Materials and Methods

Field Measurements

The survey was carried out on six cruises: 5-16 January 2005, 19-30 March 2005, 27 July - 5 August 2005, 7-17 October 2005, 16-21 December 2005, and 17-27 May 2006. In all of the sampling cruises except for the one in December 2005, the research vessel transected the whole SAB from coastline to about 500 m water depth. The survey focused on 5 cross-shelf transects that are named E-, D-, C-, B-, and A-transects respectively from north to south (Figure 1). In December 2005 the ship still transected the whole SAB, but did not cover D- and B-transects and did not go beyond the 200 m isobath. Sea level pressure was recorded using an onboard R.M. Young® barometric pressure sensor. Sea surface temperature (SST) and salinity were recorded continuously with an on-board SeaBird® flow through thermosalinography. Surface water and atmospheric xCO_2 were also measured underway during all cruises.

Surface water xCO_2 was measured using a LI-COR 7000 infrared gas analyzer coupled to a gas-water equilibrator (referred to as UGA system hereafter). The equilibrator has a total volume of about 10 liters and is equipped with a specially designed water-drain system, which maintains the level of water inside the equilibrator and prevents possible contact with the outside air (Figure 2). The LI-COR 7000 was calibrated every 6 hours using certified gas standards, which had xCO_2 values of 201.51, 350.30, and 499.60 ppm referenced against standards traceable to those of the National Institute of Standards and Technology (NIST). The water temperature right before the equilibration chamber was recorded with a YSI® temperature sensor.

The partial pressure of CO_2 in seawater at the temperature of equilibration [pCO_2 (eq), units: μatm] is calculated as:

$$pCO_2(\mathrm{eq}) = xCO_2(\mathrm{water}) \times [P_b(\mathrm{eq}) - P_w(\mathrm{eq})] \qquad (1)$$

Where, xCO_2(water) is the mole fraction concentration of seawater CO_2 in the dried sample gas flow (units: ppm); P_b(eq) is the pressure of equilibration (atm); and P_w(eq) is the water vapor pressure of equilibration (units: atm) that is calculated using salinity from the ship's thermosalinograph and temperature of equilibration that is assumed to be equal to the temperature from the temperature sensor immediately before the equilibrator. Since the pressure of equilibration was not measured in the UGA system during the survey, P_b(eq) is approximated by adding 1 mb to the barometric pressure at sea surface. The 1 mb offset is based on the average reading differences between the pressure sensor in the AOML system and the one onboard the research vessel in the October 2005 and May 2006 cruises. Then the partial pressure of CO_2 at the in-situ temperature [pCO_2(water), units: μatm] is calculated as *Takahashi et al.*, 2002]:

$$pCO_2(\text{water}) = pCO_2(\text{eq}) \times \exp[0.0423 \times (\text{SST} - T_{eq})] \qquad (2)$$

Where, SST is the in-situ sea surface temperature (units: ^oC); and T_{eq} is the temperature of equilibration (units: ^oC).

Atmospheric xCO_2 was measured 30-50 times in all cruises using the same UGA CO_2 system. The inlet of the atmospheric CO_2 pipe, made of stainless steel, was set up on the highest platform in the front of the ship. In order to avoid possible contamination from the ship's stack gases, atmospheric xCO_2 was measured only when the ship was moving and the wind was blowing from the bow. The partial pressure of CO_2 in the air [pCO_2(air), units: μatm] is calculated as:

$$pCO_2(\text{air}) = xCO_2(\text{air}) \times [P_b(\text{sea surface}) - P_w(\text{sea surface})] \qquad (3)$$

Where, xCO_2 (air) is the mole fraction concentration of atmospheric CO_2 in the dried sample gas flow (units: ppm); P_b(sea surface) is the barometric pressure at sea surface (units: atm); and P_w(sea surface) is the water vapor pressure at sea surface (units: atm). During the cruises of

October 2005 and May 2006, atmospheric xCO_2 was also measured every two hours with the AOML system.

Figure captions

Figure 1. The study area is the U.S. South Atlantic Bight from Cape Lookout, North Carolina to Cape Canaveral, Florida. The thin dotted lines on the continental shelf are the depth contours at 20, 40, and 100m, delineating the inner, middle and outer shelf. The gray arrows on the land show the annual river discharge rates. The dashed lines on the continental shelf are the typical ship track during each cruise. The dark arrows close to the ship track show the direction of the ship movement. The circles are the sampling stations, which start from the shoreline and extend to about ~500 m water depth.

Figure 2. The diagram of the CO_2 equilibrator. The equilibrator has a total volume of about 10 liters. It's composed of an equilibrium chamber, a shower head at the top, some beads to help the equilibration, and a water drain at the bottom.

Figures

Figure 1. Jiang et al.

