CRESCENDO Project Summary for 2017

WP1 Development and implementation of dynamical wetland scheme in MPI-ESM

During the last year, the wetland extent dynamics (WEED) scheme experienced a number of revision and sensitivity experiments. The model sensitivity with regard to evapotranspiration and surface runoff was found to differ strongly between the land component of the MPI-ESM (JSBACH) and the MPI Hydrology Model (MPI-HM), where the scheme was originally developed. Thus, a major part of the routines had to be adapted not only to the different infrastructure, but also to be physically consistent with the soil hydrology in JSBACH. This work was followed by an extensive optimization study. Unfortunately, the optimization was rendered invalid due to several bugs in the JSBACH-offline version, especially with regard on how the daily atmospheric forcing was processed. A number of simulations were conducted to tackle these bugs, and in cooperation with other members of the MPI-M land department, these bugs could be fixed. While the bugs were not related to the WEED scheme, they strongly affected its results. For this reason, the parameter optimization is currently repeated. With the bug fixes in the atmospheric forcing processing combined with the changes in the WEED physics, the scheme responds to changes in wetland fraction in the expected ways, such that a larger wetland fraction reduces surface runoff and increases evapotranspiration, thereby mitigating and reducing peak flow river discharge. Figure 1 shows preliminary results from one of the sensitivity simulations. Note that in WEED the term wetlands describes areas with ponding water at the surface and, hence, comprises both wetlands and lakes.

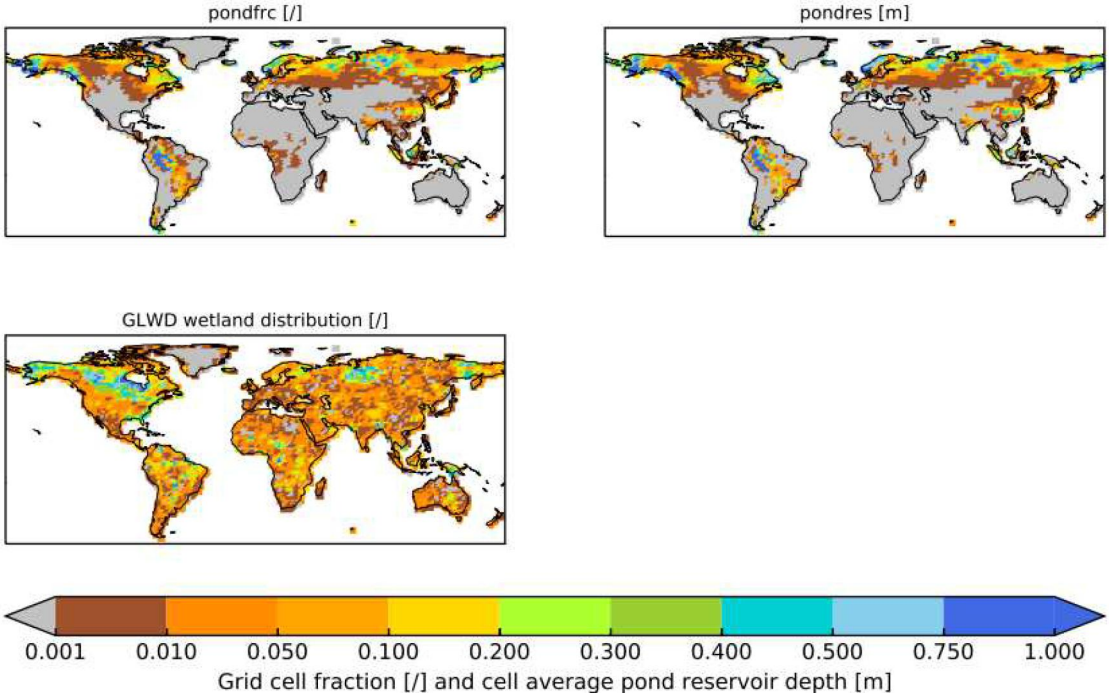

Figure 1: Simulated and observed (Global Lake and Wetland Database; GLWD) wetland fractions (left column) as well as simulated pond depths (right column) in [m].

CMIP6 related simulations

In 2017, various simulations using MPI-ESM 1.2 at LR resolution were planned that are part of different CMIP6-endorsed Model Intercomparison Projects (MIPs). Despite of a thorough planning of these simulations, their realization has been significantly delayed due to two main reasons.

1) For all of these simulations, the officially tagged CMIP6 version of MPI-ESM must be used. Note that this is a development, which is led by MPI-M, but it is conducted in cooperation with DKRZ. Originally, the release of this version was announced for May 2017, but due to various problems (e.g. with the implementation of CMORization of CMIP6-required variables), this release date has been shifted several times and is now announced for October 2017.
2) For the future scenario simulations, official CMIP6 forcing data must be used. Originally, the publication of these forcing data was announced for April 2017. The publication date was then shifted to August 2017, but the data are still not available.

Consequently, none of the planned MIP simulations could be started until today. Currently it is expected that from the various MIP simulations proposed for 2017, only those may be realized within 2017, which cover the historical period or which comprise idealized experiments. Note that during 2017, the topic of HAPPI-MIP and related simulations became prominent so that part of the requested CPU time for 2017 was used for these related simulations (see below).

