# ATMOSPHERIC PROPERTIES RECONSTRUCTION FROM THE MARS SCIENCE LABORATORY ENTRY, DESCENT AND LANDING.

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**Introduction:** The Mars Science Laboratory (MSL) landed on August 5, 2012 at 10:32 pm (PDT) in Gale Crater on Mars (4.5°S, 137.4°E) [1]. Data acquired during MSL's Entry, Descent and Landing procedure were used to reconstruct the atmospheric profiles for density, pressure and temperature. Although the results present only a snapshot of the regional atmospheric conditions at the time of entry, descent and landing of MSL, they have excellent vertical resolution and vertical extent, thereby complementing orbital observations.

We will present an overview of our atmospheric reconstruction process, the derived atmospheric profiles, and preliminary scientific interpretation of the atmospheric results.

**Methodology:** The MSL entry vehicle measured accelerations and angular velocity at a rate of 200 Hz during its descent through the Martian atmosphere using accelerometers and gyroscopes in an inertial measurement unit (IMU). These 200 Hz data determine aerodynamic accelerations up to approximately 80 km altitude. We have applied smoothing techniques previously developed for the NASA Phoenix Mars mission [2] to these acceleration data. This has allowed us to extend the reconstruction to above 120 km altitude.

Smoothed accelerations were used in conjunction with the vehicle's aerodynamic database to reconstruct atmospheric properties. The density profile was estimated using axial accelerations in the drag force equation. Corresponding pressure and temperature profiles were calculated using the hydrostatic equilibrium and ideal gas law, respectively.

In contrast to previous missions, MSL used a guided entry that resulted in periods of near-horizontal flight at approximately 20 km altitude [3], during which pressure could not be determined from hydrostatic equilibrium. Instead, atmospheric pressures at low altitudes were determined independently by the Mars Entry Atmospheric Data System (MEADS) [4]. These were used in conjunction with accelerometer-derived densities to extend the atmospheric temperature profile through the period of near-horizontal flight.

**References:** [1] "Curiosity's Landing Site: Gale Crater" from JPL's MSL site: http://mars.jpl.nasa.gov/msl/mission/timeline/prelaunch/landingsiteselection/aboutgalecrater/ [2] Withers, P. (2013) *Planet. & Space Sci.*, *79-80*, 52-55, [3] Dutta, S. *et al.* (2013) *23rd AAS/AIAA Space Flight Mechanics Meeting,* AAS 13-309, [4] Schoenenberger, M. *et al.* (2013) *23rd AAS/AIAA Space Flight Mechanics Meeting,* AAS 13-306