Geophysical Research Abstracts
Vol. 13, EGU2011-495, 2011
EGU General Assembly 2011

Terrestrial planetary atmospheric circulation regimes in a simplified GCM

Yixiong Wang and Peter Read
University of Oxford, United Kingdom (wang@atm.ox.ac.uk)

Terrestrial planetary bodies within the Solar System present us with impressively contrasting atmospheric general circulation regimes. From a physicist's point of view, all of these planets' atmospheres can be abstracted as rotating stratified fluids under the forcing of differential heating. Laboratory studies of viscous stratified rotating fluids over a considerable range of parameter conditions have been detailedly investigated for quite a long time, producing a series of well-defined regime diagrams depicting the parameter dependence of the fluid behaviour. This inspires us that similar studies on the parameter dependence of planetary atmospheric circulations could be conducted numerically using simplified GCMs which, like the rotating annulus in laboratory experiments, capture only the essential physics of the general circulation system.

In this contribution, we present our numerical exploration of a parameter space constructed by several defining dimensionless characterising parameters. Experiments were conducted using PUMA, a simplified GCM with linear physics (Newtonian cooling and Rayleigh friction), which could be viewed as a "prototype" atmosphere of terrestrial planets. The dependence of general circulation patterns on planetary rotation rate, radiative relaxation timescale, and frictional timescale etc. was investigated. And corresponding dimensionless parameters like thermal Rossby number has been constructed. The trends we observe in these experiments indicate that prediction of the structure of circulation or even climate on extra-solar terrestrial planets can be made, at least semi-quantitatively. This, together with the science community's growing interest in Earth-like exoplanets, brings a new topicality of habitability issue to this kind of fundamental study. Future work will include investigation of a much wider domain of the parameter space, with the aid of a simple non-grey radiative-convective scheme replacing the current Newtonian cooling in PUMA.