Forest cover changes (e.g., deforestation and afforestation) have profound impacts on climate through biophysical processes. Prior studies have mostly focused on the impacts of forest cover changes on temperature and precipitation. However, the impacts of forest cover changes on drought have not been sufficiently examined and remain largely unknown. In this paper, Li and the coauthors try to fill this knowledge gap using a statistical model. They found varying effects of forest cover changes on different time-scale droughts across climate zones. Moreover, the impacts of forest cover changes may vary with precipitation and temperature within a climate zone.

This paper is well organized, clearly written and presents some novel results on the impacts of forest cover change on drought. However, I am a little concerned about whether the statistical model used in this work is a useful tool to address the relevant questions. Moreover, the statistical model-based results are not sufficiently convincing due to the lack of mechanisms or explanations in some cases. I think that the methods and results should be further clarified or explained. Please see my specific comments listed below.

Major:

1. The authors used a statistical model, and the model is in principle a linear multiple regression model. While the model can reasonably reproduce the year-to-year variations in drought in equatorial, arid and temperate regions, it is difficult for us to interpret the results and mechanisms derived from such a statistical model. For example, changes in drought can be attributed to changes in forest cover,

precipitation and temperature and the interactions between the three variables in a mathematical way (Equation 5). However, how can the individual effects on drought be interpreted? Specifically, what does the effect of forest and precipitation interactions on drought (X_{forest}: X_{precip}) mean? Does X_{forest}: X_{precip} mean that precipitation changes influence forest cover and subsequently drought or forest cover changes influence precipitation and subsequently drought?

2. Owing to the shortcomings of the statistical model mentioned above, some results based on the statistical model are also not clearly explained. For example, Figure 6F shows that SPEI24 decreases as forest cover increases when precipitation is low. The authors explain that a small amount of water is transpired into the atmosphere due to a high fraction of available trees (Line 310-311). Here are two problems. First, why does a higher tree cover fraction contribute to lower evapotranspiration when precipitation is low? Second, how are changes in evapotranspiration further related to changes in drought? Moreover, Figure 6L shows that the SPEI24 increases as forest cover increases when precipitation is high. The authors explain that "the types of trees here can adapt their leaves and roots to absorb all of the excess water (Line 328-329)", but they do not explicitly explain the positive response of SPEI to forest cover changes. Furthermore, some results shown in Figure 7 are not sufficiently explained. For example, it remains unclear why the dependence of drought on temperature and precipitation varies with forest cover.

3. I note that the forest cover range (X-axis) in Figure 6 varies with region, but why?

In arid regions, forest cover ranges between 0.0383 and 0.0393 (Figure 6L), and such a range (~ 0.001) is much smaller than the historical actual changes in forest cover (Figure 2). Why? Such a small increase in forest cover even corresponds to an increase of 0.3 in SPEI24 when precipitation is high (Figure 6L). It can be estimated that historical actual loess in forest cover (~ -3) will cause a decrease of 900 in SPEI24 in arid regions.

4. The authors categorize the global land into four climate zones and aggregate the forest cover, precipitation and temperature values within a climate zone for further analysis. I can not understand why the author do this. Forest cover, precipitation and temperature are spatially highly heterogeneous within a climate zone. Therefore, why not apply the statistical model pixel by pixel?

5. The authors selected temperature, precipitation and forest cover as three independent variables to build the statistical model (Equation 5). An implicit assumption is that the authors think that temperature, precipitation and forest cover can largely explain the annual variation in drought, but why? I do not doubt the contribution of temperature and precipitation to the evaluation of drought. However, it remains unclear why the other human activities (e.g., aerosol emission) are not considered here. It is also feasible to either replace the forest cover change with other human forcing or combine the forest cover change with other human forcing to rebuild the statistical model. It is unclear how the main results shown in this manuscript would be modified if different independent variables are selected to

build the model.

6. From Figure 2 and Figure 3, I see that the drought indices show a clear decreasing trend in arid regions during the analysis period. I'm curious about whether such a trend is related to global warming. If so, this is not surprising to see a dominant contribution of temperature to the evolution of drought, as shown in Figure 5. In other words, the covariance of drought is dominated by its long-term trend, which is further related to the long-term temperature trend in arid regions. This leads to another question: whether the drought indices, temperature and precipitation need to be detrended before regression? The authors do not detrend the variables and may confound the contribution of temperature, precipitation and forest cover changes to drought at multi-time scales.

