TerraFLOPS
Service for earth-system-research

Newsletter
Deutsches Klimarechenzentrum
Modelle & Daten

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TerraFLOPS
Service für die Erdsystemforschung

Advanced Facilities...

New High Performance Computing and Visualisation Clusters

In November 2006, contracts have been signed for two new high performance computers to be installed in the DKRZ computer rooms, both based on cutting edge hard- and software technology.

The first system is a powerful **Linux cluster** intended for model simulations and data intensive pre- and- post-processing. This computer, which will be delivered by Sun Microsystems, will include 256 compute nodes, each equipped with 2 dual core 2,6 GHz processors and 4 interactive nodes with 8 dual core processors each, all connected by a very fast Infiniband network. With its nearly 1100 processing cores, the clusters total theoretical peak performance is more than 5 TeraFlops. For high-performance parallel I/O, a system based on lustre cluster file system technology with a total disk capacity of 130 TeraBytes is provided. The machine is jointly owned by the Max Planck Institute for Meteorology and by DKRZ. The Max Planck Institute pays for 75% of investment and operational costs and thus substantially increases the computing capacity available for its research. The remaining 25% of the costs are provided by the shareholders of DKRZ. This cluster offers the opportunity for DKRZ and its users to evaluate the potential of massively parallel computers and parallel cluster file systems in the context of earth system modelling. Additional 50 TeraBytes of disk storage, funded by BMBF as part of the German e-science infrastructure D–Grid, will be integrated into the cluster and will mainly act as work space for data processing within the C3–Grid project.

The second new facility is a **visualisation system** with special emphasis on the needs of earth system modellers. Core of this system is a graphics cluster, again build of dual core Opteron servers and based on the “scalable visualisation array” (SVA) technology provided by Hewlett Packard. It is equipped with 18 high end graphics cards and a high-performance parallel file system which allows for streaming and online animation of data. In cooperation with HP and Mercury Computer Systems, DKRZ aims to provide visualisation tools which are specifically adapted to the characteristics of climate model data and to leverage the hardware capabilities of the system (Figure 1). By means of remote rendering software, potentially all users of DKRZ will be able to interactively use the system from their desktop workstation or PC without the need to transfer their large data sets from the DKRZ archive to the local workstation.

...and advanced Simulations

New and Continued Computing Campaigns

During the last three years significant shares of the computing resources available at DKRZ have been used for large computational campaigns, called consortia runs. Currently an average of 25% of the computer time is used for two demanding experiments. CLM, a regional climate model based on the “Lokal Modell” of DWD is used for projections of the future west European climate, based on IPCC scenarios. The COSMOS global earth system model is used to simulate the climate of the last millennium. Both campaigns are described in more detail on the following pages. [J. Biercamp]

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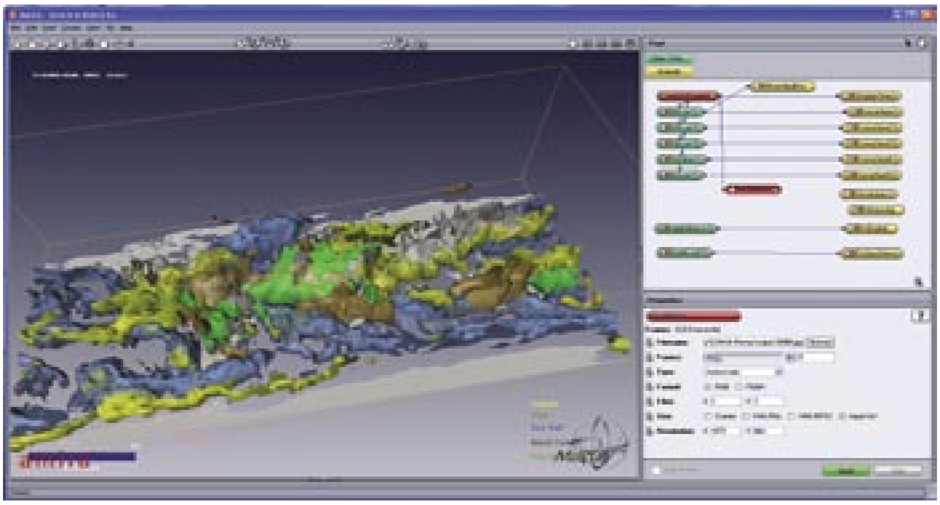


