Project: **802**

Project title: **COSMO-CLM simulations with 2-way nesting**

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Report period: **1.1.2019 - 31.12.2019**

The current status of the project

In 2013-2016 the coupled system CCLM+MPIESM using a 50km CCLM horizontal resolution was developed and tested on interannual to decadal time scales. Its interpolation accuracy was shown to be smaller than the COSMO tendency. For surface pressure it was found to be 1 Pa in flat terrain and up to 100 Pa in mountaineous regions at individual grid points. The usage of fully parallelized OASIS3-MCT coupler made the exchange of the 3D fields at every time step very efficient (10% additional time to solution). See also Will et al. (2017). The application of the system in North Atlantic improved significantly the blocking index. The coupling of CCLM+MPIESM over Europe with 18km COSMO-CLM horizontal resolution didn't show a significant upscaling effect but reduced the boundary effect of one-way coupled simulations significantly In 2017-2018 an additional coupling CCLM+ARPEGE was developd and applied over Europe. A further reduction of the interpolation error by one order of magnitude was achieved by introduction of horizontal interpolation of the pressure deviation from the standard atmosphere instead of the pressure itself and of iteration of vertical interpolation. This made the interpolation error significantly smaller than the COSMO-CLM tendency.

In 2019 a new TWC between coarse and fine grid COSMO-CLM was developed. Hereto the OASIS3-MCT interface was extended and an interpolation between the z-grids was implemented. This development is not finished yet and it is planned to test it end of 2019. This development is part of the strategy of the CLM-Community to develop a Regional Climate System Model for convection permitting scales. The 2-way coupling CCLM+CCLM is part of this strategy since a double nesting strategy is necessary to close the gap between the resolution of global climate models and convection resolving scale of 1 km. The opportunity to use 2-way coupling between the intermediate and the convection resolving atmosphere of COSMO-CLM is expected to reduce the boundary effect in the convection resolving simulation and to enable the feedback of this simulation on the intermediate scale. This feedback has been found to be relevant in simulations of the Alpine region at convection permitting scale and non-dissipative dynamics which has been successfully implemented recently in COSMO-CLM (Ogaja&Will, 2016, 2017). As shown in the report of bb0802 project, the grid scale simulation of convection was found to reduce the scale of organized circulation in the lower troposphere, which is stabilizing the atmosphere. A 2-way coupling is necessary to transport this feedback to larger scales.

Unfortunately, the corresponding 2-way coupled simulation could not be conducted yet in 2019 due to limited resources. The applicant underestimated the amount of output of the one-way coupled reference simulations and the time necessary to analyses the data statistically. The data analysis is nearly finished now and the work space is being made available for other users now step by step.

I would like to thank the DKRZ staff for the extensive support and for providing the storage resources much beyond the limit granted for this project.