AEROSPACE REPORT NO.
ATR-76(7517)-1

Space Physics Laboratory
No. SPL-76(7517)-1

(NASA-CR-146347) REDUCTION AND ANALYSIS OF ATS-6 DATA Final Report, 1 May - 15 Jul. 1975 (Aerospace Corp., El Segundo, Calif.) 26 p HC $4.00 CSCL 03B

N76-19039

Unclas
G3/93 15049

FINAL REPORT

REDUCTION AND ANALYSIS OF ATS-6 DATA

CONTRACT: NASW-2762

Period of Performance:
1 May to 15 July 1975

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Space Physics Laboratory

SEPTEMBER 1975

Laboratory Operations
THE AEROSPACE CORPORATION
El Segundo, California

This work was conducted under NASA Contract NASW-2762.

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FINAL REPORT

REDUCTION AND ANALYSIS OF ATS-6 DATA

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I. Introduction

This report summarizes the work performed under NASA contract NASW-2762 with The Aerospace Corporation. The tasks performed under this contract were meant to accelerate the development of computer programs and reduction of data returned by The Aerospace Corporation experiment on ATS-6. During the time period covered by this contract we developed and de-bugged a data reduction program which presents the Aerospace particle data and the UCLA magnetometer data in a variety of formats suitable for analysis as well as further data processing. Fifty days of data were processed through this program and analysis of these data were begun. In addition, modifications were made to an old ATS-1 program in order to enable this program to process ATS-1 data obtained simultaneously with ATS-6 data acquisitions during 1974. Some analysis of ATS-1 data and comparison with ATS-6 data also went forward. Finally, preparations were begun to transfer ATS-6 data to the National Space Science Data Center. These efforts are described in detail below.

II. Progress in Programming

The primary effort under this contract was directed toward developing an efficient and economical computer program which would reduce and present The Aerospace Corporation particle data and subsidiary data to a format suitable for analysis or further computer processing.

The ATS-6 data reduction program (QL-2) consists of three basic parts; (1) the extraction of the data from the daily experimenter tape, (2) the analysis and storage of the data, and (3) the plotting and printout routines.

The portion of program QL-2 which extracts data from the daily ATS-6 experimenter tape consists of subroutines that read from the tape the UCLA magnetometer data, proton and electron count rates and ATS-6 ephemeris data. The data is read in blocks of 64-sec and flagged for data quality and filled data. Bad data and filled data are subsequently omitted from all averages and plots.

The next phase of QL-2 analyzes the data. Proton and electron counts are converted to counts/sec and stored. When an hour of data is accumulated, hourly averages of the data are calculated and an hour of data is plotted. Magnetometer data are analyzed with version 5 of the UCSD routine (graciously provided to us by Carl McIlwain) for computing the ATS-6 magnetic field in spacecraft coordinates. The orbit-attitude information is used to transform the field into dipole coordinates (V, D, H). The magnetic field information is stored and plotted at 16-second intervals. Finally, daily plots of the electron, proton, and magnetic field data are prepared. Data are averaged over 320 second intervals and plotted.

The products of this program are plots for each hour of data and 24 hours of data. These include electron channels, high energy proton channels and low energy proton channels. Magnetic field data in dipole coordinates is plotted as well. Ephemeris information is included on the plots (latitude, longitude, and altitude). Samples of the typ s of plots produced are illustrated in Figs. 1 and 2.

Hourly averages for each particle channel are printed. The program has the option of printing all data in 64-second blocks. This includes proton and electron counts, temperature, magnetic field (V, D, H), ephemeris information (latitude, longitude, and altitude) and 64-sec averages of the electron and proton count rates for each channel. A sample of a printout of a block of data and the hourly averages for a particular day of data are presented in Figures 3 and 4.

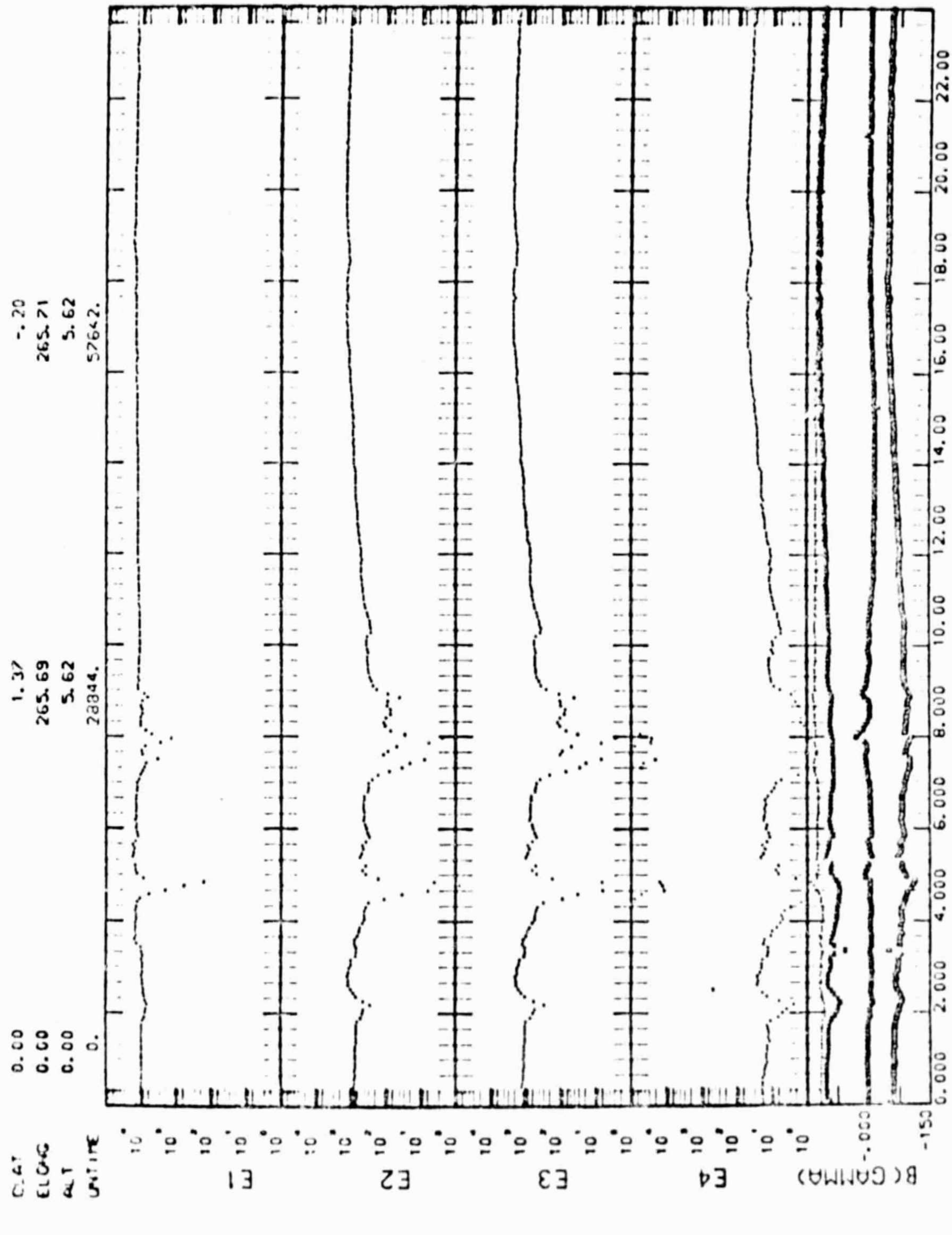

Figure 1. Plot of one day of ATS-6 data for Day 208, 1974. Electron countrates (E_i) are plotted above the V, D, H components of the geomagnetic field. Ephemeris is annotated at the top of the plot. Similar plots are also produced for the proton channels.

