RFI MEMO #038

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To: MWA Group

From: A.E.E. Rogers and J.D. Bowman

Subject: RFI Monitor at Mileura Homestead

In early December 2006 we set-up a RFI monitor at the Mileura Homestead. The unit was installed in Patrick Walsh's workshop building as sown in Figure 1. Many thanks to Patrick for mounting the R&S HK-033 antenna and providing the bench space for the monitor.

The RFI monitor hardware is similar to that described by Rogers et al (2005), consisting of the following

Antenna:	HK033
Spectrum analyzer:	Anritsu MS2711D
Preamplifier:	Mini circuits ZX60-3018G
Cable from Antenna to input:	50 feet LMR-400

The hardware is contained in an RFI shielded box which is shown open in Figure 2.

The monitor software was set-up to record a separate file each day and to automatically restart following any power interruption. This is accomplished by using a solenoid push the "on" button of the Anritsu which will automatically restart after its batteries have drained. The following parameters were used in the software set-up:

Start frequency	30 MHz
Stop frequency	330 MHz
Resolution	100 kHz
Time interval per output spectrum:	6 m 30 s

When the RFI monitor is connected to the internet these parameters can be changed and the data can be retrieved. Without internet connectivity the data can only be retrieved by opening the RFI enclosure, connecting the monitor and keyboard, and copying the data a a USB disk

using /sbin/fdisk-*l* to list devices

mount /dev/sda1 /externaldisk

The RFI electronics runs very hot. For example, on December 3, 2006 the ambient air outside was 35 C with the air inside the RFI enclosure was 43 C. We made every attempt to increase the air flow through the box but we were limited by the available fans.

Data plots

Figures 3,4, 5 and 6 show "waterfall" plots for December 3-6. These data were processed using program "tek" which calibrates the data from the 3- position switching and corrects for the "ripple" from standing waves on the cable due to antenna reflections.

Comments on the data

1] Satellite signals are always present in the 137-138 and 245-270 MHz bands.

2] The continuum from the Galaxy peaks at about 11 UT.

3] Some variable strength signal is always seen at 150.05 and 150.2 MHz.

4] Sporadic signals are seen at 175 MHz, 144 MHz and in the range of 125-150 MHz.

5] FM radio signals in the 88-108 MHz range fade in and out.

6] Occasional broadband signals are seen. These are most likely due to activity at the homestead (light switches, electric drills etc.)

The Anritsu system is sensitive to RFI at the level of about 10 K as compared with the EDGES acqiris system which detects RFI at the level of about 10 mK. Both systems see about the same level of RFI from the horizon because the HK033 has its peak gain at the horizon while the EDGES fourpoint antenna strongly rejects signals from the horizon.

Average spectral plots

Figures 7,8,9 and 10 show the average spectra for December 3-6. No attempt has been made to exclude transients in these plots.

Comments on the data

1] The data from 3 December (day 337) has a lot of noise which mostly likely originated from the workshop.

Comparison with EDGES data

Figure 11 shows the average EDGES spectrum from 80 to 320 MHZ for comparison with the RFI monitor spectrum for day 340.

Comments:

Signals coming from the sky are expected to have approximately equal strength in the 2 systems.

Frequency range MHz	Comments	RFI peak K	EDGES Peak K
245-270	Satellite down links	5×10^3	5×10^3
222.05	Coherent troposcatter	10^3	10^2
221.08	Coherent troposcatter	10^3	10^2
216.30	Coherent troposcatter	10^3	10^2

189.30	Coherent troposcatter	10^3	10^2
182.30	Coherent troposcatter	10^3	10^2
180.80	Coherent troposcatter	10^3	10^2
175.30	Coherent troposcatter	5×10^3	10^3
150.20	Telstra?	10^4	10^4
150.05	Space Junk beacons	10^4	10^4
137-138	LEO Satellite downlinks	10^5	10^5
118-137	Aircraft	Various	Various
88-108	Many FM station via tropo	10^4-10^5	1-100

During this period the troposcatter was stronger at night from 12-23 UT (8pm-7am local). The EDGES system provided about 30 dB rejection of these signals compared to the rfi monitor. The signals at around 150 MHz appears to behave more like a satellite downlink than the uplink assigned to Orbcom LEO satellites because satellite downlink the average signal strength is similar in both systems. These signals are from old US and Russian satellites like OSCAR, COSMOS etc. The signal at 150.2 MHz is most like from a transmitter allocated to Telstra 70 km north of Mileura. Figure 12, 13, 14,15,16 and 17 are zoomed "waterfall" plots which compare the signals observed by RFI with those seen by the EDGES spectrometer.

