Surface Water Measurements during the GOMECC Cruise in the Gulf of Mexico

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Abstract

The first GOMECC Cruise on board the R/V *Ronald H. Brown* from Galveston in the northern Gulf of Mexico (GOM) to Boston on the East coast was designed to obtain a snapshot of concentrations and fluxes of key carbon, physical, and biogeochemical parameters in the coastal realm. As shown in Fig. 1, the cruise included a series of three transects approximately orthogonal to the coastline in the GOM and a comprehensive set of underway measurements along the entire transect. Full water column CTD/rosette stations were occupied at 28 specified locations in the GOM. A total of 29 scientists from AOML and other government agencies and universities participated on the 26-day cruise. Water samples were collected from the 24-bottle rosette at each station and analyzed for salinity, oxygen, nutrients, dissolved inorganic carbon, total alkalinity, pCO_2, dissolved organic matter, colored dissolved organic matter, particulate organic carbon, halocarbons, alkyl nitrates, CO and phytoplankton pigments. Underway systems were in operation for measuring atmospheric CO_2 and near-surface water pCO_2, DIC, halocarbons, pH, NH_3, CO and bio-optical properties. An *in situ* spectrophotometric pH profiler was used with the CTD to measure pH profiles to a depth of 1000m. Air-sea fluxes of CO_2 and ozone were also measured using eddy correlation methods. A web site is set up to make these data available to the coastal science community.

The project is supported by the NOAA OAR (Office of Oceanic and Atmospheric Research) and the NOAA GCC (Global Carbon Cycle) programs.

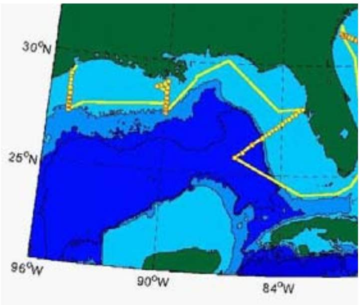


Fig. 1: GOMECC 2007 cruise tracks in the Gulf of Mexico. Three transects for water column samplings and the cruise line for continuous underway measurements along the shelf are shown.

Underway Measurements

The atmospheric and near surface water pCO_2 measurements are made by the pCO_2 underway systems. The distribution of surface water pCO_2 in the Gulf of Mexico shows that surface water pCO_2 values are elevated almost everywhere along the cruise tract, except some local areas near the coast (Fig. 2). With atmospheric CO_2 measurements made at the same time, the distribution of ΔpCO_2 can be evaluated for determining the air-sea CO_2 fluxes. In the coastal regions, ΔpCO_2 value can be affected not only by the surface water pCO_2 but also by highly variable atmospheric pCO_2. We see low surface pCO_2 in the northern Gulf of Mexico near the river delta regions. The results of oxygen measurement show that oxygen was supersaturated at the stations located closest to the coast due to high rates of primary production as indicated by elevated chlorophyll levels fueled by river borne nutrients. The surface water pCO_2 values show inverse correlation with oxygen saturation and chlorophyll values, suggesting that the drawdown of CO_2 is caused by biological processes.

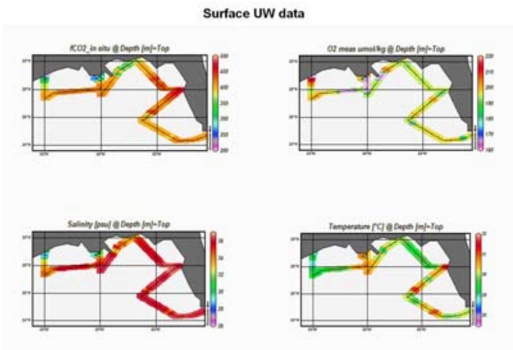


Fig. 2. Surface underway data of fCO_2, O_2, salinity and temperature. Surface water fCO_2 values are elevated along the cruise track, but low values near the coast. The O_2 concentrations are Aanderaa optode data obtained from a sensor placed in the ship's uncontaminated seawater line calibrated against discrete oxygen samples determined by Winkler titration. The data show that oxygen was supersaturated at the stations located closest to the coast due to high rates of primary production most likely fueled by river borne nutrients.

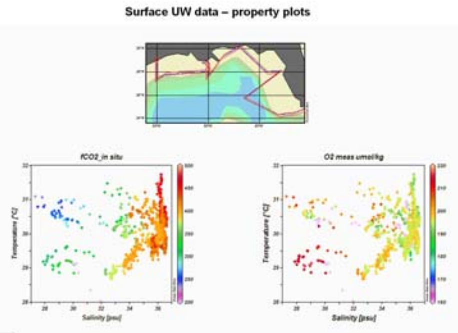


Fig. 3. Property plots for surface underway data in the Gulf of Mexico. In the left panel, the color coded fCO_2 distribution indicates that the high salinity waters show consistent high fCO_2 values.

