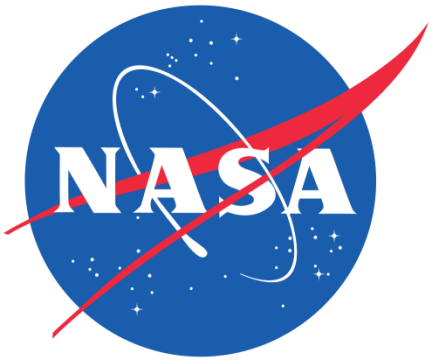
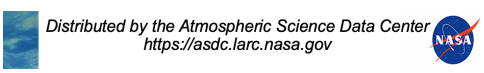


National Aeronautics and Space Administration
Langley Research Center

Stratospheric Aerosol and Gas Experiment on the International Space Station (SAGE III/ISS)

Data Products User's Guide

Version 5.3
February 2023



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Change Record

Issue	Date	Sections Affected	Description
Version 1.0	Oct 2017	All	Baseline
Version 1.1	Dec 2017	Product Content and Formats, Appendices	Lunar information added
Version 2.0	Oct 2018	All	New data format
Version 3.0	Apr 2021	All	New data format
Version 5.21	July 2022	Appendix C; Minor Version Increment	Aer_width product clarification; minor version increment
Version 5.3	February 2023	All	New data format

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Acronyms and Abbreviations

ASDC	Atmospheric Sciences Data Center
ATBD	Algorithm Theoretical Basis Document
CCD	Charge-Coupled Device
Ch	Channel
DMP	Disturbance Monitoring Package
EFOV	Effective Field of View
EOS	Earth Observing System
ETOS	Elapsed Time on Station
EVA	Extravehicular Activity
FOV	Field of View
GAMS	Gas and Aerosol Measurement Sensor
GMAO	Global Modeling and Assimilation Office
HDF	Hierarchical Data Format
IFOV	Instantaneous Field of View
InGaAs	Indium Gallium Arsenide
IR	Infrared
ISS	International Space Station
LOS	Line of Sight
MERRA-2	Modern-Era Retrospective analysis for Research and Applications, Version 2
QA	Quality Assurance
SAGE	Stratospheric Aerosol and Gas Experiment
SAM	Stratospheric Aerosol Measurement
SCF	Science Computing Facility
SP	Slant Path

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Information for using the SAGE III/ISS Data Product User's Guide

This Data Products User's Guide (Version 5.3) provides a general description of the measurement technique, instrument, mission, and sampling coverage. Additional information on these topics or details on the retrieval algorithms are provided at the websites specified below. This document also provides information on the CCD pixel assignments used for the retrieval algorithms. These assignments and the periods they represent are described in Appendix A. Instructions for accessing the SAGE III/ISS Data Product files are also provided, with detailed descriptions of their content and format given in Appendices B, C, and D.

Reference Material	Website Location
SAGE III Algorithm Theoretical Basis Documents	https://eospso.gsfc.nasa.gov/atbd-category/50
SAGE III/ISS Mission Web Site	https://sage.nasa.gov/

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Introduction

The Stratospheric Aerosol and Gas Experiment on the International Space Station (SAGE III/ISS) is an extension of the successful SAM II, SAGE I, SAGE II, and SAGE III Meteor-3M satellite experiments and is designed to acquire measurements of aerosols and gases in the stratosphere and upper troposphere (Chu and Veiga). These measurements are needed to enhance our understanding of natural and human-derived atmospheric processes. The experiment is a component of NASA's Earth Observing System (EOS) and is mounted on the ISS. The mission is managed by NASA's Langley Research Center.

The design for the SAGE III instruments included some advances which permit measurement of additional wavelengths over SAGE II. These added measurement capabilities resulted in

- improved aerosol characterization,
- improved gaseous retrievals of O_3, H_2O, and NO_2,
- extended vertical range of measurements,
- self-calibration of the instrument, independent of external data, and
- expanded sampling coverage.

Measurement Technique

The SAGE III instrument measures the attenuation of solar radiation resulting from the scattering and absorption by atmospheric constituents in the Earth's atmosphere as the spacecraft observes a sunrise or sunset event. The viewing geometry of the satellite and the radiant target (Sun) during an occultation is illustrated in Figure 1. Measurement opportunities occur when the satellite ascends or descends from behind the Earth. Measurement begins when the instrument acquires the radiant target and uses a mirror to scan the target image, in the local vertical direction, across the instrument field-of-view (FOV) aperture. A measurement is considered to occur at the point along the line of sight from the instrument to the target that comes closest to the Earth's surface (i.e., the subtangent point). The altitude of that point above the Earth's surface is commonly referred to as the tangent altitude.

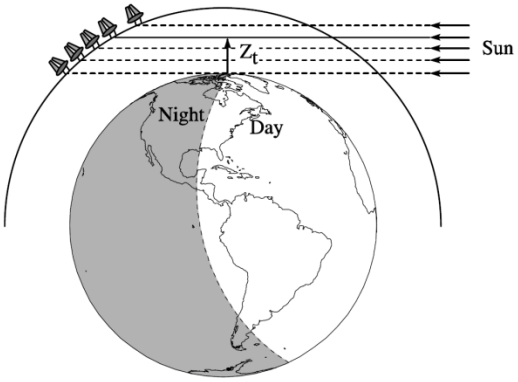

Figure 1. Occultation Geometry

The use of a scanning mirror provides multiple samples at each tangent altitude that are combined to construct transmission profiles from the Earth's surface (or cloud top) to an altitude of 100 km. Above this altitude, irradiance measurements are acquired between 100 and 300 km to characterize the instrument's performance across its wavelength range. This information is used to calibrate the instrument for each solar occultation event. By using this procedure, SAGE III data are relatively unaffected by changes in the instrument characteristics over the lifetime of the mission. A general description of the solar occultation measurement technique is provided by McCormick et al., 1979 (McCormick, Hamill and Pepin).

The atmospheric extinction at any point along the line-of-sight typically includes contributions from aerosols and several gas constituents. Figure 2 illustrates the principal extinction contributions for an altitude of 18 km. Both aerosol and molecular (Rayleigh)

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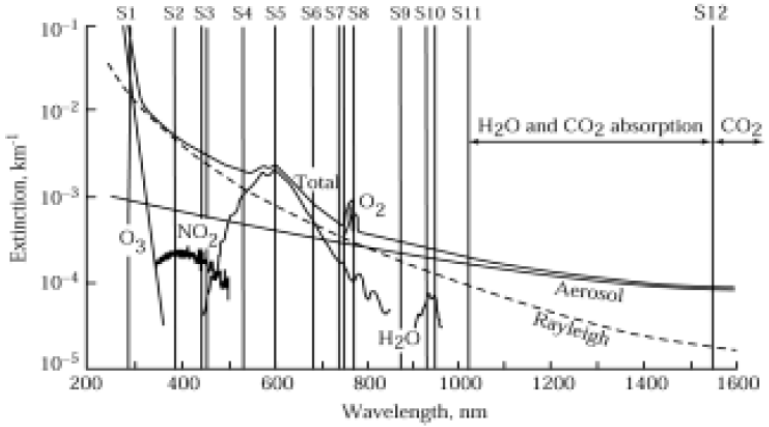

Ch #	Start-End WL (nm)	Target Species
01	284-296	O_3
02	382-387	Aerosol
03	433-451	NO_2/Aerosol
04	518-523	Aerosol
05	560-623	O_3/Aerosol
06	673-678	Aerosol
07	753-758	Aerosol
08	758-771	O_2
09	867-872	Aerosol
10	920-970	H_2O
11	1019-1025	Aerosol
12	1530-1560	Aerosol

Figure 2. Principal Extinction Contributions at 18 km
Vertical lines (S1-S12) denote spectral bands measured during solar events by SAGE III.

scattering contribute to extinction at all wavelengths. Ozone has strong absorption in the Hartley-Huggins band in the ultraviolet region of the spectrum and in the Chappius band in the visible spectrum. NO_2 absorbs between 350 and 600 nm. Water vapor has absorption lines throughout the visible spectrum, with an additional strong band near 940 nm. Although they are not depicted in this figure, NO_3 has absorption features between 500 and 650 nm, and OClO has a strong band between 380 and 400 nm.

Instrument Description and Operation

The design of the SAGE III sensor relies heavily upon the flight-proven designs used in the SAM II and SAGE I and II instruments. The SAGE III sensor assembly is illustrated in Figure 3. It consists of a pointing subsystem, an imaging subsystem, and a spectrometer. The pointing subsystem uses a scan mirror to acquire radiant energy from either the Sun or the Moon by vertically scanning across the target's image. The imaging subsystem produces a focused image of the target at the focal plane where the science aperture is located. The aperture defines the instrument's instantaneous field of view (IFOV). A removable neutral-density filter is located along the optical path of this subsystem. The filter is inserted into the optical path to attenuate the solar signal by approximately a factor of 106 and is removed for lunar measurements.

The spectrometer is located behind the science aperture and uses an 809 × 11 pixel CCD array to measure target radiation. The solar radiance between 280 and 1040 nm is measured with a spectral resolution of 1 to 2 nm along the 809 pixel dimension. An additional InGaAs infrared (IR) photodiode measures light near 1550 nm with a bandwidth of 30 nm for near infrared aerosol extinction measurements. This spectral coverage permits the measurement of multiple absorption features of each gaseous species and multiwavelength measurements of broadband extinction by aerosols. Because of limitations in the telemetry bandwidth, only 87 pixel groups (86 from the CCD and 1 from the photodiode) are transmitted from the

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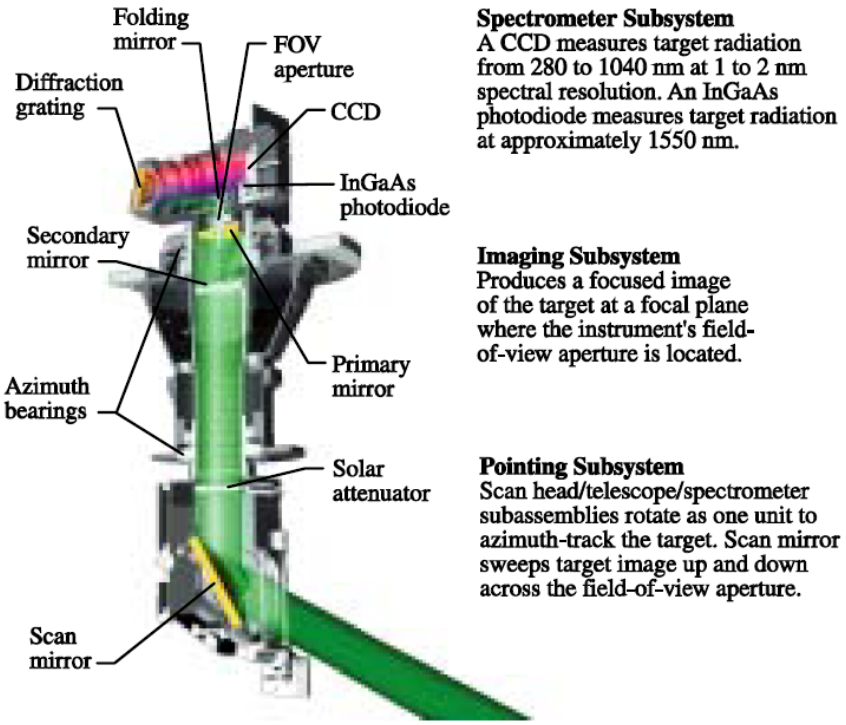

Figure 3. SAGE III Sensor Subsystems

satellite for solar occultations. These pixel groups are divided among 12 channels for solar observations and 3 channels for lunar observations. One of the features of the SAGE III/ISS instrument is the ability to reassign CCD pixels among these channels during flight to optimize instrument and retrieval performance. A listing of the different pixel assignments is provided in Appendix A.

As noted above, the CCD has 11 pixels along the horizontal direction for each of the 809 wavelength segments. The number of pixels utilized, consequently, defines the effective field of view (EFOV) in the horizontal direction. For solar measurements, 5 of the pixels are averaged at 64 samples per second, integrated during 75% of that time, which results in an EFOV of 2.3 arc-min in the horizontal. With an instantaneous field of view of 0.5 arc-min in the vertical, a vertical scan rate of 15 arc-min/sec from an orbital altitude of 400 km results in a vertical resolution of 0.5 km and a horizontal resolution of 1.5 km at the tangent point location.

For lunar measurements, the measurement integration time is increased, the sample rate is decreased to 16 samples per second, and the EFOV is widened to include all 11 elements of the CCD to improve the measurement's signal-to-noise ratio. The increased integration time results in an increase in the EFOV to 1.5 arc-min in the vertical (or 1.0 km at the tangent point). The use of all 11 pixels increases the horizontal view to 5 arc-min (or 3.3 km at the tangent point).

SAGE III/ISS Mission

The SAGE III/ISS mission is a joint research experiment between NASA, the European

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Space Agency (ESA), Thales Alenia Space-Italia (TAS-I), and Ball Aerospace & Technologies Corp. (BATC) (Szatkowski, Bradley Jr and Mauldin III). The instrument was launched as part of a resupply mission to the ISS on February 19, 2017. The ISS travels in a Low-Earth orbit at an altitude of 330-435 km at an inclination of 51.6°. With these orbital parameters, solar occultation measurement opportunities cover a large range of latitudes (between 70° S and 70° N). Solar observations are limited by beta angles in the range of -60° to +60°. Nominal sampling coverage for this mission is shown in Figure 4.

Additionally, observations are limited by ISS component obstructions, visiting vehicles, ISS maneuvers, and extravehicular activity (EVA, i.e. spacewalks). Lastly, onboard ISS activities occasionally cause vibrations that may increase the uncertainty of observations; although as of v05.30, a pointing correction is made based on data from the Disturbance Monitoring Package (DMP). More information on the use of DMP is provided in the v05.30 release notes and in Hill, et al. (2022).

