Geophysical Research Abstracts
Vol. 18, EGU2016-3662, 2016
EGU General Assembly 2016

A cyclostrophic transformed Eulerian zonal mean model for the middle atmosphere of slowly rotating planets

King-Fai Li (1), Kaixuan Yao (2), Cameron Taketa (1), Xi Zhang (3), Mao-Chang Liang (4), Xun Jiang (5), Claire Newman (6), Ka-Kit Tung (1), and Yuk L. Yung (7)

(1) University of Washington, Seattle, Washington, United States (kfli@uw.edu), (2) The Chinese University of Hong Kong, Hong Kong, (3) University of California, Santa Cruz, California, United States, (4) Academia Sinica, Taiwan, (5) University of Houston, Huston, Texax, United States, (6) Ashima Research, Pasadena, California, United States, (7) California Institute of Technology, Pasadena, California, United States

With the advance of modern computers, studies of planetary atmospheres have heavily relied on general circulation models (GCMs). Because these GCMs are usually very complicated, the simulations are sometimes difficult to understand. Here we develop a semi-analytic zonally averaged, cyclostrophic residual Eulerian model to illustrate how some of the large-scale structures of the middle atmospheric circulation can be explained qualitatively in terms of simple thermal (e.g. solar heating) and mechanical (the Eliassen-Palm flux divergence) forcings. This model is a generalization of that for fast rotating planets such as the Earth, where geostrophy dominates (Andrews and McIntyre 1987). The solution to this semi-analytic model consists of a set of modified Hough functions of the generalized Laplace's tidal equation with the cyclostrohpic terms. As an example, we apply this model to Titan. We show that the seasonal variations of the temperature and the circulation of these slowly-rotating planets can be well reproduced by adjusting only three parameters in the model: the Brunt–Väisälä bouyancy frequency, the Newtonian radiative cooling rate, and the Rayleigh friction damping rate. We will also discuss an application of this model to study the meridional transport of photochemically produced tracers that can be observed by space instruments.