Figure 1: Visualisation of ECHAM-HAM results with Amira - a product of Mercury Computer Systems

The Climate Local Model - Evaluation Results and Recent Developments

[Andreas Will, Klaus Keuler and Alexander Block, Department for Environmental Meteorology, Brandenburg University of Technology, Cottbus]

http://www.tu-cottbus.de/meteo/index.html

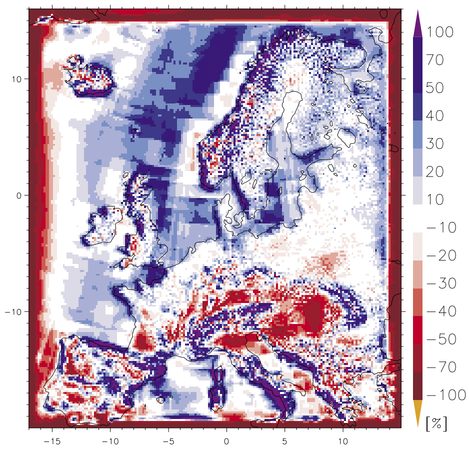
A successful and overall evaluation of the CLM was a prerequisite for conduction of the consortial runs, which will be the data basis of the BMBF research program "Research for the climate protection and protection from climate impact". We present selected results showing the quality of the model and discuss open questions in regional climate modelling, which may be further addressed using the results of the consortial runs.

The IPCC report 2001 stated the need for a substantial reduction of uncertainties in regional climate modelling and an increase of the spatial resolution of the results. Since that time the computer power increased substantially and the model physics and dynamics have been further developed in order to simulate the climate change at spatial resolutions substantially below 50 km. The new generation of non-hydrostatic regional climate models (NRCMs) even has the potential to simulate the regional climate at space scales down to 1km. However, the dynamics of the earth system at higher spatial scales has to be taken into account adequately. A quantitative evaluation of new model versions for all relevant dynamical and the important diagnostic variables like precipitation and 2m temperature is required to identify to what extent the goals have been reached and to what extent not.

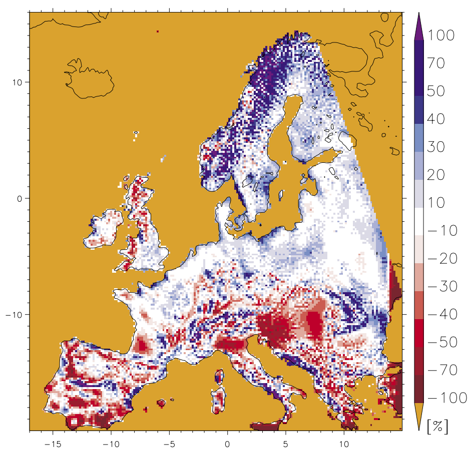
The CLM is one of the NRCMs. It has been developed since 2003 by the CLM-Community, which is an open network of actually 40 scientists from 13 different European universities and research institutions (*www.clm-community.eu*). The CLM is based on the LM, which was originally developed by the German Weather Service and which is further developed now by the COSMO consortium (*www.cosmo-model.cscs.ch*). The details of the model physics and of the model dynamics are well documented (Doms et al. (2003) and Doms et al. (2004)). The basic features of the CLM and the results of the evaluation of clm2.0 are described in Böhm et al. (2006). This quantitative evaluation of the CLM with ERA15 reanalysis as boundary conditions was a prerequisite of the consortial runs. The overall performance of the CLM could be shown to be similar to that of other RCMs.

The CLM version clm3.0 is used to conduct the actual regional climate consortial runs at DKRZ. Two different ECHAM5 climate change simulation scenarios and two different ensemble members are used as boundary conditions of the CLM-simulations at 18 km resolution over the time span 1955 to 2100 for 271x257 grid points over Europe. A short description of the configuration is given by Wunram (2006).

We show the clm3.0 evaluation (CLM004) results for the total precipitation and the 2 m temperature in Figures 2 and 3. The model configuration of the CLM004 run is the same as used for the consortial runs except for the model domain, which is smaller for CLM004 (Figure 1 and Figure 1A in Wunram (2006) for comparison).



A.



