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In-situ analysis and visualization of massively parallel computations of transitional and turbulent flows

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Massively parallel simulations generate increasing volumes of large data, whose exploitation requires large storage resources, efficient network and increasingly large post-processing facilities. In the coming era of exascale computations, there is an emerging need for new data analysis and visualization strategies.

Data manipulation, during the simulation and after, considerably slows down the analysis process, now becoming the bottleneck of high performance computing. The traditional usage consists in performing the simulations in order to write output data on disk. When dealing with three-dimensional time-dependent problems computed on thousands of cores, the volume of data generated is big and highly partitioned. As a consequence, their post-processing often requires to decrease the spatial or the time resolution in order to be performed on local platform, with less resources than on the computational machine. Another solution consists in coupling analysis with simulation, so that both are performed simultaneously.

In order to address these questions, a client-server in-situ analysis for massively parallel time-evolving computations has been developed and applied to a spectral code for the study of turbulence and transition. It is shown to have a low impact on computational time with a reasonable increase of resource usage, while enriching data exploration. Large time sequences have been analyzed. This could not have been achieved with the traditional workflow. Moreover, computational steering has been performed with real-time adjustment of the simulation parameters, thereby getting closer to a numerical experiment process.

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