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Mesoscale variability of the Faroe Bank Channel Overflow

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The Faroe Bank Channel is the deepest connection through the Greenland-Scotland ridge where dense water formed north of the ridge flows southward over the sill crest, contributing to the formation of North Atlantic Deep Water. The overflow region is characterized by high mesoscale variability and energetic oscillations, accompanied by a high degree of sea-surface level variability.

Here we report on two-month long time-series of velocity and temperature obtained from 12 moorings deployed in May 2008. The moorings form three arrays downstream of the sill crest where an additional current profiler is located. The vertical extent of the mooring lines covers a large part of the plume reaching well above the bottom boundary layer. The mesoscale oscillations in velocity and temperature are observed to dominate the records. The oscillations are highly coherent, both in the horizontal and the vertical, with an apparent period of 2.5 to 5 day which is found to be less regular than previously reported. They are associated with 100-200 m thick boluses of cold plume water flowing along the slope and significantly modulate the gradient Richardson number to allow and suppress shear-induced turbulence and vertical mixing. The oscillations are clockwise (counter-clockwise) on the upper (lower) part of the slope, suggesting a train of eddies moving past the moorings with shallow water to their right. Vorticity calculations indicate that cyclonic (anti-cyclonic) motion is associated with warm (cold) water. The core of the eddies, however, do not coincide with the maximum in plume thickness located farther down the slope. The horizontal phase velocity suggests a length scale in the along-slope direction of about 75-180 km. We find the existing theories on eddy-generation in dense overflows, notably vortex stretching and baroclinic instabilities, partly or entirely inconsistent with our observations. The presence of oscillations already at the sill region suggests a generation mechanism different from the one at play in overflows where eddies develop downstream of the sill. We find the characteristics of the mesoscale oscillations apparent in our data set to be broadly consistent with topographic Rossby waves.