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ACCURACY OF ETA COOL SEASON PRECIPITATION FORECASTS AT SALT LAKE CITY AND CEDAR CITY, UTAH

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Introduction

If meteorological guidance is to be useful to the operational forecaster, information about its accuracy for a forecast area is required. With continued improvements in modeling techniques and computational resources, one might expect corresponding improvements in the latest guidance products. The Eta model is the latest numerical guidance from the National Meteorological Center to become operational. Verification of precipitation forecasts from the Eta model has been performed over various domains and seasons (Black 1994; Mesinger et al. 1988; Dunn and Horel 1994). The Technical Attachment (TA) examines the accuracy of Eta model precipitation forecasts for the cool season at two stations in Utah.

The quantitative precipitation forecast (QPF) of the Eta was examined during the 1993-1994 winter months. The purpose of this research is to determine: 1) the quantitative precipitation bias of the Eta for Salt Lake City (SLC) in northwest Utah and Cedar City (CDC) in southwest Utah during the cool season, and 2) the accuracy of the Eta's forecasts of measurable precipitation at both stations. This TA is similar to an evaluation of the LFM (Carle 1986) and the NGM (Carle and Brady 1988). Comparisons are made among the results of the LFM study, the NGM study, and this Eta study.

Methodology and Results

Six months of Eta QPF forecasts (from AFOS product FRH73) were examined for both SLC and CDC during the period October 1, 1993 through March 31, 1994, comprised of nearly 5800 model forecasts.

The bias is examined first by comparing the amount of precipitation forecast for each 6-hour period with the observed precipitation for the corresponding period. Table 1 presents the results.

The results are similar for both SLC and CDC. The model predicts less precipitation than is observed in the early periods, and more precipitation than is observed in the later periods. The first 6-hour period is the driest of all the 6-hour periods, forecasting 47% and 60% of the amount that actually occurred for SLC and CDC, respectively. The Eta bias transitions from

dry to wet near 24 hours, and in the final 24 hours the Eta forecasts considerably more precipitation than is observed. The Eta had an overall wet bias, with 113% and 108% of the observed precipitation forecasts at SLC and CDC, respectively.

No examination of the model bias was done for the other operational models for the 1993-1994 cool season, but similar studies of the NGM and LFM, performed for previous cool seasons, have been conducted (Carle 1986; Carle and Brady 1988). The NGM showed an overall dry bias of 78% and 91% at SLC and CDC. The LFM had a significant wet bias with 151% and 175% of observed precipitation forecast at SLC and CDC.

The staff of NWSFO SLC felt, subjectively, the Eta was wetter than the NGM during the period of this study. Not surprisingly, the NGM MOS recognizes the dry bias of the NGM. In one case (from the 0000 UTC, 30 September 1994 model run), the NGM POP was 100% for SLC but the forecast precipitation for the two 6-hour periods comprising the same period of the POP was zero. Eight hundredths of an inch occurred during that 12-hour forecast period.

The accuracy of forecasts for measurable precipitation was examined next. By considering the model forecast of $\geq$0.01" in a 6-hour period, $\geq$0.01" occurred in that 6-hour period. Table 2 illustrates the results.

The number of correct forecasts generally declines with time. The greater than 70% correct forecasts in the first 6-hour period at both sites is quite impressive, although this period is nearly past by the time the data are received. The number of precipitation events forecast by the Eta increases rather markedly with time, particularly at SLC. By 42-48 hours, the Eta forecast more than 3 times as many precipitation events than were observed at SLC and more than twice as many as observed at CDC.

The overall success rate for the Eta was 43% and 50% for SLC and CDC, respectively. This compares favorably to the NGM and LFM from the aforementioned studies. The NGM success rate was 27% and 30% for SLC and CDC, while the LFM success rate was 34% and 27% for the two sites. Of course, these were for different years, and a direct comparison with the Eta for 1993-1994 was not done. The Eta's poorer performance at SLC compared to CDC might be due to the somewhat more complex topography of the Wasatch Front. Salt Lake City is surrounded by mountains on all sides except the northwest, and in that direction the Great Salt Lake provides a mesoscale source of heat and moisture. This complexity is not captured by the 80 km horizontal resolution of the model.

Finally, an examination of the amount of precipitation forecast by the Eta when precipitation was observed was done. At SLC, the model underforecast the amount of precipitation 64% of the time and overforecast the amount 31% of the time. At CDC, observed precipitation was underforecast 73% of the time and overforecast 24% of the time.

Discussion and Summary

The Eta model had an overall wet bias at SLC and CDC in that it forecasted more precipitation than was observed. In breaking down the bias by forecast period, the model actually has a dry bias in the first 24 hours, and then a strong wet bias in the 24-48 hour

period. Most of the bias was due to the prediction of too many measurable events, rather than the prediction of too much precipitation. In fact, when only events of observed precipitation were considered, the model generally underforecast the amount. It would appear the Eta model predicts too many light precipitation events in later periods. The model also predicted more events than were observed in the 0-24 hour period, but the overall total precipitation predicted during this period was less than observed. The Eta model may have a problem with spin-up of precipitation in the early periods at SLC and CDC. However, the problem is less than those found for the NGM and LFM in the aforementioned studies.

Although a direct comparison of the Eta precipitation forecasts with the NGM was not done for the 1993-1994 cool-season, comparison of these results with similar work done in past years suggests to the forecaster at NWSFO SLC that the Eta's overall ability to forecast measurable precipitation is much improved over the older NGM and LFM FRH products, especially at CDC.

This overall improvement of the Eta over the earlier NGM and LFM is encouraging since the Eta FRH73 is the latest NMC FRH guidance product. It appears to support the idea that NMC guidance products continue to improve, and the operational forecaster may place more confidence in this guidance. With the advent of the mesoscale version of the Eta, further improvement can be logically expected. The mesoscale version has a horizontal resolution of 29-km compared to 80-km for the current Eta. This higher spatial resolution should result in a better representation of Utah's mountains which are a major forcing mechanism for both SLC and CDC precipitation.

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Table 1

Amount of Precipitation Forecast by FOUS73 Divided by the Amount of Precipitation that Occurred (%)									
Fcst Period	00-06	06 12	12-18	18-24	24-30	30-36	36-42	42-48	**MEAN**
SLC	47	96	90	95	124	156	137	156	**113**
CDC	60	83	83	117	121	164	104	133	**108**

Table 2

Number of Actual Precipitation Cases Divided by the Number of Precipitation Forecasts (QPF) FOUS Data				
Forecast Period	**SLC**		**CDC**	
	Actual/Fcst	% Correct	Actual/Fcst	% Correct
00-06	21/27	75	17/24	71
06-12	22/57	39	21/35	60
12-18	23/47	49	16/32	50
18-24	25/61	41	18/38	47
24-30	25/57	44	14/40	35
30-36	25/79	32	19/44	43
36-42	25/77	32	21/43	49
42-48	27/97	28	20/47	43
MEAN	-----	**43**	-----	**50**