Comparison of an End Fed Half Wave aerial and Linked Dipole using WSPR reception reports

Introduction

This experiment attempts to compare the performance of two aerials using a single WSPRlite transmitter by measuring the SNR at common receiving sites and using a 3rd WSPR transmitter site (unrelated to the author) as a baseline.

Method

Two SOTA aerials were set up in an urban surrounding in IO91ij. The aerials, a 3 band (20/30/40m) linked dipole and a three band (20/30/40m) EFHW using SOTABeams pico-traps were mounted in an inverted V configuration on the same fibreglass telescopic pole with the apex at about 9m above ground level. The aerials were run east to west and the same end guying points used for both aerials. The aerial being tested was guyed out as an inverted V while the aerial not being tested was left unguyed and allowed to hang vertically from the pole to try and reduce interaction with the active aerial.

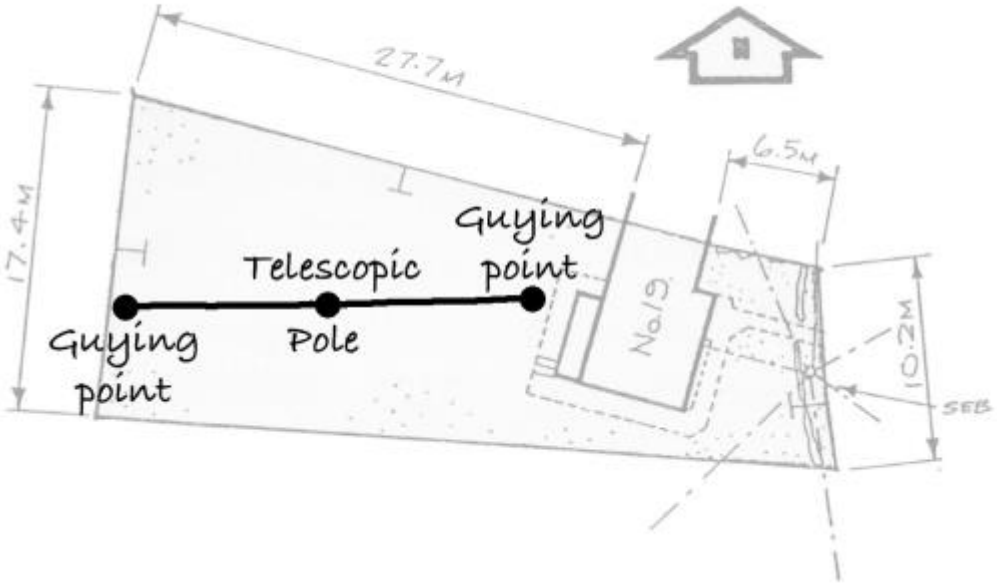

Figure 1, orientation of aerials under test (GoPOT).

The linked dipole had its links shorted to produce a half wave dipole for 40m.

Figure 2, Linked dipole (615g) and 10m telescopic mast (1.3kg).

A WSPRlite was set up to transmit on 40m using 200mW and was connected to each aerial in turn for ~1 hour between 3pm and 8.30pm UTC on 28-May-2017.
Data was gathered from DXplorer.net for the test transmissions (G0POT). The results for another station in IO91 (G3TBL) using 200mW into an indoor dipole were also gathered as a baseline.
At the end of the test period the Spots Tables for G0POT and G3TBL were downloaded from DXplorer.net with other comparative views for analysis. The data for G0POT was then aligned with that of G3TBL to try to match receiving station reports with the same timestamp for both G0POT & G3TBL. As neither station transmitted 100% of the time not all reports for G0POT had an exact match (by timestamp) for G3TBL and so results for the baselining station that were within ~+/-4 minutes were also used to give sufficient comparative data.
From the final table of results the data for any receiving station that had only recorded a signal reception report for one aerial type was deleted.

Figure 3, EFHW (245g) and 10m telescopic mast (1.3kg).

