Evaluating the effects of cohesive processes on sediment distribution in an idealized, partially-mixed estuary using a numerical model.

Danielle Tarpley, Virginia Institute of Marine Science Gloucester Point Virginia, United States. drtarpley@vims.edu
Courtney Harris, Virginia Institute of Marine Science Gloucester Point Virginia, United States. ckharris@vims.edu
Carl Friedrichs, Virginia Institute of Marine Science Gloucester Point Virginia, United States. cfried@vims.edu

An idealized two-dimensional model is designed to represent a longitudinal section of a partially-mixed estuary, accounting for a freshwater source, tides, and estuarine circulation, but neglecting across-channel variations. The Community Sediment Transport Modeling System (CSTMS) is used to simulate suspended transport, erosion, and deposition within the Regional Ocean Modeling System (ROMS). This version of the model also includes cohesive processes such as consolidation and swelling of the sediment bed; sediment-induced stratification; and variable settling velocities. To better understand the processes controlling fine-grained sediment transport in the York River, VA, the primary features of the idealized estuary mimic that system, and the model uses site-specific field measurements of erodibility and settling properties to constrain sediment transport model parameters. Simulations that include different combinations of cohesive processes are used to determine the impact of bed consolidation and swelling, and sediment-induced stratification on the depositional patterns of various sediment types along the idealized estuary and over a tidal cycle. The sediment classes represent the range of particle settling velocities (w_s) seen from in situ observations; and include resilient muddy fecal pellets (w_s = 2.4 mm s^{-1}), very fine sand (w_s = 6 mm s^{-1}), lower-density flocs (w_s = 0.8 mm s^{-1}), and unflocculated primary particles (w_s = 0.1 mm s^{-1}). Slower settling particles preferentially remain in suspension, leading to a more even spatial distribution. Faster settling sediment is more readily trapped in the estuarine region of convergence or estuarine turbidity maximum (ETM). Considering sediment-induced stratification traps sediment in the lower water column, and bed consolidation limits suspension of lower w_S sediment, then the incorporation of these processes are likely to enhance the trapping of relatively higher w_S sediment in the ETM region.