Effect of near-total solar eclipse on high frequency propagation distances using cyclical multiple frequency weak-signal propagation reporter (WSPR) transmissions

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Background: High frequency radio wave propagation during a solar eclipse has been infrequently studied. In 2024 a path of totality of solar eclipse crossed North America, making it possible to study its effects on HF transmissions.

Methods: Weak signal propagation reporter (WSPR) MFSK-type digital signals were transmitted cyclically on 80M, 40M, 30M, 20M, 17M, 15M, 12M, and 10M amateur radio bands before, during, and after the solar eclipse. Data regarding these unidirectional transmissions was recovered from a publicly available database.

Results: WSPR transmissions at 10.14 MHz and 14.09 MHz were received at longer distances at the height of the eclipse and afterwards, when compared to the time leading up to the maximum coverage of the sun.

Conclusion: Solar eclipses may have a specific effect on 30M and 20M amateur radio bands, namely causing transmissions distances to lengthen at and following maximum solar coverage.

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BACKGROUND

High frequency (HF) radio wave propagation relies on line-of-sight, ground wave, and sky wave, and has been described extensively elsewhere.[1,2] In brief, daily, seasonal, and sporadic changes in electron density in the D, E, F1, and F2 layers of the ionosphere are largely responsible for the predictably unpredictable nature of long distance HF communications.

Radio wave propagation behavior associated with solar eclipses has also been studied.[3, 4] Unsurprisingly, solar eclipses have been shown to cause disruptions to the ionosphere.[5.] Citizen scientist amateur radio operators have participated in exploring this phenomenon[6], including use of an amateur radio modality known as weak signal propagation reporter (WSPR). Researchers have also relied on amateur radio operator transmissions during on-air events known as "QSO parties" for solar eclipse radio wave propagation analysis.[7,8]

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*No such school exists, or if it does, it only has one teacher and one student. And they happen to be the same person.

WSPR is part of the WSJT-X[9] software suite available freely for download and licensed amateur radio operator use for transmission, or by the general public for reception. WSPR is a digital communication mode characterized by a 6 Hz, upper side band, time synchronized, four tone, multi-frequency-shift-keying (MFSK) with forward error correction signal that has the ability to be accurately detected and decoded in very low signal-to-noise situations.[10] WSPR is intended to be a low power amateur radio mode (i.e., less than 5 watt) that can be used to demonstrate real time propagation on specific 200 Hz band segments of frequencies ranging from 136 kHz - 1296.5 MHz.[11] The transmission is unidirectional and includes only an amateur radio operator call sign, station location by 4-letter Maidenhead grid square designation, and power level in decibels per milliwatt (dBm). WSPR transmission data, including call signs of receiving and transmitting stations, station grid square locators, time of transmission, signal-to-noise ratios, and transmission power output, are automatically uploaded to the internet, warehoused at WSPRnet.org, and can be freely accessed.[10] Many other entities utilize this data for various purposes, including WSPR Rocks![12] which repackages WSPR.net data in a more accessible format.

On April 8, 2024, a solar eclipse with a path of totality across North America took place.[13] This study investigates the variations in propagation across HF amateur radio bands during the duration of the eclipse.

METHODS

A location on farmland in Upstate New York near the path of totality of the solar eclipse was chosen. This location, personal property of the author, was hillside with fairly open sky in all directions except a bit lesser so to the south, and would be easy and convenient to deploy an antenna on. The land was located in grid square FN22 (42°N 74°W). Data regarding the eclipse was found at the U.S. Naval Observatory Astronomical Applications Department's online solar eclipse calculator[14], which showed the eclipse beginning at that location at 18:11 UTC, reaching maximum at 19:26 UTC, and ending at 20:36 UTC. Obscuration of the sun would reach 97.6%.

An end-fed half-wave antenna (EFHW) consisting of a 49:1 toroidal impedance transformer and an approximately 20M long 16awg insulated copper wire radiator were hung horizontally at approximately 20 feet from the ground using tree limbs as supports. Twenty-five feet of RG58c/u coaxial cable with connected the antenna (BNC connectors) to the transmitter (BNC male cable connector to BNC-to-SMA jumper cable to SMA transceiver connector).

