**Title**

GPU-Accelerated Atmospheric Large Eddy Simulation: Preparing DALES for the Exascale Era

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**Abstract**

Large Eddy Simulation (LES) is a mathematical technique for performing simulations of turbulent flows, such as those found in the Earth’s atmosphere. Compared to traditional numerical weather and climate models, LES is more accurate in representing turbulent processes and cloud dynamics. The computational burden of LES, however, have histor- ically limited its application to relatively small domain sizes. In this work, part of the DALES atmospheric LES model was ported to Graphics Processing Units (GPUs) using the OpenACC programming model. GPUs, originally designed for accelerating computations related to 3D computer graphics, excel at parallel computations, which are abundant in LES models. The performance of the GPU port of DALES was measured on an NVIDIA RTX 3090 in a desktop workstation and an NVIDIA A100 in the Snellius supercomputer and compared to the existing CPU implementation. For the BOMEX intercomparison case, a speedup of 11.6 was achieved versus 8 CPU cores on the desktop system, while on Snellius a speedup of 3.9 was observed compared to 128 CPU cores. Furthermore, the existing MPI parallelization of DALES was adapted such that multiple GPUs can be used simultaneously. This thesis represents a step towards the enhancement of the scalability of DALES, enabling simulations on larger domains at higher resolutions. While a substantial acceleration of DALES was achieved, further efforts are needed to port more components of the model to the GPU to facilitate the simulation of increasingly realistic meteorological phenomena.