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

Part 2: Effects of reduction in the F2 layer critical frequency (foF2)

Gwyn Griffiths G3ZIL gwyn@autonomousanalytics.com

Across the path: Annular eclipse

Ionosonde charts from Pt. Arguello CA, Boulder CO and Austin TX showed a pronounced temporary dip in the F2 layer critical frequency (foF2) coinciding with the passage of the eclipse [1]. At Boulder the dip at 16:45 UTC was to ~8.5 MHz from the ~11 MHz average for the previous five days.

Figure 1 shows time series of SNR (2.5 kHz bandwidth) for FST4W transmissions on 14 MHz and 21 MHz from WB6CXC (CM88, CA, 84% obscured) to N6GN (DN70ll, CO, 83% obscured). The eclipse was annular at the mid point.

During the eclipse 14 MHz remained open, but 21 MHz closed between 16:20–17:40 UTC. The reduced foF2 was unable to support propagation on the higher frequency on this 1560 km path. The first missed spot on 21 MHz was four minutes before maximum occultation at the mid point. The first post-eclipse spot was 76 minutes later.

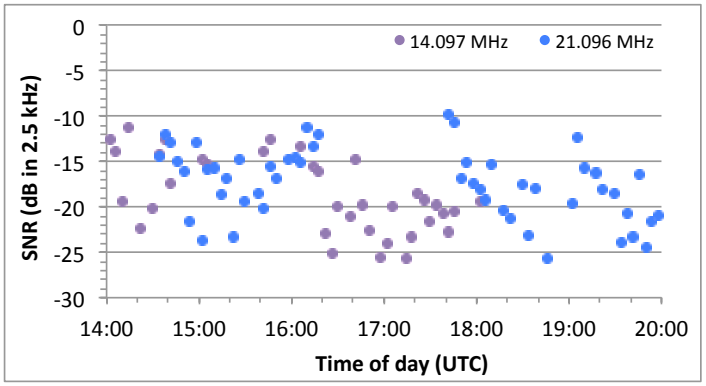

Figure 1. Time series of SNR at N6GN for FST4W transmissions from WB6CXC showing spots received on 14 MHz and 21 MHz during the eclipse.

Across the path: Partial eclipse

Band closure was not restricted to paths spanning the annular eclipse. The 1813 km path from K6RFT (EM47bg, MO, 69% obscured) to KA7OEI-1 (DN31uo, UT, 85% obscured) was entirely to the east of the track. Figure 2 shows that the gaps where no 14.097 MHz FST4W transmissions were received varied between the three antennas at KA7OEI-1. The number of sporadic spots within the gaps also varied:

- TCI530 Omnidirectional: 16:30–17:14 UTC with 1 spot in 23 transmission intervals.
- LP-1002 Log periodic heading 10° CCW of the path from K6RFT: 16:30–17:06 with 8 spots in 19 intervals.
- KLM 10-30-7 Log periodic heading 14° from 'back of the beam': 16:26–17:14 with 3 spots in 25 intervals.

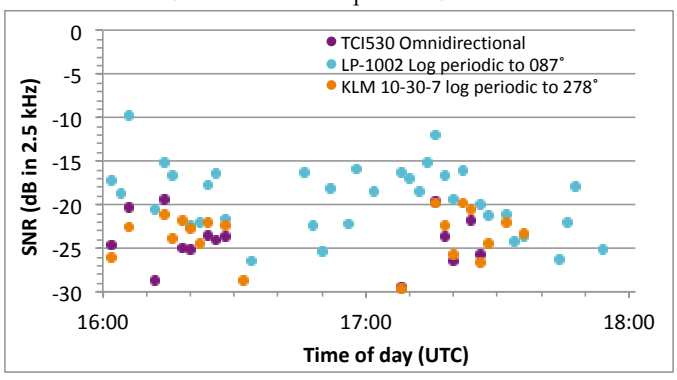

Figure 2. Time series of SNR at KA7OEI-1 on three different antennas for 14 MHz FST4W transmissions from K6RFT showing antenna-dependent gaps.

