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UV – RADIATION ABSORPTION BY OZONE IN A MODEL ATMOSPHERE USING DATA OF IBADANO

O. Sowole[1] and F. Ayedun[2]
[1]Department of Physics and Mathematics,
Tai Solarin University of Education,
Ijagun, Ijebu-Ode.
[2]Department of Physics
Tai Solarin College of Education,
Omu, Ijebu.
[a]Corresponding author: email segunsowole@yahoo.com Tel. +2348023531317

Abstract

UV- radiation absorption is studied through variation of ozone transmittance with altitude in the atmosphere for radiation in the 9.6μm absorption band 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 Ibadan in Oyo State of Nigeria is used for the computation. Computed result shows that ozone transmittance increases with altitude, except for the altitudes 6km < Z ≤8km and 10km < Z ≤16km due to absorption of UV-radiation by O_3.

Keywords: Absorption band, absorption coefficient, altitude, optical thickness, Ozone transmittance

1.0 Introduction

According to Salby (1996) ozone plays a very important role in the absorption of harmful radiation from the sun (ultraviolet radiation) rather than striking the earth surface which could lead to health hazards and destruction of plants, and is mostly found in the stratosphere.
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 altitude. More so, Sowole (2009) through research work obtained absorption of solar UV- radiation by ozone for the month of December, 2007 for Ijebu-Ode in Ogun State at altitudes 8km, and 10km < Z ≤16km .
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, absorption of solar radiation through variation in ozone transmittance with altitude at Ibadan for the month of December 2007 will be considered.

2.0 Materials and methods

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

$$\tau = \tau\,(u^{*}.\ L) \qquad (2.1)$$

where u* is expressed as:

$$u^* = u\,(P/P_o)\,\{(T_o/T)^{1/2}\} \qquad (2.2)$$

τ is defined as the ozone transmittance, L is the generalized absorption coefficient, u* is the theoretical optical thickness represented in this paper as theoretical 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 Ibadan are used for the computation. This is shown in table 1. u represents empirical absorber amount which is empirical 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, USA. The data are substituted into equations 1 and 2 to obtain theoretical ozone amount and ozone transmittance respectively.

Table 1: **Pressure and temperature at different altitudes for December**

Temperature (k)	Pressure (hPa)	Height (km)
297.2	1002.2	0.0
289.1	995.4	2.0
278.5	522.3	4.0
259.4	493.0	6.0
247.7	338.3	8.0
240.4	335.4	10.0
228.1	219.3	12.0
207.4	157.2	14.0
202.8	109.1	16.0
197.5	86.6	18.0
191.6	79.7	20.0
188.4	74.4	22.0

3.0 Results and discussion

Considering the results, fig 1shows that the theoretical ozone amount u* increases with altitude, Z, but there is a drop in u* from 0.01 atm-cm to 0.008 atm-cm at 6km < Z ≤ 8km and 0.01 atm-cm to 0.006 atm-cm at 10km < Z ≤ 16km after which there is sharp increase in u* from 0.006 atm-cm to 0.008 atm-cm at 16km < Z ≤ 22km.

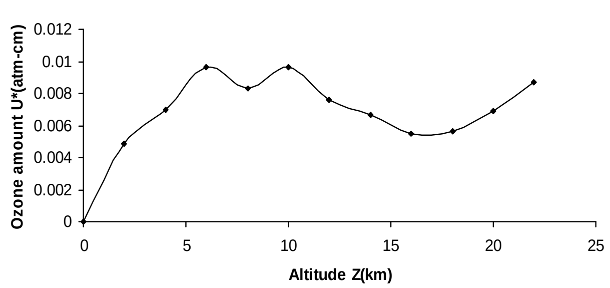

Fig 1 Variation in Ozone amount U*(atm-cm) with altitude Z(km)

More so, ozone transmittance, τ, as shown in fig 2 got reduced in response to the result obtained for ozone amount at 6km < Z ≤8km and 10km < Z ≤16km with reduction in ozone transmittance from 0.01 to 0.008 and 0.01 to 0.006 respectively.

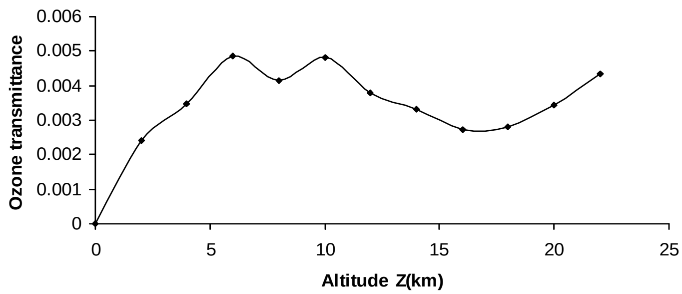

Fig 2 Variation in Ozone transmittance with altitude Z(km)

This is an indication that absorption of solar radiation (ultraviolet radiation) by O_3 took place at these exceptional altitudes: 6km < Z ≤8km and 10km < Z ≤16km as discussed by Oluwafemi (1980), leading to photo-dissociation of ozone, causing reduction in ozone amount, likewise ozone transmittance.

4.0 Conclusion

The result shows that ozone transmittance increases with altitude , Z, except for 6km < Z ≤ 8km, and 10km < Z ≤ 16km for the month of December, 2007 at Ibadan due to absorbed harmful radiation (ultraviolet radiation) from the sun by ozone, O_3, leading to photo-dissociation of ozone, causing reduction in ozone transmittance.

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