THE SPATIAL AND TEMPORAL PROBABILITY OF DUST STORM ACTIVITY IN ISIDIS, ONE OF THE TENTATIVE LANDING AREAS OF CHINA'S FIRST MARS PROBE. Peiwen Yao[1], Chenfan Li[1], Bo Li[1*], [1]Shandong Provincial Key Laboratory of Optical Astronomy and Solar-Terrestrial Environment; Institute of Space Sciences, Shandong University, Weihai, China. (E-mail address: libralibo@sdu.edu.cn)

Introduction: China will launch the first Mars mission in 2020, the selection of landing site is crucial. The formation of dust storm related with the wind and weather, it has a certain influence on visibility of the Mars surface [1], so it is meaningful to research the occurrence probability of the dust storm during the landing period. Previous studies have shown the spatial and temporal probability of Chryse, one of the tentative landing areas of China's first Mars probe. So, it is important to study the occurrence probability of dust storm in another tentative landing area, Isidis site.

Method: In this paper, we used MARCI and MOC Mars 24 to 32 years' data, drew a ring with a radius of 2000 km around the Isidis and the Southern Utopia, another pre-selected landing area of China's first Mars probe, we have identified 882 dust storms during these eight years altogether.

(1) The period (MY25 Ls=187°-262°and year PMY28 Ls=268°-305°) were excluded because of the planet-encircling dust storm in this period. Based on the recognition results, the average daily dust storm activity probability P (A) can be given by Cantor [2]:

$$P(A)=\left\{\sum_{i=1}^{8}\frac{N(i,d)\times A(i,d)}{n(d)}\right\} \quad (1)$$

In Eq (1), i is the index of the Martian year and there were a total of eight in MOC and MARCI MGDMs, $N(i, d)$ is the number of dust storms in a given sol (d), $A(i, d)$ is the dust storm area in the monitoring ring, and $n(d)$ is the number of dust storms observed in a given sol (d). The probability of repeated dust storms on the same sol (d) for eight years eight Martian years can be given by:

$$P(d)=\left\{\sum_{i=1}^{8}\frac{Is(i,d)}{8}\right\} \quad (2)$$

Where Is (i, d) represents whether there is a dust storm on the Martian year (i) sol (d). If there is a dust storm on the Martian year (i) sol (d), it is 1; when there is no dust storm, it is 0. According to Eqs (1) and (2), the daily average probability P (d, A) of dust storm considering the temporal probability and repeated probability is:

$$P(d,A)=P(d)\times P(A) \quad (3)$$

(2) We divided the 2000 km radius ring of Isidis into regular square grids with 0.5° length. The average spatial probability of dust storm in 0.5° grids in a Martian year can be calculated by:

$$P(A)=\left\{\sum_{i=1}^{8}\frac{N(i,g)\times A(i,g)}{n(g)}\right\} \quad (4)$$

In Eq (4), i is the index of the Martian year and there were a total of eight in MOC and MARCI MGDMs, $N(i, d)$ is the number of dust storms in a given grid (g), $A(i, g)$ is the dust storm area of a given grid (g), and $n(g)$ is the number of dust storms observed in a given grid (g). The probability of repeated dust storms in the same grid (g) for eight years eight Martian years can be given by:

$$P(g)=\left\{\sum_{i=1}^{8}\frac{Is(i,g)}{8}\right\} \quad (5)$$

Where $Is(i, g)$ represents whether there is a dust storm on the Martian year (i) grid (g). If there is a dust storm on the Martian year (i) grid (g), it is 1; when there is no dust storm, it is 0. According to Eqs (4) and (5), the spatial average probability $P(g, A, s)$ of dust storm considering the spatial probability and repeated probability is:

$$P(g,A,s)=P(A)\times P(g) \quad (6)$$

Results: According to Eq (3) and Eq (6), the average daily probability and average spatial probability are shown as Fig. 1 and Fig. 2, respectively.