For information the Kp index peaked at 7 on the day but was 1 – 2 during the testing. A index ~40, Sunspot count = 20 and SFI = 76.

Results

The range and distribution of receiving stations was very similar for the G0POT EFHW, G0POT Dipole and G3TBL Dipole. It was noted, however, that the G0POT/G3TBL Dipoles were the only aerials to get readings from OH2EAT in Finland (-18db) and the G0POT Dipole was the only aerial to get readings from TF4M in Iceland (-18db). These receiving stations were considered 'DX' at ~2000km compared to all other stations falling (typically) in the range 400 – 1200km.

The following map (see Figure 4) shows all of the receiving stations that provided reception reports for the G0POT EFHW, G0POT Dipole and G3TBL Dipole. From the key it can be seen that most receiving stations provided reports for both G0POT and G3TBL and a review of reports revealed that most receiving stations provided a report for both the G0POT EFHW, and the G0POT Dipole.

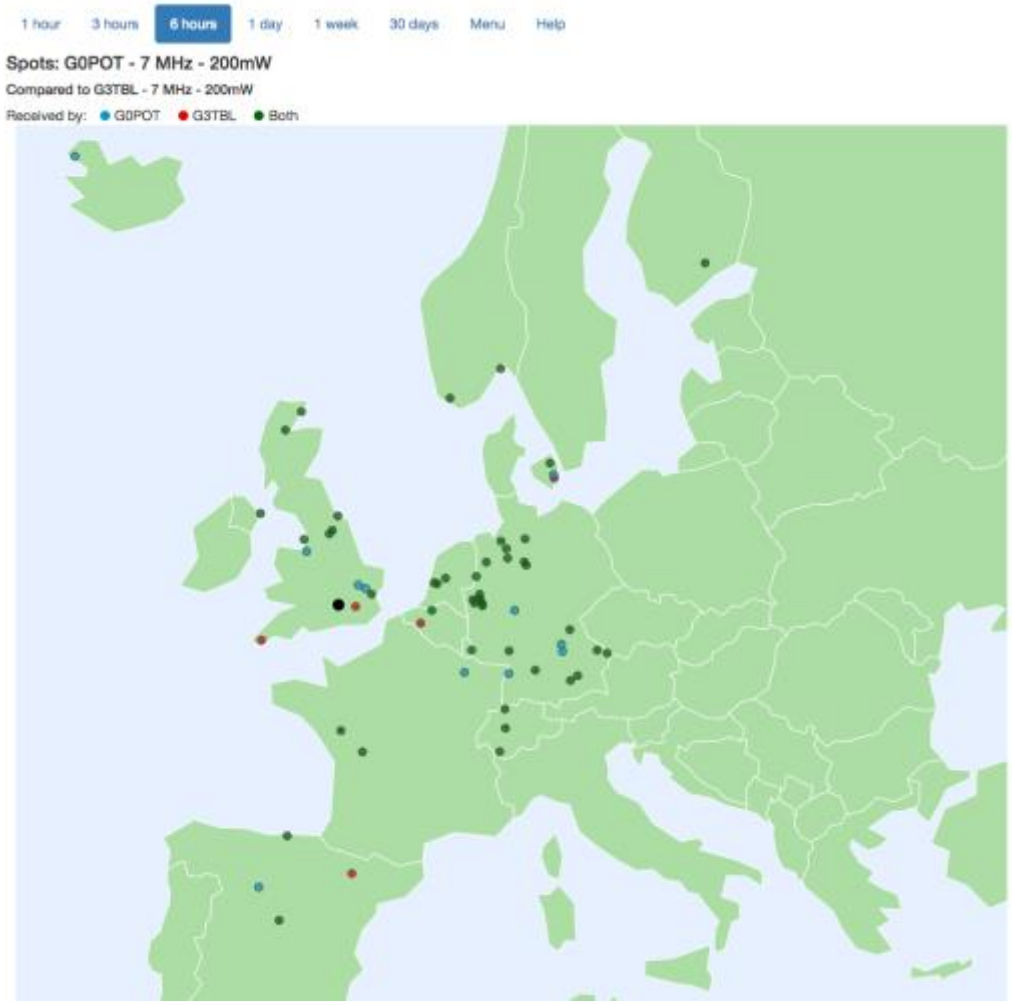

Figure 4, Geographical location of receiving stations.

