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Flattening of the equatorial bulge of annual mean APO observed in the Western Pacific during the 09/10 El Nino event

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A tracer known as **a**tmospheric **p**otential **o**xygen ($APO=O_2+1.1xCO_2$) has been proved to be useful to study air-sea gas exchange. Although both atmospheric CO_2 and O_2 concentrations are affected from the air-sea and air-land gas exchanges, APO mainly reflect the air-sea gas exchange because APO is invariant with respect to the land biotic gas exchanges (-1.1 in the definition represents the molar land biotic $-O_2$:C exchange ratio). To investigate the spatio-temporal variations in the APO over the Pacific region, we have been observing the atmospheric CO_2 and O_2 concentrations onboard commercial cargo ships sailing between Japan and US/Canada and Australia/New Zealand since December 2001. Our previous studies based on the shipboard flask measurements for 7-year period (2002-2008) revealed that the average latitudinal distribution of the annual-mean APO in the Western Pacific (from 40 deg. S to 50 deg. N) show a maximum near the equator and decreasing trends toward the mid-latitude in both hemisphere (Tohjima et al, 2012). This latitudinal distribution of the annual-mean APO is mainly attributed to the latitudinal differences in the air-sea gas exchange: outgassing fluxes around the equator and ingassing fluxes in the mid and high latitude. In the previous study, the equatorial bulge was robust and always observed during the 7-year period. However, the equatorial bulge disappeared and the latitudinal distribution was flattened especially in the Southern Hemisphere during the period from July 2009 to June 2010, when the most recent El Nino event occurred. Simulated APO based on an atmospheric transport model (NIES99) driven by a set of climatological oceanic O_2 and CO_2 fluxes also shows suppression of the equatorial bulge during El Nino periods, indicating that the atmospheric transport substantially contributes to the inter-annual change in the latitudinal distribution of the annual-mean APO. The simulated APO, however, cannot fully reconstruct the flattening of APO in the Southern Hemisphere. Thus, the suppression of the Eastern Pacific upwelling during the El Nino period might reduce O_2 and/or CO_2 outgassing around the equatorial ocean.

Keywords: atmospheric potential oxygen, APO, air-sea gas exchange, El Nino, Tropical western Pacific ocean