Some Spectral Measurements at C and Ku Bands

R. D. Norrod, R. J. Simon, W. A. Sizemore

October 5, 2005

Introduction

A GBT spectral line observer reported difficulty observing in the frequency range 3.9-4.2 GHz, and near 12.1 GHz. At the same times, he achieved satisfactory results at 4.87 GHz and 14.3-15.5 GHz. Figures 1 and 2 show an example of the problem. In response to these reports, during a test period on September 29, we ran a series of two-minute scans using the C-band and Ku-band receivers and the autocorrelation spectrometer. This report summarizes the findings.

Setup

During some GBT test time on 29 September, we setup for test observations with the 3.95-5.85 GHz (C-band) receiver. Each receiver polarization was transmitted over two even-numbered fiber IF channels. Each of the four IF channels was detected with two ACS high-speed samplers, by using redundant Converter Modules and Sampler/Filter Modules. The ACS was configured in a four bank, two samplers per bank, 800 MHz bandwidth mode. We ran 121 second scans with 10 second integrations. The signal paths are shown in Table 1.

The receiver was at the focus position and observing the sky. Local time was 11:00-14:00 EDT. The weather was light rain to partly cloudy, with temperature about 60F. For the test observations, the GBT was initially commanded toward the south at 0.00 dec., and -2 HA. We balanced the IF Rack and ACS, and ran a

Table 1: Signal Connections

XL	ODM2	CM1	SF1	Bank A, J1, Sampler 1
	ODM2	CM2	SF2	Bank B, J3, Sampler 1
YR	ODM4	CM5	SF5	Bank A, J2, Sampler 2
	ODM4	CM6	SF6	Bank B, J4, Sampler 2
XL	ODM6	CM11	SF3	Bank C, J5, Sampler 1
	ODM6	CM12	SF4	Bank D, J7, Sampler 1
YR	ODM8	CM15	SF7	Bank C, J6, Sampler 2
	ODM8	CM16	SF8	Bank D, J8, Sampler 2

