Equilibrium line altitude (ELA)-reconstructions of a Younger Dryas system in the Eastern Alps

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The key to understand paleoclimate variations in the Alps is the reconstruction of paleoglacial systems in combination with ELA calculations. The principles of ELA's are simple; it marks the line on a glacier's surface, where the ablation area and the accumulation area are in balance (Gross et al., 1976; Sugden and John, 1976). Therefore, it is possible to reconstruct paleoclimate with knowledge of the ELA. During colder and wetter climate periods the conditions favour glacier growth thus the accumulation area grows with the glacier flowing downward. Consequently, the ELA will sink to lower altitudes. The same principle can be applied in the other direction.

To estimate the former ELA's of glaciers many different methods, such as the Toe-to-Headwall Altitude Ratio, Area x Altitude, Accumulation Area Ratio or Area x Altitude Balance Ratio exist (see Benn and Lehmkuhl, 2000 for a summary), have been developed. All of them need at least a rough knowledge of the former glacier surface, which can be reconstructed with geomorphological and geological mapping of the required area (till, lateral and terminal moraines) and/or with the study of airborne laser scans.

The main problem with these methods is time, as it is a lengthy process to calculate the ELA values. Pellitero et al. (2015) built an ArcGIS toolbox, which is meant to highly reduce the time needed for the calculations of ELA's, using the Accumulation Area Ratio, Area x Altitude Balance Ratio, Area-Altitude and Kurowski method. The aim of this work is to determine the efficiency of the ArcGIS toolbox in the day-to-day workflow of ELA-calculations of Austrian alpine glaciers.

We applied and estimated the accuracy of these methods using two recent glaciers, Goldbergkees and the Pilatuskees in Salzburg, Austria. The selected areas offer a robust allostratigraphy with absolute dates of the glacial dimensions since the Younger Dryas = Egesen (Bichler et al., 2016).

Additionally, the ELA's for the Egesen as well as for the Little Ice Age (1850) have been already calculated (Bichler and Reindl, 2013) using the MELM (Maximum Elevation of Lateral Moraine) method and thus provide a good and reliable comparison.

This work shows that the accuracy of the toolbox lies within a discrepancy of 6 meters compared to the mapped values (MELM-method) (Bicher and Reindl, 2013) of the ELA of the Little Ice Age Goldbergkees and between 9 and 31 meters for the Egesen Kolm-Saigurn expansion. We conclude that the toolbox offers an efficient method to improve the ELA calculations in the Austrian Alps.