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LGM Tibetan Plateau glaciers were not much larger than today

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The Tibetan Plateau is the largest and highest elevated area on Earth with consequential impacts on regional (monsoon development) and global (CO_2 sequestering) climate patterns and evolution, and with its glaciers providing meltwater for some of the largest rivers of the world. The glacial history of the Tibetan Plateau is dominantly characterized by glaciers and ice caps centered on elevated mountain regions of the plateau, as evidenced by an extensive glacial geological record. Here we present the outcome of a five year project aiming towards a palaeoglaciological reconstruction for the Bayan Har Shan region of the northeastern Tibetan Plateau. We have used remote sensing, field studies and ^{10}Be exposure ages towards a robust reconstruction of former glaciation. Glacial landforms and sediments in Bayan Har Shan, distributed around elevated mountain areas, indicate a maximum Quaternary glaciation significantly larger than today. We have dated 40 boulders, 12 surface pebbles samples, and 15 depth profile samples (in 4 depth profiles) from 15 sites (mainly moraine ridges) using ^{10}Be exposure dating. Our boulder and pebble exposure ages range from 3 ka to 128 ka with large age spreads within populations of individual sites. Based on the premise that cosmogenic age spreads within populations are caused by post-depositional shielding which yields exposure ages younger than deglaciation ages (see Heyman et al. Abstract/Poster in session CL4.7/GM2.4/SSP2.5/SSP3.9: EGU2010-14159-1) and based on the exposure ages of the multiple sample types, all dated glacial deposits pre-date the global Last Glacial Maximum (LGM). Our results further indicate that even the innermost and highest of the dated moraines, formed by glaciers $<$10 km long, have minimum deglaciation ages of 45 ka. These results agree well with those sites on the Tibetan Plateau where samples close outside present-day glacier margins have yielded exposure ages significantly older than the LGM. In fact, for sites where exposure age studies have been performed on the Tibetan Plateau, it is a rule rather than an exception with pre-LGM exposure ages close outside present-day glacier margins. This indicates that during the LGM, when large ice sheets covered North America and northern Europe, glaciers on the northeastern Tibetan Plateau, and perhaps the plateau at large, did not grow much larger than today.

To explore the climate implications of restricted Tibetan Plateau LGM glaciers, we employ a high-resolution 3D glacier model forced with static climate perturbations of the present-day climate (WorldClim data: http://www.worldclim.org/). Allowing glaciers to grow and expand to but not exceed well-dated moraines enables us to derive and present climate constraints for the Tibetan Plateau during the LGM.