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GEOPHYSICAL INSTITUTE

of the

UNIVERSITY OF ALASKA

ABERRATIONS OF RADIO SIGNALS TRAVERSING THE AURORAL IONOSPHERE

SEMI-ANNUAL ANALYSIS REPORT

including

Data covering the period

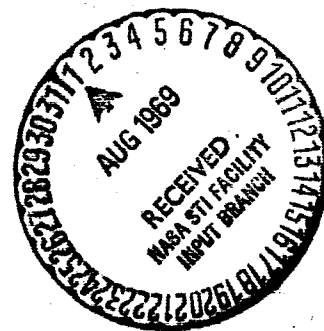
July 1, 1968 through January 31, 1969

Prepared for

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I. INTRODUCTION

This report is primarily concerned with a summary of the analysis of satellite tracking records obtained from Gilmore Creek during the period of July 1, 1968 through January 31, 1969. These data are presented mainly to indicate the decreasing trend in scintillation activity as observed through satellite records. A more detailed analysis will be given in the contract annual report when a full year's data will be available.

II. ANALYSIS OF SATELLITE RECORDS

A. Computer Program Development

A computer program has been developed for the reduction of data obtained from Gilmore Creek Satellite records. A reproduction of this program is included in Appendix A. The reduction techniques parallel those used in manual analysis and described in Sections IIC and IIIC, of report UAG R-181⁽¹⁾, with the simplifications outlined in Section IIIA of the 1967 Annual Report.⁽²⁾

B. Analysis

The records used were the "ten most disturbed" passes selected by Gilmore Creek STADAN personnel for each of seven months from July 1968 through January 1969. Seventy records were received and 68 were used for analysis. Two records were discarded due to the lack of sufficient information for proper analysis.

The average 136 MHz scintillation index for these 68 records is 1.7. This is a reduction of 40% from last year's average of 2.8. For additional comparison, the average scintillation for the 1967 contract year was 2.0 and 1.6 for the preceding year.

Figure 1 is a computer plot of average 136 MHz scintillation indices for analyzed pass records versus universal time. Figure 2 shows the monthly

average scintillation indices for the passes analyzed. Comparison of Figure 1 with the corresponding figure in the 1968 annual report shows a dramatic decrease in the number of highly disturbed passes. As described in previous reports, scintillation can be experienced in any part of the sky, but not with uniform probability of severity. Figures 2 and 3 display the average scintillation index in various sectors of the sky using a format identical to prior reports. As found in past years, scintillation was more severe in the geomagnetic northern half of the sky than in the southern half. The north-to-south ratio for this seven month period is 2.2 as compared with 1.8, 1.8 and 1.9 of the previous three years. A marked reduction over last year in scintillation activity is evident when Figure 3 is compared with Figure 2 of the 1968 Annual Report.

C. Conclusion

Comparison of these data for this seven month period with similar data from the prior year indicates a sharp decrease in the average scintillation activity. However, since these data are not complete over the period of one year they should be used only as an indicator when comparing with past information.

REFERENCES

- (1) Fremouw, E. J., "Aberrations of VHF-UHF Signal Traversing the Auroral Ionosphere", Geophysical Institute Report UAG R-181, University of Alaska, 1966.
- (2) Zonge, K. L. and E. J. Fremouw, "Aberrations of Radio Signals Traversing the Auroral Ionosphere," Geophysical Institute, University of Alaska, NASA Contract NAS5-3940, Annual Report, July, 1967.

LIST OF FIGURES

Figure 1. Average 136 MHz scintillation indices for analyzed pass records versus Universal Time.

Figure 2. Monthly average scintillation index for the "10 Most Disturbed Passes" per month from Gilmore Creek STADAN.

Figure 3. Seven month average scintillation index for disturbed passes in 36 sectors of the sky defined in geomagnetic X-Y coordinates. Dashed axes represent local geographic coordinates.

Figure 4. Quadrant averages of scintillation index based on Figure 3.

