Test Case C3.5

2^{nd} International Workshop on High-order CFD Methods

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Computational Data

Grids and schemes:

- 4 Grids with 64^3, 128^3, 256^3, 512^3 cells respectively.
- 2 Schemes: Finite Difference SBP/SAT 2^{nd} and 8^{th} order.
- Time marching: explicit RK4.

Machines:

	processor	TauBench (s)
desktop	3.40GHz Intel i7-2600	5.62
local cluster	2.67GHz Intel Xeon	7.93
national cluster	2.26GHz Intel Xeon	10.32

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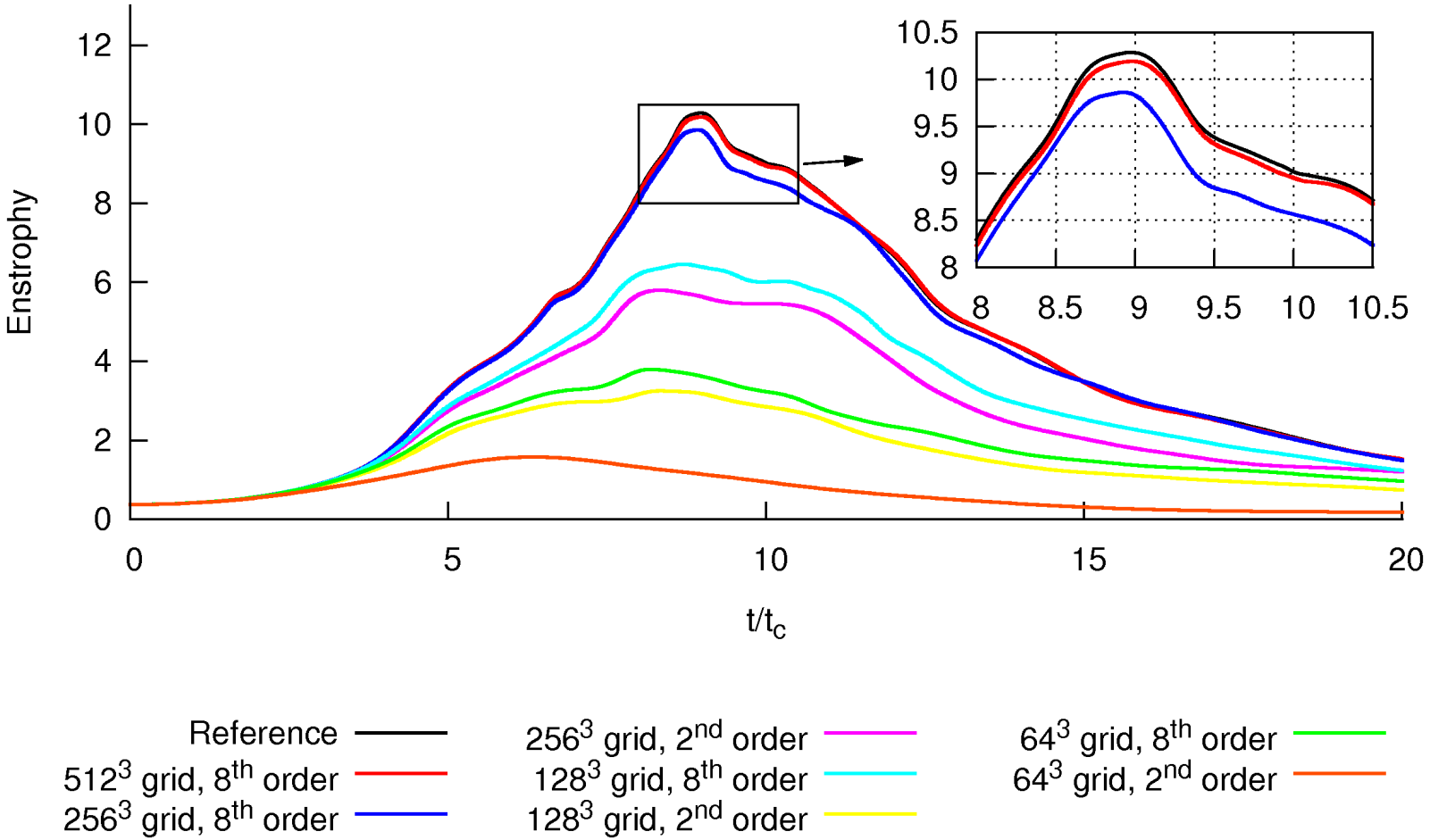
Runs

