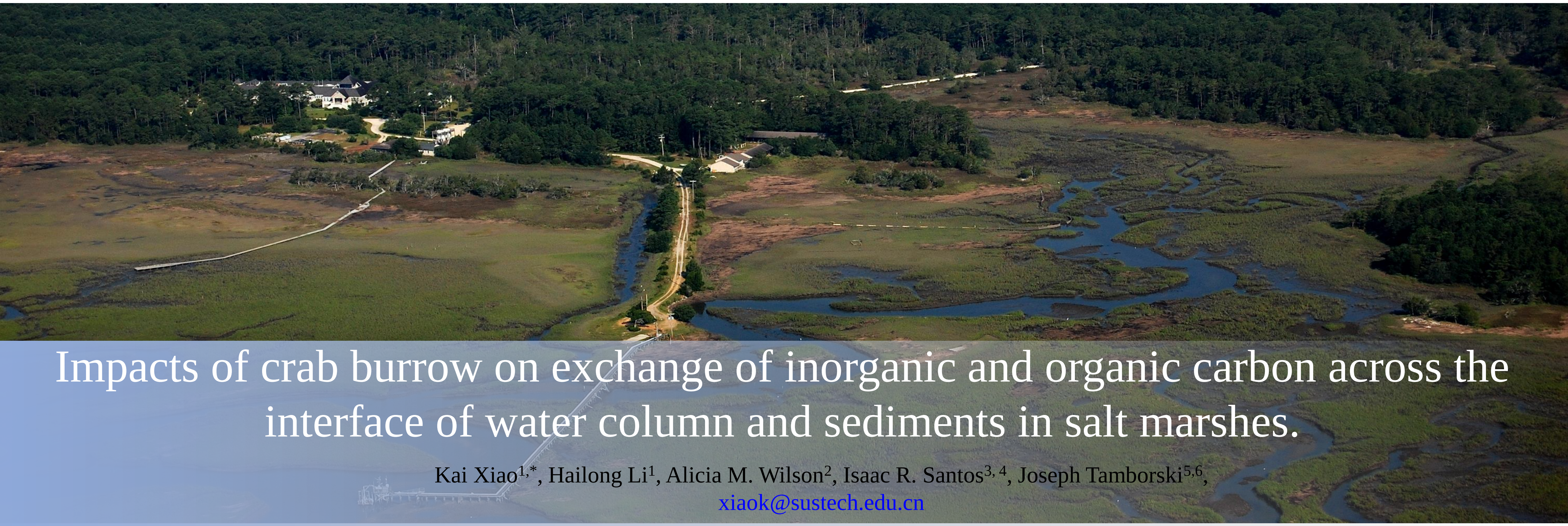

Impacts of crab burrow on exchange of inorganic and organic carbon across the interface of water column and sediments in salt marshes.

Kai Xiao[1,*], Hailong Li[1], Alicia M. Wilson[2], Isaac R. Santos[3, 4], Joseph Tamborski[5,6],
xiaok@sustech.edu.cn

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[1]State Environmental Protection Key Laboratory of Integrated Surface Water-Groundwater Pollution Control, School of Environmental Science and Engineering, Southern University of Science and Technology, Shenzhen 518055, China

[2]School of the Earth, Ocean and Environment, University of South Carolina, Columbia, SC 29208, United States

[3]National Marine Science Centre, Southern Cross University, Coffs Harbour, NSW 2450, Australia

[4]Department of Marine Sciences, University of Gothenbrug, Gothenburg, Sweden

[5]Department of Marine Chemistry and Geochemistry, Woods Hole Oceanographic Institution, Woods Hole, MA 02536, USA

[6]Dalhousie University, Centre for Water Resources Studies, Halifax, NS B3H 4R2, Canada

