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Atmospheric dynamics over Europe during the Younger Dryas revealed by palaeoglaciers.

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A dataset of 120 palaeoglaciers ranging from Morocco in the south to Svalbard in the north and from Ireland in the west to Turkey in the east, has been assembled from the literature. A robust quality control on the chronology was undertaken and, when derived from cosmogenic nuclides, ages were recalculated using the most up-to-date production rates. All the reconstructed glaciers date to the Younger Dryas. Frontal moraines/limits were used to initiate the palaeoglacier reconstructions using GlaRe, a GIS tool which generates an equilibrium profile ice surface along a single flowline and extrapolates this to out to a 3D ice surface. From the resulting glacier surfaces palaeo-ELAs were calculated within the GIS. Where multiple glaciers were reconstructed within in a region, a single ELA value was generated. Results show that ELAs decrease with latitude but have a more complex pattern with longitude. A database of 121 sites, spanning the same geographical range as the palaeoglaciers, was compiled for Younger Dryas temperature, determined from palaeoproxies, for example pollen, diatoms, coleoptera, chironimids etc. These proxy data were merged and interpolated to generate maps of average temperature for the warmest and coldest months and annual average temperature. Results show that, in general, temperature decreases with latitude. Temperature at the palaeo-ELAs were determined from the temperature maps using a lapse rate of 0.65°C/100m and the precipitation required for equilibrium was calculated. Positive precipitation anomalies are found along much of the western seaboard of Europe, with the most striking positive anomalies present in the eastern Mediterranean. Negative precipitation anomalies appear on the northern side of the Alps. This pattern is interpreted to represent a southward displaced polar frontal jet stream with a concomitant track of Atlantic mid-latitude depressions, leading to more frequent incursions of low pressure systems especially over the relatively warm eastern Mediterranean, enhancing cyclogenesis. This is similar to the modern Scandinavia (SCAND) pattern which, in its positive phase, is characterised by a high pressure anomaly over Fennoscandia and western Russia, negative pressure anomalies around the Iberian Peninsula and enhanced cyclogenesis in the central and eastern Mediterranean. During the YD the Fennoscandian Ice Sheet and permafrost across much of northern continental Europe and Russia would have generated a high pressure region leading to a persistent, enhanced SCAND circulation.