VLF/LF and the 2017 Total Solar Eclipse

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Outline

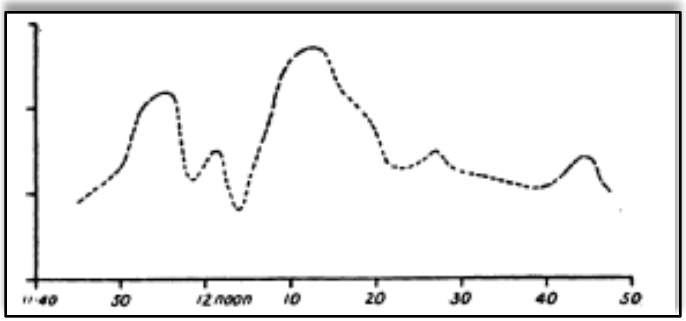
I. Historical Overview

II. Collection Effort

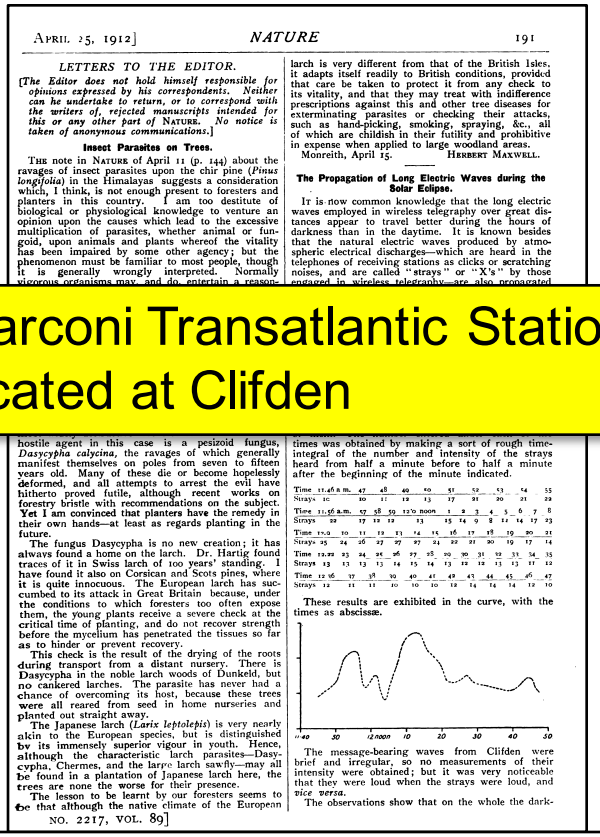
III. Conclusions

Historical Perspective

- Spatial and temporal effects of solar eclipses on radio wave propagation continue to be of interest almost 100 years after the first reported study.
  - During the eclipse on April 17, 1912, William Henry Eccles[1] (1875 – 1968), a prominent British electrical engineer and scientist, recorded discharges – clicks – strays.
  - Wavelength 5,500 meters (frequency approximately 54.545 kHz)
  - Published in Nature[2], 1912



Rough time integral of the intensity and duration of strays



LETTERS TO THE EDITOR.

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Insect Parasites on Trees.

THE note in NATURE of April 11 (p. 144) about the ravages of insect parasites upon the chir pine (*Pinus longifolia*) in the Himalayas suggests a consideration which, I think, is not enough present to foresters and planters in this country. I am too destitute of biological or physiological knowledge to venture an opinion upon the causes which lead to the excessive multiplication of parasites, whether animal or fungoid, upon animals and plants whereof the vitality has been impaired by some other agency; but the phenomenon must be familiar to most people, though it is generally wrongly interpreted. Normally vigorous organisms may and do entertain a reason-

larch is very different from that of the British Isles, it adapts itself readily to British conditions, provided that care be taken to protect it from any check to its vitality, and that they may treat with indifference prescriptions against this and other tree diseases for exterminating parasites or checking their attacks, such as hand-picking, smoking, spraying, &c., all of which are childish in their futility and prohibitive in expense when applied to large woodland areas.

Monreith, April 15. HERBERT MAXWELL.

The Propagation of Long Electric Waves during the Solar Eclipse.

