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Pacific interdecadal variability driven by tropical-subtropical interactions

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Interactions between the tropical and subtropical northern Pacific at decadal time scales are examined using uncoupled oceanic and atmospheric simulations. An atmospheric model is forced with observed Pacific sea surface temperatures (SSTs) and decadal anomalies, computed as the difference between the 2000-2009 and the 1990-1999 period, are sought. Negative decadal SST anomalies are found at the equator, with a global pattern reminiscent of the Interdecadal Pacific Oscillation (IPO). The equatorial SST anomalies are responsible for driving a weakening of the Hadley cell and atmospheric meridional heat transport. The atmosphere is then shown to produce a significant response in the subtropics, with wind stress curl anomalies in phase with the climatological mean but of opposite sign, consistent with a weakening of the oceanic subtropical gyre (STG). A global ocean model is then forced with the atmospheric decadal anomalies. In the northern Pacific, the shallow subtropical cell (STC) spins down and the meridional heat transport is reduced, resulting in positive equatorial SST anomalies. The final equatorial response is reached after the first 10 years of the experiment, consistent with Rossby wave adjustment for both the STG and the STC. The STC provides the connection between subtropical wind stress anomalies and equatorial SSTs. In fact, targeted simulations show the importance of off-equatorial wind stress anomalies in driving the oceanic response, whereas anomalous equatorial winds have no role in the SST signal reversal. We further explore the connection between STG, STC and equatorial SST with the help of an idealized model. We argue that, in our models, equatorial SST decadal variability stems from the forcing of the Pacific subtropical gyre through the atmospheric response to ENSO. The resulting Ekman pumping anomaly alters the STC and oceanic heat transport, providing a negative feedback on the SST. We thus suggest that extratropical atmospheric responses to tropical forcing have feedbacks on the ocean dynamics that lead to a time-delayed response of the tropical oceans, giving rise to a possible mechanism for multidecadal ocean-atmosphere coupled variability.