The evolution of surface flow stripes and stratigraphic folds within Kamb Ice Stream - why don't they match?

Ian Campbell[1,2], Robert Jacobel[1], Brian Welch[1], Rickard Pettersson[1,3]

[1]Physics Department, Saint Olaf College, Northfield, MN 55057

[2]Dept. of Biomedical Engineering, Georgia Institute of Technology, Atlanta, GA 30322

[3]Department of Earth Sciences, Uppsala University, Villavägen 16, SE-752 36 Uppsala, Sweden

Flow stripes seen in satellite imagery of ice streams and ice shelves are caused by surface undulations with kilometer-scale spacing and meter-scale relief and generally indicate current or recent fast ice flow. They generally form in regimes of fast ice flow, such as in outlet glaciers and ice streams, and are often visible downflow onto floating ice shelves, eg [Hulbe and Fahnestock, 2007; Wu and Jezek, 2004; Fahnestock et al., 2000]. On a similar scale, folding of internal ice stratigraphy depicted in cross-flow ice-penetrating radar profiles is also a common occurrence in ice streams, suggesting a possible relationship between the two sets of features. We have traced surface flow stripes in RADARSAT and MODIS imagery for over 200 km on Kamb Ice Stream (KIS) from the onset of streaming flow into the near-stagnant trunk. We compare the morphology and evolution of these features at the surface to the folds seen in the internal stratigraphy in cross-ice stream radar profiles at five cross-flow transects along the length of KIS. We find essentially no correspondence in the observed locations or spacings between the radar internal layer folds and the flow stripes on the surface. Flow stripes have wavelengths on the order of 1.2 – 2 km and remain roughly sub-parallel for many kilometers, eventually becoming less distinct as the ice stagnates. The wavelengths of internal layer folds are on the order of 0.5 – 3 km, generally with longer wavelengths upstream, shortening as ice flow converges in the main trunk of the ice stream. In places it is apparent that the surface flow-stripes cross over the underlying englacial folds. We explore hypotheses about how flow stripes and internal stratigraphic folds can originate and evolve differently as ice flows downstream. We suggest that following the formation of flow stripes on the ice surface they are subject to processes that can modify their morphology independent of any coeval englacial structure development, leading to changes in the pattern of folds relative to the internal layers below.