Practical investigation of the polarisation of 50MHz signals

Chris Deacon, G4IFX

HAMSCI UK 13th October 2017
Is Es similar to F2 in terms of polarisation?
Experiments at G4IFX - antenna

Innovantennas 7-ele X-POL antenna @ 20m

Separate feeders, identical feeder lengths
Experiments at G4IFX - receiver

Apache ANAN-100D, dual receivers, OpenHPSDR mRX PS

(nearly) identical receiver chains – effectively a dual channel spectrum analyser
Experiments at G4IFX – data capture

Radio Astronomy data collection utility, OpenHPSDR mRX PS

GB3RAL 25 March 2016 (propagation: tropo, 58km obstructed path with aircraft scatter)

Signal strength in dBm, Black = RX1: horizontal, Red = RX2: vertical
An early observation

G8BCG (IO70RK) at G4IFX (IO91OD) via aurora 17 March 2015 2105z
RX switching between horizontal (first) and vertical antennas

“The polarization of auroral echoes is mostly found to be closely identical with the transmitted polarization.”

“Radio Aurora”, Bengt Hultqvist and Alv Egeland; Space Science Reviews 3 (1964) 27-78
Sporadic–E single-hop

Transmitted polarisation: horizontal
Range: 1515km
Calculated polarisation angle

Transmitted polarisation: horizontal
Range: 1515km

IS0BSR/P JM49OK (50.135MHz SSB) at G4IFX IO91OD 12 May 2016 10.49z
Sporadic–E single-hop

Transmitted polarisation: vertical
Range: 1515km
Sporadic–E single-hop

Transmitted polarisation: vertical
Range: 1515km
Sporadic–E single-hop

Transmitted polarisation: vertical
Range: 1448km

IOJX JN61HV 50.00413 FSK 10W & vertical 600Hz bw 12 May 2016 15.00z (start)

Signal strength dBm

Seconds

RX1 (horizontal) RX2 (vertical)
Sporadic–E single-hop

Transmitted polarisation: vertical
Range: 1448km
What’s really happening?
Prior work by Graham Kimbell, G3TCT

GB3LER 5 August 2010 via sporadic-E, range 1059km

See Graham’s website (http://g3tct.co.uk/diversity.html) for an extensive set of 50MHz diversity recordings
BBC research report 1975

BBC RD 1975/17
RESEARCH DEPARTMENT

Ionospheric propagation in v.h.f. television Band I

L.F. Tagholm, M.B.E., F.I.E.E.
C.P. Bell, B.Sc. (Eng.)
P. Knight, M.A., Ph.D., M.I.E.E.

Research Department, Engineering Division
THE BRITISH BROADCASTING CORPORATION June 1975

Fig. 1 - Propagation paths
Transmitting stations
Receiving stations
### Average received vs transmitted polarisation:

**Table 4**

<table>
<thead>
<tr>
<th>Transmitter Frequency and Polarization</th>
<th>Receiver</th>
<th>Radiation angle, degrees</th>
<th>Year</th>
<th>Polarization ratio, dB</th>
<th>Average Polarization ratio, dB</th>
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</thead>
<tbody>
<tr>
<td>Limoges 41.28 MHz H</td>
<td>Orkney</td>
<td>4.7</td>
<td>1970</td>
<td>6.7</td>
<td>7.4</td>
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<td></td>
<td></td>
<td></td>
<td>1971</td>
<td>8.6</td>
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<tr>
<td>Divis 41.465 MHz H</td>
<td>Helsinki</td>
<td>2.0</td>
<td>1968</td>
<td>-0.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1969</td>
<td>-0.3</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>1970</td>
<td>0.1</td>
<td>-0.1</td>
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<td>1971</td>
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<td></td>
<td></td>
<td>1972</td>
<td>0.3</td>
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<tr>
<td>Monte Sambuco 49.30 MHz H</td>
<td>Kingswood</td>
<td>4.0</td>
<td>1966</td>
<td>5.8</td>
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<td></td>
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<td>1967</td>
<td>3.5</td>
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<td>Carcassonne 54.43 MHz V</td>
<td>Kingswood</td>
<td>11.0</td>
<td>1966</td>
<td>2.2</td>
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<td>1967</td>
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<td>Meldrum 58.215 MHz H</td>
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Polarisation ratio = the ratio of the signal strength for the transmitted polarisation to the signal strength for the orthogonal polarisation (dB)
Using WSJTX for bulk data collection
Initial results using JT65

As logged -

< - Minus the tropo
Polarisation distribution using FT8

Single-hop sporadic-E only, 750km - 2500km range

- Polarisation Angle
  - Mean = 39.8
  - Median = 38.5
  - Std Dev = 14.2
Calculated ground gain, five-element yagi at 20m, perfect ground

Calculated ground gain, five-element yagi at 20m, average ground

Ground Gain in Theory and Practice By Gaëtan Horlin, ON4KHG
Dubus 3/2011 (September 2011)
Fig. 11 - Median radiation angle for propagation via the sporadic-E layer
Polarisation distribution, corrected for ground gain

Single-hop sporadic-E only, 1200km - 2500km range
Ground gain correction = +2dB on vertical
Conclusions so far

- Sporadic-E signals, on a short timescale, tend to have a strong net polarisation which rotates over periods of seconds to minutes.

- This polarisation rotation is observable in single-hop, two-hop and three-hop Es.

- Averaged over longer periods, average polarisation tends to 45 degrees once differential ground gain is compensated for.

- But the frequent short-term variation seems to indicate that the incident wave is at the very least strongly elliptically polarised - otherwise such wide short-term variations in net polarisation would not be observed.

- Less formal observation shows that it’s not uncommon for an Es signal transmitted from a horizontal antenna to arrive more or less vertically polarised for long periods of time (and vice versa).
  - Sometimes signals from a given direction will all be tilted the same way.

- Auroral signals seem generally to retain their original polarisation.

- The received polarisation of tropo signals is frequently far from ‘pure’ horizontal or vertical.
Find out more…

g4ifx@uksmg.org

www.uksmg.org

http://rsgb.org/main/about-us/committees/propagation-studies-committee/

www.rsgb.org