Mars Atmosphere and Volatile Evolution (MAVEN) Mission

Imaging Ultraviolet Spectrograph

Key Parameters

PDS Archive

Software Interface Specification

[Rev. 0.8 May 11, 2015]

Prepared by

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1 Introduction

This software interface specification (SIS) describes the format and content of the Imaging Ultraviolet Spectrograph (IUVS) Planetary Data System (PDS) data archive. It includes descriptions of the data products and associated metadata, and the archive format, content, and generation pipeline.

1.1 Distribution List

Table 1: Distribution list

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1.2 Document Change Log

Table 2: Document change log

Version	Change	Date	Affected portion
0.0	Initial template (based upon MAVEN SIS Template, ver. 0.3)	2014-Feb-03	All
0.8	PDS Intial Release Review	2015-May-11	All

1.3 TBD Items

Table 3 lists items that are not yet finalized.

Table 3: List of TBD items

Item	Section(s)	Page(s)

1.4 Abbreviations

Table 4: Abbreviations and their meaning

Abbreviation	Meaning
ASCII	American Standard Code for Information Interchange
Atmos	PDS Atmospheres Node (NMSU, Las Cruces, NM)
CCSDS	Consultative Committee for Space Data Systems
CDR	Calibrated Data Record
CFDP	CCSDS File Delivery Protocol
CK	C-matrix Kernel (NAIF orientation data)
CODMAC	Committee on Data Management, Archiving, and Computing
CRC	Cyclic Redundancy Check
CU	University of Colorado (Boulder, CO)
DAP	Data Analysis Product
DDR	Derived Data Record
DMAS	Data Management and Storage
DPF	Data Processing Facility
E&PO	Education and Public Outreach
EDR	Experiment Data Record
EUV	Extreme Ultraviolet; also used for the EUV Monitor, part of LPW (SSL)
FEI	File Exchange Interface
FOV	Field of View
FTP	File Transfer Protocol
GB	Gigabyte(s)
GSFC	Goddard Space Flight Center (Greenbelt, MD)
HK	Housekeeping
HTML	Hypertext Markup Language
ICD	Interface Control Document
IM	Information Model
ISO	International Standards Organization
ITF	Instrument Team Facility
IUVS	Imaging Ultraviolet Spectrograph (LASP)

Abbreviation	Meaning
JPL	Jet Propulsion Laboratory (Pasadena, CA)
LASP	Laboratory for Atmosphere and Space Physics (CU)
LID	Logical Identifier
LIDVID	Versioned Logical Identifer
LPW	Langmuir Probe and Waves instrument (SSL)
MAG	Magnetometer instrument (GSFC)
MAVEN	Mars Atmosphere and Volatile EvolutioN
MB	Megabyte(s)
MD5	Message-Digest Algorithm 5
MOI	Mars Orbit Insertion
MOS	Mission Operations System
MSA	Mission Support Area
NAIF	Navigation and Ancillary Information Facility (JPL)
NASA	National Aeronautics and Space Administration
NGIMS	Neutral Gas and Ion Mass Spectrometer (GSFC)
NMSU	New Mexico State University (Las Cruces, NM)
NSSDC	National Space Science Data Center (GSFC)
PCK	Planetary Constants Kernel (NAIF)
PDS	Planetary Data System
PDS4	Planetary Data System Version 4
PF	Particles and Fields (instruments)
PPI	PDS Planetary Plasma Interactions Node (UCLA)
RS	Remote Sensing (instruments)
SCET	Spacecraft Event Time
SDC	Science Data Center (LASP)
SCLK	Spacecraft Clock
SEP	Solar Energetic Particle instrument (SSL)
SIS	Software Interface Specification
SOC	Science Operations Center (LASP)
SPE	Solar Particle Event

Abbreviation	Meaning
SPICE	Spacecraft, Planet, Instrument, C-matrix, and Events (NAIF data format)
SPK	Spacecraft and Planetary ephemeris Kernel (NAIF)
SSL	Space Sciences Laboratory (UCB)
STATIC	Supra-Thermal And Thermal Ion Composition instrument (SSL)
SWEA	Solar Wind Electron Analyzer (SSL)
SWIA	Solar Wind Ion Analyzer (SSL)
TBC	To Be Confirmed
TBD	To Be Determined
UCB	University of California, Berkeley
UCLA	University of California, Los Angeles
URN	Uniform Resource Name
UV	Ultraviolet
XML	eXtensible Markup Language

1.5 Glossary

Archive – A place in which public records or historical documents are preserved; also the material preserved – often used in plural. The term may be capitalized when referring to all of PDS holdings – the PDS Archive.

Basic Product – The simplest product in PDS4; one or more data objects (and their description objects), which constitute (typically) a single observation, document, etc. The only PDS4 products that are *not* basic products are collection and bundle products.

Bundle Product – A list of related collections. For example, a bundle could list a collection of raw data obtained by an instrument during its mission lifetime, a collection of the calibration products associated with the instrument, and a collection of all documentation relevant to the first two collections.

Class – The set of attributes (including a name and identifier) which describes an item defined in the PDS Information Model. A class is generic – a template from which individual items may be constructed.

Collection Product – A list of closely related basic products of a single type (e.g. observational data, browse, documents, etc.). A collection is itself a product (because it is simply a list, with its label), but it is not a *basic* product.

Data Object – A generic term for an object that is described by a description object. Data objects include both digital and non-digital objects.

Description Object – An object that describes another object. As appropriate, it will have structural and descriptive components. In PDS4 a 'description object' is a digital object – a string of bits with a predefined structure.

Digital Object – An object which consists of real electronically stored (digital) data.

Identifier – A unique character string by which a product, object, or other entity may be identified and located. Identifiers can be global, in which case they are unique across all of PDS (and its federation partners). A local identifier must be unique within a label.

Label – The aggregation of one or more description objects such that the aggregation describes a single PDS product. In the PDS4 implementation, labels are constructed using XML.

Logical Identifier (**LID**) – An identifier which identifies the set of all versions of a product.

Versioned Logical Identifier (LIDVID) – The concatenation of a logical identifier with a version identifier, providing a unique identifier for each version of product.

Manifest - A list of contents.

Metadata – Data about data – for example, a 'description object' contains information (metadata) about an 'object.'

Non-Digital Object – An object which does not consist of digital data. Non-digital objects include both physical objects like instruments, spacecraft, and planets, and non-physical objects like missions, and institutions. Non-digital objects are labeled in PDS in order to define a unique identifier (LID) by which they may be referenced across the system.

Object – A single instance of a class defined in the PDS Information Model.

PDS Information Model – The set of rules governing the structure and content of PDS metadata. While the Information Model (IM) has been implemented in XML for PDS4, the model itself is implementation independent.

Product – One or more tagged objects (digital, non-digital, or both) grouped together and having a single PDS-unique identifier. In the PDS4 implementation, the descriptions are combined into a single XML label. Although it may be possible to locate individual objects within PDS (and to find specific bit strings within digital objects), PDS4 defines 'products' to be the smallest granular unit of addressable data within its complete holdings.

Tagged Object – An entity categorized by the PDS Information Model, and described by a PDS label.

Registry – A data base that provides services for sharing content and metadata.

Repository – A place, room, or container where something is deposited or stored (often for safety).

XML – eXtensible Markup Language.

XML schema – The definition of an XML document, specifying required and optional XML elements, their order, and parent-child relationships.