Data Products and Availability

A list of the profile measurements contained in the SAGE III/ISS science data products is provided in Table 1. The reporting interval for all species is 0.5 km. These data products, with attendant metadata, are archived and available in either HDF5 or binary format

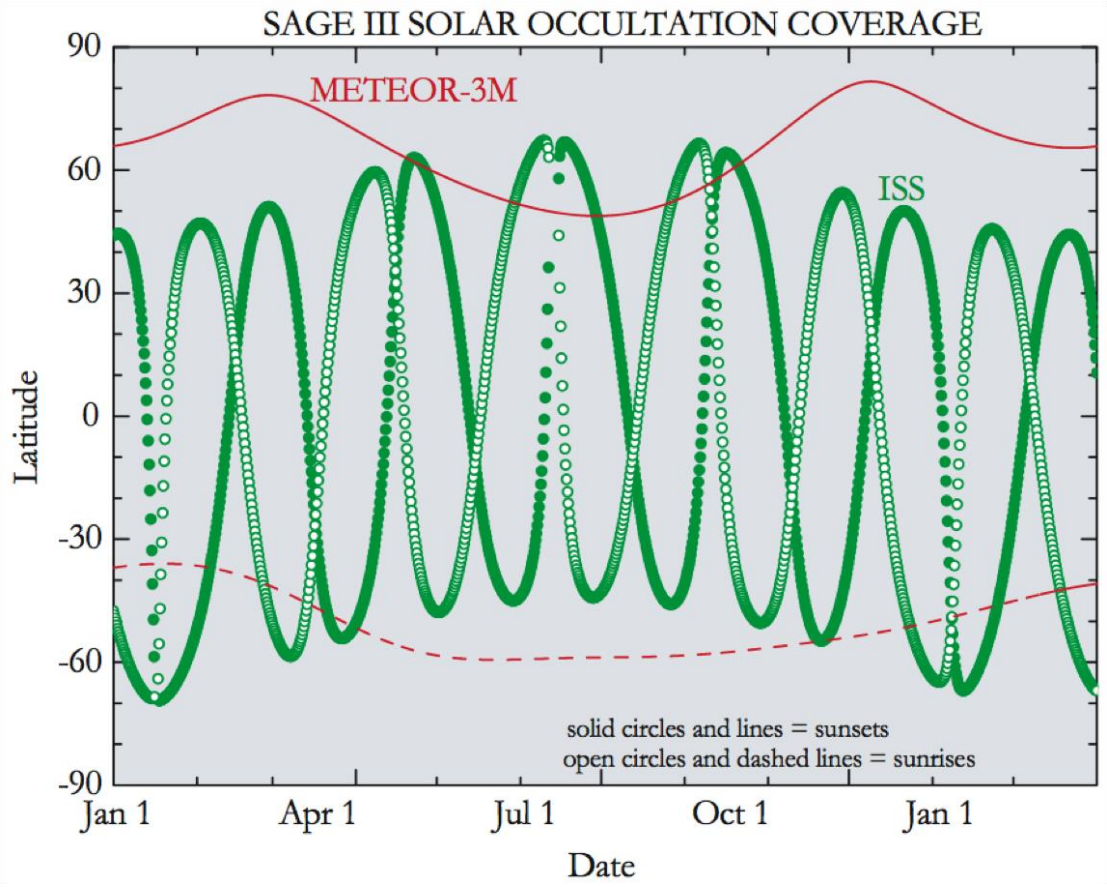

Figure 4. Nominal SAGE III/ISS Coverage Compared to SAGE III Meteor-3M Coverage

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Table 1. SAGE III Measurement Inventory

Reported Measurement	Status*	Units	Vertical Range	Mid/Lower Stratosphere Precision	Product Residence
Transmission Slant Path Transmission	Provisional	none	0 - 100 km	0.05%	Level 1B Transmission
Aerosol (9 spectral bands) Extinction Coefficient	Validated Stage 1	km^{-1}	0 - 45 km	8%	Level 2 Solar
Ozone (MLR) Concentration	Validated Stage 2	cm^{-3}	0 - 70 km	5%	Level 2 Solar
Ozone (AO3) Concentration	Validated Stage 2	cm^{-3}	0 - 70 km	5%	Level 2 Solar
Ozone (Mesospheric) Concentration	Provisional	cm^{-3}	50 - 100 km	10%	Level 2 Solar
NO_2 Concentration	Validated Stage 2	cm^{-3}	0 - 70 km	15%	Level 2 Solar
Water Vapor Concentration	Validated Stage 2	cm^{-3}	0 - 60 km	20%	Level 2 Solar
Ozone Concentration	Validated Stage 1	cm^{-3}	0 - 70 km	10%	Level 2 Lunar
NO_2 Concentration	Provisional	cm^{-3}	0 - 70 km	10%	Level 2 Lunar
NO_3 Concentration	Provisional	cm^{-3}	0 - 70 km	10%	Level 2 Lunar

* Release Status Definitions
Validated Stage 2 – Product uncertainty is estimated over a significant set of locations/time periods by comparison with suitable reference data. Results are published in the peer-reviewed literature.
Validated Stage 1 – Product uncertainty is estimated using a small number of independent measurements obtained from suitable reference data.
Provisional – These data are partially validated and improvements are continuing; quality may not be optimal since validation and quality assurance are ongoing.
Research – Suitable for validation, potentially usable for science and publication. Users cautioned.
Beta – Products intended to enable users to gain familiarity with the parameters and the data. Comment to the SAGE III team is appreciated.

from the Atmospheric Science Data Center (ASDC).

Data products are organized into individual solar or lunar event files and monthly solar or lunar files. This arrangement allows the user to select Level 1B and Level 2 products based on specified periods of time and measurement locations. SAGE III/ISS product files may be requested through the ASDC at any time.

Product Content and Formats

This section provides a description of the content and format for the HDF-EOS5 and binary Level 1B and Level 2 data products. The data formats for all binary product files are listed in detail in Appendices B, C, and D.

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This section also provides a description of the file-naming convention.
Reader software for SAGE III/ISS binary product files is available for download from the ASDC website. These readers are currently available for the IDL and Python programming languages. Readers are not provided for the SAGE III/ISS HDF product files. Due to changes in data format between versions, the latest readers are required for the latest data product version, but backward compatibility is maintained throughout the version 5.x product series.

Level 1B Transmission Product

Note: Transmission profiles currently use two different values for "fill". One is the large fill value defined in the product file (~3.4E38) to indicate missing data, the other is a small fill value (=1E-12) to indicate the calculated transmission value was zero or negative.

The Level 1B Transmission product contains the SAGE III/ISS atmospheric slant path transmission profiles at 87 spectral channels, as listed in Appendix B. The profiles are skewed vertically and extend from sea level to an altitude of 100 km in 0.5 km intervals. The standard deviation of the binned transmission data is also provided for each reported altitude and channel. These datasets have been geolocated and normalized against exoatmospheric solar measurements to produce slant path transmission profiles. Algorithm retrievals outlined in the Algorithm Theoretical Basis Document (ATBD) are used to reduce and invert this data into the Level 2 products listed in Appendix C. The Level 1B product is only available for solar measurements.
In the construction of the transmission profiles, atmospheric density information is used to correct for refraction effects. This information is derived from temperature profiles interpolated to the location and time of each SAGE III/ISS event from global gridded meteorological analyses provided by NASA GMAO's MERRA-2. These data sets extend from the surface to a pressure-altitude around 0.01 hPa (~80 km). Above this altitude, climatological temperature data are used from GRAM95. The composite temperature profile information is included in the Level 1B and Level 2 data product.

Level 2 Solar Species Products

The Level 2 Solar Species products are produced from the Level 1B Transmission profiles by using algorithms described in the ATBD. Gas absorption data sources are identified in Appendix E. A description of the Level 2 Solar Species format is provided in Appendix C. This section discusses the content of the Level 2 Solar Species organized by species. Each species includes information on its relative uncertainty. Species are reported in profiles on a geometric altitude coordinate system with a vertical resolution of 0.5 km. Diurnal corrections are not applied to the retrieved constituent values.

Aerosol

Profiles of aerosol extinction at 9 wavelengths are provided from the surface or opaque cloud top to an altitude of 45 km, where the contribution due to aerosols becomes negligible at all wavelengths. In practice, the lower altitude of an aerosol extinction profile may be limited by the dynamic range of the detector and a high, integrated slant path optical depth.

Nitrogen Dioxide

Profiles of nitrogen dioxide are provided in units of concentration over the altitude range 0 to 100 km. These profile measurements are derived from the multiple linear regression retrieval algorithm as described in the ATBD.

Ozone

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Three different profiles of ozone are provided in units of concentration over the altitude range 0 to 100 km. One profile is based upon measurements made at short wavelengths in the Hartley-Huggins band (denoted Mesospheric Ozone), a second profile is based upon measurements made at visible wavelengths in the Chappius band (denoted MLR Ozone), and a third profile is obtained using a similar approach utilized to process SAGE II data (denoted AO3 Ozone).

Water Vapor

Profiles of water vapor are provided in units of concentration over the altitude range 0 to 60 km. The water vapor products are retrieved by using a nonlinear least-squares approach from the solar occultation measurements of spectral slant path transmission.

Level 2 Lunar Species Products

The retrieval of constituent profiles from irradiance measurements acquired during lunar occultation events are more complex than those employed for solar events because they account for the spatial non-uniformity of the surface albedo of the moon and the much lower measurement signal. One important difference between the solar and lunar retrieval techniques is the absence of a Level 1B slant path transmission profile product for lunar occultation retrievals, a consequence of not being able to determine limb-darkening curves with sufficient accuracy to calibrate each lunar occultation event. The inaccuracies in the registration of the limb-darkening curve arise from small uncertainties in the pointing knowledge of the instrument in the presence of large variations in albedo across the lunar surface.

As a result of these challenges, the retrieval of lunar Level 2 products uses a different approach than is used for solar. A multiple linear regression is performed on the spectrum of relative optical depth for each packet, with the species absorption cross sections evaluated as the independent variables. Gas absorption data sources are identified in Appendix E. The resulting slant-path column densities are then bin-averaged, onion peeled, and reported on a geometric coordinate system with a vertical resolution of 0.5 km to maintain grid spacing compatibility with the solar Level 2 products. The tangent height registration of data for lunar profiles is accomplished by two methods, an ephemeris-based calculation and a comparison to a forward model of the oxygen A-band. The offset between the two methods is reported in the product.

A description of the content of these products is provided below and organized by species. Each product includes information on its relative uncertainty and a data quality assurance flag set.

A description of the lunar data product format and content is provided in Appendix D.

Ozone

Profiles of ozone are provided in units of concentration from 0 to 100 km. Profile measurements are derived from the multiple linear regression retrieval algorithm used for GAMS described in Reference (Pitts, Thomason and Zawodny).

Nitrogen Trioxide

Profiles of nitrogen trioxide are provided in units of concentration from 0 to 100 km. Profile measurements are derived from the multiple linear regression retrieval algorithm used for GAMS described in Reference (Pitts, Thomason and Zawodny).

Nitrogen Dioxide

Profiles of nitrogen dioxide are provided in units of concentration from 0 to 100 km. Profile measurements are derived from the multiple linear regression retrieval algorithm

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used for GAMS described in Reference (Pitts, Thomason and Zawodny).

File-Naming Convention

Following is a list of products and the file-naming convention for each product that shall be generated by SAGE III/ISS SCF processing.

- **L1B Solar Transmission Binary Products:**
  g3b.tb.YYYYMMDDEETTvzz.zz
- **L1B Solar Transmission HDF Products:**
  g3b.t.YYYYMMDDEETTvzz.zz
- **Level 2 Solar Binary Products:**
  g3b.sspb. YYYYMMDDEETTvzz.zz
- **Level 2 Solar HDF Products:**
  g3b.ssp.YYYYMMDDEETTvzz.zz
- **Level 2 Lunar Binary Products:**
  g3b.lspb.YYYYMMDDEETTvzz.zz
- **Level 2 Lunar HDF Products:**
  g3b.lsp.YYYYMMDDEETTvzz.zz
- **L1B Monthly Solar Transmission NETCDF Products:**
  SAGE3ISS_solar_L1_vzz.zz_YYYYMMDD-YYYYMMDD.nc
- **Level 2 Monthly Solar NETCDF Products:**
  SAGE3ISS_solar_L2_vzz.zz_YYYYMMDD-YYYYMMDD.nc
- **Level 2 Monthly Lunar NETCDF Products:**
  SAGE3ISS_lunar_L2_vzz.zz_YYYYMMDD-YYYYMMDD.nc
- **where:**
  - YYYY=year
  - MM=month
  - DD=day of month
  - EE=event number of the day
  - TT=event type (SR = sunrise, SS = sunset, MR = moonrise, MS = moonset)
  - zz.zz=Data Product Version Number

Example: g3b.tb.2017060702SSv05.30
refers to a transmission binary file for SAGE III/ISS captured on June 7, 2017 during the second event of the day, which was a sunset, and released as a product of SCF Data Product Version 05.30

Example: g3b.ssp.2017060703SRv05.30
Refers to a solar HDF5 file for SAGE III/ISS captured on June 7, 2017 during the third event of the day, which was a sunrise, and released as a product of SCF Data Product Version 05.30

Example: SAGE3ISS_solar_L2_v05.30_20170601-20170630.nc
Refers to a solar monthly NETCDF file for SAGE III/ISS capturing all solar events from June 1, 2017 through June 30, 2017 and released as a product of SCF Data Product Version 5.30

Quality Assurance Bit Flags

SAGE III Data Products are reviewed prior to their release. Profiles have values reported only for those species and altitudes where there is confidence in the ability of the algorithms to produce representative products. Each file contains bit flags that convey information about processing decisions to the user.

Event Condition QA Flags (Solar Events)
A binary bit in this 32-bit integer is set to "1" when the following event conditions occur:

Bit 0 – Nadir pointing by the hexapod platform could not be achieved.
Bit 1 – Instrument contamination door was closed.
Bit 2 – Packet-time assignments were questionable.

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Bit 3 – Large ISS vibrational disturbances were detected when collecting exoatmospheric data.
Bit 4 – Obstruction of the target by an ISS element was detected when collecting exoatmospheric data.
Bit 5 – Nominal CCD pixel-wavelength assignments were used (no exoatmospheric wavelength calibration).
Bit 6 – The sun was obstructed by the moon.
Bit 7 - Scan head pointing drift greater than 1 degree off-nadir detected during event.
Bit 8 – DMP-based pointing correction was skipped for the event.

