Delta-X:
How Can Deltas Survive a Century of Rising Seas?

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CLIVAR SUMMIT
JULY 31- AUGUST 2, 2023
SEATTLE, WASHINGTON

Solving Pressing Earth System Science Issues: NASA's Earth Venture Suborbital – 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

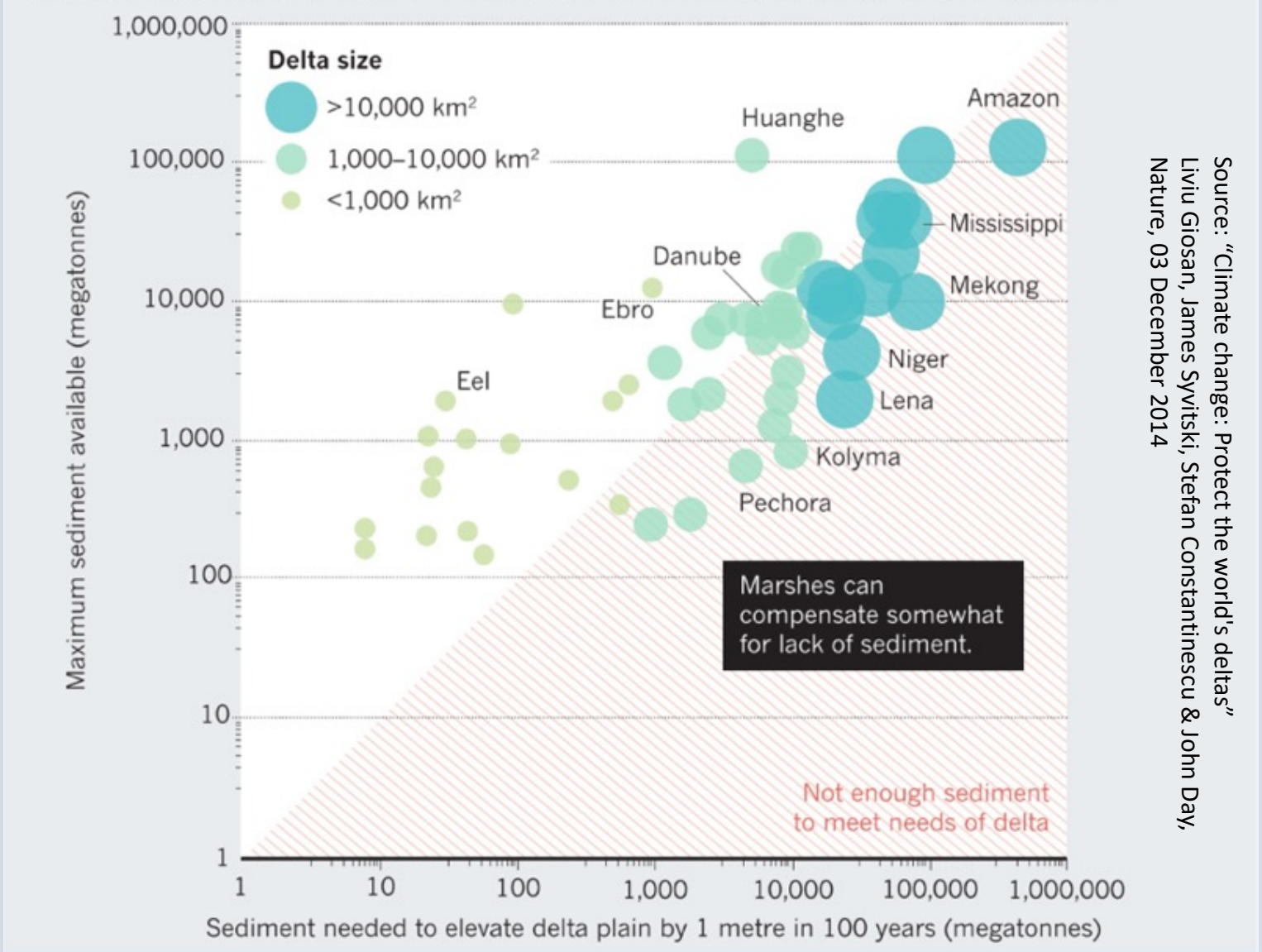
- IMPACTS:

Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms

- S-MODE:

Submesoscale Ocean Dynamics and Vertical Transport

THE WORLD'S DELTAS IN PERIL

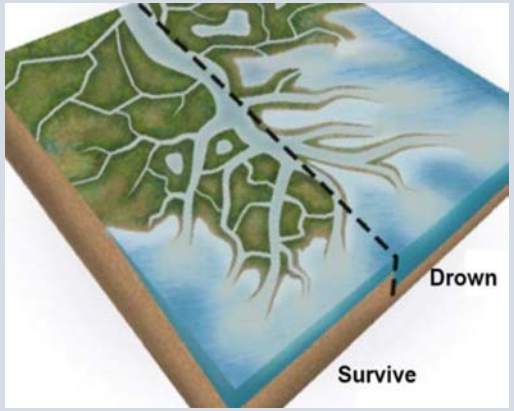


Source: "Climate change: Protect the world's deltas"
Liviu Giosan, James Syvitski, Stefan Constantinescu & John Day,
Nature, 03 December 2014