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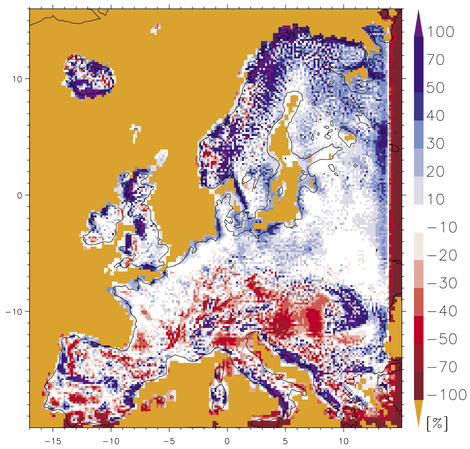

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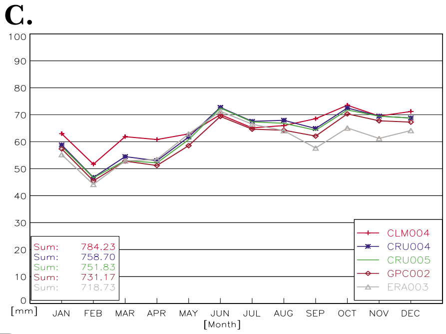

D.

Figure 2: Climatologic differences (79-93) of monthly sums of total precipitation between CLM evaluation run CLM004 and different reference data sets: A. ERA15 24h forecast, B: CRU, C: GPCC, D: area means of all data sets over CRU landpoints.

Figure 2 shows the differences between the climatological monthly precipitation (79-93) of the CLM simulation and of different reference data sets. Figure 2D exhibits the annual cycle of the area mean over the CRU-landpoints (Figure 2B) of the climatological monthly precipitation. The CLM overestimates the precipitation in Europe in winter and spring in comparison with all reference data sets, which has not to be wrong due to underestimation of snow in measurements. However, in autumn and in the early winter the ERA15 data exhibit less precipitation than CLM and the other reference data sets. The spatial distribution of the differences reveals an underestimation of precipitation in the Balkan and the Po lowlands, which is a still unsolved problem in RCMs. The strong differences at the lateral boundaries are caused by different model physics and resolutions of the driving GCM and of the RCM. The results for this sites can not be interpreted. The increased precipitation at the eastern boundary indicates small differences in the large scale dynamics between the GCM and the CLM.

The evaluation of the 2 m temperature field exhibits small deviations from ERA15 reanalysis of 0.5 K (Figure 3A) and a cold bias of 1 K in comparison to the CRU data (Figure 2B). Figures 2C and 2D exhibit a very good agreement between CLM004 and observations (CRU and DWD) over Europe (Figure 2C) and over Germany (Figure 2D) in summer but substantially lower temperatures in CLM004 in winter.

In comparison to the evaluation of clm2.0 a substantial reduction of the cold bias could be achieved due to a more consistent formulation of the surface energy budget. However, the good agreement with ERA15 reanalysis (Figure 2A, 2C), which has been used as boundary condition, indicates the strong dependence of the mean temperature of the RCM on the mean temperature of the driving model. The separation of the influence of the driving data and of model physics can be expected from ensemble simulations for present day climate and for different climate change scenarios. In this respect a substantial progress can be expected from the results of the consortial runs.

