Earth Observing System (EOS)

Tropospheric Emission Spectrometer (TES)

Science Data Processing

Standard and Special Observation

Data Products Specifications

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Version 13.0 (Science Software Release 13.0)
ESDT Version 6

D-22993

June 19, 2013

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Appendix B -- Work-Off Plan Table 2

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DOCUMENT LOG

Version	Description	Date
9.1	CR 3866 – Modify Nadir_Primary_Data – AirDensity units Modify Limb_Primary_Data – AirDensity units	5/24/2006
10.0	Add to L2 Nadir Associated Data H2O_HDO_Corr_QA	
10.0	Add to L2 Limb Associated Data H2O_HDO_Corr_QA, Modify in Limb Associated Data: dimensions on RadianceResidualMean, RadianceResidualRMS	
10.0	Add to L2 Ancillary Nadir and Limb data fields HDO_H2OratioMeasurementErrorCovariance HDO_H2OratioSystematicErrorCovariance HDO_H2OratioTotalErrorCovariance HDO_H2OaveragingKernel H2O_HDOAveragingKernel	
10.0	L2 Summary extensively revised (initial s/w release in R10)	
10.1	CR 3863 – Add to Nadir_Associated_Data – SurfaceEmissionLayerQA	5/24/2006
10.2	CR 3914 – Add dim info to SurfaceTypeFootprint and TropopausePressure	6/29/06
10.3	Minor cleanup on Summary Products Table 5-10 remove nLevels (no attributes with this dim) Table 5-10 add dim nPixels Table 5-11 PixelsUsedFlag dimensioned by nPixels Table 5-13 add dimension nLength for UTC	7/18/2006
10.4	Move UTCTime from Geolocation to Nadir Associated, Limb Associated and Ancillary; data type to string	7/24/2006
10.5	Name Special Observation Summary ESDT	8/4/2006
10.6	Add ESDT Version (Version 3) and product file designators L1B – F03_02 L2 – F04_04 L2 Summary – F01_04	8/29/06
10.7	CR3974 Update text description of CloudTo PressureError	9/7/06
10.7	CR3977 Modify attribute name for consistency SurfaceEmissionLayerQA to SurfaceEmissionLayer_QA Add to Nadir Associated Data fields of Summary Product	9/7/06
10.7	CR3979 Review and correct attributes indicating fill in R10	9/18/06
10.8	Attempt to clarify naming convention for species TATM. The filename disagrees with species name in the swath and in the data portion. This species was documented AtmT in this document; change this to TATM to match HDF file contents and swath name. Note however that the file name will remain inconsistent.	9/27/06
10.9	Modify units in L2 Product, VerticalResolution from km to meters Occurs in nadir and limb primary data fields	10/27/06
10.10	Remove references to limb CO, CH4, NO2; these products are not produced in this release	1/8/07
10.11	Increment L1B product file designator (science content designator) From F03_02	2/21/07

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Version	Description	Date
	To F03_03	
11.0	Remove "This field will be fill for R10" from the following: CloudTopPressure CloudTopPressureError AverageCloudEffOpticalDepth AverageCloudEffOpticalDepthError (Summary Product only) CloudVariability_QA Calibration_QA HDO_H2OratioSystematicErrorCovariance	12/27/06
11.0	CR4006 – Remove the following data fields H2O_TaveragingKernel T_H2OaveragingKernel T_H2Ocovariance	12/27/06
11.0	CR4045 – add non-retrieved species as separate Supplemental product file	1/2/07
11.0	CR3995 – Add to L2 Standard product AverageCloudEffOpticalDepthError	1/26/07
11.1	Add L3 Grid information	3/12/07
10.13	Correct L3 file naming convention, change hyphen preceding run id to underscore From TES-Aura_L3-<species>-<run id>_<version id>.he5 To TES-Aura_L3-<species>_<run id>_<version id>.he5	4/26/07
11.3	CR 4117 – Add H2O18 to L2 and L3 products ($H2O^{18}$). Note that this impacts L2 Standard, L2 Summary, L3 grid and L3 Browse products.	5/16/07
11.3	Correct typos	6/15/07
11.4	CR 4145 – Add SurfaceTempInitialRefined to the L2 Ancillary product – Surface temper feeding into the atmospheric profile retrieval steps	7/16/07
11.5	CR4176 – Remove H2O18 from all products	10/4/07
11.6	CR 4183 – Add O3_Ccurve_QA to L2 Nadir standard products, and also the L2 Summary Nadir products	10/19/07
11.6	Correct description of Add O3_Ccurve_QA	1/3/08
11.7	CR 4233 – Modify VMR in L2 units to vmr (lower case) Modify GridSpan in L3 to (-180..+180, -82..+82) (was 0..360, -82..+82)	3/5/08
11.8	CR 4254 – DPS – change description of AverageCloudEffOpticalDepth & AverageCloudEffOpticalDepthErr to reflect that the value will be the same for all species are taken from the cloud values at the final retrieval step	6/5/08
12.0	CR4316 – Add TropopausePressure field to all standard products.	8/12/09
12.0	CR4317 – Add OzoneTroposphericColumn, OzoneTroposphericColumnError and OzoneTroposhericColumnInitial to the all standard products.	8/12/09
12.0	CR4318 – Add CO2 as a TES standard product	8/18/09
12.0	CR4320 – Add Ammonia (NH3) as a TES standard product	8/18/09

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Version	Description	Date
12.0	CR4326 – Update DPS for R12 product update	8/18/09
12.0	CR4326 – Update DPS for CO2 Lite product	1/14/10
11.9	CR4418 – Update DPS for L1B and L2 Products for calibration schema designator. Add field Calib_Scheme to TES Common Metadata for L1B and L2 Products sections. This is R11 change.	6/22/10
12.0	Update format and content version numbers	8/5/10
12.0	CR4437 - Changed L2 Ancillary Nadir and Limb data fields from HDO_H2ORatioMeasurementErrorCovariance HDO_H2OratioSystematicErrorCovariance HDO_H2ORatioTotalErrorCovariance To HDO_H2OMeasurementErrorCovariance HDO_H2OObservationErrorCovariance HDO_H2OTotalErrorCovariance	9/14/10
12.0	CR4450: Implement netCDF augmentation for L2 Products L2_Products will be updated by netCDF dimentions: nTimes, nLevels, nLength and nFreq	11/12/10
12.0	Update description for attributes: HDO_H2OMeasurementErrorCovariance HDO_H2OObservationErrorCovariance HDO_H2OTotalErrorCovariance Update description for HDO_H2OAveragingKernel H2O_HDOAveragingKernel	11/16/10
12.0	Update Section 1.2 for ESDT versions	11/30/10
12.0	Updated Table 7-5 to note that the Level 3 CO2 Monthly products are currently not being produced.	3/3/11
12.1	Update Table 4-6, Table 5-5, Table 8-7 to rename OzoneIRFK to OzoneIRK and change dimention from (dim nTimes) to (dim nLevels x nTimes)	4/28/11
12.1	Update for N2O	7/19/11
13.0	Update for FmOzoneBandFlux and L1BOzoneBandFlux fields CR 4551	12/21/11
13.0	Specify TES-MLS output in new section CR 4610	05/14/12
13.0	Add Methanol and Formic acid as standard L2 data products & L2 Summary product CR 4612	05/21/12
13.0	Add Calculated Max OPS to L1B product file CR 4545	5/12/12
13.0	Remove the following attributes from the L2 data products – CR 4600 CALIBRATION_QA INFORMATIONCONTENT MAXNUMITERATIONS NUMBERITERPERFORMED	5/24/12

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Version	Description	Date
	RADIANCERESIDUALMAX SPECIESRETRIEVALCONVERGED DEVIATIONVSRETRIEVALCOVARIANCE BORESIGHTNADIRANGLEUNC VERTICALRESOLUTION Note: these will be 'crossed-out" in this version of the document	
13.0	Modify L1B ESDT; it will remain at ESDT Version 5. Format_Content F04_05 to reflec addition of Max_OPD – reprocessing is not necessary	
13.0	Add to the TES-MLS output the file names of MLS product files used in processing – pro TES/MLS L2 Common Metadata	6/28/12
13.0	Add Format/Content for TES/MLS product file	9/13/12
13.0	Add Desert_Emiss_QA to L2 Nadir, Summary products Add desert emissivity flag; used in all species	9/14/12
13.0	Modify TES/MLS Primary Data fields From VolumeMixingRatioProfile To CO From TESVMRProfile To TESCO (TES CO) Units for 'Totalerror' and 'Total Error Covariance' should be VMR and VMR^2 Move from Primary Data Fields to Geolocation MLSLatitude, MLSLongitude, MLSTime In TES-MLS-L2-Common-Metadata Remove TESCloudFrequency, TESEmissivityWavenumber, TESScan_Resolution, TESPressure Rename TESVerticalCoordinate to VerticalCoordinate Add to Data Description – 'TES-MLS joint' where derived from both TES & MLS data 'TES specific' where from TES data, 'MLS specific' where from MLS data	12/7/12
13.0	Add Chi2_Initial_QA, Chi2_Final_QA to L2 products to L2 Nadir, Summary products Used in all species	12/7/12
13.0	Rename Chi2_Initial_QA, Chi2_Final_QA in L2 products to ResidualNormInitial & ResidualNormFinal	1/16/13
13.0	TES-MLS, add SO to data product name and ESDT	1/31/13
13.0	TES-MLS, add TESDataVersion, MLSDataVersion to metadata	3/4/13
13.0	Modify ESDT version, format/content designators	3/28/13
13.0	The range for AverageCloudEffOpticalDepth and AverageCloudEffOpticalDepthError should be 1000-1150 cm-1	6/19/13

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1. INTRODUCTION

1.1 Identification

This is the Data Products Specification (DPS) for the JPL Tropospheric Emission Spectrometer (TES) Project.

1.2 Overview

This document provides the detailed contents and formats for the TES Standard and Special Observation Data Products produced at launch. This document applies to the following version identifiers (see Section 2.3):

TES Software Release 13

L1B ESDT Version 5 (add Max OPD)

L2 ESDT Version 6 (add methanol, formic acid as products, add additional fields)

L3_ESDT Version 4 (increament to reflect L2 modifications)

L1B file format id F04_06

L2 file format id F07_10

L2 Summary file format id F03_10

L2 Supplemental file format id F02_09

L2 TES/MLS Combined Product id F01_01

L3 Grid file format id F01_09

1.3 Document Scope

This document provides specifications for all of the TES standard data products identified in the ICD between ECS and SIPS (423-41-57-10, Volume 10) and TES special observation data products. This document provides a source of requirements to Framework for supporting the listed data types and data objects. This document provides a source of requirements to the subsystems for the contents and formats of the standard data products.

1.4 Method

This document provides the detailed contents and formats for the TES standard and special observation data products produced at launch. At that time it represents a baseline to the version of the products. Any changes to the contents or formats of the products after that time cannot occur without an update and re-release of this document

1.5 Controlling Documents

1. JPL D-17961 Level 2 Subsystem Software Requirements

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2. 423-41-64	ESDIS Project Requirements for EOS Instruments Team Science Team Science Data Processing Systems, 07-03-2001 (latest version found at http://romulus.gsfc.nasa.gov/PIMS/EMDS.html)
3. 420-TP-022-001	Release 7 Implementation Earth Science Data Model for the ECS Project, May 2004 (latest version can be found at http://edhs1.gsfc.nasa.gov/)
4. NCAR Doc#: SW- NCA-079	HDF-EOS Aura File Format Guidelines
5. 423-41-57-10	Interface Control Document (ICD) between the EOSIDS Core System (ECS) and the Science Investigator-led Processing System (SIPS), Volume 10: Tropospheric Emission Spectrometer (TES) ECS Data Flows
6. JPL D-17962	Level 1B Subsystem Software Requirements Document
7. JPL D-23176	Level-2 Functional Requirements Document

1.6 Reference Documents

1. JPL D-13017	TES Experiment Implementation Plan
2. JPL D-13214	TES Software Management Plan
3. JPL D-8501	Software Management Policies and Requirements for EOS Flight Experiments
4. JPL D-11294	TES Scientific Objectives & Approach, Goals and Requirements
5. JPL D-19450	Ground System Requirements
6. JPL D-15522	Science Software Requirements
7. JPL D-1538	TES Command and Telemetry Handbook
8. 175-TP-510-001	HDF-EOS Interface Based on HDF5, Volume 1: Overview and Examples

1.7 Applicable Documents

9. HAIS 205-CD-002-001	Software Developer's Guide to Preparation, Delivery, Integration and Test with ECS, draft version, January 1995
	EOS Reference Handbook, NASA Goddard Space Flight Center
10. 194-207-SE1-001	System Design Specification for the ECS Project, Hughes Applied Information Systems, June 1994
11. 423-16-01	Data Production Software and Science Computing Facility Standards and Guidelines, EOSDIS, October 1996

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2. OVERVIEW OF FILE STRUCTURE FOR TES SCIENCE DATA PRODUCTS

2.1 TES Products in Native HDF 5 Format

The TES standard and special observation data products at Level 1B will be implemented in Native HDF5 format.

2.1.1 HDF 5 Data Types

The HDF 5 library provides a number of datatypes with the naming convention, H5T_*arch_base*, where *arch* is an architecture name and *base* is a programming type name. The architecture (name) used by the TES ESDT product files is NATIVE. The NATIVE architecture is by design the most portable and contains C-like datatypes for the machine on which the library was compiled. These NATIVE type names are defined with the prefix "H5T_" in the HDF C library and are grouped together in the C++ class "PredType" in the HDF 5 C++ API. In this document only the prefix NATIVE and the type are listed.

Table 2-1 below shows an example of how a 32 bit integer type maps to the HDF 5 APIs and how it is listed in this document.

Table 2-1: Mapping of 32-bit Integer to HDF5 APIs

HDF 5 API	HDF 5 C++ API	Listing in this Document
H5T_NATIVE_INT32	PredType::NATIVE_INT32	NATIVE_INT32

2.2 TES Products in HDF-EOS5 Format

TES will be using the HDF-EOS5 file format to store the scientific standard and special observation products at Level 2. The HDF-EOS extension to the HDF5 library provides the capability to incorporate swath mapping of the global survey data as well as compression and complex datatype usage.

2.3 Versioning of TES Products

For standard product granules versioning information has four types and is reported in four places:

1. ESDT Version – Identifies major releases of the data. This version is apparent when ordering data through the ASDC Data Gateway or the EDG Search and Order tool. This version identifier also relates to the maturity of the data product. The ESDT Version is visible within the product files in the ECS metadata object VersionID.

2. End of standard product filename (and the ECS Metadata object LocalGranuleID for Level 2). Numbers capturing format changes and reruns/reprocessing in the format Fff_cc (see Section 2.3.1 below)..

3. ECS Metadata object LocalVersionID. Has format: "Executable Name: Clearcase Label"

4. ECS Metadata object PGEVersion. Software Release number, e.g. "R6.1.2".

5. Production History. Text block in standard product file.

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2.3.1 Versioning in Filenames

The versioning issue covers two major aspects reflecting changes in the name of a data file:

1) Data file format changes.
2) Data file content changes (coming from reruns or reprocessing)

The following naming conventions should be used to denote changes due to file format/content changes:

<*file name*>_**F**ff_cc...

where:

F = File Format placeholder
ff = 2-digit version number reflecting file Format changes
cc = 2-digit version number reflecting file Content changes

The following ground rules must be observed:

1) The two sets of identifiers may be incremented independent of each other.
2) The start default value for each set is 01.
3) Neither set can ever revert back to 01 and must always be incremented throughout the file span of the file.
4) The value of each set must always be incremented by 1.

The following are the definitions for Format and Content changes of any data file:

Format change:

1) Data type changes (new or redefined)
2) New/deleted/renamed data fields/structures
3) Dimension changes of data fields/structures

The basic rule defining a Format change is any change that must be reflected in the Data Products Specification (DPS), and therefore requires a DPS update. These DPS updates will be disseminated via change pages and captured in Clearcase, with complete releases of a new DPS version at certain time intervals.

Content change:

1) Data file created during a PGE re-run with a different set of input files or different environment.
2) Data file reprocessing where contents are updated for completeness or better accuracy/algorithm improvement.

The purpose of the content versioning number is only to reflect a particular run version, not the version of the TES science software used during the run. However, the implication would be that any re-processing run of the same PGE using a different input file set would generate product files with new contents, thus indicated by a new value for the cc field of the products' names.

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3. LEVEL 1B STANDARD AND SPECIAL OBSERVATION PRODUCTS

3.1 Overview

At Level 1B, TES produces two standard products captured in two ESDTs: TL1BN for nadir-viewed data and TL1BL for limb-viewed data. For Special Observations, there are two "products" one for Low Resolution and one for High Resolution.

The primary data stored within the L1B nadir and limb products are spectra and noise-equivalent spectral radiance (NESR) data. In addition, the standard product files contain geolocation, engineering, production history, and data quality information.

Each L1B standard and special observation product is implemented as four files (one per Focal Plane) each using the native HDF 5 file format. HDF 5 files have a default extension of ".h5". The ECS Local Granule ID (filename) for a L1B standard product is constructed using the following template:

TES-Aura_L1B-<view>_FP<FP>_r<run id>-o<orbit number>_<version id>.h5

Due to instrument lifetime concerns involving the TES Pointing Control Subsystem the means of instrument calibration was modified in April 2010. The calibration method and algorithm may be determined through the file naming convention used in the product files and also through the TES_Common metadata attribute Calib_Scheme.

Briefly, data acquired prior to April 7, 2010 will use the calibration scheme termed 'NON_SPLIT_CAL' in the TES_Common metadata attribute Calib_Scheme. Data acquired on and following April 7, 2010 will be identified in the TES_Common metadata attribute Calib_Scheme as 'SPLIT_CAL', and will additionally be identified with the designator 'C01' in the product file name for L1B, L2 and L3 product files.

On April 7, 2010 TES began collecting Global Survey data using a new split-calibration collection scheme. This calibration method as non-embedded blackbody scans bracketing the global survey. Special observation data collection was also modified on May 12, 2010. To distinguish between this new calibration scheme and data collected before these dates TES will introduce a calibration designator in the filename and product metadata.

TES-Aura_L1B-<view>_FP<FP>_r<run id>-o<orbit number>_C01_<version id>.h5

This filename with calibration designator is applicable for all global surveys with run IDs greater than or equal to 11125 and special observations with run IDs greater than or equal to 11189.

The table below lists each of the TES L1B standard products.

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Table 3-1: TES L1B Standard Products

ESDT Short Name	ECS File Type	Collection Summary	File Names
TL1BN	HDF 5	TES Aura L1B Nadir	TES-Aura_L1B-Nadir_FP1A_rnnnnnnnnnn-onnnnn_Fff_cc.h5 TES-Aura_L1B-Nadir_FP1B_rnnnnnnnnnn-onnnnn_ Fff_cc.h5 TES-Aura_L1B-Nadir_FP2A_rnnnnnnnnnn-onnnnn_ Fff_cc.h5 TES-Aura_L1B-Nadir_FP2B_rnnnnnnnnnn-onnnnn_ Fff_cc.h5
TL1BL	HDF 5	TES Aura L1B Limb	TES-Aura_L1B-Limb_FP1A_rnnnnnnnnnn-onnnnn_ Fff_cc.h5 TES-Aura_L1B-Limb_FP1B_rnnnnnnnnnn-onnnnn_ Fff_cc.h5 TES-Aura_L1B-Limb_FP2A_rnnnnnnnnnn-onnnnn_ Fff_cc.h5 TES-Aura_L1B-Limb_FP2B_rnnnnnnnnnn-onnnnn_ Fff_cc.h5
TL1BN	HDF 5	TES Aura L1B Nadir	TES-Aura_L1B-Nadir_FP1A_rnnnnnnnnnn-onnnnn_C01_Fff_cc.h5 TES-Aura_L1B-Nadir_FP1B_rnnnnnnnnnn-onnnnn_C01_ Fff_cc.h5 TES-Aura_L1B-Nadir_FP2A_rnnnnnnnnnn-onnnnn_C01_ Fff_cc.h5 TES-Aura_L1B-Nadir_FP2B_rnnnnnnnnnn-onnnnn_C01_Fff_cc.h5

The table below lists each of the TES L1B special observation products.

Table 3-2: TES L1B Special Observation Products

ESDT Short Name	ECS File Type	Collection Summary	File Names
TL1BSOL	HDF 5	TES Aura L1B Special Observation Low Resolution	TES-Aura_L1B-SO-Low_FP1A_rnnnnnnnnnn-onnnnn_Fff_cc.h5 TES-Aura_L1B- SO-Low_FP1B_rnnnnnnnnnn-onnnnn_Fff_cc.h5 TES-Aura_L1B- SO-Low_FP2A_rnnnnnnnnnn-onnnnn_Fff_cc.h5 TES-Aura_L1B- SO-Low_FP2B_rnnnnnnnnnn-onnnnn_Fff_cc.h5
TL1BSOH	HDF 5	TES Aura Special Observati High Resolution	TES-Aura_L1B- SO-High_FP1A_rnnnnnnnnnn-onnnnn_Fff_cc.h5 TES-Aura_L1B- SO-High _FP1B_rnnnnnnnnnn-onnnnn_Fff_cc.h5 TES-Aura_L1B- SO-High _FP2A_rnnnnnnnnnn-onnnnn_Fff_cc.h5 TES-Aura_L1B- SO-High _FP2B_rnnnnnnnnnn-onnnnn_Fff_cc.h5
TL1BSOL	HDF 5	TES Aura L1B Special Observation Low Resolution	TES-Aura_L1B-SO-Low_FP1A_rnnnnnnnnnn-onnnnn_C01_Fff_cc.h5 TES-Aura_L1B- SO-Low_FP1B_rnnnnnnnnnn-onnnnn_C01_Fff_cc.h5 TES-Aura_L1B- SO-Low_FP2A_rnnnnnnnnnn-onnnnn_C01_Fff_cc.h5 TES-Aura_L1B- SO-Low_FP2B_rnnnnnnnnnn-onnnnn_C01_Fff_cc.h5
TL1BSOH	HDF 5	TES Aura Special Observati High Resolution	TES-Aura_L1B- SO-High_FP1A_rnnnnnnnnnn-onnnnn_C01_Fff_cc.h5 TES-Aura_L1B- SO-High _FP1B_rnnnnnnnnnn-onnnnn_C01_Fff_cc.h5 TES-Aura_L1B- SO-High _FP2A_rnnnnnnnnnn-onnnnn_C01_Fff_cc.h5 TES-Aura_L1B- SO-High _FP2B_rnnnnnnnnnn-onnnnn_C01_Fff_cc.h5

Where the string rnnnnnnnnnn represents the ten-digit Run ID, the string onnnnn represents the starting five-digit Absolute Orbit number, the substring “Fff_cc” represents a version ID which is used to keep track of file format changes (see Section 2.3.1).

Note: TES data acquisition begins at the South Pole apex crossing, and subsequent orbits worth of data begin from there for the L1B granules. The Absolute Orbit number in the file name above is the same as the Aura orbit number at the time of the South Pole apex crossing.

For Special Observations, there is the potential for multiple products within a single orbit. These will be differentiated by Run Number. Special Observations which span multiple orbits, i.e. cross the South Pole apex, will be split into separate files.

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3.2 Nadir or Low Resolution Observations

The Nadir standard product consists of four files, where each file is composed of the Global Survey Nadir observations from one of four focal planes for a single orbit. The number of observations within an orbit is fixed for a Global Survey, but that number may change if the configuration of the Global Survey is changed.

The Low Resolution special observation product also consists of four files, where each file is composed of special observations from one of four focal planes. A special observation product is of an undetermined length and may be smaller than an orbit or larger.

The filter position for a given focal plane is in the L1B-specific metadata. This filter position determines the dimensions of the filter group objects for each file.

3.2.1 Structure of Nadir File

The structure of each of the Nadir or Low Resolution files contains groups for ECS (HDFEOS INFORMATION) and TES-specific metadata (including Production History) and groups for the data corresponding to specific filters. The data objects within each of these groups are shown in the figure below.

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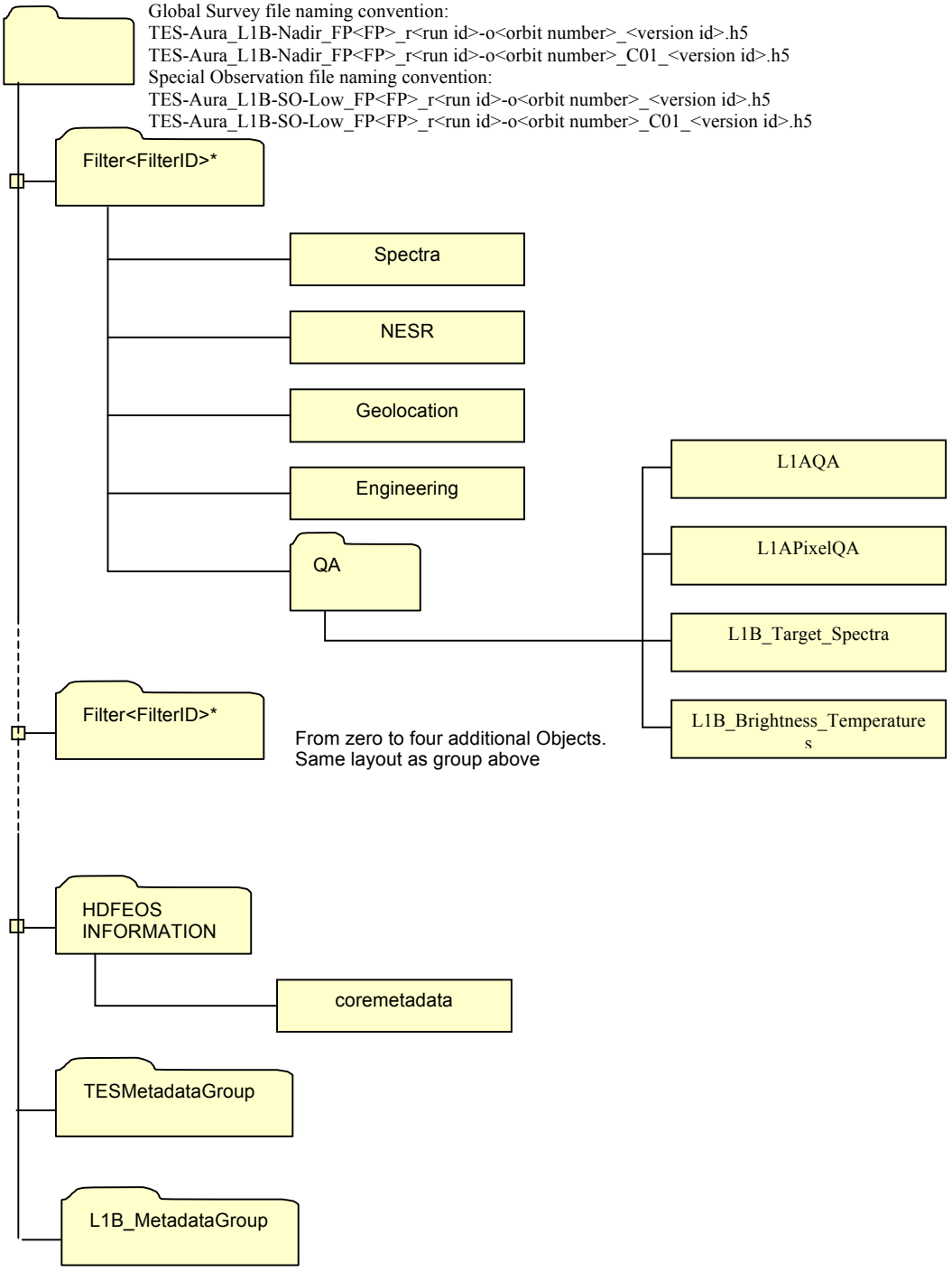

*Where <FilterID> for Nadir for the Filter Plane 1A file can be one of the following: 1A1, 1A2, 1A3, 1A4, or 1A5; for the Filter Plane 1B file can be 1B1 or 1B2; for the Filter Plane 2A file can be 2A1, 2A2, 2A3, or 2A4; and for the Filter Plane 2B file will be 2B1.

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3.3 Limb or High Resolution Observations

The Limb standard product consists of four files, where each file is composed of the Global Survey Nadir observations from one of four focal planes for a single orbit. The number of observations within an orbit is fixed for a Global Survey, but that number may change if the configuration of the Global Survey is changed.

The High Resolution special observation product also consists of four files, where each file is composed of special observations from one of four focal planes. A special observation product is of an undetermined length and may be smaller than an orbit or larger.

The filter position for a given focal plane is in the L1B-specific metadata. This filter position determines the dimensions of the filter group objects for each file.

3.3.1 Structure of Limb File

The structure of each of the Limb or High Resolution files contains groups for ECS (HDFEOS INFORMATION) and TES-specific metadata (including Production History) and groups for the data corresponding to specific filters. The data objects within each of these groups are shown in the figure below.

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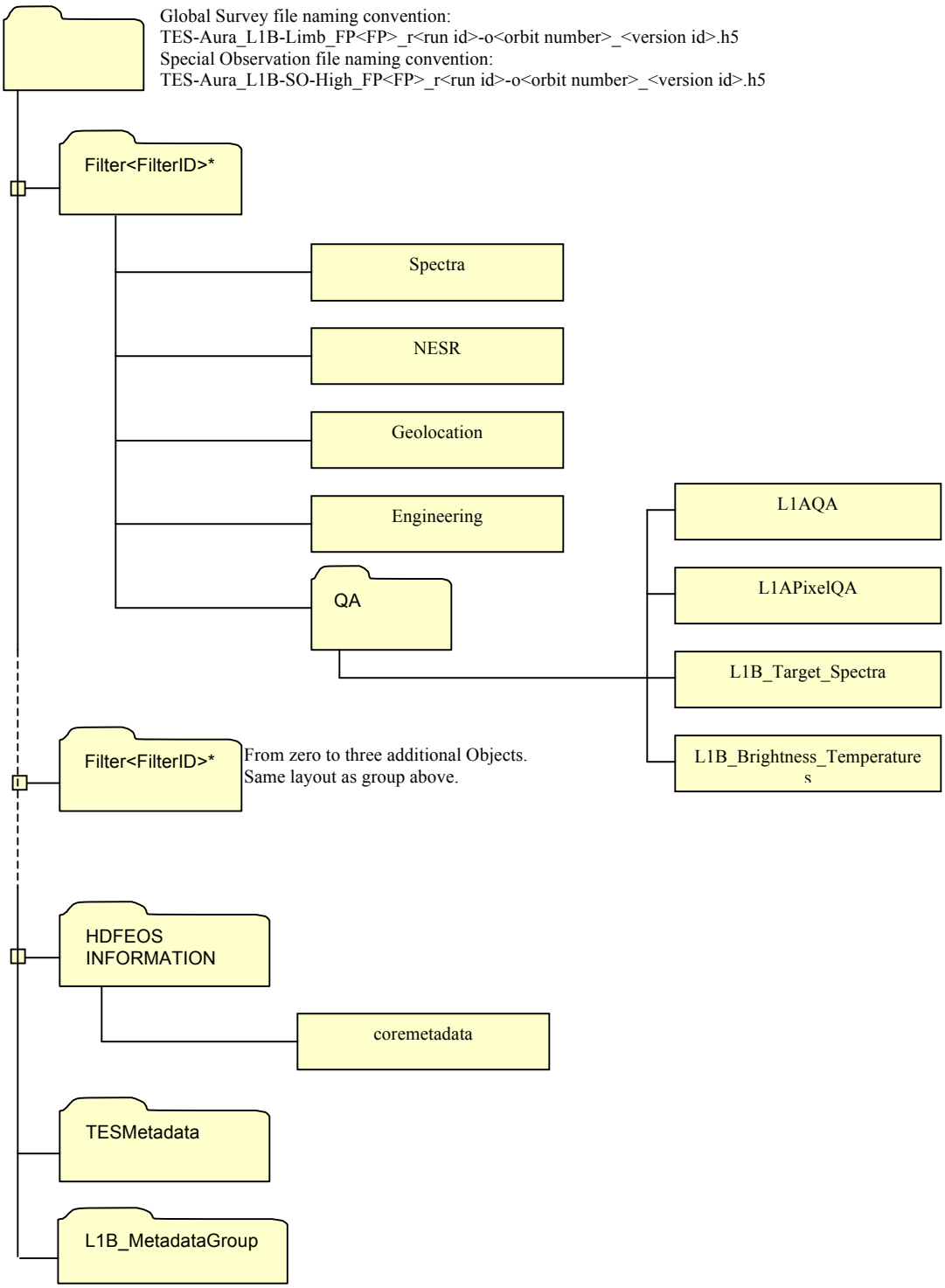

*Where <FilterID> for Limb for the Filter Plane 1A file can be one of the following: 1A1 or 1A2; for the Filter Plane 1B file can be 1B1 or 1B2; for the Filter Plane 2A file can be 2A1, 2A2, 2A3, or 2A4; and for the Filter Plane 2B file will be 2B1.

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3.4 Spectra and NESR Data

Each product captures data in four focal planes for each observation. These focal planes are 1A, 1B, 2A, and 2B. For each of these focal planes there are sixteen pixels, 0 through 15. These pixels return 32-bit float data. Along with the spectra data, NESR data has the same characteristics, ranging from pixels 0 through 15 returning 32-bit float data. See tables below for all values and definitions of the sixteen pixels in each of the four focal planes. Each focal plane/filter position has a different number of samples for each spectrum.

Table 3-3: Spectra Data Type Definition

Data Name	Data Description	Units	Data Range	Size	Type	HDF 5 Type
Spectra	Spectrum radiance sample.	$W/cm^2 /sr/cm^{-1}$	$-10^{-4} – 10^{-4}$ (fill= -999.)	32	float	NATIVE_FLOAT

Table 3-4: NESR Data Type Definition

Data Name	Data Description	Units	Data Range	Size	Type	HDF 5 Type
NESR	Noise equivalent spectral radiance sample.	$W/cm^2 /sr/cm^{-1}$	$-10^{-5} – 10^{-5}$ (fill= -999.)	32	float	NATIVE_FLOAT

Table 3-5: Focal Plane Data Dimensions

Dimension Name	Dimension Description	Dimension Size
TES_pixel_dim	Number of pixels in a TES focal plane.	16
Observations_dim	Number of sequences.	variable
Spectra_Samples_dim	Number of samples for Spectra & NESR	configurable

Dimensions are implemented in the file in "C" order, i.e. last dimension is the fastest.

Table 3-6: Focal Plane Spectra Dataset

Dataset Name	Dataset Description	Dimension List	Data Type
Spectra	Contains spectra data for all sixteen pixels in the focal plane for a nadir or a limb scan.	TES_pixel_dim Observations_dim Spectra_Samples_dim	Spectrum_type

Table 3-7: Focal Plane NESR Dataset

Dataset Name	Dataset Description	Dimension List	Data Type
NESR	Contains NESR data for all sixteen pixels in the focal plane for a nadir or a limb scan.	TES_pixel_dim Observations_dim Spectra_Samples_dim	NESR_type

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3.5 Geolocation Data

For the Nadir-viewing product files (Low or High resolution), the geolocation is calculated from the boresight. For the Limb-viewing product files (Low or High resolution), the geolocation is calculated from the tangential height.

Table 3-8: Geolocation Dataset

Dataset Name	Dataset Description	Dimension List	Data Type
Geolocation	Contains geolocation data for each sequence.	Observations_dim	Geolocation_type

Table 3-9: Geolocation Dataset Dimensions

Dimension Name	Dimension Description	Dimension Size
Observations_dim	Number of observations.	variable

The Geolocation Dataset is implemented as a compound data type (for each Observations_dim) with the following definition.

Table 3-10: Geolocation Data Type Definition: Geolocation_type

Data Name	Data Description	Units	Data Range	Size	HDF 5 Type
Time_of_Geolocation	Time of ZPD (Zero Path Difference)	TAI 93 time		64	NATIVE_DOUBLE
Geolocation_Failed	Failure indicator. False = 0 True = 1 **If True, the following data fields will be set to zero or are suspect.**	N/A	0..1	8	NATIVE_INT8
OrbitAscendingFlag	Ascending node = 1 Descending node = 0	N/A	0..1	8	NATIVE_INT8
Path_Number	Aura Path Number	N/A	1..233	8	NATIVE_UINT8
PCS_QA_Poor_Percentage	Percent data interpolated	N/A	0..100	8	NATIVE_INT8
DPREP_QA_Poor_Percentage	Percent data interpolated	N/A	0..100	8	NATIVE_INT8
Orbit_Inclination_Angle	Orbit Inclination Angle	Decimal degrees	0..180	64	NATIVE_DOUBLE
Latitude	Ground boresight location	Decimal degrees	±90.0	64	NATIVE_DOUBLE
Longitude	Ground boresight location	Decimal degrees	±180.0	64	NATIVE_DOUBLE
Elevation	Ground boresight elevation. For Nadir this is the surface geodetic elevation from DEM. For Limb this is the altitude of the tangent point.	Meters	-1000.. 100,000	32	NATIVE_FLOAT
Horizontal_Uncertainty	Uncertainty in geolocation horizontal position	Meters	-100,000.. 100,000	32	NATIVE_FLOAT
Elevation_Uncertainty	Uncertainty in geolocation elevation	Meters	-1000.. 100,000	32	NATIVE_FLOAT
Latitude_Footprint_1	Geo-location in geodetic co-ordinates of the four corners of the footprint. Nadir footprint determined by field of view of pixels. Limb footprint is ±60 km track, ±12 km crosstrack from surface expression	Decimal degrees	±90	64	NATIVE_DOUBLE
Latitude_Footprint_2		Decimal degrees	±90	64	NATIVE_DOUBLE
Latitude_Footprint_3		Decimal degrees	±90	64	NATIVE_DOUBLE

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Data Name	Data Description	Units	Data Range	Size	HDF 5 Type
Latitude_Footprint_4	of boresight tangent point. Latitude_Footprint_1=LowerLeft Latitude_Footprint_2=LowerRight Latitude_Footprint_3=UpperRight Latitude_Footprint_4=UpperLeft	Decimal degrees	±90	64	NATIVE_DOUBLE
Longitude_Footprint_1	Geo-location in geodetic co-ordinates of the four corners of the footprint. Nadir footprint determined by field of view of pixels. Limb footprint is ±60 km track, ±12 km crosstrack from surface expression of boresight tangent point Longitude_Footprint_1=LowerLeft Longitude_Footprint_2=LowerRight Longitude_Footprint_3=UpperRight Longitude_Footprint_4=UpperLeft	Decimal degrees	±180	64	NATIVE_DOUBLE
Longitude_Footprint_2		Decimal degrees	±180	64	NATIVE_DOUBLE
Longitude_Footprint_3		Decimal degrees	±180	64	NATIVE_DOUBLE
Longitude_Footprint_4		Decimal degrees	±180	64	NATIVE_DOUBLE
SurfaceElevation	Average elevation over the footprint	Meters	-1000.. 100,000	32	NATIVE_FLOAT
SurfaceElevStandardDeviation	Standard deviation of elevation over the footprint	Meters	-1000.. 100,000	32	NATIVE_FLOAT
Min_Elev_Footprint	Lowest elevation over the footprint	Meters	-1000.. 100,000	32	NATIVE_FLOAT
Max_Elev_Footprint	Greatest elevation over the footprint	Meters	-1000.. 100,000	32	NATIVE_FLOAT
Surface_Type_Footprint	From DEM, 1=Fresh Water, 2=Salt Water, 3=Land, 4=Mixed (not 100% of FW, SW, or Land)	Enumer-ated	1..4	8	NATIVE_INT8
Day_Night_Flag_Target	0=Night (False), 1=Day (True)	T/F	0..1	8	NATIVE_INT8
Day_Night_Flag_SC	0=Night (False), 1=Day (True)	T/F	0..1	8	NATIVE_INT8
LocalSolarTime	Local Mean Solar Time (hours from midnight)	Hours	0.0..24.0	32	NATIVE_FLOAT
TES_Bsight_Azimuth	TES boresight (LOS) azimuth angle relative to the local north at SC	Decimal degrees	0..360	64	NATIVE_DOUBLE
TES_Bsight_Azimuth_Uncert	Uncertainty in TES boresight azimuth angle	Decimal degrees	±180	64	NATIVE_DOUBLE
TESBoresightNadirAngle	TES boresight (LOS) nadir angle relative to the local nadir at SC	Decimal degrees	0..90	64	NATIVE_DOUBLE
TES_Bsight_Nadir_Uncert	Uncertainty in TES boresight nadir angle	Decimal degrees	±90	64	NATIVE_DOUBLE
Grd_Trk_TES_Bsight_Azimuth	TES boresight (LOS) azimuth angle relative to the local ground track	Decimal degrees	0..360	64	NATIVE_DOUBLE
SpacecraftAzimuth	TES boresight (LOS) azimuth angle relative to the local north at the geolocation	Decimal degrees	0..360	64	NATIVE_DOUBLE
SpacecraftZenith	TES boresight (LOS) zenith angle relative to the local zenith at the geolocation	Decimal degrees	0..180	64	NATIVE_DOUBLE
Tgt_Sun_Azimuth	Solar azimuth angle relative to the local north at the geolocation	Decimal degrees	0..360	64	NATIVE_DOUBLE
Tgt_Sun_Zenith_Angle	Solar zenith angle relative to the local zenith at the geolocation	Decimal degrees	0..180	64	NATIVE_DOUBLE
SolarAzimuthAngle	Solar azimuth angle relative to the local north at spacecraft point at ZPD time	Decimal degrees	0..360	64	NATIVE_DOUBLE
SolarZenithAngle	Solar zenith angle relative to the local zenith at spacecraft point at ZPD time	Decimal degrees	0..180	64	NATIVE_DOUBLE
M1_Mirror_Sun_Angle	Angle between M1 mirror normal and the sun	Decimal degrees	0..180	64	NATIVE_DOUBLE
SpacecraftLatitude	Geodetic latitude	Decimal degrees	±90	64	NATIVE_DOUBLE

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Data Name	Data Description	Units	Data Range	Size	HDF 5 Type
SpacecraftLongitude	Geodetic longitude	Decimal degrees	±180	64	NATIVE_DOUBLE
SpacecraftAltitude	Geodetic spacecraft altitude (w/ respect to geoid)	Meters	-1000.. 10,000,000	64	NATIVE_DOUBLE
Doppler_Shift	Relative frequency shift due to Doppler effect.	N/A		64	NATIVE_DOUBLE
Resolved_SC_Position_X	From ground corrected ephemeris	meters	±8,000,000	64	NATIVE_DOUBLE
Resolved_SC_Position_Y	From ground corrected ephemeris	meters	±8,000,000	64	NATIVE_DOUBLE
Resolved_SC_Position_Z	From ground corrected ephemeris	meters	±8,000,000	64	NATIVE_DOUBLE
Resolved_SC_Velocity_X	From ground corrected ephemeris	meters/ sec	±10,000.0	64	NATIVE_DOUBLE
Resolved_SC_Velocity_Y	From ground corrected ephemeris	meters/ sec	±10,000.0	64	NATIVE_DOUBLE
Resolved_SC_Velocity_Z	From ground corrected ephemeris	meters/ sec	±10,000 .0	64	NATIVE_DOUBLE
Resolved_SC_Quaternion_Q1	From ground corrected ephemeris	N/A	-1.0...1.0	64	NATIVE_DOUBLE
Resolved_SC_Quaternion_Q2	From ground corrected ephemeris	N/A	-1.0...1.0	64	NATIVE_DOUBLE
Resolved_SC_Quaternion_Q3	From ground corrected ephemeris	N/A	-1.0...1.0	64	NATIVE_DOUBLE
Resolved_SC_Quaternion_Q4	From ground corrected ephemeris	N/A	-1.0...1.0	64	NATIVE_DOUBLE
Resolved_SC_Attitude_Pitch	From ground corrected attitude	Decimal degrees	±90	64	NATIVE_DOUBLE
Resolved_SC_Attitude_Roll	From ground corrected attitude	Decimal degrees	±90	64	NATIVE_DOUBLE
Resolved_SC_Attitude_Yaw	From ground corrected attitude	Decimal degrees	±90	64	NATIVE_DOUBLE
Resolved_SC_Pitch_Rate	From ground corrected attitude	deg/sec	±0.3	64	NATIVE_DOUBLE
Resolved_SC_Roll_Rate	From ground corrected attitude	deg/sec	±0.3	64	NATIVE_DOUBLE
Resolved_SC_Yaw_Rate	From ground corrected attitude	deg/sec	±0.3	64	NATIVE_DOUBLE
PCS_Track	PCS track resolver position at time of ZPD	Decimal degrees		64	NATIVE_DOUBLE
PCS_Crosstrack	PCS crosstrack resolver position at time of ZPD	Decimal degrees		64	NATIVE_DOUBLE

3.6 Engineering Data

Table 3-11: Engineering Dataset

Dataset Name	Dataset Description	Dimension List	Data Type
Engineering	Contains engineering data.	Observations_dim	Engineering_type

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Table 3-12: Engineering Dataset Dimensions

Dimension Name	Dimension Description	Dimension Size
Observations_dim	Number of observations.	variable

The Engineering Dataset is implemented as a compound data type (for each Observation_dim) with the following definition.

