The study of the biological carbon pump based on the analysis of ocean backscatter data

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For the sake of understanding the current situation of the ocean’ s ability for uptake of atmospheric CO_2 and predict its future change by the change of the global/ocean environment, the biological carbon pump (BCP), which is one of mechanisms of the uptake of CO_2, should be quantified precisely. The study of the BCP has been conducting by, mainly, time-series sediment trap observation: time-series settling particles are collected by sediment traps which are deployed at variable depths of variable oceans and collected particles are analyzed chemically and biologically. However, time-series sediment trap observation is tough work economically and physically because the cruises by ships are required for the turnaround of sediment trap mooring system, generally, at least once a year. In addition, uncertainties of sediment trap data from its trapping efficiency and contamination of “swimmers” have been still on argument. In the 21century, the global observation network of the ARGO floats has been established. In the early stage, only water temperature and salinity data were available and it can be said that the ARGO floats contributed to only physical oceanography. After dissolve oxygen (DO) data became available, the ARGO floats started to also contribute to biogeochemical oceanography. Recently, fluorometer, pH sensor, nitrate sensor and backscatter meter can be installed on the ARGO float. The ARGO float with these sensors are called “BGC-ARGO” and BGC-ARGO floats have enabled us to study the various biogeochemical oceanography. Among these sensors, the backscatter meters can observe spatial-temporal variability of marine particles in the water column and, thus, these data possibly contribute to the BCP study. Our group has conducted the study of the BCP by the repeatable scientific cruise and time-series sediment trap observations at time-series stations in the western North Pacific subarctic region (station K2) and the subtropical region (stations S1 and KEO). After 2018, the BGC-ARGO floats have been deployed at both stations and backscatter in water column of both regions have been observed. In this study, backscatter data observed during years of 2018-2020 in the subarctic region and 2019-2021 in the subtropical region were converted to particulate organic carbon (POC) concentration data with the empirical equation and, sequentially, temporal variability in vertical profile of POC upper 1000 m were analyzed. As a result, it was revealed that the annual amplitude of POC concentration decrease with depth. Assuming the steady state and that lateral transport of POC are negligible, annual amplitude of POC concentration at respective depth can be regarded as POC flux at respective depth. The decrease of POC flux with depth is comparable to the general trend of POC flux observed by sediment trap observation. However, POC flux at deep sea in both regions were comparable although POC flux observed by sediment trap is generally larger in the subarctic region, and estimated POC flux at 100 m and 800 m were about 30 and 3 mg m^{-2} day^{-1}, respectively, which were about 1/2 –1/3 of POC flux at respective depths estimated by previous sediment trap observation. In this report, the above analytical method of POC flux is evaluated and how to utilize backscatter data and other data observed by BGC-ARGO float for the study of the BCP is discussed.

Keywords: biological carbon pump, BGC-ARGO, backscatter, POC flux

