

# Mechanisms of low-frequency oxygen variability in the North Pacific

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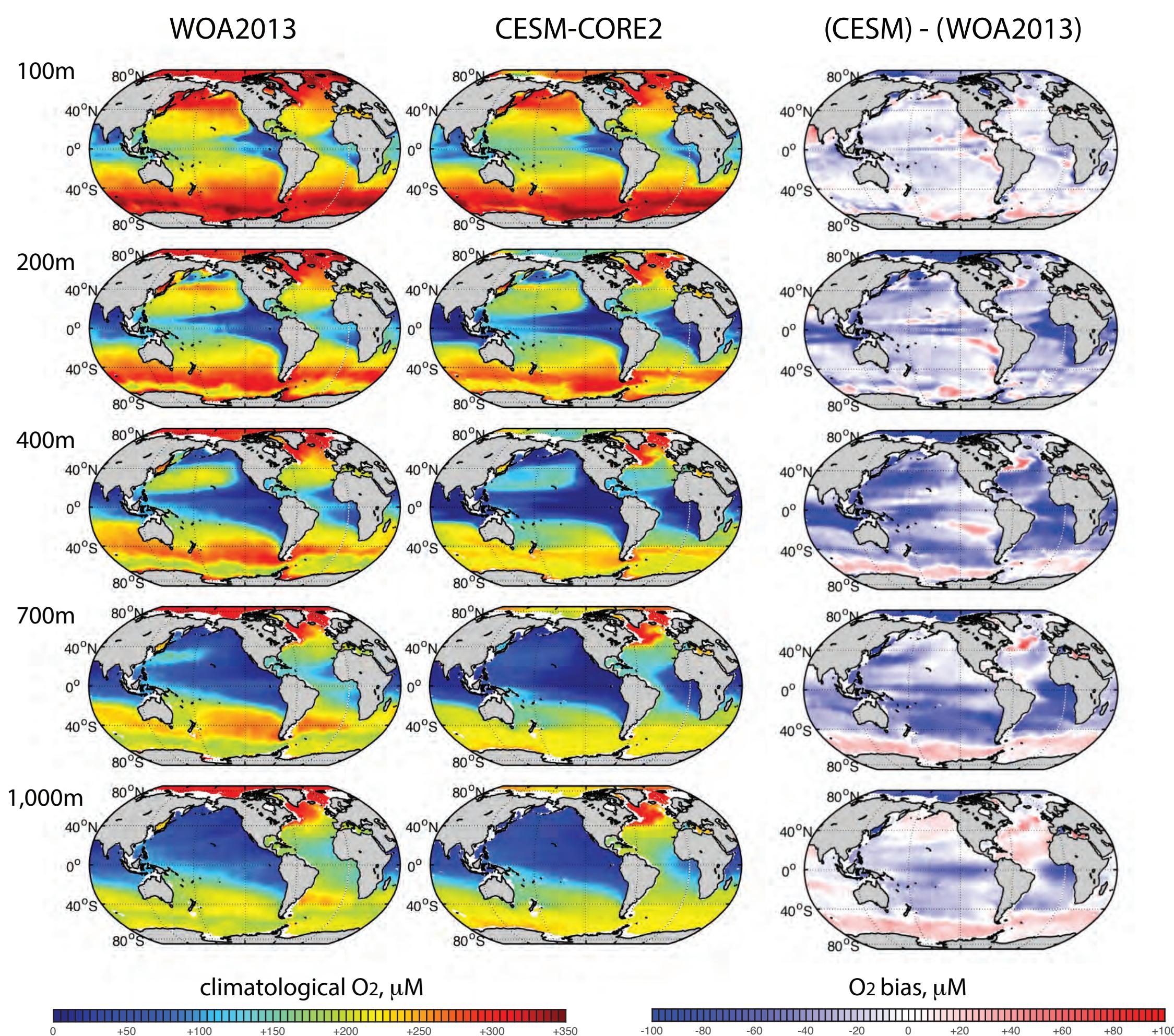
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## Objectives

We aim to examine how well an ocean hindcast simulation reproduce the observed oxygen variability in the North Pacific, and to understand the mechanism behind interannual and decadal variability.  
This project is supported by NSF (OCE-1737188, 1737282, 1737158) and JSPS (KAKENHI 18H04129, 18H04911)

