US ARMY ELECTRONICS RESEARCH & DEVELOPMENT ACTIVITY

UPPER WIND CORRELATIONS IN SOUTHWESTERN UNITED STATES

BY

ROY L. LAMBERTH

AND

DANIEL R. VEITH

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WHITE SANDS MISSILE RANGE
NEW MEXICO

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ENVIRONMENTAL SCIENCES DEPARTMENT
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ABSTRACT

Vector correlation coefficients of upper winds at El Paso, Midland, and Amarillo, Texas; Fort Huachuca, Arizona; and Albuquerque, New Mexico; and between El Paso and the other stations are presented by season, in tabular form. These include both synchronous and lagged values, and were computed for the same heights for each location, and between heights. Values of the coefficients vary from .9 to .1 and agree closely with similar studies.

A simple technique for using the correlations as a forecast aid is presented, including the necessary constants.

The total vector correlation coefficient is compared to the vector stretch correlation coefficient; the former is favored.

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INTRODUCTION

The trajectory of unguided rockets is always affected to some extent by the upper winds through which they must pass. At inland sites, firing of the larger rockets is critically dependent on the wind. Moreover, the large amount of support required is costly, must be scheduled in advance, and, if not used, is wasteful. At White Sands Missile Range (WSMR) this problem has been met with wind forecasts prepared by meteorologists. The forecast wind has been multiplied by 'ballistic factors' and a 'ballistic wind forecast' has been used [1]. These forecasts are highly subjective. In this study the correlation of the wind between El Paso and other stations, for several heights, and for several time lags, has been investigated as an objective supplement to the existing forecast techniques. The required parameters, the synoptic wind reports, are readily available via teletype. These seasonal correlation functions are also useful for estimating winds for ballistic models and for vertical wind profiles. Although the El Paso observations were made 37 miles south of Launch Area I at White Sands Missile Range, it is felt that the correlations are applicable at this site, with the possible exception of the 1.5 km data.

DATA ACQUISITION

The data used in this study consisted of twice-daily observations of wind speed and wind direction at six heights from United States Weather Bureau stations at Albuquerque, New Mexico; El Paso, Amarillo, and Midland, Texas; and from the U. S. Army Signal Corps Meteorological Team Weather Station at Fort Huachuca, Arizona (Figure 1). Data at the following heights, mean sea level, were used: 1.5, 3, 6, 9, 12, and 24 km. Since the station elevation at Albuquerque is above 1.5 km, data at this height were missing for this station.

These data, obtained from the Weather Bureau, were continuous and complete for all of the stations, except for the 1.5 km data for Albuquerque, for the three-year period 1 June 1957 through 31 May 1960. Seventy per cent of the data were original, uncorrected observations; the remainder were corrected, interpolated, extrapolated, or transferred. Transfer of the data was made only at 24 km and only from the Weather Bureau Station at Tucson to Fort Huachuca.

The data were furnished on 10,960 IBM cards, each containing the wind data for one observation time at one station. Directions were recorded to the nearest whole degree, and speeds to the nearest whole meter per second. Omitting the 1.5 km values at Albuquerque, a grand total of 63,568 individual wind observations were used.

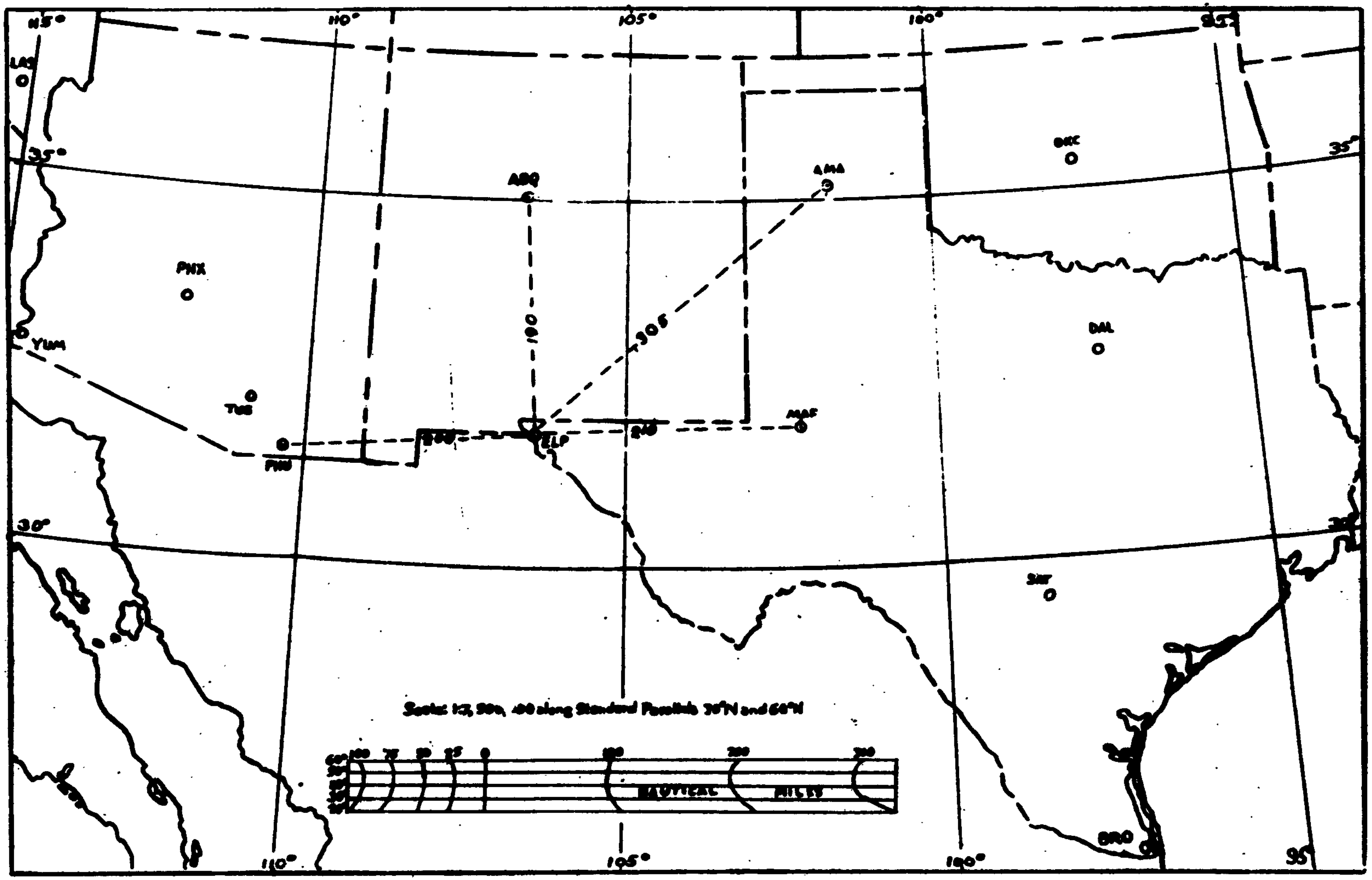

Figure 1. Part of Southwestern United States. Broken lines lead from El Paso to other locations studied in this report; distances shown from El Paso are in nautical miles.

Observations were made at 0000 and 1200 Greenwich Mean Time (1700 and 0500 Mountain Standard Time). The GMD-1 (automatic-tracking direction-finding radio), or the SCR-658 (manual-tracking direction-finding radio), was used for obtaining most of the data; a small amount were rabals (radiosonde balloons tracked with a single theodolite).

DATA PROCESSING

A program was prepared for and the data were processed by a high-speed computer. Throughout the processing the data were kept separated into the four seasons, where the seasons are defined as: winter - December, January, and February, etc. During the initial processing, the data from each station were kept separated from the other stations; later, correlations between El Paso and each of the other stations, and between El Paso and combinations of two and/or three of the other stations were computed. These correlations were also computed between data at El Paso at one level and data at other stations at the same level and at other levels. In addition some correlations were computed from data which were lagged 12, 24, 36, and 48 hours. A description of the techniques used follows.

Correlations were computed by two techniques. The first used methods discussed by Court [2] and the second used methods discussed by Durst [3]. The last section of this report compares the results obtained from both methods; however, only values of Court's correlation coefficient are published in this report. Court's coefficient was selected in preference to Durst's because the above mentioned comparison indicated it was superior when separations in space or both space and time were involved. This conclusion was reached also by Charles [4]. In addition, Durst's method assumes that the angular difference between the wind at the two locations is a constant. This objection has been discussed by Court.

The total vector correlation coefficient, Court's R_{WZ}, is an extension of simple linear correlation to multiple correlation, applied to vectors. In its completed form, R_{WZ} is the correlation coefficient of two samples of winds,

$$\sum_{k=1}^{n} W_k \quad \text{and} \quad \sum_{k=1}^{n} Z_k, \text{ where } W = Ui + Vj \text{ and } Z = Xi + Yj \text{ are wind}$$

vectors separated in space, in time, or in both time and space. The expression for Court's R_{WZ} contains the simple linear correlation coefficients

r_{ux}, r_{uy}, r_{vx}, r_{vy}, and r_{xy}, where u, v, x, y are deviations from the means $\overline{U}$, $\overline{V}$, $\overline{X}$, and $\overline{Y}$; that is, $u = U-\overline{U}$, $v = V-\overline{V}$, $x = X-\overline{X}$, and $y = Y-\overline{Y}$. R_{WZ} contains s_u^2 and s_v^2, the sample variances of u and v, respectively.

$$R^2_{WZ} = \frac{s_u^2(r^2_{ux} + r^2_{uy} - 2r_{ux}r_{uy}r_{xy}) + s_v^2(r^2_{vx} + r^2_{vy} - 2r_{vx}r_{vy}r_{xy})}{(s_u^2 + s_v^2)\ (1 - r^2_{xy})}. \quad (1)$$

By definition of the simple linear correlation coefficients:

$r^2_{ux} = \frac{s^2_{ux}}{s^2_u s^2_x}$, $r^2_{vx} = \frac{s^2_{vx}}{s^2_v s^2_x}$, etc; equation (1) becomes

$$R^2_{WZ} = \frac{s_y^2(s^2_{ux} + s^2_{vx}) + s_x^2(s^2_{uy} + s^2_{vy}) - 2s_{xy}(s_{ux}s_{uy} + s_{vx}s_{vy})}{(s_u^2 + s_v^2)\ (s_x^2 s_y^2 - s^2_{xy})}. \quad (2)$$

