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The Effect of Tropospheric Jet Latitude on Rossby Wave Breaking and on Coupling between the Stratospheric Polar Vortex and the Troposphere

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A dry General Circulation Model is used to investigate how the latitude of the tropospheric jet affects (1) coupling between the stratospheric polar vortex and the extratropical tropospheric circulation, and (2) Rossby wave breaking. The tropospheric response to an identical stratospheric vortex configuration is shown to be strongest for a jet centered near 40° and weaker for jets near either 30° or 50° by more than a factor of three. Stratosphere-focused mechanisms based on stratospheric potential vorticity inversion, eddy phase speed, and planetary wave reflection, as well as arguments based on tropospheric eddy heat flux and zonal length scale, appear to be incapable of explaining the differences in the magnitude of the jet shift. In contrast, arguments based purely on tropospheric variability involving the strength of eddy-zonal mean flow feedbacks and jet persistence, and related changes in the synoptic eddy momentum flux, appear to explain this effect. The dependence of coupling between the stratospheric polar vortex and the troposphere on tropospheric jet latitude found here is consistent with (1) the observed variability in the North Atlantic and the North Pacific, and (2) the trend in the Southern Hemisphere as projected by comprehensive models.

The shift in wavebreaking per degree latitude of jet shift is then compared for three different sources of jet movement: the baroclinic forcing imposed by the equator-to-pole temperature gradient, the imposition of a stratospheric polar vortex, and the internal variability of the mid-latitude eddy driven jet. It is demonstrated that all three sources of jet movement produce a similar change in Rossby wave breaking frequency per degree of jet shift. Hence, it is difficult (if not impossible) to isolate the ultimate cause behind the shift in Rossby wave breaking in response to the two external forcings.