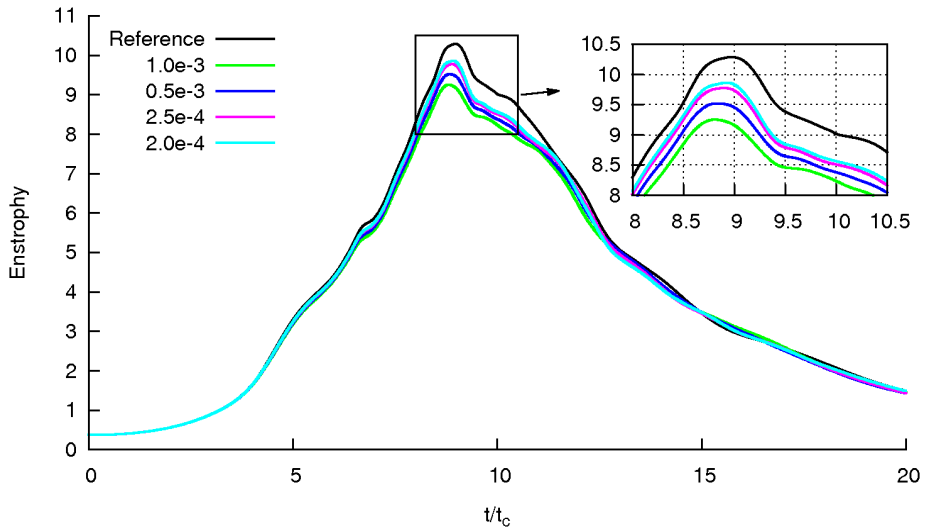
grid	scheme	♯ time steps	machine	♯ proc.	work units
64^3	2^{nd} Order	20238	desktop	2	3.74e+03
	8^{th} Order	20238			4.32e+03
128^3	2^{nd} Order	20238	desktop	2	2.81e+04
	8^{th} Order	20238			3.70e+04
256^3	2^{nd} Order	23476	local cluster	4	3.09e+05
	8^{th} Order	23476			3.59e+05
512^3	8^{th} Order	50000	nat. cluster	64	9.55e+06

Note: Work units are given for our general code (curvilinear coordinates). However, some runs were performed with a specialized code which was 5 times faster.

