Exploring River Deltas with NASA Data: The Delta-X Mission

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Earthdata Webinar
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Jet Propulsion Laboratory
California Institute of Technology

Delta-X

Solving Pressing Earth System Science Issues:
NASA's Earth Venture Suborbital – 3 (EVS-3) Missions

(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

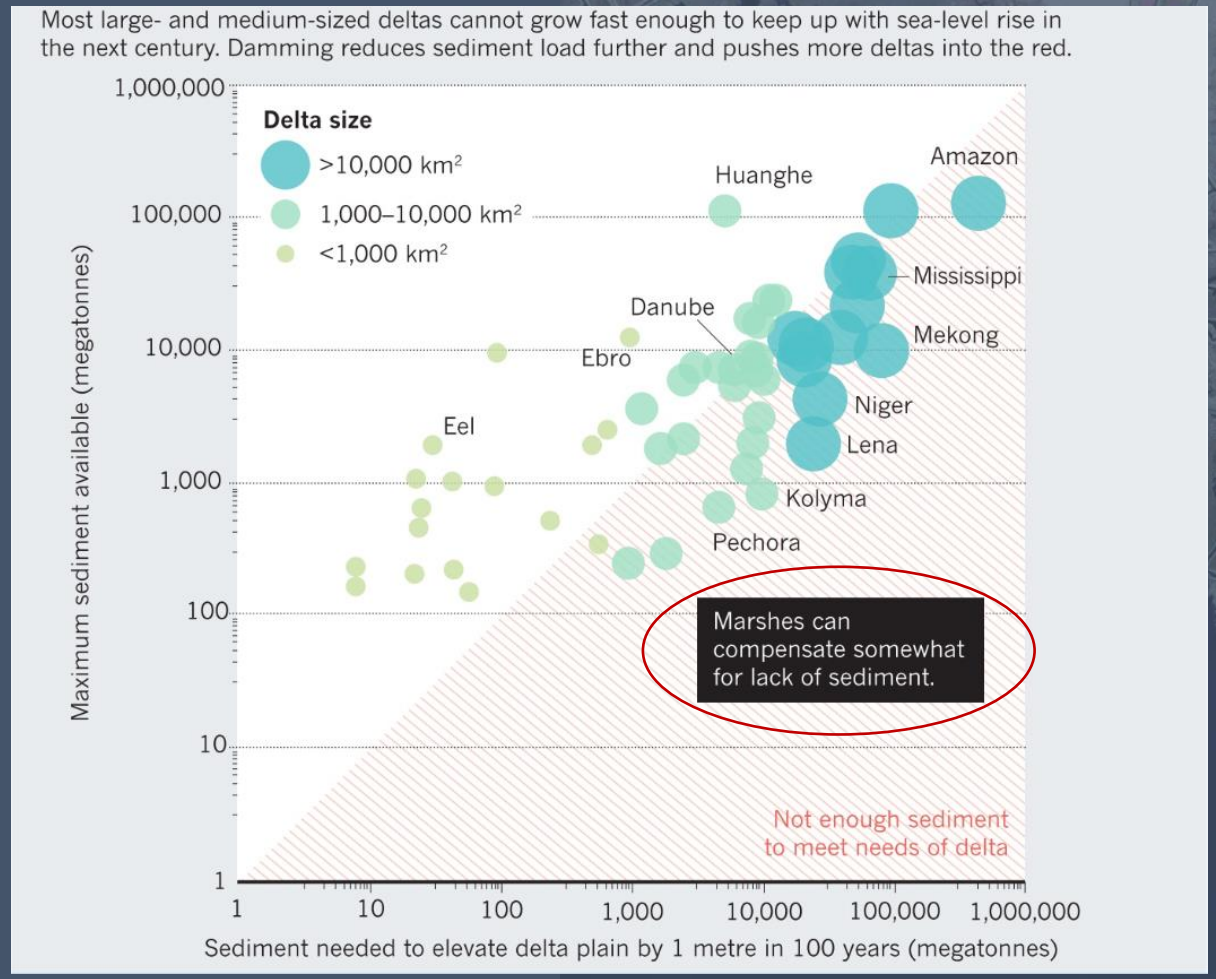
- IMPACTS:

Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms

- S-MODE:

Submesoscale Ocean Dynamics and Vertical Transport

DELTA-X: A STUDY OF LAND-BUILDING PROCESSES IN RIVER DELTAS

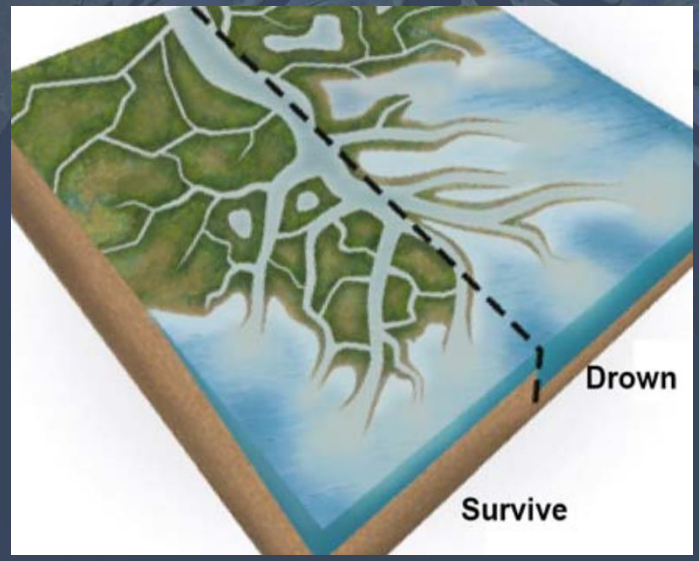


Source: “Climate change: Protect the world's deltas” Liviu Giosan, James Syvitski, Stefan Constantinescu & John Day, Nature, 03 December 2014

MOST LARGE & MEDIUM-SIZED DELTAS CANNOT GROW FAST ENOUGH TO KEEP UP WITH SEA LEVEL RISE IN THE NEXT CENTURY.

UPSTREAM DAMMING REDUCES THE SEDIMENT INFLUX FURTHER, ACCELERATING LAND LOSS.

HOWEVER, THIS “BATHTUB” MODEL ASSUMES THE ENTIRE DELTA IS LOST, BUT IN FACT SOME PARTS CAN SURVIVE.



