SATELLITE ESTIMATION OF COASTAL PCO2 AND AIR-SEA FLUX OF CARBON DIOXIDE IN THE NORTHERN GULF OF MEXICO

Steven Lohrenz[1], Wei-Jun Cai[2], Sumit Chakraborty[3], Ruoying He[4], and Hanqin Tian[5]

[1]University of Massachusetts Dartmouth
[2]University of Delaware
[3]Mote Marine Laboratory
[4]North Carolina State Univ.
[5]Auburn University

November 21, 2022

Abstract

A key to better constraining estimates of the ocean sink for fossil fuel emissions of carbon dioxide is reducing uncertainties in coastal carbon fluxes. A contributing factor in uncertainties in coastal carbon fluxes stems from the under sampling of seasonality and spatial heterogeneity. Our objectives were to i) assess satellite-based approaches that would expand the spatial and temporal coverage of the surface ocean pCO2 and sea-air CO2 flux for the northern Gulf of Mexico, and ii) investigate the seasonal and interannual variations in CO2 dynamics and possible environmental drivers. Regression tree analysis was effective in directly relating surface ocean pCO2 to satellite-retrieved (MODIS Aqua) products including chlorophyll, sea surface temperature, and dissolved/detrital absorption. Satellite-based assessments of sea surface pCO2 were made spanning the period from 2006-2010 and were used in conjunction with estimates of wind fields and atmospheric pCO2 to produce regional-scale estimates of air-sea fluxes. Seasonality was evident in air-sea fluxes of CO2, with an estimated annual average CO2 flux for the study region of -4.3 + 1.1 Tg C y-1, confirming prior findings that the Gulf of Mexico was a net CO2 sink. Interannual variability in fluxes was related to Mississippi River dissolved inorganic nitrogen inputs, an indication that human- and climate-related changes in river exports will impact coastal carbon budgets. This is the first multi-year assessment of pCO2 and air-sea flux of CO2 using satellite-derived environmental data for the northern Gulf of Mexico.

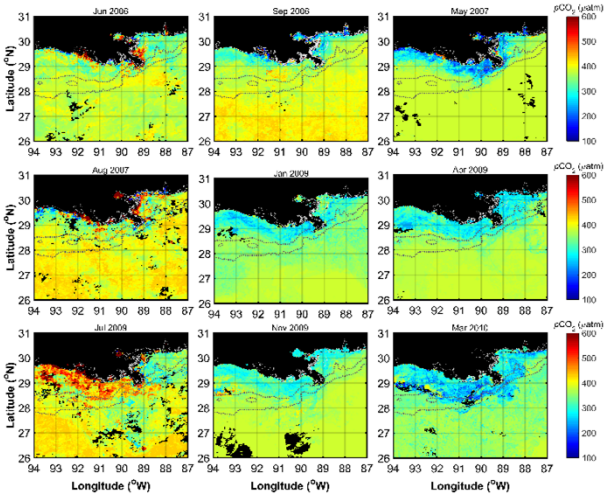
Satellite Estimation of Coastal pCO_2 and Air-sea Flux of Carbon Dioxide in the Northern Gulf of Mexico

Steven Lohrenz (U. Mass. Dartmouth, SLohrenz@umassd.edu), Sumit Chakraborty (Mote Marine Lab), Wei-Jun Cai (U. Del.), Ruoying He (NCSU), Hanqin Tian (Auburn)

