#659

MSIS-86
MN-61A
MN-61B MN-61C
NEUTRAL ATMOSPHERE MODEL

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1. INTRODUCTION:

The documentation for this data set was originally on paper, kept in NSSDC's Data Set Catalogs (DSCs). The paper documentation in the Data Set Catalogs have been made into digital images, and then collected into a single PDF file for each Data Set Catalog. The inventory information in these DSCs is current as of July 1, 2004. This inventory information is now no longer maintained in the DSCs, but is now managed in the inventory part of the NSSDC information system. The information existing in the DSCs is now not needed for locating the data files, but we did not remove that inventory information.

The offline tape datasets have now been migrated from the original magnetic tape to Archival Information Packages (AIP's).

A prior restoration may have been done on data sets, if a requestor of this data set has questions; they should send an inquiry to the request office to see if additional information exists.

2. ERRATA/CHANGE LOG:

NOTE: Changes are made in a text box, and will show up that way when displayed on screen with a PDF reader.

When printing, special settings may be required to make the text box appear on the printed output.

Version	Date	Person	Page	Description of Change
01				
02				

3 LINKS TO RELEVANT INFORMATION IN THE ONLINE NSSDC INFORMATION SYSTEM:

http://nssdc.gsfc.nasa.gov/nmc/

[NOTE: This link will take you to the main page of the NSSDC Master Catalog. There you will be able to perform searches to find additional information]

4. CATALOG MATERIALS:

a. Associated Documents To find associated documents you will need to know the document ID number and then click here.
http://nssdcftp.gsfc.nasa.gov/miscellaneous/documents/

b. Core Catalog Materials

REQ. AGENT	RAND NO.	ACQ. AGENT
SAR JFB	V0356	DKB

No New I.D. Numbers

MSIS-86

NEUTRAL ATMOSPHERE MODEL

MN-61A

MN-61B

MN-61~~B~~C

THIS DATA SET CATALOG CONSISTS OF ONE MAGNETIC TAPE. THE TAPE IS 9 TRACK 1600 BPI, ASCII AND HAS A TOTAL OF 7 FILES. THE FIRST THREE FILES ARE MN-61A WHICH WAS CREATED ON THE VAX 11/780 AND IS LABELLED. THE SECOND THREE FILES ARE MN-61B WHICH WAS CREATED ON THE PDP 11/70 AND IS UNLABELLED. THE LAST FILE IS MN-61C WHICH IS AN IBM MVS VERSION OF MN-61B. THE D AND C NUMBER IS LISTED BELOW.

D#	C#
D-74880	C-26327

DESCRIPTION OF MAGNETIC TAPE MSIS-86

NSSDC-Id MN-61B

NAME(short): MSIS on unlabeled tape

(long): Mass-Spectrometer-Incoherent-Scatter neutral atmosphere model on unlabeled tape

DATE: April 28, 1987

COMPUTER: PDP 11/70

FORMAT: 9 track, 1600 BPI, unlabelled, ASCII, 3 files, 80 characters per record

SOURCE: A. Hedin, GSFC code 614, Greenbelt, MD 20771

AGENT: D. Bilitza, GSFC/NSSDC code 633, Greenbelt, MD 20771, tel. (301) 286-9536
SPAN: NSSDCA::[BILITZA]

CONTENT:

(1) FORTRAN source code for MSIS-86 library	1068 rec	MSIS86.FOR
(2) FORTRAN test program for (1)	76 rec	M86TES.FOR
(3) output of test program	92 rec	M86TES.DAT

BRIEF DESCRIPTION:

This unlabeled, ASCII coded, 1600 BPI tape contains the functions, subroutines and a test program for the Mass-Spectrometer-Incoherent-Scatter-1986 (MSIS-86) neutral atmosphere model. This model will also constitute the upper part of the internationally recommended COSPAR International Reference Atmosphere (CIRA-86) following the decisions made at last year's COSPAR general assembly in Toulouse, France.

The MSIS model is based on the extensive data compilation and analysis work of A. E. Hedin and his collaborators: A. E. Hedin et al., J. Geophys. Res. 82, 2139-2156, 1977; A. E. Hedin, J. Geophys. Res. 88, 10170-10188, 1983; A. E. Hedin, accepted for J. Geophys. Res., 1987. Data sources for the present model include temperature and density measurements from several rockets, satellites (OGO-6, San Marco 3, Aeros-A, AE-C, AE-D, AE-E, ESRO 4 and DE-2) and incoherent scatter radars (Millstone Hill, St. Santin, Arecibo, Jicamarca, and Malvern). Since the MSIS-83 model, terms were added or changed to better represent seasonal variations in the polar regions under both quiet and magnetically disturbed conditions and local time variations in the magnetic activity effect. In addition a new species, atomic nitrogen, was added to the list of species covered by the model.

The model expects as input: year, day of year, universal time, altitude, geodetic latitude and longitude, local apparent solar time, solar F10.7 flux (for previous day and 3-month average) and magnetic Ap index (daily or Ap history for last 59 hours). For this conditions the following output parameters are calculated: number density of He, O, N2, O2, Ar, H and N, total mass density, neutral temperature and exospheric temperature. For diagnostic purposes the source code is equipped with 23 flags to turn on/off particular variations.

The tape was written on a PDP 11/70 and contains three files: (1) Fortran source code of MSIS library of subroutines and functions (1068

records), (2) Fortran test driver (76 rec), and (3) the test driver output for several examples (92 rec). The model is also available on one VAX/VMS tape, on floppy disc, and on the SPAN network.

```
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0.213315E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.948758E+01	0.884541E-02	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.113139E+00	0.169134E+00
0.145192E-01	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.107906E-01	0.299942E-04	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	-0.148930E-01
-0.787184E-02	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
-0.683420E-01	-0.441778E-01	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.229730E-01	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.868053E+00	0.236364E+00	0.134306E+00	0.103086E-01	0.000000E+00
-0.379164E-02	-0.157806E+00	0.000000E+00	-0.587644E-01	-0.312508E+00
0.000000E+00	0.437387E-01	-0.354091E-01	-0.223636E+02	0.000000E+00
-0.533976E-01	0.000000E+00	0.114091E+03	0.517497E-01	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.132397E+00
0.213315E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.342702E+03	0.157033E-01	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	-0.366278E-02
-0.116193E-02	0.000000E+00	0.000000E+00	0.113139E+00	0.169134E+00
0.178431E-01	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.162864E-01	0.316963E-04	0.127968E-01	0.000000E+00	0.000000E+00
-0.704599E-02	0.207921E-02	0.636660E-02	0.229940E+05	0.000000E+00
0.127833E-01	-0.208036E-02	-0.461820E-02	-0.629391E+02	-0.120745E-01
0.136675E-01	0.136011E-01	-0.537162E-02	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.192509E+05	0.835522E-02	0.419439E-02	0.000000E+00	0.120366E+05
0.000000E+00	0.000000E+00	0.000000E+00	-0.100034E-01	-0.233267E-02
0.972374E-02	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
-0.265079E-01	-0.209125E-01	-0.109465E-01	0.000000E+00	0.000000E+00
0.000000E+00	0.217252E-01	-0.712385E+02	-0.189428E-02	0.000000E+00
-0.602006E-02	0.169058E-01	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.290646E-01
0.348971E-02	0.000000E+00	0.501174E-01	0.550595E-01	0.000000E+00
-0.955897E-02	0.000000E+00	0.000000E+00	-0.151693E+04	0.000000E+00
0.000000E+00	0.129306E-01	0.269567E-02	0.000000E+00	0.392243E+01
-0.847690E-02	0.116896E-01	0.000000E+00	0.148967E-01	0.544521E-02
0.000000E+00	0.564918E+01	0.000000E+00	-0.772178E-02	0.000000E+00
0.000000E+00	-0.734042E+02	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00

```
      OPEN(UNIT=12,FILE='MSIS86.DAT',FORM='FORMATTED',STATUS='OLD')
      READ(12,1290) PT1,PT2,PT3,PA1,PA2,PA3,PB1,PB2,PB3,PC1,PC2,
     &   PC3,PD1,PD2,PD3,PE1,PE2,PE3,PF1,PF2,PF3,PG1,PG2,PG3,PH1,
     &   PH2,PH3,PI1,PTM,PDM
1290  FORMAT(5E13.6)
      DO 10 I=1,3
        ISDATE(I)=ISD(I)
   10 CONTINUE
      DO 20 I=1,2
        ISTIME(I)=IST(I)
   20 CONTINUE
      NAME(1)='CIRA'
      NAME(2)='-86 '
      END
C-----------------------------------------------------------------------
      SUBROUTINE GGM(ART,XLG,BG,XLM,BM)
C CALCULATES GEOMAGNETIC LONGITUDE (XLM) AND LATITUDE (BM)
C FROM GEOGRAFIC LONGITUDE (XLG) AND LATITUDE (BG) FOR ART=0
C AND REVERSE FOR ART=1. ALL ANGLES IN DEGREE.
C LATITUDE:-90 TO 90. LONGITUDE:0 TO 360 EAST.
      INTEGER ART
      FAKTOR=.0174532925
      ZPI=FAKTOR*360.
      CBG=11.4*FAKTOR
      CI=COS(CBG)
      SI=SIN(CBG)
      IF(ART.EQ.0) GOTO 10
      CBM=COS(BM*FAKTOR)
      SBM=SIN(BM*FAKTOR)
      CLM=COS(XLM*FAKTOR)
      SLM=SIN(XLM*FAKTOR)
      SBG=SBM*CI-CBM*CLM*SI
      BG=ASIN(SBG)
      CBG=COS(BG)
      SLG=(CBM*SLM)/CBG
      CLG=(SBM*SI+CBM*CLM*CI)/CBG
        IF(CLG.GT.1.) CLG=1.
        XLG=ACOS(CLG)
      IF(SLG.LT.0.0) XLG=ZPI-ACOS(CLG)
      BG=BG/FAKTOR
      XLG=XLG/FAKTOR
      XLG=XLG-69.8
      IF(XLG.LT.0.0) XLG=XLG+360.0
        RETURN
10    YLG=XLG+69.8
      CBG=COS(BG*FAKTOR)
      SBG=SIN(BG*FAKTOR)
      CLG=COS(YLG*FAKTOR)
      SLG=SIN(YLG*FAKTOR)
      SBM=SBG*CI+CBG*CLG*SI
      BM=ASIN(SBM)
      CBM=COS(BM)
      SLM=(CBG*SLG)/CBM
      CLM=(-SBG*SI+CBG*CLG*CI)/CBM
      XLM=ACOS(CLM)
      IF(SLM.LT..0) XLM=ZPI-ACOS(CLM)
      BM=BM/FAKTOR
      XLM=XLM/FAKTOR
      END
```

```
 0.996040E+00 0.385528E-01 0.303445E-02-0.105531E+00-0.607134E-02
-0.516278E-03-0.115622E+00 0.202240E-02 0.990156E-02-0.127371E+00
-0.302449E-01 0.123512E-01-0.526277E-02-0.845398E+01 0.000000E+00
 0.142370E-01 0.000000E+00 0.125818E+03 0.805486E-02 0.164419E-02
-0.621452E-05 0.311701E-02 0.000000E+00 0.386578E-02 0.132397E+00
 0.213315E+00 0.000000E+00 0.000000E+00 0.000000E+00-0.641110E-05
 0.000000E+00 0.300150E+02 0.533297E-02 0.389146E-02 0.204725E-02
 0.000000E+00 0.000000E+00-0.192645E-01 0.275905E+01 0.147284E-02
 0.341345E-03-0.117388E-02-0.354589E-03 0.113139E+00 0.169134E+00
 0.508295E-02 0.365016E-04 0.426385E-02 0.115102E-03 0.511819E-02
 0.609108E-02 0.404995E-04 0.153049E-02 0.241470E-04 0.230764E-02
 0.155267E-02 0.133722E-02-0.182318E-02-0.263007E+03 0.000000E+00
 0.137337E-02 0.995774E-03 0.000000E+00-0.108983E+03 0.562606E-02
 0.594053E-02 0.109358E-02 0.000000E+00-0.133410E-01-0.243409E-01
-0.135688E-01 0.311370E+05 0.000000E+00 0.000000E+00 0.000000E+00
-0.283023E+04 0.845583E-03 0.538706E-03 0.000000E+00 0.247956E+03
 0.292246E-02 0.000000E+00 0.000000E+00 0.747703E-04 0.887993E-03
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
-0.116540E-01-0.449173E-02-0.353189E-03-0.173933E-03-0.153218E-03
-0.565411E+00 0.777272E-02-0.911784E+02 0.645187E-03 0.000000E+00
-0.837685E-03 0.242318E-02 0.473796E-02-0.301801E-02-0.423564E-02
-0.248289E-02 0.919286E-03 0.216372E-02 0.863968E-03 0.189689E-02
 0.415654E-02 0.000000E+00 0.118068E-01 0.331190E-02 0.000000E+00
 0.120222E-02 0.000000E+00 0.000000E+00-0.307246E+01 0.000000E+00
 0.000000E+00 0.672403E-03 0.108930E-02 0.972278E-03 0.468242E+01
-0.315034E-03 0.400059E-02 0.515036E-02 0.162989E-02 0.108824E-02
 0.995261E-03 0.418955E+01-0.364059E+00 0.170182E-02 0.000000E+00
 0.000000E+00-0.320120E+01 0.000000E+00 0.580206E-02 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.104934E+01-0.288362E-01-0.207095E+00-0.103314E+00-0.702373E-02
 0.129664E-01 0.408853E+00-0.919895E-02-0.188660E-01 0.140927E+01
 0.175033E+00 0.187351E-01 0.110979E+00-0.742871E+01 0.000000E+00
 0.267143E+00-0.595979E-01 0.105038E+03-0.840963E-01-0.697632E-03
 0.206521E-05 0.765306E-03 0.000000E+00 0.000000E+00 0.126762E+00
 0.128876E+00-0.504479E-01-0.130735E-01-0.224348E-01 0.000000E+00
 0.000000E+00-0.150832E+03-0.629928E-02 0.000000E+00-0.407760E-02
 0.000000E+00 0.000000E+00 0.525725E-01-0.311486E+02-0.313351E-02
 0.275838E-02 0.000000E+00 0.000000E+00 0.111247E+00 0.108815E+00
-0.466713E-01 0.000000E+00-0.329329E-02 0.000000E+00 0.167838E-02
-0.916691E-02 0.345044E-04-0.971806E-02 0.000000E+00-0.204672E-02
-0.786899E-02-0.798285E-02 0.536515E-02-0.531172E+04 0.000000E+00
-0.642781E-02-0.171690E-02 0.000000E+00-0.679131E+02-0.179912E-01
-0.158305E-01-0.712313E-02 0.000000E+00 0.253477E-01 0.852960E-01
 0.102163E+00 0.295009E+05 0.000000E+00 0.000000E+00 0.000000E+00
-0.684625E+04-0.619098E-02-0.269289E-02 0.000000E+00-0.520231E+03
-0.633463E-02 0.000000E+00 0.000000E+00-0.602428E-02-0.407077E-02
 0.542264E-02 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.407560E-01 0.282288E-01 0.908088E-02 0.000000E+00 0.000000E+00
-0.405204E+00-0.597931E-01-0.731823E+02-0.206620E-02 0.000000E+00
-0.372723E-02-0.188146E-01-0.101794E-01 0.804633E-02 0.101090E-01
 0.873253E-02 0.238268E-01 0.480444E-02 0.171088E-02 0.396369E-01
-0.213809E-01 0.000000E+00-0.102588E+00-0.591702E-02 0.000000E+00
 0.270923E-02 0.000000E+00 0.000000E+00-0.175043E+03 0.603489E+00
-0.617589E+00 0.838098E-02 0.183871E-02-0.705329E-03-0.406644E+01
-0.509347E-02-0.284344E-01-0.124160E-01 0.133665E-01 0.393410E-02
-0.503723E-03-0.457683E+01-0.529542E+00-0.425812E-02 0.000000E+00
 0.000000E+00 0.191541E+02 0.000000E+00 0.323247E-02 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
```

```
      RETURN
      END
C-----------------------------------------------------------------------
      SUBROUTINE TSELEC(SV)
C        SET SWITCHES
      DIMENSION SV(1),SAV(25),SVV(1)
      COMMON/CSW/SW(25),ISW,SWC(25)
      DO 100 I = 1,25
        SAV(I)=SV(I)
        SW(I)=AMOD(SV(I),2.)
        IF(ABS(SV(I)).GT.0.) THEN
          SWC(I)=1.
        ELSE
          SWC(I)=0.
        ENDIF
  100 CONTINUE
      ISW=64999
      RETURN
      ENTRY TRETRV(SVV)
      DO 200 I=1,25
        SVV(I)=SAV(I)
  200 CONTINUE
      END
C-----------------------------------------------------------------------
      FUNCTION GLOB5L(P)
C      LIMITED PARAMETER VERSION OF GLOBE 9/2/82
C       CALCULATE G(L) FUNCTION FOR MSIS-86/CIRA 1986
C       Lower Thermosphere Parameters
      COMMON/LPOLY/PLG(9,4),CTLOC,STLOC,C2TLOC,S2TLOC,C3TLOC,S3TLOC,
     $ IYR,DAY,DF,DFA,APD,APDF,APT(4)/CSW/SW(25),ISW,SWC(25)
      DIMENSION P(150),T(15)
      DATA DR/1.72142E-2/,T/15*0./
      DATA DAYL/-1./,P7/-1000./,P9/-1000./,P11/-1000./
      IF(DAY.NE.DAYL.OR.P7.NE.P(7)) CD7=COS(DR*(DAY-P(7)))
      IF(DAY.NE.DAYL.OR.P9.NE.P(9)) CD9=COS(2.*DR*(DAY-P(9)))
      IF(DAY.NE.DAYL.OR.P11.NE.P(11)) CD11=COS(DR*(DAY-P(11)))
      DAYL=DAY
      P7=P(7)
      P9=P(9)
      P11=P(11)
C
      T(1)=P(2)*DFA
      T(2)=P(4)*PLG(3,1)
      T(3)=P(6)*CD7
      T(4)=(P(8) )*CD9
      T(5)=(P(10)*PLG(2,1)+P(22)*PLG(4,1))*CD11
      T(6)=0.
      T(7)=(P(14)*PLG(2,2)*CTLOC+P(15)*PLG(2,2)*STLOC)
      T(8)=(P(16)*PLG(3,3)+P(18)*PLG(5,3)
     $     +(P(20)*PLG(6,3))*CD11*SWC(5)
     $     )*C2TLOC
     $     +(P(17)*PLG(3,3)+P(19)*PLG(5,3)
     $     +(P(21)*PLG(6,3))*CD11*SWC(5)
     $     )*S2TLOC
      T(14)=(P(12)*PLG(4,4)*C3TLOC
     $     +P(25)*PLG(4,4)*S3TLOC)
      IF(SW(9).EQ.1)
     $ T(9)=APDF*(P(23)+P(24)*PLG(3,1)*SWC(2))
      IF(SW(9).EQ.-1)
     $ T(9)=(P(3)*APT(3)+P(5)*PLG(3,1)*APT(3)*SWC(2))
```

```
C       PARMS NOT USED: 13
      TT=0.
      DO 50 I=1,14
   50 TT=TT+ABS(SW(I))*T(I)
      GLOB5L=TT
      RETURN
      END
C-----------------------------------------------------------------
      FUNCTION DNET(DD,DM,ZHM,XMM,XM)
C       8/20/80
C       TURBOPAUSE CORRECTION FOR MSIS MODELS
C       Eq. A12b
      A=ZHM/(XMM-XM)
C       Eq. A12a
      YLOG=A*ALOG(DM/DD)
      IF(YLOG.LT.-10.) GO TO 10
      IF(YLOG.GT.10.)  GO TO 20
        DNET=DD*(1.+EXP(YLOG))**(1/A)
        GO TO 50
   10 CONTINUE
        DNET=DD
        GO TO 50
   20 CONTINUE
        DNET=DM
        GO TO 50
   50 CONTINUE
      RETURN
      END
C-----------------------------------------------------------------
      FUNCTION  CCOR(ALT, R,H1,ZH)
C         CHEMISTRY/DISSOCIATION CORRECTION FOR MSIS MODELS
C     Eq. A20a or Eq. A21
      E=(ALT-ZH)/H1
      IF(E.GT.70.) GO TO 20
      IF(E.LT.-70.) GO TO 10
        EX=EXP(E)
        CCOR=R/(1.+EX)
        GO TO 50
   10   CCOR=R
        GO TO 50
   20   CCOR=0.
        GO TO 50
   50 CONTINUE
      CCOR=EXP(CCOR)
       RETURN
      END
C-----------------------------------------------------------------
      SUBROUTINE PRMSG5
C          CIRA     11-FEB-86
      CHARACTER ISD(3),IST(2),NAME(2),ISDATE(3),ISTIME(2)*4
      COMMON/PARMB/GSURF,RE
      COMMON/PARM5/PT1(50),PT2(50),PT3(50),PA1(50),PA2(50),PA3(50),
     * PB1(50),PB2(50),PB3(50),PC1(50),PC2(50),PC3(50),
     * PD1(50),PD2(50),PD3(50),PE1(50),PE2(50),PE3(50),
     * PF1(50),PF2(50),PF3(50),PG1(50),PG2(50),PG3(50),
     * PH1(50),PH2(50),PH3(50),PI1(50)
      COMMON/LOWER5/PTM(8),PDM(8,7)/DATIME/ISDATE,ISTIME,NAME
      DATA ISD/'11-F','EB-8','6   '/,IST/'18:2','3:31'/
      GSURF=980.665
      RE=6356.77
```

```
      P14 = P(14)
      P18 = P(18)
      P32 = P(32)
      P39 = P(39)
C         F10.7 EFFECT
      DF = F107 - F107A
      DFA=F107A-150.
      T(1) =  P(20)*DF + P(21)*DF*DF + P(22)*DFA
     $ + P(30)*DFA**2
      F1 = 1. + (P(48)*DFA +P(20)*DF+P(21)*DF*DF)*SWC(1)
      F2 = 1. + (P(50)*DFA+P(20)*DF+P(21)*DF*DF)*SWC(1)
C        TIME INDEPENDENT
      T(2) =
     1  (P(2)*PLG(3,1) + P(3)*PLG(5,1)+P(23)*PLG(7,1))
     $ +(P(15)*PLG(3,1))*DFA*SWC(1)
     2 +P(27)*PLG(2,1)
C        SYMMETRICAL ANNUAL
      T(3) =
     1 (P(19) )*CD32
C        SYMMETRICAL SEMIANNUAL
      T(4) =
     1 (P(16)+P(17)*PLG(3,1))*CD18
C        ASYMMETRICAL ANNUAL
      T(5) =  F1*
     1  (P(10)*PLG(2,1) + P(11)*PLG(4,1))*CD14
C         ASYMMETRICAL SEMIANNUAL
      T(6) =    P(38)*PLG(2,1)*CD39
C        DIURNAL
      T71 = (P(12)*PLG(3,2) + P(36)*PLG(2,2))*CD14*SWC(5)
      T72 = (P(13)*PLG(3,2) + P(37)*PLG(2,2))*CD14*SWC(5)
      T(7) = F2*
     1 ((P(4)*PLG(2,2) + P(5)*PLG(4,2) + P(28)*PLG(6,2)
     2 + T71)*CTLOC
     4 + (P(7)*PLG(2,2) + P(8)*PLG(4,2) +P(29)*PLG(6,2)
     5 + T72)*STLOC)
C        SEMIDIURNAL
      T81 = (P(24)*PLG(4,3))*CD14*SWC(5)
      T82 = (P(34)*PLG(4,3))*CD14*SWC(5)
      T(8) = F2*
     1 ((P(6)*PLG(3,3) + P(42)*PLG(5,3) + T81)*C2TLOC
     3 +(P(9)*PLG(3,3) + P(43)*PLG(5,3) + T82)*S2TLOC)
C        TERDIURNAL
      T(14) = F2*
     1 ((P(40)*PLG(4,4)+(P(94)*PLG(5,4)+P(47)*PLG(7,4))*CD14*SWC(5))*
     $ S3TLOC
     2 +(P(41)*PLG(4,4)+(P(95)*PLG(5,4)+P(49)*PLG(7,4))*CD14*SWC(5))*
     $ C3TLOC)
C         MAGNETIC ACTIVITY BASED ON DAILY AP
      IF(SW(9).EQ.-1. .AND. P(52).NE.0.) GO TO 30
      APD=(AP(1)-4.)
      P44=P(44)
      P45=P(45)
      IF(P44.LT.0) P44=1.E-5
      APDF = (APD+(P45-1.)*(APD+(EXP(-P44  *APD)-1.)/P44  ))
      T(9)=APDF*(P(33)+P(46)*PLG(3,1)+P(35)*PLG(5,1)+
     $ (P(101)*PLG(2,1)+P(102)*PLG(4,1)+P(103)*PLG(6,1))*CD14*SWC(5)+
     $ (P(122)*PLG(2,2)+P(123)*PLG(4,2)+P(124)*PLG(6,2))*SWC(7)*
     $ COS(HR*(TLOC-P(125))))
      GO TO 40
   30 CONTINUE
```

