MOS MINIMUM TEMPERATURE ERROR RELATIVE TO WIND SPEED

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ABSTRACT

The National Weather Service provides forecasts by a technique named Model Output Statistics (MOS). Maximum and minimum temperature forecasts out to 60 hours are produced by this system. Errors in the forecast temperatures have been investigated by others through incorporating parameters not used in the MOS equations, such as cloud cover and ground snow cover. This paper investigates the MOS minimum temperature forecast error on the basis of the guidance forecast of surface wind velocity. A very definite relationship was found with the sign of the error in agreement with that meteorologically expected.

PROCEDURE

It was decided to investigate the MOS minimum temperatures at Norfolk, VA since it is well known that because of marine influences wind direction has a major influence on minimum temperatures at that location. The influence of wind velocity is less well known, and in fact the importance of wind direction might cause one to overlook the influence of wind speed. If a minimum temperature forecast error based solely on wind speed could be detected at Norfolk, it would likely be detectable at any location regardless of wind direction. Data was grouped into warm and cool seasons and collected from November 1978 through October 1979.

The first minimum temperature forecast was verified using the 1200Z forecast cycle and the 7-Layer Primitive Equation model (7-Layer PE) as well as the Limited Fine Mesh II (LFM II) both of the NWS. (Editor's note: the 7-Layer PE model has been replaced by the Spectral Model.) The 7- Layer PE was used through March 29, 1979. The LFM II was used after March 29 because MOS probability of precipitation forecasts using this model were considered superior (based on a local unpublished study).

The first minimum temperature forecast is received about noon EST and is used as guidance for the late afternoon public forecast releases. It was decided not to use forecasts further in the future since there would be more cases of error in other forecast parameters which could hide any relationship. The message which contains both the MOS temperature forecasts and the wind forecast is named the FO12 bulletin. The amount of error was tabulated with positive numbers indicating a MOS forecast being too warm and a negative number indicating it was too cold.

The wind speed forecast is also a MOS product appearing with other FO12 forecast parameters. Wind speeds from the 7-Layer PE were used through May 1, 1979. The LFM II was used after May 1 when the FO12 bulletin based on the 7-Layer PE became unavailable. Wind velocities at 1200Z were used since most minimum temperatures occur in the early morning. The forecast winds were grouped into two knot intervals from 0 to 20 knots except the 0-2 knot range comprises a 3 knot interval.

Temperature data was taken from the WSFO DCA's public verification sheets. Wind data was taken from the aviation verification sheets. Out of a possible 365 cases, 296 were recorded. Missing data was primarily the result of MOS guidance not being received, and aviation forecasters not always recording low wind speeds on their verification sheets. (Wind speeds below eight knots are not verified). Most of the missing data falls into the low speed intervals.

Preliminary investigation of the data was through use of a scatter diagram. Data was arranged with wind speed intervals along the y coordinate and temperature error along the X coordinate. Wind forecasts and temperature errors were determined for a cool season, November 1, 1978 through April 30, 1979; and a warm season, May 1, 1979 through October 31, 1979.

Temperature error and wind forecasts were compiled for each day and average temperature errors computed for each wind speed forecast interval. See Figures 1 and 3.

Results of the cool season are shown on Figure 2. Figures 4 and 5 represent the warm season. Unexpectedly, an overall bias of minus (-) 0.74 degrees (F) was determined for the warm season. Results including the bias are shown on Figure 4. To make any tendency more easily apparent, the same graph with the bias removed is shown on Figure 5. A positive (+) 0.12 degree (F) bias was found during the cool season but was not considered significant enough for an additional graph. The number of cases for each wind speed interval appear at the top or bottom of each bar.

GENERAL COMMENTS

Figures 2, 4, and 5 show a definite tendency for the MOS first period temperature forecasts to be too warm with a forecast of light winds. For example, the cool season average temperature forecast within the wind speed range 3-4 knots is a fairly substantial 4.3 degrees too warm. The same tendency appears during the warm season though the error is less.

During the warm season, MOS minimum temperatures tend to be too cold with a forecast of high winds. See Figures 4 and 5. This tendency, however, is not strongly apparent during the cool season. For instance, the wind speed intervals 13-14 knots and 17-18 knots show MOS forecasting temperatures too cold by 1.58 degrees (F) and 4.80 degrees (F) respectively. The interval 15-16 knots, however, shows temperatures 2.67 too warm.