GM6.1 Coastal wetlands: Processes, interactions, management

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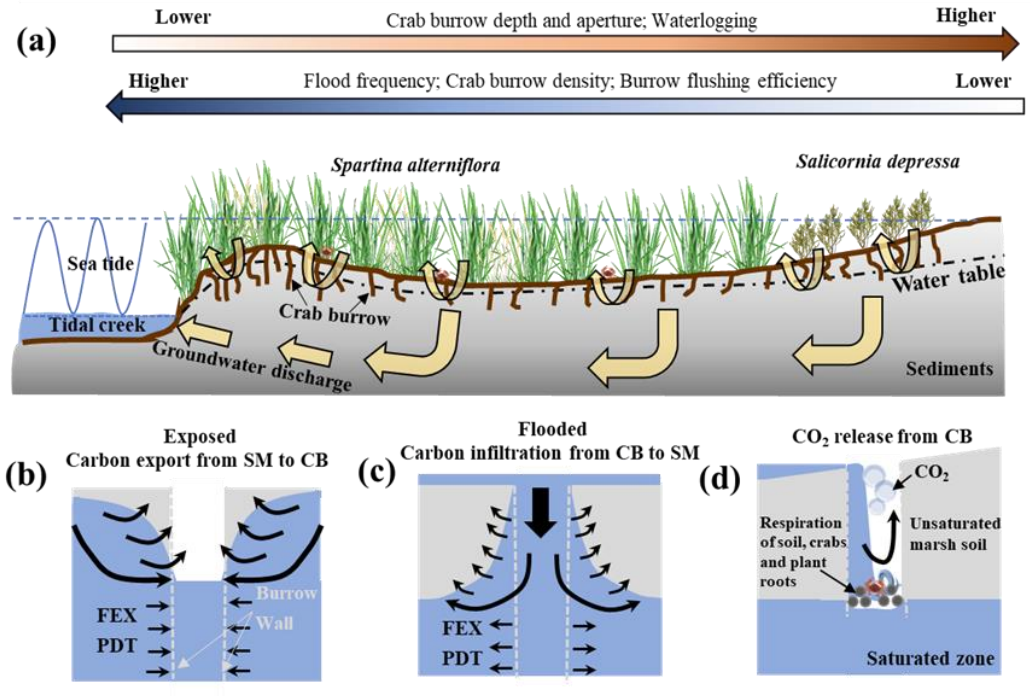
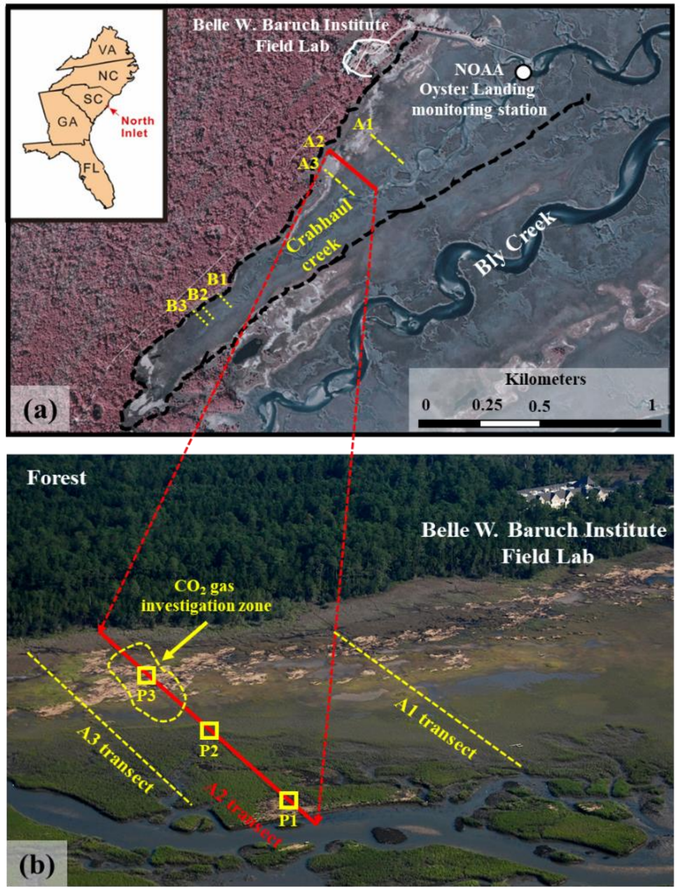
We hypothesized that (i) water flow through crab burrows creates rapidly evolving hydraulic gradients at different tidal stages that drive carbon exchange across the soil-water interface, (ii) the gas-phase CO2 concentration in crab burrows is higher than at the marsh surface because of microbial and crab respiration.



