Estimate the annual net CO2 source/sink.

Determine the influence of extreme events (storms, wind, etc.) on the GR MOoring site switch.

With increased pCO2 concentrations at the GR mooring the potential CO2 sink, of typical coastal margins, is likely decreasing.

The most likely source of increased pCO2 is from freshwater inputs and increased net biological activity. The dynamic terrestrial hydrologic cycle likely influences coastal CO2 dynamics.

**Background**

In general, continental shelves are thought to be important sinks for CO2 via consumption of dissolved inorganic carbon (DIC) from terrestrial/anthropogenic sources (1, 2) and trapping organic matter delivered to the coast via rivers (3). Marginal seas provide vital ecosystem services, such as fisheries habitats, ecotourism, and act as buffers to the open ocean trapping inorganic nutrients; yet it is the close proximity to land that also makes this ecosystem more vulnerable to climate changes (4) and increased anthropogenic CO2. Estimating coastal carbon budgets is particularly challenging as CO2 is difficult to model (5) and we are just beginning to understand the complex processes that influence CO2 dynamics. Specifically, off the southeast US coast, in the South Atlantic Bight (SAB) this is the longest continuous time series analysis of coastal air-sea CO2 fluxes (FCO2) to date.

**Objectives**

1. Estimate the annual net CO2 source/sink.
2. Determine if the annual net source/sink is changing over time and what processes may contribute to variability.

**Hypothesis**

With increased pCO2 concentrations at the GR mooring the potential CO2 sink, of typical coastal margins, is likely decreasing. The most likely source of increased pCO2 is from freshwater inputs and increased net biological activity. The dynamic terrestrial hydrologic cycle likely influences coastal CO2 dynamics.

**Methods flow chart**

1. Data from CDBAC with initial post-delivery QC
2. De-spiking (± 3 σs)
3. Known relationships of salinity (SST) and pCO2
4. Remove biologically-based CO2 (CO2, i.e. Eddy covariance)
5. Linear interpolation for no more than 2 missing three hour measurements
6. Ensemble mean for SST, salinity, wind, and streamflow
7. Cope-net sampling
8. Trend estimates to detect wet period: before and after July 2010 (1st quarter 2010-6)

**Figure 2.** Trend analysis for deseasonalized FCO2 and potential contributing factors for the length of the time series from (red line) and before and after 2010.6 (green line). Over the course of the time series there is a secular increase in pCO2 (9.1 ± 1.5 pμM y^(-1)) and wind, CO2 (0.02 ± 0.02 pμM y^(-1)) and the Alahama River stream flow (51 ± 29 m^3 y^(-1)) as a proxy for freshwater input. Prior to 2010.6 there is an increase in Alahama River flow, and SS5 that could contribute to the pCO2, increase during this time. By separating the influence of thermal versus non-thermal components of pCO2, (16) Reimer et al. (in prep) determined that there was no thermal influence on pCO2 prior to 2010.6 even though there is a significant decreasing trend, and that the likely source of increased pCO2 is increased organic matter respiration away from the coast, eutrophication, and increased production at the GR mooring due to freshwater input to the SAB. With no change in wind speed in conjunction with the lack of a thermal influence on pCO2, the increase in FCO2 is likely due to respiration of pCO2 with respect to pCO2. Even though there appears to be a relationship in pCO2, to anomalously high freshwater inputs (green line) we do not see this same response in FCO2. This is likely due to the complex interplay of in situ processes in this heterogeneous region. Episodic FCO2 drawdown may be linked to increased winter freshwater inputs.

**Figure 4.** Mean summer and winter FCO2 (left), and the trend in summer FCO2 (right); the mean winter trend is not significant. This analysis includes underway observations from cruises in January, February, and August 2005. Due to the large 95% confidence interval this trend may also not be significantly different than zero due to low sample size and high variability. This apparent increase reflects a summer increase in pCO2 (results not shown), and is likely due to supersaturation with respect to the atmosphere.

**Conclusions**

- GR mooring site switches from an annual net sink to a source. Other studies have modeled this region as a net sink (12), however, may not be the case.
- Contrary to pCO2, FCO2 does not appear to be influenced by the same episodic increase in stream flow during the wet cycle (2009-2010).
- FCO2 may be more influenced by biological drawdown than wind induced evasion.
- The wet-dry cycle, which has been found to influence pCO2, may play a different role in air-sea flux dynamics. Where biological production may first draw CO2 into the water column, however, decreased winds may still trap CO2 in the surface water. For example, summer 2010 — anomalously high pCO2, low winds, lower than expected annual sum (negative).

**What’s next…**

1. Determine the sources of variability of FCO2 at the GR mooring.
2. Determine the influence of extreme events (storms, hydrologic wet-dry cycle) on FCO2 at the GR mooring.

**References**


**Figure 3.** Annual net sum of FCO2 flux normalized to the number of days for which there are observations. While it appears that there is an increase in the annual net sum over time, the trend (40 ± 60 m^2 y^(-1)) is highly uncertain and may not be statistically different than zero. This uncertainty is likely due to the low sample size (n = 8) and large variability. We do find, however, that the site switches between a source and a sink for CO2.