NATIONAL RADIO ASTRONOMY OBSERVATORY
GREEN BANK, WEST VIRGINIA 24944

GREEN BANK INTERFERENCE OFFICE MEMO #2

Title: Observations of the Geostationary Belt at 10.68-10.7 GHz

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Background:

The American Mobile Satellite Corporation and Telesat Mobile Inc. of Canada are developing geostationary satellites that will have downlinks near the 10.68-10.7 GHz radio astronomy band. After much negotation, they have been convinced to install filters in the satellites to reduce emissions in the band to the CCIR 224 limit. The 140' telescope at Green Bank was used to observe the geostationary balt at 10.68-10.7 GHz to determine if there are emissions from other satellites in this band.

Observations:

Observations were made on November 21, 1993 from 14:00 to 19:30 UT using the 140-ft NRAO antenna. We scanned along the geostationary belt from horizon to horizon (approximately from satellite longitudes West 152 to West 7) twice, once moving the telescope at 3 degrees/minute and then at 1 degree/minute. We will ignore for the rest of this report the data taken at the faster slew rates since they agreed with the data taken at the slower rates but were three times lower in sensitivity. At all times, the telescope, which has a 3 arcmin beam at 10.690 GHz, was within 1 arcmin of the geostationary belt.

The observations used the standard Ku-band HFET receiver mounted at the telescope's Cassegrain focus. The output from a single polarization of the amplifier feed two of the sections of the Mark IV Autocorrelator backend. Each section had a 20 MHz bandwidth, one was centered at a sky frequency of 10.6925 GHz and the other at 10.6875 GHz giving a total frequency coverage of 25 MHz (from 10.6775 to 10.7025 GHz), slightly more than the 20 MHz band of interest (i.e., from 10.680 to 10.700 GHz). Since both sections used 512 channels, we had a frequency resolution of 39 KHz. Typical system temperatures were 48 K.

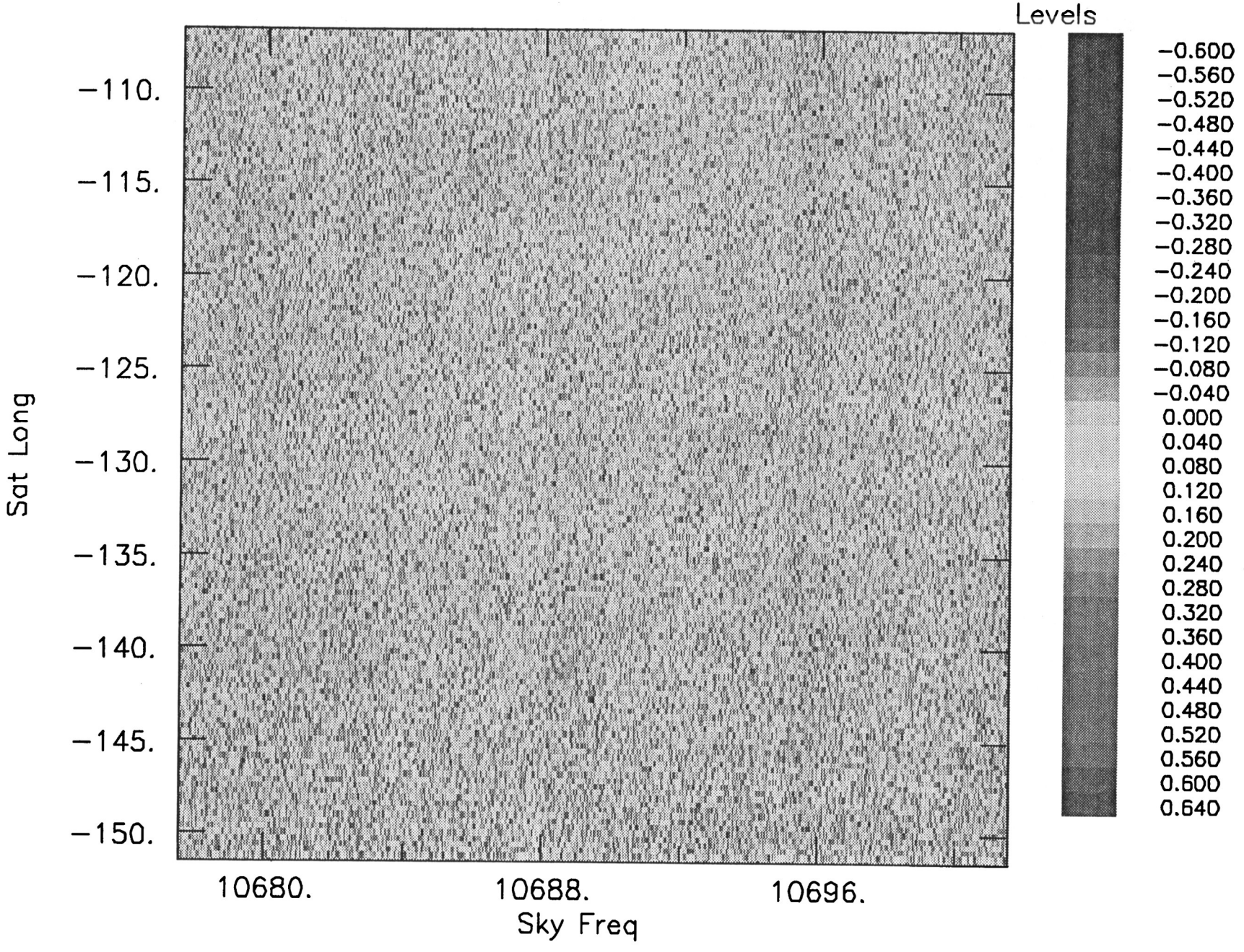
Both sections of the Autocorrelator took spectra every 20 seconds, the fastest the backend can take data. Since the telescope was slewing (for the date we are interested in) at 1 degree/minute, the telescope was moving 20 arcmin in the 20 seconds needed to take spectra. Each spectra, therefore, covered an area approximately 6.7 times larger than the telescope's beamwidth. In total, we took measurements at 488 positions with two spectra with slightly different center frequencies at each position. Using the average one-sigma rms noise level in each spectra (0.09 K), the efficiency and surface area of the telescope, plus the fact we were slewing while taking data, we calculate that our survey has a three sigma sensitivity of 9 Jy. The data are calibrated to better than 10%.

