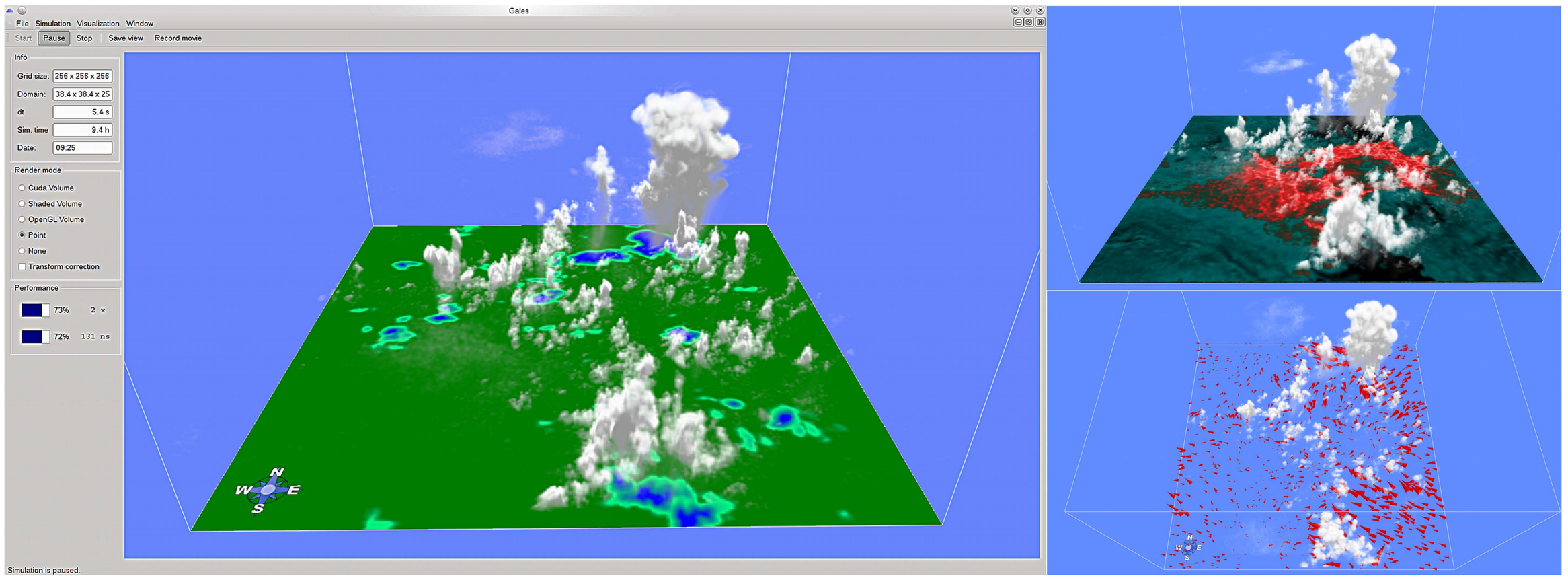
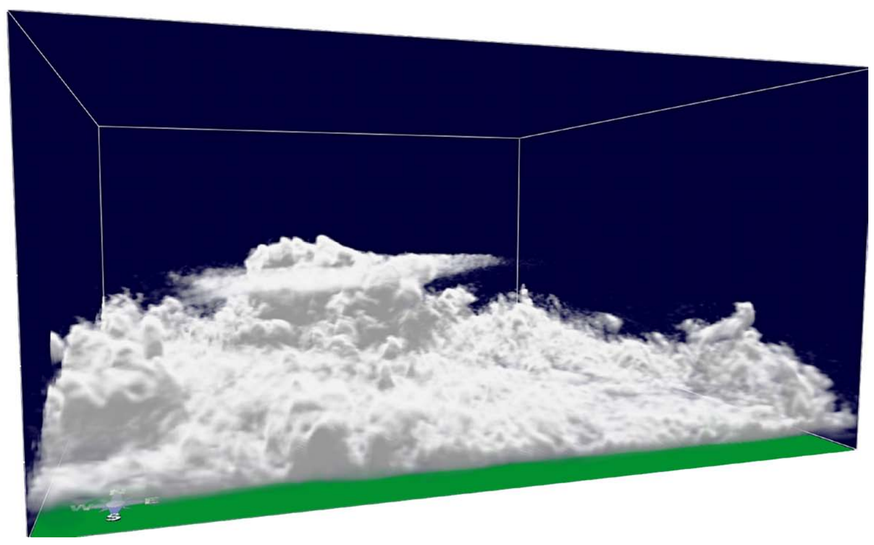
HIGH PERFORMANCE SIMULATIONS
OF TURBULENT CLOUDS ON A DESKTOP PC: EXPLOITING THE GPU

