3rd URSI AT-AP-RASC, Gran Canaria, 29 May – 3 June 2022

Assimilation Canadian High Arctic Ionospheric Model (A-CHAIM): One year of near real time ionospheric specification

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The Assimilation Canadian High Arctic Ionospheric Model (A-CHAIM) is an operational data assimilation system that provides 3D ionospheric electron density in near-real-time [1]. A-CHAIM is hosted at the University of New Brunswick and assimilates all ground and space-borne Global Navigation Satellite System (GNSS), ionosonde, Incoherent Scatter Radar, and altimeter data that is available within 3 hours of real time. The system uses a flavour of auxiliary particle filter to update the nonlinear basis functions of Empirical CHAIM (E-CHAIM) [2,3,4], which is used as the system's background model, and provides output for all regions above 45°N geomagnetic latitude. The latest version of the system has been operational since March 2021, with prior versions dating back to December 2019.

This study will examine the performance of A-CHAIM over the operating period of its latest release using datasets that are not available in near-real-time (and thereby are not assimilated), including a selection of ionosondes and in situ measurements. We will further examine the performance of the system's different latency products to assess the effect of progressive data loss and short-term forecast on system performance. Particular focus will be placed on the capacity of the system to represent shorter temporal and spatial scales than the E-CHAIM background model.

An example comparison of the model and observed foF2 amplitude spectra for intermediate time scales is presented in Figure 1. As noted in [5], E-CHAIM has limited capacity to capture ionospheric variability of these intermediate time scales; however, A-CHAIM is capable of substantially recovering the representation of these variations.

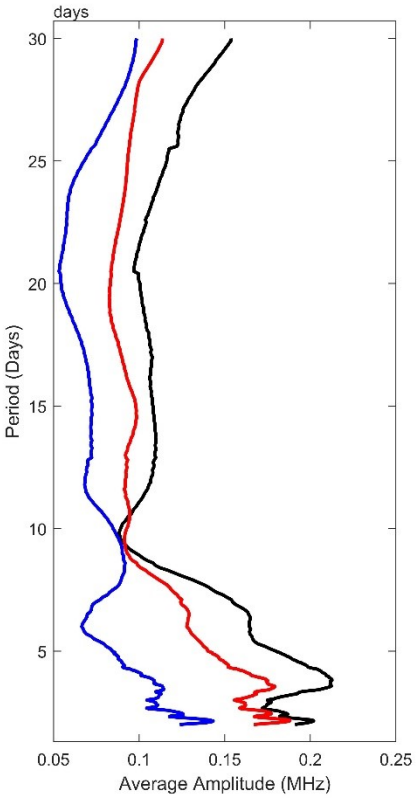

Figure 1. Average amplitude of foF2 from ionosondes measurements (black), E-CHAIM (blue) and A-CHAIM (red) at Blissville (45.6oN, 66.56oE) between March and September, 2021.

[1] Themens, D.R., B. Reid, A.M. McCaffrey, and P.T. Jayachandran (2019), The Assimilation Canadian High Arctic Ionospheric Model (A-CHAIM): Implementation, Workflow, and Performance. Report submitted to Defence Research and Development Canada for contract #W7714-186507/001/SS (https://cradpdf.drdc-rddc.gc.ca/PDFS/unc342/p811829_A1b.pdf)

[2] Themens, D.R., P.T. Jayachandran, and R.H. Varney (2017), Examining the use of the NeQuick bottomside and topside parameterizations at high latitudes, *Advances in Space Research*, 61(1), 287-294, doi: 10.1016/j.asr.2017.09.037

[3] 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

[4] 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

[5] Themens, D.R., P.T. Jayachandran, A.M. McCaffrey, and B. Reid (2020), The limits of empirical electron density modeling: Examining the capacity of E-CHAIM and the IRI for modeling intermediate (1- to 30-day) timescales at high latitudes, *Radio Science*, doi: 10.1029/2018RS006763