Table 3-13: Engineering Dataset Type Definition: Engineering_type

Data Name	Data Description	Units	Data Range	Size	HDF 5 Type
Scan	Scan number in sequence.	N/A	>0	8	NATIVE_INT8
Sequence	Sequence number in run.	N/A	>0	16	NATIVE_INT16
Time_of_Observation	Time of ZPD (Zero Path Difference)	TAI93		64	NATIVE_DOUBLE
Filter_Identification	Optical Filter Identification		For FP1A: "1", "2", "3", "4", or "5" For FP1B: "1" or "2" For FP2A: "1", "2", "3", or "4" For FP2B: "1"	8	NATIVE_CHAR
ADC_Enabled	Analog to Digital sampling	---	0 = enabled 1 = off	16	NATIVE_INT16
Elect_Filter	Filter Center Frequency	kHz	For FP1A: 0 = 8.8 kHz, 1 = 9.8, 2 = 10.7, 3 = 11.5, 4 = 12.4, 5 = DC For FP1B: 0 = 4.0, 1 = 4.4, 5 = DC For FP2A: 0 = 5.1, 1 = 6.0, 2 = 6.9, 3 = 7.7, 5 = DC For FP2B: 0 = 3.3, 5 = DC	32	NATIVE_FLOAT
Fringe_Clock_Divisor	Sets ADC Sampling Rate	---	8..15	16	NATIVE_INT16
AT_Index	Indicator as to whether the Filter Wheel is at a pre-determined index point.		0, 1	8	NATIVE_INT8

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Data Name	Data Description	Units	Data Range	Size	HDF 5 Type
Filter_Wheel_Index	Filter Wheel Index position	---	For FP1A: 0 = 1A4, 7 = 1A5, 6 = 1A1, 5 = 1A2, 4 = 1A3 For FP1B: 5 = 1B2, 4 = 1B1 For FP2A: 1 = 2A4, 0 = 2A1, 7 = 2A3, 6 = 2A2 For FP2B: 3 = 2B1	16	NATIVE_INT16
Signal_Chain_Gain	Mapping from signal chain (1A, 1B, 2A, 2B) to a gain factor.	---	0.5, 1.0, 2.0, 4.0, 32.0 Fill = -999.0	32	NATIVE_FLOAT
Detector_Temp	Measurement of a given focal plane detector temperature.	K	60 – 361 Fill = -999.0	32	NATIVE_FLOAT
Observation_Type	TES Defined Scans		1..40	16	NATIVE_INT16
ICS_Scan_Direction	Arm scan direction: 0 = reverse 1 = forward		"0", "1"	8	NATIVE_CHAR
Blackbody_Wall_Temp_#1	Blackbody Wall Temperature #1 from the Calibration Subsystem Electronics board.	K	213 – 349 Fill = -999.0	32	NATIVE_FLOAT
Blackbody_Wall_Temp_#2	Blackbody Wall Temperature #2 from the Calibration Subsystem Electronics board.	K	213 – 349 Fill = -999.0	32	NATIVE_FLOAT
Cold_Reference_Plate_Temp_#1	Cold Reference Plate Temperature #1 from the Operational Support Electronics board.	K	160 – 361 Fill = -999.0	32	NATIVE_FLOAT
Cold_Reference_Plate_Temp_#2	Cold Reference Plate Temperature #2 from the Operational Support Electronics board.	K	160 – 361 Fill = -999.0	32	NATIVE_FLOAT
Beamsplitter_Temp_#1	Beamsplitter Temperature #1 from the Operational Support Electronics board.	K	160 – 361 Fill = -999.0	32	NATIVE_FLOAT
Beamsplitter_Temp_#2	Beamsplitter Temperature #2 from the Operational Support Electronics board.	K	160 – 361 Fill = -999.0	32	NATIVE_FLOAT
Foreoptics_Temp	Foreoptics Temperature from the Engineering Data Interface board.	K	168 – 359 Fill = -999.0	32	NATIVE_FLOAT
M1_Mirror_Temp	M1 Mirror Temperature from the Postiioning Control Subsystem electonics board.	K	173 – 364 Fill = -999.0	32	NATIVE_FLOAT
M2_Mirror_Temp	M2 Mirror Temperature from the Postiioning Control Subsystem electonics board.	K	198 – 359 Fill = -999.0	32	NATIVE_FLOAT
Calibration_SS_Resistor_1	Provides the measurement data for Calibration Subsystem Calibration Resistor 1 from the Calibration Subsystem Electronics board.	Ohms	Fill = -999.0	32	NATIVE_FLOAT

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Data Name	Data Description	Units	Data Range	Size	HDF 5 Type
Calibration_SS_Resistor_2	Provides the measurement data for Calibration Subsystem Calibration Resistor 2 from the Calibration Subsystem Electronics board.	Ohms	Fill = -999.0	32	NATIVE_FLOAT
OSE_Resistor_1	Provides the measurement data for OSE Calibration Resistor 1 from the Operational Support Electronics board.	Ohms	Fill = -999.0	32	NATIVE_FLOAT
OSE_Resistor_2	Provides the measurement data for OSE Calibration Resistor 2 from the Operational Support Electronics board.	Ohms	Fill = -999.0	32	NATIVE_FLOAT

3.7 Quality Assessment (QA) Data

Quality data consists of quality flags for the scan level and quality flags for all sixteen pixels in each focal plane. Each focal plane will contain this set of quality data.

QA data are placed in the following groups. Within each group are datasets listed in subsequent tables.

Table 3-14: QA Groups

Group Name	Datasets Description	Dimension List
L1AQA	Contains quality datasets for all sixteen pixels in each focal plane for a scan within a sequence.	Observations_dim
L1APixelQA	Contains L1A quality datasets for each pixel in a specific filter for an observation	TES_pixel_dim Observations_dim
L1B_Target_Spectra	Contains L1B Target Spectra datasets	TES_pixel_dim Observations_dim
L1B_Brightness_Temperatures	Contains L1B Brightness Temperatures datasets	TES_pixel_dim (limb only) Observations_dim

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Table 3-15: QA Datasets Dimensions

Dimension Name	Dimension Description	Dimension Size
TES_pixel_dim	Number of pixels in a TES focal plane.	16
Observations_dim	Number of observations.	variable

The following is a list of the L1A QA datasets.

Table 3-16: L1AQA Group Datasets

Data Name	Data Description	Units	Data Range	Size	HDF 5 Type
L1A_Ifgm_Dropout_Occurred	Missing packet	N/A	True=1 False=0 Not Processed=9	8	NATIVE_INT8
L1A_Time_Date_Error_Occurred	Error in header	N/A	True=1 False=0 Not Processed=9	8	NATIVE_INT8
L1A_Sequence_Error_Occurred	Error in run, sequence, scan	N/A	True=1 False=0 Not Processed=9	8	NATIVE_INT8
L1A_Filter_Seq_Error_Occurred	Filter wheel position not as expected	N/A	True=1 False=0 Not Processed=9	8	NATIVE_INT8
L1A_SC_Attitude_Out_Of_Spec	Attitude not as expected	N/A	True=1 False=0 Not Processed=9	8	NATIVE_INT8
L1A_ICS_Direction_Out_Of_Sequence	ICS Scan direction not as expected	N/A	True=1 False=0 Not Processed=9	8	NATIVE_INT8
L1A_ICS_Speed_Variation_Out_Of_ Specification	ICS speed variation over spec	N/A	0..2 Not Processed=9	8	NATIVE_INT8
L1A_BB_Temperature_Out_Of_ Specification	Black body temperatures out of spec	N/A	True=1 False=0 Not Processed=9	8	NATIVE_INT8
L1A_Cold_Ref_Plate_Temperature_ Out_Of_Specification	Cold Reference Plate temperature out of spec.	N/A	True=1 False=0 Not Processed=9	8	NATIVE_INT8
L1A_Engineering_Temperatures_Out_Of _Specification	Any High Rate PRT not specified	N/A	0..2 Not Processed=9	8	NATIVE_INT8
L1A_Channel_Shift	Indicates detected telemetry channel shift	N/A	0=no shift -1…-15=shift Not Processed=9	8	NATIVE_INT8

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The following is a list of the L1A Pixel QA datasets. They are dimensioned Observations_dim x TES_pixel_dim.

Table 3-17: L1APixelQA Group Datasets

Data Name	Data Description	Units	Data Range	Size	HDF 5 Type
L1A_Spike_Occurred	10x neighboring values	N/A	True=1 False=0 Not Processed=9	8	NATIVE_INT8
L1A_DN_Overflow_Occurred	| DN | > tolerance	N/A	True=1 False=0 Not Processed=9	8	NATIVE_INT8
L1A_DN_Underflow_Occurred	| DN | < tolerance	N/A	True=1 False=0 Not Processed=9	8	NATIVE_INT8

For the following tables, Flags have the definition:
-1 = the error/quality measurement and check was not performed.
0 = the error/quality measurement was done, and the measurement did not exceed tolerance (SUCCESS).
+1 = the error/quality measurement was done, and the measurement exceeded tolerance (FAILURE).

The following datasets in L1B Target Spectra Quality are dimensioned Observations_dim x TES_pixel_dim.

Table 3-18: L1B_Target_Spectra Group Quality Datasets

Data Name	Data Description	Units	Data Range	Size	HDF 5 Type
L1B_Zero_Padding	the ratio of zero padding size to the FFT size	N/A	0.0–1.0 Fill = -999.0	32	NATIVE_FLOAT
L1B_Zero_Padding_Flag		N/A	-1,0,+1 Not Processed=9	8	NATIVE_INT8
L1B_Missing_Cal_Table_Flag	at least one calibration table is missing	N/A	-1,0,+1 Not Processed=9	8	NATIVE_INT8
L1B_Cal_Table_Quality_Flag	at least one calibration table has *suspicious* quality	N/A	-1,0,+1 Not Processed=9	8	NATIVE_INT8
L1B_Phase_Alignment	the chi-square of the imaginary of calibration ratio is too large	N/A	>= 0 Fill = -999.0	32	NATIVE_FLOAT
L1B_Phase_Alignment_Flag		N/A	-1,0,+1 Not Processed=9	8	NATIVE_INT8
L1B_Absolute_Radiance_Mean_BT	The mean of the absolute value of real target spectra after radiometric calib.		>=0; 10^{-5} Fill = -999.0	32	NATIVE_FLOAT
L1B_Absolute_Radiance_Mean_BT_Flag		N/A	-1,0,+1 Not Processed=9	8	NATIVE_INT8
L1B_NESR_Mean	NESR mean between full in-band range (full power points)		>= 0; 10^{-6} Fill = -999.0	32	NATIVE_FLOAT
L1B_NESR_Mean_Flag		N/A	-1,0,+1 Not Processed=9	8	NATIVE_INT8
L1B_Imaginary_RMS	target spectrum imaginary RMS between half power points		>= 0; 10^{-6}	32	NATIVE_FLOAT
L1B_Imaginary_RMS_Flag		N/A	-1,0,+1 Not Processed=9	8	NATIVE_INT8
L1B_Imaginary_Mean	target spectrum imaginary mean between		+/-10^{-7}	32	NATIVE_FLOAT

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Data Name	Data Description	Units	Data Range	Size	HDF 5 Type
	half power points				
L1B_Imaginary_Mean_Flag		N/A	-1,0,+1 Not Processed=9	8	NATIVE_INT8
L1B_General_Quality_Flag	See notes below	N/A	0,+1 Not Processed=9	8	NATIVE_INT8
L1B_General_Error_Flag	See notes below	N/A	0,+1 Not Processed=9	8	NATIVE_INT8
L1B_Calculated_Max_OPD	Calculated optical path difference	CM	0..16	64	NATIVE_DOUBLE

L1B_General_Quality_Flag and L1B_General_Error_Flag are binary flags they are set to 0 (good) or 1 (bad).

L1B_General_Error_Flag set equal to 1 means that at some processing step an error was detected, and the spectrum was dropped. A spectrum with its L1B_General_Error_Flag set to 1 will not appear in the final product.

L1B_General_Quality_Flag set equal to 1 means that the spectrum may have some quality problem. A spectrum that just has some quality problem does appear in final L1B product.

The following datasets in L1B Nadir Brightness Temperatures are dimensioned only by Observations_dim.

Table 3-19: L1B_Brightness_Temperatures Group Datasets for Nadir

Data Name	Data Description	Units	Data Range	Size	HDF 5 Type
L1B_Nadir_ BT_11	Average brightness temperature in band 11		-100.0—1000.0 Fill = -999.0	32	NATIVE_FLOAT
L1B_Nadir_ BT_12	Average brightness temperature in band 12		-100.0—1000.0 Fill = -999.0	32	NATIVE_FLOAT
L1B_Nadir_ BT_8	Average brightness temperature in band 8		-100.0—1000.0 Fill = -999.0	32	NATIVE_FLOAT
L1B_Nadir_ BT_5	Average brightness temperature in band 5		-100.0—1000.0 Fill = -999.0	32	NATIVE_FLOAT
L1B_Nadir_ BT_10	Average brightness temperature in band 10		-100.0—1000.0 Fill = -999.0	32	NATIVE_FLOAT
L1B_N_ Interpixel_Vari_BT10	Measure of variation in BT-10 across all pixels			32	NATIVE_FLOAT
L1B_N_ Ipix_Var_Exceeded_BT10	Nadir scene interpixel variability exceeded threshold	N/A	-1 = Test not performed, 0 = False, 1 = True	8	NATIVE_INT8
L1B_N_ Interpixel_Vari_BT11	Measure of variation in BT-11 across all pixels			32	NATIVE_FLOAT
L1B_N_ Ipix_Var_Exceeded_BT11	Nadir scene interpixel variability exceeded threshold	N/A	-1 = Test not performed, 0 = False, 1 = True	8	NATIVE_INT8

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The following datasets in L1B Limb Brightness Temperatures are dimensioned Observations_dim x TES_pixel_dim.

Table 3-20: L1B_Brightness_Temperatures Group Datasets for Limb

Data Name	Data Description	Units	Data Range	Size	HDF 5 Type
L1B_Limb_ BT_11	Average brightness temperature in band 11		-100.0—1000.0 Fill = -999.0	32	NATIVE_FLOAT
L1B_ Limb_ BT_12	Average brightness temperature in band 12		-100.0—1000.0 Fill = -999.0	32	NATIVE_FLOAT
L1B_ Limb_ BT_8	Average brightness temperature in band 8		-100.0—1000.0 Fill = -999.0	32	NATIVE_FLOAT
L1B_ Limb_ BT_5	Average brightness temperature in band 5		-100.0—1000.0 Fill = -999.0	32	NATIVE_FLOAT
L1B_ Limb_ BT_10	Average brightness temperature in band 10		-100.0—1000.0 Fill = -999.0	32	NATIVE_FLOAT

3.8 L1 ECS and TES-specific Metadata

3.8.1 Introduction

As with all ESDTs, TES ESDTs contain metadata that describes specific attributes about the data or the quality of data contained in the ESDT. Some of the basic metadata items are required by EOSDIS. These data items commonly include basic identification information and other generic information about the particular ESDT. These data items are referred to as ECS Inventory Metadata. In addition to ECS Inventory Metadata, TES ESDTs contain additional metadata more specific to the TES program. The TES-specific metadata has been subdivided into four subcategories based on the uniqueness of its origin and identification:

1. TES Production History — Production History Metadata
2. TES-Common — Metadata common to all TES ESDTs
3. TES-L1B-Common — Metadata common to all Level 1B ESDTs
4. TES-L1B-*observation specific* — Metadata unique to a particular ESDT subtype.

TES common metadata are fairly generic to the entire family of TES ESDTs or to TES L1B products. TES-L1B-*observation specific*, as described by name, are unique to a particular family of L1 ESDTs.

3.8.2 ECS Inventory Metadata

The ECS Inventory Metadata is implemented in the HDF file as text block named coremetadata within a group named HDFEOS INFORMATION.

Table 3-21: ECS Inventory Metadata

Data Layer Name	Data Description	TES Valids	Type[1]	Source
AssociatedInstrumentShortName	Instrument short name supplied by TES project.	TES	VA20	MCF
AssociatedPlatformShortName	Platform short name supplied by EOS project.	Aura	VA20	MCF
AssociatedSensorShortName	Sensor short name supplied by TES project.	FTS	VA20	MCF
OperationMode	Mode of operation of the instrument.	Routine	VA20	MCF

[1] Data types and Source given are specified in document [3] in paragraph 1.5

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Data Layer Name	Data Description	TES Valids	Type[1]	Source
ShortName	This name will identify the ESDT short name associat with the collection or granule.	(set in MCF file)	A8	MCF
VersionID	Version identifier of the ESDT data collection.	(set in MCF file)	SI	MCF
ProductionDateTime	The date and time a specific granule was produced by PGE.	YYYY-MM-DDT HH:MM:SS.SSSZ	DT	TK
SizeMBECSDataGranule	The size attribute will indicate the volume of data contained in the granule.		F10	DSS
LocalVersionID	Local version identifier for PGE defined granule versions. Takes the form "executable name: Clearcase label"		VA60	PGE
InputPointer	Description of location of Production History information.	"Production History block at: /TESMetadataGroup/ProductionHistory"	VA255	PGE
ParameterName	Scope of quality flags. For tests, refers to entire granu	Granule	A40	PGE
ScienceQualityFlag	The granule level flag applying generally to the granul and specifically to parameters at the granule level.	Passed Being Investigated Inferred Passed Suspect Failed Not Investigated Inferred Failed	VA25	DP
ScienceQualityFlagExplanation	A text explanation of the criteria used to set the ScienceQualityFlag including thresholds or other criteria.	(Free text)	VA255	DP
RangeBeginningDate	The year, month, and day when the temporal coverage period being described began.	YYYY-MM-DD	DT	PGE
RangeBeginningTime	The first hour, minute, and second of the temporal coverage period being described.	HH:MM:SSSSSSZ	T	PGE
RangeEndingDate	The last year, month, and day when the temporal coverage period being described.	YYYY-MM-DD	DT	PGE
RangeEndingTime	The last hour, minute, and second of the temporal coverage period being described.	HH:MM:SSSSSSZ	T	PGE
PGEVersion	The Release of the PGE software: e.g. "R6.1.2"		A10	PGE

3.8.3 Production History Metadata

The Production History Metadata is implemented as a single text block and written to the HDF file as a file level attribute. The Production History text block contains information about the L1 PGE and the running execution of the PGE to produce ESDT standard products. Static information in the text block describes the elements that make up the PGE like build configuration, support files and database table population. Dynamic information describes all the running parameters involved in a PGE execution for a specific RUN ID. This information is captured for both pre and post execution of the L1 Product PGE.

Table 3-22: L1 Production History

History Data	Data Description	Size (K)	State
ECS	Toolkit file for input/output file specification	23	Dynamic
Environment Variable	SIPS environment variables	5	Dynamic
Fetch	SIPS fetch list from archived	5	Dynamic
SIPS PCF	SIPS-specific PCF file for PGE processing	3	Dynamic
Workspace List (PRE)	File listing in SIPS PGE workspace prior to PGE execution	5	Dynamic
Workspace List (POST)	File listing in SIPS PGE workspace following PGE execution	5	Dynamic

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Runtime	CPU and Wallclock PGE run time	0.1	Dynamic
Control Definition	Framework Parameter Definition File for output files	1	Static
Control Parameter	Framework Parameter Specification File for output files	0.02	Static
Control Parameter (Runtime)	Framework Parameter specified in the command line of the PGE	0.02	Dynamic
TimeStamp	RUN ID begin date and end date timestamp	0.05	Dynamic
README	README file that describes production history context	1	Static
PGE Version	PGE version information	0.2	Static
PGE specific configurations	TBD	TBD	TBD

3.8.4 TES-Common Metadata

Metadata shown below is common to all TES files.

Table 3-23: TES-Common Metadata

Data Layer Name	Data Description	Units	Data Range	Size	HDF5Type
InstrumentName	TES	----			NATIVE_CHAR
ProcessLevel	L1B,L2,L3,etc.	----			NATIVE_CHAR
TAI93At0zOfGranule		----			NATIVE_DOUBLE
GlobalSurveyNumber/ID	Run ID	----	0..	64	NATIVE_INT64
GranuleMonth	Month granule was produced (from ECS MD RangeBeginningDate)		1-12	8	NATIVE_INT
GranuleDay	Day granule was produced (from ECS MD RangeBeginningDate)		1-31	8	NATIVE_INT
GranuleYear	Year granule was produced (from ECS MD RangeBeginningDate)				NATIVE_INT
SurveyMode	Type of survey, e.g., Global or Special				NATIVE_CHAR
PGEVersion	Release of PGE software: e.g. “R6.1.2”				NATIVE_CHAR
Command_Seq_ID	Command Sequence (Run) ID	N/A		32	NATIVE_INT32
Calib_Scheme	Calibration scheme with or without embedded black body scans: SPLIT_CAL or NON_SPLIT_CAL				NATIVE_CHAR

3.8.5 TES-L1B-Common Metadata

Metadata shown below is common to all TES L1B files.

The metadata item L1B_Data_Missing is calculated in the following way:

First, compute total_scans for the file, so for nadir scan is 144 and limb is 216,
then compute row_count that is in L1B_tgt_spectra_quality tables.
then compute difference between them and multiply it with 4 (number of focal planes) and 16 (number of pixels)
and then add error_count found in General_error_flag, which is count of 1's in that file
and then divide this number to total_scans * 4 * 16 and multiple by 100.

As code it looks like:

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L1B_Data_Missing =
((((total_scans - row_count) * NUM_FOCAL_PLANE * TES_PIXEL_DIM) + error_count) * 100)
/ ((total_scans * NUM_FOCAL_PLANE * TES_PIXEL_DIM));

Table 3-24: TES-L1B-Common Metadata

Data Name	Data Description	Units	Data Range	Size	HDF 5 Type
Run_Counter				32	NATIVE_INT32
Orbital_Path_ID			1..233	8	NATIVE_UINT8
Absolute_Orbit_Number				32	NATIVE_INT32
Time_Of_Observation_Start	TAI time, for first observation in file			64	NATIVE_DOUBLE
Time_Of_Observation_End	TAI time, for last observation in file			64	NATIVE_DOUBLE
Geolocation_Data_Missing	No geolocation for observation count			16	NATIVE_INT16
IceContamination	Ice contamination exceeded threshold.	N/A	0,1	8	NATIVE_INT
L1A_Data_Missing	Sum of missing scans and bad quality scans (per pixel) written as a percentage of the total number of scans for all focal planes at Level 1A	N/A	0..100.0	32	NATIVE_FLOAT
L1B_Data_Missing	Sum of missing scans and bad quality scans (per pixel) written as a percentage of the total number of scans for all focal planes at Level 1B	N/A	0..100.0	32	NATIVE_FLOAT

3.8.6 TES-L1B-Nadir Metadata

Metadata shown below is present only in TES L1B Nadir files.

Table 3-25: TES-L1B-Nadir Metadata

Data Name	Data Description	Units	Data Range	Size	HDF 5 Type
Start_Frequency	Start Frequency		500 - 3200	64	NATIVE_DOUBLE
Delta Frequency	Frequency step size		.01 - .1	64	NATIVE_DOUBLE

3.8.7 TES-L1B-Limb Metadata

Metadata shown below is present only in TES L1B Limb files.

Table 3-26: TES-L1B-Limb Metadata

Data Name	Data Description	Units	Data Range	Size	HDF 5 Type
Start_Frequency	Start Frequency		500 - 3200	64	NATIVE_DOUBLE
Delta_Frequency	Frequency step size		.01 - .1	64	NATIVE_DOUBLE

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3.8.8 TES-L1B-SO-Low Metadata

Metadata shown below is present only in TES L1B SO Low-Resolution files.

Table 3-27: TES-L1B-SO-Low Metadata

Data Name	Data Description	Units	Data Range	Size	HDF 5 Type
Start_Frequency	Start Frequency		500 - 3200	64	NATIVE_DOUBLE
Delta Frequency	Frequency step size		.01 - .1	64	NATIVE_DOUBLE
Observation_View	Specify Nadir or Limb view	N/A	'Nadir', 'Limb'		NATIVE_CHAR

3.8.9 TES-L1B-SO-High Metadata

Metadata shown below is present only in TES L1B SO High-Resolution files.

Table 3-28: TES-L1B-SO-High Metadata

Data Name	Data Description	Units	Data Range	Size	HDF 5 Type
Start_Frequency	Start Frequency		500 - 3200	64	NATIVE_DOUBLE
Delta_Frequency	Frequency step size		.01 - .1	64	NATIVE_DOUBLE
Observation_View	Specify Nadir or Limb view	N/A	'Nadir', 'Limb'		NATIVE_CHAR

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4. LEVEL 2 STANDARD AND SPECIAL OBSERVATION PRODUCTS

4.1 Overview

The TES Level 2 (L2) subsystem generates information pertaining to the abundance of trace gases in the troposphere from analysis of spectra generated from the TES Level 1B subsystem. These spectra are evaluated by L2 using modeling algorithms collectively referred to as *retrieval*. An iterative process, retrieval compares an observed spectra to a modeled spectra, determines their similarity/dissimilarity, and the modifies the modeled spectra. Nominally, the retrieval process is repeated until the modeled spectra matches the observed spectra within certain tolerances. In addition to retrieving information pertaining to the distribution of trace atmospheric gases, L2 retrieves temperature information for the sampled atmosphere. The "retrieved" information is stored for later generation of L2 Products.

Before L2 can generate its products, the retrieval process is completed for all target scenes comprising a global survey or Special Observation run. A Global Survey consists of 16 consecutive orbits at the start of a two-day cycle. A Special Observation run may be less than one orbit or span multiple orbits. There can be more than one Special Observation run in a single orbit.

Once all retrievals are performed, L2 products are produced. While each retrieval yields information pertaining to several trace molecules (and temperature), L2 products include information for one molecular species (or temperature) for an entire global survey or Special Observation run. Data are oriented in this fashion to facilitate science evaluations where only one or a minimal set of atmospheric gases are involved.

4.1.1 Standard Products

L2 standard data products are segregated by observation type (limb and nadir) to minimize the use of fill data. For nadir observations, TES L2 standard products are produced for the following molecular species: H_2O, O_3, CH_4, CO, HDO, CO2, NH3, N2O and TATM (atmosphieric temperature). For limb observations, L2 standard products include molecular species: H_2O, O_3, HDO, HNO_3, and TATM (atmospheric temperature). TES referred atmospheric temperature as TATM in TES L2 Products. According to AURA guidelines it should be Temperature. HDF5 alias is used for Temperature. L2 TES products have fields TATM and Temperature which are identical fields. Limb CO, NO2 and CH4 may be producted in future releases See Table 4-1.

Table 4-1: View and Species Types

Species	H2O	O3	CH4	CO	HDO	NO2	HNO3	TATM	CO2	NH3	N2O	CH3OH	CHOOH
Nadir Swath Object	X	X	X	X	X			X	X	X	X	X	X
Limb Swath Object	X	X			X		X	X					

To minimize the duplication of information among all these standard products, an additional standard prouduct, termed an TES L2 Ancillary Data product, will be generated as well. All TES L2 standard products report this information along a uniform UARS pressure grid ordered from ground to space.

To facilitate sharing data products between all Aura platform science teams, the organization of the L2 Standard Data Products conforms to specifications dictated in the HDF-EOS Aura File Format Guidelines (Craig, et al). These guidelines lay down the basic file format and data format specifications for all L2 standard products. While the specific referenced document should be checked for details, the guidelines specify that all L2 standard products should be generated using HDF-EOS V5.x formatting specifications. All data are to be reported as "swath" data objects. The Local Granule ID is a unique identifier for locally produced granules that are then sent to the ECS for archive. The Local Granule ID is also the filename of the standard data product produced by Level 2.

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In R12 all the L2_Products will be updated by netCDF dimentions: nTimes, nLevels, nLength and nFreq.

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The L2 standard product files are implemented using the HDF-EOS 5 file format. HDF-EOS 5 files have a default extension of ".he5". The ECS Local Granule ID (filename) for a L2 standard product is constructed using the following template:

TES-Aura_L2-<species>-<view>_r<run id>_<version id>.he5

Due to instrument lifetime concerns involving the TES Pointing Control Subsystem the means of instrument calibration was modified in April 2010. The calibration method and algorithm may be determined through the file naming convention used in the product files and also through the TES_Common metadata attribute Calib_Scheme.

Briefly, data acquired prior to April 7, 2010 will use the calibration scheme termed 'NON_SPLIT_CAL' in the TES_Common metadata attribute Calib_Scheme. Data acquired on and following April 7, 2010 will be identified in the TES_Common metadata attribute Calib_Scheme as 'SPLIT_CAL', and will additionally be identified with the designator 'C01' in the product file name for L1B, L2 and L3 product files.

On April 7, 2010 TES began collecting Global Survey data using a new split-calibration collection scheme. This calibration method as non-embedded blackbody scans bracketing the global survey. Special observation data collection was also modified on May 12, 2010. To distinguish between this new calibration scheme and data collected before these dates TES will introduce a calibration designator in the filename and product metadata.

TES-Aura_L2-<species>-<view>_r<run id>_C01_<version id>.he5

This filename with calibration designator is applicable for all global surveys with run IDs greater than or equal to 11125 and special observations with run IDs greater than or equal to 11189.

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Table 4-2: EOS Aura TES Standard Products (Level 2)

ESDT Short Name	ECS File Type	Collection Summary	Local Granule ID[a]
TL2H2ON	HDF-EOS	TES/Aura L2 H2O Nadir	TES-Aura_L2-H2O-Nadir_rnnnnnnnnnn_Fff_cc.he5
TL2H2OL	HDF-EOS	TES/Aura L2 H2O Limb	TES-Aura_L2-H2O-Limb_rnnnnnnnnnn_Fff_cc.he5
TL2O3N	HDF-EOS	TES/Aura L2 O3 Nadir	TES-Aura_L2-O3-Nadir_rnnnnnnnnnn_Fff_cc.he5
TL2O3L	HDF-EOS	TES/Aura L2 O3 Limb	TES-Aura_L2-O3-Limb_rnnnnnnnnnn_Fff_cc.he5
TL2CH4N	HDF-EOS	TES/Aura L2 CH4 Nadir	TES-Aura_L2-CH4-Nadir_rnnnnnnnnnn_Fff_cc.he5
TL2CON	HDF-EOS	TES/Aura L2 CO Nadir	TES-Aura_L2-CO-Nadir_rnnnnnnnnnn_Fff_cc.he5
TL2HDON	HDF-EOS	TES/Aura L2 HDO Nadir	TES-Aura_L2-HDO-Nadir_rnnnnnnnnnn_Fff_cc.he5
TL2HDOL	HDF-EOS	TES/Aura L2 HDO Limb	TES-Aura_L2-HDO-Limb_rnnnnnnnnnn_Fff_cc.he5
TL2HNO3L	HDF-EOS	TES/Aura L2 HNO3 Limb	TES-Aura_L2-HNO3-Limb_rnnnnnnnnnn_Fff_cc.he5
TL2ATMTN	HDF-EOS	TES/Aura L2Atmospheric Temperatures Nadir	TES-Aura_L2-ATM-TEMP-Nadir_rnnnnnnnnnn_Fff_cc.he5
TL2ATMTL	HDF-EOS	TES/Aura L2 Atmospheric Temperatures Limb	TES-Aura_L2-ATM-TEMP-Limb_rnnnnnnnnnn_Fff_cc.he5
TL2ANC	HDF-EOS	TES/Aura L2 Ancillary Data	TES-Aura_L2-ANCILLARY_rnnnnnnnnnn_Fff_cc.he5
TL2CH4L	HDF-EOS	TES/Aura L2 CH4 Limb	TES-Aura_L2-CH4-Limb_rnnnnnnnnnn_Fff_cc.he5
TL2COL	HDF-EOS	TES/Aura L2 CO Limb	TES-Aura_L2-CO-Limb_rnnnnnnnnnn_Fff_cc.he5
TL2NO2L	HDF-EOS	TES/Aura L2 NO2 Limb	TES-Aura_L2-NO2-Limb_rnnnnnnnnnn_Fff_cc.he5
TL2CO2N	HDF-EOS	TES/Aura L2 CO2 Nadir	TES-Aura_L2-CO2-Nadir_rnnnnnnnnnn_Fff_cc.he5
TL2NH3N	HDF-EOS	TES/Aura L2 NH3 Nadir	TES-Aura_L2-NH3-Nadir_rnnnnnnnnnn_Fff_cc.he5
TL2N2ON	HDF-EOS	TES/Aura L2 N2O Nadir	TES-Aura_L2-N2O-Nadir_rnnnnnnnnnn_Fff_cc.he5
TL2H2ON	HDF-EOS	TES/Aura L2 H2O Nadir	TES-Aura_L2-H2O-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5
TL2O3N	HDF-EOS	TES/Aura L2 O3 Nadir	TES-Aura_L2-O3-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5
TL2CH4N	HDF-EOS	TES/Aura L2 CH4 Nadir	TES-Aura_L2-CH4-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5
TL2CON	HDF-EOS	TES/Aura L2 CO Nadir	TES-Aura_L2-CO-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5
TL2HDON	HDF-EOS	TES/Aura L2 HDO Nadir	TES-Aura_L2-HDO-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5
TL2ATMTN	HDF-EOS	TES/Aura L2Atmospheric Temperatures Nadir	TES-Aura_L2-ATM-TEMP-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5
TL2ANC	HDF-EOS	TES/Aura L2 Ancillary Data	TES-Aura_L2-ANCILLARY_rnnnnnnnnnn_C01_Fff_cc.he5
TL2CO2N	HDF-EOS	TES/Aura L2 CO2 Nadir	TES-Aura_L2-CO2-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5
TL2NH3N	HDF-EOS	TES/Aura L2 NH3 Nadir	TES-Aura_L2-NH3-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5
TL2N2ON	HDF-EOS	TES/Aura L2 N2O Nadir	TES-Aura_L2-N2O-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5
TL2FORN	HDF-EOS	TES/Aura L2 CHOOH Nadir	TES-Aura_L2-CHOOH-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5
TL2MTLN	HDF-EOS	TES/Aura L2 CH3OH Nadir	TES-Aura_L2-CH3OH-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5

a. Limb CH4, CO and NO2 are not produced in this release.

As mentioned above, each TES L2 standard product reports information in a standardized data organization, the swath. Each swath element is bounded by (1) the number of observations in a global survey and (2) a predefined set of pressure levels representing slices through the atmosphere.

The organization of data within the swath object is based on a superset of the UARS pressure levels used to report concentrations of trace atmospheric gasses. The reporting grid is the same pressure grid used for modeling. Nadir products have 66 atmospheric reporting levels and limb products 87 atmospheric reporting levels. These levels range from 1211.53 hPa, which allows for very high surface pressure conditions, to 0.1 hPa, about 65 km. In addition, the nadir and limb products will report values directly at the surface when possible or at the observed cloud top level. Thus in the Standard Product files each nadir and limb observation can potentially contain estimates for the concentration of a particular molecule at 67 nadir and 88 limb different pressure levels within the atmosphere. However, for almost all retrieved profiles, the highest pressure levels are not observed due to a surface at lower pressure or cloud obscuration. For pressure levels corresponding to altitudes below the cloud top or surface, where measurements were not possible, a fill value will be applied.

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In the standard products, the data will be organized as shown in the diagram below. The diagram shows the organization for an example limb product at 88 pressure levels (87 + 1 surface pressure). For nadir there would be 67 pressure levels (66 + 1 surface pressure). The value retrieved at the surface pressure is placed at the level below the last valid atmospheric standard pressure level. (The user can identify the value retrieved at the surface pressure because the remaining "levels" below that will have a fill value.)

88 Levels	Obs. 1	Obs. 2	Obs. 3	Obs. 4	……..	Obs. 1149	Obs. 1150	Obs. 1151	Obs. 1152
88	Standard Pressure Level	Standard Pressure Level	Standard Pressure Level	Standard Pressure Level	……..	Standard Pressure Level	Standard Pressure Level	Standard Pressure Level	Standard Pressure Level
87	"	"	"	"	"	"	"	"	"
86	"	"	"	"	"	"	"	"	"
85	"	"	"	"	"	"	"	"	"
. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
8	"	"	"	"	……..	Surface Pressure	Standard Pressure Level	"	"
7	"	"	Standard Pressure Level	"	……..	Fill	Surface Pressure	Standard Pressure Level	"
6	"	Standard Pressure Level	Surface Pressure	Standard Pressure Level	……..	Fill	Fill	Surface Pressure	"
5	Standard Pressure Level	Surface Pressure	Fill	Surface Pressure	……..	Fill	Fill	Fill	Standard Pressure Level
4	Surface Pressure	Fill	Fill	Fill	……..	Fill	Fill	Fill	Surface Pressure
3	Fill	Fill	Fill	Fill	……..	Fill	Fill	Fill	Fill
2	Fill	Fill	Fill	Fill	……..	Fill	Fill	Fill	Fill
1	Fill	Fill	Fill	Fill	……..	Fill	Fill	Fill	Fill

Finally, other data are included with estimates for molecular concentration. Some of these data such as precision estimates are reported at the same density as the data points, while other information defines an aspect of a target scene's characteristics in a single data value

4.1.2 Special Observation Products

L2 Special Observation data products are also segregated into separate products by observation type (limb and nadir).

The L2 Special Observation files are also implemented using the HDF-EOS 5 file format. HDF-EOS 5 files have a default extension of ".he5". The filename for a L2 Special Observation product is constructed using the following template:

TES-Aura_L2-<species>-SO-<view>_r<run id>_<version id>.he5

Due to instrument lifetime concerns involving the TES Pointing Control Subsystem the means of instrument calibration was modified in April 2010. The calibration method and algorithm may be determined through the file naming convention used in the product files and also through the TES_Common metadata attribute Calib_Scheme.

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Briefly, data acquired prior to April 7, 2010 will use the calibration scheme termed 'NON_SPLIT_CAL' in the TES_Common metadata attribute Calib_Scheme. Data acquired on and following April 7, 2010 will be identified in the TES_Common metadata attribute Calib_Scheme as 'SPLIT_CAL', and will additionally be identified with the designator 'C01' in the product file name for L1B, L2 and L3 product files.

