The following will outline the methodology and results of validating a coupled Method of Characteristics (MOC) and Direct Simulation Monte Carlo (DSMC) method. This research focused specifically on modeling plume impingement, induced by Reaction Control System (RCS) thrusters that flew on the National Aeronautics and Space Administration's (NASA's) space shuttle Discovery. For each simulation, the continuum portion of the RCS thruster was simulated using MOC for solving hyperbolic Partial Differential Equations (PDEs) and computed in the NASA code, Reacting and Multi-phase Program (RAMP). The solution was then implemented as a starting condition into the NASA DSMC code, Direct Simulation and Monte Carlo Analysis Code (DAC). Typically, DSMC models rely on code-to-code validation for fidelity. The significance of this research is in its ability to validate its models against empirical data. Prior to computing solutions for these simulations, the mesh size and structure was optimized and many variants of DSMC input parameters were iterated on in order to acquire a reliable, mesh-independent, fully optimized numerical solution. This research will discuss the mathematical formulation of MOC for nozzle flow and DSMC for rarefied gases. Additionally, the following will provide an explanation of how to implement these mathematical concepts into the two solvers, RAMP and DAC. Ultimately, this research will demonstrate that the overall process illustrated herein produces results in good agreement with empirical data. As a consequence, the methodology presented hereafter is granted an increased level of confidence and will greatly contribute to the aerospace industry and its effort in understanding and predicting rarefied flow fields.

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The public is welcome to attend.