SAGE2_V6.10_AEROSOL_O3_NO2_H2O_BINARY Readme File

1.0 Introduction

This readme file provides information on the SAGE2_V6.10_AEROSOL_O3_NO2_H2O_BINARY data set. This data set includes aerosol extinction profiles at 1020, 525, 453, and 385 nanometers, number density profiles of ozone and nitrogen dioxide, plus molecular density and mixing ratio profiles of water vapor. It also includes aerosol surface area density and effective radius profiles (*Thomason, L.W., L.R. Poole, and T.R. Deshler, "A Global Climatology Of Stratospheric Aerosol Surface Area Density As Deduced From SAGE II: 1984-1994"*, J. Geophys. Res., *102, 8967-8976; 1997*.), and retrieved molecular density for the middle atmosphere (40-75 km). All profiles are at 0.5-km vertical resolution. These products are nearly global in coverage, with data spanning from 80 degrees North to 80 degrees South and covering the time period October 1984 through June 2001.

This data set is the result of a revision of the Version 6.00 processing algorithms by the NASA Langley Research Center's SAGE II Algorithm Team and is designated Version 6.10.

For more information on the SAGE II Project and a detailed description of the SAGE II Version 6.0 processing, visit the following web site (http://www-sage2.larc.nasa.gov). If users have questions, please contact the Langley ASDC Science, Users and Data Services Office at:

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This document includes the following sections:

Section 2.0 - Data Set Description
Section 3.0 - Data Format and Packaging
Section 4.0 - Science Parameter Information
Section 5.0 - Description of Sample Read Software
Section 6.0 - Implementing Sample Read Software
Section 7.0 - Sample Output
Section 8.0 - Additional Data Information

2.0 Data Set Description

The Stratospheric Aerosol and Gas Experiment (SAGE) II instrument was launched aboard the Earth Radiation Budget Satellite in October 1984. The instrument continues to provide high quality measurements of ozone, nitrogen dioxide, water vapor, and multi-wavelength aerosol extinction from the mid-troposphere to as high as the lower mesosphere. The extended lifetime of this instrument and its measurement stability enhance its value in quantifying long-term trends and variability in its species ensemble. This data set spans the period October 1984 through the present. It contains profiles of aerosol extinction at 1020, 525, 453, and 385 nanometers (nm) and number density profiles of ozone, nitrogen dioxide, and molecular density, water vapor mixing ratio, and aerosol surface area and effective radius at a vertical resolution of 0.5 km. It also includes retrieved molecular density from 40-75 km on a 0.5-km grid.

2.1 Instrumentation Description

The SAGE II instrument uses the solar occultation technique to measure solar irradiance during sunrise and sunset events with a Sun photometer. The instrument is activated during periods when the line-of-sight from the SAGE II instrument to the Sun has tangent altitudes between sea level and 150km. It is self-calibrating in that an exo-atmospheric measurement is made before a sunset or after a sunrise measurement. Attenuation of sunlight by aerosols at 1020, 525, 453, and 385 nm, by water vapor at 940 nm, by nitrogen dioxide at 453 and 448 nm, and by ozone at 600 nm, is measured and processed to produce profiles of each of these species. SAGE II instrument channels are listed in Section 8.1 below.

2.2 Differences Between Version 6.0 and 6.1

For a detailed description of all algorithm modifications, see the following SAGE II web site:

http://www-sage2.larc.nasa.gov/data/v6_data/
http://www-sage2.larc.nasa.gov/data/version_6.1/

2.3 Data Quality and Known Deficiencies

For a detailed description of all algorithm modifications, see the following SAGE II web site:

http://www-sage2.larc.nasa.gov/data/v6_data/
http://www-sage2.larc.nasa.gov/data/version_6.1/

2.4 Science Contact

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3.0 Data Format and Packaging

SAGE II Version 6.10 data contain two files per month in binary format. One file contains the revision information with spatial and temporal data for each event in a complete month (up to 930 events). The other contains the species profiles, uncertainties and some additional event specific information. Both files contain event information flags that are explained in Section 8.2.

For ease of downloading the data, the individual files have been "zipped" together into one file. To unzip the files with Info-Zip software, download the freeware and information from the following URLs:

http://www.cdrom.com/pub/infozip/

ftp://ftp.freesoftware.com/pub/infozip/

3.1 File Naming Convention

SAGE II Version 6.10 files are named according to the following convention:

sage2_v6.10_YYYYMM.zip

where YYYY is the 4 digit year and MM is the 2 digit month.

When the original file is unzipped as described above, two files are produced:

SAGE_II_INDEX_YYYYMM.6.10
SAGE_II_SPEC_YYYYMM.6.10

where YYYY is the 4 digit year and MM is the 2 digit month.

The "INDEX" file contains the revision information and the "SPEC" file contains the species profiles.

