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## Abstract View

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# Baroclinic Instability in a Downstream Varying Channel: Shelikof Strait, Alaska

**L.A. Mysak**

*Departments of Oceanography and Mathematics, University of British Columbia, Vancouver, B.C., Canada V6T 1WS*

**R.D. Muench**

*Pacific Marine Environmental Laboratory/N0AA, Seattle WA 98105*

**J.D. Schumacher**

*Pacific Marine Environmental Laboratory/N0AA, Seattle WA 98105*

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ABSTRACT

Moored current-meter observations obtained from upstream and downstream locations in Shelikof Strait, between Kodiak and Afognak Islands and the Alaskan mainland in the northwest Gulf of Alaska, show a considerable amount of low-frequency variability superimposed upon the mean southwestward along-channel flow. Moreover, the spectral properties of these low-frequency current fluctuations varied seasonally and according to location within the channel. During fag 1976, the variance spectra of the along-channel fluctuations at the upstream end of Shelikof Strait were sharply peaked at 2.86 days. At the downstream end of the Strait, some 150 km to the southwest, the variance spectrum of the cross-channel fluctuations at 100 m was peaked at 6.15 days. However, the upstream 2.86-day signal was coherent with 2.86-day fluctuations downstream, and the phase relationship between the two locations implied the presence of a downstream-traveling wave with a wavelength of 74 km and a phase speed of 26 km day$^{-1}$. (Downstream-traveling waves of similar scales have also been observed in satellite images of this region taken during fall 1979.) During winter 1977, on the other hand, the variance spectra of the current fluctuations at the upstream end of the Strait were broadly peaked at 2–3.5 days, and the fluctuations were not coherent with those downstream in this period range. However, the downstream variance spectra were peaked at 4.44 days and this signal was coherent with the upstream fluctuations. The phase relationship between the two locations implied the presence of a downstream-traveling wave with a wavelength of 94 km and a phase speed of 21 km day$^{-1}$.

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This paper attempts to explain these low-frequency current fluctuations by investigating the stability of a two-layer flow in a straight channel with a sloping bottom. It is shown that, for representative *seasonal* values of the mean current shear, density stratification and bottom slope at each end of the Strait, the mean flow is generally baroclinically unstable with respect to downstream-traveling, quasi-geostrophic wave perturbations. (A similar result is also arrived at using the classical Eady model with constant shear, stratification and depth.) More specifically, in an application of the model to the fall 1976 data, it is found that a 2.86-day period wave at the upstream end is unstable and propagates downstream with a wavelength of 92 km and a phase speed of 32 km $day^{-1}$, in good agreement with the observations. However, at the downstream end, such a wave becomes stable due to the reversal in bottom slope along the Strait. Moreover, at the downstream end, only very long period waves an unstable, with the maximally unstable wave having a period of 5.2 days. Thus the low-frequency spectral peak at 6.15 days observed at the downstream mooring is probably due to locally generated instabilities. From an application of the model to the winter 1977 data, it is found that the large 4.44-day signal observed downstream is likely due to a downstream-travelling wave that is locally unstable but which originated from the upstream end of the Strait where it was marginally unstable.

From these applications and other analyses (e.g., of vertical phase relations and of summer 1978 data), it is concluded that most of the low-frequency current fluctuations in Shelikof Strait are due to baroclinic instability of the mean flow. However, in reaching this conclusion, careful consideration had to be given to the seasonal variations in the mean state and to the changing bottom topography along the Strait.

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Headquarters: 45 Beacon Street Boston, MA 02108-3693
DC Office: 1120 G Street, NW, Suite 800 Washington DC, 20005-3826
amsinfo@ametsoc.org Phone: 617-227-2425 Fax: 617-742-8718
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