

**Radio Technology & Compatibility
Group**

Radio effects of the
1999 Total Solar Eclipse
for
Dave Eden

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Project 522

Version 2.1

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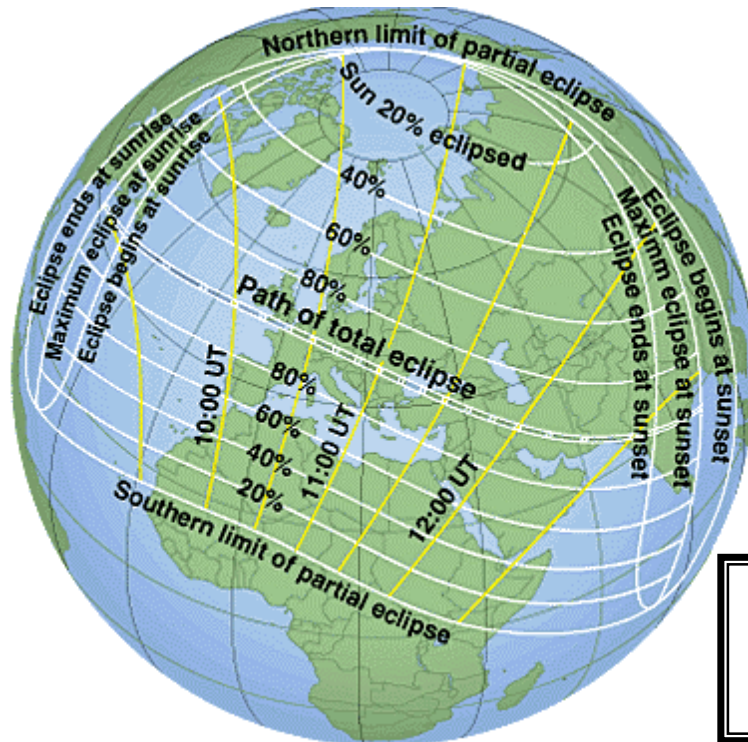
Abstract: *A rare opportunity to indirectly measure the effect of solar radiation on the ionisation of the ionised layers occurred on August 11th, 1999, when the umbra of a total solar eclipse passed over southern England. Across Europe the umbra crossed some of the most highly instrumented areas in the world, and the RA, in conjunction with Rutherford Appleton Laboratory, was tasked with measuring the received signal strength of a selection of medium and high frequency (MF, HF) stations from before, during and well after the passage of the umbra across southern England.*

Keywords: *Solar eclipse, field strength, ionisation, ionised layer.*

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1.0 Introduction

A rare opportunity to indirectly measure the effect of solar radiation on the ionisation level of the ionised layers occurred on August 11th, 1999, when the umbra¹ of a total solar eclipse passed over southern England. It started at local sunrise near eastern Canada, traversed the tip of SW England, then across central Europe, ending at sunset in the Bay of Bengal. Whilst crossing Europe, the umbra passed over one of the most highly instrumented areas in the world, and the RA, in conjunction with Rutherford Appleton Laboratory, was tasked with measuring the received signal strength of a selection of medium and high frequency (MF, HF) stations from before, during and well after the passage of the penumbra across southern England.



BOTH MAPS COURTESY OF THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)



Maps 1 & 2: Path of umbra across the earth's surface

¹ The darkest part of the shadow cast by the Moon on the earth's surface.

2.0 Method

A receiver was set up to measure the received field strengths of a selection of MF and HF stations from transmitters located in Europe. Many of the selected transmitter sites are located under the path the shadow traversed; some directly under the umbra. Maps 1 and 2 show the path of the umbra across the face of the earth.

A computer controlled the receiver and associated antenna switching equipment, and recorded the signal level from the receiver. Fig. 1 shows the equipment arrangement.

