## Daily Variation of Amount of Ozone in the Atmosphere

The improved form of Dobson's spectrophotometer using an *RCA 1P28* photo-multiplier tube enables measurements of atmospheric ozone to be made with the light from the moon. Dobson's own measurements[1] made at Oxford during November–December, 1948, showed variations of ozone on some nights, and he concluded that they could be attributed to changes in meteorological conditions. As the day-to-day variations of amount of ozone in middle latitudes are large, it would be difficult to find without prolonged observation whether there is any systematic difference between the ozone amounts during day- and night-hours. In low latitudes, however, both the total amount as well as the day-to-day variations are small during a large part of the year, and if a regular daily variation exists as might be expected from the photochemical theory of atmospheric ozone, it could be determined from a short series of observations. Accordingly, observations were made at Mount Abu and Ahmedabad in the period November 1952–April 1953, and these show clearly that there is a substantial increase of ozone during night-hours, as compared to day-hours.

Fig. 1 shows the values of $\log(I/I')$ against $\mu$, the thickness of ozone traversed by the incident light at different zenith-distances of the sun or moon, where $I$ is the intensity of a small ozone-absorbed spectral region near λ 3112 and $I'$ the corresponding intensity near λ 3323 in a less-absorbed region of the spectrum, on four days and succeeding moonlit nights. It will be seen that on each day the mean straight line connecting the night observations has a steeper slope than the line connecting the day observations, indicating a larger quantity of ozone in night.

Table 1 gives the mean day- and night-values of ozone (both uncorrected for haze) on seventeen days and nights. In every instance, the night values are larger than the day values. The average excess during night is 0·030 cm. and the extreme differences are 0·019 cm. and 0·044 cm.

Table 1. Summary of Ozone Values During Day and During Night. $x$ is the amount of ozone in cm. at S.T.P. No correction has been made for atmospheric haze

| Date | Day value of $x$ in cm. | Night value of $x$ in cm. | Difference |
|---|---|---|---|
| 29–11–52 | 0·138 | 0·163 | 0·025 |
| 30–11–52 | 0·137 | 0·162 | 0·025 |
| 1–12–52 | 0·136 | 0·160 | 0·024 |
| 2–12–52 | 0·135 | 0·157 | 0·022 |
| 22–12–52 | 0·141 | 0·171 | 0·030 |
| 23–12–52 | 0·139 | 0·172 | 0·033 |
| 24–12–52 | 0·147 | 0·174 | 0·027 |
| 26–12–52 | 0·146 | 0·188 | 0·042 |
| 27–12–52 | 0·147 | 0·191 | 0·044 |
| 28–12–52 | 0·151 | 0·170 | 0·019 |
| 29–12–52 | 0·148 | 0·184 | 0·036 |
| 30–12–52 | 0·147 | 0·177 | 0·030 |
| 1– 1–53 | 0·141 | 0·173 | 0·032 |
| 2– 1–53 | 0·140 | 0·176 | 0·036 |
| 23– 3–53 | 0·164 | 0·207 | 0·033 |
| 27– 3–53 | 0·166 | 0·196 | 0·030 |
| 3– 4–53 | 0·179 | 0·205 | 0·026 |

Table 2. Observations with λλ 3112 and 3175

| Date | Day-time $x$ | Night-time $x$ With λ 3112 | Night-time $x$ With λ 3175 |
|---|---|---|---|
| 30–11–52 | 0·137 | 0·168 | 0·174 |
| 1–12–52 | 0·137 | 0·165 | 0·168 |
| 1–12–52 | 0·136 | 0·151 | 0·149 |
| 2–12–52 | 0·135 | 0·168 | 0·162 |
| 27– 3–53 | 0·166 | 0·196 | 0·197 |
| 3– 4–53 | 0·179 | 0·205 | 0·203 |

Observations made at Ahmedabad on the same night with λ 3112/3323 and λ 3175/3399 show agreeing results. Table 2 gives the comparative values of ozone obtained with the two pairs of wave-lengths.

Fig. 2 shows the values of ozone calculated from the individual observations of sunlight and moon-