IT is now common knowledge that the long electric waves employed in wireless telegraphy over great distances appear to travel better during the hours of darkness than in the daytime. It is known besides that the natural electric waves produced by atmospheric electrical discharges—which are heard in the telephones of receiving stations as clicks or scratching noises, and are called "strays" or "X's" by those engaged in wireless telegraphy are also pronounced

hostile agent in this case is a pezizoid fungus, *Dasycypha calycina*, the ravages of which generally manifest themselves on poles from seven to fifteen years old. Many of these die or become hopelessly deformed, and all attempts to arrest the evil have hitherto proved futile, although recent works on forestry bristle with recommendations on the subject. Yet I am convinced that planters have the remedy in their own hands—at least as regards planting in the future.

The fungus Dasycypha is no new creation; it has always found a home on the larch. Dr. Hartig found traces of it in Swiss larch of 100 years' standing. I have found it also on Corsican and Scots pines, where it is quite innocuous. The European larch has succumbed to its attack in Great Britain because, under the conditions to which foresters too often expose them, the young plants receive a severe check at the critical time of planting, and do not recover strength before the mycelium has penetrated the tissues so far as to hinder or prevent recovery.

This check is the result of the drying of the roots during transport from a distant nursery. There is Dasycypha in the noble larch woods of Dunkeld, but no cankered larches. The parasite has never had a chance of overcoming its host, because these trees were all reared from seed in home nurseries and planted out straight away.

The Japanese larch (*Larix leptolepis*) is very nearly akin to the European species, but is distinguished by its immensely superior vigour in youth. Hence, although the characteristic larch parasites—Dasycypha, Chermes, and the large larch sawfly—may all be found in a plantation of Japanese larch here, the trees are none the worse for their presence.

The lesson to be learnt by our foresters seems to be that although the native climate of the European

times was obtained by making a sort of rough time-integral of the number and intensity of the strays heard from half a minute before to half a minute after the beginning of the minute indicated.

Time 11.46 a.m.	47	48	49	50	51	52	53	54	55					
Strays 10	10	11	12	13	37	91	20	21	29					
Time 11.56 a.m.	57	58	59	12 o'clock noon	1	2	3	4	5	6	7	8		
Strays 22	17	12	12	13	15	14	9	8	11	14	17	23		
Time 12.0	10	11	12	13	14	15	16	17	18	19	20	21		
Strays 25	24	26	27	27	27	23	22	21	20	19	17	14		
Time 12.22	23	24	25	26	27	28	29	30	31	32	33	34	35	
Strays 13	13	13	13	14	15	14	13	12	12	13	13	11	12	
Time 12.36	37	38	39	40	41	42	43	44	45	46	47			
Strays 12	11	11	10	10	10	12	14	14	14	12	10			

These results are exhibited in the curve, with the times as abscissæ.

The message-bearing waves from Clifden were brief and irregular, so no measurements of their intensity were obtained; but it was very noticeable that they were loud when the strays were loud, and *vice versa*.

The observations show that on the whole the dark-

Marconi Transatlantic Station located at Clifden

"Even the Lord's Justices temporarily adjourned their sittings at the Law Courts in order to witness the unusual event."

Other 1912 Solar Eclipse Studies

- The 1912 solar eclipse was also studied in France and Denmark, using the transmitter at the Eiffel Tower in Paris[3].
  - The transmitter had a frequency of 115 kHz (wavelength approximately 2,608 meters)[4].
  - The UK study was done at 54.545 kHz and the French and Danish studies were done at 115 kHz, difficult for data comparison.

101. *Wireless Telegraphy Measurements at Marburg and Graz during the Recent Eclipse of the Sun.* **E. Take** and **M. Vos.** (Deutsch. Phys. Gesell., Verh. 14. 18. pp. 837–843, Sept. 30, 1912.)—During the recent eclipse of the sun on April 17, the authors independently measured the strength of the received currents at Marburg and at Graz, respectively 530 km. and 1000 km. from Paris. The measurements at Marburg were effected by means of a galena detector and a moving-coil galvanometer having a sensitiveness of $4{\cdot}27 \times 10^{-9}$ amp. and a periodic time of 4 secs. The Eiffel Tower station sent out groups of six dashes lasting 10 secs. and divided by 10-sec. intervals. Between each dash the galvanometer was rapidly brought to rest by a short-circuiting key. The arithmetical mean of the six readings was taken, and the results are embodied in a curve in the original article. The eclipse attained its maximum in Paris at 1.10 p.m., and in Marburg at 1.21 p.m., and at the latter place was nearly total. The max. received current was recorded at the middle point between the times given above. During the eclipse no atmospheric disturbances took place. At Graz an aperiodic moving-coil