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

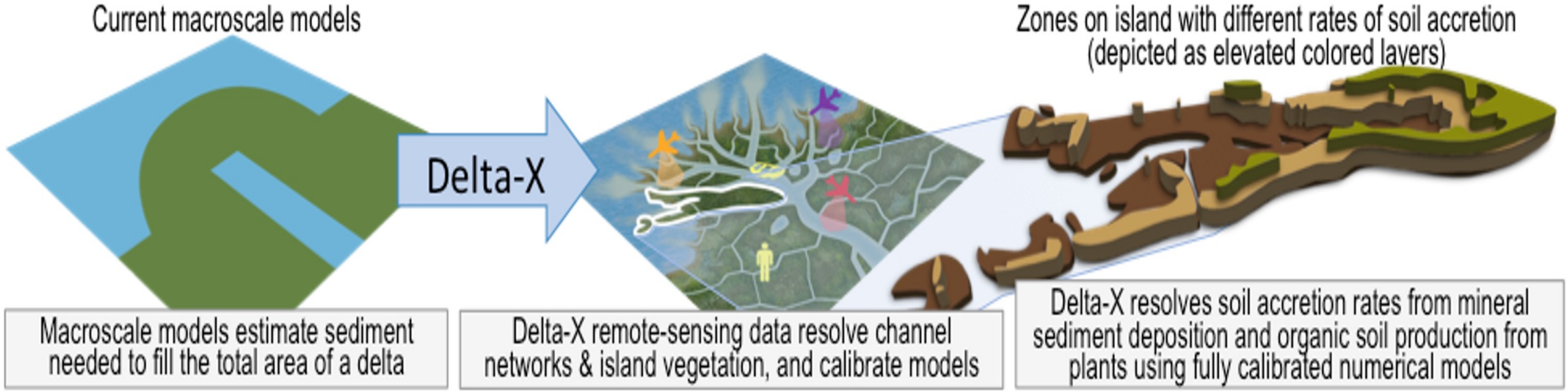
UPSTREAM DAMMING REDUCES THE SEDIMENT INFLUX FURTHER, ACCELERATING LAND LOSS.

HOWEVER, THIS "BATHTUB" MODEL ASSUMES THE ENTIRE DELTA IS LOST, WHILE IN FACT SOME PARTS MIGHT SURVIVE.



DELTA-X SCIENCE

FROM BATHTUB TO ECOGEOMORPHIC SCALES

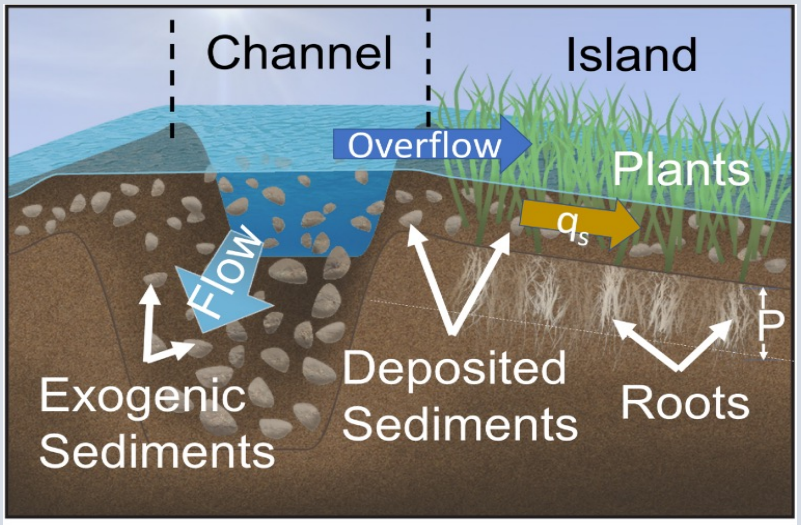


LAND LOSS AND GAIN OCCURS AT SUB-ISLAND SCALES

Delta-X Cross-Disciplinary Science
Controls on Land Building in Deltas
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.



External: Sediment

Local: Organic Soil Production

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

Role of Channel Network in delivering & removing sediment

LANDSCAPE

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

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

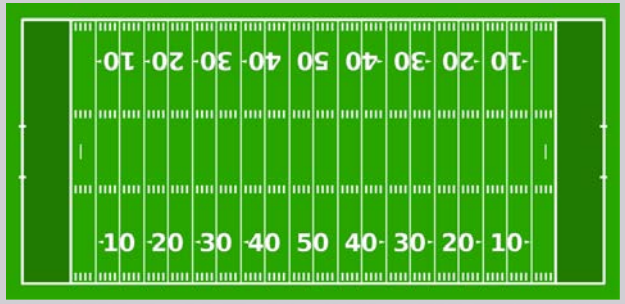
ATCHAFALYA BASIN
WAX LAKE DELTA
ATCHAFALAYA DELTA

