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FOURTH WEATHER WING

Technical Paper 66-1

PERSISTENCE PROBABILITY

August 1966

PERSISTENCE PROBABILITY

by

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August 1966

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AUTHOR'S PREFACE

Persistence is one of the most common but equivocal terms used in meteorology, having different meanings to different forecasters. Adding to this confusion is a new term introduced in recent years--"persistence probability"--also subject to misinterpretations. "Persistence probability tables" is a name given to the various types of contingency tables currently prepared by the Environmental Technical Applications Center (ETAC). These tables provide valuable climatological information on local weather changes and persistent weather conditions for different forecast periods, including the very short-range forecast period (≤ 3 hours) in which SAGE forecasters have a particular interest.

I have found from personal experience that many forecasters are not familiar with the practical applications of these tables. There are several reasons for this. First, some units are unaware of their existence since they have not yet received any tables for their terminal. Second, some units have tables available, but have difficulties in interpreting the data. Then there are others who have not yet recognized their usefulness or made any attempts to extract pertinent information.

Unfortunately, there is a conspicuous lack of published technical literature on the various types of persistence probability summaries currently available; method of construction; limitations of the tables; and suggested applications. I feel there is a definite need for technical guidance in this area and offer this paper as a contribution to this need.

In this paper, I have made an attempt to consolidate the information available in the 4th Weather Wing technical files and information obtained from 3d Weather Wing Scientific Services, 7th Weather Wing Scientific Services, and ETAC personnel. I have also included many personal ideas and suggestions.

I gratefully acknowledge the helpful suggestions and comments provided by Lt Colonel Claude Driskell, Captain Robert deMichaels, Mr. Clarence Everson and TSgt Robert Helms, and the assistance of Mrs. M. Jasmund in the typing and editorial preparation of this paper.

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2 Wea Wg (2WWAE).	5
3 Wea Wg (3WWAE).	5
5 Wea Wg (5WWAE).	5
6 Wea Wg (6WWAE).	5
7 Wea Wg (7WWAE).	5

TABLE OF CONTENTS

SECTION A - INTRODUCTION

Among the many tools available to forecasters for either preparing or evaluating short-period forecasts (0-3 hours), the one most frequently exploited is persistence. In meteorology, a persistence forecast is defined [1] as a forecast that the future weather condition will be the same as the present condition. This common definition implies no change of atmospheric conditions for an indefinite future period. Although this definition appears simple and direct, much confusion has arisen over the use of the term "persistence." The future weather condition may be the same as the present condition but this does not necessarily mean that the condition "persisted" as an unchanged weather condition during the entire period. It may have recurred after a change from the initial condition. The difficulties and confusion arise whenever one deals with hourly observations only. A series of hourly observations may show a repetition of the same weather condition indicating "persistence," but without a knowledge of inter-hourly observations (i.e., specials) one cannot distinguish between recurrence or true persistence. Since most climatological studies utilize hourly observations, we find that the terms persistence and recurrence are used rather loosely. But we shall see later that it is important to understand these differences in order to intelligently interpret climatological studies of "persistence." For the sake of this discussion, I would like to introduce some arbitrary definitions to avoid confusion.

True Persistence - The unchanging continuance of an initial weather condition during a period of time as determined from a series of hourly and special observations. This is also referred to as "straight-persistence" or "blind-persistence."

Recurrence - The repetition of an initial weather condition at some future time after a change has destroyed true persistence.

Apparent Persistence - The repetition of an initial weather condition as reported on hourly observations only. [NOTE: The weather condition may have either recurred or truly persisted, but cannot be identified.]

Trend Persistence - The continuation of an established trend in weather conditions as determined from previously recorded observations. For example, if the ceiling value was 3000 feet at 0700L and 2500 feet at 0800L, a trend-persistence forecast would yield 2000 feet at 0900L. Or putting this another way, the ceiling is said to have "trend-persisted" if the trend during one period of time is identical to the trend during a preceding and equal period of time.

In practice, we find that most meteorologists simply use the term "persistence" in meteorological discussions or technical studies which deal with the use of persistence as evaluation or forecasting tools. The applicable definition is usually apparent from the type of data used in the particular study. Most studies utilize only hourly observations since these data are readily available on punched cards and can be easily processed with electronic computers; some utilize hourly and special observations recorded on WBAN 10A's; and a few sophisticated studies utilize continuous data available from recorders (e.g., ceiling, visibility) which yield detailed time variations of weather conditions thus allowing thorough studies of true persistence or recurrence. To simplify our discussion in this paper, I will use the term--persistence--when discussing general applications and make the necessary distinctions when needed.

SECTION B - USE OF PERSISTENCE AS AN EVALUATION TOOL

The true-persistence forecast is often used as a standard of comparison in measuring the degree of skill of forecasts prepared by other methods. The persistence forecast here is considered as a professionally-unskilled forecast which forecasters should be able to surpass if any degree of skill is claimed. Other control forecasts used as a comparison standard are random forecasts and climatological forecasts. This accounts for the many types of skill scores described in meteorological literature. Many arguments arise over the validity or choice of the control forecast to use as a standard. Some feel that persistence is a good yardstick and that the acceptance or rejection of any forecast technique should be determined by its comparison to persistence.

There are others, however, who argue that persistence is a purely mechanical method and should not be used to challenge the professional application of skill and judgment by a forecaster who must scrutinize every piece of available weather information and determine if and when weather will persist or change. While overall monthly verification scores may show that persistence forecasting yields slightly higher scores than subjective forecasting, persistence forecasting fails during the critical periods of changing weather conditions. Although short-period weather changes usually occur less than 25% of the time, it is during these periods that forecaster skill and judgment are needed for the safe recovery of aircraft. It can be argued that it would be more acceptable to have a forecast system, even though subjective, which will correctly predict a large percentage of weather changes (particularly weather deteriorations) regardless of the comparison of the system against persistence.

Adding to this controversy is a third group who believe that it is not necessary to continually compare short-period forecasts against persistence because either experience or statistical studies have convinced them that persistence is the best forecast. In this group, we find some who actually advocate using persistence routinely when forecasting for periods less than 2 hours. These beliefs are fostered by statements found in some of the meteorological literature. Melpar, Inc. [2] in 1959, from a full-scale statistical investigation, drew the tentative conclusion that statistical methods developed from data spaced at one-hour intervals did not show any significant improvement over persistence. From a more recent publication [3], the statement is made "...it is generally acknowledged that forecasts of 0 to 2 hours can usually not be made which are more accurate than persistence. This means if knowledge about elements in this short time range is needed it is best to use the current observation for the forecast." It is certainly difficult to accept these conclusions in SAGE forecasting. Our ADC customer is entitled to a better forecast product than a mechanical persistence forecast.

SECTION C - USE OF PERSISTENCE AS A FORECASTING TOOL

Since there appears to be no limit to arguments in the controversy of using persistence as an evaluation tool, perhaps it is time to pursue a more positive approach and incorporate persistence into our objective and subjective forecast techniques as suggested by some groups [4], [5], in the past. In objective studies, persistence may be a very useful first-choice predictor. To incorporate it into objective studies, the current value of the predictand (phenomenon being forecast) can be used as one of the independent variables in the first scatter diagrams of a YES/NO type study. The reader is referred to reference [5] for further discussion of this application.

In subjective forecasting, the most intelligent and effective utilization of persistence appears to be through the use of "persistence probability" tables derived from climatological data. The tables are usually stratified by station, month or season, time of day and initial weather conditions (either by combined or separate ceiling/visibility categories). They yield the percent frequency (or conditional probability) of ensuing weather categories throughout a period of hours after a given initial weather category.

Table 1 is an example of one type of "persistence probability" table using four weather categories: A, B, C, D. [NOTE: It is not necessary, for purposes of this example, to know the limits of each category. The categories could be either ceiling, visibility or combined categories.]

