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Regularizing Nonlinear Systems with Discontinuous Solutions in Higher Order Methods

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Nonlinear systems of equations often demonstrate complicated regularity features that can be obfuscated by diffuse numerical methods, or methods that preserve sub-scale features that are incommensurate with the signature behavior of the fully coupled system. Using a discontinuous Galerkin finite element method, we study a nonlinear system of advection-diffusion-reaction equations and aspects of its regularity and stability. For numerical analysis, we present a family of regularized solutions consisting of: 1) a sharp, computationally efficient slope limiter, known as the BDS limiter[1], 2) a standard spectral filter[2], and 3) a novel artificial diffusion algorithm (motivated from entropy viscosity type methods) with a solution-dependent entropy sensor. We analyze these three numerical regularization methods on a classical numerical test in order to tease out the strengths and weaknesses of each, and to determine the circumstances where each is most/least appropriately applied. We then test these methods on a very large application model, to see how they perform.

REFERENCES

[1] C. Michoski, C. Dawson, E.J. Kubatko, C. Mirabito, J.J. Westerink, D. Wirasaet. Adaptive hierarchic transformations for dynamically *p*-enriched slope-limiting over discontinuous Galerkin systems of generalized equations. *Journal of Computational Physics*, Volume **230**, Issue **22**, 10 Sept. 2011.

[2] J.S. Hesthaven and T. Warburton. *Nodal discontinuous Galerkin methods*, volume 54 of Texts in Applied Mathematics. Springer, New York, 2008. Algorithms, analysis, and applications.

[3] V. Zingan, J.-L. Guermond, J. Morel, and B. Popov. Implementation of the entropy viscosity method with the discontinuous Galerkin method. *Computer Methods in Applied Mechanics and Engineering*, 253:479-490, Jan 1 2013.