```
      EXP1 = EXP(-10800.*ABS(P(52))/(1.+P(139)*(45.-ABS(LAT))))
      IF(EXP1.GT..99999) EXP1=.99999
      EXP2 = EXP(-10800.*ABS(P(54)))
      IF(EXP2.GT..99999) EXP2=.99999
      IF(P(25).LT.1.E-4) P(25)=1.E-4
      APT(1)=SG0(EXP1)
      APT(3)=SG0(EXP2)
      T(9) = APT(1)*(P(51)+P(97)*PLG(3,1)+P(55)*PLG(5,1)+
     $ (P(126)*PLG(2,1)+P(127)*PLG(4,1)+P(128)*PLG(6,1))*CD14*SWC(5)+
     $ (P(129)*PLG(2,2)+P(130)*PLG(4,2)+P(131)*PLG(6,2))*SWC(7)*
     $ COS(HR*(TLOC-P(132))))
   40 CONTINUE
      IF(SW(10).EQ.0.OR.LONG.LE.-1000.) GO TO 49
C        LONGITUDINAL
      T(11)= (1.+P(90)*PLG(2,1))*(1.+P(81)*DFA*SWC(1))*
     $((P(65)*PLG(3,2)+P(66)*PLG(5,2)+P(67)*PLG(7,2)
     $ +P(104)*PLG(2,2)+P(105)*PLG(4,2)+P(106)*PLG(6,2)
     $ +SWC(5)*(P(110)*PLG(2,2)+P(111)*PLG(4,2)+P(112)*PLG(6,2))*CD14)*
     $     COS(DGTR*LONG)
     $ +(P(91)*PLG(3,2)+P(92)*PLG(5,2)+P(93)*PLG(7,2)
     $ +P(107)*PLG(2,2)+P(108)*PLG(4,2)+P(109)*PLG(6,2)
     $ +SWC(5)*(P(113)*PLG(2,2)+P(114)*PLG(4,2)+P(115)*PLG(6,2))*CD14)*
     $  SIN(DGTR*LONG))
C        UT AND MIXED UT,LONGITUDE
      T(12)=(1.+P(96)*PLG(2,1))*(1.+P(82)*DFA*SWC(1))*
     $(1.+P(120)*PLG(2,1)*SWC(5)*CD14)*
     $((P(69)*PLG(2,1)+P(70)*PLG(4,1)+P(71)*PLG(6,1))*
     $     COS(SR*(SEC-P(72))))
      T(12)=T(12)+SWC(11)*
     $ (P(77)*PLG(4,3)+P(78)*PLG(6,3)+P(79)*PLG(8,3))*
     $     COS(SR*(SEC-P(80))+2.*DGTR*LONG)*(1.+P(138)*DFA*SWC(1))
C        UT,LONGITUDE MAGNETIC ACTIVITY
      IF(SW(9).EQ.-1. .AND. P(52).NE.0.) GO TO 45
      T(13)= APDF*SWC(11)*(1.+P(121)*PLG(2,1))*
     $((P( 61)*PLG(3,2)+P( 62)*PLG(5,2)+P( 63)*PLG(7,2))*
     $     COS(DGTR*(LONG-P( 64))))
     $ +APDF*SWC(11)*SWC(5)*
     $ (P(116)*PLG(2,2)+P(117)*PLG(4,2)+P(118)*PLG(6,2))*
     $     CD14*COS(DGTR*(LONG-P(119)))
     $ + APDF*SWC(12)*
     $ (P( 84)*PLG(2,1)+P( 85)*PLG(4,1)+P( 86)*PLG(6,1))*
     $     COS(SR*(SEC-P( 76)))
      GOTO 48
   45 CONTINUE
      T(13)=APT(1)*SWC(11)*(1.+P(133)*PLG(2,1))*
     $((P(53)*PLG(3,2)+P(99)*PLG(5,2)+P(68)*PLG(7,2))*
     $     COS(DGTR*(LONG-P(98))))
     $ +APT(1)*SWC(11)*SWC(5)*
     $ (P(134)*PLG(2,2)+P(135)*PLG(4,2)+P(136)*PLG(6,2))*
     $     CD14*COS(DGTR*(LONG-P(137)))
     $ +APT(1)*SWC(12)*
     $ (P(56)*PLG(2,1)+P(57)*PLG(4,1)+P(58)*PLG(6,1))*
     $     COS(SR*(SEC-P(59)))
   48 CONTINUE
C  PARMS NOT USED: 60,83,100,140-150
   49 TINF = 0.
      IF(SW(9).EQ.-1.) TINF=P(31)
      DO 50 I = 1,NSW
   50 TINF = TINF + ABS(SW(I))*T(I)
      GLOBE5 = TINF
```

```
C       Eq. A3a
       DD=0.666666*ZG0*DTA/TA**2 - 3.11111*(1./TA-1./T0)+
      $ 7.11111*(1./T12-1./T0)
C       Eq. A3b
       CC=ZG0*DTA/(2.*TA*TA) - (1./TA-1./T0) - 2.*DD
C       Eq. A3c
       BB=(1./TA-1./T0) - CC - DD
        Eq. A3d
       X=(-(ZG1-ZG0)/ZG0)
C       Eq. A1b
       X2=X*X
       TZ=1./(1./T0+BB*X2+CC*X2*X2+DD*X2*X2*X2)
       DENSS=TZ
       TAF=(T12-T0)/(TA-T0)
   10  IF(XM.EQ.0.) GO TO 50
       IF(TA.GT.0. .AND. TZ.GT.0.) GO TO 20
          WRITE(6,*)ALT,XM,TINF,TLB,T0,TA,II,JG,N,DV(J),IFUN,S2,ZG0,TZ
          TT=TLB
          TA=TLB
          TZ=TLB
   20  CONTINUE
C       CALCULATE DENSITY ABOVE ZA
C       Eq. A17a
       GLB=GSURF/(1.+ZLB/RE)**2
C       Eq. A16a
       GAMMA=XM*GLB/(S2*RGAS*TINF)
C       Eq. A13, A14a, & A15
       DENSA=DLB*(TLB/TT)**(1.+ALPHA+GAMMA)*EXP(-S2*GAMMA*ZG2)
       DENSS=DENSA
       IF(ALT.GE.ZA) GO TO 50
C       CALCULATE DENSITY BELOW ZA
C       Eq. A17b
       GLB=GSURF/(1.+ZA/RE)**2
C       Eq. A16b
       GAMM=XM*GLB*ZG0/RGAS
C       Eq. A13, A14b, & A15
       DENSS=DENSA*(TA/TZ)**(1.+ALPHA)*
      $ EXP(GAMM*((X-1)/T0+BB*(X*X2-1.)/3.+CC*(X2*X2*X-1.)/5.+
      $ DD*(X2*X2*X2*X-1.)/7.))
   50  CONTINUE
CCCCCCWRITE(6,100)CXM,ALT,ZA,TINF,TLB,S2,T0,S1,TA,TZ,DLB,DENSA,DENSS
CC100 FORMAT(' D',1P13E10.2)
       RETURN
       END
C-----------------------------------------------------------------------
       FUNCTION GLOBE5(YRD,SEC,LAT,LONG,TLOC,F107A,F107,AP,P)
C        CALCULATE G(L) FUNCTION FOR MSIS-86/CIRA 1986
C        Upper Thermosphere Parameters
       REAL LAT, LONG
       DIMENSION P(150),SV(25),AP(7)
       COMMON/TTEST/TINF,GB,ROUT,T(15)/CSW/SW(25),ISW,SWC(25)
      &      /LPOLY/PLG(9,4),CTLOC,STLOC,C2TLOC,S2TLOC,C3TLOC,S3TLOC,
      &              IYR,DAY,DF,DFA,APD,APDF,APT(4)
       DATA DGTR/1.74533E-2/,DR/1.72142E-2/, XL/1000./,TLL/1000./
      &  DAYL/-1./,P14/-1000./,P18/-1000./,P32/-1000./
      &  HR/.2618/,SR/7.2722E-5/,SV/25*1./,NSW/14/,P39/-1000./
C Eq. A24d
       G0(A)=(A-4.+(P(26)-1.)*(A-4.+(EXP(-ABS(P(25))*(A-4.))-1.)/
      &  ABS(P(25))))
C Eq. A24c
```

```
      SUMEX(EX)=1.+(1.-EX**19)/(1.-EX)*EX**(.5)
C Eq. A24a
      SG0(EX)=(G0(AP(2))+(G0(AP(3))*EX+G0(AP(4))*EX*EX+G0(AP(5))*EX**3
     $ +(G0(AP(6))*EX**4+G0(AP(7))*EX**12)*(1.-EX**8)/(1.-EX)))
     $ /SUMEX(EX)
      IF(ISW.NE.64999) CALL TSELEC(SV)
      T(10) = 0.
      T(11) = 0.
      T(12) = 0.
      T(13)=0.
   10 CONTINUE
      IYR = YRD/1000.
      DAY = YRD - IYR*1000.
C Eq. A22 (remainder of code)
      IF(XL.EQ.LAT)   GO TO 15
C CALCULATE LEGENDRE POLYNOMIALS
      C = SIN(LAT*DGTR)
      S = COS(LAT*DGTR)
      C2 = C*C
      C4 = C2*C2
      S2 = S*S
      PLG(2,1) = C
      PLG(3,1) = 0.5*(3.*C2 -1.)
      PLG(4,1) = 0.5*(5.*C*C2-3.*C)
      PLG(5,1) = (35.*C4 - 30.*C2 + 3.)/8.
      PLG(6,1) = (63.*C2*C2*C - 70.*C2*C + 15.*C)/8.
      PLG(7,1) = (11.*C*PLG(6,1) - 5.*PLG(5,1))/6.
      PLG(2,2) = S
      PLG(3,2) = 3.*C*S
      PLG(4,2) = 1.5*(5.*C2-1.)*S
      PLG(5,2) = 2.5*(7.*C2*C-3.*C)*S
      PLG(6,2) = 1.875*(21.*C4 - 14.*C2 +1.)*S
      PLG(7,2) = (11.*C*PLG(6,2)-6.*PLG(5,2))/5.
      PLG(3,3) = 3.*S2
      PLG(4,3) = 15.*S2*C
      PLG(5,3) = 7.5*(7.*C2 -1.)*S2
      PLG(6,3) = 3.*C*PLG(5,3)-2.*PLG(4,3)
      PLG(7,3)=(11.*C*PLG(6,3)-7.*PLG(5,3))/4.
      PLG(8,3)=(13.*C*PLG(7,3)-8.*PLG(6,3))/5.
      PLG(4,4) = 15.*S2*S
      PLG(5,4) = 105.*S2*S*C
      PLG(6,4)=(9.*C*PLG(5,4)-7.*PLG(4,4))/2.
      PLG(7,4)=(11.*C*PLG(6,4)-8.*PLG(5,4))/3.
      XL=LAT
   15 CONTINUE
      IF(TLL.EQ.TLOC)   GO TO 16
      STLOC = SIN(HR*TLOC)
      CTLOC = COS(HR*TLOC)
      S2TLOC = SIN(2.*HR*TLOC)
      C2TLOC = COS(2.*HR*TLOC)
      S3TLOC = SIN(3.*HR*TLOC)
      C3TLOC = COS(3.*HR*TLOC)
      TLL = TLOC
   16 CONTINUE
      IF(DAY.NE.DAYL.OR.P(14).NE.P14) CD14=COS(DR*(DAY-P(14)))
      IF(DAY.NE.DAYL.OR.P(14).NE.P14) C2D14=COS(DR*2*(DAY-P(14)))
      IF(DAY.NE.DAYL.OR.P(18).NE.P18) CD18=COS(2.*DR*(DAY-P(18)))
      IF(DAY.NE.DAYL.OR.P(32).NE.P32) CD32=COS(DR*(DAY-P(32)))
      IF(DAY.NE.DAYL.OR.P(39).NE.P39) CD39=COS(2.*DR*(DAY-P(39)))
      DAYL = DAY
```

```
      RL=ALOG(B28*PDM(2,5)/B40)
C       Eq. A20a
      HC40=PDM(6,5)*PDL(10,2)
      ZC40=PDM(5,5)*PDL(9,2)
      D(5)=D(5)*CCOR(ALT,RL,HC40,ZC40)
   44 CONTINUE
      IF(MASS.NE.48)   GO TO 90
   45 CONTINUE
C
C        **** HYDROGEN DENSITY ****
C
C       Eq. A18
      G1 = SW(21)*GLOBE5(YRD,SEC,GLAT,GLONG,STL,F107A,F107,AP,PD(1,6))
      DB01 = PDM(1,6)*EXP(G1)*PD(1,6)
C       Eq. A13 - A17
      D(7)=DENSS(ALT,DB01,TINF,TLB,1.,-.4,T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DD=D(7)
      IF(ALT.GT.ALTL(7).OR.SW(15).EQ.0.) GO TO 47
C       Eq. A19
      ZH01=PDM(3,6)
      B01=DENSS(ZH01,DB01,TINF,TLB,1.-XMM,-1.4,
     $  T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DM01=DENSS(ALT,B01,TINF,TLB,XMM,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
C       Eq. A12
      ZHM01=ZHM28
      D(7)=DNET(D(7),DM01,ZHM01,XMM,1.)
C       Eq. A20b
      RL=ALOG(B28*PDM(2,6)*ABS(PDL(18,2))/B01)
C       Eq. A20a
      HC01=PDM(6,6)*PDL(12,2)
      ZC01=PDM(5,6)*PDL(11,2)
      D(7)=D(7)*CCOR(ALT,RL,HC01,ZC01)
       Eq. A21
      HCC01=PDM(8,6)*PDL(20,2)
      ZCC01=PDM(7,6)*PDL(19,2)
      RC01=PDM(4,6)*PDL(21,2)
      D(7)=D(7)*CCOR(ALT,RC01,HCC01,ZCC01)
   47 CONTINUE
   48 CONTINUE
C
C        **** ATOMIC NITROGEN DENSITY ****
C
C       Eq. A18
      G14 = SW(21)*GLOBE5(YRD,SEC,GLAT,GLONG,STL,F107A,F107,AP,PD(1,7))
      DB14 = PDM(1,7)*EXP(G14)*PD(1,7)
C       Eq. A13 - A17
      D(8)=DENSS(ALT,DB14,TINF,TLB,14.,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DD=D(8)
      IF(ALT.GT.ALTL(8).OR.SW(15).EQ.0.) GO TO 49
C       Eq. A19
      ZH14=PDM(3,7)
      B14=DENSS(ZH14,DB14,TINF,TLB,14.-XMM,-1.,
     $  T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DM14=DENSS(ALT,B14,TINF,TLB,XMM,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
C       Eq. A12
      ZHM14=ZHM28
      D(8)=DNET(D(8),DM14,ZHM14,XMM,14.)
C       Eq. A20b
      RL=ALOG(B28*PDM(2,7)*ABS(PDL(3,1))/B14)
C       Eq. A20a
```

```
      HC14=PDM(6,7)*PDL(2,1)
      ZC14=PDM(5,7)*PDL(1,1)
      D(8)=D(8)*CCOR(ALT,RL,HC14,ZC14)
C       Eq. A21
      HCC14=PDM(8,7)*PDL(5,1)
      ZCC14=PDM(7,7)*PDL(4,1)
      RC14=PDM(4,7)*PDL(6,1)
      D(8)=D(8)*CCOR(ALT,RC14,HCC14,ZCC14)
   49 CONTINUE
      IF(MASS.NE.48) GO TO 90
C
C       TOTAL MASS DENSITY
C
      D(6) = 1.66E-24*(4.*D(1)+16.*D(2)+28.*D(3)+32.*D(4)+40.*D(5)+
     $       D(7)+14.*D(8))
      DB48=1.66E-24*(4.*DB04+16.*DB16+28.*DB28+32.*DB32+40.*DB40+DB01+
     $        14.*DB14)
      GO TO 90
   50 DDUM  = DENSS(ALT,1., TINF,TLB,0.,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
      GO TO 90
   90 CONTINUE
      IF(IMR.EQ.1) THEN
        DO 95 I=1,8
          D(I)=D(I)*1.E6
   95   CONTINUE
        D(6)=D(6)/1000.
      ENDIF
      RETURN
  100 FORMAT(1X,'MASS', I5, '  NOT VALID')
      ENTRY METERS(METER)
      IMR=0
      IF(METER) IMR=1
      END
C-----------------------------------------------------------------------
      FUNCTION DENSS(ALT,DLB,TINF,TLB,XM,ALPHA,TZ,ZLB,S2,T0,ZA,Z0,TR12)
C       Calculate Temperature and Density Profiles for MSIS models
      COMMON/PARMB/GSURF,RE
      COMMON/FIT/TAF
      COMMON/LSQV/MP,II,JG,LT,QPB(50),IERR,IFUN,N,J,DV(60)
      DATA RGAS/831.4/
      ZETA(ZZ,ZL)=(ZZ-ZL)*(RE+ZL)/(RE+ZZ)
      DENSS=1.
      Z=AMAX1(ALT,ZA)
C      Eq. A4a
      ZG2=ZETA(Z,ZLB)
C      Eq. A1a
      TT=TINF-(TINF-TLB)*EXP(-S2*ZG2)
      TA=TT
      TZ=TT
      DENSS=TZ
      IF(ALT.GE.ZA) GO TO 10
C      Eq. A4b
      ZG0=ZETA(Z0,ZA)
C      Eq. A2b
      DTA=(TINF-TA)*S2*((RE+ZLB)/(RE+ZA))**2
C      Eq. A3e
      T12=T0+TR12*(TA-T0)
C      Eq. A4b
      ZG1=ZETA(ALT,ZA)
C       CALCULATE TEMPERATURE BELOW ZA
```

```
      ZHM28=PDM(4,3)*PDL(6,2)
      XMD=28.-XMM
      B28=DENSS(ZH28,DB28,TINF,TLB,XMD,-1.,TZ,PTM(6),S,T0,ZA,Z0,TR12)
      IF(ALT.GT.ALTL(3).OR.SW(15).EQ.0.) GO TO 17
      DM28=DENSS(ALT,B28,TINF,TLB,XMM,0.,TZ,PTM(6),S,T0,ZA,Z0,TR12)
C       Eq. A12
      D(3)=DNET(D(3),DM28,ZHM28,XMM,28.)
   17 CONTINUE
      GO TO (20,50,20,25,90,35,40,45,25,48),  J
   20 CONTINUE
C
C       **** HE DENSITY ****
C
C       Eq. A18
      G4 = SW(21)*GLOBE5(YRD,SEC,GLAT,GLONG,STL,F107A,F107,AP,PD(1,1))
      DB04 = PDM(1,1)*EXP(G4)*PD(1,1)
C       Eq. A13 - A17
      D(1)=DENSS(ALT,DB04,TINF,TLB, 4.,-.4,T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DD=D(1)
      IF(ALT.GT.ALTL(1).OR.SW(15).EQ.0.) GO TO 24
C       Eq. A19
      ZH04=PDM(3,1)
      B04=DENSS(ZH04,DB04,TINF,TLB,4.-XMM,-1.4,
     $  T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DM04=DENSS(ALT,B04,TINF,TLB,XMM,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
C       Eq. A12
      ZHM04=ZHM28
      D(1)=DNET(D(1),DM04,ZHM04,XMM,4.)
C       Eq. A20b
      RL=ALOG(B28*PDM(2,1)/B04)
C       Eq. A20a
      ZC04=PDM(5,1)*PDL(1,2)
      HC04=PDM(6,1)*PDL(2,2)
      D(1)=D(1)*CCOR(ALT,RL,HC04,ZC04)
   24 CONTINUE
      IF(MASS.NE.48)   GO TO 90
   25 CONTINUE
C
C       **** O DENSITY ****
C
C       Eq. A18
      G16= SW(21)*GLOBE5(YRD,SEC,GLAT,GLONG,STL,F107A,F107,AP,PD(1,2))
      DB16 =  PDM(1,2)*EXP(G16)*PD(1,2)
C       Eq. A13 - A17
      D(2)=DENSS(ALT,DB16,TINF,TLB, 16.,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DD=D(2)
      IF(ALT.GT.ALTL(2).OR.SW(15).EQ.0.) GO TO 34
C  Corrected from PDM(3,1) to PDM(3,2)  12/2/85
C       Eq. A19
      ZH16=PDM(3,2)
      B16=DENSS(ZH16,DB16,TINF,TLB,16-XMM,-1.,
     $  T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DM16=DENSS(ALT,B16,TINF,TLB,XMM,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
C       Eq. A12
      ZHM16=ZHM28
      D(2)=DNET(D(2),DM16,ZHM16,XMM,16.)
C       Eq. A20b
      RL=ALOG(B28*PDM(2,2)*ABS(PDL(17,2))/B16)
        Eq. A20a
      HC16=PDM(6,2)*PDL(4,2)
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```
      ZC16=PDM(5,2)*PDL(3,2)
      D(2)=D(2)*CCOR(ALT,RL,HC16,ZC16)
C       Eq. A21
      HCC16=PDM(8,2)*PDL(14,2)
      ZCC16=PDM(7,2)*PDL(13,2)
      RC16=PDM(4,2)*PDL(15,2)
      D(2)=D(2)*CCOR(ALT,RC16,HCC16,ZCC16)
   34 CONTINUE
      IF(MASS.NE.48 .AND. MASS.NE.49) GO TO 90
   35 CONTINUE
C
C       **** O2 DENSITY ****
C
C       Eq. A18
      G32= SW(21)*GLOBE5(YRD,SEC,GLAT,GLONG,STL,F107A,F107,AP,PD(1,4))
      DB32 = PDM(1,4)*EXP(G32)*PD(1,4)
C       Eq. A13 - A17
      D(4)=DENSS(ALT,DB32,TINF,TLB, 32.,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
      IF(MASS.EQ.49) THEN
         DD=DD+2.*D(4)
      ELSE
         DD=D(4)
      ENDIF
      IF(ALT.GT.ALTL(4).OR.SW(15).EQ.0.) GO TO 39
C       Eq. A19
      ZH32=PDM(3,4)
      B32=DENSS(ZH32,DB32,TINF,TLB,32.-XMM,-1.,
     $  T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DM32=DENSS(ALT,B32,TINF,TLB,XMM,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
C       Eq. A12
      ZHM32=ZHM28
      D(4)=DNET(D(4),DM32,ZHM32,XMM,32.)
C       Eq. A20b
      RL=ALOG(B28*PDM(2,4)/B32)
C       Eq. A20a
      HC32=PDM(6,4)*PDL(8,2)
      ZC32=PDM(5,4)*PDL(7,2)
      D(4)=D(4)*CCOR(ALT,RL,HC32,ZC32)
   39 CONTINUE
      IF(MASS.NE.48)   GO TO 90
   40 CONTINUE
C
C       **** AR DENSITY ****
C
C       Eq. A18
      G40= SW(21)*GLOBE5(YRD,SEC,GLAT,GLONG,STL,F107A,F107,AP,PD(1,5))
      DB40 = PDM(1,5)*EXP(G40)*PD(1,5)
C       Eq. A13 - A17
      D(5)=DENSS(ALT,DB40,TINF,TLB, 40.,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DD=D(5)
      IF(ALT.GT.ALTL(5).OR.SW(15).EQ.0.) GO TO 44
C       Eq. A19
      ZH40=PDM(3,5)
      B40=DENSS(ZH40,DB40,TINF,TLB,40.-XMM,-1.,
     $  T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DM40=DENSS(ALT,B40,TINF,TLB,XMM,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
C       Eq. A12
      ZHM40=ZHM28
      D(5)=DNET(D(5),DM40,ZHM40,XMM,40.)
C       Eq. A20b
```

