Geophysical Research Abstracts
Vol. 21, EGU2019-17591, 2019
EGU General Assembly 2019

Trends of burnt area controls and impacts on tropical tree cover

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The decreasing trend in global burnt area, attributed to increased human impact in tropical savannas, has received a lot of recent attention. However, less attention has been directed at burnt area trends and it's drivers in fire deficient forested ecosystems where even small changes in fire could have a major impact on local biogeochemistry. We map the sensitivity of burnt area to relevant controls using a simple framework whereby limitations are imposed on fire by fuel continuity; fuel moisture; natural and human ignitions; and land use suppression. These controls are described from remotely sensed and meteorological observations and optimized against the Global Fire Emissions Database (GFED4s) burnt area observations. We use a Bayesian inference technique to optimize our framework which allows us to constrain and quantify the uncertainty of our fire controls. Fuel continuity and fuel moisture are shown to be the main controls over much of the world, decreasing burnt area by 60±2% and 41±10% respectively. This is followed by land use suppression at 29±13%, where cropland in particular is shown to affect burnt area beyond its own extent suggesting significant fragmentation effects. Ignitions only reduce burnt area by 21±19%. We use our framework to evaluate the drivers behind recent trends in burnt areas across all ecosystems. Areas with trends in more than one control, often with opposite effects on burnt area, were identified as key hotspots of fire regime change. Trends in controls have a much larger impact on burnt area outside of tropical savannas, with the biggest shifts found in tropical and boreal forest ecosystems driven by changes in climate conditions affecting fuel continuity and moisture content. We also compared the impact of fire on tree cover relative to other climate and human controls, and show that fire has a much smaller influence on tree cover in savanna ecosystem than normally assumed - reducing cover by only 1.71±0.44%. Forested areas however, are much more sensitive and therefore vulnerable to small increases in fire-induced stress. These studies have a number of implications for fire modelling. Land use has a larger impact on both fire and tree cover than fire enabled global vegetation models currently simulate. Whereas fire itself seems to have very little impact on tree cover in areas which already experience regular burning such as tropical savannas, but has the potential to impact cover under environmental change in more humid forests. This gives added impetus to understanding the impacts of fire regime trends on local ecosystem function and services in forested areas, as well as their feedback to the wider Earth System.