Europlanet TNA Report

PROJECT LEADER

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Reimbursed	Yes

Project Title – **The Moroccan desert as terrestrial analogue of Mars: In-situ characterization of eolian environments/deposits and implications for the interpretation of data from Mars**

Scientific Report Summary.

Many quantitative aspects of martian aeolian processes like for example saltation and sandblasting, are still uncertain and might be addressed in the next years by using the images acquired by Close-UP Imager (CLUPI), a microscopic imager that will be onboard of the 2018 ESA ExoMars mission. CLUPI can acquire time series images (from outcrop to microscopic scale) of Mars surface and will help to better understand active eolian processes like sand saltation, formation/evolution of transverse aeolian ridges and dunes, and rate of aeolian erosion. To (i) assess the CLUPI scientific potential for aeolian studies and to (ii) place constraints on the saltation threshold and sand blasting phenomena as a function of sand grain sizes and wind velocity, we deployed scientific instrumentations (operating 24h/day for four days) in a dune field located in the southeastern Moroccan desert that we considered as a terrestrial analog for a martian dune field. During the in-situ campaign we acquired synchronized measurements of wind velocity, atmospheric pressure, solar radiation, air and soil humidity and temperature, and wind erosion using impact sensors and sand catchers. The latter measurements were complemented with analysis of grain size distribution across aeolian dunes and ripples and its changes through time based on imaging survey of aeolian deposits at both microscopic and macroscopic scale. The soil

nearby the weather station was also collected and analyzed in our institute laboratory for a comprehensive granulometric and compositional characterization to be compared to that achieved by using only visible images taken in the field.

Full Scientific Report on the outcome of your TNA visit

The field instrumentation was deployed on 21st October at 4.0028 W and 31.1773 N (elevation 797.77 m a.s.l). It included: three sonic anemometers with integrated wind direction sensors installed at three different heights from the ground (3 m, 2 m, and 1 meter, respectively), two thermometers (at two different heights from the ground: 3 m and 2 m), one barometric pressure sensor, one relative humidity sensor, one soil temperature and humidity sensor, one solar radiation sensor, two impact sensors (Sensit), and a total of three sand catchers capable of collecting windblown sand grains (Fig. 1). The station was set to operate 24h/day and to collect measurements at 1Hz, i.e. one measure per second for each sensor (Fig. 2). The latter setup and acquisition strategy were adopted (e.g. number and type of sensors, sampling interval, height of wind speed and saltation measurements, etc.) on the basis of the published literature about analog field campaigns and to make sure that the collected measurements would have been comparable with the results from previous studies. Particularly, there are four main methods to calculate sediment transport threshold based on combined wind speed and grain saltation measurements; all the methods are based on sampling interval of 1Hz and differ on the data average techniques and post-acquisition elaboration. Consequently, the datalogger was programmed to acquire measurements at 1Hz, although this significantly impacted the datalogger memory and implied a daily visit to the station to download the data every 12 hours.

