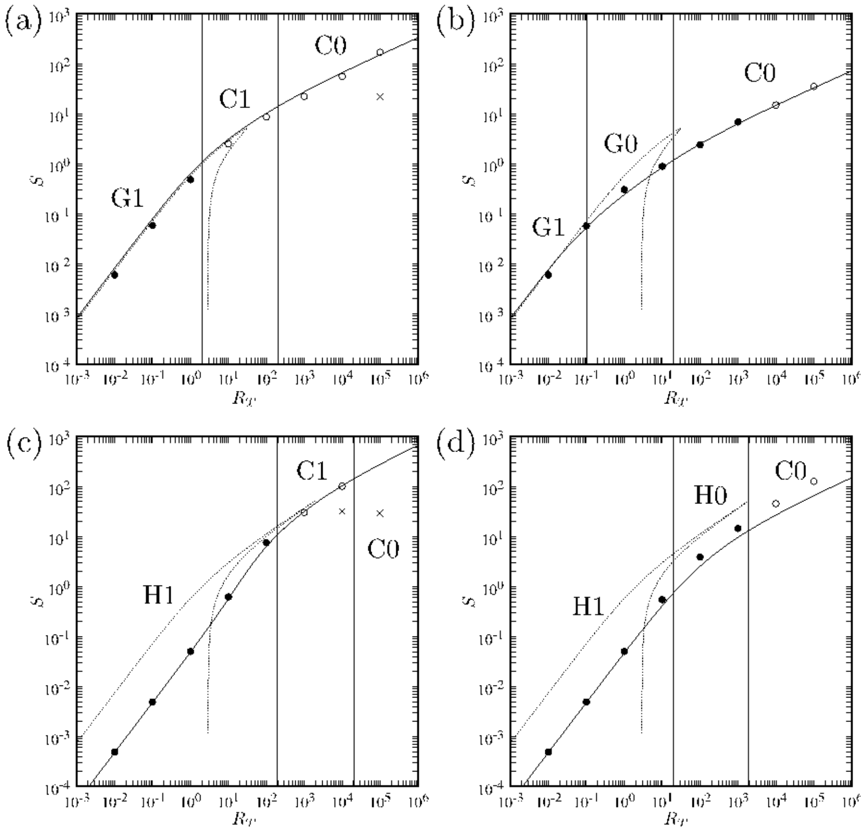
Yamamoto, H., and S. Yoden, 2013: Theoretical estimation of the superrotation strength in an idealized quasi-axisymmetric model of planetary atmospheres. *J. Meteor. Soc. Japan*, **91**, 119–141. http://dx.doi.org/10.2151/jmsj.2013-203

Figure: Superrotation strength plotted against R_T for four cases:



(a) $A = \pi^2 \times 10^{-2}$, $B = 2\pi^2 \times 10^{-2}$,
(b) $A = \pi^2$, $B = 2\pi^2 \times 10^{-2}$,
(c) $A = \pi^2 \times 10^{-3}$, $B = 2\pi^2$, and
(d) $A = \pi^2 \times 10^{-1}$, $B = 2\pi^2$.
Solid curves show the theoretical estimates. Circles show the numerical results (solid ones for steady states and open ones for statistically steady state). Dotted curves denote Matsuda's (1980) estimates. C1, C0, G1, G0, H1, and H0 indicate the estimated types of the dominant dynamical balance. Cross symbols indicate the numerical results in which the Gierasch (1975) mechanism does not work.

- This paper presents a theoretical estimation of the strength of equatorial superrotation in planetary atmospheres by exploring quasi-axisymmetric primitive equations with the effects of non-axisymmetric eddies parameterized by strong horizontal eddy diffusion. In this system, the superrotation is maintained by the Gierasch (1975) mechanism.
- A quintic equation for the superrotation strength is developed from the primitive equations; estimates are given by its unique positive solution. The solution depends only on three non-dimensional parameters: the external thermal Rossby number (R_T), the ratio of the radiative relaxation time to the timescale for the vertical diffusion ($A \equiv \pi^2 \tau \Omega E_V$), and the square of the ratio of the planetary rotation period to the geometric mean of the timescales for the horizontal and vertical diffusion ($B \equiv 20\pi^2 E_H E_V$).
- The parameter dependence of the dominant dynamical balance is also investigated. The balance is a cyclostrophic (C•), geostrophic (G•), or horizontal diffusion balance (H•), and in each balance, the equator-to-pole temperature difference is either nearly equal to that in radiative-convective equilibrium state (•1) or significantly reduced by thermal advection (•0).
- Numerical solutions of the primitive equations are obtained for a wide parameter range and the obtained superrotation strength (solid and open circles in the figure) agrees well with the theoretical estimation (solid curves), showing the validity of the present theory.