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SURFACE COMPOSITION MAPPING RADIOMETER (SCMR) DATA PROCESSING SYSTEM

Prepared by

COMPUTER SCIENCES CORPORATION

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Prepared by:

S. K. Tak — 5/11/73
S. K. Tak — Date

Approved by:

F. D. Eastham — 5/11/73
F. D. Eastham — Date
Section Manager

Dr. F. M. Calabria — 5/11/1973
Dr. F. M. Calabria — Date
Department Manager

ABSTRACT

This document describes a system of computer programs for the processing and display of data obtained from the Surface Composition Mapping Radiometer (SCMR) flown aboard the NIMBUS E satellite. The SCMR instrument provides measurements of thermal energy radiating from the earth's surface. The SCMR data processing system provides for the calibration, geographic referencing and display of data observed by the SCMR instrumentation.

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SECTION 1 - INTRODUCTION

The Surface Composition Mapping Radiometer (SCMR) is a scanning radiometer flown on the NIMBUS E satellite and is similar in operation to other infrared radiometers such as the High Resolution Infrared Radiometer (HRIR) and the Temperature Humidity Infrared Radiometer (THIR) which have been previously flown.

The SCMR has two main data channels, one centered at 8.8 microns and the other at 10.9 microns. Each channel has a 1.0 micron bandwidth and the spatial resolution, assuming a normal NIMBUS noon orbit, is 600 meters. Upon ground command a third data channel (1.2 micron) maybe substituted for the 8.8 micron channel. The 8.8 and 10.9 micron channels provide measurements of thermally radiated energy from the earth's surface and the 1.2 micron channel gives a measure of reflected energy.

The SCMR instrument is designed such that a zero volt output for the 8.8 and 10.9 micron channels corresponds to a temperature of 259^{o}K and 265.4^{o}K respectively. Any viewed surface temperature below these values will also yield a zero volt output. The upper temperature limit of both channels is approximately 335^{o}K and corresponds to a six volt output.

The SCMR instrument is operated approximately 10 minutes out of each orbit and is programmable in one minute increments.

For each rotation of the scanning mirror, rotating at 10 rps, the following information is obtained from the telemetry:

a. instrument view of space,

b. stairstep voltage calibration (0-6v) through the instrument,

c. instrument view of earth,

d. stairstep voltage calibration (0-6v) bypassing the instrument,

e. instrument view of the reference black body,

f. an analog voltage representing the temperature of the reference black body.

When the 8.8 and 10.9 micron data channels are in operation, the objective is to calculate the surface temperature of the earth and also the temperature difference ($T_{10.9} - T_{8.8}$) for each data point. When the 1.2 micron channel is substituted for the 8.8 micron channel, temperature differences are not computed, and the 1.2 micron channel data are converted to radiance values by application of pre-set calibration values.

This document describes a system of computer programs designed for the processing and display of data received from the SCMR instrument package. This system has been implemented for use on the IBM 360/91 computer and has been designed to simplify operational procedures by automating many of the recording and maintenance functions which are normally required to be performed manually.

SECTION 2 - SCMR SYSTEM DESCRIPTION

The Surface Composition Mapping Radiometer (SCMR) data processing system includes calibration, geographic referencing, catalog maintenance and selective display capabilities for the processing and display of data obtained from the SCMR sensors aboard the NIMBUS E satellite. The general data flow through this system is depicted in Figure 2-1.

The individual programs comprising this system are fully described in subsequent sections. However, the general functions performed by each are summarized below:

- The calibration program performs the initial processing of the telemetry data received. Equipment calibration data is accumulated. calibration curves are established and the sensed earth data is converted from telemetry counts to indices to master conversion tables. A calibrated data tape is output by this program for subsequent processing steps.

- The geographic referencing program accepts as input, the calibrated data tape, obtains the corresponding sub-satellite points from an ephemeris data tape and outputs an archival tape containing final sensed data related to its geographic position.

- A selective display program provides a variety of capabilities for the graphic representation of data processed through this system in the form of contour plots.

- The catalog maintenance program provides automatic record keeping of the SCMR data as it is processed through the various programs of the processing system, and provides ready access for sorting and summarization of information for reporting purposes.