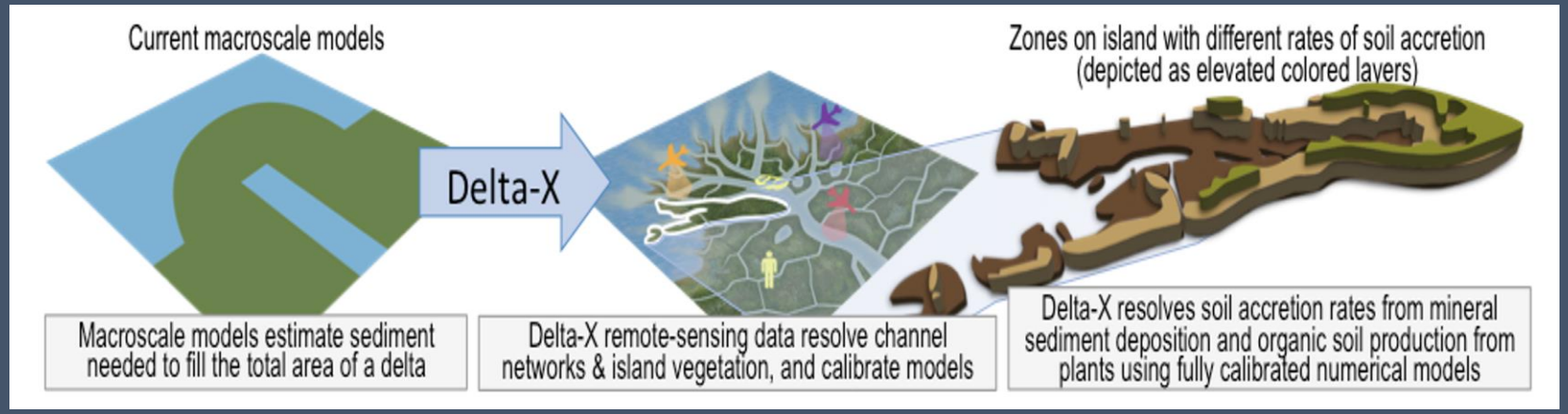
https://deltax.jpl.nasa.gov

DELTA-X

~~CAN DELTAS SURVIVE THE NEXT DECADES OF RISING SEA LEVEL?~~

HOW CAN DELTAS SURVIVE THE NEXT DECADES OF RISING SEA LEVEL?

LAND LOSS AND GAIN OCCURS AT SUB-ISLAND SCALES



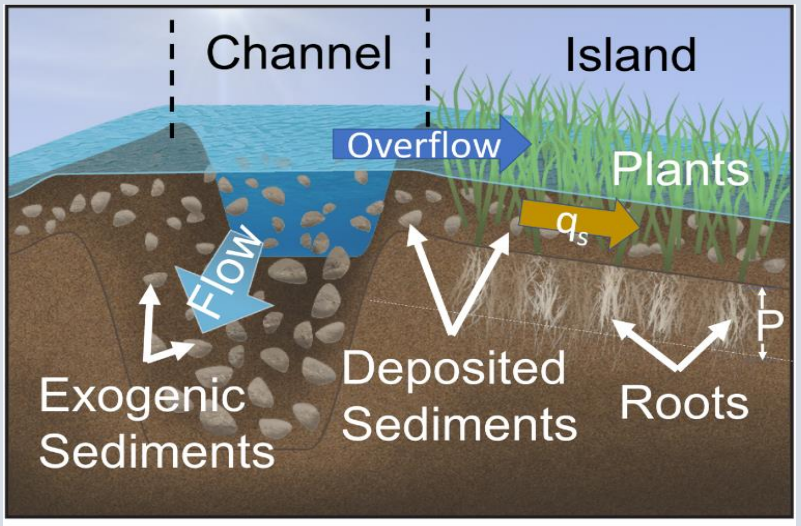
MOVE FROM BATHTUB SCALE TO ~HECTARE SCALE

Delta-X Cross-Disciplinary Science
Study Processes Controlling Land Building in Deltas

Interdependence of Hydrology – Ecology – Geomorphology

Overarching Science Question: What are the hydrological and ecological processes responsible for the resilience and vulnerability of river deltas to Relative Sea Level Rise (RSLR), and what are their relative contributions to soil elevation?

Delta-X objectives: To evaluate the roles of 1) vegetation on soil accretion rates; and 2) channel-network density and deltaic island size on soil accretion rates.



Role of Vegetation in soil production & flow of water/sediment into island interior

Role of Channel Network in delivering & removing sediment

DELTA-X TEAM

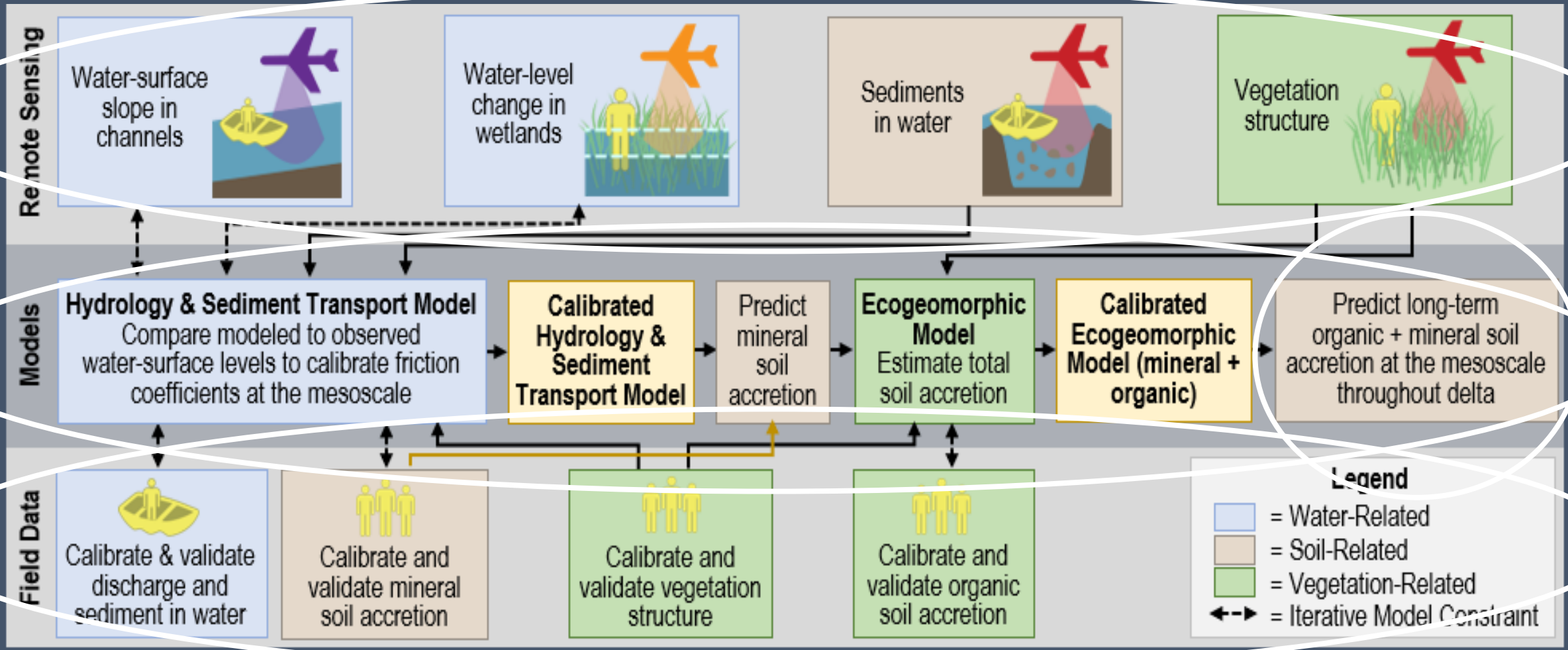
https://deltax.jpl.nasa.gov

SCIENCE TEAM CO-INVESTIGATORS

- **California**:
  - Jet Propulsion Laboratory, California Institute of Technology (**Marc Simard**, C. Jones, M. Denbina, 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)
- **Massachusetts**:
  - Boston University (C. Fichot & S. Fagherazzi)

