VISIBILITY AND LINE-OF-SIGHT EXTINCTION MEASUREMENTS WITHIN GALE CRATER DURING THE 2018/MARS YEAR 34 GLOBAL DUST STORM BY CURIOSITY. Christina L. Smith[1], J. E. Moores[1], S. D. Guzewich[2], C. A. Moore[1], D. Ellison[3]. [1]York University, 4700 Keele Street, Toronto ON, M3J1PL, Canada. Email: chrsmith@yorku.ca. [2]NASA Goddard Space Flight Center, 8800 Greenbelt Rd, Greenbelt, MD, 20771, USA. [3]NASA Jet Propoulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA, 91109, USA.

Introduction: Gale Crater, the landing site of the Mars Science Laboratory (Curiosity) Rover, is a 154 km diameter impact crater on Mars, in the center of which sits Aeolis Mons (colloquially: Mount Sharp). The topography of Gale Crater strongly affects the atmospheric mixing in and around the crater (Tyler and Barnes, 2013), which can be investigated through, amongst other methods, measuring the abundance and distribution of aerosols. Curiosity has been measuring the line-of-sight extinction within Gale Crater (the total optical depth between Curiosity and the northernmost visible section of the crater wall) since Sol 100 (Moores et al. 2015, Moore et al. 2016, 2019) and has found a strong seasonal variation of approximately 0.06 km^{-1} which repeats annually.

Prior to the onset of the 2018/Mars Year 34 Global Dust Storm, the MSL Science Team prepared a cadence of observations to be executed in the event of a global dust storm occurring (Guzewich et al 2018). This cadence included a daily image used, as in Moores et al (2015) and Moore et al. (2016, 2019), to monitor the line-of-sight optical depth. This Global Dust Storm Campaign was initiated on Sol 2075 (7th June 2018) and persisted for approximately 100 sols. In addition to these northern-rim pointing images and as part of standard operating procedure, Curiosity took a number of images of the horizon at different azimuth angles which can also be used to monitor the optical depth between the rover and various regions of Gale Crater. This abstract details the results of measuring the extinction within Gale Crater as a function of time and azimuth angle throughout the 2018/Mars Year 34 Global Dust Storm.

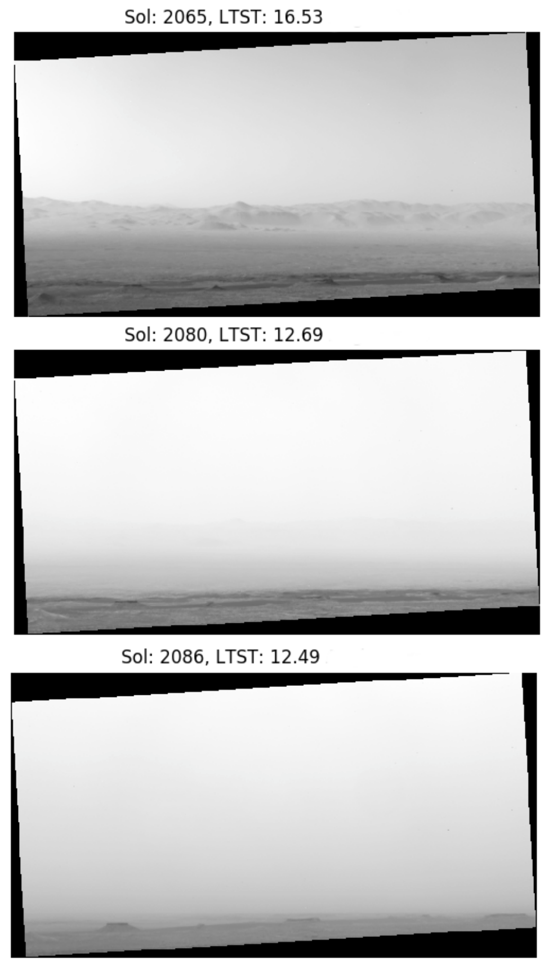

Figure 1 - North pointing images showing the initial decrease in visibility from the incoming storm.

Observations: All observations used within this work were taken with Curiosity's Navigational Camera (Navcam). Two subsets of Navcam images were used: images designed to monitor the line-of-sight extinction within Gale (North facing, 256 pixels high by 512 pixels wide) and horizon mosaics (8 different azimuths, 128 pixels high by 512 pixels wide). Examples of both can be seen in Figures 1 and 2 respectively. A total of 96 line-of-sight images were taken during the global dust storm, and a total of 208 individual horizon mosaic frames (making up a total of 26 horizon mosaics) were obtained plus an additional line-of-sight image and three mosaics (24 individual frames) taken after 2065 but prior to the initiation of the Global Dust Storm Campaign.

