NOAA's National Weather Service
Concept of Operations

River Forecast Center (RFC) Analysis and Gridded Forecast Editor Improvement

Approved: _____ Date: _____

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Revision History

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Concept of Operations

1. Introduction and Scope:

Introduction and Background:

This document defines the River Forecast Center (RFC) analysis and gridded forecast improvement operational concept. This document includes a description of the current system, a justification for the proposed change, a description of the proposed system, and a summary of anticipated changes. It was developed in concert with three other documents produced to explain the RFC analysis and gridded forecast improvement initiative. They include: the Statement of Need, Operational Requirements Document, and Program Plan.

This document defines scope and clarifies the objectives of the undertaking originated by the NOAA's National Weather Service (NWS). This effort was initiated to: 1) explore the possibility of using a grid processing tool in the RFCs, 2) address operational deficiencies identified at the RFCs, 3) provide added system functionality, 4) meet the need for a nationally supported tool that can be utilized by all RFCs to prepare the Quantitative Precipitation Forecast, and 5) improve the efficiency of the work performed at the RFCs.

The Statement of Need (SON):

SON # 04-017, RFC analysis and gridded forecast improvement, describes the need as follows: The RFCs need improvements to available software that will: 1) incorporate operational gridded forecast elements, such as maximum and minimum temperature, dew point, wind speed, wind direction, and precipitation amount, and 2) reduce the time it takes forecasters to produce forecast information utilizing climatologies and probabilistic guidance. Because the RFCs are producing Quantitative Precipitation Forecasts[i] (QPFs) using software with inherent limitations, the NWS should provide tools that will improve operational functionality (including full scale grid editing[ii] of gridded forecast elements). In essence, the NWS should provide support for a national system.

The "SON" did not address the need to formally prototype the grid editing tool for usage at the RFCs. However, the preferred means of introducing this new tool is via a prototype at one or perhaps two River Forecast Centers before implementing the tool at all sites. Moving ahead without validating the tool to some extent is a risk. Prototyping will help identify areas of the process that need improvement, recognize necessary modifications to the tool, and determine the most effective way to incorporate extended forecast evaluation and information into the digital forecast process. The proposed tool must be thoroughly tested and evaluated to examine the impacts on the forecast process, forecast accuracy, and system integrity. Several features of the new system, such as the ability to access and ingest several forecast models, must be transferable to the system, before the entire prototype has been completed. Some of the remaining enhancements can be integrated into future releases.

Related programs and projects:

There are six programs and projects that are closely related to this initiative. They include the following:

1. *Distributed Modeling Implementation Project* – An initiative to implement a robust distributed modeling system
2. *The National Digital Forecast Database (NDFD) Preprocessor project* – A project that involves delivering temperature grids from the NDFD to the NWSRFS via a preprocessor at each of the RFCs
3. *Digital Services Program* – An initiative to amalgamate greater and more diverse weather forecast information into a national digital database
4. *Application of Geographic Information Systems (GIS) at NWS RFCs* – A project to implement a GIS solution at RFCs to support their forecast operations
5. *Analysis of Record* – A project to provide the best possible observed grids
6. *Gridded MOS Forecasts* – MDL is developing gridded temperature and precipitation forecasts based on MOS technology

The requirements identified for each of these efforts will be examined to determine areas of overlap.

1.1 Identification:

Number: 05-001

Originator: **Kevin Lynott, W/OS31, 301.713.0006 x151**

Reference: See the RFC Analysis and Gridded Editor Improvement Statement of Need number 04-017 & the RFC Analysis and Gridded Forecast Improvement Operational Requirements Document

The project sponsors include representatives from each of the 13 RFCs, Office of Science and Technology, Chief Information Officer, Office of Hydrologic Development, and Office of Climate, Water, and Weather Services.

The operating centers or sites currently using a grid editing tool include the following: 1) WFOs, 2) National Centers for Environmental Prediction (NCEP), and 3) the RFCs.

2. The Current System or Situation:

2.1 Background:

In 2001, the Interactive Forecast Preparation System (IFPS) was deployed as part of the nationwide NWS Advanced Weather Interactive Processing System (AWIPS) implementation. The Graphical Forecast Editor (GFE) suite (a software system including the IFP database, the database server, and the GFE editor) was made available to

forecasters for use at the WFOs. Forecast grids of sensible weather elements made available via the NDFD have provided an ever increasing amount of information, at time scales as small as hourly and space scales of a few kilometers. The RFCs require use of this data within their forecasting operations. However, tools are not yet available to format this data or make it compatible with the systems currently being used.

