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Service for earth-system-research
Newsletter
Deutsches Klimarechenzentrum
Modelle & Daten

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TerraFLOPS
Service für die Erdsystemforschung

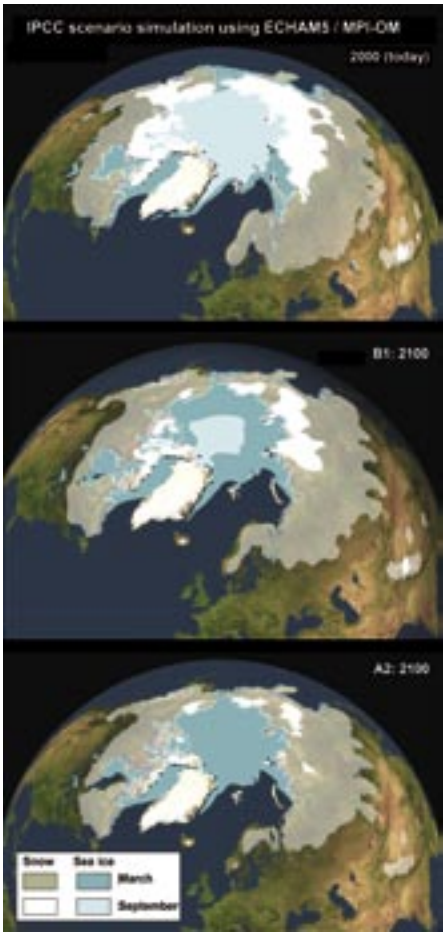

Figure 1: Simulated northern hemispheric sea ice extent and snow cover in 2000 and 2100 from a coupled model simulation using HLRE. Shown are 5-years-monthly-means for March and September for the "pessimistic" scenario A2 and the "optimistic" B1 scenario. There is a drastic reduction of the summer sea ice. As a consequence of the global warming the seasonally varying sea ice decreases between 30-50% so that the arctic might become completely ice free during late summer by the end of this century. During winter the ice freezes again, still the maximal winter expansion of sea ice also decreases visibly. The snow cover shows a similar trend. The presently snow covered areas will become smaller, even in winter. These results have been submitted to the IPCC Fourth Assessment Report (pp. 2-3).

Coordinated Community Effort:
Societally relevant data produced and made available at DKRZ

(by Joachim Biercamp) DKRZ and M&D operate powerful facilities in order to enable extensive climate simulations and thus scientific progress that otherwise would not be possible: the supercomputing and data handling system (HLRE) and the World Data Centre for Climate (WDCC).
Like a research vessel, the resources can and should be used in coordinated efforts by the community of earth system researchers to conduct cutting edge experiments which are of common interest and which depend on the availability of state-of-the-art computing and data handling technologies.

Scenario simulations for the Fourth IPCC Assessment Report

Such a "Coordinated Community Effort" was necessary to produce an important contribution to the upcoming new assessment report of IPCC. A coupled model developed at the Max-Planck-Institute for Meteorology (MPI-M) was used jointly by scientists of MPI-M and M&D to produce several scenario simulations (figure 1 and pp. 2-3). One third of the total capacity of HLRE was made available for these computations for one year. The enormous amount of computing time was provided by the community as a whole: It was taken in equal shares from the contingents of the DKRZ shareholders and from the contingent managed by the Scientific Steering Commitee (WLA). The relevant data produced by these experiments are made publically available via the WDCC (pp. 4-5)

Regional climate simulations as data source for impact studies

Based on the data produced by the global scenarios several groups joined forces to simulate the regional impact of possible climate change scenarios (pp. 5-6). Again, for one year at least one quarter of DKRZs resources will be dedicated to this exercise and the data will be pre-processed and made available to the community.

Further studies

Other society relevant data can and hopefully will be produced using HLRE as a community tool in the future. Proposals should be adressed to WLA.

In this issue

Coupled model simulation as a German contribution to the next IPCC Report

From May 2004 until May 2005 about a quarter of the DKRZ computing resources have been devoted to coupled model simulations for the fourth IPCC Report. The data produced, in this "community effort" (Konsortialrechnung), is stored in the relational data base system CERA, so that it is available to all scientists for further analysis via the World Data Centre for Climate. First results of the simulation were visualised by the DKRZ visualisation group.

In May 2005 the model simulations for the AR4 being announced in the last TerraFLOPS (No 5) have been successfully completed after one year of work by scientists from Max Planck Institute for Meteorology (MPI-M) and M&D with the help of DKRZ.