Two-hour Persistence Probability
Table for Saulte Ste. Marie in
January at Initial Time of 0400L

Probability of Weather Category at 0600L

Initial Category at 0400L	A	B	C	D
A	66.6%	22.2%	11.2%	0.0%
B	29.2%	33.3%	29.2%	8.3%
C	2.3%	9.1%	77.4%	11.2%
D	0.0%	2.9%	15.9%	81.2%

The value 33.3% in the second row represents the percentage of time that a weather category B at 0400L is followed by the same weather category B two hours later at 0600L. The value 8.3% in the second row represents the percentage of time a weather category B at 0400L changed to weather category D at 0600L. The percentage figures in any one row thus represent the probability of occurrence of each ensuing category at 0600L. This table is applicable only at 0400L during January. Additional tables are necessary for different initial times, forecast periods, and months.

The format of the above table can easily be changed to facilitate its use by including a spectrum of forecast periods. Table 2 shows how the format in Table 1 can be rearranged. [NOTE: Only one column of probability values is shown to illustrate this particular format.]

TABLE 2

Persistence Probability Table for
Saulte Ste. Marie in January at
Initial Time of 0400L

CATEGORY		HOURS LATER			
Initial	Later	1	2	3	 24
A	A	____%	66.6%	____%	
	B	____%	22.2%	____%	etc.
	C	____%	11.2%	____%	
	D	____%	0.0%	____%	
B	A	____%	29.2%	____%	
	B	____%	33.3%	____%	etc.
	C	____%	29.2%	____%	
	D	____%	8.3%	____%	
C	A	____%	2.3%	____%	
	B	____%	9.1%	____%	etc.
	C	____%	77.4%	____%	
	D	____%	11.2%	____%	
D	A	____%	0.0%	____%	
	B	____%	2.9%	____%	etc.
	C	____%	15.9%	____%	
	D	____%	81.2%	____%	

The values mean the same thing as discussed in the first example. This format allows one to determine easily the probability of any subsequent category from any initial category for any desired number of hours later. Additional tables are necessary for different initial times and months.

From the above examples, the question may arise: Why are these tables called "persistence probability tables?" Actually, the title is a misnomer. The tables show the percentage of time a given initial weather category is followed by the same or another category so many hours later. There are two reasons why the title is a misnomer. FIRST, the tables do not necessarily show the percentage of time that a given category truly persisted; the category may have only recurred. In Table 2, the value 66.6% in the first row means: of all the observations at 0400L that were category A, 66.6% of these observations were followed by a category A observation two hours later at 0600L. This does not necessarily mean that all of the observations between 0400L-0600L were category A. The electronic computer only compared the 0400L and 0600L observations. At 0530L, the category may have changed to B, C, or D, and changed back to category A at 0600L, but the computer didn't "know" this, since the comparisons are made only with hourly observations. There may even have been a change on the 0500L hourly observation, say to category B and a change back to category A at 0600L. This change would certainly be indicated in the one-hour table but would show up in the two-hour table as one of the cases in the 66.6% group that persisted. Therefore, the percentage figures may mean either true persistence or recurrence with the distinction being difficult, if not impossible to make. For this reason, I will use in the remainder of this paper, the arbitrary term, "Apparent Persistence Probability" which I personally believe is a more applicable term since most tables constructed with the electronic computer utilize only hourly observations. SECOND, in addition to providing apparent persistence probabilities of the same initial weather category, the tables also provide the probability of occurrence of other weather categories as well. Therefore, a more inclusive title for the entire table is "Conditional Probability" since all values in the tables are contingent upon a given initial weather condition; and the apparent persistence probabilities are only a part of the tables.

SECTION D - CONDITIONAL PROBABILITY TABLES

1. General Types.

There are many other names by which these tables are referred to, such as: Climatic Probability, Probability Contingency, Climatological Expectancy of Persistence (CEP), Stratified Climatology, and Percentage Frequency of Persistence of Specified Weather Categories.

They are all constructed in a similar manner, utilizing several years of hourly observations, and are stratified to account for seasonal and diurnal weather variations. The differences between the many types of tables exist in the:

a. Definition of weather category limits

b. Seasonal stratification of data

c. Diurnal stratification of data

d. Format of the tables.

Of the various organizations which have produced these tables, the two most common are the Environmental Technical Applications Center (ETAC), formerly called the Climatic Center, and Travelers Research Center, Inc., in Hartford, Conn. Much of the following discussion therefore will deal with the description of and differences between the tables produced by these agencies.

2. Definition of Weather Category Limits.

Each hourly observation is classed into a weather category either by combined ceiling and/or visibility categories or by separate ceiling categories and visibility categories.

a. Travelers Research Center. The categories used by this organization are separate ceiling and visibility classes [6]. With few exceptions, the five categories used are as follows:

Ceiling Category	Limits (ft)	Visibility Category	Limits (mi)
1	≥5000	1	≥5
2	<5000 but ≥1500	2	<5 but ≥3
3	<1500 but ≥ 500	3	<3 but ≥1
4	< 500 but ≥ 200	4	<1 but ≥1/2
5	<200	5	<1/2

b. ETAC. This organization has produced a wide variety of tables involving 25 different combinations of weather category limits depending upon individual requests from AWS units.[1] On 4 January 1963, in a special letter to all wings and groups [7], Air Weather Service invited comments on a proposal to standardize throughout AWS, the probability tables being prepared by ETAC. AWS proposed that standardized probability tables should ultimately be prepared for all detachments and disseminated as Part F of the Uniform Surface Summaries. It was felt that the individual variability of requests for probability tables from AWS units was causing too much delay in processing due to machine program changes.[2] AWS suggested one common set of standardized limits to define six combined ceiling and/or visibility categories, namely:

Category	Ceiling and/or Visibility Limits
A	<200 ft and/or <1/2 mi
B	≥200 ft but <500 ft and/or ≥1/2 mi but <1 mi
C	≥500 ft but <1500 ft and/or ≥ 1 mi but <3 mi
D	≥1500 ft but <5000 ft and/or ≥ 3 mi but <5 mi
E	≥5000 ft but <20000 ft and/or ≥ 5 mi
F	≥20000 ft and ≥ 5 mi

The writer, of course, is not aware of all the comments received on this proposal. Headquarters, 4th Weather Wing suggested separate ceiling and visibility categories rather than the proposed combined ceiling and/or visibility categories. We felt that separate categories would provide more useful information to SAGE

[1]This information was obtained by correspondence from ETAC on 31 August 1965. A listing of all combinations is on file in 4WWAE.

[2]For each different set of weather category limits, the computer program must be revised to perform the necessary processing and output functions.

forecasters who are required to predict the ceiling and visibility separately. The advantage of using separate ceiling and visibility tables as a forecast aid is apparent when one considers the fact that quite often, a combined ceiling and/or visibility category (e.g., SAGE X condition of <500 ft and/or <1 mile) may persist for several hours; yet the hourly values of either ceiling or visibility frequently show a significant change. The apparent persistence probability of a combined category therefore yields a different type of information and is believed to be less useful as a forecast aid to the SAGE forecaster.

Apparently, a variety of recommendations were made by other wings and groups, since it was subsequently learned that ETAC still prepares several types of tables using a variety of weather category limits depending upon the specific request from AWS units. Thus it appears that the attempt to standardize the probability tables did not materialize. The main differences between the various types of ETAC tables lie in the requesting unit's selection of the operational weather category limits and choice of either combined ceiling and/or visibility categories or separate ceiling and visibility categories. The seasonal and diurnal stratification of data and the table format (to be discussed later) are practically identical in all tables prepared by ETAC. Illustrations of two frequent types of weather category limits used by ETAC are shown below.

(1) <u>Illustration No. 1</u> - The following combined ceiling and/or visibility categories are used in many probability tables requested by 3d Weather Wing. The categories are consistent with those used in the 3d Weather Wing TAFOR Verification Program.