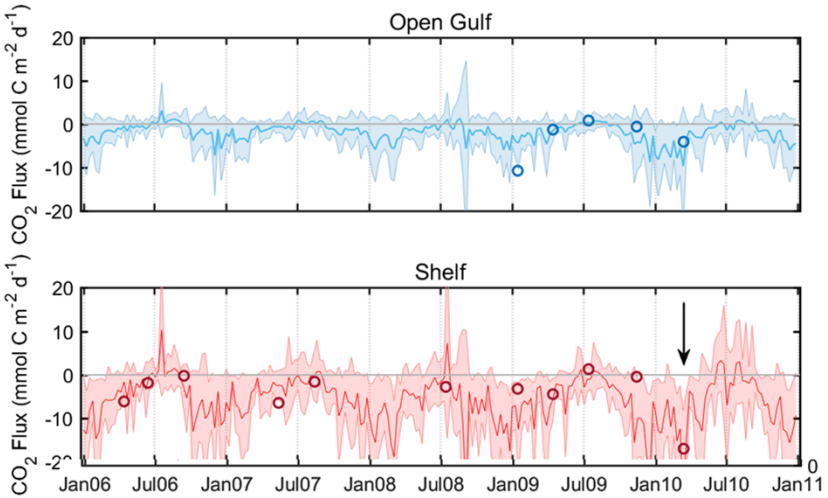
Challenge: A contributing factor in uncertainties in coastal carbon fluxes stems from the under sampling of seasonality and spatial heterogeneity. Our objectives were to i) assess satellite-based approaches that would expand the spatial and temporal coverage of the surface ocean pCO_2 and sea-air CO_2 flux for the northern Gulf of Mexico, and ii) investigate the seasonal and interannual variations in CO_2 dynamics and possible environmental drivers.

Methods: Regression tree analysis was effective in directly relating surface ocean pCO_2 to satellite-retrieved (MODIS Aqua) products including chlorophyll, sea surface temperature, and dissolved/detrital absorption. Satellite-based assessments of sea surface pCO_2 were made spanning the period from 2006-2010 and were used in conjunction with estimates of wind fields and atmospheric pCO_2 to produce regional-scale estimates of air-sea fluxes.

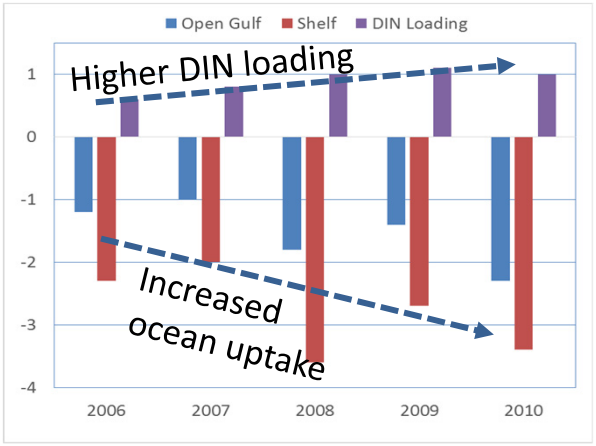
Key Findings: Seasonality was evident in air-sea fluxes of CO_2, with an estimated annual average CO_2 flux for the study region of -4.3 + 1.1 Tg C y^{-1}, confirming prior findings that the Gulf of Mexico was a net CO_2 sink. Interannual variations in fluxes were evident and related to Mississippi River dissolved inorganic nitrogen (DIN) loading.



Satellite-derived pCO_2 monthly images.



Satellite-based estimates of sea-to-air flux of CO_2 (shaded areas represent plus or minus one standard deviation). The circle symbols are results from ship-based estimates. Arrow indicates strongest negative fluxes (ocean uptake) during March 2010.



Annual CO_2 flux (Tg C y^{-1}) and DIN loading (Tg N y^{-1}) for the region.

Significance: This is the first multi-year assessment of pCO_2 and air-sea flux of CO_2 using satellite-derived environmental data for the northern Gulf of Mexico. Interannual variability in fluxes was related to Mississippi River DIN inputs, an indication that human- and climate-related changes in river exports will impact coastal carbon budgets.

Supported by funding from NASA (NNX10AU06G, NNX12AP84G, NNX14AO73G, and NNH13ZDA001N)

Lohrenz, S. E., W.-J. Cai, S. Chakraborty, W.-J. Huang, X. Guo, R. He, Z. Xue, K. Fennel, S. Howden, and H. Tian (2018), Satellite estimation of coastal pCO_2 and air-sea flux of carbon dioxide in the northern Gulf of Mexico, *Remote Sensing of Environment*, https://doi.org/10.1016/j.rse.2017.12.039