Figure 1. RFI Monitor at Mileura homestead

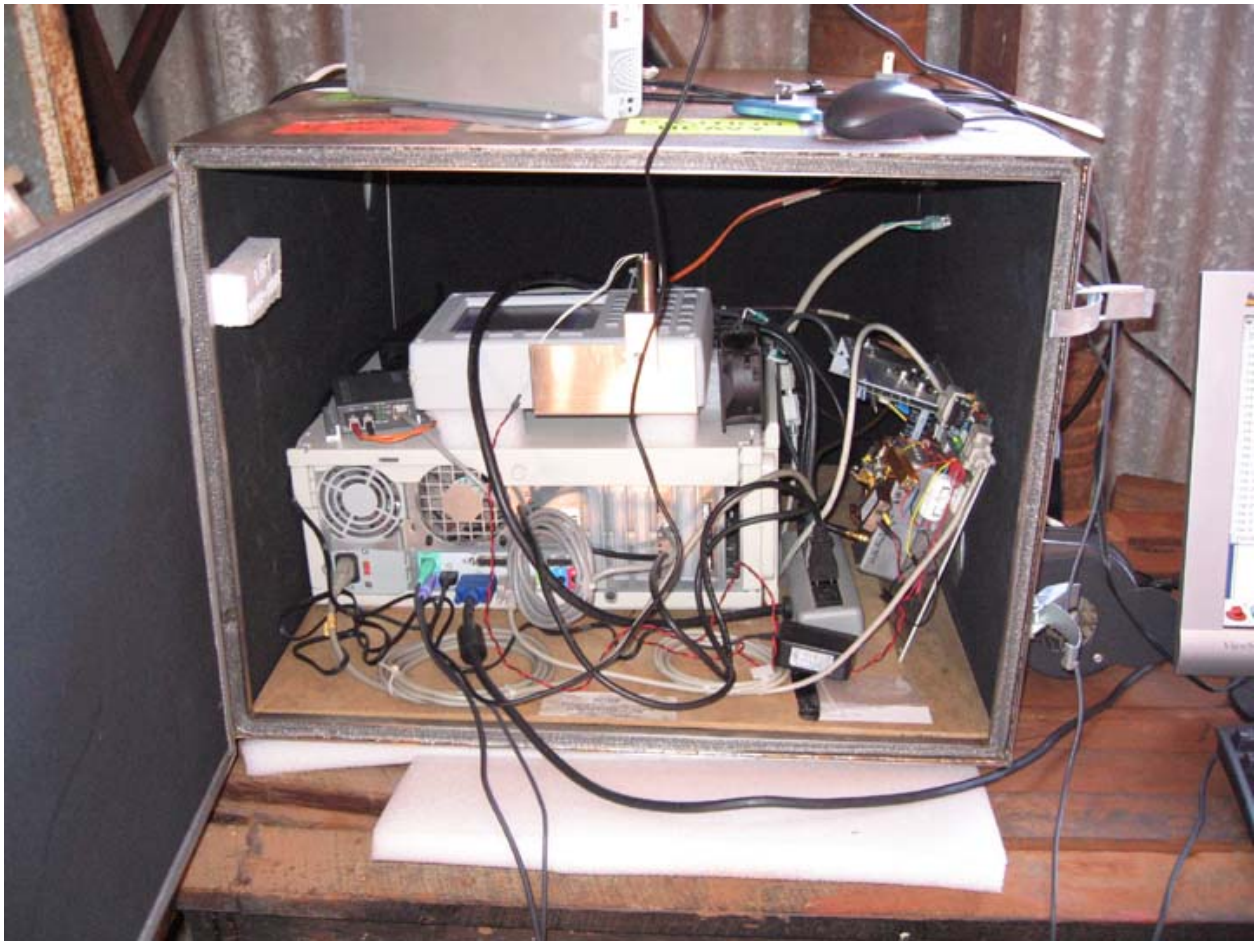


Figure 2. RFI monitor at Mileura with enclosure open.

