Low-Level Atmospheric Ducts

During 1943–46, the Signals Research and Development Establishment operated a series of experimental centimetre-wave radio links along a 60-mile oversea path across Cardigan Bay. One major purpose of the investigation, which was carried out for an inter-Service committee under the chairmanship of Sir Edward Appleton, was to determine the degree to which meteorological factors affected microwave propagation and to find out to what extent the performance of such links could be predicted from synoptic data.

In addition to the taking of continuous records of radio field-strengths, frequent measurements were made of temperature, pressure, humidity and wind velocity at the two terminal stations at Strumble Head in South Wales and Aberdaron in North Wales. We have found a fairly definite correlation between the radio field-strength and the difference between air and sea temperatures, particularly when this difference was large, for the lowest link, in which the transmitting and receiving aerials were each about 100 ft. above sea-level. Figs. 1 and 2 show the results obtained on a wave-length of 9 cm. for those periods during the twelve months from July 1945 to June 1946 when the difference between the air and sea temperatures was greater than 5° F. It will be seen from Fig. 1 that when the air temperature was more than 5° F. lower than that of the sea, a condition which obtained mainly on cold days, the field-strength usually lay between 20 and 30 decibels below the free-space value. When, however, on warm days the air temperature was more than 5° F. higher than that of the sea, the field-strength was approximately equal to the free-space value. These two field-strengths, corresponding to cold and warm days respectively, although differing appreciably, are both well above the field-strength of 70 decibels below the free-space value which would be expected on the assumption of standard atmospheric conditions for this link, which was 2·3 times the optical range.

A study of the radio results according to modern radio-meteorological theory[1] suggests that the high field-strengths in Figs. 1 and 2 are due in both cases to the presence of so-called atmospheric ducts lying directly on the sea surface. For the conditions corresponding to those in Fig. 1, the heights of the ducts appear to vary between 20 ft. and 50 ft., while for the higher field-strengths in Fig. 2 the duct heights are greater and lie between 80 ft. and 120 ft. The ducts which give rise to these high field-strengths are due singly or to a combination of a temperature inversion and a rapid decrease with height in the water-vapour pressure in the atmosphere. The presence of the low ducts of 20–50 ft. when the air (at 100 ft. above sea level) is colder than the sea is not easy to explain. It was noted that the cold conditions giving rise to these particularly low ducts were associated frequently with high wind when, incidentally, the radio signal was found to be particularly steady. We would suggest that these ducts may be due to the presence of sea spray whipped up by the wind, either directly as constituting an increase in the water content in the lowest air strata, or indirectly as a means by which evaporation is assisted in these strata by the presence of the spray. The atmospheric moisture required to form the higher ducts necessary to satisfy the field-strength values in Fig. 2 during warm weather can be explained by evaporation from the relatively cold sea.

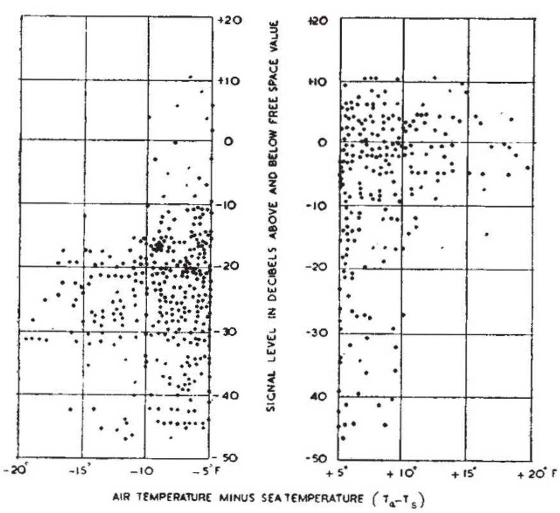

Fig. 1 Fig. 2

This relation between the radio field-strength and the difference between air and sea temperatures was studied first by Mr. H. Jarkowski, when he was in charge of the running of the Welsh stations. We regret that as he is now in Poland his name cannot be added to this note without causing undue delay. We are indebted to the Chief Scientist, Ministry of Supply, for granting permission to publish this note.

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[1] Hartree, D. R., Michel, J. G. L., and Nicholson, Phyllis, "Meteorological Factors in Radio-Wave Propagation", 127–168 (London: Physical Society).

Elastic Constants of Alum Determined by a New Ultrasonic Method

Following our work on the diffraction of light by ultrasonic waves in glasses described in an earlier communication[1], we have now obtained similar patterns in crystalline media, thus enabling us to devise a new method for determining the elastic constants.

Transparent and flawless specimens are suitably cut and polished, and stationary sound waves are maintained along specific directions of propagation. In cubic crystals, the cube and the octahedral axes are the most suitable. An X-cut or a Y-cut quartz plate is cemented on the surface of the polished prism according as it is desired to send longitudinal or transverse sound waves respectively. The sound velocities are then determined in each case in the usual manner by photographing the diffraction patterns at known frequencies. The effective elastic constants for specific directions are then calculated and the principal values deduced. Results obtained for alum along with those reported earlier by Voigt[2] and by Sundara Rao[3] employing other methods are given below in units of 10^{11} dynes/cm.^{2}.

	C_{11}	C_{12}	C_{44}
Authors	2·54	1·07	0·84
Voigt	2·43	1·009	0·843
Rao	2·56	1·07	0·86