Substituting the appropriate expressions for the variances, $s_u^2 = \frac{\Sigma u^2}{n}$, $s_v^2 = \frac{\Sigma v^2}{n}$, etc.; and the covariances, $s_{ux} = \frac{\Sigma ux}{n}$, $s_{uy} = \frac{\Sigma uy}{n}$, (2) becomes

$$R^2_{WZ} = \frac{\frac{1}{n^2}\left\{\frac{\Sigma y^2}{n}\left[(\Sigma ux)^2+(\Sigma vx)^2\right]+\frac{\Sigma x^2}{n}\left[(\Sigma uy)^2+(\Sigma vy)^2\right]-2\frac{\Sigma xy}{n}\left[(\Sigma ux)(\Sigma uy)+(\Sigma vx)(\Sigma vy)\right]\right\}}{\left[\frac{\Sigma u^2 + \Sigma v^2}{n}\right]\left[\frac{(\Sigma x^2)(\Sigma y^2)}{n^2}-\frac{(\Sigma xy)^2}{n^2}\right]}$$

$$= \frac{\Sigma y^2\left[(\Sigma ux)^2+(\Sigma vx)^2\right]+\Sigma x^2\left[(\Sigma uy)^2+(\Sigma vy)^2\right]-2\Sigma xy\left[(\Sigma ux)(\Sigma uy)+(\Sigma vx)(\Sigma vy)\right]}{\left[\Sigma u^2 + \Sigma v^2\right]\left[(\Sigma x^2)(\Sigma y^2) - (\Sigma xy)^2\right]} \quad (3)$$

a form which is much easier to compute. The basic difference between the Court R_{WZ} and the Durst r_{WZ} is that R_{WZ} employs multiple correlation of three variables, while r_{WZ} parallels more the simple correlation of two variables.

The development of Durst's correlation coefficient assumes a linear relationship between W and Z, such that $W-\overline{W} = C(Z-\overline{Z})$.

Setting $w = W-\overline{W}$ and $z = Z-\overline{Z}$, $w = Cz$, where $C = \frac{s_W}{s_Z} r_{WZ}$.

Here s_W and s_Z are the sample standard deviations of W and Z, respectivel and r_{WZ} can be Durst's combination stretch and turn correlation coefficient, or only the stretch correlation coefficient. The total stretch and turn coefficient is expressed as

$$r_{WZ} = \frac{\sqrt{(\Sigma|w||z|\cos\theta_{wz})^2 + (\Sigma|w||z|\sin\theta_{wz})^2}}{(n-1)\ s_w s_z} \tag{4}$$

in which

$$\frac{\Sigma|w||z|\cos\theta_{wz}}{(n-1)s_w s_z} = \text{coefficient of simple stretch, and}$$

$$\frac{\Sigma|w||z|\sin\theta_{wz}}{(n-1)s_w s_z} = \text{coefficient of simple turn.}$$

The coefficient of simple turn contributes very little to r_{WZ}. The coefficient of simple stretch is often computed separately. In equation (4)

$$s_w = \sqrt{\frac{\sum_{k=1}^{n} (w_{Uk}^2 + w_{Vk}^2)}{n-1}} \quad \text{and} \quad s_z = \sqrt{\frac{\sum_{k=1}^{n} (z_{Xk}^2 + z_{Yk}^2)}{n-1}}$$

are the sample standard deviations of the W's and Z's, and θ_{wz} is the angle between w and z. For easier computation, equation (4) may be written,

$$r_{WZ} = \frac{\sqrt{(\Sigma ux + \Sigma vy)^2 + (\Sigma uy - \Sigma vx)^2}}{(n-1)s_w s_z}.$$

The numerator results from definitions of the dot and cross products.

LAGGED INTERLEVEL CORRELATIONS AT INDIVIDUAL STATIONS

Interlevel correlations between the wind at various heights for individual stations, or for representative groups of stations, have been presented by Charles [5, 6], Kochanski [7], and Durst [3, 8]. Similar correlations for El Paso, Fort Huachuca, Albuquerque, Midland, and Amarillo are presented by season in Tables I through V; values for lags of 12, 24, 36, and 48 hours are also shown.

Kochanski [7] divided the northern hemisphere into three latitudinal areas separated by relatively narrow transitional bands, and presented correlation coefficients for each area. All of the stations studied in the present report were within the transitional band between his Types I and II. After corrections for station elevation from his Table II have been applied, the values of R reported here agree closely with his.

Kochanski also found that for stations in the latitude of those used in this study, summer seemed to be the only distinct season; the other seasons were very similar to each other. This seasonal characteristic is true of the correlations presented here for El Paso for zero lag; to a lesser degree it is true for lags of 12 hours. (Lags were not used in Kochanski's work.) It is not true for correlations with lags of 24 to 36 hours, and for lags of 48 hours winter appears to be the only distinct season.

The autocorrelations for El Paso from Table I are plotted in Figure 2 as a function of time and height. The plotted points on this chart, and others which follow, have been connected to form continuous curves, but it is not intended to imply that the changes between points are known to be linear. The decay of R with time is apparent for all seasons and at most heights. It is greatest in winter and smallest in summer. The curves also show that, in general, R increases with height.

LAGGED INTERLEVEL CORRELATIONS BETWEEN EL PASO AND OTHER STATIONS

In the preceding section the correlation functions were computed for individual stations. In this section the results of adding horizontal separation to the parameters already included are presented. Correlation functions were computed between El Paso and the other four stations, and between El Paso and combinations of the other stations. The combinations used were: Fort Huachuca and Albuquerque; Fort Huachuca and Midland; and Fort Huachuca, Midland, and Albuquerque. For the station combinations, the observed values of the individual stations were averaged vectorially before the correlation functions were computed.

TABLE I

LAGGED INTERLEVEL CORRELATIONS AT EL PASO

R-HUNDREDTHS

HEIGHT	SUMMER					FALL					WINTER					SPRING				
km	Lag-Hours					Lag-Hours					Lag-Hours					Lag-Hours				
msl	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48
1.5-1.5		36	30	14	06		54	35	22	17		54	32	21	16		50	35	18	10
3-1.5	45	35	27	15	13	60	49	35	21	14	61	50	32	23	18	59	49	27	15	14
3-3		54	45	28	23		69	53	32	24		63	38	23	16		60	39	22	20
6-1.5	27	27	26	22	19	34	35	30	21	18	44	44	32	22	18	42	41	29	18	18
6-3	55	53	45	37	30	63	59	47	34	27	70	62	42	31	24	67	60	41	30	27
6-6		74	64	50	43		74	54	42	35		65	40	31	25		68	47	35	32
9-3	40	40	34	31	25	46	46	38	32	24	48	49	37	27	20	48	46	37	32	29
9-6	72	66	58	47	42	74	66	55	45	39	65	53	35	29	21	65	57	44	37	33
9-9		73	61	51	44		67	48	36	31		61	35	26	28		60	51	40	37
12-3	36	37	34	28	27	41	40	34	27	25	40	39	31	25	20	47	44	37	33	31
12-6	64	63	57	51	42	64	60	50	43	38	53	46	33	26	21	66	61	49	42	35
12-9	74	69	61	53	48	73	66	56	42	37	69	61	43	27	23	73	64	52	44	37
12-12		81	69	58	51		78	57	40	30		79	56	39	27		80	60	47	40
24-12	34	34	30	31	28	38	35	29	26	25	25	23	22	22	22	34	31	29	26	24
24-24		53	40	38	39		87	78	72	69		86	71	58	47		72	62	54	49

TABLE II

LAGGED INTERLEVEL CORRELATIONS AT FORT HUACHUCA

R-HUNDREDTHS

HEIGHT	SUMMER					FALL					WINTER					SPRING				
km	Lag-Hours					Lag-Hours					Lag-Hours					Lag-Hours				
msl	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48
1.5-1.5		35	38	17	24		44	35	19	18		51	33	20	21		38	36	22	21
3-1.5	49	38	32	20	22	49	43	33	28	21	57	47	33	27	25	56	48	32	21	19
3-3		64	51	34	29		70	48	36	30		70	45	29	24		64	41	28	24
6-1.5	26	28	26	23	16	34	33	27	23	19	50	42	32	25	23	50	46	32	23	20
6-3	59	55	47	38	34	71	62	47	36	31	81	70	48	32	24	75	63	46	34	28
6-6		77	60	47	39		76	52	39	33		71	44	31	20		72	47	38	30
9-3	47	44	40	37	36	53	49	41	32	24	62	54	40	26	21	54	48	39	29	24
9-6	70	66	55	48	41	78	65	50	39	31	74	62	42	26	20	71	58	43	36	30
9-9		76	60	48	43		72	50	37	28		67	40	21	16		67	47	36	28
12-3	43	42	39	37	36	47	44	36	29	21	53	50	38	25	18	49	43	33	27	25
12-6	60	59	54	47	40	68	57	44	34	28	63	56	40	27	16	64	56	44	37	31
12-9	76	69	60	52	46	76	63	46	33	23	76	66	47	28	20	72	61	51	41	35
12-12		85	72	62	54		78	55	39	28		77	53	36	27		75	54	40	34
24-12	33	31	32	30	29	29	29	28	26	25	24	21	18	14	12	21	21	19	20	21
24-24		60	42	34	26		92	86	83	80		82	70	59	50		70	55	47	35

