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Nighttime Infrared radiative cooling and opacity inferred by REMS Ground Temperature Sensor Measurements

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Due to the low density of the Martian atmosphere, the temperature of the surface is controlled primarily by solar heating, and infrared cooling to the atmosphere and space, rather than heat exchange with the atmosphere. In the absence of solar radiation the infrared (IR) cooling, and then the nighttime surface temperatures, are directly controlled by soil termal inertia and atmospheric optical thickness (τ) at infrared wavelengths. Under non-wind conditions, and assuming no processes involving latent heat changes in the surface, for a particular site where the rover stands the main parameter controlling the IR cooling will be τ. The minimal ground temperature values at a fixed position may thus be used to detect local variations in the total dust/aerosols/cloud tickness.
The Ground Temperature Sensor (GTS) and Air Temperature Sensor (ATS) in the Rover Environmental Monitoring Station (REMS) on board the Mars Science Laboratory (MSL) Curiosity rover provides hourly ground and air temperature measurements respectively. During the first 100 sols of operation of the rover, within the area of low thermal inertia, the minimal nightime ground temperatures reached values between 180 K and 190 K. For this season the expected frost point temperature is 200 K. Variations of up to 10 K have been observed associated with dust loading at Gale at the onset of the dust season.
We will use these measurements together with line-by-line radiative transfer simulations using the Full Transfer By Optimized LINe-by-line (FUTBOLIN) code [Martín-Torres and Mlynczak, 2005] to estimate the IR atmospheric opacity and then dust/cloud coverage over the rover during the course of the MSL mission. Monitoring the dust loading and IR nightime cooling evolution during the dust season will allow for a better understanding of the influence of the atmosphere on the ground temperature and provide ground truth to models and orbiter measurements.
References

Martín-Torres, F. J. and M. G. Mlynczak, Application of FUTBOLIN (FUll Transfer By Ordinary Line-by-Line) to the analysis of the solar system and extrasolar planetary atmospheres, Bulletin of the American Astronomical Society, Vol. 37, p.1566, 2005