学 位 論 文 内 容 の 要 約

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学 位 論 文 題 名

Impacts of tides on large scale wind driven boundary currents in climate sensitive regions

（気候敏感海域における潮汐による大規模風成境界流へのインパクト）

This research aims to investigate the tidal impacts on wind-driven boundary currents and their further modification to the large-scale circulation. After decades of silence, the tidal study is re-focused by oceanographers since the tidal mixing on the continental shelf is suggested to transfer the energy from wind and heat driving surface into the deep ocean. However, the impacts of tides on the wind-driven boundary current are still overlooked, although it bathed enormous tidal activities on their pathway. For instance, the Kuril Islands, an island chain located between the Sea of Okhotsk and the North Pacific, is one of the worldclass tidal activity hotspots and regulating the interbasin exchange between two basins, which governs the intermediate water ventilation and fertilization of the nutrient-rich subpolar Pacific. Previous study suggests that the East Kamchatka Current (EKC), a western boundary current (WBC) flowing along with the Kurils Islands, drives the interbasin exchange by its partial intrusion into the Sea of Okhotsk. However, the exchange mechanism is puzzling; the simulated interbasin exchange is unrealistically small in high-resolution models if only wind-driven western boundary current is considered. The WBC overshoots passing by deep straits and does not induce exchange flows. Therefore, partial intrusion cannot be solely explained by large-scale, wind-driven circulation.

Numerical simulations demonstrate that tidal forcing is the missing mechanism that drives the exchange by steering the WBC pathway. Upstream of the deep straits, tidally-generated topography trapped waves over a bank lead to cross-slope upwelling. This upwelling enhances bottom pressure, thereby steering the WBC pathway toward the deep straits. The upwelling is identified as the source of joint-effect-of-baroclinicity-and-relief (JEBAR) in the potential vorticity equation, which is caused by tidal oscillation instead of tidally-enhanced vertical mixing. The WBC then hits the island chain and induces exchange flows.

Most of ocean general circulation models obtain the tidal impacts through the parameterization of tidally-enhanced vertical mixing. This study addresses that mixing is not a major contributor, but the topographic trapped waves. It suggests that accounting for tidal forcing in high-resolution models would facilitate the estimation of water dynamics not only between the Sea of Okhotsk and the North Pacific, but in other subpolar and polar regions where diurnal tides are dominant, such as Antarctic continental shelf. By comparison of model outputs and moorings, the tide oscillates the Antarctic Slope Current (ASC), the other wind-driven boundary current which flows along with the Antarctic continental shelf. The ASC is then strengthened and warmed by tidally-generated topographic trapped waves along with the slope. Comprehensively, in addition to the interbasin exchange problem in the North Pacific, this study implies that the inclusive of tidal forcing in high-resolution models is essential for capturing the accurate WBC's dynamics in climatically sensitive areas. The further investigation of local tidal dynamics is expected not only to be important to the regional study but also to global climate simulations.