# A PRECIPITATION NOMOGRAPH IS COMPARED TO THE MODEL LFM OUTPUT FOUS PRECIPITATION FORECASTS

BY

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## 1. INTRODUCTION

The object of this paper was to examine the relationship of precipitation with Vertical Velocity (VV) and Relative Humidity (RH) which are developed in the LFM product Fous 61. Table 1 shows the output for 12Z October 3, 1980. The numbers underlined are RH = 81 percent, VV = 02 and TT = .23 which is the rainfall amount predicted by the model for the 6 hours ending 00Z October 4th.

Table 1

FOUS61 KWBC 031200
OUTPUT FROM LFM 12Z OCT 03 80

| STA RH | R1R2R3 | VVLI | HHDDFF | TBPSTT |
|---|---|---|---|---|
| LGA081 | 848377 | 00204 | 550610 | 9007023 |
| 18076 | 837667 | 03001 | 531203 | 9005020 |
| 24059 | 776816 | -0102 | 512905 | 9006017 |
| 30060 | 736644 | 00305 | 502613 | 8909000 |
| 36062 | 686652 | 00208 | 483613 | 8812000 |
| 42059 | 666348 | -0510 | 462714 | 8616000 |
| 48059 | 656348 | -0410 | 432813 | 8419000 |

Preliminary scatter diagrams showed good relationship with these variables. It was decided to develop a nomograph using actual precipitation in place of TT - the Model LFM forecast with the two independent variables RH and VV. It was also desired to see how closely the nomograph would agree with the LFM forecast (TT).

## 2. DISCUSSION

The original LFM FOUS61 data covered the period from September 1979 to May 1980 for three stations: La Guardia, Williamsport PA, and Philadelphia PA. Both the 00Z and 12Z transmissions were used. The total number of cases was 200. The data used to test the nomograph covered the period from September 1978 to May 1979 totaling 196 cases.

## 3. METHOD

The original data was divided into class intervals of units of 10 for Vertical Velocity and in 10 percent increments for Relative Humidity. Table 2 shows how the data was organized. It shows all the data arranged by class interval for VV from -10 to 40 and RH from 60 percent to 100 percent. The average rainfall is obtained for each of the intervals. These values were used to develop charts 1,2,3, and 4.

Table 2

AVERAGES OF VV, RH, AND PRECIPITATION

| VV | RH | VV | PCPN | RH | CASES |
|---|---|---|---|---|---|
| -10-0 | 60-69 | -10 | .036 | 56.0 | 14 |
| | 70-79 | -4 | .055 | 74.6 | 16 |
| | 80-89 | -6 | .064 | 86.0 | 9 |
| 1-10 | 70-79 | 4.0 | .072 | 71.4 | 21 |
| | 80-89 | 5.6 | .112 | 84.3 | 13 |
| | 90-100 | 8.0 | .100 | 92.7 | 7 |
| 11-20 | 60-69 | 15.5 | .06 | 62.0 | 4 |
| | 70-79 | 15.3 | .36 | 74.7 | 6 |
| | 80-89 | 14.2 | .115 | 84.8 | 13 |
| | 90-100 | 15.3 | .150 | 94.5 | 15 |
| 21-30 | 70-79 | 25.0 | .120 | 72.0 | 7 |
| | 80-89 | 23.6 | .13 | 85.8 | 12 |
| | 90-100 | 24.2 | .25 | 96.5 | 33 |
| 31-40 | 80-89 | 39.0 | .29 | 81.0 | 5 |
| | 90-100 | 40.0 | .38 | 98.0 | 25 |
| | | | | TOTAL | 200 |

Charts 1 and 2 were constructed from the values shown in table 2. Note the increasing slopes of the curves with increasing values of VV and RH on both charts. Chart 3 is developed from 2 and 3 and forms the basis for the final nomograph Chart 4.

