Residual-based Artificial Viscosity on Spectral-Element Method

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ABSTRACT

In atmospheric simulation models, the treatment of damping small-scale noise in the model numerics has significant impact on the overall solution accuracy and model stability. Many atmospheric models have adopted hyper-viscosity (HV) based stabilization due to its scale-selective damping property. However, HV is prone to generating Gibbs oscillation in the presence of strong gradients which may introduce negativity in the tracer field or model instability. The diffusion coefficient is also regarded as a tuning parameter and determining the adequate coefficient value not straightforward. In this talk, a residual-based-artificial viscosity [Nazarov and Hoffman (2013), Marras et al (2015)] is developed and tested using high-order spectral-element discretization method. The Res-based viscosity results show overall best solution with nearly monotone results due to element-wise dynamically adaptive diffusion coefficient. The method is capable of capturing shocks while leaving smooth regions nearly intact with fewer parallel communication compared to HV. Overall, the res-based artificial viscosity method provides a robust, physics-based stabilization while completely removing user tunable parameter.

REFERENCES

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