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Visualization and Analysis of Climate Simulation Performance Data

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Visualization is the key process of transforming abstract (scientific) data into a graphical representation, to aid in the understanding of the information hidden within the data. Climate simulation data sets are typically quite large, time varying, and consist of many different variables sampled on an underlying grid. A large variety of climate models – and sub models – exist to simulate various aspects of the climate system.

Generally, one is mainly interested in the physical variables produced by the simulation runs, but model developers are also interested in performance data measured along with these simulations. Climate simulation models are carefully developed complex software systems, designed to run in parallel on large HPC systems. An important goal thereby is to utilize the entire hardware as efficiently as possible, that is, to distribute the workload as even as possible among the individual components. This is a very challenging task, and detailed performance data, such as timings, cache misses etc. have to be used to locate and understand performance problems in order to optimize the model implementation. Furthermore, the correlation of performance data to the processes of the application and the sub-domains of the decomposed underlying grid is vital when addressing communication and load imbalance issues. High resolution climate simulations are carried out on tens to hundreds of thousands of cores, thus yielding a vast amount of profiling data, which cannot be analyzed without appropriate visualization techniques.

This PICO presentation displays and discusses the ICON simulation model, which is jointly developed by the Max Planck Institute for Meteorology and the German Weather Service and in partnership with DKRZ. The visualization and analysis of the models performance data allows us to optimize and fine tune the model, as well as to understand its execution on the HPC system. We show and discuss our workflow, as well as present new ideas and solutions that greatly aided our understanding. The software employed is based on Avizo Green, ParaView and SimVis, as well as own developed software extensions.