Radiosonde Datalink Study

Richard Smout, John Nash, Roger Carter
Met Office, Fitzroy Road, Exeter, Devon EX1 3PB
Tel. 01392 885641, Fax. 01392 885681, richard.smout@metoffice.gov.uk

Abstract

Working Party 7C at the International Telecommunications Union is responsible for the protection of the MetAids (Meteorological Aids) band. This name is given to those devices used for meteorological purposes; typically radiosondes that operate within the bands 400.15 – 406 MHz and 1668.4 – 1700 MHz. The current study leading up to the World Radio Conference in 2007 requires that the interference criteria for radiosondes be revised. This report summarises the measurements made at Camborne, Cornwall, in South West England during April 2006. The Met Office started flying the Vaisala RS92 SGP GPS radiosonde in April 2005 following an exhaustive acceptance test which began in May and concluded in October 2004. A further evaluation of this radiosonde was performed in the WMO sponsored trial held in Mauritius in February 2005. This poster summarises the results of the measurements taken at Camborne.

Radiosonde Datalink Study

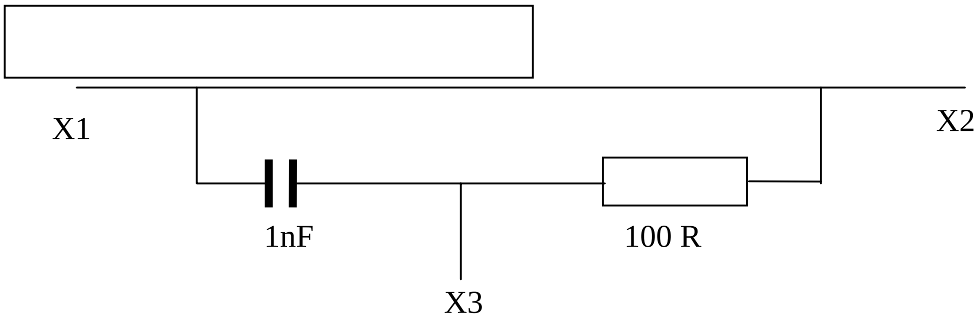
Modern radiosondes such as the Graw (DFM97 GPS), Modem (GL98) and Vaisala (RS92 SGP GPS) all use crystal controlled transmitters and require at most 48kHz band width. By changing to these new radiosondes Meteorological Services are able to demonstrate their commitment to using less of radiofrequency spectrum. The narrow band transmitter with digital modulation is less prone to interference from external sources of interference than the earlier analogue transmitters. As such radiosondes can be flown closer together in terms of frequency separation and it is hoped that a national agreement can be reached whereby part of the 403 MHz 'Metaids' band could be relinquished for other use in the UK. However, decisions as to spectrum used in the UK for future Metaids operations need to be coordinated with the radiosonde use in neighbouring countries, since radiosondes often cross national borders during flight.

The information regarding radiosondes and their transmission characteristics is limited. Study group 7C was commissioned to revise the details regarding data links and interference under recommendation ITU-R SA 1263. The data link study performed at Camborne was necessary to provide additional information as part of this work. In this test it was not possible to inject an interference signal at the antenna end. The data recorded is under typical conditions experienced at Camborne in Cornwall South West England. Antenna positioning is important. The RB21 antenna used during the trial has a similar unobstructed clear view of the horizon as the antenna used for operational measurements. .

Ofcom were asked to provide assistance with this study as they have the necessary expertise and equipment to make the measurements.

Test setup

The signal output from the Vaisala UHF antenna (RB21) was split at the RGB21 grounding adaptor feeding a signal to an Agilent E4440A 3Hz – 26.5GHz PSA Series Spectrum Analyser. The loss across the splitter was quantified using a Rohde and Schwarz portable spectrum analyser model number FSH6 100KHz to 6GHz. See figures 1 and 5 for schematics of the test configuration.



