Advanced Optimization Methods for Entropy-based Closures in Slab Geometry

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Entropy-based moment closures (so-called M_N systems) are reduced models for the kinetic equation which are parallelizable and maintain fundamental properties but require the solution of a strictly convex optimization problem at every point on the space-time mesh. The numerical solution of this optimization problem presents a major challenge to practical implementation of M_N models because basic application of Newton's method fails for some problems which show up in standard test problems. We have studied in depth the difficulties faced by the optmizer and present a few modification to allow for robust numerical solution. These modifications include adaptive change of the basis functions defining the moments, a regularization method to replace the most difficult problems with similar easier ones, and an analysis of the quadrature's role in the optimization and moment system. Finally, we use a manufactured solution method to study the effect of various modifications and parameters on the accuracy of the simulation.