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Galena and Galvanometer detector

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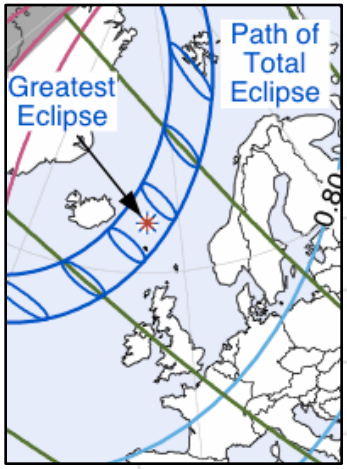
galvanometer with a galena detector was employed, and only the max. ballistic deflection of the galvanometer was read. The galvanometer was not sufficiently sensitive, and, in addition, atmospheric disturbances were in evidence. The observed deflections varied to such an extent that it was not possible to plot a suitable curve. On this account the total time of observation was divided into intervals. For each interval the mean value of the observed deflections was obtained, and in this way irregularities were eliminated. The following table gives the results :—

Time Interval.	Relative Galvanometer Deflection.
11.40 to 12.5	100
12.5 to 12.50	164
12.50 to 1.35	196
1.35 to 2.20	120
2.20 to 3.5	186

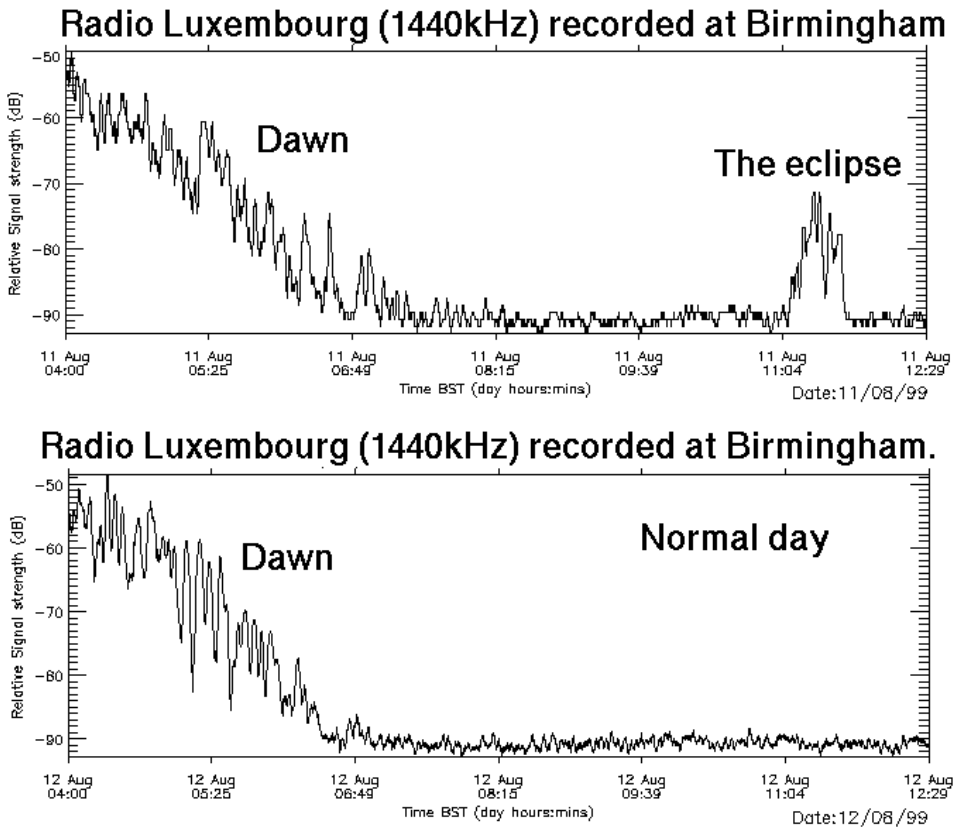
Observations were also made with a telephone, and while it was hardly possible to hear signals either before or after the eclipse, signals were decidedly perceptible during the maximum. H. H. H.

