Fast or slow?: Englacial drainage in the Greenland Ice Sheet.

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The hydrologic system of temperate and polythermal glaciers and ice caps can be dominated by the flux of surface melt water to an englacial drainage system or directly to a subglacial system. The first case implies that englacial processes exert significant control on subglacial hydrology and therefore sliding behavior. The latter case is the conventional view that implies no englacial effects on subglacial processes. These two end member scenarios stem directly from field studies. Numerous field investigations have shown that intersecting englacial passageways are relatively common, implying that large water fluxes can drain efficiently through a network of fractures. Other field studies have demonstrated that these fracture networks are not necessarily utilized and water drains directly to the bed. Here, we argue that both configurations exist and for the Greenland Ice Sheet englacial drainage dominates in many regions. We use a combination of comparative examples from smaller glaciers, and model results for Greenland catchments. Englacial drainage systems can either develop from a transient dynamic response to large surface meltwater events or long-term drainage evolution that principally results from ice flow. In the transient case, the basal water system cannot accommodate the large water flux and water is routed through an otherwise hydrologically inactive englacial fracture network allowing development of englacial conduits. The long-term case parallels observations from field sites where englacial drainage dominates due to glacier geometry and existing crevasse fields. Field studies have shown that water pressures along the base of overdeepenings typically rise above flotation and can divert water from the bed upward through the ice. Many overdeepenings exist across Greenland, and we posit that these will be dominated by englacial drainage. Many of these overdeepenings exist on outlet glaciers that are dominated by fracture networks. Unfortunately, field investigations of the physical and hydraulic characteristics of englacial pathways are typically ignored in favor of investigating basal conditions. Both can be achieved in the same drilling campaign with little additional effort.