The Impact of North Pacific Atmospheric Variability on ENSO via the "Seasonal Footprinting Mechanism"

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Abstract

Previous studies suggest that the "seasonal footprinting mechanism" (SFM), in which fluctuations in the North Pacific Oscillation (NPO), a north south dipole in the sea level pressure pattern influence the ocean. NPO-related surface heat fluxes during winter drive subtropical SST anomalies in spring, which alter the atmosphere-ocean system over the tropics in the following summer, and can influence the development of ENSO events in the following fall and winter. Here, we test the SFM hypothesis by imposing NPO-related surface heat flux forcing in an atmospheric GCM coupled to a reduced gravity ocean model in the tropics and a slab ocean in the extratropics. The forcing is only imposed through the first winter and then the model is free to evolve through the following winter. The evolution of the coupled model response to the forcing is consistent with the SFM hypothesis: the NPO-driven surface fluxes cause positive SST anomalies to form in the central and eastern subtropics during winter; these anomalies propagate towards the equator along with westerly wind anomalies during spring and reach the equator in summer and then amplify, leading to an ENSO event in the following winter. The anomalies reach the equator through a combination of thermodynamically coupled air-sea interactions and equatorial ocean dynamics. The NPO forcing caused warming in the ENSO region in ~70% of the simulations. The impact of the forcing on individual events depends on the state of the tropical atmosphere-ocean system and the evolution of the feedback to the forcing, which has implications for both interannual and decadal variability throughout the Pacific. We will also examine whether the SFM is apparent in CCSM4, NCAR's recently released climate model.