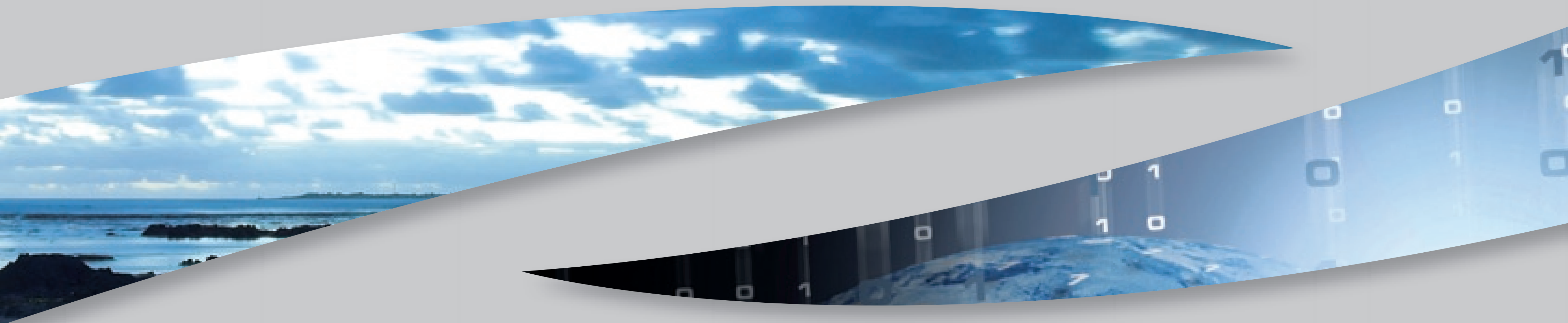
DKRZ
DEUTSCHES
KLIMARECHENZENTRUM

The Power to Understand: Supercomputing for Climate System Science



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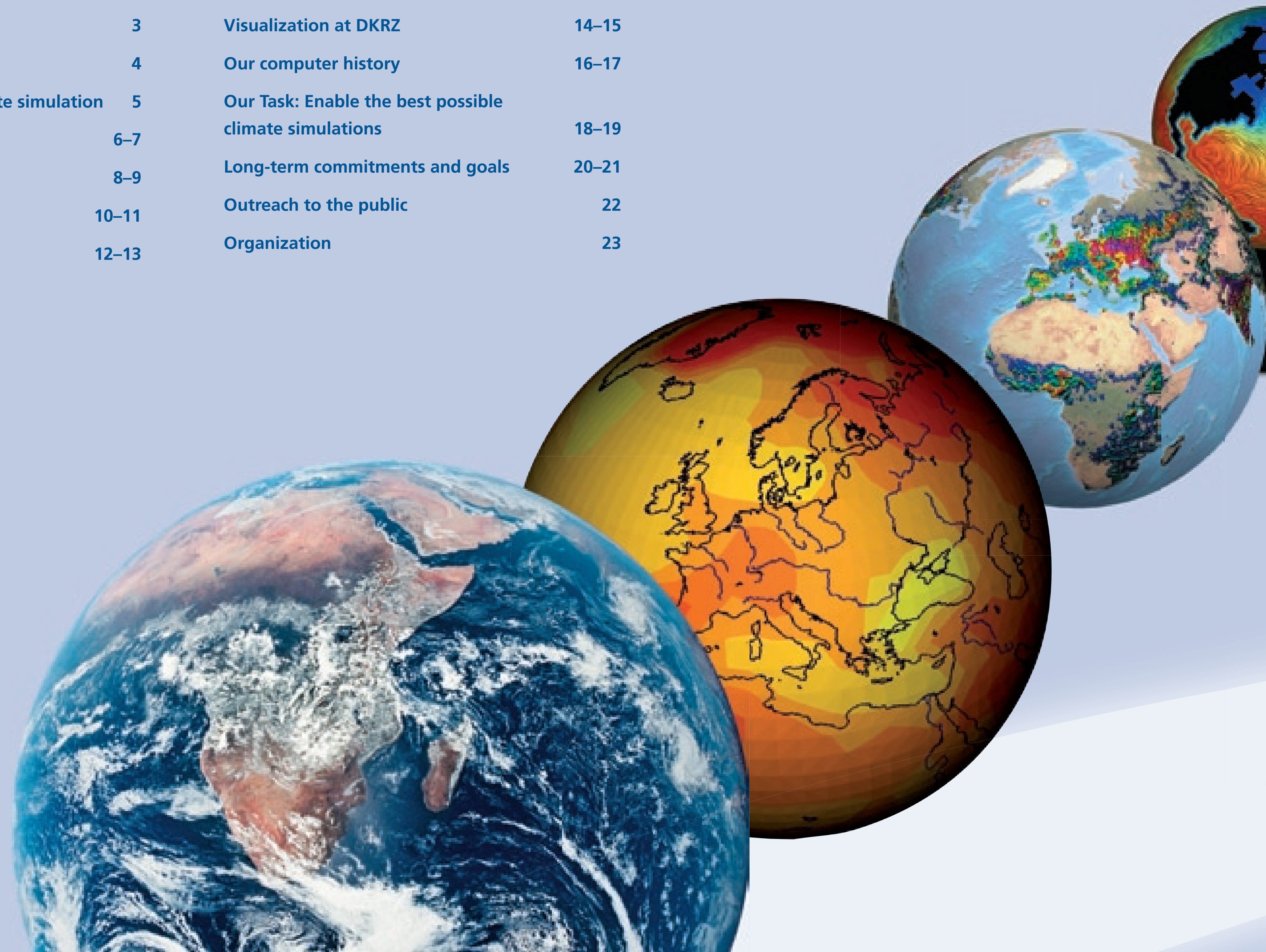


Our mission:

To provide a unique combination of world-class computer power and expert personnel to enable superior climate modeling.

People

- knowledgeable in earth science
- competent in high performance computing
- experienced in data management
- proficient in visualization

Computers

- high performance parallel computing
- world leading archiving systems
- powerful visualization

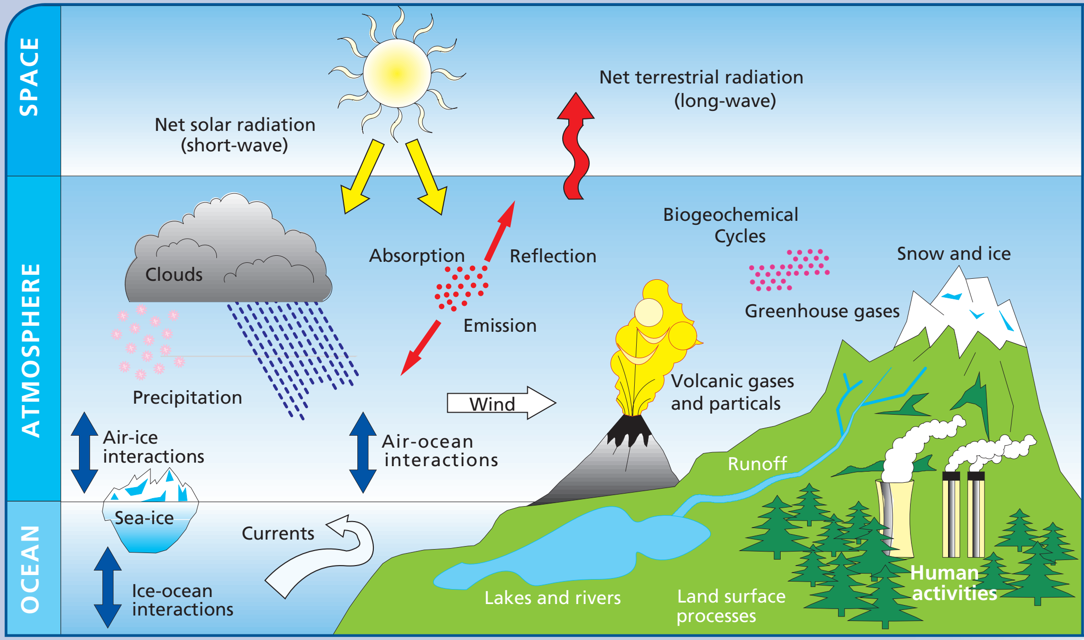
The climate problem

How will the climate evolve in the next decades? Which physical, chemical and/or biological mechanisms lead to climate variability? To what extent can we predict the evolution of the earth system? Which changes are due to natural variability and which can be attributed to human activities?

