LATE REQUEST FOR A SPECIAL PROJECT 2014–2016

MEMBER STATE: Germany……

Principal Investigator[1]: Dr. Merja Tölle……

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Other researchers: ……

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Project Title: Influence of tropical land-use transformations on local and regional climate in Sumatra

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Would you accept support for 1 year only, if necessary?	YES ☒	NO ☐

Computer resources required for 2014-2016: (The project duration is limited to a maximum of 3 years, agreed at the beginning of the project. For late requests the project will start in the current year.)		**2014**	**2015**	**2016**
High Performance Computing Facility	(units)	250000	125000	125000
Data storage capacity (total archive volume)	(gigabytes)	30000	60000	90000

*An electronic copy of this form **must be sent** via e-mail to:* *special_projects@ecmwf.int*

Electronic copy of the form sent on (please specify date): 23-10-2013

Continue overleaf

[1] The Principal Investigator will act as contact person for this Special Project and, in particular, will be asked to register the project, provide an annual progress report of the project's activities, etc.

Principal Investigator: Dr. Merja Tölle

Project Title: Influence of tropical land-use transformations on local and regional climate in Sumatra

Extended abstract

Land transformation from natural to managed ecosystems such as oil palm and rubber 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. The sink/source strength for greenhouse gases at ecosystem scale after such transformations is yet unknown. In addition, land-atmosphere feedbacks are non-linear and additionally complicated by climate change. To gain knowledge of the ecological impacts of transformation of rainforest into agricultural systems in Indonesia this project will combine measurements and modeling approaches to upscale the fluxes of carbon, nitrogen, biotic and abiotic drivers to landscape level and study their interactions between land and atmosphere. Simulations with the latest evaluated version of the regional climate model (COSMO-CLM coupled to the Community Land Model; CCLM-CLM) will be conducted with ERA-Interim data from ECMWF for model configuration and evaluation. Climate projections (A1B) modeled by General Circulation Model (from MPI or ECMWF) will be dynamically downscaled to regional and local scales by means of CCLM-CLM. The uncertainties of projections will be evaluated. The models´ outputs will be tested for biases. The land surface model coupled with the regional climate model will be parameterized with the help of our water, energy and greenhouse gas measurements and remote sensing. The effects of spatial and temporal variability on ecological functions will be quantified. With this we will improve the sustainability of land use in lowland tropical regions. This project will also contribute to CORDEX SE-Asia.

Planned work for the requested period

The main goal of the proposed project is to investigate the atmospheric effects of land use changes in transformation systems in tropical lowlands in Sumatra. The following processes need to be addressed to achieve the main goal: to assess the impact of land transformations (tropical lowland rainforest to rubber plantation and oil palm plantation) on feedbacks to regional climate via surface albedo, surface roughness and water exchange. Understanding these processes and feedbacks will provide insights how land transformations contribute to changes in regional radiative forcing and thus provide constrains for developing sustainable land use strategies to balance ecological and economic needs. Therefore, the following tasks are required:

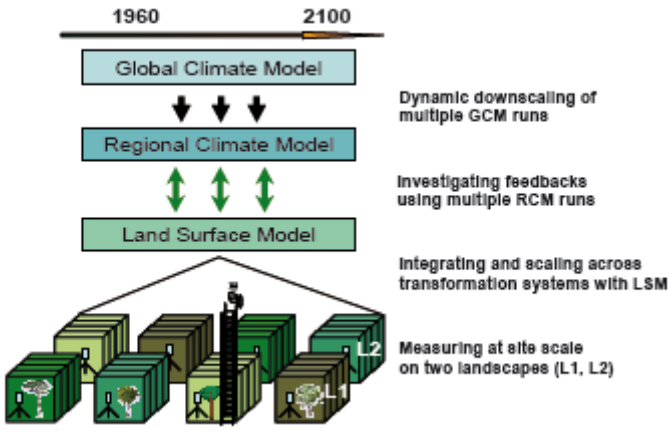

Fig. 1: Conceptual modelling and measurement framework.

Assessment of feedbacks of changing land-use on regional climate forcing Hypotheses:
H1: Local land transformation impacts both local and regional climate.
H2: Land transformation leads to non-linear responses in land-atmosphere feedbacks.