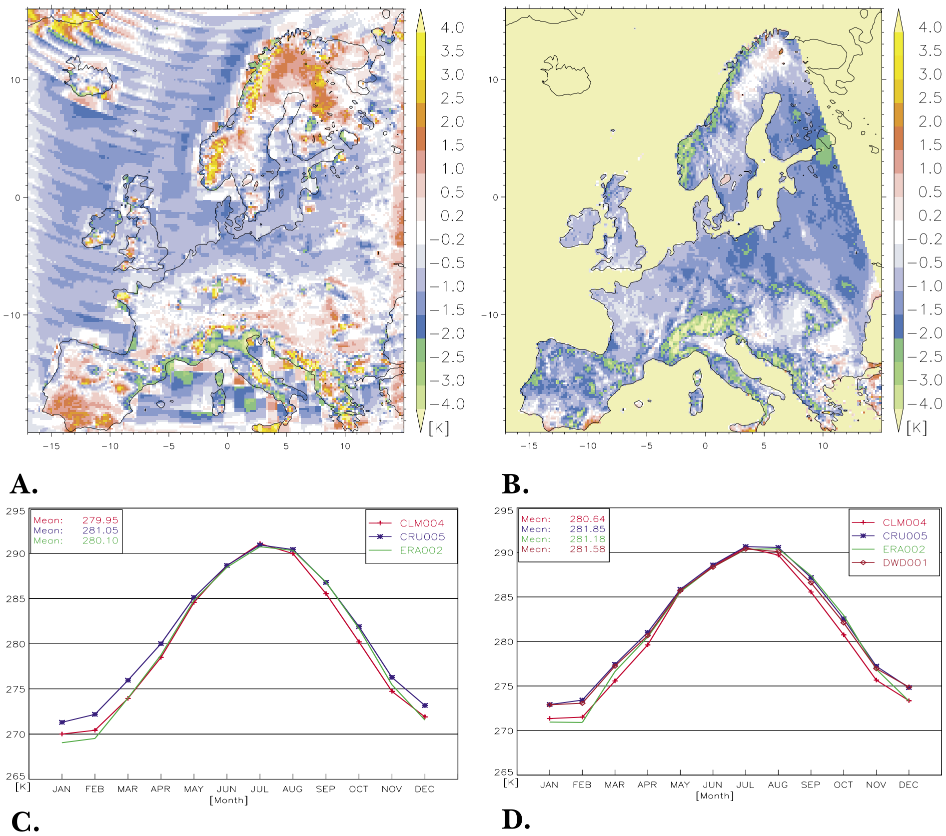

Figure 3: Differences of climatologic means (79-93, A,B) and monthly climatologies (C,D) of 2m temperature between CLM evaluation run CLM004 and different reference data sets: A. ERA15 24h forecast, B: CRU, C: area mean of CRU landpoints, D: area mean of German landpoints

Outlook:

During the last year the actual versions of the LM and of the CLM have been unified to obtain a hybrid model version for operational weather forecast and regional climate modelling. Now the COSMO consortium and the CLM-community will be able to join the skills of weather prediction and regional climate modelling in a much more efficient way than before. The hybrid model version is called LM-config. Here LM expresses the unique model version and config the different model configurations (C: climate, E: weather forecast for Europe at 7 km resolution, K: short range weather forecast for Germany at 2.8 km resolution, etc).

References

Böhm, U., Kücken, M., Ahrens, W., Block, A., Hauffe, D., Keuler, K., Rockel, B. and Will, A. (2006), “CLM - The Climate Version of LM: Brief Description and Long-Term Applications”, COSMO Newsletter, 6

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Wunram, C. (2006), “Regional climate modelling with CLM”, TerraFLOPS Newsletter 6, 5-6, Modelle und Daten, DKRZ

Regional climate modelling

[Daniela Jacob, Holger Göttel, Philip Lorenz, Susanne Pfeifer,
Max Planck Insitute for Meteorology, Hamburg]

http://www.mpimet.mpg.de

A major break through was possible with the regional climate change simulations on 10 km grid scale. Within a co-operation with the national environmental agency (UBA), REMO was used for a control simulation from 1950 to 2000 and three transient runs for the IPCC SRES scenarios A2, A1B and B1. The simulation domain covers Germany, Austria and Switzerland (Figure 4). Currently the model results are under evaluation, which focuses first on mean quantities. Possible changes for Germany at the end of this century as projected by REMO can be summarized in:

- increase of the annual mean temperature by 4°C (depends on emission amount and region)
- south and Southeast warm more than the other areas
- decrease of precipitation amount in wide areas of Germany during the summer
- increase of precipitation amount in South and Southeast during the winter
- less precipitation as snow

The simulation results offer a variety of follow-up analyses, like extreme value statistics, which is currently in progress, or impact studies. All data are stored in the CERA data base and are open for commercial and non-commercial use.

