

ON THE USE OF PERSISTENCE TO MODULATE MOS PoP FORECASTS

John E. Hovde (1)
 743 Red Oak Lane, Apt. 4B
 Park Forest South, IL 60466

ABSTRACT

The persistencies of rain and of no rain into a forecast period from the prior period are shown to be functions of the probabilities of rain in the two periods. These probabilities are taken to be their MOS PoP forecasts. The persistence effect is to modulate the MOS POP for the forecast period to a higher or lower value depending on what occurs in the prior period. Results are presented by graphs, and may be considered a disciplined strategy that gives a forecaster the when, the how, and the how much that MOS PoP forecasts are modulated by persistence.

1. INTRODUCTION

The great empirical study of the effects of persistence on climatological probabilities is ESSA Technical Memorandum WBTM TDL 31 (2). The effects are determined by actual counts with 15 years of the data. The report considers two adjacent 6-hour periods and two adjacent 12-hour periods.

The scheme described here is an effort to determine the effects of persistence on model output statistics probability of precipitation forecasts (MOS PoPs) for two adjacent 6-hour periods and two adjacent 12-hour periods. MOS PoPs can change greatly from one period to the next, so the scheme must handle any combination of adjacent period frequencies. This situation is considerably different than the method in TDL 31, wherein most climatological frequencies are equal and each is less than 50%.

Table 1. In two adjacent periods there are four possible events:

1st Period	2nd Period
Rain	Rain
Rain	No Rain
No Rain	Rain
No Rain	No Rain

If the frequencies of rain are expressed in percent, the rain values in Table 2 become rain counts per 100 cases.

Table 2.

Event	1st Period	2nd Period
Rain - Rain	Ra	Ra
Rain - No Rain	Rb	
No Rain - No Rain		Rc

Frequencies:

$$1st = Ra + Rb$$

$$2nd = Ra + Rc$$

TDL 31 and its nomenclature:

00 hours	04 *	06 hours	12 hours	
00 hours	10	12 hours	24 hours	
Forecaster Position				
Conditional Period Prob. = Climate		Verifying period Prob. = Climate		
If "Wet"		Prob. modulated by persistence to a higher value		W1 for 6-hour prds; W2 for 12-hour prds.
If "Dry"		Prob. modulated by persistence to a lower value		D1 for 6-hour prds; D2 for 12-hour prds.
This scheme and its nomenclature:				
Prior Period. * Prob. = Its latest MOS Pop		Forecast period Prob. = Its latest MOS Pop		
If "RIPP"		MOS PoP modulated by persistence to a higher value		From Graphs 1 and 3
If "NIPP"		MOS PoP modulated by persistence to a lower value		From Graphs 2 and 4

TDL-31's "Wet" is same as scheme's "RIPP" (Rain In Prior Period)
 *TDL-31's "Dry" is same as scheme's "NIPP" (No rain In Prior Period)
 *=Forecaster position on top time scales.

Contract to a two-events table (Rain Counts only), resulting in Table 3:

Table 3.

Event	1st Period	2nd Period	
Rain in 1st.	(Ra + Rb)	Ra	Probability of Rain in 2nd following Rain in 1st: $= \frac{Ra}{Ra + Rb}$
No Rain in 1st.	100 - (Ra + Rb)	Rc	Probability of Rain in 2nd following No Rain in 1st: $= \frac{Rc}{100 - (Ra + Rb)}$

Ra: rain occurs in both periods.
 Rb: rain occurs only in first period
 Rc: rain occurs only in second period

Above it is shown that, if we can get the rain counts Ra, Rb, and Rc, we can get the probabilities from the two events table (Table 3). This can be done by utilizing the "double period", made up of the two single periods. The Rain Counts, Table 4, is:

	1st Period	2nd Period	Double Period
	Ra Rb	Ra Rc	Ra Rb Rc
Total Rains	(Ra+Rb)	(Ra+Rc)	Ra+Rb+Rc

Ra =	(Ra + Rb)	+	(Ra + Rc)	-	(Ra + Rb + Rc)
=	F1	+	F2	-	Fd
Rb =	(Ra + Rb)	-	Ra		
=	F1	-	Ra		
Rc =	(Ra + Rc)	-	Ra		
=	F2	-	Ra		

Symbols: F₁ is freq. first period. F₂ is freq. second period. F_d is freq. double period.

