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Challenges and solutions for the visualization and analysis of high-resolution simulation data

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With growing data sizes and simulation complexity, the processes of visualization and analysis become technically more difficult, but at the same time also more important. This particularly holds for weather and climate simulations that are expected to produce tera- and petabytes of data per run on upcoming exascale systems. The human observer needs assistance to perceive and comprehend these large amounts of data, as well as guidance to find the important information within. The bandwidth gap between compute and storage does not ease these problems, therefore writing regular files to disk for a post-hoc analysis becomes an impractical procedure.
This presentation devises workflows to handle massive amounts of simulation data to gain insight and understanding. We discuss distributed rendering and image-based visualization, as well as in-situ visualization in detail, for which we show results from a global storm resolving large-eddy simulation run with ICON. Furthermore, we explain the process of progressive data access and multi-resolution rendering using an implementation that decomposes and compresses ICON simulation data online during the simulation run. Finally, we also elaborate on possibilities to automate the data analysis process using machine learning techniques and feature tracking algorithms.