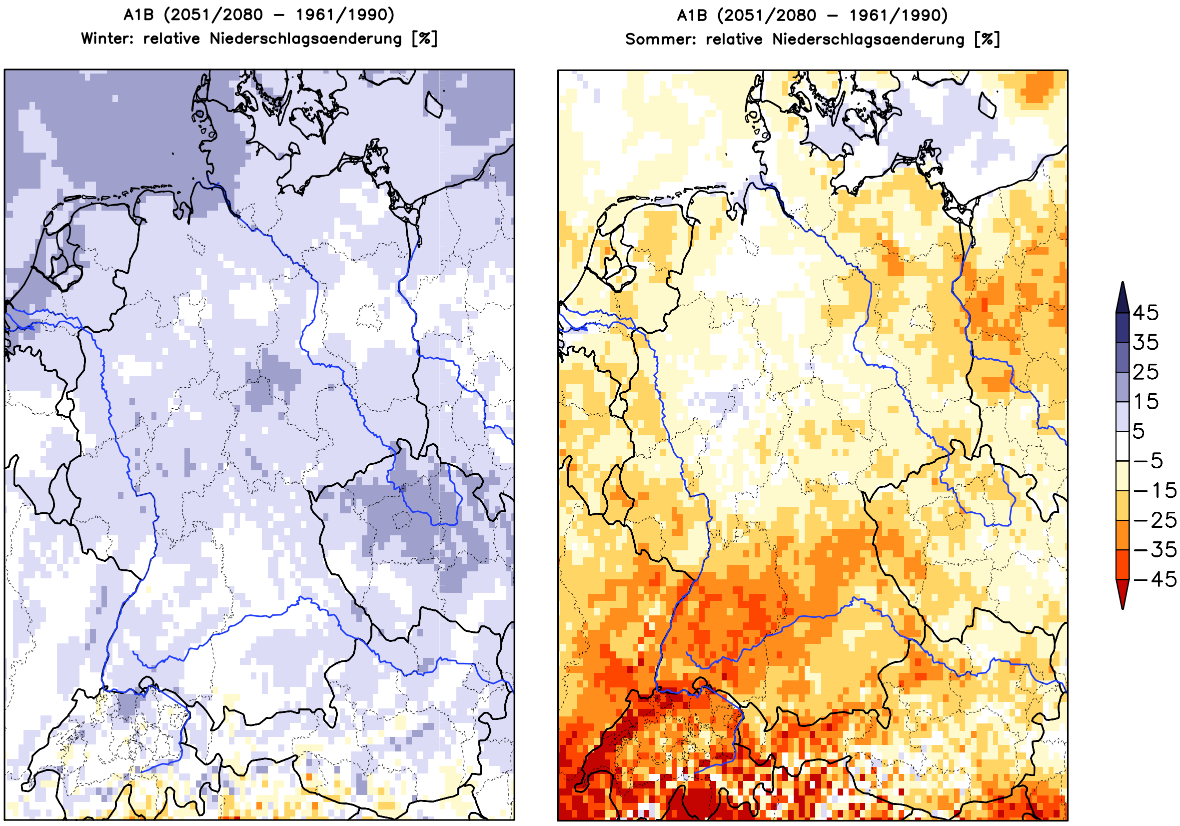

Figure 4: Climate change signal for summer (right) and winter (left) precipitation (%) for A1B. Time period: 2051/2080 minus 1961/1990

Access to Regional Climate Simulations of REMO and CLM

[Elke Keup-Thiel, Claudia Wunram, SGA / Model & Data]

http://www.mad.zmaw.de

The **RE**gional climate **MO**del **REMO** has been applied to simulate today's and future climate in high resolution for Germany, Austria and Switzerland (Figure 5). Those model calculations have been initiated by the Federal Environment Agency (Umweltbundesamt). Three IPCC scenarios (A2, A1B and B1) have been performed by REMO using the consortial runs of REMO IPCC in 0.44 degree horizontal resolution for initialization and as boundary condition. REMO calculates today's and future climate from 1950 to 2100 in about 10 km horizontal resolution (0.088 deg.). The output intervals vary from hourly to six hourly data depending on the variable. You can find more information about the **REMO-UBA** simulations at:

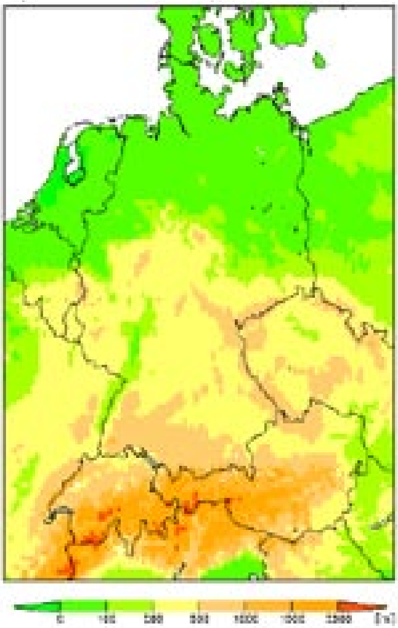

Figure 5: Model region of REMO-UBA (0.088).