Delta-X Framework

Combine hydrodynamic, ecogeomorphic, and sediment transport models to predict long-term soil accretion



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Land Loss & Gain in the Mississippi River Delta, Louisiana
(Delta-X Study Area)

ATCHAFALYA BASIN
Active Delta

1988
Gain
Loss

TERREBONNE BASIN
Inactive Delta
(No sediment input from upstream rivers)

DELTA-X FIELD & AIRBORNE CAMPAIGNS

HIGH RIVER FLOW, LOW BIOMASS

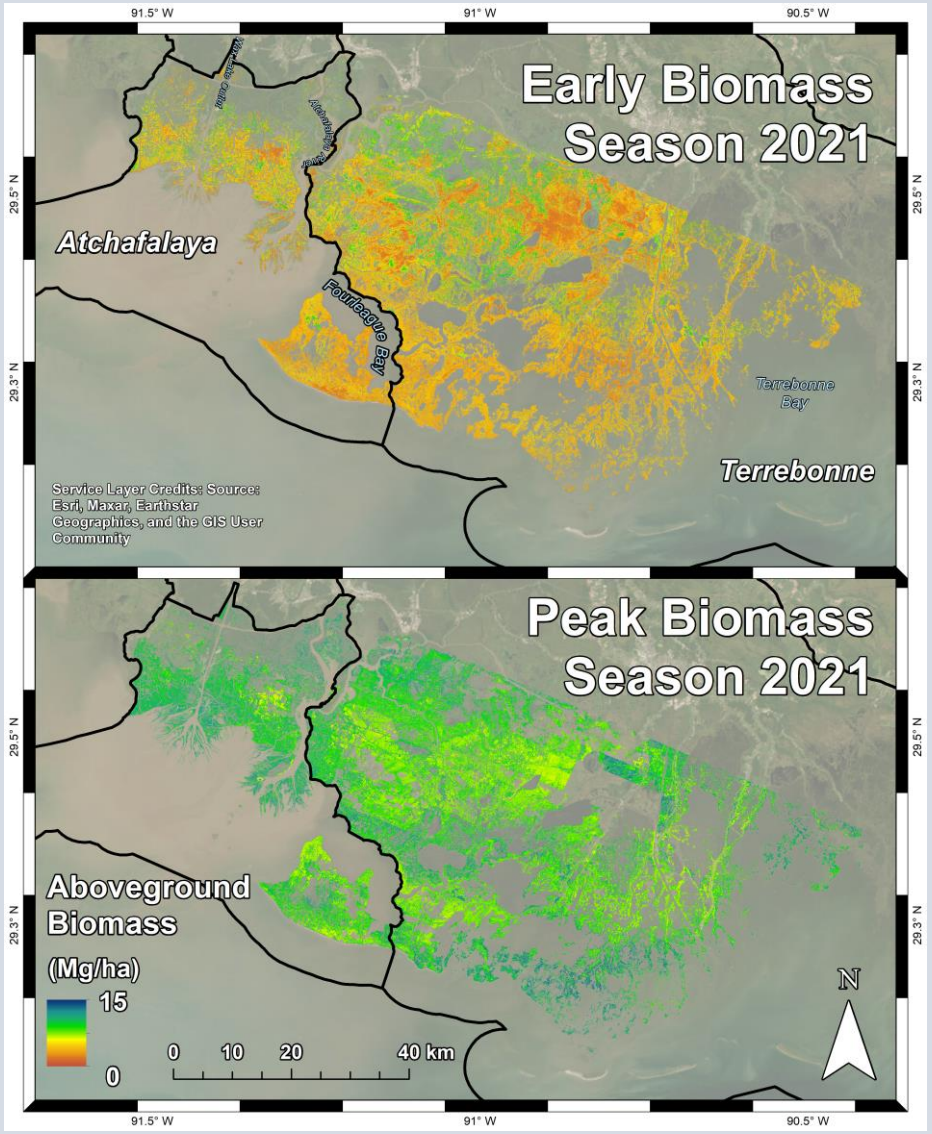
- Spring campaign 2021:
  - March 21st - April 22nd
  - 3 TIDAL STATES

