MILLIMETER ARRAY
MEMO NO. 60

FURTHER STUDY OF THE MAGDALENA MOUNTAIN SITE AND TWO NEW ARIZONA SITES AS POSSIBLE LOCATIONS FOR THE MILLIMETER ARRAY

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May, 1990

The Latest Springerville and Alpine MMA Sites and an Update on the Magdelena Mountains Site

This memo is an update of memo number 53 which explored the feasibility of using the Magdelena Mountains Range (there referred to as South Baldy), located about 40km west of Socorro, New Mexico as a site for the Millimeter Array. The Magdelena Mountains site has been modified slightly since then and two new sites have been explored. One of these sites, 33 km outside Springerville, Arizona offers almost unlimited flexibility in positioning even the largest, 3 km, arrays. However it is only slightly above the altitude restriction of 2700 m (9000 ft). Whereas the other site, 30 km outside Alpine, Arizona, is a plateau at 3000 m (9800 ft) with moderately restrictive terrain for the longer baselines. This memo will demonstrate that these new sites with easily accessible antennas can produce a u-v coverage comparable to that of the Magdelena Mountains site. Since almost all positions within the boundary of each of these new sites are possible then the most important features of the u-v coverages discussed here are the lengths of the baselines. The holes in the u-v coverage presented can be filled in with some more work on rearranging the antennas. For each set of these sites, the preliminary positions, u-v coverage, and beam sizes are discussed for the 3 km array.

Simulations for these arrays were performed using 1.0 mm for the wavelength at declinations of -30, 0, 30, and 60 degrees. A summary of the Springerville array is found in figure 1, the Terry Flat array (outside Alpine) in figure 2 and the latest Magdelena Mountains Array in figure 3. Unreduced plots of the u-v coverages can be found in figures 4 through 15 for the scaled version and figures 16 through 27 for the unscaled. The Springerville and Magdalena Mountains site plots were generated using 40 antennas whereas the Terry Flat plot used only 36. Each dish was assumed here to have a diameter of 7.5 meters.

PROCEDURE

The purpose is to demonstrate that a practical configuration of antennas at each site can produce a respectable u-v coverage at plus or minus 2000 kilowavelengths. There were two jobs involved in this task. One was to look at the topography of each site and see where it might be feasible to put antennas. The other was to simulate the array's u-v coverage at different declinations.

Accommodating the array to the topography of the the two new sites did not prove to be as big as factor as it was in the Magdelena Mountains site. After a site was chosen as a possibility, its latitude, longitude, and altitude were put into a form which could be read by the UVSIM program in AIPS. Obviously, the next step was to enter it into the UVSIM program, choosing the parameters of declination, integration time, hour angle coverage, minimum antenna elevation, and maximum amount of antenna blockage due to shadowing. Different declinations were used, but in each case the integration time was 300 seconds, the hour angle coverage was -2 to +2 hours, the minimum antenna elevation was 10 degrees, and the maximum antenna blockage allowed was 0.01 .

Then UVPLT was used to look at the results of UVSIM. Two scales were made. One was the targeted area for the array, -2 to 2 megawavelengths. The other was an unscaled plot of all points. The latter plot demonstrates the percentage of points in the target area at each declination. Consideration was given to keeping as many of the baselines as possible in the targeted area. A more in depth look at each site will be discussed later.

Finally, to look at the sidelobe levels and beamfits, UVMAP and APCLN were used with a cellsize of 0.02 arcseconds. Lists of the resultant values are given in tables 1 through 3.

SPRINGERVILLE ARRAY

The positions used in the Springerville Array can be found on the map in figure 28 along with the corresponding latitudes, longitudes, and altitudes found in table 4. It is obvious that most every thing is easily accessible, allowing for any length baseline to be created. The only drawback is the relatively low altitude of the site. Figure 1 shows the summary of the u-v coverage. The setup of a radiometer for a more detailed study of the site is in the works.

The beamfits obtained from UVMAP and APCLN, using a cellsize of 0.02 arcseconds are found in tables 2 and 3. The maximum values of the inner sidelobes as can be found in table 3.

ALPINE ARRAY

The positions of the antennas in the Alpine Array are displayed in figure 29 with their specific latitudes, longitudes, and altitudes listed in table 5. Figure 2 shows the summary of the u-v coverage at different declinations. This area is at a much higher elevation than the Springerville site, though not as spacious. One confining factor is the large number of trees found outside the area defined by the road. In the case of this site, environmental considerations are of an even greater importance since the site lies due south of the Escudilla Mountains Wilderness Area. Hopefully, it will be possible to minimize the damage to the aesthetic beauty by placing the antennas along the road and using the largest, most conspicuous, array only during the winter months. The existing road forms an oblong shape with a major axis pointing a few degrees west of north. This results in a u-v coverage for plus or minus 2 hours which is barren in the top right corner (and, consequently the lower left). If this is considered an obstacle to the total spatial frequency coverage , perhaps it could be accommodated for by using greater hour angle coverage.

Beamfits for this array can be found in tables 2 and 3 and the maximum value of the inner sidelobes can be found in table 1.

MAGDALENA MOUNTAINS SITE

(MMA memo number 53)

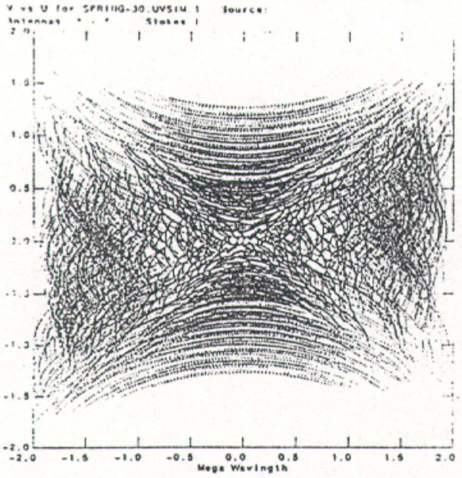
Since the last memo, more work has been done which seems to indicate that the two southern outrigger antennas are unnecessary. Therefore, they have been removed and put back into the array at a more convenient location as seen on the map in figure 30. Latest beamfits and u-v coverage can be found in tables 2 and 3 and figures 11 through 15.

CONCLUSIONS

The Millimeter Array site survey has been limited to three possible candidates: one on Magdalena Mountains site outside of Socorro, New Mexico, one outside Springerville, Arizona, and one on Terry Flat outside Alpine, Arizona. All three sites have adequate u-v coverage. Each has its benefits. The Magdalena Mountains site and Terry Flat are both well above the 2700 meter minimum elevation requirement. Each element of the Springerville and Terry Flat array is very accessible, allowing for a wide range of baselines. Of course, each site has its disadvantages; the Springerville site is barely above 2700 meters, the Magdalena Mountains site has uncompromising topography, and Terry Flat is very close to a wilderness area. Since all three sites are geographically feasible, preference as to which will be the best location for the Millimeter Array will have to be based on other considerations.

May 8, 1990

Figure 1



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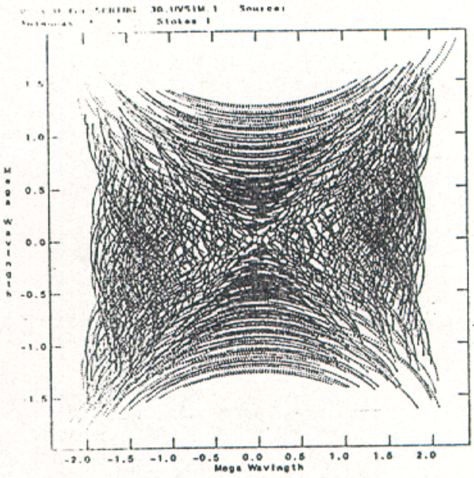

UNSCALED
SPRINGERVILLE
ARRAY
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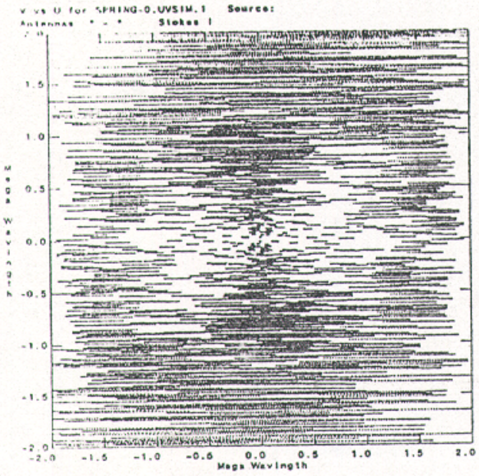

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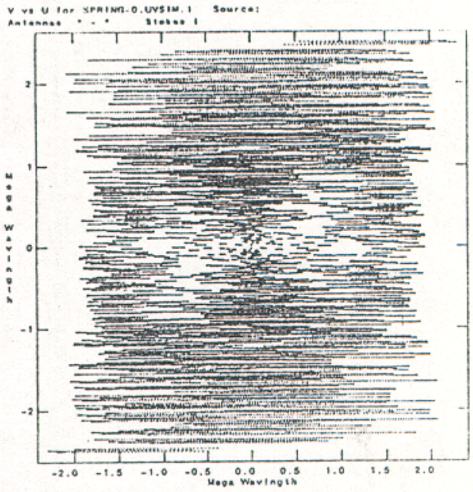
DEGREES



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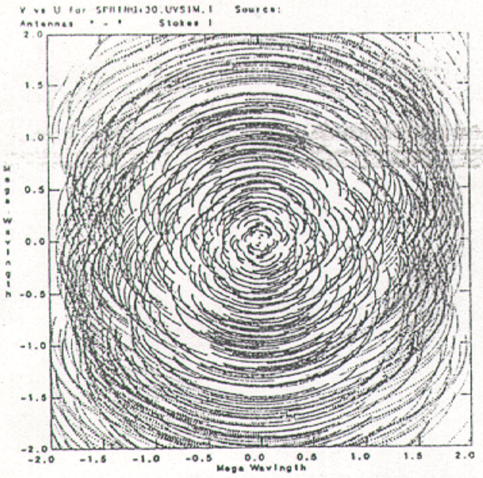

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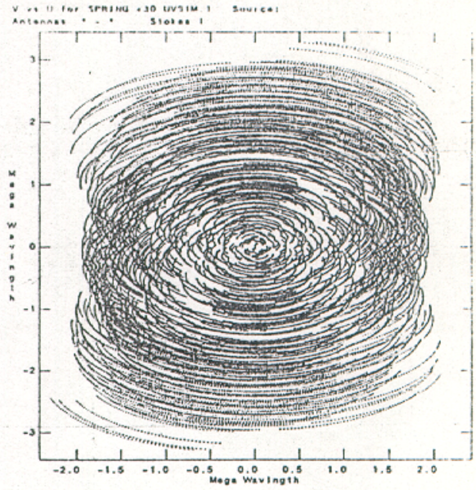

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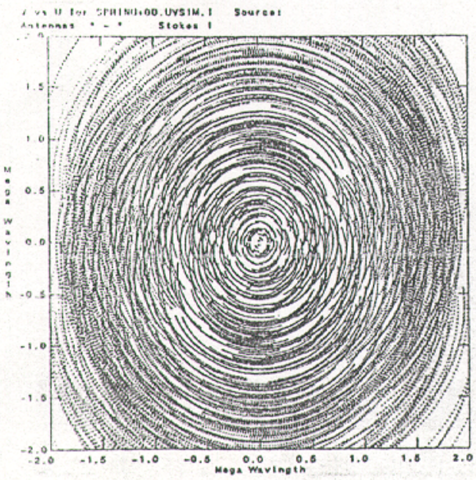

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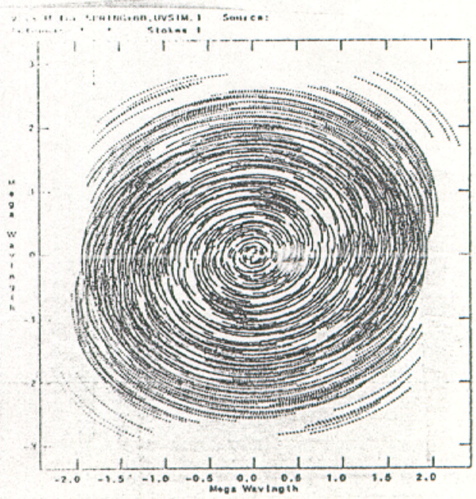
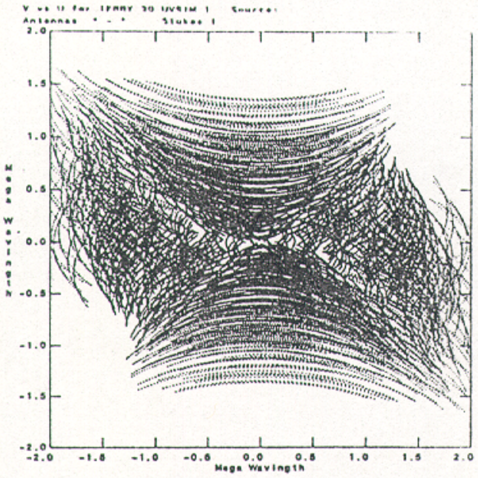


UNSCALED
SPRINGERVILLE
ARRAY
60 DEGREES

Figure 2

SCALED
TERRY FLAT
ARRAY
-30 DEGREES



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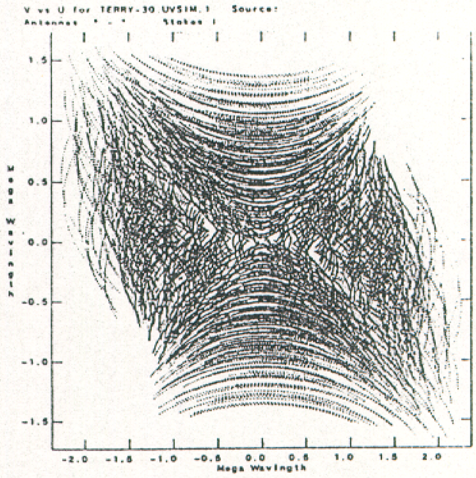

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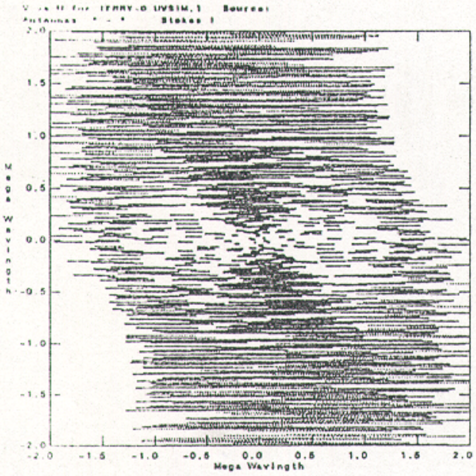

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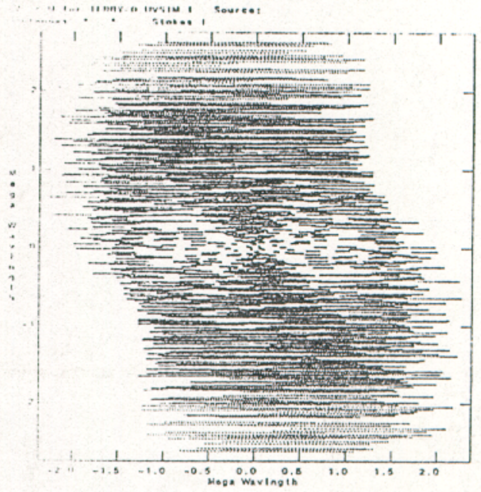

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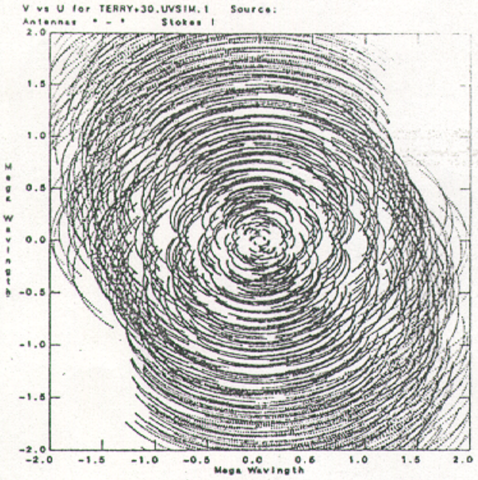

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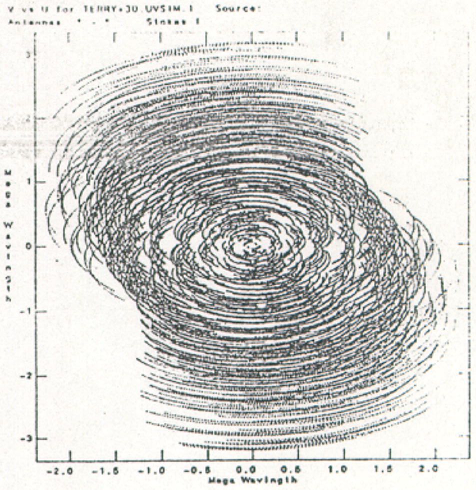