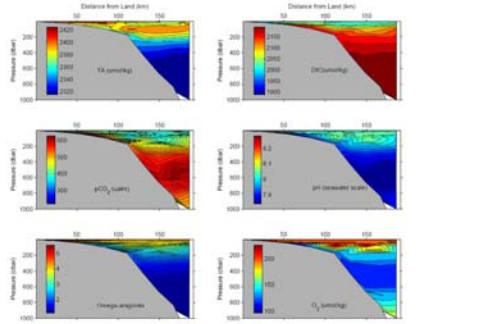


Fig. 4. Sections of several critical geochemical parameters (DIC, TA, pCO_2, pH, and O_2) on the Mississippi River transect from GOMECC. Aragonite saturation states, calculated from TA and DIC, indicate that the bottom waters of the northern GOM (outer shelf and slope) are only slightly above saturation.

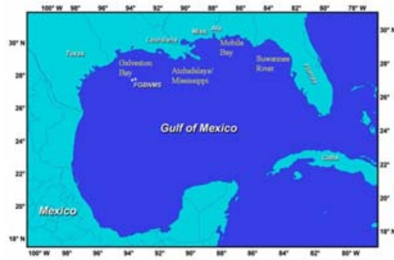
Air-Sea CO_2 Fluxes

Air-sea CO_2 fluxes were estimated from the bulk method utilizing the underway pCO_2 data and 5-day averaged remotely sensed winds (Q-Scat) and SST fields (AVHRR) that were provided by NOAA Coast watch at 0.5 by 0.5 degree resolution. The delta pCO_2 fields determined using a kriging interpolation scheme are shown in Figure 7. The figure includes observations from the Explorer of the Seas taken within two weeks of the GOMECC cruise to contrast the near-shore with open ocean data. On the whole the coastal region is a strong source of CO_2 during the cruise punctuated by sink regions directly associated with continental run-off. The observations show a strong positive correlation between ΔpCO_2 and salinity in the Gulf of Mexico with the low salinity waters of the riverine outflows being a strong CO_2 sink. This contrasts with the Southeast region where there is a negative correlation between ΔpCO_2 and salinity. This is likely due to different TA and DIC end members for the continental run-of in these regions. Along the East Coast the sources are somewhat smaller than further onshore observed from the Explorer of the Seas data that we attribute to higher biological productivity near-shore.

Initial Air-sea CO_2 flux within the coastal region estimates for 10-days spanning the cruises are:

Northern Gulf of Mexico:	0.74 ± 0.74 mol/m²/yr
East Coast:	1.19 ± 0.81 mol/m²/yr
North East:	1.19 ± 0.81 mol/m²/yr

Further improvements in the spatial and temporal estimates will be accomplished by determining regional and temporal relationships between pCO_2 and SST and color.



Map of various coastal zones in the northern Gulf of Mexico, including Galveston Bay, Atchafalaya/Mississippi, Mobile Bay, and Suwannee River. Property plots for these zones are shown below in Figures 5 and 6.

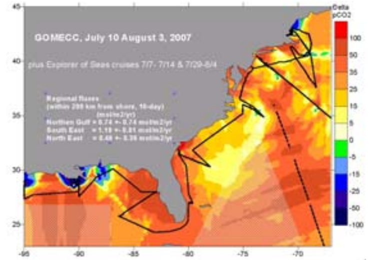


Fig. 7. Air-sea CO_2 fluxes during GOMECC survey, with extra data from Explorer of the Seas cruises 7/7 – 7/14 & 7/29 – 8/4, 2007. The map shows contours of ΔpCO_2 (µatm) distribution over the Gulf of Mexico and east coastal region.

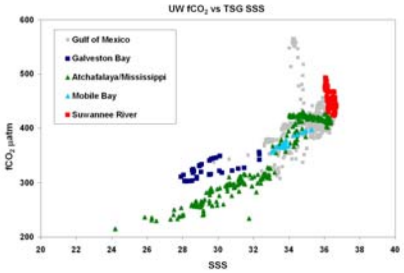


Fig. 5. Surface underway fCO_2 as a function of underway salinity grouped in four coastal zones in the Gulf of Mexico. The fCO_2 trend with surface salinity observed in Galveston Bay is clearly distinguishable from that observed in Atchafalaya/Mississippi coastal zone.

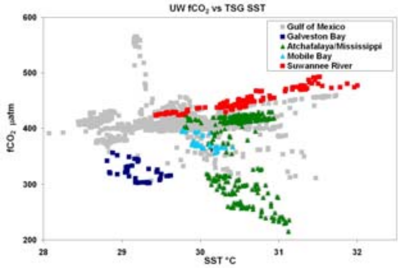


Fig. 6. Surface underway fCO_2 as a function of underway temperature of four coastal zones in the Gulf of Mexico. There does not seem to have any apparent trend between fCO_2 and temperature, but data are grouped in separate zones according to geographical locations.