Event Condition QA Flags (Lunar Events)
A binary bit in this 32-bit integer is set to "1" when the following event conditions occur:
Bit 0 – Nadir pointing by the hexapod platform could not be achieved.
Bit 1 – Instrument contamination door was closed.
Bit 2 – Packet-time assignments were questionable.
Bit 3 – This bit is not set for lunar events.
Bit 4 – Nominal CCD pixel-wavelength assignments were used (no exoatmospheric wavelength calibration).
Bit 5 - Scan head pointing drift greater than 1 degree off-nadir detected during event.

Altitude Dependent QA Flags
Each altitude bin is assigned a 32-bit integer containing QA flags. A binary bit in an integer is set to "1" when the following conditions occur:
Bit 0 – Large ISS vibrational disturbances were detected when collecting data for this altitude bin. This bit is not set for lunar events.

Retrieved Profile QA Flags

Bits 1-3 dealt with smoothing in earlier versions of the data products. There is no smoothing performed on v05.30 profiles.

Bit 4 - Retrieved slant-path profile value was negative.

Bit 5 - Retrieved slant-path profile value contained 'fill' data.

Solar Product Status and Quality

The data products have been screened by the SAGE III/ISS team in order to remove failed events and/or specific product profiles. Most of these are due to platform-related issues such as blockages and severe platform disturbances, but a few fail due to unknown instrument and/or retrieval algorithm anomalies. As a matter of practice, only the most severe failed events are removed and some thought into filtering data for less egregious data anomalies may be necessary for the user.

Ozone

The last time the "MLR" and "AO3" ozone products were thoroughly validated in a peer-reviewed publication was for v5.1 (Wang, Damadeo and Flittner). The primary differences in v5.2 were the natural tradeoff between precision and vertical resolution when vertical smoothing was removed and the reduction in low-altitude biases from a correction in spectroscopy. This was followed by a slight reduction in random noise in v5.3. While the MLR and AO3 profiles are generally in good agreement, the AO3 product has less noise in the upper stratosphere (above 40 km) and is thus the recommended ozone product. The SAGE III/ISS AO3 ozone data are of sufficient quality to be suitable for scientific research including trend studies.

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The mesospheric (i.e., "Ozone_Mes") product has been upgraded to provisional status based on ACE-FTS comparisons though it is still affected by out-of-band stray light, which is corrected using an imperfect approach developed for SAGE III/M3M, resulting in biases that are most noticeable at the lower end of the retrieval range.

In the past, SAGE III has provided a composite ozone product. This product is currently left blank as the SAGE Team feels that more thought into the construction of this product is required. It will not be released again until the mesospheric ozone product is corrected.

Aerosol Extinction Coefficient

The v5.2 aerosol extinction coefficient profiles were validated by Kalnajs and Deshler (2022). However, prior to that work the aerosol extinction coefficient products have already been used for a number of studies related to validation of other instruments (e.g., Kar et al., 2019; Rieger et al., 2019; Chen et al., 2020), documenting the impacts of recent volcanic eruptions and wildfires, and contributing to long-term studies of aerosol (e.g., Chouza et al., 2020; Kovilakam et al., 2020). Kalnajs & Deshler note the long-standing bias at 1um between SAGE and in-situ derived extinction. One additional anomaly was noted in the literature, namely a negative bias in the aerosol channels coinciding/scaling with the ozone cross-sections (illustrated in Wang et al., 2020). This bias is most noticeable in the 520, 602, and 676 nm channels, while the remaining channels appear unaffected. A simple correction involves spectrally fitting the aerosol extinction coefficient spectrum at non-affected channels to interpolate to affected channels.

Nitrogen Dioxide

The v5.1 NO2 products have undergone some preliminary validation in Dube et al. (2020) and more extensive evaluation by Strode et al. (2022). The largest change between v5.1 and v5.2 comes from the new wavelength map, resulting in a ~5% decrease in overall NO2 in the stratosphere.

Water Vapor

The last time the vertical profiles of H2O concentration were thoroughly validated in a peer-reviewed publication was for v5.1 in Davis et al. (2021) and Park et al. (2021), showing good agreement with other instruments as well as capturing patterns of stratospheric variability. Several anomalies noted in those studies were mitigated and/or improved in v5.2, most noticeable failed retrievals and enhanced sensitivity to elevated aerosol loading. Additionally, changes in the PSFs resulted in a roughly 0.3 ppm increase in stratospheric water vapor. With the combination of previous validation studies and improvements to the data, water vapor should be considered suitable for scientific studies from v5.2 onward.

Lunar Product Status and Quality

Ozone

The vertical profiles of ozone concentration have undergone some preliminary validation and the show generally good agreement with other instruments.

Nitrogen Dioxide

The vertical profiles of NO2 concentration are a provisional product with limited evaluation. While individual profiles have significant

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noise, averaging multiple profiles (e.g., over ~24 hours) to improve the precision shows lunar NO2 behaves similar to the solar NO2 product.

Nitrogen Trioxide

The vertical profiles of NO3 concentration are a provisional product with the user cautioned on the use of this data. This product tends to be rather noisy and, under most conditions, requires substantial averaging to produce a meaningful profile.

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Appendix A. SAGE III/ISS Nominal CCD Pixel Assignments

Table A1. Nominal CCD Assignments for Solar Data Collection (CCD Table Version 4)

Science Pixel Group	CCD Start Pixel	CCD End Pixel	Pixel Group Center Wavelength	Comment
0	2	2	281.916	
1	3	10	286.124	8-pixel sum
2	11	17	293.138	7-pixel sum
3	109	113	384.12	5-pixel average
4	163	163	433.091	
5	164	164	434.034	
6	165	165	434.977	
7	166	166	435.921	
8	167	167	436.864	
9	168	168	437.807	
10	169	169	438.751	
11	170	170	439.694	
12	171	171	440.637	
13	172	172	441.581	
14	173	173	442.525	
15	174	174	443.468	
16	175	175	444.412	
17	176	176	445.356	
18	177	177	446.299	
19	178	178	447.243	
20	179	179	448.187	
21	180	180	449.131	
22	181	181	450.075	
23	254	258	520.504	5-pixel average
24	299	301	562.042	3-pixel sum
25	306	308	568.648	3-pixel sum

Science Pixel Group	CCD Start Pixel	CCD End Pixel	Pixel Group Center Wavelength	Comment
26	313	315	575.255	3-pixel sum
27	320	322	581.861	3-pixel sum
28	327	329	588.466	3-pixel sum
29	334	336	595.071	3-pixel sum
30	341	343	601.674	3-pixel sum
31	348	350	608.277	3-pixel sum
32	355	357	614.879	3-pixel sum
33	362	364	621.481	3-pixel sum
34	419	423	676.133	5-pixel average
35	504	508	756.037	5-pixel average
36	509	509	758.852	
37	510	510	759.79	
38	511	511	760.728	
39	512	512	761.666	
40	513	513	762.604	
41	514	514	763.542	
42	515	515	764.48	
43	516	516	765.418	
44	517	517	766.356	
45	518	518	767.294	
46	519	519	768.232	
47	520	520	769.169	
48	521	521	770.107	
49	522	522	771.045	
50	625	629	869.207	5-pixel average
51	682	682	920.354	
52	696	696	933.339	
53	697	697	934.266	

Science Pixel Group	CCD Start Pixel	CCD End Pixel	Pixel Group Center Wavelength	Comment
54	698	698	935.193	
55	699	699	936.12	
56	700	700	937.046	
57	701	701	937.973	
58	702	702	938.9	
59	703	703	939.826	
60	704	704	940.752	
61	705	705	941.679	
62	706	706	942.605	
63	707	707	943.531	
64	708	708	944.457	
65	709	709	945.383	
66	710	710	946.309	
67	711	711	947.235	
68	712	712	948.161	
69	713	713	949.086	
70	714	714	950.012	
71	715	715	950.937	
72	716	716	951.863	
73	717	717	952.788	
74	718	718	953.714	
75	719	719	954.639	
76	720	720	955.564	
77	721	721	956.489	
78	722	722	957.414	
79	737	737	971.279	
80	789	789	1019.19	
81	790	790	1020.11	

Science Pixel Group	CCD Start Pixel	CCD End Pixel	Pixel Group Center Wavelength	Comment
82	791	791	1021.03	
83	792	792	1021.95	
84	793	793	1022.87	
85	794	794	1023.79	
86	-	-	1543.76	Photodiode

Table A2. Nominal CCD Assignments for Lunar Data Collection (CCD Table Version 2)

Science Pixel Group	CCD Start Pixel	CCD End Pixel	Pixel Group Center Wavelength	Comment
0	105	105	378.478	
1	106	106	379.418	
2	107	107	380.358	
3	108	108	381.298	
4	109	109	382.239	
5	110	110	383.179	
6	111	111	384.119	
7	112	112	385.06	
8	113	113	386	
9	114	114	386.941	
10	115	115	387.882	
11	116	116	388.822	
12	117	117	389.763	
13	118	118	390.704	
14	119	119	391.645	
15	120	120	392.585	
16	121	121	393.526	
17	122	122	394.467	
18	123	123	395.408	
19	124	124	396.349	
20	125	125	397.291	
21	126	126	398.232	
22	127	127	399.173	
23	128	128	400.114	
24	129	129	401.056	
25	130	130	401.997	
26	131	131	402.938	

Science Pixel Group	CCD Start Pixel	CCD End Pixel	Pixel Group Center Wavelength	Comment
27	132	132	403.88	
28	133	133	404.821	
29	144	144	415.182	
30	145	145	416.124	
31	146	146	417.066	
32	147	147	418.008	
33	148	148	418.95	
34	149	149	419.893	
35	150	150	420.835	
36	151	151	421.778	
37	152	152	422.72	
38	153	153	423.663	
39	154	154	424.605	
40	155	155	425.548	
41	156	156	426.491	
42	157	157	427.433	
43	158	158	428.376	
44	159	159	429.319	
45	160	160	430.262	
46	161	161	431.205	
47	162	162	432.148	
48	163	163	433.091	
49	164	164	434.034	
50	165	165	434.977	
51	166	166	435.921	
52	167	167	436.864	
53	168	168	437.807	
54	169	169	438.751	

Science Pixel Group	CCD Start Pixel	CCD End Pixel	Pixel Group Center Wavelength	Comment
55	170	170	439.694	
56	171	171	440.637	
57	172	172	441.581	
58	173	173	442.525	
59	174	174	443.468	
60	175	175	444.412	
61	176	176	445.356	
62	177	177	446.299	
63	178	178	447.243	
64	179	179	448.187	
65	180	180	449.131	
66	181	181	450.075	
67	182	182	451.019	
68	183	183	451.963	
69	184	184	452.907	
70	185	185	453.852	
71	186	186	454.796	
72	187	187	455.74	
73	188	188	456.684	
74	189	189	457.629	
75	190	190	458.573	
76	191	191	459.518	
77	192	192	460.462	
78	193	193	461.407	
79	194	194	462.352	
80	195	195	463.296	
81	196	196	464.241	
82	197	197	465.186	

Science Pixel Group	CCD Start Pixel	CCD End Pixel	Pixel Group Center Wavelength	Comment
83	198	198	466.131	
84	199	199	467.076	
85	200	200	468.021	
86	201	201	468.966	
87	202	202	469.911	
88	203	203	470.856	
89	204	204	471.801	
90	205	205	472.746	
91	206	206	473.691	
92	207	207	474.637	
93	208	208	475.582	
94	209	209	476.527	
95	210	210	477.473	
96	211	211	478.418	
97	212	212	479.364	
98	213	213	480.31	
99	214	214	481.255	
100	215	215	482.201	
101	216	216	483.147	
102	217	217	484.093	
103	218	218	485.039	
104	219	219	485.984	
105	220	220	486.93	
106	221	221	487.876	
107	222	222	488.823	
108	233	233	498.789	
109	234	234	499.733	
110	235	235	500.677	

Science Pixel Group	CCD Start Pixel	CCD End Pixel	Pixel Group Center Wavelength	Comment
111	236	236	501.621	
112	237	237	502.565	
113	238	238	503.509	
114	239	239	504.453	
115	240	240	505.398	
116	241	241	506.342	
117	242	242	507.286	
118	243	243	508.23	
119	244	244	509.174	
120	245	245	510.118	
121	246	246	511.062	
122	247	247	512.007	
123	248	248	512.951	
124	249	249	513.895	
125	250	250	514.839	
126	251	251	515.783	
127	252	252	516.727	
128	253	253	517.672	
129	254	254	518.616	
130	255	255	519.56	
131	256	256	520.504	
132	257	257	521.448	
133	258	258	522.392	
134	259	259	523.336	
135	260	260	524.28	
136	261	261	525.225	
137	262	262	526.169	
138	263	263	527.113	

Science Pixel Group	CCD Start Pixel	CCD End Pixel	Pixel Group Center Wavelength	Comment
139	264	264	528.057	
140	265	265	529.001	
141	266	266	529.945	
142	267	267	530.889	
143	268	268	531.833	
144	269	269	532.777	
145	270	270	533.722	
146	271	271	534.666	
147	272	272	535.61	
148	273	273	536.554	
149	274	274	537.498	
150	275	275	538.442	
151	276	276	539.386	
152	277	277	540.33	
153	278	278	541.274	
154	279	279	542.218	
155	280	280	543.162	
156	281	281	544.106	
157	282	282	545.05	
158	283	283	545.994	
159	284	284	546.938	
160	285	285	547.882	
161	292	292	554.49	
162	293	293	555.434	
163	294	294	556.378	
164	295	295	557.322	
165	296	296	558.266	
166	297	297	559.21	

Science Pixel Group	CCD Start Pixel	CCD End Pixel	Pixel Group Center Wavelength	Comment
167	298	298	560.154	
168	299	299	561.098	
169	300	300	562.042	
170	301	301	562.985	
171	302	302	563.929	
172	303	303	564.873	
173	304	304	565.817	
174	305	305	566.761	
175	306	306	567.705	
176	307	307	568.649	
177	308	308	569.592	
178	309	309	570.536	
179	310	310	571.48	
180	311	311	572.424	
181	312	312	573.367	
182	313	313	574.311	
183	314	314	575.255	
184	315	315	576.199	
185	316	316	577.142	
186	317	317	578.086	
187	318	318	579.03	
188	319	319	579.974	
189	320	320	580.917	
190	321	321	581.861	
191	322	322	582.805	
192	323	323	583.748	
193	324	324	584.692	
194	325	325	585.635	

