EDGES MEMO #138

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Subject: EZNEC tests for ground plane and box cover resonances

Data from the recent EDGES-2 deployment at the MRO show the intermittent resonances. An example is shown in Figure 1. This shows the calibrated spectrum and the residuals after removal of a scale factor with spectral index 2.5.

The data is from 3 minutes of data centered at 22:45 UT on day 69 2014. The 20K "dip" at 180 MHz is about 4 MHz wide. This dip is present for several hours earlier but disappears abruptly at 22:50. About a month earlier the data also had a dip at about 144 MHz. While at the time of writing this memo the origin of these resonances are unknown but are thought to be the result of intermittent connections in the ground plane or LNA box cover. In order to obtain a stable ground plane metal angle was used to help support the 2"×2" welded wire mesh.

If the end of one of these bars makes no contact with the mesh for about 16" this forms an open quarter wave stub with a resonant frequency of about 180 MHz. If this stub is 1 meter from the antenna dipole and aligned with the E field it produces a large response at the horizon and a drop in the zenith gain. With no resistive loss this dip is very large and very narrow. With 0.1 ohm resistance where the stub is shorted results in -20 dBi at the horizon and about 0.15 dB drop in zenith gain. The half power full width of the resonance is only 300 kHz. Increasing the resistive loss to 1 ohm reduces the drop in zenith gain from 0.15 dB to 0.015 dB but broadens the resonance to a width of about 3 MHz. Most of the loss of zenith gain is the result of resistive loss. Raising the height of the stub off the ground plane from 1 to 2 cm tends to broaden the resonance and shifts the resonant frequency up.

Moving the stub further away by a factor of 2 reduces the strength by a factor of 4. A resonance can be excited for all orientations of the stub at all azimuths from the dipole antenna except when the stub direction is normal to the dipole direction and is on the normal from the center of the dipole.

An open three quarter wave stub resonant at 180 MHz could be formed when an end is not connected for 48" but this condition is unlikely since the bars are attached about every 16" to 20". A half wave stub shorted to the mesh at each end could resonate at 180 MHz if it is about 32" long but the coupling is much weaker and the chance of no connection to the mesh for this distance is unlikely. However a half wave stub, shorted at each end can have its resonance moved to much lower frequencies if there is capacitance to ground. For example, a 16" long bar can resonate at 150 MHz if there is a capacitance of 5 pf to ground in the middle. The LNA is in a metal box under the antenna opening the possibility that resonances can be produced by non-continuous contact of the box cover. In this case the coupling can be very strong owing to the

proximity of the resonant surface to the antenna. In addition the capacitance tuning lowers the impedance and broadens the resonance.

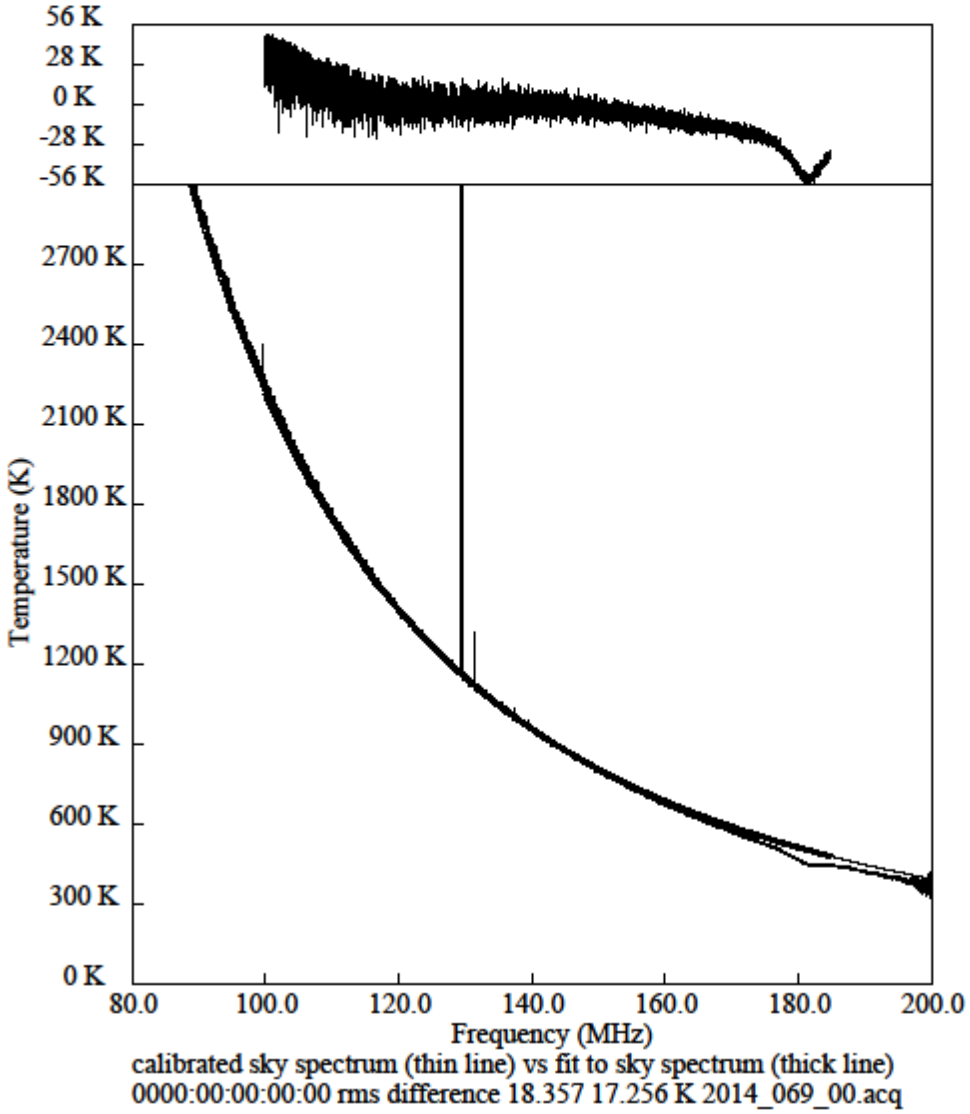

Figure 1. Example of intermittent resonance