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Weather and Reception Level on a Troposphere Link—Annual and Short-term Correlations [1]

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The weather parameters suggested by the Booker-Gordon theory are correlated with data from a troposphere link not previously reported. While the correlations over the whole year's weather cycle are high, the short term correlations practically vanish. The former without the latter lend little support to this theory.

This article reports a study of relations between weather variables and hourly median signal levels at 915 mc, received over a 134 mile tropospheric link operated under sponsorship of AFCRC [2] in 1956–57, and offers a comment on similar studies reported by others. In the present study, one of the authors collected 160 entries of signal strength over hours corresponding to the hours for collecting weather data at the Albany, Boston Harbor, Nantucket, and Portland, Me., weather stations. (The first station lies on the link axis near the receiver, and the last three surround the transmitter at Bedford, Mass.)

The 160 entries were first correlated with weather parameters averaged for both ends of the link axis. Among these were the mixing ratio (MR), in grams of water vapor per kilogram of dry air at ground level, and the stability index (SI), involving the lapse rate of temperature between 5000′ and 10,000′. The MR is not affected by changes of pressure or temperature, short of precipitation, in a given air sample, and in this sense is conservative. The SI increases as the potential energy available for turbulent mixing increases. This SI is proportional to $\gamma - \gamma_d$ in the notation of [1].[3]

The pair correlations obtained with signal level in decibels, voltage and power respectively were MR: 0.58, 0.46, 0.29; and SI 0.22, 0.11, and 0.03. A regression calculation of signal against both weather variables (clearly not orthogonal) gives R=0.60, 0.51, 0.34. The high decibel correlations point to some extended-path mechanism; whereas if voltage or power had exceeded decibels in correlations with weather, the data would suggest the importance of single scatterers.

Next the same data were grouped into 10 periods (by month, but 4 summer months were combined in pairs) so that about 16 entries fell in each period. The normalized monthly average values and rms deviations appear in figure 1. One can see a high correlation between averages; indeed, we have 0.93 for signal in decibels and MR, 0.69 for signal and SI. Within these periods, however, the correlations were much lower: the average correlation was 0.13 ± 0.27 rms deviations for signal in decibel and MR, and 0.06 ± 0.20 for signal and SI. Figure 2 shows these correlations within months.

Clearly the signal and these weather parameters have in common a marked annual cycle of variation but practically no short-term relationship. The literature gives examples of this too, for the same appears in the 0.90 correlation of refractive index with monthly medians in [2]. In references [3] and [4], data were collected over 3 to 6 months, so the annual cycle is doubtless represented. Moreover, points associated with rapid changes in either variable were rejected before making a correlation. This selection, although justified on physical grounds, is dangerous in a statistical sense, and it reduced the number of points considered to 31 and 20 respectively. The results were correlations of 0.85 between signal level and a variable combining refractive index and static stability in [3], and 0.80 for differential signal level and Richardson's stability number in [4]. The annual cycle is apparent in correlations reported earlier [5, 6, 7, 8, and 9]. Several of these reports also mention poor correlation of chosen variables with short term (diurnal) signal levels.

The Booker-Gordon theory of tropospheric propagation by "blob scatter" [10] leads one to expect more short-term correlation. Without it, the annual cycle lends little support to this theory. There are, however, some reports of good correlation in small samples with large scale weather patterns, cyclones and anticyclones [9, 11, 12], in particular one by Pickard and Stetson [13] whose method of analysis by "epochs" deserves further employment in this field of study.

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[2] Under Contract AF19(604)–1723.
[3] Figures in brackets indicate the literature references at the end of this paper.

