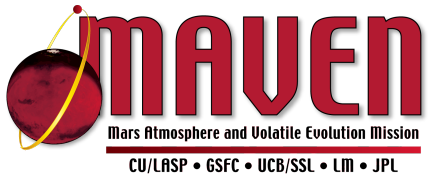

MAVEN
Mars Atmosphere and Volatile EvolutioN (MAVEN) Mission
Science Data Management
MAVEN Science Community Workshop
Dec 02, 2011
David L. Mitchell

Instrument Teams



Package	Instrument	ITF Location
Remote Sensing (RS)	Imaging Ultraviolet Spectrograph (IUVS)	University of Colorado (CU) / Laboratory for Atmospheric & Space Physics (LASP)
NGIMS	Neutral Gas and Ion Mass Spectrometer (NGIMS)	Goddard Space Flight Center (GSFC) Planetary Environment Laboratory
Particles and Fields Package (PF)	Solar Wind Electron Analyzer (SWEA)	University of California/Berkeley Space Science Laboratory (SSL)
	Solar Wind Ion Analyzer (SWIA)	
	Suprathermal and Thermal Ion Composition (STATIC)	
	Solar Energetic Particle (SEP)	
	Langmuir Probe and Waves (LPW) and EUV	University of Colorado (CU) / Laboratory for Atmospheric & Space Physics (LASP)
	Magnetometer (MAG)	Goddard Space Flight Center (GSFC) Planetary Magnetospheres Laboratory
N/A	Accelerometer Science (ACC)	Jet Propulsion Lab (JPL)

Data Level Definitions

- **Level 0:** binary packet files
  - Generated by SOC, archived with PDS
- **Quicklook:** science data products generated with predict kernels and simplified algorithms. (ITFs only, not DPF)
  - Generated by SDC using ITF software, not archived with PDS

Levels 1-3 generated by ITF's and DPF, and archived with PDS:

- **Level 1:** Extracted telemetry items/channels, no calibrations or corrections applied. (MAG, NGIMS, IUVS, ACC)
- **Level 2:** Research-grade instrument-level scientific data products in physical units. (All ITFs and DPF)
- **Level 3:** Science products derived from data of one or more instruments that have been resampled spatially or temporally to produce a merged data set. (NGIMS, IUVS, ACC)

Key Parameters

1. Key parameters are a subset of the full data

2. Key parameters are generated in a “pipeline” fashion, without the need for interactive processing by the instrument teams (apart from routine validation)

3. Key parameters can make use of approximations and assumptions to satisfy Rule 2.
   - Quality flags are provided as needed

