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SOFIP:

A Short Orbital Flux Integration Program

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E. G. Stassinopoulos
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National Space Science Data Center (NSSDC)/
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National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

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ABSTRACT

A computer code has been developed to evaluate the space radiation environment encountered by geocentric satellites. The Short Orbital Flux Integration Program (SOFIP) is a compact routine of modular composition, designed mostly with structured programming techniques in order to provide not only maximum efficiency but also core and time economy and ease of use. The program in its simplest form, that is, stripped of all modules, produces for a given input trajectory a composite integral orbit spectrum of either protons or electrons. Additional features such as running printout, exposure index, peaks per orbit, percent time in electron trapping zones, differential spectrum, solar proton fluences, and punched output are available separately or in any combination with the inclusion of the corresponding (optional) modules. The code is described in detail, and the function and usage of the various modules are explained. A program listing and sample outputs are attached.

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SOFIP:

A SHORT ORBITAL FLUX INTEGRATION PROGRAM

INTRODUCTION

The need to predict reliably satellite exposure to trapped particle radiation was realized soon after the discovery of the terrestrial charged particle radiation belts, which coincided with the advent of spaceflight. A crude "Orbital Flux Integration" (OFI) code was developed at Goddard Space Flight Center as early as 1961. Over the years, a large, sophisticated, and complex OFI system evolved from these early beginnings (UNIFLUX[1]), a system that processed and analyzed the data into several different tabular and graphical presentations.

However, with the appearance of economical minicomputers and the corresponding emphasis on small software systems, attributes like "compact", "short", "fast", and "versatile" became very important.

In this paper a Short Orbital Flux Integration Program (SOFIP) is being presented which, excluding the plotting capability, affords all the options, choices, and variations of UNIFLUX, but with substantially reduced core requirements and running times.

Two basic guidelines influenced the creation of SOFIP: structured programming and modularized organization. These were followed to the greatest degree possible or desirable.

A detailed description of the routine is given in subsequent sections, including an analysis of the method employed in the determination of integral, difference, and differential fluxes.

A review of the program organization is given in Figure 1 which depicts the structure of the fully implemented (complete) code. Logic flow and decision branching is shown in Figure 2.

The arguments of its input and output vectors (variables and parameters) are presented and described in the appropriate sections. Code listing and sample outputs are attached.

SOFIP is written in standard FORTRAN-IV computer language. Card decks are available from the National Space Science Data Center in the 029 model IBM keypunch format (EBCDIC). The cards are labelled in columns 73-80 as SOFIPxxx, where the last three columns (xxx) contain the sequential numbering, which is incremented by one.

A comparison of the time required to compile, linkage edit, and execute SOFIP is given in Table 1. The data relate to full length and stripped versions of the code, and were obtained for both electron and proton runs, by processing 720 positions in each case.

The approximate amount of storage required by SOFIP is given in Table 2, for the various parts of the program, including also the environment models, in object form.

All results were obtained on GSFC's IBM 360/91 and, unless otherwise stated, using the FORTRAN IV G compiler.

THE CURRENT ENVIRONMENT MODELS

SOFIP is designed to use Vette's standardized models of the terrestrial trapped particle environment, as distributed by the National Space Science Data Center, Greenbelt, Maryland. New models are periodically being issued to replace older versions whenever additional data or information become available that permit a significant improvement in the environment description, or that indicate a change sufficiently important to warrant such an action. All models, both for protons and electrons, represent a static environment at a given fixed epoch. However, it was possible to infer from the data used in their construction a change in average quiet-time flux levels as a function of solar cycle. To date, a continuous temporal description of this cycle dependence has not been attempted. Instead, separate models were developed for solar minimum and solar maximum conditions for either species of particles.

Current at the time of this writing are the following models:

		Solar Max	Solar Min
Protons:		AP8-MAX (1970)[2]	AP8-MIN (1964)[2]
Electrons:	Inner Zone:	AE6 (1980)[3]	AE5 (1975)[4]
	Outer Zone:	---------- AEI7-HI (1980)[5] ---------	
		---------- AEI7-LO (1980)[5] ---------	

where the numbers in parentheses indicate the specific fixed epoch (year) for which they describe the average environment.

In regards to the outer zone electron models AEI7-HI and AEI7-LO it should be noted that:

(a) the version labelled "HI" favors Vampola's fits to the OV1-19 data, while the version labelled "LO" is representative of all the other outer zone data sets presently available at NSSDC.

(b) these models do not reflect solar cycle conditions and should be used indiscriminately for both min and max phases.

(c) they are interim models which recently replaced the solar min and max versions of the older AE4.

It should also be noted that the inner zone (solar max) AE6 does not contain any "Starfish" residuals because data now indicate that these electrons are no longer present.[6]

METHOD

Integral Flux

The composite orbit spectrum for integral energies gives the total vehicle encountered fluxes, averaged into intensities per second, for 30 discrete energy levels:

$$S(>E_i) = c\Delta t \sum_{m=o}^{T} J_m(>E_i)$$

$$c=24/T*86400$$

where the summation is performed for the entire simulated mission duration T, in hours, and includes all fluxes with energies greater than E_i. Δt is the integration step-size in seconds, J_m is the instantaneous integral flux obtained from the model for the i^{th} energy level, and c is an averaging factor. Note that Δt must have values equivalent to integer minutes (See also note on page 7).

Difference Flux

The difference flux is calculated from the integral flux $S(>E_i)$ for the 30 programmed energy levels:

$$D(\Delta E_i) = S(>E_i) - S(>E_{i+1}) \qquad \text{for } i=1,\ 29$$

$$D(\Delta E_{30}) = S(>E_{30})$$

where D is the difference flux in units of particles per square centimeter per second per energy interval. It is important to remember that E is not constant over either the proton or the electron spectra.

Differential Flux

Differential fluxes are only calculated when there exist 10 or more non-zero elements in the integral spectrum. That is, fluxes must be defined for at least ten descrete energy levels. In that case, the differential fluxes are obtained from the composite orbit spectrum by analytic differentiation, using the averaged instantaneous values of the total vehicle encountered fluxes at the selected energies:

$$j(=E_i) = \frac{\partial S(>E_i)}{\partial E} \qquad \text{for } i=1,30$$

where j is the differential flux and E and S are the same as above. The results in the program output table represent the derivative of a cubic spline fitting procedure. If there are less than 10 non-zero elements available, the program bypasses these calculations.

APPLICATION AND USE

SOFIP contains two types of program sections: blocks, which are the essential parts of the program and must remain unaltered, and modules, which provide additional features and may be removed. For each block and module, the following points are discussed:

1. Function (including output produced, if any),
2. User input or user action necessary, and
3. Any restrictions, limitations, or other special considerations.

There are 11 modules in SOFIP, some of which are paired into packages which fulfill a single purpose. These packages and the output they produce are:

MODULES	Output
ORBIT L-ZONE BREAKDOWN MODULE PERCENT TIME MODULE	Percent Time Table
PEAKS PER ORBIT MODULE OUTPUT TABLES MODULE 2	Peaks per Orbit Table
GEOMAGNETIC SHIELDING MODULE SOLAR PROTON MODULE	Solar Proton Table

To obtain the desired results from one of these module packages, both modules in the particular package must be included in the run. If one module is included but the other is not, no data will be outputted from the calculation which those modules perform. However, such misuse of the module packages will neither cause the run to abend, nor affect the output of any other portion of the program.

BLOCK 0: Initialization

BLOCK 0 performs the general initialization and preparation of the program. It contains all "type" declarations (REAL, INTEGER), and all dimension, equivalence, and format statements.

The user has only to be concerned with one aspect of this initialization: the selection of the environment model(s) to be used. Lines 39-44 of SOFIP contain COMMON statements for all of the current environment models, both proton and electron:

```
C     COMMON /AP8MAC/DESCR(8), LIST(1)        SOFIP039
C     COMMON /AE6MAX/DESCR(8), LIST(1)        SOFIP040
C     COMMON /AEI7HI/DESCR7(8), LIST7(1)      SOFIP041
C     COMMON /AEI7LO/DESCR7(8), LIST7(1)      SOFIP042
C     COMMON /AE5MIN/DESCR(8), LIST(1)        SOFIP043
C     COMMON /AP8MIC/DESCR(8), LIST(1)        SOFIP044
```

For a brief discussion of the models, see the section "The Current Environment Models".

To select a particular environment model:

1. Uncomment the COMMON statement which relates to the desired model, that is, remove the "C' from column one,

2. Make sure all other COMMON statements are commented out,

3. Include in the deck to be submitted, the BLOCK DATA subroutine for the appropriate model.

Note that protons require only one model per run, while electrons require two, one for the inner zone and one for the outer zone. The two electron models are needed regardless of whether the trajectory to be processed visits only one of the two electron zones.

Because SOFIP performs calculations for only one particle species in a given run, the model(s) for only one species is needed. In other words, any one run will use <u>either</u> one proton model (AP8MAX or AP8MIN) <u>or</u> one inner zone electron <u>model</u> (AE6MAX or AE5MIN) <u>and</u> one outer zone <u>electron</u> model (AEI7HI or AEI7LO). The program cannot <u>and</u> does not check for invalid combinations of models, nor for BLOCK DATA subroutines and uncommented COMMONs statements incorrectly matched. These user errors will produce compilation, linkage, or execution errors.

Note also that there is no provision for changing models during execution. Therefore, in a multiple-orbit run, all trajectories are processed for the same species and models(s).

When SOFIP is run for electrons, a diagnostic message may be produced during compilation warning that the variable "DESCR7" in line 51 of SOFIP has already been dimensioned. Do not change this dimensioning; it is necessary when the run is for protons. The warning may be ignored.

<u>BLOCK 1: Initialization</u>

BLOCK 1 performs the initialization of quantities which must be reinitialized after each orbit of a multiple-orbit run. In this block, the input variables are read and subsequently written out. Table 3 gives the input format and a brief description of each parameter, two of which require some additional comments:

NRGYLV is the threshold-energy selector. Its value is an index into the ENERGY array. The desired value of NRGYLV is most easily obtained by looking at the Composite Orbit Spectrum from a SOFIP run for the correct particle species, and counting down to the desired energy level. The usual values are: electrons, NRGYLV=5 (0.5 MeV); protons, NRGYLV=4 (5.0 MeV).

CUTOFF determines the orbit time at which processing is to be terminated. If the end of the orbit tape is reached before orbit time reaches CUTOFF, the program will proceed as if CUTOFF had been equal to the time of the last point read. This will not cause any errors in the program.

<u>BLOCK 2: Input</u>

In BLOCK 2, the trajectory ephemeris tape is read. The program can read a tape written in either of two modes, BCD or binary. To read a BCD (EBCDIC, or formatted) tape:

1. The tape must have been written with format 6E18.8.

2. Comment out lines 133-134, 138-139, and 144.

3. Uncomment lines 132, 137, and 143.

To read a binary (unformatted) tape:

1. The first input variable, PSNTIM (see below) must have been written in single precision; the other five elements must have been written in double precision.

2. Comment out lines 132, 137, and 143.

3. Uncomment lines 133-134, 138-139, and 144.

For either input mode, each record of the tape must contain the following six variables in the order specified:

PSNTIM	T	Orbit time in decimal hours (must start at 0.0)
PSNLON	ϕ	East longitude in decimal degrees
PSNLAT	λ	North latitude in decimal degrees
PSNALT	h	Geodetic altitude in kilometers above sea level
PSNB	B	Geomagnetic field magnitude in gauss
PSNL	L	McIlwain's magnetic shell parameter in earth radii

The input parameter ISKIP controls the number of records ignored each time a new point is called for by the program; only each ISKIPth point on the input tape is actually used in performing calculations.

The positional coordinates of longitude, latitude, and altitude are not used in the flux calculations; these calculations are performed with the magnetic parameters B and L only. Therefore, it is of no significance whether latitude relates to a geocentric or a geodetic reference frame (longitude is invariant in the two systems). The altitude, however, is used to determine the position of physical perigee in the case of eccentric trajectories.

NOTE: Do not use trajectories with stepsizes of less than one minute; they will cause the program to abend. Also, the stepsize must be constant for any one orbit, because the time integration assumes that the increment is not a function of orbit position i:

$$\sum_i \text{Flux}_i \Delta t = \Delta t \sum_i \text{Flux}_i$$

BLOCK 3: Calculations

In BLOCK 3 some preparatory calculations are performed and the fluxes for the current position are obtained. No user action is necessary.

Running Printout Module

The "Running Printout Module" prints orbit and flux data for each position i used in the calculations when the input parameter KPRINT is equal to 1. If the input parameter KPRINT is not equal to 1, only each KPRINTth point is printed. The printed quantities are:

Orbit time	T_i	decimal hours
Latitude	λ_i	decimal degrees
Longitude	ϕ_i	decimal degrees
Altitude	h_i	kilometers
Field magnitude	B_i	gauss
Magnetic shell parameter	L_i	earth radii
Instantaneous flux	F_i	at the position i ($\#/cm^2 \cdot sec$)
Time integrated flux	$F_i \Delta t$	integrated over the interval from i to i+1
Orbital flux accumulation	$J=\sum_i F_i \Delta t$	sum of all fluxes encountered to this point

The first six quantities are the same as those read from the ephemeris tape. For the first position of the orbit, only the positional data are printed.

If running printout is not desired, delete this module.

Orbit L-Zone Breakdown Module

The "Orbit L-Zone Breakdown Module" determines the amount of time spent by the trajectory in each of the four zones into which magnetic space can be divided on the basis of electron trapping:

1. Inner zone: outside trapping region ($1.0 \leq L < 1.1$)

2. Inner zone: inside trapping region (1.1≤L<2.8)

3. Outer zone (2.8<L<11.0)

4. External (no trapping) (L>11.0)

These data will be used for further calculations in the "Percent Time Module".

Note that the "Orbit L-Zone Breakdown Module" must be used in conjunction with the "Percent Time Module". If the percent time information is not desired, delete both modules.

Exposure Index Module

The "Exposure Index Module" describes, for the selected processing energy, the radiation exposure in terms of nine intensity ranges, rising from "zero flux" through 10^0-10^1, 10^1-10^2, etc., to "more than 10^7 particles per square centimeter per second" in increments of one order of magnitude. The overall exposure of the trajectory to each intensity range (in decimal hours) and the total number of particles encountered while so exposed are recorded.

If the exposure index table is not desired, delete this module.

The exposure index is calculated for particles with E ≥ ENERGY(NRGYLV, species) where NRGYLV is the threshold energy selector variable (see section "BLOCK 2" for further discussion of NRGYLV).