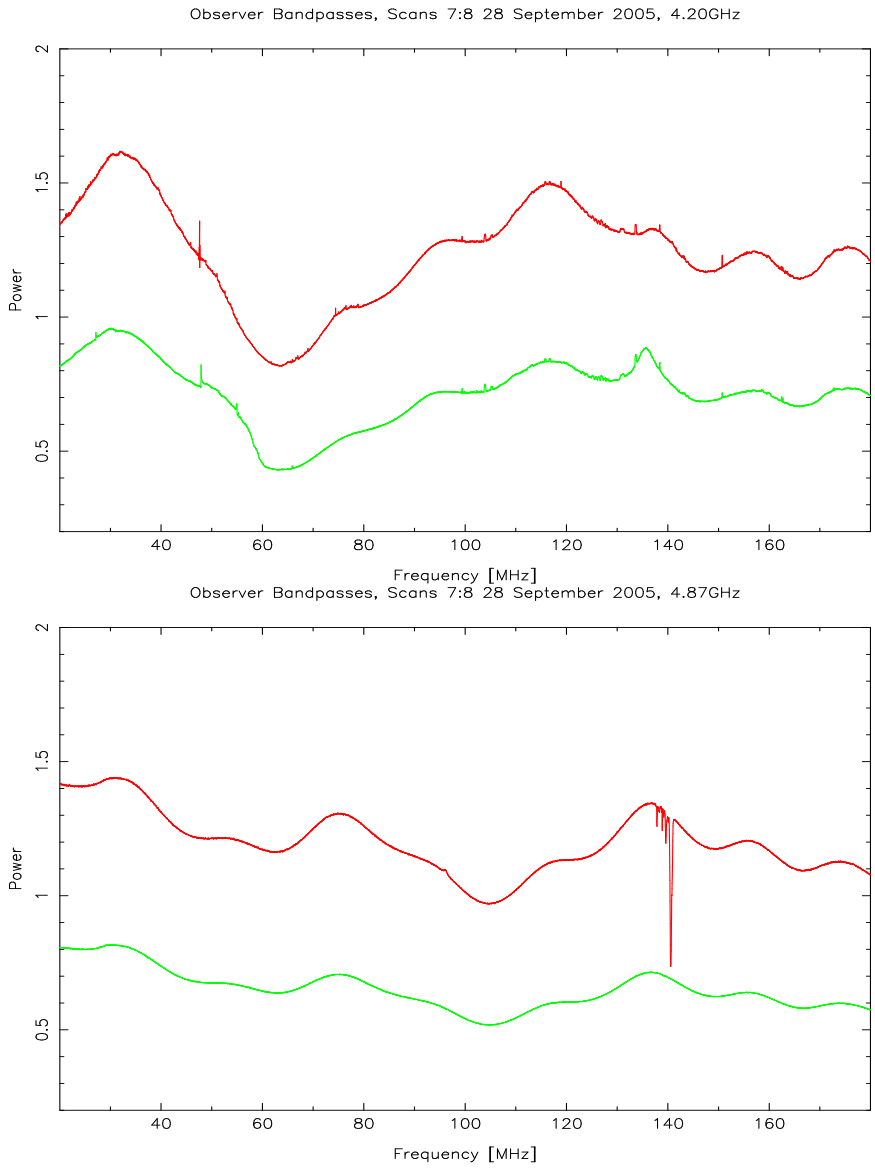

Figure 1: Raw 200MHz wide bandpasses taken by an observer the evening of September 28. The horizontal axis corresponds to the ACS IF frequency, and sky frequency increases toward the right. For the upper panel, data comes from ACS bank C, and the center frequency (100MHz) corresponds to a nominal sky frequency of 4.2GHz. For the lower panel, the center frequency corresponds to 4.87 GHz on the sky. Red traces are on-source; green traces are off-source.

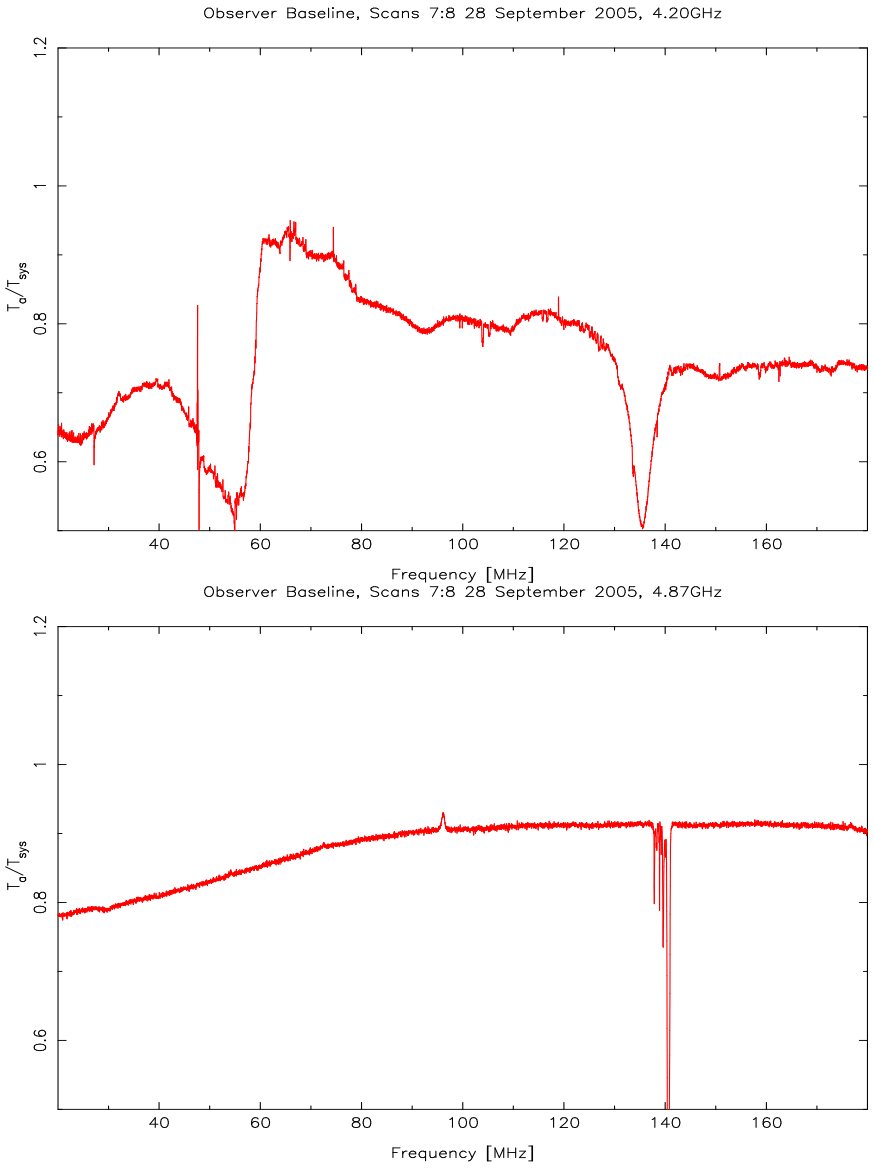

Figure 2: Baselines $((On - Off)/Off)$ for the scans shown in Figure 1. The feature at 140MHz in the lower panel is a line being observed. The baselines for the 4.2GHz channel are so irregular that the data is not usable.

