SPECIAL PROJECT PROGRESS REPORT

All the following mandatory information needs to be provided. The length should *reflect the complexity and duration* of the project.

Reporting year	2018/2019…………………………………………….……
Project Title:	Coupling and feedbacks between soil moisture and two monsoon systems for present and future climates…………………………………………….……
Computer Project Account:	spesemay…………………………………………….……
Principal Investigator(s):	Wilhelm May…………………………………………….…… …………………………………………….……
Affiliation:	Centre of Environmental and Climate Research, Lund University…………………………………………….……
Name of ECMWF scientist(s) collaborating to the project (if applicable)	…………………………………………….…… …………………………………………….……
Start date of the project:	1.1.2017…………………………………………….……
Expected end date:	31.12.2019…………………………………………….……

Computer resources allocated/used for the current year and the previous one

(if applicable)

Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	12,000,000	700,000	12,000,000	2,000,000
Data storage capacity	(Gbytes)	30,000	4,000	45,000	8,000

Summary of project objectives (10 lines max)

The overall objective of the project is to investigate the role of soil moisture for the variability of two of the most dominant monsoon systems, i.e. the West African Monsoon and the Indian Summer Monsoon, for present-day and future climate conditions. In particular, the project will investigate the physical processes governing the coupling and feedbacks between soil moisture and the two monsoons and assess the contributions of the future changes in soil moisture to the overall future changes in the variability and the mean state of these monsoons in response to the projected increases in the anthropogenic climate forcing.

Summary of problems encountered (10 lines max)

The release of the new version (v3.3) of the EC-Earth earth system model to be used for the CMIP6 experiments has been further delayed. Therefore, I have only performed a number of short test runs and several 10-year experiments with a preliminary model version instead of the long experiments that I had planned, and tested different set-ups for the prescription of the state of the land surface, i.e. included a special treatment of frozen soils. Furthermore, I have been waiting for the new version of the H-TESSEL/LPJ-GUESS offline land model consistent with the earth system model used for CMIP6.

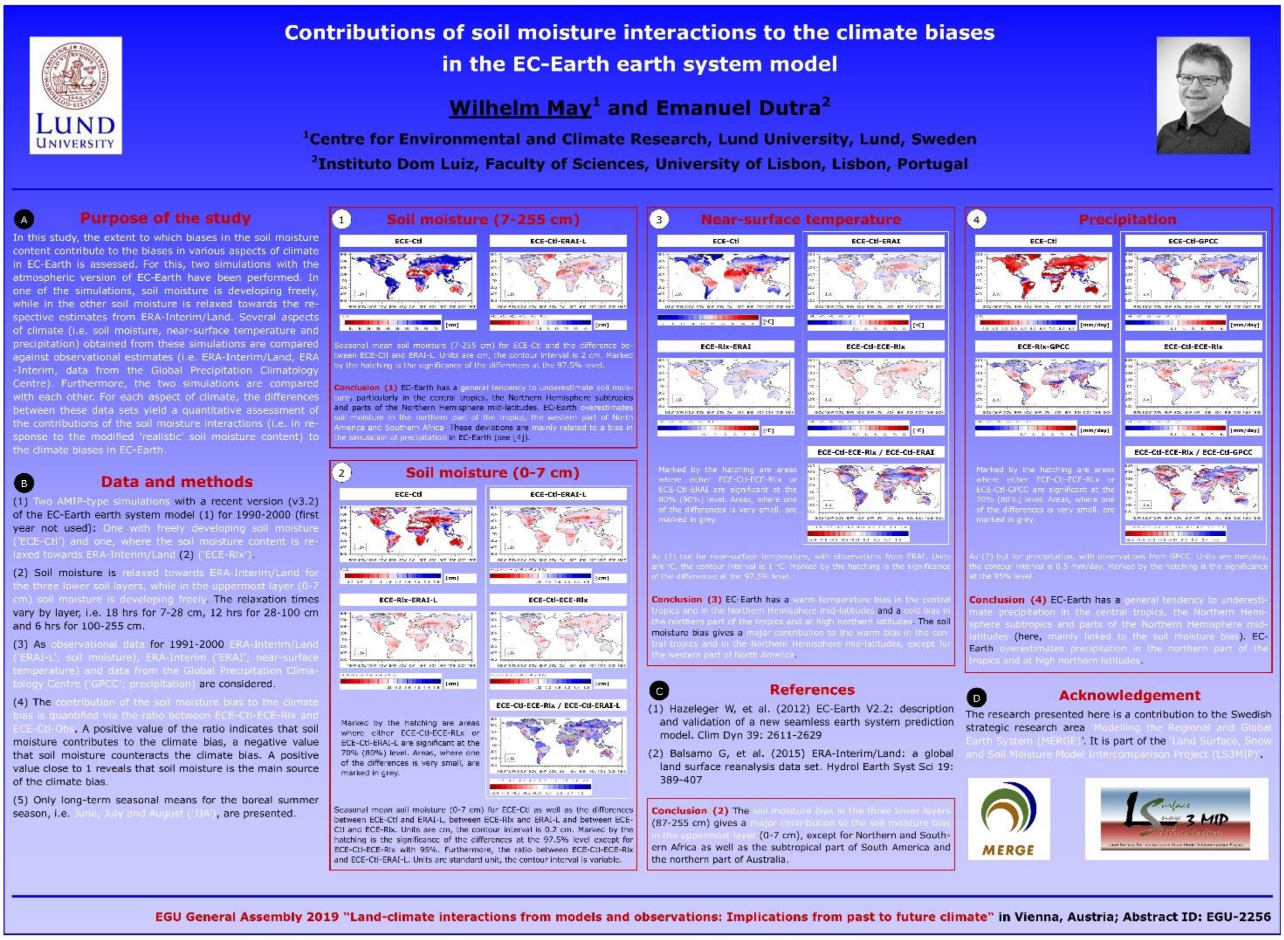
Summary of plans for the continuation of the project (10 lines max)

