

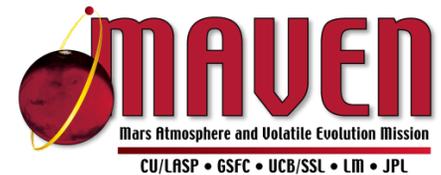
ACCEL

Presented by R. Zurek
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Accelerometer Science (ACCEL)

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Inertial Measurement Units (IMU)
[Accelerometers]

Measurement Objectives:

- Measurements: spacecraft accelerometer and orientation data
- Data Products: Vertical profiles of atmospheric density and temperature; possible wind profiles

Technical Details:

-Density derived from acceleration data a_d

$$\rho = \frac{2ma_d}{C_d S v^2} \quad m, S, v, \text{ \& } C_d = \text{spacecraft mass, X-section, velocity, \& drag coefficient}$$

-Temperature derived hydrostatically

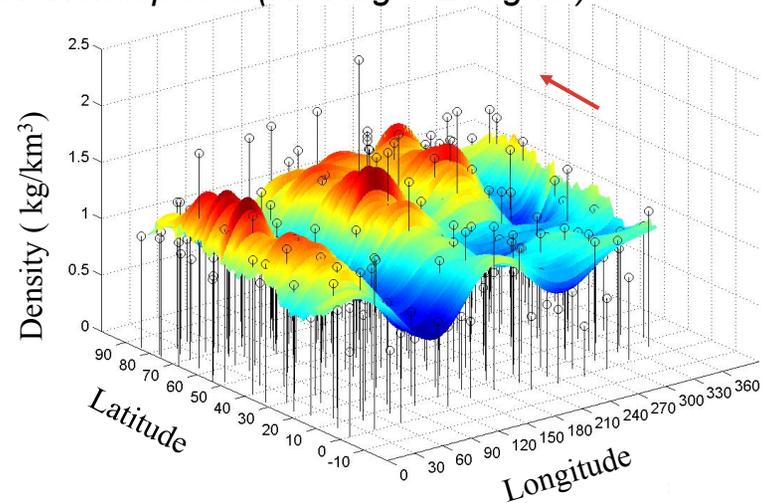
$$T = \frac{(m_a)(g)(H)}{R} \quad \text{Ideal Gas Law}$$

-Winds derived from NAV and ACS data

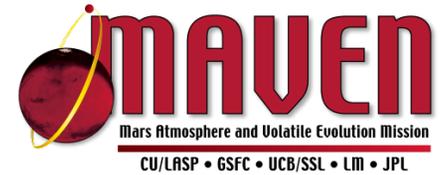
$$V_{flow} = V_{orbital} + V_{wind}$$



Atmospheric Structure: *Odyssey saw large amplitude waves during early morning in the N. Hemisphere (Keating & Bougher)*



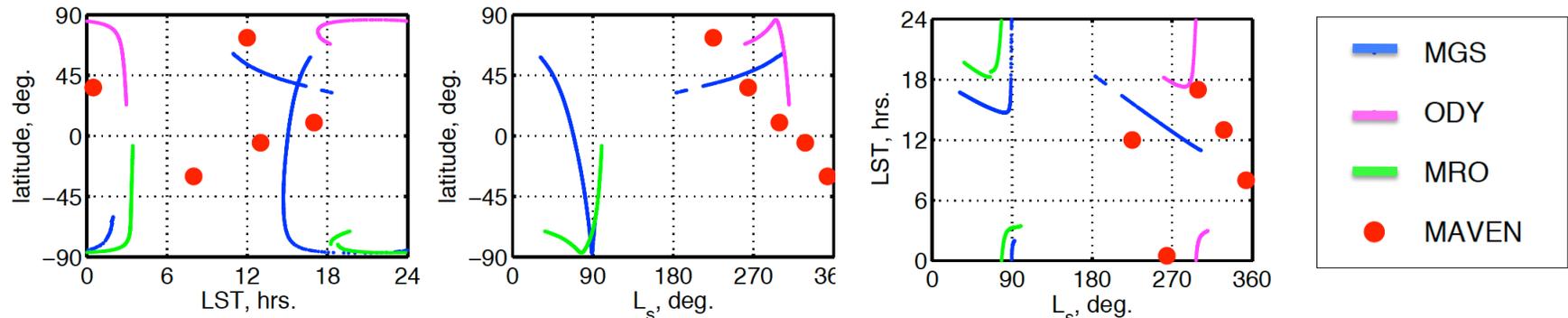
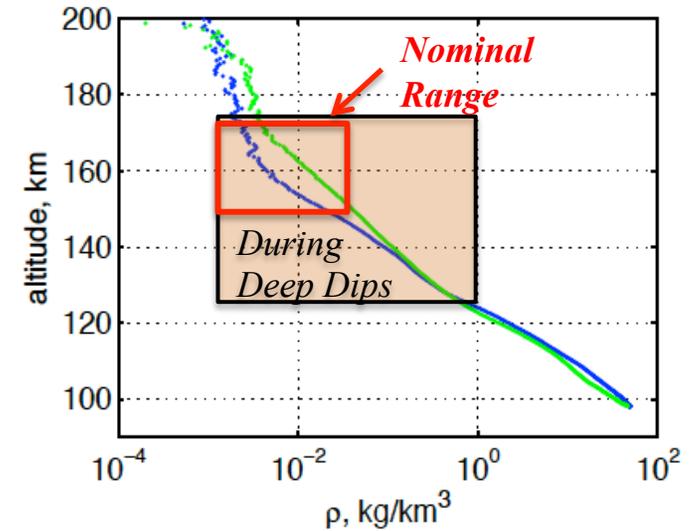
Accelerometer (ACCEL) Science