Wolverhampton Grammar School



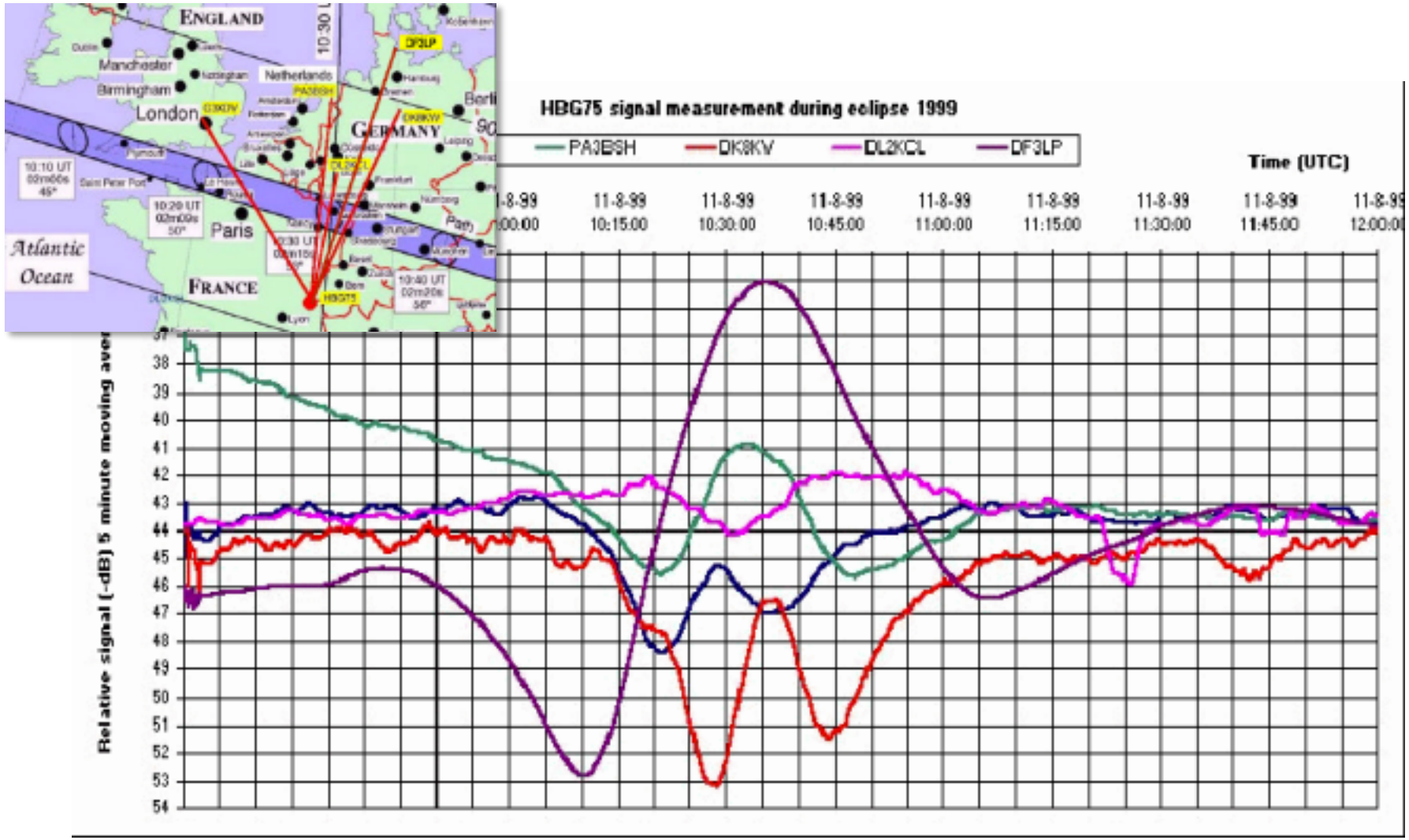
Time is local time and amplitude is in S units[5].