2.2 Operational Policies and Constraints:

The NWS issues special river forecasts and flood watches, warnings, and advisories. The operational responsibility for issuing these watches and warnings rests with the WFOs. Nevertheless, RFCs possess a great deal of hydrometeorological knowledge and provide both water resource and hydrologic forecast guidance to WFOs. Operational and policy constraints arise because the RFCs do not have the technological capability to perform full scale gridded analysis or ensure spatial consistencies. For example, RFCs in the western U.S. can't currently ingest gridded data. Modeling systems utilize point forecast data to force the hydrologic models.

2.3 Description of the Current System or Situation:

The main hydrologic forecast tool used by the RFCs is the National Weather Service River Forecast System (NWSRFS). The NWSRFS is a comprehensive set of models and hydrologic techniques used by the RFCs to conduct hydrologic forecasting. The NWSRFS has 3 main components. They are: 1) the Calibration System (CS) designed to allow the forecaster to determine model parameters for one forecast point, 2) the Operational Forecast System (OFS) used to provide short term (up to 30 days) streamflow forecasts, and 3) the Ensemble Streamflow Prediction System (ESP)[iii] which uses an ensemble technique to create probabilistic river forecasts. Two additional applications were developed to help the RFCs take advantage of the scientific workstation graphical environment. They include: 1) the Interactive Forecast Program (IFP), a graphical user interface for the OFS, which allows the user to select the area and dates to use in an OFS run and produce a graphical display of the model outputs and 2) Interactive Calibration Program (ICP) a graphical interface and display program that works with the CS.

The RFCs use two programs to create QPF; they are either the NMAP (within NAWIPS) or the Mountain Mapper software applications[iv]. Both of these programs have grid editing limitations. Limitations, particularly with NMAP, include: 1) overlay capabilities, 2) limited ability to ingest certain data (precipitation and real-time station observations), and 3) boundary discrepancies. There are no programs available to deal with temperature and freezing level forecasts.

2.4 Users of Grid Editing Tools:

1. NWS WFOs
2. NWS RFCs
3. NCEP's Hydrometeorological Prediction Center (HPC)[v]

2.5 Support Environment:

The RFC Development Manager in the Office of Hydrologic Development (OHD) is responsible for managing science and software development among RFCs to ensure the efficient and economical use of NWS resources support the NWS Hydrologic Services Program. The Hydrologic Software Engineering Branch in the Hydrologic Laboratory (HL)[vi] supports the RFCs through the design, development, testing, implementation, and maintenance of the NWSRFS.

3. Justification For and Nature of Changes:

3.1 Justification for Changes:

The capability provided by a grid editing tool could prove to be a significant benefit to RFCs. The RFCs anticipate that if a tool was available, it would improve collaboration with WFOs. A productive partnership between RFCs and the WFOs would assure better grid consistency, especially with respect to QPF and temperature forecasts. In addition, fewer steps required to produce the grids would reduce the amount of time necessary to disseminate vital forecast information to NWS customers and partners.

In the last few years, the GFE and supporting software (called the GFESuite or GFE) has become the primary tool that operational forecasters, at the WFOs, use to create and edit their gridded forecast fields. In October 2002, the Northwest River Forecast Center (NWRFC) began evaluating the use the GFE and identified requirements that would make the application more efficient for longer time ranges. During the NWRFC evaluation, modifications to precipitation, temperature, and freezing level forecasts were easily applied to particular elevations across their domain. Smart Tools were also used to modify QPF grids. The NWRFC concluded that a grid editing tool could be a significant benefit to the RFCs, barring significant workload and system overload issues. They also found the use of Intersite Coordination (ISC) grids to be timelier over those obtainable through the NDFD.

