# FLOW-3D Version 9.3 Features

## Meshing & Geometry

- Structured finite difference/control volume
- Multi-Block Gridding with:
  - Nested blocks
  - Linked blocks
- Fractional areas/volumes (FAVOR™) for efficient & accurate geometry definition
- Solids Modeler
- Imports most CAD files

## Flow Type Options

- Internal, external & free-surface flows
- Three, two & one dimensional problems
- Transient flows
- Cartesian or cylindrical coordinates
- Inviscid, viscous, laminar & turbulent flows
- Non-inertial reference frames
- Multiple scalar species
- Two-phase flows
- Heat transfer with phase change
- Saturated & unsaturated porous media

## Thermal Modeling Options

- Natural convection
- Forced convection
- Conduction in fluid & solid
- Fluid-solid heat transfer
  - Conduction
  - Specified heat flux
  - Specified solid temperature
- Heat transfer to voids from fluid/obstacles
- Distributed energy sources/sinks in fluids or solids
- Radiation by emissivity
- Viscous heating

## Numerical Modeling Options

- Volume-of-Fluid (VOF) method for fluid interfaces-TruVOF
- First, second or third order advection
- Sharp fluid interface tracking
- Implicit & explicit modeling options
- Point, line relaxation & GMRES pressure solvers
- User-defined variables, subroutines & output
- Utilities for runtime interaction during execution

## Flow Definition Options

- General initial conditions
  - Symmetry
  - Rigid walls
  - Continuative
  - Periodic
  - Specified pressure
  - Specified velocity
  - Outflow
  - Grid overlay
  - Hydrostatic
  - Custom
  - Volume flow rate
  - Surface waves
- Restart previous simulation
  - Continuation of a simulation
  - Overlay boundary conditions from a previous simulation
  - Change mesh
  - Add, delete or change model parameters

## Fluid Modeling Options

- One incompressible fluid – confined or with free surfaces
- Two incompressible fluids – miscible or with sharp interfaces
- Compressible fluid – subsonic, transonic, supersonic
- Stratified fluid
- Acoustic phenomena
- Mass particles with variable density or diameter

## Physical Modeling Options

- Scour & erosion/deposition
- Cavitation
- Phase change (liquid-vapor, liquid-solid & liquid-gas)
- Surface tension
- Thermocapillary effects
- Wall adhesion
- Wall roughness
- Vapor & gas bubbles
- Solidification & melting (heat-of-transformation table)
- Mass/momentum/energy sources
- Shear, density & temperature-dependent viscosity
- Thixotropic viscosity
- Elastic stress
- Electric field
- Elastic membranes & walls
- Evaporation residue
- Dielectric phenomena
- Electro-osmosis
- Electrostatic particles
- Electro-mechanical effects
- Joule heating
- Air entrainment
- Molecular & turbulent diffusion

## Metal Casting Models

- Solidification & melting
- Solidification shrinkage
- Microporosity
- Binary segregation during solidification
- Solid-fraction dependent latent heat release
- Thermal die cycling
- Thermal stress & deformations
- Defect tracking
- Cavitation potential model
- Lost-Foam casting model
- Semi-solid material model
- Moisture in sand & molds
- Back pressure & vents
- Shot sleeves

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## Turbulence Models

- Prandtl mixing length
- One-equation transport
- Two-equation κ—ε model
- RNG κ—ε model
- Large eddy simulation

## Porous Media Models

- Variable porosity
- Directional porosity
- General flow losses (linear & quadratic)
- Capillary pressure
- Unsaturated flow
- Heat transfer in porous media

## Two-phase & Two-component Models

- Liquid/liquid & gas/liquid interfaces
- Two-fluid mixtures
- One compressible fluid with a dispersed incompressible component
- Two-component drift-flux
- Two-component, vapor/non-condensible gases
- Phase transformations for gas-liquid & liquid-solid
- Adiabatic bubbles
- Bubbles with phase change
- Continuum fluid with discrete particles
- Scalar transport

## Shallow Flow Models

- Shallow water model
- General topography
- Wetting & drying
- Wind shear
- Ground roughness effects

## Chemistry Models

- Stiff equation solver for chemical rate equations
- Stationary or advected species

## Special Physical Models

- General Moving Object model with 6 Degrees of Freedom–user specified motion or fully-coupled with fluid flow
- Rotating/spinning obstacles
- Porous baffles & obstacles with linear & quadratic flow losses
- Collision model
- Moving object assemblies

## Discrete Particle Models

- Massless marker particles
- Mass particles of variable size/mass
- Linear & quadratic fluid-dynamic drag
- Monte-Carlo diffusion
- Particle-Fluid momentum coupling
- Coefficient of restitution or sticky particles
- Point or volumetric particle sources
- Charged particles
- Probe particles

## User Conveniences

- Mesh & initial condition generators
- Time-step control for accuracy & stability
- Automatic limited compressibility
- Convergence control
- Mentor help to optimize efficiency
- Change solution parameters as solver runs
- Manage & launch multiple simulations

## Data Processing Options

- Automatic or custom graph requests
- Interactive OpenGL-based graphics (grid overlay optional)
- Color or B/W vector, contour, 3D surface & particle plots
- Moving history & probe data
- Force & moment computations
- Animation output
- PostScript, JPEG & Bitmap output
- Streamlines
- STL geometry viewer

## Coupling with Other Programs

- Geometry input from Stereolithography (STL) files – binary or ASCII
- Geometry input from ANSYS or I'DEAS tetrahedral data
- Direct interfaces with EnSight, FIELDVIEW & Tecplot visualization programs
- PLOT3D output
- Neutral file output
- Extensive customization possibilities
- Topographic data

## Supported Platforms

**Processors**

- x86/x86-32 (Intel Pentium/Xeon, AMD Athlon/Opteron)
- x86/x86-64 (Intel Pentium/Xeon/Core, AMD Athlon/Opteron)

**Operating Systems**

- 32-bit Windows XP/Vista
- 64-bit Windows XP/Vista & Server 2003
- 32-bit Redhat Enterprise 3.0+
- 64-bit Redhat Enterprise 3.0+ & SUSE Enterprise 9.0+

## Hardware Requirements

The hardware requirements to run ***FLOW-3D*** depend on the number of physical models active during the simulation. An iso-thermal, inviscid simulation requires roughly 1GB of memory for 2.5 million computational cells in double precision. Activating turbulence & heat transfer increases the memory requirements by about 30%. A single precision solver reduces the memory requirements by roughly 40%.