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Temporal Variability in Interior Dissolved Inorganic Carbon

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Air-sea CO_2 fluxes display large temporal fluctuations on seasonal to interannual timescales, both at global and regional scales. These fluctuations in the oceanic carbon uptake suggest that the interior dissolved inorganic carbon (DIC) is equally highly variable, driven by changes in this uptake, but also by changes in circulation and biological activity. In turn, fluctuations in DIC affect the air-sea CO_2 exchange, thus altering the amount of CO_2 in the atmosphere. However, most studies at global scale have focused on the anthropogenic increase in oceanic carbon and have done so at decadal mean time scales. Consequently, to date, the seasonal and interannual variability (IAV) of the contemporary DIC (natural + anthropogenic) in the water column has not been quantitatively mapped from observations at a global scale. Here, we fill this gap by using our newly developed global ocean DIC map product "Mapped Observation-Based Oceanic DIC" (MOBO-DIC) which is based on DIC measurements from GLODAPv2.2019 and a 2-step neural network method to gap-fill and map the measurements globally until 2000 m. Its seasonal climatology (Keppler et al., 2020a) reveals that the seasonal surface DIC amplitudes range from 0 to more than 50 µmol kg^{-1}. The seasonal variations mostly stem from high DIC concentrations in winter, when mixed layers are deep, and low DIC concentrations in summer, when enhanced net community production (NCP) removes large amounts of DIC. We estimate a spring-to-fall NCP in the euphotic zone of the mid-latitudes of 3.9±2.7 Pg C yr^{-1}, which corresponds to 8.2±5.6 Pg C yr^{-1} when upscaling globally (Keppler et al., 2020b). The monthly fields of MOBO-DIC from 2004 through 2018 reveals that the largest interannual variability of DIC is found in the tropical Pacific, strongly driven by the El Niño Southern Oscillation. The DIC trend suggests that in the upper 500 m, the DIC concentration has increased by ~21 Pg C from 2004 through 2018 (i.e., ~14 Pg C $decade^{-1}$) in our study domain.

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