

Local wind direction and speed conditions during the martian dust storm occurrences in the Acidalia Planitia based on EMARS analysis

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Martian dust storms are the most characteristic meteorological phenomena on Mars. They have a significant impact on the thermal structure and circulation of the atmosphere through the radiative effects of airborne dust (Kass et al., 2016). In addition, dust storms should be a concern for future exploration, including human missions, because increased dust in the atmosphere reduces visibility and prevents solar power generation. Therefore, it is important to understand the mechanism and conditions of their occurrence, and by accurately predicting them, lead to the realization of weather forecasting on Mars. Battalio and Wang (2021) examined statistical characteristics by tracking dust storms larger than 10^5 km^2 from Mars Daily Global Maps over 8 Mars years (MY). They found that the dust storms were more frequent in the northern hemisphere during the fall and winter seasons, especially in the Acidalia Planitia. It has also been suggested that the baroclinic waves influence the northern hemisphere events (Hinson, 2006; Hinson et al., 2012). We analyzed a specific period (MY24-26, $L_s^* = 180-210^\circ$) and region (Acidalia Planitia: $40-60^\circ\text{N}$, $105^\circ\text{W}-30^\circ\text{E}$), and found that the mean wind direction before and after the events was significantly north-westerly. Furthermore, our analysis showed that northerly winds associated with the transition from the trough to the ridge of the baroclinic waves should have influenced them (Ikeda et al., The Meteorological Society of Japan Autumn meeting 2023). In fact, local winds are influenced by topography and seasonal changes in the atmospheric circulation, so it is necessary to carry out quantitative analyses on a site-by-site approach to forecast the events more accurately. This study aims to investigate the conditions for the events, focusing on the wind direction and speed in the area spanning 6° longitude \times 5° latitude.

We used the Ensemble Mars Atmosphere Reanalysis System (EMARS) dataset of east-west and north-south winds for MY24-32 (corresponding to Earth 1999-2015) (Greybush et al., 2019) and the Mars Dust Activity Dataset (MDAD) (Battalio and Wang, 2021), which summarizes dust storm activity over the same period. We obtained information from MDAD on dust storm events in MY24-32 for each $6^\circ \times 5^\circ$ area corresponding to the EMARS grid, and compiled wind direction and speed data for 1 sol^2 including the occurrence of a dust storm using the EMARS wind data as the 'occurrence' condition. In addition, the wind data for MYs in which dust storms did not occur in the same L_s and area were also compiled as the 'non-occurrence' condition, and the comparisons between the two conditions were made to investigate the dust storm occurrences.

We analyzed 8 dust storms (3 in spring $L_s = 0-60^\circ$ in the northern hemisphere, 3 in autumn $L_s = 180-240^\circ$, and 2 in winter $L_s = 300-360^\circ$) that occurred in $54 \pm 2.5^\circ\text{N}$ and $57 \pm 3^\circ\text{W}$ of the Acidalia Planitia. The results showed that the wind direction for the 'occurrence' in spring was more concentrated in the southeast to southwest direction than the 'non-occurrence'. In winter, dust storms occurred only in southwest to northwest winds, especially the west-northwest wind condition accounted for more than 30%. In spring and autumn, there were no significant differences in wind speeds between the 'occurrence' and 'non-occurrence'. On the other hand, in winter, about 70% of the 'occurrence' had wind speeds between 15 and 25 m s^{-1} , while about 60% of the 'non-occurrence' had wind speeds between 5 and 15 m s^{-1} .

In the presentation, we also plan to show the results of extending the analysis area to e.g., 18° longitude \times 15° latitude, to increase the number of cases to improve the reliability, and adapting it to the entire Acidalia Planitia, as well as the results of dust storm reproduction experiments using the obtained

occurrence conditions and a GCM (Global Climate Model).

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