The earth has undergone and is undergoing constant change. By analyzing climate archives such as ice cores, boreholes, tree rings, glaciers, pollen residues, and ocean sediments, and the study of changes in the earth's orbit around the sun, scientists are able to reconstruct climate change dating back millions of years. Throughout the earth's history there have been intervals of warming and cooling.

Today, however, the earth is warming at a rate unprecedented in human history. Since the age of industrialism during the last 150 years, humans have altered the complex interaction of natural forces, and we are now playing a distinct role in global climate change.

Investigations into the natural processes in the earth system, the impact of human actions on this system, and the resulting reactions in our environment constitute one of the greatest challenges of science.



The climate system

The climate system is a huge heat engine which is driven by the radiation from the sun. The differences in the incident solar radiation in the equatorial and polar regions, between night and day, and summer and winter generate temperature gradients which drive the atmospheric circulation. The atmospheric winds, in turn, drive the oceans currents. Energy, momentum and mass fluxes between oceans, the atmosphere, the snow and ice covered areas and plants on land and in the water govern the inner dynamics of the climate system on a broad range of time scales from hours to millennia.

Human activities like greenhouse gas emissions and land use changes influence the amount of aerosols in the atmosphere, its chemical composition as well as the biogeochemical cycle, ultimately amplifying the greenhouse effect. On geological time scales, movements of the continents, formation of mountains and variations in the earth´s orbit also influence climate.

DKRZ: The laboratory for climate simulation

The earth cannot be reproduced in a laboratory! How, then, can we understand a system so complex and dynamic? And how can we address that most pressing of questions: What does the climate hold in store for our future and for Earth's? There is only one tool – the supercomputer – capable of addressing the complexity of world climate and the endless change in both its individual components and their manifold interaction.

DKRZ, the German Climate Computing Centre, provides these tools and the associated services which are needed to investigate the processes in the climate system: Computer power, data management and guidance to use these tools efficiently.

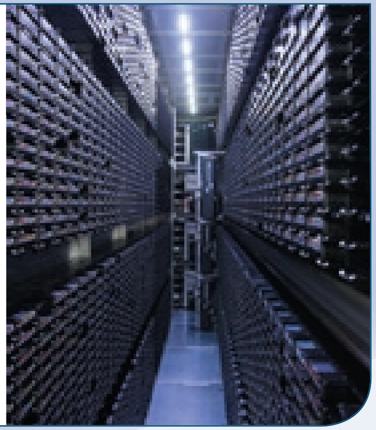
DKRZ thus constitutes an outstanding research infrastructure for model-based simulations of global climate change and its regional effects. This mission is consistent with the new High-Tech Strategy for climate protection as presented by Prof. Dr. Annette Schavan, federal minister for education and research, at the second climate research summit in Berlin in October 2007.

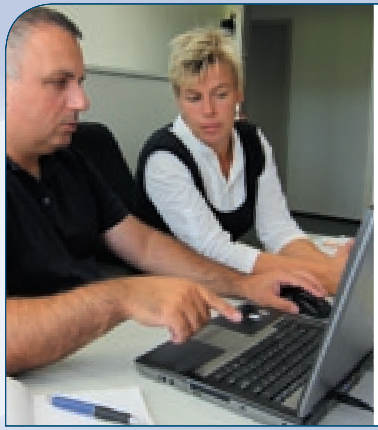
Supercomputing

Since climate simulations using numerical models make strenuous demands on computational resources, only modeling groups employing state-of-the-art supercomputers can remain competitive. The amount of computer capacity provided by DKRZ is usually not available at research institutes or universities.

Data

Climate modelers produce enormous quantities of data. DKRZ is one of the very few institutions possessing the technical capacity and scientific expertise to efficiently handle these data quantities.





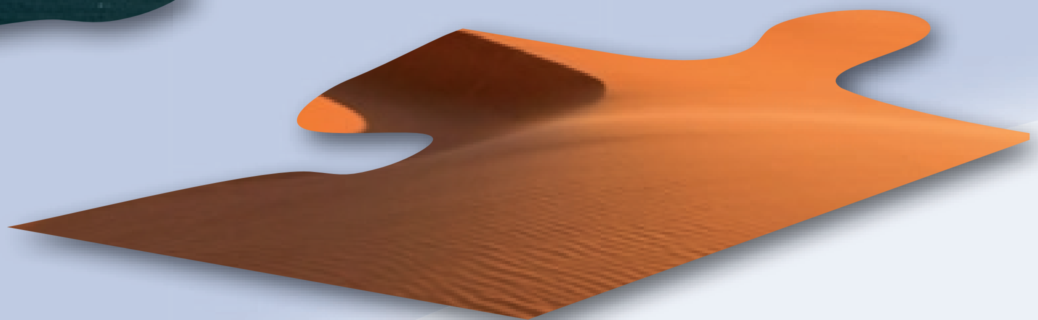
Services

DKRZ is devoted to providing the best possible services to meet the specific and demanding requirements of climate simulation. Therefore, DKRZ operates not only state-of-the-art computer systems, but also provides competence and assistance in computing and earth-system modeling as a service to the scientific community.

Modeling the climate

The ultimate aim of climate modeling is to develop a comprehensive model of the complete climate system.

However, the individual parts of the climate system are characterized by widely differing time scale ranges. This disparity makes it impossible to represent all important components of the climate system simultaneously in a single comprehensive model. Therefore, a hierarchy of climate models must be developed for different applications involving different time scales and different combinations of subsystems.



Building a climate model

Processes in the climate systems are governed by known laws of nature, such as the conservation of mass, and can be expressed as mathematical equations:

Conservation of mass

$$\frac{\partial \rho}{\partial t} + u * grad\, \rho + \rho * div\, u = 0$$

Conduction of heat

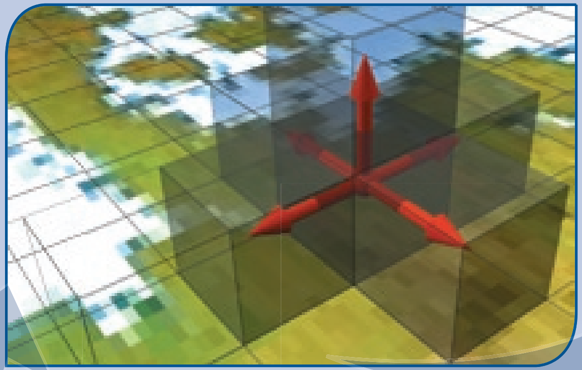
$$\frac{\partial T}{\partial t} + u\frac{\partial T}{\partial R} + \frac{v}{R}\frac{\partial T}{\partial R\varphi} + w\frac{\partial T}{\partial z} = \Delta^2(\kappa, T)$$

Equation of motion

$$\frac{d\vec{v_0}}{dt} + f(\vec{k} \times \vec{v_0}) = -\frac{1}{\rho_w}[\nabla_H(p + \rho_w g\zeta)] + \vec{F_H} + \vec{F_V}$$

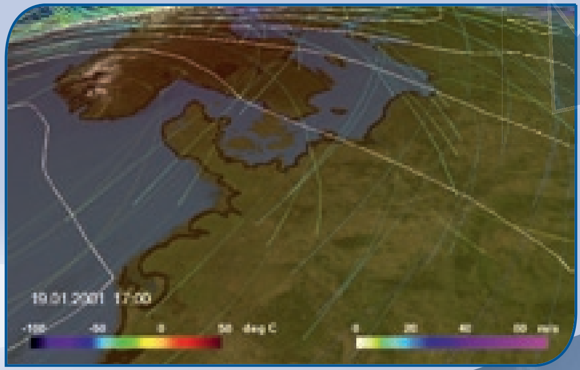
However, since it is not possible to solve these equations directly, climate researchers develop numerical models from these equations that can be solved by computers.

First, the different parts of the climate system, e.g. the atmosphere, land forms, sea ice, and oceans, must be skillfully divided into thousands of grid cells.



The evolution of climate properties such as temperature or the amount of water vapor within each grid box and the transport of these quantities between the boxes must be individually calculated using supercomputers. This process is highly complex, requiring not only a thorough understanding of the physical processes, but also great skills in supercomputer programming.

The smaller the boxes and the more processes are calculated the better the representation of the real-world climate.