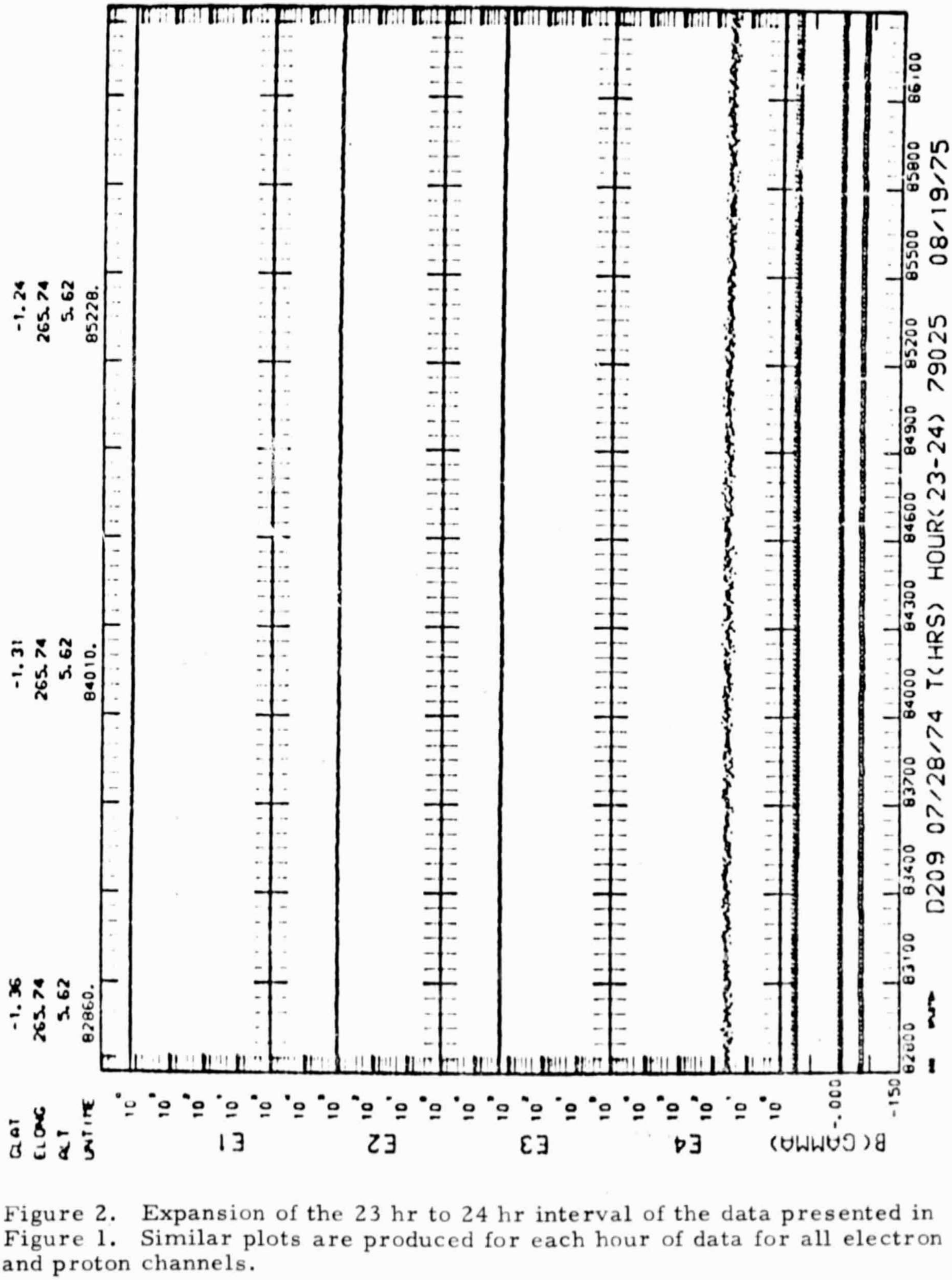

Figure 2. Expansion of the 23 hr to 24 hr interval of the data presented in Figure 1. Similar plots are produced for each hour of data for all electron and proton channels.

14127.0	766.0	1329.0	19.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.38 45.7	3.41 30.1	4.37 45.5	3.41 30.1

TAPE VSN=77777
DAY OF RUN 08/11/7

TIME= 86249.72 23HRS 57MIN 29SEC

LONGITUDE= 265.70DEGREES LATITUDE= -1.20DEGREES RADIAL DISTANCE= 5.61EARTH RADII

FRAMES	E1	E2	E3	E4	P1	P2	P3	P4	P5	P6	P7	P8	BV	BD	BH
0- 7	13823	831	1471	23	0	0	0	0	0	0	0	0	3.	-99.	64.
	14079	799	1311	17									3.	-99.	64.
8-15	14079	733	1407	22	1	0	0	0	0	0	0	0	3.	-99.	64.
	13823	767	1279	15									3.	-99.	64.
16-23	13823	767	1311	20	1	0	0	0	0	0	0	0	3.	-99.	65.
	13823	831	1343	16									3.	-99.	65.
24-31	13823	767	1247	17	0	0	0	0	0	0	0	0	3.	-99.	65.
	13823	815	1311	17									3.	-99.	65.
32-39	13567	749	1311	17	0	0	0	0	0	0	0	0	2.	-99.	65.
	13823	749	1375	13									2.	-99.	64.
40-47	13823	767	1311	13	0	0	0	0	0	0	0	0	2.	-99.	64.
	14079	815	1311	15									3.	-99.	64.
48-55	14079	767	1279	25	0	0	0	0	0	0	0	0	3.	-99.	64.
	14079	719	1343	15									4.	-99.	64.
56-63	14079	799	1247	14	0	0	0	0	0	0	0	0	4.	-99.	64.
	13823	733	1279	17									4.	-99.	64.