The following graph (see Figure 5) compares the distances to the receiving stations for the aerials on test (blue line) and the baseline aerial of G3TBL (red line). As conditions change over time the distance to receiving stations of the baseline aerial changes and therefore the performance of the EFHW and Dipole at G0POT can be compared over time against this baseline to attempt to remove the effects of propagation variations.

Note that the saw-tooth pattern in the graph is entirely artificial. During a transmission period (2 minutes) a number of stations may receive the signal. Therefore, to list them individually the graph includes an artificial timeline that gives an indication of when, during the 5.5 hour period the distances were achieved. The results for each 2-minute period were ordered by distance and therefore the graph has a saw-tooth shape where each tooth represents the reception results for a single transmission period. Where the 'tooth' is narrow only a few reception reports were received. Where the tooth is wide many reception reports were received. The number of reports from G0POT and G3TBL often varied.

Note that some results had to be removed to enable the 'Distance' data for G0POT to be compared side by side with G3TBL. This may impact the number of reception reports in an individual period in some cases. Note also that the G0POT WSPRlite was configured to transmit more frequently than that of G3TBL to get sufficient data points in a short period of time and therefore the blue line may have more 'teeth'.

The graph (see Figure 5) covers the ~5.5 hour period of the test and has been divided up to indicate which G0POT aerial was under test during each period.

