13A.2 UTILIZING SHORT RANGE ENSEMBLE POINT FORECAST SOUNDINGS FOR SEVERE WEATHER FORECASTING

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1. INTRODUCTION

The NOAA Storm Prediction Center (SPC) utilizes point forecast sounding data from a number of deterministic numerical weather prediction models as part of it's suite of data used in convective weather forecasting (Bright et. al 2006). In the past few years, the SPC has also started to use short-range ensemble (SREF) and medium-range ensemble forecast (MREF) data, but currently does not use point forecast soundings (PFCs) from ensemble forecasts. To the knowledge of the authors, current literature does not contain any articles concerning the display of ensemble PFCs, and the purpose of this paper and research is to discuss SPC's early and recent attempts at creating an approach to using these data in an operational environment for severe storms forecasting, focusing on SREF output. This topic is a rich area of possible research and exploration and our very initial attempts at using ensemble PFCs are described below.

2. DISPLAY DESIGN AND PHILOSOPHY

Attempting to display sounding information from ensemble PFCs is challenging because of the large amount of useful data that needs to be viewed and condensed into a format that is easily digested in a forecast environment. Considering that one of the main purposes of ensemble forecasts is to present a range of possible atmospheric scenarios given a set of initial conditions and perturbations, a display system that shows the variability in the member solutions is ideal. While there are certainly many possible applications of ensemble data (some known, some perhaps unknown), one of the more prominent methods is to quickly determine possible outliers in the forecast atmospheric state, or, simply, strong deviations from the mean (statistically the "best" forecast). This is important because if a portion of forecasts from the ensemble show a strong deviation from the mean, it could suggest the possibility of a different forecast solution.

As a simple, beginning approach, we decided to attempt to translate current SREF display methodologies to SREF PFC sounding displays. Some of the questions we are attempting to answer include: 1) will an ensemble mean sounding be useful, 2) do individual postage stamp plots of soundings, displayed side-by-side, provide a comprehensive display that is easy to see differences between soundings, 3) will a spaghetti diagram of all soundings displayed on top of each other show the range of possible atmospheric states, and, 4) is it possible to create a display that shows the essential elements of the range of ensemble data on a single image, easily used in a forecast environment?

Additionally, for this first attempt of a SREF sounding display, we do not consider hodographs or special methods to display the variability in the vertical wind profile.

3. EXAMPLE IMAGES FROM "SUPER TUESDAY"

Three primary display methods were tested using ensemble PFC data from the 03 UTC 5 February 2008 SREF run. The "Super Tuesday" tornado outbreak occurred on this day, with 57 deaths and 87 tornadoes. The example graphics shown in Figures 1, 2, and 3 were taken from a forecast valid at 00 UTC 6 February 2008 at Memphis, Tennessee, which is a location that was close to several violent tornadoes that occurred on that day and around that time.

The first display method we consider is that of traditional "spaghetti" diagrams, where all soundings are overlaid on top of each other. While this method shows some potential for showing the variability in the ensemble, it quickly becomes cluttered and at first look appears marginally useful, especially near the surface where the temperature and dewpoint profiles overlap.

For the second display, we create a "postage stamp" view of each of the 21 members of the SREF, along with a table of the mean most unstable CAPE (MUCAPE) and the MUCAPE of each member. This display is potentially more useful than the spaghetti diagram, though the size of each sounding does make it difficult to discern individual variability, and details of important structures such as PBL depth and capping inversions.

The third and final display image, and initially considered the most useful to date, shows the mean sounding of the vertical thermodynamic and wind profiles, along with horizontal boxes every 10 millibars that show the maximum and minimum value from any sounding (light green and light red) and the value of one standard deviation of all values at that level (dark green and dark red). Additionally, the upper right corner shows 2-d scatterplots of MUCAPE vs 0-6km shear and MUCAPE vs 0-3km helicity, with the values of those from each sounding plotted as a point against a background of conditional probabilities of severe weather reports from a localized SPC database (Dean et al 2008).

4. CONCLUSIONS

Creating displays of SREF point forecast soundings is a new area of research and potential

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application at the SPC. Displays using traditional ensemble methods show some promise at discerning the differences between soundings, but the highest quality display (Figure 3) begins to take into account statistical data such as the standard deviation of each vertical level and 2-d plots of sounding values to show potential clustering and outliers. This very initial approach to SREF sounding analysis should be considered to be in a strong testing phase and new display ideas, and well as statistical analysis methods, will be explored in the future.