series of ten two minute scans. We then commanded to a position to the North, 70.0 dec, -2 HA, and again ran ten scans. Finally, we commanded to a position toward the Jansky Lab, 25 deg EL, 69 deg Az and again ran ten scans. For each pointing, the GBT tracked the commanded RA/Dec position throughout the series of scans.

C-band Results

To analyze the data, glish procedures developed by Fisher, Balser, and Norrod during the baseline investigation project were used. The baseline value T_a/T_{sys} is calculated on a pair of scans, and corresponds to $(Scan_i - Scan_{i+1})/Scan_{i+1}$. To display the results, baselines for a series of scans were plotted, offsetting each trace for clarity. The routine steps through the series of n scans, calculates, and plots the baseline for each i=1 to n-1. No mean values are subtracted.

Figure 3 shows the results for three separate pointings of the GBT. It can be seen that the baseline quality degrades markedly below about 4.25 GHz, and varies greatly with time and with pointed position.

Ku-band Measurements

We had a brief test at Ku-band to investigate the baselines near 12 GHz. The setup was identical except the four Ku-band receiver IF channels were connected in place of the C-band IF signals. Figure 4 shows the results for one Ku-band channel (typical of all). We only had time for one telescope pointing, toward the south at 141Az, 45El. Note in Figure 4 the clear transition in the baselines at approximately 12.7 GHz (100MHz on the plot).

Summary

We are convinced that the observational difficulties in the 3.9-4.25 GHz and 12.0-12.7 GHz bands are due to RFI, most of which is due to satellite downlinks. The bands 3.7-4.2 GHz and 11.7-12.7 GHz are used primarily for geostationary satellite television downlinks. A listing of satellites in orbit and their frequencies can be found at:

http://www.monitoringtimes.com/html/mtssg.html

The "Bart's Head"-like feature seen centered at 4200 MHz, approximately 80-100 MHz wide, is most likely an airborne altimeter or perhaps a ground avoidance radar. We are attempting to get more information about these potential interfering sources.

The NRAO-GB Interference Protection Group maintains a web site which has additional information about frequency allocations, and observed RFI signals seen in Green Bank. The page can be found at:

http://www.gb.nrao.edu/IPG/

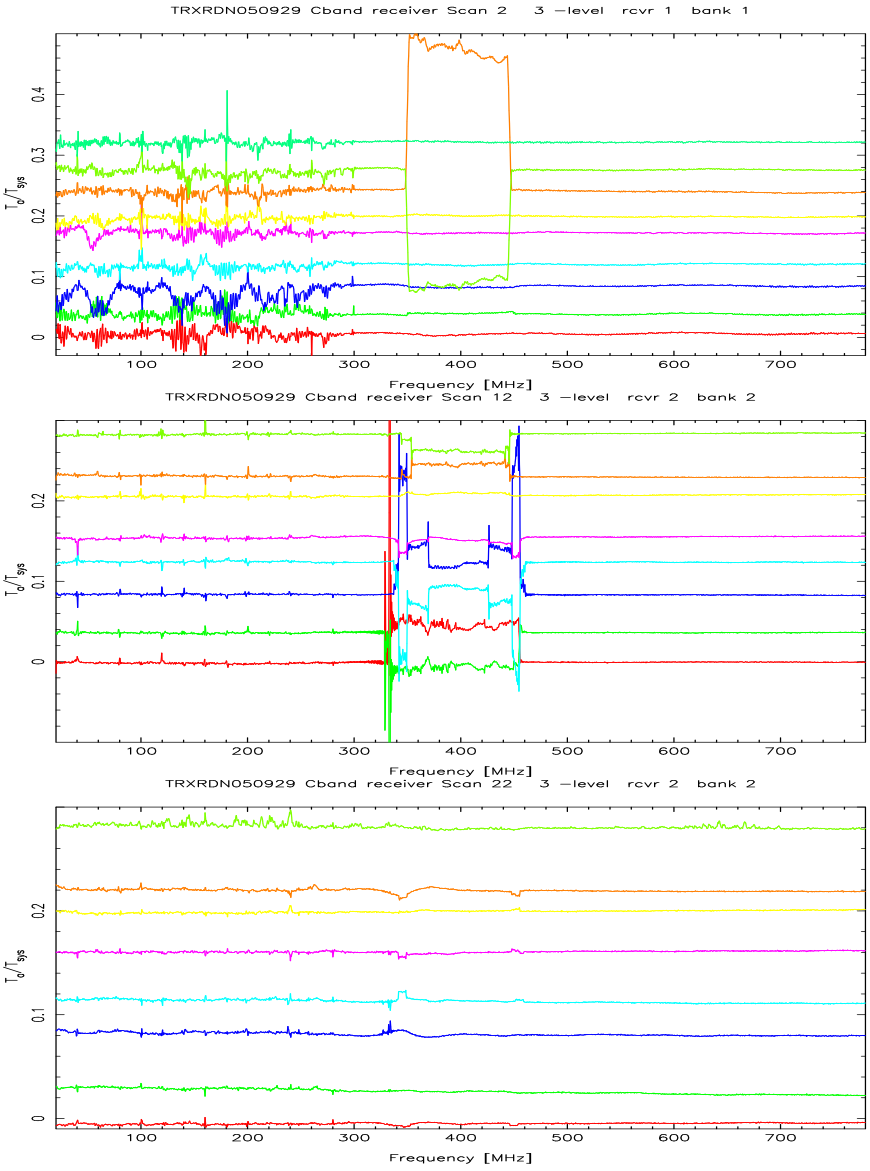

Figure 3: C-band spectral baselines for three pointings of the GBT. Upper panel: toward the south 0.0 dec, -2 HA; middle panel: Near the pole, 70.0 dec, -2 HA; lower panel: toward the Jansky Lab, 25 deg EL, 69 deg Az. In each plot, time progresses upward. The center of the horizontal axis (400 MHz) corresponds to a sky frequency of 4.2 GHz, and sky frequency increases toward the right.

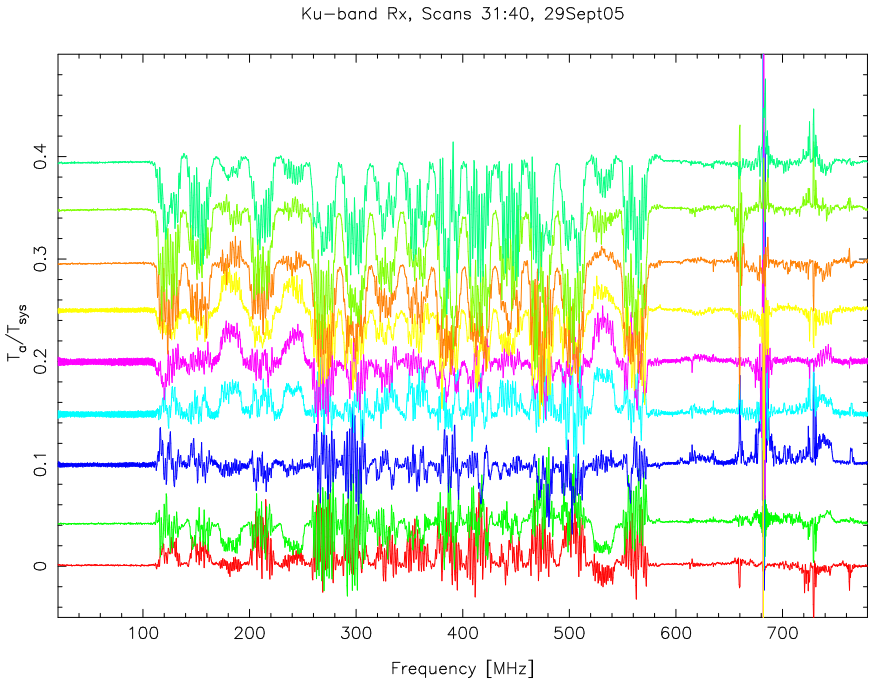

Figure 4: Spectral baselines with the Ku-band receiver. The center of the horizontal axis (400MHz) corresponds to a sky frequency of 12.4 GHz, and sky frequency increases toward the left. The GBT was tracking 0 Dec, 14.2 RA (-3 h HA).