

TAILORING MODEL FORECASTS WITH SLIDER BARS
IN THE INTERACTIVE COMPUTER WORDED FORECAST

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1. INTRODUCTION

The Interactive Computer Worded Forecast (ICWF) system, used operationally at select National Weather Service (NWS) offices across the country, enables forecasters to prepare digital forecasts of weather elements using several interactive techniques. Numerous forecast products are automatically composed and formatted from the forecaster-prepared database. This allows the forecaster to concentrate on weather and spend less time typing. The common digital database facilitates improved coordination and consistency not only among products, but between forecast shifts, and eventually between NWS forecast offices. Moreover, the ICWF digital database provides a platform for the development of advanced NWS products. Ruth and Peroutka (1993) provide an overview of ICWF and its capabilities.

The ICWF will be deployed at NWS Weather Forecast Offices (WFO) as a component of the Advanced Weather Interactive Processing System (AWIPS). With AWIPS, a much improved data stream is beginning to flow to field offices. Forecasters at AWIPS WFOs can view information from a variety of NWS numerical and statistical forecast models at greater resolutions in time and space than ever before. This should result in more detailed, timely, and accurate forecasts. A digital forecast database can support the development of new text, voice, graphical, and gridded products based on this information. However, it is essential that forecasters be able to adjust model information in the forecast database without degrading its tremendous resolution in time and space.

This paper describes a new technique which enables forecasters to adjust threshold values used in the initialization of categorical weather forecasts from model guidance. Forecasters interactively adjust threshold values with slider bars while viewing a color image of the resulting categories on the screen.

Thresholds are adjusted at selected forecast projections, interpolated in time, and then applied to intermediate grids. Model grids are not changed, but are reinterpreted with the modified threshold values. In this manner, resulting categorical forecasts remain consistent in time and space. There is no disruption to the time-space continuum of high-resolution model guidance which occurs when weather element grids are edited directly.

2. THE TIME-SPACE CONTINUUM

Since the time the ICWF was introduced into field operations a decade ago, the NWS has realized steady improvement in the quality of numerical forecast guidance provided to its field forecasters (Kalnay et al. 1996). Meteorological detail previously unseen in numerical models is now readily apparent in Meso Eta fields provided by the National Centers for Environmental Prediction (NCEP) for initialization of the ICWF. Such resolution is especially important in handling local effects due to mountains, valleys, and coastlines. The Meso Eta currently runs at 29 km resolution. The next operational model targeted for the year 2000 is expected to have a resolution of 5 km (Kalnay et al. 1996).

The performance of interpretive statistical forecast guidance has improved also (WMO 1995). Model Output Statistics (MOS) from the Nested Grid Model are available for over 700 stations in the United States. MOS forecast guidance is being developed for other NCEP models as well. In AWIPS, the Local AWIPS MOS Program (LAMP) will update MOS forecasts based on the latest hourly observations. Recently, the Techniques Development Laboratory initiated a cooperative research project with the Pennsylvania State University to develop statistical methods which can provide hourly forecast guidance at any point.

Interactive techniques used in the preparation of digital forecasts must be efficient, easy to use, and furthermore, must respect the resolution available in the model guidance from which the database was initialized. Editing tools developed by the Forecast System Laboratory for the AWIPS Forecast Preparation System (AFPS) are described by LeFebvre (1995). The Forecast Production Assistant developed by Canada's Atmospheric Environment Service (Paterson et al. 1993) employs similar tools. These systems enable

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forecasters to "paint" and manipulate areas of weather as discrete images on a grid.

In order to prepare a complete set of forecast grids useful for the automated generation of NWS products, a forecaster needs to review and edit many forecast elements. These include forecasts for temperature, dew point, snow amount, quantitative precipitation, wind direction and speed, cloud, precipitation probability and type, and obstructions to vision. If forecasts are needed at hourly resolution and for several days, the number of gridded fields which the forecaster must review and edit can be overwhelming. The greater the spatial and temporal detail the forecaster enters, the longer the forecast preparation process takes. For some forecast elements, grid interpolation methods can help. Methods to interpolate weather in time and to propagate features with derived motion vectors have been developed for AFPS (Wier 1995). However, according to Wier, categorical weather elements (e.g., precipitation) cannot be interpolated reliably, especially in situations where these elements are of greatest importance. Terrain and diurnal effects are not considered by current methods. Unless interpolation techniques are able to approach the sophistication of the numerical and statistical models from which the digital database is initialized, the tremendous detail now available from high-resolution models could be lost in the forecast preparation process.

