Investigating the Impact of Snow Cover on Permafrost Soil Temperatures in Modern Reanalysis and Data Assimilation Systems

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ABSTRACT

Soil temperatures are required as input for hydrological models and for numerical weather prediction. At high latitudes, accurate permafrost representation is important as soil respiration from melting permafrost may act as a positive feedback on warming. Validation of Arctic soil temperatures in reanalysis and Land Data Assimilation System (LDAS) products (hereafter reanalysis products) has been historically limited because widespread *in situ* reference observations have generally been unavailable. Here we validate pan-Arctic soil temperatures from eight reanalysis and Land Data Assimilation System (LDAS) products, at 1-degree spatial resolution, using *in situ* soil temperature data from diverse measurement networks across Eurasia and North America. We find that most products are biased cold by 2-7 K across the Arctic. Near-surface soil temperature biases and Root Mean Square Error (RMSE) were generally largest in the cold season, and many products overestimate the observed variability in soil temperatures over the cold season. In addition, preliminary results show that the cold season RMSE in many products was more than 1.5 times as large when snow was present in satellite-based snow cover datasets, though there is substantial variability between products. We attempt to explain the large spread in cold season Arctic soil temperatures by reconciling differences in snow cover between reanalysis products and satellite-based snow cover, and variability in snow cover between reanalysis products. Our hypothesis is that RMSE and bias in soil temperature will be largest when reanalysis products and satellite snow-cover show substantial disagreement; likely when monthly mean air temperatures are close to the freezing point. We also examine a subset of reanalysis products at a higher resolution (0.05 degrees) to test the impact of spatial resolution on soil temperature performance, and preliminary results suggest that small improvements in pan-Arctic soil temperature biases may be achieved by using higher resolution soil temperature data.

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