MEASURING THE SURFACE TEMPERATURE OF MARS WITH THE EMIRATES MARS MISSION

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Introduction: The ~55 hour orbit of the Emirates Mars Mission (EMM) or the "Hope" orbiter enables it to achieve a near-global coverage of the entire planet every 4 orbits, or 9 sols [1]. The EMIRS instrument on board EMM is an infrared spectrometer, which is used to retrieve surface temperature of the planet. Using this capability, we are able to measure surface temperature at all local times for most of the planet.

We study the diurnal and seasonal variation of the surface temperature of Mars and compare with the Mars Climate Database. We identify anomalies in these measurements and discuss the role of thermal inertia. We discuss other implications of these findings leading to a better understanding of temperature variation on Mars and its impact on weather and climate.

EMIRS/EMM: The Emirates Mars Infrared Spectrometer (EMIRS) instrument [2] on board EMM is a Fourier Transform Infra Red (FTIR) spectrometer observing in 6-100 μm wavelength range. It is designed to provide measurements of the lower atmosphere and surface of Mars by conducting thermal infrared observations of the disk. It takes ~ 20 observations per orbit or ~ 60 per week with one observation taking 29 minutes at periapsis and 11 minutes at apoapsis. It takes 4 orbits or less than 10 days to obtain the global coverage at all local times. The resolution ranges between 100 to 300 km/pixel (diameter) with up to 70° emission angle. Level 2 data products (L2) contain calibrated radiance and brightness temperature. Level 3 products (L3), used in this study, are derived from L2 and have corrected surface temperatures among other quantities. Surface temperatures (L3) are obtained using a three-step process: first the atmospheric temperatures are retrieved from the 15 μm CO_2 band, then dust optical depth and water-ice aerosol optical depths are fit, and finally the water vapor column depth is fit. This retrieval process is iterated until convergence, and quality control metrics are used to ensure the quality of final retrieved products.

The Mars Climate Database: The Mars Climate Database (MCD) [3] provides averaged data on meteorological variables such as pressure, temperature, atmospheric density and winds. It is a derived from Laboratoire de Météorologie Dynamique LMD-GCM, a Global Climate Model (GCM) of Mars, which includes a water cycle model, a chemistry model, a thermosphere model and an ionospheric model. It provides day-to-day variability of main meteorological variables and is widely used in the Mars community. In addition to the output from GCM, it provides high-resolution environmental data, year-to-year variability, dust content variations, seasonal and diurnal cycles of key meteorological variables.

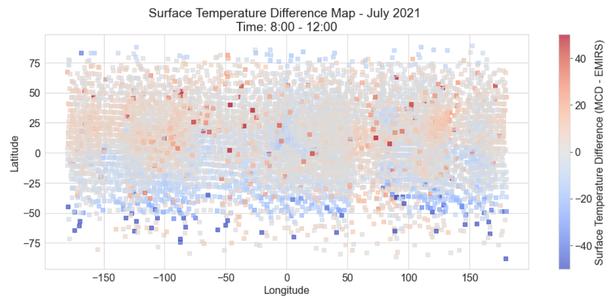

Figure 1: Surface temperature difference (Kelvin) map with 30 sol data between L_s = 65.8-78.9 at local times 8.00 to 12.00.

Results: The mission has been operating since February 2021 and has provided measurements for the most of MY 36. We average data over 30 sols in order to get good spatial and temporal resolution of temperature variability across the planet [4]. Figures 1 and 2 show the surface temperature difference map between MCD and EMIRS sols between L_s = 65.8-78.9 at local times between 8.00-12.00 and 20.00-24.00 respectively. While most of the differences are minor and expected, some differences reach up to ~ ±40K. Figures 3 and 4 show the distribution of temperature difference between MCD and EMIRS at all local times at L_s = 65.8-78.9 and L_s = 79.3-92.5 respectively. Overall, the temperature measurements from EMIRS are in agreement with MCD, however there are some anomalies, which we will discuss in our presentation and highlight the role of local thermal inertia at various spatial scales.

