Strong dynamics in tidal marsh DOC export in response to natural cycles and episodic events from continuous monitoring

Menendez, Tzortziou, Neale, Megonigal, Powers, Schmitt-Kopplin, & Gonsior. (2022): https://doi.org/10.1029/2022JG006863

Science Question

Tidal wetlands are known hotspots for carbon and nutrient exchange with adjacent waters, yet large uncertainties remain regarding the physical and biogeochemical controls on these fluxes. Continuous, long-term water bio-optical and physicochemical measurements allowed us to capture the strong variability in lateral wetland dissolved organic (DOC) fluxes in response to tidal exchange, seasonal cycles, and extreme weather events, improving estimates of C exchange across wetland-estuary interfaces.

Analysis

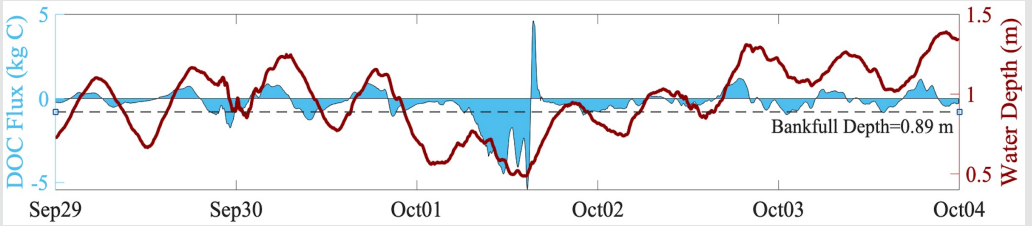
Tidal creek [DOC] was estimated from continuous in situ optical and physicochemical properties and combined with concurrent water flow to quantify DOC flux. Composition and quality of this exported material was analyzed with FT-ICR MS and optics.

Results

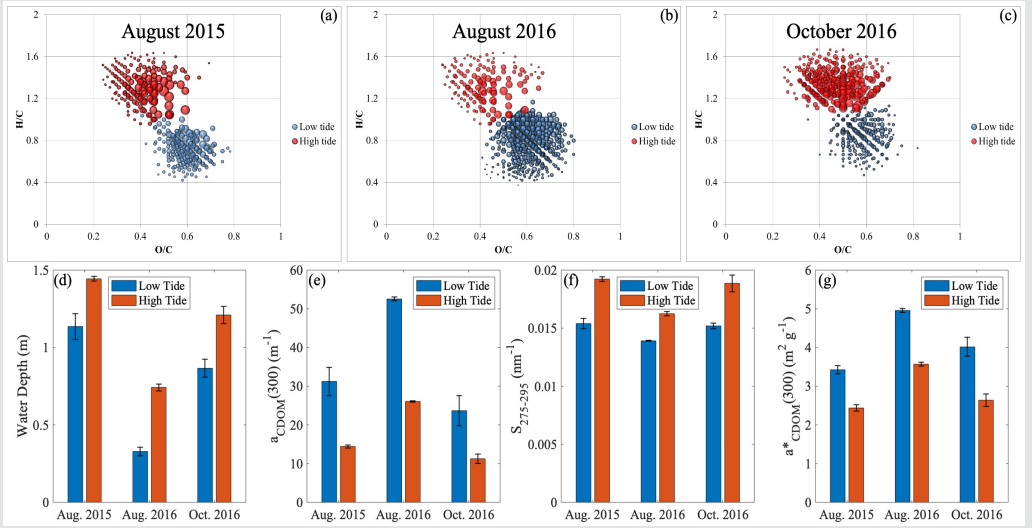
- We found a wetland to sub-estuary flux of 200.66 (±28.09) g C m^{-2} yr^{-1}, which is several times higher than previously reported fluxes for this system based on discrete tidal cycles.
- In summertime, tidal creek [DOC] was highest and dissolved organic matter quality corresponded to fresh wetland plant mobilization, but monthly DOC fluxes peaked in early fall with water flow.
- During Hurricane Joaquin in 2015, just two tidal cycles accounted for 5% of estimated annual DOC export, driven by precipitation and wind altering water flow.

Significance

Improvements in local ecosystem fluxes are needed for accurate aggregated regional and continental-scale carbon budgets. Lateral fluxes should be considered in wetland blue carbon stocks. Based on Net Ecosystem Exchange reported for this site, ~12% of annual sequestered carbon could be estimated as lost to lateral flux.



Tidal creek data from Sep. 29 through Oct. 3, 2015, coinciding with Hurricane Joaquin. DOC flux is in blue (negative=export) and channel water depth in red. On Oct. 1, a strong DOC export is seen that is caused by wind-driven water export from the tidal creek (corresponding to sustained depressed water depth).



FT-ICR MS (Fourier transform ion cyclotron resonance mass spectrometry) data analyzed from within the tidal creek at low (blue) versus high tide (red). Low tide samples show a lower ratio of H/C and higher ratio of O/C than high tide samples. This corresponds to higher aCDOM(300) (absorption of colored dissolved organic matter (CDOM) at 300 nm), lower S275–295 (spectral slope of CDOM from 275-295 nm), and higher a*CDOM(300) (DOC-specific CDOM absorption) at low tide. This is the quality of material exported from the wetland to sub-estuary.