Why we need supercomputers

Because of the high complexity and variability of the climate itself, the vast time scales involved, and the sheer quantity of empirical observations and measurements that must be accommodated, the accuracy of climate models depends upon and is limited by the available computer power.

Complexity

Climate modeling in the past mainly concentrated on the interaction of physical components and their coupling, such as fluid dynamics, radiation balance, latent and sensitive heat exchange or wind effects on the ocean. The continuous operation of the most powerful supercomputers available, however, will enable researchers to better integrate chemical and biological coupling mechanisms and to investigate the interaction between the climate and the socio-economic system.

The ultimate ambition of international climate and global climate change research is the development of a complex model of the earth system encompassing all physical and biological interactions between the atmosphere, the ocean, the cryosphere and the continental biosphere as well as social issues.

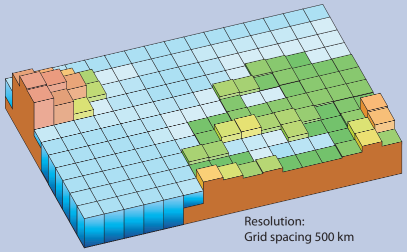
Spatial resolution

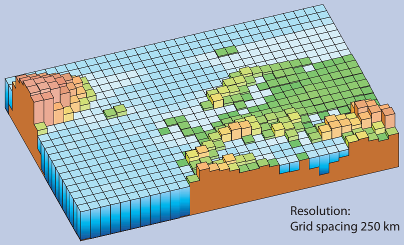
Climate models cannot compute the relevant quantities continuously in space. Instead, they divide the ocean and atmosphere into individual cells forming a gridded coordinate system. Only the mean values of the model quantities over the grid cell are considered and these are then assumed to be representative for the entire cell. The higher the spatial resolution of the model, i.e. the smaller the grid cells, the more detailed is the result. However, a doubling of the resolution of a global model implies an eightfold increase in the number of coordinate points and twice as many time steps, i.e. an increase in computing time by more than a factor of ten for the same simulation period.

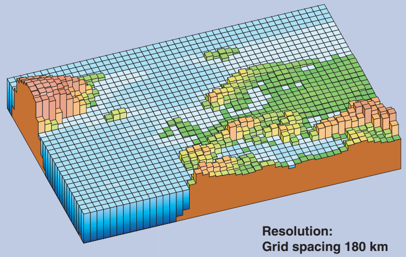
Even the most modern supercomputers are still not capable of achieving the high spatial resolution desired for comprehensive climate models.

Ensembles

Numerical models often react sensitively to slight disturbances in the initial data. For this reason the reliability of the models is sometimes questioned. The higher the computer performance becomes, the more frequently ensemble calculations can be accomplished: The model computations are repeated many times with slight variations of the initial data in a way that random variations can be distinguished from statistically proven trends. The more powerful the computer, the larger the ensembles, which in turn produces higher fidelity in the final results.







Spatial Resolution: Grid representation of Europe in climate models

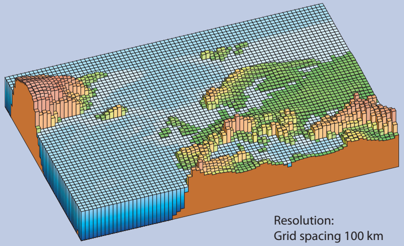
Long runs

Many scientific investigations require simulations of the earth system over a period of several centuries. This requires the ability to compute many years of simulated climate per day. Still, even today's fastest supercomputers need many months to simulate a single long climate event as for example an ice age.

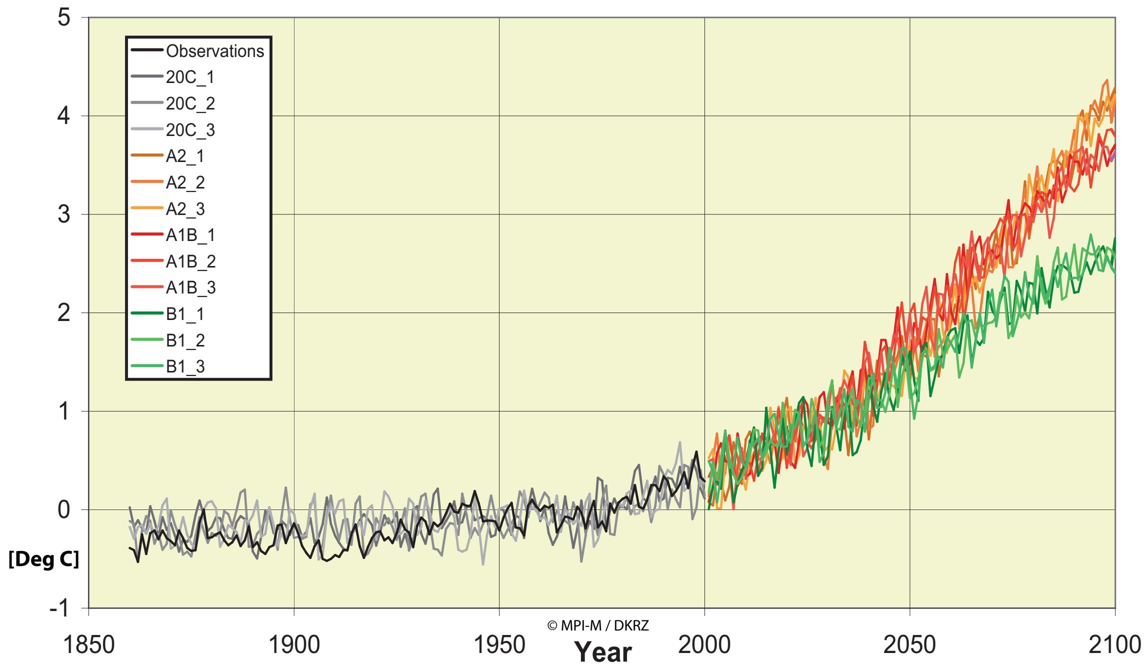
Parameterization

Processes occurring on smaller scales than that of the grid cells cannot be resolved directly by the models.

The formation of clouds is a prominent example of an irresolvable process. However, clouds cannot be neglected in a climate model because they exert a strong control on the temperature of the earth by reflecting the sun's radiation back into space, thereby contributing to the greenhouse effect. Therefore, modelers must "parameterize" the effect of clouds in the model by developing appropriate descriptions of the relevant mean cloud properties. Similar parameterizations must be devised for the exchange of heat and water vapor at the sea surface, and many other processes.



Resolution:
Grid spacing 100 km



Ensembles: Various IPCC simulations showing projections of the annual mean temperature change relatively to 1961-1991.

Supercomputing at DKRZ

High performance computing systems

"Blizzard"

In February 2009 DKRZ installed a new supercomputer called Blizzard, ranked within the Top 30 of the world's fastest computers and probably the most powerful machine worldwide being used exclusively for climate research.

The design of the system guarantees optimal performance and efficiency for ambitious state-of-the-art simulation experiments with numerical climate models. To this end procurement and selection of the machine had been based on measuring the performance of a wide range of high performance computing systems with respect to real climate model simulations.

"Tornado"

Tornado is a linux cluster which is owned jointly by the Max-Planck-Institute for Meteorology and DKRZ. While Blizzard – the main work horse of climate researchers at DKRZ – is mainly used to perform climate simulation in production mode, Tornado is used for model development and testing.

Blizzard at a glance

- Peak performance: 158 TeraFlop/s (158 trillion floating point operations per second)
- 264 IBM Power6 nodes
- 16 dual core CPUs per node (altogether 8,448 compute cores)
- more than 20 TeraByte memory
- 7,000 TeraByte of disk space until 2011
- Infiniband network: 7.6 TeraByte/s (aggregated)

Tornado at a glance

- Peak performance: 10 TeraFlop/s
- 256 Sun Fire X2200M2 compute nodes
- 2 quad core CPUs per node (altogether 2,048 compute cores)
- 8.5 TeraByte memory
- 300 TeraByte of disk space
- Infiniband network: 1 TeraByte/s (aggregated)

Numbers

The IBM Power6 computing system delivers more than 150 TeraFlop/s in peak performance. Every person on this planet needs to multiply 20,000 floating point numbers per second so that all people together reach an equivalent computing performance.

The aggregated transfer rate between all compute nodes adds up to 7 TeraByte/s, i.e. every second 150 Blue-ray discs can be transferred.

