SPACE RESEARCH COORDINATION CENTER

THE ALTITUDE OF THE SCATTERING LAYER NEAR THE MESOPAUSE OVER THE SUMMER POLES

BY

T. M. DONAHUE AND B. GUENTHER

SRCC REPORT NO. 182

UNIVERSITY OF PITTSBURGH
PITTSBURGH, PENNSYLVANIA

JANUARY 1973

The Altitude of the Scattering Layer near the Mesopause over the Summer Poles

T. M. Donahue and B. Guenther
The University of Pittsburgh
Pittsburgh, Pennsylvania 15213

ABSTRACT

The variation in radiance and altitude with time and latitude is reported for the dense scattering layers observed over the summer poles by the OGO VI airglow photometer. The average altitude was 84.3° km with a tendency for higher values on the night side than on the day side of the polar cap. The average radiance increased by a factor of 5 between day 163 and day 180, 1969 but decreased thereafter.

Recently we reported the observation of a scattering layer that develops over the summer pole near the mesopause beginning about 12 days before the solstice (Donahue et al, 1972). The discovery of these layers of which noctilucent clouds appear to be extensions was made by a narrow field horizon scanning airglow photometer aboard the OGO-6 satellite. Above 75° latitude the layers appear to contain between 4 and 8 x 10^6 cm^{-2} particles in a layer less than 5 km thick, if the particles are spherical ice crystals of 1300Å radius. This is about 50 times the optical depth of noctilucent clouds. Here we wish to report briefly a few other characteristics of these layers.

We have determined how the altitude of the layer varied with (northern) latitude for a large number of passes by the satellite between day 162 and day 186 in the summer of 1969. Variations in the orientation of the satellite finer than could be sensed and reported by the attitude control system caused significant apparent changes in the altitude of the layer. These effects could be verified and corrected for by reference to the profile of the Rayleigh scattered light. By making use of the Rayleigh scattering signal it is possible to determine the altitude of the scattering layer relative to a given pressure level for each observation. For the present this arduous exercise has not been performed. Instead we have been content to obtain the average altitude in several latitude bands each 5° wide for each Greenwich day between day 162 and day 186. The latitude bands are further divided in two halves, one on the day side and the other on the night side of the polar cap. Between 40 and 100 observations for each semi-annulus are usually available for averaging in this way.

The grand average altitude (2600 observations) was 84.3 km. In Fig. 1 the results are displayed in several ways. In Fig. 1a the average

over all latitudes for each day is presented. There seems to be a significant tendency for the average altitude of the layers to drop as the season progresses. By day 185 it is about 1.5 km below the value on day 163. And on day 186 there is a very sharp reduction. In Fig. 1b the average over all days is plotted as a function of latitude starting with the semi-annulus between 70 and 75° on the night side and ending with the semi-annulus between 75° and 70° on the day side. Here there appears to be a decided tendency for the layer to be lower on the day side. The effect is most pronounced in the 70-75° band where the layer is at 85.3 ± 0.8 km on the night side but at 82.7 ± 0.6 km on the day side. In Fig. 1c it can be seen how the altitude varied with time in each of the eight regions.

During the period from day 162 to day 185 the average radiance of the layers increased by a factor of about 5 from 10 kR/Å to 45 kR/Å (Fig. 2). There was a sharp drop at day 186. The typical maximum values observed on a pass increased from 25 kR/Å on day 163 to 120 kR/Å around day 180. On day 180 itself maximums of 250 kR/Å were seen.

Unfortunately, for technical reasons having to do with the altitude and orientation of the satellite we were never able to follow the clouds during their waning phase. Thus it is not possible to complete the description of the way that the radiance and altitude behaved as the optical thickness diminished.

Acknowledgments

This work was supported by NASA Grant NA5511077 and National Science Foundation, Atmospheric Sciences Division (Aeronomy), Grant GA-27638. We wish to thank the personnel of the OGO project for always expert support and assistance.

References

Donahue, T. M., Guenther, B. and J. E. Blamont, 1972: Noctilucent Clouds in Daytime: Circumpolar particulate layers near the summer mesopause, J. Atmos. Sci. 29, 1205, 1972.

Figure Captions

Fig. 1a Average altitude, all latitudes, as function of day in 1969.

Fig. 1b Average altitude, all observations, as function of latitude bands I, VII: 70°-75°; II, VI: 75°-80°; III, V: 80°-85°; VI 85°-90°.

Fig. 1c Average altitude in individual bands as functions of time.

Fig. 2 Maximum and average radiances observed during 24 hour periods from serial day 163 through 186.

