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TITLE: Biogeochemical Consequences of Ocean Acidification and Feedbacks to the Earth System

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ABSTRACT:

By the year 2008, the ocean had taken up approximately 140 Gt carbon corresponding to about a third of the total anthropogenic CO2 emitted to the atmosphere since the onset of industrialization (Khatiwala et al. 2009 ). As the weak acid CO2 invades the ocean, it triggers changes in ocean carbonate chemistry and ocean pH (see Chapter 1). The pH of modern ocean surface waters is already 0.1 units lower than in pre-industrial times and a decrease by 0.4 units is projected by the year 2100 in response to a business-as- usual emission pathway (Caldeira and Wickett 2003). These changes in ocean carbonate chemistry are likely to affect major ocean biogeochemical cycles, either through direct pH effects or indirect impacts on the structure and functioning of marine ecosystems. This chapter addresses the potential biogeochemical consequences of ocean acidification and associated feedbacks to the earth system, with focus on the alteration of element fluxes at the scale of the global ocean. The view taken here is on how the different effects interact and ultimately alter the atmospheric concentration of radiatively active substances, i.e. primarily greenhouse gases such as CO2 and nitrous oxide (N2O). Changes in carbonate chemistry have the potential for interacting with ocean biogeochemical cycles and creating feedbacks to climate in a myriad of ways (Box 12.1). In order to provide some structure to the discussion, direct and indirect feedbacks of ocean acidification on the earth system are distinguished. Direct feedbacks are those which directly affect radiative forcing in the atmosphere by altering the air?sea flux of radiatively active substances. Indirect feedbacks are those that first alter a biogeochemical process in the ocean, and through this change then affect the air?sea flux and ultimately the radiative forcing in the atmosphere. For example, when ocean acidification alters the production and export of organic matter by the biological pump, then this is an indirect feedback. This is because a change in the biological pump alters radiative forcing in the atmosphere indirectly by first changing the nearsurface concentrations of dissolved inorganic carbon and total alkalinity.

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