5.5 IDENTIFYING LOCAL EFFECTS IN GRIDDED FORECASTS FOR THE INTERACTIVE FORECAST PREPARATION SYSTEM

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1. INTRODUCTION

The National Weather Service is currently implementing an Interactive Forecast Preparation System (IFPS) that assists forecasters in creating forecast products. Forecasters use IFPS to create a database of digital weather forecasts. IFPS techniques use the values in this database to generate a variety of forecast products. This paper describes a set of techniques that improves the way IFPS handles weather in localized areas (local effects). The new technique allows forecasters to focus more attention on creating forecast grid fields. The techniques also provide forecasters with control over the flow of local effect information from the grids into the products generated by IFPS.

2. THE IFPS

Forecast preparation with the IFPS involves three steps. The forecaster uses objective forecasts derived from one or more numerical models to replace some or all of the current forecast database. This digital forecast is then modified by the forecaster who uses the methods described by Ruth, et al. (1998). The forecaster then generates a suite of forecast products as described by Peroutka, et al. (1998).

In IFPS, digital forecasts are stored as grids and digital forecast matrices (DFM). The gridded forecasts are spaced regularly across a Lambert conformal projection. The earliest versions of IFPS used a gridpoint spacing of 20 km; hardware improvements will allow this value to change to 5 km. DFMs define weather at a point or over a geographic region, specifying values at 3-h intervals.

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A variety of techniques keep gridded and matrix forecasts coordinated and consistent as the forecaster edits one or the other. Of particular interest is the technique that summarizes forecast values from groups of gridpoints to create DFMs. As will be shown in later sections and a companion paper (Oberfield and Pegion 2002), this process is both important and complex.

IFPS generates a set of forecasts that are consistent with each other and can be easily updated. The benefits of a digital forecast database are not limited to product generation. Forecast verification values can be extracted directly from the database, and software allows forecasters to compare their digital forecasts with those that are in preparation at neighboring sites. Moreover, the digital database itself can become a forecast product, providing NWS customers and partners the most detailed forecasts. The NWS has begun to prototype such a system; it combines forecast grids from all NWS WFOs into a National Digital Forecast Database (NDFD).

3. SUMMARIZING GRIDDED FORECASTS

Historically, DFMs have been associated with worded forecast products. This seems natural since the data model of a DFM generally matches the structure of most NWS worded forecasts. Information is summarized over geographic regions and organized by time and weather element.

While DFMs may be sufficient to generate NWS worded forecast products, they do not provide the infrastructure needed to produce the high-resolution gridded and graphical products the NWS and its partners want to generate. WFOs that use IFPS have been adding a variety of experimental graphical forecasts to their product suites over the past few years. The NDFD prototype that has recently begun will add to this trend. To generate this suite of modernized products, forecasters must shift their energy to modifying grids of weather elements rather than DFMs.

The IFPS technique that provides a “bridge” between the forecast grids and the DFMs is called the “unloader.” The unloader summarizes weather values from groups of gridpoints to produce a set of DFMs. For those weather elements that can be represented by a scalar value, the unloader performs a weighted average. For vector quantities, it determines a “prevailing” value whose magnitude is the arithmetic mean of the magnitudes found at the gridpoints and whose direction is representative of the ensemble. Elaborate algorithms manage the summarization of precipitation and obstructions to vision.

Previous versions of the unloader assumed that the weather across each forecast zone was homogeneous. This deficiency made it impossible for local effect information to be transferred from the forecast grids to theDFMs. If a forecast zone contained certain areas that could be described as valleys, gridpoint values from the valleys would be summarized together with the rest of the gridpoint values. The enhancements described in this paper directly address this issue.

4. LOCAL EFFECTS

4.1 *Local Effects in Worded Forecasts*

In worded products, localized weather is generally described by geographic phrases such as “scattered showers in the mountains” or “cooler near the shore.” Phrases of this sort can be found daily in NWS forecasts valid for areas with complex terrain. Human authors use judgement and intuition to generate forecasts that include such phrases. Modeling this human behavior computationally involves identifying a localized area where weather is different from weather in surrounding areas, choosing the correct phrase to describe the area, and constructing the worded forecast.

