Simulations of glacial ocean carbon cycle with a parameterization of stratification dependence of vertical diffusivity

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Paleo-ocean reconstructions supporting the Southern Ocean hypothesis, in which carbon storage in the deep Southern Ocean increases during the glacial ages, has not been sufficiently reproduced by previous paleoclimate modeling studies. In this study, we apply salinity restoring in the Southern Ocean and a parameterization of stratification dependence of vertical diffusivity to an ocean general circulation model and attempt to reproduce oceanic properties reconstructed from paleo-ocean proxy data at the Last Glacial Maximum (LGM). An LGM simulation including the salinity restoring expresses high bottom-water salinity associated with larger sea ice production at the LGM, and reproduces the reconstructed salinity distribution. Moreover, by considering the stratification dependence of vertical diffusivity in the global ocean, the reduced vertical mixing due to enhanced salinity stratification increases ventilation ages in the intermediate to the deep ocean. As a result, more carbon is stored in the deep ocean and the vertical gradient of dissolved inorganic carbon enlarges. This redistribution of carbon reduces atmospheric carbon dioxide concentration (pCO_2). In addition, the subsequent response of carbonate compensation may amplify the glacial reduction of atmospheric pCO_2. In our presentation, we plan to report the glacial variation of atmospheric pCO_2 explained by the response of the ocean carbon cycle including carbonate compensation in numerical simulations using an ocean general circulation model.

Keywords: ocean carbon cycle, glacial-interglacial cycle, global ocean meridional overturning circulation, carbonate compensation