SCALED
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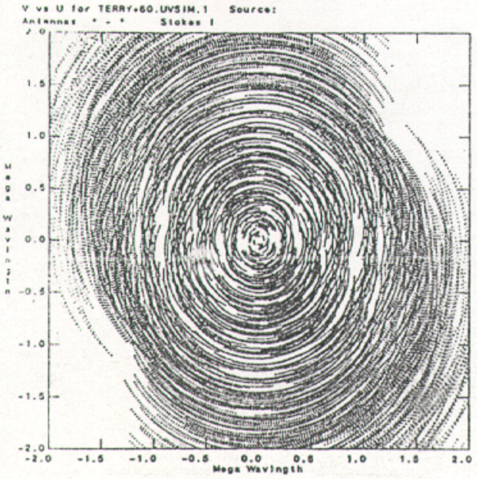

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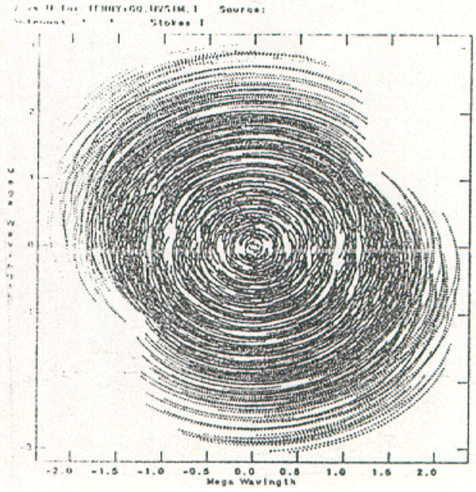

Figure 3

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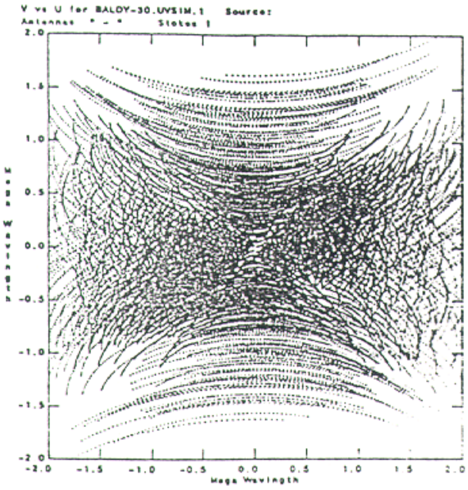

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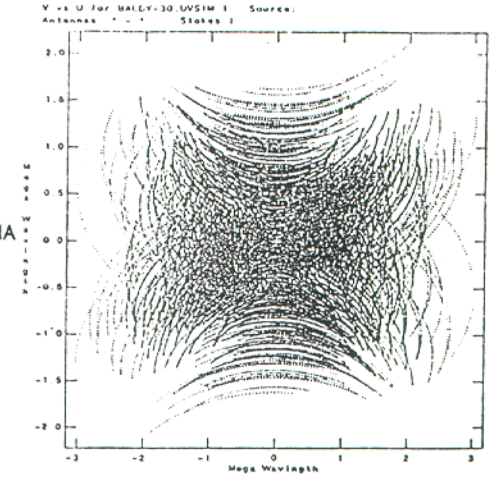

CALED MAGDALENA
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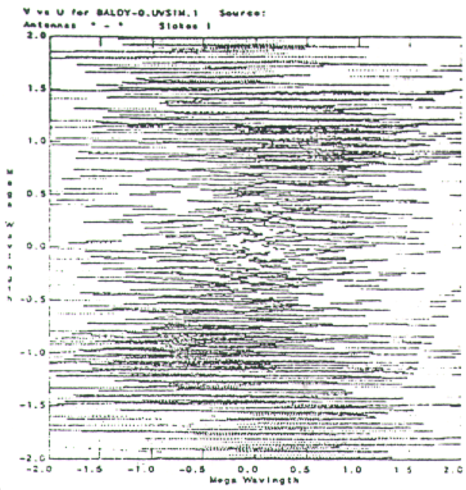

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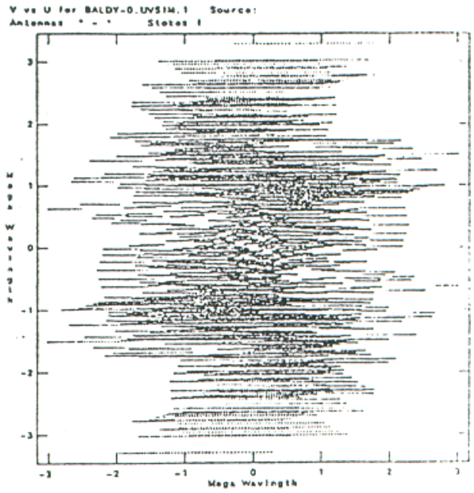

ALED MAGDALENA
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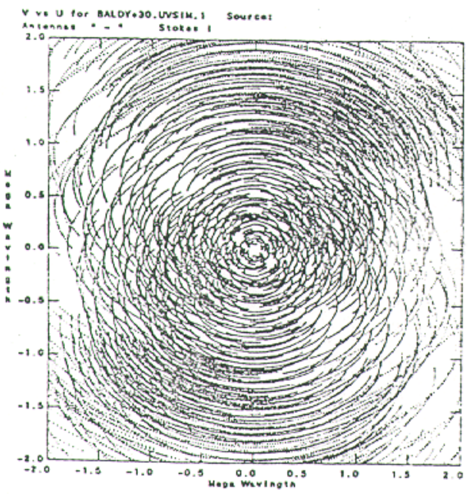
DEGREES



UNSCALED MAGDALENA
MOUNTAIN SITE
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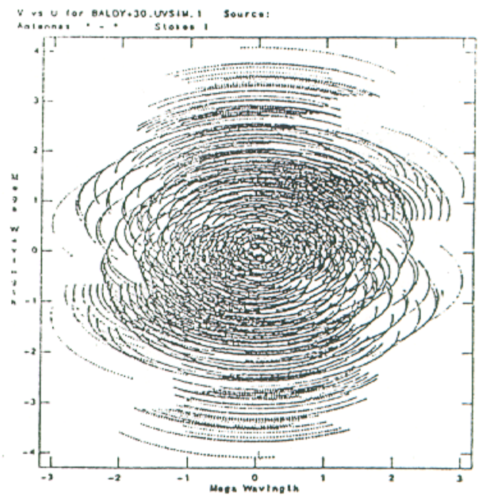

ALED MAGDALENA
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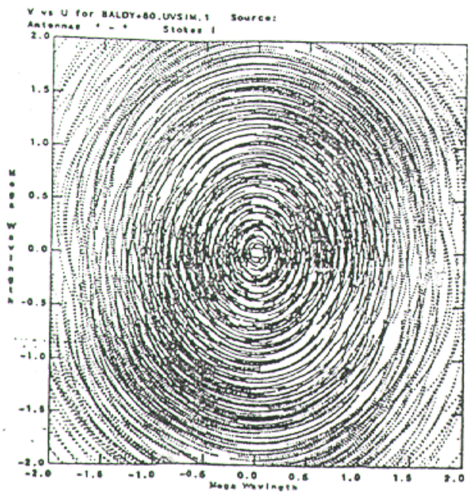
DEGREES



UNSCALED MAGDALENA
MOUNTAIN SITE
60 DEGREES

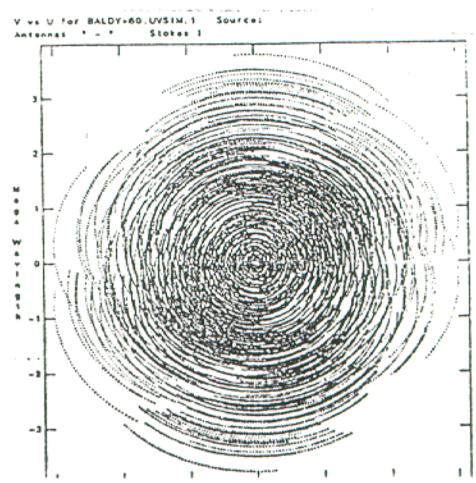
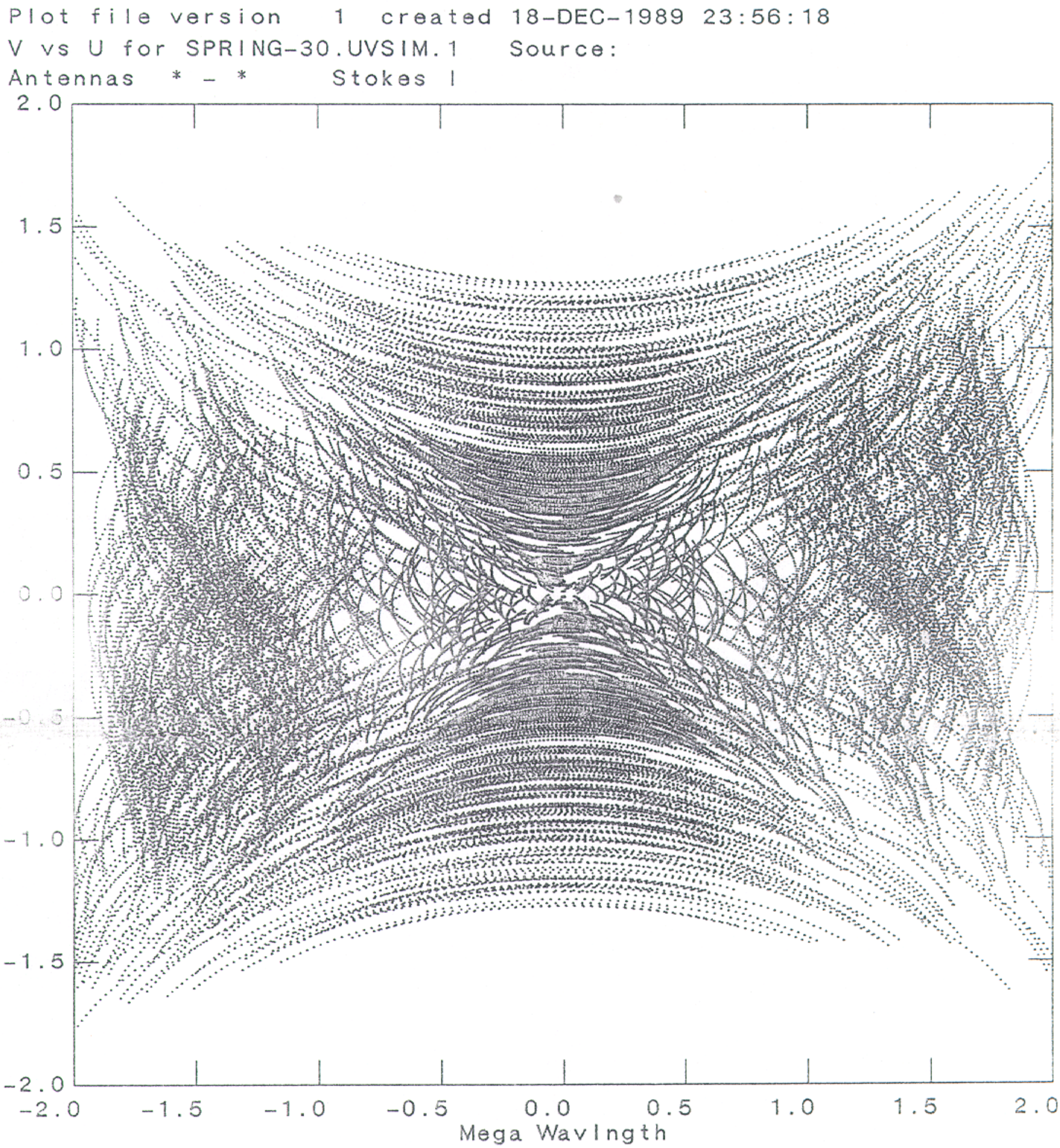


Figure 4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Mega Wavlngth
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0.0
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-1.0
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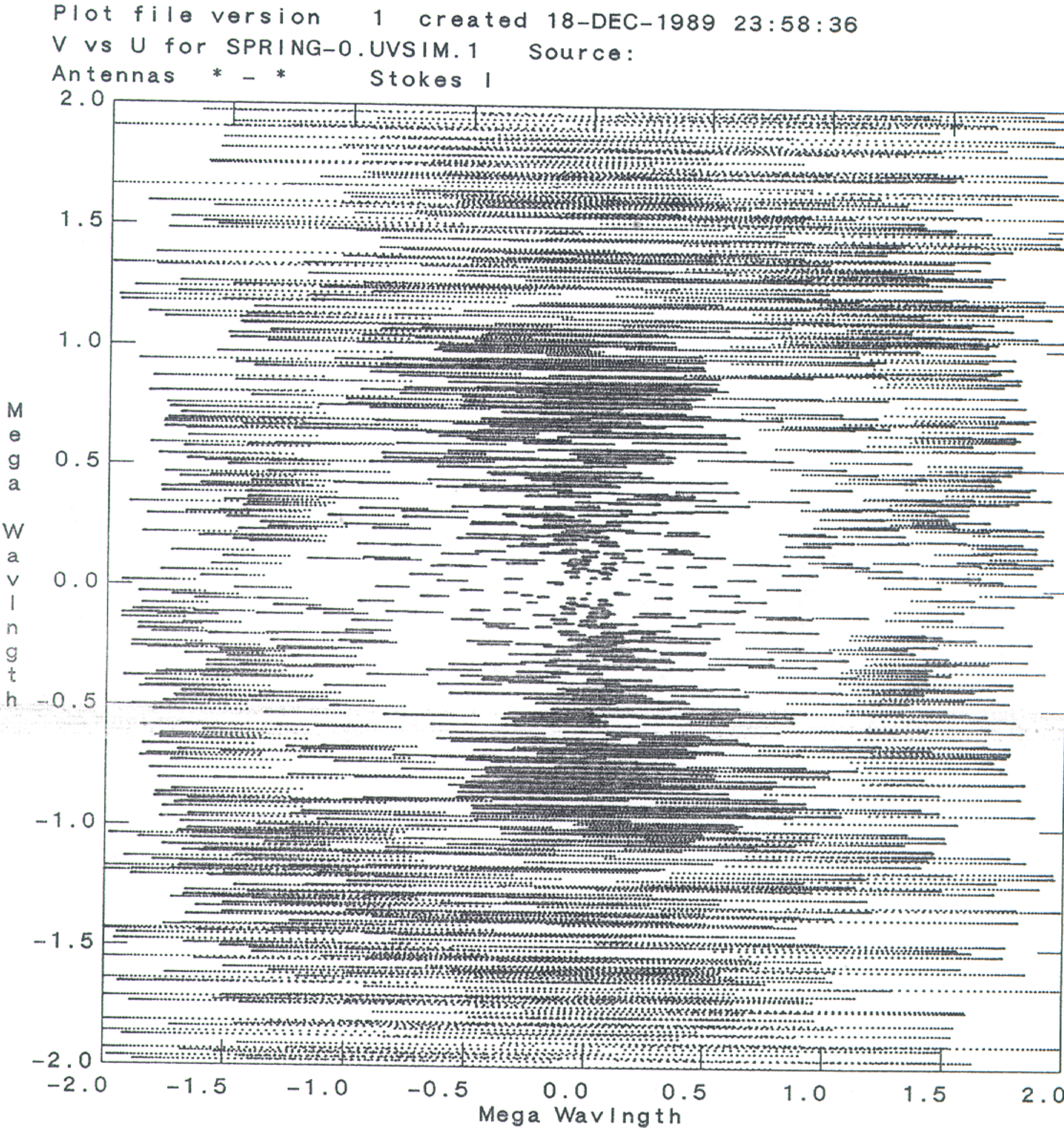
1.5
2.0

Figure 5



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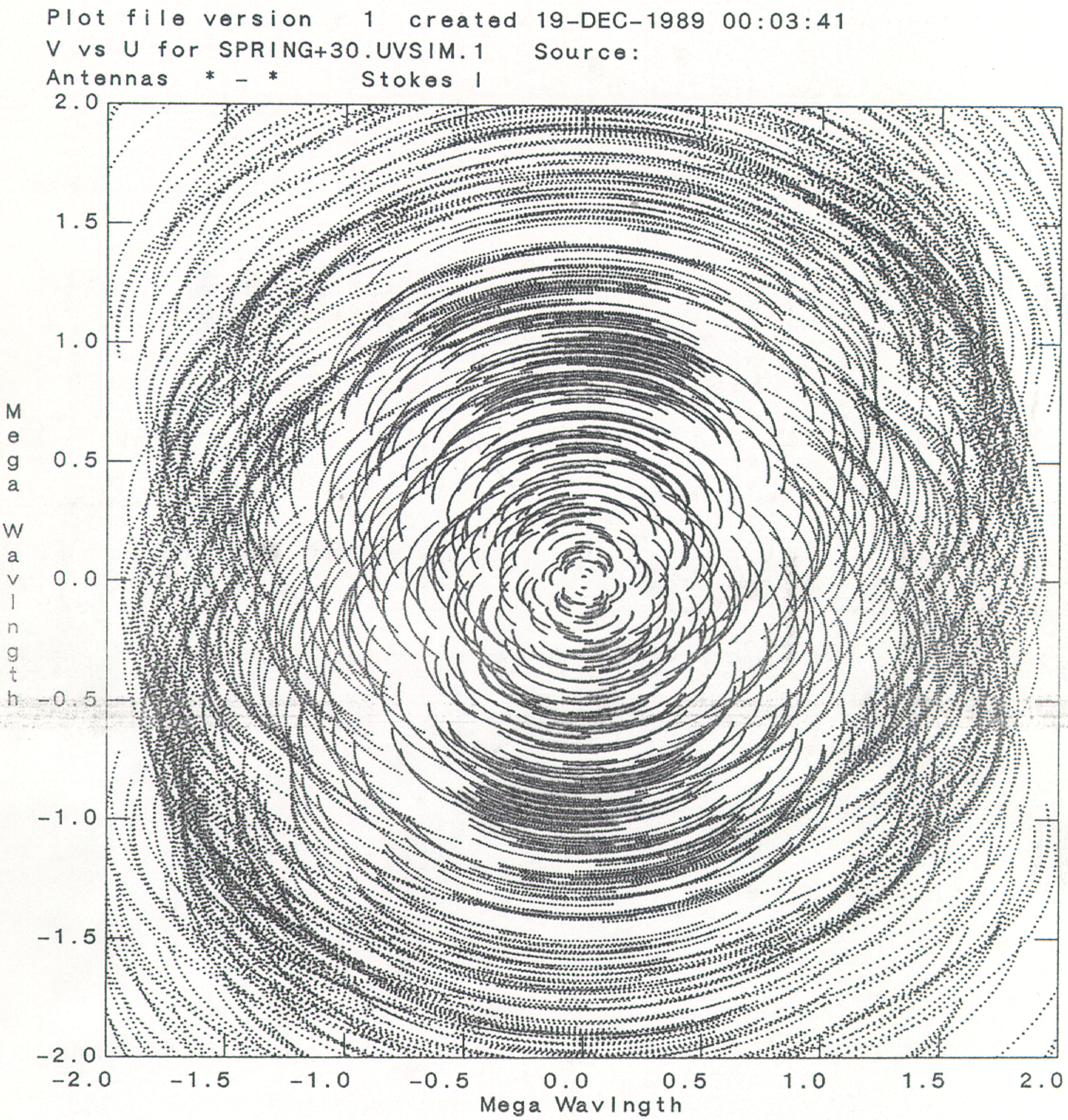
Mega Wavlngth
Mega Wavlngth