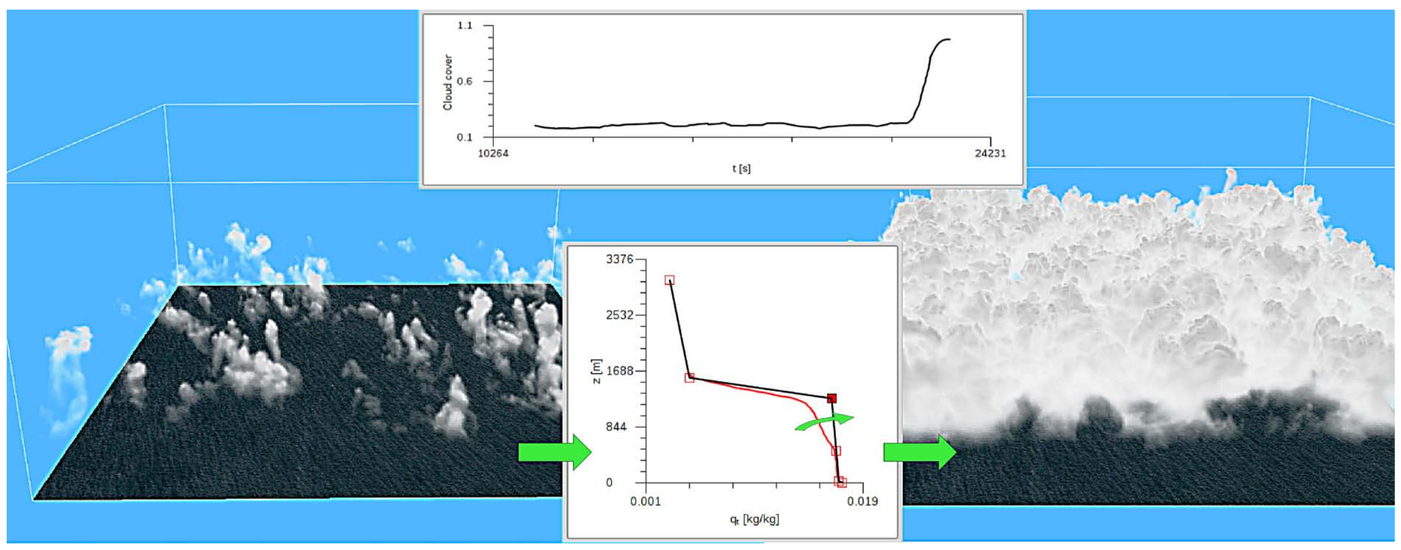
Current climate and weather models do not have the resolution to explicitly simulate cloud formation and evolution, and therefore use statistical models. Such models are often based on Large-Eddy Simulations (LES): high-resolution simulations on a small domain, running on a supercomputer. Exploiting the GPU, LES can return to the realm of the desktop computer, allowing direct communication with large-scale operational weather models.



GALES is an interactive simulation tool, providing the opportunity for the user to investigate the simulation while the running. Shown are the accumulated precipitation and 100m temperature and velocity fields.



We are currently experimentally simulating the local Dutch weather in GALES. Shown is a stormy night in October.



In GALES, the user can nudge the current simulation state (red line) towards a user specified target profile (black line with user-drawn red squares). The nudging can quickly and completely change the simulation state. Statistical plots quantify the response.

Our GPU-resident Atmospheric LES (GALES) can perform high resolution (up to 2563 cells) simulations of a part of the Earth's atmosphere, with sustained speeds comparable to those of a 32-64 core computing node. No significant calculations are performed on the CPU, allowing the data to continuously reside on the GPU. This avoids a bottleneck of GPU-CPU data transfer, and also allows the GPU to interactively render the cloud structure of the simulation, providing direct visual feedback on the simulation state, even while the simulation is running.

We are experimenting with a communication line between large-scale operational weather models and GALES, where GALES runs as a local high-resolution weather simulation. This provides a unique dataset by explicitly resolving the turbulent processes involved in the daily weather, allowing one to test scientific hypotheses in realistic weather situations.

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