```
C     ******************************************************************
      SUBROUTINE GTS5(IYD,SEC,ALT,GLAT,GLONG,STL,F107A,F107,AP,MASS,D,T)
C        MSIS-86/CIRA 1986 Neutral Thermosphere Model
C         A.E.Hedin 3/15/85;2/26/87 (Variable Names Shortened)
C     INPUT:
C        IYD - YEAR AND DAY AS YYDDD
C        SEC - UT(SEC)
C        ALT - ALTITUDE(KM) (GREATER THAN 85 KM)
C        GLAT - GEODETIC LATITUDE(DEG)
C        GLONG - GEODETIC LONGITUDE(DEG)
C        STL - LOCAL APPARENT SOLAR TIME(HRS)
C        F107A - 3 MONTH AVERAGE OF F10.7 FLUX
C        F107 - DAILY F10.7 FLUX FOR PREVIOUS DAY
C        AP - MAGNETIC INDEX(DAILY) OR WHEN SW(9)=-1. :
C           - ARRAY CONTAINING:
C             (1) DAILY AP
C             (2) 3 HR AP INDEX FOR CURRENT TIME
C             (3) 3 HR AP INDEX FOR 3 HRS BEFORE CURRENT TIME
C             (4) 3 HR AP INDEX FOR 6 HRS BEFORE CURRENT TIME
C             (5) 3 HR AP INDEX FOR 9 HRS BEFORE CURRENT TIME
C             (6) AVERAGE OF EIGHT 3 HR AP INDICIES FROM 12 TO 33 HRS PRIOR
C                    TO CURRENT TIME
C             (7) AVERAGE OF EIGHT 3 HR AP INDICIES FROM 36 TO 59 HRS PRIOR
C                    TO CURRENT TIME
C        MASS - MASS NUMBER (ONLY DENSITY FOR SELECTED GAS IS
C                 CALCULATED.  MASS 0 IS TEMPERATURE.  MASS 48 FOR ALL.
C     OUTPUT:
C        D(1) - HE NUMBER DENSITY(CM-3)
C        D(2) - O NUMBER DENSITY(CM-3)
C        D(3) - N2 NUMBER DENSITY(CM-3)
C        D(4) - O2 NUMBER DENSITY(CM-3)
C        D(5) - AR NUMBER DENSITY(CM-3)
C        D(6) - TOTAL MASS DENSITY(GM/CM3)
C        D(7) - H NUMBER DENSITY(CM-3)
C        D(8) - N NUMBER DENSITY(CM-3)
C        T(1) - EXOSPHERIC TEMPERATURE
C        T(2) - TEMPERATURE AT ALT
C
C      TO GET OUTPUT IN M-3 and KG/M3:   CALL METERS(.TRUE.)
C
C          ADDITIONAL COMMENTS
C           (1) LOWER BOUND QUANTITIES IN COMMON/GTS3C/
C           (2) TO TURN ON AND OFF PARTICULAR VARIATIONS CALL TSELEC(SW)
C               WHERE SW IS A 25 ELEMENT ARRAY CONTAINING 0. FOR OFF, 1.
C               FOR ON, OR 2. FOR MAIN EFFECTS OFF BUT CROSS TERMS ON
C               FOR THE FOLLOWING VARIATIONS
C               1 - F10.7 EFFECT ON MEAN  2 - TIME INDEPENDENT
C               3 - SYMMETRICAL ANNUAL    4 - SYMMETRICAL SEMIANNUAL
C               5 - ASYMMETRICAL ANNUAL   6 - ASYMMETRICAL SEMIANNUAL
C               7 - DIURNAL               8 - SEMIDIURNAL
C               9 - DAILY AP             10 - ALL UT/LONG EFFECTS
C              11 - LONGITUDINAL         12 - UT AND MIXED UT/LONG
C              13 - MIXED AP/UT/LONG     14 - TERDIURNAL
C              15 - DEPARTURES FROM DIFFUSIVE EQUILIBRIUM
C              16 - ALL TINF VAR         17 - ALL TLB VAR
C              18 - ALL T0 VAR           19 - ALL S VAR
C              20 - ALL Z0 VAR           21 - ALL NLB VAR
C              22 - ALL TR12 VAR         23 - TURBO SCALE HEIGHT VAR
C
C              To get current values of SW: CALL TRETRV(SW)
```

```
C
      LOGICAL METER
      DIMENSION D(8),T(2),MT(10),AP(7),ALTL(8)
      CHARACTER NAME(2)*4
      COMMON/GTS3C/TLB,S,DB04,DB16,DB28,DB32,DB40,DB48,DB01,ZA,T0,Z0
     $ ,G0,RL,DD,DB14
      COMMON/LOWER5/PTM(8),PDM(8,7)
      COMMON/PARM5/PT(150),PD(150,7),PS(150),PDL(25,2)
      COMMON/CSW/SW(25),ISW,SWC(25)
      COMMON/TTEST/TINFG,GB,ROUT,TT(15)
      COMMON/DATIME/ISDATE(3),ISTIME(2),NAME
      DATA MT/48,0,4,16,28,32,40,1,49,14/,IFL/0/
      DATA ALTL/200.,300.,150.,200.,240.,450.,320.,450./
      DATA IMR/0/
      IF(IFL.EQ.0) THEN
        CALL PRMSG5
        IFL=1
      ENDIF
      YRD=IYD
C       Eq. A7
      TINF=PTM(1)*(1.+SW(16)*GLOBE5(YRD,SEC,GLAT,GLONG,STL,F107A,F107,
     $ AP,PT))*PT(1)
      ZA=PTM(5)*PDL(16,2)
C       Eq. A9
      T0=PTM(3)*PD(76,3)*(1.+SW(18)*GLOB5L(PD(76,3)))
C       Eq. A8
      TLB=PTM(2)*(1.+SW(17)*GLOB5L(PD(26,3)))*PD(26,3)
C       Eq. A10
      Z0=PTM(7)*(1.+SW(20)*GLOB5L(PD(51,3)))*PD(51,3)
C       Eq. A6
      G0=PTM(4)*PS(1)
     $ *(1.+SW(19)*GLOBE5(YRD,SEC,GLAT,GLONG,STL,F107A,F107,
     $ AP,PS))
C       Eq. A5
      S=G0/(TINF-TLB)
C       Eq. A11
      TR12=PD(101,3)*(1.+SW(22)*GLOB5L(PD(101,3)))
      T(1)=TINF
      IF(MASS.EQ.0) GO TO 50
C       Eq. A18  N2
      G28=SW(21)*GLOB5L(PD(1,3))
      YRD=IYD
      T(1)=TINF
      XMM=PDM(5,3)
      DO 10 J = 1,10
      IF(MASS.EQ.MT(J))   GO TO 15
   10 CONTINUE
      WRITE(6,100) MASS
      GO TO 90
   15 IF(ALT.GT.ALTL(6).AND.MASS.NE.28.AND.MASS.NE.48) GO TO 17
C
C       **** N2 DENSITY ****
C
C       Eq. A18
      DB28 = PDM(1,3)*EXP(G28)*PD(1,3)
C       Eq. A13 - A17
      D(3)=DENSS(ALT,DB28,TINF,TLB, 28.,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DD=D(3)
C       Eq. A19
      ZH28=PDM(3,3)
```

```
      IF(ISELEC.GT.0) THEN
        ISWI(ISELEC)=IVALUE
        SWI(ISELEC)=IVALUE*1.0
        GOTO 5521
      ENDIF
      CALL TSELEC(SWI)
      IF(NOTBEG) GOTO 3293
300   IF(JMAG.EQ.1) THEN
        IMZ(1)='GEOM'
        IMZ(2)='GEOM'
      ENDIF
      NOTBEG=.TRUE.
      IF((IVAR.EQ.6).AND.(BVAR.GT.24.0)) THEN
        IMZ(5)='U.T.'
      ENDIF
        WRITE(AGNR,8193) ITEXT(IVAR),IMZ(IVAR)
8193  FORMAT(//////////3X,A5,8X,'NUMBER DENSITIES/CM-3     MASS',
     & ' DENSITY  TEMPERATURE/K'/4X,A4,4X,'   O          N2    ',
     & '     O2        G*CM-3        TN   TEXO')
        XVAR(1)=LATI
        XVAR(2)=LONGI
        XVAR(3)=F107
        XVAR(4)=F107M
        XVAR(5)=DAYNR
        XVAR(6)=HOUR
        XVAR(7)=HEIGHT
        XVAR(8)=AP(1)
        LFD=0
        XVAR(IVAR)=BVAR-SVAR
2123    XVAR(IVAR)=XVAR(IVAR)+SVAR
        LFD=LFD+1
        IF(JMAG.GT.0) THEN
           MLAT=XVAR(1)
           MLONG=XVAR(2)
        ELSE
           LATI=XVAR(1)
           LONGI=XVAR(2)
        ENDIF
        F107=XVAR(3)
        F107M=XVAR(4)
        IF(IVAR.EQ.4) F107=F107M
        DAYNR=XVAR(5)
        HOUR=XVAR(6)
        HEIGHT=XVAR(7)
        AP(1)=XVAR(8)
C
C MSIS CALCULATION
C
        IF((LFD.EQ.1).OR.(IVAR.LT.3))
     &          CALL GGM(JMAG,LONGI,LATI,MLONG,MLAT)
        IF(UTLT) GOTO 3820
        IF(HOUR.LE.24.0) GOTO 3819
          UT=HOUR-25.0
          HOUR=UT+LONGI/15.
          IF(HOUR.GT.24.0) HOUR=HOUR-24.0
          GOTO 3820
3819      UT=HOUR-LONGI/15.
          IF(UT.LT.0.0) UT=UT+24.
3820    UTSEC=UT*3600.0
        CALL GTS5(DAYNR,UTSEC,HEIGHT,LATI,LONGI,HOUR,F107M,F107,
```

```
     &          AP(1),48,DEN,TEMP)
      XCOR=XVAR(IVAR)
      OUTF(1,LFD)=XCOR
      DO 2918 LL=1,8
2918  OUTF(LL+1,LFD)=DEN(LL)
      OUTF(10,LFD)=TEMP(1)
      OUTF(11,LFD)=TEMP(2)
      WRITE(AGNR,7117) XCOR,DEN(2),DEN(3),DEN(4),DEN(6),
     &  INT(TEMP(2)+.5),INT(TEMP(1)+.5)
7117  FORMAT(1X,F7.1,1X,3(1X,1PE10.3),2X,1PE9.3,2X,2I6)
      IF(XCOR.LT.EVAR) GOTO 2123
2289  WRITE(AGNR,2193) LATI,LONGI,HEIGHT,F107,DAYNR,HOUR
     &   ,AP(1),MLAT,MLONG,F107M,UT
2193  FORMAT(1X,74('-')/' LATI/LONG=',F5.1,'/',F5.1,'  H=',F6.1,
     &  '  F10.7 =',F5.1,'  DAY:',I3,'  LT:',F4.1,'  AP=',F4.1/
     &  ' MLAT/MLON=',F5.1,'/',F5.1,12X,'F10.7M=',F5.1,11X,
     &  'UT:',F4.1/1X,74('-'))
        OUT1=.TRUE.
3918  WRITE(MONITO,5600)
5600  FORMAT(1X/' **** DO YOU WANT TO CONTINUE?'/1X,60('-')/
     &  ' "0"  QUIT AND EXIT        "1"  NEW PARAMETERS'/
     &  ' "2"  OTHER OUTPUT WINDOW'/1X,60('-')/)
      READ(EGNR,*) IALL
      IF(IALL.EQ.1) GOTO 3293
      IF(IALL.EQ.0) GOTO 2978
      IF(OUT1) GOTO 1938
        WRITE(AGNR,8193) ITEXT(IVAR),IMZ(IVAR)
      DO 2891 I=1,LANZ
2891  WRITE(AGNR,7117) OUTF(1,I),OUTF(3,I),OUTF(4,I),OUTF(5,I),
     &  OUTF(7,I),INT(OUTF(11,I)+.5),INT(OUTF(10,I)+.5)
      WRITE(AGNR,2193) LATI,LONGI,HEIGHT,F107,DAYNR,HOUR
     &   ,AP(1),MLAT,MLONG,F107M,UT
      OUT1=.TRUE.
      GOTO 3918
1938  WRITE(AGNR,8195) ITEXT(IVAR),IMZ(IVAR)
8195  FORMAT(//////////3X,A5,13X,'NUMBER DENSITIES/CM-3',12X,
     &  'TEMPERATURE/K'/4X,A4,7X,'HE',9X,'AR',9X,'H',
     &  10X,'N',9X,'TN')
      DO 2899 I=1,LANZ
2899  WRITE(AGNR,7119) OUTF(1,I),OUTF(2,I),OUTF(6,I),
     &  OUTF(8,I),OUTF(9,I),INT(OUTF(11,I)+.5)
7119  FORMAT(1X,F7.1,1X,4(1X,1PE10.3),2X,I6)
      WRITE(AGNR,2193) LATI,LONGI,HEIGHT,F107,DAYNR,HOUR
     &   ,AP(1),MLAT,MLONG,F107M,UT
      OUT1=.FALSE.
      GOTO 3918
2978  STOP
      END
```

```
     & ' TIME is assumed, otherwise LOCAL TIME'/1X,70('-')/)
      READ(EGNR,*) BVAR,EVAR,SVAR
      LANZ=INT((EVAR-BVAR)/SVAR)+1
      IF(NOTBEG) GOTO 3293
 3332 WRITE(MONITO,6006) JMAG
 6006 FORMAT(1X//1X,'JMAG ?',50X,'#',I1,'#'//' !! "0" geodatic',
     &  ' longitude and latitude'/' !! "1"    geomagnetic   ... '/
     &  1X,60('-')/)
      READ(EGNR,*) JMAG
      IF(NOTBEG) GOTO 3293
      IVARNR=IVARNR+1
      IF(IVARNR.EQ.IVAR) GOTO 7339
 3329 WRITE(MONITO,5000) LATI
 5000 FORMAT(1X//1X,'LATITUDE ?   !NORTH!    [DEGREE,DECIMAL]',
     & 13X,'#',F5.1,'#'/1X,60('-')/)
      READ(EGNR,*) LATI
      IF(NOTBEG) GOTO 3293
 7339 IVARNR=IVARNR+1
      IF(IVARNR.EQ.IVAR) GOTO 7500
 3339 WRITE(MONITO,6001) LONGI
 6001 FORMAT(1X//1X,'LONGITUDE ?   !EAST!    [DEGREE,DECIMAL]',
     & 13X,'#',F5.1,'#'/1X,60('-')/)
      READ(EGNR,*) LONGI
      IF(NOTBEG) GOTO 3293
 7500 IVARNR=IVARNR+1
      IF(IVARNR.EQ.IVAR) GOTO 7701
 3500 WRITE(MONITO,6003) F107
 6003 FORMAT(1X//1X,'10.7CM SOLAR RADIO FLUX ?    * PREVIOUS DAY *',
     &  8X,'#',F5.1,'#'/1X,60('-')/)
      READ(EGNR,*) F107
      IF(NOTBEG) GOTO 3293
 7701 IVARNR=IVARNR+1
      IF(IVARNR.EQ.IVAR) GOTO 7501
 5701 WRITE(MONITO,6013) F107M
 6013 FORMAT(1X//1X,'10.7CM SOLAR RADIO FLUX ?   * MONTHLY AVERAGE *',
     &  6X,'#',F5.1,'#'/1X,60('-')/)
      READ(EGNR,*) F107M
      IF(NOTBEG) GOTO 3293
 7501 IVARNR=IVARNR+1
      IF(IVARNR.EQ.IVAR) GOTO 7502
 5501 WRITE(MONITO,6004) DAYNR
 6004 FORMAT(1X//1X,'DAY OF YEAR ?',8X,'* DDD *',27X,'#',I3,'#'/
     &  1X,60('-')/)
      READ(EGNR,*) DAYNR
      IF(NOTBEG) GOTO 3293
 7502 IVARNR=IVARNR+1
      IF(IVARNR.EQ.IVAR) GOTO 7331
 5502 WRITE(MONITO,6005) HOUR
 6005 FORMAT(1X//1X,'LOCAL TIME ?',8X,'[HOURS, DECIMAL]',18X,'#',F4.1,
     &  '#'//' !! HOUR is LOCAL TIME or UNIVERSAL TIME plus "25"'/
     &  ' !! HOUR=-1  you provide LOCAL TIME and UNIVERSAL TIME'/
     &  1X,60('-')/)
      READ(EGNR,*) HOUR
      UTLT=.FALSE.
      IF(HOUR.LT.0.0) THEN
        WRITE(MONITO,6605)
 6605   FORMAT(//' LOCAL TIME, UNIVERSAL TIME ?    [HOURS, DECIMAL]'
     &      /1X,60('-')/)
        READ(EGNR,*) HOUR,UT
        UTLT=.TRUE.
```

```
      ENDIF
      IF(NOTBEG) GOTO 3293
7331  IVARNR=IVARNR+1
      IF(IVARNR.EQ.IVAR) GOTO 5551
3331  WRITE(MONITO,6002) HEIGHT
6002  FORMAT(1X//1X,'ALTITUDE ?    [KM]',35X,'#',F5.1,'#'/
     & 1X,60('-')/)
      READ(EGNR,*) HEIGHT
      IF(NOTBEG) GOTO 3293
5551  IVARNR=IVARNR+1
      IF(IVARNR.EQ.IVAR) GOTO 5505
6780  WRITE(MONITO,7732) AP(1)
7732  FORMAT(1X//1X,'AP-INDEX ?    * MAGNETIC ACTIVITY *',18X,'#',
     & F5.1,'#'//' !! "-1"   ENTER DETAILLED AP HISTORY FOR 59 HOURS'
     & /' !!         PRIOR TO CURRENT TIME'/1X,60('-')/)
      READ(EGNR,*) AP(1)
      IF(AP(1).GT.-1.0) GOTO 3999
        ISWI(9)=-1
3813    WRITE(MONITO,6620) (AP(J),J=1,7)
6620    FORMAT(' 1  DAILY AP',45X,'#',F4.1,'#'/' 2  3-H(OUR)-AP INDEX',
     &   ' FOR CURRENT TIME',19X,'#',F4.1,'#'/' 3  3-H-AP INDEX FOR ',
     &   '3 HRS BEFORE CURRENT TIME',11X,'#',F4.1,'#'/' 4  3-H-AP ',
     &   'INDEX FOR 6 HRS BEFORE CURRENT TIME',11X,'#',F4.1,'#'/
     &   ' 5  3-H-AP INDEX FOR 9 HRS BEFORE CURRENT TIME',11X,'#',F4.1,
     &   '#'/' 6  AVERAGE OF 3-H-AP INDICIES FROM 12 TO 33 HRS ',
     &   'BEFORE  #',F4.1,'#'/' 7  AVERAGE OF 3-H-AP INDICIES FROM ',
     &   '36 TO 59 HRS BEFORE  #',F4.1,'#'/1X,70('-')/' ENTER:',
     &   ' NUMBER    (0 TO CONTINUE)'/)
        READ(EGNR,*) NRAP
        IF(NRAP.GT.0) THEN
          WRITE(MONITO,3812) NRAP
3812      FORMAT(1X,'AP(',I1,')=')
          READ(EGNR,*) AP(NRAP)
          GOTO 3813
        ENDIF
3999  IF(NOTBEG) GOTO 3293
5505  IF(NOTBEG) CALL TRETRV(SWI)
        IF(ISWI(9).LT.0) SWI(9)=ISWI(9)*1.0
        DO 3919 J=1,25
3919    ISWI(J)=INT(SWI(J))
5521  WRITE(MONITO,5030) (ISWI(J),J=1,23)
5030  FORMAT(1X//' SELECTION OF PARTICULAR VARIATIONS:  ON/OFF (1/0)'/
     & 5X,'2  MAIN EFFECT OFF, BUT CROSS TERMS ON',5X,'-1  SPECIAL'/
     & 1X,70('-')/' 1  F10.7 EFFECT ON MEAN   #',I1,'#',9X,'2  TIME',
     & ' INDEPENDENT        #',I1,'#'/' 3  SYMMETRICAL ANNUAL     #',
     & I1,'#',9X,'4  SYMMETRICAL SEMI-ANNUAL #',I1,'#'/' 5  ASYMMETR',
     & 'ICAL ANNUAL    #',I1,'#',9X,'6  ASYMMETRICAL SEMI-ANNUAL#',I1,
     & '#'/' 7  DIURNAL',16X,'#',I1,'#',9X,'8  SEMI-DIURNAL',12X,'#',
     & I1,'#'/' 9  DAILY AP (-1 HISTORY) #',I2,'#',8X,'10  ALL UT/LO',
     & 'NG EFFECTS     #',I1,'#'/' 11 LONGITUDINAL',11X,'#',I1,'#',8X,
     & '12  UT AND MIXED UT/LONG    #',I1,'#'/' 13 MIXED AP/UT/LONG',
     & 7X,'#',I1,'#',8X,'14  TER-DIURNAL',13X,'#',I1,'#'/' 15 DEPART',
     & 'URES FROM DIFF. EQUIL. #',I1,'#  16  ALL TINF VARIATION',6X,
     & '#',I1,'#'/' 17 ALL TLB VARIATION      #',I1,'#',8X,'18  ALL',
     & ' T0 VARIATION        #',I1,'#'/' 19 ALL S VARIATION        #',
     & I1,'#',8X,'20  ALL Z0 VARIATION        #',I1,'#'/' 21 ALL NLB',
     & ' VARIATION      #',I1,'#',8X,'22  ALL TR12 VARIATION      #',
     & I1,'#'/' 23 TURBO SCALE HEIGHT VARIATION #',I1,'#'/1X,70('-')/
     & ' ENTER: NUMBER, NEW FLAG     OR: "0,0" TO CONTINUE'/)
      READ(EGNR,*) ISELEC,IVALUE
```