Figure 6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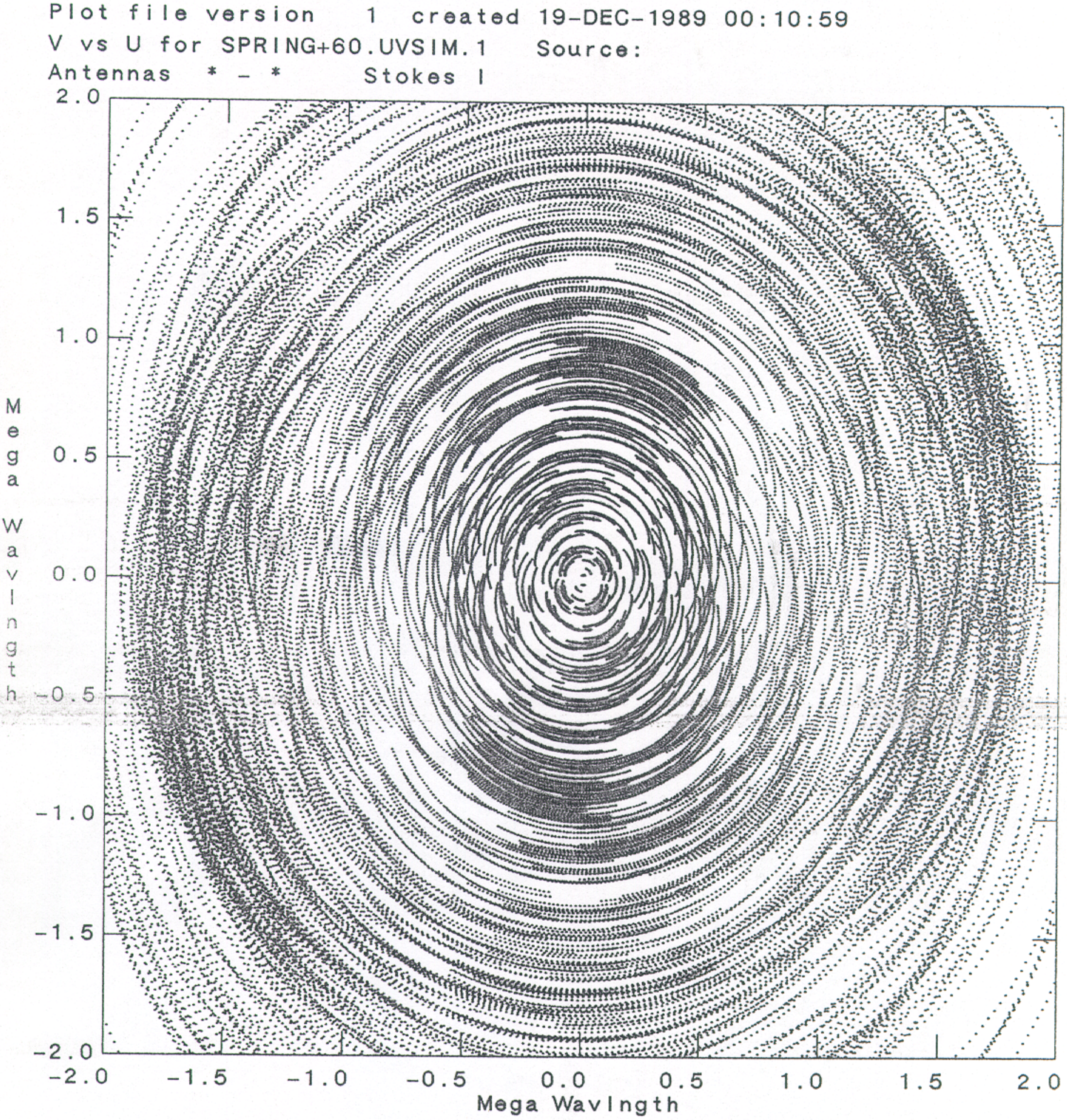
-2.0

Figure 7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1.5
2.0
Mega Wavlngth

Figure 8

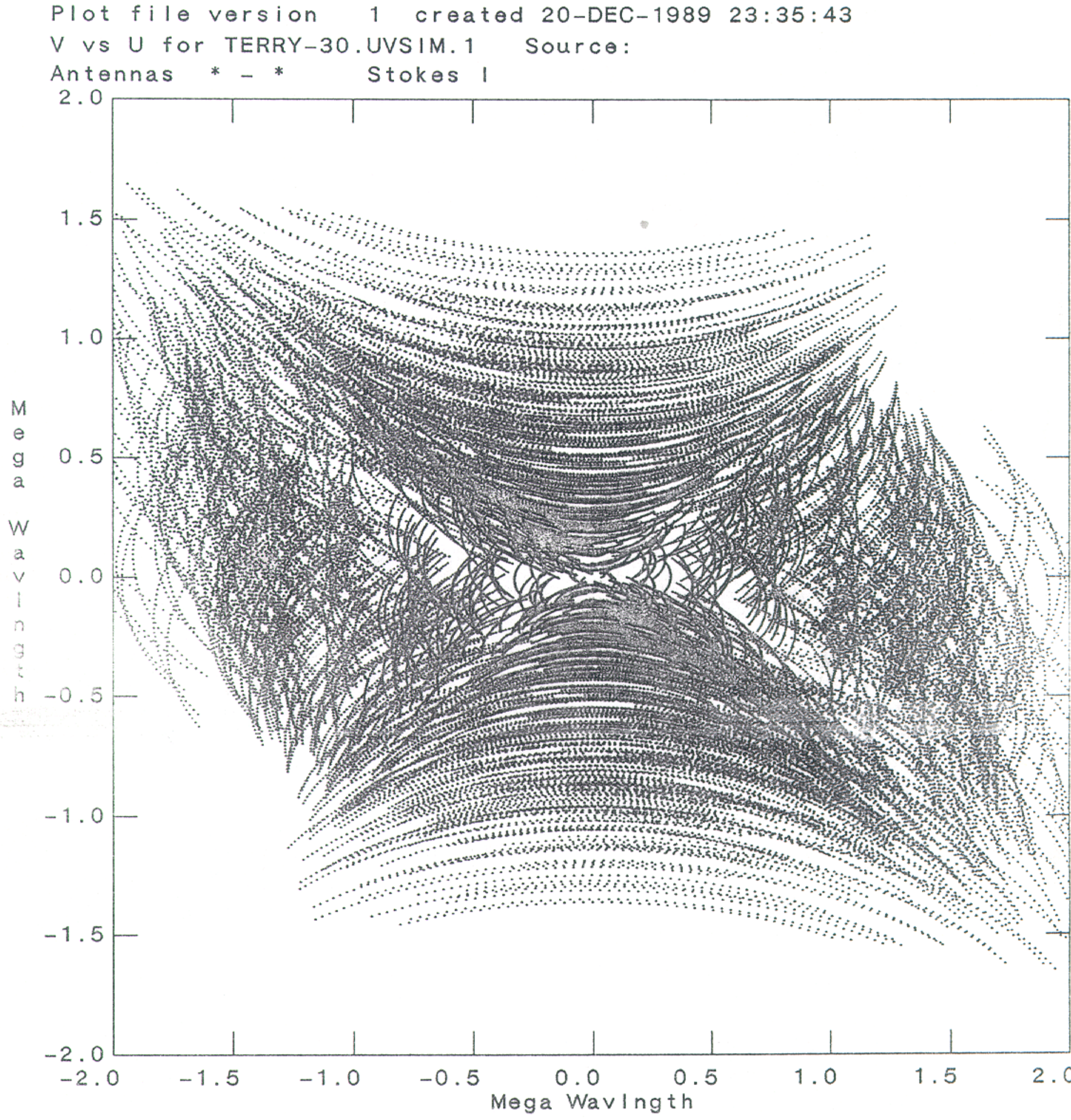
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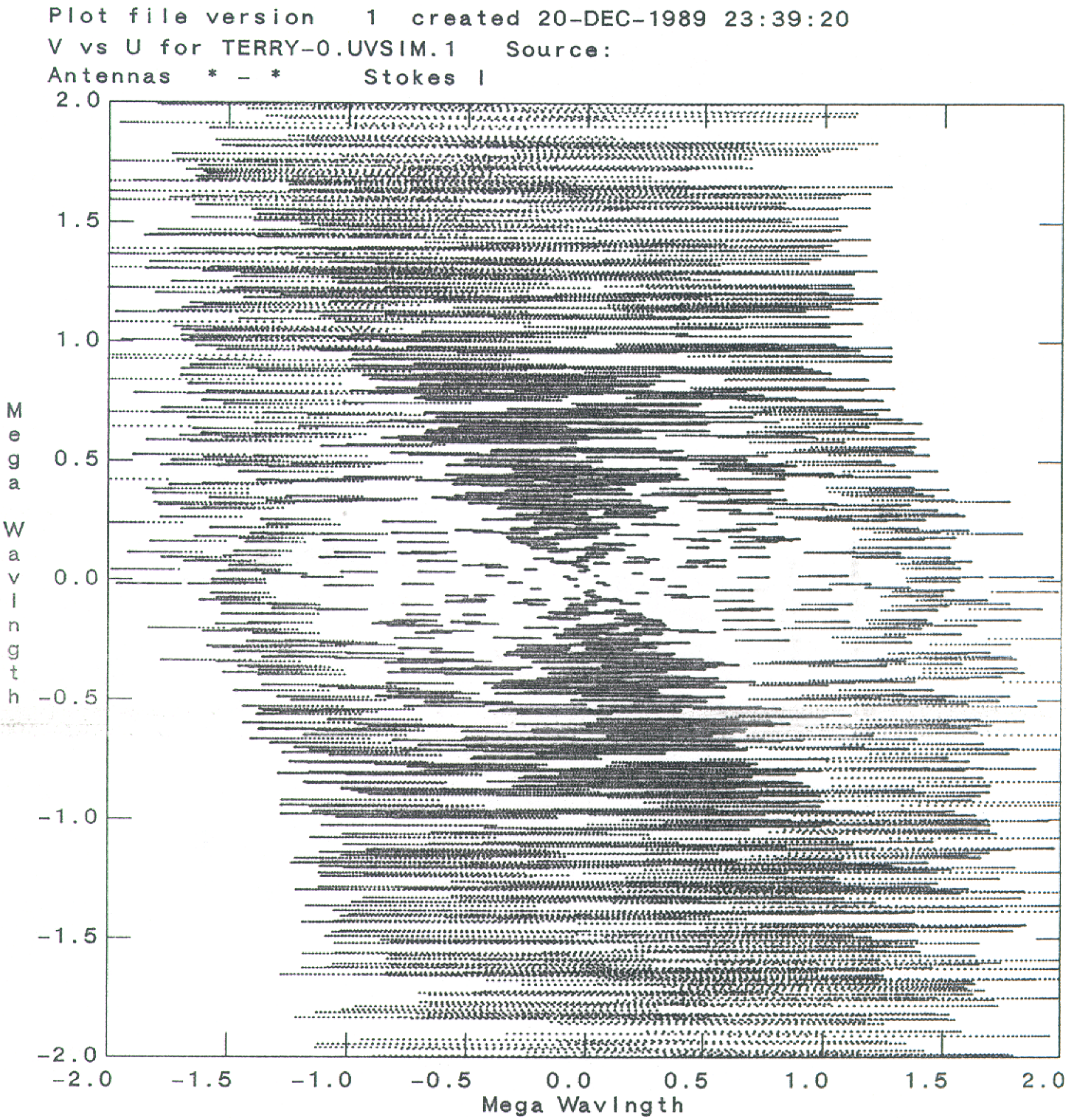
Figure 9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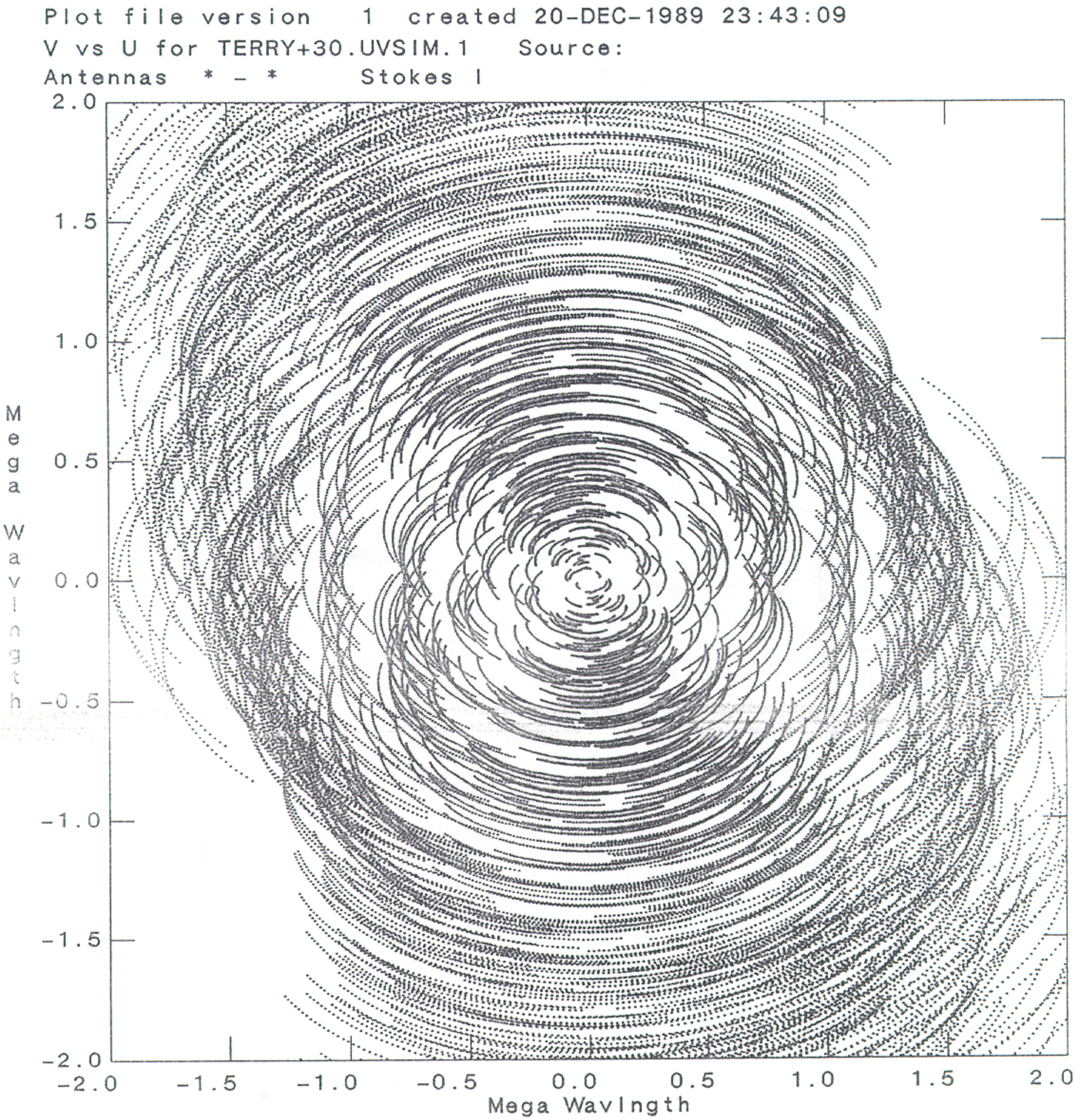
Mega Wavlngth