LOW RIVER FLOW, HIGH BIOMASS

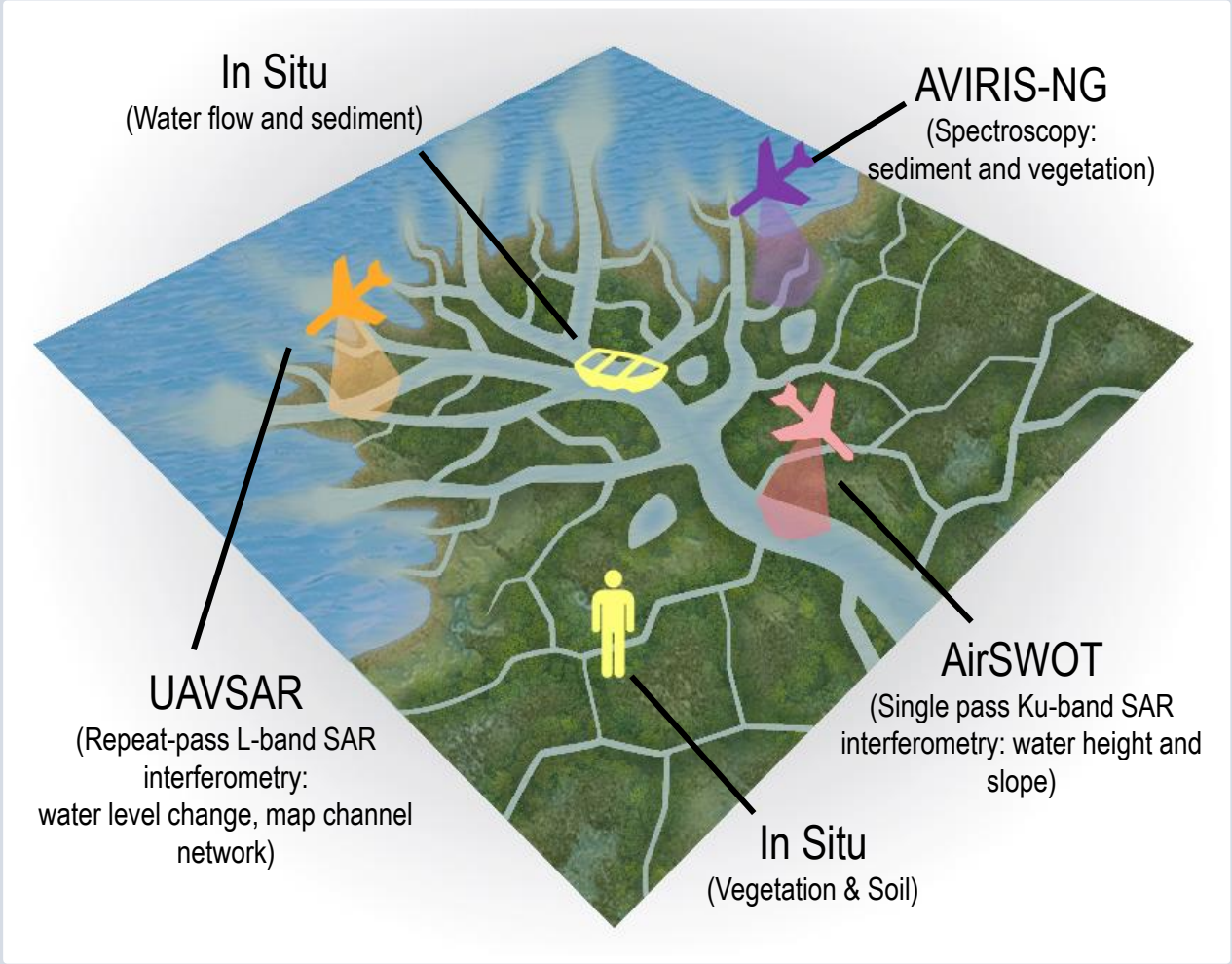
- Fall campaign 2021:
  - August 16th - September 26th
  - 2 TIDAL STATES

Demonstration Delta-X (Pre-Delta-X) campaigns

- May 2015 (Spring)
- October 2016 (Fall)



CALIBRATION / VALIDATION DATA TO SUPPORT MODEL DEVELOPMENT

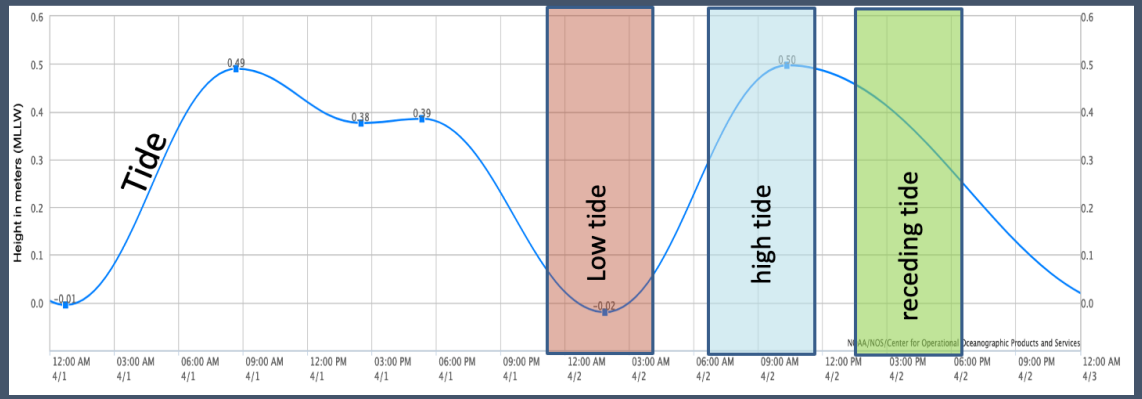


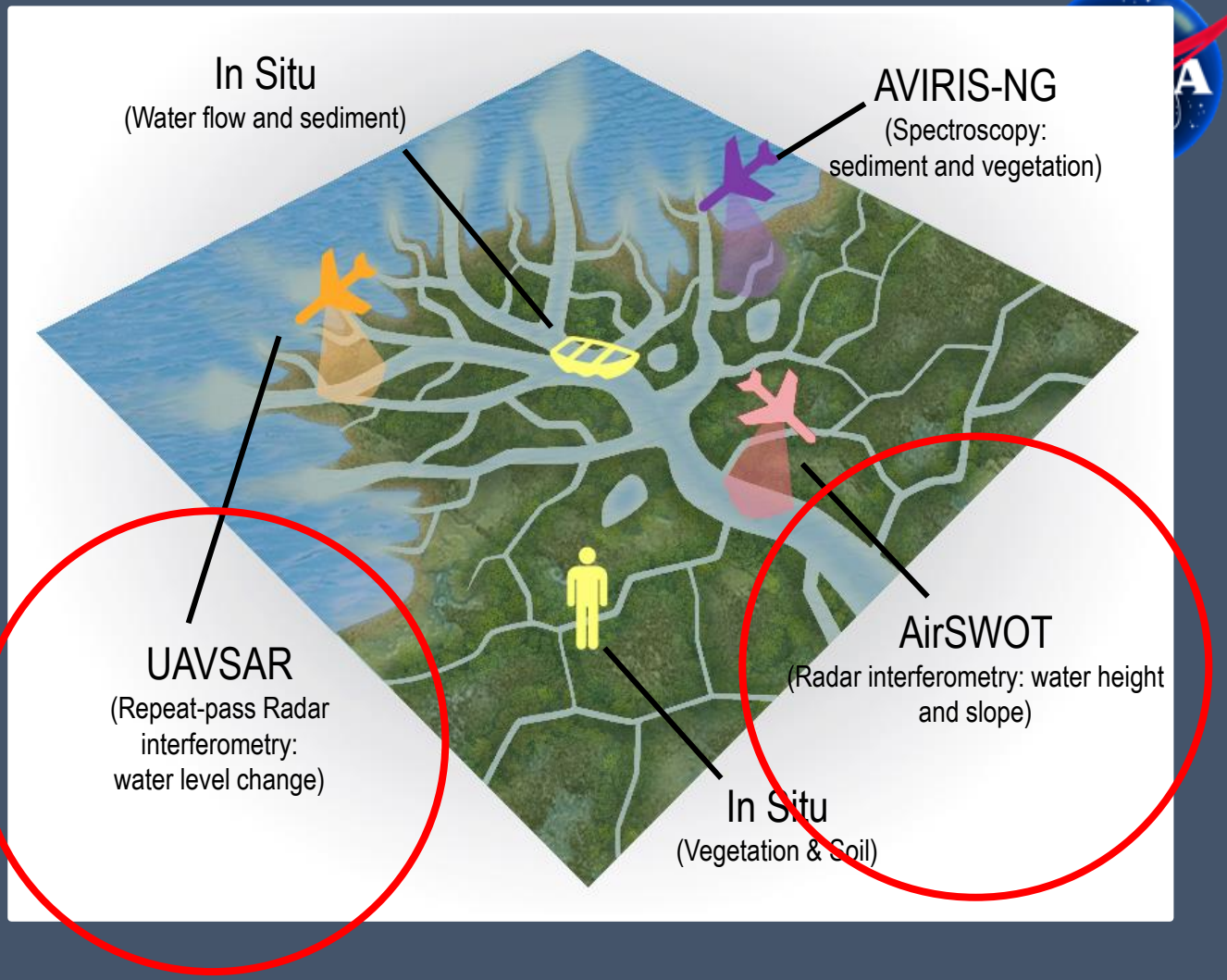
(Not to scale)

