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Seasonal variability of the effect of coral reefs on seawater CO2 and air-sea CO2 exchange

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Limnol. Oceanogr., 47(1), 2002, 43-52 | DOI: 10.4319/lo.2002.47.1.0043

ABSTRACT: There are complex physical and biological processes controlling the exchange of carbon dioxide (CO₄) between the ocean and atmosphere. In coral reef ecosystems, the balance of biological processes such as calcium carbonate (CaCO₄) formation and organic carbon production can either lead to CO, being retained in the oceanic environment (i.e., oceanic sink of CO,) or returned to the atmosphere through gas exchange (oceanic source of CO,). What remains uncertain is the fate of CO, in reefs subject to seasonal change and the annual balance of air-sea CO, flux in such systems. Here it is shown that the Bermuda coral reef acts as a sourc of CO, to seawater overlying the reef. The magnitude of this source of CO, varies seasonally in response to changes in the reef community between coral- and macroalga-dominated states, reflecting changes in the net balance between calcification and organic carbon production. With knowledge of the calcification rate (~5.6 to 10.6 g CaCO, m⁻² d⁻¹) and observed modification in seawater fCO, by reef metabolism, rates (20.6 to 3.3 g C m² d'') and seasonal patterns of macroalgal productivity were estimated. Whether the Bermuda coral reef system acts as an oceanic sink or source of CO, to the atmosphere not only depends on this seasonal variation, but, more importantly, depends on the pre-existing air-sea CO, disequilibrium of open ocean waters surrounding the reef system. The Bermuda coral reef system serves as a useful model for understanding the fate of CO, in other reefs, particularly those reefs changing because of environmental stress.

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