Table 4 shows that, if the double period frequency can be derived from the frequencies of the two periods, then Ra, Rb, and Rc can be determined. The assumption necessary and the method of determining the double period frequencies for all combinations of single-period frequencies from 5% to 90% follow.

2. GETTING THE DOUBLE-PERIOD FREQUENCIES FROM ALL COMBINATIONS OF SINGLE-PERIOD FREQUENCIES

There are 2 steps:

First, get double-period frequencies when single-period frequencies are the same. This requires the assumption:

$$\frac{\text{rain freq. double prd}}{\text{rain freq. single prd}} = \frac{3}{2} = 1.50 = \text{the RATIO.}$$

These are graphed and tabled in Figure 1.

Second, get double-period frequencies from any combination of single-period frequencies. The procedure may be illustrated by an example:

Single Prd Freq	Single Prd Freq	Double Prd Freq
40%	40%	60%
30	40	55
20	40	50
10	40	45
0	40	40

using the assumption above by linear interpolation between 60% (for 40% and 40%) and the 40% (for 0% and 40%)

OBVIOUS

The Interpolation Graph is Graph 1. It covers all combinations of single-period frequencies from 5% to 90%.

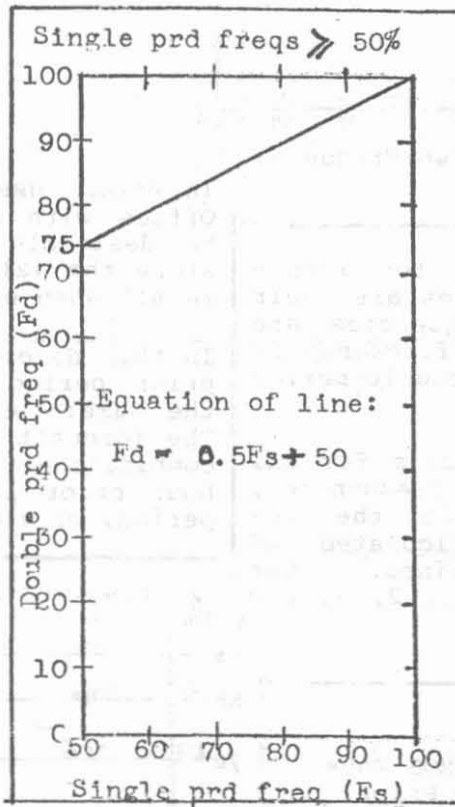
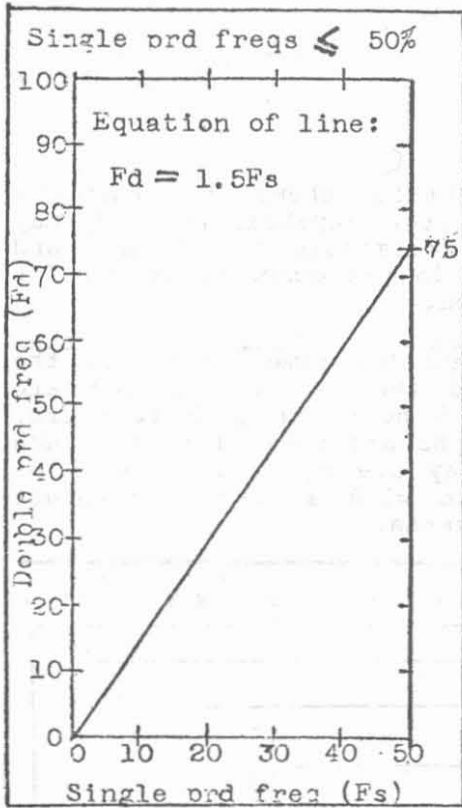


Table from above:

Fs	Fs	Fd
02	02	03
05	05	075
10	10	15
20	20	30
30	30	45
40	40	60
50	50	75

Table from above:

Fs	Fs	Fd
50	50	75
60	60	80
70	70	85
80	80	90
90	90	95

Symbols:

Fd is frequency of double period.
Fs is frequency of single period.