The antenna was poorly tuned, with the radiator length requiring shortening for better performance when analyzed with a 1-channel RigExpert AA55 Zoom[15] vector network analyzer. A sampling of VSWRs at various frequencies showed: 11 VSWR at 3.8 MHz, 3.7 VSWR at 7.175 MHz, 2.1 VSWR at 14.225 MHz, 4.8 VSWR at 21.275 MHz, and 3.2 VSWR at 28.3 MHz. Regardless of the overall high VSWRs, the antenna was utilized without trimming for this experiment.

The transmitter used is a commercially available Zachtek WSPR desktop transmitter.[16] The transmitter was preprogrammed to cycle through the WSPR frequency allocations of the 80m, 40m, 30m, 20m, 17m, 15m, 12m and 10m amateur radio bands. Transmissions lasted nearly two minutes per each band, for a total of 14 minutes through each cycle. A four minute rest between cycles would occur, and then the sequence would begin again. The transmitter has an attached GPS unit that provides accurate timing and location.

The transmitter has no receive capabilities and all transmissions were unidirectional. Transmitting power output was 200mW.

Each 14 minute cycle through all of the bands was designated as a "time slot" for the purpose of this experiment. Time slot assignments are shown in Table 1. The transmitter stayed on the air from 17:20 UTC (before the start of the eclipse) to 20:38 UTC (after it ended), for a total of 12 complete cycles.

Table 1. Time Slot Assignments for Duration of Solar Eclipse

Time Slot	**Eastern Daylight Time (-04:00 UTC)**	**Coordinated Universal Time (UTC)**
1	13:20 to 13:34	17:20 to 17:34
2	13:38 to 13:52	17:38 to 17:52
3	13:56 to 14:10	17:56 to 18:10
4 (start)[1]	14:14 to 14:28	18:14 to 18:28
5	14:32 to 14:46	18:32 to 18:46
6	14:50 to 15:04	18:50 to 19:04
7	15:08 to 15:22	19:08 to 19:22
8 (max.)[1]	15:26 to 15:40	19:26 to 19:40
9	15:44 to 15:58	19:44 to 19:58
10	16:02 to 16:16	20:02 to 20:16
11 (end)[1]	16:20 to 16:34	20:20 to 20:34
12	16:38 to 16:52	20:38 to 20:52

[1]Indicates start, maximum coverage, and end times of solar eclipse at transmitter location (Maidenhead grid square FN22vr)

Data, namely number of spots (i.e., the term given to the event of a station receiving a WSPR transmission), distance from the transmitter to receiving stations (km), signal-to-noise ratio (dB), and receiver Maidenhead grid square location, is extracted from WSPR Rocks![12] and analyzed with Libre Calc spreadsheet and an online Mann-Whitney U (MWU) calculator[13] for non-parametric data.

Spots were sorted by band and then by time slot. For each band, the spots of any given time slot were statistically compared to the remainder of the spots in all of the other time slots for distances between transmitter and receiver, as well as for signal-to-noise ratio (SNR).

Statistical analysis for distances was initially evaluated as a 2-tailed MWU with a $\rho < 0.05$ considered significant. Significant results were subsequently analyzed with 1-tail MWU to assess for directionality (i.e., whether the distances of individual spots of a particular time slot were greater or less than the overall spots of a particular band.)

Table 2. 80 METERS – WSPR Propagation Distance And Signal-To-Noise Ratio Across Duration Of Solar Eclipse

Time slot	Distance (km)								SNR (dB)
	# spots	mean	SD[1]	median	min.	max.	ρ (2-tail)[2]	ρ (1-tail)[2]	mean
1	5	208	79	227	78	291	0.441	--	-20
2	6	252	129	232	78	472	0.955	--	-21
3	5	208	79	227	78	291	0.441	--	-20
4 (start)[3]	5	251	41	237	205	307	0.692	--	-21
5	6	245	44	232	203	307	0.932	--	-23
6	5	268	35	280	227	307	0.231	--	-24
7	10	227	61	236	130	307	0.705	--	-23
8 (max.)[3]	17	319	227	278	130	1123	0.121	--	-20
9	8	256	115	245	78	483	0.750	--	-16
10	16	236	106	232	78	483	0.542	--	-20
11 (end)[3]	12	215	70	232	78	307	0.396	--	-18
12	7	227	78	227	78	307	0.780	--	-17

