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6. AUTHOR(S)

Ehud Heyman
Elene E. Tsedilina

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Ramot -University Authority for Applied Research and Industrial Development Ltd., P.O.B. 39296, Tel-Aviv 61392, Israel

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13. ABSTRACT (Maximum 200 words)

ABSTRACT

The processing and the analysis of the computer sounding vertical ionograms for the station Roquetes, Spain was made from June to November of 1991 (approximately 4300 ionograms) for the evaluation of F spread echo and scattered conditions in F layer. The examples of the ionograms with spread and disturbed signals and first results of their analysis are given for 1991.

KEY WORDS
Ionosphere, F layer, analysis, computer vertical ionograms, spread of the echo, indexes, processing, probability, number of cases, sporadic layer Fs

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ATTACHMENT 1
PAGE 1 OF 2

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CORRELATION AND GRADIENT CHARACTERISTICS OF IONOSPHERIC PARAMETERS IN EUROPE

by

E. Heyman
E. E. Tsedilina
O.V. Weitsman

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CONTRACT NUMBER N68171-94-C-9119

3rd Interim Report

March 1994 - May 1994

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1. STATEMENT OF WORK

For the period under review we continued the computer processing of the vertical ionograms from the station Roquetes, Spain, 1991. This work has been done, as the work in the 2nd Interim Report, for the reason of the evaluation of spread F echo or the scattering conditions in the upper ionosphere (F1, F2 layers). The method of indication of the spread of the echo or determination of disturbances in the signals of the F traces of first reflection was evaluated in the previous period of work. This method was used without changes for analysis of the traces on the ionograms. A short description of this method was done in the 2nd Interim Report N68171-94-C-9119. For the sake of reader convenience we give below the description of this method too.

The evaluated indexes and the letters in the tables (see table in Appendix) which describe the spread and disturbed F traces are the next ones. Strong disturbed traces in F region with frequency spread are determined by the letters f, ff, fff (accordingly with numerical points 4, 5, 6) that describe strong, very strong and very, very strong disturbed traces with frequency spread of signals. Corresponding range spread of echo was determined by the letter r, and mixed type of spread - by both letters rf. The letters c, cc, ccc with points 1, 2, 3 are used for determining the traces with very small, small and close to strong types of spread. Approximately the letters c, f, ff and fff describe the traces with frequency brouding and the width of the echo in 0.5-0.8 MHz, 0.8-1.0 MHz, 1.0-1.5 MHz, 1.5-2 MHz. We use also evaluative letters such as B - for absorbtion, S - for noises, w - for week signal, A - for breaks in traces, E - for covering F traces by repeating reflections from E region (from E, E_S layers), T - for technical reasons of violations. The dash means the absence of the ionogram or the trace at the ionogram, the absence of the dash or indexes c, f, r means the normal echo (See table in Appendix).

The results of processing approximately 8500 ionograms for one year of 1991 were obtained. Parts of these results were given in the 2nd Interim Report. The results of processing the second part of ionograms for 1991 and their analysis are given here in Tables 1-4 and Figures 1-4. Examples of ionograms with different indexes for F echoes and evaluating operative table for October 1991 are shown in Appendix.

Hour probability P_h of scattered F traces, equal to Σ_i / N, where Σ_i is the sum of hour points for considered month and time and N is the number of

ionograms with evaluated F traces, is given for 1991 in Table 1 and for summer and autumn of 1991 in Figure 1. According to definition of this probability usual state of F traces has probability close to 1. This is seen in Tab. 1 and Fig 1. It can be explained of the fact that very little amount of traces is observed without any disturbances. In this case they have no points and their probability $P_h = 0$. The most amounts of cases have indexes ccc or points 1. They are the cases with few disturbances. That why the main hour probability of traces with scattered signals P_h is close to 1 (see also table in Appendix). Notice here that analogies' data for winter and spring were given in 2d Interim Report.

Numbers N_s of F traces with strong spread for 1991 (indexes f, ff, fff, r, rf) are given in Table 2 for whole year and in Figure 2 for summer and autumn of 1991.