Science Pixel Group	CCD Start Pixel	CCD End Pixel	Pixel Group Center Wavelength	Comment
195	326	326	586.579	
196	327	327	587.522	
197	328	328	588.466	
198	329	329	589.41	
199	330	330	590.353	
200	331	331	591.297	
201	332	332	592.24	
202	333	333	593.184	
203	334	334	594.127	
204	335	335	595.071	
205	336	336	596.014	
206	337	337	596.957	
207	338	338	597.901	
208	339	339	598.844	
209	340	340	599.788	
210	341	341	600.731	
211	342	342	601.674	
212	343	343	602.618	
213	344	344	603.561	
214	345	345	604.504	
215	346	346	605.448	
216	347	347	606.391	
217	348	348	607.334	
218	349	349	608.277	
219	350	350	609.221	
220	351	351	610.164	
221	352	352	611.107	
222	353	353	612.05	

Science Pixel Group	CCD Start Pixel	CCD End Pixel	Pixel Group Center Wavelength	Comment
223	354	354	612.993	
224	355	355	613.936	
225	356	356	614.879	
226	357	357	615.823	
227	358	358	616.766	
228	359	359	617.709	
229	360	360	618.652	
230	361	361	619.595	
231	362	362	620.538	
232	363	363	621.481	
233	364	364	622.424	
234	365	365	623.366	
235	366	366	624.309	
236	367	367	625.252	
237	368	368	626.195	
238	369	369	627.138	
239	370	370	628.081	
240	371	371	629.024	
241	372	372	629.966	
242	373	373	630.909	
243	374	374	631.852	
244	375	375	632.795	
245	376	376	633.737	
246	377	377	634.68	
247	378	378	635.623	
248	379	379	636.565	
249	380	380	637.508	
250	381	381	638.45	

Science Pixel Group	CCD Start Pixel	CCD End Pixel	Pixel Group Center Wavelength	Comment
251	382	382	639.393	
252	383	383	640.336	
253	384	384	641.278	
254	385	385	642.221	
255	386	386	643.163	
256	387	387	644.105	
257	388	388	645.048	
258	389	389	645.99	
259	390	390	646.933	
260	391	391	647.875	
261	392	392	648.817	
262	393	393	649.76	
263	394	394	650.702	
264	395	395	651.644	
265	396	396	652.586	
266	397	397	653.528	
267	398	398	654.471	
268	399	399	655.413	
269	400	400	656.355	
270	401	401	657.297	
271	402	402	658.239	
272	403	403	659.181	
273	404	404	660.123	
274	405	405	661.065	
275	406	406	662.007	
276	407	407	662.949	
277	408	408	663.891	
278	409	409	664.833	

Science Pixel Group	CCD Start Pixel	CCD End Pixel	Pixel Group Center Wavelength	Comment
279	410	410	665.775	
280	411	411	666.716	
281	412	412	667.658	
282	413	413	668.6	
283	414	414	669.542	
284	415	415	670.483	
285	416	416	671.425	
286	417	417	672.367	
287	418	418	673.308	
288	419	419	674.25	
289	420	420	675.191	
290	421	421	676.133	
291	422	422	677.074	
292	423	423	678.016	
293	424	424	678.957	
294	425	425	679.899	
295	426	426	680.84	
296	427	427	681.781	
297	428	428	682.723	
298	429	429	683.664	
299	430	430	684.605	
300	431	431	685.547	
301	432	432	686.488	
302	433	433	687.429	
303	434	434	688.37	
304	435	435	689.311	
305	436	436	690.252	
306	437	437	691.193	

Science Pixel Group	CCD Start Pixel	CCD End Pixel	Pixel Group Center Wavelength	Comment
307	438	438	692.134	
308	439	439	693.075	
309	440	440	694.016	
310	441	441	694.957	
311	442	442	695.898	
312	443	443	696.839	
313	505	506	755.568	2-pixel average
314	507	508	757.444	2-pixel average
315	509	509	758.852	
316	510	510	759.79	
317	511	511	760.728	
318	512	512	761.666	
319	513	513	762.604	
320	514	514	763.542	
321	515	515	764.48	
322	516	516	765.418	
323	517	517	766.356	
324	518	518	767.294	
325	519	519	768.232	
326	520	520	769.169	
327	521	521	770.107	
328	522	522	771.045	
329	523	523	771.982	
330	524	524	772.92	
331	525	525	773.858	
332	526	526	774.795	
333	527	527	775.732	
334	528	528	776.67	

Science Pixel Group	CCD Start Pixel	CCD End Pixel	Pixel Group Center Wavelength	Comment
335	529	529	777.607	
336	530	530	778.544	
337	531	531	779.482	

Appendix B. SAGE III/ISS Level 1B Solar Transmission Products

Table B1. Binary File Format Sheet: SAGE III/ISS Level 1B Solar Transmission Product

Field Start	Field End	Num Values	F90 Type	Start Byte	End Byte	Description	Units
0	0	1	C12	0	11	EVENT_ID	*
1	1	1	I4	12	15	OLD_EVENT_ID	*
2	2	1	I4	16	19	DATE	*
3	3	1	R8	20	27	YEAR_FRACTION	*
4	4	1	R4	28	31	LATITUDE	degrees
5	5	1	R4	32	35	LONGITUDE	degrees
6	6	1	I4	36	39	TIME (HHMMSS)	UTC
7	7	1	I4	40	43	INT_FILL_VALUE	*
8	8	1	R4	44	47	FLT_FILL_VALUE	*
9	9	1	I4	48	51	MISSION_ID	*
10	10	1	R4	52	55	L0DO_VERSION	*
11	11	1	I4	56	59	CCDVERSION	*
12	12	1	R4	60	63	L0_VERSION	*
13	13	1	R4	64	67	SOFTWARE_VERSION	*
14	14	1	R4	68	71	DATAPRODUCT_VERSION	*
15	15	1	R4	72	75	SPECTROSCOPIC_DATABASE_VERSION	*
16	16	1	R4	76	79	GRAM95_VERSION	*
17	17	1	R4	80	83	MET_VERSION	*
18	18	1	R4	84	87	BIN_HEIGHT	km
19	19	1	I4	88	91	PROFILE_COUNT	*
20	20	1	I4	92	95	NUM_GRND_TRK	*
21	21	1	I4	96	99	NUM_PRESS_GRID	*
22	22	1	I4	100	103	NUM_CCDPXLGRPS	*
23	23	1	I4	104	107	NUM_ALT_BINS	*
24	24	1	I4	108	111	SC_EVT_TYPE *(Sunrise = 1; Sunset = 2)*	*
25	25	1	I4	112	115	GND_EVT_TYPE *(Sunrise = 1; Sunset = 2)*	*

26	26	1	R4	116	119	BETAANGLE_SOLAR		degrees
27	27	1	I4	120	123	AURORA_FLAG *(N/A)*		*
28	28	1	I4	124	127	EPHEMERIS_SOURCE *(GPS = 5)*		*
29	39	11	I4	128	171	GT_DATE	*Ground track-indexed data for 11 tangent altitudes from 0km to 100km at 10km intervals*	*
40	50	11	I4	172	215	GT_TIME		*
51	61	11	R4	216	259	GT_LATITUDE		*
62	72	11	R4	260	303	GT_LONGITUDE		*
73	83	11	R4	304	347	GT_RAY_DIR		degrees
84	94	11	R4	348	391	SPACE_CRAFT_LAT		degrees
95	105	11	R4	392	435	SPACE_CRAFT_LON		degrees
106	116	11	R4	436	479	SPACE_CRAFT_ALT		degrees
117	316	200	R4	480	1279	ALTITUDE		km
317	516	200	R4	1280	2079	GEOPOTENTIAL_ALT		km
517	716	200	R4	2080	2879	PRESSURE		hPa
717	916	200	R4	2880	3679	PRESSURE_UNCERT		hPa
917	1116	200	R4	3680	4479	TEMPERATURE		K
1117	1316	200	R4	4480	5279	TEMPERATURE_UNCERT		K
1317	1516	200	R4	5280	6079	NEUTRAL_DENSITY		cm^{-3}
1517	1716	200	R4	6080	6879	NEUTRAL_DENSITY_UNCERT		cm^{-3}
1717	1916	200	I4	6880	7679	TEMP_PRESSURE_SOURCE *(GRAM95 = 0; MERRA-2 = 2)*		*
1917	1917	1	R4	7680	7683	TROP_TEMP		K
1918	1918	1	R4	7684	7687	TROP_ALT		km
1919	1919	1	R4	7688	7691	TROP_PRESS		hPa
1920	1991	72	R4	7692	7979	MET_PRESSURE	Pressure surface-indexed data	hPa
1992	2063	72	R4	7980	8267	MET_TEMP		K
2064	2135	72	R4	8268	8555	MET_TEMP_UNC		K
2136	2207	72	R4	8556	8843	MET_ALTITUDE		km
2208	2208	1	I4	8844	8847	MET_SOURCE *(GRAM95 = 0; MERRA-2 = 2)*		*
2209	2209	1	R4	8848	8851	CCD_TEMPERATURE		°C
2210	2210	1	R4	8852	8855	SPECTROMETER_ZENITH_TEMPERATURE		°C

2211	2211	1	R4	8856	8859	CCD_TEMPERATURE_MINUS_TEC	°C
2212	2212	1	I4	8860	8863	EPHEMERIS_QUALITY (0 - Missing 1 - Nominal 2 - Expanded Interpolation Time Window 3 - Time Gap/Bad Data)	*
2213	2213	1	R4	8864	8867	SPECCALSHIFT	nm
2214	2214	1	R4	8868	8871	SPECCALSTRETCH	nm/pixel
2215	2216	2	R4	8872	8879	AZIMUTHANGLE	degrees
2217	2217	1	I4	8880	8883	QAFLAG	*
2218	2417	200	I4	8884	9683	QAFLAG_ALTITUDE	*
2418	2503	86	I4	9684	10027	START_PIXEL_NUM	*
2504	2589	86	I4	10028	10371	END_PIXEL_NUM	*
2590	2676	87	R4	10372	10719	CENTRAL_WAVELENGTH	nm
2677	2763	87	R4	10720	11067	HALF_BANDWIDTH	nm
2764	2963	200	R4	11068	11867	DMP Elevation Pointing Offset Magnitude Pixel Group 0	rad
2964	3163	200	R4	11868	12667	DMP Elevation Pointing Offset Fraction Pixel Group 0	*
3164	3363	200	R4	12668	13467	DMP Elevation Pointing Offset Magnitude Pixel Group 1	rad
3364	3563	200	R4	13468	14267	DMP Elevation Pointing Offset Fraction Pixel Group 1	*
3564	3763	200	R4	14268	15067	DMP Elevation Pointing Offset Magnitude Pixel Group 2	rad
3764	3963	200	R4	15068	15867	DMP Elevation Pointing Offset Fraction Pixel Group 2	*
3964	4163	200	R4	15868	16667	DMP Elevation Pointing Offset Magnitude Pixel Group 3	rad
4164	4363	200	R4	16668	17467	DMP Elevation Pointing Offset Fraction Pixel Group 3	*
4364	4563	200	R4	17468	18267	DMP Elevation Pointing Offset Magnitude Pixel Group 4	rad
4564	4763	200	R4	18268	19067	DMP Elevation Pointing Offset Fraction Pixel Group 4	*
4764	4963	200	R4	19068	19867	DMP Elevation Pointing Offset Magnitude Pixel Group 5	rad
4964	5163	200	R4	19868	20667	DMP Elevation Pointing Offset Fraction Pixel Group 5	*
5164	5363	200	R4	20668	21467	DMP Elevation Pointing Offset Magnitude Pixel Group 6	rad
5364	5563	200	R4	21468	22267	DMP Elevation Pointing Offset Fraction Pixel Group 6	*
5564	5763	200	R4	22268	23067	DMP Elevation Pointing Offset Magnitude Pixel Group 7	rad
5764	5963	200	R4	23068	23867	DMP Elevation Pointing Offset Fraction Pixel Group 7	*
5964	6163	200	R4	23868	24667	DMP Elevation Pointing Offset Magnitude Pixel Group 8	rad
6164	6363	200	R4	24668	25467	DMP Elevation Pointing Offset Fraction Pixel Group 8	*

6364	6563	200	R4	25468	26267	DMP Elevation Pointing Offset Magnitude Pixel Group 9	rad
6564	6763	200	R4	26268	27067	DMP Elevation Pointing Offset Fraction Pixel Group 9	*
6764	6963	200	R4	27068	27867	DMP Elevation Pointing Offset Magnitude Pixel Group 10	rad
6964	7163	200	R4	27868	28667	DMP Elevation Pointing Offset Fraction Pixel Group 10	*
7164	7363	200	R4	28668	29467	DMP Elevation Pointing Offset Magnitude Pixel Group 11	rad
7364	7563	200	R4	29468	30267	DMP Elevation Pointing Offset Fraction Pixel Group 11	*
7564	7763	200	R4	30268	31067	DMP Elevation Pointing Offset Magnitude Pixel Group 12	rad
7764	7963	200	R4	31068	31867	DMP Elevation Pointing Offset Fraction Pixel Group 12	*
7964	8163	200	R4	31868	32667	DMP Elevation Pointing Offset Magnitude Pixel Group 13	rad
8164	8363	200	R4	32668	33467	DMP Elevation Pointing Offset Fraction Pixel Group 13	*
8364	8563	200	R4	33468	34267	DMP Elevation Pointing Offset Magnitude Pixel Group 14	rad
8564	8763	200	R4	34268	35067	DMP Elevation Pointing Offset Fraction Pixel Group 14	*
8764	8963	200	R4	35068	35867	DMP Elevation Pointing Offset Magnitude Pixel Group 15	rad
8964	9163	200	R4	35868	36667	DMP Elevation Pointing Offset Fraction Pixel Group 15	*
9164	9363	200	R4	36668	37467	DMP Elevation Pointing Offset Magnitude Pixel Group 16	rad
9364	9563	200	R4	37468	38267	DMP Elevation Pointing Offset Fraction Pixel Group 16	*
9564	9763	200	R4	38268	39067	DMP Elevation Pointing Offset Magnitude Pixel Group 17	rad
9764	9963	200	R4	39068	39867	DMP Elevation Pointing Offset Fraction Pixel Group 17	*
9964	10163	200	R4	39868	40667	DMP Elevation Pointing Offset Magnitude Pixel Group 18	rad
10164	10363	200	R4	40668	41467	DMP Elevation Pointing Offset Fraction Pixel Group 18	*
10364	10563	200	R4	41468	42267	DMP Elevation Pointing Offset Magnitude Pixel Group 19	rad
10564	10763	200	R4	42268	43067	DMP Elevation Pointing Offset Fraction Pixel Group 19	*
10764	10963	200	R4	43068	43867	DMP Elevation Pointing Offset Magnitude Pixel Group 20	rad
10964	11163	200	R4	43868	44667	DMP Elevation Pointing Offset Fraction Pixel Group 20	*
11164	11363	200	R4	44668	45467	DMP Elevation Pointing Offset Magnitude Pixel Group 21	rad
11364	11563	200	R4	45468	46267	DMP Elevation Pointing Offset Fraction Pixel Group 21	*
11564	11763	200	R4	46268	47067	DMP Elevation Pointing Offset Magnitude Pixel Group 22	rad
11764	11963	200	R4	47068	47867	DMP Elevation Pointing Offset Fraction Pixel Group 22	*
11964	12163	200	R4	47868	48667	DMP Elevation Pointing Offset Magnitude Pixel Group 23	rad
12164	12363	200	R4	48668	49467	DMP Elevation Pointing Offset Fraction Pixel Group 23	*

