Project: **1067**

Project title: **Fire-vegetation-climate interactions**

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Report period: **2018-01-01 to 2018-12-31**

I investigated the influence of changes in human ignitions, ignitions in general and expansion of pasture area on the stability of the tropical rainforests. Due to the feedbacks between fire-vegetation and atmosphere the tropical rainforests are usually expected to loose their stability with strong increases in fire activity or strong decreases in forest cover. Fire activity thereby reduces the tree or forest cover and increases the grass cover, reduced forest cover leads to reduced transpiration and therefore can lead to reduced precipitation. Increases in grass cover increase the flammability and decreases in precipitation lead to drier conditions, both changes can therefore further increase fire activity. A strong feedback between fire and vegetation leading to a multi-stability of vegetation was already identified in a previous study (Lasslop et al. 2016). The presence of multiple stable states indicates the presence of tipping points and potential for rapid transitions in the system.

To investigate the resilience of the rain forests to changes in fire activity and pasture extent, I used an amip setup with prescribed present day sea surface temperatures and sea ice content. I then (1) increased the human ignitions using the spatial patterns based on population density of present day(2xIgnitions), (2) based on projected population density of 2100 (Future population), (3) set the pasture fractions to globally constant values (pasture 0.1 and pasture 0.5). Pasture is used here simply as a grassland that does not participate in the vegetation dynamics. Simulation length was 100 years.

Results reveal a strong resilience of tropical rainforests (Figure 1). No abrupt shifts were induced by changes in pasture or fire activity. Changes in forest extent only happen at the forest edges (Figure 2) with rather smooth transitions.

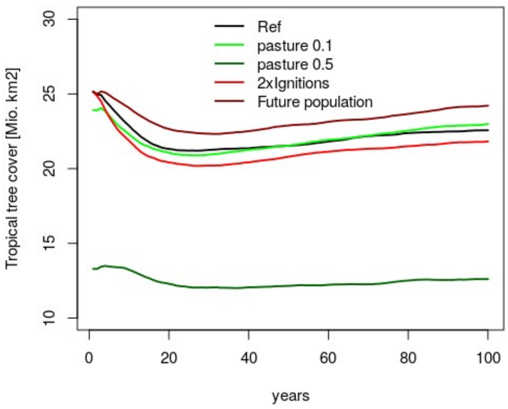

Figure 1: Time series of tropical tree cover (between -30° and 30° latitude) for all experiments.

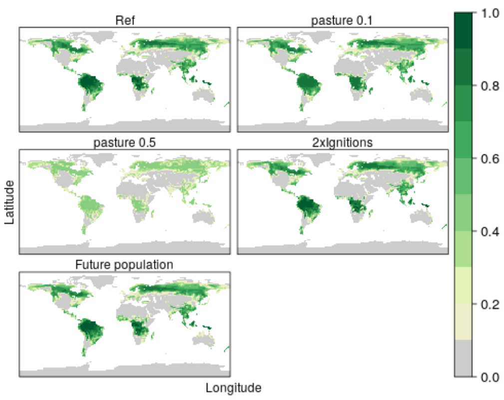

Figure 2: Spatial variation of tree cover (fraction of gridcell) of the final year of the simulations.

The simulation with high pasture fraction (pasture 0.5) has a marked lower tree cover, but the tree cover does not decrease further throughout the simulation. Increases in ignitions (2xIgnitions) slightly decreases the tree cover. Using the future population density increases tree cover, due to higher fire suppression. This is in agreement with the recently found decrease in global burned area due to humans (Andela et al 2017). No destabilisation of forest areas was found for any of the setups (Figure 2).

Remaining computing time will be used to test whether the resilience of the tropical forest is due to the ignition patterns, by using a spatially constant ignition number.

References

Andela N, Morton DC, Giglio L, et al including Lasslop, G (2017) A human-driven decline in global burned area. Science 356:1356–1362.

Lasslop G, Brovkin V, Reick CH, Bathiany S, Kloster S (2016) Multiple stable states of tree cover in a global land surface model due to a fire-vegetation feedback. Geophys Res Lett. doi: 10.1002/2016GL069365.