Response to Anonymous Referee #1

We thank the referee for this thorough review and for the numerous constructive suggestions. We agree with the need of further improvements in the manuscript organization. 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.

In this manuscript, the authors modify the phenology algorithm of SWAT in simulating tropical vegetation. This work provided some interesting discussion of limitations in SWAT plant module. I have several major concerns about this work. First, writing of this work should be further improved to make it publishable. Second, organization of the introduction and method sections should be changed following requirement of a scholarly journal.

Response: We appreciate the anonymous referee the constructive and valuable comments. We agree on the need of further improvement on the write up and organization. Therefore, we have substantially improved the write up and the organization in the revised manuscript.

line 47, what does this mean? do you mean that SWAT could not represent changes deciduous forest?

Response: No, we are referring to the mismatch between the SWAT dormancy period and the dry season, where dormancy is a function of water and temperature stress. According to Wagner et al. (2011) the SWAT simulated LAI for deciduous forest in India is not realistic because the dormancy in SWAT is related to daylength and latitude. As a result the authors shifted the dormancy period in SWAT to the dry season months and hence improved the LAI simulation. As pointed by referee #2, we have further improved this text in the revised manuscript (lines 50-52).

line 55, extra space.

Response: removed.

line 58, for -> of. To simulate

Response: Modified accordingly.

line 59, a rainy season

Response: Updated.

line 67-68 in this sentence should be moved to the method section

Response: We agree with this suggestion. We have moved that to the methodology section in the modified manuscript.

line 71-81, I expected to see objectives of this work, but the authors are describing their methodology, which should be moved to the next section (method)

Response: The authors agree with the referee. We have clearly stated objective in the revised manuscript (line 74-77) that reads as "..The objective this study is to improve the vegetation growth module of SWAT model for trees and perennials in the tropics. Towards this the use of the SMI within a predefined transition months as a dynamic trigger for new vegetation growth cycle will be explored. The modified SWAT (SWAT-T) model will be evaluated using 8-day MODIS LAI and Remote sensing-based ET. Additionally, the model will be evaluated using observed daily streamflow. "

line 92, a long rainy season

Response: Updated.

line 93, across what?

Response: across the basin. We have added this in the revised manuscript.

section 2.2.1 was copied from the SWAT manual. I suggest to condense this part significantly, or move it to a supplementary section

Response: This is a summary of the vegetation growth module in SWAT based on the manual and published literatures. As suggested, we have considerably reduced the summary of the SWAT vegetation growth module in the revised manuscript (lines 135-165).

line 172-173, this is not correct. Kill and dormancy are totally different. If some one use this to regulate phenology, they must have made mistakes.

Response: We agree that dormancy and kill are different concepts in SWAT. Dormancy is a function of daylength and latitude, and dormancy starts at the shortest day of the year for trees and perennials in tropics. Whereas, the kill operation in SWAT stops plant growth at a specified time using either date calendar or fractional potential heat unit (Nietch et al. 2011). The default management setting in SWAT has planting/beginning of the growing season and kill/end of the growing season at 0.15 and 1.2 FR_{PHU}, respectively for trees and perennials. The management setting are important for several agroforestery operations..

line 175-181, these discussions should be presented in your Introduction, or the Discussion section

Response: We agree on this suggestion. We excluded part of this paragraph in the revised manuscript.

line 183, what are the data source of P and PET?

Response: The P is based on historical local gauge observations in and around the basin. PET is based on observation based global PET from Trabscaou and Zomer (2009). We have added the sources in the revised manuscript (line 187).

line 192-193, remove these two sentences

Response: We disagree with the referee. These sentences are important because in larger basins there could be variation in climate. As a result, there could be difference in seasonality of rainfall across the watersheds, thereby SOS changes.

line 201-207, do you have any reference to support your rules?

Response: the fundamental rule for the start of new growing season is the SMI (i.e. P/PET). When the SMI exceeds a user defined threshold a new growth cycle is triggered within a predefined period annually. This concept is somewhat similar to the Water Requirement Satisfaction Index (WRSI), which is a ratio of actual evapotranspiration to PET (Verdin and Kalver 2002). The threshold for the SMI to trigger new growing season is set to 0.5, meaning the rainfall satisfies 50% of the atmospheric water demand (PET). Even though this threshold could vary from place to place, growing season in general is defined as the time when average precipitation is greater than half of the average PET (Mcnally et al. 2015).

line 238, a... site?

Response: The 8-day MODIS LAI has 1000 m spatial resolution and therefore to avoid land –cover class mix during aggregation of pixels, we used selected sample sites (shown in Figure 1b) to mask the MODIS LAI for each representative land-cover classes. We believe such approaches improve the reliability of the LAI estimates for each representative land-cover types.

line 242, why lai of 1.5 is removed?

