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Ocean-atmosphere coupled Pacific Decadal variability simulated by a climate model

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Currently, the mechanisms for Pacific Decadal Oscillation (PDO) are still disputed, and in particular the atmosphere response to the ocean in the mid-latitude remains a key uncertainty. In this study, we investigate two potential feedbacks – a local positive and a delayed negative – for the PDO based on a long-term control simulation using the ECHAM5/MPI-OM coupled model, due to its robust performance in reproducing the variability of PDO. The positive feedback is as follows. In PDO positive phase, the meridional sea surface temperature (SST) gradient is intensified and this strengthens the lower level atmospheric baroclinicity in the mid-latitudes, leading to the enhancement of Aleutian low and zonal wind. These atmospheric changes reinforce the meridional SST temperature gradient through the divergence of ocean surface currents. The increased heat flux loss over the anomalously warm water and decreased heat flux loss over the anomalously cold water in turn reinforce the lower atmospheric meridional temperature gradient, baroclinicity and atmospheric circulation anomalies, forming a local positive feedback for PDO. The delayed negative feedback arises, because the intensified meridional SST gradient also generates an anticyclonic wind stress in the central North Pacific, warming the upper ocean by Ekman convergence, and then the warming upper ocean enhances the Kuroshio and transports warm water to the mid-latitudes in the western North Pacific that finally reduces the meridional SST gradient after 18 years of the peak PDO phase. These results demonstrate the significant contributions of the meridional SST gradient, instead of the SST itself, for the evolution of PDO.