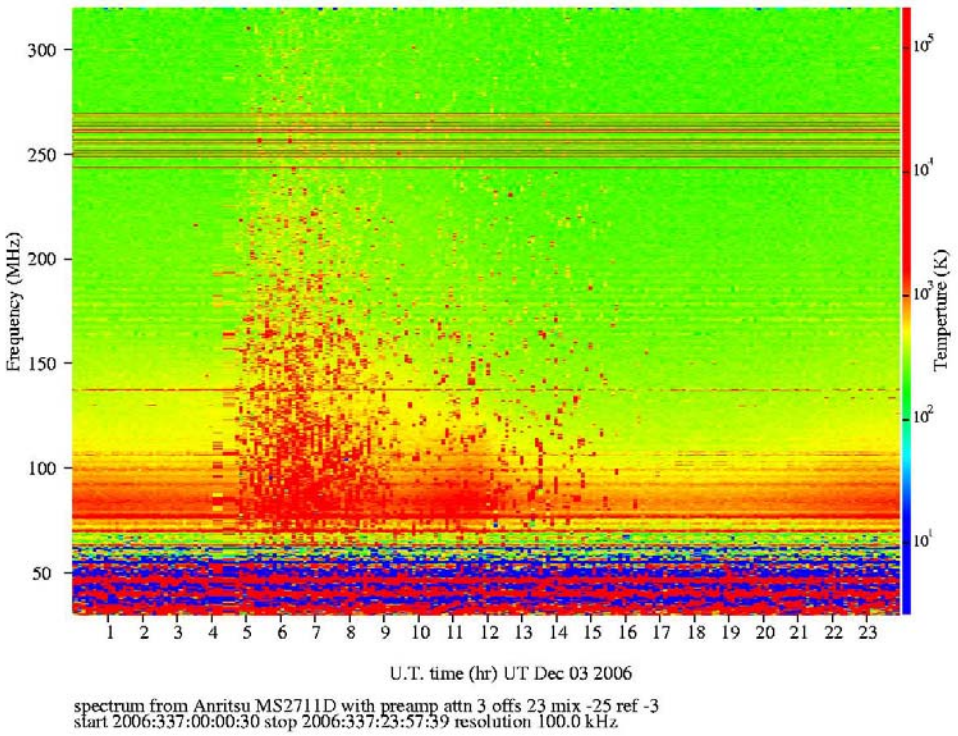


Figure 3.

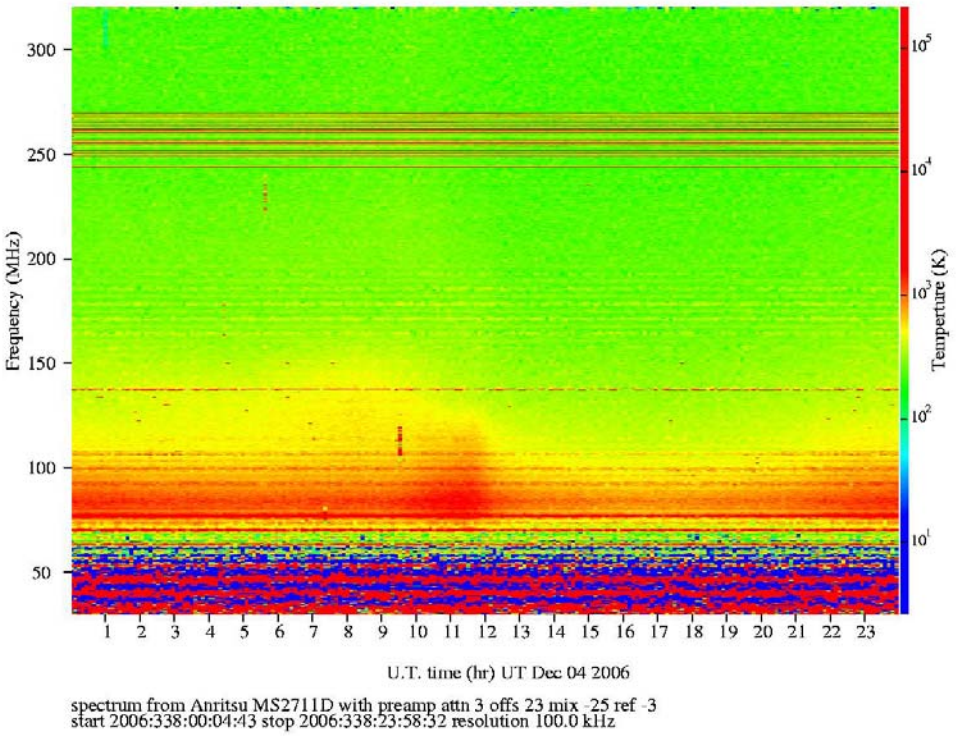


Figure 4.

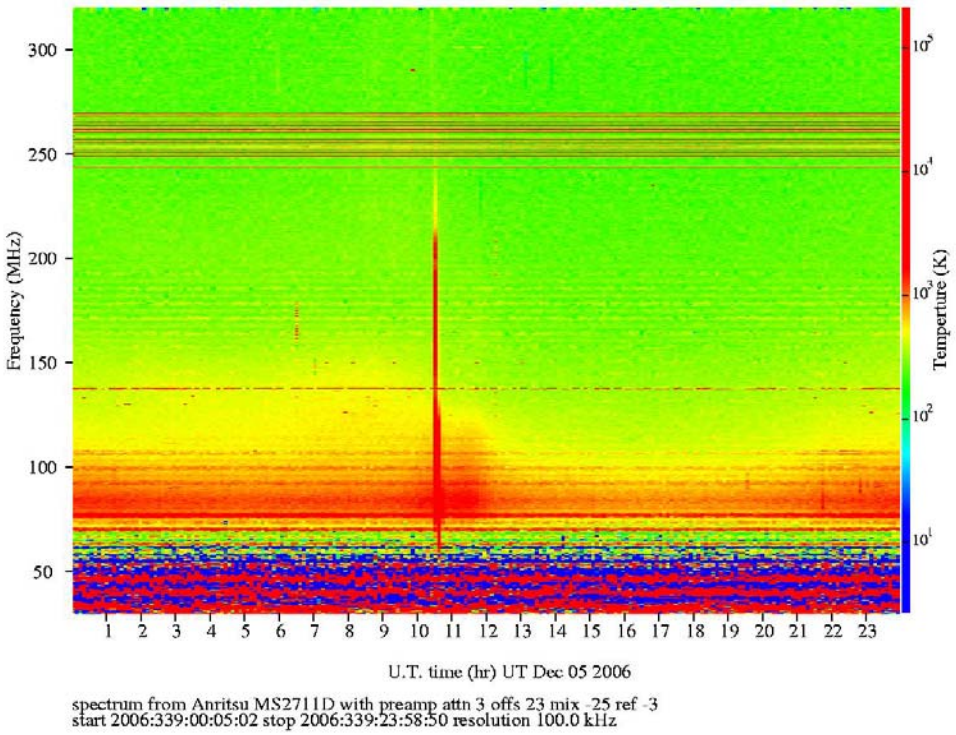


Figure 5.

