Scientific Computing Within the ORNL Modeling and Simulation Group: Computational Physics

The ORNL Modeling and Simulation Group (MSG) develops sophisticated numerical solutions for a wide range of scientific, engineering, and operational applications. MSG’s core competency is computational physics and engineering, and within this context we have extensive expertise in the Computational Physics (CP) focus area. MSG’s CP activities emphasize fusion-plasma and electrical-transmission simulations executed in close collaboration with the ORNL Fusion Energy Program. MSG’s CP problem solving scope encompasses an extremely diverse set of solution techniques, computing platforms, and applications. Software developed, modified, and/or maintained by MSG to support these simulations include AVAC which integrates field-line equations for design of stellarator coils, B2.5 for 2D simulation of multifluid plasma transport, COILOPT for design optimization of magnetic coils, DEGAS for Monte Carlo based 3D transport of neutral particles, and OPA for modeling the dynamics of power grid systems. Recent MSG CP applications include, but are certainly not limited to, the following.

- Design optimization of complex magnetic coil systems for compact stellarators that maximize plasma confinement and stability.
- Analysis of experimental plasma-edge-fluctuation data to establish the influence that large edge transport fluctuations have on the macroscopic transport of plasma within the tokomak and stellarator.
- Data-constrained modeling of tokomak discharges to reconstruct the plasma within the containment volume and characterize heat and particle-fluxes interaction with vessel walls.
- Study of plasma ballooning-mode and pseudo-chaotic behaviors, and their affect on plasma confinement.
- Development of a numerical method for solving fractional-order PDE’s representative of tracer particles in turbulent pressure-driven plasma flows.
- Modeling of power generator dispatch and the self-organization of load growth and network upgrades in response to electrical transmission system blackouts.

These applied scientific computing capabilities represent an extremely versatile modeling and simulation resource for a broad range of R&D, industrial, homeland defense, and military applications. We welcome the opportunity to discuss your potential applications and ways MSG can contribute to a solution.