TABLE III

LAGGED INTERLEVEL CORRELATIONS AT ALBUQUERQUE

R-HUNDREDTHS

HEIGHT	SUMMER					FALL					WINTER					SPRING				
km	Lag-Hours					Lag-Hours					Lag-Hours					Lag-Hours				
msl	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48
1.5-1.5																				
3-1.5																				
3-3		28	35	14	14		62	45	28	23		53	35	25	22		50	35	23	22
6-1.5																				
6-3	42	44	32	28	24	66	60	43	30	24	67	58	40	32	25	63	53	37	29	24
6-6		60	54	47	40		71	50	35	25		63	39	28	22		58	41	32	27
9-3	32	34	31	26	24	48	43	32	23	19	49	44	36	26	20	48	46	39	31	23
9-6	67	70	54	48	41	74	59	41	29	21	74	55	36	25	20	69	57	40	32	24
9-9		71	58	47	38		63	35	19	14		56	27	17	16		66	40	27	19
12-3	30	31	29	28	25	44	43	39	31	26	47	48	43	32	25	50	51	46	40	32
12-6	58	63	58	54	47	67	61	47	35	28	69	62	44	31	24	67	64	51	41	40
12-9	77	68	59	53	45	75	66	45	28	22	77	63	40	23	22	72	65	50	38	30
12-12		8	70	59	51		78	54	36	27		75	47	29	22		78	57	43	34
24-12	33	33	32	32	27	26	28	27	24	24	21	19	18	19	17	31	32	32	31	29
24-24		58	47	41	40		90	79	69	62		91	78	56	58		85	67	50	37

TABLE IV

LAGGED INTERLEVEL CORRELATIONS AT MIDLAND

R-HUNDREDTHS

HEIGHT	SUMMER					FALL					WINTER					SPRING				
km	Lag-Hours					Lag-Hours					Lag-Hours					Lag-Hours				
msl	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48
1.5-1.5		41	54	22	29		52	34	20	18		52	26	17	15		52	29	14	13
3-1.5	41	47	28	32	18	54	48	30	24	20	53	51	35	23	15	51	39	24	17	16
3-3		55	48	29	26		64	47	35	28		58	39	22	15		57	39	30	29
6-1.5	33	32	33	27	27	36	36	32	26	21	36	44	36	27	18	37	35	27	19	15
6-3	57	53	43	35	27	65	63	54	43	35	71	64	44	29	19	66	61	47	36	29
6-6		67	61	43	37		74	55	43	35		66	40	26	17		69	48	38	34
9-3	41	37	35	28	24	43	44	41	36	33	51	49	33	24	17	50	46	41	33	20
9-6	63	58	52	41	35	73	65	50	39	33	73	57	34	21	15	72	61	45	37	32
9-9		67	56	46	41		74	55	41	33		61	31	15	08		65	43	37	32
12-3	33	33	34	29	25	41	45	43	37	31	44	46	40	28	20	44	45	42	34	31
12-6	45	51	46	39	33	66	62	51	41	32	61	54	38	24	20	65	61	50	40	36
12-9	72	65	59	49	44	78	72	57	44	36	64	61	39	21	14	71	63	47	35	31
12-12		79	70	61	54		82	64	50	42		76	51	34	24		80	60	47	43
24-12	37	36	34	31	30	48	46	44	42	41	21	23	26	24	24	39	36	34	32	29
24-24		54	39	36	36		92	84	77	71		89	76	64	54		86	73	64	56

TABLE V

LAGGED INTERLEVEL CORRELATIONS AT AMARILLO

R-HUNDREDTHS

HEIGHT	SUMMER					FALL					WINTER					SPRING				
km	Lag-Hours					Lag-Hours					Lag-Hours					Lag-Hours				
msl	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48
1.5-1.5		42	37	16	17		43	23	13	16		45	17	12	12		49	26	13	10
3-1.5	46	42	30	27	19	48	38	22	20	17	59	44	26	16	13	57	42	22	15	10
3-3		51	43	25	30		57	39	26	22		54	29	16	14		49	27	19	19
6-1.5	30	30	29	24	26	27	27	24	20	16	31	40	31	22	14	29	34	26	23	21
6-3	54	54	45	40	33	65	63	48	35	27	71	64	45	28	21	64	59	40	33	32
6-6		69	57	42	38		67	48	35	28		63	39	27	20		63	45	38	35
9-3	35	38	36	34	28	48	48	41	28	24	52	52	38	23	20	44	46	37	30	28
9-6	68	62	54	43	39	73	57	40	30	26	76	58	35	25	18	70	56	42	34	31
9-9		68	55	43	35		58	36	22	21		59	31	19	14		63	41	32	27
12-3	26	33	34	31	29	48	52	47	37	30	54	60	47	34	25	46	51	44	37	32
12-6	58	58	53	45	39	72	64	47	37	29	75	67	48	34	23	74	68	52	44	39
12-9	73	68	58	47	40	78	64	45	31	25	78	65	42	27	19	76	66	49	38	31
12-12		77	66	53	46		76	55	39	31		78	54	38	28		77	61	49	41
24-12	22	22	21	30	21	38	38	35	33	31	34	29	24	22	19	44	41	37	33	26
24-24		57	42	33	28		88	82	78	75		86	74	66	62		73	61	52	47

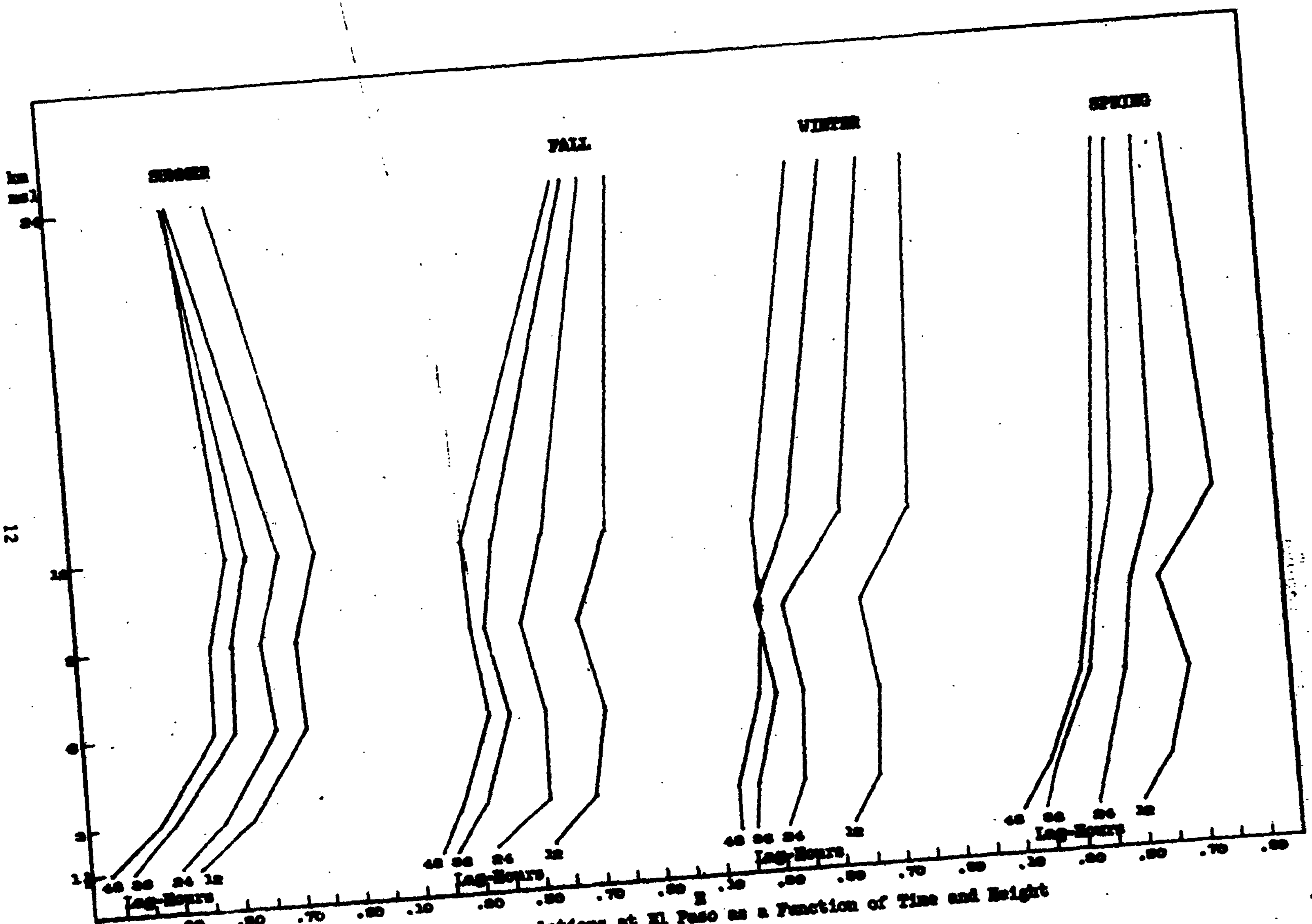

Figure 2. Seasonal Correlations at El Paso as a Function of Time and Height

Seasonal values of the correlation functions for each of the stations and station combinations, for lags of 0, 12, 24, 36, and 48 hours, and for various height combinations, are presented in Tables VI through XII. In these tables the first of the figures in the "Height" block refers to the wind at El Paso; the second figure is for the other station or station combination.

In order to evaluate these correlation functions which included space separation, arithmetic means were prepared for each station and station combination and compared with the same value computed at El Paso alone. Means included values only for the summer and winter, only for time lags of 24 and 48 hours, and only for height pairs of 6-6 km, 9-9 km, 12-12 km, and 24-24 km. Comparisons were made at the same heights, because these functions were usually larger than the interlevel functions. These 16 values for each station were assumed to have equal weight and usefulness. The results, in Table XIII, show that, even though two of the station combinations do have slightly larger mean values than El Paso alone, the differences are too small to have any practical usefulness.

TABLE XIII

MEAN R FOR HEIGHTS OF 6, 9, 12, AND 24 km, AND LAGS OF 24 AND 48 HOURS

STATION OR STATION COMBINATION	MEAN R, HUNDREDTHS
El Paso vs Fort Huachuca-Albuquerque	48
El Paso vs Fort Huachuca - Albuquerque-Midland	48
El Paso vs El Paso	46
El Paso vs Fort Huachuca-Midland	46
El Paso vs Fort Huachuca	43
El Paso vs Albuquerque	40
El Paso vs Amarillo	37
El Paso vs Midland	36

Seasonal correlations between El Paso and some of the stations as a function of height and time are shown in Figures 3 through 7.