3.2 Description of Desired Changes:

The RFCs need improvements to available software and system architectures. This effort will help identify user needs and, perhaps more importantly, shape evolving requirements. Ultimately, this effort will define all of the critical software requirements. Based on anticipated needs, the following changes are desired:

1. A nationally supported graphical editing tool designed for all RFC domains

2. A tool that will reduce the time it takes forecasters to produce forecast information utilizing climatologies and probabilistic guidance

3. A process that will allow forecasters time to determine the root cause for

model inconsistencies and make necessary adjustments

4. A tool that can incorporate operational gridded forecast elements, such as maximum and minimum temperature, dew point, wind speed, wind direction, and precipitation amount

5. A tool with the ability to quickly apply and save grid changes

6. A tool that will provide for effective coordination with neighboring RFCs and WFOs

7. A tool that will allow RFCs to fix errors that may arise from the output grids

8. A tool that will utilize the grids from the NDFD and ISC to run the preprocessor, and to create a time series for input to the NWSRFS

9. A tool that will format information into a Standard Hydrometeorological Exchange Format (SHEF) message, which would go through a standard data ingest path before ending up in the system. This ability needs to be provided for both point and areal data.

3.3 Priorities among Changes:

New or modified aspects of the user needs: In brief, the expectations are as follows:

1. The tool shall be nationally supported
2. The tool shall enable the NWS (WFOs, RFCs, and NCEP offices) to collaborate on forecast grids for creation of a national digital database of weather information. Consideration should be given to Hydrometeorological Analysis and Support (HAS) generated precipitation and forecast grids
3. The tool shall provide enhanced operational functionality, including the ability to arbitrarily edit a forecast or observed grid of any element
4. The tool shall produce timely forecasts over large domains
5. The tool shall account for complex terrain
6. The tool shall provide for or assist in verification
7. The tool shall provide event driven forecasts in formats that meet the needs of NWS customers and partners
8. The tool shall incorporate climate information
9. The tool shall provide methods to handle boundary inconsistencies between WFOs in the RFC domain
10. The tool shall provide the capability to use intermediate updates from the WFOs outside of the normal NDFD issuance times

Summary of the deficiencies or limitations: Current system shortcomings include:

1. Insufficient national support of NMAP and Mountain Mapper

2. Lacks the tools necessary to improve collaboration with WFOs
3. Incomplete overlay capabilities
4. Limited ability to ingest certain data
5. The amount of time necessary to produce forecast information is excessive
6. Boundary discrepancies

3.4 Assumptions and Constraints:

Assumptions: The tool will have the necessary features and performance capability to produce timely forecasts. Software, hardware, disk space, system maintenance, processing requirements, and performance needs will be evaluated and accommodated.

Processing requirements will increase tremendously with each WFO gridded dataset. RFCs cover much larger areas than WFOs. This requires more processing capability. Incorporation of a gridded forecast editor at RFCs will necessitate training, better assessment of precipitation forecast skill, development of better verification tools, and an assessment of forecast discontinuities. Most importantly, a methodology for forecast elements between the various NWS offices will be needed.

1. **Maintenance and capacity** – Adaptable product generation capabilities of a tool will provide output products in different formats (i.e., grids, graphics, and text). These flexible datasets will require increased system maintenance and additional disk space. Based on experience gained at the NWRFC, substantial investment will be required in computer hardware to run the tool at the RFCs.

2. **Improving precipitation forecasting (QPF) skill** – Improved QPF skill depends on several factors including 1) increasing the amount of data available 2) use of advanced data assimilation 3) improvement of model and physical parameterizations, resolution, and model post-processing techniques, and 4) addressing inherent forecast uncertainties using ensembles or other appropriate probabilistic models.

3. **Training** – A training effort for RFC personnel on the grid editing tool is required prior to the implementation of the new tool. As a result, additional training dollars will be needed.

4. **Verification** – Improved verification schemes are necessary to assess forecast grid skill. Analysis of Record (AOR) of observation grids should be implemented to ensure consistency and accuracy, and to improve forecast skill for all lead times.

5. **Discontinuities** – Based on recent experience with ISC, NDFD QPF, and other grids in the database, challenges such as discontinuities at geographical or political boundaries exist. These issues must be addressed.

6. **Collaboration and coordination** – Collaborated forecast grids are expected to be the largest improvement from the deployment of a gridded forecast editing tool at RFCs. Currently, there is no robust national collaboration effort in the gridded forecast process that involves the RFCs. Therefore, collaboration of RFC products will be required to ensure consistency and quality. Inconsistencies between precipitation and temperature time series used for model calibration will also have to be resolved. A mechanism must be in place in the OFS to identify the source of the forecast time, determine how data adjustments should be made, and remove any time series inconsistencies.

