Geophysical Research Abstracts
Vol. 19, EGU2017-10335, 2017
EGU General Assembly 2017

Modelling future fire probability in the Brazilian Amazon under different land-use and climate change scenarios

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Climate and land-use change are expected to amplify fire incidence in the Amazon. Modelling the influence of land-use and climate change scenarios on fire occurrence is therefore important to better understand their impacts on the carbon emissions and ecosystems' degradation in the region. Here we use the Maximum Entropy method (MaxEnt) to estimate the impact of different climate and land-use change scenarios on the relative fire probability (RFP) during the 2071-2099 period in the Brazilian Amazon with a 0.25° spatial resolution. The model was calibrated using satellite-based fire detections during the 2006-2015 period (hereafter "baseline"). The land-use change variables were obtained considering alternative pathways of clear-cut deforestation, secondary vegetation and old growth forest degradation resulting from major socioeconomic, institutional and environmental dynamics in the region. The climatic variables were generated using a regional model (ETA) nested in an earth system global model (HadGEM2-ES). A land-use "sustainability" scenario considering that institutional and political conditions would favour the increase in forest regeneration and decrease of the old growth forest degradation and clear-cut deforestation rates was combined with the representative concentration pathway (RCP) 4.5 climatic scenario (hereafter SUST-4.5). To access the worst-case scenario of fire incidence, a "fragmentation" land-use scenario, representing the opposite tendency of the "sustainability" conditions, was combined with the climatic variables resulting from the RCP 8.5 (FRAG-8.5). The test AUC (area under de curve) metric (0.768 ± 0.018) indicated satisfactory model performance. In the FRAG-8.5 scenario 63% ($\sim$2.900.000 km2) of the study region shows from 0.35 to 0.55 of RFP, while in the baseline and under the SUST-4.5 scenario, 30% and 40% of the region is within this range of RFP, respectively. Conversely, in the baseline 29% of the area shows up to 0.1 RFP, but this proportion decreases to 26% and 9% under the SUST-4.5 and FRAG-8.5 scenarios, respectively. Fire regime is likely to play a key role in future Amazonian ecosystems degradation and further work is necessary to better understand its feedbacks with climate and land-use change.