October 2023 Annular Eclipse Propagation Anomalies at HF: Preview of FST4W Observations

Part 0: Introduction

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Introduction

HamSci, the Ham Radio Science Citizen Investigation [1], is a platform with objectives to "*advance scientific research and understanding through amateur radio activities*" and to encourage development and up-take on new supporting technologies. A premier HamSci activity for 2023-24 is the Festival of Eclipse Ionospheric Science [1]. Targeting the 14 October 2023 annular and 8 April 2024 total eclipses over North America multiple events have been organised to improve our understanding of sun-ionosphere-earth relationships through radio propagation experiments. There is much still to learn. For example, observations from the 2017 eclipse over N. America were the first to show ionospheric bow waves (as with a ship) that had been predicted by theory.

An informal group of radio amateurs with shared interests in the technology and applications of WSJT-X weak signal modes have used innovative receiver and transmitter hardware, software, and the under-appreciated FST4W mode, to contribute to HamSci objectives. We used FST4W because it measures the frequency spread, which can be used to identify propagation modes [2]. These notes are their story.

Transmitters and receivers

Figure 1 shows locations of participating FST4W transmitters (red) and receivers (yellow) in the region with at least 60% occultation during the 14 October 2023 eclipse. Some closely located stations are hidden. To arrive at this favourable geometry, covering one- and two-hop along- and across-eclipse paths, several stations hosted purpose-built Turn Island Systems [3] multiband transmitters (K6RFT, KV6X, TI4JWC WB6CXC at CM88 and CN88, WO7I). Figure 2 shows the transmitter at TI4JWC, with the multiband Hy-Gain AV680 in Figure 3. KA7OEI used a portable custom multi-mode, multiband transmitter [4] that also transmitted precision carrier frequencies for Doppler shift measurements. Other FST4W transmitters used QRP Labs' QDX. In all cases, master oscillators were GPSDOs or, at KA7OEI, a rubidium standard. These measures assured frequency spread and absolute accuracy of better than 5 mHz from the transmitters.

Receive sites used multiband KiwiSDRs and RX888 SDRs, the latter running 'KA9Q radio' [5] within the WsprDaemon reporting package [6]. Figure 4 shows the AI6VN portable station at an annular eclipse site near Winnemucca, Nevada.

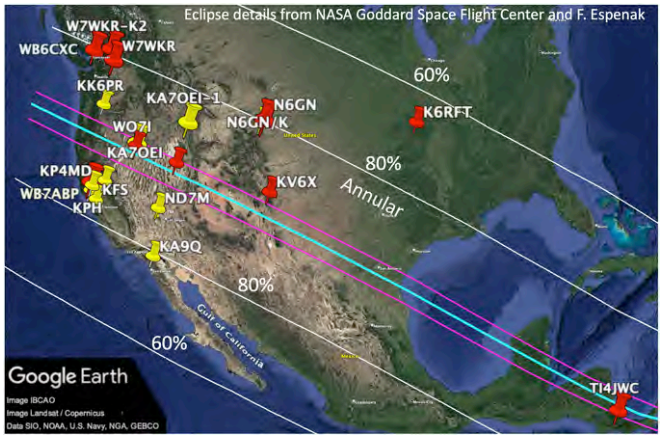
All the FST4W data gathered by these stations is open access. A Guide is available [5], with an Annex on access methods. Alternatively, sites wspr.rocks and wspr.live provide access and graphical outputs. Please acknowledge Rob Robinett AI6VN and individual data contributors in any output.

Previews of eclipse effects on propagation

We'll issue topic-specific one-page previews [7], beginning with:

- Anomalies from D region absorption changes.
- Effects of reduction in the F2 layer critical frequency.

Others will include: effects on frequency spread, mean Doppler shift, multiband operations and propagating disturbances.



From top: Figure 1. Map of the annular eclipse in cyan with the white lines either side at 80% and 60% occultation. Map pins show locations of transmitters (red) and receivers (yellow) described in these initial previews. Credit: Google Earth and NASA GSFC F.Espenak. Figure 2. Turn Island Systems BeaconBlaster-6 multiband FST4W transmitter at TI4JWC. Figure 3. Hy-Gain AV680 vertical antenna at TI4JWC operable on all bands 6–80 m except 60 m. Figures 2 and 3 credit John Clark. Figure 4. AI6VN portable receiver station at Winnemucca, Nevada with an RX888 multiband receiver using KA9Q radio and WsprDaemon recording software. Just visible to the left is the 40 m Beverage antenna. Pictured are Gary Crum KK7DV, Tom Bunch WO7I and Rob Robinett AI6VN. Image credit Gary Crum

References

1. https://hamsci.org and https://hamsci.org/eclipse
2. http://wsprdaemon.org/Griffiths_FST4W_2023_HamSCI.pdf
3. https://turnislandsystems.com/
4. http://ka7oei.blogspot.com/
5. https://github.com/ka9q/ka9q-radio
6. http://wsprdaemon.org - and see guide on the Timescale page.
7. For updates see posts at https://groups.io/g/wsprdaemon