Category	Ceiling and/or Visibility Limits
G	<300 ft and/or <1 mi
I	≥300 ft but <1500 ft and/or ≥1 mi but <3 mi
VL	≥1500 ft but <5000 ft and/or ≥3 mi but <5 mi
V5	≥5000 ft and ≥5 mi

(2) <u>Illustration No. 2</u> - The following separate ceiling and visibility categories are found in tables entitled "Percentage Frequency of Persistence of Specified Weather Categories" received aperiodically by 4WWAE and by a few 4th Weather Wing

detachments prior to 1965. In these tables, the weather category limits are broken down by separate ceiling and visibility classes, rather than by combined ceiling/visibility categories.

Ceiling Category	Limits (ft)	Visibility Category	Limits (mi)
A	<200	J	<1/2
B	≥200 but < 500	K	≥1/2 but <1
C	≥500 but < 1500	L	≥ 1 but <2
D	≥1500 but < 5000	M	≥ 2 but <3
E	≥5000 but <20000	N	≥ 3 but <5
F	≥20000	O	≥5

3. Diurnal and Seasonal Stratification of Initial Data. These stratifications of the hourly data are made to account for diurnal and seasonal weather variations. There is common agreement on the need for some sort of initial stratification but the degree of stratification is controversial.

a. Travelers Research Center. This agency feels that the stratification should be limited to only two seasons per year (viz., May-October and November-April) and two diurnal periods per day (viz., warm surface period from sunrise to sunset and cold surface period from sunset to sunrise). The Travelers group found in their investigations of various combinations of hours and seasons [6], [8], [9], that any further stratification decreased the reliability of the tables. They felt that too fine a breakdown reduces the number of cases ("thins" out the data) available for calculating the probabilities to a point where the probabilities are not stable when applied to a new sample of data. [NOTE: It is the writer's personal opinion that while too much stratification may possibly decrease statistical reliability, too little stratification may also decrease utility! Perhaps it would be best to simply use more than ten years of data.]

b. ETAC. This agency stratifies the data by individual month and by eight 3-hourly time groupings per day (viz., 00-02, 03-05, ... 21-23). It is not known whether the ETAC stratifications were selected arbitrarily or determined from statistical investigations. These stratifications are more beneficial to SAGE forecasters than those prepared by the Travelers group, since the ETAC tables provide the forecaster with updated probabilities each month and for each separate three-hour period of the day. ETAC apparently compensates for the "data-thinning" problem by utilizing more data. For example, the probability tables for Otis AFB incorporated nearly 17 years of hourly data. An inspection of ETAC tables reveals significant differences in the probabilities between individual months and between different 3-hour periods of the day (even within a given daylight or nighttime period). These variations, which are important to SAGE forecasters, are hidden in the two-season and two-period grouping procedure used by Travelers.

c. <u>4th Weather Wing</u>. This headquarters believes that while the ETAC tables are more useful as an aid to SAGE forecasters than the Travelers type, further stratification by each individual hour of the day would be a more beneficial aid. Even the 3-hour ETAC time groupings often mask the short-period weather variations during certain hours of the day, particularly at coastal stations or terminals with large diurnal variations. It is true that any further stratification would introduce a degree of unreliability if sufficient data are not available, but hourly stratifications would be more useful as an aid to the forecaster who must prepare short-period forecasts at least once each hour. Hourly stratifications would also better describe the local characteristics of short-period weather changes, particularly during poor initial weather conditions. Figure 1 illustrates the differences between 3-hourly and 1-hourly initial time groupings for Otis AFB, Mass., during November. Figure 1 shows the apparent persistence probability of an initial ceiling category <200 feet for 1, 2, 3, 4, 5, and 6 hours after initial times between 0600L and 0800L. When all the initial times are grouped (e.g., the "06-08" line), we find the probability to be 40% two hours after any initial time between 0600L-0800L. This 40% value is applicable at 0600L, 0700L or 0800L since all data for these three initial times were "lumped" together. The probabilities for each individual hourly initial time shows significant variations. The probability value two hours after an initial time of 0600L is 59%; after 0700L is 33%; and after 0800L is 17%. The value of 40% obtained from 3-hour time groupings represents a sort of mean during the period. Some may argue that individual hourly stratifications do not provide sufficient data. In the above example, there were 17 cases at 0600L, 12 cases at 0700L and 12 cases at 0800L.

Although the statistical significance of the few cases may be questionable, the question arises whether or not it is more important to provide the forecaster with information about each specific hour during the past 17 years and let him decide how

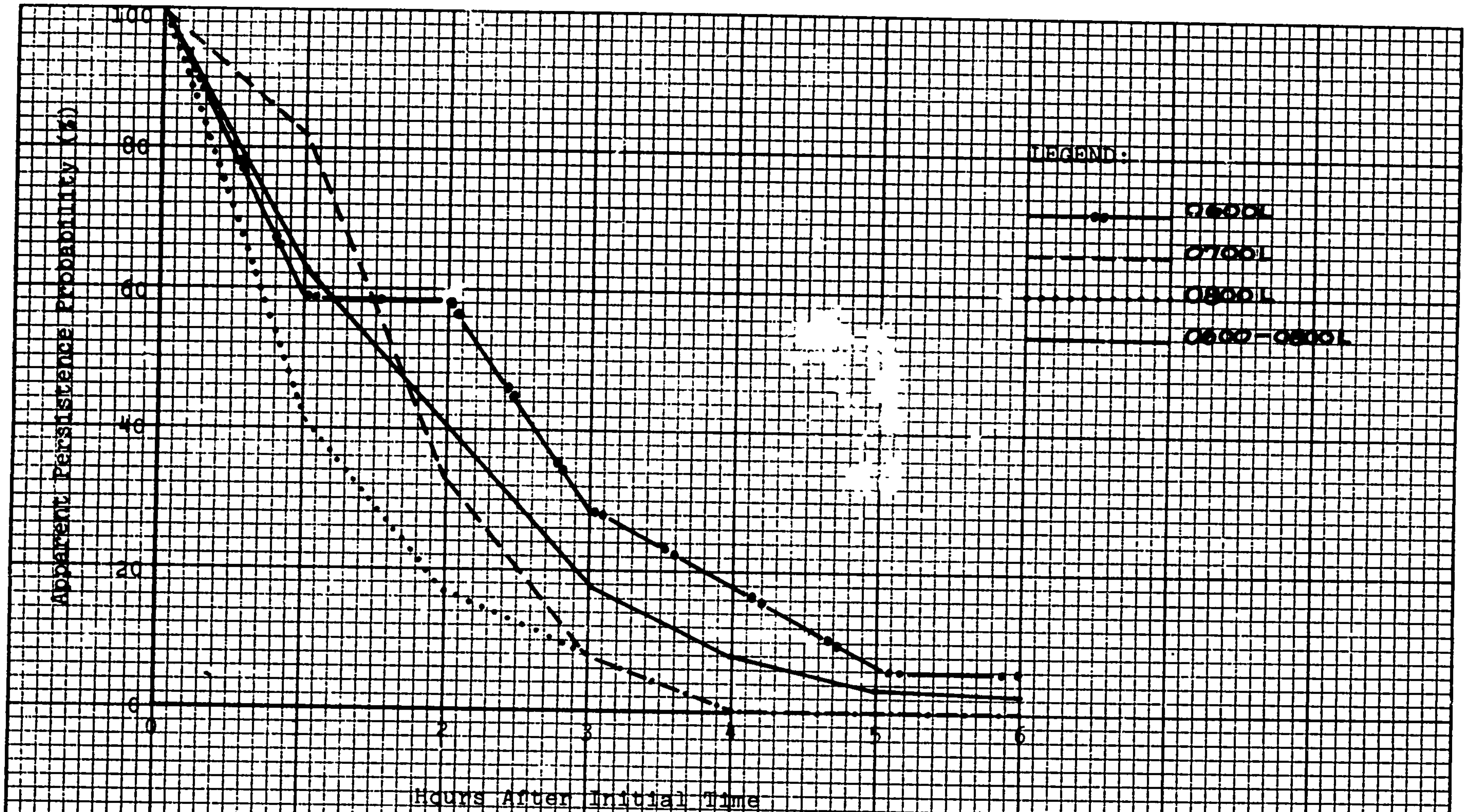

FIGURE 1: Differences Between 3-Hour and 1-Hour Initial Time Grouping at Otis AFB, Mass., During November for Ceilings <200'

