Surface nutrients in the North Pacific from ship-of-opportunity observation

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National Institute for Environmental Studies (NIES, Japan) and Institute of Ocean Sciences (IOS, Canada) has carried out ship of opportunity measurements of nutrients (phosphate, nitrate, and silicate) and partial pressure of CO_2 since late 1980s. Using the ship of opportunity data and others, seasonal to decadal variability of sea surface nutrients and dissolved inorganic carbon (DIC) in the North Pacific were clarified. Nutrient and DIC concentrations were high in the subarctic in winter and low in the subtropics. In the summer, substantial amount of nutrients remained unutilized in subarctic and the northern part of the subarctic-subtropical boundary region. In the subtropics, nutrients were almost entirely depleted throughout the year, while DIC concentrations showed a north-south gradient and significant seasonal change. Nutrients and DIC showed a large seasonal drawdown in the western subarctic region, while the drawdown in the eastern subarctic region was weaker, especially for silicate. The subarctic-subtropical boundary region also showed a large seasonal drawdown, which was most prominent for DIC and less obvious for nitrate and silicate. In the interannual time scale, the Pacific Decadal Oscillation was related to a nutrients and DIC seesaw pattern between the subarctic-subtropical boundary region and the Alaskan Gyre through the changes in horizontal advection, vertical mixing and biological production. When the North Pacific Gyre Oscillation was in the positive phase, nutrient concentrations in the subarctic were higher than the mean states. Trends of phosphate and silicate averaged over the North Pacific were negative, while nitrate trend was insignificant.

Keywords: phosphate, nitrate, silicate, PDO, NPGO, long-term trend

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