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Fire in CMIP5: sensitivity to global climate change

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Fire is the most important disturbance process for vegetation impacting the land carbon cycle globally. Only recently fire models have been developed that are able to represent the important role of fire for vegetation dynamics and land carbon cycling on that scale. Here, we investigate how fire is represented in Earth System Models (ESMs) that participated in the 5th Climate Model Intercomparison Project (CMIP5).

Burned area and carbon emissions from fire are among the variables reported in CMIP5. ESMs from CMIP5 use common simulation and output protocols, enabling direct comparisons between models. For this study ESMs were selected from the CMIP5 repository based on the availability of burned area and/or carbon emissions from fires for the historical and the *rcp2.6/4.5/8.5* simulations. Sensitivities to global climate changes are, in addition, analyzed using the CMIP5 idealized simulations with 1% increase in atmospheric CO_2 concentrations up to 4x CO_2 present day atmospheric concentration conditions. This simulation is accompanied by two simulations that allow for the separation of the overall climate change impact on fire occurrence in those caused through CO_2 affecting only the climate and those caused through CO_2 fertilisation alone.

All ESMs analyzed show an increase in fire carbon emissions with climate change for the 1% CO_2 simulation. Three out of 4 ESMs show a decrease in fire carbon emissions when climate is the only controlling factor. CO_2 fertilisation increases fire carbon emissions and even overrides the influence of climate leading to increasing fire emissions in the simulation where both climate and fertilization effects are accounted for. One model, however, shows a different behaviour. Here, fire carbon emissions increase as a response to changes in climate alone, whereas the CO_2 fertilisation leads to a slight decrease in fire carbon emissions. This model is the only model including nitrogen as a limiting nutrient in the analyzed ESMs simulation, which might explain the different behavior.