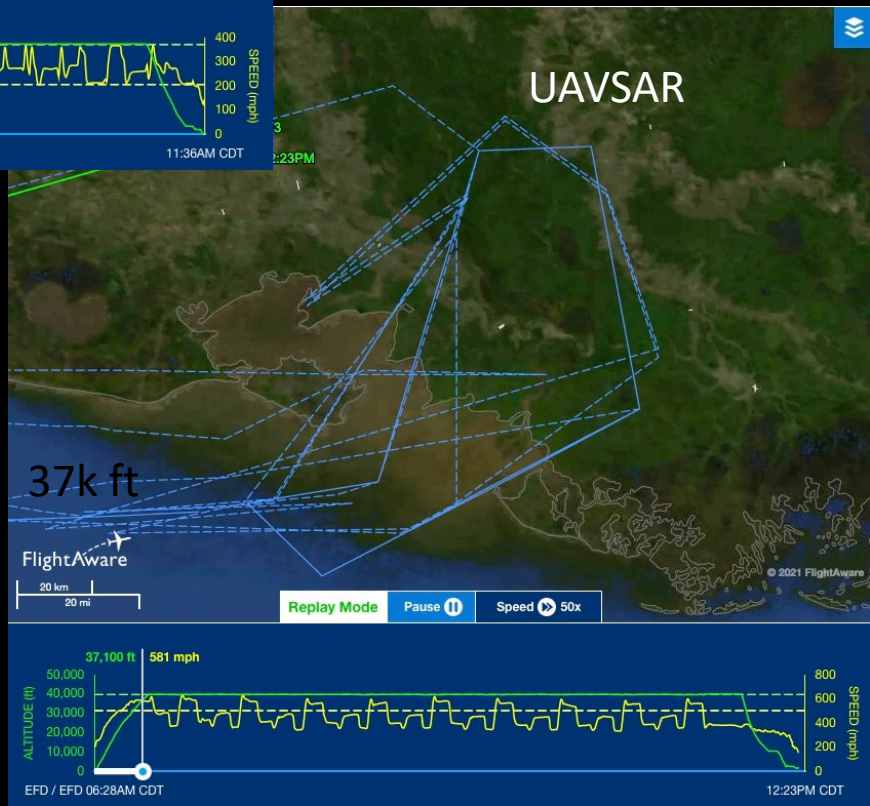
Example flight patterns: April 1st

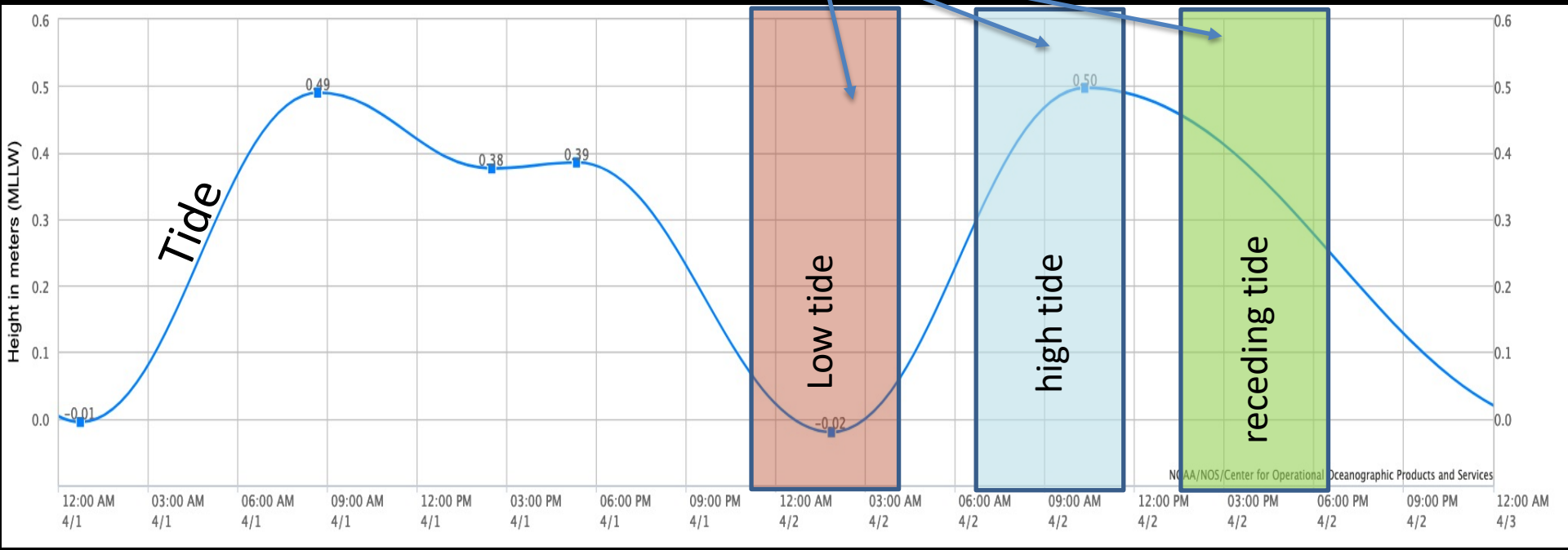
These patterns were repeated 3 times to capture around high, low and receding tides. (nb: pattern differs in each of the 3 regions)





