Manuscript: tcd-5-2197-2011: Multi-scale validation of a new soil freezing scheme for a land-surface model with physically-based hydrology

Major remarks

The manuscript presents a new version of the ORCHIDEE land surface model that comprises melting and freezing processes. A strong point of the paper is that the validation of the new model version is conducted over a range of scales.

With regard to the comparison of model data to the Stefan solution, the motivation of this doesn’t become fully clear to me. Isn’t it a mere technical test that the programmed parameterizations have been done adequately? Especially as the validity of a process description working on the laboratory scale doesn’t say anything about its usefulness on the grid scale and in real terrains. In this respect it seems to me that this comparison (Sect. 3) is taking too much space and may be shortened.

In Sect. 4.2.1, simulated snow data are compared to the snow depth product of Foster and Davy (1988) for the year 1987. This product comprises a long term snow data climatology.

Excerpt from dataset documentation: “3.1 Objective/Purpose. Create a global mid-monthly mean snow depth climatology with highest resolution possible using all available station data for the months of September through June.” and “6.3 Temporal Characteristics. 6.3.1 Temporal Coverage. This is a climatology data set, therefore it is not year specific.6.3.2 Temporal Resolution. Climatology represents an average snow depth value for mid-month.”

Therefore, comparing only one year of simulated data to the climatology is essentially wrong. Consequently, this whole part of the manuscript focusing on the year 1987 has to be revised to take this into account.

In general the English needs some improvement, as some sentences are difficult to read. In addition, the use of singular and plural (see several suggestions for corrections below) may be enhanced. I recommend proof reading of a native English speaker.

In summary the paper may be accepted for publication after major revisions are conducted.

Minor Comments

In the following suggestions for editorial corrections are marked in Italic.

Abstract - page 2198 - line 10
The word “centrimetric” doesn’t seem to exist in the English language. Please rewrite!

Sect. 1 - page 2199 - line 13
Generally, watersheds underlain …

Sect. 1 - page 2200 - line 6
“… is all the more crucial…”
No proper English. Please rewrite!

Sect. 1 - page 2200 - line 4-9
Too long sentence that is difficult to read. Please rewrite!

Sect. 2.1 - page 2203 - line 17/18
… for the respective USDA …

Sect. 2.2 - page 2206 - line 4
… does not evolve …”
What is meant by evolve? … does not change?

Sect. 2.2 - page 2207 - line 18
… are detailed in Table 3, …

Sect. 2.2 - page 2208 - line 17
… properties in the land …

Sect. 2.2 - page 2210 - line 1
The use of upper case letters for the two approaches (linear and thermodynamical) looks awkward and is not necessary.

Sect. 2.2 - page 2210 - line 14
Results yielded by …

Sect. 2.2 - page 2210 - line 22
… discarded as too difficult …

Sect. 3.1 - page 2213 - line 13
… factor of more than 2 in the near future.

Sect. 3.1 - page 2213 - line 14
… the vertical model discretization …

Sect. 3.1 - page 2213 - line 22-26
Use real verbs to construct your sentence, not symbols as ~.

Sect. 3.1 - page 2213 - line 27
The default model time step …

Sect. 3.1 - page 2214 - line 18-19
We consider an error in latent heat as significant when …

Sect. 3.1 - page 2215 - line 17
“all the more”
No proper English. Please rewrite!

Sect. 3.2 - page 2216 – line 10
… flux transfer coefficient mentioned …

Sect. 3.2 - page 2216 – line 16-18
Sentence is difficult to read. Please rewrite!
… by a less drastic reduction …

… evaluate the performance of …

… interesting information about …

… and performance of other land surface models.

… measurements are related to the …

… incoming radiation used … … simulation is based …

… and induced latent energy differences are of …

It is written: “… as soil moisture is only modeled in terms of anomaly.”

I don’t understand this. In the model description, you specify, e.g., that you calculate actual soil water fluxes, and that “soil thermal properties depend on the water content”, etc., which would not be possible with an anomaly approach. Please clarify!

… river discharge measurements.

In most cases, the singular form of discharge is more appropriate!

… only carried out with …

… over into the summer.

…more conductive than …

These datasets include active… …different depths, respectively.

The use of “respectively” is often wrong. It usually should come in the end of a sentence.

… model performance …
Sect. 4.2.1 - page 2225 – line 1
... of gridded model outputs ...

Sect. 4.2.1 - page 2225 – line 6-7
... boreholes located ~15 km apart from each other on the Yamal peninsula differs by about 3
3 K; ...

Sect. 4.2.2 - page 2225 – line 19-24
This last part of the section starting with “The likely increase ...” doesn’t belong to a result
section. This should be part of the introduction/motivation of the study.

Sect. 4.2.3 - page 2226 – line 9
... are carried out over ...

Sect. 4.2.3 - page 2227 – line 19
... would likely maintain ...

Sect. 5 - page 2229 – line 5
... partly attributed to ...

Sect. 5 - page 2229 – line 10-11
... scheme catches the specific ... ... by permafrost with an increased accuracy.

Sect. 5 - page 2229 – line 13
This will ...

**Table 3**
In the main text, it is written for the standard scheme:
“The first thermal layer is 4.3 cm thick and the thickness of 10 each layer is multiplied by 2 as
the layers get deeper.”

And for water:
“The uppermost layer is 2mm thick and the thickness of the layers increases as a geometric
sequence of ratio 2 with increasing depth, leading to a total default depth of 2m for
hydrological processes.”

These values are not consistent with Table 3:
Assuming the values are valid for the middle of the layer, as an example:
Temperature: 2*1.8=3.6 is not equal to 4.3 cm
Water: 2*0.05 = 1 is not equal to 0.2 cm.
I also cannot identify the maximum depth of 2 m in the table. (I stopped here to check other
values).

Please correct and check carefully!

**Fig. 2**
The lines are very difficult to separate. Lines are too thin and colours are too similar. Please
improve!

**Fig. 5**
What do you mean with afferent? Why there are two curves at 12 h, which are difficult to distinguish (to thin, similar colour)?

… thick) should be compared to …

Fig. 6 caption
… compared to available … … in the DATA and …