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USERS MANUAL FOR C CLOUD S DATABASE

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This technical report has been reviewed and is approved for publication.

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This report provides detailed instructions to access and utilize a prototype computer-based global climatology of total sky cover cloud statistics known as C Cloud S.

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I. INTRODUCTION

This Users Manual provides detailed instructions for applications programmers to access and utilize a prototype computer-based global* climatology of total sky cover cloud statistics known as "C Cloud S."

A. Background

C Cloud S (Climatology of Cloud Statistics) makes available to engineers, systems designers, climatologists, and meteorologists a compact, automated, fast response database of mean sky cover and scale distance parameters (see Boehm, 1987). It is not a historical database; that is, what was observed on a given day is not available in C Cloud S. It is intended to provide the basic climatology input to stochastic sky cover simulators that generate sequences of observations statistically resembling sky cover observations.

C Cloud S was developed by ST Systems Corporation (STX) for the Atmospheric Sciences Division of the Air Force Geophysics Laboratory (AFGL). AFGL sponsored development of the database and the computer techniques necessary to use it for mapping global sky cover in recognition of their clear relevance and value to military weapon systems design (sky cover simulation modeling), deployment, and operations. In creating the database STX took full advantage of earlier studies at AFGL that established the algorithms and basic techniques for applying sky cover climatologies to the mapping of global sky cover.

* Because of lack of data in the polar areas, sky cover statistics are provided for the region between 60^{o} North and 60^{o} South latitudes.

C Cloud S blends into one standardized set of statistics a variety of existing sky cover climatologies with various periods of record and based on various types of observations. The basis for this standardization is the work of Burger and Gringorten at AFGL.

Burger and Gringorten (1984) derived analytical expressions that use only two parameters (mean sky cover and scale distance) to calculate the complete distribution of sky cover as seen by a surface observer. Mean sky cover is defined as the single point probability of clouds averaged over an observer's sky dome. Scale distance is a measure of how fast the correlation of sky cover decays over distance. For example, for locations with predominantly cumulus sky cover the scale distance is quite small (0.4 km) while locations with predominantly stratiform sky cover have longer scale distances (5.0 km or greater). Burger (1985) derived values for these two parameters from approximately 2,000 sky cover distributions archived by various sources over the world which he analyzed by hand. He then plotted equal area maps of the parameters to produce a <u>World Atlas of Total Sky Cover</u> for visual reference on a global scale.

Burger tested the distribution at a wide variety of locations and found a 1.4% RMS difference between the observed sky cover distributions and his distribution. Thus the Burger distribution, using only the two parameters of mean sky cover and scale distance, not only gives an excellent description of the fractional sky cover climatology, but also permits extremely economical and efficient data storage.

B. Organization

The first step taken by STX in automating mean sky cover and scale distance parameters to create the C Cloud S database was to prepare the data for rapid and efficient processing. Section II details the data sources, processing procedures, and data file formats for the database. Then given the data in appropriately processed form, a prototype global sky cover mapping scheme was developed. Section III describes the prototype software. The mapping scheme developed is unique in that changes in sky cover distributions from location to location and in time take place gradually and are not categorized into sets of regions of rigid sky cover climatologies with defined boundaries, as is done in many cloud atlases.

II. DEVELOPMENT OF THE C CLOUD S DATABASE

A. Description of Burger Data Processing

When developing algorithms for computing sky cover frequency distributions, Burger (1985) computed and formatted on tape initial means and scale distance parameters for more than 2,000 stations around the world. This data ensemble of initial means and scale distance parameters ("Burger data") was made available to STX, which archived a common format for subsequent data processing, analysis, and sky cover mapping procedures.

The overall structure for processing the Burger data is depicted in Fig. 1. Detailed descriptions of the software to process these data and the data file format documentation follow.

Imbedded in the software are several subroutines developed by Harms (1986) that were extremely useful in initiating Burger's algorithms for computing sky cover climatologies. Much of the theory in Burger's model development of sky cover distributions was created by Gringorten (1979).

All software development and data file generation described in this manual was carried out using FORTRAN V on the AFGL Cyber 180/860 computer system.

1. PROGRAM NAME: CCOVR Version 1.0 3/5/87

PURPOSE: To read Burger data from tape to permanent disk file for subsequent interactive processing

INPUT: Magnetic Tape #4125
1600 BPI

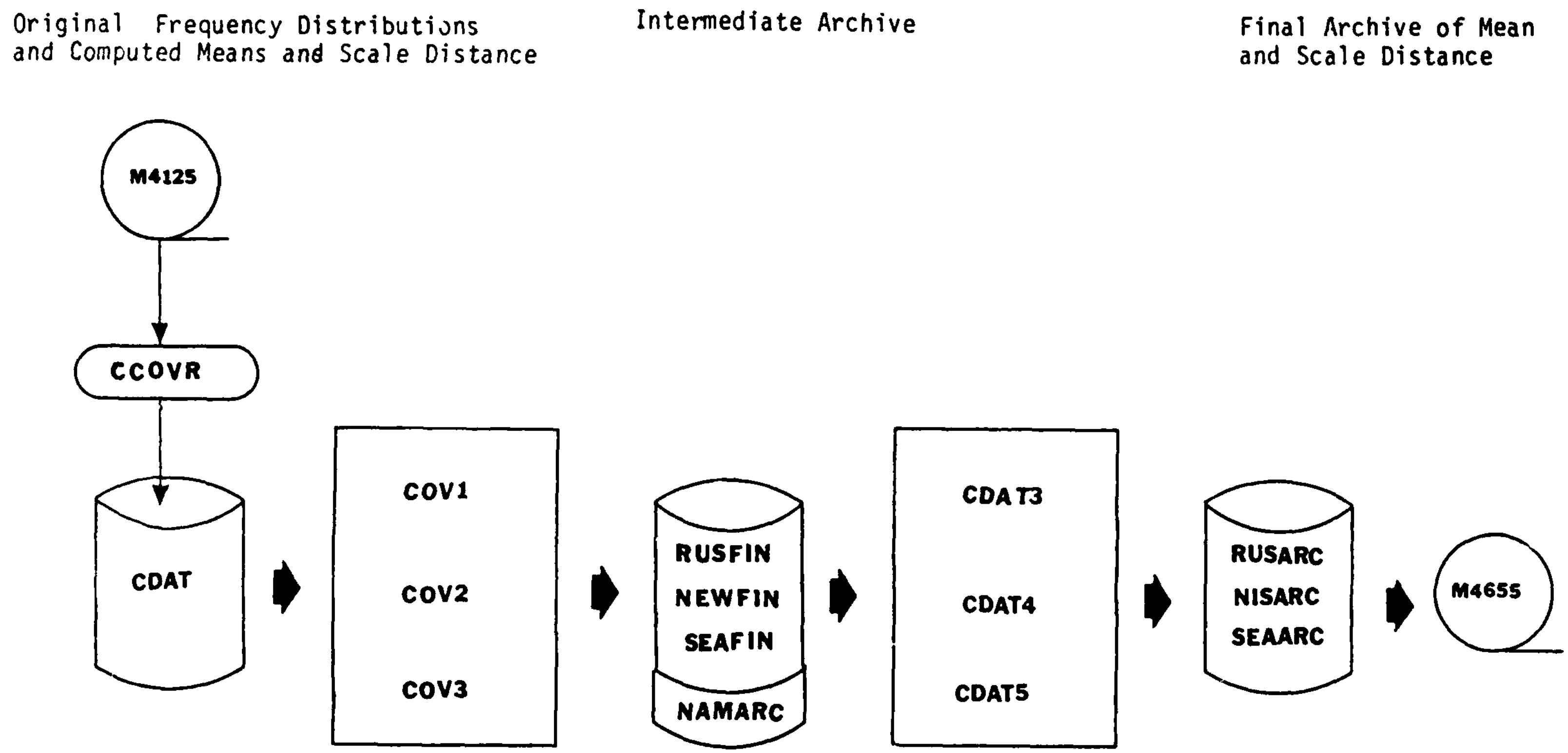

Fig. 1 Processing Configuration for Archiving Burger Data

Nine Track

ASCII

No Label Tape

<u>OUTPUT</u>: Permanent disk file named CDAT

<u>REMARKS</u>: Tape M4125, assembled by Burger (1985), contains names, locations, sky cover frequency distributions, means, and scale distance parameters for over 2,000 weather reporting stations around the world. The data on tape are assembled in three separate files.

CDAT file 1 contains sky cover data derived from 266 Revised Uniform Summaries of Weather Observations (RUSSOWs) obtained from the National Technical Information Service (NTIS).

CDAT file 2 contains locations and sky cover parameters compiled from ship weather observations. The main data source for this file was the NAV Atlas (NAVAIR 50-1C-528). The data are given in the form of cumulative percent frequency curves from 0- to 8-eighths sky cover. Some 222 daily averages of sky cover were averaged over the four mid-season months of January, April, July, and October.

CDAT file 3 is the largest data file, containing sky cover climatologies for 1846 stations world wide. Climate data from the National Intelligence Survey (NIS) were the main source of statistics for this file. The data consist of: a mean sky cover; the probability of being less than or equal to a certain fractional coverage, such as 2/8 or 3/10; and the probability of exceeding a certain coverage, such as 6/8 or 7/10.

<u>FORMATS</u>: Data for the first station in each of the three CDAT files are presented in Table 1.

TABLE 1. SAMPLE OUTPUT OF CDAT FILES

CDAT FILE 1

```
1   1 FORT RUCKER, ALABAMA                         AT 31 DEG, 16 MIN N    85 DEG, 43 MIN W  AT ELEVATION    93
 JANUARY      .303  .026  .049  .030  .026  .015  .032  .029  .035  .026 9.999  .560
 JANUARY      .178  .037  .046  .034  .028  .018  .030  .032  .057  .055 9.999  .660
 JANUARY      .154  .040  .040  .036  .046  .027  .039  .048  .065  .075 9.999  .560
 JANUARY      .244  .050  .053  .036  .032  .026  .032  .038  .044  .035 9.999  .570
 APRIL        .371  .052  .042  .045  .031  .018  .029  .036  .053  .024 9.999  .450
 APRIL        .182  .047  .052  .047  .037  .031  .029  .046  .061  .062 9.999  .620
 APRIL        .156  .032  .035  .037  .040  .060  .054  .100  .117  .060 9.999  .630
 APRIL        .231  .050  .067  .064  .050  .041  .058  .070  .070  .040 9.999  .510
 JULY         .341  .066  .089  .078  .049  .036  .048  .049  .059  .032 9.999  .380
 JULY         .065  .059  .067  .077  .062  .043  .049  .083  .106  .095 9.999  .640
 JULY         .005  .007  .018  .042  .094  .090  .073  .140  .164  .102 9.999  .730
 JULY         .017  .022  .041  .034  .046  .042  .059  .101  .123  .108 9.999  .770
 OCTOBER      .553  .036  .034  .027  .021  .012  .022  .032  .032  .014 9.999  .320
 OCTOBER      .328  .084  .042  .043  .038  .025  .022  .034  .052  .055 9.999  .460
 OCTOBER      .248  .071  .067  .048  .061  .047  .038  .038  .075  .073 9.999  .490
 OCTOBER      .395  .079  .066  .041  .036  .024  .041  .037  .042  .022 9.999  .380
3.34   2.55   1.81   2.55   2.77   1.89   1.18   1.54   1.24    .87    .44    .76   3.19   2.17   1.46   2.12
```

CDAT FILE 2

```
  1 AT 61 DEG,  0 MIN N    65 DEG,  0 MIN W
 JANUARY     0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 9.999
 APRIL       0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 9.999
 JULY         .080  .130  .180  .270  .330  .380  .470  .530  .830  .660
 OCTOBER      .090  .120  .190  .240  .290  .310  .440  .560  .980  .660
  0.00   0.00   1.38   1.06
```

CDAT FILE 3

```
   1001 AMSTERDAM, NETHERLANDS                      AT 52 DEG, 19 MIN N    4 DEG, 47 MIN E  AT ELEVATION 5
 JANUARY     2.00  8.00  .390  .230  .680  .190  .390  .710  .130  .350  .250  .190  .390  .710
  0.00   1.98   0.00   1.98
 APRIL       2.00  8.00  .400  .570  .520  .200  .500  .660  .170  .570  .650  .270  .630  .550
  2.95   1.29    .89   1.16
 JULY        2.00  8.00  .320  .580  .560  .160  .450  .690  .130  .520  .680  .190  .550  .600
  1.72   1.27    .85   1.10
 OCTOBER     2.00  6.00  .350  .550  .550  .190  .450  .660  .130  .420  .700  .190  .520  .630
  2.45   1.57   1.24   1.20
```

The first line of an eighteen line record in file 1 contains station location information that can be read as follows:

```
        READ(NTAPE,8000)ISCODE,STNAME,LATDEG,LATMIN,LATDIR,
        LONDEG,LONMIN,LONDIR,LEVAT
8000    FORMAT(2X,I3,4A10,3X,I3,5X,I3,5X,A1,3X,
        I3,5X,I3,5X,A1,5X,I5)
```

The variables have the following definitions:

ISCODE:	Burger Station Number
STNAME:	Station Name
LATDEG:	Latitude Degrees
LATMIN:	Minutes of Latitude
LATDIR:	N-North, S-South
LONDEG:	Longitude Degrees
LONMIN:	Minutes of Longitude
LONDIR:	E-East, W-West
LEVAT:	Station Elevation Meters above Sea Level

The next sixteen lines contain frequency of occurrence of sky cover categorized in tenths together with mean sky cover for four mid-season months averaged over the local standard time periods of 0000-0200, 0600-0800, 1200-1400, and 1800-2000 hours, respectively. The value in the overcast category is set to missing (9.999). The last value in each line is the mean sky cover parameter (P_0). Use the following format statement to read these data lines:

```
        READ(NTAPE,8001)MONTH,(FREQ(J),J=1,10),DUM,P0
8001    FORMAT(A10,F7.3,11F6.3)
```

Variables are:

MONTH: Month of the Year

FREQ: Normalized Sky Cover Frequency; Ten Categories (0/10-9/10)

DUM: Dummy Variables

P_0: Mean Sky Cover Probability

The final line in the record contains the sixteen scale distance values (r) in the following format:

```
      READ(NTAPE,8002)(R(J),J=1,16)
8002  FORMAT(10X,16F7.2)
```

The first four r values correspond to the first four January months, the next four to Aprils, etc.