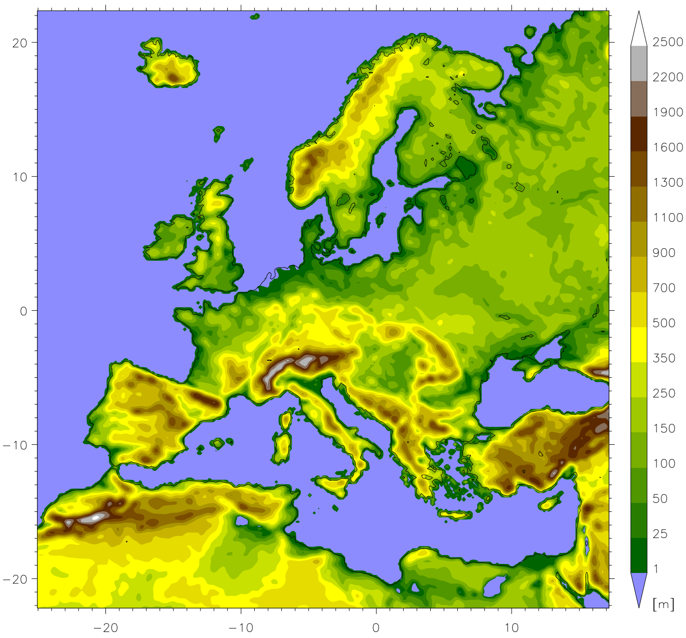

Figure 6: Model region of CLM (0.165).

http://www.mpimet.mpg.de/wissenschaft/ueberblick/atmosphaere-im-erdsystem/regionale-klimamodellierung/remo-uba.html

The **C**limate **L**ocal **M**odel (**CLM**) calculates the west European climate of today and future decades from 1960 to 2100 in about 20 km horizontal resolution (0.165 deg, Figure 6). The CLM simulation of today's climate and the IPCC scenarios A1B and B1 are directly driven by results from the coupled ocean atmosphere model ECHAM5-MPIOM. You can obtain more information about the CLM simulations and the experiment plan at the homepage of SGA (Service Group Adaptation):

http://sga.wdc-climate.de

Choose the topic 'consortial regional climate model runs'.

The direct model output is stored in the database system of the World Data Center for Climate (WDCC) in Hamburg. Two interfaces are provided in order to access data from the WDCC. The interactive Graphical User Interface (GUI) allows for web-based catalogue inspection and data retrieval:

http://cera-www.dkrz.de

The application programming interface called 'jblob' can be used in Unix scripts in order to download larger amounts of data:

http://pluto.dkrz.de/CERA/jblob

The presented regional climate model simulation experiments can be addressed in GUI by selection of the project 'REMO-UBA' or 'CLM_regional_climate_model_runs'. The WDCC GUI provides detailed catalogue information for the project related model runs ('experiments'). Additionally a complete list of datasets of each experiment is given. The data download is organized by the 'Data Order Form' that specifies data reduction and processing options: selection of subset of time series, selection of geographical region and format conversion. The complete functionality is available for the data formats NetCDF/CF and GRIB1.

The usage of the REMO-UBA data is possible after acceptance of the usage conditions. A usage contract has to be signed and sent to Federal Environment Agency. Please contact *remo-daten@dkrz.de* for further details.

CoMmunity SiMulations of the last Millennium

[Johann Jungclaus, Max Planck Insitute for Meteorology, Hamburg]

http://www.mpimet.mpg.de

During the August 2006 meeting the WLA approved the project "CoMmunity SiMulations of the last Millennium" (COMSIMM) and granted resources for consortial runs.

Knowledge of past climate variability is crucial for understanding current and future climate trends. For the first time, sufficient computational resources are available to carry out millennial-scale simulations with a comprehensive Earth System Model. Within the Community Earth System Modelling (*http://cosmos.enes.org*) initiative, a community effort has been initiated to carry out such simulations using the COSMOS ESM.