5. REFERENCES

Bright, D.R., and R.H. Grumm, 2006: Application of Climate Statistics and Ensemble Forecasts in the Prediction of Severe Weather Episodes. Preprints, 23nd Conf. Severe Local Storms, St. Louis MO, CD-ROM.

Dean, Andrew R., and R. S. Schneider, 2008: Forecast challenges at the NWS Storm Prediction Center relating to the frequency of favorable severe storm environments. Preprints, 24th Conference on Severe Local Storms, 27-31 October, Amer. Meteor. Soc., Savannah, Georgia, CD-ROM.

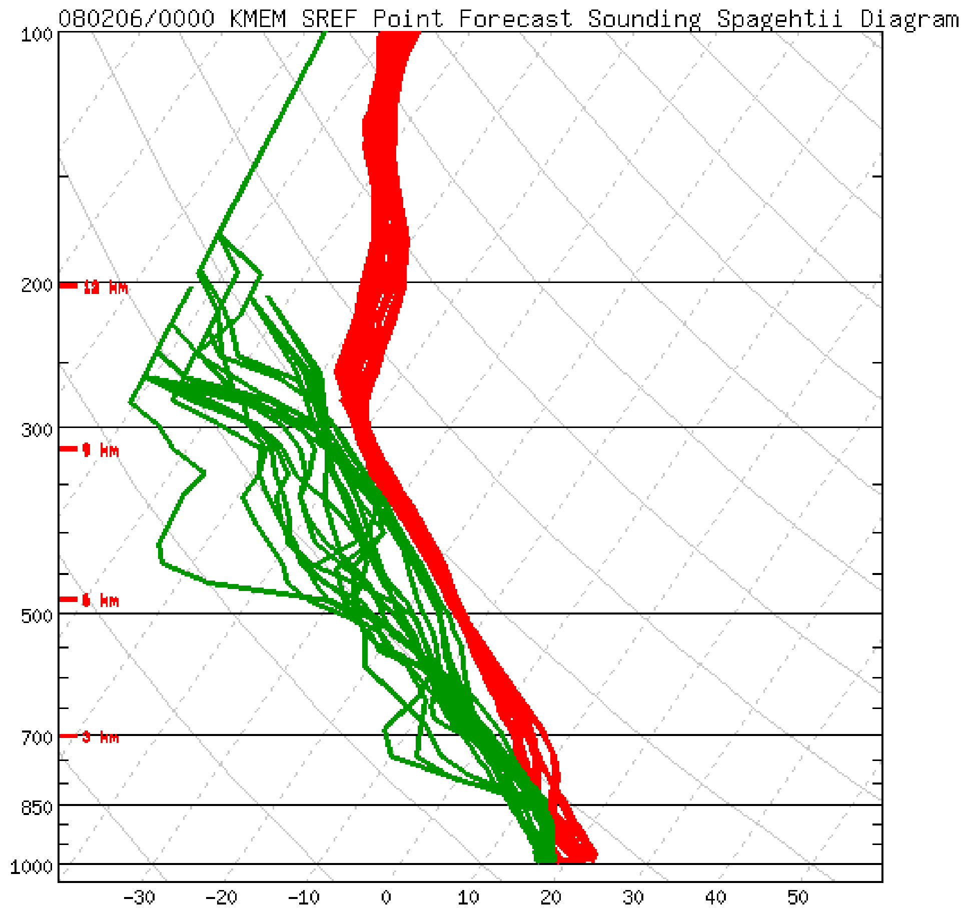


Figure 1. “Spaghetti” diagram of SREF point forecast soundings overlaid together. Red (green) lines denote temperature (dewpoint) profiles.

