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OPTICAL THICKNESS OF THE OLYMPUS CLOUD:

Y.NARUMI, Kyushu-Tokai University,Kumamoto 862,JAPAN.

Considering the seasonal cycle of water on Mars, it is very important to understand the nature of the water ice cloud on Mars, for example, the blue-white cloud over the Tharsis region, the polar hoods of the north and south polar regions. As the first approach to examine the nature of those clouds, we have estimated the optical thickness of the "Olympus cloud". In the afternoon of the Martian northern summer, a blue-white bright cloud has been often observed to appear near the summit of the Olympus Mons(20°N, 137°W). This cloud is usually called as the "Olympus cloud". The relative brightness of this cloud to the cloud-free point at the same location were determined from the photographic observations by Hida and Kwasan observatories in the 1982 apparition. Fig.1 shows the observed relative brightness of the cloud from the blue negatives(effective wavelength of 0.4μm) as a function of the Mars Local Time(MLT). Using the Discrete-Ordinate Method for radiative transfer to the inhomogeneous cloudy atmosphere, we calculated the reflected intensities from the top of the cloud having various optical thickness. Comparing those intensities with those from the cloud-free point, we estimated the diurnal variation of the optical thickness of the cloud.

The calculation scheme of the Discrete-Ordinate Method for the inhomogeneous cloudy atmosphere is based on Liou(1) and Moriyama(2). They calculated the reflected fluxes from the cloud. We expanded this scheme to the reflected intensity calculation using the Delta-M approximation for the strongly asymmetric phase function of ice cloud particles(Wiscombe(3)). The entire atmosphere is devided into ten homogeneous layers of 3km thick. Each layer includes the atmospheric gas(CO_2), dust particles, and ice cloud particles in different ratio from the other layers. The boundary and continuity conditions are as following: at the top of the atmosphere there is no diffuse downward intensity; at the interface of each homogeneous layer the upward and downward intensities have to be continuous; and at the bottom of the atmosphere, assuming an isotropic reflection surface with an albedo A_s, the upward intensities can be expressed in terms of the downward diffuse flux and the downward direct solar flux.

The scattering phase function of the Martian ice cloud particles is unknown, but it may be nonspherical. So that we approximated the laboratory data for the nonspherical ice particles by Sassen and Liou(4) with the semi-empirical theory of Pollack and Cuzzi(5). For the dust particles in the Martian atmosphere we adopted the phase function obtained from the Viking Lander Camera's observation (Pollack et al.(6)). We assumed the optical thickness of CO_2 gas and dust particles as 0.01 and 0.1, respectively and A_s=0.061 for λ =0.4 μm.

As the height of the Olympus cloud is unknown, we have examined three cases of the height distribution of cloud; (a) Low cloud case (cloud height is 0-15km), (b) Middle cloud case(9-24km), (c) High cloud case(15-30km). The calculated results show that the obtained optical thickness are scarcely affected by the height distribution of cloud. Fig.2 shows the estimated optical thickness from the Middle cloud case as a function of MLT. From Fig.2 it is found that the Olympus cloud appears near the local noon of Mars, and reaches the maximum optical thickness of about 0.8 in the early afternoon, then falls off slowly thereafter. The maximum optical thickness of about 0.8 is not contradict with the results from the Viking Orbiter observations(Christensen and Zurek(7)). We would like to estimate the optical thickness of the polar hoods and to examine the thermal effect of the polar hoods to the growth of the polar caps.

REFERENCES

1. Liou,K.N.(1975) J.Geophys.Res.,vol.80,3434-3440.
2. Moriyama,S.(1978) Atmospheric Environment,vol.12,1875-1887.
3. Wiscombe,W.J.(1977) J.Atmos.Sci.,vol.34,1408-1422.
4. Sassen,K. and Liou,K.N.(1979) J.Atmos.Sci.,vol.36,838-851.
5. Pollack,J.B. and Cuzzi,J.N.(1980) J.Atmos.Sci.,vol.37,868-881.
6. Pollack,J.B.,Colburn,D.,Kahn,R.,Hunter,J.,Camp,W.V.,Carlston,C.E., and Wolf,M.R.(1977) J.Geophys.Res.,vol.82,4479-4496.
7. Christensen,P.R. and Zurek,R.W.(1984) J.Geophys.Res.,vol.89,4587-4596.

