CHARACTERIZATION OF THE MARTIAN THERMOSPHERE USING MAVEN ACCELEROMETER AND REACTION WHEEL DATASETS: EARLY MISSION RESULTS. R. W. Zurek[1], R. H. Tolson[2], S. W. Bougher[3], D. Baird[4], D. Kass[1], M. Smith[5], B. Cantor[6], S. Demcak[1], [1]Jet Propulsion Laboratory, Pasadena, CA 91109 (rzurek@lpl.nasa.gov); [2]National Institute of Aerospace, Hampton, VA, 23666; [3]AOSS Department, University of Michigan, Ann Arbor, MI 48189 (bougher@umich.edu); [4]NASA Johnson Spaceflight Center, Houston, TX, 77058; [5]NASA Goddard Space Flight Center, Greenbelt, MD 20771; [6]Malin Space Science Systems, San Diego, CA 92191.

Introduction: The Mars thermosphere-ionosphere-exosphere (TIE) system constitutes the atmospheric reservoir (i.e. available cold and hot planetary neutral and thermal ion species) that regulates present day escape processes from the planet [1]. Without knowledge of the physics and chemistry creating this TIE region and driving its variations (e.g., solar cycle, seasonal, diurnal), it is not possible to constrain either the short-term or long-term histories of atmosphere escape. Thus, characterization of this upper atmosphere reservoir is one of the major science objectives of the MAVEN mission [2].

The structure of the upper atmosphere of Mars (above ~100 km) has been probed in-situ mainly using spacecraft accelerometers during the aerobraking phases of 3 previous Mars orbiters [3]. In a similar manner, the MAVEN Accelerometer Experiment (ACC) uses atmospheric drag accelerations sensed by inertial measurement units (IMU) onboard the spacecraft to recover atmospheric density along the orbiter path and below ~ 160 km. These densities are employed to estimate hydrostatic 'vertical' density and temperature profiles, along track and altitudinal density waves, and latitudinal and longitudinal density variations. In addition, mass densities can be derived utilizing spacecraft reaction wheel (RW) datasets (plus the subtraction of all other non-atmospheric torques). This novel technique enables mass densities to be retrieved below ~200 km, from which scale heights and temperatures can also be inferred.

We investigate both initial RW derived mass densities/temperatures over the first ~300 orbits (mostly dayside sampling prior to 17-DEC-2014) and later orbits (when periapsis occurs on the nightside at Northern mid-to-high latitudes). In addition, first results from the first Deep Dip campaign (10-17 February 2015) are presented making use of IMU derived mass densities/temperatures as periapsis altitudes are lowered to ~125 km on the nightside. Trends (e.g. latitude, local time, diurnal) of extracted densities and inferred temperatures are examined and compared with previous aerobraking measurements of comparable seasonal sampling (e.g. nightside Odyssey) [4].

MAVEN ACC/RW Results: Results to date indicate:

(a) Profiles from many aeropasses can be retrieved from the RW data., many as high as 200 km. As expected, there is a significant change of scale height with altitude.
(b) No winter warming comparable to that viewed by Odyssey appears to have been sampled.
(c) The large density variability at high latitude is is consistent with earlier aerobraking missions. While that variability reflects the time and spatial variability of the polar vortex, it does not have a robust correlation to particular lower atmosphere wave structure as seen by MRO.
(d) Some effects of lower atmosphere regional dust storms have been detected, even though the MAVEN periapsis has been close to its northernmost excursion while the dust hazes are most prominent in the southern hemisphere.
(e) The environment experienced during the first Deep Dip will be contrasted with the nominal periapsis altitudes higher in the thermosphere.

References:

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