GLOBAL WAVELENGTH SURVEY OF MARTIAN LARGE RIPPLES AND TARS. D. A. Vaz[1], S. Silvestro[2,3], M. Chojnacki[4], D. C. A. Silva[1]. [1]Centre for Earth and Space Research of the University of Coimbra, Coimbra, Portugal (davidvaz@uc.pt); [2]INAF Osservatorio Astronomico di Capodimonte, Napoli, Italy; [3]SETI Institute, Mountain View, CA; [4]Planetary Science Institute, Lakewood, CO.

Introduction and objectives: The mechanism/s responsible for sediment entrainment by wind and bedform migration on Mars are a matter of debate [1,2]. Martian large ripples (LRs) migrate under present-day low pressure conditions and have been interpreted has fluid/wind drag ripples [3] or as bedforms formed by aeolian saltation/splash [4]. An important constraint to this debate is the relation between bedform wavelength and atmospheric density (as a function of elevation). This relation was described based on the mapping of 25 areas located in the Tharsis region [5] and later complemented by the wavelength measurement of dark-toned LRs in other 11 areas [3]. Lapotre el al. [3] proposed that the fluid drag theory fits the measured wavelength *vs.* atmospheric density relation, a view not shared by Lorenz [1].

The main objective of this work is to re-evaluate how well the wind drag hypothesis can predict bedforms' spacing on Mars, and for this purpose we employ an improved measurement technique that allows the mapping of entire dune fields. In addition, we significantly increased the number of mapped areas and extended the range of sampled elevations.

Data and methods: We performed an automated mapping of bedforms and obtained continuous wavelength measurements for the same 36 HiRISE images analyzed in previous studies. In order to extend the range of sampled elevations and fill in gaps, 39 other areas were mapped (Figure 1).

We applied a new method to identify the location of the bedforms and extract several morphometric attributes from the HiRISE images. It consists in a windowed multiscale spectral decomposition and analysis, followed by a supervised classification stage using neural networks. Bedforms wavelength and albedo are plotted in 2D histograms and threshold values are iteratively defined for each area (Figure 2). We used a two-class scheme to keep our results consistent with previous surveys, segmenting LRs and TARs/megaripples. We validated our approach and compared the results for the areas previously analyzed by others. Finally, we evaluate the survey results in the context of wind drag model predictions [3].

Results: The adopted technique can accurately identify the bedforms (overall accuracy of 94%) and provide precise wavelength measurements within a ±12% confidence interval. The targeted bedforms have

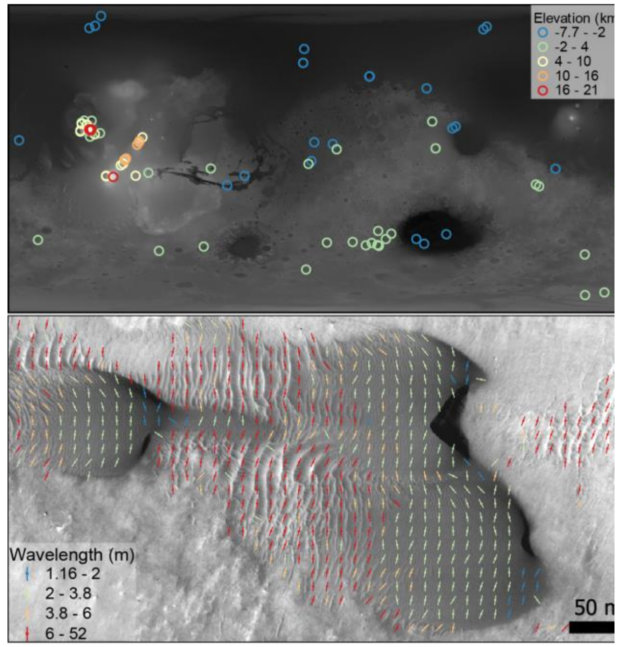

Figure 1 – (top) Location and elevation of the 75 study areas. (bottom) Example of the mapped bedforms (ESP_027864_2295), symbols denote the trend and wavelength of large ripples ($\lambda < 3.8$ m) and megaripples/TARs ($\lambda > 3.8$ m).

crests spaced between 1 and 100 m, and include large ripples, megaripples and TARs. Figure 1 shows a detailed view, while Figure 1 show the complete image mapping enabled by the adopted technique. The 2D histogram shown in that same figure highlights the two main bedform populations that are present in this area and depict the computed summary statistics.

We found a good agreement between our average LRs wavelengths and the ones reported in [3] (average 9% difference). The same does not happen for the Tharsis bedforms studied in [5], where measurements are significantly and systematically underestimated (73% difference).

