DUST DEPOSITION AND REMOVAL FROM THE MARS SCIENCE LABORATORY UV SENSOR. A. Vicente-Retortillo[1], G. M. Martinez[1], N. O. Renno[1] and M. T. Lemmon[2], [1]University of Michigan, Ann Arbor, Michigan, USA (alvarode@umich.edu; gemartin@umich.edu; nrenno@umich.edu), [2]Texas A&M University, College Station, Texas, USA.

Introduction: The Rover Environmental Monitoring Station (REMS) onboard the Mars Science Laboratory (MSL) mission has a UV sensor (UVS) that for the first time is measuring the UV radiation flux at the surface of Mars. The UVS is comprised of six photodiodes to measure the UV flux in the range 200-380, 320-380, 280-320, 200-280, 230-290 and 300-350 nm [1]. The UVS has completed more than two Martian years (MY) of measurements at Gale Crater (4.6°S, 137.4°E), providing coverage ranging from diurnal to interannual timescales [2, 3].

Due to its location on the rover deck, the UVS has been exposed to dust deposition. Figure 1 shows the UVS at the beginning of the mission (sol 36, top) and approximately two Martian years later (sol 1314, bottom).

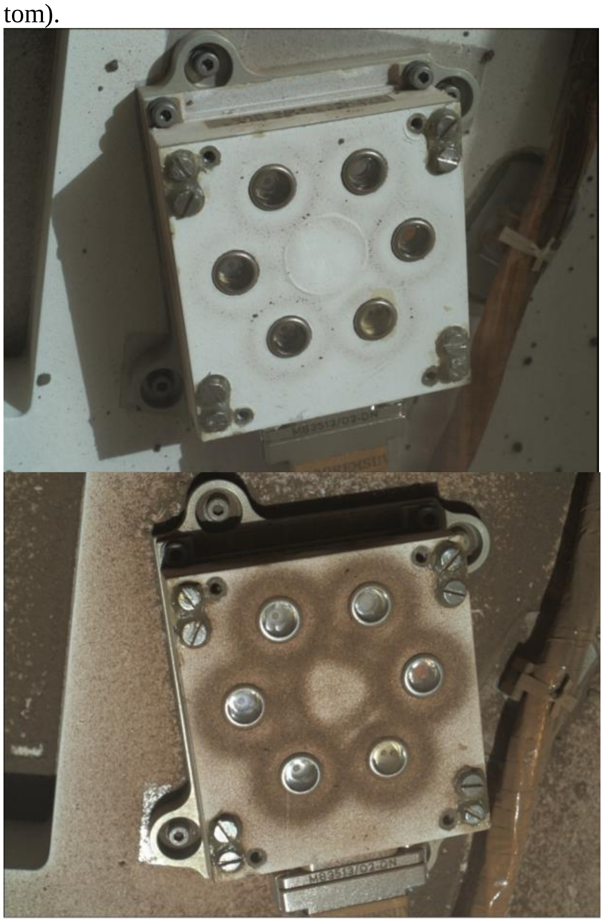

Figure 1. MAHLI images of the REMS UV Sensor on sols 36 (left) and 1314 (right). A significant amount of dust has been deposited on the sensor. The effect is particularly apparent around the circular magnets that surround each photodiode, but it is also noticeable on the windows of the sensor, as shown below.

Dust deposited on the UVS causes underestimation in measured UV fluxes and complicates the analyses of the seasonal and interannual evolution of UV radiation at the surface of Gale Crater. As an example, we show UVA fluxes measured on sols 76 and 745 in Figure 2. Since Mastcam dust opacity values and Sun-Mars distance were roughly the same on both sols, similar UVA levels are expected. However, UVA fluxes measured during the second Martian year of the mission (blue curve) are significantly lower than during the first year (red curve) because of the effect of dust deposited on the sensor.

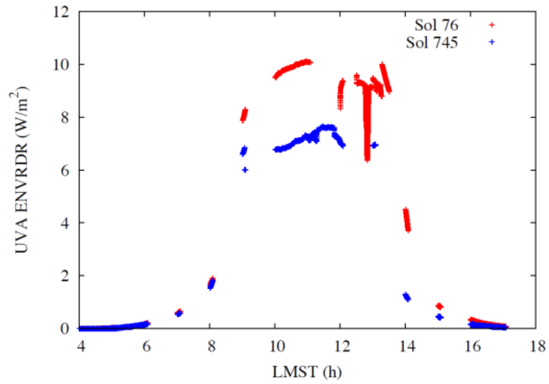

Figure 2. Diurnal evolution of UVA fluxes (ENVRDR products) on sols 76 and 745.

Here we present the temporal evolution of the attenuation of the UV radiation caused by the dust deposited on the UVS. Our results can help to improve our understanding of dust deposition, transport and lifting at Gale Crater, as well as of the temporal evolution of the performance of solar panels at the Martian surface.

