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Model intercomparison of idealized global deforestation experiments

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We present first results of idealized deforestation experiment designed within the Land Use Model Intercomparison Project (LUMIP). In order to obtain a robust signal-to-noise ratio and to harmonize deforestation implementation across participating ESMs, global forest extent is linearly decreased by 20 million km^2 for the 30% of most forested grid cells over a period of 50 years starting from pre-industrial climate conditions. This experimental setup is in favor of predominantly tropical deforestation patterns, however, there is also substantial boreal deforestation. In this experiment, atmospheric and oceanic physical processes respond to large-scale deforestation while other forcings such as atmospheric CO_2 concentration and aerosol load are kept constant at the pre-industrial level.

First analysis of results from ESMs participating in the LUMIP experiments reveal a general cooling trend in response to deforestation, although a spread in an amplitude of response is substantial. In boreal region there is significant cooling effect, presumably due to an increase in surface albedo, while tropical deforestation results in a regional warming in most of models. A sensitivity of temperature change per forest fraction change on a grid cell level, $\partial T/\partial F$, likely could be used as a generic response for any forest change scenario, although it is complicated by mixing together local and non-local effects. We also quantified so-called “zero effect latitude” at which forest cover change does not have pronounced biogeophysical effect. It is located in northern subtropics in most models.

Analyses of ensemble-members of three models (MPI-ESM1.2-LR, IPSL-CM6A-LR, and CESM2) indicate that the “time of emergence” of climate response, when signal becomes larger than a noise, is quite different among the models. However, when we compare the “deforested fraction of emergence”, the model responses become much more coherent. Biomass and soil carbon storages are decreasing with time, and their “time of emergence” is much shorter comparing to the temperature and precipitation. More results of biogeophysical and biogeochemical responses to deforestation will be presented.