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Temporal variation of dissolved inorganic carbon in the subsurface water of the western North Pacific subarctic region

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It is possible that the recent ocean has varied due to the artificial greenhouse warming effects and/or the natural climate change. Time series observations at fixed stations (e.g., ALOHA (subtropical North Pacific), BATS (subtropical North Atlantic), KNOT (western North Pacific subarctic region)) are important to understand temporal variation of chemical species in the ocean. At Station BATS and KNOT, the increase of dissolved inorganic carbon (DIC) in the subsurface water includes the anthropogenic and non-anthropogenic CO_2 [Bates et al., 2002; Wakita et al., 2005].

DIC and related chemical species have been measured from 1992 to 2006 at Station KNOT (44˚N, 155˚E) and K2 (47˚N, 160˚E) in the western North Pacific subarctic region. DIC and apparent oxygen utilization (AOU) in the subsurface water (26.7-27.2$\sigma_\theta)$ appeared not to increase and showed a declining tendency from 2001 to 2006, although temporal variations at KNOT was more scattered than those at K2. These variations decreased with increasing density. The change of DIC in the subsurface water is controlled by the gas exchange of CO_2 at the air-sea interface (DIC$_{air-sea})$, the decomposition of organic matter (DIC$_{org})$ and the dissolution of calcium carbonate (DIC$_{CaCO3})$. DIC$_{org}$ and DIC$_{CaCO3}$ have positive relationships to AOU and potential alkalinity (PA), respectively. Since PA remained constant during the past 15 years at KNOT and K2, DIC$_{air-sea}$ can be calculated by using DIC, AOU and the stoichiometric ratio of carbon to oxygen at the organic matter decomposition (117/170,

Anderson and Sarmiento, 1994), as following,

$$\mathrm{DIC}_{air-sea} = \mathrm{DIC} - 117/170 * \mathrm{AOU}$$

$\mathrm{DIC}_{air-sea}$ at KNOT and K2 has increased in the intermediate water (26.7-27.2σ_θ) for the period from 1992 to 2006 (0.6-1.9 μmol/kg/yr). The increase rate decreased with increasing density. The accumulation rate of CO_2 in the western North Pacific subarctic region was estimated to be 0.43 mol/m^2/yr. The accumulation rate of anthropogenic CO_2 in this region is calculated to be a maximum of 0.3 mol/m^2/yr by using anthropogenic CO_2 column inventory ($<$30mol/m^2) [Sabine et al., 2004]. This rate was smaller than our result, indicating that the accumulation rate would have been increasing in the past 10 years. It suggests the increase in the accumulation of CO_2 liberated back to atmosphere at the region of intermediate water formation (non-anthropogenic CO_2).