

Response to referee #2

Dear referee,

Thank you very much for your kind review. The time and effort put into the reading of our manuscript and writing this review is greatly appreciated. Furthermore, thank you for recognizing our work as a potential useful contribution to the existing literature. Below, we will address your major concerns and questions.

First, we agree that while our dataset covers the entire neo-tropics, the analysis is focused specifically on the Amazon basin. Therefore, it would indeed be appropriate to change the title into: "Drought effects on leaf fall, leaf flushing and stem growth in the Amazon basin; reconciling remote sensing data and field observations".

Considering the imbalance of leaf litterfall and stem growth observations over time in the dataset, it is true that the density of observations changes over time and that this might impact the model uncertainties as well. We now show these trends in a new supplementary figure (Figure 1). In general, there was an increase in observations of both leaf litterfall and stem growth in the 2000's compared to the 1980's and 1990's (Figure 1a). However, since 2010 there has been a steady decline in the number of observations per year which can at least partly be explained by a larger contribution of data that is presently not published or under embargo. There is also a positive trend in the normalized root mean squared error (RMSE) of the leaf litterfall and stem growth model estimates (Figure 1b) suggesting that the relative model error increases over time in both models. For stem growth, the increasing trend in NRMSE is mainly driven by the decline of the averaged predicted stem growth in the dataset while the absolute error did not change over time (Figure 1c). In the case of leaf litterfall, the increase in NRMSE over time is driven by the increase in absolute error (Figure 1c) despite the increase of average leaf litterfall over time. This suggests that despite more data being available in recent year, the model error is actually higher compared to the 1980's and 1990's. We acknowledge that these issues were not specifically discussed in our manuscript. In the revised manuscript we will examine these uncertainties in more detail. Furthermore, the dataset compiled for this study will become public in the final stages of the publication process.

