

General comments

Snow and its insulation effects are critical for accurately simulating soil temperature and permafrost in high latitudes. This paper assessed the skills of nine land surface models based on the response patterns of T_{soil} and the difference of $T_{\text{soil}} - T_{\text{air}}$ to snow depth in winter in high latitudes. The observed patterns at 268 climate stations in Russia were used as ground truth. Such an assessment is better than direct point-by-point comparison with station observations. It reveals some structural issues of the models in simulating snow depths and its insulation effects on soil temperature. The results from the observation stations are interesting as well. The data source is solid, the results and analysis are detailed and well presented in most parts. It is worthy to be published.

Specific comments

The authors put several lines in abstract about near-surface permafrost. However permafrost results were not described in results and discussion sections, and it is only mentioned in summary and conclusion section. A somewhat proportional amount of description (in terms of length or importance) should be given in results and discussion sections so that it can be included in the summary and abstract. You need to add at least one paragraph about permafrost in the result (as suggested below) or in discussion sections.

P.9: Before analyzing the $T_{\text{air}} - d_{\text{snow}} - T_{\text{soil}}$ relationship, it would be interesting to briefly describe the modeled distribution and errors in snow depth and soil temperature comparing with observations in Russia. The section 4.1.2 about snow depth can be moved to here (table 3 in supplementary can be moved to here as well), and add something similar about the soil temperature. With the soil temperature results, you may add the results of permafrost extent and distribution as you mentioned in the summary and abstract. You may well aware and it is worthwhile to emphasize that the simulated snow depth and soil temperature could be influenced by inputs of the model, and the station observations have limitations in spatial coverage (covers only part of Russia, and may not well represent the grids). However, the response patterns of T_{soil} and $T_{\text{soil}} - T_{\text{air}}$ To D_{snow} should be consistent and can real deeper structural issues of the models.

P.8, Line 11-13: "We assume that ...in winter". I feel such an assumption is not necessary. The effects of soil moisture and texture do have effects but is much smaller than that of snow. You may revise it to "The effects of other factors on ΔT are much smaller than that of snow" or delete the sentence.

P12, L2-5: This sentence does not connect well with the previous one (why LPJ-GUESS produces very low correlation coefficients). In addition, the meaning of the sentence is problematic. The correlation between the snowfall and its simulated snow depth and soil temperature should be somewhat consistent. As you indicated in section 4, the effects of inputs are limited.

P12, L21-24: "the average ... of Fig. 4." The authors seem like to provide a single criterion (one ratio) to assess the behavior of the models. Observations show clearly the difference between deep and shallow snow conditions. It would be better to assess the models for both deep and snow conditions, and Fig. 4 already show such results. In this paragraph, the "stronger relationship" means "higher correlation

coefficient” or “larger slope in the regression equations”? The term “gradient” used in the abstract and here actually means the slope of the regression between T_{soil} and T_{air} . Gradient between T_{soil} and T_{air} can be misunderstood as changes of temperature from soil to air. Probably it is better to indicate its true meaning (slope of the regression, or the ratio between T_{soil} and T_{air} in winter). It is very similar to the freezing season n-factor used in permafrost modeling. You may compare to the winter n-factors used by others.

Minor points

P.3, L2: revise “modelling” to “modeling”

P.3, L6: replace “as expressed by” to “in the”, delete the two commas around “(ΔT)”.

P.4, L14: references are needed at the end of “... soil temperature” to support the statement.

P.5, L24-25: “these simulated relationships”: it is not clear what do you mean about “these relationships” without read the entire paper.

P.6, L10: “divided in 14 layers”, revise “in” to “into”

P8, L.31-33: “the sentences “We illustrate ... 3 regimes.” seems can be simplified as “We illustrate the dependence of T_{soil} on T_{air} for three T_{air} ranges”.

You used “Larger snow depth”, “higher snow depth”. Probably can be revised as “thicker snow”, or “when the snow is deep”, or “with increase in snow depth” etc.

P9, L10: You do not need to redefine the symbols of ΔT and d_{snow} here. Actually, I feel you can replace the word descriptions by the symbols in many places, at least do not need to mention both the word description and symbols.

P9, L29, L31: $\Delta T/d_{snow}$ do mean a ratio as shown in Table 2. Revise “ $\Delta T/d_{snow}$ relationship”, to “ ΔT - d_{snow} relationship” here and many other places.

P9, L31: “Figure 2 views the $\Delta T/d_{snow}$ relationship in the complementary form of the PDFS of ...”, revised as “Figure 2 shows the ΔT - d_{snow} relationship in a complementary form using the PDFS of

P10, L6: “the better models”, revise to “the five successful models”

P10, L11: “that affect the air soil temperature difference”, revise to “that affect the thermal conductivity of the snow”.

P11, L25: “reasonable pattern correlation coefficient with observations”, probably means “reasonable spatial pattern of correlation coefficient comparing to that of the observations”. L34: “a reverse pattern correlation than observations” revise to “a reverse spatial pattern comparing to that of the observations”

P13, L6: “emphasizing the weakening role of snow depth for T_{soil} under thick snow conditions”. Probably should be “emphasizing the reduced sensitivity of T_{soil} to snow depth under thick snow conditions”

Figures: revise “AirT” to “ T_{air} ”