Publ. Astron. Obs. Belgrade No. 86 (2009), 409 - 410 *MSc thesis*

UPGRADING AERONOMICAL MODELS OF UPPER PLANETARY ATMOSPHERE USING TOTAL DENSITY MODEL: EARTH'S UPPER ATMOSPHERE FROM NRLMSISE-00 TO TD88Up

B. ŠURLAN[1,2]

[1] *Mathematical Institute of the Serbian Academy of Sciences and Arts, Kneza Mihaila 36, 11001 Belgrade, Republic of Serbia*

[2] *Department of Astronomy, Faculty of Mathematics, University of Belgrade Studentski trg 16, 11000 Belgrade, Republic of Serbia*

E–mail: brankica74@matf.bg.ac.yu

Abstract. After launching first Earth's satellite it was concluded that orbital elements of low Earth's orbit (LEO) satellites and their changes are connected with changes in the upper atmosphere. One of the perturbing forces which influence LEO satellite motion is atmospheric drag. Since that time, atmospheric drag is used for the study of the upper layers of planetary atmospheres. Also, for predicting the orbit of LEO satellites with satisfying accuracy it is necessary to know the distribution and variation of atmospheric density, which can be obtained from one of the existing atmospheric models.

Till now, many models of Earth's atmosphere were made. Currently, the mostly used models are aeronomical models. In this thesis one of the aeronomical models of Earth's atmosphere, the NRLMSISE-00 (Naval Research Laboratory Mass Spectrometer and Incoherent Scatter Radar Extended) model (Picone et al. 2002), was used as a reference model. Aeronomical models are very precise and effective for certain purposes but in the theory of satellite motion many difficulties in their application appear. The better way is to define an analytical model of density atmosphere distribution that would enable analytical treatment of the satellite orbital elements perturbations and also to obtain the constants of models using reverse procedure. One such analytical model is the TD (Total Density) model of neutral Earth's thermosphere (Sehnal 1988) and also some of versions of this model (Sehnal and Pospíšilová 1988, Bezděk and Vokrouhlický 2004).

The main task of this thesis was improving one version of the TD model, the TD88 model, to the new TD88Up model, which should be analytical representation of the aeronomical NRLMSISE-00 model. This new model should have better agreement with predictions of the NRLMSISE-00 model, so that it can be more efficiently and with more accuracy used in the theory of satellite motion.

Procedure of determination new coefficients of the TD88 model in the region from 200 to 500 km is presented. As a first step, comparison between the NRLMSISE-00 and the TD models was done. Applying the least square method by varying two parameters to fit differences between these models, parameters of this comparation was obtained (Šegan and Šurlan 2005). After that, applying similar procedure on the TD88 model and varying all parameters of the model, the new TD88Up model was obtained.

The TD88Up model was compared to the TD88 and the NRLMSISE-00 models, and its differences with respect to these models were estimated. Total relative deviation and total mean square error of TD88Up model with respect to the NRLMSISE-00 model underlines essential improvement with respect to the TD88 model.

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