Figure 2 (left) illustrates the components of the climate model used (a coupled atmosphere-ocean-land-sea-ice model) ECHAM5 / MPI-OM developed at MPI-M. Altogether 18 individual experiments were realised with this model simulating about 5000 years which required approximately 400.000 CPU-hours. Some experiments were repeated with a preliminary version of the COSMOS earth system model (figure 2, right; cf. TerraFLOPS No 5), including a detailed representation of tropospheric aerosols and the biogeochemistry of the ocean.

The model output of the new IPCC simulations amount to approximately 400 TeraBytes whereof 115 TeraBytes, are already included into the relational data base system CERA (figure 3). Being of special interest for various earth system research studies the results of these intricate simulations are partly preprocessed and stored operationally on CERA and are available to the community (for instructions how to access these data see pp. 4-5).

First Results

Several results of the simulations were animated and visualised at DKRZ. Examples are given in figure 1 (cover page) and in figures 4-6. More images as well as various animation can be found at ***hppt://www.dkrz.de/dkrz/science/IPCC_AR4/scenarios_AR4_Intro.***

[J. Meyer, M. Böttinger, J. Biercamp]

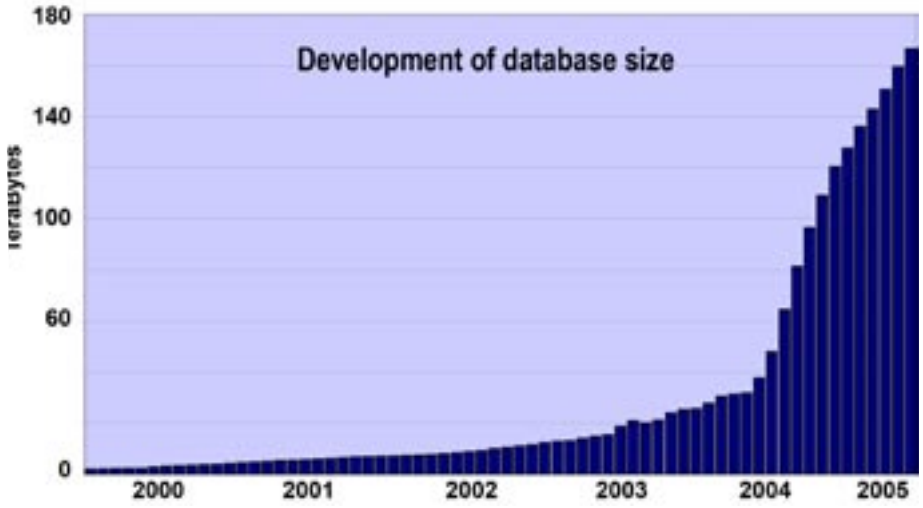

Figure 3: Growth of the CERA climate database. An extraordinary steep increase can be observed since summer 2004. Midyear 2005, 170 TeraBytes were stored in the data base. Two third of the data (115 TeraBytes) can be attributed to IPCC simulations. Further IPCC data are still waiting to be included into the database.