BCB during the 1999 eclipse



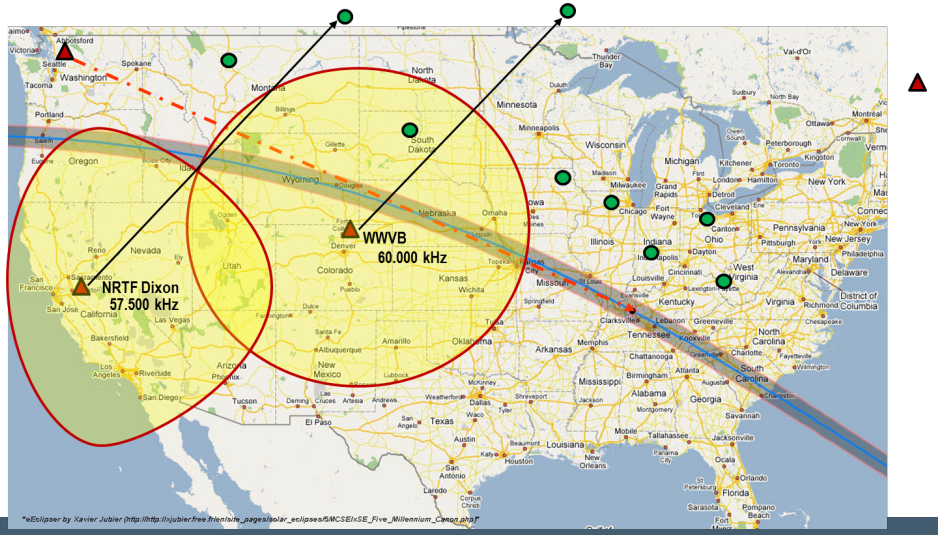
Plot of the variation in the received CW radio signal as recorded in the Birmingham RA Regional Office in the UK of the 1440 kHz (±1.4 kHz) carrier emanating from Radio Luxembourg at Marnach (a) for the morning of the total solar eclipse and (b) the morning after the eclipse[6].

75 kHz reception 1999 solar eclipse[7]



Eclipse Mob Consortium

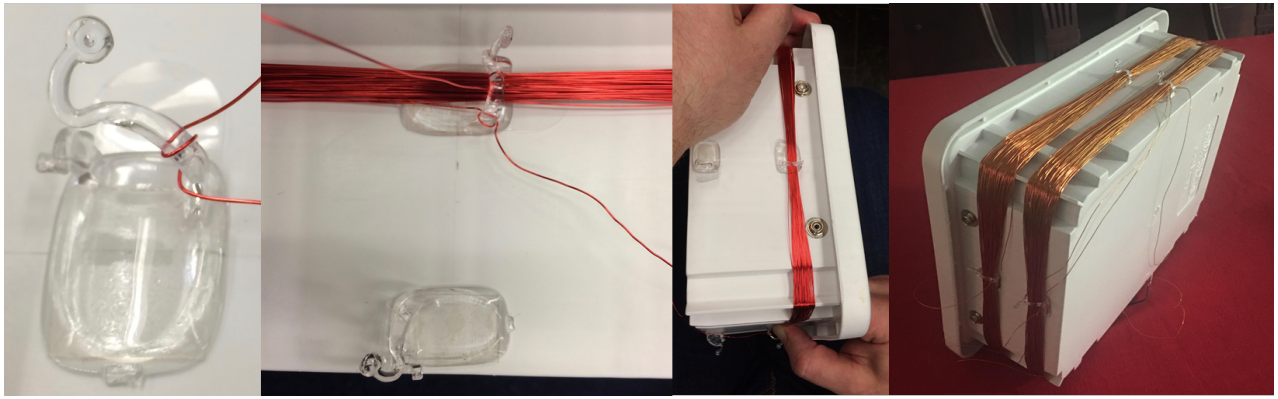
- The 2017 Total Solar Eclipse will provide an excellent opportunity to observe propagation interaction with the ionosphere across the continental U.S.
  - A crowd-source collection of signals across a number of different short, medium and long-paths.
  - Signals will be collected before, during and after the total eclipse.
  - Amplitude changes reported at each location.
  - Goal: Disseminate large data collection across the scientific community.