The techniques for adjusting model guidance presented in this paper do not afford the forecaster the same control that is available by editing weather directly. However, they can be used to prepare high-resolution forecast products in a time-effective manner—an important consideration for reaching NWS target staffing goals. The forecaster chooses a model that provides a reasonable first-guess forecast and then relies on that model to describe spatial and temporal details which are consistent with his or her adjusted forecast. This is possible because threshold adjustments do not disrupt the time-space continuum of the original model guidance. Where necessary, direct grid editing or matrix editing tools can then be used to fine-tune or update the adjusted model forecast.

3. ADJUSTING THRESHOLDS

The ICWF Master Menu coordinates the flow of forecast data between interactive techniques. A grid modification program is used to prepare forecasts for key elements by drawing and editing contours on the AWIPS Local Area grid. A matrix editor is used to prepare detailed forecasts for zones and stations. An aviation forecast editor enables the forecaster to prepare aerodrome forecasts. And a Watch, Warning, and Advisory interface enables forecasters to enter and manage information specific to critical weather events.

The ICWF slider bar interface provides the option to adjust model thresholds for wind, cloud, precipitation, and obstruction to vision forecasts. These elements were previously unavailable for modification

as gridded fields within the ICWF. Although the ICWF Master Menu supports several alternatives, a forecaster would normally tailor model forecasts with slider bars when beginning to prepare a forecast package with new guidance. Adjusted thresholds can then be used to initialize editors used to prepare detailed forecasts for service areas (e.g., public, aviation, fire weather).

Slider bars are used to select a value from a range of values. They are common in meteorological workstations (Mosher 1995). Fig. 1 shows the ICWF slider bar interface for thunderstorms. One slider bar is provided to adjust threshold probabilities for each of six categories. For example, to increase the area where chance thunderstorms is forecast, a forecaster would move the chance slider bar to the right while viewing the color-coded chance area enlarge on the screen. In effect, this lowers the threshold probability required in the model guidance for a categorical chance of thunderstorms which in turn allows more gridpoints to enter the chance category for the displayed forecast projection.

Animation controls in the lower left of the screen allow the forecaster to loop images of categorical weather for all forecast projections. The forecaster can stop the loop and adjust thresholds at as many hours as desired. Threshold settings are linearly interpolated for intermediate hours. This means that if a forecaster lowers model thresholds to achieve more thunderstorms in the morning and then raises model thresholds to decrease thunderstorm activity in the evening, model guidance for thunderstorms that afternoon would be interpreted with near default threshold values. A time line window positioned near the top of Fig. 1 indicates hours for which the forecaster has adjusted thresholds. This window can also be used to select forecast projections directly and to copy sets of thresholds from one hour to another.

Table 1 shows categories for forecast elements in the ICWF slider bar interface. New forecast values at gridpoints are determined from threshold adjustments

Table 1. Slider categories for forecast elements.

Forecast element	Slider categories
Wind Speed	Light, Moderate, Strong, Very Strong
Wind Direction	N, NE, E, SE, ..., NW
Cloud Amount	Scattered, Broken1, Broken2, Overcast
Pcpn Prob.	Slight, Chance, Likely, Definite
Pcpn Type	Frozen, Freezing, Mixed
Pcpn Character	Showers, Drizzle
Thunderstorm	Slight, Chance, Likely, Definite, Slight Severe, Chance Severe
Obstructions to Vision	Fog, Haze, Dense Fog

