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Wind-forced depth-dependent currents over the eastern Beaufort Sea continental slope

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The shelfbreak current over the Beaufort Sea continental slope is known to be one of the most energetic features of the Beaufort Sea hydrography. This current transports a fraction of the Pacific-derived water along the Beaufort Sea continental slope towards Fram Strait. The oceanographic mooring deployed over the Canadian (eastern) Beaufort Sea continental slope in October 2003 at 300 m depth recorded current velocity through 28-108 m depths over two consecutive years until September 2005.

Data analysis revealed that the high energetic currents show two different modes of the depth-dependent behavior. The downwelling favourable local wind associated with cyclones passing north of the Beaufort Sea continental slope toward the Canadian Archipelago generates depth-intensified shelfbreak currents with along-slope northeastward flow up to 120 cm/s. A surface Ekman on-shore transport and associated increase of the sea surface heights over the shelf produce a cross-slope pressure gradient that drives an along-slope northeastward geostrophic flow, in the same direction as the wind. In contrast, the surface intensified currents with along-slope westward flow are observed in response to the upwelling favourable wind forcing associated with the Pacific-born cyclones passing south of the Beaufort Sea coast. The upwelling favourable northeasterly winds generate a surface Ekman transport that moves surface waters offshore. The associated cross-slope pressure gradient drives an along-slope southwestward barotropic flow.

The wind-driven barotropic flow generated by downwelling- and upwelling-favourable wind forcing is superimposed on the background geostrophic bottom-intensified shelfbreak current. For the downwelling events, this amplifies the depth-intensified background baroclinic circulation with enhanced Pacific water transport towards Canadian Archipelago and Fram Strait. For the upwelling events, the shelfbreak current is reversed. This results in surface-intensified flow in the opposite direction.