12364	12563	200	R4	49468	50267	DMP Elevation Pointing Offset Magnitude Pixel Group 24	rad
12564	12763	200	R4	50268	51067	DMP Elevation Pointing Offset Fraction Pixel Group 24	*
12764	12963	200	R4	51068	51867	DMP Elevation Pointing Offset Magnitude Pixel Group 25	rad
12964	13163	200	R4	51868	52667	DMP Elevation Pointing Offset Fraction Pixel Group 25	*
13164	13363	200	R4	52668	53467	DMP Elevation Pointing Offset Magnitude Pixel Group 26	rad
13364	13563	200	R4	53468	54267	DMP Elevation Pointing Offset Fraction Pixel Group 26	*
13564	13763	200	R4	54268	55067	DMP Elevation Pointing Offset Magnitude Pixel Group 27	rad
13764	13963	200	R4	55068	55867	DMP Elevation Pointing Offset Fraction Pixel Group 27	*
13964	14163	200	R4	55868	56667	DMP Elevation Pointing Offset Magnitude Pixel Group 28	rad
14164	14363	200	R4	56668	57467	DMP Elevation Pointing Offset Fraction Pixel Group 28	*
14364	14563	200	R4	57468	58267	DMP Elevation Pointing Offset Magnitude Pixel Group 29	rad
14564	14763	200	R4	58268	59067	DMP Elevation Pointing Offset Fraction Pixel Group 29	*
14764	14963	200	R4	59068	59867	DMP Elevation Pointing Offset Magnitude Pixel Group 30	rad
14964	15163	200	R4	59868	60667	DMP Elevation Pointing Offset Fraction Pixel Group 30	*
15164	15363	200	R4	60668	61467	DMP Elevation Pointing Offset Magnitude Pixel Group 31	rad
15364	15563	200	R4	61468	62267	DMP Elevation Pointing Offset Fraction Pixel Group 31	*
15564	15763	200	R4	62268	63067	DMP Elevation Pointing Offset Magnitude Pixel Group 32	rad
15764	15963	200	R4	63068	63867	DMP Elevation Pointing Offset Fraction Pixel Group 32	*
15964	16163	200	R4	63868	64667	DMP Elevation Pointing Offset Magnitude Pixel Group 33	rad
16164	16363	200	R4	64668	65467	DMP Elevation Pointing Offset Fraction Pixel Group 33	*
16364	16563	200	R4	65468	66267	DMP Elevation Pointing Offset Magnitude Pixel Group 34	rad
16564	16763	200	R4	66268	67067	DMP Elevation Pointing Offset Fraction Pixel Group 34	*
16764	16963	200	R4	67068	67867	DMP Elevation Pointing Offset Magnitude Pixel Group 35	rad
16964	17163	200	R4	67868	68667	DMP Elevation Pointing Offset Fraction Pixel Group 35	*
17164	17363	200	R4	68668	69467	DMP Elevation Pointing Offset Magnitude Pixel Group 36	rad
17364	17563	200	R4	69468	70267	DMP Elevation Pointing Offset Fraction Pixel Group 36	*
17564	17763	200	R4	70268	71067	DMP Elevation Pointing Offset Magnitude Pixel Group 37	rad
17764	17963	200	R4	71068	71867	DMP Elevation Pointing Offset Fraction Pixel Group 37	*
17964	18163	200	R4	71868	72667	DMP Elevation Pointing Offset Magnitude Pixel Group 38	rad
18164	18363	200	R4	72668	73467	DMP Elevation Pointing Offset Fraction Pixel Group 38	*

18364	18563	200	R4	73468	74267	DMP Elevation Pointing Offset Magnitude Pixel Group 39	rad
18564	18763	200	R4	74268	75067	DMP Elevation Pointing Offset Fraction Pixel Group 39	*
18764	18963	200	R4	75068	75867	DMP Elevation Pointing Offset Magnitude Pixel Group 40	rad
18964	19163	200	R4	75868	76667	DMP Elevation Pointing Offset Fraction Pixel Group 40	*
19164	19363	200	R4	76668	77467	DMP Elevation Pointing Offset Magnitude Pixel Group 41	rad
19364	19563	200	R4	77468	78267	DMP Elevation Pointing Offset Fraction Pixel Group 41	*
19564	19763	200	R4	78268	79067	DMP Elevation Pointing Offset Magnitude Pixel Group 42	rad
19764	19963	200	R4	79068	79867	DMP Elevation Pointing Offset Fraction Pixel Group 42	*
19964	20163	200	R4	79868	80667	DMP Elevation Pointing Offset Magnitude Pixel Group 43	rad
20164	20363	200	R4	80668	81467	DMP Elevation Pointing Offset Fraction Pixel Group 43	*
20364	20563	200	R4	81468	82267	DMP Elevation Pointing Offset Magnitude Pixel Group 44	rad
20564	20763	200	R4	82268	83067	DMP Elevation Pointing Offset Fraction Pixel Group 44	*
20764	20963	200	R4	83068	83867	DMP Elevation Pointing Offset Magnitude Pixel Group 45	rad
20964	21163	200	R4	83868	84667	DMP Elevation Pointing Offset Fraction Pixel Group 45	*
21164	21363	200	R4	84668	85467	DMP Elevation Pointing Offset Magnitude Pixel Group 46	rad
21364	21563	200	R4	85468	86267	DMP Elevation Pointing Offset Fraction Pixel Group 46	*
21564	21763	200	R4	86268	87067	DMP Elevation Pointing Offset Magnitude Pixel Group 47	rad
21764	21963	200	R4	87068	87867	DMP Elevation Pointing Offset Fraction Pixel Group 47	*
21964	22163	200	R4	87868	88667	DMP Elevation Pointing Offset Magnitude Pixel Group 48	rad
22164	22363	200	R4	88668	89467	DMP Elevation Pointing Offset Fraction Pixel Group 48	*
22364	22563	200	R4	89468	90267	DMP Elevation Pointing Offset Magnitude Pixel Group 49	rad
22564	22763	200	R4	90268	91067	DMP Elevation Pointing Offset Fraction Pixel Group 49	*
22764	22963	200	R4	91068	91867	DMP Elevation Pointing Offset Magnitude Pixel Group 50	rad
22964	23163	200	R4	91868	92667	DMP Elevation Pointing Offset Fraction Pixel Group 50	*
23164	23363	200	R4	92668	93467	DMP Elevation Pointing Offset Magnitude Pixel Group 51	rad
23364	23563	200	R4	93468	94267	DMP Elevation Pointing Offset Fraction Pixel Group 51	*
23564	23763	200	R4	94268	95067	DMP Elevation Pointing Offset Magnitude Pixel Group 52	rad
23764	23963	200	R4	95068	95867	DMP Elevation Pointing Offset Fraction Pixel Group 52	*
23964	24163	200	R4	95868	96667	DMP Elevation Pointing Offset Magnitude Pixel Group 53	rad
24164	24363	200	R4	96668	97467	DMP Elevation Pointing Offset Fraction Pixel Group 53	*

24364	24563	200	R4	97468	98267	DMP Elevation Pointing Offset Magnitude Pixel Group 54	rad
24564	24763	200	R4	98268	99067	DMP Elevation Pointing Offset Fraction Pixel Group 54	*
24764	24963	200	R4	99068	99867	DMP Elevation Pointing Offset Magnitude Pixel Group 55	rad
24964	25163	200	R4	99868	100667	DMP Elevation Pointing Offset Fraction Pixel Group 55	*
25164	25363	200	R4	100668	101467	DMP Elevation Pointing Offset Magnitude Pixel Group 56	rad
25364	25563	200	R4	101468	102267	DMP Elevation Pointing Offset Fraction Pixel Group 56	*
25564	25763	200	R4	102268	103067	DMP Elevation Pointing Offset Magnitude Pixel Group 57	rad
25764	25963	200	R4	103068	103867	DMP Elevation Pointing Offset Fraction Pixel Group 57	*
25964	26163	200	R4	103868	104667	DMP Elevation Pointing Offset Magnitude Pixel Group 58	rad
26164	26363	200	R4	104668	105467	DMP Elevation Pointing Offset Fraction Pixel Group 58	*
26364	26563	200	R4	105468	106267	DMP Elevation Pointing Offset Magnitude Pixel Group 59	rad
26564	26763	200	R4	106268	107067	DMP Elevation Pointing Offset Fraction Pixel Group 59	*
26764	26963	200	R4	107068	107867	DMP Elevation Pointing Offset Magnitude Pixel Group 60	rad
26964	27163	200	R4	107868	108667	DMP Elevation Pointing Offset Fraction Pixel Group 60	*
27164	27363	200	R4	108668	109467	DMP Elevation Pointing Offset Magnitude Pixel Group 61	rad
27364	27563	200	R4	109468	110267	DMP Elevation Pointing Offset Fraction Pixel Group 61	*
27564	27763	200	R4	110268	111067	DMP Elevation Pointing Offset Magnitude Pixel Group 62	rad
27764	27963	200	R4	111068	111867	DMP Elevation Pointing Offset Fraction Pixel Group 62	*
27964	28163	200	R4	111868	112667	DMP Elevation Pointing Offset Magnitude Pixel Group 63	rad
28164	28363	200	R4	112668	113467	DMP Elevation Pointing Offset Fraction Pixel Group 63	*
28364	28563	200	R4	113468	114267	DMP Elevation Pointing Offset Magnitude Pixel Group 64	rad
28564	28763	200	R4	114268	115067	DMP Elevation Pointing Offset Fraction Pixel Group 64	*
28764	28963	200	R4	115068	115867	DMP Elevation Pointing Offset Magnitude Pixel Group 65	rad
28964	29163	200	R4	115868	116667	DMP Elevation Pointing Offset Fraction Pixel Group 65	*
29164	29363	200	R4	116668	117467	DMP Elevation Pointing Offset Magnitude Pixel Group 66	rad
29364	29563	200	R4	117468	118267	DMP Elevation Pointing Offset Fraction Pixel Group 66	*
29564	29763	200	R4	118268	119067	DMP Elevation Pointing Offset Magnitude Pixel Group 67	rad
29764	29963	200	R4	119068	119867	DMP Elevation Pointing Offset Fraction Pixel Group 67	*
29964	30163	200	R4	119868	120667	DMP Elevation Pointing Offset Magnitude Pixel Group 68	rad
30164	30363	200	R4	120668	121467	DMP Elevation Pointing Offset Fraction Pixel Group 68	*

30364	30563	200	R4	121468	122267	DMP Elevation Pointing Offset Magnitude Pixel Group 69	rad
30564	30763	200	R4	122268	123067	DMP Elevation Pointing Offset Fraction Pixel Group 69	*
30764	30963	200	R4	123068	123867	DMP Elevation Pointing Offset Magnitude Pixel Group 70	rad
30964	31163	200	R4	123868	124667	DMP Elevation Pointing Offset Fraction Pixel Group 70	*
31163	31363	200	R4	124668	125467	DMP Elevation Pointing Offset Magnitude Pixel Group 71	rad
31364	31563	200	R4	125468	126267	DMP Elevation Pointing Offset Fraction Pixel Group 71	*
31564	31763	200	R4	126268	127067	DMP Elevation Pointing Offset Magnitude Pixel Group 72	rad
31764	31963	200	R4	127068	127867	DMP Elevation Pointing Offset Fraction Pixel Group 72	*
31964	32163	200	R4	127868	128667	DMP Elevation Pointing Offset Magnitude Pixel Group 73	rad
32164	32363	200	R4	128668	129467	DMP Elevation Pointing Offset Fraction Pixel Group 73	*
32364	32563	200	R4	129468	130267	DMP Elevation Pointing Offset Magnitude Pixel Group 74	rad
32564	32763	200	R4	130268	131067	DMP Elevation Pointing Offset Fraction Pixel Group 74	*
32764	32963	200	R4	131068	131867	DMP Elevation Pointing Offset Magnitude Pixel Group 75	rad
32964	33163	200	R4	131868	132667	DMP Elevation Pointing Offset Fraction Pixel Group 75	*
33164	33363	200	R4	132668	133467	DMP Elevation Pointing Offset Magnitude Pixel Group 76	rad
33364	33563	200	R4	133468	134267	DMP Elevation Pointing Offset Fraction Pixel Group 76	*
33564	33763	200	R4	134268	135067	DMP Elevation Pointing Offset Magnitude Pixel Group 77	rad
33764	33963	200	R4	135068	135867	DMP Elevation Pointing Offset Fraction Pixel Group 77	*
33964	34163	200	R4	135868	136667	DMP Elevation Pointing Offset Magnitude Pixel Group 78	rad
34164	34363	200	R4	136668	137467	DMP Elevation Pointing Offset Fraction Pixel Group 78	*
34364	34563	200	R4	137468	138267	DMP Elevation Pointing Offset Magnitude Pixel Group 79	rad
34564	34763	200	R4	138268	139067	DMP Elevation Pointing Offset Fraction Pixel Group 79	*
34764	34963	200	R4	139068	139867	DMP Elevation Pointing Offset Magnitude Pixel Group 80	rad
34964	35163	200	R4	139868	140667	DMP Elevation Pointing Offset Fraction Pixel Group 80	*
35164	35363	200	R4	140668	141467	DMP Elevation Pointing Offset Magnitude Pixel Group 81	rad
35364	35563	200	R4	141468	142267	DMP Elevation Pointing Offset Fraction Pixel Group 81	*
35564	35763	200	R4	142268	143067	DMP Elevation Pointing Offset Magnitude Pixel Group 82	rad
35764	35963	200	R4	143068	143867	DMP Elevation Pointing Offset Fraction Pixel Group 82	*
35964	36163	200	R4	143868	144667	DMP Elevation Pointing Offset Magnitude Pixel Group 83	rad
36164	36363	200	R4	144668	145467	DMP Elevation Pointing Offset Fraction Pixel Group 83	*