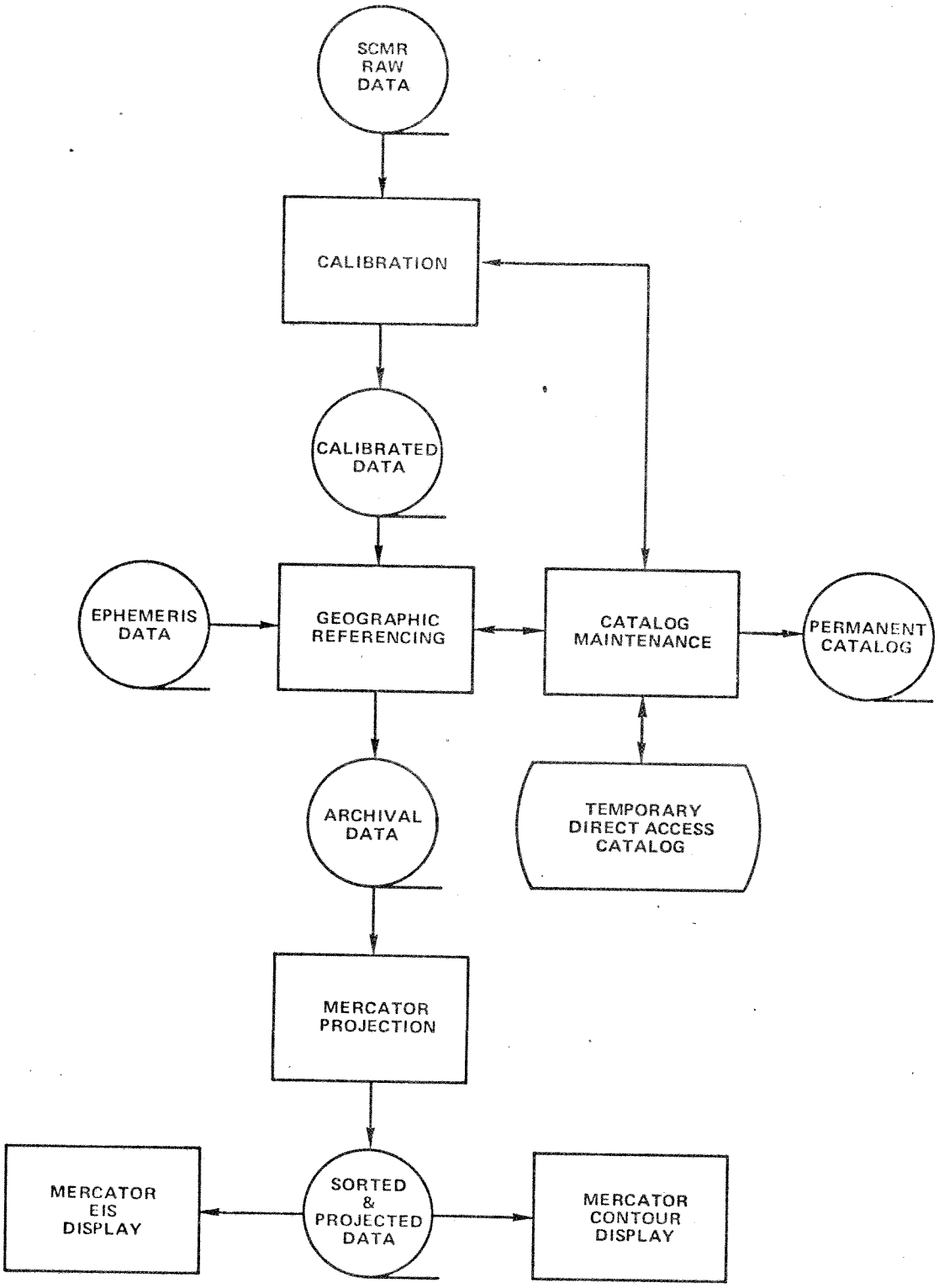

Figure 2-1. SCMR Data Processing System

SECTION 3 - CALIBRATION PROGRAM

3.1 PROGRAM DESCRIPTION

The primary purpose of the SCMR Calibration Program (SCMCAL) is to provide accurate conversion of the raw earth data, as seen by the SCMR sensors, from telemetry counts to its corresponding value of absolute temperature. This conversion is accomplished in the following manner:

1. For each input record, an average value is determined for each of the calibration and reference data segments, separate values being computed corresponding to each operating data channel.

2. The individual averages determined for each record are accumulated to maintain a running average of each data segment covering 11 records (1.1 sec of sampled data).

3. The running averages are used to construct conversion tables to be used for the conversion of the sensed earth data (telemetry counts) to corresponding values of voltage, radiance and temperature.

Program operation is such that the conversion tables are constructed from the previous 1.1 seconds of calibration data (11 input records).

For optimization in handling the large volumes of data received from the SCMR equipment, the conversion of earth data is accomplished by using the telemetry count of each data point as an index to an appropriate table to retrieve its

corresponding calibrated value of voltage, radiance or temperature.

The following mathematical operations are utilized in construction of the conversion tables. Output voltage (telemetry counts) is assumed to be linear with respect to energy input (radiance sensed by the SCMR instrument).

1. Using the calibration levels (instrument bypassed) on either side of the measured black body temperature (V_T, given in telemetry counts), the corresponding analog voltage (V_i) is obtained by linear interpolation.

2. The analog voltage representing black body temperature is then converted to absolute temperature from a table of analog voltage vs. temperature (Table 1). The black body temperature used in subsequent construction of conversion tables is an average of the black body temperatures as measured by the 10.9μ and 8.8μ channels. When the 1.2μ channel is substituted for the 8.8μ channel, only the 10.9μ channel black body temperature is used in construction of the 10.9μ conversion tables. Conversion of the 1.2μ channel data is made by direct linear interpolation from the values of Table 3-2.

3. Using the computed black body temperature and the computed 0 v level, temperature and corresponding radiance values are determined for each operating channel.

$$\omega(\lambda, T) = \frac{C_1}{\lambda^5} \times \frac{\Delta_\lambda}{\exp\left[C_2/\lambda T \right] - 1}$$

where; $\omega(\lambda, T)$ = Radiance (ω/cm^2)

λ = Channel mid-point (μ)

Δ_λ = Bandwidth $(= 1\mu)$

T = Temperature (^oK)

$C_1 = 37413$

$C_2 = 14388$

4. Using the instrument calibration values, a table of voltages is constructed by linear interpolation to obtain a voltage corresponding to each possible telemetry count configuration (0-255).

5. From the values of 3. and the tables of 4. the following values can now be determined for each operating channel;

   a. Nominal Radiance Slope

   $$NRS = \frac{\text{Black Body Radiance - 0 volt Radiance}}{\text{Black Body Reference (Housing) voltage}} \qquad (W.cm^{-2}.V^{-1})$$

   b. Radiance for each of 256 possible voltages $(W.cm^{-2})$

   $\omega_i = \text{Voltage}_i \times NRS + 0 \text{ volt Radiance}$

c. Temperature for each of 256 possible voltages

$$T_i = \frac{C_2}{\lambda \ \mathrm{Ln}\left(\frac{C_1}{\lambda^5 \times \omega_i} + 1\right)}$$

Using the calibration and conversion tables established in the preceeding steps, each earth data point viewed by the SCMR sensors (8-bit telemetry count) is used as an index to the appropriate table to retrieve a corresponding value of temperature (voltage for the 1.2μ channel). This retrieved table value of temperature or voltage is now converted to an 8-bit integer value for use as an index to a master conversion table contained on the output tape, and is placed in the array to be output. When all viewed points for the current record have been thus treated, an output record is written on the Calibrated Data Tape. Appendix C describes the format of this tape.

The above process is repeated until the end of the selected interval is reached (maximum of 7 minutes of data) at which time this interval is recorded in the SCMR catalog and the run terminates.

