REQUEST FOR ADDITIONAL RESOURCES IN THE CURRENT YEAR FOR AN EXISTING SPECIAL PROJECT

MEMBER STATE: Germany

Principal Investigator[1]**:** Stefan Kollet

Affiliation: IBG3 (Agrosphere), Research Centre Jülich, Germany

Address: Wilhelm-Johnen-Straße
52425 Jülich
Germany

E-mail: s.kollet@fz-juelich.de

Other researchers: Jessica Keune (Meteorological Institute, University of Bonn), Samuel Zipper (visting scientist from McGill University, Montreal, Canada)

Project title: Integrated simulations of the terrestrial system over the European CORDEX domain

Project account: **SP DE KOLL**

Additional computer resources requested for	**2017**
High Performance Computing Facility (units)	6.000.000
Data storage capacity (total) (Gbytes)	

Continue overleaf

1The Principal Investigator is the contact person for this Special Project

Technical reasons and scientific justifications why additional resources are needed

This is a technical report to request additional resources for the accounting period 2017.
The objective of this special project is to perform high-resolution fully coupled aquifer-to-atmosphere simulations over the European CORDEX domain. The simulations are performed with the integrated Terrestrial Systems Modeling Platform, TerrSysMP, consisting of the three-dimensional surface-subsurface model ParFlow, the Community Land Model CLM3.5 and the numerical weather prediction model COSMO of the German Weather Service (Shrestha et al., 2014; Gasper et al., 2014). The simulation results are used to interrogate the two-way feedbacks of groundwater and soil moisture dynamics with essential climate variables, such as air temperature and precipitation, at continental scales. The simulations were finalized, but an issue with the frequency in the coupling of the modelling systems required additional compute time and additional testing.

Moreover, the study was extended to include the anthropogenic impact on the terrestrial water cycle. Here, a flagship study is performed using realistic daily estimates of human water management for the year 2003, i.e. considering explicit removal of groundwater storage and irrigation in fully coupled aquifer-to-atmosphere simulations. Up-to-date, this study is unique, as it is the first study which considers not only irrigation, but also groundwater abstraction within a physics-based integrated modeling system, and hence allows us to analyse the water-management induced feedbacks on precipitation. The current experiment design comprises 4 water management simulations using two water management data sets (Wada et al. (2012, 2016) and Siebert et al. (2010); Siebert and Doell (2010)) and two irrigation schedules (day-time vs. night-time irrigation). Up-to-date, 1 water management simulation is currently running, but additional simulations are needed to address the uncertainty of the precipitation feedback with respect to the water management quantities and practices. These simulations constitute the last chapter of the PhD thesis from Jessica Keune. Table 1 summarizes the (minimum) compute time for a one-year water management simulation. Additional compute time is needed for post-processing, archiving and analysis.

Table 1. Compute time needed for a single water management simulation with increased time steps for the hydrologic compartments (3 minutes for ParFlow and CLM, 1 minute for COSMO) and a 3-minutes-coupling frequency, using a total of 14 nodes, i.e. 504 tasks with 12*12 tasks for ParFlow, 16*16 tasks for COSMO and 6*6 tasks for CLM3.5.

Simulation period	Average / Total wall clock time	Average / Total SBU
1 month	45135s (13h)	101.922
1 year	541622s (155h)	1.223.067

Additional resources are mainly needed for two reasons:
1) The requested compute time was underestimated, as a subset of simulations had to be repeated due to an issue related to the temporal frequency in the coupling of the modeling system and the coupling with the oceans. In this context, the time step of the hydrologic compartments (ParFlow and CLM3.5) was increased and required additional compute time.
2) The water management simulations constitute the last chapter of the PhD thesis from Jessica Keune. In order to finalize the water management simulations in time, including all post-processing procedures, we kindly request additional **6.000.000 SBU** for the accounting period 2017.

References:

Gasper, F., K. Goergen, P. Shrestha, M. Sulis, J. Rihani, M. Geimer, and S. Kollet (2014), Implementation and scaling of the fully coupled Terrestrial Systems Modeling Platform (TerrSysMP v1.0) in a massively parallel supercomputing environment – a case study on JUQUEEN (IBM Blue Gene/Q), Geoscientific Model Development, 7(5), 2531–2543, doi: 10.5194/gmd-7-2531-2014.

Siebert, S., and P. Doell (2010), Quantifying blue and green virtual water contents in global crop production as well as potential production losses without irrigation, Journal of Hydrology, 384(3–4), 198–217, doi: 10.1016/j.jhydrol.2009.07.031

Siebert, S., J. Burke, J. M. Faures, K. Frenken, J. Hoogeveen, P. Doell, and F. T. Portmann (2010), Groundwater use for irrigation – a global inventory, Hydrol. Earth Syst. Sci., 14, 1863-1880, doi: 10.5194/hess-14-1863-2010.

Shrestha, P., M. Sulis, M. Masbou, S. Kollet, and C. Simmer (2014), A scale-consistent Terrestrial Systems Modeling Platform based on COSMO, CLM and ParFlow. Monthly Weather Review, 140422120610007, doi: 10.1175/MWR-D-14-00029.1.

Wada, Y., L. P. H van Beek, and M. F. P. Bierkens (2012), Nonsustainable groundwater sustaining irrigation: A global assessment, Water Resources Research, 48, W00L06, doi: 10.1029/2011WR010562.

Wada, Y., I. E. M. de Graaf, and L. P. H. van Beek (2016), High-resolution modeling of human and climate impacts on global water resources, J. Adv. Model. Earth Syst., 8, 735–763, doi: 10.1002/2015MS000618.