Surface Water pCO_2 Measurements from Ships

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Project Summary

The oceans are the largest sustained sink of anthropogenic carbon with a flux into the ocean of about 2 10^{15} grams (= 2 gigaton) of carbon each year thereby partially mitigating the rapid increase of this climate forcing gas in the atmosphere. To provide meaningful projections of future atmospheric CO_2 levels, and surface oceanic CO_2 concentrations we must constrain the flux of CO_2 across the air-water interface. The goal for the mature surface ocean CO_2 observing system is to accomplish this to within 20 % on regional and seasonal scales. This will be accomplished through creation of seasonal sea-air CO_2 flux maps that will feed directly into national and international assessments. Of particular interest is quantification and attribution of variability and trends. In this project four NOAA investigators and three academic principal investigators have outfitted 16 research and commercial vessels with automated carbon dioxide analyzers as well as thermosalinographs (TSGs) to measure the temperature, salinity and partial pressure of CO_2 (pCO_2) in surface water and air in order to determine the carbon exchange between the ocean and atmosphere. This task is coordinated at national level with the U.S. Carbon Cycle Science Program and its subcommittee on Ocean Carbon and Climate Change (OCCC). Collaborative efforts are underway to combine datasets, and create and update global climatologies that are lead by our academic collaborator T. Takahashi of LDEO/Columbia. Furthermore we assemble, document and serve global datasets through the Surface Ocean Carbon Atlas (SOCAT) run under the auspices of the International Ocean Carbon Coordination project (IOCCP). Approximately half of the SOCAT data comes from the participants of the pCO_2 from ships effort.

Documenting carbon sources and sinks relies critically on other efforts undertaken under sponsorship of the Climate Observation Division (COD) including implementation of the ship lines, and moored and drifting buoys. The surface water pCO_2 programs support climate services by providing knowledge and quantification of the radiatively important gas, carbon dioxide. The data are used along with robust interpolation methods utilizing remotely sensed products to produce bi-monthly sea-air CO_2 flux fields that are served on the web with a three to six month lag. Products and data are used in the international Regional Carbon Cycle Assessment Project (RECCAP) of the Global Carbon Program (GCP) that will feed into the IPCC assessments. Ultimately, this work will contribute to policy on greenhouse gas management and assessments of perturbations of the surface ocean (ocean acidification).

The project is a partnership of the Atlantic Oceanographic and Meteorological Laboratory (AOML) and its Global Ocean Observing System (GOOS) center, the Pacific Marine

Environmental Laboratory (PMEL), the Lamont-Doherty Earth Observatory (LDEO) of Columbia University, the Rosenstiel School of Marine and Atmospheric Science (RSMAS) of the University of Miami, and the Bermuda Institute of Ocean Sciences (BIOS). The partners are responsible for operation of the pCO_2 systems on the ships, auxiliary measurements, data reduction, and data management. The following ships had pCO_2 systems on them during part or all of the performance period: NOAA ships *Ronald H. Brown, Gordon Gunter, Ka'imimoana* and *Henry B. Bigelow;* Container ships *Schulte, Oleander, Barcelona Express, Reykjafoss* and *Las Cuevas,* research vessels *RVIB Palmer, Gould, Langseth* and *Healy,* M/V *Turmoil*, RCCL cruise ship *Explorer of the Seas*, and UNOLS research vessels *Atlantic Explorer* (ship owned and operated by BIOS), and *Walton Smith* (owned and operated by RSMAS). This effort is the largest single coordinated entity of obtaining surface water CO_2 data in the world. Approximately 500 K new data points are acquired each year. As outlined below, outfitting of some of the ships was funded from other sources but all the data was reduced and collated in a uniform manner and provided to CDIAC as part of this effort. Similar to the previous years, several ships were taken off lines and several new ships were outfitted. The final data sets are combined and sent to CDIAC for dissemination and archival, and to the efforts of T. Takahashi as well as the SOCAT effort. All work follows established principles of monitoring climate forcing gases and biogeochemical cycles.