4. Key parameters are in ASCII format

5. Key parameters are full-fledged MAVEN L2 data products

6. Key parameters are archived and delivered to the PDS

Data Product Formats

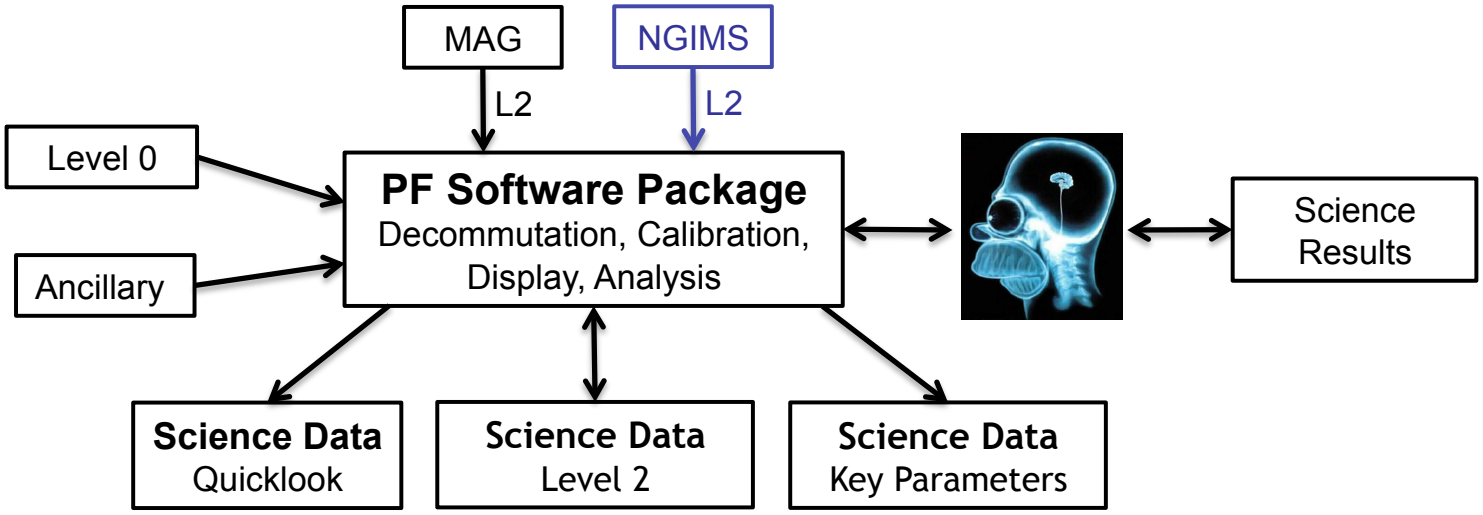
	Description	Format
Level 1	MAG, NGIMS L1	ASCII
Level 1B	IUVS L1B apoapsis images, periapsis limb scans, coronal scans, stellar occultations	FITS
Level 2	IUVS L2 apoapsis images, periapsis limb scans, coronal scans, stellar occultations	CDF
	NGIMS L2 derived data record	ASCII
	PF STATIC, SWIA, SWEA, SEP L2	CDF
	LPW L2	
	LPW-EUV L2	
	MAG L2	ASCII
	Key Parameters (all instruments)	ASCII
Level 3	IUVS L3	CDF
	NGIMS L3 resampled data record	ASCII

Data Access

Where do I get the data?

- PDS will host all data for the Science Community
- PF data will go to Planetary Plasma Interactions Node (PPI) at UCLA
  - PPI is the lead node for MAVEN
  - Ray Walker is the node manager
- NGIMS and IUVS data will go to Atmospheres Node at NMSU
- Ancillary data and SPICE kernels will go to NAIF node
  - As permitted by ITAR restrictions

PF Software Tools



Level 0:
- CCSDS packets separated by instrument
- One file per UT day (SCET) per instrument

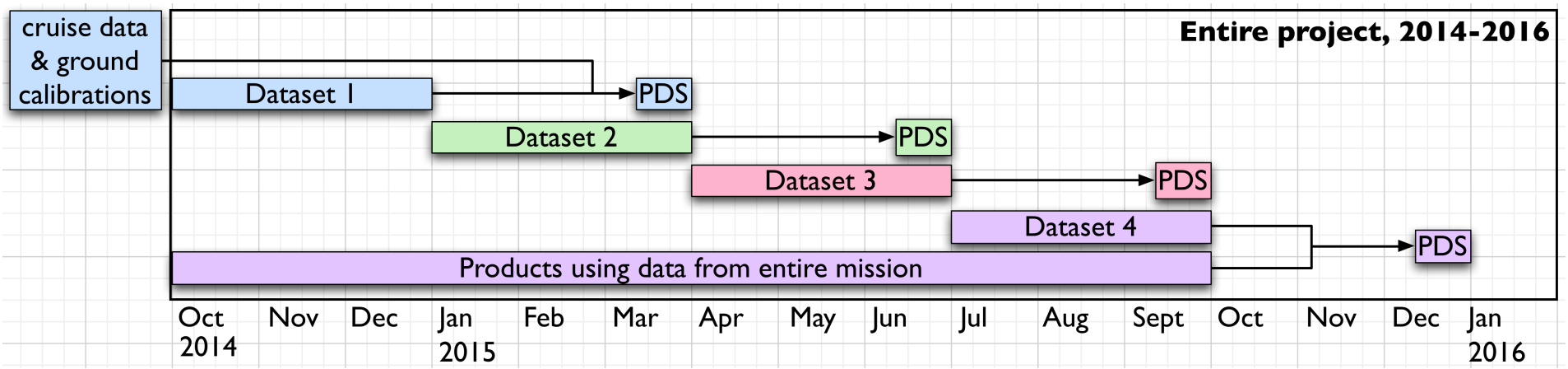
Quicklook:
- Produced by the SDC
- Data in instrumental units, both CDF and ASCII
- Assess instruments and Mars environment
- Identify periods of interest for Archive selection
- Early analysis by entire MAVEN science team

