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Subglacial bedform orientation, one-dimensional size, and directional shape measurement method accuracy

Marco G. Jorge and Tracy A. Brennand
Simon Fraser University, Department of Geography, Burnaby, BC, Canada

This study is an assessment of previously reported automated methods and of a new method for measuring longitudinal subglacial bedform (LSB) morphometry. It evaluates the adequacy (accuracy and precision) of orientation, length and longitudinal asymmetry data derived from the longest straight line (LSL) enclosed by the LSB's footprint, the footprint's minimum bounding rectangle longitudinal axis (RLA) and the footprint's standard deviational ellipse (SDE) longitudinal axis (LA) (new method), and the adequacy of length based on an ellipse fitted to the area and perimeter of the footprint (elliptical length). Tests are based on 100 manually mapped drumlins and mega-scale glacial lineations representing the size and shape range of LSBs in the Puget Lowland drumlin field, WA, USA. Data from manually drawn LAs are used as reference for method evaluation. With the exception of elliptical length, errors decrease rapidly with increasing footprint elongation (decreasing potential angular divergence between LAs). For LSBs with elongation <5 and excluding the 5% largest errors (outliers), 1) the LSL, RLA and SDE methods had very small mean absolute error (MAE) in all measures (e.g., MAE <5º in orientation and <5 m in length); they can be confidently used to characterize the central tendency of LSB samples. 2) When analyzing data spatially at large cartographic scales, the LSL method should be avoided for orientation (36% of the errors were larger than 5º). 3) Elliptical length was the least accurate of all methods (MAE of 56.1 m and 15% of the errors larger than 5%); its use should be discontinued. 4) The relative adequacy of the LSL and RLA depends on footprint shape; SDE computed with the footprint's structural vertices is relatively shape-independent and is the preferred method. This study is significant also for negative-relief, and fluvial and aeolian bedforms.