Project: **1068**
Project title: **ViWA - Virtual Water Values**
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BMBF-Project number: 02WGR1423E
Report period: **2018-01-01 to 2018-12-31**

Summary: The aim of the BMBF-project ViWA is to provide information from the local to the global scale in order to develop praxis-relevant solutions for the efficient and sustainable use of the global water resources. Within ViWA a multi-disciplinary monitoring and modelling framework is developed and applied. HZG-GERICS contributes to ViWA by providing high-resolution global-scale climate information using a multi-domain downscaling approach as well as by sophisticated analysis of natural climate variability effecting global water resources.
After approval of the computing time proposal for the ViWA-project on 19.12.2017 by the scientific steering committee (WLA) for the period 01.01.-31.12.2018 high-resolution climate simulations with the limit area model REMO driven by ERA-Interim are started or continued (for the Europe domain) on the HPC-mistral for all 9 selected CORDEX-domains [1] Europe, Africa, Australia, North America, Middle America, South America, East Asia, Central Asia and Southeast Asia (see Fig.1). So far eight of nine experiments are simulated for the period 2005-2017 with a resolution of 0.11° and hourly output. A selection of post-processed REMO data fields was transferred to the ViWA project partner LMU after a quality check. They use the data for the period 2015-2017 as input for the agro-hydrological model PROMET. This model simulates prototypically three recent years with a spatial resolution of 1 km to investigate globally the water cycle in view of the efficiency and sustainability of the agricultural production and compare the results with satellite based observations. Until mid of October about 75% of the approved node hours are used up and about 80% of the approved disk space is occupied by the produced model data. The utilization of available disk space in the WORK directory fluctuates currently between 85% und 100 %.

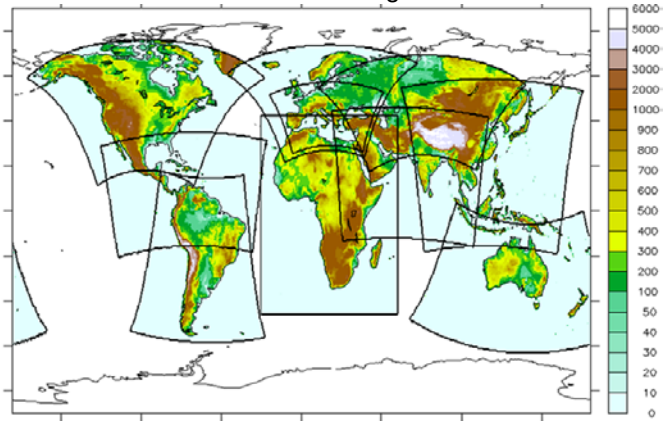

Figure 1: The CORDEX-domains und orography [m] (after Evans, J., 2011: CORDEX - An international climate downscaling initiative. *Proc. 19th Intl Congr. Modelling and Simulation.*)

Methodology: The reanalysis data ERA-Interim for the period 2005-2017 are dynamically and statistically downscaled with a multi-domain approach (see Fig. 2). The ERA-data having a resolution of 80km form the driving data of the hydrostatic REMO-model (version: remo2015_v2_mpi) that produces data on a 12x12 km grid. Afterwards, the REMO output is downscaled to 1km to form the input of the PROMET model. The extension and the coordinates of the individual model domains comply with the domain specifications of the CORDEX-initiative. HZG GERICS takes full responsibility for the dynamical downscaling method. The LMU applies a statistical regression method to downscale the REMO data fields to 1km resolution.

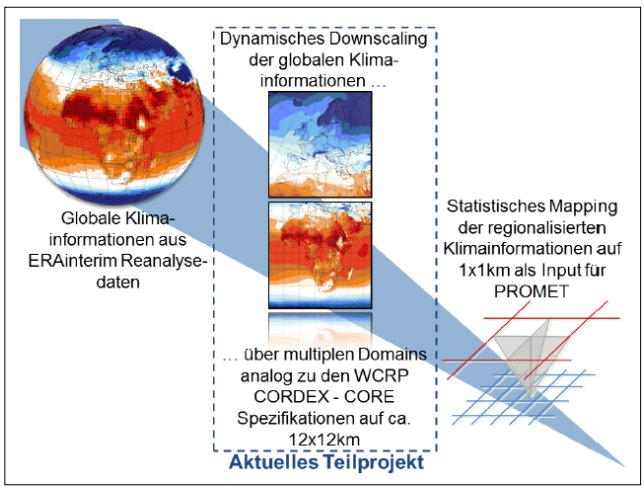

Figure 2: Multi-domain approach for the dynamical-statistical downscaling of ERA-Interim data within the ViWA project.