Mean month probability P_m of traces with scattered signals and sum number $N_d = \Sigma N_s$ of strong disturbed traces (f, ff, fff, rf, r) for every month of 1991 are given in Table 3 and shown in Figures 3 and 4.

There is hour probability for every month of 1991 $P_N = N_c / N$ of F spread, where N_c is the sum of all frequency and range spread cases with indexes c, f, ff, fff, fr, r for all indicated hours in every day of each month of 1991, for station Roquetes, in Tab. 4. Here N is the number of ionograms with reflected signals for all indicated hours during every month.

One can see from obtained data the diurnal, season and terminator effects in the appearance of strong F spread echoes and scattered F traces. Detailed analysis of this data will be given in Final Report.

2. PUBLICATIONS

1. H. Soicher, F. Gorman, E. E. Tsedilina and O. V. Weitsman, Comparison of the IRI-90 with measured ionospheric parameters at midlatitudes, Adv. Space Res., 16, No 1, (1)129-(1)132, 1995.

3. RESEARCH PROGRAMS

Next we are going to consider and perform the work:

1. To obtain the probability of appearance of sporadic E_s with $f_oE_s > 3$ MHz for the station Roquetes, Spain, 1991.

2. To separate all cases with full absorbtion of the signals in ionograms for 1991 and give their morphological statistics for one year.

3. To perform some special analysis and give geophysical interpretation of the diurnal, seasonal and terminator dependencies of observed spread of F echo and scattered signals at midlatitudes.

4. Estimation of correlation characteristics of the parameter f_oF2/f_oE.

5. A preparation of the results of the ionogram analysis for Final report and publications.

Table 1. Probability Ph of F traces with scattered signals ; Roquetes .Spain ,1991 .

Hour\Mon	Dec -Jan	February	March	April	May	June	July	August	September	October	November	P
01	1.31	1.39	1.33	1.68	1.40	2.25	2.57	2.30	1.74	1.82	1.33	1.74
02	1.25	1.30	1.07	1.60	1.50	2.75	2.61	2.67	1.63	1.83	1.75	1.81
03	1.50	1.65	1.17	1.70	1.60	2.75	2.55	2.33	1.81	1.77	1.88	1.88
04	1.20	1.43	1.68	1.60	1.70	2.75	2.65	2.38	1.85	1.75	2.12	1.92
05	1.90	1.23	1.67	1.90	2.10	2.24	2.71	2.48	2.32	1.72	1.80	2.01
06	1.50	1.14	1.66	2.10	2.70	2.41	3.13	2.74	3.10	2.28	2.00	2.25
07	1.75	1.64	1.07	2.05	2.40	2.16	3.10	2.97	3.30	2.80	2.29	2.32
08	1.50	1.77	1.30	1.60	1.50	1.84	2.24	2.36	2.63	2.81	2.04	1.96
09	2.35	1.61	1.17	1.30	1.40	1.26	1.94	2.07	2.47	1.90	1.93	1.76
10	1.90	1.29	1.17	1.13	1.20	1.00	1.53	1.61	1.83	1.55	1.66	1.44
11	1.30	1.12	1.10	0.94	1.10	1.16	1.92	1.64	1.71	1.74	1.83	1.41
12	1.48	1.28	0.87	0.94	1.20	1.33	1.50	1.63	1.78	1.59	1.79	1.46
13	1.52	1.20	0.83	1.17	0.70	0.90	1.48	1.59	1.71	1.65	1.64	1.31
14	1.50	1.24	0.85	1.16	0.80	1.05	1.16	1.63	1.83	1.71	1.79	1.34
15	1.86	1.16	0.97	1.28	0.90	0.75	1.48	1.65	1.89	1.97	1.86	1.43
16	2.11	1.28	1.00	1.10	0.80	1.31	1.64	1.75	2.00	2.03	1.68	1.52
17	1.35	1.04	1.07	1.80	1.30	1.61	2.15	2.10	2.07	1.97	1.81	1.66
18	0.84	0.60	1.04	1.95	1.80	1.76	2.38	2.18	2.03	1.96	1.64	1.65
19	1.01	1.32	0.75	1.40	1.60	1.86	2.25	1.86	2.03	1.96	1.25	1.57
20	1.02	1.12	0.73	1.25	1.30	1.26	1.92	1.85	1.86	1.93	1.77	1.46
21	1.81	0.83	1.07	1.20	1.07	1.80	2.11	2.11	1.67	1.84	1.12	1.51
22	1.45	1.12	1.00	1.10	1.20	1.86	2.43	2.38	1.83	1.81	1.61	1.62
23	1.25	0.83	0.90	1.25	1.50	2.24	2.31	2.41	1.57	1.93	1.76	1.63
24	1.38	0.67	1.13	1.26	1.70	1.97	2.46	2.31	1.54	1.87	1.48	1.62