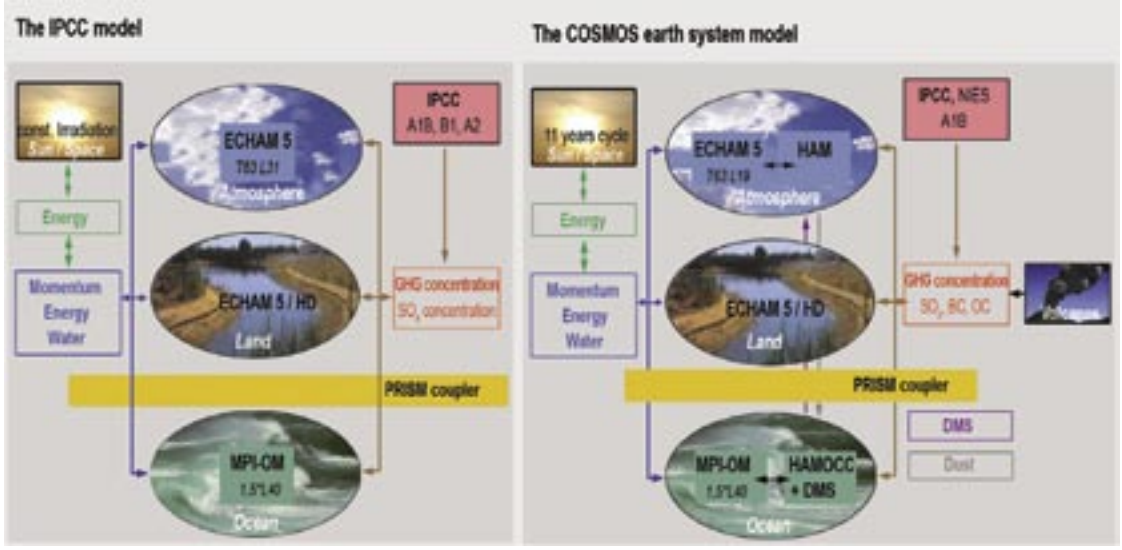

Figure 2: Model components and forcings of the applied climate models for the IPCC scenarios simulations: On the left side the ECHAM5/MPI-OM. On the right the preliminary version of the COSMOS earth system model, including a detailed representation of tropospheric aerosols and the biogeochemistry of the ocean.

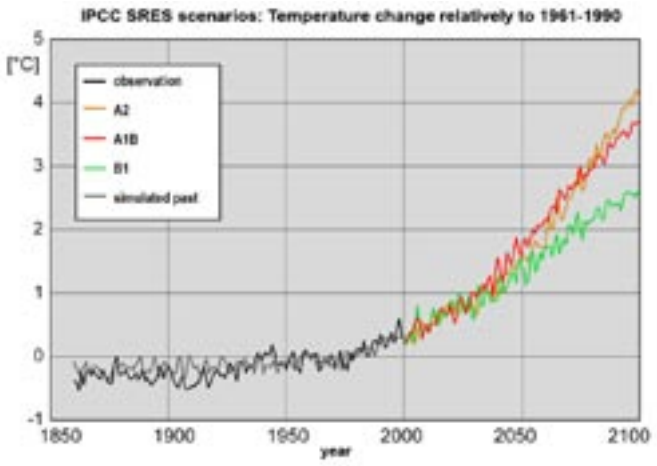

Figure 4: Simulated and observed temperature between 1860 and 2000 and simulated future temperature for three different emission scenarios. The comparison of the temporal development of the 2-m-temperature shows the possible reactions of the climate system to changing greenhouse gas concentrations within the next 100 years. The curves show a mean global warming of 2,5 to 4,1°C until the end of this century.

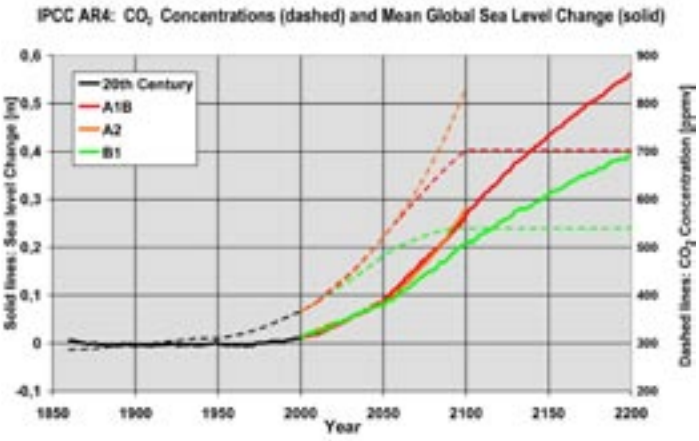

Figure 5: Changes of the mean global sea level (solid lines) are strongly influenced by the level of greenhouse gas concentrations in the atmosphere (dashed lines). The simulations show that - depending on the emission scenario - a global mean sea level change of 21 to 28 cm (compared to the period 1961-1990) can be expected. Note that for the scenarios A1B and B1 the simulations have been continued with constant concentrations (values of 2100) for the period between 2100 and 2200. However, since the ocean is able to store large amounts of heat, the sea level will continue to rise even when the greenhouse gas concentrations have reached their maximum.