The drop across X1 – X2 was 2.1 dBs and X1 – X3 was 1.8 dBs. The gain of the corner reflector is quoted in the Vaisala manual as 12dBs and the pre amp gain 20 dBs. The antenna RB21 was connected to X1, SPS220 (MW21) to X2 and the spectrum analyser to X3. Attenuators were not used in the setup due to the highly sensitive input of the Agilent spectrum analyser.

The signal strength data rate output from the Agilent Spectrum Analyser was set at 1 minute intervals. The data output from the Vaisala system was the full 1 second resolution so this was imported in to RSKOMP (radiosonde data comparison software written by Sergey Kurnosenko), the data rate was then reduced to minute values and exported to Microsoft Excel where it was combined with the signal strength values from the Agilent.

In total 16 flights were flown, with a maximum range of 225 kms reached on the last flight. Figure 2 summarises all of the flights, flight 2 (yellow trace) had the lowest signal strength when compared against the other flights. Over all there was consistent repeatability between flights with the most variation at the start of the ascent, which can be seen in the standard deviations in Figure 4. Figure 3 shows the average for all the flights. As an attenuator was not used the signal strength readings are higher than what would normally be expected.

Prior to launch the Vaisala RS92 SGP GPS radiosonde transmits at reduced power to conserve the battery. Following launch after a pressure decrease of 50hPa the radiosonde switches to higher power of approximately 100 mWatts. The switch from low to higher power can be seen in figure 3 between 0.5 and 1 km.

Only 1 flight suffered large loss of wind information, 14%, possibly caused by the radiosonde failing to deploy correctly under the balloon because the suspension cord did not unwind correctly. The other flights suffered less than 1 percent data loss.

UK radiosonde stations have two frequencies allocated, primary and spare. A test was conducted placing a working high power RS92 SGP GPS radiosonde on the wind vane and anemometer tower at Camborne. A low power RS92 AGP GPS radiosonde was flown as normal just 200 KHz away in frequency. No interference or signal loss was observed.