INTENSIVE STUDY SITES: FRESHWATER, INTERMEIDIATE, AND SALINE SITES IN BOTH BASINS

Radars fly at same time
Timed to catch different parts of the tidal cycle

In situ:
Water flow (ADCP)
Water level gauges
- Channels
- Islands

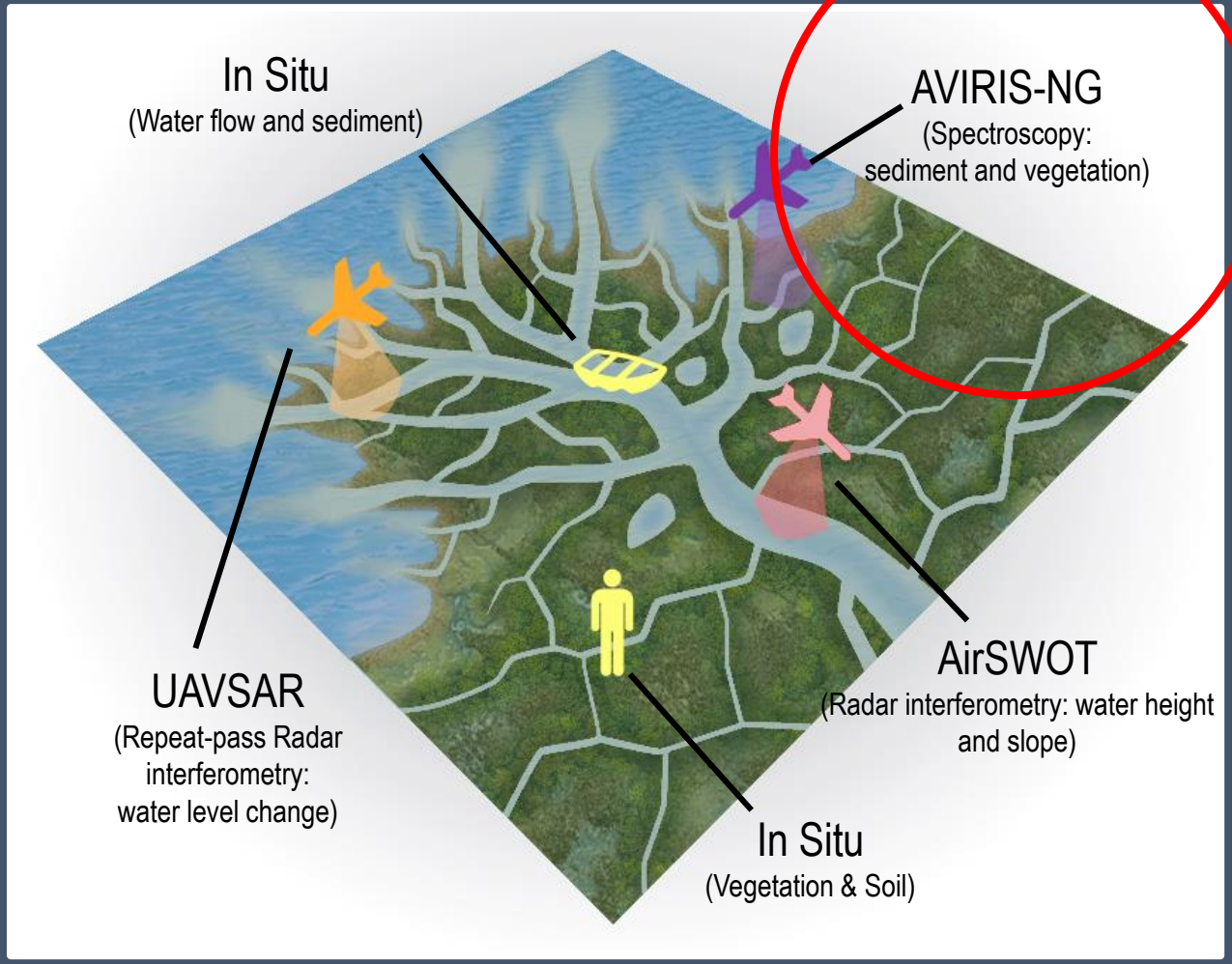




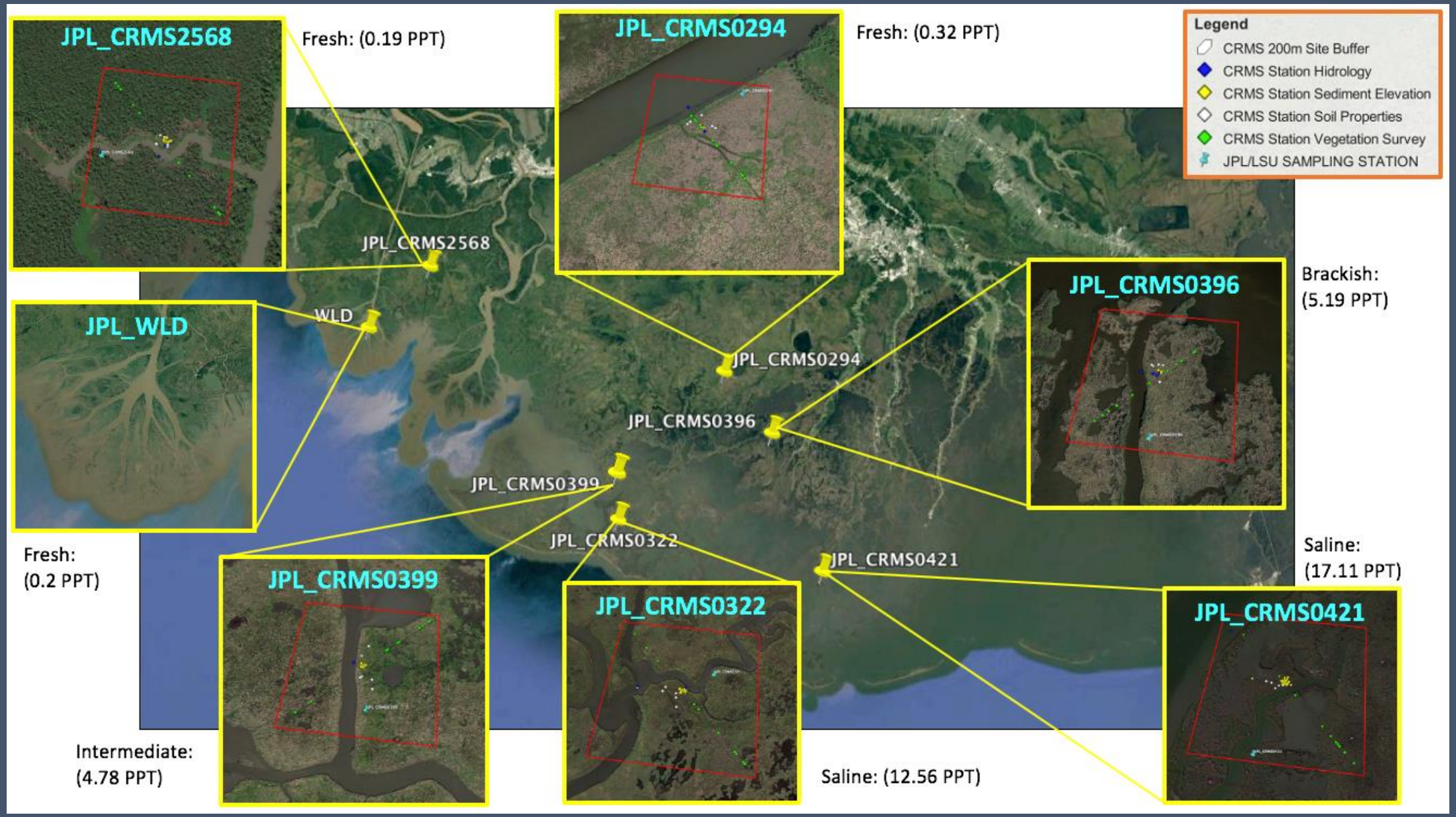
Spectrometer images channels for sediment concentration

In situ (during flights): suspended sediment concentration, grain size distribution

