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New quasi-Newton solver for transport equations[1] JOHAN CARLSSON, JOHN R. CARY, ALEX PLETZER, Tech-X Corporation — A new quasi-Newton algorithm has been developed for systems in which the Jacobian has a block structure, as is the case for finite-difference approximations of transport equations where the fluxes depend only on the local field values and their gradients. A primary goal of this work is to minimize the number of numerically expensive flux calculations (e.g. diffusivities). Secondary design considerations were 2^{nd} order temporal and spatial discretization error, good numerical stability, and a modular design. Like the most common quasi-Newton algorithm, the Broyden method, our new quasi-Newton approach, the Block Hyper-Secant (BHS) approximation, uses flux evaluations from previous Newton iterations to approximate the Jacobian. If the flux evaluations dominate the computation time, the approximate Jacobian is thus free. Unlike Broyden, the BHS approximation converges toward the finite-difference Jacobian after sufficiently many iterations. An implicit transport solver, 2^{nd} order in time and space, has been implemented using the BHS solver to calculate the field increments. Numerical studies will be presented of its spatial and temporal accuracy as well as stability for time steps exceeding the CFL limit by many orders of magnitude. The FACETS FSP project has started using the BHS solver for core transport simulations and preliminary results will be presented.

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