Example for January 1986,

original file:	sage2_v6.10_198601.zip
resulting files:	SAGE_II_INDEX_198601.6.10
	SAGE_II_SPEC_198601.6.10

4.0 Science Parameter Information

4.1 Altitude Range for Species

----------PLEASE UPDATE----------

Species	Range (km)
Ozone	5-60
NO2	15-60
Aerosol	1-45
Water Vapor	MSL-40

4.2 Data File Contents

The following abbreviations have been used in the description of the file contents.

alt - altitude
Arr - array
Char - character string
Ele - Element
ext - extinction
H20 - water vapor
Int - Integer
LaRC - Langley Research Center
Lat - latitude
Lon - longitude
Max - maximum
Met - Meteorology
Min - minimum
NO2 - nitrogen dioxide
O3 - ozone
sr - sunrise
ss - sunset

4.2.1 Index File Contents

Revision Info:

Field	Type	Description
Num_Prof	4-byte Int	Number of profiles (records) in file
Met_Rev_Date	4-byte Int	LaRC Met Model Rev Date (yyyymmdd)
Driver_Rev	8-byte Char	LaRC Driver version (eg. 6.0a)
Transmission_Rev	8-byte Char	LaRC Transmission version
Inversion_Rev	8-byte Char	LaRC Inversion version
Spectroscopy_Rev	8-byte Char	LaRC Inversion version
Eph_File_Name	32-byte Char	Ephemeris file name
Met_File_Name	32-byte Char	Met file name
Ref_File_Name	32-byte Char	Refraction file name
Trans_File_Name	32 -byte Char	Transmission file name
Spec_File_Name	32-byte Char	Species profile file name
FillVal	4-byte Real	Fill value

Altitude grid and range info:

Grid_Size	4-byte Real	Altitude Grid spacing
Alt_Grid	4-byte Real Arr w/ 200	Ele Geometric Alt
Alt_Mid_Atm	4-byte Real Arr w/ 70 Ele	Geometric Alt for Dens_Mid_Atm (see Species file)
Range_Trans	4-byte Real Arr w/ 2 Ele	Transmission Min & Max alt
Range_O3	4-byte Real Arr w/ 2 Ele	Ozone Density Min & Max alt
Range_NO2	4-byte Real Arr w/ 2 Ele	NO2 Density Min & Max alt
Range_H2O	4-byte Real Arr w/ 2 Ele	H2O Density Min & Max alt
Range_Ext	4-byte Real Arr w/ 2 Ele	Aerosol Extinction Min & Max alt
Range_Density	4-byte Real Arr w/ 2 Ele	Density Min & Max alt
Range_Surface	4-byte Real Arr w/ 2 Ele	Surface Area Min & Max alt

Event Specific Info useful for data subsetting:

YYYYMMDD	4-byte Int Arr w/ 930 Ele	Event Date (yyyymmdd) at 30 km
event_num	4-byte Int Arr w/ 930 Ele	The event number
HHMMSS	4-byte Int Arr w/ 930 Ele	Event Time (hhmmss) at 30 km
Day_Frac	4-byte Real Arr w/ 930 Ele	Time of Year (ddd.fraction)
Lat	4-byte Real Arr w/ 930 Ele	Sub-tangent Lat at 30km (-90 to 90)
Lon	4-byte Real Arr w/ 930 Ele	Sub-tangent Lon at 30km (-180 to 180)
Beta	4-byte Real Arr w/ 930 Ele	Spacecraft Beta angle (degrees)
Duration	4-byte Real Arr w/ 930	Ele Duration of event (seconds)
Type_Sat	2-byte Int Arr w/ 930	Ele Event Type, Instrument (0=sr, 1=ss)
Type_Tan	2-byte Int Arr w/ 930	Ele Event Type, Local (0=sr,1=ss)

Process Tracking Flag info:

Processing Success:		
Dropped	4-byte Int Arr w/ 930 Ele	Value is non-zero if event is dropped
InfVec	4-byte Int Arr w/ 930 Ele	32 bits describing the event processing
Ephemeris:		
Eph_Cre_Date	4-byte Int Arr w/ 930 Ele	Record creation date (yyyymmdd)
Eph_Cre_Time	4-byte Int Arr w/ 930 Ele	Record creation time (hhmmss)
Met:		
Met_Cre_Date	4-byte Int Arr w/ 930 Ele	Record creation date (yyyymmdd)
Met_Cre_Time	4-byte Int Arr w/ 930 Ele	Record creation time (hhmmss)
Refraction:		
Ref_Cre_Date	4-byte Int Arr w/ 930 Ele	Record creation date (yyyymmdd)
Ref_Cre_Time	4-byte Int Arr w/ 930 Ele	Record creation time (hhmmss)
Transmission:		
TRANS_Cre_Date	4-byte Int Arr w/ 930 Ele	Record creation date (yyyymmdd)
TRANS_Cre_Time	4-byte Int Arr w/ 930 Ele	Record creation time (hhmmss)
Inversion:		
SPECIES_Cre_Date	4-byte Int Arr w/ 930 Ele	Record creation date (yyyymmdd)
SPECIES_Cre_Time	4-byte Int Arr w/ 930 Ele	Record creation time (hhmmss)

