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A precipitation parameterization for the Empirical Canadian High Arctic Ionospheric Model (E-CHAIM)

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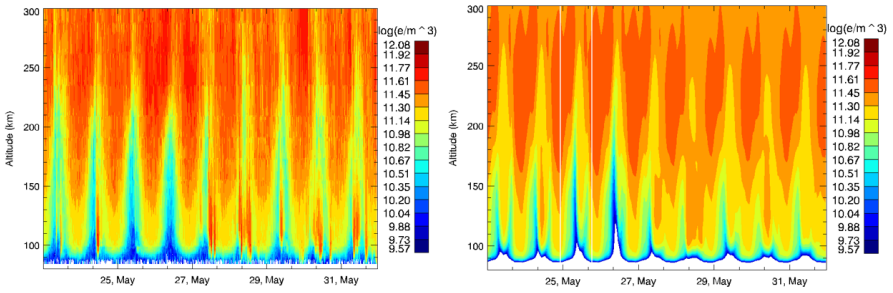
The Empirical Canadian High Arctic Ionospheric Model (E-CHAIM) [1,2,3] was developed as an alternative to the use of traditional global empirical ionospheric models at high latitudes, namely the International Reference Ionosphere (IRI) [4] and NeQuick [5]. While E-CHAIM has been demonstrated to significantly outperform those models at high latitudes [1,2], it lacks the implementation of an auroral precipitation scheme and as such does not account for significantly enhanced E-Region densities in that region [3]. In this study, we will present the new auroral precipitation module that has been developed for implementation with E-CHAIM. Assuming a Maxwellian energy distribution, the scheme uses a Fang et. al. (2010) [6] parameterization with an NRLMSIS background neutral atmosphere to represent the vertical structure of precipitation-induced ionization for an input precipitation flux and mean energy. Precipitation flux and mean energy are then modeled based on TIMED GUVI- and DMSP SSUSI-inferred precipitation characteristics. Beginning with an overview of how the parameterization was implemented, we will further validate the model against Incoherent Scatter Radar (ISR) measurements of auroral electron density and compare the performance of the model with what can be achieved with the parameterization when using the Zhang and Paxton (2008) [7] mean precipitation flux and energy model. An example comparison between Poker Flat Incoherent Scatter Radar observations and those using the E-CHAIM parameterization with Zhang and Paxton (2008) [7] mean energies and fluxes is presented in Figure 1.



PFISR ZP2008 E-CHAIM

Figure 1. Altitude-time logarithmic contours of electron density from PFISR and from E-CHAIM using the Kp-driven ZP2008 mean energy and flux model for May 23-31, 2016.

References

[1] Themens, D.R., P.T. Jayachandran, A.M. McCaffrey, B. Reid, and R.H. Varney (2019). A bottomside parameterization for the Empirical Canadian High Artic Ionospheric Model (E-CHAIM), *Radio Sci.*, doi: 10.1029/2018RS006748

[2] Themens, D.R., et al. (2018). Topside Electron Density Representations for Middle and High Latitudes: A Topside Parameterization for E-CHAIM based on the NeQuick, *J. Geophys. Res. Space Physics*, 123, doi: 10.1002/2017JA024817

[3] Themens, D.R., P.T. Jayachandran, I. Galkin, and C. Hall (2017). The Empirical Canadian High Arctic Ionospheric Model (E-CHAIM): NmF2 and hmF2, *J. Geophys. Res. Space Physics*, doi: 10.1002/2017JA024398

[4] Bilitza, D., L.-A. McKinnell, B.W. Reinisch, and T. Fuller-Rowell (2011). The international reference ionosphere today and in the future. *J. Geodesy* , **85**, pp. 909-920, doi: 10.1007/s00190-010-0427-x

[5] Nava, B., P. Coïsson, and S.M. Radicella (2008), A new version of the NeQuick ionosphere electron density model. J. Atmos. and Solar-Terr. Phys., 70(15), 1856-1862 doi:10.1016/j.jastp.2008.01.015

[6] Fang, X., Randall, C. E., Lummerzheim, D., Wang, W., Lu, G., Solomon, S. C., and Frahm, R. A. (2010), Parameterization of monoenergetic electron impact ionization, Geophys. Res. Lett., 37, L22106, doi:10.1029/2010GL045406

[7] Zhang, Y. and L.J. Paxton (2008). An empirical Kp-dependent global auroral model based on TIMED/GUVI FUV data, Journal of Atmospheric and Solar-Terrestrial Physics, 70, 1231-1242, doi:10.1016/j.jastp.2008.003.008