Horizontal diffusion due to medium-scale eddies in Meridional Ocean Circulation of Southern Ocean

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To clarify the effect of the eddy on the structure of the Southern Ocean meridional circulation the mooring observation data was analyzed. The mooring was located at 110E-61S (water depth:4340 m), near the southern limit of the Antarctic Circumpolar Current (ACC),for one year from January 2017 to January 2018. A barotropic structure that vibrates in almost the same phase in the vertical direction in both water temperature and current velocity was noticeably observed. The cycle of flow velocity fluctuation was about 80 days from summer to autumn and 60 or shorter days in winter, and it was observed that the flow velocity itself weakened a little. Since the flow obtained in the mooring system corresponds well with the quasi-geostrophic current estimated from the sea level altitude from the satellite, it was thought that this current velocity fluctuation is associated with the medium-scale eddy that is prominently seen in the sea level data. The annual and seasonal average currents do not show a velocity structure that indicates so-called meridional vertical circulation, that is, a northward flow in the bottom layer, but showed a baroclinic flow in the east-west direction and a remarkable barotropic flow in southward direction in summer to autumn. It was found that there is a close relationship between this change in the structure of the average flow, the overhang of the seasonal sea ice region to the low latitude side, and the change in sea level. As a result of examining the mechanical balance, it was found that the southward barotropic flow can be almost explained by the Sverdrup transport and the bottom pressure torque. As a result of examining characteristics of the quasi-geostrophic eddy, its horizontal scale was about 50 km in average and almost same from 1000 dbar to the seafloor. It was shown that the horizontal temperature flux due to this vortex motion is about an order of magnitude larger than the flux in the vertical direction due to turbulence. It was found that the Southern Ocean Indian Ocean sector has a higher eddy energy in the seasonal sea ice region than other sectors. The reason why the water mass distribution suggesting meridional circulation is formed in this region is due to the quasi-geostrophic eddy, namely, the structure of temperature and salinity was considered to be formed by the horizontal balance between the horizontal eddy diffusivity and southward barotropic flow.

Keywords: Meridional Ocean Circulation of Southern Ocean, Horizontal eddy diffusion, Antarctic Circumpolar Current

