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The (mis)conception of an average Quaternary equilibrium line altitude

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The glacier equilibrium line altitude (ELA) represents the elevation on the glacier surface at which the amount of mass gained (via precipitation, avalanching and windblown snow, equals the amount of ice lost (via ablation and sublimation, over the mass balance year. The ELA can be measured on modern glaciers or calculated for reconstructed, former glaciers. Despite its simple definition, the ELA represents an incredibly powerful, quantitative expression of the relationship between glaciers and climate. As a glacier responds dynamically to climate, so does the ELA. Precipitation at the glacier ELA has been empirically linked to ablation season temperature. Thus, the reconstruction of former glacier geometries and their ELAs leads to the quantification of palaeoclimate.

In recent years, the concept of an “average Quaternary ELA” (or “mean Quaternary ELA”) has become popular because of the role it might play in relation to the glacial buzzsaw hypothesis, i.e. the idea that glacial erosion could offset mountain uplift and therefore control and limit the growth of mountains. Attempts to determine the average Quaternary ELA have been undertaken, leading to some interesting conclusions. For example, it has been argued that the floor altitudes of glacial cirques can be used as a measure of average Quaternary ELA, therefore implying that average Quaternary mountain glaciers expansion was confined to the topmost portion of alpine valleys.

Time has passed from these initial attempts to determine the average Quaternary ELA and more palaeoclimatic and palaeoglaciological data have become available, so it is appropriate to reconsider these calculations and perhaps question the validity of such a concept. To do so, we revisit how the idea of an average Quaternary ELA developed and what such a parameter would really mean. We do so in light of a new quantitative study on the average ELA relative to both a single glacial cycle and multiple glaciations experienced during the past 2.6 million years, i.e. the Quaternary. Collectively, this new study presents a very different perspective than previously suggested.