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DYNAMICS OF INTENSIFIED UPWELLING/DOWNWELLING FLOW IN A SUBMARINE CANYON (ABSTRACT)

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It has been considered that intensified upwelling/downwelling in a submarine canyon indenting continental shelf plays an important role in the shelf-basin exchange in the Arctic Ocean. The intensified upwelling supplies high salinity and high temperature water originating from the Atlantic Water onto the shelf region. On the other hand, intensified downwelling supplies the shelf water with rich dissolved Si into the basin at the depth of the cold halocline. JAMSTEC took CTD and mooring observations in the Chukchi Sea and the Beaufort Sea during 1992 -1996. The current records at the head of the Barrow Canyon showed strong reverse flow, mainly governed by the barotropic component, with speed exceeding 100 cm/s. The direction of the reverse flow strongly depended on the wind direction. The objective of the present study is to examine the dynamics of the intensified upwelling/downwelling in a submarine canyon using a 3-D numerical model (GFDL MOM1).

A simple submarine canyon lying at the shelf break in the Arctic Ocean is employed, and the flow is driven by an idealized zonal surface stress. The major results are as follows. The westward (eastward) surface stress induces northward (southward) Ekman transportation generating upwelling (downwelling) near the shelf break, and a meridional barotropic pressure gradient is established. The high (low) pressure on the shelf break is propagated into the canyon by topographic Rossby waves. Then the pressure gradient is enhanced at the eastern side of the canyon and the strong upwelling (downwelling) is established through the same mechanism as the western boundary current. The numerical results also show the dynamical difference between the upwelling and downwelling as follows. In the upwelling case, the intensified upwelling is enhanced and maintained over 1 week. On the other hand, in the downwelling case, the intensification disappears within a couple of days and the flow along the depth contour governs the entire region. In the upwelling case, the upwelling generates an anticyclonic vortex on the western shelf of the canyon. The anticyclonic vortex has a positive feedback to intensify the upwelling, the flow induced by the anticyclonic vortex has the same direction of the upwelling in the canyon. On the other hand, in the downwelling case, at the beginning of the calculation the downwelling generates a cyclonic vortex in the canyon through the same dynamics as the upwelling case. However the cyclonic vortex is affected by the topographic beta-effect, and is soon radiated far away from the canyon as a topographic Rossby wave. As a result, the current becomes parallel to the contours of bottom topography and the intensification of the downwelling stops. This is the reason why the intensification of the downwelling cannot be maintained for a long time.

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