Radar flights timed with tides

UAVSAR/AirSWOT flight windows/data acquisition



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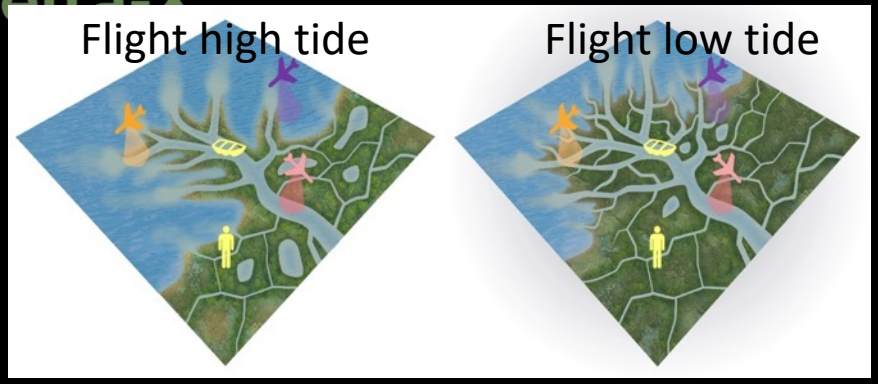
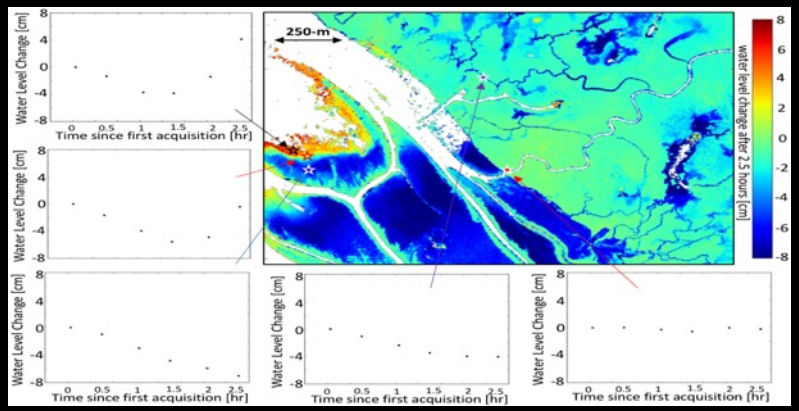
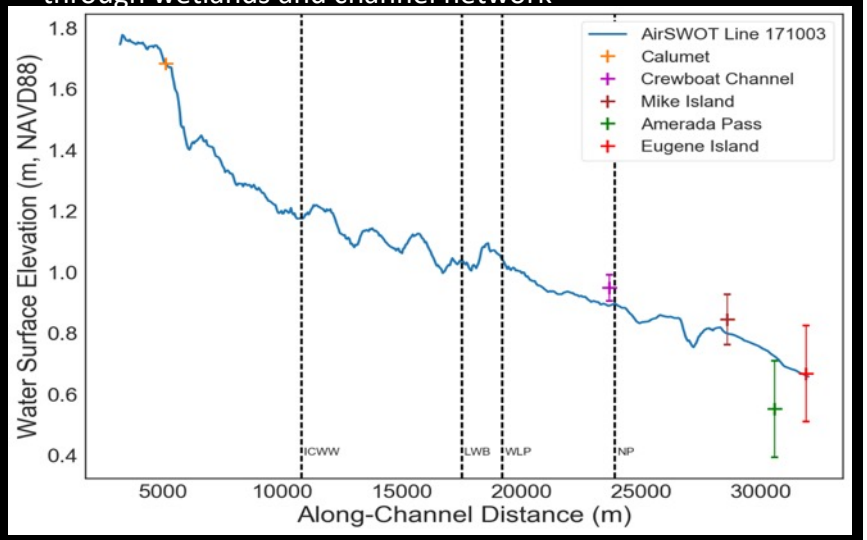
Remote Sensing measurements



