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Constraints on glacier bedrock roughness from spectral analysis of glacier forefields

Jacob Woodard[1], Lucas Zoet[1], Neal Iverson[2], and Christian Helanow[2]
[1]University of Wisconsin-Madison, Department of Geoscience, Madison, United States of America (jwoodard2@wisc.edu)
[2]Iowa State University of Science and Technology, Department of Geological and Atmospheric Sciences, Ames, United States of America

The slip of hard bedded glaciers partly depends on the morphology of their beds. Thus, constraints on subglacial bedrock morphology are imperative for accurate forecasting of glacier flow rates. Digital elevation models (DEMs) from ten valley glacier and ice-sheet forefields were used to analyze the spectral patterns of recently deglaciated bedrock. Valley glacier DEM length scales are 0.1 m - 100 m, while ice sheet DEM length scales are 10 m -1000 m. We observe a higher spectral roughness and aspect ratio (i.e. bump height/wavelength) for valley glaciers than ice-sheet forefields. However, forefield aspect ratios span a narrow range and decrease with increasing length scale at a consistent rate despite a range of bedrock lithologies analyzed. This implies that bedrock shear strength (τ) scales with length scale (L), as $\tau \sim L^{-0.37}$, closely matching the bulk strength scaling relation seen in fault rocks (Brodsky et al., 2016). These morphological constraints of forefields allow extrapolation of bedrock roughness beneath active glaciers that can help predict sliding rates.

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