

We would like to thank the reviewer for the constructive comments that helped to make the manuscript more understandable. In the following, we list the reviewers' comments in black and our reply in blue. When appropriate, we show the revised part of the manuscript in green in this response letter. Note that references to locations in the manuscript correspond to the marked-up version of the manuscript, if not stated otherwise.

The most important changes include the following:

-We have revised the parameterization of the vegetation surface roughness, which led to the elimination of the parameter VAI_{off} . Accordingly, the vegetation surface roughness in the current model revision differs from the previous revision, which slightly affects all of the presented results, but without altering the main conclusions.

-The formulation of the text was improved in particular in Sections 2.2, 2.3, 4.1, 5.2, and 6.

-We decided to add the cloud masking in panels (a) and (d) of Figs. 8 and 11 for consistency within these figures.

CLM does not explicitly compute and output the LST. It is necessary to give the equation for the LST computation in text.

We have added a description of LST computation in CLM in the Section 4.2 (L455-463).

The processing MODIS LST in section 4.1 is stated in texts and is not easy to be captured. It suggests giving the bullet-point of each procedure as these in section 4.2.

We agree that this section was difficult to follow. We do not think however that a bullet-point list is the appropriate measure to solve this, as some steps require more background information, are parallel rather than sequential to other steps, and/or are inseparably connected to other steps. Therefore, we decided to rewrite and restructure this section to make it more understandable (L433-453). If the reviewer would like to read a more detailed description of the method, we kindly refer the reviewer to previous studies that employed the same methodology (Duveiller et al., 2018 and Duveiller et al., 2021).

In both L488-489 and L491-493, the relationships between incoming shortwave radiation and LST seems oppositely.

Thank you, this was a mistake. This sentence now reads (L572-574):

Over the northern mid- and high-latitudes, an **increase** in cloud cover during summer coincides with a reduction in daytime LSTs due to less incoming shortwave radiation (Figs. A4).

From the computation equation of LST (e.g., Yang et al. 2008 in reference list; Wang et al. 2014), the long-wave radiations (both incoming and outgoing) directly determine the LST magnitude. The incoming longwave radiation may change due to the cloud cover. The incoming shortwave radiation does not directly influence LST. Therefore, it is necessary to explain the possible mechanisms behind the relationship between incoming shortwave radiation and LST/cloud cover.

The calculation of the LST in CLM5.0 has been revised in comparison to CLM4.0, as is now described in the text thanks to a previous comment of the reviewer (L455-463). The current computation of the LST is linked to the temperatures of the leaves and ground and to their respective energy balances and not only to the longwave radiation fluxes. Accordingly, the resultant LST is affected by all energy fluxes rather than just the longwave radiation. We hope that the description of the LST computation in our simulations clarifies this. Also, we would like to thank the reviewer for making us aware of the study from Wang et al. (2014), which supports our revisions of the ground surface roughness and our results. We cited this study where appropriate (L69, L80).

References

Duveiller, G., Hooker, J., and Cescatti, A.: The mark of vegetation change on Earth's surface energy balance, *Nat. Commun.*, 9, <https://doi.org/10.5194/essd-2018-24>, 2018.

Duveiller, G., Filipponi, F., Ceglar, A., et al.: Revealing the widespread potential of forests to increase low level cloud cover, *Nat. Commun.*, 12, <https://doi.org/10.1038/s41467-021-24551-5>, 2021