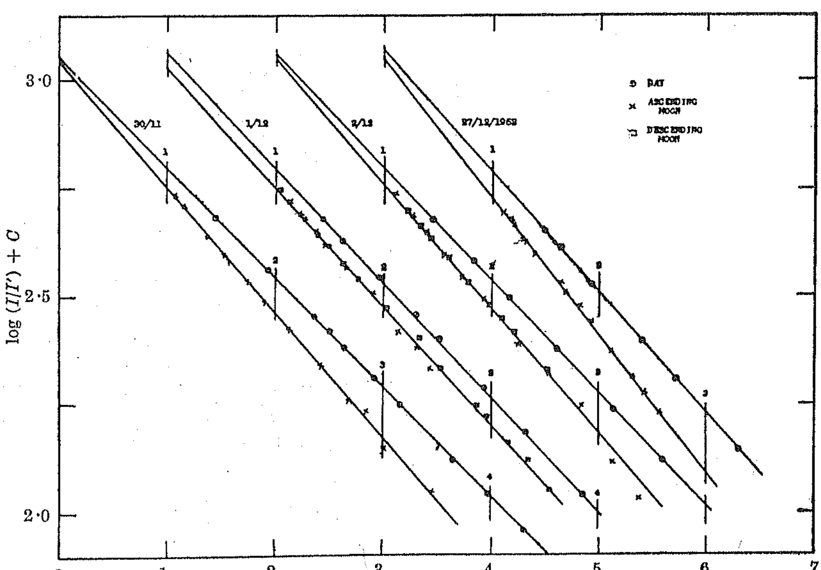


Fig. 1. Values of log ($I_{3112}/I_{3323}$) + $C$ plotted against atmospheric ozone path with sunlight and moonlight

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light on a number of days. The increase of ozone from the day value to the night value takes place within an hour after sunset. The change from night to day value after sunrise is also rapid. These indicate that the seat of the observed changes is high up in the atmosphere, where the recombination of oxygen atoms and molecules to form ozone after sunset and the photolysis of ozone at sunrise are very rapid. It may be expected that these daily variations of ozone extend to higher latitudes.

Estimates have been made by H. U. Dütsch[2], R. A. Craig[3], D. R. Bates and M. Nicolet[4] and Johnson, Purcell, Tousey and Watanabe[5], of the number of oxygen atoms at different levels in the atmosphere from 30 km. to 90 km. during day-time. From the values calculated by F. S. Johnson and collaborators using the rocket-data of intensity distribution in solar radiation in the ultra-violet, the equilibrium amount of daytime atomic oxygen in the atmosphere can be shown to be approximately 0·020 cm. between 90 and 70 km., and 0·010 cm. between 70 km. and 40 km., with the amount decreasing rapidly at lower heights.

This suggests that the night-time increase of ozone is due to the recombination of 'odd oxygen atoms' with oxygen molecules above the region of maximum ozone concentration and below the main region of Runge-Schumann oxygen absorption.

It may be noted in passing that extraordinarily low values of ozone were recorded at Mount Abu on many days in November and December 1952.

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A fuller discussion will appear elsewhere.

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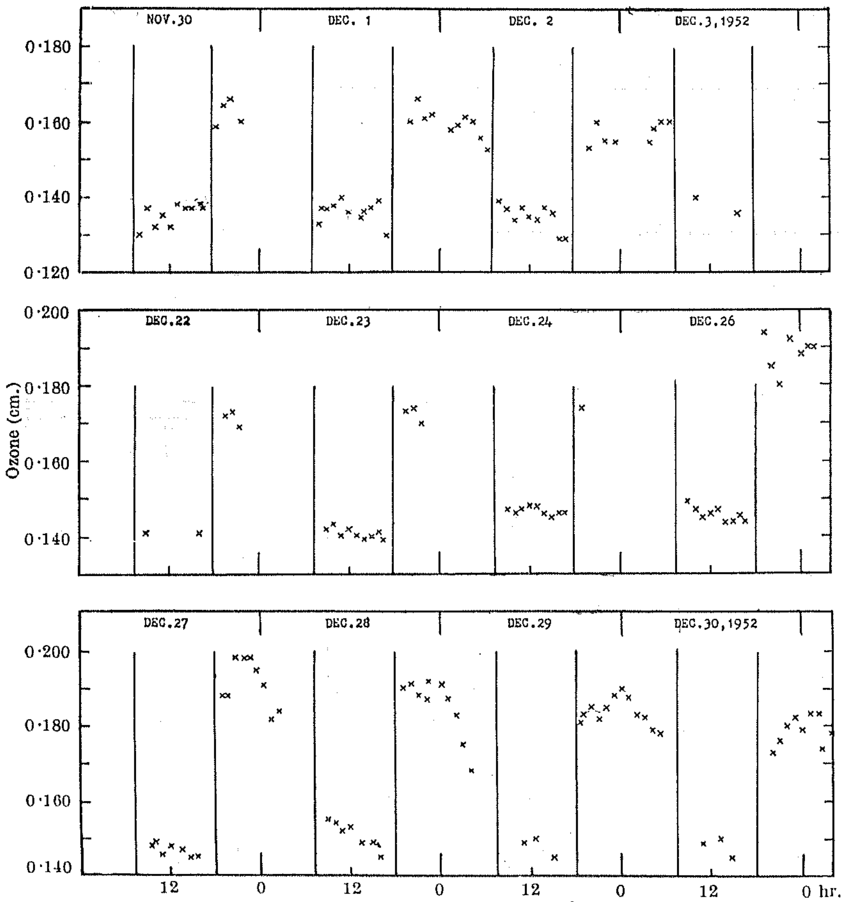


Fig. 2. Values of atmospheric ozone measured at Mt. Ab ith sunlight and moonlight