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 thermal inertia and atmospheric optical thickness ($\tau$) 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 $\tau$. The minimal ground temperature values at a
fixed position may thus be used to detect local variations in the total dust/aerosol/cloud thickness.

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 nighttime 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 nighttime 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