Peaks-Per-Orbit Module

The "Peaks-per-Orbit Module" determines:

1. the instantaneous peak flux per period, in number of particles/cm^2·sec with energies greater than or equal to the threshold energy selected by NRGYLV,

2. the time (in hours) and position (in h-ϕ-λ and B-L coordinates) at which the peak flux is encountered, and

3. the total number of particles accumulated per period.

The "Peaks-per-Orbit Module" must be used in conjunction with the "Output Tables Module 2". If the peak data is not desired, delete both modules.

Geomagnetic Shielding Module

This module determines the amount of time the vehicle spends in regions of space where L > 5, for later calculations in the "Solar Proton Module".

The "Geomagnetic Shielding Module", must be used in conjunction with the "Solar Proton Module". If Solar Proton data is not desired, delete both modules.

BLOCK 4: Looping

BLOCK 4 concludes the trajectory ephemeris read-loop. All blocks and modules between Block 2 (trajectory input) and Block 4 are executed for each inputted point of the trajectory. No user action is required.

BLOCK 5: Output Preparation

In BLOCK 5, the calculations for the composite orbit spectrum are performed. No user action is required.

Percent Time Module

The "Percent Time Module" takes the information stored in the "Orbit L-Zone Breakdown Module", i.e., the number of times the vehicle visits each of the four zones defined in that module, and calculates the percent of total orbit time spent in each; this data is then printed.

If the percent time table is not desired, delete both this module and the "Orbit L-Zone Breakdown Module".

Differential Spectrum Module

The "Differential Spectrum Module" calls subroutine DSPCTR, which calculates the differential spectrum from the total integral fluxes obtained from the environment models.

If the differential spectrum is desired, include subroutine DSPCTR and this module. If the differential spectrum is not desired, delete this module.

Solar Proton Module

This module calculates the exposure factor (i.e., the fraction of the orbit during which the vehicle is not geomagnetically shielded, but is exposed to the interplanetary intensities of energetic solar protons) from the value stored in the "Geomagnetic Shielding Module". It then calls the subroutine SOLPRO[7], which calculates probabilistic solar fluences at preselected energy levels as a function of mission duration τ and confidence level Q.

There are two elements in the solar proton module which the user may wish to alter to meet his specific needs:

1. Mission duration τ: (REAL*4, variable name in code: T)

   τ determines the time interval, in non-fractional months, for which the solar proton calculations are to be performed. The code is preprogrammed for one year mission duration (τ=12). If a different length of time is desired, edit card 276 accordingly. The permissible range of τ values is from 1 to 72 months.

2. Confidence level Q: (INTEGER*4; variable name in code: IQ)

   Q denotes the level of confidence, in percent, which the user wishes to assign to the results; namely, that for the specified mission duration the calculated fluences are the smallest values that will not be exceeded by actually encountered intensities. The preprogrammed confidence level is 90%. If a different value of Q is desired, edit card 278 accordingly. Permissible values of the variable IQ are integers between 80 and 99, inclusive.

If the solar proton information is desired:

1. include this module and the "Geomagnetic Shielding Module", and

2. include subroutine SOLPRO in the deck to be submitted.

Otherwise delete the "Solar Proton" and "Geomagnetic Shielding Modules".

Output-Punch Module

This module produces a card deck containing some of the calculated results. Each card, with exception of the header cards, contains a label in columns 73-78 and a sequence number in columns 79-80. The label indicates the particle species and whether the card contains energies, integral fluxes, or differential fluxes. The sequence number will reflect the card's position in the particular section of the deck to which it belongs, e.g., integral fluxes, or solar proton energies; sequence numbers range from 1 to 5 (in the solar proton sections, 1 to 4).

See Table 4 for a description of the punched output.

If the "Solar Proton Module" was not included in the run, or if the trajectory was completely shielded geomagnetically, no cards for solar protons are punched.

Output-Tables Module 1

When the program is used in its simplest form, this module should be included if tabular output is desired. It produces a composite orbit spectrum table, containing:

1. Integral energy levels, in MeV,

2. Average orbit integrated spectrum, in particles per square centimeter per second,

3. Difference flux, in particles per square centimeter per second per ΔE, and

4. A column labelled "differential flux", which contains only zeroes.

When the "Differential Spectrum Module" is included and if there are ten or more non-zero elements given in the integral spectrum, items (1), (2), and (3) remain the same, but (4) now contains average differential flux values, in units of particles per square centimeter per second per keV.

For more information on the calculation of either of these fluxes, see the section on "Method".

This module also prints two additional, independent tables for (a) the exposure index, and (b) the solar proton results. The exposure index table presents in the first column the intensity ranges, in the second column the total duration of trajectory exposure to each intensity range, and in the last column the total number of particles encountered while so exposed. The solar proton table lists in the header the mission duration TAU, the confidence level Q, the number of anomalously large events NALE predicted for TAU and Q, and the geomagnetically determined exposure factor used in the calculations, and presents two columns containing respectively the energy levels in MeV, and the total fluence per square centimeter for each energy.

If the "Solar Proton Module" and/or the "Exposure Index Module" have not been included in the run, then the corresponding tables do not appear in the print out.

If no tabular output is required, delete the "Output-Tables Module 1".

Output-Tables Module 2

This module prints the results calculated in the "Peaks-per-Orbit Module". There are nine columns on this table. Column 1 is an orbit counting device, based on the period of the orbit. Column 2 gives the absolute instantaneous peak flux encountered during that orbit. Columns 3, 4, and 5 indicate the spacecraft position in geocentric coordinates at which the peak was encountered, while columns 6, 7, and 8 denote respectively the time and the magnetic B-L coordinates for this event. Finally, the last column indicates the total flux encountered during that particular orbit. It is advisable to disregard the last line on this table because many times that orbit is incomplete and the fluxes or positions shown do not correspond to true peaks.

BLOCK 6: Program Termination

In Block 6, the program returns to the beginning of BLOCK 1 where it checks whether there is another trajectory to be processed. If no other trajectory is to be processed, the run terminates. No user action is necessary.

ACKNOWLEDGEMENTS

We wish to thank Drs. R. Hilberg and M. Teague for many helpful discussions and constructive suggestions.

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Table 1

Running Times of SOFIP for 720 Input Positions on the IBM 360/91 Computer

	Compile	Link	Execute	Total
Protons				
Stripped	.06/.03	.00/.14	.06/.04	.12/.21
All	.11/.04	.00/.18	.08/.06	.19/.28
Electrons				
Stripped	.06/.03	.00/.15	.06/.04	.12/.22
All	.11/.04	.00/.18	.09/.06	.20/.28

Times are given in decimal minutes. The first figure in each entry is for CPU, and the second is for I/O. Values are averages of three runs for each type and species.

Table 2

Core Requirements for SOFIP

	Core required for source program (in 1000 bytes)
SOFIP+	
Stripped	11.8
All Modules	16.8
TRARA1+	1.5
TRARA2+	2.5
SOLPRO+	2.4
DSPCTR+	8.4
FORTRAN Library Functions	
Stripped	22.7
All Modules	24.6
Environment Models*: For proton runs	26.1 or 26.8
For electron runs	35.6 or 37.3
See table below for size of individual models	
AP8MAC	26.1
AP8MIC	26.8
AEI7HI	17.5
AEI7LO	15.8
AE6MAX	19.8
AE5MIN	19.8

+Compiled under FORTRAN G
*Compiled under FORTRAN H
If SOFIP with all modules, TRARA1, TRARA2, SOLPRO, and DSPCTR are compiled under FORTRAN H, the results will be a total of 3.3K less than these.

TABLE 3

Input Parameters: Description and Format

Card	Columns	Format	Name	Description
1	1-12	3A4	NAME*	Any 12-character alphanumeric description of vehicle or orbit
	20-22	I3	INCL*	Approximate orbit inclination in degrees
	30-35	I6	IPRG*	Approximate orbit perigee in kilometers
	40-45	I6	IAPG*	Approximate orbit apogee in kilometers
	50-51	I2	MODEL*	Number of field model (from ALLMAG[8]) used in calculation of magnetic parameters B and L in conversion of trajectory ephemeris
	60-68	F9.6	PERIOD	Mathematical period of orbit in decimal hours
	70-76	F7.2	BLTIME*	Epoch for which the coefficients of the field model were evaluated for the B-L calculations, in decimal years A.D.
2	1-2	I2	NRGYLV	Threshold energy selector for running printout, exposure index, and peaks
	10-13	I4	ITAPE*	Orbit tape identifier
	20-21	I2	NTABLS	Number of copies of tables to be produced
	30-35	F6.2	CUTOFF	Orbit time (in decimal hours) at which run is to be terminated
	40-41	I2	ISKIP	Program will process only every ISKIPth point on trajectory tape. ISKIP=1, all points are processed.
	50-51	I2	KPRINT	The "Running-Printout-Module", if included in the run, will print only every KPRINTth point of the trajectory points read. Note: KPRINT=0 will cause the program to abend.

Format of input: (3A4,7X,I3,7X,I6,4X,I6,4X,I2,8X,F9.6,1X,F7.2 /I2,7X,I4,6X,I2,8X,F6.2,4X,I2,8X,I2)

*Starred quantities are not required for calculations, but are used only for labelling output.

TABLE 4

Punched Output: Description and Format

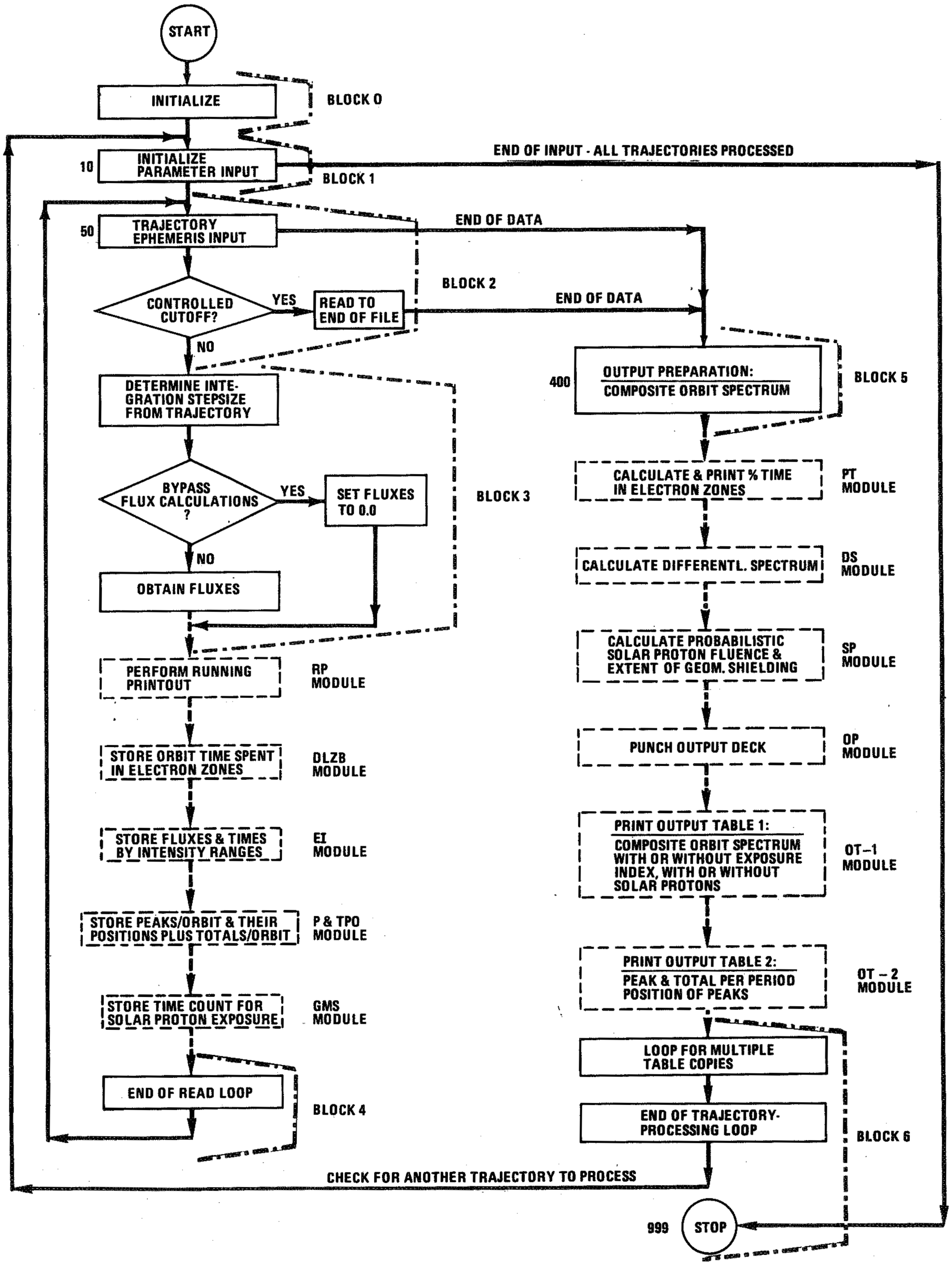
Card	Variable(s) Format	Comments
1	NAME(3),INCL,IPRG,IAPG,MODEL,BLTIME 3A4,1X,I2,'/',I5,'-',I6,1X,'I(#/CM**2-SEC) D(#/CM**2-SEC-KEV) MOD/TM=',I1,'/',F6.1	Header card containing vehicle identification*, inclination*, perigee*, apogee*, the units of the differential and integral fluxes which are to to be punched, and the model number (from ALLMAG[8]) and epoch for which the B and L of the trajectory tape were calculated*.
2-6	ENERGY(30,ITYPE) 1P6E12.4	The 30 integral threshold energies, in MeV, for the particle species considered in this run.
7-11	AIFLXS(30) 1P6E12.4	The orbit integrated, integral fluxes for the 30 energy levels punched previously, averaged into units of particles/cm^2·sec.
12-16	DIFSPC(30) 1P6E12.4	The differential fluxes obtained from the preceeding integral spectrum in units of particles/cm^2·sec·keV. Zeros will be punched if the "Differential Spectrum Module" was omitted.
17	IQ,T,INALE,EXPFCT 'SOLAR PROTONS #ENERGIES=20 Q=',I2,' TAU=',F4.1,' NALE=',I1,' EXPFCTR=',F5.2	Header card giving the number of Solar Proton energy levels processed, and containing confidence level Q, mission duration tau, number of AL events for given Q and tau, and geomagnetic shielding effect in the form of an exposure factor.
18-21	SPNRG(20) 1P5E12.4	The 20 integral threshold energies, in MeV, for the solar flare protons.
22-25	F(20) 1P5E12.4	The total unattenuated interplanetary solar flare proton fluences for the preceeding integral spectrum, modified by the exposure factor punched above, and for the Q and tau given in the solar proton header card, in units of particles/cm^2.

