JP1.7 ENHANCEMENTS TO A NEW CONVECTIVE SOUNDING ANALYSIS PROGRAM FOR AWIPS

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1. Introduction

Mesoscale analysis is an important component of forecasting and warning-decision making. Prior to the development of severe weather, mesoscale analysis (e.g., sounding and model forecast analysis, etc.) can be used to anticipate convective initiation, convective mode, and a range of possible scenarios for which the forecaster can be prepared. During severe weather, mesoscale analysis (e.g., surface and objective analysis, etc.) can be used to refine expectations. This paper focuses on improving operational sounding analysis as one important component of mesoscale analysis.

While there are many challenges to effectively apply mesoscale analysis to forecasting and warning operations, there are also challenges in obtaining mesoscale analysis information in the operational Advanced Weather Interactive Processing System (AWIPS) environment employed by the National Weather Service (NWS). For example, many of the forecast parameters available in AWIPS are not documented in terms of their calculation technique, and in addition, many new forecast parameters [e.g., 0–3-km convective available potential energy (CAPE) and 0–1-km storm-relative helicity (SRH)] are unavailable or are difficult to obtain with the current tools.

To address some of these issues, Bunkers (2002) developed a sounding analysis program that uses operational AWIPS grids to calculate and display numerous forecasting and warning parameters. Some of the notable components of this program include: utilizing the virtual temperate correction for instability calculations, storm motion parameters calculated using the Internal Dynamics (ID) method (Bunkers et al 2000), variable parcel lifting methods, inclusion of climatological parameters, and some relatively recent forecast parameters such as 0–3-km CAPE and 0–1-km SRH. In this AWIPS local application, the model choice and grid points are fixed in a configuration file to always calculate values for pre-defined locations for specific models. This paper will focus on an addition to the program to make the model and point selection easier with a graphical interface.

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2. AWIPS Sounding and Bunkers' Version Sounding Program

The AWIPS has the ability to display both skewT-logP diagrams and hodographs for any point in the model domain. In AWIPS, the sounding option works through the Volume Browser interface and the Interactive Points Tool to generate a skew-T chart for a specific data source and location. Within the Display in 2 Dimensions (D2D) AWIPS display interface, the user drags a point on a map to the desired location to generate the sounding. The AWIPS sounding shows the entire vertical profile from the AWIPS grids, which are a subset of the native grids.

Bunkers (2002) developed several scripts and a C program which calculated all of the desired convective parameters and output the data as a text product for viewing on the AWIPS machine running this local application. For a specific model (e.g., the RUC2 or MesoEta), a script is needed to describe the model forecast hour increment and specify the selected grid point. The horizontal grid point is chosen by manually determining the closest model grid point to the desired location. The model lower level used to define the lowest vertical grid point above the surface is determined by choosing the closest model pressure level above an estimated station pressure. The application is run to extract the data and calculate a suite of forecast parameters.

3. Newly Developed Graphical User Interface (GUI) and Software Description

In order to minimize the user's operations at a basic level and enhance the Bunkers sounding program being used with various models, the Bunkers (2002) code was modified to include a tcl/tk graphical user interface (GUI) for model sounding analysis (see Fig. 1). The code was also modified to extract all model related information from netCDF files and the AWIPS system to reduce model specific configuration on the user end. With the new version, there is no required knowledge of the data structure to request model calculations. This program is designed for both real-time operational forecasting and archived case research. For real-time use with AWIPS, the program utilizes the FXA_DATA variable in the environment to look for grid data. When using the program for case research, the FXA_DATA variable needs to be set to the case location to look for the grid data. The main steps involved with running the program are: setting the case location (FXA_DATA variable),

