Impacts of the tides and atmospheric forcing variability on dissolved oxygen and salinity in the subarctic North Pacific

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Abstracts

The impacts of the variation in the wind forcing and 18.6-year tide (K1) cycle on the concentration of the dissolved oxygen (DO) in the intermediate waters of the western and eastern parts of the subarctic North Pacific were analyzed. Our results demonstrate that the interannual changes of DO in seasonal in the intermediate waters and their salinity in the western subarctic Pacific can be described very accurately by a linear combination of the intensity of the Aleutian Low pressure system (NPI index) and zonal momentum flux (45-52°N, 165°E-170°W) in winter, and an annually averaged cubic of tidal amplitude for the central Aleutian and northern Kuril regions. The residual signal shows a good correlation with the temporal variations of DO in the Alaskan Gyre.

Abstracts
Schematic representation of the current and frontal systems in the northern North Pacific (adapted from Favorite et al. [1976] and Ohtani [2001]).
Temporal variations in DO ($\mu$mol/l/kg) in the western (48°-60°N, 160°-170°E) subarctic Pacific and Okhotsk Sea at $\sigma_{\text{θ}} = 27.0$. DO data were grouped by year and then for each group an average and its 95% confidence intervals (error bars) were computed. The blue line [AB1] shows the temporal variation in the North Pacific index, smoothed with a 5-year running mean.
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$\text{S} -$ Western Subarctic Gyre

$\text{A} -$ Alaskan Gyre

*Graph showing data points and trends for S and A Gyres.*
A. Temporal variations of surface (40 – 60 m) salinity in the southern Okhotsk Sea, and the NP index in winter (December – March). Red solid line is the NP temporal variations, smoothed with a three-year running mean.

B. Temporal variations of the Amur River discharge, May-October Precipitation Rate (45-55°N, 120-135°E), and the NP index in summer (May-October). Green solid line is the NP temporal variations, smoothed with a three-year running mean.
Temporal variations of the depth of isopycnals of 26.8 and 27.0 in the Okhotsk Sea.
Temporal variations of the dissolved oxygen at 26.8 $\sigma_\theta$ and 27 $\sigma_\theta$ in the southern and central parts of the Okhotsk Sea (a), and the NPI in winter (b).
Dissolved oxygen (A) and dissolved inorganic carbon (B) versus temperature at $\sigma_{\theta} = 26.8$ and $\sigma_{\theta} = 27.0$. 
Profiles of the potential density (A) and salinity (B), and dissolved oxygen versus potential density in the Alaska Gyre (WOCE data, P16N, P17N) and Western Subarctic Gyre (WOCE data, P13N).
Temporal variation of the annually averaged difference (GT) between the Mean High Water and Lower Low Water in the Adak and Paramusir Islands (A) and the distributions of the surface (50m) salinity and dissolved oxygen at $\sigma_\theta=26.8$. Across the Aleutian (B) and Kuril Straits (C, D).
A) Temporal variations of dissolved oxygen at $\sigma_\theta = 26.8$ in the Alaska Current region and at Stn "PAPA". B) Dissolved oxygen versus temperature at $\sigma_\theta = 26.8$ in the Alaska Gyre region. C) Temporal variations of the residual DO at $\sigma_\theta = 26.8$ at Stn "PAPA" (the difference between the measured and calculated by Eq. (1) the concentration of dissolved oxygen), and NP index with 3 year time lag. Thick solid line is the NP, smoothed with three–year running mean.
Distributions of the temperature and dissolved oxygen at \( \sigma = 26.8 \) sections in the North Pacific. WOCE data: P13 (165° E, 1992), P14 (180°, 1995), and P17N (135° W, 2001).
Conclusions

Our results demonstrate that to offer a reasonable description of the processes that make up the interannual variations in the physical and chemical parameters of the surface and intermediate waters of the subarctic North Pacific, a model with the subarctic basin dynamic and the atmospheric forcing by observed climatology should be applied. In addition, the model should account the changes in the density of the outcropping of isopycnal surfaces caused by the changes in the salinity stratification of the subarctic North Pacific.

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