Figure 10



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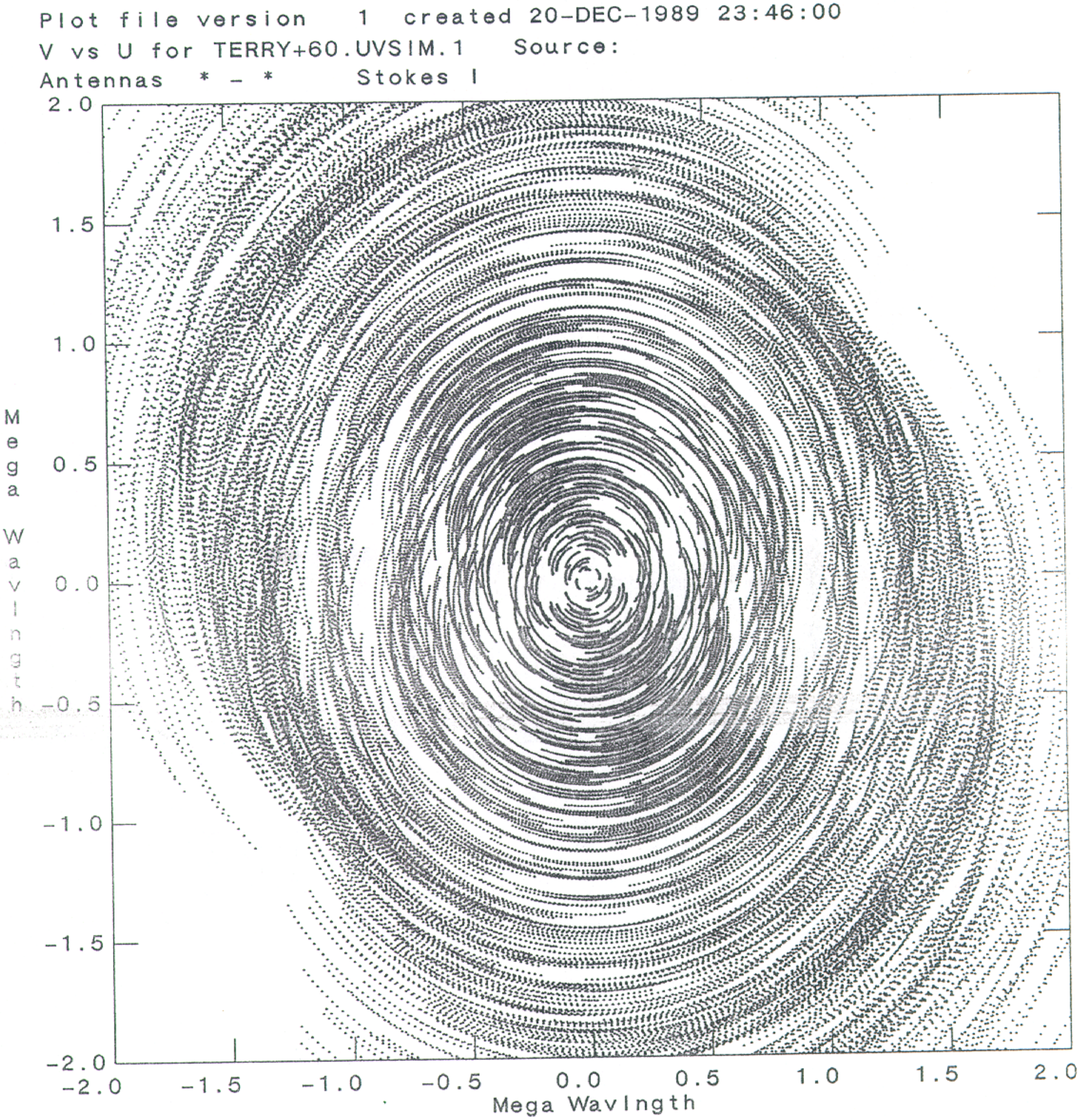
Mega Wavlngth

Figure 11



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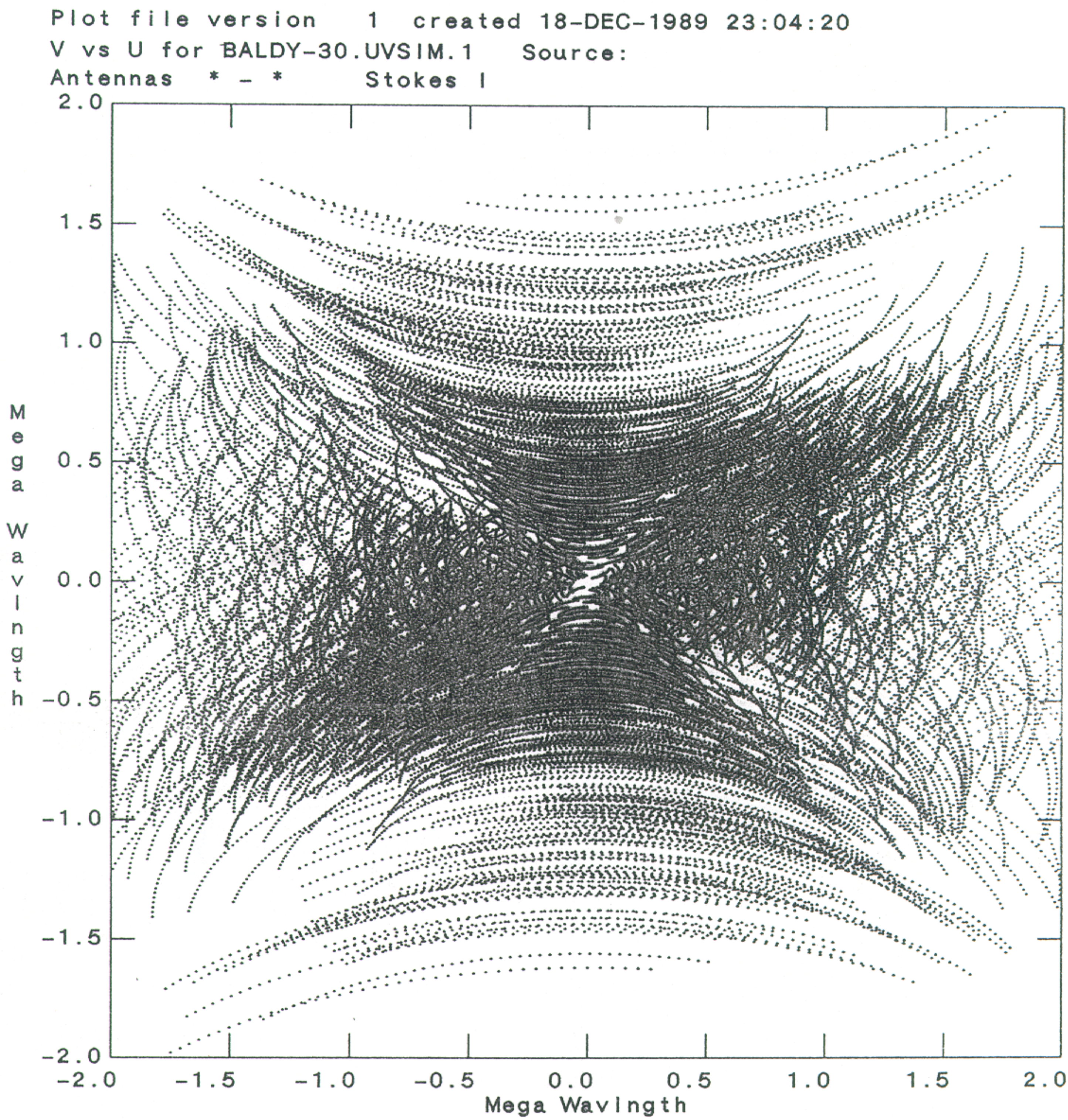
Mega Wavlngth

Figure 12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Mega Wavlngth
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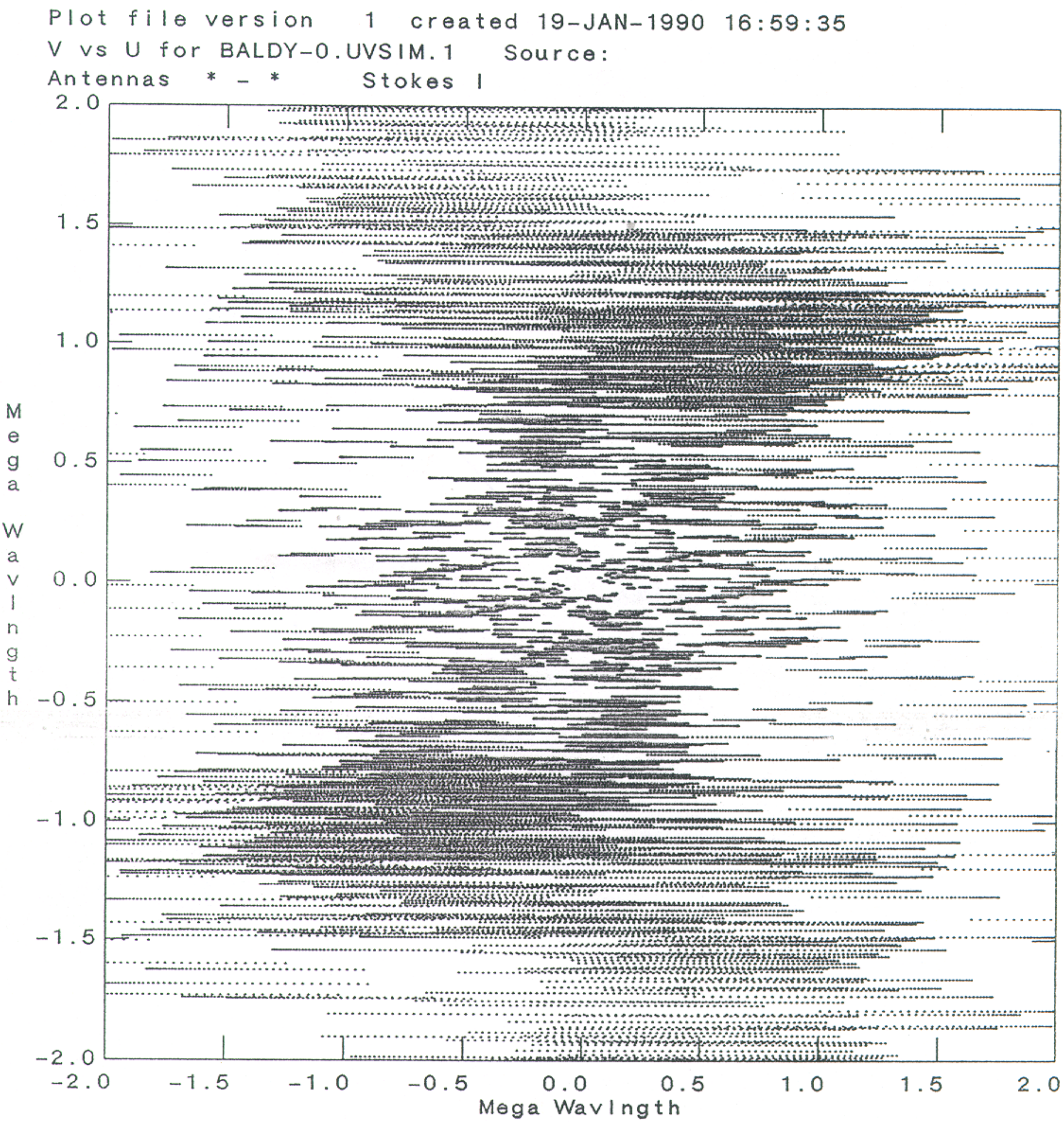
2.0

Figure 13



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Mega Wavlngth
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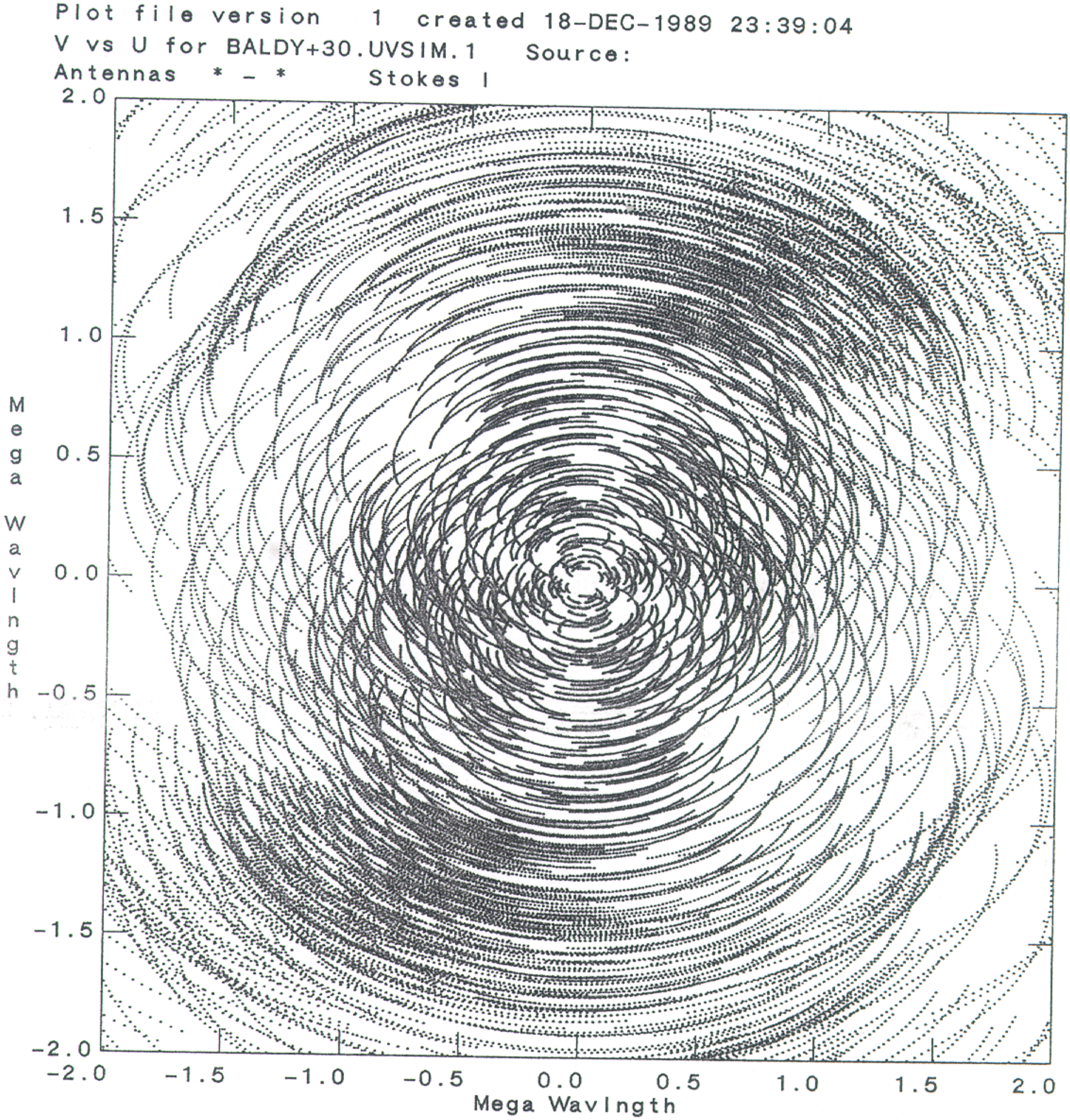
2.0
Mega Wavlngth

