SPECIAL PROJECT FINAL REPORT

All the following mandatory information needs to be provided.

Project Title:	Modelling local and regional climate in Sumatra/Indonesia with WRFCLM taking into account tropical land-use transformations
Computer Project Account:	spdeknoh
Start Year - End Year :	1/2015 – 12/2015
Principal Investigator(s)	Alexander Knohl
Affiliation/Address:	Abteilung Bioklimatologie Georg-August Universität Göttingen Germany
Other Researchers (Name/Affiliation):	Andre Ringeler Abteilung Bioklimatologie Georg-August Universität Göttingen

The following should cover the entire project duration.

Summary of project objectives

(10 lines max)

This project aimed at implementing a regional climate and land surface modelling approach for studying the interactions between different land-use types and the atmosphere in Indonesia. We used the current version of the regional climate model WRF (V3.5) coupled to the Community Land Model CLM4 driven by ERA-Interim data to assess ongoing and past land-use changes in Sumatra/Indonesia. Climate projections (SRES A1B and RCP 6) modelled by a General Circulation Model were dynamically downscaled to Sumatra and then land-use change to atmosphere feedbacks were investigated considering future changing climate.

Summary of problems encountered

(If you encountered any problems of a more technical nature, please describe them here.)

End of 2014 we had an unexpected change of our project scientist making it necessary to request quickly new high performance computing resources. In order to fulfil the requirements for the final report for our project funded by the German Research Foundation in due time, we split the workload and requested resources at ECMWF and DKRZ (Germany) in parallel. DRKZ granted the resources first and we thus used the DRKZ resources for the project. The project ended in 12/2015.

Summary of results

(This section should comprise up to 10 pages and can be replaced by a short summary plus an existing scientific report on the project.)

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. 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.

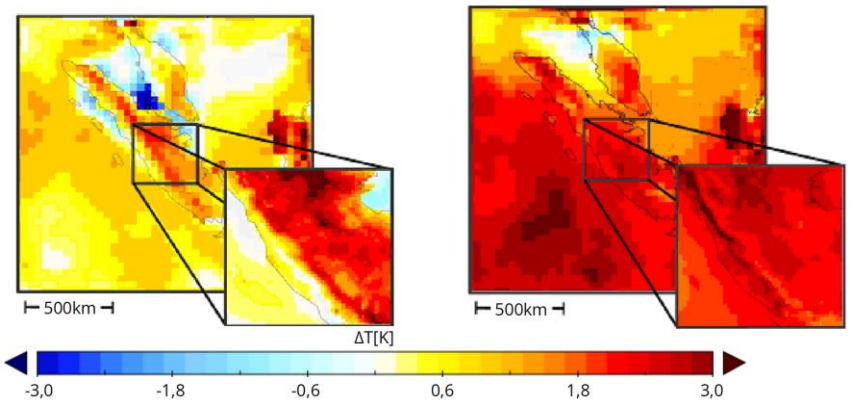

Fig. 1. Simulated change (future minus presence) in surface air temperature (2 m) over Sumatra (50x50 km resolution) and Jambi province (cut-out with 10x10 km resolution) for the period 2001 to 2055 (left) and 2001 to 2080 (right)

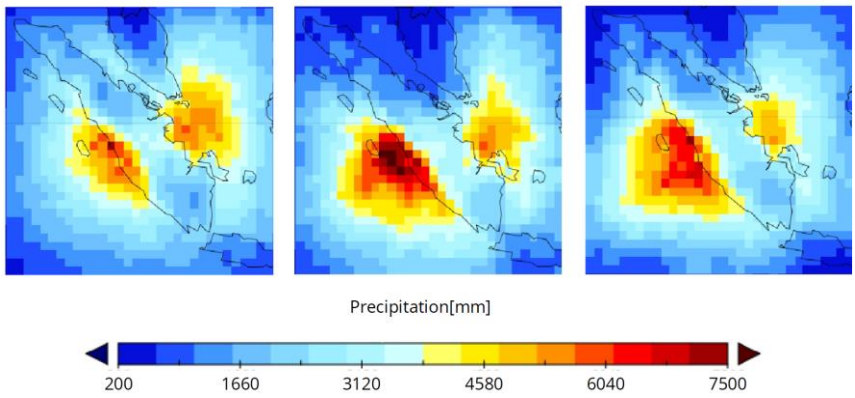

Fig 2. Simulated yearly precipitation sum over Sumatra (50x50 km resolution) for the periods 2001-2005, 2051-2055, and 2076-2080

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. 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 in an area north of PT Reki / Harapan) 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). The change in the mean temperature is small 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 changes in respect to the temperature maxima, however, indicates possible risks during El-Nino Southern Oscillation events. The small simulated effect in the mean temperature 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.

Akkermans T et al. (2014) The regional climate impact of a realistic future deforestation scenario in the Congo Basin J Clim 27:2714-2734. doi: 10.1175/jcli-d-13-00361.1
Chotamonsak C et al. (2011) Projected climate change over Southeast Asia simulated using a WRF regional climate model. Atmos Sci Lett 12:213-219. doi: 10.1002/asl.313
Dee DP et al. (2011) The ERA-Interim reanalysis: configuration and performance of the data assimilation system. Q J Roy Meteorol Soc 137:553-597. doi: 10.1002/qj.828

List of publications/reports from the project with complete references

none

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Future plans

The project ended in 12/2015. At the moment, no new activities are planned.