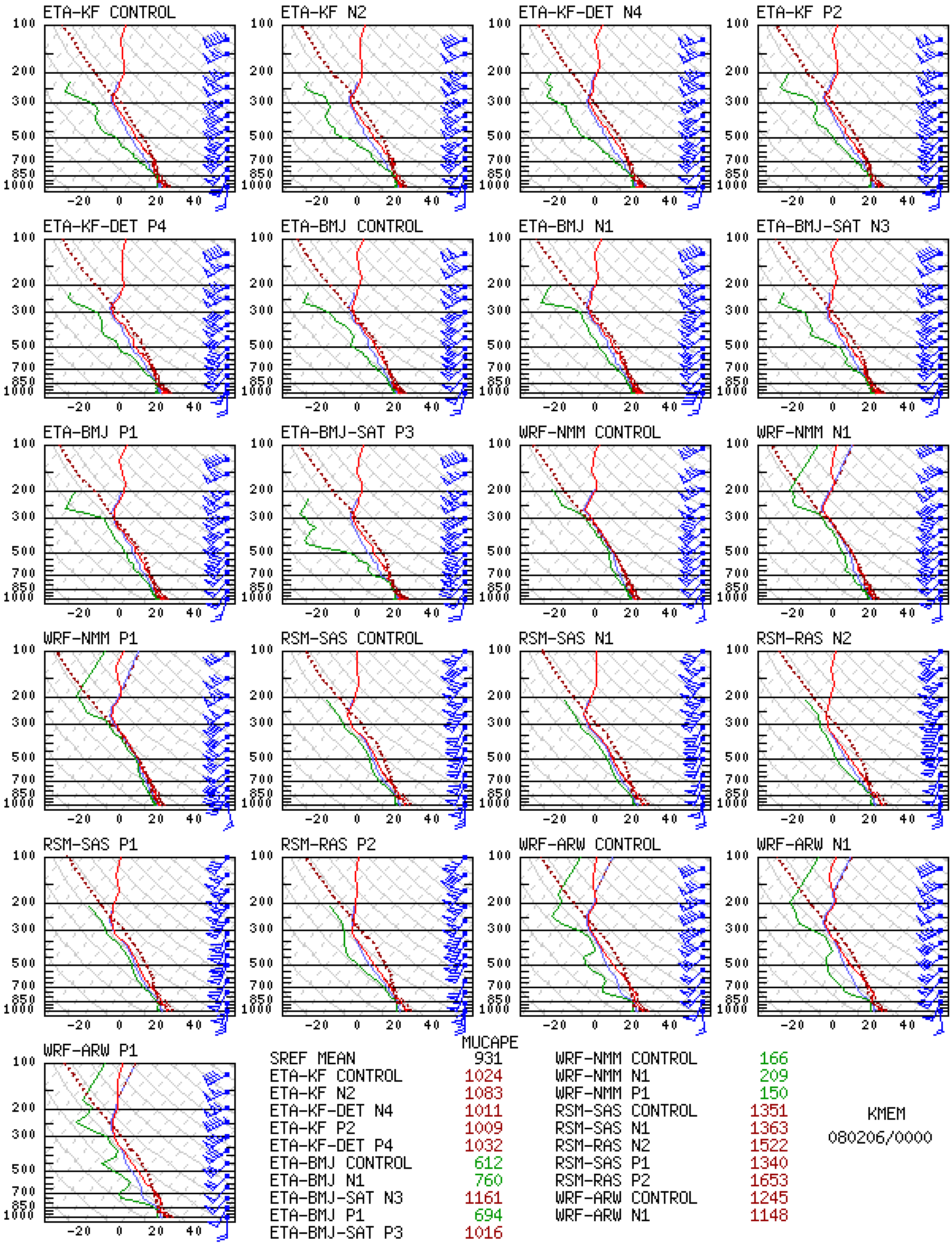
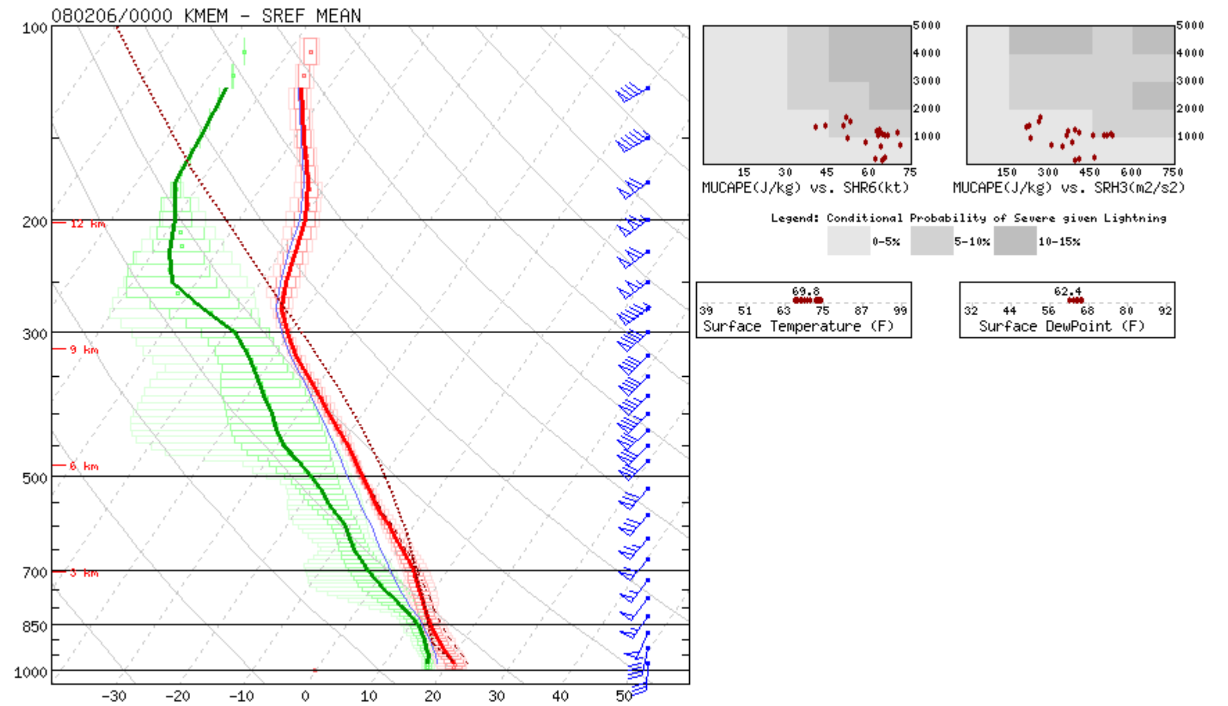