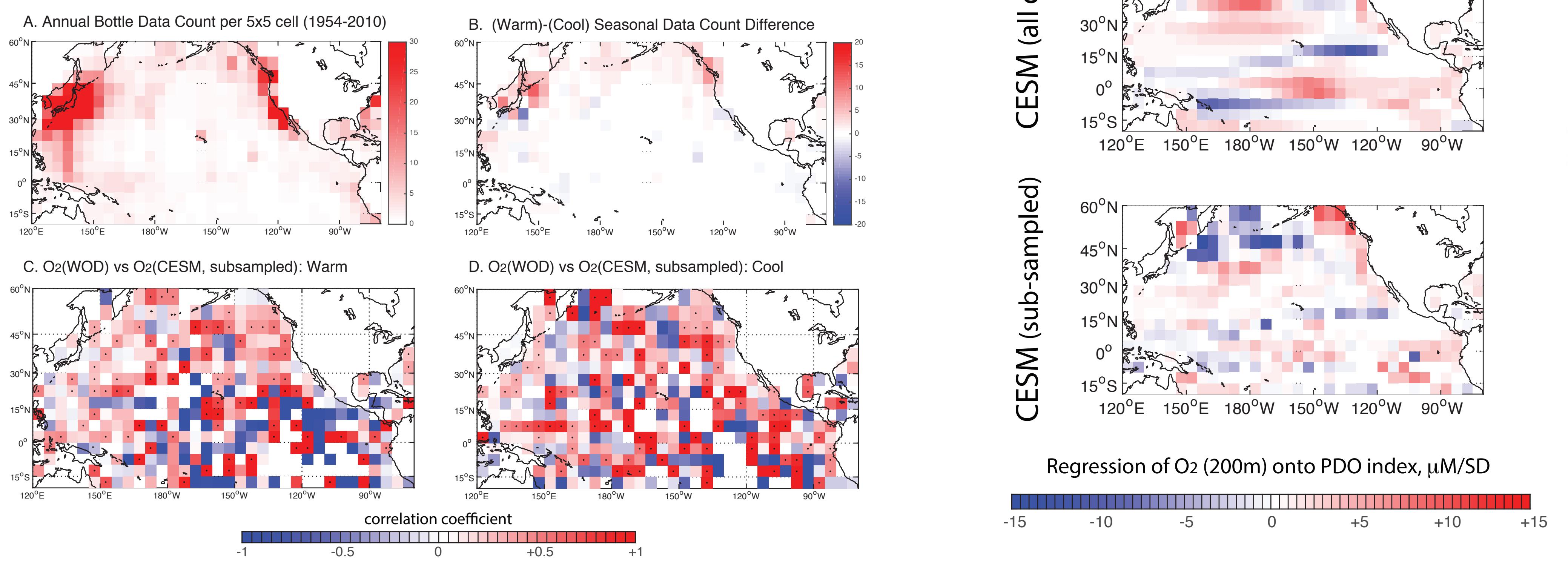
## CESM-CORE2 simulation

Ocean biogeochemistry is simulated using ocean-ice configuration of CESM-BGC model forced by observed atmospheric variability (CORE2-IAV forcing, 1948-2015). Generally the model underestimates subsurface oxygen relative to climatological observation (World Ocean Atlas). Our analysis focus on the outputs at 200m depth.



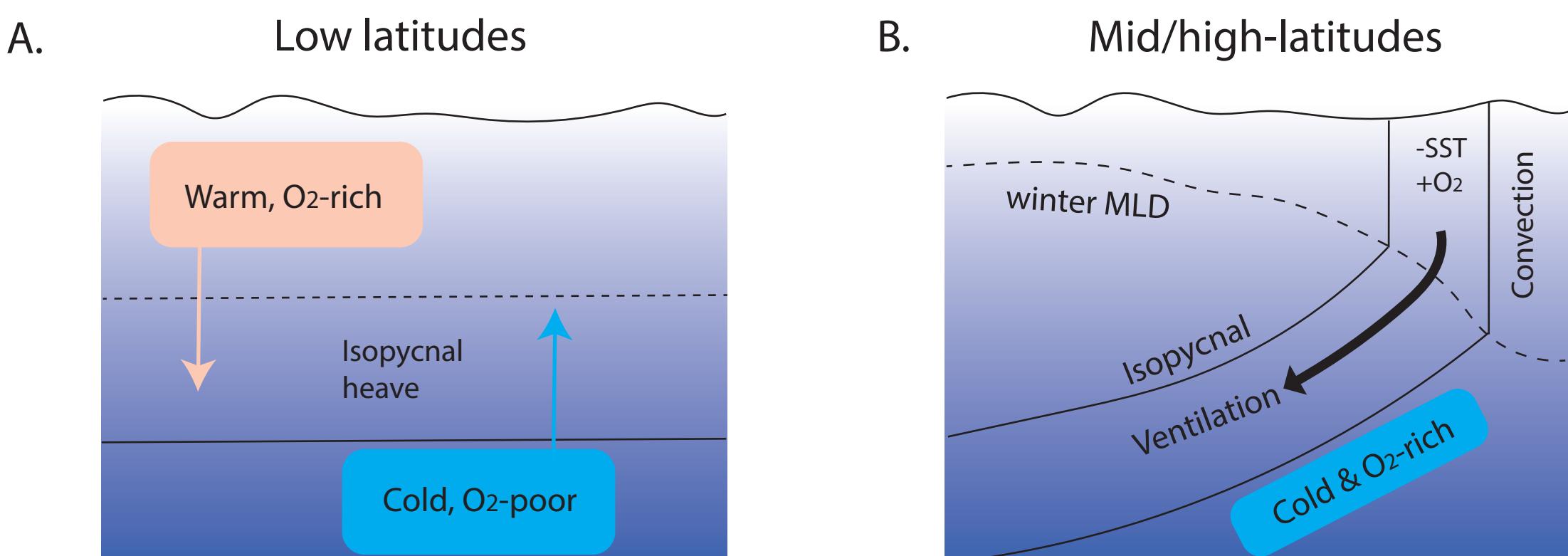
## World Ocean Database

- World Ocean Database (WOD) is used to estimate the variability of O<sub>2</sub>. The historical data is gridded onto a 5°x5° longitude-latitude grid at standard depth levels.
- Observations are biased near the well populated regions and during warm seasons.