4.2.2 Species File Contents

Field	Type	Description
Tan_Alt	4-byte Real Arr w/ 8 Ele	Center-of-Sun Tangent Alt (km)
Tan_Lat	4-byte Real Arr w/ 8 Ele	Center-of-Sun Lat (deg)
Tan_Lon	4-byte Real Arr w/ 8 Ele	Center-of-Sun Lon (deg)
NMC_Pres	4-byte Real Arr w/ 140 Ele	Pressure (mb) (0.5-70km)
NMC_Temp	4-byte Real Arr w/ 140 Ele	Temperature (K), (0.5-70km)
NMC_Dens	4-byte Real Arr w/ 140 Ele	Density (molecules/cm3) (.5-70km)
NMC_Dens_Err	2-byte Int Arr w/ 140 Ele	Density Uncertainty (%x100)(.5-70km)
Trop_Height	4-byte Real Arr w/ 1 Ele	Tropopause height in km
Wavelength	4-byte Real Arr w/ 7 Ele	Channel wavelengths
O3	4-byte Real Arr w/ 140 Ele	O3 number density (cm-3)
NO2	4-byte Real Arr w/ 100 Ele	NO2 number density (cm-3)
H2O	4-byte Real Arr w/ 100 Ele	H2O number density (ppp)
Ext386	4-byte Real Arr w/ 80 Ele	386 nm aerosol extinction (1/km)
Ext452	4-byte Real Arr w/ 80 Ele	452 nm aerosol extinction (1/km)
Ext525	4-byte Real Arr w/ 80 Ele	525 nm aerosol extinction (1/km)
Ext1020	4-byte Real Arr w/ 80 Ele	1020 nm aerosol extinction (1/km)
Density	4-byte Real Arr w/ 140 Ele	Molecular density (1/cm^3)
SurfDen	4-byte Real Arr w/ 80 Ele	Aerosol surface area density (micrometer^2/cm^3)
Radius	4-byte Real Arr w/ 80 Ele	Aerosol effective radius (micrometer)
Dens_Mid_Atm	4-byte Real Arr w/ 70 Ele	Middle atmosphere retrieved density (1/cm^3)
O3_Err	2-byte Int Arr w/ 140 Ele	O3 number density uncertainty (%x100)
NO2_Err	2-byte Int Arr w/ 100 Ele	NO2 number density uncertainty (%x100)
H2O_Err	2-byte Int Arr w/ 100 Ele	H2O number density uncertainty (%x100)
Ext386_Err	2-byte Int Arr w/ 80 Ele	386 nm aerosol ext. uncertainty %x100)
Ext452_Err	2-byte Int Arr w/ 80 Ele	452 nm aerosol ext. uncertainty (%x100)
Ext525_Err	2-byte Int Arr w/ 80 Ele	525 nm aerosol ext. uncertainty (%x100)
Ext1020_Err	2-byte Int Arr w/ 80 Ele	1020 nm aerosol ext. uncertainty (%x100)
Density_Err	2-byte Int Arr w/ 140 Ele	Density uncertainty (%x100)
SurfDen_Err	2-byte Int Arr w/ 80 Ele	Aerosol surface area density uncertainty (%x100)
Radius_Err	2-byte Int Arr w/ 80 Ele	Aerosol effective radius uncertainty (%x100)
Dens_Mid_Atm_Err	2-byte Int Arr w/70 Ele	Middle atmosphere density uncertainty (%x100)
InfVec		2-byte Int Arr w/ 140 Ele Bit-wise quality flags

5.0 Description of Sample Read Software

An Interactive Data Language (IDL) program is provided for reading the SAGE II Version 6.10 data files. Instructions and Fortran 90 modules that may be used to read the data are also available, see Section 8.3 for more details.

The SAGE II team has provided both programs. The IDL program allows users to display graphically the data. This IDL package was designed for the "experienced" IDL user. There is a second IDL piece of code that allows the user to read one "event" or the entire file. This code converts the entire file into ASCII. Once in ASCII, the user is able to port the output to his/her favorite software.

There is a Fortran 90 package available. This package contains modules to be used to read the data. This is NOT a complete sample read software package.

6.0 Implementation of the Sample Read Software

To run the IDL package, please refer to the "README" included in the package.

To run the IDL code, sagetext_v6.10.pro, which converts the data from binary into ASCII, follow these instructions:

From the command line, type the following commands:

```
commandline> idl
IDL> .compile sagetext_v6.10.pro
% Compiled module: GETINDEXNAME.
% Compiled module: SAGETEXT.
IDL>sagetext
Please call sagetext using the filename of the file to read. Also provide the record number to read,
or answer the prompts. You may also use the output keyword to specify the output file.Usage
examples:
1. Writes record 100 of SAGE_II_SPEC_199804.6.10 to sage.dat
 sagetext,'SAGE_II_SPEC_199804.6.10',100
2. If the record number is left off, you will be prompted.
 sagetext,'SAGE_II_SPEC_199804.6.10
3. In this example, output is written to 'output.dat'
 sagetext,'SAGE_II_SPEC_199804.6.10',100,output='output.dat'
IDL>sagetext,'SAGE_II_SPEC_199804.6.10
Enter the starting record number (or Enter for first record of the file):
0
Enter the ending record number (or Enter for the last record of the file):
930
% Compiled module: READSTRUCTS.
% Compiled module: REVERSE.
```

```
% Compiled module: GETSTRUCTINFO.
% Compiled module: INDEXINFO_60D.
% Compiled module: INDEXINFO_610.
% Compiled module: TRANSINFO_600.
% Compiled module: REFRACTINFO_60D.
% Compiled module: METINFO.
% Compiled module: METINFO_610.
% Compiled module: EPHINFO_Y2K.
% Compiled module: SPECINFO_600.
% Compiled module: SPECINFO_610.
% Compiled module: SWAP_ENDIAN.
The specified record number are outside the range for this file.
Please try again with records between 0 and 559.
IDL>sagetext,'SAGE_II_SPEC_199804.6.10
Enter the starting record number (or Enter for first record of the file):
0
Enter the ending record number (or Enter for the last record of the file):
559
IDL>exit
```

Look into your working directory and you should have a file called sage.dat.