1.6 MAVEN Mission Overview

The MAVEN mission is scheduled to launch on an Atlas V between November 18 and December 7, 2013. After a ten-month ballistic cruise phase, Mars orbit insertion will occur on or after September 22, 2014. Following a 5-week transition phase, the spacecraft will orbit Mars at a 75° inclination, with a 4.5 hour period and periapsis altitude of 140-170 km (density corridor of 0.05-0.15 kg/km^3). Over a one-Earth-year period, periapsis will precess over a wide range of latitude and local time, while MAVEN obtains detailed measurements of the upper atmosphere, ionosphere, planetary corona, solar wind, interplanetary/Mars magnetic fields, solar EUV and solar energetic particles, thus defining the interactions between the Sun and Mars. MAVEN will explore down to the homopause during a series of five 5-day "deep dip" campaigns for which periapsis will be lowered to an atmospheric density of 2 kg/km^3 (~125 km altitude) in order to sample the transition from the collisional lower atmosphere to the collisionless upper atmosphere. These five campaigns will be interspersed though the mission to sample the subsolar region, the dawn and dusk terminators, the anti-solar region, and the north pole.

1.6.1 Mission Objectives

The primary science objectives of the MAVEN project will be to provide a comprehensive picture of the present state of the upper atmosphere and ionosphere of Mars and the processes controlling them and to determine how loss of volatiles to outer space in the present epoch varies with changing solar conditions. Knowing how these processes respond to the Sun's energy inputs will enable scientists, for the first time, to reliably project processes backward in time to study atmosphere and volatile evolution. MAVEN will deliver definitive answers to high-priority science questions about atmospheric loss (including water) to space that will greatly enhance our understanding of the climate history of Mars. Measurements made by MAVEN will allow us to determine the role that escape to space has played in the evolution of the Mars atmosphere, an essential component of the quest to "follow the water" on Mars. MAVEN will accomplish this by achieving science objectives that answer three key science questions:

- What is the current state of the upper atmosphere and what processes control it?
- What is the escape rate at the present epoch and how does it relate to the controlling processes?
- What has the total loss to space been through time?

MAVEN will achieve these objectives by measuring the structure, composition, and variability of the Martian upper atmosphere, and it will separate the roles of different loss mechanisms for both neutrals and ions. MAVEN will sample all relevant regions of the Martian atmosphere/ionosphere system—from the termination of the well-mixed portion of the atmosphere (the "homopause"), through the diffusive region and main ionosphere layer, up into the collisionless exosphere, and through the magnetosphere and into the solar wind and downstream tail of the planet where loss of neutrals and ionization occurs to space—at all relevant latitudes and local solar times. To allow a meaningful projection of escape back in time, measurements of escaping species will be made simultaneously with measurements of the energy drivers and the controlling magnetic field over a range of solar conditions. Together with measurements of the isotope ratios of major species, which constrain the net loss to space over time, this approach will allow thorough identification of the role that atmospheric escape plays today and to extrapolate to earlier epochs.

1.6.2 Payload

MAVEN will use the following science instruments to measure the Martian upper atmospheric and ionospheric properties, the magnetic field environment, the solar wind, and solar radiation and particle inputs:

- NGIMS Package:
  - Neutral Gas and Ion Mass Spectrometer (NGIMS) measures the composition, isotope ratios, and scale heights of thermal ions and neutrals.
- RS Package:
  - Imaging Ultraviolet Spectrograph (IUVS) remotely measures UV spectra in four modes: limb scans, planetary mapping, coronal mapping and stellar occultations. These measurements provide the global composition, isotope ratios, and structure of the upper atmosphere, ionosphere, and corona.
- PF Package:
  - Supra-Thermal and Thermal Ion Composition (STATIC) instrument measures the velocity distributions and mass composition of thermal and suprathermal ions from below escape energy to pickup ion energies.
  - Solar Energetic Particle (SEP) instrument measures the energy spectrum and angular distribution of solar energetic electrons (30 keV – 1 MeV) and ions (30 keV – 12 MeV).
  - Solar Wind Ion Analyzer (SWIA) measures solar wind and magnetosheath ion density, temperature, and bulk flow velocity. These measurements are used to determine the charge exchange rate and the solar wind dynamic pressure.
  - Solar Wind Electron Analyzer (SWEA) measures energy and angular distributions of 5 eV to 5 keV solar wind, magnetosheath, and auroral electrons, as well as ionospheric photoelectrons. These measurements are used to constrain the plasma environment, magnetic field topology and electron impact ionization rate.
  - Langmuir Probe and Waves (LPW) instrument measures the electron density and temperature and electric field in the Mars environment. The instrument includes an EUV Monitor that measures the EUV input into Mars atmosphere in three broadband energy channels.
  - Magnetometer (MAG) measures the vector magnetic field in all regions traversed by MAVEN in its orbit.

1.7 SIS Content Overview

Section 2 describes the IUVS instrument. Section 3 gives an overview of data organization and data flow. Section 4 describes data archive generation, delivery, and validation. Section 5 describes the archive structure and archive production responsibilities. Section 6 describes the file formats used in the archive, including the data product record structures. Individuals involved with generating the archive volumes are listed in Appendix A. Appendix B contains a description of the MAVEN science data file naming conventions. Appendix C, Appendix D, and Appendix E contain sample PDS product labels. Appendix F describes IUVS archive product PDS deliveries formats and conventions.

1.8 Scope of this document

The specifications in this SIS apply to all IUVS products submitted for archive to the Planetary Data System (PDS), for all phases of the MAVEN mission. This document includes descriptions of archive products that are produced by both the IUVS team and by PDS.

1.9 Applicable Documents

[1] Planetary Data System Data Provider's Handbook, TBD.

[2] Planetary Data System Standards Reference, TBD.

[3] Planetary Science Data Dictionary Document, TBD.

[4] Planetary Data System (PDS) PDS4 Information Model Specification, Version 1.1.0.1.

[5] Mars Atmosphere and Volatile Evolution (MAVEN) Science Data Management Plan, Rev. C, doc. no.MAVEN-SOPS-PLAN-0068.

[6] King, T., and J. Mafi, Archive of MAVEN CDF in PDS4, July 16, 2013.

1.10 Audience

This document serves both as a SIS and Interface Control Document (ICD). It describes both the archiving procedure and responsibilities, and data archive conventions and format. It is designed to be used both by the instrument teams in generating the archive, and by those wishing to understand the format and content of the IUVS PDS data product archive collection. Typically, these individuals would include scientists, data analysts, and software engineers.

2 Instrument Descriptions

2.1 Science Objectives

The MAVEN mission has four science goals that the on-board instrumentation will seek to address.

1. Determine the role that loss of volatiles from the Mars atmosphere to space has played through time.
2. Determine the current state of the upper atmosphere, ionosphere, and interactions with the solar wind.
3. Determine the current rates of escape of neutral gases and ions to space and the processes controlling them.
4. Determine the ratios of stable isotopes that will tell Mars' history of loss through time.

To address these four mission goals, the MAVEN IUVS has three measurements it will make during the primary mission. The three measurements, which encompass these goals, are as follows.

1. Profiles and column abundances of H, C, N, O, CO, N_2, and CO_2 from the homopause up to two scale heights (~1500 km for coronal H and O, ~24 km for CO_2) above the exobase with a vertical resolution of one scale height for each species and 25% accuracy.
2. Profiles and column abundances of C^+ and CO_2^+, from the ionospheric main peak up to the nominal ionopause with one O_2^+ scale height vertical resolution and 25% accuracy.
3. D/H ratio above the homopause with sufficient accuracy (~30%) to capture spatial/temporal variations (factor of 2) and compare with measured D/H in bulk atmosphere.

2.2 Detectors

IUVS is an imaging ultraviolet spectrograph which simultaneously images far ultraviolet (FUV) and middle ultraviolet (MUV) spectra onto paired Hamatsu V5180M image intensifiers with Cypress CYIH1SM1000AA-HHCS CMOS array detectors. Second order (110-190nm) light from the beamsplitter is measured by the FUV detector (with a CsI photocathode and MgF_2 window) while first-order (180-340 nm) light is transmitted to the MUV detector (with a CsTe photocathode and synthetic silica window). A spectral resolution of 0.6 nm and 1.2 nm is achieved for the FUV and MUV, respectively.

