6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

ANALYSIS AND DESIGN OF ALGEBRAIC FLUX CORRECTION SCHEMES PRESERVING THE EIGENVALUE RANGE OF SYMMETRIC TENSORS

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This work extends the algebraic flux correction paradigm [2] to finite element discretizations of conservation laws for symmetric tensor fields. The proposed algorithms are designed to enforce discrete maximum principles and preserve the eigenvalue range of evolving tensors. To that end, a continuous Galerkin approximation is modified by adding a linear artificial diffusion operator and a nonlinear antidiffusive correction. The latter is decomposed into edge-based fluxes and constrained to prevent violations of local bounds for the minimal and maximal eigenvalues. In contrast to the flux-corrected transport (FCT) algorithm developed in [3] and geometric slope limiting techniques for stress tensors [4], the admissible eigenvalue range is defined implicitly and the limited antidiffusive terms are incorporated into the residual of the nonlinear system. In addition to scalar limiters that use a common correction factor for all components of a tensor-valued antidiffusive flux, tensor limiters are designed using spectral decompositions. The new limiter functions are analyzed using tensorial extensions of the theoretical framework developed in [1] for scalar convection-diffusion equations. The proposed methodology is backed by rigorous proofs of eigenvalue range preservation and Lipschitz continuity. Convergence of pseudo time-stepping methods to stationary solutions is demonstrated in numerical studies.

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