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Glaciated orogenic wedges: sensitivity of tectonics to climate change

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There is much interest in determining the influence of climate change on orogen evolution, with recent analytical studies focusing on the influence of rivers on critical wedge systems (Hilley and Strecker, 2004; Whipple and Meade, 2004; Roe et al, in press). We present an analogous analytical study that examines the evolution of a glaciated orogen. Glacial erosion in this study is process based, where the rate of surface erosion is linked to the sliding velocity of the ice. The orogen is assumed to retain its critical angle, with matching rock uplift and erosion rates that are spatially non-uniform. Under these conditions, the rates of rock uplift are highest toward the edges of the orogen and lowest at the centre. Furthermore, the erosional flux is very sensitive to changes in climate. The total rate of erosion is approximately linearly sensitive to the precipitation rate, so precipitation and orogen width also scale approximately linearly. The distribution of rock uplift across the glaciated orogen is maximized at the glacier's equilibrium line altitude, which is largely controlled by temperature. These results stand in contrast to those expected for fluvially dominated orogens, as the rock uplift pattern is opposite. The width of orogens that are glacially controlled are also at least as twice as sensitive to precipitation rates compared to those that are fluvially controlled.