MARS SOUNDSCAPE : ONE YEAR OF ACOUSTIC SURVEY AT JEZERO CRATER

David Mimoun[1], Naomi Murdoch[1] Martin Gillier[1] Alexander Stott[1], Baptiste Chide[2], Sara Navarro[7], Claire Newman[8,], Manuel de la Torre Juárez[5], Jose Antonio Rodríguez Manfredi[7], Sylvestre Maurice[3], Roger Wiens[2]. [1]Institut Supérieur de l'Aéronautique et de l'Espace, Toulouse, France, [2]Los Alamos National Laboratory, Los Alamos, NM, United States . [3]Institut de Recherche en Astrophysique et Planétologie, Toulouse, France. [4]Universidad del País Vasco, Bilbao, Spain, [5]Cornell University, Ithaca, NY, United States, [5]Jet Propulsion Laboratory, Pasadena, CA, United States. [7]Centro de Astrobiologia, INTA, Madrid, Spain, [8]Aeolis Research

Introduction: The Perseverance rover has landed on Feb. 18, 2021 on the surface of Mars. If its primary science objective is to sample rocks that will eventually will be brought back to Earth, it has also achieved the first ever sound measurements on Mars, thanks to its first two microphones operating at the surface of Mars. The EDL microphone [1] being located on the rover body, and the SuperCam microphone [2] located on the SuperCam Mast Unit. After having recorded the first sounds on Mars while the Mast Unit was still stowed, the SuperCam microphone has proven to be a very useful tool, allowing to open a new window of acoustic measurements at Jezero crater.

SuperCam microphone science objectives : The SuperCam microphone was primarily designed to complement the SuperCam Laser Induced Breakdown Spectroscopy (LIBS) measurements [3,4] by providing an proxy for the roughness of the rocks analyzed by the LIBS, [5] through the analysis of the sound wave created by the plasma expansion when the laser vaporizes the rock. Two other secondary objectives were to provide insights on the Martian atmosphere and to support other rover experiments such as MOXIE [6] by recording their sounds.

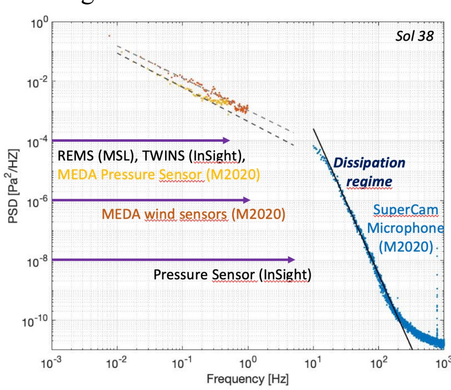

Figure 1 : The SuperCam microphone complements atmospheric sensors at high frequency

Atmospheric measurements

A summary of the preliminary results is detailed in [7] but we will focus here on the acoustic survey that has been done since the first days of the rover landing. In addition to the rock / LIBS investigations, we have included the microphone recordings as a complement of the MEDA atmospheric suite : the overarching atmospheric science goal of the SuperCam microphone is to characterize the Martian atmospheric dynamics at high frequency. Several sequences of passive microphone recordings (i.e. without LIBS firing), alone or coupled with imaging sequences have been planned regularly. Given the limits in rover resources used, a passive microphone observational cadence of 8 recordings/month has been planned.

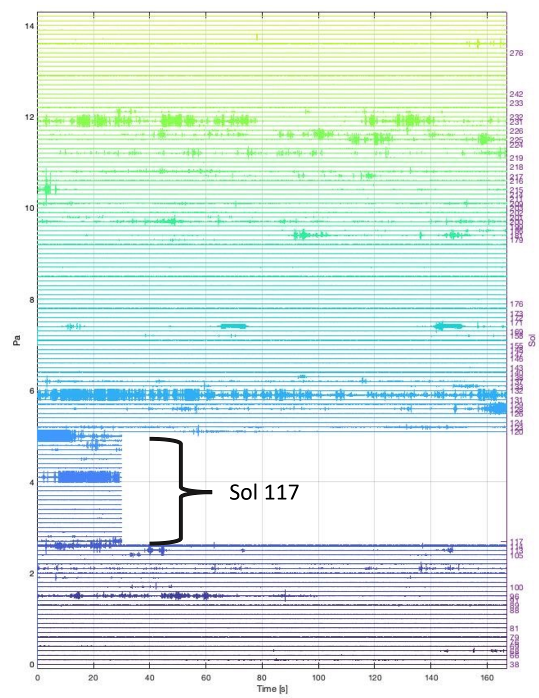

Figure 2 : summary of Passive ATM Mic +MOXIE recordings as a function of Sol up to sol 276. Sol 117 is a cross calibration between MEDA and Supercam Microphone

The measurement pattern included a sampling of local hours and possibly a coupling with dust devils movies, in order to be able to have synergetic measurements of atmospheric events. The first results gathered from this measurement campaign allowed us first to be able to confirm the link between the microphone measurements and the wind speed at high frequency, but also to study the variability of atmospheric properties (such as the turbulence spectrum), as a function of the solar local time.

In the atmosphere, shear-produced turbulent kinetic energy is generated in the form of large eddies at the scale of the boundary layer. These eddies cascade into smaller and smaller eddies by an inertial mechanism (‘inertial regime’). Eventually, at the very small scale, viscous forces become important and the eddies are dissipated (’dissipation regime’). This dissipation is intrinsically linked to the planetary boundary layer dynamics - a larger dissipation leads to a more rapid turbulence decay in turn suppressing small-scale wind gustiness, and vice versa.

Coupled measurements of atmospheric events
In addition to these mere statistical results, we were also able to witness a few synergetic measurements, such as coupled SuperCam Microphone/ Wind / Imaging of high amplitude vortices and dust devils. We have also preliminary indication that we were able to record saltation noise, that we previously considered as very unlikely due to the height (2.1 m) of the SuperCam microphone.

(Preliminary) Conclusion
One year of acoustic survey has helped us to draw an outline of the acoustic portrait of Jezero crater : due to the sound attenuation by its tenuous atmosphere, Mars is, most of the time, a very quiet place, where the highest gain of our microphone records a less noisy background than everything we have been able to record on Earth. However, the variability of the aeroacoustic sounds due to the wind open a new window of high frequency measurements on the Martian atmosphere, that we have just started exploring.

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