Hydrology and Earth System Sciences Discussions

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Comment on hess-2021-164

Anonymous Referee #2

Referee comment on "Daily soil temperature modeling improved by integrating observed snow cover and estimated soil moisture in the USA Great Plains" by Haidong Zhao et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-164-RC2, 2021

Review of HESS-2021-164, "Daily soil temperature modeling improved by integrating observed snow cover and estimated soil moisture in the US Great Plains"

Synopsis:

This manuscript seeks to improve an empirical 10 cm bare soil temperature prediction for the Great Plains by incorporating snow cover, soil moisture, and additional previous temperature data. Data from are validated against a multi-state mesonet and show a reduction in root mean squared error.

The importance of knowing soil temperature data for hydrologic and agricultural applications is quite clear, the rationale for an empirical approach very understandable, and the key parameters that increase thermal mass (increased soil moisture and cover) are rational for model improvement. The topic is of high relevance for readers of *Hydrology and Earth System Sciences*.

Major comments:

While I think this manuscript may be a useful contribution to the literature, I have two major comments that I feel need addressing. One is on the input data to the model. The model seeks to predict soil temperature, but it needs soil moisture as an input. Soil moisture seems to be at least as difficult to measure, if not more so, than soil temperature, so the practical utility of this specific model seems suspect. It would have been much more useful if a satellite-based soil moisture/snow cover product such as those available from SMAP or Sentinel (Das et al., 2019) were used as inputs. Similarly, the soil texture product used in this study is at much coarser resolution than products such as POLARIS (Chaney et al., 2016), which are available at 30m resolution. I really think this analysis would be much stronger if these products were used. At the very least, I think more explanation and discussion is needed around this.

The second issue I see is with validation. Both the NRCS SCAN and Oklahoma MESONET sites don't report soil T at 10 cm (they are reporting at 4 and 8 cm for NRCS) and 4 cm for MESONET. Please discuss how you use these data from different depths to train and validate a model that is at 10 cm?

Specific comments:

Figs 5., 7, and 9: While RMSE is an important validation statistic, I would consider reporting other statistics such as BIAS and maybe the Nash-Sutcliffe Efficiency. RMSE really integrates both precision and accuracy while other statistics can help assess these independently.

References:

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Das, N. N., Entekhabi, D., Dunbar, R. S., Chaubell, M. J., Colliander, A., Yueh, S., Jagdhuber, T., Chen, F., Crow, W., O'Neill, P. E., Walker, J. P., Berg, A., Bosch, D. D., Caldwell, T., Cosh, M. H., Collins, C. H., Lopez-Baeza, E., and Thibeault, M.: The SMAP and Copernicus Sentinel 1A/B microwave active-passive high resolution surface soil moisture product, Remote Sensing of Environment, 233, 111380, https://doi.org/10.1016/j.rse.2019.111380, 2019.