[1]Signal-to-noise ratio

[2]Mann-Whitney U test; (<) indicates that the distance from the KM1NDY WSPR beacon to stations receiving spots at that particular time slot were significantly less than the all of the rest of the receiver stations at all of the times slots for this particular band; (>) indicates that the distance to the receiver stations at a particular time slot were significantly more than the rest of the receiver stations at all time slots for that band.

[3]Indicates start, maximum coverage, and end times of solar eclipse at transmitter location (maidenhead grid square FN22vr)

Table 3. 40 METERS – WSPR Propagation Distance And Signal-To-Noise Ratio Across Duration Of Solar Eclipse

Time slot	Distance (km)								SNR (dB)
	# spots	mean	SD[1]	median	min.	max.	ρ (2-tail)[2]	ρ (1-tail)[2]	mean
1	41	298	124	282	58	492	0.372	--	-9
2	41	312	181	282	58	1123	0.330	--	-10
3	36	315	135	280	78	614	0.711	--	-12
4 (start)[3]	45	319	152	302	58	768	0.829	--	-11
5	35	327	131	302	91	614	0.799	--	-12
6	32	311	199	262	58	1144	0.189	--	-8
7	***46***	***524***	***400***	***388***	***78***	***1560***	***0.006***	***0.003 (>)***	-11
8 (max.)[3]	34	378	235	227	91	1144	0.475	--	-10
9	39	304	189	284	0	1144	0.183	--	-12
10	52	416	349	308	0	1775	0.407	--	-11
11 (end)[3]	48	394	279	308	0	1144	0.412	--	-12
12	33	302	134	307	58	725	0.760	--	***-7***[*]

[1]Signal-to-noise ratio

[2]Mann-Whitney U test; (<) indicates that the distance from the KM1NDY WSPR beacon to stations receiving spots at that particular time slot were significantly less than the all of the rest of the receiver stations at all of the times slots for this particular band; (>) indicates that the distance to the receiver stations at a particular time slot were significantly more than the rest of the receiver stations at all time slots for that band.

[3]Indicates start, maximum coverage, and end times of solar eclipse at transmitter location (maidenhead grid square FN22vr)

[*]$\rho < 0.05$

Table 4. 30 METERS – WSPR Propagation Distance And Signal-To-Noise Ratio Across Duration Of Solar Eclipse

Time slot	Distance (km)								SNR (dB)
	# spots	mean	SD[1]	median	min.	max.	ρ (2-tail)[2]	ρ (1-tail)[2]	mean
1	21	***784***	***448***	***656***	***0***	***1810***	***0.049***	***0.024 (<)***	-15
2	20	803	370	739	446	1545	0.098	--	-18
3	22	***603***	***276***	***493***	***78***	***1123***	***0.000***	***0.000 (<)***	-15
4 (start)[3]	21	810	408	769	414	1810	0.067	--	***-10***[*]
5	23	***762***	***406***	***725***	***78***	***1545***	***0.030***	***0.015 (<)***	-15
6	16	***712***	***301***	***691***	***414***	***1545***	***0.020***	***0.010 (<)***	-15
7	23	945	455	879	414	1839	0.738	--	-17
8 (max.)[3]	20	***1295***	***629***	***1066***	***656***	***3053***	***0.027***	***0.014 (>)***	-18
9	28	***2207***	***2308***	***1074***	***0***	***6745***	***0.014***	***0.007 (>)***	-19
10	25	***2469***	***2127***	***1490***	***725***	***6733***	***0.000***	***0.000(>)***	-19
11 (end)[3]	12	890	321	872	88	1490	0.980	--	-14
12	30	***2650***	***2385***	***1358***	***477***	***6745***	***0.000***	***0.000 (>)***	-19

[1]Signal-to-noise ratio

[2]Mann-Whitney U test; (<) indicates that the distance from the KM1NDY WSPR beacon to stations receiving spots at that particular time slot were significantly less than the all of the rest of the receiver stations at all of the times slots for this particular band; (>) indicates that the distance to the receiver stations at a particular time slot were significantly more than the rest of the receiver stations at all time slots for that band.