36364	36563	200	R4	145468	146267	DMP Elevation Pointing Offset Magnitude Pixel Group 84	rad
36564	36763	200	R4	146268	147067	DMP Elevation Pointing Offset Fraction Pixel Group 84	*
36764	36963	200	R4	147068	147867	DMP Elevation Pointing Offset Magnitude Pixel Group 85	rad
36964	37163	200	R4	147868	148667	DMP Elevation Pointing Offset Fraction Pixel Group 85	*
37164	37363	200	R4	148668	149467	DMP Elevation Pointing Offset Magnitude Pixel Group 86	rad
37364	37563	200	R4	149468	150267	DMP Elevation Pointing Offset Fraction Pixel Group 86	*
37564	37763	200	R4	150268	151067	TRANSMISSION Pixel Group 0	*
37764	37963	200	R4	151068	151867	TRANSMISSION Uncertainty Pixel Group 0	*
37964	38163	200	I4	151868	152667	TRANSQA Pixel Group 0	*
38164	38363	200	R4	152668	153467	TRANSMISSION Pixel Group 1	*
38364	38563	200	R4	153468	154267	TRANSMISSION Uncertainty Pixel Group 1	*
38564	38763	200	I4	154268	155067	TRANSQA Pixel Group 1	*
38764	38963	200	R4	155068	155867	TRANSMISSION Pixel Group 2	*
38964	39163	200	R4	155868	156667	TRANSMISSION Uncertainty Pixel Group 2	*
39164	39363	200	I4	156668	157467	TRANSQA Pixel Group 2	*
39364	39563	200	R4	157468	158267	TRANSMISSION Pixel Group 3	*
39564	39763	200	R4	158268	159067	TRANSMISSION Uncertainty Pixel Group 3	*
39764	39963	200	I4	159068	159867	TRANSQA Pixel Group 3	*
39964	40163	200	R4	159868	160667	TRANSMISSION Pixel Group 4	*
40164	40363	200	R4	160668	161467	TRANSMISSION Uncertainty Pixel Group 4	*
40364	40563	200	I4	161468	162267	TRANSQA Pixel Group 4	*
40564	40763	200	R4	162268	163067	TRANSMISSION Pixel Group 5	*
40764	40963	200	R4	163068	163867	TRANSMISSION Uncertainty Pixel Group 5	*
40964	41163	200	I4	163868	164667	TRANSQA Pixel Group 5	*
41164	41363	200	R4	164668	165467	TRANSMISSION Pixel Group 6	*
41364	41563	200	R4	165468	166267	TRANSMISSION Uncertainty Pixel Group 6	*
41564	41763	200	I4	166268	167067	TRANSQA Pixel Group 6	*
41764	41963	200	R4	167068	167867	TRANSMISSION Pixel Group 7	*
41964	42163	200	R4	167868	168667	TRANSMISSION Uncertainty Pixel Group 7	*
42164	42363	200	I4	168668	169467	TRANSQA Pixel Group 7	*

42364	42563	200	R4	169468	170267	TRANSMISSION Pixel Group 8	*
42564	42763	200	R4	170268	171067	TRANSMISSION Uncertainty Pixel Group 8	*
42764	42963	200	I4	171068	171867	TRANSQA Pixel Group 8	*
42964	43163	200	R4	171868	172667	TRANSMISSION Pixel Group 9	*
43164	43363	200	R4	172668	173467	TRANSMISSION Uncertainty Pixel Group 9	*
43364	43563	200	I4	173468	174267	TRANSQA Pixel Group 9	*
43564	43763	200	R4	174268	175067	TRANSMISSION Pixel Group 10	*
43764	43963	200	R4	175068	175867	TRANSMISSION Uncertainty Pixel Group 10	*
43964	44163	200	I4	175868	176667	TRANSQA Pixel Group 10	*
44164	44363	200	R4	176668	177467	TRANSMISSION Pixel Group 11	*
44364	44563	200	R4	177468	178267	TRANSMISSION Uncertainty Pixel Group 11	*
44564	44763	200	I4	178268	179067	TRANSQA Pixel Group 11	*
44764	44963	200	R4	179068	179867	TRANSMISSION Pixel Group 12	*
44964	45163	200	R4	179868	180667	TRANSMISSION Uncertainty Pixel Group 12	*
45164	45363	200	I4	180668	181467	TRANSQA Pixel Group 12	*
45364	45563	200	R4	181468	182267	TRANSMISSION Pixel Group 13	*
45564	45763	200	R4	182268	183067	TRANSMISSION Uncertainty Pixel Group 13	*
45764	45963	200	I4	183068	183867	TRANSQA Pixel Group 13	*
45964	46163	200	R4	183868	184667	TRANSMISSION Pixel Group 14	*
46164	46363	200	R4	184668	185467	TRANSMISSION Uncertainty Pixel Group 14	*
46364	46563	200	I4	185468	186267	TRANSQA Pixel Group 14	*
46564	46763	200	R4	186268	187067	TRANSMISSION Pixel Group 15	*
46764	46963	200	R4	187068	187867	TRANSMISSION Uncertainty Pixel Group 15	*
46964	47163	200	I4	187868	188667	TRANSQA Pixel Group 15	*
47164	47363	200	R4	188668	189467	TRANSMISSION Pixel Group 16	*
47364	47563	200	R4	189468	190267	TRANSMISSION Uncertainty Pixel Group 16	*
47564	47763	200	I4	190268	191067	TRANSQA Pixel Group 16	*
47764	47963	200	R4	191068	191867	TRANSMISSION Pixel Group 17	*
47964	48163	200	R4	191868	192667	TRANSMISSION Uncertainty Pixel Group 17	*
48164	48363	200	I4	192668	193467	TRANSQA Pixel Group 17	*

48364	48563	200	R4	193468	194267	TRANSMISSION Pixel Group 18	*
48564	48763	200	R4	194268	195067	TRANSMISSION Uncertainty Pixel Group 18	*
48764	48963	200	I4	195068	195867	TRANSQA Pixel Group 18	*
48964	49163	200	R4	195868	196667	TRANSMISSION Pixel Group 19	*
49164	49363	200	R4	196668	197467	TRANSMISSION Uncertainty Pixel Group 19	*
49364	49563	200	I4	197468	198267	TRANSQA Pixel Group 19	*
49564	49763	200	R4	198268	199067	TRANSMISSION Pixel Group 20	*
49764	49963	200	R4	199068	199867	TRANSMISSION Uncertainty Pixel Group 20	*
49964	50163	200	I4	199868	200667	TRANSQA Pixel Group 20	*
50164	50363	200	R4	200668	201467	TRANSMISSION Pixel Group 21	*
50364	50563	200	R4	201468	202267	TRANSMISSION Uncertainty Pixel Group 21	*
50564	50763	200	I4	202268	203067	TRANSQA Pixel Group 21	*
50764	50963	200	R4	203068	203867	TRANSMISSION Pixel Group 22	*
50964	51163	200	R4	203868	204667	TRANSMISSION Uncertainty Pixel Group 22	*
51164	51363	200	I4	204668	205467	TRANSQA Pixel Group 22	*
51364	51563	200	R4	205468	206267	TRANSMISSION Pixel Group 23	*
51564	51763	200	R4	206268	207067	TRANSMISSION Uncertainty Pixel Group 23	*
51764	51963	200	I4	207068	207867	TRANSQA Pixel Group 23	*
51964	52163	200	R4	207868	208667	TRANSMISSION Pixel Group 24	*
52164	52363	200	R4	208668	209467	TRANSMISSION Uncertainty Pixel Group 24	*
52364	52563	200	I4	209468	210267	TRANSQA Pixel Group 24	*
52564	52763	200	R4	210268	211067	TRANSMISSION Pixel Group 25	*
52764	52963	200	R4	211068	211867	TRANSMISSION Uncertainty Pixel Group 25	*
52964	53163	200	I4	211868	212667	TRANSQA Pixel Group 25	*
53164	53363	200	R4	212668	213467	TRANSMISSION Pixel Group 26	*
53364	53563	200	R4	213468	214267	TRANSMISSION Uncertainty Pixel Group 26	*
53564	53763	200	I4	214268	215067	TRANSQA Pixel Group 26	*
53764	53963	200	R4	215068	215867	TRANSMISSION Pixel Group 27	*
53964	54163	200	R4	215868	216667	TRANSMISSION Uncertainty Pixel Group 27	*
54164	54363	200	I4	216668	217467	TRANSQA Pixel Group 27	*

54364	54563	200	R4	217468	218267	TRANSMISSION Pixel Group 28	*
54564	54763	200	R4	218268	219067	TRANSMISSION Uncertainty Pixel Group 28	*
54764	54963	200	I4	219068	219867	TRANSQA Pixel Group 28	*
54964	55163	200	R4	219868	220667	TRANSMISSION Pixel Group 29	*
55164	55363	200	R4	220668	221467	TRANSMISSION Uncertainty Pixel Group 29	*
55364	55563	200	I4	221468	222267	TRANSQA Pixel Group 29	*
55564	55763	200	R4	222268	223067	TRANSMISSION Pixel Group 30	*
55764	55963	200	R4	223068	223867	TRANSMISSION Uncertainty Pixel Group 30	*
55964	56163	200	I4	223868	224667	TRANSQA Pixel Group 30	*
56164	56363	200	R4	224668	225467	TRANSMISSION Pixel Group 31	*
56364	56563	200	R4	225468	226267	TRANSMISSION Uncertainty Pixel Group 31	*
56564	56763	200	I4	226268	227067	TRANSQA Pixel Group 31	*
56764	56963	200	R4	227068	227867	TRANSMISSION Pixel Group 32	*
56964	57163	200	R4	227868	228667	TRANSMISSION Uncertainty Pixel Group 32	*
57164	57363	200	I4	228668	229467	TRANSQA Pixel Group 32	*
57364	57563	200	R4	229468	230267	TRANSMISSION Pixel Group 33	*
57564	57763	200	R4	230268	231067	TRANSMISSION Uncertainty Pixel Group 33	*
57764	57963	200	I4	231068	231867	TRANSQA Pixel Group 33	*
57964	58163	200	R4	231868	232667	TRANSMISSION Pixel Group 34	*
58164	58363	200	R4	232668	233467	TRANSMISSION Uncertainty Pixel Group 34	*
58364	58563	200	I4	233468	234267	TRANSQA Pixel Group 34	*
58564	58763	200	R4	234268	235067	TRANSMISSION Pixel Group 35	*
58764	58963	200	R4	235068	235867	TRANSMISSION Uncertainty Pixel Group 35	*
58964	59163	200	I4	235868	236667	TRANSQA Pixel Group 35	*
59164	59363	200	R4	236668	237467	TRANSMISSION Pixel Group 36	*
59364	59563	200	R4	237468	238267	TRANSMISSION Uncertainty Pixel Group 36	*
59564	59763	200	I4	238268	239067	TRANSQA Pixel Group 36	*
59764	59963	200	R4	239068	239867	TRANSMISSION Pixel Group 37	*
59974	60163	200	R4	239868	240667	TRANSMISSION Uncertainty Pixel Group 37	*
60164	60363	200	I4	240668	241467	TRANSQA Pixel Group 37	*

60364	60563	200	R4	241468	242267	TRANSMISSION Pixel Group 38	*
60564	60763	200	R4	242268	243067	TRANSMISSION Uncertainty Pixel Group 38	*
60764	60963	200	I4	243068	243867	TRANSQA Pixel Group 38	*
60964	61163	200	R4	243868	244667	TRANSMISSION Pixel Group 39	*
61164	61363	200	R4	244668	245467	TRANSMISSION Uncertainty Pixel Group 39	*
61364	61563	200	I4	245468	246267	TRANSQA Pixel Group 39	*
61564	61763	200	R4	246268	247067	TRANSMISSION Pixel Group 40	*
61764	61963	200	R4	247068	247867	TRANSMISSION Uncertainty Pixel Group 40	*
61964	62163	200	I4	247868	248667	TRANSQA Pixel Group 40	*
62164	62363	200	R4	248668	249467	TRANSMISSION Pixel Group 41	*
62364	62563	200	R4	249468	250267	TRANSMISSION Uncertainty Pixel Group 41	*
62564	62763	200	I4	250268	251067	TRANSQA Pixel Group 41	*
62764	62963	200	R4	251068	251867	TRANSMISSION Pixel Group 42	*
62964	63163	200	R4	251868	252667	TRANSMISSION Uncertainty Pixel Group 42	*
63164	63363	200	I4	252668	253467	TRANSQA Pixel Group 42	*
63364	63563	200	R4	253468	254267	TRANSMISSION Pixel Group 43	*
63564	63763	200	R4	254268	255067	TRANSMISSION Uncertainty Pixel Group 43	*
63764	63963	200	I4	255068	255867	TRANSQA Pixel Group 43	*
63964	64163	200	R4	255868	256667	TRANSMISSION Pixel Group 44	*
64164	64363	200	R4	256668	257467	TRANSMISSION Uncertainty Pixel Group 44	*
64364	64563	200	I4	257468	258267	TRANSQA Pixel Group 44	*
64564	64763	200	R4	258268	259067	TRANSMISSION Pixel Group 45	*
64764	64963	200	R4	259068	259867	TRANSMISSION Uncertainty Pixel Group 45	*
64964	65163	200	I4	259868	260667	TRANSQA Pixel Group 45	*
65164	65363	200	R4	260668	261467	TRANSMISSION Pixel Group 46	*
65364	65563	200	R4	261468	262267	TRANSMISSION Uncertainty Pixel Group 46	*
65564	65763	200	I4	262268	263067	TRANSQA Pixel Group 46	*
65764	65963	200	R4	263068	263867	TRANSMISSION Pixel Group 47	*
65964	66163	200	R4	263868	264667	TRANSMISSION Uncertainty Pixel Group 47	*
66164	66363	200	I4	264668	265467	TRANSQA Pixel Group 47	*

