A TEXAS HIPLEX FORECAST 'DECISION TREE' LP-74

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by

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ABSTRACT

The southern branch of the High Plains Cooperative Program (HIPLEX) has completed two years of experimentation and data collection. It is apparent that an objective forecasting decision tree is needed for the purpose of quantifying input parameters and further defining forecasting techniques.

The report summarizes a study which began with post-stratification of all 1976 and 1977 Texas HIPLEX forecast days on the basis of surface observations. Using these and upper air sounding data, the Montana HIPLEX Single Class Stratification Scale and the Temperature Moisture Index were revised to fit Texas HIPLEX data. Forecast predictor variables were identified for operational forecast day delineation, and a first generation Forecast Decision Tree was developed on the basis of the results.

It was found that the most critical input parameter in determining operational and non-operational day status is the presence of a recognizable forcing mechanism.

KEY WORDS AND DOCUMENT ANALYSIS

(a) Descriptors: Weather Modification/weather forecasting/objective forecasting techniques/forecast decision tree/mesoscale

(b) Identifiers: High Plains Cooperative Program (HIPLEX); Big Spring, Texas; Texas HIPLEX

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A TEXAS HIPLEX FORECASTING "DECISION TREE"

Introduction

During the 1976 and 1977 Texas High Plains Cooperative Program (HIPLEX) field seasons, forecast predictor variables and observational data were accumulated. Using data collected from May through September of both years, a first generation Forecasting Decision Tree was developed. The data were organized and examined in an effort to fulfill the forecasting needs of the Texas HIPLEX project by making available an objective forecasting decision making process.

It was the objective of this study to develop a decision tree that consisted of a series of branches, each with limiting numerical values. It was intended that the use of each branch of the tree rely as little as possible on subjectivity. Processed predictor variables provided an adequate basis for arriving at a reasonable prestratification of the day's convective activity. By utilizing appropriate variables, the forecaster should then be able to obtain either a twelve or twenty-four hour forecast.

The 1976 and 1977 Texas HIPLEX forecast operational area was described as "a sixty nautical-mile radius semicircle West of Highway 84"[1/] (Figure 1). This included all of the Colorado River Municipal Water District (CRMWD) cloud-seeding target area, as well as Texas A & M University's mesoscale rawinsonde launch sites at Big Spring, Post, and Robert Lee. This area was well within the observational range of both Snyder and Big Spring-based radar equipment. Visual surface observations were also possible over much of the area due to the relatively flat terrain.

1/ Texas HIPLEX Conference, Big Spring, February 1977.

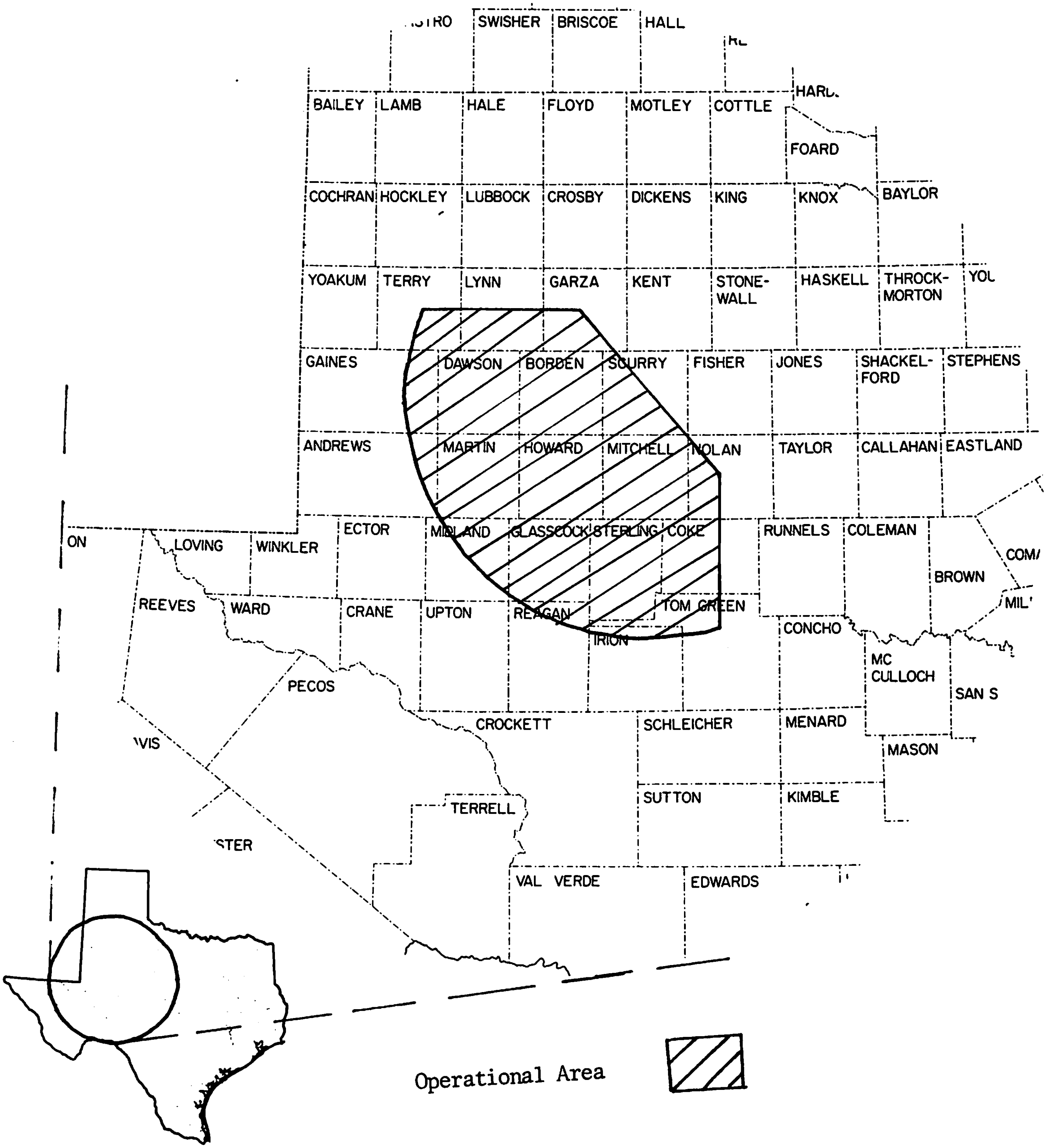


FIGURE I. Texas HIPLEX Operational Area.

Stratification of Texas HIPLEX Forecast Days

In order to assess properly the convective activity of each Texas HIPLEX forecast day and to relate the day's activity to synoptic predictor variables, each Texas HIPLEX forecast day in 1976 and 1977 was "stratified" on the basis of convective characteristics.

The surface observations taken at Howard County Airport, Big Spring radar data, and the CRMWD pilot's reports (in addition to National Weather Service and military surface observations) were examined for each day to summarize that day according to a modified version of the Hartzell Single Stratification Scale.[1/] The Hartzell scale ranges from Class 1 (clear or cirrus) to Class 9 (widespread precipitation from overcast nimbostratus) (Table 1).

Minor deviations of Class 7 and 9 from the Hartzell method were made for the Texas HIPLEX area due to regional climatological and topographic influences. The Montana Class 7 convective index provided for cumulonimbus systems which develop over higher terrain southwest of Miles City and move through the target area as a large cluster of convective cells. In Texas, it appeared likely that mesoscale cumulonimbus systems described in Class 7 developed because of upslope motion over higher terrain southwest of the operational area and/or the influence of some associated surface mesoscale feature, i.e, dry line, convergence line, surface trough; then propagate across the operational area as a line of convective cells.

The Montana Class 9 convective index provides for days with widespread precipitation from overcast nimbostratus. The Class 9 Texas convective index day varies from the Class 9 Montana convective index day in that the Texas airmass is characteristically much warmer and more unstable, producing thunderstorm activity embedded within the widespread lighter precipitation.

1/ Hartzell, Curtis, "Development of Objective Forecasting Technical for the Montana HIPLEX Project Area," August, 1977, page 4.

Table 1. Class Definitions of the Convective Index[a/]

Class No.	Definition
1	Clear or cirrus and non-precipitating mid-level altocumulus or altostratus
2	Mid-level clouds with virga or RW-; no low level clouds
3	Non-precipitating low level convective clouds (i.e. stratocumulus to small congestus)
4	Towering cumulus with virga but no rain reaching ground
5	Towering cumulus with light rainshowers which developed within the operational area either randomly or in lines, no cumulonimbus observed
6	Similar to 5 with cumulonimbus and thunderstorms which developed within operational area in addition to towering cumulus
7	Mesoscale cumulonimbus system which developed W-SW of operational area due to upslope and/or dry line-sfc trough and moved across operational area as line of thunderstorms or rainshowers
8	Mesoscale cumulonimbus system developed along synoptic feature (i.e., front or short wave aloft) and moved across operational area as line of thunderstorms or rainshowers
9	Widespread precipitation from overcast nimbostratus with embedded cumulonimbus

a/ Modified for West Texas HIPLEX Operational Area from Hartzell, 1977.

The most common Texas-HIPLEX day was Class 3, or fair weather cumulus-type day, with the next common Texas-HIPLEX day being of Class 6, or that having cumulonimbi which developed within the operational area (Figure II). Tables B-I and B-II (Appendix B) summarize each of the convective index class stratification types of the 1976-1977 Texas HIPLEX forecast days.

The total number of Texas-HIPLEX days used in this report was 166, 80 days in 1976 and 86 in 1977. Of the 173 recorded days, two in 1976 and five in 1977 were not included in the stratification because a local upper-air sounding was not taken. Without a local sounding, no comparative data were available for use in the analysis.

Eighty-five days of the 166 days used in this analysis verified as operational days, while 81 days verified as non-operational days. The definition of an operational day, as given in the 1977 Texas-HIPLEX operations plan , was: "A day in which, during daylight hours, there exists convective ensembles within the present Texas-HIPLEX operational area with at least one cell of 7,000 ft. vertical development, that cell having a cloud base not exceeding 12,000 ft. AGL, and the cell top temperature $\leq$ -5°C."

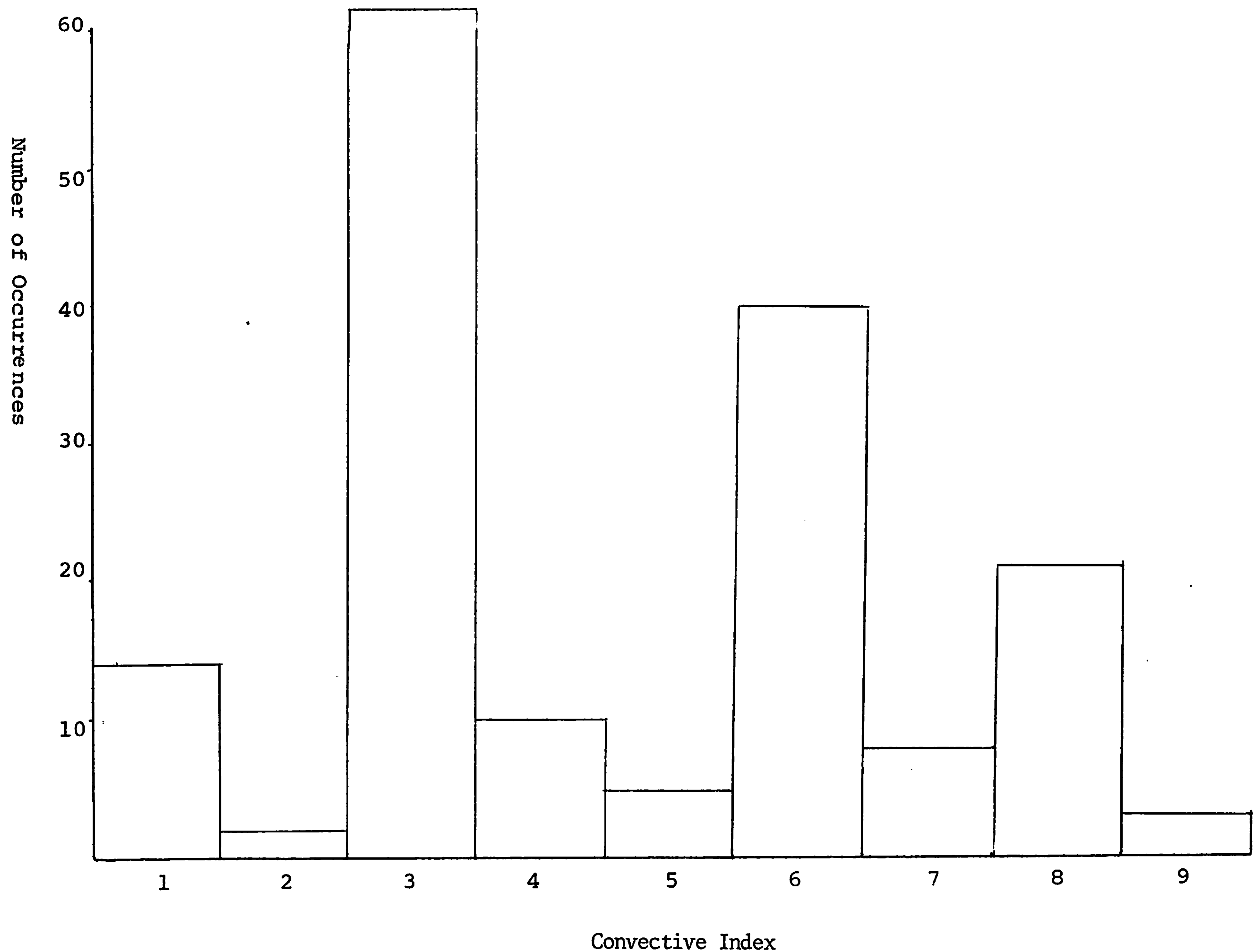


FIGURE II: Convective Index Histogram of Texas HIPLEX Days, 1976-77.

