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Quasi-stationary Jets in the North Pacific Subarctic Frontal Zone: Formation Mechanisms and Roles in the Salt Transport

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The subarctic frontal zone (SAFZ) in the North Pacific is the boundary between the wind-driven subtropical gyre and the subpolar gyre. Recently, it was found that quasi-stationary jets (QSJs) originating in the Kuroshio Extension advect warm and saline water to the SAFZ. The Kuroshio water encounters the subarctic water, forming a thermohaline front in-between (Isoguchi et al., 2006; Wagawa et al., 2014). The QSJs are pathways of the saline water from the subtropical gyre to the subpolar gyre. We found in a numerical experiment that ocean surface salinity in the subpolar gyre varies when the basin-scale wind changes. The salt transport changes through the QSJs is likely responsible for this surface salinity change. A part of the saline water via the QSJ should be advected finally to the Sea of Okhotsk and affect ventilation of the intermediate layer of the North Pacific.

The QSJ's position is remarkably stationary. The jet tends to be located over the eastern flank of a topographic mound off the Kamchatska-Japan Trench, although it is as high as 500 m in the deep Pacific Ocean of a total depth of 5500 m. In this study, characteristic curves of the baroclinic Rossby waves, derived from the ocean reanalysis data provided by the Japan Coastal Ocean Prediction Experiment (JCOPE), are used to discuss the formation of the QSJ. The phase speed of the baroclinic Rossby waves is affected by the barotropic flow (Nishigaki and Mitsudera, 2010), particularly in the high latitudes where β is small and stratification is weak. Because of this baroclinic-phase-speed dependence on the barotropic flow, the surface baroclinic jet can be affected by the topography although its height is so low. Here we show that a characteristic curve originating in the subtropical gyre and that originating in the subpolar gyre meet at the location where the QSJ is present. This is a hyperbolic point of the characteristics, so-called the Rossby repeller. A surface baroclinic jet is formed along the characteristics that diverge from the hyperbolic point, because the pycnocline displacement varies discontinuously across these diverging characteristics. The barotropic flow over the low topographic mound is particularly important because the baroclinic Rossby waves in the subpolar gyre propagate southwestward along the characteristics, deformed by the barotropic flow over the mound, toward the hyperbolic point where they meet the barroclinic Rossby waves in the subtropical gyre. Formation mechanisms will be discussed further by numerical experiments using a simple two-layer model.

Keywords: Subarctic frontal zone, baroclinic Rossby-wave characteristics, barotropic flow generation