CDAT file 2 contains sky cover data compiled from ship reports. The first line in this file contains location information that can be read using the following format:

```
      READ(NTAPE,9000)ISCODE,LATD,LATM,LATR,LOND,LONNM,LONR
9000  FORMAT(1X,I3,3X,I3,5X,I3,5X,A1,3X,I3,5X,I3,5X,A1)
```

The variables are:

ISCODE: Burger Station Number

LATD: Latitude Degrees

LATM: Minutes of Latitude

LATR: N-North, S-South

LOND: Longitude Degrees

LONNM: Minutes of Longitude

LONR: E-East, W-West

Cumulative sky amount frequency distributions for nine sky cover categories for each of four mid-season months together with mean sky cover may be read next using:

```
      READ(NTAPE,9001)MONTH,(FREQ(J),J=1,9),P0
9001  FORMAT(1X,A10,10F6.3)
```

where:

MONTH: Month of Year

FREQ(J): Cumulative Frequency Probability for Nine Sky Amount Categories

P_0: Mean Sky Cover Probability

The last line consists of scale distance parameters for the four mid-season months and is read using:

```
      READ(NTAPE,9002)(R(I),I=1,4)
9002  FORMAT(1X,4F7.2)
```

The first station in file 3 has nine lines of data. The first line defines NIS station location information that can be read using the following format:

```
      READ(NTAPE,9010)ISTA,(NAME(J),J=1,4),LAT,LATM,LA,
      LON,LONM,LO,IELEV
9010  FORMAT(3X,I7,4A10,4X,I3,5X,I3,5X,A1,1X,I5,5X,
      I3,5X,A1,14X,I7)
```

Variables are defined as:

ISTA: Burger Station Number

NAME: Station Name

LAT: Latitude

LATM: Minutes of Latitude

LA: N-North, S-South

LON: Longitude

LONM: Minutes of Longitude

LO: E-East, W-West

IELEV: Elevation of Station in Meters

Next, two lines of information are given for each of four mid-season months. The first line contains frequencies of sky cover amount and mean sky cover values in the following format:

```
        READ(NTAPE,9011)MONTH,F1,F2(PF1(J),PF2(J),P0(J),J=1,4)
9011    FORMAT(1X,A10,2F6.2,12F6.3)
```

The variables are:

MONTH: Month of Year

F1: Fractional Coverage Threshold One

F2: Fractional Coverage Threshold Two

PF1: Probability of Being $\leq$ F1

PF2: Probability of Being > F2

P_0: Mean Sky Cover Probability

J=1,4: Data Are Averaged Over the Four Local Standard Time Groups of 0000-0200, 0600-0800, 1200-1400, and 1800-2000

The second line consists of the four scale distance values computed and tabulated for the four local time groups defined above. These data parameters can be read using the following format statement:

```
        READ(NTAPE,9012)(R(J),J=1,4)
9012    FORMAT(1X,F6.2,3F7.2)
```

2. <u>PROGRAM NAME</u>: COV1, COV2, and COV3 Version 1.0 3/7/87

<u>PURPOSE</u>: To create preliminary formatting software and generate NAMARC file

<u>INPUT</u>: COV1 inputs data from CDAT file 1
COV2 inputs data from CDAT file 2
COV3 inputs data from CDAT file 3

<u>OUTPUT</u>: CDAT files are cleaned and separated into unique temporary files with names RUSFIN, NEWFIN, and SEAFIN. A fourth file call NAMARC is also created that contains only header

records describing station identification. Since period of record information was not archived in the original CDAT database, all data record sources were reviewed and wherever a period of record information was available it was edited into the appropriate NAMARC record.

Table 2 lists portions of the NAMARC data file. A NAMARC line can be read using the following format:

```
      READ(NTAPE,100)IREC,NUM,XLAT,XLON,(IP(J),J=1,4),NL,
      ICM,ICS,IC,NAME,IEL
100   FORMAT(2I5,F6.2,F7.2,4I2,I2,2I3,I1,3A10,A3,I6)
```

Variables for NAMARC format are:

IREC: Record Number
NUM: Burger Station Number
XLAT: Latitude (+ North, - South)
XLON: Longitude (+ East, - West)
IP: Period of Record; Right Justified (72 = 1972)
NL: Number of Data Lines
ICM: Number of Mean Sky Cover Values
ICS: Number of Scale Distance Parameters
IC: Data Code (1) RUSARC, (2) NISARC, (3) SEAARC, (4) DATARC
NAME: Station Name
IEL: Station Elevation in Meters above Sea Level

3. PROGRAM NAME: CDAT3, CDAT4, and CDAT5 Version 1.0 3/15/87

PURPOSE: To archive all station locations and means and scale distance parameters into a final common format suitable for optimum future processing applications

INPUT: CDAT3 inputs data from file RUSFIN
CDAT4 inputs data from file NEWFIN
CDAT5 inputs data from file SEAFIN

TABLE 2. NAMARC SAMPLE OUTPUT

```
   1    1 31.27 -85.725470 0 0 8 16 161 FORT RUCKER, ALABAMA                93
   2    2 51.88-176.6346655068 8 15 151 ADAK, ALASKA                         5
   3    3 61.17-149.985365 0 0 8 16 161 ANCHORAGE, ALASKA                   40
   4    4 70.13-143.634770 0 0 8 16 161 BARTER ISLAND, ALASKA                6
   5    5 53.85-166.5346475054 8 15 151 DUTCH HARBOR, ALASKA                 3
   6    6 64.82-147.874870 0 0 8 16 161 FAIRBANKS, ALASKA                    0
   7    8 64.85-147.584660 0 0 8 16 161 FAIRBANKS, ALASKA,LADD AFB         138
   8    9 64.67-147.104668 0 0 8 16 161 FAIRBANKS, ALASKA/EIELSON AFB      128
   9   10 58.37-134.584870 0 0 8 16 161 JUNEAU, ALASKA APT                   7
  10   11 64.50-165.434570 0 0 8 16 161 NOME, ALASKA                         7
```

⋮

```
 267 1001 52.32    4.78 0 0 0 0 8 16 142 AMSTERDAM, NETHERLANDS              5
 268 1002 52.10    5.18 0 0 0 0 8 16 162 DEBILT                             10
 269 1003 52.07    5.92 0 0 0 0 8 16 162 DEELEN                            172
 270 1004 52.97    4.80 0 0 0 0 8 16 162 DEN HELDER                         18
 271 1005 53.13    6.58 0 0 0 0 8 16 162 EELDE                              16
 272 1006 51.55    4.95 0 0 0 0 8 16 162 GILZE                              39
 273 1007 51.93    3.67 0 0 0 0 8 16 162 GOERCE LIGHTSHIP                   10
 274 1008 53.20    5.784959 0 0 8 16 162 LEEUWARDEN                          5
 275 1009 53.48    5.13 0 0 0 0 8 16 162 TERSHELLING LIGHTSHIP              10
 276 1010 53.02    4.37 0 0 0 0 8 16 162 TEXEL LIGHTSHIP                    10
 277 1011 52.08    4.30 0 0 0 0 8 16 152 THE HAGUE                          13
```

⋮

```
2113  274 61.00 -65.0018541973 2  2  23                                      0
2114  275 64.00 -53.0018541973 2  4  43                                      0
2115  276 65.00  -9.0018541973 2  4  43                                      0
2116  277 61.00  -4.0018541973 2  4  43                                      0
2117  278 66.00  10.0018541973 2  4  43                                      0
2118  279 70.00  33.0018541973 2  4  43                                      0
2119  280 54.00-440.0018541973 2  4  43                                      0
2120  281 68.00 -38.0018541973 2  4  43                                      0
2121  282 57.00 -26.0018541973 2  4  43                                      0
2122  283 57.00 -11.0018541973 2  4  43                                      0
2123  284 57.00   2.0018541973 2  4  43                                      0
```

⋮

OUTPUT: All data archived in a common format

FORMATS: Data are tabulated into a single common format but remain as three separate files that are now called RUSARC, NISARC, and SEAARC. (DATARC is a fourth file to be discussed in the next section.) Table 3 lists the data associated with the first station found in each file.

A header line, the first line of each group of data, contains station identification parameters that are read using the format statement described below:

COLUMN	VARIABLE	FORMAT	DESCRIPTION
1 - 5	IREC	I5	Record Number
6 - 10	ISTA	I5	Burger Station Number
11 - 16	XLAT	F6.2	Latitude (+ NORTH; - SOUTH)
17 - 23	XLON	F7.2	Longitude (+ EAST; - WEST)
24 - 31	IPOR	4I2	Period of record right justified for RUSARC, NISARC, and DATARC (year 72 = 1972) SEAARC POR is in whole years (1972)
32 - 33	NL	I2	Number of data lines for this station
34 - 39	ICM, ICS	2I3	ICM = Number of mean values ICS = Number of scale distance values
40	IC	I1	CODE1 specifying RUSARC data CODE2 specifying NISARC data CODE3 specifying SEAARC data CODE4 specifying DATARC data
41 - 73	STNAME	3A10,A3	STATION NAME
74 - 79	IEL	I6	Station elevation in meters above sea level

TABLE 3. MEAN AND SCALE DISTANCE PARAMETER ARCHIVE (FINAL)

RUSARC

```
1      1 31.27 -85.725470 0 0 8 16 161 FORT RUCKER, ALABAMA                  93
M      1 31.27 -85.721 560   0    0 450    0    0 380    0    0 320   0   0
S      1 31.27 -85.721 334   0    0 277    0    0 124    0    0 319   0   0
M      1 31.27 -85.727 660   0    0 620    0    0 640    0    0 460   0   0
S      1 31.27 -85.727 255   0    0 189    0    0  87    0    0 217   0   0
M      1 31.27 -85.72D 660   0    0 630    0    0 730    0    0 490   0   0
S      1 31.27 -85.72D 181   0    0 118    0    0  44    0    0 146   0   0
M      1 31.27 -85.72J 570   0    0 510    0    0 770    0    0 380   0   0
S      1 31.27 -85.72J 255   0    0 154    0    0  76    0    0 212   0   0
```

NISARC

```
267 1001 52.32    4.78 0 0 0 0 8 16 142 AMSTERDAM, NETHERLANDS                 5
  M 1001 52.32    4.781 680   0    0 520    0    0 560    0    0 550   0   0
  S 1001 52.32    4.781   0   0    0 295    0    0 172    0    0 245   0   0
  M 1001 52.32    4.787 710   0    0 660    0    0 690    0    0 660   0   0
  S 1001 52.32    4.787 198   0    0 129    0    0 127    0    0 157   0   0
  M 1001 52.32    4.78D 250   0    0 650    0    0 680    0    0 700   0   0
  S 1001 52.32    4.78D   0   0    0  89    0    0  85    0    0 124   0   0
  M 1001 52.32    4.78J 710   0    0 550    0    0 600    0    0 630   0   0
  S 1001 52.32    4.78J 198   0    0 116    0    0 110    0    0 120   0   0
```

SEAARC

```
2113  274 61.00 -65.0018541973 2  2  23
   M  274 61.00 -65.000    0   0  0   0   0    0 660    0    0 660   0   0     0
   S  274 61.00 -65.000    0   0  0   0   0    0 138    0    0 106   0   0
```

DATARC

```
233510803 48.00     7.857382 0 0722882884 FREIBURG GERM.                     300
   M10803 48.00     7.850 781 672 646 546 567 621 561 472 464 669 688 759
   S10803 48.00     7.850 192 194 130 164 139  98 119 105 146 148 190 173
   P10803 48.00     7.850 196 190 204 200 204 196 207 211 209 230 208 233
   M10803 48.00     7.851 739 694 625 565 594 591 545 470 476 687 687 740
   S10803 48.00     7.851 177 182 169 182 142 131 127 123 135 161 203 193
   P10803 48.00     7.851 299 274 306 290 304 295 299 307 296 303 289 295
   M10803 48.00     7.852 800 708 647 549 555 562 566 476 443 682 718 747
   S10803 48.00     7.852 184 184 156 187 185 134 141 122 177 141 201 181
   P10803 48.00     7.852 193 181 204 197 206 195 200 203 201 231 207 237
   M10803 48.00     7.853 788 717 648 568 574 577 554 468 475 685 694 773
   S10803 48.00     7.853 168 198 151 200 189 124 153 123 200 137 210 175
   P10803 48.00     7.853 196 186 204 194 209 199 197 207 199 235 212 240
   M10803 48.00     7.854 773 693 673 581 609 620 583 482 481 696 702 766
```

Two keyworded lines of data then follow the header lines. Keyword "M" denotes a line containing mean sky cover values in integer format for each of twelve months starting with January. Keyword "S" denotes a line of data consisting of scale distance parameters in integer form. A detailed description of the format for keyworded data lines follows:

COLUMN	VARIABLE	FORMAT	DESCRIPTION
1 - 5	KEYWORD	4X, A1	Keyword describing type of data line M = Data for Mean Sky Cover (P_O * 1000) S = Data for Scale Distance (r * 100) P = Data for population values
6 - 10	ISTA	I5	Burger Station Number
11 - 16	XLAT	F6.2	Latitude (+ NORTH; - SOUTH)
17 - 23	XLON	F7.2	Longitude (+ EAST; - WEST)
24	IT	A1	Local Standard Time - 0 1 2 3 4 CODED - 0 1 2 3 4 5 6 7 8 9 10 CODED - 5 6 7 8 9 A 11 12 13 14 CODED - B C D E 15 16 17 18 CODED - F G H I 19 20 21 22 23 CODED - J K L M N
25 - 72	DATA(J)	12I4	Keyword M: data are mean sky covers for each of 12 months starting with JAN Keyword S: data are scale distances for each of 12 months starting with JAN Keyword P: data are populations

Note: Columns set to zero indicate no data

<u>REMARKS</u>: Population values for the DATARC file have been retained and can be distinguished from the other parameters

by the keyword "P". Population values PV for RUSARC and NISARC may be computed using the input parameter IPOR by:

$$PV = \{[IPOR(2)-IPOR(1) + 1] + [IPOR(4)-IPOR(3) + 1]\} * 3D.$$

Period of record for SEAARC data may be computed using:

$$PV = \{[IPOR(3)*100 + IPOR(4)] - [IPOR(1)*100 + IPOR(2)] + 1\} * 3D$$

D = Number of Days in the Month.