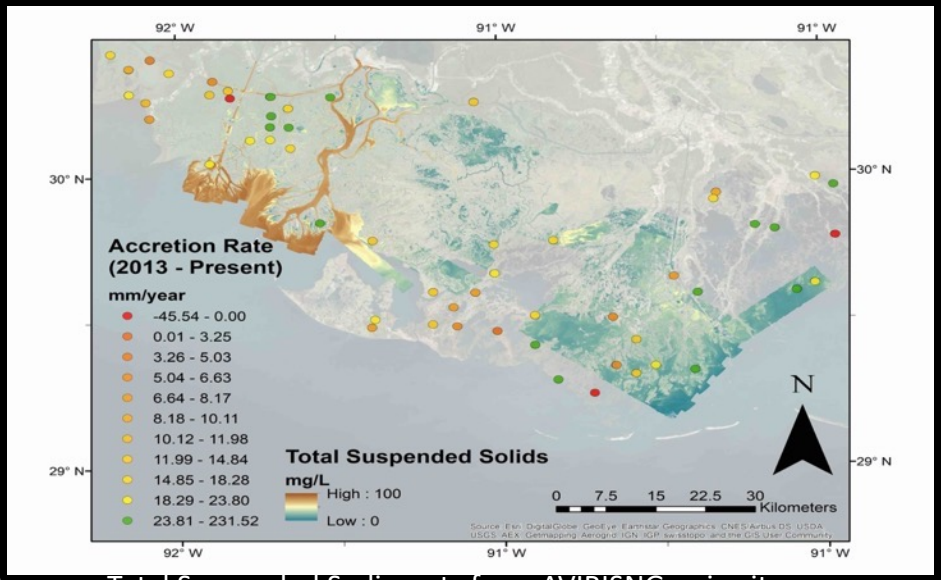
Flight during rising and falling tide to capture water seeping through wetlands and channel network



Water level change within wetland from UAVSAR (to 5mm)



Water surface slope measurement from AirSWOT (1cm/km)



