

Annular Modes in the Tropical Circulation

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Annular modes in the extratropics have received much attention for their insight into the dynamics of the midlatitude atmosphere and their predictive utility. However, the tropics have received much less attention, as the amplitude of geopotential anomalies there is comparatively small. Recent work by Gerber and Thompson (2017) found that the tropical circulation is in many ways more dynamically annular (exhibiting positive correlations around a latitude circle) than the extratropical circulation (which exhibits primarily a statistical annularity). This study explores the annularity of the tropical circulation and relates it to existing understanding of tropical dynamics.

We examine varying definitions of the tropical annularity using reanalyses and a hierarchy of models. The results suggest that a simple index based on zonal mean geopotential height at the equator well quantifies the annular variability of the tropics. This tropical annular mode is partially related to known modes of variability in the stratosphere (the Semi-Annual Oscillation and Quasi-Biennial Oscillation) and, more weakly, in the troposphere (the El-Nino/Southern Oscillation and Madden-Julian Oscillation), but overall captures new dynamics. The models allow us to probe the impact of zonal asymmetries (topography and SSTs) and moist processes on the annular variability. The meridional structure of the modes is strongly influenced by topography and sea surface temperatures, and we find a surprising zonal asymmetry in the upper troposphere. We also investigate the vertical structure of the annular motions, which like the extratropical annular modes, evidences stratosphere-troposphere coupling. Within the troposphere, however, we find evidence of downward propagation from the tropopause to the surface on a time scale of 10 days, followed by a somewhat weaker upward propagating signal. Further study with a hierarchy of idealized models suggests that vertical propagation is associated with convectively-coupled waves. Implications of tropical annularity for atmospheric predictability will also be discussed.

Key words: atmospheric dynamics, annular modes, tropical waves, idealized modeling, predictability

References

Gerber, E. and D. Thompson, 2017: *Journal of the Atmospheric Sciences*, **70**, 317–332.