NATIONAL RADIO ASTRONOMY OBSERVATORY
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APPLICATION OF SYSTEM TEMPERATURE TO VLA DATA

N. R. Vandenberg

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During the observing session of August 1 to 3, there were 16 hours allotted to observing program AH6 (Hjellming and Vandenberg). The application of the system temperature to the calibrator data taken during this run has been examined in some detail, and this report summarizes the results.

The data consisted of 16 hours during which we alternated between 6 and 20 cm. The primary calibrator was 3C418; in addition there were a few scans on 3C286, 3C345, and 3C147. Flux densities assumed for these sources were taken from the most recent epoch observations as reported by Fomalont. At the beginning of the run, 3C418 was rising (system temperatures somewhat high) and antenna 3 was shadowed by at most 7 meters. No other antennas were shadowed during scans on calibrators.

The antenna gains were derived from the correlator data by using the program ANTSOL which solves for the amplitudes using a least squares technique and for the phases using a reference antenna to define zero phase. The program first applies the current gain table (in this case containing secant z and shadowing corrections) and normalizes by the flux density, then computes scan averages for all the correlators, and then does the solutions. The resulting voltage amplitudes were squared and averaged over all scans; the averages are listed in the first column of the tables. These averages have a typical rms of approximately 4.5% at 6 cm and 8% at 20 cm. It is obvious that some antenna-IFs had very low sensitivity, notably 2A, 4A, and 6A at 20 cm, and 2A, 2C, 4A, 6A, and 6C at 6 cm. The average of all these amplitudes has an rms of about 50%. Excluding the obviously low data, the rms is reduced to about 30%. The main purpose of this analysis was to determine which of the low amplitudes are the result of high system temperatures, and can therefore be corrected, and which are due to other effects.

The system temperatures were derived from monitor data logged during the run. The program GTTSYS was used to compute the system temperature as the ratio of total power to switched power (cal signal). The second column of the tables lists the average (over the entire 16 hours) of this ratio, and its associated rms. In most cases the cal signal was very stable, and the total power increased somewhat toward low elevations. The low elevation data was eliminated from the averages. The only very bad measurements occurred for antenna 1C at 20 cm, which has an rms of 77%. The average rms for the remaining measurements is 11% at 20 cm and 7% at 6 cm. The actual system temperatures were then computed by multiplying the total power-to-cal ratios by the actual cal signal temperatures times 40. These are listed in the third column of the tables. The overall average of the system temperatures has an rms of 50%. Eliminating the very high or low values reduces the rms to about 30%. The determination of system temperature in this manner differs in some cases from the temperature directly measured at the antenna, but only the monitor data-derived temperatures are used here.

Finally, the product of the antenna gains with the corresponding system temperature are listed in the last column of the tables. If the system temperature is the only influence on the gains, then its application should result in the same final amplitude for all antennas and IFs. In some cases the system temperature does bring the antenna amplitude to the nominal values, but in many more cases there exist problems with this method.

At 6 cm antennas 1, 3, and 4 appear to be without problems. For antennas 1 and 3 both the system temperatures and antenna gains are near the nominal values (about 60K and 0.300, respectively) and their product is near the nominal value of 18. For antenna 4, the system temperature was high, the amplitude correspondingly low, and their product is near nominal. Antennas 2, 5, and 6 have problems, however. For antenna 2, the system temperature is nominal, but the amplitudes are low by about a factor of 2 to 3. This may be related to a faulty paramp at this antenna. Antenna 5 has anomalously low system temperatures but not correspondingly high amplitudes. Antenna 6 has very high system temperatures, but low sensitivity by a factor of about 1.5 in channel A and a factor of 6 in channel C. This is probably due to the moisture found in the 6 cm feed during the run.

At 20 cm antennas 5A and 6C had a nominal system temperature and antenna amplitude. For antennas 1A, 2C, 4, 5C, and 6A the system temperature is high but the amplitude is low so the corrected amplitudes are near nominal. Problems exist for the other antenna-IFs. For 1C, the amplitude appears near nominal but the system temperature is high by about a factor of 3. For 2A and 6A, the system temperature is high but the corrected amplitude is still too low.

The conclusion drawn from all this is that the system temperature correction to visibility data is not ready for general application yet. There exist problems at more than half of the antennas. Empirical calibration of the data and elimination of low sensitivity antenna-IF data is necessary.

TABLE I

6 cm DATA

Data: 28 5-minute scans on 3C418, 3C286, 3C345, 3C147.
All data are power values.

IF	1000*<gain>	(TP/cal)*Tcal		Tsys(K)	Tsys*<gain>
1A	363	1.45 ±	.07	58	21.1
1C	350	1.37	.22	55	19.2
2A	99	1.68	.07	67	6.6
2C	219	1.33	.04	53	11.6
3A	312	1.69	.07	68	21.2
3C	---(no channel)	1.96	.07	78	----
4A	158	3.44	.40	138	21.8
4C	242	2.30	.24	92	22.3
5A	308	0.69	.04	28	8.6
5C	388	0.51	.05	20	7.8
6A	88	3.76	.21	150	13.2
6C	11	7.55	.11	302	3.3

TABLE II

20 cm DATA

Data: 16 5-minute scans on 3C418, 3C286, 3C345, 3C147.
All data are power values.

IF	1000*<gain>	(TP/cal)*Tcal		Tsys(K)	Tsys*<gain>
1A	177	1.92 ±	.14	119	21.1
1C	224	4.01	3.1	269	60.2
2A	84	0.79	.06	84	7.1
2C	238	1.30	.11	90	21.4
3A	368	3.44	.51	---	----
3C	---(no channel)	----	---	---	----
4A	39	1.44	.07	468	18.2
4C	173	0.49	.03	155	26.8
5A	334	0.92	.13	66	22.0
5C	255	1.49	.26	97	24.7
6A	64	1.85	.31	111	7.1
6C	336	0.65	.08	48	16.1