The IBM Power6 is set up with 264 compute nodes being connected with each other by 51 km of cable. The computing system bears a weight of approximately 35 tons.

Services related to high performance computing

In addition to running top-of-the-line, high-performance computing facilities specifically tailored to the needs of climate modeling, DKRZ also provides a full portfolio of services required to make efficient use of these valuable and unique resources.

Optimization

Modern supercomputers are highly complex systems. Machines of the size run by DKRZ make use of the latest technical developments and are unique in the sense that they are built to purpose – there may be very few comparable systems in the world, but no other system is configured exactly like DKRZ's. To fully exploit the supercomputer's potential, deep knowledge of its characteristics and operation is indispensable. That DKRZ can offer such knowledge is particularly valuable to climate researchers, who might not be that familiar with it.

DKRZ domain experts, who thoroughly understand the technical computational aspects, are also familiar with the specific nature and requirements of climate models.

Climate simulation runs

A substantial portion of DKRZ's computer resources is devoted to so-called "consortia runs", climate simulations that are of interest to a broad, interdisciplinary research community. These simulations are carried out in close cooperation between DKRZ staff and scientists. The resulting data is made freely available to the scientific community.

Parallelization

Until quite recently the speed of a single CPU doubled roughly every two years. The new rule of thumb says that the number of computational cores will double every two years. The first DKRZ system, only twenty years ago, had one single central processing unit. The current DKRZ computer has more than 8,000 cores. The next generation, to be installed in a few years, will have tens of thousands of cores. DKRZ experts support climate scientists in parallelizing their applications to make the most efficient use of such highly parallel computers.

Research

The gap between the theoretical computing speed of a high performance computer and the real speed of an average application running on it increases with every new generation of computers. For future computers new programming paradigms have to be developed in order to be able to exploit the computational power they provide. DKRZ is involved in research projects dealing with these problems focusing specifically on the needs of climate models.

Education

The ongoing education of our users is particularly important to us. DKRZ conducts regular workshops to inform its users of the most efficient and cautious use of our computing resources. More advanced training sessions focus on enhancing programming skills.

Data at DKRZ

Data Storage System

HPSS: High performance storage system

DKRZ is running one of the world's largest scientific data archives. The climate simulation data stored accumulated to 10 PetaByte in 2009.

Because of the rapid increase in power available with each new generation of supercomputers, the amount of data DKRZ has to handle grows exponentially. During the life of DKRZ's current system, about 10 PetaByte of data will be produced every year. With the next high-performance computer, which is expected to be installed around 2014, data growth will again increase by an order of magnitude.

The DKRZ archive at a glance

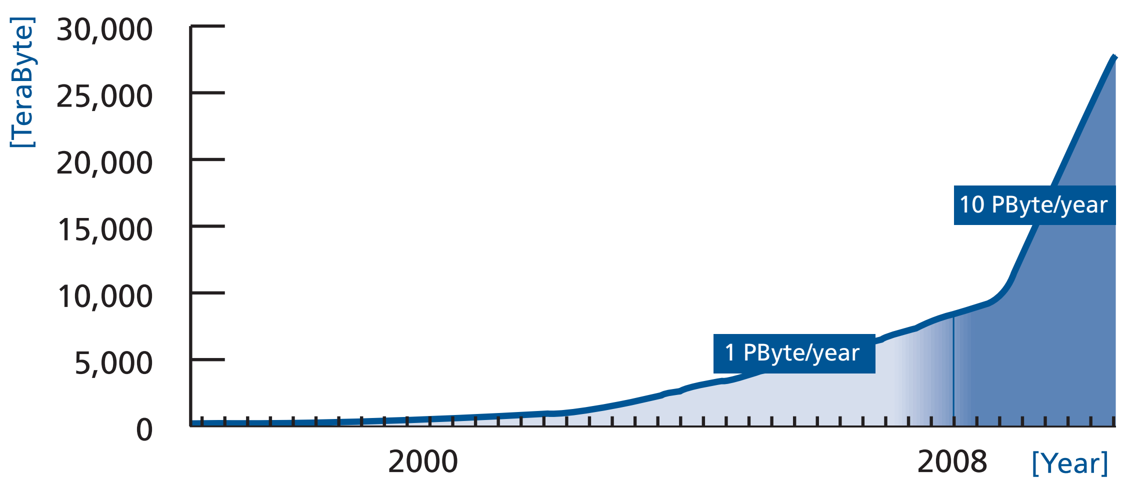
- 7 automatic Sun StorageTek SL8500 tape libraries
- 8 robots per library
- more than 60,000 magnetic cartridges
- 78 tape drives
- total capacity: over 60 PetaByte
- bandwidth 5 GigaByte/s (bidirectional)

Numbers

Currently DKRZ produces 10 PetaByte, i.e. 10,000 TeraByte of data per year. This corresponds to two million video-DVDs.

The data can be written and read with a bandwidth of 5 GigaByte/s, i.e. every second the content of one DVD can be transferred from disk to tape.

View into the interior of one of the DKRZ's tape libraries showing hundreds of data cartridges



Exponential data growth at DKRZ

Data services for earth sciences

DKRZ's continuously increasing computing capabilities have led to permanently new challenges for storing, retrieving and handling of data. DKRZ provides assistance, tools and processing hardware on the highest level to deal with the very large data sets that are typical for earth system modeling.

WDCC: World Data Centre for Climate

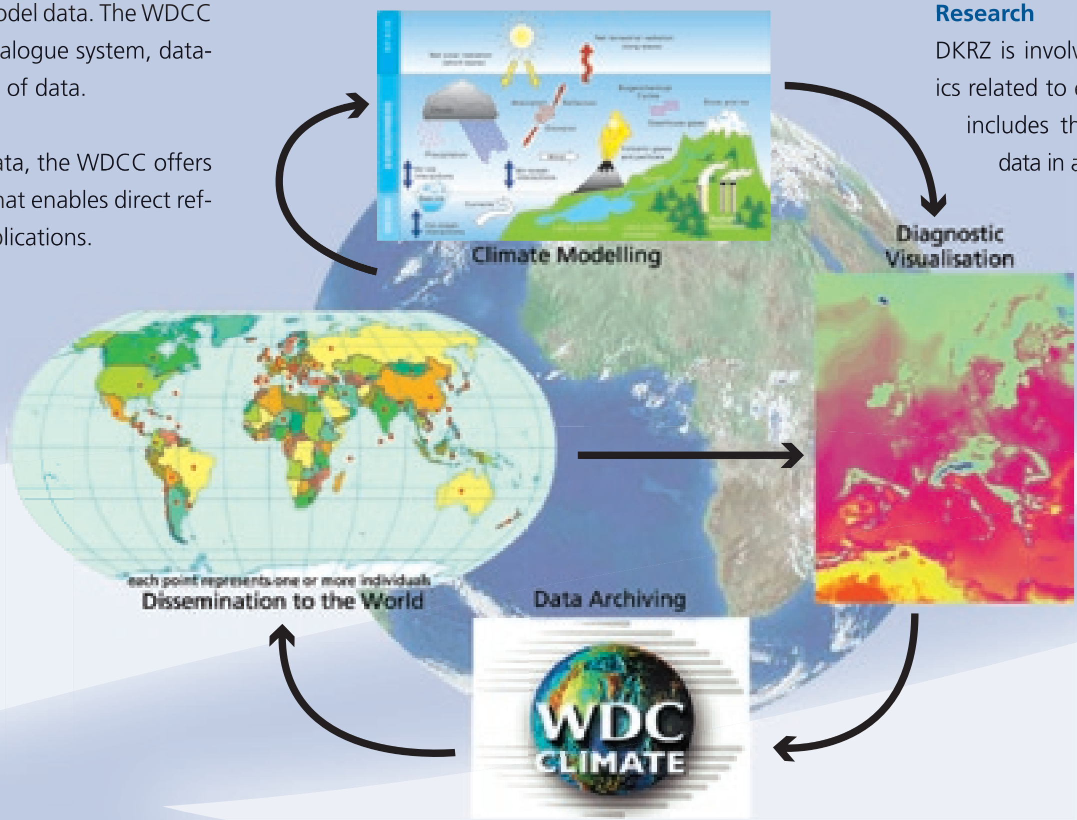
The WDCC at DKRZ – endorsed by the International Council for Science – offers scientists long-term archiving and preservation of earth-system model data. The WDCC facilities include data storage, a catalogue system, data-handling tools, and documentation of data.