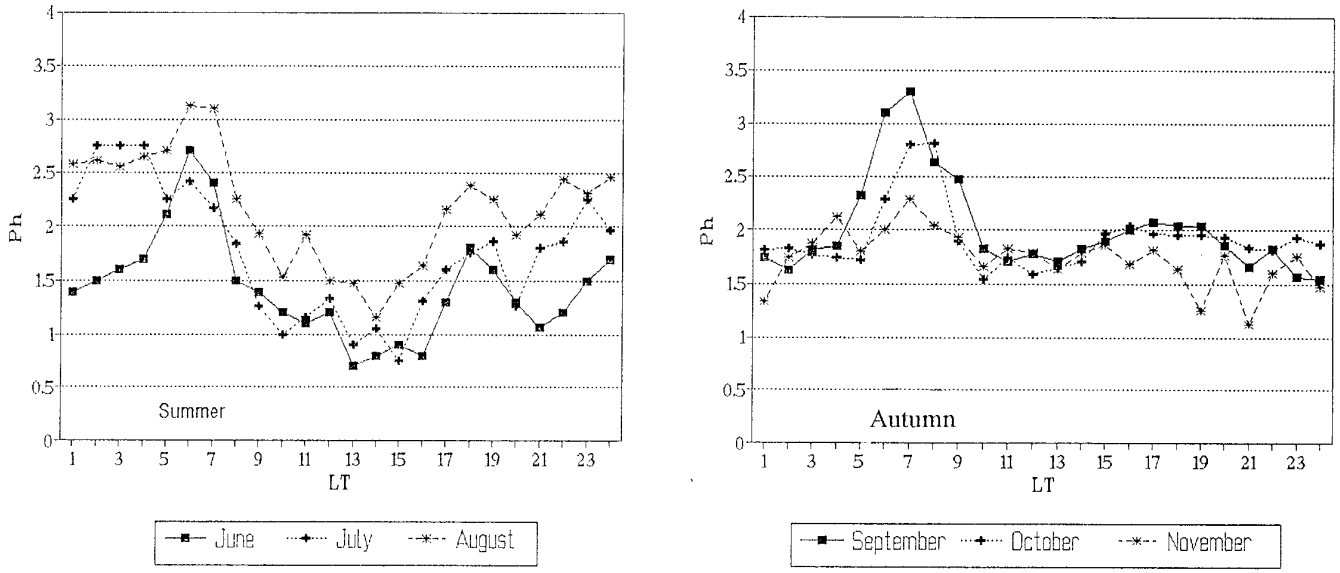

Fig.1 . Variations of hour probability Ph , Roquetes , June - November ,1991.

Table 2. Number Ns of F traces with strong spread (f , ff , fff , fr , r) ; Roquetes , Spain , 1991.

