7.4 AN INTEGRATED FORECASTING SYSTEM FOR OZONE PREDICTIONS IN TENNESSEE

Qi Mao* and Stephen F. Mueller
Tennessee Valley Authority, Muscle Shoals, Alabama

1. OVERVIEW

The Tennessee Valley Authority developed an integrated ozone forecasting system prior to the 2001 ozone season. It was built upon the NCEP Regional Spectral Model (RSM), two multivariate regression models, and a real-time ozone monitoring network. The RSM was run in-house once a day to provide 48-hour weather forecasts over the southeast U. S. There were two regression models, one applicable to the whole spectrum of observed ozone values and termed “Model-L”, and the other applicable only to ozone concentrations greater than 75 ppb, denoted as “Model-H”. These models were derived from two years of historical ozone records and RSM outputs for middle Tennessee (the Nashville metropolitan area) and east Tennessee/Southwest Virginia (near the Tri-Cities area of Johnson City-Kingsport-Bristol). The maximum 8-hour average ozone concentrations from sixteen monitoring sites of the two areas were used in the development of the regression models and the operation of the forecasts. This integrated system was operated by a TVA ozone forecasting team in conjunction with the state air pollution department of Tennessee during the 2001 ozone season. Forecasts of ozone for tomorrow at either site included a primary forecast (PF) issued by 14:45 CDT and an updated forecast (UF) by 9:00 CDT the next morning. This paper presents results of the 2001 ozone forecasts for middle and east Tennessee, with the focus on forecast evaluations and areas for future improvements.

2. RESULTS

The 2001 ozone forecasts began May 1 for Nashville/Middle TN and May 25 for Tri Cities/East TN. Both ended on September 30. Excluding days of missing forecasts due to various causes, there were total of 145 and 123 effective forecast days for Nashville and Tri-Cities, respectively. Forecast evaluations are focused on qualitative and quantitative aspects. A conditional predictability is computed to characterize models and forecasters skills and identify areas where future improvements may be needed.

* *Corresponding author address*: Dr. Qi Mao, TVA, P.O. Box 1010, Muscle Shoals, AL 35662-1010; e-mail: qmao@tva.gov.

Table 1. Ozone public advisory categories

	Green (G)	Yellow (Y)	Orange (O)	Red (R)
Ozone ppb	0 - 64	65 - 84	85 - 104	105 - 124

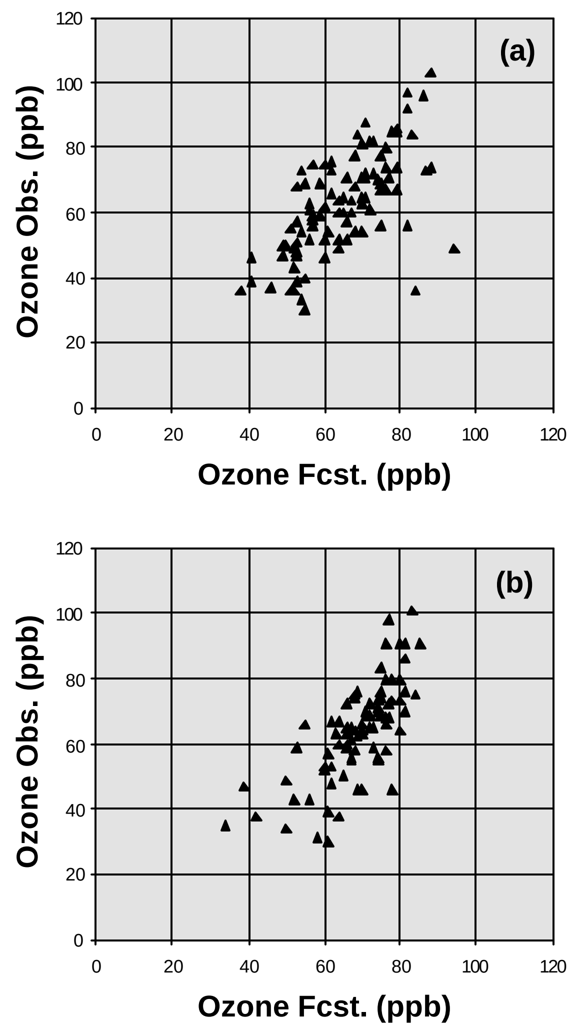

Fig 1. PF vs. Obs. for BNA (a) and TRI (b).