On April 7, 2010 TES began collecting Global Survey data using a new split-calibration collection scheme. This calibration method as non-embedded blackbody scans bracketing the global survey. Special observation data collection was also modified on May 12, 2010. To distinguish between this new calibration scheme and data collected before these dates TES will introduce a calibration designator in the filename and product metadata.

TES-Aura_L2-<species>-SO-<view>_r<run id>_C01_<version id>.he5

This filename with calibration designator is applicable for all global surveys with run IDs greater than or equal to 11125 and special observations with run IDs greater than or equal to 11189.

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Table 4-3: EOS Aura TES Special Observation Products (Level 2)

ESDT Short Name	ECS File Type	Collection Summary	Local Granule ID[a]
TL2H2ONS	HDF-EOS	TES/Aura L2 H2O Nadir Special Observation	TES-Aura_L2-H2O-SO-Nadir_rnnnnnnnnnn_ Fff_cc.he5
TL2H2OLS	HDF-EOS	TES/Aura L2 H2O Limb Special Observation	TES-Aura_L2-H2O-SO-Limb_rnnnnnnnnnn_ Fff_cc.he5
TL2O3NS	HDF-EOS	TES/Aura L2 O3 Nadir Special Observation	TES-Aura_L2-O3-SO-Nadir_rnnnnnnnnnn_ Fff_cc.he5
TL2O3LS	HDF-EOS	TES/Aura L2 O3 Limb Special Observation	TES-Aura_L2-O3-SO-Limb_rnnnnnnnnnn_ Fff_cc.he5
TL2CH4NS	HDF-EOS	TES/Aura L2 CH4 Nadir Special Observation	TES-Aura_L2-CH4-SO-Nadir_rnnnnnnnnnn_ Fff_cc.he5
TL2CONS	HDF-EOS	TES/Aura L2 CO Nadir Special Observation	TES-Aura_L2-CO-SO-Nadir_rnnnnnnnnnn_ Fff_cc.he5
TL2HDONS	HDF-EOS	TES/Aura L2 HDO Nadir Special Observation	TES-Aura_L2-HDO-SO-Nadir_rnnnnnnnnnn_ Fff_cc.he5
TL2HDOLS	HDF-EOS	TES/Aura L2 HDO Limb Special Observation	TES-Aura_L2-HDO-SO-Limb_rnnnnnnnnnn_ Fff_cc.he5
TL2HNO3S	HDF-EOS	TES/Aura L2 HNO3 Limb Special Observation	TES-Aura_L2-HNO3-SO-Limb_rnnnnnnnnnn_ Fff_cc.he5
TL2TNS	HDF-EOS	TES/Aura L2Atmospheric Temperatures Nadir Special Observation	TES-Aura_L2-ATM-TEMP-SO-Nadir_rnnnnnnnnnn_ Fff_cc.he5
TL2TLS	HDF-EOS	TES/Aura L2 Atmospheric Temperature Limb Special Observation	TES-Aura_L2-ATM-TEMP-SO-Limb_rnnnnnnnnnn_ Fff_cc.he5
TL2ANCS	HDF-EOS	TES/Aura L2 Ancillary Special Observation Data	TES-Aura_L2-ANCILLARY-SO_rnnnnnnnnnn_ Fff_cc.he5
TL2CH4LS	HDF-EOS	TES/Aura L2 CH4 Limb Special Observation	TES-Aura_L2-CH4-SO-Limb_rnnnnnnnnnn_ Fff_cc.he5
TL2COLS	HDF-EOS	TES/Aura L2 CO Limb Special Observation	TES-Aura_L2-CO-SO-Limb_rnnnnnnnnnn_ Fff_cc.he5
TL2NO2S	HDF-EOS	TES/Aura L2 NO2 Limb Special Observation	TES-Aura_L2-NO2-SO-Limb_rnnnnnnnnnn_ Fff_cc.he5
TL2CO2NS	HDF-EOS	TES/Aura L2 CO2 Nadir Special Obsrvation	TES-Aura_L2-CO2-SO-Nadir_rnnnnnnnnnn_ Fff_cc.he5
TL2NH3NS	HDF-EOS	TES/Aura L2 NH3 Nadir Special Observation	TES-Aura_L2-NH3-SO-Nadir_rnnnnnnnnnn_ Fff_cc.he5
TL2N2ONS	HDF-EOS	TES/Aura L2 N2O Nadir Special Observation	TES-Aura_L2-N2O-SO-Nadir_rnnnnnnnnnn_ Fff_cc.he5
TL2H2ONS	HDF-EOS	TES/Aura L2 H2O Nadir Special Observation	TES-Aura_L2-H2O-SO-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5
TL2O3NS	HDF-EOS	TES/Aura L2 O3 Nadir Special Observation	TES-Aura_L2-O3-SO-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5
TL2CH4NS	HDF-EOS	TES/Aura L2 CH4 Nadir Special Observation	TES-Aura_L2-CH4-SO-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5
TL2CONS	HDF-EOS	TES/Aura L2 CO Nadir Special Observation	TES-Aura_L2-CO-SO-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5
TL2HDONS	HDF-EOS	TES/Aura L2 HDO Nadir Special Observation	TES-Aura_L2-HDO-SO-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5
TL2TNS	HDF-EOS	TES/Aura L2Atmospheric Temperatures Nadir Special Observation	TES-Aura_L2-ATM-TEMP-SO-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5
TL2ANCS	HDF-EOS	TES/Aura L2 Ancillary Special Observation Data	TES-Aura_L2-ANCILLARY-SO_rnnnnnnnnnn_C01_Fff_cc.he5
TL2CO2NS	HDF-EOS	TES/Aura L2 CO2 Nadir Special Obsrvation	TES-Aura_L2-CO2-SO-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5
TL2NH3NS	HDF-EOS	TES/Aura L2 NH3 Nadir Special Observation	TES-Aura_L2-NH3-SO-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5
TL2N2ONS	HDF-EOS	TES/Aura L2 N2O Nadir Special Observation	TES-Aura_L2-N2O-SO-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5

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ESDT Short Name	ECS File Type	Collection Summary	Local Granule ID[a]
TL2FORNS	HDF-EOS	TES/Aura L2 CHOOH Nadir Special Observation	TES-Aura_L2-CHOOH-SO-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5
TL2MTLNS	HDF-EOS	TES/Aura L2 CH3OH Nadir Special Observation	TES-Aura_L2-CH3OH-SO-Nadir_rnnnnnnnnnn_C01_Fff_cc.he5

a. Limb CH4, CO and NO2 are not produced in this release

As above for Standard Products, each TES L2 Special Observation product reports information in a standardized data organization, the swath. Each swath element is bounded by (1) the number of observations in a Special Observation run and (2) a predefined set of pressure levels representing slices through the atmosphere as described above.

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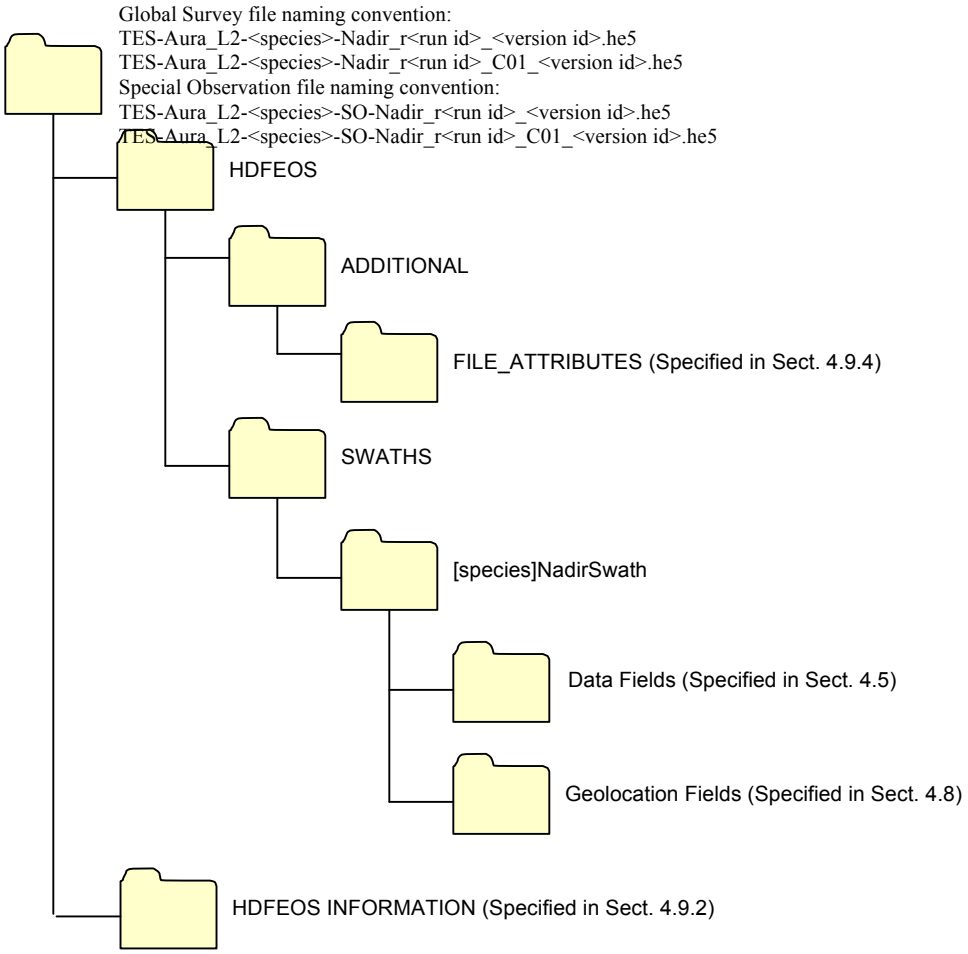
4.2 Nadir File Structure

The file structure of each nadir standard or special observation product is depicted in the figure below. In addition to the swath object (described above), each nadir standard product also contains descriptive metadata. The organization and layout of metadata conforms to HDF-EOS guidelines. First, an ECS Metadata block, metadata that includes a set of mandatory data describing attributes about the standard product is found at the beginning of every standard product. TES-specific metadata follows the ECS metadata. These metadata fields are used to describe TES specific details. Some of these data will be common among all TES products, some common only to TES Level 2 products, and some specific only to Nadir L2 products.



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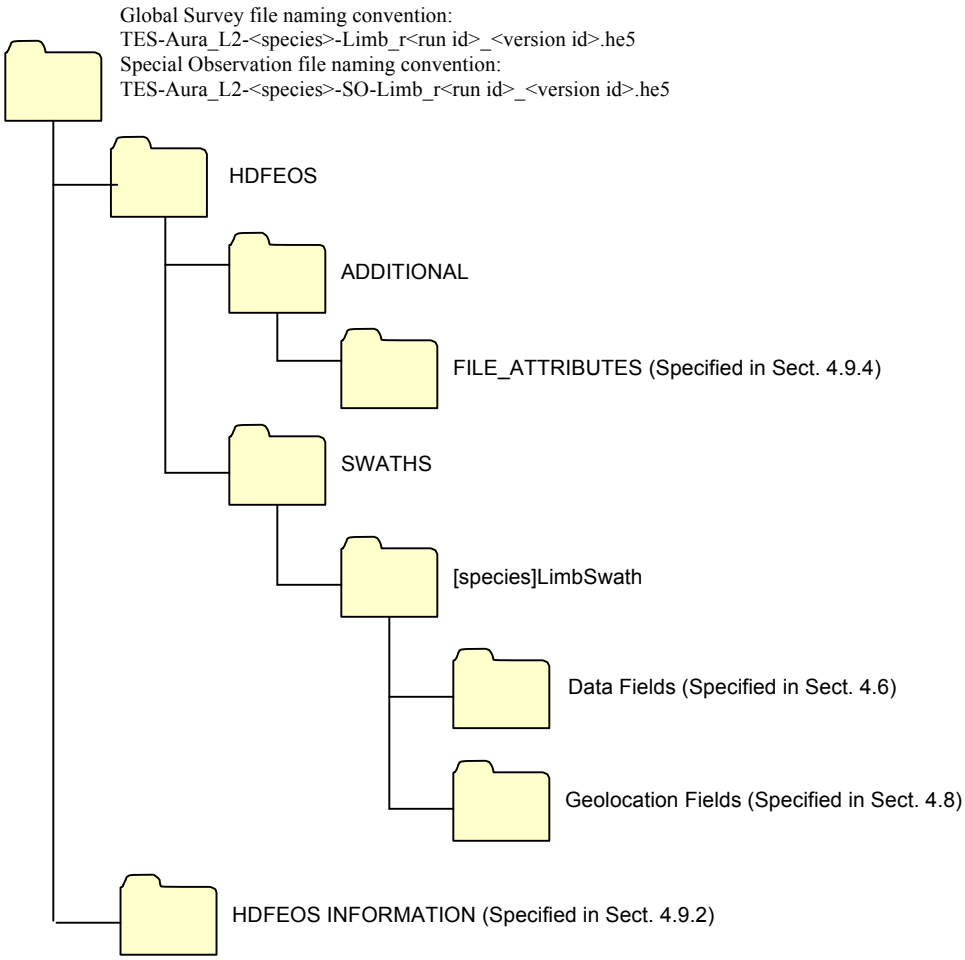
4.3 Limb File Structure

Similar in structure to the Nadir data product above , the Limb or High-Resolution product consists of both metadata and a swath data object (see figure below).



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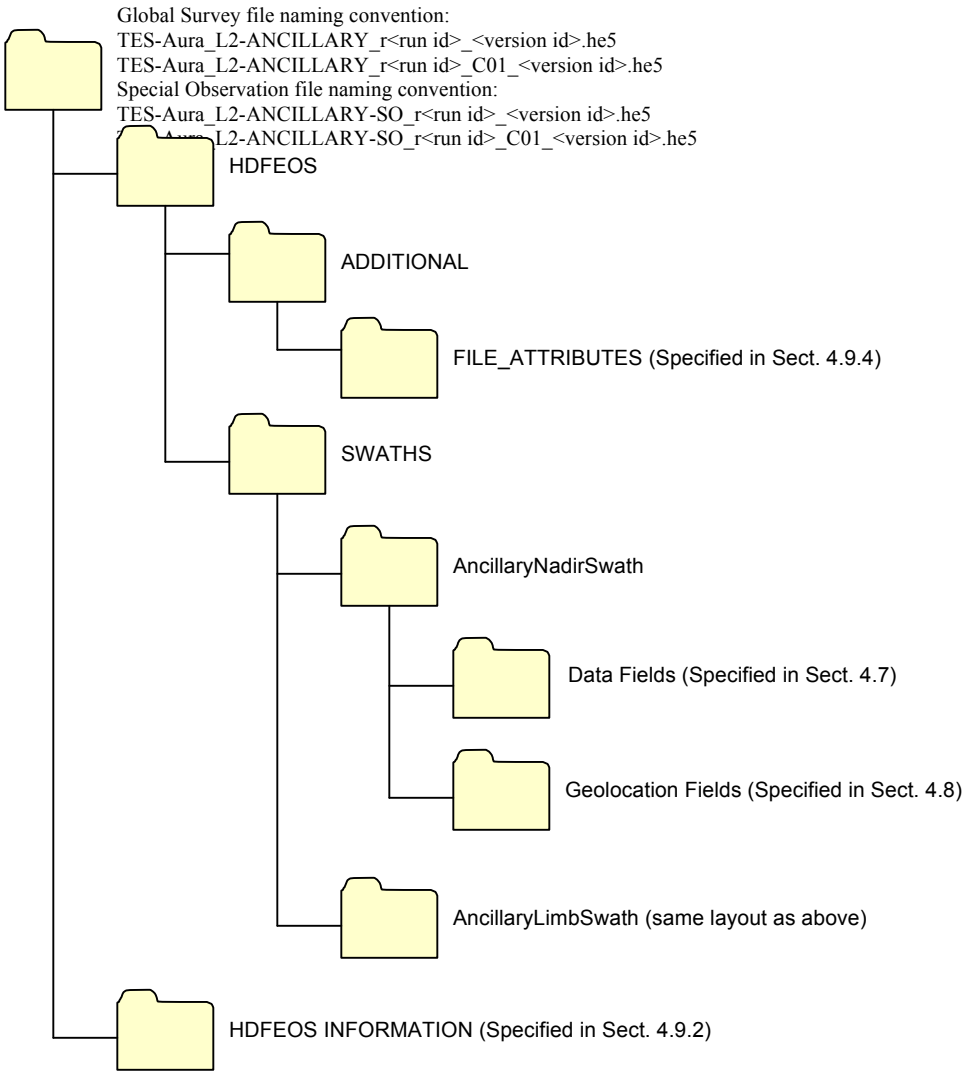
4.4 Ancillary File Structure

There are a number data items common to both Nadir and Limb observations that are consistent for all species for a given global survey or Special Observation run. Rather than replicate these items repeatedly with each file, these data items have been incorporated into a single file termed the TES L2 Ancillary Data product. Thus, the Ancillary product would be required as a partner to any L2 nadir or limb product. If for a given Global Survey or Special Observation run, no data are acquired for a particular viewing mode (Nadir or Limb) or all data for that mode are missing, the corresponding object (AncillaryNadirSwath or AncillayLimbSwath) is not written.

See figure below.



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4.5 Nadir Data Fields

The Nadir Data Fields consist of primary data fields, which are vmr or temperature profiles and other data dimensioned by time and pressure levels, and the associated data fields, which are only dimensioned by time.

Each Data Field will be annotated using HDF-EOS Local Attributes which are listed in the table below. Data Field Attributes are a feature which can be useful in annotating plots as well as describing the data product to input routines.

Attribute Name	Attribute Description	Size	HDF-EOS 5 Type
MissingValue	Contains the value for missing or fill dat 32 float : -999.0 64 double: -999.0 32 int : -999 16 int : -999 8 int : -99		Same type as Data Field
Title	For labeling a plot or axis.		NATIVE_CHAR
Units	Labeling units (for labeling color bars, converting between units, etc).		NATIVE_CHAR
UniqueFieldDefinition	Describes if definition of field is shared with other Aura Instruments ("Aura-Shared", "X-Specific", where X=Instrument Name, "X-Y[-Z]-Shared" where X,Y, and optional Z are instrume names (in alphabetical order)		NATIVE_CHAR

4.5.1 Nadir Primary Data Fields

The table below shows the swath data dimensions. The pressure levels as shown in this table are the 66 pressure levels plus one surface level as described in the Overview (Section 4.1).

All nadir swath data fields are based on a unified data structure and are used to report results of retrievals of spectra received from the L1B subsystem. The vmr data for the particular species of interest is the primary data element of each swath data layer. It is accompanied by various indices of error that help in evaluating the quality of the retrieval.

Table 4-3: Primary Data Dimensions Definitions

Dimension Name	Valid Value (Description)
nLevels	Number of reported pressure levels (66+Surface)
nTimes	Number of reported observations

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Table 4-4: Nadir Primary Data Fields

Data Field Name / Title *	Data Descriptions	Units	Data Range	Size	HDF-EOS 5 Type
[species] Temperature(Atmospheric Temperature) H2O HDO O3 CH4 CO CO2 NH3 N2O CHOOH CH3OH	vmr data or temperature data (dim nLevels x nTimes)	vmr or K		32	NATIVE_FLOAT
[species]Precision	Square-roots of diagonal elements of the measurement error covariance. See comment for TotalError regarding use. (dim nLevels x nTimes)	ln(vmr) or K		32	NATIVE_FLOAT
TotalError	Square-roots of diagonal elements the output total error covariance (includes smoothing error, systematic error, and measurement error). For T_{ATM}, these values are the error bars. For atmospheric species, the positive error bar is: error+ = exp(ln(vmr) + error) - vm The negative error bar is: error- = vmr - exp(ln(vmr) - error) (dim nLevels x nTimes)	ln(vmr) or K		32	NATIVE_FLOAT
~~VerticalResolution~~	Estimate of vertical resolution using the FWHM of averaging kernels (dim nLevels x nTimes)	meters		32	NATIVE_FLOAT
ConstraintVector	Constraint vector used in the retrieval (dim nLevels x nTimes)	vmr or K		32	NATIVE_FLOAT
AveragingKernel	The averaging kernel is the sensitivity of the estimated state to variations in the atmospheric state. The rows of the averaging kernel represent the sensitivity of the estimated state at a specific pressure level to variations in the atmospheric state at all levels. The columns of averaging kernel represent the sensitivity of the estimated state at all levels to variations in the atmospheric state at specific pressure level. For temperature, this is the sensitivity of the retrieved temperature to the true temperature. For atmospheric species this is the sensitivity of retrieved ln(vmr) to the true ln(vmr). (dim nLevels x nLevels x nTimes)	N/A		32	NATIVE_FLOAT

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Data Field Name / Title *	Data Descriptions	Units	Data Range	Size	HDF-EOS 5 Type
TotalErrorCovariance	Sum of measurement, systematic, and smoothing error covariances. For T_{ATM}, this is the covariance of the error of temperature. For atmospheric species, this is the covariance of the error of ln(vmr). (dim nLevels x nLevels x nTimes)	ln(vmr)^2 or K^2		32	NATIVE_FLOAT
MeasurementErrorCovariance	Propagated measured radiance noise. See comment for TotalErrorCovariance. (dim nLevels x nLevels x nTimes)	ln(vmr)^2 or K^		32	NATIVE_FLOAT
ObservationErrorCovariance	Measurement + systematic + cross-state errors. The utility of the observation error is for comparisons with other measurements and for assimilation. The smoothing error is accounted for when one applies the averaging kernel, so the observation error accounts for everything else. See comment for TotalErrorCovariance. (dim nLevels x nLevels x nTimes)	ln(vmr)^2 or K^		32	NATIVE_FLOAT
Initial	Initial vmr data or temperature data (for retrieved temperature) used in the retrieval (dim nLevels x nTimes)	vmr or K		32	NATIVE_FLOAT
AveragingKernelDiagonal	Diagonal of the averaging kernel, which shows retrieval sensitivity. For temperature, this is the sensitivity of the retrieved temperature to the true temperature. For atmospheric species this is the sensitivity of retrieved ln(vmr) to the true ln(vmr). (dim nLevels x nTimes)	N/A		32	NATIVE_FLOAT
AirDensity	Air density for each pressure level (dim nLevels x nTimes)	Molec/m^3	0-1e+26	32	NATIVE_FLOAT
Pressure	List of the Pressure Levels used (dim nLevels x nTimes)	hPa	0.001-1300.0	32	NATIVE_FLOAT
Altitude	Derived altitude for each pressure level (dim nLevels x nTimes)	meters	0-70000	32	NATIVE_FLOAT

* Where [species] equals H2O, O3, CH4, CO, HDO, CO2, NH3, N2O or Temperature

Ideally, species and associated precision and quality measures will be populated for all Target Scenes in the global survey. However, there will be times where completing retrievals will not be possible. The causes will be varied and might be due to bad spectra (based on evaluation by L1B), excessive cloud cover, or the retrieval was not performed for scheduling or other administrative reasons. Regardless of the cause for missing data, certain swath data fields will be set to a fill value according HDF-EOS Aura File Format Guidelines. Additionally, cloud cover may prevent retrieval down to the Earth's surface, resulting in partial retrievals. When such cases occur, pressure layers will contain fill values when no data exists.

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4.5.2 Nadir Associated Data Fields

The table below provides the associated data dimensions. The data items shown in the following tables are also included in the Swath Data as Associated Data:

Table 4-5: Associated Data Field Dimensions Definitions

Dimension Name	Valid Value (Description)
nTimes	Number of reported observations
nFreq	25 frequencies (values listed in TES-L2-Common metadata)
nLevels	Number of reported pressure levels (66+Surface)

Table 4-6: Nadir Associated Data Fields

Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
Scan_Averaged_Count	Number of scans averaged into a single target scene. (dim nTimes)	N/A	1-40 1 = no averaging	8	NATIVE_INT8
SpeciesRetrievalQuality	Species Retrieval Quality flag. True means retrieval passed quality check and reported errors are accurate. (dim nTimes)	N/A	0 = poor qualit 1 = passed quality check	8	NATIVE_INT8
CloudTopPressure	Pressure of inferred cloud top (species independent) (dim nTimes)	hPa	0.001 --1300.0	32	NATIVE_FLOAT
CloudTopPressureError	Error on Cloud Top Pressure. The positive error bar is error+ = exp(ln(CloudTopPressure + error) - CloudTopPressure. The negative error bar is error- = CloudTopPressure - exp(ln(CloudTopPressure - error). (dim nTimes)	hPa	-1..7	32	NATIVE_FLOAT
CloudEffectiveOpticalDepth	Vertical optical depth for the retrieved non-scattering cloud calculated at 25 frequencies listed in TES-L2-Common-Metadata (dim nTimes x nFreq)	N/A	0.0--500.0	32	NATIVE_FLOAT
CloudEffectiveOpticalDepthError	Error for Cloud Effective Optical Depth calculated at 25 frequencies listed in TES-L2-Common-Metadata (dim nTimes x nFreq)	N/A	0.0--500.0	32	NATIVE_FLOAT
AverageCloudEffOpticalDepth	Quality value: the cloud mean optica depth from 975 – 1200 cm-1. This is the same value for all species and tak from values at the final retrieval step. (dim nTimes)	cm-1	1000-1150	32	NATIVE_FLOAT
AverageCloudEffOpticalDepthError	Error for Cloud Effective Optical Dep calculated using a weighted average c frequencies between 975 & 1200. Th is the same value for all species and taken from values at the final retrieva step. (dim nTimes)	cm-1	1000-1150	32	NATIVE_FLOAT

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Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
SurfaceTemperature	Retrieved surface temperature from the last atmospheric temperature retrieval step (dim nTimes)	K	150.0 - 350	32	NATIVE_FLOAT
SurfaceTempError	Error in retrieved surface temperature (dim nTimes)	K	0.0 – 20.0	32	NATIVE_FLOAT
SurfaceTempInitial	Initial surface temperature at the start of the retrieval process, currently take from GMAO. (dim nTimes)	K	150.0 - 350	32	NATIVE_FLOAT
SurfaceTempDegreesOfFreedom	Degrees of freedom for surface temperature (dim nTimes)	N/A	0.0 – 2.0	32	NATIVE_FLOAT
SurfaceTempObservationError	Measurement + systematic + cross-st errors. The utility of the observation error is for comparisons with other measurements and for assimilation. The smoothing error is accounted for when one applies the averaging kerne so the observation error accounts for everything else. (dim nTimes)	K	0-50	32	NATIVE_FLOAT
SurfaceTempConstraint	Surface temperature value used to constrain the retrieval (species independent) (dim nTimes)	K	150.0 - 350	32	NATIVE_FLOAT
SurfaceTempPrecision	Square-root of diagonal element of th measurement error covariance (dim nTimes)	K	0.0 – 20.0	32	NATIVE_FLOAT
TotalColumnDensity	Total column amount computed from the retrieved profile. For the Atmospheric Temperature Product this will be a fill value. (dim nTimes)	Molec/cm^2	0 – 10^28	32	NATIVE_FLOAT
TotalColumnDensityError	Error in total column amount computed from total error covariance For the Atmospheric Temperature Product this will be a fill value. (dim nTimes)	Molec/cm^2	0 – 10^28	32	NATIVE_FLOAT
TotalColumnDensityInitial	Total column amount computed from the initial profile. For the Atmospheric Temperature Product this will be a fill value. (dim nTimes)	Molec/cm^2	0 – 10^28	32	NATIVE_FLOAT
~~SpeciesRetrievalConverged~~	Indicates whether the non-linear least squares solver converged to a minimum. True=1, False=0 (dim nTimes)	N/A	0 or 1 (Boolean)	8	NATIVE_INT8
~~DeviationVsRetrievalCovariance~~	Deviation vs. Retrieval Covariance (dim nTimes)	N/A	-10000.0 – 10000.0	32	NATIVE_FLOAT
RadianceResidualMean	Mean of the model and data radiance difference (per species). (dim nTimes)	N/A	-1000.0 – 1000.0	32	NATIVE_FLOAT
RadianceResidualRMS	RMS of model and data difference (dim nTimes)	N/A	0.0 – 100.0	32	NATIVE_FLOAT
~~RadianceResidualMax~~	Maximum absolute difference between model and data (dim nTimes)	N/A	-10000.0 – 10000.0	32	NATIVE_FLOAT

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Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
~~NumberIterPerformed~~	Actual number of iterations performed (dim nTimes)	Integer	Small number, typically < 8 and could be 0	8	NATIVE_INT8
~~MaxNumIterations~~	Maximum number of iterations allowed for convergence (dim nTimes)	N/A	<100	8	NATIVE_INT8
DegreesOfFreedomForSignal	Number of independent parameters for the profile (trace of the averaging kernel) (dim nTimes)	N/A	0.0—1000.0	32	NATIVE_FLOAT
~~InformationContent~~	Relative decrease in error volume with respect to a priori (dim nTimes)	N/A	-100.0—1000.0	32	NATIVE_FLOAT
CloudVariability_QA	Quality value calculated from cloud variability. This will be fill for the species HDO and H2O. (dim nTimes)	N/A	0- 100	32	NATIVE_FLOAT
KDotDL_QA	Quality value calculating the signal left in the residual. This is the maximum of the dot product of the Jacobian (K) and the Radiance (L) divided by sqrt(K dot K) * sqrt(L dot L) (dim nTimes)	N/A	-100 - 100	32	NATIVE_FLOAT
LDotDL_QA	Quality value calculating the signal left in the residual. This is the dot product of the radiance (L) with the residual (dL) divided by sqrt(L dot L) * sqrt(dL dot dL) (dim nTimes)	N/A	-100 - 100	32	NATIVE_FLOAT
~~Calibration_QA~~	Quality value of calculated from the calibration factors. This will be fill for the species HDO and H2O. (dim nTimes)	N/A	-2 - 2	32	NATIVE_FLOAT
H2O_HDO_Corr_QA	Checks that the H2O estimated in H2O / HDO step is consistent with H2O from TATM step. This will be fill in all products except H2O and HDO. (dim nTimes)	N/A	-50.0 – 50.0	32	NATIVE_FLOAT
SurfaceEmissMean_QA	Quality value comparing the retrieved emissivity to the initial emissivity. Fi for ocean and limb scenes. This will b fill for the species HDO and H2O. (dim nTimes)	N/A	-2 - 2	32	NATIVE_FLOAT
SurfaceTempVsApriori_QA	Quality value comparing the surface temperature to a priori value (dim nTimes)	K	-100 - 100	32	NATIVE_FLOAT
SurfaceTempVsAtmTemp_QA	Quality value comparing the surface temperature to the lowest atmospheri pressure. This will be fill for the species CO, CH4, HDO, and H2O. (dim nTimes)	K	-100 - 100	32	NATIVE_FLOAT
SurfaceEmissionLayer_QA	Quality value comparing the atmospheric temperature to the surfac temperature when ozone near the surface is elevated. This field will be fill for C CH4, HDO and most H2O	N/A	-100 - 100	32	NATIVE_FLOAT

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Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
Desert_Emiss_QA	Quality value probable high silicate geological content with possible impact on retrieval (probable impact for methanol retrieval). (dim nTimes)	N/A	1-Good QA 0=Bad QA	2	NATIVE_INT8
UTCTime	UTC time of ZPD (Zero Path Difference) 27 character string. (dim nTimes x nLength)	N/A		28	HE5T_CHARSTRING String data type
O3_Ccurve_QA	Quality value indicating ozone with an unrealistic lapse rate, with values too high in the near-surface layers and too low around 350-200 hPa. 0=bad QA, 1=good QA Fill and default value = -99 (dim nTimes)	N/A	1=Good QA, 0=Poor QA	8	NATIVE_INT8
TropopausePressure	Pressure between the troposphere and stratosphere used to calculate the tropospheric column (dim nTimes)	hPa	10 - 1300	32	NATIVE_FLOAT
OzoneTroposphericColumn	Column amount from the surface to TropopausePressue computed from the retrieved profile. (dim nTimes)	Molec/ cm^2	0 – 10^28	32	NATIVE_FLOAT
OzoneTroposphericColumnError	Error in the column amount from the surface to TropopausePressue computed from the total error covariance. (dim nTimes)	Molec/ cm^2	0 – 10^28	32	NATIVE_FLOAT
OzoneTroposphericColumnInitia	Initial column amount from the surface to TropopausePressue computed from the initial profile. (dim nTimes)	Molec/ cm^2	0 – 10^28	32	NATIVE_FLOAT
OzoneIRK	OzoneIRK is the sensitivity to the outgoing longwave radiation in th 10 micron band to variations in ozone at each pressure level. (dim nLevels x nTimes)	(milli-watts/ m^2)/ppb	-100 to 100	32	NATIVE_FLOAT
FmOzoneBandFlux	The long-wave ozone radiative flux from Measured radiance (dim nTimes)	W/m^2		32	NATIVE_FLOAT
L1BOzoneBandFlux	The long-wave ozone radiative flux from calculated radiance (dim nTimes)	W/m^2		32	NATIVE_FLOAT
ResidualNormInitial	Cost function used in quality determination for methanol (reported for all species)		0-999	32	NATIVE_FLOAT
ResidualNormFinal	Cost function used in quality determination for methanol (reported for all species)		0-999	32	NATIVE_FLOAT

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4.6 Limb Data Fields

Like the Nadir Data Fields, the Limb Data Fields consist of the primary data fields, which are vmr or temperature profiles and other data dimensioned by time and pressure levels, and the associated data fields, which are only dimensioned by time.

Each Data Field will be annotated using HDF-EOS Local Attributes which are listed in the table below. Data Field Attributes are a feature which can be useful in annotating plots as well as describing the data product to input routines.

Attribute Name	Attribute Description	Size	HDF-EOS 5 Type
MissingValue	Contains the value for missing or fill data. 32 float : -999.0 64 double: -999.0 32 int : -999 16 int : -999 8 int : -99		Same type as Data Field
Title	For labeling a plot or axis.		NATIVE_CHAR
Units	Labeling units (for labeling color bars, converting between units, etc).		NATIVE_CHAR
UniqueFieldDefinition	Describes if definition of field is shared with other Aura Instruments ("Aura-Shared", "X-Specific", where X=Instrument Name, "X-Y[-Z]-Shared" where X,Y, and optional Z are instrumer names (in alphabetical order)		NATIVE_CHAR

4.6.1 Limb Primary Data Fields

All swath data fields are based on a unified data structure and are used to report results of retrievals of spectra received from the L1B subsystem. The vmr data for the particular species of interest is the primary data element of each swath data layer. It is accompanied by various indices of error that help in evaluating the quality of the retrieval.

Ideally, species and associated precision and quality measures will be populated for all Target Scenes in the global survey. However, there will be times where completing retrievals will not be possible. The causes will be varied and might be due to bad spectra (based on evaluation by L1B), excessive cloud cover, or the retrieval was not performed for scheduling or other administrative reasons. Regardless of the cause for missing data, certain swath data fields will be set to a fill value according to the HDF-EOS Aura File Format Guidelines. Additionally, cloud cover may prevent retrieval down to the Earth's surface, resulting in partial retrievals. When such cases occur, pressure layers will contain fill values when no data exists.

Table 4-7: Primary Data Fields Dimensions Definitions

Dimension Name	Valid Value (Description)
nLevels	Number of reported pressure levels (88)
nTimes	Number of reported observations

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Table 4-8: Limb Primary Data Fields

Data Field Name / Title *	Data Descriptions	Units	Data Range	Size	HDF-EOS 5 Type
[species] Temperature (Atmospheric Temperature) H2O HDO O3 HNO3 (Limb CH4, CO and NO2 are not produced in this release)	vmr data or temperature data (for retrieved temperature) (dim nLevels x nTimes)	vmr or K		32	NATIVE_FLOAT
[species]Precision	Square-roots of diagonal elements of the measurement error covariance. See comment for TotalError regarding use. (dim nLevels x nTimes)	ln(vmr) or K		32	NATIVE_FLOAT
TotalError	Square-roots of diagonal elements o the output total error covariance (includes smoothing error, systemat error, and measurement error). For T_{ATM}, these values are the error bars For atmospheric species, the positiv error bar is: error+ = exp(ln(vmr) + error) - vmr. The negative error bar is: error- = vmr - exp(ln(vmr) - erro (dim nLevels x nTimes)	ln(vmr) or K		32	NATIVE_FLOAT
~~VerticalResolution~~	Estimate of vertical resolution using the FWHM of averaging kernels (dim nLevels x nTimes)	meters		32	NATIVE_FLOAT
ConstraintVector	Constraint vector used in the retrieval (dim nLevels x nTimes)	vmr or K		32	NATIVE_FLOAT
AveragingKernel	The averaging kernel is the sensitivity of the estimated state to variations in the atmospheric state. The rows of the averaging kernel represent the sensitivity of the estimated state at a specific pressure level to variations in the atmospheric state at all levels. The columns of averaging kernel represent the sensitivity of the estimated state at all levels to variations in the atmospheric state at specific pressure level. For temperature, this is the sensitivity of the retrieved temperature to the true temperature. For atmospheric species this is the sensitivity of retrieved ln(vmr) to the true ln(vmr). (dim nLevels x nLevels x nTimes)	N/A		32	NATIVE_FLOAT
TotalErrorCovariance	Sum of measurement, systematic, and smoothing error covariances. For T_{ATM}, this is the covariance of the error of temperature. For atmospheric species, this is the covariance of the error of ln(vmr). (dim nLevels x nLevels x nTimes)	ln(vmr)^2 or K^2		32	NATIVE_FLOAT

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Data Field Name / Title *	Data Descriptions	Units	Data Range	Size	HDF-EOS 5 Type
MeasurementErrorCovariance	Propagated measured radiance noise. See comment for TotalErrorCovariance. (dim nLevels x nLevels x nTimes)	ln(vmr)^2 or K^2		32	NATIVE_FLOAT
ObservationErrorCovariance	Measurement + systematic + cross-state errors. The utility of the observation error is for comparisons with other measurements and for assimilation. The smoothing error is accounted for when one applies the averaging kernel, so the observation error accounts for everything else. See comment for TotalErrorCovariance. (dim nLevels x nLevels x nTimes)	ln(vmr)^2 or K^2		32	NATIVE_FLOAT
Initial	Initial vmr data or temperature data (for retrieved temperature) used in the retrieval (dim nLevels x nTimes)	vmr or K		32	NATIVE_FLOAT
AveragingKernelDiagonal	Diagonal of the averaging kernel, which shows retrieval sensitivity. For temperature, this is the sensitivity of the retrieved temperature to the true temperature. For atmospheric species this is the sensitivity of retrieved ln(vmr) to the true ln(vmr). (dim nLevels x nTimes)	N/A		32	NATIVE_FLOAT
AirDensity	Air density for each pressure level (dim nLevels x nTimes)	Molec/m^3	0-1e+26	32	NATIVE_FLOAT
Pressure	List of the 88 Pressure Levels used (dim nLevels x nTimes)	hPa	0.001-1300.0	32	NATIVE_FLOAT
Altitude	Derived altitude for each pressure level (dim nLevels x nTimes)	meters	0-70000	32	NATIVE_FLOAT

* Where [species] equals H2O, O3, HDO, HNO3, or Temperature. Limb CH4, CO and NO2 are not produced in this release

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4.6.2 Limb Associated Data Fields

The table below provides the associated data dimensions. The data items shown in the following tables are also included in the Swath Data as Associated Data:

Table 4-9: Associated Data Field Dimensions Definitions

Dimension Name	Valid Value (Description)
nTimes	Number of reported observations
nFreq	25 frequencies (values listed in TES-L2-Common metadata
nPixels	16 number of pixels from one focal plane

Table 4-10: Limb Associated Data Fields

Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
SpeciesRetrievalQuality	Species Retrieval Quality flag. True means retrieval passed quality check and reported errors are accurate. (dim nTimes)	N/A	0 = poor quality 1 = passed quality chec	8	NATIVE_INT8
CloudTopPressure	Pressure of inferred cloud top (specie independent) (dim nTimes)	hPa	0.001 -- 1300.0	32	NATIVE_FLOAT
CloudTopPressureError	Error on Cloud Top Pressure. The positive error bar is error+ = exp(ln(CloudTopPressure + error) - CloudTopPressure. The negative error bar is error- = CloudTopPressure - exp(ln(CloudTopPressure - error). (dim nTimes)	hPa	-1..7	32	NATIVE_FLOAT
CloudEffectiveOpticalDepth	Vertical optical depth for the retrieved non-scattering cloud calculated at 25 frequencies listed in TES-L2-Common-Metadata (dim nTimes x nFreq)	N/A	0.0--500.0	32	NATIVE_FLOAT
CloudEffectiveOpticalDepthErr or	Error for Cloud Effective Optical Depth calculated at 25 frequencies listed in TES-L2-Common-Metadata (dim nTimes x nFreq)	N/A	0.0--500.0	32	NATIVE_FLOAT
AverageCloudEffOpticalDepth	Quality value: the cloud mean optica depth from 975 – 1200 cm-1. This is the same value for all species and tak from values at the final retrieval step. (dim nTimes)	cm-1	1000-1150	32	NATIVE_FLOAT

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Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
AverageCloudEffOpticalDepth Error	Error for Cloud Effective Optical Dep calculated using a weighted average c frequencies between 975 & 1200. Th is the same value for all species and taken from values at the final retrieva step. (dim nTimes)	cm-1	1000-1150	32	NATIVE_FLOAT
TotalColumnDensity	Total column amount computed from the retrieved profile. For the Atmospheric Temperature Product this will be a fill value. (dim nTimes)	Molec/cm^2	0 – 10^28	32	NATIVE_FLOAT
TotalColumnDensityError	Error in total column amount computed from total error covariance For the Atmospheric Temperature Product this will be a fill value. (dim nTimes)	Molec/cm^2	0 – 10^28	32	NATIVE_FLOAT
TotalColumnDensityInitial	Total column amount computed from the initial profile. For the Atmospheric Temperature Product this will be a fill value. (dim nTimes)	Molec/cm^2	0 – 10^28	32	NATIVE_FLOAT
~~SpeciesRetrievalConverged~~	Indicates whether the non-linear least squares solver converged to a minimum. True=1, False=0 (dim nTimes)	N/A	0 or 1 (Boolean)	8	NATIVE_INT8
~~DeviationVsRetrievalCovariance~~	Deviation vs. Retrieval Covariance (dim nTimes)	N/A	-10000.0 – 10000.0	32	NATIVE_FLOAT
RadianceResidualMean	Mean of the model and data radiance difference (per species). Per pixel from focal plane used in retrieval. (dim nTimes x nPixels)	N/A	-1000.0 – 1000.0	32	NATIVE_FLOAT
RadianceResidualRMS	RMS of model and data difference. Per pixel from focal plane used in retrieval. (dim nTimes x nPixels)	N/A	0.0 – 100.0	32	NATIVE_FLOAT
~~RadianceResidualMax~~	Maximum absolute difference betwee model and data (dim nTimes)	N/A	-10000.0 – 10000.0	32	NATIVE_FLOAT
~~NumberIterPerformed~~	Actual number of iterations performe (dim nTimes)	Integer	Small number, typically < 8 and could be 0	8	NATIVE_INT8
~~MaxNumIterations~~	Maximum number of iterations allow for convergence (dim nTimes)	N/A	< 100	8	NATIVE_INT8
DegreesOfFreedomForSignal	Number of independent parameters for the profile (trace of the averaging kernel) (dim nTimes)	N/A	0.0—1000.0	32	NATIVE_FLOAT
~~InformationContent~~	Relative decrease in error volume with respect to a priori (dim nTimes)	N/A	-100.0—1000.0	32	NATIVE_FLOAT
CloudVariability_QA	Quality value calculated from cloud variability (dim nTimes)	N/A	0- 100	32	NATIVE_FLOAT

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Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
KDotDL_QA	Quality value calculating the signal left in the residual. This is the maximum of the dot product of the Jacobian (K) and the Radiance (L) divided by sqrt(K dot K) * sqrt(L dot L) (dim nTimes)	N/A	-100 - 100	32	NATIVE_FLOAT
LDotDL_QA	Quality value calculating the signal left in the residual. This is the dot product of the radiance (L) with the residual (dL) divided by sqrt(L dot L) * sqrt(dL dot dL) (dim nTimes)	N/A	-100 - 100	32	NATIVE_FLOAT
~~Calibration_QA~~	Quality value of calculated from the calibration factors. This will be fill fo the species HDO and H2O. (dim nTimes)	N/A	-2 - 2	32	NATIVE_FLOAT
H2O_HDO_Corr_QA	Checks that the H2O estimated in H2O / HDO step is consistent with H2O from TATM step. This will be fill in all products except H2O and HDO. (dim nTimes)	N/A	-50.0 – 50.0	32	NATIVE_FLOAT
UTCTime	UTC time of ZPD (Zero Path Difference) 27 character string. (dim nTimes x nLength)	N/A		28	HE5T_CHARSTRING String data type
TropopausePressure	Pressure between the troposphere and stratosphere used to calculate the tropospheric column (dim nTimes)	hPa	10 - 1300	32	NATIVE_FLOAT

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4.7 Ancillary Data Fields

The Ancillary ESDT contains the Associated Data Fields common to all species that were not included in the individual species files. One Ancillary ESDT will be created for each global survey. If for a given Global Survey or Special Observation run, no data are acquired for a particular viewing mode (Nadir or Limb) or all data for that mode are missing, the corresponding object (AncillaryNadirSwath or AncillayLimbSwath) is not written.

