Modelling the drought sensitivity in the Amazon rainforest

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Background

- Tropical Rainforests are significantly important for global climate change through associated changes in carbon and hydrological cycle.
- Biogeochemical dynamic model, have been widely used to simulate the geographic pattern and time course of e.g. terrestrial carbon balance.
- However, there are still considerable disagreements between model simulations and observations especially in tropic region. For instance, most models fail to capture Amazon greening up during dry season (Saleska et al., 2016).
- Therefore, the mechanisms for Amazon greening up in dry period needs to be studied in order to improve model performance of vegetation dynamics in tropic region.

Hypothesis

- During dry season, trees are able to take water from deep soil or groundwater due to deep roots. Such processes are missing in most of current dynamic vegetation model.

Materials and methods

Dynamic global vegetation model

- LPJGUESS model (Smith et al., 2001), one of the most commonly used model of dynamic vegetation models, is used in this study (Fig. 1). Spatial resolution is 0.5 degrees.
- The current LPJGUESS model assumes that there are two soil layer with constant soil depth, i.e. 0.5 m for the upper layer and 1 m for the bottom layer.

Input Data for the model

- CRUNCEP data set: precipitation, temperature, radiation, carbon deposition.
- Soil depth data (Pelletier et al., 2016): average soil and sedimentary deposition thickness, spatial resolution of 30 arc seconds.
- Water table depth data (Fan et al., 2013): 30 arc seconds resolution.

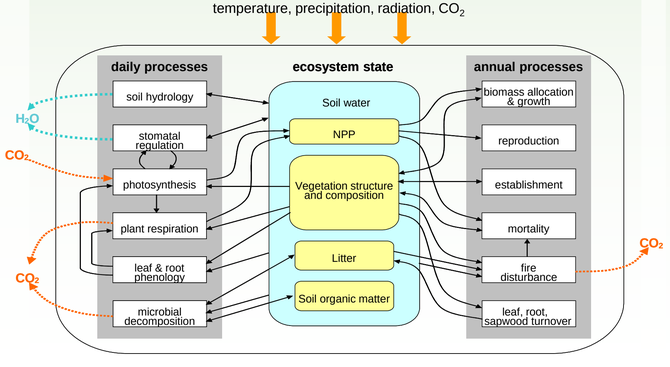

Figure 1. LPJGUESS model

Materials and methods

- **Dryness, water table depth, biome type and soil depth**

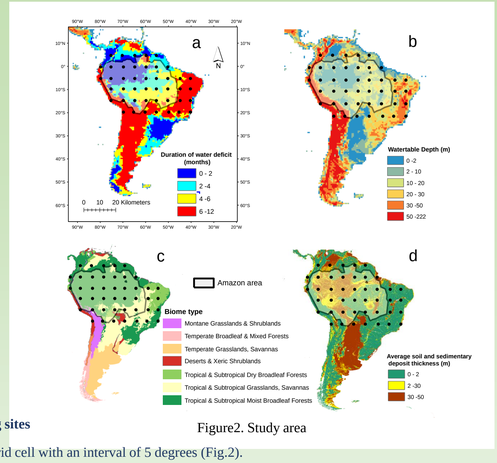

Figure2. Study area

Sampling sites

- 44 grid cell with an interval of 5 degrees (Fig.2).
- Croplands are excluded based on land cover data with spatial resolution of 5 arc minutes (Erb, K.-H, 2007).

Validation

- Gross Primary Production (GPP), one of ecological term to describe terrestrial carbon balance, is taken as an indicator for model evaluation.
- GPP data produced in MTE Jung et al. (2011) is considered as 'observations'.