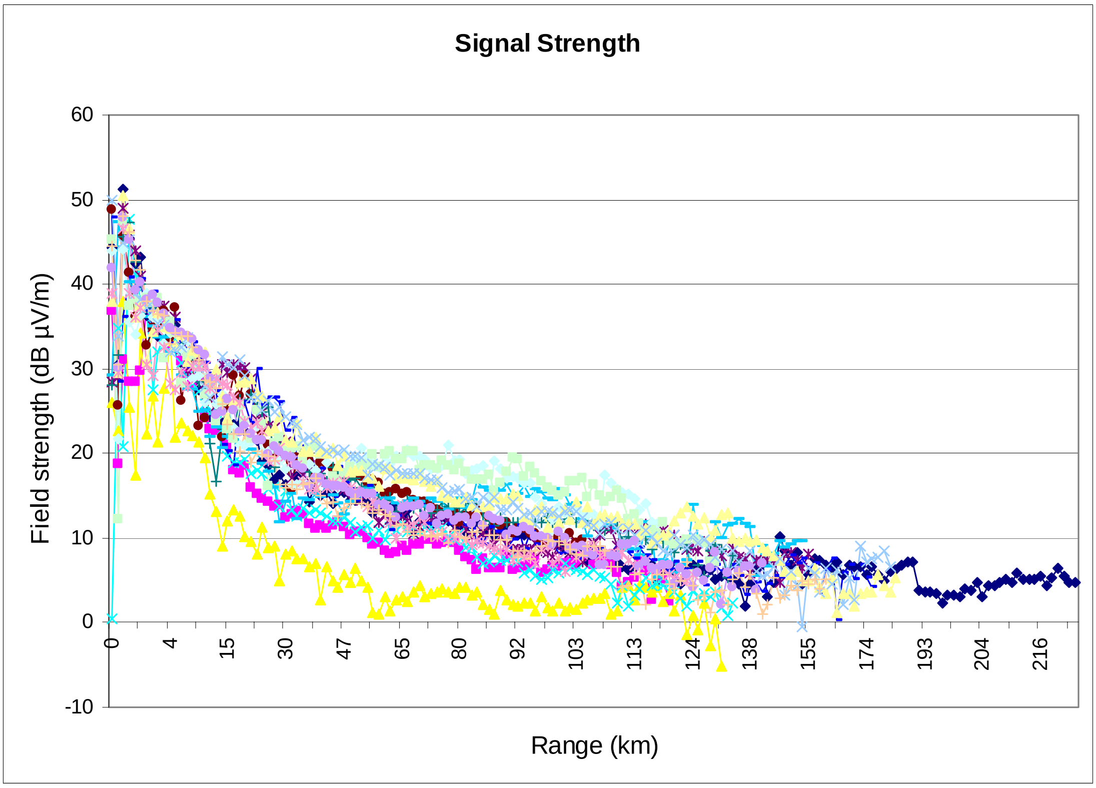


Fig. 2, signal strength (dB µVolts per meter); against range (km).

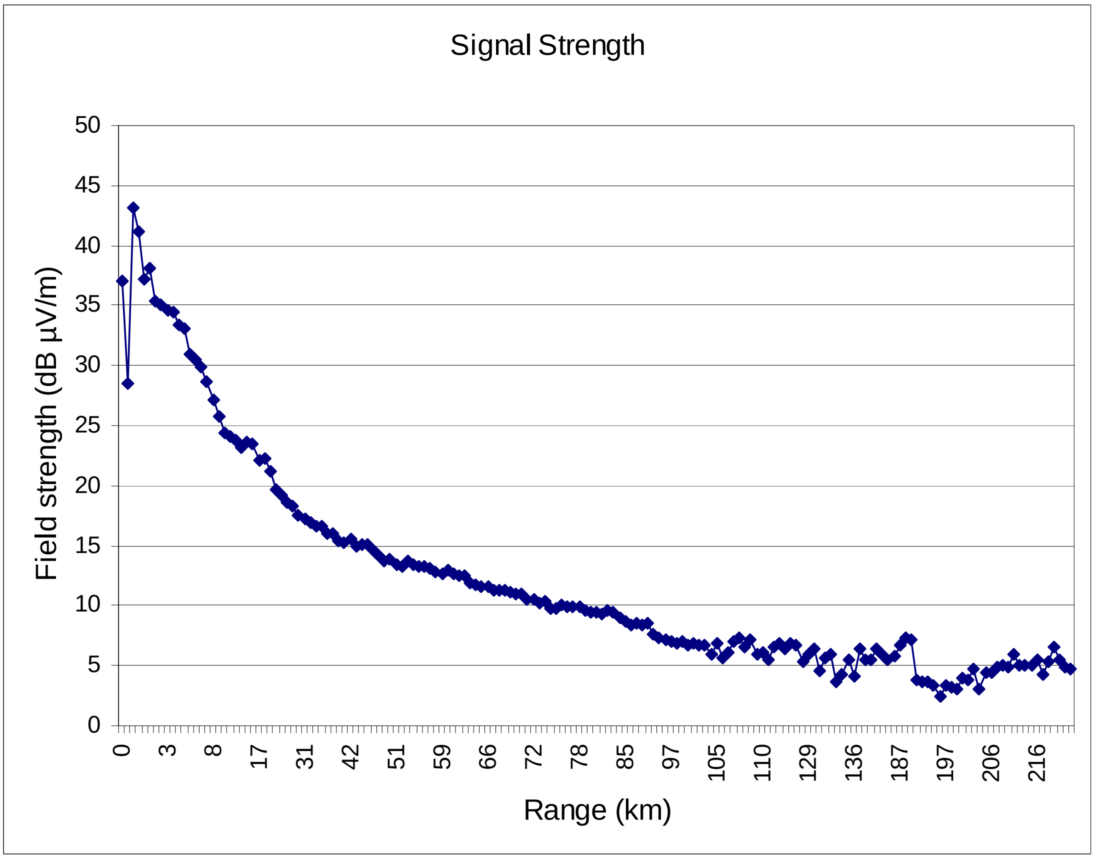


Fig. 3, Average signal strength (dB µVolts per meter); against range (km).

