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Observation and Modeling of Satellite-Sensed Meanders and Eddies off Vancouver Island

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ABSTRACT

A long time series of satellite infrared images spanning the period 21 July–8 October 1980 reveals the evolution of long (160 km) and short (80 km) wavelength meanders of the California Current System off Vancouver Island. Midway in the series, strong interactions occurred between the two meander scales. Although the shorter meanders were initially more energetic, they were eventually dominated by the longer meanders. Near the end of the time series, detached mesoscale eddies were formed from the longer meanders. Current meter data from the period before meander growth clearly indicates the presence of a strong vertical shear near 150 m, which consists of a southeastward surface current and a northwestward undercurrent. It is argued in this paper that the observed shear flow is the energy source for the meanders and eddies seen in the satellite images.

A four-layer, quasi-geostrophic model is used to represent the California Current System off Vancouver Island. The two upper layers represent the surface current and undercurrent respectively, and the two lower layers describe the deep ocean. Linear stability theory suggests that the vertical shear between the two currents maintains meander growth through the mechanism of baroclinic instability. Nonlinear numerical calculations simulate the engulfment of the shorter meander by the longer meanders and also the formation of the detached eddies. An energy analysis indicates two mechanisms at work during engulfment of the shorter meanders. One involves a stronger stabilization of the shorter meanders resulting from an inverse Reynolds stress, and the other consists of a direct nonlinear interaction which transfers energy from the shorter meanders to the longer meanders.

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