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Reconstructing plateau icefields: Evaluating empirical and modelled approaches

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Glacial landforms are widely utilised to reconstruct former glacier geometries with a common aim to estimate the Equilibrium Line Altitudes (ELAs) and from these, infer palaeoclimatic conditions. Such inferences may be studied on a regional scale and used to correlate climatic gradients across large distances (e.g., Europe). In Britain, the traditional approach uses geomorphological mapping with hand contouring to derive the palaeo-ice surface. Recently, ice surface modelling enables an equilibrium profile reconstruction tuned using the geomorphology. Both methods permit derivation of palaeo-climate but no study has compared the two methods for the same ice-mass. This is important because either approach may result in differences in glacier limits, ELAs and palaeo-climate. This research uses both methods to reconstruct a plateau icefield and quantifies the results from a cartographic and geometrical aspect.

Detailed geomorphological mapping of the Tweedsmuir Hills in the Southern Uplands, Scotland ($c.$ 320 km^2) was conducted to examine the extent of Younger Dryas (YD; 12.9 -11.7 cal. ka BP) glaciation. Landform evidence indicates a plateau icefield configuration of two separate ice-masses during the YD covering an area $c.$ 45 km^2 and 25 km^2. The interpreted age is supported by new radiocarbon dating of basal stratigraphies and Terrestrial Cosmogenic Nuclide Analysis (TCNA) of in situ boulders.

Both techniques produce similar configurations however; the model results in a coarser resolution requiring further processing if a cartographic map is required. When landforms are absent or fragmentary (e.g., trimlines and lateral moraines), like in many accumulation zones on plateau icefields, the geomorphological approach increasingly relies on extrapolation between lines of evidence and on the individual's perception of how the ice-mass ought to look. In some locations this results in an underestimation of the ice surface compared to the modelled surface most likely due to reworking and paraglacial modification. It is suggested the model produces an overall more holistic reconstruction, providing glaciological insights into an otherwise static reconstruction. The model should not replace the traditional technique but should be used in conjunction since it provides important insights into likely boundary conditions, including shear stress, the presence of plateau ice and thickness.