DecReg Part D
Regional Decadal Predictability

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The DecReg project: an overview

The DKRZ project bb0667 covers a subpart of the MiKlip (Mittelfristige Klimaprognose) DecReg project, specifically the part of the University of Mainz. Project partners are the Institute for Meteorology and Climate Research of the Karlsruhe Institut of Technology (KIT), the Institute for Atmospheric and Environmental Sciences of the Goethe University of Frankfurt/Main, the German Meteorological Service (DWD) and the Institute for Atmospheric Physics (IPA-MZ) of the Johannes-Gutenberg University of Mainz. The joint research project DecReg aims at an assessment of the feasibility, the added value, the prospects and the limitations of regional decadal "predictive" hindcasts; this is a prerequisite for any attempt to perform future predictions. The regional climate of selected periods of the past decades is reconstructed with the regional climate model CCLM via dynamical downscaling of GCM decadal "predictive" hindcasts; the GCM datasets include the ones produced within this project (by IPA-MZ), within the other modules of MiKlip, and also results from other GCMs (e.g., CMIP5). Different model setups and coupling strategies will be assessed; horizontal resolution is 0.22°. The investigated region is Central Europe, selected for reasons of availability of temporally and spatially high resolution initialisation and validation data. The statistical and climatological validation of ensembles of such simulations against sets (ensembles) of gridded observations is an essential part of this project. The combination of high resolution simulations with ensemble methods, which is a unique feature of this project, enable a reliable analysis of the occurrence and statistics of climate extremes like heavy precipitation (esp. summer precipitation, which is connected with small scale processes) and extended dry periods within the forecast window.

The project is coordinated by KIT.

The DKRZ project bb0677 covers only the part of the DecReg project located at the IPA of the University of Mainz.

Model setup:

Global: Apart from the investigation of the influence of the resolution of the driving model, the ECHAM resolution will be T63L47MA in accordance with the available global CMIP5 / MiKlip simulation in MiKlip phase DS1.
Regional: In all simulations COSMO-CLM/MESSy is used in 0.22°L40 resolution for a model domain located over Europe as in CORDEX-EU.

Period: The hind-cast period will be from 2000-2010 as most observational data are available for this period.

Global Average 2000-2010

	NUDG	ECMWFSST	SSTCLIM	GPCP
precipitation (ls + conv)	2,93	2,98	2,97	2,68
ls precipitation	1,37	1,57	1,56	
conv precipitation	1,56	1,41	1,41	

Europe Average 2000-2010

precipitation (ls + conv)	1,54	1,67	1,64	1,86
ls precipitation	1,18	1,32	1,32	
conv precipitation	0,36	0,34	0,32	

Table 1: List of average daily precipitation [mm/day] for the three simulations and the GPCP data. Top: global averages; bottom averages over Europe (25°W – 45°E, 25°N-75°N). "ls" stands for large scale precipitation and "conv" for convective precipitation.

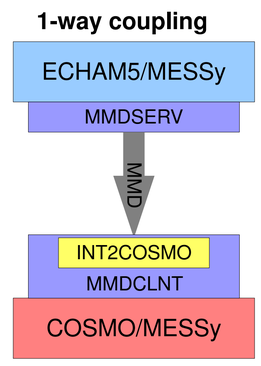

Figure 1: *Schematic illustration of a MECO(1) setup.The MESSy submodel MMDCLNT calculates the initial and boundary data as required by COSMO-CLM. For this purpose, the MESSy submodel MMDSERV broadcasts the required global data sets via the Multi-Model-Driver (MMD) library to the client model. MMD uses the message passing interface (MPI) facilities.*

Global simulations (performed 2012):

Three global simulations have been performed:
- a control simulation using ECMWF analyses for a full nudging of the SSTs and the atmosphere (NUDG),
- a sensitivity study using only ECMWF analyses initial conditions, but an AMIP2 SST climatology (SSTCLIM) and
- a second sensitivity simulation using ECMWF analyses for initial conditions and for SSTs (ECMWFSST).

In addition to our own assessments, we will provide off-line boundary data from the global model to our project partners.