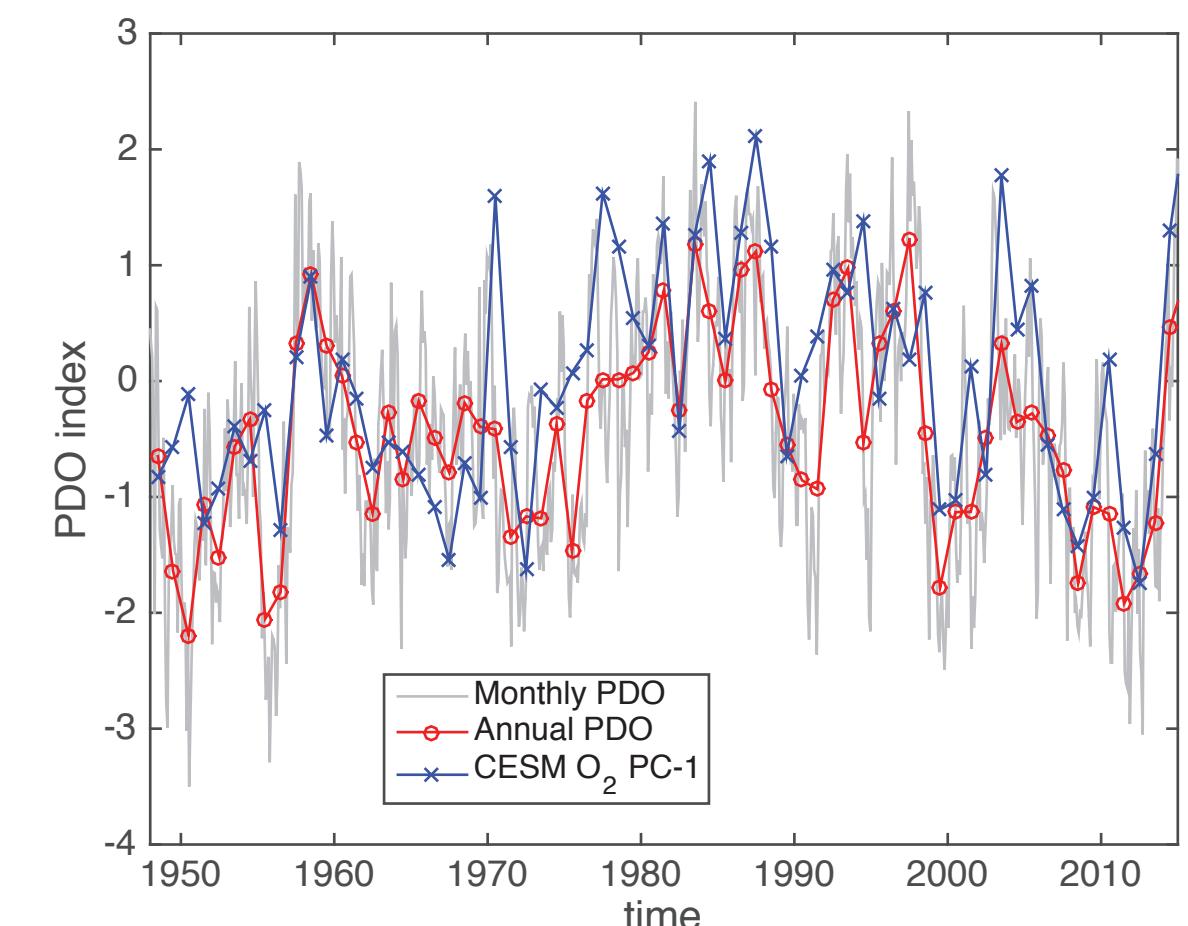
## Mechanism

- Tropics: vertical shifts of water masses (heave): positive correlation between T and O<sub>2</sub>
- Mid latitudes: ventilation and subduction: negative correlation between T and O<sub>2</sub>