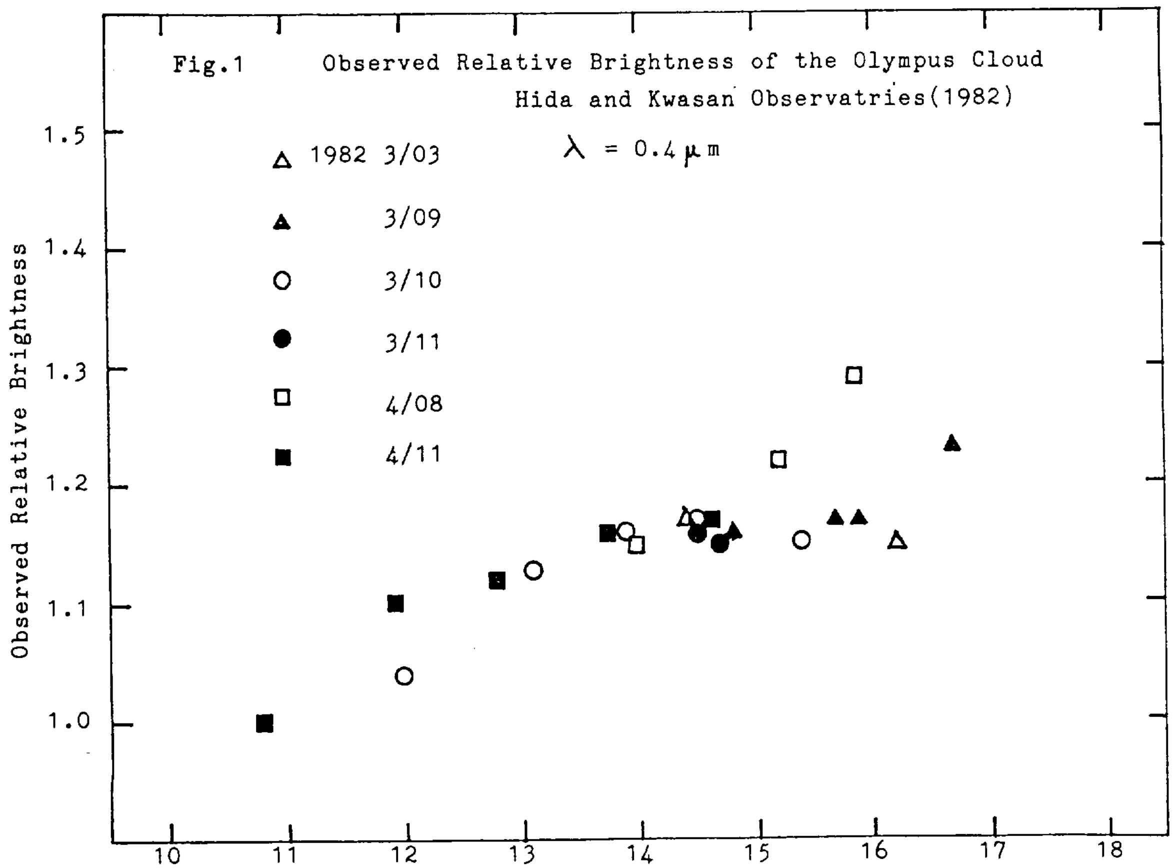
Fig.1 Observed Relative Brightness of the Olympus Cloud
Hida and Kwasan Observatries(1982)
1982 3/03
3/09
3/10
3/11
4/08
4/11
λ = 0.4 μm
Observed Relative Brightness
1.5
1.4
1.3
1.2
1.1
1.0
10
11
12
13
14
15
16
17
18

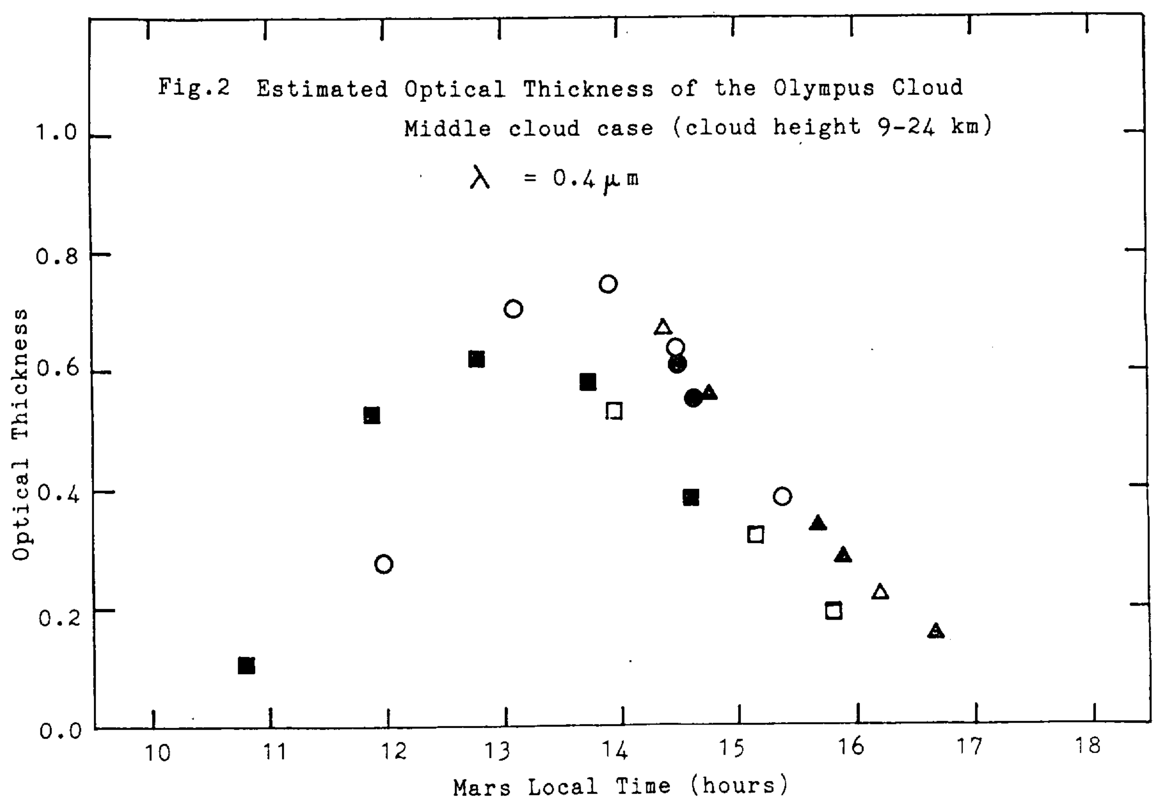
Fig.2 Estimated Optical Thickness of the Olympus Cloud
Middle cloud case (cloud height 9-24 km)
λ = 0.4 μm
Optical Thickness
1.0
0.8
0.6
0.4
0.2
0.0
10
11
12
13
14
15
16
17
18
Mars Local Time (hours)