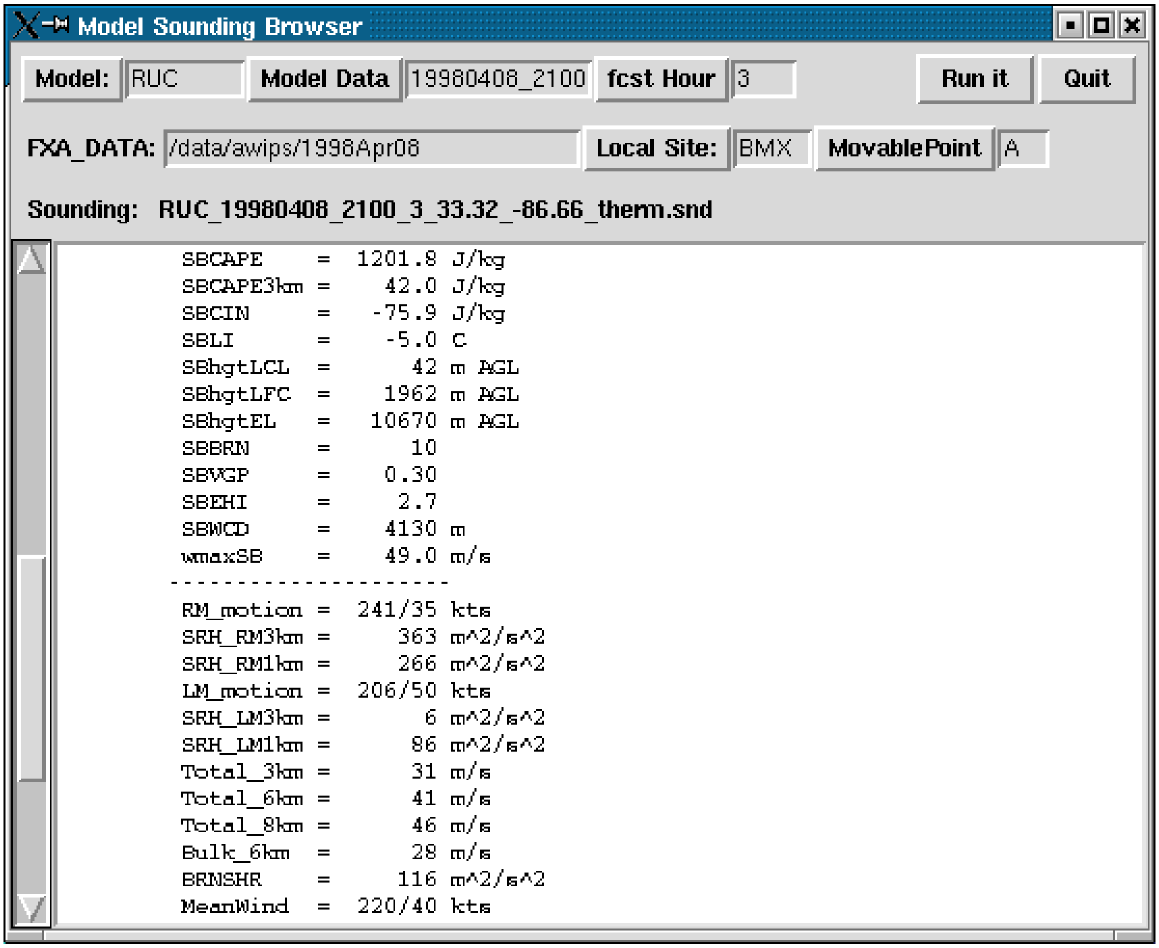

Fig. 1. Model Sounding Browser interface.

extracting the model information, extracting the model data, and calculating the parameters.

3.1 *Extracting Model Information*

To generate a model sounding, all model-related information is extracted from model netCDF files and AWIPS configuration files. As with the AWIPS soundings, the AWIPS Interactive Points Tool is utilized to select the desired point from the AWIPS graphical interface. The extracted model information includes: available model data source and forecast hours, available county warning areas (CWAs), topography, the model layers and vertical resolution, etc.

A utility called ncRead (developed by Carl Dierking from NWS Juneau, AK) is used to extract variable data from netCDF files. To use ncRead requires knowledge of the data format and structure such as the variable names defined in the file, grid location (I and j values), and starting and ending edges. To determine the nearest gridpoint (i, j) to the latitude and longitude of the selected point, a geographic information file is created. These steps will be described in more detail with the following introduction to the menu buttons in the GUI.

a. Model

The Model pull-down menu, shown in Fig. 2, contains a predefined model list, e.g., Eta, MesoEta and RUC, etc. Users can choose a model from this list, and if it exists, it will be used to calculate the parameter suite. The model list can be modified by changing the file, model.txt. However, whenever adding a new model into the list, modifications in the tcl/tk and C programs might be needed.