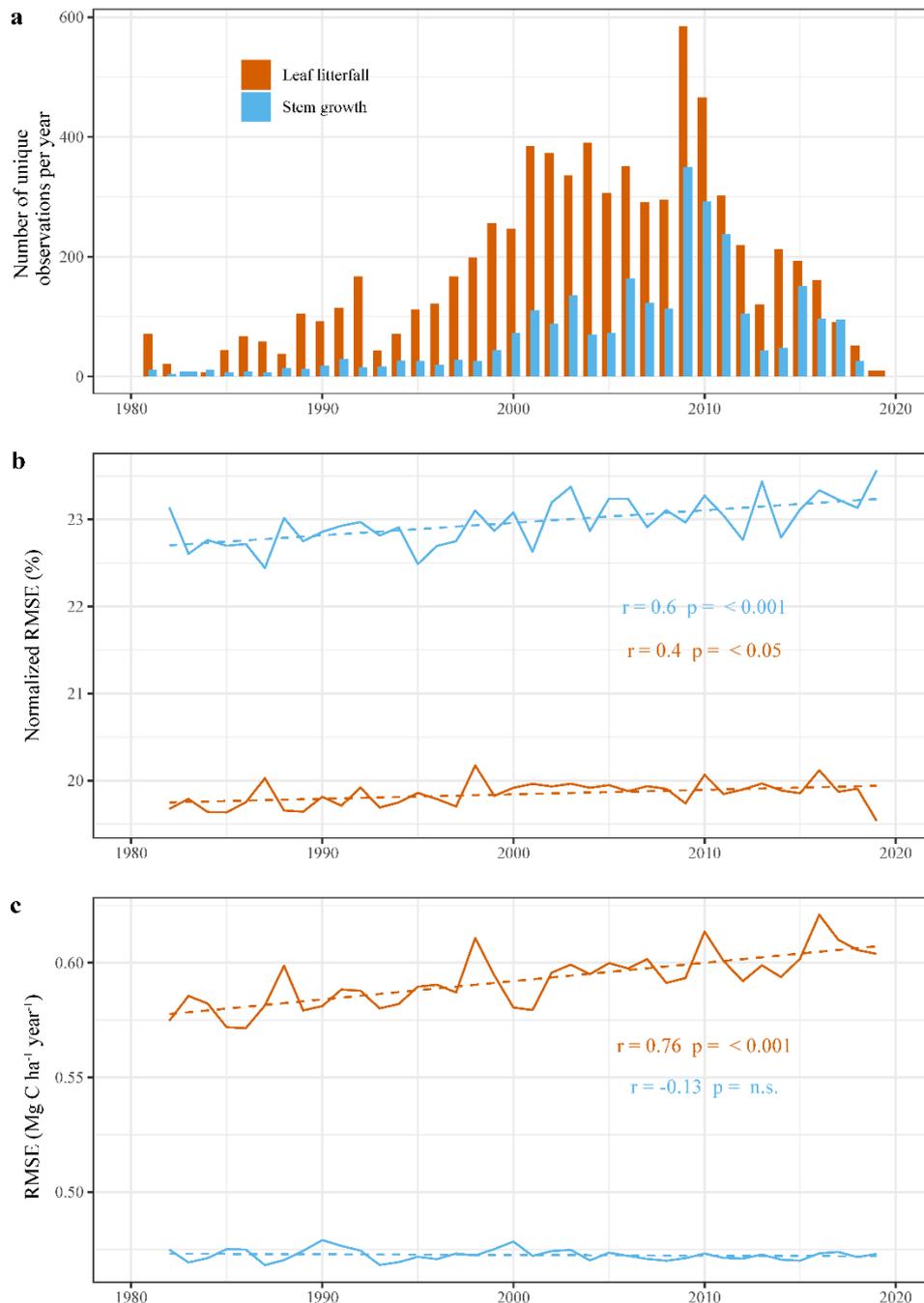


Figure 1 New supplementary figure showing the change in leaf litterfall and stem growth observations in the dataset and the error of the leaf litterfall and stem growth estimates over time. The normalized root mean squared error (RMSE) is calculated as the RMSE divided by the predicted average stem growth and leaf litterfall.

We have “cropped” the model output for the analyses to cover the extent of the Amazon basin. This was done because the focus of the study was on the drought related changes in forest growth that occurred in the Amazon basin. Furthermore, the figures were cropped to cover the area of interest as local differences cannot be identified if the entire study area was shown (details are lost when “zooming out”). Furthermore, as can be observed in for example Figure 3 and briefly discussed in the results (L345-348), different responses in the modelled stem growth and leaf litterfall and the remote sensing data are shown for the humid forests of the Amazon basin and the more dry Cerrado and caatinga regions. It would have made the paper considerably lengthier if we had to

examine the drought-induced changes that occurred in every region or ecosystem covered by the model output. However, we agree that these choices have not been explicitly mentioned in the introduction or methods sections of the manuscript. We will highlight our choices considering the region of interest in the revised version of the manuscript.

Thank you for noting the significant negative anomaly in soil moisture and positive anomaly in VPD in April 2006 that can be observed in Figure 8 of the manuscript and the associated negative anomalies in stem growth in the same period. We believe that this can be considered a short drought period, which indeed seems more anomalously dry compared to the 2005 drought. This period was not mentioned in the results of the current version of the manuscript as there is to our knowledge no mention of this 2006 drought event in the literature. One explanation for this is that this drought occurred in the middle of the wet season in the western Amazon so that it was probably not recognized as a drought and did not result in a significant physiological impact on the vegetation. However, we agree that this period should at least be mentioned in the results and we will discuss this 2006 event in the revised version of the manuscript.

We agree that in the conclusion we do not reveal our opinions about whether remote sensing and ground-based trends can be reconciled and whether ground based carbon sequestration is overestimated. What we aimed to communicate in the discussion is that remote sensing techniques differ considerably in what they measure and how these measurements are related to forest growth and “health”. For example, we show that canopy greening is not a good proxy of above-ground growth or drought stress in evergreen tropical forests. Furthermore, we show that ground-based estimates can be upscaled using climate data and other geospatial datasets to obtain a different temporal trend in stem growth compared to when the measurements of largely the same inventory plots are averaged. It would be interesting for future research to examine which upscaling technique provides the most accurate trend estimation, but for now we cannot confidently conclude which technique is more appropriate. In the revised version of the manuscript, we will more elaborately mention these issues and considerations in the conclusion.

Thank you again for your review and we hope that in our response we have addressed all your major concerns and questions regarding our manuscript. We will carefully address all your minor and major comments when revising our manuscript, which will definitely enhance the quality of the revised manuscript.

On behalf of my co-authors,

Thomas Janssen