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A glacial perspective on the impact of North Atlantic stadials on terrestrial climate

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The British Isles contain a rich glacial-geologic record of cryospheric behaviour in the NE North Atlantic basin, with enormous potential for establishing the timing, causes, and mechanisms of key climate events. We present a cosmogenic 10Be surface-exposure chronology from northern Scotland that, together with glacial-geomorphic mapping, reconstructs the nature of cryospheric change – and thus climate variability – since the Last Glacial Maximum. Our specific focus is Heinrich Stadial 1 (18,300–14,700 years ago), arguably the most significant abrupt climate event of the last glacial cycle, and the shorter Younger Dryas stadial, both of which are prominent features in global palaeoclimate records. Such chronologic constraint is needed because of currently conflicting models of how stadial events impact terrestrial environments and a recent hypothesis attributing this disparity to enhanced seasonality in the North Atlantic basin. To date, we have measured 10Be in > 60 samples from glacial erratics located on moraines deposited by the British ice sheet, as it retreated from the continental shelf to its mountain source regions, and from moraines corresponding to subsequent episodes of alpine glaciation. Our preliminary results indicate that, despite depressed sea-surface temperatures in much of the North Atlantic, Heinrich Stadial 1 was characterised on land by widespread deglaciation driven by atmospheric warming, a pattern that is suggestive of pronounced seasonality at that time. Our data also suggest that a subsequent phase of alpine glaciation (known locally as the Loch Lomond Readvance) culminated significantly earlier than other recent estimates, bringing into question the widely held association of this advance with the Younger Dryas. With the growing focus on the full expression of stadials, and the inherent vulnerability of Europe to shifts in North Atlantic climate, developing the extant record of terrestrial glaciation and comparing these data to marine records is a critical step towards understanding the drivers of abrupt climate change.