SCALABLE NON-LINEAR COMPACT SCHEMES

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Weighted non-linear compact schemes combine the non-oscillatory behavior of the WENO schemes [1] with the high spectral resolution of compact schemes [2], for example the hybrid compact-WENO schemes [3] and the CRWENO schemes [4]. Both these schemes require solving solution-dependent systems of equations at each time step/stage, and thus limiting their applicability towards massively-parallel simulations, such as in [5].

In this study, we consider the scalable implementation of non-linear, tridiagonal compact schemes. We analyze a parallel tridiagonal solver for the system of equations on one-dimensional grid lines that solves the interior points in parallel and the sub-domain boundary points iteratively. The iterative solution is solved to a higher accuracy than that of the reconstruction scheme and the numerical properties are independent of the domain decomposition. We alleviate global communications by fixing the number of iterations a priori instead of using tolerance-based exit criteria. We investigate the scalability of this approach, especially the computational efficiency of the compact schemes as a function of domain size per processor, and compare it to that of the non-compact WENO scheme. We show that non-linear compact schemes are computationally more efficient for per-processor domain sizes of practical relevance.

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