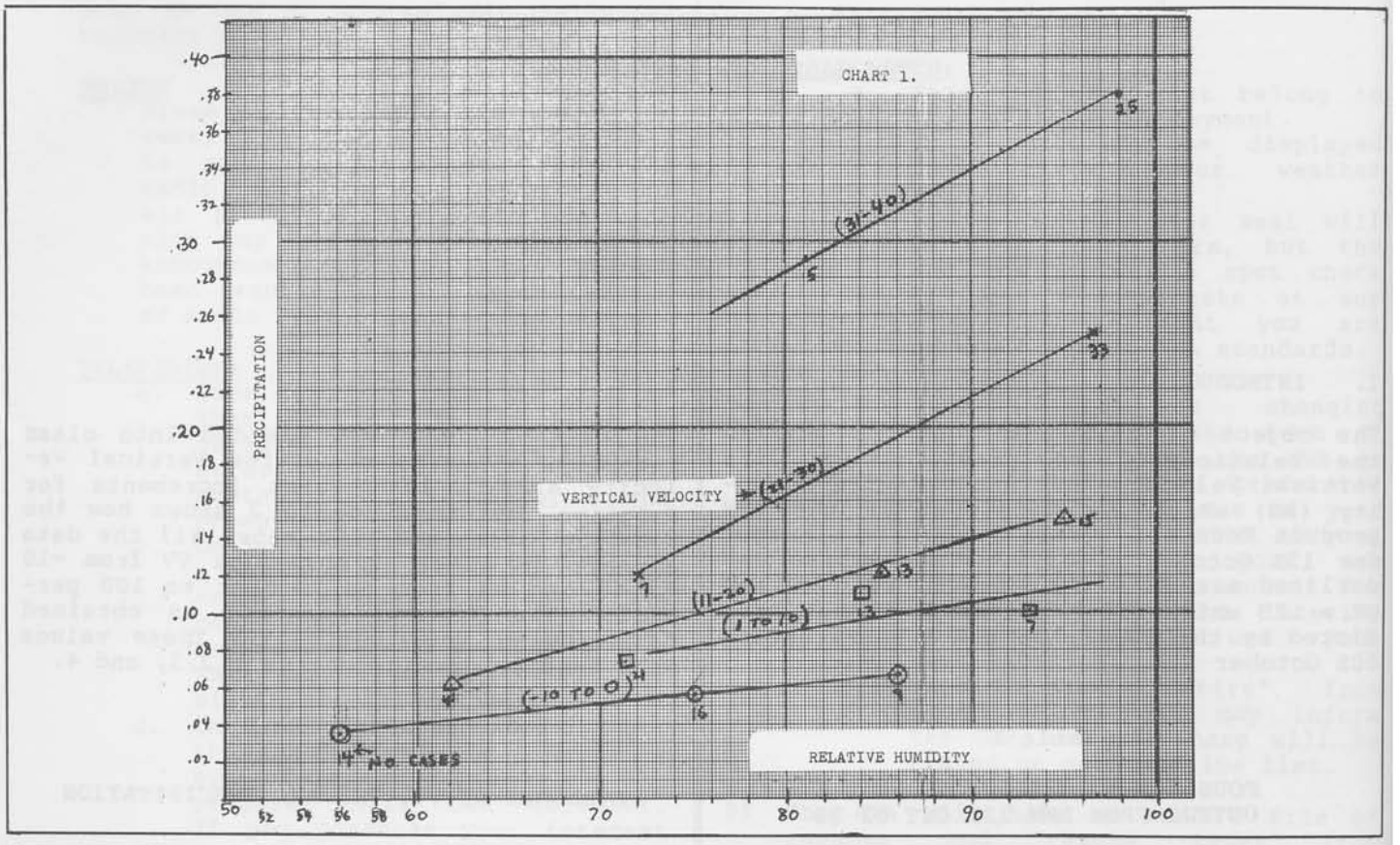


CHART 1.
PRECIPITATION
VERTICAL VELOCITY
RELATIVE HUMIDITY
(31-40)
(21-30)
(11-20)
(1 TO 10)
(-10 TO 0)
NO CASES
.40
.38
.36
.34
.32
.30
.28
.26
.24
.22
.20
.18
.16
.14
.12
.10
.08
.06
.04
.02
50
52
54
56
58
60
70
80
90
100

