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What is the role of historical and future anthropogenically-induced land-cover change on the surface climate of West Africa? Results from the LUCID and LUCID-CMIP5 intercomparison project

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West Africa has been highlighted as a hot spot of land surface–atmosphere interactions. A significant climate feature in this region is the West African monsoon (WAM), which variability dominants the climate variability. The role of historical anthropogenically induced land-cover change on the surface climate of West Africa is assessed using the outputs of the project Land-Use and Climate, IDentification of Robust Impacts (LUCID). Focusing the analysis on Sahel and Guinea, the results reveal that even though a common experimental design are used among the seven climate LUCID models, the areas of crops and pastures are specific for each Land Surface Model (LSM) due to different interpretations of land-use changes. In addition, the historical effects of land-use changes are not regionally significant among the seven climate models due to a small land-use change prescribed in these regions, the intercomparison analysis reveals a very contrasted responses between the models which transforms crops and pastures to desert fraction and others which deforest massively. Despite this various characterization within the seven LSMs, the results reveal that the change in surface albedo, leaf area index, and roughness surface is roughly proportional in Guinea to the amount of deforestation imposed on the individual models. The analysis highlights also the importance of having a realistic land-cover distribution to correctly represent the present-day surface climate in West African regions. The obtained results show that there is neither better nor worse performance among the climate models than others in these regions. Furthermore, there is no consistency among the various models regarding the response on both imposed land cover map to present day surface climate resulting in uncertainty in the representation of atmospheric processes. These climatic effects of land-use changes are relatively small compared to those resulting from the increased greenhouse gases. Therefore, for a number of variables, the analyses reveal an opposite sign in Sahel and a similar sign for the Guinea region in relation to the estimated responses of increasing greenhouse gas concentration.
On the other hand, the effects of land-use changes on climate are also assessed using specified-concentration simulations complementary to the representative concentration pathway 8.5 (RCP 8.5) scenarios performed for phase 5 of the Coupled Model Intercomparison Project (CMIP5). This analysis focuses on differences in climate and land–atmosphere fluxes between the ensemble averages of simulations with and without land-use changes by the end of the twenty-first century. Even though common land-use scenarios are used, the areas of crops and pastures are specific for each LSM due to different interpretations of LULCC. The analysis reveals that effects of land-use changes are globally not significant, whereas they are significant in West african regions with land-use changes exceeding 10%.