Project Details

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Topic: Shock acceleration of solar energetic particles by interplanetary CMEs

Project Title:
TOPLA: A new empirical representation of the F-region topside and plasmasphere for the International Reference Ionosphere

PI Name: Dieter Bilitza
PI Email: dbilitza@gmu.edu
Affiliation: Raytheon Technical Services Company
Project Member(s):
- Huang, Xueqin ; Co-I; University of Massachusetts Lowell
- Reinisch, Bodo ; Co-I; University of Massachusetts Lowell
- Gallagher, Dennis Lee; Co-I; NASA Marshall Space Flight Center

Summary:
We propose to develop a new data-based F-region TOpside and PLAsmasphere (TOPLA) model for the electron density (Ne) and temperature (Te) for inclusion in the International Reference Ionosphere (IRI) model using newly available satellite data and models for these regions. IRI is widely used for the specification of ionospheric conditions and is currently under consideration as the International Standardization Organization (ISO) standard for ionospheric parameters. IRI s great significance for LWS science lies in its role as the observation-based background ionosphere for theoretical coupling studies between different regions, for radio wave propagation studies, for the evaluation of tomographic and numerical techniques (GPS), and as benchmark against which the skill-level of physics-based forecast models is measured. Additionally, IRI helps to teach and popularize space science through its usage for college course work and for web interfaces that visualize and explain the space environment.

Recently, a number of new data sets have become available that help to fill coverage gaps of earlier studies and that can provide the database for a systematic improvement of the IRI topside model. Specifically our study will overcome the following shortcomings of the current IRI topside model: (1) overestimation of densities above 700 km by a factor of 2 and more, (3) unrealistically steep density profiles at high latitudes during very high solar activities, (4) no solar cycle variations and no semi-annual variations for the electron temperature, (5) discontinuities or unphysical gradients when merging with plasmaspheric models. Our topside Ne model will be based on Alouette 1, 2, and ISIS 1, 2 topside sounder data and will use a Chapman-function with a height-varying scale-height H(h) that allows merging the topside profile with the plasmasphere model. The Ne model for the plasmasphere will rely on IMAGE/RPI data and will be based on combining and further developing the modeling approaches introduced by CoIs Reinisch and Huang based on IMAGE data and by CoI Gallagher based on DE and ISEE data. For the electron temperature the goal is to develop the first empirical model that fully accounts for solar cycle variations based on a large volume of satellite in situ measurements.

A special focus will be the correct representation of (a) altitudinal and latitudinal extent of the Equator Anomaly region, (b) latitudinal, diurnal, and seasonal differences in the solar cycle variation of temperatures and densities, and (c) diurnal, latitudinal, and solar and magnetic activity variations of the topside transition height. Results of this study will provide substantial improvements in characterizing the ionosphere/ plasmasphere environment in support of manned and unmanned space exploration. The enhanced IRI model will provide a key baseline for studying geomagnetic storm effects on the ionosphere and plasmasphere.

Publication References:

Summary: no summary

Reference: Sojka, Jan J.; Nicolls, Michael; van Eyken, Anthony; Heinselman, Craig; Bilitza, Dieter; (2011), 24/7 Solar minimum polar cap and auroral ion temperature observations, Advances in Space Research, Volume 48, Issue 1, p. 1-11, doi: 10.1016/j.asr.2011.03.005