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Moffatt eddies at the base of ice sheets[1] COLIN R. MEYER, Harvard Univ, TIMOTHY T. CREYTS, LDEO-Columbia Univ, JAMES R. RICE, Harvard Univ — Despite extensive radar surveys of the deep ice, the conditions at the base of ice sheets remain uncertain. Complex structures that include large stratigraphic folds and basal freeze-on ice appear to be related to topography. In many locations beneath both Greenland and Antarctica, ice flows across deep valleys, potentially forming viscous eddies that can confound the interpretation of ice-bed processes. To understand the formation of these eddies, we use a set up analogous to that of Moffatt (1964), where our domain is a subglacial valley. We numerically solve the non-Newtonian Stokes equations with a shear-thinning power-law rheology to determine the critical valley angle for the eddies to form. The shear-thinning nature of ice allows for greater shear localization and, therefore, ice requires smaller valley angles (steeper slopes) to form eddies than a Newtonian fluid. Due to the significant variation of temperature from the warm base to the cold surface of the ice sheet, we analyze eddy formation when the rheology is temperature dependent. The warmer basal ice is less viscous and eddies form in larger valley angles (shallower slopes). Finally, we solve for the ice flow over topography from the Gamburtsev subglacial mountains and show Moffatt eddies in the subglacial valleys.

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Colin R. Meyer
Harvard Univ

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