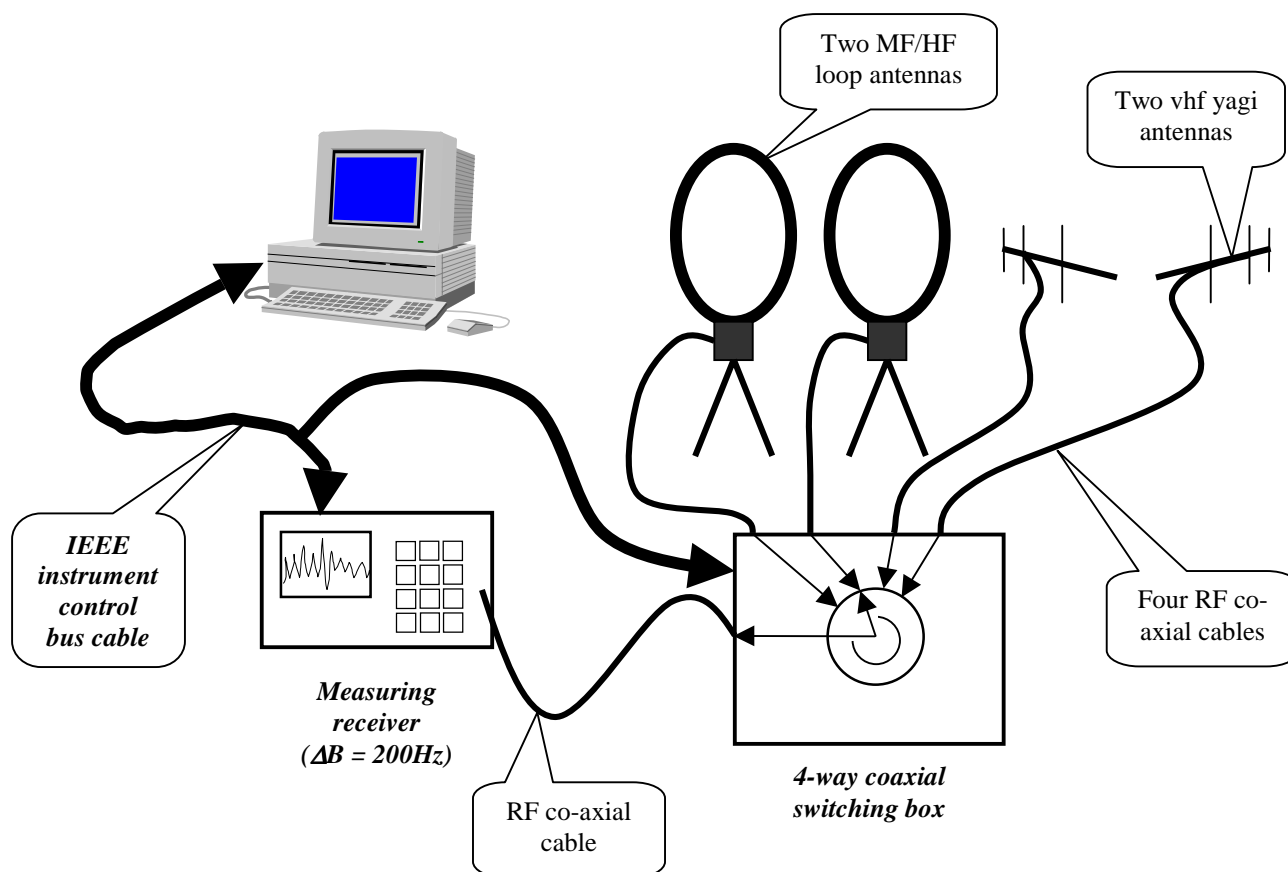


Fig. 1: Test equipment arrangement

3.0 Results

Figures 2 and 3 show how the atmosphere², sun spot number and signal strength of a selection of stations varied during the period of the eclipse. The most noticeable effects occurred on signals received from MF transmitters located close to the umbra, such as Marnach in Luxembourg, (1440 kHz) and Heussweiler in Germany (1422 kHz). The co-channel Spanish stations, La Coruna and others, on 639 kHz, were not audible at Whyteleafe (see graph). (This frequency was suggested by the Rutherford Appleton Laboratory for the general public to report on.) A selection of VHF stations was also measured, but no discernible effect was noted, and no results are presented in this report. (All the raw data is available on electronic media.) The predicted Co-ordinated Universal Time (UTC) timings of the event at 51.5°N / 0.167°W, (21.9 km north of Whyteleafe), were, according to NASA: First contact: 09:03:33
 Maximum eclipse: .. 10:19:51, 96.8% of Sun’s disk obscured
 Last contact: 11:39:57.