Finally, the entire ensemble of software and data files discussed thus far is spooled to tape M4655 for permanent retention.

4. PROGRAM NAME: DISPLD Version 1.0 6/5/87

PURPOSE: *To produce global displays of data availability*

INPUT: Latitude and longitude coordinates of the stations in data files RUSARC, NISARC, and SEAARC are input and plotted on world maps.

OUTPUT: Points are plotted on world maps to display the spatial distribution of data available in each file. Fig. 2 shows the global distribution of stations contained in file RUSARC. The majority of points in this file are over North America and to a lesser extent over eastern Europe and the Far East. Fig. 3 presents the distribution of stations in NISARC, showing extensive coverage over eastern Europe, India and Southeast Asia. In the Southern Hemisphere coverage is shown over South America, Africa, and Australia. The distribution of sky cover reports from ship locations is shown in Fig. 4.

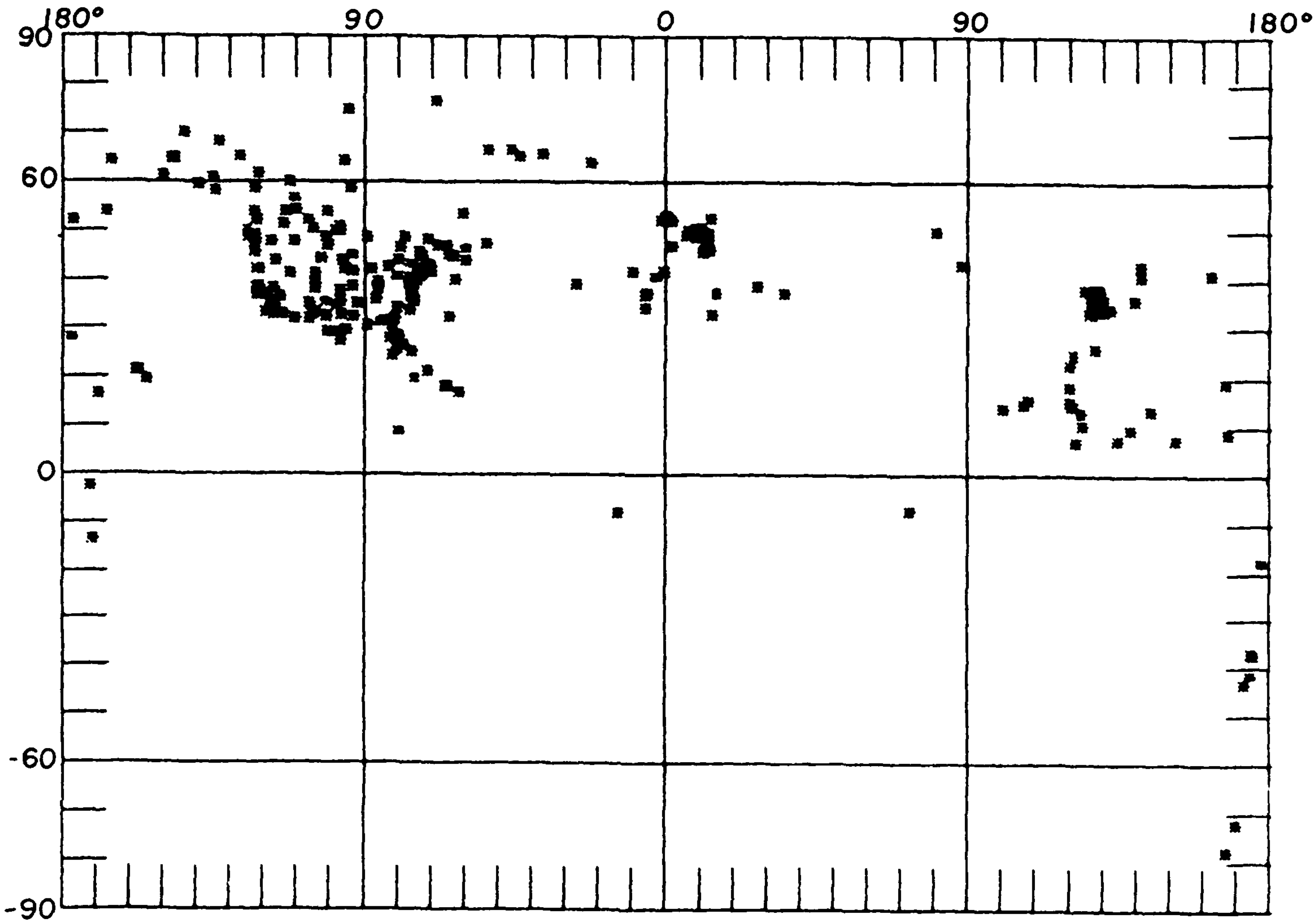

Fig. 2 Global Distribution of 266 Stations Archived in File RUSARC

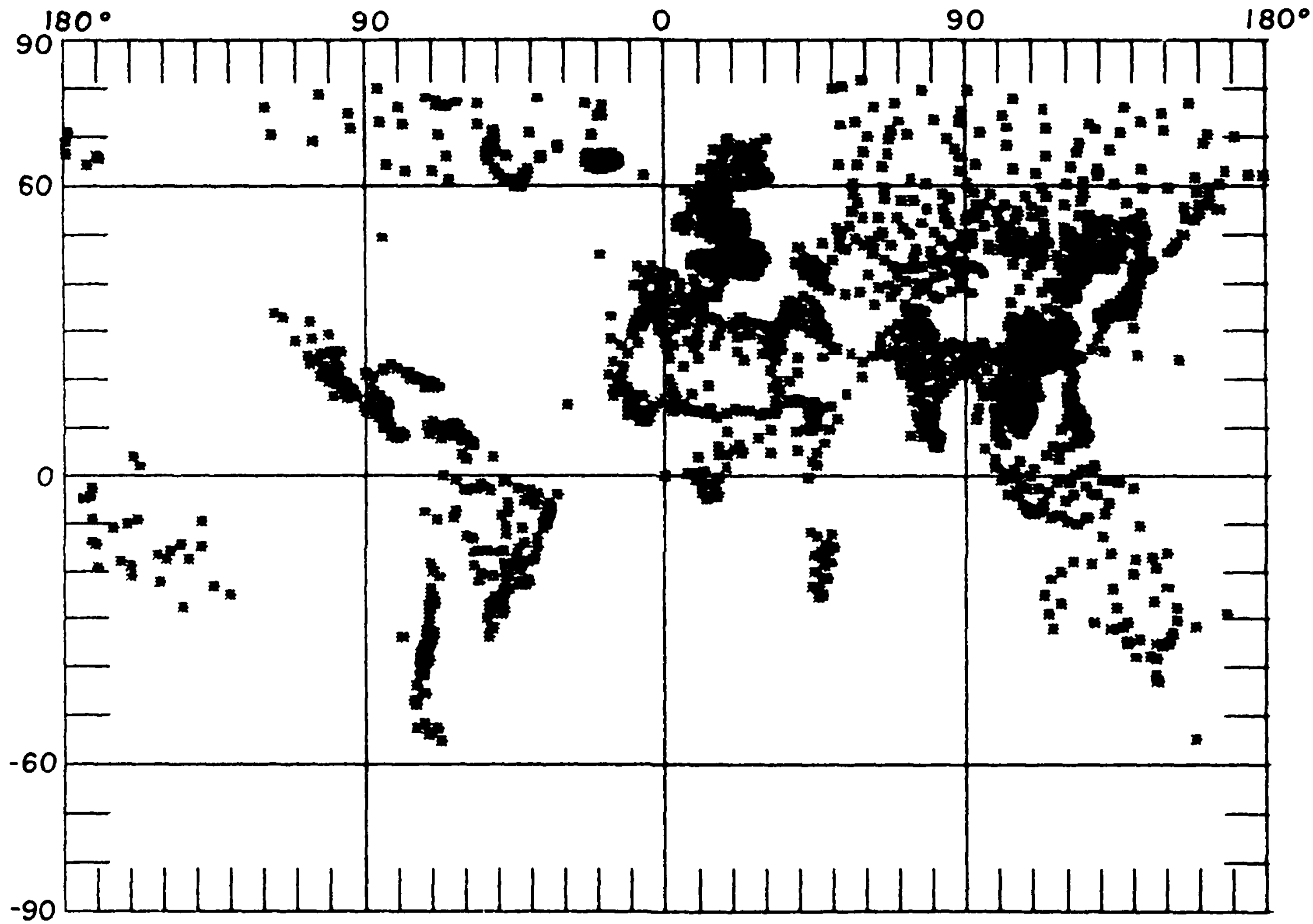

Fig. 3 Global Distribution of 1846 Stations Archived in File NISARC

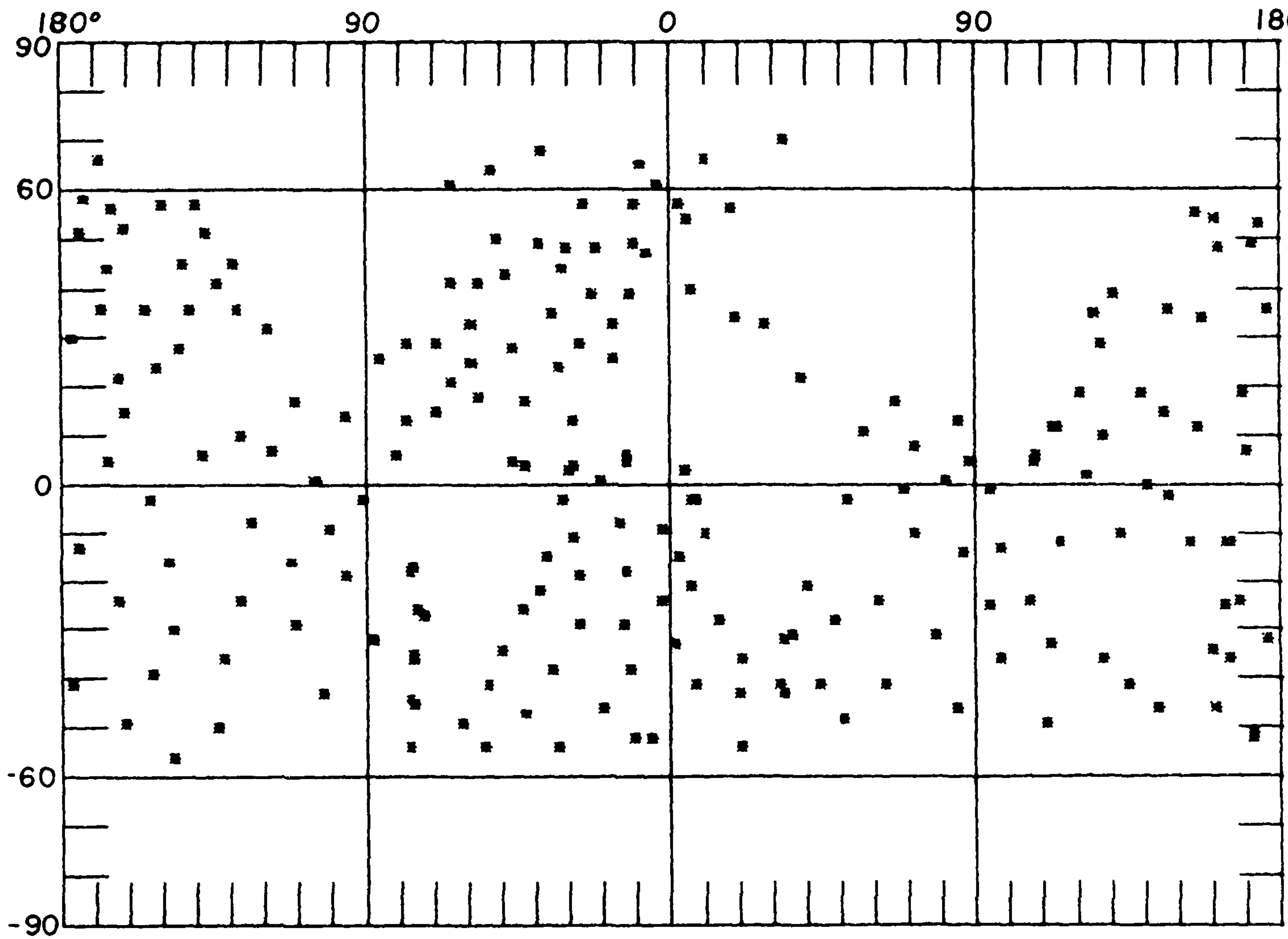

Fig. 4 Global Distribution of 222 Ship Reports Archived in File SEAARC

5. <u>PROGRAM NAME</u>: PLAT Version 1.0 7/10/87

<u>PURPOSE</u>: To plot out archived data values for data interpretation

<u>INPUT</u>: Mean and scale distance parameters from the final archived files

<u>OUTPUT</u>: Fig. 5 is a sample of the output generated by program PLAT. Mean sky cover probabilities vs. latitude from the RUSARC data file for January are displayed on the left. Scale distances have been converted to Z values using the equation below and are plotted on the right side of Fig. 5.

Scale distance may be scaled uniformly by:

$$Z = \frac{\ln\left(\frac{\sqrt{A}}{r}\right)}{\ln 2}$$

where:

A is the sky dome area constant (2,424 km^2), and
r is the scale distance.

Data plotted for different local standard times are distinguished by symbols defined at the top of the figure.