Maximum Temperature/Convective Temperature

It is believed that the formation of convective cells in non-forcing situations, in part, relies on the relationship between maximum temperature due to surface heating (Tm) and convective temperature (Tc).[1] The forcing situation is defined as a day when a surface or an upper-air forcing mechanism was observed in the operational area at the time of the 12Z sounding. A forcing mechanism for the Texas-HIPLEX area shall include a dry line, a convergence line, surface trough, short wave, cold air advection aloft, or a closed upper-air low. The non-forcing situation is defined as a day when none of the aforementioned forcing mechanisms are present. The convective temperature is defined as that temperature which a parcel of air near the surface must achieve to become sufficiently bouyant to reach the convective condensation level (CCL). It is hypothesized that if the value of the ratio, Tm/Tc, is equal to or greater than one cumulus formation may be anticipated that day. If the ratio, Tm/Tc, is less than one no cumulus development may be anticipated by the forecaster.

Special consideration in forecasting maximum temperature and convective temperature then must be given to achieve the most accurate forecast possible of non-forcing convective development. A linear regression analysis was performed to see how well the ratio of observed surface maximum temperature to convective temperature (Tm/Tc) predicted the occurrence of cumulus clouds. In this regression, the maximum observed temperature was recorded from instrumentation housed in an instrument shelter at Howard County Airport. The convective temperature was extracted from the EDN[2] product GPCM[3], based on the morning Big

1 Hess, S.L., 7.3 The Parcel Method. Introduction to Theoretical Meteorology, 1959, pp. 95-100.
2 Environmental Data Network, U.S. Bureau of Reclamation
3 Great Plains Cloud Model

Spring sounding (employing a 20-mb mixing depth). In this analysis, class 3 or higher CI days were defined as convectively active days.

From the 148 forecast days in which Tc was computed, the ratio of observed surface maximum temperature to convective temperature explained only 7.2 percent of the variance of convective occurrence. However, since the attainment of convective temperature plays a prominent role in cumulus development during non-forcing days, it was reasonable to examine separately the non-forcing days in the regression analysis.

Seventy-five non-forcing days during the 1976 and 1977 Texas HIPLEX period were examined. After filtering the forcing days from the data, the Tm/Tc ratio explained only 6.4 percent of the variance of convective occurrence. This seems to suggest that the Tm/Tc ratio is not by itself, a reliable predictor of cumulus formation for the Texas HIPLEX area.

An examination of Table II further supports the inability of the Tm/Tc ratio to predict cumulus formation.

Table II. Airmass Convection Breakdown

N[a/] = 75	CI > 3	CI < 3	Total
Tm/Tc ≥ 1.0	53	5	58
Tm/Tc < 1.0	13	4	17
Total	66	9	75

a/ Non-forcing days.

Table II shows that during most of the convectively active days (53 of 66) the surface maximum temperature reached the computed convective temperature. However, this also occurred during the majority (5 of 9) of the non-convectively active days. Furthermore, of the 17 days in which the surface maximum temperature did not attain the computed convective temperature, Tm/Tc<1.0, 13 were convectively active.

The inability of the Tm/Tc ratio to predict cumulus formation under non-forcing conditions may be attributed to the inability of the Great Plains Cloud Model to predict convective temperature. These computer models often oversimplify the actual meteorological situation. Also, the output from any computer model is dependent on the input data, which in this particular cloud model is the morning sounding. In order to use the GPCM the forecaster must assume: (a) the morning sounding is representative of the entire airmass over the forecast area; (b) the airmass is static (there exists no advection of moisture, temperature, or vorticity), and (c) topographic discontinuities do not exist; i.e., unequal surface heating and mixing over the forecast area are not present. Unless the forecaster accounts for airmass transformation (the advection of moisture, temperature, and vorticity anticipated between morning sounding time and afternoon peak heating time in the preprogramming of the input data, the computer product will not be an effective convection predictor. Thus, when GPCM is used to compute Tc, the computer provides the forecaster with a Tc for the unmixed ambient airmass at the time and place the sounding is taken. Unequal heating and terrain inducements along with other aforementioned complications will often cause convection to occur either above or below the Tc computed for the particular sounding station of interest.

It seems that the Tm/Tc ratio should not be used as a branching mechanism in an objective forecasting decision tree for the Texas HIPLEX operational area. Therefore, it is necessary to consider other predictor variables.

Temperature and Moisture

While developing the operational Texas HIPLEX forecast, a selection of temperature, moisture and synoptic forcing data were extracted from the Environmental Data Network via a data terminal connection to the Bureau's Denver computer, and from NMC facsimile synoptic data received in-house. The relative importance of each parameter as a predictor variable was sometimes unclear. Therefore, each parameter, individually or in consonance with other input parameters, must be examined to determine its ability to forecast convective development (as reflected in the convective index, CI).

Hartzell (1977) reported that one of the most important relationships in forecasting deep convection over the Montana HIPLEX target area was the amount of precipitable water in the atmosphere from the surface to the 700 mb level and the temperature of the airmass. This airmass temperature (AT), in degrees Celsius, was approximated by summing the 850 mb, 700 mb and 500 mb termperatures.

Hartzell reasoned that less precipitable water is required to initiate deep convection with a cool airmass than with a warm airmass. He developed an index, which he labeled as the Temperature Moisture Index, to relate airmass temperature to the amount of precipitable water available. The same two variables were examined for the Texas HIPLEX area using a different approach.

Because precipitable water and temperature have different units and different scales of measurement, it was necessary to normalize both variables by making them dimensionless. This was accomplished by subtracting the sample mean from the observed value and dividing the difference by the sample standard deviation.

Figures III and IV are scatter diagrams of the transformed variables, with the normalized airmass temperature (N_{AT}) plotted along the ordinate and the normalized values of precipitable water (N_{pw}), measured from the surface

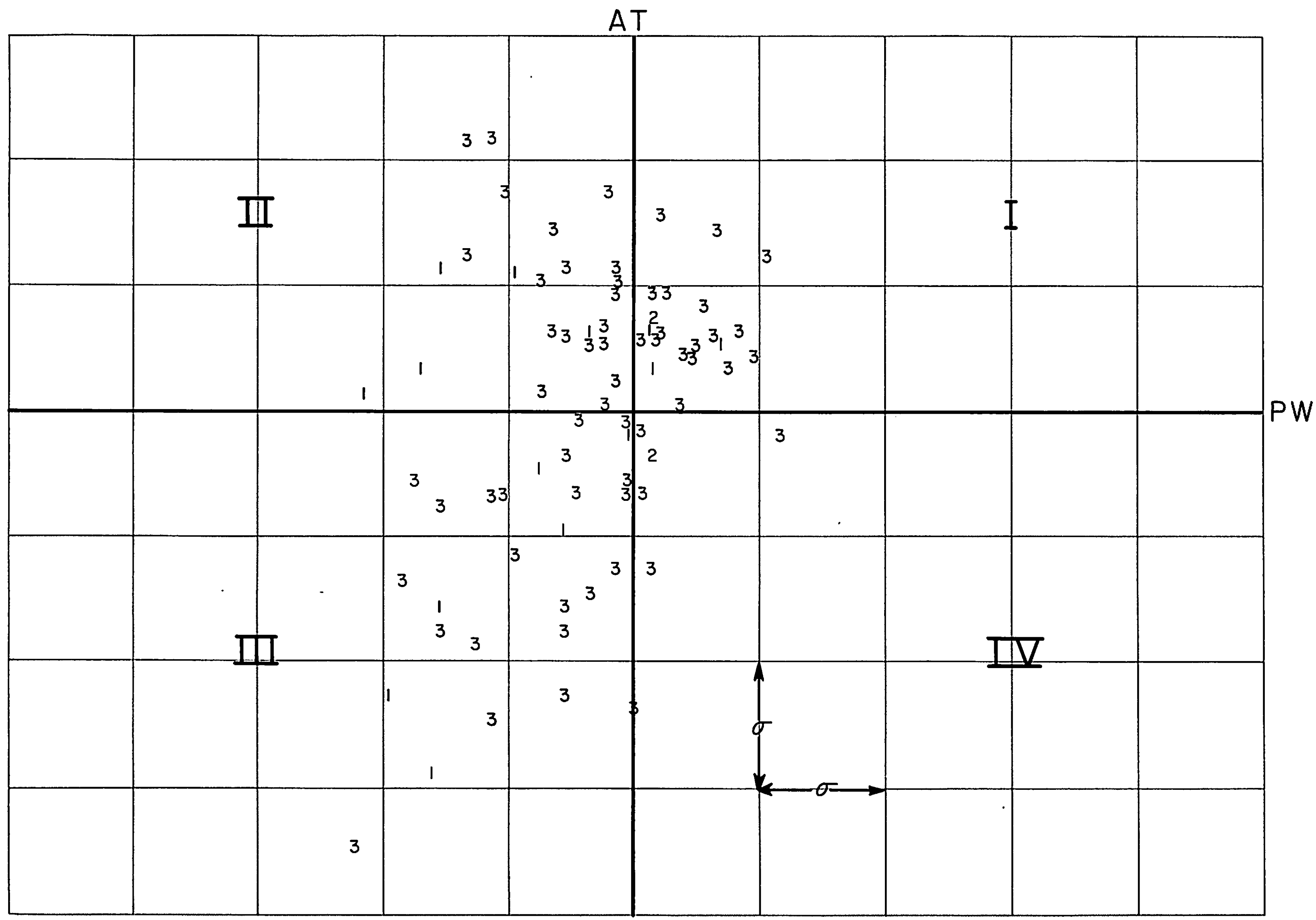


Figure III.—Quadrant Location of Non-Operational Days (Convective Index Numbers are Shown)

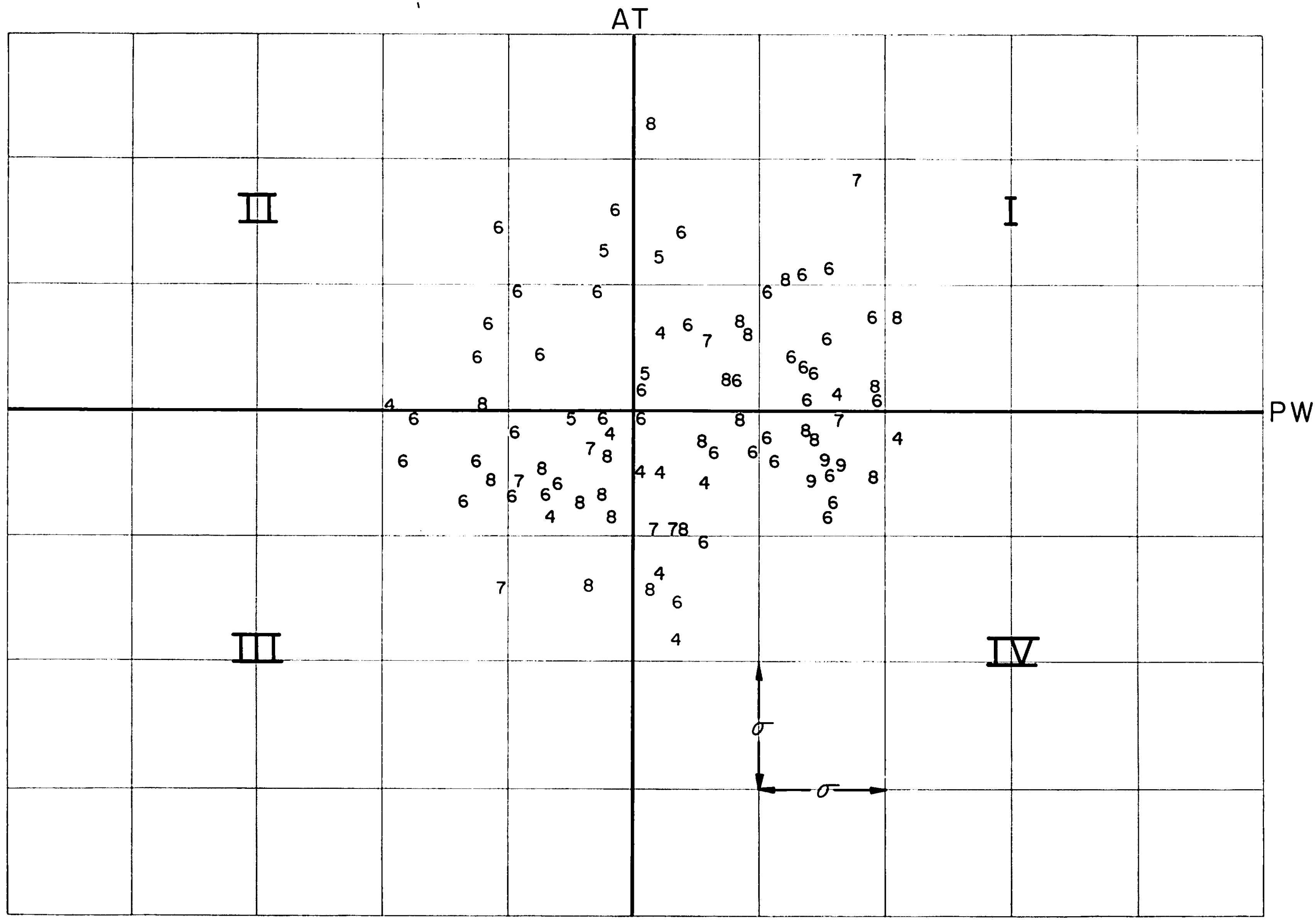


Figure IV.—Quadrant Location of Operational Days (Convective Index Numbers are Shown) to 500 mb, plotted along the abscissa. Figure III examines only convective class 1, 2 and 3 days, which are non-operational days, and Figure IV examines convective class 4, 5, 6, 7, 8 and 9 days, which are operational days.

