METEOROLOGY

Variations in Ozone associated with the Oscillations of Equatorial Stratospheric Wind

THE recent discovery by Ebdon and Veryard[1,2] and by Reed *et al.*[3] of a biannual oscillation in the equatorial stratospheric winds has aroused considerable interest in the physics and dynamics of the stratosphere. It is now well established that the zonal winds in the stratosphere over the equatorial regions of the entire globe alternate in direction between east and west, one cycle of reversal taking a period of about 26 months. An oscillation of a similar period has been observed in the equatorial stratospheric temperatures also. Further, there is evidence from available aerological observations that the biannual wave is propagated slowly downwards from a level at about 30 km or perhaps even higher.

The region in the equatorial stratosphere which is most affected by the oscillation (25–30 km) happens to be one where the absolute concentration of ozone is also high. As vertical motion in this region can affect the total ozone content, it is only logical to examine whether there are any systematic variations in ozone parallel with the 26-month wind oscillation. Funk and Garnham[4] have very recently reported a 24-month cycle in the total ozone content at Brisbane (23·5° S.) and Aspendale (38° S.) in the southern hemisphere. Evidently this ozone oscillation and the equatorial stratospheric wind oscillation, which have nearly identical periods, are inter-related.

With the view of detecting a similar ozone oscillation in the northern hemisphere, the ozone data of Kodaikanal (10° N.) and Abu (24° N.)/Ahmedabad (23° N.) for the period 1958–62 were analysed. The biannual oscillation could be clearly traced at Kodaikanal but has been found to be considerably distorted at Abu/Ahmedabad. Far more significant than the oscillation itself is the new result that the year-to-year fluctuations of ozone at Kodaikanal (corrected for annual variation) are almost exactly out of phase with those at Brisbane in Australia (27·5° S.).

The analytical procedure adopted for this investigation was briefly as follows. Since each station has its own distinct pattern of annual variation depending on its location, it was considered necessary to eliminate this effect from the observational series. From the monthly mean ozone amounts for the five consecutive years 1958–62, short-period averages or 'normals' were calculated for each month. With respect to such normals, the departure or anomaly for each month of each year was obtained. This procedure was all that could be done with a limited series of ozone observations. The concept of a short-period normal appears to be justified in view of the fact that the pattern of annual variation at each of the stations under study followed more or less the same trend from year to year. Such an analysis was made in the case of four stations, namely, Abu/Ahmedabad and Kodaikanal in the northern hemisphere and Brisbane (27·5° S.) and Aspendale (38° S.) in the southern hemisphere. The results for the Australian stations covered the five-year period 1957–61. The results in respect of Kodaikanal and Brisbane are shown in Fig. 1 wherein the 3-month overlapping means of anomalies have been plotted. The most striking feature of the diagram is the mutually inverse nature of the long-period variations at the two stations. During epochs when the ozone content (corrected for annual variations) increased in the northern hemisphere it appears to have decreased in the southern hemisphere. The quasi-period of approximately 25 months is discernible

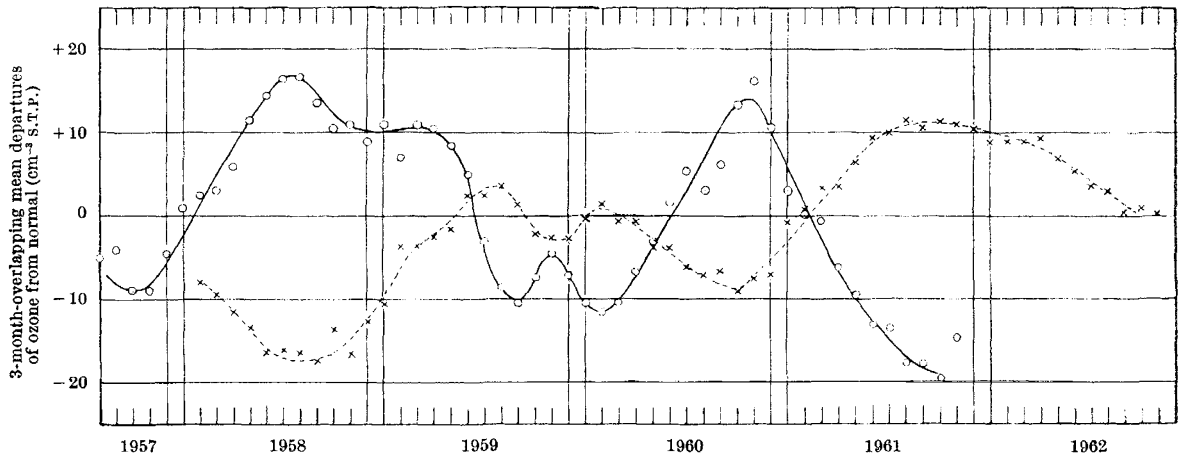

Fig. 1. Year-to-year variation of ozone in the two hemispheres (after correcting for seasonal variation). ×, Kodaikanal (10° N.); ○, Brisbane (27·5° S.)

at both the stations with inverse phases. During the period September 1959–February 1960, there have been some anomalous changes, too, but these have also been of opposite signs in the two hemispheres. To express the relationship more quantitatively, correlation coefficients between the contemporaneous smoothed monthly anomalies at each pair of stations were worked out, each coefficient being based on 48 pairs of values covering four years. These are given in Table 1.

Table 1

	Aspendale	Brisbane	Kodaikanal
Abu/Ahmedabad	− 0·39	− 0·68	+ 0·53
Kodaikanal	− 0·86	− 0·86	—
Brisbane	+ 0·88	—	—

The ozone variations between Kodaikanal on one hand and Brisbane and Aspendale on the other are significantly correlated negatively. Those between Brisbane and Aspendale are also significantly correlated positively, as is to be expected. These results indicate that the variations in ozone at all the three stations are mutually connected and seem to suggest the existence of large-scale inter-hemispherical circulations in the stratosphere. In the northern hemisphere, the 26-month ozone oscillation does not seem to extend beyond 20° latitude whereas in the southern hemisphere it extends at least as far south as latitude 40°. Further details of this investigation will be published elsewhere.

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[1] Ebdon, R. A., and Veryard, R. G., *Nature*, **189**, 791 (1961).
[2] Ebdon, R. A., and Veryard, R. G., *Met. Mag.*, **90**, 125 (1961).
[3] Reed, R. H., *et al.*, *J. Geophys. Res.*, **66**, 813 (1961).
[4] Funk, J. P., and Garnham, G. L., *Tellus*, **14**, 378 (1962).