*taken directly from input

FIGURE 1: MODULAR STRUCTURE AND ARRANGEMENT OF SOFIP

BLOCK 0 INITIALIZATION OF PROGRAM	38-88
BLOCK 1 INITIALIZATION OF DATA PARAMETER INPUT	89-130
BLOCK 2 INPUT POSITIONAL DATA FROM TAPE (TRAJECTORY)	131-146
BLOCK 3 OBTAIN FLUXES PERFORM CALCULATIONS	147-174
RUNNING PRINTOUT MODULE PRINT POSITIONAL DATA	175-192
ORBIT L-ZONE BREAKDOWN MODULE COUNT TIMES EACH ZONE IS VISITED	193-201
EXPOSURE INDEX MODULE STORE FLUXES AND TIMES BY INTENSITY RANGES	202-213
PEAKS PER ORBIT MODULE DETERMINE PEAKS AND POSITION, PLUS TOTAL, PER PERIOD	214-237
GEOMAGNETIC SHIELDING MODULE DETERMINE WHETHER POSITION IS GEOMAGNETIC- ALLY SHIELDED (STEP COUNT FOR L <5)	238-240
BLOCK 4 END OF READ LOOP	241-243
BLOCK 5 OUTPUT PREPARATION	244-254
PERCENT TIME MODULE CALCULATE PERCENTAGE OF TOTAL TIME SPENT IN EACH ZONE	255-271
DIFFERENTIAL SPECTRUM MODULE CALL SUBROUTINE DSPCTR	272-273
SOLAR PROTON MODULE CALL SUBROUTINE SOLPRO	274-287
OUTPUT PUNCH MODULE PUNCH INTEGRAL AND DIFFERENTIAL SPECTRA, SOLAR PROTONS	288-307
OUTPUT MODULE TABLE 1 WITH ORBIT INTEGRATED SPECTRUM AND WITH OR WITHOUT DIFFERENTIAL SPECTRUM AND/OR EXPOSURE INDEX AND/OR SOLAR PROTONS	308-381
OUTPUT MODULE TABLE 2 PEAKS AND POSITION PLUS TOTAL PER PERIOD	382-396
BLOCK 6 PROGRAM TERMINATION	397-401

FIGURE 2: FLOW DIAGRAM FOR SOFIP



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***********************************************************************SOFIP001
************    SHORT ORBITAL FLUX INTEGRATION PROGRAM      **********SOFIP002
*******     FOR USE WITH NSSDC'S STANDARD ENVIRONMENT MODELS     *******SOFIP003
***********************************************************************SOFIP004
** DESIGNED AND TESTED BY STASSINOPOULOS, HEBERT, BUTLER, & BARTH     **SOFIP005
** CODE 601, NASA/GODDARD SPACE FLIGHT CENTER: GREENBELT, MD. 20771 **SOFIP006
** SINGLE PRECISION DECK FOR FORTRAN IV   (EBCDIC,029 PUNCH)          **SOFIP007
** TRAJECTORY INPUT FROM UNFORMATTED BINARY OR BCD FORMATTED TAPE     **SOFIP008
***********************************************************************SOFIP009
***                                                                     SOFIP010
***   INPUT PARAMETERS:                                                 SOFIP011
***   * NAME   : 12-CHARACTER MISSION (OR PROJECT) NAME                 SOFIP012
***   * INCL   : APPROXIMATE INCLINATION OF ORBIT PLANE IN DEGREES (I*4)SOFIP013
***   * IPRG   : APPROXIMATE PERIGEE ALTITUDE IN KILOMETERS         (I*4)SOFIP014
***   * IAPG   : APPROXIMATE APOGEE ALTITUDE IN KILOMETERS          (I*4)SOFIP015
***   * MODEL  : NUMBER OF FIELD-MODEL USED IN B/L CALCULATION      (R*4)SOFIP016
***   * PERIOD: MATHEMATICAL PERIOD OF ORBIT IN HOURS               (R*4)SOFIP017
***   * BLTIME: EPOCH OF FIELD-MODEL USED IN B/L CALCULATION        (R*4)SOFIP018
***   * NRGYLV: THRESHOLD-ENERGY SELECTOR FOR RUNNING PRINTOUT      (I*4)SOFIP019
***   * ITAPE  : B/L ORBIT TAPE IDENTIFIER, < 10000                 (I*4)SOFIP020
***   * NTABLS: # OF OUTPUT-TABLE SETS PER TRAJECTORY               (I*4)SOFIP021
***   * CUTOFF: ORBIT DURATION IN DECIMAL HOURS                     (R*4)SOFIP022
***   * ISKIP  : POSITION SKIPPING CONTROL                          (I*4)SOFIP023
***   * KPRINT: RUNNING PRINTOUT CONTROL                            (I*4)SOFIP024
***                                                                     SOFIP025
***   INPUT VARIABLES:                                                  SOFIP026
***   * PSNTIM:  POSITIONAL TIME (DECIMAL HOURS)                        SOFIP027
***   * PSNLON:       "      LONGITUDE (DEGREES)                        SOFIP028
***   * PSNLAT:       "      LATITUDE (DEGREES)                         SOFIP029
***   * PSNALT:       "      ALTITUDE (KILOMETERS)                      SOFIP030
***   * PSNB  :       "      FIELD MAGNITUDE (GAUSS)                    SOFIP031
***   * PSNL  :       "      SHELL PARAMETER (EARTH RADII)              SOFIP032
***********************************************************************SOFIP033
*** TO READ BCD FORMATTED ORBIT TAPES, UNCOMMENT LINES 132,137,& 143.   SOFIP034
*** COMMENT OUT LINES 133-134,138-139,& 144.                            SOFIP035
*** TO READ UNFORMATTED BINARY ORBIT TAPES, UNCOMMENT LINES 133-134,    SOFIP036
*** 138-139,& 144.  COMMENT OUT LINES 132,137,& 143.                    SOFIP037
*** *******************  BLOCK 0: INITIALIZATION  ******************SOFIP038
      COMMON /AP8MAC/DESCR(8).LIST(1)                                   SOFIP039
      COMMON /AE6MAX/DESCR(8),LIST(1)                                   SOFIP040
      COMMON /AEI7HI/DESCR7(8),LIST7(1)                                 SOFIP041
      COMMON /AEI7LO/DESCR7(8),LIST7(1)                                 SOFIP042
      COMMON /AE5MIN/DESCR(8),LIST(1)                                   SOFIP043
```

```
      COMMON /AP8MIC/DESCR(8),LIST(1)
      REAL MODLAB*8(4,7)/'HENDRICK','S&CAIN 9','9-TERM G','SFC 9/65',' C
     $AIN FT','.AL. 120','-TERM GS','FC 12/66',' CAIN&LA','NGEL 143','-T
     $ERM PO','GO 10/68',' CAIN&SW','EENEY 12','0-TERM P','OGO 8/69','
     $  IGRF',' 1965.0 ','80-TERM ','10/68   ',' LEATON ','MALIN EV','AN
     $S 80-T','ERM 1965','   HURWI','TZ US C&','GS 168-T','ERM 1970'/,
     $MODLBL*8(4),AP8/' AP8'/,MAX/'MAX '/,MIN/'MIN '/,LOW/'S LO'/,
     $MAC/'MAC'/,DESCR7(8),BINDMY*8(5),ADUMMY(6),MOD7/'LO-7'/
      REAL ENERGY(31,2)/2.,3.,4.,5.,6.,8.,10.,15.,20.,25.,30.,35.,40.,
     $45.,50.,55.,60.,70.,80.,90.,100.,125.,150.,175.,200.,250.,300.,
     $350.,400.,500.,0.,.1,.2,.3,.4,.5,.6,.7,.8,.9,1.,1.25,1.5,1.75,2.,
     $2.25,2.5,2.75,3.,3.25,3.5,3.75,4.,4.25,4.5,4.75,5.,5.5,6.,6.5,7.,
     $0.0/,SPNRG(20)/10.,20.,30.,40.,50.,60.,70.,80.,90.,100.,110.,120.,
     $130.,140.,150.,160.,170.,180.,190.,200./
      INTEGER NRGRNG(10,2)/1,3,5,7,12,20,22,26,30,31,1,5,8,10,12,13,14,
     $22,30,31/,IZONE(120)/10*1,17*2,93*3/,NRBITO/1/
      DIMENSION FLUXES(30),ALGFLX(30),ALNFLX(30),DIFSPC(30),EXPFLX(10),
     $PKVALU(50,8),AIFLXS(30),ENRNGS(11),EXPTIM(10),IYMD(3),LCOUNT(4),
     $DIFFLX(30),NAME(3),PKFLX(50),PKTIM(50),PTIME(4),
     $PKLON(50),PKLAT(50),PKALT(50),PKB(50),PKL(50),TAUFLX(50),F(20)
      EQUIVALENCE(PKVALU(1,1),PKFLX(1)),(PKVALU(1,2),PKLON(1)),(PKVALU(1
     $,3),PKLAT(1)),(PKVALU(1,4),PKALT(1)),(PKVALU(1,5),PKTIM(1)),(PKVAL
     $U(1,6),PKB(1)),(PKVALU(1,7),PKL(1)),(PKVALU(1,8),TAUFLX(1))
      REAL TYPLBL(3,2)/'  PR','OTON','S   ','ELEC','TRON','S HI'/,
     $EIRNGS(11)/'0.E0','1.E0','1.E1','1.E2','1.E3','1.E4','1.E5',
     $'1.E6','1.E7','OVER',' '/,XLABEL*8(3,2)/'PRNRGY','PRINTG','PRDIFF'
     $,'ELNRGY','ELINTG','ELDIFF'/,PROTLB*8(2)/'SPNRGY','SPFLUX'/
    1 FORMAT('1NAME  = ',3A4/' INCL  = ',I3/' IPRG  = ', I6/' IAPG = ',
     $I6/' ITAPE = ',I4/' MODEL = ',I2/' PERIOD= ',F9.6/
     $' BLTIME= ',F7.2/' NRGLEV= ',I2/' NTABLS= ',I2/' CUTOFF= ',F6.2/
     $' ISKIP= ',I2/' KPRINT= ',I2//)
    2 FORMAT('1',131('*')/' * SOFIP : SHORT ORBITAL FLUX INTEGR. PROGRAM
     $ FOR STANDARD NSSDC PROTON AND ELECTRON ENVIR. MODELS (SPECIES CON
     $SIDERED SEPARATELY) *'/' * MAGNETIC PARAMETERS B AND L COMPUTED WI
     $TH GEOMAGN. FIELD MODEL',I3,': ',4A8,' * COEFF. UPDATED TO:',F7.1,
     $' *'/' * PROJECT :',3A4,' * INCLIN=',I3,'DEG * PERIG=',I5,'KM * AP
     $OG=',I6,'KM * B/L TAPE=TD',I4,' * PERIOD=',F7.3,'HRS * SOLAR ',A3,
     $'IMUM      *'/' * FOR INFORMATION OR EXPLANATION CONTACT E.G. STASS
     $INOPOULOS AT NASA-GSFC,CODE 601, GREENBELT, MARYLAND 20771, TEL.(3
     $01)-344-8067 *'/1X,131('*')//)
    3 FORMAT(2('1'/12('0'/)/53X,28('*')/53X,'**',6X,3A4,6X,'**'/53X,'**'
     $,I3,'DEG/',I5,'KM/',I6,'KM **'/53X,28('*')/))
    4 FORMAT (3A4,7X,I3,7X,I6,4X,I6,4X,I2,8X,F9.6,1X,F7.2/I2,7X,I4,
     $6X,I2,8X,F6.2,4X,I2,8X,I2)
    5 FORMAT(6E18.8)
```

```
C *** ******************** BLOCK 1: INITIALIZATION ******************SOFIP089
   10 READ(5,4,END=999) NAME,INCL,IPRG,IAPG,MODEL,PERIOD,BLTIME,NRGYLV, SOFIP090
     $ITAPE,NTABLS,CUTOFF,ISKIP,KPRINT                                  SOFIP091
      ITYPE=1                                                           SOFIP092
      WRITE(6,3) (NAME,INCL,IPRG,IAPG,I=1,2)                            SOFIP093
      NORBIT=1                                                          SOFIP094
      IPASS=1                                                           SOFIP095
      IPRINT=KPRINT                                                     SOFIP096
      ASSIGN 110 TO NGO2                                                SOFIP097
      L=0                                                               SOFIP098
      LSUM=0                                                            SOFIP099
      EXPECT=0.0                                                        SOFIP100
      XAMNIM=MAX                                                        SOFIP101
      ISWTCH=1                                                          SOFIP102
      IF(DESCR(1).EQ.AP8) GO TO 15                                      SOFIP103
      ITYPE = 2                                                         SOFIP104
      ASSIGN 120 TO NGO2                                                SOFIP105
      IF(DESCR(2).NE.MAX) XAMNIM=MIN                                    SOFIP106
      IF(DESCR7(2).EQ.MOD7) TYPLBL(3,2)=LOW                             SOFIP107
      GO TO 17                                                          SOFIP108
   15 IF(DESCR(2).NE.MAC)  XAMNIM=MIN                                   SOFIP109
   17 DO 20 I=1,4                                                       SOFIP110
      LCOUNT(I)=0                                                       SOFIP111
   20 MODLBL(I) = MODLAB(I,MODEL)                                       SOFIP112
      TAU = PERIOD                                                      SOFIP113
      FLXSUM = 0.0                                                      SOFIP114
      OFLXSM = 0.0                                                      SOFIP115
      PEAK = -1.0                                                       SOFIP116
      DO 30 NRNG=1,10                                                   SOFIP117
      ENRNGS(NRNG) = ENERGY(NRGRNG(NRNG,ITYPE),ITYPE)                   SOFIP118
      EXPTIM(NRNG) = 0.0                                                SOFIP119
   30 EXPFLX(NRNG) = 0.0                                                SOFIP120
      DO 35 NRGSP=1,20                                                  SOFIP121
   35 F(NRGSP)=0.0                                                      SOFIP122
      DO 40 NRG=1,30                                                    SOFIP123
      AIFLXS(NRG)=0.0                                                   SOFIP124
      ALNFLX(NRG) = 0.0                                                 SOFIP125
      DIFSPC(NRG) = 0.0                                                 SOFIP126
   40 FLUXES(NRG) = 0.0                                                 SOFIP127
C *** WRITE OUT INPUT PARAMETERS                                        SOFIP128
      WRITE(6,1)NAME,INCL,IPRG,IAPG,ITAPE,MODEL,PERIOD,BLTIME,NRGYLV,   SOFIP129
     $NTABLS,CUTOFF,ISKIP,KPRINT                                        SOFIP130
C *** ************************ BLOCK 2: INPUT ***********************SOFIP131
C     READ(9,5,END=400,ERR=10)PSNTM1,PSNLN1,PSNLT1,PSNAL1,PSNB1,PSNL1   SOFIP132
      READ(9,END=400,ERR=10)PSNTM1,PSNLN1,DUMMY,PSNLT1,DUMMY,PSNAL1,    SOFIP133
```