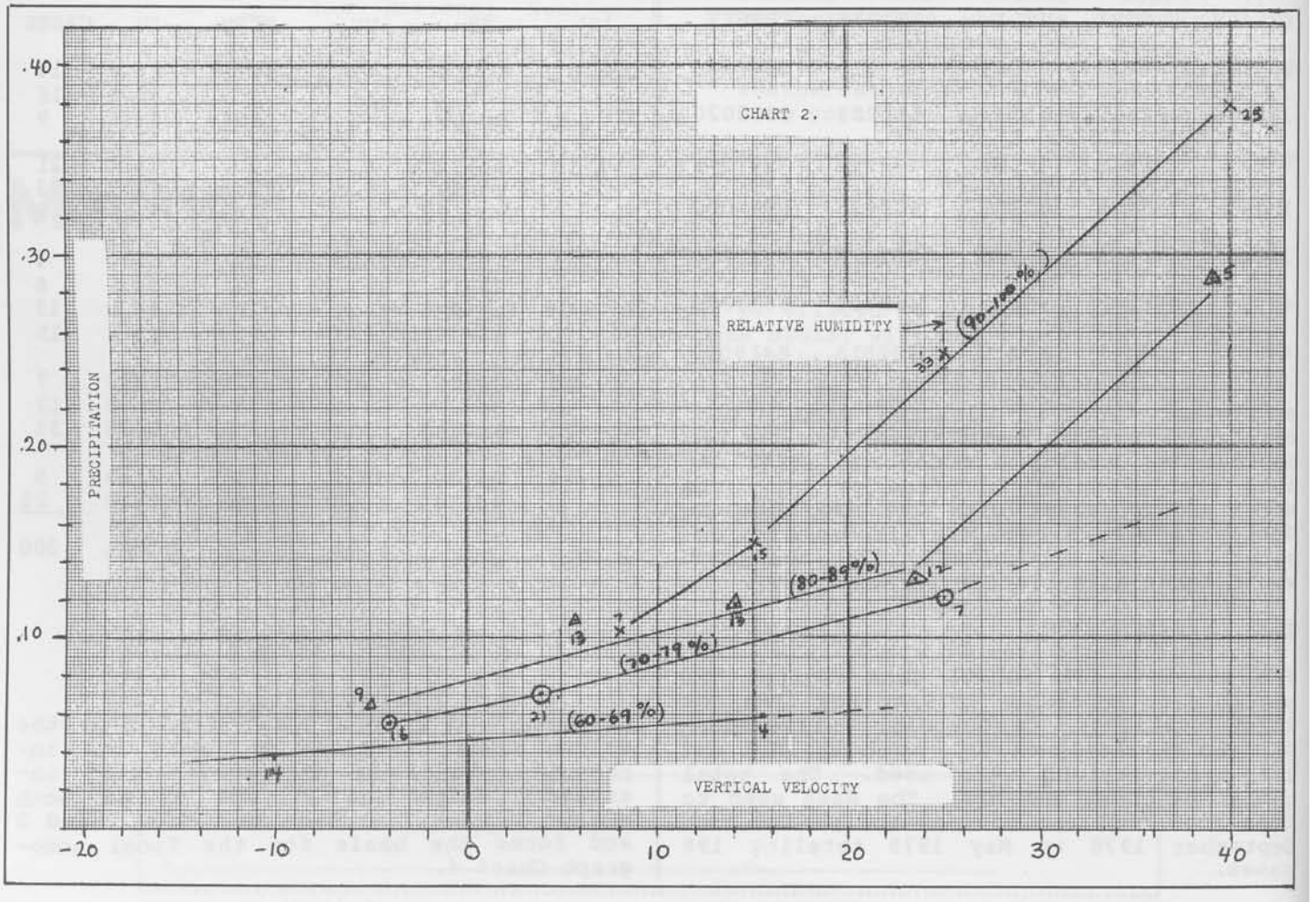


CHART 2.
PRECIPITATION
RELATIVE HUMIDITY
VERTICAL VELOCITY
(90-100%)
(80-89%)
(70-79%)
(60-69%)
.40
.30
.20
.10
-20
-10
0
10
20
30
40

