

SPECIAL PROJECT PROGRESS REPORT

Progress Reports should be 2 to 10 pages in length, depending on importance of the project. All the following mandatory information needs to be provided.

Reporting year 2011

Project Title: Regional Ensemble Prediction

Computer Project Account: spderemo

Principal Investigator(s): Prof. Dr. Daniela Jacob

Affiliation: Max Planck Institute for Meteorology

Name of ECMWF scientist(s) collaborating to the project (if applicable)

Start date of the project: 2007

Expected end date: 2011

Computer resources allocated/used for the current year and the previous one (if applicable)

Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	92000	0	104000	0
Data storage capacity	(Gbytes)	8500	0	8500	0

Summary of project objectives

Exploitation of different regional ensemble techniques with ECMWF meteorological fields as lateral boundary conditions for seasonal to decadal time scales.

Summary of problems encountered (if any)

Summary of results of the current year (from July of previous year to June of current year)

Since the previous progress report the refinement and testing of the new stochastic physics (SP) scheme has been finished. For a better understanding we will quickly review the SP scheme of REMO.

In current climate models sub grid scale processes are often implemented by so called bulk parametrizations. These parametrizations often describe only the mean influence of these processes on the climate of the model. The basic assumption for only using the mean is the idea of having a sufficient number of, e.g., convective clouds in a grid box that form a large ensemble of clouds. This assumption is questionable in some cases because deviations from this ensemble mean might be important. Especially when grid box sizes are getting smaller the concept of a “large ensemble” does not hold any more. One possible solution is to mimic higher order moments like the variance by means of a stochastic process. In this way the classical and often computationally cheap parametrizations can be kept in the model and are complemented by a stochastic process adding the missing variability.

In REMO the SP is implemented by perturbing the physical tendencies from the parametrizations of the REMO model by means of a stochastic model that rests on the concept of a Markov random field. The stochastic perturbation of a tendency ϕ is expressed by

$$\phi^{stoch} = (1 + \alpha) \phi \quad (1)$$

where α is given by

$$\alpha = \alpha_{i,j}^t = 0.2 \beta \alpha_{i,j}^{t-1} + \sum_{|k-i| \leq 1, |l-j| \leq 1, (k,l) \neq (i,j)} 0.1 \beta \alpha_{k,l}^{t-1} + \gamma \epsilon_{i,j}. \quad (2)$$

The parameter β governs a temporal autocorrelation, γ is an amplitude to control the strength of the random number ϵ which is drawn from a normal distribution with zero mean and unit variance.

To test different set ups the regional climate model REMO all runs share the same perfect boundary conditions and SST from ERA40 reanalysis. The resolution of the model was set to 0.5° on a domain with 81 times 91 grid boxes and 20 vertical levels covering Europe (see Figure 3). In total one control and 18 SP runs were conducted (to avoid big data transfers and a waste of computing time for preparing boundary data these runs were carried out at MPI-M). In the perturbed runs different values for the random number amplitude, different combinations of perturbed tendencies and different initialization of the random numbers were tested.

In the following a few results always comparing the control run to the perturbed runs or observations will be shown. Only runs with the same perturbation to all tendencies on every level are used. First results for summer (JJA) near surface temperature with different strengths of γ are shown in Figure 2. It can be seen that with increasing strength of the random number amplitude the cooling effect over land in most parts of the simulation domain becomes stronger. This result does not change significantly if we use different initializations for the random number generator.

