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CREATING MOS EQUATIONS FOR RAWS STATIONS USING DIGITAL MODEL DATA

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DENNIS D. GETTMAN

I. INTRODUCTION

Model Output Statistics (MOS) forecasts of temperature, dew point, winds, clouds, and precipitation for major population centers throughout the United States have been available for many years now. These forecasts have been a valuable source of guidance to the public and aviation forecaster. MOS forecasts, however, offer little or no guidance to the fire weather meteorologist in the West. His/her task is to provide forecasts of temperature, dew point, winds, clouds, and precipitation, but the MOS guidance, in nearly every case, is for valley locations. The vast majority of the fire weather forecast domain is above the valley floors.

During the past 10 years, various land management agencies have purchased remote automated weather stations (RAWS) and sited them throughout the remote regions of the West. There are now approximately 50 of these sites within Medford, Oregon's fire weather district alone. With reliable weather observations from remote areas of Medford's district available "around the clock", development of forecast guidance became possible. It was our goal to produce forecasts of the RAWS observation parameters, (temperature, wind, dew point, and fuel moisture), at 3-hour intervals, just as it was available for valley sites in the LFM-MOS guidance (FPC) messages on AFOS.

Model digital guidance, RAWS and NWS surface observations, and upper-air observations for stations in or near Medford, Oregon's fire weather district were databased for a period of approximately two years. Although this was below TDL's standard of three years, it was thought that the data would provide a more reliable source of guidance than no guidance at all. The data were processed and equations produced. The equations were used to compute temperature, dew point, wind, and fuel moisture forecasts for 44 RAWS sites in the Medford district.

This paper will describe the methods used at WSO Medford to collect the data, process the data, and produce forecasts.

II. DATA COLLECTION

The goal of this project was to produce forecasts of temperature, wind, dew point, and fuel moisture at 3-hour intervals from 6 hours to 48 hours for every RAWS site in Medford, Oregon's fire weather district. Standard regression analysis would be used to correlate a body of observational data with a set of predictors. The predictors, at this stage of the project, were unknown. If "perfect prog" equations were to be produced, surface and upper-air data from surrounding stations would be required. If "MOS" equations were to be produced, digital model forecast data for stations surrounding the Medford district would be required.

Rather than limit the project to a certain set of predictors, we decided to collect all the data available and decide at a later date the type of equations we would produce. Thus, our minimum data requirements included:

1. 3-hourly observations from every RAWS site in Medford's district.

2. 3-hourly observations from NWS stations in central and southern Oregon and northern California.

3. Upper-air data (both mandatory and significant) from Salem, Oregon; Medford, Oregon; and Boise, Idaho.

4. 12-hour and 24-hour winds aloft (AFOS FD) forecasts for North Bend, Oregon; Redmond, Oregon; Lakeview, Oregon; and Montague, California.

5. 12-hour to 48-hour LFM model digital guidance (FRH) for Portland, Oregon; Medford, Oregon; and Boise, Idaho.

6. 12-hour to 48-hour NGM model digital guidance (FRHT) for Portland, Oregon; Medford, Oregon; and Boise, Idaho.

7. 6-hour to 48-hour LFM-MOS guidance (FPC) for Eugene, Oregon; North Bend, Oregon; Medford, Oregon; Redmond, Oregon; and Burns, Oregon.

With the data requirements for the project set, we turned our attention to the collection of the data. Collection procedures would have to be automated for the project to succeed. An office PC would have to be used as the collection device since RAWS data could not be obtained on AFOS. With this in mind, we wrote script files for the MIRROR PC communications software and used this in conjunction with the SCHD.EXE "autoscheduler" program. This allowed us to access the Forest Service AFFIRMS computer and download RAWS data, then access AFOS and download observational and model digital forecast data at set times during the day. The PC ran in "unattended" mode throughout the data collection process.

Once the data were collected, a certain amount of processing was required. A general purpose decoder (DECODER.EXE) was written to extract information collected from AFOS and AFFIRMS and store it in various disk files. DECODER.EXE was placed on the autoscheduler so that it would run as soon as the data were collected. Another program, ARCHIVE.EXE, was written to transfer data from the disk files to a diskette on a monthly basis.

