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Arc Simulation with a Tightly Coupled Near-Wall Non-Equilibrium Sheath-Layer Model[1] W. A. HAGEN, University of Illinois, I. V. ADAMOVICH, Ohio State University, J. B. FREUND, University of Illinois — Representing all the length and time scales of discharge in a numerical simulation can be prohibitively expensive for large-scale discharges such as in arc heaters. Simplifications, especially a local thermal equilibrium approximation, can reduce computational cost and is appropriate over much of the domain in such an application. However, equilibrium fails near electrodes. We develop and test a near-wall closure model to capture these non-equilibrium and integrate it with a bulk local equilibrium approximation to limit total computational cost. A boundary layer approximation is made such that the near-wall region is locally one dimensional, and multi-fluid non-equilibrium plasma simulations are solved using appropriate methods for coping with their numerical stiffness (due to electron transport) and are then tabulated for inclusion as boundary conditions in the full domain. The approach is demonstrated in an arc discharge with tungsten electrodes at atmospheric pressures. Agreement for total arc voltage depends upon inclusion of the non-equilibrium sheath representation and its coupling with the overall equilibrium simulation.

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