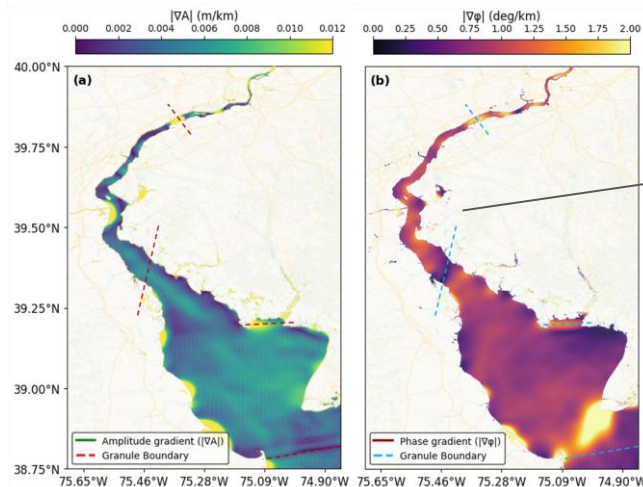
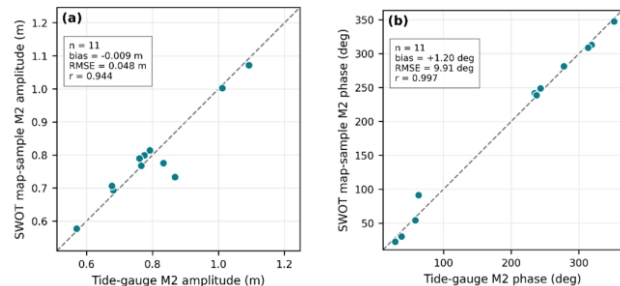
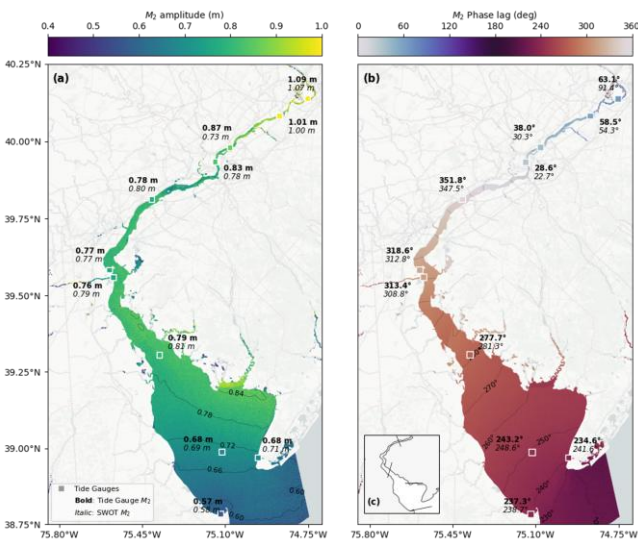
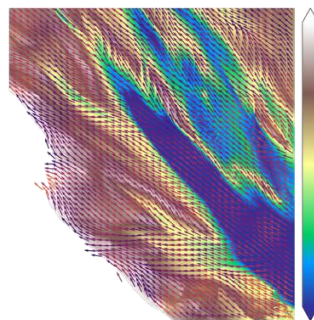


SWOT observes tidal dynamics in estuarine environments

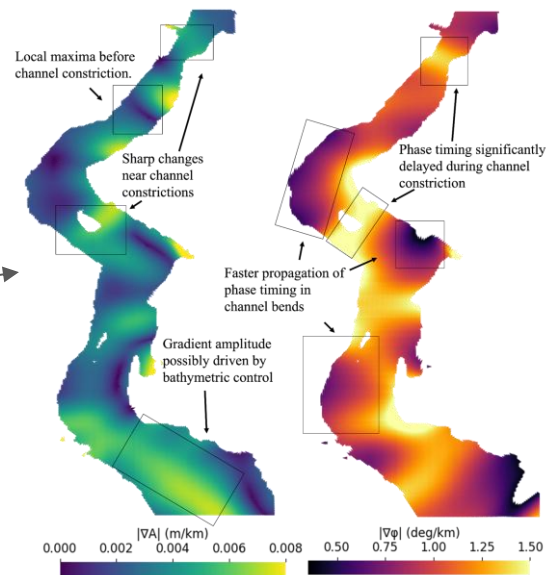
SWOT-derived M2 amplitude and phase resolve coherent spatial tidal structure throughout Delaware Bay and the Delaware River. Amplitude increases upstream to approximately 1.1 m, while phase captures continuous tidal propagation through the estuary. Comparison with 11 tide gauges shows strong agreement in amplitude ($R^2 = 0.94$) and phase ($R^2 = 0.997$).



We characterize changes in tidal dynamics from the spatial gradients of the SWOT-derived M2 field. Gradients of the smoothed complex tidal coefficients reveal previously unresolved spatial organization, including localized amplification near channel constrictions and systematic changes in phase propagation through channel bends and transitions in estuarine geometry.



The phase-gradient direction is strongly aligned with the deeper channel network, showing that the direction of tidal-wave propagation follows the dominant bathymetric pathways (left). As a preliminary extension, machine-learning tests indicate that the spatial tidal structure contains information about the underlying bathymetry, with tidal features able to recover the broad structure of a smoothed bathymetric target (right)



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