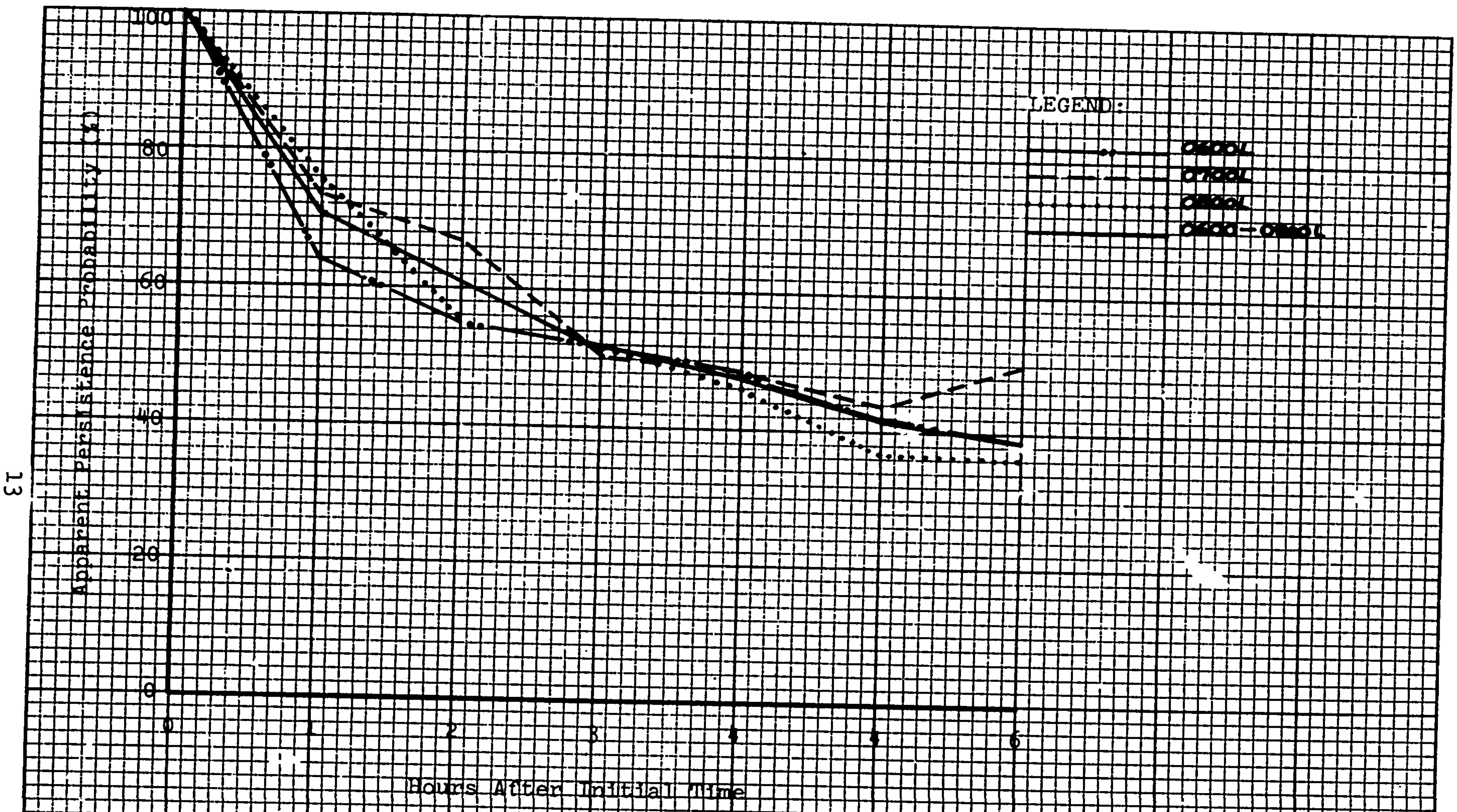

FIGURE 2: Differences Between 3-Hour and 1-Hour Initial Time Grouping at Otis AFB, Mass., During November for Ceilings $\geq$1500' but <5000'.

to use this information. Furthermore, if tables are constructed for each individual hour of the day, they can always be condensed by combining different initial times (by grouping 2-hour, 3-hour, etc.), if and when the need arises.

During some periods of the day, or for certain ceiling or visibility categories, there is little if any significant difference between 1-hour and 3-hour initial time groupings or possibly even between 1-hour and 12-hour groupings (as done by Travelers). For example, consider Figure 2 which shows the apparent persistence probability of an initial ceiling category ≥1500 feet but <5000 feet at Otis AFB for the same month and time of day as Figure 1. Note the insignificant differences between 1-hour and 3-hour groupings for this higher ceiling category. For ceilings >5000 feet, there is practically no difference.

An inspection of any table for most localities will also reveal important variations in probabilities between individual months for the same initial weather category and initial time. This is particularly true for ceilings <5000 feet and visibilities <5 miles. Figure 3 illustrates the monthly variation in the 3-hour apparent persistence probability for an initial ceiling category <200 feet at an initial time of 0600L for Otis AFB, Massachusetts. In January, for example, the 3-hour apparent persistence probability of an initial ceiling category <200 feet at 0600L is 59% (meaning that 59% of all hourly observations at 0900L subsequent to an 0600L observation of <200 feet also showed the same ceiling category). The curve in Figure 3 shows the monthly variations, many of which are significantly different and would be masked if several months were combined together.

In summary, it appears more reasonable to stratify the initial data by individual hour and by individual month to portray the necessary detail required in short-period forecasting. If standardized tables are stratified in this manner, a degree of flexibility is introduced which allows the user at a later time to either combine initial times or months depending upon the values for his particular location. This flexibility is lost, however, if the initial data are originally stratified in larger hourly or monthly increments.

4. Construction of Probability Tables.

The tables are constructed by first tabulating for each initial weather category the number of times (frequency count) that each category is subsequently observed at

