THERMAL INERTIA AND ALBEDO AT JEZERO CRATER AS OBSERVED FROM THE MARS 2020 MEDA INSTRUMENT.

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Introduction: The Mars Environmental Dynamics Analyzer (MEDA) is one of the seven scientific instruments onboard the Mars 2020 mission [1]. MEDA includes 6 sensors measuring the environmental conditions across Perseverance's traverse (Fig. 1).

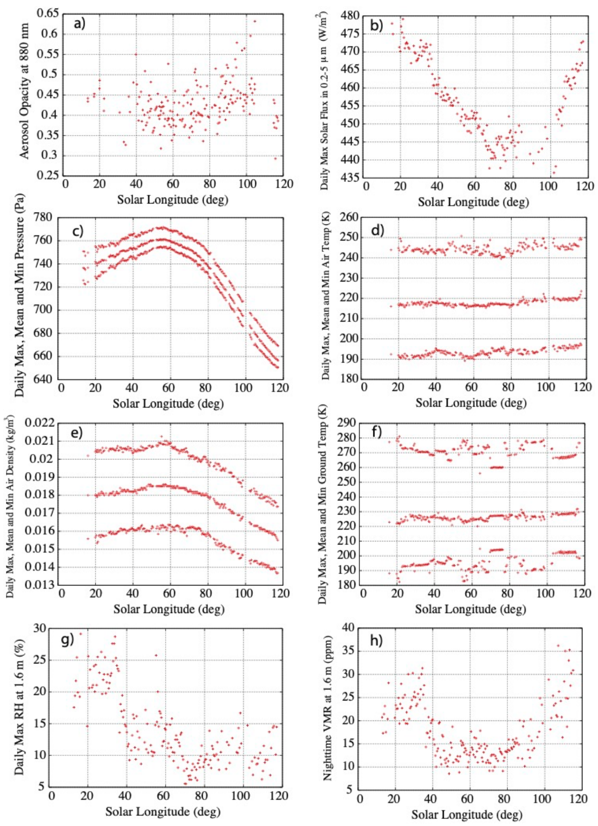

Figure 1. ***(a)*** *Aerosol opacity at 880 nm;* ***(b)*** *Daily max downwelling solar flux (0.2–5 μm);* ***(c-d)*** *Daily mean atmospheric pressure and temperature at 1.4 m;* ***(e-f)*** *Daily max, mean and min atmospheric air density at 1.4 m and ground temperature;* ***(g)*** *Daily max atmospheric relative humidity at 1.6 m;* ***(h)*** *Nighttime (04:00-06:00) water vapor VMR during the first 241 sols.*

MEDA's measurements of downwelling (0.2–1.2 μm) and reflected (0.3–3 μm) solar flux, downwelling atmospheric IR (6.5–30 μm) flux, and upwelling IR (6.5–30 μm) flux emitted by the surface allow for the first in situ estimation of the net radiative balance on Mars [2]. Along with ground temperature [3], these measurements allow the direct estimation of thermal inertia (TI) and broadband albedo at spatial scales of a few m^2 [1-2].

Thermal Inertia: We obtain TI for sols in which the rover was parked. We use MEDA measurements to calculate the surface energy budget, which is then used as the upper boundary condition to solve the heat conduction equation for homogeneous terrains [2]. On each sol, TI is obtained by minimizing the difference between measured and numerically simulated values of the diurnal amplitude of ground temperature. Results are shown in Fig. 2.

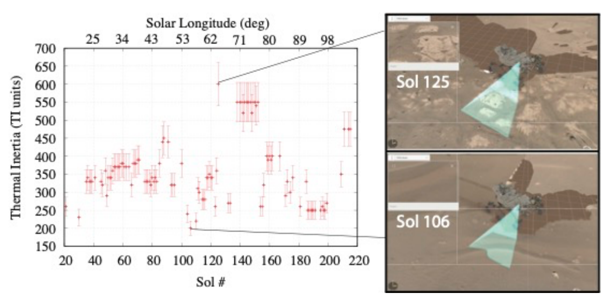

Figure 2. ***(Left)*** *Thermal Inertia values for the first 221 sols of the M2020 mission.* ***(Right)*** *Field of view of MEDA measurements of ground temperature corresponding to the terrains with the highest (sol 125, bedrock) and lowest (sol 106, sand) TI values.*

We show in Fig. 3 a comparison between TI values retrieved from THEMIS (squares) and obtained from MEDA (circles). While THEMIS values range between 200 and 450, MEDA values range between 200 and 600 TI units. Departures are explained by the different spatial resolution of both datasets.

