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New neutral density estimates and forecasts in the framework of project ESPRIT

Andreas Strasser¹, Sandro Krauss¹, Manuel Scherf², Barbara Suesser-Rechberger¹, and Helmut Lammer²

¹TU Graz, Institute of Geodesy, Graz, Austria (andreas.strasser@tugraz.at)

²IWF, Austrian Academy of Sciences, Graz, Austria

In the ongoing project ESPRIT, a goal is to investigate the contribution of the chemical composition and associated chemical reactions to the Earth's upper atmosphere. This is realized through a combined analysis of thermospheric neutral density estimates and the exploration of external parameters of the interplanetary space, including variations in the magnetic field and the merged electric field. Regarding changes in the chemical composition of the Earth's atmosphere, which might cause heating and cooling effects, we investigated TIMED/SABER measurements in conjunction with findings from the 1D first-principles hydrodynamic upper atmosphere model Kompot code, which shows some significant expansion in the density profile mainly based on the increased XUV flux from the Sun. The neutral mass densities were processed based on accelerometer measurements as well as on kinematic orbit information (Süsser-Rechberger et al. 2022). This allowed us to successfully process kinematic orbits for 19 different satellites at an altitude range of approximately 400 to 1300 km. Both approaches are realized using the in-house software package GROOPS. During the evaluation, significant improvements in the processing and parametrization could be achieved compared to previous solutions, especially through refined models for solar radiation pressure, the Earth's re-radiation, the thermal radiation of the satellite itself and the consideration of the chemical composition of the atmosphere. Based on these new neutral density estimates, investigations regarding the effects of solar eruptions on the various satellites are performed and used for attempting to forecast the orbital decay of LEO satellites.