Geophysical Research Abstracts
Vol. 15, EGU2013-232-1, 2013
EGU General Assembly 2013

Emergence of large scale structures in beta plane turbulence

Nikolaos Bakas and Petros Ioannou
National and Kapodistrian University of Athens, Department of Physics, Athens, Greece (nikos.bakas@gmail.com)

Turbulent flows are observed to be self-organized into large scale structures such as zonal jets and coherent vortices. The simplest model that retains the relevant dynamics is a barotropic flow in a beta-plane channel with turbulence sustained by random stirring. Non-linear integrations of this model show that as the energy input rate of the forcing is increased, the homogeneity of the flow is broken first by the emergence of non-zonal, coherent, westward propagating structures and second for larger energy input rates the emergence of zonal jets. We use a non-equilibrium statistical theory, Stochastic Structural Stability Theory (SSST), to address the emergence of these coherent structures. Employing the tools of SSST, we construct a coupled dynamical system governing the joint evolution of the coherent flow and of the second order statistics of the turbulent eddies. We then treat the structural stability of a homogeneous equilibrium with no mean flow analytically. We find that non-zonal and zonal coherent structures appear as the result of structural instability and equilibrate at finite amplitude. We also find that SSST accurately predicts the critical energy input rates for the emergence of both non-zonal and zonal coherent structures in the non-linear integrations as well as the characteristics (scale, amplitude and phase speed) of these structures.