Comments on "Mechanistic insights into tropical circulation and hydroclimate responses to future forest cover change" by Fahrenbach et al.

If the symbol Δ refers to different states in forest cover, this study seeks to identify the mechanisms driving the Δ(P −E) pattern over the tropics from a dynamics perspective and to reconcile the apparent mismatch between the tropical Δ(P −E) and ΔNEI, where P is precipitation, E is evaporation and NEI is net energy input into the atmosphere. The methodology is based on comparing future scenario simulations from seven multi-ensemble models participating in the Land Use Model Intercomparison Project (LUMIP).

The main finding are as follows, in which are most pronounced over Africa

1. Afforestation and avoided deforestation lead to a robust increase in precipitation and evapotranspiration, alongside widespread decreases in net precipitation (precipitation minus evaporation) in the tropics.

2. The tropical hydroclimate response to future forest cover change is largely independent of the background climate under low- and medium-warming scenarios.

3. The changes in net precipitation over Africa are driven by the competing effects of surface drag-induced reduction of lower-tropospheric winds and net energy input-induced strengthening of deep-convective upper-tropospheric circulations.

The text itself is exceptionally well written. The review part is particularly interesting. The emphasis is on mechanisms rather than on a simple description of differences between simulated climate.

We thank the reviewer for their comments and questions. Below, we address each of the comments (original comments in black and answers in blue):

<u>Main comments:</u>

1) Why is the response stronger over Africa? Is there a signal over the Amazon?

We thank the reviewer for this question regarding the regional differences in the simulated response. The stronger response observed over Africa, particularly in precipitation (P), evaporation (E), and their difference (P-E) over land, is primarily attributed to the significantly larger land-use change forcing in this region compared to the Amazon. As shown in Figure 1, the forest cover difference between the scenarios is substantially greater over Africa. Specifically, while the afforestation in scenario S1 over time are quite similar for both the Amazon and Africa (Fig. S1a), scenario S3 predicts large-scale deforestation over Africa, whereas changes over the Amazon are significantly smaller (Fig. S1b). Consequently, the difference between the S1 and S3 scenarios reveals a small afforestation signal over the Amazon but a large-scale avoided deforestation signal over Africa (Figure S1c). This substantial land-use change forcing over Africa leads directly to a pronounced local signal in the hydrological cycle (Fig. 2-4).

Regarding the presence of a signal over the Amazon, the simulations indeed show a response, albeit smaller in magnitude compared to Africa (Fig. S5). Similar to the African response, a small increase in P and E is observed over the Amazonian regions where land-use change occurs. Concurrently, temperatures decrease over these regions. This indicates that while the differences in land-use change scenarios over the Amazon are less extensive than over Africa, it still shows a small but consistent local hydrological and temperature response. We have added the following sentence to the manuscript to mention this response (L.222-224): "Note that while the Amazon also shows a consistent hydrological and temperature response, it is smaller in magnitude, consistent with the less extensive forest cover difference between the S1 and S3 scenarios (Fig. 1, S1)."

2) Why aren't the PBL processes considered? Where is the PBL top in Fig. 8?

We thank the reviewer for their question regarding the Planetary Boundary Layer (PBL) processes. In our study, convergence within the PBL is fundamental to the omega-scaling approach (Equation 3, Fig. 3f, 4f), and throughout the manuscript, we examine both convective and mechanical (turbulent) influences on convergence in the PBL (summary in Figure 8). While we agree regarding the importance of PBL processes, we were not able to *directly* analyse changes in the PBL height. This is primarily because the PBL height variable ("bldep") is not available for any model participating in the LUMIP simulations and since the models do not output data at a sufficiently high vertical resolution to calculate the PBL height.

However, an *approximate indication* of the PBL top can be inferred from Figure 5, namely as the height where the influence of surface roughness changes on wind anomalies diminishes. Specifically, the wind anomalies are no longer significantly influenced by the roughness change above 700-800 hPa, which can be considered an approximate representation of the PBL top in the context of these simulations.