4.2 *Local Effects in DFMs*

Calkins and Peroutka (1997) describe the process IFPS uses to construct a worded forecast that contains local effect phrases. Forecasters identify the areas with localized weather and then create DFMs that digitally describe the weather in these local effect areas. IFPS phrase generation software then generates worded forecasts by comparing these local effect DFMs with DFMs valid for the rest of the area (the so-called base area).

4.3 *Local Effects in Gridded Forecasts*

It is generally a simple matter to represent localized weather on a grid field, provided the grid spacing is small enough to accurately resolve which gridpoints are located in local effect areas. Gridpoints that are located in local effect areas and base areas are each assigned values appropriate for their areas. For many NWS Weather Forecast Offices, the 20-km grid spacing used in the original implementation of IFPS is too coarse to realistically represent the local effect areas they commonly include in their worded forecasts. The latest implementations of IFPS use a 5-km grid spacing which improves the situation considerably.

Both of the IFPS applications that modify gridded forecasts (model interpretation and grid editing) provide techniques that allow a forecaster to easily introduce localized weather into one or more grids. Both maintain a site-configured list of “edit areas.” Edit areas are named collections of gridpoints (or the geographic instructions required to identify the gridpoints). Names of edit areas that might apply to local effects might include “valleys” or “coast.” For example, Figs. 1 and 2 show the geographic outline of a forecast zone (West Virginia Zone 47) in black. The grey area within the forecast zone shows those areas that could be described with the name “valleys.”

Selecting an appropriate local effect phrase to describe a given meteorological situation is not trivial. The various phrases used to describe local effects often overlap. Examples include “over the mountains,” “in the higher elevations,” “above 7000 feet,” etc. In some cases, these variations represent the artistic license of human authors. In other cases, the variations represent subtle shades of meaning that cannot be readily discerned by an objective analysis of the gridded forecast.

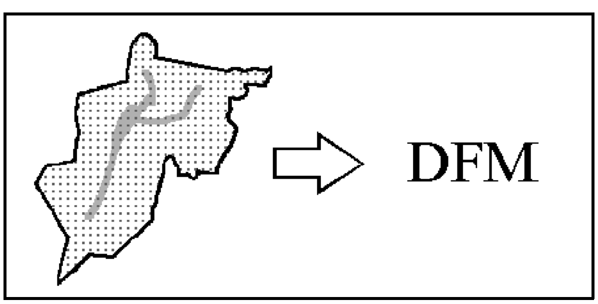

Figure 1: Illustration of gridpoints from a forecast zone being summarized without regard to local terrain.

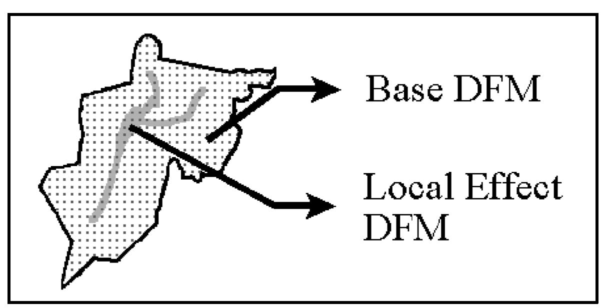

Figure 2: Illustration of gridpoints from a forecast zone being summarized with consideration given to local terrain.

5. IDENTIFYING LOCAL EFFECTS

IFPS allows the forecaster to identify those local effect areas that will appear in worded forecasts. Forecasters use the Graphical User Interface (GUI) shown in Fig. 3 to choose which local effect phrases apply to each region for each weather element and forecast period. This ensemble of information is called the local effect mapping, and it is preserved from one forecast issuance period to the next as part of the digital database. Thus, if a forecaster adds a local effect for Day 4 to today's forecast, the forecaster who prepares tomorrow's forecast will find that phrase chosen for Day 3.