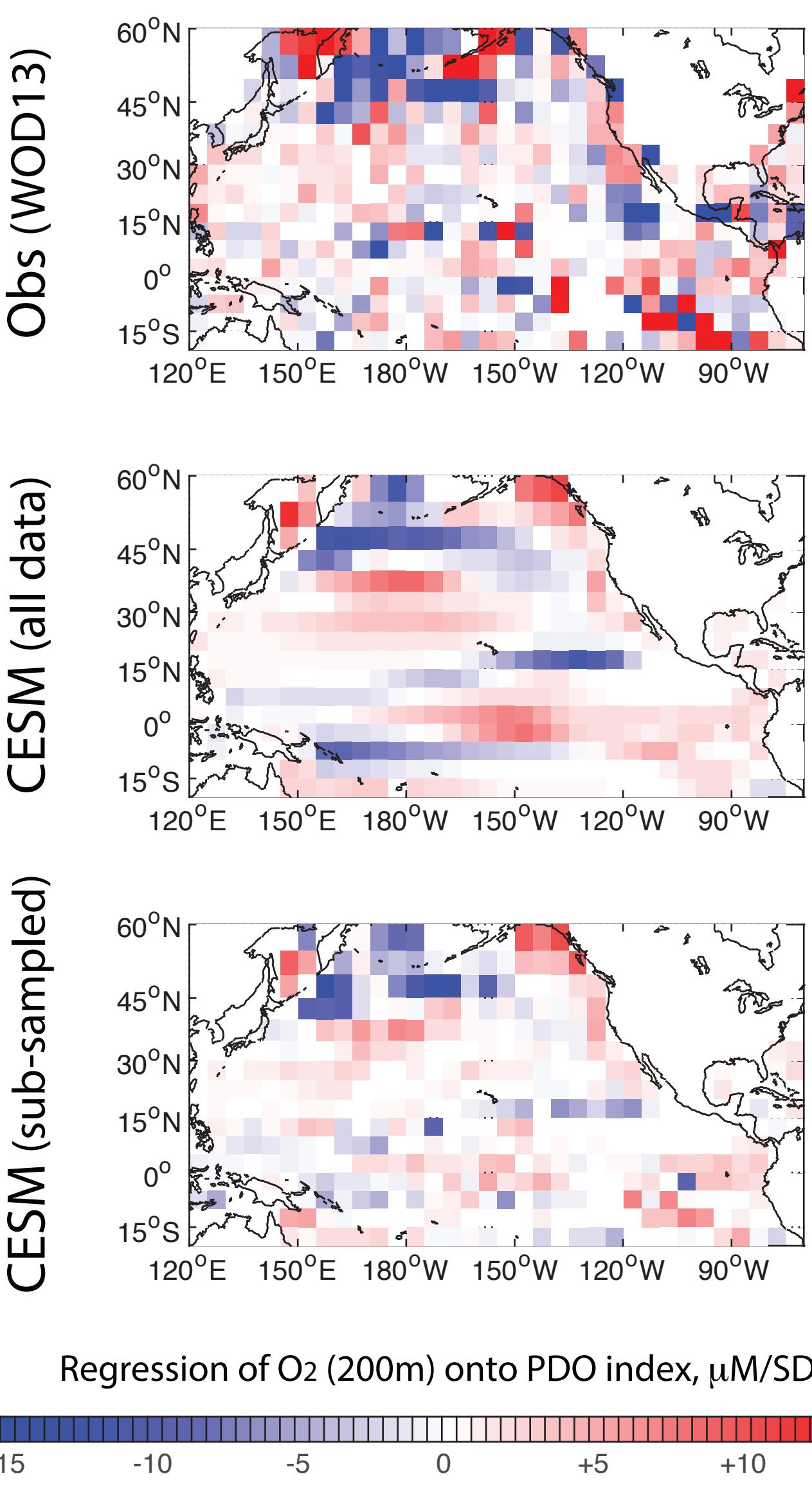


## Pacific Decadal Oscillation

- The dominant mode of North Pacific climate, PDO, drives the water mass shifts and ventilation changes, acting as the pacemaker.



