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Hydrology and Earth System Sciences Discussions

Interactive comment on “Influence of thermodynamic soil and vegetation parameterizations on the simulation of soil temperature states and surface fluxes by the Noah LSm over a Tibetan plateau site” *by* R. van der Velde et al.

R. van der Velde et al.

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We would like to thank the referee for his constructive comments. Below you will find our detailed responses and modifications to the text. Unfortunately, it is impossible to upload a revised version of manuscript and, therefore, the added equations, table and figure are not readable. A fully revised version of the manuscript is available upon request.

Comment 1: Data set: It is not clear who made the in situ observations at the Naqu

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Interactive Discussion

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site. The authors? Has a description of this data set been published before ?

Authors’ response: The Naqu site has been setup and is, currently, operated by the Institute of Tibetan Plateau Research of the Chinese Academy of Science; the group of Prof. Y. Ma, whom is one of the authors. Nowadays, the Naqu site forms a part of the meso-scale observational network installed in the Naqu river basin in the framework of the GAME and CAMP/Tibet field campaigns. These data sets have been extensively used in various studies to improve the understanding on water and energy change between the land surface and atmosphere over the Tibetan Plateau. To make this clear, the following text is added to section 2.1:

“This station is part of the meso-scale observational network previously installed in the Naqu river basin in the framework of the GAME (GEWEX (Global Energy and Water cycle Experiment) Asian Monsoon Experiment) and CAMP (CEOP (Coordinated Enhanced Observing Period) Asia-Australia Monsoon Project)/Tibet field campaigns. The heat flux measurements collected during these field campaigns have been extensively used to improve the understanding on the water and energy exchange between the land surface and atmosphere over the Tibetan Plateau (e.g. Ma et al. 2002, Ma et al. 2005, Yang et al. 2005, Yang et al. 2008).”

Comment 2: On p. 460, it is stated that "From the data record of Naqu station a 7-day 15 period from 3 to 10 September 2005 has been selected for this investigation." Why those 7 days? Why not working with the entire data set?

Authors’ response: Despite the wealth of soil and atmosphere measurements, rainfall measurements were found to be unreliable (probably due to malfunction of the logging system or tipping mechanism). Since rainfall is such a crucial forcing variable in land surface process models a dry period was selected for this investigation. Based on the available soil moisture and incoming solar radiation measurements determine the timeframe from the 3rd to the 10th of September a being the largest summer period without rain. To clarify this issue we have added the following to section 2.1:

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“From the data record of Naqu station only a 7-day period from 3rd to 10th September (2005) has been selected. This short period has been selected because the measured rainfall amounts were found to be unreliable due to mechanical difficulties with the logging system and the tipping mechanism of the rain gauge. Since rainfall is such a crucial forcing variable, the period between 3rd and 10th September (2005) is used being the longest summer period without precipitation based on available soil moisture and incoming shortwave radiation measurements. Although the selected period is identified as completely dry, the soil moisture measurements indicate that prior to September 3rd several intensive rain events wetted the land surface. The selected period represents, thus, a typical dry-down cycle, which is, in general, a solid basis for validation of LSm parameterizations.”

Comment 3: Have the authors verified that the best-fit parameters, valid for this period, do not lower the scores for other periods? I tend to believe that 7 days are not enough to get sufficient confidence in the optimised parametersm (especially for the physiological parameters).

Authors’ response: Due to the lack of reliable rainfall measurements (discussed in the previous comment), we do not have the luxury to validate the optimized parameters. The objective of this investigation is, however, to identify the adjustments in soil and vegetation parameterizations required to reconstruct the temperature states in the soil profile and surface energy fluxes measured over the Tibetan study site. With this study, we intend to provide an indication in terms of adjustments in the soil and vegetation parameterizations on how to improve the Noah performance over the Tibetan Plateau.

Comment 4: In particular, I don’t think Topt should be tuned. This value should be derived from the literature or from the flux measurements.In Europe, most altitude grassland present a Topt of about 10_C (e.g. Gilmanov et al., 2007, Agric. Ecosys. Environ., 121, 93-120, doi:10.1016/j.agee.2006.12.008). P. 474: "Parameters Rgl and Hs characterize optimum transpiration conditions in terms of the incoming solar radia-

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tion and humidity, which are bounded by physical constraints and not expected to be significantly different for the Tibetan Plateau. On the other hand, the Rc,min and Topt are parameters more related to plant physiology and could be significantly different for the selected site." I would not say that. Rgl and Hs are as much related to plant physiology as Rc,min and Topt.