III. DATA PROCESSING

During the period of data collection, a decision was reached to use the "MOS" approach to generate equations. The "MOS" approach consists of correlating observed weather conditions with numerical model data valid at that time. The underlying assumption with this approach was that the model data would exhibit consistent biases. Equations developed by correlating model data with observed data would take into account the model biases and thus be more accurate. Digital guidance from the NGM (AFOS FRHT messages) offered finer vertical resolution of temperature and humidity for its forecast points. Thus, predictor data were taken from the 12, 24, 36, and 48 hour output from this message for Medford, Oregon. In addition, winds aloft data from the AFOS FD messages for the FD station nearest the RAWS station were used for the 6-hour to 24-hour forecast period.

Once sufficient data were collected, they were assembled into a format that could be imported into a statistical program. Two programs were written for this purpose, GETDAT.EXE and MAKE1.EXE. GETDAT accessed the monthly RAWS observation data files and pulled out the predictand. For example, if we were working on predicting daytime temperatures (18Z to 03Z), GETDAT would pull the temperatures for this period out of the monthly RAWS files and assemble them into one temperature file per station. MAKE1 would pull the NGM model digital data verifying at 00Z out of FRHT files and the FD wind data verifying at 00Z out of the FD files. MAKE1 would then append these data to the files created by GETDAT. The resulting single data file for each RAWS station was ready to be imported into the statistical software package (SOLO).

The SOLO software required several "script files" to be written so that the imported data could be assembled into Julian date order and the warm and cold season data separated.

SOLO offered a wide range of options in performing statistical analyses. This allowed us to speed up the variable selection process. Potential predictors included:

1. The NGM model forecast for Medford precipitation, humidity (three levels), vertical velocity, lifted index, sea level pressure, boundary layer wind (vector components), thickness, and temperature (three levels).

2. The nearest FD station forecast of 3,000, 6,000, 9,000, 12,000, and 18,000 feet winds (vector components).

3. The observed value of the predictand yesterday.

Care was taken during the selection process so that no more than two related predictors were chosen. For example, of the four temperature variables, temperature at sigma levels 1, 3, and 5, and thickness, only two were allowed as predictors at any one time. This was done to reduce the possibility of collinearity among the predictors. Collinearity tends to make the resulting equations unstable. Medford's district was divided along the Cascades and a set of best predictors was assembled for each predictand and for each portion of Medford's district. For daytime temperatures (18Z to 03Z) west of the Cascades, the following set of predictors were assembled for the 6-hour to 24-hour forecast period:

1. Observed temperature yesterday.

2. Sea level pressure at Medford at 00Z.

3. Boundary layer wind at Medford at 00Z.

4. 1000-500 mb thickness at Medford at 00Z.

5. Temperature at sigma level 1 at Medford at 00Z.

6. 12,000 feet wind at the closest FD station at 00Z.

7. A weighted combination of boundary layer humidity and humidity at sigma levels 2-9 at Medford at 00Z.

Once these variables had been selected, robust multiple regression analysis was used to process the data. The regression coefficients output by SOLO were accessed by the program DBPARAMS.EXE, assembled into an equation and stored in an equation database file. A sample SOLO multiple regression report is shown in Figure 1. In this report, the regression coefficients of the 12-hour temperature forecast verifying at 00Z for Butte Falls are shown under the **Parameter Estimate** column. These coefficients are assembled into the prediction equation shown beneath the report.

In like manner, predictors for the other weather parameters were selected, regression analysis performed, and equations output. Through the use of

SOLO "script files" this process was almost fully automated.

SOLO "runs" produced equation outputs for one forecast parameter for one time period (either day or night) and one season (hot or cold). Twenty equations were produced per RAWS station bringing the total number of equations produced per run to 880. Each run used all of the programs mentioned above and took between 24 and 30 continuous hours of processing using a 20 MHZ 386 COMPAQ computer. Since only warm season equations were produced, a total of 10 runs were required to output equations for temperature, dew point, wind speed, wind direction, and fuel moisture. Fortunately, the process was almost completely automated. After a few hours of setup time, the process was started, and ran to completion without operator input.

IV. FORECAST PRODUCTION

With the equations databased, software was written to produce "MOS" forecasts for 44 RAWS stations in the Medford fire weather district. A MIRROR script was written to download the FD and FRHT digital guidance from AFOS to a PC. Previously databased RAWS observations were available at the PC to improve forecast skill during the first 24 hours of the forecast cycle. A program (MOS.EXE) was written to decode the digital guidance and RAWS data, access the equation database, and output forecasts. Figures 2 through 4 are examples of MOS.EXE output.