B. Description of DATSAV Data Processing

Hourly meteorological observations in the form of magnetic tapes for sixty-six weather stations were acquired from the U.S. Air Force Environmental Technical Applications Center (USAFETAC). These data were useful not only for providing hourly mean and scale distance parameters but were also extremely useful in the study of spatial and temporal sky cover correlation. Hour to hour observations in the DATSAV data make it possible to generate contingency tables of sky cover observed at one station with the sky cover observed at another some distance away or with itself at some

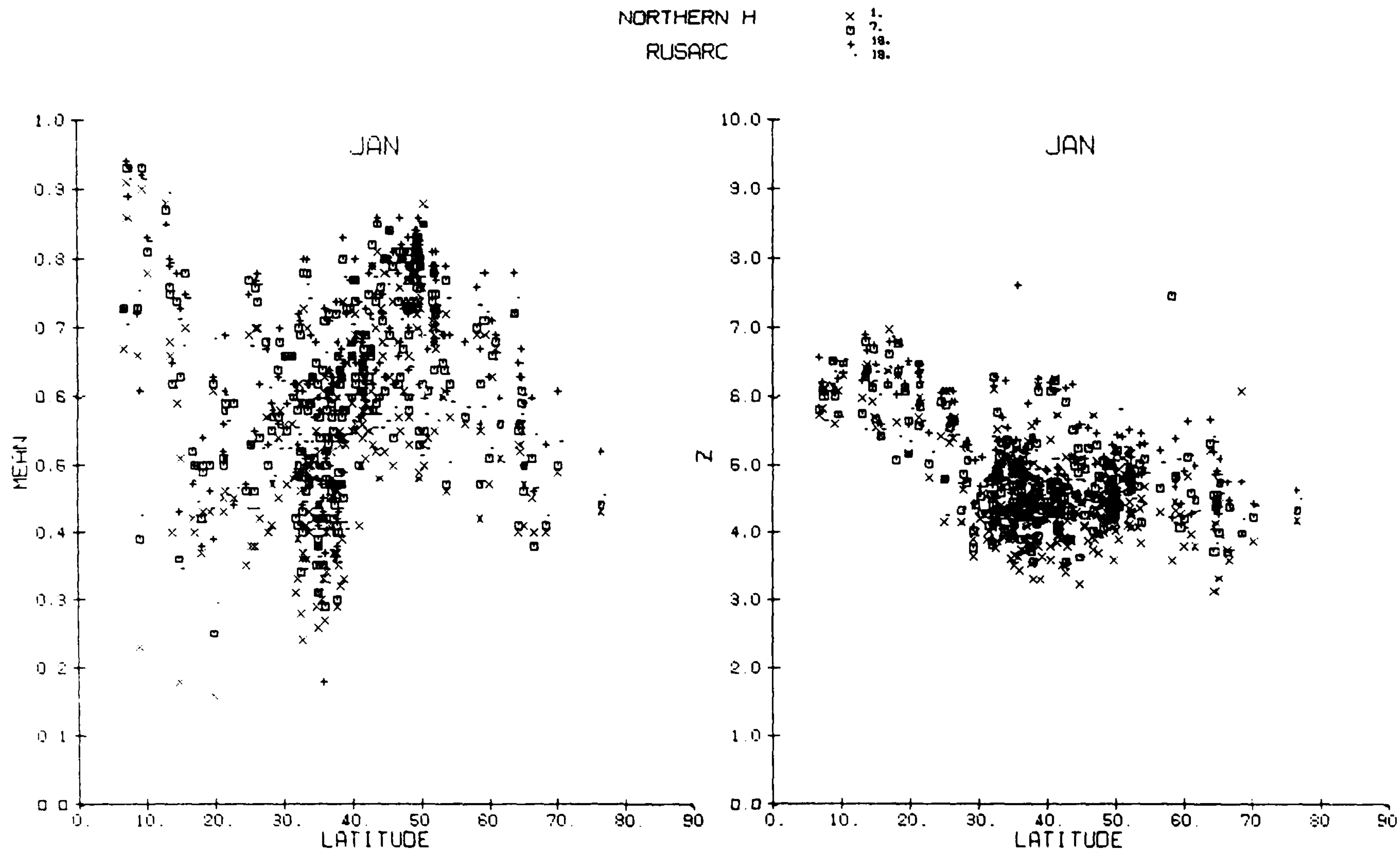

Fig. 5 Output of Program PLAT Showing Mean and Scale Distance (Z) Parameters from File RUSARC

predetermined later time. These data were processed and archived into final form by the programs shown in Fig. 6.

1. PROGRAM NAME: GETCOV Version 2.0 4/25/87

PURPOSE: To extract hourly sky amount observations from DATSAV data tapes and store the observations in a form suitable for subsequent processing

INPUT: Magnetic Tapes in DATSAV Format
1600 BPI
Nine Track
Binary
Standard Label Tape

OUTPUT: Hourly cloud observations densely packed in binary form for random access file manipulation on a Cyber 180/860 60-bit computer

REMARKS: The ground observed meteorological data are contained on 66 tapes covering selected line-oriented (located along a fixed directional line) stations over eastern Europe, Australia, South America, Hawaii, Alaska, and central U.S. The data, including documentation of DATSAV format (Reference Manual, 1977), cover the period 1973-1983.

Each tape contains surface observations for a single station. Some tapes contain data archived every hour for 24 hours a day while others archive only mandatory six-hourly GMT synoptic observations.

Sky cover data in DATSAV format are in two basic forms, synoptic code and Airways code. Synoptic code reports the total fraction of the celestial dome covered in octas (0- through 8-eighths; 9 meaning obscured), while Airways code denotes sky conditions as scattered, broken, overcast,

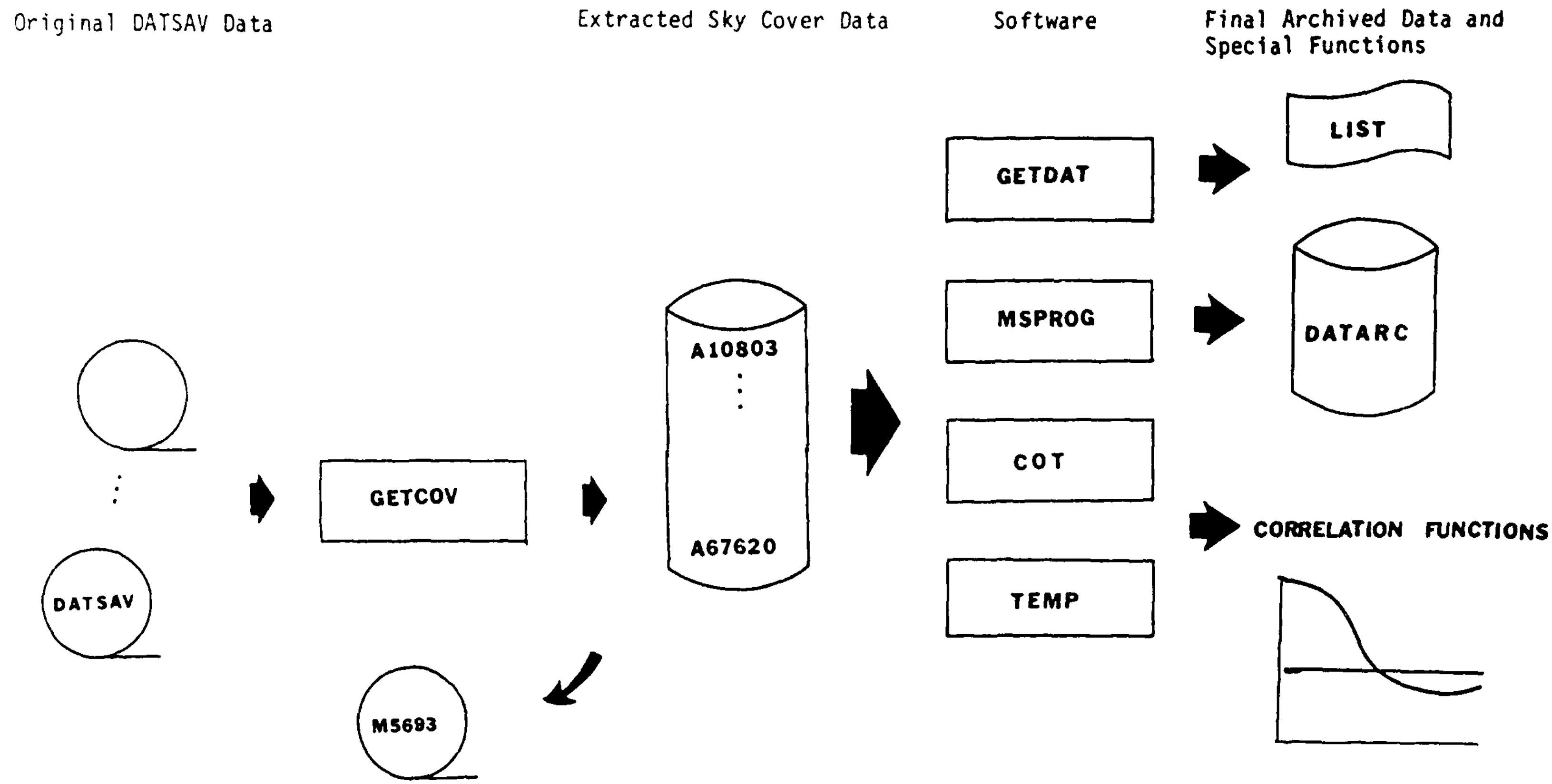

Fig. 6 DATSAV Data Processing Configuration for DATARC Archiving and Special Processing

obscured, or partially obscured. Definitions of cloud cover codes and other information are listed in Table 4.

TABLE 4. SKY COVER CODING ASSIGNMENTS

DATSAV Tape Code	Data Compaction Code	Sky Cover Conditions	Clear/Cloudy Conversion Code
Synoptic			
0	1	Clear	1
1	2	.1 octas	1
2	3	.2	1
3	4	.3	1
4	5	.4	1
5	6	.5	10
6	7	.6	10
7	8	.7	10
8	9	.8	10
9	10	Obscured	10
Airways			
0	1	Clear	1
-2	12	Scattered	1
-7	13	Broken	10
-8	14	Overcast	10
-9	15	Obscured	10
-10	16	Partially Obscured	1
65535	31	Missing Data	31

Program GETCOV converts the incoming sky cover codes to data compaction codes shown in Table 4. The largest compaction code number is 31 or 37 to the base eight which can be contained in a five-bit byte. Since the mainframe computer being utilized is a 60-bit word addressable machine, 12 five-bit bytes can fit in one word. Two words can then be used to store 24 five-bit bytes or one day (24 hours) of sky cover observations. Sixty-two words (2 X 31 days) will hold an entire month of observations. Adding two more words for station numbers and latitude-longitude locators brings the total number of words to 64, which becomes a single physical record length for one month's data. Final size of a random access data set required to store all sky cover observations for a single station is 132 records (12 mos X 11 yrs). The compacted data sets are stored for further processing under file directory names, such as A10803, meaning data from block 10 in West Germany for station number 803, Freiburg, Germany.

Finally, all compacted sky cover data sets are spooled onto magnetic tape M5693 for permanent retention.

2. PROGRAM NAME: GETDAT Version 1.0 9/15/85

PURPOSE: To list out entire contents of compacted data sets derived from program GETCOV for quality assurance and data availability statistics

INPUT: Compacted random access data sets created by program GETCOV (see Subroutine RGETDT, pp. 29-30)

OUTPUT: Hourly sky cover observations extracted from DATSAV data tapes are printed out for data verification and availability statistics.

3. PROGRAM NAME: MSPROG Version 1.0 1/5/87

PURPOSE: To derive mean sky cover, scale distance, and population parameters from compacted DATSAV sky amount observations for further data archiving

INPUT: Compacted sky amount observations assembled by program GETCOV (see Subroutine RGETDT, pp. 29-30)

OUTPUT: DATARC Archive

REMARKS: Program MSPROG contains the routines for computing means and scale distance parameters from sky amount frequency distributions that are categorized by eighths or by Airways code.

Hourly means and scale distance were processed and archived in the same format as the Burger data (see DATARC Table 3). The keyword "P" was added so that population counts could be included in the data set. Global distribution of 66 archived DATARC stations is shown in Fig. 7.

4. PROGRAM NAME: COT Version 1.0 10/15/85

PURPOSE: To provide the logic for setting up contingency tables to compute spatial sky cover correlations

INPUT: Compacted sky amount observations assembled by program GETCOV (see Subroutine RGETDT, pp. 29-30)

OUTPUT: Spatial sky cover correlation functions

REMARKS: This version of the program uses algorithm AS87 (Martinson and Hamdan, 1975) to calculate polychoric estimates of spatial sky cover correlation. With the addition of code described by Beardwood (1977), the program will compute estimates of correlation coefficients from four-fold tables (tetrachoric correlations) as well.