Tools for collection are available at <http://eclipsemob.org>

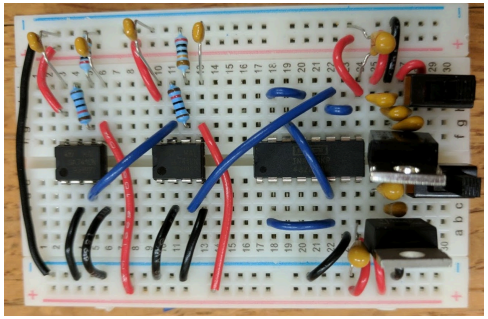
DIY Eclipse Mob Kits and Instructions

Antenna design with step-by-step instructions

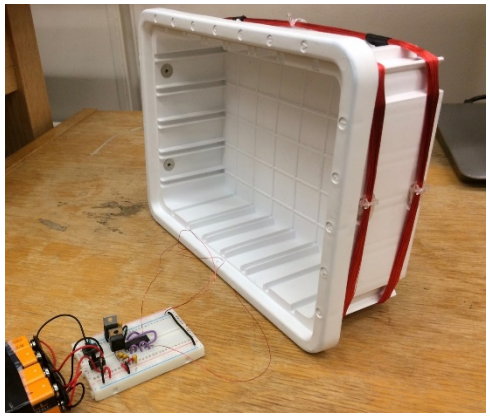


Available receiver kits
100 kits distributed, more ordered

▼ Integration

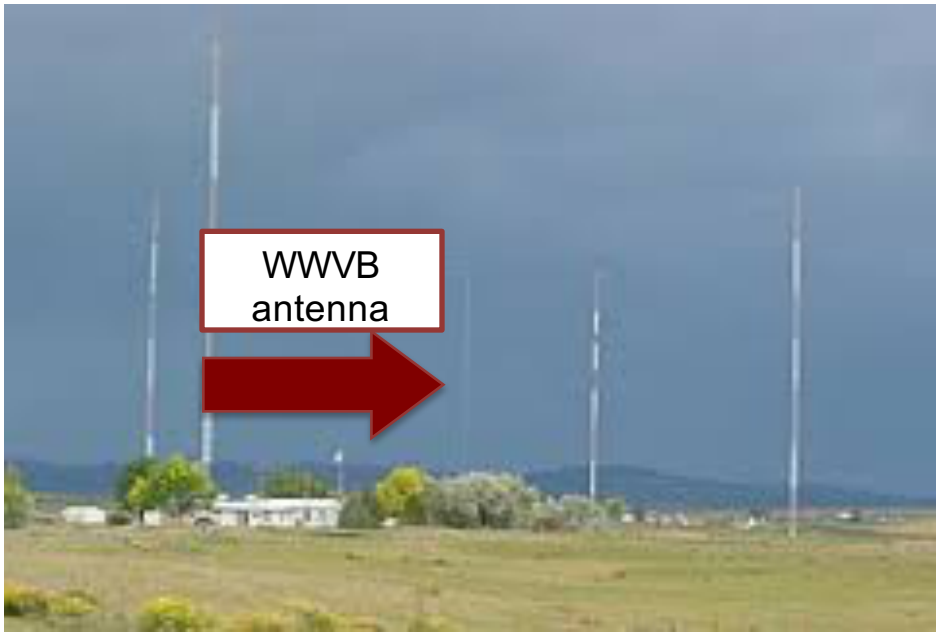


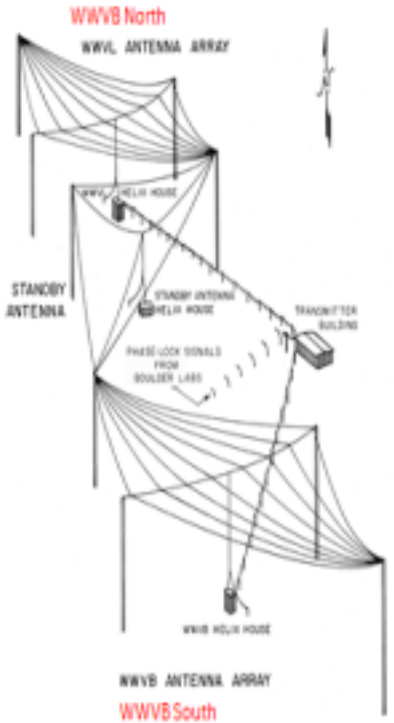
Basic designed based on [8]



