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Abstract

Traveling Ionospheric Disturbances (TIDs) are propagating variations in ionospheric electron densities that affect radio communications and can help with understanding energy transport throughout the coupled magnetosphere-ionosphere-neutral atmosphere system. Large scale TIDs (LSTIDs) have periods T ≈30-180 min, horizontal phase velocities vH≈ 100- 250 m/s, and horizontal wavelengths H>1000 km and are believed to be generated either by geomagnetic activity or atmospheric sources. TIDs create concavities in the ionospheric electron density profile that move horizontally with the TID and cause skip-distance focusing effects for high frequency (3-30 MHz) radio signals propagating through the ionosphere. The signature of this phenomena is manifest as periodic variations in contact ranges in HF amateur radio communication reports recorded by automated monitoring systems such as the Weak Signal Propagation Reporting Network (WSPRNet) and the Reverse Beacon Network (RBN). In this study, members of the Ham Radio Science Citizen Investigation (HamSCI) present a climatology of LSTID activity using observations on the 1.8, 3.5, 7, 14, 21, and 28 MHz amateur radio bands from 2017. Results will be organized as a function observation frequency, longitudinal sector (North America and Europe), season, and geomagnetic activity level. Connections to geospace are explored via SYM-H and Auroral Electrojet indexes, while neutral atmospheric sources are explored using NASA's Modern-Era Retrospective Analysis for Research and Applications Version 2 (MERRA-2).

Introduction

In this study, we are searching for TID sources by analyzing observations from distributed passive radio receiver networks and amateur ham radio transmissions. We determine TID parameters visually finding quasi-periodic variations in the minimum HF signal distance within WSPRNet and RBN ham radio observations. This is then applied to a statistical study of TIDs observed by ham radio data for 2017 and compared to similar studies using SuperDARN radars. Seasonal dependencies are identified in the observed TIDs.

Data and Methodology

WSPRNet and RBN are automated communication observation networks that are voluntarily operated by amateur radio operators that can monitor and log radio signals. Each datum ("spot") includes information on the transmitter, receiver, time, and frequency. Using data from these networks, two dimensional histograms were created that show:

- Density of spots (from RBN and WSPRNet) per distance (between transmitter and receiver).
- Maps of selected geographic location showing midpoint location of the spot data.
- Perceived fading in HF propagation due to refraction changes caused by TIDs.



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US, and were then searched manually for TID signatures.





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Only the US climatology data was used for this comparison given that the location of the SuperDARN blackstone beams is closer in coverage to the ham radio data from the continental US. Both appear to be consistent with one another, showing more TID activity during the winter months. SuperDARN is unable to have any observations in the summer months due to the lack of ground scatter, an issue not present in the ham radio data.

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