Figure 1. Double-period frequencies of two single periods, each with same frequency. In left-hand plot the double-period frequency is assumed to be 1.50 times the single-period frequency up to a limit of 75%. In right-hand plot the double-period frequency varies linearly from that 75% point to its 100% limit.

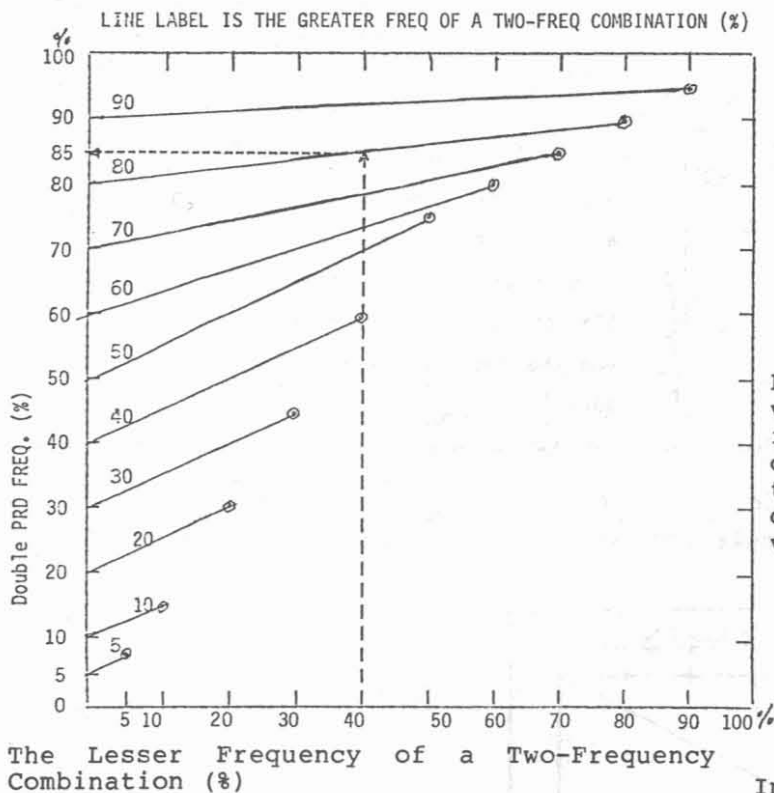


Figure 2. Double-period frequencies from various combinations of single-period frequencies. One of the end-point values of the labelled lines occurs when one of the single-period frequencies is 0%; the other when the two are the same. Linear variation assumed.

Double-period frequency values for right-hand end points of labelled lines are their values when single-period frequencies are the same. For example; if one frequency is 40% and the other is 80%, double-period frequency is 85%.

With the double-period frequencies for all combinations of single-period frequencies, the values of Ra, Rb, and Rc for the two-events table (Table 3) were calculated and the two probabilities determined. The results are graphed as Graphs 1, 2, 3, and 4, respectively.

In actual use of this scheme at a Forecast Office with computer capabilities, it may be desirable to eliminate the Graphs and store the values in the computer memory for recall when wanted.

In this development the time lengths of the prior period and the forecast period are the same: each 6 hours or each 12 hours. The forecast graphs are valid for each such combination. They are not valid for a 6-hour prior period with a 12-hour forecast period, or vice-versa.