Climate history requires that these experiments are started in the year 800 and run until the year 2000. To discriminate between internal variability, natural external forcing (orbital, solar, volcanic), and the anthropogenically induced land-use-change and greenhouse-gas forcings, it is necessary to carry out an ensemble of several (min. three) 1200-year long integrations with a relatively high-resolution ESM. The results expected from the simulations will allow to

(1) comprehensively evaluate the model used for climate projection in the framework of past variability
(2) to explore in-depth the role of solar, volcanic, and land-use-change and their role in the 20th century warming
(3) to investigate interannual, multi-decadal to multi-century climate variability, atmospheric modes (e.g. NAO, ENSO), and ocean circulation changes
(4) to assess regional climate change and regional/global scale teleconnections
(5) to identify regional „hot-spots“ where climate change manifests itself particularly
(6) to evaluate the model's low frequency ecosystem feedbacks
(7) to test statistical methods

Performing millennia-long integrations in ensemble mode is a challenge, both in terms of required computing time, data transfer systems, and storage capacities. Innovative infrastructure and sophisticated environments, such as offered by DKRZ, is necessary to perform and manage such a project.

More information is available at: *http://www.mpimet.mpg.de/en/wissenschaft/working-groups/millennium.html*

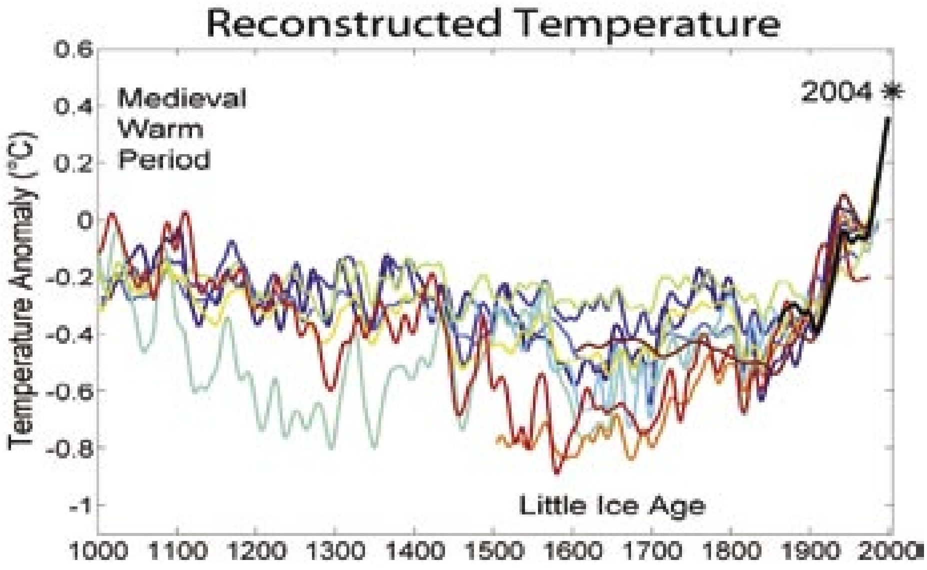

Figure 7: Comparison of 10 different published reconstructions of mean temperature changes during the last 1000 years.

(Source and more information at: http://www.globalwarmingart.com/wiki/Image:1000_Year_Temperature_Comparison.png)

DKRZ wins best demonstration award at International Grid Conference

At the EGEE'06 conference in Genf in September 2006 Kerstin Ronneberger und Stefan Kindermann from DKRZ demonstrated their basic grid-enabled climate analysis workflow and were awarded with the prize for one of the two best demonstrations of applications on the Grid.

Developments from the German C3Grid project were adapted for and combined with the grid infrastructure of the European EGEE project to search, to access, and to process climate data. The data, resulting from observations or modelling studies, are distributed over many archives, and vary tremendously in accessibility and quality. The demonstrated approach allows for uniform search and access of the different German data-centres, hiding their implementation details. The methods are based on international standards, guaranteeing sustainability and expandability.

News from WLA

At its meeting on August, 29th, 2006 the Scientific Steering Committee of DKRZ and M&D (WLA) thanked Prof. Dirk Olbers, who retired from the Committee, for his valuable contributions.

Thenceforward the Alfred Wegener Institute is represented by Prof. Gerrit Lohmann.

The WLA introduced Prof. Martin Heimann as its new chairman and Prof. Andreas Hense as vice-chairman. The executive comittee is completed by Prof. Rupert Klein as former WLA chairman.

