Paper ID: 40925
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SPACE SYSTEMS SYMPOSIUM (D1)
Technologies to Enable Space Systems (3)

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SIMULATION OF HYPERSONIC FREE FLIGHT DYNAMICS AND SUPPORT MODULE SEPARATION OF THE HEXAFLY-INT GLIDER

Abstract

A strong coupling scheme between Computational Fluid Dynamics (CFD) and Rigid Body Dynamics (RBD) allows the simulation of the dynamic behavior of vehicles in flight. In contrast to wind tunnel or flight test the simulation allows parameter studies with relatively low effort especially for hypersonic applications.

The coupled equations are iteratively solved within every physical time step by repeatedly solving the involved disciplines CFD and RBD separately based on the exchanged coupling quantities. These are on CFD side aerodynamic loads (forces and moments) and on RBD side the motion state (position and velocities). The simulation of more than one body is realized by the technique of overlapping grids.

In this work the described simulation technique is applied to the hypersonic vehicle which is under development within the HEXAFLY-International project in cooperation with partners from Europe, Russian Federation, Brazil, and Australia. The aim of the project is the flight of a 3 m self-controlled glider configuration with high aerodynamic efficiency in order to provide flight data to validate aero- and structural dynamic design tools.

Of special interest for the flight is the separation between the glider and the gliders support module between 40 and 60 km altitude at a flight Mach number of 7, as well as the dynamic behavior of the glider itself. Parallel to the simulations, experiments using the free-flight technique are carried out by researchers from University of New South Wales Canberra in the hypersonic wind tunnel of the University of Southern Queensland in Toowoomba.

After a detailed description of the simulation technique the paper will discuss the simulation results of the separation process for different initial conditions. Investigated parameters are the sideslip and the flap defection angle of the vehicle. Also a non-ideal initiation of the separation is of interest for safety reasons. Additional computation with dedicated wind tunnel conditions have been carried out for comparison with the shock tunnel experimental data.