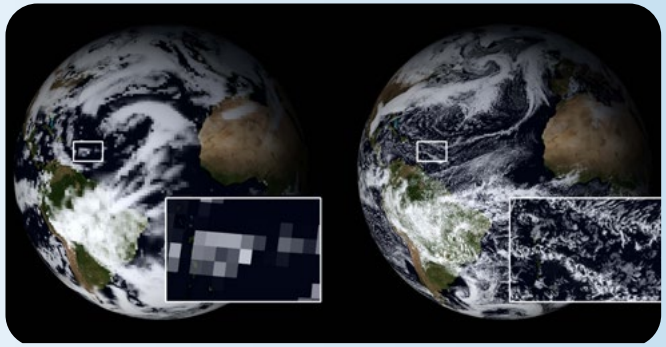
Climate Modelling

Storm-resolving earth system models with resolutions of a few kilometers enable global simulations of small-scale processes, such as the formation of thunderstorm cells. Upcoming exascale high-performance computers will for the first time have the power to perform such simulations over longer time periods, but also pose a great challenge to the appropriate programming.

DKRZ is involved in a number of projects that address this challenge. The European Centre of Excellence in Simulation of Weather and Climate in Europe (ESiWACE), coordinated by DKRZ, is working to improve global weather and climate models by increasing the spatial resolution (see figure in the right). The project NextGEMS will further develop the established ICON and IFS models to enable multidecadal (30-year) projections of future climate change.



Clouds on a February day in simulations with a resolution of about 80 km, as common in CMIP6 simulations (left), and with a resolution of 2.5 km (right). Although the CMIP6 model captures, e.g., the large-scale cloud formation in the Caribbean, the simulation on the right additionally represents many details of the cloud structures and thus the behavior of different cloud types. With the much more detailed representation of atmospheric circulation, drastically improved climate predictions are expected as soon as sufficiently long time-periods can be simulated. The weather situation of both simulations differs since the models were initialized with different starting data.

DKRZ

German Climate Computing Center

PARTNER FOR CLIMATE RESEARCH

DKRZ: Partner for Climate Research

The German Climate Computing Center (DKRZ) is a unique national supercomputing center for climate and earth system research. Anthropogenic climate change belongs to the major scientific and societal challenges of our time. Extensive simulations with coupled climate models are an indispensable tool to investigate natural processes in the Earth system and to estimate possible future climate changes.

DKRZ provides the German climate research community with high performance computers, storage systems and data archiving systems that have been specifically selected and optimized for climate modeling workflows.

The DKRZ is a non-profit and non-commercial limited liability company with four shareholders.

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HPC-System "Levante"

- Installation in 2021-2022
- Atos BullSequana XH2000 supercomputer
- NVIDIA Mellanox HDR 100/200G Infiniband
- 132 Petabyte disk storage by DDN
- CPU partition
  - more than 2,850 compute nodes with 2 AMD EPYC CPUs
  - 128 cores per node, more than 370.000 cores in total
  - 14 PetaFLOPS peak performance
  - 815 Terabyte main memory
- GPU partition
  - 60 GPU nodes each equipped with 2 AMD CPUs and 4 Nvidia GPUs
  - 2.8 PetaFLOPS peak performance
  - 30 Terabyte main memory
  - 5 Terabyte graphics memory

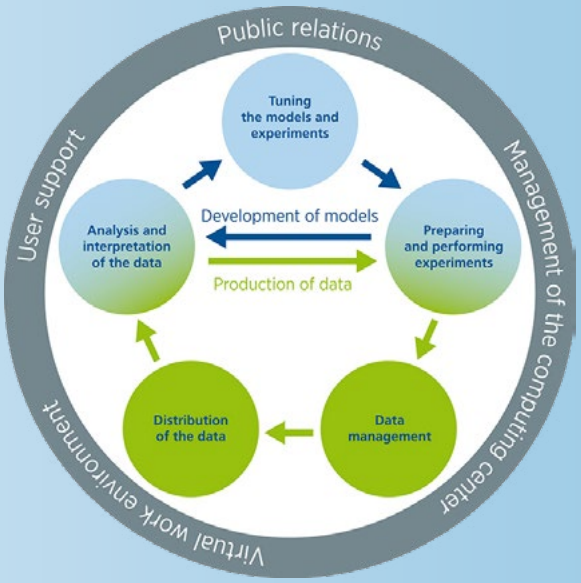
Data Archive

In order to ensure a continuous flow of climate data from the high performance computer to the archiving system and fast access to archived data, DKRZ operates one of the world's largest and most powerful data archives. As of early 2022, the archive encompasses more than 120 Petabyte of climate simulation data spread over 33 million files. The current HSM system is designed for handling up to 1 Exabyte.

Services for Climate Research

In addition to operating the supercomputer and storage systems, DKRZ offers a wide spectrum of services to support the scientific workflow of climate modeling. Many interrelated steps are involved in developing the climate model, from adjusting the models to optimizing the model codes to finally running the models more efficiently.

In the next few years, the first exascale supercomputers with a performance of more than a trillion (10^{18}) computing operations per second and a heterogeneous architecture of CPUs and GPUs are expected. The DKRZ team supports its users adapting the existing software to such systems.



Two newly established groups at DKRZ cover the applicability and practical use of artificial intelligence and machine learning methods in climate science and offer, beside the research, user support on this topic.

The data production workflow includes the preparation and execution of experiments, data management, distribution, as well as data analysis and visualization. In all these areas, DKRZ offers its users numerous services and helps optimize the data flows.