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IMPACT OF ATMOSPHERIC PERTURBATIONS ON TETHERED SATELLITE SYSTEMS

Abstract

This paper studies the impact of atmospheric perturbations on the dynamics of space tether systems using recent atmospheric models. The dynamic behaviour of space tether systems is directly affected by the atmospheric drag perturbations. Models of the atmosphere around the Earth have always been important to a complete study of space tether systems especially in the estimation of atmospheric drag. However, many existing studies employ models that have not accounted for recently discovered phenomena in the atmosphere. As such, the estimates of atmospheric density derived from these models can be improved.

In the present work, we show how the new models of the atmosphere differ from the models commonly used in the dynamic analysis of space tether systems and how these changes influence the dynamic behavior of space tether systems in the station-keeping phase. The models under consideration in this paper are the Jacchia-Bowman 2008 (JB2008) model and the Drag Temperature Model 2013 (DTM-2013). In the first part of the paper, we briefly discuss the predecessors to the new models which have been derived either empirically or semi-empirically. We then describe the recently observed phenomena (diurnal variations, seasonal variations, magnetic field variations and variations from the solar cycle) that prompted improvements to the existing models and demonstrate how the new models address these phenomena. We discuss the introduction of new solar proxies and new geomagnetic indices which were obtained from data made available from satellites such as CHAMP, GRACE, Stella, Starlette and GOCE and ground-based instruments.

The second part of the paper involves the application of the JB2008 model and the DTM-2013 model to a space tether system. The new models will give us an estimate of the density of the atmosphere and, thus, an estimate of the drag acting on the space tether system. We incorporate these values of density into our model for a space tether system and compare them with the results from our previous model that used a simple atmospheric model. This helps us determine whether the new models of the atmosphere have a significant impact on the prediction of dynamic behavior of a space tether system. These simulations for the model of the space tether system in different atmospheric models are performed in MATLAB/Simulink.