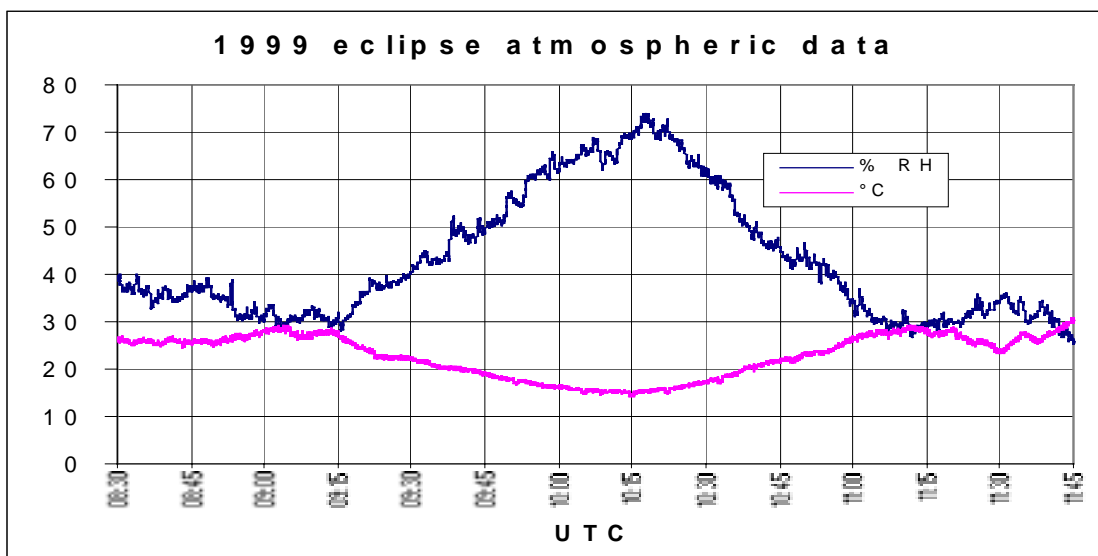


Fig. 2: Atmospheric data at Whyteleafe during eclipse

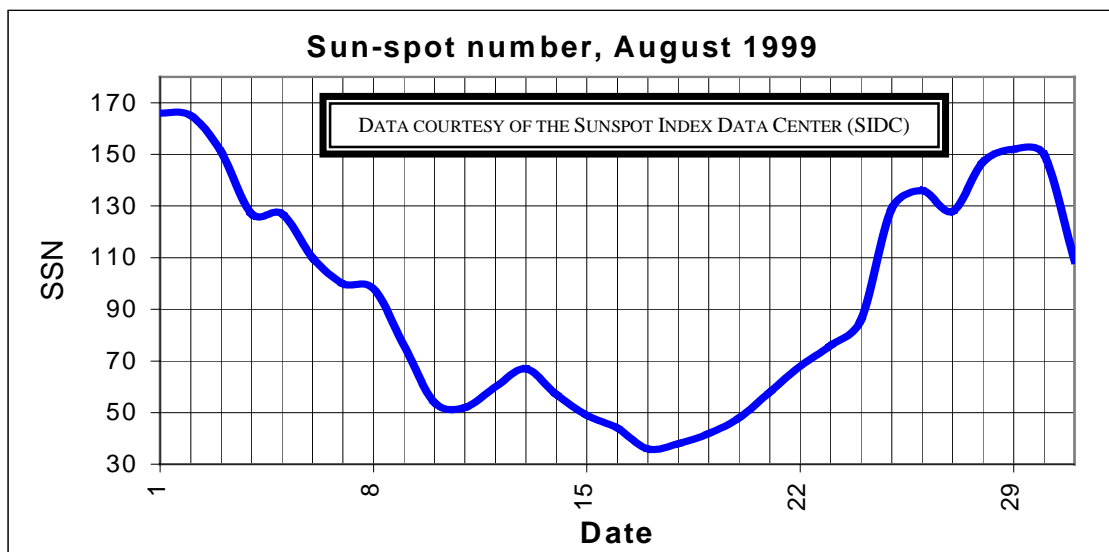


Fig. 3: Sun spot number (SIDC)

² These data were collected in the open air, and the temperature sensor was not especially protected from direct solar radiation.

