Analysis of near-surface permafrost monitoring station data from Alaska

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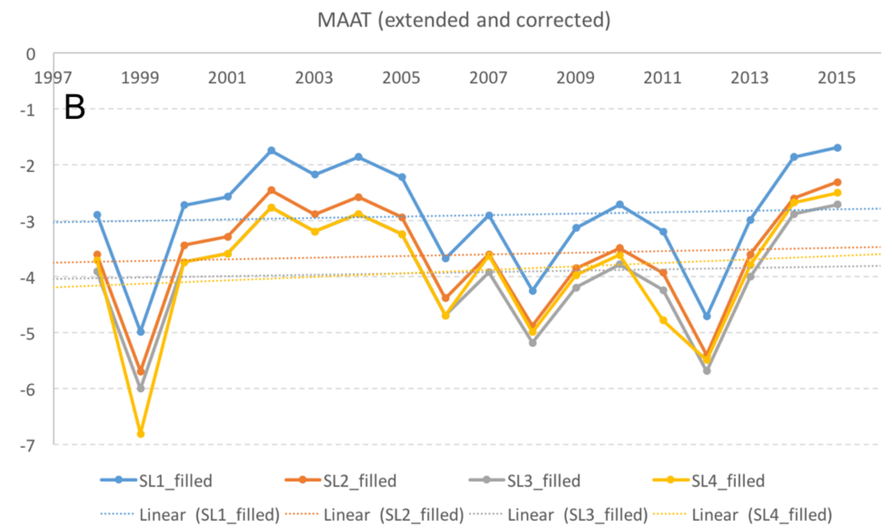
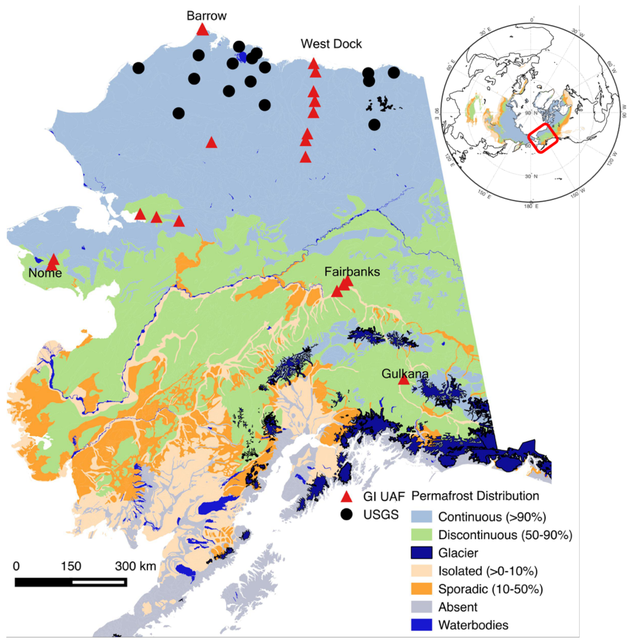
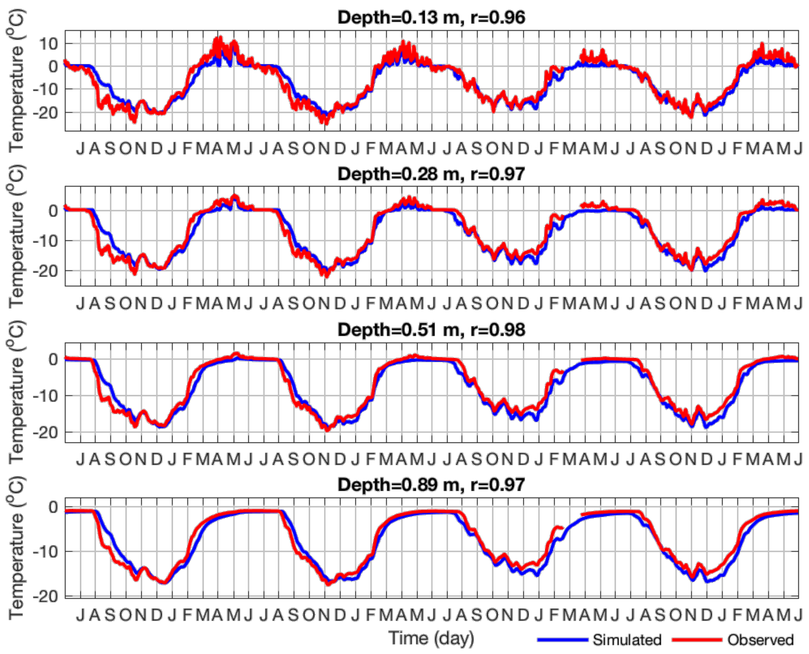
ABSTRACT Recent observations of near-surface soil temperatures over the Circumpolar Arctic show continuing warming of the permafrost-affected soils. A near-surface permafrost dataset is needed to better understand the corresponding climate impact and constrain the permafrost thermal and spatial conditions in land system models. In this study, we compile shallow ground temperature measurements collected by the U. S. Geological Survey (USGS) and by the Geophysical Institute, University of Alaska Fairbanks (UAF) permafrost monitoring networks in Alaska. We document the workflow and summarize the data collection methods used by USGS and UAF. The compiled Alaskan dataset includes air and ground temperature data, volumetric water content, and snow depth measured since 1998. This dataset represents an initial effort in consolidating the information on near-surface permafrost dynamics in the Northern Alaska. The results of the data analysis show a strong difference in trend between Interior and North Slope sites. As an immediate application of the dataset we derived a relationship between the thermal offset at the ground surface and snow depths, which could serve as a physical benchmark for modelers. The calculated linear trend using extrapolated data series indicate an increase in mean annual temperature at 1 m in the range of 1.5–1.9°C for the North Slope and stable warming but maintain above 0°C for the Interior over the next 20–25 years.

