Subtropical estuarine carbon budget under various hydrologic extremes and implications on the lateral carbon exchange from tidal wetlands

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Science Question: Elucidating carbon budget and its variability in poorly studied subtropical coast that spans a wide hydrologic spectrum, from extreme drought to storm-induced flooding.

Analysis: Under various hydrologic extremes ranging from drought to flooding, a mass balance model from field data was constructed for carbon fluxes and their variabilities in four estuaries along the northwestern Gulf of Mexico (nwGOM) coast over a four-year period (2014 – 2018).

Results:

- Lateral exchanges of TOC and DIC reach 4.5 ± 5.7 and 8.9 ± 1.4 $mol \cdot C \cdot m^{-2} \cdot yr^{-1}$, accounting for 86.5% and 62.7% of total TOC and DIC inputs into these estuaries, respectively;
- A relatively high regional CO_2 efflux (4.0 ± 0.7 $mol \cdot C \cdot m^{-2} \cdot yr^{-1}$), two times the average value in North American coastal estuaries;
- Storm or hurricane-induced flooding can elevate CO_2 efflux by 2 – 10 times in short periods of time. Flood following a drought also increases lateral TOC exchange (from -3.5 ± 4.7 to 67.8 ± 17.6 $mmol \cdot C \cdot m^{-2} \cdot d^{-1}$) but decreases lateral DIC exchange (from 28.9 ± 3.5 to -7.1 ± 7.6 $mmol \cdot C \cdot m^{-2} \cdot d^{-1}$).

Significance:

- Estuarine carbon fluxes are highly dynamic based on hydrologic conditions;
- Lateral exchanges from tidal wetlands dominate the total carbon loading to the nwGOM estuaries;
- Annual CO_2 emission from the nwGOM estuaries is twice as much as the average value from the North American estuaries;
- Interpretation of estuarine carbon budget requires greater spatiotemporal coverage.

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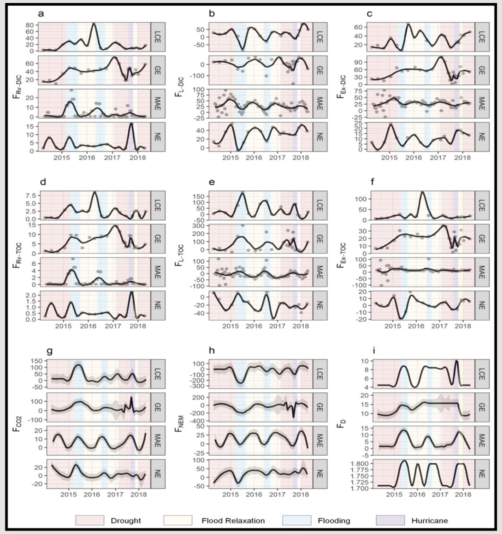

Figure 1. Observed and modeled carbon fluxes in four nwGOM estuaries, shaded areas denote the 95% confidence level based on locally weighted least squares regression (loess). (unit: *$mmol \cdot C \cdot m^{-2} \cdot d^{-1}$*)

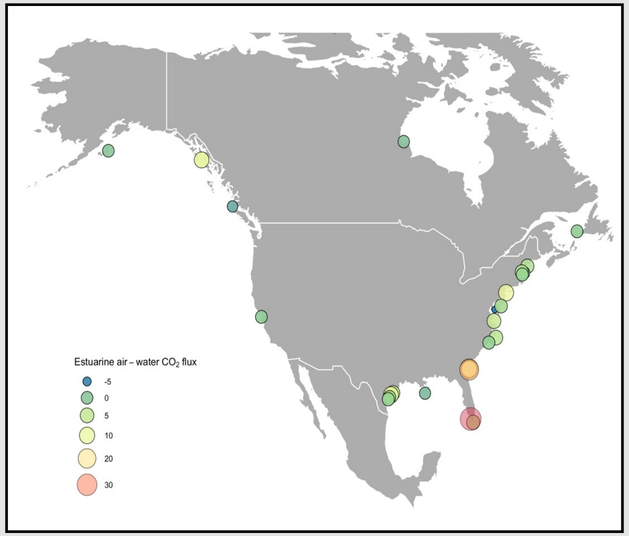

Figure 2. Observed estuarine air-water CO_2 fluxes in North American coast. (unit: *$mol \cdot C \cdot m^{-2} \cdot yr^{-1}$*)

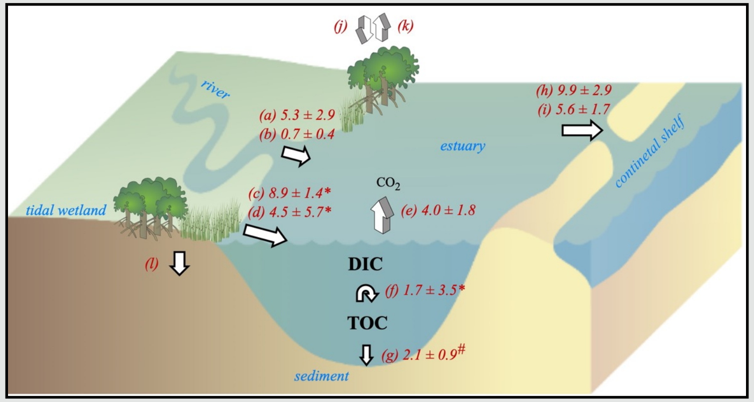

Figure 3. A schematic representation of integrated carbon fluxes in the nwGOM estuaries. (a) riverine DIC input; (b) riverine TOC input; (c) lateral DIC exchange between tidal wetlands and estuaries; (d) lateral TOC exchange between tidal wetlands and estuaries; (e) air-water CO_2 flux; (f) pelagic and benthic NEM; (g) sediment TOC burial; (h) DIC export to the open ocean; (i) TOC export to the open ocean; (j) carbon fixation by tidal wetland; (k) CO_2 evasion from tidal wetland; (l) carbon sequestration within tidal wetland. # denotes values are based on the literature data; * denotes values dependent on other fluxes. (unit: *$mol \cdot C \cdot m^{-2} \cdot yr^{-1}$*)