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Geoscientific Model Development Discussions

Interactive comment on "Closing the Energy Balance using a Canopy Heat Capacity – A physically based Approach for the Land Component JSBACHv3.11" *by* Marvin Heidkamp et al.

Anonymous Referee #1

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In modelling the land surface one has to deal with the coupling of the atmosphere-soil interface to the atmospheric conditions, and with the coupling to the soil. This paper describes an important improvement of the JSBACH land component (JSBACH) of the MPI-EMS model. In the original (reference) scheme the temperature of the first soil layer serves both goals, coupling to the atmosphere and coupling to the deeper soil. The improvement is performed in two steps. First a skin-layer is introduced which is coupled to the first soil layer through a skin conductivity. This is assumed to work for bare soil and low vegetation. A second step is taken for tall vegetation where the ther-

mal heat capacity is now reintroduced for the biomass influence. It is shown that this improved model better resolves the diurnal cycle of temperature. Further it is shown that it also has an impact on the average temperature, as temperature responses differ for night and day among the new scheme and the reference scheme.

The paper is well written, the subject of the paper is relevant as a correct representation of land processes is at the heart of good weather, climate and transport models. The model changes are clearly layed-out, and relevant analysis are performed to show the impact of the model changes. However, there are some issues in the paper that has to be resolved before the paper can be accepted.

Main criticism:

1) As one of the proposed changes in the surface model (SkIn) are based on ideas that has already been developed by others 20 years ago. See Viterbo and Beljaars, (1995) and the references to Betts et al. (1993) and Beljaars and Betts (1993), two points arise:

a) It would be interesting to learn why these changes has not been introduced earlier in the JSBACH scheme. Were there, for example, other positive aspects in the performance of the JSBACH model that favored a conservative approach?

b) It would be informative for the reader to compare the results/improvements found by the authors for the current model, with the findings of the authors mentioned above for the ECMWF-model.

2) The rationale for Eq. 6 is unclear. A reference to Moore and Fisch (1986) is given, but I fail to see that their approach correspond to the approach given in the current paper. It is a change in q (specific humidity) that induces a change in latent heat storage in the vegetation air column. A change in q can occur while T_sfc stays constant. Thus Eq. 6 seems not to capture the process the authors try to describe.

3) P11 L5-15: In principle I can follow the reasoning of the authors here, but I think

the situation is a bit more complicated. Indeed T_sfc in the SkIn scheme responds instantaneously to the radiative forcing, but the coupling to the soil through the skin conductivity is also present. This may also induce time (phase) shifts. Please comment.

Minor issues:

4) For clarity it is good to mention that Eq 2, 3 and 4 are complicated non-linear implicit equations in T_sfc as T_sfc also arise to the 4th power in the long wave upward component and in the expressions for H and LE.

5) P10 L21: integrated -> accumulated

6) P9 L6 When referring to Figure 2 the term S_soil has not been defined yet. As I understand it correctly, it is the left hand side of Eq 2 (with negative sign). Please clarify this in the text.

7) P10 L23. It is surprising that the reference scheme shows this instability. With a system with such large thermal inertia I would expect a stable solution. Can the authors comment on that?

8) P12 L1 extent -> magnitude

9) P16 L22 Why not mention approaches taken in other atmospheric models, like TESSEL in the ECMWF-model

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