Abstract View

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Bimodality of the Kuroshio

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ABSTRACT

A barotropic ocean model is used to study the bimodal behavior of the Kuroshio to the south of Japan. By considering the combined effects of the beta plane, the Kyushu coastal perturbation, the Izu Ridge and the SW-NE tilted coastline, the two frequently observed meander patterns have been numerically verified as the two quasi-steady solutions contained n the model, The small-meander state is identified as an upstream disturbance largely forced by the Izu Ridge; its width decreases as the strength of the current increases. The large meander state is forced by the presence of both the Kyushu wedge and the Izu Ridge topography. For small volume transports the large meander state behaves like the small meander state, in that the meander width decreases as the current speed increases; for large volume transports it behaves like a lee Rossby wave, in that the width of the meander increases as the current speed increases.

The birth of the large meander state occurs as a consequence of the ocean spin-down. Prior to the generation of the large meander state, the Kyushu wedge excites small meanders and eddies which propagate eastward at a speed of several miles a day. This model result agrees well with observations.

The bimodality of the Kuroshio is identified as an example of multiple equilibrium states (Charney and Fierl). Below a volume transport of 30 Sv, only the small meander state exists. The large meander state and the small meander state coexist in a range of volume transports from 30 to 60 Sv. Beyond 60 Sv, a strongly nonstationary solution develops and the structure of the meander can no longer be determined by the present model.