## PDO-O<sub>2</sub> relationship

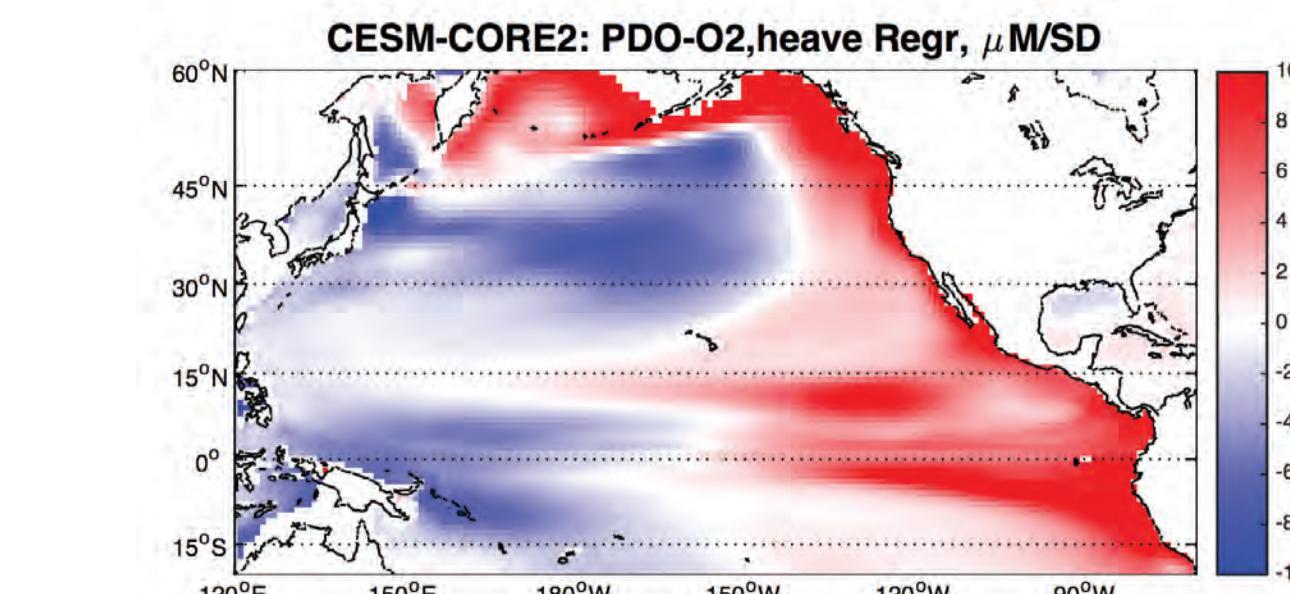


## Water mass shifts vs Ventilation

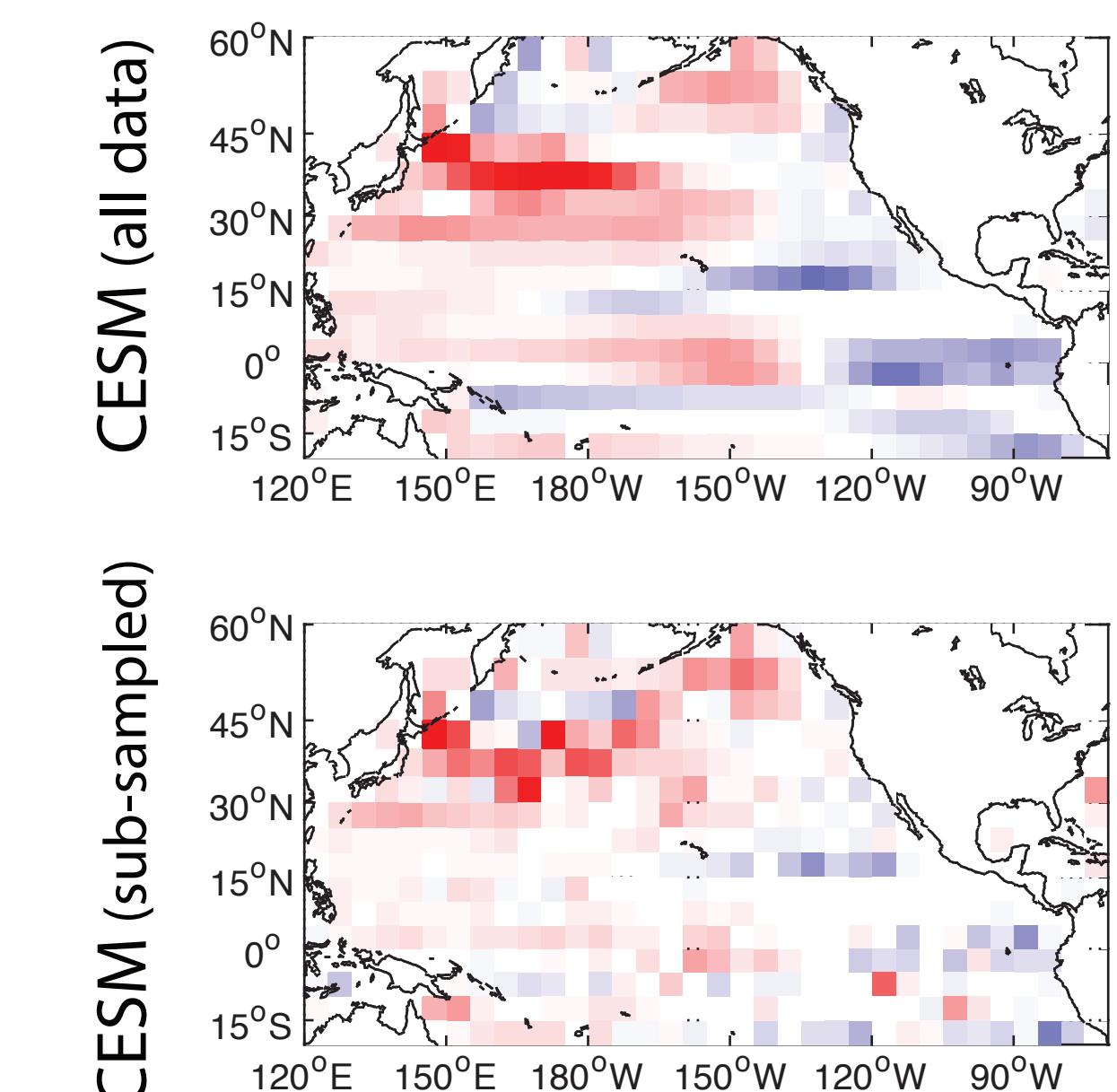
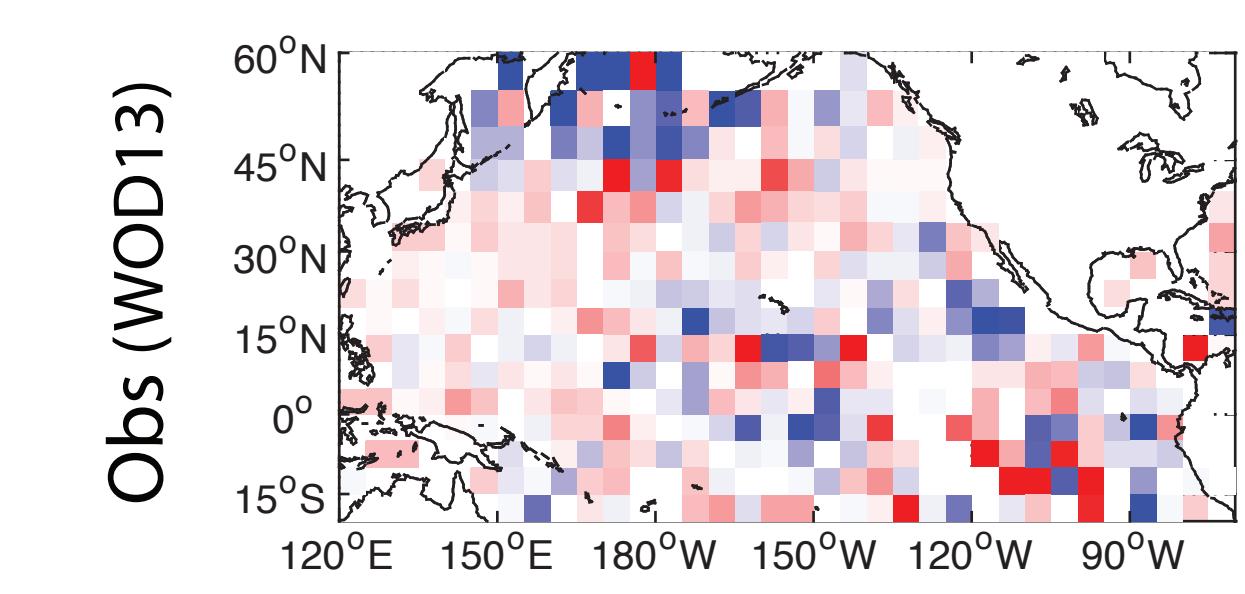
- Vertical water mass shifts (heave) causes oxygen anomalies, and its effect is calculated using potential density anomalies.