```
C*****************************************************************
C**************** MSIS-86 THERMOSPHERE MODEL *********************
C*****************************************************************
C****************** M86DRI.FOR, APRIL 1987 ***********************
C******************    DRIVER PROGRAM      ***********************
C*****************************************************************
C*** THIS PROGRAM PRODUCES PROFILES OF                          ***
C***      NEUTRAL TEMPERATURE                                   ***
C***      EXOSPHERIC TEMPERATURE                                ***
C***      NUMBER DENSITIES OF He, O, N2, O2, Ar, H and N        ***
C***      TOTAL MASS DENSITY                                    ***
C*****************************************************************
C*** FOR SPECIFIED                                              ***
C***      DAY OF YEAR                                           ***
C***      GEODATIC OR GEOMAGNETIC LATITUDE AND LONGITUDE        ***
C***      ALTITUDE                                              ***
C***      10.7 CM SOLAR RADIO FLUX, DAILY (FOR PREVIOUS DAY)    ***
C***                AND 3-MONTHS AVERAGE                        ***
C***      LOCAL (APPARENT SOLAR) OR UNIVERSAL TIME              ***
C***      MAGNETIC INDEX Ap, DAILY OR HISTORY                   ***
C***      YOUR CHOICE OF VARIABLE                               ***
C*****************************************************************
C*****************************************************************
C*     --------------------ADDRESSES-----------------------      *
C*     I  DR. A. E. HEDIN              DR. D. BILITZA       I    *
C*     I  GSFC CODE 614                GSFC/NSSDC CODE 633  I    *
C*     I  GREENBELT, MD 20771          GREENBELT, MD 20771  I    *
C*     I  USA                          USA                  I    *
C*     -------------------------------------------------------    *
C*****************************************************************
C*****************************************************************
C*****************************************************************
C*********       ALL ANGLES ARE IN DEGREE            **************
C*********     ALL NUMBER DENSITIES ARE IN CM-3      **************
C*********     ALL MASS DENSITIES ARE IN G/CM+3      **************
C*********       ALL ALTITUDES ARE IN KM             **************
C*********     ALL TEMPERATURES ARE IN KELVIN        **************
C*****************************************************************
C*******************  OPTIONS  ******************************
C*****************************************************************
C* HOUR        IS   LOCAL TIME   OR   UNIVERSAL TIME + 25         *
C* JMAG        =0 GEOGRAFIC LATITUDE AND LONGITUDE EXPECTED       *
C*             =1 GEOMAGNETIC LATITUDE AND LONGITUDE EXPECTED     *
C* TO TURN ON/OFF 23 PARTICULAR VARIATIONS CALL "TSELEC(SW)"      *
C*             TO SET THE 23 FLAGS SW. TO GET CURRENT VALUES OF   *
C*             SW CALL "TRETRV(SW)".                              *
C*****************************************************************
C*****************************************************************
C*****************************************************************
      INTEGER EGNR,AGNR,DAYNR
      REAL LATI,LONGI,MLAT,MLONG
      CHARACTER ITEXT(8)*5
      CHARACTER IMZ(8)*4
      DIMENSION DEN(8),TEMP(2),AP(16),XVAR(8),ISWI(25),SWI(25),
     &  OUTF(11,30)
      COMMON/GTS3C/DL(16)
      LOGICAL UTLT,NOTBEG,OUT1
      DATA IMZ/'GEOD','GEOD',' DAY',' MON','    ','L.T.','    ',
     &  '    '/,ITEXT/' LATI',' LONG','F10.7','F10.7',' DAY ',
     &  ' HOUR',' H/KM','  AP '/,LATI,LONGI,HEIGHT,F107,F107M,
```

```
     &  DAYNR,HOUR,AP(1),IVAR,BVAR,EVAR,SVAR/45.1,293.1,100,
     &  100,100,231,12.5,0,6,100,1000,100/,ISWI/25*1/,SWI/25*1.0/
      UMR=ATAN(1.0)*4./180.
      ALOG2=ALOG(2.)
C
C FIRST SPECIFY YOUR COMPUTERS CHANNEL NUMBERS ....................
C EGNR=INPUT, MONITO=MONITOR, KONSOL=MESSAGES.....................
C AGNR=OUTPUT (OUTPUT IS DISPLAYED OR STORED IN FILE OUTPUT.IRI)...
C
      EGNR=5
      MONITO=6
      WRITE(MONITO,5100)
5100  FORMAT(1X/////4X,49('*')/4X,
     & '********* MSIS THERMOSPHERE MODEL 1986 **********'/4X,
     & 49('*')/////1X,'THIS PROGRAM ALLOWS YOU TO PRODUCE MSIS-',
     & 'PROFILES IN LATITUDE,'/' LONGITUDE,SOLAR ACTIVITY,DAY',
     & ',TIME,ALTITUDE OR MAGNETIC ACTIVITY.')
      NOTBEG=.FALSE.
      GOTO 5508
3293  WRITE(MONITO,5602) LATI,LONGI,HEIGHT,F107,F107M,DAYNR,HOUR,
     & AP(1)
5602  FORMAT(1X//' **** WHICH PARAMETER DO YOU WANT TO ',
     & 'CHANGE?'/1X,70('-')/' 0  NO FURTHER CHANGES, CALCULATE',
     & ' PROFILE'/' 1  LATITUDE  #',F5.1,'#',8X,'7  GEOD. OR ',
     & 'GEOMAGNETIC'/' 2  LONGITUDE #',F5.1,'#',8X,'8  SELECTION',
     & ' OF VARIABLE'/' 3  ALTITUDE  #',F6.1,'#',7X,'9  VARIABLE ',
     & 'RANGE'/' 4  F10.7      #',F5.1,'#',7X,'10  F10.7M  #',
     & F5.1,'#'/' 5  DAY       #',I3,'#',9X,'11  ON/OFF FOR PART',
     & 'ICULAR VARIATIONS'/' 6  HOUR      #',F5.1,'#',7X,'12  DIS',
     & 'PLAY OR STORE'/28X,'13  AP      #',F5.1,'#'/
     & 1X,70('-')/' ENTER NUMBER'/)
      READ(EGNR,*) ISWIT
      GOTO (5300,3329,3339,3331,3500,5501,5502,3332,5503,5504,
     &    5701,5505,5508,6780) ISWIT+1
5508  WRITE(MONITO,5123)
5123  FORMAT(/////' DO YOU WANT YOUR MSIS-PROFILES'/5X,
     & 'DISPLAYED ON YOUR MONITOR: TYPE "0"'/5X,
     & 'STORED IN FILE OUTPUT.MSI: TYPE "1"'/1X,60('-')/)
      READ(EGNR,*) JAGNR
      IVARNR=0
      AGNR=6
      IF(JAGNR.EQ.1) THEN
        OPEN(UNIT=16,FILE='OUTPUT.MSI',STATUS='NEW',FORM='FORMATTED')
        AGNR=16
      ENDIF
      IF(NOTBEG) GOTO 3293
5503  WRITE(MONITO,5040) IVAR
5040  FORMAT(1X//' SELECT YOUR VARIABLE:',33X,'#LAST:',I1,'#'//34X,
     &  'Geodatic or geomagnetic cordinates'/34X,'are assumed ',
     &  'depending on your later'/' 1  LATITUDE    5  DAY OF YEAR',4X,
     &  'selection of JMAG.'/' 2  LONGITUDE   6  HOUR',11X,
     &  'Variation in UNIVERSAL TIME is selected'/' 3  F10.7',7X,
     &  '7  ALTITUDE',7X,'by adding "25" to your BEGIN and END'/
     &  ' 4  F10.7M',6X,'8  AP',13X,'hours.'/34X,'If you select ',
     &  'F10.7M, F10.7 = F10.7M'/34X,'will be assumed.'/1X,70('-')/)
      READ(EGNR,*) IVAR
5504  WRITE(MONITO,5044) BVAR,EVAR,SVAR
5044  FORMAT(1X//' CHOOSE YOUR VARIABLE RANGE:',5X,' BEGIN, END, S',
     & 'TEPWIDTH ?'/32X,'#',3F8.1,'#'//' !! if your variable is HOUR ',
     & 'and you add "25" to your BEGIN and'/' !! END hours UNIVERSAL',
```

DESCRIPTION OF MAGNETIC TAPE MSIS-86-VAX

NSSDC-Id: MN-61A

NAME(short): MSIS on VAX/VMS tape

(long): Mass-Spectrometer-Incoherent-Scatter neutral atmosphere model on VAX/VMS tape

DATE: April 28, 1987

COMPUTER: VAX 11/780, created in VAX/VMS with COPY

FORMAT: 9 track, 1600 BPI, labeled (MSIS86), ASCII, 3 files,

SOURCE: A. Hedin, GSFC code 614, Greenbelt, MD 20771

AGENT: D. Bilitza, GSFC/NSSDC code 633, Greenbelt, MD 20771, tel. (301) 286-9536
SPAN: NSSDCA::[BILITZA]

CONTENT:

(1) FORTRAN source code for MSIS-86 library	MSIS86.FOR
(2) FORTRAN test program for (1)	M86TES.FOR
(3) output of test program	M86TES.DAT
(4) executable module of (2)	M86TES.EXE

BRIEF DESCRIPTION:

This labeled (MSIS86), ASCII coded, 1600 BPI tape contains the functions, subroutines and a test program for the Mass-Spectrometer-Incoherent-Scatter-1986 (MSIS-86) neutral atmosphere model. This model will also constitute the upper part of the internationally recommended COSPAR International Reference Atmosphere (CIRA-86) following the decisions made at last year's COSPAR general assembly in Toulouse,France.

The MSIS model is based on the extensive data compilation and analysis work of A. E. Hedin and his collaborators: A. E. Hedin et al., J. Geophys. Res. 82, 2139-2156, 1977; A. E. Hedin, J. Geophys. Res. 88, 10170-10188, 1983; A. E. Hedin, accepted for J. Geophys. Res., 1987. Data sources for the present model include temperature and density measurements from several rockets, satellites (OGO-6, San Marco 3, Aeros-A, AE-C, AE-D, AE-E, ESRO 4 and DE-2) and incoherent scatter radars (Millstone Hill, St. Santin, Arecibo, Jicamarca, and Malvern). Since the MSIS-83 model, terms were added or changed to better represent seasonal variations in the polar regions under both quiet and magnetically disturbed conditions and local time variations in the magnetic activity effect. In addition a new species, atomic nitrogen, was added to the list of species covered by the model.

The model expects as input: year, day of year, universal time, altitude, geodetic latitude and longitude, local apparent solar time, solar F10.7 flux (for previous day and 3-month average) and magnetic Ap index (daily or Ap history for last 59 hours). For this conditions the following output parameters are calculated: number density of He, O, N2, O2, Ar, H and N, total mass density, neutral temperature and exospheric temperature. For diagnostic purposes the source code is equipped with 23 flags to turn on/off particular variations.

The tape was created in VAX/VMS with COPY and contains four files:
(1) Fortran source code of MSIS library of subroutines and functions

(2) Fortran test driver, (3) test driver output for several examples (4) executable module of (2). The model is also available on one VAX/VMS tape, on floppy disc, and on the SPAN network.

```
      OPEN(UNIT=12,FILE='MSIS86.DAT',FORM='FORMATTED',STATUS='OLD')
      READ(12,1290) PT1,PT2,PT3,PA1,PA2,PA3,PB1,PB2,PB3,PC1,PC2,
     &   PC3,PD1,PD2,PD3,PE1,PE2,PE3,PF1,PF2,PF3,PG1,PG2,PG3,PH1,
     &   PH2,PH3,PI1,PTM,PDM
1290  FORMAT(5E13.6)
      DO 10 I=1,3
        ISDATE(I)=ISD(I)
   10 CONTINUE
      DO 20 I=1,2
        ISTIME(I)=IST(I)
   20 CONTINUE
      NAME(1)='CIRA'
      NAME(2)='-86 '
      END
C-----------------------------------------------------------------------
      SUBROUTINE GGM(ART,XLG,BG,XLM,BM)
C CALCULATES GEOMAGNETIC LONGITUDE (XLM) AND LATITUDE (BM)
C FROM GEOGRAFIC LONGITUDE (XLG) AND LATITUDE (BG) FOR ART=0
C AND REVERSE FOR ART=1. ALL ANGLES IN DEGREE.
C LATITUDE:-90 TO 90. LONGITUDE:0 TO 360 EAST.
      INTEGER ART
      FAKTOR=.0174532925
      ZPI=FAKTOR*360.
      CBG=11.4*FAKTOR
      CI=COS(CBG)
      SI=SIN(CBG)
      IF(ART.EQ.0) GOTO 10
      CBM=COS(BM*FAKTOR)
      SBM=SIN(BM*FAKTOR)
      CLM=COS(XLM*FAKTOR)
      SLM=SIN(XLM*FAKTOR)
      SBG=SBM*CI-CBM*CLM*SI
      BG=ASIN(SBG)
      CBG=COS(BG)
      SLG=(CBM*SLM)/CBG
      CLG=(SBM*SI+CBM*CLM*CI)/CBG
        IF(CLG.GT.1.) CLG=1.
        XLG=ACOS(CLG)
      IF(SLG.LT.0.0) XLG=ZPI-ACOS(CLG)
      BG=BG/FAKTOR
      XLG=XLG/FAKTOR
      XLG=XLG-69.8
      IF(XLG.LT.0.0) XLG=XLG+360.0
        RETURN
10    YLG=XLG+69.8
      CBG=COS(BG*FAKTOR)
      SBG=SIN(BG*FAKTOR)
      CLG=COS(YLG*FAKTOR)
      SLG=SIN(YLG*FAKTOR)
      SBM=SBG*CI+CBG*CLG*SI
      BM=ASIN(SBM)
      CBM=COS(BM)
      SLM=(CBG*SLG)/CBM
      CLM=(-SBG*SI+CBG*CLG*CI)/CBM
      XLM=ACOS(CLM)
      IF(SLM.LT..0) XLM=ZPI-ACOS(CLM)
      BM=BM/FAKTOR
      XLM=XLM/FAKTOR
      END
```

```
 0.996040E+00 0.385528E-01 0.303445E-02-0.105531E+00-0.607134E-02
-0.516278E-03-0.115622E+00 0.202240E-02 0.990156E-02-0.127371E+00
-0.302449E-01 0.123512E-01-0.526277E-02-0.845398E+01 0.000000E+00
 0.142370E-01 0.000000E+00 0.125818E+03 0.805486E-02 0.164419E-02
-0.621452E-05 0.311701E-02 0.000000E+00 0.386578E-02 0.132397E+00
 0.213315E+00 0.000000E+00 0.000000E+00 0.000000E+00-0.641110E-05
 0.000000E+00 0.300150E+02 0.533297E-02 0.389146E-02 0.204725E-02
 0.000000E+00 0.000000E+00-0.192645E-01 0.275905E+01 0.147284E-02
 0.341345E-03-0.117388E-02-0.354589E-03 0.113139E+00 0.169134E+00
 0.508295E-02 0.365016E-04 0.426385E-02 0.115102E-03 0.511819E-02
 0.609108E-02 0.404995E-04 0.153049E-02 0.241470E-04 0.230764E-02
 0.155267E-02 0.133722E-02-0.182318E-02-0.263007E+03 0.000000E+00
 0.137337E-02 0.995774E-03 0.000000E+00-0.108983E+03 0.562606E-02
 0.594053E-02 0.109358E-02 0.000000E+00-0.133410E-01-0.243409E-01
-0.135688E-01 0.311370E+05 0.000000E+00 0.000000E+00 0.000000E+00
-0.283023E+04 0.845583E-03 0.538706E-03 0.000000E+00 0.247956E+03
 0.292246E-02 0.000000E+00 0.000000E+00 0.747703E-04 0.887993E-03
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
-0.116540E-01-0.449173E-02-0.353189E-03-0.173933E-03-0.153218E-03
-0.565411E+00 0.777272E-02-0.911784E+02 0.645187E-03 0.000000E+00
-0.837685E-03 0.242318E-02 0.473796E-02-0.301801E-02-0.423564E-02
-0.248289E-02 0.919286E-03 0.216372E-02 0.863968E-03 0.189689E-02
 0.415654E-02 0.000000E+00 0.118068E-01 0.331190E-02 0.000000E+00
 0.120222E-02 0.000000E+00 0.000000E+00-0.307246E+01 0.000000E+00
 0.000000E+00 0.672403E-03 0.108930E-02 0.972278E-03 0.468242E+01
-0.315034E-03 0.400059E-02 0.515036E-02 0.162989E-02 0.108824E-02
 0.995261E-03 0.418955E+01-0.364059E+00 0.170182E-02 0.000000E+00
 0.000000E+00-0.320120E+01 0.000000E+00 0.580206E-02 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.104934E+01-0.288362E-01-0.207095E+00-0.103314E+00-0.702373E-02
 0.129664E-01 0.408853E+00-0.919895E-02-0.188660E-01 0.140927E+01
 0.175033E+00 0.187351E-01 0.110979E+00-0.742871E+01 0.000000E+00
 0.267143E+00-0.595979E-01 0.105038E+03-0.840963E-01-0.697632E-03
 0.206521E-05 0.765306E-03 0.000000E+00 0.000000E+00 0.126762E+00
 0.128876E+00-0.504479E-01-0.130735E-01-0.224348E-01 0.000000E+00
 0.000000E+00-0.150832E+03-0.629928E-02 0.000000E+00-0.407760E-02
 0.000000E+00 0.000000E+00 0.525725E-01-0.311486E+02-0.313351E-02
 0.275838E-02 0.000000E+00 0.000000E+00 0.111247E+00 0.108815E+00
-0.466713E-01 0.000000E+00-0.329329E-02 0.000000E+00 0.167838E-02
-0.916691E-02 0.345044E-04-0.971806E-02 0.000000E+00-0.204672E-02
-0.786899E-02-0.798285E-02 0.536515E-02-0.531172E+04 0.000000E+00
-0.642781E-02-0.171690E-02 0.000000E+00-0.679131E+02-0.179912E-01
-0.158305E-01-0.712313E-02 0.000000E+00 0.253477E-01 0.852960E-01
 0.102163E+00 0.295009E+05 0.000000E+00 0.000000E+00 0.000000E+00
-0.684625E+04-0.619098E-02-0.269289E-02 0.000000E+00-0.520231E+03
-0.633463E-02 0.000000E+00 0.000000E+00-0.602428E-02-0.407077E-02
 0.542264E-02 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.407560E-01 0.282288E-01 0.908088E-02 0.000000E+00 0.000000E+00
-0.405204E+00-0.597931E-01-0.731823E+02-0.206620E-02 0.000000E+00
-0.372723E-02-0.188146E-01-0.101794E-01 0.804633E-02 0.101090E-01
 0.873253E-02 0.238268E-01 0.480444E-02 0.171088E-02 0.396369E-01
-0.213809E-01 0.000000E+00-0.102588E+00-0.591702E-02 0.000000E+00
 0.270923E-02 0.000000E+00 0.000000E+00-0.175043E+03 0.603489E+00
-0.617589E+00 0.838098E-02 0.183871E-02-0.705329E-03-0.406644E+01
-0.509347E-02-0.284344E-01-0.124160E-01 0.133665E-01 0.393410E-02
-0.503723E-03-0.457683E+01-0.529542E+00-0.425812E-02 0.000000E+00
 0.000000E+00 0.191541E+02 0.000000E+00 0.323247E-02 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
```

```
      RETURN
      END
C-----------------------------------------------------------------------
      SUBROUTINE TSELEC(SV)
C        SET SWITCHES
      DIMENSION SV(1),SAV(25),SVV(1)
      COMMON/CSW/SW(25),ISW,SWC(25)
      DO 100 I = 1,25
        SAV(I)=SV(I)
        SW(I)=AMOD(SV(I),2.)
        IF(ABS(SV(I)).GT.0.) THEN
          SWC(I)=1.
        ELSE
          SWC(I)=0.
        ENDIF
  100 CONTINUE
      ISW=64999
      RETURN
      ENTRY TRETRV(SVV)
      DO 200 I=1,25
        SVV(I)=SAV(I)
  200 CONTINUE
      END
C-----------------------------------------------------------------------
      FUNCTION GLOB5L(P)
C      LIMITED PARAMETER VERSION OF GLOBE 9/2/82
C       CALCULATE G(L) FUNCTION FOR MSIS-86/CIRA 1986
C       Lower Thermosphere Parameters
      COMMON/LPOLY/PLG(9,4),CTLOC,STLOC,C2TLOC,S2TLOC,C3TLOC,S3TLOC,
     $ IYR,DAY,DF,DFA,APD,APDF,APT(4)/CSW/SW(25),ISW,SWC(25)
      DIMENSION P(150),T(15)
      DATA DR/1.72142E-2/,T/15*0./
      DATA DAYL/-1./,P7/-1000./,P9/-1000./,P11/-1000./
      IF(DAY.NE.DAYL.OR.P7.NE.P(7)) CD7=COS(DR*(DAY-P(7)))
      IF(DAY.NE.DAYL.OR.P9.NE.P(9)) CD9=COS(2.*DR*(DAY-P(9)))
      IF(DAY.NE.DAYL.OR.P11.NE.P(11)) CD11=COS(DR*(DAY-P(11)))
      DAYL=DAY
      P7=P(7)
      P9=P(9)
      P11=P(11)
C
      T(1)=P(2)*DFA
      T(2)=P(4)*PLG(3,1)
      T(3)=P(6)*CD7
      T(4)=(P(8) )*CD9
      T(5)=(P(10)*PLG(2,1)+P(22)*PLG(4,1))*CD11
      T(6)=0.
      T(7)=(P(14)*PLG(2,2)*CTLOC+P(15)*PLG(2,2)*STLOC)
      T(8)=(P(16)*PLG(3,3)+P(18)*PLG(5,3)
     $     +(P(20)*PLG(6,3))*CD11*SWC(5)
     $     )*C2TLOC
     $     +(P(17)*PLG(3,3)+P(19)*PLG(5,3)
     $     +(P(21)*PLG(6,3))*CD11*SWC(5)
     $     )*S2TLOC
      T(14)=(P(12)*PLG(4,4)*C3TLOC
     $     +P(25)*PLG(4,4)*S3TLOC)
      IF(SW(9).EQ.1)
     $ T(9)=APDF*(P(23)+P(24)*PLG(3,1)*SWC(2))
      IF(SW(9).EQ.-1)
     $ T(9)=(P(3)*APT(3)+P(5)*PLG(3,1)*APT(3)*SWC(2))
```

```
C       PARMS NOT USED: 13
      TT=0.
      DO 50 I=1,14
   50 TT=TT+ABS(SW(I))*T(I)
      GLOB5L=TT
      RETURN
      END
C-----------------------------------------------------------------------
      FUNCTION DNET(DD,DM,ZHM,XMM,XM)
C       8/20/80
C       TURBOPAUSE CORRECTION FOR MSIS MODELS
C       Eq. A12b
      A=ZHM/(XMM-XM)
C       Eq. A12a
      YLOG=A*ALOG(DM/DD)
      IF(YLOG.LT.-10.) GO TO 10
      IF(YLOG.GT.10.)  GO TO 20
        DNET=DD*(1.+EXP(YLOG))**(1/A)
        GO TO 50
   10 CONTINUE
        DNET=DD
        GO TO 50
   20 CONTINUE
        DNET=DM
        GO TO 50
   50 CONTINUE
      RETURN
      END
C-----------------------------------------------------------------------
      FUNCTION  CCOR(ALT, R,H1,ZH)
C         CHEMISTRY/DISSOCIATION CORRECTION FOR MSIS MODELS
C     Eq. A20a or Eq. A21
      E=(ALT-ZH)/H1
      IF(E.GT.70.) GO TO 20
      IF(E.LT.-70.) GO TO 10
        EX=EXP(E)
        CCOR=R/(1.+EX)
        GO TO 50
   10   CCOR=R
        GO TO 50
   20   CCOR=0.
        GO TO 50
   50 CONTINUE
      CCOR=EXP(CCOR)
       RETURN
      END
C-----------------------------------------------------------------------
      SUBROUTINE PRMSG5
C           CIRA     11-FEB-86
      CHARACTER ISD(3),IST(2),NAME(2),ISDATE(3),ISTIME(2)*4
      COMMON/PARMB/GSURF,RE
      COMMON/PARM5/PT1(50),PT2(50),PT3(50),PA1(50),PA2(50),PA3(50),
     * PB1(50),PB2(50),PB3(50),PC1(50),PC2(50),PC3(50),
     * PD1(50),PD2(50),PD3(50),PE1(50),PE2(50),PE3(50),
     * PF1(50),PF2(50),PF3(50),PG1(50),PG2(50),PG3(50),
     * PH1(50),PH2(50),PH3(50),PI1(50)
      COMMON/LOWER5/PTM(8),PDM(8,7)/DATIME/ISDATE,ISTIME,NAME
      DATA ISD/'11-F','EB-8','6   '/,IST/'18:2','3:31'/
      GSURF=980.665
      RE=6356.77
```

