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TOWARDS THE GENERALISATION OF THERMAL FLUX DATA FOR THE IMPROVEMENT OF ATMOSPHERIC ENTRY AND SPACECRAFT DEORBITING SIMULATIONS

Abstract

The accuracy of numerically simulated atmospheric entry scenarios is of key concern to space agencies and hardware manufacturers around the world, particularly in the case of spacecraft heating. This study describes a numerical analysis framework designed to improve the accuracy of such analyses via the production of generalised thermal flux datasets. Polynomial coefficients extracted from these datasets are intended to be introduced into analysis codes which make use of tumble-averaged heat flux assumptions, and provide an improved description of the temperature variance about sharp edges with angles of the order of 90^{o}. The presented data is also intended to be used as part of a future experimental validation study which will utilise a low density wind tunnel and time dependent thermal imaging.

A brief review of current assessment tools is presented, followed by a series of three-dimensional, equilibrium DSMC analyses, run using the OpenFOAM Open Source numerical solver suite. These scenarios simulate rarefied (slip regime) flow as it develops over straight and curved sharp edges - such as those seen in common satellite geometries – at varying angles of pitch and yaw. The data from these analyses are then treated with polynomial curve and surface fitting functions such that relationships between the analyses' initial conditions and the non-dimensional mean surface heat fluxes are derived.