

# Autonomous carbon dioxide measurements of air-water and horizontal atmospheric fluxes at the continental boundaries

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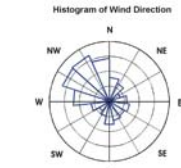
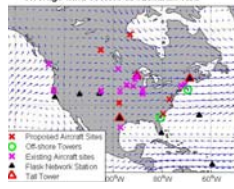
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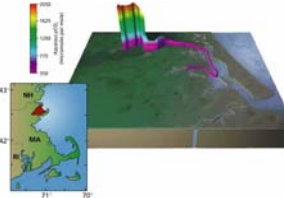
## Abstract

NACP specifies several priorities including: 1) quantifying estuarine, river, and coastal margin processes connecting land to ocean CO<sub>2</sub> dynamics; 2) monitoring atmospheric CO<sub>2</sub> and other trace gases crossing the land/coastal boundary; and 3) understanding energetic coastal processes that influence atmospheric carbon dioxide in the marine atmospheric boundary layer. Here we begin to explore and understand the NACP domain and show prototype observing systems and preliminary data.

## Atmospheric Transport



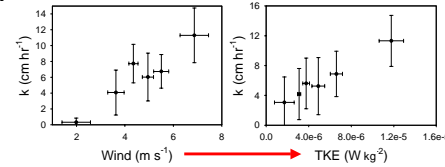
Example of an estuary with high dissolved carbon



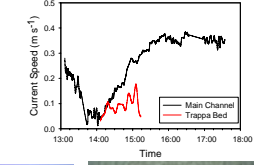
## Surface Processes Instrument Platform



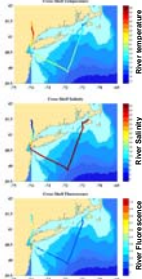
## Shallow Water Gas Exchange



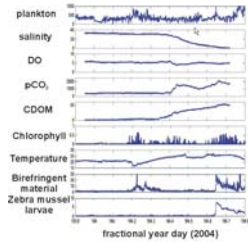
Hudson River SAV: Nina Caraco, Jon Cole, Sally MacIntyre, Pete Raymond



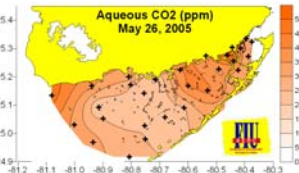
## Rivers and Inland Waters



## Coastal 100-m isobath to zero salinity

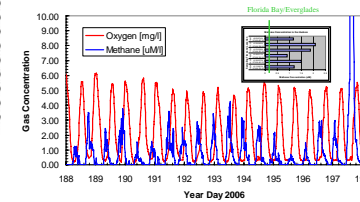


## Florida Bay and Everglades CO<sub>2</sub>



In Collaboration with Pete Raymond (Yale); and Joe Boyer (FIU).

## Hudson River Aquatic Vegetation

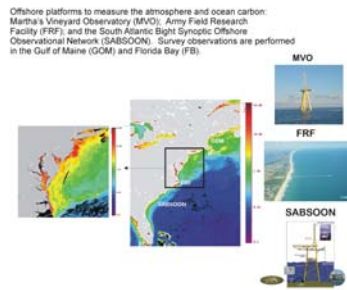


## Health in the Hudson Observatory

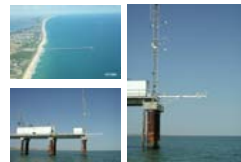


In Collaboration with Pete Raymond (Yale); Joe Salisbury (UNH); Doug Vandemark (UNH); Scott Gallager (WHOI); Rocky Geyer (WHOI).

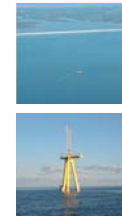
## Coastal CO<sub>2</sub> Observing Systems



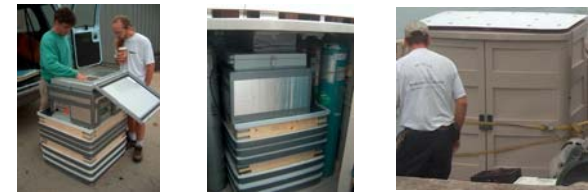
## Duck Field Research Facility, NC



In collaboration with Chris Zappa



## High-Resolution CO<sub>2</sub> Tower-Bases System



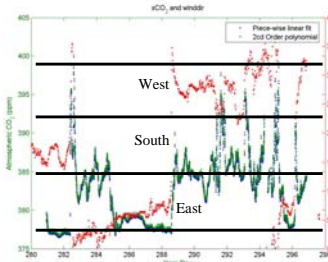
## Introduction

The primary goal of this project parallels that of the North American Carbon Program (NACP) which is to monitor atmospheric and ocean CO<sub>2</sub> levels off the east coast of North America in an effort to quantify CO<sub>2</sub> emissions and uptake on the continent and adjoining coastal regions. Here the design features of a remote CO<sub>2</sub> measuring system is described that will be installed at two offshore sites (green circles) on the North America East coast. The first of these two systems is currently located 3 miles off the coast of Martha's Vineyard, Massachusetts on Martha's Vineyard Coastal Observatory (MVCO), and the second one will be located 40 miles off the coast of Georgia on the South Atlantic Bight Synoptic Offshore Observational Network (SABSOON). In collaboration with Tim Newberger (Lamont-Doherty Earth Observatory).

## Long-term sustainability

In addition to mitigating the effects of short term temperature variability this system also is also designed to operate remotely for periods greater than 6 months. The following features allow this long term sustainability:

- 1) Low flow reference gas will last for greater than 1 year;
- 2) Re-use of sample air to dry incoming air allows greater than 6-month drying capacity with water vapor levels less than 160 ppm;
- 3) Remote operation through internet allows trouble shooting and automatic data uploading 24-hours a day;
- 4) Temperature modulation allows less frequent calibrations thus minimizing the consumption of standards.



## Atmospheric CO<sub>2</sub> Observations

A segment of data collected between October 7 through 24, 2005 indicate a strong correlation between wind direction and atmospheric CO<sub>2</sub> concentration. From the west, southwest, much higher concentrations that are indicative of an industrial source. It is interesting to note that the largest point source, New York City, New York is almost 200 miles away and is thus unlikely to be the source of CO<sub>2</sub> concentrations greater than 400 ppm. Alternatively, southwest sea breezes could be recirculating air from the Boston, Massachusetts vicinity. If sea breezes are the cause of this variability then high resolution models (less than 5%) will be needed to properly assimilate this data.

## Differential Air-Water Carbon Dioxide System

Differential Air-Water Carbon Dioxide System. Error less than 1 ppm when the equilibrator water supply was turned off. January aqueous pCO<sub>2</sub> values on the shelf in the MAB are undersaturated, as expected.

## Special Design Features

**Flow Control:** Given large temperature effects on the pressure regulators and the need for a low internal volume flow controller to minimize purge time, a mechanical flow controller was incorporated that uses a stepper motor for needle valve actuation. The flow rate is monitored down stream of the NDIR analyzer but the flow control occurs upstream.

**Target Gas:** Because standards are not flowing through the exact same path as the sample gas, a gas of known concentrations is treated as a "sample" as well as a "standard". The "sample" pump pulls this "target gas" through the atmospheric sample path as well as through the upstream Nafion dryer.

**Drying:** Long term drying with out the need for large quantities of a drying gas is achieved by re-drying the outflow sample and standard gases and re-using them as a drying gas for each Nafion dryer. 4A Molecular sieve is used as a drier because of its high water capacity and its ability to dry to a low dew point.