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Note on Ozone Observations made with Moonlight

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ABSTRACT. There is an apparent increase in ozone amount when measured with the Dobson spectrophotometer using moonlight and C or D wavelengths instead of A. The increase becomes insignificant when the differential AD or CD method is used. The apparent increase in ozone is found to be due to a rapid increase in large-particle scattering which occurs shortly after sunset and disappears within a couple of hours after sunrise.

In previous communications from Ahmedabad, it has been pointed out that when ozone observations are made on clear nights with moonlight, there is an apparent increase in ozone amount over that observed either on the preceding or succeeding day with sunlight (Ramanathan and Ramana Murthy 1953*, Ramanathan, Shah and Angreji 1961). This increase is much larger when the observations are made with D than with C wavelengths, and more with C than with A. This night-time increase was shown to be due not to ozone but to an increase in large particle scattering, whose contribution to attenuation is practically independent of wavelength. When due correction is made for this increased attenuation, the ozone amounts are found to be nearly the same during day as well as during night. Comparative near-simultaneous observations made with A, C and D wave-lengths with sunlight and moonlight and the corresponding values of x_{AD}, x_A, x_C, x_D, and of $\delta - \delta'$ are given in Table 1. $(\partial - \partial') = (x_\lambda - x_{AD})\,(\alpha - \alpha')_\lambda$.

At the Ozone Conference in Albuquerque (1964), Dr. Komhyr of the U. S. Weather Bureau pointed out the need for a parallax correction to the calculated zenith angle Z of the moon when observations are taken with the focussed moon. This arises from the fact that the distance of the moon from the earth is only about 60 times the earth's radius and observations are made from the earth's surface and not from its centre. A correction has, therefore, to be applied to the calculated zenith distance of the moon. The magnitude of $\triangle \cos Z$ (to be subtracted from $\cos Z$) increases from 0 when $\cos Z = 1{\cdot}00$ to $0{\cdot}006$, when $\cos Z = 0{\cdot}80$ and to $0{\cdot}015$ when $\cos Z = 0{\cdot}30$. We are indebted to Dr. Komhyr for providing a copy of the table which he has prepared.

The large values of $\delta - \delta'$ and the corresponding apparent large increases in $x_D - x_{AD}$ and $x_C - x_{AD}$ during night may be noted. This emphasizes the importance of using the differential x_{AD} or x_{CD} method when making ozone observations with moonlight,

*The observations made at Abu in 1952-53 showed that the night-time increase in attenuation took place within about an hour after sunset and that the morning decrease occurred within about an hour or two of the sunrise

TABLE 1

Ozone absorption coefficients and haze corrections with sun and moon observations at Ahmedabad

Date		$x_{AD} = x$	$x_A - x$	$x_C - x$	$x_D - x$	$(\delta - \delta')_A$	$(\alpha - \alpha')_A$	$(\alpha - \alpha')_D$	$(\alpha - \alpha')_C$
10 Nov 1962	Sun	0·243	0·003	0·006	0·024	0·006	1·742	0·352	0·805
10/11 Nov 1962	Moon	0·242	0·019	0·042	0·089	0·033	1·744	0·347	0·802
29 Nov 1963	Sun	0·224	0·004	0·007	0·020	0·007	1·743	0·354	0·793
29/30 Nov 1963	Moon	0·222	0·016	0·032	0·075	0·028	1·743	0·347	0·788
2 Jan 1964	Sun	0·234	0·007	0·016	0·030	0·012	1·742	0·352	0·807
2/3 Jan 1964	Moon	0·231	0·023	0·050	0·105	0·040	1·745	0·342	0·801
28 Apr 1964	Sun	0·261	0·003	0·006	0·016	0·006	1·742	0·352	0·794
28/29 Apr 1964	Moon	0·258	0·011	0·025	0·047	0·019	1·744	0·344	0·802

NOTE: (1) The values of x_{AD} are nearly the same during day and the same night. x_A, x_C, x_D have been calculated, assuming $(\alpha - \alpha')$ for A, C and D to be 1·742, 0·800 and 0·354 and neglecting haze correction.

(2) x_D, x_C, x_A, x and the differences $x_\lambda - x$ are much larger in night than in day — showing increase in large particle scattering during night

(3) If these differences are attributed to the same values of $(\delta - \delta')$ for A, C and D wave-lengths, the value of the relative ozone absorption for C wave-length is found to be about 0·800 as against 0·865 according to Vigroux' measurements

REFERENCES

Ramanathan, K. R. and Ramana Murthy, Bh. V. 1953 *Nature*, **172**, p. 633.

Ramanathan, K. R., Shah, G. M. and Angreji, P. D. 1961 IUGG Monogr. No. 19, Symp. atmos. Ozone, Arosa, p. 13.