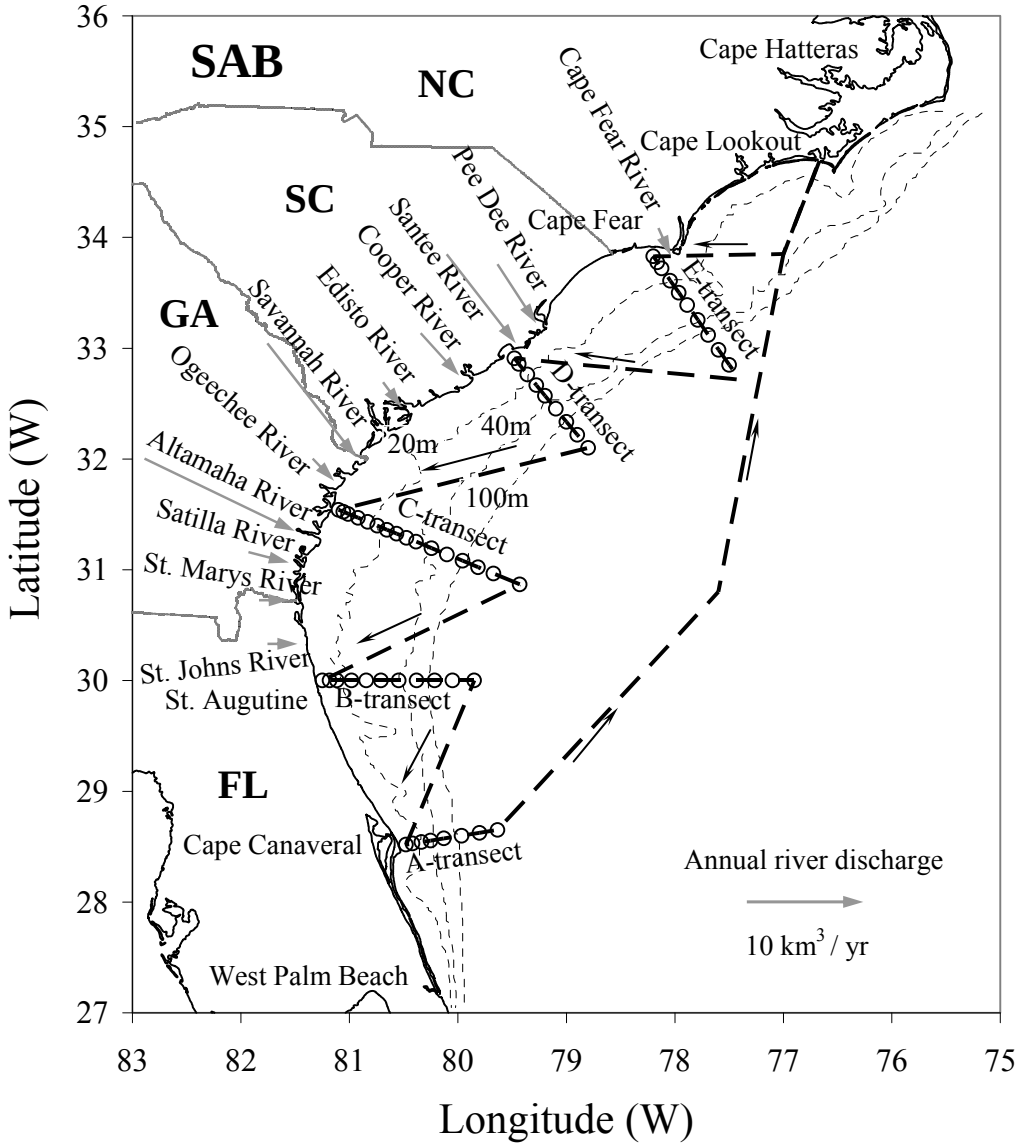
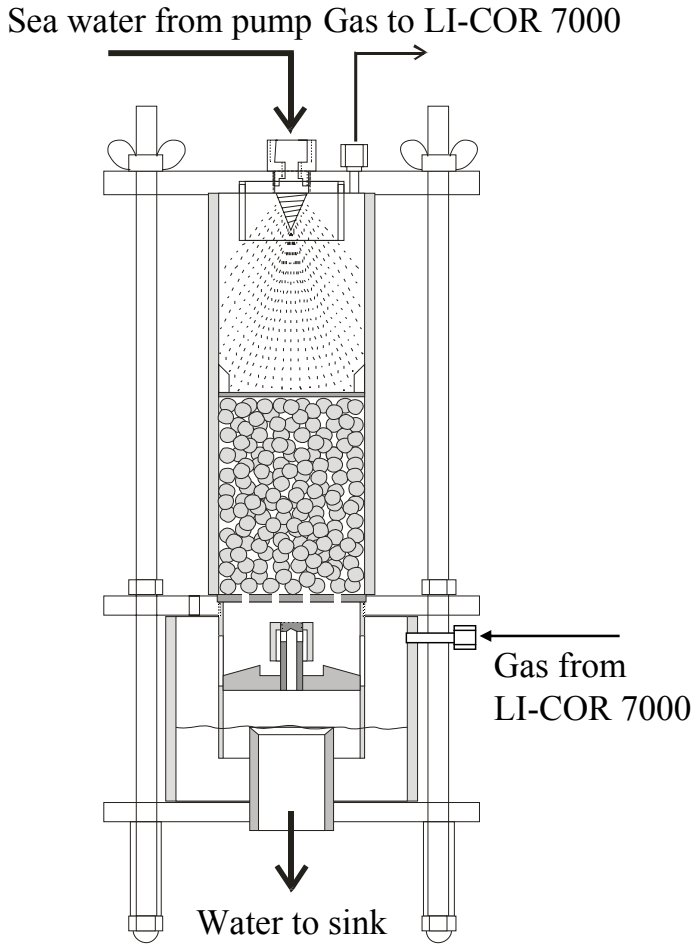
Figure 2. Jiang et al.