```
     $DUMMY,PSNB1,DUMMY,PSNL1,DUMMY
      TMLAST = PSNTM1
   50 DO 60 ISKP=1,ISKIP
C     READ(9,5,END=400,ERR=10) PSNTIM,PSNLON,PSNLAT,PSNALT,PSNB,PSNL
      READ(9,END=400,ERR=10)PSNTIM,PSNLON,DUMMY,PSNLAT,DUMMY,PSNALT,
     $DUMMY,PSNB,DUMMY,PSNL,DUMMY
   60 CONTINUE
      IF(PSNTIM.LE.CUTOFF) GO TO 65
C *** DUMMY READ LOOP TO READ TO END OF FILE
C  66 READ(9,5,END=400,ERR=10) ADUMMY
   66 READ(9,END=400,ERR=10) BINTIM,BINDMY
      GO TO 66
   65 CONTINUE
C *** *********************  BLOCK 3: CALCULATIONS  *******************
C *** CALCULATE KPSTEP (NUMBER OF MINUTES BETWEEN POINTS ON B/L TAPE)
      GO TO (70,80), IPASS
   70 KPSTEP = INT((PSNTIM-TMLAST)/.0166667+0.1)
   80 TMLAST = PSNTIM
C *** TEST L-VALUE  & BYPASS FLUX CALCULATIONS IF WARRANTED
      IF(PSNL.GT.0.0.AND.PSNL.LT.12.0) GO TO NGO2,(110,120)
      DO 100 NRG=1,30
  100 FLUXES(NRG) = 0.0
      GO TO 170
C *** OBTAIN COMMON LOGARITHM OF POSITIONAL FLUXES (ALGFLX)
C *** PROTONS
  110 CALL TRARA1(DESCR,LIST,PSNL,PSNB,ENERGY(1,1),ALGFLX(1),30)
      GO TO 140
C *** ELECTRONS
  120 IF(INT(100.0*PSNL+0.2).LE.280) GO TO 130
      CALL TRARA1(DESCR7,LIST7,PSNL,PSNB,ENERGY(1,2),ALGFLX(1),30)
      GO TO 140
  130 CALL TRARA1(DESCR,LIST,  PSNL,PSNB,ENERGY(1,2),ALGFLX(1),30)
C *** CONVERT LOG-FLUX TO FLUX
  140 DO 150 NRG=1,30
      FLUXES(NRG) = 10.0**ALGFLX(NRG)
  150 IF(FLUXES(NRG).LT.1.001) FLUXES(NRG) = 0.0
C *** SUM FLUXES FOR (A) RUNNING PRINTOUT, (B) TABULAR OUTPUT
      FLXSUM = FLXSUM+FLUXES(NRGYLV)*FLOAT(KPSTEP)*60.
      DO 160 NRG=1,30
  160 AIFLXS(NRG) = AIFLXS(NRG)+FLUXES(NRG)
  170 CONTINUE
C *** *******************  RUNNING PRINTOUT MODULE  *******************
      GO TO (200,210),IPASS
  200 WRITE (6,2) MODEL,MODLBL,BLTIME,NAME,INCL,IPRG,IAPG,ITAPE,PERIOD,
     $XAMNIM
```

```
      WRITE (6,201)(TYPLBL(I,ITYPE),I=1,3), ENERGY(NRGYLV,ITYPE)        SOFIP179
  201 FORMAT('0',21X,'***** ',3A4,'(E>',G9.3,'MEV)    *****'//     '  LONGSOFIP180
     $.     LAT.     ALT.     FIELD     LINE    ORBIT     POSITIONAL  TIME-INTESOFIP181
     $G      ORBITAL'/' ',T28,'-B-',T37,'-L-      TIME          FLUX      PSTNL SOFIP182
     $FLUX    FLUX(SUM)'/'   (DEG)     (DEG)     (KM)   (GAUSS)   (E.R.)   (HRS)SOFIP183
     $    #/CM**2/SEC')                                                 SOFIP184
      WRITE(6,202)PSNTM1,PSNLN1,PSNLT1,PSNAL1,PSNB1,PSNL1               SOFIP185
  202 FORMAT(' ',T41,F9.5,T2,F7.2,1X,F6.2,1X,F8.1,1X,F8.5,1X,F5.2,T50,  SOFIP186
     $7(2X,1PE10.3))                                                    SOFIP187
  210 IF(MOD(IPRINT,KPRINT).NE.0) GO TO 220                             SOFIP188
      TIFLUX = FLUXES(NRGYLV)*FLOAT(KPSTEP)*60.                         SOFIP189
      WRITE(6,202)PSNTIM,PSNLON,PSNLAT,PSNALT,PSNB,PSNL,                SOFIP190
     $FLUXES(NRGYLV),TIFLUX,FLXSUM                                      SOFIP191
  220 IPRINT=IPRINT+1                                                   SOFIP192
C *** *****************  ORBIT L-ZONE BREAKDOWN MODULE  ***************SOFIP193
C *** *******  THIS MODULE MUST BE USED WITH PERCENT TIME MODULE  ******SOFIP194
C *** STORE TIME IN INNER & OUTER ZONE, EXTERNAL                        SOFIP195
      IF(PSNL.LT.0.0.OR.PSNL.GT.11.0) GO TO 250                         SOFIP196
      IZ = IZONE(INT(PSNL/.1))                                          SOFIP197
      LCOUNT(IZ) = LCOUNT(IZ) + 1                                       SOFIP198
      GO TO 260                                                         SOFIP199
  250 LCOUNT(4) = LCOUNT(4)+1                                           SOFIP200
  260 CONTINUE                                                          SOFIP201
C *** *********************  EXPOSURE INDEX MODULE  *******************SOFIP202
C *** STORE FLUXES AND TIMES IN INTENSITY RANGES                        SOFIP203
      GO TO(270,280),IPASS                                              SOFIP204
  270 ISWTCH=ISWTCH+1                                                   SOFIP205
  280 INTRNG = (8-INT(1.0-SIGN(0.5,ALGFLX(NRGYLV)-7.0)) *               SOFIP206
     $(7-INT(ALGFLX(NRGYLV)))) * INT(1.0+SIGN(0.5,                      SOFIP207
     $FLUXES(NRGYLV)-1.0009))+1                                         SOFIP208
      EXPFLX(INTRNG)=EXPFLX(INTRNG)+FLUXES(NRGYLV)*60.0*FLOAT(          SOFIP209
     $KPSTEP)                                                           SOFIP210
      EXPFLX(10)=EXPFLX(10)+FLUXES(NRGYLV)*60.0*FLOAT(KPSTEP)           SOFIP211
      EXPTIM(INTRNG) = EXPTIM(INTRNG) + FLOAT(KPSTEP) * .0166667         SOFIP212
      EXPTIM(10) = EXPTIM(10) + FLOAT(KPSTEP) * .0166667                 SOFIP213
C *** ***************  PEAK AND TOTALS PER ORBIT MODULE  **************SOFIP214
C *** DETERMINE ORBIT NUMBER AND TOTAL FLUXES PER ORBIT                 SOFIP215
      IF(PSNTIM.LT.TAU) GO TO 300                                       SOFIP216
      PEAK = -1.0                                                       SOFIP217
      TAUFLX(NORBIT) = FLXSUM-OFLXSM                                    SOFIP218
      OFLXSM = FLXSUM                                                   SOFIP219
      NRBITO=NORBIT                                                     SOFIP220
      NORBIT = NORBIT+1                                                 SOFIP221
      TAU = NORBIT * PERIOD                                             SOFIP222
      IF(NORBIT.LE.50) GO TO 300                                        SOFIP223
```

```
      WRITE(6,301)                                                      SOFIP224
  301 FORMAT('0ERROR: NORBIT EXCEEDS LIMIT OF 50.   ************')     SOFIP225
      STOP                                                              SOFIP226
C *** DETERMINE FLUX PEAKS AND POSITIONS PER ORBIT                       SOFIP227
  300 IF(FLUXES(NRGYLV).LE.PEAK) GO TO 310                              SOFIP228
      PKFLX(NORBIT) = FLUXES(NRGYLV)                                    SOFIP229
      PKTIM(NORBIT) = PSNTIM                                            SOFIP230
      PKLON(NORBIT) = PSNLON                                            SOFIP231
      PKLAT(NORBIT) = PSNLAT                                            SOFIP232
      PKALT(NORBIT) = PSNALT                                            SOFIP233
      PKB(NORBIT) = PSNB                                                SOFIP234
      PKL(NORBIT) = PSNL                                                SOFIP235
      PEAK = FLUXES(NRGYLV)                                             SOFIP236
  310 CONTINUE                                                          SOFIP237
C *** *****************  GEOMAGNETIC SHIELDING MODULE  *****************SOFIP238
C *** *******  THIS MODULE MUST BE USED WITH SOLAR PROTON MODULE  ******SOFIP239
      IF(INT(PSNL).GE.5.OR.PSNL.LE.0.0) L=L+1                           SOFIP240
C *** ************  BLOCK 4: LOOPING  (READ-LOOP ENDS HERE)  ***********SOFIP241
      IPASS=2                                                           SOFIP242
      GO TO 50                                                          SOFIP243
C *** ******************  BLOCK 5: OUTPUT PREPARATION  *****************SOFIP244
C *** COMPOSITE ORBIT SPECTRUM                                          SOFIP245
  400 AFCTRS = (KPSTEP*1440.0) / (PSNTIM*86400.0)                       SOFIP246
      DO 410 NRG=1,30                                                   SOFIP247
      AIFLXS(NRG) = AIFLXS(NRG)*AFCTRS                                  SOFIP248
      IF(AIFLXS(NRG).LE.0.0) GO TO 440                                  SOFIP249
      ALNFLX(NRG) = ALOG(AIFLXS(NRG))                                   SOFIP250
  410 CONTINUE                                                          SOFIP251
  440 DO 450 NRG=1,29                                                   SOFIP252
  450 DIFFLX(NRG) = AIFLXS(NRG)-AIFLXS(NRG+1)                           SOFIP253
      DIFFLX(30) = AIFLXS(30)                                           SOFIP254
C *** **********************  PERCENT TIME MODULE  ********************SOFIP255
C *** **  THIS MODULE MUST BE USED WITH ORBIT L-ZONE BREAKDOWN MODULE  *SOFIP256
C *** CALCULATE AND PRINT PERCENT TIME TABLE                            SOFIP257
      LSUM=LCOUNT(1) + LCOUNT(2) + LCOUNT(3) + LCOUNT(4)                SOFIP258
      IF(LSUM.EQ.0) GO TO 470                                           SOFIP259
      DO 460 IL=1,4                                                     SOFIP260
  460 PTIME(IL)=FLOAT(LCOUNT(IL)*KPSTEP)*1.66667/TMLAST                 SOFIP261
      PTIZ=PTIME(1)+PTIME(2)                                            SOFIP262
      WRITE(6,401)PTIZ,(PTIME(II),II=1,4),PSNTIM                        SOFIP263
  470 CONTINUE                                                          SOFIP264
  401 FORMAT('0***** PERCENT OF TOTAL LIFETIME SPENT INSIDE AND OUTSIDE SOFIP265
     $TRAPPED PARTICLE RADIATION BELT ****'//6X,'INNER ZONE (1.0 <= L < SOFIP266
     $2.8)  : ',F6.2,' %'/18X,'OUTSIDE TRAPPING REGION (1.0 <= L < 1.1) SOFIP267
     $: ',F6.2,' %'/18X,'INSIDE TRAPPING REGION  (1.1 <= L < 2.8) : ',  SOFIP268
```

```
     $F6.2,' %'/6X,'OUTER ZONE (2.8 <= L <= 11.0) : ',F6.2,' %'/6X,'EXTESOFIP269
     $RNAL    (L > 11.0)          : ',F6.2,' %'//' TOTAL ORBIT TIME IS :',SOFIP270
     $F8.2,' HOURS')                                                    SOFIP271
C *** ***************** DIFFERENTIAL SPECTRUM MODULE  ****************SOFIP272
      CALL DSPCTR(ALNFLX(1),ENERGY(1,ITYPE),DIFSPC(1))                  SOFIP273
C *** ********************** SOLAR PROTON MODULE  ********************SOFIP274
C *** ****  THIS MODULE MUST BE USED WITH GEOMAG. SHIELDING MODULE  ****SOFIP275
      T=12.                                                             SOFIP276
      IT=T                                                              SOFIP277
      IQ=90                                                             SOFIP278
      ISWTCH=ISWTCH+2                                                   SOFIP279
      IF(L.LE.0) GO TO 510                                              SOFIP280
      CALL SOLPRO(T,IQ,F,INALE)                                         SOFIP281
      EXPOTM=FLOAT(L*KPSTEP)*.0166667                                   SOFIP282
      EXPFCT=(EXPOTM/PSNTIM)                                            SOFIP283
      DO 500 J=1,20                                                     SOFIP284
      F(J)=F(J)*EXPFCT                                                  SOFIP285
  500 CONTINUE                                                          SOFIP286
  510 CONTINUE                                                          SOFIP287
C *** ********************** OUTPUT PUNCH MODULE  ********************SOFIP288
C *** PUNCHES ENERGY, INTEG AND DIFF FLUX, SOLAR PROTONS IF PRESENT     SOFIP289
      WRITE(7,605) NAME,INCL,IPRG,IAPG,MODEL,BLTIME                     SOFIP290
      WRITE(7,602)((ENERGY((II-1)*6+JJ,ITYPE),JJ=1,6),XLABEL(1,ITYPE),IISOFIP291
     $,II=1,5)                                                          SOFIP292
      WRITE(7,602)((AIFLXS((II-1)*6+JJ),JJ=1,6),XLABEL(2,ITYPE),II,II=1,SOFIP293
     $5)                                                                SOFIP294
      WRITE(7,602)((DIFSPC((II-1)*6+JJ),JJ=1,6),XLABEL(3,ITYPE),II,II=1,SOFIP295
     $5)                                                                SOFIP296
      IF(L.LE.0) GO TO 600                                              SOFIP297
      WRITE(7,603) IQ,T,INALE,EXPFCT                                    SOFIP298
      WRITE(7,604)((SPNRG((II-1)*5+JJ),JJ=1,5),PROTLB(1),II,II=1,4)     SOFIP299
      WRITE(7,604)((F((II-1)*5+JJ),JJ=1,5),PROTLB(2),II,II=1,4)         SOFIP300
  600 CONTINUE                                                          SOFIP301
  602 FORMAT(1P6E12.4,A6,I2)                                            SOFIP302
  603 FORMAT('SOLAR PROTONS  #ENERGIES=20   Q=',I2,'  TAU=',F4.1,       SOFIP303
     $'  NALE=',I1,'  EXPFCTR=',F5.2)                                   SOFIP304
  604 FORMAT(1P5E12.4,12X,A6,I2)                                        SOFIP305
  605 FORMAT(3A4,1X,I2,'/',I5,'-',I6,1X,'I(#/CM**2-SEC) D(#/CM**2-SEC-KESOFIP306
     $V) MOD/TM=',I1,'/',F6.1)                                          SOFIP307
C *** ******************** OUTPUT TABLES MODULE 1  *******************SOFIP308
      DO 900 NTBL=1,NTABLS                                              SOFIP309
      WRITE(6,2) MODEL,MODLBL,BLTIME,NAME,INCL,IPRG,IAPG,ITAPE,PERIOD,  SOFIP310
     $XAMNIM                                                            SOFIP311
      GO TO (710,700,730,720),ISWTCH                                    SOFIP312
C *** COMPOSITE ORBIT SPECTRUM AND EXPOSURE INDEX                       SOFIP313
```

