

### The Blue Clearing at Syrtis Major and its Relation to Equatorial Clouds: 1997 and 1999 Observations

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**Introduction:** We observed Mars with a CCD camera attached to the 65 cm refractor at Hida Observatory in the 1997 apparition, and the 60 inch reflector at Steward Observatory in the 1999 apparition. In both of the observational periods it was summer in the northern hemisphere of Mars. Many clouds appeared in the equatorial region and mid latitudes of the northern hemisphere. Those clouds are classified into morning, afternoon, and evening clouds. The morning and evening clouds have a large dimension extending from mid latitudes in the southern hemisphere to mid latitudes in the northern hemisphere. The afternoon clouds tend to appear near local noon at large volcanoes in Tharsis and Elysium. They are visible through the local afternoon. Their dimension is considerably smaller than morning and evening clouds. Clouds of those three types are the most active in late spring to mid summer in the northern hemisphere. In this period low latitudes are overspread with clouds, and the equatorial cloud belt is formed. The cloud belt extends from 10° S to 30° N ([1], [2]).

Figure 1 shows the cloud belt in 1999. It was exposed in blue. In this image, a bright spot is visible near the light-hand limb and a large bright area near the south pole. They are an afternoon cloud at Elysium and a cloud on Hellas, respectively. Near the disk center, Syrtis Major is dimly seen.

In general, dark surface features are not identified in blue, because the surface albedo is almost uniform everywhere in blue. However they are occasionally visible in blue. This phenomenon is "blue clearing" in a classical term.

**Blue Clearing in Syrtis Major Region in 1997:** Analyses of the images exposed in blue on 1997 March 3, 4, 5 and 9 have been proceeded. In this observational period, it was on March 5 that the blue clearing was most clearly seen.

We have examined the diurnal variation of the contrast between Syrtis Major and the adjacent bright areas, and have also calculated the diurnal variation of the cloud opacity in the dark feature of Syrtis Major and the bright areas of Arabia and Isidis.

Syrtis Major lies between bright areas of Arabia and Isidis, hence we selected several data points around the following three points: (290° W, 15° N) in

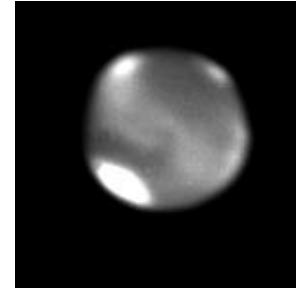


Figure 1. Blue Clearing in Syrtis Major region. The equatorial cloud belt can be seen. Large bright spot near the south pole is the cloud on Hellas.

Syrtis Major, (310° W, 10° N) in Arabia, and (275° W, 15° N) in Isidis. We also selected some cloud-free reference points around the central meridian in mid-to high latitudes in the northern hemisphere. Then the contrast between the data points and the reference points can be derived. The degree of blue clearing at Syrtis Major, i.e., the its visibility in blue, depends on the contrast between Syrtis Major and the adjacent bright areas. We define the degree of blue clearing at Syrtis Major as follows:

$$D = (B_b - B_s) / B_b \times 100 ,$$

where  $B_b$  is the brightness of the data point in Isidis or Arabia, and  $B_s$  is that of Syrtis Major. In Figure 2, the degree of blue clearing is plotted against the Martian local time (MLT) at Syrtis Major; 12 MLT is the local noon. The degree of blue clearing  $D$  rapidly decreases toward evening. The observations in 1982 show that the degree of blue clearing  $D$  increases with MLT during the morning and reaches a peak around local noon ([3]).

We also calculated the cloud opacity at Syrtis Major in 1997 periods and derived its diurnal variations. The optical depth gets to a minimum at around 13 MLT.

**1999 observations:** Similar analyses of the images exposed in blue on 1999 April 20 have also been proceeded.

In this apparition, the blue clearing phenomena in Syrtis Major region were generally less clear than in 1997 apparition. Preliminary analyses suggest that

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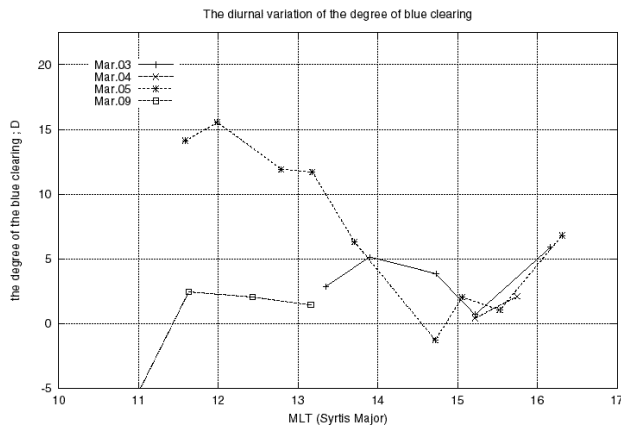


Figure 2. Diurnal variation of the degree of the blue clearing  $D$ .

it may be because the equatorial clouds were considerably thick and/or the opposition effect was weak. We attribute both of the reasons to their seasonal variations.

We have tried to find the correlation of the diurnal variation of  $D$  to that of the cloud opacity in Syrtis Major region, and some plausible interpretations will be presented here.

**Summary:** The difference of the cloud optical depth  $\Delta\tau$  between Arabia and Syrtis Major is shown in Figure 3. The feature of  $\Delta\tau$  decreasing in the afternoon is similar to that of the degree of blue clearing  $D$ .

The facts we have described here suggest that the morning clouds keep the minimum opacity even in midday and shift to the evening clouds increasing their opacities, and that the contrast between Syrtis Major and the adjacent bright areas gets larger because the cloud opacity at Syrtis Major decreases around local noon.

**References:** [1] Clancy, R. T., A. W. Grossman, M. J. Wolff et al. (1996) *Icarus* 122, 36.  
 [2] James, P. B., J. F. Bell III, R. T. Clancy et al. (1996) *J. Geophys. Res.* 101, 18883.  
 [3] Akabane, T., K. Iwasaki, and Y. Saito. (1990) *J. Geophys. Res.* 95, 14649.

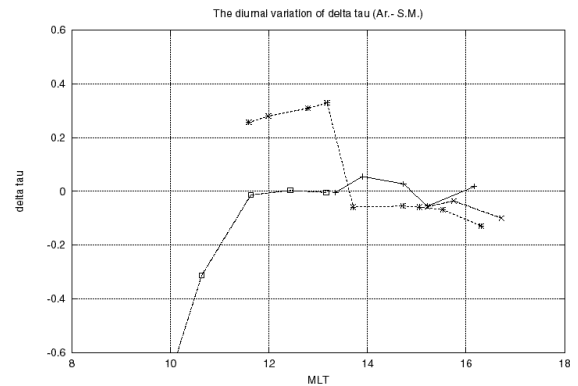


Figure 3. Diurnal variation of the difference between the optical depth at Syrtis Major and that at Arabia.