b. *Model Data*

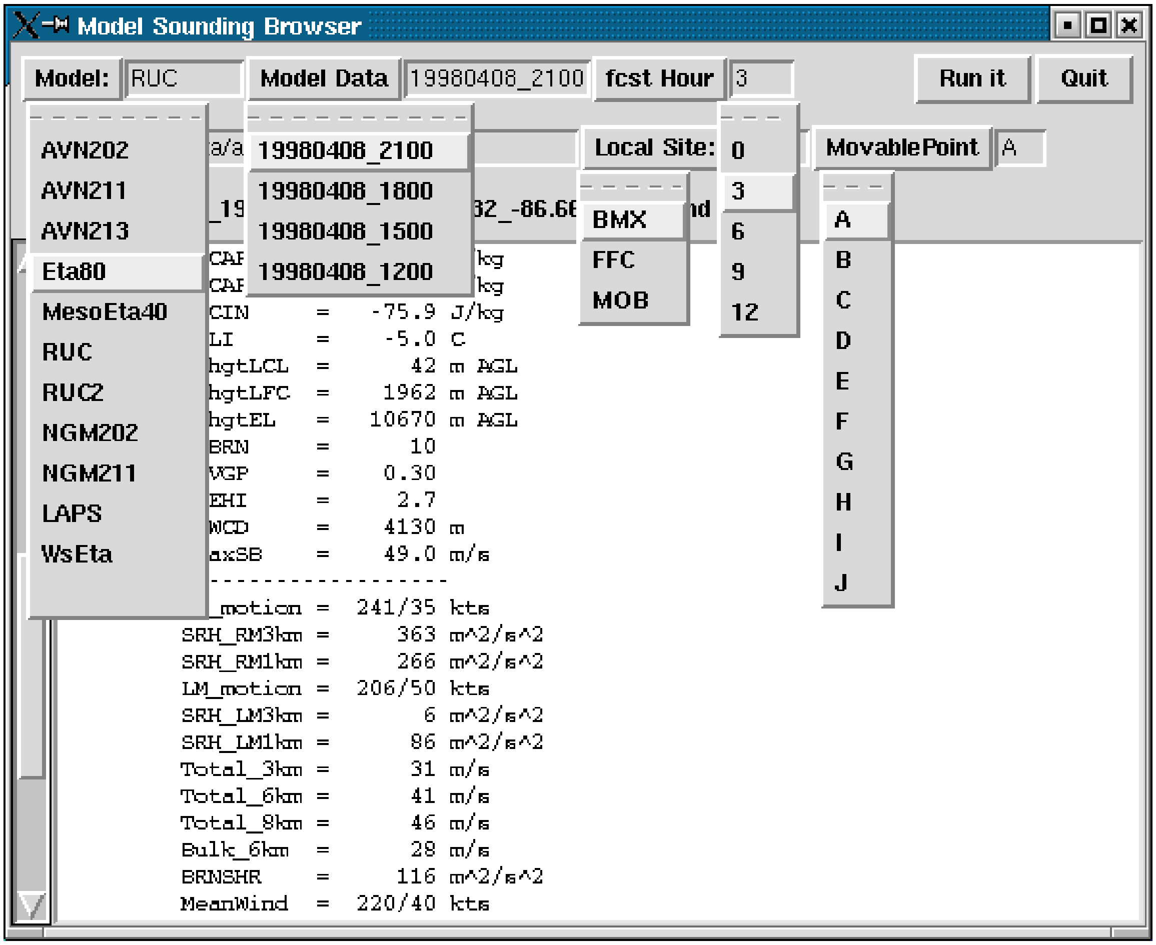

Fig. 2. The pull-down menus used to select the model sounding.

When clicking the Model Data menu button (Fig. 2) for a selected model, the software will automatically check and list the available model data sources which are stored in the FXA_DATA tree. Users can choose one of the model data sources by clicking on it.

c. Fcst Hour

The Fcst Hour pull-down menu (Fig. 2) shows the forecast hours of the selected model data source. The model forecast hour information is extracted from the selected model by using ncRead. For different models, the increment and length of forecast hour vary. For example, for the Eta80 model, the increment is six-hourly, and it makes a 2.5-day forecast; for the MesoEta, the increment is three-hourly.

d. Local Site

The available local sites (i.e., CWAs) are listed from the appropriate localizationDataSets directory. Fig. 2 shows an example, in which there are three local sites to choose from. The local site selected here should be the same as the local site used to start the D2D interface.

e. MovablePoint

For a given CWA, the MovablePoint menu contains 10 (A-J) interactive point labels which are used to determine the geographic location of sounding analysis. The user can move a point to the location of interest using D2D. The latitude and longitude of the point will be retrieved from a file, movablePointX.txt (X will be A, B, …, J), in the localizationDataSets/CWA subdirectory (e.g., BMX). Using a locally written lat-lon to Cartesian conversion program, ll_to_xy, and a file containing model geographic information, the latitude and longitude of the point are converted to the grid-point coordinates, and the nearest grid point is determined. The nearest grid-point information is used in running the ncRead program.

