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A simple GCM model study on the relationship between ENSO and the Southern Annular Mode

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This study examines the relationship between (El Niño/Southern Oscillation) ENSO and Southern Annular Mode (SAM) events during austral spring with an idealized general circulation model. A series of model calculations are performed to address basic dynamical questions such as why positive (negative) intraseasonal SAM events are observed to occur much more frequently during La Niña (El Niño). Seven different model runs are performed; a control run, three El Niño and three La Niña runs, each with a fixed heating field. For the set of three El Niño (La Niña) runs, the first run has a zonally-symmetric heating (cooling) field, the second run a zonally-asymmetric heating/cooling field, and the third run combines both fields.

The model runs with the full heating field are found to yield the same relationship between the phase of ENSO and the preferred phase for SAM events as is observed in the atmosphere. The same (opposite) phase relationship between ENSO and the SAM events was found in the model runs that included only zonally-symmetric (zonally-asymmetric) heating. Since a reduced (increased) midlatitude meridional potential vorticity gradient has been linked to a greater frequency of positive (negative) phase SAM events, the meridional potential vorticity gradient in the various model runs was compared. It was found that the zonally symmetric tropical heating associated with El Niño (La Niña) strengthens (weakens) the midlatitude meridional potential vorticity gradient. In contrast, for the runs with zonally asymmetric heating, the opposite relationship between ENSO and the meridional potential vorticity gradient is obtained. For all model runs, these alterations to the meridional potential vorticity gradient occurred through changes to the midlatitude synoptic-scale eddy heat and momentum fluxes. These results suggest that the phase preference of SAM events during ENSO arises from the impact of the zonal mean heating on the midlatitude meridional potential vorticity gradient.