Table 3-1. Black Body Volt/Temp. Conversion Table

Voltage	0.00V	0.25V	0.50V	0.75V
0.00(V)	323.87 (^{o}K)	323.87 (^{o}K)	323.87 (^{o}K)	323.87 (^{o}K)
1.00	320.83	317.78	314.99	312.46
2.00	309.92	307.39	305.11	302.82
3.00	299.78	289.26	295.98	293.96
4.00	291.67	298.40	287.11	284.83
5.00	282.56	280.53	277.99	275.72
6.00	273.44			

Table 3-2. 1.2μ Channel Volt/Radiance Conversion Table

Analog Voltage (V)	Corresponding Radiance (mW)
0.00	0.0
1.62	15.5
2.93	31.3
4.16	46.9
5.38	62.8

3.2 USER'S GUIDE

The SCMR calibration program is invoked by a small FORTRAN driver which reads two data cards containing selection criteria for the given run. Parameters not input are given the indicated default values.

Input Card No. 1

Cols.	Description	Format	Default
12-20	Calibration start time (HH MM SS)	3I3	00 00 00
33-41	Calibration stop time (HH MM SS)	3I3	24 00 00
53-57	Output calibration tape no.	I5	0
66-73	Area covered by data	2A4	blank

Input Card No. 2

Cols.	Description	Format	Default
12-15	8.8μ black body temp. increment	F4.1	1.7
30-33	10.9μ black body temp. increment	F4.1	0.5
56-59	Calibration printout interval	I4	600
75-79	10.9μ channel wavelength	F5.2	10.55

Required DD cards: 1, 2, 3, 4

SECTION 4 - GEOGRAPHIC REFERENCING PROGRAM

4.1 PROGRAM DESCRIPTION

The SCMR location program provides geographic referencing of the SCMR calibrated data. Appropriate calls are made to the GEOCTR[1] program to establish 101 pairs of latitude and longitude which are then placed with the calibrated data and output to an SCMR archive tape. Initializing values of roll, pitch, and yaw are determined by the ATTADJ subroutine and the SCMR catalog is appropriately updated.

4.2 USER'S GUIDE

The SCMR location program is invoked by:

CALL SCMRLC

A single input card is required as follows:

Cols.	Description	Format
11-13	SCMR catalog data set reference no.	I3
31-34	SCMR archive tape no. being written	I4

Required DD cards: 1, 2, 4, 10, 11, 12, 13, 14

[1] CSC, 3000-093-01TN, Sub-Satellite Locator Program - GEOCTR, October 1973.

SECTION 5 - DISPLAY PROGRAMS

5.1 PROGRAM DESCRIPTION

Two programs are available to obtain Mercator projected displays of selected areas of SCMR data. One program utilizes the Wolf Plotting and Contouring Package (GSFC Library #A00227) to produce a display in the form of temperature contours. This program provides the capability of producing selected areas for display by printer plot, SC-4020 microfilm and/or CalComp 12- or 30-inch plots. Contour plots may be produced for any combination of selected data channels (10.5-, 8.8/1.2-, and/or 10.5-8.8-micron data). A second program provides selection of a single area and single channel for production of an EIS color picture.

Both of the above display programs require as input a prepared tape containing latitude, longitude (I, J) positions of each data point, sorted in descending order. An I, J computation program extracts, from the SCMR archive tape, an overall area selected for display. A latitude and longitude position is computed for each data point within the selected area. This position is then converted to an I, J grid position within an imaginary world map Mercator coordinate system by

$$J = (360 - LON) \times 160 \qquad LON = 0^{o} \text{ to } 360^{o} \text{ W}$$

$$I = \frac{\ell n \left[\tan\left(45 + \frac{LAT}{2}\right)\right]}{160} \qquad LAT = -80^{o} \text{ to } +80^{o}$$

Channel data and the associated I, J positions are then output to tape for descending sort by the IBM sort/merge program.

5.2 USER'S GUIDE

5.2.1 Area Selection Program for Mercator Display Programs

The area selection and I, J computation program requires a single input card as follows:

Cols.			
8-10	Deg	South latitude limit	-80^{o} to $+80^{o}$
12, 13	Min		
19-21	Deg	North latitude limit	
23, 24	Min		
34-36	Deg	East longitude limit	0^{o} to 360^{o} W
38, 39	Min		
46-48	Deg	West longitude limit	
50, 51	Min		
61, 62	Deg	Nadir angle limit	

Approximate time requirements for a selected area 10^{o} latitude by 10^{o} longitude are as follows:

