Ionospheric Prediction models in PITHIA-NRF e-Science Center

Anna Belehaki

Research Director, IAASARS, National Observatory of Athens

Coordinator of the PITHIA-NRF project

The talk reviews ionospheric prediction models that are made accessible through the PITHIA-NRF e-Science Center. Prediction models provide the estimates of ionospheric characteristics in hindcast, nowcast and forecast mode. Currently available models in the e-Science Center are empirical, semi-empirical and assimilative. Fully empirical models are built on the statistical analysis of dynamic processes and the stochastic inference of their behavior without taking into account any theoretical considerations. Semi-empirical models require understanding of the underlying physics in order to include the most appropriate and informative physical parameters in the stochastic approach. Data assimilative techniques take a background model and apply a correction based on a set of observed data and estimated errors that are present in both observations and background values. Weighting factors are applied in the difference between background and observed values to determine the correction needed to be done in the forecast.

Depending on the ionospheric phenomena are dealing with and their predictive capability, PITHIA-NRF models can be classified in 4 groups: Long-term prediction models, ionospheric specification models, short-term forecasting models and electron density reconstruction models. More specifically, the Simplified Ionospheric Regional Model (SIRM)-based ionospheric maps provide long-term predictions of the foF2 characteristics. Numerical mapping algorithms are ionospheric specification models that nowcast the TEC and foF2 characteristics in global and regional scales. Ray Tracing models determine the refracted propagation paths of high-frequency radio signals in the ionosphere and determine the sensitivities of these paths to changes of the input model parameters. The Solar Wind driven autoregressive model for Ionospheric short-term Forecast (SWIF) provides short term forecasts of the foF2 characteristic at a single location or over a region. In addition, an important asset of PITHIA-NRF is the registration of the International Reference Ionosphere model (IRI) in the e-science center and its real-time assimilative version IRI-based Real-Time Assimilative Mapping system (IRTAM). IRI is recognized as the official standard for the Earth's ionosphere by the International Standardization Organization, the International Union of Radio Science, the Committee on Space Research, and the European Cooperation for Space Standardization. IRI is an empirical (data-based) model representing the primary ionospheric parameters based on the long data record that exists from ground and space observations of the ionosphere. IRTAM assimilates foF2, hmF2, B0, and B1 measurements from the ground-based GIRO ionosonde network into IRI. In addition to these 4 groups of ionospheric prediction models, PITHIA-NRF has registered several models in the e-science center that nowcast ionospheric

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irregularities such as the TechTIDE group of models that identify in real-time Travelling Ionospheric Disturbances over Europe and the GBSC model that provides Ionospheric Scintillation Climatology with ground-based GNSS receivers.

During the project, the e-science center will provide access to additional models and depending on the requirements of the users, more functionalities can be made available such as provision of the source code and run the model on request.

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