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Younger Dryas equilibrium line altitudes and precipitation patterns in the Alps

Hanns Kerschner (1), Andrew Moran (1), and Susan Ivy-Ochs (2)

(1) Universität Innsbruck, Institut für Geographie, Innsbruck, Austria (hanns.kerschner@uibk.ac.at), (2) ETH Zürich, Ion Beam Physics, Zürich, Switzerland

Moraine systems of the "Egesen Stadial" are widespread and easily identifiable features in the Alps. Absolute dating with terrestrial cosmogenic radionuclides shows that the maximum extent was reached during the early Younger Dryas (YD), probably as a reaction to the intense climatic downturn subsequent to Lateglacial Interstadial. In recent years, several new studies and the availability of high-quality laser-scan hillshades and orthophotos allowed a significant extension of the database of YD glaciers as "palaeoprecipitation gauges" to large hitherto unmapped regions in the Austrian and Swiss Alps.

The equilibrium line altitude (ELA) of the glaciers and its lowering relative to the Little Ice Age ELA (dELA) shows a distinct and systematic spatial pattern. Along the northern slope of the Alps, dELAs are usually large (around 400 m and perhaps even more), while dELAs range around 200 m in the well sheltered areas of the central Alps, e.g. in the Engadine and in western Tyrol.

Both stochastic glacier-climate models (e.g. Ohmura et al. 1992) and the heat- and mass balance equation (Kuhn 1981) allow the reconstruction of precipitation change under the assumption of a spatially constant summer temperature depression, which in turn can be estimated from biological proxies. This allows to draw the spatial pattern of precipitation change with considerable detail. Precipitation change is clearly controlled by the local relief like high mountain chains, deeply incised and long valleys and mountain passes. Generally the contrast between the northern fringe of the Alps and the interior was more pronounced than today. Climate in the Northern and and Northwestern Alps was rather wet with precipitation totals eventually exceeding modern annual sums. The central Alps received 20 - 30% less precipitation than today, mainly due to reduced winter precipitation. In the southern Alps, still scarce spatial information points to precipitation sums which were approximately similar to modern values. As winter precipitation was probably much smaller than today, seasonal contrasts were more pronounced.

In total, the pattern of YD precipitation change is remarkably similar to precipitation patterns caused by westerly and northwesterly cyclonic airflow during the present-day hydrologic winter (October - March).

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