Since the version (v.3.3.1) of the EC-Earth earth system model for the CMIP6 simulations and the corresponding version of the H-TESSEL/LPJ-GUESS now have become available, I will continue with the investigation of the role of soil moisture for the climate biases in EC-Earth. For this, I will run H-TESSEL/LPJ-GUESS forced with the meteorological data from ERA5 to provide a realistic representation of the observed state of the land surface. The soil moisture data from this simulation will then be prescribed to the atmospheric version of EC-Earth. In parallel, I will perform a corresponding simulation without restricting the simulated soil moisture. It is also planned to test the specific role of the dynamical vegetation simulated by LPJ-GUESS, interactively coupled to EC-Earth.

List of publications/reports from the project with complete references

I gave an oral presentation entitled “Contributions of soil moisture interactions to the climate biases in the EC-Earth earth system model” at the LandMIP meeting in Toulouse, France, where the status of the three land-related intercomparison projects LS3MIP, LUMIP and C4MIP was discussed.

I also presented a poster entitled “Contributions of soil moisture interactions to the climate biases in the EC-Earth earth system model” at the EGU General Assembly in Vienna, Austria.



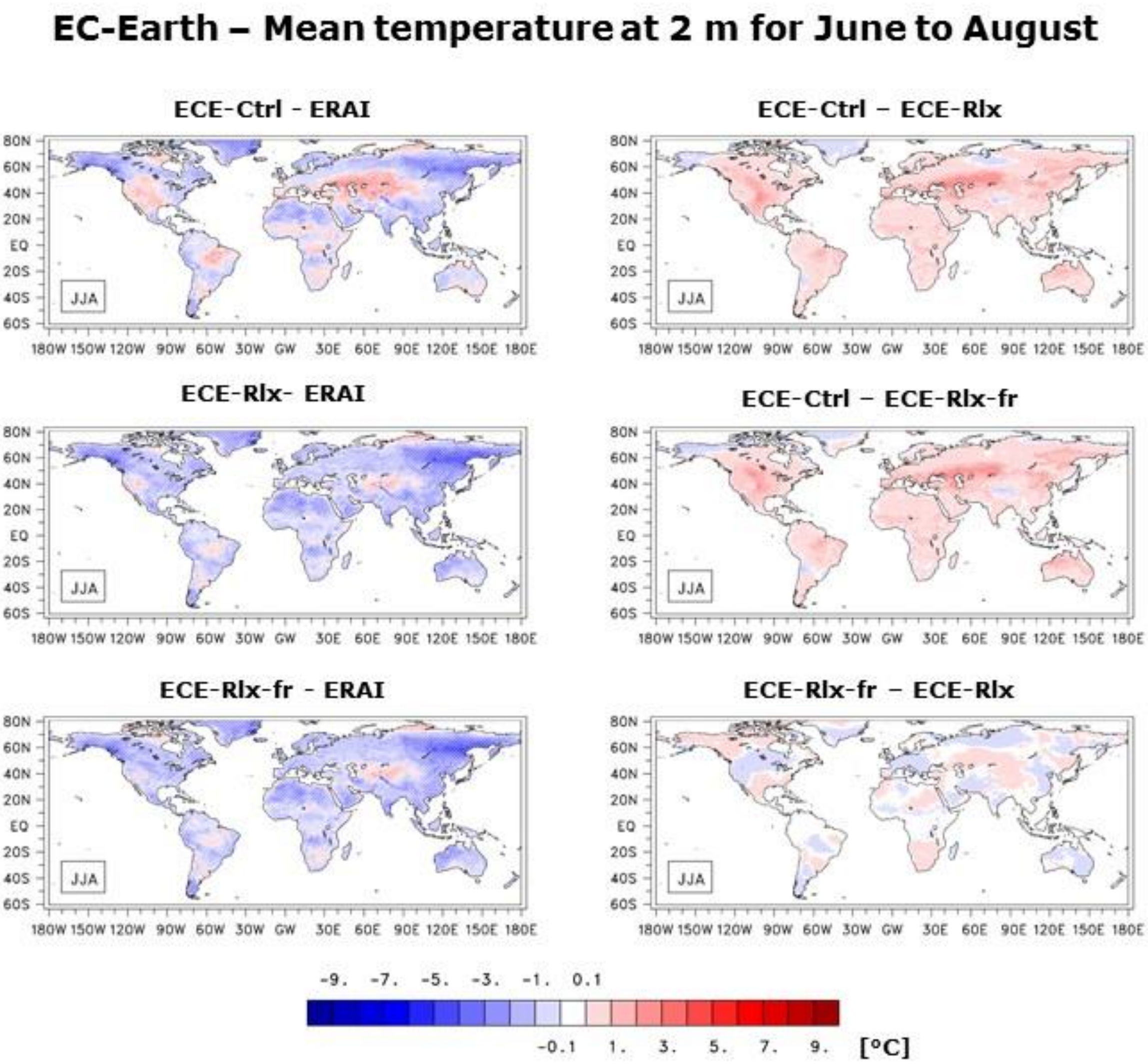
Furthermore, I presented the work in the project at working group meetings in the EC-Earth consortium.