Enstrophy Evolution



Influence of Artificial Dissipation

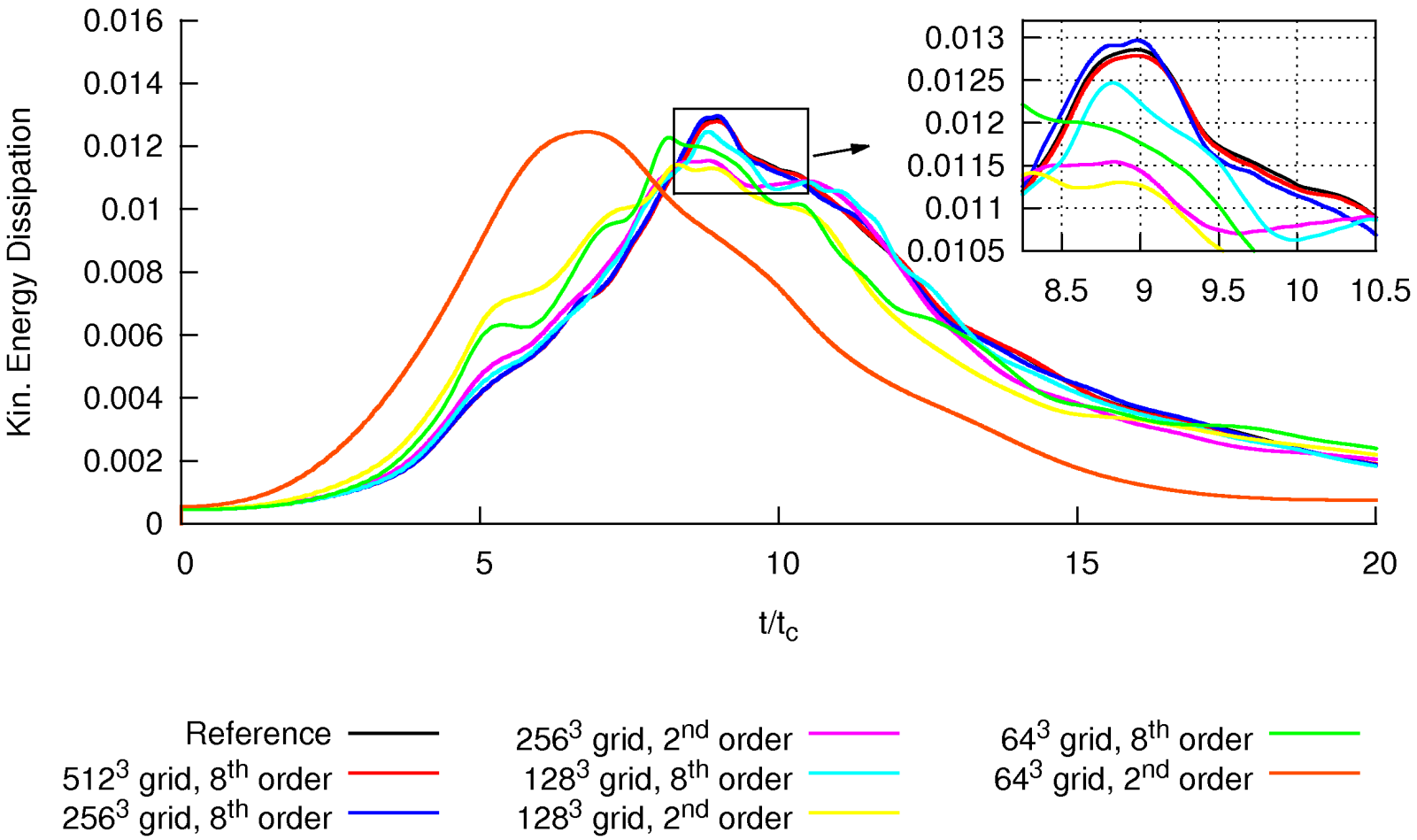


Enstrophy evolution on the 256^3 grid, 8^{th} order scheme: results for different values of the artificial dissipation constant.

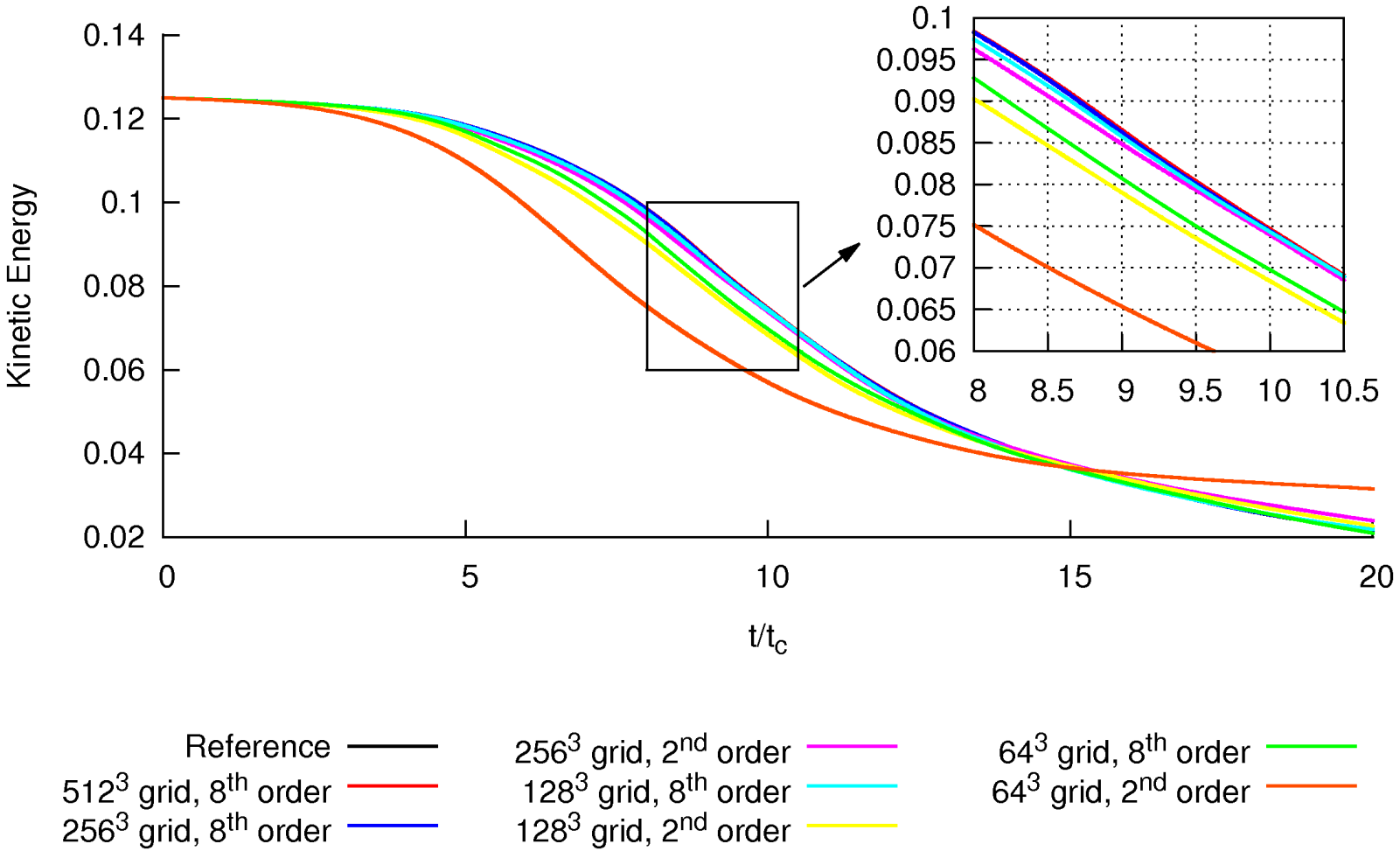
Artificial dissipation term:

- Fully consistent with the SBP/SAT schemes
- In the interior it reduces to an 'appropriate' high-order undivided difference
- Multiplied locally by the spectral radius of the flux Jacobian and globally by a constant (see picture)
- The less the better

Dissipation of Kinetic Energy



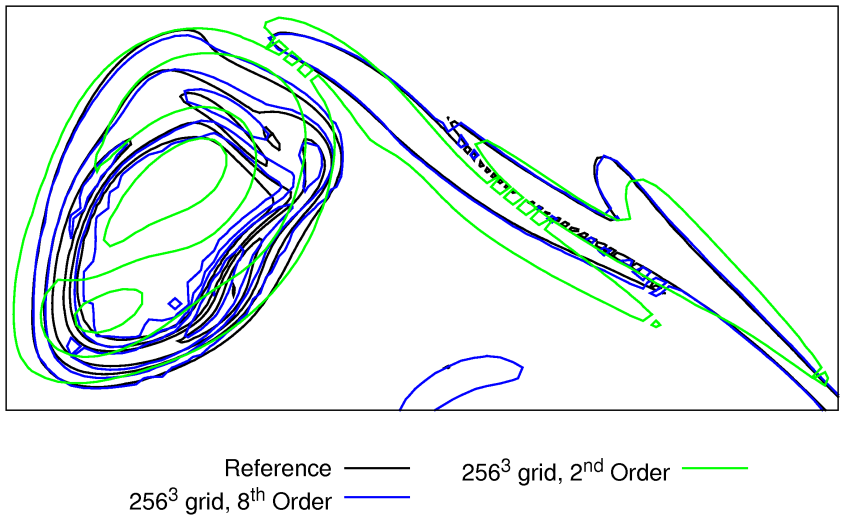
Kinetic Energy



Iso-contours of Vorticity Norm @ $t/tc = 8$, $x/L = -\pi$

512^3 grid

256^3 grid



Conclusions

- Computationally intensive
- A specialized code was found to be 5 times faster than our general one, which suffers the overhead of solving the NS eqs. in curvilinear coordinates on cartesian grids.
- As expected, decreasing the amount of artificial dissipation leads to better results
- Difficult to check the design accuracy of the schemes (grid converged solution for a DNS?)
- On the 512^3 grid with the 8^{th} order scheme, results are very close to the reference solution.

Thank you