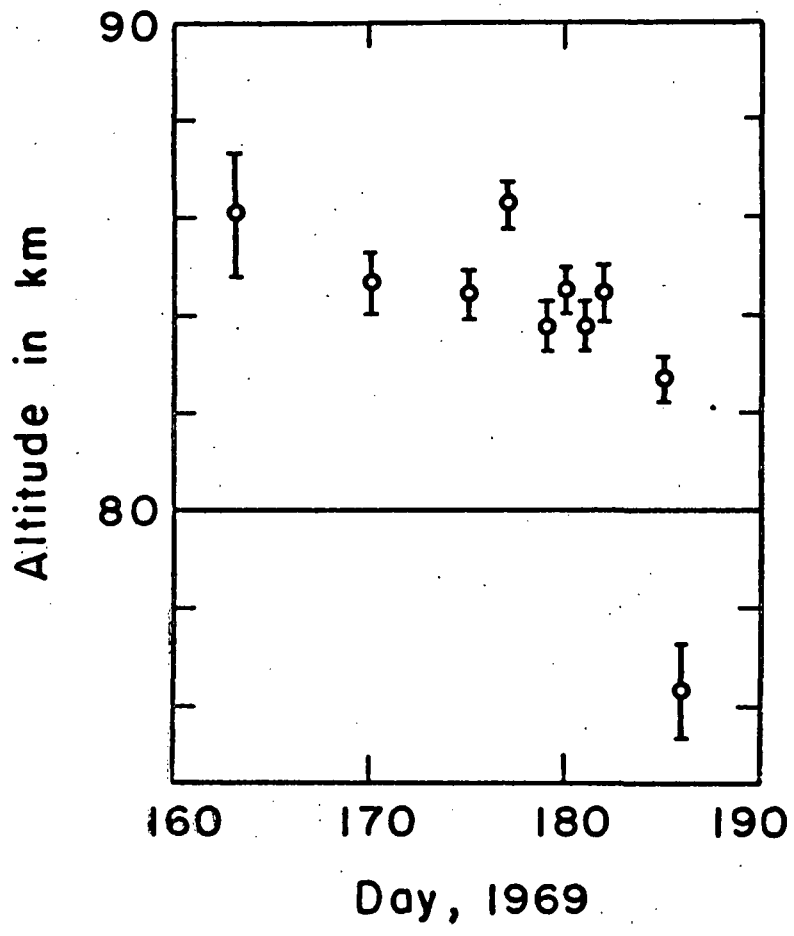

Figure 1a

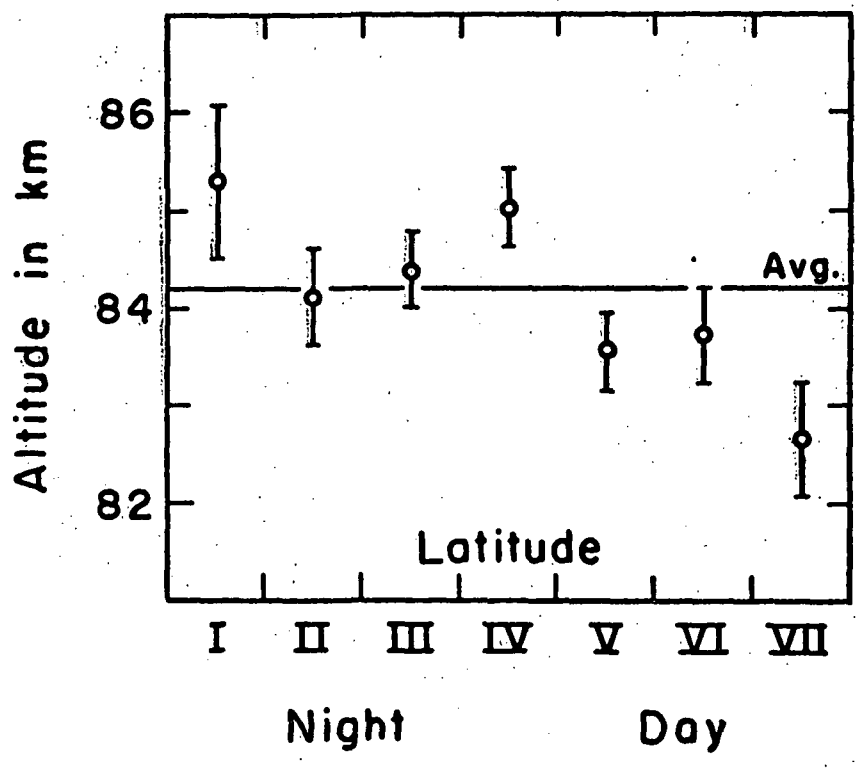
Altitude in km
86
84
82
Avg.
Latitude
I
II
III
IV
V
VI
VII
Night
Day