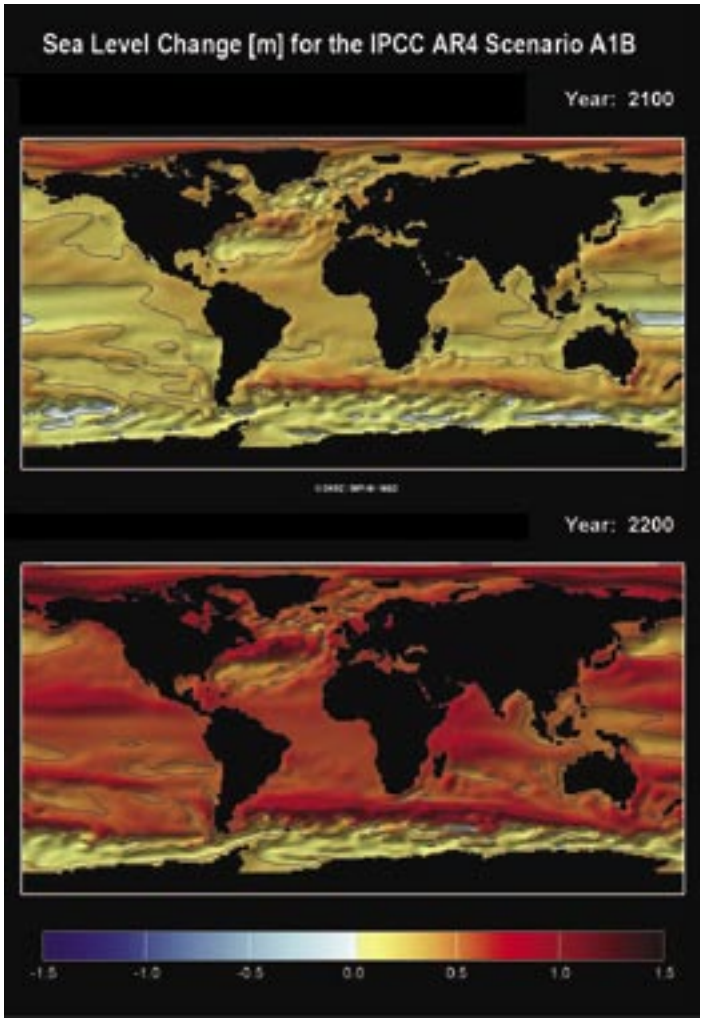

Figure 6: Simulated sea level change for IPCC scenario A1B in 2100 and 2200. The projected mean global sea level rise of 28 cm for 2100 and 56 cm for 2200 (see also figure 5) can be attributed to the steric expansion of the water masses. Regional differences in the sea level changes are caused by changes of the ocean circulation and the hydrologic cycle (precipitation minus evaporation).

Climate Change Signal Analysis using Bayesian Statistics

Another contribution to IPCC AR4 has been produced by scientists from the Meteorological Institute of the University Bonn in cooperation with the Meteorological Research Institute of KMA, Korea and M&D. They applied a statistical approach to ensemble runs with the ECHO-G model and to multi model ensembles.

For these experiments nearly 20.000 CPUh were provided by DKRZ. Every experiment, simulating 250 years, produced 1,2 TeraBytes data for the atmosphere and 50 GigaBytes data for the ocean - adding up together to approximately 20 TeraBytes.
These data will also be made publically available.
For more informations see:

http://www.dkrz.de/report_2005 (➜ 193)

Community access to data from the IPCC experiments performed at DKRZ

The IPCC scenarios meet the requirements defined for the IPCC WG I data base on PCMDI [1] , which serves as a data archive for the new Assessment Report No 4 of the IPCC. Thus a subset of daily and monthly averaged data are included in the IPCC Model Output Archive at PCMDI: [2]. Some of the data are also available from the IPCC-Data Distribution Centre: [3].

However, the total amount of data currently available at DKRZ (Table 1) is about 115 TeraBytes and includess 6-hourly and monthly data originating from ECHAM5 scenario runs. These data are stored as time series of 2-dimensional fields in the data base CERA which permits online access to the data.

Online access to the data base

A complete list of global scenario runs (stored as experiments within the data base) can be found on [4]. This page also gives access to the information on the individual data sets (link 'experiment') and a code list (link 'parameter') for variables that are available from these experiments. The experiment information available from these pages is directly created from the meta-data stored in the CERA data base. The experiment description also supplies the user with comprehensive meta-data information of specific data sets (variables). This includes information on spatial and temporal coverage and on the total size of the stored data.

The data access for download is carried out by means of a java based applet which is running in an internet browser (with java plugin installed) or alternatively by applying the command line (java-) tool jblob.

The data base browser is the standard tool for directly accessing and browsing the meta-data content of the entire data base and hence to have a look on the complete data base content. This is done by accessing the data base from the internet.

The data base browser (starting from URL: [5]) allows different strategies to look for specific data sets. They may focus on the characteristics of the data sets or on the experimental setup.

When looking for specific variables, the search is first focused on the topic meta-data which describe the physical quantities and will point to all those data sets that are associated with them. In most cases, a refinement is required here because of the large number of data sets (about 60.000 up to now) that matches normally the topic search.