The more random distribution of average temperature error during the cool season and at high wind speeds probably results from the following:

1. The data sample for wind speed intervals above 13-14 knots is small.

2. Forecasts of high winds often precede, accompany, and follow strong fronts. The model's ability to correctly, or incorrectly forecast the speed of a particular front and its associated temperature advection adds randomness to the temperatures error. If the model forecasts a front too slow/fast, the corresponding minimum temperature forecast may be too warm/cold even though wind speed forecasts either side of the front remain high.

3. Assuming the speed of a front is correctly forecast, its effect on the average diurnal temperature variation may be dramatic. Warming may occur at night, cooling during the day. 12Z wind speeds are used for comparison because this time is closest to the average time of minimum temperature. Strong temperature advection may cause the actual minimum temperature to occur at times considerably distant from the 12Z wind forecast thus weakening the validity of the comparison.

CONCLUSION

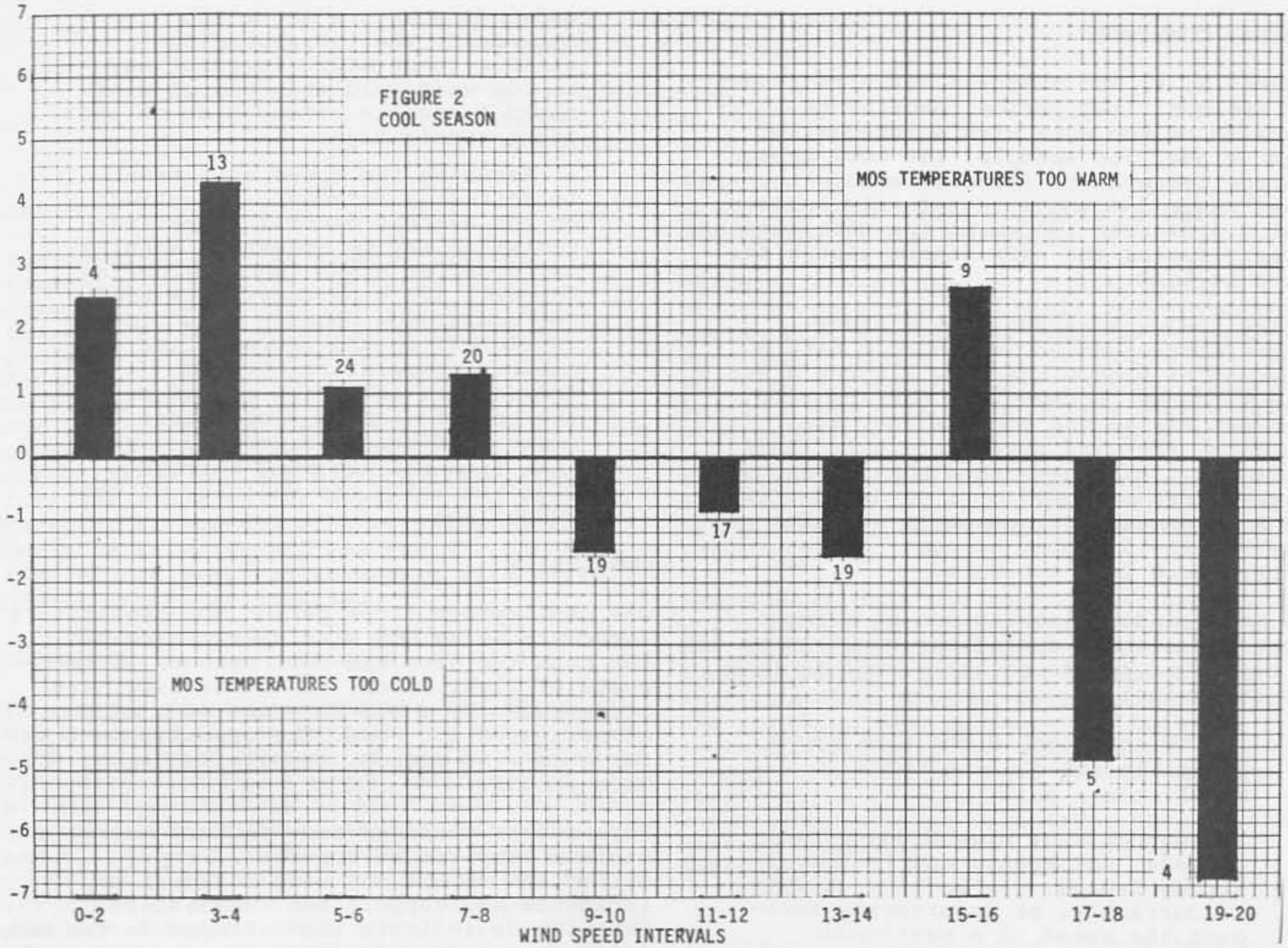
One can improve first period MOS temperature forecasts using MOS wind speed forecasts. For both the warm and cool seasons, forecasts of light winds, on the average, are accompanied by a MOS forecast of minimum temperatures too warm. The opposite is true for high wind speeds, especially during the warm season.