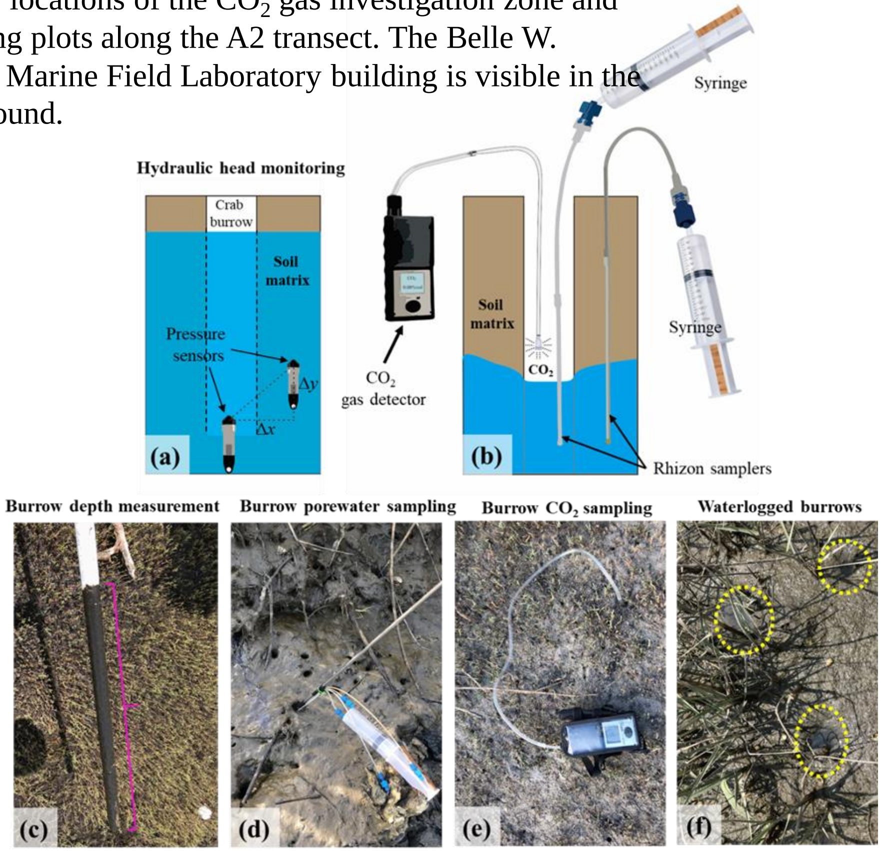
PEX: pore water exchange; PDT: passive diffusion transport

Panels of schematic diagrams (a) summarizing the within-marsh variations of the marsh surface elevation, marsh zonation and the crab burrow information, and showing the carbon exchange processes between crab burrows and the surrounding soil matrix: (b) dissolved carbon exports from the soil matrix (SM) into the crab burrows (CB) by PEX and PDT when the marsh soils are exposed; (b) surface water preferentially infiltrates into the crab burrows when the marsh soil are flooded and then the dissolved carbon recharges the surrounding matrix by PEX and PDT; (c) CO_2 gas, which could be produced by respirations of soil, crabs and marsh rhizospheres, releases from the crab burrow to the air due to the push of irrigated seawater.

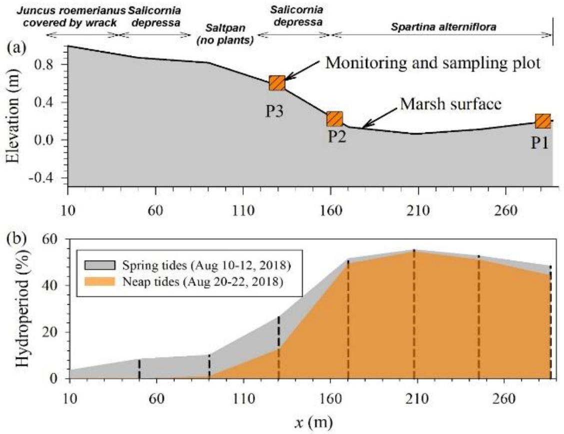
Monitoring and Sampling



The locations of field sites: (a) Crabhaul Creek basin (black dashed line) and the NERRS intertidal transects (A1-A3 and B1-B3); (b) aerial photograph showing the relative locations of the CO_2 gas investigation zone and sampling plots along the A2 transect. The Belle W. Baruch Marine Field Laboratory building is visible in the background.