[3]Indicates start, maximum coverage, and end times of solar eclipse at transmitter location (maidenhead grid square FN22vr)

[*]$\rho < 0.05$

Table 5. 20 METERS – WSPR Propagation Distance And Signal-To-Noise Ratio Across Duration Of Solar Eclipse

Time slot	Distance (km)								SNR (dB)
	# spots	mean	SD[1]	median	min.	max.	ρ (2-tail)[2]	ρ (1-tail)[2]	mean
1	14	1377	740	1063	802	3053	0.145	n/a	-12
2	8	***1451***	***982***	***965***	***802***	***3053***	***0.047***	***0.024 (<)***	-13
3	15	***957***	***178***	***931***	***796***	***1469***	***0.000***	***0.000 (<)***	***-11****
4 (start)[3]	33	2319	1667	1545	802	6144	0.285	n/a	-15
5	23	***1317***	***781***	***1054***	***802***	***3557***	***0.007***	***0.004 (<)***	***-12****
6	7	***1015***	***156***	***1054***	***796***	***1243***	***0.037***	***0.019 (<)***	-13
7	31	1987	1341	1184	923	6144	0.411	n/a	-14
8 (max.)[3]	8	2787	2252	1404	931	6144	0.284	n/a	-11
9	4	1312	218	1337	1071	1503	0.704	n/a	-17
10	34	***2646***	***1828***	***1490***	***1054***	***6745***	***0.000***	***0.000 (>)***	***-18****
11 (end)[3]	32	***2485***	***1987***	***351***	***862***	***6110***	***0.016***	***0.008 (>)***	-15
12	23	1541	1158	1079	931	6144	0.448	n/a	-13

[1]Signal-to-noise ratio

[2]Mann-Whitney U test; (<) indicates that the distance from the KM1NDY WSPR beacon to stations receiving spots at that particular time slot were significantly less than the all of the rest of the receiver stations at all of the times slots for this particular band; (>) indicates that the distance to the receiver stations at a particular time slot were significantly more than the rest of the receiver stations at all time slots for that band.

[3]Indicates start, maximum coverage, and end times of solar eclipse at transmitter location (maidenhead grid square FN22vr)

$^*\rho < 0.05$

Table 6. 17 METERS – WSPR Propagation Distance And Signal-To-Noise Ratio Across Duration Of Solar Eclipse

Time slot	Distance (km)								SNR (dB)
	# spots	mean	SD[1]	median	min.	max.	ρ (2-tail)[2]	ρ (1-tail)[2]	mean
1	18	3155	1632	3223	1377	6006	0.665	n/a	-19
2	14	2966	1356	3094	1490	5762	0.894	n/a	-19
3	20	3277	1386	3242	1490	5917	0.579	n/a	-15
4 (start)[3]	15	2718	1417	2506	1377	5762	0.166	n/a	***-14****
5	24	3843	2398	3683	1490	13225	0.084	n/a	-16
6	10	***2193***	***744***	***2133***	***1377***	***3431***	***0.028***	***0.014 (<)***	-19
7	17	2806	1375	3038	1377	6745	0.339	n/a	-16
8 (max.)[3]	12	2616	1203	2446	1123	4039	0.347	n/a	-14
9	21	3385	1915	2997	1123	6361	0.705	n/a	***-24****
10	7	2419	745	2483	1498	3689	0.211	n/a	-18
11 (end)[3]	26	3567	1704	3683	1069	6745	0.124	n/a	***-21****
12	25	3058	1301	3431	1069	6252	0.903	n/a	-16

[1]Signal-to-noise ratio

[2]Mann-Whitney U test; (<) indicates that the distance from the KM1NDY WSPR beacon to stations receiving spots at that particular time slot were significantly less than the all of the rest of the receiver stations at all of the times slots for this particular band; (>) indicates that the distance to the receiver stations at a particular time slot were significantly more than the rest of the receiver stations at all time slots for that band.