	CPU	I/O
selection	3.0	1.0
sorting	5.0	20.0

Run deck setup for a combined selection and sorting run is as follows:

```
//     EXEC  PGM=IPAFS,PARM=XREF
//SORCE.SYSIN  DD *
        CALL COMPIL
        STOP
        END
//CIJ  EXEC CLG  SGH,REGION.GO=220K
//LKED.SYSLIB   DD DSN=K3.SOUT.SL CLIB1,DISP=SHR
//GO.ARCHIVE    DD UNIT=(9TRACK,,DEFER),DISP=(OLD,KEEP),LABEL=(1,BLP),
//                 VOL=SER=L34..                  INPUT SCAR ARCHIVE TAPE
//GO.SORTAPE    DD UNIT=(9TRACK,,DEFER),DISP=(NEW,PASS),LABEL=(1,BLP),
//   VOL=SER=L3457,DSN=&&SORTOUT                  FINAL SORTED OUTPUT TAPE
//GO.SORTAPE    DD UNIT=(9TRACK,,DEFER),DISP=(NEW,PASS),LABEL=(1,BLP),
//   VOL=SER=L3438,DSN=&&TEPSRT                   INT. TAPE TO BE SORTED
//GO.DATA5 DD *
  LAT=/ 32 00/ - / 40 00/: LON=/ 114 00/ - / 124 00/:NADIR=/35/:
//SORT EXEC PGM=SORT,PARM='CORE=700000',REGION=700K
//SORTLIB DD DSN=SYS1.SORTLIB,DISP=SHR
//SYSOUT DD SYSOUT=A
//SORTIN DD DISP=(OLD,DELETE),LABEL=(1,NL),DSN=&&TEPSRT,
// DCB=(RECFM=FB,LRECL=20,BLKSIZE=32000),VOL=REF=*.CIJ.GO.SORTAPE
//SORTWK01 DD UNIT=2314,SPACE=(TRK,(500),,CONTIG)
//SORTWK02 DD UNIT=2314,SPACE=(TRK,(500),,CONTIG)
//SORTWK03 DD UNIT=2314,SPACE=(TRK,(500),,CONTIG)
//SORTWK04 DD UNIT=2314,SPACE=(TRK,(500),,CONTIG)
//SORTWK05 DD UNIT=2314,SPACE=(TRK,(500),,CONTIG)
//SORTWK06 DD UNIT=2314,SPACE=(TRK,(500),,CONTIG)
//SORTWK07 DD UNIT=2314,SPACE=(TRK,(500),,CONTIG)
//SORTWK08 DD UNIT=2314,SPACE=(TRK,(500),,CONTIG)
//SORTWK09 DD UNIT=2314,SPACE=(TRK,(500),,CONTIG)
//SORTWK10 DD UNIT=2314,SPACE=(TRK,(500),,CONTIG)
//SORTWK11 DD UNIT=2314,SPACE=(TRK,(500),,CONTIG)
//SORTWK12 DD UNIT=2314,SPACE=(TRK,(500),,CONTIG)
//S[illegible]  [illegible]T=[illegible],S[illegible]=([illegible],([illegible]),,C[illegible]TIG)
//S[illegible]  [illegible]T=[illegible],[illegible]=([illegible],([illegible]),,[illegible]TIG)
//S[illegible]  [illegible]T=[illegible],[illegible]=([illegible],([illegible]),,C[illegible]TIG)
//SORTOUT [illegible]=([illegible]),[illegible]=(2,[illegible]),[illegible]=*.SORTIN,
//   V[illegible]=*.CIJ.[illegible](9[illegible],,[illegible])
//SYSIN [illegible]
 S[illegible] FIELDS=(1,[illegible]),[illegible]
//   [illegible]
```

5.2.2 Contour Program (Mercator Projection)

Control parameters for the contour program are provided by the input of two NAMELIST strings, defined as follows:

NAMELIST/PLOTS/

Name	Type	Description
PRINTR	I*4	$\neq 0$; printer plot
CALCMP	I*4	>0; 30-inch CalComp plot 0; 12-inch CalComp plot
SC4020	I*4	$\neq 0$; SC-4020 microfilm
CTRLVL	R*4	Increment (^{o}K) for contour levels
NCHNL	I*4	Channel selection for display 0 10.5 micron 1 8.8 2 (10.5 - 8.8) 3 1.2 4 10.5 and 8.8 5 10.5 and (10.5 - 8.8) 6 8.8 and (10.5 - 8.8) 7 10.5 and 1.2 8 10.5 and 8.8 and (10.5 - 8.8)
LONAVG	I*4	Number of points to be averaged in longitude
LATAVG	I*4	Number of points to be averaged in latitude
LONSEG	I*4	Number of longitude segments to be output
LATSEG	I*4	Number of latitude segments to be output
SUPRES	R*4	Minimum value to be contoured

NAMELIST/POSNS/

Name	Type	Description
TOPLAT	R*4	Northern plot limit (-80° to +80°)
BOTLAT	R*4	Southern plot limit
WESTLN	R*4	Western plot limit (0 - 360°W)
EASTLN	R*4	Eastern plot limit

Following these NAMELIST inputs, an 80-character identification field is required for plot labeling.

A sample run deck setup is as follows:

```
//    EXEC FORTRANH,PARM='XREF
//SOURCE.SYSIN DD *
      DIMENSION PLARY(35000)
      DATA PLDIM/35000./
      COMMON/BUF/BUF(97632)
C       PLDIM MUST BE DIMENSIONED > IX * IY
C          WHERE: IX = 120*(WESTLN - EASTLN)/LONAVG
C                 IY = 200*(TOPLAT - BOTLAT)/LATAVG
C         BUF MUST BE DIMENSIONED > PLDIM/16 + 2002
      CALL SCNRPL (PLARY,PLDIM)
      STOP
      END
//   EXEC LINKGO,REGION.GO=400K
//LINK.SYSLIB DD DSN=SYS2.SCOMV.SLOCLIB1,DISP=SHR
//            DD DSN=SYS2.MOLEPLOT,DISP=SHR
//GO.FT22F001 DD DCB=(RECFM=FB,BLKSIZE=7200,LRECL=400),DSN=&&SFL2,
//            UNIT=2314,SPACE=(CYL,(2,1))
//GO.FT23F001 DD DCB=(RECFM=FB,BLKSIZE=7200,LRECL=400),DSN=&&SFL3,
//            UNIT=2314,SPACE=(CYL,(2,1))
//GO.SORTAPE DD UNIT=(7TRACK,,DEFER),DISP=(OLD,KEEP),LABEL=(1,SL),
//            VOL=SER=L73457
//GO.PLOTAPE  DD DCB=(,RECFM=1),LABEL=(,SL,,OUT),UNIT=(7TRACK,,DEFER),
//            VOL=SER=L73456
//GO.MOLEPLOT DD DCB=(,RECFM=1),LABEL=(,SL,,OUT),UNIT=(7TRACK,,DEFER),
//            VOL=SER=L73455
//GO.SYSIN DD *
 $PLOTS PRINT=1, CALCMP=-1, SC4020=1, STRLVL=2.00, HOMPL=0,
        LONAVG=2,  LATAVG=2,  LONSEC=1,  LATSEC=1,  SUBSEC=200.0,  SEND
 &POSNS TOPLAT=55.0,  BOTLAT=33.0,  WESTLN=121.5,  EASTLN=116.0,  $END
                          POSTHUE CALIFORNIA SEGMENT
```

5.2.3 EIS Color Program (Mercator Projection)

Control parameters for the color program are provided by the input of two NAMELIST strings, defined as follows:

NAMELIST/POSNS/

Name	Type	Description
TOPLAT	R*4	Northern plot limit (-80^{o} to $+80^{o}$)
BOTLAT	R*4	Southern plot limit
WESTLN	R*4	Western plot limit ($0-360^{o}$W)
EASTLN	R*4	Eastern plot limit
CHANEL	I*4	Channel selection for display 1. 1.2 2. 10.5 3. 8.8 4. 10.5 - 8.8

NAMELIST/COLORS/

Name	Type	Description
NCOLOR	I*4	Number of color levels to be used
BOTTOM	I*4	Count value to be assigned color (NCOLOR)
DELTA	I*4	Incremental count for assignment of subsequent levels

A sample run deck setup is as follows:

```
//    EXEC FORTRAGH
//SOURCE.SYSIN DD *
       CALL PGMERC
       STOP
       END
//    EXEC LINKGO,REGION.GO=175K
//LINK.SYSLIB DD DSN=KB.SPGNU.SLOCLIB1,DISP=SHR
//GO.SORTAPE DD UNIT=(9TRACK,,DEFER),DISP=(OLD,KEEP),LABEL=(1,BLP),
//              VOL=SER=13437
//GO.PICTUR    DD DCB=(,DEN=1),LABEL=(,BLP,,OUT),UNIT=(7TRACK,,DEFER),
//              VOL=SER=13436
//GO.SYSUDUMP DD SYSOUT=A
 &POSNS TOPLAT=40.0, BOTLAT=32.0, WESTLN=124., EASTLN=114., CHANEL=3, &END
 &COLORS  HCOLOR=10,  BOTTOM=25,  DELTA=10,  &END
```

SCMR SORTED I, J TAPE FORMAT

File 1 - Header Date BLKSIZE=232, LRECL=232, RECFM=F, DEN=3

Word	Format	Description
1-40	EBCDIC	ID data from raw data tape
42	R*4	Minimum latitude ($+90^{o}$)
43	R*4	Minimum longitude (0^{o} - 360^{o}W)
44	R*4	Maximum latitude ($+90^{o}$)
45	R*4	Maximum longitude (0^{o} - 360^{o}W)
46	I*4	Minimum I
47	I*4	Minimum J (J = 0 to 57600 for longitude = 360^{o}W to 0^{o}W)
48	I*4	Maximum I
49	I*4	Maximum J (I = -22333 to +22333 for latitude = -80^{o} to $+80^{o}$)
50	I*4	Orbit number
51	I*4	Archive start time (HHMMSS)
52	I*4	Archive stop time (HHMMSS)
53	I*4	Buffer number

Word	Format	Description
54	I*4	Channel flag 0 = 8.8 1 = 1.2
55	R*4	Number of J's/Degree longitude = 160
56	I*4	Year } Date of data
57	I*4	Month } Date of data
58	I*4	Day } Date of data

File 2 - Data records BLKSIZE=32000, LRECL=20, RECFM=FB, DEN=3

Bytes	Format	Description
1, 2	I*2	I latitude coordinate position
3, 4	I*2	J longitude coordinate position
5-8	R*4	Channel 1 (8.8) temperature
9-12	R*4	Channel 2 (10.5) temperature
13-16	R*4	Difference (10.5 - 8.8) temperature
17	L*1	Channel 1 (8.8) index
18	L*1	Channel 2 (10.5) index
19, 20	I*2	Difference (10.5 - 8.8) index

SECTION 6 - CATALOG MAINTENANCE PROGRAM

6.1 PROGRAM DESCRIPTION

The purpose of the Catalog Maintenance Program (CMP) is to provide automatic record keeping of NIMBUS SCMR data as it is processed through the various programs of the processing system. This program performs automatically most of the recording functions required to maintain up to date information as to the SCMR data available, the various stages through which it has been processed and the intermediate and terminal locations of this data. In addition, since this information is contained both on resident disk storage and magnetic tape, it is readily accessible for computer sorting and summarization.

The CMP will be called, by each program in the SCMR data processing system, at the beginning and ending of each data interval requested for processing. The first call will establish the catalog entry to be accessed and provide locator information. The last call will complete the entry with information describing the interval. For an interval not previously processed (calibration) a unique Data Set Reference Number (DSRN) will be established for use in identifying this interval by subsequent processing requests (geographic referencing, display) and summary reporting.

The SCMR catalog may be accessed and updated from several processing programs concurrently, obviating the necessity of single run submissions. The one exception to this, is when the request is made for transfer of catalog

data from disk to tape. At this time, all subsequent catalog modifications (updating and replacement) are inhibited to allow verification of transfer prior to overwriting by new data. Release of the catalog is then accomplished by an appropriate call and normal processing may then be continued.

Appropriate messages are issued by the maintenance program relating to the content of the catalog, previous catalog actions and when transfer to tape should be accomplished.

6.2 USER'S GUIDE

The CMP, in addition to the functions performed through calls by the various processing programs, is called upon directly to provide listing or other manipulation of data which it contains. The following describes the options available and the required calling sequence parameters, including those normally used by the processing system. See Appendix A for content of the catalog and Appendix E for the job control cards required for its utilization.

CALL CATLG (IN, IS, LIST)

* IN - Indicates function to be performed

* IS - Identifies source of call (if from a processing program)

LIST - Input data array

IN = 1: Initialize record with requested interval

2: Complete record with interval data

3: Return catalog data for given DSRN (no catalog entry made)

4: Transfer catalog to tape

5: Re-set catalog after successful tape transfer

6: List entire catalog

7: List current run additions to catalog

8: Clear and initialize catalog

9: Replace provided catalog entries

10: Compress the catalog

Delete those entries for which No. of scans [LIST(3)] = 0

IS = 1; Calibration

2; Geographic referencing

3; Display program

* IN and IS must be defined INTEGER*2

Input Data Array

LIST ( )	Description	Format	Source
1	0	I	CAL
	DSRN		All others
2	Orbit no.	I	CAL
3	No. of scans in interval	I	CAL
4	1.2μ flag (= 1 when operational)	I	CAL
5	8.8μ Black body temperature (avg)	F	CAL
6	8.8μ Space voltage (avg)	F	CAL

