A Numerical Comparison of the HWENO Method Based on Different Numerical Fluxes

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May 5, 2020

Abstract

The HWENO (Hermite weighted essentially non-oscillatory) schemes are high order, high-resolution methods suitable for conservation law and convection dominated simulations with possible discontinuous or sharp gradient solutions. In most of the literature, although there are many other numerical fluxes available, the Lax-Friedrichs numerical flux is used frequently due to its simplicity. In this paper, we will study an alternative finite difference HWENO method. The core of this method is that its numerical flux framework breaks the limitations of the traditional mathematical form of numerical flux and is suitable for many different forms of numerical flux. And we systematically investigate the performance of the HWENO method and present quantitative comparisons for hyperbolic conservation laws based on different numerical fluxes. The spatial terms are discretized by using finite difference HWENO scheme and the time terms are performed by using TVD Runge-Kutta method. The HWENO method is proposed based on the original WENO methodology for solving hyperbolic conservation laws. Therefore, the HWENO scheme is similar to the classic WENO scheme achieved by using numerical flux as a building block, and their performances are closely related to the properties of the numerical fluxes. Hence, we study the performance of HWENO method based on different numerical fluxes, including the first-order monotone fluxes and second-order TVD fluxes, with the objective of obtaining better performance for the conservation laws by choosing suitable numerical fluxes. The detailed discussion focuses on the one-dimensional system case, including the issues of CPU cost, accuracy, non-oscillatory property.

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