In situ (synchronicity not required): Spectrometer vegetation
In situ vegetation, soil, elevation, bathymetry



Delta-X Intensive Study Sites



VEGETATION AND SOIL SAMPLING


Above Ground Biomass


Below Ground Biomass


Feldspar layers for soil accretion


Soil Accretion


Vegetation Structure

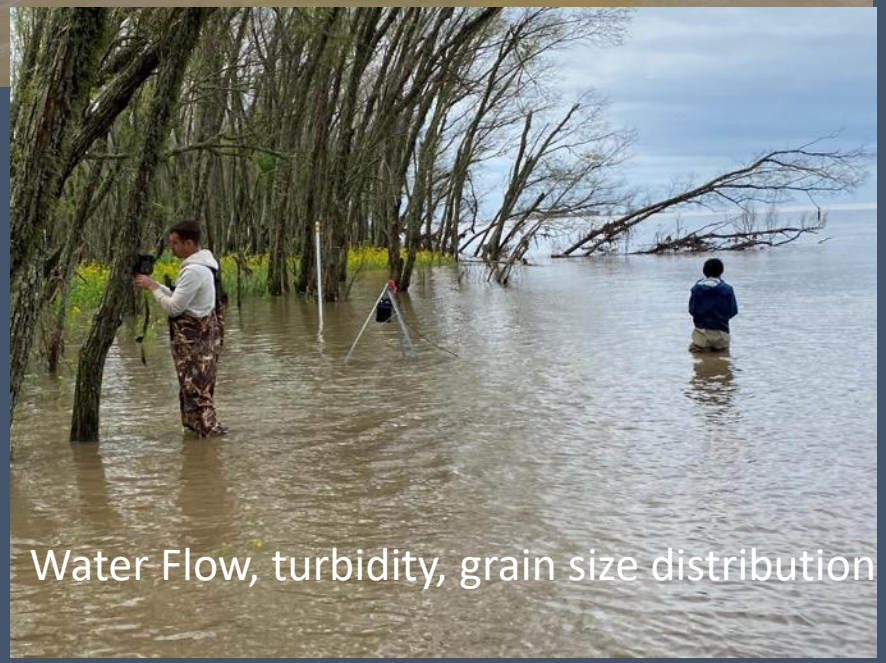
Water Quality And Dynamics

(channels and islands)


