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Temperature dependency of rain ratio obtained by a 3-D ecosystem-biogeochemical model

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We developed a 3-D ecosystem-biogeochemical model extended from NEMURO (North Pacific Ecosystem Model Used for Regional Oceanography) of PICES (North Pacific Marine Science Organization), which can explicitly represent the nitrate, calcium and silicate cycles, and applied it to the western North Pacific. The model effectively reproduced the observed horizontal distributions and seasonal variation of physical and biogeochemical fields. We investigated how rain ratio (a ratio of calcium carbonate to organic carbon in export production) is determined by ecosystem dynamics and biogeochemical cycles. The annually averaged rain ratio increases with temperature from 0.05 in the subarctic region to 0.15 in the subtropical region. This increase is the result of both (1) a change in the dominant phytoplankton group from diatom to the other small phytoplankton including cocolithophorids (i.e. increase in production ratio of CaCO3 to POC) and (2) an increase in export production ratio of CaCO3 to POC in the surface water which increases with temperature. Although decomposition rates of CaCO3 and POC have the same temperature dependencies in our model, it is interesting that the export production ratio has the temperature dependency, since the decomposition rate of POC is larger than that of CaCO3. A similar mechanism can be applied to changes in Si/N ratio (a ratio of opal to organic carbon in export production).