Summary of results

During the last year, the code of the EC-Earth earth system model has been installed on cca has been updated to version 3.3, and I have implemented and tested a relaxation routine for the soil moisture content in the climate model. I have extended the relaxation routine so that it considers the special case of frozen soils, where the relaxation of soil moisture is suppressed. Buy this, artificial melting in order to gain additional soil water and, thus, an artificial disturbance of the energy fluxes in the land surface. Also, the code of the H-TESSEL/LPJ-GUESS offline land model has been installed on cca.

I have, among others, performed several 10-year experiments (1990-2000) with the updated version of EC-Earth, a standard simulation (“ECE-Ctl”) and two simulations, where the soil moisture content was relaxed against the climatology from ERA-Interim/Land, which here was considered as a realistic representation of the observed state of the land surface. In one of the simulations with the relaxed soil moisture the special case of frozen soils was considered (“ECE-Rlx-fr”), in the other simulation it was not (“ECE-Rlx”). In the case of frozen soils, soil moisture is not updated in order to avoid freezing (if soil moisture is added) and melting (if soil moisture is removed) and, thus, disturbing the energy balance in the soil.

The standard simulation ECE-Ctrl shows both negative and positive biases against ERA-Interim (ERAI) in the seasonal mean temperature (upper left panel). Positive differences, corresponding to too warm temperatures simulated by EC-Earth, are found in the western part of North America and Amazonia, in Central Asia as well as in Western and Southern Africa. When relaxing against the soil moisture from ERA-Interim/Land, the geographical distribution of the temperature bias changes so that the extent of the regions with too warm temperatures in EC-Earth is typically reduced and the negative differences, corresponding to too cold temperatures simulated by EC-Earth, are somewhat stronger than for ECE-Ctrl. This is the case for with (lower left panel) and without (middle left panel) the special treatment of frozen soils. In fact, the differences between the two simulations (lower right panel) do not show any strong systematic differences, indicating that the effect of treating frozen soils specially, in this season mainly in the permafrost regions of the high northern latitudes, is limited in EC-Earth. The generally positive differences between ECE-Ctrl and the two other simulations (upper and middle right panels), illustrating warmer temperatures in the standard simulation are consistent with an overall tendency of lower soil moisture over most of the global land areas in ECE-Ctrl. The lower soil moisture content affects the turbulent energy fluxes at the land surface with increased fluxes of sensible heat and reduced fluxes of latent heat. The increased fluxes of sensible heat, in turn, lead to warmer near-surface temperatures. As a consequence, prescribing realistic soil moisture conditions generally reduces the temperature bias in EC-Earth in the regions, where the standard model is too warm, and increases the temperature bias where the standard model is too cold.


EC-Earth – Mean temperature at 2 m for June to August
ECE-Ctrl - ERAI
ECE-Ctrl – ECE-Rlx
ECE-Rlx- ERAI
ECE-Ctrl – ECE-Rlx-fr
ECE-Rlx-fr - ERAI
ECE-Rlx-fr – ECE-Rlx
JJA
80N 60N 40N 20N EQ 20S 40S 60S
180W 150W 120W 90W 60W 30W GW 30E 60E 90E 120E 150E 180E
-9. -7. -5. -3. -1. 0.1
-0.1 1. 3. 5. 7. 9.
[°C]