Using the NRAO single-dish data reduction program, UniPops, we took each spectra and differenced it with its previous spectra so as to remove the instrumental bandpass. We then fitted and removed a low-order polynomial from each spectra. Then, we took for each measured position the two spectra from the two Autocorrelator sections (each 20 MHz wide but with slightly different center frequencies) and produced spectra with a 25 MHz bandwidth. The resulting spectra were arranged into a matrix, with axes of frequency and satellite longitude. In order to display the data in an easily-understood way, we broke up the matrix into four sections with different ranges in satellite longitudes and created the grey-scale renditions of Figures 1-4. To the sensitivity limits of our survey, no narrow-band sources were found. Strong continuum sources would not have been detected using our data reduction techniques.

Figures 1-4: Grey-scale renditions of the intensities measured while the telescope was slewing at 1 degree/minute along the geostationary belt. Each plot covers, along the y-axis, a different range of satellite longitude and, along the x-axis, the same 25 MHz-wide range of frequency (10.6775 to 10.7025 GHz). The darkening of the upper edge of Figure 4 resulted from observing below the horizon. The combination of the four figures represents all of the data in our survey.

Conclusions:

The geostationary belt from 152 degrees to 7 degrees west longitude is free from emissions in the 10.68-10.7 GHz radio astronomy band. The successful negotations with the American Mobile Satellite Corporation and Telesat Mobile Inc. of Canada will hopefully insure that this band will remain free from emission in the near future and may set a precedence for cooperation between radio astronomy and commercial users of this spectra.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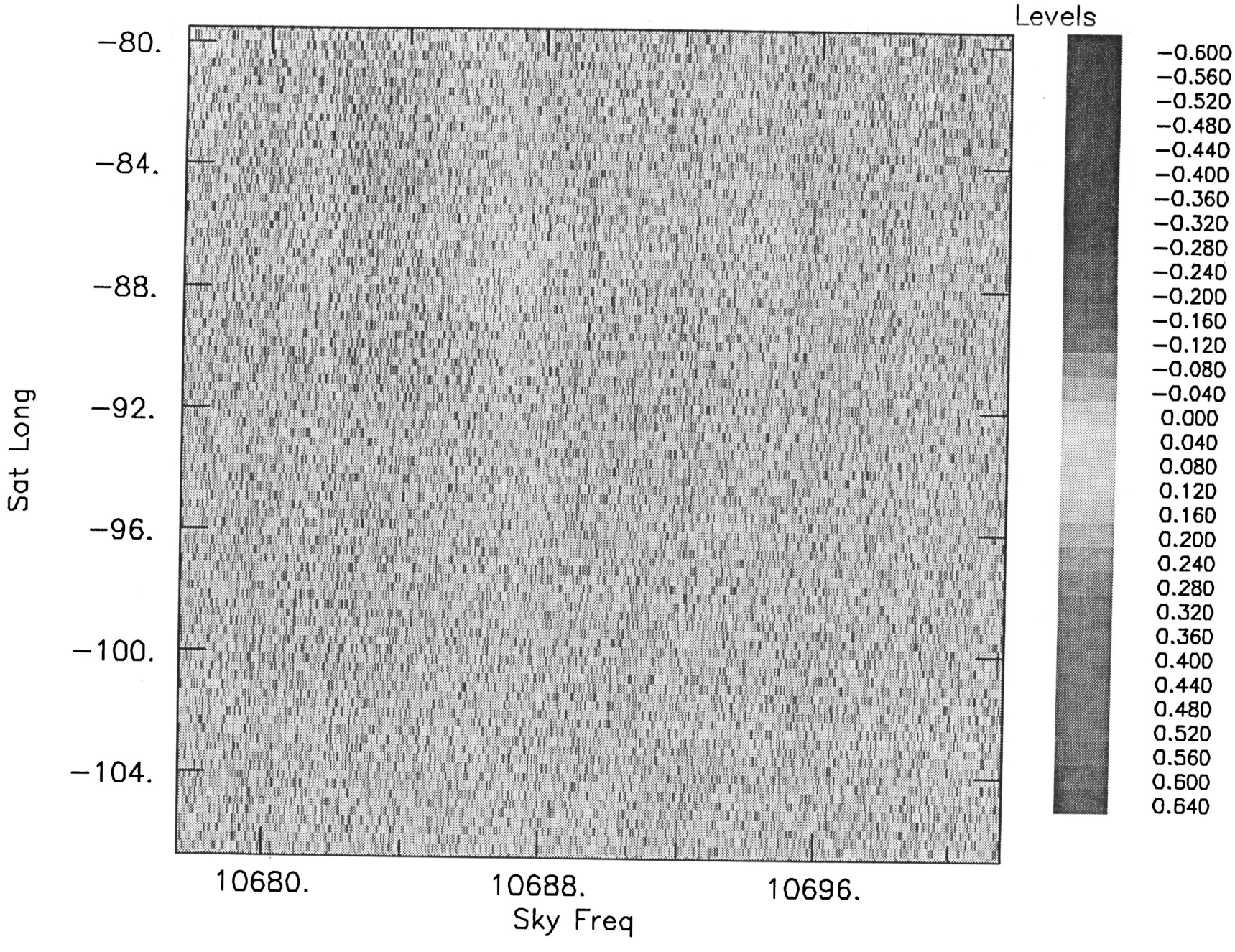
−0.440
−0.400
−0.360
−0.320
−0.280
−0.240
−0.200
−0.160
−0.120
−0.080
−0.040
0.000
0.040
0.080
0.120
0.160
0.200
0.240
0.280
0.320
0.360
0.400
0.440
0.480
0.520
0.560
0.600
0.640
Sat Long
−110.
−115.
−120.
−125.
−130.
−135.
−140.
−145.
−150.
10680.
10688.
10696.
Sky Freq
STRIP 1
Comment:
11/21/93

