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# The relative effectiveness high-resolution methods in simulating compressible mixing

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High-resolution methods are necessary for the effective computation of compressible mixing. A large number of methods are available, but there is relatively little guidance on which methods are more appropriate or efficient under which circumstances. Some of the more popular methods available are PLM and PPM, (Woodward & Colella 198e) and the weighted ENO method (Jiang & Shu 1996). We will also consider more recent monotonicity preserving methods that can be applied to either the above formulations to achieve greater accuracy and efficiency per unit mesh (Rider, Greenough & Kamm 2003). We examine this question using the results computed for several standard problems at several comparable meshes and including a comparison with experimental data. We will use a number of measures. We will evaluate method convergence and produce accuracy estimates. This works springboards from a recent evaluation of WENO and PLM for 1-D shock physics problems where the PLM method was demonstrated to be more computationally efficient than WENO for these problems.

We will also examine the development of a cylindrical column(s) of SF6 accelerated by a shock wave resulting the Richtmyer-Meshkov instability. The idealized problem was constructed in order to compare compute codes and consists of a single Gaussian cylinder of SF6 accelerated by a Mach 1.2 shock and a very similar flow has been studied experimentally. Finally, the performance on the Taylor-Green vortex problem shows the ability of the method to compute three dimensional vortex dynamics ultimately leading to turbulence. In Table 1 we show a comparison at early time and late time using the entropy as the metric. Our calculations were conducted on two meshes, $32^3$ and $64^3$. We see that the WENO method is outperformed at both early and late time by either of the PLM or PPM methods. This advantage grows as the flow becomes more nonlinear at late times and the newer xPLM and xPPM methods.

| T=2 | | | | | | T=10 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Grid | PLM | PPM | WENO | xPLM | xPPM | PLM | PPM | WENO | xPLM | xPPM |
| $32^3$ | 4.0e-04 | 1.5e-04 | 9.e-04 | 2.6e-04 | 5.0e-04 | 0.030 | 0.029 | 0.039 | 0.029 | 0.026 |
| $64^3$ | 4.4e-05 | 1.2e-05 | 7.4e-05 | 3.7e-05 | 7.0e-06 | 0.024 | 0.022 | 0.030 | 0.023 | 0.021 |
| CPU | 1.00 | 0.93 | 17.00 | 1.30 | 1.45 | 15.35 | 14.21 | 261.0 | 19.93 | 22.22 |

Table 1. Error comparison for the Taylor-Green problem in terms of entropy and relative CPU time.

## References

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