These three setups have been chosen in order to assess the prediction capability of the global model:
- The NUDG simulation provides a high quality GCM based reference hindcast and reference boundary data for COSMO/MESSy. ECHAM, forced towards ECMWF data during the hindcast period, will give insight on how good the climate prediction can be, since the nudged simulation is supposed to be the best hindcast possible.
- The SSTCLIM simulation corresponds to an uninitialised climate prediction with guessed SSTs.
- The usage of "observed" SSTs in the ECMWFSST simulation is considered the best possible replacement for prognostically calculated SSTs in a prediction simulation using an ocean model.

Figure 2-4 and Table1 present preliminary results of the comparison of the three simulations.

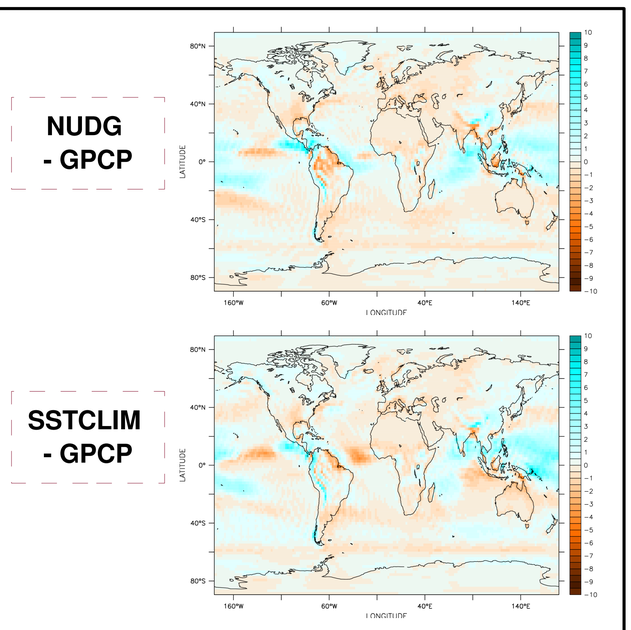

Figure 4: as Figure 2 for global fields

Part D of the DecReg project (= DKRZ project bb0667): An Introduction

ECHAM/MESSy(→COSMO-CLM/MESSy)^n (shortly called MECO(n) = **M**ESSy-fied **ECHAM** and **CO**SMO models nested **n**-times) is a flexible on-line coupled GCM-RCM system. It will be used to study the impact of the coupling strategy and the model physics of the driving model on the quality of the regional predictions. The MECO(n) system was developed in the framework of MACCHIATO (see www.staff.uni-mainz.de/kerkweg/MACCHIATO), a project funded by DFG. The chemistry climate model ECHAM/MESSy (Jöckel et al., 2005, 2006) as driving model provides the boundary data for COSMO-CLM/MESSy on-line, i.e., the data is exchanged via the memory and not by dumping these data to the disk, therefore speeding up the simulation. This offers the possibility to study important aspects of the coupling strategy in a systematic and flexible way. Throughout the whole funding period of the MiKlip project, we (Uni-MZ) will use a typical MECO(1) setup, i.e., one COSMO-CLM/MESSy instance nested into the global model ECHAM5/MESSy. Figure 1 shows a schematic illustration of the data transfer from one model to the other in a MECO(1) system.
Condensed, the dependence of the regional prediction on the resolution of the driving model, the coupling time step and the physical parameters chosen in the driving model will be investigated.