```
 0.127515E+01-0.210472E+00-0.177924E+00 0.218900E+00 0.288436E-01
 0.190077E-01 0.291001E+00 0.217437E-01-0.105186E-01 0.436141E+00
 0.107605E+00 0.330755E-01 0.400581E-01-0.958051E+01 0.000000E+00
 0.154028E-01 0.000000E+00 0.734194E+02 0.496540E-01-0.595906E-02
 0.384512E-04-0.136000E-01 0.000000E+00 0.000000E+00 0.132397E+00
 0.213315E+00-0.416610E-01 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.146276E+03-0.198408E-01 0.000000E+00 0.132530E-01
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00-0.104687E-03
-0.147562E-02 0.000000E+00 0.000000E+00 0.113139E+00 0.169134E+00
-0.126913E-01 0.000000E+00 0.000000E+00 0.000000E+00-0.608370E-02
-0.257587E-01 0.319022E-04 0.000000E+00 0.000000E+00 0.156644E-01
 0.103640E-01 0.105771E-02 0.000000E+00 0.357949E+04 0.000000E+00
-0.125672E-02 0.152783E-02 0.130518E-02 0.755558E+01-0.920341E-02
-0.209142E-01-0.134106E-01 0.000000E+00-0.483312E-01 0.830900E-01
 0.988009E-01-0.141148E+05 0.000000E+00 0.000000E+00 0.000000E+00
-0.105513E+04 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.673442E-02 0.201691E-02
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.598019E-01 0.633298E-02-0.112871E-02 0.000000E+00 0.000000E+00
 0.000000E+00-0.128604E-01 0.000000E+00 0.000000E+00 0.000000E+00
-0.494960E-02-0.136415E-01-0.115039E-01 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00-0.586860E-02-0.141732E-02 0.213697E-02 0.263845E+01
-0.834186E-02-0.187336E-01-0.190870E-01-0.803810E-02-0.284279E-02
 0.256722E-02 0.171429E+01 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.573587E+02-0.398747E+00 0.000000E+00-0.529554E+00-0.582186E-02
 0.714177E-01-0.679279E+00-0.167715E+00-0.642434E-01-0.211569E+00
 0.159922E+00-0.171024E-03-0.115885E+00 0.651603E+01 0.000000E+00
-0.176683E+00 0.650395E-01 0.143504E+01 0.928208E-01 0.511662E-02
 0.000000E+00 0.995121E-02 0.000000E+00 0.000000E+00 0.132397E+00
 0.213315E+00 0.101451E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.567667E+02 0.238192E-02 0.000000E+00-0.188240E-01
 0.000000E+00 0.000000E+00 0.476218E-01 0.235206E+02 0.475901E-02
 0.576162E-02 0.151815E-01-0.192730E-01 0.113139E+00 0.169134E+00
-0.288771E-01 0.000000E+00 0.000000E+00 0.000000E+00 0.118418E-02
-0.368927E-02 0.314704E-04 0.882198E-02 0.000000E+00-0.192562E-01
-0.258674E-02-0.219913E-01 0.000000E+00 0.438655E+04 0.000000E+00
 0.760126E-02 0.259438E-02 0.172310E-02 0.779204E+02 0.797786E-03
-0.770510E-02 0.190982E-02 0.272707E-02 0.101016E-01 0.116537E+00
-0.312236E-02 0.139783E+05 0.000000E+00 0.000000E+00 0.000000E+00
-0.130712E+04 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00-0.320544E-02-0.206970E-01
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.159010E-01-0.191427E-02-0.342829E-01 0.000000E+00 0.000000E+00
 0.000000E+00-0.345379E-01 0.894518E+02 0.171556E-02 0.000000E+00
-0.765278E-02-0.208987E-03-0.157393E-01 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00-0.860673E-02-0.119922E-01-0.646356E-02-0.300107E+01
-0.932511E-02-0.150205E-01-0.867835E-02-0.764801E-02-0.131495E-01
-0.676720E-02-0.182396E+01 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
```

```
0.951363E+00-0.467542E-01 0.120260E+00 0.000000E+00 0.000000E+00
0.191357E-01 0.000000E+00 0.000000E+00 0.125429E-02-0.133240E+00
0.000000E+00 0.000000E+00 0.000000E+00-0.845398E+01 0.000000E+00
0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
0.000000E+00 0.252317E-02 0.000000E+00-0.973404E-02 0.132397E+00
0.213315E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
0.000000E+00 0.000000E+00 0.000000E+00-0.718482E-03 0.000000E+00
0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
0.000000E+00 0.787683E-02-0.233698E-02 0.113139E+00 0.169134E+00
0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
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0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
0.933804E+00 0.547446E+01 0.153263E+00 0.919303E+00 0.164109E+02
0.427083E+01 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
0.115897E+01 0.471094E+00 0.109459E+01 0.525012E+01 0.100000E+01
0.100000E+01 0.103999E+01 0.767132E+00 0.110514E+01 0.175636E+01
0.110845E+01 0.233439E+01 0.796532E+00 0.431520E+01 0.407300E+01
0.101885E+01 0.239547E+00 0.253791E-05 0.842931E+00 0.104192E+01
0.200202E+01 0.100000E+01 0.100000E+01 0.100000E+01 0.100000E+01
0.104130E+04 0.386000E+03 0.190000E+03 0.166728E+02 0.115000E+03
0.120000E+03 0.945537E+02 0.000000E+00 0.245600E+08 0.671072E-05
0.100000E+03 0.000000E+00 0.110000E+03 0.100000E+02 0.000000E+00
0.000000E+00 0.859400E+11 0.540000E+00 0.105000E+03-0.800000E+01
0.110000E+03 0.100000E+02 0.900000E+02 0.200000E+01 0.281000E+12
0.000000E+00 0.105000E+03 0.280000E+02 0.289500E+02 0.000000E+00
0.000000E+00 0.000000E+00 0.330000E+11 0.268270E+00 0.105000E+03
0.000000E+00 0.110000E+03 0.100000E+02 0.000000E+00 0.000000E+00
0.133000E+10 0.119615E-01 0.105000E+03 0.000000E+00 0.110000E+03
0.100000E+02 0.000000E+00 0.000000E+00 0.176100E+06 0.100000E+01
0.950000E+02-0.800000E+01 0.110000E+03 0.100000E+02 0.900000E+02
0.200000E+01 0.100000E+08 0.100000E+01 0.105000E+03-0.800000E+01
0.110000E+03 0.100000E+02 0.900000E+02 0.200000E+01
```

```
      P14 = P(14)
      P18 = P(18)
      P32 = P(32)
      P39 = P(39)
C         F10.7 EFFECT
      DF = F107 - F107A
      DFA=F107A-150.
      T(1) =  P(20)*DF + P(21)*DF*DF + P(22)*DFA
     $ + P(30)*DFA**2
      F1 = 1. + (P(48)*DFA +P(20)*DF+P(21)*DF*DF)*SWC(1)
      F2 = 1. + (P(50)*DFA+P(20)*DF+P(21)*DF*DF)*SWC(1)
C        TIME INDEPENDENT
      T(2) =
     1  (P(2)*PLG(3,1) + P(3)*PLG(5,1)+P(23)*PLG(7,1))
     $ +(P(15)*PLG(3,1))*DFA*SWC(1)
     2 +P(27)*PLG(2,1)
C        SYMMETRICAL ANNUAL
      T(3) =
     1 (P(19) )*CD32
C        SYMMETRICAL SEMIANNUAL
      T(4) =
     1 (P(16)+P(17)*PLG(3,1))*CD18
C        ASYMMETRICAL ANNUAL
      T(5) =  F1*
     1  (P(10)*PLG(2,1) + P(11)*PLG(4,1))*CD14
C         ASYMMETRICAL SEMIANNUAL
      T(6) =    P(38)*PLG(2,1)*CD39
C        DIURNAL
      T71 = (P(12)*PLG(3,2) + P(36)*PLG(2,2))*CD14*SWC(5)
      T72 = (P(13)*PLG(3,2) + P(37)*PLG(2,2))*CD14*SWC(5)
      T(7) = F2*
     1 ((P(4)*PLG(2,2) + P(5)*PLG(4,2) + P(28)*PLG(6,2)
     2 + T71)*CTLOC
     4 + (P(7)*PLG(2,2) + P(8)*PLG(4,2) +P(29)*PLG(6,2)
     5 + T72)*STLOC)
C        SEMIDIURNAL
      T81 = (P(24)*PLG(4,3))*CD14*SWC(5)
      T82 = (P(34)*PLG(4,3))*CD14*SWC(5)
      T(8) = F2*
     1 ((P(6)*PLG(3,3) + P(42)*PLG(5,3) + T81)*C2TLOC
     3 +(P(9)*PLG(3,3) + P(43)*PLG(5,3) + T82)*S2TLOC)
C        TERDIURNAL
      T(14) = F2*
     1 ((P(40)*PLG(4,4)+(P(94)*PLG(5,4)+P(47)*PLG(7,4))*CD14*SWC(5))*
     $ S3TLOC
     2 +(P(41)*PLG(4,4)+(P(95)*PLG(5,4)+P(49)*PLG(7,4))*CD14*SWC(5))*
     $ C3TLOC)
C         MAGNETIC ACTIVITY BASED ON DAILY AP
      IF(SW(9).EQ.-1. .AND. P(52).NE.0.) GO TO 30
      APD=(AP(1)-4.)
      P44=P(44)
      P45=P(45)
      IF(P44.LT.0) P44=1.E-5
      APDF = (APD+(P45-1.)*(APD+(EXP(-P44  *APD)-1.)/P44  ))
      T(9)=APDF*(P(33)+P(46)*PLG(3,1)+P(35)*PLG(5,1)+
     $ (P(101)*PLG(2,1)+P(102)*PLG(4,1)+P(103)*PLG(6,1))*CD14*SWC(5)+
     $ (P(122)*PLG(2,2)+P(123)*PLG(4,2)+P(124)*PLG(6,2))*SWC(7)*
     $ COS(HR*(TLOC-P(125))))
      GO TO 40
   30 CONTINUE
```

```
      EXP1 = EXP(-10800.*ABS(P(52))/(1.+P(139)*(45.-ABS(LAT))))
      IF(EXP1.GT..99999) EXP1=.99999
      EXP2 = EXP(-10800.*ABS(P(54)))
      IF(EXP2.GT..99999) EXP2=.99999
      IF(P(25).LT.1.E-4) P(25)=1.E-4
      APT(1)=SG0(EXP1)
      APT(3)=SG0(EXP2)
      T(9) = APT(1)*(P(51)+P(97)*PLG(3,1)+P(55)*PLG(5,1)+
     $ (P(126)*PLG(2,1)+P(127)*PLG(4,1)+P(128)*PLG(6,1))*CD14*SWC(5)+
     $ (P(129)*PLG(2,2)+P(130)*PLG(4,2)+P(131)*PLG(6,2))*SWC(7)*
     $ COS(HR*(TLOC-P(132))))
   40 CONTINUE
      IF(SW(10).EQ.0.OR.LONG.LE.-1000.) GO TO 49
C        LONGITUDINAL
      T(11)= (1.+P(90)*PLG(2,1))*(1.+P(81)*DFA*SWC(1))*
     $((P(65)*PLG(3,2)+P(66)*PLG(5,2)+P(67)*PLG(7,2)
     $ +P(104)*PLG(2,2)+P(105)*PLG(4,2)+P(106)*PLG(6,2)
     $ +SWC(5)*(P(110)*PLG(2,2)+P(111)*PLG(4,2)+P(112)*PLG(6,2))*CD14)*
     $     COS(DGTR*LONG)
     $ +(P(91)*PLG(3,2)+P(92)*PLG(5,2)+P(93)*PLG(7,2)
     $ +P(107)*PLG(2,2)+P(108)*PLG(4,2)+P(109)*PLG(6,2)
     $ +SWC(5)*(P(113)*PLG(2,2)+P(114)*PLG(4,2)+P(115)*PLG(6,2))*CD14)*
     $  SIN(DGTR*LONG))
C        UT AND MIXED UT,LONGITUDE
      T(12)=(1.+P(96)*PLG(2,1))*(1.+P(82)*DFA*SWC(1))*
     $(1.+P(120)*PLG(2,1)*SWC(5)*CD14)*
     $((P(69)*PLG(2,1)+P(70)*PLG(4,1)+P(71)*PLG(6,1))*
     $     COS(SR*(SEC-P(72))))
      T(12)=T(12)+SWC(11)*
     $ (P(77)*PLG(4,3)+P(78)*PLG(6,3)+P(79)*PLG(8,3))*
     $     COS(SR*(SEC-P(80))+2.*DGTR*LONG)*(1.+P(138)*DFA*SWC(1))
C        UT,LONGITUDE MAGNETIC ACTIVITY
      IF(SW(9).EQ.-1. .AND. P(52).NE.0.) GO TO 45
      T(13)= APDF*SWC(11)*(1.+P(121)*PLG(2,1))*
     $((P( 61)*PLG(3,2)+P( 62)*PLG(5,2)+P( 63)*PLG(7,2))*
     $     COS(DGTR*(LONG-P( 64))))
     $ +APDF*SWC(11)*SWC(5)*
     $ (P(116)*PLG(2,2)+P(117)*PLG(4,2)+P(118)*PLG(6,2))*
     $     CD14*COS(DGTR*(LONG-P(119)))
     $ + APDF*SWC(12)*
     $ (P( 84)*PLG(2,1)+P( 85)*PLG(4,1)+P( 86)*PLG(6,1))*
     $     COS(SR*(SEC-P( 76)))
      GOTO 48
   45 CONTINUE
      T(13)=APT(1)*SWC(11)*(1.+P(133)*PLG(2,1))*
     $((P(53)*PLG(3,2)+P(99)*PLG(5,2)+P(68)*PLG(7,2))*
     $     COS(DGTR*(LONG-P(98))))
     $ +APT(1)*SWC(11)*SWC(5)*
     $ (P(134)*PLG(2,2)+P(135)*PLG(4,2)+P(136)*PLG(6,2))*
     $     CD14*COS(DGTR*(LONG-P(137)))
     $ +APT(1)*SWC(12)*
     $ (P(56)*PLG(2,1)+P(57)*PLG(4,1)+P(58)*PLG(6,1))*
     $     COS(SR*(SEC-P(59)))
   48 CONTINUE
C  PARMS NOT USED: 60,83,100,140-150
   49 TINF = 0.
      IF(SW(9).EQ.-1.) TINF=P(31)
      DO 50 I = 1,NSW
   50 TINF = TINF + ABS(SW(I))*T(I)
      GLOBE5 = TINF
```

```
C       Eq. A3a
        DD=0.666666*ZG0*DTA/TA**2 - 3.11111*(1./TA-1./T0)+
       $ 7.11111*(1./T12-1./T0)
C       Eq. A3b
        CC=ZG0*DTA/(2.*TA*TA) - (1./TA-1./T0) - 2.*DD
C       Eq. A3c
        BB=(1./TA-1./T0) - CC - DD
        Eq. A3d
        X=(-(ZG1-ZG0)/ZG0)
C       Eq. A1b
        X2=X*X
        TZ=1./(1./T0+BB*X2+CC*X2*X2+DD*X2*X2*X2)
        DENSS=TZ
        TAF=(T12-T0)/(TA-T0)
   10   IF(XM.EQ.0.) GO TO 50
        IF(TA.GT.0. .AND. TZ.GT.0.) GO TO 20
           WRITE(6,*)ALT,XM,TINF,TLB,T0,TA,II,JG,N,DV(J),IFUN,S2,ZG0,TZ
           TT=TLB
           TA=TLB
           TZ=TLB
   20   CONTINUE
C       CALCULATE DENSITY ABOVE ZA
C       Eq. A17a
        GLB=GSURF/(1.+ZLB/RE)**2
C       Eq. A16a
        GAMMA=XM*GLB/(S2*RGAS*TINF)
C       Eq. A13, A14a, & A15
        DENSA=DLB*(TLB/TT)**(1.+ALPHA+GAMMA)*EXP(-S2*GAMMA*ZG2)
        DENSS=DENSA
        IF(ALT.GE.ZA) GO TO 50
C       CALCULATE DENSITY BELOW ZA
C       Eq. A17b
        GLB=GSURF/(1.+ZA/RE)**2
C       Eq. A16b
        GAMM=XM*GLB*ZG0/RGAS
C       Eq. A13, A14b, & A15
        DENSS=DENSA*(TA/TZ)**(1.+ALPHA)*
       $ EXP(GAMM*((X-1)/T0+BB*(X*X2-1.)/3.+CC*(X2*X2*X-1.)/5.+
       $ DD*(X2*X2*X2*X-1.)/7.))
   50   CONTINUE
CCCCCCWRITE(6,100)CXM,ALT,ZA,TINF,TLB,S2,T0,S1,TA,TZ,DLB,DENSA,DENSS
CC100 FORMAT(' D',1P13E10.2)
        RETURN
        END
C-----------------------------------------------------------------------
        FUNCTION GLOBE5(YRD,SEC,LAT,LONG,TLOC,F107A,F107,AP,P)
C         CALCULATE G(L) FUNCTION FOR MSIS-86/CIRA 1986
C         Upper Thermosphere Parameters
        REAL LAT, LONG
        DIMENSION P(150),SV(25),AP(7)
        COMMON/TTEST/TINF,GB,ROUT,T(15)/CSW/SW(25),ISW,SWC(25)
       &      /LPOLY/PLG(9,4),CTLOC,STLOC,C2TLOC,S2TLOC,C3TLOC,S3TLOC,
       &             IYR,DAY,DF,DFA,APD,APDF,APT(4)
        DATA DGTR/1.74533E-2/,DR/1.72142E-2/, XL/1000./,TLL/1000./
       &  DAYL/-1./,P14/-1000./,P18/-1000./,P32/-1000./
       &  HR/.2618/,SR/7.2722E-5/,SV/25*1./,NSW/14/,P39/-1000./
C Eq. A24d
        G0(A)=(A-4.+(P(26)-1.)*(A-4.+(EXP(-ABS(P(25))*(A-4.))-1.)/
       &  ABS(P(25))))
C Eq. A24c
```

```
      SUMEX(EX)=1.+(1.-EX**19)/(1.-EX)*EX**(.5)
C Eq. A24a
      SG0(EX)=(G0(AP(2))+(G0(AP(3))*EX+G0(AP(4))*EX*EX+G0(AP(5))*EX**3
     $ +(G0(AP(6))*EX**4+G0(AP(7))*EX**12)*(1.-EX**8)/(1.-EX)))
     $ /SUMEX(EX)
      IF(ISW.NE.64999) CALL TSELEC(SV)
      T(10) = 0.
      T(11) = 0.
      T(12) = 0.
      T(13)=0.
   10 CONTINUE
      IYR = YRD/1000.
      DAY = YRD - IYR*1000.
C Eq. A22 (remainder of code)
      IF(XL.EQ.LAT)   GO TO 15
C CALCULATE LEGENDRE POLYNOMIALS
      C = SIN(LAT*DGTR)
      S = COS(LAT*DGTR)
      C2 = C*C
      C4 = C2*C2
      S2 = S*S
      PLG(2,1) = C
      PLG(3,1) = 0.5*(3.*C2 -1.)
      PLG(4,1) = 0.5*(5.*C*C2-3.*C)
      PLG(5,1) = (35.*C4 - 30.*C2 + 3.)/8.
      PLG(6,1) = (63.*C2*C2*C - 70.*C2*C + 15.*C)/8.
      PLG(7,1) = (11.*C*PLG(6,1) - 5.*PLG(5,1))/6.
      PLG(2,2) = S
      PLG(3,2) = 3.*C*S
      PLG(4,2) = 1.5*(5.*C2-1.)*S
      PLG(5,2) = 2.5*(7.*C2*C-3.*C)*S
      PLG(6,2) = 1.875*(21.*C4 - 14.*C2 +1.)*S
      PLG(7,2) = (11.*C*PLG(6,2)-6.*PLG(5,2))/5.
      PLG(3,3) = 3.*S2
      PLG(4,3) = 15.*S2*C
      PLG(5,3) = 7.5*(7.*C2 -1.)*S2
      PLG(6,3) = 3.*C*PLG(5,3)-2.*PLG(4,3)
      PLG(7,3)=(11.*C*PLG(6,3)-7.*PLG(5,3))/4.
      PLG(8,3)=(13.*C*PLG(7,3)-8.*PLG(6,3))/5.
      PLG(4,4) = 15.*S2*S
      PLG(5,4) = 105.*S2*S*C
      PLG(6,4)=(9.*C*PLG(5,4)-7.*PLG(4,4))/2.
      PLG(7,4)=(11.*C*PLG(6,4)-8.*PLG(5,4))/3.
      XL=LAT
   15 CONTINUE
      IF(TLL.EQ.TLOC)   GO TO 16
      STLOC = SIN(HR*TLOC)
      CTLOC = COS(HR*TLOC)
      S2TLOC = SIN(2.*HR*TLOC)
      C2TLOC = COS(2.*HR*TLOC)
      S3TLOC = SIN(3.*HR*TLOC)
      C3TLOC = COS(3.*HR*TLOC)
      TLL = TLOC
   16 CONTINUE
      IF(DAY.NE.DAYL.OR.P(14).NE.P14) CD14=COS(DR*(DAY-P(14)))
      IF(DAY.NE.DAYL.OR.P(14).NE.P14) C2D14=COS(DR*2*(DAY-P(14)))
      IF(DAY.NE.DAYL.OR.P(18).NE.P18) CD18=COS(2.*DR*(DAY-P(18)))
      IF(DAY.NE.DAYL.OR.P(32).NE.P32) CD32=COS(DR*(DAY-P(32)))
      IF(DAY.NE.DAYL.OR.P(39).NE.P39) CD39=COS(2.*DR*(DAY-P(39)))
      DAYL = DAY
```

```
      RL=ALOG(B28*PDM(2,5)/B40)
C       Eq. A20a
      HC40=PDM(6,5)*PDL(10,2)
      ZC40=PDM(5,5)*PDL(9,2)
      D(5)=D(5)*CCOR(ALT,RL,HC40,ZC40)
   44 CONTINUE
      IF(MASS.NE.48)   GO TO 90
   45 CONTINUE
C
C        **** HYDROGEN DENSITY ****
C
C       Eq. A18
      G1 = SW(21)*GLOBE5(YRD,SEC,GLAT,GLONG,STL,F107A,F107,AP,PD(1,6))
      DB01 = PDM(1,6)*EXP(G1)*PD(1,6)
C       Eq. A13 - A17
      D(7)=DENSS(ALT,DB01,TINF,TLB,1.,-.4,T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DD=D(7)
      IF(ALT.GT.ALTL(7).OR.SW(15).EQ.0.) GO TO 47
C       Eq. A19
      ZH01=PDM(3,6)
      B01=DENSS(ZH01,DB01,TINF,TLB,1.-XMM,-1.4,
     $  T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DM01=DENSS(ALT,B01,TINF,TLB,XMM,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
C       Eq. A12
      ZHM01=ZHM28
      D(7)=DNET(D(7),DM01,ZHM01,XMM,1.)
C       Eq. A20b
      RL=ALOG(B28*PDM(2,6)*ABS(PDL(18,2))/B01)
C       Eq. A20a
      HC01=PDM(6,6)*PDL(12,2)
      ZC01=PDM(5,6)*PDL(11,2)
      D(7)=D(7)*CCOR(ALT,RL,HC01,ZC01)
       Eq. A21
      HCC01=PDM(8,6)*PDL(20,2)
      ZCC01=PDM(7,6)*PDL(19,2)
      RC01=PDM(4,6)*PDL(21,2)
      D(7)=D(7)*CCOR(ALT,RC01,HCC01,ZCC01)
   47 CONTINUE
   48 CONTINUE
C
C        **** ATOMIC NITROGEN DENSITY ****
C
C       Eq. A18
      G14 = SW(21)*GLOBE5(YRD,SEC,GLAT,GLONG,STL,F107A,F107,AP,PD(1,7))
      DB14 = PDM(1,7)*EXP(G14)*PD(1,7)
C       Eq. A13 - A17
      D(8)=DENSS(ALT,DB14,TINF,TLB,14.,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DD=D(8)
      IF(ALT.GT.ALTL(8).OR.SW(15).EQ.0.) GO TO 49
C       Eq. A19
      ZH14=PDM(3,7)
      B14=DENSS(ZH14,DB14,TINF,TLB,14.-XMM,-1.,
     $  T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DM14=DENSS(ALT,B14,TINF,TLB,XMM,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
C       Eq. A12
      ZHM14=ZHM28
      D(8)=DNET(D(8),DM14,ZHM14,XMM,14.)
C       Eq. A20b
      RL=ALOG(B28*PDM(2,7)*ABS(PDL(3,1))/B14)
C       Eq. A20a
```

