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The effect of tides, wind and vegetation seasonality in controlling water and sediment fluxes in Poplar Island (MD), USA

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Salt marsh morphologies are commonly affected by strong tidal processes that regulate sediment accretion rates. Here, we investigate how the interplay between tides, wind, and vegetation affect sediment dynamics in a low energy salt marsh at the Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island. The project is an active restoration site where fine-grained material dredged from the shipping channels in the upper Chesapeake Bay is being used to restore remote island tidal marsh habitat in mid-Chesapeake Bay (Maryland, USA) Tidal currents were measured over multiple tidal cycles during different seasons in the inlet and tidal creeks of one marsh at Poplar Island, using Acoustic Doppler Current Profilers (ADCP) to estimate water flows to be compared with locally measured wind speed and direction. Sediment fluxes were determined by estimating acoustic backscatter with ADCPs and validated against total suspended solids (TSS) measurements taken on site. A high-resolution survey was conducted to capture channel cross sections and salt marsh morphology. The relative importance of water flows, wind speed and direction, and vegetative traits were evaluated by multiple regression analysis. By applying a numerical model, Delft3D, to field data, we seek to identify eco-geomorphological factors influencing sediment distribution during different seasons. Channel morphology influences flood-ebb dominance in marshes, where deep, narrow channels promote high tidal velocities and incision, increasing sediment suspension and reducing resilience in Poplar Island's marshes. Our results identified a significant relationship between tidal currents and backscatter intensity, and our model results suggest that plant phenology plays an important role in sediment accretion and building resilience. However, concerns about erosion and sediment export have been highlighted by our study, showing the highest fluxes in suspended sediment concentrations coinciding with peak ebb tides. Understanding the drivers of salt marsh morphodynamics is vital for informing restoration practices and designs to improve resilience.