Positive values along the abscissa and ordinate imply greater than normal values of precipitable water and airmass temperature, respectively. Consequently, those days which fell into quadrant I were days that had a moist and warm atmosphere. Those days which fell into quadrant II were days that had a dry and warm atmosphere. Those days which fell into quadrant III were days with a dry and cool atmosphere. And those days which fell into quadrant IV were days with a cool and moist atmosphere. The further the normalized values are from the ordinate and abscissa the more extreme the day was relative to precipitable water and airmass temperature, respectively.

Figures III and IV suggest that except in extreme cases, quadrant location in quadrants I, II or III can not adequately discriminate between operational days and non-operational days. However, in the extreme cases some discrimination can be detected. In quadrant I those days that exceed one standard deviation of precipitable water were operational days. In quadrant II those days that exceed one and one-half precipitable water and airmass temperature standard deviation were non-operational. In quadrant III, those days that exceed two airmass temperature standard deviations were non-operational days. However, in quadrant IV those values that exceed the airmass temperature and precipitable water means by one-half standard deviation were exclusively operational days.

As a first step, this method seems to discriminate operational days from non-operational days in the extreme cases for quadrants I, II and III and in almost all cases for quadrant IV.

Forcing and Non-Forcing Days

The next step in developing a Texas HIPLEX forecast decision tree was to examine the potentially forcing days and the potentially non-forcing days within the quadrants I, II and III.

Table III is a breakdown of forcing and non-forcing days as observed in quadrants I, II, III and IV.

Table III. Breakdown of Operational and Non-Operational Days by Presence of Forcing Mechanism

Quadrant II

	Op.	Non-Op.
Forcing	9	1
Non-Forcing	1	23

Quadrant I

	Op.	Non-Op.
Forcing	25	0
Non-Forcing	3	21

Quadrant III

	Op.	Non-Op.
Forcing	22	1
Non-Forcing	0	26

Quadrant IV

	Op.	Non-Op.
Forcing	21	0
Non-Forcing	8	5

Clearly, on those days that fall into quadrants I, II or III, the presence of a trigger was a good indicator of an operational day. Likewise, in quadrants I, II and III the absence of a trigger was a good indicator of a non-operational day. The discrimination of forcing and non-forcing days in quadrant IV did not do as well when forecasting operational days. However, as suggested earlier, those days which fall into quadrant IV are almost exclusively operational days.

The presence (absence) of a trigger for those days whose normalized values of airmass temperature and precipitable water in quadrants I, II and III seems to be a good discriminator of operational days (non-operational days). In quadrant IV the best discriminate was the quadrant itself.

Twelve-Hour Barotropic Vorticity Advection

It has been established that a critical factor for forecasting an operational day over the Texas HIPLEX area was the presence of a forcing mechanism. Also, the presence of sufficient moisture coupled with a cool atmosphere has been established as an indicator of conditions conducive to the formation of convective activity. Barotropic vorticity advection (VA), as extracted from the twelve-hour prognosis provided by the morning facsimile product, provides additional information that may allow for further stratification of each forecast period.

No numerical values of VA were recorded during the 1976 field season. Therefore, only the 86 1977 forecast days were examined. Of these 86 forecast days, only those days that had values greater than or equal to 1.5 and less than or equal to -1.5 were used. Table IV shows the relationship of twelve-hour barotropic vorticity advection to operational and non-operational days.

Table IV. Relationship of Twelve-Hour Barotropic Vorticity Advection to Operational and Non-Operational Texas HIPLEX Forecast Days, 1977

Vorticity Advection	Operational Days	Non-Operational Days	Total
VA $\leq$ -1.5	6	8	14
VA $\geq$ +1.5	5	4	9
Total	11	12	23

Of the 14 forecast days during 1977 in which twelve-hour barotropic vorticity advection was less than or equal to -1.5, six were operational days and five of the six had a trigger mechanism. Of the nine days in which the twelve-hour barotropic vorticity advection was greater than or equal to 1.5, four were non-operational days.

It appears, therefore, that the effects of the low-level convergence and positive vertical motion (PVM) implied by strong positive vorticity advection were over shadowed by mechanical or dynamic forcing. Additionally, the ridging and subsidence aloft implied by strong negative vorticity advection was outweighed by the effects of mechanical forcing. The results were that twelve-hour barotropic vorticity advection was not a good operational/non-operational day discriminator. However, this parameter may still be useful in the discrimination of sub-types.

Examination of Individual Convective Classes

Having sorted the most critical forecast predicator variables, i.e., the presence of a forcing mechanism, moisture and airmass temperature, the forecast decision tree can now be branched twice:

I. Mechanical/Dynamic Forcing Present

   A. Sufficient moisture for airmass convection
   B. Insufficient moisture for airmass convection

II. Airmass Convection Day (no forcing)

   A. Sufficient moisture for airmass convection
   B. Insufficient moisture for airmass convection

The maximum temperature/convective temperature ratio was rejected as a forecast predictor variable because of its apparent unreliability in forecasting cumulus formation.

In order to forecast the individual convective class days, a final sorting of predictors must be done by examining each convective class. By examining each class separately, characteristic predictors may be revealed and a more refined branching of the decision tree may be implemented.

However, the reader should understand that in order to establish confidence in the predictor variables to identify each of nine individual convective class days, additional years of data are required.

CI 1: 14 Cases

Definition: "Clear or cirrus and non-precipitating mid-level altocumulus or altostratus"

Eleven of the 14 convective index 1 days were recorded in quadrants II and III indicating moisture as an important variable for this index (Figure V). The remaining three convective index 1 days were recorded in quadrant I. These days were only marginally moist. No trigger was observed in the target area during any of the 14 convective index 1 days.

CI 2: 2 Cases

Definition: "Mid-level clouds with virga or RW-; no low-level clouds"

Only two days were classified as convective index 2 days. No trigger was observed on either day. Interestingly, both were slightly moist, possibly suggesting sufficient moisture for convection (Figure VI). However, in both cases the lowest level (sfc-850 mb) was quite dry. In fact, the GPCM predicted cloud bases in excess of 12,000 AGL, thus exceeding HIPLEX criteria.

CI 3: 62 Cases

Definition: "Non-precipitating low-level convective clouds (i.e., stratocumulus or cumulus to small cumulus conjectus)

Of the 62 convective index 3 cases, 60 were airmass situations, i.e. no trigger observed in the target area. The two cases with triggers were located in quadrant II and III, indicating below normal moisture for the

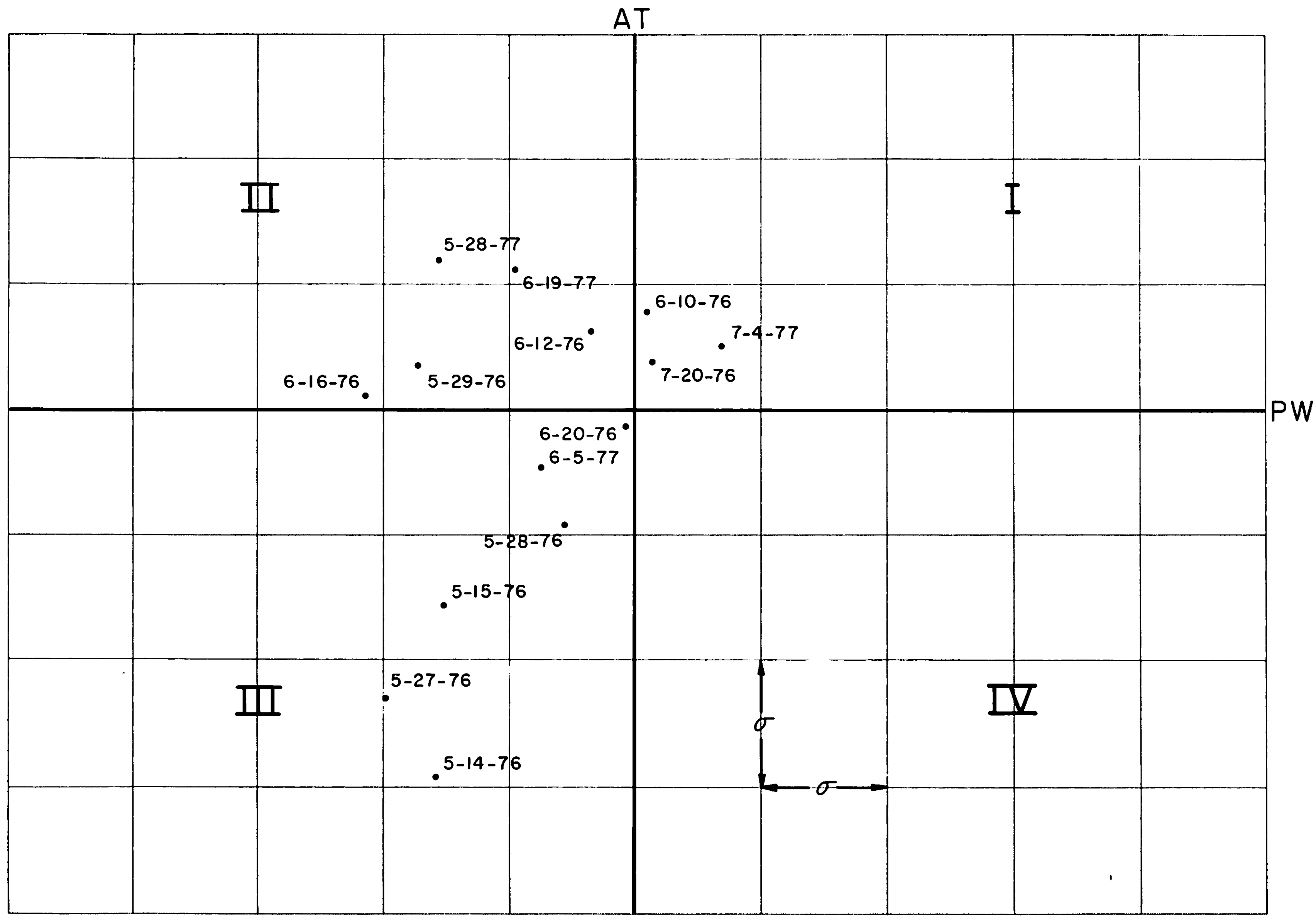


Figure V.–Quadrant Location of Convective Index No. 1 Days

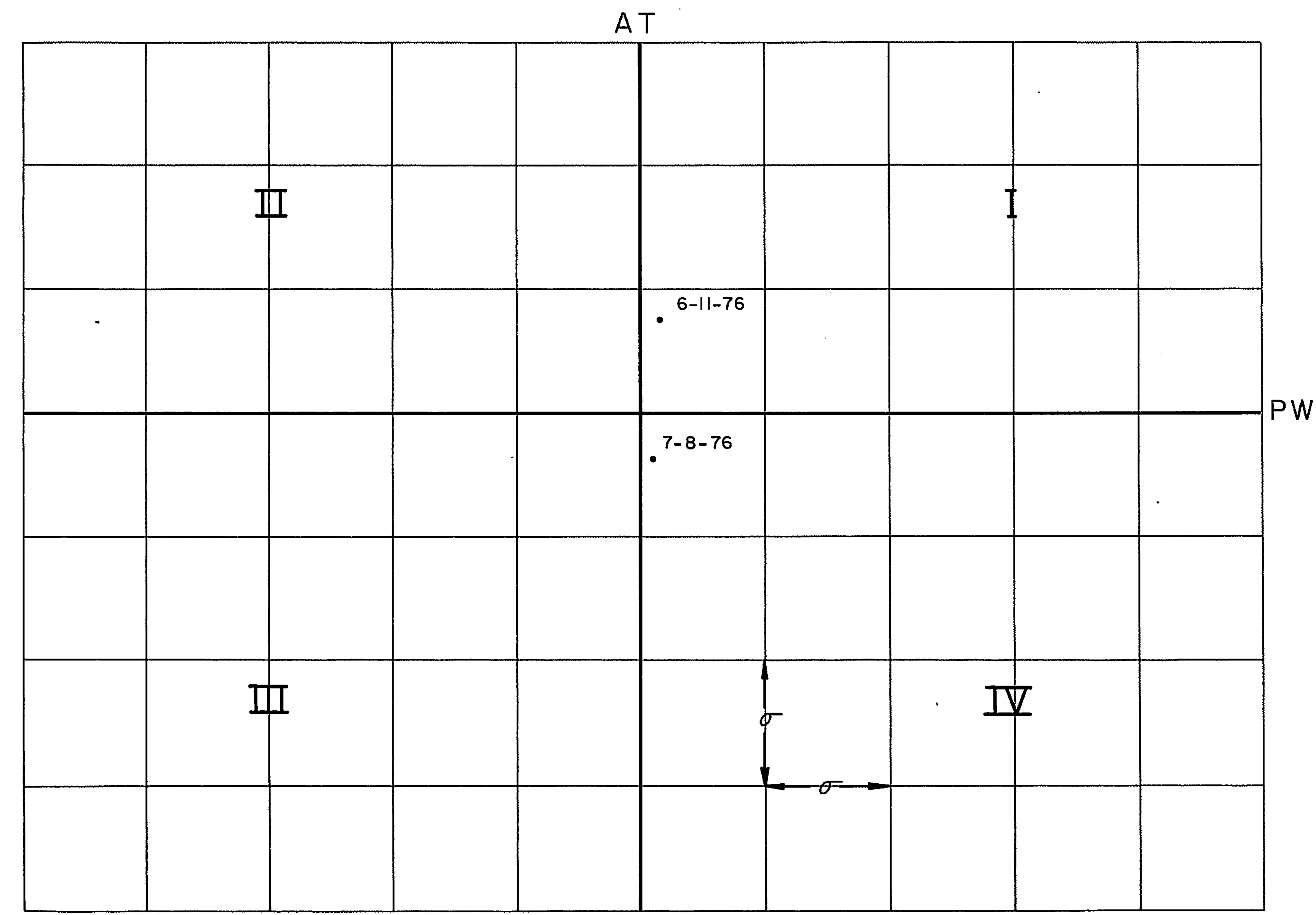


Figure VI.—Quadrant Location of Convective Index No. 2 Days two days (Figure VII). Of the remaining 60 airmass cases, 36 were located in quadrants II and III, indicating below normal moisture, and 26 were located in quadrants I and IV. Of the latter, 20 were located in quadrant I, leaving only six in quadrant IV. Of the six in quadrant IV, five had inversions capping their convective development and were within one-half standard deviation of the precipitable water mean. Quadrant location on Convective Index 3 days seems to be important only in quadrant IV.