TERREBONNE BASIN

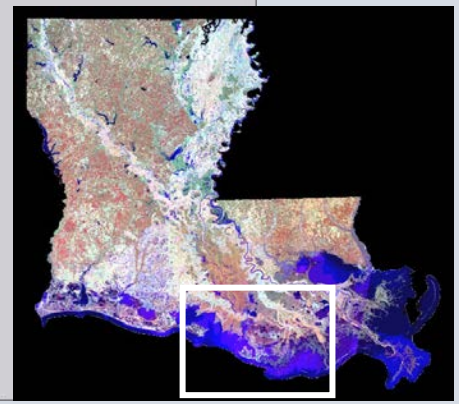
1988

Gain

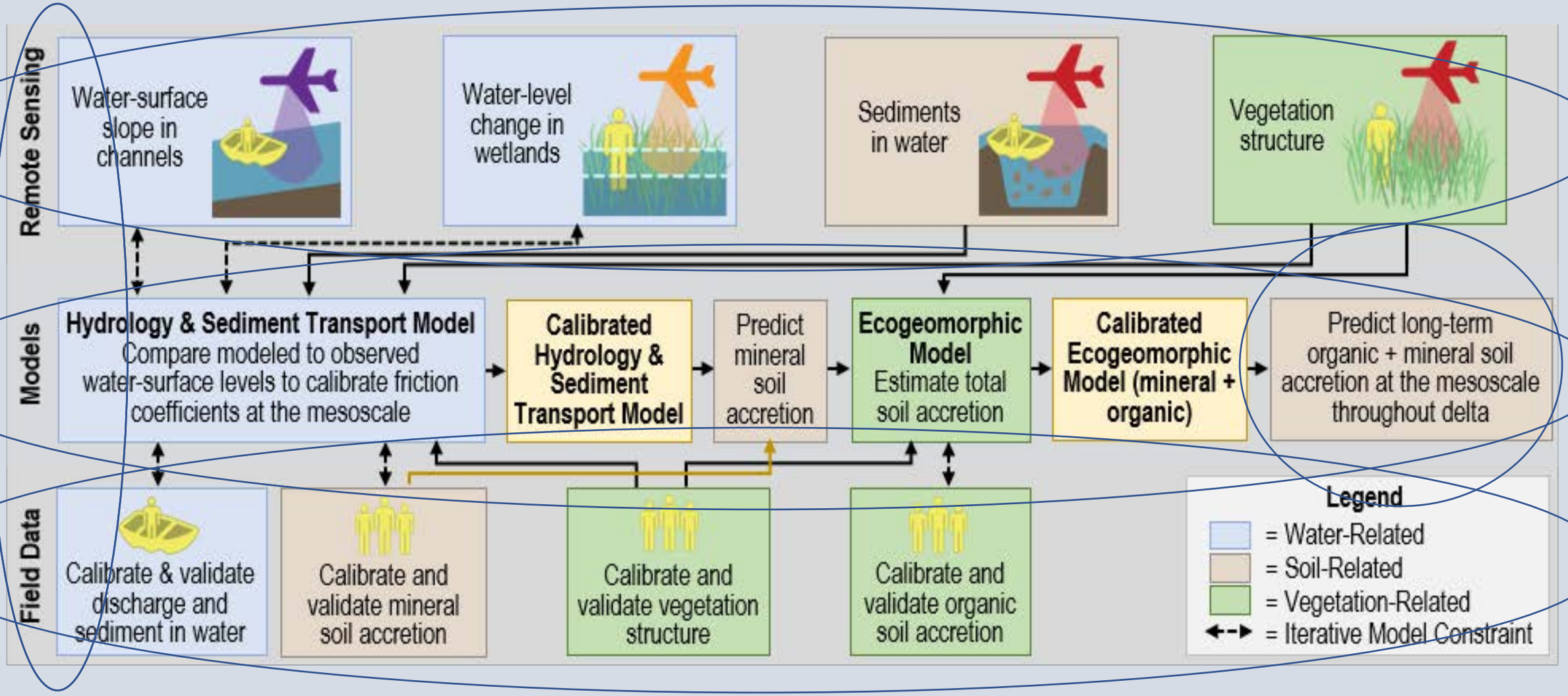
Loss



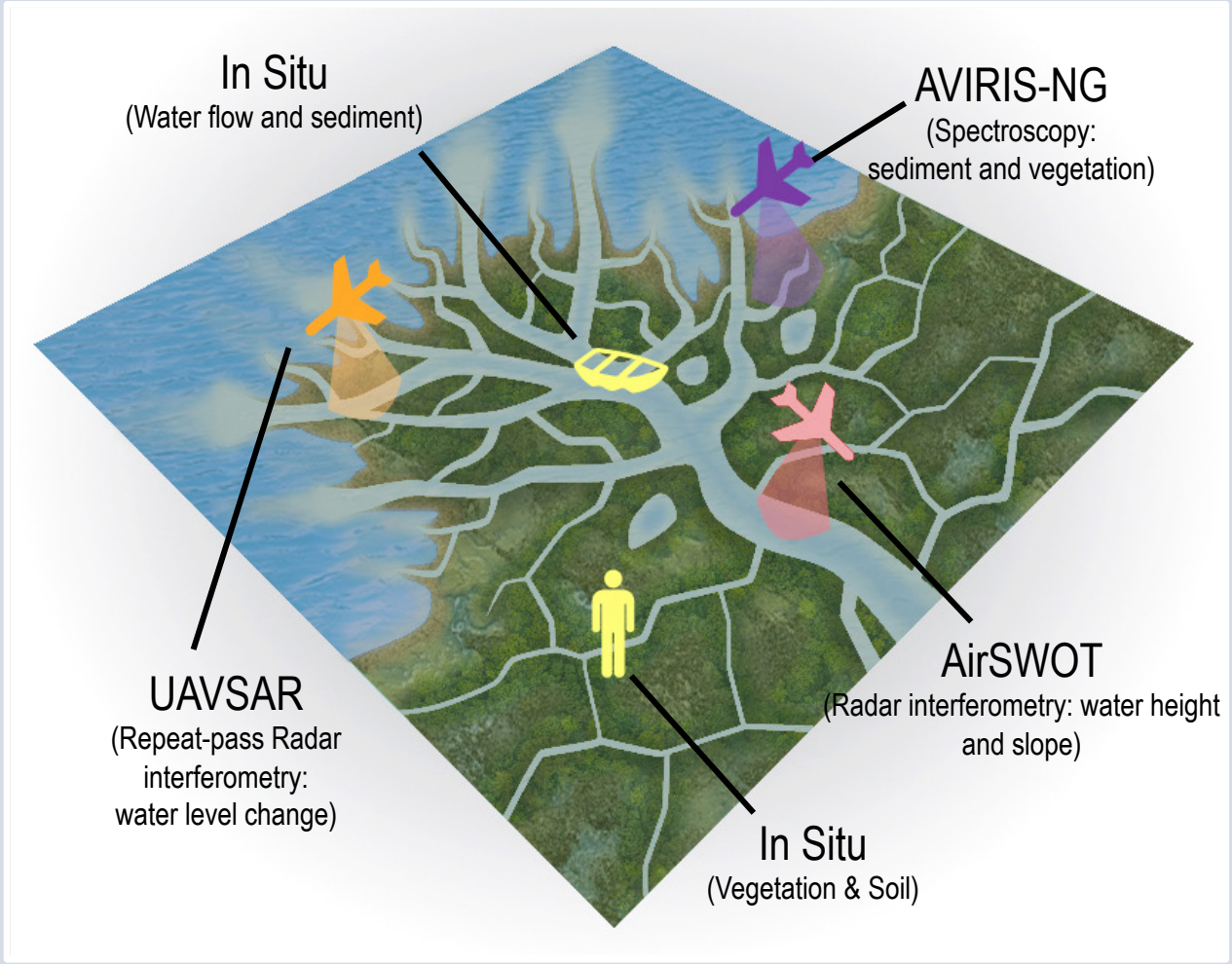
Loss rate ~
1 football field/hr



DELTA-X FRAMEWORK



CALIBRATION / VALIDATION DATA TO SUPPORT MODEL DEVELOPMENT