7. In Figure 6, the authors show the responses of drought indices to forest cover changes at different precipitation (or temperature) levels with temperature (or precipitation) fixed at its median. It is unclear whether the main results would be modified if temperature or precipitation is fixed at other levels (e.g., maximum or minimum).

8. In Figure 6 and 7, the authors only show the results for SPEI03 and SPEI24. It is fine to only show these two drought indices in the main text, but the results for the other indices (i.e., SPEI06, SPEI12 and scPDSI) should be provided, for example, in the supplementary material.

Minor:

1. Line 6: “forest fraction” -> “forest cover fraction”.

2. Line 9: “The impact of forest cover” -> “The impact of forest cover changes”.

3. Line 10-12: “forest cover’s impact” -> “the impact of forest cover changes”

4. Line 38-39: “forests typically have a low surface albedo” -> “the typically low surface albedo of forests”.

5. Line 39-42: I think that the large uncertainty in the temperature effect of afforestation/deforestation in the mid-latitude is MAINLY caused by the radiative (i.e., albedo) and nonradiative (i.e., roughness and evapotranspiration) effects being similar in magnitude but opposite in sign. The background climate, forest types or analysis methods, as mentioned by the authors, just further enlarge such an uncertainty.

6. Line 47-58: In this paragraph, the authors review the impacts of deforestation/afforestation on precipitation in previous studies. I find that most references cited here are either old (before 2010) or review articles (e.g., Bonan, 2008; Perugini et al., 2017). Numerous important studies have examined the impacts of deforestation/afforestation on precipitation based on observations (Leite-Filho et al. 2021; Smith et al. 2023) and simulations (Liang et al. 2022; Luo et al. 2022) in recent years. I recommend the authors to update the references in this

paragraph.

7. Line 60: “And it is” -> “Drought is”.

8. Line 106-107: “…, which maps…”. What does “which” refer to? SPEI or SPI? Rephrase this sentence. When I first read this sentence, I interpreted “which” as “SPEI”. As such, I cannot understand why the authors say that the SPEI use precipitation as the only input but later they say that potential evapotranspiration is also used. I later realized that “which” refers to “SPI”.

9. Section 2.2: In this section, you should tell the readers what the magnitude and sign of the SPEI and scPDSI mean. For example, what are the possible ranges of the indices? What do the positive or negative values of the indices mean? What do higher or lower values of the indices mean?

10. Figure 3: The description of figure caption is inaccurate. It should be the annual means of precipitation and temperature aggregated analogously to the aggregation level of the drought index, rather than the annual temperature and precipitation.

11. Line 193-194: Why not considering the interactions between X_1 and X_2 (i.e., X_1:X_2) and X_1 and X_3 (i.e., X_1:X_3)? Do you assume that X_1 is independent of X_2 and X_3?

12. Line 199: Why are the forth and fifth right-hand terms are the same in Equation 5?

13. Line 200-201: What do the annual mean precipitation (i.e., X_{precip}) and temperature (i.e., X_{temp}) refer to? Do they refer to the commonly used mean values of

precipitation and temperature or the mean values of the precipitation and temperature aggregated to the aggregation level of the drought index (as mentioned in Line 172)? Clarify the "annual mean" here. Does Dτ also refer to the annual mean values of scPDSI or SPEI?

14. Line 228: What does $\hat{y}_i$ denote?

15. Line 275: "ominates" might be "dominates"?

16. Line 320-321: High/low temperatures lead to a notable negative/positive response of SPEI03 to forest cover, instead of decrease/increase in forest cover.

References:

Leite-Filho, A.T., et al. 2021: Deforestation reduces rainfall and agricultural revenues in the Brazilian Amazon. *Nature Communications*, 12, 2591.

Liang, Y., et al. 2022: Deforestation drives desiccation in global monsoon region. *Earth's Future*, 10, e2022EF002863.

Luo, X., et al. 2022: The biophysical impacts of deforestation on precipitation: results from the CMIP6 model intercomparison. *Journal of Climate*, 35(11), 3293-3311.

Smith, C., et al. 2023: Tropical deforestation causes large reductions in observed precipitation. *Nature*, 615, 270–275.