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Global glacier dynamics during the last ten Pleistocene glacial cycles: assessing patterns, similarities and contrasts between different cold stages

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Glacier mass balance is directly influenced by summer temperatures and precipitation. The timing of glacier advance and retreat depends on the interplay of these two variables and global patterns vary depending on the relative changes in summer temperatures and precipitation, especially winter precipitation in the case of mid-latitude glaciers. Glaciers are known to have reached their maximum extents at a range of times during the last glacial cycle (Weichselian/Wisconsinan Stage, etc.). Some reached their maximum in Marine Isotope Stage (MIS) 2 close to the global Last Glacial Maximum (LGM) when global sea levels were at their lowest. Some sectors of the largest mid-latitude ice sheets in the Northern Hemisphere (Laurentide, British-Irish, SE Fennoscandian) appear to have reached their maximum extent around this time and these ice sheets probably dominated the global sea-level signal at the LGM. Other ice sheets and large ice caps reached their maximum extent before this, many achieving their maximum in MIS 3, 4 or earlier (New Zealand, Patagonia, East Antarctica, Himalaya-Tibet, Cordilleran, Alaska, SW Fennoscandia). In northern Eurasia, the Barents-Kara ice sheet reached its maximum extent early in the last glacial cycle (late MIS 5). Improvements in geochronology offer the opportunity to assess these variations and to compare them with earlier, Middle Pleistocene glaciations, some of which were the most extensive recorded in the Quaternary. The global patterns of glaciation observed for the last glacial cycle, one of the longest recorded in the Pleistocene, provide a template for understanding previous glacial cycles. The pattern of ice build-up, advances and retreats can be linked to glacier size, proximity to the major oceans (continentality) and also to changes in global solar radiation receipt at different latitudes. Whilst glacier growth is modulated by variations in solar radiation, it is the feedback mechanisms between glacier size and climatic continentality that control the spatial and temporal patterns of glaciation during glacier cycles. This paper explores this hypothesis for the last ten glacial cycles (late Early to Late Pleistocene).