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

IN SITU MEASUREMENTS

Water Level

FIELD & AIRBORNE CAMPAIGNS

HIGH RIVER FLOW, LOW BIOMASS

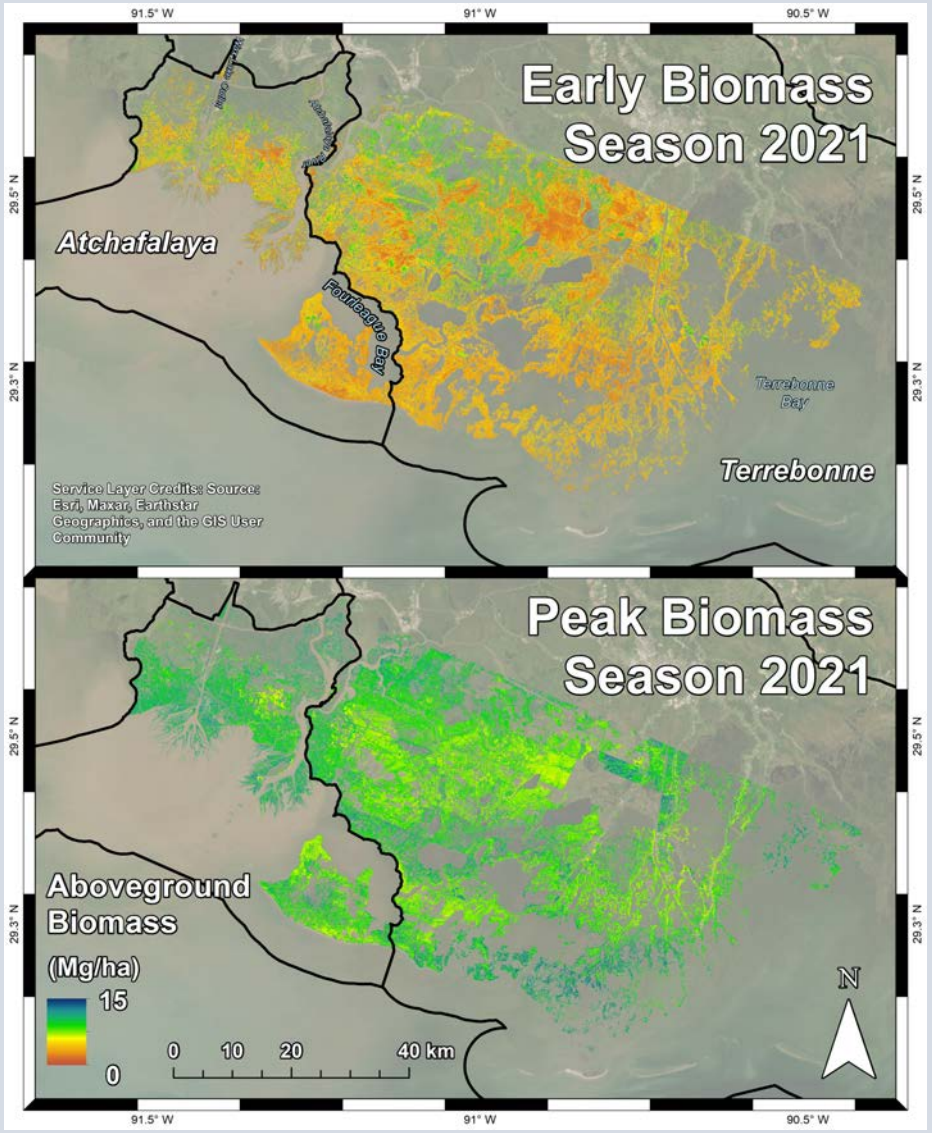
- Spring campaign 2021:
  - March 21st - April 22nd
  - 3 TIDAL STATES

