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GTP/MMM Joint Seminar

National Center for Atmospheric Research

Inverse Energy Cascade, the Rhines Scale, Rossby Waves, and Large-Scale Circulations on Giant Planets and in the Terrestrial Oceans

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Abstract:

A notion of the cascade arrest in the context of continuously forced flows is revised using both theoretical analysis and numerical simulations. It will be demonstrated that the up-scale energy propagation cannot be stopped by a β-effect and can only be absorbed by friction. Furthermore, a β-effect cannot arrest the cascade in a sense of transition from a nonlinear turbulent regime to propagation of linear Rossby waves. The Rhines scale, L_R, has different meanings in different flows. In unsteady flows, for example, L_R can be identified with the moving "energy front"' propagating to ever smaller wave-numbers until stopped by the large-scale drag or the domain boundaries. In a steady-state, two-dimensional turbulence with a β-effect may develop various flow regimes which are classified in terms of a new non-dimensional parameter, R_β. Two of these regimes will be highlighted; a friction dominated one identified with macroturbulence, and a strongly anisotropic regime referred to as zonostrophic. In the latter, the Rhines scale is, in fact, a scale of the large-scale friction. Spectral analysis in the frequency domain demonstrates that L_R cannot be viewed as a scale separating turbulence and Rossby waves; it will be shown that Rossby waves coexist with turbulence on all scales including those much smaller than L_R. In the zonostrophic regime, the interaction between turbulence and waves is strong resulting in the distortion of the waves. Classification of various flows will be presented showing that in the Grenoble experiment and the terrestrial oceans the flows are marginally zonostrophic while in the weather layers of the solar giant planets the flows are strongly zonostrophic.

When:
11 October 2006
Wednesday, 10:30 a.m. (Refreshments will be served at 10:15am)

Where:
Foothills Lab Bldg 2
Room 1003

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