V. RESULTS

Verification of MOS.EXE output was performed for the period June 26, 1991 to September 6, 1991. Three approaches were taken for verification.

1. Effect on Station NFDRS Forecasts.

Since a forecast aid may be judged by the improvement its use brings to operational forecasting, I compared the results of this year's National Fire Danger Rating System (NFDRS) forecasts with the previous two years. The NFDRS forecast is a prediction of the value of various weather parameters at 1300 LST the next day. The forecast is issued at 1430 LST.

Four elements were examined: temperature, humidity, wind speed, and fuel moisture. It should be noted that during the verification period, the MOS.EXE output was considered in the NFDRS forecast about 50 percent of the time. The results are shown in Figure 5.

With the exception of zone 615 (the coastal zone), improvement was observed in the overall forecast. The district-wide statistics showed that in 1991, the lowest average error for each of the forecast elements occurred. The greatest improvement over persistence for each element occurred in 1991 and thus the skill score for the 1991 season was the highest.

Clearly, the 1991 season NFDRS forecasts were superior to those of 1989 and 1990. It could be argued that the use of MOS.EXE output played a part in the improvement.

2. Comparison of Actual Forecasts (FCST) with MOS.EXE Forecasts (RMOS).

A second set of statistics were generated comparing the NFDRS forecasts issued by Medford with the forecasts derived from the MOS.EXE output. Comparisons of three elements, temperature, humidity, and wind speed were performed. Fuel moisture comparison could not be made because MOS.EXE predicts the experimental 10-hour fuel moisture. The NFDRS uses actual 10-hour fuel stick measurements for the most part. The results are shown in Figure 6. FCST statistics differ slightly from those shown in Figure 5 because statistics were generated only for those dates when both FCST and RMOS data were available.

The statistics show that actual forecasts (FCST) of temperatures were superior to MOS.EXE (RMOS) forecasts. The opposite was true for humidity and wind. The overall skill score, if all three parameters are combined, would favor the MOS.EXE output.

3. Comparison of FPC Output and MOS.EXE Output.

The first two verification schemes tested the validity of the MOS.EXE 24-hour forecasts for 1300 LST. In this last scheme, verification of 3 hourly temperature and dew-point forecasts was performed and compared to the 3 hourly LFM-MOS guidance (FPC) temperature and dew point predictions. Since MOS.EXE does not generate forecasts for any FPC stations, a MOS.EXE station in the same climate zone as an FPC station was selected. The verification statistics for both stations were then compared. It was assumed that MOS.EXE forecasts approaching the skill of FPC forecasts would be acceptable. The results are shown in Figure 7.

The FPC predictions for Medford were very good and were superior, in most cases, to the MOS.EXE predictions for Butte Falls. The FPC forecasts for Eugene, however, were rather poor and easily beaten by the MOS.EXE output for Elkton. East of the Cascades, FPC output for Redmond was compared with the MOS.EXE output for Gerber Reservoir. In most cases, the MOS.EXE forecasts were better.

In general, the results of the verification justify further investment of time into refining the equations for the current RAWS stations and generating equations for additional RAWS sites.

VI. FUTURE PLANS

1. We are continuing to database digital guidance and RAWS observational data as in the past. This winter we expect to re-run the equations using a larger database. This should improve forecast skill.

2. New RAWS sites have come on line since the start of this project. We expect to generate equations for these new sites this winter.

3. Only warm season equations have been developed. We hope this winter to add cold season equations as well.

4. With a larger database and with lightning strike data we have received from ERL, we hope to develop probability of precipitation and lightning activity level forecasts. First-guess forecasts of these parameters would further improve the service we provide our users.

5. An OS/2 program was written this summer to decode AFOS graphics into grid point data. This program has been installed on MicroSWIS. Daily, it decodes the full suite of NGM and AVN contoured graphics, 178 graphics in all, with no noticeable degradation of satellite display capability. These data will be archived and used to generate improved MOS equations in 1993.

VII. ACKNOWLEDGEMENTS

I would like to thank Western Region Headquarters for purchasing the statistical software used in this project. The "SOLO" analysis tools allowed us to identify quickly the best predictors for a particular item. Its "script" language allowed us to automate processing. Without these two things, the regression analysis for the 44 RAWS stations would have taken several months, instead of a couple of weeks.