Along the path of the eclipse

TI4JWC, Costa Rica (EK70wb, 93% obscured), located just to the west of the greatest eclipse point, transmitted FST4W signals every 2 minutes on six bands simultaneously. From the resulting rich data set Figure 3 shows when spots were received at four stations close in on both sides of the track of annularity on 28.126 MHz: KPH (CM88mc, CA), KFS (CM87tj, CA), KA7OEI-1 (DN10cw, UT) and ND7M (DM16xf, NV). The bottom graph shows that the inter-hop skip zone on this two-hop path must have been at less than 4300 km prior to and after the eclipse, increasing to between 4500 km and 4850 km during the eclipse. However, while the band did not close beyond 4850 km the circuit reliability during the eclipse, top graph, was reduced at KFS and KPH, both with the same form.

The reappearance of spots at ~18:00 UTC at KA7OEI-1 and ND7M is tentatively explained as follows: As the eclipse travels southeast it first affects the ionosphere at the second hop. Later, when over the ground reflection, and its effect has diminished, spots return. Next, the first hop is affected: the gap returns. Ray trace experiments will be made to test this hypothesis.

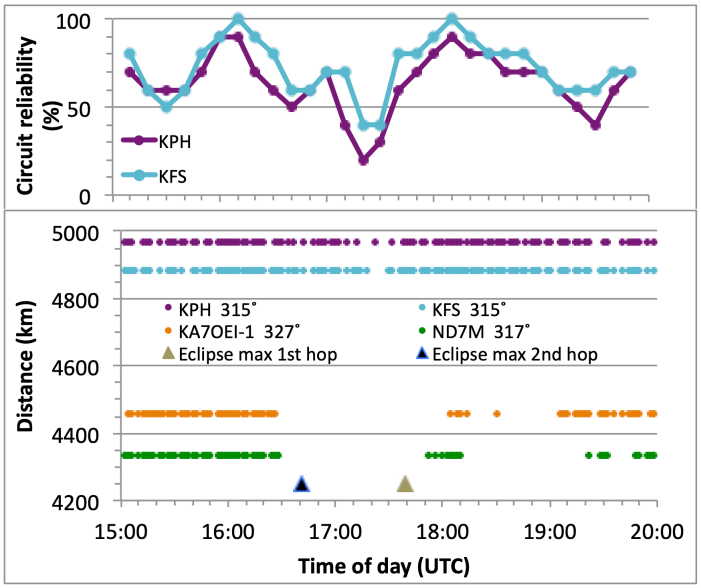

Figure 3. Top: Circuit reliability for the paths from TI4JWC to KPH and KFS as % of transmissions every 2 minutes received in 20-minute intervals. Bottom: Spots denote time of FST4W transmissions received from TI4JWC with range on 28 MHz, and path heading noted. The eclipse track from TI4JWC was ~321°. Also shown are the times of maximum eclipse at the locations of the first and second hops.

Data availability

The data shown here is part of an extensive dataset gathered by WsprDaemon. All data is open access. A Guide is available [2], with an Annex on access methods. Sites wspr.rocks and wspr.live also provide access and graphical outputs. Please acknowledge Rob Robinett AI6VN and individual data contributors in any output as below.

References

1. e.g. see https://sites.google.com/view/eclipse2023charts
2. http://wsprdaemon.org - see guide on the Timescale page.

Acknowledgment

Data acquisition for this preview was only possible through the efforts of Rob Robinett AI6VN, Paul Elliot WB6CXC, Glenn Elmore N6GN, Peter Freeman K6RFT, Clint Turner (for KA7OEI-1), John Clark TI4JWC, the Maritime Radio Historical Society and Craig McCartney W6DRZ (for KPH), Globe Wireless Radio Services and KFS Radio Club (for KFS) and Dennis Benischek ND7M. V1. 26 Oct 2023