

Analysis of spatio-temporal structures of the thermospheric density

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The Earth's upper atmosphere comprising the thermosphere and the ionosphere exhibits a dynamically coupled non-linear system in terms of chemical and physical processes. The system also interacts with the magnetosphere as well as the lower atmosphere. Several stand-alone or coupled models have been developed to reveal the behaviour of atmospheric target parameters and their interactions such as the neutral and charged particle density of the thermosphere from different perspectives which are, for instance, based on pure physical or (semi) empirical models as well as data assimilative approaches combining available models with new set of observations. The thermospheric neutral density, for instance, plays a crucial role within the equation of motion of Earth orbiting objects at low altitudes since the drag force is one of the largest non-gravitational perturbations and a function of the thermospheric integral density. Besides, the density estimation is of critical consideration for re-entry operations, manoeuvre planning, collision avoidance, precise orbit determination (POD) and satellite lifetime planning.

There exist several empirical thermospheric models, which have been used in satellite orbit determination, e.g. the JB2008 or the DTM2013 model. They all include different gas species and provide thermospheric temperature and density as functions of the instantaneous position in altitude, latitude and longitude, as well as the local solar time, solar and geomagnetic storm indices and the harmonics of the year's fraction.

In this contribution we study the global spatial and temporal behaviour of the thermospheric density provided by the models JB2008 or the DTM2013. Based on these insights we set up a concept for an empirical model of the thermospheric density. In the future step appropriate model parameters will be estimated from high precise satellite laser ranging observations. This work is related to the DFG project INSIGHT (Interactions of Low-orbiting Satellites with the Surrounding Ionosphere and Thermosphere).