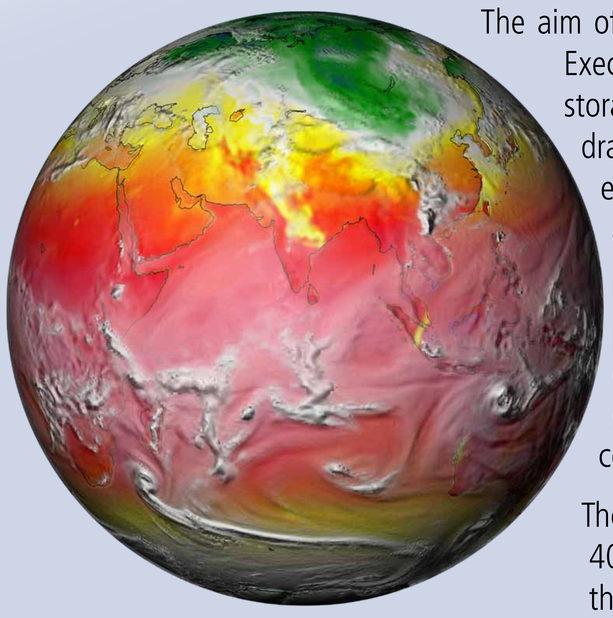
Data generation and optimization

DKRZ - DATA INTENSIVE CLIMATE SCIENCE

Climate models and climate model data



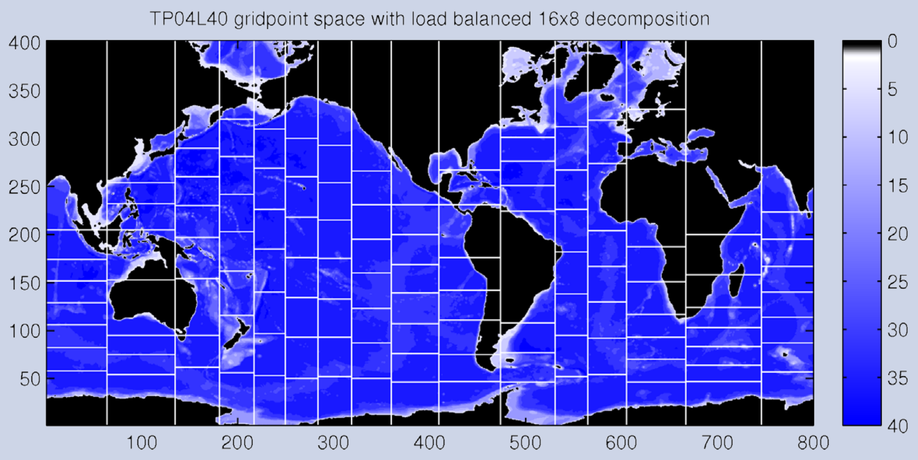
„STORM“: simulated temperature and clouds.

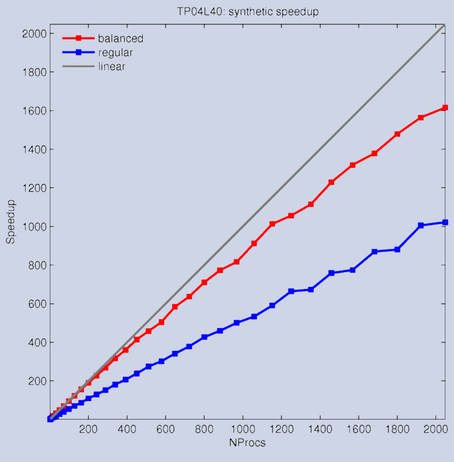
The aim of climate modeling is to develop a comprehensive model of the complete climate system. Executing these climate models always challenge the capacity of DKRZ`s computational and storage resources to their limit. The computational complexity and generated data volume increase drastically if a finer resolution is used, if additional physical processes are included or if ensemble experiments are executed.