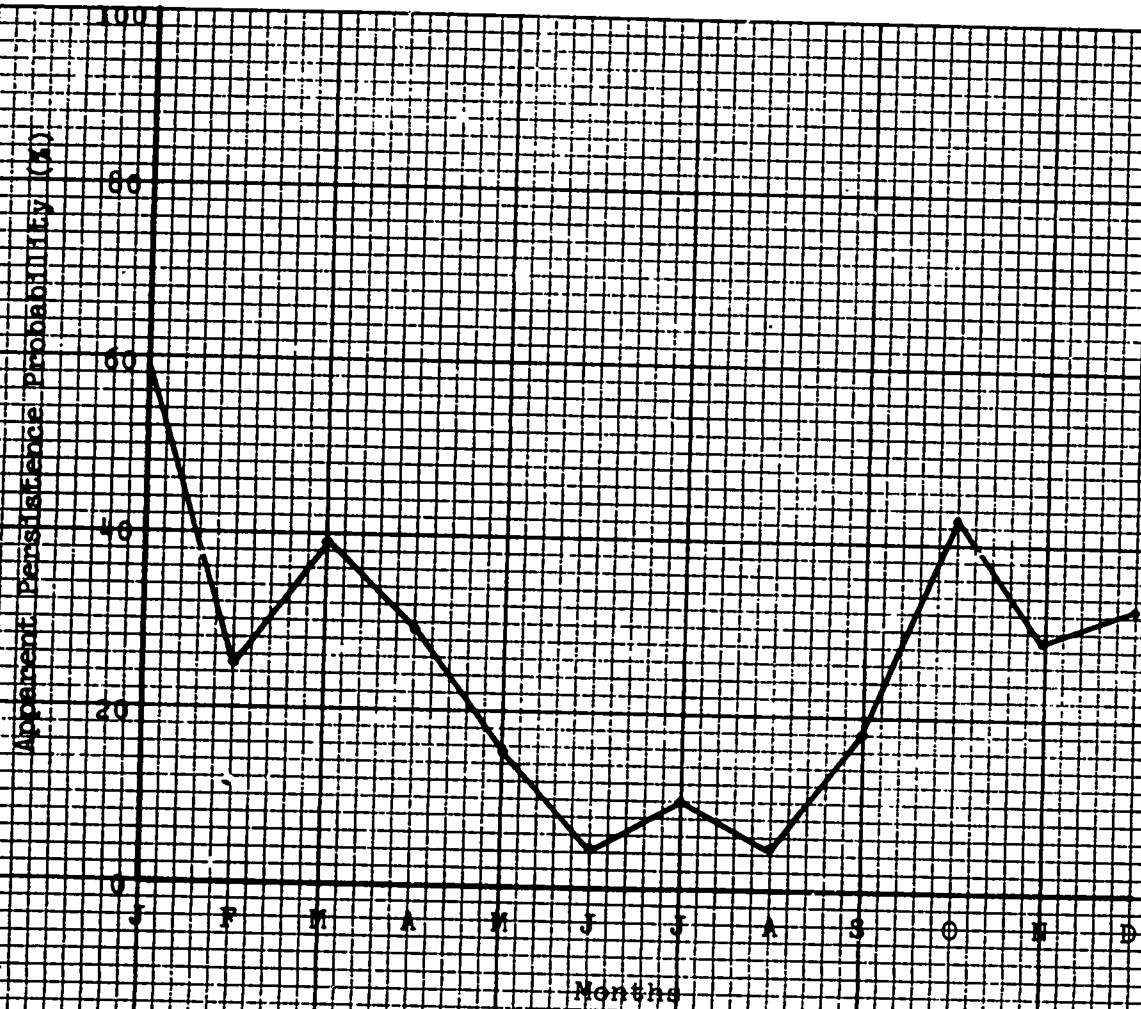

FIGURE 3: Monthly Variation of 3-Hour Apparent Persistence Probability at Otis AFB, Mass., for Initial Ceiling Category <200' and Initial Time 0600L.

given time intervals later. These time intervals vary among different agencies. Travelers Research Center uses a mixture of time intervals between 2 and 9 hours. ETAC uses hourly intervals from 1 through 12 hours, then every 3 hours through 24 hours, and every 6 hours through 48 hours. The following example will illustrate how the tabulations are converted to percent frequency. Consider five categories of ceiling defined by certain class limits, A, B, C, D, and E. Table 3 is a hypothetical example of a frequency-count table for a particular hour of day and month for initial category A. Similar tabulations are made for each of the other four initial ceiling categories (B, C, D, E).

TABLE 3

Ceiling Frequency Count for Pew, Texas

INITIAL HOUR: 0400 LST MONTH: January

CATEGORY		HOURS LATER	
Initial	Later	1	2. 24
A (95 cases)	A	40	20
	B	30	50
	C	23	14
	D	0	10
	E	0	0
	Total	93 cases	94 cases

The 95 initial category A cases is the number of times that ceilings in category A were observed at the initial hour of 0400 LST. The 40 cases in the first column represents the number of times that ceilings in category A were also observed one hour later. Other entries in this column show the number of times other categories were observed one hour after the initial time. Note that of the original 95 cases in which a category A ceiling was observed at 0400 LST, only 93 cases were correlated (or paired) with observations one hour later. Two cases were lost due to missing observations. It must be remembered that the same number of initial-hour observations may or may not be available for pairing with any individual later hour. Two hours after initial time, 94 cases were available for pairing. In the third hour, we might find 95 cases again available for pairing.

The frequency counts are converted to percentage frequencies (to the nearest whole percent) by dividing each entry in Table 3 by its column total. For example, the 40 cases in the first column is converted to a percent frequency by dividing 40 by 93 or 43%.

Table 4 illustrates the final form of the ceiling table for 0400 LST during January, for an initial ceiling category A. The same computations are made for the remaining four initial ceiling categories. In a similar manner, a visibility table is constructed for various categories of visibility.

TABLE 4

Ceiling Conditional Probability for Pew, Texas

INITIAL HOUR: 0400 LST MONTH: January

CATEGORY		HOURS LATER	
Initial	Later	1	2. 24
A	A	43%	21%
	B	32%	53%
	C	25%	15%
	D	0%	11%
	E	0%	0%
B	A	etc.	etc.
	B		
	C		
	D		
	E		
C	etc.		

The final table shows the percentage frequency that an observation reporting occurrence of an initial ceiling category is followed at certain time intervals by each of the five ceiling categories. The table therefore shows not only the apparent persistence probability of the initial ceiling category, but also includes the probability of occurrence of other categories to which the initial category has changed. For example, consider the initial category A portion of the table. The row values for "Later--Category A" (43%, 21%. . .) represent the apparent persistence probabilities; when the initial category is B, the row values for "Later--Category B" show the apparent persistence probabilities; etc. [NOTE: Please remember that only one particular row in each section of the conditional probability table represents the apparent persistence probabilities.]

SECTION E - 4TH WEATHER WING PROBABILITY TABLES

1. General Discussion.

On 22 September 1965, after it was learned that AWS-wide standardized tables would not be routinely disseminated by ETAC, 4WWAE initiated a request to ETAC for a specialized type of table particularly tailored for use as a short-period forecast aid for all bases of interest within NORAD. A suspense date of September 1966 was chosen for the completion of all tables. All 4th Weather Wing units were subsequently notified [10] of the 4th Weather Wing proposal and kept posted on the status of the 4th Weather Wing project [11]. Copies of the complete list of bases were also sent to all 4th Weather Wing squadrons.

2. Description of 4th Weather Wing Tables.

a. Weather Category Limits. The 4th Weather Wing tables include separate ceiling and visibility categories. The class limits are consistent with the display categories and amendment criteria described in NORAD Manual 55-3. These categories are:

Ceiling Category	Limits (ft)	Visibility Category	Limits (mi)
A	<200	J	<1/2
B	≥ 200 but < 500	K	≥1/2 but <1
C	≥ 500 but <1000	L	≥ 1 but <2
D	≥1000 but <1500	M	≥ 2 but <3
E	≥1500 but <5000	N	≥ 3 but <5
F	≥5000	O	≥5

b. Stratification of Initial Data. For the reasons discussed earlier in this paper, a conditional probability table is constructed for each hour of the day and for each month of the year.

c. Forecast Periods. The time intervals in these tables are 1, 2, 3, 4, 5, 6, 12, and 24 hours after the initial time. This is a considerable reduction in the number of periods previously used in tables prepared by ETAC. The main reason for condensing the periods was to allow sufficient space to print both the ceiling tables and visibility tables on a single sheet, thus enhancing their use in the station.

d. Table Format. The format of the 4th Weather Wing tables is shown in Table 5. This is an illustration of a set of ceiling and visibility tables for Colorado Springs, Colorado, for an initial time 0600L during the month of January. The table shows the conditional probabilities for each of the six initial ceiling categories and six visibility categories. For each initial category, the total number of cases that were available for pairing are shown in the bottom row of each section labeled "Cases." At the bottom of each page is listed the total observations and percentage frequency (to the nearest tenth) for each initial category and all categories combined (i.e., the total number of hourly observations used in constructing the table). The percentage frequencies of each initial category are compatible with the type of information found in the Uniform Summaries. In order to avoid confusion, it should be noted that ETAC selected a different title for these tables using the term "Conditional Climatology" instead of "Conditional Probability." As long as the reader understands the contents of these tables and how the values are derived, this should not cause any problem. Needless to say, the reader will undoubtedly

