Dissipation processes of internal waves generated by geostrophic flows impinging on bottom topography

*Anne Takahashi[1], Toshiyuki Hibiya[1], Yuki Tanaka[1]

1.Department of Earth and Planetary Science, Graduate School of Science, University of Tokyo

In the Southern Ocean, bottom-reaching Antarctic Circumpolar Current (ACC) impinges on rough bathymetric features creating internal lee waves. Recent microstructure observations carried out in the ACC region showed the existence of bottom-enhanced turbulent dissipation which is thought to be explained in terms of breaking of internal lee waves emanating from rough ocean bottom (Sheen et al., 2013; Waterman et al., 2013).

On the basis of weakly nonlinear theory together with the results from numerical experiments, Nikurashin and Ferrari (2010) showed that geostrophic flows impinging on rough ocean bottom also excite vigorous inertial oscillations which then interact with high-wavenumber internal lee waves to create bottom-intensified mixing hotspots. However, their theory and numerical experiments are too much simplified to be applied to the realistic situation in the ACC region. For example, a background internal wave field is not taken into account in their study.

In the present study, we investigate (1) the behavior of internal lee waves in the presence of inertial oscillations, and (2) whether inertial oscillations play an important role even in the presence of the background internal wave field (Garrett-Munk internal wave field). For this purpose, we carry out a series of numerical experiments where a depth-independent geostrophic flow is assumed to impinge on idealized topographic features.

It is shown that, as the slope of bottom topography becomes steep, the generated internal lee waves partially break. The divergence of the vertical flux of horizontal momentum drives the inertial oscillations, which then extend upward to more than 1000m above the ocean bottom, interacting with internal lee waves emanating from the ocean bottom as well as the background internal waves. Of special interest is that the bottom-generated internal lee waves are mostly affected by the interaction with the inertial oscillations rather than with the background internal wave field, while increasing their vertical wavenumbers up to the breaking limit. Thus, we can conclude that steep bottom topography plays a key role in transferring energy from geostrophic flows to turbulent dissipation via the interaction between inertial oscillations and internal lee waves.

Keywords: Southern Ocean, Antarctic Circumpolar Current, internal lee wave, inertial oscillation, Garrett-Munk internal wave field

