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Ionospheric specification with modern ionogram scaling and data assimilation tools

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We present results of the ionospheric specification using real-time tools for ionogram processing OASIS (Optimal Approach System for Ionogram Scaling) and assimilation of the extracted ionospheric parameters RIPE (Regional Ionospheric Profile Estimator). OASIS performs an automatic extraction of the traces from oblique and vertical soundings; infers the ionospheric profile parameters and assesses its scaling quality. The ionospheric parameters are extracted by minimizing the difference between the real ionogram measurements and the ones modeled with raytracing using specific ionospheric characteristics. The uncertainties of the extracted parameters are estimated based on the evaluation of the goodness of the fit and application of the Kalman Filtering technique. The latest OASIS version features a number of improvements: blanketing sporadic Es detection, interference condition identification, processing of ionograms with missing part of the traces, and others. Machine Learning algorithms are also used to evaluate the feasibility of the OASIS scaling quality self-assessment, initiation of the fitting, and as an alternative mean to process ionograms. The obtained ionospheric parameters are assimilated RIPE [1] which operates on ratios of measured ionospheric profile parameters to IRI climatological predictions.

A comprehensive validation of the ionospheric specification provided by OASIS and RIPE is performed by comparison of the measured and modeled oblique ionograms which were calculated using the ionosphere specification made by RIPE driven by a large amount of oblique sounding data processed with OASIS. The modeled oblique ionograms are calculated with Pharlap [2] toolbox using 3D magnetoionic rayracing. We show an improvement in the modeling of the observed MUF (of the order of 10-15%) as well as improvement in the bottomside part of the trace (over 10 km).

We present analysis of the validation results and discuss the ways to further improve the performance of OASIS.

[1] A. Hoskinson, D. Paznukhov, W. McNeil, C. Carrano, M. Proctor, and K. Groves, "Parametric Data-Assimilative Ionospheric Specification and Validation," in *Proceedings of the 4th URSI Atlantic Radio Science Conference – AT-RASC 2024*, Gran Canaria, Spain: URSI – International Union of Radio Science, 2024. doi: 10.46620/URSIATRASC24/QSWP8569.

[2] Cervera M. A. and T. J. Harris (2014), Modelling ionospheric disturbance features in quasi-vertically incident ionograms using 3D magneto-ionic raytracing and atmospheric gravity waves, J. Geophys. Res. Space Physics, 119, 431-440, doi:10.1002/2013JA019247