$$O'_{2, \text{heave}} = \left( \frac{\partial \bar{\rho}_2}{\partial z} \right) \left( \frac{\partial \rho_\theta}{\partial z} \right)^{-1} \rho'_\theta \quad \longleftrightarrow \quad O'_{2, \text{res}} = O'_2 - O'_{2, \text{heave}}$$

### PDO-O<sub>2</sub>,heave relationship

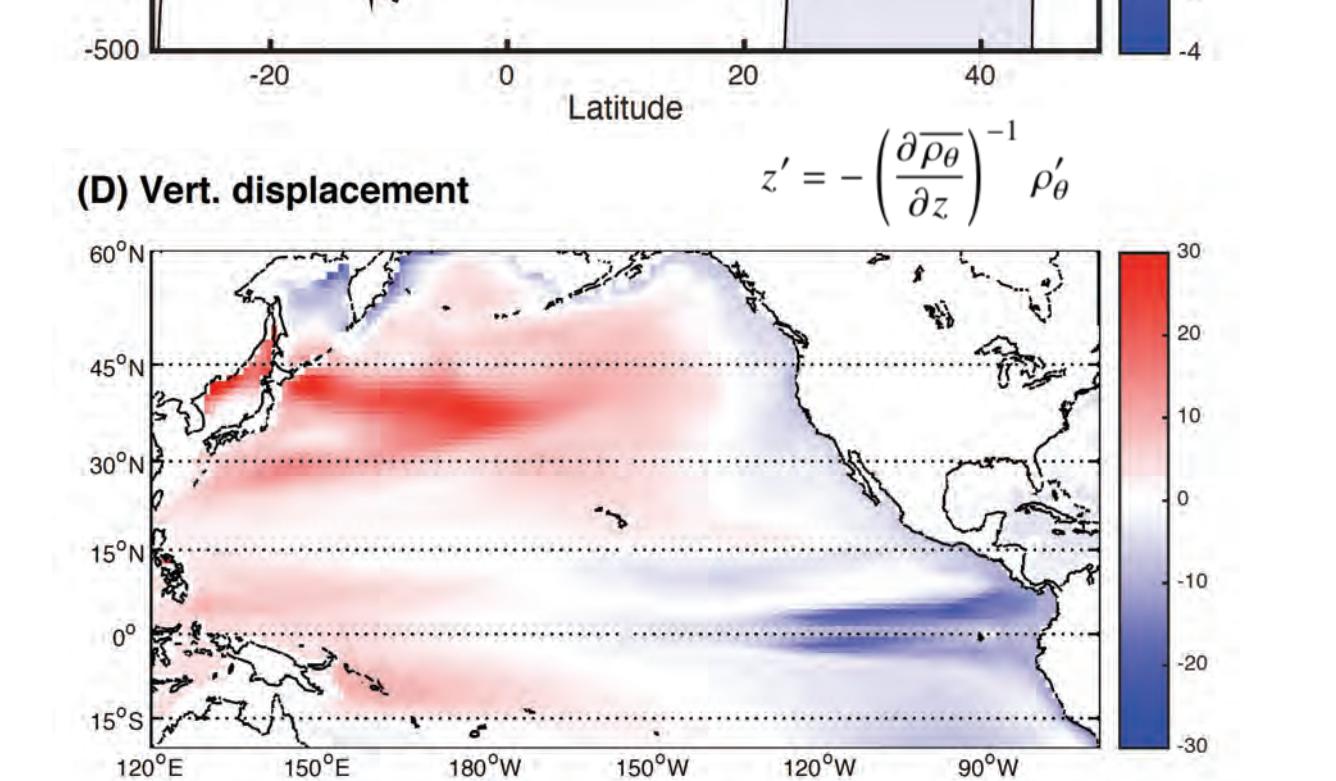
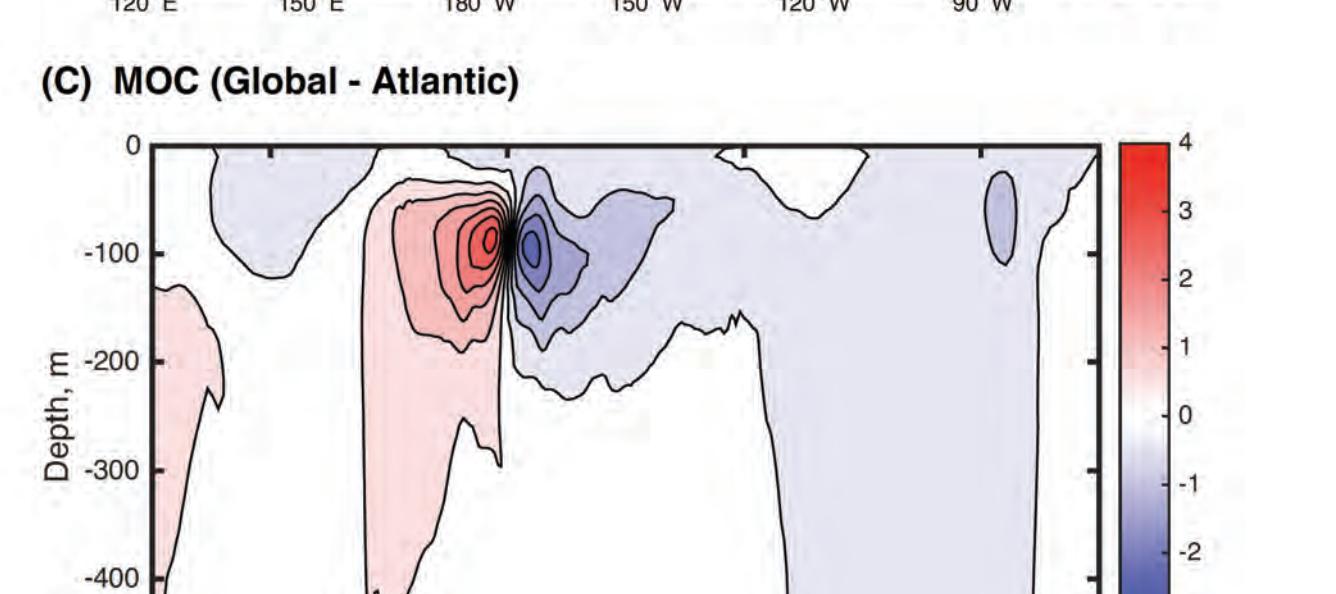
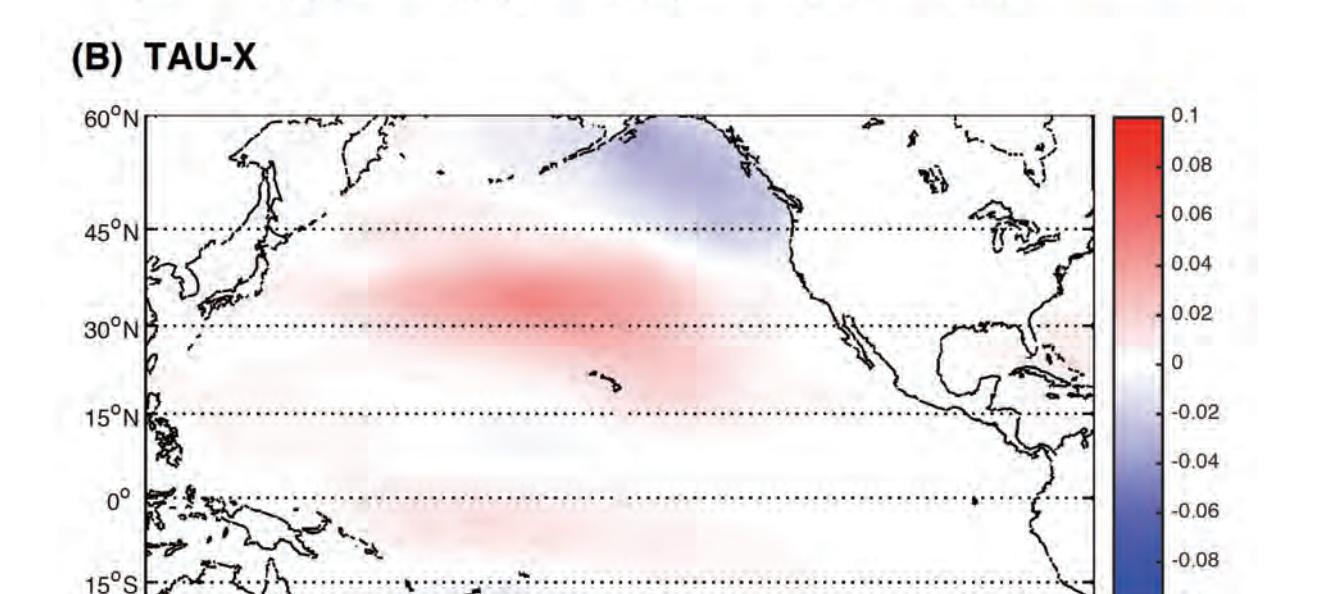
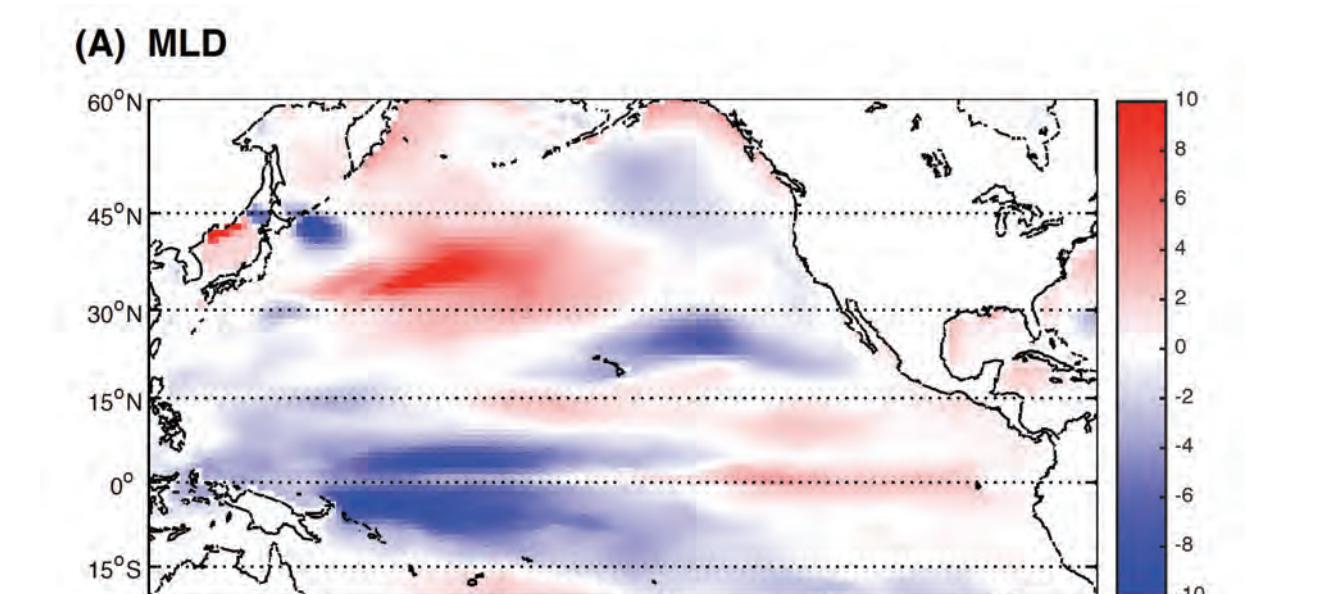