Authors’ response: We have selected to optimize the Rc,min because in the study Kahan et al. (2006) calibration of this parameter was found to be crucial to improve the simulated partitioning of the heat fluxes of the SSib LSM. In addition, we found that adjustments in Noah’s parameter Topt, currently fixed at a value of 24.85 oC, are needed to improve the performance. We agree with the referee that deriving such plant physiological parameters should be obtained from long term data sets. This reaches, however, beyond the scope of this investigation, but we have modified the text in order to reflect these standpoints better. Moreover, the impression that the Rgl and Hs parameter are not related to the plant physiology has been reconsidered. The text has been changed as follows:

“Amelioration of inconsistencies in simulating the partitioning between H and λE can be obtained by adopting an aerodynamic approach through reconsideration of kB-1 parameterization (e.g. Yang et al. 2008). However, Kahan et al. (2006) demonstrated that the simulation of the heat flux partitioning can also be improved by calibrating the vegetation parameters and showed that most notably an adjustment in stomatal resistance is needed to increase model performance. Similarly, the Rc,min of the Noah vegetation parameterization is used, here, to improve the simulated heat flux partitioning. In addition, the optimum temperature for transpiration (Topt), currently fixed at a value of 24.85 oC, may need to be tuned to represent the Tibetan conditions. Ideally, the Rc,min and Topt would be obtained from long term data sets as has been done by Gimanov et al. (2008). This reaches, however, beyond our objective to identify the adjustments in soil and vegetation parameterization needed to improve Noah’s performance over the selected Tibetan site for the 7-day pe-

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Interactive Comment

riod.”

Comment 5: Note that the optimal Rc,min may account for errors in the prescribed LAI (5 m2m-2 ?).

Authors’ response: See our detailed response below comment 6 of referee 1.

Comment 6: Site specific results? It is shown that improving the representation of soil processes close to the surface (by adding another layer) has a limited influence on the overall model performance. Is there any reason to think that this result is specific to this site (and why)? It is likely that other processes are badly represented by the model. Some of them are listed in the discussion section. Have those shortcomings been identified previously, on other sites?

Authors’ response: The authors would like to thank the referee for his comment. We are sorry read that the referee has interpreted that adding a thin soil layer does not improve the model performance. The study shows that the adjustment in soil processes does result in a better simulation of the temperatures across the soil profile. However, as noted by the referee, the overall the simulation of the partitioning of the heat fluxes does not improve do to these adjustments. Explanations for the discrepancies between the measured and simulated heat fluxes are presented in the paper. First, the vegetation parameterization used for global Noah applications is not representative for the Tibetan environment. This issue is addressed in section 5.2 through the optimization of the Rc,min and Topt parameters. Of course, optimization is performed for a single Tibetan site and a short period, but we can expect that similar changes in the Noah vegetation parameterization are needed for other sites on the Tibetan Plateau. We are not aware of studied that have performed a similar analysis using Tibetan observations. However, Kahan et al. (2006) found that calibration of the Rc,min parameter was needed to improve the model performance over sites in Niger, which is also cited. Second, previous investigations (Ma et al. 2005 and Yang et al. 2003) have shown unusually strong diurnal kB-1 variations on the Tibetan Plateau. A

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different kB-1 parameterization would, therefore, also contribute to a better model performance. This issue is addressed in the discussion, but a complete detailed analysis would reach beyond the scope of this investigation. Third, in Noah, a linearization of the surface energy balance is utilized to compute the Tskin. In the discussion, it is shown that this approximation may lead to a large underestimation Tskin during daytime. We are not aware of the studies that have identified this shortcoming before and are, therefore, not able to compare our findings to the results of others.

Comment 7: Eq. 2: how is Kih determined ?

Authors’ response: The “ ” is thermal heat conductivity under the initial soil moisture conditions of the analyzed period, which is derived from the measured soil heat flux at a soil depth of 10 cm (G10) and the soil temperature gradient. We admit this was previously not clear from the text. Therefore, we added “ ” is parenthesis after “κh under the initial soil moisture conditions ( ).

Comment 8: Eq. 15: what is the meaning of theta ? Authors’ response: Thanks for this remark, the theta is a typo and remove from equation 15, which is now equation 20

Comment 9: - p. 474, L. 11: "by adopting"? Authors’ response: Thanks, “adopted” has been changed to “adopting”

Comment 10: - p. 475, L. 27: "the represents" Authors’ response: Thanks, the word “the” has been removed

Comment 11: - p. 478, L. 11: "the adding" Authors’ response: Thanks, the word “the” has been removed

Comment 12: - p. 498: "except"? Authors’ response: Thanks, “expect” has been changed to “except”

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