Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Towards Sparse-Direct Interaction Perturbation (SDIP) for Variable-Density Flow[1] DAVID PETTY, CARLOS PANTANO, University of Illinois Urbana Champaign — A numerical method has been developed to solve the set of integro-differential equations which result from applying the Sparse Direct-Interaction Perturbation (SDIP) technique to the low-speed, variable-density Navier-Stokes equations. This type of turbulence is at the heart of mixing and combustion applications. SDIP is a second-order moment closure theory that has particular relevance to the modeling of fluid turbulence. The strongly nonlinear numerical problem has been formulated as a system of equations using finite differences in time decorrelation, interpolation, variable-order quadratures, and mesh adaptation. The solution to this system has been made practicable by the construction of the full Jacobian of the numerical method using the Automatic Differentiation by Over-Loading in C++ (ADOL-C) library. Special coordinate transformations were found to be essential for robust calculations of integrals that are not absolutely convergent; cancellations of singularities must be treated accurately. Progress towards the determination of the turbulence kinetic energy spectrum and velocity-scalar cospectra of the low-speed, variable-density Navier-Stokes equations derived from the SDIP solver will be discussed.

[1]The authors would like to thank the grant support for this research provided by the Air Force Office of Scientific Research, and the Department of Energy

David Petty
University of Illinois Urbana Champaign

Date submitted: 28 Jul 2015 Electronic form version 1.4