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Deglaciation chronology in southern Norway following the Last Glacial Maximum

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Growth and decay of Quaternary glaciers and ice sheets had fundamental implications for environmental changes worldwide. The chronology of the last deglaciation following the Last Glacial Maximum (LGM, 26.5-20 ka) and its ice marginal positions in Norway are generally perceived as being well constrained. The detailed vertical extent in Norway remains, however, still uncertain over large areas. The knowledge of the vertical dimension of the LGM ice sheet can provide crucial information on palaeo-environmental factors like sea-level changes, atmospheric and oceanic circulation, (de-)glaciation patterns, which are important variables for climate modelling. The interpretation of differently weathered bedrock in mountain areas affected by Quaternary glaciation can be crucial for determining ice-sheet behaviour and thickness. Based on 10Be terrestrial cosmogenic nuclide dating and Schmidt-hammer exposure age-dating (SHD) performed in eastern and western South Norway, we provide new insights in (de)glaciation patterns, landform evolution and estimate ice thickness during and following the LGM. We present the first numerical dates from the western study area showing that deglaciation started $\sim$4 ka earlier and ice sheet downwasting lasted longer than assumed. SHD ages obtained from periglacial and related landforms (e.g. rock-slope failures, pronival ramparts) in this area point to their stabilization during the Holocene Thermal Maximum ($\sim$8-5 ka). The rock-slope failures investigated did not occur shortly after local deglaciation, it appears that they cluster around warm periods due to climate-driven factors, like decreasing permafrost depth or increasing cleft-water pressure. Exposed bedrock at the summit in the eastern study area yields a 10Be exposure age predating the Late Weichselian Maximum of 43.7 $\pm$ 1.9 ka, possibly indicating ice free areas during the LGM. Instead of the inferred ice coverage at $\sim$15 ka, our SHD ages from blockfields suggest ice-free and severe periglacial conditions occurred earlier. Landforms above 1450 m a.s.l. (e.g. sorted stone polygons, blockstreams) do not show any form of reactivation during cold periods within the Late Glacial or the Holocene. Our results have wider implications on the glaciation history of the area. The results point to a more complex ice sheet behaviour than previously expected. Therefore, we suggest a more complex and topographically controlled configuration of the LGM ice sheet in relation to previous reconstructions.