Effects of the Indonesian Throughflow on the generation and propagation of internal tides in Lombok Strait

*Taira Nagai[1], Toshiyuki Hibiya[1]

1. Graduate School of Science, The University of Tokyo

Tidal mixing in the Indonesian Seas is one of the indispensable pieces in predicting the large scale oceanic circulation as well as the global atmospheric circulation. To investigate the spatial distribution of tidal mixing intensity in the Indonesian Seas, a number of researchers have carried out numerical experiments using baroclinic tide models without taking into account the effects of the Indonesian Throughflow (ITF). However, the speed of the ITF is actually comparable to that of the barotropic tidal currents especially in narrow straits in the archipelago, so that the ITF must come into play in the generation and propagation processes of internal tides.

In the present study, we investigate the effects of the ITF on the generation and propagation of internal tides, taking an example of Lombok Strait, one of the prominent generation regions of internal tides in the Indonesian Archipelago. Using a vertical two-dimensional numerical model, we find that the southward (northward) propagating internal tide energy increases (decreases) when the southward ITF is superposed on the barotropic tidal flow. To clarify the physical mechanism causing such anisotropic internal tide propagation, we investigate the generation process of internal tides in terms of the internal Froude number $Fr = (U_0 \pm U_T) / c_n$ (U_T : tidal current velocity, U_0 : current velocity of the ITF, c_n : phase velocity of the n-th mode) following Hibiya (1986, 1988). It is found that the southward combined flow $U_0 + U_T$ is too strong to create the critical Froude number with respect to each of the low mode internal tides over the southward gentle slope of the bottom topography, whereas the northward combined flow $U_0 - U_T$ is such that the critical Froude number with respect to each of the low mode internal tides results over the northward steep slope of the bottom topography; the low mode internal tides thus amplified over the northward steep slope of the bottom topography then propagate southward as the barotropic tidal flow weakens.

In the Indonesian Seas, the ITF thus plays indispensable role in creating the spatial distribution of internal tide energy available for tidal mixing processes.

Keywords: Anisotropic internal tide propagation, Indonesian Throughflow, Lombok Strait