LOW RIVER FLOW, HIGH BIOMASS

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

Pre-Delta-X campaigns

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

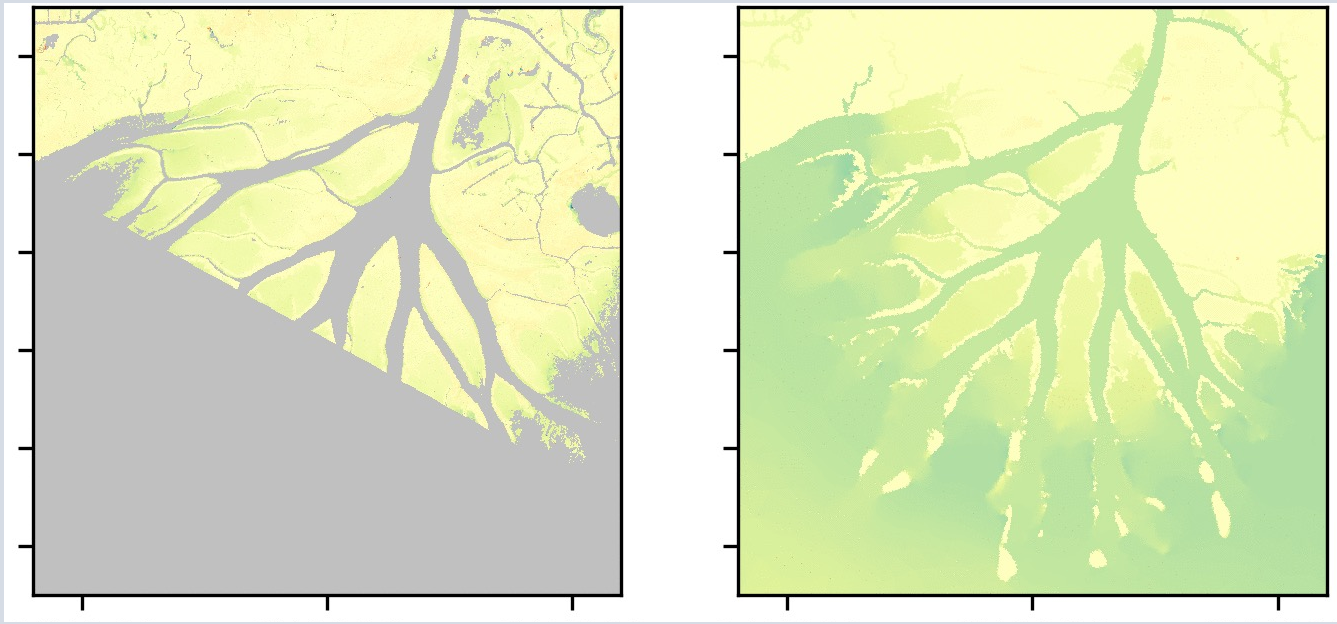


MODELS
(Ecosystem organic production + hydrodynamics + sediment transport)

- Delft3D
  - Includes sediment transport, deposition, elevation change
  - 90m grid overall with 10m grid at 7 intensive sites
  - Storm surge and erosion
- ANUGA
  - Irregular grid full domain (Atchafalaya+Terrebonne)
  - Cal/val with remote sensing data
  - Does not include sediment transport, deposition and elevation change
- TELEMAC
  - Includes sediment transport, deposition, elevation change
  - Irregular grid full domain (Atchafalaya+Terrebonne)
  - Uses ANUGA-based calibrated inputs
- NUMAR (La. State Univ.)
  - Productivity at ecogeomorphic scale

