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# Ground surface temperature variation across scales on northeastern Qinghai-Tibet Plateau

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Ground surface temperature (GST), measured at 5–10 cm into the ground, is essential for understanding the climate change impacts in the Earth Critical Zone, especially in cold regions. This work goal was to identify the GST variations from local to landscape scale on similar and different environmental conditions (e.g. elevation, landcover). The study area is located in the southern part of the Headwater Area of the Yellow River (HAYR), a representative area of alpine discontinuous permafrost on the Qinghai-Tibet Plateau. GST was recorded from 2019 to 2020 at 39 sites scattered on a local and landscape scale (2 and 50 $km^2$), and on a transect along the highway with an elevational difference of 800 m. A statistically significant correlation was identified between mean annual GST (MAGST) with landcover (0.37, $p < 0.05$) and elevation (−0.76, $p < 0.001$). The analysis of variance (ANOVA) showed significant differences in MAGST between sites located in bare ground and vegetation but not between meadow and swamp meadow. At the local scale, the MAGST was higher in meadows (−0.3 to −0.6 °C) than in swamp meadows (−0.6 to −1.4 °C) and bare ground (−1.2 and −2 °C). The difference in MAGST between sites covered by vegetation and bare ground was 1.7 °C, and up to 1 °C between sites with the same landcover. The sites from the landscape scale revealed a similar pattern but with higher differences in MAGST, reaching 2.4 °C between vegetated and bare ground sites. The decrease of MAGST with elevation is most obvious for the sites located in bare ground ($R^2 = 0.83$, $p < 0.001$) than in meadow ($R^2 = 0.64$, $p < 0.003$) and swamp meadow ($R^2 = 0.49$, $p < 0.002$). An elevational threshold was found at 4600–4700 m from where MAGST is becoming negative. The disturbance of the highway seems to influence the GST regime and subsequently the permafrost degradation. GST monitoring will help to identify the permafrost thaw patterns at a high spatial resolution, and to better understand the rapid shrinkage of thermokarst lakes in the HAYR.