PHYSICAL AND BIOGEOCHEMICAL CONTROLS ON THE DISTRIBUTION OF CARBON DIOXIDE IN THE NORTH PACIFIC OCEAN

A THESIS SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAII IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

IN

OCEANOGRAPHY

DECEMBER 1997

By

Daniel Woods Sadler

Thesis Committee:

Fred Mackenzie, Chairperson
Christopher Winn
Yuan-Hui Li

CHAPTER 5
CONCLUSIONS

The distribution of carbon dioxide in the North Pacific is controlled by a variety of physical and biogeochemical processes. The comprehensive set of carbon measurements collected during P14N furthers our understanding of these processes in several ways.

The FCO_2 of surface waters is controlled by a combination of physical and biogeochemical processes. In the Bering Sea, biological production can remove CO_2 from surface waters. During P14N, a spring phytoplankton bloom was encountered which lowered FCO_2sw below atmospheric levels over the shelf and into the basin. Physical processes dominated in the region of the Aleutian Arc where tidal mixing brought cold, high CO_2 waters to the surface, elevating FCO_2sw above equilibrium with the atmosphere. Other fluctuations in FCO_2 were associated with surface currents and frontal regions. Atypical of the climatological data (Landrum *et al.*, submitted; Tans *et al.*, 1990; Takahashi *et al.*, 1991; Weiss *et al.*, 1992), the subtropical Pacific was a source of CO_2 to the atmosphere during July, 1993. This observation is attributed to the warmer than usual sea surface temperatures associated with the prolonged 1992-1993 ENSO event.

Changes in the distribution of carbon in intermediate waters are controlled by the decomposition of organic material, dissolution of carbonates and physical mixing of water masses. Along the σ_θ=26.8 density horizon, changes in TCO_2 are predominately due to decomposing organic matter. Because these waters are near saturation with respect to carbonate minerals, carbonate dissolution contributes little TCO_2 to the water. Organic decomposition is responsible for most of the change in TCO_2 along σ_θ=27.35. However,

these deeper waters are undersaturated with respect to carbonate minerals and carbonate dissolution does contribute carbon to these waters.

Combining results from P14N with previous studies of the North Pacific, I found that, basinwide, geochemical processes are responsible for the existence of high carbon waters, and circulation determines their lateral position. The waters lying off of the coast of Central America are old and have accumulated carbon from decomposing organic matter. They intrude westward between the NEC and NECC producing the tongue of high TCO_2, low O_2 waters seen along σ_θ=26.8 and σ_θ=27.35 in the vicinity of 10°-20°N. Farther north, the general circulation of the subtropical Gyre concentrates older, high carbon waters in the Northeast Pacific near Alaska. A deeper return flow moves these waters southwest across the basin producing the high carbon, low oxygen feature seen along σ_θ=27.35.