Effects of radial distribution of thermal diffusivity on critical modes of anelasticthermal convection in rotating spherical shells

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Linear stability analysis of anelasitc thermal convection in a rotating spherical shell with thermal diffusivities varying in the radial direction is performed. The structures of critical convection are obtained in the cases of four different radial distributions of thermal diffusivity; (1) κ is constant, (2) κT_0 is constant, (3) $\kappa \rho_0$ is constant, and (4) $\kappa \rho_0 T_0$ is constant, where κ is the thermal diffusivity, T_0 is the temperature of basic state, and ρ_0 is the density of basic state, respectively. The ratio of inner and outer radii, the Prandtl number, the polytrope index, and the density ratio are 0.35, 1, 2, and 5, respectively. The value of the Ekman number is 10^{-3} or 10^{-5} . In the case of (1), where the setup is same as that of the anelastic dynamo benchmark (Jones et al., 2011), the structure of critical convection is concentrated near the outer boundary of the spherical shell around the equator. However, in the cases of (2), (3) and (4), the convection columns attach the inner boundary of the spherical shell.

A rapidly rotating annuls model for anelastic systems is developed by assuming that convection structure is uniform in the axial direction taking into account the strong effect of Coriolis force. The annulus model well explains the characteristics of critical convection obtained numerically, such as critical azimuthal wavenumber, frequency, Rayleigh number, and the cylindrically radial location of convection coulumns.

The radial distribution of thermal diffusivity is important for convection structure, because it determines the distribution of radial basic entropy gradient which is crucial for location of convection columns.

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