```
      HC14=PDM(6,7)*PDL(2,1)
      ZC14=PDM(5,7)*PDL(1,1)
      D(8)=D(8)*CCOR(ALT,RL,HC14,ZC14)
C       Eq. A21
      HCC14=PDM(8,7)*PDL(5,1)
      ZCC14=PDM(7,7)*PDL(4,1)
      RC14=PDM(4,7)*PDL(6,1)
      D(8)=D(8)*CCOR(ALT,RC14,HCC14,ZCC14)
   49 CONTINUE
      IF(MASS.NE.48) GO TO 90
C
C       TOTAL MASS DENSITY
C
      D(6) = 1.66E-24*(4.*D(1)+16.*D(2)+28.*D(3)+32.*D(4)+40.*D(5)+
     $       D(7)+14.*D(8))
      DB48=1.66E-24*(4.*DB04+16.*DB16+28.*DB28+32.*DB32+40.*DB40+DB01+
     $        14.*DB14)
      GO TO 90
   50 DDUM  = DENSS(ALT,1., TINF,TLB,0.,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
      GO TO 90
   90 CONTINUE
      IF(IMR.EQ.1) THEN
        DO 95 I=1,8
          D(I)=D(I)*1.E6
   95   CONTINUE
        D(6)=D(6)/1000.
      ENDIF
      RETURN
  100 FORMAT(1X,'MASS', I5, '  NOT VALID')
      ENTRY METERS(METER)
      IMR=0
      IF(METER) IMR=1
      END
C-----------------------------------------------------------------------
      FUNCTION DENSS(ALT,DLB,TINF,TLB,XM,ALPHA,TZ,ZLB,S2,T0,ZA,Z0,TR12)
C       Calculate Temperature and Density Profiles for MSIS models
      COMMON/PARMB/GSURF,RE
      COMMON/FIT/TAF
      COMMON/LSQV/MP,II,JG,LT,QPB(50),IERR,IFUN,N,J,DV(60)
      DATA RGAS/831.4/
      ZETA(ZZ,ZL)=(ZZ-ZL)*(RE+ZL)/(RE+ZZ)
      DENSS=1.
      Z=AMAX1(ALT,ZA)
C      Eq. A4a
      ZG2=ZETA(Z,ZLB)
C      Eq. A1a
      TT=TINF-(TINF-TLB)*EXP(-S2*ZG2)
      TA=TT
      TZ=TT
      DENSS=TZ
      IF(ALT.GE.ZA) GO TO 10
C      Eq. A4b
      ZG0=ZETA(Z0,ZA)
C      Eq. A2b
      DTA=(TINF-TA)*S2*((RE+ZLB)/(RE+ZA))**2
C      Eq. A3e
      T12=T0+TR12*(TA-T0)
C      Eq. A4b
      ZG1=ZETA(ALT,ZA)
C       CALCULATE TEMPERATURE BELOW ZA
```

```
      ZHM28=PDM(4,3)*PDL(6,2)
      XMD=28.-XMM
      B28=DENSS(ZH28,DB28,TINF,TLB,XMD,-1.,TZ,PTM(6),S,T0,ZA,Z0,TR12)
      IF(ALT.GT.ALTL(3).OR.SW(15).EQ.0.) GO TO 17
      DM28=DENSS(ALT,B28,TINF,TLB,XMM,0.,TZ,PTM(6),S,T0,ZA,Z0,TR12)
C       Eq. A12
      D(3)=DNET(D(3),DM28,ZHM28,XMM,28.)
   17 CONTINUE
      GO TO (20,50,20,25,90,35,40,45,25,48),  J
   20 CONTINUE
C
C       **** HE DENSITY ****
C
C       Eq. A18
      G4 = SW(21)*GLOBE5(YRD,SEC,GLAT,GLONG,STL,F107A,F107,AP,PD(1,1))
      DB04 = PDM(1,1)*EXP(G4)*PD(1,1)
C       Eq. A13 - A17
      D(1)=DENSS(ALT,DB04,TINF,TLB, 4.,-.4,T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DD=D(1)
      IF(ALT.GT.ALTL(1).OR.SW(15).EQ.0.) GO TO 24
C       Eq. A19
      ZH04=PDM(3,1)
      B04=DENSS(ZH04,DB04,TINF,TLB,4.-XMM,-1.4,
     $  T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DM04=DENSS(ALT,B04,TINF,TLB,XMM,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
C       Eq. A12
      ZHM04=ZHM28
      D(1)=DNET(D(1),DM04,ZHM04,XMM,4.)
C       Eq. A20b
      RL=ALOG(B28*PDM(2,1)/B04)
C       Eq. A20a
      ZC04=PDM(5,1)*PDL(1,2)
      HC04=PDM(6,1)*PDL(2,2)
      D(1)=D(1)*CCOR(ALT,RL,HC04,ZC04)
   24 CONTINUE
      IF(MASS.NE.48)   GO TO 90
   25 CONTINUE
C
C       **** O DENSITY ****
C
C       Eq. A18
      G16= SW(21)*GLOBE5(YRD,SEC,GLAT,GLONG,STL,F107A,F107,AP,PD(1,2))
      DB16 =  PDM(1,2)*EXP(G16)*PD(1,2)
C       Eq. A13 - A17
      D(2)=DENSS(ALT,DB16,TINF,TLB, 16.,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DD=D(2)
      IF(ALT.GT.ALTL(2).OR.SW(15).EQ.0.) GO TO 34
C  Corrected from PDM(3,1) to PDM(3,2)  12/2/85
C       Eq. A19
      ZH16=PDM(3,2)
      B16=DENSS(ZH16,DB16,TINF,TLB,16-XMM,-1.,
     $  T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DM16=DENSS(ALT,B16,TINF,TLB,XMM,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
C       Eq. A12
      ZHM16=ZHM28
      D(2)=DNET(D(2),DM16,ZHM16,XMM,16.)
C       Eq. A20b
      RL=ALOG(B28*PDM(2,2)*ABS(PDL(17,2))/B16)
        Eq. A20a
      HC16=PDM(6,2)*PDL(4,2)
```

```
      ZC16=PDM(5,2)*PDL(3,2)
      D(2)=D(2)*CCOR(ALT,RL,HC16,ZC16)
C       Eq. A21
      HCC16=PDM(8,2)*PDL(14,2)
      ZCC16=PDM(7,2)*PDL(13,2)
      RC16=PDM(4,2)*PDL(15,2)
      D(2)=D(2)*CCOR(ALT,RC16,HCC16,ZCC16)
   34 CONTINUE
      IF(MASS.NE.48 .AND. MASS.NE.49) GO TO 90
   35 CONTINUE
C
C       **** O2 DENSITY ****
C
C       Eq. A18
      G32= SW(21)*GLOBE5(YRD,SEC,GLAT,GLONG,STL,F107A,F107,AP,PD(1,4))
      DB32 = PDM(1,4)*EXP(G32)*PD(1,4)
C       Eq. A13 - A17
      D(4)=DENSS(ALT,DB32,TINF,TLB, 32.,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
      IF(MASS.EQ.49) THEN
         DD=DD+2.*D(4)
      ELSE
         DD=D(4)
      ENDIF
      IF(ALT.GT.ALTL(4).OR.SW(15).EQ.0.) GO TO 39
C       Eq. A19
      ZH32=PDM(3,4)
      B32=DENSS(ZH32,DB32,TINF,TLB,32.-XMM,-1.,
     $  T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DM32=DENSS(ALT,B32,TINF,TLB,XMM,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
C       Eq. A12
      ZHM32=ZHM28
      D(4)=DNET(D(4),DM32,ZHM32,XMM,32.)
C       Eq. A20b
      RL=ALOG(B28*PDM(2,4)/B32)
C       Eq. A20a
      HC32=PDM(6,4)*PDL(8,2)
      ZC32=PDM(5,4)*PDL(7,2)
      D(4)=D(4)*CCOR(ALT,RL,HC32,ZC32)
   39 CONTINUE
      IF(MASS.NE.48)   GO TO 90
   40 CONTINUE
C
C       **** AR DENSITY ****
C
C       Eq. A18
      G40= SW(21)*GLOBE5(YRD,SEC,GLAT,GLONG,STL,F107A,F107,AP,PD(1,5))
      DB40 = PDM(1,5)*EXP(G40)*PD(1,5)
C       Eq. A13 - A17
      D(5)=DENSS(ALT,DB40,TINF,TLB, 40.,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DD=D(5)
      IF(ALT.GT.ALTL(5).OR.SW(15).EQ.0.) GO TO 44
C       Eq. A19
      ZH40=PDM(3,5)
      B40=DENSS(ZH40,DB40,TINF,TLB,40.-XMM,-1.,
     $  T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DM40=DENSS(ALT,B40,TINF,TLB,XMM,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
C       Eq. A12
      ZHM40=ZHM28
      D(5)=DNET(D(5),DM40,ZHM40,XMM,40.)
C       Eq. A20b
```

```
C     ******************************************************************
      SUBROUTINE GTS5(IYD,SEC,ALT,GLAT,GLONG,STL,F107A,F107,AP,MASS,D,T)
C        MSIS-86/CIRA 1986 Neutral Thermosphere Model
C         A.E.Hedin 3/15/85;2/26/87 (Variable Names Shortened)
C     INPUT:
C        IYD - YEAR AND DAY AS YYDDD
C        SEC - UT(SEC)
C        ALT - ALTITUDE(KM) (GREATER THAN 85 KM)
C        GLAT - GEODETIC LATITUDE(DEG)
C        GLONG - GEODETIC LONGITUDE(DEG)
C        STL - LOCAL APPARENT SOLAR TIME(HRS)
C        F107A - 3 MONTH AVERAGE OF F10.7 FLUX
C        F107 - DAILY F10.7 FLUX FOR PREVIOUS DAY
C        AP - MAGNETIC INDEX(DAILY) OR WHEN SW(9)=-1. :
C           - ARRAY CONTAINING:
C             (1) DAILY AP
C             (2) 3 HR AP INDEX FOR CURRENT TIME
C             (3) 3 HR AP INDEX FOR 3 HRS BEFORE CURRENT TIME
C             (4) 3 HR AP INDEX FOR 6 HRS BEFORE CURRENT TIME
C             (5) 3 HR AP INDEX FOR 9 HRS BEFORE CURRENT TIME
C             (6) AVERAGE OF EIGHT 3 HR AP INDICIES FROM 12 TO 33 HRS PRIOR
C                    TO CURRENT TIME
C             (7) AVERAGE OF EIGHT 3 HR AP INDICIES FROM 36 TO 59 HRS PRIOR
C                    TO CURRENT TIME
C        MASS - MASS NUMBER (ONLY DENSITY FOR SELECTED GAS IS
C                 CALCULATED.  MASS 0 IS TEMPERATURE.  MASS 48 FOR ALL.
C     OUTPUT:
C        D(1) - HE NUMBER DENSITY(CM-3)
C        D(2) - O NUMBER DENSITY(CM-3)
C        D(3) - N2 NUMBER DENSITY(CM-3)
C        D(4) - O2 NUMBER DENSITY(CM-3)
C        D(5) - AR NUMBER DENSITY(CM-3)
C        D(6) - TOTAL MASS DENSITY(GM/CM3)
C        D(7) - H NUMBER DENSITY(CM-3)
C        D(8) - N NUMBER DENSITY(CM-3)
C        T(1) - EXOSPHERIC TEMPERATURE
C        T(2) - TEMPERATURE AT ALT
C
C     TO GET OUTPUT IN M-3 and KG/M3:   CALL METERS(.TRUE.)
C
C         ADDITIONAL COMMENTS
C          (1) LOWER BOUND QUANTITIES IN COMMON/GTS3C/
C          (2) TO TURN ON AND OFF PARTICULAR VARIATIONS CALL TSELEC(SW)
C              WHERE SW IS A 25 ELEMENT ARRAY CONTAINING 0. FOR OFF, 1.
C              FOR ON, OR 2. FOR MAIN EFFECTS OFF BUT CROSS TERMS ON
C              FOR THE FOLLOWING VARIATIONS
C              1 - F10.7 EFFECT ON MEAN   2 - TIME INDEPENDENT
C              3 - SYMMETRICAL ANNUAL     4 - SYMMETRICAL SEMIANNUAL
C              5 - ASYMMETRICAL ANNUAL    6 - ASYMMETRICAL SEMIANNUAL
C              7 - DIURNAL                8 - SEMIDIURNAL
C              9 - DAILY AP              10 - ALL UT/LONG EFFECTS
C             11 - LONGITUDINAL          12 - UT AND MIXED UT/LONG
C             13 - MIXED AP/UT/LONG      14 - TERDIURNAL
C             15 - DEPARTURES FROM DIFFUSIVE EQUILIBRIUM
C             16 - ALL TINF VAR          17 - ALL TLB VAR
C             18 - ALL T0 VAR            19 - ALL S VAR
C             20 - ALL Z0 VAR            21 - ALL NLB VAR
C             22 - ALL TR12 VAR          23 - TURBO SCALE HEIGHT VAR
C
C             To get current values of SW: CALL TRETRV(SW)
```

```
C
      LOGICAL METER
      DIMENSION D(8),T(2),MT(10),AP(7),ALTL(8)
      CHARACTER NAME(2)*4
      COMMON/GTS3C/TLB,S,DB04,DB16,DB28,DB32,DB40,DB48,DB01,ZA,T0,Z0
     $ ,G0,RL,DD,DB14
      COMMON/LOWER5/PTM(8),PDM(8,7)
      COMMON/PARM5/PT(150),PD(150,7),PS(150),PDL(25,2)
      COMMON/CSW/SW(25),ISW,SWC(25)
      COMMON/TTEST/TINFG,GB,ROUT,TT(15)
      COMMON/DATIME/ISDATE(3),ISTIME(2),NAME
      DATA MT/48,0,4,16,28,32,40,1,49,14/,IFL/0/
      DATA ALTL/200.,300.,150.,200.,240.,450.,320.,450./
      DATA IMR/0/
      IF(IFL.EQ.0) THEN
        CALL PRMSG5
        IFL=1
      ENDIF
      YRD=IYD
C       Eq. A7
      TINF=PTM(1)*(1.+SW(16)*GLOBE5(YRD,SEC,GLAT,GLONG,STL,F107A,F107,
     $ AP,PT))*PT(1)
      ZA=PTM(5)*PDL(16,2)
C       Eq. A9
      T0=PTM(3)*PD(76,3)*(1.+SW(18)*GLOB5L(PD(76,3)))
C       Eq. A8
      TLB=PTM(2)*(1.+SW(17)*GLOB5L(PD(26,3)))*PD(26,3)
C       Eq. A10
      Z0=PTM(7)*(1.+SW(20)*GLOB5L(PD(51,3)))*PD(51,3)
C       Eq. A6
      G0=PTM(4)*PS(1)
     $ *(1.+SW(19)*GLOBE5(YRD,SEC,GLAT,GLONG,STL,F107A,F107,
     $ AP,PS))
C       Eq. A5
      S=G0/(TINF-TLB)
C       Eq. A11
      TR12=PD(101,3)*(1.+SW(22)*GLOB5L(PD(101,3)))
      T(1)=TINF
      IF(MASS.EQ.0) GO TO 50
C       Eq. A18  N2
      G28=SW(21)*GLOB5L(PD(1,3))
      YRD=IYD
      T(1)=TINF
      XMM=PDM(5,3)
      DO 10 J = 1,10
      IF(MASS.EQ.MT(J))   GO TO 15
   10 CONTINUE
      WRITE(6,100) MASS
      GO TO 90
   15 IF(ALT.GT.ALTL(6).AND.MASS.NE.28.AND.MASS.NE.48) GO TO 17
C
C       **** N2 DENSITY ****
C
C       Eq. A18
      DB28 = PDM(1,3)*EXP(G28)*PD(1,3)
C       Eq. A13 - A17
      D(3)=DENSS(ALT,DB28,TINF,TLB, 28.,0.,T(2),PTM(6),S,T0,ZA,Z0,TR12)
      DD=D(3)
C       Eq. A19
      ZH28=PDM(3,3)
```

```
      IF(ISELEC.GT.0) THEN
        ISWI(ISELEC)=IVALUE
        SWI(ISELEC)=IVALUE*1.0
        GOTO 5521
      ENDIF
      CALL TSELEC(SWI)
      IF(NOTBEG) GOTO 3293
3300  IF(JMAG.EQ.1) THEN
        IMZ(1)='GEOM'
        IMZ(2)='GEOM'
      ENDIF
      NOTBEG=.TRUE.
      IF((IVAR.EQ.6).AND.(BVAR.GT.24.0)) THEN
        IMZ(5)='U.T.'
      ENDIF
        WRITE(AGNR,8193) ITEXT(IVAR),IMZ(IVAR)
8193  FORMAT(//////////3X,A5,8X,'NUMBER DENSITIES/CM-3      MASS',
     & ' DENSITY  TEMPERATURE/K'/4X,A4,4X,'   O          N2     ',
     & '      O2        G*CM-3        TN    TEXO')
        XVAR(1)=LATI
        XVAR(2)=LONGI
        XVAR(3)=F107
        XVAR(4)=F107M
        XVAR(5)=DAYNR
        XVAR(6)=HOUR
        XVAR(7)=HEIGHT
        XVAR(8)=AP(1)
        LFD=0
        XVAR(IVAR)=BVAR-SVAR
2123    XVAR(IVAR)=XVAR(IVAR)+SVAR
        LFD=LFD+1
        IF(JMAG.GT.0) THEN
           MLAT=XVAR(1)
           MLONG=XVAR(2)
        ELSE
           LATI=XVAR(1)
           LONGI=XVAR(2)
        ENDIF
        F107=XVAR(3)
        F107M=XVAR(4)
        IF(IVAR.EQ.4) F107=F107M
        DAYNR=XVAR(5)
        HOUR=XVAR(6)
        HEIGHT=XVAR(7)
        AP(1)=XVAR(8)
C
C MSIS CALCULATION
C
        IF((LFD.EQ.1).OR.(IVAR.LT.3))
     &          CALL GGM(JMAG,LONGI,LATI,MLONG,MLAT)
        IF(UTLT) GOTO 3820
        IF(HOUR.LE.24.0) GOTO 3819
          UT=HOUR-25.0
          HOUR=UT+LONGI/15.
          IF(HOUR.GT.24.0) HOUR=HOUR-24.0
          GOTO 3820
3819      UT=HOUR-LONGI/15.
          IF(UT.LT.0.0) UT=UT+24.
3820    UTSEC=UT*3600.0
        CALL GTS5(DAYNR,UTSEC,HEIGHT,LATI,LONGI,HOUR,F107M,F107,
```

```
     &           AP(1),48,DEN,TEMP)
      XCOR=XVAR(IVAR)
      OUTF(1,LFD)=XCOR
      DO 2918 LL=1,8
2918  OUTF(LL+1,LFD)=DEN(LL)
      OUTF(10,LFD)=TEMP(1)
      OUTF(11,LFD)=TEMP(2)
      WRITE(AGNR,7117) XCOR,DEN(2),DEN(3),DEN(4),DEN(6),
     &  INT(TEMP(2)+.5),INT(TEMP(1)+.5)
7117  FORMAT(1X,F7.1,1X,3(1X,1PE10.3),2X,1PE9.3,2X,2I6)
      IF(XCOR.LT.EVAR) GOTO 2123
2289  WRITE(AGNR,2193) LATI,LONGI,HEIGHT,F107,DAYNR,HOUR
     &   ,AP(1),MLAT,MLONG,F107M,UT
2193  FORMAT(1X,74('-')/' LATI/LONG=',F5.1,'/',F5.1,'  H=',F6.1,
     &  '  F10.7 =',F5.1,'  DAY:',I3,'  LT:',F4.1,'  AP=',F4.1/
     &  ' MLAT/MLON=',F5.1,'/',F5.1,12X,'F10.7M=',F5.1,11X,
     &  'UT:',F4.1/1X,74('-'))
        OUT1=.TRUE.
3918  WRITE(MONITO,5600)
5600  FORMAT(1X/' **** DO YOU WANT TO CONTINUE?'/1X,60('-')/
     &  ' "0"  QUIT AND EXIT        "1"  NEW PARAMETERS'/
     &  ' "2"  OTHER OUTPUT WINDOW'/1X,60('-')/)
      READ(EGNR,*) IALL
      IF(IALL.EQ.1) GOTO 3293
      IF(IALL.EQ.0) GOTO 2978
      IF(OUT1) GOTO 1938
        WRITE(AGNR,8193) ITEXT(IVAR),IMZ(IVAR)
      DO 2891 I=1,LANZ
2891  WRITE(AGNR,7117) OUTF(1,I),OUTF(3,I),OUTF(4,I),OUTF(5,I),
     &  OUTF(7,I),INT(OUTF(11,I)+.5),INT(OUTF(10,I)+.5)
      WRITE(AGNR,2193) LATI,LONGI,HEIGHT,F107,DAYNR,HOUR
     &   ,AP(1),MLAT,MLONG,F107M,UT
      OUT1=.TRUE.
      GOTO 3918
1938  WRITE(AGNR,8195) ITEXT(IVAR),IMZ(IVAR)
8195  FORMAT(//////////3X,A5,13X,'NUMBER DENSITIES/CM-3',12X,
     &  'TEMPERATURE/K'/4X,A4,7X,'HE',9X,'AR',9X,'H',
     &  10X,'N',9X,'TN')
      DO 2899 I=1,LANZ
2899  WRITE(AGNR,7119) OUTF(1,I),OUTF(2,I),OUTF(6,I),
     &  OUTF(8,I),OUTF(9,I),INT(OUTF(11,I)+.5)
7119  FORMAT(1X,F7.1,1X,4(1X,1PE10.3),2X,I6)
      WRITE(AGNR,2193) LATI,LONGI,HEIGHT,F107,DAYNR,HOUR
     &   ,AP(1),MLAT,MLONG,F107M,UT
      OUT1=.FALSE.
      GOTO 3918
2978  STOP
      END
```