View this file in your favorite ASCII text package. Enclosed is a sample output of the file. This output consists only of the first record/event in the file.

```
-----------------------------------------------'
Record Count =  0.00000
NUM_PROF   560
MET_REV_DATE 20010827
DRIVER_REV  6.10
TRANSMISSION_REV  6.10
INVERSION_REV  6.10
SPECTROSCOPY_REV  6.10
EPH_FILE_NAME  SAGE_II_EPHEM_199804.6.10
MET_FILE_NAME  SAGE_II_MET_199804.6.10
REF_FILE_NAME  SAGE_II_REF_199804.6.10
TRANS_FILE_NAME  SAGE_II_TRANS_199804.6.10
SPEC_FILE_NAME  SAGE_II_SPEC_199804.6.10
FILLVAL  -999.000
GRID_SIZE  0.500000
ALT_GRID
  0.500000  1.00000  1.50000  2.00000  2.50000 3.00000
  3.50000  4.00000  4.50000  5.00000  5.50000 6.00000
  6.50000  7.00000  7.50000  8.00000  8.50000 9.00000
  9.50000  10.0000  10.5000  11.0000  11.5000 12.0000
  12.5000  13.0000  13.5000  14.0000  14.5000 15.0000
```

15.5000 16.0000 16.5000 17.0000 17.5000 18.0000
18.5000 19.0000 19.5000 20.0000 20.5000 21.0000
21.5000 22.0000 22.5000 23.0000 23.5000 24.0000
24.5000 25.0000 25.5000 26.0000 26.5000 27.0000
27.5000 28.0000 28.5000 29.0000 29.5000 30.0000
30.5000 31.0000 31.5000 32.0000 32.5000 33.0000
33.5000 34.0000 34.5000 35.0000 35.5000 36.0000
36.5000 37.0000 37.5000 38.0000 38.5000 39.0000
39.5000 40.0000 40.5000 41.0000 41.5000 42.0000
42.5000 43.0000 43.5000 44.0000 44.5000 45.0000
45.5000 46.0000 46.5000 47.0000 47.5000 48.0000
48.5000 49.0000 49.5000 50.0000 50.5000 51.0000
51.5000 52.0000 52.5000 53.0000 53.5000 54.0000
54.5000 55.0000 55.5000 56.0000 56.5000 57.0000
57.5000 58.0000 58.5000 59.0000 59.5000 60.0000
60.5000 61.0000 61.5000 62.0000 62.5000 63.0000
63.5000 64.0000 64.5000 65.0000 65.5000 66.0000
66.5000 67.0000 67.5000 68.0000 68.5000 69.0000
69.5000 70.0000 70.5000 71.0000 71.5000 72.0000
72.5000 73.0000 73.5000 74.0000 74.5000 75.0000
75.5000 76.0000 76.5000 77.0000 77.5000 78.0000
78.5000 79.0000 79.5000 80.0000 80.5000 81.0000
81.5000 82.0000 82.5000 83.0000 83.5000 84.0000
84.5000 85.0000 85.5000 86.0000 86.5000 87.0000
87.5000 88.0000 88.5000 89.0000 89.5000 90.0000
90.5000 91.0000 91.5000 92.0000 92.5000 93.0000
93.5000 94.0000 94.5000 95.0000 95.5000 96.0000
96.5000 97.0000 97.5000 98.0000 98.5000 99.0000
99.5000 100.000

ALT_MID_ATM
40.5000 41.0000 41.5000 42.0000 42.5000 43.0000
43.5000 44.0000 44.5000 45.0000 45.5000 46.0000
46.5000 47.0000 47.5000 48.0000 48.5000 49.0000
49.5000 50.0000 50.5000 51.0000 51.5000 52.0000
52.5000 53.0000 53.5000 54.0000 54.5000 55.0000
55.5000 56.0000 56.5000 57.0000 57.5000 58.0000
58.5000 59.0000 59.5000 60.0000 60.5000 61.0000
61.5000 62.0000 62.5000 63.0000 63.5000 64.0000
64.5000 65.0000 65.5000 66.0000 66.5000 67.0000
67.5000 68.0000 68.5000 69.0000 69.5000 70.0000
70.5000 71.0000 71.5000 72.0000 72.5000 73.0000
73.5000 74.0000 74.5000 75.0000
RANGE_TRANS
0.500000 100.000
RANGE_O3

0.500000 70.0000
RANGE_NO2
0.500000 50.0000
RANGE_H2O
0.500000 50.0000
RANGE_EXT
0.500000 40.0000
RANGE_DENSITY
0.500000 70.0000
RESERVED
0.500000 40.0000
YYYYMMDD 19980410
EVENT_NUM 1
HHMMSS 32939
DAY_FRAC 100.146
LAT -56.4767
LON -153.642
BETA -36.6157
DURATION 127.375
TYPE_SAT 1
TYPE_TAN 1
DROPPED 0
INFVEC 2
EPH_CRE_DATE 20010828
EPH_CRE_TIME 224134
MET_CRE_DATE 20010914
MET_CRE_TIME 160522
REF_CRE_DATE 20010828
REF_CRE_TIME 224209
TRANS_CRE_DATE 20010917
TRANS_CRE_TIME 231555
SPECIES_CRE_DATE 20010922
SPECIES_CRE_TIME 22028