Hour\Mon	Dec-Jan	February	March	April	May	June	July	August	September	October	November	Σ
01		1		1		5	8	5		4	1	25
02				1	1	7	8	6		4	2	29
03			1	2	3	9	6	6		3	2	32
04	1	2	2	2	4	8	6	5	2	1	3	36
05	2	1	2		4	3	7	4	2		2	27
06	3	1	3	3	5	8	9	7	7	2	5	53
07	2			3	6	3	10	8	11	5		46
08	2				2	1	2	4	4	6	2	21
09	3						1	3	1		1	6
10	1						1	1			1	3
11							1	1			2	4
12								1				1
13							1		2		1	4
14				1					1	1		3
15				1					1		1	3
16									1			1
17					1		1	1	1			4
18				1	2	1	3	1			1	9
19						1	1	3				5
20	1						1				2	3
21	3					1	4	3				8
22	2						5	2		2	2	11
23	2					4	7	2			2	15
24	1					2	6	3	1	2	2	16

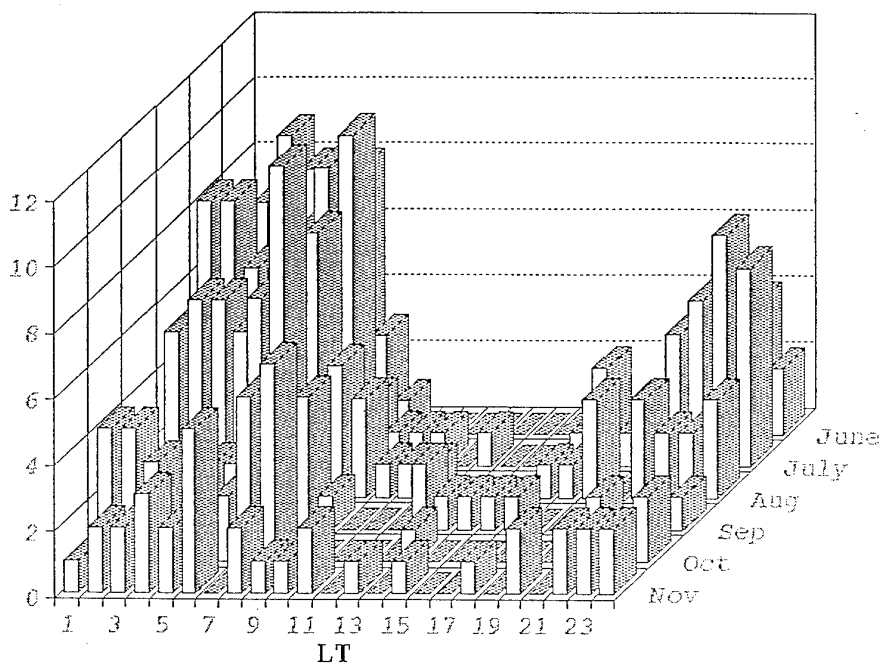

Fig . 2 . Number of F traces with strong spread ; Roquetes , Spaine , 1991 .

Table 3. Mean month probability Pm of F traces with scattered signals and full number Nd of strong disturbed traces (f , ff , fff , fr , r) for 1991 ; R-mean sunspot number .

Month	Dec-Jan	February	March	April	May	June	July	August	September	October	November
Pm	1.50	1.21	1.08	1.44	1.40	1.75	2.18	2.13	2.01	1.93	1.74
Nd	23	5	8	15	29	53	90	63	34	30	32
R	140.6	167.9	141.9	140.0	121.3	189.7	173.7	176.3	125.3	144.1	108.2

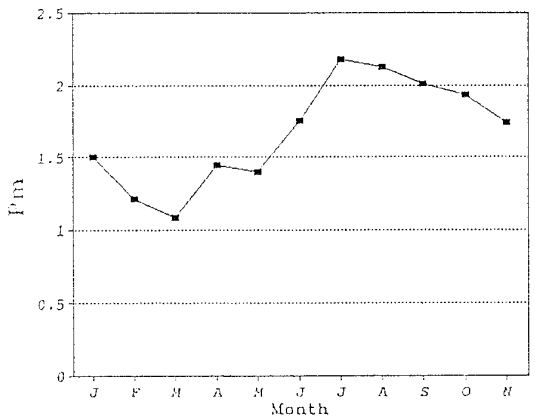

Fig. 3. Mean month probability of F traces with scattered signals ; Roquetes ; Spaine , 1991.

