Abstract View

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The Fusion of Isolated Nonlinear Eddies

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ABSTRACT

The interaction of two isolated lens-like eddies is examined with the aid of an inviscid nonlinear model. The barotropic layer in which the lenses are embedded is infinitely deep so that there is no interaction between the eddies unless their edges touch each other. It is assumed that the latter is brought about by a mean flow which relaxes after pushing the eddies against each other and forming a "figure 8" structure.

Using qualitative arguments (based on continuity and conservation of energy along the eddies' edge) it is shown that, once a "figure 8" shape is established, intrusions along the eddies' peripheries are generated. These intrusions resemble "arms" or "tentacles" and their structure gives the impression that one vortex is "hugging" the other. As time goes on the tentacles become longer and longer and, ultimately, the eddies are entirely converted into very long spiral-like tentacles. These spiraled tentacles are adjacent to each other so that the final result is a *single* vortex containing the fluid of the two parent eddies. It is speculated that the above process leads to the actual merging of lens-like eddies in the ocean.

Because of the inherent nonlinearity and the fact that the problem is three-dimensional (x, y, t), the complete details of the above process cannot be described analytically. Therefore, one cannot prove in a rigorous manner that the above process is the only possible merging mechanism. It is, however, possible to rigorously show analytically and experimentally that the intrusions and tentacles are *inevitable*. For this purpose, one of the interacting eddies is conceptually replaced by a solid cylinder. Initially, the cylinder drifts toward the eddy; subsequently, it is pushed slightly into the eddy and is then held fixed. The subsequent events are examined in a rigorous mathematical and experimental manner.

It is found that as the cylinder is forced into the eddy, a band of eddy water starts enveloping the cylinder in the clockwise direction. This tentacle continues to intrude along the cylinder parameter until it ultimately reattaches itself to the eddy, forming a "padlock" flow. Simple laboratory experiments on a rotating table clearly demonstrate that a "padlock" flow is indeed established when a lens is interacting with a solid cylinder. Using the details of this process it is argued that, in the actual eddy–eddy interaction case, intrusions must be established and that, consequently,

merging of the two eddies is inevitable.

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