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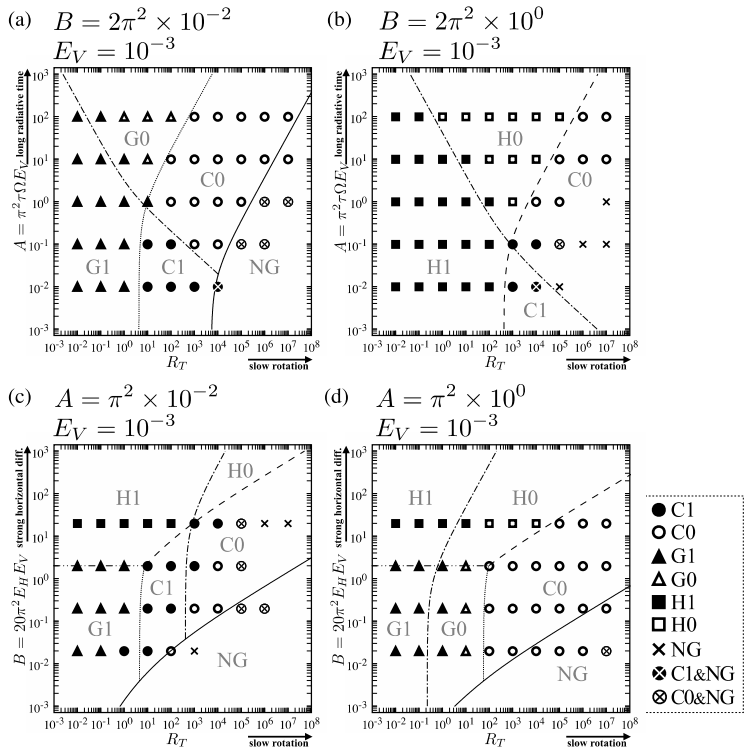

Figure 1. Theoretically obtained regime diagrams (boundaries are shown by curves with five line types) and numerically obtained distribution of the regimes (plotted by signs described in the legend) at R_T-A cross sections (a, b) and R_T-B cross sections (c, d). R_T is the external thermal Rossby number, A is a non-dimensional measure of radiative forcing, and B is that of horizontal diffusion. There are six regimes based on the dynamical balance shown by C1, C0, G1, G0, H1, and H0, where the balance is cyclostrophic (C•), geostrophic (G•), or horizontal diffusion (H•) balance with the meridional temperature difference mainly determined by radiative heating (•1) or thermal advection (•0). NG region displays the parametric limit of the theoretical model predicted by our analysis; cross signs indicate non-Gierasch-mechanism solutions obtained numerically. Signs of cross with circle show that multiple equilibrium solutions are obtained.

- This paper presents regime diagrams showing the parametric dependence of dynamical balance in a superrotating atmosphere produced in a quasi-axisymmetric idealized system with strong horizontal diffusion studied previously by the present authors (Yamamoto and Yoden 2013). In this system, the superrotation is maintained by the Gierasch (1975) mechanism.
- Boundaries of the regimes based on the dynamical balance (denoted by C1, C0, G1, G0, H1, and H0) are determined by analyzing the theoretical model proposed in Yamamoto and Yoden. A parametric limit showing a lower limit for the horizontal diffusion in the Gierasch mechanism is also estimated from the theoretical model and included in the regime diagrams (NG).
- The theoretical regime diagram tells us that the superrotation in the cyclostrophic balance is realized when the horizontal Ekman number is in a certain range of two to three orders as shown by the shape of C1 and C0 regions in panels (c) and (d). Its width is mainly controlled by the vertical Ekman number.
- Compared with numerical solutions, the theoretical regime diagrams agree well with the numerical results in most regions, showing the validity of the theoretical model. The fact that multiple equilibrium solutions are obtained in NG region as in panel (a) shows that the Gierasch mechanism can maintain the superrotation even with the horizontal diffusion weaker than the predicted lower limit but cannot generate it from a motionless state.