[3]Indicates start, maximum coverage, and end times of solar eclipse at transmitter location (maidenhead grid square FN22vr)

$^*\rho < 0.05$

Table 7. 15 METERS – WSPR Propagation Distance And Signal-To-Noise Ratio Across Duration Of Solar Eclipse

Time slot	Distance (km)								SNR (dB)
	# spots	mean	SD[1]	median	min.	max.	ρ (2-tail)[2]	ρ (1-tail)[2]	mean
1	19	3718	1110	3708	1839	6006	0.226	n/a	-17
2	16	3296	1043	3687	1545	5230	0.986	n/a	-16
3	13	3599	1244	3708	1545	6745	0.648	n/a	***-11****
4 (start)[3]	16	3226	1081	3686	1545	5114	0.692	n/a	***-18****
5	9	3064	1352	3689	1545	5033	0.758	n/a	-12
6	7	3321	1100	3880	1593	4022	0.714	n/a	-16
7	4	2869	1335	2931	1593	4022	0.689	n/a	-9
8 (max.)[3]	5	2534	337	2506	2108	3053	0.055	n/a	-17
9	6	2857	687	3012	1714	3746	0.157	n/a	-15
10	11	3426	669	3689	2108	4039	0.600	n/a	-16
11 (end)[3]	13	3112	1037	3431	581	4039	0.700	n/a	-14
12	15	3725	1450	3708	1796	6745	0.395	n/a	-14

[1]Signal-to-noise ratio

[2]Mann-Whitney U test; (<) indicates that the distance from the KM1NDY WSPR beacon to stations receiving spots at that particular time slot were significantly less than the all of the rest of the receiver stations at all of the times slots for this particular band; (>) indicates that the distance to the receiver stations at a particular time slot were significantly more than the rest of the receiver stations at all time slots for that band.

[3]Indicates start, maximum coverage, and end times of solar eclipse at transmitter location (maidenhead grid square FN22vr)

$^{*}\rho < 0.05$

Table 8. 12 METERS – WSPR Propagation Distance And Signal-To-Noise Ratio Across Duration Of Solar Eclipse

Time slot	Distance (km)								SNR (dB)
	# spots	mean	SD[1]	median	min.	max.	ρ (2-tail)[2]	ρ (1-tail)[2]	mean
1	11	3410	1271	3053	1852	6756	0.916	n/a	-17
2	12	***4802***	***1757***	***4683***	***2496***	***6756***	***0.009***	**0.005 (>)**	-19
3	9	3032	540	3053	2264	3746	0.376	n/a	-18
4 (start)[3]	9	3452	1148	3431	1852	6006	0.702	n/a	-17
5	9	3736	1794	3053	1852	6745	0.957	n/a	-17
6	6	2615	839	2775	1490	3743	0.094	n/a	-16
7	7	2797	926	3053	1490	3746	0.338	n/a	-19
8 (max.)[3]	8	2871	893	3053	1490	3746	0.347	n/a	-15
9	15	3168	770	3431	1490	3991	0.942	n/a	-17
10	6	3484	365	3587	3053	3880	0.209	n/a	-18
11 (end)[3]	6	3048	496	3053	2496	3746	0.708	n/a	***-10****
12	2	3242	267	3242	3053	3431	0.990	n/a	-15

[1]Signal-to-noise ratio

[2]Mann-Whitney U test; (<) indicates that the distance from the KM1NDY WSPR beacon to stations receiving spots at that particular time slot were significantly less than the all of the rest of the receiver stations at all of the times slots for this particular band; (>) indicates that the distance to the receiver stations at a particular time slot were significantly more than the rest of the receiver stations at all time slots for that band.