Further information about WLA and its meetings are found on: *http://www.mad.zmaw.de/scient-steering-board/*

Change in DKRZ Management

On October, 1st, 2006 Manfred Meinecke took over the responsibilities of the managing director of DKRZ from Maximilian Prugger. Mr. Meinecke, who was Deputy Secretary General of the Max Planck Society for four years before his retirement, always had a strong relationship with DKRZ. He was significantly involved in the foundation of DKRZ in 1987, when he was heading the finance department of the Max Planck Society.

Dive into Science and "Surf the Earth"

Researcher´s Night 2006 in Hamburg

On September 22th, 2006, DKRZ participated in the Researcher´s Night "Surf the Earth" at the ZMAW in Hamburg. This event was funded by the EU as part of the Researcher´s Night 2006 Initiative [1] and took place simultaneously with 30 further Researcher´s Nights all over Europe.

With the theme "Dive into science and surf through climate research", Surf the Earth gave people the opportunity to meet researchers from ZMAW, GKSS, the staff of DKRZ and many more people specialised in the earth system, the deep sea, geophysics, oceanography, fisheries, climate research, geology and chemistry etc. The event also enabled people to obtain an insight into the everyday life of a researcher.

DKRZ gave guided tours to its night-lit, high-performance computer on the 15th floor of the Geomatikum, simultaneously, offering people the opportunity to take advantage a the stunning night view over Hamburg. Supported by the company "Visenso", DKRZ also presented a virtual reality visualisation of the aerosol-climate model ECHAM-HAM.

More than 1.000 people used the opportunity to view and examine the offered demonstrations, presentations and experiments. For more photos see [3].

Figure 8: For families and their children a special kids´ laboratory was offered including for example a climate rally, interactive experiments, the climate game "Wind of Changes" and launching real air balloons (photo: M. Böttinger).

Figure 9: In a special dive container research frogman demonstrated the use of marine research instruments (photo: G. Kleinhoff).

[1] http://ec.europa.eu/research/researchersineurope/events/event_2216_en.htm

[2] http://www.wissensnacht.de/

[3] http://www.zmaw.de/Die_Wissensnacht_Surf_the_Ear.84.0.html

Figure 10: In the open-air area visitors could not only follow the demonstration of marine research instruments or the use of a cloud-radar but also beef up themselves at an Indian buffet for the final researcher party with DJ Elbe (photo: G. Kleinhoff).

Figure 11: A guided tour to the facilities of HLRE - DKRZs high performance computer system for earth system research (photo: M. Böttinger).

Figure 12: Visitors being fascinated by the virtual reality visualisation of the aerosol-climate model ECHAM-HAM (photo: G. Kleinhoff).

OUR SERVICES

- **Computer Time For Earth System Modelling:**
  Top level computing ressources and archive capacity are available to all interested research groups working on climate and earth system modelling. DKRZs scientific steering committee (WLA) selects admissible projects.
  Information: *http://www.dkrz.de/projects*
  Email: *projects@dkrz.de*
  Contact: *Joachim Biercamp (ext -314)*

- **Support for users:**
  Support for porting models to DKRZ computers, support for model optimisation, visualisation services and general user support to all users.
  Information: *http://www.dkrz.de/support*
  Email: *beratung@dkrz.de*
  Contact: *Help Desk (ext -275)*

- **Latest Online Information:**
  Announcements and latest news regarding DKRZ facilities and services: ***http://www.dkrz.de/news*** (or ***http://www.dkrz.de/news/ann*** for registered users).

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- **Community climate models:**
  M&D provides numerical models and diagnostic software as well as user support for their application and carries out comprehensive climate model runs.
  Information: *http://www.mad.zmaw.de*
  Email: *model@dkrz.de*
  Contact: *Stephanie Legutke (ext -104)*

- **Data Support:**
  Provision, maintenance and easy access of climate research relevant data of different research groups as well as post-processing tools and the support of users of the climate data base.
  Information: *http://www.wdc-climate.de*
  Email: *data@dkrz.de*
  Contact: *Michael Lautenschlager (ext -297)*

- **Mailinglist:**
  For news regarding M&D, such as announcements of workshops and conferences, new models and datasets, changes in accessing M&D etc. send "***subscribe mad_info***" to ***majordomo@dkrz.de*** .

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