Geophysical Research Abstracts
Vol. 16, EGU2014-76, 2014
EGU General Assembly 2014

Diffusive fluid particle advection in an ellipsoidal vortex under external shear

Evgeny Ryzhov (1), Konstantin Koshel (1,2), and Vladimir Zhmur (3)

(1) V.I.Il'ichev Pacific Oceanological Institute, Vladivostok, Russian Federation (ryzhovea@poi.dvo.ru), (2) Far Eastern Federal University, Vladivostok, Russian Federation (kvkoshel@poi.dvo.ru), (3) P. P. Shirshov Institute of Oceanology, Moscow, Russian Federation (zhmur-vladimir@mail.ru)

We study diffusive fluid particle advection on the basis of an analytical model for a constant-vorticity distributed vortex, namely the ellipsoidal vortex embedded in a constant-buoyancy frequency shear flow. Without the diffusive feature, the model is well-studied, and it has been already established that the model allows Lagrangian chaotic mixing of fluid particles outside the ellipsoid vortex to occur. The model allows the vortex to perform three types of motion [1], namely, two periodic – rotation and oscillation, and one aperiodic – infinite elongation. The periodic ones are of special interest, since the periodic motion of the ellipsoidal vortex perturbs the dynamics of neighboring fluid particles making them exponentially diverge. This exponential divergence is known to indicate the Lagrangian chaos manifestation. However, the fluid particles within the vortex always move regular, since no non-stationary perturbations affect them. As the particles move regular, they cannot cross the vortex's boundary implying that the volume of the vortex is always constant, so, the vortex cannot disappear, which never chances in nature as it is common knowledge that all the vortices eventually break down. Thus, to handle this restriction, we suggest implementing diffusion to the model, letting fluid particles have a chance to transit through the vortex's boundary. Taking into consideration the diffusion term, we study the fluid particle transport in a steady state (the boundary of the ellipsoidal vortex does not change in time) and in a periodically perturbed state (the boundary of the ellipsoidal vortex changes in time periodically) within the time scope corresponding to the characteristic lifecycle of a mesoscale oceanic eddy. An increase of the fluid particle transport through the boundary in the perturbed state in comparison with the steady state due to the irregular dynamics of the surrounding flow is shown. The applicability scopes of the investigation for studying oceanic eddies in nature are discussed.

[1] Zhmur, V. V., Ryzhov, E. A., and Koshel, K. V.: Ellipsoidal vortex in a nonuniform flow: Dynamics and chaotic advections, J. Mar. Res., 69, 435–461, 2011.
[2] Koshel, K. V., Ryzhov, E. A., and Zhmur, V. V.: Diffusion-affected passive scalar transport in an ellipsoidal vortex in a shear flow, Nonlinear Processes Geophys., 20, 107–119, 2013.