CI 4: 10 Cases

Definition: "Towering cumulus with virga"

There were 10 convective index 4 days during the 1976 and 1977 season. Six days were airmass days and four days had a trigger. Five of the six airmass days were in quadrants I and IV, while the four trigger days were located in quadrants II and III (Figure VIII). The remaining airmass day was located in quadrant I and was the only convective index 4 day with VA reported.

CI 5: 5 Cases

Definition: "Towering cumulus with light rainshowers which developed within the operational area either randomly or in lines; no cumulonimbus observed"

Of the five convective index 5 days, four were triggered. Three of the five days, including the airmass day, were located in quadrant I (Figure IX). All days were within one-half standard deviation of the PW mean.

CI 6: 40 Cases

Definition: "Similar to class 5 with cumulonimbus and thunderstorms which developed within the operational area in addition to towering cumulus"

Of the 40 convective index 6 days, 37 were triggered. All three of the airmass days were located in quadrant IV, indicating a moist and cool

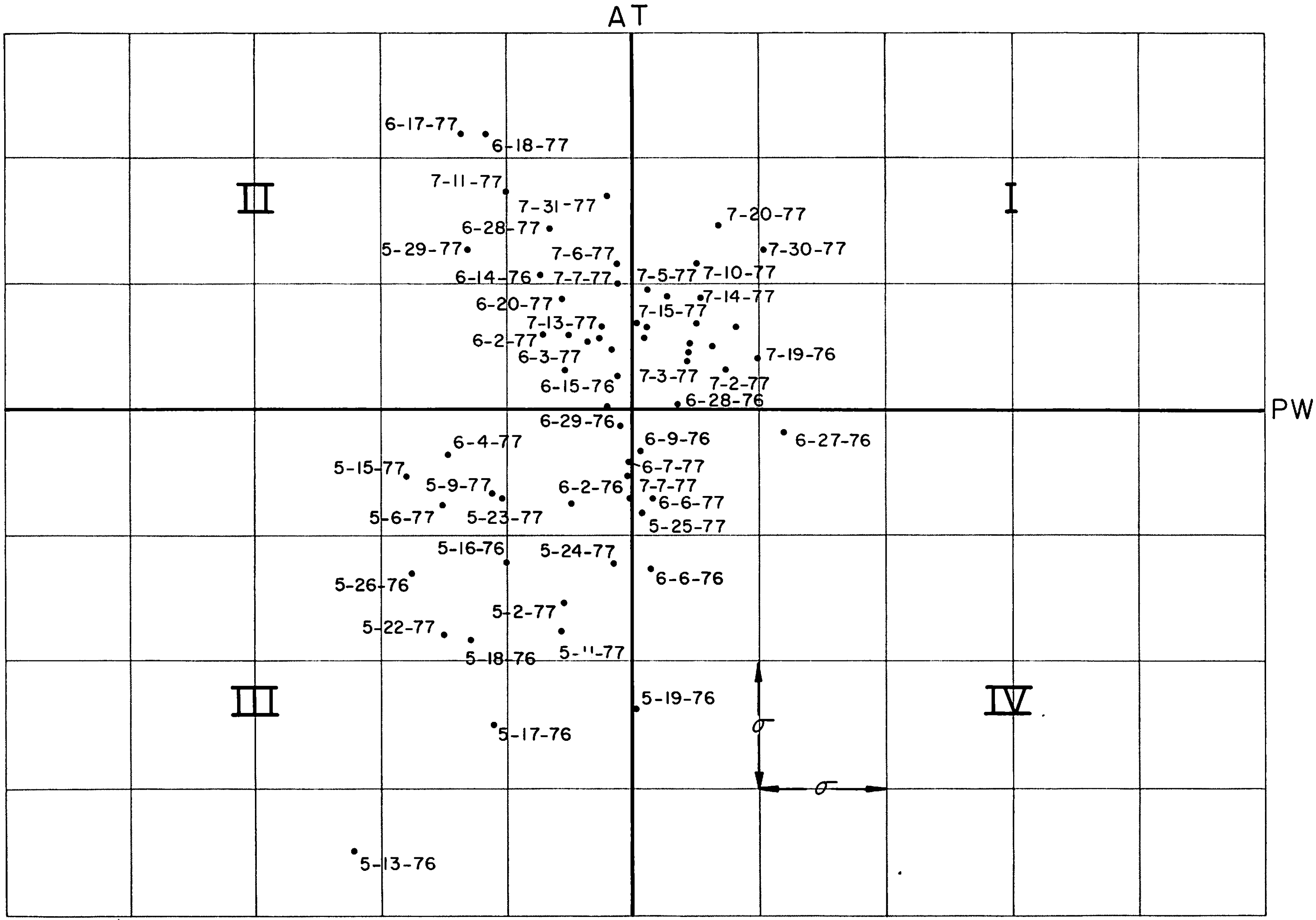


Figure VII.–Quadrant Location of Convective Index No. 3 Days
(Due to the Number of Convective Index No. 3 Days Only Selected Points Were Dated)