TABLE VI

LAGGED INTERLEVEL CORRELATIONS BETWEEN EL PASO AND FORT HUACHUCA

R-HUNDREDTHS

HEIGHT	SUMMER					FALL					WINTER					SPRING				
km	Lag-Hours					Lag-Hours					Lag-Hours					Lag-Hours				
msl	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48
3-3	45	44	37	31	25	66	62	51	38	32	72	68	48	30	23	63	60	47	32	22
6-3	51	53	53	45	38	54	58	50	41	32	62	62	49	33	26	61	61	49	43	27
6-6	66	67	63	53	47	67	68	56	42	34	68	66	49	35	28	69	71	54	38	30
9-3	40	42	43	39	36	39	44	42	35	27	49	50	40	28	18	44	48	41	34	28
9-6	60	61	58	49	42	53	57	51	41	32	56	57	42	28	21	57	58	47	38	33
9-9	65	66	61	51	42	56	60	54	41	33	66	58	38	24	21	63	66	51	39	33
12-6	55	57	53	48	43	46	47	39	30	25	47	49	41	30	23	50	56	50	42	35
12-9	62	64	60	52	46	51	51	43	32	24	57	58	47	34	26	57	61	52	43	34
12-12	63	70	63	54	49	60	60	51	40	29	62	63	52	39	30	64	64	55	46	39
24-12	33	35	35	35	33	30	30	28	27	24	26	22	19	17	17	30	27	23	20	22
24-24	40	33	31	31	30	74	73	72	71	69	50	52	52	51	48	42	42	41	41	41

TABLE VII

LAGGED INTERLEVEL CORRELATIONS BETWEEN EL PASO AND ALBUQUERQUE

R-HUNDREDTHS

HEIGHT	SUMMER					FALL					WINTER					SPRING				
km	Lag-Hours					Lag-Hours					Lag-Hours					Lag-Hours				
msl	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48
3-3	49	45	35	23	16	69	63	46	29	22	66	62	42	26	17	65	52	38	28	20
6-3	36	38	32	24	20	53	54	43	33	27	52	52	43	30	22	54	51	38	30	28
6-6	66	63	55	47	38	71	69	53	39	30	65	58	42	30	22	65	61	46	36	31
9-3	26	28	27	21	18	32	30	30	26	23	37	38	33	23	18	37	36	32	28	25
9-6	54	56	49	42	39	49	48	38	34	30	48	46	31	23	19	46	47	39	33	31
9-9	63	59	50	42	32	52	51	40	28	23	55	48	29	20	19	52	48	43	32	26
12-6	52	52	47	44	40	45	46	37	28	24	43	43	35	27	24	49	52	45	38	33
12-9	57	55	49	43	37	49	50	37	24	17	49	47	33	24	21	51	52	46	38	32
12-12	68	67	60	52	45	59	56	46	33	24	56	52	42	30	23	65	62	52	42	36
24-12	24	26	23	24	22	26	22	21	18	17	19	16	17	20	22	29	27	23	21	20
24-24	39	35	38	32	32	55	54	52	47	48	62	62	58	53	48	48	47	44	42	38

TABLE VIII

LAGGED INTERLEVEL CORRELATIONS BETWEEN EL PASO AND MIDLAND

R-HUNDREDTHS

HEIGHT	SUMMER					FALL					WINTER					SPRING				
km	Lag-Hours					Lag-Hours					Lag-Hours					Lag-Hours				
msl	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48
3-3	49	44	33	26	20	71	57	42	28	23	72	46	25	16	13	66	49	33	25	25
6-3	53	47	40	34	27	63	55	45	35	29	65	47	32	23	18	63	53	39	30	29
6-6	68	58	53	41	36	73	56	42	34	29	65	43	28	20	15	69	54	40	37	30
9-3	42	37	34	28	26	46	43	39	34	28	42	36	24	19	14	46	42	35	33	31
9-6	59	53	47	40	33	59	51	43	38	34	51	37	28	22	17	56	48	41	33	30
9-9	65	57	49	41	34	61	51	45	41	36	51	35	24	22	21	60	52	42	31	27
12-6	54	52	46	41	33	53	43	35	29	25	45	36	30	27	22	60	52	44	39	36
12-9	64	58	53	46	43	60	51	42	35	29	48	35	24	18	16	59	49	39	31	29
12-12	73	68	63	56	50	63	51	43	32	28	52	43	32	23	19	68	57	47	41	37
24-12	32	31	29	29	27	44	43	41	40	38	17	17	18	18	20	30	29	27	25	24
24-24	41	43	40	37	34	68	68	69	69	68	57	54	47	41	35	60	58	56	53	52

TABLE IX

LAGGED INTERLEVEL CORRELATIONS BETWEEN EL PASO AND AMARILLO

R-HUNDREDTHS

HEIGHT	SUMMER					FALL					WINTER					SPRING				
km	Lag-Hours					Lag-Hours					Lag-Hours					Lag-Hours				
msl	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48
3-3	40	42	30	25	17	60	51	37	26	24	62	45	28	20	18	56	45	31	24	24
6-3	45	43	38	35	32	53	46	37	28	26	52	43	31	21	18	53	43	33	30	29
6-6	60	53	49	38	33	68	54	41	32	27	63	41	27	21	20	64	48	35	31	31
9-3	36	34	32	29	27	36	33	32	28	25	32	31	25	21	18	36	31	27	27	27
9-6	52	48	43	38	31	51	47	39	34	31	43	37	25	20	13	46	39	33	29	28
9-9	61	56	48	41	35	57	52	42	36	32	55	39	27	21	14	56	45	35	28	26
12-6	46	46	41	37	31	46	39	32	26	21	41	34	28	26	22	53	45	37	34	31
12-9	56	53	48	42	37	53	47	35	26	23	49	38	25	21	17	54	47	37	32	26
12-12	60	55	50	46	41	64	53	42	34	28	57	48	36	30	24	64	55	45	39	35
24-12	24	24	20	20	19	28	27	25	22	19	24	22	20	21	22	30	29	28	27	30
24-24	44	42	39	36	33	67	65	64	64	63	61	62	61	58	53	50	49	48	48	45

TABLE X

LAGGED INTERLEVEL CORRELATIONS BETWEEN EL PASO AND A COMBINATION OF FORT HUACHUCA AND ALBUQUERQUE

R-HUNDREDTHS

HEIGHT	SUMMER					FALL					WINTER					SPRING				
km	Lag-Hours					Lag-Hours					Lag-Hours					Lag-Hours				
msl	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48
3-3	55	53	44	32	24	76	70	54	37	30	77	73	50	30	19	73	64	48	33	24
6-3	54	56	51	43	35	59	63	52	42	33	64	65	52	35	26	65	64	49	37	32
6-6	74	73	66	56	48	76	76	61	45	34	74	70	51	36	28	74	73	55	41	34
9-3	40	43	43	36	32	38	42	39	33	28	47	49	40	28	19	46	48	42	35	29
9-6	64	65	60	52	45	55	57	48	39	32	58	57	41	28	22	57	57	47	40	35
9-9	72	71	63	51	41	61	63	52	38	30	65	58	36	24	21	63	64	53	40	33
12-6	60	61	56	52	47	49	51	42	31	26	50	51	42	32	25	55	60	42	44	38
12-9	67	67	61	53	46	56	57	45	31	22	58	57	44	32	25	60	62	53	43	35
12-12	78	74	66	57	50	67	65	54	40	29	66	64	52	38	29	72	70	60	48	41
24-12	30	31	30	31	29	31	29	28	25	22	25	21	19	20	21	31	28	24	22	23
24-24	47	41	41	38	38	74	72	71	68	67	62	64	63	60	56	53	53	51	49	47

TABLE XI

LAGGED INTERLEVEL CORRELATIONS BETWEEN EL PASO AND A COMBINATION OF FORT HUACHUCA AND MIDLAND

R-HUNDREDTHS

HEIGHT	SUMMER					FALL					WINTER					SPRING				
km	Lag-Hours					Lag-Hours					Lag-Hours					Lag-Hours				
msl	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48
3-3	57	53	42	33	24	79	68	51	37	30	80	64	41	25	19	74	61	44	32	26
6-3	63	60	55	48	39	67	64	54	43	35	72	62	45	32	24	71	65	50	37	33
6-6	78	75	68	56	49	81	72	55	43	35	77	62	44	31	23	79	70	52	37	33
9-3	49	47	46	40	36	48	51	46	39	30	52	48	36	26	17	52	51	44	38	34
9-6	70	67	62	52	44	65	61	51	42	36	61	52	38	28	20	63	59	49	41	36
9-9	77	72	65	53	44	72	64	52	42	37	66	52	33	26	23	71	66	52	39	34
12-6	64	63	58	52	45	58	52	42	33	28	52	48	38	28	22	63	61	53	45	40
12-9	74	71	65	57	51	67	60	48	37	30	62	53	38	26	22	68	63	51	41	36
12-12	85	80	72	63	56	75	66	54	42	33	68	62	48	35	26	76	69	58	49	43
24-12	37	37	36	36	33	41	39	37	35	32	22	20	20	20	22	32	30	27	25	25
24-24	49	46	44	42	39	78	77	77	76	75	51	52	51	49	46	61	59	57	56	54

TABLE XII

LAGGED INTERLEVEL CORRELATIONS BETWEEN EL PASO AND A COMBINATION OF FORT HUACHUCA, ALBUQUERQUE, AND MIDLAND

R-HUNDREDTHS

HEIGHT	SUMMER					FALL					WINTER					SPRING				
km	Lag-Hours					Lag-Hours					Lag-Hours					Lag-Hours				
msl	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48
3-3	61	58	46	34	24	82	72	54	37	29	82	69	45	27	18	77	64	46	33	36
6-3	62	61	55	46	37	67	66	54	43	35	71	64	48	33	25	71	66	50	38	34
6-6	81	77	69	57	49	83	76	59	45	35	80	66	47	33	24	80	72	54	40	35
9-3	47	47	46	38	34	45	47	43	36	30	50	48	37	27	19	51	51	44	38	33
9-6	70	69	66	53	46	62	60	50	41	34	61	54	38	28	21	62	59	49	41	37
9-9	79	74	65	53	43	71	66	53	41	34	67	55	34	26	23	70	66	54	41	34
12-6	65	65	59	54	47	57	53	43	33	28	53	50	40	30	25	63	63	54	46	41
12-9	74	72	65	56	50	67	62	49	35	27	62	55	39	27	24	68	65	54	43	36
12-12	85	80	72	62	55	76	69	56	42	31	69	63	50	36	37	79	73	61	51	44
24-12	34	35	33	33	30	36	35	32	29	26	22	20	20	21	23	33	31	28	26	25
24-24	52	48	47	44	42	78	77	76	74	73	62	63	61	57	53	65	63	61	59	56