Within the consortia project STORM a global coupled atmosphere-ocean-model with very high spatial resolution is developed and applied for research into the role of small scale processes within the climate system. The ocean model component has a horizontal resolution of approximately 10 km and vertically 80 model layers, yielding a total of nearly 700 Mio grid points on a tripolar curvilinear grid. The STORM ocean simulations utilize 1920 blizzard cores and approximately 1.3 TeraByte memory.

The atmosphere simulations were performed on 256 CPUs of blizzard, with a grid spacing of 40 - 50 km and a time step of less than a second. Altogether one simulation consumes more than 100,000 CPU hours, and thus requires not only state of the art computational resources but also exhaustive storage capacities.

„STORM“: simulated circiumpolar current.





Climate model code optimization

Model codes are confronted with the regular technological change of HPC systems. The complexity of parallel programming will even increase on future hardware. Scalability of the computational load and high performance I/O are of key importance. Thus DKRZ provides not only parallel programming courses but actively engages itself in climate code optimization.

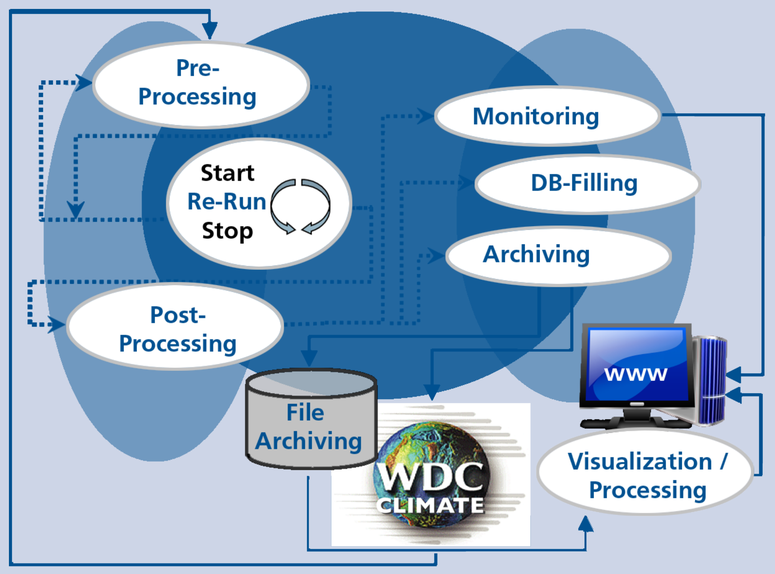
The ScalES project, funded by the BMBF, illustrates a specific optimization: The partitioning of the model domain is optimized to achieve a uniform processing load on the processors of the HPC system, which improves the speed-up characteristic of the parallel code.

Model run optimization

The Integrated Model and Data Infrastructure (IMDI) supports modeling activities such as source code analysis, model development, compilation, experiment execution and graphical monitoring, as well as result archiving, retrieval, processing, and visualization. At DKRZ the latter facets connect the modeling activities with the ICSU World Data Center for Climate (WDCC) and the HPSS tape archive.

A climate modeling experiment consists of a number of different tasks (the ovals in the diagram), each of which can be switched on or off when the experiment is configured (dashed lines: process flow, solid lines: data flow). **Optimization is required with respect to workflow management:**

- In order to enable **synchronization between model calculations and data processing** the required data processing time in the HPC environment must be smaller than the required model calculation time.
- The different data processing streams have to be managed with respect to **seamless execution of the (parallel) data streams** and with respect to **optimal usage of the data resources** in the HPC environment.