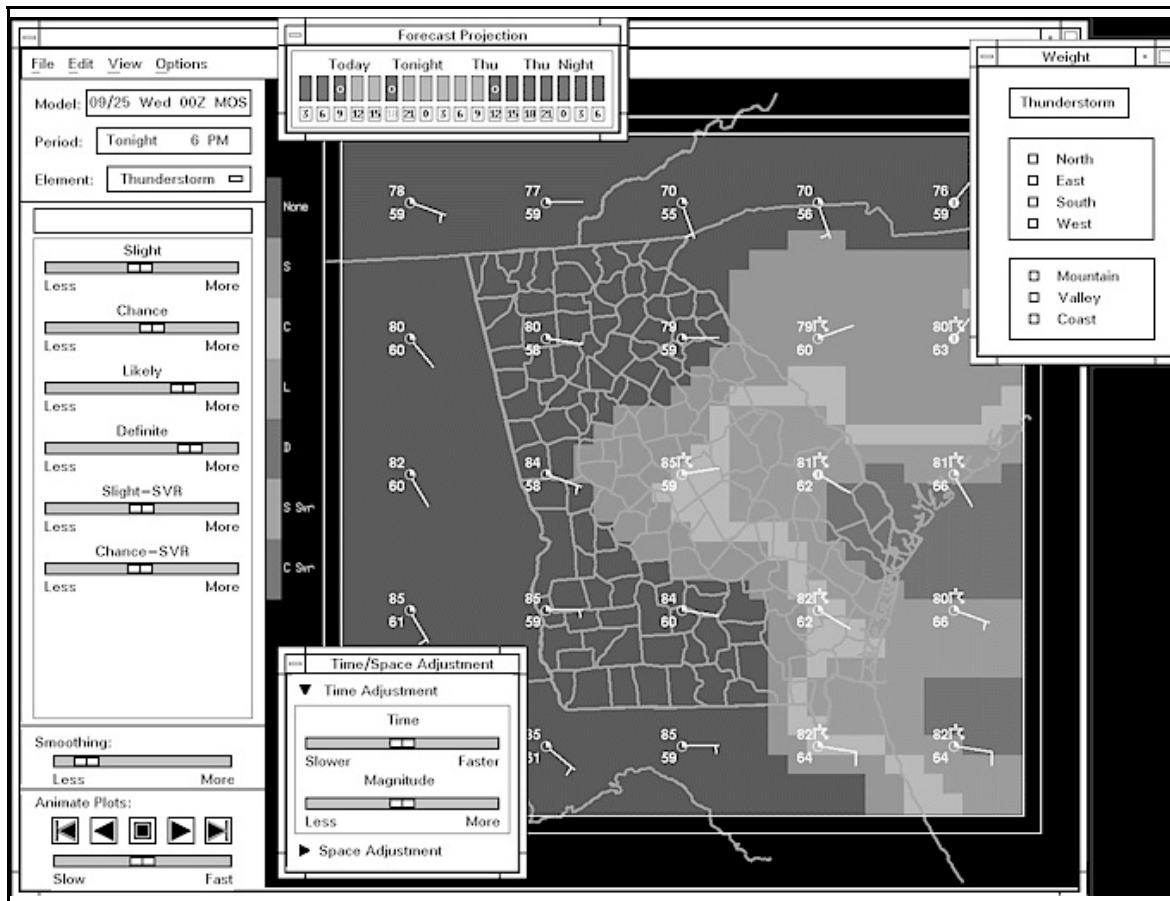


Figure 1. Slider bar interface for thunderstorms.

by one of two methods. For wind direction, wind speed, cloud amount, precipitation probability, and thunderstorms, forecast values within the categorical ranges defined by the adjusted thresholds are remapped to fit the original office-defined ranges. Fig. 2 illustrates how wind speeds are remapped based on adjustments to the original wind category thresholds. For these elements, categories are used to reshape a continuous range of forecast values. The name, number, and size of each category is arbitrary and can be chosen to suit the local forecast office. Potentially, any continuous field could be adjusted in this manner.

