551.521.17 : 551.510.534

HEATING RATE DUE TO ULTRA-VIOLET ABSORPTION BY OZONE OVER INDIA

1. Vertical distribution of ozone concentration obtained from rocket ozonesonde measurement at Trivandrum, India have been used to obtain heating rate due to solar ultra-violet absorption by ozone. Results obtained show that the heating rate is maximum in the upper layer of stratosphere (45-55 km) and this heating is mainly contributed by absorption in Hartley band. Results are compared with global mean heating rate and found that they are in good agreement.

2. Negative lapse rate of temperature in the stratosphere is attributed to the presence of ozone layer which has special optical property of absorbing incoming solar ultra-violet (UV) radiation and thereby heating the atmosphere. This heating mechanism is dominant in the tropical region. India, a tropical country has recently started a systematic programme of atmospheric ozone measurements based on rocket ozonesondes which can give the vertical profile of ozone concentrations up to an altitude of 70 km or more. So far, no study has been reported on the heating rate due to UV-absorption by ozone based on this data. Therefore, an effort has been made to obtain the vertical profile of this heating rate as follows.

3. *Methodology and Data used* — Vertical distribution of ozone concentration obtained from day and night series of 1980 and 1981 rocket ozonesonde measurement at Thumba near Trivandrum (8°29′ N, 76° 57′E) have been taken from Subbaraya (1983). Recently available data of solar spectral irradience and photoabsorption cross-section compiled by Deshpande and Mitra (1983) have been adopted to calculate the photodissociation coefficient of O_3 in two bands of UV-region, *viz.*, Hartley band : 2000 to 3100° A and Huggins band : 3100 to 3400° A. The following formulae have been employed to compute the photodissociation rate (J) and the actual heating rate (Q) per unit volume at a level z respectively.

(*i*) *Photodissociation rate coefficient*

$$J_{0_3}(z) = \Sigma\, Q_{0_3}(\lambda).\ \sigma(\lambda).\ L_T.\ \exp\left[-\sum_{\lambda}\sigma(\lambda)\right] \times \left[O_3(z)\right]\left[\left(1+\frac{2z}{R}-\cos^2\phi\right)^{-\frac{1}{2}}\right] \quad (1)$$

where, $\cos\phi = \cos\theta\ \cos\wedge\ \cos\delta + \sin\wedge\ \sin\delta$ and $Q_i(\lambda)$, the quantum efficiency at wave length λ; $\sigma(\lambda)$, the absorption cross-section; L_T, the solar photon flux (no. of photos/cm^2 at the top of the atmosphere); $O_3(z)$, the number density of ozone at height z; R, radius of the earth; $\wedge$, the latitude of the earth; δ, the solar declination angle; θ, the zenith angle.

(*ii*) *Actual heating rate*

$$Q(z) = [O_3] \int_{v} J(z).\ (hv - D_{o_3} - E_{o_3})\, dv \quad (2)$$

where h is Plank's constant, D_{o_3} is dissociation energy and E_{o_3} is excitation energy.

The calculations are worked out for the month of July and the length of the daytime at Trivandrum city given in parts of 24 hours is taken as 0.519 and weighted mean value of $\cos\phi$ is 0.593.

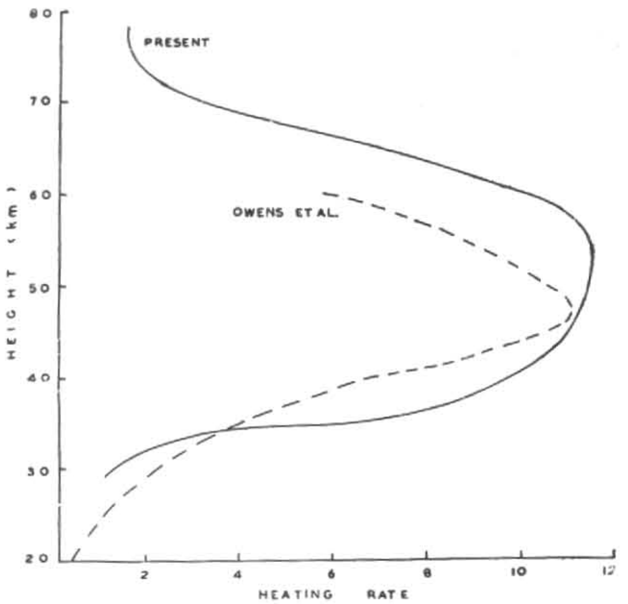

Fig. 1. Actual heating rate (°K/day) due to solar radiation absorption by ozone

4. *Results and discussion* — The actual heating rate due to solar radiation absorption by ozone in the stratosphere is presented in Fig. 1. It can be seen that, it is maximum in the upper layer of stratosphere (45-55 km). Although ozone concentration is maximum at about 25 km, heating is not maximum over there and an appreciable amount of ozone is also present in troposphere where heating is negligible, because all the solar radiation that could be absorved by O_3 has already been absorbed at higher levels. Above 60 km, the heating rate decreases sharply. Further, it is found that the absorption of radiation in the Hartley band is the principal mechanism of heating the atmosphere in stratosphere whereas heating due to Huggins & Chappuis band is not negligible in the lower stratosphere.

Owens *et al.* (1985) have calculated global mean heating rate due to solar absorption by O_3 based upon U.S. Standard Atmosphere (1976) ozone profile. Present calculations are compared with their calculations in Fig. 1. It can be seen that the qualitative variation of both the curves is almost same, however, heating rate in our computation is seen little higher than that of Owens *et al.* (1985). This may be because of present calculations which are carried out for tropical region and it is well known that ozone concentration as well as solar flux in tropical region is more.

References

Deshpande, S.D. and Mitra, A.P., 1983, *Sci. Rep.* May 1983, IS-RC-IMAP-SR-11-83, published by P. N. Jayaraman, IMAP programme Office, Bangalore, India.

Owens, A.J., Hales, C.H., Filkin, D.L., Miller, C., Steed J.M. and Jessum, A. J. P., 1985, *J. geophys. Res.*, **90**, DA, 2283-2311.

Subbaraya, B.H., 1983, Proc. of INDO-US workshop on global ozone problem, Jan 1983, printed by INSDOC, New Delhi.

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