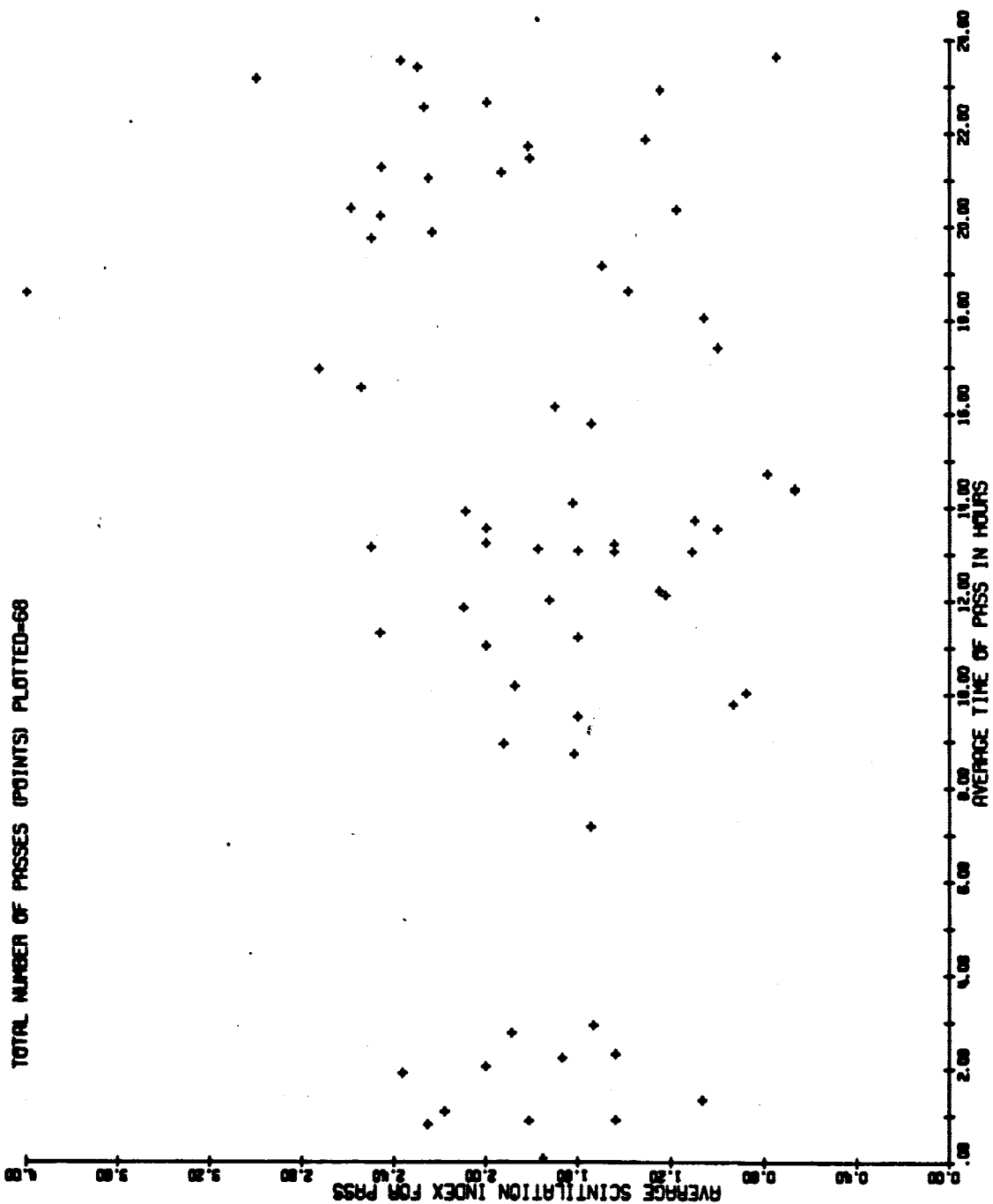


Fig. 1. Average 136 MHz scintillation indices for analyzed pass records versus Universal Time.