For precipitation type, precipitation character, and obstructions to vision, categorical probabilities are compared to determine the best category at each gridpoint. Fig. 3 shows how categorical forecasts are chosen for precipitation type. Adjustments to thresholds for frozen, freezing, and mixed precipitation

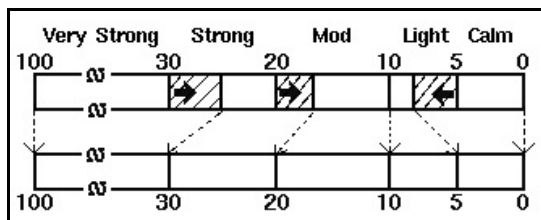


Figure 2. Remapping of wind speed (in mph).

determine the requisite probabilities for five types of precipitation. For example, the forecaster can adjust the position of the rain/snow line by raising or lowering the threshold probability required for frozen precipitation. The threshold for mixed precipitation is offset from the frozen threshold. Moving its slider bar adjusts the size of the area of mixed precipitation on the grid.

Running a slider bar back and forth allows forecasters to view "what if" scenarios. For instance, if freezing precipitation is not the preferred category at any gridpoint, moving the slider bar to the right would progressively reveal areas where this hazardous precipitation is most likely to form. Using slider bars this way in effect "animates" model guidance in the dimension of probability. This allows forecasters to view probabilistic information in model guidance graphically.

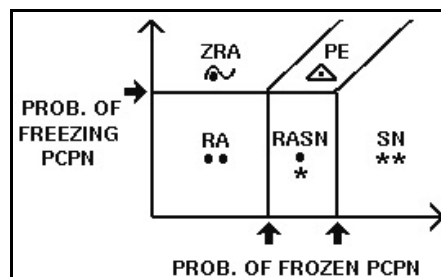


Figure 3. Selection of precipitation type.

Currently, ICWF slider bars can be used to adjust MOS (updated by LAMP) or Meso Eta model guidance. MOS probabilistic forecasts for categorical events are provided directly from regression equations. Probabilities for categorical events are derived from model parameters within the Meso Eta model. Default threshold values for MOS categories are provided to each office based on climatological frequencies. WFOs can set default thresholds for Meso Eta forecasts to tune performance as needed.

4. TARGETING ADJUSTMENTS

Much of the power and flexibility of the ICWF slider bar interface is derived from its ability to target adjustments in time and space. Threshold adjustments can be weighted toward specific regions of the grid or local terrain features. This can yield categorical forecasts such as snow in the mountains, fog in the valleys, and thunderstorms along the coast. Related features in model fields (e.g., moisture convergence) can also be used as weights.

If more afternoon thunderstorms were desired only along the Atlantic coastline, the forecaster could select geographic weights (i.e., east and coast) from the menu shown in the upper right of Fig 1. As the forecaster moves a thunderstorm slider to the right, thresholds are progressively lowered for those points along the east coast. By moving the slider bar, the forecaster does not actually create thunderstorms in the forecast database, but instead makes it progressively "easier" for the forecast model to initialize thunderstorms in that region of the grid. Diurnal influences and the shape of the coastline are reflected in the forecast to the extent that these influences are handled in the original model guidance. Each office can create their own sets of geographic weights.

When the ICWF is deployed with AWIPS, forecasters will be able to weight slider bar adjustments using parameters derived from model grids. For instance, forecasters could choose to lower thunderstorm thresholds at gridpoints where they judge the model has underestimated atmospheric lift based on positive vorticity advection, potential vorticity anomalies, Q-vector divergence, etc. The resulting increase in thunderstorm activity would then match in time the movement of the selected model feature across the forecast area.

The forecaster can also use slider bars to reposition model forecasts in time and space. The menu in the lower left of Fig. 1 interactively "speeds up" or "slows down" model guidance by looking forward or backward in time, respectively. Slider bars control the adjustment in hours and the degree of influence on the current grid. Other slider bars are available to shift model guidance north, south, east, or west. Slider settings for time and space adjustments are linearly interpolated and applied to intermediate grids in the same manner as model thresholds.

5. CONCLUSION

Interactive forecast preparation systems employ a variety of techniques to prepare a digital database of weather forecasts. The technique described in this paper is unique in that it allows the forecaster to adjust the forecast while preserving the temporal and spatial resolution in the original model guidance. Slider bars are currently available to adjust model thresholds at four NWS WFOs that prepare forecasts with the ICWF operationally. This may be a practical approach for future use at NCEP in preparing value-added grids for national dissemination in support of the modernized end-to-end forecast process.

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