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The role of linear interference in the Annular Mode response to tropical SST forcing

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Recent observational and modeling studies have demonstrated a link between eastern tropical Pacific Ocean (TPO) warming associated with the El Niño-Southern Oscillation and the negative phase of the wintertime northern Annular Mode (NAM). The TPO-NAM link involves a Rossby wave teleconnection from the Tropics to the extratropics, and an increase in polar stratospheric wave driving that in turn induces a negative NAM anomaly in the stratosphere and troposphere. Previous work further suggests that tropical Indian Ocean (TIO) warming is associated with a positive NAM anomaly, which is of opposite sign to the TPO case. To better understand the dynamics of tropical influences on the NAM, we investigate the NAM response to imposed TPO and TIO warmings in two atmospheric general circulation models. The NAM responses to the two warmings have opposite sign and can be of surprisingly similar amplitude even though the TIO forcing is relatively weak. It is shown that the sign and strength of the NAM response is often simply related to the phasing, and hence the linear interference, between the Rossby wave response and the climatological stationary wave. The TPO (TIO) wave response reinforces (attenuates) the climatological wave and therefore weakens (strengthens) the stratospheric jet and leads to a negative (positive) NAM response. In a suite of sensitivity tests, we demonstrate a simple scaling between the strength of the tropical SST forcing, the tropical convective heating response and the strength of the forced extratropical Rossby wave. However, in all cases the NAM response is dominated by linear interference effects, which are highly sensitive to a combination climatological and forced wave structure. Thus, prediction of the extratropical response to tropical forcing depends on knowledge of both the phase and amplitude of the Rossby waves.