Each Data Field will be annotated using HDF-EOS Local Attributes which are listed in the table below. Data Field Attributes are a feature which can be useful in annotating plots as well as describing the data product to input routines.

Attribute Name	Attribute Description	Size	Type	HDF-EOS 5 Type
MissingValue	Contains the value for missing or fill data. 32 float : -999.0 64 double: -999.0 32 int : -999 16 int : -999 8 int : -99			Same type as Data Field
Title	For labeling a plot or axis.		char	NATIVE_CHAR
Units	Labeling units (for labeling color bars, converting between units, etc).		char	NATIVE_CHAR
UniqueFieldDefinition	Describes if definition of field is shared with other Aura Instruments ("Aura-Shared", "X-Specific", where X=Instrument Name, "X-Y[-Z]-Shared" where X,Y, and optional Z are instrumer names (in alphabetical order)		char	NATIVE_CHAR

Each Ancillary ESDT will consist of two Ancillary Data swaths, Nadir and Limb. Each Ancillary Data swath will contain the following data items:

Table 4-11: Ancillary Data Dimensions Definitions

Dimension Name	Valid Value (Description)
nTimes	Number of reported observations
nFreq	121 emissivity wavenumbers (listed in TES-L2-Common metadata)
nLevels	Number of reported pressure levels
nPixels	64 total number of pixels

Table 4-12: Ancillary Nadir Data Fields

Ancillary Data Fields / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
SpacecraftLatitude	Geodetic latitude referenced to WGS84 ellipsoid (dim nTimes)	Decimal degrees	± 90.0	32	NATIVE_FLOAT
SpacecraftLongitude	Longitude referenced to WGS84 ellipsoid (dim nTimes)	Decimal degrees	± 180.0	32	NATIVE_FLOAT

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Ancillary Data Fields / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
SpacecraftAltitude	Height referenced to WGS84 ellipsoid (dim nTimes)	meters		32	NATIVE_FLOAT
OrbitAscendingFlag	True=1, False=0 (dim nTimes)	N/A	0 or 1 (Boolean	8	NATIVE_INT8
SolarAzimuthAngle	Solar azimuth angle relative to the local north at the geolocation. (From geolocation table) (dim nTimes)	Decimal degrees		32	NATIVE_FLOAT
PixelsUsedFlag	True=1, False=0 (dim nTimes x nPixels)	N/A	64 chars, one for each pixel	520 total	NATIVE_CHAR
SurfaceEmissivity	Retrieved surface emissivity for land nadir targets. Fill values for scenes where emissivity not retrieved. (dim nFreq x nTimes)	N/A	0.0 - 2.0	32	NATIVE_FLOAT
SurfaceEmissErrors	Errors in retrieved surface emissivity for land nadir targets. Fill values for scenes where emissivity not retrieved. (dim nFreq x nTimes)	N/A		32	NATIVE_FLOAT
SurfaceEmissConstraint	A priori surface emissivity for land nadir targets. Fill values for scenes where emissivity not retrieved. (dim nFreq x nTimes)	N/A	0.0 - 2.0	32	NATIVE_FLOAT
SurfaceEmissInitial	Initial surface emissivity land nadir targets. (dim nFreq x nTimes)	N/A	0.0 - 2.0	32	NATIVE_FLOAT
HDO_H2OMeasurementErrorCovariance	The HDO-H2O off diagonal component of the measurement error covariance (dim nLevels x nLevels x nTimes)	N/A	-4.0 – 4.0	32	NATIVE_FLOAT
HDO_H2OObservationErrorCovariance	The HDO-H2O off diagonal component for the Observation error covariance (dim nLevels x nLevels x nTimes)	N/A	-4.0 – 4.0	32	NATIVE_FLOAT
HDO_H2OTotalErrorCovariance	The HDO-H2O off diagonal component of the total error covariance (dim nLevels x nLevels x nTimes)	N/A	-4.0 – 4.0	32	NATIVE_FLOAT
HDO_H2OAveragingKernel	The averaging kernel is the sensitivity of the estimated state to variations in the atmospheric state. The rows of the averaging kernel represent the sensitivity of the estimated state at a specific pressure level to variations in the atmospheric state at all levels. The columns of averaging kernel represent the sensitivity of the estimated state at all levels to variations in the atmospheric state at specific pressure level. Averaging kernel terms for joint HDO and water retrieval (influence of H2O on HDO) (dim nLevels x nLevels x nTimes)	N/A	-10.0 –10.0	32	NATIVE_FLOAT

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Ancillary Data Fields / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
H2O_HDOAveragingKernel	The averaging kernel is the sensitivity of the estimated state to variations in the atmospheric state. The rows of the averaging kernel represent the sensitivity of the estimated state at a specific pressure level to variations in the atmospheric state at all levels. The columns of averaging kernel represent the sensitivity of the estimated state at all levels to variations in the atmospheric state at specific pressure level. Averaging kernel terms for joint HDO and water retrieval (influence of HDO on H2O) (dim nLevels x nLevels x nTimes)	N/A	-10.0 – 10.0	32	NATIVE_FLOAT
Filter_Position_1A	Filter position for Focal Plane 1A (dim nTimes)	N/A	1-5	8	NATIVE_INT8
Filter_Position_1B	Filter position for Focal Plane 1B (dim nTimes)	N/A	1-2	8	NATIVE_INT8
Filter_Position_2A	Filter position for Focal Plane 2A (dim nTimes)	N/A	1-4	8	NATIVE_INT8
Filter_Position_2B	Filter position for Focal Plane 2B (dim nTimes)	N/A	1	8	NATIVE_INT8
UTCTime	UTC time of ZPD (Zero Path Difference) 27 character string. (dim nTimes x nLength)	N/A		28	HE5T_CHARSTRING String data type
SurfaceTempInitialRefined	Surface temperature feeding into the atmospheric profile retrieval steps. This temperature may be the same as SurfaceTempInitial or it may have undergone an initial guess refinement. (dim nTimes)	K	150.0 - 350	32	NATIVE_FLOAT

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Table 4-13: Ancillary Limb Data Fields

Ancillary Data Fields / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
SpacecraftLatitude	Geodetic latitude referenced to WGS84 ellipsoid (dim nTimes)	Decimal degrees	± 90.0	32	NATIVE_FLOAT
SpacecraftLongitude	Longitude referenced to WGS84 ellipsoid (dim nTimes)	Decimal degrees	± 180.0	32	NATIVE_FLOAT
SpacecraftAltitude	Height referenced to WGS84 ellipsoid (dim nTimes)	meters		32	NATIVE_FLOAT
OrbitAscendingFlag	True=1, False=0 (dim nTimes)	N/A	0 or 1 (Boolean	8	NATIVE_INT8
SolarAzimuthAngle	Solar azimuth angle relative to local north at the spacecraft. (dim nTimes)	Decimal degrees		32	NATIVE_FLOAT
PixelsUsedFlag	True=1, False=0 (dim nTimes x nPixels)	N/A	64 chars, one for each pixel	520 total	NATIVE_CHAR
RetrievedPointingAngle	Retrieved value of the boresight nadir angles using TES limb spectral radiances. (Limb only) (dim nTimes)	Decimal degrees		32	NATIVE_FLOAT
RetrievedPointingAngleError	Error of retrieved value of the boresight nad angles using TES limb spectral radiances. (Limb only) (dim nTimes)	Decimal degrees		32	NATIVE_FLOAT
HDO_H2OMeasurementErrorCovariance	The HDO-H2O off diagonal component of the measurement error covariance (dim nLevels x nLevels x nTimes)	N/A	-4.0 – 4.0	32	NATIVE_FLOAT
HDO_H2OObservationErrorCovariance	The HDO-H2O off diagonal component for the Observation error covariance (dim nLevels x nLevels x nTimes)	N/A	-4.0 – 4.0	32	NATIVE_FLOAT
HDO_H2OTotalErrorCovariance	The HDO-H2O off diagonal component of the total error covariance (dim nLevels x nLevels x nTimes)	N/A	-4.0 – 4.0	32	NATIVE_FLOAT
HDO_H2OAveragingKernel	The averaging kernel is the sensitivity of the estimated state to variations in the atmospheric state. The rows of the averaging kernel represent the sensitivity of the estimated state at a specific pressure level to variations in the atmospheric state at all levels. The columns of averaging kernel represent the sensitivity of the estimated state at all levels to variations in the atmospheric state at specific pressure level. Averaging kernel terms for joint HDO and water retrieval (influence of H2O on HDO) (dim nLevels x nLevels x nTimes)	N/A	-10.0 –10.0	32	NATIVE_FLOAT

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Ancillary Data Fields / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
H2O_HDOAveragingKernel	The averaging kernel is the sensitivity of the estimated state to variations in the atmospheric state. The rows of the averaging kernel represent the sensitivity of the estimated state at a specific pressure level to variations in the atmospheric state at all levels. The columns of averaging kernel represent the sensitivity of the estimated state at all levels to variations in the atmospheric state at specific pressure level. Averaging kernel terms for joint HDO and water retrieval (influence of HDO on H2O) (dim nLevels x nLevels x nTimes)	N/A	-10.0 – 10.0	32	NATIVE_FLOAT
Filter_Position_1A	Filter position for Focal Plane 1A (dim nTimes)	N/A	1-5	8	NATIVE_INT8
Filter_Position_1B	Filter position for Focal Plane 1B (dim nTimes)	N/A	1-2	8	NATIVE_INT8
Filter_Position_2A	Filter position for Focal Plane 2A (dim nTimes)	N/A	1-4	8	NATIVE_INT8
Filter_Position_2B	Filter position for Focal Plane 2B (dim nTimes)	N/A	1	8	NATIVE_INT8
UTCTime	UTC time of ZPD (Zero Path Difference) 27 character string. (dim nTimes x nLength)	N/A		28	HE5T_CHARSTRING String data type

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4.8 Geolocation Fields

The Geolocation Data is used to provide generic geolocation and spacecraft pointing information. This information is included with each species specific ESDT and copied identically into the Ancillary ESDT.

Each Data Field will be annotated using HDF-EOS Local Attributes which are listed in the table below. Data Field Attributes are a feature which can be useful in annotating plots as well as describing the data product to input routines.

Attribute Name	Attribute Description	Size	HDF-EOS 5 Type
MissingValue	Contains the value for missing or fill data. 32 float : -999.0 64 double: -999.0 32 int : -999 16 int : -999 8 int : -99		Same type as Data Field
Title	For labeling a plot or axis.		NATIVE_CHAR
Units	Labeling units (for labeling color bars, converting between units, etc).		NATIVE_CHAR
UniqueFieldDefinition	Describes if definition of field is shared with other Aura Instruments ("Aura-Shared", "X-Specific", where X=Instrument Name, "X-Y[-Z]-Shared" where X,Y, and optional Z are instrumer names (in alphabetical order)		NATIVE_CHAR

Table 4-14: Geolocation Dimensions

Dimension Name	Valid Value (Description)
nTimes	Number of reported observations

Table 4-15: Nadir Geolocation Fields

Geolocation Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
Sequence	Sequence number within a run (dim nTimes)	N/A		16	NATIVE_INT16
Scan	Scan number within a sequence, or if averaging was performed, first scan of an averaged set. (dim nTimes)	N/A		16	NATIVE_INT16
Time	Time (TAI93) of ZPD (Zero Path Difference) (dim nTimes)	sec		64	NATIVE_DOUBLE
DayNightFlag	Flag for day or night (dim nTimes)	N/A	0 = night 1 = day	8	NATIVE_INT8
Latitude	Geodetic Latitude (dim nTimes)	Decimal degrees	± 90.0	32	NATIVE_FLOAT
Longitude	Geodetic Longitude (dim nTimes)	Decimal degrees	± 180.0	32	NATIVE_FLOAT
SurfaceElevStandardDeviation	From DEM, standard deviation of average elevation over footprint (dim nTimes)	meters		32	NATIVE_FLOAT

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SurfaceTypeFootprint	From DEM, 1=Fresh Water, 2=Salt Water, 3=Land, 4=Mixed (not 100% of FW, SW, or Land). If averaging was performed, refers to first scan of an averaged set. (dim nTimes)	Enumer-ated	1..4	8	NATIVE_INT8
DominantSurfaceType	From the USGS Global Land Cover Characteristics Data Base described at: http://edcsns17.cr.usgs.gov/glcc/globdoc2_0.html If averaging was performed, refers to first scan of an averaged set. 1 = Urban and Built-Up Land 2 = Dryland Cropland and Pasture 3 = Irrigated Cropland and Pasture 4 = Mixed Dryland/Irrigated Cropland and Pasture 5 = Cropland/Grassland Mosaic 6 = Cropland/Woodland Mosaic 7 = Grassland 8 = Shrubland 9 = Mixed Shrubland/Grassland 10 = Savanna 11 = Deciduous Broadleaf Forest 12 = Deciduous Needleleaf Forest 13 = Evergreen Broadleaf Forest 14 = Evergreen Needleleaf Forest 15 = Mixed Forest 16 = Water Bodies 17 = Herbaceous Wetland 18 = Wooded Wetland 19 = Barren or Sparsely Vegetated 20 = Herbaceous Tundra 21 = Wooded Tundra 22 = Mixed Tundra 23 = Bare Ground Tundra 24 = Snow or Ice 90 = Alluvial Sand 99 = Interrupted Areas (Goodes Homolosine Projection) 100 = Alluvial Sand (dim nTimes)	Enumera ted	1-24, 99, 100	8	NATIVE_INT8
BoresightNadirAngle	TES boresight (LOS) nadir angle relative to the local nadir at SC (dim nTimes)	Decimal degrees	0..90	64	NATIVE_DOUBLE
~~BoresightNadirAngleUnc~~	Uncertainty in TES boresight nadir angle (dim nTimes)	Decimal degrees	±90	64	NATIVE_DOUBLE
BoresightAzimuth	TES boresight (LOS) azimuth angle relative to the local north at SC (dim nTimes)	Decimal degrees	0..360	64	NATIVE_DOUBLE
SolarZenithAngle	Solar zenith relative to the local zenith at the spacecraft (dim nTimes)	Decimal degrees	0--180	32	NATIVE_FLOAT
LocalSolarTime	Local solar time at target geolocation. Computed from target longitude and UTC. (dim nTimes)	hours		32	NATIVE_FLOAT
Tgt_SpacecraftZenith	TES boresight (LOS) zenith angle relative to the local zenith at the target geolocation. (dim nTimes)	Decimal degrees	±90	32	NATIVE_FLOAT

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Tgt_SpacecraftAzimuth	TES boresight (LOS) azimuth angle relative to the local north at the target geolocation. (dim nTimes)	Decimal degrees (east of north)	±90	32	NATIVE_FLOAT
Latitude_Footprint_1	Geo-location in geodetic co-ordinates of the four corners of the footprint. Nadir footprint determined by field of view of pixels. Limb footprint is ±60 km track, ±12 km crosstrack from surface expression of boresight tangent point. Latitude_Footprint_1=LowerLeft Latitude_Footprint_2=LowerRight Latitude_Footprint_3=UpperRight Latitude_Footprint_4=UpperLeft (dim nTimes)	Decimal degrees	±90	64	NATIVE_DOUBLE
Latitude_Footprint_2		Decimal degrees	±90	64	NATIVE_DOUBLE
Latitude_Footprint_3		Decimal degrees	±90	64	NATIVE_DOUBLE
Latitude_Footprint_4		Decimal degrees	±90	64	NATIVE_DOUBLE
Longitude_Footprint_1	Geo-location in geodetic co-ordinates of the four corners of the footprint. Nadir footprint determined by field of view of pixels. Limb footprint is ±60 km track, ±12 km crosstrack from surface expression of boresight tangent point Longitude_Footprint_1=LowerLeft Longitude_Footprint_2=LowerRight Longitude_Footprint_3=UpperRight Longitude_Footprint_4=UpperLeft (dim nTimes)	Decimal degrees	±180	64	NATIVE_DOUBLE
Longitude_Footprint_2		Decimal degrees	±180	64	NATIVE_DOUBLE
Longitude_Footprint_3		Decimal degrees	±180	64	NATIVE_DOUBLE
Longitude_Footprint_4		Decimal degrees	±180	64	NATIVE_DOUBLE

Table 4-16: Limb Geolocation Fields

Geolocation Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
Sequence	Sequence number within a run (dim nTimes)	N/A		16	NATIVE_INT16
Scan	Scan number within a sequence, or if averaging was performed, first scan of an averaged set. (dim nTimes)	N/A		16	NATIVE_INT16
Time	Time (TAI93) of ZPD (Zero Path Difference) (dim nTimes)	sec		64	NATIVE_DOUBLE
DayNightFlag	Flag for day or night (dim nTimes)	N/A	0 = night 1 = day	8	NATIVE_INT8
Latitude	Geodetic Latitude (dim nTimes)	Decimal degrees	± 90.0	32	NATIVE_FLOAT
Longitude	Geodetic Longitude (dim nTimes)	Decimal degrees	± 180.0	32	NATIVE_FLOAT
SurfaceElevStandardDeviation	From DEM, standard deviation of average elevation over footprint (dim nTimes)	meters		32	NATIVE_FLOAT
SurfaceTypeFootprint	From DEM, 1=Fresh Water, 2=Salt Water, 3=Land, 4=Mixed (not 100% of FW, SW, or Land). If averaging was performed, refers to first scan of an averaged set. (dim nTimes)	Enumer-ated	1..4	8	NATIVE_INT8
BoresightNadirAngle	TES boresight (LOS) nadir angle relative to local nadir at SC (dim nTimes)	Decimal degrees	0..180	64	NATIVE_DOUBLE

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~~BoresightNadirAngleUnc~~	Uncertainty in TES boresight nadir angle (dim nTimes)	Decimal degrees	±90	64	NATIVE_DOUBLE
BoresightTangentHeight	Geodetic elevation of instrument boresight at the tangent point (around 16 km) (dim nTimes)	meters		32	NATIVE_FLOAT
BoresightTangentHeightUnc	TES Boresight Tangent Height uncertainty (dim nTimes)	meters		32	NATIVE_FLOAT
BoresightAzimuth	TES boresight (LOS) azimuth angle relative to local north at SC (dim nTimes)	Decimal degrees	0..360	64	NATIVE_DOUBLE
SolarZenithAngle	Solar zenith relative to the local zenith at the spacecraft (dim nTimes)	Decimal degrees		32	NATIVE_FLOAT
LocalSolarTime	Local solar time at target geolocation. Computed from target longitude and UTC. (dim nTimes)	hours		32	NATIVE_FLOAT
Tgt_SpacecraftZenith	TES boresight (LOS) zenith angle relative to the local zenith at the target geolocation. (dim nTimes)	Decimal degrees	±90	32	NATIVE_FLOAT
Tgt_SpacecraftAzimuth	TES boresight (LOS) azimuth angle relative to the local north at the target geolocation. (dim nTimes)	Decimal degrees (east of north)	±90	32	NATIVE_FLOAT
Latitude_Footprint_1	Geo-location in geodetic co-ordinates of the four corners of the footprint. Nadir footprint determined by field of view of pixels. Limb footprint is ±60 km track, ±12 km crosstrack from surface expression of boresight tangent point. Latitude_Footprint_1=LowerLeft Latitude_Footprint_2=LowerRight Latitude_Footprint_3=UpperRight Latitude_Footprint_4=UpperLeft (dim nTimes)	Decimal degrees	±90	64	NATIVE_DOUBLE
Latitude_Footprint_2		Decimal degrees	±90	64	NATIVE_DOUBLE
Latitude_Footprint_3		Decimal degrees	±90	64	NATIVE_DOUBLE
Latitude_Footprint_4		Decimal degrees	±90	64	NATIVE_DOUBLE
Longitude_Footprint_1	Geo-location in geodetic co-ordinates of the four corners of the footprint. Nadir footprint determined by field of view of pixels. Limb footprint is ±60 km track, ±12 km crosstrack from surface expression of boresight tangent point Longitude_Footprint_1=LowerLeft Longitude_Footprint_2=LowerRight Longitude_Footprint_3=UpperRight Longitude_Footprint_4=UpperLeft (dim nTimes)	Decimal degrees	±180	64	NATIVE_DOUBLE
Longitude_Footprint_2		Decimal degrees	±180	64	NATIVE_DOUBLE
Longitude_Footprint_3		Decimal degrees	±180	64	NATIVE_DOUBLE
Longitude_Footprint_4		Decimal degrees	±180	64	NATIVE_DOUBLE

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4.9 L2 ECS and TES-specific Metadata

4.9.1 Introduction

As with all ESDTs, TES ESDTs contain metadata that describes specific attributes about the data or the quality of data contained in the ESDT. Some of the basic metadata items are required by EOSDIS. These data items commonly include basic identification information and other generic information about the particular ESDT. These data items are referred to as ECS Inventory Metadata. In addition to ECS Inventory Metadata, additional TES ESDTs contain additional metadata more specific to the TES program. The TES-specific metadata has been subdivided into four subcategories based on the uniqueness of its origin and identification:

1. Production History — Production History Metadata
2. TES-Common — Metadata common to all TES ESDTs
3. TES-L2-Common — Metadata common to all Level 2 ESDTs
4. TES-L2-*observation specific* — Metadata unique to a particular ESDT subtype.

TES common metadata are fairly generic to the entire family of TES ESDTs or to TES L2 products. TES-L2-*observation specific*, as described by name, are unique to a particular family of L2 ESDTs.

4.9.2 ECS Inventory Metadata

The table below shows the ECS Inventory Metadata. The ECS Inventory Metadata is implemented in the HDF file as text block named coremetadata within a group named HDFEOS INFORMATION.

Table 4-17: ECS Inventory Metadata

Data Layer Name	Data Description	TES Valids	Type[2]	Source
AssociatedInstrumentShortName	Instrument short name supplied by TES project.	TES	VA20	MCF
AssociatedPlatformShortName	Platform short name supplied by EOS project.	Aura	VA20	MCF
AssociatedSensorShortName	Sensor short name supplied by TES project.	FTS	VA20	MCF
OperationMode	Mode of operation of the instrument.	Calibration Routine	VA20	MCF
ShortName	This name will identify the ESDT short name associated with the collection or granule.	(set in MCF)	A8	MCF
VersionID	Version identifier of the ESDT data collection.	(set in MCF)	SI	MCF
ProductionDateTime	The date and time a specific granule was produced a PGE.	YYYY-MM-DDT HH:MM:SS.SSSZ	DT	TK
SizeMBECSDataGranule	The size attribute will indicate the volume of data contained in the granule.		F10	DSS
LocalGranuleID	Unique identifier for locally produced granule that ECS ingests and is required to capture.	e.g., TES-Aura_L2-H2O-Nadir_r0000000001_F01_01.he5	VA80	PGE
LocalVersionID	Local version identifier for PGE defined granule versions. Takes the form “executable name: Clearcase label”		VA60	PGE
InputPointer	Description of location of Production History information.	“Production History block at: /HDFEOS/ADDITIONAL/FILE_ATTRIBUTES/PRODUCTION_HISTORY”	VA255	PGE

[2] Data types and Sources given are specified in document [3] on page 1-1.

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Data Layer Name	Data Description	TES Valids	Type[2]	Source
ParameterName	Scope of quality flags. For TES, refers to entire granule.	Granule	A40	PGE
ScienceQualityFlag	The granule level flag applying generally to the granule and specifically to parameters at the granule level.	Passed Failed Being Investigated Not Investigated Inferred Passed Inferred Failed Suspect	VA25	DP
ScienceQualityFlagExplanation	A text explanation of the criteria used to set the ScienceQualityFlag including thresholds or other criteria.	(Free text)	VA255	DP
RangeBeginningDate	The year, month, and day when the temporal coverage period being described began.	YYYY-MM-DD	DT	PGE
RangeBeginningTime	The first hour, minute, and second of the temporal coverage period being described.	HH:MM:SSSSSSZ	T	PGE
RangeEndingDate	The last year, month, and day when the temporal coverage period being described.	YYYY-MM-DD	DT	PGE
RangeEndingTime	The last hour, minute, and second of the temporal coverage period being described.	HH:MM:SSSSSSZ	T	PGE
PGEVersion	The Release of the PGE software: e.g. "R6.1.2"		A10	PGE

4.9.3 Production History Metadata

The Production History Metadata is implemented as a single text block and written to the HDF file as a file level attribute. The Production History text block contains information about the L2 PGE and the running execution of the PGE to produce ESDT standard products. Static information in the text block describes the elements that make up the PGE like build configuration, support files and database table population. Dynamic information describes all the running parameters involved in a PGE execution for a specific RUN ID. This information is captured for both pre and post execution of the L2 Product PGE.

Table 4-18: L2 Production History

History Data	Data Description	Size (K)	State
ECS	Toolkit file for input/output file specification	23	Dynamic
Environment Variable	SIPS environment variables	5	Dynamic
Fetch	SIPS fetch list from archived	5	Dynamic
SIPS PCF	SIPS-specific PCF file for PGE processing	3	Dynamic
Workspace List (PRE)	File listing in SIPS PGE workspace prior to PGE execution	5	Dynamic
Workspace List (POST)	File listing in SIPS PGE workspace following PGE execution	5	Dynamic
Runtime	CPU and Wallclock PGE run time	0.1	Dynamic
Control Definition	Framework Parameter Definition File for output files	1	Static
Control Parameter	Framework Parameter Specification File for output files	0.02	Static
Control Parameter (Runtime)	Framework Parameter specified in the command line of the PGE	0.02	Dynamic
TimeStamp	RUN ID begin date and end date timestamp	0.05	Dynamic
README	README file that describes production history context	1	Static
PGE Version	PGE version information	0.2	Static
PGE specific configurations	TBD	TBD	TBD

4.9.4 TES-Common Metadata

Metadata shown below is common to all TES files. For Level 2, these are implemented as File Level Attributes (HDF-EOS Global File Attributes). This is information that helps to describe this particular data set. It can be useful

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in labeling plots, calculating dates, etc.. These will be set via calls to he5_ehwrglatt(HE5_EHwriteglbattr for C users).

Table 4-19: TES-Common-Metadata

Data Layer Name	Data Description	Valids	Size	HDF-EOS 5 Type
InstrumentName	TES			NATIVE_CHAR
ProcessLevel	L1B,L2,L3,etc.			NATIVE_CHAR
TAI93At0zOfGranule				NATIVE_DOUBLE
GlobalSurveyNumber/ID	Run ID			NATIVE_INT
GranuleMonth	Month granule was produced (from ECS MD RangeBeginningDate)	1-12	8	NATIVE_INT
GranuleDay	Day granule was produced (from ECS MD RangeBeginningDate)	1-31	8	NATIVE_INT
GranuleYear	Year granule was produced (from ECS MD RangeBeginningDate)			NATIVE_INT
SurveyMode	Type of survey, e.g., Global or Special			NATIVE_CHAR
PGEVersion	Release of PGE Software: e.g. "R6.1.2"			NATIVE_CHAR
Command_Seq_ID	Command Sequence (Run) ID	N/A	32	NATIVE_INT32
Calib_Scheme	Calibration scheme with or without embedded black body scans: SPLIT_CAL or NON_SPLIT_CAL			NATIVE_CHAR

4.9.5 TES-L2-Common

Metadata shown below is common to all TES L2 files. These are implemented as Swath Level Attributes (HDF-EOS Group Attributes). This is information which helps describe the swath to which it is attached.

Table 4-20: TES-L2-Common-Metadata

Data Layer Name	Data Description	Data Range	Units	Size	HDF-EOS 5 Type
VerticalCoordinate	"Pressure","Altitude", "Potential Temperature"				NATIVE_CHAR
CloudFrequency	Wave number array corresponding to retrieved Cloud Effective Optical Depth points. 25 values.	600.0--2250.0	cm^{-1}	32	NATIVE_FLOAT
EmissivityWavenumber	Wavenumber array corresponding to retrieval emissivity points. 121 values.	600.0 – 3500.0	cm^{-1}	32	NATIVE_FLOAT

4.9.6 TES-L2-Nadir Metadata

Metadata shown below are common to all TES L2 Nadir files. These are implemented as Swath Level Attributes (HDF-EOS Group Attributes) attached to the NadirSwath groups. This is information which helps describe the swath to which it is attached.

Table 4-21: TES-L2-Nadir-Metadata

Data Layer Name	Data Definition	Data Range	Units	Size	HDF-EOS 5 Type

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Data Layer Name	Data Definition	Data Range	Units	Size	HDF-EOS 5 Type
Scan_Resolution	Designates Low or High Resolution for this view	'High', 'Low			NATIVE_CHAR
Pressure	Dimensioned over superset of UARS Levels only. 66 values.		hPa	32	NATIVE_FLOAT

4.9.7 TES-L2-Limb Metadata

Metadata shown below are common to all TES L2 Limb files. These are implemented as Swath Level Attributes (HDF-EOS Group Attributes) attached to the LimbSwath group. This is information which helps describe the swath to which it is attached.

Table 4-22: TES-L2-Limb-Metadata

Data Layer Name	Definition	Data Range	Units	Size	HDF-EOS 5 Type
Scan_Resolution	Designates Low or High Resolution for this view	'High', 'Low			NATIVE_CHAR
Pressure	Dimensioned over superset of UARS Levels only. 87 values.		hPa	32	NATIVE_FLOAT

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5. LEVEL 2 SUMMARY PRODUCT

5.1 Overview

The Level 2 Summary Product is essentially a subset of all of the L2 Standard or Special Observation Products (see Section 4) generated for a run combined into one product. Specifically, what is not included in the Summary Product are the matrices such as the Averaging Kernels and Error Covariances that take up a majority of the data volume of the Standard Products (including the Ancillary Product).

These subset of data for each species and of ancillary data are combined into one file. Besides having fewer data fields per species, in addition, the number of pressure levels the data are reported on is less: only the standard 15 UARS pressure levels plus the surface or cloud top.

For nadir observations, TES L2 standard products are produced for the following molecular species: H_2O, O_3, CH_4, CO, HDO, CO2, NH3 and AtmT (atmosphieric temperature TATM). For limb observations, L2 standard products include more molecular species: H_2O, O_3, CH_4, CO, HDO, NO_2, HNO_3, and AtmT. TES referred atmospheric temperature as TATM in TES L2 Products. According to AURA guidelines it should be Temperature. HDF5 alias is used for Temperature. L2 TES products have fields TATM and Temperature which are identical fields. When combined into one Summary Product, each view and species combination then becomes a Swath object within the file (though not all view/species combinations may be present.)

Table 5-1: View and Species Types

Species	H2O	O3	CH4	CO	HDO	NO2	HNO3	TATM	CO2	NH3	N2O	CH3OH	CHOOH
Nadir Swath Objects	X	X	X	X	X			X	X	X	X	X	X
Limb Swath Objects	X	X			X		X	X					

Limb CH4, CO and NO2 are not produced in this release

In addition, a subset of datafields from the TES L2 Ancillary Data product is placed into Swath objects in the file.

To facilitate sharing data products between all Aura platform science teams, the organization of the L2 Summary Product also conforms to specifications dictated in the HDF-EOS Aura File Format Guidelines (Craig, et al). These guidelines lay down the basic file format and data format specifications for all L2 standard products. The L2 Summary Product though only contains a subset of all of the data and geolocation fields identified as TES parameters.

The Local Granule ID is a unique identifier for locally produced granules that are then sent to the ECS for archive. The Local Granule ID is also the filename of the data product produced by Level 2. The L2 Summary product file is also implemented using the HDF-EOS 5 file format. HDF-EOS 5 files have a default extension of ".he5". The ECS Local Granule ID (filename) for a L2 Summary product is constructed using the following template:

TES-Aura_L2-SUMMARY_r<run id>_<version id>.he5 (Global Survey information)

TES-Aura_L2-SUMMARY-SO_r<run id>_<version id>.he5 (Special Observation information)

Due to instrument lifetime concerns involving the TES Pointing Control Subsystem the means of instrument calibration was modified in April 2010. The calibration method and algorithm may be determined through the file naming convention used in the product files and also through the TES_Common metadata attribute Calib_Scheme.

Briefly, data acquired prior to April 7, 2010 will use the calibration scheme termed 'NON_SPLIT_CAL' in the TES_Common metadata attribute Calib_Scheme. Data acquired on and following April 7, 2010 will be identified in

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the TES_Common metadata attribute Calib_Scheme as 'SPLIT_CAL', and will additionally be identified with the designator 'C01' in the product file name for L1B, L2 and L3 product files.

On April 7, 2010 TES began collecting Global Survey data using a new split-calibration collection scheme. This calibration method as non-embedded blackbody scans bracketing the global survey. Special observation data collection was also modified on May 12, 2010. To distinguish between this new calibration scheme and data collected before these dates TES will introduce a calibration designator in the filename and product metadata.

TES-Aura_L2-SUMMARY_r<run id>_C01_<version id>.he5 (Global Survey information)

TES-Aura_L2-SUMMARY-SO_r<run id>_C01_<version id>.he5 (Special Observation information)

This filename with calibration designator is applicable for all global surveys with run IDs greater than or equal to 11125 and special observations with run IDs greater than or equal to 11189.

The table below lists each of the TES L2 Summary product ESDT.

Table 5-2: TES L2 Summary Products

ESDT Short Name	ECS File Type	Collection Summary	Local Granule ID
TL2SUM	HDF-EOS 5	TES Aura L2 Summary Product Global Survey	TES-Aura_L2-SUMMARY_rnnnnnnnnn_Fff_cc.he5
TL2SUMS	HDF-EOS 5	TES Aura L2 Summary Product Special Observation	TES-Aura_L2-SUMMARY-SO_rnnnnnnnnn_Fff_cc.he5
TL2SUM	HDF-EOS 5	TES Aura L2 Summary Product Global Survey	TES-Aura_L2-SUMMARY_rnnnnnnnnn_C01_Fff_cc.he5
TL2SUMS	HDF-EOS 5	TES Aura L2 Summary Product Special Observation	TES-Aura_L2-SUMMARY-SO_rnnnnnnnnn_C01_Fff_cc.he5

5.2 Summary Product File Structure

The file structure of the Summary Product is depicted in the figure below. In addition to the swath objects, each standard product also contains descriptive metadata. The organization and layout of metadata conforms to HDF-EOS guidelines. First, an ECS Metadata block, metadata that includes a set of mandatory data describing attributes about the standard product is found at the beginning of every standard product. TES-specific metadata follows the ECS metadata. These metadata fields are used to describe TES specific details. Some of these data will be common among all TES products, some common only to TES Level 2 products, and some specific only to the L2 Summary product.

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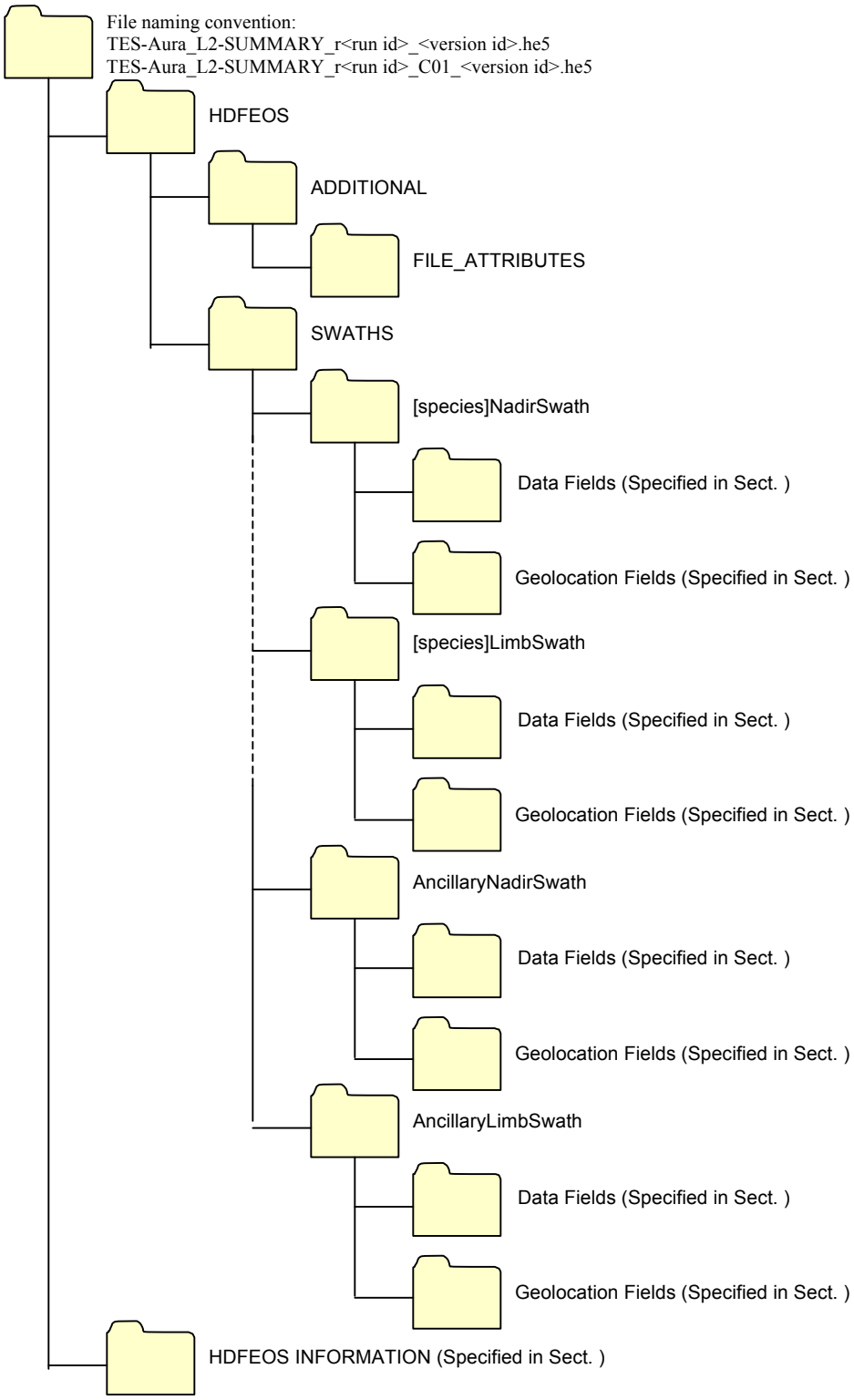

There can be multiple [species]NadirSwath and [species]LimbSwath in the file, where [species] can be H2O, O3, CH4, CO, HDO, NO2, HNO3, CO2, NH3 or TATM (Atmospheric Temperature).