Level 2:
- Complete data (PDS-compliant CDF format)
- Key Parameters (ASCII table)
- Research grade, fully calibrated, validated
- Principal data product for science analysis

PF Software package:
- Written in IDL (MAG team also uses Fortran)
- Developed for >20 years & numerous missions (e.g., WIND, MGS, THEMIS)
- Available to the MAVEN team throughout the mission (mirrored at the SOC)
- Available to outside scientists when the first Level 2 and Key Parameter data are released

PDS Delivery Schedule

Delivery	Coverage	Contents
April 2015	Oct 2014 – Dec 2014	Cruise data, cal data, 3 months' L1-3.
July 2015	Jan 2015 – Mar 2015	3 months' L1-3 data
October 2015	Apr 2015 – Jun 2015	3 months' L1-3 data
January 2016	Jul 2015 – Oct 2015	All mission data including L3s that require entire mission dataset



Backup Slides

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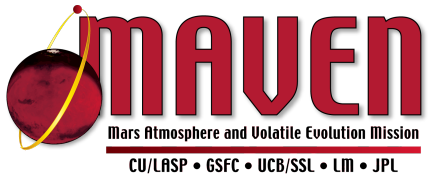
Details of Key Parameters Follows

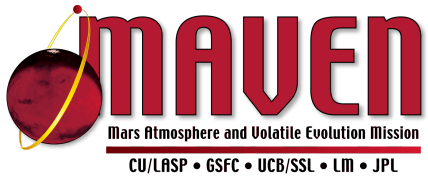
PF Science Data Products (1)



All produced within the PF Software Package, except as noted in RED.

PF Data Products		
Instrument	**Data Level**	**Description**
STATIC	QL	Ion energy/angle/mass distributions Ion energy/angle distributions Ion energy/mass distributions
	2	Same as QL, except fully calibrated and validated
SWIA	QL	Ion energy/angle distributions Ion energy spectra (integrated over angle) Proton moments (n, V, P, Q)
	2	Same as QL, except fully calibrated and validated Ground moments (calculated from energy/angle distributions with full corrections)
SWEA	QL	Electron energy/angle distributions Electron pitch angle distributions for selected energies Electron energy spectra (partial densities)
	2	Same as QL, except fully calibrated and validated Ground pitch angle distributions (calculated from energy/angle distributions with full corrections)

PF Science Data Products (2)



All produced within the PF Software Package, except as noted in RED.

PF Data Products		
Instrument	**Data Level**	**Description**
SEP	QL	Energetic electron energy spectra for each of four look directions Energetic ion energy spectra for each of four look directions
	2	Same as L1, except fully calibrated and validated
MAG	QL	Magnetic field vectors in payload coordinates with nominal calibrations (produced by SDC)
	1	Same as QL (produced by MAG Team)
	2	Magnetic field vectors in body-fixed geographic and MSO coordinates, fully calibrated and validated
LPW	QL	n, T from fits, Power spectra, Electric field
	2	Same as L1, except fully calibrated and validated
LPW-EUV	QL	Currents from each diode at instrument time resolution
	2	Irradiances in diode bandpasses at instrument time resolution
	3	Modeled full solar EUV spectrum, minute, orbit, and daily averages (produced by EUV team at LASP)

In Situ Key Parameters (< 500 km)

- LPW
  - Thermal electron density and temperature
  - Electric field wave power (0.5-3 Hz, 2-130 Hz, 130-500 Hz)
  - Spacecraft potential
- LPW-EUV
  - EUV irradiance (0.1-7 nm, 17-22 nm, Ly-α)

4-sec cadence

- SWEA
  - Suprathermal electron energy spectrum shape parameter
  - Electron reflection coefficient at 100 and 300 eV
- STATIC
  - H^+, O^+, and O_2^+ density, temperature, and bulk flow velocity
- MAG
  - Magnetic field vectors in MSO and GEO coordinates
  - Magnetic field RMS

In Situ Key Parameters (< 500 km)

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- SEP
  - Ion flux (0.030 – 1 MeV and 1 – 6 MeV) in 4 look directions
  - Electron flux (30 – 300 keV) in 4 look directions
  - Look directions in MSO coordinates
- NGIMS
  - He, N, O, CO, N2, NO, O_2, Ar, CO_2 density
  - O_2^+, CO_2^+, NO^+, O^+, CO^+, C^+, N_2^+, OH^+, N^+ density