LIST ( )	Description	Format	Source
7	Calibrated data tape no.	I	CAL
8	Archive data tape no.	I	LOC
9	Interval start time	I	CAL
10	Interval stop time	I	CAL
11	Sub-satellite latitude (start)	F	LOC
12	Sub-satellite longitude (start)	F	LOC
13	Satellite altitude	F	LOC
14	Sub-satellite latitude (stop)	F	LOC
15	8.8μ temperature at 0v (avg)	F	CAL
16	10.9μ temperature at 0v (avg)	F	CAL
17	8.8μ Space temperature (avg)	F	CAL
18	8.8μ Housing temperature (avg)	F	CAL
19	Time jumps	I	CAL
20	10.9μ Black body temperature (avg)	F	CAL
21	10.9μ Space voltage (avg)	F	CAL
22	Microfilm log number	I	DIS
23	Calcomp log number	I	DIS
24	Printer plot log number	I	DIS
25	Sun right ascension	F	LOC
26	Sun declination	F	LOC
27	Sub-satellite longitude (stop)		LOC
28	10.9μ space temperature (avg)	F	CAL

LIST ( )	Description	Format	Source
29	10.9μ housing temperature (avg)	F	CAL
30	Raw data buffer no.	I	CAL
31,32	8-character area	A	CAL
33-40	Not used		

Usage Requirements:

For IN = 4; LIST (1) should contain the tape number to receive the catalog data.

For IN = 5, 8, 9; IS must = 605, to prevent inadvertent modification of catalog data.

For IS ≠ 1; LIST (1) should contain the previously established DSRN in order to provide proper update of the corresponding catalog entry for this interval.

For IN = 9;

LIST (2) = Catalog request no. to be modified
(= 605 to correct maintenance data)

LIST (3) = number of values to be replaced

LIST (I) = catalog word number to be replaced

LIST (I + 1) = replacement value

I = 4, 2*J + 2, 2

Required DD cards: 1, 2, 10 (for IN = 4)

APPENDICES

APPENDIX A - SCMR CATALOG FORMAT

A.1 DIRECT ACCESS CATALOG FILE

The SCMR direct access catalog file is contained on a permanently resident disk storage device within the IBM 360/91 system and is therefore directly accessible by all programs within the SCMR processing system. This file contains 270 data records of 40 words each and provides summary data pertaining to each interval of processed data. Two additional records follow these data records and contain information used by the catalog maintenance program.

A.1.1 Data Record Content

Same as input list described in Section 6.2

A.1.2 Maintenance Record Content

Word No.	Description	Format
1	D. A. record no. of last entry	I
2, 3	Date of last entry	A
4	Source code making last entry	I
5, 6	Date of last initialization	A
7, 8	Date of last tape transfer	A
9	First DSRN in this file	I
10	Last DSRN established	I
11	If $\neq 0$, file being held for transfer validation	I
12	Tape no. of last catalog transfer	I

APPENDIX B - RAW DATA TAPE FORMAT

The SCMR raw data is provided on a single file 9-track 1600 BPI tape containing no more than seven minutes of satellite data. Each digitized data point is represented by a unipolar 8-bit binary code. Data from each channel is interleaved such that odd bytes refer to one data set and even bytes to the other. A header record of 60 bytes provides identification and time information. All data records are of the same length and correspond to one full data scan. As the scanning mirror rotates at 10 rps, this provides a maximum of 4200 records/tape. The content of each record is as follows.

No. of Bytes	
(1) 60	header information
(2) 62	synch pulse N 5 volts
(3) 127	instrument view of space
(4) 186	(0-6v) stairstep calibration through the instrument
(5) 6950	viewed earth data
(6) 374	(0-6v) stairstep calibration (instrument bypassed)
(7) 274	instrument view of the reference black body (V_c)
(8) 62	analog voltage representing temperature of the black body (V_T)

All of these except (1) contain interleaved data from two channels as described above.

When channel 1 substitution takes place (the 1.2μ channel instead of the 8.8μ channel) internal calibration values are used for conversion of 1.2μ channel data to radiance. In this instance, the channel 1 calibration data contained within the record data is only for reference monitoring and not for data conversion.

A complete discussion of the digitization process, associated quality checks performed and the digital tape content may be found in the GSFC document "NIMBUS-E SCMR DATA PROCESSING SYSTEM", I-564-72-404, dated October 1972.

APPENDIX C - CALIBRATED/ARCHIVAL DATA TAPE FORMAT

The end product of the SCMR Data Processing System is the SCMR archive tape containing temperature, radiance and precise geographical locations of the earth scanned points. The SCMR calibration tape is the output of calibration programs and is prepared in identical format to the archive tape. The two tapes are described as a single tape, the only difference being that those data locations in the archive tape containing position data provided by the locator program are set to zeros in the CAL tape.

This tape is a single file 9-track 1600 BPI tape prepared on S360 and has data in BCD/EBCDIC format. The tape has a header record followed by data records containing no more than seven minutes of satellite data. The 8000 byte header record identifies the interval and is followed by up to 4200 records containing the data for each rotation of the scanning mirror. All data records are 8000 bytes long and each earth data point is represented by an 8-bit (0-255) index to the master conversion tables. Data from each channel is interleaved such that odd bytes refer to the 8.8 μ channel (1.2 μ channel when operational). Each data record contains locator information applicable to the beginning of the maximum 7 minute interval followed by geographical reference scans for scanner rotation. The locator information is organized in 32-bit floating points words.

Each scan of geographical reference data contains 101 latitudes plus 101 longitudes of earth viewed points, each point corresponding to a specified nadir angle of the scanning mirror. The first point of the scan corresponds to -50 degrees of nadir angle while successive scan points correspond to nadir angles at 1 degree increments, thus the last scan point belong to +50 degrees of nadir angle. There is one scan for each rotation of the sensor to the maximum of 4200 scans. The contents of header record and data records are described on the following page.

