Interaction of a Pair of Intrathermocline Lenses with a Surface Synoptic Cyclonic Eddy

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Résumé

Intrathermocline lenses are vortex patches (anticyclonic or cyclonic) localized at intermediate horizons (600–1600 m) of ocean. They are observed everywhere in the World Ocean, but mainly in the North Atlantic. A typical situation is when anticyclonic and cyclonic lenes are located near each other and both are affected by a large-scale vortex [1]. In this paper, we study some mechanisms of interaction of a pair of intrathermoclinic lenses with a synoptic surface vortex. We use a three-layer quasi-geostrophic model with a density stratification in the form of a two-step piecewise constant function that approximates the mean multi-year vertical density distribution of the North Atlantic. Anticyclonic and cyclonic intrathermoclinic lenses are presented in the form of vortex patches with potential vorticities of negative and positive signs, respectively, and with horizontal scales of the order of the Rossby deformation radius. The surface cyclone, having a radius of 4 times larger, is represented by a vortex patch of the upper layer. The bottom layer is considered as passive.
Numerical simulations were performed using a three-layer version of the contour dynamics/surgery method [2]. A large number of experiments were carried out with different initial configurations of vortices: both lenses are located under a synoptic vortex, or both lenses are located under the periphery of a surface vortex, or one of the lenses is under a vortex, the second is outside it, etc.

Calculations show that: (1) the vortex of the upper layer always forms a cyclonic twist of the middle layer as a whole and the intrathermoclinic pair in particular; (2) a pair of intrathermocline vortices always induces a displacement of the surface synoptic eddy; (3) if both lenses are quite far from the surface eddy during their movement, then under their influence it moves while remaining compact;(4) if the lenses approach the area under the vortex, then this always causes complete or partial destruction of the surface eddy; (5) the resulting two-layer vortex structure can form either a finite or infinite configuration.

References

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