15.7 EVOLUTION OF DIGITAL FORECASTS AT NWS FORECAST OFFICES

Lynn P. Maximuk*
National Weather Service, Kansas City/Pleasant Hill, MO

1. INTRODUCTION

The National Weather Service (NWS) has begun production and dissemination of a National Digital Forecast Database (NDFD). The NDFD provides a means where forecasters can prepare and maintain a high resolution forecast information source which offers great promise to enhance partnerships with governmental agencies and the private weather enterprise, as well as provide better service for the protection of life and property and the enhancement of the national economy.

Along with this promise come several challenges for forecasters at NWS Weather Forecast Offices (WFO). Maintaining an on-demand, highly detailed forecast database, in addition to a scheduled forecast product suite, is a major change in philosophy from traditional forecast office operations. The ability to provide high resolution digital forecast information has mandated that forecasters change their work methods for preparation and maintenance of the NDFD, modify the quality assessment processes to ensure current, accurate forecast information, and more actively manage workload during high impact weather events. This paper will identify and discuss the changes in WFO forecast operations due to the production of gridded digital forecasts.

2. VISION AND PHILOSOPHY OF OPERATIONS

In August 2003 the National Weather Service Corporate Board approved an Operations Vision and Philosophy. The Vision was "A flexible, agile operations, founded on distributed, local expertise, which: optimizes modern technology, emphasizes situational awareness, in weather, water and climate services, in order to provide timely and accurate forecasts, warnings and information: using a collaborative process, and with emphasis on hazardous and high-impact events, to protect life and property and enhance the national economy. The Philosophy of Weather Forecast Office Operations further states that offices should be "priority event driven, focus on service and information flow, and relies on collaboration."

This vision and philosophy recognized the change in workload associated with providing timely, more detailed forecast information to customers. The transition from providing scheduled worded, or tabular, forecast information to providing the underlying informational building blocks of those products via gridded forecast fields has proven quite challenging to the WFO forecaster. Several issues come into play as the WFO forecaster makes the transition. Some of the major issues are: **focus of effort driven by events** rather than schedules; **collaboration** – leveraging agency expertise to minimize WFO forecaster workload and maximize forecast quality; **forecast quality -** that is timeliness, consistency, and accuracy; **verification** – gridded versus point. Software and hardware changes at the WFO have also been significant players in the evolution of digital forecast operations, however this paper will focus on the forecast operations as the most significant software and hardware issues have, or are being addressed.

3. PRIORITY EVENT DRIVEN FOCUS

Software and hardware advances have given WFO forecasters tools to provide increased forecast resolution while guidance information from models and NWS national

*Corresponding author address: Lynn P. Maximuk, 1803 North 7 Hwy, Pleasant Hill, MO 64080; email: Lynn.Maximuk@noaa.gov

centers continue to improve. WFO forecasters are modifying their work processes to best leverage the inclination to increase workload to provide higher resolution forecast information against workload savings possible by maximizing use of forecast guidance tools. In addition to this routine demand for resource management, forecasters are being challenged to maintain timely highly detailed forecast grids while providing warning and advisory services for high impact weather events.

Forecasters in general have evolved into a routine where they use their analytical and local weather effects expertise to determine where the existing forecast database needs modification based upon more current information or events They then focus their preparation and maintenance resources on those weather elements and time periods. In essence they nudge, or adjust, the existing forecast database toward the preferred solution. In this way workload is saved as the local effects injected by the forecasters are maintained as the forecast database moves through time. This is methodology evolved at many WFOs to provide forecast consistency, to minimize the number of forecast grids which must be manipulated and because the current guidance resolution is much more coarse than that in the NDFD The coarse guidance resolution requires modification to add in local effects. One could view this as forecasters staying with a forecast until new information indicates that it be adjusted. Even when forecast guidance resolution matches that of the NDFD it appears that this operational paradigm will have value for the foreseeable future as forecasters will be required to insert local effects, and the human element adds consistency to forecasts where forecast model runs have a tendency to show rapid changes in their solutions. This operational paradigm is much different than the traditional schedule driven product issuances of the past when a forecast update was essentially prepared from scratch at each update cycle. As a result WFO forecasters have had to adjust their forecast process to ensure that they can maximize depiction of their analytical and diagnostic skills in the forecast database. Additionally, the forecasters predominantly distribute workload in preparation and maintenance of the forecast database based upon weather events, or time periods rather than upon programmatic responsibilities. In this way the shift supervisors have the ability to manage resources to best address high impact weather events while leaving forecasts which don't need modification alone.

During severe, or unusual high impact weather events WFO forecasters are increasingly turning to backup capabilities to essentially load shed when the demands of those events impact with their ability to update and prepare forecast grids. Software now allows offices to adjust workload to meet event demands by augmenting staff and/or redistributing routine tasks to other National Weather Service offices or centers. Since the existing forecast database may be easily moved to the backup office for manipulation, this method is being used with increasing frequency. By off loading routine forecast operations during high impact weather events local WFO staff may be better used to provide enhanced information flow and warning and advisory service. While local NWS offices provide valuable information and interpretation services on an ongoing basis, the ability to adjust responsibilities on the fly provides increased flexibility in reallocating resources to best deal with the problem of the day. This teamwork across NWS offices has already shown its worth during several major severe weather outbreaks.

4. Collaboration

NWS WFOs have traditionally coordinated weather forecasts to gain consistency across borders of forecast responsibility. In most instances WFOs worked with guidance from numerical models and national centers to more or less independently arrive at a forecast solution for their area of responsibility. They then coordinated on differences across boundaries, usually via telephone calls. As the NWS moved toward producing an NDFD forecasters were provided with with tools to work together more collaboratively in determining the forecast solution. The exchange of inter-site coordination grids along with the use of chat rooms and meet-me conference calls have all greatly improved the forecast collaboration between offices in developing meteorologically consistent forecast solutions.