Forecasters consider many factors making a minimum temperature forecast. Proper evaluation of the MOS wind forecast may influence and support the forecasters thinking or indicate that changes in the MOS guidance are in order. Either way, MOS wind forecasts should receive important consideration.

COOL SEASON NOVEMBER 1 THROUGH APRIL 30

WIND SPEED(KTS)	(-)	SUM (-)	0's	(+)	SUM (+)	ADD SUMS	CASES	SUM / CASES
0-2	3,2	5	0	6,9	15	+10	4	+2.50
3-4	4,2	6	0	1,2,4,10,8, 27,10	62	+56	13	+4.31
5-6	11,8,7,4, 3,6,1	40	3	4,3,12,5,12, 7,10,13	66	+26	24	+1.08
7-8	9,7,8,2,1	27	2	1,6,3,12,6, 14,8	50	+23	20	+1.15
9-10	9,8,7,6, 15,8,2	56	1	4,6,4,6,8	28	-28	19	-1.47
11-12	10,7,5, 3,9	34	6	1,4,4,5,6	20	-14	17	- .82
13-14	14,9,8,5, 3,10,2	51	1	2,3,4,5,7	21	-30	19	-1.58
15-16	6,4	10	0	6,5,12,11	34	+24	9	+2.67
17-18	16,12,5	33	0	4,5	9	-24	5	-4.80
19-20	21,4,3	28	0	1	1	-27	4	-6.75
TOTAL BIAS	+ .119							

FIGURE 1



WARM SEASON MAY 1 THROUGH OCTOBER 31

SPEED(KTS	(-)	SUM (-)	O's	(+)	SUM (+)	ADD SUMS	CASES	SUM / CASES	ADD + .74
0-2	5,8,6,2	21	2	1,2,3, 10,7	23	+ 3	14	+ .21	+ .95
3-4	10,4,21, 10,5	50	5	2,6,6, 8,5,7,9	43	- 7	37	- .19	+ .55
5-6	18,20,8 9,12,8	75	2	4,6,4, 5,12,11	42	-33	37	- .89	- .15
7-8	10,12,10, 24,9,8,3	76	2	4,9,4, 15,6,11	49	-27	35	- .77	- .03
9-10	9,14,6, 2,6	37	2	3,4,12	19	-19	20	- .90	- .16
11-12	9,8,7,5, 4,6,1	40	2	3,4	7	-33	15	-2.20	-1.46
13-14	6,3,1	10		4	4	- 6	4	-1.50	- .76
TOTAL BIAS	-.74								

