J156-019 Room: 101B Time: May 14 14:52-15:03

Topographic effects on the seasonal energy cycle of a two-layer wind-driven subtropical gyre

Toshihiro Sakamoto[1]

[1] Earth and Planetary Sci., Tokyo Univ.

We investigate how the bottom slope affects the time-dependent global energy balance of a two-layer subtropical gyre driven by seasonal winds in order to reformulate the concept joint effect of baroclinicity and bottom relief (JEBAR) based on energetics rather than vorticity dynamics. It is shown that the role of JEBAR in this situation is to transfer energy between the barotropic and baroclinic fields. Since a deep current tends to flow in meridional directions along a meridional ridge, the geostrophically balanced pressure-gradient forces can perform work on the zonal barotropic flow over the ridge. The direction of the deep motion, and hence the sign of the work is reversed seasonally because the pressure field in the lower layer exhibits an anticyclonic tendency in winter and a cyclonic tendency in summer. The topographic beta effect strengthens the work on the northwest and southeast sides of the ridge, so that the net contribution from the ridge region is negative in winter and positive in summer. On the other hand, this work must be canceled by enhancing the energy conversion to satisfy the energy equation. As a result, the ridge not only accelerates but also seasonally reverses the sign of the rate of energy conversion. With some modification, a meridional trench and a western continental slope turn out to have qualitatively the same effect on the seasonal transport variation. Therefore, the annual range in the barotropic transport of the gyre is, to varying degrees, reduced irrespective of the details of the large-scale bottom topography.

From the above result (Sakamoto and Umetsu 2006) together with a companion paper (Sakamoto 2005), the role of bottom topography on the dynamics of a large-scale (non-eddying) ocean circulation may be viewed from a wider perspective as follows. Baroclinic and topographic effects are joined together; this joint effect may create vorticity but, unlike external forces, does not become a source or sink of energy. More generally, bottom topography enables the barotropic and baroclinic fields to interchange with each other by vorticity creation or elimination which entails changes in the density field and by net energy transfer between potential and barotropic kinetic forms over the whole closed gyre. The concept of JEBAR associated with the vorticity equation represents only one side of this interchangeability via topography. The extended dynamic properties may suitably applied to explain the mechanism of the seasonal cycle in the Kuroshio transport.