Results: After completion of the necessary spin-up time extending over the period 2005-2014, the relevant

1 CORDEX = COordinated Regional Downscaling EXperiment

data for the ViWA project are produced over the period 2015-2017 with REMO. The hourly data having 12km resolution are prepared for the CORDEX domains and supplied to LMU. It turns out that the planned spin-up phase of 10 years suffices to ensure a stable simulation in all REMO model domains. Fig. 3 shows exemplary an oscillation of monthly mean soil temperature at 3m depth for a grid point in North Africa. Obviously, the amplitude reaches a quasi-steady state after about 80 months. The shape of the oscillation time series depends on the latitude, soil type and hemisphere.

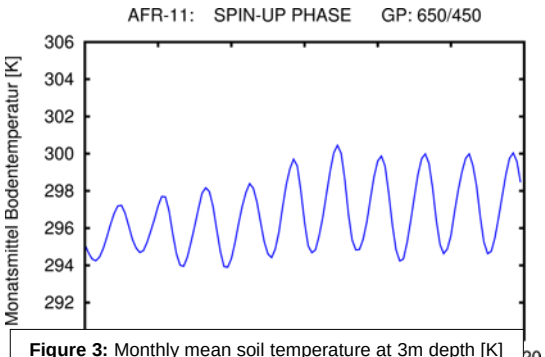

Figure 3: Monthly mean soil temperature at 3m depth [K] as a function of time for a grid point in North Africa. The arrow denotes the end of the spin up phase.

The model quality of REMO in comparison with ERA-Interim reanalysis can be measured with the BIAS. For this purpose the reanalysis data are interpolated to the finer REMO-grid. The bias reveals only small values as seen for example for the precipitation (table 1). One focus of the ViWA project is beside others on natural climate fluctuations under which the El-Nino phenomenon (ENSO) is the strongest one. This event returns in periods of some years and has regionally a large impact on the global hydrological cycle in the atmosphere, in particular the precipitation.

Domain:	REMO: mean [mm/day]	ERA-Interim: mean [mm/day]	BIAS: [mm/day]
Europa	2.26	2.00	0.26
Africa	1.94	1.97	-0.03

Table 1: Average precipitation [mm/day] for REMO (left) and ERA-Interim (middle) for the model domains Europe and Africa. The right columns contains the model bias for the two domains.

A reasonable measure for the fluctuation of precipitation is given by the standard deviation. Fig. 4a shows this quantity for the period 2015-2017 in March within the model domain Europe. It turns out that regions with higher values are often associated with land sea contrasts where large temperature and humidity gradients occur (e.g. east coast of Greenland), with enhanced orography (mountain ranges) and with typical cyclone tracks (North East Atlantic). Fig. 4b shows the difference of the standard deviation between REMO and ERA-Interim. It becomes evident that REMO exhibits significantly higher precipitation activity and finer structured precipitation pattern.

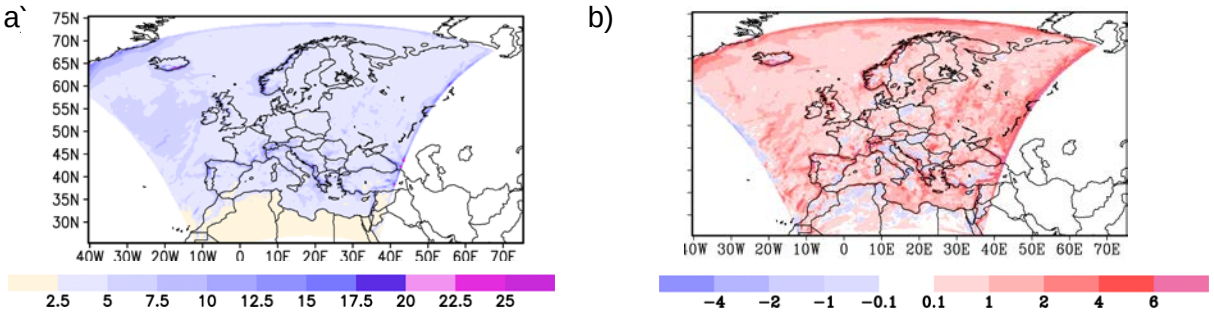

Figure 4: a) Standard deviation of REMO precipitation [mm/day] for the period 2015-2017 in March within the CORDEX domain Europe. b) difference of precipitation standard deviation [mm/day] between REMO and ERA-Interim for the same period and domain.