3.2 *Extracting Model Data and Running the Sounding program*

For most models, surface-level data (e.g., Fixed Height Above Ground (FHAG) 10 wind, FHAG 2 temperature and relative humidity, surface pressure) and upper-level data are in the same model file (except for the MesoEta). The model topography is used to determine the model lower level. Therefore, all levels whose heights are beneath the topography are ignored. The information about each model vertical layer structure is read from the netCDF file. For instance, for the MesoEta model, a 25-mb increment is set for 1000-600 mb, and 50-mb increment for 550-100 mb.

With model description information retrieved from preprocessing, extraction of model data, such as height, pressure, temperature, relative humidity, and wind, is relatively simple using ncRead. However, more attention should be given to the various variables for different models. For example, there are no surface pressure data in the MesoEta model. Furthermore, in contrast to most other models, there is no dew point temperature in the WorkStation Eta model (only specific humidity).

After model information and data extraction, clicking the "Run it" button (shown in Fig. 1) will execute convective parameter calculation. The C program, convectSnd, has been modified from convectRuc (Bunkers 2002). The main modifications involve removing hardwired vertical layers and considering various models, so that the enhanced program can be used for various model soundings.

4. Application Considerations

The sounding analysis program offers a comprehensive set of forecast parameters for severe convection. Some of the notable parameters that are not available in the current AWIPS sounding analysis include a low-level mixed-layer CAPE, the virtual temperature correction for all thermodynamic calculations, 0–3-km CAPE, 0–3-km SRH with the ID storm motion method, and 0–1-km SRH. When using these new parameters in this program there are a few issues to keep in mind. The virtual temperature correction, which factors in the effect of moisture on buoyancy (particularly important in low levels), will result in a 10-20% higher value compared to calculations that don't factor in this important effect (Rasmussen and Doswell 1994). The relative difference is more pronounced for lower capes. While this correction is theoretically sound, it will require the user to slightly calibrate the values relative to experience with programs that haven't included this correction. Because the effect of moisture on buoyancy is maximized in lower levels, the correction may have a larger relative effect for low-level buoyancy calculations, such as 0–3-km CAPE.

One of the more important considerations in using the sounding program on the operational AWIPS grids is the effect of vertical resolution of the grids on the calculations. For some of the RUC and ETA grids in AWIPS, the vertical resolution is 50 mb, whereas the native grids have many more grid points, particularly in low-levels. Comparison with the raw data in a few cases suggests the resolution difference can significantly affect helicity estimates. The 0–3-km SRH can vary by 10-20 % due to resolution, with a much greater effect for 0–1-km SRH. Most soundings derived from the AWIPS grids only contain 2-3 grid points in the lowest 1 km, so the low-level shear estimates should be used with caution based on the resolution of the data. Thus, manual inspection of the data on a skew-T and hodograph are in important step in effectively understanding the raw data and using the calculations effectively.

5. Conclusions and Future Work

The improvements to the Bunkers (2002) sounding analysis presented in this paper make it easier to perform sounding analysis utilizing new forecast parameters in an operational AWIPS environment. One limitation to using this local application is the effect of limited vertical resolution in the AWIPS grids. Low-level shear parameters such as 0–3-km SRH, and particularly 0–1-km SRH, are degraded due to the poor vertical resolution in many of the models. One potential solution for the resolution problem lies in using a new dataset coming in Build 5.2.1 of AWIPS in Spring/Summer of 2002. In this build, the native model output for selected points across the country will be ingested into the AWIPS data stream via BUFR files. The point profiles contain the full resolution model data, but the list of potential sites is fixed.

Other potential upgrades to the current program (besides utilizing the new BUFR profiles) include a surface input parameter modification component. Other new parameters will be added, including using 0–1-km bulk shear, which may be less sensitive to the vertical resolution problem.

6. Acknowledgements

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7. References

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