Task 1 Downscaling of climate scenario
Simulations with the latest evaluated version of the regional climate model (COSMO-CLM v4.8_19 coupled to the Community Land Model; CCLM-CLM) will be conducted with ERA-Interim data from ECMWF for model configuration and evaluation. A regional climate modeling framework will be developed for Jambi region and Western Indonesia. The regional climate model (COSMO-CLM coupled to the Community Land

Model; CCLM-CLM) will be used to dynamically scale down the runs of a General Circulation Model (GCM) based on emission scenario and a reference scenario (20th century scenario, C20) to regional level taking into account regional and local features (Fig. 1). It is planned to use at least one SRES scenario (A1B), however if the new scenarios for the IPCC AR5 will be made available at the beginning of the project the new ones will be used. To decrease model bias and assess uncertainties it is planned to use several runs (mini-ensemble) of at least one coupled GCM (from MPI or ECMWF) with spatial resolution of app 2°×2°. Additionally, available data of the Coupled Model Intercomparison Project (CMIP5) will be surveyed in order to choose an alternative fully coupled GCM with biogeochemistry feedbacks. It is advisable to implement as many GCM-RCM combinations as possible. However taking into account realistically the short project duration and considerable time required to collect actual input data for Land Surface Model it will be seen how many combinations will be possible to address. As spatial resolutions of CCLM are still too coarse for the task of the project it is planned to perform a one-way double nesting to scale down to 1-2 km resolution for Sumatra. Model runs will be carried out for the period 1960-2100. The period of 1970-2000 will be taken as reference or "present conditions". The results for "present" as well as "coupled present C20/A1B" – 1980-2010 will be analyzed and compared with available long term meteorological measurements (from Indonesian Weather Service and global gridded data sets). In case a model bias (difference modeled "present" vs. observed "present") will be recorded for some meteorological variables, the bias will be corrected statistically.

Expected outputs
• Downscaled climate scenario A1B (including C20) for the period 1960-2100 – several runs
• Bias-corrected modeled meteorological variables where necessary

Task 2 Incorporating vegetation feedback into regional model
The Community Land Model in CCLM will be adapted regionally. Land surface properties of the transformation systems (albedo, roughness, leaf area index (LAI), soil profiles, etc) will be parameterized based on pre-existing data from: (a) own new measurements over oil palm plantation, (b) STORMA dataset (including our climate tower at Bariri), (c) other FLUXNET flux towers in SE Asia, and (d) remote sensing data from MODIS (e.g. albedo, LAI, biomass) and land cover map and regionalization products. The model will use data on current land-use as the initial input. The measured responses of the transformation systems (oil palm) at local level to the variability of "present" climate, published data and analysis of remote sensing information will be used to parameterize the Community Land Model (CLM). The coupled CCLM-CLM model will be run for "present conditions" (1970-2000) with present land use within the period thus taking into account the responses of vegetation types. The results will be compared to the original RCM calculations for C20 to evaluate the types and magnitudes of climatic influence on ecosystems and their feedbacks to climate forcing as well as land use change effects on regional climate.

Expected outputs
• New sub-grid parameterizations of different land use types in regional climate model
• Feedbacks of lowland rainforest, jungle rubber, rubber plantations and oil palm plantation ecosystems to changing climatic forcing

Required computing time and amount of storage space

The CCLM coupled to CLM will require in the first year more SBU units as additional test simulations for performance and evaluation will be carried out. We require 250000 SBU for the first year 2014, 125000 SBU for the second year 2015 and 125000 SBU for the third year 2016.

Table 1: Experiments with CCLM-CLM:

Experiments	Description	Years of simulation
CCLM-CLM	Present climate	40 years with ERA-Interim or ERA40
CCLM-CLM	Present climate	A1B 40 years
CCLM-CLM	Future climate	C20 40 Jahre

Storage:
We store daily values of high resolution simulations and request for three years: 90000 GB, that is 30000 GB per year.

We will adjust the above values as soon as first simulations will be carried out at ECMWF.

Publications on land use changes and high resolution climate models

Tölle, M. H. 2013: *Less future warming and precipitation with fine scale resolution regional climate models*. (Submitted)

Tölle, M. H., O. Gutjahr, J. Thiele, G. Busch 2013: *Increasing bioenergy production on arable land - does the regional and local climate respond? Germany as a case study.* (In Review)

Tölle, M. H., C. Moseley, O. Panferov, G. Busch, A. Knohl, 2013: *Water supply patterns in Germany under climate change conditions*, Biogeosciences, 10: 2959-2972, DOI:10.5194/bg-10-2959-2013

Tölle, M. H., O. Gutjahr, J. C. Thiele, G. Busch: *How will the local and regional climate respond to bioenergy motivated agricultural transformations? Germany as a realistic case study*. Poster, Gordon Research Conference on Radiation and Climate 2013, New England, USA, 8-12 April, 2013

Tölle, M.H., O. Panferov: *Impact of poplar plantations on the regional climate in Central Germany*. Talk, *9.* Deutsche Klimatagung, Albert-Ludwigs-Universität Freiburg, 9.-12. Oktober *2012*