Figure 2. “Postage stamp” diagram of each SREF point forecast sounding displayed side-by-side.



	MUCAPE (J/KG)	75LR (C/KM)	100MMR (G/KG)	500T (C)	PWAT (In)
SREF MEAN	931	6.7	11.6	-12.8	1.31
ETA-KF CONTROL	1024	7.6	12.6	-13.9	1.39
ETA-KF N2	1083	7.6	12.8	-13.9	1.39
ETA-KF-DET N4	1011	7.1	12.3	-13.1	1.36
ETA-KF P2	1009	7.5	12.3	-13.9	1.44
ETA-KF-DET P4	1032	7.3	12.3	-13.9	1.40
ETA-BMJ CONTROL	612	6.4	11.6	-13.1	1.28
ETA-BMJ N1	760	6.3	11.9	-12.9	1.34
ETA-BMJ-SAT N3	1161	6.8	12.6	-13.5	1.40
ETA-BMJ P1	694	6.4	11.6	-13.3	1.31
ETA-BMJ-SAT P3	1016	6.9	12.4	-13.9	1.35
WRF-NMM CONTROL	166	6.5	11.2	-13.4	1.35
WRF-NMM N1	209	6.2	11.1	-13.0	1.27
WRF-NMM P1	150	6.6	11.1	-13.5	1.41
RSM-SAS CONTROL	1351	6.9	12.5	-13.1	1.50
RSM-SAS N1	1363	7.0	12.3	-13.4	1.46
RSM-RAS N2	1522	7.4	12.7	-14.0	1.49
RSM-SAS P1	1340	6.9	12.6	-13.1	1.53
RSM-RAS P2	1653	7.4	13.0	-13.7	1.54
WRF-ARW CONTROL	1245	7.6	12.5	-13.0	1.19
WRF-ARW N1	1148	7.7	12.3	-13.1	1.19

Figure 3. Composite diagram of mean SREF sounding and a table of thermodynamic statistics, 2-d graphs of each ensemble member (represented as a point) displayed over SPC climatological information, and 1-d graphs of each ensemble member (also represented as a point) of surface temperature and dewpoint.