For selected and quality-checked data, the WDCC offers a primary data publication service that enables direct references to the data in scientific publications.

Most data held at WDCC is freely accessible via a graphical user interface on the World Wide Web. In 2009, the climate data stored at the database amounted to more than 400 TeraByte.

Generation of data for the community

Within consortia runs, climate simulation data of interest to a broad community of researchers is generated, processed and made publicly available by DKRZ staff in close cooperation with scientists.



IPCC data node and gateway

The Intergovernmental Panel on Climate Change (IPCC) regularly produces assessment reports on climate change based on climate simulation data produced by dozens of international research teams. DKRZ is one of the very few centers worldwide acting both as a "data node" to store data subsets and as a "gateway" providing access for the international community of scientists and policy-makers to the distributed data archives.

Research

DKRZ is involved in research projects dealing with topics related to efficient and robust handling of data. This includes the description and annotation of climate data in a standardized and internationally compatible way, the detection of data needed for specific research projects and technical solutions for storage and easy retrieval of data from distributed data archives.

Visualization at DKRZ

Visualization system

Due to the increasing size of data, the statistical and visual analysis of climate simulations is increasingly becoming a challenge.

Generally, data visualization is one of the key technologies in the process of understanding and communicating results of extensive numerical simulations such as those carried out with coupled earth system models. Until recently, interactive data visualization was typically performed locally on the scientist's personal workstations. This concept requires a very fast network connection between the computing centre and the local workstations in order to be able to transfer large data within acceptable time frames. Also, the local workstations are required to be quite powerful with respect to their CPU power, disk space, main memory, and graphics cards.

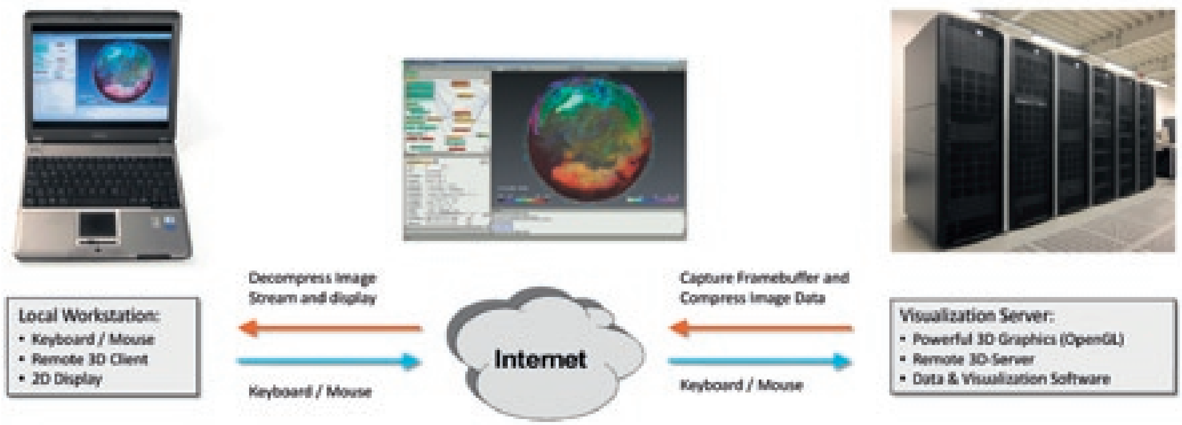
DKRZ visualization server

- 8 visualization nodes HP XW 9400
- 1 SMP-Vis Node HP dl 585
- 18 NVidia FX5500 Graphics Cards
- 48 TeraByte disk space
- Infiniband network

In 2007, DKRZ introduced a visualization server with the aim to overcome the drawbacks implied by the workflow described above. A central visualization server, located within the DKRZ local networks, allows immediate and efficient access to data stored at DKRZ. This visualization server is a clustered system of powerful graphics workstations, a fast interconnect and a high performance parallel storage system.

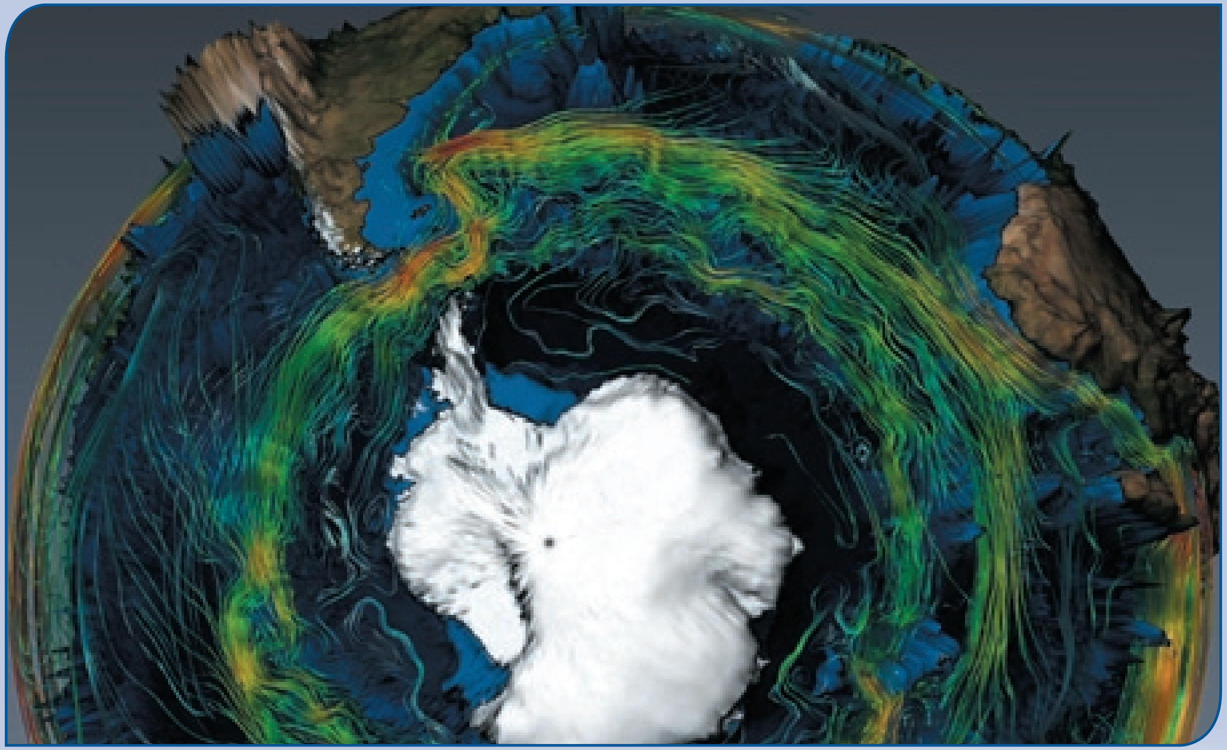
A client server solution for remote 3D rendering completes the framework: the 3D visualization is efficiently rendered on the central 3D graphics hardware. The image data stream is continuously read back and sent to the client's local workstation. By the use of this technique, only this image data has to be sent across the network, while the large data sets can be kept within DKRZ's high performance infrastructure.

Locally at DKRZ, a high resolution Virtual Reality (VR) Powerwall can be used to interactively inspect highly complex 3D data.



DKRZ offers the possibility of remote 3D rendering

Visualization services

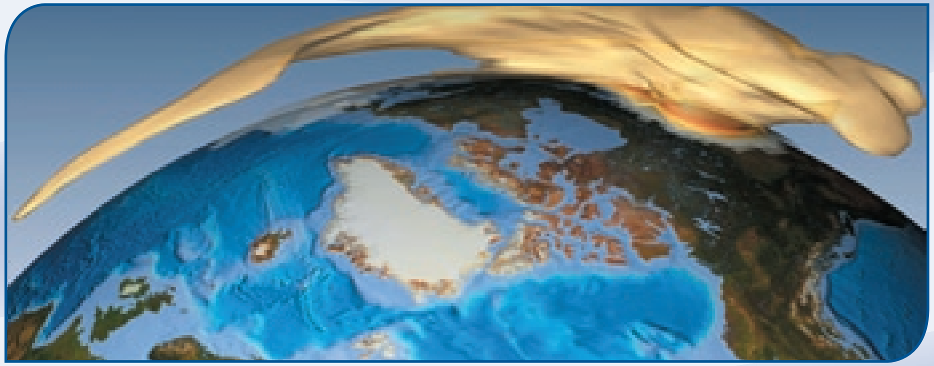


Visualization of the simulated Antarctic circumpolar current with "illuminated streamlines". (Data: MPI-OM ocean model)

Typical data sets produced by earth system models are 3D, multi-variate and time dependent. Interactive visual data analysis improves and accelerates user comprehension of the extensive results of these simulations. Furthermore, good visualizations are helpful for the dissemination of scientific results in publications and presentations.