Summary: Due to the unique orbit of EMM, it is now possible to study the temperature variability of the surface of Mars at all local times across the planet. We compare EMM results with MCD and discuss temperature anomalies and the role of thermal inertia at various spatial scales.

References: **[1]** Hessa Almatroushi et al. "Emirates Mars mission characterization of Mars atmosphere dynamics and processes". In: *Space Science Reviews* 217.8 (2021), pp. 1–31. **[2]** Christopher S Edwards et al. "The

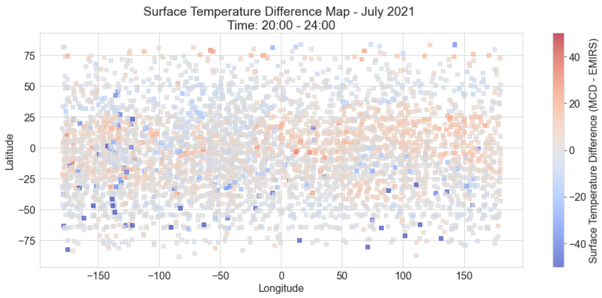

Figure 2: Surface temperature difference (Kelvin) map with 30 sol data between L_s = 65.8-78.9 at local times 20.00 to 24.00.

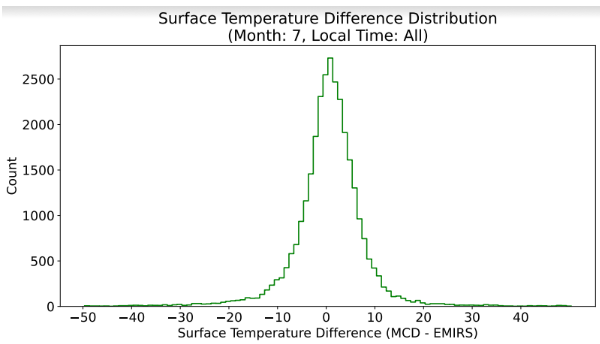

Figure 3: Surface temperature difference (Kelvin) distribution with 30 sol data between L_s = 65.8-78.9 for all local times.

Emirates Mars Mission (EMM) Emirates Mars InfraRed Spectrometer (EMIRS) Instrument". In: *Space science reviews* 217.7 (2021), pp. 1–50. **[3]** Ehouarn Millour et al. "The Mars climate database (MCD version 5.2)". In: *European planetary science congress*. Vol. 10. 2015, pp. 2015–2438. **[4]** Dimitra Atri et al. "Diurnal variation of the surface temperature of Mars with the Emirates Mars Mission: a comparison with Curiosity and Perseverance rover measurements". In: *Monthly Notices of the Royal Astronomical Society: Letters* 518.1 (Oct. 2022), pp. L1–L6. ISSN: 1745-3925. DOI: 10.1093/mnrasl/slac094. eprint: https://academic.oup.com/mnrasl/article-pdf/518/1/L1/46680881/slac094.pdf. URL: https://doi.org/10.1093/mnrasl/slac094.

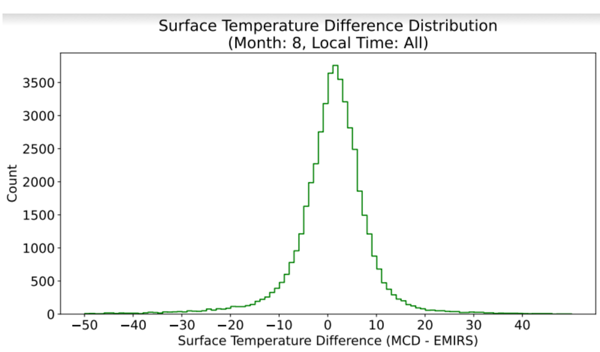

Figure 4: Surface temperature difference (Kelvin) distribution with 30 sol data between L_s = 79.3-92.5 for all local times.