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Sporadic E in Middle Latitudes

IN a recent paper, Layzer¹ suggested that most middle latitude sporadic E layers are formed by discontinuities in the vertical motion of the neutral gas. Following his notation, w is the vertical velocity of ionization, and u_z the neutral gas vertical velocity. Neglecting horizontal air movements and polarization fields, we have $w \simeq u_z \{ \sin^2 \chi + \cos^2 \chi / (1 + r^2) \}$ where χ is the angle of dip and r is the ratio of gyro-frequency to collision frequency of ions.

We see that as χ increases, so the magnitude of w increases (slightly if $r \ll 1$, more rapidly as r approaches unity), and hence sporadic E layers should occur most often where χ is large.

The opposite is, however, the case². Whereas the critical frequency of sporadic E is greater than 5 Mc/s for about 20 per cent of the time at $\chi = 20^\circ$, it is greater than 5 Mc/s for less than 5 per cent of the time at $\chi = 70^\circ$. (This decrease is almost certainly related to the decrease in the horizontal component of the Earth's magnetic field.) The same conclusion is reached by considering sporadic occurrence along a line of geographic latitude for which one would expect the neutral air movements to be statistically similar.

It is concluded that most middle latitude sporadic E is not caused by discontinuities in the vertical motion of the neutral gas.

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Optical Radar Evidence for Atmospheric Dust Layers around 85 km Altitude

IN a recent letter Poultney¹ has examined the evidence in favour of the existence of an atmospheric dust layer in the region about 85 km above the Earth's surface. In particular he claims that there is reliable evidence for this claim from observations using the ground based experimental method of examining the intensity of light back scattered from a vertical laser beam, or what is called laser radar. This technique is in use at several stations including Cambridge, Mass., U.S.A.²; College Park, Maryland, U.S.A.³; Kingston, Jamaica⁴; and Slough, England⁵.

There is good evidence for the existence of particulate matter at about an altitude of 85 km from observations on the noctilucent clouds which are observed at high latitudes; the evidence of a similar region at lower latitudes is much rarer. In particular many of the results obtained so far from laser radar studies of the upper atmosphere are still, we think, rather questionable.

Poultney has quoted from our results⁴. He suggests that we have measured the scattering cross section at a height of 75 km to be 10^{-11} cm^{-1} . When due attention is paid to the statistical fluctuations on the signal measured (a limited count of a number of photons arriving at random), however, our result would be that the scattering cross section measured at 73 km was between 4×10^{-12} and $2 \times 10^{-11} \text{ cm}^{-1}$. The value lies between these limits with a statistical probability of 70 per cent only. The theoretical Rayleigh scattering from that height assuming the U.S. Standard Atmosphere number density of molecules is 3×10^{-12} . Poultney concludes that the measured cross section is greater than that expected theoretically and consequently that this supports the existence of aerosols at this height in addition to air molecules. It will be seen that when the probable error of the result is allowed for, the excess of scattering over that to be expected is hardly significant.

Although at the time when we communicated our results to *Nature* we had eliminated the contribution of fluorescence to the measured signal, however, we had not then discovered a further source of spurious signal, which we now know must have contributed to our previous results. This additional noise source is a result of the fact that when the photomultiplier is briefly but strongly illuminated from scattering of the laser pulse by the lower atmosphere, this illumination causes the noise level of the photomultiplier to rise above the normal noise level for a short period. By protecting the photomultiplier from the returned signal during, and for a brief interval after, the transmitted pulse, this noise source is removed, and consequently the apparent signal strength from higher altitudes is reduced. Results of a more reliable series of observations were given in a recent paper⁶. From these results the scattering cross section from the level of 78 km region is measured to be between 6×10^{-13} and $1.8 \times 10^{-12} \text{ cm}^{-1}$ whereas the theoretical cross section is calculated as $1.4 \times 10^{-12} \text{ cm}^{-1}$.

Consequently, we do not feel that our results provide evidence of the existence of a dust layer about 80 km. As far as the atmosphere over Jamaica is concerned, our results establish that at the time of our observations any dust present was many factors below the quantity indicated over Cambridge or Maryland, not only at 78 km but also up to 100 km. The simple explanation would be to suggest that the dust layer over Jamaica is absent because of either the lower latitude or (and this is much less likely) because Jamaica is outside any large industrial area. Both these suggestions, however, are negated when we examine the results obtained at Slough, England⁵, which is at a higher latitude and in an industrial area; these results are extremely similar to our own. Consequently, an unexplained difference remains between the various measurements.

It is of interest to note that the Maryland group are using an arrangement which allows them to utilize the same optics for transmitting and receiving. This system requires a very rapid optical transmit/receive switch which is operated mechanically. Fluorescence suppression and internal scattering are major problems which have to be overcome. The published results of the group indicate quite a high scattering cross section throughout the whole of the height range over which results are quoted (75 km and above). The signal received at 75 km on the one night quoted which did not suggest sources of scattering with maxima above 75 km is certainly above the level to be expected from molecular scattering with the equipment described. This would suggest that at all heights