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PROSPECTS FOR GROUND-BASED REMOTE SENSING OF ATMOSPHERIC PARAMETERS

By C.G. Little

Dr. Little, from the Environmental Science Services Administration Research Laboratory at Boulder, Colorado, U.S.A. discussed the advantages and disadvantages of remote sensing devices. The advantages include the fact that remote sensing makes any part of the atmosphere more easily accessible, it can be continuous in time and space, and it is well suited to sensing large volumes of space. The disadvantages include its limited space resolution (for some purposes), the difficulty of attaining high accuracy and its high cost.

"Passive" techniques rely on the reception of naturally occurring electromagnetic (or acoustic) radiation. For example, a highly directional antenna directed vertically can measure the power received in the oxygen absorption band at about 60 GHz, and the "inversion" technique (making use of the temperature dependence of the oxygen spectrum) may then be used to derive the temperature profile. Work at the ESSA laboratories at Boulder, including a theoretical analysis of the errors, has shown that useful profile measurements may be made up to 10 km. The same technique may also be used to obtain water vapour profiles from knowledge of the water vapour spectrum. Also the microwave radiometer can in principle be used to scan a cloud and obtain its liquid water content, through knowledge of the absorption spectrum of water droplets.

"Active" techniques employ man-made signals, and include line-of-sight propagation between spaced transmitters and receivers. The refractive index of air depends on frequency and density, so using two optical frequencies the mean temperature over the path can be measured to an accuracy of 0.3°C with a sensitivity of 0.03°C . Using visible and microwave frequencies, temperature and water vapour can be measured to 0.03°C and 0.01 mb. In a second line-of-sight technique, the shadow bands produced by atmospheric turbulence in a laser beam projected on a screen can be used to measure the mean transverse and vertical wind in sections along the path.

A second group of "active" techniques involves the use of mono-static (transmitter and receiver at the same location) or bi-static (spaced transmitter and receiver) systems to measure scattering. This group includes the application of the Doppler radar technique to precipitating particles, which has recently been extended to obtain the velocity spectrum within a cloud. Snowstorm data have been shown to fit the $5/3$ spectrum law. Three radars could give the total wind field, including spectra, for a thunderstorm.

Dr. Little concluded with a discussion of the great potential of the acoustic radar technique now being used by L.G. McAllister of Weapons Research Establishment, South Australia. Acoustic radiation is far more sensitive to temperature, water vapour and wind than electromagnetic radiation, by several orders of magnitude. With a mono-static system the temperature fluctuation spectrum can be obtained from the back-scattered power, and the wind velocity can be obtained from the direction of the back-scattered signal. With a bi-static system the wind spectrum can be measured. With a multi-frequency system the water vapour profile can be measured, since absorption by water vapour is frequency dependent. In principle it is possible to obtain the temperature profile and perhaps the spectrum of humidity fluctuations. All these may be obtained continuously in both time and space, with spectra of temperature and wind over three decades of wavelength.

P. J. R. S.