CMIP5 model analysis of future changes in ocean net primary production by focusing on different response among the individual oceans and models

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Previous modeling studies show that global primary production will decrease in the future because stratification caused by global warming reduces supply of nutrient from the deep ocean. Previous studies mainly emphasized the importance of nutrient limitation in explaining the changes in primary production; however, phytoplankton growth is actually determined by temperature limitation, light limitation and nutrient limitation. Moreover, although future changes of primary production differ depending on areas, many prior researches discuss only global mean mechanisms and it is not well understood how the mechanisms differ depending on the individual oceans. The purpose of this study is to quantitatively evaluate contribution of each limitation factor for explaining the future changes in primary production in the individual oceans by using 9 CMIP5 models. First, we calculate temperature limitation, light limitation and nutrient limitation for each model, which are not directly available from CMIP5 output data. After that, we quantitatively evaluate main drivers for changes in primary production not only for the global ocean but also for low latitudes, the North Atlantic Ocean, the North Pacific Ocean, the Arctic Ocean and the Southern Ocean, separately. By quantitative evaluation on limitation factors of primary production, we show that the future changes in primary production due to global warming is controlled by not only nutrient limitation but also warming-induced enhancement of phytoplankton growth and decreasing biomass caused by enhanced grazing. Moreover, we show that future changes in primary production and its mechanisms differ among the individual oceans.

Keywords: Ocean primary production, Global warming, CMIP5 model