Colorado WWVB Transmitter

US Government Time and Frequency Transmitter at 60 kHz

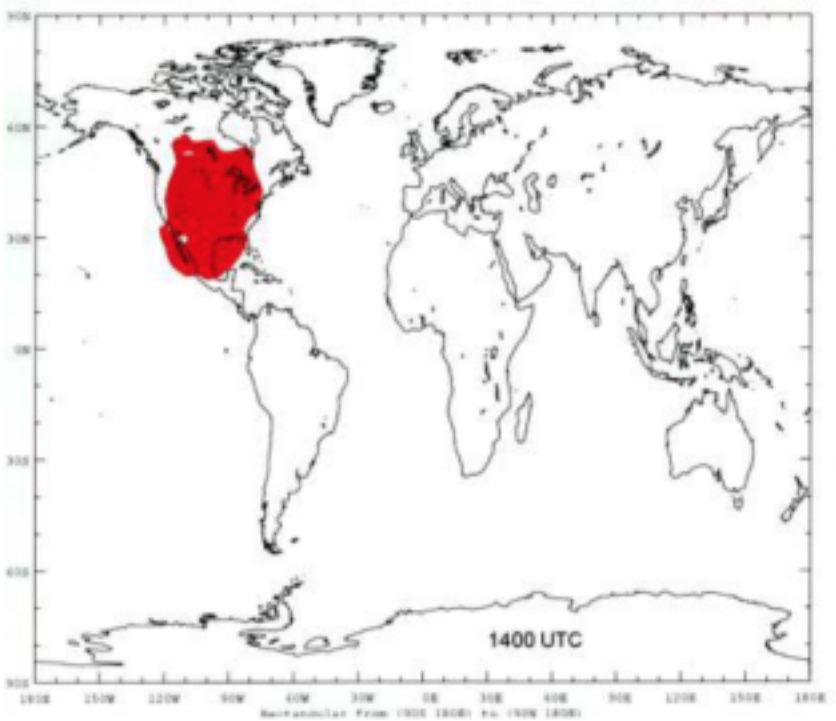




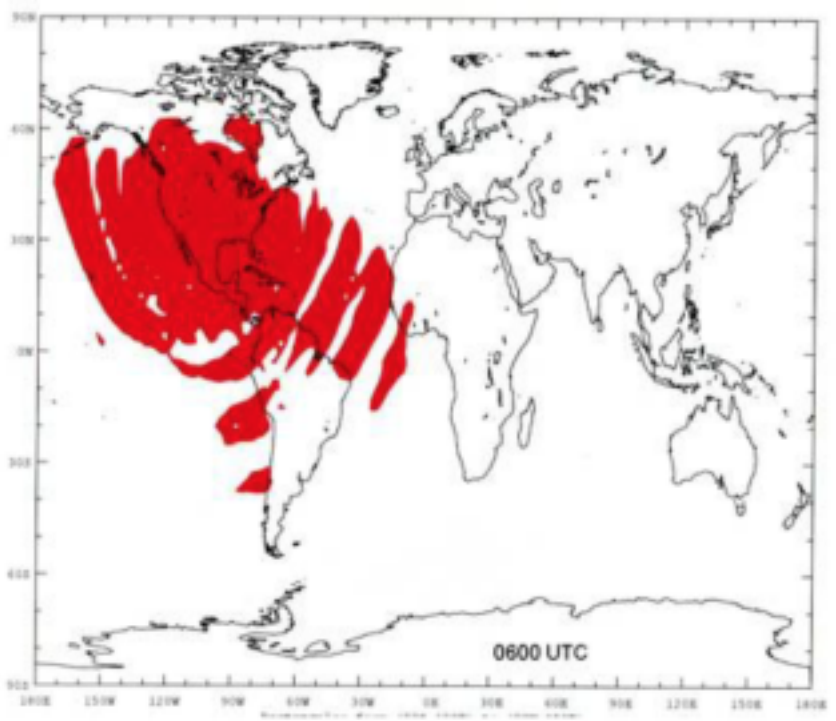
Images from NIST.gov

Coverage Plots

- WWVB Coverage Plots during day and night



Daylight Coverage Area

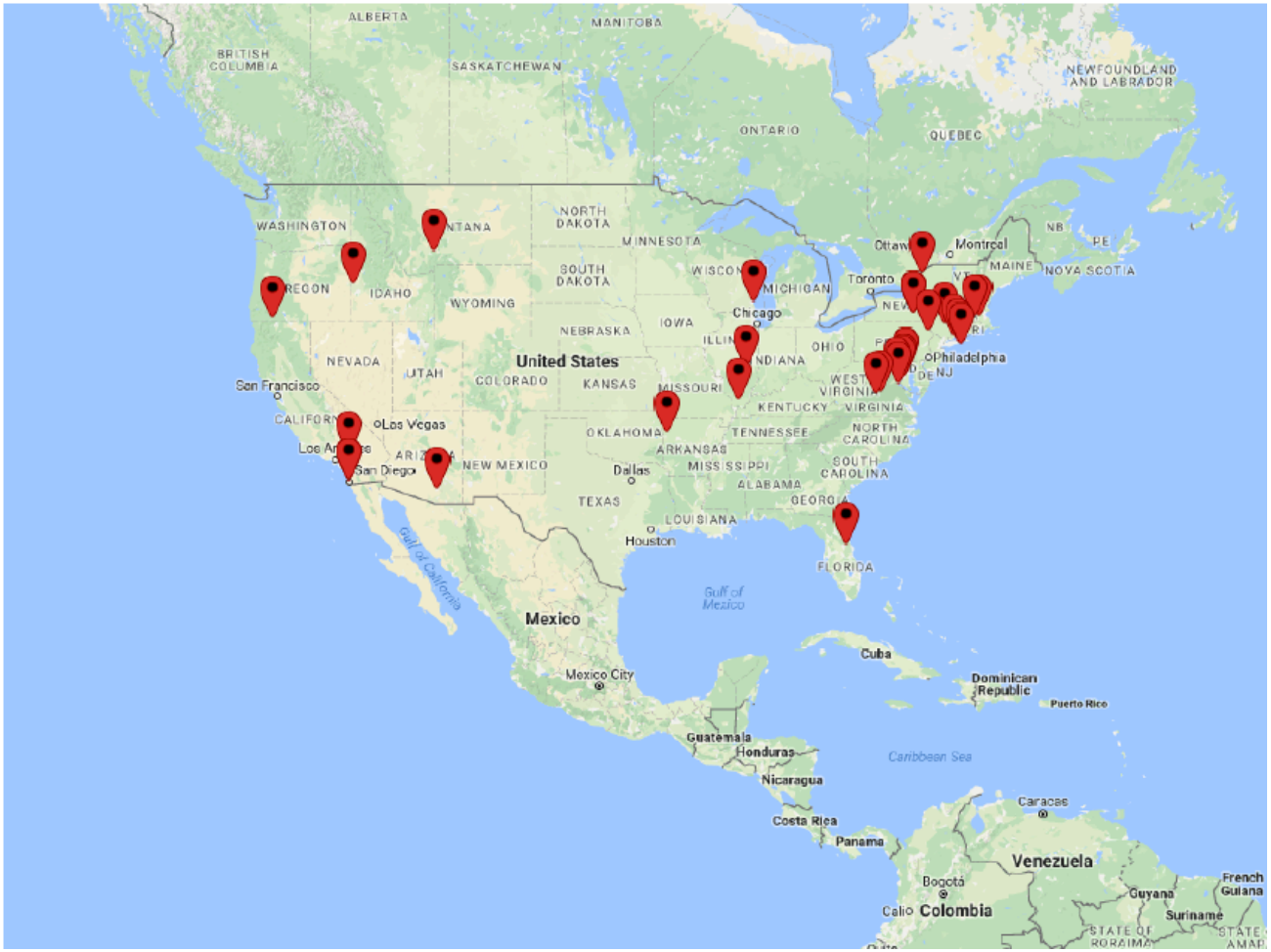


Nighttime Coverage Area

Image Nist.gov

[?] source NIST.gov

Current Coverage



Conclusions

In the past, many studies investigated radio wave and solar eclipse interactions

A number of tools and methodologies exist today to perform improved studies

This presentation outlined the EclipseMob effort to be undertaken during the August 21, 2017 solar eclipse

We welcome participation!

EclipseMob.org

Notes and references

[1] Fellow of the Royal Society, President of the Physics Society, President of the Institute of Electrical Engineers and President of the Radio Society of Great Britain

[2] W. H. Eccles, “Propagation of Long Electric Waves during the Solar Eclipse” Nature, April 25, 1912

[3] Images from de.wikipedia.org

[4] Telegraphy and Telephony, 1912

[5] Eclipse 2015 – RSGB Experiment downloaded from http://forums.thersgb.org/index.php?threads/early-results-from-eclipse-experiments.128

[6] “Radio and the 1999 UK Total Solar Eclipse”, Dr. Ruth Bamford, May 2000

[7] M. Sanders, 1999. "Solar eclipse effect on the propagation of LF radio signals" from December 3, 1999, available at URL: http://www.xs4all.nl/~misan/eclipse.htm

[8] Hagen, Tom. "A Portable, Calibrated VLF Field Strength Measurement Receiver and Loop Antenna." Society of Amateur Radio Astronomers Association West Conference, 2015