Sensitivity of Near-Surface Temperature Forecasts to Soil Properties over a Sparsely Vegetated Dryland Region

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Abstract

Weather Research and Forecasting Model (WRF) forecasts over the Great Salt Lake Desert erroneously underpredict nocturnal cooling over sparsely vegetated silt loam soil textures with a mean positive bias error in temperature at 2 m (AGL) of 3.4°C in the early morning [1200 UTC (0500 LST)]. This bias is related to the improper initialization of soil moisture initialization and the parameterization of soil thermal conductivity in silt loam soil. Forecasts of 2-m temperature can be improved by initializing with observed soil moisture and by replacing the Johansen (1975) parameterization of soil thermal conductivity in the Noah land-surface model with that proposed by McCumber and Pielke (1981) for silt loam and sandy loam soil texture classes. Case studies demonstrate how these changes reduce the single-day bias in 2-m temperature over silt loam soil textures at night by as much as 4.3°C. The biggest near-surface temperature improvement occurred during low soil-moisture periods, but this improvement is very sensitive to the initialized soil moisture. Predicted ground heat flux and soil thermal conductivity also more closely match observations made over silt loam soil when the McCumber and Pielke (1981) method is used along with observed soil moisture. We anticipate similar results in other dryland regions with analogous soil types, sparse vegetation, and low soil moisture.