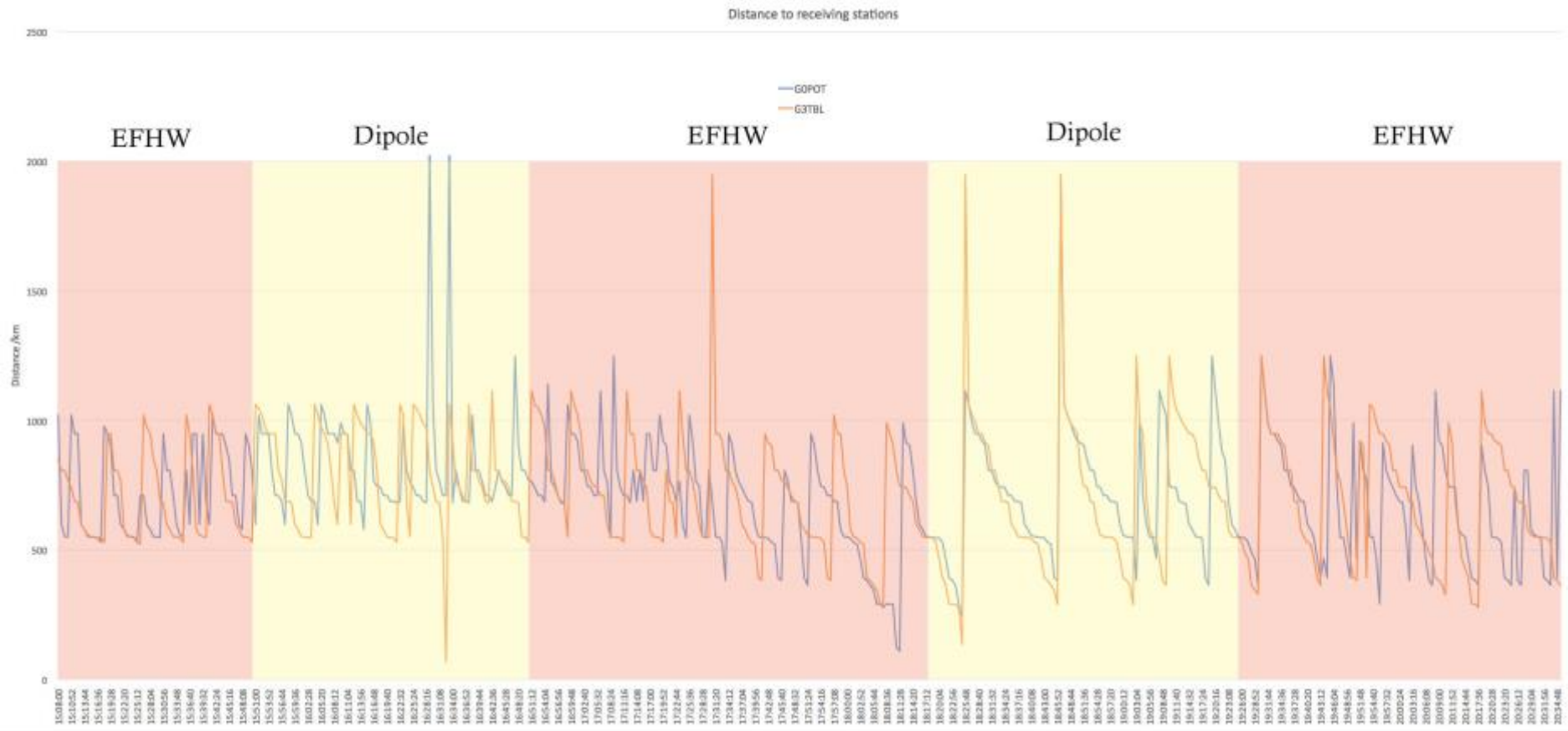

Figure 5, Distance to receiving stations.

The width of the 'teeth' (indicating the number of reception reports to a given transmission period) are reasonably coherent between G0POT & G3TBL throughout the experiment suggesting the number of reception reports for the G0POT EFHW and G0POT Dipole were similar.
With the exception of just a few outliers the distance performance was also reasonably coherent between the two stations throughout the experiment also suggesting the performance of the two G0POT aerials was similar however it is noted that the two DX reception reports for G0POT were on the Dipole.

In Figure 6, for each receiving station, we compare the mean SNR of the signals received from the G3TBL Dipole and either the G0POT EFHW or the G0POT Dipole. 'ds' is the difference in received SNR between the G0POT aerial and the G3TBL aerial and therefore, for each receiving station we can calculate the mean difference (or average ds). A positive 'ds' means that the G0POT aerial performed better than the baseline G3TBL Dipole, a negative 'ds' means the G0POT aerial performed worse than the baseline G3TBL Dipole. This Average of ds [db] gives a direct comparison between the G0POT EHFW and G0POT Dipole.

RX Station	Average of SNR(G0POT) [db]	Average of SNR(G3TBL) [db]	Average of ds [db]
DC5AL-R			
Dipole	-17.40	-19.40	2.00
EFHW	-20.20	-17.00	-3.20
DF2JP			
Dipole	-13.60	-18.00	4.40
EFHW	-18.50	-15.00	-3.50
DF4UE			
Dipole	-18.50	-22.13	3.63
EFHW	-18.10	-20.40	2.30
DF5FH			
Dipole	-21.86	-21.29	-0.57
EFHW	-22.13	-24.88	2.75
DF8OE			
Dipole	-24.20	-25.60	1.40
EFHW	-24.20	-22.60	-1.60
DG2NPE			
Dipole	-22.33	-26.67	4.33
EFHW	-21.33	-28.33	7.00
DH5RAE			
Dipole	-19.57	-22.71	3.14
EFHW	-21.00	-24.50	3.50
DK6UG			
Dipole	-25.40	-26.60	1.20
EFHW	-23.00	-21.80	-1.20
DK8FT			
Dipole	-20.67	-21.33	0.67
EFHW	-21.57	-22.29	0.71
DK8FT/A			
Dipole	-21.80	-23.40	1.60
EFHW	-22.00	-24.20	2.20
DK8JP/1			
Dipole	-20.00	-18.50	-1.50
EFHW	-17.00	-16.00	-1.00
DL/PA0EHG			
Dipole	-19.33	-16.67	-2.67

