

## **CORDEX Flagship Pilot Study "LUCAS - Land Use & Climate Across Scales" - Impact of land use changes on climate in Europe across spatial and temporal scales**

### Overview

The CORDEX flagship pilot study LUCAS (Land Use & Climate Across Scales) was initiated jointly by EURO-CORDEX and LUCID (Land-Use and Climate, IDentification of robust impacts). Land use changes are an important human forcing on climate, especially in relation to forcing by the low emission scenarios. The direct effects of land use changes on local to regional climate can exceed those associated with global mean warming. Up to now, this important human climate forcing is not sufficiently represented in regional climate model (RCM) climate change projections. In LUCAS, we want to include this important human regional climate forcing into RCMs and understand its direct impacts on the climate in Europe.

The overall objective of LUCAS is to identify robust biophysical impacts of land use changes on climate across regional to local spatial scales and at various time scales from extreme events to multiple decades. In this context, land use changes (LUC) refer to anthropogenic land cover conversions as well as land management practises. We identified major science questions to be addressed:

- How sensitive are the regional climate models to LUC and how is this interrelated to land-atmosphere coupling in different regions among the suite of models?
- How large is the relative contribution of LUC to detected past and potential future climate trends ?
- How do land use practices modulate climate variability? Can local LUC reduce or amplify extreme climate conditions?
- What is the effect of spatial resolution on the magnitude and robustness of LUC-induced climate changes?

We initiate a new era of coordinated regional climate model (RCM) ensemble LUC experiments on high spatial resolutions based on consistent land use dynamics for the past and the future. We include a new generation of RCMs which couple regional atmosphere interactively with further components of the regional earth system, e.g. terrestrial biosphere and hydrosphere. Land use pathways will be chosen in cooperation with land use modelling experts. The multi-model experiments will be conducted over multiple gridded nests from continental simulations down to resolutions below 5 km. Simulated variables and fine-scale processes will be evaluated against multi-variable observations from flux towers, satellite sensors and new airborne and spaceborn radar techniques, new diagnostics for investigating the effects of LUC on climate will be developed.

The LUCAS project is designed in three phases with idealized experiments on continental scale in phase 1, "realistic" experiments on continental scale in phase 2, and high resolution

experiments in spatially refined pilot regions in phase 3. The LUCAS Kick-off meeting was held in Hamburg, at the Climate Service Center, back to back with the EURO-CORDEX General Assembly 2017. During the Kick-off meeting, the experiment protocol for LUCAS phase 1 was discussed and major decisions on the experiment plan, the choice of land forcing and how to implement it consistently into RCMs were done. We start with idealized experiments for the European continent in order to investigate and inter-compare model sensitivities to extreme land use change forcing. In the FOREST experiment, we maximize the forest fraction in those model grid cells where trees can realistically grow. In the GRASS experiment, we turn trees into grassland with the ratio of C3 and C4 grasses based on present day distribution. In LUCAS phase 2, evaluation simulations driven by re-analyses data and reconstructed historical land use changes are planned, as well as future climate projections based on RCPs and potential future land use pathways including both land cover and land management changes. The high resolution experiments in phase 3 shall be conducted over multiple gridded nests to refine the continental simulations down to resolutions below 5 km, in order to investigate feedbacks of local scale land use dynamics on climate. For this experiment one identical pilot region with Med-CORDEX/EURO-CORDEX FPS on Convective Phenomena is planned.

We would like to invite the research community, also beyond EURO-CORDEX, to engage in this new initiative. We want to better connect expertise of global and regional modelling activities related to land use and climate dynamics and develop a better link to land use policies and socio-economic land use modelling with local perspectives. We are interested in CORDEX cross-domain collaborations towards coordinated LUC experiments over multiple world regions.

20 European institutions are currently involved in LUCAS. It is coordinated jointly by Diana Rechid from Climate Service Center Germany (GERICS) at Helmholtz Zentrum Geesthacht; Nathalie de Noblet-Ducoudré from Laboratoire des Sciences du Climat et de l'Environnement, Institute Pierre Simon Laplace, France; Edouard Davin from Eidgenössische Technische Hochschule Zurich, Switzerland; and Eleni Katragkou from Department of Meteorology and Climatology, School of Geology, Aristotle University of Thessaloniki, Greece. If you are interested in this initiative, please contact [diana.rechid@hzg.de](mailto:diana.rechid@hzg.de)