

Interactive comment on “The Impact of Drought on Soil Moisture Trends across Brazilian Biomes” by Flavio Lopes Ribeiro et al.

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Received and published: 15 July 2020

Dear Reviewer,

Thank you for your comments and suggestions.

I am sorry for the late response. We were having some very interesting discussions on how to answer each of your comments.

Please, find the answers below:

Answers

Major Comment #1:

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Reviewer comment: The first 5 cm of soil is not representative of soil water storage.

Response: We agree that satellite soil moisture represents only a shallow soil layer and we do not attempt to represent the impact of drought on the complete soil profile based only on satellite soil moisture data. However, the negative impacts of drought can be detected in different components of the water cycle, including superficial soil moisture. The propose of this article is to demonstrate the benefits of integrating satellite soil moisture observations into drought monitoring such as feasibility of soil moisture products, greater spatial coverage (much better than weather stations), high temporal resolution, comparability with other areas of the world, repeatability of results, etc. Having said that, we will edit the document clarifying that we do not mean to represent soil water storage along the complete soil profile.

Reviewer comment: Amazon or Cerrado soils can be very deep and clayey. Although in tropical soils the organic layer can be thin, deeper layers still represent an important water storage. Also, the rooting system grows below the first 5 cm, so these soil moisture estimates cannot directly inform us on plant available water storage and, consequently, on risks for vegetation productivity.

Response: Agree. On the other hand, soil moisture at the first 5cm is a good predictor of land and atmosphere interactions and key for the detection of soil aridity conditions that are directly related with the loss of soil biodiversity and therefore with soil productivity. Thus, soil moisture at the surface is directly affected by drought conditions and could be also used as indicator (i.e., proxy) of the water contained at deeper layers. We will edit the document to highlight the value of superficial soil moisture (0-5cm) as an indicator of drought negative effects. We support these findings with previous literature reporting drought conditions in biomes where we detect soil moisture decline.

Reviewer comment: Another important aspect of surface soil moisture is that the first 5 cm are expected to be very dynamic, since it is the first layer exposed to the atmosphere. As a result, one expects a weak autocorrelation, so that it is difficult and

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ambitious to link the observed soil moisture trends (over 7 years) to the occurrence of specific droughts during the study period. The authors should at least amply discuss this, because this is an important aspect limiting the use of satellite soil moisture.

Response: The study period (2009 – 2015) was marked by successive droughts across Brazil, registered and confirmed by different monitoring instruments such as the Integrated Drought Index (IDI), which combines the Standardized Precipitation Index (SPI) and the Vegetation Health Index (VHI) (Cunha et al., 2019) and Municipal Emergency Declarations all over the country. While we agree with some of the limitations of satellite soil moisture, we also highlight that larger drought affected areas (e.g., the Caatinga biome) are consistent with our results. Following the reviewer recommendation, we will increase the discussion about the limiting factors of soil moisture as indicators of drought negative effects (e.g., soil moisture decline).

Major comment #2: Reviwer comment: In my opinion, to put their study into context it is key that the authors show how commonly use droughts indexes vary during the study period. One example is the popular Palmer drought index, but there are others. A comparison between these indexes and the soil moisture trends analyzed by the authors might help understand if some information that is missing in drought indexes can be retrieved from soil moisture analyses. In my opinion, this would be critical to evaluate the impact of the paper.

Response: That's a good suggestion and would help clarify the first major comment and confirm the consistency of our results. For that we will creating a new sub section with a validation of the 5cm SM compared with OCO-2-based SIF product (GOSIF) and linear relationships between SIF (Solar-induced chlorophyll fluorescence) and GPP (gross primary production) used to map GPP globally at a 0.05° spatial resolution and 8-day time step, as proposed by Li, X.*, Xiao, J. (2019): <https://www.mdpi.com/2072-4292/11/21/2563> We even produced a map of primary productivity trends 2009-2015 for Brazil retrieving data form Orbiting Carbon Observatory-2 (OCO-2) which only confirms our results (attached).

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Minor comments

Reviwer comment: In the introduction the authors say: “Soil moisture decline reduces biomass: : :”. I would be careful here. A soil moisture decline may limit vegetation growth and microbial activity, but only if soil moisture declines below critical water stress thresholds.

Response: Sure. We will rephrase it.

Reviwer comment: In the same paragraph, the sentence “Indeed, temporal variability of soil moisture in a given biome is needed..” is not very clear. I suggest rephrasing and elaborating a bit.

Response: This sentence is based on the evidences that soil moisture is an integral component of the interactions between climate and the earth's surface that lead to geographical variability of climate. What we are trying to stress here is that beyond being just a resultant statistic, soil moisture itself is an active variable of the local climate and can be add value and precision to the monitoring evaluation of the impacts of drought at the biome level.

Reviwer comment:Two paragraphs later “Most work has been focused on the semi-arid..”. It is not clear why this paragraph is placed here. What work are they referring to? Besides the abstract, this is the first time they mention Brazil in the paper and the reader does not know why. This paragraph should probably be moved to later in the introduction.

Response: You're right. We will move the following paragraph up (“In this study, we use satellite soil moisture data from the European Space Agency (ESA) to analyze the impact of drought across all Brazilian biomes...”) as a bridge to indroduce the importance of assessing soil moisture to analyze the impact of drought across all Brazilian biomes. The sentence about the semiardi region will be moved further down the indroduction.

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Please also note the supplement to this comment:
<https://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2020-185/nhess-2020-185-AC1-supplement.pdf>

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2020-185>, 2020.

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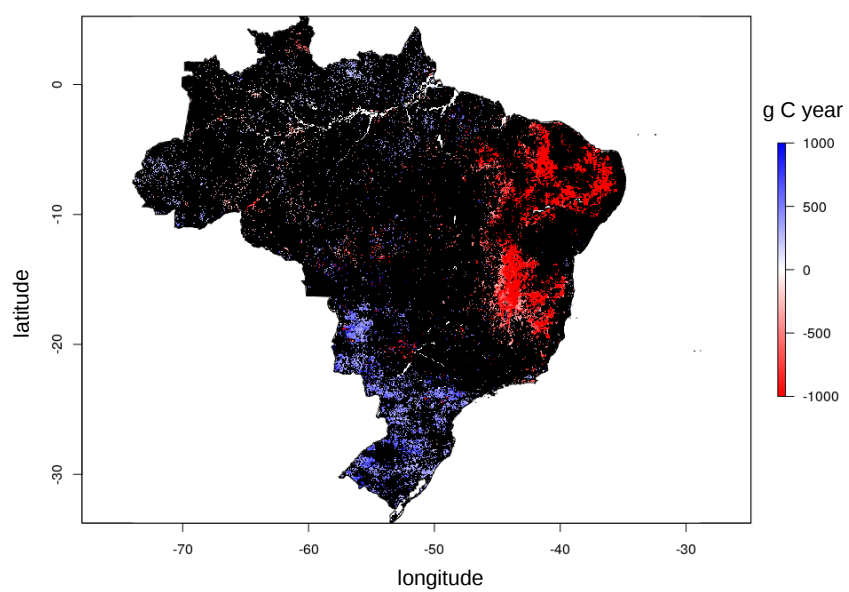


Fig. 1. OCO-2_GPP_BRazil_2009-2015

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