```
     & ' TIME is assumed, otherwise LOCAL TIME'/1X,70('-')/)
      READ(EGNR,*) BVAR,EVAR,SVAR
      LANZ=INT((EVAR-BVAR)/SVAR)+1
      IF(NOTBEG) GOTO 3293
 3332 WRITE(MONITO,6006) JMAG
 6006 FORMAT(1X//1X,'JMAG ?',50X,'#',I1,'#'//' !! "0" geodatic',
     &  ' longitude and latitude'/' !! "1"    geomagnetic   ... '/
     &  1X,60('-')/)
      READ(EGNR,*) JMAG
      IF(NOTBEG) GOTO 3293
      IVARNR=IVARNR+1
      IF(IVARNR.EQ.IVAR) GOTO 7339
 3329 WRITE(MONITO,5000) LATI
 5000 FORMAT(1X//1X,'LATITUDE ?   !NORTH!    [DEGREE,DECIMAL]',
     & 13X,'#',F5.1,'#'/1X,60('-')/)
      READ(EGNR,*) LATI
      IF(NOTBEG) GOTO 3293
 7339 IVARNR=IVARNR+1
      IF(IVARNR.EQ.IVAR) GOTO 7500
 3339 WRITE(MONITO,6001) LONGI
 6001 FORMAT(1X//1X,'LONGITUDE ?   !EAST!    [DEGREE,DECIMAL]',
     & 13X,'#',F5.1,'#'/1X,60('-')/)
      READ(EGNR,*) LONGI
      IF(NOTBEG) GOTO 3293
 7500 IVARNR=IVARNR+1
      IF(IVARNR.EQ.IVAR) GOTO 7701
 3500 WRITE(MONITO,6003) F107
 6003 FORMAT(1X//1X,'10.7CM SOLAR RADIO FLUX ?    * PREVIOUS DAY *',
     &  8X,'#',F5.1,'#'/1X,60('-')/)
      READ(EGNR,*) F107
      IF(NOTBEG) GOTO 3293
 7701 IVARNR=IVARNR+1
      IF(IVARNR.EQ.IVAR) GOTO 7501
 5701 WRITE(MONITO,6013) F107M
 6013 FORMAT(1X//1X,'10.7CM SOLAR RADIO FLUX ?   * MONTHLY AVERAGE *',
     &  6X,'#',F5.1,'#'/1X,60('-')/)
      READ(EGNR,*) F107M
      IF(NOTBEG) GOTO 3293
 7501 IVARNR=IVARNR+1
      IF(IVARNR.EQ.IVAR) GOTO 7502
 5501 WRITE(MONITO,6004) DAYNR
 6004 FORMAT(1X//1X,'DAY OF YEAR ?',8X,'* DDD *',27X,'#',I3,'#'/
     &  1X,60('-')/)
      READ(EGNR,*) DAYNR
      IF(NOTBEG) GOTO 3293
 7502 IVARNR=IVARNR+1
      IF(IVARNR.EQ.IVAR) GOTO 7331
 5502 WRITE(MONITO,6005) HOUR
 6005 FORMAT(1X//1X,'LOCAL TIME ?',8X,'[HOURS, DECIMAL]',18X,'#',F4.1,
     &  '#'//' !! HOUR is LOCAL TIME or UNIVERSAL TIME plus "25"'/
     &  ' !! HOUR=-1  you provide LOCAL TIME and UNIVERSAL TIME'/
     &  1X,60('-')/)
      READ(EGNR,*) HOUR
      UTLT=.FALSE.
      IF(HOUR.LT.0.0) THEN
        WRITE(MONITO,6605)
 6605   FORMAT(//' LOCAL TIME, UNIVERSAL TIME ?    [HOURS, DECIMAL]'
     &      /1X,60('-')/)
        READ(EGNR,*) HOUR,UT
        UTLT=.TRUE.
```

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      ENDIF
      IF(NOTBEG) GOTO 3293
7331  IVARNR=IVARNR+1
      IF(IVARNR.EQ.IVAR) GOTO 5551
3331  WRITE(MONITO,6002) HEIGHT
6002  FORMAT(1X//1X,'ALTITUDE ?    [KM]',35X,'#',F5.1,'#'/
     & 1X,60('-')/)
      READ(EGNR,*) HEIGHT
      IF(NOTBEG) GOTO 3293
5551  IVARNR=IVARNR+1
      IF(IVARNR.EQ.IVAR) GOTO 5505
6780  WRITE(MONITO,7732) AP(1)
7732  FORMAT(1X//1X,'AP-INDEX ?    * MAGNETIC ACTIVITY *',18X,'#',
     & F5.1,'#'//' !! "-1"   ENTER DETAILLED AP HISTORY FOR 59 HOURS'
     & /' !!        PRIOR TO CURRENT TIME'/1X,60('-')/)
      READ(EGNR,*) AP(1)
      IF(AP(1).GT.-1.0) GOTO 3999
        ISWI(9)=-1
3813    WRITE(MONITO,6620) (AP(J),J=1,7)
6620    FORMAT(' 1  DAILY AP',45X,'#',F4.1,'#'/' 2  3-H(OUR)-AP INDEX',
     &   ' FOR CURRENT TIME',19X,'#',F4.1,'#'/' 3  3-H-AP INDEX FOR ',
     &   '3 HRS BEFORE CURRENT TIME',11X,'#',F4.1,'#'/' 4  3-H-AP ',
     &   'INDEX FOR 6 HRS BEFORE CURRENT TIME',11X,'#',F4.1,'#'/
     &   ' 5  3-H-AP INDEX FOR 9 HRS BEFORE CURRENT TIME',11X,'#',F4.1,
     &   '#'/' 6  AVERAGE OF 3-H-AP INDICIES FROM 12 TO 33 HRS ',
     &   'BEFORE  #',F4.1,'#'/' 7  AVERAGE OF 3-H-AP INDICIES FROM ',
     &   '36 TO 59 HRS BEFORE  #',F4.1,'#'/1X,70('-')/' ENTER:',
     &   ' NUMBER    (0 TO CONTINUE)'/)
        READ(EGNR,*) NRAP
        IF(NRAP.GT.0) THEN
          WRITE(MONITO,3812) NRAP
3812      FORMAT(1X,'AP(',I1,')=')
          READ(EGNR,*) AP(NRAP)
          GOTO 3813
        ENDIF
3999  IF(NOTBEG) GOTO 3293
5505  IF(NOTBEG) CALL TRETRV(SWI)
        IF(ISWI(9).LT.0) SWI(9)=ISWI(9)*1.0
        DO 3919 J=1,25
3919    ISWI(J)=INT(SWI(J))
5521  WRITE(MONITO,5030) (ISWI(J),J=1,23)
5030  FORMAT(1X//' SELECTION OF PARTICULAR VARIATIONS:  ON/OFF (1/0)'/
     & 5X,'2  MAIN EFFECT OFF, BUT CROSS TERMS ON',5X,'-1  SPECIAL'/
     & 1X,70('-')/' 1  F10.7 EFFECT ON MEAN   #',I1,'#',9X,'2  TIME',
     & ' INDEPENDENT        #',I1,'#'/' 3  SYMMETRICAL ANNUAL     #',
     & I1,'#',9X,'4  SYMMETRICAL SEMI-ANNUAL #',I1,'#'/' 5  ASYMMETR',
     & 'ICAL ANNUAL    #',I1,'#',9X,'6  ASYMMETRICAL SEMI-ANNUAL#',I1,
     & '#'/' 7  DIURNAL',16X,'#',I1,'#',9X,'8  SEMI-DIURNAL',12X,'#',
     & I1,'#'/' 9  DAILY AP (-1 HISTORY) #',I2,'#',8X,'10  ALL UT/LO',
     & 'NG EFFECTS     #',I1,'#'/' 11 LONGITUDINAL',11X,'#',I1,'#',8X,
     & '12  UT AND MIXED UT/LONG    #',I1,'#'/' 13 MIXED AP/UT/LONG',
     & 7X,'#',I1,'#',8X,'14  TER-DIURNAL',13X,'#',I1,'#'/' 15 DEPART',
     & 'URES FROM DIFF. EQUIL. #',I1,'#  16  ALL TINF VARIATION',6X,
     & '#',I1,'#'/' 17 ALL TLB VARIATION      #',I1,'#',8X,'18  ALL',
     & ' T0 VARIATION        #',I1,'#'/' 19 ALL S VARIATION        #',
     & I1,'#',8X,'20  ALL Z0 VARIATION        #',I1,'#'/' 21 ALL NLB',
     & ' VARIATION      #',I1,'#',8X,'22  ALL TR12 VARIATION      #',
     & I1,'#'/' 23 TURBO SCALE HEIGHT VARIATION #',I1,'#'/1X,70('-')/
     & ' ENTER: NUMBER, NEW FLAG     OR: "0,0" TO CONTINUE'/)
      READ(EGNR,*) ISELEC,IVALUE
```

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C*****************************************************************
C**************** MSIS-86 THERMOSPHERE MODEL *********************
C*****************************************************************
C****************** M86DRI.FOR, APRIL 1987 ***********************
C******************    DRIVER PROGRAM      ***********************
C*****************************************************************
C*** THIS PROGRAM PRODUCES PROFILES OF                          ***
C***      NEUTRAL TEMPERATURE                                   ***
C***      EXOSPHERIC TEMPERATURE                                ***
C***      NUMBER DENSITIES OF He, O, N2, O2, Ar, H and N        ***
C***      TOTAL MASS DENSITY                                    ***
C*****************************************************************
C*** FOR SPECIFIED                                              ***
C***      DAY OF YEAR                                           ***
C***      GEODATIC OR GEOMAGNETIC LATITUDE AND LONGITUDE        ***
C***      ALTITUDE                                              ***
C***      10.7 CM SOLAR RADIO FLUX, DAILY (FOR PREVIOUS DAY)    ***
C***                AND 3-MONTHS AVERAGE                        ***
C***      LOCAL (APPARENT SOLAR) OR UNIVERSAL TIME              ***
C***      MAGNETIC INDEX Ap, DAILY OR HISTORY                   ***
C***      YOUR CHOICE OF VARIABLE                               ***
C*****************************************************************
C*****************************************************************
C*     --------------------ADDRESSES-----------------------      *
C*     I  DR. A. E. HEDIN              DR. D. BILITZA       I    *
C*     I  GSFC CODE 614                GSFC/NSSDC CODE 633  I    *
C*     I  GREENBELT, MD 20771          GREENBELT, MD 20771  I    *
C*     I  USA                          USA                  I    *
C*     -------------------------------------------------------    *
C*****************************************************************
C*****************************************************************
C*****************************************************************
C*********       ALL ANGLES ARE IN DEGREE            **************
C*********     ALL NUMBER DENSITIES ARE IN CM-3      **************
C*********     ALL MASS DENSITIES ARE IN G/CM+3      **************
C*********       ALL ALTITUDES ARE IN KM             **************
C*********     ALL TEMPERATURES ARE IN KELVIN        **************
C*****************************************************************
C*******************  OPTIONS  ******************************
C*****************************************************************
C* HOUR        IS   LOCAL TIME   OR   UNIVERSAL TIME + 25         *
C* JMAG        =0 GEOGRAFIC LATITUDE AND LONGITUDE EXPECTED       *
C*             =1 GEOMAGNETIC LATITUDE AND LONGITUDE EXPECTED     *
C* TO TURN ON/OFF 23 PARTICULAR VARIATIONS CALL "TSELEC(SW)"      *
C*             TO SET THE 23 FLAGS SW. TO GET CURRENT VALUES OF   *
C*             SW CALL "TRETRV(SW)".                              *
C*****************************************************************
C*****************************************************************
C*****************************************************************
      INTEGER EGNR,AGNR,DAYNR
      REAL LATI,LONGI,MLAT,MLONG
      CHARACTER ITEXT(8)*5
      CHARACTER IMZ(8)*4
      DIMENSION DEN(8),TEMP(2),AP(16),XVAR(8),ISWI(25),SWI(25),
     &  OUTF(11,30)
      COMMON/GTS3C/DL(16)
      LOGICAL UTLT,NOTBEG,OUT1
      DATA IMZ/'GEOD','GEOD',' DAY',' MON','    ','L.T.','    ',
     &  '    '/,ITEXT/' LATI',' LONG','F10.7','F10.7',' DAY ',
     &  ' HOUR',' H/KM','  AP '/,LATI,LONGI,HEIGHT,F107,F107M,
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     &  DAYNR,HOUR,AP(1),IVAR,BVAR,EVAR,SVAR/45.1,293.1,100,
     &  100,100,231,12.5,0,6,100,1000,100/,ISWI/25*1/,SWI/25*1.0/
      UMR=ATAN(1.0)*4./180.
      ALOG2=ALOG(2.)
C
C FIRST SPECIFY YOUR COMPUTERS CHANNEL NUMBERS ....................
C EGNR=INPUT, MONITO=MONITOR, KONSOL=MESSAGES.....................
C AGNR=OUTPUT (OUTPUT IS DISPLAYED OR STORED IN FILE OUTPUT.IRI)...
C
      EGNR=5
      MONITO=6
      WRITE(MONITO,5100)
5100  FORMAT(1X/////4X,49('*')/4X,
     & '********* MSIS THERMOSPHERE MODEL 1986 **********'/4X,
     & 49('*')/////1X,'THIS PROGRAM ALLOWS YOU TO PRODUCE MSIS-',
     & 'PROFILES IN LATITUDE,'/' LONGITUDE,SOLAR ACTIVITY,DAY',
     & ',TIME,ALTITUDE OR MAGNETIC ACTIVITY.')
      NOTBEG=.FALSE.
      GOTO 5508
3293  WRITE(MONITO,5602) LATI,LONGI,HEIGHT,F107,F107M,DAYNR,HOUR,
     & AP(1)
5602  FORMAT(1X//' **** WHICH PARAMETER DO YOU WANT TO ',
     & 'CHANGE?'/1X,70('-')/' 0  NO FURTHER CHANGES, CALCULATE',
     & ' PROFILE'/' 1  LATITUDE  #',F5.1,'#',8X,'7  GEOD. OR ',
     & 'GEOMAGNETIC'/' 2  LONGITUDE #',F5.1,'#',8X,'8  SELECTION',
     & ' OF VARIABLE'/' 3  ALTITUDE  #',F6.1,'#',7X,'9  VARIABLE ',
     & 'RANGE'/' 4  F10.7     #',F5.1,'#',7X,'10  F10.7M  #',
     & F5.1,'#'/' 5  DAY       #',I3,'#',9X,'11  ON/OFF FOR PART',
     & 'ICULAR VARIATIONS'/' 6  HOUR      #',F5.1,'#',7X,'12  DIS',
     & 'PLAY OR STORE'/28X,'13  AP      #',F5.1,'#'/
     & 1X,70('-')/' ENTER NUMBER'/)
      READ(EGNR,*) ISWIT
      GOTO (5300,3329,3339,3331,3500,5501,5502,3332,5503,5504,
     &    5701,5505,5508,6780) ISWIT+1
5508  WRITE(MONITO,5123)
5123  FORMAT(/////' DO YOU WANT YOUR MSIS-PROFILES'/5X,
     & 'DISPLAYED ON YOUR MONITOR: TYPE "0"'/5X,
     & 'STORED IN FILE OUTPUT.MSI: TYPE "1"'/1X,60('-')/)
      READ(EGNR,*) JAGNR
      IVARNR=0
      AGNR=6
      IF(JAGNR.EQ.1) THEN
        OPEN(UNIT=16,FILE='OUTPUT.MSI',STATUS='NEW',FORM='FORMATTED')
        AGNR=16
      ENDIF
      IF(NOTBEG) GOTO 3293
5503  WRITE(MONITO,5040) IVAR
5040  FORMAT(1X//' SELECT YOUR VARIABLE:',33X,'#LAST:',I1,'#'//34X,
     &  'Geodatic or geomagnetic cordinates'/34X,'are assumed ',
     &  'depending on your later'/' 1  LATITUDE    5  DAY OF YEAR',4X,
     &  'selection of JMAG.'/' 2  LONGITUDE   6  HOUR',11X,
     &  'Variation in UNIVERSAL TIME is selected'/' 3  F10.7',7X,
     &  '7  ALTITUDE',7X,'by adding "25" to your BEGIN and END'/
     &  ' 4  F10.7M',6X,'8  AP',13X,'hours.'/34X,'If you select ',
     &  'F10.7M, F10.7 = F10.7M'/34X,'will be assumed.'/1X,70('-')/)
      READ(EGNR,*) IVAR
5504  WRITE(MONITO,5044) BVAR,EVAR,SVAR
5044  FORMAT(1X//' CHOOSE YOUR VARIABLE RANGE:',5X,' BEGIN, END, S',
     & 'TEPWIDTH ?'/32X,'#',3F8.1,'#'//' !! if your variable is HOUR ',
     & 'and you add "25" to your BEGIN and'/' !! END hours UNIVERSAL',
```

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 0.931113E+00-0.138721E+00-0.133457E+00-0.529542E-01-0.444983E-02
 0.135264E-01 0.598075E-01-0.362880E-01-0.312798E-01 0.372068E+00
 0.295974E-01 0.120509E-01 0.521995E-01-0.778888E+01 0.000000E+00
 0.118634E+00-0.204495E-01 0.103280E+03 0.982432E-01 0.477694E-03
 0.000000E+00 0.274372E-02 0.000000E+00 0.000000E+00 0.757809E-01
 0.171403E+00-0.105205E-01 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00-0.873348E+01-0.581094E-02 0.000000E+00-0.814944E-02
 0.000000E+00 0.000000E+00 0.517255E-01-0.153028E+02-0.348932E-02
 0.961771E-03 0.557732E-02-0.454180E-03 0.988213E-01 0.940456E-01
-0.318797E-01 0.000000E+00 0.000000E+00 0.000000E+00 0.232122E-02
-0.600220E-02 0.277654E-04-0.322019E-02 0.000000E+00-0.378551E-02
-0.334809E-02-0.170668E-02 0.000000E+00 0.636184E+04 0.000000E+00
 0.159986E-02-0.388204E-02-0.164825E-02-0.747955E+02-0.105360E-01
-0.945723E-02-0.159824E-02-0.706730E-03-0.168513E-01-0.113023E+00
-0.636637E-01-0.137709E+05 0.000000E+00 0.000000E+00 0.000000E+00
-0.152368E+05-0.586061E-02-0.253108E-02 0.000000E+00-0.254837E+04
-0.328988E-02 0.000000E+00 0.000000E+00-0.276364E-02 0.967923E-02
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.434255E-01 0.114020E-01-0.618447E-02 0.000000E+00 0.000000E+00
-0.302568E+00-0.327694E-01-0.671589E+02-0.228340E-02 0.000000E+00
 0.306230E-02-0.465113E-02-0.973421E-02 0.128326E-01 0.788553E-02
 0.797197E-02-0.120760E-01-0.767547E-02-0.120755E-02-0.298523E-01
-0.126560E-01 0.000000E+00-0.568350E-01-0.153039E-01 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.242911E-02-0.401347E-02-0.219074E-02 0.311281E+01
 0.323251E-02-0.639523E-02-0.663069E-02-0.304403E-03-0.401920E-02
-0.118708E-02 0.415211E+01-0.201896E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.106903E+01 0.377113E-03 0.000000E+00 0.000000E+00 0.000000E+00
 0.898481E-01-0.236325E+02 0.208180E-01 0.139638E+03-0.119444E+00
 0.845398E+01-0.399776E-05 0.000000E+00 0.366210E-02-0.178929E-02
 0.190412E-01-0.392257E-01 0.632343E-02 0.548144E-02 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00-0.243022E-02
 0.976619E+00 0.568478E-03 0.582026E-02 0.000000E+00 0.621998E-02
 0.000000E+00 0.000000E+00 0.107674E-01 0.893820E+02-0.192414E-01
-0.845398E+01 0.000000E+00 0.000000E+00-0.200200E-01-0.195833E-02
-0.938391E-02 0.131480E-01-0.260147E-02-0.808556E-03 0.511651E-04
 0.255717E-02 0.000000E+00 0.466814E-02 0.664196E-02 0.000000E+00
 0.998594E+00 0.190038E-03 0.000000E+00-0.243825E-01 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.522105E-01
-0.845398E+01 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.767271E-02 0.564539E-02-0.270623E-02-0.526454E-03 0.137075E-02
 0.133060E-02 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.949197E+00 0.000000E+00 0.000000E+00-0.768008E-01 0.000000E+00
 0.000000E+00 0.000000E+00-0.137993E-01-0.140136E+01 0.120481E+00
-0.845398E+01 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.987746E-02 0.175330E-02-0.688835E-03 0.287022E-02 0.000000E+00
 0.000000E+00 0.744513E-01 0.000000E+00 0.000000E+00 0.000000E+00
 0.152840E+00 0.000000E+00 0.000000E+00 0.116252E+01 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00-0.649190E+00
-0.845398E+01 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
-0.584949E-01-0.102105E+00 0.299153E-01-0.486227E-01 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
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0.931402E+00	0.137976E+00	0.000000E+00	0.323736E-03	0.000000E+00
-0.910906E-02	0.707506E-01	0.000000E+00	-0.516650E-01	0.689755E-01
0.000000E+00	0.000000E+00	0.000000E+00	-0.845398E+01	0.000000E+00
0.281140E-01	0.000000E+00	0.736009E+02	0.596604E-01	0.000000E+00
0.000000E+00	-0.151792E-02	0.000000E+00	0.000000E+00	0.132397E+00
0.213315E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.948758E+01	0.884541E-02	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.113139E+00	0.169134E+00
0.145192E-01	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.107906E-01	0.299942E-04	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	-0.148930E-01
-0.787184E-02	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
-0.683420E-01	-0.441778E-01	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.229730E-01	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.868053E+00	0.236364E+00	0.134306E+00	0.103086E-01	0.000000E+00
-0.379164E-02	-0.157806E+00	0.000000E+00	-0.587644E-01	-0.312508E+00
0.000000E+00	0.437387E-01	-0.354091E-01	-0.223636E+02	0.000000E+00
-0.533976E-01	0.000000E+00	0.114091E+03	0.517497E-01	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.132397E+00
0.213315E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.342702E+03	0.157033E-01	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	-0.366278E-02
-0.116193E-02	0.000000E+00	0.000000E+00	0.113139E+00	0.169134E+00
0.178431E-01	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.162864E-01	0.316963E-04	0.127968E-01	0.000000E+00	0.000000E+00
-0.704599E-02	0.207921E-02	0.636660E-02	0.229940E+05	0.000000E+00
0.127833E-01	-0.208036E-02	-0.461820E-02	-0.629391E+02	-0.120745E-01
0.136675E-01	0.136011E-01	-0.537162E-02	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.192509E+05	0.835522E-02	0.419439E-02	0.000000E+00	0.120366E+05
0.000000E+00	0.000000E+00	0.000000E+00	-0.100034E-01	-0.233267E-02
0.972374E-02	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
-0.265079E-01	-0.209125E-01	-0.109465E-01	0.000000E+00	0.000000E+00
0.000000E+00	0.217252E-01	-0.712385E+02	-0.189428E-02	0.000000E+00
-0.602006E-02	0.169058E-01	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.290646E-01
0.348971E-02	0.000000E+00	0.501174E-01	0.550595E-01	0.000000E+00
-0.955897E-02	0.000000E+00	0.000000E+00	-0.151693E+04	0.000000E+00
0.000000E+00	0.129306E-01	0.269567E-02	0.000000E+00	0.392243E+01
-0.847690E-02	0.116896E-01	0.000000E+00	0.148967E-01	0.544521E-02
0.000000E+00	0.564918E+01	0.000000E+00	-0.772178E-02	0.000000E+00
0.000000E+00	-0.734042E+02	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00

```
$EXE TPLIST BS

INPUT PARAMETERS ARE:  AS FL=1=1 1 1 1

 TAPE NO.  1             FILE NO.  1
 RECORD   1              LENGTH   80
VOL1MSIS86                                                                 3

 TAPE NO.  1             FILE NO.  1
 RECORD   5              LENGTH   80
HDR4                                                         00

***** JOB DONE.
$EXE TPLIST BS

INPUT PARAMETERS ARE:  AS FL=1=1 1 1 2

 TAPE NO.  1             FILE NO.  2
 RECORD   1              LENGTH   2048
0075C   ************************************************************0076     SUBROUTINE GTS
5(IYD,SEC,ALT,GLAT,GLONG,STL,F107A,F107,AP,MASS,D,T)0057C       MSIS-86/CIRA 1986 Neutral Thermosp
here Model0066C        A.E.Hedin 3/15/85;2/26/87 (Variable Names Shortenec)0016C     INPUT:0040C
      IYD - YEAR AND DAY AS YYDDD0026C        SEC - UT(SEC)0052C        ALT - ALTITUDE(KM) (GREATER
 THAN 85 KM)0042C       GLAT - GEODETIC LATITUDE(DEG)0044C       GLONG - GEODETIC LONGITUDE(DEG)0
049C        STL - LOCAL APPARENT SOLAR TIME(HRS)0050C       F107A - 3 MONTH AVERAGE OF F10.7 FLUX0
053C        F107 - DAILY F10.7 FLUX FOR PREVIOUS DAY0059C        AP - MAGNETIC INDEX(DAILY) OR WHEN
 SW(9)=-1. :0035C         - ARRAY CONTAINING:0030C          (1) DAILY AP0052C            (2)
3 HR AP INDEX FOR CURRENT TIME0065C          (3) 3 HR AP INDEX FOR 3 HRS BEFORE CURRENT TIME0065
C          (4) 3 HR AP INDEX FOR 6 HRS BEFORE CURRENT TIME0065C            (5) 3 HR AP INDEX FO
R 9 HRS BEFORE CURRENT TIME0079C           (6) AVERAGE OF EIGHT 3 HR AP INDICIES FROM 12 TO 33 HR
S PRIOR0040C               TO CURRENT TIME0079C            (7) AVERAGE OF EIGHT 3 HR AP INDIC
IES FROM 36 TO 59 HRS PRIOR0040C                 TO CURRENT TIME0065C        MASS - MASS NUMBER
(ONLY DENSITY FOR SELECTED GAS IS0075C                 CALCULATED. MASS 0 IS TEMPERATURE. MASS 48
 FOR ALL.0018C     OUTPUT: 0043C        D(1) - HE NUMBER DENSITY(CM-3)0042C         D(2) - O NUMBER
DENSITY(CM-3)0043C        D(3) - N2 NUMBER DENSITY(CM-3)0043C        D(4) - O2 NUMBER DENSITY(CM-3)
0043C       D(5) - AR NUMBER DENSITY(CM-3)0046C        D(6) - TOTAL MASS DENSITY(GM/CM3)0042C
   D(7) - H NUMBER DENSITY(CM-3)0042C       D(8) - N NUMBER DENSITY(CM-3)0042C         T(1) - EXOSP
HERIC TEMPERATURE0038C        T(2) - TEMPERATURE AT ALT0005C0065C      TO GET OUTPUT IN M-3 and KG/
M3:  CALL METERS(.TRUE.) 0005C0034C          ADDITIONAL COMMENTS0059C          (1) LOWER BOUND QU
ANTITIES IN COMMON/GTS3C/^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^