For the interactive 3D visualization and analysis of 3D data, DKRZ offers appropriate state-of-the-art software solutions to its users, which benefit from the architecture of DKRZ's visualization server. The XGreen extension, a supplement to the interactive GUI-driven 3D visualization software Avizo, was developed in cooperation with DKRZ especially for applications in earth system sciences. Among other new features, Avizo with the XGreen extension supports the direct import of the data formats commonly used in climate research and is able to interactively visualize the data – with different map projections, using different visualization methods and in combination with the geographic context, i.e. topography and satellite image of the earth.

The 3D visualization solutions can also be used in a Virtual Reality mode with DKRZ's high resolution VR Powerwall. The stereoscopic display in combination with the tracking allows for an intuitive examination of details even in complex visualizations.



Simulated volcano eruption. The isosurface shows the ash cloud. (Data: MPI-M)

Our computer history

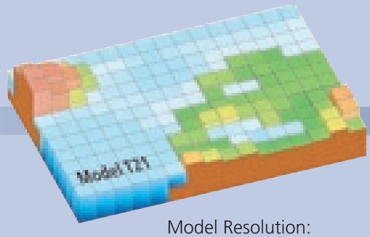
1985: Control Data Cyber-205
- 1 CPU
- 0.2 GFlop/s
- 0.032 GByte memory

1988: Cray 2-S
- 4 CPUs
- 2 GFlop/s
- 1 GByte memory

1994: Cray C-916
- 16 CPUs
- 16 GFlop/s
- 2 GB memory + 4 GB SSD

2002: NEC SX-6
- 192 CPUs
- 1,536 GFlop/s
- 1,536 GByte memory

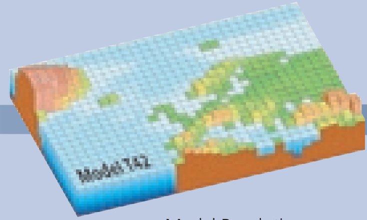
1985



Model Resolution:
Grid Distance 500 km

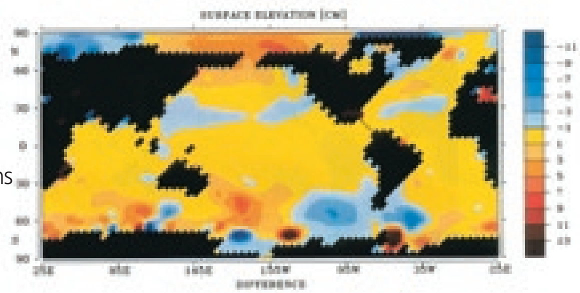
- Simulations with 3D atmosphere models or with 3D ocean models
- Coupled model: 3D atmosphere and mixed layer ocean
- Simulation time: months to years
- Grid spacing in atmosphere: 500 km

1990

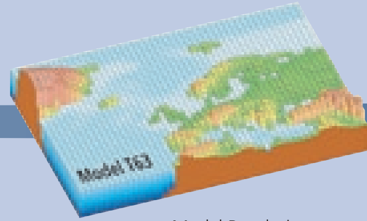


Model Resolution:
Grid Distance 250 km

- First simulations with a coupled 3D atmosphere-ocean model
- Grid spacing: 500 km
- CO_2 doubling experiments, first transient CO_2 increase simulations
- Flux correction
- Total simulated time: 200 years

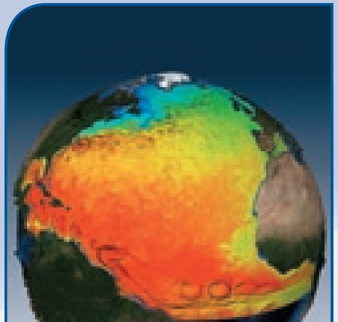


1995



Model Resolution:
Grid Distance 180 km

- Transient CO_2 scenario simulations
- coupled 3D atmosphere-ocean models
- 2D aerosol forcing
- Flux correction
- Total simulation time: hundreds of model years
- Grid spacing: 250–500 km

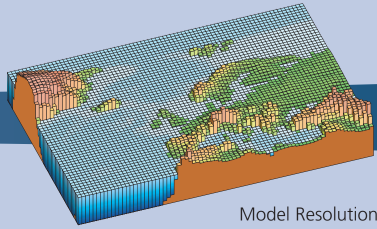


- High resolution regional models

2009: IBM Power6

- 8,448 CPUs
- 158,000 GFlop/s
- 20,000 GByte memory

2004



Model Resolution:
Grid Distance 100 km

2010

- Transient CO_2 scenario simulations
- coupled 3D atmosphere-ocean models
- 3D aerosol forcing
- Hydrological land-model
- No flux correction necessary
- Grid spacing: 180 km
- Ensemble simulations (3 realizations)
- Total of 5,000 model years
- Produced data: 150 TeraByte

- Transient CO_2 scenario simulations
- 3D atmosphere-ocean models
- carbon cycle including land biosphere and ocean biogeochemistry
- 3D aerosol forcing
- Grid spacing: 50 – 100 km
- 10,000 model years
- Produced data: approximately 3 PetaByte

Computer power and scientific progress

The increasing performance of DKRZs supercomputers during the last two decades enabled substantial progress in the development of realistic climate models. In 1987, when DKRZ was founded, the CDC Cyber-205 only allowed simulations of either the atmosphere or the ocean. Likewise, the computational grid had to be very coarse, and the length of simulations was limited to a few years.

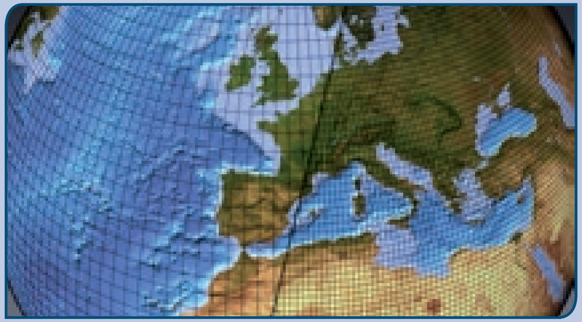
Since then, each new system at DKRZ allowed for the extension of the simulation length, for the inclusion of more processes and for the increase of spatial resolution with the result of more realistic simulations. But even today, with currently one of the most powerful computer systems worldwide used for earth system research, the resolution and fidelity of climate simulations is still constrained by computational limitations.

Our Task: Enable the best possible climate simulations

Climate projections

Extensive greenhouse gas scenario simulations are regularly carried out by the world's leading climate modeling groups within the context of the "IPCC Assessment Reports" (see box). The German simulations, which contribute to this effort, are mainly performed on DKRZ's supercomputers. These simulations always challenge the capacity of DKRZ's computational resources to their limit.

For the German climate community, DKRZ's systems and services have been proven to be indispensable for the accomplishment of such extraordinary simulation projects.



Model resolution used for the IPCC Assessment Reports (left: AR4, right: AR5)

IPCC

The IPCC – the Intergovernmental Panel on Climate Change – is a scientific intergovernmental body set up in 1988 by the World Meteorological Organization (WMO) and by the United Nations Environment Program (UNEP). Since then, four Assessment Reports have been compiled by the IPCC: 1990, 1995, 2001 and 2007.

The fourth Assessment Report

In 2004, approximately a quarter of the available computing resources on DKRZ's previous supercomputer (thus 6 NEC SX-6 nodes operating 24 hours the day) were exclusively used for the climate projections whose results contributed to the fourth Assessment Report.

The simulations were realized with the coupled atmosphere ocean model ECHAM5 / MPI-OM. The atmospheric model component had a horizontal resolution of approximately 180 km with vertically 31 model levels. The ocean model was used with a regionally varying horizontal resolution between approximately 10 km and 150 km.

