4.3. The summer heatwave in 2022 and its role in permafrost and periglacial conditions at the historic Hochtor mountain pass, Hohe Tauern Range, Austria

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Abstract: Air temperatures in the meteorological summer 2022 (June-August) were 1.3°C higher than normal averaged over Europe. We analysed the long-term warming effects at a high mountain pass in central Austria (Hochtor, 2576 m asl, 47.08°N, 12.84°E). Archaeological finds along the former travel route passing Hochtor suggest that this mountain pass was used in prehistoric times. Solifluction processes caused the displacement of archaeological finds

from their original positions with implications for present periglacial research. We worked on the research question how ongoing climate change caused modifications in the ground thermal regime and subsequently on permafrost and periglacial conditions at this site. The aims were: (1) to analyse ground temperature and permafrost conditions and trends, (2) to evaluate changes of potential frost-related weathering, and (3) to assess the impact of the recent atmospheric warming including the summer 2022 on the ground thermal conditions since the late 19th century at Hochtor. We used long-term ground temperature data (2010-2022) from depths down to 60 cm, repeated electrical resistivity tomography (ERT) measurements from two years (2019, 2022), and auxiliary data dating back to 1887 (instrumental data) or Roman times (archaeological finds). Our results indicate that Hochtor changed in 2010-2022 from an active permafrost site to an inactive one with a supra-permafrost talik zone in between the seasonally thawing and freezing top layer and the permafrost. As revealed by time-lapse ERT analyses, a mean annual resistivity decreasing rate of 3.9 to 5.2% yr-1 indicates distinct and profile-wide permafrost degradation at three ERT profiles. The summers of 2003, 2015, 2019 and 2022 were the four warmest ones in the period 1887-2020. We conclude that the resistivity changes are not the single effect of the summer heatwave of 2022 but must be seen as a long-term signal of permafrost degradation which has increased significantly in the recent past.