2.3 Electronics

IUVS is part of the MAVEN Remote Sensing Package. Controlling electronics are part of the Remote Sensing Data Processing Unit (RSDPU), which is located on the spacecraft bus and consists of a 69R000 microprocessor, serial detector interfaces for data and command transfers, dual-port SRAM for data storage, a MIL-STD 1553 spacecraft interface, and a high-speed serial data channel on a common backplane.

2.4 Measured Parameters

Each IUVS detector readout, independent of operational mode (see section 2.5), returns data in data numbers (DN) versus wavelength and position along the aperture. The binning of the detector readouts in the spectral and spatial domains varies with operational mode. Higher level processed and derived data products convert the measured data numbers to the quantity of spectral radiance in units of Rayleighs per nanometer (R/nm) and local column and volumetric densities for relevant species.

2.5 Operational Modes

The IUVS operates in four separate modes, periapse limb scans, apoapse planetary mapping, coronal scans, and stellar occultations, depending on the location of the MAVEN spacecraft in its orbit around Mars. The apoapse planetary mapping mode produces maps of emission brightness for individual species across the disk of Mars. For the altitude scanning modes (periapse limb scans and coronal scans), altitude maps of emission brightness are produced for each species at measured locations. Stellar occultation observations produce line of sight column density for each species based on the changing absorption of stellar flux.

2.6 Operational Considerations

The IUVS instrument is commanded off during the five Deep Dip campaigns that MAVEN undertakes in its nominal mission. This is taken as a precaution to avoid damage from the 6 kV high voltage supplied to the image intensifier.

2.7 Ground Calibration

Normal Mode: IUVS normal-mode radiometric sensitivity was measured using both detector standards (comparison of instrument response to that from a calibrated photodiode) and irradiance standards (calibrated lamps). Both approaches are traceable to National Institute of Standards and Technology (NIST) standards. In the former calibration approach we used a vacuum facility equipped with a 2.3-mfocal-length collimator that had a scanning monochromator positioned at its focal plane. The monochromator's exit slit was masked to 1 mm in height and the slit was adjusted to be less than 0.2 mm wide so that beam of light exiting the collimator had less than a 0.2 milliradian angular extent. A hollow cathode lamp using flowing H2, N2, O2, and CO2 was placed at the entrance slit provided spectra with both molecular emissions and isolated atomic emissions. A pair of photomultiplier tubes (PMTs) with pulse-amplifier-discriminators and 2.54-mmsquare apertures were placed on a translation stage in the vacuum chamber and coaligned to the IUVS. One of these was equipped with a CsI photocathode and a MgF2 window for FUV calibrations and the other with a CsTe photocathode and a fused silica window for MUV calibrations. The PMTs' quantum efficiencies were determined as a function of wavelength by comparing their outputs to a photodiode whose absolute quantum efficiency as a function of wavelength was measured by NIST (Canfield et al. 1973). This allowed us to determine a map of input beam irradiance (photons cm−2 sec−1) as a function of position within the vacuum chamber by scanning the two PMTs in a raster pattern and measuring their outputs. IUVS responsivity, R(λj ,θk) (R = TOptics ·QePc ·GDet ·GADC) was determined at 20 discrete wavelengths and 7 heights along the slit. A measurement sequence for each wavelength and angle began setting the monochromator to an isolated atomic emission line and mapping the beam with the appropriate PMT. Once map was complete, the PMT was placed in the center of the raster and its count rate was recorded. Next the PMT was translated aside and the IUVS placed at the center of the raster and rotated in elevation to the measurement angle, θk , where the DN rate was measured. Finally the PMT was reinserted and its count rate was measured for a second time to determine lamp drift. (No more than a few percent drift was ever observed during a measurement sequence). Two separate measurement sequences were performed; one with the monochromator grating grooves parallel to those of IUVS and one with them perpendicular. These were averaged to account for polarization effects that may have been introduced because the monochromator grating acts as a polarizer and the IUVS grating acts as an analyzer. (The effects were only a few percent, probably because the IUVS grating operates very near the Littrow configuration (James & Sternberg 1969).) Care was taken to accurately account for parallax between the PMTs whose apertures were in one plane and the IUVS whose entrance pupil was in another.

The irradiance standards approach is performed at ambient pressure and can only be used for MUV. It employs lamps that have their spectral irradiance (i.e., photons cm−2 sec−1 nm−1) directly traceable to NIST standard sources. In this approach a calibrated lamp (irradiance standard) is placed in front of a Spectrolon® screen providing an extended source with a radiance (i.e., photons cm−2 sec−1 nm−1 str−1). Radiance is calculated from the product of lamp irradiance at the screen multiplied by screen reflectance (Georgiev and Butler 2007; Stiegman et al. 1993). When IUVS views a screen that is large enough to fill both its entrance pupil and its field of view the output DN rate from the MUV detector divided by the screen radiance is a direct measure of the quantity A · λ · R(λj ,θk) · Ω(θk). A measurement sequence includes observations of the screen followed by a dark measurement, obtained by closing the MUV electronic shutter. This is followed by a similar sequence with the screen by a black cloth. Assuming that the cloth reflectance is ≤4 % provides a good measure of the ambient backgrounds, which result when light from the lamp is re- flected from walls and other objects within the lab into the IUVS field of view. Additionally, measurements are made at a range of instrument-screen separations in order to determine atmospheric absorption, which is small but significant, particularly for wavelengths 200 nm, and an FEL lamp (Walker et al. 1987), which was calibrated for λ > 250 nm, were used for IUVS. The different spectral properties of these lamps provide insight into the scattered light performance of the IUVS spectrograph.

Echelle Mode: The echelle mode responsivity was estimated before calibration to be 0.36 * 0.56 * 0.5 ~ 0.1 of the normal mode value. This is based on the echelle spectrograph beam filling factor of 0.36. (The effective echelle grating width is W * cos(β) = 24.1 mm compared to w = 66.7 mm for the normal mode (Bottema 1981), the transmission of the MgF2 prism, which when used in double pass is 0.752 = 0.56, and the relative echelle grating/normal grating groove efficiency of 0.5 (Content et al. 1996).) This estimate was validated at 121.567 nm by taking images in normal and echelle modes while the IUVS viewed the vacuum collimator with the monochromator set to transmit H Lyman alpha emission from its hollow cathode lamp. The ratio of the total DNs within each of the two measured profiles was Total(Echelle)/Total(Normal mode) ~0.096. Thus responsivity of the echelle mode is ~1.3 DN/photon for 121.567 nm. The echelle mode signal for atmosphere emission is 66 times smaller because the etendue and optical throughput are 6.6 and 10 times less, respectively, than normal mode.

2.8 Inflight Calibration

Calibration of the IUVS instrument in flight utilizes UV bright stellar targets with well-established spectral fluxes (e.g. Alpha Crucis, Beta Centauri, Beta Canis Majoris, etc.). Two stellar calibration activities were performed during the cruise phase of the mission, with repeated observations being made on orbit to monitor potential changes in sensitivity. Analysis of this data, reconciliation with ground calibration, and application to airglow observations at Mars is ongoing. To reflect this, a systematic uncertainty of 50% has conservatively been applied to all radiances.

3 Data Overview

This section provides a high level description of archive organization under the PDS4 Information Model (IM) as well as the flow of the data from the spacecraft through delivery to PDS. Unless specified elsewhere in this document, the MAVEN IUVS archive conforms with version 1.1.0.1 of the PDS4 IM [4].

3.1 Data Processing Levels

A number of different systems may be used to describe data processing level. This document refers to data by their PDS4 processing level. Table 5 provides a description of these levels along with the equivalent designations used in other systems.

