

Geosci. Model Dev. Discuss., referee comment RC2
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Comment on gmd-2021-69

Anonymous Referee #2

Referee comment on "Afforestation impact on soil temperature in regional climate model simulations over Europe" by Giannis Sofiadis et al., Geosci. Model Dev. Discuss.,
<https://doi.org/10.5194/gmd-2021-69-RC2>, 2021

The study under review by Sofiadis et al., complements the previous work by Davin et al. (2020) on the biogeophysical impacts of forestation in Europe, both undertaken within the important CORDEX Flagship Pilot Study LUCAS (Land Use and Climate Across Scales). The current work further exploits the multi-RCM output of afforestation experiments (forest minus grass) and reveals (to name a few key results) the crucial role of the employed land surface models, and a dampening of the annual ground heat flux cycle which explains the inter-model variance in the annual amplitude of soil temperature. Also a response to afforestation was indicated of the summer land surface cooling in forested areas compared to open land. This work is nicely written and presented, with adequate statistical and graphical aspects and sound science. It is a valuable contribution towards the understanding of land use change role (or impact) on regional climate (and change).

Science Comments

lines 79-84: a brief justification may be needed here on why this study focuses on the "soil temperature profile" (by looking at the 1 m below ground in section 3.1) and not , also, the uppermost soil layer (= surface) temperature which is ultimately connected to the radiative and heat fluxes that drive the overlying air temperature, the surface climate parameter of main interest

line 98: as opposed to which PBL scheme in WRFb-NoahMP?

lines 125-128: is thermal diffusivity κ (see below) parameterised in the RCMs land surface schemes (and therefore derives from moisture affecting heat capacity, as you mention) or it is taken as a constant from look-up tables? Could this property be shown for each model (especially if the authors feel it would assist interpretation of results)?

From textbooks (pages 397-398 of McIlveen (2010) or section VIII.B. Conduction of Heat in Soil in Hillel (2003)) the thermal diffusivity is defined as:

$\kappa = k/(\rho C)$ where

k = thermal conductivity

ρ = density

C = specific heat capacity

The authors may consider the information in the Chen and Kling (1996) for better introducing and perhaps diagnosing in future studies, the thermal diffusivity κ .
lines 128-129: the fact that "GHF is calculated as the residual of surface energy balance because the actual GHF outputs were not available in most models" assumes that model surface energy budgets are balanced, something that it may not be the case for, e.g., WRF (section 3.3 in Constantinidou et al., 2020a)
lines 169-170: Would it be useful to also show (in the Supplementary), not only the forest minus grass effect on the "annual amplitude of soil temperature (AAST) at 1 meter below the ground surface" (as done here), but the absolute value of annual land surface (skin) temperature as well?
line 230: Regarding the afforestation response of GHF, "Scandinavia appears to be the most sensitive among the regions". Any reasons?
lines 425-427: Can you also connect the results with the overarching ambition expressed in line 65 to "better constrain and represent the LUC biophysical forcing in regional climate simulations over Europe"?
lines 431-432: these proposed evaluations should critically include the land surface temperature, as in Constantinidou et al. (2020b)

Minor/Technical Comments

The English need to be checked again as there are a few grammatical errors or suboptimal expressions (some of them are listed below).

line 48: more correctly "On the contrary"
line 85: "second heat conduction law" can be written, more neatly, as "Fourier's second law of heat conduction". Same in lines 120, 226, 289
line 122: in equation (1), strictly, the derivative symbols should be replaced with partial differentials
line 127: "is the only variable which influence" should be "is the only variable which influences"
line 291: "since affecting" should be replaced with "since it affects"
line 402: replace "conducted an approach of" with "employed"

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