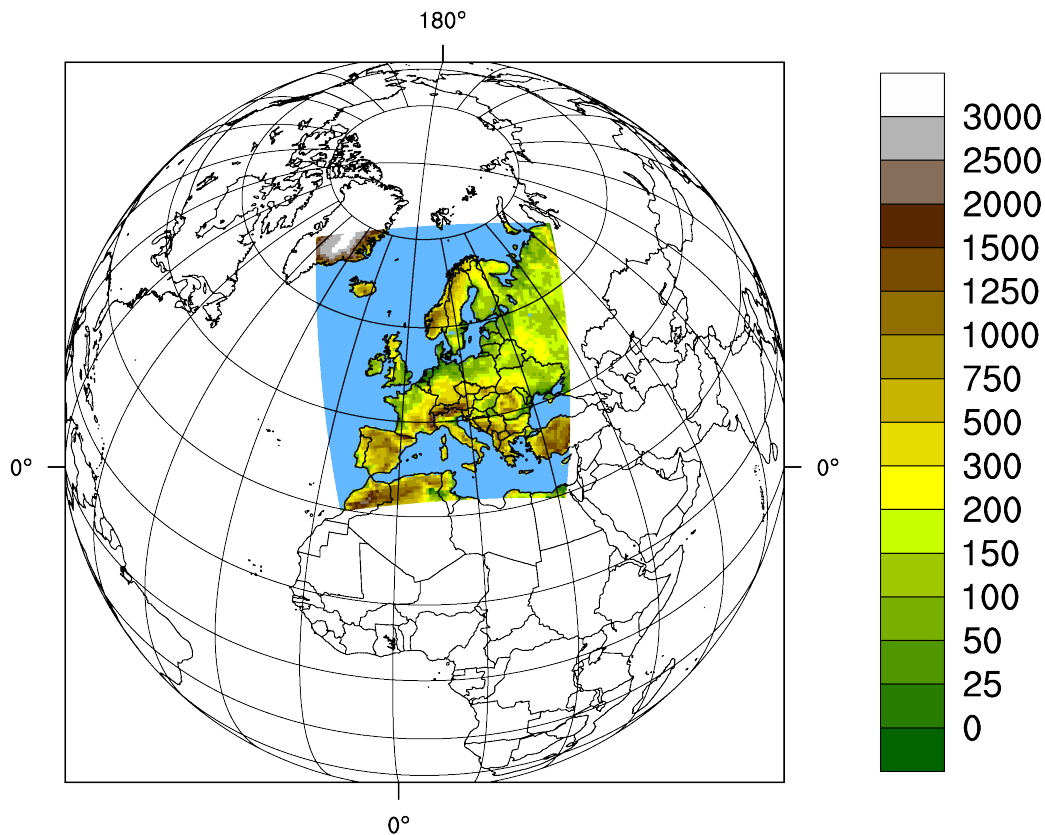


Figure 1: Orographie in [m] of the domain used for the experiments.

Looking at the same season for precipitation (Figure 3) it becomes clear that part of the cooling is associated with increased precipitation. Although the picture for precipitation is quite patchy and might be considered as pure noise.

If we compare the control run with observations (Figure 4) it shows that the simulations with SP have a reduced difference to observations in temperature and partly in precipitation. We have to point out here that most of the effects are only in a range of 10%-20% but are strongest – at least for temperature – in regions with the biggest difference to CRU data.

More results including other seasons and different combinations of perturbed tendencies will be published in an upcoming paper. Preliminary conclusions from these experiments are that the SP scheme is working in REMO and may improve the model performance especially in summer. Some further analysis on, e.g., extremes will be done in the future.

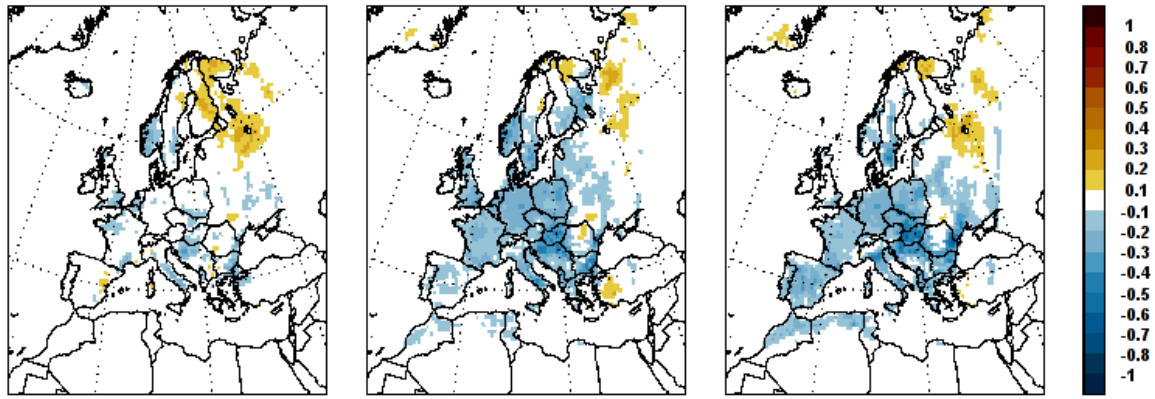


Figure 2: Summer (JJA) near surface temperature difference in [K] to the control run without SP scheme. From left to right results for different strengths of γ are shown (0.2, 0.4, 0.6).