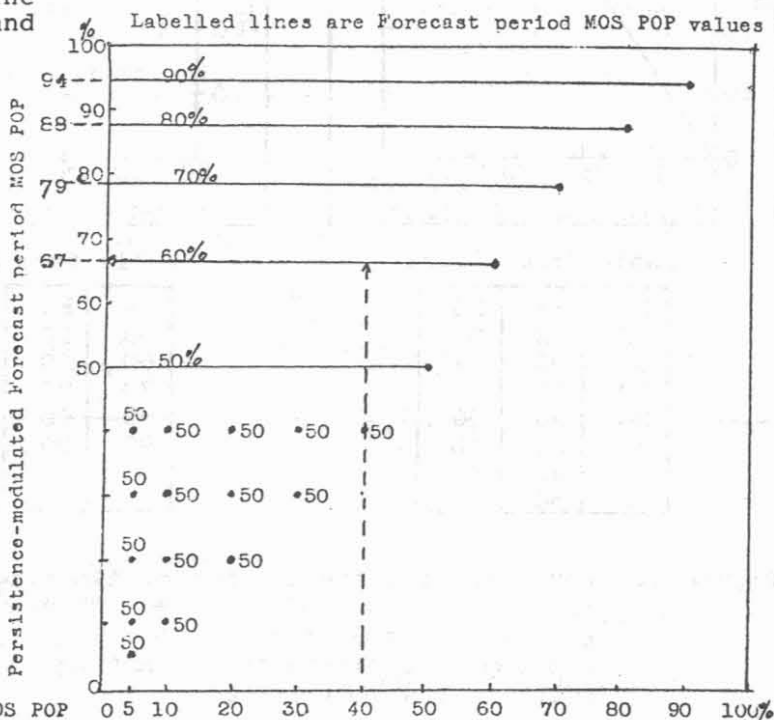
Graph 1.

Modulated Forecast Period MOS POPs When Rain in Prior Period; Prior Period MOS POP ≤ Forecast Period MOS POP (a RIPP Graph).

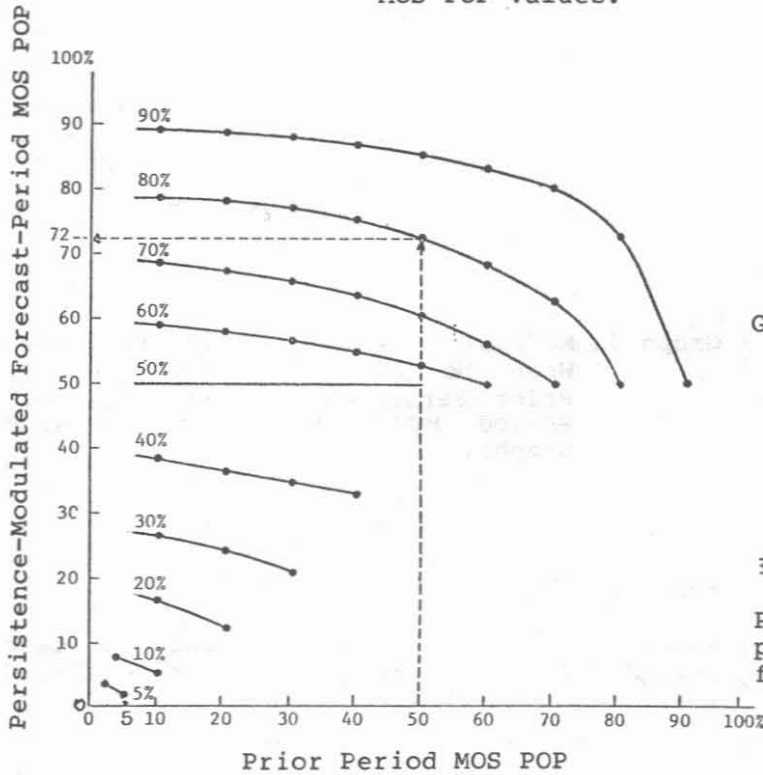
Examples:

A. Prior period MOS POP 40% and forecast period MOS POP 60%, persistence-modulated forecast period MOS POP is 67%.

B. Prior period MOS POP 10% and forecast period MOS POP 30%, persistence-modulated forecast period MOS POP is 50%.



Curve Values are Forecast-Period
MOS POP Values.



Graph 2. Modulated Forecast Period MOS PoPs When No Rain in Prior Period; Prior Period MOS PoP \leq Forecast Period MOS PoP (a NIPP Graph).

Example:

Prior period MOS POP 50% and forecast period MOS POP 80%, persistence-modulated forecast period MOS POP is 72%.

Graph 3. Modulated Forecast Period MOS PoPs When Rain in Prior Period; Prior Period MOS PoPs $>$ Forecast Period MOS PoP (a RIPP Graph).

Example:

Prior period MOS POP 80% and forecast period MOS POP 60%, persistence-modulated period MOS POP is 65%.