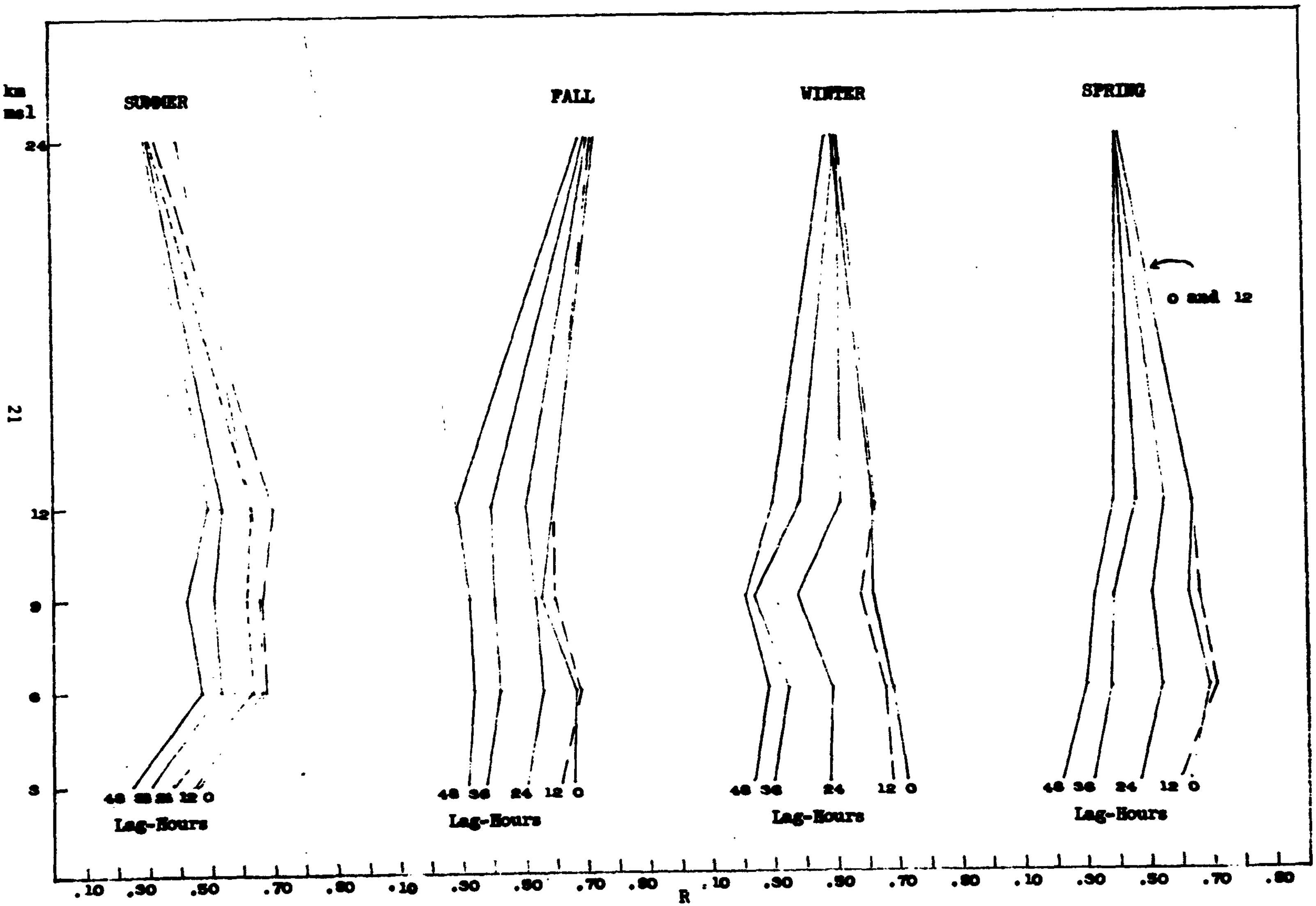

Figure 3. Seasonal Correlations Between El Paso and Fort Huachuca as a Function of Time and Height

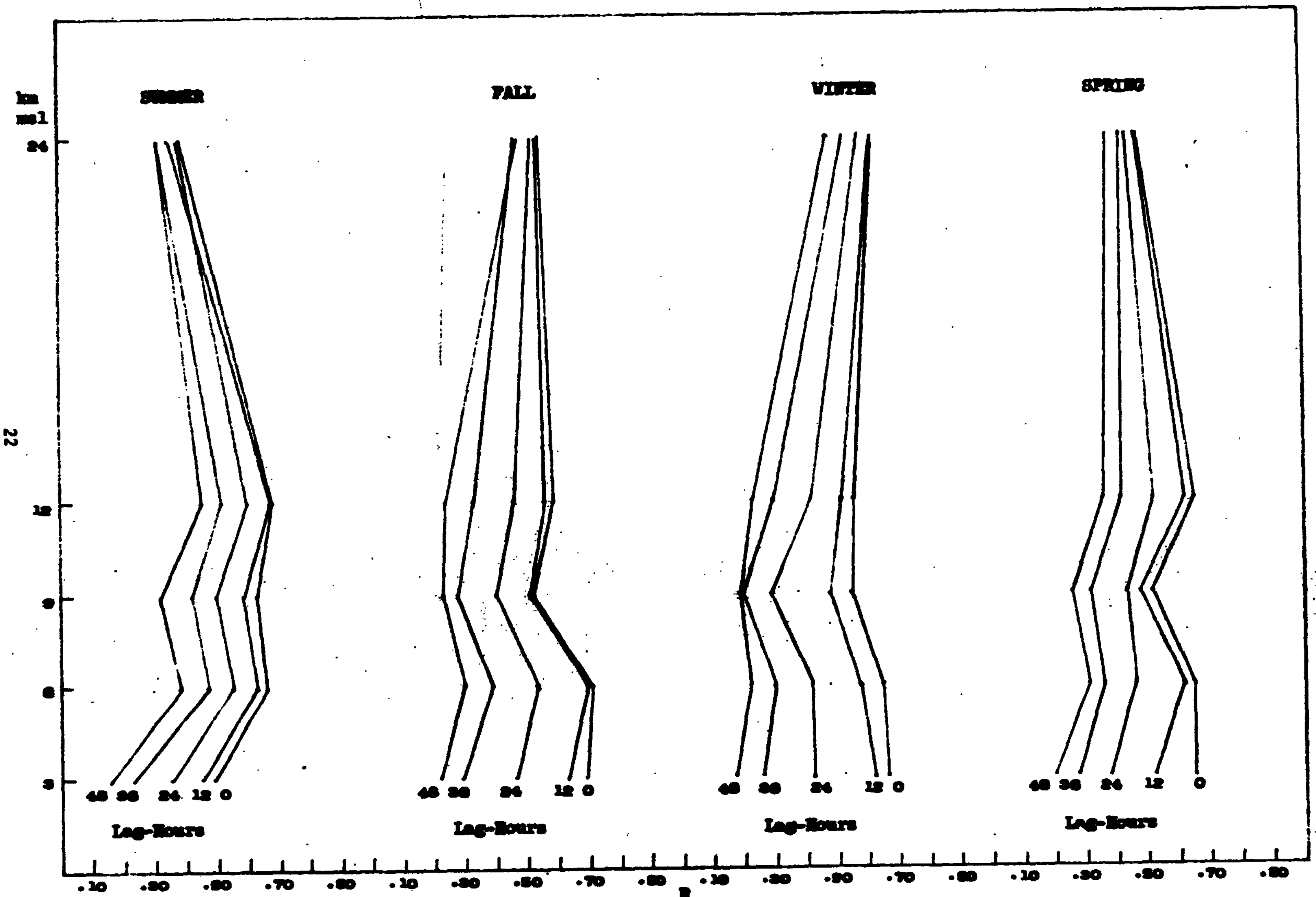

Figure 4. Seasonal Correlations Between El Paso and Albuquerque as a Function of Time and Height

