Diagonal Spectral Deferred Correction for 3D Rayleigh-Benard convection

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Rayleigh-Benard convection (RBC) is a complex benchmark for incompressible flow. Turbulent dynamics make it a difficult problem to speed up using parallel-in-time methods. However, recent advances in diagonal preconditioners for the iterative time-stepping method spectral deferred correction (SDC) enabled small-scale time parallelism with high parallel efficiency, even for hyperbolic problems. In this talk we first show that time-parallel SDC can outperform state-of-the-art, time-serial, reference Runge-Kutta methods for our 3D pseudo-spectral IMEX discretization of RBC using a range of numerical experiments. Then, we show space-time parallel speedup on CPUs and GPUs, demonstrating the ability of diagonal SDC to extend the scaling capabilities beyond the limits of spatial parallelism at high parallel efficiency. To illustrate practicability of the method, we benchmark implementations within the SDC prototyping library pySDC and the space-discretization framework Dedalus.