Asymptotic models for wave-vortex interactions

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Approximately 90% of oceans kinetic energy is contained in mesoscale vortices that are in geostrophic and hydrostatic balance (Ferrari and Wunsch 2009, Chelton et al. 2011). The constraints of rapid rotation and strong stratification inhibits efficient energy dissipation of these vortices. Although numerous potential energy sinks of mesoscale vortices have been suggested over the past few years (Sen et al., 2013, Zhai et al., 2010, Nikurashin et al., 2013, D'Asaro et al., 2011), none of these involve direct energetic interactions between internal gravity waves and vortices. This is paradoxical, since the ocean is rich in a wide spectrum of internal gravity waves, generated by wind and tidal forcings.

This project will examine energy exchanges between internal gravity waves and balanced vortices using asymptotic models. The goal is to derive coupled wave-vortex asymptotic models (see Xie and Vanneste 2015, Wagner and Young 2016, and Nazarenko et al. 1995 for example). Simplified asymptotic models for the wave field evolution, similar to those derived in Thomas et al. (2017), Thomas (2017), Thomas and Yamada (2018), will be developed and coupled with vortical evolution equations such as the quasi-geostrophic equation (Salmon 1978, Vallis 2006) to examine the direction and magnitude of energy exchanges between waves and vortices.

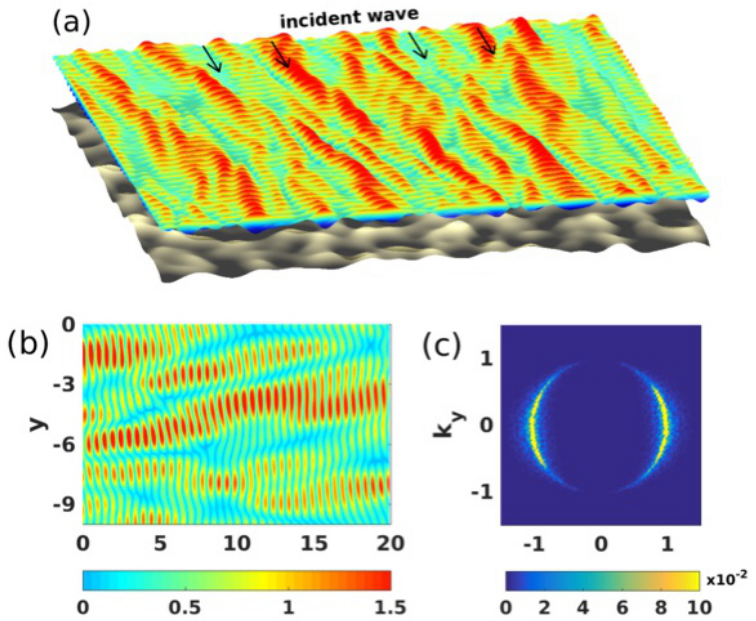

Figure 1: Scattering of waves by a vortical field. Can waves extract energy from the vortical flow in this process?

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