Geophysical Research Abstracts
Vol. 15, EGU2013-2597-2, 2013
EGU General Assembly 2013

Turbulence in Planetary Atmospheres

Petros Ioannou (1) and Brian Farrell (2)

(1) Department of Physics, National and Kapodistrian University of Athens, Athens, Greece (pjioannou@phys.uoa.gr), (2) School of Engineering and Applied Sciences, Harvard University, Cambridge, U.S.A. (farrell@seas.harvard.edu)

A survey of the solar system reveals a variety of turbulent regimes in the large scale circulation of planetary atmospheres. These regimes include convectively forced turbulence in Jupiter's atmosphere and self maintained baroclinic turbulence in the Earth's midlatitude atmosphere. A general theory of turbulent equilibria, Stochastic Structural Stability Theory (SSST), and its expression in mechanistic models for the maintenance of statistically steady turbulent states in planetary atmospheres will be described and applied to obtain the turbulent equilibria that determine the general circulation of Jupiter's atmosphere and of the Earth's midlatitude atmosphere. Among the phenomena explained by the statistically steady fixed points of the SSST system are spontaneous self organization of turbulent flows into large spatial scale jets; geophysical examples of which include the Jovian banded winds and the Earth's polar front jet. The theory reveals the existence of a manifold of nonlinear equilibria in planetary turbulence corresponding to different climate regimes. Also explained is emergence of marginally stable, highly non-normal equilibria in baroclinic turbulence. These states characterize both observations and simulations of strongly turbulent baroclinic flows and are referred to generically as baroclinically adjusted states. The baroclinically adjusted state is revealed to be not simply a marginally stable state but to have the structure of a specific fixed point equilibrium. In addition it will be shown that these equilibria naturally imply power law relations such as that between heat flux and temperature gradient.