Subgrid scale methods nearshore and across the coastal floodplain to overcome resolution limitations in MPAS-O

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During ordinary tidal cycles and storm-forced events, ocean waters penetrate the coastal zone and interact with complex stream flow networks, wetlands, marshes, and the coastal floodplain. Simultaneously, upland runoff and regional rainfall flow through the coastal zone, making their way to the ocean. Correctly resolving the terrestrial-aquatic interface is crucial for accurate coastal hydrodynamic simulations and determining the sediment, chemical, geochemical, and biological exchanges between inland coastal waters and the open ocean.

It is critical to correctly resolve the volume of the exchanges, current speeds, dissipation, shape and volume of estuaries and other small-scale coastal systems, and complex non-linearities of the advectively driven inlet flow exchanges. Resolving this in MPAS-O would require coastal mesh resolution two orders of magnitude finer than currently employed. While the use of MPAS-O’s unstructured meshes allows flexibility in placing local resolution, resolving the TAI down to tens of meters over large regions will still lead to a prohibitive number of degrees-of-freedom and will be impractical

Our goal is to extend the capabilities of MPAS-Ocean to include coastal flooding using recently developed subgrid techniques. These techniques use integral properties of high-resolution bathymetry, topography, and land cover to introduce corrections into coarser resolution models, and can improve accuracy greatly near the land-water interface while having no significant effects in deeper regions. These methods will be incorporated into the external two-dimensional barotropic mode of the MPAS-Ocean; their extension to the internal three-dimensional baroclinic mode in different vertical coordinates will be investigated and implemented into the MPAS-Ocean.