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# ***Interactive comment on “Global changes in dryland vegetation dynamics (1988–2008) assessed by satellite remote sensing: combining a new passive microwave vegetation density record with reflective greenness data” by N. Andela***

**Anonymous Referee #1**

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The manuscript presents a very interesting explorative study for the combined use of long-term NDVI a novel vegetation optical depth data set to study dryland vegetation dynamics over time. The complimentary character of the two datasets makes the study innovative and worth to be published in Biogeosciences. Nevertheless, several issues should be addressed first.

Major issues

1. Based on the title "combining a new ..." and the theoretical discussion in Section 2 I was expecting a more quantitative approach for combining the two observables.

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In contrast, in many places the work is rather suggestive and not backed up by hard facts, such as validation results. Many times wordings like “suggest”, “may have been”, “could” etc are used. I’d suggest to either strengthen the quantitative aspects or to ease a bit the expectations by modifying the title and the introduction.

2. Throughout the manuscript, NDVI and VOD are compared 1:1 (e.g. the discussion on page 17 stating that NDVI has less distinct trends than VOD; Fig. 8). Even though both indices commonly range between 0 and 1, it is not said that these can be directly compared as their relationship to vegetation density is not linear. Possibly the data first need to be standardized before comparison.

3. Both VOD and NDVI datasets are based on multiple input data sources with differing quality over time. The potential impact of the varying quality needs to be discussed.

4. Why is the analysis only performed until 2008, while both datasets are available until 2010? Including 2009+2010 would make the conclusions drawn from the analysis much more robust, as the strong La Nina event of 2010 may have flipped several of the trends observed until 2008.

5. The manuscript is overly long with many repetitions. I expect that the text can be shortened with about 30% without losing any of its strength.

#### Minor issues

P2.I7: The NDVI is not only sensitive to chlorophyll and canopy cover fraction but also to leaf area index, leaf angle distribution, and several other canopy characteristics.

Even though NDVI and VOD are very valuable indicators to study dryland vegetation dynamics and bush encroachment, especially at the global scale, also hyperspectral data are widely used for this purpose (e.g. Oldeland et al, 2010). The readers should at least refer to the use of this technique in the introduction.

P5.I6: “NDVI does not penetrate vegetation...”. This is not true. On the one hand the formulation is technically incorrect (it is not the NDVI that penetrates, but the radiance),

but above all, the NDVI often does provide information of the substrate, otherwise the signal would always be more or less flat (i.e. close to 1) and not show any dynamics.

It is true that the NDVI saturates for dense vegetation, but does the VOD never saturate? To my knowledge it does as well for very dense vegetation.

Section 2: the linear mixture concept is not new and has been used for more than 20 years in remote sensing research. Reference shall be provided. Also mention that the mixing model is a very simplified one because transmittance and multiple scattering is not accounted for.

P7.L14ff: “Although there is...” reference shall be given for this statement.

P9: the four expectations are formulated in a confusing way. I suppose that 1) “an increase in the herbaceous biomass component” should be “an increase in the relative fraction of the herbaceous biomass component”? Similarly for 4) “a decrease in the relative fraction of the herbaceous biomass component”? Please clarify.

P9.L21-23: “Sensor characteristics...” Sentence is out of place and can be removed.

P10.L9ff: also say something about the quality over time.

P10.L16-18: How realistic is it to assume homogeneous precipitation in a grid cell over areas that are strongly controlled by convective precipitation?

P10.L20: you decided to use a static land cover map for a 20 year period? You should spend a few words on how this possibly affects the results of this study.

P12.L19 (and many other places): You use the term “expected” vegetation/anomalies versus “observed”. Personally, I think that the term expected is not appropriately chosen in this context. What you actually mean is the variation explained by your API model. Therefore, I’d suggest to use another term (e.g., “explained”, or “estimated”)

P13: First you explain why you should use anomalies and not the absolute values, while in the end you mention again that you also analysed the absolute values. This makes

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the reasoning unnecessarily complicated (also in the results (p16.L6ff) and discussion). Just mention that you analysed both and what different information both measures give you. Related to this, the one figure in the appendix can be moved to the main text.

P15: Explain how differences in temporal data coverage between pixels were accounted for in the slope estimation.

P17.L16: “... NDVI overall had less distinct trends...” Can this be said so easily? Are we really looking at the same units? Besides the differences seem to be very subtle and not significant (Fig. 8).

Section 6.1: Not really a discussion, most of this has already been said before-> remove/condense.

Section 6.3: Recently, a study was published on trends in remotely sensed soil moisture over almost the same period (1988-2010; Dorigo et al., 2010). Please discuss the results obtained in your study in the light of the results obtained by Dorigo et al. as vegetation dynamics are closely related to soil moisture availability.

P22.L7: “In those regions....understory”. Do you have evidence for this? Literature?

P25.L17-19: The period 2001-2011 does not agree with your study period.

P28.L7: “Spatial distribution of trends...” This is very suggestive. Do you have evidence for this? And does CO2 really play an important role in areas that are strongly water-limited (reference)?

P28.L21-22: Do you have evidence of advances in agricultural practices over these areas?

Fig.4: Negative significant correlations should not be masked but also shown as this provides valuable information.

Technical corrections

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P4.L8: “spatial extenT”

P10.I7: AMSR should be AMSR-E; AMSR-E is a sensor and TRMM a platform/mission  
-> Use sensor name (TMI) for the latter too.

P12.L4-5: “Following Evans.... used” Rephrase.

P16.L24: “While global trends...” -> “While OBSERVED global trends ...”

P18.L10: “Trend in annual mean minus TRENDS IN annual minimum NDVI ...”

#### References

Oldeland, J. Dorigo, W., Wesuls, D., Jürgens, N. (2010). Mapping bush encroaching species by seasonal differences in hyperspectral imagery. Remote Sensing 2(6), 1416-1438.

Dorigo, W.A., de Jeu, R.A.M, Chung, D., Parinussa, R.M., Liu, Y., Wagner, W., Fernandez-Prieto, D. (2012) Evaluating global trends (1988-2010) in harmonized multi-satellite soil moisture data. Geophysical Research Letters, 39, L18405

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