An observation-based synthetic reconstruction of surface ocean inorganic carbon variables

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Ocean acidification is an issue of great concern for the global carbon cycle and has adverse impacts on marine ecosystem and socioeconomical activities such as fisheries and tourism industries. In order to project the ocean acidification as well as the carbon-climate feedback with high confidence, it is critical to understand the current status, variability and trends of ocean inorganic carbon variables and carbon sink. However, oceanographic observations have been conducted sparsely in time and space, and it is still needed to reconstruct carbon system variables in global scale from spatiotemporally limited observations in spite of the recent increase in observations of those variables. We made synthetic reconstructions of surface ocean total alkalinity (TA) and dissolved inorganic carbon (DIC) by monthly 1°×1° grid for the period from 1993 to 2018 based on measurements of CO_2 partial pressure in surface seawaters (pCO_2 sea) and TA by using a multiple linear regression approach. The gridded data of DIC and TA were converted to pCO_2sea, pH and aragonite saturation state according to seawater carbonate chemistry, and sea-air CO_2 flux in combination with atmospheric CO_2 and wind speed. The estimated mean annual ocean CO_2 uptake and its trend of increase were 2.0±0.5 PgC/year and 0.3±0.1 (PgC/year)/decade, respectively, showing significant decadal variability of decrease of sink in 1990s and increase after 2000. The globally averaged pH trend was estimated to be -0.0181±0.0001/decade, which is consistent with atmospheric CO_2 growth. The gridded data of sea-air CO_2 flux analyzed in this study can be used as a prior ocean flux in atmospheric inversion analysis, and the global pH could help verifying the indicator for sustainable development goals SDG 14.3.

Keywords: oceanic carbon sink, ocean acidification, SDGs