5. PROGRAM NAME: TEMP Version 1.0 10/20/85

PURPOSE: To provide the logic for setting up contingency tables to compute temporal sky cover correlations

INPUT: Compacted sky cover observations assembled by program GETCOV (see Subroutine RGETDT, pp. 29-30)

OUTPUT: Temporal sky correlation functions

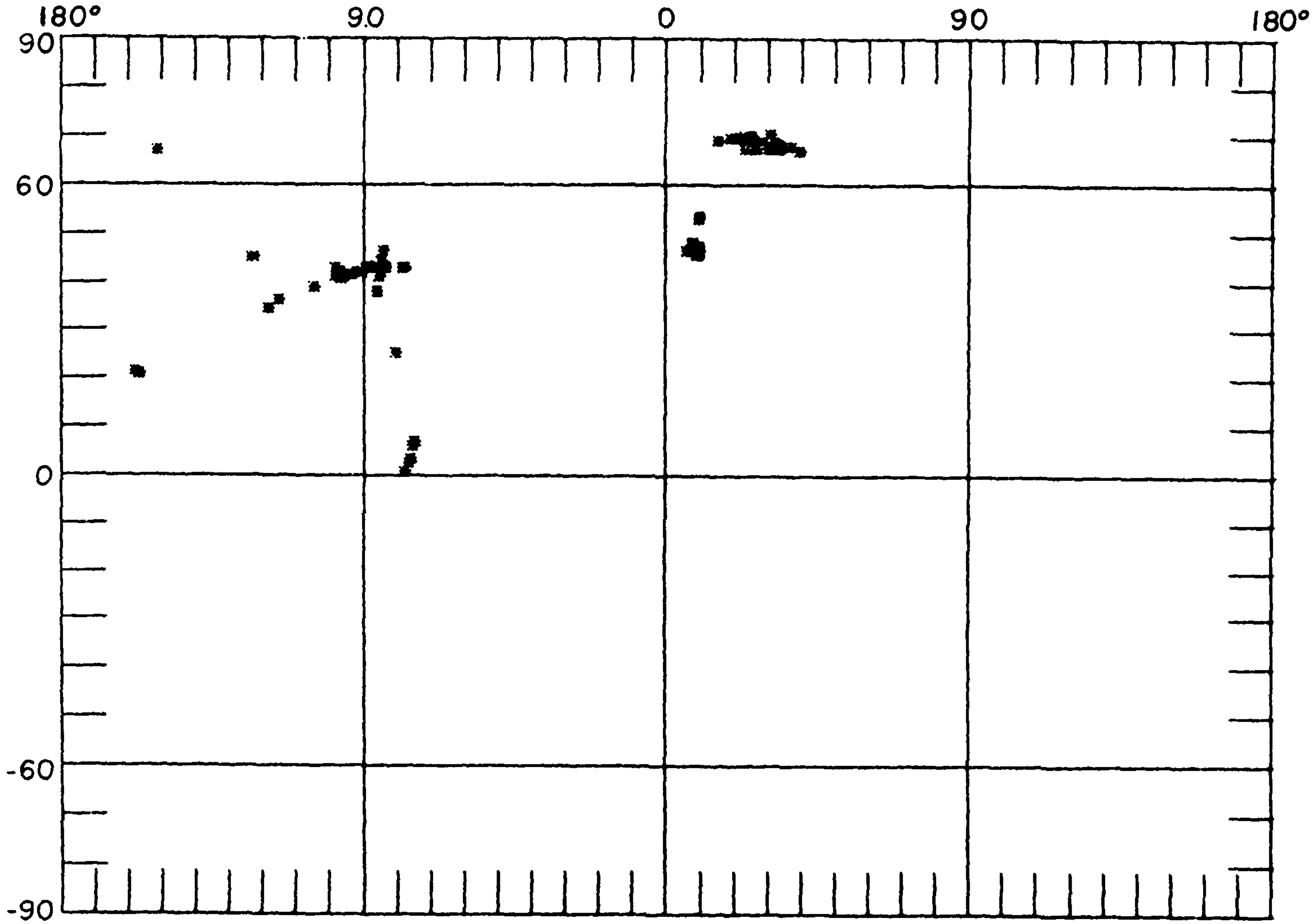

Fig. 7 Global Distribution of 66 Stations Archived in File DATARC

REMARKS: This program uses the same algorithms for computing correlation as does program COT.

6. PROGRAM NAME: Subroutine RGETDT Version 1.0 9/15/85

PURPOSE: To read compacted sky cover observations from disk

INPUT: Compacted sky cover observations are input to programs GETDAT, MSPROG, COT, and TEMP by use of this routine and the labeled common statement:

```
COMMON/AREA/MINDEX(145),IDT(64),IDATA(24,31),ISTA,
XLAT,XLONG
```

The variables of the common area are:

MINDEX(145):	145 Physical Records Stored
IDT(64):	64 Packed Words of Information in Each Record
IDATA(24,31):	Area Used to Store 24 Hours and 31 Days of Unpacked Sky Cover Observations
ISTA:	Station Number
XLAT:	Latitude of Station
XLONG:	Longitude of Station

The OPEN statement for random access input is:

```
CALL OPENMS(NTAPE,MINDEX,145,0)
```

To read data, use the following READ statement:

```
CALL READMS(NTAPE,IDT,64,INDEX)
```

where:

INDEX is an index of the record of interest given a month and a year between 1973 and 1984.

Hence:

INDEX = (MONTH-1) + 12(YEAR-1) + 1, and

IDT = Buffer of Size 64 Words.

All 24 sky cover observations in a day for a given month are unpacked and ready for further processing in array IDATA upon return from this routine.

C. Description of NCAR Cloud Data Processing

The data sample of means and scale distance parameters was significantly expanded by addition of data acquired from the National Center for Atmospheric Research (Hahn, 1987). Hahn's term "cloud cover," which is used in this section (C), is synonymous with "sky cover" as used elsewhere throughout the manual. NCAR cloud information on a single tape contains global maps with typically a 5^{o} latitude by 5^{o} longitude grid size of long term monthly and/or seasonal total cloud cover, cloud type amounts and frequencies of occurrence, low cloud base heights, harmonic analyses of annual and diurnal cycles, inter-annual variations and trends, and cloud co-occurrences. Means and standard deviations of cloud cover observations in this data ensemble were suitably tabulated for use of Burger's algorithms to derive means and scale distance parameters at many grid points over the globe. Fig. 8 depicts the software developed to process the NCAR data for eventual integration into the C Cloud S database.

1. PROGRAM NAME: FETCH Version 1.0 8/17/87

PURPOSE: To extract selected map group climatologies from the NCAR global cloud data tape (land observations)

INPUT: Tape # M5550
6250 BPI
Nine Track
ASCII
No Label Tape

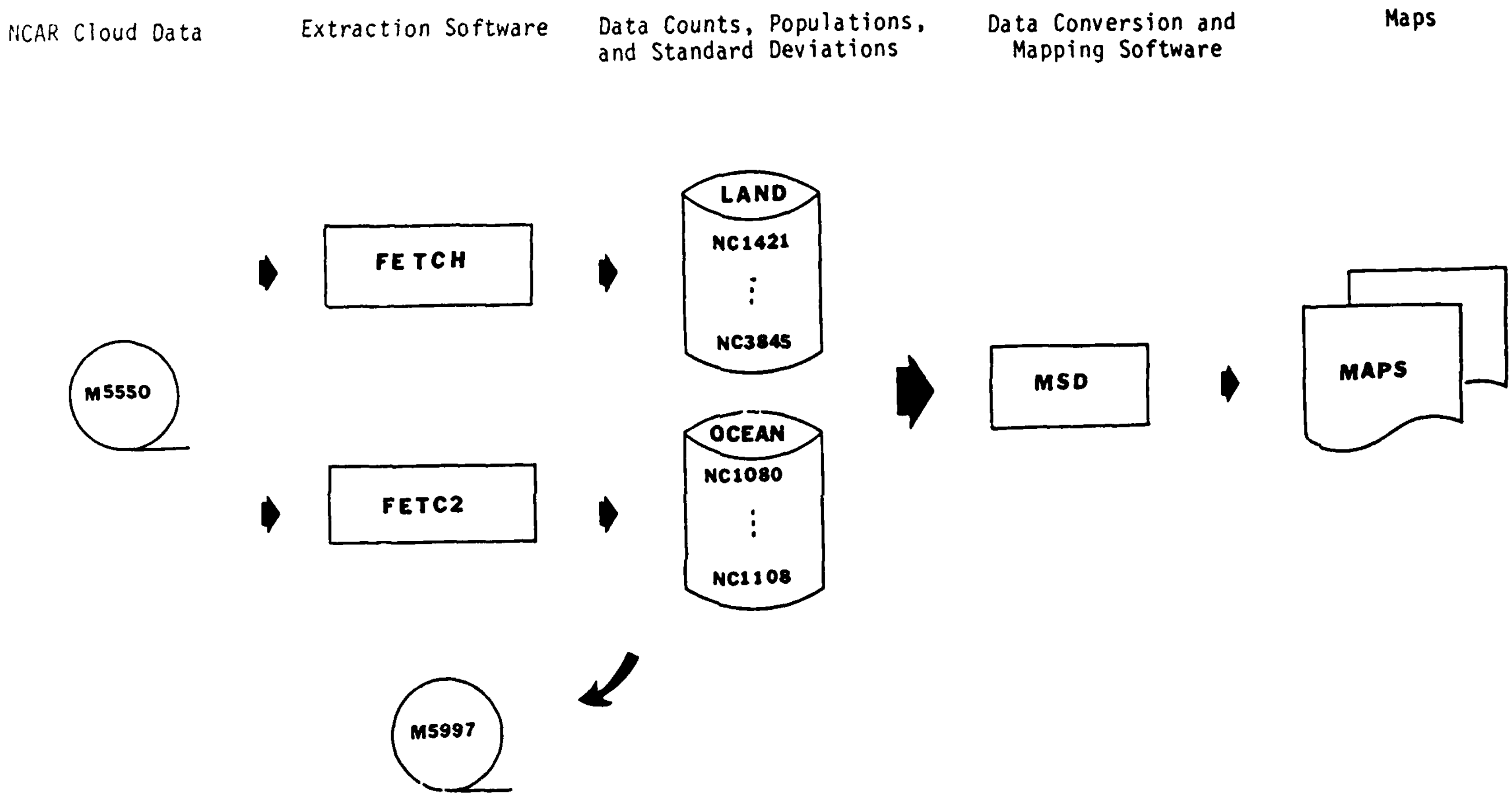

Fig. 8 Processing of NCAR Climatological Data

OUTPUT: Thirty-two map groups were extracted from the NCAR global cloud data tape and stored on permanent disk file for further processing. Each map contains mean cloud cover, standard deviation, and population counts of cloud cover observations from land stations, stratified every eight hours for four seasons. Maps are in GMT.

2. PROGRAM NAME: FETC2 Version 1.0 8/20/87

PURPOSE: To extract selected map group climatologies from the NCAR global cloud data tape (ocean observations)

INPUT: Tape # 5550 (File 6)
6250 BPI
Nine Track
ASCII
No Label

OUTPUT: Thirty-two map groups were extracted from the NCAR data tape. Each map contains mean cloud cover, standard deviations, and population counts of cloud cover observations over ocean areas every eight hours for four seasons.

REMARKS: Land and ocean maps of NCAR data on disk file are spooled to tape M5997 for permanent retention.

3. PROGRAM NAME: MSD Version 1.0 9/10/87

PURPOSE: To map mean cloud cover and scale distance parameters using NCAR cloud data

INPUT: NCAR global cloud data extracted from programs FETCH and FETC2

OUTPUT: NCAR cloud statistics are converted to mean and scale distance parameters using Burger's algorithms. The

program converts these parameters into integer values and displays the result in the form of maps. Fig. 9 is an example of a map generated showing mean cloud cover from the NCAR map group number 1080. Fig. 10 is a map of scale distances scaled to Z values and displayed in integer format.
REMARKS: The standard deviation SD in the NCAR data had to be adjusted in order to use Burger's algorithms to compute scale distance correctly. The adjustment to the NCAR standard deviation used is:

$$SD = SD' * \frac{(N - 1)}{N}$$

where:

SD' is the NCAR standard deviation at a grid point, and
N is the NCAR population count at a grid point.

Grid points consisting of population counts less than ten were excluded from the analysis.

D. Description of 3DNEPH Data Processing

Six years of 3DNEPH data covering the period 1977 through 1982, together with documentation, were acquired from the USAF Environmental Technical Applications Center. This data ensemble contains cloud cover observations derived from earth-viewing satellite systems. Parts of this large database have been processed to investigate techniques for converting the data into means and scale distance parameters to provide sufficient coverage over data-sparse regions of the globe. Two such programs are described.

