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Tests of ground-wave communication at 500 kHz

by

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Abstract

WD2XSH stations conducted tests of ground-wave communication during the summer of 2008. Transmissions were made from several stations to one or more receiving stations. Most transmissions used CW, but some used QRSS3 or QRSS10. The communication path was evaluated in terms of the fraction of the signal that could be copied. At distances up to 300 km, the percentage copied was 95 percent or more for most signals.

Indexing Terms

Radio, amateur
MF
Propagation, ground-wave

1. INTRODUCTION

Tests were conducted in the summer of 2008 to investigate the reliability of 500-kHz ground-wave paths. The transmitting and receiving stations (Figure 1) were divided into ten clusters. The objective was to obtain multiple evaluations of each path.

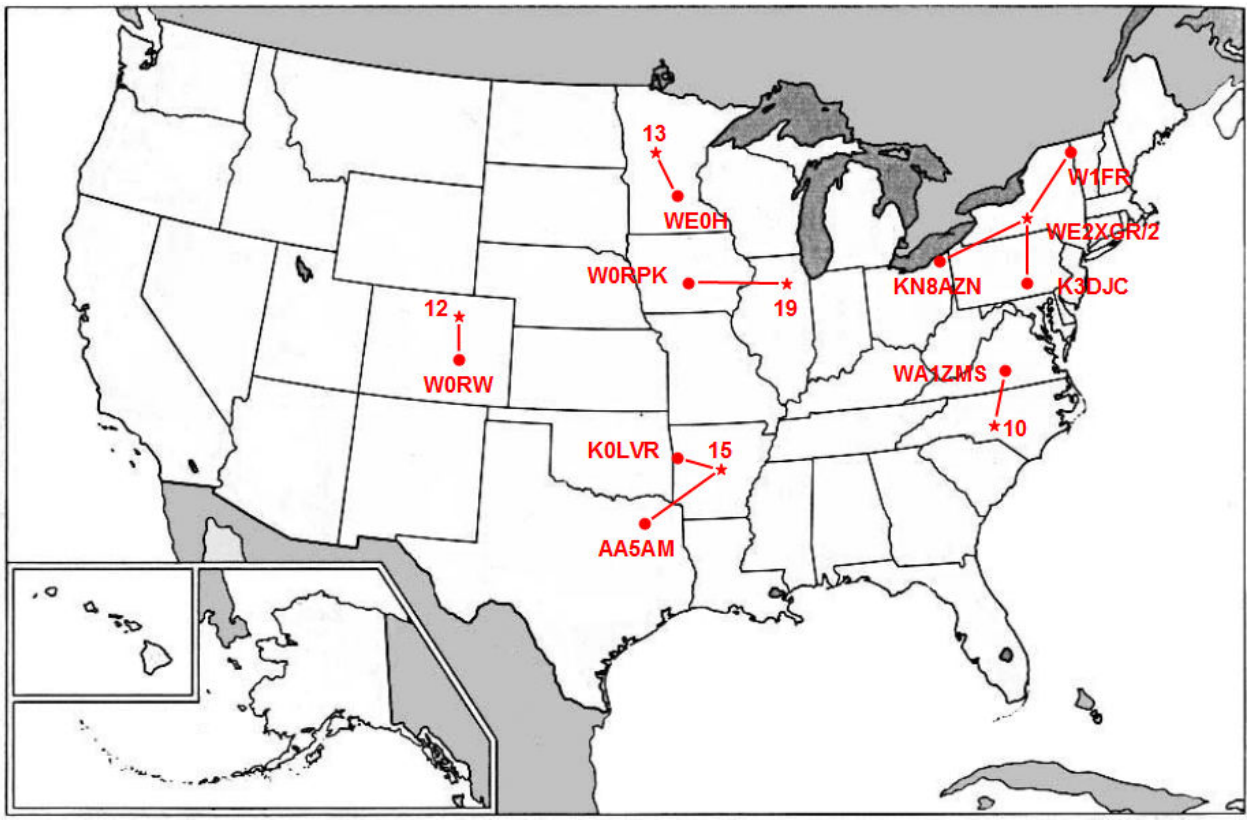

Figure 1. Stations.

The communication paths were evaluated in terms of "percent copy"; i.e., the percent of the time that the signal could be successfully decoded. Most tests used normal-speed CW, but QRSS3 and QRSS10 were also used. While the number of evaluations was smaller than hoped, the experiment nonetheless produced some useful results.

The coordinates, distances, and bearings of the different paths are given in Appendix A. The data are summarized on a path-by-path basis in Appendix B.

2. RESULTS

The copy factors for each path with multiple reports (minimum 5) are shown in Figure 2. The copy factors are shown in Figure 3 as functions of distance. In Figure 2, the number on the horizontal axis indicates the cluster. Letters below the cluster number identify the receiver (e.g., "AZN" = "KN8AZN") or the months (e.g., "68" = "June, August") included in the averages.