Sample Output From "SOLO" Regression Analysis

-- Multiple Regression --

Date/Time 03-10-1991 06:58:25
Data Base Name E:/solo\warmbbs (Warm Season Temperature Data for Butte Falls)
Description Subset of bbs2 created 03-10-1991

Multiple Regression Report

Robust Weights--Iteration No. 2
Dependent Variable: 00Z-TEMP

Independent Variable	Parameter Estimate	Stndized Estimate	Standard Error	t-value (b=0)	Prob. Level	Seq. R-Sqr	Simple R-Sqr
Intercept	6.667884	0.0000	2.828181	2.36	0.0201		
00Z-YTMP	.1337995	0.1416	.2379E-01	5.62	0.0000	0.7241	0.7241
P12-SLP	.1526011	0.0409	.5770E-01	2.64	0.0093	0.7362	0.0114
P12-UWND	-.4347643	-0.1370	.6429E-01	-6.76	0.0000	0.7734	0.1323
P12-VWND	.1595E-01	0.0089	.3773E-01	0.42	0.6733	0.7739	0.0356
P12-THK	.599137	0.454	.8129E-01	7.37	0.0000	0.9448	0.9317
P12-TMP1	.402186	0.2949	.8796E-01	4.57	0.0000	0.9601	0.9202
P12-120U	.8241E-01	0.0657	.2402E-01	3.43	0.0008	0.9616	0.0939
P12-120V	-.567E-01	-0.0612	.2171E-01	-2.61	0.0101	0.9619	0.0181
P12-R1R2	-.2153669	-0.2224	.2014E-01	-10.69	0.0000	0.9807	0.4770

Regression Equation Developed From the Report

TEMP = 6.67 + 0.134 * YTMP + 0.153 * SLP - 0.435 * UWND + 0.016 * VWND +
0.599 * THK + 0.402 * TMP1 + 0.082 * 120U - 0.057 * 120V - 0.215 * R1R2

Analysis of Variance Report

Robust Weights--Iteration No. 2
Dependent Variable: 00Z-TEMP

Source	df	Sums of Squares (Sequential)	Mean Square	F-RatioProb	Level
Constant	1	549293.6	549293.6		
Model	9	14461.32	1606.814	660.94	0.000
Error	117	284.4384	2.431097		
Total	126	14745.76	117.0299		

Root Mean Square Error	1.559198
Mean of Dependent Variable	76.48814
Coefficient of Variation	2.038483E-02
R Squared	0.9807
Adjusted R Squared	0.9792

Figure 1.

MOS.EXE Single Station Forecast Product

MOS output for OnionMtn 09/18/0000Z

Category	18 06Z	18 09Z	18 12Z	18 15Z	18 18Z	18 21Z	19 00Z	19 03Z	19 06Z	19 09Z	19 12Z	19 15Z	19 18Z	19 21Z	20 00Z	20 03Z
Temp	69	71	71	77	81	88	92	80	65	66	67	72	80	87	90	78
Max/Min	69						92				64				90	
Dew point	41	23	28	36	39	39	35	36	43	32	35	42	46	45	38	43
Humidity	36	16	20	23	22	18	13	21	45	28	30	34	30	23	16	29
Max/Min			42				8				50				13	
Wind Dir	6	85	110	103	92	23	347	343	348	39	96	102	73	324	294	315
Wind Spd	3	5	6	8	7	4	5	10	8	5	3	7	4	2	6	9
Max			12				15				11				12	
10hr FM	4	3	4	3	4	4	3	2	7	8	8	7	6	4	3	2
Max/Min			4				2				8				2	

Figure 2.
MOS.EXE Zone Forecast Product

MOS output for Zone 617 09/18/0000Z

Category	18 06Z	18 09Z	18 12Z	18 15Z	18 18Z	18 21Z	19 00Z	19 03Z	19 06Z	19 09Z	19 12Z	19 15Z	19 18Z	19 21Z	20 00Z	20 03Z
Temp	68	66	63	67	83	94	95	85	68	64	61	65	80	90	91	83
24hr Chg									-5	to	2		-7	to	-1	
Dew point	44	43	41	41	43	36	39	39	46	46	45	48	49	48	48	49
Humidity	44	45	47	39	24	15	16	21	49	56	59	56	35	25	25	32
24hr Chg									-4	to	23		5	to	14	
Wind Spd	2	2	2	1	2	4	5	3	1	1	1	0	2	5	5	4
24hr Chg											-1			0		
10hr FM	10	12	13	15	11	7	4	4	10	13	15	16	14	9	6	5
24hr Chg										2				2		

NFDRS 19/21Z Temp -4 Hum 10 Wind 1 10hr FM 2

Figure 3.

