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A Review of Indices used in Thermosphere Models

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Atmospheric density models are used in satellite orbit determination and prediction programs to compute the atmospheric drag force, as well as in upper atmosphere studies. They predict temperature and (partial) density as a function of altitude, latitude, local solar time, day-of-year, and indices related to the state of atmospheric heating due to solar EUV emissions and solar wind. New models are being developed in the framework of the European 7th framework programme ATMOP (Advanced Thermosphere Modelling for Orbit Prediction), and an analysis of (the relevance of) indices is a large part of the effort.
The solar spectral irradiance in the UV/EUV range is essential to characterize the amount of solar energy the upper atmosphere receives. Because of the lack of long-term and/or continuous observations, F10.7 is used in all upper atmosphere models as a proxy for solar activity. Solar inputs that are more representative of atmospheric heating are crucial to model improvement, and the SEM and MgII indices correlate better with density on short time scales than F10.7 for example. However, these data sets are available since 1996 and 1978 (nb: as a composite), respectively, so well after missions that provided important data for modeling (e.g. Atmosphere Explorer).
The variability of the thermosphere due to geomagnetic activity can be of the order of 100s of percent on time scales of hours. Presently, models use the 3-hourly planetary indices ap or am, augmented by hourly Dst in case of the JB2008 model. The temporal and spatial resolutions of these indices only allow the accurate modeling of orbit-averaged storm effects.
The accelerometers on the CHAMP and GRACE satellites have made it possible to accumulate near-continuous records of thermosphere density between about 300 and 490 km since May 2001, and July 2002, respectively. The temporal and latitudinal responses of the thermosphere to geomagnetic disturbances, i.e. space weather, as well as variations on time scales larger than a solar rotation, have been extensively studied using these exceptional datasets.
This presentation aims at giving a review of indices currently used or under development, and their relevance to space weather and space climate modeling.