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NUMERICAL ANALYSIS OF HYPERSONIC FLOW COUPLED WITH RADIATION AROUND BLUNT-NOSED MODELS

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ABSTRACT. In the present work, numerical simulations are carried out in a non-continuum hypersonic regime to analyze the flow properties in the shock layer of a blunt body. Radiative transfer equation is added to the existing Navier-Stokes based solver. The solver is developed within OpenFOAM framework and accommodates features to model thermodynamic properties of high-temperature gases and non-equilibrium boundary conditions. The radiative transport equation is solved using spherical harmonics (P1) and finite volume discrete ordinate method (fvDOM) approximations. The aerothermodynamics of high-temperature non-equilibrium flow-field over blunt-nosed models have been analyzed using our solver and results are validated with DSMC data. Good agreement has been observed with DSMC data and significant improvement is seen when compared to the conventional high-speed compressible flow solver. The results have shown that a considerable amount of heat escapes from the shock-layer region, hence resulting in radiative cooling. It is observed that, if no radiative heat transfer is considered in the solver, it overpredicts the temperature and shock-layer thickness. Therefore incorporation of radiation along with all the non-equilibrium effects in the rarefied hypersonic regime is imperative.