2024 Workshop: Ionospheric Scintillation and Plasma Density Irregularities

Long title

Mid- to High-Latitude Plasma Density Irregularities and Impacts on Ionospheric Scintillation

Conveners

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Description

This session will focus on ionospheric scintillation in the presence of plasma density structures at the mid- to high-latitudes. Such plasma structuring is often enhanced during geomagnetically disturbed times (e.g., geomagnetic storms and auroral substorms), and causes increased scintillation compared to quiet times. Plasma density gradients set up by energetic particle precipitations, often from magnetotail activity, leads to both refractive and diffractive effects on radio waves propagating through the ionosphere from a GNSS satellite to a ground-based receiver. Here we aim to examine ionospheric plasma structure and stability in relation to GNSS phase and amplitude scintillation. Presentations on the development of plasma irregularities related to scintillation, and the specific processes of diffractive and refractive scintillation are encouraged.

Agenda

13:30-13:40 : Opening Remarks

13:40-14:00 : *Forecasting Irregularities in the SPARTA Center of Excellence* - Keith Groves

14:00-14:15 : *Solar Flare-Induced Gradient Drift Instability Observed by SuperDARN HF Radars* - Shibaji Chakraborty

14:15-14:30 : *TEC Variations and Scintillation Associated with STEVE* - Richard Chen

14:30-14:45 : *Multiscale Simulations of Scintillation Using the FDTD Method* - Alex Green

14:45-15:00 : *Whistler-Driven TEC Perturbations and Density Gradients, Preconditioning for Scintillation* - Yangyang Shen

15:00-15:15 : *Phase and Amplitude Scintillations Associated with Polar Cap Patches: Statistical and Event Analyses* - Alanah Cardenas-O'Toole

15:15-15:30 : *Scintillation Sources and Tracking through Physics-Based Sensor Fusion* - Joshua Semeter

Justification

Phase and amplitude scintillation of GNSS radio waves traveling from satellites to receivers through ionospheric plasma at mid- to high-latitudes leads to reduced ability to obtain accurate position, navigation and timing (PNT), which impacts a variety of societally important operational systems. It is clear that plasma density enhancements in the high- to mid-latitudes during geomagnetically active times contribute to this problem, modifying both refractive and diffractive effects. These mesoscale plasma density structures undergo spatio-temporal evolution as the scintillation is occurring. Many questions remain unanswered about the distinct effects on GNSS scintillation induced by a wide variety discrete auroral structures. Phase and amplitude scintillation both occur in these regions, but their similarities and differences in altitude, magnetic latitude and magnetic latitude are still widely debated. In addition, with regard to diffractive scintillation, it is unclear what plasma instability magnifies the density irregularities to cause appreciable effects. Finally, several indices (ROTI, sigma_phi, S_4, IFLC, etc.) are often applied to characterize scintillation effects, and the indices do not always agree, and also vary in relation to optical Fresnel radius and frequency. In short, ionospheric scintillation is a unified topic of study with many questions in need of resolution through focused community-wide collaborative efforts.

A wide variety of observational and instrumentation strategies apply to this topic as well, including scatter radars, GPS satellites and receivers, ground magnetometers and all-sky imagery. Data assimilation techniques and total electron content maps, both data-based and model based, are often used in order to study local and global plasma density structuring in response to solar wind driving of the magnetosphereionosphere system. These approaches, when integrated, will allow further clarification of the general geospace system and its dynamical evolution.

Related to CEDAR Science Thrusts:

Encourage and undertake a systems perspective of geospace

Explore processes related to geospace evolution

Develop observational and instrumentation strategies for geospace system studies

Fuse the knowledge base across disciplines in the geosciences

Manage, mine, and manipulate geoscience/geospace data and models

Workshop format

Short Presentations

Keywords

Ionospheric Scintillation, Total Electron Content, Plasma Density Irregularities, GNSS

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