Statistical Analysis

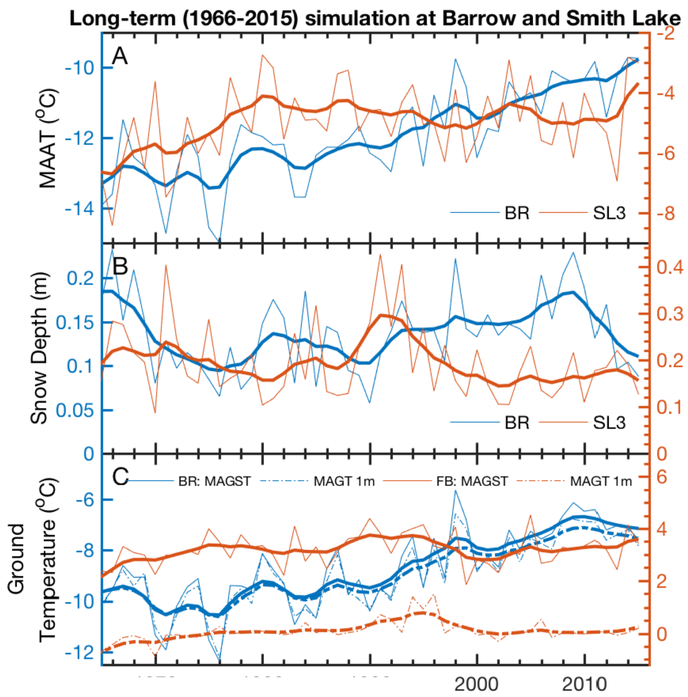


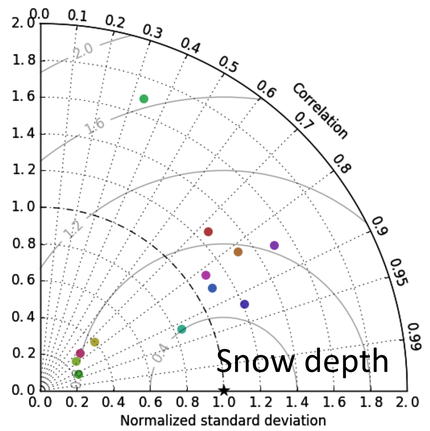


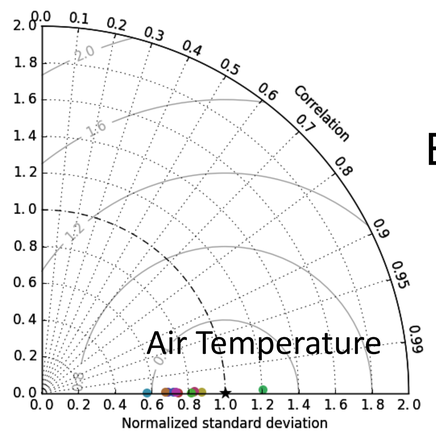
Locations of USGS and GI UAF permafrost monitoring stations in Alaska.



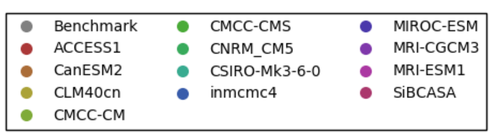
Numerical Application: Calibration and long-term reconstruction