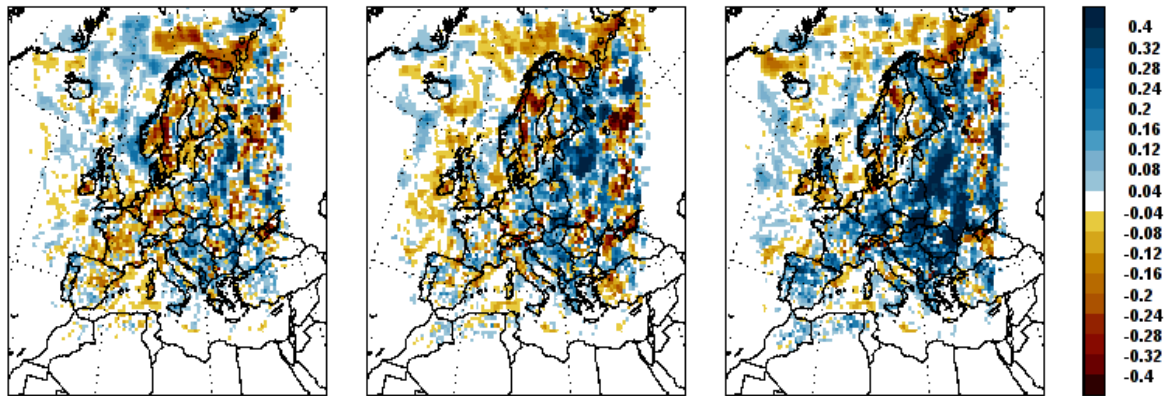


Figure 3: Same as Figure 2 but for precipitation in [mm/d].

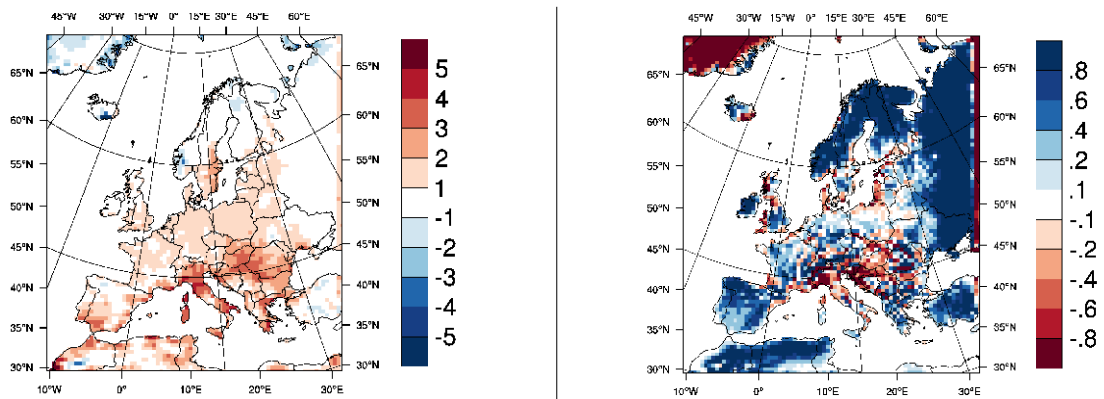


Figure 4: JJA temperature difference in [K] (left) and precipitation difference in [mm/d] (right) of the control run compared to observations (CRU 3.0).

Summary of plans for the continuation of the project

Before this projects ends at the end of 2011 we would like to run some seasonal forecasts from the ENSEMBLES seasonal stream 1 simulations with REMO including the SP scheme and compare results and performance to the runs conducted in the last two years.