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IMPLICIT LOWER-UPPER/APPROXIMATE-FACTORIZATION SCHEMES FOR INCOMPRESSIBLE FLOWS. W. Roger Briley, Shyam S. Neerarambam, and David L. Whitfield. *National Science Foundation Engineering Research Center for Computational Field Simulation, Mississippi State University, Mississippi State, Mississippi 39762.*

A lower-upper/approximate-factorization (LU/AF) scheme is developed for the incompressible Euler or Navier–Stokes equations. The LU/AF scheme contains an iteration parameter that can be adjusted to improve iterative convergence rate. The LU/AF scheme is to be used in conjunction with linearized implicit approximations and artificial compressibility to compute steady solutions, and within sub-iterations to compute unsteady solutions. Formulations based on time linearization with and without sub-iteration and on Newton linearization are developed using spatial difference operators. The spatial approximation used includes upwind differencing based on Roe's approximate Riemann solver and van Leer's MUSCL scheme, with numerically computed implicit flux linearizations. Simple one-dimensional diffusion and advection/diffusion problems are first studied analytically to provide insight for development of the Navier–Stokes algorithm. The optimal values of both time step and LU/AF parameter are determined for a test problem consisting of two-dimensional flow past a NACA 0012 airfoil, with a highly stretched grid. The optimal parameter provides a consistent improvement in convergence rate for four test cases having different grids and Reynolds numbers and, also, for an inviscid case. The scheme can be easily extended to three dimensions and adapted for compressible flows.

COMPARISON OF THE CALCULATIONS OF THE STABILITY PROPERTIES OF A SPECIFIC STELLARATOR EQUILIBRIUM WITH DIFFERENT MHD STABILITY CODES. Y. Nakamura,* T. Matsumoto,* M. Wakatani,* S. A. Galkin,† V. V. Drozdov,† A. A. Martynov,† Yu. Yu. Poshekhonov,† K. Ichiguchi,‡ L. Garcia,§ B. A. Carreras,‖ C. Nührenberg (née Schwab),¶ W. A. Cooper,** and J. L. Johnson††. **Plasma Physics Laboratory, Kyoto University, Kyoto, Japan; †Keldysh Institute of Applied Mathematics, Moscow, Russia; ‡National Institute for Fusion Science, Nagoya, Japan; §Universidad Carlos III de Madrid, Madrid, Spain; ‖Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830; ¶Max-Planck-Institut für Plasmaphysik, Garching, Germany; **Centre de Recherches en Physique des Plasmas, Association Euratom–Confederation Suisse, Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland; and ††Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08543.*

A particular configuration of the LHD stellarator with an unusually flat pressure profile has been chosen to be a test case for comparison of the MHD stability property predictions of different three-dimensional and averaged codes for the purpose of code comparison and validation. In particular, two relatively localized instabilities, the fastest growing modes with toroidal mode numbers $n = 2$ and $n = 3$, were studied using several different codes, with the good agreement that has been found providing justification for the use of either of them for equilibria of the type considered.

VORTEX EROSION AND AMALGAMATION IN A NEW MODEL OF LARGE SCALE FLOW ON THE SPHERE. G. R. Stuhne and W. R. Peltier. *Department of Physics, University of Toronto, Toronto, Ontario, Canada M5S 1A7.*

The pseudo-spectral methodology that is typically employed to simulate fluid flow in spherical geometry exhibits, among other limitations, a severe degradation of performance at high resolution. Finite element models based upon the application of multigrid methods may be designed so as to avoid this defect while also allowing for greater local control over the computational mesh. We describe herein the details of the mathematical methods that are required to implement such a computational structure and apply these methods to design a model based upon the two dimensional spherical barotropic vorticity equation, the simplest framework within which their viability may be tested. The model is thereafter employed in the analysis of two essentially inviscid nonlinear dynamical problems in order to provide proof of concept. The first of these test problems entails repeating a well-known pseudospectral calculation of the erosion of a polar vortex under slow, quasi-steady, Rossby wave forcing at low zonal wavenumber. The second test problem concerns the simulation of the nonlinear development of the instability of a zonal shear band into a train of like signed vortices which subsequently amalgamate through the nonlinear pairing interaction. Results of these test calculations, as well as those based upon additional analyses that we discuss herein, demonstrate that the performance of our initial methodology meets the basic criteria of fluid flow simulation. This suggests, on the basis of theoretical efficiency, that optimized versions could eventually compete with the large production codes which are in operation today. Our future intent is to further develop this computational structure so as to create a new class of three-dimensional general circulation models that may be employed in a wide variety of astrophysical and atmosphere–ocean applications.

COMPARISON OF SOME FLUX CORRECTED TRANSPORT AND TOTAL VARIATION DIMINISHING NUMERICAL SCHEMES FOR HYDRODYNAMIC AND MAGNETOHYDRODYNAMIC PROBLEMS. Gábor Tóth* and Dušan Odstrčil†. **Sterrenkundig Instituut, Utrecht, The Netherlands; and †Astronomical Institute, Ondřejov, Czech Republic.*

Two versions of flux corrected transport and two versions of total variation diminishing schemes are tested for several one- and two-dimensional hydrodynamic and magnetohydrodynamic problems. Two of the schemes, YDFCT and TVDLF, are tested extensively for the first time. The results give an insight into the limitations of the methods, their relative strengths and weaknesses. Some subtle points of the algorithms and the effects of selecting different options for certain methods are emphasised.

A SYNCHRONOUS AND ITERATIVE FLUX-CORRECTION FORMALISM FOR COUPLED TRANSPORT EQUATIONS. Christoph Schär* and Piotr K. Smolarkiewicz†. **Atmospheric Physics ETH, Zürich, Switzerland; and †National Center for Atmospheric Research, Boulder, Colorado.*

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Many problems of fluid dynamics involve the coupled transport of several, density-like, dependent variables (for instance, densities of mass and momenta in elastic flows). In this paper, a conservative and synchronous flux-corrected transport (FCT) formalism is developed which aims at a consistent transport of such variables. The technique differs from traditional FCT algorithms in two respects. First, the limiting of transportive fluxes of the primary variables (e.g., mass and momentum) does not derive from smooth estimates of the variables, but it derives from analytic constraints implied by the Lagrangian form of the governing continuity equations, which are imposed on the specific mixing ratios of the variables (e.g., velocity components). Second, the traditional FCT limiting based on sufficiency conditions is augmented by an iterative procedure which approaches the necessity requirements. This procedure can also be used in the framework of traditional FCT schemes, and a demonstration is provided that it can significantly reduce some of the pathological behaviors of FCT algorithms. Although the approach derived is applicable to the transport of arbitrary conserved quantities, it is particularly useful for the synchronous transport of mass and momenta in elastic flows, where it assures intrinsic stability of the algorithm regardless of the magnitude of the mass-density variable. This latter property becomes especially important in fluids with large density variations, or in models with a material ''vertical'' coordinate (e.g., geophysical hydrostatic stratified flows in isopycnic/isentropic coordinates), where material surfaces can collapse to zero-mass layers admitting, therefore, arbitrarily large local Courant numbers.