Discussion and conclusions: In Fig. 3 we plotted the LRs wavelength vs. the atmospheric density (derived from elevation) and the wind drag model predictions (see [3] for details). This plot suggests that the bedforms located in the Tharsis region (the same analyzed in [5]) form a different cluster, apart from the dark-toned LRs which cover dunes elsewhere on Mars. The distinctive nature of the meter-scale bedforms located in the Tharsis region is further supported by

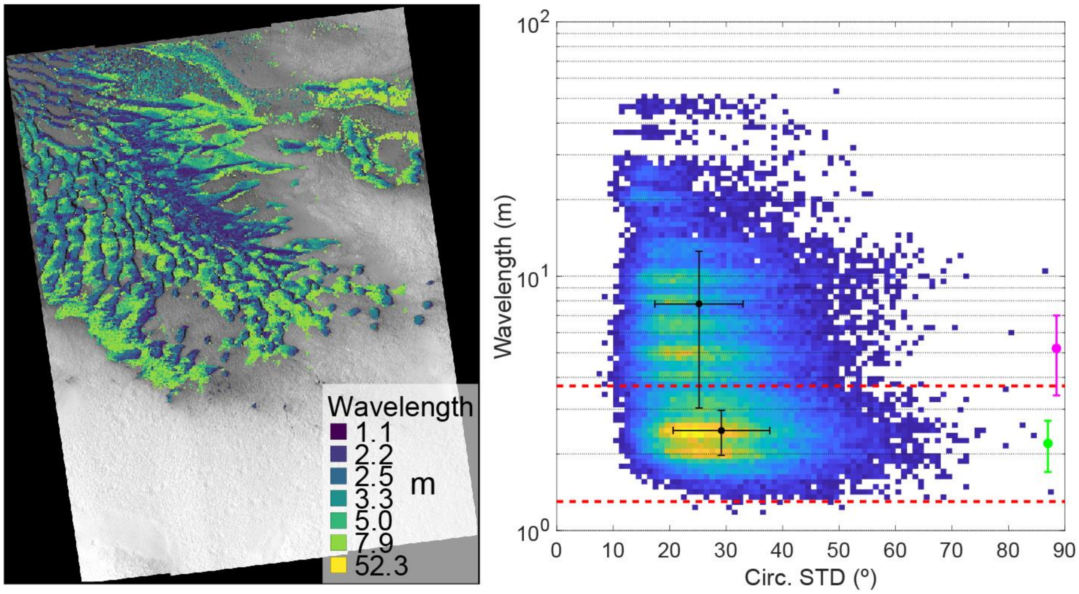

Figure 2 – (Left) Example of bedform wavelength measurements (ESP_027864_2295). (Right) 2D histogram used to segment two classes of bedforms: large ripples and megaripples/TARs. The red dashed lines correspond to the wavelength thresholds used to partition the bedforms (1.3 and 3.8 m?), while the black dots correspond to the computed average and standard deviation for each class. Green (large ripples) and magenta dots (megaripples/TARs), which are located near the right edge of the plot, correspond to the summary statistics computed by [3]. LRs' wavelength peak around 2.5 m while megaripples/TARs average is ~8 m, our average values match the previous estimates for the dark-toned ripples, while for TARs we see a larger mismatch.

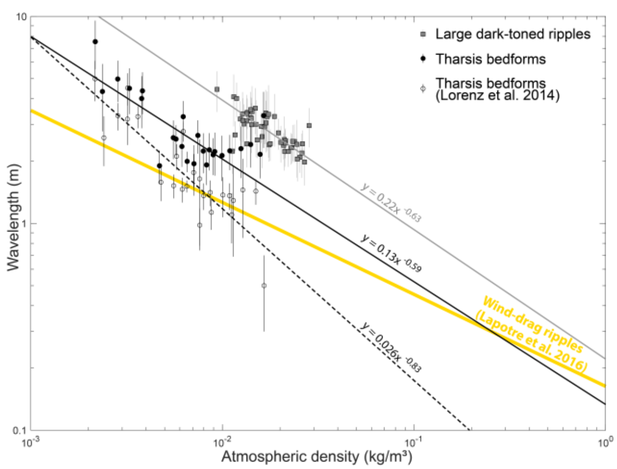

Figure 3 – Bedform wavelength data and fluid drag model predictions [3]. The new survey suggests: 1) the wavelength of the Tharsis bedforms mapped in [5] was underestimated; 2) the Tharsis bedforms form a different population; 3) the updated Tharsis measurements follow a similar trend (and show some overlap) to the dark-toned ripples sampled elsewhere on Mars; 4) even so, both populations do not strictly follow the model predictions.

other evidence: 1) they do not form/cover dunes; 2) they have higher albedos (suggesting an increased dust content [6]); and 3) in some areas form unique patterns (e.g. honeycomb or yardang-like patterns [4, 5]). We argue that Tharsis bedforms have distinct characteristics, and that merging the two populations to evaluate the wind drag hypothesis (like was done in [2 - Fig. 3]) is not appropriate. Even so, we note that the wavelength of both populations show a similar inverse dependence to atmospheric density, contrary to the previous Tharsis dataset that presented a distinctive steeper variation [1].

The fitted regression lines have a higher gradient and do not seem to perfectly match the fluid-drag model predictions. A more quantitative and conclusive comparison between the new survey data and the wind drag model predictions will be presented at the conference.

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References: [1] Lorenz, R. D. (2020), *JGR*, 125(10), 12–15. [2] Lapotre, M. G. A. et al. (2021), *JGR*, 126(2), 1–8. [3] Lapotre M. G. A., et al. (2016), *Science*, 80, 353(6294), 55–58. [4] R. Sullivan, et al. (2020), *JGR* 125(10), 1–39. [5] R. D. Lorenz, et al. (2014), *Icarus*, 230, 77–80. [6] N. T. Bridges et al. (2010), *Icarus*, 205 (1), 165–182.