Impact of Tidal Vertical Mixing to Barotropic Water Exchange between the Sea of Okhotsk and Pacific through Diffusive Adjustment with Turbulent Closure Scheme

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The pattern of exchange flow between the Sea of Okhotsk and Pacific is a system composed by an Okhotsk-ward inflow through Kruzenshtern strait in north and a Pacific-ward outflow through Bussol strait in south. One of major theories for explaining the dynamic of water exchange through Kuril Island Chain is the turbulence induced by tidal vertical mixing. Turbulence is an important physical process in geostrophic boundary layer, and because of the complexity of topographic in Kuril island chain, the breaking of internal tides in island coast area leads to increase the thickness of surface mixing layer and causes tilting of isopycnal layer in vicinity. The tilting of isopycnal layer around islands forms a clockwise flow along the shore by geostrophic adjustment. However, above process is majorly broclinicly, and how can it impact to barotropic component is still unknown.

By setting the tidal force as a controlled variable, results from realistic OGCM model COCO show only the case with tidal forcing can consistent with the exchange flow pattern as historical observation (Fig.1). Besides, the vertical diffusivity values also show the magnitude difference in summer time, which the flow in north strait in non-tidal case is opposite to tidal one (Fig.2). Therefore, we designed four experiments for understanding the impact of tidal diffusive adjustment in summer: 1. install vertical diffusivity value generated by tidal case into non-tidal run; 2. install vertical diffusivity value generated by non-tidal case into tidal run; 3. set the vertical diffusivity value as zero in tidal case and 4. in non-tidal case as well. Further, for preventing the underestimates the depth of the mixing layer in Mellor-Yamada turbulence closure scheme, two more experiments with the larger vertical diffusivity mask are applied in both tidal and non-tidal case. After calculating the fraction of baroclinic and barotropic components in either north strait or southern strait, results show the vertical mixing dose influence the strength of volume transported but not the direction as original tidal and non-tidal case shows. Hence, for further understanding the impact of vertical diffusivity, we start a tidal forcing run with non-tidal initial conditions to detect the relationship between the flow direction and magnitiude of vertical diffusivity values by time developing. But the baroclinic result implies that the vertical mixing might not be the main reason to control the flow direction (Fig.3).

This study also implies the tidal impacts in OGCM is not only the vertical mixing, but other geostrophic fluid dynamics might occur, especially the interaction of topography with tidal waves. Therefore, for reproducing the real ocean phenomena, movement of tidal waves should be considered.

Keywords: OGCM, tidal mixing , Okhotsk, cross-basin exchange system

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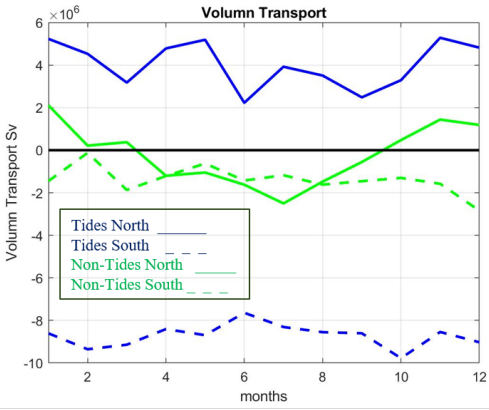

Fig.1: volume transportation in tidal and non-tidal run.
Positive value is Okhotsk-ward and negative value is Pacific-ward flow.

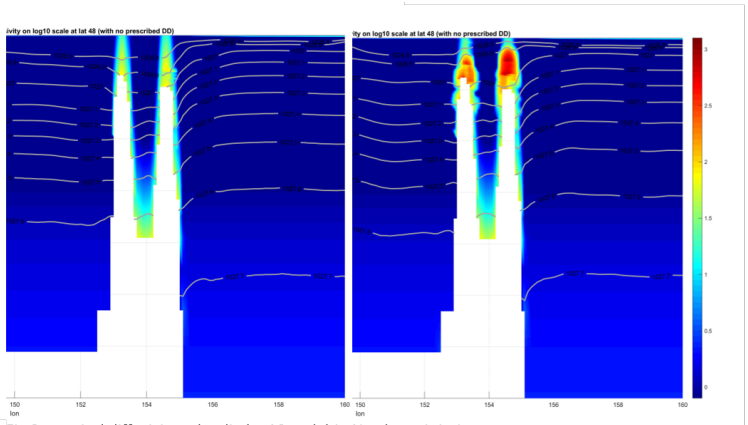

Fig.2: vertical diffusivity value (in log10 scale) in North strait in June, left one is non-tidal run and right is tidal run.

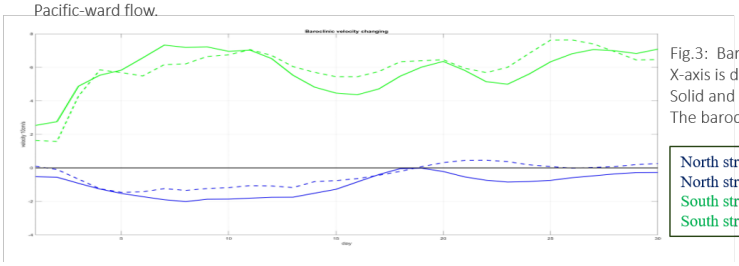

Fig.3: Baroclinic components in the tidal run with non-tidal initial condition.
X-axis is day and y-axis is velocity. Blue line is north strait and green line is south strait.
Solid and dot line are upper and lower isopycal layer, respectively.
The baroclinic velocity is stable after a week running.

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