1. PROGRAM NAME: MESH4 Version 1.0 12/1/87

PURPOSE: To read and unpack 3DNEPH data tapes

SZLOVEARSNTITYFM

CLOUD COVER (PERCENT) MAP GROUP 1080 5 2548341 0 921

S																																	N	0E
0	0	0	0	0	0	0	88	72	64	58	60	67	74	67	50	55	50	32	0	0	0	0	0	43	44	68	0	0	0	0	0	0	50	
0	0	0	85	89	90	90	81	78	69	61	66	74	78	72	56	58	48	54	0	0	0	0	0	52	48	0	70	73	77	77	0	0	0	
0	0	0	0	0	0	0	85	74	72	58	58	65	62	64	59	68	0	0	0	0	0	0	39	49	51	51	0	0	0	0	79	81	0	
0	0	0	81	88	87	90	84	78	59	40	39	0	0	0	0	0	0	0	0	0	0	0	50	50	52	0	73	71	66	71	0	0	0	
0	0	0	0	0	0	0	80	67	49	47	0	0	0	0	0	0	0	0	0	0	0	0	48	54	58	0	0	0	0	0	0	0	65	
0	0	0	86	90	91	87	86	71	59	57	0	0	0	0	0	0	0	0	0	0	0	0	47	51	64	0	0	76	64	54	0	0	0	
																																		30E
0	0	0	0	0	0	0	82	72	58	64	59	52	82	0	0	0	0	0	0	0	0	16	44	48	66	65	0	0	0	0	82	82	0	
0	0	0	76	90	91	91	87	76	67	53	47	44	45	0	51	43	0	0	0	26	19	17	50	45	64	78	0	0	75	80	0	0	0	
0	0	0	0	0	0	0	88	74	62	56	47	42	49	46	41	30	28	0	25	24	44	0	0	0	58	0	0	0	0	0	0	0	0	
0	0	0	81	93	89	88	87	70	67	59	50	55	55	56	44	39	34	39	26	0	0	29	78	0	0	0	0	0	0	78	0	0	0	
0	0	0	0	0	0	0	78	77	66	60	57	48	47	56	48	46	40	40	31	21	38	27	0	0	0	0	0	0	0	0	88	63	0	
0	0	0	74	89	91	90	86	80	72	61	55	45	45	49	58	50	45	45	38	23	19	23	0	0	0	0	0	0	0	85	0	0	0	
																																		60E
0	0	0	0	0	0	0	85	79	78	70	53	47	46	53	55	52	43	44	39	29	19	35	0	0	0	0	0	0	0	0	0	0	75	
0	0	0	81	90	90	89	84	77	77	68	56	51	49	51	56	54	47	38	31	21	14	31	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	83	85	78	64	59	56	52	57	59	56	49	34	25	14	13	0	0	0	0	0	0	0	0	0	53	0	0	
0	0	0	77	92	91	87	89	81	82	70	60	57	57	56	62	58	52	45	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	90	84	79	71	63	60	61	61	62	64	60	55	44	36	0	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	88	94	92	90	86	87	81	71	66	60	62	61	69	67	62	61	44	30	28	0	0	0	0	0	0	0	0	0	0	0	0	
																																		90E
0	0	0	0	0	0	0	89	83	83	75	69	67	63	64	69	72	66	63	40	29	23	0	0	0	0	0	0	0	0	0	41	0	0	
0	0	0	78	91	90	91	85	84	81	77	76	73	66	63	72	80	79	68	49	40	0	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	87	84	81	78	79	74	69	59	75	80	73	63	55	0	0	0	0	0	0	0	0	0	0	0	0	0	67	
0	0	0	74	90	89	84	91	82	80	77	69	67	62	61	78	79	74	68	63	76	87	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	82	79	73	55	47	45	52	59	77	78	80	70	64	65	74	0	0	0	0	0	0	0	0	0	50	57	0	
0	0	0	71	90	89	81	75	78	70	55	0	35	47	59	72	80	68	64	57	56	76	74	54	45	0	0	0	0	0	0	0	0	0	
																																		120E
0	0	0	0	0	0	0	84	76	72	60	0	0	59	65	70	84	64	60	58	62	75	81	66	55	53	0	0	0	0	0	0	0	0	
0	0	0	83	93	85	82	86	80	73	68	0	0	0	67	68	69	66	64	64	62	70	77	76	54	57	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	80	77	70	52	0	0	0	70	71	76	71	65	63	61	65	73	71	74	51	0	0	0	0	0	0	63	0	
0	0	0	74	91	87	85	89	76	67	54	0	0	65	71	75	79	70	68	62	59	63	68	69	76	69	56	85	69	0	0	0	0	0	
0	0	0	0	0	0	0	84	70	64	0	0	0	62	71	75	77	70	66	58	56	60	65	74	66	71	73	0	0	0	0	0	0	50	
0	0	0	83	91	87	83	79	66	58	0	0	60	63	62	78	76	67	64	55	53	57	65	76	79	74	81	81	77	0	0	0	0	0	
																																		150E
0	0	0	0	0	0	0	77	70	61	56	58	56	54	62	71	70	68	67	56	50	55	64	73	79	81	84	0	0	0	0	55	55	0	
0	0	0	90	91	91	81	78	74	65	60	55	53	56	64	70	68	66	69	54	48	54	63	71	78	81	80	75	71	82	0	0	0	0	
0	0	0	0	0	0	0	80	74	67	61	56	56	58	66	69	67	71	69	55	48	51	61	72	78	79	82	0	0	0	0	0	0	0	
0	0	0	89	92	89	83	78	70	65	61	58	57	60	66	73	67	71	67	53	47	51	60	71	76	79	80	79	77	70	0	0	0	0	
0	68	80	0	0	0	0	75	61	62	59	60	62	60	70	73	63	64	68	50	48	51	58	69	76	79	80	0	0	0	0	47	50	0	
0	0	0	90	91	87	81	77	63	55	59	59	61	61	71	74	64	67	70	53	50	52	61	69	76	79	80	84	88	79	0	0	0	0	
																																		180E
0	0	0	0	0	0	0	75	69	63	63	62	63	64	69	71	57	61	68	51	49	52	62	70	77	79	79	0	0	0	0	0	0	46	
0	0	0	92	86	83	82	82	73	66	65	68	66	63	70	63	52	64	66	52	51	52	64	71	77	78	81	83	86	82	73	0	0	0	
0	82	91	0	0	0	0	74	75	70	65	67	64	67	67	64	51	55	66	54	50	52	64	71	77	79	81	0	0	0	0	64	54	0	
0	0	0	93	90	83	83	81	72	73	65	68	67	69	68	57	49	55	68	55	52	54	64	73	78	80	81	82	84	78	0	0	0	0	
0	0	0	0	0	0	0	81	77	70	67	68	67	67	69	58	48	54	71	56	50	55	65	73	79	82	83	0	0	0	0	0	0	0	
0	0	0	90	91	85	87	79	73	73	70	69	68	65	67	51	44	55	72	60	56	60	65	73	79	81	82	83	78	71	0	0	0	0	
																																		210E
0	90	92	0	0	0	0	76	78	73	68	70	70	66	60	57	47	56	73	65	60	60	67	75	79	82	82	0	0	0	0	55	47	0	
0	0	0	95	92	88	80	74	79	73	73	66	68	64	56	44	42	53	77	64	63	63	68	74	79	82	83	84	82	74	0	0	0	0	
0	0	0	0	0	0	0	85	82	73	73	66	65	59	53	44	39	55	73	67	65	65	71	75	80	82	83	0	0	0	0	0	0	45	
0	0	0	91	93	84	89	73	78	73	68	62	59	61	47	44	38	52	74	68	68	70	72	75	78	81	82	84	81	0	0	0	0	0	
0	0	79	0	0	0	0	86	79	71	67	62	59	54	44	40	40	60	74	68	72	72	72	71	73	78	81	0	0	0	0	37	50	0	
0	0	0	93	91	92	83	71	77	71	66	61	57	56	44	42	40	58	72	67	72	71	67	61	62	73	78	81	0	0	0	0	0	0	
																																		240E
0	0	0	0	0	0	0	80	76	56	66	55	57	51	44	43	43	59	70	68	70	62	51	51	0	0	0	0	0	0	0	0	0	0	
0	0	0	95	93	75	87	82	82	82	63	58	53	51	48	45	50	62	70	62	61	46	43	58	0	0	0	0	0	0	0	0	0	0	
0	0	94	0	0	0	0	86	0	77	61	51	54	53	48	51	49	68	60	54	47	48	58	0	0	0	0	0	0	0	0	0	52	0	
0	0	0	87	94	80	85	0	0	72	64	56	53	51	50	50	54	62	54	43	37	0	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	70	77	60	49	55	53	51	52	53	70	50	28	30	68	67	0	0	0	0	0	0	0	0	0	0	41	
0	0	0	94	86	89	81	0	71	72	56	61	58	51	52	55	57	72	43	23	36	56	63	0	0	0	0	0	0	0	0	0	0	0	
																																		270E
0	0	78	0	0	0	0	86	76	78	63	60	65	64	58	55	58	72	39	22	51	55	61	55	0	0	0	0	0	0	0	60	0	0	
0	0	0	89	92	89	79	89	73	72	61	67	67	65	57	52	63	72	50	53	51	48	52	51	0	77	79	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	80	75	69	58	66	75	64	59	55	0	73	49	47	41	48	54	61	54	73	0	0	0	0	0	0	0	0	
0	0	0	89	89	81	63	87	63	41	43	66	65	64	0	0	0	0	0	33	37	44	54	67	68	60	69	66	59	0	0	0	0	0	
0	0	0	0	0	0	0	62	56	0	0	0	0	0	0	0	0	0	0	36	39	45	53	65	79	72	60	0	0	0	0	62	64	0	
0	0	0	81	84	83	69	56	52	51	0	0	0	0	0	0	0	0	46	36	37	43	52	63	78	75	68	69	78	84	0	0	0	0	
																																		300E
0	0	0	0	0	0	0	62	48	52	52	0	0	0	0	0	0	0	42	40	38	43	50	61	75	82	76	0	0	0	0	0	0	63	
0	0	0	72	87	88	76	77	63	50	49	0	0	0	0	0	0	58	48	42	38	42	48	60	72	80	78	82	87	78	74	0	0	0	
0	65	97	0	0	0	0	76	63	53	53	58	64	0	0	0	49	61	54	42	43	42	50	59	69	76	82	0	0	0	0	54	68	0	
0	0	0	96	93	93	86	79	70	64	53	51	51	0	0	0	46	59	59	45	41	46	50	58	67	78	82	86	82	68	0	0	0	0	
0	0	0	0	0	0	0	80	71	68	65	58	48	44	39	40	40	58	58	50	45	47	51	58	65	72	79	0	0	0	0	0	0	0	
0	0	0	93	92	92	85	82	62	60	64	52	51	46	40	37	41	59	60	55	48	49	52	58	65	70	76	79	81	75	78	0	0	0	
																																		330E
0	77	86	0	0	0	0	85	78	64	64	53	52	46	40	39	44	63	59	50	43	51	54	58	64	71	75	0	0	0	0	71	60	0	
0	0	0	92	91	91	91	82	70	58	62	48	38	42	42	38	40	56	47	42	39	42	50	60	66	70	74	76	77	77	82	0	0	0	
0	0	0	0	0	0	0	81	79	68	62	48	44	44	44	40	42	51	31	27	27	25	37	57	66	70	73	0	0	0	0	0	0	53	
0	0	0	92	93	91	90	0	69	70	55	46	46	50	48	47	46	51	37	30	0	0	42	53	60	63	73	73	74	77	79	0	0	0	
0	0	78	0	0	0	0	84	62	72	55	43	54	57	56	44	51	49	43	0	0	0	46	43	45	61	72	0	0	0	0	73	74	0	
0	0	0	84	92	92	87	89	71	70	56	52	56	65	57	48	50	46	38	0	0	0	0	0	38	62	68	66	67	78	81	0	0	0	
																																		360E