Those refinement criteria may be the project or experiment which is usually associated with specific scenarios. But temporal resolution, spatial resolution or temporal coverage are important characteristics for the usability of the data as well. Currently this information is not accessible for direct search but is included already into the meta-data. Thus a closer look to the corresponding meta-data is required for the data to be considered. However, even the experiment's name will provide an indication on the data content. Thus the experiments acronym includes amongst others codes for model(s), horizontal and vertical resolution and scenario. As an example the experiment name: EH5-T63L31_OM-GR1.5L40_A1B_3 indicates ECHAM5 (EH5) atmosphere-model with T63 resolution and 31 levels (T63L31) coupled to the MPI-OM ocean model (OM) with 1.5 degree resolution and 40

Table 1: Short list of IPCC experiments from which data are available at DKRZ, for detail see [4]

Name	Period	Short Description
EH5-T63L31_OM-GR1.5L40_CTL	2150-2655	Pre-industrial control experiment
EH5-T63L31_OM-GR1.5L40_20C_1	1860-2000	20th century with anthropogenic forcing (greenhouse gases, sulfate), 3 realisations
EH5-T63L31_OM-GR1.5L40_20C_1	2001-2100	Commitment experiment with constant concentrations (year 2000), 3 realisations
EH5-T63L31_OM-GR1.5L40_A1B_1	2001-2100	SRES scenario: A1B (initialised in year 2000 of 20C_1), 3 realisations
EH5-T63L31_OM-GR1.5L40_A1B_1	2101-2200	Commitment experiment with constant concentrations (year 2100), 3 realisations
EH5-T63L31_OM-GR1.5L40_B1_1	2001-2100	SRES scenario B1 (initialised in year 2000 of 20C_1), 3 realisations
EH5-T63L31_OM-GR1.5L40_B1_1	2101-2200	Commitment experiment with constant concentrations (year 2100), 3 realisations
EH5-T63L31_OM-GR1.5L40_A2_1	2001-2100	SRES scenario A2 (initialised in year 2000 of 20C_1), 3 realisations
EH5-T63L31_OM_1CO2_1	1860-1930	CO_2 only: Annual increase of 1% until CO_2 doubling, 3 realisations
EH5-T63L31_OM_1CO2_1	1931-2080	stabilisation at CO_2 doubling, 3 realisations
EH5-T63L31_OM-GR1.5_CMIP4_1	1930-2000 2001-2188	CO_2 only: Annual increase of 1% until CO_2 quadrupling, stabilisation at CO_2 quadrupling

levels (GR1.5L40).(A1B) indicates the SRES A1B IPCC forcing scenario while (3) is the 3rd member of an ensemble of runs.

The second way of searching the data is to select a keyword and/or a project at the experiment level. This will reduce the assortment to a matching set of experiments. Even in this case the experiment name will give hints on additional characteristics as mentioned above.

The data base browser additionally enables those users who have got an user account (free of charge) to download data sets (or parts of it) directly to the local disk.

Since most data are part of the WDCC [6], these data are freely accessible due to the rules of the ICSU [7].

For more details on the data access please refer to [5], where you can start the data base browser but also find some usage links.

Currently a new browser version is being developed. It will improve the functionality for searching the meta-data to get meta-data information. Future capabilities will include cutting of regions from the data set, a more comfortable time selection and a download of meta-data. A first look to the new meta-data view can be found on [8].