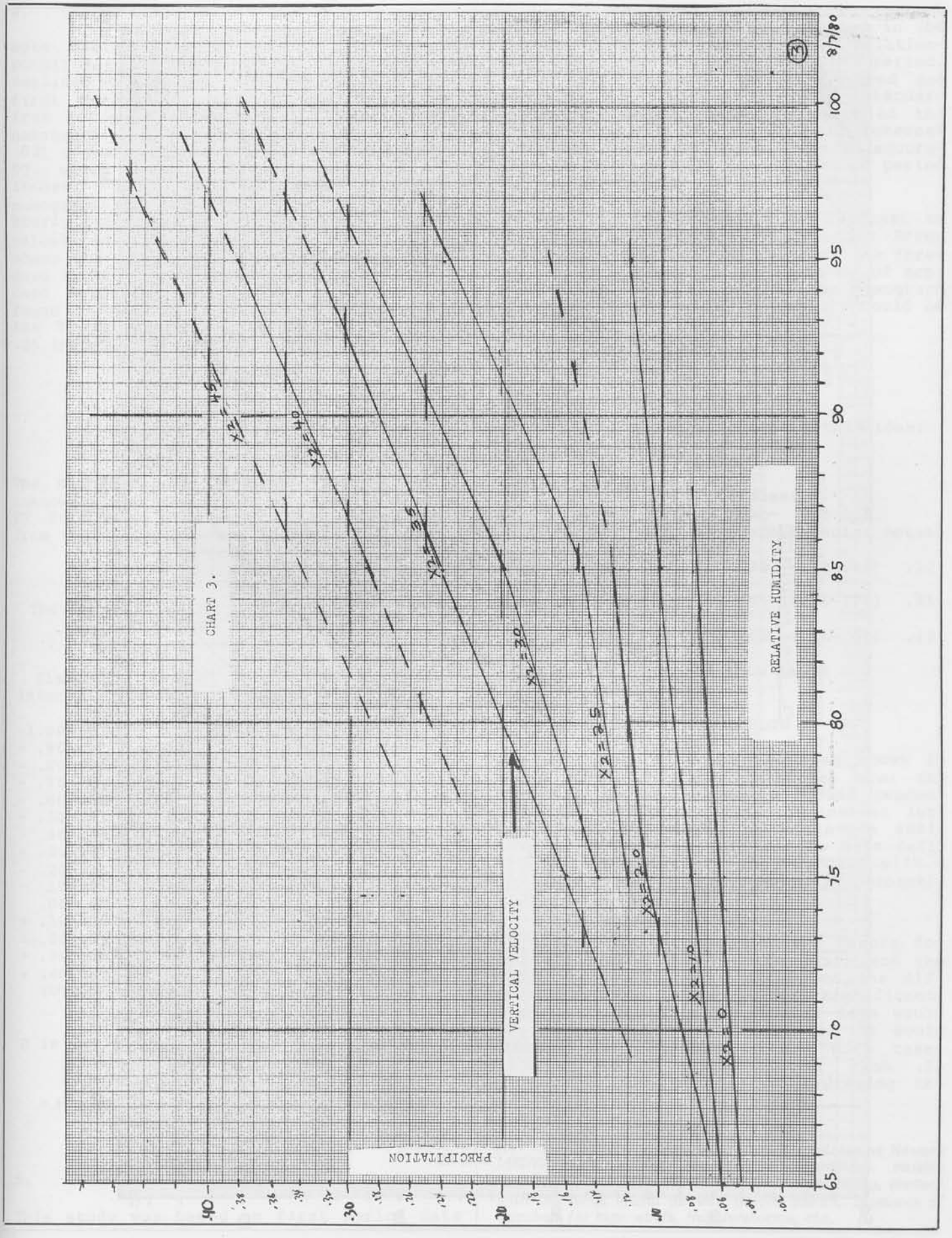