The screen capture in Fig. 3 shows a portion of a WFO's County Warning Area on the right side of the screen. (The example comes from the Charleston, West Virginia WFO.) Forecast zone boundaries are delineated and the zones are labeled with codes such as WVZ010. Heavy lines are drawn around groups of forecast zones to show that forecasts for each member of these groups will be identical. The Local Effects Selector GUI allows the forecaster to arrange the zone groups. One group is currently selected and contains forecast zones WVZ038, WVZ039, WVZ040, WVZ046, and WVZ047. The dialog on the left side of the screen shows that the forecaster has chosen to highlight differences in the valley areas of this group of zones. Differences in temperatures will be highlighted in forecasts valid both tonight and the following night. The GUI allows the forecaster to specify local effects for other elements, geographic areas, and times as needed.

It is possible to automate the process of identifying local effect areas. Automating this task would obviate the need for the Local Effect Selector altogether. Such a technique could analyze various sets of gridpoints trying to identify discontinuities in the forecast fields. The path chosen for IFPS, however, was to have the forecaster point out local effects. This approach has two advantages. First, the wide variety local effect phrases used by forecasters and their similarity make it likely that an automated selection technique would choose local effect areas that the forecast did not intend. Situations like this generally frustrate forecasters as they first undo the work the automated technique did and then redo the work to their own liking. Second, it was thought that the local effect mappings would be a valuable item to pass from one forecast to the next.

6. SUMMARIZING GRIDS WITH LOCAL EFFECTS

Fig. 4 illustrates some of the data flows that occur as forecasters use IFPS to create a forecast that includes local effects. Forecasters use IFPS techniques such as Model Interpretation and Grid Editing to create a set of forecast grids. During this process, gridpoints in geographically interesting areas (e. g., valleys) are assigned forecast values that are generally different from values in the surrounding terrain. Forecasters then use the Local Effects Selector (See Fig. 3.) to select local effect mappings. Once the forecaster has designated which areas should be highlighted by local effect phrases, the IFPS unloader summarizes the weather values on the forecast grids to generate two sets of DFMs. The first set of DFMs is said to be valid for the base area. The local effect DFMs are created by summarizing the forecast values over each local effect area. With DFMs available, the