Table 5: Data processing level designations

PDS4 processing level	PDS4 processing level description	MAVEN Processing Level	CODMAC Level	IUVS Level
Raw	Original data from an instrument. If compression, reformatting, packetization*, or other translation has been applied to facilitate data transmission or storage, those processes are reversed so that the archived data are in a PDS approved archive format.	0	1	0
Reduced	Data that have been processed beyond the raw stage but which are not yet entirely independent of the instrument.	1	2	1A
Calibrated	Data converted to physical units entirely independent of the instrument.	2	3	1B
Derived	Results that have been distilled from one or more calibrated data products (for example, maps, gravity or magnetic fields, or ring particle size distributions). Supplementary data, such as calibration tables or tables of viewing geometry, used to interpret observational data should also be classified as 'derived' data if not easily matched to one of the other three categories.	3+	4+	1C+

* PDS does not accept packetized data (CODMAC level 1/NASA level 0) as fulfilling the requirement for the archive of raw data. The PDS/PPI Atmos node, however, has agreed to an exception for the MAVEN mission with the understanding that the MAVEN packetized data are not compressed, and may be described as fixed width binary tables. Typically the minimum reduction level accepted by PDS for "raw" data is CODMAC level 2, or NASA level 1A.

3.2 Products

A PDS product consists of one or more digital and/or non-digital objects, and an accompanying PDS label file. Labeled digital objects are data products (i.e. electronically stored files). Labeled non-digital objects are physical and conceptual entities which have been described by a PDS label. PDS labels provide identification and description information for labeled objects. The PDS label defines a Logical Identifier (LID) by which any PDS labeled product is referenced throughout the system. In PDS4 labels are XML formatted ASCII files. More information on the formatting of PDS labels is provided in Section 6.2. More information on the usage of LIDs and the formation of MAVEN LIDs is provided in Section 5.1.

3.3 Product Organization

The highest level of organization for PDS archive is the bundle. A bundle is a list of one or more related collection products which may be of different types. A collection is a list of one or more related basic products which are all of the same type. Figure 1 below illustrates these relationships.

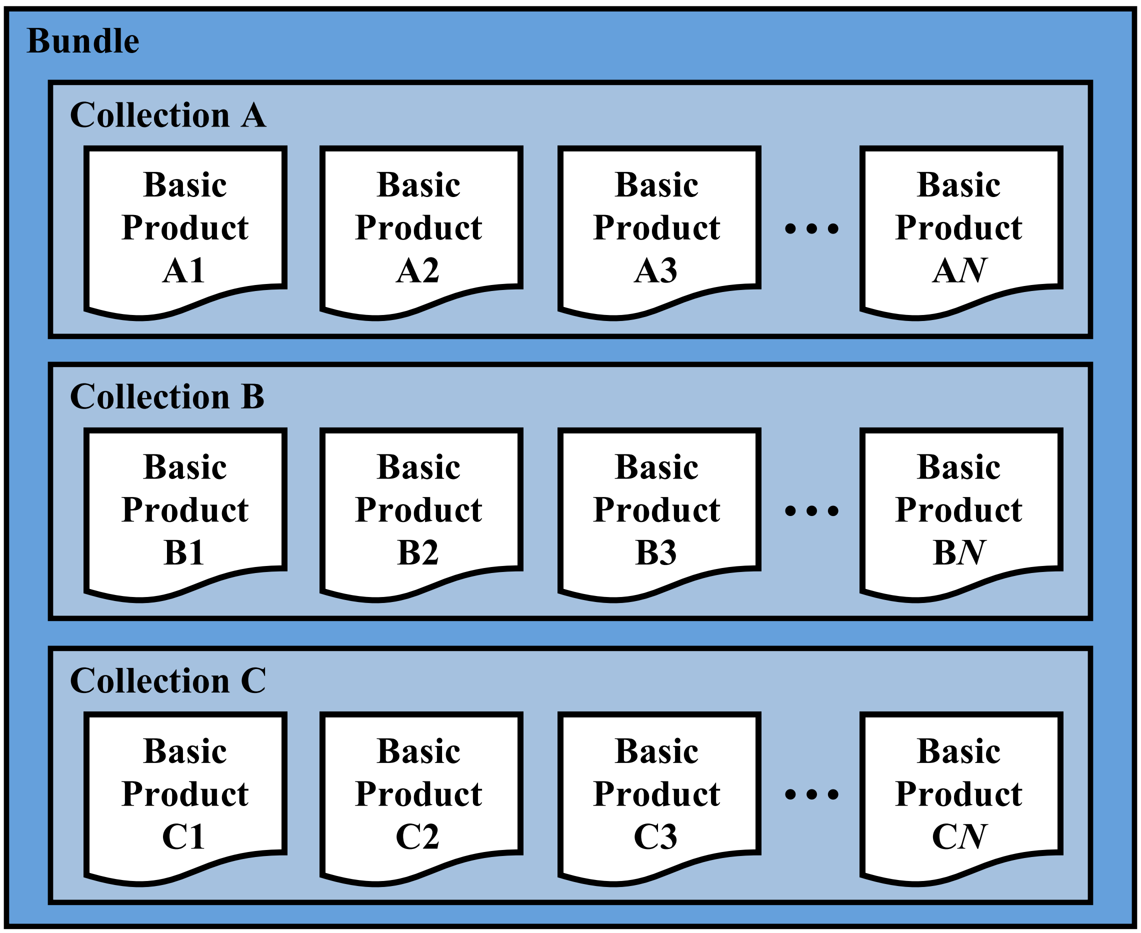

Figure 1: A graphical depiction of the relationship among bundles, collections, and basic products.

Bundles and collections are logical structures, not necessarily tied to any physical directory structure or organization. Bundle and collection membership is established by a member inventory list. Bundle member inventory lists are provided in the bundle product labels themselves. Collection member inventory lists are provided in separate collection inventory table files. Sample bundle and collection labels are provided in Appendix C and Appendix D, respectively.

3.3.1 Collection and Basic Product Types

Collections are limited to a single type of basic products. The types of archive collections that are defined in PDS4 are listed in Table 6.

Table 6: Collection product types

Collection Type	Description
Browse	Contains products intended for data characterization, search, and viewing, and not for scientific research or publication.
Calibration	Contains data and files necessary for the calibration of basic products.
Context	Contains products which provide for the unique identification of objects which form the context for scientific observations (*e.g.* spacecraft, observatories, instruments, targets, etc.).
Document	Contains electronic document products which are part of the PDS Archive.
Data	Contains scientific data products intended for research and publication.
SPICE	Contains NAIF SPICE kernels.
XML_Schema	Contains XML schemas and related products which may be used for generating and validating PDS4 labels.

3.4 Bundle Products

The IUVS data archive is organized into 1 bundle. A description of this bundle is provided in Table 7. A more detailed description of the contents and format of the bundle is provided in Section 5.2.

Table 7: IUVS Bundles

Bundle Logical Identifier	PDS4 Reduction Level	Description	Data Provider
urn:nasa:pds:maven.kp.iuvs	Derived	Summary of observed emission feature radiances and derived quantities (eg density profiles, temperatures, column abundances)	IUVS ITF

3.5 Data Flow

This section describes only those portions of the MAVEN data flow that are directly connected to archiving the PF KP data. A full description of MAVEN data flow is provided in the MAVEN Science Data Management Plan [5].

The PF KP data files will consist of ASCII files generated by the ITFs (and DPFs as applicable, as determined by the SDWG) as part of their data processing, and will be delivered to the SDC for access by the MAVEN team and eventual archiving at the PDS as with all other science data products.

Data bundles intended for the archive are identified in Table 7.

4 Archive Generation

The IUVS archive products are produced by the IUVS instrument team in cooperation with the SDC, and with the support of the PDS Atmospheres Node at New Mexico State University. The archive volume creation process described in this section sets out the roles and responsibilities of each of these groups. The assignment of tasks has been agreed upon by all parties. Archived data received by the Atmos Node from the IUVS team are made available to PDS users electronically as soon as practicable but no later two weeks after the delivery and validation of the data.

