NASA's 2009 MARS SCIENCE LABORATORY: AN UPDATE. A. R. Vasavada[1] and the MSL Science Team, [1]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109 USA.

Introduction: The Mars Science Laboratory, NASA's next rover mission to Mars, will launch in Fall 2009 and begin science operations in late 2010. Its overall scientific goal is to explore and quantitatively assess a local region on Mars' surface as a potential habitat for life, past or present. The MSL rover is designed to carry ten scientific instruments and a sample acquisition, processing, and distribution system. The various payload elements will work together to detect and study potential sampling targets with remote and in situ measurements, to acquire samples of rock or soil and analyze them in onboard lab instruments, and to observe the environment around the rover. The primary mission will last one Mars year.

The rover and its entry, descent, and landing system are designed with the capability to access a wide range of latitudes and elevations on Mars, so that the landing site selection may be responsive to late-breaking results from the ongoing analysis of data from previous and current missions, including Mars Express and Mars Reconnaissance Orbiter. The landing error ellipse is relatively small (~20 km radius), while the roving range is large (also ~20 km), allowing the selection of a km-scale landing site target on Mars.

Science Objectives: Assessment of present habitability requires an evaluation of the characteristics of the environment and the processes that influence it from microscopic to regional scales and a comparison of these characteristics with what is known about the capacity of life as we know it to exist in such environments. Determination of past habitability has the added requirement of inferring environments and processes in the past from observation in the present. Such assessments require integration of a wide variety of chemical, physical, and geological observations.

The MSL mission has four major science objectives. The first is to assess the biological potential of at least one target environment by determining the nature and inventory of organic carbon compounds, searching for the chemical building blocks of life, and identifying features that may record the actions of biologically relevant processes. The second objective is to characterize the geology of the landing region at all appropriate spatial scales by investigating the chemical, isotopic, and mineralogical composition of surface and near-surface materials, and interpreting the processes that have formed rocks and soils. The third objective is to investigate planetary processes of relevance to past habitability (including the role of water) by assessing the long timescale atmospheric evolution and determining the present state, distribution, and cycling of water and CO_2. The fourth objective is to characterize the broad spectrum of surface radiation, including galactic cosmic radiation, solar proton events, and secondary neutrons.

These observations and measurements will individually be of great scientific interest and importance, but the overall scientific goal of assessing present and past habitability of environments at the visited sites will only come from their comprehensive integration, and this is consequently a key feature of the proposed mission. Each of the ten instruments contributes to multiple science objectives, while most science objectives involve contributions from four or more instruments. Science operations, data analysis, and dissemination of results will be integrated by and coordinated through the MSL Project Science Group, consisting of the Project Scientist, Program Scientist, and investigation PIs.

Scientific Investigations: There are ten PI-led scientific investigations, each related to a single payload instrument or suite of instruments. They may be classified into the following groups:

Mast-based remote sensing: Mounted on a ~1-m mast are MastCam, a color, stereo imaging system provided by Malin Space Science Systems (PI: Michael Malin), and ChemCam, a laser-induced breakdown spectrometer and remote micro-imager provided by Los Alamos National Laboratory (PI: Roger Wiens).

Contact science: On the end of the robotic arm are APXS, an alpha-particle and X-ray spectrometer provided by the Canadian Space Agency (PI: Ralf Gellert, U. Guelph), and MAHLI, a hand-lens imager provided by Malin Space Science Systems (PI: Kenneth Edgett).

Analytical lab instruments: Located within the rover chassis are CheMin, which analyzes delivered samples with X-ray diffraction and fluorescence, provided by NASA Ames Research Center (PI: David Blake), and the SAM instrument suite, which contains a gas chromatograph, mass spectrometer, and tunable laser spectrometer, provided by NASA Goddard Space Flight Center (PI: Paul Mahaffy).

Environmental measurements: RAD is a radiation detector provided by Southwest Research Institute (PI: Don Hassler). REMS is a meteorology package and UV sensor provided by the Spanish Ministry of Science (PI: Luis Vázquez, Centro de Astrobiología/INTA-CSIC). DAN is an active neutron spectrometer provided by the Federal Space Agency of Russia (PI: Igor Mitrofanov, Space Research Institute). MARDI is a descent imager provided by Malin Space Science Systems (PI: Michael Malin).

The sample acquisition, processing, and distribution system consists of a five degree-of-freedom robotic arm, a scoop, a tool for brushing and abrading rock surfaces, a coring device, and devices that process collected rock and soil samples into particulates and deliver them to the analytical lab instruments.

All scientific data returned by the rover will be validated and archived in the Planetary Data System in a timely manner.

More detailed information on the mission and its scientific payload may be found at: http://mars.jpl.nasa.gov/msl.

Landing Site Selection and Community Participation: The MSL investigations currently involve over 120 scientists from seven countries. However, there are several opportunities for additional members of the Mars science community in the MSL mission. The MSL landing site selection process will be informed by a series of open workshops, starting in late Spring 2006. Information on participating in these workshops may be found at http://webgis.wr.usgs.gov/msl. In addition, NASA plans to select a number of scientists to participate in the operations and data analysis phases of the project. These opportunities will be announced through the normal NASA process.