ATMOSPHERIC SCIENCE WITH THE MARS 2020 ROVER - THE MEDA INSTRUMENT

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Introduction:

The Mars 2020 rover mission is part of NASA's Mars Exploration Program, a long-term effort of robotic exploration of the red planet. Designed to advance high-priority science goals for Mars exploration, the mission would address key questions about the potential for life on Mars. The mission would also provide opportunities to gather knowledge and demonstrate technologies that address the challenges of future human expeditions to Mars.

The *Mars Environmental Dynamics Analyzer* (MEDA) is an integrated full suite of sensors designed to address the Mars 2020 mission objectives of characterization of dust size and morphology and surface weather measurements [1].

MEDA's international collaboration also responds to Mars Program objectives and Mars Strategic Knowledge Gap investigations for Human Exploration identified by the MEPAG [2].

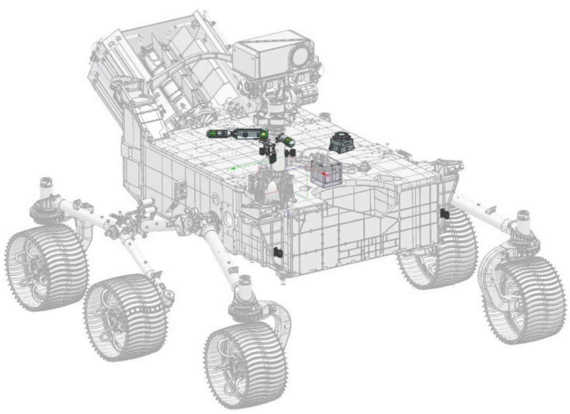

Figure 1 MEDA assemblies distributed over the Mars 2020 rover (Picture courtesy of NASA-JPL/Caltech)

The MEDA payload carries high heritage from the currently-in-use *Rover Environmental Monitoring Station (REMS)* [3] and the *PanCam/HazCam* [4] instruments aboard the *Mars Science Laboratory (MSL)* mission, as well as common elements with the TWINS payload planned for InSight. MEDA can monitor dust and surface meteorology autonomously and will be capable of sampling environmental conditions in parallel to other Mars 2020 investigations [such as e.g. the Mars Oxygen ISRU Experiment (MOXIE), designed to produce oxygen from Martian atmospheric carbon dioxide].

MEDA investigations:

MEDA's sensors will characterize the climate near the Martian surface. Those sensors are a dust and optical radiation sensor (RDS) that includes a dedicated camera (SkyCam), pressure sensor (PS), relative humidity sensor (HS), wind sensor (WS), 5 air temperature sensors (ATS), and a thermal infrared sensor (TIRS) for net flux and ground temperature.

The solar radiation sensors will track direct and diffuse radiation in a geometry that characterizes the prevailing environmental dust properties [5, 6], the behavior of solar radiation on subdiurnal time scales, and the impact of solar radiation on local photochemistry, thus supporting assessments of the preservation potential for organics on a cache sample. The other sensors will enable comparisons to the environments found at other locations explored by environmental packages aboard previous landers and rovers on Mars. The MSL REMS heritage additionally permits easy comparisons to the meteorological station currently operating on Gale Crater.

Thus, MEDA's 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. 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. The relationship between the surface environment and the large-scale dynamics observed from orbiting instruments.

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

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

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

h. How pressure, humidity, temperature and winds influence the ISRU engineering efficiency.

i. How the MEDA observations agree with models extrapolations to the Martian surface.

Instrument concept and its accommodation on the Rover:

To ensure the investigation goals, the MEDA sensor locations have been selected searching to minimize the influence of the Rover geometry on the sensors. As a consequence, there are several ATS and WS all distributed such that there is always one upwind of the Rover. Two MEDA air temperature sensors will be accommodated on the sides of the Rover providing local lapse rate information, the RDS will be on the Rover deck, the pressure sensor and the MEDA CPU will be inside the Rover, and the rest of sensors, HS, TIRS, and 3 ATS will be on the Rover Remote Sensing Mast.

Figures 2 and 3 show the different sensor elements and the accommodation on the Rover.

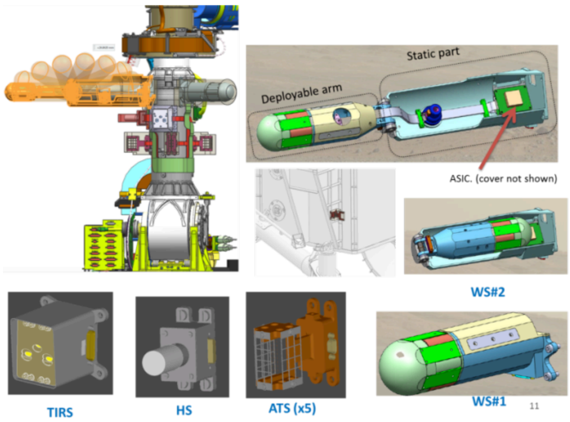

Figure 2 MEDA elements on the Rover Remote Sensing Mast

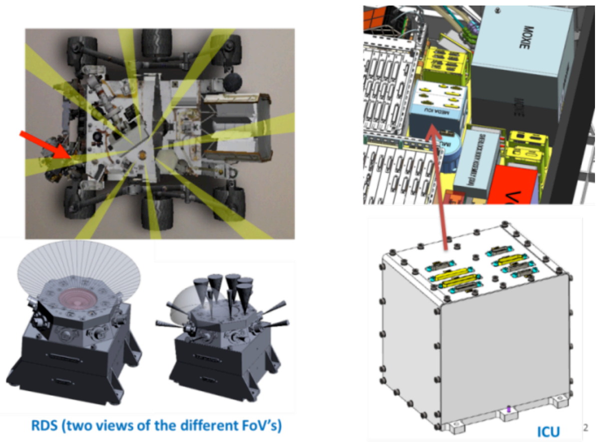

Figure 3 MEDA elements accommodated on the Rover Deck

MEDA's Operation approach:

The success of MEDA science is mainly based on measurement regularity. Thus, MEDA is designed to operate autonomous, continuous and independently of the Rover on the basis of the so-called Observation Tables (OT), that occasionally will be uploaded and stored into the instrument. These OTs will drive the instrument observations and activities with the indicated sensors, rates and durations.

MEDA's baseline operational scenario is to measure 30 min/hour, with 1 Hz frequency (MEDA's maximum sampling rate is 2 Hz), 7 images/sol, and around the clock. However, the operational scenario will be able to change as a function of the available Rover power and data volume.

Acknowledgements:

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