



# GASP<sup>®</sup> v5.0 FEATURES



**AeroSoft**

*AeroSoft's Multi-Physics Solver*

## Basic Features

- Solves steady and unsteady 3-D, Reynolds-Averaged, Navier-Stokes Equations (RANS) and subsets:
  - Thin-layer Navier-Stokes (TLNS)
  - Parabolized Navier-Stokes (PNS)
  - Incompressible Navier-Stokes
  - Euler equations
- Solves steady and unsteady 3-D heat equation including conjugate heat transfer
- Solves the steady and unsteady linear Sensitivity Equations

## Physical Modeling – Inviscid Fluxes

- Roe, Modified-Roe, AUSM+ and Van Leer flux splittings
- Yee low dissipation flux scheme
- Preconditioned-Roe (extends application to  $M \ll 1$ )
- Preconditioned Weiss-Smith flux scheme
- Artificial Compressibility (Incompressible flow only)
- Higher order MUSCL reconstruction
- True high-order ENO reconstruction

## Physical Modeling – Thermodynamic and Transport Properties

- Equilibrium and non-equilibrium (U.S. only) thermodynamics models
- NASA GRC extended curve fit option
- Extended transport properties for air to 30,000 K

## Physical Modeling – Chemistry Models

- Species and Reaction databases for thermo-chemical properties
- Stand alone database manager
- Extended rate equation curve fits
- Complete reaction sets for existing chemistry models
- Park's two-temperature kinetic model for ionizing air

## Physical Modeling – Two Phase Flow

- Lagrangian formulation for particle tracking
- Support for solid and liquid particles
- Evaporation models
- Compatible with steady and time dependent simulations
- Wall rebound models
- Drag models

## Physical Modeling - Turbulence Models

- Baldwin-Lomax algebraic model in any two logical directions (structured only)
- Spalart Allmaras one-equation model (w/ Detached Eddy Simulation (DES))
- $k-\epsilon$  (high Re, Chien and Lam Bremhorst)
- $k-\omega$  (Wilcox '88, '98 & '06 formulations, including compressibility)
- $k-l$  (Smith and Goldberg)
- Mentor's SST model for  $k-\omega$
- Reynolds Stress Model (Wilcox Stress- $\omega$ )
- Supports user-input intermittency values for transition modeling

## Physical Modeling – Solid Thermodynamics

- Material database with properties
- Variable temperature properties supported
- Solids with different materials supported

## Physical Modeling – High Energy Lasers (U.S. Only)

- Output HEL specific variables
- Stable Resonator Optics Model
- COIL and HF Chemistry Models \*

\* Available upon request.

## Discretization

- Multi-block structured/unstructured grid topology
- Unstructured mesh support for tetrahedra, hexahedra, prisms, and pyramids
- Chimera/Overset grids (structured grids only)
- Built in hole-cutting and stencil selection and peeling
- Robust treatment of orphans
- Surface projection for overlapping viscous grids
- Dual fringe point interpolation for increased spatial accuracy
- 3-D visualization and statistics for holes, interpolation cells and orphans
- Point-to-point and non-matching zonal boundary interpolation
- Automated point-to-point zonal boundary detection
- Automated mesh sequencing

## Temporal Accuracy

- Steady state option
- 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> order time accurate option
- Implicit Dual-time-stepping and Newton sub-iterations
- Explicit Runge-Kutta
- Solution and grid files separate for all saved time steps
- Time-dependent freestream conditions applied to any boundary condition

## Motion Modeling

- Kinematics models: (U.S. Only)
  - 6 DOF models, multiple bodies, constrained / unconstrained
  - Constrained motion database
- Chimera calculations automated between time steps

## Time Integration

- Full Implicit 3-D solvers (Symmetric Point Gauss Seidel, Point Jacobi)
- Implicit coupling across point to point zonal boundaries
- Implicit boundary conditions
- Uncoupling of systems including turbulence and chemistry for improved computational efficiency
- Operator splitting for chemical source terms (using DVODE)
- Euler Explicit Solver

## Parallel Computing

- Distributed memory model using MPI
- Support for most parallel computers, including clusters
- Integrated domain decomposition is transparent to the user
- Support for full implicit time integration in parallel
- Parallel Hole cutting and Chimera stencil searches
- Support for semi-automated load balancing
- Different domain decomposition on different grid sequences

## Graphical User Interfaces

- All GUI interfaces integrated into single application (both pre- and post-processing in a single application)
- Complete integration with the 3-D viewing window
- Most features accessible from a single window
  - Extensive use of “tab sheets” and tables for organization and layout
- Graphics states saved in problem file

## Solution/Convergence Monitor

- Watch points
  - Print any variable anywhere in the domain at each time step
  - Automated creation of separate files for separate iterations and physical time steps
  - Integrate quantities each time step (skin friction, lift or drag)

## Miscellaneous

- Hierarchical-tree based organization of problem geometry
  - Group zones and surfaces in distinct families (support for nesting families within one another)
  - Drag and drop surfaces and zones to create line plots, and volume rendering
- Control execution of GASP based upon families (time integration methods act on a family of zones)
- Kinematics motion models act on a family of zones
- Apply boundary conditions from within a physical model based upon Surface families
- Each physical model can have unlimited number of “freestream” definitions
  - Each boundary condition can be set based upon different “freestream”
- Support for user-specified unit systems
  - Create an auxiliary file with conversion factors from SI to users unit system
  - GASP will read the auxiliary file and all output will be converted to and from that unit system

## Solution Visualization

- Redesigned solution visualization from within the GUI
- Leverages VTK open source library
- Support for most visualization primitives
  - Line or flooded contours, isosurfaces, velocity vectors, Streamlines using tubes, ribbons, and bubbles, cutting planes
- Line plotting from within the GUI
- Creation of movies and snapshots

## Post-Processing

- Support for PLOT3D, TECPLOT, Enight and Fieldview
- Simplified user interface for computing integrated quantities (e.g., lift and drag)
- Support for blanking within plot3d type output
- English and SI, and user defined unit systems
- Automatic execution of post-processing at end of CFD run
- Access to all time levels stored in the solution files
- User defined output variables