The Role of Extratropical Cooling/Warming in Determining the Level of El Nino–Southern Oscillation (ENSO) Activity

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The coupled model of the Institute of Atmospheric Physics (IAP) is used to investigate the effects of extratropical cooling and warming on the tropical Pacific climate. The IAP coupled model is a fully coupled GCM without any flux correction. The model has been used in many aspects of climate modeling, including the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) climate change and paleoclimate simulations. In this study, the IAP coupled model is subjected to cooling or heating over the extratropical Pacific.

Consistent with earlier findings, an elevated (reduced) level of ENSO activity in response to an increase (decrease) in the cooling over the extratropical region is found. The changes in the time-mean structure of the equatorial upper ocean are also found to be very different between the case in which ocean–atmosphere is coupled over the equatorial region and the case in which the ocean–atmosphere over the equatorial region is decoupled. For example, in the uncoupled run, the thermocline water across the entire equatorial Pacific is cooled in response to an increase in the extratropical cooling. In the corresponding coupled run, the changes in the equatorial upper-ocean temperature in the extratropical cooling resemble a La Nina situation—a deeper thermocline in the western and central Pacific accompanied by a shallower thermocline in the eastern Pacific. Conversely, with coupling, the response of the equatorial upper ocean to extratropical cooling resembles an El Nino situation. These results ascertain the role of extratropical ocean (and therefore the polar latitudes) in determining the amplitude of ENSO. The results also underscore the importance of ocean–atmosphere coupling in the interaction between the tropical Pacific and the extratropical Pacific.