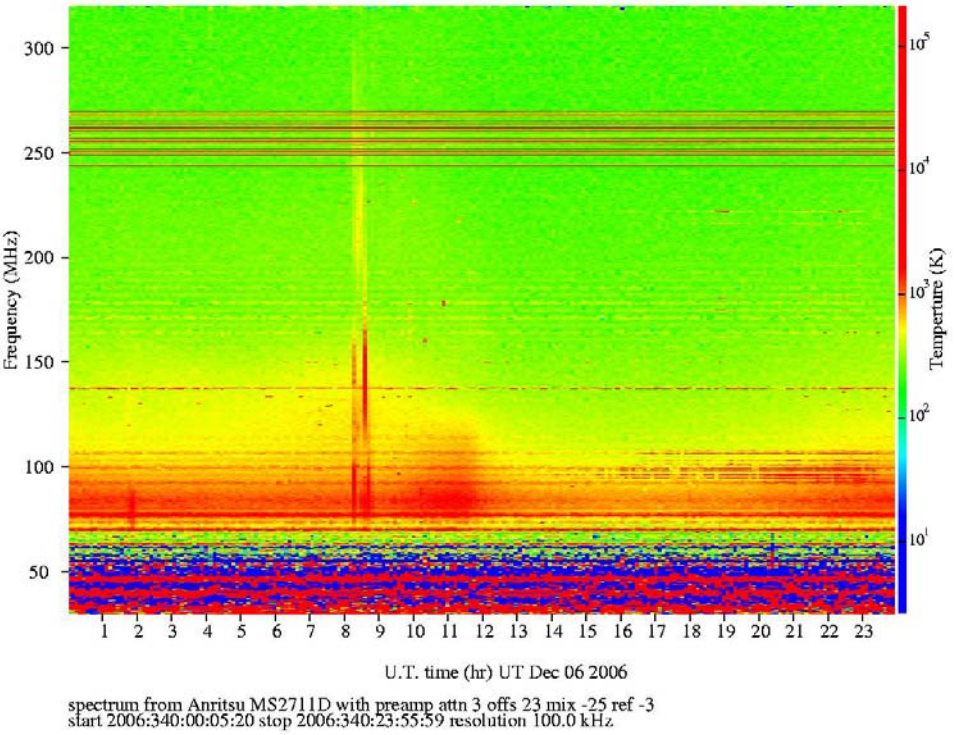
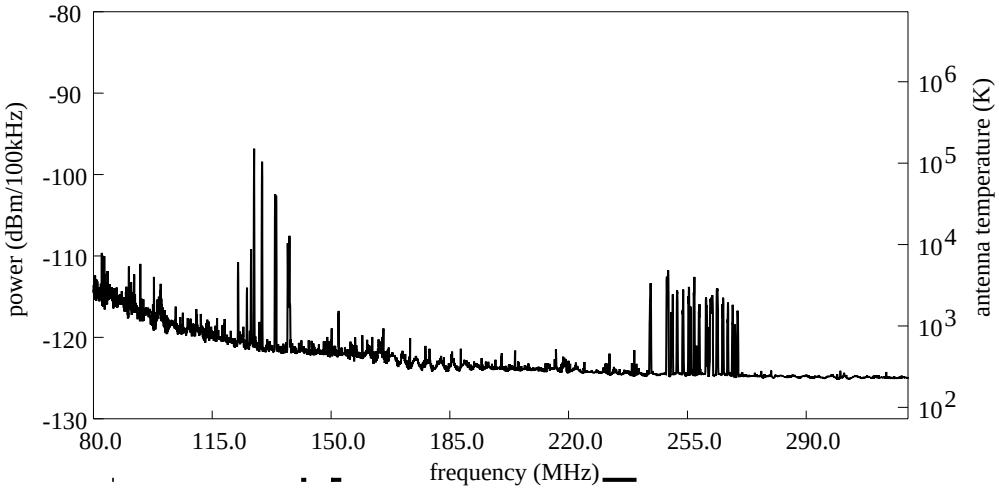