TAN_ALT
0.00000 10.0000 20.0000 30.0000 40.0000 50.0000
60.0000 70.0000
TAN_LAT
-56.8522 -56.6648 -56.4767 -56.2878 -56.0980 -55.9074
-55.7159 -55.5234
TAN_LON
-153.850 -153.746 -153.642 -153.539 -153.436 -153.334
-153.232 -153.130
NMC_PRES
938.040 882.185 829.176 778.907 731.324 686.322
643.741 603.403 565.209 529.068 494.880 462.486

431.821 402.815 375.320 349.363 324.888 301.827
280.137 259.756 240.625 222.748 206.069 190.543
176.169 162.868 150.562 139.207 128.700 118.977
109.979 101.653 93.9428 86.8183 80.2380 74.1601
68.5471 63.3643 58.5747 54.1483 50.0575 46.2712
42.7742 39.5444 36.5610 33.8051 31.2591 28.9066
26.7338 24.7273 22.8741 21.1624 19.5811 18.1201
16.7702 15.5226 14.3696 13.3038 12.3185 11.4075
10.5651 9.78919 9.07905 8.42179 7.81338 7.25009
6.72849 6.24541 5.79794 5.38339 4.99925 4.64101
4.31025 4.00474 3.72242 3.46141 3.22000 2.99663
2.78985 2.59835 2.42093 2.25649 2.10401 1.96235
1.83022 1.70741 1.59323 1.48705 1.38828 1.29638
1.21086 1.13124 1.05711 0.987995 0.923184 0.862629
0.806051 0.753189 0.704808 0.659561 0.617254 0.577682
0.540638 0.505932 0.473389 0.442858 0.414207 0.387326
0.362117 0.338482 0.316323 0.295550 0.276078 0.257829
0.240730 0.224713 0.209712 0.195665 0.182515 0.170209
0.158694 0.147922 0.137850 0.128432 0.119629 0.111402
0.103716 0.0965366 0.0898316 0.0835720 0.0777299 0.0722794
0.0671957 0.0624551 0.0580355 0.0539161 0.0500773 0.0465009
0.0431695 0.0400676

NMC_TEMP

278.251 275.868 273.582 271.442 269.302 266.982
264.261 261.541 258.821 256.101 253.289 249.971
246.653 243.335 240.145 236.970 233.794 230.619
227.685 224.772 222.420 220.634 218.847 218.050
217.866 217.682 217.497 217.277 217.055 216.833
216.611 216.389 216.448 216.580 216.713 216.845
216.959 217.020 217.081 217.142 217.203 217.398
217.595 217.793 217.990 218.187 218.384 218.649
218.988 219.328 219.668 220.007 220.347 220.686
221.026 221.365 221.705 222.045 222.384 222.724
223.063 223.444 223.928 224.412 224.896 225.380
225.864 226.349 226.833 227.317 227.803 229.107
230.411 231.715 233.019 234.323 235.627 236.931
238.235 239.539 240.843 242.147 243.451 244.637
245.509 246.381 247.253 248.124 248.996 249.868
250.740 251.612 252.483 253.204 253.226 253.248
253.271 253.293 253.368 253.525 253.724 253.727
253.519 253.073 252.409 251.591 250.716 249.899
249.153 248.346 247.539 246.671 245.802 244.932
244.061 243.188 242.315 241.440 240.566 239.708
238.851 238.013 237.175 236.335 235.496 234.656
233.816 232.975 232.135 231.335 230.535 229.777
229.020 228.262 227.504 226.746 225.988 225.230

224.472 223.769
NMC_DENS
2.44180e+19 2.31625e+19 2.19526e+19 2.07843e+19 1.96697e+19 1.86197e+19
1.76443e+19 1.67107e+19 1.58174e+19 1.49633e+19 1.41518e+19 1.34009e+19
1.26807e+19 1.19902e+19 1.13202e+19 1.06785e+19 1.00653e+19 9.47959e+18
8.91174e+18 8.37047e+18 7.83598e+18 7.31254e+18 6.82024e+18 6.32938e+18
5.85687e+18 5.41927e+18 5.01404e+18 4.64061e+18 4.29473e+18 3.97432e+18
3.67752e+18 3.40261e+18 3.14367e+18 2.90348e+18 2.68177e+18 2.47712e+18
2.28843e+18 2.11481e+18 1.95441e+18 1.80621e+18 1.66928e+18 1.54163e+18
1.42383e+18 1.31513e+18 1.21481e+18 1.12222e+18 1.03677e+18 9.57583e+17
8.84231e+17 8.16598e+17 7.54231e+17 6.96713e+17 6.43660e+17 5.94719e+17
5.49567e+17 5.07904e+17 4.69456e+17 4.33971e+17 4.01217e+17 3.70979e+17
3.43060e+17 3.17325e+17 2.93669e+17 2.71822e+17 2.51642e+17 2.32999e+17
2.15772e+17 1.99853e+17 1.85138e+17 1.71534e+17 1.58954e+17 1.46724e+17
1.35496e+17 1.25183e+17 1.15707e+17 1.06995e+17 9.89824e+16 9.16088e+16
8.48206e+16 7.85684e+16 7.28074e+16 6.74965e+16 6.25984e+16 5.81006e+16
5.39962e+16 5.01947e+16 4.66729e+16 4.34093e+16 4.03841e+16 3.75793e+16
3.49781e+16 3.25650e+16 3.03259e+16 2.82625e+16 2.64062e+16 2.46720e+16
2.30518e+16 2.15381e+16 2.01486e+16 1.88434e+16 1.76209e+16 1.64911e+16
1.54463e+16 1.44801e+16 1.35844e+16 1.27496e+16 1.19664e+16 1.12263e+16
1.05271e+16 9.87198e+15 9.25577e+15 8.67839e+15 8.13526e+15 7.62453e+15
7.14429e+15 6.69286e+15 6.26856e+15 5.86988e+15 5.49531e+15 5.14309e+15
4.81236e+15 4.50152e+15 4.20982e+15 3.93614e+15 3.67942e+15 3.43866e+15
3.21291e+15 3.00129e+15 2.80295e+15 2.61665e+15 2.44218e+15 2.27842e+15
2.12518e+15 1.98181e+15 1.84770e+15 1.72229e+15 1.60503e+15 1.49541e+15
1.39297e+15 1.29694e+15
NMC_DENS_ERR
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199 201 204 207 210 213 216 219 222
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231 230 230 230 230 229 229 231 237
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TROP_HEIGHT
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WAVELENGTH