EFHW	-17.00	-17.50	0.50
DL0HT			
Dipole	-19.40	-24.60	5.20
EFHW	-21.33	-27.00	5.67
DL1KAI			
Dipole	-18.20	-21.80	3.60
EFHW	-18.33	-22.67	4.33
DL2ZZ			
Dipole	-17.71	-22.43	4.71
EFHW	-19.00	-11.80	-7.20
DL5RBD			
Dipole	-16.83	-22.00	5.17
EFHW	-21.50	-23.50	2.00
DL6OW-R			
Dipole	-24.50	-26.50	2.00
EFHW	-20.00	-17.00	-3.00
EA4BPN/P			
Dipole	-19.00	-27.00	8.00
EFHW	-21.50	-27.50	6.00
F5OIH			
Dipole	-11.67	-20.33	8.67
EFHW	-16.88	-15.88	-1.00
G4CPD			
Dipole	-18.25	-12.75	-5.50
EFHW	-19.00	-10.00	-9.00
GI7UGV			
Dipole	-12.00	-17.75	5.75
EFHW	-15.50	-17.00	1.50
GM3YKP			
Dipole	-6.00	-14.00	8.00
EFHW	-9.50	-11.17	1.67
GM4SFW			
Dipole	-20.00	-28.00	8.00
EFHW	-18.25	-19.75	1.50
HB9MHB			
Dipole	-20.00	-24.00	4.00
EFHW	-19.08	-20.75	1.67
HB9UQF			
Dipole	-12.00	-24.00	12.00
EFHW	-26.00	-25.00	-1.00
LA3JJ/RX2			
Dipole	-17.50	-22.50	Are their
EFHW	-21.25	-19.25	-2.00
LA7RTA			
Dipole	-19.67	-20.67	1.00
EFHW	-29.00	-25.00	-4.00
LX1DQ			
Dipole	-13.00	-16.00	3.00
EFHW	-15.50	-14.50	-1.00
ON7KO			
Dipole	-10.60	-13.00	2.40
EFHW	-9.33	-15.67	6.33
OZ1AAB			
Dipole	-21.00	-24.86	3.86
EFHW	-25.00	-22.00	-3.00
PH2M			
Dipole	-12.40	-16.40	4.00
EFHW	-13.00	-15.80	2.80
PI4THT			
Dipole	-14.60	-18.60	4.00

EFHW	-18.80	-13.60	-5.20
PI9ESA			
Dipole	-19.33	-21.00	1.67
EFHW	-18.67	-13.67	-5.00

Figure 6, Comparison of mean SNR reports from receiving stations.

Mean G0POT Dipole performance compared to G3TBL Dipole = 3.40 db
Mean G0POT EFHW performance compared to G3TBL Dipole = 0.06 db

Discussion

The performance in the field of the EFHW has been good and it has proved very effective as a simple and lightweight SOTA aerial but the results above suggest that its performance is below that of a linked dipole. However, the difference between them is marginal when erected so close to the ground in an inverted V configuration and represents just one s-point at the receiving station.
Given the simplicity of the EFHW set up and it's weight (just 2/5 of the linked dipole weight) and considering it's performance it still appears to be an acceptable and compelling solution for SOTA and portable operating.

Future improvements to running comparative analysis:

- Running the test over a longer period of time may provide a greater number of comparative data points. It was challenging to align the G0POT data with the G3TBL data as the WSPRlite at G0POT was set up to transmit far more often than the transmitter at G3TBL.
- Compare to a geographically close horizontal aerial erected outdoors in a similar configuration.
- Use two WSPRlites so that measurements can be taken in parallel.
- Establish what WSPR SNR constitutes a workable path for CW or SSB communications at a chosen power output (say, QRP) and discount reception reports that fall below that threshold.