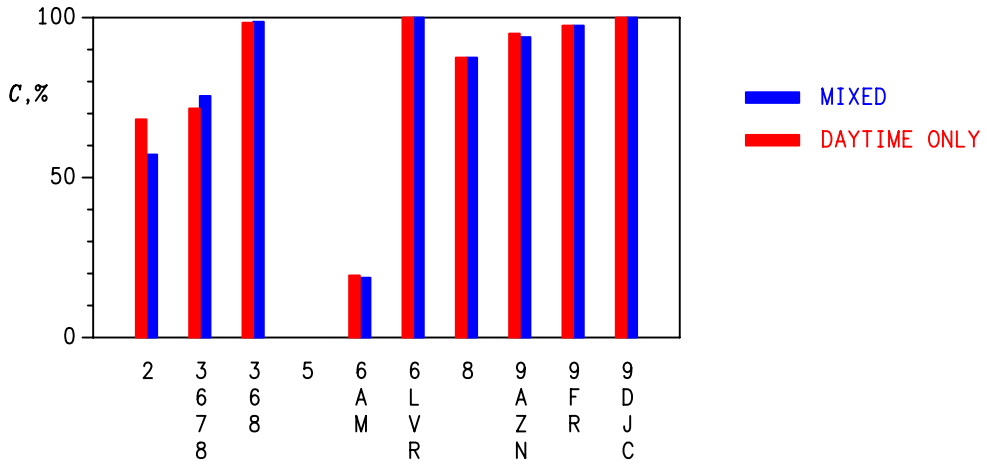

Figure 2. Copy factors by cluster.

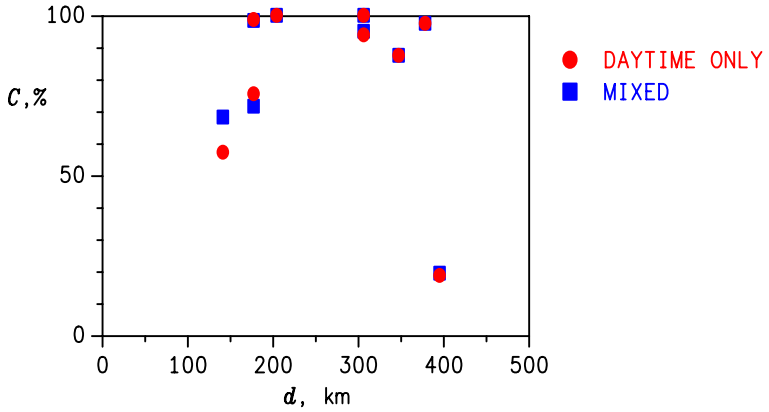

Figure 3. Copy factors as functions of distance.

Cluster 1

The transmitting station, WD2XSH/20, was off the air for antenna work.

Cluster 2

Cluster 2 had a single 141-km path from WD2XSH/12 to W0RW. This path is entirely over mountainous, irregular terrain. For the 17 daytime reports, the copy factor was 68 percent. For all 29 reports (day, night, and transistion), the copy percentage drops to 57 percent. The variance is high. When no signal was detected, the problem was usually a high noise level.

Cluster 3

Cluster 3 had a single path from WD2XSH/13 to WD2XSH/16. During the months of June and August the percent copy for 32 - 39 reports is nearly 100 percent. However, during July it is close to zero. The cause of this discrepancy is not known.

Cluster 4

Cluster 4 involved WD2XSH/6 transmitting to assorted receiving stations at distances of 50 to 223 mi. With one exception (two reports), there was only one report per path. Consequently the reliability of these links was not determined.

Cluster 5

Cluster 5 used WD2XSH/19 as the transmitter and W0RPK as the receiver. The path runs for 440 km over relatively flat land with good conductivity. While ground-wave communication has been demonstrated on this path, the four attempts did not produce any successful copy.

Cluster 6

Cluster 6 involved QRSS3 transmissions from WD2XSH/15 and receptions by four different stations at distances from 75 to 395 km. Only two paths had multiple reports. For the 204-km path, the communication reliablity was 100 percent. However, for the 395-km path the copy percent was only 19.

Cluster 8

In Cluster 8, WD2XSH/10 transmitted to several stations. Only WD4NGG filed multiple reports. The reliability was 87.5 percent for that 347-km path.

Cluster 9

Cluster 9 used WE2XGR/2 as the transmitter. Multiple reception reports were filed by KN8AZN (306 km), WD2XSH/14 (378 km), and K3DJC (306 km). The percent copy was between 94 and 100 percent.