FIGURE 1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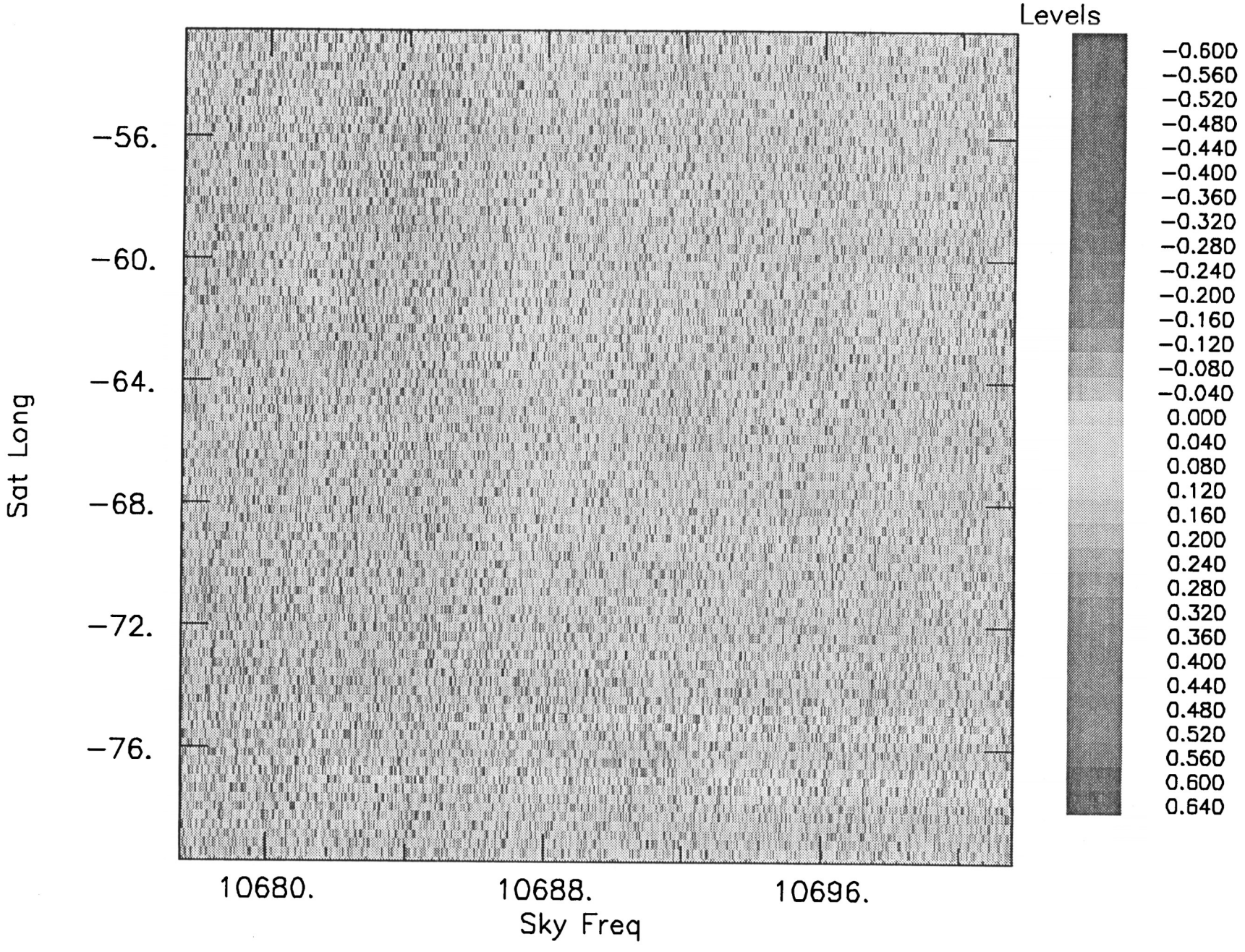
−0.520
−0.480
−0.440
−0.400
−0.360
−0.320
−0.280
−0.240
−0.200
−0.160
−0.120
−0.080
−0.040
0.000
0.040
0.080
0.120
0.160
0.200
0.240
0.280
0.320
0.360
0.400
0.440
0.480
0.520
0.560
0.600
0.640
−80.
−84.
−88.
−92.
−96.
−100.
−104.
Sat Long
10680.
10688.
10696.
Sky Freq
STRIP 1
Comment:
11/21/93

