

Interactive comment on “Spatio-temporal vegetation dynamics and relationship with climate over East Africa” by John Musau et al.

Anonymous Referee #2

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Review The article investigates vegetation-land surface-atmosphere, through analysis of vegetation trends in East Africa (using LAI) for the period 1982 to 2011 and their relation to climatic variables. The idea is interesting, and has been motivation of substantial recent work correctly identified and cited in the paper. However, there are several issues that undermine the value of the contribution, including some aspects of methodology and the lack of clarity, particularly in the discussion portion. These issues will be further discussed below.

Major issues:

1. One of the problems with the analysis/methodology is that one of the variables used to understand feedbacks between vegetation and climate is API. API is defined in the paper as antecedent Precipitation index (computed using equation (1) in the

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text). The rationale for using this variable is that it reflects “soil moisture”. Though this is a reasonable assumption, and the value of API can be obviously assumed to exert an effect in vegetation, it is less clear that API can be considered a climatic variable, and used to study the effect of vegetation on “future climate” (see further comments in points 3 and 4). Please note that equation (1) is equivalent to using the following equation: $API_j = \sum (K_i P_{j-i})$ (which is a weighted average of previous values of Precipitation). Because of the high value of K, the value of API has a strong dependence on past values of P, which affects past values of LAI. Note also that the use of equation 1 induces a high correlation structure in API. Therefore LAI(t) a significant correlation with API(t+1) is not surprising. I think that the authors should use P and not API in the analysis (or at least in the lead LAI analysis), particularly to infer the impact of vegetation in future climate (it will obviously have an effect in soil moisture!), the important question is whether it will have an effect in climatic variables like P.

2. Methods: Section 3.2.2 is very unclear:

2.1. The authors state: “A random sample encapsulating 25% of the total pixels was then selected after removing NoData cases resulting to a total of 7,179 data points.” This statement is not explained, what are the NoData cases? How were they selected?

2.2. Why is the data aggregated seasonally?

2.3. Why/how are these four models selected? Is it an arbitrary choice?

2.4. What are models III and IV trying to show? Are these supposed to be models for predicting API? Please note that as API represents a weighted average of the history of precipitation (and not precipitation in The MAM season), these two models loose meaning.

2.5. The choice of variables in equations I to IV should be physically explained. In addition to explaining why you choose these combinations of variables for this equations (i.e., the question in the previous point), you should also explain what does each

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equation explain in terms of physics, or equivalently, the physical interpretation of the results.

It seems that probably, looking at equations III and IV and based on the coefficients given in tables 2 and 3, that adding LAI for DJF will enhance the results for equation I and II, so why not doing this? What are you trying to capture in these equations?. The selection of variables seems arbitrary, and no attempt to explain the selection has been made. It is therefore no surprising that the results from this analysis are a bit vague (section 4.3.2, see also next point on the results of models III and IV).

3. An additional problem with the use of API appears when looking at the spatial regression analysis (section 3.2.2.).

The problem mentioned in point 1, is exacerbated in the analysis and interpretation of results from Equation IV. Please note that the very high regression coefficient presented in table 2 for the OLS and GWR models are partially capturing this problem. The “history of precipitation” is directly correlated to the values on the previous three months (it has been computed using those values!), leading to the obvious result described in page 13, lines 5-6 that state “API DJF” is the most significant explanatory factor in API MAM (please note that this directly comes from the use of equation 1!, the equation is ill posed and the correlation is forced into the equation).

Please also note that the interpretation of the results from model III are also affected by this problem. Any results based on API, as API has strong autocorrelation and therefore, it is not surprising that will show high correlation with variables, in particular LAI in previous time steps, without meaning that vegetation is impacting future precipitation.

4. Figure 7a. As explained in earlier points, the results presented in Figure 7a are not surprising, due to the definition of API. It is not clear that this strong correlation suggests a vegetation influence on (future) Precipitation, as it might just reflect a strong correlation with past precipitation amounts. Here, an analysis of LAI lead on precipitation (not API) would be more meaningful, as done in previous work cited in the paper

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(for example: Li et al. 2006, Hoscilo et al., 2015, Notaro et al., 2006).

5. The discussion section in pages 13-14 is very unclear. The text is not clear partly due to poor grammar, but mostly due to lack of a clear logic linking the statements to the results and figures given in section 4. Many statements are not well explained so they appear unsubstantiated or unrelated to the results of the previous section. Below are some examples of lack of clarity and/or (apparently) unsubstantiated statements.

6. Page 14, lines 8-9 mention: “The slow variance of LAI is exceeded by the large internal atmospheric variability thus instantaneous correlations show mainly the vegetation response to climatic variables”. What do you mean by slow variance of LAI? This statement is unclear.

7. Page 14, lines 15-18 mention: “It is also clear that areas with significant LAI trends do not show significant instantaneous correlations with API but show significant negative correlation with leading API which implies increased green up during the dry season.” Where is this shown in the results? Please link to figures or previous statements in section 4.

8. Page 14, lines 22-23, mention: “Spatial extent of the negatively correlated areas with leading API increase with longer time lags” I don’t think this is shown in the figures/results.... It seems unsubstantiated.

9. Page 14, lines 23-28, mention: “Due to the expected growth in greenhouse gas concentrations, Cook and Vizy (2012) projected severe decreases in the number of growing-season days in East Africa by the mid-twenty-first century. In addition Congo basin”, please explain the link to your results. This sentence seems to follow from the previous one, but the link to the results presented in the paper is not clear.

10. Page 14, line 26 mentions: “Adhikari et al. (2015) reported that the expected increase in Tmin and Tmax in the region ranges from 1.4°C to 5.5°C by 2090s”. Again here, the link to your results is not obvious.

11. Page 14, lines 31-32 mentions: “Correlations with leading LAI show significant vegetation forcing on precipitation in the region, also reported by Alessandri and Navarra (2008)”. As discussed in points 1,3 and 4 above, it is inadequate to state that this study looks at leading LAI forcing on precipitation... API reflects the “history” of past precipitation events, so it is incorrect to say that LAI lags API.

12. Please note that the text, jumps from discussing T to API, back and forth and is very difficult to follow (see for example the text in lines 30 to 35).

13. Page 15, lines 3-5, mention figure 9 and state: “The significant high positive vegetation feedback on precipitation shown in Figure 9 is partly due to the fast vegetation response to API in the arid and semi-arid areas (Figure 5) mainly characterized by shrubs and grasses”. This looks like a circular argument, please explain better, while remembering that API might be used as a proxy for soil moisture (as mentioned later in this paragraph) but it is not P!

14. Finally, the discussion of the results from the spatial regression analysis is weak. Perhaps because the rationale and physical significance of the selection of equations I to IV is not clearly stated and analysed.

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