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0.386195
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-999.000 -999.000 4.14246e+11 2.09431e+11 1.35093e+11 3.07845e+11
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-999.000 -999.000 -999.000 -999.000
H2O

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1.26807e+19 1.19902e+19 1.13202e+19 1.06785e+19 1.00653e+19 9.47959e+18
8.91174e+18 8.37047e+18 7.83598e+18 7.31254e+18 6.82024e+18 6.32938e+18
5.85687e+18 5.41927e+18 5.01404e+18 4.64061e+18 4.29473e+18 3.97432e+18
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1.39297e+15 1.29694e+15
SURFDEN
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2.04226e+16 1.71976e+16 9.95694e+15 9.91164e+15 1.29178e+16 1.36888e+16

1.09317e+16 4.44095e+15 3.06342e+15 1.04633e+16 1.43122e+16 5.62722e+15
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1.02648e+15 1.22359e+14 4.65488e+13 1.52068e+15 6.41775e+15 5.40872e+15
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89 83 81 79 75 75 78 67 66
71 69 67 73 74 74 82 20 205
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709 720 731 726 743 778 952 912 870
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-999 -999 -999 -999 -999 -999 -999 -999 -999
-999 -999 343 64 1039 2567 2386 3415 3021
4033 3587 6015 1590 3586 3089 2659 2098 1641
1403 1248 1270 1175 1089 1177 1131 1287 1352
1685 1647 1986 1658 1691 1749 2525 2739 3063
3301 4636 4498 4034 1306 1397 1433 1396 1438
1564 1621 1653 1727 1829 1826 2092 1198 3276
2177 2134 2124 1936 9319 8146 -999 -999
EXT1020_ERR
-999 -999 -999 -999 -999 -999 -999 -999 -999
-999 -999 -999 -999 265 369 245 163 86
132 103 112 30 159 603 867 605 438
419 753 817 163 510 403 181 479 524
237 297 247 263 223 297 235 222 468
256 204 142 129 336 195 204 496 578
324 508 567 163 867 1060 1172 988 289
1508 489 668 1301 307 1111 5885 2382 -999
-999 -999 -999 -999 -999 -999 -999 -999
DENSITY_ERR
183 185 186 188 189 191 193 195 197

199 201 204 207 210 213 216 219 222
225 228 230 232 234 235 235 235 235
236 236 236 236 237 227 215 204 195
188 188 188 188 188 196 204 212 219
225 231 234 233 233 232 232 232 231
231 230 230 230 230 229 229 231 237
242 247 252 256 260 264 267 271 279
286 293 300 306 311 317 321 326 330
333 336 340 343 347 351 354 357 360
362 365 367 371 384 397 409 420 474
473 473 473 473 474 475 477 479 480
482 483 485 486 488 490 492 493 495
497 499 501 502 504 506 508 510 511
513 515 517 519 521 522 524 526 527
529 531 533 535 536
SURFDEN_ERR
10000 10000 10000 10000 10000 10000 10000 10000 10000
10000 10000 10000 10000 265 369 245 163 86
132 103 113 18 276 2337 3025 3826 3430
5074 4098 6903 1441 3780 3340 3045 2152 2107
1883 1748 1974 2123 1994 2058 2126 2272 3003
3511 3979 4624 10000 10000 10000 10000 10000 10000
10000 10000 10000 10000 10000 10000 10000 10000 10000
10000 10000 10000 10000 10000 10000 10000 10000 10000
10000 10000 10000 10000 10000 10000 10000 10000
RADIUS_ERR
10000 10000 10000 10000 10000 10000 10000 10000 10000
10000 10000 10000 10000 10000 10000 10000 10000 10000
10000 10000 233 34 491 1999 1636 2467 2170
2774 2570 4303 1240 2652 2262 1904 1567 1119
938 818 791 677 623 690 638 751 693
897 801 989 10000 10000 10000 10000 10000 10000
10000 10000 10000 10000 10000 10000 10000 10000 10000
10000 10000 10000 10000 10000 10000 10000 10000 10000
10000 10000 10000 10000 10000 10000 10000 10000
DENS_MID_ATM_ERR
68 243 215 157 659 198 606 877 95
175 1240 150 466 444 1377 287 829 256
846 265 1231 1601 998 653 1004 1338 1844
594 2455 1355 784 4032 1326 3253 1375 2798
1362 533 7117 3141 2724 2087 835 13306 10376
18751 30000 7118 2963 5036 30000 7795 5937 16566
19992 30000 30000 30000 764 3983 8683 11754 30000
-999 -999 -999 -999 -999 -999 -999
INFVEC
-999 -999 -999 -999 -999 -999 -999 -999 -999

