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CLEARING INDEX VERIFICATION STUDY

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Introduction

A verification study of gridded forecasts of air quality parameters from the Forecast Systems Laboratory's Graphical Forecast Editor (GFE) has been completed. The study compared GFE surface weather grids and actual parameters calculated from soundings at Salt Lake City (SLC), UT and Grand Junction (GJT), CO. GFE grids of mixing height (depth of the well mixed boundary layer), transport wind (average wind in the mixed layer) and the Clearing Index (index of stability and transport) were evaluated. Eta forecasts for 18Z and 00Z valid times were examined and compared with the 00Z sounding. GFE surface temperature (T) fields and maximum temperature (MaxT) fields were utilized in calculating the mixing height. The calculations using MaxT proved superior to calculations using T grids.

Results

Salt Lake City

	MIXING HEIGHT (feet agl)		TRANSPORT WIND (knots)		CLEARING INDEX		TOTAL COUNT (independent forecasts)
	18Z	00Z	18Z	00Z	18Z	00Z	
MAE	836	765	4.1	5	138	120	204
BIAS	15	-293	3.9	4.6	47	23	204
COUNT	102	102	same count		same count		

Table 1

Grand Junction

	MIXING HEIGHT (feet agl)		TRANSPORT WIND (knots)		CLEARING INDEX		TOTAL COUNT (independent forecasts)
	18Z	00Z	18Z	00Z	18Z	00Z	
MAE	999	1335	6.3	7.5	160	166	203
BIAS	-259	-657	5.5	6.7	58	31	203
COUNT	101	102	same count		same count		

Table 2

Discussion

All results above were derived from grids calculated using maximum temperature (MaxT) and the following procedure. GFE grids (10 km resolution) were initialized using the 80 km (AWIPS grid 211) Eta model grids. Forecasts for 18Z and 00Z were examined at various lead times from F06 to F60. The GFE forecasts for mixing height, transport wind and Clearing Index were compared with actual values calculated using observed maximum temperatures and upper air observations. No adjustment was made for precipitation. Mean absolute error (MAE) and mean error (BIAS) were calculated using standard equations (Meier and Barker 1993).

A mixing height "smart tool" was used to generate the mixing height grids. The smart tool utilized Eta D2D grids with 50 millibar vertical resolution. At each GFE grid point the tool searches upwards in the GFE sounding for the point were potential temperature is equal to, or greater than, the surface potential temperature. That level minus terrain height was assigned as the mixing height (above ground level). Transport wind was determined by the GFE initialization routines (Wier 1999). Clearing Index was then calculated with another tool where:

Clearing Index = (Mixing Height (agl in feet) /100) X transport wind (knots)

Grids were then saved to the official database and text data was generated for each element at SLC and GJT for each forecast time.

The dataset was gathered in a very stable time of the year (late October to early December 2000) when valley inversions are common and mixed layer depth and Clearing Index are typically low. GFE forecasts and upper-air observations were available for 38 days at SLC during the data collection period. Average observed mixing height was 1578 feet. Average transport wind was 7 knots and average Clearing Index was 187. For GJT, averages were 2518 feet, 6.6 knots and Clearing Index of 196 on 36 separate days. In general, a Clearing Index below 500 is poor ventilation, 500-1000 is moderate and 1000+ is excellent ventilation and mixing. Clearing Index is arbitrarily considered 1000+ when measurable precipitation is observed due to the cleansing effect of precipitation on an airmass.

During the data collection period the observed Clearing Index (not counting precipitation) at SLC was above 1000 on 3 days. GFE forecasts were available for two of these events. On the first one (Nov 2 - observed CI 1033) GFE Clearing Index forecasts ranged from 527 to 768. So, the gridded forecasts indicated the change to moderate, or better mixing with room for improvement. For the second case (Dec 11 - observed CI 1598) GFE forecasts ranged from 206 to 1000. Only 2 of 8 forecasts indicated a CI above 500. This error is attributed to large errors in Eta mid-level temperatures which resulted in an inaccurate lapse rates. The weather regime was characterized by rapidly moving short waves, and the Eta model was having a hard time with the specific timing and magnitude of the short waves. This case featured precipitation and the forecaster would have adjusted the grids to indicate a high CI (CI >1000) due to the likelihood of measurable precipitation on December 11, despite the GFE grids indicating continuing stagnant conditions.

Conclusions

Both temperature and maximum temperature GFE surface weather grids were examined with MaxT yielding the best results (presented above). The results are encouraging with a small bias. Mixed depth errors averaged around 1000 feet and Clearing Index average errors only around 100. Transport wind exhibited a relatively large positive bias. This had a pronounced effect on the Clearing Index forecasts for GJT (table 2). Mixing height forecasts at GJT exhibited a negative bias, yet Clearing Index forecasts had a positive bias. This was due to the influence of the larger than observed transport winds in the GFE grids. A new GFE software release (December 2000) allows a better calculation of transport wind using wind fields imported from the AWIPS D2D grids. With the latest GFE tools transport winds are generally lower and the distribution has more mesoscale variation than transport wind calculated with the old GFE initialization procedures. Transport wind errors presented above will likely decrease in the future due to these improvements. Further improvements are likely when the MesoEta AWIPS grids are brought into the GFE system. The MesoEta grids provide 40 km base horizontal grid resolution which are then used to initialize 10 km resolution GFE grids. The MesoEta grids provide 25 millibar vertical resolution. This higher resolution data will likely result in more accurate mixing height and transport wind values, which will improve the Clearing Index forecasts.

During the fall of 2000, the GFE gridded forecast of mixing height, transport wind and Clearing Index were very good as indicated by the results presented above. This study will need to be repeated with the MesoEta grids and during a less stable time of the year to further evaluate the gridded approach to air quality and smoke management forecasts. However, the results suggest we should move ahead with new air quality and smoke management products and services using the GFE.

References

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