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Hydrology and Earth System Sciences Discussions

Interactive comment on "Inter-comparison of two land-surface schemes applied on different scales and their feedbacks while coupled with a regional climate model" *by* F. Zabel et al.

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Dear Referee #1,

First thanks for your critical point of view which helps us to improve our paper.

Regarding to your major comments in terms of our methodology, we would first like to respond in general to that issue:

In our approach, we hard-coded two options within the MM5 source code that allow to use either the NOAH-LSM or PROMET as land surface module for MM5, thus providing

the lower boundary conditions (for MM5) at each time step. Case 1 is the regular case, where the NOAH-LSM provides the lower boundary conditions for MM5. As you mentioned, this is due to the fact that the NOAH-LSM is an integral part of MM5. In Case 2, the NOAH-LSM is by-passed (replaced by PROMET) and PROMET now supplies the lower boundary conditions for MM5.

Therefore, as you can see, we took special care of not mixing any fluxes. Both LSMs are clearly separated and are not mixed within this methodology!

The full coupling allows PROMET not only to be driven with meteorological data from MM5 (one-way coupling) but also to be used as a fully coupled LSM within MM5 (two-way coupling). Chen and Dudhia (2001) already suggested applying a hydrological model for a land surface module in regional climate models in order to refine the view on the land surface within RCMs.

"Partly motivated by these model intercomparison experiments, there are efforts to take the strengths of these LSMs originally designed for atmospheric applications and apply them to surface hydrologic models or vice versa (Chen et al. 1996; Liang et al. 1999)."

Further, two-way-coupling between PROMET and MM5 means that the feedback effects of the PROMET land surface on the atmosphere can be investigated. By passing the land surface energy fluxes from the hydrological model PROMET back to the climate model, the changed land surface conditions are affecting the state of the atmosphere within MM5. Those atmospheric feedbacks in turn are affecting the land surface fluxes in PROMET.

In order to compare PROMET and NOAH correctly, you will surely agree that both land surface models should be driven with the same meteorological data from any source (observed data from meteorological stations or any model). Therefore, we first compared simulated evapotranspiration between NOAH and PROMET, both driven with the same meteorological data in Sect. 5.1. This demonstrates the different behavior of the NOAH-LSM and PROMET that can only be due to different model approaches, differ-

ent model physics, parameterizations and different spatial resolution and that cannot be due to different meteorological drivers. Only thus, the model differencese can be figured out.

Later, we analyzed the impact of the different land surface energy fluxes on the atmosphere (Sect. 5.2) by fully coupling PROMET with MM5 bilaterally (which means returning the PROMET land surface energy fluxes to MM5 and completely replacing NOAH).

Finally, Sect. 5.3 analyzes how the atmospheric feedbacks in turn affect the PROMET land surface conditions.

The aim of this paper, as written in the title, is not only to compare the NOAH-LSM and PROMET, but also to identify feedback effects from the land surface model to the atmosphere model, which are triggered by replacing the MM5 land surface module NOAH with PROMET.

Point 1: The NOAH-LSM is an integral part of MM5 but basically can also operate as a standalone land surface model. MM5 can also be used with other LSMs, such as the OSU-LSM or the PX LSM. Further, the NOAH-LSM later is by-passed in the source code of MM5. This is the reason why the NOAH-LSM was not placed inside the MM5-box in Figure 1.

Point 2: In this paper, both LSMs are compared to each other and their feedback effects to the atmosphere are analyzed and discussed. A comparison with observation is done in another paper as it would blow up the content of this paper. As you mentioned correctly, we are comparing two fundamentally different LSMs, as they evolved from different disciplinary background (NOAH from meteorological - PROMET from the hydrological background). Therefore, those differences are pointed out and analyzed in this paper without saying that one is better than the other.

Point 3: When PROMET fluxes are passed back to MM5 (two-way coupled mode),

MM5 does not use NOAH fluxes at all (see also Figure 1, right graphic). The reason behind the two-way coupling is to 1) make the coupling with PROMET more consistent than the one-way coupling approach and 2) to take feedback effects between PROMET and MM5 into account.

Point 4: What you suppose to be not possible is exactly what we actually did. For the pure model comparison, we are taking RCM meteolorogical output to drive a) the NOAH-land surface module and b) PROMET. Further, for the study of the feedback effects, we did not "simply taking met ouput from a RCM to drive PROMET", but developed and applied the full two-way coupling approach.

Regarding you minor comments: Thank you for your minor comments. We corrected all minor comments you mentioned. The color bar can be read in a printed (DIN A4) version but can also be enlarged.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 7091, 2011.