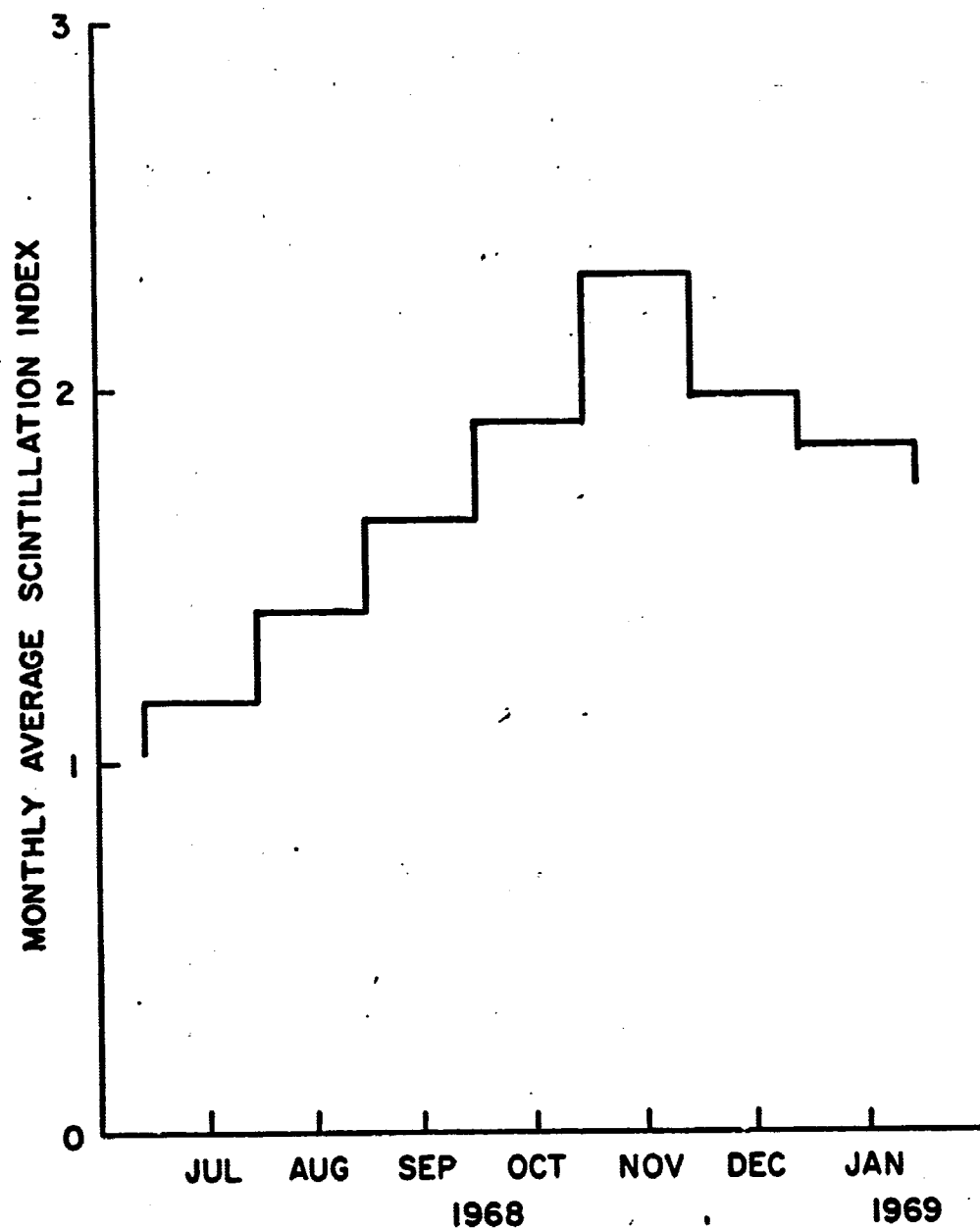


Fig. 2. Monthly average scintillation index for the "10 Most Disturbed Passes" per month from Gilmore Creek STADAN.