CHANNEL AVERAGES

FRAMES	E1	E2	E3	E4	P1	P2	P3	P4	P5	P6	P7	P8	T1	T2	T3	T4
	13903.0	784.0	1321.0	17.2	.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.39 45.9	3.41 30.1	4.38 45.7	3.41 30.1

TAPE VSN=77777
DAY OF RUN 08/11/7

TIME= 86313.72 23HRS 58MIN 33SEC

LONGITUDE= 265.70DEGREES LATITUDE= -1.19DEGREES RADIAL DISTANCE= 5.61EARTH RADII

FRAMES	E1	E2	E3	E4	P1	P2	P3	P4	P5	P6	P7	P8	BV	BD	BH
0- 7	13823	815	1215	16	0	0	0	0	0	0	0	0	3.	-99.	64.
	14079	783	1247	13									3.	-99.	64.
8-15	13823	799	1311	17	0	0	0	0	0	0	0	0	2.	-99.	64.
	13823	783	1247	19									2.	-99.	63.
16-23	13823	783	1247	23	1	0	0	0	0	0	0	0	3.	-99.	63.
	14079	767	1215	11									3.	-99.	63.
24-31	13823	863	1247	18									3.	-99.	63.
	14079	735	1279	22									3.	-99.	63.
32-39	13823	751	1215	15									3.	-99.	63.
	14079	735	1279	9									3.	-99.	63.
40-47	13823	831	1279	24									3.	-99.	63.
	13823	783	1279	21									3.	-99.	63.
48-55	14079	799	1215	14									3.	-99.	63.

Figure 3. Printout of all data channels, performance parameters, magnetometer data and ephemeris information. These printouts are ordinarily suppressed to reduce the cost and bulk of the data handled.

6

DATE OF RECORDING 08/18/74
DAY OF YEAR 230
TAPE VSN=79015
DAY OF RUN 08/28/7

ATS-F HOURLY-AVERAGES

	E1	E2	E3	E4	P1	P2	P3	P4	P5	P6	P7	P8
0-1	.42E+04	.35E+02	.34E+02	.29E+00	.28E-01	.94E-02	.47E-02	.24E-02	0.	.24E-02	.31E-01	.23E-02
1-2	.34E+04	.27E+02	.33E+02	.22E+00	.44E-01	.27E-01	.44E-02	0.	0.	.13E-01	.38E-01	.44E-02
2-3	.28E+04	.34E+02	.21E+02	.23E+00	.47E-01	.89E-02	.22E-02	0.	.22E-02	.89E-02	.33E-01	.89E-02
3-4	.31E+04	.16E+02	.13E+02	.17E+00	.38E-01	.13E-01	.45E-02	.22E-02	0.	.67E-02	.20E-01	0.
4-5	.36E+04	.13E+02	.11E+02	.20E+00	.40E-01	.18E-01	.89E-02	0.	0.	.22E-02	.31E-01	.67E-02
5-6	.52E+03	.61E+00	.39E+00	.11E+00	.36E-01	.29E-01	.44E-02	0.	0.	.45E-02	.29E-01	.45E-02
6-7	.28E+03	.43E+00	.35E+00	.14E+00	.22E-01	.16E-01	.89E-02	0.	0.	.13E-01	.40E-01	.67E-02
7-8	.44E+04	.13E+02	.11E+02	.17E+00	.27E-01	.20E-01	.89E-02	0.	0.	.45E-02	.27E-01	.22E-02
8-9	.51E+04	.24E+02	.20E+02	.21E+00	.47E-01	.13E-01	.13E-01	.22E-02	0.	.22E-02	.31E-01	.67E-02
9-10	.56E+04	.16E+02	.92E+01	.15E+00	.47E-01	.16E-01	.67E-02	0.	0.	.44E-02	.42E-01	.89E-02
10-11	.59E+04	.11E+02	.63E+01	.17E+00	.31E-01	.24E-01	.67E-02	0.	0.	.89E-02	.53E-01	.22E-02
11-12	.57E+04	.99E+01	.68E+01	.16E+00	.54E-01	.16E-01	.89E-02	.45E-02	.16E-01	.22E-02	.38E-01	.45E-02
12-13	.50E+04	.12E+02	.93E+01	.17E+00	.51E-01	.18E-01	.67E-02	0.	0.	.22E-02	.31E-01	0.
13-14	.44E+04	.13E+02	.11E+02	.21E+00	.38E-01	.25E-01	.67E-02	0.	0.	.11E-01	.33E-01	.11E-01
14-15	.53E+04	.36E+02	.37E+02	.40E+00	.38E-01	.24E-01	.22E-02	0.	0.	.89E-02	.20E-01	.67E-02
15-16	.55E+04	.47E+02	.61E+02	.34E+00	.33E-01	.31E-01	.89E-02	.22E-02	0.	.67E-02	.36E-01	.22E-02
16-17	.53E+04	.50E+02	.57E+02	.59E+00	.33E-01	.33E-01	.89E-02	0.	0.	.11E-01	.22E-01	.22E-02
17-18	.55E+04	.42E+02	.53E+02	.45E+00	.31E-01	.31E-01	.44E-02	.22E-02	0.	.13E-01	.29E-01	.67E-02
18-19	.53E+04	.43E+02	.51E+02	.48E+00	.20E-01	.20E-01	.67E-02	0.	0.	.67E-02	.40E-01	0.
19-20	.52E+04	.38E+02	.46E+02	.38E+00	.43E-01	.18E-01	.89E-02	0.	0.	0.	.24E-01	.45E-02
20-21	.50E+04	.32E+02	.40E+02	.40E+00	.39E-01	.20E-01	.14E-01	.23E-02	0.	.68E-02	.41E-01	.23E-02
21-22	.45E+04	.86E+02	.31E+02	.32E+00	.16E+02	.16E+02	.46E-02	.23E-02	0.	.68E-02	.32E-01	.68E-02
22-23	.37E+04	.36E+02	.37E+02	.27E+00	.40E-01	.22E-01	.22E-02	0.	0.	.45E-02	.33E-01	.67E-02
23-24	.17E+04	.19E+02	.20E+02	.31E+00	.33E-01	.27E-01	.45E-02	0.	0.	.11E-01	.20E-01	.22E-02

Figure 4. Hourly averages of the countrates for all channels of data for Day 230, 1974. Those data are also stored on tape for further processing.

III. Progress in Data Handling

The receipt, cataloging, handling and retrieval of ATS-6 data has proven to be unexpectedly burdensome and considerable effort has been expended in this area. There are two causes for this unexpected workload:

1) Well after launch the data tape format was changed to include the UCLA magnetometer data onto the experimenters tapes, rather than providing the magnetometer data separately. This step is of considerable convenience in the data reduction phases of the effort, but has resulted in two species of data tapes in the system (three, if one counts the quick look tapes) with sufficiently different format that confusion is possible.

2) Some difficulty was encountered by GSFC in providing correct orbit/attitude data. This problem was discovered sufficiently late that GSFC found it necessary to re-generate some of the early data tapes. This has resulted in there being more than one "final" data tape being available for a given day of data, with the last-generated tape containing the best orbit-altitude information.