### PDO-O<sub>2</sub>,res relationship

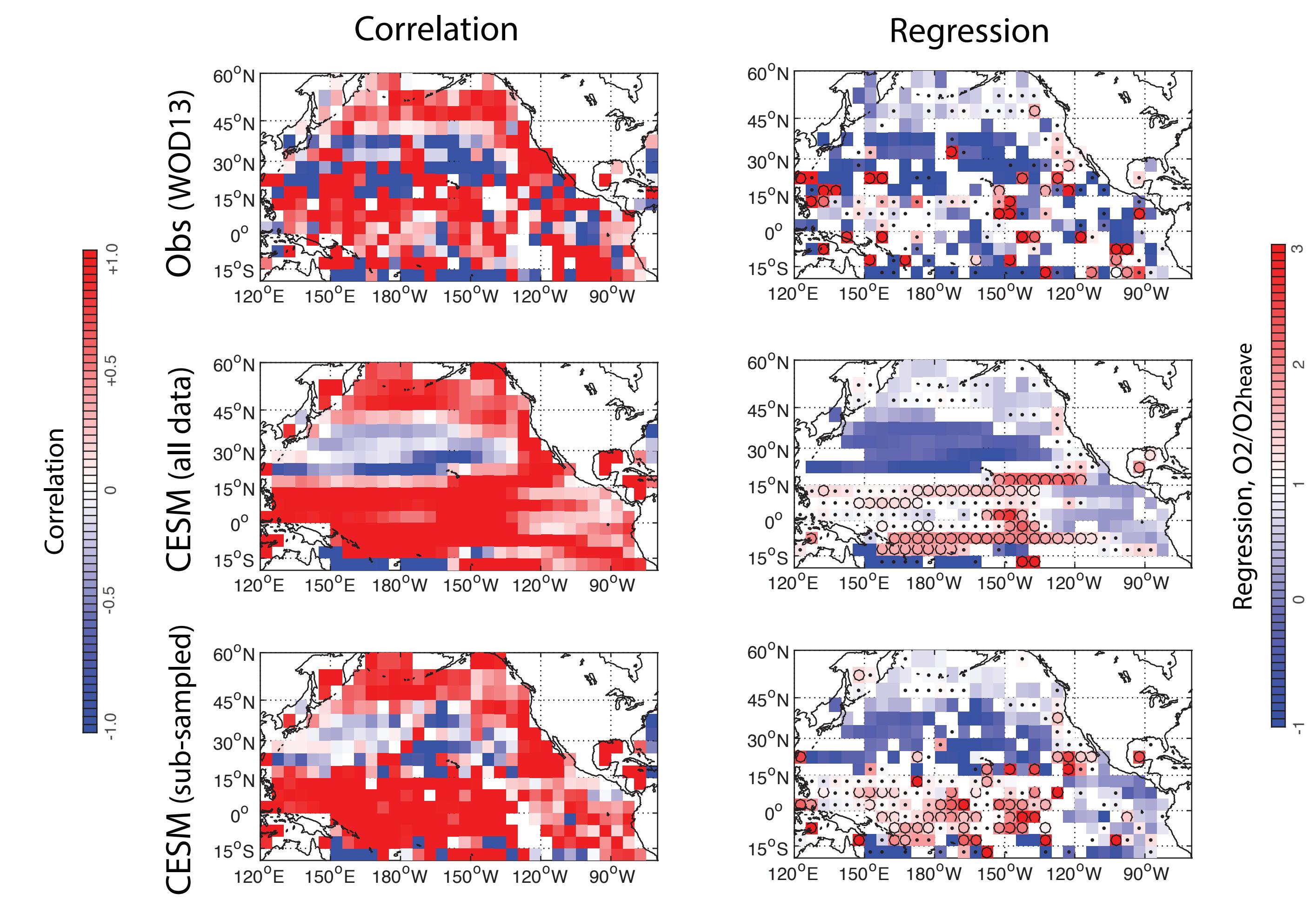


- Under a warm PDO phase, mid-latitude westerly gets stronger, winter MLD deepens, subtropical cell slows down, and isopycnals shift vertically.

## PDO impacts on ventilation and water mass shifts



## Heave and O<sub>2</sub>: beyond PDO



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