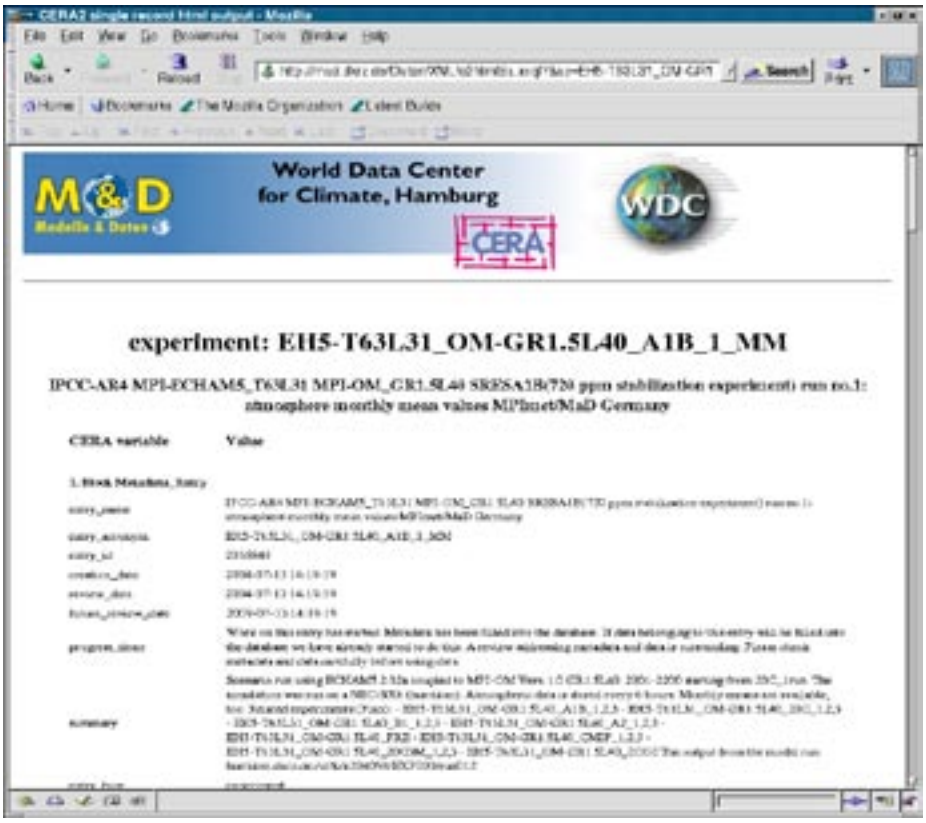

Figure 7: Metadata representation in a web browser

[1] *http://www-pcmdi.llnl.gov/ipcc/standard_output.html*
[2] *http://www-pcmdi.llnl.gov/ipcc/about_ipcc.php*
[3] *http://ipcc-ddc.cru. uea.ac.uk/*
[4] *http://www.mad.zmaw.de/IPCC/ipcc.wg1.html*
[5] *http://cera-www.dkrz.de/CERA*
[6] *http://www.mad.zmaw.de/wdcc/*
[7] *http://www.ngdc.noaa.gov/ wdc/guide/gdsystema.html*
[8] *http://mad.zmaw.de/WINI/*

Regional Data

Data from regional simulations described below will also become available via CERA.

[Hans Luthardt]

Regional climate modelling with CLM

The local model of the Deutscher Wetterdienst (Germany's National Meteorological Service) is used in its climate version (CLM) to simulate the regional climate of today (1960-2000) and future decades in Europe (2000-2100). The high spatial resolution of 0.165° provides a good basis for regional climate investigations.

The regional model is forced 6 hourly by global climate model runs with ECHAM5/ MPI-OM under several climate conditions. The actual climate of the 20th century is simulated by three 20th century realisation runs, which are all based on the same control run, but set off at different initialisation times. The climate of the 21st century is modelled with respect to three IPCC-climate scenarios (A1B, B1, A2) with different assumptions regarding the development of global greenhouse gas concentrations.

The output of the regional model will be divided into three different data streams with its specific characteristics. The overall output format is netCDF. Data stream 1 is intended for future model forcing purposes and will be lead into the UT-archive file system per time step. Data stream 2 will be converted into time series before being archived in the CERA database and is intended e.g. for model inter-comparisons. Unlike the other two data streams, data stream 3 will be derotated into a regular geographical grid with 0.2° resolution. For the data transformation between the

respective grids the same method as for REMO data will be used. The stream 3 data will be provided via CERA as time series and used in the context of the BMBF projects dealing with adaptation to climate changes, which are attended by SGA.

In accordance with the ENSEMBLE project, the model domain covers the west European region and is given in figure 8. The model variables are calculated as two-dimensional near surface fields and three dimensional soil and atmospheric fields, respectively. The soil fields are simulated on 10 different levels with a maximum depth of 15 meters. The atmospheric fields are given on 6 pressure levels (200, 500, 700, 850, 925 and 1000 hPa). The time intervals of the output fields range from 1 to 12 hours and include daily output fields, depending on the respective variables.

The CLM model runs will start this fall with a consortial status on the DKRZ machines and will presumably be finished in summer 2006. The data is archived in CERA, which is described on ***www.wdc-climate.de***.