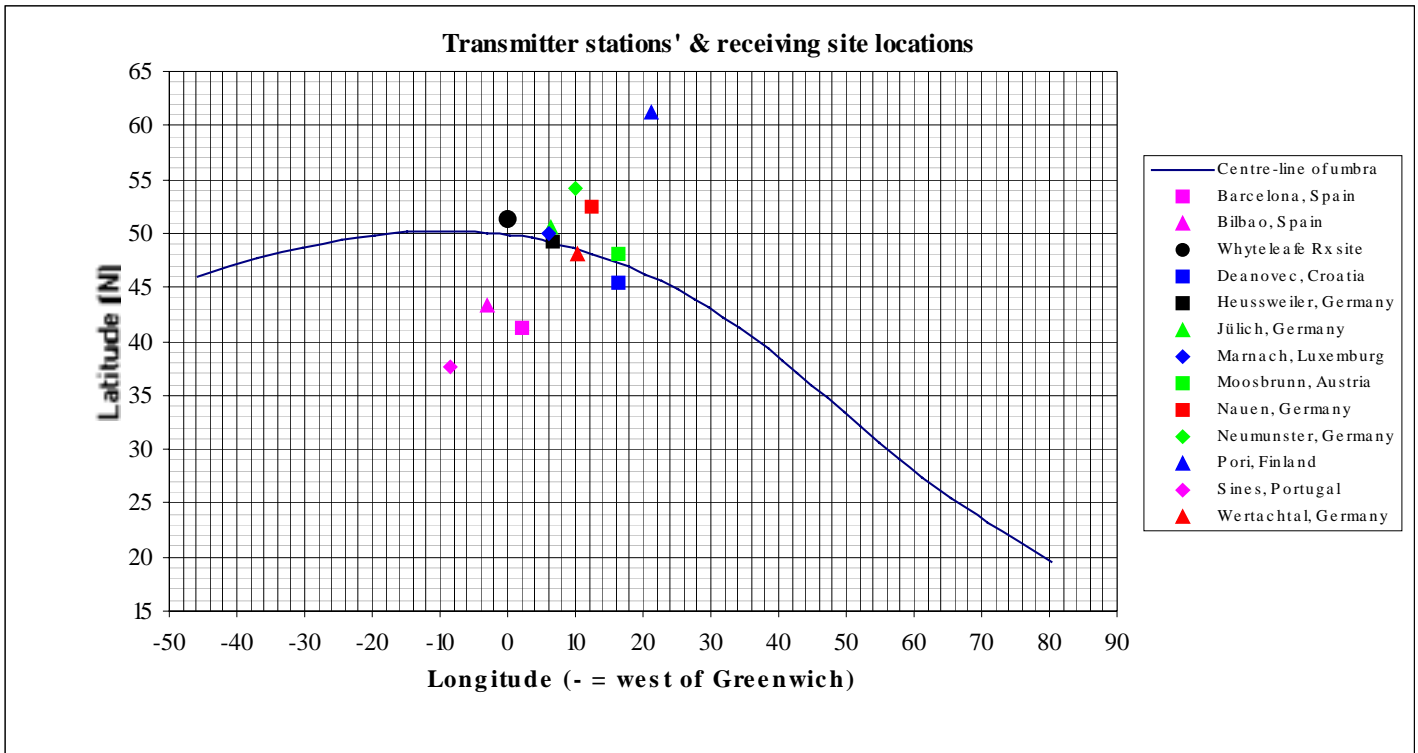


Fig. 4: Locations of receiving and transmitter sites

UTC	Longitude of centreline of umbra on 11 th Aug, 1999		
09:35	045.69°W		
09:40	037.005°W	11:10	027.493°E
09:45	030.312°W	11:15	029.733°E
09:50	024.622°W	11:20	031.932°E
09:55	019.573°W	11:25	034.1°E
10:00	014.988°W	11:30	036.252°E
10:05	010.76°W	11:35	038.397°E
10:10	006.823°W	11:40	040.553°E
10:15	003.133°W	11:45	042.735°E
10:20	000.343°E	11:50	044.963°E
10:25	003.632°E	11:55	047.262°E
10:30	006.755°E	12:00	049.66°E
10:35	009.728°E	12:05	052.198°E
10:40	012.568°E	12:10	054.932°E
10:45	015.287°E	12:15	057.942°E
10:50	017.989°E	12:20	061.363°E
10:55	020.413°E	12:25	065.45°E
11:00	022.843°E	12:30	070.805°E
11:05	025.2°E	12:35	080.4°E

Table 1: Locations of umbra during eclipse event

Whyteleafe receiver site	51.303°N	00.09°W
Barcelona, Spain	41.3°N	02.08°E
Bilbao, Spain	43.33°N	03.03°W
Deanovec, Croatia	45.42°N	16.29°E
Heussweiler, Germany	49.21°N	06.55°E
Jülich, Germany	50.57°N	06.22°E
Marnach, Luxembourg	50.02°N	06.04°E
Moosbrunn, Austria	48.0°N	16.28°E
Neumunster, Germany	54.08°N	09.93°E
Wertachtal, Germany	48.05°N	10.41°E