4.1 Data Processing and Production Pipeline

The following sections describe the process by which data products in each of the IUVS bundles listed in Table 7 are produced.

4.1.1 KP Data Production Pipeline

The IUVS KP files summarize important observed emission features and derived quantities from nominal modes of operation (limb scans, coronal scans, echelle mode scans, disk imaging, and stellar occultations). These key parameters are condensed from the more detailed IUVS L1C and L2 data products (see the IUVS SIS for more information on these products). One L1C and one L2 FITS file are produced for each observation mode per orbit. The information in these files is then distilled into a single ASCII KP file for each orbit. This pipeline is implemented in the IDL language.

4.2 Data Validation

4.2.1 Instrument Team Validation

Data products generated from the automated pipeline described in 4.1 are to be spot-checked by post-doctoral researchers from the IUVS ITF. As the mission progresses and familiarity with the operational idiosyncrasies of the instrument advances, automated procedures for validating data products will be developed as appropriate.

4.2.2 MAVEN Science Team Validation

It is anticipated that individual scientists on the MAVEN Science Team will perform their own validation of the data after dissemination of the data products. The IUVS ITF will accept input from these contributors to improve the automated data product processing pipeline and instrument team validation process.

4.2.3 PDS Peer Review

The Atmos node will conduct a full peer review of all of the data types that the IUVS team intends to archive. The review data will consist of fully formed bundles populated with candidate final versions of the data and other products and the associated metadata.

Table 8: MAVEN PDS review schedule

Date	Activity	Responsible Team
2014-May through 2014-Aug	Calibrated and derived data product, archive structure, and SIS peer review	SDC
2014-Nov-01	Start of Science Operations	
2015-Mar-02	Delivery #1 Due to PDS	ITF/SDC
2015-Mar through 2015-Apr	Calibrated and derived data peer review	PDS
2015-May-01	Delivery #1 Release to the Public (Start of Science Ops + 6 months)	PDS

Reviews will include a preliminary delivery of sample products for validation and comment by PDS Atmos and Engineering node personnel. The data provider will then address the comments coming out of the preliminary review, and generate a full archive delivery to be used for the peer review.

Reviewers will include MAVEN Project and IUVS team representatives, researchers from outside of the MAVEN project, and PDS personnel from the Engineering and Atmos nodes. Reviewers will examine the sample data products to determine whether the data meet the stated science objectives of the instrument and the needs of the scientific community and to verify that the accompanying metadata are accurate and complete. The peer review committee will identify any liens on the data that must be resolved before the data can be 'certified' by PDS, a process by which data are made public as minor errors are corrected.

In addition to verifying the validity of the review data, this review will be used to verify that the data production pipeline by which the archive products are generated is robust. Additional deliveries made using this same pipeline will be validated at the Atmos node, but will not require additional external review.

As expertise with the instrument and data develops the IUVS team may decide that changes to the structure or content of its archive products are warranted. Any changes to the archive products or to the data production pipeline will require an additional round of review to verify that the revised products still meet the original scientific and archival requirements or whether those criteria have been appropriately modified. Whether subsequent reviews require external reviewers will be decided on a case-by-case basis and will depend upon the nature of the changes. A comprehensive record of modifications to the archive structure and content is kept in the Modification_History element of the collection and bundle products.

The instrument team and other researchers are encouraged to archive additional IUVS products that cover specific observations or data-taking activities. The schedule and structure of any additional archives are not covered by this document and should be worked out with the Atmos node.

4.3 Data Transfer Methods and Delivery Schedule

The SOC is responsible for delivering data products to the PDS for long-term archiving. While ITFs are primarily responsible for the design and generation of calibrated and derived data archives, the archival process is managed by the SOC. The SOC (in coordination with the ITFs) will also be primarily responsible for the design and generation of the raw data archive. The first PDS delivery will take place within 6 months of the start of science operations. Additional deliveries will occur every following 3 months and one final delivery will be made after the end of the mission. Science data are delivered to the PDS within 6 months of its collection. If it becomes necessary to reprocess data which have already been delivered to the archive, the ITFs will reprocess the data and deliver them to the SDC for inclusion in the next archive delivery. A summary of this schedule is provided in Table 9 below.

Table 9: Archive bundle delivery schedule

Bundle Logical Identifier	First Delivery to PDS	Delivery Schedule	Estimated Delivery Size
urn:nasa:pds:maven.kp.iuvs	No later than 6 months after the start of science operations	Every 3 months	500 MB

Each delivery will comprise both data and ancillary data files organized into directory structures consistent with the archive design described in Section 5, and combined into a deliverable file(s) using file archive and compression software. When these files are unpacked at the Atmos Node in the appropriate location, the constituent files will be organized into the archive structure.

Archive deliveries are made in the form of a “delivery package”. Delivery packages include all of the data being transferred along with a transfer manifest, which helps to identify all of the products included in the delivery, and a checksum manifest which helps to insure that integrity of the data is maintained through the delivery. The format of these files is described in Section 6.3.

Data are transferred electronically (using the *ssh* protocol) from the SOC to an agreed upon location within the Atmos file system. Atmos will provide the SOC a user account for this purpose. Each delivery package is made in the form of a compressed *tar* archive. Only those files that have changed since the last delivery are included. The Atmos operator will decompress the data, and verify that the archive is complete using the transfer and MD5 checksum manifests that were included in the delivery package. Archive delivery status will be tracked using a system defined by the Atmos node.

Following receipt of a data delivery, Atmos will reorganize the data into its PDS archive structure within its online data system. Atmos will also update any of the required files associated with a PDS archive as necessitated by the data reorganization. Newly delivered data are made available publicly through the Atmos online system once accompanying labels and other documentation have been validated. It is anticipated that this validation process will require no more than fourteen working days from receipt of the data by Atmos. However, the first few data deliveries may require more time for the Atmos Node to process before the data are made publicly available.

The MAVEN prime mission begins approximately 5 weeks following MOI and lasts for 1 Earth-year. Table 9 shows the data delivery schedule for the entire mission.

4.4 Data Product and Archive Volume Size Estimates

IUVS KP data products consist of ASCII files that span a single orbit. Each file is approximately 1 MB in size.

4.5 Data Validation

Routine data deliveries to the PDS are validated at the Atmos node to ensure that the delivery meets PDS standards, and that the data conform to the SIS as approved in the peer review. As long as there are no changes to the data product formats, or data production pipeline, no additional external review will be conducted.

4.6 Backups and duplicates

The Atmos Node keeps three copies of each archive product. One copy is the primary online archive copy, another is an onsite backup copy, and the final copy is an off-site backup copy. Once the archive products are fully validated and approved for inclusion in the archive, copies of the products are sent to the National Space Science Data Center (NSSDC) for long-term archive in a NASA-approved deep-storage facility. The Atmos Node may maintain additional copies of the archive products, either on or off-site as deemed necessary. The process for the dissemination and preservation of IUVS data is illustrated in Figure 2.