[Claudia Wunram]

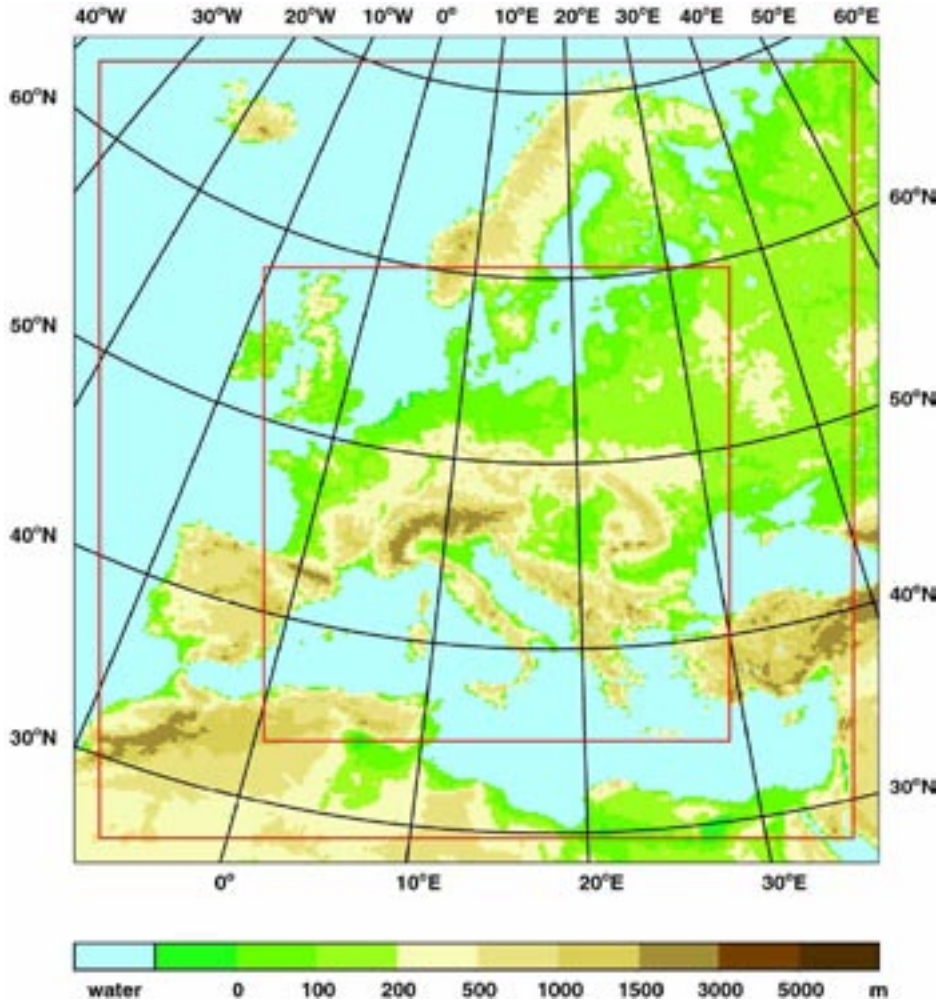

Figure 8: Map of the entire model domain of the CLM runs. Big red square shows the domain without sponge, the smaller square the subdomain for nesting.

Service Group Adaptation (SGA) established at M&D

The service group adaptation (SGA) has been established since May 2005 in the context of the group „Model and Data" (M&D) at the Max Planck Institute for Meteorology, Hamburg. SGA is part of BMBF's new funding priority „Research for Climate Protection and Protection from Climate Impacts". Under the overarching policy principle of sustainability the funding concept pursues the aim of translating existing knowledge of the climate into the solution of application-oriented topics. This includes protection of the climate in the long term, i.e. via the reduction of greenhouse gas emissions, but also the protection from the consequences of short-term climate changes and extreme weather events, a theme which has become very topical lately.

Weather and climate play an increasingly important role in various sectors of the economy and society. This has to be taken into account in business management and planning strategies, especially on a regional basis. Even if the emissions of greenhouse gases are reduced, there will still be a damaging impact on the ecological and climate system in the future. Thus it is necessary to develop strategies to make it possible to adapt to those impacts of global warming that are already known today to be unpreventable. Moreover we need to be able to adapt better to climate and weather changes already on a short timescale. The timely adoption of suitable adaptation measures can not only reduce economic losses but may also give rise to new business opportunities.

BMBF's funding priority „Research for Climate Protection and Protection from Climate Impacts" focuses at several topics, applications and regions in Germany. Keeping the long-term need to develop new integrative strategies in mind, a common data base and methodological background for the projects dealing with adaptation processes is needed. This task is addressed by the Service Group Adaptation (SGA).

