2023 Workshop: Traveling Ionospheric Disturbances

Long title
Traveling Ionospheric Disturbances Driven from Above and from Below
Grand Challenge
Conveners
Kate Zawdie
Jeff Klenzing
Meghan Burleigh
Shunrong Zhang
Pavel Inchin
Steve Kaeppler
Danielle Markowski
Lakshmi Narayanan
Matt Zettergren
kate.zawdie@nrl.navy.mil
Description

This session will focus on the identification and source differentiation of traveling ionospheric disturbances (TIDs), which are frequently observed in the ionosphere at all latitudes and longitudes. TIDs can be driven from above by solar and magnetospheric disturbances, or driven from below by lower atmospheric and surface forcing, including but not limited to tropospheric weather events (hurricanes, tornadoes, tropical cyclones, thunderstorms, etc.), earthquakes, tsunamis, volcanic eruptions, explosions, and spacecraft launches. TIDs generated from different types of sources may exhibit similar or very different characteristics in their spatial and temporal scales, periodicities, propagation speeds and directions. Meanwhile, TIDs generated from the same type of sources may exhibit different characteristics depending on the local atmospheric and ionospheric conditions. Therefore, it remains a challenge to distinguish TIDs from different types of sources in ionospheric observations. We solicit theoretical, observational, and modeling contributions on better understanding of the origins, generation mechanisms, and characteristics of TIDs. In particular, we welcome innovative approaches to identify and differentiate TIDs generated from various sources.

Agenda

16:00 Welcome

16:05-17:15 Talks (Each talk ~5 minutes with an additional 2 minutes for questions)

- Olu Jonah: Automated detection and Characterization of wave structures obtained from GNSS measurements
- Angeline Burrell: Large Scale Traveling Ionospheric Disturbances in the Topside Ionosphere
- Asti Bhatt: MANGO green and red line imager network in mid-latitudes
- Joe Hughes: The N Dimensional Lomb Scargle Periodogram for Characterizing TIDs
- Masaru Kogure: Medium-Scale Traveling Ionospheric Disturbances Created by Primary Gravity Waves Generated by a Weather Front in WACCM-X/SAMI3
- Shantanab Debchoudhury: Observations of enhanced TID and AGW activity during the winter storm of December 2022
- Komal Kumari: Lower Atmospheric Sources of Observed Thermosphere Medium Scale Traveling Atmospheric Disturbances over Alaska during the 2012-2013 Winter Months
- Matthew Woodward: Systematic Statistical Identification of Lower Region Ionosphere Acoustic Waves through VLF Remote Sensing
- Russell Cosgrove: An electromagnetic calculation of electric field mapping that finds very unexpected results
- Gang Lu: On the relationship between traveling atmospheric and ionospheric disturbances
- Michael Hartinger: Sources of Ultra Low Frequency Total Electron Content Perturbations

17:25-18:00 Discussion and Mission Planning

File upload
Russell Cosgrove's talk (7.25 MB)
Matthew Woodward's talk (7.6 MB)
Joe Hughes' talk (8.61 MB)

Justification

Traveling Ionospheric Disturbances (TIDs) are a ubiquitous feature that are observed as propagating density perturbations in the F-region ionosphere. They have been detected by many different instruments over many decades. Various physical processes are believed to be responsible for the generation of these wave-like features. TIDs can be driven from above by solar and magnetospheric disturbances, or driven from below by lower atmospheric and surface forcing, including but not limited to tropospheric weather events (hurricanes, tornadoes, tropical cyclones, thunderstorms, etc.), earthquakes, tsunamis, volcanic eruptions, explosions, and spacecraft launches. TIDs generated from different types of sources may exhibit similar or very different characteristics in their spatial and temporal scales, periods, propagation speeds and directions. Meanwhile, TIDs generated from the same type of sources may exhibit different characteristics depending on the local atmospheric and ionospheric conditions. Therefore, it remains a challenge to distinguish TIDs from different types of sources in ionospheric observations.

A key obstacle in developing future space weather forecast systems is to predict the physical mechanisms (and their scales) that drive regional ionospheric perturbations, such as TIDs. There have been recent efforts to mitigate the effects of TIDs on HF geolocation, but in order to predict TID occurrence, their generation mechanisms must be understood. The sparse nature of measurements in the ionosphere makes it unlikely that these questions can be answered via observational methods alone. Comprehensive modeling studies combined with new, multi-instrument observations will be required to obtain closure on these science questions.

Related to CEDAR Science Thrusts:
Explore exchange processes at boundaries and transitions in geospace
Develop observational and instrumentation strategies for geospace system studies
Workshop format
Short Presentations
Keywords
Traveling Ionosphere Disturbance, Magnetosphere-Ionosphere-Atmosphere Interactions
View PDF