MOS.EXE Zone Collective Product

Mos Zone Collective 09/18/0000Z

Zone 615		Temperature			Humidity		
Station		Vrfy	12/24hr	36/48hr	Vrfy	12/24hr	36/48hr
	Powers	47/ 97	51/ 93	53/ 86	100/ 24	100/ 26	100/ 37

Zone 616		Temperature			Humidity		
Station		Vrfy	12/24hr	36/48hr	Vrfy	12/24hr	36/48hr
	Burnt	66/ 94	66/ 92	61/ 85	53/ 27	78/ 27	86/ 43
	Elkton	60/ 96	63/100	60/ 94	74/ 25	95/ 25	99/ 35
	HawleyButte	69/ 92	72/ 94	66/ 90	42/ 22	49/ 22	61/ 33
	SilverButte	67/ 92	72/ 92	66/ 90	37/ 18	57/ 15	59/ 21
	MtYoncalla	61/ 93	66/ 95	63/ 88	78/ 27	76/ 23	80/ 35

Zone 617		Temperature			Humidity		
Station		Vrfy	12/24hr	36/48hr	Vrfy	12/24hr	36/48hr
	Buckeye	51/ 98	57/100	58/ 97	62/ 5	75/ 5	76/ 10
	Grandad	57/ 97	62/101	61/ 96	60/ 13	60/ 13	61/ 16
	SugarLoaf	66/ 92	67/ 90	64/ 87	41/ 22	62/ 20	68/ 33
	TaftBench	66/ 95	68/ 96	64/ 91	45/ 20	59/ 20	61/ 31
	Toketee	54/ 95	51/ 95	50/ 94	55/ 10	100/ 11	100/ 26

Zone 619		Temperature			Humidity		
Station		Vrfy	12/24hr	36/48hr	Vrfy	12/24hr	36/48hr
	BaldKnob	68/ 83	73/ 86	65/ 81	36/ 13	38/ 21	58/ 35
	LawsonCr	61/103	63/ 98	60/ 95	53/ 20	73/ 14	76/ 24
	QuailPr	68/ 87	68/ 90	64/ 86	40/ 21	37/ 20	61/ 31
	WheelerCr	61/ 94	61/ 94	57/ 88	60/ 27	97/ 18	100/ 32

Zone 620		Temperature			Humidity		
Station		Vrfy	12/24hr	36/48hr	Vrfy	12/24hr	36/48hr
	Agness	48/ 99	53/ 99	56/ 94	100/ 19	100/ 12	100/ 23
	Indigo	70/ 92	74/ 92	70/ 88	35/ 19	42/ 16	29/ 12
	OnionMtn	68/ 88	69/ 92	64/ 90	35/ 16	42/ 13	50/ 13
	Provolt	43/ 97	45/ 97	49/ 95	93/ 19	100/ 18	93/ 26

Zone 621		Temperature			Humidity		
Station		Vrfy	12/24hr	36/48hr	Vrfy	12/24hr	36/48hr
	BuckPk	60/ 88	61/ 89	61/ 90	33/ 13	44/ 10	50/ 16
	CrazyPk	61/ 92	64/ 95	62/ 92	37/ 20	44/ 13	54/ 20
	SquawPk	71/ 84	71/ 86	68/ 86	24/ 13	31/ 12	44/ 19

Zone 622		Temperature			Humidity		
Station		Vrfy	12/24hr	36/48hr	Vrfy	12/24hr	36/48hr
	BigButte	44/ 94	48/ 98	52/ 96	82/ 15	100/ 12	100/ 19
	IllinoisVly	40/102	49/106	53/104	100/ 7	100/ 7	100/ 9
	StarRs	54/101	59/104	62/102	52/ 11	60/ 10	76/ 9

Figure 4.