Methodology: We have developed a methodology to correct UV fluxes from the effect of dust deposition by calculating a parameter (called dust attenuation factor) that depends only on the amount of dust deposited on the UVS and thus can be used to quantify this effect. The dust attenuation factor is obtained from photodiode outputs currents (TELRDR products), ancillary data records containing the geometry of the rover and the sun (ADR products), in combination with UV radiances simulated with a Monte Carlo radiative transfer model [2] that includes radiative properties calculated from refractive indices provided in [4] and which is in excellent agreement with DISORT and COMIMART [2,5], fed with Mastcam opacities at 880 nm [2].

Results: Figure 3 shows the temporal evolution of the dust attenuation factor of the UVA (top) and UVE (bottom) channels. A dust attenuation factor value equal to 1 indicates that there is no additional attenuation caused by deposited dust compared to the beginning of the mission, while a value equal to 0.5 indicates that 50% of the incoming radiation is attenuated by dust deposited on the sensor.

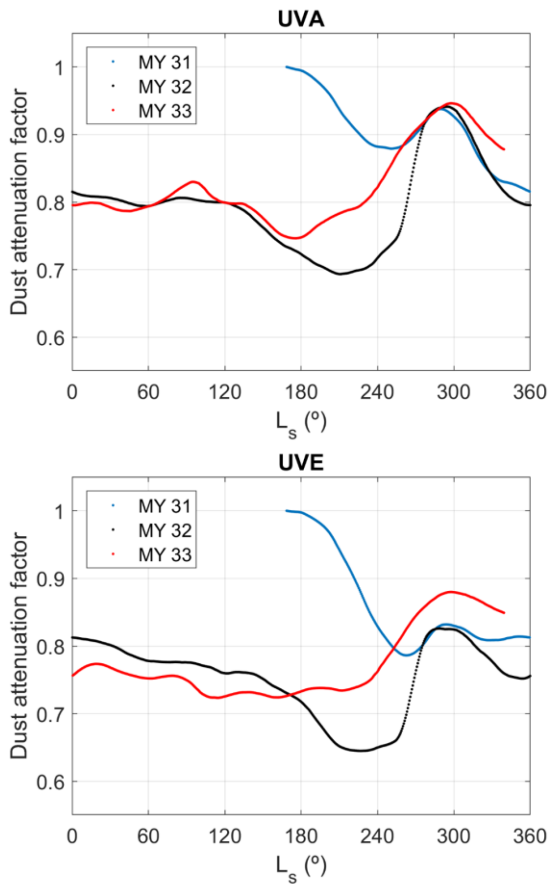

Figure 3. Temporal evolution of the dust attenuation factor obtained for the UVA (top) and UVE (bottom) channels.

The dust attenuation factor shows a very similar temporal evolution for all the channels. During the first year of the mission (MY 32, blue) there is an abrupt decrease in the dust attenuation factor (which indicates an increase in the amount of dust deposited on the UVS) between L_s ~180º and L_s ~ 250º. Since then, the dust attenuation factor shows a seasonal behavior with features that are observed both in MY 32 (black) and MY 33 (red).

The most striking feature is the increase in the dust attenuation factor, which indicates removal of dust from the UVS, observed around L_s = 270º. This is the time of the year with the highest frequency of sudden pressure drops detected by the MSL mission, which can be caused by dust devils and by mechanically forced turbulence [6], and with strong and persistent northerly and northwesterly winds at Gale Crater [7].

Future work: We plan to calculate the dust attenuation factor for the six UV channels and to further analyze and discuss potential explanations for the temporal evolution of the dust deposited on the UVS [8].

Furthermore, dust deposition on the UVS and a non-physical discontinuity in the calibration functions when the solar zenith angle is above 30º cause time-dependent errors in the UV fluxes that can be found in the Planetary Data System (PDS). We plan to correct the UV fluxes on each of the six UVS bands and to make these results available in the PDS [9].

References: [1] Gómez-Elvira, J., et al. (2012) *Space Sci. Rev*. 170 (1-4), 583-640. [2] Vicente-Retortillo, Á., et al. (2017) *Geophys. Res. Lett.*, 44, 3502-3508. [3] Smith, M. D., et al. (2016) *Icarus*, 280, 234-248. [4] Wolff, M.J., et al. (2010) *Icarus*, 208 (1), 143–155. [5] Vicente-Retortillo, A. et al. (2015) *J. Space Weather Spac.*, 5, A33. [6] Ordonez-Etxeberria, I. et al. (2018) *Icarus*, 299, 308-330. [7] Rafkin, S. C. R., et al. (2016) *Icarus*, 280, 114–138 [8] Vicente-Retortillo, A. et al. (2018a) *Geophys. Res. Lett.* (in preparation). [9] Vicente-Retortillo, A. et al. (2018b) *J. Geophys. Res.: Planets* (in preparation).