CONDITIONAL CLIMATOLOGY

STATION 93037 COLORADO SPRINGS COLO WBAS — JANUARY — HOUR 06 LST

CEILING CATEGORY INITIAL	LATER	HOURS LATER 1	2	3	4	5	6	12	24
A	A								
	B	67	67	33	33				
	C				33	33	33		
	D								
	E								
	F	33	33	67	33	67	67	100	100
	CASES	3	3	3	3	3	3	3	3
B	A								
	B	40	20						
	C	40	60	20	20	20	20	20	
	D			20	20	20	20		
	E				20	20			20
	F	20	20	60	40	40	60	80	80
	CASES	5	5	5	5	5	5	5	5
C	A								
	B	13	6		6	6	13	6	
	C	50	44	19	13			6	13
	D	13	6	25	6	13	6		13
	E	19	19	19	13	13	19	25	6
	F	6	25	38	63	69	63	63	69
	CASES	16	16	16	16	16	16	16	16
D	A								
	B			17	17	17	17		
	C	33	33	17	17	17	17	17	
	D	50	33	17	17	17	33	17	
	E	17	33	50	50	33	17	33	17
	F					17	17	33	83
	CASES	6	6	6	6	6	6	6	6
E	A								
	B			4					
	C			8	12	8	4	8	4
	D	12	16	4	4	4	12	8	
	E	40	44	36	36	28	24	28	24
	F	48	40	48	48	60	60	56	72
	CASES	25	25	25	25	25	25	25	25
F	A								1
	B		0	0		0	0	0	1
	C		0	1	1	1	1	2	2
	D	0	1	0	1	1	2	1	1
	E	0	1	2	2	3	2	4	4
	F	99	97	96	96	95	95	93	91
	CASES	441	441	441	440	441	441	441	441

INITIAL CATEGORY	ALL	A	B	C	D	E	F
PERCENTAGE	100.0	.6	1.0	3.2	1.2	5.0	88.9
TOTAL OBS	496	3	5	16	6	25	441

VISIBILITY CATEGORY INITIAL	LATER	HOURS LATER 1	2	3	4	5	6	12	24
J	J	33	67	33	33				
	K	33				33			
	L								
	M								33
	N								
	O	33	33	67	67	67	100	100	67
	CASES	3	3	3	3	3	3	3	3
K	J		33						
	K	67	33	33	33				
	L					33	33		
	M	33		33			33		
	N		33	33	33	33	33	33	
	O				33	33		67	100
	CASES	3	3	3	3	3	3	3	3
L	J								
	K	20	20						
	L	20	20	20	10	10	20		
	M	30	30	30	20	10	10		
	N	20			20	20	10		10
	O	10	30	50	50	60	60	100	90
	CASES	10	10	10	10	10	10	10	10
M	J								
	K	20	20	20	20				20
	L		20	20	20	40	40		
	M	60	20	20		20	20		
	N	20	20	20	20				
	O		20	20	40	40	40	100	80
	CASES	5	5	5	5	5	5	5	5
N	J								
	K	13						13	
	L	13		13	25	13	13		
	M	13	13	13					13
	N	38	50	13		13			13
	O	25	38	63	75	75	88	88	75
	CASES	8	8	8	8	8	8	8	8
O	J							0	1
	K		0	0	0	0		1	0
	L		1	1	1	2	2	1	2
	M	0	1	0	0	0	1	1	1
	N	1	2	2	2	2	2	0	1
	O	98	96	96	96	95	96	97	95
	CASES	467	467	467	466	467	467	467	467

	ALL	J	K	L	M	N	O
	100.0	.6	.6	2.0	1.0	1.6	94.2
	496	3	3	10	5	8	467

TABLE 6 - SAMPLE 4th WEATHER WING CONDITIONAL PROBABILITY TABLE

hear these tables referred to by many other names in the future, in addition to those already mentioned earlier in this paper (Section D, paragraph 1).

SECTION F - SUGGESTED USES OF 4TH WEATHER WING PROBABILITY TABLES

1. Discussion.

One of the most important values of these tables is that they provide a means of systematically incorporating valuable climatological information in the daily forecast-preparation routine. Individual experience with the tables will reveal many practical uses at different localities, particularly as an aid in short-period forecasting. Although desirable, it is premature to attempt to publish a consolidated list of specific applications gleaned from detachments, since detachments are still in the early stages of studying and developing routine uses. Such a list may be feasible in the future, however.

Much of the following discussion therefore is based upon the writer's personal experience and should be considered only as suggestions and opinions to provide a starting point from which to develop uses in the detachment.

2. General Applications.

a. Increase knowledge of local weather changes. Because these tables are stratified by individual hours, they should equip the forecaster, particularly those newly assigned, with comprehensive information on short-period ceiling and visibility variations peculiar to the local area. The routine climatological uniform summaries do not provide sufficient detail to gain this understanding. A thorough knowledge of the local characteristics of different types of weather changes is a prerequisite to short-period forecast improvement.

b. Encourage more intelligent use of persistence as a forecast tool.

The general unqualified statement voiced by many meteorologists, that a true persistence forecast (i.e., using current observation as the forecast) is the best forecast for periods less than three hours, is not true! This defeatist attitude should be squelched. An inspection of the 4th Weather Wing tables shows that the apparent persistence probability for initial ceiling categories below 1500 feet (viz., categories A, B, C, D) and visibility categories below 3 miles (viz., categories J, K, L, M) is seldom above 50% at the second and third hour following the initial condition (and quite frequently, at the first hour at many localities). This also holds true in many cases for initial ceiling category E ($\geq$1500 feet but <5000 feet) and initial category N ($\geq$3 miles but <5 miles). In fact, it is actually difficult to find an initial time for any of these categories at many localities where the third-hour apparent persistence probability exceeds 50%. Yet, advocates of true-persistence forecasting for the 0-3 hour forecast period claim that weather conditions persist during this period a "large" percentage of time. It is true that whenever ceilings are above 5000 feet or visibilities above 5 miles, the apparent persistence probabilities are usually above 85%. Whenever the complete spectrum of weather conditions are "lumped" together, we would probably find the general figure of approximately 75% for apparent persistence probability in the majority of cases.

But this is misleading! During periods when the ceiling is less than 5000 feet or visibilities less than 5 miles (which can occur 25% of the time or higher), true-persistence forecasting would yield poor verification results. Thus, the conclusion cited in [3] that "...it is best to use the current observation for the forecast..." is <u>not</u> valid during these periods. An estimate of the low verification scores that would be obtained in straight-persistence forecasting during these periods is the relatively low apparent persistence probability percentages in the tables.

As a forecast aid, persistence must be used more intelligently. There are situations when true-persistence indeed may be the best forecast--and other situations when weather changes are more probable. The reliability of persistence as a forecast aid varies with the initial weather condition, and also seasonally, diurnally and geographically. The 4th Weather Wing tables certainly are not a panacea, but they should encourage a more intelligent use of persistence as a forecast aid and provide useful information to be considered while appraising the current synoptic situation.

c. <u>Provide a more useful comparison standard in verification systems</u>. As mentioned earlier (SECTION B), a true-persistence forecast is often used as a comparison standard in measuring the degree of success of a particular forecast method. Rather than using a true-persistence forecast as the standard, a better measure of skill would be to use a purely statistical forecast from the tables, selecting the most probable ceiling or visibility category as the standard of comparison. If desired, skill scores could be computed using this statistical forecast as the control forecast.

d. <u>Focus attention on rare occurrences.</u>

Since the tables provide a condensed and ready reference of hourly climatological information on ceilings and visibilities heretofore unavailable, they encourage a routine consideration of climatological information before issuing forecasts. Such a procedure will alert the forecaster to the existence or likelihood of rare events (or anomalous ceiling and visibility conditions peculiar to the local area) and it will cause the forecaster to appraise (or reappraise) the current synoptic situation more carefully.

During periods when the apparent persistence probabilities are extremely low, a forecaster must carefully consider all available data for evidence of impending weather changes; he certainly should have strong overriding synoptic evidence if he predicts a continuance of the current ceiling (or visibility) category. On the other hand, there are periods when the apparent persistence probabilities are high and a forecaster needs good evidence to support a forecast of deteriorating or improving weather conditions. In all situations, the data in the tables must be considered together with all other available meteorological information (e.g., LASC's, upstream weather reports, specials, etc.) before making the forecast. The tables only serve as a useful alerting device for these rare occurrences.

