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Attributing the global increase in permafrost temperatures to human induced climate change

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Permafrost temperatures are increasing at the global scale, resulting in permafrost degradation. Besides substantial impacts on Arctic and Alpine hydrology and the stability of landscapes and infrastructure, permafrost degradation can trigger a large-scale release of carbon to the atmosphere with possible global climate feedbacks. Although increasing global air temperature is unanimously linked to human emissions into the atmosphere, the attribution of observed permafrost warming to anthropogenic climate change has so far mostly relied on anecdotal evidence. Here we apply a climate change detection and attribution approach to long permafrost temperature records from 15 boreholes located in the northern Hemisphere and simulated soil temperatures obtained from global climate models contributing to the sixth phase of the Coupled Model Intercomparison Project (CMIP6). We show that observed and simulated trends in permafrost temperature are only consistent if the effect of human emissions on the climate system is considered in the simulations. Moreover, the analysis also reveals that neither simulated pre-industrial climate variability nor the effects natural drivers of climate change (e.g. impacts of large volcanic eruptions) suffice to explain the observed trends. While these results are most significant for a global mean assessment, our analysis also reveals that simulated effects of anthropogenic climate change on permafrost temperature are also consistent with the observed record at the station scale. In summary, the quantitative combination of observed and simulated evidence supports the conclusion that anthropogenic climate change is the key driver of increasing permafrost temperatures with implications for carbon cycle-climate feedbacks at the planetary scale.