MARS STUDENT CLIMATE LANDER. D. L. Nuding.[1] Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO 80305 (danielle.nuding@colorado.edu).

Introduction: The Mars Student Climate Lander (MSCL)[1] was a study conducted at the Jet Propulsion Laboratory by a student team supported by the National Space Grant Consortia. This student designed mission will provide a low mass, low volume, self-sufficient payload with a suite of instruments capable of meeting aggressive science goals to characterize the surface of Mars. The payload was designed to piggy-back on a Mars Science Laboratory (MSL) sized rover and be dropped off on the surface after landing.

In order to fully characterize Mars, both its history and present state, we need to understand its atmosphere and global climate. Studying atmospheric science on Mars is a high priority according to the Mars Exploration Program Analysis Group (MEPAG) [2]. Past missions have taken numerous global surveys of the Martian atmosphere looking down from orbit, but only a few have looked up from the surface. Studying the near surface and boundary layer climate environments are scientifically useful for a broad range of reasons, including understanding dust and water transport, long-term climate modeling, potential habitability, and particularly future human exploration. Understanding the surface environment can directly contribute to the search for life on Mars and allow scientists to further understand what conditions to expect prior to planning manned missions.

In addition, the Martian boundary layer is responsible for the dynamics of the lower atmosphere, and surface data can significantly contribute to future Mars sample return missions. The Martian boundary layer has a fascinating diurnal cycle. It can sink as low as the surface during the Martian night and rise up to several kilometers high at the peak of the sol. Since it has such a different dynamic behavior compared to Earth's boundary layer, there is a lot of information that engineers need to become familiar with before they can design a rocket that will successfully leave the Martian atmosphere and return to Earth.

A global network of climate landers would provide an invaluable in-situ dataset to enhance numerical model predictions. Orbiters have provided useful atmospheric data for the upper to midlevel atmosphere, but data for the lower atmosphere is still lacking. The dataset has been established by Viking [3], Pathfinder [4], and Phoenix's [5] meteorology packages. These missions contributed to the surface observations of temperature, pressure, wind, and atmospheric composition measurements. The meteorology package aboard MSL (REMS) will also provide valuable temperature, pressure, and wind measurements but expands the package to include crucial ultraviolet radiation measurements [6]. MSCL will be able to provide similar datasets to better understand the surface environmental conditions that future human missions may encounter, ideally in several locations on the Martian surface.

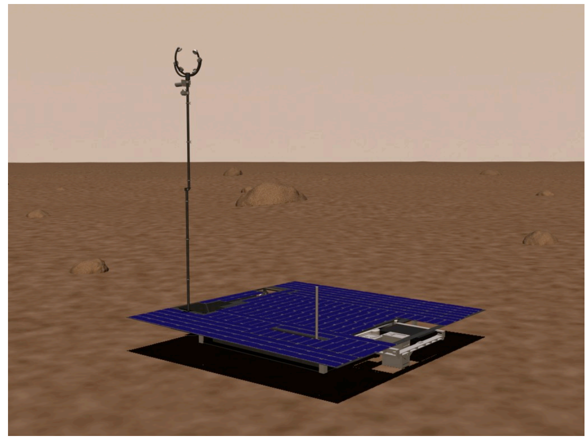

Figure 1 MSCL with the mast fully deployed after dropoff from parent rover.

Science Objectives: The science objectives were defined according to NASA Exploration priorities. MEPAG science goals clearly advocate for the need to determine atmospheric states that affect entry, descent, and landing (EDL) and launching techniques. A better understanding of the ionizing radiation environment is also crucial to the health of future human explorers. With these priorities in mind, the science objectives were defined as the following:

Primary: Quantify the near-surface environment as it pertains to potential habitability and human exploration.

Secondary: Determine the variability and conditions in the boundary layer.

MSCL is capable of characterizing surface weather conditions and quantifying the radiation environment. The instrument suite will conduct direct measurements of surface pressure, temperature, humidity, wind velocity, and ultraviolet and high-energy radiation doses. In addition, indirect measurements of thermal lapse rate and surface water vapor flux can be derived with this instrument suite.

To address the secondary science objective, the instrument suite will be capable of characterizing the aerosol concentration profile, air temperature profile, integrated water column, and atmospheric dust opacity.

The thermal balance between the surface and lower atmosphere will also be quantified.

Instrument Package: The instrumentation package is directly related to the two science objectives. In order to satisfy the surface and boundary layer measurement requirements, the following instruments were selected: six thermocouples, a humidity sensor, a sonic anemometer, an upward looking and downward looking radiometer, a barometer, a lidar, and a camera. The instrument layout, seen in Figure 2, is designed to simultaneously achieve optimum science measurements and satisfy extremely restrictive engineering requirements.

Conclusions: Studying the near-surface and boundary layer climate environment is not only scientifically valuable but can provide insight required to plan for future human exploration missions. MSCL's observations will be able to answer questions related to radiation environment, dust transport, water vapor transport, temperature and pressure fluctuations, aerosol concentrations, and habitability. The local (possibly global if a network is established) observed surface conditions will provide the missing data points for numerical global climate models whose accuracy is crucial for successful Mars Sample Return and human exploration missions.

References: [1] Pennar et al. (2007) MSCL *Summer Study Report*. [2] Johnson J. R. et al. (2010) *MEPAG*. [3] Chamberlain T. E. et al (1976) *AMS Bulletin* Vol. 57, No. 9. [4] Golombek, M. P. (1997) *JGR* Vol. 102, No E2, PP. 3953-3965. [5] Taylor P. A. (2008), *JGR*, Vol. 113, E00A10. [6] Gómez-Elvira, J., and the REMS Team. (2008). *LPSC Conference Abstracts*, Abstract 1647.

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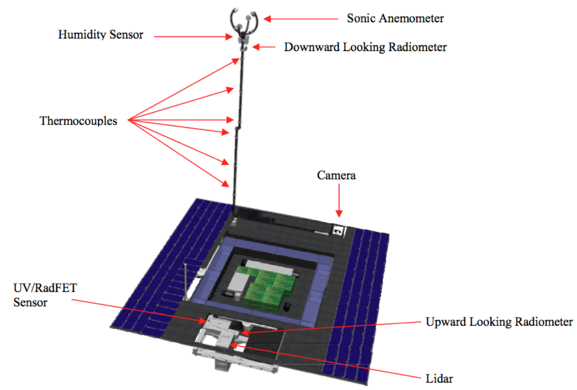

Figure 2 The MSCL instrumentation layout.