Summary of NFDRS Forecasts 1989-1991

Zone #		**1989**				**1990**				**1991**			
		Tmp	Hum	Wnd	10FM	Tmp	Hum	Wnd	10FM	Tmp	Hum	Wnd	10FM
615	avg error	3.70	9.30	1.59	3.09	3.98	10.40	1.19	2.75	5.08	10.17	1.39	2.62
	persistence	4.78	10.80	1.42	4.36	5.13	10.94	1.13	4.05	5.92	11.03	1.05	3.37
	% improve	22.6	13.9	-12.0	29.1	22.4	4.9	-5.3	32.1	14.2	7.8	-32.4	22.2
617	avg error	4.87	11.49	1.77	3.79	4.33	9.69	1.17	4.23	2.99	8.48	1.14	2.40
	persistence	5.88	12.29	1.79	4.60	6.42	12.71	.84	4.83	4.77	10.97	1.06	3.04
	% improve	17.2	6.5	1.1	17.6	32.6	23.8	-39.3	12.4	37.3	22.7	-7.5	21.1
619	avg error	4.02	10.65	2.03	2.88	3.79	8.81	1.39	2.47	3.05	7.95	2.03	2.03
	persistence	5.68	11.95	1.89	3.53	4.31	8.27	1.16	2.24	5.37	1.86	1.77	1.73
	% improve	29.2	10.9	-7.4	18.4	12.1	-6.5	-19.8	-10.3	43.2	33.0	-14.8	-17.3
620	avg error	3.05	9.51	1.82	2.23	3.79	8.34	2.43	2.43	2.68	7.00	2.00	1.60
	persistence	4.57	10.57	1.98	2.55	4.94	9.49	2.57	2.57	5.22	9.62	2.44	2.61
	% improve	33.2	15.2	8.1	8.6	23.3	12.1	6.1	6.1	48.6	27.2	22.0	38.7
621	avg error	2.92	8.94	1.47	1.95	3.73	7.36	1.28	2.66	2.92	7.84	1.18	2.03
	persistence	5.28	10.69	1.17	2.63	5.59	10.36	1.25	3.33	4.74	9.99	1.39	2.54
	% improve	44.7	16.4	-25.6	25.9	33.3	29.0	-2.4	20.1	38.4	21.5	15.1	20.1
622	avg error	2.83	9.62	1.33	3.10	4.22	9.59	1.55	2.98	2.51	7.66	1.36	2.23
	persistence	5.74	10.28	1.13	3.08	6.02	13.10	1.35	3.63	4.93	10.22	1.37	2.65
	% improve	50.7	6.4	-17.7	-.6	29.9	26.8	-14.8	17.9	49.1	25.0	.7	15.8
623	avg error	2.94	7.19	1.15	1.81	4.34	8.91	1.25	2.39	2.79	6.89	.84	2.05
	persistence	4.82	9.94	1.16	2.63	5.24	10.29	1.27	2.81	4.60	9.04	.79	2.72
	% improve	39.0	27.7	.8	31.1	17.2	13.4	1.6	14.9	39.3	23.4	-6.3	24.6
624	avg error	2.82	6.35		1.80	3.43	7.17		1.81	2.97	6.15		1.70
	persistence	4.10	7.25		2.05	4.18	8.09		2.02	4.21	7.10		2.06
	% improve	31.2	12.4		12.2	17.9	11.4		10.4	29.5	13.4		17.5

District-Wide Average 1989-1991

	1989 Tmp	Hum	Wnd	10FM	1990 Tmp	Hum	Wnd	10FM	1991 Tmp	Hum	Wnd	10FM
avg error	3.40	9.13	1.59	2.58	3.96	8.78	1.47	2.72	3.12	7.77	1.42	2.08
persistence	5.11	10.52	1.51	3.18	5.23	10.41	1.37	3.19	4.97	9.98	1.40	2.59
% improve	33.5	13.2	-5.3	18.9	24.3	15.7	-7.3	14.7	37.2	22.1	-1.4	19.7

Skill Score - (Sum of improvements to persistence)

1989	1990	1991
60.3	47.4	77.6

Figure 5.