Method: Some of the standard assumptions used in previous works (Moores et al. 2015, Moore et al. 2016, 2018) to measure the line-of-sight extinction from the radiance of the sky, crater rim, and ground in images broke down during the Global Dust Storm. This is primarily due to the extreme optical depths of approximately 8.5 (Guzewich et al., 2018) experienced during the global dust storm, resulting in the crater wall becoming completely obscured and even foreground features becoming at least partially obscured by dust. Thus, a different method of extinction estimation was required.

Using the digital elevation model, constructed from High/Super Resolution Stereo Camera images (HRSC) on-board the Mars Express orbiter (Gwinner et al. 2010), and correlating with every image (see Fig. 3 for an example), the maximum visible distance was measured for every image. To determine an estimated extinction coefficient from the maximum measured distance, Koschmieder's Law (Koschmieder, 1924) for daytime visibility was applied:

$$\beta\left(km^{-1}\right)=\frac{-\ln(0.05)}{D(km)}$$

where β is the extinction coefficient in km, D is the distance of the furthest discernible feature and 0.05 was used as the contrast threshold.

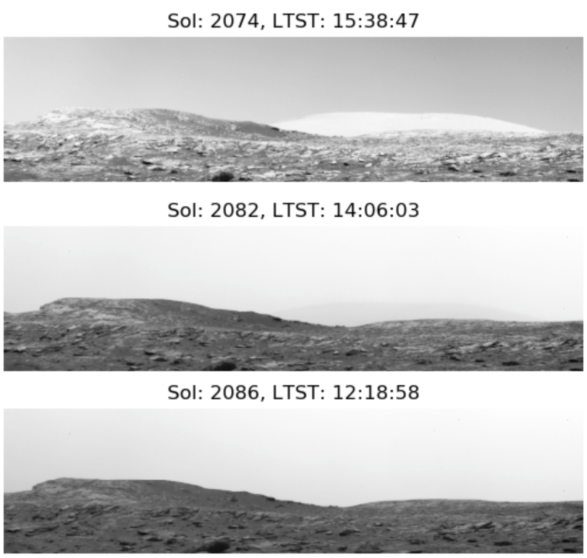

Figure 2 - East facing images showing the initial decrease in visibility – note the disappearance of Aeolis Mons by Sol 2086.

Results: The preliminary results for all north facing images are shown in Figure 4. There is an initial increase in extinction from standard seasonal values, peaking around Sol 2095, several sols later than the peak of the column optical depth above the rover (Guzewich et al, 2018). There then follows a steady decline down to approximately seasonal values of 0.1 km^{-1} or below by Sol 2150. The peak value is approximately ten times larger than previous years' measured peak values (Moore et al. 2016, 2018). All other azimuthal pointings are currently in progress and the results will be available by the date of the Lunar and Planetary Sciences Conference.

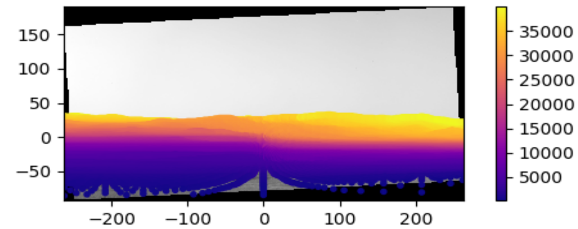

Figure 3 - Example digital terrain modeled field of view for the north-facing image on Sol 2075. Color bar indicates distance from the rover in meters.

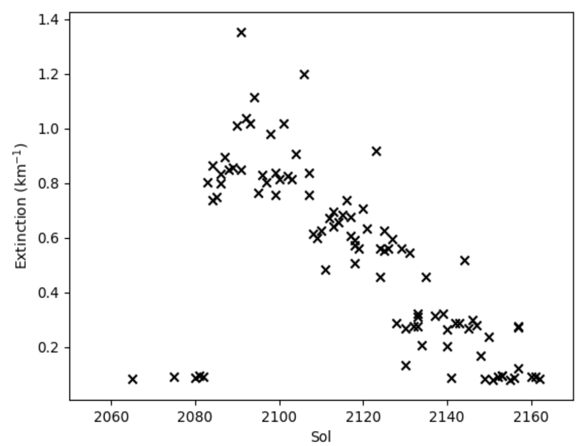

Figure 4 - Calculated extinction values (in km^{-1}) for all north-facing images during the global dust storm.

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