The impact of remineralization depth on the air–sea carbon balance

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Abstract

As particulate organic carbon rains down from the surface ocean it is respired back to carbon dioxide and released into the ocean's interior. The depth at which this sinking carbon is converted back to carbon dioxide—known as the remineralization depth—depends on the balance between particle sinking speeds and their rate of decay. A host of climate-sensitive factors can affect this balance, including temperature[1], oxygen concentration[2], stratification, community composition[3, 4] and the mineral content of the sinking particles[5]. Here we use a three-dimensional global ocean biogeochemistry model to show that a modest change in remineralization depth can have a substantial impact on atmospheric carbon dioxide concentrations. For example, when the depth at which 63% of sinking carbon is respired increases by 24 m globally, atmospheric carbon dioxide concentrations fall by 10–27 ppm. This reduction in atmospheric carbon dioxide concentration results from the redistribution of remineralized carbon from intermediate waters to bottom waters. As a consequence of the reduced concentration of respired carbon in upper ocean waters, atmospheric carbon dioxide is preferentially stored in newly formed North Atlantic Deep Water. We suggest that atmospheric carbon dioxide concentrations are highly sensitive to the potential changes in remineralization depth that may be caused by climate change.