SFB 754 | Ocean Deoxygenation: Drivers and Consequences · Past · Present · Future ·

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Mechanisms of low-frequency oxygen variability in the North Pacific

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This study investigates the mechanisms of interannual and decadal variability of dissolved oxygen (O_2) in the North Pacific using historical bottle O_2 data and a physical-biogeochemical hindcast simulation. An ocean-ice configuration of the Community Earth System Model (CESM) is used to for the hindcast. The simulated variability of upper ocean (200m) O_2 is broadly consistent with observations in the western and eastern Pacific where sampling density is relatively higher. The dominant mode of O_2 variability in this depth range explains 24.8% of the variance and is significantly correlated with the Pacific Decadal Oscillation (PDO) index ($r = 0.68$). Two major mechanisms are proposed as null hypotheses by which the PDO controls O_2 variability. Vertical movement of isopycnals ("heave") may drive O_2 variability in deep tropics. Isopycnal surfaces are depressed in the eastern tropics under the positive (El Nino-like) phase of PDO, leading to O_2 increases in the upper water column. In contrast to the tropics, changes in subduction associated with the PDO are the primary control on extra-tropical O_2 variability. These hypotheses are tested by contrasting the anomalies of O_2 and heave-induced O_2 where the latter is calculated from potential density anomalies. At 200m depth, isopycnal heave is the leading control on O_2 variability except for the central subtropics, downstream of the subduction region. Further examination of the amplitude of O_2 anomealies reveals that the null hypothesis cannot fully explain the tropical O_2 variability, likely indicating the reinforcing changes in the biological O_2 consumption. These mechanisms, synchronized with the PDO, develops a basin-scale pattern of O_2 variability that are comparable in magnitude to the projected rates of ocean deoxygenation in this century.

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