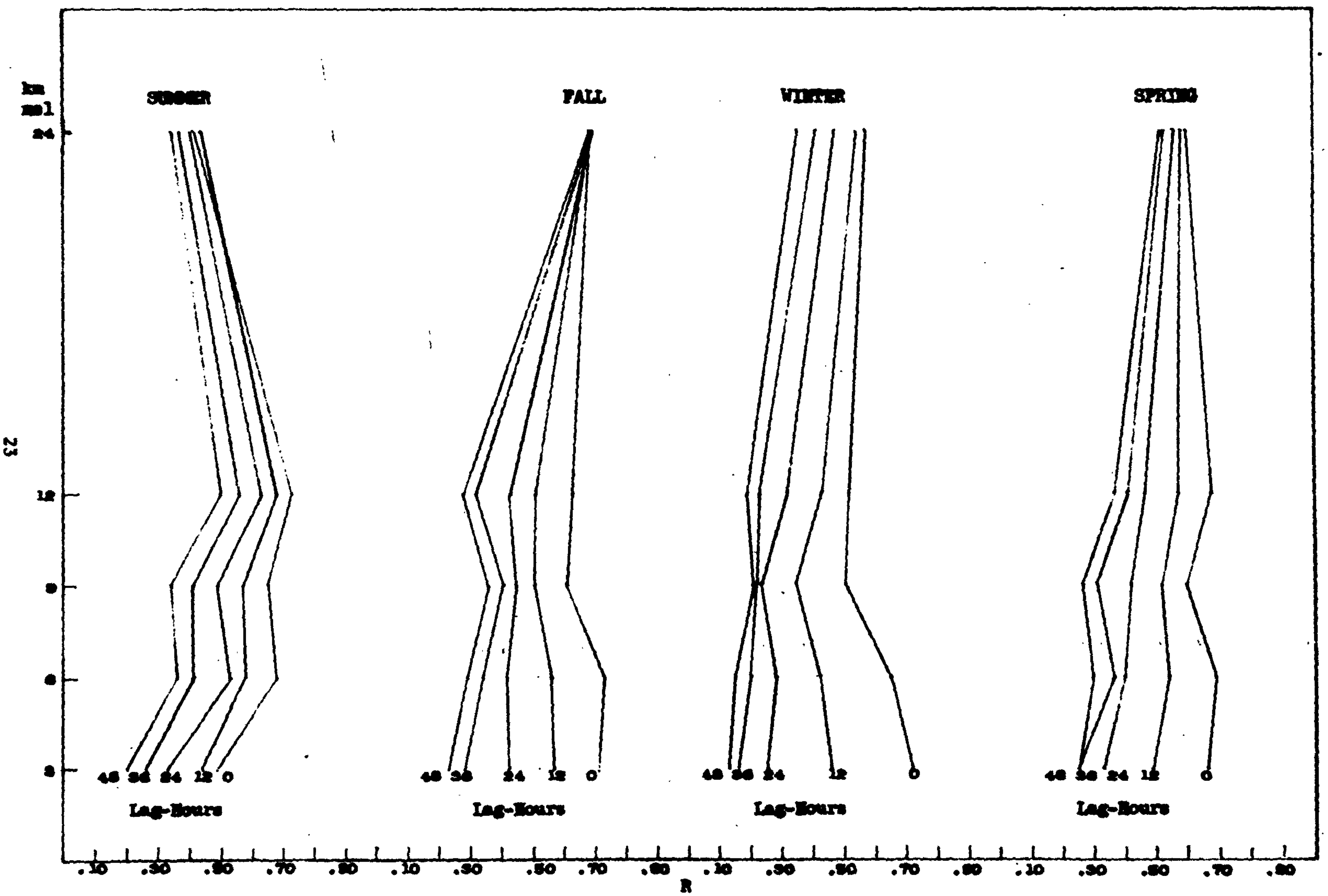

Figure 5. Seasonal Correlations Between El Paso and Midland as a Function of Time and Height

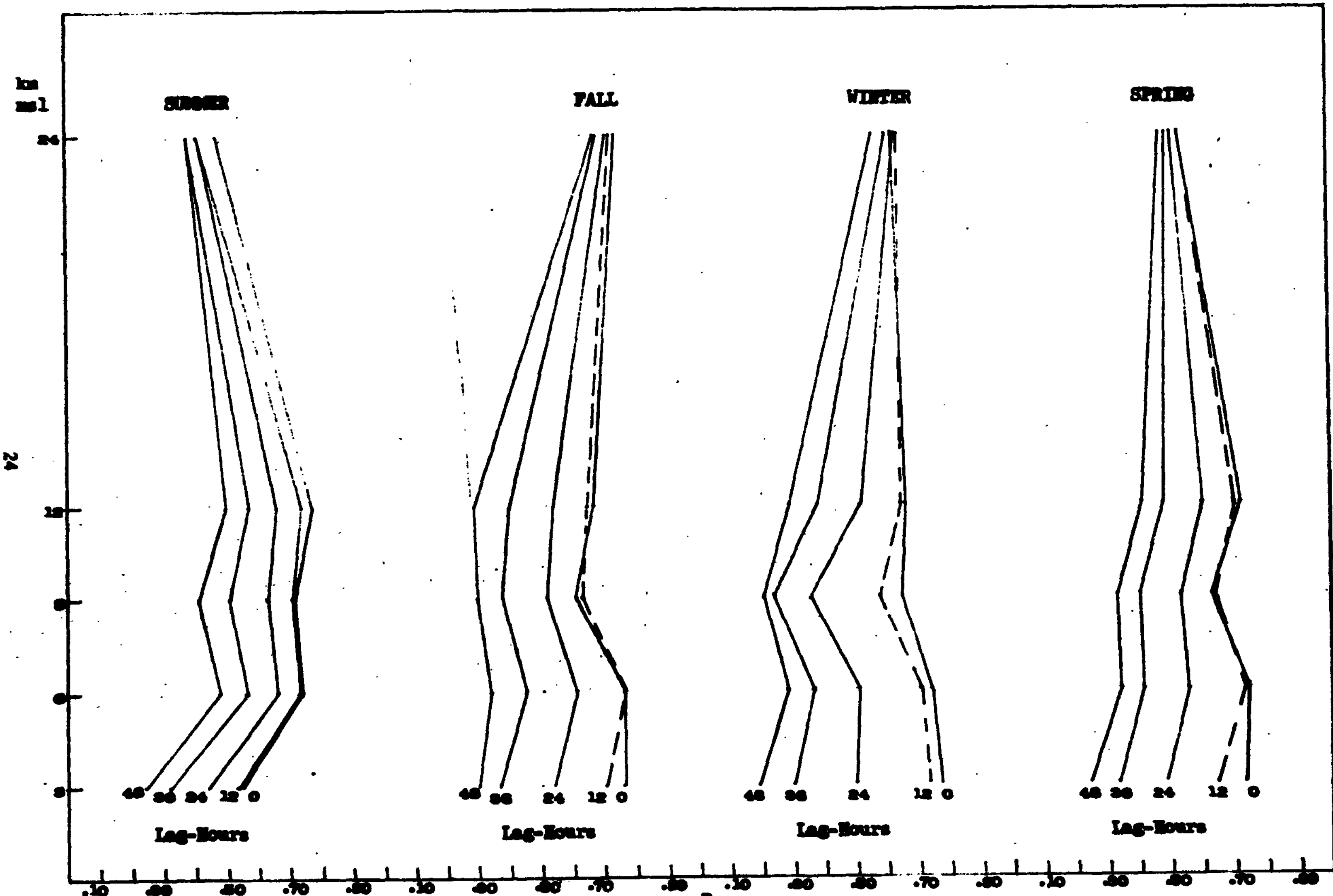

Figure 6. Seasonal Correlations Between El Paso and a Combination of Fort Huachuca and Albuquerque as a Function of Time and Height

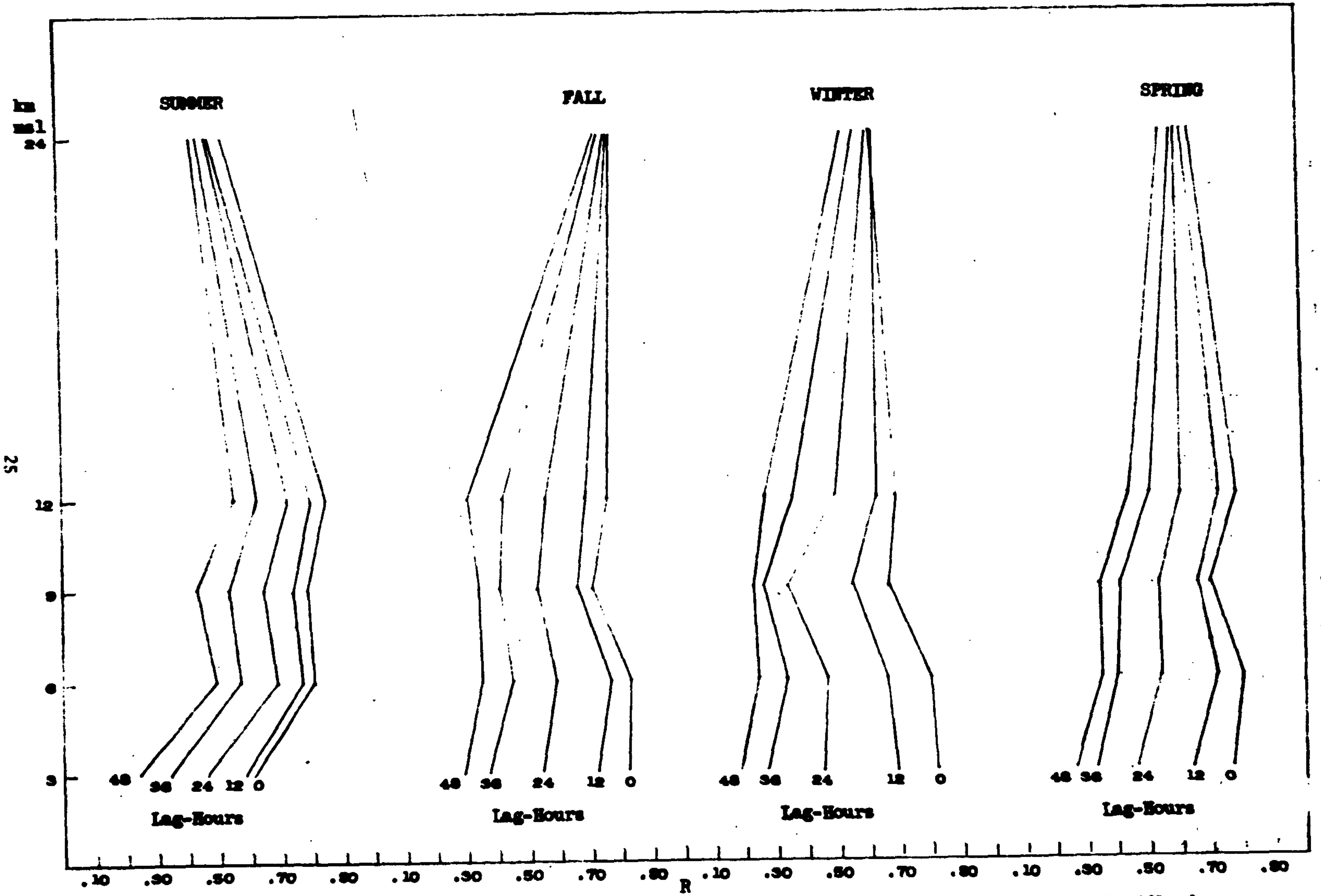

Figure 7. Seasonal Correlations Between El Paso and a Combination of Fort Huachuca, Albuquerque, and Midland as a Function of Time and Height

USE OF CORRELATION COEFFICIENTS FOR PREDICTING WIND

One of the purposes of this study was the development of an objective wind forecasting technique. The correlation coefficients shown in this report can be used for this purpose and this section will outline the necessary procedures. The required regression equation is,

$$W-\overline{W} = \frac{s_W}{s_Z} R_{WZ}[Z-\overline{Z}]. \tag{5}$$

In actual use equation (5) is rewritten as two equations, with small changes in notation, as,

$$x_W = \overline{x}_W + \frac{s_W}{s_Z} R_{WZ}\left[x_Z - \overline{x}_Z \right] \tag{6}$$

and

$$y_W = \overline{y}_W + \frac{s_W}{s_Z} R_{WZ}\left[y_Z - \overline{y}_Z \right]. \tag{7}$$

Equations (6) and (7) forecast, respectively, the east and north components of the wind at W. The forecasted wind will have a speed, $\sqrt{(x_W)^2 + (y_W)^2}$ and a direction, $\tan^{-1}\left(\frac{y_W}{x_W}\right)$. The required parameters for equations (6) and (7) are:

x_Z, the east component of the observed wind at station Z.

y_Z, the north component of the observed wind at station Z.