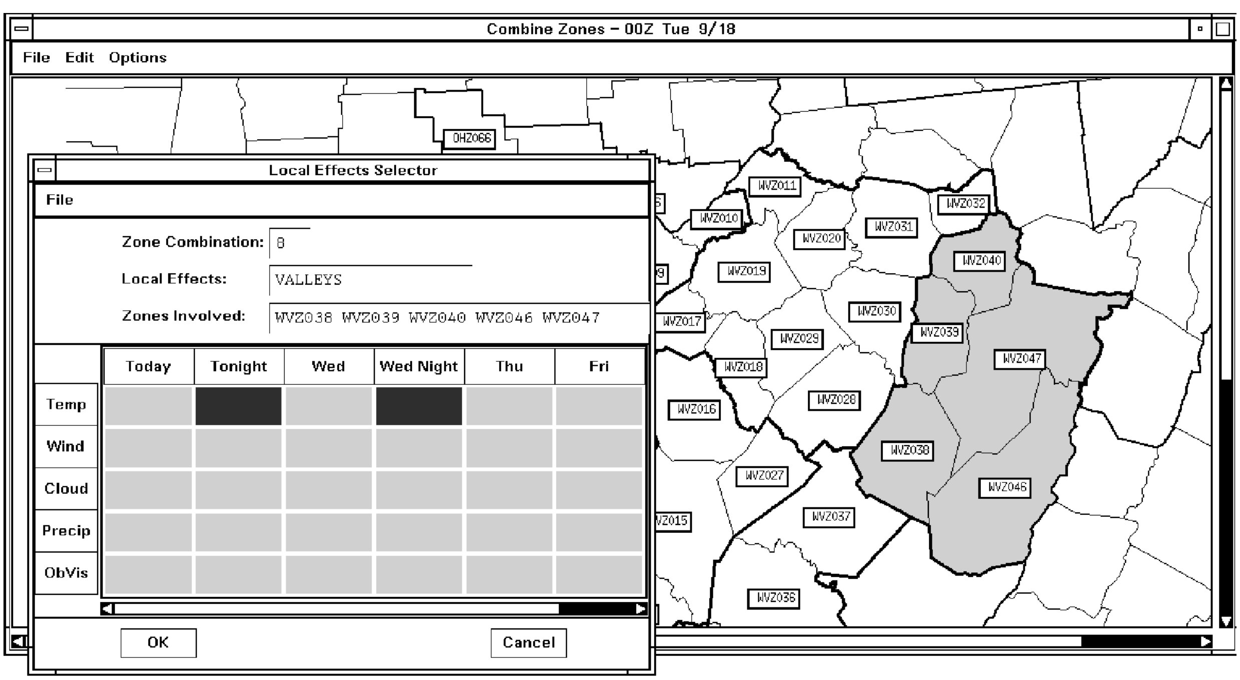

Figure 3: Graphical User Interface for Selecting Local Effect Areas.

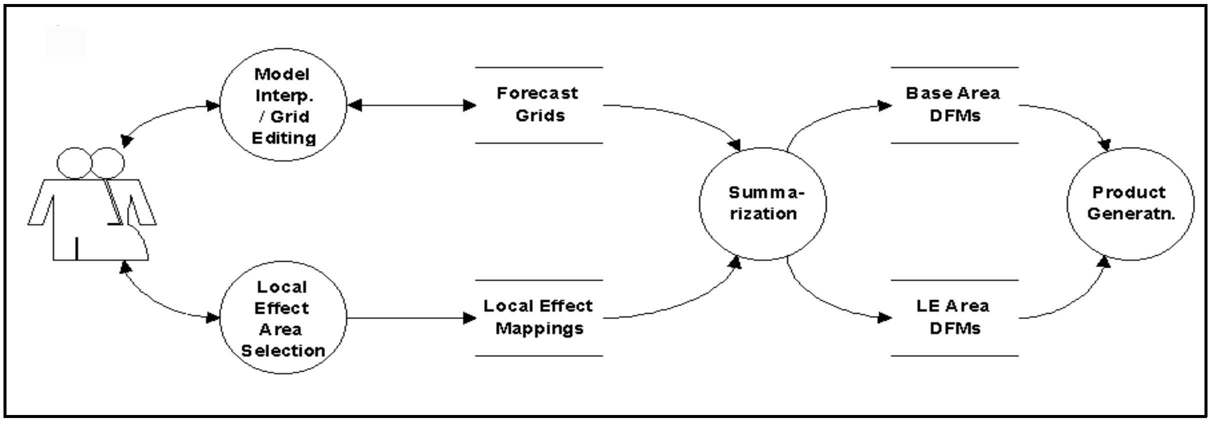

Figure 4: Summarizing Gridded Forecasts that Include Local Effects

IFPS product generation techniques can produce worded forecasts with the appropriate phrases.

Figs. 1 and 2 illustrate the process from another perspective. Fig. 1 shows the behavior of previous versions of the unloader. Note that all gridpoints are summarized into a single DFM with no consideration for geography. Fig. 2 shows the new technique. All gridpoints that are positioned in valley areas are summarized into a local effect DFM while the rest of the gridpoints are summarized into a base area DFM.

Once the gridded forecasts have been summarized into base area and local effect DFMs, the product generation techniques described by Calkins and Peroutka (1997) can generate appropriate text and tabular forecasts. The IFPS matrix editor can also be used to modify the base area and local effect DFMs if the forecaster chooses.

7. **CONCLUSIONS**

Generating worded forecasts that emulate the behavior of human authors is challenging and complicated. The techniques presented here allow a forecaster to control the overall characteristics of the forecast, including the use of local effect phrases.

8. **REFERENCES**

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