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5.3 Nadir Objects Data Fields

The Nadir Data Fields consist of primary data fields, which are vmr or temperature profiles and other data dimensioned by time and pressure levels, and the associated data fields, which are only dimensioned by time.

Each Data Field will be annotated using HDF-EOS Local Attributes which are listed in the table below. Data Field Attributes are a feature which can be useful in annotating plots as well as describing the data product to input routines.

Attribute Name	Attribute Description	Size	HDF-EOS 5 Type
MissingValue	Contains the value for missing or fill data. 32 float : -999.0 64 double: -999.0 32 int : -999 16 int : -999 8 int : -99		Same type as Data Field
Title	For labeling a plot or axis.		NATIVE_CHAR
Units	Labeling units (for labeling color bars, converting between units, etc).		NATIVE_CHAR
UniqueFieldDefinition	Describes if definition of field is shared with other Aura Instruments ("Aura-Shared", "X-Specific", where X=Instrument Name, "X-Y[-Z]-Shared" where X,Y, and optional Z are instrumer names (in alphabetical order)		NATIVE_CHAR

5.3.1 Nadir Primary Data Fields

The table below shows the swath data dimensions. The pressure levels as shown in this table are the 15 pressure levels plus one surface level as described in the Overview.

All nadir swath data fields are based on a unified data structure and are used to report results of retrievals of spectra received from the L1B subsystem. The vmr data for the particular species of interest is the primary data element of each swath data layer. It is accompanied by various indices of error that help in evaluating the quality of the retrieval.

Ideally, species and associated precision and quality measures will be populated for all Target Scenes in the global survey. However, there will be times where completing retrievals will not be possible. The causes will be varied and might be due to bad spectra (based on evaluation by L1B), excessive cloud cover, or the retrieval was not performed for scheduling or other administrative reasons. Regardless of the cause for missing data, certain swath data fields will be set to a fill value according to the HDF-EOS Aura File Format Guidelines. Additionally, cloud cover may prevent retrieval down to the Earth's surface, resulting in partial retrievals. When such cases occur, pressure layers will contain fill values when no data exists.

Table 5-2: Primary Data Dimensions Definitions

Dimension Name	Valid Value (Description)
nLevels	16 pressure levels
nTimes	Number of reported observations

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Table 5-3: Nadir Primary Data Fields

Data Field Name / Title *	Data Descriptions	Units	Data Range	Size	HDF-EOS 5 Type
[species] Temperature(Atmospheric Temperature) H2O HDO O3 CH4 CO CO2 NH3 CHOOH CH3OH	vmr data or temperature data (dim nLevels x nTimes)	vmr or K		32	NATIVE_FLOAT
[species]Precision	Square-roots of diagonal elements of the measurement error covariance. See comment for TotalError regarding use. (dim nLevels x nTimes)	ln(vmr) or K		32	NATIVE_FLOAT
TotalError	Square-roots of diagonal elements the output total error covariance (includes smoothing error, systematic error, and measurement error). For T_{ATM}, these values are the error bars. For atmospheric species, the positive error bar is: error+ = exp(ln(vmr) + error) - vm The negative error bar is: error- = vmr - exp(ln(vmr) - error) (dim nLevels x nTimes)	ln(vmr) or K		32	NATIVE_FLOAT
Initial	Initial vmr data or temperature data (for retrieved temperature) used in the retrieval (dim nLevels x nTimes)	vmr or K		32	NATIVE_FLOAT
Pressure	List of the 16 Pressure Levels used (dim nLevels x nTimes)	hPa	0.001-1300.0	32	NATIVE_FLOAT
Altitude	Derived altitude for each pressure level (dim nLevels x nTimes)	Meters	0-70000	32	NATIVE_FLOAT

* Where [species] equals H2O, O3, CH4, CO, HDO, CO2, NH3 or Temperature

5.3.2 Nadir Associated Data Fields

The table below provides the associated data dimensions. The data items shown in the following tables are also included in the Swath Data as Associated Data:

Table 5-4: Associated Data Field Dimensions Definitions

Dimension Name	Valid Value (Description)
nTimes	Number of reported observations
nLevels	Number of reported pressure levels (66+Surface)

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Table 5-5: Nadir Associated Data Fields

Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
Scan_Averaged_Count	Number of scans averaged into a single target scene (dim nTimes)	N/A	1-40 1 = no averaging	8	NATIVE_INT8
SpeciesRetrievalQuality	Species Retrieval Quality flag. True means retrieval passed quality check and reported errors are accurate. (dim nTimes)	N/A	0 = poor quality 1 = passed quality chec	8	NATIVE_INT8
CloudTopPressure	Pressure of inferred cloud top (specie independent) (dim nTimes)	hPa	0.001 -- 1300.0	32	NATIVE_FLOAT
CloudTopPressureError	Error on Cloud Top Pressure. The positive error bar is error+ = exp(ln(CloudTopPressure + error) - CloudTopPressure. The negative error bar is error- = CloudTopPressure - exp(ln(CloudTopPressure - error). (dim nTimes)	hPa	-1..7	32	NATIVE_FLOAT
AverageCloudEffOpticalDepth	Quality value: the cloud mean optica depth from 975 – 1200 cm-1. This is the same value for all species and tak from values at the final retrieval step. (dim nTimes)	cm-1	1000-1150	32	NATIVE_FLOAT
AverageCloudEffOpticalDepth Error	Error for Cloud Effective Optical Dep calculated using a weighted average c frequencies between 975 & 1200. Th is the same value for all species and taken from values at the final retrieva step. (dim nTimes)	cm-1	1000-1150	32	NATIVE_FLOAT
SurfaceTemperature	Retrieved surface temperature from the last atmospheric temperature retrieval step (dim nTimes)	K	150.0 - 350	32	NATIVE_FLOAT
SurfaceTempError	Error in retrieved surface temperature (dim nTimes)	K	0.0 – 20.0	32	NATIVE_FLOAT
SurfaceTempInitial	Initial surface temperature at the start of the retrieval process, currently take from GMAO. (dim nTimes)	K	150.0 - 350	32	NATIVE_FLOAT
SurfaceTempDegreesOfFreedor	Degrees of freedom for surface temperature (dim nTimes)	N/A	0.0 – 2.0	32	NATIVE_FLOAT
SurfaceTempObservationErro r	Measurement + systematic + cross-sta errors. The utility of the observation error is for comparisons with other measurements and for assimilation. The smoothing error is accounted for when one applies the averaging kerne so the observation error accounts for everything else. (dim nTimes)	K	0-50	32	NATIVE_FLOAT
SurfaceTempPrecision	Square-root of diagonal element of th measurement error covariance (dim nTimes)	K	0.0 – 20.0	32	NATIVE_FLOAT

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Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
TotalColumnDensity	Total column amount computed from the retrieved profile. For the Atmospheric Temperature Product this will be a fill value. (dim nTimes)	Molec/cm^2	0 – 10^28	32	NATIVE_FLOAT
TotalColumnDensityError	Error in total column amount computed from total error covariance For the Atmospheric Temperature Product this will be a fill value. (dim nTimes)	Molec/cm^2	0 – 10^28	32	NATIVE_FLOAT
TotalColumnDensityInitial	Total column amount computed from the initial profile. For the Atmospheric Temperature Product this will be a fill value. (dim nTimes)	Molec/cm^2	0 – 10^28	32	NATIVE_FLOAT
~~SpeciesRetrievalConverged~~	Indicates whether the non-linear least squares solver converged to a minimum. True=1, False=0 (dim nTimes)	N/A	0 or 1 (Boolean)	8	NATIVE_INT8
~~DeviationVsRetrievalCovariance~~	Deviation vs. Retrieval Covariance (dim nTimes)	N/A	-10000.0 – 10000.0	32	NATIVE_FLOAT
RadianceResidualMean	Mean of the model and data radiance difference (per species). (dim nTimes)	N/A	-1000.0 – 1000.0	32	NATIVE_FLOAT
RadianceResidualRMS	RMS of model and data difference (dim nTimes)	N/A	0.0 – 100.0	32	NATIVE_FLOAT
~~RadianceResidualMax~~	Maximum absolute difference between model and data (dim nTimes)	N/A	-10000.0 – 10000.0	32	NATIVE_FLOAT
~~NumberIterPerformed~~	Actual number of iterations performed (dim nTimes)	Integer	Small number, typically < 8 and could be 0	8	NATIVE_INT8
~~MaxNumIterations~~	Maximum number of iterations allowed for convergence (dim nTimes)	N/A	<100	8	NATIVE_INT8
DegreesOfFreedomForSignal	Number of independent parameters for the profile (trace of the averaging kernel) (dim nTimes)	N/A	0.0—1000.0	32	NATIVE_FLOAT
~~InformationContent~~	Relative decrease in error volume with respect to a priori (dim nTimes)	N/A	-100.0—1000.0	32	NATIVE_FLOAT
CloudVariability_QA	Quality value calculated from cloud variability. This will be fill for the species HDO and H2O. (dim nTimes)	N/A	0- 100	32	NATIVE_FLOAT
KDotDL_QA	Quality value calculating the signal left in the residual. This is the maximum of the dot product of the Jacobian (K) and the Radiance (L) divided by sqrt(K dot K) * sqrt(L dot L) (dim nTimes)	N/A	-100 - 100	32	NATIVE_FLOAT

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Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
LDotDL_QA	Quality value calculating the signal left in the residual. This is the dot product of the radiance (L) with the residual (dL) divided by sqrt(L dot L) * sqrt(dL dot dL) (dim nTimes)	N/A	-100 - 100	32	NATIVE_FLOAT
~~Calibration_QA~~	Quality value of calculated from the calibration factors. This will be fill for the species HDO and H2O. (dim nTimes)	N/A	-2 - 2	32	NATIVE_FLOAT
H2O_HDO_Corr_QA	Checks that the H2O estimated in H2O / HDO step is consistent with H2O from TATM step. This will be fill in all products except H2O and HDO. (dim nTimes)	N/A	-50.0 – 50.0	32	NATIVE_FLOAT
SurfaceEmissMean_QA	Quality value comparing the retrieved emissivity to the initial emissivity. Fill for ocean and limb scenes. This will be fill for the species HDO and H2O. (dim nTimes)	N/A	-2 - 2	32	NATIVE_FLOAT
SurfaceTempVsApriori_QA	Quality value comparing the surface temperature to a priori value (dim nTimes)	K	-100 - 100	32	NATIVE_FLOAT
SurfaceTempVsAtmTemp_QA	Quality value comparing the surface temperature to the lowest atmospheric pressure. This will be fill for the species CO, CH4, HDO, and H2O. (dim nTimes)	K	-100 - 100	32	NATIVE_FLOAT
UTCTime	UTC time of ZPD (Zero Path Difference) 27 character string. (dim nTimes x nLength)	N/A		28	HE5T_CHARSTRING String data type
SurfaceEmissionLayer_QA	Quality value comparing the atmospheric temperature to the surfac temperature when ozone near the surface is elevated. This field will be fill for C(CH4, HDO and most H2O	N/A	-100 - 100	32	NATIVE_FLOAT
O3_Ccurve_QA	Quality value indicating ozone with an unrealistic lapse rate, with values too high in the near-surface layers and too low around 350-200 hPa. 0=bad QA, 1=good QA Fill and default value = -99 (dim nTimes)	N/A	0=Good QA 1=Poor QA	8	NATIVE_INT8
TropopausePressure	Pressure between the troposphere and stratosphere used to calculate the tropospheric column (dim nTimes)	hPa	10 - 1300	32	NATIVE_FLOAT
OzoneTroposphericColumn	Column amount from the surface to TropopausePressue computed from the retrieved profile. (dim nTimes)	Molec/cm^2	0 – 10^28	32	NATIVE_FLOAT

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Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
OzoneTroposphericColumnErro	Error in the column amount from the surface to TropopausePressue computed from the total error covariance. (dim nTimes)	Molec/cm^2	0 – 10^28	32	NATIVE_FLOAT
OzoneTroposphericColumnIniti	Initial column amount from the surface to TropopausePressue computed from the initial profile. (dim nTimes)	Molec/cm^2	0 – 10^28	32	NATIVE_FLOAT
OzoneIRK	OzoneIRK is the sensitivity to the outgoing longwave radiation in th 10 micron band to variations in ozone at each pressure level. (dim nLevels x nTimes)	(milli-watts/ m^2)/ppb	-100 to 100	32	NATIVE_FLOAT
FmOzoneBandFlux	The long-wave ozone radiative flux from Measured radiance (dim nTimes)	W/m^2		32	NATIVE_FLOAT
L1BOzoneBandFlux	The long-wave ozone radiative flux from calculated radiance (dim nTimes)	W/m^2		32	NATIVE_FLOAT
ResidualNormInitial	Cost function used in quality determination for methanol (reported for all species)		0-999	32	NATIVE_FLOAT
ResidualNormFinal	Cost function used in quality determination for methanol (reported for all species)		0-999	32	NATIVE_FLOAT

5.4 Limb Objects Data Fields

Like the Nadir Data Fields, the Limb Data Fields consist of the primary data fields, which are vmr or temperature profiles and other data dimensioned by time and pressure levels, and the associated data fields, which are only dimensioned by time.

Each Data Field will be annotated using HDF-EOS Local Attributes which are listed in the table below. Data Field Attributes are a feature which can be useful in annotating plots as well as describing the data product to input routines.

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Attribute Name	Attribute Description	Size	HDF-EOS 5 Type
MissingValue	Contains the value for missing or fill data. 32 float : -999.0 64 double: -999.0 32 int : -999 16 int : -999 8 int : -99		Same type as Data Field
Title	For labeling a plot or axis.		NATIVE_CHAR
Units	Labeling units (for labeling color bars, converting between units, etc).		NATIVE_CHAR
UniqueFieldDefinition	Describes if definition of field is shared with other Aura Instruments ("Aura-Shared", "X-Specific", where X=Instrument Name, "X-Y[-Z]-Shared" where X,Y, and optional Z are instrumer names (in alphabetical order)		NATIVE_CHAR

5.4.1 Limb Primary Data Fields

All swath data fields are based on a unified data structure and are used to report results of retrievals of spectra received from the L1B subsystem. The vmr data for the particular species of interest is the primary data element of each swath data layer. It is accompanied by various indices of error that help in evaluating the quality of the retrieval.

Ideally, species and associated precision and quality measures will be populated for all Target Scenes in the global survey. However, there will be times where completing retrievals will not be possible. The causes will be varied and might be due to bad spectra (based on evaluation by L1B), excessive cloud cover, or the retrieval was not performed for scheduling or other administrative reasons. Regardless of the cause for missing data, certain swath data fields will be set to a fill value according HDF-EOS Aura File Format Guidelines. Additionally, cloud cover may prevent retrieval down to the Earth's surface, resulting in partial retrievals. When such cases occur, pressure layers will contain fill values when no data exists.

Table 5-6: Primary Data Fields Dimensions Definitions

Dimension Name	Valid Value (Description)
nLevels	16 pressure levels
nTimes	Number of reported observations

Table 5-7: Limb Primary Data Fields

Data Field Name / Title *	Data Descriptions	Units	Data Range	Size	HDF-EOS 5 Type
[species] Temperature (Atmospheric Temperature) H2O HDO O3 HNO3 (Limb CH4, CO and NO2 are not produced in this release)	vmr data or temperature data (for retrieved temperature) (dim nLevels x nTimes)	vmr or K		32	NATIVE_FLOAT
[species]Precision	Square-roots of diagonal elements of the measurement error covariance. See comment for TotalError regarding use. (dim nLevels x nTimes)	ln(vmr) or K		32	NATIVE_FLOAT

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Data Field Name / Title *	Data Descriptions	Units	Data Range	Size	HDF-EOS 5 Type
TotalError	Square-roots of diagonal elements of the output total error covariance (includes smoothing error, systematic error, and measurement error). For T_{ATM}, these values are the error bars. For atmospheric species, the positive error bar is: error+ = exp(ln(vmr) + error) - vmr. The negative error bar is: error- = vmr - exp(ln(vmr) - error) (dim nLevels x nTimes)	ln(vmr) or K		32	NATIVE_FLOAT
Initial	Initial vmr data or temperature data (for retrieved temperature) used in the retrieval (dim nLevels x nTimes)	vmr or K		32	NATIVE_FLOAT
Pressure	List of the 16 Pressure Levels used (dim nLevels x nTimes)	hPa	0.001-1300.0	32	NATIVE_FLOAT
Altitude	Derived altitude for each pressure level (dim nLevels x nTimes)	meters	0-70000	32	NATIVE_FLOAT

* Where [species] equals H2O, O3, HDO, HNO3, or Temperature. Limb CH4, CO and NO2 are not produced in this release

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5.4.2 Limb Associated Data Fields

The table below provides the associated data dimensions. The data items shown in the following tables are also included in the Swath Data as Associated Data:

Table 5-8: Associated Data Field Dimensions Definitions

Dimension Name	Valid Value (Description)
nTimes	Number of reported observations
nPixels	16 number of pixels from one focal plane

Table 5-9: Limb Associated Data Fields

Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
SpeciesRetrievalQuality	Species Retrieval Quality flag. True means retrieval passed quality check ar reported errors are accurate. (dim nTimes)	N/A	0 = poor quality 1 = passed quality chec	8	NATIVE_INT8
CloudTopPressure	Pressure of inferred cloud top (species independent) (dim nTimes)	hPa	0.001 -- 1300.0	32	NATIVE_FLOAT
CloudTopPressureError	Error on Cloud Top Pressure. The positive error bar is error+ = exp(ln(CloudTopPressure + error) - CloudTopPressure. The negative error bar is error- = CloudTopPressure - exp(ln(CloudTopPressure - error). (dim nTimes)	hPa	-1..7	32	NATIVE_FLOAT
AverageCloudEffOpticalDepth	Quality value: the cloud mean optical depth from 975 – 1200 cm-1. This is tl same value for all species and taken fr values at the final retrieval step. (dim nTimes)	cm-1	1000-1150	32	NATIVE_FLOAT
AverageCloudEffOpticalDepthErr or	Error for Cloud Effective Optical Dept calculated using a weighted average of frequencies between 975 & 1200. This is the same value for all species and taken from values at the final retrieval step. (dim nTimes)	cm-1	1000-1150	32	NATIVE_FLOAT
TotalColumnDensity	Total column amount computed from the retrieved profile. For the Atmospheric Temperature Product this will be a fill value. (dim nTimes)	Molec/cm^2	0 – 10^28	32	NATIVE_FLOAT
TotalColumnDensityError	Error in total column amount computed from total error covariance For the Atmospheric Temperature Product this will be a fill value. (dim nTimes)	Molec/cm^2	0 – 10^28	32	NATIVE_FLOAT

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Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
TotalColumnDensityInitial	Total column amount computed from the initial profile. For the Atmospheric Temperature datset this will be a fill value. (dim nTimes)	Molec/cm^2	0 – 10^28	32	NATIVE_FLOAT
~~SpeciesRetrievalConverged~~	Indicates whether the non-linear least squares solver converged to a minimun True=1, False=0 (dim nTimes)	N/A	0 or 1 (Boolean)	8	NATIVE_INT8
~~DeviationVsRetrievalCovariance~~	Deviation vs. Retrieval Covariance (dim nTimes)	N/A	-10000.0 – 10000.0	32	NATIVE_FLOAT
RadianceResidualMean	Mean of the model and data radiance difference (per species). Per pixel from focal plane used in retrieval. (dim nTimes x nPixels)	N/A	-1000.0 – 1000.0	32	NATIVE_FLOAT
RadianceResidualRMS	RMS of model and data difference. Per pixel from focal plane used in retrieval. (dim nTimes x nPixels)	N/A	0.0 – 100.0	32	NATIVE_FLOAT
~~RadianceResidualMax~~	Maximum absolute difference between model and data (dim nTimes)	N/A	-10000.0 – 10000.0	32	NATIVE_FLOAT
~~NumberIterPerformed~~	Actual number of iterations performed (dim nTimes)	Integer	Small number, typically < 8 and could be 0	8	NATIVE_INT8
~~MaxNumIterations~~	Maximum number of iterations allowed for convergence (dim nTimes)	N/A	< 100	8	NATIVE_INT8
DegreesOfFreedomForSignal	Number of independent parameters for the profile (trace of the averaging kernel) (dim nTimes)	N/A	0.0—1000.0	32	NATIVE_FLOAT
~~InformationContent~~	Relative decrease in error volume with respect to a priori (dim nTimes)	N/A	-100.0—1000.0	32	NATIVE_FLOAT
CloudVariability_QA	Quality value calculated from cloud variability (dim nTimes)	N/A	0- 100	32	NATIVE_FLOAT
KDotDL_QA	Quality value calculating the signal left in the residual. This is the maximum of the dot product of the Jacobian (K) and the Radiance (L) divided by sqrt(K dot K) * sqrt(L dot L) (dim nTimes)	N/A	-100 - 100	32	NATIVE_FLOAT
LDotDL_QA	Quality value calculating the signal left in the residual. This is the dot product of the radiance (L) with the residual (dL) divided by sqrt(L dot L) * sqrt(dL dot dL) (dim nTimes)	N/A	-100 - 100	32	NATIVE_FLOAT
~~Calibration_QA~~	Quality value of calculated from the calibration factors. This will be fill for the species HDO and H2O. (dim nTimes)	N/A	-2 - 2	32	NATIVE_FLOAT

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Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
H2O_HDO_Corr_QA	Checks that the H2O estimated in H2O / HDO step is consistent with H2O from TATM step. This will be fill in all products except H2O and HDO. (dim nTimes)	N/A	-50.0 – 50.0	32	NATIVE_FLOAT
UTCTime	UTC time of ZPD (Zero Path Difference) 27 character string. (dim nTimes x nLength)	N/A		28	HE5T_CHARSTRING String data type
TropopausePressure	Pressure between the troposphere and stratosphere used to calculate the tropospheric column (dim nTimes)	hPa	10 - 1300	32	NATIVE_FLOAT

5.5 Ancillary Objects Data Fields

The Ancillary Objects contains the Associated Data Fields common to all species.

Each Data Field will be annotated using HDF-EOS Local Attributes which are listed in the table below. Data Field Attributes are a feature which can be useful in annotating plots as well as describing the data product to input routines.

Attribute Name	Attribute Description	Size	HDF-EOS 5 Type
MissingValue	Contains the value for missing or fill data. 32 float : -999.0 64 double: -999.0 32 int : -999 16 int : -999 8 int : -99		Same type as Data Field
Title	For labeling a plot or axis.		NATIVE_CHAR
Units	Labeling units (for labeling color bars, converting between units, etc).		NATIVE_CHAR
UniqueFieldDefinition	Describes if definition of field is shared with other Aura Instruments ("Aura-Shared", "X-Specific", where X=Instrument Name, "X-Y[-Z]-Shared" where X,Y, and optional Z are instrumer names (in alphabetical order)		NATIVE_CHAR

Table 5-10: Ancillary Data Dimensions Definitions

Dimension Name	Valid Value (Description)
nTimes	Number of reported observations
nFreq	121 emissivity wavenumbers (listed in TES-L2-Common metadata)
nPixels	64 total number of pixels

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Table 5-11: Ancillary Nadir Data Fields

Ancillary Data Fields / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
SpacecraftLatitude	Geodetic latitude referenced to WGS84 ellipsoid (dim nTimes)	degrees	± 90.0	32	NATIVE_FLOAT
SpacecraftLongitude	Longitude referenced to WGS84 ellipsoid (dim nTimes)	degrees	± 180.0	32	NATIVE_FLOAT
SpacecraftAltitude	Height referenced to WGS84 ellipsoid (dim nTimes)	meters		32	NATIVE_FLOAT
OrbitAscendingFlag	True=1, False=0 (dim nTimes)	N/A	0 or 1 (Boolean)	8	NATIVE_INT8
SolarAzimuthAngle	Solar azimuth angle relative to the local north at the geolocation. (From geolocation table) (dim nTimes)	degrees		32	NATIVE_FLOAT
PixelsUsedFlag	True=1, False=0 (dim nPixels)	N/A	64 chars, one for each pixel	520	NATIVE_CHAR
SurfaceEmissivity	Retrieved surface emissivity for land nadir targets. Fill values for scenes where emissivity not retrieved. (dim nFreq x nTimes)	N/A	0.0 - 2.0	32	NATIVE_FLOAT
SurfaceEmissErrors	Errors in retrieved surface emissivity for land nadir targets. Fill values for scenes where emissivity not retrieved. (dim nFreq x nTimes)	N/A		32	NATIVE_FLOAT
SurfaceEmissInitial	Initial surface emissivity land nadir targets. (dim nFreq x nTimes)	N/A	0.0 - 2.0	32	NATIVE_FLOAT
Filter_Position_1A	Filter position for Focal Plane 1A (dim nTimes)	N/A	1-5	8	NATIVE_INT8
Filter_Position_1B	Filter position for Focal Plane 1B (dim nTimes)	N/A	1-2	8	NATIVE_INT8
Filter_Position_2A	Filter position for Focal Plane 2A (dim nTimes)	N/A	1-4	8	NATIVE_INT8
Filter_Position_2B	Filter position for Focal Plane 2B (dim nTimes)	N/A	1	8	NATIVE_INT8
UTCTime	UTC time of ZPD (Zero Path Difference) 27 character string. (dim nTimes x nLength)	N/A		28	HE5T_CHARSTRING String data type
SurfaceTempInitialRefined	Surface temperature feeding into the atmospheric profile retrieval steps. This temperature may be the same as SurfaceTempInitial or it may have undergone an initial guess refinement. (dim nTimes)	K	150.0 - 350	32	NATIVE_FLOAT

Table 5-12: Ancillary Limb Data Fields

Ancillary Data Fields / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
SpacecraftLatitude	Geodetic latitude referenced to WGS84 ellipsoid (dim nTimes)	degrees	± 90.0	32	NATIVE_FLOAT

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Ancillary Data Fields / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
SpacecraftLongitude	Longitude referenced to WGS84 ellipsoid (dim nTimes)	degrees	± 180.0	32	NATIVE_FLOAT
SpacecraftAltitude	Height referenced to WGS84 ellipsoid (dim nTimes)	meters		32	NATIVE_FLOAT
OrbitAscendingFlag	True=1, False=0 (dim nTimes)	N/A	0 or 1 (Boolean)	8	NATIVE_INT8
SolarAzimuthAngle	Solar azimuth angle relative to local north at the spacecraft. (dim nTimes)	degrees		32	NATIVE_FLOAT
PixelsUsedFlag	True=1, False=0 (dim nTimes)	N/A	64 chars, one for each pixel	520	NATIVE_CHAR
RetrievedPointingAngle	Retrieved value of the boresight nadir angles using TES limb spectral radiances. (Limb only) (dim nTimes)	degrees		32	NATIVE_FLOAT
RetrievedPointingAngleError	Error of retrieved value of the boresight nad angles using TES limb spectral radiances. (Limb only) (dim nTimes)	degrees		32	NATIVE_FLOAT
Filter_Position_1A	Filter position for Focal Plane 1A (dim nTimes)	N/A	1-5	8	NATIVE_INT8
Filter_Position_1B	Filter position for Focal Plane 1B (dim nTimes)	N/A	1-2	8	NATIVE_INT8
Filter_Position_2A	Filter position for Focal Plane 2A (dim nTimes)	N/A	1-4	8	NATIVE_INT8
Filter_Position_2B	Filter position for Focal Plane 2B (dim nTimes)	N/A	1	8	NATIVE_INT8
UTCTime	UTC time of ZPD (Zero Path Difference) 27 character string. (dim nTimes x nLength)	N/A		28	HE5T_CHARSTRING String data type”

5.6 Geolocation Fields

The Geolocation Data is used to provide generic geolocation and spacecraft pointing information. This information is included with each species and ancillary Swath.

Each Data Field will be annotated using HDF-EOS Local Attributes which are listed in the table below. Data Field Attributes are a feature which can be useful in annotating plots as well as describing the data product to input routines.

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Attribute Name	Attribute Description	Size	HDF-EOS 5 Type
MissingValue	Contains the value for missing or fill data. 32 float : -999.0 64 double: -999.0 32 int : -999 16 int : -999 8 int : -99		Same type as Data Field
Title	For labeling a plot or axis.		NATIVE_CHAR
Units	Labeling units (for labeling color bars, converting between units, etc).		NATIVE_CHAR
UniqueFieldDefinition	Describes if definition of field is shared with other Aura Instruments ("Aura-Shared", "X-Specific", where X=Instrument Name, "X-Y[-Z]-Shared" where X,Y, and optional Z are instrumer names (in alphabetical order)		NATIVE_CHAR

The values used for these attributes are also in the data fields tables below.

Table 5-13: Geolocation Dimensions

Dimension Name	Valid Value (Description)
nTimes	Number of reported observations

Table 5-14: Nadir Geolocation Fields

Geolocation Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
Sequence	Sequence number within a run (dim nTimes)	N/A		16	NATIVE_INT16
Scan	Scan number within a sequence, or if averaging was performed, first scan of an averaged set. (dim nTimes)	N/A		16	NATIVE_INT16
Time	Time (TAI93) of ZPD (Zero Path Difference) (dim nTimes)	sec		64	NATIVE_DOUBLE
DayNightFlag	Flag for day or night (dim nTimes)	N/A	0 = night 1 = day	8	NATIVE_INT8
Latitude	Geodetic Latitude (dim nTimes)	Decimal degrees	± 90.0	32	NATIVE_FLOAT
Longitude	Geodetic Longitude (dim nTimes)	Decimal degrees	± 180.0	32	NATIVE_FLOAT
SurfaceElevStandardDeviation	From DEM, standard deviation of average elevation over footprint (dim nTimes)	meters		32	NATIVE_FLOAT

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SurfaceTypeFootprint	From DEM, 1=Fresh Water, 2=Salt Water, 3=Land, 4=Mixed (not 100% of FW, SW, or Land) (dim nTimes)	Enumer-ated	1..4	8	NATIVE_INT8
DominantSurfaceType	From the USGS Global Land Cover Characteristics Data Base described at: http://edcsns17.cr.usgs.gov/glcc/globdoc2_0.html If averaging was performed, refers to first scan of an averaged set. 1 = Urban and Built-Up Land 2 = Dryland Cropland and Pasture 3 = Irrigated Cropland and Pasture 4 = Mixed Dryland/Irrigated Cropland and Pasture 5 = Cropland/Grassland Mosaic 6 = Cropland/Woodland Mosaic 7 = Grassland 8 = Shrubland 9 = Mixed Shrubland/Grassland 10 = Savanna 11 = Deciduous Broadleaf Forest 12 = Deciduous Needleleaf Forest 13 = Evergreen Broadleaf Forest 14 = Evergreen Needleleaf Forest 15 = Mixed Forest 16 = Water Bodies 17 = Herbaceous Wetland 18 = Wooded Wetland 19 = Barren or Sparsely Vegetated 20 = Herbaceous Tundra 21 = Wooded Tundra 22 = Mixed Tundra 23 = Bare Ground Tundra 24 = Snow or Ice 90 = Alluvial Sand 99 = Interrupted Areas (Goodes Homolosine Projection) 100 = Alluvial Sand (dim nTimes)	Enumera ted	1-24, 99, 100	8	NATIVE_INT8
BoresightNadirAngle	TES boresight (LOS) nadir angle relative to the local nadir at SC (dim nTimes)	Decimal degrees	0..90	64	NATIVE_DOUBLE
~~BoresightNadirAngleUnc~~	Uncertainty in TES boresight nadir angle (dim nTimes)	Decimal degrees	±90	64	NATIVE_DOUBLE
BoresightAzimuth	TES boresight (LOS) azimuth angle relative to the local north at SC (dim nTimes)	Decimal degrees	0..360	64	NATIVE_DOUBLE
SolarZenithAngle	Solar zenith relative to the local zenith at the spacecraft (dim nTimes)	degrees	0--180	32	NATIVE_FLOAT
LocalSolarTime	Local solar time at target geolocation. Computed from target longitude and UTC. (dim nTimes)	hours		32	NATIVE_FLOAT
Tgt_SpacecraftZenith	TES boresight (LOS) zenith angle relative to the local zenith at the target geolocation. (dim nTimes)	degrees	±90	32	NATIVE_FLOAT

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Tgt_SpacecraftAzimuth	TES boresight (LOS) azimuth angle relative to the local north at the target geolocation. (dim nTimes)	degrees (ea of north)	±90	32	NATIVE_FLOAT

Table 5-15: Limb Geolocation Fields

Geolocation Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
Sequence	Sequence number within a run (dim nTimes)	N/A		16	NATIVE_INT16
Scan	Scan number within a sequence, or if averaging was performed, first scan of an averaged set. (dim nTimes)	N/A		16	NATIVE_INT16
Time	Time (TAI93) of ZPD (Zero Path Difference) (dim nTimes)	sec		64	NATIVE_DOUBLE
DayNightFlag	Flag for day or night (dim nTimes)	N/A	0 = night 1 = day	8	NATIVE_INT8
Latitude	Geodetic Latitude (dim nTimes)	Decimal degrees	± 90.0	32	NATIVE_FLOAT
Longitude	Geodetic Longitude (dim nTimes)	Decimal degrees	± 180.0	32	NATIVE_FLOAT
SurfaceElevStandardDeviation	From DEM, standard deviation of average elevation over footprint (dim nTimes)	meters		32	NATIVE_FLOAT
SurfaceTypeFootprint	From DEM, 1=Fresh Water, 2=Salt Water, 3=Land, 4=Mixed (not 100% of FW, SW, or Land) (dim nTimes)	Enumer-ated	1..4	8	NATIVE_INT8
BoresightNadirAngle	TES boresight (LOS) nadir angle relative to local nadir at SC (dim nTimes)	Decimal degrees	0..180	64	NATIVE_DOUBLE
~~BoresightNadirAngleUnc~~	Uncertainty in TES boresight nadir angle (dim nTimes)	Decimal degrees	±90	64	NATIVE_DOUBLE
BoresightTangentHeight	Geodetic elevation of instrument boresight at the tangent point (around 16 km) (dim nTimes)	meters		32	NATIVE_FLOAT
BoresightTangentHeightUnc	TES Boresight Tangent Height uncertainty (dim nTimes)	meters		32	NATIVE_FLOAT
BoresightAzimuth	TES boresight (LOS) azimuth angle relative to local north at SC (dim nTimes)	Decimal degrees	0..360	64	NATIVE_DOUBLE
SolarZenithAngle	Solar zenith relative to the local zenith at the spacecraft (dim nTimes)	degrees		32	NATIVE_FLOAT
LocalSolarTime	Local solar time at target geolocation. Computed from target longitude and UTC. (dim nTimes)	hours		32	NATIVE_FLOAT

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Tgt_SpacecraftZenith	TES boresight (LOS) zenith angle relative to the local zenith at the target geolocation. (dim nTimes)	degrees	±90	32	NATIVE_FLOAT
Tgt_SpacecraftAzimuth	TES boresight (LOS) azimuth angle relative to the local north at the target geolocation. (dim nTimes)	degrees (ea of north)	±90	32	NATIVE_FLOAT

5.7 L2 ECS and TES-specific Metadata

5.7.1 Introduction

As with all ESDTs, TES ESDTs contain metadata that describes specific attributes about the data or the quality of data contained in the ESDT. Some of the basic metadata items are required by EOSDIS. These data items commonly include basic identification information and other generic information about the particular ESDT. These data items are referred to as ECS Inventory Metadata. In addition to ECS Inventory Metadata, additional TES ESDTs contain additional metadata more specific to the TES program. The TES-specific metadata has been subdivided into subcategories based on the uniqueness of its origin and identification:

1. Production History — Production History Metadata
2. TES-Common — Metadata common to all TES ESDTs
3. TES-L2-Common — Metadata common to all Level 2 ESDTs

TES common metadata are fairly generic to the entire family of TES ESDTs or to TES L2 products. TES-L2-*observation specific*, as described by name, are unique to a particular family of L2 ESDTs.

5.7.2 ECS Inventory Metadata

The table below shows the ECS Inventory Metadata. The ECS Inventory Metadata is implemented in the HDF file as text block named coremetadata within a group named HDFEOS INFORMATION.

Table 5-16: ECS Inventory Metadata

Data Layer Name	Data Description	TES Valids	Type[3]	Source
AssociatedInstrumentShortName	Instrument short name supplied by TES project.	TES	VA20	MCF
AssociatedPlatformShortName	Platform short name supplied by EOS project.	Aura	VA20	MCF
AssociatedSensorShortName	Sensor short name supplied by TES project.	FTS	VA20	MCF
OperationMode	Mode of operation of the instrument.	Calibration Routine	VA20	MCF
ShortName	This name will identify the ESDT short name associated with the collection or granule.	(set in MCF)	A8	MCF
VersionID	Version identifier of the ESDT data collection.	(set in MCF)	SI	MCF

[3] Data types and Sources given are specified in document [3] on page 1-1.

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Data Layer Name	Data Description	TES Valids	Type[3]	Source
ProductionDateTime	The date and time a specific granule was produced a PGE.	YYYY-MM-DDT HH:MM:SS.SSSZ	DT	TK
SizeMBECSDataGranule	The size attribute will indicate the volume of data contained in the granule.		F10	DSS
LocalGranuleID	Unique identifier for locally produced granule that ECS ingests and is required to capture.	e.g., TES-Aura_L2-SUMMARY_r0000000001_F01_01.he5	VA80	PGE
LocalVersionID	Local version identifier for PGE defined granule versions. Takes the form "executable name: Clearcase label"		VA60	PGE
InputPointer	Description of location of Production History information.	"Production History block at: /HDFEOS/ADDITIONAL/FILE_ATTRIBUTES/PRODUCTION_HISTORY"	VA255	PGE
ParameterName	Scope of quality flags. For TES, refers to entire granule.	Granule	A40	PGE
ScienceQualityFlag	The granule level flag applying generally to the granule and specifically to parameters at the granule level.	Passed Failed Being Investigated Not Investigated Inferred Passed Inferred Failed Suspect	VA25	DP
ScienceQualityFlagExplanation	A text explanation of the criteria used to set the ScienceQualityFlag including thresholds or other criteria.	(Free text)	VA255	DP
RangeBeginningDate	The year, month, and day when the temporal coverage period being described began.	YYYY-MM-DD	DT	PGE
RangeBeginningTime	The first hour, minute, and second of the temporal coverage period being described.	HH:MM:SS.SSSZ	T	PGE
RangeEndingDate	The last year, month, and day when the temporal coverage period being described.	YYYY-MM-DD	DT	PGE
RangeEndingTime	The last hour, minute, and second of the temporal coverage period being described.	HH:MM:SS.SSSZ	T	PGE
PGEVersion	The Release of the PGE software: e.g. "R6.1.2"		A10	PGE

5.7.3 Production History Metadata

The Production History Metadata is implemented as a single text block and written to the HDF file as a file level attribute. The Production History text block contains information about the L2 PGE and the running execution of the PGE to produce ESDT standard products. Static information in the text block describes the elements that make up the PGE like build configuration, support files and database table population. Dynamic information describes all the running parameters involved in a PGE execution for a specific RUN ID. This information is captured for both pre and post execution of the L2 Product PGE.

Table 5-17: L2 Production History

History Data	Data Description	Size (K)	State
ECS	Toolkit file for input/output file specification	23	Dynamic
Environment Variable	SIPS environment variables	5	Dynamic
Fetch	SIPS fetch list from archived	5	Dynamic
SIPS PCF	SIPS-specific PCF file for PGE processing	3	Dynamic
Workspace List (PRE)	File listing in SIPS PGE workspace prior to PGE execution	5	Dynamic
Workspace List (POST)	File listing in SIPS PGE workspace following PGE execution	5	Dynamic
Runtime	CPU and Wallclock PGE run time	0.1	Dynamic

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Control Definition	Framework Parameter Definition File for output files	1	Static
Control Parameter	Framework Parameter Specification File for output files	0.02	Static
Control Parameter (Runtime)	Framework Parameter specified in the command line of the PGE	0.02	Dynamic
TimeStamp	RUN ID begin date and end date timestamp	0.05	Dynamic
README	README file that describes production history context	1	Static
PGE Version	PGE version information	0.2	Static
PGE specific configurations	TBD	TBD	TBD

5.7.4 TES-Common Metadata

Metadata shown below is common to all TES files. For Level 2, these are implemented as File Level Attributes (HDF-EOS Global File Attributes). This is information that helps to describe this particular data set. It can be useful in labeling plots, calculating dates, etc.. These will be set via calls to he5_ehwrglatt(HE5_EHwriteglbattr for C users).

Table 5-18: TES-Common-Metadata

Data Layer Name	Data Description	Valids	Size	Type	HDF-EOS 5 Type
InstrumentName	TES			char	NATIVE_CHAR
ProcessLevel	L1B,L2,L3,etc.			char	NATIVE_CHAR
TAI93At0zOfGranule				double	NATIVE_DOUBLE
GlobalSurveyNumber/ID	Run ID			int	NATIVE_INT
GranuleMonth	Month granule was produced (from ECS MD RangeBeginningDate)	1-12	8	int	NATIVE_INT
GranuleDay	Day granule was produced (from ECS MD RangeBeginningDate)	1-31	8	int	NATIVE_INT
GranuleYear	Year granule was produced (from ECS MD RangeBeginningDate)			int	NATIVE_INT
SurveyMode	Type of survey, e.g., Global or Special			char	NATIVE_CHAR
PGEVersion	Release of PGE Software: e.g. "R6.1.2"			char	NATIVE_CHAR
Command_Seq_ID	Command Sequence (Run) ID	N/A	32	int	NATIVE_INT32
Calib_Scheme	Calibration scheme with or without embedded black body scans: SPLIT_CAL or NON_SPLIT_CAL				NATIVE_CHAR

5.7.5 TES-L2-Common

Metadata shown below is common to all TES L2 files. These are implemented as Swath Level Attributes (HDF-EOS Group Attributes). This is information which helps describe the swath to which it is attached.