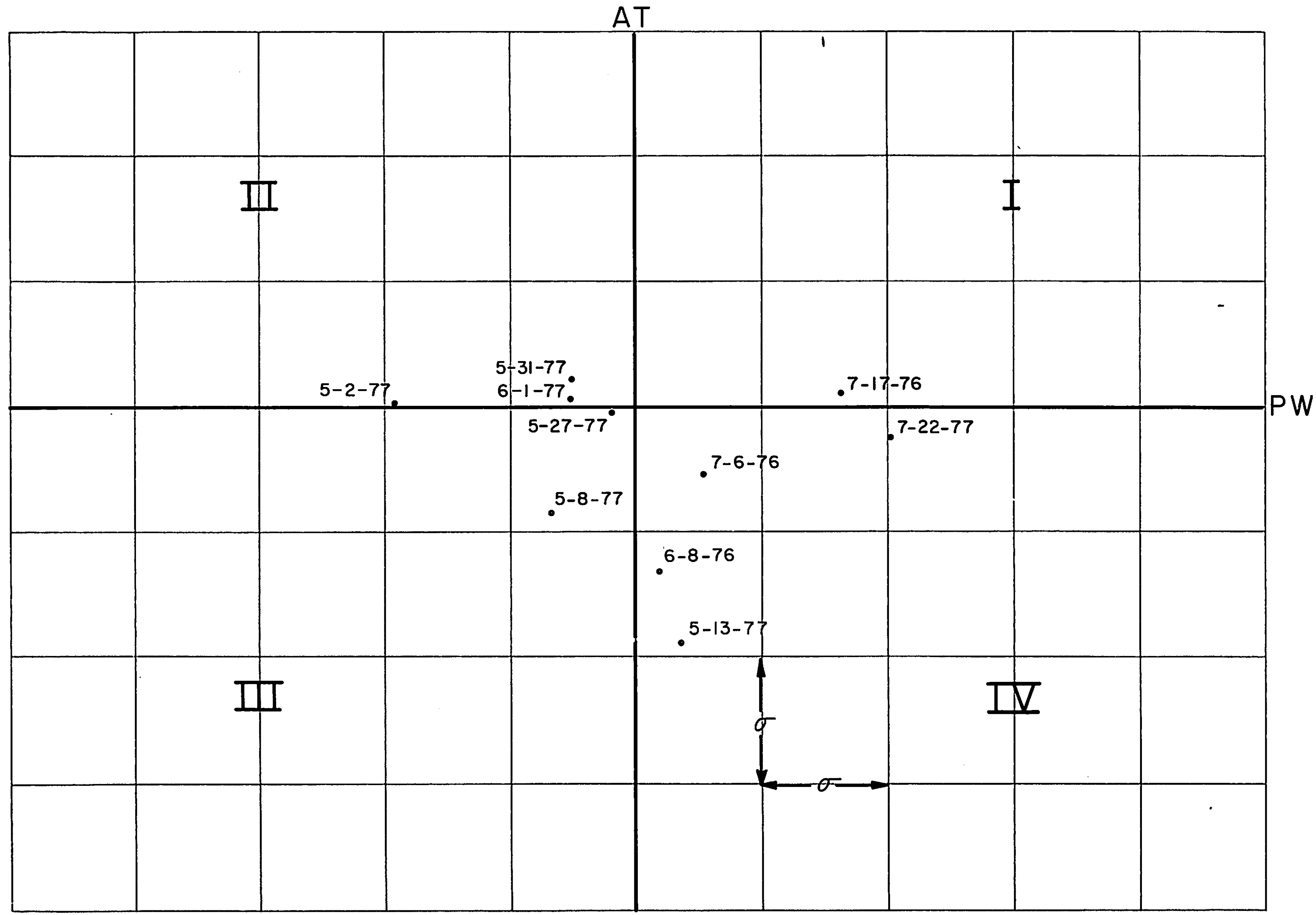


Figure VIII.—Quadrant Location of Convective Index No. 4 Days

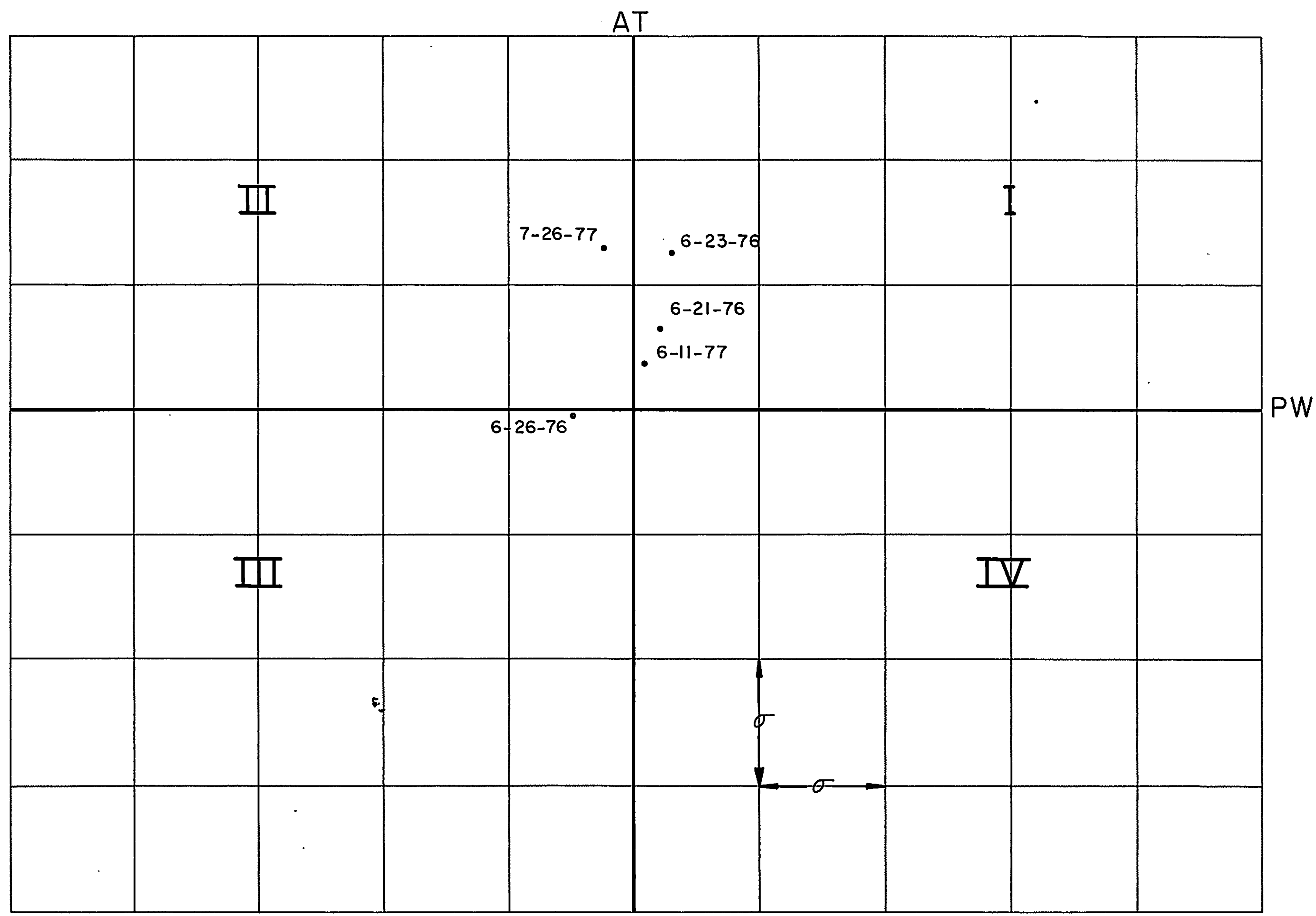


Figure IX.—Quadrant Location of Convective Index No. 5 Days

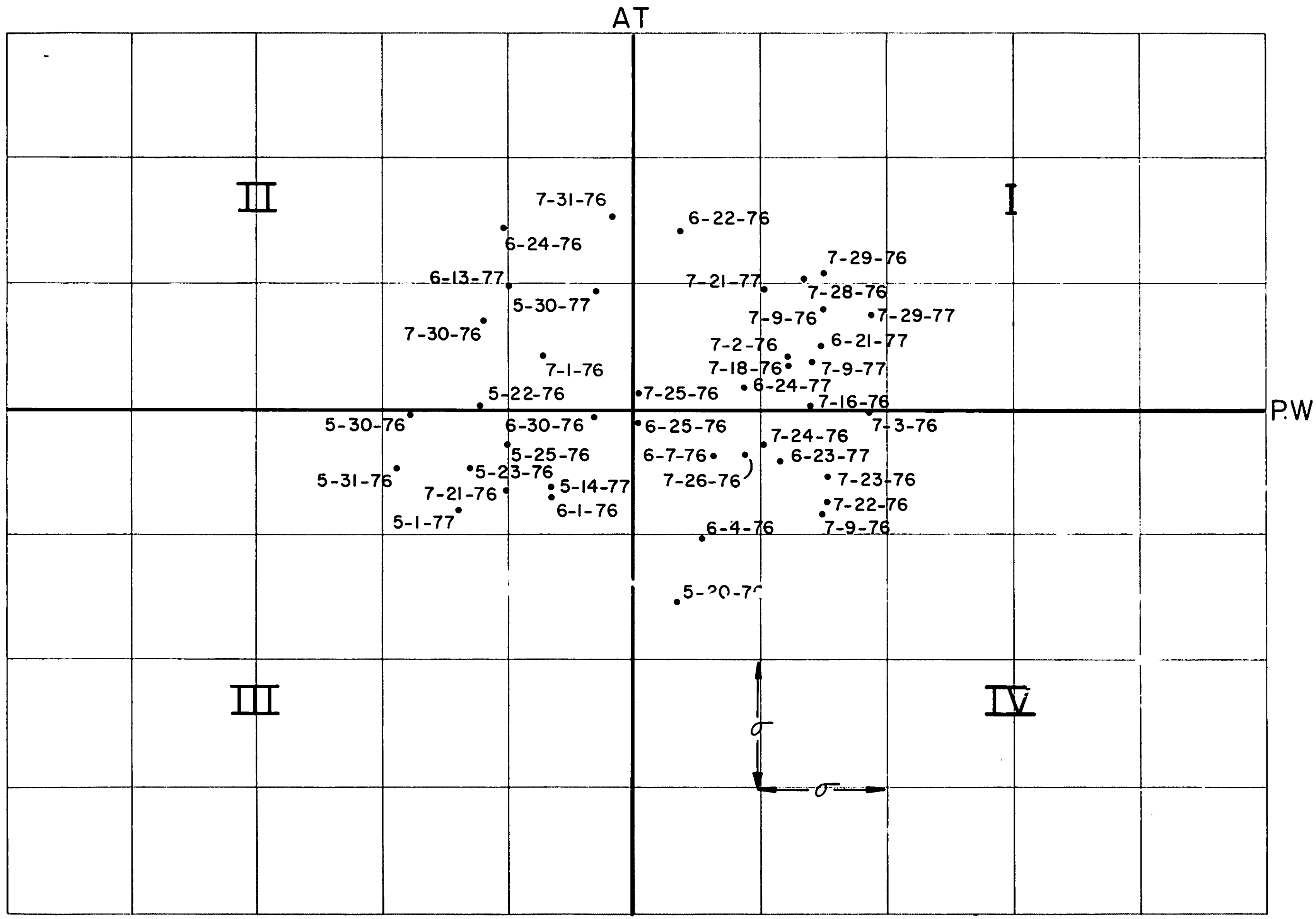


Figure X.—Quadrant Location of Convective Index No. 6 Days

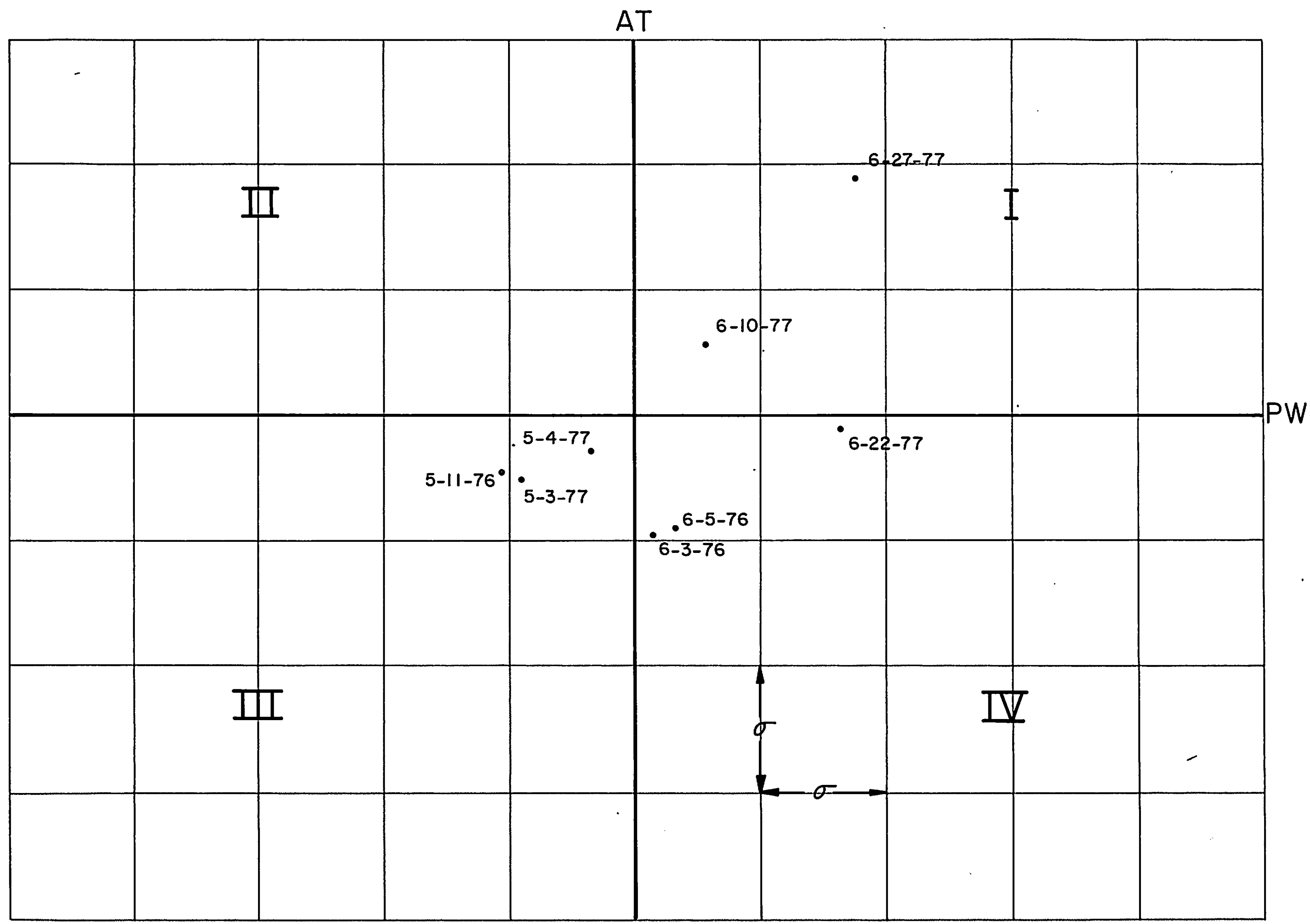


Figure XI.—Quadrant Location of Convective Index No. 7 Days atmosphere (Figure X). It is notable that in each of these three cases southeasterly flow existed from the surface to 500 mb. The quadrant location on triggered convective index 6 days seems unimportant, except that precipitation was observed to be heavier for those days in quadrants I and IV. Sixteen triggered days were located in quadrants II and III and 21 triggered days were in quadrant I and IV. Convective index quadrant III days tend to occur early in the season, primarily in May and early June, producing light precipitation amounts.

CI 7: 8 Cases

Definition: 'Mesoscale cumulonimbus system which developed W-SW of operational area due to upslope and/or dryline-surface trough and moved across operational area as a line of thunderstorms and/or rainshowers"

Five of the eight cases were located in quadrants I and IV (Figure XI). All but two of the convective index 7 cases were set off by a trigger, e.g., along which the thunderstorm activity formed and moved northeast across the HIPLEX operational area. In the other two cases, activity formed entirely due to upslope low-level surface trajectories: activity formed southwest of the operational area and moved with the southwesterly 700 to 500 mb flow across the operational area.

All convective index 7 cases were observed to have rather steep 850-500 mb lapse rates. Also, all had southwesterly flow at 700 mb by mid-afternoon, although not all had southwesterly flow at 700 mb at the time of the morning sounding. This mid-level wind pattern allowed northeasterly movement of cells into the HIPLEX area.

CI 8: 22 Cases

Definition: 'Mesoscale system which developed along synoptic feature (i.e., cold front or short wave aloft) and moved across the operational area as a line of thunderstorms and/or rainshowers"

