CORRELATED ATMOSPHERIC VARIATIONS USING OPTIMIZATION OF DFT PARAMETERS FOR MONTE CARLO SIMULATIONS OF INDIAN SPACE MISSIONS

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Abstract

In space systems, atmospheric parameters are required for launch vehicle trajectory design and simulations, aerodynamic load characterization, Monte Carlo trajectory dispersion studies, re-entry of spent stages, safe recovery of reusable stages, etc. A need is felt to modify existing models over the Indian region to assimilate appropriate atmospheric dispersions. The correlated connectivity of the atmospheric profiles measured over various altitude regimes has to be ensured. A new methodology to generate any required number of atmospheric profiles is carried out in this paper. The dynamic processes of the lower and upper atmosphere are markedly different, leading to different mathematical models to generate the respective profiles. For the generation of lower altitude temperature profiles, Discrete Fourier Transform strategy is utilized; and for upper altitudes, Cumulative Distribution Function is used. Corresponding pressure and density profiles are generated using hypsometric equations. The variations in the atmospheric temperature profiles at different frequencies need to be captured to ascertain correct parameter bounds, particularly for density profiles. To generate any number of Monte Carlo atmospheric profiles replicating the observed variation and dispersion bounds in all frequency bands, a unique evolutionary optimization methodology is devised to ensure the required balance between convergence and diversification.

Keywords: Space Mission Trajectories, Monte Carlo Simulations, Atmospheric Profiles, Atmospheric Bounds, Evolutionary Optimization