Table 5-19: TES-L2-Common-Metadata

Data Layer Name	Data Description	Data Range	Size	Type	HDF-EOS 5 Type
Pressure	Dimensioned over superset of nUARSLevels only. 87 values.			32	NATIVE_FLOAT
VerticalCoordinate	"Pressure","Altitude", "Potential Temperature"				NATIVE_CHAR
CloudFrequency	Wave number array corresponding to retrieved Cloud Effective Optical Depth points. 25 values.	600.0--2250.0	cm^{-1}	32	NATIVE_FLOAT
EmissivityWavenumber	Wavenumber array corresponding to retrieval emissivity points. 119 values.	600.0 – 3500.0	cm^{-1}	32	NATIVE_FLOAT

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6. LEVEL 2 SUPPLEMENTAL PRODUCT

6.1 Overview

The Level 2 Supplemental Product contains information on non-retrieved species that are used as input to the L2 Retrieval PGE. This information is obtained from a climitology input source termed Mozart (Model of Ozone And Related Tracers). The Supplemental Product provides target scene level information from the Mozart product and may be used to assist in the independent processing of retrievals. One Supplemental Product file will be produced per TES instrument "Run", and will contain target scene information in the same order as the L2 Standard data product.

To facilitate sharing data products between all Aura platform science teams, the organization of the L2 Supplemental Product conforms to specifications dictated in the HDF-EOS Aura File Format Guidelines (Craig, et al). These guidelines lay down the basic file format and data format specifications for all L2 swath products.

The Local Granule ID is a unique identifier for locally produced granules that are then sent to the ECS for archive. The Local Granule ID is also the filename of the data product produced by Level 2. The L2 Supplemental product file is implemented using the HDF-EOS 5 file format. HDF-EOS 5 files have a default extension of ".he5". The ECS Local Granule ID (filename) for a L2 Supplemental product is constructed using the following template:

TES-Aura_L2-SUPPLEMENTAL_r<run id>_<version id>.he5 (Global Survey information)

TES-Aura_L2-SUPPLEMENTAL-SO_r<run id>_<version id>.he5 (Special Observation information)

Due to instrument lifetime concerns involving the TES Pointing Control Subsystem the means of instrument calibration was modified in April 2010. The calibration method and algorithm may be determined through the file naming convention used in the product files and also through the TES_Common metadata attribute Calib_Scheme.

Briefly, data acquired prior to April 7, 2010 will use the calibration scheme termed 'NON_SPLIT_CAL' in the TES_Common metadata attribute Calib_Scheme. Data acquired on and following April 7, 2010 will be identified in the TES_Common metadata attribute Calib_Scheme as 'SPLIT_CAL', and will additionally be identified with the designator 'C01' in the product file name for L1B, L2 and L3 product files.

On April 7, 2010 TES began collecting Global Survey data using a new split-calibration collection scheme. This calibration method as non-embedded blackbody scans bracketing the global survey. Special observation data collection was also modified on May 12, 2010. To distinguish between this new calibration scheme and data collected before these dates TES will introduce a calibration designator in the filename and product metadata.

TES-Aura_L2-SUPPLEMENTAL_r<run id>_C01_<version id>.he5 (Global Survey information)

TES-Aura_L2-SUPPLEMENTAL-SO_r<run id>_C01_<version id>.he5 (Special Observation information)

This filename with calibration designator is applicable for all global surveys with run IDs greater than or equal to 11125 and special observations with run IDs greater than or equal to 11189.

The table below lists each of the TES L2 Supplemental Product ESDT.

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Table 6-1: TES L2 Supplemental Products

ESDT Short Name	ECS File Type	Collection Summary	Local Granule ID
TL2SUP	HDF-EOS 5	TES Aura L2 Supplemental Product Global Survey	TES-Aura_L2-SUPPLEMENTAL_rnnnnnnnnn_Fff_cc.he5
TL2SUPS	HDF-EOS 5	TES Aura L2 Supplemental lProduc Special Observation	TES-Aura_L2-SUPPLEMENTAL-SO_rnnnnnnnnn_Fff_cc.he5
TL2SUP	HDF-EOS 5	TES Aura L2 Supplemental Product Global Survey	TES-Aura_L2-SUPPLEMENTAL_rnnnnnnnnn_C01_Fff_cc.h
TL2SUPS	HDF-EOS 5	TES Aura L2 Supplemental lProduc Special Observation	TES-Aura_L2-SUPPLEMENTAL-SO_rnnnnnnnnn_C01_Fff_cc.he5

6.2 Supplemental Product File Structure

The file structure of the Supplemental Product is depicted in the figure below. In addition to the swath objects, each standard product also contains descriptive metadata. The organization and layout of metadata conforms to HDF-EOS guidelines. First, an ECS Metadata block, metadata that includes a set of mandatory data describing attributes about the standard product is found at the beginning of every standard product. TES-specific metadata follows the ECS metadata.

The indexes into the Supplemental NadirSwath and LimbSwath objects will match the indexes into the Nadir and Limb L2 Standard data product objects (described in Section 4). The common indexes between the L2 Supplemental product and L2 Standard products are nLevels and nTimes.

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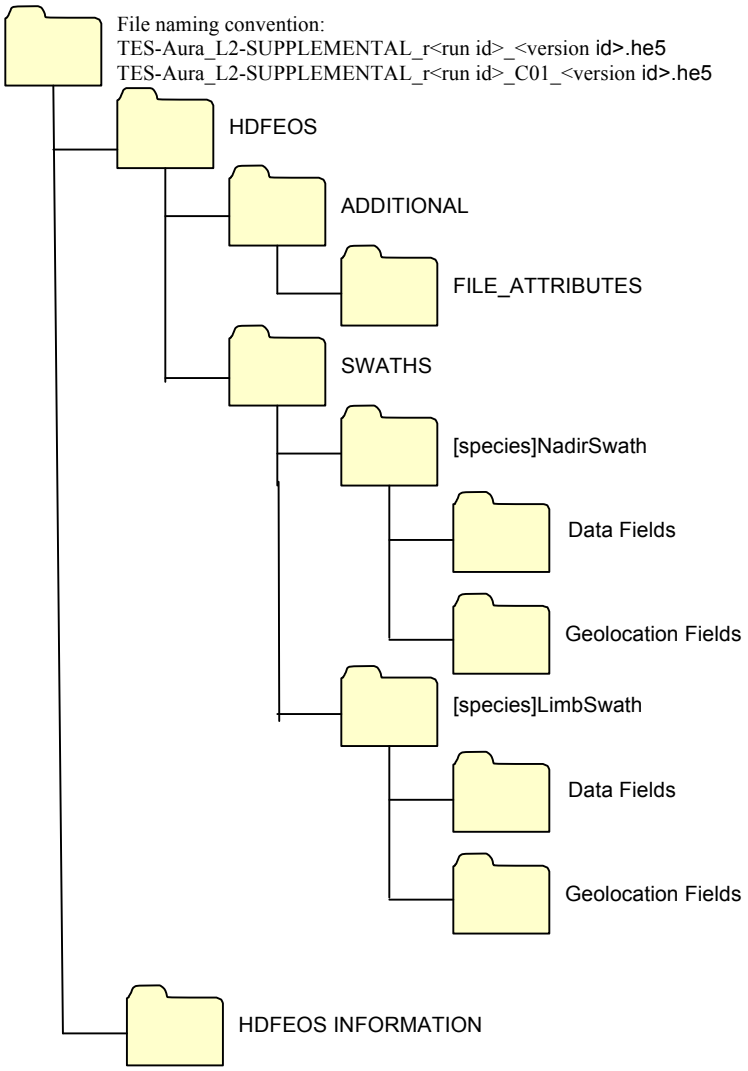

Table 6-2 presents the species, by view mode that will be present in the Supplemental product file.

Table 6-2: Supplemental Products - View and Species Types

Species	CO2	N2O	CH4	CFC11	CFC12
Nadir Swath Object	X	X			
Limb Swath Object	X	X	X	X	X

The non-retrieved species present in each view and target scene is dependent on the L2 Retrieval strategy used to process that target scene. Non-retrieved species data may contain fill when that species is not used in L2 Retrieval for a

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particular target scene. For example, in R11 retrieval strategy, O3 is used as a non-retrieved species in Limb scan 4 but not in Limb scans 5 and 6. That non-retrieved species, O3, would be fill data in scans 5 and 6.

6.3 Nadir Objects Data Fields

The Nadir Data Fields consist of primary data fields, vmr and Pressure, ordered by time and pressure levels.

Each Data Field will be annotated using HDF-EOS Local Attributes which are listed in the table below. Data Field Attributes are a feature which can be useful in annotating plots as well as describing the data product to input routines.

Attribute Name	Attribute Description	Size	HDF-EOS 5 Type
MissingValue	Contains the value for missing or fill data. 32 float : -999.0 64 double: -999.0 32 int : -999 16 int : -999 8 int : -99		Same type as Data Field
Title	For labeling a plot or axis.		NATIVE_CHAR
Units	Labeling units (for labeling color bars, converting between units, etc).		NATIVE_CHAR
UniqueFieldDefinition	Describes if definition of field is shared with other Aura Instruments ("Aura-Shared", "X-Specific", where X=Instrument Name, "X-Y[-Z]-Shared" where X,Y, and optional Z are instrumer names (in alphabetical order)		NATIVE_CHAR

6.3.1 Nadir Primary Data Fields

The table below shows the swath data dimensions. The pressure levels as shown in this table are the 66 pressure levels plus one surface level as described in the Overview.

Ideally, species and associated precision and quality measures will be populated for all target scenes in the global survey. However, there will be times where completing retrievals will not be possible. If target scene retrieval data is not present in the L2 standard product files, that target scene will likewise not be present in the supplemental product.

Table 6-3: Primary Data Dimensions Definitions

Dimension Name	Valid Value (Description)
nLevels	Number of pressure levels (66+1)
nTimes	Number of reported observations

Table 6-4: Nadir Primary Data Fields

Data Field Name / Title	Data Descriptions	Units	Data Range	Size	HDF-EOS 5 Type
[species] N2O CO2	Initial vmr data (dim nLevels x nTimes)	vmr or K		32	NATIVE_FLOAT
Pressure	List of the pressure levels used (dim nLevels x nTimes)	hPa	0.001-1300.0	32	NATIVE_FLOAT

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6.4 Limb Objects Data Fields

Like the Nadir Data Fields, the Limb Data Fields consist of the primary data fields, vmr and Pressure, ordered by time and pressure levels.

.

Each Data Field will be annotated using HDF-EOS Local Attributes which are listed in the table below. Data Field Attributes are a feature which can be useful in annotating plots as well as describing the data product to input routines.

Attribute Name	Attribute Description	Size	HDF-EOS 5 Type
MissingValue	Contains the value for missing or fill data. 32 float : -999.0 64 double: -999.0 32 int : -999 16 int : -999 8 int : -99		Same type as Data Field
Title	For labeling a plot or axis.		NATIVE_CHAR
Units	Labeling units (for labeling color bars, converting between units, etc).		NATIVE_CHAR
UniqueFieldDefinition	Describes if definition of field is shared with other Aura Instruments ("Aura-Shared", "X-Specific", where X=Instrument Name, "X-Y[-Z]-Shared" where X,Y, and optional Z are instrumer names (in alphabetical order)		NATIVE_CHAR

6.4.1 Limb Primary Data Fields

The table below shows the swath data dimensions. The pressure levels as shown in this table are the 87 pressure levels plus one surface level as described in the Overview.

Ideally, species and associated precision and quality measures will be populated for all Target Scenes in the global survey. However, there will be times where completing retrievals will not be possible. The causes will be varied and might be due to bad spectra (based on evaluation by L1B), excessive cloud cover, or the retrieval was not performed for scheduling or other administrative reasons. Regardless of the cause for missing data, certain swath data fields will be set to a fill value according HDF-EOS Aura File Format Guidelines. Additionally, cloud cover may prevent retrieval down to the Earth's surface, resulting in partial retrievals. When such cases occur, pressure layers will contain fill values when no data exists.

Table 6-5: Primary Data Fields Dimensions Definitions

Dimension Name	Valid Value (Description)
nLevels	Number of pressure levels (87+1)
nTimes	Number of reported observations

Table 6-6: Limb Primary Data Fields

Data Field Name / Title	Data Descriptions	Units	Data Range	Size	HDF-EOS 5 Type
[species] CH4, CO2, N2O, CFC11 CFC12	vmr data (dim nLevels x nTimes)	vmr or K		32	NATIVE_FLOAT

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Data Field Name / Title	Data Descriptions	Units	Data Range	Size	HDF-EOS 5 Type
Pressure	List of the pressure levels used (dim nLevels x nTimes)	hPa	0.001-1300.0	32	NATIVE_FLOAT

6.5 Geolocation Fields (Limb and Nadir)

The Geolocation Data is used to provide generic geolocation information. This object is common in structure to both nadir and limb.

Each Data Field will be annotated using HDF-EOS Local Attributes which are listed in the table below. Data Field Attributes are a feature which can be useful in annotating plots as well as describing the data product to input routines.

Attribute Name	Attribute Description	Size	HDF-EOS 5 Type
MissingValue	Contains the value for missing or fill data. 32 float : -999.0 64 double: -999.0 32 int : -999 16 int : -999 8 int : -99		Same type as Data Field
Title	For labeling a plot or axis.		NATIVE_CHAR
Units	Labeling units (for labeling color bars, converting between units, etc).		NATIVE_CHAR
UniqueFieldDefinition	Describes if definition of field is shared with other Aura Instruments ("Aura-Shared", "X-Specific", where X=Instrument Name, "X-Y[-Z]-Shared" where X,Y, and optional Z are instrumer names (in alphabetical order)		NATIVE_CHAR

The values used for these attributes are also in the data fields tables below.

Table 6-7: Geolocation Dimensions

Dimension Name	Valid Value (Description)
nTimes	Number of reported observations

Table 6-8: Geolocation Fields

Geolocation Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
Latitude	Geodetic Latitude (dim nTimes)	Decimal degrees	± 90.0	32	NATIVE_FLOAT
Longitude	Geodetic Longitude (dim nTimes)	Decimal degrees	± 180.0	32	NATIVE_FLOAT
Sequence	Sequence number within a run (dim nTimes)	N/A		16	NATIVE_INT16
Scan	Scan number within a sequence, or if averaging was performed, first scan of an averaged set. (dim nTimes)	N/A		16	NATIVE_INT16

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6.6 L2 ECS and TES-specific Metadata

6.6.1 Introduction

As with all ESDTs, TES ESDTs contain metadata that describes specific attributes about the data or the quality of data contained in the ESDT. Some of the basic metadata items are required by EOSDIS. These data items commonly include basic identification information and other generic information about the particular ESDT. These data items are referred to as ECS Inventory Metadata. In addition to ECS Inventory Metadata, additional TES ESDTs contain additional metadata more specific to the TES program. The TES-specific metadata has been subdivided into subcategories based on the uniqueness of its origin and identification:

1. Production History — Production History Metadata
2. TES-Common — Metadata common to all TES ESDTs
3. TES-L2-Common — Metadata common to all Level 2 ESDTs

TES common metadata are fairly generic to the entire family of TES ESDTs or to TES L2 products. TES-L2-*observation specific*, as described by name, are unique to a particular family of L2 ESDTs.

6.6.2 ECS Inventory Metadata

The table below shows the ECS Inventory Metadata. The ECS Inventory Metadata is implemented in the HDF file as text block named coremetadata within a group named HDFEOS INFORMATION.

Table 6-9: ECS Inventory Metadata

Data Layer Name	Data Description	TES Valids	Type[4]	Source
AssociatedInstrumentShortName	Instrument short name supplied by TES project.	TES	VA20	MCF
AssociatedPlatformShortName	Platform short name supplied by EOS project.	Aura	VA20	MCF
AssociatedSensorShortName	Sensor short name supplied by TES project.	FTS	VA20	MCF
OperationMode	Mode of operation of the instrument.	Calibration Routine	VA20	MCF
ShortName	This name will identify the ESDT short name associated with the collection or granule.	(set in MCF)	A8	MCF
VersionID	Version identifier of the ESDT data collection.	(set in MCF)	SI	MCF
ProductionDateTime	The date and time a specific granule was produced a PGE.	YYYY-MM-DDT HH:MM:SS.SSSZ	DT	TK
SizeMBECSDataGranule	The size attribute will indicate the volume of data contained in the granule.		F10	DSS
LocalGranuleID	Unique identifier for locally produced granule that ECS ingests and is required to capture.	e.g., TES-Aura_L2-SUMMARY_r0000000001_F01_01.he5	VA80	PGE
LocalVersionID	Local version identifier for PGE defined granule versions. Takes the form “executable name: Clearcase label”		VA60	PGE

Data types and Sources given are specified in document [3] on page 1-1.

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Data Layer Name	Data Description	TES Valids	Type[4]	Source
InputPointer	Description of location of Production History information.	"Production History block at: /HDFEOS/ADDITIONAL/FILE_ATTRIBUTES/PRODUCTION_HISTORY"	VA255	PGE
ParameterName	Scope of quality flags. For TES, refers to entire granule.	Granule	A40	PGE
ScienceQualityFlag	The granule level flag applying generally to the granule and specifically to parameters at the granule level.	Passed Failed Being Investigated Not Investigated Inferred Passed Inferred Failed Suspect	VA25	DP
ScienceQualityFlagExplanation	A text explanation of the criteria used to set the ScienceQualityFlag including thresholds or other criteria.	(Free text)	VA255	DP
RangeBeginningDate	The year, month, and day when the temporal coverage period being described began.	YYYY-MM-DD	DT	PGE
RangeBeginningTime	The first hour, minute, and second of the temporal coverage period being described.	HH:MM:SS.SSSZ	T	PGE
RangeEndingDate	The last year, month, and day when the temporal coverage period being described.	YYYY-MM-DD	DT	PGE
RangeEndingTime	The last hour, minute, and second of the temporal coverage period being described.	HH:MM:SS.SSSZ	T	PGE
PGEVersion	The Release of the PGE software: e.g. "R6.1.2"		A10	PGE

6.6.3 Production History Metadata

The Production History Metadata is implemented as a single text block and written to the HDF file as a file level attribute. The Production History text block contains information about the L2 PGE and the running execution of the PGE to produce ESDT standard products. Static information in the text block describes the elements that make up the PGE like build configuration, support files and database table population. Dynamic information describes all the running parameters involved in a PGE execution for a specific RUN ID. This information is captured for both pre and post execution of the L2 Product PGE.

Table 6-10: L2 Production History

History Data	Data Description	Size (K)	State
ECS	Toolkit file for input/output file specification	23	Dynamic
Environment Variable	SIPS environment variables	5	Dynamic
Fetch	SIPS fetch list from archived	5	Dynamic
SIPS PCF	SIPS-specific PCF file for PGE processing	3	Dynamic
Workspace List (PRE)	File listing in SIPS PGE workspace prior to PGE execution	5	Dynamic
Workspace List (POST)	File listing in SIPS PGE workspace following PGE execution	5	Dynamic
Runtime	CPU and Wallclock PGE run time	0.1	Dynamic
Control Definition	Framework Parameter Definition File for output files	1	Static
Control Parameter	Framework Parameter Specification File for output files	0.02	Static
Control Parameter (Runtime)	Framework Parameter specified in the command line of the PGE	0.02	Dynamic
TimeStamp	RUN ID begin date and end date timestamp	0.05	Dynamic
README	README file that describes production history context	1	Static
PGE Version	PGE version information	0.2	Static
PGE specific configurations	TBD	TBD	TBD

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6.6.4 TES-Common Metadata

Metadata shown below is common to all TES files. For Level 2, these are implemented as File Level Attributes (HDF-EOS Global File Attributes). This is information that helps to describe this particular data set. It can be useful in labeling plots, calculating dates, etc.

Table 6-11: TES-Common-Metadata

Data Layer Name	Data Description	Valids	Size	Type	HDF-EOS 5 Type
InstrumentName	TES			char	NATIVE_CHAR
ProcessLevel	L1B,L2,L3,etc.			char	NATIVE_CHAR
TAI93At0zOfGranule				double	NATIVE_DOUBLE
GlobalSurveyNumber/ID	Run ID			int	NATIVE_INT
GranuleMonth	Month granule was produced (from ECS MD RangeBeginningDate)	1-12	8	int	NATIVE_INT
GranuleDay	Day granule was produced (from ECS MD RangeBeginningDate)	1-31	8	int	NATIVE_INT
GranuleYear	Year granule was produced (from ECS MD RangeBeginningDate)			int	NATIVE_INT
SurveyMode	Type of survey, e.g., Global or Special			char	NATIVE_CHAR
PGEVersion	Release of PGE Software: e.g. "R6.1.2"			char	NATIVE_CHAR
Command_Seq_ID	Command Sequence (Run) ID	N/A	32	int	NATIVE_INT32
Calib_Scheme	Calibration scheme with or without embedded black body scans: SPLIT_CAL or NON_SPLIT_CAL				NATIVE_CHAR

6.6.5 TES-L2-Common

Metadata shown below is common to all TES L2 files. These are implemented as Swath Level Attributes (HDF-EOS Group Attributes). This is information which helps describe the swath to which it is attached.

Table 6-2: TES-L2-Common-Metadata

Data Layer Name	Data Description	Data Range	Size	Type	HDF-EOS 5 Type
Pressure	Dimensioned over superset of nUARSLevels only . 87 values.			32	NATIVE_FLOAT
VerticalCoordinate	"Pressure","Altitude", "Potential Temperature"				NATIVE_CHAR
CloudFrequency	Wave number array corresponding to retrieved Cloud Effective Optical Depth points. 25 values.	600.0--2250.0	cm^{-1}	32	NATIVE_FLOAT
EmissivityWavenumber	Wavenumber array corresponding to retrieval emissivity points. 119 values.	600.0 – 3500.0	cm^{-1}	32	NATIVE_FLOAT

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7. LEVEL 3 STANDARD GRID PRODUCTS

7.1 Overview

The objective of TES SDP L3 subsystem is to interpolate the L2 atmospheric profiles collected in a Global Survey onto a global grid uniform in latitude and longitude that will provide a 3-D representation of the distribution of atmospheric gasses. Daily, 8-day and monthly averages of L2 profiles and browse images will also be provided.

The L3 standard data products are composed of L3 HDF-EOS grid data.

A separate product file is produced for each different atmospheric species. Each of these files is referred to an Earth Science Data Type (ESDT). TES obtains data in two basic observation modes: Limb or Nadir. The product file may contain, in separate folders, limb data, nadir data, or both folders may be present.

Specific to L3 processing are the terms "Daily", "8-Day", and "Monthly" representing the approximate time coverage of the L3 products. However the input data granules to the L3 process will be complete Global Surveys; in other words a Global Survey will not be split in relation to time when input to the L3 processes even if they exceed the usual understood meanings of a day or month. More specifically:

Daily L3 products represent a single Global Survey (approximately 23.7 hours)
8-Day L3 products represent four Global Surveys initiated within that time period (a GS is scheduled every other day)
Monthly L3 products represent Global Surveys that are initiated within that calendar month.

The data granules defined for L3 standard products are "daily", "8-day", and "monthly". L3 data is provided at uniform grids in latitude and longitude and at selected pressure levels.

For nadir observations, L3 standard products are produced for the molecular species: H_2O, O_3, CO, CH_4, HDO, CO2, NH3 and TATM (atmospheric temperature). For limb observations, L3 standard products are produced for the molecular species: H_2O, O_3, CO, CH_4, NO_2, HDO, HNO_3, and TATM (atmospheric temperature). TES referred atmospheric temperature as TATM in TES L3 Products. According to AURA guidelines it should be Temperature. HDF5 alias is used for Temperature. L3 TES products have fields TATM and Temperature which are identical fields. Species with diurnal variations are nadir atmospheric temperature for nadir and NO_2 for limb. Limb CO, NO2 and CH4 may be produced in future releases See Table 6-1. L3 standard products will only be generated from global survey (GS) measurements and not from special observations/investigations.

8-Day products will be producted in future realeases.

The table below illustrates the molecular species and temperature reported for L2 nadir and limb retrievals, and which profiles are to be processed by the L3 Product PGEs under this release. Note that Limb CH4, CO, and NO2 will not be produced in this software release.

Table 7-1: View and Species Types

Species	H2O	O3	CH4	CO	NO2	HNO3	HDO	TATM	CO2	NH3
Nadir Grid Objects	x	x	x	x	-	-	x	x	x	x
Limb Grid Objects	x	x				x	x	x		

The L3 standard product files are implemented using the HDF-EOS 5 file format. HDF-EOS 5 files have a default extension of ".he5". The ECS Local Granule ID (filename) for a L3 standard product is constructed using the following template:

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Table 7-2: L3 Data File Name Convention and Notation

File Type	File Name Convention
daily	TES-Aura_L3-<species>_<run id>_<version id>.he5
8-day	TES-Aura_L3-<species>-8D<year><doy>_<version id>.he5
monthly	TES-Aura_L3-<species>-M<year><month>_<version id>.he5

Notation	Format	Description
<doy>	**d**ddd	<doy>: first day of the 8-day period **d** : day of year format placeholder ddd : 3-digit number representing day of year
<month>	**m**mm	**m** : month format placeholder mm : 2-digit number representing month
<run id>	**r**nnnnnnnnnn	**r** : Run ID format placeholder nnnnnnnnnn : string representing 10-digit Run ID
<version id>	**F**ff_cc	**F** : File format placeholder ff : 2-digit version number reflecting file format changes cc : 2-digit version number reflecting content changes
<year>	yyyy	yyyy: 4-digit number representing year

Due to instrument lifetime concerns involving the TES Pointing Control Subsystem the means of instrument calibration was modified in April 2010. The calibration method and algorithm may be determined through the file naming convention used in the product files and also through the TES_Common metadata attribute Calib_Scheme.

Briefly, data acquired prior to April 7, 2010 will use the calibration scheme termed 'NON_SPLIT_CAL' in the TES_Common metadata attribute Calib_Scheme. Data acquired on and following April 7, 2010 will be identified in the TES_Common metadata attribute Calib_Scheme as 'SPLIT_CAL', and will additionally be identified with the designator 'C01' in the product file name for L1B, L2 and L3 product files.

On April 7, 2010 TES began collecting Global Survey data using a new split-calibration collection scheme. This calibration method as non-embedded blackbody scans bracketing the global survey. Special observation data collection was also modified on May 12, 2010. To distinguish between this new calibration scheme and data collected before these dates TES will introduce a calibration designator in the filename and product metadata.

This filename with calibration designator is applicable for all global surveys with run IDs greater than or equal to 11125 and special observations with run IDs greater than or equal to 11189.

The table below lists each of the TES L3 standard data product ESDTs for "daily" format.

Table 7-3: L3 Daily Standard Product Data Files

ESDT Descriptor	<species>	<view mode>	File Name
TL3ATD	ATM-TEMP	Nadir / Limb	TES-Aura_L3-ATM-TEMP_<run id>_<version id>.he5
TL3H2OD	H2O	Nadir / Limb	TES-Aura_L3-H2O_<run id>_<version id>.he5
TL3O3D	O3	Nadir / Limb	TES-Aura_L3-O3_<run id>_<version id>.he5
TL3COD	CO	Nadir / Limb	TES-Aura_L3-CO_<run id>_<version id>.he5
TL3CH4D	CH4	Nadir / Limb	TES-Aura_L3-CH4_<run id>_<version id>.he5
TL3HDOD	HDO	Nadir / Limb	TES-Aura_L3-HDO_<run id>_<version id>.he5
TL3HNOD	HNO3	Limb	TES-Aura_L3-HNO3_<run id>_<version id>.he5
TL2NH3D	NH3	Nadir	TES-Aura_L3-NH3_<run id>_<version id>.he5

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TL3ATD	ATM-TEMP	Nadir / Limb	TES-Aura_L3-ATM-TEMP_<run id>_C01_<version id>.he5
TL3H2OD	H2O	Nadir / Limb	TES-Aura_L3-H2O_<run id>_C01_<version id>.he5
TL3O3D	O3	Nadir / Limb	TES-Aura_L3-O3_<run id>_C01_<version id>.he5
TL3COD	CO	Nadir / Limb	TES-Aura_L3-CO_<run id>_C01_<version id>.he5
TL3CH4D	CH4	Nadir / Limb	TES-Aura_L3-CH4_<run id>_C01_<version id>.he5
TL3HDOD	HDO	Nadir / Limb	TES-Aura_L3-HDO_<run id>_C01_<version id>.he5

The table below lists each of the TES L3 standard data product ESDTs for "8-day" format.

Table 7-4: L3 8-Day Standard Product Data Files

ESDT Descriptor	<species>	<view mode>	File Name
TL3NO2_8	NO2	Limb	TES-Aura_L3-NO2-8D<year><doy>_<version id>.he5

8-Day product will not be produced in this release.

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The table below lists each of the TES L3 standard data product ESDTs for "monthly" format.

Table 7-5: L3 Monthly Standard Product Data Files

ESDT Descriptor	<species>	<view mode>	File Name
TL3ATM	ATM-TEMP	Nadir/Limb	TES-Aura_L3-ATM-TEMP-M<year><month>_<version id>.he5
TL3H2OM	H2O	Nadir/Limb	TES-Aura_L3-H2O-M<year><month>_<version id>.he5
TL3O3M	O3	Nadir/Limb	TES-Aura_L3-O3-M<year><month>_<version id>.he5
TL3COM	CO	Nadir/Limb	TES-Aura_L3-CO-M<year><month>_<version id>.he5
TL3CH4M	CH4	Nadir/Limb	TES-Aura_L3-CH4-M<year><month>_<version id>.he5
TL3NO2M	NO2	Limb	TES-Aura_L3-NO2-M<year><month>_<version id>.he5
TL3HDOM	HDO	Nadir/Limb	TES-Aura_L3-HDO-M<year><month>_<version id>.he5
TL3HNOM	HNO3	Limb	TES-Aura_L3-HNO3-M<year><month>_<version id>.he5
TL3CO2M	CO2	Nadir	TES-Aura_L3-CO2-M<year><month>_<version id>.he5
TL3ATM	ATM-TEMP	Nadir/Limb	TES-Aura_L3-ATM-TEMP-M<year><month>_C01_<version id>.he5
TL3H2OM	H2O	Nadir/Limb	TES-Aura_L3-H2O-M<year><month>_C01_<version id>.he5
TL3O3M	O3	Nadir/Limb	TES-Aura_L3-O3-M<year><month>_C01_<version id>.he5
TL3COM	CO	Nadir/Limb	TES-Aura_L3-CO-M<year><month>_C01_<version id>.he5
TL3CH4M	CH4	Nadir/Limb	TES-Aura_L3-CH4-M<year><month>_C01_<version id>.he5
TL3HDOM	HDO	Nadir/Limb	TES-Aura_L3-HDO-M<year><month>_C01_<version id>.he5
TL3CO2M	CO2	Nadir	TES-Aura_L3-CO2-M<year><month>_C01_<version id>.he5

Limb NO2 are not produced in this release

CO2 Monthly products are currently not being produced in Release 12.

7.2 L3 Product File Structures

The file structures of each L3 standard data products are depicted in the figures below. In addition to the grid object, each L3 standard product also contains descriptive metadata. The organization and layout of metadata conforms to ECS guidelines. First, an ECS Metadata block, metadata that includes a set of mandatory data describing attributes about the standard product is found at the beginning of every standard product. TES-specific metadata follows the ECS metadata. These metadata fields are used to describe TES specific details. Some of these data will be common among all TES products, some common only to TES Level 3 products, and some specific only to "daily", "8-day" and "monthly" products.

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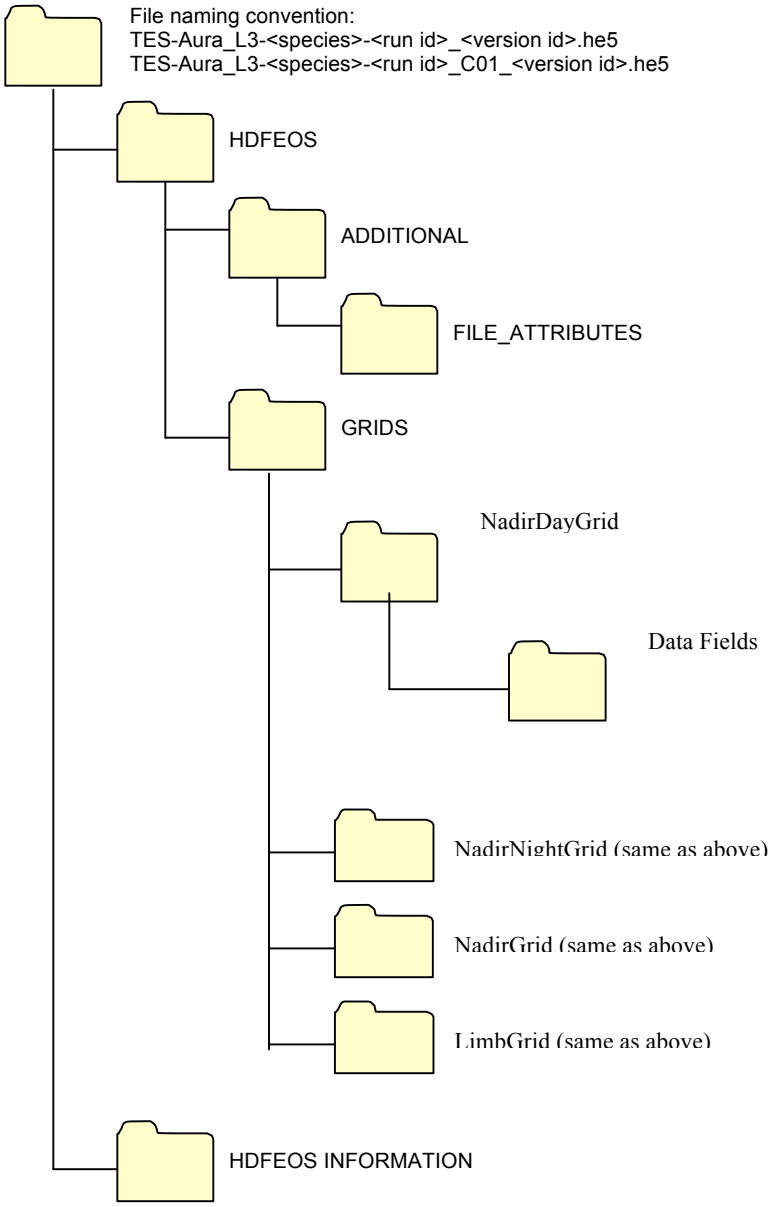
7.2.1 Daily Grid File



For Nadir scans, atmospheric temperature files contain NadirDayGrid and NadirNightGrid datagroups, and for all other species (H2O, O3, CO, CH4, HDO, HNO3, NH3) will have only NadirGrid.

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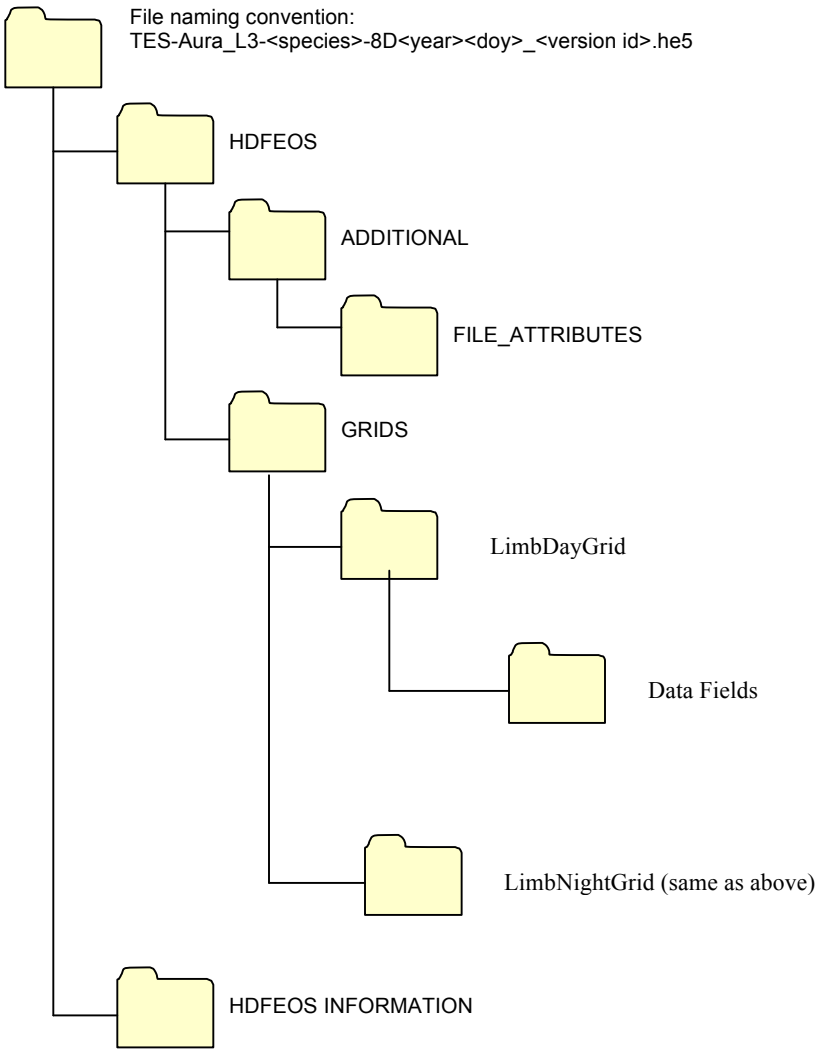
7.2.2 8-Day Grid File



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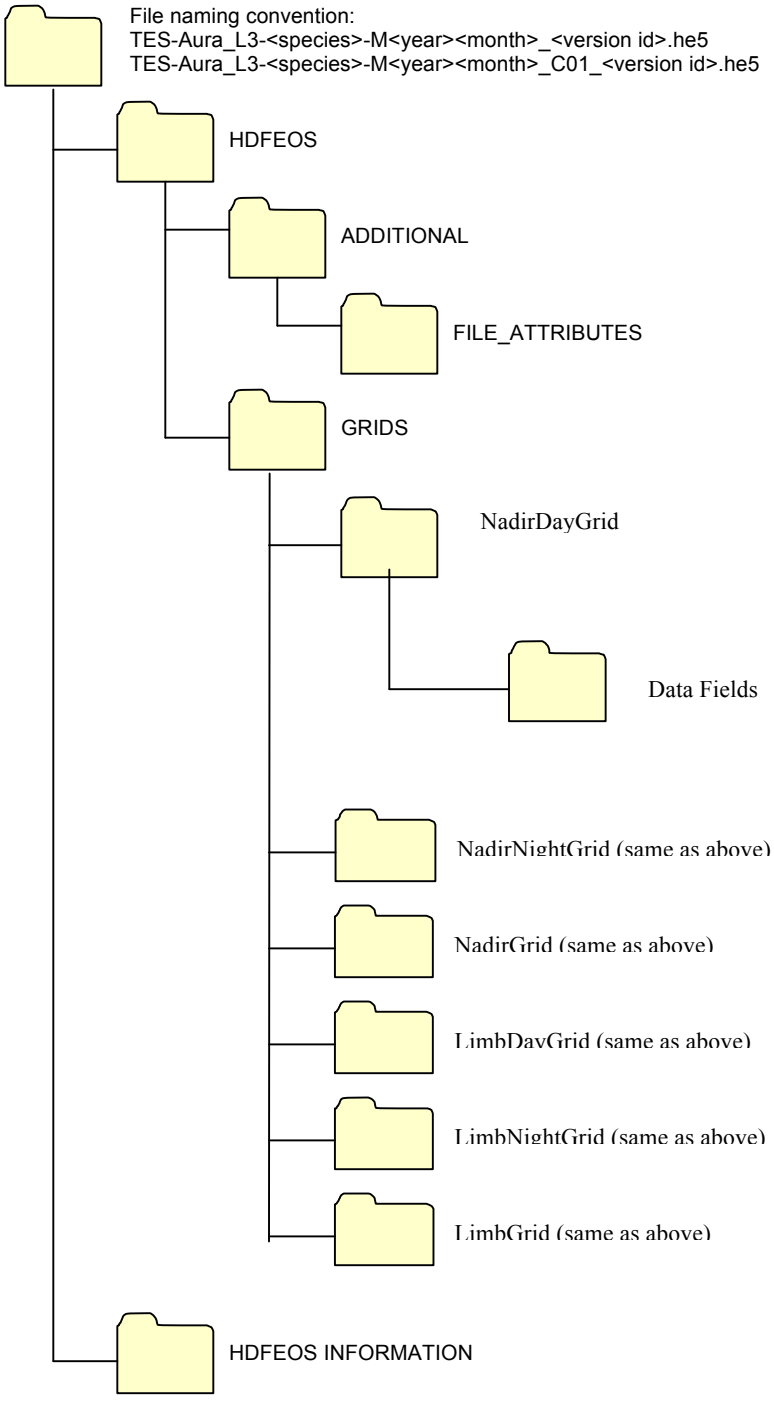
7.2.3 Monthly Grid File



For Nadir scans, atmospheric temperature files contain NadirDayGrid and NadirNightGrid datagroups, for Limb scan NO2 contains LimbDayGrid and LimbNightGrid and for all other species (H2O, O3, CO, CH4, HDO, HNO3, CO2, NH3) will have only NadirGrid and LimbGrid.

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7.3 Daily Data Fields

The Daily Data Fields consist of standard data fields. There is a format difference between ATM_TEMP and other species data fields.

