Uneven wetting under climate change is causing diverse variations in the thawing of frozen ground on the Tibetan Plateau

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This chain of mountains is located at the northern edge of the Tibetan Plateau, has an altitude of more than 4600 m, and is classified as a permafrost region. The geology is complex and the natural conditions are harsh. Credit: Chen Cheng

The Tibetan Plateau has experienced prominent warming and wetting since the mid-1990s that has altered the thermal and hydrological properties of its frozen ground. In a new study, published in *Advances in Atmospheric Sciences*, scientists used the Community Land Surface Model to uncover that the dual effect of this wetting and the projected increase in precipitation over the Tibetan Plateau in the future is becoming a critical factor in determining the thermodynamics of the frozen ground.

The lead author of the study, Dr. Xuewei Fang from the School of Atmospheric Sciences at Chengdu University of Information Technology in China, explains that, "In the face of the greatest increase in the occurrence frequency of heavy precipitation over the entire Tibetan Plateau, we need to address how warming and wetting might be jointly influencing the thermal responses of the permafrost and seasonally frozen ground to climate change."

Dr. Fang and her colleagues used the average annual precipitation as a criterion to divide the Tibetan Plateau into an arid zone (annual precipitation: annual precipitation: > 800 mm).

Results showed that, compared with 1961–1990, the average annual air temperature and precipitation over the Tibetan Plateau during 1991–2010 increased by 0.72℃ and 75.64 mm, respectively. Spatially, the arid and semi-arid zones became warmer and wetter, while the humid and semi-humid zones became warmer but drier.

The team also compared the freezing and thawing durations of the ground surface in the two periods, and found that the wetting in drier regions before the 1990s prolonged the duration of freezing of the frozen ground and that the continuously wetting after the 1990s reduced the thawing period. This implies that the substantial wetting in arid areas has exerted the opposite warming effect on the permafrost body since the 1990s, with the permafrost area having shrunk by 28%.

This finding lies in contrast to the frozen ground presented in wetter regions, i.e., the decline in precipitation in the humid zones has prolonged the thawing duration in seasonally frozen ground significantly since the start of the 1990s. A drying and warming environment tends to enhance heat loss at the ground surface, thereby decreasing the heat supply for the melting of ice and extending the thawing process.

"Next, we plan to investigate how energy and water fluxes in the frozen ground interact with wetting and warming conditions," concludes Dr. Fang.

More information: Xuewei Fang et al, Response of Freezing/Thawing Indexes to the Wetting Trend under Warming Climate Conditions over the Qinghai -Tibetan Plateau during 1961–2010: A Numerical Simulation, *Advances in Atmospheric Sciences* (2022). DOI: 10.1007/s00376-022-2109-z

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