Measured

Modeled



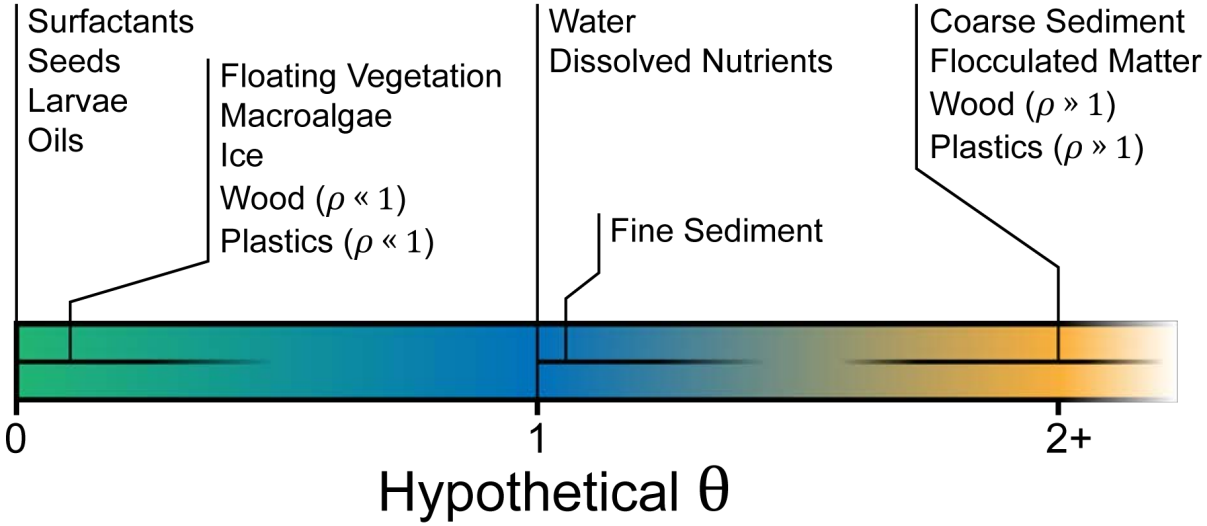
Mesh, channel, and bathymetric corrections guided by integrating remote sensing results

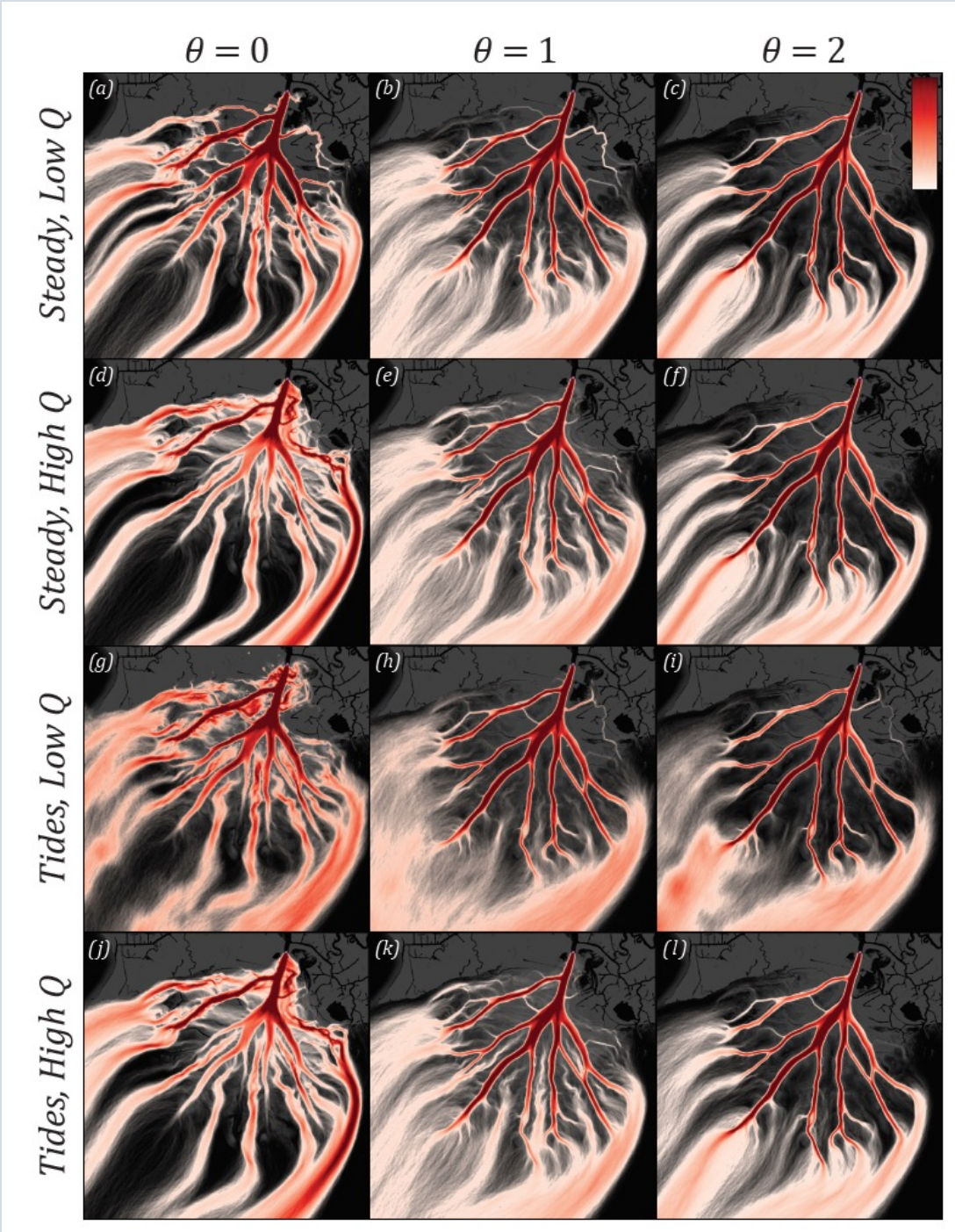
RESEARCH In PROGRESS

(Topic 1: Sediment Transport vs. Hydrological Connectivity)

The connectivity of fluvially transported materials can be quite different from the connectivity of water. Thus, using water connectivity as a proxy for other materials may lead to the wrong estimates of how much material is delivered to the island interiors.

