Data analysis of mixing due to interaction of vortex and internal waves with OFES30.

*KAORU ITO[1], Tomohiro Nakamura[1]

1. Hokkaido University

Vertical mixing is a primary factor of vertical heat flux and transportation of substances. It contributes to fundamental processes in the ocean such as the thermohaline circulation, nutrient supply, etc. Vertical mixing is mainly caused by the breaking of internal waves. The breaking of internal waves have been studied in the context of the quiet ocean without a background flow. Recently, some studies have pointed that the interaction between a vortex and internal gravity waves affects the mixing. A data analysis of Argo Floats indirectly indicated that high vertical diffusion coefficient found on the region where vortices are energetic. The previous theoretical or numerical studies handle the interaction problem with WKB like methods, which assume a scale separation between a large vortex and small waves. However, in the ocean, there are many small, strong vortices like submeso-scale ones are abundant. In addition, there are vortices that have the same spatial scale as internal tides. These vortices violate the scale separation assumption, so that previous methods are invalid for such a case. Thus we numerically investigated the interaction of the vortices and internal waves. Then, the result is applied to the output of a high-resolution ocean general circulation model. NUMERICAL EXPERIMENTS: We used a three dimensional non-hydrostatic model. As the initial condition, a vortex and internal waves that propagate toward the vortex are put. The initial vortices are sampled from the output of OFES30 (Masumoto et al., 2004; Sasaki et al., 2012), internal waves are assumed as the first vertical mode of M2 internal tide. The results show that a parameter that scales advection by a vortex classifies the phenomena of interaction. This parameter arises from our non-dimensional analysis of the shallow-water system. If the parameter exceeds a specific value, a part of the incident waves are trapped in vortices. The parameter and trapped rate of incident wave energy show a monotonous relation. We regard the parameter as an indicator of ineteraction-induced mixing (here after mixing indicator). DATA ANALYSIS: We investigated the statistics of the mixing indicator in the Pacific with OFES30. Seasonal variation of the mixing indicator is, high in winter and spring, low in summer and autumn. This is mainly due to the activity of submeso-scale vortices. Median of the mixing indicator shows trapping regime through out the year. Remarkably the magnitude of the mixing indicator differs greatly with latitudes. High mixing indicator is especially located at the Kuroshio Extension, around Hawaii, and The Torres Strait. Around Hawaii, the location of high mixing indicator agrees with the autumn bloom in the low nutrient region. So the interaction between vortex and internal wave is one of the candidate physical processes of the bloom. These results suggest that mixing due to interaction of vortex and internal waves are not negligible in the Pacific.