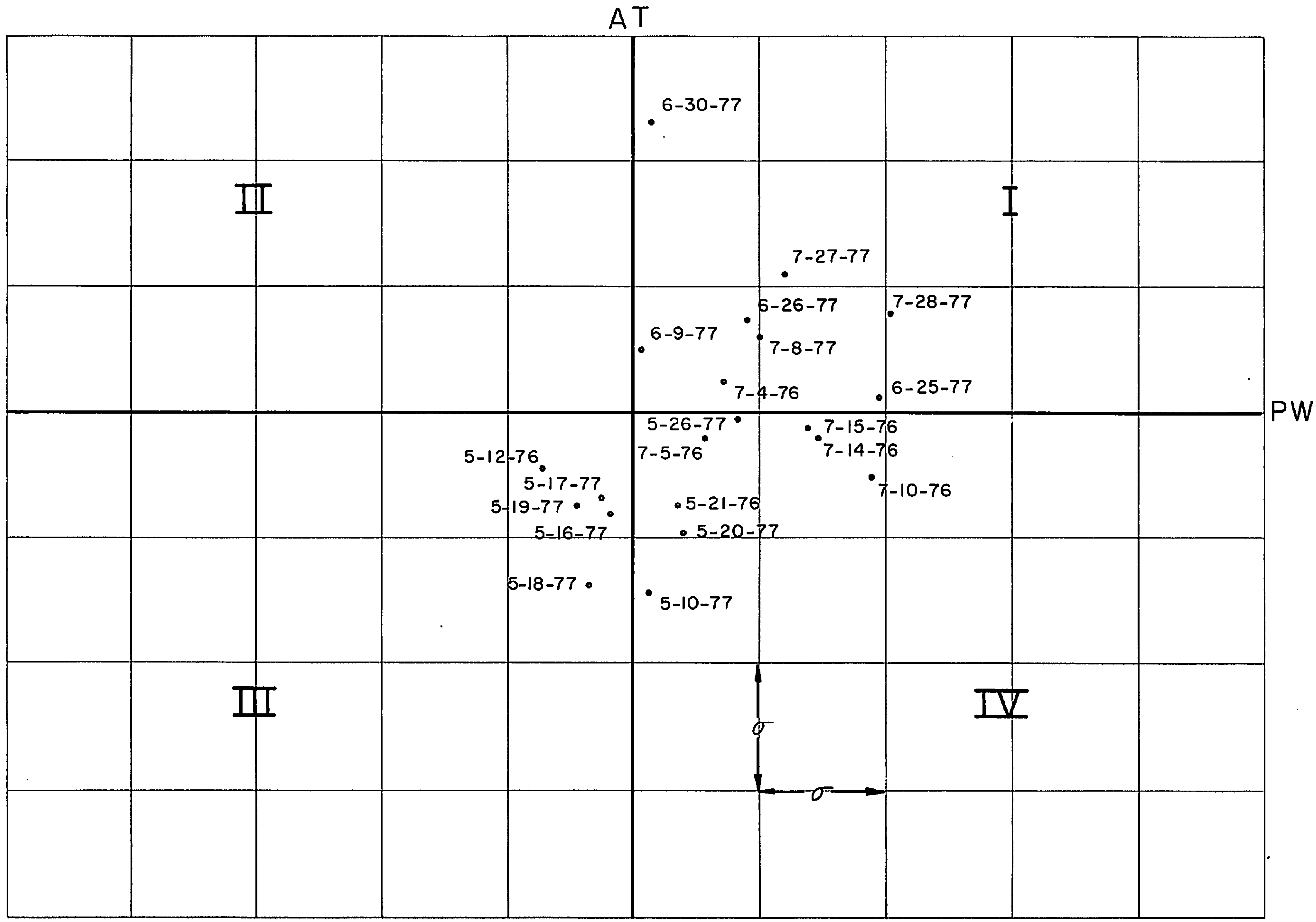


Figure XII.—Quadrant Location of Convective Index No. 8 Days

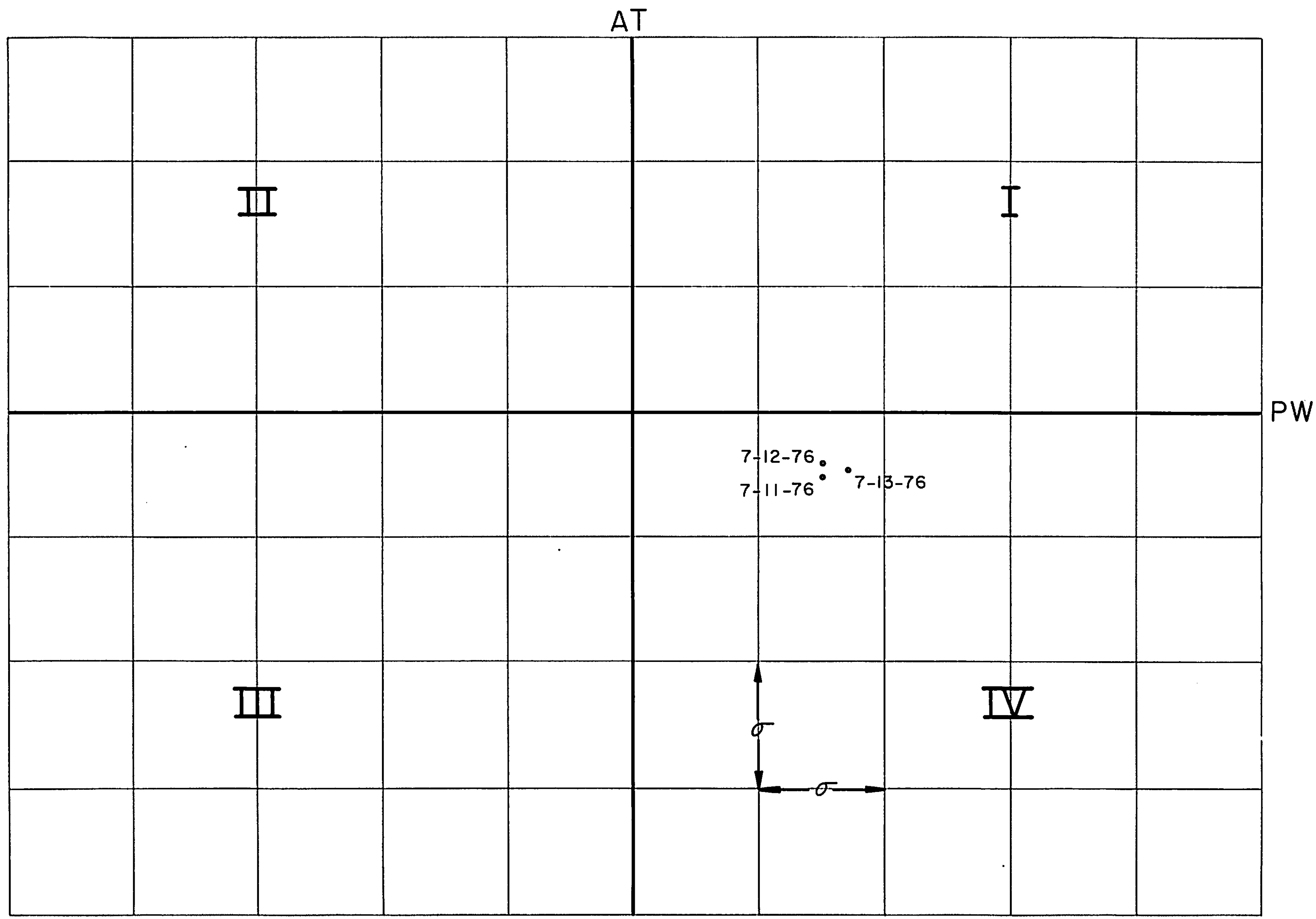


Figure XIII.—Quadrant Location of Convective Index No. 9 Days

Of the 22 convective index 8 cases, five had below normal moisture (Figure XII). All cases, by definition, were triggered. Of the 20 cases in which twelve-hour vorticity advection was recorded (fifteen of these were numerically recorded) only three had NVA. All cases in which VA $\geq$ +1.5 were class 8 cases, and all resulted in heavy precipitation over the operational area.

CI 9: 3 Cases

Definition: "Widespread precipitation from overcast nimbostratus" with embedded cumulonimbus

All three convective index 9 days occurred in succession, and were quite similar in character. All were set off by a 500 mb short wave and were located in quadrant IV with no inversion (Figure XIII). It was this characteristic, when combined with southeasterly flow from the surface through 500 mb, that set off widespread precipitation over the Texas HIPLEX operational area. Note that because of the high moisture levels and surface to 500 mb southeasterly flow, the characteristics of the convective index 9 day are quite similar to those of the convective 6 airmass day.

Forecast Decision Tree

The Texas HIPLEX Forecast Decision Tree is an exercise in applying the results of the preceding analysis to create the most straight-forward logical, and objective forecast process possible. The major branches are the most important predictor variable products, while the minor branches subdivide into specific categories of stratified convective classes.

Initially, an examination is needed to determine the presence of a forcing mechanism. If one exists, there is a good chance for an operational day. If not, there exists the possibility of airmass activity. Immediately following the check for forcing, an examination is made to determine if sufficient moisture exists to produce convection. The quadrant location of the moisture variable is a demarcation, on forcing days, between moderate and light rain. On airmass days, it discriminated operational days from some of the non-operational days.

Upon reaching this level on non-forcing days, the quadrant location is determined. If the index computation for the day is in quadrants I or IV, convective index 2, 3, 4, 5 or 6 may result. If the index computation for the day is located in quadrants II or III a convective index 1, 2, 3, or 4 day may result. If the quadrant I and IV have quite dry lower levels (sfc-850) a convective index 2 day is indicated. If a low level inversion does not exist, a check for negative vorticity advection is made. If NVA exists, a CI 4 day is expected. If NVA does not exist, a final check is made for other repressive conditions at 500 mb. If they are present, convection is again restricted to convective index 1, 2 or 3. If no subsidence is apparent and convection is basically unrestricted, a convective index 5 or 6 day is anticipated.

If a forcing mechanism is present, a check is made (as in airmass situations) of quadrant location. Unlike airmass conditions in which quadrant location is an indicator of the potential for precipitation, the quadrant location simply delineates between the atmosphere's capability to produce either heavy or only light to moderate precipitation.

If, therefore, the day is located in quadrant II or III, there exists less potential for heavier precipitation. Under this condition a non-operational day is possible. If mesoscale systems are not detected, a test for PVA is made. If PVA is $\geq+1.5$, frontal or short wave thunderstorms will develop in mesoscale lines for a class 8 day with moderate precipitation.

Figure XIV: Texas HIPLEX Forecast Decision Tree (Part 1)

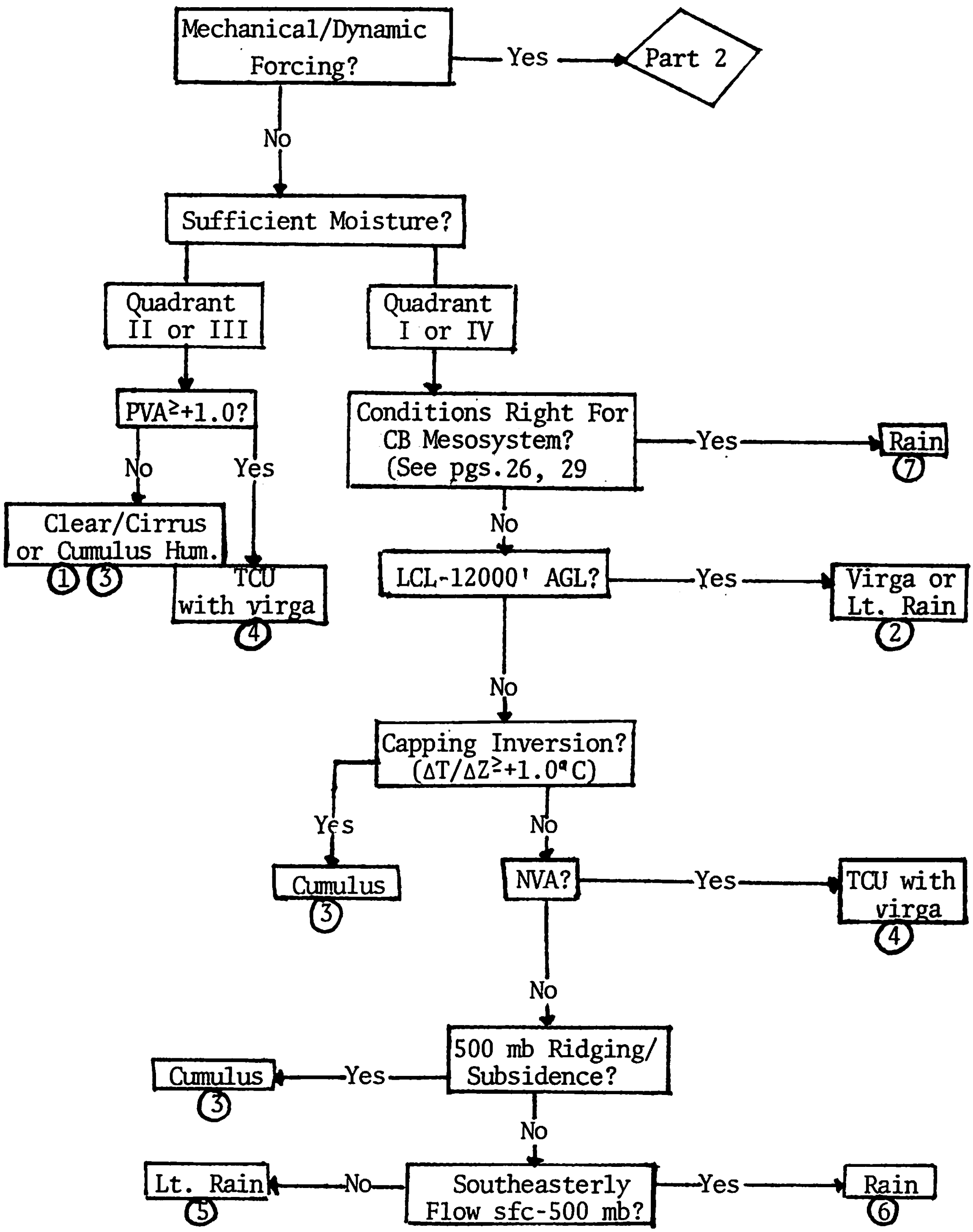
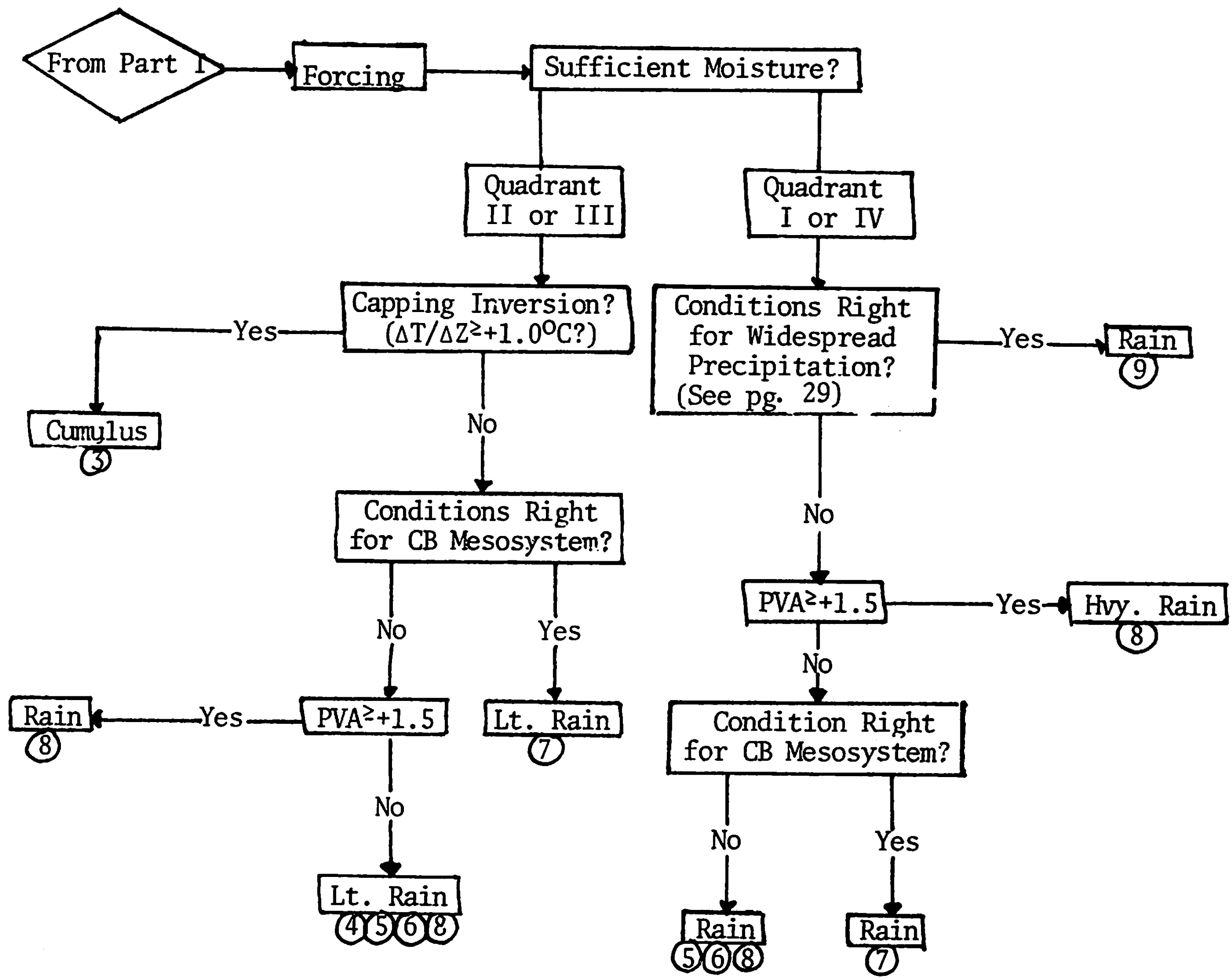


Figure XIV: Part 2



If no PVA is present, a lower energy situation is present and less precipitation in the form of class 4, 5, 6 or 8 results.

