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PMELORNL/CDIAC-115 Comparison of the Carbon System Parameters at the Global CO2 Survey Crossover Locations in the North and South Pacific Ocean, 1990-1996As a collaborative program to measure global ocean carbon inventories and provide estimates of the anthropogenic carbon dioxide (CO2) uptake by the oceans, the National Oceanic and Atmospheric Administration and the U.S. Department of Energy have sponsored the collection of ocean carbon measurements as part of the World Ocean Circulation Experiment and Ocean-Atmosphere Carbon Exchange Study cruises. The cruises discussed here occurred in the North and South Pacific from 1990 through 1996. The carbon parameters from these 30 crossover locations have been compared to ensure that a consistent global data set emerges from the survey cruises. The results indicate that for dissolved inorganic carbon,fugacity of CO2, and pH, the agreements at most crossover locations are well within the design specifications for the global CO2 survey. whereas, in the case of total alkalinity, the agreement between crossover locations is not as close. 1. INTRODUCTION Human activity is rapidly changing the trace gas composition of the earths atmosphere, apparently causing greenhouse warming from excess carbon dioxide (CO2) along with other trace gas species, such as water vapor, chlorofluorocarbons (CFCs), methane, and nitrous oxide. These gases play a critical role

in controlling the earths climate because they increase the infrared opacity of the atmosphere, causing the planetary surface to warm. Of all the anthropogenic CO2 that has ever been produced, only about half remains in the atmosphere. it is the "missing" CO2 for which the global ocean is considered to be the dominant sink for the man-made increase. Future decisions on regulating emissions of "greenhouse gases" should be based on more accurate models that have been adequately tested against a well-designed system of measurements. Predicting global climate change, as a consequence of CO2 emissions, requires coupled atmosphere/ocean/terrestrial biosphere models that realistically simulate the rate of growth of CO2 in the atmosphere, as well as its removal, redistribution, and storage in the oceans and terrestrial biosphere. The construction of a believable present-day carbon budget is essential for the skillful prediction of atmospheric CO2 and temperature from given emission scenarios. The worlds oceans, widely recognized to be the major long-term control on the rate of CO2 increases in the atmosphere, are believed to be absorbing about 2.0 GtC yr-1 (nearly 30 to 40% of the annual release from fossil fuels). Our present understanding of oceanic sources and sinks for CO2 is derived from a combination of field data, that are limited by sparse temporal and spatial coverage, and model results that are validated by comparisons with oceanic bomb 14C profiles. CO2 measurements taken on the World Ocean Circulation Experiment (WOCE) cruises, which began in 1990, have provided an accurate benchmark of the ocean inventory of CO2 and other properties. These measurements were

cosponsored by the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Department of Energy (DOE) via the U.S. Joint Global Ocean Flux Study (JGOFS) Program. Investigators supported by these funding agencies have collaborated to examine data collected during the WOCE and Ocean-Atmosphere Carbon Exchange Study (OACES) cruises. This report addresses the consistency of oceanic carbon dioxide system parameters during 1990-1996 in the North and South Pacific. The four parameters of the oceanic carbon dioxide system are dissolved inorganic carbon (DIC), fugacity of CO2 (fCO2), total alkalinity (TAlk), and pH. This report compares the carbon system parameters, along with salinity and dissolved oxygen (O2), against sigma theta () where cruises overlapped throughout the Pacific Ocean basin. Similar comparisons have been made for oceanic carbon in the Indian Ocean (Johnson et al. 1998. Millero et al. 1998). In addition, comparisons of nutrient data have been compiled (Gordon et al. 1998). The cruise data for this report will be made available through the OACES and the Carbon Dioxide Information Analysis Center (CDIAC) data management centers. The Pacific Ocean cruises occurred from 1990-1996, and data have been compared at 30 locations where cruises overlapped in the North and South Pacific Ocean (Fig. 1). We do not address survey stations in the Pacific where no crossovers occurred. In addition, carbon and hydrographic data collected during some of the Pacific expedition cruises (i.e., P2, P12, and S4I) were not available in time for this report. 2. ANALYTICAL METHODS Analyses of all carbon

parameters were performed following the techniques outlined in the "Handbook of Methods for the Analysis of the Various Parameters of the Carbon Dioxide System in Sea Water" (DOE 1994). Certified Reference Materials (CRMs) were used on all cruises as secondary standards for DIC, unless otherwise noted. Discussion of the preparation and use of CRMs is available in detail (UNESCO 1991. Dickson 1992. Dickson, Anderson, and Afghan, unpublished manuscript. Dickson, Afghan, and Anderson, unpublished manuscript). These materials consisted of a matrix of natural, sterile seawater. They were bottled in large batches into 500-mL borosilicate glass containers, sealed to prevent contamination, and shipped to the institutes participating in this study. These secondary standards were then analyzed at sea over the course of each of the cruises as a means to verify accuracy. Certification of the reference material for DIC is based on manometric analyses in the shore-based laboratory of Charles D. Keeling of Scripps Institution of Oceanography (SIO) over a period of several months (UNESCO 1991. Guenther 1994. Keeling, C. D., personal communication, 1999). Since CRMs were analyzed routinely for DIC during most cruises used in this report, all groups analyzing for TAlk on those cruises subsequently analyzed CRMs as well. this enabled post-cruise corrections to be made to the TAlk data based on archived samples that were analyzed at Dr. Keelings laboratory at SIO. CRMs were not available for any other carbon parameter discussed in this report. Analyses of salinity and O2 followed WOCE Hydrographic Program (WHP) protocol (WOCE 1994). 

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