[3]Indicates start, maximum coverage, and end times of solar eclipse at transmitter location (maidenhead grid square FN22vr)

$^{*}\rho < 0.05$

Table 9. 10 METERS – WSPR Propagation Distance And Signal-To-Noise Ratio Across Duration Of Solar Eclipse

Time slot	Distance (km)								SNR (dB)
	# spots	mean	SD[1]	median	min.	max.	ρ (2-tail)[2]	ρ (1-tail)[2]	mean
1	2	3798	341	3798	3557	4039	0.207	n/a	-19
2	6	3251	483	3161	2756	4039	0.451	n/a	-17
3	8	3414	428	3407	2834	4039	0.955	n/a	-18
4 (start)[3]	13	3276	452	3257	2546	4039	0.372	n/a	-15
5	11	3316	501	3494	2274	3831	0.670	n/a	-16
6	5	3162	385	3053	2834	3831	0.196	n/a	-15
7	6	3622	500	3790	2834	4039	0.229	n/a	-22
8 (max.)[3]	6	2830	1083	3192	1490	4039	0.232	n/a	-21
9	7	***3779***	***384***	***3923***	***2994***	***4039***	***0.025***	***0.013 (>)***	-22
10	3	3530	523	3557	2995	4039	0.697	n/a	-19
11 (end)[3]	11	3380	370	3431	2756	3932	0.811	n/a	-18
12	12	3445	365	3623	2756	3831	0.676	n/a	-16

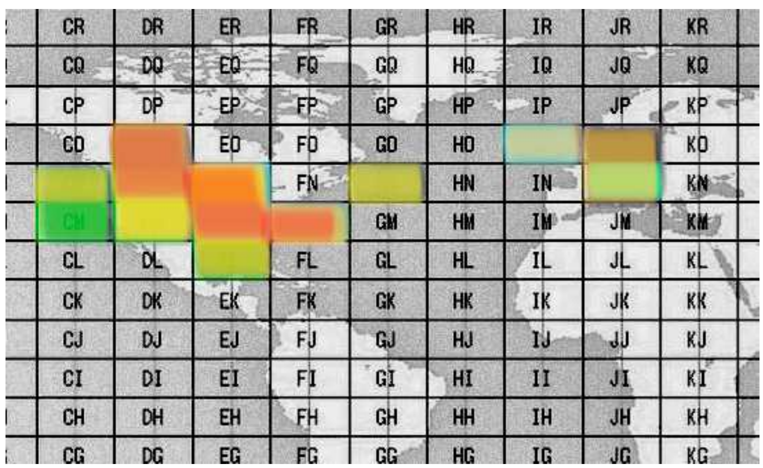
[1]Signal-to-noise ratio

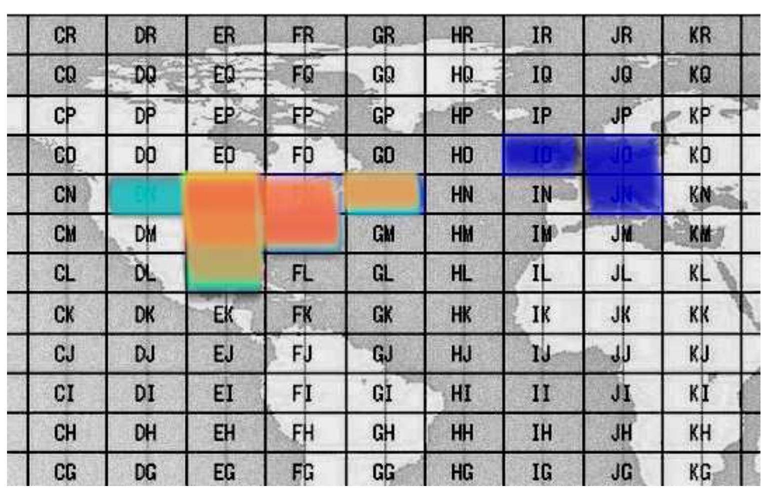
[2]Mann-Whitney U test; (<) indicates that the distance from the KM1NDY WSPR beacon to stations receiving spots at that particular time slot were significantly less than the all of the rest of the receiver stations at all of the times slots for this particular band; (>) indicates that the distance to the receiver stations at a particular time slot were significantly more than the rest of the receiver stations at all time slots for that band.

