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A model study of the dependence of stratosphere Southern Annular Mode events on ENSO

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A multi-level PE model is used to investigate the dependence of stratospheric Southern Annular Mode (SAM) events on ENSO. The model flow is radiatively relaxed toward El Niño, La Niña, and neutral background flows for the austral spring. Relative to climatology, the El Niño tropospheric background flow has a stronger subtropical jet, and a weaker midlatitude eddy-driven jet. The La Niña background flow shows opposite characteristics. For the El Niño run, compared to the neutral run, on the poleward side of the eddy-driven jet, more frequent synoptic-scale wave breaking along with enhanced vertical planetary wave propagation is found. These planetary waves decelerate the stratospheric polar vortex and excite the negative phase of SAM in the stratosphere. For the La Niña run, a reduction in synoptic-scale wave breaking and vertical planetary wave propagation leads to a stronger stratospheric polar vortex and the excitation of the positive phase of SAM in the stratosphere.

These differences in vertical planetary wave propagation are attributed to the impact of the El Niño and La Niña background flows on the frequency of synoptic-scale wave breaking and the subsequent upscale energy cascade and generation of planetary waves. For both SAM phases, these events are followed by the downward descent of SAM anomalies into the troposphere. This coupling process between the troposphere and stratosphere results in the preference of the positive (negative) phase of SAM events during La Niña (El Niño).