Each Data Field will be annotated using HDF-EOS Local Attributes which are listed in the table below. Data Field Attributes are a feature which can be useful in annotating plots as well as describing the data product to input routines. These attributes will be set via calls to he5_gdwrlattr (HE5_GDwritelocattr for C users).

Attribute Name	Attribute Description	Size	HDF-EOS 5 Type
MissingValue	Contains the value for missing or fill data. 32 float : -999.0 64 double: -999.0 32 int : -999 16 int : -999 8 int : -99		Same type as Data Field
Title	For labeling a plot or axis.		NATIVE_CHAR
Units	Labeling units (for labeling color bars, converting between units, etc).		NATIVE_CHAR
UniqueFieldDefinition	Describes if definition of field is shared with other Aura Instruments ("Aura-Shared", "X-Specific", where X=Instrument Name, "X-Y[-Z]-Shared" where X,Y, and optional Z are instrumer names (in alphabetical order)		NATIVE_CHAR

7.3.1 Daily Standard Data Fields

The tables below show the grid data dimensions and daily data fields.

Table 7-6: Daily Standard Data Dimensions Definitions

Dimension Name	Valid Value (Description)
XDim	90 - Number of longitudes from -180 to 180 degree at 4 degree spacing
YDim	83 - Number of latitudes ±82 at 2 degree spacing
nLevels	15 - Number of L3 pressure levels (excludes surface)

Table 7-7: Daily Standard Data Fields for ATM_TEMP

Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
<species> Temperature(Atmospheric Temperature)	Pressure-level data (dim XDim x YDim x nLevels)	K		32	NATIVE-FLOAT
<species>AtSurface	Pressure-level data at surface (dim XDim x YDim)	K		32	NATIVE-FLOAT
SurfaceTemperature	Temperature at the earth surface measured at Day (dim XDim x YDim)	K	150.0 – 350.0	32	NATIVE-FLOAT

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Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
SurfacePressure	Surface Pressure (dim XDim x YDim)	hPa		32	NATIVE-FLOAT
Latitude	L3 latitudes, ±82°at 2 degree spacing (dim YDim)	deg	-82 - +82	32	NATIVE-FLOAT
Longitude	L3 longitudes, from ±180° at 4 degree spacing (dim XDim)	deg	-180 - +180	32	NATIVE-FLOAT
Pressure	L3 pressure levels (excludes surface) (dim nLevels)	hPa.	4.6 – 1000	32	NATIVE-FLOAT

Table 7-8: Daily Standard Data Fields for H2O, O3, CO, CH4, HDO, HNO3, NH3 species

Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
<species> H2O HDO O3 CH4 CO HNO3 NH3	Pressure-level data (dim XDim x Ydim x nLevels)	vmr		32	NATIVE-FLOAT
<species>AtSurface	Pressure-level data at surface (dim Xdim x Ydim)	vmr		32	NATIVE-FLOAT
TotalColumnDensity	Total column density data (dim XDim x YDim)	Molecules/cm^2	$0 – 10^{28}$	32	NATIVE-FLOAT
SurfacePressure	Surface Pressure (dim XDim x YDim)	hPa		32	NATIVE-FLOAT
OzoneTropColumn	Ozone Trop Column data (dim Xdim x Ydim) **This Field is present only in O3 product**	Molecules/cm^2	$0 – 10^{28}$	32	NATIVE-FLOAT
Latitude	L3 latitudes, ±82°at 2 degree spacing (dim YDim)	deg	-82 - +82	32	NATIVE-FLOAT
Longitude	L3 longitudes, from ±180° at 4 degree spacing (dim XDim)	deg	-180 - +180	32	NATIVE-FLOAT
Pressure	L3 pressure levels (excludes surface) (dim nLevels)	hPa.	4.6 – 1000	32	NATIVE-FLOAT

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7.4 8-Day Data Fields

The 8-Day Grid Data Fields consist of standard data fields.

Each Data Field will be annotated using HDF-EOS Local Attributes which are listed in the table below. Data Field Attributes are a feature which can be useful in annotating plots as well as describing the data product to input routines. These attributes will be set via calls to he5_gdwrlattr (HE5_GDwritelocattr for C users).

Attribute Name	Attribute Description	Size	HDF-EOS 5 Type
MissingValue	Contains the value for missing or fill data. 32 float : -999.0 64 double: -999.0 32 int : -999 16 int : -999 8 int : -99		Same type as Data Field
Title	For labeling a plot or axis.		NATIVE_CHAR
Units	Labeling units (for labeling color bars, converting between units, etc).		NATIVE_CHAR
UniqueFieldDefinition	Describes if definition of field is shared with other Aura Instruments ("Aura-Shared", "X-Specific", where X=Instrument Name, "X-Y[-Z]-Shared" where X,Y, and optional Z are instrumer names (in alphabetical order)		NATIVE_CHAR

7.4.1 8-Day Standard Data Fields

The tables below show the grid data dimensions and 8-day grid data fields.

Table 7-9: 8-Day Standard Data Dimensions Definitions

Dimension Name	Valid Value (Description)
XDim	90 - Number of longitudes from -180 to 180 degree at 4 degree spacing
YDim	83 - Number of latitudes ±82 at 2 degree spacing
nLevels	15 - Number of L3 pressure levels (excludes surface)

Table 7-10: 8-Day Standard Data Fields

Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
<species> NO2	Average pressure-level data (dim XDim x YDim x nLevels)	vmr		32	NATIVE-FLOAT
<species>AtSurface	Average pressure-level data at surface (dim XDim x YDim)	vmr		32	NATIVE-FLOAT
TotalColumnDensity	Average total column density data (dim XDim x YDim)	Molecules/ cm^2	$0 - 10^{28}$	32	NATIVE-FLOAT

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Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
<species>DataCount	Number of pressure level data points (dim XDim x YDim x nLevels)	N/A	>0	16	NATIVE_INT16
<species>StdDeviation	Standard deviation of pressure level values (dim XDim x YDim x nLevels)	vmr		32	NATIVE_FLOAT
<species>Maximum	Maximum value of pressure level data (dim XDim x YDim x nLevels)	vmr		32	NATIVE_FLOAT
<species>Minimum	Minimum value of pressure level data (dim XDim x YDim x nLevels)	vmr		32	NATIVE_FLOAT
TotColDensDataCount	Number of total column density data points (dim XDim x YDim)	N/A	> 0	16	NATIVE_INT16
TotColDensStdDeviation	Standard deviation of total column density values (dim XDim x YDim)	Molecules/ cm^2	0 - 10^{28}	32	NATIVE_FLOAT
TotColDensMaximum	Maximum value of total column density data (dim XDim x YDim)	Molecules/ cm^2	0 - 10^{28}	32	NATIVE_FLOAT
TotColDensMinimum	Minimum value of total column density data (dim XDim x YDim)	Molecules/ cm^2	0 - 10^{28}	32	NATIVE_FLOAT
Latitude	L3 latitudes, ±82°at 2 degree spacing (dim YDim)	deg	-82 - +82	32	NATIVE-FLOAT
Longitude	L3 longitudes, from ±180° at 4 degree spacing (dim XDim)	deg	-180 - +180	32	NATIVE-FLOAT
Pressure	L3 pressure levels (excludes surface) (dim nLevels)	hPa.	4.6 – 1000	32	NATIVE-FLOAT

7.5 Monthly Data Fields

The Monthly Grid Data Fields consist of standard data fields.

Each Data Field will be annotated using HDF-EOS Local Attributes which are listed in the table below. Data Field Attributes are a feature which can be useful in annotating plots as well as describing the data product to input routines. These attributes will be set via calls to he5_gdwrlattr (HE5_GDwritelocattr for C users).

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Attribute Name	Attribute Description	Size	HDF-EOS 5 Type
MissingValue	Contains the value for missing or fill data. 32 float : -999.0 64 double: -999.0 32 int : -999 16 int : -999 8 int : -99		Same type as Data Field
Title	For labeling a plot or axis.		NATIVE_CHAR
Units	Labeling units (for labeling color bars, converting between units, etc).		NATIVE_CHAR
UniqueFieldDefinition	Describes if definition of field is shared with other Aura Instruments ("Aura-Shared", "X-Specific", where X=Instrument Name, "X-Y[-Z]-Shared" where X,Y, and optional Z are instrumer names (in alphabetical order)		NATIVE_CHAR

7.5.1 Monthly Standard Data Fields

The tables below show the grid data dimensions and monthly grid data fields.

Table 7-11: Monthly Standard Data Dimensions Definitions

Dimension Name	Valid Value (Description)
XDim	90 - Number of longitudes from -180 to 180 degree at 4 degree spacing
YDim	83 - Number of latitudes ±82 at 2 degree spacing
nLevels	15 - Number of L3 pressure levels (excludes surface)

Table 7-12: Monthly Standard Data Fields for ATM_TEMP

Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
<species> Temperature	Average pressure-level data (dim XDim x YDim x nLevels)	K		32	NATIVE-FLOAT
<species>DataCount	Number of pressure level data points (dim XDim x YDim x nLevels	N/A	>0	16	NATIVE_INT16
<species>StdDeviation	Standard deviation of pressure level values (dim XDim x YDim x nLevels)	N/A		32	NATIVE_FLOAT
<species>Maximum	Maximum value of pressure level data (dim XDim x YDim x nLevels)	K		32	NATIVE_FLOAT

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Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
<species>Minimum	Minimum value of pressure level data (dim XDim x YDim x nLevels)	K		32	NATIVE_FLOAT
Latitude	L3 latitudes, ±82°at 2 degree spacing (dim YDim)	deg	-82 - +82	32	NATIVE-FLOAT
Longitude	L3 longitudes, from ±180° at 4 degree spacing (dim XDim)	deg	-180 - +180	32	NATIVE-FLOAT
Pressure	L3 pressure levels (excludes surface) (dim nLevels)	hPa.	4.6 – 1000	32	NATIVE-FLOAT

Table 7-13: Monthly Standard Data Fields for H2O, O3, CO, CH4, HDO, HNO3, CO2, NH3 species

Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
<species> H2O HDO O3 CH4 CO NO2 HNO3 CO2 NH3	Average pressure-level data (dim XDim x YDim x nLevels)	vmr		32	NATIVE-FLOAT
<species>DataCount	Number of pressure level data points (dim XDim x YDim x nLevels	N/A	>0	16	NATIVE_INT16
<species>StdDeviation	Standard deviation of pressure level values (dim XDim x YDim x nLevels)	N/A		32	NATIVE_FLOAT
<species>Maximum	Maximum value of pressure level data (dim XDim x YDim x nLevels)	vmr		32	NATIVE_FLOAT
<species>Minimum	Minimum value of pressure level data (dim XDim x YDim x nLevels)	vmr		32	NATIVE_FLOAT
TotalColumnDensity	Average total column density data (dim XDim x YDim)	Molecules/ cm^2	0 - 10^{28}	32	NATIVE-FLOAT
TotColDensDataCount	Number of total column density data points (dim XDim x YDim)	N/A	> 0	16	NATIVE_INT16

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Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
TotColDensStdDeviation	Standard deviation of total column density values (dim XDim x YDim)	N/A	0 - 10^{28}	32	NATIVE_FLOAT
TotColDensMaximum	Maximum value of total column density data (dim XDim x YDim)	Molecules/ cm^2	0 - 10^{28}	32	NATIVE_FLOAT
TotColDensMinimum	Minimum value of total column density data (dim XDim x YDim)	Molecules/ cm^2	0 - 10^{28}	32	NATIVE_FLOAT
OzoneTropColumn	Ozone Trop Column data (dim Xdim x Ydim) **This Field is present only in O3 product**	Molecules/ cm^2	0 – 10^{28}	32	NATIVE-FLOAT
Latitude	L3 latitudes, ±82°at 2 degree spacing (dim YDim)	Deg	-82 - +82	32	NATIVE-FLOAT
Longitude	L3 longitudes, from ±180° at 4 degree spacing (dim XDim)	Deg	-180 - +180	32	NATIVE-FLOAT
Pressure	L3 pressure levels (excludes surface) (dim nLevels)	hPa.	4.6 – 1000	32	NATIVE-FLOAT

7.6 L3 ECS and TES-specific Metadata

7.6.1 Introduction

As with all ESDTs, TES ESDTs contain metadata that describes specific attributes about the data or the quality of data contained in the ESDT. Some of the basic metadata items are required by EOSDIS. These data items commonly include basic identification information and other generic information about the particular ESDT. These data items are referred to as ECS Inventory Metadata. In addition to ECS Inventory Metadata, additional TES ESDTs contain additional metadata more specific to the TES program. The TES-specific metadata has been subdivided into subcategories based on the uniqueness of its origin and identification:

4. Production History — Production History Metadata
5. TES-Common — Metadata common to all TES ESDTs
6. TES-L3-Common — Metadata common to all Level 3 ESDTs

TES common metadata are fairly generic to the entire family of TES ESDTs or to TES L3 products.

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7.6.2 ECS Inventory Metadata

The table below shows the ECS Inventory Metadata. The ECS Inventory Metadata is implemented in the HDF file as text block named coremetadata within a group named HDFEOS INFORMATION.

Table 7-14: ECS Inventory Metadata

Data Layer Name	Data Description	TES Valids	Type[5]	Source
AssociatedInstrumentShortName	Instrument short name supplied by TES project.	TES	VA20	MCF
AssociatedPlatformShortName	Platform short name supplied by EOS project.	Aura	VA20	MCF
AssociatedSensorShortName	Sensor short name supplied by TES project.	FTS	VA20	MCF
OperationMode	Mode of operation of the instrument.	Calibration Routine	VA20	MCF
ShortName	This name will identify the ESDT short name associated with the collection or granule.	(set in MCF)	A8	MCF
VersionID	Version identifier of the ESDT data collection.	(set in MCF)	SI	MCF
ProductionDateTime	The date and time a specific granule was produced a PGE.	YYYY-MM-DDT HH:MM:SS.SSSZ	DT	TK
SizeMBECSDataGranule	The size attribute will indicate the volume of data contained in the granule.		F10	DSS
LocalGranuleID	Unique identifier for locally produced granule that ECS ingests and is required to capture.	e.g., TES-Aura_L2-SUMMARY_r0000000001_F01_01.he5	VA80	PGE
LocalVersionID	Local version identifier for PGE defined granule versions. Takes the form “executable name: Clearcase label”		VA60	PGE
InputPointer	Description of location of Production History information.	“Production History block at: /HDFEOS/ADDITIONAL/FILE_ATTRIBUTES/PRODUCTION_HISTORY”	VA255	PGE
ParameterName	Scope of quality flags. For TES, refers to entire granule.	Granule	A40	PGE
ScienceQualityFlag	The granule level flag applying generally to the granule and specifically to parameters at the granule level.	Passed Failed Being Investigated Not Investigated Inferred Passed Inferred Failed Suspect	VA25	DP
ScienceQualityFlagExplanation	A text explanation of the criteria used to set the ScienceQualityFlag including thresholds or other criteria.	(Free text)	VA255	DP
RangeBeginningDate	The year, month, and day when the temporal coverage period being described began.	YYYY-MM-DD	DT	PGE
RangeBeginningTime	The first hour, minute, and second of the temporal coverage period being described.	HH:MM:SS.SSSZ	T	PGE
RangeEndingDate	The last year, month, and day when the temporal coverage period being described.	YYYY-MM-DD	DT	PGE
RangeEndingTime	The last hour, minute, and second of the temporal coverage period being described.	HH:MM:SS.SSSZ	T	PGE
PGEVersion	The Release of the PGE software: e.g. “R6.1.2”		A10	PGE

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7.6.3 Production History Metadata

The Production History Metadata is implemented as a single text block and written to the HDF file as a file level attribute. The Production History text block contains information about the L3 PGE and the running execution of the PGE to produce ESDT standard products. Static information in the text block describes the elements that make up the PGE like build configuration, support files and database table population. Dynamic information describes all the running parameters involved in a PGE execution for a specific RUN ID. This information is captured for both pre and post execution of the L3 Product PGE.

Table 7-15: L3 Production History

History Data	Data Description	Size (K)	State
ECS	Toolkit file for input/output file specification	23	Dynamic
Environment Variable	SIPS environment variables	5	Dynamic
Fetch	SIPS fetch list from archived	5	Dynamic
SIPS PCF	SIPS-specific PCF file for PGE processing	3	Dynamic
Workspace List (PRE)	File listing in SIPS PGE workspace prior to PGE execution	5	Dynamic
Workspace List (POST)	File listing in SIPS PGE workspace following PGE execution	5	Dynamic
Runtime	CPU and Wallclock PGE run time	0.1	Dynamic
Control Definition	Framework Parameter Definition File for output files	1	Static
Control Parameter	Framework Parameter Specification File for output files	0.02	Static
Control Parameter (Runtime)	Framework Parameter specified in the command line of the PGE	0.02	Dynamic
TimeStamp	RUN ID begin date and end date timestamp	0.05	Dynamic
README	README file that describes production history context	1	Static
PGE Version	PGE version information	0.2	Static
PGE specific configurations	TBD	TBD	TBD

7.6.4 TES-Common Metadata

Metadata shown below is common to all TES files. For Level 3, these are implemented as File Level Attributes (HDF-EOS Global File Attributes). This is information that helps to describe this particular data set. It can be useful in labeling plots, calculating dates, etc. These will be set via calls to he5_ehwrglatt(HE5_EHwriteglbattr for C users).

Table 7-16: TES-Common-Metadata

Data Layer Name	Data Description	Valids	Size	Type	HDF-EOS 5 Type
InstrumentName	TES			char	NATIVE_CHAR
ProcessLevel	L1B,L2,L3,etc.			char	NATIVE_CHAR
OrbitNumber	16(daily) or 2 (8-day/monthly) orbit numbers		32	int	NAATIVE_INT32
OrbitPeriod	16 (daily) or 2 (8-day/monthly) orbit periods, microseconds (Fill value -999 for this release)		64	double	NATIVE_DOUBLE
TAI93At0zOfGranule			64	double	NATIVE_DOUBLE
GlobalSurveyNumber	Run IDs (run ids contributing to the products)			char	NATIVE_CHAR
GranuleMonth	Month granule was produced (from ECS MD RangeBeginningDate)	1-12	8	int	NATIVE_INT
GranuleDay	Day granule was produced (from ECS MD RangeBeginningDate)	1-31	8	int	NATIVE_INT

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Data Layer Name	Data Description	Valids	Size	Type	HDF-EOS 5 Type
GranuleYear	Year granule was produced (from ECS MD RangeBeginningDate)		32	int	NATIVE_INT
GranuleDayOfYear	Day of year granule produced	1 - 365	16	int	NATIVE_INT16
SurveyMode	Type of survey, e.g., Global or Special			char	NATIVE_CHAR
PGEVersion	Release of PGE Software: e.g. "R6.1.2"			char	NATIVE_CHAR
StartUTC	UTC time of start of granule. (from ECS MD RangeBeginningDate)			char	NATIVE_CHAR
EndUTC	UTC time of end of granule. (from ECS MD RangeEndingDate)			char	NATIVE_CHAR
Period	"Daily", "8-Day", or "Monthly"			char	NATIVE_CHAR
Command_Seq_ID	Command Sequence (Run) ID	N/A	32	int	NATIVE_INT32
Calib_Scheme	Calibration scheme with or without embedded black body scans: SPLIT_CAL or NON_SPLIT_CAL				NATIVE_CHAR

7.6.5 TES-L3-Common

Metadata shown below is common to all TES L3 files. These are implemented as Grid Level Attributes. This is information which helps describe the grid to which it is attached. These will be set via calls to he5_gdwrattr (HE5_GDwriteattr for C users).

Table 7-17: TES-L3-Common-Metadata

Data Layer Name	Data Description	Data Range	Units	Size	HDF-EOS 5 Type
Projection	Geographic				NATIVE_CHAR
GridOrigin	Center				NATIVE_CHAR
Grid Spacing	(4,2)				NATIVE_CHAR
GridSpacingUnit	deg				NATIVE_CHAR
GridSpan	(-180,+180,-82,+82)				NATIVE_CHAR
GridSpanUnit	deg				NATIVE_CHAR

7.6.6 L3 Daily Common metadata

Metadata shown below is common to daily L3 Products.

Table 7-18: TES-L3-Daily-Common-Metadata

Data Layer Name	Data Description	Data Range	Units	Size	HDF-EOS 5 Type
TriangleVertDistMax	Maximum distance from any of the three vertices of the Delaunay triangles to a given L2 data point.	0 to 5000		32	NATIVE_FLOAT
GlobalSurveyL3Algorithm	"Along orbit interpolation, Delaunay sphere triangulation, and 2-D linear interpolation"				NATIVE_CHAR

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7.6.7 L3 8-Day Common metadata

Metadata shown below is common to 8-day L3 Products.

Table 7-19: TES-L3-8-Day-Common-Metadata

Data Layer Name	Data Description	Data Range	Units	Size	HDF-EOS 5 Type
DeltaFullLatitude	Latitude defining the size of bin box used to average L2 data	5 - 50	Degrees	32	NATIVE_FLOAT
DeltaFullLongitude	Longitude defining the size of bin box used to average L2 data	5 - 50	Degrees	32	NATIVE_FLOAT
8-DayL3Algorithm	"Binning average, L2 data weighted inversely by error and distance to L3 geolocation point"		N/A		NATIVE_CHAR

7.6.8 L3 Monthly Common metadata

Metadata shown below is common to monthly L3 Products.

Table 7-20: TES-L3-Monthly-Common-Metadata

Data Layer Name	Data Description	Data Range	Units	Size	HDF-EOS 5 Type
DeltaFullLatitude	Latitude defining the size of bin box used to average L2 data	5 - 50	Degrees	32	NATIVE_FLOAT
DeltaFullLongitude	Longitude defining the size of bin box used to average L2 data	5 - 50	Degrees	32	NATIVE_FLOAT
MonthlyL3Algorithm	"Binning average, L2 data weighted inversely by error and distance to L3 geolocation point"		N/A	32	NATIVE_CHAR

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8. LEVEL 2 CO2 LITE PRODUCT

8.1 Overview

The TES Level 2 CO2 Lite Product is a monthly aggregation of the TES L2 CO2 data provided on a reduced pressure grid. It stacks all nadir target scenes for the month, ordered by time, with no data averaging. When available, the product includes TES special observations in addition to the global surveys in the aggregation. L2 CO2 Lite data product is generated for nadir observations only.

To facilitate sharing data products between all Aura platform science teams, the organization of the L2 Standard Data Products conforms to specifications dictated in the HDF-EOS Aura File Format Guidelines (Craig, et al). These guidelines lay down the basic file format and data format specifications for all L2 standard products. While the specific referenced document should be checked for details, the guidelines specify that all L2 standard products should be generated using HDF-EOS V5.x formatting specifications. All data are to be reported as "swath" data objects. The L2 CO2 Lite product file is implemented using the HDF-EOS 5 file format. HDF-EOS 5 files have a default extension of ".he5". The ECS Local Granule ID (filename) for a L2 CO2 Lite is constructed using the following template:

TES-Aura_L2-CO2L-<view>_<year>m<month>_<version id>.he5

Due to instrument lifetime concerns involving the TES Pointing Control Subsystem the means of instrument calibration was modified in April 2010. The calibration method and algorithm may be determined through the file naming convention used in the product files and also through the TES_Common metadata attribute Calib_Scheme.

Briefly, data acquired prior to April 7, 2010 will use the calibration scheme termed 'NON_SPLIT_CAL' in the TES_Common metadata attribute Calib_Scheme. Data acquired on and following April 7, 2010 will be identified in the TES_Common metadata attribute Calib_Scheme as 'SPLIT_CAL', and will additionally be identified with the designator 'C01' in the product file name for L1B, L2 and L3 product files.

On April 7, 2010 TES began collecting Global Survey data using a new split-calibration collection scheme. This calibration method as non-embedded blackbody scans bracketing the global survey. Special observation data collection was also modified on May 12, 2010. To distinguish between this new calibration scheme and data collected before these dates TES will introduce a calibration designator in the filename and product metadata.

TES-Aura_L2-CO2L-<view>_<year>m<month>_C01_<version id>.he5

This filename with calibration designator is applicable for all global surveys with run IDs greater than or equal to 11125 and special observations with run IDs greater than or equal to 11189.

Table 8-1: EOS Aura TES Level 2 CO2 Lite

ESDT Short Name	ECS File Type	Collection Summary	Local Granule ID[a]
TL2CO2L	HDF-EOS	TES/Aura L2 CO2 Lite Nadir	TES-Aura_L2-CO2L-Nadir_<year>m<month>_Fff_cc.he5
TL2CO2L	HDF-EOS	TES/Aura L2 CO2 Lite Nadir	TES-Aura_L2-CO2L-Nadir_<year>m<month>_C01_Fff_cc.he5

As mentioned above, each TES L2 CO2 Lite product reports information in a standardized data organization, the swath.

The CO2 volume mixing ratio proflies within the swath object are reported on a subsetted pressure grid when compared to the standard TES CO2 product. The pressure levels for CO2 Lite products are the same as the retrieval levels. Two dimensional fields, such as surface temperature, are unchanged from the standard TES CO2 product.

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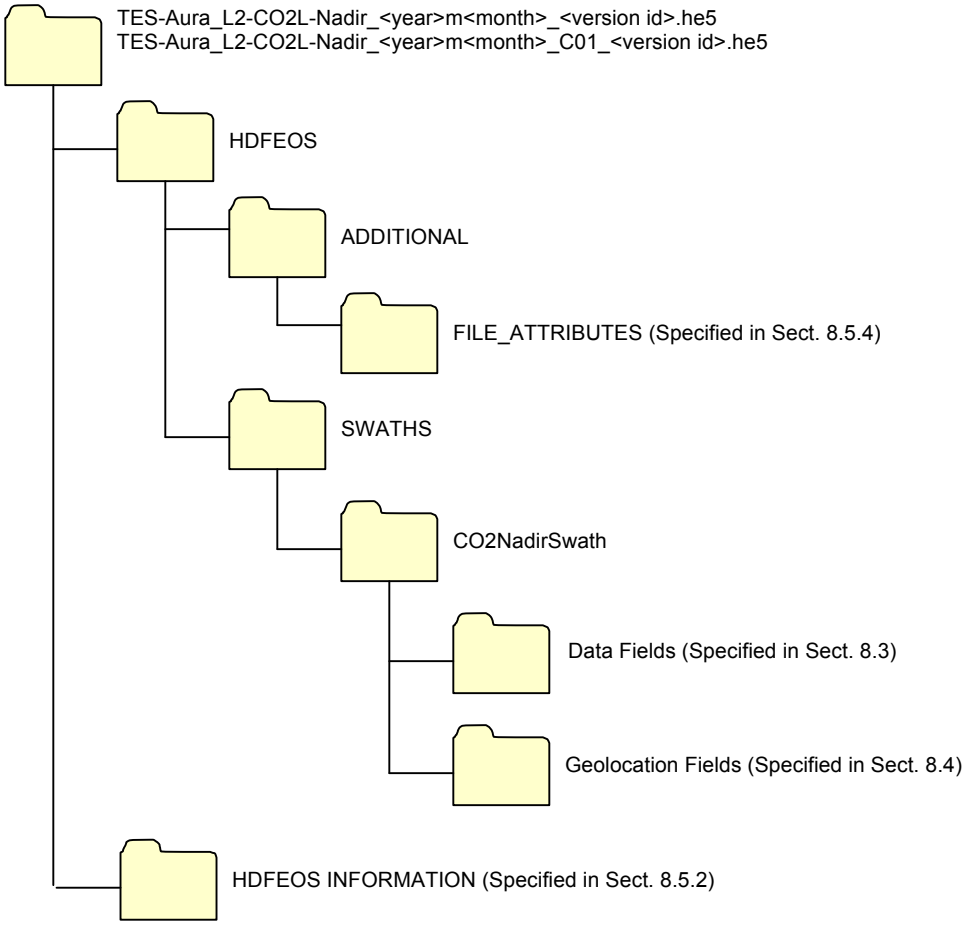
8.2 CO2 Lite File Structure

The file structure of CO2 Lite observation product is depicted in the figure below. In addition to the swath object (described above), each product also contains descriptive metadata. The organization and layout of metadata conforms to HDF-EOS guidelines. First, an ECS Metadata block, metadata that includes a set of mandatory data describing attributes about the standard product is found at the beginning of every product. TES-specific metadata follows the ECS metadata. These metadata fields are used to describe TES specific details. Some of these data will be common among all TES products, some common only to CO2 Lite product.



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8.3 CO2 Lite Data Fields

The CO2 Lite Data Fields consist of primary data fields, which are vmr or temperature profiles and other data dimensioned by time and pressure levels, and the associated data fields, which are only dimensioned by time.

Each Data Field will be annotated using HDF-EOS Local Attributes which are listed in the table below. Data Field Attributes are a feature which can be useful in annotating plots as well as describing the data product to input routines.

Attribute Name	Attribute Description	Size	HDF-EOS 5 Type
MissingValue	Contains the value for missing or fill dat 32 float : -999.0 64 double: -999.0 32 int : -999 16 int : -999 8 int : -99		Same type as Data Field
Title	For labeling a plot or axis.		NATIVE_CHAR
Units	Labeling units (for labeling color bars, converting between units, etc).		NATIVE_CHAR
UniqueFieldDefinition	Describes if definition of field is shared with other Aura Instruments ("Aura-Shared", "X-Specific", where X=Instrument Name, "X-Y[-Z]-Shared" where X,Y, and optional Z are instrume names (in alphabetical order)		NATIVE_CHAR

8.3.1 CO2 Lite Primary Data Fields

The table below shows the swath data dimensions. The pressure levels are the same as retrieval levels as described in the Overview (Section 8.1).

All swath data fields are based on a unified data structure and are used to report results of retrievals of spectra received from the L1B subsystem. The vmr data for the particular species of interest is the primary data element of each swath data layer. It is accompanied by various indices of error that help in evaluating the quality of the retrieval.

Table 8-2: Primary Data Dimensions Definitions

Dimension Name	Valid Value (Description)
nLevels	Number of reported pressure levels
nTimes	Number of reported observations for specified calendar month (GS+ SO)

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Table 8-3: CO2 Lite Primary Data Fields

Data Field Name / Title *	Data Descriptions	Units	Data Range	Size	HDF-EOS 5 Type
CO2	vmr data (dim nLevels x nTimes)	vmr or K		32	NATIVE_FLOAT
CO2Precision	Square-roots of diagonal elements of the measurement error covariance. See comment for TotalError regarding use. (dim nLevels x nTimes)	ln(vmr) or K		32	NATIVE_FLOAT
TotalError	Square-roots of diagonal elements the output total error covariance (includes smoothing error, systematic error, and measurement error). For atmospheric species, the positive error bar is: error+ = exp(ln(vmr) + error) - vmr. The negative error bar is: error- = vmr exp(ln(vmr) - error) (dim nLevels x nTimes)	ln(vmr) or K		32	NATIVE_FLOAT
~~VerticalResolution~~	Estimate of vertical resolution using the FWHM of averaging kernels (dim nLevels x nTimes)	meters		32	NATIVE_FLOAT
ConstraintVector	Constraint vector used in the retrieval (dim nLevels x nTimes)	vmr or K		32	NATIVE_FLOAT
AveragingKernel	The averaging kernel is the sensitivity of the estimated state to variations in the atmospheric state. The rows of the averaging kernel represent the sensitivity of the estimated state at a specific pressure level to variations in the atmospheric state at all levels. The columns of averaging kernel represent the sensitivity of the estimated state at all levels to variations in the atmospheric state at specific pressure level. For atmospheric species this is the sensitivity of retrieved ln(vmr) to the true ln(vmr). (dim nLevels x nLevels x nTimes)	N/A		32	NATIVE_FLOAT
TotalErrorCovariance	Sum of measurement, systematic, and smoothing error covariances. For atmospheric species, this is the covariance of the error of ln(vmr). (dim nLevels x nLevels x nTimes)	ln(vmr)^2 or K^2		32	NATIVE_FLOAT
MeasurementErrorCovariance	Propagated measured radiance noise. See comment for TotalErrorCovariance. (dim nLevels x nLevels x nTimes)	ln(vmr)^2 or K^		32	NATIVE_FLOAT

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Data Field Name / Title *	Data Descriptions	Units	Data Range	Size	HDF-EOS 5 Type
ObservationErrorCovariance	Measurement + systematic + cross-state errors. The utility of the observation error is for comparisons with other measurements and for assimilation. The smoothing error is accounted for when one applies the averaging kernel, so the observation error accounts for everything else. See comment for TotalErrorCovariance. (dim nLevels x nLevels x nTimes)	ln(vmr)^2 or K^		32	NATIVE_FLOAT
Initial	Initial vmr data or temperature data (for retrieved temperature) used in the retrieval (dim nLevels x nTimes)	vmr or K		32	NATIVE_FLOAT
AveragingKernelDiagonal	Diagonal of the averaging kernel, which shows retrieval sensitivity. For temperature, this is the sensitivity of the retrieved temperature to the true temperature. For atmospheric species this is the sensitivity of retrieved ln(vmr) to the true ln(vmr). (dim nLevels x nTimes)	N/A		32	NATIVE_FLOAT
AirDensity	Air density for each pressure level (dim nLevels x nTimes)	Molec/m^3	0-1e+26	32	NATIVE_FLOAT
Pressure	List of the Pressure Levels used (dim nLevels x nTimes)	hPa	0.001-1300.0	32	NATIVE_FLOAT
Altitude	Derived altitude for each pressure level (dim nLevels x nTimes)	meters	0-70000	32	NATIVE_FLOAT

Ideally, CO2, CO2Precision and quality measures will be populated for all Target Scenes for the global surveys and special observations for the specified calendar month. However, there will be times where completing retrievals will not be possible. The causes will be varied and might be due to bad spectra (based on evaluation by L1B), excessive cloud cover, or the retrieval was not performed for scheduling or other administrative reasons. Regardless of the cause for missing data, certain swath data fields will be set to a fill value according HDF-EOS Aura File Format Guidelines. Additionally, cloud cover may prevent retrieval down to the Earth's surface, resulting in partial retrievals. When such cases occur, pressure layers will contain fill values when no data exists.

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8.3.2 CO2 Lite Associated Data Fields

The table below provides the associated data dimensions. The data items shown in the following tables are also included in the Swath Data as Associated Data:

Table 8-4: Associated Data Field Dimensions Definitions

Dimension Name	Valid Value (Description)
nTimes	Number of reported observations for specified calendar month (GS+ SO)
nFreq	25 frequencies (values listed in TES-L2-Common metadata)
nLevels	Number of reported pressure levels

Table 8-5: CO2 Lite Associated Data Fields

Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
Scan_Averaged_Count	Number of scans averaged into a single target scene. (dim nTimes)	N/A	1-40 1 = no averaging	8	NATIVE_INT8
SpeciesRetrievalQuality	Species Retrieval Quality flag. True means retrieval passed quality check and reported errors are accurate. (dim nTimes)	N/A	0 = poor qualit 1 = passed quality check	8	NATIVE_INT8
CloudTopPressure	Pressure of inferred cloud top (species independent) (dim nTimes)	hPa	0.001 --1300.0	32	NATIVE_FLOAT
CloudTopPressureError	Error on Cloud Top Pressure. The positive error bar is error+ = exp(ln(CloudTopPressure + error) - CloudTopPressure. The negative error bar is error- = CloudTopPressure - exp(ln(CloudTopPressure - error). (dim nTimes)	hPa	-1..7	32	NATIVE_FLOAT
CloudEffectiveOpticalDepth	Vertical optical depth for the retrieved non-scattering cloud calculated at 25 frequencies listed in TES-L2-Common-Metadata (dim nTimes x nFreq)	N/A	0.0--500.0	32	NATIVE_FLOAT
CloudEffectiveOpticalDepthError	Error for Cloud Effective Optical Depth calculated at 25 frequencies listed in TES-L2-Common-Metadata (dim nTimes x nFreq)	N/A	0.0--500.0	32	NATIVE_FLOAT
AverageCloudEffOpticalDepth	Quality value: the cloud mean optica depth from 975 – 1200 cm-1. This is the same value for all species and tak from values at the final retrieval step. (dim nTimes)	N/A	1000-1150	32	NATIVE_FLOAT
AverageCloudEffOpticalDepthError	Error for Cloud Effective Optical Dep calculated using a weighted average o frequencies between 975 & 1200. Th is the same value for all species and taken from values at the final retrieva step. (dim nTimes)	N/A	1000-1150	32	NATIVE_FLOAT

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Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
SurfaceTemperature	Retrieved surface temperature from the last atmospheric temperature retrieval step (dim nTimes)	K	150.0 - 350	32	NATIVE_FLOAT
SurfaceTempError	Error in retrieved surface temperature (dim nTimes)	K	0.0 – 20.0	32	NATIVE_FLOAT
SurfaceTempInitial	Initial surface temperature at the start of the retrieval process, currently take from GMAO. (dim nTimes)	K	150.0 - 350	32	NATIVE_FLOAT
SurfaceTempDegreesOfFreedom	Degrees of freedom for surface temperature (dim nTimes)	N/A	0.0 – 2.0	32	NATIVE_FLOAT
SurfaceTempObservationError	Measurement + systematic + cross-st errors. The utility of the observation error is for comparisons with other measurements and for assimilation. The smoothing error is accounted for when one applies the averaging kerne so the observation error accounts for everything else. (dim nTimes)	K	0-50	32	NATIVE_FLOAT
SurfaceTempConstraint	Surface temperature value used to constrain the retrieval (species independent) (dim nTimes)	K	150.0 - 350	32	NATIVE_FLOAT
SurfaceTempPrecision	Square-root of diagonal element of th measurement error covariance (dim nTimes)	K	0.0 – 20.0	32	NATIVE_FLOAT
TotalColumnDensity	Total column amount computed from the retrieved profile. For the Atmospheric Temperature Product this will be a fill value. (dim nTimes)	Molec/cm^2	0 – 10^28	32	NATIVE_FLOAT
TotalColumnDensityError	Error in total column amount computed from total error covariance For the Atmospheric Temperature Product this will be a fill value. (dim nTimes)	Molec/cm^2	0 – 10^28	32	NATIVE_FLOAT
TotalColumnDensityInitial	Total column amount computed from the initial profile. For the Atmospheric Temperature Product this will be a fill value. (dim nTimes)	Molec/cm^2	0 – 10^28	32	NATIVE_FLOAT
~~SpeciesRetrievalConverged~~	Indicates whether the non-linear least squares solver converged to a minimum. True=1, False=0 (dim nTimes)	N/A	0 or 1 (Boolean)	8	NATIVE_INT8
~~DeviationVsRetrievalCovariance~~	Deviation vs. Retrieval Covariance (dim nTimes)	N/A	-10000.0 – 10000.0	32	NATIVE_FLOAT
RadianceResidualMean	Mean of the model and data radiance difference (per species). (dim nTimes)	N/A	-1000.0 – 1000.0	32	NATIVE_FLOAT
RadianceResidualRMS	RMS of model and data difference (dim nTimes)	N/A	0.0 – 100.0	32	NATIVE_FLOAT
~~RadianceResidualMax~~	Maximum absolute difference between model and data (dim nTimes)	N/A	-10000.0 – 10000.0	32	NATIVE_FLOAT

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Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
~~NumberIterPerformed~~	Actual number of iterations performed (dim nTimes)	Integer	Small number, typically < 8 and could be 0	8	NATIVE_INT8
~~MaxNumIterations~~	Maximum number of iterations allowed for convergence (dim nTimes)	N/A	<100	8	NATIVE_INT8
DegreesOfFreedomForSignal	Number of independent parameters for the profile (trace of the averaging kernel) (dim nTimes)	N/A	0.0—1000.0	32	NATIVE_FLOAT
~~InformationContent~~	Relative decrease in error volume with respect to a priori (dim nTimes)	N/A	-100.0—1000.0	32	NATIVE_FLOAT
CloudVariability_QA	Quality value calculated from cloud variability. This will be fill for the species HDO and H2O. (dim nTimes)	N/A	0- 100	32	NATIVE_FLOAT
KDotDL_QA	Quality value calculating the signal left in the residual. This is the maximum of the dot product of the Jacobian (K) and the Radiance (L) divided by sqrt(K dot K) * sqrt(L dot L) (dim nTimes)	N/A	-100 - 100	32	NATIVE_FLOAT
LDotDL_QA	Quality value calculating the signal left in the residual. This is the dot product of the radiance (L) with the residual (dL) divided by sqrt(L dot L) * sqrt(dL dot dL) (dim nTimes)	N/A	-100 - 100	32	NATIVE_FLOAT
~~Calibration_QA~~	Quality value of calculated from the calibration factors. This will be fill for the species HDO and H2O. (dim nTimes)	N/A	-2 - 2	32	NATIVE_FLOAT
H2O_HDO_Corr_QA	Checks that the H2O estimated in H2O / HDO step is consistent with H2O from TATM step. This will be fill in all products except H2O and HDO. (dim nTimes)	N/A	-50.0 – 50.0	32	NATIVE_FLOAT
SurfaceEmissMean_QA	Quality value comparing the retrieved emissivity to the initial emissivity. Fi for ocean and limb scenes. This will b fill for the species HDO and H2O. (dim nTimes)	N/A	-2 - 2	32	NATIVE_FLOAT
SurfaceTempVsApriori_QA	Quality value comparing the surface temperature to a priori value (dim nTimes)	K	-100 - 100	32	NATIVE_FLOAT
SurfaceTempVsAtmTemp_QA	Quality value comparing the surface temperature to the lowest atmospheri pressure. This will be fill for the species CO, CH4, HDO, and H2O. (dim nTimes)	K	-100 - 100	32	NATIVE_FLOAT
SurfaceEmissionLayer_QA	Quality value comparing the atmospheric temperature to the surfac temperature when ozone near the surface is elevated. This field will be fill for C CH4, HDO and most H2O	N/A	-100 - 100	32	NATIVE_FLOAT

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Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
UTCTime	UTC time of ZPD (Zero Path Difference) 27 character string. (dim nTimes x nLength)	N/A		28	HE5T_CHARSTRING String data type
TropopausePressure	Pressure between the troposphere and stratosphere used to calculate the tropospheric column (dim nTimes)	hPa	10 - 1300	32	NATIVE_FLOAT
OzoneTroposphericColumn	Column amount from the surface to TropopausePressue computed from the retrieved profile. (dim nTimes)	Molec/ cm^2	0 – 10^28	32	NATIVE_FLOAT
OzoneTroposphericColumnError	Error in the column amount from the surface to TropopausePressue computed from the total error covariance. (dim nTimes)	Molec/ cm^2	0 – 10^28	32	NATIVE_FLOAT
OzoneTroposphericColumnInitia	Initial column amount from the surface to TropopausePressue computed from the initial profile. (dim nTimes)	Molec/ cm^2	0 – 10^28	32	NATIVE_FLOAT
O3_Ccurve_QA	Quality value indicating ozone with an unrealistic lapse rate, with values too high in the near-surface layers and too low around 350-200 hPa. 0=bad QA, 1=good QA Fill and default value = -99 (dim nTimes)	N/A	1=Good QA, 0=Poor QA	8	NATIVE_INT8
OzoneIRK	OzoneIRK is the sensitivity to the outgoing longwave radiation in th 10 micron band to variations in ozone at each pressure level. (dim nLevels x nTimes)	(milli-watts/ m^2)/ppb	-100 to 100	32	NATIVE_FLOAT
FmOzoneBandFlux	The long-wave ozone radiative flux from Measured radiance (dim nTimes)	W/m^2		32	NATIVE_FLOAT
L1BOzoneBandFlux	The long-wave ozone radiative flux from calculated radiance (dim nTimes)	W/m^2		32	NATIVE_FLOAT

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8.4 Geolocation Fields

The Geolocation Data is used to provide generic geolocation and spacecraft pointing information..

