High-Resolution Ocean and Atmosphere pCO_2 Time-Series Measurements

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Project Summary

Fossil fuel carbon sources and the growth of atmospheric carbon dioxide (CO_2) are reasonably well known based on economic reconstructions and atmospheric monitoring. Global carbon budgets suggest that over decadal timescales the ocean is absorbing, on average, approximately one third of the CO_2 released from human activity. However, the inter-annual variability in the ocean uptake and variability in the basic regional patterns of the air-sea CO_2 fluxes are poorly known at this time.

Ocean carbon measurements have shown significant biogeochemical variability over a wide range of timescales from sub-diurnal to decadal periods. In situ measurements are also providing a growing body of evidence that episodic phenomena are extremely important causes of variability in CO_2 and related biogeochemical properties. Time-series records are essential for characterizing the natural variability and secular trends in the ocean carbon cycle and for determining the physical and biological mechanisms controlling the system. The biological and chemical responses to natural perturbations (e.g., El Niño/Southern Oscillation, dust deposition events) are particularly important with regard to evaluating potential responses to anthropogenic forcing and for evaluating the prognostic models used in future climate projections. Ship-based time-series measurements are impractical for routinely measuring variability over intervals from a week to a month, they cannot be made during storms or high-sea conditions, and they are too expensive for remote locations. Instrumental advances over the past 15 years have led to autonomous moorings capable of sampling properties of chemical, biological, and physical interest with resolutions as good as a minute and duty cycles of a year or more. Although these new technologies are still underutilized, they have been identified as a critical component of the global ocean observing system for climate.

The primary mission of this project is to evaluate the variability in air-sea CO_2 fluxes by conducting high resolution time-series measurements of atmospheric boundary layer and surface ocean CO_2 partial pressure (pCO_2). The Moored Autonomous pCO_2 ($MAPCO_2$) system collects CO_2 data from surface seawater and marine boundary air every three hours for up to a year at a time before they need servicing. Daily summary files of the measurements are transmitted back to PMEL where the data are examined and plots of the results are posted to the web in near-real time. In FY2011, PMEL maintained twelve sites initiated in previous years. With twelve moorings currently fitted with pCO_2 systems, we are currently at 24% completion of the open ocean moored CO_2 program goal.
A global network of surface ocean and atmospheric CO_2 observations will make a substantial contribution to the production of seasonal CO_2 flux maps for the global oceans. The long-term goal of this program is to populate the network of Ocean Sustained Interdisciplinary Time-series Environment observation System (OceanSITES; www.oceansites.org) so that CO_2 fluxes will become a standard part of the global flux mooring network. This effort has been endorsed by the

OceanSITES science team. The moored CO_2 program directly addresses key element (7) Ocean Carbon Network, as outlined in the Program Plan, but also provides a value added component to elements (3) Tropical Moored Buoys and (6) Ocean Reference Stations.

Users of these data include scientists investigating high frequency variability in surface ocean properties, data synthesis groups developing air-sea CO_2 flux maps (e.g. Takahashi climatology, Surface Ocean CO_2 Atlas [SOCAT], NOAA flux maps) and researchers studying ocean acidification. The data are currently being used to evaluate regional and global carbon models. Several of the near real-time buoy displays are used in web pages and graphics used to inform the general public and policy makers about the ocean carbon system. Additional information can be found at: www.pmel.noaa.gov/co2/story/Buoys+and+Autonomous+Systems