1. Project overview

Regio_Predict is a project within the BMBF funded program MiKlip which has been established to derive a decadal climate prediction system. It is the coordination project of MiKlip Module-C which works on the downscaling of global climate predictions. MiKlip started in 2011 and will end in 2015.

Decadal prediction is located in the transition zone between weather prediction – as an initial value problem – and the long-term climate projections – as a forced boundary condition problem. It utilizes the memory in certain compartments of the earth system like the ocean as well as the changing climate forcing by the greenhouse gases. The potential predictability on the interannual to decadal timescales arises from process chains over large spatial scales – which have to be covered by global earth-system models. But there is also a need for regional scale research. On the one hand users of decadal predictions are focused mostly on the regional impacts on the other hand variability might arise on the regional scales and feed back to the larger scales.

MiKlip is structured into 3 development stages (baseline, prototype and synthesis). During each phase a prediction ensemble will be generated to analyse the progress which has been made in MiKlip with respect to model development, initialization and ensemble generation.

2. Range of planned research work from the scientific view

As the coordination project REGIO_PREDICT performs several over-arching scientific and technical tasks for the MiKlip regionalization module. The scientific contribution addresses the integrating analysis of the ensemble simulations for Europe from the models REMO and COSMO-CLM (CCLM). The joint simulations provided by several projects within MiKlip-C will be analysed using ensemble methods to estimate the skill of the regional predictions for various geographic regions and for the various hindcast periods since 1960. The project aims at the synthesis of Module-C with respect to bridge the gap between the global models and the needs of the potential users.

Regional reference simulations are needed to assess the skill of the model system driven by initialized global simulations with respect to un-initialized simulations or re-analysis driven experiments. A part of these reference simulations using the regional climate model CCLM have to be provided by Regio_Predict.

3. Computational aspects

Here we apply for computing time and storage capacities for the simulations with COSMO-CLM (CCLM) for the period 1.1. – 31.12. 2013. The project is expected to end in August 2015. For this periods follow-up application at DKRZ for 2014 and 2015 are planned.

In addition, the data provided by the global MiKlip simulations at DKRZ have to be pre-processed for several other module-C projects also using CCLM. To avoid duplicating this first step within all the these project, REGIO_PREDICT offers to
perform this first processing step, if sufficient work space will be granted to perform this task and provide them to the other projects when needed.

4. Numerical methods

At the moment MiKlip Module-C uses the latest evaluated version of the CCLM code as it has been used within the CORDEX historical and future scenario simulations. In later stages updated MiKlip-specific versions of CCLM will be used.

5. HLRE 2 suitability

CCLM is very well adapted to the HLRE2 infrastructure. Therefore, it is intensively been used for instance for the regionalization of different CMIP5 climate models within the frame of CORDEX and in several other MiKlip projects.

6. Performance benefits

Since the regional climate model CCLM is massively parallelized the performance on blizzard will reach up to two model years per real day on the large model grid (about 232 x 226 x 40 grid boxes) depending on the number of nodes (two or four) used in SMT mode.

7. Required resources

It is planned to run in 2013 CCLM driven by the un-initialized CMIP5 MPI-ESM-LR simulations (3 members) for the period 1960-2010 in the MiKlip-C Europe configuration with 0.22° resolution. This amounts in 150 simulation years. These simulations should be used as a reference to determine the benefit of initialized forecasts versus un-initialized climate projections.

At a later stage (2014) a new set of reference simulations might be needed for the regional MiKlip synthesis ensemble prediction system.

Based on the experience from the DEPARTURE simulations on blizzard we estimate a necessary computing time of 280,000 CPUh including I/O processing (Table 1). For ensemble analysis and the pre-preprocessing we apply for additional 20,000 CPUh.

The estimated storage needed consists of the work space for a single simulation including I/O to about 12,000GB on and 36,000GB on the archive (for all 3 simulations). The work space to perform the ensemble analysis and to provide the initial driving data from the MiKlip GCM ensemble to other projects using CLM is estimated to be additional 10,000GB for the work space and the archive.

Table 1: Basic expected HPC resources for one simulation year; given are the CPU-time in node-hours per simulation year and the storage requirements per simulation year including input and out data.

<table>
<thead>
<tr>
<th>Model</th>
<th>No. Grid Points</th>
<th>CPUh/Year</th>
<th>Storage/Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCLM</td>
<td>232 x 226 x 40</td>
<td>1865</td>
<td>230 GB</td>
</tr>
</tbody>
</table>

Table 2: Total HPC resources application for the year 2013

<table>
<thead>
<tr>
<th>Simulation Years</th>
<th>Total CPUh</th>
<th>Workspace (GB)</th>
<th>Docu (GB)</th>
<th>Archive (GB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>300.000</td>
<td>22.000</td>
<td>3.000</td>
<td>46.000</td>
</tr>
</tbody>
</table>
8. Additional value to other projects

The planned work contributes also to other projects within the MiKlip framework. The data from the step of the CCLM simulations (pre-preprocessing of the global input data) will be offered to the Module-C projects working with CCLM (DecReg, DEPARTURE, LACEPS, PRODEF).

The synthesis of the regional prediction ensemble will be done in collaboration with the Module-C projects DecReg, LACEPS, PRODEF and REDCLIP.

The regional ensemble plus the reference simulations will also be evaluated with in the Module-D project INTEGRATION as well as in several Module-E projects.