FIGURE 3

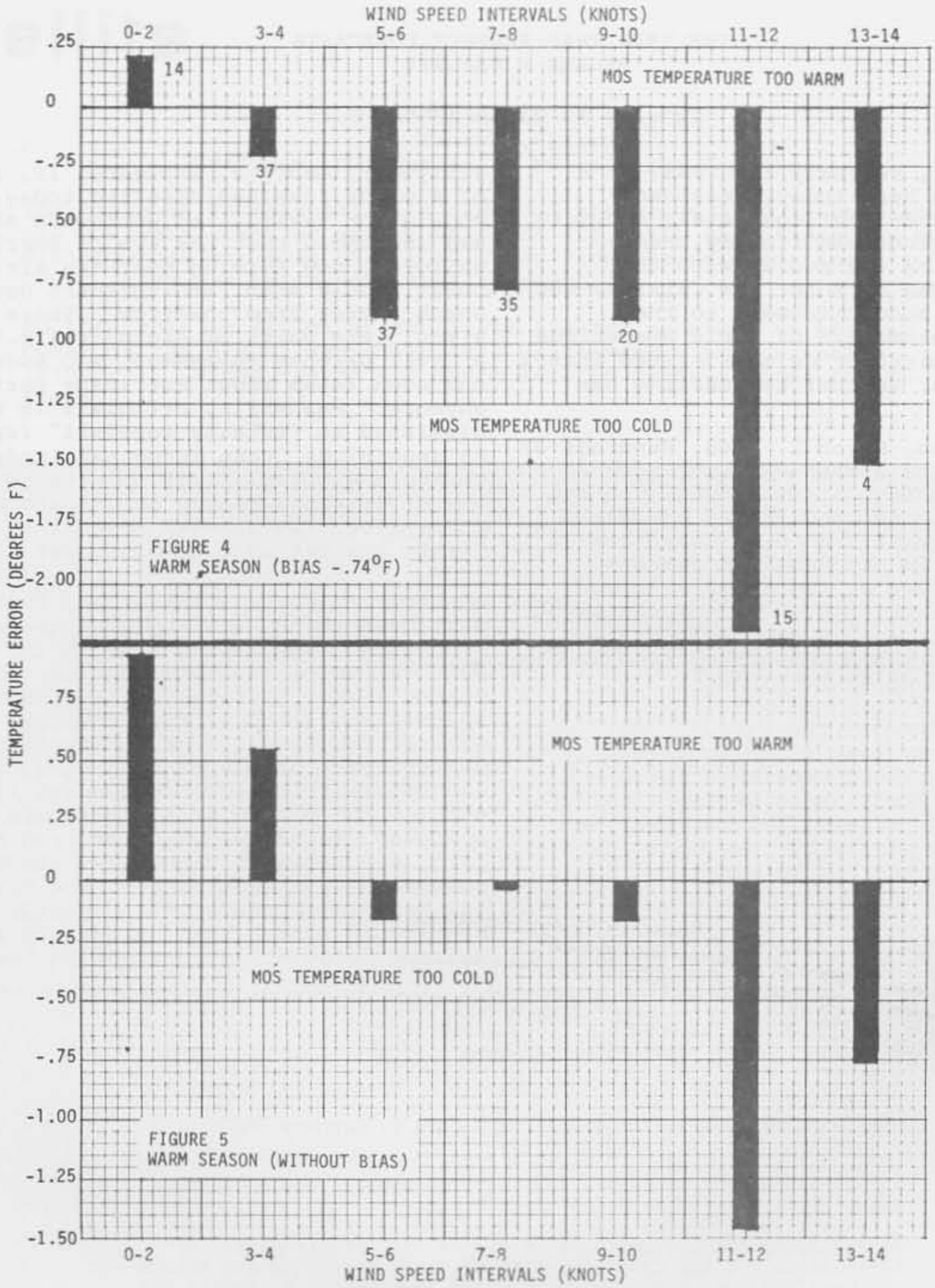


FIGURE 4
WARM SEASON (BIAS -.74°F)

FIGURE 5
WARM SEASON (WITHOUT BIAS)

NOTE FROM THE AUTHOR: The Spectral Model has recently replaced the 7-Layer PE, and is felt not to interfere with the purpose of this paper. The overall purpose is to bring to the attention of forecasters the possibilities of investigating relationships between several quantitatively derived variables, and that their relationships when investigated statistically may lead to improved forecasts. Whatever model is used, this overall idea remains the same.

FOOTNOTE

1. Clifford Crowley is a graduate of Florida State University and has been employed by the National Weather Service since 1969. He has a wide variety of Weather Service experience including assignments at WSO Cincinnati, Ohio; WSO Bridgeport, Conn.; WSFO Raleigh, NC; and is currently at WSFO Washington, DC.