Geoscientific
Model Development
Discussions

Interactive comment on "Evaluation of North Eurasian snow-off dates in the ECHAM5.4 atmospheric GCM" *by* P. Räisänen et al.

P. Räisänen et al.

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We thank Richard L.H. Essery for his constructive comments on the manuscript. Point-by-point responses to the comments are provided below. The referee comments are written in *italic* font, and our responses in normal font.

Comment: *Räisänen et al. investigate the ability of a specific atmospheric climate model (ECHAM5) to reproduce the annual duration of snow cover for Northern Eurasia, and assess the possibility of improving the simulations by constraining model fields to be closer to reality or changing model parameter values. Although by no means the first such investigation, this is an interesting and worthwhile study. For the benefit of readers who are not familiar with the details of current practice in*

modelling snow processes, it should be pointed out that there are climate models that address all of the limitations of ECHAM5 identified by the authors: unrealistic temperature dependence of snow albedo, combined energy balance for subgrid snow and snow-free land fractions, and lack of snow shading by forest canopies. A good exemplar of the state of the art in snow parametrizations for climate modelling is given by the CLM land-surface model used in the CESM climate model; see http://www.cesm.ucar.edu/models/cesm1.0/clm/CLM4_Tech_Note.pdf.

Response: The fact that there are climate models with more sophisticated treatment of snow than that in ECHAM5.4 (in particular the CESM model) will be mentioned in the revised manuscript (at the end of the Discussion section). Please see also our response to the last comment.

Comment: *page 3672, lines 21-22 (also 3673, 28 and 3681, 20-21). Please consider doi:10.1029/2010EO450004.*

Response: In the revised manuscript, these sentences will be rewritten so that the use of parentheses is eliminated.

Comment: *3673, 23. Derksen and Brown (doi:10.1029/2012GL053387) is another important recent work evaluating CMIP5 snow cover simulations.*

Response: This reference will be added to the Introduction of the revised manuscript.

Comment: *3679, 25. Brackets required around LAI + SAI.*

Response: This will be corrected.

Comment: *3684, 18. "locally exceeds 20 days" or "exceeds 20 days locally" would be better.*

Response: Thanks. We prefer the first form.

Comment: *3685, 14. Snow does not necessarily persist longer in forests than on open ground – the recent review of observations by Lundquist et al. (doi:10.1002/wrcr.20504) shows shorter duration for forests in warmer regions.*

3686, 27. Again, less snow is often observed to accumulate in forests due to canopy interception than on nearby open ground that is not affected by wind scour; see, for example, Figure 4 in Lundquist et al. or Essery et al. (doi:10.1175 /2009BAMS2629.1).

Response: The discussion of this issue will be modified in the revised manuscript. Thus, it will be mentioned that the later snow-off in forests than on open ground is consistent with the findings of Lundquist et al. (2013) for northern regions, but it will also be noted that the opposite behaviour has been observed in more southern regions with warmer winters. A brief discussion on the various (opposing) physical mechanisms influencing the difference in snow-off timing between forested and non-forested regions will also be added.

Comment: *3687, 14. "makes snow-off occur".*

Response: This will be corrected in the revised manuscript.

Comment: *3693, 25. For future work with CMIP5 model outputs, it would be interesting to see if the CLASS land surface scheme (which is an unusual example of a model with separate energy budgets for snow and snow-free land) in the CanCM4 climate model behaves differently from ECHAM5.*

Response: At the end of the Discussion section (section 6) in the revised manuscript, it will be mentioned that there are climate models in which the snow scheme addresses either some or all of the deficiences identified for ECHAM5 in this work, and which might therefore be expected to behave better (or at least differently) than ECHAM5. The CESM/CLM4 and CanCM4/CLASS will be mentioned as specific examples.

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