MARS SCIENCE LABORATORY: FIRST 100 SOLS MONITORING THE ATMOSPHERE AND ENVIRONMENT WITHIN GALE CRATER.

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Introduction: The Mars Science Laboratory rover, *Curiosity*, landed within 155-km Gale Crater on August 5th. It is designed to conduct an investigation of modern and ancient habitable environments [1], primarily as recorded in the geology and geochemistry of the crater's floor and interior mound of layered sediments. The mission at Gale Crater also places a number of highly capable atmospheric and environmental sensors within a unique equatorial setting 4.5 km below the Mars areoid and between the crater rim and a 5-km high mountain.

The MSL scientific payload [1] includes a quadrupole mass spectrometer and tunable laser spectrometer that measures chemical and isotopic composition, including high-accuracy measurements of CO_2, CH_4, and H_2O from samples of atmosphere or gas evolved from solid samples (SAM QMS and TLS); a meteorology suite with sensors dedicated to pressure, wind, air and ground temperature, humidity, and ultraviolet radiation (REMS); a detector for measuring charged and neutral particles over a broad energy range (RAD); an active and passive neutron spectrometer capable of sensing subsurface water to 0.5 m (DAN); and science and engineering cameras that observe the distribution and dynamics of winds, dust, and water in the atmosphere and aeolian processes at the surface (MARDI, Mastcam, Hazcam, Navcam, MAHLI, ChemCam-RMI). The rover system was designed to allow the radiation and meteorology experiments to acquire data at regular intervals over all local times. The mission lifetime was chosen in part to observe the climatology over a full Mars year.

Together these capabilities will address present-day meteorology at a variety of scales; climatology and cycles of CO_2, water, and dust; and atmospheric chemistry and radiation relevant for studies of habitability and planetary evolution. Grotzinger et al. [2] present a summary of mission results related to geology and geochemistry.

Atmospheric Composition: Three searches for atmospheric methane using absorption bands near 3.27-μm were undertaken with SAM-TLS on sols 79, 81, and 106, with no definitive detection. The TLS also measured the isotopic ratios of D/H and $^{18}O/^{16}O$ in water, and $^{13}C/^{12}C$, $^{18}O/^{16}O$, $^{17}O/^{16}O$ and $^{13}C^{18}O/^{12}C^{16}O$ in carbon dioxide, all using absorption bands near 2.78 μm. SAM-QMS contributed measurements of $^{40}Ar/^{36}Ar$, $^{15}N/^{14}N$, and $\delta^{13}C$ in CO_2, with additional species forthcoming. Results support models of massive atmospheric loss over Mars' history. Significant differences were found in the abundances and isotopic ratios of Ar and N_2 relative to Viking, potentially involving seasonal variability.

Meteorology: Surface pressure records contain signatures of convective vortices, thermal tides, and seasonal variations of atmospheric mass. Thermal tides are significantly larger in amplitude than observed at the Viking sites, and contain higher-order structure potentially related to the topographic setting. Pressure dips ~20s in duration have shapes and local time distributions that mimic those of dust devils seen by other missions, suggesting convective vortices, yet dust lifting is not definitively observed so far. REMS ground temperatures are useful for determinations of surface thermophysical properties. Relative humidity results are being validated but show large variability over each sol. Wind retrievals are viable but delayed by development of new algorithms to account for damage to a subset of the sensors. Models suggest that regional circulations related to the crater and mound topography may dominate the dynamics through forcing of slope winds and supression of the planetary boundary layer [3]. The sensitivity and simultaneous 1-Hz sampling of the various sensors show a rich variety of phenomena related to insolation, dynamics, sensible heat transfer, and rover thermal contamination/shadowing, often seen in multiple sensors.

Energetic Particle Environment: RAD detects primary particles from galactic cosmic rays and solar particle events, as well as secondaries created by the interaction of these particles with the atmosphere and surface, and by spacecraft materials during the cruise to Mars. RAD operated for 220 days during the journey to Mars, providing dose rates and dose equivalent rates relevant for future crewed missions. Since sol 13 of the surface mission, RAD has operated nearly continuously, finding dose equivalent rates less than half of that above the atmosphere, and showing variation with atmospheric pressure. Five solar events were observed in cruise, but none yet on the surface.

Subsurface Hydrogen: DAN has been used regularly over the firts 100 sols in its active, neutron pulsing mode (58 observations), and in its passive, detector-only mode (113 observations). One of its two detectors is shielded from thermal neutrons, allowing a separation of thermally moderated (by hydrogen) neutrons from epithermal neutrons. Both active and passive measurements show variable abundance of subsurface hydrogen over the traversed region, but restricted to overall low values of inferred water (0.5-2.5% wt). Active measurements suggest that the upper few 10s of cm of the subsurface is drier than that below. Chlorine (and Fe to a lesser extent) in the subsurface absorb neutrons, complicating the water retrievals but providing additional compositional information.

Imaging: Following methods developed for previous Mars landed missions, all 11 cameras (and six spares) on Curiosity are useful for atmospheric and environmental monitoring. The first results from the surface mission include inferences about dust lifted by the landing engines from the descent movie including-frames acquired after landing, Hazard Camera images acquired just after landing, and Mastcam images of scours excavated by the engine plumes. Mastcam multispectral solar and sky images are used to derive the opacity, vertical distribution, and photometric properties of atmospheric dust and water. Mastcam images of its calibration target provide a record of dust accumulation, while images of the ground are used to search for frost. Wide-angle Navigation Camera images are used to survey for dust devils, clouds, and suspended dust. Dust billows have been tracked in successive Navcam images to derive regional winds. Navcam, Mastcam, MAHLI, and ChemCam-RMI images of the landscape and surface materials provide constraints on the properties of surface fines and surface-atmosphere interactions, such as the presence of drifts, bedforms, and ventifacts, and their relationship to the wind field.

References: [1] Grotzinger J. P. et. al. (2012) *Space Sci Rev.*, *170*, 5-56. [2] Grotzinger J. P. et al. (2013) *LPS XXXXIV*, This Volume. [3] Tyler D. and Barnes J. R. (2013) *Mars Journal*, submitted.