EGU2020-9106
https://doi.org/10.5194/egusphere-egu2020-9106
EGU General Assembly 2020

Recent ground thermal dynamics and variations in northern Eurasia

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Ground thermal regime in cold environments is key to understanding the effects of climate change on surface–atmosphere feedbacks. The northern Eurasia, covering over half of terrestrial areas north of 40°N, is sensitive to the ongoing climate change due to underlain permafrost and seasonal frost. Here, we quantify the recent ground thermal dynamics and variations over northern Eurasia by compiling measurements of soil temperature data over 457 sites at multiple depths from 1975-2016. Our analysis shows that the mean annual ground temperature has significant warming trends by 0.30–0.31 °C/decade at depths of 0.8, 1.6, and 3.2 m. We found that the changes in annual maximum ground temperatures were more pronounced than mean annual ground temperatures with a weakened warming magnitude (0.40 to 0.31°C/decade) from upper to lower ground. Our results also suggest the substantial differences in warming magnitudes through parameters and depths over different frost-related areas. The ground over continuous permafrost area warmed faster than non-continuous permafrost and seasonal frost areas in shallow ground (0.8 and 1.6 m depth) but slower in deeper ground (3.2 m). Our study highlights the varied ground temperature evolutions at multiple depths and different frost-related ground, suggesting the importance of separated discussions on different frost-affected ground in application and future research. Noteworthy, the results indicate that the significant ground warming can promote greenhouse gas emissions from soil to atmosphere, further accelerating climate change.