Table 2: Locations of featured receiving and transmitter sites

Station name or location	Transmitter located in	Frequency	Latitude	Longitude
Allouis	F	0.162MHz		
Nador	MRC	0.171MHz		
Zelendorf	D	0.177MHz		
Solec Kujawski	POL	0.225MHz		
Junglinster	LUX	0.234MHz		
Les Trembles	ALG	0.549MHz		
Bilbao & others	E	0.639MHz		
Seville	E	0.684MHz		
Flensburg	D	0.702MHz		
Barcelona	E	0.738MHz		
Rome	I	0.846MHz		
Alger	ALG	0.891MHz		
Neumunster	D	1.269MHz		
Heussweiler	D	1.422MHz		
Marnach	LUX	1.44MHz		
Holzkirchen	D	1.593MHz		
Santa Maria di Galeria	CVA	1.611MHz	42.03N	12.19E
Unknown	G	5.875MHz		
Deanovec	HRV	5.92MHz	45.42N	16.29E
Flevo-Zeewolde	HOL	5.955MHz	52.21N	5.27E
Unknown	D	5.965MHz		
Wavre	BEL	5.985MHz	50.45N	4.35E
Unknown	D	6.015MHz		
Flevo-Zeewolde	HOL	6.045MHz	52.21N	5.27E
Litomysl	CZE	6.055MHz	49.48N	16.1E
San Gabriel	POR	6.075MHz	38.45N	8.4W
Pori	FIN	6.12MHz	61.28N	21.35E
Unknown	D	6.14MHz		
Moosbrunn	AUT	6.155MHz	48.00N	16.28E
Unknown	F	6.175MHz		
Unknown	D	7.13MHz		
Unknown	HNG	7.135MHz		
Unknown	ALB	7.1482MHz		
Unknown	G	7.155MHz		
Deanovec	HRV	7.165MHz	45.42N	16.29E
Unknown	D	7.175MHz		
Unknown	D	7.255MHz		
Litomysl	CZE	7.345MHz	49.48N	16.1E
Unknown	ALB	7.385MHz		
Galbeni	ROU	9.4MHz	46.45N	26.52E
Unknown	G	9.41MHz		
Unknown	SVK	9.44MHz		
Unknown	ALB	9.49MHz		
Unknown	D	9.52MHz		
Tiganesti	ROU	9.53MHz	44.45N	26.05E
Unknown	D	9.535MHz		
Tiganesti	ROU	9.57MHz	44.45N	26.05E
Unknown	D	9.62MHz		

Unknown	D	9.625MHz		
Unknown	G	9.635MHz		
Unknown	D	9.64MHz		
Unknown	D	9.65MHz		
Szekesfehervár	HNG	9.655MHz	47.1N	18.24E
Jászberény	HNG	9.66MHz	47.35N	19.52E
Tiganesti	ROU	9.665MHz	44.45N	26.05E
Unknown	D	9.69MHz		
Unknown	D	9.7MHz		
Nador	MRC	9.725MHz	34.58N	2.55W
Unknown	D	9.77MHz		
San Gabriel	POR	9.78MHz	38.45N	8.4W
Unknown	F	9.805MHz		
Unknown	G	9.815MHz		
Deanovec	HRV	9.83MHz	45.42N	16.29E
Unknown	G	9.855MHz		
Wavre	BEL	9.925MHz	50.45N	4.35E
Litomysl	CZE	11.6MHz	49.48N	16.1E
Unknown	D	11.615MHz		
Litomysl	CZE	11.64MHz	49.48N	16.1E
Unknown	F	11.67MHz		
Unknown	G, D	11.68MHz		
Unknown	G	11.71MHz		
Nador	MRC	11.725MHz	34.58N	2.55W
Unknown	ROU	11.735MHz		
Unknown	ROU	11.74MHz		
Unknown	ROU	11.775MHz		
Unknown	G	11.795MHz		
Unknown	ROU	11.81MHz		
Bijeljina	BIH	11.835MHz	44.42N	19.10E
Unknown	D	11.885MHz		
Unknown	D	11.905MHz		
Unknown	MRC, POR	11.915MHz		
Unknown	D	11.97MHz		
Unknown	D, SVK	11.99MHz		
San Gabriel	POR	12.015MHz	38.45N	8.4W
Unknown	D	12.08MHz		
Unknown	F	13.61MHz		
Unknown	G	13.645MHz		
Unknown	G	13.66MHz		
Unknown	G	13.67MHz		
Unknown	G	13.685MHz		
Unknown	D	13.7MHz		
Unknown	SVK	13.715MHz		
Moosbrunn	AUT	13.73MHz	48.00N	16.28E
Unknown	G, BEL	13.745MHz		
Unknown	D	13.79MHz		
Unknown	G	15.105MHz		
Unknown	G	15.115MHz		
Nador	MRC	15.125MHz	34.58N	2.55W
Unknown	F	15.155MHz		

