Atmospheric Noise at 33·5 GHz

At millimetre wavelengths, any signal transmitted through the atmosphere will be attenuated by the oxygen and water vapour content of the atmosphere. This attenuation is well known[1] and can be calculated given the temperature and water vapour content of the atmosphere (available from radiosonde data). This type of attenuation varies slowly throughout the year and is effectively constant over periods of 3–4 days (ref. 2).

A signal will also be attenuated by the liquid water content of any cloud it passes through. A series of observations at 33·5 GHz has been made on clouds using a horn antenna with a beamwidth to half-power of 3° × 4° and a Dicke radiometer having an r.m.s. noise of 0·7° K (10 s time constant referred to the horn input (paper by A. M. F., J. C. S. Richards and I. H. H., in preparation)). Observations were made at three zenith angles, z = 32°, 55° and 75°. The effective temperature of a cloud is given by

$$T_{\text{effective}} = (1 - \varepsilon)\, T_{\text{physical}}$$

where ε is the transmission coefficient of the cloud. As a cloud of high attenuation passes through the beam, the observed temperature rises by $T_{\text{effective}}$ (Fig. 1). The results show a secant z dependence and a daily variation which is to be discussed elsewhere by Foster.

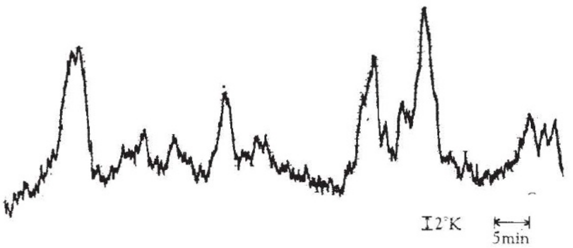

Fig. 1. Typical record of cumulus cloud.

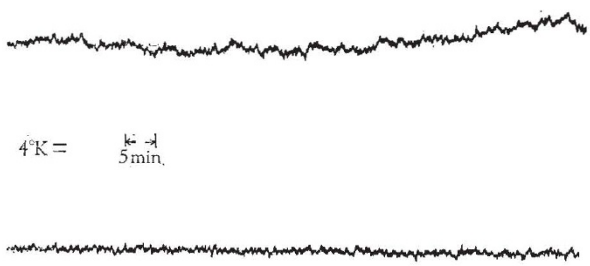

Fig. 2. Upper trace: typical record on a clear day. Lower trace: aerial replaced by a matched load in liquid nitrogen.

There remains a residual effect in which, for all zenith angles, there is a noise-like component equivalent to 1·4° K r.m.s. for 70 per cent of the time (Fig. 2). This is most marked on days of cumulus cloud (in other words, convective activity) and is usually absent around midnight. The most obvious explanation is that it is due to very local convective activity. The total radiation temperature from the whole atmosphere, due to water vapour and oxygen, is 25°–30° K at 9 mm. The temperature contribution from the liquid water content of a cumulonimbus cloud may exceed 200° K. Because the attenuation of liquid water droplets is very high (a hundred times that due to water vapour[1]), it may be that condensation occurs irregularly in cells of small size. This noise compared with the figure of 0·2° K suggested by Urhaug[3] for 8 GHz.

Observations using the horn switched against a very small horn (beam 11° × 14°) eliminated the temperature changes due to clouds when both horns were pointed in the same direction. This is presumably because they are more than 10° across. The noise-like component was not eliminated, showing it to be of smaller scale. Observations are planned to find the scale of these irregularities.

This atmospheric noise may prove to be a limiting factor on radio-astronomical observations at millimetre wavelengths if it is of very small scale.

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1 Gunn, K. L. S., and East, T. W. R., *Roy. Met. Soc. J.*, **80**, 522 (1954).
2 Wulfsberg, K. N., *Radio Science*, **2**, 319 (1967).
3 Urhaug, T., *Pub. Nat. Radio Astron. Obs.*, 1 (1962).

Interstellar Dust and Diamonds

None of the classical models for the interstellar dust grains fit in with all the modern observations. Pure graphite particles produce insufficient extinction in the far ultraviolet[1]. The strong absorption band in the infrared predicted for ice or ice-coated graphite particles is not observed[2]. Neither type of particle has the combined properties of high albedo and nearly isotropic phase function needed to fit the observations of the diffuse galactic radiation[3]. These difficulties would be eliminated if the dust grains contain an abundant element in an allotropic form not considered previously: carbon in the form of diamond.

Diamonds are transparent at long wavelengths, but they absorb strongly beyond a fundamental absorption edge at about 2300 Å (Fig. 1), which corresponds to the minimum energy for a transition to the conduction band[4]. Some diamonds also show a secondary absorption edge at 3320 Å, quite variable in strength, which is associated with

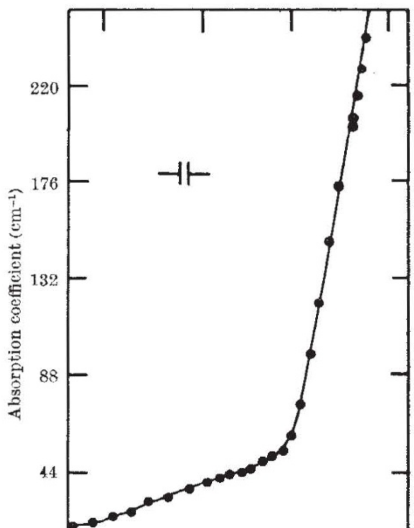

Fig. 1. Absorption edge spectrum of a type IIb diamond[13].