Canadian Association of Physicists
Association canadienne des physiciens et physiciennes

Contribution ID: **98** Type: **Oral (Non-Student) / Orale (non-étudiant(e))**

An analysis of WWV's 10 MHz signal received in New Jersey

Tuesday 10 June 2025 11:30 (15 minutes)

This study investigates the impact of ionospheric variability on High Frequency (HF; 3-30 MHz) skywave propagation, a critical aspect of long-range radio communication. Using a dedicated HamSCI Grape V1 low-IF receiver (K2MFF) at the New Jersey Institute of Technology (NJIT) in Newark, New Jersey, we analyzed long-term Doppler residual measurements of the 10 MHz WWV signal from Fort Collins, Colorado. The observations reveal a strong correlation between stable daytime propagation and a Cauchy distribution of Doppler residuals, while sporadic nighttime conditions align more with a combination of exponential power and log-normal statistics. This pattern persisted, except during periods of atypical solar irradiance, such as solar flares and eclipses. We compare these findings with numerical raytracing simulations using an IRI ionosphere model, allowing for the visualization of the signal's ray path and the geolocation of the ionospheric altitudes (100-400 km) responsible for observed features. Raytracing attributed daytime signal stability to multi-hop mode superposition, while nighttime oscillations—hypothesized to be traveling ionospheric disturbances (TIDs)—were linked to ionospheric variability under 1-hop propagation. By examining diurnal variations in Doppler residuals, this work provides HF operators with a better understanding of ionospheric dynamics and their impact on HF communication, ultimately contributing to improved prediction of propagation conditions and more effective use of the HF spectrum. Additionally, this work provides a foundation for interpreting real-time propagation data and understanding the effects of solar activity and ionospheric variations on signal quality and reliability for amateur radio communication.

Keyword-1

Citizen Science

Keyword-2

High Frequency

Keyword-3

Ionosphere

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Session Classification: (DASP) T1-2 Ionosphere, Thermosphere, and Radio Propagation | Ionosphère, thermosphère et propagation radioélectrique (DPAE)

Track Classification: Technical Sessions / Sessions techniques: Atmospheric and Space Physics / Physique atmosphérique et spatiale (DASP/DPAE)