developed for identifying the line-segment orientation by inspecting the cell volume fractions. The new cell volume fraction field is obtained by integrating the advected area underneath the interface line segment. As an example, this technique is applied to the capillary driven viscous flow of an initially elliptic, two-dimensional fluid zone. The problem is posed mathematically as a solution of the Navier–Stokes equations with moving free surface boundary conditions. The damping motion of the fluid zone is observed through transport of the free surface, which is related to the instantaneous internal velocity field under the influence of surface tension and viscous forces.

A TREATMENT OF DISCONTINUITIES IN SHOCK-CAPTURING FINITE DIFFERENCE METHODS. De-kang Mao, *University of California at Los Angeles, Los Angeles, California, USA.*

In this paper a treatment to sharpen discontinuities for shock capturing methods is introduced. The treatment is a modification of the underlying scheme that makes the computation on each side of the discontinuity use information only from that side. The modification is done by adding specific artificial terms to the underlying scheme. The correctness of the discontinuity's location is guaranteed by some limitation of the artificial terms. Shock tracking ideas are involved in the treatment; however, no lower dimensional grid is needed to fit the discontinuity. A high resolution technique is set up to find out the location of the discontinuity within the cell. Several numerical examples including spontaneous shocks, linear discontinuity calculations, and the blast waves problem are presented.

COMPUTER SIMULATIONS OF MULTIPLICATIVE STOCHASTIC DIFFERENTIAL EQUATIONS. P. D. Drummond and I. K. Mortimer, *The University of Queensland, St. Lucia, AUSTRALIA.*

A class of robust algorithms for the computer simulation of stochastic differential equations with multiplicative noise is investigated. Excellent agreement is obtained with the known analytic behaviour of the Kubo oscillator in the white noise limit. The algorithms include a known first-order one-dimensional explicit method, as well as implicit methods of increased stability. A distinction is drawn between classes of stochastic differential equations depending on the type of spatial variation or curvature defined by the diffusion tensor. This allows greatly simplified numerical implementations of the new algorithms in certain cases. The results of different techniques are compared for the case of the Kubo oscillator, where a semi-implicit technique gives the greatest accuracy.

MULTI-DOMAIN SIMULATIONS OF THE TIME-DEPENDENT NAVIER–STOKES EQUATIONS: BENCHMARK ERROR ANALYSIS OF SOME NESTING PROCEDURES. Terry L. Clark and William D. Hall, *National Center for Atmospheric Research, Boulder, Colorado, USA.*

This paper presents a benchmark error analysis of various approaches for treating multiple domain calculations within an anelastic finite difference model. One-way and two-way interactive nesting errors with and without temporal refinement are evaluated. The two-way interactive nesting approach is one where solutions between fine and coarse grid domains are matched through the simple post insertion of data. On the other hand, the equations can be matched by using the pressure defect correction approach. It is shown that, for the present model, the two-way interactive nesting method gives identical results to multi-domain solutions using the pressure defect correction approach. The present results indicate that in this type of anelastic framework, *a priori* matching of the equations is equivalent to the *a posteriori* matching of the solutions. This result is attributed to the inflexible nature of the Neumann boundary conditions on the fine mesh pressure which need to be specified from the coarse mesh. Since a large number of meteorological models employ the hydrostatic assumption, it is of interest to know of nesting errors attributable to this approximation. The results presented indicate essentially equivalent error levels for both the hydrostatic and non-hydrostatic systems of equations for the present case of airflow over an isolated mountain. It is shown how nesting technology can be used in a virtual sense to reduce the central memory requirements for large array sized numerical simulations. Nesting can be used in this sense to decompose the maximum memory working space required without affecting the results.

NUMERICAL MODELING OF ELECTROMAGNETIC CASTING PROCESSES. O. Besson, J. Bourgeois, P.-A. Chevalier, J. Rappaz, and R. Touzani, *Ecole Polytechnique Fédérale, Lausanne, SWITZERLAND.*

The main goal of this paper is to present a numerical model describing the major physical phenomena involved in electromagnetic casting industrial processes as precisely as possible. Under suitable physical assumptions, we derive the set of equations in the two-dimensional case; we describe in detail the numerical methods used to solve such equations and derive an iterative algorithm. Numerical results describing the case of an aluminium ingot are presented in order to show the efficiency of the method.

AN IMPROVEMENT OF FRACTIONAL-STEP METHODS FOR THE INCOMPRESSIBLE NAVIER–STOKES EQUATIONS. Hung Le and Parviz Moin, *Stanford University, Stanford, California, USA.*

A numerical method for computing three-dimensional, unsteady incompressible flows is presented. The method is a predictor–corrector technique combined with a fractional step method. Each time step is advanced in three sub-steps. The novel feature of the present scheme is that the Poisson equation for the pressure is solved only at the final sub-step resulting in substantial savings in computing time. It is shown that the method allows a larger CFL number and reduces the computing cost without loss of accuracy by satisfying the continuity equation only at the last sub-step. Numerical solutions for the decaying vortices and flow over a backward-facing step are obtained and compared with analytical and other numerical results.

NUMERICALLY INDUCED STOCHASTICITY. Alex Friedman, *Lawrence Livermore National Laboratory, Livermore, California, USA*; Steven P. Auerbach, *Science Applications International Corp., Emeryville, California, USA.*

The true motion of a particle in a one-dimensional potential well is regular, since conservation of energy constrains the velocity v at each value of the coordinate x. Nonetheless, when the orbit is computed numerically, stochastic behavior can result. We have considered simple integrators as *mappings* from (x, v) at one discrete time level to (x, v) at the next. In general, when the timestep size Δ is small enough, there are closed orbits, while for larger values there is chaos. Chaos can result for surprisingly small values of Δ in cases where the physical phase plane includes a separatrix. The behavior of the leapfrog mover as applied to motion in a particular double-well potential is examined in detail. Here, the onset of stochasticity occurs at step sizes much smaller than the stability threshold associated with the harmonic dependence of the potential at large $|x|$. Other one-dimensional wells and movers are also treated; implications of the area-preserving and energy conserving attributes possessed by some movers are discussed. A new variant of the standard map, displaying symmetry about both $x=0$ and $v=0$ in its phase plane, is introduced.

LONG-TIME BEHAVIOR OF NUMERICALLY COMPUTED ORBITS: SMALL AND INTERMEDIATE TIMESTEP ANALYSIS OF ONE-DIMENSIONAL SYSTEMS. Steven P. Auerbach, *Science Applications International Corporation, Emeryville, California, USA*; Alex Friedman, *Lawrence Livermore National Laboratory, Livermore, California, USA.*

The long-time behavior of numerically computed orbits in one-dimensional systems is studied by deriving a continuous-time "pseudo-dynamics" equivalent to the discrete-time numerical dynamics. The derivation applies to any numerical algorithm which conserves phase-space volume. A conservation law of the continuous-time system (conservation of the "pseudo-Hamiltonian") guarantees that the numerical