WHY IS IT IMPORTANT? BECAUSE EXCHANGE OF WATER IS OFTEN CONSIDERED A PROXY FOR EXCHANGE OF SEDIMENTS





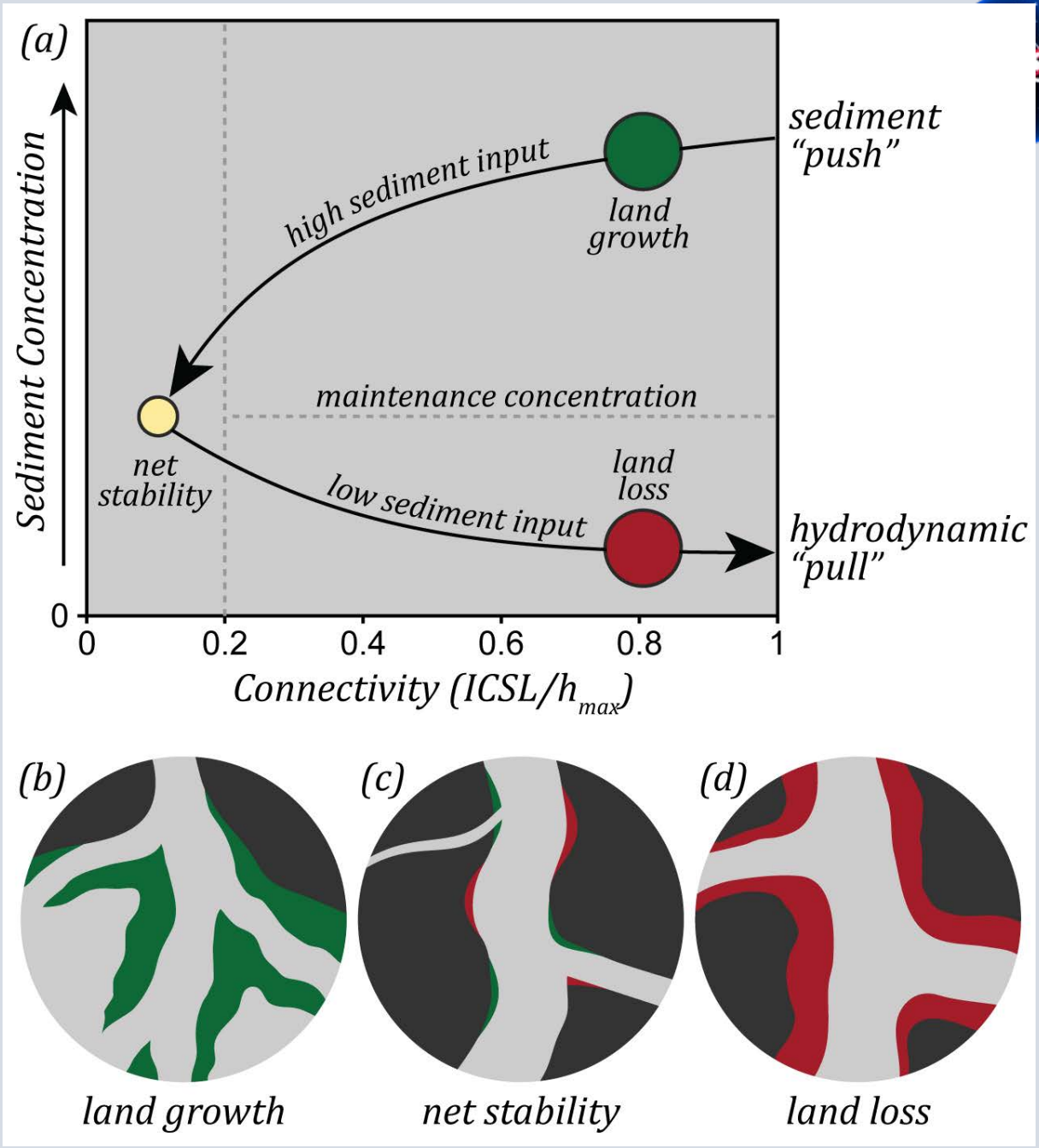
Wright et al., Journal of Geophysical Research-Earth Surface, 2022

RESEARCH In PROGRESS

(Topic 2: Sediment Starvation & Hydrological Connectivity)

