Seasonal variation in total alkalinity in subtropical-subpolar transition area off eastern Japan

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Seasonal variation in total alkalinity has been insufficiently considered in discussing oceanic CO_2 system since it is smaller than that of the partial pressure of CO_2 and dissolved inorganic carbon. Here we compiled hydrographic observations in the western North Pacific off Japan (28–50°N, 140–165°E) for the period of 2011–2015. This dataset we use is sufficient to assess the seasonal variation of TA as it includes the discrete value of TA and related parameters (*e.g.* temperature, salinity and nutrients) in all months other than January and February.

We excluded the variation of TA being accompanied by the evaporation and precipitation of seawater by normalizing TA to salinity = 35 (nTA_{35} = TA*35/*S*). Surface nTA_{35} showed very little seasonal variation and were 2290–2300 μmol kg^{-1} in the subtropical region to the south of Kuroshio extension throughout the year. In subpolar region to the north of 46°N, data was seasonally confined in May and June. Surface nTA_{35} in subpolar region (5–6°C) was 2355–2370 μmol kg^{-1} and almost equivalent to that in subsurface temperature minimum layer (< 2°C) which corresponds to the remnant of the winter mixed layer. Therefore, the seasonal variation of TA was supposed to be small in the subpolar region. In subtropical-subpolar transition area between these two regions, however, nTA_{35} showed considerable seasonal variation as large as 80 μmol kg^{-1}. It was lower in summer while higher in winter. This indicated the intrusion subtropical water with low nTA_{35} to higher latitude in summer.

We compared observed TA in the transition area with estimated TA by multiple linear regressions by *Lee et al.* [2006]. There were no large discrepancies between estimated TA and observed TA in June and August. However, estimated TA was significantly larger than observed TA by 20–30 μmol kg^{-1} in March and December. This inconsistency in winter was possibly due to the seasonal bias in the dataset stored in GLODAP database which was applied to make regressions in *Lee et al.* [2006]. In order to reproduce the seasonal variation in TA subtropical-subpolar transition area properly, it is essential to consider the data in other than summer.

We will also discuss the difference between observed TA and estimated TA from another regression given by *Takatani et al.* [2014].

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