Figure 1b

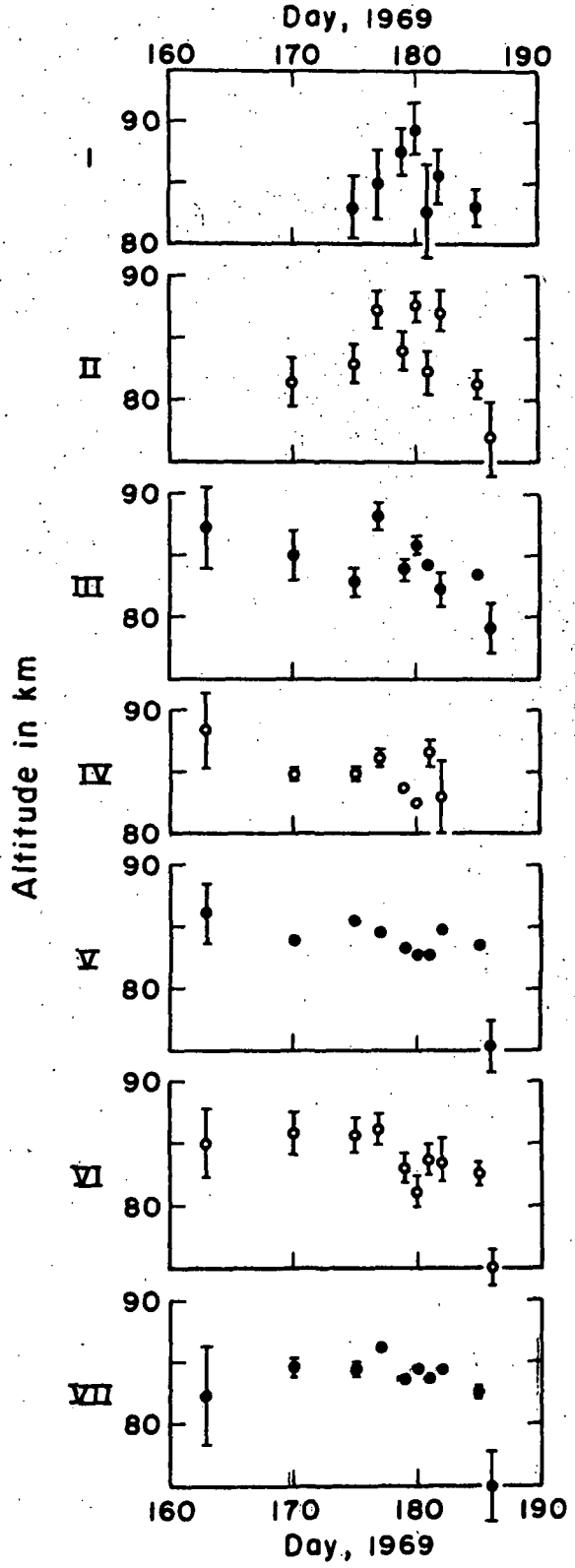
Day, 1969
160
170
180
190
90
80
I
II
III
IV
V
VI
VII
Altitude in km
Day, 1969

Figure 1c

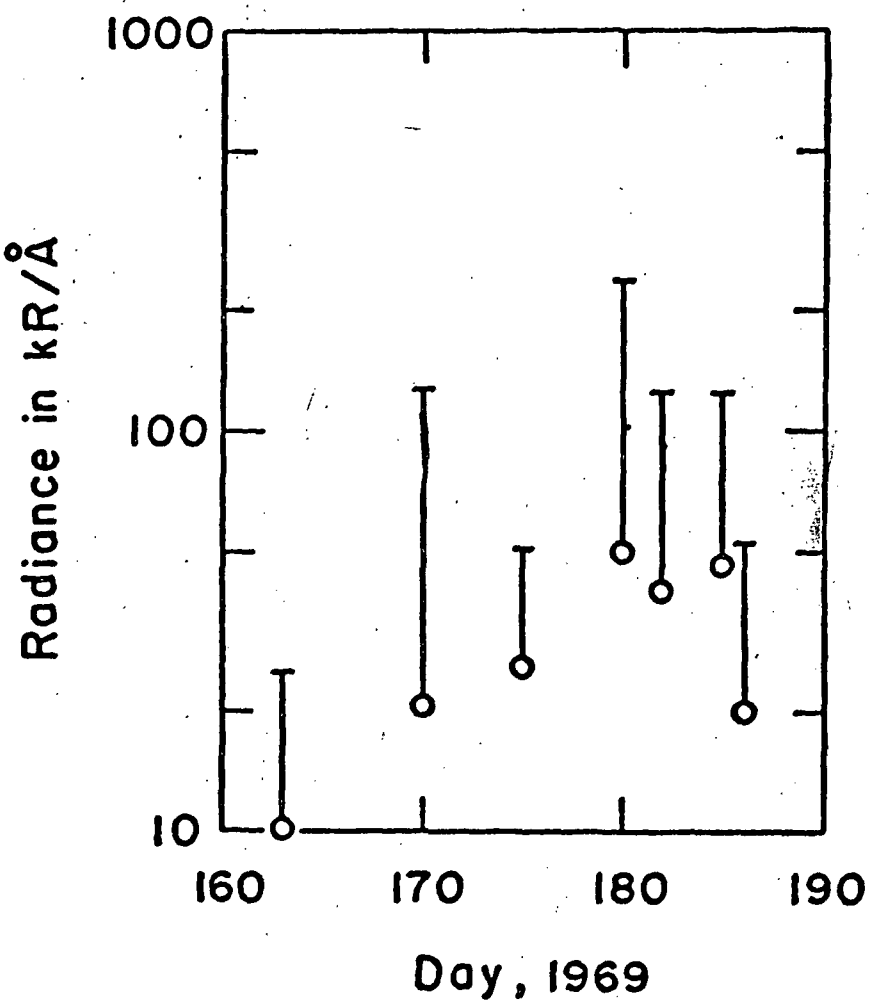

Figure 2