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Momentum transport and mixing by internal lee waves and a vortical wake: laboratory and numerical experiments

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The Antarctic Circumpolar current is recognized as the main source of ocean mixing with strong impact on Earth climate. Field campaigns in the Southern Ocean have revealed that the interaction of this current (and of geostrophic eddies) with bottom topography can radiate internal gravity waves whose momentum transport contributes to dissipation and mixing in the ocean interior (Naveira-Garabato et al 2004). This process has been studied numerically and theoretically by a few authors, considering an idealised topography in a vertical plane (Nikurashin and Ferrari 2010) or a model of a realistic three-dimensional topography (Nikurashin et al 2013). Dossman et al (2016) addressed this problem with laboratory experiments, by studying the flow generated behind a ridge in a non rotating configuration.

A three-dimensional topography behaves very differently from a two-dimensional one, because the fluid can flow horizontally around the topography as well as rise above it, thus possibly generating a vortical wake behind the topography and a lee wave field above it. The competition between the vortical wake and the lee wave field can be estimated by the concept of dividing streamline.

We have reproduced this process in a linearly stratified fluid on the Coriolis rotating platform, 13 m in diameter, and with joint three-dimensional numerical experiments. An idealized topography is considered, made of either a single or multiple spherical caps. The objective of this work is to estimate the relative contribution of the turbulent wake and of lee wave breaking on fluid mixing, namely, from an oceanic view point, the relative amounts of local and interior mixing, depending on the flow parameters. The effect of rotation on the lee wave field appears to be an essential ingredient to promote interior mixing, as will be discussed during the talk among other results.

References :

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