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Changes in the Oceanic Carbonate System due to Anthropogenic and Natural Changes

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Total dissolved inorganic CO\textsubscript{2} (TCO\textsubscript{2}), total alkalinity (TA), pH and partial pressure of CO\textsubscript{2} (pCO\textsubscript{2}) are the four parameters that are used to study the oceanic carbonate system. The World Ocean Circulation Experiment (WOCE) and the Joint Global Ocean Flux Study (JGOFS) Hydrographic Program in the 1990s and the CLIVAR/CO\textsubscript{2} Repeat Hydrography Program in the 2000s provide data that are used to examine the effect of changing CO\textsubscript{2} levels in the oceans. The results from these studies are used to quantify the effects of the uptake of anthropogenic CO\textsubscript{2} on the chemistry of the oceans. In addition, CO\textsubscript{2} levels in the ocean are affected by the distribution of water masses, by primary production and by the oxidation of organic matter. To elucidate these effects, we chose to identify the water masses using an optimum multi parameter analysis (OMP). This allows us to attribute the changes in the distribution due to the different factors. In this paper, transects in the Atlantic (A16), Pacific (P16) and Indian (I9) oceans are used to show how the pH of ocean waters is decreasing in different water masses. The decreasing pH results in shoaling of the aragonite saturation horizon. Changes observed in the thermocline are affected by oxidation of organic carbon and the dissolution of anthropogenic CO\textsubscript{2}.

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