MEDA, AN ENVIRONMENTAL AND METEOROLOGICAL PACKAGE FOR THE MARS 2020 MISION.

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Introduction: The *Mars Environmental Dynamics Analyzer* (MEDA) has been selected as one of the seven payload investigations onboard the NASA Mars 2020 rover mission [1].

MEDA is a contributed legacy of the Mars Science Laboratory's REMS (Rover Environmental Monitoring Station), a modular sensor set designed to address two Mars 2020 investigation goals: "characterization of dust size and morphology", and "surface weather measurements", while exploiting the REMS [2] and PanCam/HazCam [3] heritage. MEDA is designed to be more than a dust characterization and MET station package; it offers synergies with the goals of other payload investigations on Mars 2020 (specially with the MOXIE investigation –*Mars Oxygen ISRU Experiment*-, designed to produce oxygen from Martian atmospheric carbon dioxide), as well as respond to more general Mars Program objectives, and Mars Strategic Knowledge Gap investigations [4].

MEDA will continue the long line of Mars meteorological packages from Viking, to Pathfinder, Phoenix, MSL, and, hopefully, InSight, thereby expanding surface environmental measurements to span nearly half a century. The MEDA team includes scientists and engineers from most of these missions, providing a wealth of experience that will contribute to successful development and operations.

MEDA goals and objectives: MEDA's goal is to help understand the Martian surface conditionsby sampling the near surface environment. Its sensors will enable comparisons to the measurements obtained at other locations previously explored on Mars. The MSL REMS heritage additionally permits easier comparisons to the meteorological station presently operating in Gale Crater.

The measurement objectives are:

a. The physical and optical properties of the local atmospheric aerosols. Particle abundance, size distribution, shape, phase function, and how these optical properties relate to the meteorological cycles (diurnal, seasonal, interannual).

b. The conditions leading to dust lifting and how the aerosol diurnal cycle responds to the local atmospheric wind regimes.

c. To determine how the current environmental pressure, temperature, relative humidity, solar radiation, net infrared radiation, and winds at the landing site differ from those at the Viking, Phoenix, Pathfinder, and Curiosity locations.

d. Probe the relationship between the surface environment and the large-scale dynamics observed from orbiting instruments.

e. Investigate the energy and water fluxes between the surface and the lower atmosphere of Mars near the rover.

f. Measure the annual cycles of the solar UV, visible and NIR radiation on the surface of Mars.

g. Obtain the environmental context for weathering and preservation potential of a possible cache sample.

h. Investigate how pressure, humidity, temperature and winds influence the ISRU engineering efficiency?

i. Form linkages between the MEDA observations and models extrapolated to the Martian surface.

MEDA's concept: MEDA will carry a dust and optical radiation sensor, pressure sensor, relative humidity sensor, wind sensor, air temperature sensors, thermal infrared net flux and ground temperature sensor. They monitor autonomously around the clock. The solar radiation sensor is designed to track direct and diffuse radiation in a geometry that characterizes both, the prevailing environmental dust properties [5,6], and the behavior of solar radiation on subdiurnal time scales. This helps constraint and model the impact of solar radiation on local photochemistry, thus supporting assessments of the preservation potential for organics on a cache sample.

Table 1 shows the investigation traceability matrix listing and linking the MEDA sensors, to observables and goals.

Table 1. MEDA baseline design flow from goals and objectives.

Mars 2020 AO Threshold Science Objectives	MEDA Science Goals	MEDA Scientific Measurement Requirements	
		Observables	Physical Parameters
Objective D.2 Characterization of Dust size and morphology	Determine optical properties of Martian dust and how it changes with time and meteorological conditions	Angular dependence of diffuse VIS solar light (sideways cone radiation sensor)	Dust phase function, optical shape and size distribution
		Angular dependence of scattered light near Sun (CCD)	Optical depth and size distribution
Objective D.3 Make Surface Weather Measurements to Validate Global Atmospheric Models	Determine the dynamics of the Martian environment Thermal environment Global dust and CO_2 cycles Wind characteristics Surface temperature and fluxes with the low atmosphere	Thermistors resistance (thermocouple)	Air Temperature
		Piezoelectric Capacitor (pressure sensor)	Atmospheric Pressure
		Heat fluxes to maintain constant ΔT between reference temperature and 4 dice (hot plate anemometers)	Wind velocity and Wind direction
		Thermal radiation in several bands (ground looking thermal IR sensors)	Regolith surface temperature and emissivity.
	Characterize the solar radiation environment at the surface of Mars and its potential effects on life	UV-VIS-NIR irradiance fluxes (whole sky FOV photodiodes with filters)	UV flux and O_3
		Thermal radiation in several bands (upward TIR sensors)	Air temperature at 0.6Pa
	Understand the Martian hydrological cycle	Capacitance (relative humidity sensor)	Relative humidity

Resolving dust and environmental variables over many time scales is required to understand (a) the predictive capabilities of models of the near surface environment on Mars, and (b) assess how the environment affects operational ISRU and rover engineering cycles. Therefore, MEDA's operations concept is to work autonomously and continuously with programmable continuuous temporal coverage and a variable sampling rate, even during rover sleep periods.

It is intended to accommodate MEDA's wind, humidity, air temperature and net thermal infrared radiation flux sensors on a dedicated and deployable mast placed in the port-front corner of the rover deck, to protect them from the rover geometry and thermal influences. Dust and solar radiation sensors will be placed over the rover deck, to maximize their unobstructed fields of view.

References:

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