Figure 14



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Mega Wavlngth
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-1.0
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1.5
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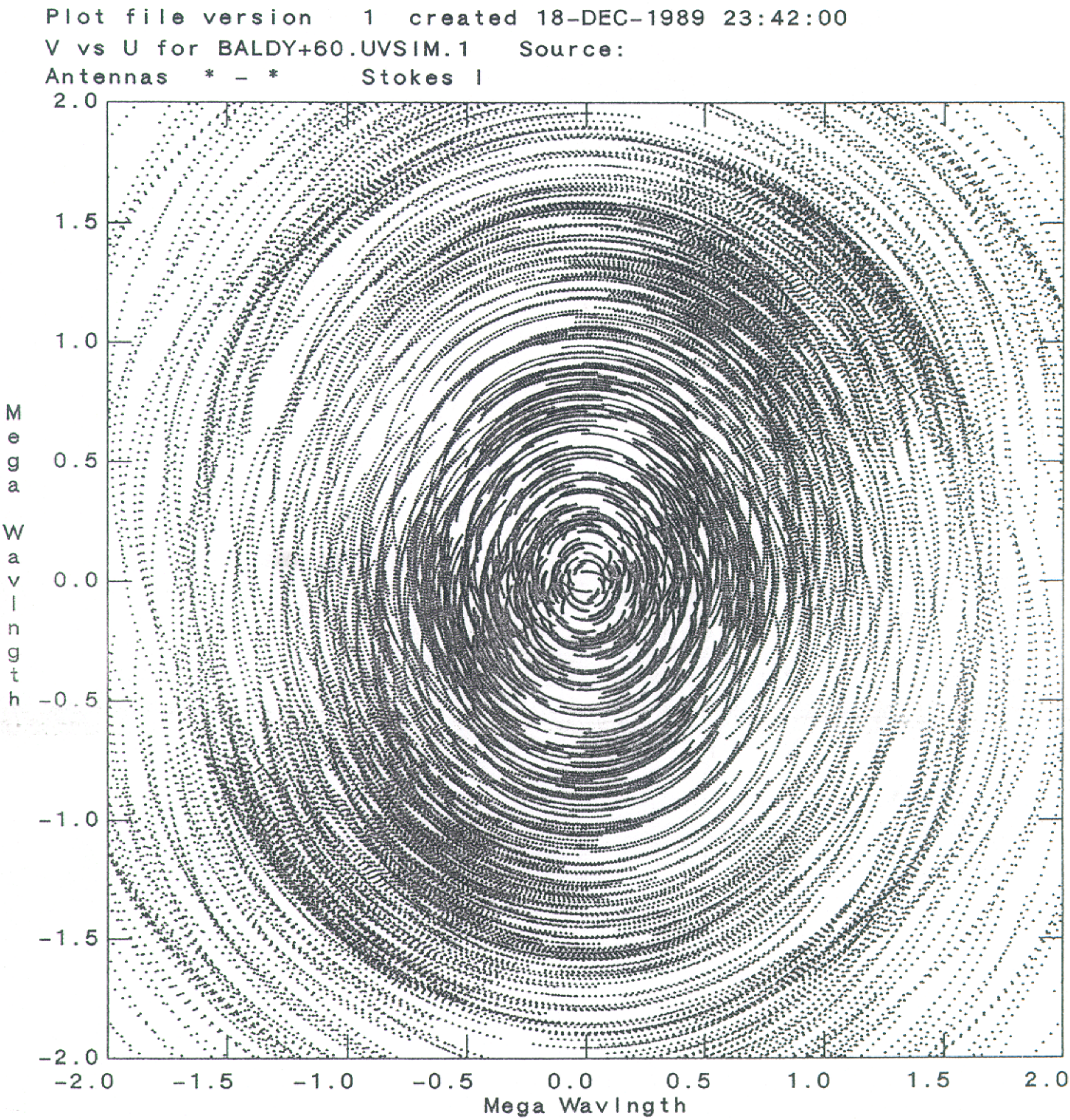
Figure 15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Mega Wavlength
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1.5
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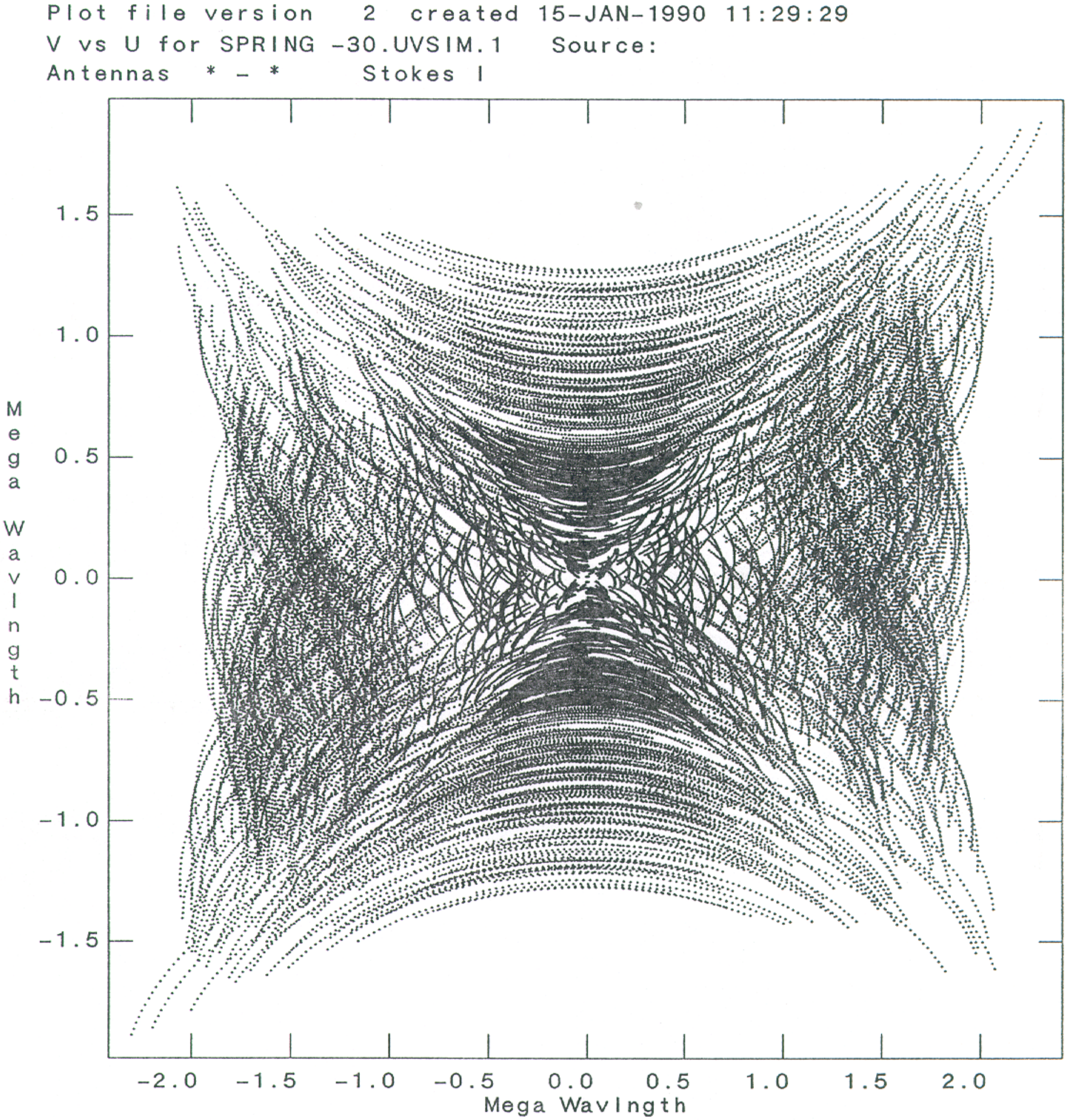
Figure 16



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Mega Wavlngth
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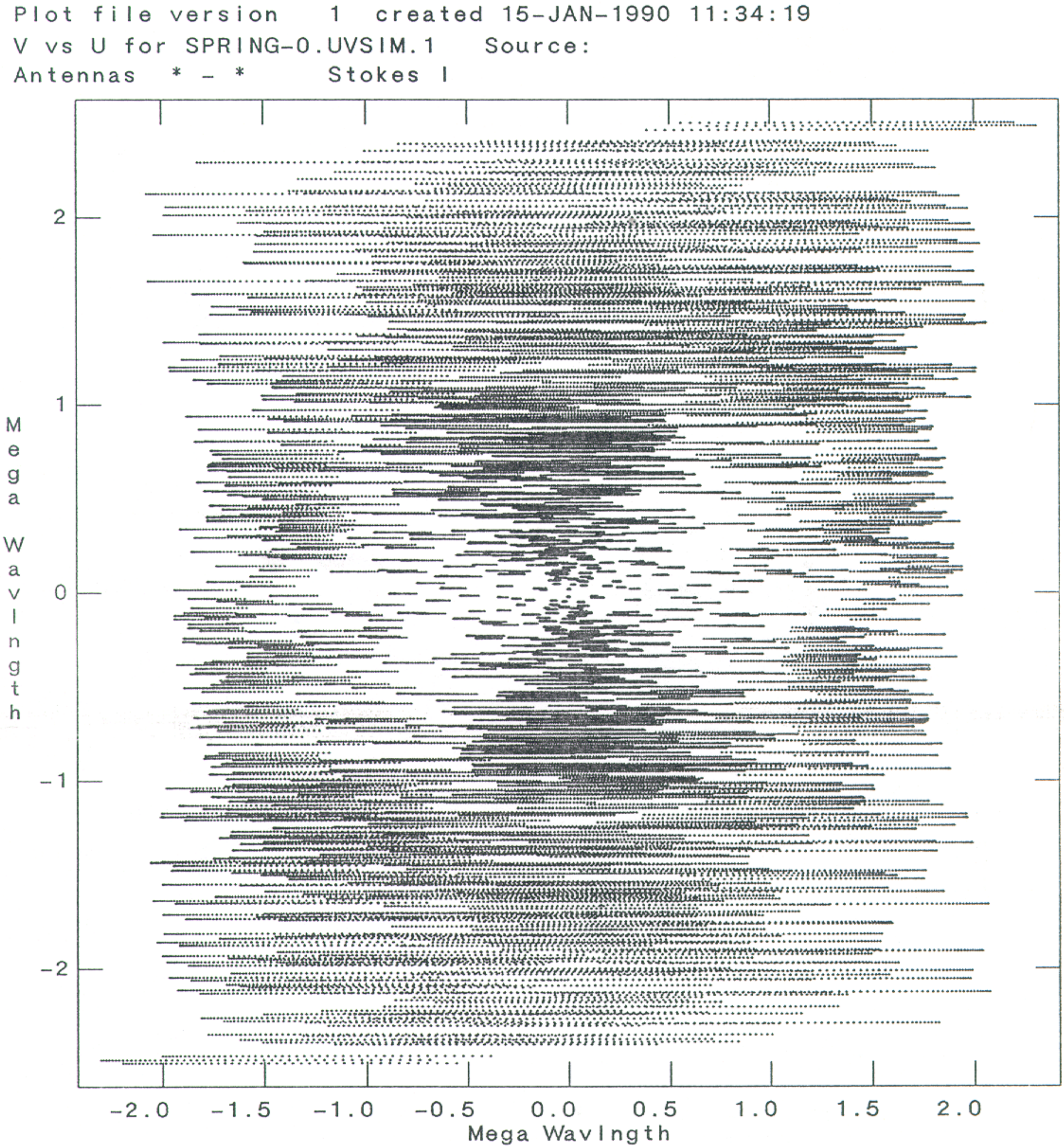
1.5
2.0
Mega Wavlngth

Figure 17



Plot file version 1 created 15-JAN-1990 11:34:19
V vs U for SPRING-0.UVSIM.1 Source:
Antennas * - * Stokes I
Mega Wavlngth
Mega Wavlngth
-2.0 -1.5 -1.0 -0.5 0.0 0.5 1.0 1.5 2.0
2 1 0 -1 -2

Figure 18

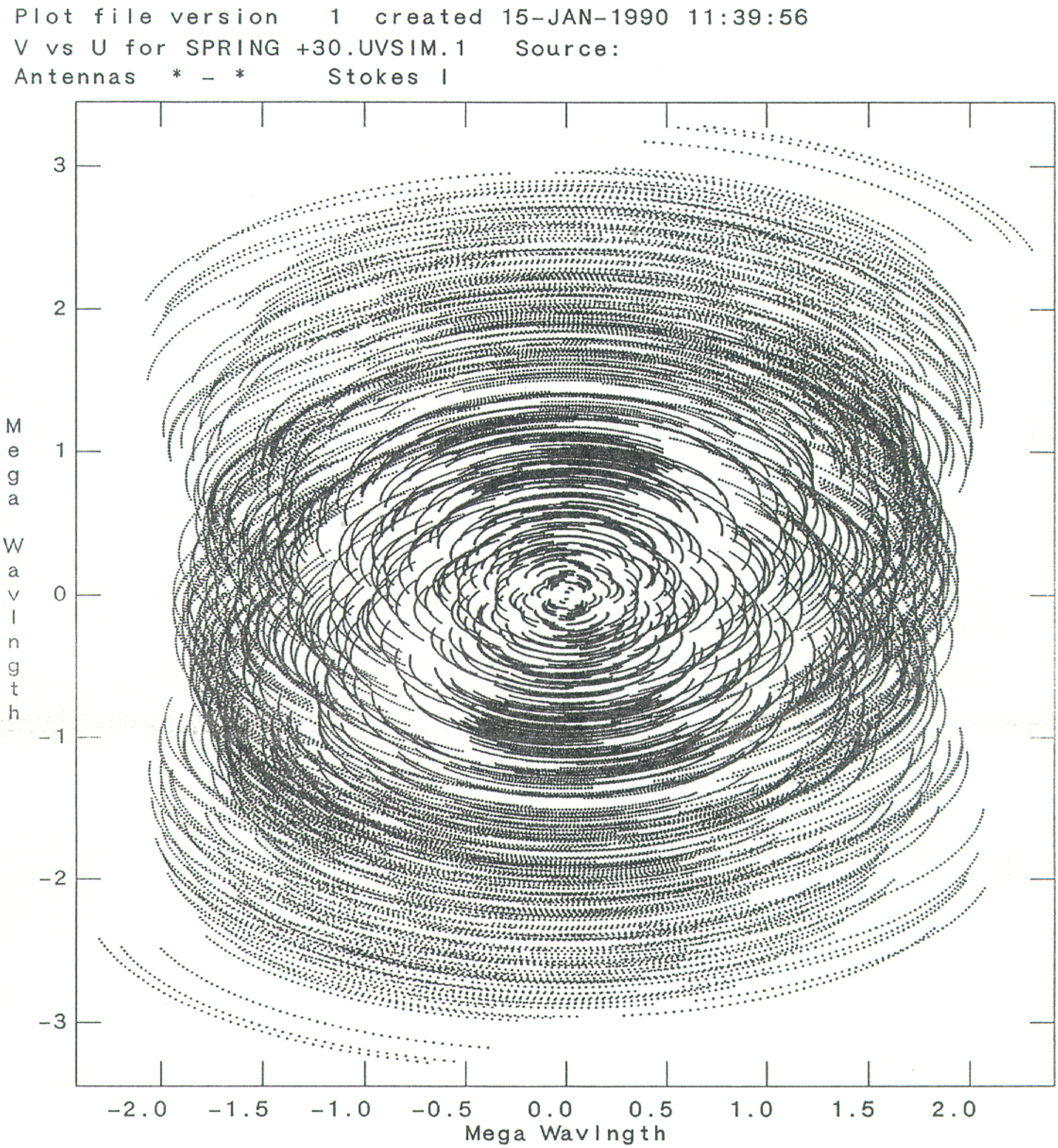

Plot file version 1 created 15-JAN-1990 11:39:56
V vs U for SPRING +30.UVSIM.1 Source:
Antennas * - * Stokes I
3
2
1
0
-1
-2
-3
Mega Wavlngth
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Mega Wavlngth

Figure 19

Plot file version 1 created 15-JAN-1990 11:46:05
V vs U for SPRING+60.UVSIM.1 Source:
Antennas * - * Stokes I