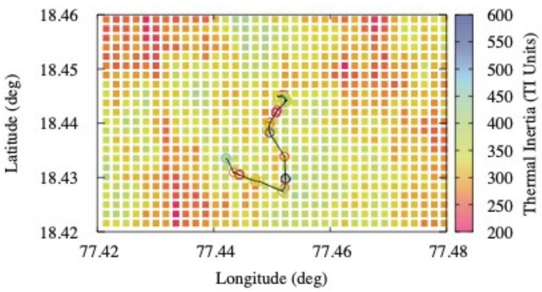

Figure 3. *Thermal inertia values as a function of lat/lon retrieved from THEMIS (squares; 100m/px) and obtained from MEDA (circles; a few m²). The black line represents the rover's traverse for the first 241 sols.*

Albedo: We obtain albedo by using MEDA measurements of downwelling (0.2–1.2 µm) and reflected (0.3–3 µm) solar flux. Then, we use a radiative transfer model [4] to convert both fluxes to 0.2–5 µm. Additionally, a correction to remove the effects of dust deposited on MEDA's photodiodes is applied. Results of albedo values at noon are shown in Fig. 4.

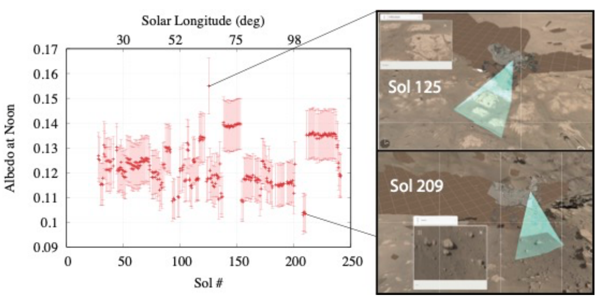

Figure 4. (Left) *Albedo values at noon for the first 241 sols of the M2020 mission.* ***(Right)*** *Field of view of MEDA measurements of reflected solar flux corresponding to the terrains with the highest (sol 125) and lowest (sol 209) albedo values.*

Fig. 5 shows the diurnal evolution of the broadband albedo on sols 50 and 69. The albedo shows a minimum value close to noon on both sols, increasing towards sunrise and sunset as the solar zenith angle (SZA) approaches 90°. The relative maximum at ~08:00 and ~17:00 LMST occurs when SZA is ~55° and, therefore, the specular reflection is within TIRS' field of view [3]. This non-Lambertian behavior is similar in other sols, regardless of the type of terrain.

Lambertian albedo values at Jezero retrieved from TES between 0.3–2.9 µm [6], and from Omega at 1.08 µm, are ~0.15 and 0.19, respectively. These values correspond to the terrain traversed by Perseverance during the first 241 sols of the M2020 mission. Satellite values are significantly larger than those typically observed by MEDA at noon (Fig. 4). These discrepancies are likely explained by the different spatial resolution, local time, and Lambertian assumption.

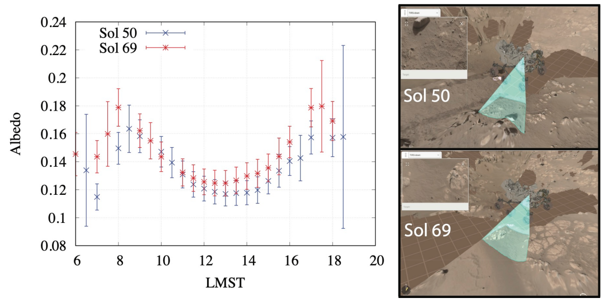

Figure 5. (Left) *Diurnal evolution of broadband albedo on sols 50 (blue) and 69 (red).* ***(Right)*** *Field of view of MEDA measurements of reflected solar flux on these two sols.*

Summary and Future Work: MEDA's novel measurements of the net radiative balance at the surface allow for the direct estimation of thermal inertia and broadband albedo across Perseverance's traverse.

TI values derived from MEDA for the first 221 sols range between 200 (sand dune) and 600 (bedrock) TI units, while orbital values retrieved from THEMIS range between 200 and 450 TI units.

Broadband albedo measured by MEDA shows a strong non-Lambertian behavior, with a diurnal minimum at around noon ranging between 0.10 and 0.16, then increasing towards sunrise and sunset. Lambertian values retrieved from TES and OMEGA are 0.15 and 0.19, respectively.

As ongoing work, we are characterizing the non-Lambertian behavior of albedo as a function of rover geometry and terrain. Also, we are analyzing the differences between MEDA and satellite values of albedo and thermal inertia as a function of spatial resolution and local time.

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References: [1] Rodríguez-Manfredi J. A. et al. (2021) *Space Sci. Rev*., 217.3, 1-86. [2] Martínez G. M. et al. (2021) *JGR:Planets*, 126.9, e2020JE006804. [3] Sebastián E. et al. (2020) *Measurement*, 164, 107968. [4] Vicente-Retortillo A. et al. (2015) *J. Space Weather. Space Clim*., 5, A33.