The objective of the service group is to intensify the trans-disciplinary coo-

peration between climate data users from business and society and from different scientific fields. In this context it is crucial that the problems and questions coming from the potential user groups from numerous branches of business and various areas of society are at the centre of future research activities. One of SGA's main efforts is to establish a dialogue with the users, who might not be familiar with handling climate models and data. Advice is given appropriate to the specific project members with respect to the handling and application of climate model and observational data.
SGA's main tasks are to define a standardised basis for applied regional modelling (CLM model), to process and consolidate the output of regional climate modelling under the condition of different climate scenarios and to make it available to the participating projects in the BMBF funding priority. On top of that, SGA includes the data of the routine observations of the Germany's National Meteorological Service (Deutscher Wetterdienst, DWD) as well as observations from other European countries and supplies it to the project members.
An additional scientist located at the DWD, Offenbach, provides support to the Hamburg SGA team in dealing with the supply, digitalisation and homogenisation of observational data.
In Hamburg SGA is represented by Dr. Elke Keup-Thiel and Dr. Claudia Wunram. For questions, comments and further input, please contact: <*sga@dkrz.de*>. Further information will be available on SGA's website at: ***http://sga.wdc-climate.de*** (currently under construction).
The activity of the SGA is supervised by a coordinating group, which consists of representatives of the following institutes: the „Model and Data" group at Max Planck Institute for Meteorology, Hamburg, the GKSS research centre, Geesthacht, and the DWD, Offenbach.

[Claudia Wunram]

Towards a new data management concept at DKRZ

Besides supercomputing DKRZ provides extensive data services for the user community. Archiving of data is organised in a very conveniant and transparent way for the users via the UNIX filesystem. The global file system (GFS) provides direct access to the data via a disk cash of 70 TeraByte from which it is automatically copied into tape based mass storage system with a capacity of curently 6 PetaByte.
For today's scientific work, data and their fast retrieval and reliable archiving is of central and increasing importance. DFG requires for funding projects a committment on "Proposals for Safeguarding Good Scientific Practice" (*Grundsätze zur Sicherung guter wissenschaftlicher Praxis*). This includes the recommendation, that primary data as the basis for publication shall be kept accessible for ten years [1]. In addition, from a more scientific view the easy access to as many simulation results as possible will give raise to many new possible experiments. Therefore, the data archiving strategies have to be reconsidered and the DKRZ usergroup has requested a new data management concept which meets the requirments in a sustainable way.
Up to now most mass data produced at DKRZ is stored directly on tape without classification and without a special service level agreement with respect to long term archiving. A working group consisting of members of DKRZ, M&D and the usergroup proposed a data management concept, which could serve as a basis for further discussions.
Most data stored at DKRZ can be associated to HLRE-projects. Three archive classes should be defined in the future.

1. Working Data

- This includes all data actually worked on, e.g. raw model data during the simulation experiment.
- These data should reside on disk to guarantie fast and frequent access.
- These data have a relatively short life time and disk quota for indivudal users as well as for scientific projects are defined.

2. Project Data

- This class involves data of the project which are less frequently used but are needed throughout the lifetime of the project.
- These data will be removed some time after the related project has ended.
- For reasons of economy no second copies of these data can be stored.

3. Long term archive data

- All data relevant to publication or data of special common interest (e.g. simulation results for IPCC)
- Archived for a long time (~10 years).
- The data have to be well documented in a standardised way.
- Data are read only and cannot be changed.
- To minimise the risk for data loss, safety copies of the data are generated. It would be desirable to store at least a subset of these backups outside DKRZ in co-operation with another institution.

Implementation of this strategie requires the introduction of schemes for accounting of data and for allocation of storage capacity to projects.
Once this is in place DKRZ will provide as a next step the possibility to request second copies of specified data to be written on separete tapes, e.g. using the CERA data base.
These basic ideas for a data management concept are under discussion. Contributions from users are welcome and should be send to J. Biercamp (DKRZ, <*biercamp@dkrz.de*>), M. Lautenschlager (M&D, <*lautenschlager@dkrz.de*>) or B. Fritzsch (usergroup, <*fritzsch@awi-bremerhaven.de*>).

[Bernadette Fritzsch]
[Joachim Biercamp]

[1] Recommendations of the Commission on Professional Self Regulation in Science, Proposals for Safeguarding Good Scientific Practice, DFG, January 1998

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/ClimateModels*
  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.mad.zmaw.de/ClimateData*
  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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