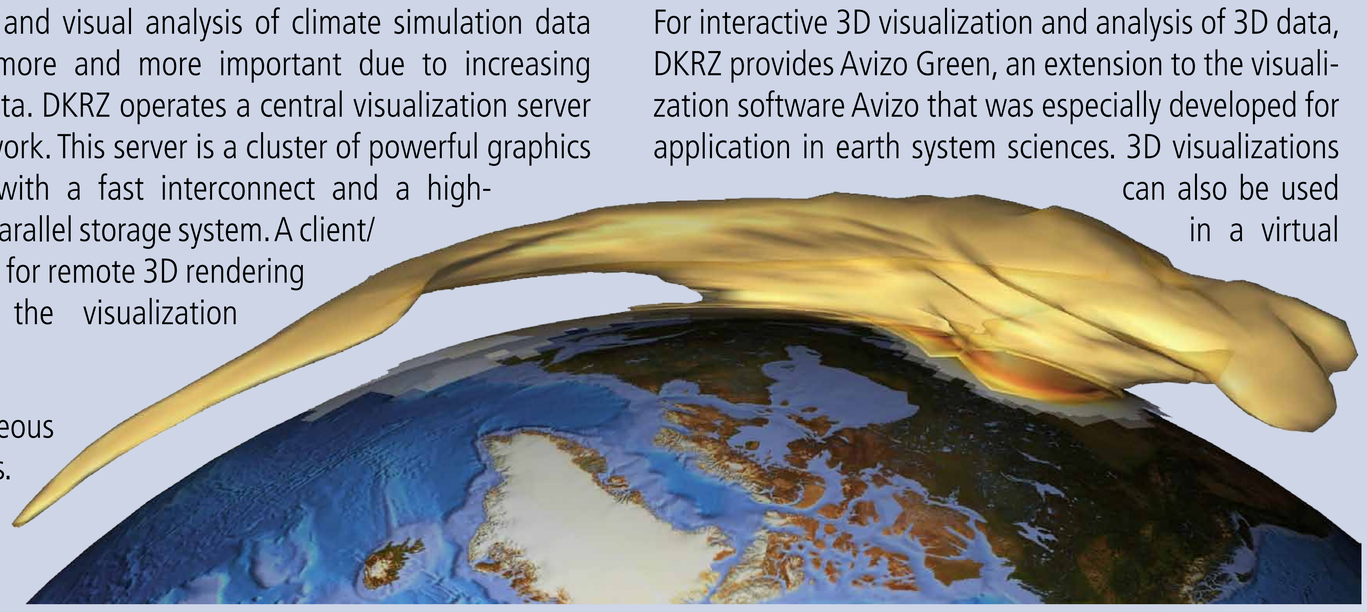


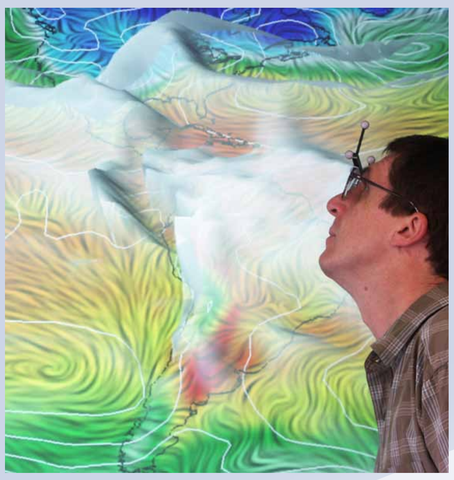
Visualization

The statistical and visual analysis of climate simulation data has become more and more important due to increasing amounts of data. DKRZ operates a central visualization server within its network. This server is a cluster of powerful graphics workstations with a fast interconnect and a high-performance parallel storage system. A client/server solution for remote 3D rendering complements the visualization system.

The heterogeneous system consists of 10 visualization nodes. Since the supercomputer's GPFS filesystem is mounted over a powerful network (10 GE), the model data can be directly visualized.

For interactive 3D visualization and analysis of 3D data, DKRZ provides Avizo Green, an extension to the visualization software Avizo that was especially developed for application in earth system sciences. 3D visualizations can also be used in a virtual reality mode with DKRZ's high resolution VR Powerwall.





DKRZ
DEUTSCHES
KLIMARECHENZENTRUM

www.dkrz.de
Poster 2