

Observed strengthening of the Pacific Equatorial Undercurrent in the SODA record: coupled mechanisms, ocean dynamics, and implications

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The Pacific equatorial undercurrent (EUC) plays a crucial role in global climate and geochemical cycles. It delivers cold, CO₂ - and nutrient-rich water to the eastern Pacific where it feeds the cold tongue. Here, EUC water contributes to the largest oceanic source of atmospheric CO₂ and to maintaining the zonal sea surface temperature (SST) gradient across the Pacific. This thermal gradient is one of the primary drivers of tropical Pacific atmospheric circulation, which affects global weather patterns and climate. Thus, changes in EUC intensity could have dramatic geochemical and climatic repercussions.

Long-term trends in the SODA reanalysis indicate that the EUC has strengthened by as much as 16% since the mid-nineteenth century. Analysis of the zonal momentum budget in the equatorial Pacific explicitly diagnose the mechanisms responsible for this intensification and identify two dynamically distinct seasonal periods (boreal spring and summer) that account for the majority of the EUC's strengthening.

We propose that EUC intensification is key to reconciling the controversial and paradoxical co-occurrence of Walker circulation slow-down and zonal SST-gradient strengthening in the equatorial Pacific. Additionally, this provides support for the proposed ocean "thermostat" control on tropical Pacific circulation response to CO₂ forcing and reemphasizes that it is imperative for global climate models to rigorously incorporate ocean dynamics in order to produce accurate forecasts.