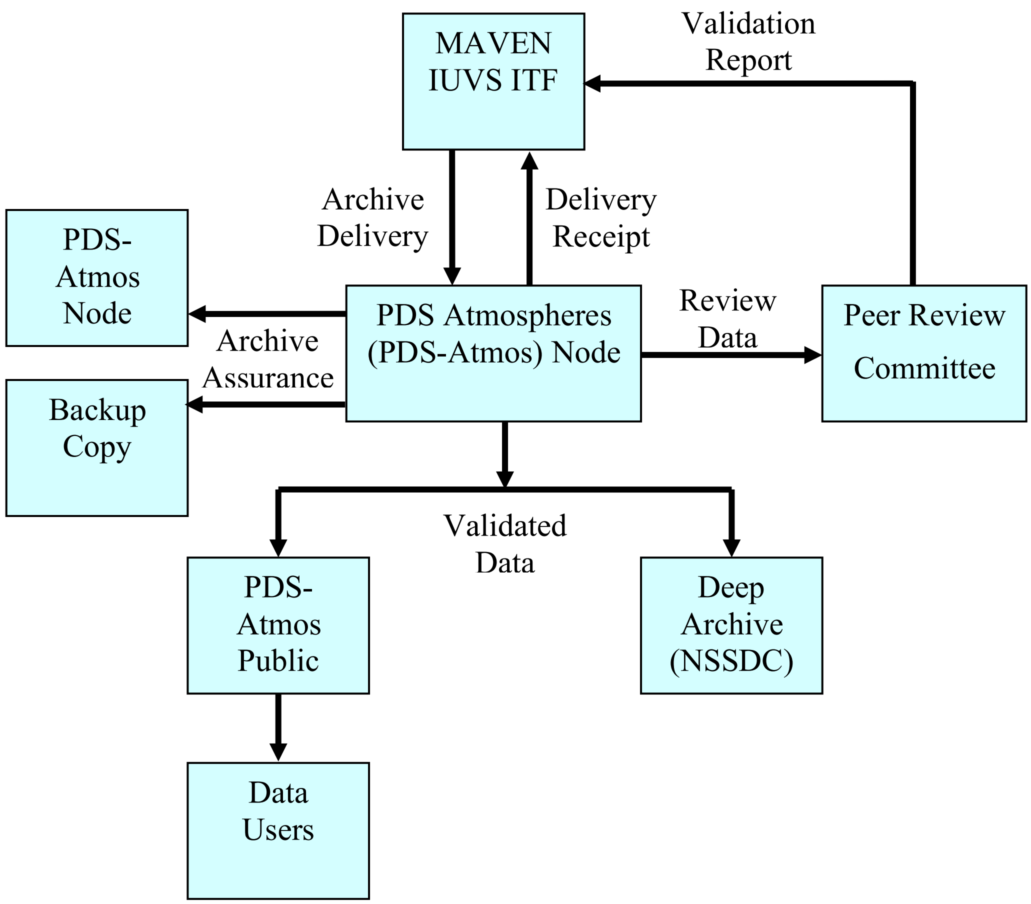

Figure 2: Duplication and dissemination of IUVS archive products at PDS/Atmos.

5 Archive organization and naming

This section describes the basic organization of an IUVS bundle, and the naming conventions used for the product logical identifiers, and bundle, collection, and basic product filenames.

5.1 Logical Identifiers

Every product in PDS is assigned an identifier which allows it to be uniquely identified across the system. This identifier is referred to as a Logical Identifier or LID. A LIDVID (Versioned Logical Identifier) includes product version information, and allows different versions of a specific product to be referenced uniquely. A product's LID and VID are defined as separate attributes in the product label. LIDs and VIDs are assigned by the entity generating the labels and are formed according to the conventions described in sections 5.1.1 and 5.1.2 below. The uniqueness of a product's LIDVID may be verified using the PDS Registry and Harvest tools.

5.1.1 LID Formation

LIDs take the form of a Uniform Resource Name (URN). LIDs are restricted to ASCII lower case letters, digits, dash, underscore, and period. Colons are also used, but only to separate prescribed components of the LID. Within one of these prescribed components dash, underscore, or period are used as separators. LIDs are limited in length to 255 characters.

MAVEN IUVS LIDs are formed according to the following conventions:

- Bundle LIDs are formed by appending a bundle specific ID to the MAVEN IUVS base ID:

  urn:nasa:pds:maven.iuvs.<bundle ID>

  Since all PDS bundle LIDs are constructed this way, the combination of maven.iuvs.bundle must be unique across all products archived with the PDS.

- Collection LIDs are formed by appending a collection specific ID to the collection's parent bundle LID:

  urn:nasa:pds:maven.iuvs.<bundle ID>:<collection ID>

  Since the collection LID is based on the bundle LID, which is unique across PDS, the only additional condition is that the collection ID must be unique across the bundle. Collection IDs correspond to the collection type (e.g. "browse", "data", "document", etc.). Additional descriptive information may be appended to the collection type (e.g. "data-raw", "data-calibrated", etc.) to insure that multiple collections of the same type within a single bundle have unique LIDs.

- Basic product LIDs are formed by appending a product specific ID to the product's parent collection LID:

  urn:nasa:pds:maven.iuvs.<bundle ID>:<collection ID>:<product ID>

  Since the product LID is based on the collection LID, which is unique across PDS, the only additional condition is that the product ID must be unique across the collection. See Appendix B for a detailed explanation of IUVS product ID descriptor conventions.

A list of IUVS KP bundle LIDs is provided in Table 7. Collection LIDs are listed in Table 10.

5.1.2 VID Formation

Product version ID's consist of major and minor components separated by a "." (M.n). Both components of the VID are integer values. The major component is initialized to a value of "1", and the minor component is initialized to a value of "0". The minor component resets to "0" when the major component is incremented.

5.2 IUVS Archive Contents

The IUVS archive includes the bundle listed in Table 7. The following sections describe the contents of this bundle in greater detail.

5.2.1 IUVS KP Bundle

The IUVS KP bundle contains key parameter data files, along with supporting documentation. Collections containing PDS context and XML schema information are also present.

Table 10: IUVS collections

Collection LID	Description
urn:nasa:pds:maven.kp.iuvs:data	ASCII files with key parameter data
urn:nasa:pds: maven.kp.iuvs:document	Documentation for the kp.iuvs bundle.
urn:nasa:pds: maven.kp.iuvs:context	PDS context products referenced by products in the kp.iuvs archive bundle.
urn:nasa:pds: maven.kp.iuvs:xml_schema	XML schema and Schematron files referenced by products in the kp.iuvs archive bundle.

5.2.1.1 IUVS KP Data Collection

The IUVS KP data collection contains ASCII files that summarize important observed emission features and derived quantities from nominal modes of operation (limb scans, coronal scans, echelle mode scans, disk imaging, and stellar occultations. The data are regularly binned in altitude or latitude and longitude, as appropriate. Each files corresponds to a single MAVEN orbit. Not every observation mode is executed on every orbit.

5.2.1.2 IUVS KP Document Collection

The IUVS KP document collection contains documents that are useful for understanding and using the KP bundle. Table 11 contains a list of the documents included in this collection, along with the LID, and responsible group. Following this a brief description of each document is also provided.

Table 11: IUVS Science Data Documents

Document Name	LID	Responsiblility
MAVEN Science Data Management Plan	urn:nasa:pds:maven:document:sdmp	MAVEN Project

Document Name	LID	Responsiblility
MAVEN IUVS Archive SIS	urn:nasa:pds:maven.iuvs:document:sis	IUVS Team
MAVEN Mission Description	urn:nasa:pds:maven:document:mission.description	MAVEN Project
MAVEN Spacecraft Description	urn:nasa:pds:maven:document:spacecraft.description	MAVEN Project
IUVS Instrument Description	urn:nasa:pds:maven.iuvs:document: iuvs.instrument.description	IUVS Team
IUVS Calibration Description	urn:nasa:pds:maven.iuvs.calibrated:document:calibration.description	IUVS Team

MAVEN Science Data Management Plan – describes the data requirements for the MAVEN mission and the plan by which the MAVEN data system will meet those requirements

MAVEN IUVS Archive SIS – describes the format and content of the IUVS PDS data archive, including descriptions of the data products and associated metadata, and the archive format, content, and generation pipeline (this document)

MAVEN Mission Description – describes the MAVEN mission.

MAVEN Spacecraft Description – describes the MAVEN spacecraft.

IUVS Instrument Description – describes the MAVEN IUVS instrument.

IUVS Calibration Description – describes the algorithms and procedures used to apply the calibration performed on the data included in this bundle.