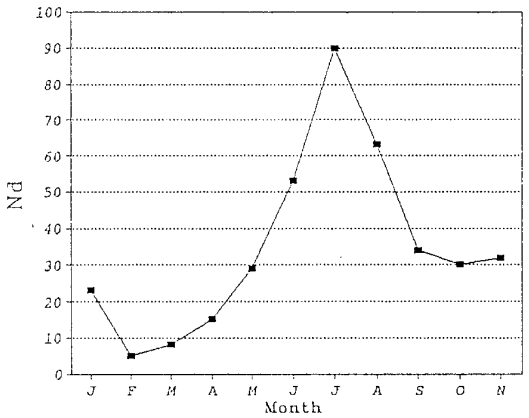

Fig. 4. Full number of full disturbed traces for 1991 , Roquetes , Spain .

Table 4. Probability $P_N = N_c / N$, N - number of days , N_c - number of cases c , f , ff , fff ,r ; Roquetes , Spain ,1991.

Hour\Mon	Dec-Jan	February	March	April	May	June	July	August	September	October	November
01	0.100	0.130	0.067	0.110	0.130	0.460	0.430	0.400	0.190	0.210	0.170
02	0.200	0.130	0.033	0.220	0.140	0.540	0.640	0.570	0.074	0.207	0.290
03	0.200	0.170	0.069	0.110	0.170	0.540	0.480	0.500	0.190	0.200	0.290
04	0.160	0.130	0.210	0.220	0.200	0.500	0.500	0.340	0.300	0.250	0.400
05	0.200	0.045	0.130	0.220	0.330	0.380	0.540	0.520	0.320	0.240	0.280
06	0.160	0.015	0.140	0.440	0.550	0.410	0.800	0.560	0.860	0.410	0.350
07	0.220	0.045	0.036	0.520	0.430	0.320	0.760	0.660	0.900	0.630	0.320
08	0.170	0.180	0.037	0.170	0.170	0.320	0.240	0.320	0.670	0.650	0.390
09	0.440	0.043	0	0.055	0.097	0.053	0.210	0.190	0.470	0.200	0.074
10	0.110	0.083	0	0.063	0.074	0.059	0.120	0.071	0.170	0.034	0.103
11	0.050	0.042	0	0.059	0	0	0.170	0.120	0.071	0.068	0.103
12	0.050	0.040	0	0.059	0.080	0	0.170	0.110	0.074	0	0.071
13	0.050	0.040	0	0.055	0	0	0.190	0.069	0.140	0	0.071
14	0.050	0.040	0	0.110	0.036	0.053	0.040	0.170	0.140	0.068	0.035
15	0.200	0.040	0	0.055	0.034	0	0.160	0.065	0.071	0.097	0.071
16	0.200	0	0	0.050	0.070	0.115	0.110	0.071	0.107	0.032	0
17	0.050	0.080	0	0.200	0.035	0.106	0.350	0.130	0.036	0	0.038
18	0.050	0.040	0	0.300	0.170	0.240	0.450	0.140	0.069	0.074	0.080
19	0.060	0	0	0.050	0.101	0.276	0.320	0.036	0.067	0.170	0.100
20	0.160	0	0	0.050	0.071	0.037	0.320	0.077	0.034	0.240	0.190
21	0.260	0	0	0	0.037	0.130	0.380	0.260	0.033	0.190	0.160
22	0.160	0.080	0	0	0.034	0.170	0.430	0.420	0.210	0.260	0.190
23	0.160	0	0.067	0.050	0.140	0.410	0.380	0.440	0.071	0.170	0.200
24	0.240	0	0.067	0.050	0.260	0.310	0.360	0.480	0.180	0.270	0.160