Water Quality

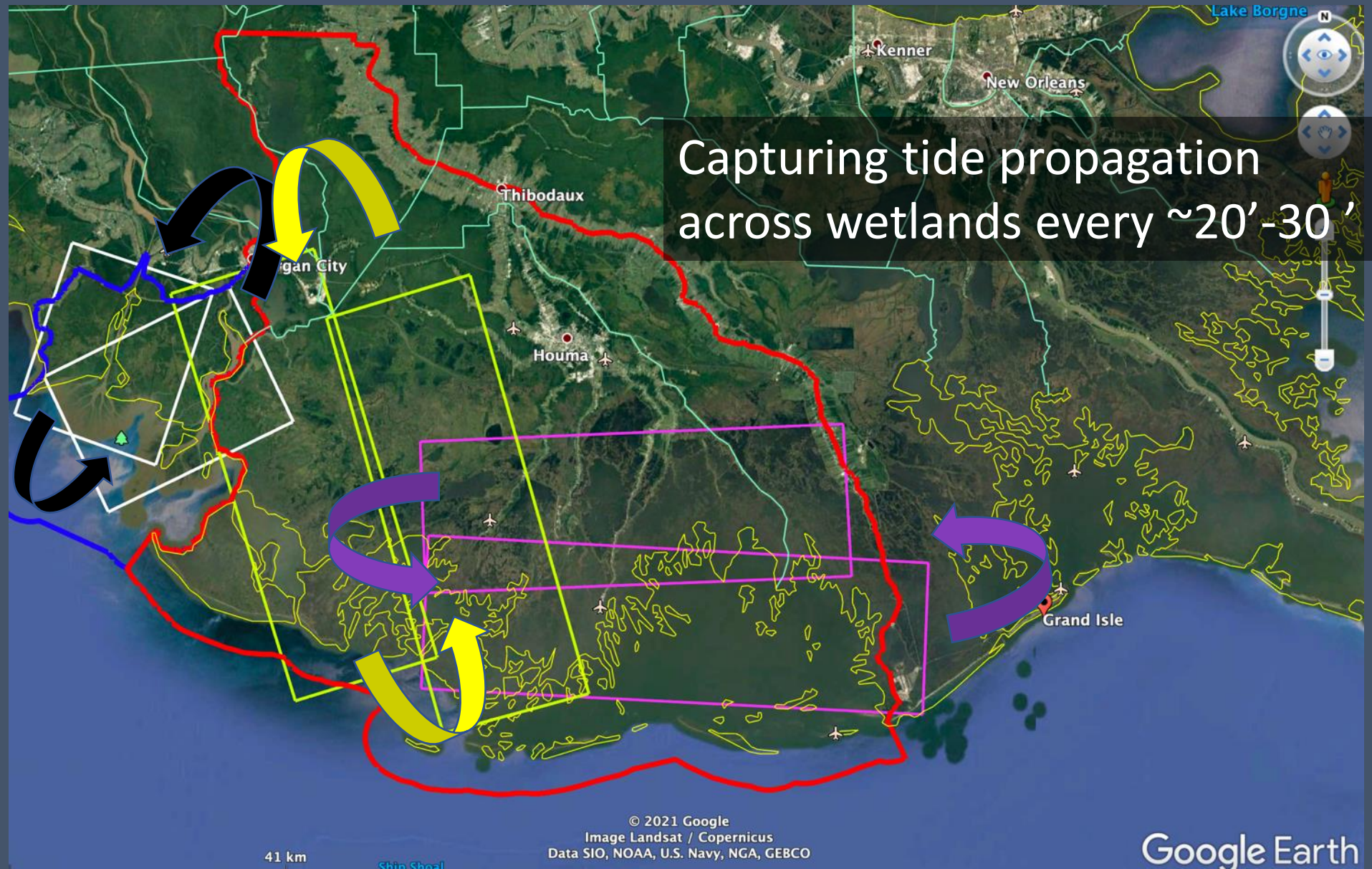

Water Flow (ADCP)


Water Level

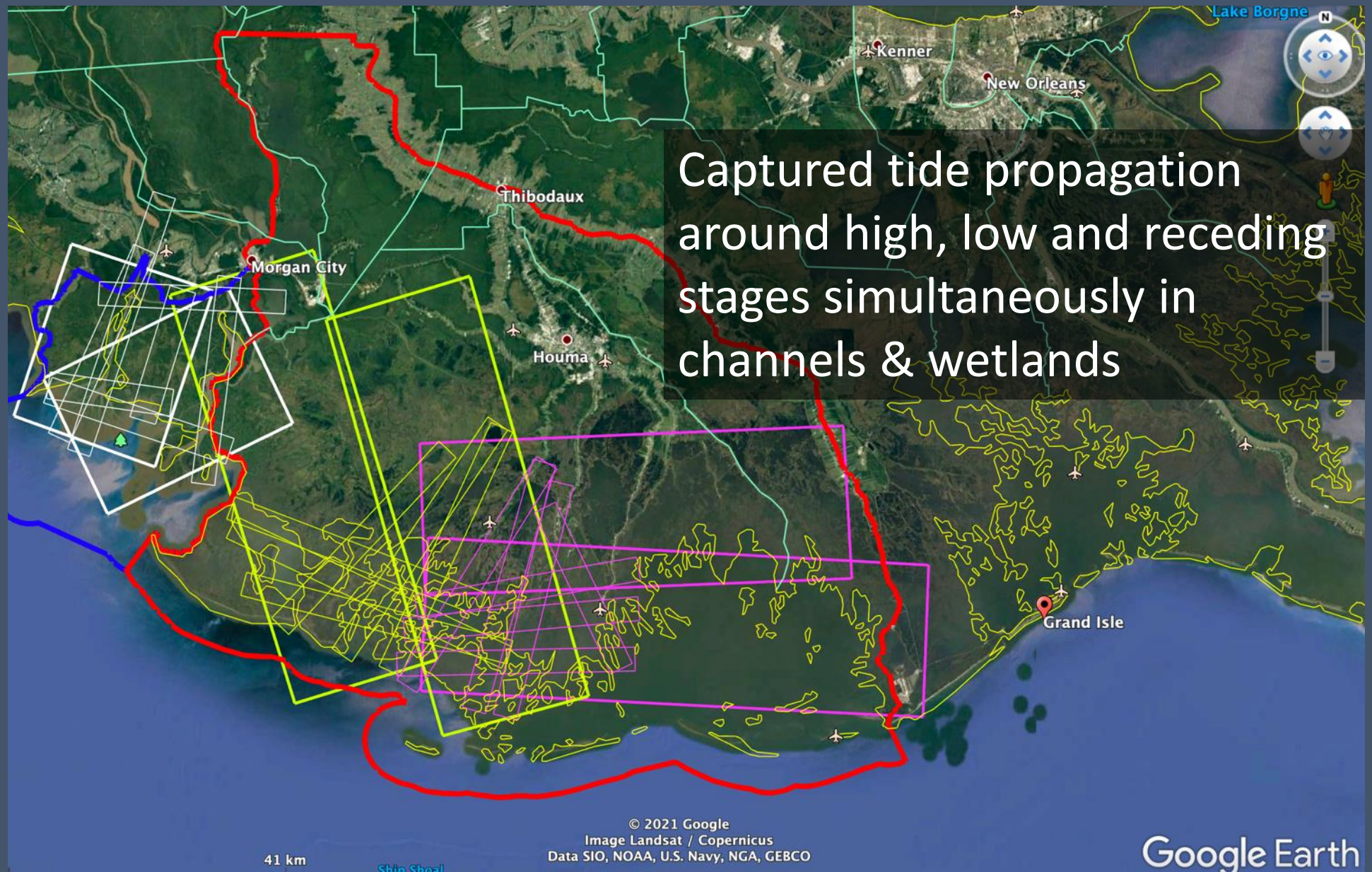

Water Flow, turbidity, grain size distribution

UAVSAR Flight Pattern (repeat pass InSAR (DInSAR))