Unknown	F	15.195MHz		
Unknown	D	15.37MHz		
Unknown	G	15.485MHz		
DF0AAB	Amateur radio beacon	28.2112MHz	54.3125N	10.5417E
OK0EGB	Amateur radio beacon	28.22MHz		
OH9TEN	Amateur radio beacon	28.228MHz	66.3542N	27.2083E
LA4TEN	Amateur radio beacon	28.2376MHz	60.2708N	5.04167E
SK5TEN	Amateur radio beacon	28.246MHz	59.4375N	16.875E
F5TMJ	Amateur radio beacon	28.247MHz	43.5208N	1.54167E
9A0TEN	Amateur radio beacon	28.268MHz	45.6042N	17.2083E
5B4CY	Amateur radio beacon	28.2776MHz	34.7292N	33.2917E
DF0THD	Amateur radio beacon	28.2826MHz	49.8542N	8.625E
SK7TEN	Amateur radio beacon	28.2904MHz	57.7708N	14.9583E
SK2TEN	Amateur radio beacon	28.295MHz	65.0625N	18.625E
EA3JA	Amateur radio beacon	28.298MHz	41.3542N	2.125E
LA5TEN	Amateur radio beacon	28.325MHz	59.8958N	10.7917E
ES0SIX	Amateur radio beacon	50.01MHz	58.2708N	23.2917E
SV9SIX	Amateur radio beacon	50.011MHz	35.3125N	25.125E
OK0EKX	Amateur radio beacon	50.014MHz		
S55ZRS	Amateur radio beacon	50.021MHz	46.1042N	15.0417E
OZ7IGY	Amateur radio beacon	50.023MHz	55.6042N	11.7917E
SR55SIX	Amateur radio beacon	50.028MHz		
SR6SIX	Amateur radio beacon	50.03MHz	51.3125N	16.625E
CT0WW	Amateur radio beacon	50.0376MHz	41.1875N	7.45833W
SV1SIX	Amateur radio beacon	50.04MHz	37.9792N	23.7083E
LA7SIX	Amateur radio beacon	50.051MHz	69.6042N	18.9583E
OZ6VHF	Amateur radio beacon	50.054MHz	57.3542N	10.375E
OH9SIX	Amateur radio beacon	50.067MHz	66.3542N	27.2083E
SK3SIX	Amateur radio beacon	50.07MHz	61.2292N	15.9583N
YO3KWJ	Amateur radio beacon	50.075MHz	44.3958N	26.125E
YU1SIX	Amateur radio beacon	50.087MHz	43.5625N	20.875E
5B4CY	Amateur radio beacon	50.499MHz	34.8125N	33.2917E

Table 3: Locations of all measured HF transmitter sites

Where the location is shown as “Unknown” this is because either the transmission may have emanated from more than one site, or the location data is not available to the author.

