Structure and dynamics of decadal variability of the meridional geostrophic transport in the tropical North Pacific Ocean in observations and in CMIP5 climate models

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The meridional geostrophic transports in the interior tropical and subtropical gyres of the North Pacific Ocean are estimated based on the hydrographic data of the Global Ocean Heat and Salt Content Data. The decadal to inter-decadal variations of the observed meridional geostrophic transports along 8ºN across the Pacific basin are found to precede the Pacific Decadal Oscillation (PDO) or the Inter-Pacific Decadal Oscillation (IPO) at the lead time of 3 to 5 years above the 95% significance level. This result suggests that the decadal variability of the Pacific is predictable if the meridional transport of the tropical gyre is used as a precursor. However, this predictability is not found in the CMIP5 coupled simulations and in the OFES ocean simulation, suggesting significant deficiencies of these oceanic and climate system models in simulating and predicting the decadal variability of the Pacific Ocean. The dynamics of the meridional transports are investigated using the Sverdrup theory. The simulated meridional transport anomalies in the CMIP5 and the OFES models are consistent with the Sverdrup theory at the decadal time scales, suggesting linear dynamics of the variability, whereas the observed meridional geostrophic transport anomalies differ from the Sverdrup theory significantly in the tropical North Pacific Ocean. The comparison suggests that the model deficiencies in simulating and predicting the Pacific decadal variability are primarily due to the neglect of the nonlinear processes in the tropical ocean.

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