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Interactive comment on "Soil moisture redistribution and its effect on inter-annual active layer temperature and thickness variations in a dry loess terrace in Adventdalen, Svalbard" *by* C. Schuh et al.

Anonymous Referee #2

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Review of manuscript tc-2016-173 "Soil moisture resdistribution and its effect on inter-annual active layer temperature and thickness variations in a dry loess terrace in Adventdalen, Svalbard" by C. Schuh et al.

General comments:
This manuscript investigates freeze/thaw dynamics in a soil profile for a 14-years time series of measured data from the UNISCALM-site on Svalbard with the aid of a numerical model. Specifically, for a homogeneous silt profile, the van Genuchten parameters α and n are varied in a reasonable range. Differences in thaw depth, water and ice

content are interpreted i) for a quasi-synthetic test case using upper and lower boundary conditions measured in the field and ii) compared to field observations. The paper is very well written and fits well into the scope of The Cryosphere. I have one major concern which is the fit between measured and modeled data which – in my opinion - needs major revision or restructuring of the paper before the manuscript can be recommended for publication.

Major comments: Run in a quasi-synthetic mode, the model is very helpful for exploring the effects of variations in van Genuchten α and n on thaw depth as well as water and ice distribution throughout a silty soil profile (cf. Fig. 3). In this case, a rather simple test case is generated where modelled data depend only on the chosen parameterizations of the soil profile and the imposed upper and lower boundary conditions. With these simulations, processes can be interpreted based on the assumed conceptual model without real linkage to field observations and this is done very well in this study. However, as soon as simulations are compared to measured field data, especially Figure 4 shows that there are still large discrepancies between modelled data and observations and the model is not yet able to reproduce freeze/thaw processes observed in the field. For example, it is definitely not sufficient when summer data at one depth of the profile fit to summer simulations of one test case and winter data at the same depth of the profile fit to winter data of another test case. Here, the challenge is to set up a conceptual model and to find a parameterization that is able to reproduce observations (temperature, moisture, ice content) at all depths during the complete time series before processes occurring at the site can be interpreted and quantified safely. Finding such a paramterization could be quite some effort, so probably it is the better choice for this paper to reduce the study to the synthetic cases and remove the sections comparing measured and modelled data. The alternative would be to "calibrate" the model such that simulations are able to reproduce the field observations.

Specific comments:

P 1, L 28: correct "temperatures"

P 2, L 26: Which controlling factors? Please add related information.

P 3, L 18-21: The two specific aims are very closely related. Please reformulate the major aims of the study.

P 4, L 29: correct “100 m x 100” m or “100 x 100 m^2”

P 5, L 10: please add probe to Table 2 P 6, L 28: The vertical resolution of the model (0.1 m) is rather coarse. Especially, close to the ground surface, resolutions of 0.01 m or even less are often required to adequately reproduce temperature and moisture gradients. Did the authors check the performance of the model in this regard?

P 6, L 31: please add reference for the chosen parameter set

P7, L 9-14: Please clarify initial condition: As far as I understand, capillary pressure was linearly interpolated with 0 hPa at 1.2 m depth and -120 hPa at ground surface?

P 7, L 21: please correct: linearly

P 8, Sect. 4.1: Table 5 is not very well suited for comparing measured and modelled data. A plot like Figure 4 would be much more helpful for assessing the quality of the different models.

P 9, L- 13: correct “system”

P 9, Section 4.2: Case studies discussed in the text and shown in Fig. 4 are not the same. Simulations shown in Fig. 4 do not reproduce measured values.

Sect. 5: The general discussion of the influence of α and n on the processes occurring in the soil profile is well done and okay as long as it is based on the synthetic cases.

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