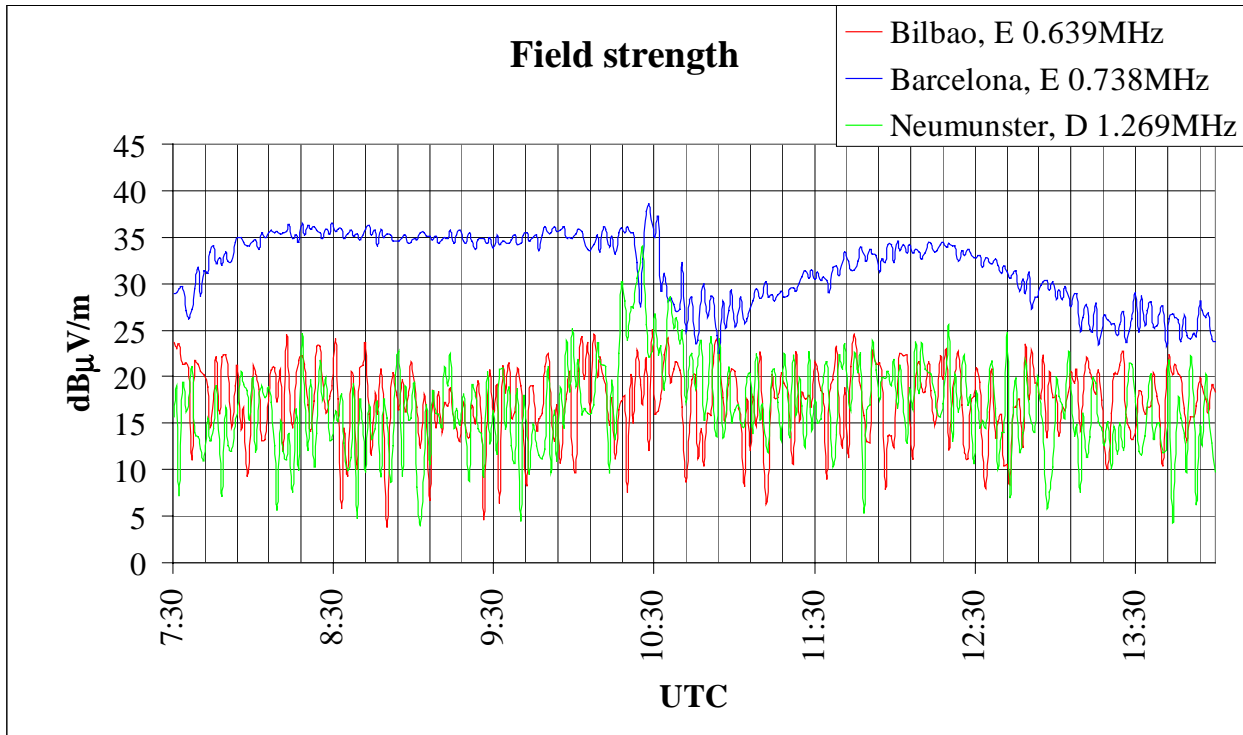


Fig. 5: Received field strengths from named stations

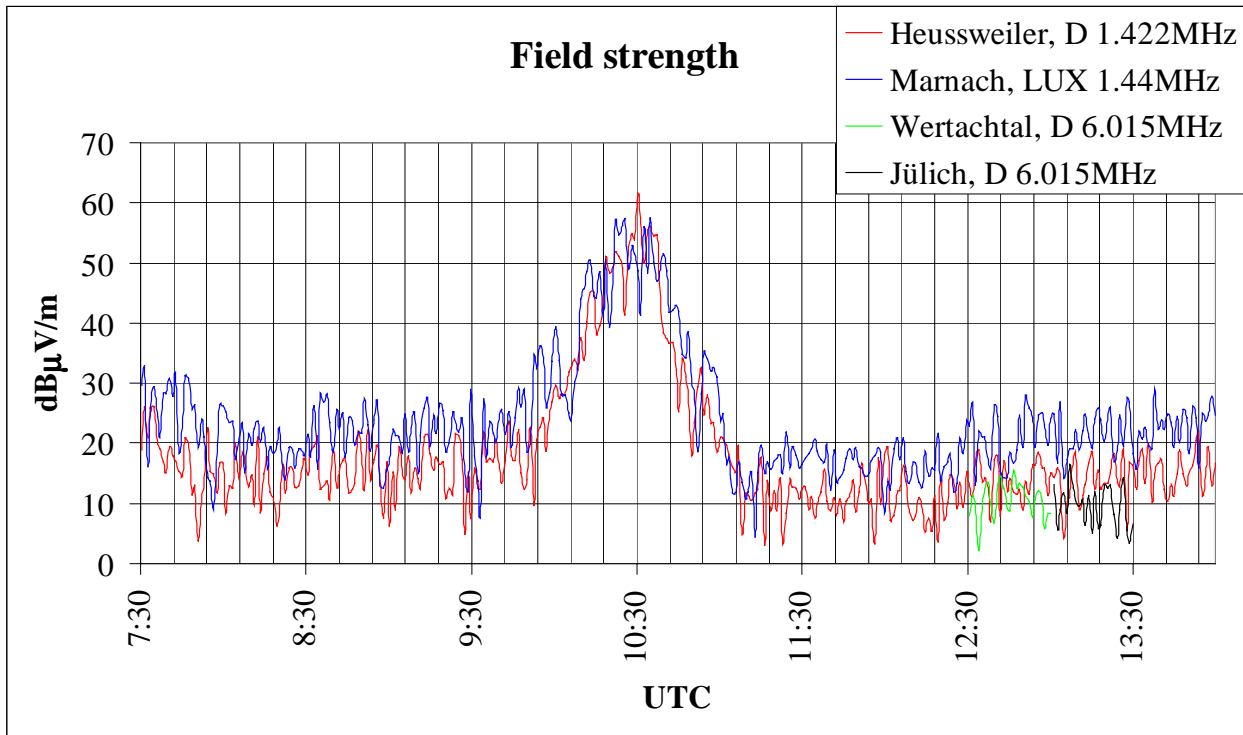


Fig. 6: Received field strengths from named stations

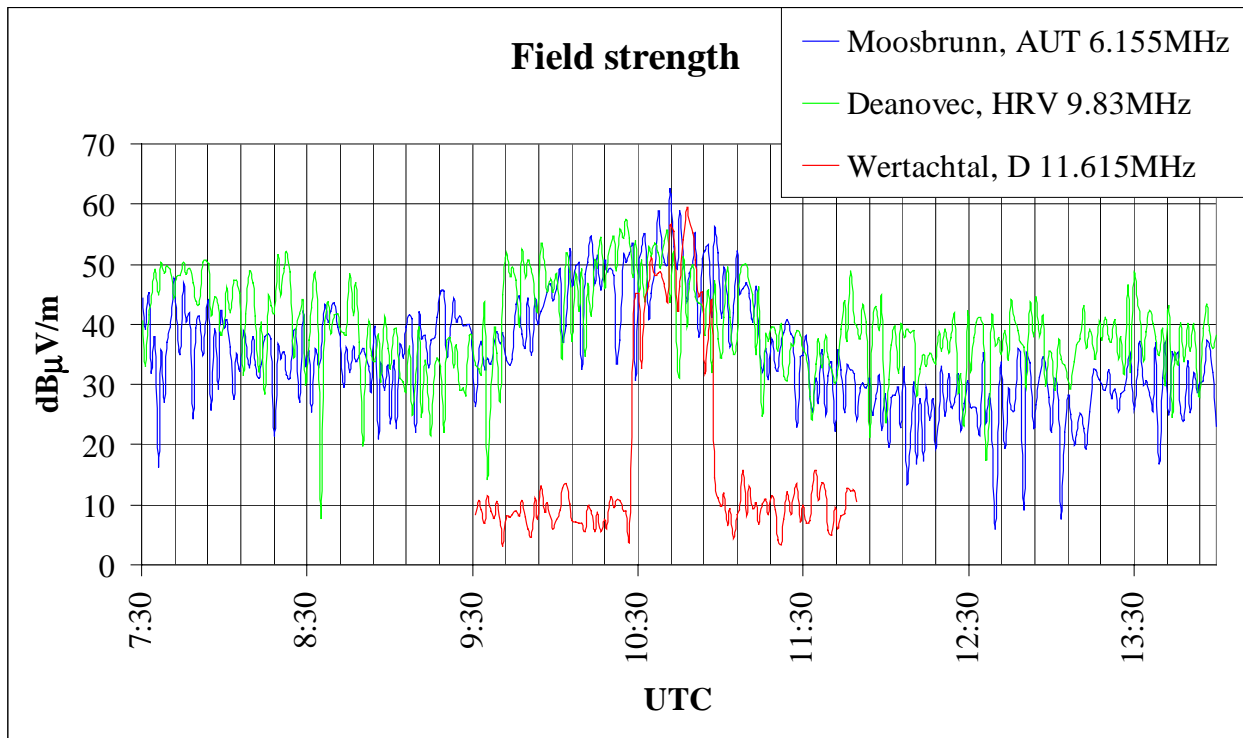


Fig. 7: Received field strengths from named stations

4.0 Equipment List

Plant Number	Manufacturer	Model Number	Equipment Type	Serial Number
133	COUTANT	LQT100	AC-DC Power Supply	6H1273L
878	EPSON	FX-800	Printer	10002838
917	ROHDE & SCHWARZ	HFH2-Z2	Antenna Loop	880936/0015
921	LINHOF	STATIV	Tripod	314 883/004
1110	HUBER+SUHNER AG.	4901.01.A	Coupler/Divider	1110
1360	HEWLETT-PACKARD	461A	Amplifier Preamplifier	0946A06426
2115	ROHDE & SCHWARZ	HFH2-Z2	Antenna Loop	830749/0015
