



Effects of Salinity Variations on Subsurface Flow in Salt Marshes

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Abstract:

Salt marshes are important wetlands at the ocean-land interface. They are influenced by various physical and biogeochemical processes. Among these processes, subsurface flow and associated solute transport play a significant role in determining the material exchange with coastal water. Tidally-driven near-creek circulation leads to a rapid exchange mechanism between marsh sediments and coastal waters. Numerous studies have been carried out to examine the subsurface flow and associated solute transport processes under the influences of tidal fluctuation, evapotranspiration, stratigraphy, regional flow, topography and soil properties. Furthermore, spatial and temporal salinity variations in surface water and pore-water commonly exist in salt marshes, due to the combined effects of tidal inundation, precipitation and evapotranspiration. Many recent studies on pore-water flow in salt marshes have neglected such salinity variations, in particular, the density contrast between the surface water and pore-water, which may lead to significant modifications of the pore-water flow. We will demonstrate, based on results from both laboratory experiments and numerical simulations that (1) a near-creek circulation clearly exists when there is no density effect; (2) once the salinity contrast reaches a certain level, instabilities in the form of fingers occur, leading to more rapid exchange between surface water and groundwater; (3) density effect (upward gradient) enhances the exchange between the surface and subsurface water in the marsh sediments, especially in the marsh interior; and (4) both the number and size of fingers change gradually from the near-creek zone to the marsh interior, due to the strong tidally-driven advective process occurring near the creek. Near the creek there are less but larger fingers, while in the marsh interior there are more fingers with smaller size.

Keywords: Salt marsh; density effect; subsurface flow; finger.