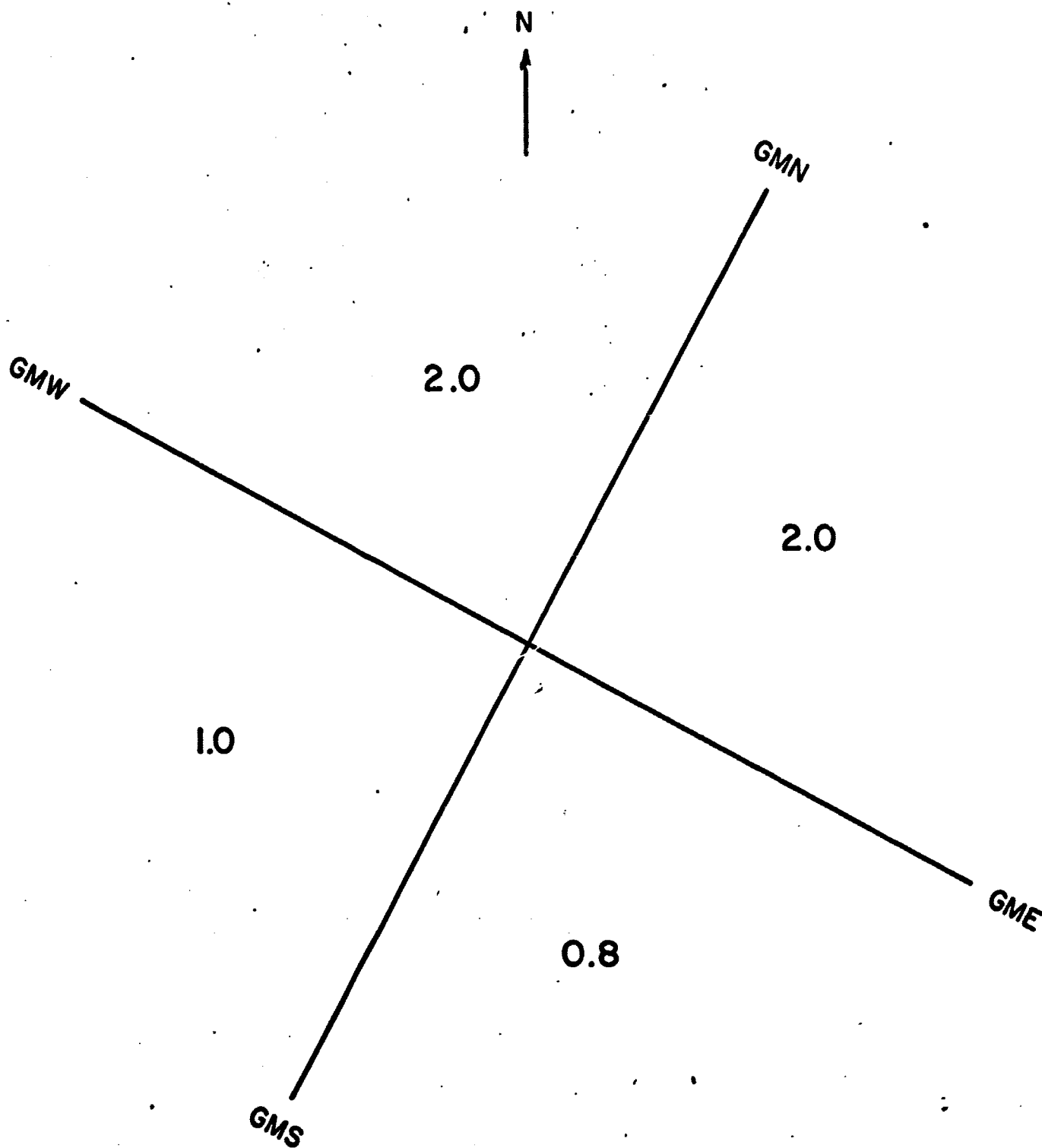


Fig. 4. Quadrant averages of scintillation index based on Fig. 3.

APPENDIX A

DOS FORTRAN IV 360/40

PROGRAM MODIFIED APRIL 4,69 TO INCLUDE

1. AVE.SCINTILATION FOR EACH MONTH
2. A SUMMARY OF ALL MONTHS PLOT OF TIME(AVERAGE OF TIME OF PASS)
VS. THE AVERAGE SCINTILATION

PROGRAM MODIFIED APRIL 21,69 TO INCLUDE A 6X6 TABLE FOR A GROUP OF MONTHS (SAME GROUP FOR PLOT IN ITEM 2 ABOVE) AND ALSO FOR AN AVE. SCINTILLATION FOR THE GROUP.

FORMAT FOR KEYPUNCHING SCINTILATION INDEXS FOR KEN ZONGE

COL 1-10 R.J.+PUNCH DECIMAL REV NO. NORM/TIME

COL 12-13 YEAR (DUP)

COL 15-16 MONTH (DUP) ***

COL 18-19 DAY (DUP.USUALLY)

COL 21-22 HOUR (DUP.USUALLY)

COL 24-25 MIN

COL 28-30 S INDEX FOR GILMORE

COL 32-37 ELEV PUNCH DECIMAL

COL 38-43 AZ PUNCH DECIMAL

COL 45-50 RESERVED FOR SATELLITE NUMBER

*** WHEN ALL DATA FOR A MONTH IS PUNCHED PUNCH A CARD WITH 99 IN MONTH COLUMNS(COL 15-16)

PLACE A CARD WITH 98 IN COLS 15-16 AFTER THE 99 CARD IF IT IS THE LAST MONTH OF A GROUP COMBINED TO MAKE A TIME VS AVE. SCINTILATION PLOT.

