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Paleoclimatic insights from mapping the global distribution of non-glacial cryogenic landforms in sub-humid montane environments.

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Much of the 'periglacial' literature is based on landforms and observations from either high mountains or continental environments dominated by strong winter cooling and/or permafrost conditions. Cryogenic conditions occur in many other settings and some of the most widespread are montane landscapes in mid- to low latitudes. In Australia observations of 'periglacial' landforms have traditionally been limited to higher elevation regions of the Australian Alps and central Tasmania. However, the distribution of relict cryogenic landforms is much wider and extends well into sub-tropical latitudes along the eastern highlands of Australia. Here we map the distribution of relict block deposits (block streams and block fields) of known cryogenic origin so as to delineate the limits of 'periglacial' climatic conditions during cold phases in the Late Quaternary. The mapping is based on image analyses supported by extensive and intensive ground truthing. Three distinct regimes are recognised – a high elevation winter wet regime (Mt Kosciuszko style); a temperate maritime westerly regime (Tasmania style) and, unexpectedly, an east coast (sub-tropical) regime (New England style).

We utilise bio-climatic modelling to derive modern climate parameters from the distribution of the block deposits so as to map regions affected by cryogenic conditions in late Quaternary cold periods. We assumed that relative changes in mean cooling and precipitation would be shared by other mid-latitude climate locales worldwide and predicted the likely distribution of block deposits in these areas. A literature review confirms the presence of 'periglacial' style block deposits in the predicted regions, including part of the Iberian Peninsula, the Atlas and Drakensburg Mountains of Africa, the Mediterranean island of Sardinia, the higher volcanoes of Mexico and parts of China, all of which have mean annual precipitation similar to the New England area. However, we also note that many of these areas have winter wet (Mediterranean) climates and when seasonality of precipitation is included, winter dry New England becomes an anomaly. We conclude that in addition to significant cooling, winter moisture balance was more positive, in northern New South Wales during cooler climate periods.