$\overline{x}_Z$, the mean of the east component of the wind at station Z.

$\overline{y}_Z$, the mean of the north component of the wind at station Z.

$\overline{x}_W$, the mean of the east component of the wind at station W.

$\overline{y}_W$, the mean of the north component of the wind at station W.

R_{WZ}, the total vector correlation coefficient.

$\frac{s_W}{s_Z}$, the ratio of the total vector deviation at station W to that at station Z.

The observed wind at Z station will usually come from teletype synoptic reports; the R_{WZ}'s are found in preceding tables. All the other values are constants which are presented for certain selected combinations in Tables XIV through XX which follow. Note that for individual stations there is only one set of components.

Tests of the foregoing techniques with independent data have not been made. The computational data were used with a similar technique and the standard errors of the components evaluated. These have not been analyzed in detail but averaged about 10 mps for the north components and about 9 mps for the east components. The errors generally increased with increasing lags.

COMPARISON OF THE TOTAL VECTOR CORRELATION COEFFICIENT [COURT'S R] WITH THE TOTAL STRETCH AND TURN CORRELATION COEFFICIENT [DURST'S r]

A comparison of the total vector correlation coefficient [Court's R] and Durst's stretch and turn correlation coefficient [r] is an interesting side light of this study. Court points out that these values cannot be readily compared due to the difference in the manner in which they are computed. However Charles [4] has presented results of a study in which the quantities were compared.

The data studied in this section were the correlations between El Paso and Fort Huachuca, for a lag of zero, showing space separation, and for a lag of 48 hours, showing separation in both space and time. Each correlation coefficient was computed from 180-184 scalar wind pairs and described the correlation for a particular season and a particular year. Data for each season for each of three years for the 11 height combinations shown in Table VI were used, making a total of 132 values. These annual values are used only in this section; elsewhere in this study correlations were computed for the full three-year period. The difference between R and r did not vary much with the seasons or with the different height combinations, hence data from all heights and all seasons were combined.

The results of this comparison are shown in Figure 8 where the scattergram on the left is for lag zero, space separation only, while on the right, separation with both space and time is shown.

As found by Charles, R was always $\geq$ r. The difference between the two increased with the lag; as the time increased, Durst's r decreased faster than did Court's R. For R less than about .30, r appears questionable. Charles used 450 data pairs in his study and surmised that, with fewer pairs, the threshold value of r for important discrepancy with R would be larger than .30. The two scattergrams shown here, computed from 180 data pairs, appear very similar to his, and indicate the critical value .30 holds for as few as 180 pairs.

TABLE XIV

CONSTANTS FOR PREDICTING WIND AT EL PASO, (W), FROM WIND AT FORT HUACHUCA, (Z)

SUMMER

	Meters Per Second				
Height km	$\bar{x}_w$	$\bar{y}_w$	$\bar{x}_z$	$\bar{y}_z$	$\frac{s_w}{s_z}$
3-3	- .84	- .27	- .54	- .56	.99
6-6	- .16	- .61	-1.94	- .78	.96
9-9	- 1.07	- 2.34	-2.76	- 2.42	.93
12-12	.46	- 6.04	-3.81	- 6.84	.95
24-[illegible]					

FALL

	Meters Per Second				
Height km	$\bar{x}_w$	$\bar{y}_w$	$\bar{x}_z$	$\bar{y}_z$	$\frac{s_w}{s_z}$
3-3	- .96	- 4.00	- 1.66	- 2.25	1.05
6-6	- 1.22	- 9.04	- 1.25	- 7.45	.99
9-9	-10.51	-12.67	- 4.80	-11.47	.93
12-12	- 1.57	-24.58	- 1.34	-19.93	.92

WINTER

	Meters Per Second				
Height km	$\bar{x}_w$	$\bar{y}_w$	$\bar{x}_z$	$\bar{y}_z$	$\frac{s_w}{s_z}$
3-3	.77	- 8.27	.34	- 5.54	.97
6-6	2.26	-15.30	2.84	-13.34	.97
9-9	- 6.54	-17.89	-7.00	-16.22	1.04
12-12	1.95	-30.87	2.21	-27.96	1.05
24-24	-14.99	- 5.00	1.12	-1.70	.97

SPRING

	Meters Per Second				
Height km	$\bar{x}_w$	$\bar{y}_w$	$\bar{x}_z$	$\bar{y}_z$	$\frac{s_w}{s_z}$
3-3	-1.06	- 7.60	- 2.41	- 4.97	1.01
6-6	- .86	-14.80	- 1.16	-12.71	1.02
9-9	-13.08	-17.79	-10.84	-16.02	1.06
12-12	- .96	-31.59	- 1.31	-28.69	1.05
24-24	1.74	1.41	- .01	2.96	1.36

TABLE XV

CONSTANTS FOR PREDICTING WIND AT EL PASO, (W), FROM WIND AT FORT HUACHUCA-ALBUQUERQUE, (Z)

SUMMER					
	Meters Per Second				
Height km	$\bar{x}_w$	$\bar{y}_w$	$\bar{x}_z$	$\bar{y}_z$	$\frac{s_w}{s_z}$
3-3	- .84	- .27	- .57	- 1.43	1.27
6-6	- .16	- .61	- 1.19	- 2.52	1.11
9-9	- 1.07	- 2.34	- 2.92	- 4.04	1.03
12-12	.46	- 6.04	- 2.61	- 9.09	1.04
24-24	.08	14.52	.34	12.79	1.21

FALL					
	Meters Per Second				
Height km	$\bar{x}_w$	$\bar{y}_w$	$\bar{x}_z$	$\bar{y}_z$	$\frac{s_w}{s_z}$
3-3	- 9.60	- 4.00	- .62	- 3.23	1.22
6-6	- 1.22	- 9.04	1.00	- 8.32	1.09
9-9	-10.51	-12.67	- 4.78	-11.70	1.05
12-12	- 1.57	-24.58	- 3.62	-21.66	1.06
24-24	.58	.90	- .04	- .16	1.16

WINTER					
	Meters Per Second				
Height km	$\bar{x}_w$	$\bar{y}_w$	$\bar{x}_z$	$\bar{y}_z$	$\frac{s_w}{s_z}$
3-3	.77	- 8.27	1.59	- 6.16	1.19
6-6	2.26	-15.30	3.24	-13.76	1.12
9-9	- 6.54	-17.89	-6.42	-16.64	1.13
12-12	1.95	-30.87	2.62	-28.45	1.20
24-24	-14.99	- 5.00	1.65	- 2.55	1.13

SPRING					
	Meters Per Second				
Height km	$\bar{x}_w$	$\bar{y}_w$	$\bar{x}_z$	$\bar{y}_z$	$\frac{s_w}{s_z}$
3-3	- 1.06	- 7.60	- 1.17	- 5.61	1.18
6-6	- .86	-14.80	- .44	-13.66	1.09
9-9	-13.08	-17.79	-10.19	-16.58	1.08
12-12	- .96	-31.59	- .40	-29.26	1.16
24-24	1.74	1.41	1.20	1.60	1.54

TABLE XVI

CONSTANTS FOR PREDICTING WIND AT EL PASO

SUMMER

Height km	Meters Per Second $\bar{x}$	$\bar{y}$	$\frac{s_v}{s_z}$
3-3	- .54	- .56	.99
6-6	-1.94	- .78	.99
9-9	-2.76	- 2.42	.99
12-12	-3.81	- 6.84	.98
24-24	.29	13.84	.99

FALL

Height km	Meters Per Second $\bar{x}$	$\bar{y}$	$\frac{s_v}{s_z}$
3-3	- 1.66	- 2.25	1.01
6-6	- 1.25	- 7.45	1.00
9-9	- 4.80	-11.47	1.00
12-12	- 1.34	-19.93	.99
24-24	- .12	.55	.99

WINTER

Height km	Meters Per Second $\bar{x}$	$\bar{y}$	$\frac{s_v}{s_z}$
3-3	.34	- 5.54	1.00
6-6	2.84	-13.34	1.00
9-9	-7.00	-16.22	1.00
12-12	2.21	-27.96	1.01
24-24	1.12	- 1.70	1.00

SPRING

Height km	Meters Per Second $\bar{x}$	$\bar{y}$	$\frac{s_v}{s_z}$
3-3	- 2.41	- 4.97	.97
6-6	- 1.16	-12.71	.99
9-9	-10.84	-16.02	.99
12-12	- 1.31	-28.69	.99
24-24	- .01	2.96	1.00

TABLE XVII

CONSTANTS FOR PREDICTING WIND AT FORT HUACHUCA

SUMMER			
	Meters Per Second		
Height km	$\bar{x}$	$\bar{y}$	$\frac{s_w}{s_z}$
3-3	- .54	- .56	.99
6-6	-1.94	- .78	.99
9-9	-2.76	- 2.42	.99
12-12	-3.81	- 6.84	.98
24-24	.29	13.84	.99

FALL			
	Meters Per Second		
Height km	$\bar{x}$	$\bar{y}$	$\frac{s_w}{s_z}$
3-3	- 1.66	- 2.25	1.01
6-6	- 1.25	- 7.45	1.00
9-9	- 4.80	-11.47	1.00
12-12	- 1.34	-19.93	.99
24-24	- .12	.55	.99