While responsibility for the individual documents varies, the document collection itself is managed by the PDS/Atmos node.

5.2.1.3 IUVS KP Context Collection

The IUVS calibrated data context collection contains a list of the context products describing objects referenced by products in the IUVS calibrated data bundle. Context products are used to define the LID's by which PDS4 data products identify the objects which form the context in which the scientific observations were made (e.g. spacecraft, instrument, target, etc.). These products are created and maintained by PDS and are listed here for reference only.

5.2.1.4 IUVS KP XML_Schema Collection

The IUVS KP data XML Schema collection contains a list of the XML schema and Schematron documents which define the correct format and content for PDS4 metadata files.

The PDS4 master schema and Schematron are produced, managed, and provided to MAVEN by PDS. The MAVEN mission manages the MAVEN mission schema and Schematron which contain parameter definitions which are unique to the MAVEN project. A full list of the schema and Schematron documents relevant to the KP bundle are list in Table 12.

Table 12: IUVS KP Science Data XML_Schema Products

XML Document	Steward	Product LID
PDS Master Schema, v. 1.1.0.0	PDS	
PDS Master Schematron, v. 1.1.0.0	PDS	
MAVEN Mission Schema, v. 1.0	MAVEN	
MAVEN Mission Schematron, v. 1.0	MAVEN	

6 Archive product formats

Data that comprise the IUVS archives are formatted in accordance with PDS specifications [see *Planetary Science Data Dictionary* [4], *PDS Data Provider's Handbook* [2], and *PDS Standards Reference* [3]. This section provides details on the formats used for each of the products included in the archive.

6.1 Data File Formats

This section describes the format and record structure of each of the data file types.

6.1.1 KP data file structure

KP data files will be archived as fixed width ASCII tables with ASCII headers. Each file is accompanied by a PDS label file (*.xml). KP files are internally partitioned into sections for each observation mode executed during the orbit associated with an individual file. Not all modes are executed on every orbit. The following tables describe the structure of each mode.

Table 13: Geometry Common to All Modes

Field Name	Dimension	Data Type	Units	Description
TIME_START	[1]	string	n/a	start time (UTC STRING)
TIME_STOP	[1]	string	n/a	stop time (UTC STRING)
SZA	[1]	float	deg	mean solar zenith angle at tangent point or disk intercept
LOCAL_TIME	[1]	float	hours	mean local solar time at tangent point or disk intercept
LAT	[1]	float	deg	mean latitude of tangent point or disk intercept in geographic coordinates
LON	[1]	float	deg	mean planetocentric longitude (positive East, -180 to 180) of tangent point or disk intercept in geographic coordinates
LAT_MSO	[1]	float	deg	mean latitude of tangent point or disk intercept in MSO frame
LON_MSO	[1]	float	deg	mean planetocentric longitude (positive East, -180 to 180) of tangent point or disk intercept in MSO frame
MARS_SEASON_LS	[1]	float	deg	solar longitude measured from the vernal equinox

ORBIT_NUMBER	[1]	UINT	n/a	orbit number at start time
SC_GEO_X	[1]	double	km	X component of spacecraft position in IAU MARS frame
SC_GEO_Y	[1]	double	km	Y component of spacecraft position in IAU MARS frame
SC_GEO_Z	[1]	double	km	Z component of spacecraft position in IAU MARS frame
SC_MSO_X	[1]	double	km	X component of spacecraft position in MSO frame
SC_MSO_Y	[1]	double	km	Y component of spacecraft position in MSO frame
SC_MSO_Z	[1]	double	km	Z component of spacecraft position in MSO frame
SUN_GEO_X	[1]	double	km	X component of Sun position in IAU MARS frame
SUN_GEO_Y	[1]	double	km	Y component of Sun position in IAU MARS frame
SUN_GEO_Z	[1]	double	km	Z component of Sun position in IAU MARS frame
SC_GEO_LON	[1]	float	deg	subspacecraft longitude
SC_GEO_LAT	[1]	float	deg	subspacecraft latitude
SC_MSO_LON	[1]	float	deg	subspacecraft longitude in MSO frame
SC_MSO_LAT	[1]	float	deg	subspacecraft latitude in MSO frame
SUBSOL_GEO_LON	[1]	float	deg	subsolar longitude
SUBSOL_GEO_LAT	[1]	float	deg	subsolar latitude
SC_SZA	[1]	float	deg	sub-spacecraft solar zenith angle
SC_LOCAL_TIME	[1]	float	hours	sub-spacecraft local time, 24hr
SC_ALT	[1]	float	km	subspacecraft altitude (relative to ?)
MARS_SUN_DIST	[1]	float	km	distance from Mars to the Sun

Table 14: PERIAPSE

Field Name	Dimension	Data Type	Units	Description
SCALE_HEIGHT	[1]	float	km	scale height (CO_2, CO, H, O, C, N, N_2)
SCALE_HEIGHT_UNC	[1]	float	km	scale height uncertainty
DENSITY	[7,N_ALT]	float	cm^3	density (CO_2, CO, H, O, C, N, N_2) on regular altitude grid (5km steps)
DENSITY_UNC	[7,N_ALT]	float	cm^3	density random uncertainty
DENSITY_SYS_UNC	[7,N_ALT]	float	cm^3	density systematic uncertainty
RADIANCE	[11,N_ALT]	float	kR	radiance for (CO_2^+ UVD, CO Cameron, H 1216, O_1304 O_1356, O_2972, C_1561 C_1657, N_1493, N_2, NO) on regular altitude grid (5km steps)
RADIANCE_UNC	[11,N_ALT]	float	kR	radiance random uncertainty
RADIANCE__SYS_UNC	[11,N_ALT]	float	%	radiance systematic uncertainty
TEMPERATURE	[1]	float	K	temperature of the bulk atmosphere from CO_2
TEMPERATURE_UNC	[1]	float	K	temperature uncertainty

Table 15: CORONA LORES HIGH ALT

Field Name	Dimension	Data Type	Units	Description
HALF_INT_DISTANCE	[6]	float	km	half-intensity distance for 6 species (H, O_1304, O_1356, C_1561, C_1657, N)
HALF_INT_DISTANCE_UNC	[6]	float	km	half-intensity distance uncertainty for 6 species (H, O_1304, O_1356, C_1561, C_1657, N)
DENSITY	[4,N_INT]	float	cm^3	density for 4 species (H, O, C, N)
DENSITY_UNC	[4,N_INT]	float	cm^3	density random uncertainty
DENSITY_SYS_UNC	[6,N_INT]	float	cm^3	density systematic uncertainty
RADIANCE	[6,N_INT]	float	kR	radiance for 6 features (H, O_1304, O_1356, C_1561, C_1657, N) at native altitude grid of observation

RADIANCE_UNC	[6,N_INT]	float	kR	radiance random uncertainty
RADIANCE_SYS_UNC	[6,N_INT]	float	%	radiance systematic uncertainty

Table 16: APOAPSE DISK

Field Name	**Dimension**	**Data Type**	**Units**	**Description**
SOLAR_ZENITH_ANGLE_BACKPLANE	[90,45]	float	deg	solar zenith angle as a 360x180deg cylindrical map binned 4x4deg
LOCAL_TIME_BACKPLANE	[90,45]	float	hours	local time as a 360x180deg cylindrical map binned 4x4deg
OZONE_DEPTH	[90,45]	float	cm^{-2}	ozone column as a 360x180deg cylindrical map binned 4x4deg
OZONE_DEPTH_UNC	[90,45]	float	cm^{-2}	ozone column uncertainty
ALBEDO	[90,45]	float	n/a	surface albedo as a 360x180deg cylindrical map binned 4x4deg
ALBEDO_UNC	[90,45]	float	n/a	surface albedo uncertainty
AURORAL_INDEX	[90,45]	byte	n/a	auroral activity index as a 360x180deg cylindrical map binned 4x4deg
DUST_DEPTH	[90,45]	float	n/a	dust/cloud optical depth as a 360x180deg cylindrical map binned 4x4deg
DUST_DEPTH_UNC	[90,45]	float	n/a	dust/cloud optical depth uncertainty
RADIANCE_*	[90,45]	float	kR	radiances for 4 species (H, O_1304, CO, NO) as a 360x180deg cylindrical map binned 4x4deg
RADIANCE_*_UNC	[90,45]	float	kR	radiance random uncertainty
RADIANCE_SYS_UNC	[90,45]	float	%	radiance systematic uncertainty

6.2 PDS Labels

PDS labels are ASCII text files written, in the eXtensible Markup Language (XML). All product labels are detached from the digital files (if any) containing the data objects they describe (except Product_Bundle). There is one label for every product. Each product, however, may contain one or more data objects. The data objects of a given product may all reside in a single file, or they may be stored in multiple separate files. PDS4 label files must end with the file extension ".xml".

