RADIATION MODELING FOR THE REENTRY OF THE HAYABUSA SAMPLE RETURN CAPSULE

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Abstract

On June 13, 2010 the Japanese Hayabusa capsule performed its reentry into the Earth's atmosphere over Australia after a seven year journey to the asteroid Itokawa. The reentry was studied by numerous imaging and spectroscopic instruments onboard NASA's DC-8 Airborne Laboratory and from three sites on the ground, in order to measure surface and plasma radiation generated by the Hayabusa Sample Return Capsule (SRC).

Before flight, computations of the flow field around the forebody were performed using the in-house code *DPLR* [1, 2] assuming an 11-species (N_2, O_2, NO, NO^+, N_2^+, O_2^+, N, O, N^+, O^+, and e^-) air in thermochemical nonequilibrium at peak heating. The results were used as input for the material response code FIAT [3] to calculate surface temperatures of the heat shield. Finally, the thermal radiation of the glowing heat shield was computed based on these temperatures and propagated to the predicted observation position taking into account the influence of the observation angle and of atmospheric extinction yielding estimates of thermal radiation to be measured by the observing instruments during reentry. These estimates were used to provide calibration sources of appropriate brightness.

Post flight, the flow solutions were recomputed to include the whole flow field around the capsule at 11 points along the reentry trajectory using updated trajectory information. Again, material response was taken into account to obtain most reliable surface temperature information. These data will be used to compute thermal radiation of the glowing heat shield and plasma radiation by the shock/post-shock layer system to support analysis of the experimental observation data. For this purpose, lines of sight data are being extracted from the flow field volume grids and plasma radiation will be computed using *NEQAIR* [4] which is a line-by-line spectroscopic code with one-dimensional transport of radiation intensity. The procedures being used were already successfully applied to the analysis of the observation of the Stardust reentry [5].

Details of the numerical procedures and the calibration approach will be provided in the full-length paper.

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