Response to T. Brussée

The authors appreciate very much T. Brussée for his time and forwarding interesting reflections and questions.We therefore have addressed all the comments below point-by-point (italics). We have attached as supplementary material the revised manuscript with changes in blue.

General reflection:
I liked reading your paper very much, I think your assumptions given for your theory on LAI behaviour are valid and an added value to the SWAT model. They align with my findings on the weaknesses of SWAT in modelling in the tropics.

Response: We are glad to hear this encouraging remark.

What is your opinion on how SWAT calculates the maximum transpiration using the Hargreaves or P-T method, at times when the LAI > 3? Is it realistic that the maximum transpiration remains equal when the LAI is 3 and when the LAI is 4? I refer to the formula for calculating maximum transpiration as you also give in eq.5 of Alemayehu et al (2015):
Et = E'0 if LAI > 3.0 (m2/m2)

Response: These are interesting questions. In SWAT when either Hargreaves (Hargreaves et al., 1985) or Priestley-Taylor (Priestley and Taylor, 1972) reference evapotranspiration (PET) method is used, unlike the Penman-Monteith (Monteith, 1965) method, the potential transpiration is computed empirically as function of adjusted daily PET and LAI. For land covers with LAI above 3, the daily potential transpiration is equal under similar atmospheric condition. However, the actual plant transpiration is further limited by the actual soil water availability. As far as our experience, if the LAI is represented realistically these PET methods can reliably estimate the maximum plant water demand under optimal condition on a given day.

I found it very interesting that you initiate the LAI by using the ratio of P to PET, instead of soil moisture and reading the argument this is a good alteration to what Strauch and Volk (2013) did in their research. Also nice that SWAT-T can better account for climatic variations.

Response: We are happy that you have pointed out the main part of the manuscript.
Line 10-11 "*where the major plant growth controlling factor is the rainfall (via soil moisture) rather than temperature."* – it seems as if you mean to say that temperature is the preferred plant growth controlling factor, maybe you can cut the sentences up into two sentences: **1)** However, SWAT has limitations in simulating the seasonal growth cycles for trees and perennial vegetation in tropics. **2)** In the tropics plant growth is mainly controlled by rainfall (via soil moisture), whereas in SWAT plant growth is temperature controlled.

Response: Indeed the sentence is long, however, it clearly states the limitation of SWAT for tropical ecosystem since it does not take into account rainfall Therefore, we would like to keep it as it is.

Line 57 "Normalized Vegetation Index (NDVI)" – shouldn't this be: "Normalized Vegetation Difference Index (NDVI)"?

Response: Well spotted. Modified accordingly.

Line 97"poorly drained soils cover the plateau" I was wondering what you meant with "plateau". I guess the Mau escarpment?

Response: No that is referring the landscape in the lower section of the basin.

Line 192-193 Does this mean that there can be set two starts of the rainfall seasons (SOS) for a bimodal rainfall regime? : So there is an end of the dry season [SOS1] and a beginning of the rainy season [SOS2] for the long rains (for the Mara for example) and there is another end of the dry season [SOS3] and a beginning of the rainy season for the short rains [SOS4] ?

Response: No, there is one phenological cycle per year regardless of the rainfall pattern. Therefore, we need to predefine only two months for the transition months.

Line 196 "*pentad ratio*" – I had never heard of this, I don't know whether it is a common term (maybe it's because I am a non-native speaker of English), but to make it easier to read you might also just say " five day ratio".

Response: Pentad is a conventional term that refers to five days aggregate. We have now included for further clarity '…5 days…' in the revised manuscript (line 185).

Line 302-306 This trial-and-error process was it done manually or with for example SWAT-CUP? And if so, did you have some sort of a steps that you followed in this procedure? I am curious because personal experience taught me that altering these five LAI parameters in SWAT-CUP or directly in the input .mgt or .plant files, could give pretty random outcomes in terms of LAI curves or PET, and results of altering multiple LAI parameters at the same time are difficult to predict

Response: We did the calibration manually. It is true that manual calibration of distributed hydrological models like SWAT with many parameters is not a trivial task. SWAT plant parameters related to the vegetation growth dynamics were calibrated by comparing with 8-day MODIS LAI timeseries. It is not uncommon to come up with good model performance for the wrong reason and therefore, we used our expert knowledge to guide the trial and error process while adjusting the parameters.

Line 308-309 Do you know why Kilonzo (2014) [Penmann-Monteith] and Mwangi (2016)[Hargreaves] recommend using a minimum LAI for FRSE of respectively 3 and 4? For Mwangi this worked very well. For tropical forest in Brasil this is reasonable, but looking at the mean annual LAI in the FRSE of the Mau escarpment of 2.6 this seems too high of an estimate. I also saw in **figure 7** That you had set the minimum LAI for SWAT-T to about 2.2 and maximum LAI to 5. Was this just for the purpose of giving an example at the same setting as the default or was this also the value as used in your simulations?

Response: Both Kilonzo (2014) and Mwangi et al. (2016) stated that they used literature values for forest LAI. In this study, we used 8-day filtered LAI from 2002-2009 to determine the minimum LAI. Indeed Mwangi et al. (2016) improved SWAT simulated LAI by reducing the Fraction heat unit (FR_{PHU}) to very low values (0.001) and setting the minimum LAI to 3. These changes improved the LAI simulation at the *start of new simulation in January every year, however, the minimum LAI during the summer months due to the latitude and daylength dependent dormancy needs to march with the dry season months. Our simulation in Figure 7 was with default SWAT parameters to explore the effect of the modification on the vegetation growth module.*

Line 334-336 "We also notice the SWAT-T simulated potential transpiration is consistent while changing the PET method to Hargreaves method in SWAT (results not shown here)."
Interesting! Is this also the case for the PET at times where LAI > 3 ?
Did you also try using the Priestley-Taylor (P-T)?
Personal modelling experience in the region taught me that the annual PET using the P-T method is often lower then when using the Hargreaves or P-M, thus giving a lower AET, thus implicating that there is more water in the catchment system to "play with" as in comparison to the P-M or Hargreaves.

Response: We appreciate the fact that you are sharing your experience. The potential transpiration calculation requires simulated actual LAI and canopy height to compute the canopy resistance and the aerodynamic resistance while using P-M method. The P-T and the HG methods require only simulated LAI to compute the daily potential transpiration. Therefore, realistic representation of the temporal LAI dynamics in SWAT is crucial for reliable potential transpiration. We have shown the inconsistencies in the simulated potential transpiration (i.e. considerable zero values) due to unrealistic LAI simulations using the PM (i.e. data intensive) and the HG (i.e. less data intensive) methods. We believe that if the seasonal dynamics of the LAI is represented well the potential transpiration computed by one of the PET methods would work well. In fact, the underestimation with the actual ET would affect the water balance. We have reflected these points in the revised manuscript.