National Aeronautics and Space Administration

FY23 Topic Areas Research and Technology Development (TRTD)

Hydrodynamics Across the Land-Ocean Aquatic Continuum (LOAC)

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Strategic Focus Area: Water and carbon cycles

Objectives: We define the LOAC as the transition zone between terrestrial ecosystems and the very near-shore coastal ocean, which includes tide-impacted inland waters and wetlands, estuaries and near-shore coastal waters (no more than a few kilometers on coastal shelf) (Fig. 1). The longer-term goal of this study is to estimate and monitor the exchange of water and its constituents across the LOAC with hydrodynamic models calibrated and validated with altimeter and interferometric radar missions—essentially upscaling Delta-X globally. The objectives leverage ongoing Delta-X, SWOT and NISAR projects:1-Demonstrate the retrieval of instantaneous (i.e. observed) water fluxes across the LOAC using altimeter data and hydrodynamic models.2-Evaluate the potential and limitations of current missions in calibrating hydrodynamic models:3-Develop and publish a JPL database and software library specific to the LOAC.4-Support the Design of a LOAC-specific mission.

Background: Altimetric instruments typically focus on offshore measurements of water surface elevation with kilometer-scale resolutions. Studying the LOAC requires resolving complex coastal landscapes with hydrological features (ie. lake, lagoons, wetlands, rivers, channels and estuaries) with various scales.

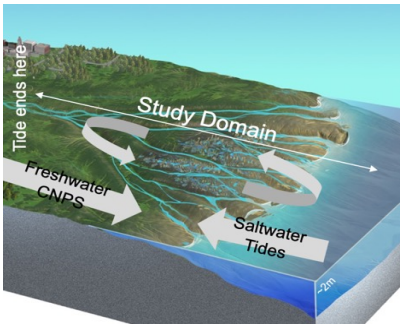

Figure 1: *LOAC research domain*

Approach and Results: Our innovative approach uses altimetry and hydrodynamic models to advance our understanding of hydrodynamic processes across the LOAC, and ultimately evaluate their role in the regional and global water and carbon cycles. We focus on the cal/val of hydrodynamic models with spaceborne altimetry (GEDI, ICESAT-2, SWOT) and repeat-pass interferometry (ALOS/PALSAR-1/2, Sentinel-1a/b, NISAR). These are essentially 'virtual gauges' in main (ie. large) channels, lagoons, lakes, wetlands and near-shore, and available InSAR is used in wetlands. We quantitatively evaluated each altimetric source from gauged deltas and estuaries, and upscale to ungagged deltaic parts and other deltas using the time-series of altimetric measurements to calibrate and validate our hydrodynamic model implementations. We collected, processed, and archived global datasets of GEDI and ICESAT-2 along 53 global coastline regions that include river deltas and estuaries. Those have been published on a new LOAC website (Figure 2, https://landscape.jpl.nasa.gov/cgi-bin/data-search.pl). We used data from green (ICESAT-2 and airborne) and red (GEDI and airborne) altimetric lidar instruments and demonstrated high potential for single water surface elevation measurements (i.e., snapshot) with sparse repeat measurements. ICESAT-2 was also used to profile shallow bathymetry. Hydrodynamic models were implemented and parallelized on Gattaca computer cluster for 48 river deltas and estuaries, and a tutorial was developed and transferred to Gabonese colleagues. A NTR was submitted for our hydrodynamic model implementation (NPO 52605: "Building Open-Source Hydrodynamic Models Using ANUGA Software"

Major Achievements:
1. New website and global database: https://landscape.jpl.nasa.gov/cgi-bin/data-search.pl
2. Parallelized hydrodynamic model implementation
3. NTR NPO 52605: "Building Open-Source Hydrodynamic Models Using ANUGA Software"
4. Marc Simard won the NASA DSI project: STV for Coastal Wetlands
5. Alex Christensen submitted a NASA ROSES' ECIPES (Early Career) proposal:" Coastal Wetland Connectivity as an Indicator of Vulnerability"

Significance/Benefits to JPL and NASA: The goal is to ultimately upscale Delta-X to global river deltas and estuaries using multi-source spaceborne remote sensing, including altimeters, repeat-pass radar interferometers and optical sensors. Global hydrodynamics of the LOAC is an unoccupied science and applications niche that JPL could lead. We developed methodologies with existing altimetric missions, essentially creating a "virtual" LOAC mission, to capture data gaps and to assert JPL leadership before proceeding to the design of a LOAC-specific mission. The quantitative aspects of the tasks will be useful to determine an Science and Applications Traceability Matrix to define a future LOAC mission.

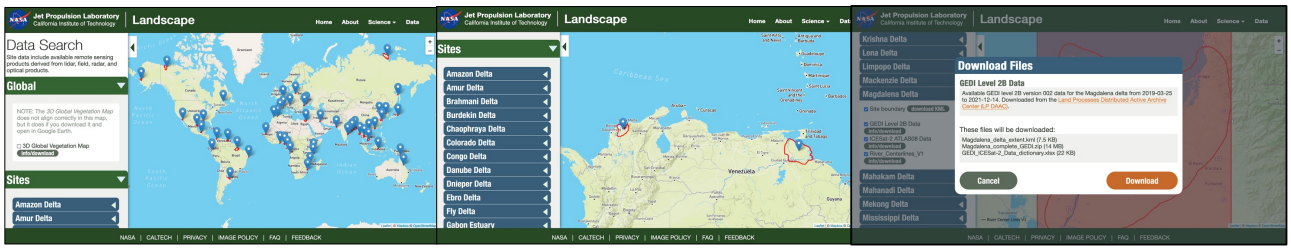

Figure 2: new website and database of global river deltas and estuaries provides access to LOAC specific altimetric datasets and other ancillary map products.

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