APPENDIX

foF2	foF1	foE	foEs	MUF	M3000	h'F	h'F2	h'E	h'ES	fmin	fxI	fF	fE
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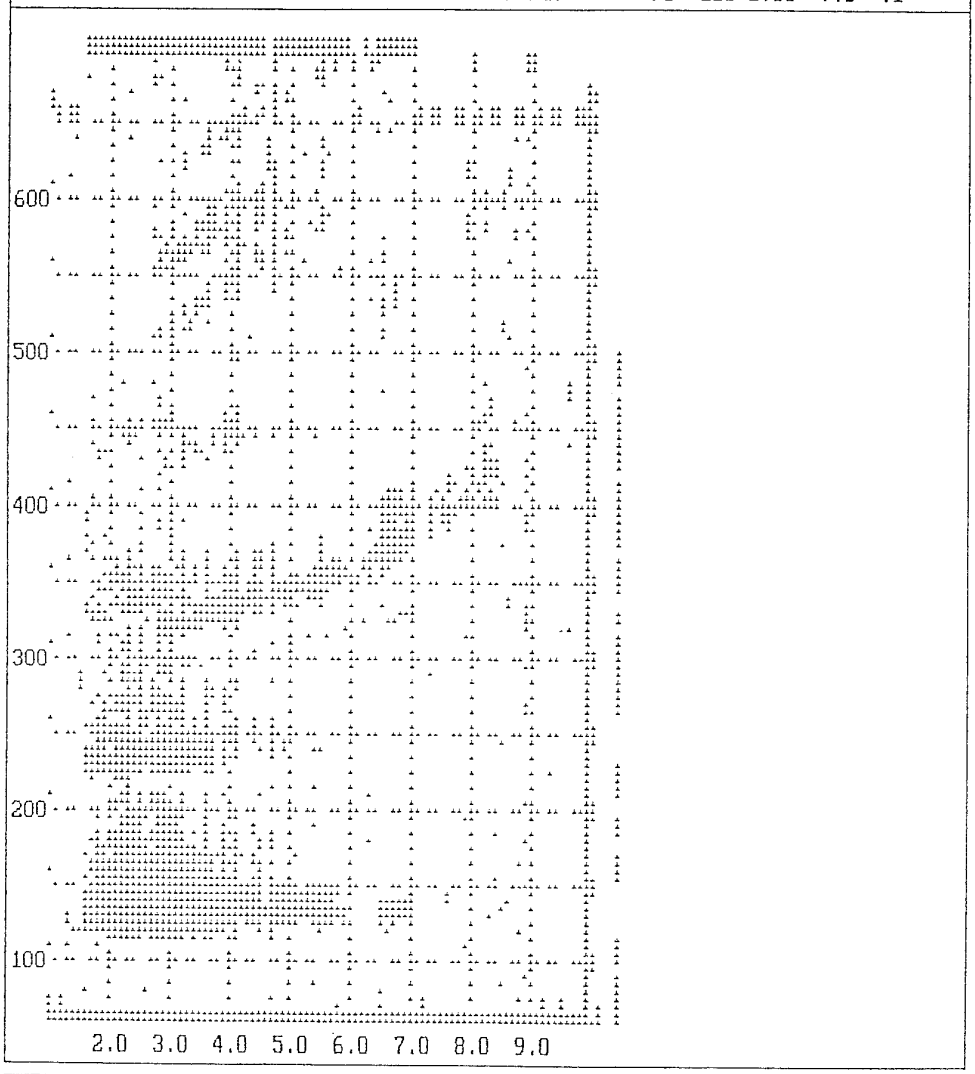