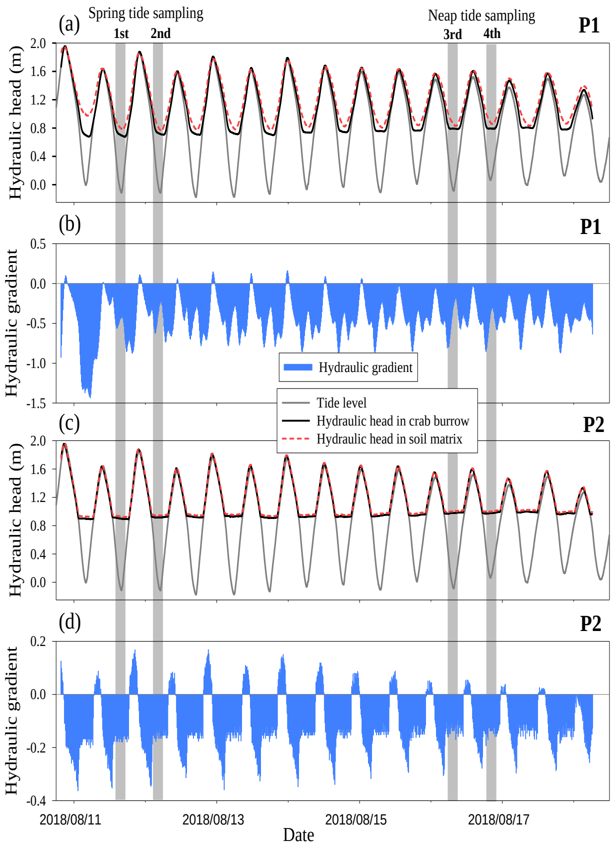
Schematic diagrams and field photos showing (a) the monitoring method of hydraulic pressure in a crab burrow and surrounding soil matrix (not to scale), (b) the sampling method for CO_2 gas and porewater (not to scale), (c) the measurement of burrow depth prior to the installation of pressure sensor using a PVC tube (diameter=1.5 cm), (d) the porewater sampling process in a crab burrow using a Rhizon sampler supported by a thin and rigid metal rod, (e) the CO_2 gas sampling process in a crab burrow, and (f) crab burrows in the short *Spartina* zone under waterlogged conditions that frustrating gas sampling at low tides. Photo Credit: Kai Xiao.



The spatial distribution of (a) surface elevation and marsh zonation along the A2 transect, and (b) the calculated hydroperiod of marsh surface according to water level in NOAA Oyster Landing station during the sampling periods. The horizontal axis “x” indicates the seaward distance away from the forest edge toward the Crabhaul creek.

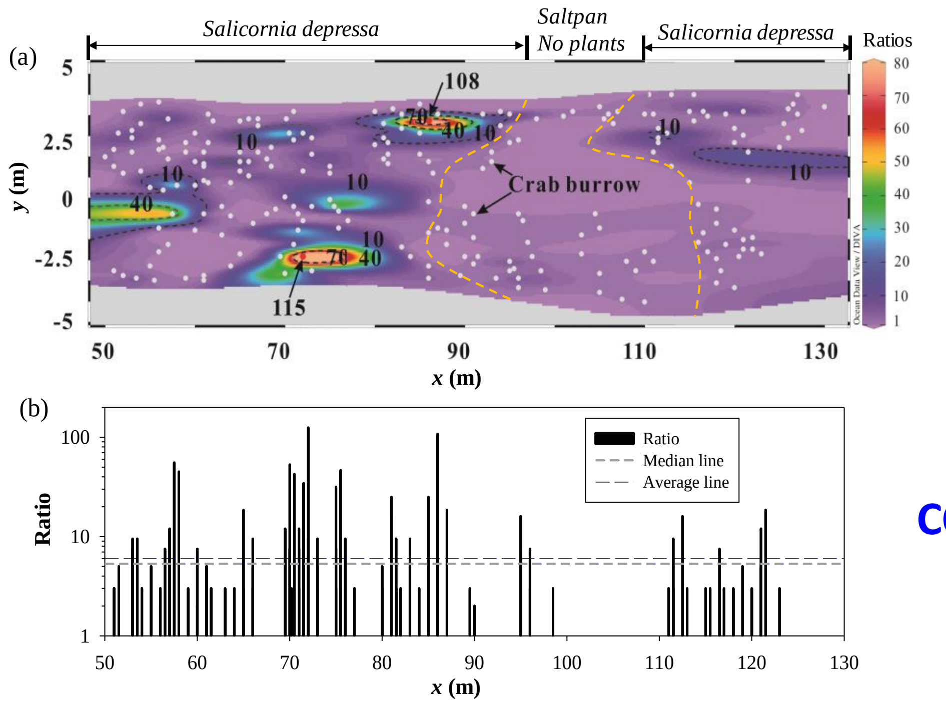
Field monitoring results

Hydraulic exchange process between crab burrows and surrounding soil matrix



Time series of hydraulic head in crab burrows (black solid line), the surrounding soil matrix (red dashed line), the sea tides (gray solid line) and calculated hydraulic gradient (blue histogram) at P1 (a-b) and P2 (c-d). The four vertical gray bands indicate four sampling campaigns. A negative hydraulic gradient indicates porewater flow from the surrounding soil matrix (SM) to the crab burrow (CB). The positive gradients indicate the opposite direction. Note that the scales of vertical axis differ between b and d. Although three monitoring plots were set up along the A2 transect, measurements were only successfully at P1 and P2. The deeper unsaturated zone and longer unsaturated period at P3 led to poorer hydraulic connectivity than at P1 and P2. Therefore, only the remaining time series of hydraulic heads at P1 and P2 are shown.

