Stable and Accurate Filtering Procedures for High Order Summation-By-Parts Schemes

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Abstract

The study of so called transmission problems in [1] revealed that successful numerical filtering may include a delicate balance between the need to remove high frequency oscillations (filter often for accuracy) and the need to avoid possible growth (filter seldom for stability). In this talk we investigate this contradiction, and propose different avenues for improved functionality.

The filter operators derived in [2] are the basic building blocks. We demonstrate that explicit use of the basic filter operators guarantee accuracy but lead to instabilities, while an implicit implementation preserve stability but degrade accuracy. We also prove that a specific accuracy condition is necessary for stability, and that the basic operators do not satisfy that condition. Finally, new modified filter operators that satisfy the specific accuracy conditions, are stable in combination with summation-by-parts operators [3], and can be used both explicitly and implicitly are constructed. The new operators are shown to efficiently damp the highest frequencies on the grid, including the π-mode.

[1] J. Nordström & V. Linders, *Well-posed and stable transmission problems*, Journal of Computational Physics, Volume 364, pp 95-110, 2018.

[2] C. A. Kennedy & M. H. Carpenter, Comparison of several numerical methods for simulation of compressible shear layers, in: NASA technical paper 3438, Langley research, 1997.

[3] M. Svärd & J. Nordström, *Review of summation-by-parts schemes for initial-boundary-value problems*, Journal of Computational Physics, Vol. 268, pp. 17-38, 2014.