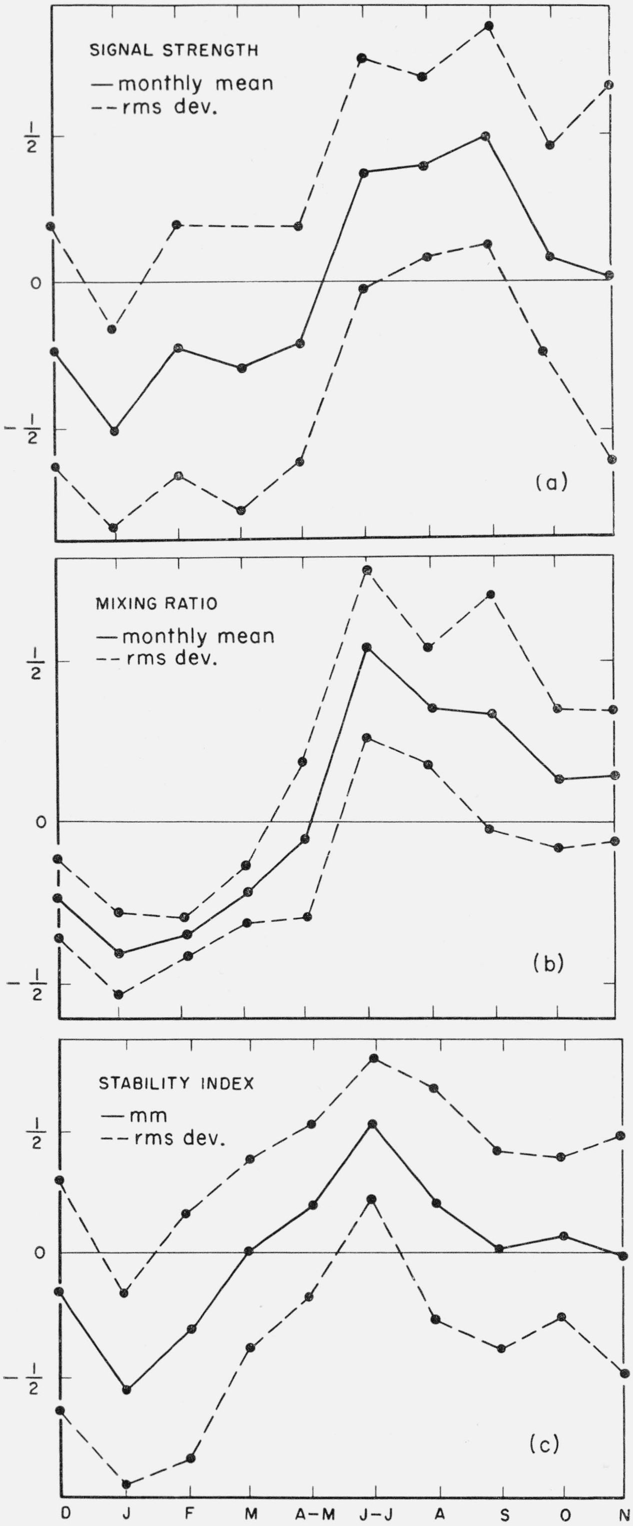

FIGURE 1. *Signal strength and two weather parameters, normalized monthly average values in 1956–57, and RMS deviations.*

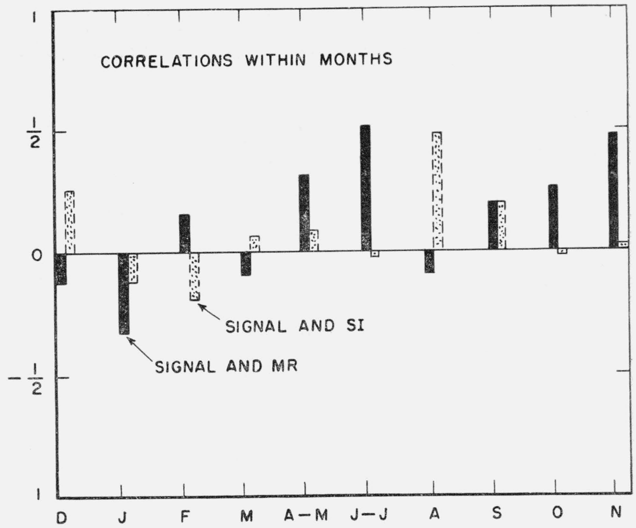

FIGURE 2. *Correlations within months between signal level and two weather parameters.*

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