Time Domain Tool Validation Using ARES I-X Flight Data

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Abstract

The ARES I-X vehicle was launched from NASA's Kennedy Space Center (KSC) on October 28, 2009 at approximately 11:30 EDT. ARES I-X was the first test flight for NASA's ARES I launch vehicle, and it was the first non-Shuttle launch vehicle designed and flown by NASA since Saturn. The ARES I-X had a 4-segment solid rocket booster (SRB) first stage and a dummy upper stage (US) to emulate the properties of the ARES I US. During ARES I-X pre-flight modeling and analysis, six (6) independent time domain simulation tools were developed and cross validated. Each tool represents an independent implementation of a common set of models and parameters in a different simulation framework and architecture. Post flight data and reconstructed models provide the means to validate a subset of the simulations against actual flight data and to assess the accuracy of pre-flight dispersion analysis. Post flight data consists of telemetered Operational Flight Instrumentation (OFI) data primarily focused on flight computer outputs and sensor measurements as well as Best Estimated Trajectory (BET) data that estimates vehicle state information from all available measurement sources. While pre-flight models were found to provide a reasonable prediction of the vehicle flight, reconstructed models were generated to better represent and simulate the ARES I-X flight. Post flight reconstructed models include: SRB propulsion model, thrust vector bias models, mass properties, base aerodynamics, and Meteorological Estimated Trajectory (wind and atmospheric data). The result of the effort is a set of independently developed, high fidelity, time-domain simulation tools that have been cross validated and validated against flight data. This paper presents the process and results of high fidelity aerospace modeling, simulation, analysis and tool validation in the time domain.

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