PLACE A CARD WITH 97 IN COLS 15-16 AFTER THE 98 CARD IF THERE IS NO MORE DATA TO HANDLE WITH THIS RUN.

SPECIAL NOTES

1. PUNCH ONLY THOSE LINES WHERE A S INDEX IS INDICATED.(IGNORE TOTALS OR AVERAGES)
2. IGNORE ANY PLUS OR MINUS SIGNS ASSOCIATED WITH THE S INDEX

DIMENSION NUM(6,6),TOT(6,6),ALAB(80),DATAP(256),TIMEP(500),
IAVSCPT(500),NUMG(6,6),TOTG(6,6)
CALL PLOTST (DATAP(256),256)

ZERO OUT SUM AREAS

999 IFIRST=C

IMCONT=0

```

IH24=0
RNL=0.
NMON=0.
NGROUP=C
ISINP=C.
TOTMON=0.
TOTGRP=0.0
TTIME=0.
NINPAS=0
NPOINT=0
IDAYL=C
DO 22 M=1,6
DO 22 L=1,6
NUMG(M,L)=0
22 TOTG(M,L)=0.0
1 DO 2 M=1,6
DO 2 L=1,6
NUM(M,L)=0
2 TOT(M,L)=0.0

```

```

C
C   TITLE COLUMNS FOR DATA LISTING
C   WRITE(3,3010)
3010 FORMAT('1','REV.NO.NORM/TIME   YEAR MON DAY  HOUR MIN  S INDEX  EL
ELEVATION  AZIMUTH  SAT. NO.   NEW X   NEW Y')
C
C   READ DATA CARD
C   1. IF MONTH IS 99 GO TO MONTH END OUTPUT (50) (AFTER GOING TO NEW
C   REV. SECTION)
C   2. IF MONTH IS 98 GO TO AVESCIN VS TIME OUTPUT(200)
C   3. IF MONTH IS 97 JOB IS DONE SO GO TO CALL EXIT(197)
C
99 READ(1,1000)REVNUM,(ALAB(K),K=8,10),IY,IMON,IDAY,IHOUR,IMIN,S,EL,
IAZ,(ALAB(K),K=45,50)
1000 FORMAT(F6.0,1X,3A1,5(1X,I2),2X,F3.0,1X,2F6.1,1X,6A1)
      IF(IMON-99)3,49,3
      3 IF(IMON-98)100,200,100
100 IF(IMON-97)101,197,101
101 IMOUT=IMON
    IYOUT=IY
C
C   IF IFIRST=0 DO NOT TEST FOR NEW DAY OR NEW REV. NUMBER
C   BUT INSTEAD STORE DAY IN IDAYL AND REVNUM IN RNL AND MAKE IFIRST=1
C   IF(IFIRST)110,102,110
102 IDAYL=IDAY
    RNL=REVNUM
    IFIRST=1
    GO TO 113
C
C   IF A NEW REV NO. HAS OCCURRED FIND AVE TIME OF PASS AND AVESCIN
110 IF(RNL-REVNUM)300,111,300
C
C   IF A NEW DAY HAS OCCURRED (WITHIN THE SAME REV.NO.) ADD 24 TO IH24
111 IF(IDAYL-IDAY)112,113,112
112 IH24=24+IH24
    IDAYL=IDAY