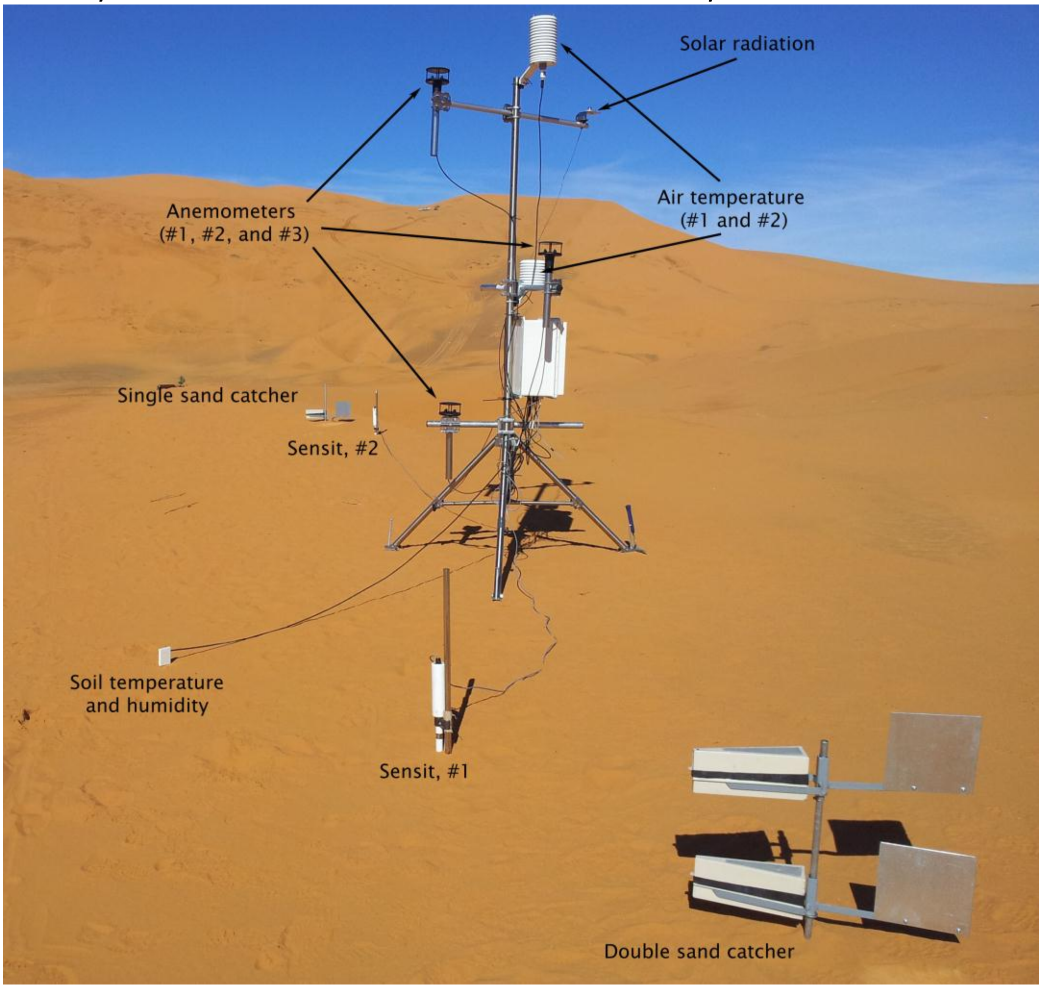

Figure 1 – Field instrumentation setup

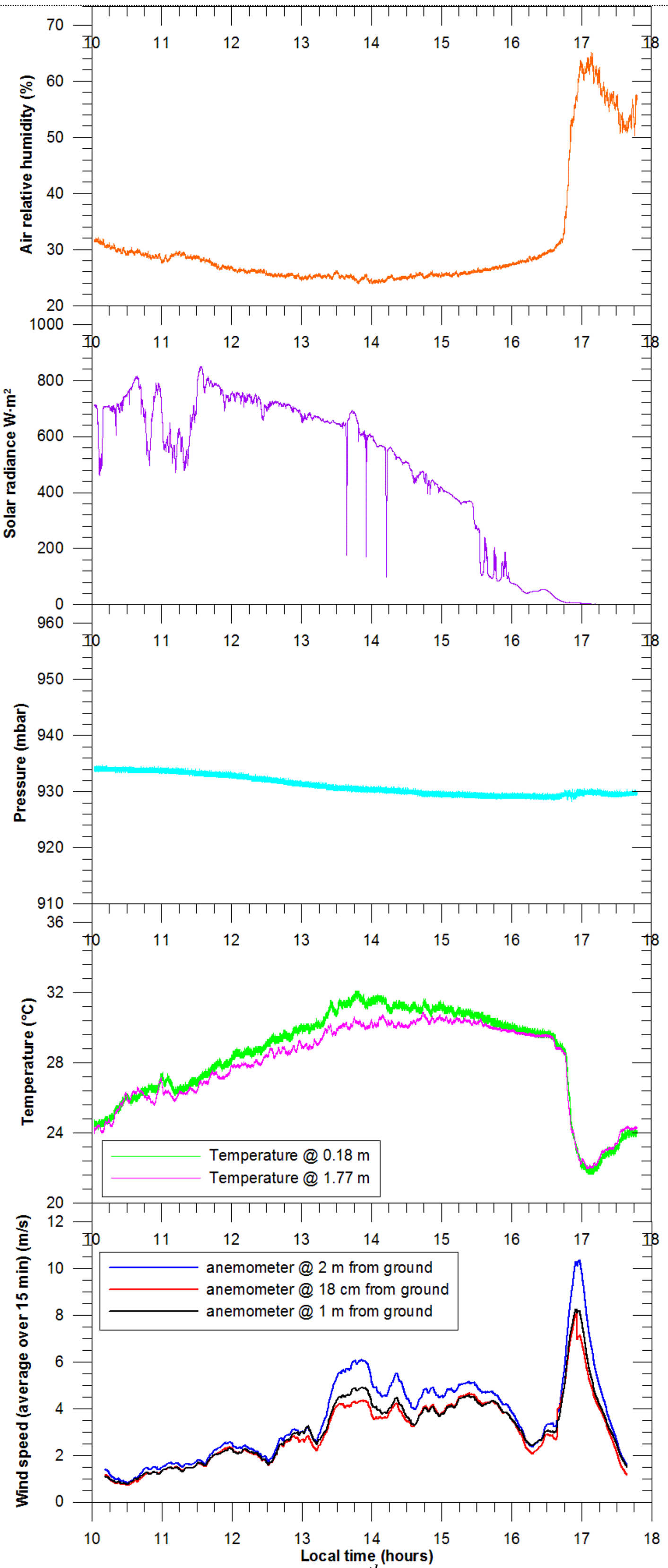

Figure 2 – Measurements' plot relative to the 24th October: at about 16:30 a thunderstorm hit the field site. Note that during this day the heights from the ground of thermometers and anemometers were slightly changed with respect to the original acquisition setup as described in the main text

All the instruments were working properly and the campaign was, operationally speaking, very successful. However, the impact sensors did not acquire a statistically significant set of measurements due to the fact that wind speeds were not as high as required for the onset of sand transportation and saltation. In fact, the highest wind speeds (close to 10 m/s) were registered during the thunderstorm occurred on 24th October (Fig. 2). Concurrently, the impact sensors detected saltation activity for a few tens of seconds (before the soil got wet), however these saltation measurements were not taken into account since they might have been affected by the rain drops' impact energy resulting in false positive measurements. Therefore, due to the lack of an adequate wind regime we could not acquire synchronized measurements of wind velocity and wind transportation during the campaign. For this reason, we plan to visit again the site next year for a second and longer field campaign during the most windy season in the region (March-July). Nevertheless all the other environmental parameters, such as temperature, humidity, solar radiation, etc. were characterized, as well as the bulk sand of the field site. Sand from approximately the first 3 cm of ground was collected nearby the station to characterize it from the sedimentary and mineralogical point of view using standard laboratory measurements. A representative sand sample quantity was taken in order to describe all the bulk size distribution in the following way: A total of 3 kg of sand was mixed in order to have a homogeneous grain size distribution. From this sample a total amount reported in Table 1 was extracted for sieving using 25, 50, 10, 150, 200, and 500 µm meshes.