A system was developed to log in the arrival of each data tape, record the relevant characteristics of that tape, transfer the tape to The Aerospace Corporation Information Processing Division and, subsequently, record the processing and other operations performed on each data tape. The system is simple yet flexible and is working satisfactorily.

A sample of a page of the data log is presented as Figure 5.

DAY	DATE	TAPE ID	AODAL	TAPE NO.	NO. FILES	QUICK LOOK	LOG	DATE GEN TAPE	MK0	MK1
224	08/12/74	NL5093F	741203013	72237	6	NO	YES	11/16/74		X
224	08/12/74	NJ5204K	740924022	72228	6	NO	YES	09/09/74		
225	08/13/74	NG3605K	741205003	79022	6	NO	YES	11/16/74		X
225	08/13/74	NJ4507H	46008	72169	6	NO	YES	08/28/74		
226	08/14/74	NG3606D	741203016	79017	6	NO	YES	11/16/74		X
226	08/14/74	NE3084A	46005	72166	6	NO	YES	09/04/74		
227	08/15/74	NL5007A	741203012	79013	10	NO	YES	11/15/74		X
228	08/16/74	NL5106F	741203015	79016	9	NO	YES	11/16/74		X
229	08/17/74	NL5492I	741203009	79010	8	NO	YES	11/16/74		X
230	08/18/74	NL5156F	741203014	79015	6	NO	YES	11/15/74		X
231	08/19/74	NJ3130F	741203005	79006	7	NO	YES	11/18/74		X
232	08/20/74	NF9960B	750128019	79183	12	NO	YES	01/22/75		X
232	08/20/74	NL7879E			12	NO	YES	06/21/75		
233	08/21/74	NM0296J	741205015	79034	13	NO	YES	11/29/74		B
234	08/22/74	NL5383C	741127002	79000	12	NO	YES	11/21/74		X
235	08/23/74	NL9081E	741205010	79029	7	NO	YES	11/28/74		X
236	08/24/74	NL5602G	741127001	72325	12	NO	YES	11/21/74		B
236	08/24/74	NM8221H	750102009	79108	6	NO	YES			
237	08/25/74	NS3204H	750701011		6	NO	YES	07/13/75		
237	08/25/74	ND6452A	750128020	79184	6	NO	YES	01/22/75		X
237	08/25/74	NS3204H			6	NO	YES			
238	08/26/74	NM5136J	750102006	79105	7	NO	YES	12/16/74		X
239	08/27/74	NL9812K	741205014	79033	9	NO	YES	11/29/74		X
240	08/28/74	NG5095C	741205008	79027	10	NO	YES	11/27/74		B
241	08/29/74	NL9948A	741216020	79073	7	NO	YES	11/30/74		X

Figure 5. Sample page of data log for ATS-6 data, giving dates, tape numbers, and processing status.

IV. Progress in Data Reduction

A. ATS-6 Data Reduction

The program developed under this contract has been used to reduce 100 days of ATS-6 data. Table I presents a summary of the dates for which ATS-6 data has now been processed; shows there also are the days for which processing had been done using the earlier version of the data reduction program. The output of this data reduction process consists of: a) plots of electron and proton count rates and UCLA magnetometer information for each day of data on two time scales (hourly and daily plots; b) complete printouts of selected days of days of data and printouts of the hourly averages of electron and proton fluxes for each day of data that was processed; c) storage on tape of the hourly averages for further processing. The analysis of the averaged data is described in Section VB .

The cost of processing each day of ATS data in the manner described above is about $[illegible]0.00. The operational aspects of data processing with this program (and the data handling system described earlier) are sufficiently simple and rapid that it has been found possible to process as many as five days of data per working day.

TABLE I

Summary of ATS-6 Data Processed by Day Number, 1974

O Processed through Quick Look Program

X Processed through program developed under present contract

160	161	162	163	164	165o	166o	167o	168o	169o
170o	171o	172o	173o	174o	175o	176o	177o	178o	179o
180o	181o	182o	183o	184o	185o	186o	187o	188o	189o
190o	191o	192o	193o	194o	195o	196o	197o	198o	199o
200o	201■	202■	203■	204■	205■	206o	207o	208■	209■
210■	211■	212	213o	214■	215x	216x	217x	218x	219
220	221x	222	223	224x	225x	226x	227x	228x	229x
230x	231x	232x	233	234x	235x	236	237x	238x	239x
240	241x	242x	243x	244	245x	246x	247x	248-	249x
250x	251x	252	253x	254	255x	256x	257	258x	259x
260	261x	262x	263	264	265	266	267	268	269
270	271	272	273	274	275	276	277	278	279
280	281	282	283	284	285	286	287	288	289
290	291	292	293	294	295	296	297	298	299
300	301	302	303	304	305	306	307	308o	309
310o	311o	312	313	314	315o	316	317	318	319o
320	321o	322	323	324o	325	326	327	328o	329
330	331	332	333	334	335	336	337	338	339
340	341	342	343	344	345	346	347	348	349
350	351	352	353	354	355	356	357	358	359
360	361	362	363	364	365				

B. ATS-1 Data Reduction

The ATS-1 spacecraft, launched in late 1966 and stationed at 150° W longitude in the synchronous orbit, contains a particle spectrometer designed and developed by The Aerospace Corporation. This particle spectrometer was still operating at the time of the launch of ATS-6 in 1974 and, in order to take advantage of the availability of data from two very similar particle detectors stationed at the synchronous orbit but separated in longitude, we requested NASA to acquire ATS-1 data for selected time periods of interest. The time periods when ATS-1 data was acquired were: a two week period in the summer of 1974, shortly after ATS-6 launch; a two week period during the vernal equinox in 1975 and a period of time coinciding with the move of ATS-6 from 94° W to 35° E.

In order to process ATS-1 data, it was found necessary to modify the original data reduction program (written in 1967) to accomodate hardware and compiler changes which had taken place at Aerospace as well as to make the graphical outputs compatible with the ATS-6 graphics. In addition, it was found after preliminary processing of ATS-1 data, that some slight changes in the performance parameter outputs of the experiment caused the old computer program to reject good data. A small software change corrected this problem and the revised ATS-1 program has been used to process all ATS-1 data available to us (Days 196-212, 1974). Portion of these processed ATS-1 data have been made available to the University of Minnesota for their use in ATS-1/ATS-6 correlative studies. When 1975 ATS-1 data becomes available, we expect to be able to process these data in short order.

V. Scientific Analysis

A. Phenomenology of Trapped Energetic Electrons

We have now had the opportunity to examine a significant body of ATS-6 energetic electron data and are in a position to provide a preliminary description of the phenomenology exhibited by energetic electrons as observed by ATS-6. Of particular value for these interpretations has been the availability of UCLA ATS-6 magnetometer data made available to all the ATS-6 experimenters and also our ATS-1 data obtained simultaneously with ATS-6 observations. ATS-1/ATS-6 comparisons are discussed in detail in Section V-D; here we concentrate on connecting the ATS-6 electron observations to the changes in the geomagnetic field.

