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Influence of Amazonian deforestation on the future evolution of regional surface fluxes, circulation, surface temperature and precipitation

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The extent of the Amazon rainforest is projected to drastically decrease in future decades because of land-use changes. Previous climate modelling studies have found that the biogeophysical effects of future Amazonian deforestation will likely increase surface temperatures and reduce precipitation locally. However, the magnitude of these changes and the potential existence of tipping points in the underlying relationships is still highly uncertain. Using a Regional Climate Model at a resolution of about 50 km over the South American continent, we perform four ERA-interim-driven simulations with prescribed land cover maps corresponding to present-day vegetation, two deforestation scenarios for the 21^{st} century, and a totally-deforested Amazon case. In response to projected land cover changes for 2100, we find an annual mean surface temperature increase of 0.5°C over the Amazonian region and an annual mean decrease in rainfall of 0.17 mm/day compared to present-day conditions. These estimates reach 0.75°C and 0.22 mm/day in the total-deforestation case. However, the mean decrease in precipitation hides the fact that there also is a redistribution in rainfall amounts within the region, with central and western Amazon getting drier and eastern Amazon getting wetter. This results from regional variations in the changes of surface energy and water fluxes, which lead to a reorganisation of the regional-scale circulation.
We also compare our results to those from 28 previous modelling studies. We show that the historical development of climate models did not modify the median estimate of the Amazonian climate sensitivity to deforestation, but led to a reduction of its uncertainty. Our results suggest that the biogeophysical effects of deforestation alone are unlikely to lead to a tipping point in the evolution of the regional climate under present-day climate conditions. However, the conducted synthesis of the literature reveals that this behaviour may be model-dependent, and the greenhouse gas-induced climate forcing and biogeochemical feedbacks should also be taken into account to fully assess the future climate of this region.