Geophysical Research Abstracts
Vol. 12, EGU2010-110-1, 2010
EGU General Assembly 2010

Background currents in the models of stratified fluid

Evgeny Ryzhov and Konstantin Koshel
Pacific Oceanological Institute of FEB RAS, Vladivostok, Russia (ryzhovea@poi.dvo.ru)

The background currents concept [1-2], used in the paper, gives a relatively simple opportunity to formulate various dynamically-consistent models of geophysical fluxes. In such cases, the background current is the one, characterized by the horizontal uniformly distribution of potential vorticity, which minimizing mechanic energy of a flow.

With the help of a systematic procedure of the background current construction [1], the three-layered model of inviscid uncompressible fluid has been obtained in the paper. A singular topographic bottom elevation is introduced into third bottom layer providing the quasigeostrophic approximation. Due to the elevation, disturbances on the layers separations arise in between of the fluid layers. These disturbances play the role of regular elevation in the upper and middle layer. Thus, using the background currents concept, three independent stream functions for each layers, describing a singular topographic flow in the bottom layer [3], and two regular flows in the upper and middle layer, have been formulated.

When the velocity of the inducing flow is equal to the definite value, vortical movement can arise in the upper and middle layers, whereas in the bottom layer due to the singular elevation a vortex always exists. Similar vortical distribution in the layers one can get by variation of the stratification parameters (widths and densities in the layers) under the fixed velocity of the inducing flow. Also by changing the above mentioned parameters, one can get the models of vortices with a various range of linear scales.

A harmonic perturbation of the inducing flow results in chaotic advection of particles in the vortical structures [2]. For our study, we use the term of the rotation frequency, it means the frequency of fluid particle rotation above an elliptical point. The shape of the rotation frequency curves under the unperturbed inducing flow, when the system parameters (widths, densities and velocities) vary, determines different chaotic advection patterns [2]. Also the distinct differences between the optimal for chaos developing frequency intervals of the perturbation in such cases are determined by this shape of the frequency curves.

Concerning the upper and middle regular layers, one can resume that these layers are equivalent. Indeed, by changing the geometrical system parameters and the inducing flow velocity, it is possible to get various sizes of the vortical structures and, hence, various curves of the rotation frequencies, which with accordance to [2] to determine the chaotic advection patterns of the system. In additional to work [2], which sufficiently detailed concerning the properties of a two-layered model, we can summarize that the dynamics in layers with a regular velocity field in such multilayer models is similar. That is one can find such parameters of the system, so dynamics of particles, for instance, in the upper layer of a four-layered model coincides with the dynamics in the third layer of the model under another set of the parameters. However, under fixed set of the parameters, in fact, the dynamics in layers can be considerable different.

Acknowledgments

Support for this study has been provided by the Russian Fund for Fundamental Studies Grant No. 08-05-00061-a and FEB RAS Grants No. 09-I-17-07, 09-II–07-002, 09-III-A-07-319.

References

1. Kozlov V.F.,1995. Background currents in geophysical fluid dynamics. Izv. Akad. Nauk, Fiz. Atmos. Okeana, 31(2), 245-250.

2. Izrailsky Yu.G., Koshel K.V., Stepanov D.V., 2008. Determination of optimal excitation frequency range in background flows. CHAOS, 18, 013-107.

3. Gryanik V.M., Tevs M.V., 1989. Dynamics of singular geostrophical vortices in a N-level model of the atmosphere (ocean). Izvestiya Atmospheric and Oceanic Physics, 25, 179-188.