CO_2 concentrations in the burrows

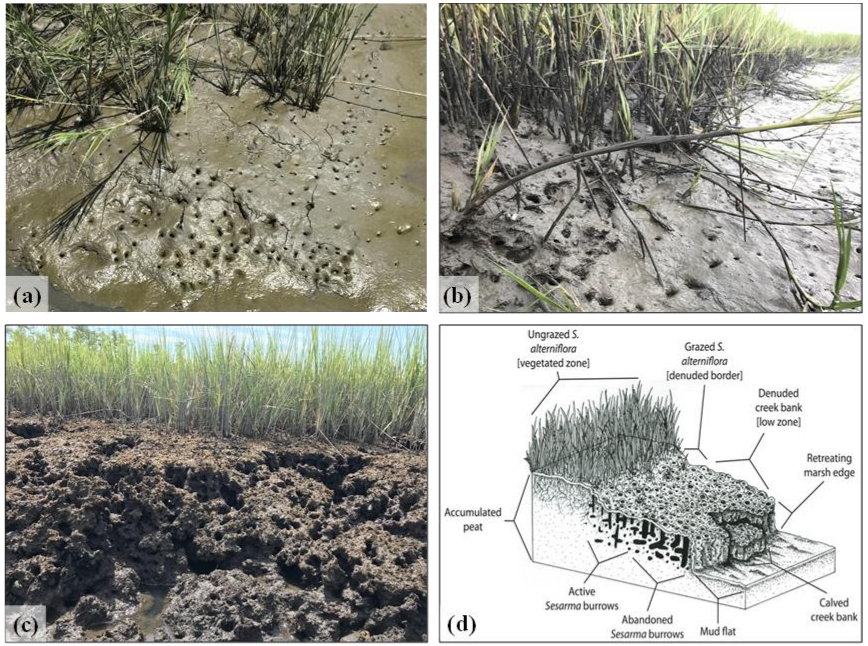


Ratios of CO_2 gas concentration in crab burrows to those above the soil surface: (a) spatial variation. Each circle indicates an independent crab burrow and the color represent the value range. The horizontal axis “*x*” indicates the seaward distance away from the forest edge toward the Crabhaul creek. The vertical axis “y” indicates the distance perpendicular to the A2 transect; (b) as a function of distance away from the forest edge. Note that the above spatial distribution of crab burrows did not necessarily reflect their real abundances in salt marshes because we only sampled the relatively large crab burrows (burrow opening >1 cm) in salt marshes.

Preliminary results

The burrow-induced carbon export consisted of two pathways: the dissolved phase carbon export (i.e., DIC and DOC) and the gas phase carbon export (i.e., CO2 emission).
The dissolved phase carbon export is subject to solute transport between crab burrows and the surrounding soil matrix, which is determined by the model of porewater advection (PEX) and diffusion (PDT).

The preliminary results reported that all of the calculated PDT C fluxes were at least two orders of magnitude lower than PEX C fluxes demonstrating how porewater advective flow dominates the dissolved-phase carbon exchange between crab burrows and the surrounding soil matrix. Further, gas phase CO2 export was lower than the PDT but within the same order of magnitude. Thus, in ranking carbon export rates is that: **PEX > PDT > gas phase CO2 release**.



Crab burrows have good effects on promote substance cycling and marsh growth . However, high density of crabs may result in dieback zone by their herbivore activities and mediating water flow, either of which can create large bare patches of soil which are vulnerable to erosion.

The photo gallery showing the current condition of burrowing activity in different creekbank zones at (a) the entrance, (b) the middle (i.e., the NERRS's A2 transect), and (c) the headwaters of Crabhaul creek basin. Photo credit: Kai Xiao. (d) The schematic diagram showing the dieback of salt marshes in the creekbank zone with massive crab burrows (Karberg 2015, https://ncfscience.org/2015/12/22/salt-marsh-dieback-and-the-purple-marsh-crab-on-nantucket/).

Thank you for you attention!