Header Record

Bytes	Word	Format	Description
1-160	1-40	EBCDIC	Data identification from raw data tape
160 -6308	41-1577		Master conversion tables
160 -1188	41-297	R*4	8.8μ temperature
1189-2112	298-553	R*4	Radiance
2113-3236	554-809	R*4	10.9μ temperature
3237-4280	810-1065	R*4	Radiance
4261-5280	1066-1320	R*4	1.2μ voltage
5281-6308	1322-1577	R*4	Radiance
6309-6316	1578-1579	EBCDIC	Calibration processing date (YR/MO/DY)
6317-6328	1780-1782	EBCDIC	Calibration processing time (HR:MN:SS. sss)
6329-6332	1783	R*4	Number of samples per degree nadir angle
6333-6336	1784	R*4	Sample corresponding to 0 degree nadir angle

Data Record

Bytes	Word	Format	Description
1-4	1	I*4	Day of Data
5-8	2	I*4	Record Time (milliseconds of day)
9-10	3	I*2	Channel indicator (0 = 8.8μ; 1 = 1.2μ)
11-12	3-1/2	I*2	Data Flag from raw data record
13-6960	4-1740 1/2	I*1	8-bit indices to master conversion tables e.g. 13 = 8.8 or 1.2; 14 = 10.9; 15 = 8.8 or 1.2; 16= 10.9

Bytes	Word	Format	Description
6961-6964	1741	R*4	Greenwich hour angle of Aries (degrees)
6965-6968	1742	R*4	SSP Latitude (degrees, + 90^{o})
6969-6972	1743	R*4	SSP Longitude (degrees West Longitude)
6973-6976	1744		Spares
6977-6980	1745	R*4	Satellite height (km)
6981-6984	1746	I*4	Day/night/twilight indicator: 0 = day; 1 = twilight; 2 = night
6985-7000	1747-1750		Spares
7000-7404	1751-1851	R*4	Latitude positions (degrees + 90) corresponding to each of the 101 nadir angles
7405-7808	1852-1952	R*4	Longitude positions (degrees W) corresponding to each of the 101 nadir angles

Each scan contains up to 3475 data samples and 101 latitude-longitude points corresponding to specified nadir angles as mentioned above. Given the 101 points, the intermediate latitude-longitude points corresponding to each data sample could be obtained using quadratic interpolation. To maintain the accuracy of computed points within the instrument resolution, the following formula may be used to interpolate intermediate points.

Let (ϕ_1, λ_1), (ϕ_2, λ_2) and (ϕ_3, λ_3) are latitudes-longitudes at intervals t_1, t_2 and t_3 respectively such that $\Delta t = t_3 - t_2 - t_1$. Then, the latitude-longitude (ϕ, λ) at a given point t, where $t_1 < t < t_2$ is given by

$$\phi = \phi_1 + \frac{(t - t_1)}{\Delta t} \cdot (\phi_2 - \phi_1) + \frac{(t - t_1)(t - t_2)}{2(\Delta t)^2} \cdot (\phi_3 - 2\phi_2 + \phi_1)$$

and

$$\lambda = \lambda_1 + \frac{(t - t_1)}{\Delta t} \cdot \left[(\lambda_2 - \lambda_1) + \frac{t - t_2}{2\,\Delta t} \cdot (\lambda_3 - 2\lambda_2 + \lambda_1)\right]$$

APPENDIX D - UTILITY SUBROUTINE DESCRIPTIONS

Name: DATTIM

Calling Sequence: DATTIM (K, ID, IT, ICD, ICT)

Input:

K = 1 to convert data
= 2 to convert time
= 3 to convert both
= 9 to return ID = YYDDD

ID Binary date

IT Binary time

Output:

K = 0 valid data returned
= >0 illegal data, same values as input
= <0 illegal input code (K)

ICD 8 character date (MM/DD/YY)

ICT 12 character time (HH:MN:SS.SSS)

ID Integer date for input K=9 (YYDDD)

Description: This subroutine converts binary time and date to character format for printing and is called primarily by the subroutine SYSDT which accesses the S360 internal time and date.

Name: FILTER

Calling Sequence: FILTER (ARY)

Input:

ARY (1)	Return Code 0=OK, 1=EOF
First Call;	initializes core and gets header data
ARY (11)	orbit number
(12)	buffer
(13)	day
(14)	start time
(15)	stop time
(16)	year

The 40 word header record is transferred to the first 40 words of COMMON/ OUTREC/

Subsequent calls;

ARY (2)	day of data
(3)	record time (ms of day)
(4)	record time (sec of day)
(6)	record date-time (YDDDHHMM)

The data record returned for calibration is transferred to the area of COMMON/ INREC/

Description: This routine initially calls the subroutine RDFLTR to determine whether or not input SCMR data is to be filtered prior to calibration. Appropriate switches are set and for a filter run the necessary additional core storage is obtained. This routine also performs the delay by one scan of the 10.5μ channel data for both filter and non-filter runs. Record time is that associated with the 8.8μ data channel.

Required DD cards: 1,3

Name: PLTRAW

Calling Sequence: PLTRAW

Input: One data card as follows:

COL	
15 - 18	First record to be plotted
33 - 36	Last record to be plotted
47	Channel selection (1=8.8μ, 2=10.5μ 3=both)

Description: This routine produces an output tape for submission to the Calcomp plotter. Each selected record is displayed by a single line plot of approximately 40 inches in length. A maximum of 12 records (6 records if both channels are selected) are displayed on a 30 inch picture at which time the plot is advanced for another set of 12. The plot is identified by orbit and record number.

Required DD cards: 1, 3, 6

Name: PRTRAW

Calling Sequence: PRTRAW (IR1, IR2)

Input:

IR1 First record to be listed

IR2 Last record to be listed

Description: This routine provides a printout of selected records from the SCMR raw data tape. Tape header identification data is unpacked and labeled appropriately. The data for each channel is listed separately and is identified by time and category (sync, space, earth, etc).