2376	CHASE EMC LTD	CHA9410	Antenna Dipole	NSN
2377	CHASE EMC LTD	CHA9410	Antenna Dipole	NSN
2521	HUBER+SUHNER AG.	4901.01.A	Coupler/Divider	NSN
2584	CASIO ELECTRONICS CO LTD	QV-100C	Camera	4006022 B
2593	AOR LTD JAPAN	AR5000	RECEIVER WIDEBAND VHF/UHF	070488
2594	AOR LTD JAPAN	AR5000	RECEIVER WIDEBAND VHF/UHF	070487
2595	AOR LTD JAPAN	AR5000	RECEIVER WIDEBAND VHF/UHF	070498
2596	AOR LTD JAPAN	AR5000	RECEIVER WIDEBAND VHF/UHF	070499
2732	MINI-CIRCUITS	ZESC-2-11	Coupler/Divider	NSN
2733	MINI-CIRCUITS	ZESC-2-11	Coupler/Divider	NSN
2734	MINI-CIRCUITS	ZESC-2-11	Coupler/Divider	NSN
2821	HUBER+SUHNER AG.	4901.01.A	Coupler/Divider	NSN
2832	ROHDE & SCHWARZ	ESCS30	EMC measuring receiver	828985/0015
2851	HUBER+SUHNER AG.	4901.01A	Coupler/Divider	NSN

END OF REPORT