 TAPE NO.  1             FILE NO.  2
 RECORD   25             LENGTH   2048
0028C          LOWER BOUNDARY0076       DATA PTM/       1.04130E+03, 3.86000E+02, 1.90000E+02, 1.66728
E+01,0063       *  1.15000E+02, 1.20000E+02, 9.45537E+01, 0.00000E+00/0019       DATA PDM/0076      *
                 2.45600E+07, 6.71072E-06, 1.00000E+02, 0.00000E+00,0063       *  1.10000E+02, 1.00000E+0
1, 0.00000E+00, 0.00000E+00,0076       *                  8.59400E+10, 5.40000E-01, 1.05000E+02,-8.00000
E+00,0063       *  1.10000E+02, 1.00000E+01, 9.00000E+01, 2.00000E+00,0076       *                2.8100
0E+11, 0.00000E+00, 1.05000E+02, 2.80000E+01,0063       *  2.89500E+01, 0.00000E+00, 0.00000E+00, 0.0
0000E+00,0076       *              3.30000E+10, 2.68270E-01, 1.05000E+02, 0.00000E+00,0063       *  1.
10000E+02, 1.00000E+01, 0.00000E+00, 0.00000E+00,0076       *                1.33000E+09, 1.19615E-02,
 1.05000E+02, 0.00000E+00,0063       *  1.10000E+02, 1.00000E+01, 0.00000E+00, 0.00000E+00,0076      *
                  1.76100E+05, 1.00000E+00, 9.50000E+01,-8.00000E+00,0063       *  1.10000E+02, 1.00000E
+01, 9.00000E+01, 2.00000E+00,0076       *                1.00000E+07, 1.00000E+00, 1.05000E+02,-8.000
00E+00,0063       *  1.10000E+02, 1.00000E+01, 9.00000E+01, 2.00000E+00/0021       DO 10 I=1,30028
    ISDATE(I)=ISD(I)0018   10 CONTINUE0021       DO 20 I=1,20028       ISTIME(I)=IST(I)0018   20 CO
NTINUE0024       NAME(1)='CIRA'0024       NAME(2)='-86 '0013       END^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
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MSIS-86
Neutral Atmospheric Model
MN-61A
D74880
(26327)
Files 1-3

```
$ASS IN TBC
$EXE TPLIST BS

INPUT PARAMETERS ARE:  AS FL=1=1 1 1 1

 TAPE NO.   1              FILE NO.   1
 RECORD   1                LENGTH   80
VOL1MSIS86                                                                    3

 TAPE NO.   1              FILE NO.   1
 RECORD   5                LENGTH   80
HDR4                                                                  00

***** JOB DONE.
$EXE TPLIST BS

INPUT PARAMETERS ARE:  AS FL=1=1 1 1 2

 TAPE NO.   1              FILE NO.   2
 RECORD   1                LENGTH   2048
0075C    ************************************************************0076      SUBROUTINE GTS
5(IYD,SEC,ALT,GLAT,GLONG,STL,F107A,F107,AP,MASS,D,T)0057C       MSIS-86/CIRA 1986 Neutral Thermosp
here Model0066C         A.E.Hedin 3/15/85;2/26/87 (Variable Names Shortened)0016C     INPUT:0040C
      IYD - YEAR AND DAY AS YYDDD0026C        SEC - UT(SEC)0052C        ALT - ALTITUDE(KM) (GREATER
 THAN 85 KM)0042C        GLAT - GEODETIC LATITUDE(DEG)0044C        GLONG - GEODETIC LONGITUDE(DEG)0
049C         STL - LOCAL APPARENT SOLAR TIME(HRS)0050C        F107A - 3 MONTH AVERAGE OF F10.7 FLUX0
053C         F107 - DAILY F10.7 FLUX FOR PREVIOUS DAY0059C        AP - MAGNETIC INDEX(DAILY) OR WHEN
 SW(9)=-1. :0035C          - ARRAY CONTAINING:0030C             (1) DAILY AP0052C             (2)
3 HR AP INDEX FOR CURRENT TIME0065C               (3) 3 HR AP INDEX FOR 3 HRS BEFORE CURRENT TIME0065
C           (4) 3 HR AP INDEX FOR 6 HRS BEFORE CURRENT TIME0065C               (5) 3 HR AP INDEX FO
R 9 HRS BEFORE CURRENT TIME0079C              (6) AVERAGE OF EIGHT 3 HR AP INDICIES FROM 12 TO 33 HR
S PRIOR0040C                    TO CURRENT TIME0079C             (7) AVERAGE OF EIGHT 3 HR AP INDIC
IES FROM 36 TO 59 HRS PRIOR0040C                    TO CURRENT TIME0065C          MASS - MASS NUMBER
(ONLY DENSITY FOR SELECTED GAS IS0075C                  CALCULATED.  MASS 0 IS TEMPERATURE.  MASS 48
 FOR ALL.0018C     OUTPUT: 0043C        D(1) - HE NUMBER DENSITY(CM-3)0042C          D(2) - O NUMBER
DENSITY(CM-3)0043C        D(3) - N2 NUMBER DENSITY(CM-3)0043C          D(4) - O2 NUMBER DENSITY(CM-3)
0043C        D(5) - AR NUMBER DENSITY(CM-3)0046C        D(6) - TOTAL MASS DENSITY(GM/CM3)0042C
   D(7) - H NUMBER DENSITY(CM-3)0042C        D(8) - N NUMBER DENSITY(CM-3)0042C          T(1) - EXOSP
HERIC TEMPERATURE0038C        T(2) - TEMPERATURE AT ALT0005C0065C        TO GET OUTPUT IN M-3 and KG/
M3:   CALL METERS(.TRUE.) 0005C0034C          ADDITIONAL COMMENTS0059C             (1) LOWER BOUND QU
ANTITIES IN COMMON/GTS3C/^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^

 TAPE NO.   1              FILE NO.   2
 RECORD   25               LENGTH   2048
0028C          LOWER BOUNDARY0076       DATA PTM/      1.04130E+03, 3.86000E+02, 1.90000E+02, 1.66728
E+01,0063      *  1.15000E+02, 1.20000E+02, 9.45537E+01, 0.00000E+00/0019        DATA PDM/0076      *
          2.45600E+07, 6.71072E-06, 1.00000E+02, 0.00000E+00,0063      *  1.10000E+02, 1.00000E+0
1, 0.00000E+00, 0.00000E+00,0076      *              8.59400E+10, 5.40000E-01, 1.05000E+02,-8.00000
E+00,0063      *  1.10000E+02, 1.00000E+01, 9.00000E+01, 2.00000E+00,0076      *                2.8100
0E+11, 0.00000E+00, 1.05000E+02, 2.80000E+01,0063      *  2.89500E+01, 0.00000E+00, 0.00000E+00, 0.0
0000E+00,0076      *              3.30000E+10, 2.68270E-01, 1.05000E+02, 0.00000E+00,0063      *  1.
10000E+02, 1.00000E+01, 0.00000E+00, 0.00000E+00,0076      *              1.33000E+09, 1.19615E-02,
 1.05000E+02, 0.00000E+00,0063      *  1.10000E+02, 1.00000E+01, 0.00000E+00, 0.00000E+00,0076      *
          1.76100E+05, 1.00000E+00, 9.50000E+01,-8.00000E+00,0063      *  1.10000E+02, 1.00000E
+01, 9.00000E+01, 2.00000E+00,0076      *              1.00000E+07, 1.00000E+00, 1.05000E+02,-8.000
00E+00,0063      *  1.10000E+02, 1.00000E+01, 9.00000E+01, 2.00000E+00/0021        DO 10 I=1,30028
     ISDATE(I)=ISD(I)0018    10 CONTINUE0021        DO 20 I=1,20028         ISTIME(I)=IST(I)0018   20 CO
NTINUE0024       NAME(1)='CIRA'0024       NAME(2)='-86 '0013       END^^^^^^^^^^^^^^^^^^^^^^^^^^^^
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PRINTED IN U.S.A.

```
***** JOB DONE.
$EXE TPLIST BS

INPUT PARAMETERS ARE:  AS FL=1=1 1 1 3

 TAPE NO.   1              FILE NO.   3
 RECORD   1                LENGTH   80
EOF1MSIS86.FOR        MSIS86000100010001 87083 87180 000025DECFILE11A

 TAPE NO.   1              FILE NO.   3
 RECORD   4                LENGTH   80
EOF4                                                          00

***** JOB DONE.
$WEO LPS
$$
$NOP
$NOP
```

PRINTED IN U.S.A.

MSIS-86
Neutral Atmospheric
Model
MN-61B
D74880
C26328
Files 4-6

```
$NOP ********* SOUT12A ***********
$EXE TPLIST BS

INPUT PARAMETERS ARE:  AS FL=2=1 3 1 1

 TAPE NO.   1              FILE NO.   1
 RECORD   1                LENGTH   80
C   ***********************************************************************

 TAPE NO.   1              FILE NO.   1
 RECORD   2                LENGTH   80
      SUBROUTINE GTS5(IYD,SEC,ALT,GLAT,GLONG,STL,F107A,F107,AP,MASS,D,T)

 TAPE NO.   1              FILE NO.   1
 RECORD   1068             LENGTH   80
      END

 TAPE NO.   1              FILE NO.   2
 RECORD   1                LENGTH   80
C       TEST DRIVER FOR GTS5 (MSIS86 THERMOSPHERE MODEL)

 TAPE NO.   1              FILE NO.   2
 RECORD   2                LENGTH   80
      DIMENSION D(8,10),T(2,10)

 TAPE NO.   1              FILE NO.   2
 RECORD   76               LENGTH   80
      END

 TAPE NO.   1              FILE NO.   3
 RECORD   1                LENGTH   80
  6.68E+05 1.08E+08 2.07E+07 6.73E+05 4.23E+03 3.97E-15 3.50E+04 3.61E+06

 TAPE NO.   1              FILE NO.   3
 RECORD   2                LENGTH   80
     1.277E+03 1.270E+03

 TAPE NO.   1              FILE NO.   3
 RECORD   92               LENGTH   80
 RHO      4.302E-15   2.302E-15   1.277E-15   4.392E-15   4.901E-15

***** JOB DONE.
$WEO LPS


$$
$ASS IN TB0
$EXE IPNDSF 80
```

PRINTED IN U.S.A.

RICE UNIVERSITY
DEPARTMENT OF SPACE PHYSICS AND ASTRONOMY
WIESS SCHOOL OF NATURAL SCIENCES
POST OFFICE BOX 1892
HOUSTON, TEXAS 77251
TELEPHONE: (713) 527-4939
TELEX # 556457

August 4, 1987

Patricia A. Ross
Manager, Request Coordination
National Space Science Data Center
Goddard Space Flight Center
Code 633.4
Greenbelt MD 20771

Re: Control Number RF 4263

Dear Ms. Ross:

Thank you for sending the tape containing the MSIS-86 Neutral Atmospheric Model. We were able to get the programs working on our IBM MVS system with a small amout of effort. We compiled the program using VSFORTRAN which is an ANSI standard FORTRAN77 compiler.

I am returning your tape with the modified version of the MSIS-86 model written on the tape. The tape is an unlabelled, 1600 BPI, 9-track tape. The record length is 80 characters. There is one ASCII file on the tape.

There were four modifications we had to make to get the program working on our system. The program, in its current form, should still run under DEC Fortran.

The first problem was that several routines had a character constant was assigned to an integer variable. We solved this by changing the integer variable to a character variable. This problem occured with the variables: NAME, ISD, IST, ISDATE, and ISTIME; in the routines: GTS5, and PRMSG5.

The second problem was the use of dummy arguments in dimensioning arrays passed to subroutines. While this didn't generate fatal errors, it did generate several hundred unsightly warnings. To fix it the dimension was changed from a dummy 1 to the generic *. This problem was encountered with the variables: P, and AP; in the routines: GLOBE5, and GLOBE5L.

The third problem was the use of data statements to initialize a global common. VSFORTRAN does not allow named commons to be initialized in this manner except inside a BLOCK DATA subprogram. This problem was encountered with the named commons: PARMB, PARM5, and LOWER5; in the subroutine PRMSG5.

The last problem was the only logic error resulting from the difference in compilers. On the 81st line of the subroutine GTS5, there was a statement that included a reference to the common array SW and also referenced the function GLOBE5. The common array SW is not initialized until after GLOBE5 is called the

first time. Our compiler apparently takes the values of the variable at the time it is referenced, so SW was not initialized properly and this resulted in wrong results for the first run of the model. We fixed this by moving the reference to GLOBE5 to the statement before the reference to SW.

Thank you again for sending us this software. I hope our revisions will be helpful to others using IBM VSFORTRAN.

Sincerely yours,

Bryan Bales

Bryan A. Bales
Programmer/Analyst

Enclosures:
Magnetic tape containing:
Modified MSIS-86 Neutral Atmospheric Model
Listing of Tape

MSIS-86
MN-61C
UNLABELED
IBM VERSION
D 74880
C 26327
file 7

```
C     ***********************************************************************
        SUBROUTINE GTS5(IYD,SEC,ALT,GLAT,GLONG,STL,F107A,F107,AP,MASS,D,T)
           MSIS-86/CIRA 1986 NEUTRAL THERMOSPHERE MODEL
            A.E.HEDIN 3/15/85;2/26/87 (VARIABLE NAMES SHORTENED)
C       INPUT:
           IYD - YEAR AND DAY AS YYDDD
           SEC - UT(SEC)
           ALT - ALTITUDE(KM) (GREATER THAN 85 KM)
           GLAT - GEODETIC LATITUDE(DEG)
           GLONG - GEODETIC LONGITUDE(DEG)
           STL - LOCAL APPARENT SOLAR TIME(HRS)
           F107A - 3 MONTH AVERAGE OF F10.7 FLUX
           F107 - DAILY F10.7 FLUX FOR PREVIOUS DAY
           AP - MAGNETIC INDEX(DAILY) OR WHEN SW(9)=-1. :
              - ARRAY CONTAINING:
                 (1) DAILY AP
                 (2) 3 HR AP INDEX FOR CURRENT TIME
                 (3) 3 HR AP INDEX FOR 3 HRS BEFORE CURRENT TIME
                 (4) 3 HR AP INDEX FOR 6 HRS BEFORE CURRENT TIME
                 (5) 3 HR AP INDEX FOR 9 HRS BEFORE CURRENT TIME
                 (6) AVERAGE OF EIGHT 3 HR AP INDICIES FROM 12 TO 33 HRS PR
                        TO CURRENT TIME
                 (7) AVERAGE OF EIGHT 3 HR AP INDICIES FROM 36 TO 59 HRS PR
                        TO CURRENT TIME
           MASS - MASS NUMBER (ONLY DENSITY FOR SELECTED GAS IS
                    CALCULATED.  MASS 0 IS TEMPERATURE.  MASS 48 FOR ALL.
C       OUTPUT:
           D(1) - HE NUMBER DENSITY(CM-3)
           D(2) - O NUMBER DENSITY(CM-3)
           D(3) - N2 NUMBER DENSITY(CM-3)
           D(4) - O2 NUMBER DENSITY(CM-3)
           D(5) - AR NUMBER DENSITY(CM-3)
           D(6) - TOTAL MASS DENSITY(GM/CM3)
           D(7) - H NUMBER DENSITY(CM-3)
           D(8) - N NUMBER DENSITY(CM-3)
           T(1) - EXOSPHERIC TEMPERATURE
           T(2) - TEMPERATURE AT ALT
C
C       TO GET OUTPUT IN M-3 AND KG/M3:   CALL METERS(.TRUE.)
C
C          ADDITIONAL COMMENTS
C           (1) LOWER BOUND QUANTITIES IN COMMON/GTS3C/
C           (2) TO TURN ON AND OFF PARTICULAR VARIATIONS CALL TSELEC(SW)
C                WHERE SW IS A 25 ELEMENT ARRAY CONTAINING 0. FOR OFF, 1.
C                FOR ON, OR 2. FOR MAIN EFFECTS OFF BUT CROSS TERMS ON
C                FOR THE FOLLOWING VARIATIONS
C                1 - F10.7 EFFECT ON MEAN   2 - TIME INDEPENDENT
C                3 - SYMMETRICAL ANNUAL     4 - SYMMETRICAL SEMIANNUAL
C                5 - ASYMMETRICAL ANNUAL    6 - ASYMMETRICAL SEMIANNUAL
C                7 - DIURNAL                8 - SEMIDIURNAL
C                9 - DAILY AP              10 - ALL UT/LONG EFFECTS
C               11 - LONGITUDINAL          12 - UT AND MIXED UT/LONG
C               13 - MIXED AP/UT/LONG      14 - TERDIURNAL
C               15 - DEPARTURES FROM DIFFUSIVE EQUILIBRIUM
C               16 - ALL TINF VAR          17 - ALL TLB VAR
C               18 - ALL TO VAR            19 - ALL S VAR
C               20 - ALL ZO VAR            21 - ALL NLB VAR
C               22 - ALL TR12 VAR          23 - TURBO SCALE HEIGHT VAR
C
C               TO GET CURRENT VALUES OF SW: CALL TRETRV(SW)
```

```
C
      LOGICAL METER
      CHARACTER*4 NAME,ISDATE,ISTIME
      DIMENSION D(8),T(2),MT(10),AP(1),ALTL(6)
      COMMON/GTS3C/TLB,S,DB04,DB16,DB28,DB32,DB40,DB48,DB01,ZA,TO,ZO
     $ ,GO,RL,DD,DB14
      COMMON/LOWER5/PTM(8),PDM(8,7)
      COMMON/FARM5/PT(150),PD(150,7),PS(150),PDL(25,2)
      COMMON/CSW/SW(25),ISW,SWC(25)
      COMMON/TTEST/TINFG,GB,ROUT,TT(15)
      COMMON/DATIME/ISDATE(3),ISTIME(2),NAME(2)
      DATA MT/48,0,4,16,28,32,40,1,49,14/,IFL/0/
      DATA ALTL/200.,300.,150.,200.,240.,450.,320.,450./
      DATA IMR/0/
      IF(IFL.EQ.1.AND.NAME(1).EQ.'CIRA'.AND.NAME(2).EQ.'-86 ') GO TO 5
      CALL FRMSG5
      IFL=1
    5 CONTINUE
      YRD=IYD
C       EQ. A7
      GLOBE = GLOBE5(YRD,SEC,GLAT,GLONG,STL,F107A,F107,AP,PT)
      TINF=PTM(1)*(1.+SW(16)*GLOBE)*PT(1)
      ZA=PTM(5)*PDL(16,2)
C       EQ. A9
      TO=PTM(3)*PD(76,3)*(1.+SW(18)*GLOB5L(PD(76,3)))
C       EQ. A8
      TLB=PTM(2)*(1.+SW(17)*GLOB5L(PD(26,3)))*PD(26,3)
C       EQ. A10
      ZO=PTM(7)*(1.+SW(20)*GLOB5L(PD(51,3)))*PD(51,3)
C       EQ. A6
      GO=PTM(4)*PS(1)
     $ *(1.+SW(19)*GLOBE5(YRD,SEC,GLAT,GLONG,STL,F107A,F107,
     $ AP,PS))
C       EQ. A5
      S=GO/(TINF-TLB)
C       EQ. A11
      TR12=PD(101,3)*(1.+SW(22)*GLOB5L(PD(101,3)))
      T(1)=TINF
      IF(MASS.EQ.0) GO TO 50
C       EQ. A18  N2
      G28=SW(21)*GLOB5L(PD(1,3))
      YRD=IYD
      T(1)=TINF
      XNM=PDM(5,3)
      DO 10 J = 1,10
      IF(MASS.EQ.MT(J))   GO TO 15
   10 CONTINUE
      WRITE(6,100) MASS
      GO TO 90
   15 IF(ALT.GT.ALTL(6).AND.MASS.NE.28.AND.MASS.NE.48) GO TO 17
C
C       **** N2 DENSITY ****
C
C       EQ. A18
      DB28 = PDM(1,3)*EXP(G28)*PD(1,3)
C       EQ. A13 - A17
      D(3)=DENSS(ALT,DB28,TINF,TLB, 28.,0.,T(2),PTM(6),S,TO,ZA,ZO,TR12)
      DD=D(3)
C       EQ. A19
      ZH28=PDM(3,3)
      ZHM28=PDM(4,3)*PDL(6,2)
```

Call to function GLOBE5 moved to allow SW array to be initialized before it is used in TINF assignment.

```
     *  0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00/
      DATA PH3/
     *  0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00,
     *  0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00,
     *  0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00,
     *  0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00,
     *  0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00,
     *  0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00,
     *  0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00,
     *  0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00,
     *  0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00,
     *  0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00,
     *  0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00/
C          TURBO
      DATA PI1/
     *  9.33804E-01, 5.47446E+00, 1.53263E-01, 9.19303E-01, 1.64109E+01,
     *  4.27083E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00,
     *  0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00,
     *  0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00,
     *  0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00,
     *  1.15857E+00, 4.71094E-01, 1.09459E+00, 5.25012E+00, 1.00000E+00,
     *  1.00000E+00, 1.03999E+00, 7.67132E-01, 1.10514E+00, 1.75636E+00,
     *  1.10845E+00, 2.33439E+00, 7.96532E-01, 4.31520E+00, 4.07300E+00,
     *  1.01865E+00, 2.39547E-01, 2.53791E-06, 8.42931E-01, 1.04192E+00,
     *  2.00202E+00, 1.00000E+00, 1.00000E+00, 1.00000E+00, 1.00000E+00/
C         LOWER BOUNDARY
      DATA PTM/        1.04130E+03, 3.86000E+02, 1.90000E+02, 1.66728E+01,
     *  1.15000E+02, 1.20000E+02, 9.45537E+01, 0.00000E+00/
      DATA PDM/
     *                 2.45600E+07, 6.71072E-06, 1.00000E+02, 0.00000E+00,
     *  1.10000E+02, 1.00000E+01, 0.00000E+00, 0.00000E+00,
     *                 8.59400E+10, 5.40000E-01, 1.05000E+02,-8.00000E+00,
     *  1.10000E+02, 1.00000E+01, 9.00000E+01, 2.00000E+00,
     *                 2.81000E+11, 0.00000E+00, 1.05000E+02, 2.80000E+01,
     *  2.89500E+01, 0.00000E+00, 0.00000E+00, 0.00000E+00,
     *                 3.30000E+10, 2.68270E-01, 1.05000E+02, 0.00000E+00,
     *  1.10000E+02, 1.00000E+01, 0.00000E+00, 0.00000E+00,
     *                 1.33000E+09, 1.19615E-02, 1.05000E+02, 0.00000E+00,
     *  1.10000E+02, 1.00000E+01, 0.00000E+00, 0.00000E+00,
     *                 1.76100E+05, 1.00000E+00, 9.50000E+01,-8.00000E+00,
     *  1.10000E+02, 1.00000E+01, 9.00000E+01, 2.00000E+00,
     *                 1.00000E+07, 1.00000E+00, 1.05000E+02,-8.00000E+00,
     *  1.10000E+02, 1.00000E+01, 9.00000E+01, 2.00000E+00/
      END
```