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Radiation pressure modelling for improving neutral thermosphere density and crosswind data products.

H?ADCZUK Natalia
Delft University of Technology, Delft, Netherlands

VAN DEN IJSSEL Jose (Delft University of Technology, Delft, The Netherlands)
SIEMES Christian (Delft University of Technology, Delft, The Netherlands)
VISSER Pieter (Delft University of Technology, Delft, The Netherlands)
KODIKARA Timothy (German Aerospace Center (DLR), Neustrelitz, Germany)

Abstract

Uncertainties in the radiation pressure modelling at altitudes above 450 km play a significant role in the thermosphere density and crosswind observations, especially during low solar activity conditions when the along-track radiation pressure and aerodynamic accelerations match in magnitude. The GRACE-FO mission has been operating for several years at such high altitudes during both low and rising solar activity, serving as a perfect opportunity to study the effects of radiation pressure.

In our approach to solar radiation pressure modelling, we employ the high-fidelity geometry model of GRACE-FO, augmented with parameters describing the thermo-optical surface properties. We finetuned those parameters to obtain more accurate accelerations than when using the parameters specified in the mission's handbook. We then used ray-tracing techniques on the augmented geometry models to derive the force coefficients, accounting for shadowing and multiple reflections.

The thermal radiation pressure accounts for one-fifth of total cross-track radiation pressure acceleration. To calculate the thermal radiation, we use the in-situ measurements from thermistors that monitor the temperature in several locations on the outer surfaces of the GRACE-FO satellites. This gives us insight into selecting the realistic thermal model control parameters and improves the crosswind observations. Additionally, having access to the thermistors data provides valuable understanding for other missions such as CHAMP and GRACE, for which such measurements are not publicly available.

In this presentation, we will show a comprehensive approach to improve the radiation pressure modelling based on the example of the GRACE-FO satellite. Furthermore, we will present enhanced and consistently processed neutral mass densities and crosswind observations for the GRACE and GRACE-FO missions, determine the impact of radiation pressure modelling errors on these datasets, and compare the results with thermosphere models, including the TIE-GCM model.