If the day is located in quadrants I or IV, a potential heavy rain situation is present. A check for class 9 conditions is made to determine if moderate widespread precipitation is expected. If class 9 conditions are not present, a test for PVA is made. When PVA is $\geq$ +1.5 a heavy rain class 8 day may be expected with possible severe weather. When strong PVA is absent the heavy rain situation is therefore unlikely and a check for class 7 CB mesosystem conditions is made. If these conditions are present the rainshowers and thunderstorms will produce moderate precipitation as they drift over the operational area. If these conditions are absent, a class 5, 6 or 8 moderate rain day is to be expected.

Summary

It has been shown that mechanical/dynamic forcing accounts for nearly 90 percent of all operational days in the Texas HIPLEX area. A temperature/mositure analysis was devised and employed to segregate operational and non-operational airmass days and to segregate light and heavy precipitation on forcing days.

The convective temperature, as computed by GPCM from the morning Texas HIPLEX sounding, was shown to be an unreliable indicator of convective cumulus development. It was therefore not used in the decision tree.

Clearly, the most critical input parameter in the decision tree was that of the presence of mechanical/dynamic triggers. Unfortunately, it was also the most subjective. Very careful examination of synoptic surface and upper air data as well as mesoscale data was required to render the finest product. Without a reliable forcing forecast, the remainder of the tree was virtually useless.

Conclusions

This initial effort for developing a forecast decision tree for the Texas HIPLEX project area, includes several branch points which remain highly subjective. Further research will enable assignment of values to these points, such as the 500 mb ridging and subsidence, where a limiting temperature may be quantified.

Many of the daily weather conditions describe two, three, or four individual CI classes. Further analysis and field testing will refine these CI classes.

This decision tree was developed for use as an indicator for the 1978 field season at Big Spring-Snyder, Texas. Its use will include the prestratification of forecast days, based on the post-stratification of the 1976-1977 data and the post-stratification of 1978 forecast days for the purpose of off-season analysis. Both twelve and twenty-four hour forecasts are to be developed through use of the decision tree.

The additional data accumulated during the 1978 field season will play an important role in refining the decision tree and its use. Refinement of the tree should include the rendering of individual class forecasts and forecasts for potential severe weather on CI class 6, 7 and 8 days.

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APPENDIX A: Raw Data

Table A-1. Precipitable Water: SFC to 500 MB (cm)

1976				1977					
May	PW	June	PW	May	PW	June	PW	July	PW
11	1.56	21	2.54	1	1.34	11	2.45	22	3.92
12	1.85	22	2.68	2	0.94	12	----	23	2.99
13	0.71	23	2.57	3	1.70	13	1.65	24	----
14	1.17	24	1.60	4	2.12	14	2.72	25	2.53
15	1.24	25	2.41	5	2.23	15	2.30	26	2.18
16	1.63	26	2.00	6	1.23	16	1.99	27	3.30
17	1.55	27	3.28	7	----	17	1.36	28	3.94
18	1.37	28	2.66	8	1.88	18	1.50	29	3.83
19	2.38	29	2.31	9	1.54	19	1.66	30	3.16
20	2.65	30	2.14	10	2.48	20	1.96	31	2.22
21	2.64	July		11	1.95	21	3.54		
22	1.46	1	1.82	12	1.94	22	3.64		
23	1.41	2	3.31	13	2.67	23	3.27		
24	1.33	3	3.83	14	1.89	24	3.04		
25	1.64	4	2.93	15	1.03	25	3.85		
26	0.96	5	2.83	16	2.24	26	3.05		
27	0.87	6	2.81	17	2.19	27	3.72		
28	1.95	7	2.31	18	2.10	28	1.89		
29	1.09	8	2.46	19	2.05	29	2.73		
30	1.04	9	3.53	20	2.67	30	2.49		
31	0.98	10	3.84	21	----	July			
June		11	3.50	22	1.24	1	2.46		
1	1.90	12	3.53	23	1.58	2	2.94		
2	2.01	13	3.66	24	2.25	3	2.71		
3	2.49	14	3.49	25	2.42	4	2.91		
4	2.81	15	3.44	26	3.02	5	2.48		
5	2.64	16	3.46	27	2.24	6	2.28		
6	2.48	17	3.63	28	1.22	7	2.30		
7	2.87	18	3.32	29	1.39	8	3.13		
8	2.53	19	3.12	30	2.17	9	3.45		
9	2.43	20	2.50	31	2.00	10	2.77		
10	2.46	21	1.63	June		11	1.60		
11	2.51	22	3.54	1	2.00	12	2.58		
12	2.12	23	3.56	2	1.87	13	2.20		
13	----	24	3.17	3	2.11	14	2.79		
14	1.83	25	2.42	4	1.29	15	2.40		
15	2.18	26	3.07	5	1.82	16	2.85		
16	0.76	27	2.27	6	2.49	17	----		
17	2.74	28	3.40	7	2.36	18	----		
18	1.99	29	3.54	8	2.22	19	2.48		
19	2.36	30	1.49	9	2.44	20	2.90		
20	2.33	31	2.27	10	2.81	21	3.18		

Table A-II. Airmass Temperatures (°C)

1976				1977						
May	AT	June	AT	May	AT		June	AT	July	AT
11	+8.7	21	+24.1	1	+13.5		12	-----	23	+24.3
12	+16.1	22	+30.1	2	+19.5		13	+26.9	24	-----
13	-6.5	23	+28.7	3	+15.5		14	+22.5	25	+31.3
14	-2.3	24	+30.3	4	+17.3		15	+21.5	26	+29.1
15	+7.7	25	+18.7	5	+16.7		16	+23.9	27	+27.6
16	+10.3	26	+19.1	6	+13.7		17	+35.9	28	+25.3
17	+0.9	27	+17.9	7	-----		18	+35.9	29	+24.9
18	+5.7	28	+19.7	8	+13.1		19	+27.7	30	+28.7
19	+1.7	29	+18.5	9	+14.1		20	+26.1	31	+32.3
20	+7.9	30	+19.1	10	+8.7		21	+23.3		
21	+13.9	July		11	+6.3		22	+18.7		
22	+19.7	1	+22.9	12	+7.9		23	+16.3		
23	+16.1	2	+22.5	13	+5.5		24	+21.3		
24	-----	3	+19.9	14	+14.4		25	+20.3		
25	+17.3	4	+21.3	15	+15.3		26	+24.9		
26	+9.3	5	+17.9	16	+13.3		27	+33.3		
27	+2.3	6	+15.1	17	+14.3		28	+30.3		
28	+12.5	7	+15.5	18	+9.1		29	+22.7		
29	+22.1	8	+16.7	19	+13.9		30	+36.7		
30	+19.3	9	+13.3	20	+12.5		July			
31	+15.9	10	+15.5	21	-----		1	+23.7		
June		11	+15.5	22	+6.1		2	+21.9		
1	+14.5	12	+16.3	23	+14.1		3	+23.1		
2	+14.3	13	+15.9	24	+10.3		4	+23.3		
3	+12.1	14	+17.9	25	+14.5		5	+26.5		
4	+11.7	15	+18.3	26	+18.9		6	+27.9		
5	+12.5	16	+19.7	27	+17.7		7	+27.3		
6	+9.9	17	+20.3	28	+28.3		8	+23.9		
7	+16.7	18	+22.3	29	+28.9		9	+22.5		
8	+9.5	19	+22.5	30	+26.5		10	+27.9		
9	+18.1	20	+22.3	31	+21.1		11	+32.5		
10	+24.5	21	+14.4	1	+20.1	J	12	+26.3		
11	+25.1	22	+13.9	2	+24.1	u	13	+24.5		
12	+24.1	23	+15.5	3	+23.5	n	14	+25.7		
13	-----	24	+17.5	4	+16.7	e	15	+24.5		
14	+27.5	25	+20.7	5	+16.1		16	+23.3		
15	+23.7	26	+16.9	6	+13.9		17	-----		
16	+20.5	27	+23.1	7	+16.3		18	-----		
17	+24.7	28	+27.1	8	+19.5		19	+23.9		
18	+21.9	29	+27.7	9	+23.3		20	+30.1		
19	+14.1	30	+24.7	10	+23.7		21	+26.5		
20	+18.5	31	+30.9	11	+22.3		22	+17.7		

Table A-III. Twelve-Hour Barotropic Vorticity Advection (1977 Only)

Recorded for $\frac{\delta v}{\delta t} \geq |1.0|$ in statistical computations					
May	$\frac{\delta v}{\delta t}$	June	$\frac{\delta v}{\delta t}$	July	$\frac{\delta v}{\delta t}$
1	-1.5	1	0.0	1	0.0
2	+1.0	2	0.0	2	0.0
3	-0.5	3	0.0	3	-0.5
4	-2.0	4	0.0	4	-0.5
5	+4.0	5	+0.5	5	0.0
6	-1.5	6	0.0	6	0.0
7	--	7	0.0	7	0.0
8	0.0	8	0.0	8	+0.5
9	-1.5	9	-0.5	9	0.0
10	0.0	10	-1.5	10	+1.0
11	0.0	11	0.0	11	+0.5
12	0.0	12	--	12	0.0
13	-1.5	13	0.0	13	-0.5
14	0.0	14	-1.0	14	0.0
15	+1.0	15	0.0	15	0.0
16	+0.5	16	0.0	16	0.0
17	0.0	17	0.0	17	--
18	+2.0	18	-1.0	18	--
19	+1.5	19	-0.5	19	0.0
20	+4.0	20	-1.0	20	0.0
21	--	21	-1.5	21	0.0
22	+0.5	22	0.0	22	0.0
23	0.0	23	+0.5	23	0.0
24	-1.0	24	-1.0	24	--
25	0.0	25	0.0	25	0.0
26	+2.5	26	+0.5	26	0.0
27	-1.5	27	+0.5	27	0.0
28	-1.0	28	+0.5	28	0.0
29	+1.0	29	0.0	29	0.0
30	+0.5	30	-0.5	30	0.0
31	-0.5			31	+0.5

Table A-IV. Forecast Maximum Temperatures, Observed Maximum Temperatures, And Convective Temperatures, 1977

May	T_{fm}	T_m	T_c	June	T_{fm}	T_m	T_c	July	T_{fm}	T_m	T_c
1	88	84	87	1	93	91	91	1	98	93	93
2	87	82	88	2	96	96	92	2	97	93	89
3	84	83	86	3	97	95	93	3	95	93	89
4	84	90	88	4	95	92	87	4	93	93	92
5	88	83	87	5	93	91	94	5	95	95	88
6	88	87	78	6	93	93	79	6	95	95	84
7	86	86	--	7	87	92	83	7	97	96	92
8	86	87	89	8	95	95	90	8	96	94	87
9	88	86	85	9	97	97	90	9	94	93	83
10	83	82	75	10	98	98	96	10	98	97	91
11	83	79	85	11	98	98	96	11	97	98	101
12	76	76	81	12	95	94	96	12	98	96	94
13	78	82	80	13	100	101	95	13	95	94	89
14	83	88	87	14	102	96	94	14	96	96	94
15	87	89	91	15	100	96	93	15	97	95	84
16	88	88	74	16	100	101	94	16	98	97	86
17	87	87	72	17	104	104	107	17	98	97	90
18	88	88	89	18	106	103	105	18	97	96	87
19	87	87	85	19	100	99	103	19	97	95	82
20	87	85	70	20	96	94	104	20	96	98	86
21	88	86	98	21	93	91	87	21	98	93	86
22	90	89	84	22	90	82	73	22	89	89	79
23	90	87	89	23	88	84	71	23	100	94	88
24	88	84	72	24	90	92	83	24	100	98	91
25	86	83	85	25	92	93	88	25	102	100	101
26	77	83	75	26	98	97	93	26	101	100	95
27	88	96	87	27	100	99	95	27	102	99	91
28	96	100	90	28	100	96	96	28	96	96	90
29	100	103	92	29	93	93	72	29	98	95	88
30	100	100	97	30	91	96	87	30	101	98	91
31	92	90	--					31	100	102	102

Table A-V. Convective Class Index

Class 1: 14 cases

Date	Trigger	N_{AT}	N_{PW}	850-600 mb inv.	subsidence	12-hr. $\frac{\delta v}{\delta t}$
5/14/76	N	-2.88	-1.60	Yes	---	Neg.
5/15	N	-1.55	-1.51	Yes	---	Neg.
5/27	N	-2.21	-1.99	Yes	---	Neg.
5/28	N	-0.92	-0.57	No	---	Neg.
5/29	N	+0.36	-1.70	No	---	Neg.
6/10	N	+0.68	0.11	Yes	---	Neg.
6/12	N	+0.62	-0.34	No	---	Neg.
6/16	N	+0.15	-2.14	No	---	Neg.
6/20	N	-0.12	-0.07	Yes	---	Neg.
7/20	N	+0.38	+0.16	No	Meso-sub.	Pos.
5/28/77	N	+1.18	-1.53	No	---	-1.0
6/5	N	-0.44	-0.74	No	---	+0.5
6/19	N	+1.10	-0.95	Yes	---	-0.5
7/4	N	+0.52	0.70	Yes	---	-0.5

Class 2: 2 cases

Date	Trigger	N_{AT}	N_{PW}	850-600 mb inv.	subsidence	12-hr. $\frac{\delta v}{\delta t}$
6/11/76	N	+0.76	0.17	Yes	---	Neg.
7/8	N	-0.36	0.11	Yes	---	Pos.