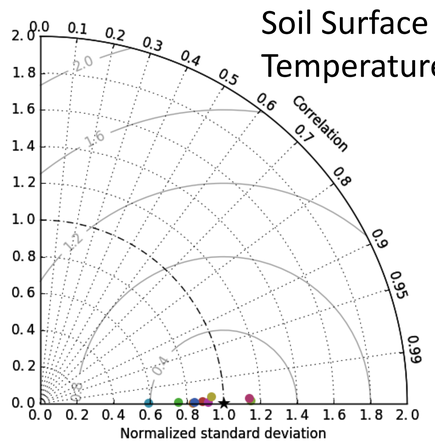


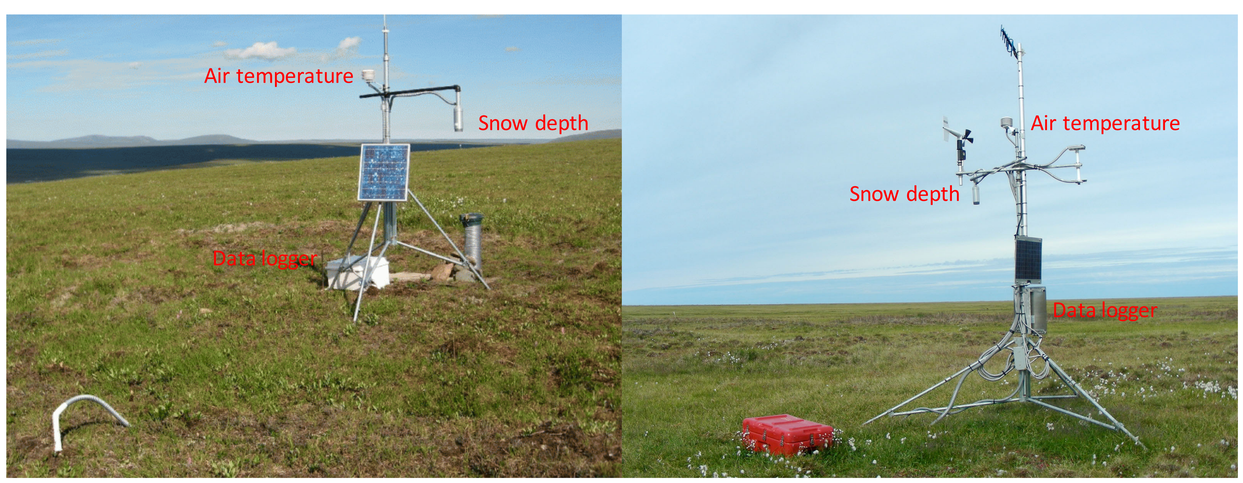




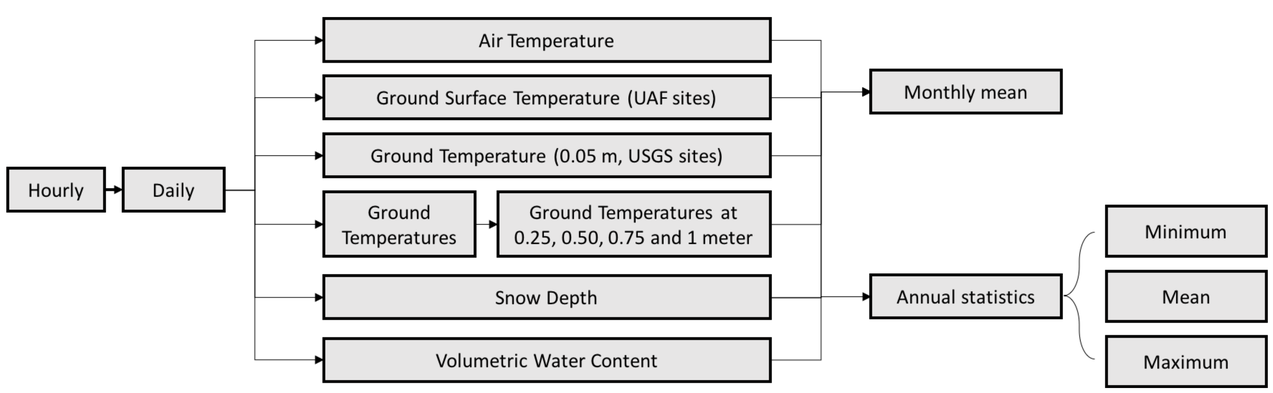
Modeling Evaluation







Typical permafrost observing stations. Left is Imnaviat 1 site (68.64°N, 149.35°W) in GI UAF network (source: http://permafrost.gi.alaska.edu/site/im1); right is Drew Point station (70.86°N, 153.91°W) in USGS network (source: http://pubs.usgs.gov/ds/0977/DrewPoint/DrewPoint.html).



Schematic representation of the data processing workflow used to compile the permafrost dataset for Alaska.

CONCLUSIONS Near-surface permafrost monitoring stations represent a unique data stream that gives us real-time information on the current changes in the upper soil thermal conditions. This study outlines the workflow of data processing and data analysis which could be applied to other regions and countries extending the current dataset to the entire North America and further to the global permafrost domain. The compiled dataset could be used to improve the results of the permafrost modeling in Alaska and to develop more permafrost related benchmarks.

ACKNOWLEDGEMENTS

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