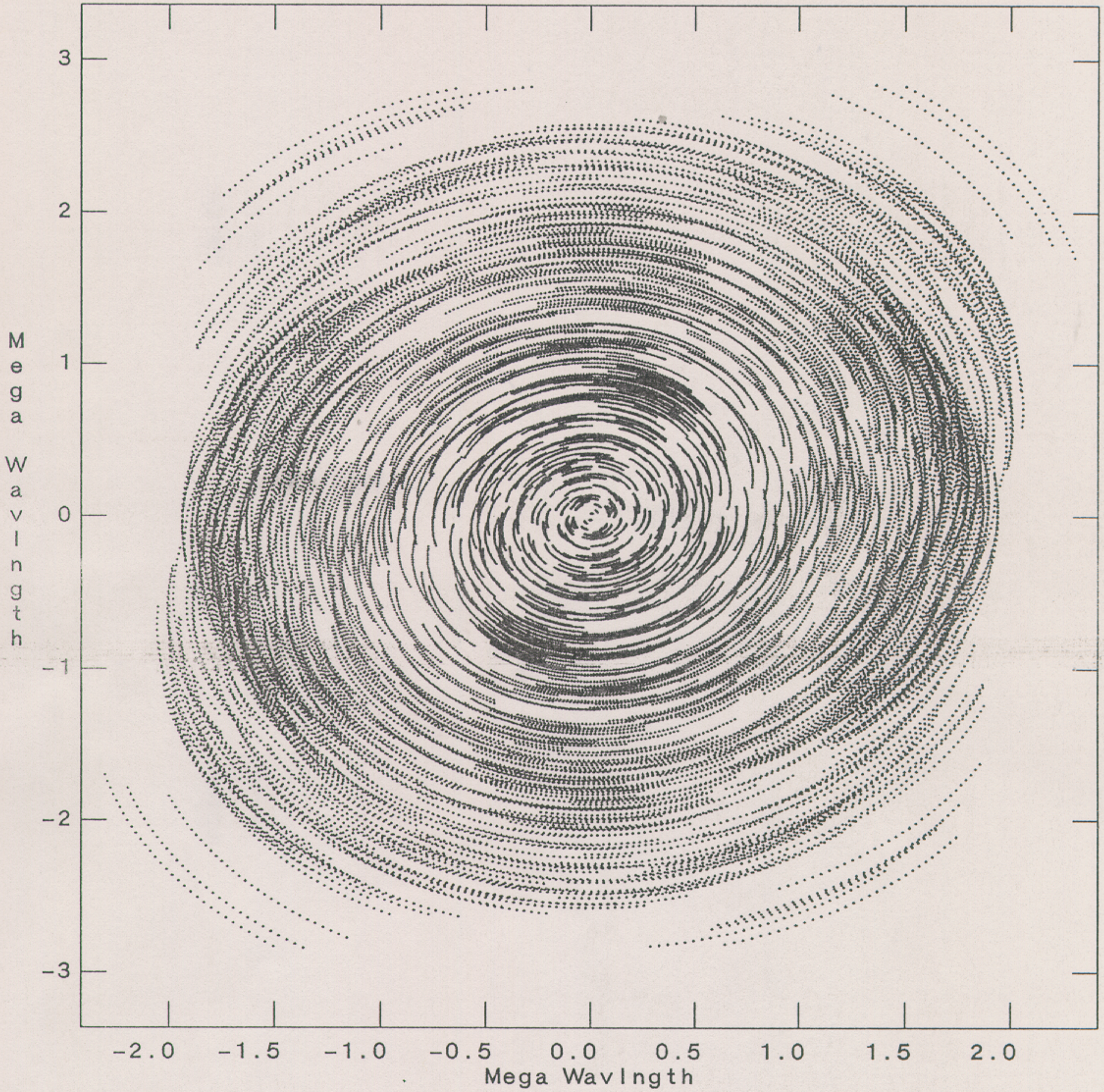


Figure 20

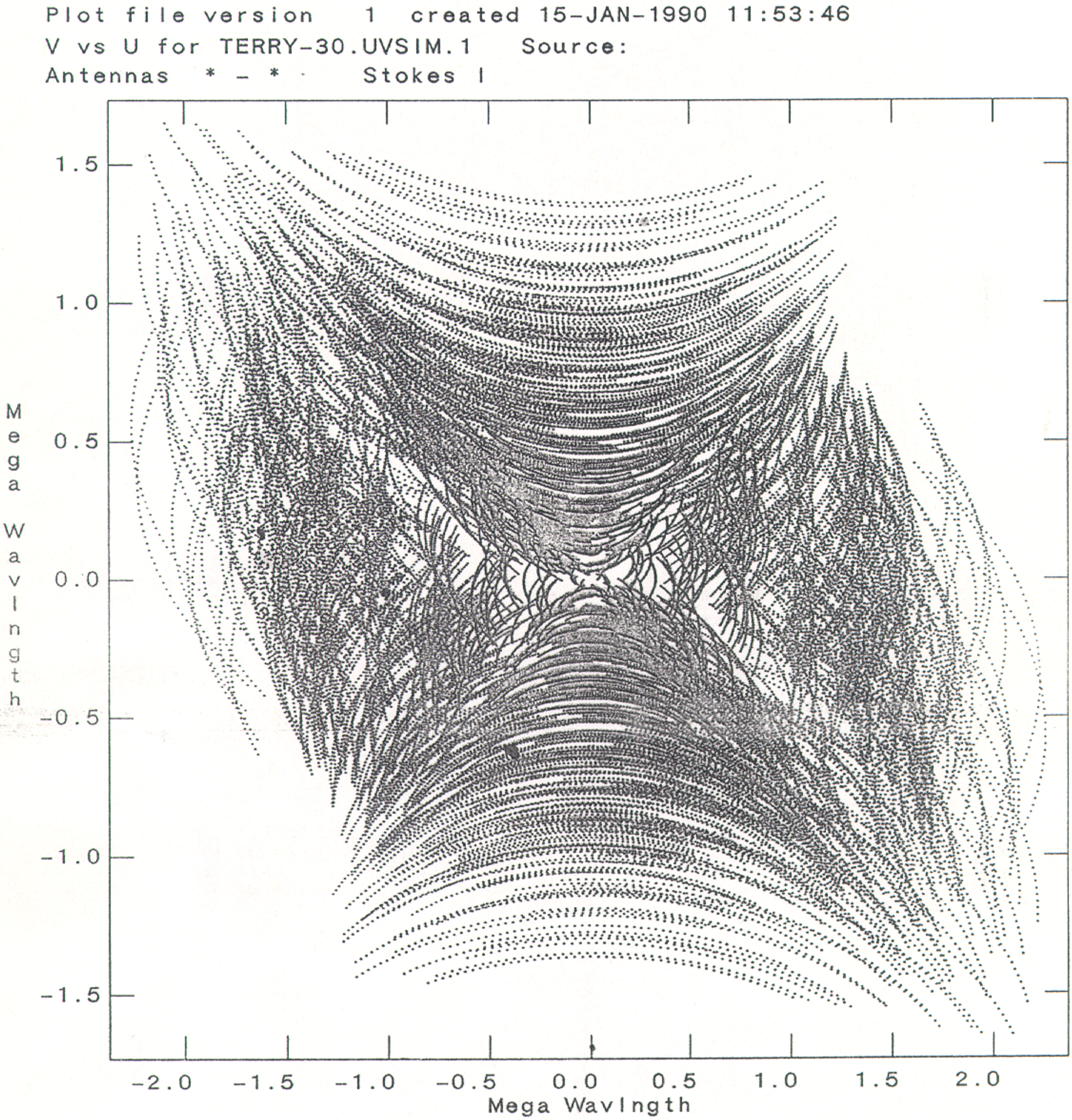
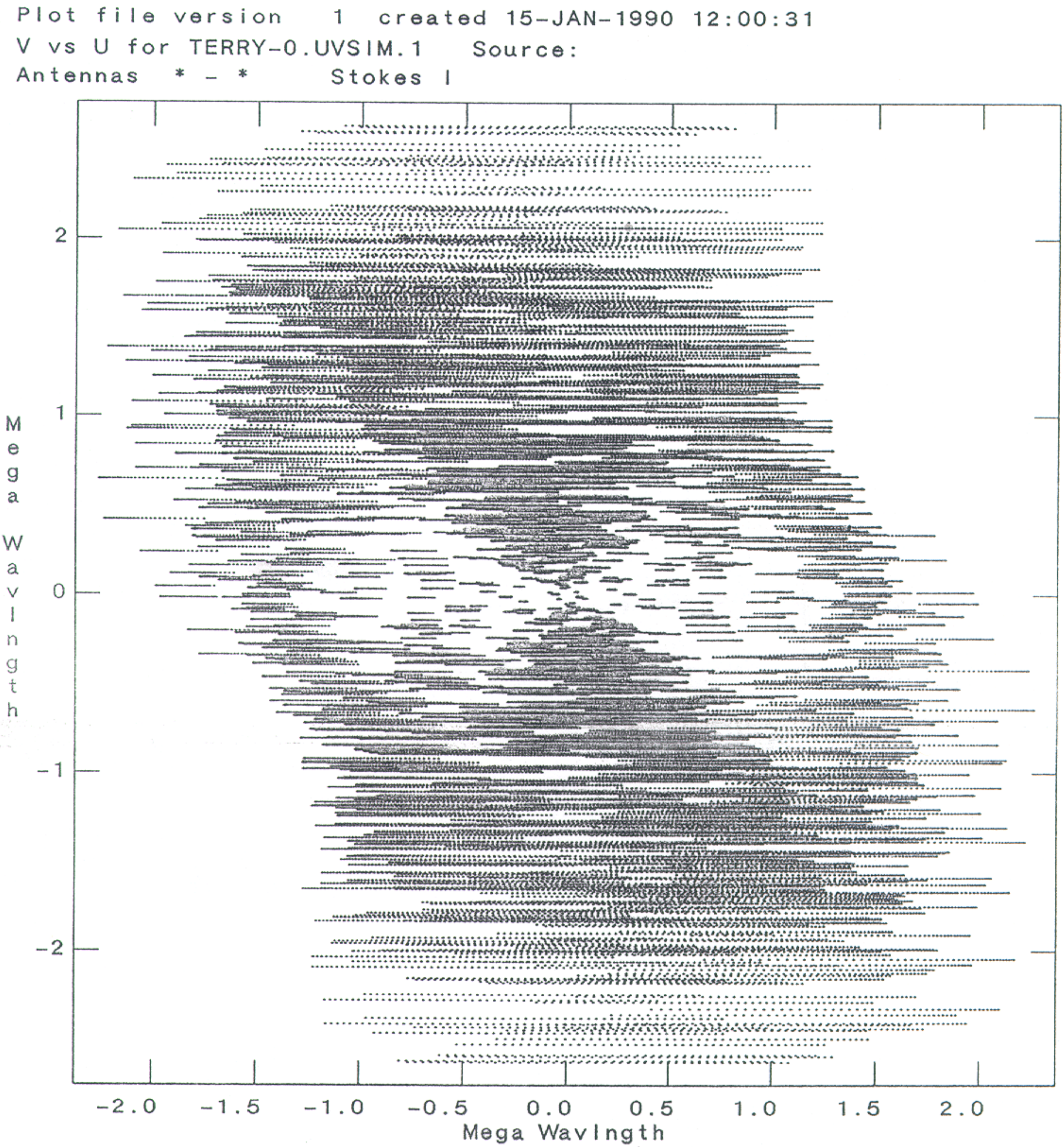
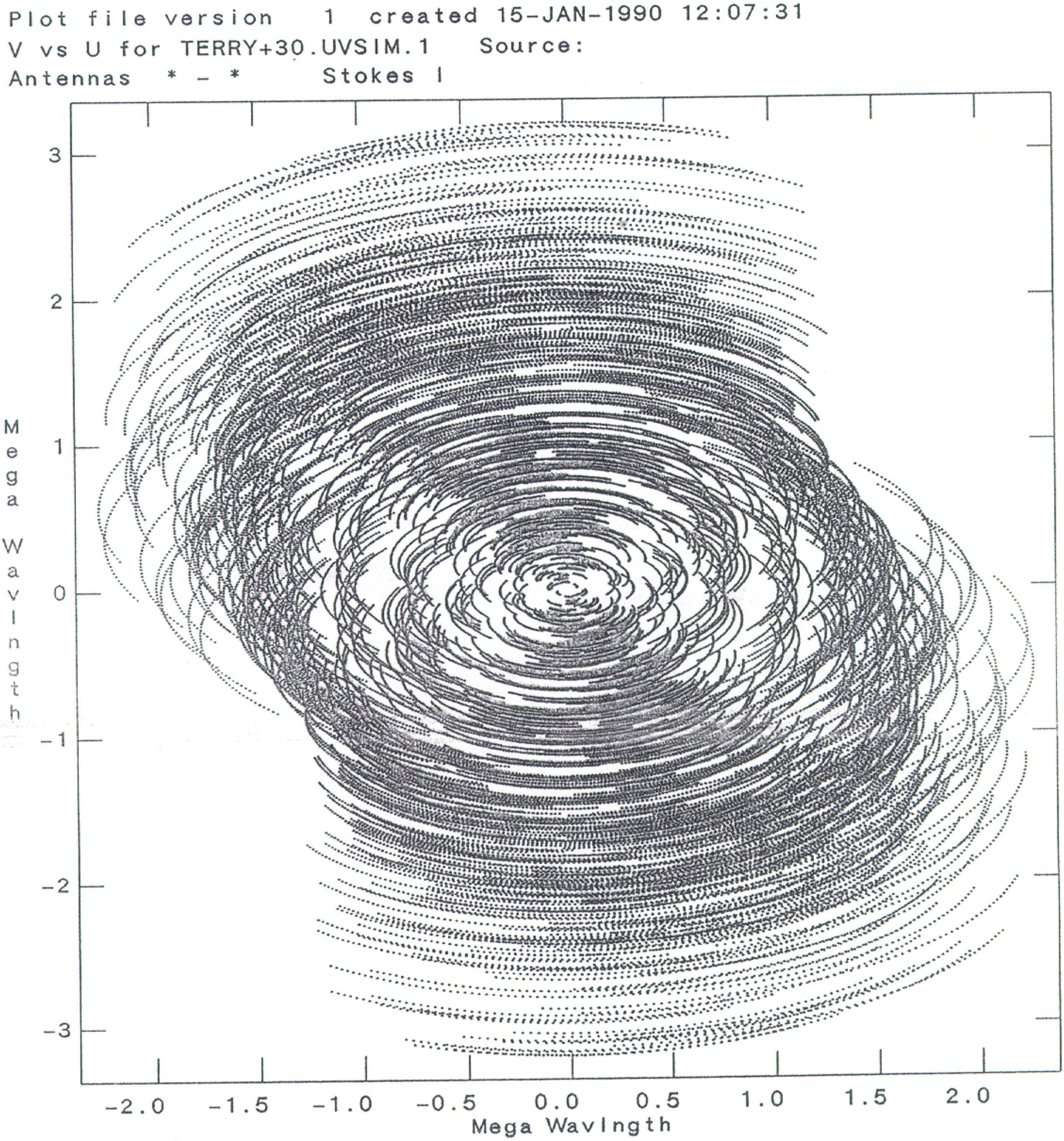

Plot file version 1 created 15-JAN-1990 11:53:46
V vs U for TERRY-30.UVSIM.1 Source:
Antennas * - * Stokes I
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
Mega Wavlngth
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Mega Wavlngth

Figure 21



Plot file version 1 created 15-JAN-1990 12:00:31
V vs U for TERRY-0.UVSIM.1 Source:
Antennas * - * Stokes I
2
1
0
-1
-2
Mega Wavlngth
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Mega Wavlngth

Figure 22



Plot file version 1 created 15-JAN-1990 12:07:31
V vs U for TERRY+30.UVSIM.1 Source:
Antennas * - * Stokes I
Mega Wavlngth
3
2
1
0
-1
-2
-3
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Mega Wavlngth

Figure 23

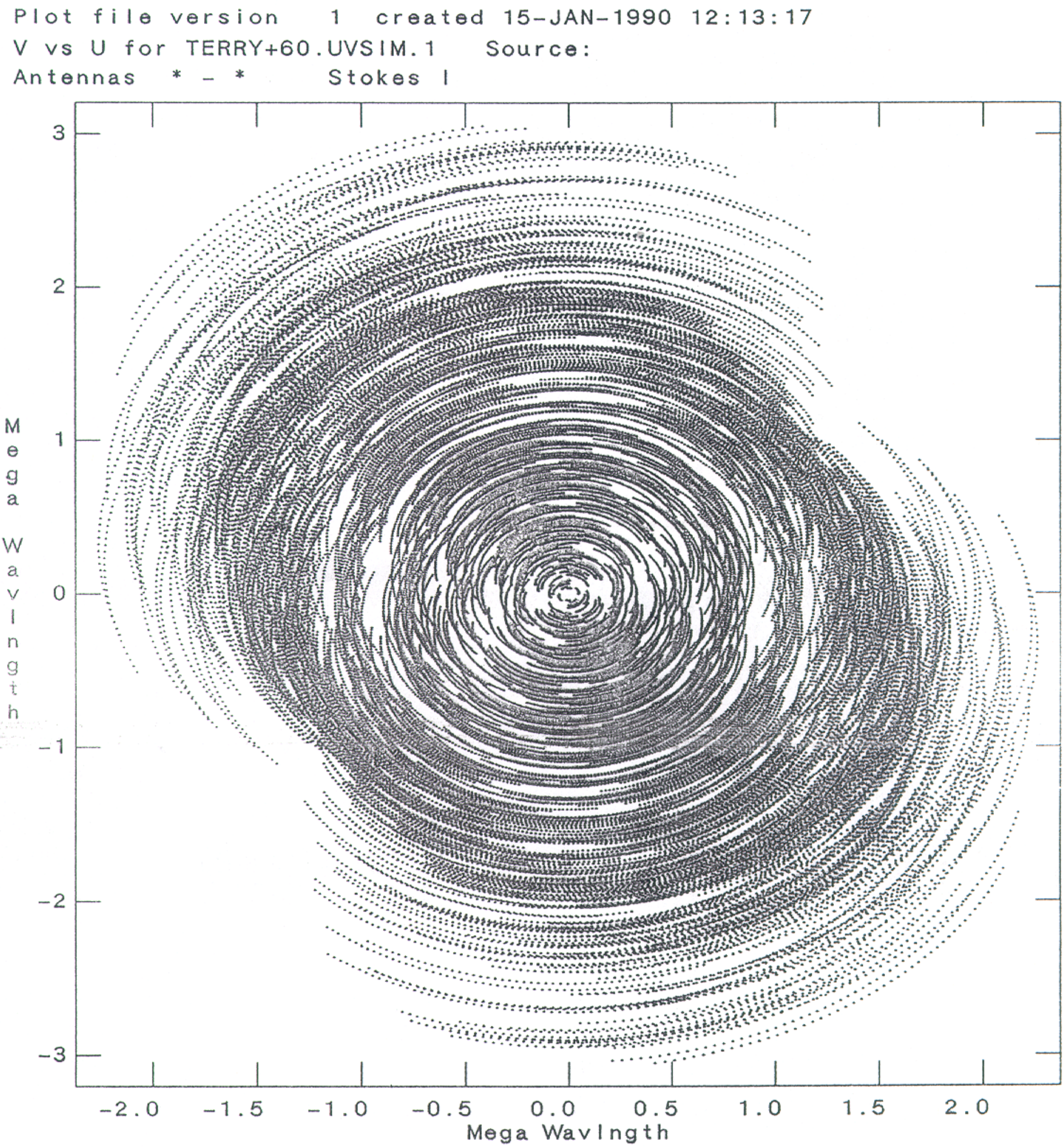
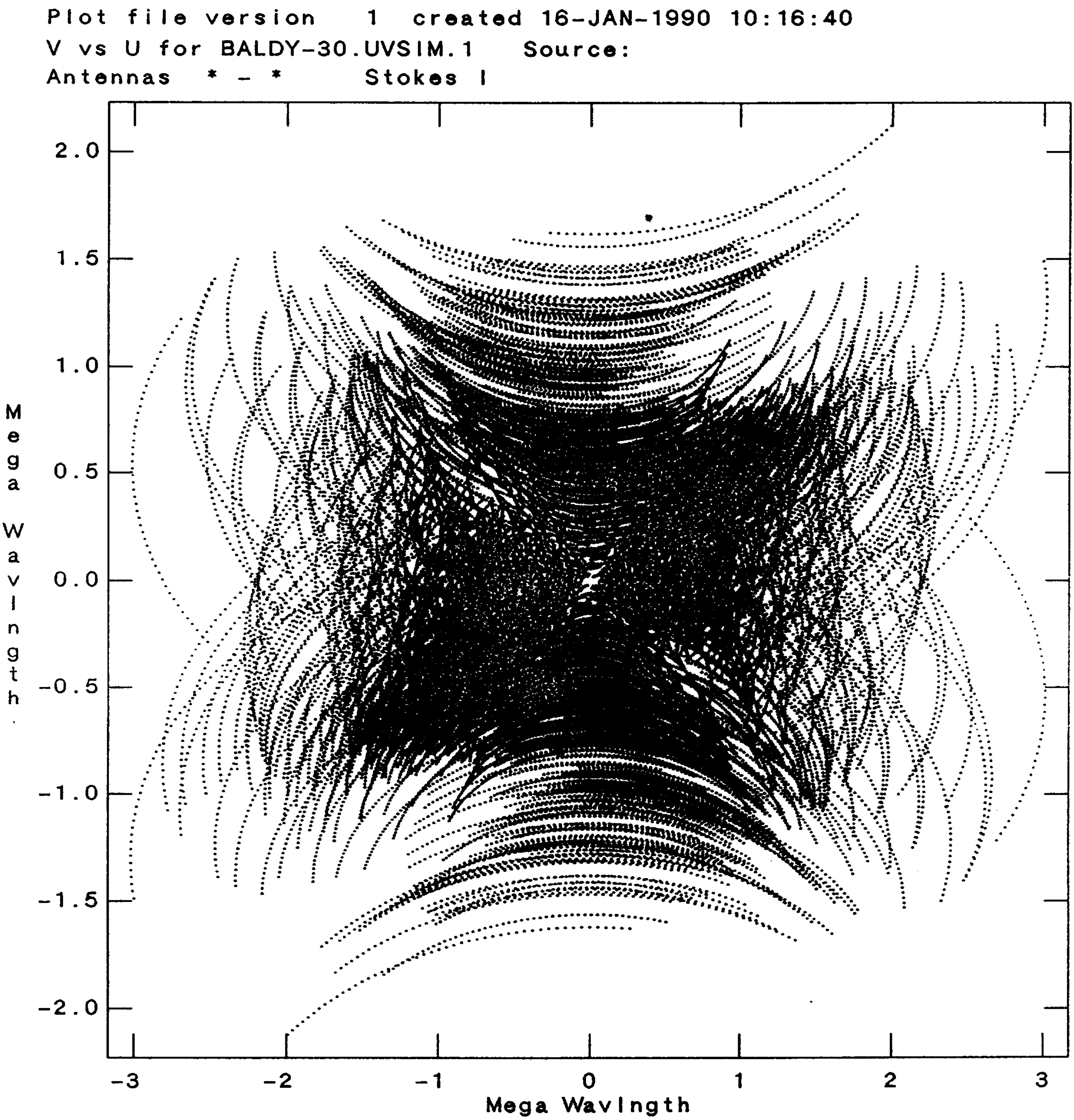