Table 1 Size mass distribution of the bulk desert sand at field site

grain size (micron)	Sand grain distribution (%)
200-500	91.21140143
150-200	7.125890736
100-200	0.950118765
50-100	0.475059382
25-50	0.237529691

After sieving each grain size class was weighted and normalized to % (Table 1). Spectroscopic measurements were used to assess the mineral composition of the collecting sand. For the purpose a Bruker Equinox 55 FTIR instrument coupled with a diffuse reflectance accessory was used. The infrared measurement of the bulk sample evidenced the dominance of reststrahlen bands of quartz as well as the combination bands of carbonates. Analysis of MIR spectral region for the small grain size contamination was done comparing the expected transparency features response for the main mineral components. The expected transparency features for quartz shows that the sand is well sorted with little to no grain size less than 25 µm. The same response is for the case of carbonates.
Finally, despite the lack of significant instrumental measurements (Sensit) for saltation activity, very few sand grains were found inside the sand catcher on 23rd and 24th October. The latter samples were transported to our laboratory and we are in the process of analyzing them from the compositional and granulometric point of view using our institutional scanning electron microscope (SEM) with integrated energy-dispersive X-ray spectroscopy (EDX). Preliminary results suggest that windblown sand was relatively well sorted with average grain major axis equal to 273.57 µm (± 80.96), 285.91 µm (± 63.47), 252.28 µm (± 64.14) and average grain minor axis equal to 199.44 µm (± 60.91), 220.20 µm (± 49.51), 183.75 µm (± 45.48), for the three samples analyzed so far, respectively.

- Host approval The host is required to approve the report agreeing it is an accurate account of the research performed.