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Mechanism of Interannual Cross-equatorial Overturning Anomalies in the Pacific Ocean

The meridional overturning circulation (MOC) transports heat and mass within the ocean. MOC variations are driven by changes in wind stress and density. A recent study (Tandon et al., J. Phys. Oceanogr., 2020) has shown that interannual variability of the global MOC is dominated by variability in the Pacific MOC, and this variability is characterized by a prominent cross-equatorial cell (CEC) spanning the tropics between 20°S and 20°N. This CEC is a potentially important influence on interannual climate variability, but the mechanism responsible for this CEC is not understood. Our research seeks to elucidate the mechanism of the CEC. In this study, we investigate the CEC mechanism using version 4.2 of the Estimating the Circulation and Climate of the Ocean (ECCO) state estimate covering the period 1992-2011. Our analysis shows that the CEC is driven by the following mechanistic chain: 1) Interannual anomalies of meridional wind stress generate temperature anomalies near the equator. 2) These temperature anomalies in turn generate equatorially antisymmetric anomalies of sea surface height (SSH). 3) These SSH anomalies drive cross-equatorial flow in the upper Pacific Ocean (above approximately 1000 m). 4) This anomalous cross-equatorial flow in the upper Pacific drives compensating flow in the deep Pacific. This mechanism contrasts with that responsible for anomalous cross-equatorial overturning on seasonal timescales, which is primarily the Ekman response to equatorially antisymmetric anomalies of zonal wind stress (Jayne and Marotzke, Rev. Geophys., 2001). On interannual timescales, however, the zonal wind stress anomalies associated with the CEC are equatorially symmetric (rather than antisymmetric), and steric SSH variations are the dominant driver of the CEC.

Which theme does your abstract refer to?

Ocean and coupled reanalysis

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