Fig. 9 Cloud Cover Map Computed from NCAR Data

```
                                                       SZLOVEARSNTITYFM
   SCALE DISTANCE X 100 MAP GROUP  1080    5 2548341 0 921
S                                                                                                  N   0E
0  0  0  0  0  0  0 86 91115 93 84 89 72 82 80 76 72100  0  0  0  0  0 67105125  0  0  0  0  0  0162
0  0  0117 97109112111123110 88 80 65 77 93 92 77 79 93  0  0  0  0  0 67 81  0 64 51 55 56  0  0  0
0  0  0  0  0  0  0145 93 82 73 69120107 99 89115  0  0  0  0  0  0121 61103149  0  0  0  0 61 97  0
0  0  0147107 89165169 80 78 72242  0  0  0  0  0  0  0  0  0  0  0 85 55113  0170128204 68  0  0  0
0  0  0  0  0  0  0159 86 75 80  0  0  0  0  0  0  0  0  0  0  0  0 68 69171  0  0  0  0  0  0  0129
0  0  0103 86101104118101 79 85  0  0  0  0  0  0  0  0  0  0  0  0 58 91145  0  0153294235  0  0  0
                                                                                                      30E
0  0  0  0  0  0  0143 85 84 77 72 73 85  0  0  0  0  0  0  0  0103 69 96128180  0  0  0  0 51115  0
0  0  0117 80 86112147101 89 81 59 55 71  0 64 66  0  0  0 71 60 96117100136 80  0  0 73106  0  0  0
0  0  0  0  0  0  0101106114 79 58 75 65 56 57 51 55  0 73 84 89  0  0  0101  0  0  0  0  0  0  0  0
0  0  0 97 56 89127150 91 88 96 69 69 38 64 57 46 50 55 41  0  0154 85  0  0  0  0  0  0157  0  0  0
0  0  0  0  0  0  0 92100 85 99 81 56 54 54 60 62 52 46 45 67116106  0  0  0  0  0  0  0  0 72 60  0
0  0  0118 85 67 71 88 91 93104 79 58 56 59 67 71 61 58 46 60 78107  0  0  0  0  0  0  0105  0  0  0
                                                                                                      60E
0  0  0  0  0  0  0111 85 80 88 62 68 55 62 71 73 61 55 49 63 71 62  0  0  0  0  0  0  0  0  0  0 93
0  0  0 93102 62 68102 87 87 81 56 66 63 58 75 78 70 46 54 69118140  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0 74 59 81 78 54 56 55 59 66 64 64 48 55 83169  0  0  0  0  0  0  0  0  0163  0  0
0  0  0 89 73 71 62 50 81 68 67 60 52 49 52 60 58 57 54 58  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0 98 68 87 60 59 54 49 48 64 54 58 47 53 69  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0 38 66 69 58 75 62 73 61 61 49 43 48 51 55 51 46 55 75 96  0  0  0  0  0  0  0  0  0  0  0
                                                                                                      90E
0  0  0  0  0  0  0 57 83 70 65 57 53 49 46 53 53 47 41 57 77146  0  0  0  0  0  0  0  0  0168  0  0
0  0  0125 96 80 68 90 51 74 64 59 55 51 43 52 53 49 41 49 67  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0 62106 64 74 57 61 54 51 50 68 44 38 50  0  0  0  0  0  0  0  0  0  0  0  0  0 77
0  0  0122 97 65 87 60 60 62 66 64 53 48 47 49 45 40 38 45 46113  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0 96 80 87 70 74 61 56 58 56 53 49 44 38 40 76  0  0  0  0  0  0  0  0  0 47 61  0
0  0  0117 86 75 62 82 69 71 93  0 76 64 57 53 44 48 43 38 38 64110 82158  0  0  0  0  0  0  0  0  0
                                                                                                     120E
0  0  0  0  0  0  0 58 72 62 89  0  0 70 50 50 63 50 50 55 51 41 75 93 98107  0  0  0  0  0  0  0  0
0  0  0140 70 80 76 58 57 61 92  0  0  0 62 47 40 45 43 39 41 48 44 55120 79  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0 97 67 67 81  0  0  0 48 49 44 48 42 42 41 47 41 46 56 78  0  0  0  0  0  0 91  0
0  0  0 88 90 53 62 56 68 67 97  0  0 73 51 48 50 45 44 45 45 48 43 43 72 52 86 59 69  0  0  0  0  0
0  0  0  0  0  0  0 77 65 66  0  0  0 66 48 48 48 44 43 38 39 46 47 38 42 41 48  0  0  0  0  0  0213
0  0  0148 91 86 92 46 66 77  0  0 55 54 48 47 47 41 38 38 39 48 47 38 38 40 44 81 88  0  0  0  0  0
                                                                                                     150E
0  0  0  0  0  0  0 74 63 67 63 53 44 41 41 42 40 41 42 41 41 48 45 38 38 38 38  0  0  0  0 38122  0
0  0  0 78 94 77 69 62 73 58 52 51 49 46 46 44 41 45 41 40 42 49 45 38 38 39 38 41 72 60  0  0  0  0
0  0  0  0  0  0  0 60 74 60 53 48 49 47 47 43 45 48 41 44 44 49 46 39 40 39 41  0  0  0  0  0  0  0
0  0  0 84 81 74 59 63 70 59 53 48 45 50 46 43 48 48 44 44 42 46 44 41 42 45 44 44 89126  0  0  0  0
0 86 81  0  0  0  0 68 61 62 52 55 48 43 40 55 48 43 51 44 43 46 44 41 43 47 47  0  0  0  0150148  0
0  0  0 89 81 66 64 68 70 59 51 48 47 44 40 45 51 57 50 44 46 44 44 43 48 47 49 38 47 84  0  0  0  0
                                                                                                     180E
0  0  0  0  0  0  0 66 73 52 57 60 47 47 47 43 42 48 54 49 45 43 46 46 51 49 55  0  0  0  0  0  0191
0  0  0 64123 70 72 54 72 53 52 53 53 45 43 45 43 41 39 45 45 41 50 47 52 54 53 43 46 67 76  0  0  0
0 80 61  0  0  0  0 58 60 56 54 59 47 47 48 48 41 43 45 42 45 42 50 45 51 50 57  0  0  0  0186203  0
0  0  0 71121 50 80 67 52 56 53 58 50 46 44 49 38 48 49 46 46 42 46 45 52 54 57 42 50111  0  0  0  0
0  0  0  0  0  0  0 72 79 63 56 53 51 45 57 38 39 45 47 44 46 44 46 44 51 56 56  0  0  0  0  0  0  0
0  0  0119 60 76117 65 63 68 58 54 50 48 46 42 39 52 46 43 47 39 44 43 48 56 58 44 74114  0  0  0  0
                                                                                                     210E
0 65130  0  0  0  0 91 58 60 58 55 49 42 46 43 46 51 51 48 47 42 39 42 48 56 56  0  0  0  0 78 88  0
0  0  0 51 51 91 74 70 71 56 62 54 45 42 44 38 38 47 51 46 46 45 41 40 46 55 54 41 61145  0  0  0  0
0  0  0  0  0  0  0 68 63 67 67 52 42 43 40 43 46 45 50 49 46 48 43 38 45 55 53  0  0  0  0  0  0246
0  0  0 95 61140105 55 55 55 60 43 42 45 39 39 40 46 49 49 48 50 46 41 45 55 51 46 90  0  0  0  0  0
0  0117  0  0  0  0 48 38 75 57 50 45 41 38 38 45 57 47 57 47 52 52 50 51 61 57  0  0  0  0123165  0
0  0  0112 68171 58 54 51 77 54 48 39 39 38 38 41 59 57 47 50 55 58 63 77 85 88102  0  0  0  0  0  0
                                                                                                     240E
0  0  0  0  0  0  0 98 41 73 58 41 38 38 39 39 48 48 54 49 49 62 73 72  0  0  0  0  0  0  0  0  0  0
0  0  0 97104106109 71 77 60 50 47 38 39 46 43 55 58 51 48 52 69 84 76  0  0  0  0  0  0  0  0  0  0
0  0 79  0  0  0  0 57  0 58 47 46 44 39 42 51 54 62 54 47 58 67 84  0  0  0  0  0  0  0  0  0 79  0
0  0  0107 94 63 72  0  0 95 49 43 45 42 47 53 64 66 49 44 50  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0 38 61 52 45 45 43 52 54 64 58 45 48 50 89104  0  0  0  0  0  0  0  0  0  0320
0  0  0 87 93 51 41  0 65 76 52 48 47 47 51 62 57 61 54 41 76 69 64  0  0  0  0  0  0  0  0  0  0  0
                                                                                                     270E
0  0119  0  0  0  0 38 52 54 59 61 71 56 52 53 65 56 54 57 61 47 43126  0  0  0  0  0  0  0 71  0  0
0  0  0 67121 38 69 44 43 45 43 49 63 53 42 59 65 63 47 42 42 43 62111  0 80 90  0  0  0  0  0  0  0
0  0  0  0  0  0  0 84 72 43 53 61 72 64 52 64  0 54 59 38 38 53 41 53110106  0  0  0  0  0  0  0  0
0  0  0138 75 54 69 76 79108147118 86 64  0  0  0  0  0 41 38 41 43 44 55105133 43 53  0  0  0  0  0
0  0  0  0  0  0  0 49 48  0  0  0  0  0  0  0  0  0 38 38 38 45 55 50 61148  0  0  0  0128 89  0
0  0  0102 91 62 52 71 64100  0  0  0  0  0  0  0  0 68 44 38 41 54 51 50 58 98160103163  0  0  0  0
                                                                                                     300E
0  0  0  0  0  0  0 78100 94114  0  0  0  0  0  0  0 53 44 39 39 51 53 48 54 85  0  0  0  0  0  0 67
0  0  0157 85 84 77 64 62 80 82  0  0  0  0  0  0 56 54 48 43 43 46 51 51 60 82 81 77 98 92  0  0  0
0128 38  0  0  0  0 84 82 57 87 81 96  0  0  0 86 66 57 48 51 45 45 48 45 64 73  0  0  0  0225 77  0
0  0  0 74 85 65108 89 82 85 80 78 98  0  0  0 79 64 66 57 50 50 49 47 49 49 61 72 81132  0  0  0  0
0  0  0  0  0  0  0 81 87 88 76 91 90 64 45 50 58 66 63 61 55 54 51 47 47 54 52  0  0  0  0  0  0  0
0  0  0163148 98 80157127 92 98 78 65 57 49 42 47 67 67 68 65 58 60 53 45 55 55 52 63 68131  0  0  0
                                                                                                     330E
0141115  0  0  0  0145 92 94 87 70 55 48 46 51 57 60 62 72 67 78 64 56 47 49 53  0  0  0  0 80 69  0
0  0  0107107128 89 96154 87 91 57 48 52 54 49 48 67 83 89 83 66 57 61 53 50 55 50 59 61 77  0     0
0  0  0  0  0  0  0109 97127 84 67 53 61 65 64 61 78 86 84 86 65 51 57 60 52 49  0  0  0  0  0  0129
0  0  0 86 83120110  0109102 83 63 64 69 79 68 70 50 70 91  0  0 69 45 45 62 44 51 53 56 89  0  0  0
0  0 87  0  0  0  0192114131 80 65 74 76 83 69 56 59100  0  0  0 88 80 65 60 43  0  0  0  0 97 70  0
0  0  0112190 91134148121124 84 79 81 93 82 62 62 70 95  0  0  0  0  0 74114 68 77 74 52 89  0  0  0
                                                                                                     360E
```

Fig. 10 Scale Distance (Z) Computed from NCAR Data

INPUT: 3DNEPH Tapes
6250 BPI
Nine Track
Binary
No Label

Global cloud cover distributions derived from earth-viewing satellite systems are densely packed onto two separate magnetic tapes, one for the Northern Hemisphere and another for the Southern Hemisphere. For each hemisphere data are stored in a one-eighth mesh AFGWC (Air Force Global Weather Central) grid consisting of 512 X 512 array elements. According to Fye (1978) the grid system used for the 3DNEPH is a subset of the basic horizontal AFGWC 200 nm macroscale grid. This subset is one-eighth of the 200 nm grid, resulting in an average grid spacing of approximately 25 nm.

OUTPUT: Because of the large volume of data on each 3DNEPH tape, output of unpacked cloud cover observations from these tapes is currently stored onto a second tape. The unpacked data are utilized in the development of algorithms to convert the data into mean and scale distance parameters.

FORMATS: 3DNEPH data are unpacked and formatted onto a second tape in the following formats:

```
    WRITE(NTAPE,100)IY,MO,MH,JJ1,JJ2,II1,II2
100 FORMAT(1X,3I2,4I4)
```

The variables of this header record are:

- IY: Two-digit Year
- MO: Month of Year
- MH: GMT Hour of Observation
- JJ1: J Coordinate of Grid Cell (1st value)
- JJ2: J Coordinate of Grid Cell (2nd value)

II1: I Coordinate of Grid Cell (1st value)

II2: I Coordinate of Grid Cell (2nd value)

Data for seventeen grid cells are then written in the following format:

```
    DO 50 K=1,17
    WRITE(NTAPE,101)(ID(J),J=1,22)
50  CONTINUE
```

The variable ID is defined as:

ID(1):	Total Cloud Amount
ID(2) thru ID(22):	Data for 21 Cloud Amount Categories

2. <u>PROGRAM NAME</u>: PROC Version 1.0 12/15/87

<u>PURPOSE</u>: To locate and output portions of unpacked 3DNEPH data for investigation

<u>INPUT</u>: 3DNEPH data generated by program MESH4, and selected grid cell numbers

<u>OUTPUT</u>: I and J grid cell coordinates for selected 3DNEPH grid cells are converted to latitude, longitude coordinates and displayed together with cloud cover data associated with each cell.

<u>FORMATS</u>: Data are read using the same formats as for program MESH4.

III. PROTOTYPE SOFTWARE FOR MAPPING GLOBAL SKY COVER

Section II of this report documents the development of a database containing means and scale distance parameters. This section describes the application of that database to produce maps of global sky cover.

One approach to mapping sky cover on a global scale, given two types of parameters randomly spaced over the globe, is to devise accurate interpolation algorithms that will rapidly compute sky cover values given any point on earth. Basically, the algorithm interpolates mean and scale distance parameters in four respects: first, by day; then time of day; then by latitude and longitude. Such an algorithm is presented in this section.

1. PROGRAM NAME: TIMDAY Version 1.0 7/22/87

PURPOSE: Using a Fourier series and Choleski regression, to generate coefficients that can be used to compute or interpolate accurately mean and scale distance parameters given any day and time of day for a single location

INPUT: Archived mean sky cover and scale distance parameters

OUTPUT: Several test runs were initiated to determine the optimum number of Fourier terms needed to interpolate accurately input values of mean sky cover and scale distance to any day and time of day. Fig. 11 shows the amount of error introduced into the interpolation when the number of terms used in the Fourier series is reduced or increased.

Vertical rectangular shapes in the figure represent input sky cover values and single vertical lines represent interpolated values. Tenths of sky cover shown are for Fort Rucker, AL, for the four mid-season months of January, April,

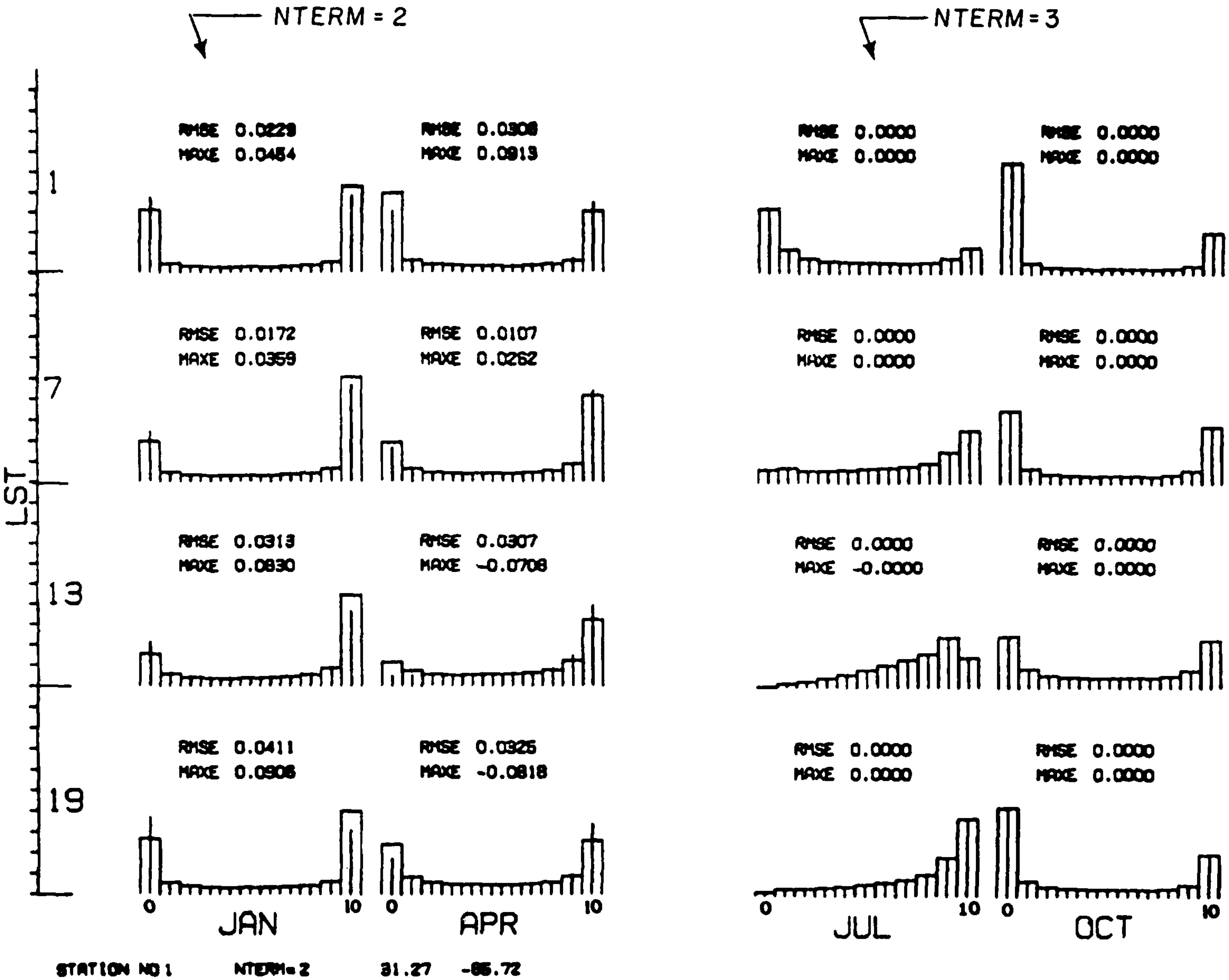

Fig. 11 Program TIMDAY Test Output Error Analysis

July, and October and for the four local standard hours 0100, 0700, 1300, and 1900. The typical error associated with a decrease in the number of Fourier terms used to generate the data is shown on the left. A near perfect fit to the data is obtained when the number of terms is larger, as evidenced by the fit on the right side of the figure.