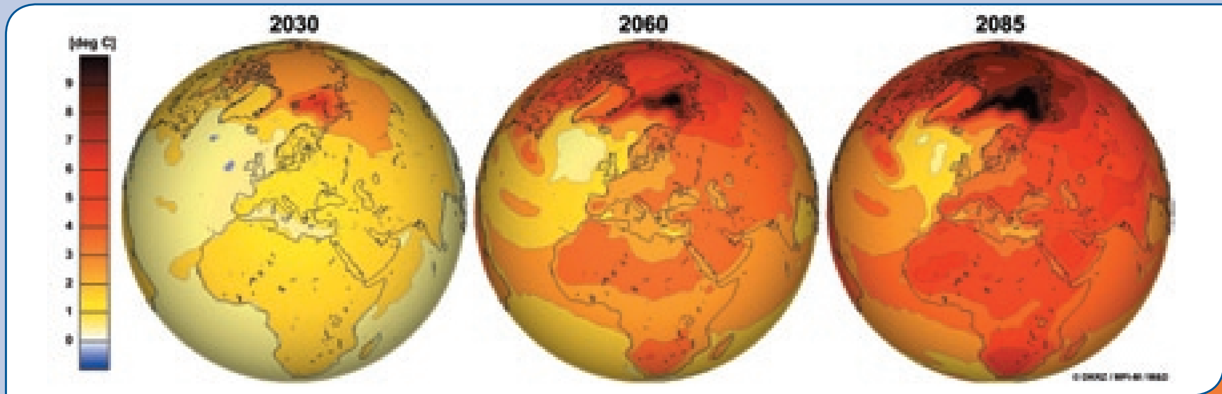
The results of the simulations were stored operationally in a relational database. They are available at WDCC to scientists for further analysis. The model output of these IPCC simulations, which were stored in the climate database, amount to more than 150 TeraByte.

The fifth Assessment Report

Enabled by the new supercomputer installed at DKRZ in 2009, the simulations for the next IPCC report are performed with considerably higher spatial resolution then the previous experiments. The atmosphere model will run with a horizontal grid interval of 80 km (as compared to 180 km for the previous version), the ocean model will use a horizontal grid interval of 0.4 degree, which approximates to 45 km. With this increased resolution, physical processes such as strong storms or ocean eddies can be simulated more realistically.

Furthermore, the new model computes many additional processes, including processes in the land biosphere and in the oceans biogeochemistry in order to interactively simulate the full carbon cycle.

The computational effort necessary to carry out the new simulations with this substantially enhanced and extended model will approximately by 100 times the effort used for the previous simulations.

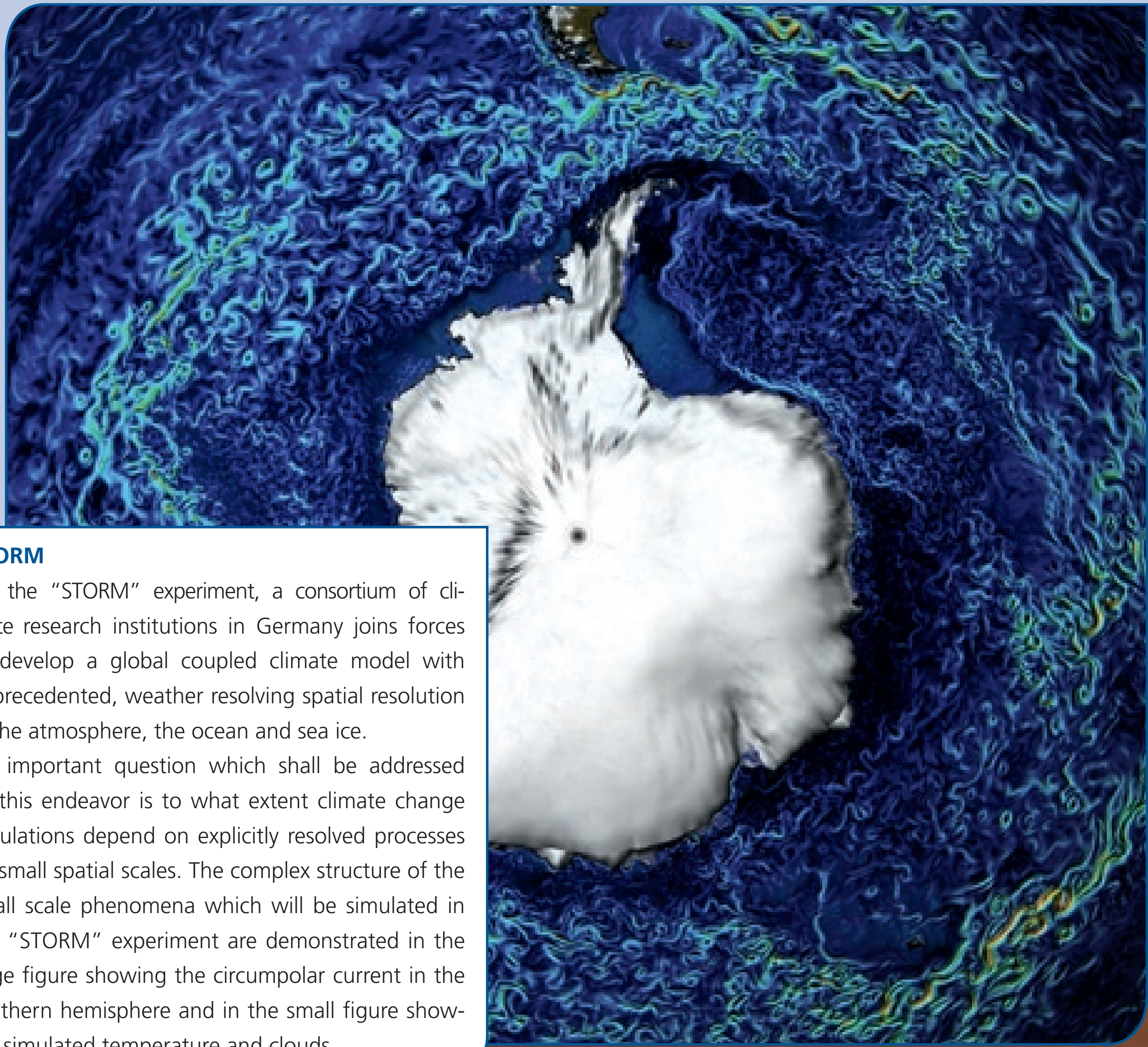


Temperature change simulated with a coupled atmosphere-ocean model for the fourth IPCC Assessment Report

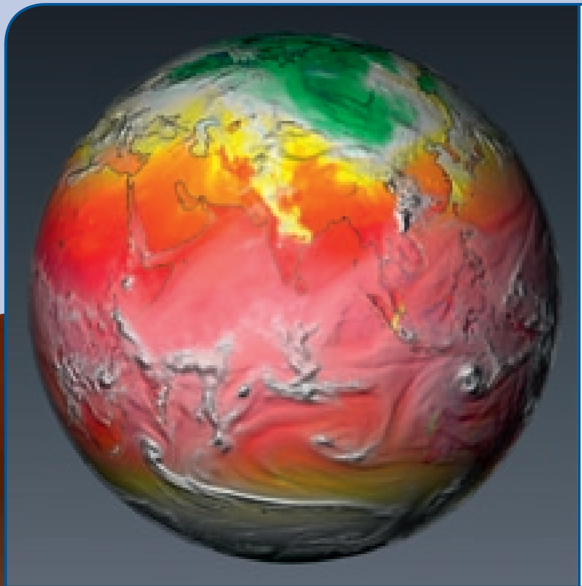
Cutting edge science

The world-class computational and data management facilities provided by DKRZ and dedicated to climate and earth system modeling enable scientists to design and perform intricate model experiments which were not even possible only a few years ago and which can be carried out only at very few places in the world.

Such cutting edge simulations of the earth system and its interactions produce unique data sets for the climate community in Germany and abroad, from which breakthroughs are to be expected in many fields of climate research.



Circumpolar current in the southern hemisphere



Simulated temperature and clouds

STORM

For the "STORM" experiment, a consortium of climate research institutions in Germany joins forces to develop a global coupled climate model with unprecedented, weather resolving spatial resolution in the atmosphere, the ocean and sea ice.

