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Title

A standard model for the investigation of aerodynamic and aerothermal loads on a re-usable launch vehicle

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Abstract

Aeronautical engineers have a long history of developing standardized models for wind tunnel calibrations and data comparisons between facilities. They are extremely useful in providing baseline datasets for correlation of results, data repeatability over time and verifying model installation or data acquisition systems. Reference models are also particularly relevant from the perspective of numerical analyses, where different assumptions and solver settings can be experimented with to determine solution sensitivity to certain parameters. A standardized reference model typically fulfills two main criteria. Firstly, they are simplistic in shape with a precisely defined geometry and secondly, they are representative of realistic configurations to ensure that the results are relevant. Examples of existing standard models include the AGARD-B, ONERA-M and the Standard Dynamics Model (SDM) [1], which have been circulating for decades. Recently models such as the NASA CRM [2] and the SSAM-Gen5 provide more up to date and relevant aircraft geometries from the past 10 to 20 years.

While aeronautical engineers are well covered with standard aircraft models, the space community is not. Given the sudden and urgent interest in re-usable spacecraft over the past decade, a reference model which serves the research community in facilitating validation of numerical techniques in the generation of aerodynamic and aerothermal data over the entire trajectory is lacking. The purpose of this paper is to introduce a re-usable launch vehicle geometry where computational models and results will be made openly available to the research community. It is envisioned that this model will serve as a consistent validation case to promote collaboration and further research into the technical challenges associated with re-usable launch vehicles.

This paper will first introduce the vehicle geometry and trajectory based on the flight path of in-service vehicles. Results from selected ascent and descent trajectory points will be presented and will contain aerodynamic coefficients and surface heating distributions. These are the first of many test cases which will look to address common questions with these types of vehicles, including but not limited to, surface heating through retro-propulsion and aerodynamic glide phases, plume-plume and plume-structure interactions, as well as vehicle stability and control.

References

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