```
  700 WRITE (6,701) (TYPLBL(K,ITYPE),K=1,3),ENERGY(NRGYLV,ITYPE),        SOFIP314
     $(ENERGY(N,ITYPE),AIFLXS(N),DIFFLX(N),DIFSPC(N),FIRNGS(N),          SOFIP315
     $FIRNGS(N+1),EXPTIM(N),EXPFLX(N),N=1,10),(ENERGY(N,ITYPE),AIFLXS(N)SOFIP316
     $,DIFFLX(N),DIFSPC(N),N=11,30)                                      SOFIP317
  701 FORMAT ('+',41X,16('*'),3X,3A4,2X,16('*')/' ',41X,49('*')////'0', SOFIP318
     $T18,15('*'),' COMPOSITE ORBIT SPECTRUM ',15('*'),T80,'** EXPOSURE SOFIP319
     $INDEX:ENERGY>',G9.2,T112,'MEV **'/'0',T18,'ENERGY      AVERAGED    SOFIP320
     $    DIFFERENCE     AVERAGED DIFFE-      INTENSITY    EXPOSURE   TOSOFIP321
     $TAL # OF'/' ',T18,'LEVELS   INTEGRAL FLUX   INTEGRAL FLUX    RENTISOFIP322
     $AL FLUX',10X,'RANGES      DURATION   ACCUMULATED'/' ',T18,'>(MEV) SOFIP323
     $   #/CM**2/SEC      #/CM**2/SEC/DE  #/CM**2/SEC/KEV       #/CM**2/SECSOFIP324
     $    (HOURS)      PARTICLES'/'0',T18,0PG9.4,T23,'     ',1PE9.3,7X,   SOFIP325
     $1PE9.3,8X,1PE9.3,T81,2A4,T81,'ZERO FLUX',1X,0PF10.3,1X,1PE13.3/8('SOFIP326
     $ ',T18,0PG9.4,1PE9.3,7X,1PE9.3,8X,1PE9.3,T81,A4,'-',A4,1X,0PF10.3,SOFIP327
     $1X,1PE13.3/),' ',T18,0PG9.4,1PE9.3,7X,1PE9.3,8X,1PE9.3/' ',T81,2A4SOFIP328
     $,T81,'     TOTAL',1X,0PF10.3,1X,1PE13.3,20(T18,0PG9.4,1PE9.3,7X,   SOFIP329
     $1PE9.3,8X,1PE9.3/' '))                                             SOFIP330
      GO TO 750                                                          SOFIP331
C *** COMPOSITE ORBIT SPECTRUM ONLY                                      SOFIP332
  710 WRITE (6,702) (TYPLBL(K,ITYPE),K=1,3),(ENERGY(N,ITYPE),AIFLXS(N), SOFIP333
     $DIFFLX(N),DIFSPC(N),N=1,30)                                        SOFIP334
  702 FORMAT ('+',41X,16('*'),3X,3A4,2X,16('*')/' ',41X,49('*')////'0', SOFIP335
     $T40,15('*'),' COMPOSITE ORBIT SPECTRUM ',15('*')/'0',T40,'ENERGY  SOFIP336
     $    AVERAGED      DIFFERENCE       AVERAGED DIFFE-'/' ',T40,'LEVELS SOFIP337
     $   INTEGRAL FLUX  INTEGRAL FLUX      RENTIAL FLUX'/' ',T40,'>(MEV)  SOFIP338
     $   #/CM**2/SEC   #/CM**2/SEC/DE     #/CM**2/SEC/KEV'//30(' ',T41,   SOFIP339
     $0PG9.4,T46,'      ',1PE9.3,6X,1PE9.3,8X,1PE9.3/))                  SOFIP340
      GO TO 750                                                          SOFIP341
C *** COMPOSITE ORBIT SPECTRUM WITH SOLAR PROTONS AND EXPOSURE INDEX     SOFIP342
  720 WRITE(6,703)(TYPLBL(K,ITYPE),K=1,3),IT,IQ,INALE,ENERGY(NRGYLV,     SOFIP343
     $ITYPE),EXPFCT,(ENERGY(N,ITYPE),AIFLXS(N),DIFFLX(N),DIFSPC(N),SPNRGSOFIP344
     $(N),F(N),FIRNGS(N),FIRNGS(N+1),EXPTIM(N),EXPFLX(N),N=1,10),(ENERGYSOFIP345
     $(N,ITYPE),AIFLXS(N),DIFFLX(N),DIFSPC(N),SPNRG(N),F(N),N=11,20),    SOFIP346
     $(ENERGY(N,ITYPE),AIFLXS(N),DIFFLX(N),DIFSPC(N),N=21,30)            SOFIP347
  703 FORMAT('+',41X,16('*'),3X,3A4,2X,16('*')/' ',41X,49('*')////'0',  SOFIP348
     $62X,'**** SOLAR PROTONS ****'//63X,'FOR TAU=',I2,',Q=',I2,': NALE=SOFIP349
     $',I1/3X,15('*'),' COMPOSITE ORBIT SPECTRUM ',15('*'),5X,'WITH GEOMSOFIP350
     $AG SHIELDING',8X,'** EXPOSURE INDEX: ENERGY>',G9.4,T125,' MEV **'/SOFIP351
     $64X,'(EXPOSR FACTOR=',F4.2,')'//3X,'ENERGY      AVERAGED        DIFFSOFIP352
     $ERENCE      AVERAGED DIFF-        ENERGY        TOTAL           INTENSOFIP353
     $SITY     EXPOSURE    TOTAL # OF'/3X,'LEVELS    INTEGRAL FLUX  INTEGRASOFIP354
     $L FLUX     RENTIAL FLUX          LEVELS        FLUENCE           RANGESSOFIP355
     $S       DURATION    ACCUMULATED'/3X,'>(MEV)      #/CM**2/SEC  #/CM**2/SOFIP356
     $SEC/DE    #/CM**2/SEC/KEV        >(MEV)        #/CM**2           #/CM**2SOFIP357
     $/SEC    (HOURS)       PARTICLES'//T4,0PG9.4,T9,'       ',1PE9.3,6X,   SOFIP358
```

```
     $1PE9.3,7X,1PE9.3,11X,0PF4.0,7X,1PE9.3,T95,2A4,T95,'ZERO FLUX',
     $0PF11.3,1PE14.3/8(T4,0PG9.4,T9,'          ',1PE9.3,6X,1PE9.3,7X,1PE9.3
     $,11X,0PF4.0,7X,1PE9.3,9X,A4,'-',A4,0PF11.3,1PE14.3/),T4,0PG9.4,T9,
     $'       ',1PE9.3,6X,1PE9.3,7X,1PE9.3,11X,0PF4.0,7X,1PE9.3,T95,2A4,
     $T95,'     TOTAL',0PF11.3,1PE14.3/10(T4,0PG9.4,T9,'          ',1PE9.3,6X
     $,1PE9.3,7X,1PE9.3,11X,0PF4.0,7X,1PE9.3/),10(T4,0PG9.4,T9,'          ',
     $1PE9.3,6X,1PE9.3,7X,1PE9.3/))
      GO TO 750
C *** COMPOSITE ORBIT SPECTRUM WITH SOLAR PROTONS
  730 WRITE(6,704)(TYPLBL(K,ITYPE),K=1,3),IT,IQ,INALE,EXPFCT,(ENERGY(N,
     $ITYPE),AIFLXS(N),DIFFLX(N),DIFSPC(N),SPNRG(N),F(N),N=1,20),
     $(ENERGY(N,ITYPE),AIFLXS(N),DIFFLX(N),DIFSPC(N),N=21,30)
  704 FORMAT('+',41X,16('*'),3X,3A4,2X,16('*')/' ',41X,49('*')////T93,
     $'**** SOLAR PROTONS ****'//T93,'FOR TAU=',I2,',Q=',I2,': NALE=',
     $I1/19X,15('*'),' COMPOSITE ORBIT SPECTRUM ',15('*'),18X,'WITH GEOM
     $AG SHIELDING'/T94,'(EXPOSR FACTOR=',F4.2,')'//19X,'ENERGY      AVER
     $AGED          DIFFERENCE       AVERAGED DIFF-',20X,'ENERGY         TOTAL'
     $/19X,'LEVELS   INTEGRAL FLUX  INTEGRAL FLUX    RENTIAL FLUX',22X,
     $'LEVELS         FLUENCE'/19X,'>(MEV)      #/CM**2/SEC  #/CM**2/SEC/DE
     $ #/CM**2/SEC/KEV',20X,'>(MEV)          #/CM**2'//20(T20,0PG9.4,T25,'
     $     ',1PE9.3,6X,1PE9.3,7X,1PE9.3,24X,0PF4.0,7X,1PE9.3/),10(T20,
     $0PG9.4,T25,'          ',1PE9.3,6X,1PE9.3,7X,1PE9.3/))
  750 CONTINUE
C *** ******************** OUTPUT TABLES MODULE 2 ********************
C *** PEAK AND TOTAL FLUXES PER PERIOD
      WRITE(6,2) MODEL,MODLBL,BLTIME,NAME,INCL,IPRG,IAPG,ITAPE,PERIOD,
     $XAMNIM
      WRITE(6,801)(TYPLBL(K,ITYPE),K=1,3),ENERGY(NRGYLV,ITYPE),
     $(N,(PKVALU(N,K),K=1,8),N=1,NRBITO)
  801 FORMAT(                  '+',T35,24('*'),3X,3A4,2X,27('*')/' ',T35,
     $'** TABLE OF PEAK AND TOTAL FLUXES PER PERIOD : ENERGY >',G9.2,T97
     $,    'MEV **'/' ',T35,68('*')//'0',13X,'PERIOD      PEAK FLUX       PO
     $SITION AT WHICH ENCOUNTERED     ORBIT TIME      FIELD(B)      LINE(L)
     $  TOTAL FLUX'/' ',13X,'NUMBER      ENCOUNTERED      LONGITUDE  LATITUD
     $E  ALTITUDE',41X,'PER ORBIT'/  ' ',23X,'#/CM**2/SEC ',2(5X,'(DEG)'
     $),6X,'(KM)',7X,'(HOURS)',6X,'(GAUSS)        (E.R.)        #/CM**2/ORBIT'
     $//(' ',14X,I4,1PE14.3,0PF13.3,F10.2,F12.2,F13.5,F12.5,F10.2,1PE15.
     $3))
C *** ***************** BLOCK 6: PROGRAM TERMINATION *****************
  900 CONTINUE
      GO TO 10
  999 STOP
      END
```

```
C *** ***************  DIFFERENTIAL SPECTRUM SUBROUTINE  ***************
C *** CALCULATES FIRST DERIVATIVES OF INPUT SPECTRUM DEFINED BY FF VS XX
C *** INPUT:    XX - 30 INTEGRAL THRESHOLD ENERGIES, IN MEV          (R*4)
C ***           FF - ALOG OF THE INTEGRAL FLUXES FOR THE 30 ENERGY   (R*4)
C ***                LEVELS, IN PARTICLES/CM**2/SEC
C *** OUTPUT:   DD - DIFFERENTIAL FLUXES OBTAINED FROM THE INTEGRAL  (R*4)
C ***                FLUXES, IN PARTICLES/CM**2/SEC/KEV
C *** *****************************************************************
C *** THIS IS A MODIFIED VERSION OF A PROGRAM (DCSIEU) OBTAINED FROM
C *** IMSL LIBRARY 1:  AUTHOR/IMPLEMENTOR - C.L.SMITH
C *** *****************************************************************
      SUBROUTINE DSPCTR(FF.XX.DD)
      IMPLICIT REAL*8(A-H.O-Z)
      REAL*4 DD,FF,XX
      DIMENSION F(30),X(30),D(30),H(500),FF(30) ,XX(30) ,DD(30)
      DATA EPSLN,OMEGA/1.D-6,1.0717968D0/
C *** DATA INITIALIZATION
      M=0
      DO 5 L=1,30
    5 DD(L)=0.0
C *** DETERMINE SIZE OF ARRAY: OBTAIN M & K INDICES
C ***   M = # OF NONZERO FLUXES - 1:  K = # OF NONZERO FLUXES
      DO 10 K=1,30
      IF(FF(K).EQ.0.)       GO TO 15
      M=K-1
      F(K)=FF(K)+ALOG(1000.)
      X(K)=XX(K)*1000.D0
   10 D(K)=X(K)
   15 K=M+1
      IF(K.LT.10) GO TO 170
C *** SMOOTHING INTEGRAL FLUX
      CALL SMOOTH(X.F.M)
C *** CALCULATE SECOND DERIVATIVES USING CENTRAL DIFFERENCES
      DO 30 I=1,M
         H(I)=X(I+1)-X(I)
   30    H(K +I)=(F(I+1)-F(I))/H(I)
      DO 40  I=2,M
         H(2*K+I)=H(I-1)+H(I)
         H(3*K+I)=.5*H(I-1)/H (2*K+I)
         H(4*K+I)=(H(K+I)-H(K+I-1))/H(2*K+I)
         H(5*K+I)=H(4*K+I)+H(4*K+I)
   40    H(6*K+I)=H(5*K+I)+H(4*K+I)
      H(5*K+1)=0.
```

