

Response of phytoplankton community structure to global warming

HASHIOKA, Taketo^{1*} ; HIRATA, Takafumi² ; CHIBA, Sanae¹ ; YAMANAKA, Yasuhiro²

¹JAMSTEC, ²Hokkaido Univ.

In recent studies using high-performance liquid chromatography (HPLC) pigment data, empirical relationships between total chl-a concentration and a phytoplankton size/PFT fraction on a global scale are shown. For example, a fraction of diatoms increases with total chl-a concentration. The same tendencies can be seen in the most of the hindcast experiments by current PFT models of MARine Ecosystem Model Intercomparison Project (MAREMIP) and Coupled Model Intercomparison Project Phase5 (CMIP5) although the reproduced absolute values of a phytoplankton fraction still has large uncertainties. Then, two different mechanisms can be expected as potential responses of phytoplankton community to global warming. One is a possibility that the phytoplankton community structure (i.e., relationships between a phytoplankton fraction and total chl-a concentration) can be significantly changed by changes in ecosystem dynamics under global warming condition (e.g., changes in grazing pass/strength, decomposition/mortality/respiration rate and phytoplankton stoichiometry). Another possibility is that the plankton community shifts to the other stable states associated with changes in total chl-a concentration (e.g., by decrease/increase in nutrient supply to the surface ocean by changes in stratification) while maintaining the current relationship between a phytoplankton fraction and total chl-a concentration. To clarify impacts of both effects, we analyzed model results of future simulation, which was conducted by CMIP5 and MAREMIP under the RCP8.5 emission scenario. PFT model more than half showed that relationships between phytoplankton composition and total chl-a concentration are stable against environmental changes associated with global warming. In these model results, changes in phytoplankton composition are mainly caused by plankton community shifts associated with changes in total chl-a concentration. This result suggests the possibility that current empirical relationships obtained by HPLC would be maintained in a future environment. Based on this hypothesis, we project a potential future community structure of phytoplankton using a multi-model ensemble mean of future changes in total chl-a concentration with the empirical relationship of HPLC. Some other models projected large changes in the community structure in specific regions and seasons. These results also suggest potentially important mechanisms, regions and seasons.

Keywords: Phytoplankton, Community structure, Global warming