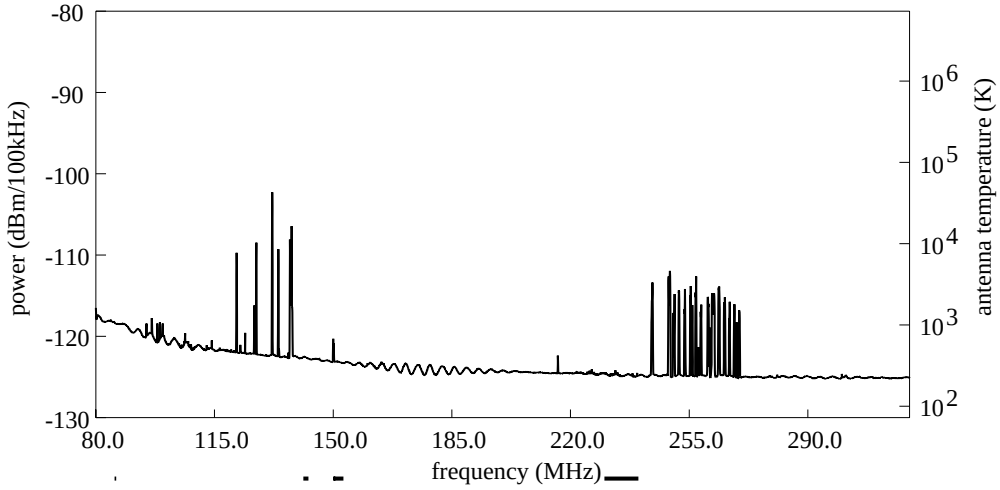
Figure 6.



noisesource calibrated
spectrum from Anritsu MS2711D with preamp attn 3 offs 23 mix -25 ref -3 vbw 300
start 2006:337:00:00:30 stop 2006:337:23:57:39 resolution 100.0 kHz

Wed Jan 3 17:03:21 2007

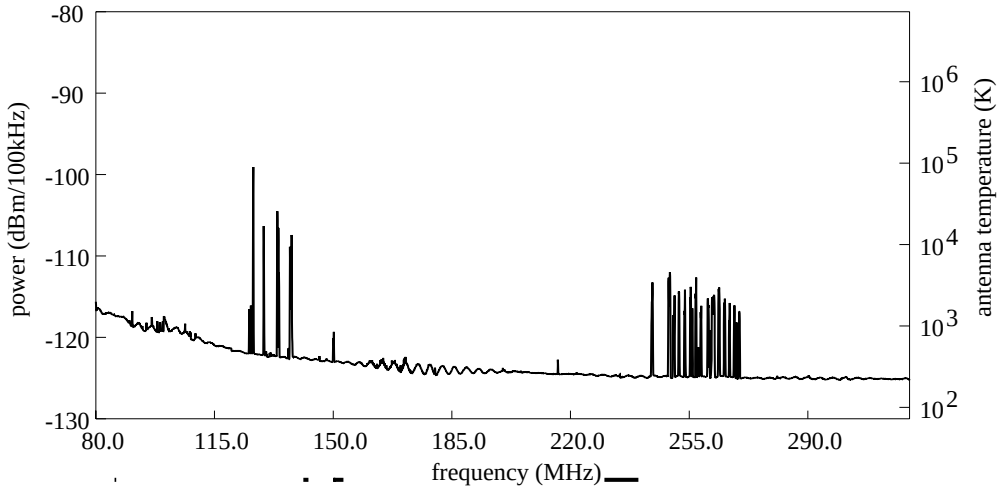
Fig 7.



noisesource calibrated
spectrum from Anritsu MS2711D with preamp attn 3 offs 23 mix -25 ref -3 vbw 300
start 2006:338:00:04:43 stop 2006:338:23:58:32 resolution 100.0 kHz

Wed Jan 3 17:03:24 2007

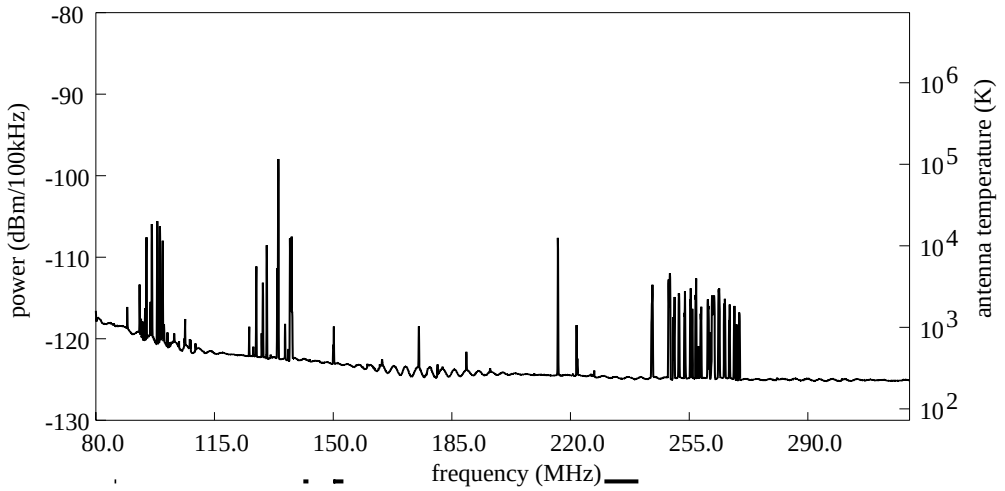
Fig. 8



noisesource calibrated
spectrum from Anritsu MS2711D with preamp attn 3 offs 23 mix -25 ref -3 vbw 300
start 2006:339:00:05:02 stop 2006:339:23:58:50 resolution 100.0 kHz