Total Suspended Sediments from AVIRISNG vs in situ accretion rates within 20mg/L

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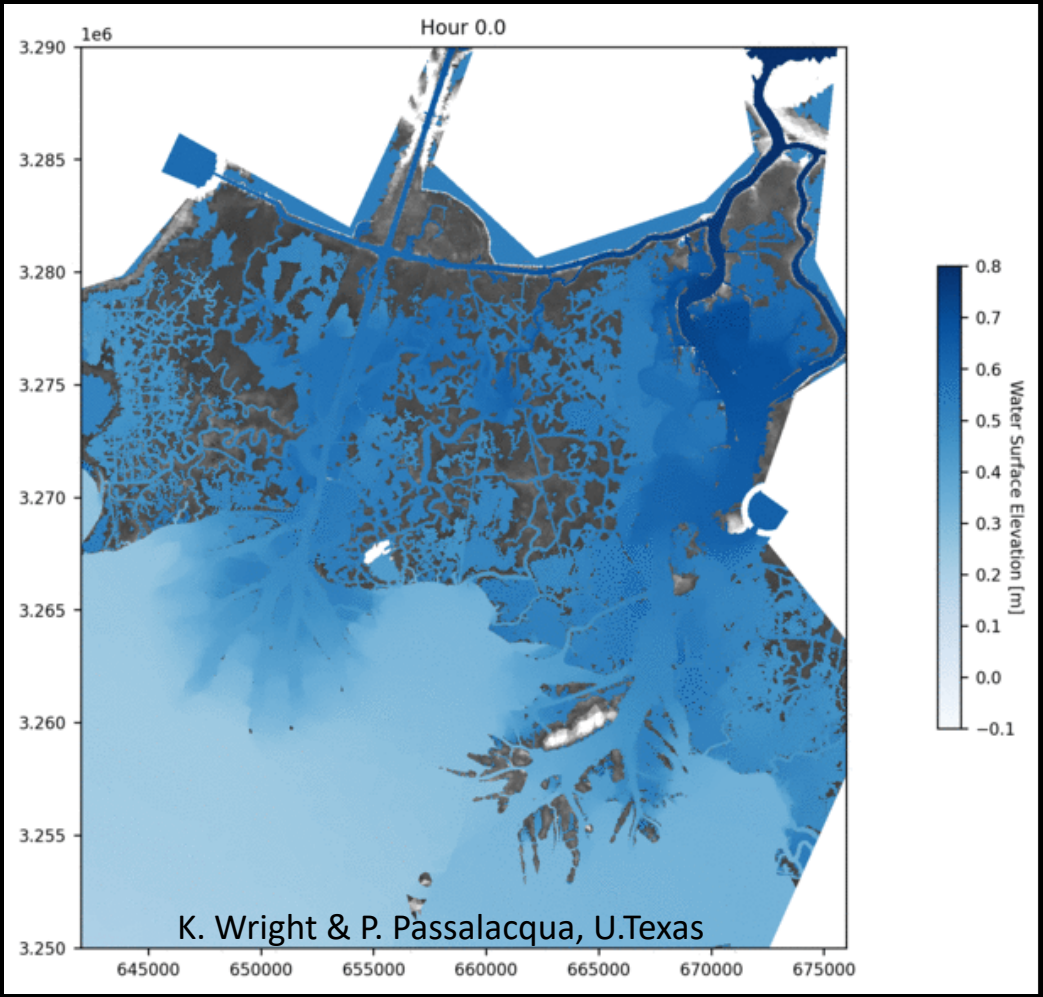
Hydrodynamic Models

(Atchafalaya Basin)