It should be noted that quite frequently the tables will indicate that certain types of ceiling or visibility conditions have <u>never</u> been observed during the entire record of hourly observations. This does not necessarily mean it can't happen in the future but a forecaster should definitely find strong justification to "fight" these odds.

Consider Table 5 for example. Note that when an initial ceiling category A (<200 feet) is observed at 0600L during January (a condition which has only occurred 3 times in 17 years), the apparent persistence probability is 0% for all subsequent hours, which means of course that this category was never observed to "persist" on subsequent hourly observations. During the first two hours we find 2 cases (67%) in which the ceiling improved to category B and one case improved to category F. A true-persistence forecast in this case would be extremely radical. Depending upon other meteorological information, the forecaster should decide whether to forecast a slow or rapid improvement.

Further inspections of Table 5 will reveal many other situations where the probability is 0% and highlights periods which require considerable caution. [NOTE: Read the introductory page of each set of tables and note that a blank space indicates a nonoccurrence or 0% probability; a zero in the tables represents at least one occurrence or a percent frequency of less than 0.5%.]

3. Portrayal of Data for Daily Use.

a. Daily use of the tables will undoubtedly provide most detachments with a variety of ideas concerning methods of displaying the data in different forms, reorganizing the book of tables, color coding, etc. There is no single procedure which will satisfy the operational needs of all stations. Experience will dictate the best method for each individual base weather station or division station. Actually, the tables are already organized into a rather simple format with the ceiling and visibility probabilities on a single sheet. This in itself is a considerable improvement over many of the tables prepared in the past which required two sheets each for displaying six categories of ceiling and visibility probabilities; and the ceiling tables were grouped together in the first half of the book and the visibility tables in the second half.

At the expense of printing the tables on slightly larger sheets, the format of the 4th Weather Wing tables have eliminated much of the need to reorganize or condense the book of tables. There are a few suggestions, however, based upon limited personal experience, which may be worthy of further consideration and experimentation by detachments preparing short-period (≤ 3 hours) forecasts (either trend forecasts or SAGE computer forecasts).

(1) With an oval-shaped template, outline on each page the set of apparent persistence probability values for the first three hours after each initial ceiling and visibility category (except for category F and category 0). This will expedite the extraction, interpretation and comparisons of key information. As a substitute for a template, one can merely shade these values in yellow (preferably using a felt-tip marker with the new fast-drying ink such as a Carter's "HI-LITER" pen).

(2) A colored symbol (e.g., red x, red dot, etc ,) can be used to "flag"

the ceiling and visibility conditions which have <u>never</u> occurred during the period of record. These are indicated by blank spaces in the tables. As a start you may wish to restrict yourself to only the first three hours after initial time.

(3) In some fashion, mark the highest probability values in each table (such as underlining, circling, asterisks, etc.). If desired, a connecting line may be drawn through these values.

(4) Whenever a ceiling or visibility condition is observed which has never (or rarely) occurred previously during the period of record, a notation, such as year of occurrence, can be made on the appropriate table. This can serve to update the tables and will provide a useful reference for developing case files of rare events, or for future seminars on synoptic situations which are associated with anomalous ceiling and visibility conditions. This documentation will be invaluable during subsequent years and particularly for newly assigned forecasters.

b. To ensure routine use, the tables must be filed in a location readily accessible to the duty forecaster, and station policy should emphasize the consideration of the probability data as a preliminary step in the forecast-preparation routine. Detachments may want to reorganize their books since the book of tables in its present form may be too bulky for efficient use, particularly in division stations whose forecast responsibility includes several terminals. The following suggestions are offered for consideration.

(1) Use gummed tabs to identify each month, and retain the book in its present form.

(2) Divide the book into months or seasons and keep only the tables for the current month or season in a handy position for the duty forecaster.

(3) Cut each sheet into two parts, separating the ceiling and visibility tables, and file both tables on both sides of a 3-ring transparent notebook filler. A complete set of tables for each month would be contained in 24 transparent fillers which can then be filed (and better preserved) in a 3-ring notebook. If this is done, however, the month and hour must be written (or stamped) at the head of the <u>ceiling</u> table to avoid any confusion in case the table is misplaced or slips from the transparent filler. The month and hour are already printed at the head of the visibility table. The first page of each notebook should also contain a copy of the

class limits for each ceiling and visibility category for reference purposes.

SECTION G - OTHER TYPES OF PROBABILITY TABLES

1. Discussion.

Thus far, we have concerned ourselves with only one particular type of probability table. This is the most common type, dealing with ceiling and visibility, in which the probability of occurrence of a given ceiling or visibility category at a future time is contingent only upon the existing ceiling or visibility category and the initial time of day and month. We find that even when dealing with this particular type, there can be several variations depending upon: choice of the weather category limits (separate or combined ceiling/visibility); seasonal stratification of the initial data (individual months or seasonal periods); diurnal stratification of the initial data (individual hourly, 3-hour or 12-hour groupings); and forecast periods (single forecast period or spectrum of forecast periods per table). There are also other types of probability tables, dealing with ceiling, visibility and and precipitation, which have been or can be derived. To complete this paper, a discussion of other existing or possible types will be presented for general interest and to provide suggestions for further study.

2. Other Variations of Ceiling and Visibility Probability Tables.

a. True-Persistence Tables. As discussed in Section C, a major weakness of probability tables derived from hourly observations is the fact that one cannot distinguish between recurrence or true-persistence of a given ceiling or visibility category. Although desirable, it appears that a true-persistence probability table cannot be derived by computer methods, but would have to be constructed manually utilizing all special observations from WBAN's, since these data are not available on punch cards or magnetic tape at the National Weather Records Center in Asheville, North Carolina. The writer is not aware of the existence of any true-persistence probability table, but we should recognize the fact that such a table would be much more useful as an aid in short-period forecasting. It may be quite some time before we see a table of this type.

b. True-Hourly-Persistence Tables. This is an arbitrary name for a possible ceiling and visibility table which would distinguish between recurrence and persistence from hourly observations only. This type of table would be similar to our present 4th Weather Wing tables, but in addition would include information concerning the hourly duration probability of any given initial ceiling and visibility category. For example, with an initial category B at 0400L, the probability value for the same category, say three hours after initial time, would represent the percentage of time that category B was observed on all three successive hourly observations after the initial time (e.g., 0500L, 0600L, and 0700L). The present 4th Weather Wing tables do not yield this type of information, but we are considering the inclusion of such data in future tables.

c. Persistence-Trend Tables. These tables are a rather unique type which were devised by Captain Juri V. Nou [12] in 1961 for Wright-Patterson AFB, Ohio. These tables are derived by comparing an initial weather category (defined by certain ceiling and visibility criteria) with hourly observations covering the preceding 24 hours, and selecting the relationship which is most indicative of future weather categories. This technique combines persistence (existing weather) with trend (past weather) and yields a set of tables, referred to as "Optimum Probabilities for Persistence-Trend Forecasts," used to select the most probable weather category at 3, 9, 15 and 21 hours after each of four initial forecast-start times (00Z, 06Z, 12Z, 18Z). These initial times were selected to coincide with the four times TAFOR's were issued daily. The technique is extremely interesting and the reader should study the original report to gain a complete understanding. [NOTE: Copies of this study are available from the Defense Documentation Center and may be obtained through 4WWAE or your squadron Scientific Services Officer.]

d. Duration Probability Tables. A new type of table was introduced by the Meteorological Branch of Canada's Department of Transport (DOT) in 1965 [13], which provides valuable statistics on the duration of poor weather conditions. It is an experimental type of summary, shown as Table III in the reference cited above. The summary stratifies hourly observations of a combined ceiling/visibility category by individual month, onset hour of the first occurrence of the category, and duration of the condition. The only category used thus far is one referred to as "Range 3" which is defined as an observation with ceilings less than 200 feet and/or visibilities less than 1/2 mile; however, the technique can be applied to any particular ceiling and/or visibility category. An illustration of the table format and a portion of the entries are shown below for Vancouver for the month of January.