Wed Jan 3 17:03:27 2007

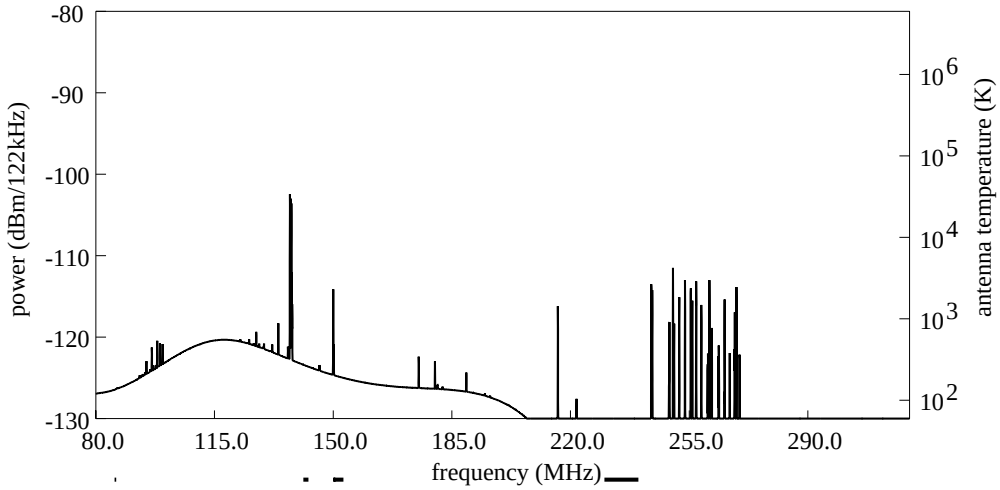
Fig 9



noisesource calibrated
spectrum from Anritsu MS2711D with preamp attn 3 offs 23 mix -25 ref -3 vbw 300
start 2006:340:00:05:20 stop 2006:340:23:55:59 resolution 100.0 kHz

Wed Jan 3 17:03:31 2007

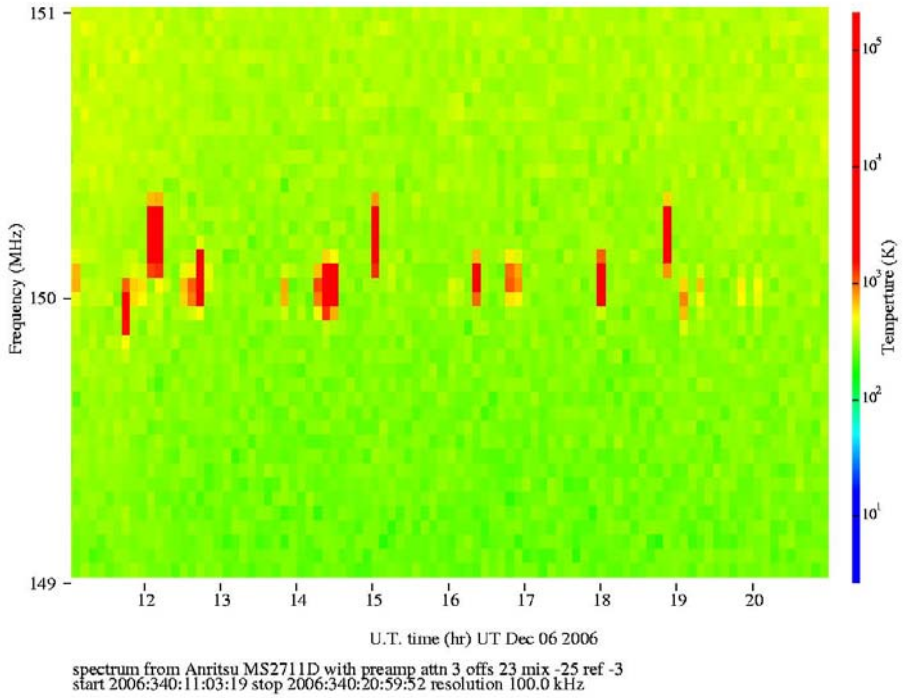
Fig 10



noisesource calibrated
spectrum from EDGES offs 0 mix 0 ref 0
start 2006:340:10:38:26 stop 2006:340:21:04:48 resolution 122.0 kHz

Wed Jan 3 19:54:21 2007

Figure 11



spectrum from Anritsu MS2711D with preamp attn 3 offs 23 mix -25 ref -3
start 2006:340:11:03:19 stop 2006:340:20:59:52 resolution 100.0 kHz