```
      H(6*K)=0.
C *** BEGIN ITERATION ON SECOND DERIVATIVES
      KCOUNT=0
   50 ETA=0.
      KCOUNT=KCOUNT+1
      DO 70  I=2,M
         W=(H(6*K+I)-H(3*K+I)*H(5*K+I-1)-(.5-H(3*K+I))*H(5*K+I+1)-H(5*K+
     $   I)*OMEGA)
         IF (DABS(W).LE.ETA) GO TO 60
         ETA=DABS(W)
   60    H(5*K+I)=H(5*K+I)+W
   70 CONTINUE
      IF(KCOUNT.GT.5*K)GO TO 170
      IF (ETA.GE.EPSLN) GO TO 50
C *** CONVERGENCE OBTAINED
      DO 80 I=1,M
   80    H(7*K+I)=(H(5*K+1+I)-H(5*K+I))/H(I)
      DO 140 J=1,K
         I=1
         IF (D(J).EQ.X(1))GO TO 130
         IF (D(J)-X(K )) 100,110,110
   90    IF (D(J)-X(I)) 120,130,100
  100    I=I+1
         GO TO 90
  110    I=K
  120    I=I-1
C *** COMPUTE D(J)
  130    HT1=D(J)-X(I)
         HT2=D(J)-X(I+1)
         PROD=HT1*HT2
         H(8*K+J)=H(5*K+I)+HT1*H(7*K+I)
         DELSQS=(H(5*K+I)+H(5*K+1+I)+H(8*K+J))/6.
  140    D(J)=-(H(K +I)+(HT1+HT2)*DELSQS+PROD*H(7*K+I)*.1666667)
C *** SMOOTHING DIFFERENTIAL FLUX
      CALL SMOOTH(X,D,M)
      DO 160 I=1,K
      F(I)=2.718281828D0**(F(I)-ALOG(1000.))
  160 DD(I)      =D(I)*F(I)
  170 RETURN
      END
C
C *** SMOOTH DATA BY 3-POINT AVERAGING OVER EQUAL INTERVALS
      SUBROUTINE SMOOTH(X,F,M)
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION X(30),F(30)
```

```
      FINTER(X1,X2,X3,Y1,Y2,Y3,XIN)=Y1*(XIN-X2)*(XIN-X3)/
     $((X1-X2)*(X1-X3)) + Y2*(XIN-X1)*(XIN-X3)/((X2-X1)*(X2-X3))
     $                  + Y3*(XIN-X1)*(XIN-X2)/((X3-X1)*(X3-X2))
C
      FI = F(1)
      DO 20 I=2,M
        SIZE1 = X(I) - X(I-1)
        SIZE2 = X(I+1) - X(I)
C *** CHECK FOR EQUAL STEPSIZES
        IF(DABS(SIZE1-SIZE2).LT.0.001) GO TO 200
        IF(SIZE2.GT.SIZE1) GO TO 210
C *** STEPSIZE DECREASES - FIT CURVE AND INTERPOLATE BACKWARD
        F2 = F(I+1)
        XINTER = X(I) - SIZE2
        F1 = FINTER(X(I-1),X(I),X(I+1),FI,F(I),F2,XINTER)
        GO TO 300
C *** STEPSIZE INCREASES - FIT CURVE AND INTERPOLATE FORWARD
  210   F1 = FI
        XINTER = X(I) + SIZE1
        F2 = FINTER(X(I-1),X(I),X(I+1),F1,F(I),F(I+1),XINTER)
        GO TO 300
C *** STEPSIZES ARE EQUAL - AVERAGE OVER EXISTING VALUES
  200   F1 = FI
        F2 = F(I+1)
C
C *** PERFORM AVERAGING
  300   FNEW = (F1+2.0*F(I)+F2)/4.
        FI = F(I)
        F(I) = FNEW
   20 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE SOLPRO(TAU,IQ,F,INALE)
C *** MODIFIED 9/77 TO RETURN INALE(# OF AL EVENTS) TO CALLING PROGRAM
C *** INTERPLANETARY SOLAR PROTON FLUX AT 1 AU (FROM E>10 TO E>200 MEV
C *** FOR ANOMALOUSLY LARGE (AL) EVENTS AND FROM E>10 TO E>100 MEV FOR
C *** ORDINARY (OR) EVENTS)
C *** SINGLE PRECISION DECK IN STANDARD FORTRAN IV FOR IBM 360 MACHINES
C *** (EBCDIC, 029 PUNCH) OR OTHER COMPATIBLE SYSTEMS.
C *** PROGRAM DESIGNED AND TESTED BY E.G. STASSINOPOULOS, CODE 601,
C *** NASA GODDARD SPACE FLIGHT CENTER, GREENBELT, MARYLAND 20771 .
C *******************************************************************
C ****  INPUT: TAU     MISSION DURATION IN MONTHS (REAL*4)
C ****         IQ      CONFIDENCE LEVEL THAT CALCULATED FLUENCE F(N)
C ****                 WILL NOT BE EXCEEDED (INTEGER*4)
C **** OUTPUT: F(N)    SPECTRUM OF INTEGRAL SOLAR PROTON FLUENCE FOR
C ****                 ENERGIES E>10*N (1=<N=<20) FOR AL EVENTS
C ****                 ENERGIES E>10*N (1=<N=<10) FOR OR EVENTS
C ****         INALE   # OF AL EVENTS FOR GIVEN TAU AND Q
      REAL NALE,NALECF(7,20)/-.1571,.2707,-.1269E-1,.4428E-3,-.8185E-5,
     $.7754E-7,-.2939E-9,-.1870,.1951,-.6559E-2,.1990E-3,-.3618E-5,
     $.3740E-7,-.1599E-9,-.2007,.1497,-.3179E-2,.5730E-4,-.4664E-6,
     $.1764E-8,0.,-.1882,.1228,-.1936E-2,.2660E-4,-.1022E-6,2*0.,
     $-.2214,.1149,-.1871E-2,.2695E-4,-.1116E-6,2*0.,-.2470,.1062,
     $-.1658E-2,.2367E-4,-.9465E-7,2*0.,-.2509,.8710E-1,-.8300E-3,
     $.8438E-5,3*0.,-.2923,.8932E-1,-.1023E-2,.1029E-4,3*0.,-.3222,
     $.8648E-1,-.9992E-3,.9935E-5,3*0.,-.3518,.8417E-1,-.1000E-2,
     $.9956E-5,3*0.,-.3698,.7951E-1,-.8983E-3,.8940E-5,3*0.,-.2771,
     $.5473E-1,-.1543E-4,4*0., -.2818,.5072E-1,.2511E-4,4*0.,-.2845,
     $.4717E-1,.5664E-4,4*0.,-.2947,.4405E-1,.8507E-4,4*0.,-.2923,
     $.4111E-1,.1106E-3,4*0.,-.2981,.3853E-1,.1312E-3,4*0.,-.3002,
     $.3585E-1,.1529E-3,4*0.,-.3001,.3312E-1,.1781E-3,4*0.,-.3141,
     $.3248E-1,.1654E-3,4*0./,F(20),G(20)
      REAL ORFLXC(5,9)/.154047E3,-.522258E4,.714275E5,-.432747E6,.955315
     $E6,.198004E3,-.448788E4,.438148E5,-.196046E6,.32552E6,.529120E3,
     $-.122227E5,.112869E6,-.465084E6,.710572E6,.121141E4,-.266412E5,
     $.226778E6,-.85728E6,.120444E7,.452062E4,-.103248E6,.896085E6,
     $-.346028E7,.499852E7,.272028E4,-.499088E5,.35305E6,-.111929E7,
     $.133386E7,.275597E4,-.469718E5,.314729E6,-.960383E6,.11165E7,
     $.570997E4,-.799689E5,.381074E6,-.610714E6,0.,.101E3,4*0./
      INTEGER INDEX(20)/2*7,6,3*5,5*4,9*3/
    1 FORMAT(' TAU=',F4.0,' IQ=',I3,3X,'PARAMETER(S) EXCEED PROGRAM LIMI
     $TS')
    2 FORMAT(2X,'FOR THE COMBINATION OF TAU AND IQ GIVEN, NO SIGNIFICANT
```

```
     $ SOLAR PROTON FLUXES ARE TO BE EXPECTED. TAU=',F6.2,' IO=',I2)
      IF(TAU.GT.72..OR.IO.LT.80)GO TO 500
      IP=100-IO
      M=INDEX(IP)
      NALE=0.
      DO 300 J=1,M
  300 NALE=NALE+NALECF(J,IP)*TAU**(J-1)
      INALE=NALE+1.0001
      IF(INALE.GT.0) GO TO 400
C *** CALCULATIONS FOR OR-EVENT CONDITIONS
      IT=TAU
      IF(IT.EQ.1.AND.IP.GT.16) GO TO 700
      P=FLOAT(IP)/100.
      OF=0.
      DO 100 J=1,5
  100 OF=OF+ORFLXC(J,IT)* P**(J-1)*1.E7
      E=10.
      DO 200 N=1,10
      G(N)=EXP(.0158*(30.-E))
      F(N)=OF*G(N)
  200 E=E+10.
      GO TO 800
C *** CALCULATIONS FOR AL-EVENT CONDITIONS
  400 E=10.
      DO 600 N=1,20
      F(N)=7.9E9*EXP((30.-E)/26.5)*INALE
  600 E=E+10.
      GO TO 800
  700 WRITE(6,2) TAU,IO
      GO TO 800
  500 WRITE (6,1) TAU,IO
  800 RETURN
      END
```

```
*****************************
**      SOFIP TEST         **
** 90DEG/ 2000KM/  2000KM **
*****************************
```


Header Page

```
NAME   = TEST 90/2000
INCL   =  90
IPRG   =   2000
IAPG =    2000
ITAPE = 5116
MODEL =  5
PERIOD=  2.119969
BLTIME= 1974.10
NRGLEV=  4
NTABLS=  3
CUTOFF=  23.99
ISKIP=  1
KPRINT=  1
```

T-2
Parameter Output

