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Numerical experiments on the Tsushima Warm Current

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Effects of the changes in bottom topography and non-linearity of the western boundary current on the separation position of the Tsushima Warm Current (TWC) are investigated using a primitive equation model in a simplified model domain which consists of a deep ocean, a continental shelf and a marginal sea (Fig. 1). The model ocean is vertically straified initially and a sinusoidal wind stress is applied only to the deep ocean to establish an anticyclonic circulation. The non-linear effect is examined by changing the horizontal eddy viscosity.

According to the model results, the outflow strait of the marginal sea plays a role in setting up an inflow into the marginal sea. The amount of the inflow is about 2 Sv, 5% of the total volume transport of the western boundary current. The separation position of the TWC is little affected by the hump-like topography the southern strait of t he marginal sea but is sensitive to the orientation of the depth discontinuity. As the orientation of the isobath tilts more to the north the separation takes place more to the west. The non-linear effect also contributes to changes in the separation position. As it increases the separation takes place more to the west.

To examine the seasonal variation of the Kuroshio and the separation of the TWC in the East China Sea, prognostic model with realistic topography and geometry (Fig. 2) was also used. The model is forced by seasonal varying wind stress (Hellerman & Rosenstein, 1983) and monthly surface temperature and salinity (Levitus, 1994). Relaxation time scale of surface forcing is 30 days. The horizontal grid spacing is variable with 0.2° interval in the western marginal sea area (23°N - 50°N, 118°E - 143°E) and 0.5° or 1.0° interval elsewhere. According to the model results, the Kuroshio flows along the shelf break and its mainstream is trapped over the continental slope. The estimated annual mean volume transport is about 25 Sv. thru the Tokara Strait. The Kuroshio water intrudes onto the East China Sea across the steep topography northeast of the Taiwan. This water separates into two branches: one (hereafter referred to as Kuroshio Branch I) after turning anticyclonically rejoins the Kuroshio mainstream and the other (hereafter referred to as Kuroshio Branch II) flows along the isobaths of 100m - 200m depths in the East China Sea. Kuroshio Branch II is extended to the left flank of the deep trough southwest of Kyushu. At the left flank southwest of Kyushu, Kuroshio Branch II divide into two branches again: one flows into the East Sea thru the Korea Strait and the other joins to the Kuroshio mainstream (Fig. 3). Kuroshio Branch II shows more seasonal variability than Kuroshio mainstream in its flow pattern. In fall, Kuroshio Branch II disappears, so the separation of the TWC takes place directly from the Kuroshio at the left flank of the deep trough southwest of Kyushu. The northward flow along the eastern coast of the China mainly originating from the Taiwan Strait appears throughout the year. A part of it separates from the chinese coast around 31°N forming an anticyclonic circulation and flows inshore of Kuroshio Branch II. The circulation in the Yellow Sea is anticyclonic and the southward flow appears along the Korean coast all the year round.

From the results of the simple and realistic model, we conclude that the separation, controlled by the orientation of the continental shelf and the nonlinearity of the Kuroshio, of the TWC from the Kuroshio takes place at the northeastern part of the Taiwan. The TWC seems to be separated directly from the Kuroshio southwest of Kyushu in fall when the volume transport of the Kuroshio is minimum and the southwestward flow in the East China Sea is strenghtened.

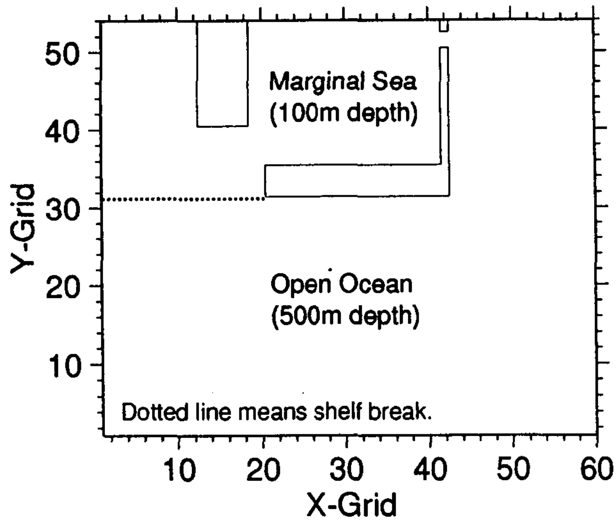

Fig. 1. The simple model basin.