2.1 *Qualitative Evaluation*

Table 1 shows part of the ozone public advisory categories and their corresponding 8-hour values. Color O was the highest category recorded for both areas. In general, ozone was under-predicted for Orange and over-predicted for Green in both areas (Fig.1).

2.2 *Quantitative Evaluation*

Figure 2 shows mean biases (a) and absolute errors (b) for PF and UF. Although BNA has relatively smaller bias compared with TRI, the mean absolute error are similar, with slight difference in UF between the two areas.

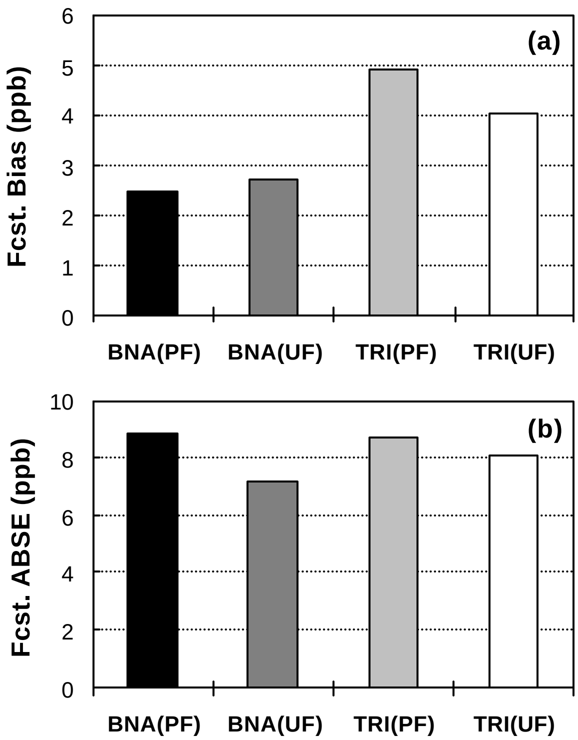

Fig. 2 Forecast error statistics for PF and UF.

2.3 *Conditional Predictability*

Because a forecaster was allowed, by choosing either Model-L or Model-H, to make a forecast, forecast performance depended on both the forecasters and the models. A conditional predictability index (CPI) is computed to identify areas where improvements on forecaster's skill and/or model capabilities are needed.

The CPI is defined similar to conditional probability but measured in percentage as follows:

$$CPI = CPI\left\{Index = S, P, M \,\middle|\, Obs. = G, Y, O\right\}$$

Where indices *S, P* and *M* are defined as

S: At least one model hit the right category and a forecaster made the right call (no improvement is needed);
P: At least one model hit the right category but a forecaster did not make the right call (forecaster's skill needs to be improved);
M: Both models did not hit the right category thus a forecaster did not make the right call (models need to be improved).

Table 2a

	G	Y	O	all
S	73.7	68.3	22.2	68.3
P	2.6	30.0	55.6	17.2
M	23.7	1.7	22.2	14.5

Table 2b

	G	Y	O	all
S	47.0	90.0	14.3	62.6
P	1.5	10.0	14.3	5.7
M	51.5	0.0	71.4	31.7

Results of CPI are shown in Table 2a (BNA) and Table 2b (TRI). For BNA, both the models and forecasters performed well in Green and Yellow. The skill of the forecasters needs to be improved especially in Orange. For TRI, both the models and forecasters did much better in predicting Yellow. Further improvement of models is necessary for making better predictions of ozone for the lower and higher concentrations.

3. CONCLUDING REMARKS

Results of BNA and TRI ozone forecasts over the period of May through September 2001 indicate that a dynamic/statistical forecast approach blended with a forecaster's synoptical analysis and interpretation of model output produced good forecasts for ozone concentrations in the Green and Yellow for the BNA and Yellow for the TRI areas. The forecast error statistics were not significantly different from similar approaches used elsewhere (Cobourn and Hubbard, 1999), which suggests the limit of the linear regression models and the accuracy of RSM being able to predict important weather elements that affect near surface ozone formation. Improvements on the models and forecasters are needed, especially for higher ozone episodes when forecasts matter the most. Strategies for forecast improvements are currently investigated.

4. REFERENCE

Cobourn, W.G., and M.C. Hubbard, 1999: An enhanced ozone forecasting model using air mass trajectory analysis. Atmos. Environ., **33**, 4663-4674.