66364	66563	200	R4	265468	266267	TRANSMISSION Pixel Group 48	*
66564	66763	200	R4	266268	267067	TRANSMISSION Uncertainty Pixel Group 48	*
66764	66963	200	I4	267068	267867	TRANSQA Pixel Group 48	*
66964	67163	200	R4	267868	268667	TRANSMISSION Pixel Group 49	*
67164	67363	200	R4	268668	269467	TRANSMISSION Uncertainty Pixel Group 49	*
67364	67563	200	I4	269468	270267	TRANSQA Pixel Group 49	*
67564	67763	200	R4	270268	271067	TRANSMISSION Pixel Group 50	*
67764	67963	200	R4	271068	271867	TRANSMISSION Uncertainty Pixel Group 50	*
67964	68163	200	I4	271868	272667	TRANSQA Pixel Group 50	*
68164	68363	200	R4	272668	273467	TRANSMISSION Pixel Group 51	*
68364	68563	200	R4	273468	274267	TRANSMISSION Uncertainty Pixel Group 51	*
68564	68763	200	I4	274268	275067	TRANSQA Pixel Group 51	*
68754	68963	200	R4	275068	275867	TRANSMISSION Pixel Group 52	*
68964	69163	200	R4	275868	276667	TRANSMISSION Uncertainty Pixel Group 52	*
69164	69363	200	I4	276668	277467	TRANSQA Pixel Group 52	*
69364	69563	200	R4	277468	278267	TRANSMISSION Pixel Group 53	*
69564	69763	200	R4	278268	279067	TRANSMISSION Uncertainty Pixel Group 53	*
69764	69963	200	I4	279068	279867	TRANSQA Pixel Group 53	*
69964	70163	200	R4	279868	280667	TRANSMISSION Pixel Group 54	*
70164	70363	200	R4	280668	281467	TRANSMISSION Uncertainty Pixel Group 54	*
70363	70563	200	I4	281468	282267	TRANSQA Pixel Group 54	*
70564	70763	200	R4	282268	283067	TRANSMISSION Pixel Group 55	*
70764	70963	200	R4	283068	283867	TRANSMISSION Uncertainty Pixel Group 55	*
70964	71163	200	I4	283868	284667	TRANSQA Pixel Group 55	*
71164	71363	200	R4	284668	285467	TRANSMISSION Pixel Group 56	*
71364	71563	200	R4	285468	286267	TRANSMISSION Uncertainty Pixel Group 56	*
71564	71763	200	I4	286268	287067	TRANSQA Pixel Group 56	*
71764	71963	200	R4	287068	287867	TRANSMISSION Pixel Group 57	*
71964	72163	200	R4	287868	288667	TRANSMISSION Uncertainty Pixel Group 57	*
72164	72363	200	I4	288668	289467	TRANSQA Pixel Group 57	*

72364	72563	200	R4	289468	290267	TRANSMISSION Pixel Group 58	*
72564	72763	200	R4	290268	291067	TRANSMISSION Uncertainty Pixel Group 58	*
72764	72963	200	I4	291068	291867	TRANSQA Pixel Group 58	*
72964	73163	200	R4	291868	292667	TRANSMISSION Pixel Group 59	*
73164	73363	200	R4	292668	293467	TRANSMISSION Uncertainty Pixel Group 59	*
73364	73563	200	I4	293468	294267	TRANSQA Pixel Group 59	*
73564	73763	200	R4	294268	295067	TRANSMISSION Pixel Group 60	*
73764	73963	200	R4	295068	295867	TRANSMISSION Uncertainty Pixel Group 60	*
73964	74163	200	I4	295868	296667	TRANSQA Pixel Group 60	*
74164	74363	200	R4	296668	297467	TRANSMISSION Pixel Group 61	*
74364	74563	200	R4	297468	298267	TRANSMISSION Uncertainty Pixel Group 61	*
74564	74763	200	I4	298268	299067	TRANSQA Pixel Group 61	*
74764	74963	200	R4	299068	299867	TRANSMISSION Pixel Group 62	*
74964	75163	200	R4	299868	300667	TRANSMISSION Uncertainty Pixel Group 62	*
75164	75363	200	I4	300668	301467	TRANSQA Pixel Group 62	*
75364	75563	200	R4	301468	302267	TRANSMISSION Pixel Group 63	*
75564	75763	200	R4	302268	303067	TRANSMISSION Uncertainty Pixel Group 63	*
75764	75963	200	I4	303068	303867	TRANSQA Pixel Group 63	*
75964	76163	200	R4	303868	304667	TRANSMISSION Pixel Group 64	*
76164	76363	200	R4	304668	305467	TRANSMISSION Uncertainty Pixel Group 64	*
76364	76563	200	I4	305468	306267	TRANSQA Pixel Group 64	*
76564	76763	200	R4	306268	307067	TRANSMISSION Pixel Group 65	*
76764	76963	200	R4	307068	307867	TRANSMISSION Uncertainty Pixel Group 65	*
76964	77163	200	I4	307868	308667	TRANSQA Pixel Group 65	*
77164	77363	200	R4	308668	309467	TRANSMISSION Pixel Group 66	*
77364	77563	200	R4	309468	310267	TRANSMISSION Uncertainty Pixel Group 66	*
77564	77763	200	I4	310268	311067	TRANSQA Pixel Group 66	*
77764	77963	200	R4	311068	311867	TRANSMISSION Pixel Group 67	*
77964	78163	200	R4	311868	312667	TRANSMISSION Uncertainty Pixel Group 67	*
78164	78363	200	I4	312668	313467	TRANSQA Pixel Group 67	*

78364	78563	200	R4	313468	314267	TRANSMISSION Pixel Group 68	*
78564	78763	200	R4	314268	315067	TRANSMISSION Uncertainty Pixel Group 68	*
78764	78963	200	I4	315068	315867	TRANSQA Pixel Group 68	*
78964	79163	200	R4	315868	316667	TRANSMISSION Pixel Group 69	*
79164	79363	200	R4	316668	317467	TRANSMISSION Uncertainty Pixel Group 69	*
79364	79563	200	I4	317468	318267	TRANSQA Pixel Group 69	*
79564	79763	200	R4	318268	319067	TRANSMISSION Pixel Group 70	*
79764	79963	200	R4	319068	319867	TRANSMISSION Uncertainty Pixel Group 70	*
79964	80163	200	I4	319868	320667	TRANSQA Pixel Group 70	*
80164	80363	200	R4	320668	321467	TRANSMISSION Pixel Group 71	*
80364	80563	200	R4	321468	322267	TRANSMISSION Uncertainty Pixel Group 71	*
80564	80763	200	I4	322268	323067	TRANSQA Pixel Group 71	*
80764	80963	200	R4	323068	323867	TRANSMISSION Pixel Group 72	*
80964	81163	200	R4	323868	324667	TRANSMISSION Uncertainty Pixel Group 72	*
81164	81363	200	I4	324668	325467	TRANSQA Pixel Group 72	*
81364	81563	200	R4	325468	326267	TRANSMISSION Pixel Group 73	*
81564	81763	200	R4	326268	327067	TRANSMISSION Uncertainty Pixel Group 73	*
81764	81963	200	I4	327068	327867	TRANSQA Pixel Group 73	*
81964	82163	200	R4	327868	328667	TRANSMISSION Pixel Group 74	*
82164	82363	200	R4	328668	329467	TRANSMISSION Uncertainty Pixel Group 74	*
82364	82563	200	I4	329468	330267	TRANSQA Pixel Group 74	*
82564	82763	200	R4	330268	331067	TRANSMISSION Pixel Group 75	*
82764	82963	200	R4	331068	331867	TRANSMISSION Uncertainty Pixel Group 75	*
82964	83163	200	I4	331868	332667	TRANSQA Pixel Group 75	*
83164	83363	200	R4	332668	333467	TRANSMISSION Pixel Group 76	*
83364	83563	200	R4	333468	334267	TRANSMISSION Uncertainty Pixel Group 76	*
83564	83763	200	I4	334268	335067	TRANSQA Pixel Group 76	*
83764	83963	200	R4	335068	335867	TRANSMISSION Pixel Group 77	*
83964	84163	200	R4	335868	336667	TRANSMISSION Uncertainty Pixel Group 77	*
84163	84363	200	I4	336668	337467	TRANSQA Pixel Group 77	*

84364	84563	200	R4	337468	338267	TRANSMISSION Pixel Group 78	*
84564	84763	200	R4	338268	339067	TRANSMISSION Uncertainty Pixel Group 78	*
84764	84963	200	I4	339068	339867	TRANSQA Pixel Group 78	*
84964	85163	200	R4	339868	340667	TRANSMISSION Pixel Group 79	*
85164	85363	200	R4	340668	341467	TRANSMISSION Uncertainty Pixel Group 79	*
85364	85563	200	I4	341468	342267	TRANSQA Pixel Group 79	*
85564	85763	200	R4	342268	343067	TRANSMISSION Pixel Group 80	*
85764	85963	200	R4	343068	343867	TRANSMISSION Uncertainty Pixel Group 80	*
85964	86163	200	I4	343868	344667	TRANSQA Pixel Group 80	*
86164	86363	200	R4	344668	345467	TRANSMISSION Pixel Group 81	*
86364	86563	200	R4	345468	346267	TRANSMISSION Uncertainty Pixel Group 81	*
86564	86763	200	I4	346268	347067	TRANSQA Pixel Group 81	*
86764	86963	200	R4	347068	347867	TRANSMISSION Pixel Group 82	*
86964	87163	200	R4	347868	348667	TRANSMISSION Uncertainty Pixel Group 82	*
87164	87363	200	I4	348668	349467	TRANSQA Pixel Group 82	*
87364	87563	200	R4	349468	350267	TRANSMISSION Pixel Group 83	*
87564	87763	200	R4	350268	351067	TRANSMISSION Uncertainty Pixel Group 83	*
87764	87963	200	I4	351068	351867	TRANSQA Pixel Group 83	*
87964	88163	200	R4	351868	352667	TRANSMISSION Pixel Group 84	*
88164	88363	200	R4	352668	353467	TRANSMISSION Uncertainty Pixel Group 84	*
88364	88563	200	I4	353468	354267	TRANSQA Pixel Group 84	*
88564	88763	200	R4	354268	355067	TRANSMISSION Pixel Group 85	*
88764	88963	200	R4	355068	355867	TRANSMISSION Uncertainty Pixel Group 85	*
88964	89163	200	I4	355868	356667	TRANSQA Pixel Group 85	*
89164	89363	200	R4	356668	357467	TRANSMISSION Pixel Group 86	*
89364	89563	200	R4	357468	358267	TRANSMISSION Uncertainty Pixel Group 86	*
89564	89763	200	I4	358268	359067	TRANSQA Pixel Group 86	*

Appendix C. SAGE III/ISS Level 2 Solar Species Products

Table C1. Binary File Format Sheet: SAGE III/ISS Level 2 Solar Species Product

Field Start	Field End	Num Values	F90 Type	Start Byte	End Byte	Description	Units
0	0	1	C12	0	11	EVENT_ID	*
1	1	1	I4	12	15	OLD_EVENT_ID	*
2	2	1	I4	16	19	DATE	*
3	3	1	R8	20	27	YEAR_FRACTION	*
4	4	1	R4	28	31	LATITUDE	degrees
5	5	1	R4	32	35	LONGITUDE	degrees
6	6	1	I4	36	39	TIME (HHMMSS)	UTC
7	7	1	I4	40	43	INT_FILL_VALUE	*
8	8	1	R4	44	47	FLT_FILL_VALUE	*
9	9	1	I4	48	51	MISSION_ID	*
10	10	1	R4	52	55	L0DO_VERSION	*
11	11	1	I4	56	59	CCDTABLE_VERSION	*
12	12	1	R4	60	63	L0_VERSION	*
13	13	1	R4	64	67	SOFTWARE_VERSION	*
14	14	1	R4	68	71	DATAPRODUCT_VERSION	*
15	15	1	R4	72	75	SPECTROSCOPIC_DATABASE_VERSION	*
16	16	1	R4	76	79	GRAM95_VERSION	*
17	17	1	R4	80	83	MET_VERSION	*
18	18	1	R4	84	87	BIN_HEIGHT	km
19	19	1	I4	88	91	NUM_BINS	*
20	20	1	I4	92	95	NUM_MET_GRID	*
21	21	1	I4	96	99	NUM_AER_CHANNELS	*
22	22	1	I4	100	103	NUM_GRND_TRK	*
23	23	1	I4	104	107	NUM_AER_BINS	*
24	24	1	I4	108	111	SC_EVT_TYPE *(Sunrise = 1; Sunset = 2)*	*
25	25	1	I4	112	115	GND_EVT_TYPE *(Sunrise = 1; Sunset = 2)*	*

26	26	1	R4	116	119	BETAANGLE_SOLAR		degrees
27	27	1	I4	120	123	AURORA_FLAG *(N/A)*		*
28	28	1	I4	124	127	EPHEMERIS_SOURCE *(GPS = 5)*		*
29	39	11	I4	128	171	GT_DATE	*Ground track-indexed data for 11 tangent altitudes from 0km to 100km at 10km intervals*	*
40	50	11	I4	172	215	GT_TIME		*
51	61	11	R4	216	259	GT_LATITUDE		degrees
62	72	11	R4	260	303	GT_LONGITUDE		degrees
73	83	11	R4	304	347	GT_RAY_DIR		degrees
84	94	11	R4	348	391	SPACE_CRAFT_LAT		degrees
95	105	11	R4	392	435	SPACE_CRAFT_LON		degrees
106	116	11	R4	436	479	SPACE_CRAFT_ALT		degrees
117	316	200	I4	480	1279	HOMOGENEITY		*
317	516	200	R4	1280	2079	ALTITUDE		km
517	716	200	R4	2080	2879	GEOPOTENTIAL_ALT		km
717	916	200	R4	2880	3679	TEMPERATURE		K
917	1116	200	R4	3680	4479	TEMPERATURE_UNCERT		K
1117	1316	200	R4	4480	5279	PRESSURE		hPa
1317	1516	200	R4	5280	6079	PRESSURE_UNCERT		hPa
1517	1716	200	R4	6080	6879	NEUTRAL_DENSITY		cm^{-3}
1717	1916	200	R4	6880	7679	NEUTRAL_DENSITY_UNCERT		cm^{-3}
1917	2116	200	I4	7680	8479	TEMP_PRESSURE_SOURCE *(GRAM95 = 0; MERRA-2 = 2)*		*
2117	2117	1	R4	8480	8483	TROP_TEMP		K
2118	2118	1	R4	8484	8487	TROP_ALT		km
2119	2119	1	R4	8488	8491	TROP_PRESS		hPa
2120	2191	72	R4	8492	8779	MET_PRESSURE	Pressure surface-indexed data	hPa
2192	2263	72	R4	8780	9067	MET_TEMP		K
2264	2335	72	R4	9068	9355	MET_TEMP_UNC		K
2336	2407	72	R4	9356	9643	MET_ALTITUDE		km
2408	2408	1	I4	9644	9647	MET_SOURCE *(GRAM95 = 0; MERRA-2 = 2)*		*
2409	2409	1	R4	9648	9651	CCD_TEMPERATURE		°C

