Carbon Budgets in Northwestern Gulf of Mexico Coastal Estuaries

Hongming Yao[1,1], Paul A Montagna[1,1], Michael S Wetz[1,1], Cory J Staryk[1,1], and Xinping Hu[1,1]

[1]Texas A&M University-Corpus Christi

November 30, 2022

Abstract

As coastal areas become more vulnerable to climatic impacts, the need for understanding estuarine carbon budgets with sufficient spatiotemporal resolution arises. Under various hydrologic extremes ranging from drought to hurricane-induced flooding, a mass balance model has been 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). Loading of total organic carbon (TOC) and dissolved inorganic carbon (DIC) to estuaries include riverine discharge and lateral exchange from tidal wetland. The lateral exchanges of TOC and DIC reach 4.5 ± 5.7 and 8.9 ± 1.4 mol·C·m-2·yr-1, accounting for 86.5% and 62.7% of total TOC and DIC inputs into these estuaries, respectively. A relatively high regional CO2 efflux (4.0 ± 0.7 mol·C·m-2·yr-1) has been found, which is two times of the average value in North American coastal estuaries based on a previous study. Meanwhile, oceanic export is the major pathway for TOC (5.6 ± 1.7 mol·C·m-2·yr-1, 81.2% of total) and DIC (9.9 ± 2.9 mol·C·m-2·yr-1, 69.7% of total) loss. Yet uncertainties remain due to a varying extent of remineralization coastwide. In addition, the carbon budget exhibits high variability in response to the hydrologic changes. For example, storm or hurricane induced flooding can elevate CO2 efflux by 2 – 10 times in short periods of time. Flood following a drought state also increases lateral TOC exchange (from -3.5 ± 4.7 to 67.8 ± 17.6 mmol·C·m-2·d-1) but decreases lateral DIC exchange (from 28.9 ± 3.5 to -7.1 ± 7.6 mmol·C·m-2·d-1). The large variability of carbon budgets highlights the importance of high-resolution spatiotemporal coverage under different hydrologic conditions, as well as the significance of carbon contribution from tidal wetland on coastal carbon cycling.

Hosted file

`essoar.10504662.2.docx` available at https://authorea.com/users/561522/articles/608956-carbon-budgets-in-northwestern-gulf-of-mexico-coastal-estuaries

Carbon Budgets in Northwestern Gulf of Mexico Coastal Estuaries

Early Version

Hongming Yao[1], Paul A. Montagna[2], Michael S. Wetz[2], Cory J. Staryk[1,2], and Xinping Hu[1,2,*]

[1]Department of Physical and Environmental Sciences, Texas A&M University-Corpus Christi, Texas 78412, United States

[2]Harte Research Institute for Gulf of Mexico Studies, Texas A&M University-Corpus Christi, Texas 78412, United States

Highlights:

- Estuarine carbon fluxes are highly dynamic from drought to hurricane-induced flood.
- Lateral exchanges from tidal wetlands dominate the total carbon loading.
- Annual CO_2 emission from nwGOM estuaries is double of the North American estuaries average.
- Interpretation of estuarine carbon budget requires a better spatiotemporal coverage to face the future climate change challenge.

Abstract

As coastal areas become more vulnerable to climatic impacts, the need for understanding estuarine carbon budgets with sufficient spatiotemporal resolution arises. Under various hydrologic extremes ranging from drought to hurricane-induced flooding, a mass balance model has been 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). Loading of total organic carbon (TOC) and dissolved inorganic carbon (DIC) to estuaries include riverine discharge and lateral exchange from tidal wetland. The 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 $mol \cdot C \cdot m^{-2} \cdot yr^{-1}$) has been found, which is two times of the average value in North American coastal estuaries based on a previous study. Meanwhile, oceanic export is the major pathway for TOC (5.6 ± 1.7 $mol \cdot C \cdot m^{-2} \cdot yr^{-1}$, 81.2% of total) and DIC (9.9 ± 2.9 $mol \cdot C \cdot m^{-2} \cdot yr^{-1}$, 69.7% of total) loss. Yet uncertainties remain due to a varying extent of remineralization coastwide. In addition, the carbon budget exhibits high variability in response to the hydrologic changes. For example, storm or hurricane induced flooding can elevate CO_2 efflux by 2 – 10 times in short periods of time. Flood following a drought state 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 $mmol \cdot C \cdot m^{-2} \cdot d^{-1}$). The

large variability of carbon budgets highlights the importance of high-resolution spatiotemporal coverage under different hydrologic conditions, as well as the significance of carbon contribution from tidal wetland on coastal carbon cycling.