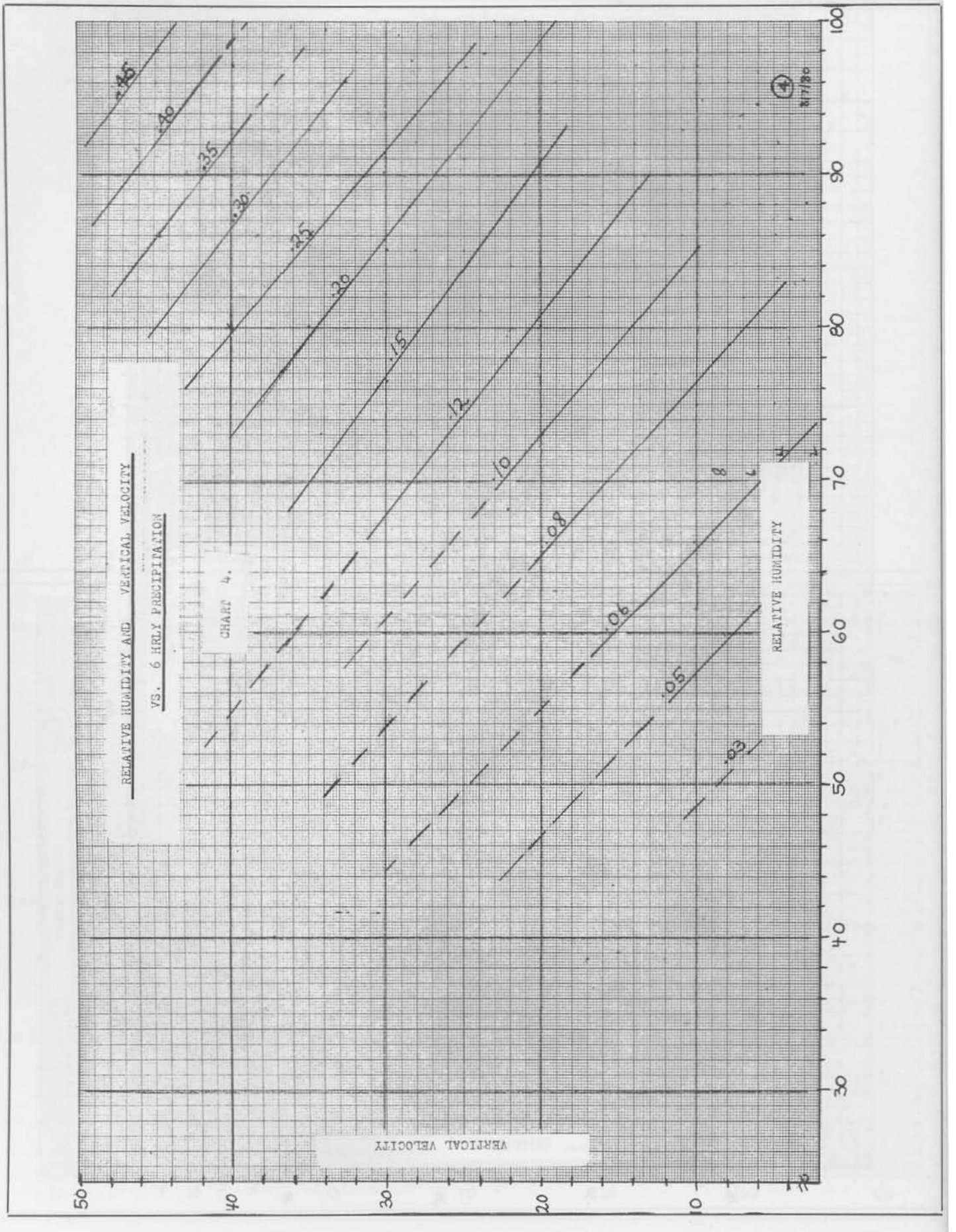