```
*****************************************************************************************************************************
* SOFIP : SHORT ORBITAL FLUX INTEGR. PRCGRAM FOR STANDARD NSSDC PROTON AND ELECTRON ENVIR. MODELS (SPECIES CONSIDERED SEPARATELY) *
* MAGNETIC PARAMETERS B AND L COMPUTED WITH GEOMAGN. FIELD MODEL  5:     IGRF 1965.0 80-TERM 10/68    * COEFF. UPDATED TO: 1974.1 *
* PROJECT :TEST 90/2000 * INCLIN= 90DEG * PERIG= 2000KM * APOG=  2000KM * B/L TAPE=TD5116 * PERIOD=  2.120HRS * SOLAR MAXIMUM      *
* FOR INFORMATION OR EXPLANATION CONTACT E.G. STASSINOPOULOS AT NASA-GSFC.CODE 601, GREENBELT, MARYLAND 20771, TEL.(301)-344-8067 *
*****************************************************************************************************************************
```

***** PROTONS (E> 5.00 MEV) *****

LONG. (DEG)	LAT. (DEG)	ALT. (KM)	FIELD -B- (GAUSS)	LINE -L- (E.R.)	ORBIT TIME (HRS)	POSITIONAL FLUX #/CM**2/SEC	TIME-INTEG PSTNL FLUX	ORBITAL FLUX(SUM)
-99.73	0.02	1994.0	0.14110	1.36	0.0			
-100.23	5.70	1994.2	0.15100	1.42	0.03333	2.339E 04	2.806E 06	2.806E 06
-100.73	11.37	1994.7	0.16342	1.51	0.06667	1.692E 04	2.031E 06	4.837E 06
-101.23	17.05	1995.5	0.17749	1.65	0.10000	1.011E 04	1.213E 06	6.050E 06
-101.73	22.72	1996.6	0.19234	1.84	0.13333	4.953E 03	5.944E 05	6.644E 06
-102.24	28.39	1997.9	0.20714	2.12	0.16667	3.589E 03	4.307E 05	7.075E 06
-102.74	34.06	1999.5	0.22114	2.51	0.20000	9.497E 02	1.140E 05	7.189E 06
-103.24	39.73	2001.1	0.23371	3.09	0.23333	5.265E 01	6.318E 03	7.195E 06
-103.74	45.40	2002.8	0.24437	3.96	0.26667	0.0	0.0	7.195E 06
-104.24	51.06	2004.4	0.25282	5.36	0.30000	0.0	0.0	7.195E 06
-104.74	56.73	2006.0	0.25896	7.78	0.33333	0.0	0.0	7.195E 06
-105.24	62.39	2007.3	0.26294	12.43	0.36667	0.0	0.0	7.195E 06
-105.74	68.05	2008.5	-1.00000	-1.00	0.40000	0.0	0.0	7.195E 06
-106.25	73.71	2009.4	-1.00000	-1.00	0.43333	0.0	0.0	7.195E 06
-106.75	79.37	2010.0	-1.00000	-1.00	0.46667	0.0	0.0	7.195E 06
-107.24	85.03	2010.2	-1.00000	-1.00	0.50000	0.0	0.0	7.195E 06
72.19	89.31	2010.1	-1.00000	-1.00	0.53333	0.0	0.0	7.195E 06
71.74	83.65	2009.6	-1.00000	-1.00	0.56667	0.0	0.0	7.195E 06
71.24	77.99	2008.8	0.26230	12.01	0.60000	0.0	0.0	7.195E 06
70.74	72.33	2007.6	0.25992	7.58	0.63333	0.0	0.0	7.195E 06
70.24	66.67	2006.2	0.25619	5.25	0.66667	0.0	0.0	7.195E 06
69.74	61.00	2004.5	0.25076	3.87	0.70000	0.0	0.0	7.195E 06
69.24	55.34	2002.6	0.24343	3.01	0.73333	8.072E 01	9.686E 03	7.205E 06
68.74	49.67	2000.6	0.23417	2.43	0.76667	7.752E 02	9.303E 04	7.298E 06
68.24	44.00	1998.6	0.22314	2.C4	0.80000	1.557E 03	1.868E 05	7.485E 06
67.74	38.32	1996.6	0.21069	1.76	0.83333	1.659E 03	1.990E 05	7.684E 06
67.23	32.65	1994.7	0.19741	1.57	0.86667	4.108E 03	4.930E 05	8.177E 06
66.73	26.97	1993.0	0.18415	1.43	0.90000	6.102E 03	7.322E 05	8.909E 06
66.23	21.29	1991.5	0.17203	1.34	0.93333	8.266E 03	9.919E 05	9.901E 06
65.73	15.61	1990.3	0.16230	1.29	0.96667	1.031E 04	1.237E 06	1.114E 07
65.23	9.93	1989.4	0.15608	1.26	1.00000	1.155E 04	1.386E 06	1.252E 07
64.73	4.25	1988.9	0.15392	1.27	1.03333	1.350E 04	1.620E 06	1.414E 07
64.23	-1.44	1988.8	0.15554	1.31	1.06667	1.730E 04	2.076E 06	1.622E 07
63.72	-7.12	1989.1	0.16002	1.38	1.10000	1.513E 04	1.816E 06	1.804E 07
63.22	-12.80	1989.8	0.16619	1.49	1.13333	1.491E 04	1.789E 06	1.983E 07
62.72	-18.48	1990.9	0.17308	1.65	1.16667	1.205E 04	1.446E 06	2.127E 07
62.22	-24.16	1992.2	0.18010	1.87	1.20000	8.208E 03	9.850E 05	2.226E 07
61.72	-29.84	1993.8	0.18701	2.17	1.23333	7.568E 03	9.081E 05	2.316E 07
61.22	-35.52	1995.7	0.19380	2.57	1.26667	1.777E 03	2.133E 05	2.338E 07
60.72	-41.19	1997.6	0.20057	3.14	1.30000	7.793E 01	9.352E 03	2.339E 07
60.22	-46.86	1999.7	0.20739	3.94	1.33333	0.0	0.0	2.339E 07
59.71	-52.53	2001.7	0.21427	5.10	1.36666	0.0	0.0	2.339E 07
59.21	-58.20	2003.6	0.22116	6.87	1.40000	0.0	0.0	2.339E 07
58.71	-63.86	2005.4	0.22789	9.61	1.43333	0.0	0.0	2.339E 07
58.21	-69.53	2007.0	0.23425	13.83	1.46667	0.0	0.0	2.339E 07
57.71	-75.19	2008.3	-1.00000	-1.00	1.50000	0.0	0.0	2.339E 07
57.21	-80.85	2009.3	-1.00000	-1.00	1.53333	0.0	0.0	2.339E 07
56.71	-86.51	2009.9	-1.00000	-1.00	1.56667	0.0	0.0	2.339E 07
-123.80	-87.83	2010.2	-1.00000	-1.00	1.60000	0.0	0.0	2.339E 07
-124.30	-82.17	2010.2	-1.00000	-1.00	1.63333	0.0	0.0	2.339E 07
-124.80	-76.51	2009.7	0.24785	8.25	1.66667	0.0	0.0	2.339E 07
-125.30	-70.85	2009.0	0.24372	5.93	1.70000	0.0	0.0	2.339E 07
-125.80	-65.19	2007.9	0.23761	4.45	1.73333	0.0	0.0	2.339E 07
-126.30	-59.53	2006.6	0.22970	3.48	1.76667	5.619E 00	6.743E 02	2.339E 07
-126.80	-53.87	2005.2	0.22024	2.83	1.80000	3.318E 02	3.981E 04	2.343E 07
-127.31	-48.20	2003.5	0.20956	2.37	1.83333	2.961E 03	3.553E 05	2.378E 07
-127.81	-42.53	2001.9	0.19802	2.04	1.86666	5.884E 03	7.060E 05	2.449E 07
-128.31	-36.87	2000.2	0.18603	1.80	1.90000	6.749E 03	8.099E 05	2.530E 07
-128.81	-31.20	1998.6	0.17411	1.62	1.93333	1.168E 04	1.401E 06	2.670E 07
-129.31	-25.52	1997.2	0.16288	1.50	1.96667	1.700E 04	2.040E 06	2.874E 07
-129.81	-19.85	1996.0	0.15309	1.41	2.00000	2.143E 04	2.572E 06	3.131E 07
-130.31	-14.18	1995.0	0.14558	1.35	2.03333	2.601E 04	3.121E 06	3.443E 07

Beginning of Running Printout

-84.17	-65.24	2008.1	0.20507	3.42	22.89999	1.952E 01	2.343E 03	8.400E 08
-84.67	-59.58	2006.9	0.19271	2.76	22.93330	7.613E 02	9.136E 04	8.401E 08
-85.17	-53.91	2005.4	0.18030	2.31	22.96666	6.676E 03	8.012E 05	8.409E 08
-85.68	-48.25	2003.8	0.16828	2.00	22.99998	1.580E 04	1.896E 06	8.428E 08
-86.18	-42.58	2002.2	0.15704	1.78	23.03331	2.085E 04	2.502E 06	8.453E 08
-86.68	-36.91	2000.5	0.14696	1.62	23.06667	3.203E 04	3.844E 06	8.491E 08
-87.18	-31.25	1999.0	0.13844	1.51	23.09999	4.250E 04	5.100E 06	8.542E 08
-87.68	-25.57	1997.5	0.13194	1.43	23.13332	4.992E 04	5.991E 06	8.602E 08
-88.18	-19.90	1996.3	0.12800	1.38	23.16664	5.732E 04	6.878E 06	8.671E 08
-88.68	-14.23	1995.4	0.12716	1.35	23.20000	5.855E 04	7.026E 06	8.741E 08
-89.18	-8.55	1994.7	0.12983	1.35	23.23331	5.195E 04	6.234E 06	8.803E 08
-89.69	-2.88	1994.3	0.13610	1.37	23.26666	3.948E 04	4.738E 06	8.851E 08
-90.19	2.80	1994.3	0.14567	1.42	23.29999	2.863E 04	3.436E 06	8.885E 08
-90.69	8.47	1994.7	0.15790	1.50	23.33331	2.068E 04	2.482E 06	8.910E 08
-91.19	14.15	1995.3	0.17196	1.62	23.36664	1.272E 04	1.526E 06	8.925E 08
-91.69	19.82	1996.3	0.18700	1.80	23.39999	6.474E 03	7.769E 05	8.933E 08
-92.19	25.49	1997.5	0.20217	2.05	23.43330	4.860E 03	5.833E 05	8.939E 08
-92.69	31.16	1998.9	0.21671	2.41	23.46666	2.435E 03	2.922E 05	8.942E 08
-93.19	36.83	2000.4	0.22995	2.92	23.49998	1.340E 02	1.608E 04	8.942E 08
-93.70	42.50	2002.1	0.24136	3.71	23.53331	0.0	0.0	8.942E 08
-94.20	48.17	2003.7	0.25058	4.94	23.56667	0.0	0.0	8.942E 08
-94.70	53.83	2005.3	0.25745	7.02	23.59999	0.0	0.0	8.942E 08
-95.20	59.50	2006.8	0.26205	10.93	23.63332	0.0	0.0	8.942E 08
-95.70	65.16	2008.0	0.26466	19.48	23.66664	0.0	0.0	8.942E 08
-96.20	70.82	2009.0	-1.00000	-1.00	23.70000	0.0	0.0	8.942E 08
-96.70	76.48	2009.8	-1.00000	-1.00	23.73331	0.0	0.0	8.942E 08
-97.20	82.14	2010.1	-1.00000	-1.00	23.76666	0.0	0.0	8.942E 08
-97.70	87.80	2010.2	-1.00000	-1.00	23.79999	0.0	0.0	8.942E 08
81.78	86.54	2009.9	-1.00000	-1.00	23.83331	0.0	0.0	8.942E 08
81.29	80.88	2009.2	0.26379	15.41	23.86664	0.0	0.0	8.942E 08
80.79	75.22	2008.1	0.26251	9.18	23.89999	0.0	0.0	8.942E 08
80.29	69.56	2006.8	0.26016	6.12	23.93330	0.0	0.0	8.942E 08
79.78	63.90	2005.2	0.25625	4.40	23.96666	0.0	0.0	8.942E 08

```
***** PERCENT CF TOTAL LIFETIME SPENT INSIDE AND CUTSIDE TRA?PED PARTICLE RADIATION BELT ****

     INNER ZONE (1.0 <= L < 2.8)  :   51.60 %
                 OUTSIDE TRAPPING REGICN (1.0 <= L < 1.1) :    0.0  %
                 INSIDE TRAPPING REGION  (1.1 <= L < 2.8) :   51.60 %
     OUTER ZONE (2.8 <= L <= 11.0) :   26.84 %
     EXTERNAL   (L > 11.0)         :   21.56 %

TOTAL ORBIT TIME IS :    24.00 HOURS
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Percent Time Table

Final Part of Running Printout with Percent Time Table

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*******************************************************************************************************************************
* SOFIP : SHORT ORBITAL FLUX INTEGR. PRCGRAM FOR STANDARD NSSDC PROTON AND ELECTRON ENVIR. MCDELS (SPECIES CONSIDERED SEPARATELY) *
* MAGNETIC PARAMETERS B AND L COMPUTED WITH GEOMAGN. FIELD MODEL  5:     IGRF 1965.0 80-TERM 10/68     * COEFF. UPDATED TO: 1974.1 *
* PROJECT :TEST 90/2000 * INCLIN= 90CEG * PERIG= 2000KM * APOG=  2000KM * B/L TAPE=TD5116 * PERIOD=  2.120HRS * SOLAR MINIMUM      *
* FOR INFORMATION OR EXPLANATION CONTACT E.G. STASSINOPOULOS AT NASA-GSFC,CODE 601, GREENBELT, MARYLAND 20771, TEL.(301)-344-8067 *
*******************************************************************************************************************************

                    ****************     PROTCNS      ****************
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             *************** COMPCSITE ORBIT SPECTRUM ***************
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ENERGY LEVELS >(MEV)	AVERAGED INTEGRAL FLUX #/CM**2/SEC	DIFFERENCE INTEGRAL FLUX #/CM**2/SEC/DE	AVERAGED DIFFE-RENTIAL FLUX #/CM**2/SEC/KEV
2.000	1.646E 04	2.454E 03	0.0
3.000	1.401E 04	1.667E 03	0.0
4.000	1.234E 04	1.218E 03	0.0
5.000	1.112E 04	9.428E 02	0.0
6.000	1.018E 04	1.615E 03	0.0
8.000	8.564E 03	1.247E 03	0.0
10.00	7.318E 03	1.642E 03	0.0
15.00	5.675E 03	1.203E 03	0.0
20.00	4.472E 03	4.420E 02	0.0
25.00	4.030E 03	3.913E 02	0.0
30.00	3.639E 03	2.295E 02	0.0
35.00	3.409E 03	2.138E 02	0.0
40.00	3.195E 03	1.993E 02	0.0
45.00	2.996E 03	1.860E 02	0.0
50.00	2.810E 03	1.528E 02	0.0
55.00	2.657E 03	1.441E 02	0.0
60.00	2.513E 03	2.642E 02	0.0
70.00	2.249E 03	2.355E 02	0.0
80.00	2.014E 03	2.100E 02	0.0
90.00	1.804E 03	1.874E 02	0.0
100.0	1.616E 03	3.818E 02	0.0
125.0	1.234E 03	2.901E 02	0.0
150.0	9.444E 02	2.209E 02	0.0
175.0	7.235E 02	1.685E 02	0.0
200.0	5.549E 02	2.143E 02	0.0
250.0	3.407E 02	1.311E 02	0.0
300.0	2.096E 02	8.042E 01	0.0
350.0	1.292E 02	4.944E 01	0.0
400.0	7.973E 01	4.925E 01	0.0
500.0	3.047E 01	3.047E 01	0.0

Output Table 1 without Differential Spectrum, Solar Protons, or Exposure Index - Protons

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*******************************************************************************************************************************
* SOFIP : SHORT ORBITAL FLUX INTEGR. PROGRAM FOR STANDARD NSSDC PROTON AND ELECTRON ENVIR. MODELS (SPECIES CONSIDERED SEPARATELY) *
* MAGNETIC PARAMETERS B AND L COMPUTED WITH GEOMAGN. FIELD MODEL  5:      IGRF 1965.0 80-TERM 10/68     * COEFF. UPDATED TO: 1974.1 *
* PROJECT :SOFIP TEST    * INCLIN= 90DEG * PERIG= 2000KM * APOG=  2000KM * B/L TAPE=TD5116 * PERIOD=  2.12OHRS * SOLAR MINIMUM      *
* FOR INFORMATION OR EXPLANATION CONTACT E.G. STASSINOPOULOS AT NASA-GSFC,CODE 601, GREENBELT, MARYLAND 20771, TEL.(301)-344-8067 *
*******************************************************************************************************************************

                    ****************    ELECTRONS LO    ****************
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               *************** COMPOSITE ORBIT SPECTRUM ***************
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ENERGY LEVELS >(MEV)	AVERAGED INTEGRAL FLUX #/CM**2/SEC	DIFFERENCE INTEGRAL FLUX #/CM**2/SEC/DE	AVERAGED DIFFE- RENTIAL FLUX #/CM**2/SEC/KEV
.1000	7.454E 06	4.716E 06	0.0
.2000	2.738E 06	1.521E 06	0.0
.3000	1.217E 06	5.630E 05	0.0
.4000	6.538E 05	2.962E 05	0.0
.5000	3.576E 05	1.111E 05	0.0
.6000	2.465E C5	7.425E 04	0.0
.7000	1.722E 05	4.388E 04	0.0
.8000	1.284E 05	2.718E 04	0.0
.9000	1.012E C5	2.117E 04	0.0
1.000	8.001E 04	3.057E 04	0.0
1.250	4.944E 04	1.877E 04	0.0
1.500	3.067E 04	1.046E 04	0.0
1.750	2.021E C4	6.862E 03	0.0
2.000	1.334E 04	3.930E 03	0.0
2.250	9.414E 03	2.740E 03	0.0
2.500	6.674E C3	3.037E 03	0.0
2.750	3.637E C3	1.449E 03	0.0
3.000	2.188E 03	1.003E 03	0.0
3.250	1.185E C3	4.794E 02	0.0
3.500	7.055E C2	2.620E 02	0.0
3.750	4.435E 02	1.567E 02	0.0
4.000	2.868E 02	1.484E 02	0.0
4.250	1.384E 02	7.141E 01	0.0
4.500	6.702E 01	3.451E 01	0.0
4.750	3.252E 01	1.669E 01	0.0
5.000	1.583E 01	1.428E 01	0.0
5.500	1.550E 00	1.525E 00	0.0
6.000	2.509E-02	2.509E-02	0.0
6.500	0.0	0.0	0.0
7.000	0.0	0.0	0.0

Output Table 1 without Differential Spectrum, Solar Protons, or Exposure Index - Electrons