The variations in the electron fluxes at ATS-6 are very closely related to changes in the magnetic field vector. In particular, it appears that, quite often, in the night-time quadrant, ATS-6 enters a region where the configuration of the geomagnetic field is tail-like, i. e., a very large V component (radially outward) of the magnetic field is observed by the magnetometer. Inevitably, the fluxes of electrons with energies greater than 700 keV decrease markedly or vanish totally. Fluxes of 150-600 keV electrons, while showing decreases and marked variations, do not vanish. Conversely, a decrease in the absolute magnitude of the V component, i. e., a return to a more dipole-like configuration of the magnetic field, results in the reappearance of energetic electron fluxes.

The observations described in the above paragraph were typical of the data obtained in the summer of 1974. Examination of a limited set of data obtained in the fall of 1974 appears to show a somewhat less dynamic situation. Excursions into the tail region, i. e., the observation of a large V component of the field and simultaneous disappearance of energetic electrons appear to occur less frequently. It is still too early to say whether this is a true seasonal effect, i. e., a decrease of the effective magnetic latitude of ATS-6 or merely an artifact of a limited data sample.

The above discussion has dealt with the electron phenomenology on time scale of the order of a day. There is, of course, considerable variability of the electron fluxes as much shorter time scales. Again, the

UCLA magnetometer data has been most helpful in categorizing the various classes of flux variations we have observed.

Particularly interesting are instances of flux dropout on time scales of the order of an hour. These dropouts are characterized by changes in the D and V components of the field related in such a way as to suggest that ATS-6 has entered a region of current fluxes parallel to the H direction. Clearly, if this supposition is correct, the particles of this current system are, in some way, removing the energetic electrons and creating a dropout. These short-period dropouts will be subjected to further study in collaboration with the ATS-6 experimenters.

B. Preliminary ATS-6 Electron Environment Model

There is, at the present time, considerable interest in obtaining data on the energetic electron environment of the outer zone. This interest arises because recent production lots of CMOS (complementary metal oxide semiconductor) chips have shown sensitivity to radiation damage at dosages around 10^4 rads, i.e., a factor of $\approx$ 100 lower than the susceptibility level of earlier CMOS lots. These CMOS chips are widely used in spacecraft systems. The evaluation whether these "soft" CMOS need to be shielded in a particular application requires more accurate knowledge of the electron radiation environment. Since, typically, electronic components are buried under some shielding, the spectrum of energetic electrons is of considerable interest and the ATS-6 data can provide relevant and timely information to spacecraft designers and operators.

Accordingly, we have carried out a compilation of a limited set of ATS-6 data in order to prepare an environmental model along the lines described in (Ref. 1, 2, 3). ATS-6 electron fluxes for 45 days from Day 201 1974 through Day 250 1974, were formed into hourly averages for each energy channel. These averages were then sorted to give the probability $P(F>F_{\chi})$ of observing an integral flux greater than F_{χ}. The results of this study are presented in Fig. 6

Comparison of the data presented with model environments indicate good agreement with the AE4 environment (Ref. 4) at energies below 1.5 Mev. At higher energies, electron fluxes as observed by ATS-6 appear to be higher than predicted by AE4. Recall that the ATS-6 data for this study was obtained off the equator while the AE4 data shown in Fig. 6 represents equatorial fluxes. Hence the differences at higher energies may be even greater than shown.

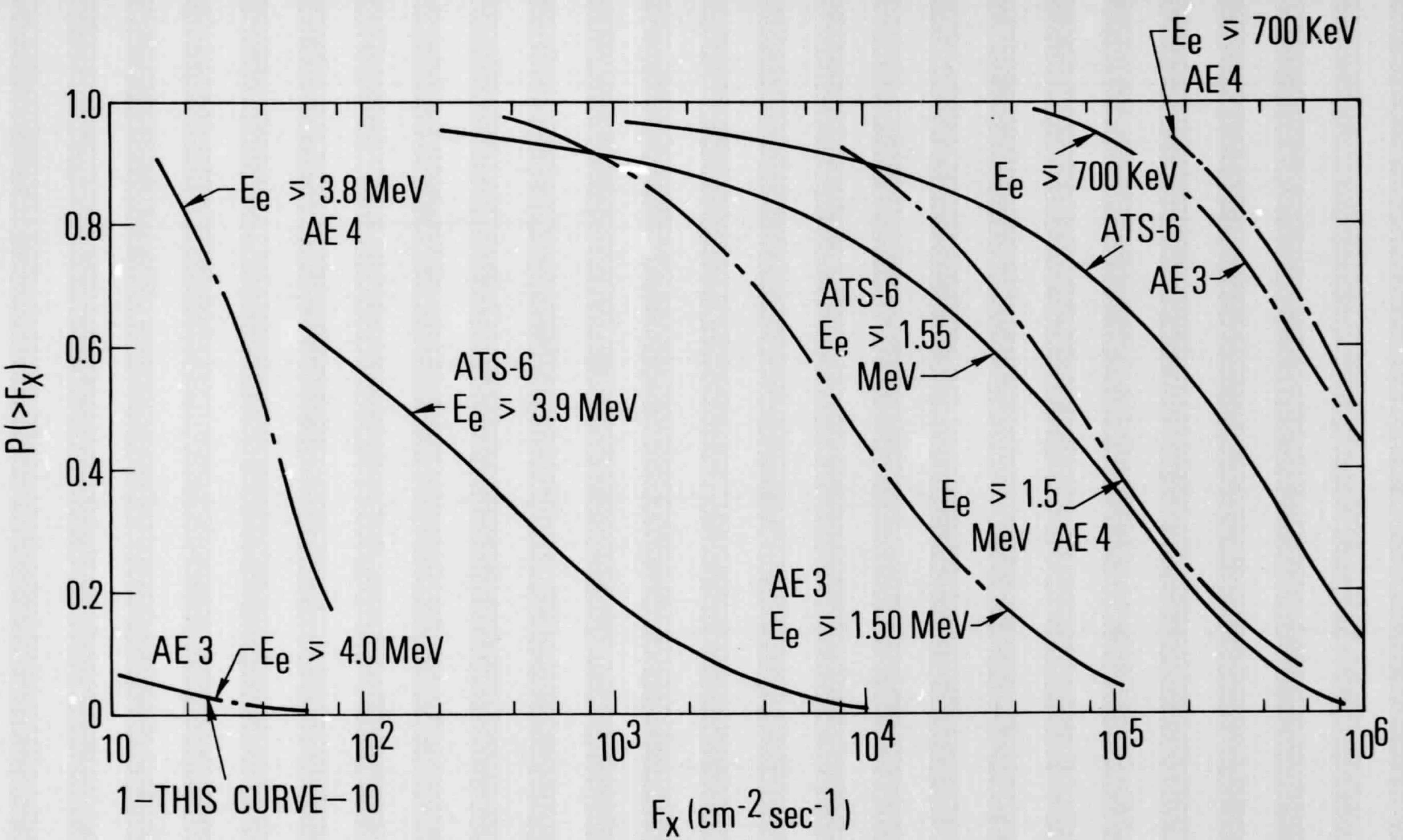

Figure 6. Probability for observing an integral flux greater than F_X for three ATS-6 electron channels (solid curve). The AE3 model and AE4 environment is also indicated.