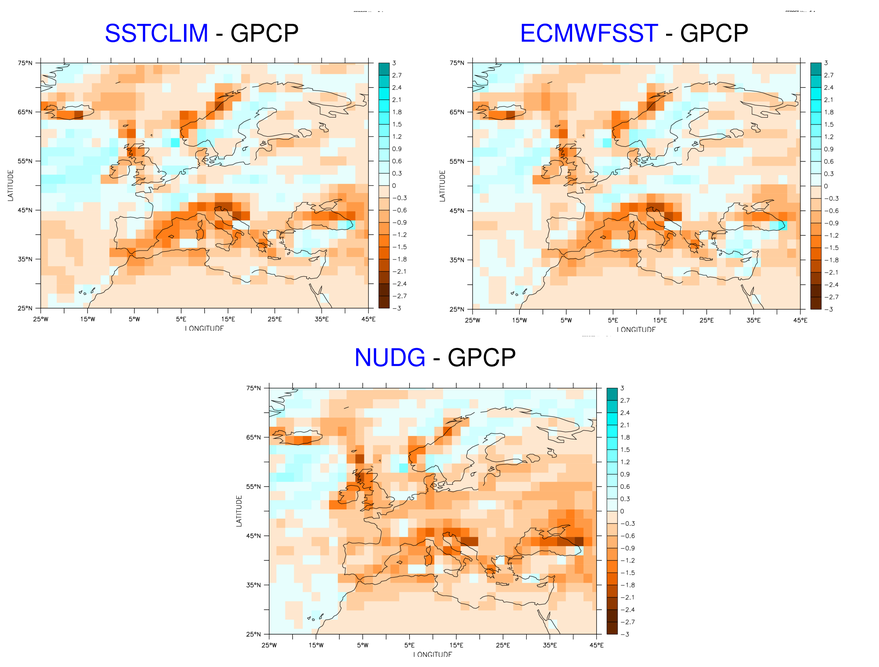

Figure 2: Difference of the simulated and the analysed (observed) monthly mean precipitation (in [mm/day]) in the period from 2000 to 2010. The GPCP data (Global Precipitation Climatology Project; http://precip.gsfc.nasa.gov) were used as observations. The three panels correspond to the three global simulations performed so far in the DecReg-Part D project.

Preliminary Results I:

Figure 2 shows, that all simulations produce less precipitation over Europe in the period 2000-2010. Moreover, the NUDG simulation, which is expected to be the best possible, is the driest over Europe. However, Table 1 and Figure 3 and 4 clarify, that, from a global point of view, the simulations predict too much precipitation. On the global scale, as for Europe, the NUDG simulation produces the smallest amount of precipitation. Hence, the NUDG simulations fits globally the observations better than the other two simulations.
A comparison between the ECMWFSST and the SSTCLIM simulation yields pretty much the same amount of precipitation, revealing a very small influence of the variability of the SSTs to multi-year large area averages.

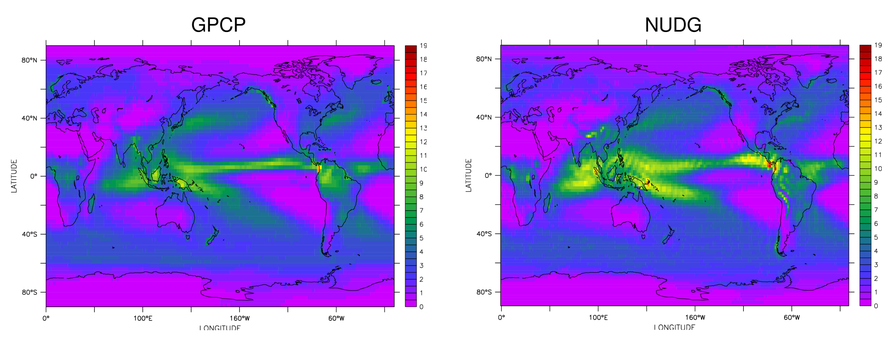

Figure 3: Daily precipitation [mm/day] averaged over the period 2000-2010. Left: GPCP data; right: the NUDG simulation

Future plans:

In 2013 two investigations are planned
- The influence of the resolution of the driving model on the regional model is assessed by additional simulations in different horizontal resolutions of ECHAM (e.g., T63, T106), additionally, the influence of the vertical resolution of the driving model will be examined.
- The impact of the coupling time interval will be investigated by applying different coupling intervals between the time step length of the driving model and the interval normally used in climate simulations (6 hours).

For the remainder of the project (2014/2015) additional simulations varying the driving models physics are proposed:
- The influence of the model physics parameterisations of the driving model on the performance of the regional model will be assessed. This will be achieved by choosing different parameterisations for the same process as provided by ECHAM/MESSy: e.g., one of five different convection schemes, different realisations of the radiation calculations and/or including an on-line coupled ocean.
- Furthermore, the sensitivity of COSMO-CLM/MESSy to different ozone and aerosol distributions used in the radiation scheme will be tested by replacing the standard ozone and aerosol climatologies by on-line calculated ozone and aerosol distributions provided by ECHAM/MESSy.