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Relationship between interannual variation in the changing rate of APO trend at Cape Ochi-ishi and PDO

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Since atmospheric potential oxygen (APO=O_2+1.1xCO_2) mainly reflects the air-sea gas exchange of O_2 and CO_2 by definition, the spatio-temporal variations in APO are expected to constrain the ocean biogeochemical process and dynamics. Here we examine the relationship between temporal variations in APO trend observed at Cape Ochi-ishi (COI; 43.2^{o}N, 145.5^{o}E) and the Pacific Decadal Oscillation (PDO) index to investigate the causes for the inter-annual variations in the APO trend. The PDO is a long-term Pacific climate variability, having two extreme phases which is classified by basin-scale patterns of the sea surface temperature (SST) anomaly. When the SST anomalies are cool in the northern North Pacific and warm in the tropical Pacific, the PDO index has positive value. And the opposite pattern of the SST anomalies correspond to the negative PDO index. The cool SST enhances the ocean vertical ventilation which brings deeper waters with depleted O_2 to the surface, causing the O_2 ingassing. The cool SST also enhances the ingassing flux by increasing gas solubility. To the contrary, the enhanced ocean vertical ventilation brings the subsurface nutrients to the surface, enhancing the O_2 outgassing through the increase in the ocean primary production. Thus, the correlation analysis between the changing rate of the APO trend (dAPO/dt) at COI and the PDO index would allow us to investigate how the SST anomaly in the northern North Pacific affect the air-sea gas exchanges. Unfortunately, there is no significant correlation between dAPO/dt and the POD index. However, when dAPO/dt and the PDO index are decomposed into the middle ($0.3<f<0.6$ cycle/yr) and low ($f<0.3$ cycle/yr) frequency domains by using a digital filtering technique, the scatter plots of the middle-term and long-term variations show significant negative and positive correlations, respectively. These results might suggest that the ventilation/thermal effect is dominant for the middle-term SST variation while the biotic effect exceeds it for the long-term SST variation.

Keywords: APO, atmospheric oxygen, PDO, atmospheric CO2, air-sea gas exchange