Figure 12

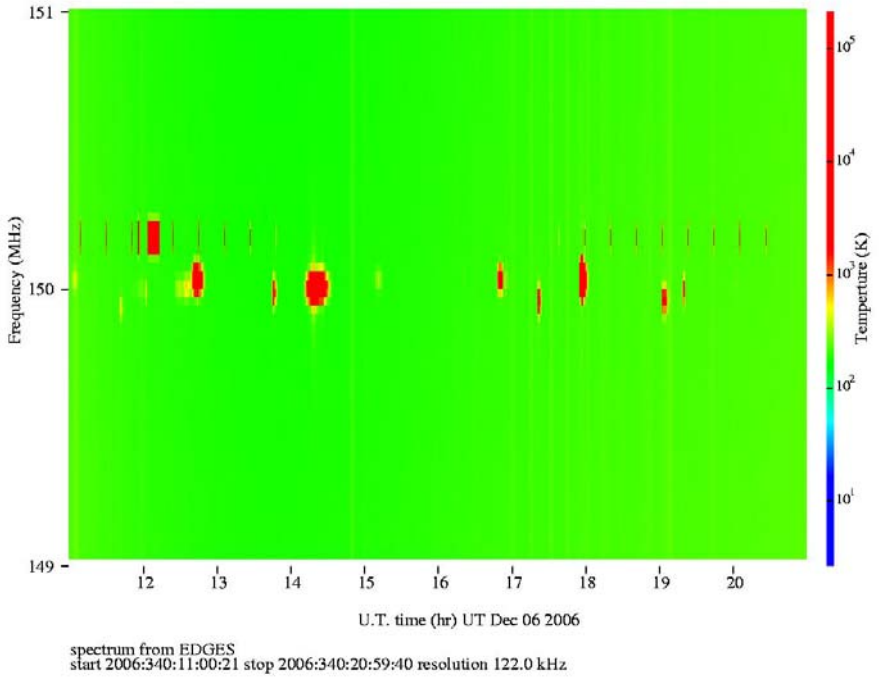


Figure 13

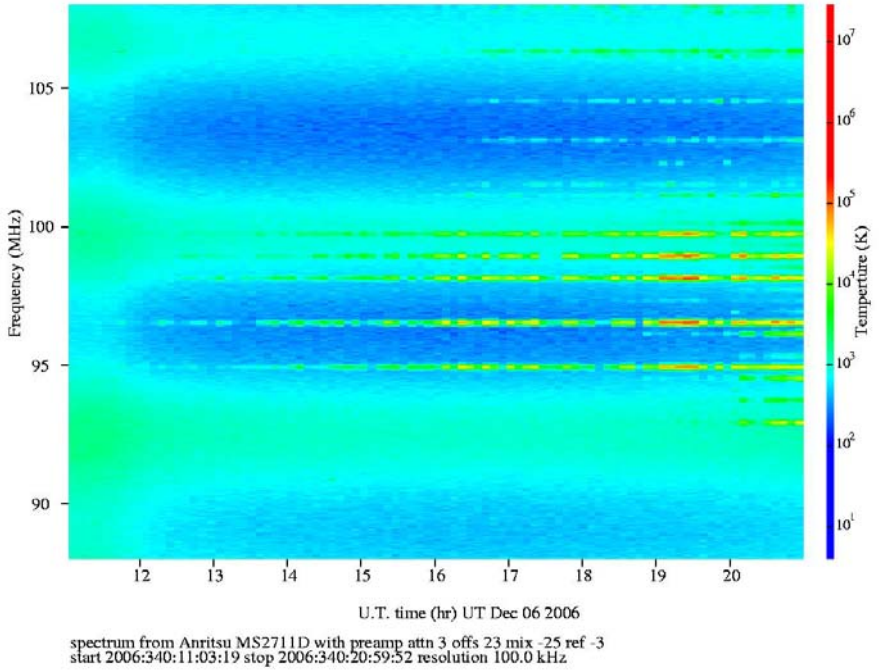


Figure 14

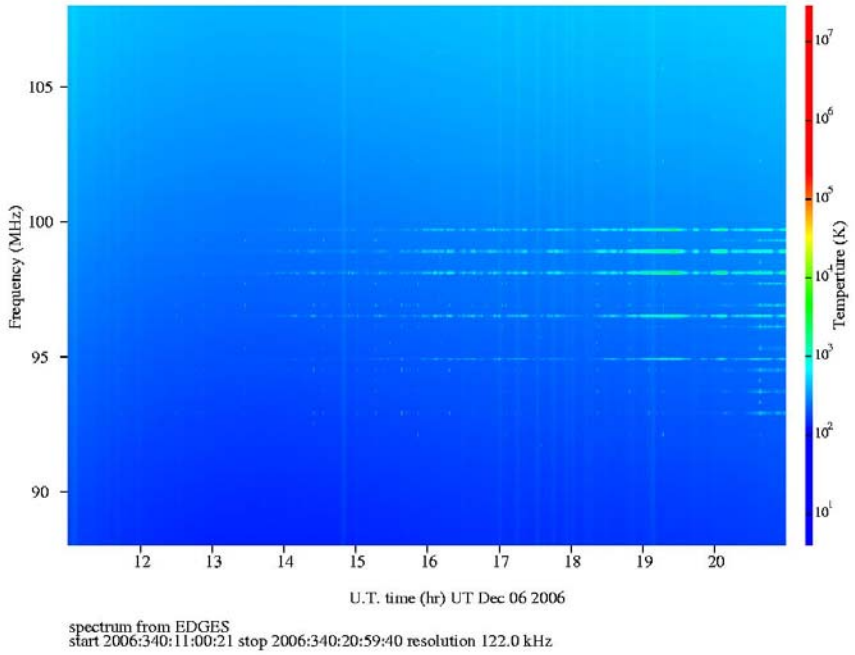


Figure 15

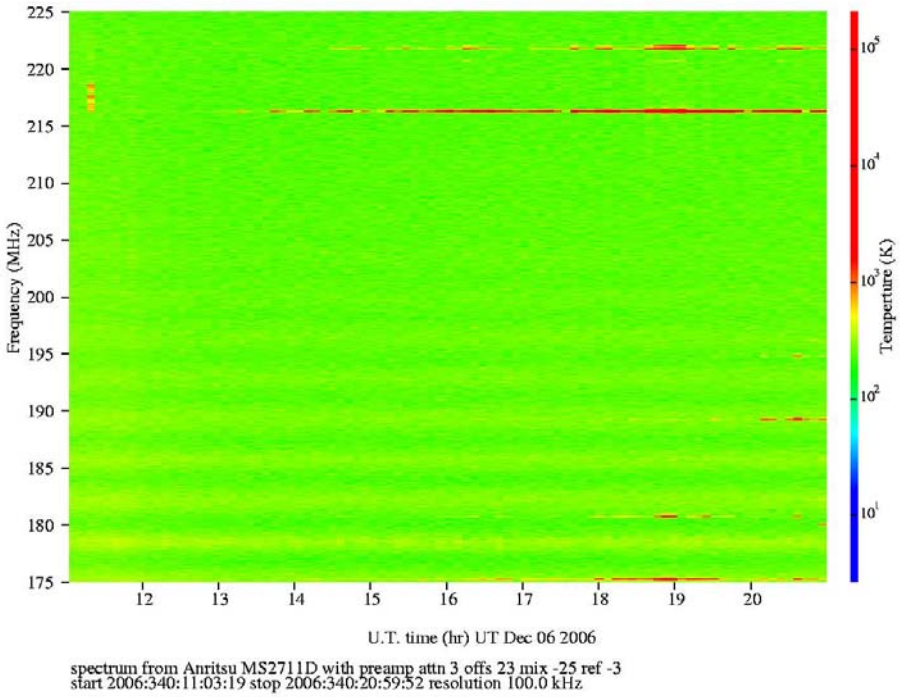


Figure 16

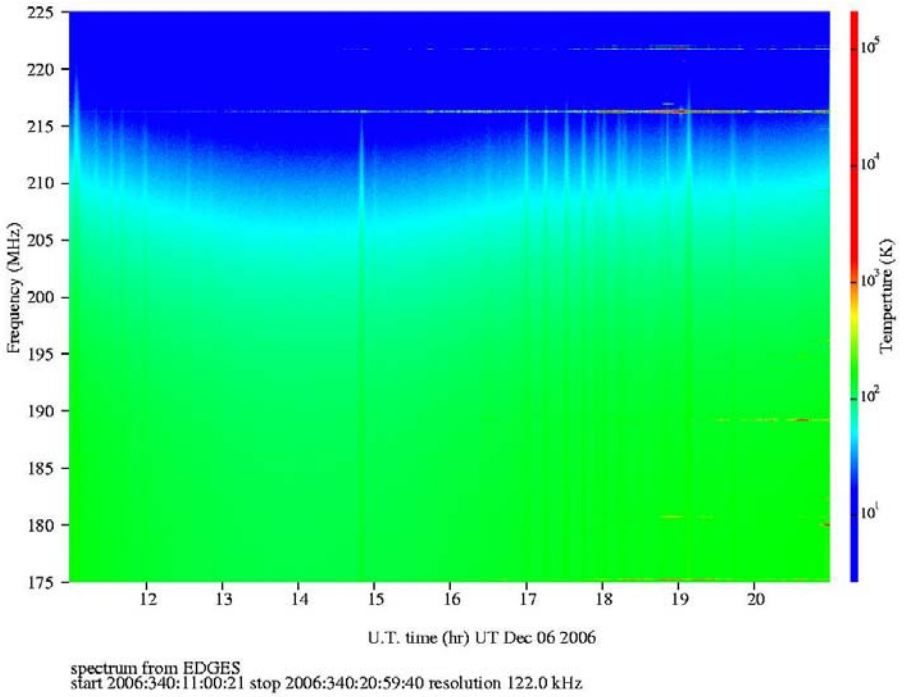

225
220
215
210
205
200
195
190
185
180
175
Frequency (MHz)
12
13
14
15
16
17
18
19
20
U.T. time (hr) UT Dec 06 2006
10^5
10^4
10^3
10^2
10^1
Temperture (K)
spectrum from EDGES
start 2006:340:11:00:21 stop 2006:340:20:59:40 resolution 122.0 kHz

Figure 17