Comparison of Actual Forecasts to MOS.EXE Forecasts

Zone 615		Zone 617		Zone 619	
FCST Temp Error	5.04	FCST Temp Error	2.80	FCST Temp Error	3.19
RMOS Temp Error	5.33	RMOS Temp Error	3.67	RMOS Temp Error	3.39
Persistence	6.31	Persistence	5.53	Persistence	5.25
FCST Humidity Error	10.65	FCST Humidity Error	8.69	FCST Humidity Error	8.04
RMOS Humidity Error	8.76	RMOS Humidity Error	7.29	RMOS Humidity Error	6.52
Persistence	11.11	Persistence	11.36	Persistence	10.94
FCST Wind Spd Error	1.35	FCST Wind Spd Error	1.20	FCST Wind Spd Error	2.22
RMOS Wind Spd Error	.85	RMOS Wind Spd Error	.88	RMOS Wind Spd Error	1.60
Persistence	1.06	Persistence	1.06	Persistence	1.59

Zone 620		Zone 621		Zone 622	
FCST Temp Error	3.08	FCST Temp Error	3.19	FCST Temp Error	2.67
RMOS Temp Error	3.35	RMOS Temp Error	3.45	RMOS Temp Error	2.99
Persistence	5.00	Persistence	4.80	Persistence	4.56
FCST Humidity Error	7.44	FCST Humidity Error	7.68	FCST Humidity Error	6.76
RMOS Humidity Error	6.50	RMOS Humidity Error	7.91	RMOS Humidity Error	7.32
Persistence	9.24	Persistence	9.45	Persistence	9.84
FCST Wind Spd Error	2.31	FCST Wind Spd Error	1.44	FCST Wind Spd Error	1.50
RMOS Wind Spd Error	2.24	RMOS Wind Spd Error	1.54	RMOS Wind Spd Error	1.45
Persistence	1.88	Persistence	1.37	Persistence	1.45

Zone 623		Zone 624	
FCST Temp Error	2.83	FCST Temp Error	2.88
RMOS Temp Error	3.34	RMOS Temp Error	2.78
Persistence	5.13	Persistence	4.05
FCST Humidity Error	6.78	FCST Humidity Error	5.41
RMOS Humidity Error	7.26	RMOS Humidity Error	5.17
Persistence	11.14	Persistence	6.52
FCST Wind Spd Error	.88	FCST Wind Spd Error	1.95
RMOS Wind Spd Error	1.02	RMOS Wind Spd Error	1.55
Persistence	1.12	Persistence	1.54

District-Wide Averages

Temperature		Humidity		Wind Speed	
FCST	3.21	FCST	7.68	FCST	1.61
RMOS	3.53	RMOS	7.09	RMOS	1.39
Pers	5.08	Pers	9.95	Pers	1.38

Figure 6.

Comparison of FPC Forecasts and MOS.EXE Forecast for Stations in Similar Climate Zones

FPC Station - Medford		MOS.EXE Station - Butte Falls	
12HR Temp Error	2.35	12HR Temp Error	2.76
12HR Dewpt Error	2.88	12HR Dewpt Error	3.14
24HR Temp Error	2.40	24HR Temp Error	2.95
24HR Dewpt Error	3.41	24HR Dewpt Error	2.44
36HR Temp Error	2.34	36HR Temp Error	3.04
36HR Dewpt Error	2.94	36HR Dewpt Error	3.25
48HR Temp Error	2.45	48HR Temp Error	3.23
48HR Dewpt Error	3.54	48HR Dewpt Error	3.17

FPC Station - Eugene		MOS.EXE Station - Elkton	
12HR Temp Error	6.32	12HR Temp Error	3.42
12HR Dewpt Error	5.39	12HR Dewpt Error	3.02
24HR Temp Error	4.02	24HR Temp Error	2.93
24HR Dewpt Error	6.29	24HR Dewpt Error	2.31
36HR Temp Error	5.99	36HR Temp Error	4.19
36HR Dewpt Error	5.22	36HR Dewpt Error	3.27
48HR Temp Error	4.22	48HR Temp Error	3.56
48HR Dewpt Error	6.53	48HR Dewpt Error	2.54

FPC Station - Redmond		MOS.EXE Station - Gerber	
12HR Temp Error	3.54	12HR Temp Error	3.58
12HR Dewpt Error	7.53	12HR Dewpt Error	4.04
24HR Temp Error	5.64	24HR Temp Error	3.05
24HR Dewpt Error	7.64	24HR Dewpt Error	4.98
36HR Temp Error	3.67	36HR Temp Error	4.45
36HR Dewpt Error	7.33	36HR Dewpt Error	4.04
48HR Temp Error	5.81	48HR Temp Error	4.13
48HR Dewpt Error	7.44	48HR Dewpt Error	4.74

Figure 7.

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