Required DD cards: 1, 3

Name: RDFLTR

Calling Sequence: RDFLTR (LIST)

Input: None

Output:

LIST (1)	summation of input matrix of 10.5 data
LIST (2)	summation of input matrix for 8.8 data
LIST (3)	0 = values input for filter run 1 = values not input, no filtering required

Description: This routine is called initially by the subroutine FILTER to read from cards the filtering constants to be used for the filtering of SCMR raw data prior to calibration. If no cards are input, the returned value indicates to the program that an unfiltered calibration is to be run.

Required DD cards: 1

Optional input cards containing 5x5 matrix constants for each channel. Five cards of five values each are required for first the 10.5μ channel and then five cards for the 8.8μ channel. FORMAT (10F5.0)

Name: SCRAW

Calling Sequence: SCRAW (ARRAY, TIME, IER)

Input: None

Output:

IER	Return Code	0 = read OK 1 = end of file

First Call

TIME	N/A	
ARRAY (1-40)	40 words header data	(EBCDIC)
(41)	orbit number	(I)
(42)	buffer number	(I)
(43)	day of data	(I)
(44)	start time	(I, HHMMSS)
(45)	stop time	(I, HHMMSS)

Subsequent calls

TIME	ms of day
ARRAY	8320 words of alternating channel data; channel 1 (8.8μ or 1.2μ) in odd locations and channel 2 (10.5μ) in even locations in the following order:

Word No.	Category	No. of each Channel
1- 62	Sync	62
63- 186	Space	124
187- 560	Int. Cal	374
561-7510	Earth	6950
7511-7884	Ext. Cal	374
7885-8258	Housing	374
8258-8320	Black Body	62

Required DD cards: 1,3

Name: PRTDTA

Calling Sequence: PRTDTA (IR1, IR2, ID1, ID2, NCH)

Input

IR1 First record

IR2 Last record

ID1 First data position in record

ID2 Last data position in record

NCH Channel data to be listed

1 = 8.8μ or 1.2μ channel

2 = 10.9μ channel

3 = Both channels

Description: This routine provides a printout of selected data areas from the calibrated or archive data tape. All tape header identification data is output (including the master conversion tables) followed by the data (index values) from the selected area.

Required DD cards: 1, 4

APPENDIX E - DD CARD REQUIREMENTS

This section lists all DD cards that are required by the various areas of the SCMR Data Processing System. Where applicable, cards are listed twice and are marked as follows:

* Required for initial allocation and initialization.

** Required during normal production operation.

The DD cards required by the various processing programs are listed by number following the User's Guide for that program. Those numbers correspond to the card numbers given here.

1. SCMR Program Library

```
* //DDNAME DD DSNAME=K3.SOGNW.SCMROLIB,DISP=(,CATLG),
//  UNIT=2314,VOL=SER=M2USR2,SPACE=(TRK,(20,,7))
**//LINK.SYSLIB DD DSNAME=K3.SOGNW.SCMROLIB,
    DISP=SHR
```

2. Direct Access Catalog

```
*//GO.FT25F001 DD DSNAME=K3.SOGNW.SCMRCTLG,
    DISP=(,CATLG),
//  UNIT=2314,VOL=SER=M2USR5,SPACE=(100,500),
//  DCB=(,DSORG=DA,RECFM=F,BLKSIZE=100)
**//GO.FT25F001 DD DSNAME=K3.SOGNW.SCMRCTLG,
    DISP=SHR
```

3. Raw Digital Data Tape

```
//GO.SCMRTP DD UNIT=(9TRACK,,DEFER),DISP=(OLD,KEEP),
//  LABEL=(1,BLP),DCB=(RECFM=F,BLKSIZE=8328,
    LRECL=8328),VOL=SER=LXXXX
```

4. CAL/Archive Tape

```
//GO.FT30F001 DD UNIT=(9TRACK,,DEFER),DISP=(OLD,KEEP),
//  LABEL=(1,BLP),DCB=(RECFM=FB,BLKSIZE=32000,
    LRECL=8000),
//  VOL=SER=LXXXX
```

5. Microfilm Plot Tape

```
//GO.WOLF4020 DD DCB=(,DEN=1),LABEL=(,BLP,,OUT),
//  UNIT=(7TRACK,,DEFER),VOL=SER=LXXXX
```

6. CalComp Plot Tape

```
//GO.PLOTAPE DD DCB=(,DEN=1),LABEL=(,BLP,,OUT),
  UNIT=(7TRACK,,DEFER),
//  DSN=RUNID,VOL=SER=LXXXX
```

7. Area Selection Temporary Storage

```
//GO.FT35F001 DD DSN=&TMP3,DCB=DSORG=DA,UNIT=2314,
//  SPACE=(200,25)
```

8. Temporary Storage for Second Channel Data

```
//GO.FT22F001 DD DCB=(RECFM=VBS,BLKSIZE=3508,LRECL=354),
//  DSN=&TMP1,UNIT=2314,SPACE=(CYL,(2,1))
```

9. Temporary Storage for Third Channel Data

```
//GO.FT23F001 DD DCB=(RECFM=VBS,BLKSIZE=3508,LRECL=354),
//  DSN=&TMP2,UNIT=2314,SPACE=(CYL,(2,1))
```

10. SCMR Location Library

```
//LINK.SYSLIB DD DSN=K3.SOGNW.SLOCLIB1,DISP=SHR
```

11. NIMBUS-5 Right Ascension/Declination Tables

```
//GO.FT40F001 DD DSN=K3.SOGNW.LOCTABL,DISP=SHR
```

12. GEOCTR Message Data Set

```
//GO.FT30F001 DD SYSOUT=A,DCB=(RECFM=VBA,LRECL=137,
// BLKSIZE=141)
```

13. Output Archive Tape

```
//GO.FT35F001 DD UNIT=(9TRACK,,DEFER),DISP=(OLD,KEEP),
//  LABEL=(1,BLP),DCB=(RECFM=FB,FLKSIZE=32000,LRECL=8000),
//  VOL=SER=LXXXX
```

14. Input Ephemeris Tape

```
//GO.EPHEM1 DD DISP=SHR,UNIT=(9TRACK,,DEFER),
// LABEL=(1,BLP),VOL=SER=LXXXX
```