Autonomous Cross-Shelf Transects of Air-Sea CO_2 Flux with OASIS ASVs

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1. Overview

- An Autonomous Surface Vehicle (ASV) called OASIS (Ocean-Atmosphere Sensor Integration System) is being utilized for autonomous cross-shelf transects within the Mid-Atlantic Bight
- A wide range of measurements are made of the upper ocean and atmospheric surface boundary layer, making possible studies of air-sea interaction
- Goals of the research are to quantify the air-sea CO_2 fluxes and gas transfer velocity k, then analyze the influence on k of winds, tidal current, density fronts, etc.
- The air-sea flux of CO_2 is computed using both the direct eddy covariance and gradient flux methods
- Results from a recent transect are shown to demonstrate the platform's performance and some CO_2 computations
- A fleet of autonomous OASIS vehicles can sample large coastal regions at relatively low expense, helping provide the observations needed to quantify the role of continental shelves in the global carbon cycle

3. Autonomous CO_2 Methods

- Measure $pCO_{2,water}$ by pumping water from 0.5 m depth to an equilibrator, pumping the equilibrator air to an LI-840, and recirculating
- Measure $pCO_{2,air}$ and the CO_2 number density (C) at heights of 0.5 m and 5.0 m by pumping air through another LI-840, alternating at 10-minute intervals using an automatic valve switcher
- Compute:

  $\Delta pCO_2 = pCO_{2,water} - pCO_{2,air}$, the difference across the air-sea interface

  $\partial C/\partial z$ in the atmospheric boundary layer using these measurements

  ΔC_{aq} across the aqueous mass boundary layer using:

  $\Delta C_{aq} = K_0 \, \Delta pCO_2$, where $K_0(sal,T)$ is the estimated CO_2 solubility
- Estimate the air-sea flux (F) using:

  direct eddy covariance measurements, as corrected for vessel motion with the inertial sensor and GPS (McGillis et al., 2001a)

  the gradient flux technique (e.g., McGillis et al., 2001b)
- Estimate the gas transfer velocity (k) (McGillis & Wanninkhof, 2006):
  $F = k\Delta C_{aq}$

5. The Future is Bright… Literally

- The fourth OASIS vessel, under construction, will have no "doghouse" on top, so will have ~33% better solar charging capabilities (no shading) and much lower windage. It will also have a wind generator on the mast.
- Plans for this summer include bi-weekly cross-shelf transects, with greater duration and distance
- The goal with OASIS #4 is to stay at sea for a week or longer by August

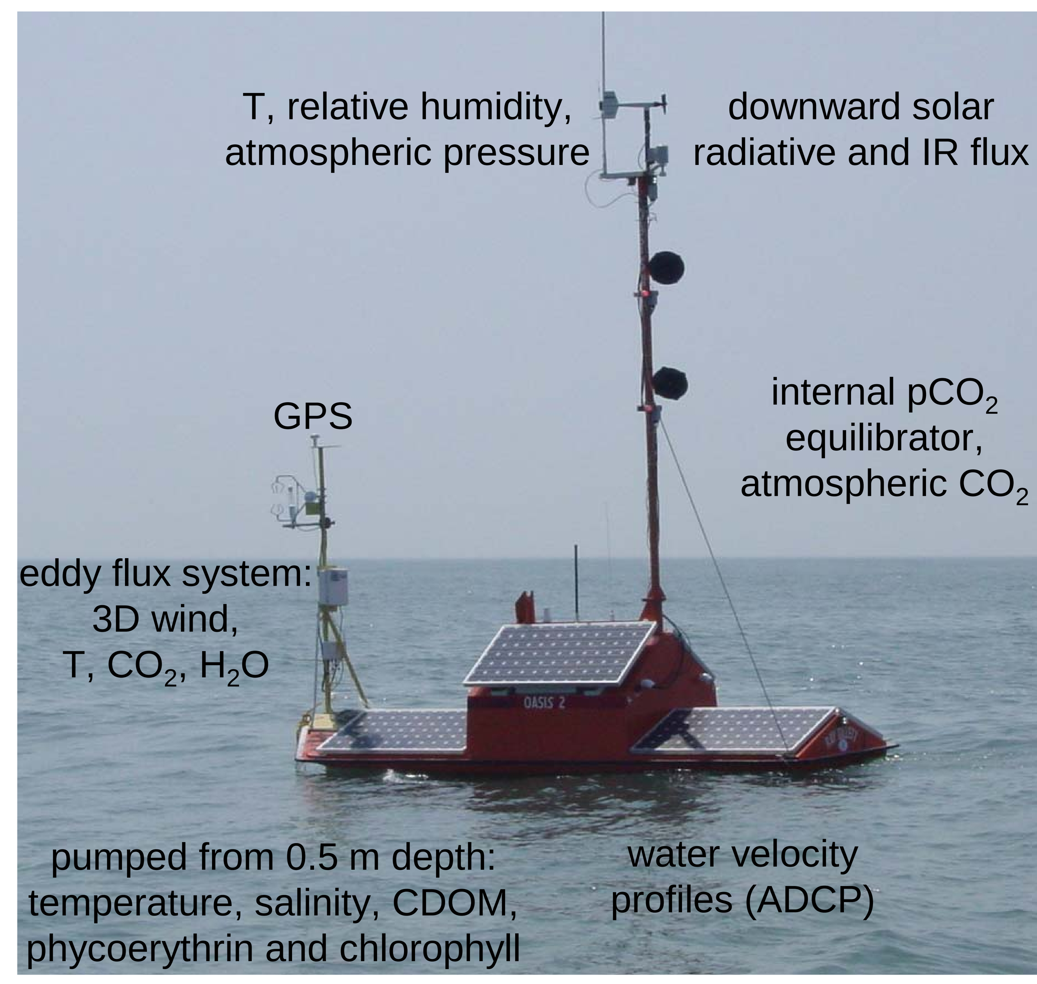
REFERENCES

McGillis, W. R., and R. Wanninkhof, 2006. Aqueous CO2 gradients for air-sea flux estimates. J. Marine Chemistry, 98, 100-108.

McGillis, W. R., J. B. Edson, J. E. Hare, and C. W. Fairall, 2001a. Direct covariance air-sea CO2 fluxes. J. of Geophysical Research, Vol. 106, No. C8, 16,729-16,745.

McGillis, W. R., J. B. Edson, J. D. Ware, J. W. H. Dacey, J. E. Hare, C. W. Fairall, and R. Wanninkhof, 2001b. Carbon dioxide flux techniques performed during GasEx-98. J. Marine Chemistry, 75, 267-280.

2. OASIS ASV Payload



Internal Payload

equilibrator

4. Results: Mid-Atlantic Bight

- On October 17. 2007, OASIS #2 performed a cross-shelf transect completing about half the COBY line, the air-sea CO2 payload sampled along the entire transect
- On April 24, 2008, OASIS #2 performed a cross-shelf transect completing the entire COBY line. However, due to a datalogger failure, very little CO_2 data is available