WINTER			
	Meters Per Second		
Height km	$\bar{x}$	$\bar{y}$	$\frac{s_w}{s_z}$
3-3	.34	- 5.54	1.00
6-6	2.84	-13.34	1.00
9-9	-7.00	-16.22	1.00
12-12	2.21	-27.96	1.01
24-24	1.12	- 1.70	1.00

SPRING			
	Meters Per Second		
Height km	$\bar{x}$	$\bar{y}$	$\frac{s_w}{s_z}$
3-3	- 2.41	- 4.97	.97
6-6	- 1.16	-12.71	.99
9-9	-10.84	-16.02	.99
12-12	- 1.31	-28.69	.99
24-24	- .01	2.96	1.00

TABLE XVIII

CONSTANTS FOR PREDICTING WIND AT ALBUQUERQUE

SUMMER			
	Meters Per Second		
Height km	$\bar{x}$	$\bar{y}$	$\frac{s_v}{s_z}$
3-3	- .60	- 2.30	1.00
6-6	- .44	- 4.25	1.00
9-9	-3.08	-5.65	1.00
12-12	-1.40	-11.35	1.00
24-24	.38	11.74	1.00

FALL			
	Meters Per Second		
Height km	$\bar{x}$	$\bar{y}$	$\frac{s_v}{s_z}$
3-3	.42	- 4.22	1.00
6-6	.43	- 9.19	1.01
9-9	-4.75	-11.93	1.01
12-12	- .04	-23.39	1.00
24-24	.20	.88	1.01

WINTER			
	Meters Per Second		
Height km	$\bar{x}$	$\bar{y}$	$\frac{s_v}{s_z}$
3-3	2.83	- 6.77	1.00
6-6	3.64	-14.19	1.00
9-9	-5.85	-17.06	1.00
12-12	5.67	-28.95	1.00
24-24	2.19	- 1.73	1.00

SPRING			
	Meters Per Second		
Height km	$\bar{x}$	$\bar{y}$	$\frac{s_v}{s_z}$
3-3	.08	- 6.24	1.00
6-6	.28	-14.61	.99
9-9	-9.53	-17.13	1.00
12-12	.52	-29.83	1.00
24-24	2.39	.25	1.00

TABLE XIX

CONSTANTS FOR PREDICTING WIND AT MIDLAND

SUMMER			
	Meters Per Second		
Height km	$\bar{x}$	$\bar{y}$	$\frac{s_w}{s_z}$
3-3	- 1.14	.64	1.00
6-6	1.32	.55	1.00
9-9	.82	- 2.50	1.01
12-12	2.04	- 5.32	1.00
24-24	.25	14.29	1.00

FALL			
	Meters Per Second		
Height km	$\bar{x}$	$\bar{y}$	$\frac{s_w}{s_z}$
3-3	- .82	- 4.34	1.00
6-6	- 1.00	- 9.64	1.00
9-9	-10.06	-14.34	1.01
12-12	- 2.45	-27.20	1.00
24-24	- 3.06	.50	.99

WINTER			
	Meters Per Second		
Height km	$\bar{x}$	$\bar{y}$	$\frac{s_w}{s_z}$
3-3	1.35	- 9.39	1.00
6-6	1.27	-18.32	1.00
9-9	-12.68	-22.37	1.00
12-12	- .68	-37.12	1.00
24-24	1.40	- 4.75	1.01

SPRING			
	Meters Per Second		
Height km	$\bar{x}$	$\bar{y}$	$\frac{s_w}{s_z}$
3-3	- .61	- 7.34	.99
6-6	.88	-15.92	.99
9-9	-12.93	-19.16	.98
12-12	- 1.16	-32.78	1.00
24-24	.17	1.04	.99

TABLE XX

CONSTANTS FOR PREDICTING WIND AT AMARILLO

SUMMER			
	Meters Per Second		
Height km	$\bar{x}$	$\bar{y}$	$\frac{s_w}{s_z}$
3-3	-1.57	- 2.80	1.00
6-6	1.45	- 3.90	1.00
9-9	- .36	- 4.98	1.00
12-12	1.86	- 9.04	1.01
24-24	.27	11.30	.99

FALL			
	Meters Per Second		
Height km	$\bar{x}$	$\bar{y}$	$\frac{s_w}{s_z}$
3-3	- .87	- 5.46	1.00
6-6	1.21	-10.06	1.01
9-9	-7.33	-13.37	1.00
12-12	- .54	-24.22	1.00
24-24	- .55	- 1.44	.99

WINTER			
	Meters Per Second		
Height km	$\bar{x}$	$\bar{y}$	$\frac{s_w}{s_z}$
3-3	1.94	- 8.14	1.00
6-6	3.49	-15.90	1.00
9-9	-9.01	-19.14	1.00
12-12	1.79	-31.38	1.00
24-24	1.61	- 4.47	1.00

SPRING			
	Meters Per Second		
Height km	$\bar{x}$	$\bar{y}$	$\frac{s_w}{s_z}$
3-3	.31	- 7.89	.99
6-6	.96	-14.38	.99
9-9	-9.65	-16.43	.99
12-12	-3.13	-26.00	.99
24-24	.06	- .44	1.00

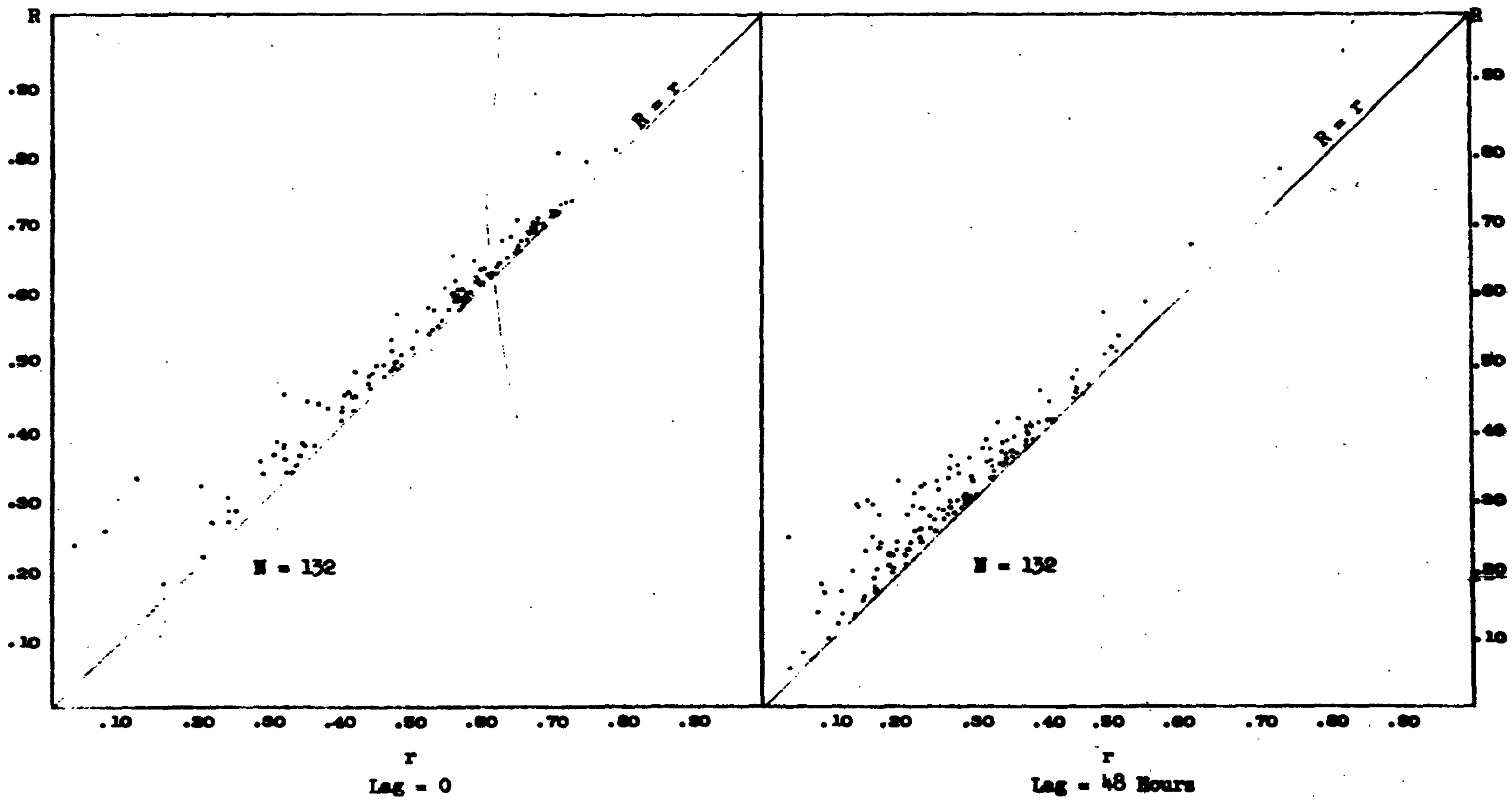

Figure 8. Comparison of Court's R and Durst's r Between El Paso and Fort Huachuca for Lag 0 and for Lag of 48 Hours

CONCLUSIONS

Although correlations between stations and station combinations were slightly higher than those at individual stations, it is concluded that, for routine forecasts, the individual stations will give almost as good results, with fewer computations. No height combinations were found which equaled the correlations computed at the same heights, i.e. to 6 km vs 6 km, etc. The values of R generally increased with height and decreased with time.

The effectiveness of the R's as a forecast aid was not investigated, but this will be done in the future in conjunction with the firing of the larger rockets.

Court's total vector correlation coefficient, R, is considered superior to Durst's stretch and turn correlation coefficient, r, especially when space, or both space and time are being considered.

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WILLIAM G. SKINNER
COLONEL, SIGNAL CORPS
COMMANDING

Approval. Technical Report ERDA-45 has been reviewed and approved for publication:

for Lloyd White
CLARENCE L. MORRISON
Lt Colonel, Signal Corps
Director
Environmental Sciences Department

Willis L. Webb
WILLIS L. WEBB
Chief Scientist
Environmental Sciences Department

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A simple technique for using the correlations as a forecast aid is presented, including the necessary constants.

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