Project: **929**
Project title: **Land-Atmosphere interactions under different land-use scenarios in Indonesia**
Project lead: **Alexander Knohl**
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Summary of results of the current year

Nested regional climate simulations were performed with the non-hydrostatic regional climate Weather Research and Forecast (WRF 3.6) model coupled to the Community Land Model (CLM 4.0) and with the CLWRF extension providing the projected increase in the greenhouse gases CO_2, N_2O, CH_4, CFC11, and CFC12 concentrations according to the SRES A1B Emission Scenario (IPCC, 2000). The model setup comprises a one-way nesting strategy with three nesting levels of about 50x50km (d01), 10x10km (d02) and finally 2x2km (d03, d04) for the core sites. For modelling the future climate of Sumatra, we used the climate scenario A1B simulated with the coupled atmosphere–ocean Global Circulation Model ECHAM5/MPI-OM (run 1) as input for our model chain. A RCP 6 simulation is planned for of 2016. Using the supercomputer facilities at the German Climate Computing Center (DKRZ), we dynamically downscaled the results of the global model for the time periods 2026-30, 2051-2055, and 2076-80 and compared it to 2001-2005 as reference. The land use/cover change simulations use the same domain setup and are driven by ERA-Interim climate data (Dee et al. 2011) for the period 1995-2000.

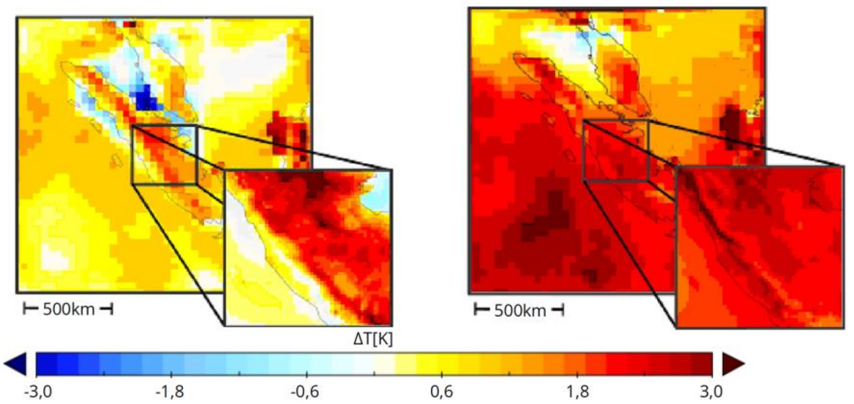

Fig. 1. Simulated change (future minus presence) in surface air temperature (2 m) over Sumatra (50x50 km resolution) and Jambi province (cut-out with 10x10 km resolution) for the period 2001 to 2055 (left) and 2001 to 2080 (right)

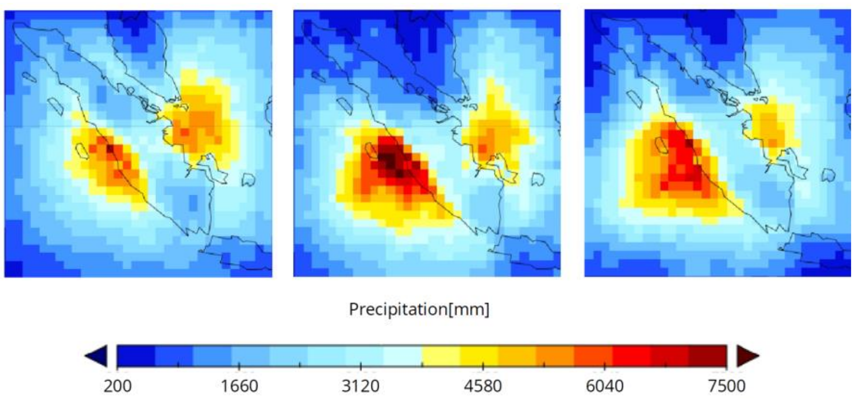

Fig 2. Simulated yearly precipitation sum over Sumatra (50x50 km resolution) for the periods 2001-2005, 2051-2055, and 2076-2080

The results from this modelling exercises show a significant increase of the air temperature at 2 m (Fig. 1) under anthropogenic climate change (Scenario A1B). Particularly, the high resolution climate projections (10 x 10 km resolution cut-outs in Fig. 1) indicate – due to the more appropriate terrain representation - a local air temperature increase up to 2.5 K for the period 2051 - 2055 and up to 4 K for the period 2076 - 2080 in comparison to the reference period 2001 - 2005. The simulated temperature increase in the 50 x 50 km resolution is slightly lower and comparable to results from WRF simulations for SE Asia with 80x80 km grid cell size (Chotamonsak et al. 2011). Contrary to Chotamonsak et al. (2011) we found no clear change in amount and pattern of precipitation over land for the periods 2051-2055 and 2076 to 2080 (Fig. 2).

The change of land use/cover directly affects the energy and water budget of the surface via changes in albedo, surface roughness and evapotranspiration (Bonan 2008). For a land-use change experiment, we used current climate (1995-2000) and converted agricultural areas and secondary forest in the model domain (2 x 2 km resolution covering the core plots in the Harapan landscape) to mature oil palm plantation following current trends in land-use change. Such land-use change resulted in only a very small temperature change of < 0.2 K in the mean and < 0.5 K in minimum and maximum temperature (data not shown). This is negligible compared to the climate change signal (1.5 to 4 K, Fig. 1). This is lower compared to a deforestation simulation in the Congo basis (Akkermans et al. 2014) where land use effects up to 0.7 K in the mean temperature where found. The small simulated effect in our study is probably due to the similar biophysical properties (e.g. albedo) of mature oil palm compared to forest. Simulated energy fluxes, however, show a stronger response to land use change with an increase of the Bowen ratio (sensible over latent heat fluxes) from 0.11 for rainforests to 0.17 for mature oil palm and 0.39 for young oil palm (annual mean diurnal values, data not shown) indicating a fundamental change in the energy supply to the atmosphere.