C. ATS-1 Electron Environment Model

In an earlier report (Ref. 2) we had analyzed ATS-1 data for the 1966, 1967, 1968 time interval and had prepared a compilation of data which presented the probabilities of observing electron fluxes above various energy thresholds as a function of local time, magnetic activity, etc.

It was of interest to perform a similar analysis on the limited data set of ATS-1 data obtained in mid-1974 in order to compare these results with the earlier work.

We chose, for this comparison, to analyze the E_3 (>1.05 MeV) and E_4 (>1.9 MeV) data channels because we expected that the detectors associated with these channels were less affected by radiation damage than the less heavily shielded detectors.

ATS-1 data (integral fluxes >1.05, >1.9 MeV) for Days 196-212, 1974 were formed into hourly averages and the probability $P(F>F_\chi)$ of observing an integral flux greater than F_χ was calculated. These results are presented in Fig. 7, where we also present the results of the earlier (1966-1968) study.

The surprising result emerges that the flux of energetic electrons at the synchronous orbit was, on the average, higher during 1974 than during the 1966-1968 time period. This result is admittedly very preliminary, being based on a very limited data set which may not at all be representative of the average magnetospheric conditions existing during all of 1974. The period for which data were available in 1974 (15 through 31 July) was marked by relative magnetic quiet. Qualitatively, we might expect that during a period of extended magnetic quiet, the energetic electron fluxes can build up, on the average, to high levels without being wiped out by frequent magnetic storms. Thus, on the average, trapped fluxes during solar minimum might exceed the average fluxes observed during solar maximum when recurrent magnetic activity prevents the buildup of high fluxes of trapped electrons (through increased loss rates from the region of observation through precipitation and diffusion). It is important to note that these arguments apply only at high L-values, or lower L-shells the converse situation appears to be true because increased magnetic activity increases the flux of energetic electrons which are found at, say, L=4.

The ATS-1 comparison described earlier and presented in Figure 7 might be questioned on the basis that instrumental performance

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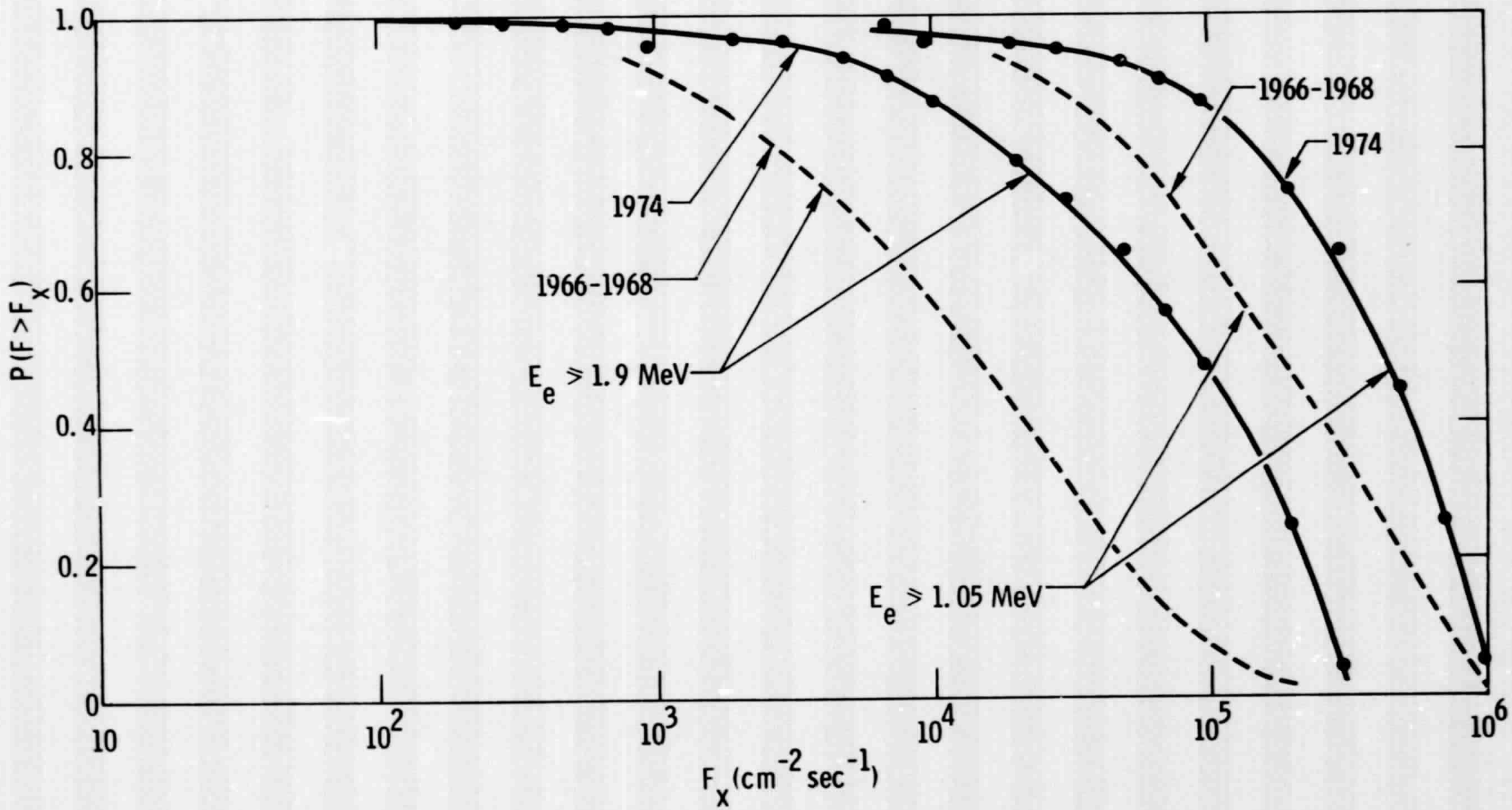

Figure 7. Comparison of ATS-1 data obtained (primarily) in 1967 with 1974 observations. Plotted are the probabilities of observing integral fluxes greater than F_χ for two electron energy thresholds.

had degraded to the point that such a comparison was no longer valid. Recall, however, that the energy thresholds on the channels used in this comparison are determined primarily by the thickness of the shielding covering the detectors -- an invariant of the system. All reasonable modes of degradation of the ATS-1 experiment lead us to expect a lower counting rate for an instrument damaged by radiation. We therefore conclude that the observations made in 1974 are valid.

