**The Cryosphere
Discussions**

Interactive comment on "Modeling the impact of wintertime rain events on the thermal regime of permafrost" *by* S. Westermann et al.

Anonymous Referee #1

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Comments to the paper: Modeling the impact of wintertime rain events on the thermal regime of permafrost

by Westermann et al.

General comments:

The paper is about an important topic within the general discussion about climate change and its impact on permafrost in Arctic regions. I recommend this paper for publications with some revisions.

a) I appreciate the development of a new and simple model, such it is presented in this paper. However, such a new model should be tested by existing and more sophisticated model approaches. A wealth of such models is today freely available and

applicable. Therefore, I would recommend to make similar simulations with already existing process models in cryospheric sciences, which are all include the effect of rain water percorlation in a snow pack such as Snowpack (Bartelt and Lehning 2002, Lehning et al. 2002 a, b), Geotop (Zanotti et al. 2004, Rignon et al. 2006), Coup (Gustavsson 2004, Stähli and Jansson 1998), Somars (Greuell and Konzelmann 1994), Sntherm (Jordan 1991) and many more. As this task, may overburden the current paper, I would recommend that such a comparison should be definitively done in a later paper.

b) It is not well explained in the paper how the model reacts, if once ice is generated after the first refreezing of the rain water on the ground surface. As the conditions changes remarkably having ice instead of snow on the ground, the question arises what a second or third rainfall event would cause for a change in the ground temperatures. As once ice is generated, any further rainfall events will have a much less strong impact on the ground temperatures as the first one. This effect is in addition enhanced when considering a slightly undulated topography resulting in a faster runoff and therefore reducing remarkably the effect of the warm rain water to the underlying ground temperatures.

Specific comments:

1. p. 1699, line 3: I would suggest to use the expression process-based model instead of physical model

2. p. 1699, line 10 and 11: There exist a lot of literature about this topic beside of Kane et al. 2001 -> see added literature below.

3. p. 1700, line 21: years instead of year

4. p. 1707, line 28: the authors set the temperature at 10 m constant to -3.9°C with the same average temperature at a measured depth of 1.52 m. This would imply that from 1.52 m to 10 m is no gradient at all and therefore no heat flux would occur. Are

the authors sure that this assumption can be made?

5. p. 1710, line 26: Why do the authors make this control run with only heat conduction. Nobody would apply such a model today for the objectives the authors give in their paper. It would be much better to compare the model of the authors to an already developed sophisticated model as mentioned above. Therefore, I recommend to remove this comparison with the model, where the infiltration routine is deactivated from the paper.

6. p.1712, line 16, and p. 1713, line 25: The production of snowmelt water should be definitely implemented in a final model version. May, it would improve the current model results remarkably.

7. p.1716, line 2: impact on the soil instead of impact the soil

8. p.1716, line 25 to 27: see general comment 2 above

9. p.1717, line 6: the authors state that wintertime rain events may amplify the warming of permafrost temperatures. However, they should consider that once a rain fall event occurred having generated one or several ice layers on the ground surface: a) the snow cover thickness will be reduced and the thermal resistance of the snowpack will therefore be reduced and b) the new ice layers have in addition a much higher heat conductivity. Both effects would allow a much more efficient cooling if an atmospheric cooling would follow the warm rain fall events, somehow counteracting the warming effects of the rain fall events before. See also general comment 2 above. Is the here presented model able to include such effects?

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