Project Details

ROSES ID: NNH20ZDA001N
Selection Year: 2020
Program Element: Focused Science Topic

Topic: Modeling and Validation of Ionospheric Irregularities and Scintillations

Project Title:
Characteristics of High Frequency Radio Propagation and Scintillation in the Polar-Cap Ionosphere

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Summary:
The topic of the proposed work is ionospheric scintillation in the polar-cap ionosphere, more specifically, scintillation measured in the high frequency (HF; 3-30 MHz) portion of the radio spectrum. The overarching objective of the is to advance our understanding of ionospheric scintillation in the northern polar-cap ionosphere through the analysis of radio science data from an HF receiver in low Earth orbit, and modeling studies. The proposed work is guided by three science questions: do diffractive effects contribute significantly to HF scintillation in the polar cap; what geophysical phenomena are responsible for HF scintillation; and, what is the relationship between HF scintillation and radar scattering in the polar-cap ionosphere?

To accomplish this, we will analyze 7 years of spaceborne HF receiver measurements (over 350) of well known and characterized HF radar systems located in the high-latitude region for signatures of ionospheric scintillation. Ionospheric and HF ray trace modeling will be used to synthesize magnetoionic, instrumental, and other expected contributors of fluctuations in amplitude and phase measured by the receive, to help identify scintillation contributions from refractive and diffractive effects created by ionospheric irregularities. The modeling will incorporate data sets from other geospace sensors, including incoherent and coherent scatter radar systems, to help constrain and validate the modelling work and interpret the HF receiver data. Ionospheric scintillation signatures caused by refraction and diffraction will be identified and correlated with the occurrence of geophysical phenomena in the region, such as large scale plasma density irregularities and particle precipitation, as well as regional geomagnetic conditions to identify scintillation generation mechanisms and sources.

The HF receiver measurements at the heart of this work are unique in that provide signal amplitude, phase, and polarization parameters of the received signal in the polar cap at a sub-second temporal resolution - a capability that is virtually unprecedented in polar-cap radio science. As such, the proposed work has the potential to dramatically transform our knowledge of ionospheric scintillation and plasma dynamics in the region by providing the necessary data and analysis that can be used to advance modeling and other theoretical work targeting the complex plasma processes generating plasma density irregularities and scintillation in the region.

The proposed work is timely and directly responds to the Heliophysics LWS solicitation. It will undertake "modeling and validation of ionospheric irregularities and scintillation" (FST # 1). Its objectives and science questions address each of the combined objectives of the 2014 Science Plan and the 2013 National Research Council Decadal Strategy for Solar and Space Physics report, outlined on page B.1-1 of the NASA ROSES 2020 document. The work will provide the critical information required to study and characterize the ionospheric scintillation in the space environment; advance the understanding of the connection between these phenomena and its space weather drivers; and produce results from which scintillation detection and forecasting methodologies can be developed to mitigate their negative effects.

Publication References:

no references