```

C
 C FIND PASS TIME IN HOURS AND DECIMAL
 113 AMIN=IMIN
 AHOUR=IHOUR+IH24
 PTIME=AHOUR+(AMIN/60.)
 TTIME=TTIME+PTIME
 NINPAS=NINPAS+1
 NMON=NMON+1
 NGROUP=NGROUP+1
 TOTMON=TOTMON+S
 TOTGRP=TOTGRP+S
 TSINP=TSINP+S
 C
 C CONVERT AZ GEOGRAPHIC TO GEOMAGNETIC
 400 AZM=AZ-29.
 C
 C CONVERT AZM AND EL TO RADIANS FOR USE IN COMPUTATIONS
 AZMR=AZM*.0174533
 ELR=EL*.0174533
 C
 C CONVERT TO X AND Y
 F1=COS(ELR)
 F2=COS(AZMR)
 F3=SIN(ELR)
 F4=SIN(AZMR)
 YM=ATAN((F1*F2)/(SQRT(ABS(F1*F1*F4*F4+F3*F3))))*57.2958
 XM=ATAN((F1*F4)/F3)*57.2958
 C
 C PRINT THE DATA FOR CHECKOUT PURPOSES
 WRITE(3,3011)REVNUM,(ALAB(K),K=6,10),IY,IMON,IDAY,IHOUR,IMIN,S,EL,
 1AZ,(ALAB(K),K=45,50),XM,YM
 3011 FORMAT(' ',5X,F6.0,' ',3A1,6X,2(I2,2X),I2,4X,I2,2X,I2,F9.2,F10.2,
 1F9.2,3X,6A1,1X,2F10.2)
 C CHECK DATA TO MAKE SURE BOTH X AND Y ARE LESS THAN 90DEG+OR-
 IF(ABS(XM)-90.)4,40,40
 4 IF(ABS(YM)-90.)5,40,40
 40 WRITE(3,3000)EL,AZ,XM,YM
 3000 FORMAT('0','THE FOLLOWING COORDINATES ARE OUT OF THIS WORLD.',/,
 1E=',F8.2,3X,'A=',F8.2,3X,'XMAG=',F8.2,3X,'YMAG=',F8.2)
 GO TO 99
 C BOTH X + Y ARE BETWEEN -90 AND +90 SO FIND SUBSCRIPTS AND STORE
 5 A=-1.
 NX=(120.+XM)/30.
 NY=(120.+YM*A)/30.
 NUM(NX,NY)=NUM(NX,NY)+1
 NUMG(NX,NY)=NUMG(NX,NY)+1
 TOT(NX,NY)=TOT(NX,NY)+S
 TOTG(NX,NY)=TOTG(NX,NY)+S
 GO TO 99
 C
 C A NEW PASS HAS BEEN SENSED
 C FIND AVE TIME OF PASS AND AVE SIN. AND ADD ONE TO NUMBER OF POINTS
 C ON PLOT
 C
 300 NPOINT=NPOINT+1

```

ATT=TTIME/NINPAS
IF(ATT-24)302,302,301
301 ATT=ATT-24.
302 TIMEP(NPOINT)=ATT
AVSCPT(NPOINT)=TSINP/NINPAS
C
C WRITE A LINE AT THE END OF EACH REV NUMBER
WRITE(3,3100)TIMEP(NPOINT),AVSCPT(NPOINT), NINPAS
3100 FORMAT(' ', 'AVERAGE TIME OF PASS IN HOURS=', F8.3, ' AVERAGE SCIN
1TILLATION=', F7.3, ' NUMBER IN PASS=', I4, '/')
IFIRST=0
IH24=0
NINPAS=0
TTIME=0.0
TSINP=0.0
RNL=REVNUM
IDAYL=IDAY
C
C IF IMCONT=1 WE ARE HERE BECAUSE AN END OF MONTH HAS BEEN SENSED
C SO WE WISH TO CONTINUE BY OUTPUTING THE MONTHLY 6X6 TABLE
C
C IF IMCONT=0 WE WISH TO HANDLE AS THE FIRST DATA CARD IN NEW PASS
IF(IMCONT)50,386,50
386 WRITE(3,3010)
GO TO 113
C
C A SUMMARY PLOT IS DESIRED AS 98 CARD HAS BEEN SENSED
200 NP1=NPCINT+1
NP2=NPCINT+2
TIMEP(NP1)=0.0
TIMEP(NP2)=2.0
AVSCPT(NP1)=0.0
AVSCPT(NP2)=0.4
CALL AXIS(0.0,0.0, 'AVERAGE TIME OF PASS IN HOURS', -29,12.,0.0,0.0,
12.0,20.)
CALL AXIS(0.0,0.0, 'AVERAGE SCINTILLATION INDEX FOR PASS', 36,10.0,
190.0,0.0,0.4,10.0)
FPN=NPCINT
CALL SYMBOL(1.0,10.0,.14, 'TOTAL NUMBER OF PASSES (POINTS) PLOTTED=
',0.0,40)
CALL NUMBER(-0.0,-0.0,-0.0,FPN,0.0,-1)
C
CALL LINE(TIMEP,AVSCPT,NPOINT,1,-1,3)
C
GO TO NEW ZERO
CALL PLOT(15.0,0.0,-3)
C
C PRINT OUT THE 6X6 TABLE FOR THE GROUP (TITLE,CALCULATE ETC.)
WRITE(3,3020)IMOUT,IYOUT
3020 FORMAT('1', 'TABLE OF SCINTILLATION AVERAGES FOR THE GROUP OF MONTH
1S ENDING WITH MONTH=', I3, ' YEAR=', I3, '/')
C
C CALCULATE AVERAGES AND PUT IN TOTG ARRAY
DO 16 M=1,6
DO 16 L=1,6
IF(NUMG(M,L))18,17,18