-999 -999 -999 -999 28743 28743 28743 28743 24647
24647 24647 24646 24645 17604 1988 1604 1220 1220
1220 1220 1220 1155 1026 1154 1154 1154 1154
1154 1282 1410 1410 1538 1538 1666 1794 1922
1922 1922 1922 1922 1922 1922 1922 1922 1922
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Notice the counter starts with zero. Each month can potentially have up to 930 records, but most months have fewer. If you wish to print out every record in the data file, do not enter values for the starting and ending record number, but simply hit Enter (Return) at each prompt. Every record in the month will be printed out.

8.2 Bit Flag Meaning

Bit flags are used in both the index and species files to convey significant information about the inversion process. Index bit flags refer to an entire event while species bit flags are both species and altitude dependent. In general, severity increases with increasing value. Some flags are primarily kept as keys to the developers. A set bit flag does not necessarily indicate that an event should be considered flawed. The data set has been designed to indicate data validity through uncertainty estimates and, in the case of serious failure, missing data.

8.2.1 Index File Bit Flags

Name	Bit Number	Meaning
pmc_present	0	Polar Mesospheric Cloud (PMC) found in profile between 70 and 90 km
h2o_zero_found	1	Zero or negative mixing ratio inferred
h2o_slow_convergence	2	Water vapor retrieval required more than 20 iterations
h2o_ega_failure	3	Emissivity Curve-of-Growth Approximation (EGA) tool failure
default_nmc_temp_errors	4	A default uncertainty profile was used because no NCEP provided uncertainty were available
incomplete_nmc_data	8	One or more mandatory levels were missing from NCEP data
mirror_model	15	Mirror reflectivity is modeled; insufficient high altitude data

twomey_non_conv_rayleigh	19	Twomey-Chahine (T-C) inversion routine failure for Rayleigh retrieval
twomey_non_conv_386_Aero	20	T-C inversion routine failure for 386 nm aerosol extinction retrieval
twomey_non_conv_452_Aero	21	T-C inversion routine failure for 452 nm aerosol extinction retrieval
twomey_non_conv_525_Aero	22	T-C inversion routine failure for 525 nm aerosol extinction retrieval
twomey_non_conv_1020_Aero	23	T-C inversion routine failure for 1020 nm aerosol extinction retrieval
twomey_non_conv_NO2	24	T-C inversion routine failure for NO2 retrieval
twomey_non_conv_ozone	25	T-C inversion routine failure for ozone retrieval
no_shock_correction	30	No correction for the electrical transient was performed; usually a short event with too few extraterrestrial solar irradiance available

8.2.2 Species File Bit Flags

Name	Bit Number	Meaning
separation_method	0-2	Method used to separate between ozone, NO2, and aerosol
one_chan_aerosol_corr	3	Aerosol correction based on 1020nm aerosol only
no_935_aerosol_corr	4	No aerosol correction in the water vapor retrieval (based on the 935nm channel)
trans_summary	5	Non-standard transmission processing (see transmission bit flags for detailed information)
no2_extrap	6	Relevant to water vapor retrieval NO2 is extrapolated at this altitude based on a vertical profile that terminated at a higher altitude
water_vapor_ratio	7-10	Together, these bits give the water vapor optical depth ratio, in percent, capped at 15. ("15" is 15% or greater).
large_525_od	11	525nm aerosol slant path optical depth is large and may influence ozone retrieval
large_1020_od	12	1020nm aerosol slant path optical depth is large and may influence ozone retrieval
no_h2o_corr	13	Ozone not corrected for water vapor
in_troposphere	14	Altitude is below the NCEP-provided tropopause altitude

8.2.3 Species Separation Method Bit Flags

Name	Bit Number	Meaning
no_aerosol_method	0	Four channels used (3-6); Ozone, NO2, no aerosol inferred
trans_no_aero_to_five_chan	1	Transition
standard_method	2	Five channels used (1,3-6); Ozone, NO2, and aerosol (3)
trans_five_chan_to_low	3	Transition
four_chan_method	4	Four channels used (1,3-5); Ozone, aerosol (3)
trans_four_chan_to_three_chan	5	Transition
three_chan_method	6	Three channels used (1,3,4); Ozone, aerosol (2)
extension_method	7	Channel 1 only, aerosol (1)

8.3 Reading The Data Using Fortran 90

Fortran compilers handle unformatted binary data in different ways, it is difficult to provide read software for the SAGE II data that will work with all hardware systems and all compilers. General instructions provided by SAGE II are given below.

