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1 Diurnal fluctuations in glacier motion and ice deformation: Haut Glacier d'Arolla, Switzerland.

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In order to better understand the relationship between hydraulically-induced basal motion and glacier ice deformation over short timescales, measurements of surface velocity, ice deformation (at 50% and 90% ice depth) and proglacial stream discharge were made at Haut Glacier d'Arolla, Switzerland at high enough temporal resolutions to determine diurnal patterns of variation in each. Significant correlations were observed between variations in glacier surface velocity above a basal "slippery spot" and variations in tilt of an englacial tiltmeter enclosed in the glacier at 90% ice depth c.145 m down-glacier. This indicates that localised, diurnal, hydraulically-induced variations in basal sliding create stresses that propagate through the glacier and force diurnal variations in internal deformation immediately down-glacier. Further minor peaks in ice deformation at 90% depth and damped, lagged variations in deformation at 50% ice depth are interpreted in the context of previous diurnal investigations into hydrology and dynamics at the glacier. These are believed to be caused by the propagation of longitudinal stresses from more distant basal sliding events as melt-water inputs to the subglacial drainage system are progressively delayed by a thicker snowpack further up-glacier. It is proposed that such high frequency, small magnitude hydrological and dynamic processes will subject basal ice to quite different stress regimes than experienced by the glacier as a whole. This may be significant in trying to understand anomalous vertical velocity profiles measured above and down-glacier of basal slippery spots which have shown evidence for "plug flow" and extrusion flow over annual timescales.