Each Data Field will be annotated using HDF-EOS Local Attributes which are listed in the table below. Data Field Attributes are a feature which can be useful in annotating plots as well as describing the data product to input routines.

Attribute Name	Attribute Description	Size	HDF-EOS 5 Type
MissingValue	Contains the value for missing or fill data. 32 float : -999.0 64 double: -999.0 32 int : -999 16 int : -999 8 int : -99		Same type as Data Field
Title	For labeling a plot or axis.		NATIVE_CHAR
Units	Labeling units (for labeling color bars, converting between units, etc).		NATIVE_CHAR
UniqueFieldDefinition	Describes if definition of field is shared with other Aura Instruments ("Aura-Shared", "X-Specific", where X=Instrument Name, "X-Y[-Z]-Shared" where X,Y, and optional Z are instrumer names (in alphabetical order)		NATIVE_CHAR

Table 8-8: Geolocation Dimensions

Dimension Name	Valid Value (Description)
nTimes	Number of reported observations for specified calendar month (GS+SO)

Table 8-9: CO2 Lite Geolocation Fields

Geolocation Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
Run	RunId	N/A		32	NATIVE_INT32
Sequence	Sequence number within a run (dim nTimes)	N/A		16	NATIVE_INT16
Scan	Scan number within a sequence, or if averaging was performed, first scan of an averaged set. (dim nTimes)	N/A		16	NATIVE_INT16
Time	Time (TAI93) of ZPD (Zero Path Difference) (dim nTimes)	sec		64	NATIVE_DOUBLE
DayNightFlag	Flag for day or night (dim nTimes)	N/A	0 = night 1 = day	8	NATIVE_INT8
Latitude	Geodetic Latitude (dim nTimes)	Decimal degrees	± 90.0	32	NATIVE_FLOAT
Longitude	Geodetic Longitude (dim nTimes)	Decimal degrees	± 180.0	32	NATIVE_FLOAT

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SurfaceElevStandardDeviation	From DEM, standard deviation of average elevation over footprint (dim nTimes)	meters		32	NATIVE_FLOAT
SurfaceTypeFootprint	From DEM, 1=Fresh Water, 2=Salt Water, 3=Land, 4=Mixed (not 100% of FW, SW, or Land). If averaging was performed, refers to first scan of an averaged set. (dim nTimes)	Enumer-ated	1..4	8	NATIVE_INT8
DominantSurfaceType	From the USGS Global Land Cover Characteristics Data Base described at: http://edcsns17.cr.usgs.gov/glcc/globdoc2_0.html If averaging was performed, refers to first scan of an averaged set. 1 = Urban and Built-Up Land 2 = Dryland Cropland and Pasture 3 = Irrigated Cropland and Pasture 4 = Mixed Dryland/Irrigated Cropland and Pasture 5 = Cropland/Grassland Mosaic 6 = Cropland/Woodland Mosaic 7 = Grassland 8 = Shrubland 9 = Mixed Shrubland/Grassland 10 = Savanna 11 = Deciduous Broadleaf Forest 12 = Deciduous Needleleaf Forest 13 = Evergreen Broadleaf Forest 14 = Evergreen Needleleaf Forest 15 = Mixed Forest 16 = Water Bodies 17 = Herbaceous Wetland 18 = Wooded Wetland 19 = Barren or Sparsely Vegetated 20 = Herbaceous Tundra 21 = Wooded Tundra 22 = Mixed Tundra 23 = Bare Ground Tundra 24 = Snow or Ice 90 = Alluvial Sand 99 = Interrupted Areas (Goodes Homolosine Projection) 100 = Alluvial Sand (dim nTimes)	Enumera ted	1-24, 99, 100	8	NATIVE_INT8
BoresightNadirAngle	TES boresight (LOS) nadir angle relative to the local nadir at SC (dim nTimes)	Decimal degrees	0..90	64	NATIVE_DOUBLE
~~BoresightNadirAngleUne~~	Uncertainty in TES boresight nadir angle (dim nTimes)	Decimal degrees	±90	64	NATIVE_DOUBLE
BoresightAzimuth	TES boresight (LOS) azimuth angle relative to the local north at SC (dim nTimes)	Decimal degrees	0..360	64	NATIVE_DOUBLE
SolarZenithAngle	Solar zenith relative to the local zenith at the spacecraft (dim nTimes)	Decimal degrees	0--180	32	NATIVE_FLOAT
LocalSolarTime	Local solar time at target geolocation. Computed from target longitude and UTC. (dim nTimes)	hours		32	NATIVE_FLOAT

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Tgt_SpacecraftZenith	TES boresight (LOS) zenith angle relative to the local zenith at the target geolocation. (dim nTimes)	Decimal degrees	±90	32	NATIVE_FLOAT
Tgt_SpacecraftAzimuth	TES boresight (LOS) azimuth angle relative to the local north at the target geolocation. (dim nTimes)	Decimal degrees (east of north)	±90	32	NATIVE_FLOAT
Latitude_Footprint_1	Geo-location in geodetic co-ordinates of the four corners of the footprint. Nadir footprint determined by field of view of pixels. Limb footprint is ±60 km track, ±12 km crosstrack from surface expression of boresight tangent point. Latitude_Footprint_1=LowerLeft Latitude_Footprint_2=LowerRight Latitude_Footprint_3=UpperRight Latitude_Footprint_4=UpperLeft (dim nTimes)	Decimal degrees	±90	64	NATIVE_DOUBLE
Latitude_Footprint_2		Decimal degrees	±90	64	NATIVE_DOUBLE
Latitude_Footprint_3		Decimal degrees	±90	64	NATIVE_DOUBLE
Latitude_Footprint_4		Decimal degrees	±90	64	NATIVE_DOUBLE
Longitude_Footprint_1	Geo-location in geodetic co-ordinates of the four corners of the footprint. Nadir footprint determined by field of view of pixels. Limb footprint is ±60 km track, ±12 km crosstrack from surface expression of boresight tangent point Longitude_Footprint_1=LowerLeft Longitude_Footprint_2=LowerRight Longitude_Footprint_3=UpperRight Longitude_Footprint_4=UpperLeft (dim nTimes)	Decimal degrees	±180	64	NATIVE_DOUBLE
Longitude_Footprint_2		Decimal degrees	±180	64	NATIVE_DOUBLE
Longitude_Footprint_3		Decimal degrees	±180	64	NATIVE_DOUBLE
Longitude_Footprint_4		Decimal degrees	±180	64	NATIVE_DOUBLE

8.5 L2 ECS and TES-specific Metadata

8.5.1 Introduction

As with all ESDTs, TES ESDTs contain metadata that describes specific attributes about the data or the quality of data contained in the ESDT. Some of the basic metadata items are required by EOSDIS. These data items commonly include basic identification information and other generic information about the particular ESDT. These data items are referred to as ECS Inventory Metadata. In addition to ECS Inventory Metadata, additional TES ESDTs contain additional metadata more specific to the TES program. The TES-specific metadata has been subdivided into four subcategories based on the uniqueness of its origin and identification:

1. Production History — Production History Metadata
2. TES-Common — Metadata common to all TES ESDTs
3. TES-L2-Common — Metadata common to all Level 2 ESDTs
4. TES-L2-*observation specific* — Metadata unique to a particular ESDT subtype.

TES common metadata are fairly generic to the entire family of TES ESDTs or to TES L2 products. TES-L2-*observation specific*, as described by name, are unique to a particular family of L2 ESDTs.

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8.5.2 ECS Inventory Metadata

The table below shows the ECS Inventory Metadata. The ECS Inventory Metadata is implemented in the HDF file as text block named coremetadata within a group named HDFEOS INFORMATION.

Table 8-11: ECS Inventory Metadata

Data Layer Name	Data Description	TES Valids	Type[6]	Source
AssociatedInstrumentShortName	Instrument short name supplied by TES project.	TES	VA20	MCF
AssociatedPlatformShortName	Platform short name supplied by EOS project.	Aura	VA20	MCF
AssociatedSensorShortName	Sensor short name supplied by TES project.	FTS	VA20	MCF
OperationMode	Mode of operation of the instrument.	Calibration Routine	VA20	MCF
ShortName	This name will identify the ESDT short name associated with the collection or granule.	(set in MCF)	A8	MCF
VersionID	Version identifier of the ESDT data collection.	(set in MCF)	SI	MCF
ProductionDateTime	The date and time a specific granule was produced a PGE.	YYYY-MM-DDT HH:MM:SS.SSSZ	DT	TK
SizeMBECSDataGranule	The size attribute will indicate the volume of data contained in the granule.		F10	DSS
LocalGranuleID	Unique identifier for locally produced granule that ECS ingests and is required to capture.	e.g., TES-Aura_L2-H2O-Nadir_r0000000001_F01_01.he5	VA80	PGE
LocalVersionID	Local version identifier for PGE defined granule versions. Takes the form “executable name: Clearcase label”		VA60	PGE
InputPointer	Description of location of Production History information.	“Production History block at: /HDFEOS/ADDITIONAL/FILE_ATTRIBUTES/PRODUCTION_HISTORY”	VA255	PGE
ParameterName	Scope of quality flags. For TES, refers to entire granule.	Granule	A40	PGE
ScienceQualityFlag	The granule level flag applying generally to the granule and specifically to parameters at the granule level.	Passed Failed Being Investigated Not Investigated Inferred Passed Inferred Failed Suspect	VA25	DP
ScienceQualityFlagExplanation	A text explanation of the criteria used to set the ScienceQualityFlag including thresholds or other criteria.	(Free text)	VA255	DP
RangeBeginningDate	The year, month, and day when the temporal coverage period being described began.	YYYY-MM-DD	DT	PGE
RangeBeginningTime	The first hour, minute, and second of the temporal coverage period being described.	HH:MM:SSSSSSZ	T	PGE
RangeEndingDate	The last year, month, and day when the temporal coverage period being described.	YYYY-MM-DD	DT	PGE
RangeEndingTime	The last hour, minute, and second of the temporal coverage period being described.	HH:MM:SSSSSSZ	T	PGE
PGEVersion	The Release of the PGE software: e.g. “R6.1.2”		A10	PGE

[6] Data types and Sources given are specified in document [3] on page 1-1.

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8.5.3 Production History Metadata

The Production History Metadata is implemented as a single text block and written to the HDF file as a file level attribute. The Production History text block contains information about the L2 PGE and the running execution of the PGE to produce ESDT standard products. Static information in the text block describes the elements that make up the PGE like build configuration, support files and database table population. Dynamic information describes all the running parameters involved in a PGE execution for a specific RUN ID. This information is captured for both pre and post execution of the L2 Product PGE.

Table 8-12: L2 Production History

History Data	Data Description	Size (K)	State
ECS	Toolkit file for input/output file specification	23	Dynamic
Environment Variable	SIPS environment variables	5	Dynamic
Fetch	SIPS fetch list from archived	5	Dynamic
SIPS PCF	SIPS-specific PCF file for PGE processing	3	Dynamic
Workspace List (PRE)	File listing in SIPS PGE workspace prior to PGE execution	5	Dynamic
Workspace List (POST)	File listing in SIPS PGE workspace following PGE execution	5	Dynamic
Runtime	CPU and Wallclock PGE run time	0.1	Dynamic
Control Definition	Framework Parameter Definition File for output files	1	Static
Control Parameter	Framework Parameter Specification File for output files	0.02	Static
Control Parameter (Runtime)	Framework Parameter specified in the command line of the PGE	0.02	Dynamic
TimeStamp	RUN ID begin date and end date timestamp	0.05	Dynamic
README	README file that describes production history context	1	Static
PGE Version	PGE version information	0.2	Static
PGE specific configurations	TBD	TBD	TBD

8.5.4 TES-Common Metadata

Metadata shown below is common to all TES files. For Level 2, these are implemented as File Level Attributes (HDF-EOS Global File Attributes). This is information that helps to describe this particular data set. It can be useful in labeling plots, calculating dates, etc.. These will be set via calls to he5_ehwrglatt(HE5_EHwriteglbattr for C users).

Table 8-13: TES-Common-Metadata

Data Layer Name	Data Description	Valids	Size	HDF-EOS 5 Type
InstrumentName	TES			NATIVE_CHAR
ProcessLevel	L1B,L2,L3,etc.			NATIVE_CHAR
TAI93At0zOfGranule				NATIVE_DOUBLE
GlobalSurveyNumber/ID	Starting Run ID for specified calendar month			NATIVE_INT
GranuleMonth	Month granule was produced (from ECS MD RangeBeginningDate)	1-12	8	NATIVE_INT
GranuleDay	Day granule was produced (from ECS MD RangeBeginningDate)	1-31	8	NATIVE_INT
GranuleYear	Year granule was produced (from ECS MD RangeBeginningDate)			NATIVE_INT
SurveyMode	Type of survey, e.g., Global or Special			NATIVE_CHAR
PGEVersion	Release of PGE Software: e.g. "R6.1.2"			NATIVE_CHAR
Command_Seq_ID	Command Sequence (Run) ID	N/A	32	NATIVE_INT32

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Data Layer Name	Data Description	Valids	Size	HDF-EOS 5 Type
Calib_Scheme	Calibration scheme with or without embedded black body scans: SPLIT_CAL or NON_SPLIT_CAL			NATIVE_CHAR

8.5.5 TES-L2-Common

Metadata shown below is common to all TES L2 files. These are implemented as Swath Level Attributes (HDF-EOS Group Attributes). This is information which helps describe the swath to which it is attached.

Table 8-14: TES-L2-Common-Metadata

Data Layer Name	Data Description	Data Range	Units	Size	HDF-EOS 5 Type
VerticalCoordinate	"Pressure","Altitude", "Potential Temperature"				NATIVE_CHAR
CloudFrequency	Wave number array corresponding to retrieved Cloud Effective Optical Depth points. 25 values.	600.0--2250.0	cm^{-1}	32	NATIVE_FLOAT
EmissivityWavenumber	Wavenumber array corresponding to retrieval emissivity points. 121 values.	600.0 – 3500.0	cm^{-1}	32	NATIVE_FLOAT

8.5.6 TES-L2-Nadir Metadata

Metadata shown below are common to all TES L2 Nadir files. These are implemented as Swath Level Attributes (HDF-EOS Group Attributes) attached to the NadirSwath groups. This is information which helps describe the swath to which it is attached.

Table 8-15: TES-L2-Nadir-Metadata

Data Layer Name	Data Definition	Data Range	Units	Size	HDF-EOS 5 Type
Scan_Resolution	Designates Low or High Resolution for this view	'High', 'Low			NATIVE_CHAR
Pressure	List of pressure level of CO2Lite, First is maximum of over all targets and others are 510.898, 133.352, 10. 0.1		hPa	32	NATIVE_FLOAT

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9. TES-MLS COMBINED PRODUCTS

9.1 Overview

TES-MLS Combined Products will be considered Level 2 products. Each supported Combined Product parallels a TES Level 2 Standard Nadir Product. These are detailed in Section 4. There is currently one such Standard Nadir Product for the following nine molecular species H_2O, O_3, CH_4, CO, HDO, CO2, NH3, N2O and TATM (atmosphieric temperature). This suggests the potential for nine TES-MLS combined products. However, there will initially be limited support for TES-MLS Combined Products – a single one for CO only. This limited initial support is reflected in the remainder of this section.

In a TES-MLS Combined Product, TES Retrievals from a standard product are improved using MLS data. For each target scene that qualifies for inclusion in the product, the results continue to be cast in terms of TES with latitude, longitude, time and the pressure grid all preserved as in the associated Level 2 Nadir Product. For each TES L2 Standard Nadir Product file that has matching MLS data, there will typically be one TES-MLS Combined Product file. Target scenes where data quality is poor or that are not between latitudes 84.5S and 84.5N do not qualify for inclusion in the combined product.

To facilitate sharing data products between all Aura platform science teams, the organization of the L2 Standard Data Products conform to specifications dictated in the HDF-EOS Aura File Format Guidelines (Craig, et al). These guidelines lay down the basic file format and data format specifications for all L2 standard products. These guidelines attempt to address combined products as well. They specify that all L2 products should be generated using HDF-EOS V5.x formatting specifications. All data are to be reported as "swath" data objects. TES-MLS Combined Product files will conform to these guidelines whenever possible - the datasest will be composed of HDF-EOS 5 files containing swaths. HDF-EOS 5 files have a default extension of ".he5".

The TES convention of using separate version identifiers for format and content impacts TES-MLS Combined Product filenames. This follows straightforwardly from the Guidelines. When this is combined with the species-specific and runid-specific nature of the associated TES Level 2 Standard Nadir Product files, it follows that the ECS Local Granule ID (filename) for TES-MLS Combined Products can be constructed using the following template:

TES-MLS-Aura_L2<species>_r<runid>_F<format>_<content>.he5 (Global Survey)

TES-MLS-Aura_L2<species>-SO_r<runid>_F<format>_<content>.he5 (Special Observation)

Table 9.1 shows Earth Science Data Type information for the TES-MLS combined product for CO.

Table 9-1: EOS Aura TES-MLS Combined Product Earth Science Data Types

ESDT Short Name	ECS File Type	Collection Summary	Local Granule ID[a]
TML2CO	HDF-EOS	TES/MLS/Aura/Joint L2 CO	TES-MLS_Aura_L2-CO_r<runid>_F<format>_<content>.he5
TML2COS	HDF-EOS	TES/MLS/Aura/Joint L2 CO	TES-MLS_Aura_L2-CO-SO_r<runid>_F<format>_<content>.he5

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In brief - each TES-MLS Combined Product reports information in a standardized data organization known as the 'swath'. A volume mixing ratio profile within each swath is reported on the same TES pressure grid as in the associated TES Level 2 Standard Nadir Product profile and improves upon it. The unimproved VMR profile from TES L2 is preserved as well. Select geolocation-related fields applicable to the matched MLS data will be preserved in support of analysis by the end user of the product. Further details are outlined in the remainder of this section.

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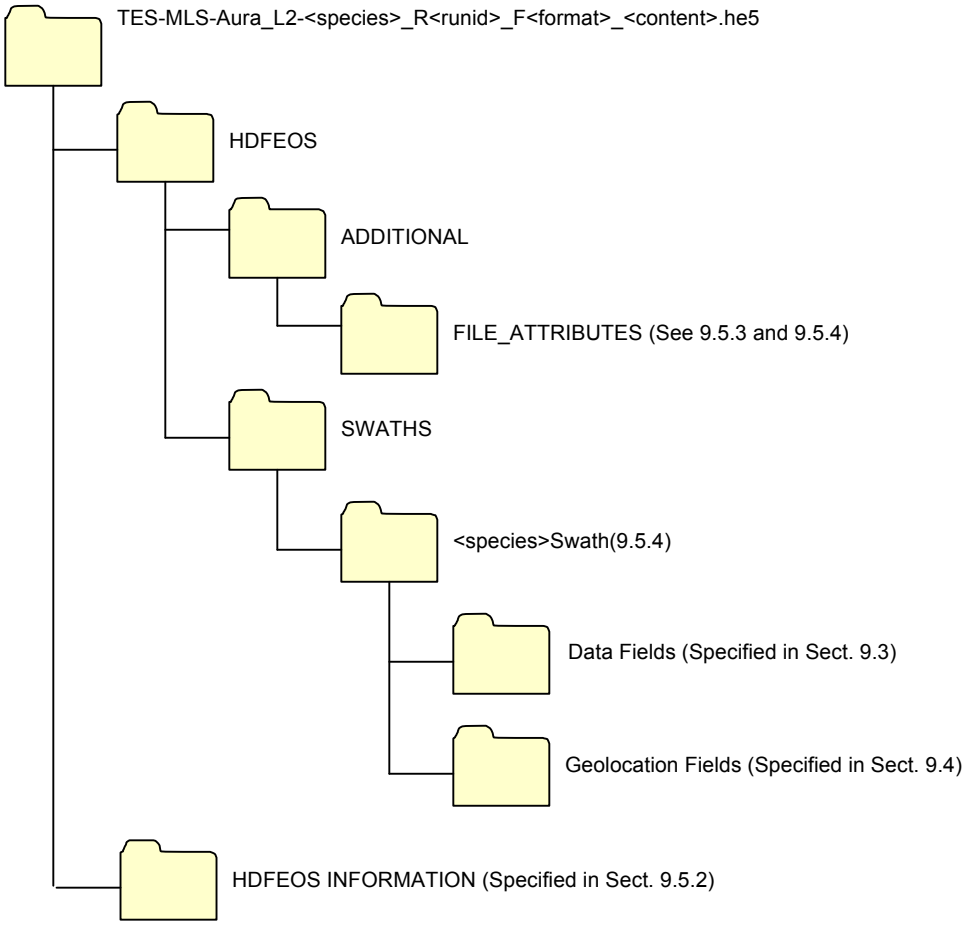
9.2 TES-MLS Combined Product File Structure

The file structure of a TES-MLS Combined Product is depicted in the figure below. In addition to the swath data and geolocation fields further described in 9.3 and 9.4, each product also contains descriptive metadata. We attempt to cast the organization and layout of the metadata in term of HDF-EOS guidelines (including those for Joint Products) to the maximum extent possible.

First, an ECS Metadata block, metadata that includes a set of mandatory data describing attributes of the product is included. This is at the HDFEOS Information level. This metadata summarizes the granule as well as the two instruments and their operating modes for the time period associated with the granule. See 9.5.2 and Appendix C of the Guidelines for Joint Products. Production History and TES-MLS-specific metadata are provided as well. Production History metadata is in a block at the file attributes level. See 9.5.3. TES-MLS-specific metadata are at both the file attributes and swath levels. See 9.5.4.



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9.3 TES-MLS Combined Product Data Fields

The TES-MLS Combined Product Data Fields consist of primary data fields, which are vmr or temperature profiles and other data dimensioned by time and pressure levels, and the associated data fields, which are only dimensioned by time. For this Joint product we choose to prefix Data Field Names with the name of the instrument (TES or MLS) when the field's values will come unmodified from the L2 Data Products for that instrument. When the field's values will be a result of computations performed using both TES and MLS inputs, we choose to use neither prefix.

Each Data Field will be annotated using HDF-EOS Local Attributes which are listed in the table below. Data Field Attributes are a feature which can be useful in annotating plots as well as describing the data product to input routines.

Attribute Name	Attribute Description	Size	HDF-EOS 5 Type
MissingValue	Contains the value for missing o fill data. 32 float : -999.0 64 double: -999.0 32 int : -999 16 int : -999 8 int : -99		Same type as Data Field
Title	For labeling a plot or axis.		NATIVE_CHAR
Units	Labeling units (for labeling colo bars, converting between units, etc).		NATIVE_CHAR
UniqueFieldDefinition	Describes if definition of field is shared with other Aura Instruments ("Aura-Shared", "X Specific", where X=Instrument Name, "X-Y[-Z]-Shared" where X,Y, and optional Z are instrument names (in alphabetic order)		NATIVE_CHAR

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9.3.1 TES-MLS Combined Product Primary Data Fields

The table below shows the swath data dimensions.

Swath data fields are used to report the results of retrievals using both TES and MLS inputs. The improved vmr data is the primary data element of each swath. It is accompanied by various indices of error that help in characterizing the quality of the retrieval or in characterizing the input data that was used.

Table 9-2: Primary Data Dimensions Definitions

Dimension Name	Valid Value (Description)
nLevels	Number of reported pressure levels
nTimes	Number of Scans for the TES run for which matching MLS data was found

Table 9-3: TES-MLS Combined Product Primary Data Fields

Data Field Name / Title *	Data Descriptions	Units	Data Range	Size	HDF-EOS 5 Type
[species] CO	Jointly retrieved VMR data using TES/MLS measurements, TES-MLS joint (dim nLevels x nTimes)	vmr		32	NATIVE_ FLOAT
TotalError	Square-roots of diagonal elements of the output total error covariance. TES-MLS joint (dim nLevels x nTimes)	vmr		32	NATIVE_ FLOAT
ConstraintVector	Constraint vector used in the joint retrieval (This release – same as the TES Constraint Vector) TES-MLS joint (dim nLevels x nTimes)	vmr		32	NATIVE_ FLOAT

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Data Field Name / Title *	Data Descriptions	Units	Data Range	Size	HDF-EOS 5 Type
AveragingKernel	The averaging kernel is the sensitivity o the estimated state to variations in the atmospheric state. The rows of the averaging kernel represent the sensitivit of the estimated state at a specific pressure level to variations in the atmospheric state at all levels. The columns of averaging kernel represent t sensitivity of the estimated state at all levels to variations in the atmospheric state at specific pressure level TES-MLS joint (dim nLevels x nLevels x nTimes)	N/A		32	NATIVE_ FLOAT
TotalErrorCovariance	Sum of measurement, systematic, and smoothing error covariances. For atmospheric species, this is the covariance of the error of vmr. TES-MLS join (dim nLevels x nLevels x nTimes)	Vmr^2		32	NATIVE_ FLOAT

Ideally, all Primary Data Fields will be populated for all target scenes for global surveys with TES retrievals for which there exists matching MLS data. However, there will be times where calculating improved retrievals will not be possible. Regardless of the cause for missing data, certain swath data fields will be set to a fill value according HDF-EOS Aura File Format Guidelines.

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9.3.2 TES-MLS Combined Product Associated Data Fields

The table below provides the associated data dimensions. The data items shown in the following tables are also included in the Swath Data as Associated Data:

Table 9-4: Associated Data Field Dimensions Definitions

Dimension Name	Valid Value (Description)
nTimes	Number of Scans for the TES run for which matching MLS data was found
nLevels	Number of reported pressure levels

Table 9-5: TES-MLS Combined Product Associated Data Fields

Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
TES[species] TESCO	VMR data from TES Level 2 TES specific (dim nLevels x nTimes)	vmr		32	NATIVE_ FLOAT
SpeciesRetrievalQuality	Species Retrieval Quality flag. True means retrieval passed quality check ar reported errors are accurate. TES-MLS joint Fill in this release (-99) (dim nTimes)	N/A	0 = poor quality 1 = passed quality check	8	NATIVE_ INT8
TotalColumnDensity	Total column amount computed from the retrieved profile. TES-MLS joint Fill in this release (-999.9) (dim nTimes)	Mole cm^2	0 – 10^28	32	NATIVE_ FLOAT

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Data Fields Name / Title	Data Description	Units	Data Range	Size	HDF-EOS 5 Type
TotalColumnDensityError	Error in total column amount computed from total error covariance TES-MLS joint Fill in this release (-999.9) (dim nTimes)	Mole cm^2	0 – 10^28	32	NATIVE_ FLOAT
DegreesOfFreedomForSignal	Number of independent parameters for the profile (trace of the averaging kernel) TES-MLS joint (dim nTimes)	N/A	0.0—1000.0	32	NATIVE_ FLOAT
TESUTCTime	UTC time of ZPD (Zero Path Difference) 27 character string. TES Specific (dim nTimes)	N/A		28	HE5T_CHARSTRING String data type
TESDayNightFlag	TES Day Night Flag TES specific (dim nTimes)	N/A	0 = night 1 = day	8	NATIVE_ INT8
ProfileDistance	Distance between TES profile and MLS Profile Matched TES-MLS joint (dim nTimes)	Km		32	NATIVE_ FLOAT

9.4 Geolocation Fields

The Geolocation Data is used to provide generic geolocation and spacecraft pointing information.

Each Data Field will be annotated using HDF-EOS Local Attributes which are listed in the table below. Data Field Attributes are a feature which can be useful in annotating plots as well as describing the data product to input routines.

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Attribute Name	Attribute Description	Size	HDF-EOS 5 Type
MissingValue	Contains the value for missing o fill data. 32 float : -999.0 64 double: -999.0 32 int : -999 16 int : -999 8 int : -99		Same type as Data Field
Title	For labeling a plot or axis.		NATIVE_CHAR
Units	Labeling units (for labeling colo bars, converting between units, etc).		NATIVE_CHAR
UniqueFieldDefinition	Describes if definition of field is shared with other Aura Instruments ("Aura-Shared", "X Specific", where X=Instrument Name, "X-Y[-Z]-Shared" where X,Y, and optional Z are instrument names (in alphabetic order)		NATIVE_CHAR

Table 9-8: Geolocation Dimensions

Dimension Name	Valid Value (Description)
nTimes	Number of Scans for the TES run for which matching MLS data was found
nLevels	Number of reported pressure levels

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Table 9-9: TES-MLS Combined Product Geolocation Fields

Geolocation Fields Name / Title	Data Description	Units	Data Rang	Size	HDF-EOS 5 Type
Sequence	TES Sequence number within a run TES specific (dim nTimes)	N/A		16	NATIVE_ INT16
Scan	TES Scan number within a sequence, or if averaging was performed, first scan of an averaged set. TES specific (dim nTimes)	N/A		16	NATIVE_ INT16
Time	TES Time (TAI93) of ZPD (Zero Path Difference) TES specific (dim nTimes)	sec		64	NATIVE_ DOUBLE
Latitude	TES Geodetic Latitude TES specific (dim nTimes)	Decimal degrees	± 90.0	32	NATIVE_ FLOAT
Longitude	TES Geodetic Longitude TES specific (dim nTimes)	Decimal degrees	± 180.0	32	NATIVE_ FLOAT
Pressure	Pressure TES-MLS joint (dim nTimes x nLevels)	hPa		32	NATIVE_ FLOAT

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TESAltitude	Derived altitude for each pressure level TES specific (dim nLevels x nTimes)	meters	0-70000	32	NATIVE_ FLOAT
MLSLatitude	Geodetic Latitude, from MLS data MLS specific (dim nTimes)	Decimal degrees	± 90.0	32	NATIVE_ FLOAT
MLSLongitude	Geodetic Longitude, from MLS data MLS specific (dim nTimes)	Decimal degrees	± 180.0	32	NATIVE_ FLOAT
MLSTime	Time, from MLS data(TAI93) MLS specific (dim nTimes)	sec		64	NATIVE_ DOUBLE

9.5 Combined Product Metadata

9.5.1 Introduction

As with all ESDTs, TES-MLS ESDTs contain metadata that describes specific attributes about the data or the quality of data contained in the ESDT. Some of the basic metadata items are required by EOSDIS. These data items commonly include basic identification information and other generic information about the particular ESDT. These data items are referred to as ECS Inventory Metadata. In addition to ECS Inventory Metadata, TES-MLS ESDTs contain additional metadata that are more specific to TES-MLS. The TES-MLS-specific metadata has been subdivided into two subcategories based on the uniqueness of its origin and identification:

1. Production History — Production History Metadata
2. TES-MLS-Common — Metadata common to all TES-MLS ESDTs

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9.5.2 ECS Inventory Metadata

The table below shows the ECS Inventory Metadata. The ECS Inventory Metadata is implemented in the HDF file as text block named coremetadata within a group named HDFEOS INFORMATION.

Table 9-11: ECS Inventory Metadata

Data Layer Name	Data Description	TES Valids	Type[7]	Source
ShortName	This name will identify the ESDT short name associated with the collection or granule.	(set in MCF)	A8	MCF
VersionID	Version identifier of the ESDT data collection.	(set in MCF)	SI	MCF
ProductionDateTime	The date and time a specific granule was produced by a PGE.	YYYY-MM-DD HH:MM:SS.SSS	DT	TK
SizeMBECSDataGranule	The size attribute will indicate the volume of data contained in the granule.		F10	DSS
LocalGranuleID	Unique identifier for locally produced granule that ECS ingests and is required to capture.	e.g., TES-Aura_L2-H2O-Nadir_r000000001_F01_01.he5	VA80	PGE
LocalVersionID	Local version identifier for PGE defined granule versions. Takes the form "executable name: Clearcase label"		VA60	PGE
ParameterName	Scope of quality flags. For TES-MLS, refers to entire granule.	Granule	A40	PGE
ScienceQualityFlag	The granule level flag applying generally to the granule and specifically to parameters at the granule level.	Passed Failed Being Investigated Not Investigated Inferred Passed Inferred Failed Suspect	VA25	DP

[7] Data types and Sources given are specified in document [3] on page 1-1.

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Data Layer Name	Data Description	TES Valids	Type[7]	Source
ScienceQualityFlagExplanation	A text explanation of the criteria used to set the ScienceQualityFlag including thresholds or other criteria.	(Free text)	VA255	DP
RangeBeginningDate	The year, month, and day when the temporal coverage period being describe began.	YYYY-MM-DD	DT	PGE
RangeBeginningTime	The first hour, minute, and second of the temporal coverage period being described.	HH:MM:SSSSS Z	T	PGE
RangeEndingDate	The last year, month, and day when the temporal coverage period being described.	YYYY-MM-DD	DT	PGE
RangeEndingTime	The last hour, minute, and second of the temporal coverage period being described.	HH:MM:SSSSS Z	T	PGE
PGEVersion	The Release of the PGE software: e.g. "R6.1.2"		A10	PGE

Table 9-12: ECS Inventory Metadata ASSOCIATEDPLATFORMFORINSTRUMENT

In addition to the Metadata shown in Table 9-11 there is another subgroup within coremetadata for ECS Inventory Metadata – ASSOCIATEDPLATFORMINSTRUMENTSENSOR. Within this group there are two additional subgroups with the name ASSOCIATEDPLATFORMFORINSTRUMENTSENSORCONTAINER – and within each of these, the fields in Table 9-12 are repeated for each of the two instruments for the Joint product. See Appendix C in the Guidelines document regarding Metadata for Joint Products.

Data Layer Name	Data Description	TES Valids	Type[8]	Source
AssociatedInstrumentShortName	Instrument short name supplied by project.	TES, MLS	VA20	MCF
AssociatedPlatformShortName	Platform short name supplied by project.	Aura	VA20	MCF
AssociatedSensorShortName	Sensor short name supplied by project.	FTS, ??	VA20	MCF
OperationMode	Mode of operation of the instrument	Calibration Routine	VA20	MCF

Table 9-12: ECS Inventory Metadata ASSOCIATEDPLATFORMFORINSTRUMENT

[8] Data types and Sources given are specified in document [3] on page 1-1.

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9.5.3 ECS Collection Metadata

In addition to the Metadata shown above there is an additional subgroup within ECS Collection Level Metadata – AdditionalAttribute - that is user defined. Within this group there are two additional subgroups with the name TESDataVersion and MLSDataVersion.

Data Name	Data Description	TES Valids	Typ	Source
TESDataVersion	TES release ID for TES data in product.	3 digit number, leading 0s	VA1	MCF
MLSDataVersion	MLS release number for MLS data in product	Floating point, 3 digits, two digits to right of decimal	F4	MCF

Table 9-13: ECS Collection Level Metadata ADDITIONALATTRIBUTE

9.5.4 Production History Metadata

The Production History Metadata is implemented as a single text block and written to the HDF file as a file level attribute. The Production History text block contains information about the TES-MLS Retrieval PGE and the running execution of the PGE to produce ESDT standard products. Static information in the text block describes the elements that make up the PGE like build configuration, support files and database table population. Dynamic information describes all the running parameters involved in a PGE execution for a specific RUN ID. This information is captured for both pre and post execution of the TES-MLS PGE.

Table 9-14: L2 Production History

History Data	Data Description	Size (K)	State
ECS	Toolkit file for input/output file specification	23	Dynamic
Environment Variable	SIPS environment variables	5	Dynamic
Fetch	SIPS fetch list from archived	5	Dynamic
SIPS PCF	SIPS-specific PCF file for PGE processing	3	Dynamic
Workspace List (PRE)	File listing in SIPS PGE workspace prior to PGE execution	5	Dynamic
Workspace List (POST)	File listing in SIPS PGE workspace following PGE executio	5	Dynamic
Runtime	CPU and Wallclock PGE run time	0.1	Dynamic
Control Definition	Framework Parameter Definition File for output files	1	Static
Control Parameter	Framework Parameter Specification File for output files	0.02	Static

[9] Data types and Sources given are specified in document [3] on page 1-1.

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Control Parameter (Runtime)	Framework Parameter specified in the command line of the PGE	0.02	Dynamic
TimeStamp	RUN ID begin date and end date timestamp	0.05	Dynamic
README	README file that describes production history context	1	Static
PGE Version	PGE version information	0.2	Static
PGE specific configurations	TBD	TBD	TBD

9.5.5 TES-MLS-Common Metadata

Metadata shown in Table 9-14 and 9-15 is common to all TES-MLS files.

Those in Table 9-14 are implemented as File Level Attributes (HDF-EOS Global File Attributes). This is information that helps to describe the data set. These can be useful in labeling plots, calculating dates, etc.. These will be set via calls to he5_ehwrglatt(HE5_EHwriteglbattr for C users).

Those in Table 9-15 are implemented as Swath Level Attributes (HDF-EOS Group Attributes). This is information that helps describe the swath to which it is attached.

Table 9-15: TES-Common-Metadata (File Level)

Data Layer Name	Data Description	Valids	Size	HDF-EOS 5 Type
InstrumentName	Instrument Name	TES-MLS		NATIVE_CHAR
ProcessLevel	L1B,L2,L3,etc.	L2		NATIVE_CHAR
TAI93At0zOfGranule				NATIVE_DOUBLE
GlobalSurveyNumber/Special Observation Number	Run ID			NATIVE_INT
GranuleMonth	Month granule was produced (from ECS MD RangeBeginningDate)	1-12	8	NATIVE_INT
GranuleDay	Day granule was produced (from ECS MD RangeBeginningDate)	1-31	8	NATIVE_INT
GranuleYear	Year granule was produced (from ECS MD RangeBeginningDate)			NATIVE_INT
SurveyMode	Type of survey, e.g., Global or Special			NATIVE_CHAR

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Data Layer Name	Data Description	Valids	Size	HDF-EOS 5 Type
PGEVersion	Release of PGE Software: e. "R6.1.2"			NATIVE_CHAR
Command_Seq_ID	Command Sequence (Run) I	N/A	32	NATIVE_INT32

Table 9-16: TES-MLS-L2-Common-Metadata (Swath Level)

Data Layer Name	Data Description	Data Rang	Units	Size	HDF-EOS 5 Type
VerticalCoordinate	"Pressure"				NATIVE_CHAR
MLS_L1B_File1	MLS L1B radiance file used i processing				NATIVE_CHAR
MLS_L1B_File2	MLS L1B radiance file used i processing				NATIVE_CHAR
MLS_L2_File1	MLS L2 profile file used in processing				NATIVE_CHAR
MLS_L2_File2	MLS L2 profile file used in processing				NATIVE_CHAR

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APPENDIX A -- ACRONYMS

API	Application Program Interface
BB	Black Body
DEM	Digital Elevation Model
DPS	Data Products Specification
ECI	Earth-Centered Inertial
ECS	EOSDIS Core System
EOS	Earth Observation System
EOSDIS	EOS Data and Information System
ESDIS	Earth Science Data and Information System
ESDT	Earth Science Data Type
FP	Focal Plane
FWHM	Full Width at Half Maximum
GDS	Ground Data System
HAIS	Hughes Applied Information Systems
HDF	Hierarchical Data Format
ICD	Interface Control Document
ICS	Interferometer Control System
ID	Identification
JPL	Jet Propulsion Laboratory
LOS	Line of Sight
MCF	Metadata Control File
MD	Metadata
NCAR	National Center for Atmospheric Research
NESR	Noise-Equivalent Spectral Radiance
OSE	Operational Support Equipment
OSP	Operational Support Product
PCS	Position Control System
PGE	Product Generation Executive
PRT	Platinum Resistance Thermistor
RMS	Root-Mean-Square
SC	Spacecraft
SIPS	Science Investigator-led Processing System
TAI	International Atomic Time
TBD	To Be Determined
TES	Tropospheric Emission Spectrometer
UARS	Upper Atmosphere Research Satellite
vmr	Volume Mixing Ratio
ZPD	Zero Path Difference

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APPENDIX B -- WORK-OFF PLAN TABLE

Section or Table Number	What's Missing	Targeted Release

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