Analysis of additional ATS-1 data, obtained in 1975, is in progress.

D. ATS-1/ATS-6 Data Comparisons

The first data on energetic electrons obtained by ATS-6 showed that the electron fluxes were much more dynamic than earlier observations (Ref. 5) on ATS-1 had indicated. ATS-6 data indicated the virtual dissappearance of energetic electrons during portions of the orbit in the night-time quadrant. Such "dropouts" were observed only rarely on ATS-1. In order to make a quantitative check on this impression, data was obtained from the experiment from ATS for the same time period for a direct comparison of ATS-6 and ATS-1 energetic electrons observations. These comparisons are illustrated in Figures 8 and 9. Figure 8 illustrates observations made during a magnetically quiet period (Day 201) which was preceeded by three days of magnetic quiet. In general, ATS-6 and ATS-1 energetic electron count-rates show similar behavior. The sharp decreases in flux near 0430 UT and 0630 UT visible in the ATS-6 data are the results of substorms. Note that the effects of substorm on the energetic electrons are much attenuated at ATS-1 as compared to ATS-6.

During geomagnetically active periods, there is a very substantial difference in the count-rates observed by the two spacecraft. Figure 9 illustrates a comparison of observations made at ATS-6 and ATS-1 during a disturbed period. Note the total disappearance of flux at ATS-6 while ATS-1 always observes finite fluxes.

The differences phenomenology appear to be due to the different magnetic latitudes of the spacecraft. ATS-6 is located at about 10° magnetic latitude at its location of 94° W longitude, while ATS-1 is almost exactly on the magnetic equator at 150° W. The $\sim 10^{\circ}$ difference in magnetic latitude appears to be sufficient to place ATS-6, at times, into regions of space devoid of energetic electrons. Substorms, for example, as illustrated in Figure 8, have a greater effect on the energetic particle population off the magnetic equator. We can postulate that, during the later stages of a substorm, the geomagnetic field relaxes to more dipole-like configuration and the boundary of energetic particle trapping moves inward and equatorward past the ATS-6 spacecraft.

The comparisons of ATS-6 data with ATS-1, while still preliminary, indicate a surprisingly steep gradient in the energetic electron population as one moves away from the equator, in other words, a disk-like region of trapping of energetic electrons near 6.6 R_e.

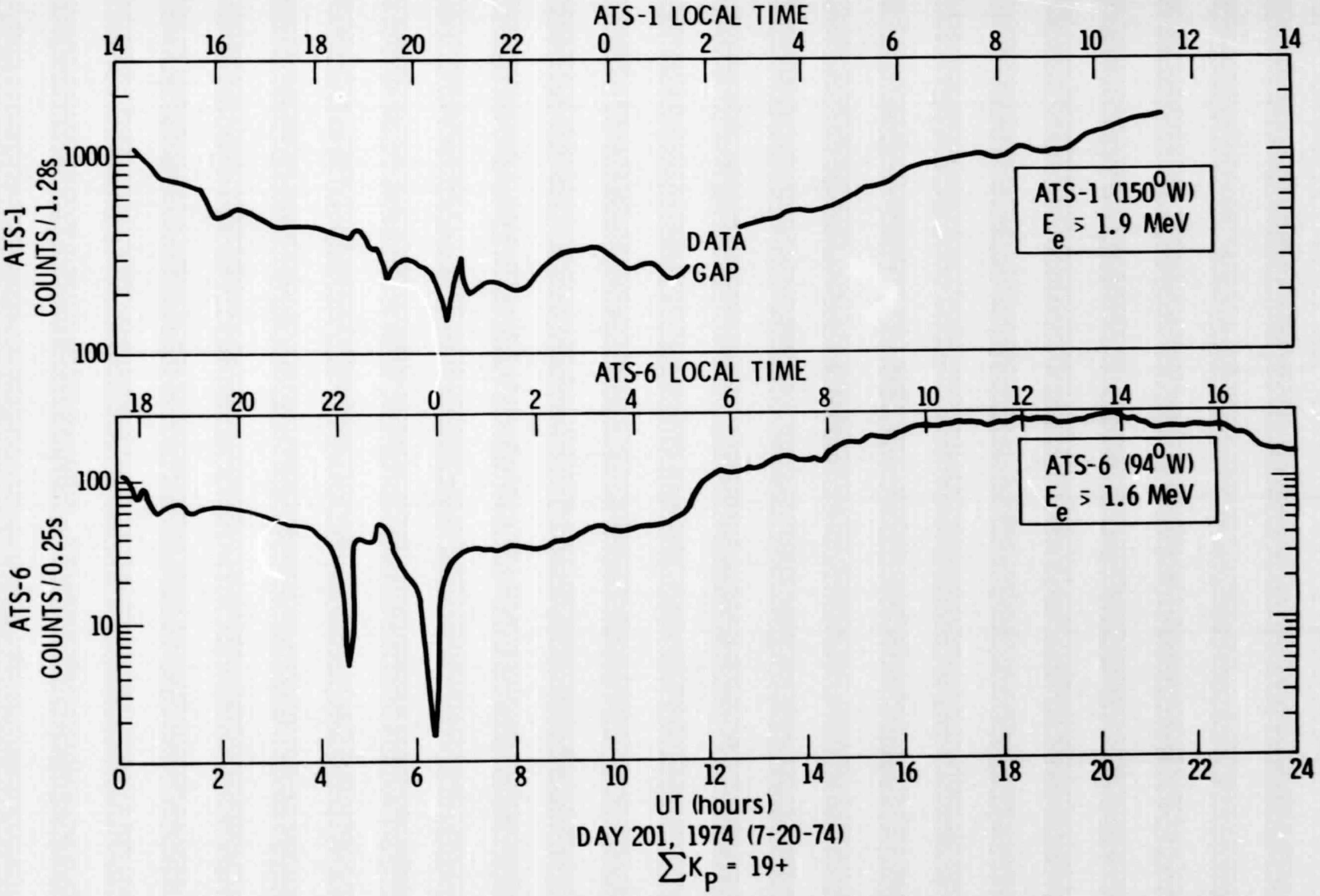

Figure 8 . Comparison of ATS-1 electron observations with ATS-6 electron observations during a geomagnetically quiet day. Local times for both spacecraft are given above the respective plots.