8.3.1 Getting Started

The Fortran 90 modules and sample output are available from the SAGE II data table (http://eosweb.larc.nasa.gov/PRODOCS/sage2/table_sage2.html). The package is distributed in zip format. The zip file contains all Fortran 90 code, sample output and a list of contents. Use Info-Zip software to unzip them. Information about downloading and using this freeware is available at the following URL:

http://www.cdrom.com/pub/infozip/zipped

Data files are unformatted binary files written on a DEC Alpha by a program compiled using the DIGITAL Fortran 90 V5.2-705 compiler. The data consists of two and four byte little endian integers and single and double precision little endian IEEE floating point data. The following code fragments and suggestions should be sufficient for reading the SAGE II data files on a DEC Alpha or PC.

To open and read a species data file, use the Fortran 90 program read_species.f90 that uses the module specinfo.f90. The text file SAGE_II_SPEC_198410.6.10.txt, contains the first two records of the data file SAGE_II_SPEC_198410.6.10 and has been provided for test purposes. The module formatspec.f90, can be used to print one species record at a time with a standard format. These files can be used to check that the species files are being read correctly.

To test, call the module formatspec twice, once for each of the first two records of SAGE_II_SPEC_198410.6.10. The arguments for this module are the output file unit number and the entire record represented as a speciesinfo structure. The resulting output file should be identical to SAGE_II_SPEC_198410.6.10.txt. If it isn't, there are several possible causes.

8.3.2 Byte Swapping

The SAGE II structure files contain little-endian data that is multiple byte data are stored with the least significant byte first. Certain hardware systems, such as Sun workstations, store data with the most significant byte first. Users of such systems will need to perform byte swapping in order for the data to be read correctly.

Some compilers provide various methods for performing byte-swapping automatically, although no such provision is given in the Fortran 90 standard. Look for a non-standard keyword to the open statement, such as "convert". Also look for ways to specify that byte swapping should be performed using compiler options, run-time options, or system environment variables. Detailed information on these methods will be found in the documentation accompanying the Fortran 90 compiler.

Some of these methods may not work for data in user-defined types. If so, the read statement will have to be modified to read each component of the species structure separately. For example, the statement

```
read(unit=unit,rec=recnum) spec
```

will have to be modified as

```
read(unit=unit,rec=recnum) spec%tan_alt,spec%tan_lat,spec%tan_lon, &
  spec%nmc_pres,spec%nmc_temp,spec%nmc_dens, &
{etc.}
```

If the data still are not being read correctly, proceed to the Section 8.3.3.

If no automatic method to perform byte swapping is found, it will have to be done manually in the application program. Four byte integers and reals should have all four bytes reversed, so that what is read as (byte-1)(byte-2)(byte-3)(byte-4) becomes (byte-4)(byte-3)(byte-2)(byte-1). Two byte integers will simply have the even and odd bytes interchanged, (byte-1)(byte-2) becomes (byte-2)(byte-1).

Another option is to use the Fortran 90 intrinsic routine mvbits, as in the Fortran 90 fragment four-byte swap. However, mvbits accepts only integer arguments. One way around this limitation is to read all the four-byte real data as four-byte integer data, swap the bytes, and re-write the data to a temporary file. The temporary file can then be read in the normal way.

8.3.3 Trouble-Shooting Other Possible Problems

Because there is nothing in the Fortran 90 standard specifying how different compilers treat binary unformatted data, it is possible that other irregularities can cause difficulties in reading SAGE II data.

One encountering such difficulties should first examine the expected record size. The following statements were included in the read_species.f90 code fragment:

```
type(speciesinfo) spec
inquire(iolength=lrspec) spec
```

The result, "lrspec", should be a multiple of 1912. If it is not, it may be that the size of individual components is different from expected. Perform inquiry statements on arrays of integers of kind=2 and kind=4 and reals of kind=4 to determine if the following are true:

1. The size of integer (kind=4) should be the same as real (kind=4).
2. The size of integer (kind=4) should be twice the size of integer (kind=2).
3. The size of a variable of type "speciesinfo" should be 1332 times the size of a (kind=4) variable plus 1160 times the size of a (kind=2).

Note that the inquiry statement should be done on arrays rather than on scalars. The reason is that the "iolength" of a single (kind=2) integer may be the same as a single (kind=4) integer in order to ensure that data are aligned on natural byte boundaries. However, an array of 100 (kind=2) integers would be expected to be half the size of an array of 100 (kind=4) integers. Since two byte integers appear in the species structure only in arrays of even length, the iolength of an array is more relevant.

On some compilers, some of the given conditions may be false. For instance, the WorkShop F90 compiler that is used on many Sun systems reads and writes all integers as four bytes. In other words, the kind specification (or the "n" in "integer*n") controls only the precision and range of the integer, not the amount of memory used for the variable. For this reason, it is impossible to read two-byte integers in a straightforward way. One option is to create a dummy structure which represents arrays of (kind=2) integers as arrays of (kind=4) integers of half the length. Then the intrinsic routine "mvbits" can be used to split the bytes apart.

The third condition specifies that the size of the "speciesinfo" record be equal to the sum of the sizes of its parts. If this is not true, then the compiler pads the structure in a way different from the way it was written. This padding is not expected, because the "speciesinfo" type is already defined in such a way that the data are aligned on natural byte boundaries. A natural boundary is a multiple of the size of the data item. Alignment on natural byte boundaries improves the efficiency of data storage and many compilers ensure this alignment by padding misaligned data. If for some reason padding similar to this is being performed, examine the documentation accompanying the compiler for a way to turn it off. Reading the data one component at a time, as described in Section 8.3.2 Byte-Swapping, would also most likely solve this problem.

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