4-sec cadence

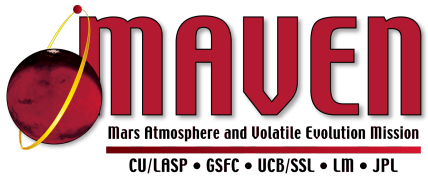
- Ephemeris
  - MSO and GEO coordinates of spacecraft
  - GEO longitude and latitude of spacecraft
  - Solar zenith angle, local time, altitude of spacecraft
  - Spacecraft attitude in MSO and GEO coordinates
  - APP attitude in MSO and GEO coordinates
  - Mars season (Ls)
  - MSO and GEO coordinates of IUVS limb scans & occultations
  - Orbit number

In Situ Key Parameters (> 500 km)

- LPW
  - Electric field wave power (0.5-3 Hz, 2-130 Hz, 130-500 Hz)
  - Spacecraft potential
- LPW-EUV
  - EUV irradiance (0.1-7 nm, 17-22 nm, Ly-α)
- SWEA
  - Solar wind electron density and temperature
  - Suprathermal electron energy spectrum shape parameter
  - Electron reflection coefficient at 100 and 300 eV
- SWIA
  - H+ density, temperature and bulk flow velocity
  - Solar wind dynamic pressure

8-sec cadence

In Situ Key Parameters (> 500 km)



- STATIC
  - H^+, He++ omni-directional flux
  - H+, He++ characteristic energy, direction, angular width
  - Pickup ion omni-directional flux
  - Pickup ion characteristic energy, direction, angular width
- MAG
  - Magnetic field vectors in MSO and GEO coordinates
  - Magnetic field RMS
- SEP
  - Ion flux (0.030 – 1 MeV and 1 – 6 MeV) in 4 look directions
  - Electron flux (30 – 300 keV) in 4 look directions
  - Look directions in MSO coordinates
- Ephemeris
  - Same as low-altitude ephemeris parameters

8-sec cadence

Proposed IUVS Key Parameters

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Periapsis Limb Scans:

- Two data products will be provided as KP's:

- 1) Emission profiles can be characterized as fitted top-side scale heights from the measured emission variation with altitude, along with the altitude and brightness of the peak emission. These values can be provided within ~ 1 week using predicts for location and pointing (these are IUVS level 1b data). We can deliver measured values for the above at the beginning, middle, and end of each periapsis passage.

- 2) Density values can be derived for the main species after some analysis and modeling, expected ~ 2 months after data are obtained (these are IUVS level 2 data). These values will be delivered as density vs altitude.

Each of these sets of KP's will require added information about the effective location where the measurements apply, typically the minimum altitude along the line of sight of IUVS.

Proposed IUVS Key Parameters

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Periapsis Limb Scans:

- The emissions that will be observed are broken down into two categories, optically thin and thick along the line of sight:

- a) Optically thin emissions/species:

- O from 1356 Å CO from 1316 Å and 1151 Å
- CO_2 and CO_2^+ from a combination of the CO_2^+ UVD and FDB bands
- N from 1200 Å N_2 2700 Å complex
- (And maybe C from the 1261 Å and 1279 Å complexes)

- b) Optically thick emissions:

- H from Ly alpha (1216 Å) O from 1304 Å triplet
- C from 1561 and 1657 Å lines

Proposed IUVS Key Parameters

Coronal Scans: Derive the half-intensity distance for various emissions listed below from observations of emission intensity vs altitude:

7 atomic: H (1215.67), D (1215.33), O (1304, 1356), C (1561, 1657), N (1200)

- Also specify the location for each observation (parameters TBD).

Stellar Occultations: Provide densities vs altitude for the main species and the location for which those densities apply (the minimum altitude along LOS).

- Species to be included: CO2, O2, O3, dust/aerosols
- Note that the occultations will be in campaigns, thus there will be a burst of data followed by weeks of no new results.

Apoapsis Data: The apoapsis images of various emissions do not map easily into key parameters. The images will be provided to the science team as summary plots, and folded into the visualization software. We plan to add in the future "auroral activity", "ozone depth", and "NO emission" indices or images as we gain experience with the images and their reduction.