Plot file version 1 created 15-JAN-1990 12:13:17
V vs U for TERRY+60.UVSIM.1 Source:
Antennas * - * Stokes I
Mega Wavlngth
Mega Wavlngth
3
2
1
0
-1
-2
-3
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0

Figure 24



Plot file version 1 created 16-JAN-1990 10:16:40
V vs U for BALDY-30.UVSIM.1 Source:
Antennas * - * Stokes I
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
Mega Wavlngth
-3
-2
-1
0
1
2
3
Mega Wavlngth

Figure 25

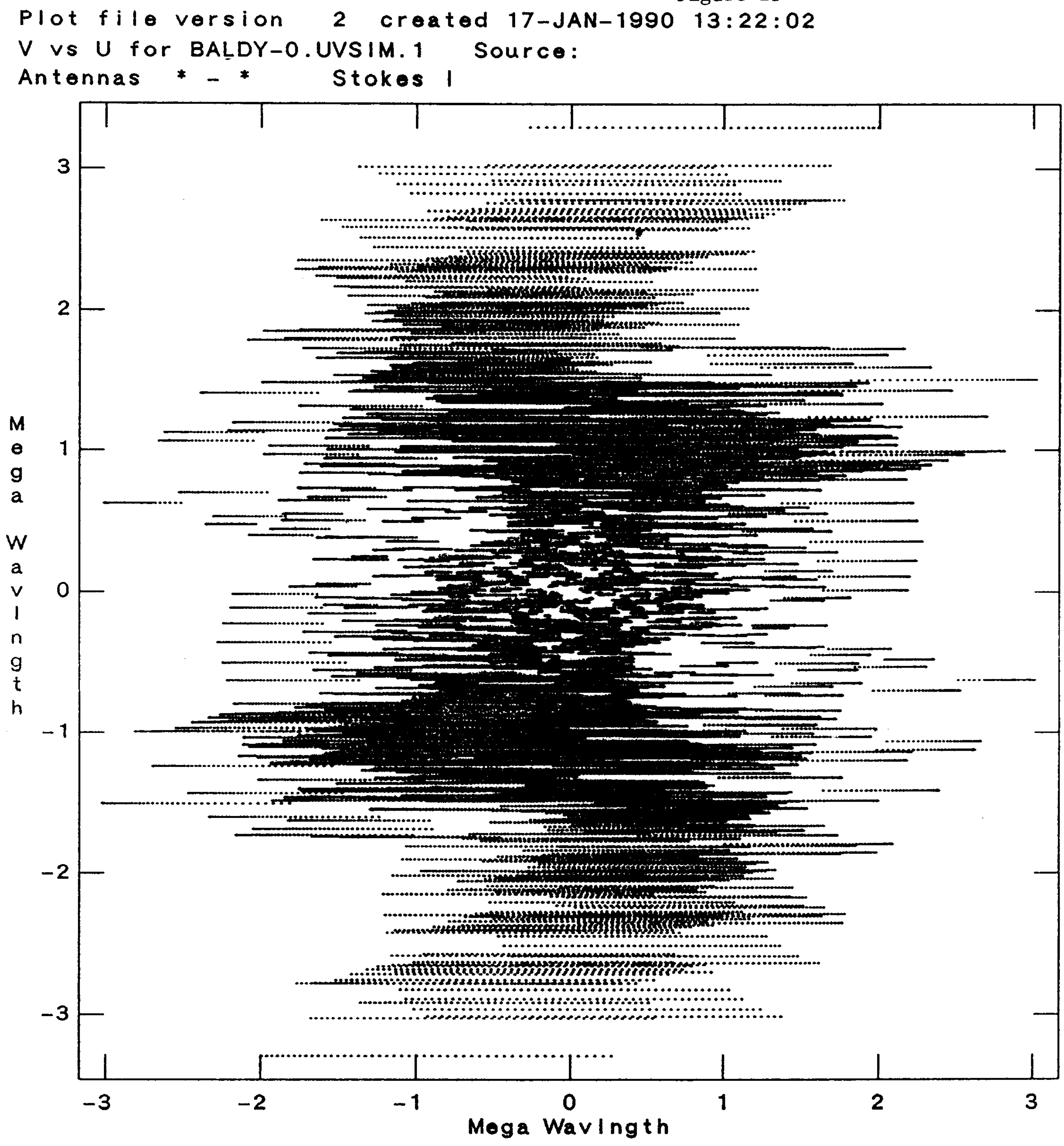

Plot file version 2 created 17-JAN-1990 13:22:02
V vs U for BALDY-0.UVSIM.1 Source:
Antennas * - * Stokes I
Mega Wavlngth
3
2
1
0
-1
-2
-3
Mega Wavlngth
-3
-2
-1
0
1
2
3

Figure 26

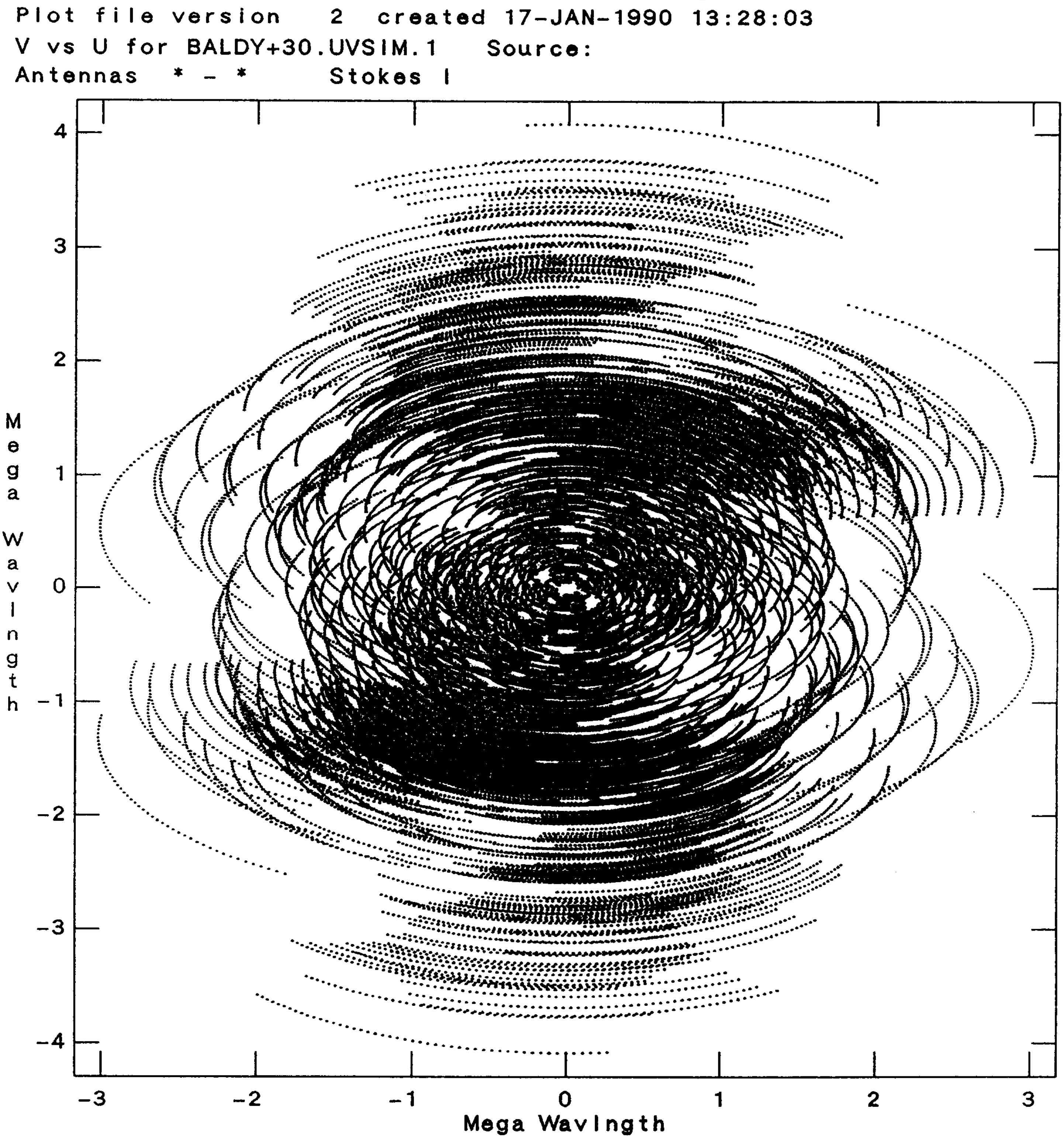
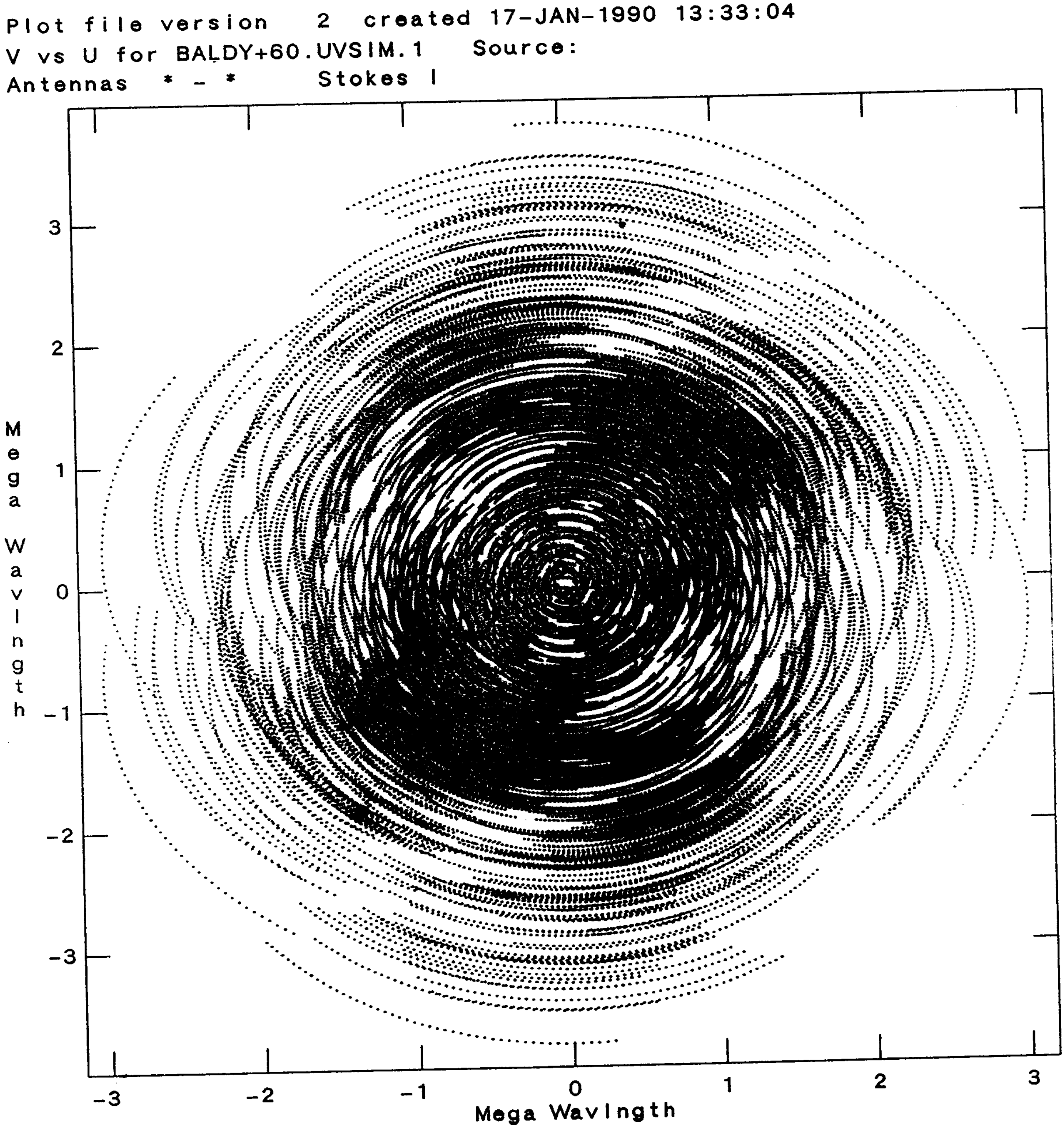

Plot file version 2 created 17-JAN-1990 13:28:03
V vs U for BALDY+30.UVSIM.1 Source:
Antennas * - * Stokes I
4
3
2
1
0
−1
−2
−3
−4
Mega Wavlngth
−3
−2
−1
0
1
2
3
Mega Wavlngth

Figure 27



Plot file version 2 created 17-JAN-1990 13:33:04
V vs U for BALDY+60.UVSIM.1 Source:
Antennas * - * Stokes I
3
2
1
0
-1
-2
-3
Mega Wavlngth
-3
-2
-1
0
1
2
3
Mega Wavlngth

