Carbon dioxide (CO2) is the major currency during biological production or destruction of organic matter (OM) and is the dominant greenhouse gas. Atmospheric CO2 is fixed into biomass in the land and is subsequently transported via rivers into the ocean where it may be metabolized by inorganic carbon and either released back to the atmosphere or exported into the deep ocean. Thus CO2 flux between the atmosphere and the ocean is a critical variable in global carbon cycle models. An argument can be made that increasing terrestrial inputs associated with land use change, increasing discharge of sewage and other anthropogenic materials, and changes in the terrestrial hydrological cycle would tend to shift the coastal oceans in particular toward being a source of CO2. Margin ecosystems receive massive inputs of terrestrial organic and mineral matter and exhibit intense geochemical and biological processing of carbon and other elements. In addition, they exchange large amounts of matter and energy with the open ocean. The complex and variable nature of coastal margins poses significant challenges to efforts to characterize the carbon signals in these regions.

A series of recent syntheses highlight the lack of information about the northern Gulf of Mexico (e.g., Borges et al. 2005; Cai et al., 2006; Chavez and Takaahashi, 2006) highlight the need for additional data regarding carbon fluxes in the Gulf of Mexico.

Satellite-based regional approaches (e.g., Leffete et al., 2002; Ono et al., 2003; Olson et al., 2004; Lohrenz and Cai, 2006) can be used to extend the spatial and temporal coverage for broad scale assessments of pCO2 distributions and air-sea fluxes of CO2.

Initial studies in June 2003 (Lohrenz and Cai, 2006) revealed regions of low pCO2 near the river plume, which indicated net uptake in those regions (Fig. 2). Overall, for the region encompassed by the entire image, there was a net surface-in-water flux estimated at 2.0 – 4.2 mmol C m^-2 d^-1. A key question will be the degree to which satellite imagery can be used to provide regional assessments of carbon system properties over regional spatial scales and seasonal time scales. This will depend on the extent to which algorithms can be generalized beyond a single set of in situ observations.

We examined this question by comparing principal component loadings and regression coefficients for four different periods. We have employed a combined strategy of ship-based and satellite observations to provide spatial and temporal coverage for broad-scale assessments of CO2 distributions and air-sea fluxes of CO2. The primary objective of our research is to apply these approaches to the characterization of pCO2 and air-sea fluxes of CO2 in the river influenced margin of the northern Gulf of Mexico.

**RESULTS**

Studies were conducted in August 2004, October 2005, and April 2006 spanning a range of seasonal and river discharge conditions (Fig. 3). Estimates of pCO2 from PCA-derived empirical algorithms showed strong correlations between measured and predicted pCO2 (Fig. 4). R-squared values were 0.927 in August 2004, 0.974 in October 2005, and 0.897 in April 2006. The empirical algorithms were used to produce the pCO2 images (Fig. 5).

In contrast to the net uptake of CO2 in June, air-sea flux estimates revealed a net release during all other cruises. October 2005 followed two major storm events (Katrina and Rita) accompanied by coastal flooding. Fluxes were also high during April 2006 due to a combination of high pCO2 in the nearshore waters and high winds. Winds during both the October and April surveys were high (~12-15 m s^-1). These estimates are driven to a large extent by high values in the outer and inner shelf regions as seen in Fig. 5 and these regions represent a source of significant uncertainty in coastal carbon budgets.

Measured rates of sea-to-air flux for the river outflow region were comparable to those reported for other coastal studies including Friederich et al. (2002) for a coastal upwelling region in S. Califomia-22 to 140 mmol C m^-2 d^-1, Bates et al. (2005) for a coastal upwelling off Oregon (~20 mmol C m^-2 d^-1), Chavez and Takahashi (2006) for the Gulf of Mexico and Caribbean (2.2+1.5 mmol C m^-2 d^-1) and Cai et al. (2006) for low latitude western boundary current shelves (2.7+2.1 mmol C m^-2 d^-1).

More recent surveys of the northern Gulf have extended over a larger area and similarly reveal evidence of a strong biological pump in June 2006 resulting in lower levels of surface pCO2. The biological pump appeared to be less active in September 2006, which could likely be attributed to relatively low river discharge and correspondingly low rates of autotrophic carbon fixation.

Satellite-derived regional assessments of pCO2 were used in conjunction with estimates of wind fields to produce regional-scale estimates of air-sea fluxes. Various sets of the gas transfer velocity, k, vs. wind speed relationships (Wanninkhof and McGillis, 1999, Nightingale et al., 2000; McGillis et al., 2001) were used to provide a range of values bracket the gas flux.

**CONCLUSIONS**

Our findings suggest the late spring and early summer is a period of lower surface pCO2 corresponding to a strong biological pump. The biological pump appeared to be less active in September 2006, which could likely be attributed to relatively low river discharge and correspondingly low rates of autotrophic carbon fixation.

More information is needed over a larger region in the Gulf of Mexico and other coastal regions to better constrain CO2 fluxes at the continental margins. Such information should help to refine models estimating North American carbon fluxes and improve their performance for predicting change and management strategies. More extensive spatial and temporal resolution of patterns is needed. Future studies funded through NASA and NSF are in the initial stages and

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