## Project: 858

## Project title: A Limited-Area Climate Ensemble Prediction System (LACEPS)

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To support policy making decisions on national and regional level with respect to climatological issues the downscaling of global climate predictions to the regional scale is essential for the economic and social benefits of climate forecasts on all time scales and, thus, also on the decadal time scale.

The general goal of LACEPS was the development of an ensemble prediction system for regional decadal climate prediction employing the regional climate model COSMO-CLM. The ensemble is based on the perturbation strategies "initialization" and "model physics". It is intended to cover the range of all possible outcomes. The target variables are the 2 m air temperature and the precipitation.

In cooperation with the module C projects RegioPredict and DecReg three versions of a regional decadal climate ensemble using COSMO-CLM are created based on the perturbation strategy "initialization". Two ensemble versions are performed for the EURO-CORDEX domain at 0.22° horizontal grid width. As forcing ten realizations of the global climate model MPI-ESM-LR of baselines 0 and 1 are used for the decades 1960, 1970, 1980, 1990, and 2000, respectively. The third ensemble version is created on the same domain at 0.44° grid width. The decadal simulations are started yearly in the time period 1961 to 2012. In contrast to the ensembles on the 0.22° grid the simulation times overlap and allow an elimination of possibly characteristics induced by the lead time. A further regional ensemble is created by COSMO-CLM at 0.22° for the perturbation strategy "model physics" by varying parameters of the model physics.

The figure attached shows the ensemble spread score (ESS) of the forcing model MPI-ESM-LR and COSMO-CLM for the whole year as well as summer (JJA) and winter (DJF) separately. The COSMO-CLM ESS shows for the year as well as DJF larger areas close to the perfect value of one compared to the forcing model MPI-ESM-LR especially over North and Eastern Europe. The positive ESS values over the Balkans remain with the same intensity. This effect becomes obvious with the area means (see figure). Over Scandinavia the COSMO-CLM ensemble is under dispersive during DJF, i.e. the mean ensemble spread is slightly smaller than the mean forcast error. In JJA the COSMO-CLM ensemble more over dispersive in Eastern and Southeastern Europa compared to MPI-ESM, but the ESS over Scandinavia is distinctly closer to the perfect value of one. In spring (MAM) and autumn (SON) the COSMO-CLM area mean ESS over Europe (not shown) is closer to one compared to MPI-ESM.

The estimation of the reliability of the regional COSMO-CLM ensembles shows that ten ensemble members based on the perturbation strategy "initialization" are most sufficiently dispersive for annual, seasonal, and monthly means of the 2 m air temperature. For precipitation this strategy is, however, underdispersive. The ensemble based on the perturbation strategy "model physics" is generally underdispersive for both 2 m air temperature and precipitation in the present case.

A prototype of the ensemble prediction system is established in LACEPS for the region of Europe (EURO-CORDEX domain). The horizontal resolution of the model domain is 0.22°, some tests on a model grid with a resolution of 0.11° are carried out. The driving data of COSMO-CLM are results of MPI-ESM-LR data from MiKlip baselines 0 and 1. The final generation of the ensemble will be done by applying three different techniques: 1.) perturbations of the initial values by using driving data from MPI-ESM runs started at different days, 2.) perturbations of physics by varying tuning factors and constant values used in physical parameterizations as well as using different physical parameterizations, and 3.) perturbations of boundary data by varying e.g. the sea surface temperature.



Ensemble Spread Score for the annual mean 2 m air temperature anomalies (upper panel) and in the winter (DJF, middle panel) and summer months (JJA, lower panel), The initial condition ensemble comprises 10 decadal hindcasts for MPI-ESM-LR Baseline 0 (left panel) and COSMO-CLM (right panel) for the lead time 2 to 9 years averaged over the 5 decades 1961 to 2010. The number in the upper left corner represents the area averages.