2. PROGRAM NAME: SUNCOR Version 1.0 7/25/87

PURPOSE: To correlate mean sky cover scale distance parameters with sunrise and sunset time lines

INPUT: Archived mean sky cover and scale distance parameters from selected stations interpolated over days and times of day using program TIMDAY

OUTPUT: Sunrise and sunset time lines were computed and superimposed on the contoured sky cover parameters for visual interpretation. Fig. 12 shows results of this procedure for Fairbanks, Alaska, and Fairfield, CA.

3. PROGRAM NAME: A6060 Version 1.0 12/15/87

PURPOSE: To generate coefficients that can be used to compute or interpolate accurately mean sky cover and scale distance parameters for any longitude and for any latitude between 60° North and 60° South

INPUT: Archived mean sky cover or scale distance parameters and the desired number of coefficients to be computed together with a number describing the amount of input data

OUTPUT: Coefficients generated by program A6060 are written to a file for further processing.

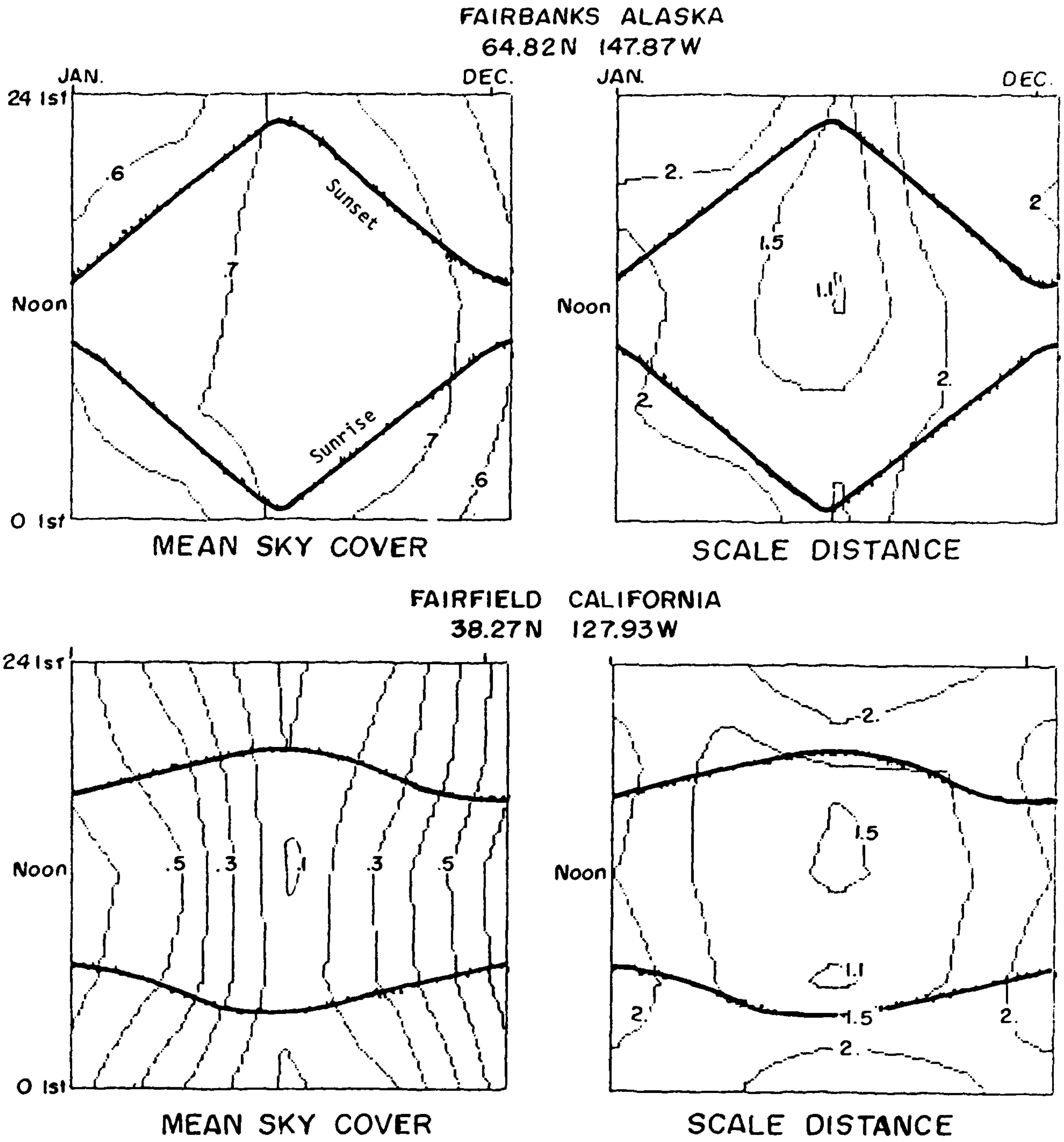

Fig. 12 Correlation of Sunrise and Sunset with Mean Sky Cover and Scale Distance

REMARKS: The program uses a Fourier series to generate coefficients for interpolating values in the longitudinal direction. Legendre coefficients are generated to interpolate values along latitude lines.

In developing this program computer storage requirements and timing considerations were of concern. Mapping accuracy increases as the number of input values and coefficients increases. Storage requirements increase linearly with data amount but processing time increases exponentially as the number of desired coefficients increases. Input of about 500 climatologies and computation of 80 coefficients appears to be appropriate for accurate mapping.

FORMAT: Coefficients are written in the following format:

```
    DO 10 J=1,NC
    WRITE(NDISK,100)J,A(J)
100 FORMAT(I6,E15.4)
 10 CONTINUE
```

Variables are defined as:

NC: Number of Coefficients
J: Index Counter
A: Coefficients

4. PROGRAM NAME: MAPDIS Version 1.0 12/28/87

PURPOSE: To map mean sky cover and scale distance

INPUT: Coefficients generated by program A6060 and the size of the array used to store them

OUTPUT: The coefficients are used with a Fourier series and a Legendre polynomial to produce maps of mean sky cover or scale distance on a global scale from 60^{o} North to 60^{o} South latitude.

FORMAT: Coefficients are read in the following format:

```
    DO 10 J=1,NC
    READ(NDISK,100)J,A(J)
100 FORMAT(I6,E15.4)
 10 CONTINUE
```

Variables are defined as:

NC: Number of Coefficients
J: Index Counter
A: Coefficients

REMARKS: A routine called CATMAP was incorporated that uses a bilinear interpolation technique to contour data arrays into patterns that are produced on a line printer. Fig. 13 displays a map of mean sky cover generated using data from the January 0000 LST RUSARC and SEAARC files. Fig. 14 is a map of scale distance where scale distance values have been converted to Z values for presentation purposes.

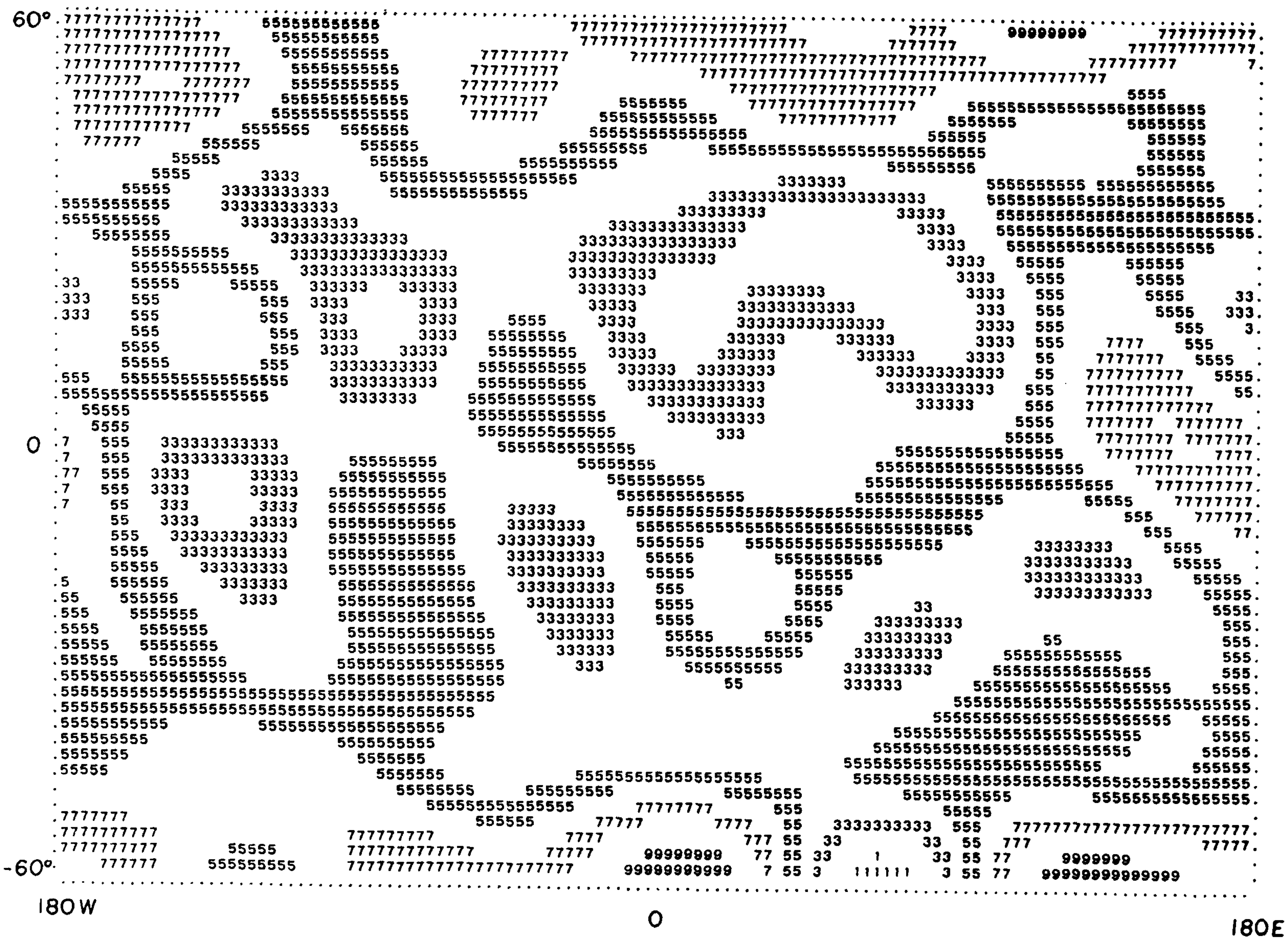

Fig. 13 Map of Mean Sky Cover

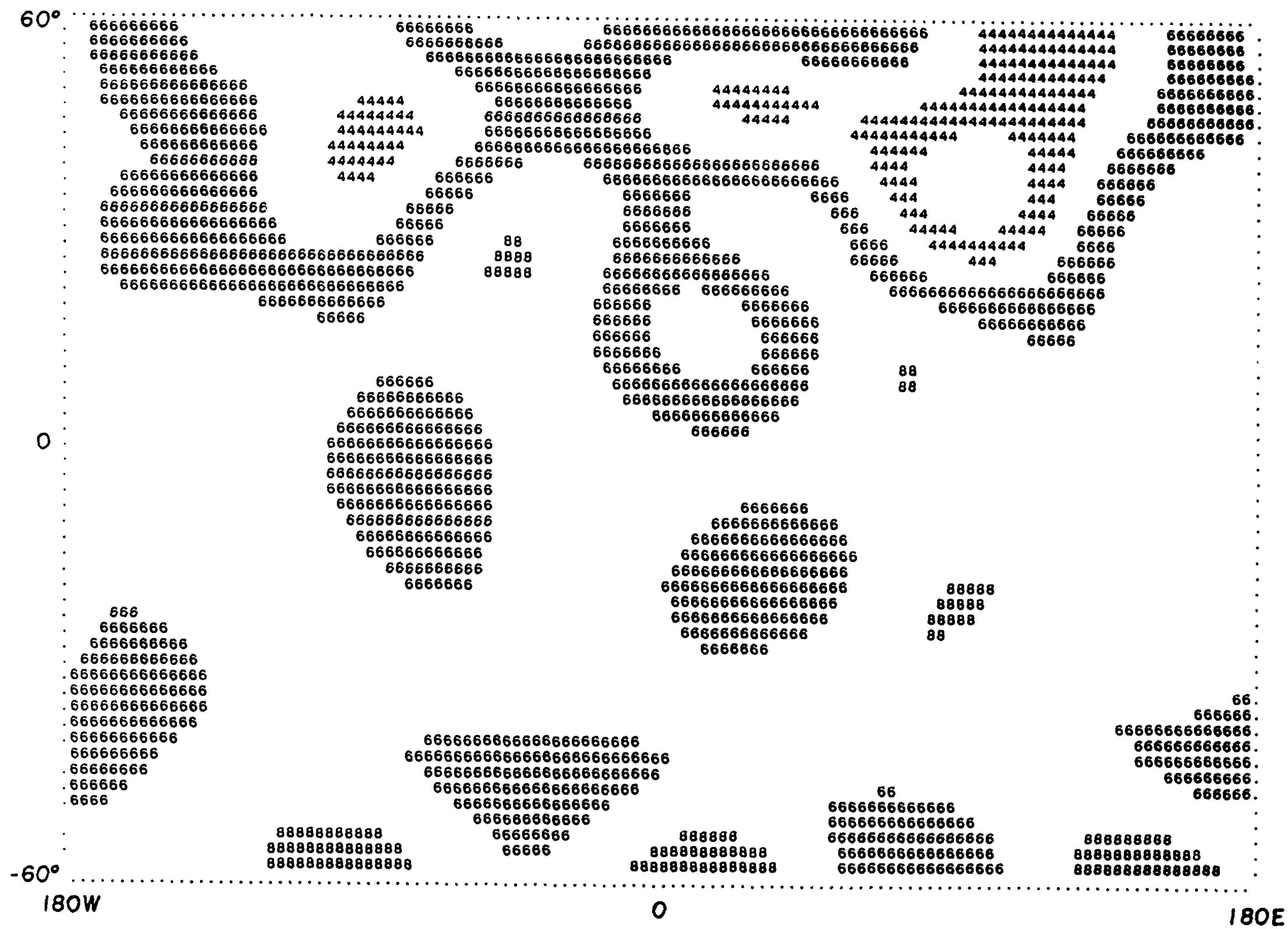

Fig. 14 Scale Distance (Z)

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