Extract of Table III from Canadian Summary
"Meteorological Conditions at Canadian Airports"

			ONSET HOUR						
MO	DURATION IN HOURS	TOTAL CASES	00	01	02	03	04	05	 23
01	1	27	1	1	2	1	2	2	
01	2	20		1	2	1	1	1	etc.
01	3	9		1	1		1	1	
01	4	1							
01	5	6							etc.
01	6	4							
01	7-9	3							
01	10-12	4	1	1	1				etc.
01	13-18	3	1	1					
01	19-24	6							
01	>24	1							etc.
TOTAL CASES		84	3	5	6	2	4	4	etc.

The table shows the number of times that the ceiling and/or visibility first lowered to <200 feet and/or <1/2 mile at each hour, tabulated according to the number of hours conditions persisted in this range. For example, the second row of values shows that there were 20 periods (not hourly observations) in which the weather category was first observed (after a deterioration) and lasted only two hours. The 20 onset cases are then broken down by individual onset hour.

The table shows only frequencies (not percentage frequencies) and one can determine the duration probability by simply comparing the total number of times the weather category occurred for the first time (column totals) with the actual number of cases for any selected duration. Consider the "02" onset hour column. There were six periods in ten years where the weather category was first observed at 0200 LST; two cases lasted one hour (33%), 2 cases lasted 2 hours (33%), 1 case lasted 3 hours (16.5%), and 1 case lasted 10-12 hours (16.5%). The figures may be cumulated to state that 5 of the 6 cases lasted three hours or less. Consider the "05" onset hour column where there were only 4 previous occurrences in 10 years; of these, *none* lasted more than 3 hours.

The summary is rather interesting since each individual *period* of ceiling/visibility conditions <200 feet and/or <1/2 mile is treated separately, yielding the duration probability as a function of the original onset time of the occurrence, not as a simple function of hour of day (as in our 4th Weather Wing tables) which does not include the previous duration of the weather category. The main disadvantage of the Canadian tables lies in the fact that they do not yield any information on the probability of other subsequent weather categories--information which is equally useful especially when dealing with intermediate weather categories where weather conditions can either improve or deteriorate. The Canadian tables do, however, provide more representative information on apparent persistence probability than our 4th Weather Wing tables.

It is interesting to note that the inclusion of onset times of a given weather category was initially considered by 4th Weather Wing in 1960. An experimental climatological study [14] on duration probabilities of seven initial ceiling/visibility categories showed the past duration (or previous hours of occurrence) of a given category affected the duration probability for one and two hours in the future. We hope to incorporate this important parameter in future 4th Weather Wing tables.

e. *1st Weather Wing Persistence Summaries*. In 1965, 1st Weather Wing published a series of probability tables for several bases in Vietnam [15]. The tables include two initial categories of combined ceiling/visibility conditions (and a precipitation category). The two initial categories selected were: (1) <1500 feet and/or <3 miles and (2) <5000 feet and/or <5 miles. The initial data are stratified by month, individual hour of day, and duration of the initial condition from onset time. Only frequencies are shown and the reader must calculate the percentage frequency or probability. In general, these tables yield about the same information as the Canadian tables discussed earlier. The tables yield the duration probability of the above weather conditions from initial onset time and the probability that the same condition will recur on one or more succeeding days at the same hour.

f. *Other Possible Stratifications of Initial Data*. In addition to the stratifications of the initial hourly data by month, time of day and duration of the initial weather category from initial onset time, there are other possible stratifications which may yield more representative probabilities and which are currently being considered for future tables.

(1) Wind direction. All things equal, there are certain localities where the probability of any subsequent weather category certainly varies with wind direction. It is reasonable to assume that at coastal stations, particularly the Gulf Coast, the apparent persistence probabilities of low ceiling categories would be higher during onshore rather than offshore wind regimes. Or in mountainous areas, the apparent persistence probability of a given initial ceiling category would be higher during upslope situations.

(2) Responsible weather phenomena. Experience has shown that the apparent persistence probability of certain visibility conditions vary with the causative factor. As an illustration, in the Great Lakes region, the one-hour apparent persistence probability of visibilities less than one mile caused by fog is approximately 80% but is only about 50% when caused by snow. On the east coast, however, the one-hour apparent persistence probabilities are about 65% in fog situations and 90% in snow situations. These estimates were obtained from a series of wintertime weather deterioration studies conducted by 4WWSS in 1959 [16].

(3) Combined synoptic parameters. The initial data may also be stratified by combined groups of several parameters (e.g., time of day, wind direction, wind speed, responsible weather phenomena, dew points, etc.) This gets rather involved, however, since each parameter is defined by various class limits and to cover all combinations, a catalog of tables or a "forecast register" must be constructed. This technique is referred to as a "Grouping Method," which is thoroughly described in many publications, particularly in the comprehensive report by Melpar, Inc. [2].

It is obvious from the discussion above that there appears to be no limit to the number of ways in which to stratify the initial data. One must remember, however, that the inclusion of every additional parameter "thins" out the data available for calculating percentage frequencies or probability. A point may be reached where too much stratification may not yield meaningful results. Careful consideration, therefore, must be given to the degree of stratification required for either "standardized" tables or for "custom-made" tables specifically tailored for particular locations.

3. Precipitation Probability Tables.

a. 1st Weather Wing Persistence Summaries [15]. These summaries, discussed earlier in paragraph 2e, also contain precipitation duration probabilities. The precipitation tables are interpreted in the same manner as the ceiling/visibility tables.

b. USWB Precipitation Conditional Probability Tables. In 1966, the Weather Bureau Eastern Region initiated an experimental project to prepare precipitation conditional climatology (probability) tables for use as a forecast aid at eight USWB stations in the region. This project is described in detail in an Eastern Region Technical Memorandum by F. L. Zuckerberg [17]. This technique stratifies hourly observations of precipitation (using specified definitions) by individual month, eight categories of wind direction and three wind speed categories. To use the tables, a forecaster is required to make a wind forecast and then enter the appropriate table to find the precipitation probability. This project is rather new, and the results of current evaluations and availability of funds will determine whether or not additional tables will be constructed for each forecasting office in the region. The purpose of these experiments is to provide objective aids to USWB forecasters who are now required to specify local point probabilities of precipitation in their daily forecasts.

SECTION H - SUMMARY

This paper has attempted to consolidate many ideas--both published and suggested --concerning the use of "persistence" as a practical meteorological tool, with specific emphasis on the development and uses of the wide variety of ceiling and visibility "persistence probability" tables which have become increasingly popular in recent years. Although these tables are not new, there has been a revival in interest since the introduction of Electronic Data Processing methods in the field of meteorology which have accelerated the many statistical manipulations required in the construction of probability tables. Heretofore, the job of constructing such tables by manual methods was too great and discouraged many agencies from developing such tables.

While "persistence probability" tables are not a panacea for terminal weather forecasting, they are a valuable forecast aid which equip the forecaster with comprehensive information on diurnal and seasonal weather variations peculiar to the local area. They are particularly valuable in short-period forecasting ($\leq$3 hours), where short-period weather changes pose the greatest forecast problems. Emphasis on the use of probability tables as a forecast aid has been expressed in many fine articles by other AWS wings [18] [19] [20] [21], and in a recent AWS briefing [22], and AWS article [23]. Because of the many potential uses of probability tables, we can expect continued emphasis in the future. It rests now upon the forecaster to gain experience in using these tables and make contributions for future papers or articles on this important subject.

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13. ABSTRACT

This paper consolidates many ideas--both published and suggested--concerning the use of persistence as a practical forecast tool. Specific emphasis is placed on the construction of ceiling and visibility persistence probability (or conditional probability) tables and suggested uses as a short-period forecast aid. The paper contains a survey of published literature available in the technical files of Headquarters, 4th Weather Wing and presents many ideas and suggestions for designing improved probability tables.

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