Geophysical Research Abstracts, Vol. 8, 06218, 2006
SRef-ID: 1607-7962/gra/EGU06-A-06218

Instabilities of a barotropic detached shear layer in a rotating fluid

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In this experiment, we seek new insights into the dynamics and instabilities of a barotropic detached shear layer. This work follows from previous studies, whose results were not entirely conclusive. We have been studying such a shear layer with flat, stepped or conical end walls in a cylindrical domain, using both laboratorial and numerical experiments. Hence, the effect of a topographically-induced 'planetary' vorticity gradient is explored.

The detached shear layer occurs tangential to two differentially rotating sections of adjustable height. Above a critical value of horizontal stress the flow is driven to an unstable limit, beyond which it develops chains of vortices organized in an azimuthal wave. Experimental velocity fields are obtained by particle tracking, whereas the detailed structure of the shear layer is resolved in the $rz-plane$, using a 2D Navier-Stokes computational model.

In most cases, the onset of instability is found to be in qualitative agreement with other theoretical predictions and results for the instability criterion. For opposite values of stress, we observe a weak asymmetry in the wavenumber which seems to depend on the relative height of the differentially rotating section and the rigid lid. In the near future we intend to implement the 3D version of the model and provide further analyses of the experimental data.