The production of a high resolution forecast data base has focused attention on ensuring that forecast grids from WFOs are meteorologically consistent, and do not reflect "political meteorology" based upon political jurisdictional boundaries. Since the NDFD is a high resolution one stop shopping location, for a wealth of weather forecast information, differences are much more visible than they were with the worded forecasts of the past. Initially forecasters were reluctant to change the coordination processes with which they had become familiar. However as they became more comfortable with the collaborative tools provided, and have gained familiarity with the composition and use of the NDFD, the amount of collaboration and the meteorological consistency of the gridded forecasts has improved dramatically. There is much more science sharing taking place between WFOs and national centers in real time. Collaboration of a large number of forecast grids can be quite a workload. As a result one of the remaining challenges is how to maximize efficiency while integrating the expertise of the various local WFOs and national centers. Leveraging that expertise will result in a more accurate and consistent forecast database while reducing workload at the WFO so resources may be freed up to provide more customer service, especially in interpretation of weather forecast information and the forging of stronger partnerships with stakeholders.

5. FORECAST QUALITY

The transition from scheduled, broadly worded forecasts, to an "always current" high resolution forecast database has presented quality assurance challenges to the WFO forecaster. Traditional measures of timeliness – meeting a scheduled deadline - are no longer valid as customers may pull data at any time, and a quick review of forecast wording does not reflect the quality of the end product since many products are automatically prepared by formatters. Forecasters were also challenged in how to evaluate the consistency of the high resolution forecast grids as traditional consistency measures were not very detailed as broadly worded forecasts averaged over time and space did not readily reflect inconsistencies.

Movement in addressing the quality assurance concerns has not been as rapid as in other areas of the digital forecast evolution. While tools are available to assess forecast quality, most are immature and not well understood by many forecasters. It has been very difficult to move WFO forecasters away from the "packaged" based forecast mindset where the scheduled legacy text products were the driver. During the past year considerable progress has been made toward changing forecaster emphasis from text products to the underlying grids. This has led to increased efforts toward developing and using effective quality assurance tools. However much remains to be accomplished in this area, especially in the short term (12-24 hours) where the WFO forecaster has the greatest potential to add value to the forecast database. There is considerable on-going debate on what should be measured, and how. The development of quality assessment tools remains fertile ground for improving the service provided via the NDFD gridded forecasts.

6. VERIFICATION

A cornerstone for maintaining and improving forecast quality is verification of forecast accuracy. Verification of a forecast grid has been a topic of much discussion and activity as traditional verification methods center on point forecast verification. While point forecast verification statistics may be used to get an indication of the accuracy of a forecast grid, that methodology has limitations, especially in areas with highly variable terrain or land/water interfaces. A universally accepted gridded verification system is not in place, so WFO forecasters have been working on local, or regional, methods to verify the accuracy of their gridded forecasts as part of their quality assurance process. This feedback is an important metric which forecasters may use to modify forecast processes and grid manipulation techniques.

Verification feedback to WFO forecasters is one of the areas where the evolution to gridded forecasts is least mature. Discussion on how to best verify a forecast grid are ongoing with participation by the public, private and academic communities. Early indications are that the accuracy of the forecast at traditional verification points has remained consistent. As WFO forecasters seek to validate the accuracy of their gridded forecasts there has been an increase in identification of, and access to, additional observational data from which a gridded observation of record may be created for comparison to gridded forecasts. Unquestionably much work remains to be completed in this area, and development of a gridded verification should be a high priority.

7. CONCLUSIONS

WFO forecasters have made considerable progress in their evolution to digital forecasts. The movement toward the vision and philosophy of operations which was distributed by the NWS Corporate Board in August 2003 has been commendable. Forecasters are routinely making decisions to best use shift forecast team resources to provide a high level of information service to partners and customers. Flexible assignment of duties, service backup when necessary, and increased collaboration between WFOs and national centers has become the norm in many WFOs. As a result a more consistent, accurate forecast database is available. The transition from a generalized, scheduled product suite to a frequently updated high resolution forecast database has been complicated by the requirement to maintain both structures during the transition, but WFO forecasters have shown great dedication and persistency in making the changes to operations happen.

Collaboration between WFOs and national forecast centers has expanded greatly during the implementation of the NDFD. The results have been impressive with increased science sharing between offices in near real time. However, work remains on developing methods to better leverage expertise at all levels of the agency to efficiently provide a high resolution, consistent forecast database for partners and customers. Accomplishment of this will require that all of the national forecast centers become actively involved in routine forecast collaboration, and continuing refinement of collaboration tools and methodologies.

WFO forecasters as well as the Office of Science and Technology Meteorological Development Laboratory have responded well to the challenge of monitoring and ensuring gridded forecast quality. Since this was a fundamental change in established quality assurance process, where text or tabular products were reviewed for format and accuracy, progress has been slow. Real time feedback on forecast timeliness and accuracy is becoming available while software and processes are developed. This has allowed WFO forecasters to produce high quality in a subset of the initial experimental NDFD grids. Those grid elements are scheduled to become official before the beginning of calendar year 2005, with several additional grids likely to become official during 2005.

The potential to provide a richly enhanced weather forecast information service makes the trials and tribulations during the evolution of the digital forecast process worth the effort. As partners and customers increase their ability to gather and manipulate high resolution gridded forecast information into their decision making applications the NWS WFO forecasters appear ready to meet that challenge.