This is based on the long term LAI timeseries during the rainy season (i.e. the peak growing season), whereby the LAI values are above 2.0 m^2/m^2. Therefore, LAI values during the rainy season below 1.5 are replaced with interpolated values. We have provided this information in the revised manuscript (line 233).

line 245, what break?

Response: This break is referring to unrealistically low LAI values due to noise and cloud contamination. Sudden break in LAI could also happen due to anthropogenic effects (land use change. Fire, etc.).

line 253-254, I donot understand how the LAI patterns match precipitation.

Response: For the dominant part of the basin, the long rainy season is from March to May with a peak in April. Also, the basin gets short rain from October to December. On the other hand, we note the LAI seasonal pattern, whereby the lower LAI values are observed in the dry months (July to Sept). This is supported by a correlation of 0.66 seasonally in the humid part. This is discussed further in the seasonality of LAI and its association with rainfall in the revised manuscript (lines 411-416).

line 259-260, awkward expression. consider to improve

Response: We have improved this in the revised manuscript (lines 253-254) that reads as "ET is one of the major components in a basin water balance, which is influenced by the seasonal vegetation growth cycle."

line 270, change the term 'flow'to stream flow or river discharge through out the manuscript

Response: Modified accordingly.

line 272-273, remove the second period

Response: Removed.

line 285, seasonality of what?

Response: LAI is missing here. We have included this in the revised manuscript (line 404).

line 290-291, I am not convinced that lai reflects changes in rainfall. you need to provide some statistical information here. And what about the correlation between temperature and lai?

Response: There is a fair association between seasonal rainfall and LAI in the humid part with correlation up to 0.66. The correlation (0.81) is even stronger for the lower part of the basin due to the clear seasonality of rainfall, albeit with one month lag. Since temperature is not a limiting factor on vegetation growth in tropics, we did not consider that in our analysis.

line 306-308. very confusing

Response: The minimum LAI for a land cover could vary inter-annually depending on the climatic condition. However, this minimum LAI for each land cover need to be provided in SWAT plant database, meaning the minimum LAI during dormancy for a specific land cover does not change inter-annually and hence it is constant.

line 311 figure 5 only show two land covers. What about the other two?

Response: The plot for Tea and RNGB are excluded since the observed patterns are somewhat similar to FRSE and RNGE, respectively.

line 316. I do not see seasonal variation from figure 5

Response: Figure 5 depicts the seasonal pattern. The seasonal variation is depicted as the range between the maximum and minimum LAI values. In this regard note that the range in LAI that is normalized with the annual average MODIS LAI is more considerable (up to 82%) for grass and shrub cover types.

line 325, in October

Response: Updated accordingly.

line 328, was, first

Response: Modified.

line 329, second

Response: Modified.

line 330, a 8-day scale

Response: updated accordingly.

line 339-341. do not understand what does this mean

Response: We have further improved the clarity in the revised manuscript (lines 326-332) that reads as "With this management setting, the simulated LAI is zero at the beginning of each simulation year for all types of vegetation cover. Mwang et al. (2016) improved the SWAT LAI simulation with this management setting using FR_{PHU} of 0.001 to start the growing season and minimum LAI of 3.0 for evergreen forest. Yet, this change is region specific and cannot be transferred. As shown in Figure 4 and Figure 5, this can also be partly improved using a date scheduling (Date) for the start and the end of the vegetation growth cycle (i.e. instead of heat unit). Additionally, all the management setting can be removed (no mgt) and vegetation is growing since the start of the simulation (i.e. IGRO=1)."

line 344, consider to revise

Response: We have modified this in the revised manuscript.

line 351-353, not clear. consider to revise

Response: We have revised this in the modified manuscript (lines 352-356)

line 361, I do not see improvement in runoff

Response: we did show improvements in simulated LAI but we highlighted the SWAT-T is able to reproduce the observed streamflow.

line 387-389, remove this sentence

Response: We have revised this paragraph.

line 396-406. It is surprising that the authors did not evaluate SWAT ET simulations

Response: We in fact evaluated the SWAT-T simulated ET against ET-RS at 8-day. Since SWAT is not a fully distributed and gridded model, we have not done a pixel level spatial evaluation. Nevertheless, we have depicted the agreement between LAI and ET qualitatively using one rainy month and one dry month from year 2002 at HRU level. Also, we have shown the temporal dynamics of ET using 8 years average monthly ET.

line 412. Is this a sentence?

Response: We have updated this sentence in the revised manuscript (lines 478-479).