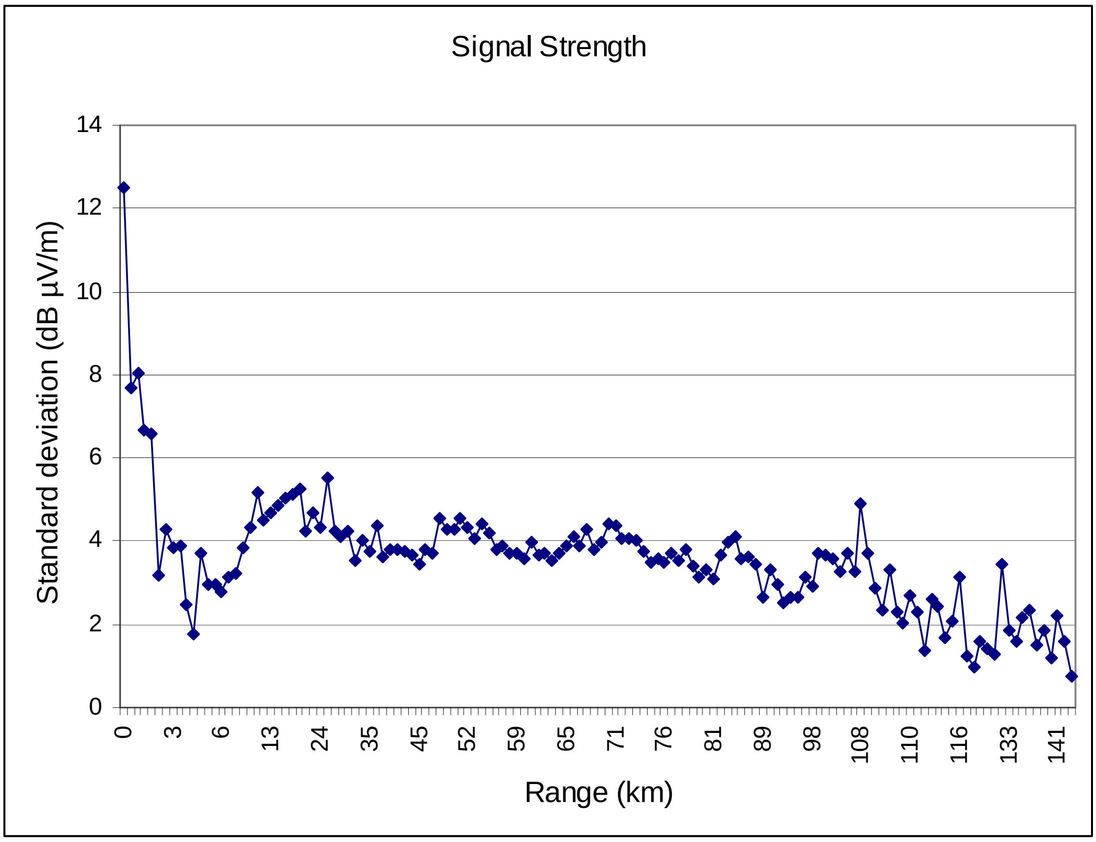


Fig. 4, Signal strength standard deviation (dB µVolts per meter); against range (km).

