Ionosphere Variability II: Advances in theory and modeling

Paper outline (Preliminary)

Abstract

1. Introduction

Introduction to the objectives of the paper - link to SW roadmap considerations relevant to ionospheric prediction/modeling, e.g.:

- New modeling capabilities to advance ionospheric monitoring (nowcast) and forecasting with longer lead times (user needs).
- Upgrade ionospheric models (MLTI) with assimilation capability
- Understand/Quantify the benefits of data assimilation in ionospheric modeling and forecast.
- Validate models' performance quantitatively based on archival information
- Enhance current understanding: Understand factors that control electron density variations during geomagnetic storms; physics causing scintillation in radio signals (in particular plasma turbulence at high latitudes and bubble formation at equatorial latitude); coupling between neutral atmospheric dynamics (wind and waves) and ionospheric disturbances.

2. Ionospheric Modeling and Forecasts

2.1 Ionospheric models

Brief overview of ionospheric prediction models available for ionospheric specification (nowcast and forecast) applications. In response to the SW roadmap's considerations, the emphasis shall be given to recent model developments (2015 - onwards) for regional and global coverage and to modeling activities that accommodate data incorporation.

a. Empirical models
b. Physics-based models
c. Data-driven models

- Data assimilation models / ionospheric tomography
- Machine learning techniques
- Statistical models

2.2 Ionospheric forecasting capabilities

Brief discussion on present ionospheric forecasting capabilities in regional and global scales, mainly extracted from the information provided in sections 2.1 to report on any improvements and identify requirements towards the expansion of the ionospheric forecasting window to more than 2 days ahead, a high priority research concept indicated in the SW roadmap.

2.3 Assessment of ionospheric models' performance

Models' assessment is a strong requirement for the transition of research tools to operations. This section aims to highlight relevant international initiatives taking into account also the specification of metrics considering users' requirements

2.4 Access to models

This section aims to address topics/ initiatives/activities facilitating (present or future) improvements in the access to ionospheric models.

3. Understanding the physics behind the ionospheric response

Focus on topics identified in the SW roadmap, as key input for further improvements:

a. Understanding the factors that control electron density variations during geomagnetic storms ***(reference to G1 paper)***
b. Understanding the physics causing scintillation in radio signals (in particular plasma turbulence at high latitudes and bubble formation at equatorial latitude)
c. Coupling between neutral atmospheric dynamics (wind and waves) and ionospheric disturbances.

4. Discussion and Conclusions

- Discussion of the results in terms of opportunities/challenges/recommendations reported in the SW roadmap (Schrijver et al. 2015).
  - This section is expected to provide input on ionospheric data requirements as input for models ***(link to G2B1 paper)***.
  - The expansion of the forecasting horizon may need definition and forecast of ionospheric drivers in the sun, the solar wind, the magnetosphere and the lower atmosphere ***(reference to S3, H1-H2, S2, G1, G2A papers)*****.**
- Report on progress/gaps/improvements as input to Tier 3, 4 papers.

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