HAPPI-land

The Half a degree Additional warming, Prognosis and Projected Impacts - Land-use (HAPPI-Land) scenario experiment (investigates the biogeophysical impacts of different land-use scenarios on climate in a 1.5°C compared to a 2.0°C warmer world. This experiment, led by ETH, is a multi-model approach and participation of MPI-ESM highly valued. While a few simulations could be taken from the HAPPI-MIP project run at DKRZ, further experiments were needed to disentangle the effects of such land-use projections. Like in the HAPPI-MIP project, two decadal time-slice experiments were set up to generate multiple ensemble members. Time slices covered the periods of 2006-2015 and 2090-2100. These simulations were conducted with the MPI-ESM in AMIP set-up, e.g. prescribed ocean SSTs and prescribed CO2 and aerosol forcings. Scripts were kindly provided by the DKRZ and were executed by the MPI-LES department. An overview of simulations is given in Table 1. Unfortunately, the simulations had to be repeated in September 2017 due to an erroneous sea-ice cover input file.

Our model output is already being analysed and about to be submitted. The focus of this analysis is the effect of two different land-use scenarios (SSP1 and SSP2) created to reach the 1.5°C target on hot extremes. Figure 2 shows the changes in annual maximum temperature (TXx) for the MPI-ESM model under 1.5°C and 2.0°C climate. Regionally, the effects of land-use may exceed those of half a degree of additional warming. Therefore, this research is highly relevant. HAPPI-Land simulations with MPI-ESM are highlighted in the paper by Hirsch et al. submitted to PNAS.

References

A. L. Hirsch, B. P. Guillod, S. I. Seneviratne, U. Beyerle, L.R. Boysen, V. Brovkin, E. L. Davin, J. C. Doelman, H. Kim, D. M. Mitchell, T. Nitta, H. Shiogama, S. Sparrow, E. Stehfest, D. P. van Vuuren, S. Wilson. Land use implications for climate extremes in low emission scenarios: Results from HAPPI-Land, PNAS, submitted.

Table 1 Overview of HAPPI-Land simulations.

	Land-use		
Ensemble members	**2006-2100**	**2090-2100, 1.5°**	**2090-2100, 2.0°**
10	SSP1 2006-2015		
20		SSP1 2010	SSP1 2010
20		SSP1 2095	SSP1 2095
20		SSP2 2095	SSP2 2095
20		RCP2.6 2095	RCP2.6 2095
90 Simulations			
Storage on HPSS	Raw size 170 Gb à sim = 15.3 Tb		
	C20C size 8.4Gb à sim = 756 Gb		

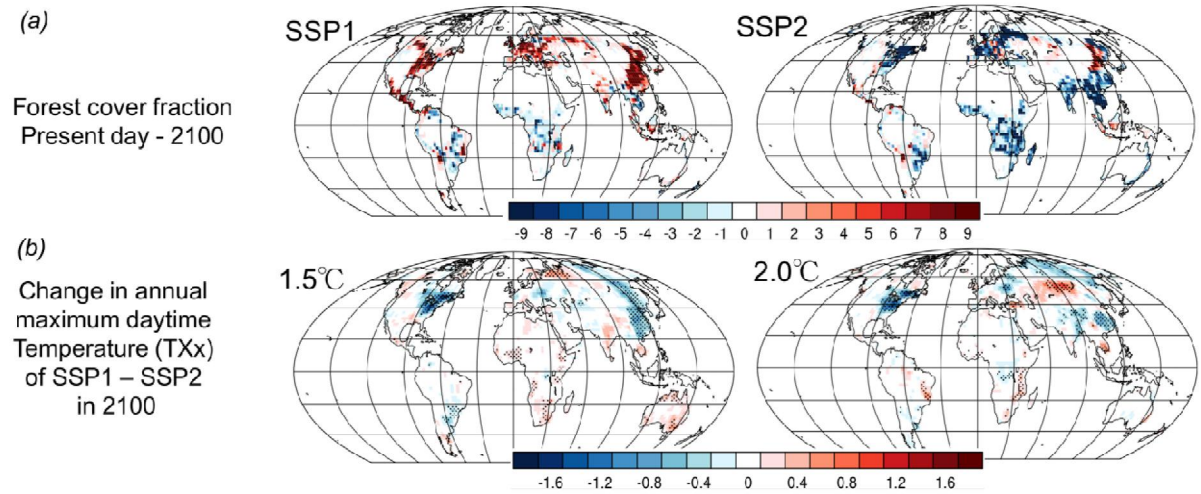

Figure 2: Results for the MPI-ESM participating in HAPPI-Land. (a) Shows forest cover in JSBACH in 2100 for SSP1 and SSP2 and (b) their distinct effects on TXx under 1.5 and 2.0 ℃ climate based on 10 time-slice ensembles.

Clues MIP

In addition to HAPPI-Land, offline JSBACH simulations are conducted for historical and future land-use scenarios combined with 1.5°C and 2.0°C climate projections. This international study is led by the University of Exeter to investigate the effects of these land-use and climate projections on ecosystem services such as water and carbon fluxes. The study focuses on the mitigation potential assumed in the land-use scenarios SSP1 and SSP2 e.g. if land surface models reach similar potentials as Integrated Assessment Models.

For this study, JSBACH was already spun-up offline, and transient historical simulations are currently running. For further analysis in combination with previous HAPPI-Land runs, daily output will be written out. This study should be finished by the end of 2017.

Table 2 List of JSBACH offline simulations conducted for Clues-MIP. Climate forcing is derived from HadGEM2-ES (A), CSIRO-Mk3-6-0 (B) and GFDL-ESM2G (C).

Land-use	**Climate**			
Land-use	**1850-1920**	**1920-1970**	**1970-2100 1.5°C**	**1970-2100 2.0°C**
Historical	A	ABC	ABC	ABC
SSP2-baseline			ABC	ABC
SSP2-RCP2.6			ABC	ABC
SSP2-RCP1.9			ABC	ABC
Spinup	120 JSB + 14000 Cbalance + 160 JSB			
Resources				
Number of simulations years	280+70	50*3	130*9	130*9
Total	2840 years			
Node hours	289			
Arch (GB)	5680			
Work (GB)	11360			
Doku (GB)	11360			