1991 DAY 180 22:59 UT FOF2= 7.0 MHz

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29 June 1991, index f

foF2	foF1	foE	foEs	MUF	M3000	h'F	h'F2	h'E	h'ES	fmin	fxI	fF	fE
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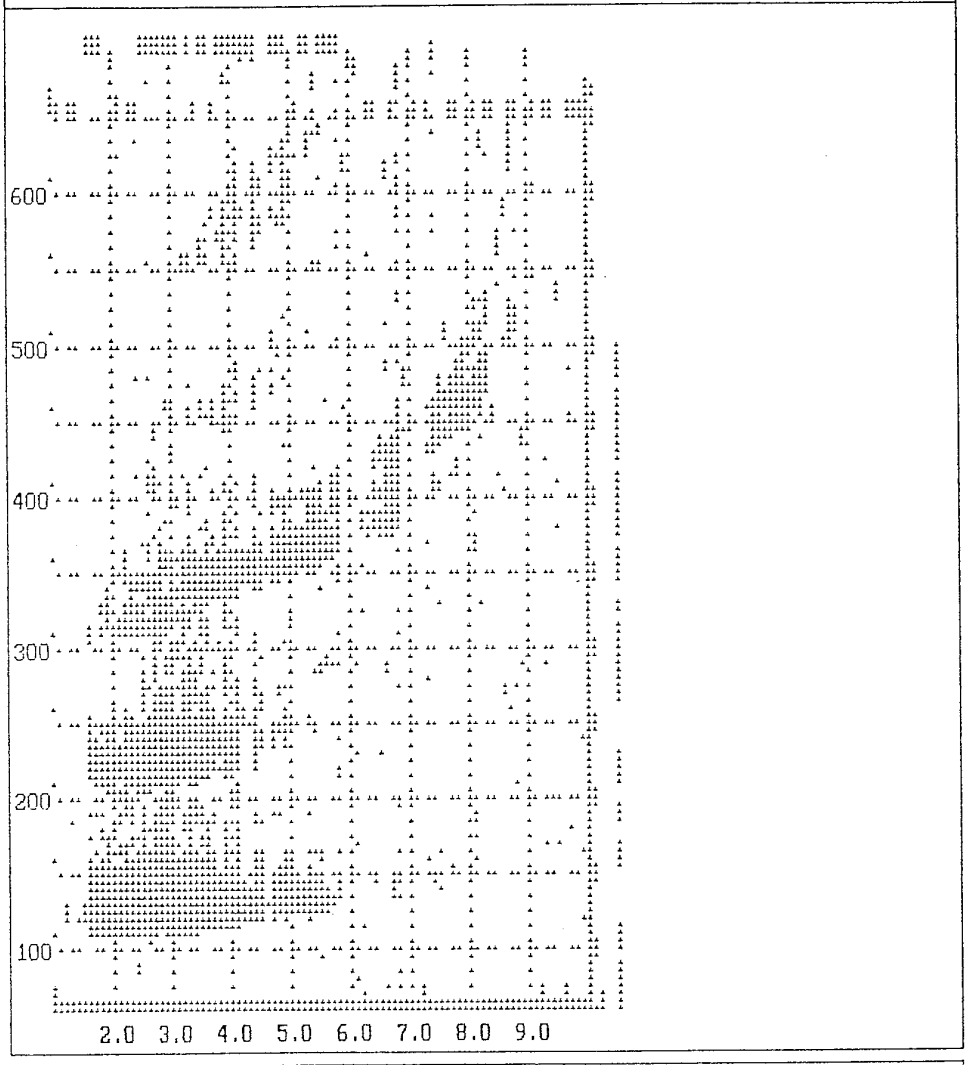

