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Impact of decadal climate variability on Pacific oxygen changes in MPI-ESM's large ensemble simulations

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Ocean deoxygenation is one of the major stressors on marine ecosystems under anthropogenic climate change. Observational studies indicate a decadal decline in oceanic oxygen. Because of limited spatiotemporal sampling frequency and potential impacts of decadal climate variability on dissolved oxygen, it is often challenging to conclude from observations whether the decrease in dissolved oxygen is due to anthropogenic climate change. Particularly, the decadal changes in dissolved oxygen in the Pacific Ocean may be linked to the Pacific Decadal Oscillation (PDO) [Czeschel et al., 2012; Schmidtko et al., 2017], but the mechanisms and representation of this linkage in the Earth System Models (ESMs) are not well understood.

To address these issues, we analyze the 100 ensemble member outputs from the Max Planck Institute for Meteorology Earth System Model's (MPI-ESM) large ensemble simulations for the historical period (1850-2005). The foci and key questions of this study are: 1) Is decadal changes in dissolved oxygen in the Pacific Ocean linked to the Pacific Decadal Oscillation (PDO) in the large ensemble simulations? 2) What are the mechanisms linking the decadal changes in dissolved oxygen and the PDO? To address these questions, we performed 20-year running trend analysis (similar to the method used in Kosaka and Xie, 2016) on PDO indices and basin-wide oceanic oxygen indices in the Pacific Ocean (for both mid to high latitudes and tropics) calculated from the 100 ensemble members. The 20-year running trend analysis shows that 20-30% of the ensemble members exhibit linkage between decadal oxygen changes and the PDO. However, we found that 70-80% of the simulated decadal oxygen changes are not necessarily associated with the PDO. This indicates that there are other possible mechanisms that could lead to decadal variability of dissolved oxygen in the Pacific Ocean. In this presentation, we will further discuss what causes the differences in the link between Pacific oxygen trends and the PDO. The results from our study advance our understanding on how internal climate variability influences ocean biogeochemical cycles on decadal timescales, which is also important for gaining better understanding of the observed trends and variability of ocean biogeochemical tracers.

References

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