```

```

17 TOTG(M,L)=0.0
GO TO 16
18 B=NUMG(M,L)
TOTG(M,L)=TOTG(M,L)/B
16 CONTINUE

```

```

C
C TITLE COLS. AND PRINT OUT DATA FOR GROUP
WRITE(3,3003)
WRITE(3,3004)
DO 19 J=1,6
LAB1=120-(J*30)
LAB2=LAB1-30
19 WRITE(3,3005)LAB1,LAB2,(TOTG(K,J),NUMG(K,J),K=1,6)

```

```

C
C FIND AVESIN FOR GROUP AND PRINT IT WITH NO. OF OBSERVATIONS IN
C GROUP
AVEGRP=TOTGRP/NGROUP
WRITE(3,3021)NGROUP,AVEGRP
3021 FORMAT('0','NUMBER OF OBSERVATIONS IN GROUP=',I5,' AVERAGE SCIN
1TILLATION FOR GROUP=',F10.3)
TOTGRP=0.0
NGROUP=0
GO TO 999

```

```

C
C THE PLOT IS NOW DONE AND ANOTHER GROUP CAN BE DONE

```

```

C
C AN END OF MONTH HAS BEEN SENSED - OUTPUT (CALCULATE AVERAGES INTO
C TOT ARRAYS)

```

```

C
C HOWEVER FIRST IT IS NECESSARY TO CONSIDER THAT THIS IS THE END OF
C A PASS- SO GO BACK AND FIND AVE. TIME, AVE. SCIN. AND PRINT LINE

```

```

49 IMCONT=1
GO TO 300
50 WRITE(3,3001)IYOUT,IMOUT
3001 FORMAT('1','TABLE OF SCINTILLATION AVERAGES FOR YEAR=',I3,' MONTH
1=',I3,///)
IMCONT=0.
DO 6 M=1,6
DO 6 L=1,6
IF(NUM(M,L))8,7,8
7 TOT(M,L)=0.0
GO TO 6
8 B=NUM(M,L)
TOT(M,L)=TOT(M,L)/B
6 CONTINUE

```

```

C
C TITLE THE COLUMNS AND THEN PRINT OUT DATA
WRITE(3,3003)
3003 FORMAT('0',16X,'-90. TO -60.',8X,'-60. TO -30.',8X,'-30. TO 0.0 ',
18X,' 0.0 TO +30.',8X,'+30. TO +60.',8X,'+60. TO +90.')
WRITE(3,3004)
3004 FORMAT(' ',12X,6(' AVE.SIN. NUMBER '))
DO 9 J=1,6
LAB1=120-(J*30)

```

```

LAB2=LAB1-30
9 WRITE(3,3005)LAB1,LAB2,(TOT(K,J),NUM(K,J),K=1,6)
3005 FORMAT('0',I4,' TO',I4,6(F10.3,2X,I5,3X))
C
C FIND THE AVESCI FOR MONTH AND PRINT IT WITH NUM. OF OBSERVATIONS
C IN MONTH - THEN RESET THESE TOTALS
AVEMON=TOTMON/NMON
WRITE(3,3200)NMON,AVEMON
3200 FORMAT('0','NUMBER OF OBSERVATIONS IN MONTH=',I4,' AVERAGE SCINT
ILLATION FOR MONTH=',F10.3)
TOTMON=0.0
NMON=0
GO TO 1
197 CALL EXIT
END

```