1991 DAY 210 23:59 UT FOF2= 5.8 MHz

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29 July 1991, index fff

October 91

d \ h	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	cc	cc	cc	ccc	cc	C	C	ccE	ccB	ccc	cc	cc	cc	C	cc	ccN	ccNA	ccNA	ccAS	ccA	cc	SC	cc	ccc	
2	ccc	cc			ccc	C	CS	P	CW	-B	ccAB	ccNA	cc	ccA	ccA	ccNA	ccNA	ccA	CA	ccc	C	C	cc	—	
3	—	—	—	—	—	—	—	C	ccBA	cc	cc	cc	cc	cc	cc	ccNA	ccNA	ccA	ccA	ccA	ccc	cc	cc	C	
4	cc	cc	cc	cc	cc	cc	P	CA	cc	ccc	ccc	ccc	ccc	ccc	ccNA	ccNA	ccNA	ccNA	ccA	CS	ccc	ccc	C	cc	
5	ccW	W	ccW	—	—	CW	CAW	CW	ccW	ccc	cccA	ccA	ccAS	PEB	CEN	ccAB	ccNA	CA	ccAB	ccAB	ccAW	ccc	ccc	W	
6	W	cccB	cc	cc	C	C	CA	P	CW	CN	ccB	cc	cc	ccc	ccN	CNA	ccNA	ccAN	CA	CA	ccA	ccAT	ccN	cc	
7	C	cc	ccc	cc	cc	C	P	P	CW	cc	cc	cc	ccN	cc	ccNA	ccNE	ccNA	ccA	ccA	ccAB	C	P	cc	CA	
8		cc	cc	ccc	ccc	C	CE	CEA	ccE	cc	cc	ccN	ccA	cc	CNT	cc	ccNA	ccA	ccA	cc	cc	cc	cc		
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23	cc	cc	cc		ccc	cc	cc	ccA	ccc	ccA	cc	ccc	ccN	NNA	ccNA	ccNA	ccA	ccAT	ccAT	ccA	N		C	cc	
24	ccc	cc		ccA	ccc	ccc	CCF	CNA	cc	ccc	ccA	ccc	ccA	ccA	ccA	ccA	ccA	ccAB	-B	ccAB	ccc	cc	cc	cc	
25	cc	ccc	cc	cc	ccc		CA	ccAE	ccA	ccA	ccA	ccA	ccA	cc	ccA	ccA	ccA	ccA	ccA	ccA	ccA	ccA	ccAE	CEA	$p_d = \frac{762}{24}$
26	ccE	CCE	ccc	ccc	cc	cc	cc	ccE	-BT	cc	ccA	ccA	ccA	ccNA	ccN	ccNA	ccA	A	ccc		cc	ccW	ccW	ccE	
27	PE	P		ccc	C	cc	C	cc		ccc	CB	cc	ccW	ccNB	ccNE	ccNN	ccEAB	-BE	ccBW	-EB	ccWB	CBE	-BE	ccSB	$= 1,93$
28	-BE	CBE	PN	-BE	CNE	cc	P	CE	CE	ccB	cc	-B	ccBA	ccBA	ccA	ccA	ccA	-BE	-BE	CEA	ccAE	CEA	-BE	CA	
29	ccA	ccA	cc	ccS	W	-BW	ccW	ccW	ccWS	-BE	CBE	-BW	cc	ccW	CNf	ccN	cc	CW	ccc	ccc	cc	P	P	PP	$N_d = 30$
30	P	P	P	P	CW	ccc	ccc	cc	cc	BE	BE	ccA	ccc	cc	ccc	ccA	ccAN	cc	ccc	C	C	C	CE	P	
31	P	P		cccW	cccW	C	ccA	ccA	cccA	ccA	ccc	cccA	cccA	cccA	ccA	ccA	ccA	ccAB	ccAB	ccc	ccc		CBE	W	
S_i	5+120 6+12+5	5+126 6+126	5+130 9+210	5+20 8+13	9+20 21	4+124 30+5	2+120 42+18+5	2+20 42+24	7+132 18	10+132 3	6+42 6	12+134	8+42	10+136	7+148	2+158	1+160	1+146	7+138	7+128	9+150 18	8+52 18+8	7+146	3+126 18+8	
ΣS_i	54	55	55	59	50	66	84	87	57	45	54	46	57	53	61	63	61	53	57	56	57	56	56	56	
N	28	29	30	30	29	29	30	31	30	29	31	29	31	31	31	31	31	27	26	29	31	31	29	30	
P	1.80	1.83	1.77	1.75	1.72	2.28	2.8	2.81	1.9	1.55	1.74	1.59	1.85	1.71	1.97	2.03	1.97	1.96	1.96	1.93	1.84	1.81	1.93	1.87	
	54/7	55/7	55/3	59/1		66/2	84/5	87/6				46/2		53/3								56/2		56/2	