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Variation in Ozone Transmittance with Height in a Model Atmosphere: Sagamu in Ogun State of Nigeria

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Abstract

Variation of ozone transmittance with height in the atmosphere for radiation in the 9.6μm absorption band is studied using Goody's model atmosphere with cubic spline interpolation technique to improve the quality of the curve. The data comprising of pressure and temperature at different altitudes (0-22km) for the month of December, 2007 for Sagamu in Ogun State of Nigeria is used for the computation. Computed result shows that ozone transmittance increases with height, except for the altitudes 8km, and 10km $< Z \leq$16km due to absorption by O_3.

Keywords: Absorption coefficient, altitude, model atmosphere, optical thickness, Ozone transmittance

Introduction

Ozone as one of the trace gases in the atmosphere, mostly found in the stratosphere absorbs the harmful radiation from the sun (ultraviolet radiation) rather than striking the earth surface (Salby, 1996).

Ozone transmittance is the ratio of the intensity of radiation passing through it, I, to the intensity of radiation before it passes through it, I_o. It can also be expressed in other form as will be seen later.

Earlier, Sowole (2004) showed the variation of ozone transmittance with height in the atmosphere using Elsasser and Culbertson (1960) atmospheric radiation table and Goody – Houghton's model atmosphere (1977), in which transmittance increased with height.

Due to the fact that ozone layer is getting depleted Levine (1992) by the natural and human activities, transmittance by ozone in turn are being affected negatively.

In this paper, variation in ozone transmittance with height in Sagamu for the month of December 2007 will be considered.

Materials and Methods

Goody (1954) model from (see Elsasser and Culbertson, 1960) atmospheric radiation table is adopted for this work, where transmittance is expressed as:

$$\tau = \tau\ (u^*.\ L)$$

where u* is expressed as:

$$u^* = u\ (P/P_o)\{(T_o/T)^{1/2}\}$$

τ is defined as the ozone transmittance, L is the generalized absorption coefficient, u* is the 'reduced' optical thickness represented in this paper as 'reduced' ozone amount, which depends on pressure (P) and temperature (T) at different altitudes. P_o and T_o are the standard conditions of pressure and temperature on the surface of the earth.

The measured pressure (P) and temperature (T) of the ambient air at different altitudes, Z, (0-22 km) for Ijebu-Ode are used for the computation. This is shown in table 1. u represents empirical absorber amount which is ozone amount and its generalized absorption coefficient L value of ozone which are obtained from U.S National Oceanic and Atmospheric Administration Climate Monitoring and Diagnostic Laboratory Ozone Sonde Vertical Profile Data Report (2007) taken at Huntsville, Alabama station with location 13^0N, 54^0W.

Table 1: Pressure and temperature at different altitudes for December

Temperature (k)	**Pressure (hPa)**	**Height (km)**
298.4	1002.1	0.0
290.7	995.2	2.0
279.3	522.2	4.0
259.6	493.2	6.0
248.2	338.1	8.0
241.3	334.9	10.0
229.7	219.5	12.0
208.3	156.7	14.0
204.4	109.2	16.0
199.4	86.3	18.0
193.5	79.1	20.0
189.5	73.9	22.0

Results and Discussion

Considering the results, fig 1shows that the reduced ozone amount u* increases with altitude, Z, but there is a drop at 8km, likewise at 10km < Z ≤16km after which there is sharp increase till Z = 22km.

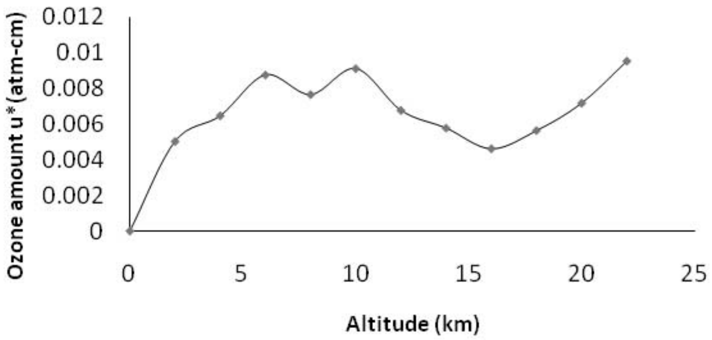

Figure 1: Variation in ozone amount u* with altitude.

More so, ozone transmittance, τ, as shown in fig 2 got reduced in response to the result obtained for ozone amount at 8km, 10km < Z ≤16km as shown in fig 1. The reductions in ozone transmittance at these altitudes were as a result of absorption by O_3 as discussed by Oluwafemi (1980), with photo-dissociation of ozone, causing reduction in ozone amount likewise ozone transmittance.

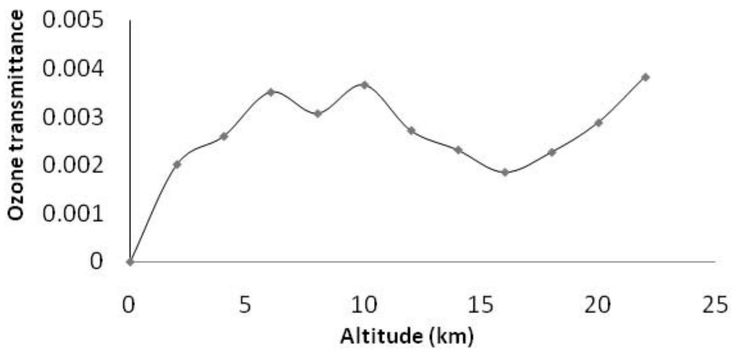

Figure 2: Variation in ozone transmittance with altitude.

Conclusion

The result shows that ozone transmittance increases with altitude or height, Z, except for 8km, 10km < Z ≤16km for the month of December, 2007 due to absorption by ozone.

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