CHART 3.
PRECIPITATION
VERTICAL VELOCITY
RELATIVE HUMIDITY
X2=.40
X2=.35
X2=.30
X2=.25
X2=.20
X2=.15
X2=.10
8/7/80
100
95
90
85
80
75
70
65
.40
.30
.20


RELATIVE HUMIDITY AND VERTICAL VELOCITY
VS. 6 HRLY PRECIPITATION
CHART 4.
.45
.40
.35
.30
.25
.20
.15
.12
.10
.08
.06
.05
.03
RELATIVE HUMIDITY
VERTICAL VELOCITY
100
90
80
70
60
50
40
30
50
40
30
20
10

## 4. USE OF CHART 4

Note Table 1, which is the LFM output FOUS61 for 12Z October 3 1980 and the underlined values for RH, VV and TT. The first period forecast for October 3 is from 18Z to 00Z October 4. Entering the nomograph with the values for RH (81), VV (02) gives a forecast value of .07 inches. TT, which is the LFM estimate is .23 inches. When the estimates from the nomograph are compared to the actual 6 hourly precipitation the Standard Error is calculated to be .22 inches. Table 3 shows the method for calculating the Standard Error. In a similar manner the Standard Error (S.E.) of the Test Data was found to be .17. The difference between the TT forecasts and the actual data was .25 inches. In summary we have:

| | S.E. |
|---|---|
| Original Data | .22 |
| Test Data | .17 |
| FOUS 61 | .25 |

The significance of these differences is unknown. The average errors indicated the TT forecasts were too high while those from the nomograph were too low.

Table 3

The Standard Error of Nomograph Forecasts VS Actual Precipitation

| Class Interval | Freq. Of Error | D | Freq X D | Freq X $D^2$ |
|---|---|---|---|---|
| -1.00-.91 | 1 | -10 | -10 | 100 |
| - .90-.81 | 2 | - 9 | -18 | 162 |
| - .80-.71 | 2 | - 8 | -16 | 128 |
| - .70-.61 | 2 | - 7 | -14 | 98 |
| - .60-.51 | 2 | - 6 | -12 | 72 |
| - .50-.41 | 7 | - 5 | -35 | 175 |
| - .40-.31 | 3 | - 4 | -12 | 48 |
| - .30-.21 | 7 | - 3 | -21 | 63 |
| - .20-.11 | 13 | - 2 | -26 | 52 |
| - .10-.01 | 24 | - 1 | -24 | 24 |
| .00+.09 | 79 | 0 | 0 | 0 |
| + .10+.19 | 31 | 1 | 31 | 31 |
| + .20+.29 | 7 | 2 | 14 | 28 |
| + .30+.39 | 2 | 3 | 6 | 18 |
| + .40+.49 | 0 | 4 | 0 | 0 |
| TOTALS | 182 | - | -137 | 999 |

D is Deviation

$$S.E. = .1 \times \sqrt{\frac{999}{182} - \left(\frac{-137}{182}\right)^2} = .1 \times \sqrt{5.48 - .56} = .22$$

## 5. EXTENSION OF THE METHOD

This study was based on first period data only. It has been found that the second and third periods could be included in the forecast because the statistical relationship holds regardless of the time period. Preliminary sampling for the second and third period indicate that the standard errors are quite close to those of the first period. It may be that the forecast values of RH and VV deteriorate in accuracy as the length of the forecast period increases.

In addition to extending the forecast to two or three periods the Standard Error could be used to give a range of the forecast value with a confidence level of near 70 percent. If for example the nomograph forecast was .45 inches the range could be calculated as follows:

$$(\text{Forecast Value} \pm \text{S.E.}) = (.45 \pm .20) = .25 \text{ to } .65$$

Table 4 further illustrates this idea:

Table 4

| Date | Time | RH | VV | Forecast Nomograph | 70% C.L. Forecast | Actual |
|---|---|---|---|---|---|---|
| 3/21 | 01-0700 | 97 | 22 | .20 | ( 0-.40) | .22 |
| 3/21 | 07-1300 | 100 | 51 | .55 | (.35-.75) | .81 |
| 3/21 | 13-1900 | 97 | 47 | .45 | (.25-.65) | .49 |

70% C.L. is 70% Confidence Level

## 6. COMMENTS AND CONCLUSION

The use of confidence limits as shown in Table 4 has certain advantages over the single value given in the FOUS61 product (TT) by giving the user an insight into the limits of making precipitation estimates. It permits the user to make definite statements about the forecast with a definite degree of confidence (70 percent).

As stated earlier the Standard Errors for the original data, the test data and the FOUS61 were all quite close and the differences were probably not significant. Therefore the addition of more data would not reduce the forecast errors. It would however be desirable to add more cases with rainfall values greater than .25 inches for the purpose of redrawing the nomograph.

*(1) Mr. Blake is a Meteorological Technician at Newark International Airport where the operations routine includes pilot briefing, adaptive local forecasting, contact with the news media as well as the public, issuances of warnings for high winds, thunderstorms, etc.*