2410	2410	1	R4	9652	9655	SPECTROMETER_ZENITH_TEMPERATURE		°C
2411	2411	1	R4	9656	9659	CCD_TEMPERATURE_MINUS_TEC		°C
2412	2412	1	I4	9660	9663	EPHEMERIS_QUALITY (0 - Missing 1 - Nominal 2 - Expanded Interpolation Time Window 3 - Time Gap/Bad Data)		*
2413	2413	1	R4	9664	9667	SPECCALSHIFT		nm
2414	2414	1	R4	9668	9671	SPECCALSTRETCH		nm/pixel
2415	2416	2	R4	9672	9679	AZIMUTHANGLE		degrees
2417	2417	1	I4	9680	9683	QAFLAG		*
2418	2617	200	I4	9684	10483	QAFLAG_ALTITUDE		*
2618	2817	200	R4	10484	11283	OZONE_COMPOSITE		cm^{-3}
2818	3017	200	R4	11284	12083	OZONE_COMPOSITE_UNCERT		cm^{-3}
3018	3217	200	I4	12084	12883	OZONE_COMPOSITE_QA		*
3218	3417	200	R4	12884	13683	OZONE_MES		cm^{-3}
3418	3617	200	R4	13684	14483	OZONE_MES_UNCERT		cm^{-3}
3618	3817	200	I4	14484	15283	OZONE_MES_QA		*
3818	4017	200	R4	15284	16083	OZONE_MLR		cm^{-3}
4018	4217	200	R4	16084	16883	OZONE_MLR_UNCERT		cm^{-3}
4218	4417	200	I4	16884	17683	OZONE_MLR_QA		*
4418	4617	200	R4	17684	18483	OZONE_AO3		cm^{-3}
4618	4817	200	R4	18484	19283	OZONE_AO3_UNCERT		cm^{-3}
4818	5017	200	I4	19284	20083	OZONE_AO3_QA		*
5018	5217	200	R4	20084	20883	H2O		cm^{-3}
5218	5417	200	R4	20884	21683	H2O_UNCERT		cm^{-3}
5418	5617	200	I4	21684	22483	H2O_QA		*
5618	5817	200	R4	22484	23283	NO2		cm^{-3}
5818	6017	200	R4	23284	24083	NO2_UNCERT		cm^{-3}
6018	6217	200	I4	24084	24883	NO2_QA		*
6218	6417	200	R4	24884	25683	RETTEMP	*Retrieved meteorological profiles (currently disabled)*	K
6418	6617	200	R4	25684	26483	RETTEMP_UNCERT		K
6618	6817	200	R4	26484	27283	RETPRESS		hPa

6818	7017	200	R4	27284	28083	RETPRESS_UNCERT		hPa
7018	7217	200	I4	28084	28883	RETTP_QA		*
7218	7226	9	R4	28884	28919	AER_WAVELENGTH		nm
7227	7235	9	R4	28920	28955	AER_WIDTH (Aerosol channel half-width)		nm
7236	7244	9	R4	28956	28991	MOLECULAR_SCT		cm^3/km
7245	7253	9	R4	28992	29027	MOLECULAR_SCT_UNCERT		cm^3/km
7254	7262	9	R4	29028	29063	STRAT_AER_OD		*
7263	7271	9	R4	29064	29099	STRAT_AER_OD_UNCERT		*
7272	7280	9	I4	29100	29135	STRAT_AER_OD_QA (32 = STRAT_AER_OD is Fill)		*
7281	7370	90	R4	29136	29495	AEREXT Channel 1		km^{-1}
7371	7460	90	R4	29496	29855	AEREXT_UNCERT Channel 1		km^{-1}
7461	7550	90	I4	29856	30215	AERQA Channel 1		*
7551	7640	90	R4	30216	30575	AEREXT Channel 2		km^{-1}
7641	7730	90	R4	30576	30935	AEREXT_UNCERT Channel 2		km^{-1}
7731	7820	90	I4	30936	31295	AERQA Channel 2		*
7821	7910	90	R4	31296	31655	AEREXT Channel 3		km^{-1}
7911	8000	90	R4	31656	32015	AEREXT_UNCERT Channel 3		km^{-1}
8001	8090	90	I4	32016	32375	AERQA Channel 3		*
8091	8180	90	R4	32376	32735	AEREXT Channel 4		km^{-1}
8181	8270	90	R4	32736	33095	AEREXT_UNCERT Channel 4		km^{-1}
8271	8360	90	I4	33096	33455	AERQA Channel 4		*
8361	8450	90	R4	33456	33815	AEREXT Channel 5		km^{-1}
8451	8540	90	R4	33816	34175	AEREXT_UNCERT Channel 5		km^{-1}
8541	8630	90	I4	34176	34535	AERQA Channel 5		*
8631	8720	90	R4	34536	34895	AEREXT Channel 6		km^{-1}
8721	8810	90	R4	34896	35255	AEREXT_UNCERT Channel 6		km^{-1}
8811	8900	90	I4	35256	35615	AERQA Channel 6		*
8901	8990	90	R4	35616	35975	AEREXT Channel 7		km^{-1}
8991	9080	90	R4	35976	36335	AEREXT_UNCERT Channel 7		km^{-1}
9081	9170	90	I4	36336	36695	AERQA Channel 7		*

9171	9260	90	R4	36696	37055	AEREXT Channel 8	km^{-1}
9261	9350	90	R4	37056	37415	AEREXT_UNCERT Channel 8	km^{-1}
9351	9440	90	I4	37416	37775	AERQA Channel 8	*
9441	9530	90	R4	37776	38135	AEREXT Channel 9	km^{-1}
9531	9620	90	R4	38136	38495	AEREXT_UNCERT Channel 9	km^{-1}
9621	9710	90	I4	38496	38855	AERQA Channel 9	*

Appendix D. SAGE III/ISS Level 2 Lunar Species Products

Table D1. Binary File Format Sheet: SAGE III/ISS Level 2 Lunar Species Product

Field Start	Field End	Num Values	F90 Type	Start Byte	End Byte	Description	Units
0	0	1	C12	0	11	EVENT_ID	*
1	1	1	I4	12	15	OLD_EVENT_ID	*
2	2	1	I4	16	19	DATE	*
3	3	1	R8	20	27	YEAR_FRACTION	*
4	4	1	R4	28	31	LATITUDE	degrees
5	5	1	R4	32	35	LONGITUDE	degrees
6	6	1	I4	36	39	TIME (HHMMSS)	UTC
7	7	1	I4	40	43	INT_FILL_VALUE	*
8	8	1	R4	44	47	FLT_FILL_VALUE	*
9	9	1	I4	48	51	MISSION_ID	*
10	10	1	R4	52	55	L0DO_VERSION	*
11	11	1	I4	56	59	CCDTABLE_VERSION	*
12	12	1	R4	60	63	L0_VERSION	*
13	13	1	R4	64	67	SOFTWARE_VERSION	*
14	14	1	R4	68	71	DATAPRODUCT_VERSION	*
15	15	1	R4	72	75	SPECTROSCOPIC_DATABASE_VERSION	*
16	16	1	R4	76	79	GRAM95_VERSION	*
17	17	1	R4	80	83	MET_VERSION	*
18	18	1	R4	84	87	LUN_MODEL_VER	*
19	19	1	R4	88	91	LUN_ALBEDO_VER	*
20	20	1	R4	92	95	BIN_HEIGHT	km
21	21	1	I4	96	99	NUM_ALT_BINS	*
22	22	1	I4	100	103	NUM_PRESS_GRID	*
23	23	1	I4	104	107	NUM_GRND_TRK	*
24	24	1	I4	108	111	SC_EVT_TYPE *(Moonrise = 3; Moonset = 4)*	*
25	25	1	I4	112	115	GND_EVT_TYPE *(Moonrise = 3; Moonset = 4)*	*

26	26	1	R4	116	119	BETAANGLE_LUNAR		degrees
27	27	1	R4	120	123	LUNARPHASE		*
28	28	1	R4	124	127	ZENITHANGLE		degrees
29	29	1	I4	128	131	AURORA_FLAG *(N/A)*		*
30	30	1	I4	132	135	EPHEMERIS_SOURCE *(GPS = 5)*		*
31	41	11	I4	136	179	GT_DATE	*Ground track-indexed data for 11 tangent altitudes from 0km to 100km at 10km intervals*	*
42	52	11	I4	180	223	GT_TIME		*
53	63	11	R4	224	267	GT_LATITUDE		degrees
64	74	11	R4	268	311	GT_LONGITUDE		degrees
75	85	11	R4	312	355	GT_RAY_DIR		degrees
86	96	11	R4	356	399	SPACE_CRAFT_LAT		degrees
97	107	11	R4	400	443	SPACE_CRAFT_LON		degrees
108	118	11	R4	444	487	SPACE_CRAFT_ALT		km
119	318	200	R4	488	1287	ALTITUDE		km
319	518	200	R4	1288	2087	GEOPOTENTIAL_ALT		km
519	718	200	R4	2088	2887	TEMPERATURE		K
719	918	200	R4	2888	3687	TEMPERATURE_UNCERT		K
919	1118	200	R4	3688	4487	PRESSURE		hPa
1119	1318	200	R4	4488	5287	PRESSURE_UNCERT		hPa
1319	1518	200	R4	5288	6087	NEUTRAL_DENSITY		cm^{-3}
1519	1718	200	R4	6088	6887	NEUTRAL_DENSITY_UNCERT		cm^{-3}
1719	1918	200	I4	6888	7687	TEMP_PRESSURE_SOURCE *(GRAM95 = 0; MERRA-2 = 2)*		*
1919	1919	1	R4	7688	7691	TROP_TEMP		K
1920	1920	1	R4	7692	7695	TROP_ALT		km
1921	1921	1	R4	7696	7699	TROP_PRESS		hPa
1922	1993	72	R4	7700	7987	MET_PRESSURE	Pressure surface-indexed data	hPa
1994	2065	72	R4	7988	8275	MET_TEMP		K
2066	2137	72	R4	8276	8563	MET_TEMP_UNC		K
2138	2209	72	R4	8564	8851	MET_ALTITUDE		km
2210	2210	1	I4	8852	8855	MET_SOURCE *(GRAM95 = 0; MERRA-2 = 2)*		*

2211	2211	1	R4	8856	8859	CCD_TEMPERATURE	°C
2212	2212	1	R4	8860	8863	SPECTROMETER_ZENITH_TEMPERATURE	°C
2213	2213	1	R4	8864	8867	CCD_TEMPERATURE_MINUS_TEC	°C
2214	2214	1	I4	8868	8871	EPHEMERIS_QUALITY (0 - Missing 1 - Nominal 2 - Expanded Interpolation Time Window 3 - Time Gap/Bad Data)	*
2215	2215	1	R4	8872	8875	SPECCALSHIFT	nm
2216	2216	1	R4	8876	8879	SPECCALSTRETCH	nm/pixel
2217	2218	2	R4	8880	8887	AZIMUTHANGLE	degrees
2219	2219	1	I4	8888	8891	QAFLAG	*
2220	2419	200	I4	8892	9691	QAFLAG_ALTITUDE	*
2420	2619	200	I4	9692	10491	ABANDALTREGQA (N/A)	*
2620	2620	1	R4	10492	10495	ABANDALTREGOFFSET	km
2621	2820	200	R4	10496	11295	OZONE	cm^{-3}
2821	3020	200	R4	11296	12095	OZONE_UNCERT	cm^{-3}
3021	3220	200	I4	12096	12895	OZONEQA	*
3221	3420	200	R4	12896	13695	NO2	cm^{-3}
3421	3620	200	R4	13696	14495	NO2_UNCERT	cm^{-3}
3621	3820	200	I4	14496	15295	NO2QA	*
3821	4020	200	R4	15296	16095	NO3	cm^{-3}
4021	4220	200	R4	16096	16895	NO3_UNCERT	cm^{-3}
4221	4420	200	I4	16896	17695	NO3QA	*
4421	4620	200	R4	17696	18495	OCLO	cm^{-3}
4621	4820	200	R4	18496	19295	OCLO_UNCERT	cm^{-3}
4821	5020	200	I4	19296	20095	OCLOQA	*

Appendix E. Reference Absorption Cross Sections for Gas Retrievals

Table E1. Absorption Spectrum Data Source by Species

Gas Species	Source
Ozone	SCIAMACHY O_3 Version 3.0, Dec. 2004 (Bogumil, Orphal and Homann)
Nitrogen Dioxide	SCIAMACHY NO_2 Version 1.0, Aug. 2000 (Bogumil, Orphal and Homann)
Nitrogen Trioxide	Yokelson 1994 (Yokelson, Burkholder and Fox)
Water Vapor	HITRAN 2004 (Rothman, Jacquemart and Barbe)
Chlorine Dioxide	SCIAMACHY OClO Version 1.0, Aug. 2000 (Bogumil, Orphal and Homann)
Dioxygen	HITRAN 2004 (Rothman, Jacquemart and Barbe)
Tetraoxygen	Greenblatt 1990 (Greenblatt, Orlando and Burkholder)
Rayleigh-Scattering	Bucholtz 1995 (Bucholtz)