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Three-dimensional Quasi-Geostrophic Convection in the Rotating Cylindrical Annulus with Steeply Sloping Endwalls[1] KEITH JULIEN, MICHAEL CALKINS, PHILIPPE MARTI, University of Colorado at Boulder —
The rotating cylindrical annulus geometry was first developed by Busse (JFM 1970) as a simplified analogue for studying convection in rapidly rotating spherical geometries. Though it has provided a more tractable two-dimensional model than the sphere, it is formally limited to asymptotically small slopes and thus weak velocities in the direction parallel to the rotation axis. We present an asymptotically reduced three-dimensional equation set to model quasi-geostrophic convection in the annulus geometry where order one slopes are permissible; this model provides a closer analogue to quasi-geostrophic convection in spheres and spherical shells where steeply sloping boundaries are present. A linear stability analysis of the reduced equations shows that a new class of three-dimensional, convectively-driven Rossby waves is present in this system. The gravest modes exhibit strong axial variations as the slope of the boundaries becomes large. Additionally, higher-order eigenmodes showing increasingly complex axial dependence are found that possess critical Rayleigh numbers close to that of the gravest mode.

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