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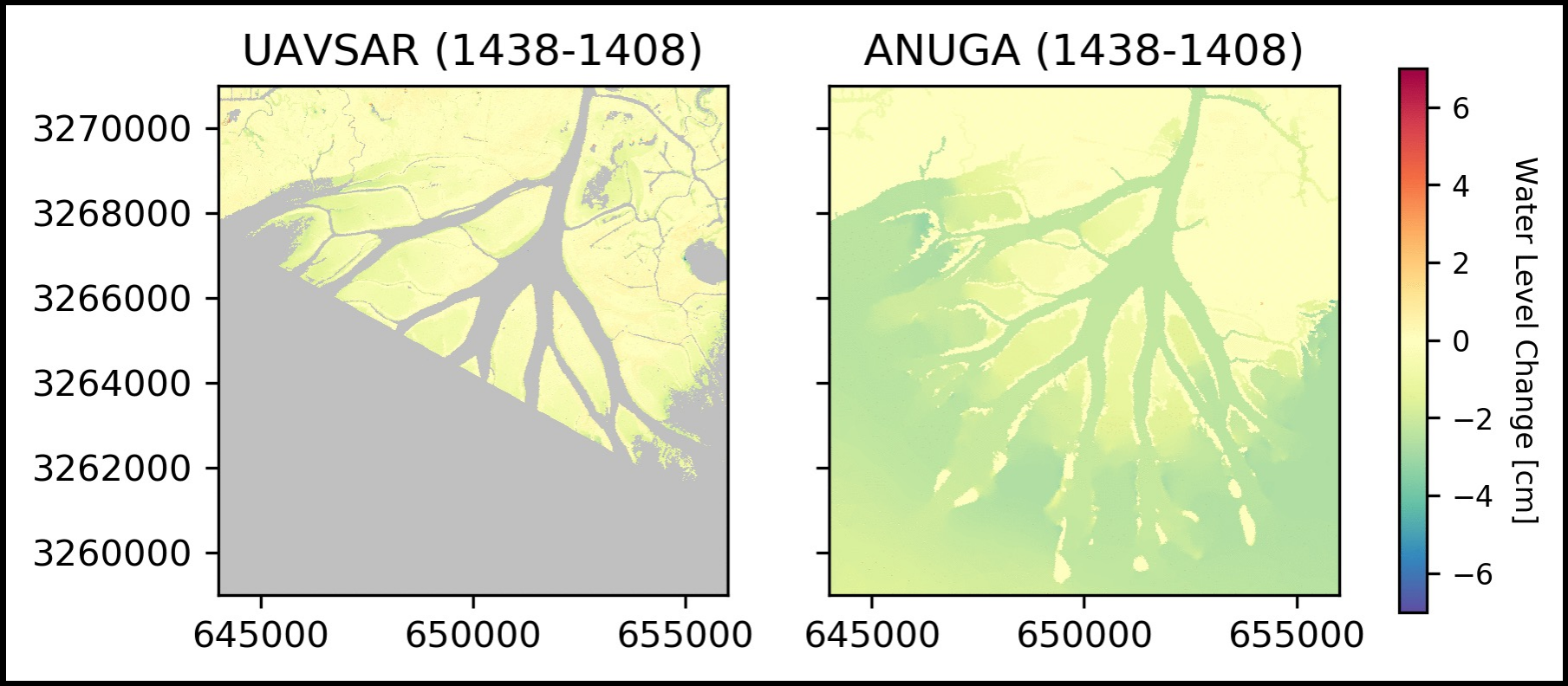
Model calibration and validation



Observed (UAVSAR and AirSWOT) and modeled (U. Boston and U. Texas) water level changes.

Jet Propulsion Laboratory
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Delta-X Publications

Published articles using the 2016 Pre-Delta-X datasets:

- Denbina, M., Simard, M., Rodriguez, E., Wu, X., Chen, A. and Pavelsky, T., 2019. Mapping water surface elevation and slope in the Mississippi River delta using the AirSWOT Ka-Band interferometric synthetic aperture radar. Remote Sensing, 11(23), p. 2739.
- Jensen, D., Simard, M., Cavanaugh, K., Sheng, Y., Fichot, C.G., Pavelsky, T. and Twilley, R., 2019. Improving the transferability of suspended solid estimation in wetland and deltaic waters with an empirical hyperspectral approach. Remote Sensing, 11(13), p.1629.

Submitted using the 2016 Pre-Delta-X datasets:

- "Using Rapid Repeat SAR Interferometry to improve Hydrodynamic Models of flood propagation in Coastal Wetlands"
  Journal: *Advances in Water Resources*
  Authors: Xiaohe Zhang, Cathleen Jones, Talib Oliver-Cabrera, Simard Marc, Sergio Fagherazzi
- "InSAR Phase Unwrapping Error Correction for Rapid Repeat Measurements of Water Level Change in Wetlands"
  Journal: *IEEE Transactions on Geoscience and Remote Sensing (TGRS)*
  Authors: Talib Oliver-Cabrera, Cathleen Jones, Yunjun Zhang, and Marc Simard
- "Storm surge and tidal dissipation in deltaic wetlands"
  Journal: *Journal of Geophysical Research*
  Authors: Giovanna Nordio, Sergio Fagherazzi