Class 3: 62 cases

Date	Trigger	N_{AT}	N_{PW}	850-600 mb inv.	subsidence	12-hr. $\frac{\delta v}{\delta t}$
5/13/76	N	-3.44	-2.21	No	--	Neg.
5/16	N	-1.21	-0.99	Yes	---	Neg.
5/17	N	-2.45	-1.10	No	---	Neg.
5/18	N	-1.82	-1.33	No	---	Neg.
5/19	N	-2.35	0.0	Yes	---	Pos.
5/26	N	-1.34	-1.88	No	---	Pos.
6/2	N	-0.68	-0.49	Yes	---	Neg.
6/6	N	-1.26	0.13	No	Yes	Nil
6/9	N	-0.17	0.07	Yes	---	Neg.
6/14	F	+1.07	-0.73	Yes	---	Nil
6/15	N	+0.57	-0.26	Yes	---	Pos.
6/18	N	-0.33	-0.52	Yes	---	Neg.
6/19	N	-0.70	-0.03	No	Yes	Neg.
6/27	N	-0.20	1.19	No	---	Pos.
6/28	N	0.04	0.37	Yes	---	Pos.

Table A-V. Convective Class Index--Continued

Class 3 (cont.) Date	Trigger	N_{AT}	N_{PW}	850-600 mb inv.	subsi- dence	12-hr. $\frac{\delta V}{\delta t}$
6/29	N	-0.12	-0.09	No	---	Pos.
7/7	N	-0.52	-0.09	Yes	---	Pos.
7/19	N	0.41	0.98	Yes	---	Neg.
7/27	N	0.49	-0.15	Yes	---	Neg.
5/6/77	N	-0.76	-1.52	Yes	---	-1.5
5/9	N	-0.70	-1.11	No	---	-1.5
5/11	F	-1.74	-0.57	Yes	---	Nil
5/12	N	-1.53	-0.58	No	---	Nil
5/15	N	-0.54	-1.78	No	---	+1.0
5/22	N	-1.76	-1.51	Yes	---	+0.5
5/23	N	-0.70	-1.06	Yes	---	Nil
5/24	N	-1.21	-0.17	Yes	---	-1.0
5/25	N	-0.65	0.05	Yes	---	Nil
5/29	N	1.26	-1.31	No	---	+1.0
6/2	N	0.62	-0.67	No	---	Nil
6/3	N	0.54	-0.36	No	---	Nil
6/4	N	-0.36	-1.44	Yes	---	Nil
6/6	N	-0.73	0.15	Yes	---	Nil
6/7	N	-0.41	-0.03	Yes	---	Nil
6/8	N	0.01	-0.21	No	---	Nil
6/14	N	0.41	0.45	No	Yes	-1.0
6/15	N	0.28	-0.11	No	---	Nil
6/16	N	0.60	-0.52	No	---	Nil
/617	N	2.19	-1.35	No	---	Nil
6/18	N	2.19	-1.16	Yes	---	-1.0
6/20	N	-2.23	-0.55	Yes	---	-1.0
6/28	N	1.45	-0.65	No	---	+0.5
6/29	N	0.44	0.46	Yes	---	Nil
7/1	N	0.57	0.11	No	---	Nil
7/2	N	0.33	0.74	No	Yes	Nil
7/3	N	0.49	0.44	Yes	---	-0.5
7/5	N	0.94	0.13	No	---	Nil
7/6	N	1.13	-0.13	No	---	Nil
7/7	N	1.05	-0.11	No	---	Nil
7/10	N	1.13	0.52	Yes	---	+1.0
7/11	N	1.74	-1.03	No	---	+0.5
7/12	N	0.92	0.26	No	Yes	Nil
7/13	N	0.68	-0.24	Yes	---	-0.5
7/14	N	0.84	0.54	No	Yes	Nil
7/15	N	0.68	0.03	No	---	Nil
7/16	N	0.52	0.62	Yes	---	Nil
7/19	N	0.60	0.13	No	Yes	Nil
7/20	N	1.42	0.69	Yes	---	Nil
7/23	N	0.65	0.81	No	Yes	Nil
7/25	N	1.58	0.20	No	---	Nil
7/30	N	1.23	1.03	No	---	Nil
7/31	N	1.71	-0.21	Yes	---	+0.5

Table A-V. Convective Class Index--Continued

Class 4: 10 cases

Date	Trigger	N_{AT}	N_{PW}	850-600 mb inv.	12-hr. $\frac{\delta v}{\delta t}$
6/8/76	N	-1.31	0.20	No	Pos.
7/6	N	-0.57	0.57	Yes	Neg.
7/17	N	+0.12	1.65	No	Neg.
5/2/77	N	0.01	-1.90	No	+1.0
5/8	SW	-0.84	-0.66	Yes	Nil
5/13	N	-1.84	0.38	No	-1.5
5/27	SW	-0.23	-0.18	Yes	-1.5
5/31	F	0.23	-0.50	Yes	-0.5
6/1	F	0.09	-0.50	No	Nil
7/22	N	-0.23	2.03	No	Nil

Class 5: 5 cases

Date	Trigger	N_{AT}	N_{PW}	850-600 mb inv.	12-hr. $\frac{\delta v}{\delta t}$
6/21/76	SW	0.62	0.21	Yes	Neg.
6/23	DL	1.23	0.25	No	Pos.
6/26	DL	-0.04	-0.50	Yes	Pos.
6/11/77	N	0.38	0.09	Yes	Nil
7/26	F	1.29	-0.26	No	Nil

Class 6: 40 cases

Date	Trigger	N_{AT}	N_{PW}	850-600 mb inv.	12-hr. $\frac{\delta v}{\delta t}$
5/20/76	SW/ST	-1.53	0.36	No	Pos.
5/22	F	0.04	-1.22	Yes	Nil
5/23	F	-0.44	-1.28	No	Nil
5/25	F	-0.28	-0.98	No	Pos.
5/30	F	-0.01	-1.77	No	Pos.
5/31	DL	-0.46	-1.85	No	Pos.
6/1	F	-0.65	-0.63	Yes	Neg.
6/4	ST	-1.02	0.57	No	Neg.
6/7	SW	-0.36	0.65	No	Neg.
6/17	DL	0.70	0.48	Yes	Pos.
6/22	DL	1.42	0.40	No	Pos.
6/24	F	1.45	-1.03	No	Neg.
6/25	F	-0.09	0.04	No	Pos.

Table A-V. Convective Class Index--Continued

Class 6 (cont.)

Date	Trigger	N_{AT}	N_{PW}	850-600 mb inv.	12-hr. $\frac{\delta v}{\delta t}$
6/30	F	-0.04	-0.32	Yes	Neg.
7/1	DL	0.46	-0.74	No	Pos.
7/2	ST	0.41	+1.23	Yes	Neg.
7/3	ST	0.07	1.92	No	Pos.
7/9	SW	-0.81	1.52	No	Pos.
7/16	F	0.04	1.43	Yes	Pos.
7/18	F	0.38	1.25	No	Pos.
7/21/76	SW	-0.66	-0.99	Yes	Pos.
7/22	N	-0.73	1.53	No	Pos.
7/23	SW	-0.52	1.56	No	Neg.
7/24	N	-0.25	1.04	No	Pos.
7/25	SW	0.17	0.05	No	Pos.
7/26	N	-0.33	0.91	No	Pos.
7/28	F	1.02	1.35	No	Neg.
7/29	F	1.10	1.53	Yes	Nil
7/30	SW-ST	0.70	-1.18	No	Pos.
7/31	ST	1.53	-0.15	Yes	Pos.
5/1/77	ST	-0.78	-1.37	No	-1.5
5/14	F	-0.66	-0.65	Yes	Nil
5/30	SW-ST	0.94	-0.28	Yes	+0.5
6/13	SW	0.99	-0.96	No	Nil
6/21	DL	0.52	1.53	Yes	-1.5
6/23	SW-DL	-0.41	1.18	Yes	+0.5
6/24	ST	0.25	0.87	No	-1.0
7/9	F	0.41	1.41	No	Nil
7/21	F	0.94	1.06	No	Nil
7/29	F-SW	0.73	1.92	No	Nil

Class 7: 8 cases

Date	Trigger	N_{AT}	N_{PW}	850-600 mb inv.	12-hr. $\frac{\delta v}{\delta t}$
5/11/76	DL	-1.42	-1.08	No	---
6/3	ST	-0.97	0.15	No	Neg.
6/5	ST	-0.92	0.34	No	Pos.
5/3/77	DL	-0.52	-0.90	Yes	-0.5
5/4	ST	-0.28	-0.34	No	-2.0
6/10	N	0.57	0.57	Yes	-0.5
6/22	N	-0.09	1.66	Yes	Nil
6/27	DL	1.84	1.77	Yes	+0.5

Table A-V. Convective Class Index--Continued

Class 8: 22 cases

Date	Trigger	N_{AT}	N_{PW}	850-600 mb inv.	12-hr. $\frac{\delta v}{\delta t}$
5/12/76	F	-0.44	-0.70	No	---
5/21	SW	0.04	-1.22	No	---
7/4	SW	0.25	0.73	Yes	Pos.
7/5	F	-0.20	0.59	No	Pos.
7/10	SW	-0.52	1.93	No	Neg.
7/14	SW	-0.20	1.47	No	Pos.
7/15	SW	-0.15	1.40	Yes	Pos.
5/5/77	F	-0.36	-0.20	No	+4.0
5/10	F	-1.42	0.13	No	Nil
5/16	F	-0.81	-0.18	Yes	+0.5
5/17	F	-0.68	-0.25	Yes	Nil
5/18	F	-1.37	-0.37	Yes	+2.0
5/19	F	-0.73	-0.44	Yes	+1.5
5/20	F	-0.92	0.38	Yes	+4.0
5/26	F	-0.07	0.85	Yes	+2.5
6/9	SW	-0.52	-1.18	Yes	-0.5
6/25	SW-F	0.12	1.94	Yes	Nil
6/26	F	0.73	0.89	Yes	+0.5
6/30	F	2.29	0.15	Yes	-0.5
7/8	F	0.60	0.99	No	+0.5
7/27	F	1.09	1.22	No	Nil
7/28	F	0.78	2.06	No	Nil

Class 9: 3 cases

Date	Trigger	N_{AT}	N_{PW}	850-600 mb inv.	12-hr. $\frac{\delta v}{\delta t}$
7/11/76	SW	-0.52	1.48	No	Pos.
7/12	SW	-0.41	1.52	No	Nil
7/13	SW	-0.46	1.69	No	Pos.

APPENDIX B: Tables

Table B-I: Texas HIPLEX Convective Index Class Stratification, 1976-1977

	1976			1977		
Date	May	June	July	May	June	July
1		6	6	6	4	3
2		3	6	4	3	3
3		7	6	7	3	3
4		6	8	7	3	1
5		7	8	3	1	3
6		3	4	3	3	3
7		6	3	-	3	3
8		4	2	4	3	8
9		3	6	3	8	6
10		1	8	8	7	3
11	7	2	9	3	5	3
12	8	1	9	3	-	3
13	3	-	9	4	6	3
14	1	3	8	6	3	3
15	1	3	8	3	3	3
16	3	1	6	8	3	3
17	3	3	4	8	3	-
18	3	3	6	8	3	-
19	3	3	3	8	1	3
20	6	1	1	8	3	3
21	8	5	6	-	6	6
22	6	6	6	3	7	4
23	6	5	6	3	6	3
24	-	6	6	3	6	-
25	6	6	6	3	8	3
26	3	5	6	8	8	5
27	1	3	3	4	7	8
28	1	3	6	1	3	8
29	1	3	6	3	3	6
30	6	6	6	6	8	3
31	6		6	4		3

Table B-II. Statistical Summary of Convective Index Stratification of the 1976-1977 Texas-HIPLEX Forecast Days.

Class	No. Case	Rel. Freq.	Cum Freq.	Rel. Cum. Freq.
1	14	.0843	14	.0843
2	2	.0120	16	.0964
3	62	.3735	78	.4699
4	10	.0602	88	.5301
5	5	.0301	93	.5602
6	40	.2410	133	.8012
7	8	.0482	141	.8494
8	22	.1325	163	.9819
9	3	.0181	166	1.0000

Table B-III. Breakdown of Convective Index Classes

Class	1	2	3	4	5	6	7	8	9	TOTAL
# in Class	14	2	62	10	5	40	8	22	3	166
AT	17.7	20.9	19.9	16.0	24.7	20.2	17.7	18.7	15.9	19.4
PW_{s-5}	1.72	2.49	2.16	2.46	2.35	2.58	2.59	2.83	3.56	2.39
N_{at}	-.225	+0.20	0.066	-.451	+0.70	+0.11	-0.225	-0.093	-0.46	0
N_{pw}	-0.87	+0.145	-0.291	+0.106	-0.040	+0.264	+0.277	+0.594	1.56	0

Table B-IV. Summary of Airmass Convection Operational Day Characteristics

Date	CI	AT	PW_{S-5}	N_{AT}	N_{PW}
6/8/76	4	9.5	2.53	-1.31	0.20
7/6	4	15.1	2.81	-0.57	0.57
7/17	4	20.3	3.63	+0.12	1.65
7/22	6	13.9	3.54	-0.73	1.53
7/24	6	17.5	3.17	-0.25	1.04
7/26	6	16.9	3.07	-0.33	0.91
6/10/77	7	23.7	2.81	0.57	0.57
6/11	5	22.3	2.45	0.38	0.09
6/22	7	18.7	3.64	-0.09	1.66
SAMPLE MEAN	5.4	17.5	3.07	-0.25	0.91
POP. MEAN	4.6	19.4	2.39	0	0

Table B-V. Summary of Triggered Non-Operational Days

Date	CI	AT	PW_{S-5}	N_{AT}	N_{PW}
6/14/77	3	27.5	1.83	+1.07	-0.73
5/11/77	3	6.3	1.95	-1.74	-0.57
SAMPLE MEAN	3	16.9	1.89	-0.34	-0.65
POP. MEAN	4.6	19.4	2.39	0	0