Cluster 10

Transmissions were made from WD2XSH/17, WE2XGR/1, and WE2XGR/2 to W1HK, W1XP, and WE2XGR/2. Unfortunately, only one or two reports were submitted for each path.

3. CONCLUSIONS

In most cases, ground-wave communication was reliable at distances up to 300 km. One exception was the mountainous terrain in the path of cluster 2. The other is the unknown problem in cluster 3 during July. At distances much over 300 km, ground-wave communication does not appear to be reliable.

Paths involving night-time or transitional conditions were slightly less reliable than those involving only daytime ground wave.

These results suggest that amateurs could use 500 kHz for reliable regional emergency communication at distances up to 300 km.

Unfortunately, the number of paths with a sufficient number of reports was small. It is therefore desireable to conduct more tests with the goal of obtaining at least ten reports per path. To simplify data reduction, these tests should not include any paths shorter than 30 km or longer than 400 km.

APPENDIX A. COORDINATES, DISTANCES, AND BEARINGS

Station		Lat, °	Long, °	*d*, km	β, °	COMMENT
Cluster 2, Captain AI8Z - WD2XSH/12						
WD2XSH/12	AI8Z	39.97413	-105.486			
WD2XSH/21	W0RW	38.8122	-104.851	140.888	-0.25	
Cluster 3, Captain K0JO - WD2XSH/13 (SK)						
WD2XSH/13	K0JO	46.61177	-94.8009			
WD2XSH/12	AI8Z	39.97413	-105.486	1140.299	-69.272	not GW
WD2XSH/16	WE0H	45.38154	-93.3615	177.086	33.872	
Cluster 4, Captain W5THT - WD2XSH/6						
WD2XSH/6	W5THT	30.36168	-89.1361			
WD2XSH/2	W5TVW	30.44969	-90.5329	134.921	-94.876	
K4FF		27.99532	-82.3875	709.094	82.39	? GW
K5GY		30.50474	-89.1278	15.934	178.834	too close
K5OAZ		31.16493	-89.6338	101.648	-151.132	
N5FG		30.85836	-89.1364	55.419	-178.291	
W4WLF		30.36004	-89.12	0	0	close
Dumas				48	90	30 mi east along coast
N5GH		32.17901	-90.118	223.596	-155.177	
W5FKX		29.96891	-90.2094	112.545	-67.21	

Cluster 5, Captain K9EUI - WD2XSH/19

WD2XSH/19	K9EUI	41.84672	-88.319			
W0RPK		41.4379	-93.5682	440.485	-87.692	

Cluster 6, Captain W5OR - WD2XSH/15

WD2XSH/15	W5OR	34.83097	-92.5287			
WB5FDP		34.77189	-92.3784	15.309	60.2	
AA5AM		33.30634	-96.3858	395.416	-74.939	
WA5KQU		34.79588	-92.3956	13.073	67.964	
W5FRG		35.46509	-93.4716	111.499	-135.134	
WA5BDU		35.28116	-93.1389	75.131	-137.274	
K0LVR		36.11339	-94.1304	204.32	-141.03	
W9ECH		35.82678	-92.575	111.323	177.795	

Cluster 8, Captain W4DEX - WD2XSH/10

WD2XSH/10	W4DEX	35.25594	-80.3833			
WD4NGG		32.16477	-80.7544	347.002	11.402	
W4VHH		35.50774	-80.3177	28.726	-175.645	
W4SC		33.90585	-81.2547	170.797	-12.324	
K4LY		35.06747	-82.106	158.734	-68.314	
W4NUS		35.16527	-80.7889	38.401	-58.855	
WK4R		35.88352	-81.5809	129.435	-108.271	
WA1ZMS		37.3942	-79.2377	260.145	173.691	
WD2XSH/11	WS4S	36.22791	-85.5502	480.795	-94.029	GW?

Cluster 9, Captain KN8AZN

WE2XGR/6		42.6681	-77.0744			
KN8AZN		41.8458	-80.6114	306.471	-57.45	8
WD2XSH/14		44.50831	-73.1469	378.38	144.9	3
K3DJC		39.94538	-76.7168	305.609	25.7	5
WE2XGR/2		41.7581	-73.0011	351.943	96.51	0
WE2XGR/3		42.32	-71.8286	433.732	109.07	9
WD2XSH/17		42.07938	-70.7058	529.509	108.3	9 GW?
WD2XSH/5		43.12524	-71.5164	457.577	120.56	7
WA1ZMS		37.3942	-79.2377	617.413	0.63	2 not GW

Cluster 10, Captain W1HK

W1HK		42.4066	-71.4973		
W1XP		42.604	-71.542	22.317	-144.261
WD2XSH/17	AA1A	42.07938	-70.7058	74.968	88.135
WE2XGR/1	K2ORS	42.3653	-71.3356	14.149	97.495
WE2XGR/2	W1VD	41.7581	-73.0011	144.177	-34.682

