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Using Navier-Stokes to Characterize Re-Entry of Microscale Vehicles SUDHARSAN THIRUVENKADAM, HARRIS BEN, The University of Texas at Arlington, Arlington, Texas — Atmospheric reentry vehicles experience different flow regimes during flight due to the change in atmospheric density. This change in density creates non-equilibrium regions on the order of one mean free path, called as Knudsen layer. In the design of atmospheric reentry vehicles, the flux variations near solid surface are of critical importance. The traditional CFD simulations which use Navier Stokes equations fail to predict the flow in Knudsen layer. These areas where the rarefaction effects begin to dominate can be quantified by the Knudsen breakdown parameter. The Direct Simulation Monte Carlo (DSMC) method, although accurate for all flow regimes, it is computationally expensive as the number of simulating molecules increases. We developed a method that models the Knudsen Layer by using Navier Stokes equations with Maxwell-Smoluchowski slip boundary conditions and DSMC for low (Kn < 0.1) and high (Kn > 0.1) Knudsen numbers respectively. This study investigates the surface properties of a flat plate with Nitrogen gas flow from continuum to rarefied regimes. Computational fluid dynamics and DSMC results are obtained for different test conditions. The results demonstrate that the Knudsen layer can be predicted with DSMC and continuum approach for all flow regimes.

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