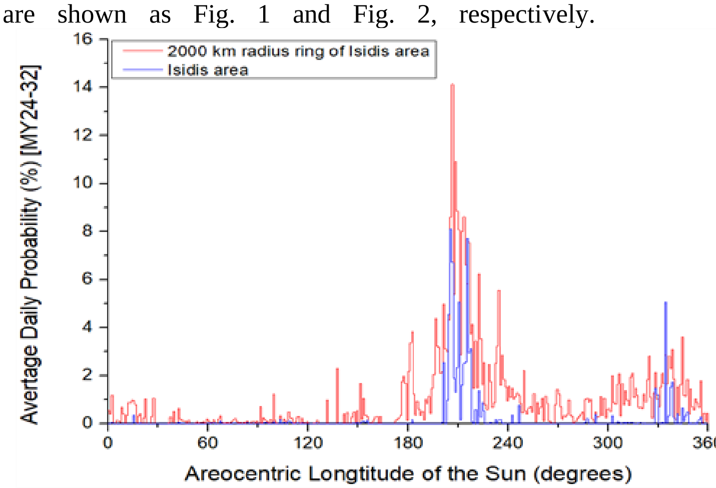

Fig.1 Daily average dust storm frequency as a function of Ls for the Isidis site area (blue color) and within its 2000 km radius ring (red color), binned in 1° of Ls.

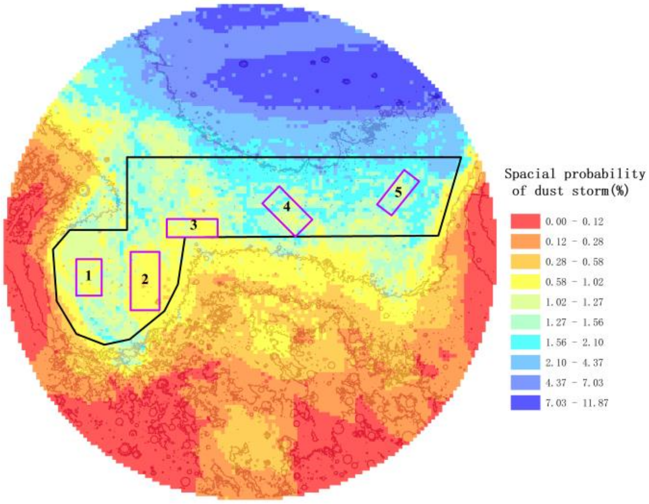

Fig.2 The spatial probability of dust storm activity within 2000 km radius ring of Isidis site area in MY in 0.5° grids. The black polygon shows the Isidis site area. Topography is shown with black contours (1.5 km interval) for reference. The purple rectangles marked with number 1-5 are the PLAs

(1) We calculated the daily probability of dust storms occurrences for eight years in the 2000 km ring (Fig.1). The average daily probability of dust storm in the 2000 km ring of Isidis site is 0.99% during a Martian year. Besides, we have found the occurrence of dust storms shows obvious seasonal and inconsecutive. The dust storm mainly occurring in two window periods, Ls=176°-250° and Ls=300°-356° with average daily probability of 2.93% and 1.91%. These periods belong to autumn and winter in the northern hemisphere, respectively. The transformation of dust storm activity is related with the seasonal fluctuation of ice cap in the northern polar. The dust storm activity in Isidis mainly came from the northern polar cap region and Utopia, but there are also a small number of dust storms came from the southern hemisphere (Hellas) which travelled northward. At the same time, we found the optimal time range for landing is Ls=20°-55° in EDL season with a lower average daily probability ranged from $\leqslant$ 0.5% and an average probability of 0.2%.

(2) We used 0.5 °×0.5 ° square grids to segment the 2000 km ring to calculate the average probability of dust storm happened in each grid during eight Martian years (Fig.2). Our results show that the spatial probability of dust storm reduced from north to south and the highest spatial probability is 11.9% in the southern plain of Utopia. Utopia is an important source of dust storm in the northern hemisphere. The dust storm originated form the Utopia and then migrated to the south, crossed the equator, and finally spread and dissipated in the low-latitude regions of the southern hemisphere. While, there is a fork of distribution of dust storm probability in the middle of the ring, which is due to the moving sequence of dust storm. The Utopia sequences, one sequence turned slightly eastward toward the southeast to Hesperia. The other sequence turned westward through the north of Isidis and went around the area north of Hellas [1]. In addition, dust storms originating in the Hellas plain also pass through the southern part of the study area as they move northeast. In the end, according to spatial probability, we selected five preferred landing areas with lower dust storm probability. The areas of five PLAs are 61486.1 km^2, 112432 km^2, 61486.1 km^2, 74934.1 km^2 and 61486.1 km^2, with an average spatial probability of 0.73%, 1.01%, 0.67%, 1.4% and 1.2% during a whole Martian year.

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References: [1] Wang, H., & Richardson, M. I. (2015) Icarus, 251, 112-127. [2] Cantor, B. A. et al. (2019). Icarus. 321, 161-170.