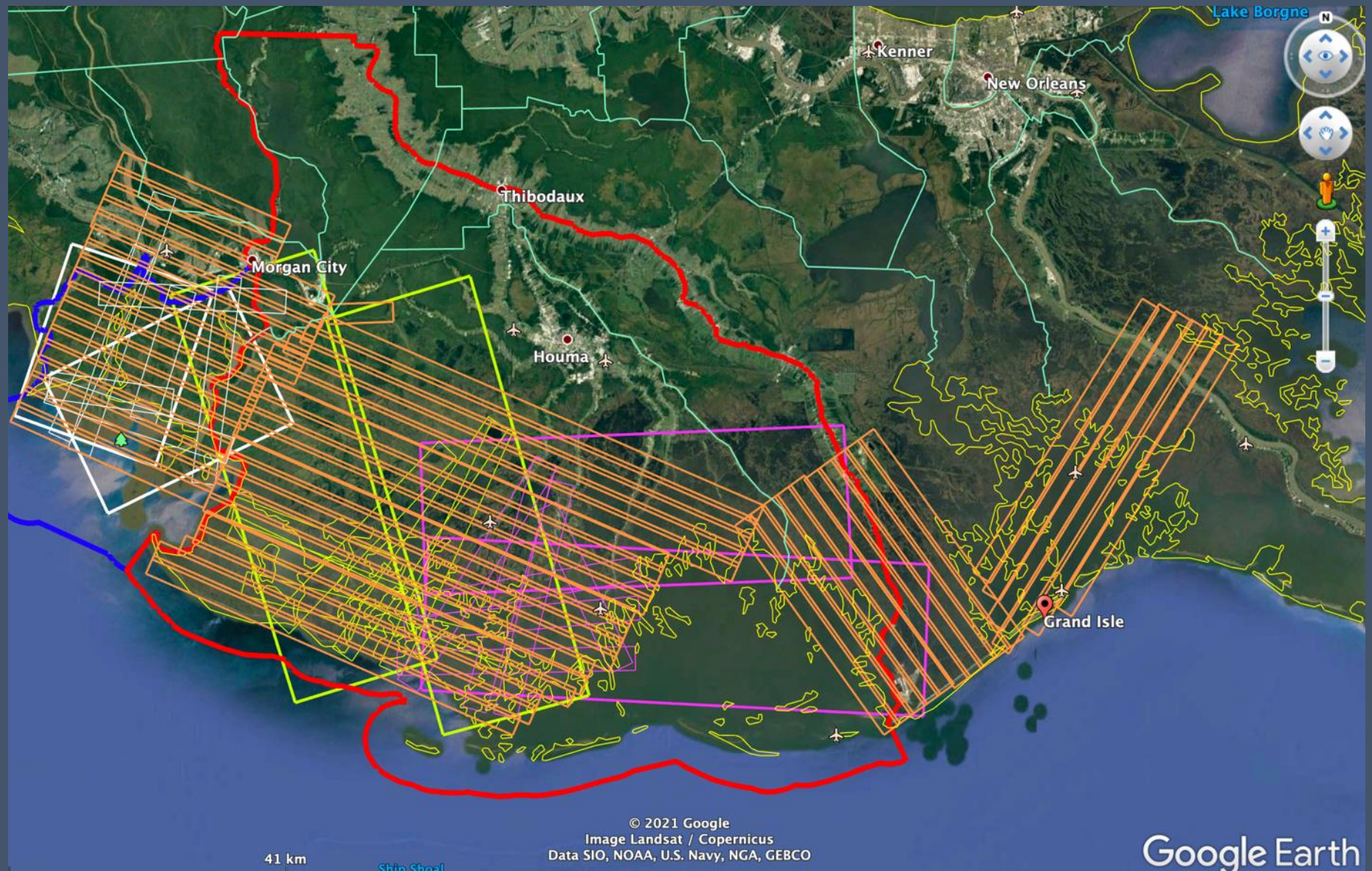
White = Atchafalaya, Yellow = West Terrebonne, Purple = East Terrebonne



Add AirSWOT single-pass InSAR flight lines
Focus on main water channels

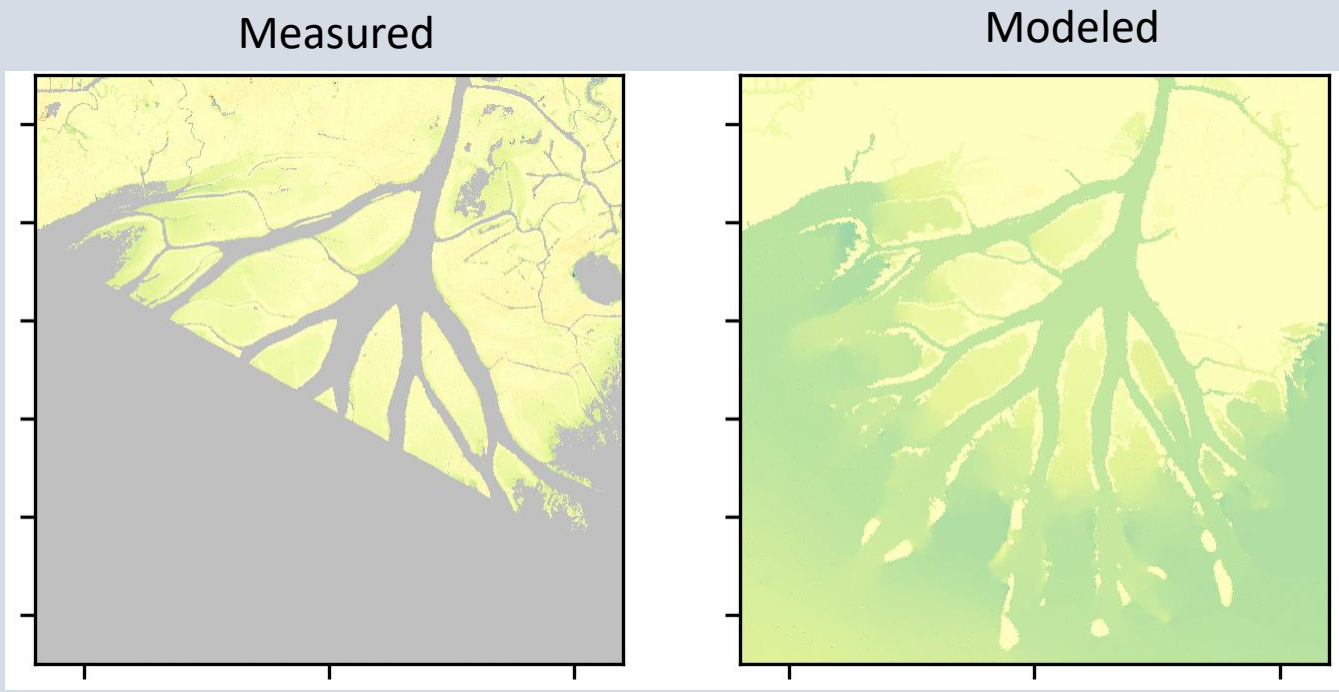


Add AVIRIS-NG Spectrometer coverage
Image entire area to get vegetation & all channels



MODELS
(Eco-hydrodynamic-sediment transport)

- Delft3D
  - Hydrodynamic model, includes sediment transport, deposition, elevation change
  - 1 - 90m grid overall with 10m grid at 7 intensive sites
  - 2 - 30-m grid
  - 3 - Irregular grid, full domain (In progress)
  - Incorporates storm surge and erosion
- ANUGA
  - Hydrodynamic model,
  - Irregular grid full domain (Atchafalaya+Terrebonne)
  - Cal/val with remote sensing data
  - Does not include sediment transport, deposition and elevation change
- NUMAR (La. State Univ.)
  - Organic productivity at the ecogeomorphic scale (~hectare)
- DORADO
  - Lagrangian transport model for water and sediment
- TELEMAC
  - Includes sediment transport, deposition, elevation change
  - Irregular grid
  - Uses ANUGA-based calibrated inputs



Mesh, channel, and bathymetric corrections guided by integrating remote sensing results

DELTA-X DATA & MODEL REPOSITORY