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Abstracts of Papers to Appear

Toward the Ultimate Conservative Scheme: Following the Quest. R. Abgrall. Mathématiques Appliquées de Bordeaux, Université Bordeaux I, 351 Cours de la Libération, 33 405 Talence Cedex, France.

The aim of this paper is to develop a class of numerical schemes that work on triangular finite element type meshes and to compute steady transonic flows. The schemes are extensions of the PSI (positive stream-wise invariant) scheme of Struijs and are built directly on the system of the Euler equation for fluid mechanics. They are a blending between a first-order scheme and a second-order scheme and the blending is realized from entropy considerations. It is formally second-order accurate at steady state. Several numerical examples are shown to demonstrate the stability and the accuracy of these schemes.

An Implicit Multigrid Method for Turbulent Combustion. Peter Gerlinger,* Helge Möbus,† and Dieter Brüggemann.‡ *DLR-VT, Stuttgart, Pfaffenwaldring 38-40, 70569 Stuttgart, Germany; †ITLR, Universität Stuttgart, Pfaffenwaldring 31, 70550 Stuttgart, Germany; and ‡LTTT, Universität Bayreuth, Universitätsstr. 30, 95440 Bayreuth, Germany.

An implicit multigrid scheme is presented for solving the Navier-Stokes, turbulence, species, and variance transport equations describing turbulent combustion. Turbulence chemistry interaction is included by use of presumed probability density functions (pdf). To avoid stiffness problems associated with chemically reacting flows, time integration is performed by an implicit LU–SGS algorithm. This requires the formation of a Jacobian source term. The complete, analytically derived Jacobian source term, including assumed pdf modeling, is given in the present paper. Thus, the high numerical stability of the original algorithm is maintained. Convergence acceleration is accomplished by a non-linear multigrid method. Strongly non-linear source terms in species, turbulence, and variance conservation equations usually keep multigrid methods from converging. It is shown that freezing of coarse grid source terms, including spatial derivatives and restriction damping in regions of high chemical activity, may remedy this problem. Two finite-rate chemistry test cases with methane and hydrogen combustion at supersonic speed demonstrate a strong reduction in required CPU time.

The Surface Gradient Method for the Treatment of Source Terms in the Shallow Water Equations. J. G. Zhou, D. M. Causon, C. G. Mingham, and D. M. Ingram. Centre for Mathematical Modelling and Flow Analysis, The Manchester Metropolitan University, Manchester M1 5GD, United Kingdom.

A novel scheme has been developed for data reconstruction within a Godunov-type method for solving the shallow water equations with source terms. Unlike conventional data reconstruction methods based on conservative variables, the water surface level is chosen as the basis for data reconstruction. This provides accurate values of the conservative variables at cell interfaces, so the fluxes can be accurately calculated with a Riemann solver. The main advantages are: (1) a simple centered discretisation is used for the source terms; (2) the scheme is no more complicated than the conventional method for the homogeneous terms; (3) small perturbations in the water surface elevation can be accurately predicted; and (4) the method is generally suitable for both steady and unsteady shallow water problems. The accuracy of the scheme has been verified by recourse to both steady and unsteady flow problems. Excellent agreement has been obtained between the numerical predictions and analytical solutions. The results indicate that the new scheme is accurate, simple, efficient, and robust.

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A High-Order Eulerian Godunov Method for Elastic/Plastic Flow in Solids. G. H. Miller†,‡ and P. Colella.† †Applied Numerical Algorithms Group, Lawrence Berkeley National Laboratory, Berkeley, California 94720; and ‡Department of Applied Science, University of California, Davis, One Shields Avenue, Davis, California 95616.

We present an explicit second-order accurate Godunov finite difference method for the solution of the equations of solid mechanics in 1, 2, and 3 spatial dimensions. The solid mechanics equations are solved in non-conservation form, with the novel application of a diffusion-like correction to enforce the gauge condition that the deformation tensor be the gradient of a vector. Physically conserved flow variables (e.g., mass, momentum, and energy) are strictly conserved; only the deformation gradient field is not. Verification examples demonstrate the accurate capturing of plastic and elastic shock waves across approximately five computational cells. 2D and 3D results are obtained without spatial operator splitting.