APPENDIX B. COMMUNICATION RELIABILITY

Cluster 2

Sunrise to Sunset = 12:00 - 02:00
Daytime only = 13:00 - 01:00, exclusive filtering

XMTR	RCVR	*d*, km	ALL REPORTS			DAYTIME ONLY		
			N	AVG	SD	*N*	AVG	SD
WD2XSH/12	W0RW	141	29	57.2	41.9	17	68.2	36.3

Cluster 3

Sunrise to Sunset = 11:00 - 01:00
Daytime only = 12:00 - 00:00, exclusive filtering

XMTR	RCVR	*d*, km	ALL REPORTS			DAYTIME ONLY		
			N	AVG	SD	*N*	AVG	SD
WD2XSH/13	WD2XSH/16	177	51	75.5	42.4	44	71.6	44.4
exclude July		177	39	98.7	7.9	32	98.4	8.7

Cluster 4

XMTR	RCVR	*d*, km	ALL REPORTS			DAYTIME ONLY		
			N	AVG	SD	*N*	AVG	SD
WD2XSH/6	Multiple	50-223	8	82.5	17.8	6	81.7	20.0

Cluster 5

XMTR	RCVR	*d*, km	ALL REPORTS			DAYTIME ONLY		
			N	AVG	SD	*N*	AVG	SD
WD2XSH/19	W0RPK	440	4	0	0	4	0	0

Cluster 6

XMTR	RCVR	*d*, km	ALL REPORTS			DAYTIME ONLY		
			N	AVG	SD	*N*	AVG	SD
WD2XSH/15	AA5AM	395	72	18.7	27.5	69	19.4	27.9
WD2XSH/15	WA5BDU	75	2	100.0	0	1	100.0	-
WD2XSH/15	K0LVR	204	12	100.0	0	8	100.0	0
WD2XSH/15	W9ECH	111	2	62.5	12.5	1	75.0	0
WD2XSH/15	All	75-395	88	32.4	38.7	78	28.4	36.0

All QRSS3 except AA5AM which is a mix of QRSS3 and 10.

Cluster 8

XMTR	RCVR	*d*, km	ALL REPORTS			DAYTIME ONLY		
			N	AVG	SD	*N*	AVG	SD
WD2XSH/10	WD4NGG	347	6	87.5	27.9	6	87.5	27.9
WD2XSH/10	W4VHH	29	1	100.0	-	1	100.0	-
WD2XSH/10	W4SC	171	1	100.0	-	1	100.0	-
WD2XSH/10	K4LY	159	1	100.0	-	1	100.0	-
WD2XSH/10	W4NUS	38	1	100.0	-	1	100.0	-
WD2XSH/10	WK4R	129	1	100.0	-	1	100.0	-
WD2XSH/10	WA1ZMS	260	1	100.0	-	1	100.0	-
WD2XSH/10	WD2XSH/11	481	1	0.0	-	1	0.0	-

All but one are one-shot reports

Cluster 9

Sunrise to Sunset = 10:00 - 23:59
Daytime only = 11:00 - 23:00, exclusive filtering

XMTR	RCVR	*d*, km	ALL REPORTS			DAYTIME ONLY		
			N	AVG	SD	*N*	AVG	SD
Ground Wave								
WE2XGR/6	KN8AZN	306	32	93.9	16.6	20	95.0	17.7
WE2XGR/6	WD2XSH/14	378	6	97.5	5.5	6	97.5	5.5
WE2XGR/6	K3DJC	306	5	100.0	0.0	1	100.0	-
WE2XGR/6	WE2XGR/2	352	1	100.0	-	0	-	-
WE2XGR/6	All GW		44	95.2	14.5	26	95.6	15.8
Too far to be sure								
WE2XGR/6	WE2XGR/3	434	1	100.0	0.0	1	100.0	0.0
WE2XGR/6	WD2XSH/17	530	5	90.0	20.0	2	100.0	0.0
WE2XGR/6	WD2XSH/5	458	1	60.0	-	1	60.0	-
WE2XGR/6	WA1ZMS/4	617	1	100.0	-	0	-	-
WE2XGR/6	All		52	94.2	15,6			

Cluster 10

XMTR	RCVR	*d*, km	ALL REPORTS			DAYTIME ONLY		
			N	AVG	SD	*N*	AVG	SD
WD2XSH/17	W1HK	75	1	100.0	-	1	100.0	-
WE2XGR/1	W1HK	14	2	100.0	-	2	100.0	-
WE2XGR/1	W1XP	32	1	100.0	-	1	100.0	-
WE2XGR/1	WE2XGR/2	154	1	100.0	-	1	100.0	-
WE2XGR/2	W1HK	144	1	100.0	-	1	100.0	-

All 100% but not many data, only one has more than one report.