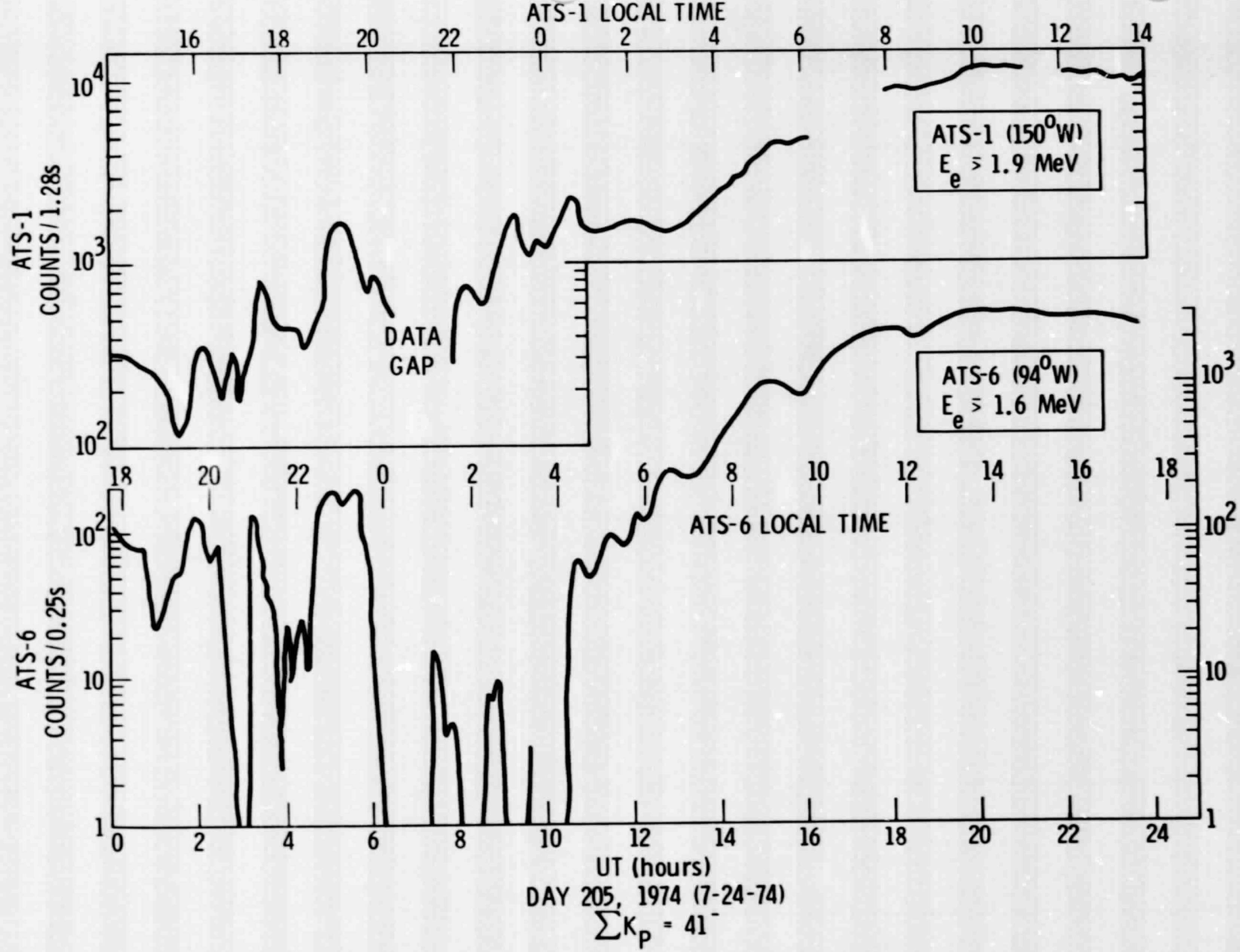

Figure 9 . Comparison of ATS-1 electron observations with ATS-6 electron observations during a time period when the geomagnetic field is disturbed.

E. Studies of Access of Solar Protons

ATS-6 data obtained during the solar proton events of July, 1974 and September, 1974 have been reduced and are being analyzed in order to study: a) the penetration of solar protons to the synchronous altitude, b) the effects of changes in the geomagnetic field on the efficiency of penetration and c) the effect of impulsive changes (sudden commencement) on the solar proton fluxes. Solar proton data for covering the same time period, but obtained outside the magnetosphere have been obtained and are being studied.

VI. Transfer of ATS-6 Data to NSSDC

Preliminary discussions were held with Dr. Reames of NSSDC regarding the transfer of our ATS-6 data to the Data Center. The format of the present production output appears, to first approximation, to be compatible with the needs of NSSDC. There appears to be a need for additional documentation regarding our experiment as well as documentation describing the processing of the data and the formats of the outputs.

Assuming that no major anomalies in the data are discovered in our present and future production runs, the details of the transfer process will be reviewed with NSSDC before the end of 1975 and data transfer will begin in early 1976.

VII. Future Plans

Future efforts in this project can be logically divided into two categories: program/data reduction improvements and scientific analysis of the data. Describing plans in the former area is considerably simpler than attempting to forecast the directions the data analysis will take.

A. Program/data reduction improvements

Although very considerable progress has been made in developing an efficient data reduction program, there is still room for improvement, both in economics as well as presentation format. The list below of additional tasks is meant to be representative, not exhaustive.

1. Document existing program
2. Incorporate iterative (spectrum-sensitive) techniques for count to flux conversion
3. Coordinate with NSSDC and change output format, if required, to be compatible with NSSDC requirements
4. Develop additional routines for data handling and presentation
   a. B-field presentation and correlation with e-fluxes
   b. Input of geophysical data
   c. Analysis of long-term data and data trends

B. Scientific Analysis

The following projects are being pursued. The list is indicative of the priority being given to each task.

1. Construction of ATS-6 model electron environment
2. Comparison of ATS-6 data with ATS-1 data
3. Investigation of the solar proton events of July and September of 1974
4. Cataloging of periodic oscillations observed in the electron flux
5. Cataloging short period flux drop-outs which may be indicative of Birkeland currents.

VIII. Acknowledgements

We are grateful to Dr. C. Gregory for providing the programming support for this project and to Ms. F. Twillie for the organization of the tape handling and production processing of ATS-6 data. Mr. E. Lehnhof and Ms. J. Tweedie were responsible for ATS-1 reprogramming efforts and processing, respectively.

This work was performed under contract NASW-2762 with The Aerospace Corporation.

VIII. References

1. Vette, J. I. and Lucero, A. B., "Models of the Trapped Radiation Environment, Volume III, Electrons at Synchronous Altitudes," NASA SP-3024 (1967).
2. Paulikas, G. A., Blake, J. B. and Palmer, J. A., "Energetic Electrons at the Synchronous Altitude: A Compilation of Data," Aerospace Corporation report No. TR-0066(5260-20)-4 (November 1969).
3. Paulikas, G. A. and Blake, J. G., "The Particle Environment at the Synchronous Altitude, Models of The Trapped Radiation Environment, Vol. VII. Long Term Variations," NASA SP-3024 (1971).
4. Singley, G. W., and J. I. Vette, "A Model Environment for Outer Zone Electrons, NSSDC 72-13, (December 1972).
5. Paulikas, G. A., Blake, J. B., Freden, S. C., and Imamoto, S. S., "Observations of Energetic Electrons at Synchronous Altitude, 1. General Features and Diurnal Variations," J. Geophys. Res. 73, 4915 (1968).