Interactions between the Responses of North American Climate to El Niño/La Niña and to Secular Warming Trend in the Indian-Western Pacific Oceans

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The modulation of El Niño and La Niña responses by the long-term sea surface temperature (SST) warming trend in the Indian-Western Pacific (IWP) Ocean has been investigated using a large suite of sensitivity integrations with atmospheric general circulation models. These model runs entail the prescription of anomalous SST conditions corresponding to composite El Niño or La Niña episodes, to SST increases associated with secular warming in IWP, and to combinations of IWP warming and El Niño/La Niña. These SST forcings are derived from observations in the 1950-2000 period, as well as from coupled model simulations and projections based on the climate settings of the 1951-2000 and 2001-2050 epochs, respectively. Emphasis is placed on the wintertime responses in 200-mb height and various indicators of surface climate in the North American sector.

The model responses to El Niño and La Niña forcings are in agreement with the observed interannual anomalies associated with warm and cold episodes occurring in the 1950-2000 era. The wintertime model responses in North America to IWP warming bear a distinct positive (negative) spatial correlation with the corresponding responses to La Niña (El Niño). Hence the amplitude of the combined responses to IWP warming and La Niña is notably higher than that to IWP warming and El Niño. As the SST continues to rise in the IWP sector, the strength of various meteorological anomalies accompanying La Niña (El Niño) will increase (decrease) with time. The response of North American climate and the zonal mean circulation to the combined effects of IWP forcing and La Niña (El Niño) is approximately equal to the linear sum of the separate effects of IWP warming and La Niña (El Niño).

The summertime responses to IWP warming bear some similarity to the meteorological anomalies accompanying extended droughts and heat waves over the continental U.S.