A03 – Influence of tropical land-use transformations on local and regional climate in Sumatra/Indonesia

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Project summary

Land transformation from natural to managed ecosystems such as oil palm plantations might result in changes of greenhouse gas fluxes (CO_2 and CH_4) and of local and regional climate due to land-atmosphere feedbacks after changed surface properties. In this project, we combine measurements and modeling approaches to study the exchange of greenhouse gases (GHG) and biophysical feedbacks between land and atmosphere.

Aims

- To estimate CO_2, CH_4 and energy fluxes in oil palm plantations in the Jambi province
- To assess changes of fluxes during the development of oil palm plantations – productive vs non-productive
- To establish relationships between GHG fluxes and environmental variables
- To downscale future climate for Jambi province
- To study the effects of increasing oil palm plantations on local and regional climate

Methods – experimental

- Eddy covariance measurements of CO_2, CH_4 and energy fluxes.
- Initially set in a non-productive oil palm plantation (2 years old) and moved to a productive plantation (12 years old).

2 years old (non-productive) plantation

12 years old (productive) plantation

Methods – modelling

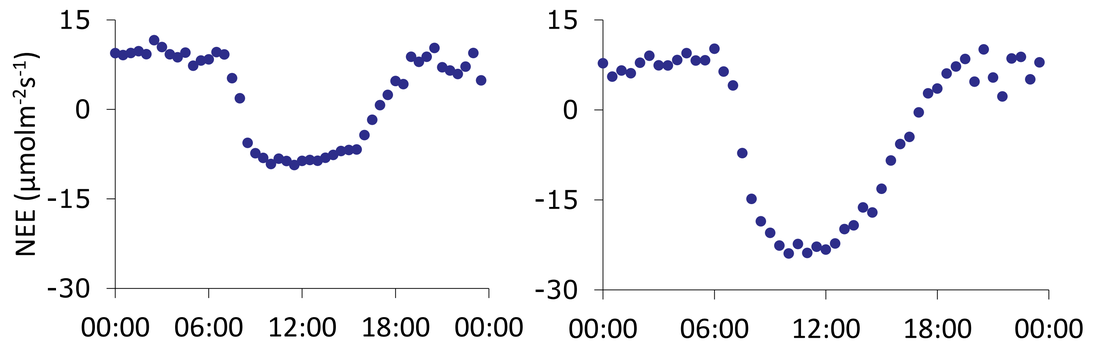
- Nested regional climate simulations are done with the non-hydrostatic regional climate Weather Research and Forecast (WRF 3.6) model coupled to the Community Land Model (CLM 4.0).
- The setup comprises an one-way nesting strategy with three nesting levels of about 50x50km, 10x10km and finally 2x2km for the field sites.
- The land use change simulations are driven by ERA-Interim climate data (1995-2000).
- Dynamic downscaling of future climate use the A1B run of ECHAM5/MPI-OM SRES as input.

Status

- Measurements in 2 year old plantation running for 7 months July 2013 – February 2014
- EC tower in 12 year old plantation running since March 2014
- Modeling future climate for the time slices 2026-30, 2051-2055, and 2076-80 with 2001-2005 as reference.
- Modeling present climate at field sites for current land use and for land use conversions oil palm to agriculture and agriculture to oil palm.

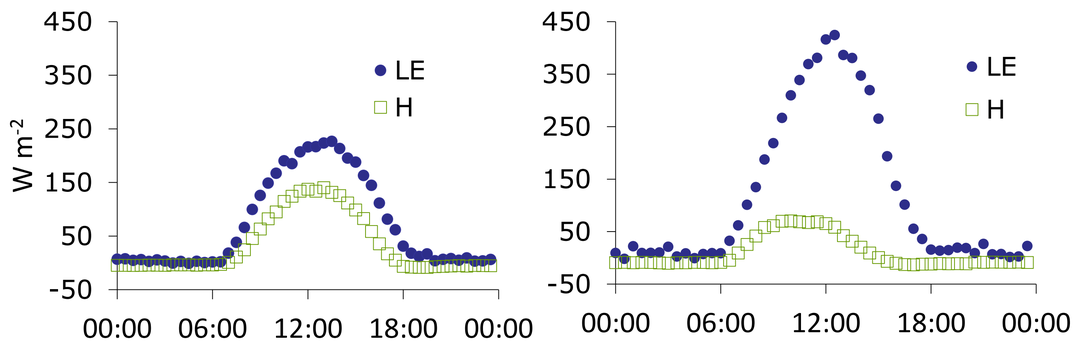
Preliminary results

Larger CO_2 uptake in productive oil palm plantation.



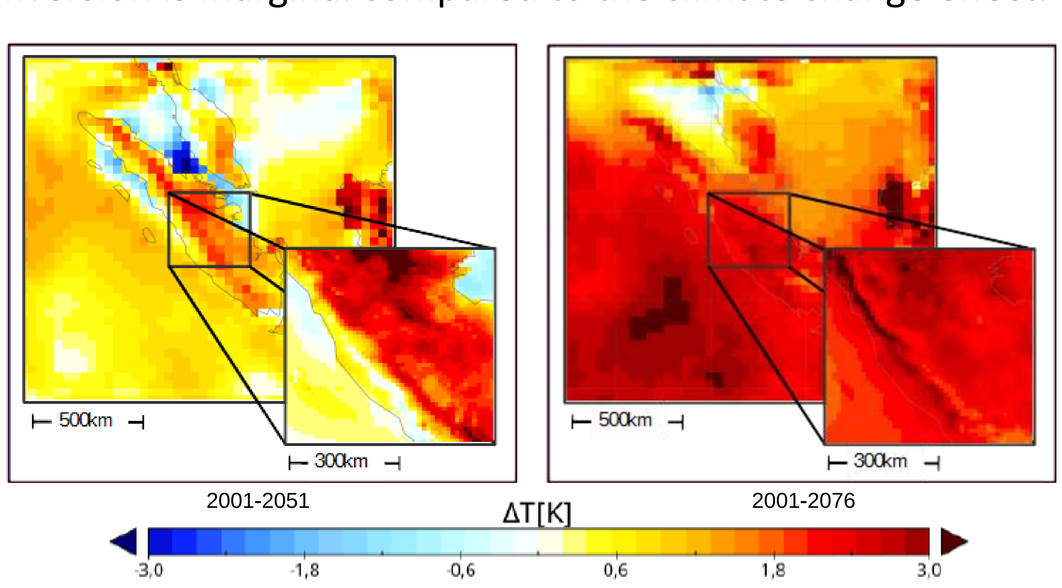
Diurnal cycle of Net Ecosystem Exchange (NEE) in 2 years old (left) and 12 years old (right) plantations.

Different ratios of latent and sensible heat fluxes at different stages of oil palm development. Larger amount of energy used for evapotranspiration in productive oil palm plantation.



Diurnal cycle of Latent (LE) and Sensible (H) heat fluxes in 2 years old (left) and 12 years old (right) plantations.

Under anthropogenic climate change (Scenario A1B), the air temperature (2 m) of Sumatra will rise up to 2.5K for the year 2051 and up to 3K for the year 2076. The effect of land use conversion is marginal compared to the climate change effect.



Change of the annual mean temperature from year 2001 to 2051 (left) and 2001 to 2076 (left)