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気候値データおよびCMIP5実験結果を用いた海洋生物ポンプの診断
Vector digram analysis of ocean carbon pumps: application to the climatological data and CMIP5 simulations

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The ocean stores 60 times more carbon than the atmosphere and therefore the ocean carbon cycle has a critical role in controlling the atmospheric CO2 concentration. By using the three dimensional distribution of dissolved carbon concentration (DIC), total alkalinity (ALK), phosphate, and salinity, four types of ocean carbon pumps (organic matter, calcium carbonate, gas exchange, and freshwater flux pumps) are defined here and I propose a method with which individual effects of four carbon pumps on atmospheric CO2 concentration can be quantitatively evaluated. By applying this method to the climatology, the contributions of four carbon pump components to atmospheric CO2 are clearly evaluated in one figure (the vector diagram); each carbon pump component is represented by one vector and its contribution to pCO2 can be measured from the difference in the contour values between the beginning and the end of the vector. The same analysis is also applied to the CMIP5 earth system model simulations. Although all models reproduce the same level of the atmospheric CO2 concentration as the climatology, it is shown that contributions from four carbon pumps are not the same among models. This study demonstrates that the vector diagram analysis introduced here is a powerful tool for quantifying the individual contributions of the ocean carbon pumps on atmospheric CO2 concentration and also a useful tool for evaluating the reproducibility of ocean carbon cycle models.