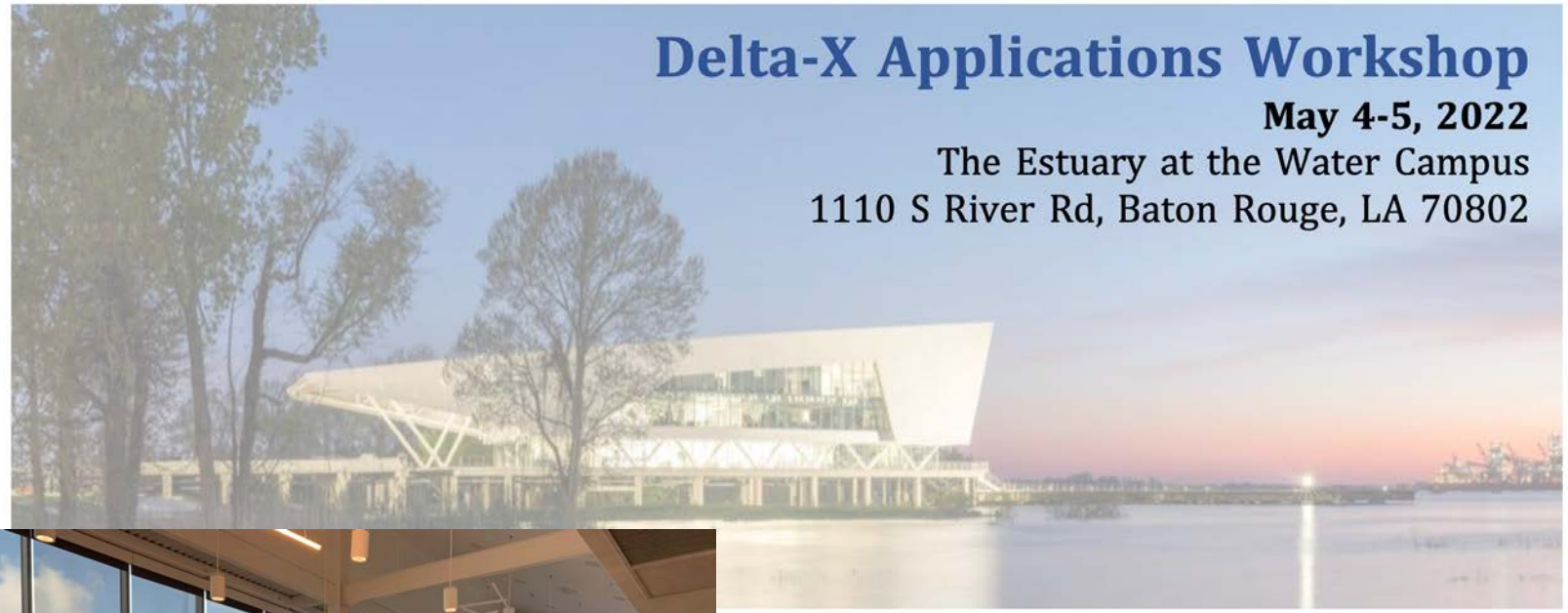
Network connectivity does not always promote system sustainability – in the Terrebonne Basin, channel connectivity is associated with land loss rather than with land gain. It is the combination of connectivity and the state of the system that control whether the system is moving towards a stable or unstable configuration.

WHY IS IT IMPORTANT? BECAUSE IT IS USUALLY EXPECTED THAT CONNECTIVITY, OR REESTABLISHING CONNECTIVITY, WILL LEAD TO IMPROVEMENTS OF THE SYSTEM UNDER ALL CONDITIONS



Wright & Passalacqua, in preparation

COMMUNITY ENGAGEMENT
DELTA-X APPLICATIONS WORKSHOP 2022



Developed analysis Python Notebooks for all data sets (in situ & airborne)

Attendees used the Notebooks through Google CoLab to process the Delta-X data themselves

All training material available online

- 56 total attendees from 21 different institutions
- State of Louisiana
  - **Coastal Restoration & Protection Agency**
  - Louisiana Geological Survey
- **NGO**
  - **Water Institute of the Gulf**
- Federal
  - Oak Ridge National Lab
  - USACE
  - USGS Wetland Center, Lafayette, LA
- Private
  - Baird
  - Duplantis Design Group
  - FTN Associates, Ltd.
- University
  - Louisiana State University
  - Southern University A&M College
  - Tulane
  - UCLA
  - University of Louisiana at Lafayette
  - University of Rouen Normandy
- All Delta-X Institutions

Delta-X Airborne Instruments
(NASA Airborne Science prototypes for NASA Earth Science missions)

UAVSAR (for NISAR)

- L- band Radar, full-pol, 6m
- Water level changes within marshes
- Map of channel network

JSC Gulfstream III

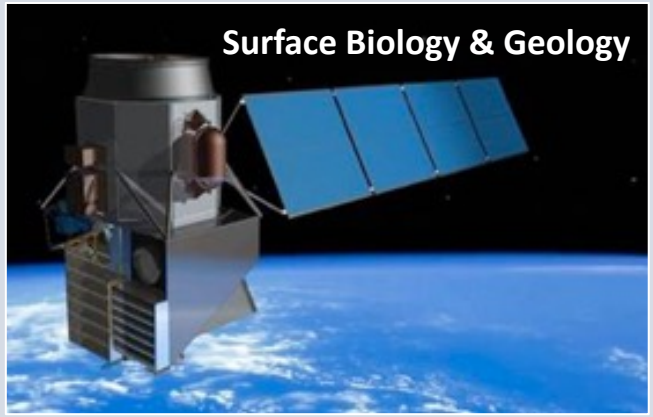
AirSWOT (for SWOT)

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

Dynamic Aviation King Air B200

AVIRIS-NG (for SBG & more)

- Imaging spectroscopy (432 bands at 4m)
- Vegetation species and structure classification
- Sediment concentrations in water



DELTA-X TEAM & DATA / MODELS

https://deltax.jpl.nasa.gov

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)

FIND DATA HERE

https://daac.ornl.gov/cgi-bin/dataset_lister.pl?p=41

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