[3]Indicates start, maximum coverage, and end times of solar eclipse at transmitter location (maidenhead grid square FN22vr)

Table 10. 20M & 30M Heat Maps

Time Slot	Color Code
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	





Maps showing locations of spots for the 20M (top) and 30M (bottom) amateur radio bands. Only the first two characters of the Maidenhead grid square are shown. The locations are color-coded based on time slot, and each grid square may have more than one overlapping color. The transmitter was at FN.

RESULTS

Each amateur radio HF band from 80M to 10M is separated into time slots. For each time slot, the number of spots, mean distance between the transmitting and receiving stations, standard deviation (SD), median distance, minimum distance, and maximum distance is recorded in Tables 2-9. Two-tail MWU, and if relevant, 1-tail MWU results are also indicated. Signifcant results with $\rho < 0.05$ are italicized. The mean SNR is shown and marked with an asterisk when significant. In total, 1612 spots were recorded from the beginning to the ending of the experiment. Transmitted frequencies for each amateur radio band were centered around the established WSPR frequencies of 3.57 MHz, 7.04 MHz, 10.14 MHz, 14.09 MHz, 18.1 MHz, 21.09 MHz, 24.92 MHz, and 28.12 MHz.

No time slots in the 80M or 15M bands had aggregate spot distances that were significantly different than the rest of the spots at other time slots. The 10M, 12M, 17M, and 40M bands each had one time slot with spot distances that were significantly different from spot distances seen at all other time slots for that band.

The 20M and 30M amateur radio bands did however show significant changes in distances, and these changes seem to fluctuate in sync with the stages of the solar eclipse. Aggregate spot distances were significantly shorter in several time slots for each band prior to the start of the eclipse and while the eclipse was approaching maximum coverage. Once the eclipse was at maximum however, this flipped for both 20M and 30M, with both bands showing time slots with spots at significantly greater distances as the eclipse receded and finally ended.

Heat maps of the spot locations were prepared by using a color code to represent each time slot for the 20M and 30M bands (Table 10). Each grid square that received transmissions during a particular time slot was marked with its assigned color, and these colors may overlap if the location was reached during different time slots. In general these heat maps show that the transmissions in the later time slots for these bands were received at greater distances both in easterly and westerly directions when compared with earlier time slots.

DISCUSSION

The data presented here seems to show that there are changes in propagation of 10.14 MHz and 14.09 MHz WSPR signals that correlate to the obfuscation cycle of a near-total solar eclipse. In particular in the period before and leading up to the maximum coverage of the sun, distances between the transmitting station within the eclipse path and receiving stations elsewhere are shorter compared to the distances recorded at the time of maximum coverage and later.

There are many potentially confounding factors in this sort of experiment that need to be considered. Radio wave propagation is fickle in normal circumstances, so just the general ionospheric conditions could be responsible for the observations seen. Time of day with normal solar progression also influences the propagations patterns of various high frequency wavelengths. Low placement of the antenna at only 25 feet from the ground may have an effect on the transmission take-off angle that influences propagation. Conditions of the earth surface, such as soil type, hills, and elevation, at the sight of the antenna may effect propagation. None of these, or any other potential factors, were modeled in this research. Receive stations alson could not be controlled for, and there was no way to know for certain if they were receiving consistently under the same conditions throughout the duration of the experiment. No changes, however, to the transmitter or its antenna were made throughout the duration of the experiment, thus at least controlling for the station originating the WSPR signals.

CONCLUSION

While certainly more work needs to be done on a larger controlled scale, including modeling the various confounding factors that influence propagation where possible, this research suggests that a solar eclipse nearing totality may cause transmissions around 10 and 14 MHz to be received at greater distances at the height of an eclipse and afterwards when compared to those received prior to the point of maximum solar obfuscation.

ATTRIBUTES

The world grid square map was modified from one found on the internet (http://www4.plala.or.jp/nomrax/GL/800x400.gif).

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