Deltas and Estuaries: The SWOT Revolution

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Estuaries facilitate the transport of pollutants, sediments, and major nutrients such as carbon, from the terrestrial to the marine environment. The magnitude of its fluxes controls global carbon cycling dynamics and play a regulatory role in biological and physical processes from river headwaters to mouths, and beyond, in coastal and marine systems. Hence, a direct long-term quantification of river discharge is needed to better understand and predict the spatiotemporal dynamics of material transported across the land-sea continuum and the potential effects that may arise from climate and anthropogenic changes. We expect the near-comprehensive and frequent water surface elevation coverage of SWOT will revolutionize our understanding of coastal deltas and estuaries, globally. However, these highly dynamic and spatially complex systems offer methodological challenges that must be addressed prior to SWOT launch.

Our goal is to advance SWOT capabilities in deltas and estuaries, by developing algorithms to generate SWOT products specific to these regions. This proposal is divided into the following specific objectives:

1. Generate a set of detailed spatio-temporal base-maps of coastal deltas and estuaries to support SWOT retrieval of water surface elevation and slope.
2. Improve accuracy of SWOT estimation of water surface elevation and slope in deltaic and estuarine environments.
3. Evaluate methods for reconstruction of tidal signal using SWOT data.
4. Explore the use of ancillary spaceborne remote sensing datasets.
5. Process and evaluate the performance of SWOT in the Mississippi River Floodplain and the St-Lawrence Estuary.
6. Generate global water surface elevation and slope for coastal deltas and estuaries.

Our approach considers the global context of SWOT while leveraging the continued progress in hydrodynamic modeling the Mississippi River Delta region and the St. Lawrence estuary. Until the launch of SWOT expected in 2022, we propose to use these models to address objectives 1, 2 and 3. The method relies on a spatiotemporally adaptive object-based algorithm that uses ancillary data (objective 4) to anticipate the impact of layover and account for time- dependent effects from seasonal discharge and/or vegetation growth. Data from SWOT's point cloud are mapped—and averaged —into predetermined water surface objects designed to improve accuracy of water surface elevation. After launch, this algorithm will be used to process the real SWOT data and generate water surface elevation and slope in global deltas and estuaries. But given the predominant impact of tides and its role in controlling discharge, slope may not be the best determinant for discharge. Thus, we go further and evaluate new data-driven empirical approaches to reconstruct continuous tidal signals from temporally sparse satellite data (e.g. SWOT) based on regression methods (objective 3). Again, prior to launch, we use SWOT simulations as a baseline dataset to evaluate the reconstruction methods performance in these two regions. A new method assessment with real SWOT data will be performed once they become available. Objective 6 is achieved by applying the new algorithms to generate global products.

In addressing the objectives, our team seeks to provide guidance to the SWOT project about measurement requirements, product definition, geophysical error sources, algorithm development, calibration and validation. We will continue acting as a liaison with the broader science and applications communities interested in these coastal regions.