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PERFORMANCE PORTABLE FINITE VOLUME MAGNETOHYDRODYNAMICS FOR THE EXASCALE ERA

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Computational plasma models such as magnetohydrodynamics (MHD) and particle-in-cell (PIC) are essential tools in modern plasma physics. They can be used to complement physical experiments, inform future avenues of research, and provide insight into plasma phenomena that are difficult to create and control in a laboratory. The more detailed and physically realistic simulations can require the computational resources of entire supercomputers. As larger computing resources become available, we are able to conduct more refined plasma simulations, which can deepen our understanding of the behavior of plasmas. However, constraints in computer chip manufacturing are leading the next generation of supercomputers to employ a variety of novel architectures, usually with many more processing units. Until recently, each new architecture can require a separate, non-trivial rewrite of a simulation code. A current goal in computational science is the creation of programming paradigms for writing performance portable code: code that can run efficiently at high performance on many different supercomputer architectures. To explore the development of performance portable plasma simulation codes, we are currently modifying a CPU-only finite volume astrophysical MHD code to run efficiently on both CPUs and GPUs, using Kokkos, a performance portability library. I will present the strategies we used for implementing MHD using Kokkos and the challenges we encountered while attempting to achieve maximum performance on different platforms. In addition, I will discuss performance results for multiple architectures compared against the original code. The strategies, challenges, and results presented will allow other research groups to straightforwardly adopt this approach to prepare their own codes for the exascale era. (SAND No: SAND2019-2048 A)

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