Radiative Transfer and Error Analysis Methods for the MSL/REMS Ground Temperature Sensor

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Temperature sensors explore the near surface atmospheric boundary layer (ABL) over an extended region of the Martian surface. The atmospheric boundary layer plays an important role in the general circulation and the local atmospheric dynamics of Mars. In both cases, the ABL controls the coupling of the atmosphere and the surface [Zurek, et al., 1992]. This coupling is exhibited in the energy exchange between the near surface regolith and the near surface atmosphere and is driven by the solar insolation. Ground temperature sensors (GTS) on REMS (Rover Enviromental Monitoring Station)/MSL(Mars Science Laboratory) provide the data needed to study both the thermal inertia properties of the regolith and rocks beneath the MSL rover and to study the conditions for convection in the near surface ABL.

The GTS includes three thermopile detectors, with infrared bands at 8-14 μm, 14.5-15.5 μm, and 16-20 μm [Gómez-Elvira et al., 2009]. The three sensors are clustered in a single location on the MSL mast and have a common field of view on the surface of Mars allowing the three sensors to be used in combination. The 15-μm sounds the atmosphere between the sensors and the surface. With a calibrated weighting function, this sensor will measure the temperature of the atmosphere just above the surface. The 8-14-μm and 16-20 μm sensors both measure the surface temperature, but by working on both sides of the 15 -μm CO_2 band, the variation in emissivity of the surface minerals across the thermal wavelengths can be factored into the surface temperature calculations. Using the Full Transfer By Optimized LINe-by-line (FUTBOLIN) code [Martín-Torres and Mlynczak, 2005] we have developed an energy balance and radiative transfer retrieval method for the REMS GTS. With the Mars Weather Research and Forcasting (MarsWRF) model [Richardson et al., 2008], we run large eddy simulations (LES) to model ground temperatures and near surface air temperatures. Using these LES temperatures, we can test the GTS retrieval process, including an assessment of the sources of errors in the retrieval process. By using the LES temperatures as synthetic data, we assess the perfomance of the REMS GTS as well as determine, through the error analysis, the calibration data critical path in
the spectral retrieval process.