FIGURE 2


Levels
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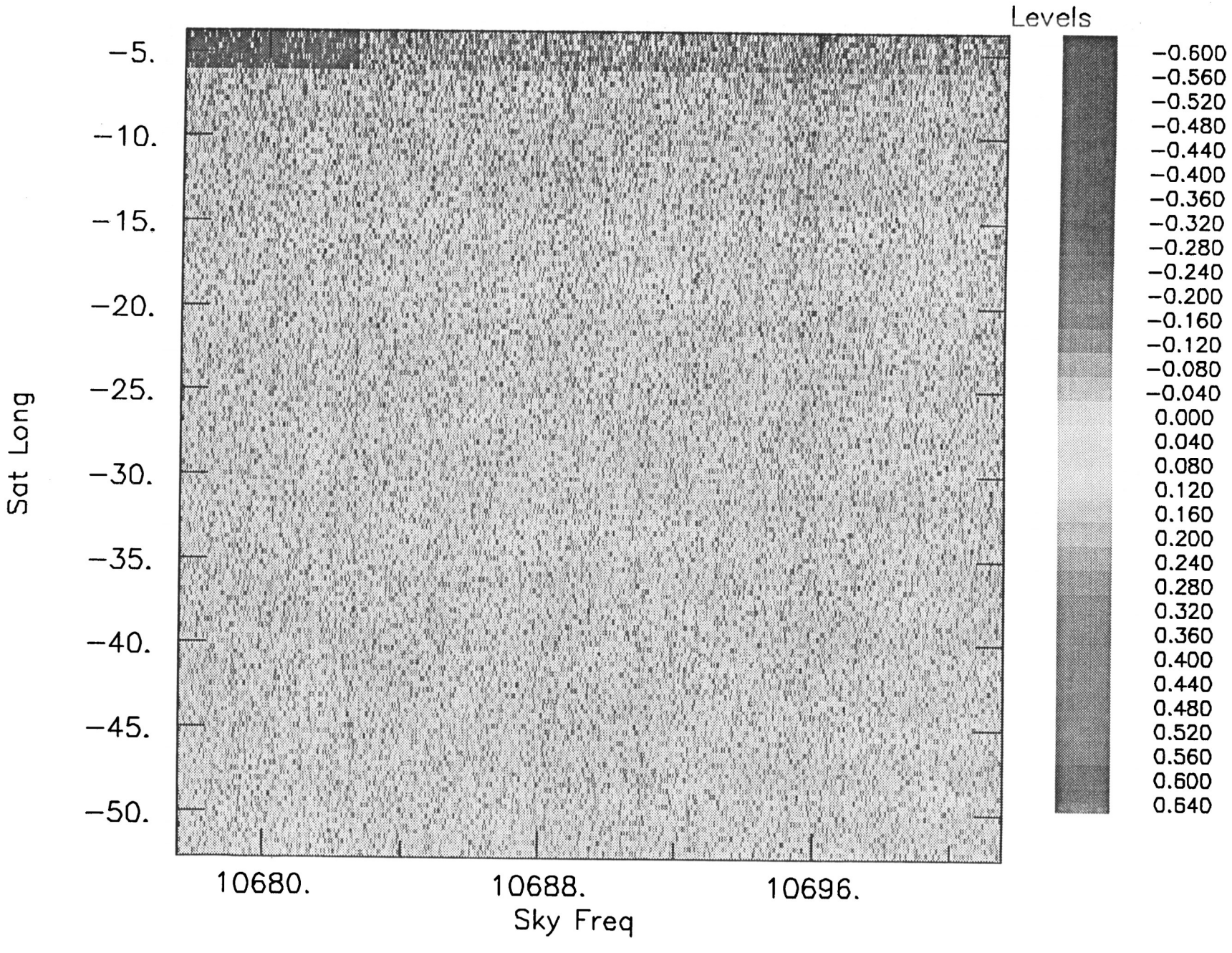
−0.560
−0.520
−0.480
−0.440
−0.400
−0.360
−0.320
−0.280
−0.240
−0.200
−0.160
−0.120
−0.080
−0.040
0.000
0.040
0.080
0.120
0.160
0.200
0.240
0.280
0.320
0.360
0.400
0.440
0.480
0.520
0.560
0.600
0.640
Sat Long
−56.
−60.
−64.
−68.
−72.
−76.
10680.
10688.
10696.
Sky Freq
STRIP 1
Comment:
11/21/93

FIGURE 3


Levels
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−0.560
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−0.440
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−0.360
−0.320
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−0.240
−0.200
−0.160
−0.120
−0.080
−0.040
0.000
0.040
0.080
0.120
0.160
0.200
0.240
0.280
0.320
0.360
0.400
0.440
0.480
0.520
0.560
0.600
0.640
−5.
−10.
−15.
−20.
−25.
−30.
−35.
−40.
−45.
−50.
Sat Long
10680.
10688.
10696.
Sky Freq
STRIP 1
Comment:
11/21/93

FIGURE 4