Figure 28

CONTOUR INTERVAL 80 FEET

DATUM IS MEAN SEA LEVEL

Figure 29

TERRY FLAT

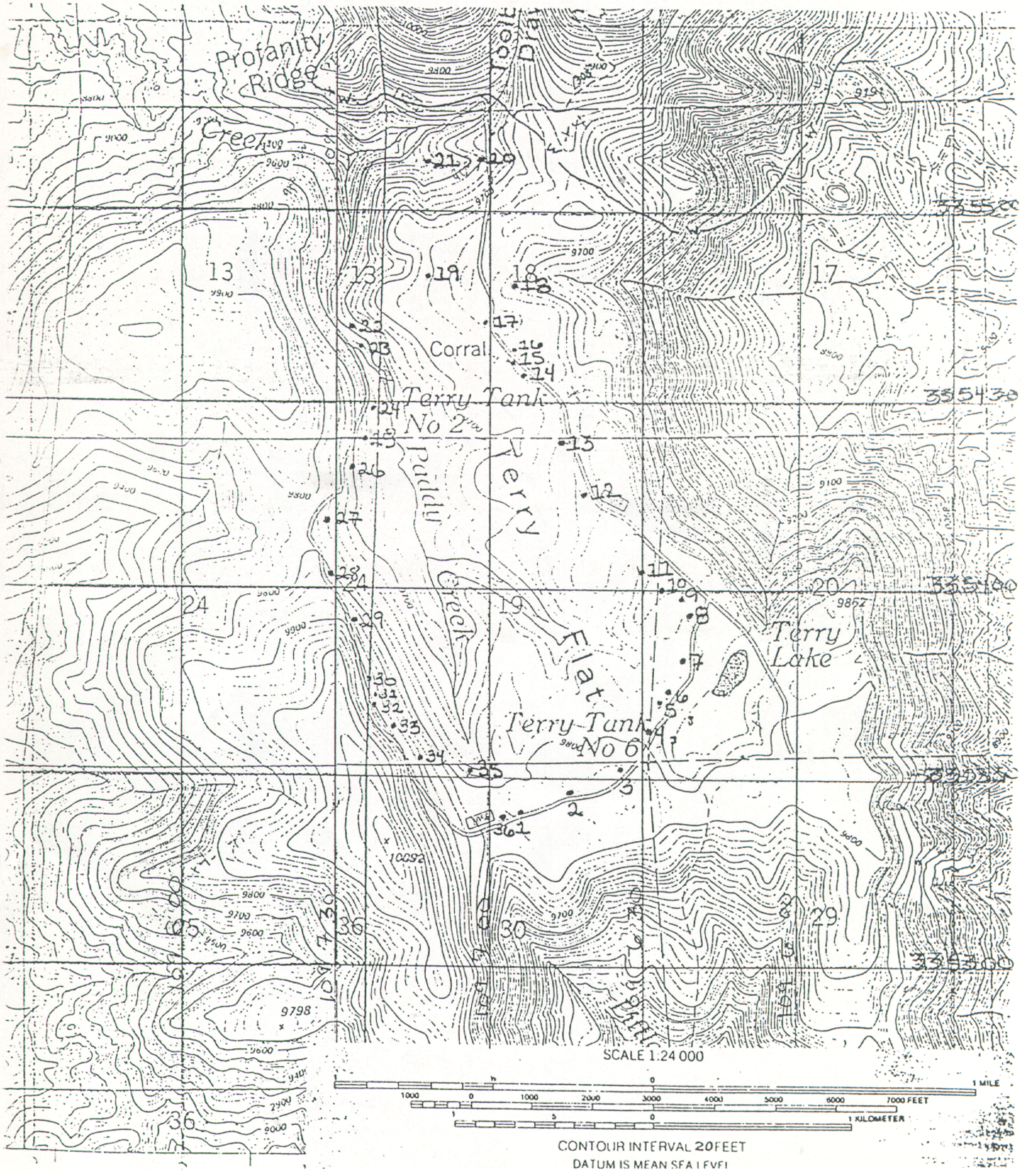


Figure 30

MAGDALENA MOUNTAINS SITE

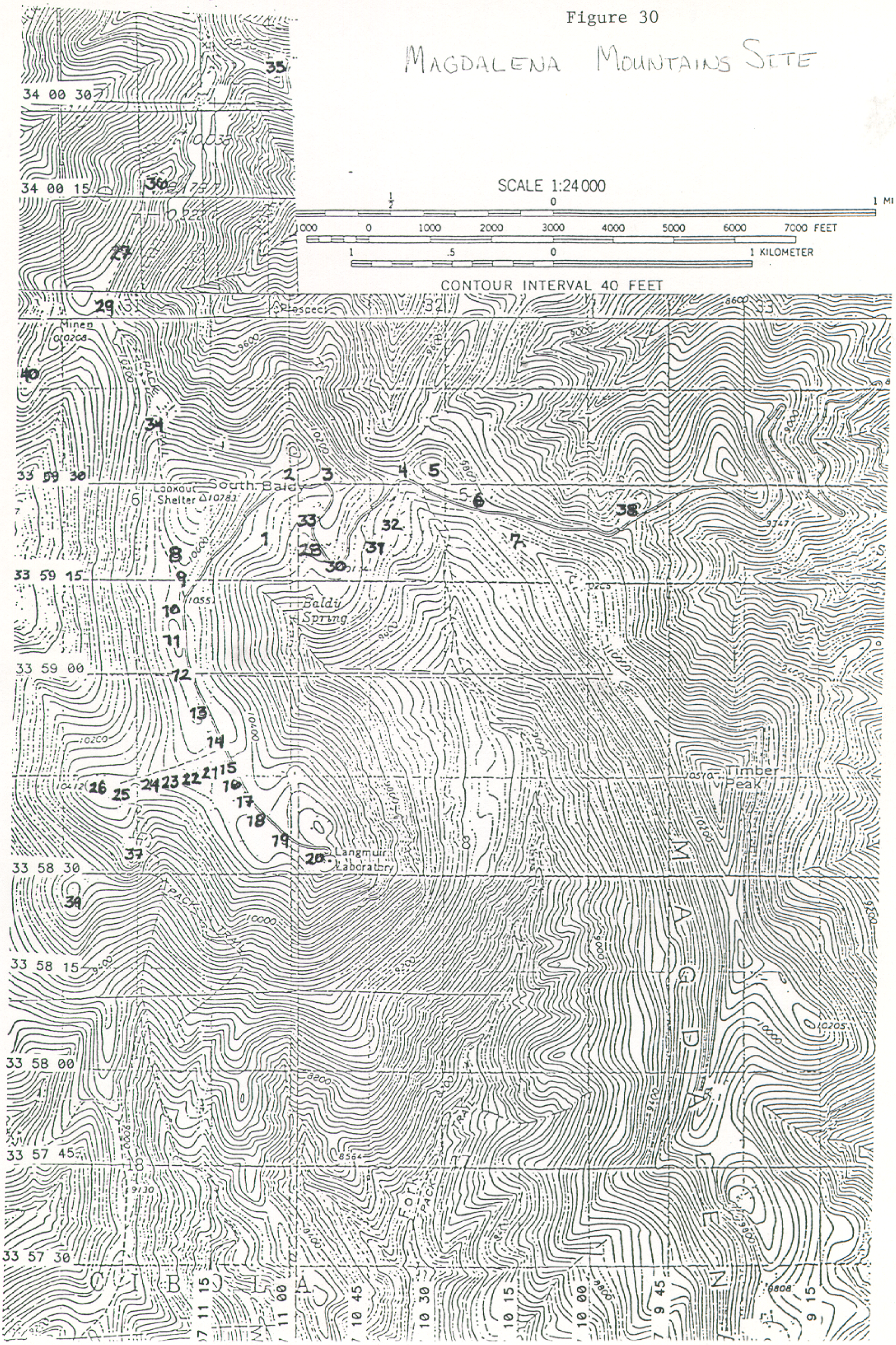


Table 1

MAXIMUM INNER SIDELOBE LEVEL FOR THE TERRY FLAT, SPRINGERVILLE, AND MAGDALENA MOUNTAIN SITES

DECLINATION	TERRY FLAT (percent)	SPRINGERVILLE (percent)	MAGDALENA MOUNTAIN (percent)
NATURAL WEIGHTING			
-30	13	20	6
0	16	20	15
+30	16	20	14
+60	16	20	11
UNIFORM WEIGHTING			
-30	8	14	3
0	8	14	8
+30	11	18	9
+60	11	14	6

Table 2

FULL WIDTH HALF MAXIMUM OF THE TERRY FLAT, SPRINGERVILLE, AND THE MAGDALENA MOUNTAIN SITES WITH NATURAL WEIGHTING AT ONE MILLIMETER WAVELENGTHS

DECLINATION	FULL WIDTH HALF MAXIMUM (arcsecond)		ROTATION ANGLE
TERRY FLAT			
-30	0.125	0.089	15.8
0	0.095	0.071	68.9
30	0.093	0.059	77.1
60	0.094	0.065	74.45
SPRINGERVILLE			
-30	0.116	0.073	-11.9
0	0.078	0.069	-60.5
30	0.075	0.059	-74.0
60	0.075	0.066	-67.8
MAGDALENA MOUNTAIN			
-30	0.134	0.088	-8.1
0	0.090	0.074	-70.3
30	0.089	0.058	-79.1
60	0.089	0.066	-73.1

Table 3

FULL WIDTH HALF MAXIMUM OF THE TERRY FLAT, SPRINGERVILLE, AND MAGDALENA MOUNTAIN SITES WITH UNIFORM WEIGHTING AT ONE MILLIMETER WAVELENGTHS

DECLINATION	FULL WIDTH HALF MAXIMUM (arcsecond)		ROTATION ANGLE
TERRY FLAT			
-30	0.109	0.079	16.6
0	0.096	0.061	74.0
30	0.087	0.054	77.8
60	0.089	0.060	75.0
SPRINGERVILLE			
-30	0.103	0.065	-11.0
0	0.077	0.060	-71.0
30	0.071	0.054	-73.2
60	0.071	0.062	-66.5
MAGDALENA MOUNTAIN			
-30	0.111	0.072	-2.3
0	0.082	0.058	-84.3
30	0.078	0.052	-81.0
60	0.079	0.056	-79.6

Table 4

LATITUDES, LONGITUDES, AND ALTITUDES FOR THE SPRINGERVILLE ARRAY

SITE NUMBER	LATITUDE	LONGITUDE	ALTITUDE (meters)
1)	33.0 57.0 7.11	109.0 20.0 14.54	2804
2)	33.0 57.0 10.27	109.0 20.0 35.45	2816
3)	33.0 57.0 12.67	109.0 20.0 32.73	2822
4)	33.0 57.0 18.17	109.0 20.0 56.36	2822
5)	33.0 57.0 22.91	109.0 20.0 50.91	2841
6)	33.0 57.0 31.58	109.0 20.0 54.56	2847
7)	33.0 57.0 37.11	109.0 20.0 16.36	2853
8)	33.0 57.0 59.48	109.0 20.0 11.82	2853
9)	33.0 57.0 45.01	109.0 20.0 30.00	2853
10)	33.0 58.0 57.65	109.0 20.0 9.09	2853
11)	33.0 58.0 2.37	109.0 20.0 10.91	2853
12)	33.0 58.0 8.69	109.0 20.0 13.64	2853
13)	33.0 58.0 12.64	109.0 20.0 15.45	2853
14)	33.0 58.0 17.38	109.0 20.0 17.27	2847
15)	33.0 58.0 33.94	109.0 20.0 34.55	2841
16)	33.0 58.0 39.48	109.0 20.0 12.73	2829
17)	33.0 58.0 40.27	109.0 20.0 18.18	2822
18)	33.0 58.0 10.27	109.0 20.0 20.00	2822
19)	33.0 58.0 38.64	109.0 20.0 26.36	2829
20)	33.0 58.0 35.95	109.0 21.0 3.64	2841
21)	33.0 58.0 29.23	109.0 21.0 17.27	2847
22)	33.0 58.0 26.86	109.0 21.0 13.64	2835
23)	33.0 58.0 25.28	109.0 21.0 14.54	2829
24)	33.0 58.0 21.33	109.0 21.0 18.18	2822
25)	33.0 58.0 11.85	109.0 21.0 22.73	2816
26)	33.0 58.0 7.11	109.0 20.0 23.63	2816
27)	33.0 57.0 58.44	109.0 21.0 24.54	2847
28)	33.0 57.0 55.28	109.0 21.0 21.33	2822
29)	33.0 57.0 53.70	109.0 21.0 24.54	2822
30)	33.0 57.0 52.91	109.0 21.0 24.54	2822
31)	33.0 57.0 43.43	109.0 21.0 23.63	2822
32)	33.0 57.0 35.53	109.0 21.0 20.00	2822
33)	33.0 57.0 2.37	109.0 21.0 18.18	2822
34)	33.0 57.0 26.86	109.0 21.0 15.45	2822
35)	33.0 57.0 19.75	109.0 21.0 10.00	2916
36)	33.0 57.0 17.38	109.0 21.0 7.27	2804
37)	33.0 57.0 11.85	109.0 21.0 0.00	2789
38)	33.0 57.0 7.11	109.0 20.0 49.09	2798
39)	33.0 57.0 22.91	109.0 21.0 11.82	2816
40)	33.0 57.0 26.86	109.0 20.0 18.18	2847

LATITUDES, LONGITUDES, AND ALTITUDES FOR THE TERRY FLAT ARRAY

SITE NUMBER	LATITUDE	LONGITUDE	ALTITUDE (meters)
1)	33.0 53.0 24.49	109.0 6.0 52.73	2993
2)	33.0 53.0 28.44	109.0 6.0 43.64	2993
3)	33.0 53.0 31.58	109.0 6.0 33.64	2993
4)	33.0 53.0 37.90	109.0 6.0 30.0	2987
5)	33.0 53.0 43.43	109.0 6.0 25.45	2971
6)	33.0 53.0 44.22	109.0 6.0 23.63	2971
7)	33.0 53.0 48.94	109.0 6.0 21.84	2965
8)	33.0 53.0 56.86	109.0 6.0 20.91	2965
9)	33.0 53.0 59.33	109.0 6.0 22.73	2971
10)	33.0 54.0 0.00	109.0 6.0 26.36	2971
11)	33.0 54.0 3.16	109.0 6.0 30.90	2965
12)	33.0 54.0 15.80	109.0 6.0 40.00	2965
13)	33.0 54.0 24.49	109.0 6.0 40.91	2959
14)	33.0 54.0 33.16	109.0 6.0 51.86	2959
15)	33.0 54.0 34.74	109.0 6.0 52.73	2959
16)	33.0 54.0 36.32	109.0 6.0 52.73	2969
17)	33.0 54.0 43.43	109.0 7.0 0.00	2965
18)	33.0 54.0 49.75	109.0 6.0 55.45	2959
19)	33.0 54.0 50.54	109.0 7.0 11.82	2959
20)	33.0 55.0 8.64	109.0 7.0 1.82	2932
21)	33.0 55.0 7.90	109.0 7.0 10.91	2908
22)	33.0 54.0 41.85	109.0 7.0 22.91	2926
23)	33.0 54.0 38.69	109.0 7.0 20.00	2926
24)	33.0 54.0 29.33	109.0 7.0 21.82	2950
25)	33.0 54.0 24.49	109.0 7.0 22.73	2920
26)	33.0 54.0 19.75	109.0 7.0 23.36	2957
27)	33.0 54.0 11.85	109.0 7.0 31.82	2965
28)	33.0 54.0 2.73	109.0 7.0 31.82	2987
29)	33.0 53.0 55.28	109.0 7.0 25.54	3006
30)	33.0 53.0 47.38	109.0 7.0 22.73	3012
31)	33.0 53.0 45.01	109.0 7.0 21.82	3012
32)	33.0 53.0 50.54	109.0 7.0 20.00	3000
33)	33.0 53.0 37.90	109.0 7.0 16.36	3006
34)	33.0 53.0 32.37	109.0 7.0 13.64	3018
35)	33.0 53.0 31.58	109.0 7.0 3.64	2965
36)	33.0 53.0 25.28	109.0 6.0 55.45	2971

Table 6

LATITUDES, LONGITUDES, AND ALTITUDES FOR THE MAGDALENA MOUNTAIN SITE ARRAY

SITE NUMBER	LATITUDE	LONGITUDE	ALTITUDE (meters)
1)	33.0 59.0 22.46	107.0 11.0 4.22	3170
2)	33.0 59.0 30.52	107.0 10.0 58.99	3158
3)	33.0 59.0 30.78	107.0 10.0 51.12	3139
4)	33.0 59.0 31.2	107.0 10.0 36.51	3023
5)	33.0 59.0 32.09	107.0 10.0 31.24	3060
6)	33.0 59.0 27.72	107.0 10.0 22.48	3030
7)	33.0 59.0 21.04	107.0 10.0 14.53	3036
8)	33.0 59.0 18.87	107.0 11.0 18.06	3237
9)	33.0 59.0 15.37	107.0 11.0 18.06	3225
10)	33.0 59.0 11.04	107.0 11.0 19.30	3219
11)	33.0 59.0 5.48	107.0 11.0 19.61	3237
12)	33.0 59.0 0.00	107.0 11.0 17.19	3225
13)	33.0 58.0 55.27	107.0 11.0 14.96	3219
14)	33.0 58.0 49.29	107.0 11.0 11.74	3197
15)	33.0 58.0 46.78	107.0 11.0 10.50	3194
16)	33.0 58.0 44.85	107.0 11.0 8.99	3190
17)	33.0 58.0 40.00	107.0 11.0 5.89	3190
18)	33.0 58.0 37.30	107.0 11.0 3.1	3194
19)	33.0 58.0 34.17	107.0 10.0 59.30	3206
20)	33.0 58.0 31.98	107.0 10.0 54.34	3218
21)	33.0 58.0 46.26	107.0 11.0 14.53	3200
22)	33.0 58.0 45.48	107.0 11.0 17.44	3194
23)	33.0 58.0 44.43	107.0 11.0 21.86	3182
24)	33.0 58.0 43.29	107.0 11.0 26.2	3164
25)	33.0 58.0 42.40	107.0 11.0 31.86	3164
26)	33.0 58.0 42.09	107.0 11.0 36.82	3173
27)	34.0 0.0 6.31	107.0 11.0 34.69	3109
28)	33.0 59.0 20.53	107.0 10.0 56.05	3023
29)	34.0 0.0 3.81	107.0 11.0 36.57	3115
30)	33.0 59.0 21.09	107.0 10.0 47.76	3083
31)	33.0 59.0 19.74	107.0 10.0 45.0	3036
32)	33.0 59.0 23.68	107.0 10.0 39.38	3011
33)	33.0 59.0 25.26	107.0 10.0 41.25	3189
34)	33.0 59.0 40.26	107.0 11.0 26.25	3146
35)	34.0 00.0 34.74	107.0 11.0 3.75	2999
36)	34.0 00.0 17.50	107.0 11.0 23.52	3109
37)	33.0 58.0 33.16	107.0 11.0 30.0	3109
38)	33.0 59.0 26.84	107.0 9.0 54.5	2902
39)	33.0 58.0 25.26	107.0 11.0 43.12	3024
40)	33.0 59.0 47.36	107.0 11.0 51.6	3084