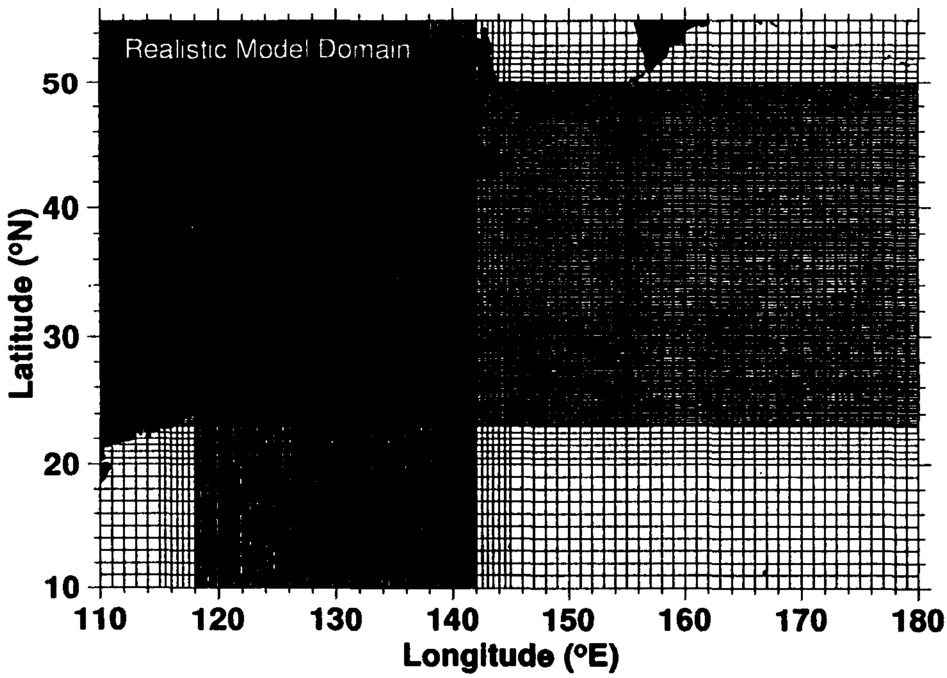

Fig. 2. The realistic model basin.

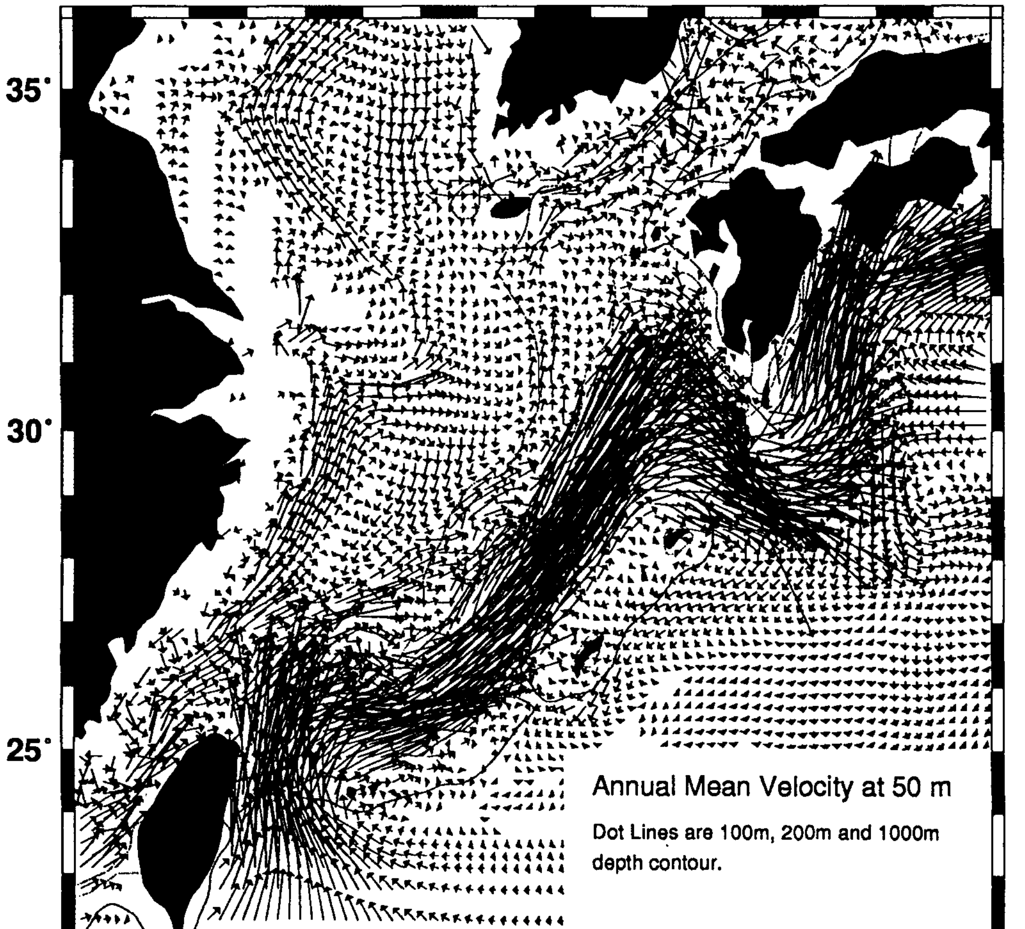

Fig. 3. Annual mean velocity plot at 50m depth.