

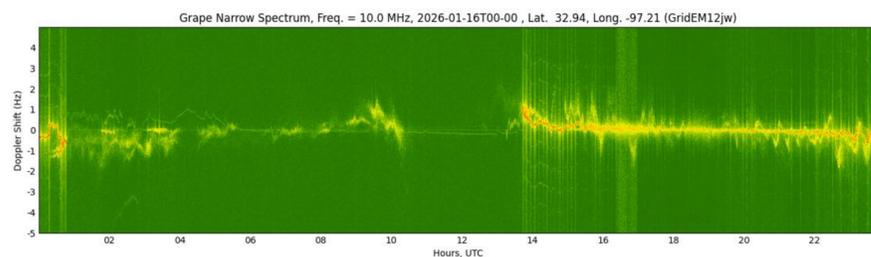
An Atlas of Forms Seen on HF Personal Space Weather Station Traces to Help Users Recognize and Analyze Events

Bob Mattaliano (N6RFM), Gwyn Griffiths (G3ZIL), Gary Mikitin (AF8A), Dave Swartz (W0DAS), Mary Lou West (KC2NMC)

Abstract

The ionosphere and our high frequency communications probing it are complicated. We are writing an atlas of forms to aid people in recognizing and understanding things seen on GRAPE/WSPR Daemon traces. Examples include a solar eclipse, a CME hitting the Earth's magnetosphere, a solar flare, and two-hop side scatter. Entries would be categorized by date as well as by type of event. Users are encouraged to submit puzzling examples to be considered by a content review team. We propose that this atlas be added to the HamSCI website. Further, we seek to expand this effort by encouraging contributions from operators of all types of Personal Space Weather Stations in the HamSCI network.

Ever Wonder What These Features Mean?



Atlas Content

Aim is to help citizen scientists learn as they progress to understand more complex examples.

- Principles of Operation – GRAPE and WSPRDaemon Family members
- Doppler Spectrum Plot Overview
- Local Dawn
- Local Sunset
- Propagation Types Frequently Observed - E Region, Two-hop F Region, Two-hop F and E Region, Two-hop sidescatter, Sporadic E, Travelling Ionospheric Disturbances (TIDs)
- Ionosondes
- Absorption
- Map of Personal Space Weather Station Distributions
- Comparing results from two stations at different distances receiving the same time signal source
- Total solar eclipse
- Solar X-ray flare
- System artifacts, etc.

Visit the prototype Atlas webpages!

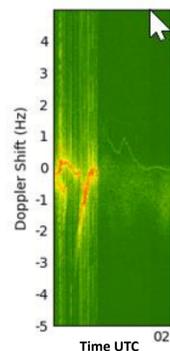


Figure 1. One-hop F region propagation, then the band rapidly closes.

Figure 2. Travelling Ionospheric Disturbance (TID) - a wave-like disturbance in the ionosphere that propagates over long distances.

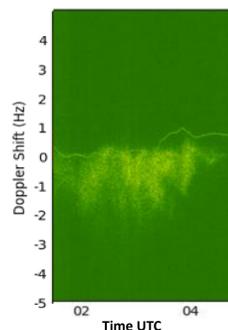
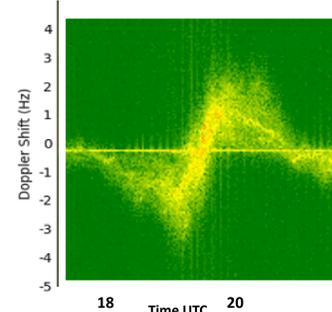


Figure 3. Very weak two-hop F region side-scatter - when radio signals reach a receiver after two ionospheric hops with a ground scatter in between. Since the receiver is not directly in line of propagation, weaker and more scattered signals are observed. The faint thin line is an artifact.

Figure 4. Solar Eclipse - S-curve's negative Doppler shifts show the ionosphere's reflection layer receding upwards when the Moon covers the Sun, then the positive section indicates the return of the ionizing sunlight as the Moon leaves the face of the Sun. (Stephen Newell N5TNL, AR, 7.85 MHz, CHU, 4/8/2024).

Solar X-Ray Flare Event

On January 18, 2026, a long-duration X1.9-class solar flare occurred (<https://www.swpc.noaa.gov/news/x-class-flare-activity-observed-18-January-2026>). Ionospheric impacts, as measured by disruption of WWV 10 MHz signals to EM12jw were first observed on 19 January 2026 at ~ 2030Z resulting in dramatic off-scale variations in Doppler shift. Figure 5 illustrates that this coronal mass ejection continued to impact the ionosphere several days after first Earth impact.



Secondary CME Impact

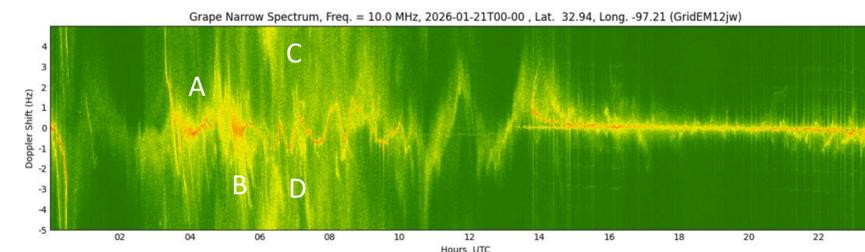


Figure 5. Secondary impact of the CME on 10 MHz propagation from WWV to EM12jw on 21 January 2026 at ~ 0300- 1015Z. C. The red trace (A) must be great circle path one-hop F region propagation because of a) its narrow spectral width (it is a fine trace) signifying great circle path and b) the Doppler variations distinguish it from steady near-zero Doppler for propagation characteristic of E region paths. Weak (B) and very wide traces are two-hop sidescatter from the F region likely from multiple locations. Large positive and negative two-hop sidescatter Doppler shifts C and D are very unusual and deserve further investigation.

Summary

- To help users of all skill levels understand and interpret GRAPE/WSPRDaemon results, we are preparing an atlas of forms. Our goal is that this resource will ultimately be made available on the HamSCI website.
- GRAPE/WSPRDaemon users are asked to submit puzzling examples to be considered by a content review team.
- We hope this effort will encourage users of all device types in the HamSCI PSWS community to contribute content.

References

- Collins, K., et al., 2021. IEEE Geoscience and Remote Sensing Letters, 19, pp.1-5.
 Collins, K., et al. Earth System Science Data Discussions, 2022, pp.1-21.
 Griffiths, G., et al. In AGU Fall Meeting Abstracts (Vol. 2023, pp. SA01-01).
 Griffiths, G., 2025. HamSCI Workshop, March 2025.

Plots shown were prepared using plotspectrum_V4a.py. W. Engelke, AB4EJ, University of Alabama (https://github.com/HamSCI/DRF_processing).

Acknowledgements

We are grateful to the entire HamSCI PSWS Community for ongoing support and encouragement.