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******************************************************************************************************************************
* SOFIP : SHORT ORBITAL FLUX INTEGR. PRCGRAM FOR STANDARD NSSDC PROTON AND ELECTRON ENVIR. MCDELS (SPECIES CONSIDERED SEPARATELY) *
* MAGNETIC PARAMETERS B AND L COMPUTED WITH GEOMAGN. FIELD MODEL  5:    IGRF 1965.0 80-TERM 10/68    * COEFF. UPDATED TO: 1974.1 *
* PROJECT :TEST 90/2000 * INCLIN= 90DEG * PERIG= 2000KM * APOG=  2000KM * B/L TAPE=TD5116 * PERIOD=  2.120HRS * SOLAR MAXIMUM    *
* FOR INFORMATION OR EXPLANATION CONTACT E.G. STASSINOPOULOS AT NASA-GSFC,CODE 601, GREENBELT, MARYLAND 20771, TEL.(301)-344-8067 *
******************************************************************************************************************************
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**************** PROTONS ****************
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*************** COMPOSITE ORBIT SPECTRUM ***************

ENERGY LEVELS >(MEV)	AVERAGED INTEGRAL FLUX #/CM**2/SEC	DIFFERENCE INTEGRAL FLUX #/CM**2/SEC/DE	AVERAGED DIFF-RENTIAL FLUX #/CM**2/SEC/KEV
2.000	1.504E 04	2.134E 03	2.242E 00
3.000	1.291E 04	1.468E 03	1.728E 00
4.000	1.144E 04	1.089E 03	1.297E 00
5.000	1.035E 04	8.553E 02	1.002E 00
6.000	9.494E 03	1.536E 03	8.395E-01
8.000	7.958E 03	1.190E 03	6.461E-01
10.00	6.768E 03	1.519E 03	4.689E-01
15.00	5.249E 03	1.113E 03	2.529E-01
20.00	4.136E 03	4.300E 02	1.471E-01
25.00	3.706E 03	3.791E 02	9.040E-02
30.00	3.327E 03	2.165E 02	5.933E-02
35.00	3.110E 03	2.013E 02	4.529E-02
40.00	2.909E 03	1.873E 02	3.901E-02
45.00	2.722E 03	1.744E 02	3.522E-02
50.00	2.547E 03	1.386E 02	3.117E-02
55.00	2.409E 03	1.307E 02	2.762E-02
60.00	2.278E 03	2.397E 02	2.535E-02
70.00	2.038E 03	2.136E 02	2.259E-02
80.00	1.825E 03	1.905E 02	2.016E-02
90.00	1.634E 03	1.700E 02	1.796E-02
100.0	1.464E 03	3.468E 02	1.598E-02
125.0	1.117E 03	2.633E 02	1.205E-02
150.0	8.540E 02	2.003E 02	9.156E-03
175.0	6.537E 02	1.527E 02	6.906E-03
200.0	5.010E 02	1.934E 02	5.146E-03
250.0	3.076E 02	1.183E 02	3.020E-03
300.0	1.893E 02	7.255E 01	1.833E-03
350.0	1.167E 02	4.461E 01	1.127E-03
400.0	7.213E 01	4.448E 01	6.939E-04
500.0	2.765E 01	2.765E 01	2.649E-04

**** SOLAR PROTONS ****

FOR TAU=12,Q=90: NALE=1
WITH GEOMAG SHIELDING
(EXPOSR FACTOR=0.34)

ENERGY LEVELS >(MEV)	TOTAL FLUENCE #/CM**2
10.	5.741E 09
20.	3.937E 09
30.	2.699E 09
40.	1.851E 09
50.	1.269E 09
60.	8.701E 08
70.	5.966E 08
80.	4.091E 08
90.	2.805E 08
100.	1.923E 08
110.	1.319E 08
120.	9.042E 07
130.	6.200E 07
140.	4.251E 07
150.	2.915E 07
160.	1.999E 07
170.	1.370E 07
180.	9.396E 06
190.	6.443E 06
200.	4.418E 06

** EXPOSURE INDEX: ENERGY>5.000 MEV **

INTENSITY RANGES #/CM**2/SEC	EXPOSURE DURATION (HOURS)	TOTAL # OF ACCUMULATED PARTICLES
ZERO FLUX	10.100	0.0
1.E0-1.E1	0.100	2.749E 03
1.E1-1.E2	1.000	1.686E 05
1.E2-1.E3	1.333	2.225E 06
1.E3-1.E4	5.000	8.745E 07
1.E4-1.E5	6.267	7.407E 08
1.E5-1.E6	0.167	6.368E 07
1.E6-1.E7	0.0	0.0
1.E7-OVER	0.0	0.0
TOTAL	23.964	8.942E 08

Output Table 1 with Differential Spectrum, Solar Protons, and Exposure Index - Protons

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***********************************************************************************************************************************
* SOFIP : SHORT ORBITAL FLUX INTEGR. PROGRAM FOR STANDARD NSSDC PROTON AND ELECTRON ENVIR. MODELS (SPECIES CONSIDERED SEPARATELY) *
* MAGNETIC PARAMETERS B AND L COMPUTED WITH GEOMAGN. FIELD MODEL  5:      IGRF 1965.0 80-TERM 10/68      * COEFF. UPDATED TO: 1974.1 *
* PROJECT :SOFIP TEST    * INCLIN= 90DEG * PERIG= 2000KM * APOG=  2000KM * B/L TAPE=TD5116 * PERIOD=  2.120HRS * SOLAR MAXIMUM      *
* F3R INFORMATION OR EXPLANATION CONTACT E.G. STASSINOPOULOS AT NASA-GSFC,CODE 601, GREENBELT, MARYLAND 20771, TEL.(301)-344-8067 *
***********************************************************************************************************************************
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**************** ELECTRONS HI ****************
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**************** COMPOSITE ORBIT SPECTRUM ****************

ENERGY LEVELS >(MEV)	AVERAGED INTEGRAL FLUX #/CM**2/SEC	DIFFERENCE INTEGRAL FLUX #/CM**2/SEC/DE	AVERAGED DIFF-RENTIAL FLUX #/CM**2/SEC/KEV
.1000	1.511E 07	8.096E 06	1.175E 05
.2000	7.012E 06	4.037E 06	5.685E 04
.3000	2.976E 06	1.821E 06	2.557E 04
.4000	1.154E 06	6.924E 05	9.787E 03
.5000	4.621E 05	1.672E 05	3.515E 03
.6000	2.949E 05	1.014E 05	1.461E 03
.7000	1.934E 05	5.586E 04	7.461E 02
.8000	1.376E 05	3.302E 04	4.435E 02
.9000	1.046E 05	2.455E 04	2.844E 02
1.000	8.001E 04	2.859E 04	1.869E 02
1.250	5.143E 04	1.799E 04	9.252E 01
1.500	3.343E 04	1.033E 04	5.388E 01
1.750	2.311E 04	7.046E 03	3.426E 01
2.000	1.606E 04	4.479E 03	2.256E 01
2.250	1.158E 04	3.185E 03	1.673E 01
2.500	8.395E 03	3.395E 03	1.303E 01
2.750	5.000E 03	1.735E 03	8.791E 00
3.000	3.265E 03	9.799E 02	5.154E 00
3.250	2.285E 03	5.342E 02	2.950E 00
3.500	1.751E 03	3.551E 02	1.833E 00
3.750	1.396E 03	2.645E 02	1.395E 00
4.000	1.131E 03	3.415E 02	1.256E 00
4.250	7.897E 02	2.370E 02	1.059E 00
4.500	5.527E 02	1.653E 02	7.869E-01
4.750	3.874E 02	1.155E 02	6.004E-01
5.000	2.719E 02	1.917E 02	4.885E-01
5.500	8.018E 01	5.648E 01	2.194E-01
6.000	2.370E 01	2.159E 01	6.402E-02
6.500	2.113E 00	2.113E 00	9.518E-03
7.000	0.0	0.0	0.0

**** SOLAR PROTONS ****

FOR TAU=12,Q=90: NALE=1
WITH GEOMAG SHIELDING
(EXPOSR FACTOR=0.34)

ENERGY LEVELS >(MEV)	TOTAL FLUENCE #/CM**2
10.	5.741E 09
20.	3.937E 09
30.	2.699E 09
40.	1.851E 09
50.	1.269E 09
60.	8.701E 08
70.	5.966E 08
80.	4.091E 08
90.	2.805E 08
100.	1.923E 08
110.	1.319E 08
120.	9.042E 07
130.	6.200E 07
140.	4.251E 07
150.	2.915E 07
160.	1.999E 07
170.	1.370E 07
180.	9.396E 06
190.	6.443E 06
200.	4.418E 06

** EXPOSURE INDEX: ENERGY>.5000 MEV **

INTENSITY RANGES #/CM**2/SEC	EXPOSURE DURATION (HOURS)	TOTAL # OF ACCUMULATED PARTICLES
ZERO FLUX	5.333	0.0
1.E0-1.E1	0.033	2.171E 02
1.E1-1.E2	0.200	1.575E 04
1.E2-1.E3	0.333	5.981E 05
1.E3-1.E4	1.733	2.886E 07
1.E4-1.E5	3.267	5.272E 08
1.E5-1.E6	9.367	1.317E 10
1.E6-1.E7	3.700	2.619E 10
1.E7-OVER	0.0	0.0
TOTAL	23.964	3.993E 10

Output Table 1 with Differential Spectrum, Solar Protons, and Exposure Index - Electrons

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* MAGNETIC PARAMETERS B AND L COMPUTED WITH GEOMAGN. FIELD MODEL 5: IGRF 1965.0 80-TERM 10/68 * COEFF. UPDATED TO: 1974.1 *
* PROJECT :TEST 90/2000 * INCLIN= 90DEG * PERIG= 2000KM * APOG= 2000KM * B/L TAPE=TD5116 * PERIOD= 2.120HRS * SOLAR MAXIMUM *
* FOR INFORMATION OR EXPLANATION CONTACT E.G. STASSINOPOULOS AT NASA-GSFC.CODE 601, GREENBELT, MARYLAND 20771, TEL.(301)-344-8067 *

PROTONS

** TABLE OF PEAK AND TOTAL FLUXES PER PERIOD : ENERGY > 5.0 MEV **

PERIOD NUMBER	PEAK FLUX ENCOUNTERED #/CM**2/SEC	POSITION AT WHICH ENCOUNTERED LONGITUDE (DEG)	LATITUDE (DEG)	ALTITUDE (KM)	ORBIT TIME (HOURS)	FIELD(B) (GAUSS)	LINE(L) (E.R.)	TOTAL FLUX PER ORBIT #/CM**2/ORBIT
1	3.253E 04	-131.316	-2.83	1993.99	2.10000	0.14041	1.31	4.552E 07
2	3.599E 04	31.637	-9.95	1989.39	3.23333	0.14089	1.46	6.160E 07
3	6.541E 04	-0.451	-12.79	1989.68	5.36666	0.12769	1.50	8.547E 07
4	1.059E 05	-33.040	-21.31	1991.28	7.53333	0.11669	1.50	1.200E 08
5	9.788E 04	-64.626	-18.46	1990.65	9.63333	0.11720	1.39	9.174E 07
6	4.973E 04	-96.212	-15.62	1990.13	11.73333	0.13084	1.35	5.599E 07
7	3.321E 04	-127.298	-7.08	1988.98	13.80000	0.13994	1.31	6.099E 07
8	5.778E 04	6.577	-11.38	1994.78	16.86664	0.13019	1.49	7.891E 07
9	9.856E 04	-25.511	-8.54	1994.54	18.99998	0.11706	1.40	1.187E 08
10	1.099E 05	-56.596	-17.06	1995.76	21.06667	0.11493	1.40	1.089E 08
11	5.855E 04	-88.683	-14.23	1995.36	23.20000	0.12716	1.35	6.306E 07

Output Table 2 - Protons

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* SOFIP : SHORT ORBITAL FLUX INTEGR. PROGRAM FOR STANDARD NSSDC PROTON AND ELECTRON ENVIR. MODELS (SPECIES CONSIDERED SEPARATELY) *
* MAGNETIC PARAMETERS B AND L COMPUTED WITH GEOMAGN. FIELD MODEL  5:    IGRF 1965.0 80-TERM 10/68    * COEFF. UPDATED TO: 1974.1 *
* PROJECT :SOFIP TEST   * INCLIN= 90DEG * PERIG= 2000KM * APOG=  2000KM * B/L TAPE=TD5116 * PERIOD=  2.120HRS * SOLAR MAXIMUM     *
* FOR INFORMATION OR EXPLANATION CONTACT E.G. STASSINOPOULOS AT NASA-GSFC,CODE 601, GREENBELT, MARYLAND 20771, TEL.(301)-344-8067 *
******************************************************************************************************************************

                    ***********************   ELECTRONS HI   **************************
                    ** TABLE OF PEAK AND TOTAL FLUXES PER PERIOD : ENERGY > 0.50  MEV **
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PERIOD NUMBER	PEAK FLUX ENCOUNTERED #/CM**2/SEC	POSITION AT WHICH ENCOUNTERED LONGITUDE (DEG)	LATITUDE (DEG)	ALTITUDE (KM)	ORBIT TIME (HOURS)	FIELD(B) (GAUSS)	LINE(L) (E.R.)	TOTAL FLUX PER ORBIT #/CM**2/ORBIT
1	1.980E 06	-129.812	-19.85	1995.97	2.00000	0.15309	1.41	2.649E 09
2	2.216E 06	31.637	-9.95	1989.39	3.23333	0.14089	1.46	3.260E 09
3	2.940E 06	0.051	-7.11	1989.01	5.33333	0.12639	1.42	3.779E 09
4	3.536E 06	-32.538	-15.63	1990.08	7.50000	0.11529	1.44	4.472E 09
5	3.309E 06	-65.127	-24.14	1992.01	9.66667	0.11888	1.43	3.650E 09
6	2.405E 06	-97.215	-26.98	1992.82	11.80000	0.14082	1.45	2.971E 09
7	2.337E 06	38.162	-8.54	1994.46	14.76667	0.14306	1.43	3.259E 09
8	2.805E 06	6.075	-5.70	1994.27	16.89999	0.12839	1.41	3.710E 09
9	3.508E 06	-25.009	-14.22	1995.21	18.96666	0.11709	1.45	4.749E 09
10	3.504E 06	-56.094	-22.73	1996.85	21.03331	0.11561	1.44	4.193E 09
11	2.730E 06	-87.680	-25.57	1997.54	23.13332	0.13194	1.43	2.986E 09

Output Table 2 - Electrons

NASA

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771