The structure of PDS label files is governed by the XML documents described in Section 6.2.1.

6.2.1 XML Documents

For the MAVEN mission PDS labels will conform to the PDS master schema based upon the 1.1.0.1 version of the PDS Information Model for structure, and the 1.1.0.1 version of the PDS schematron for content. By use of an XML editor these documents may be used to validate the structure and content of the product labels.

The PDS master schema and schematron documents are produced, managed, and supplied to MAVEN by the PDS. In addition to these documents, the MAVEN mission has produced additional XML documents which govern the products in this archive. These documents contain attribute and parameter definitions specific to the MAVEN mission. A full list of XML documents associated with this archive is provided in **Error! Reference source not found.**. A list of the XML documents associated with this archive is included in this document in the XML_Schema collection section for each bundle.

Examples of PDS labels required for the IUVS archive are shown in Appendix C (bundle products), Appendix D (collection products), and Appendix E (basic products).

6.3 Delivery Package

Data transfers, whether from data providers to PDS or from PDS to data users or to the deep archive, are accomplished using delivery packages. Delivery packages include the following required elements:

1. The package which consists of a compressed bundle of the products being transferred.
2. A transfer manifest which maps each product's LIDVID to the physical location of the product label in the package after uncompression.
3. A checksum manifest which lists the MD5 checksum of each file included in the package after uncompression.

IUVS archive delivery packages (including the transfer and checksum manifests) for delivery to PDS are produced at the MAVEN SDC.

6.3.1 The Package

The directory structure used in for the delivery package is described in the Appendix in Section F.1. Delivery packages are compressed using tar/gzip and are transferred electronically using the ssh protocol.

6.3.2 Transfer Manifest

The "transfer manifest" is a file provided with each transfer to, from, or within PDS. The transfer manifest is external to the delivery package. It contains an entry for each label file in the package, and maps the product LIDVID to the file specification name for the associated product's label file. Details of the structure of the transfer manifest are provided in Section F.2.

The transfer manifest is external to the delivery package, and is not an archive product. As a result, it does not require a PDS label.

6.3.3 Checksum Manifest

The checksum manifest contains an MD5 checksum for every file included as part of the delivery package. This includes both the PDS product labels and the files containing the digital objects which they describe. The format used for a checksum manifest is the standard output generated by the md5deep utility. Details of the structure of the checksum manifest are provided in section F.3.

The checksum manifest is external to the delivery package, and is not an archive product. As a result, it does not require a PDS label.

Appendix A Support staff and cognizant persons

Table 13: Archive support staff

IUVS team			
Name	**Address**	**Phone**	**Email**
Dr. Justin Deighan IUVS Archivist	Laboratory for Atmospheric and Space Physics Space Science Building (SPSC) University of Colorado 3665 Discovery Drive Boulder, Colorado 80303 USA	+001 303 735 0542	justin.deighan@lasp.colorado.edu
Mr. Chris Jeppesen Data Systems Engineer	Laboratory for Atmospheric and Space Physics Space Science Building (SPSC) University of Colorado 3665 Discovery Drive Boulder, Colorado 80303 USA	+001 303 492 2469	chris.jeppesen@lasp.colorado.edu

UCLA			
Name	**Address**	**Phone**	**Email**
Dr. Reta Beebe Atmospheres Node Manager	Dept. of Astronomy, MSC 4500 New Mexico State University P.O. Box 30001 Las Cruces, NM USA	+1 575 646 1938	rbeebe@nmsu.edu
Mr. Lyle Huber Atmospheres Node Archive Manager	Dept. of Astronomy, MSC 4500 New Mexico State University P.O. Box 30001 Las Cruces, NM USA	+1 575 646 1862	lhuber@nmsu.edu

Appendix B Naming conventions for MAVEN science data files

This section describes the naming convention used for science data files for the MAVEN mission.

Raw (MAVEN Level 0):

mvn_<inst>_<grouping>_l0_< yyyy><mm><dd>_v<xx>.dat

Level 1, 2, 3+:

mvn_<inst>_<level>_<descriptor>_<yyyy><mm><dd>T<hh><mm><ss>_v<xx>_r<yy>.<ext>

Code	**Description**
<inst>	3-letter instrument ID
<grouping>	Three-letter code: options are all, svy, and arc for all data, survey data, and archive data respectively. Primarily for PF to divide their survey and archive data at Level 0.
<yyyy>	4-digit year
<mm>	2-digit month, *e.g.* 01, 12
<dd>	2-digit day of month, *e.g.* 02, 31
<hh>	2-digit hour, separated from the date by T. OPTIONAL.
<mm>	2-digit minute. OPTIONAL.
<ss>	2-digit second. OPTIONAL.
v<xx>	2-digit data version: is this a new version of a previous file, though the same software version was used for both? (Likely to be used in the case of retransmits to fill in data gaps)
r<yy>	2-digit software version: which version of the software was used to create this data product?
<descriptor>	A description of the data. Defined by the creator of the dataset. There are no underscores in the value.
.<ext>	File type extension: .fits, .txt, .cdf, .png
<level>	A code indicating the MAVEN processing level of the data (valid values: l1, l2, l3)

Instrument name	**<instrument>**
IUVS	iuv
NGIMS	ngi
LPW	lpw
MAG	mag
SEP	sep
SWIA	swi
SWEA	swe
STATIC	sta
PF package	pfp

Appendix C Sample Bundle Product Label

This section provides a sample bundle product label.

Appendix D Sample Collection Product Label

This section provides a sample collection product label.

Appendix E Sample Data Product Labels

This section provides sample product labels for the various data types described in this document. The large sizes of IUVS XML label files make them inappropriate to reproduce here. Instead, the following external sample file is available for examination:

mvn_kp_iuvs_20141018T204300.xml

Appendix F PDS Delivery Package Manifest File Record Structures

The delivery package includes two manifest files: a transfer manifest, and MD5 checksum manifest. When delivered as part of a data delivery, these two files are not PDS archive products, and do not require PDS labels files. The format of each of these files is described below.

F.1 Transfer Package Directory Structure

The delivery structure follows a temporal scheme, with the top level being designated by year of data collection, and the second level within that by numerical month (e.g. January = 01).

F.2 Transfer Manifest Record Structure

The transfer manifest is defined as a two field fixed-width table where each row of the table describes one of the products in the package. The first field defines the LIDVID of each product in the package. The second field defines the file specification name of the corresponding product label in the package. The file specification name defines the name and location of the product relative to the location of the bundle product.

F.3 Checksum Manifest Record Structure

The checksum manifest consists of two fields: a 32 character hexadecimal (using lowercase letters) MD5, and a file specification from the root directory of the unzipped delivery package to every file included in the package. The file specification uses forward slashes ("/") as path delimiters. The two fields are separated by two spaces. Manifest records may be of variable length. This is the standard output format for a variety of MD5 checksum tools (*e.g*. md5deep, etc.).