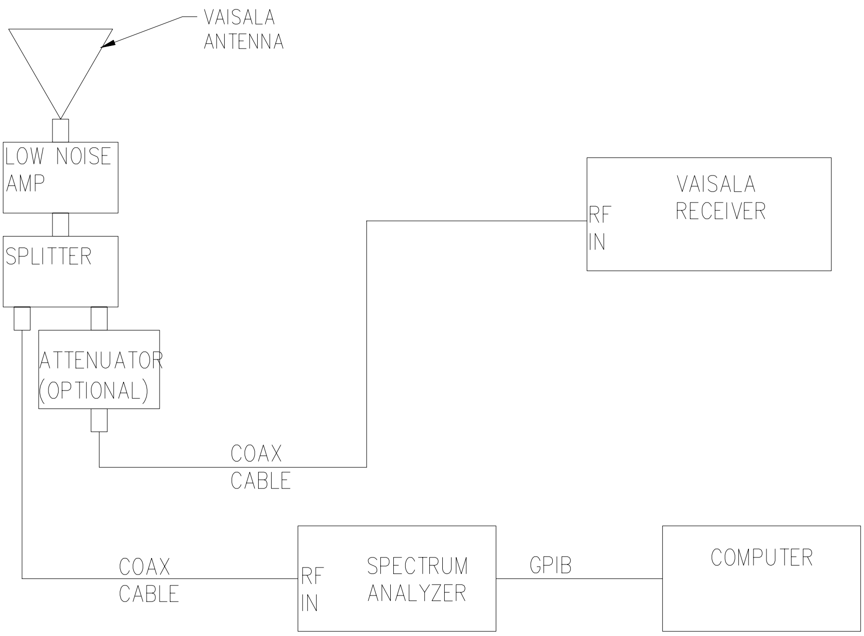


Figure 5, Diagram of measurement setup, note that the optional attenuator was not used.

<u>Reduced spectrum feasibility study</u>.

The Met Office is performing a feasibility study to investigate the effects of reducing the amount of spectrum used for operational radiosonde ascents. Initially Aberporth, Camborne and Larkhill stations in Wales and southern England will be flying radiosondes in the range of 404.2 to 404.6 MHz.

Conclusions

Apart from the second flight which showed a low signal to noise ratio all other flights showed characteristics that were as expected.

The stable transmitters in the radiosondes and high quality receivers within the ground stations allow data to be retrieved when the signal to noise level is low. Digital modulation and narrow band transmitters allows the separation in terms of frequency between stations to be reduced.

Figure 4 illustrates good repeatability between the radiosondes flown over the test period.

Recommendations for further work

The Met Office has the capability to fly radiosondes from three other manufacturers, Graw, Modem and Sippican Lockheed Martin. It would be useful to characterise these radiosondes as well.

The maximum range over which the radiosondes can fly was not fully realised during the week of the test. It may be necessary to repeat the exercise but instead hire a spectrum analyser for the winter period, rather than allocate a week to perform the test! Study group 7 have asked to know the receiver noise floor relative to the signal levels you measured; and from that, the minimum signal-to-noise ratio required for reliable data reception. Work is ongoing!

Appendix A
Field Strength Calculation

Antenna quoted as 12 dB (related to dipole) i.e. 12 dBd
Antenna related to isotropic radiator = 12 + 2.15 = 14.15 dBi
Antenna Factor (calculated from antenna gain related to an isotropic radiator)
Ant Factor = 20 log10 FREQUENCY (MHz) – Antenna Gain in dBi – 29.8 (constant)
= 20 log 402 – 14.15 – 29.8
AF = 8
Correction Factor = AF – LNA Gain + Cable Loss + Splitter / dc Block and lead loss
= 8 – 20 + 5 + 1.8 dB
= -5.2 dB
Field Strength = Signal (dBμV) -5.2 dBμV/m
The calculation has a negative value because an attenuator was not available for the test. The engineers from Ofcom were confident that this would not jeopardise the trial given the sensitivity of the Agilent E4440A Spectrum Analyser.
Through out the test radiosondes were flown tuned to either 401.5 MHz or 402.7 MHz.

Acknowledgements
The test was performed with collaboration of James Loughlin and David Thorpe from Ofcom their assistance is much appreciated.
David Franc, National Oceanic & Atmospheric Administration.
Ilkka Ikonen, Vaisala Oyj.