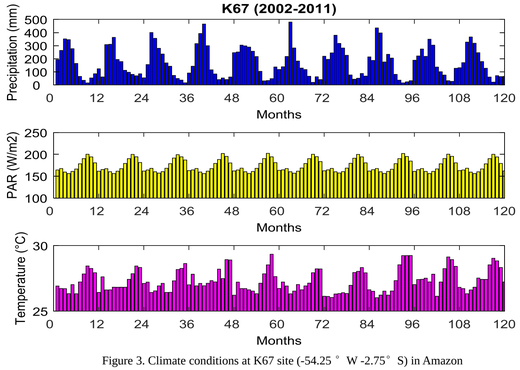

Figure 3. Climate conditions at K67 site (-54.25 ° W -2.75° S) in Amazon

Results

- **Results after increasing soil depth and including groundwater**

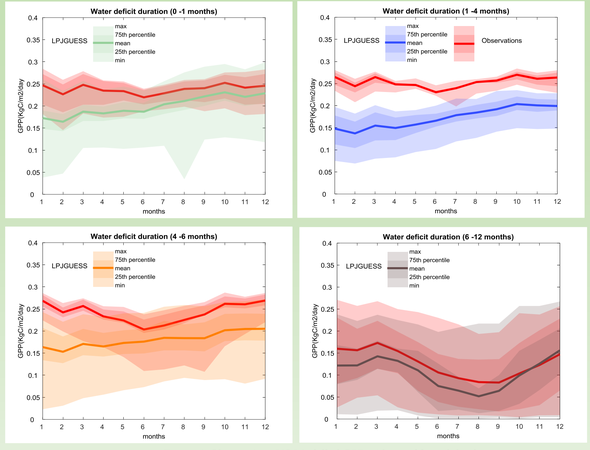

Figure 4 Observations VS Modelled GPP with variable soil depth and groundwater for sites with different duration of water deficit

- **Results from the old model**

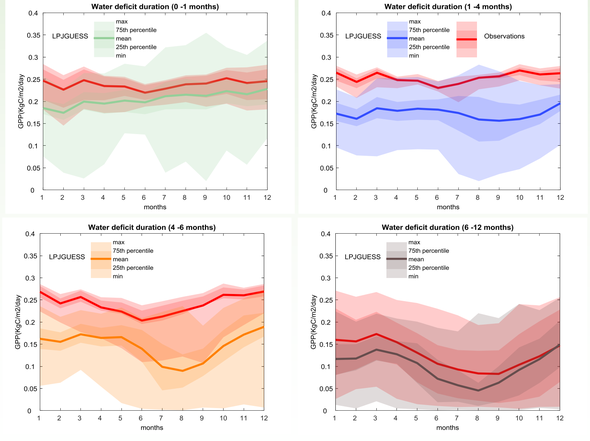

Figure5. Observations vs Modelled GPP from the old model for sites with different duration of water deficit

Results

- **Results after increasing soil depth**

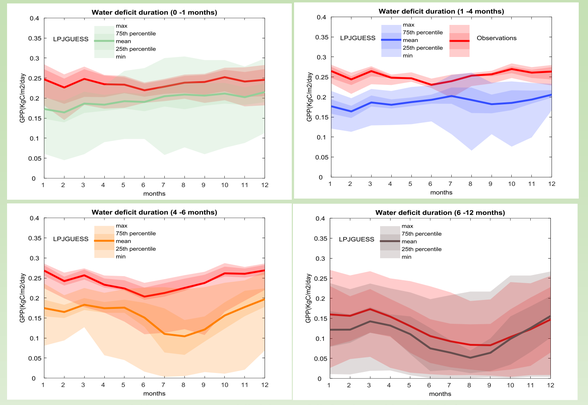

Figure.6 Observations vs Modelled GPP modelled with variable soil depth for sites with different duration of water deficit

Discussions and Conclusions

- Groundwater plays a more important role than deep soil regarding to tropical rainforests greening up in dry period, while previous studies found that by mainly increasing soil depth, GPP could maintain in the dry period for tropic rainforests (Baker et al., 2008; Poulter et al., 2009).
- It is found that trees have stronger demand of groundwater when water table is deeper. Groundwater could contribute to a large proportion of Amazon evapotranspiration (Fan, 2017).
- The seasonality of GPP is still not well captured compared to observations based on the fact that the trend of modelled GPP before dry season is an inverse of observations. Therefore, in order to enhance our understanding of the ecosystem response of tropical forests to climate, more mechanisms need to be investigated.

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