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Efficient visualization of unsteady and huge scalar and vector fields

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The simulation of climate data tends to produce very large data sets, which hardly can be processed in classical post-processing visualization applications. Within the most traditional post-processing scenarios the visualization pipeline consisting of the processes data generation, visualization mapping and rendering is distributed into two parts over the network or separated via file transfer: the data generation on a supercomputer on the one hand and the other tasks on a special visualization system on the other hand. That way either temporary data sets with huge volume have to be transferred over the network, which leads to bandwidth bottlenecks and volume limitations. As an alternative all simulation and visualization processes are integrated in a monolithic application, where just 2D pixel data is stored, which reduces the user's possibilities for 3D interaction with visualization to frame skipping.
Within the Climate Visualization Lab – as part of the Cluster of Excellence "Integrated Climate System Analysis and Prediction" (CliSAP at the University of Hamburg, in cooperation with the German Climate Computing Center (DKRZ) – we plan to integrate a different approach, which has been proven to be successful in former meteorology applications, e.g. PALM (Parallel Large Eddy Simulation Model). Our software framework DSVR is based on the separation of the process chain between the mapping and the rendering processes. We have developed a parallelized visualization library based on MPI and evaluated on various supercomputers. DSVR can be used to integrate the visualization into a parallel simulation model to support in-situ processing, resulting in a sequence of time-based geometric 3D objects which can be interactively rendered in a separate 3D viewer application.
To meet the actual requirements (a) to visualize existing data sets, (b) to support more than rectilinear grids, and (c) to integrate in-situ processing in the ICON model, all based on our DSVR framework and methods, we are developing a stand-alone post-processor, adding further data structures and mapping algorithms, and cooperating with the ICON developers and users. With the implementation of a DSVR-based post-processor, a milestone was achieved. By using the DSVR post-processor the mentioned 3 processes are completely separated: the data set is processed in a batch mode – e.g. on the same supercomputer, which the data is generated on – and the interactive 3D rendering is done afterwards on the scientist's local system.
At the actual status of implementation the DSVR post-processor supports the generation of isosurfaces and colored slicers on volume data set time series based on rectilinear grids as well as the visualization of pathlines on time varying flow fields based on either rectilinear grids or prism grids. The software implementation and evaluation is done on the supercomputers at DKRZ, including scalability tests using ICON output files in NetCDF format.
The next milestones will be (a) the in-situ integration of the DSVR library in the ICON model and (b) the implementation of an isosurface algorithm for prism grids.