ACCEL team will:

- Utilize measurements by the MAVEN spacecraft accelerometers to determine upper atmospheric structure during the MAVEN mission
- Derive atmospheric density and temperature profiles across a range of latitudes, longitudes and local times:
 - 5 Prime Mission Deep Dips (from ~170 km down to ~125 km)
 - Nominal orbit periapsis corridor (~170 to ~150 km)
- Investigate the ability to derive winds from perturbations to spacecraft orientation

MRO Profile from Aerobraking Orbit



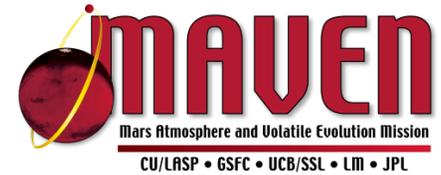
These diagrams show how the MAVEN Deep Dip profiles (red dots) of density and temperature derived from accelerometer data will complement the local solar time, seasonal (areocentric longitude L_s) and latitude coverage in the 170 to 125 km altitude range previously sampled by Mars Global Surveyor, Mars Odyssey and Mars Reconnaissance Orbiter during their aerobraking phases.

Science Activities



- **Produce quick-look and final products of atmospheric profiles of density and temperature as derived from Accelerometer data**
- **Science Analysis**
 - Improve our understanding of upper atmospheric structure and processes by extending previous Accelerometer datasets obtained by MGS, ODY, MRO for science analysis
 - Investigate derivation of atmospheric winds
 - See next slide
- **Support MAVEN operations during the Deep Dips (DD)**
 - Check on PTE performance and atmospheric behavior with daily analyses
 - Highly valuable for first Deep Dip campaign
- **Support MAVEN Science Analyses**
 - Perform DD calibration of NGIMS (after the fact) to assist with data analysis that uses several datasets (IUVS, NGIMS, ACCEL) making use of best telemetry
 - Calibration to complement what is already planned using IUVS.
- **Improve engineering data bases and scientific models**
 - MarsGRAM, etc.
 - Compare results with models for validation, especially MTGCM

Science Focus



- **Specific Science Phenomena and Coverage Goals**

- Latitudinal variations of densities and temperatures as a function of season and local time
- Inter-annual variations by comparison to previous data sets
- Solar driven variations (e.g. thermospheric temperature responses to solar flux variations over the solar cycle and solar rotation) by comparison to model simulations with MAVEN inputs
- Upper atmospheric response to lower atmosphere activity (e.g., dust storms) by correlation with ODY and MRO observations for
- *Illustrative References:*
 - *Keating et al., The structure of the upper atmosphere of Mars: In situ measurements from Mars Global Surveyor, **Science**, 279, 1672-1676, 1998.*
 - *Bougher et al., Mars Global Surveyor aerobraking: Atmospheric trends and model interpretation, **Adv. In Space Res.**, 23, (11), 1887-1897, 1999.*
 - *Tolson et al., Application of accelerometer data to mars odyssey aerobraking and atmospheric modeling, **J. Spacecraft & Rockets**; 42 (3):435-443, 2005.*