An important question which shall be addressed by this endeavor is to what extent climate change simulations depend on explicitly resolved processes on small spatial scales. The complex structure of the small scale phenomena which will be simulated in the "STORM" experiment are demonstrated in the large figure showing the circumpolar current in the southern hemisphere and in the small figure showing simulated temperature and clouds.

Long-term commitments and goals

Environmental responsibility

High performance computing environments comprise hundreds of thousands of electronic components. Therefore, they require large amounts of electrical power and produce thermal heat. Providing power to operate and to cool today's supercomputers stands as a major obstacle to future growth of computational performance.

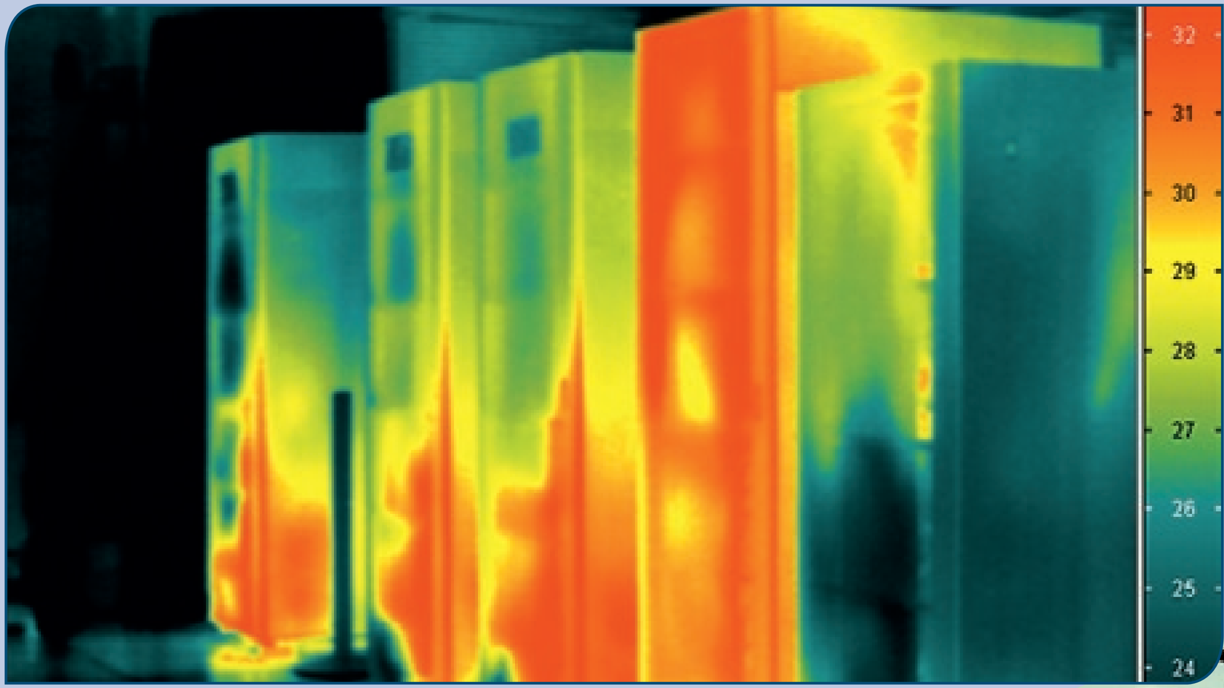
The electricity bill over the lifetime of a supercomputer approaches its acquisition costs, and it may well exceed them as hardware costs decrease while electricity costs increase. Further, power generation emits CO_2, turning high performance computing into an environmentally relevant activity.

DKRZ assumes its responsibility to reduce the economic and ecological impact of its systems.

First, DKRZ's high performance computing environment is powered by CO_2 emission-free regenerative power. Second, DKRZ will develop mechanisms to reduce the per-application energy consumption.

Thomas Ludwig, DKRZ's director, a professor for computer sciences at the University of Hamburg, conducts research on energy efficiency in high performance computing. His department investigates the concept of selectively and temporarily deactivating unused hardware components. We complement this effort at DKRZ with a staff responsible for energy management at our facility.

The Free and Hanseatic City of Hamburg will be the European Green Capital in 2011.
DKRZ fully supports Hamburg to realize its ambitious climate protection goals.



Hot and cold areas of the computer racks reflect different usage patterns of the machine.


Thermal isolation of cold aisles prevents a mixture of airflows and improves efficiency of the air conditioning and cooling.

Sustained performance and service

DKRZ is a uniquely competent national centre for earth-system modeling.

We are committed to

- Competence with application tuning in order to reduce as well the time-to-solution as the watthours-to-solution values for our applications
- Competence with data management to provide efficient long term access to valuable result data stored on magnetic media
- Competence with visualization to render comprehensive computational results understandable for the human brain and vision.
- Competence with energy efficiency to reduce costs and ecological footprint of climate system research

Powerful computers and excellent people effectuate a synergy that yields researchers an indispensable tool for gaining a deeper understanding of our earth system.

Even though there is no doubt that climate is vulnerable to mankind's activity, many questions remain unsolved at the quantitative level. The services provided by DKRZ are indispensible for German climate researchers to answer these questions and to provide the public and policy-makers with a reliable basis for climate and environmental protection policy.

The installation of a data center and a new computer system at DKRZ in the year 2009 is an important milestone on our way to sustain these services on the highest quality level in the foreseeable future.

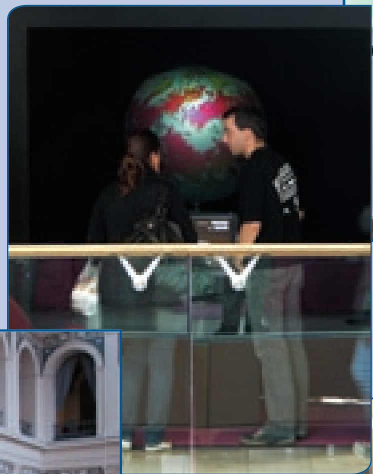
It is up to the society to use the results wisely to help to create a livable and lasting environment for all of us.

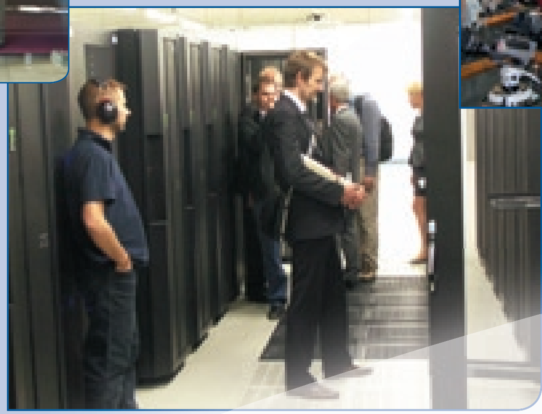
Outreach to the public

Climate change is one of the greatest environmental, social, and economic challenges facing the world today. DKRZ has a long history of delivering high-quality climate research to the public. DKRZ employees have proven themselves willing sources of information to newspaper and magazine journalists and TV reporters.

DKRZ actively seeks to inform the public about its work and the results of climate modeling by offering lectures, guided tours and information sessions.

DKRZ regularly participates in events like "Researchers' Nights" or "Science Nights and presents its work at national and international computing conferences such as CeBIT and the International Supercomputing Conference.





Organization

DKRZ is a non-profit limited liability company with, at present, four shareholders:

- Max-Planck-Society
- Free and Hanseatic City of Hamburg represented by the University Hamburg
- GKSS Research Centre Geesthacht
- Alfred Wegener Institute for Polar and Marine Research Bremerhaven

DKRZ is lead by:
Prof. Dr. Thomas Ludwig, scientific and technical director
Michael Truchseß, administrative director

In 2009, DKRZ moved into its new building, which was funded by the City of Hamburg and is part of the university campus. At the same time, a new supercomputer system funded by the federal minister for education and research was installed.

The new DKRZ building located in the Bundesstraße 45a in Hamburg.

Network

DKRZ is integrated in several national, European and international cooperation projects.

The **KlimaCampus Hamburg** combines expertise in nature, social science and the humanities to target climate change issues.

Gauss Allianz for Supercomputing is a cooperation of the twelve leading German high performance computing centers.

The **European Network for Earth System Modeling** funded by EU aims at the development of a European infrastructure for earth system modeling.

DKRZ

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