Issues: Aside from the constraints mentioned above, system issues are highlighted in a paper titled Northwest River Forecast Center GFE / ISC Grid Investigation and Utilization[1]. They are taken directly as follows:

1. Difficult to use all WFO Intersite Coordination (ISC) grids
2. Limited availability of training and support
3. Lack of tools for RFC to deal with grid inconsistencies
4. High learning curve for Python and developing procedures and CRON applications
5. The time needed to generate NWSRFS forecasts without analysis
6. All input is in NetCDF

4. Description of the Proposed System:

The proposed tool is a graphical on-screen editor that allows forecasters to create a detailed numerical gridded database of forecasted and observed weather information. The tool must be able to perform all of the functions of the current GFE deployed in the WFOs. In addition, there are enhancements identified which should significantly improve the functioning of the system. They are as follows:

1. Ability to access and ingest several forecast data sources (PRISM, HPC, GFS, NAM, MOS - both points and grids)
2. Verification capability
3. Ability to perform real-time mesoscale analysis of all forecast grids, and ingest and display observations
4. Ability to perform in complex terrain and provide boundary smoothing techniques
5. Ability to function over each RFC domain
6. Ability to allow for non-contiguous Future Mean Areal Precipitation (FMAP). The tool should handle small basin areas that are below the resolutions of current ISC grids

[1] written by Don Laurine, Martin Lee, and Harold Opitz, dated June 2004

4.1 Background, Objectives, and Scope:

The capability to view and edit high resolution grids at RFCs is critical for operational use at the RFCs. Consequently, dependable software must be made available to RFCs for this purpose.

4.2 Modes of Operation:

- The RFCs require that the preprocessor run on-site
- The preprocessor should run independent of NWSRFS
- The preprocessor will write directly to NWSRFS as the Mean Areal Precipitation Function (MAPX) preprocessor does
- Customers and partners must be able to send output to a SHEF file, XML, and other standard ASCII text files for customers and partners
- The preprocessor should write to SHEF (in order to accommodate point station data in NWSRFS)

4.3 User Classes and/or Other Involved Personnel:

User Class	Responsibilities	Skill Level	Work Activities	Mode of interaction
RFC Forecasters	Use grid information to support forecasts, watches and warnings, guidance and outlook products	o Knowledge of theoretical and applied hydrology, especially in the area of hydrology/hydraulic principles as they apply to hydrologic modeling and operational river forecasting o A basic knowledge of applied meteorology o Knowledge of WFO operations and an understanding of the complexity of hydrologic characteristics at WFO boundaries o Knowledge of current QPF methodology and its associated application to hydrologic forecasting	Overall program leadership for the HAS activities are conducted at the RFC Analysis and assimilation of real-time hydrometeorological data using operational hydrometeorological expertise in conjunction with advanced processing techniques, data sources, and equipment Assimilation and quality control of hydrometeorological forecasts for input to the RFC operational forecast system Production of forecast and guidance products for the RFC area of responsibility using meteorological and hydrological expertise Perform operational hydrologic forecasting shifts on an occasional rotation with other hydrologic forecasters Perform hydrometeorological verification activities on QPFs and temperature forecasts used in the RFC operational forecast system Serve as a bridge between the RFC and operations at all WFOs in the RFC area Under the direction and oversight of the HIC and DOH, lead the development and improvement of hydrometeorological operations and procedures used by the RFC and WFOS, with the goal of improving forecast accuracy and operational efficiency	WFO contacts are made to provide hydrometeorological assistance to forecasters that use RFC forecasts and guidance products to produce public products, and to achieve consistency in the application of RFC forecasts and guidance and forecast products among all WFOs in the RFC area. WFO contacts are also made to coordinate development and improvement of techniques and procedures to enhance the flow of hydrometeorological support between the two offices. Contacts with other RFC personnel are made to coordinate operational and developmental activities
WFO Forecasters	Use grid information to issue forecasts, watches and warnings, outlook products	o Extensive training and experience in operational meteorology, or an advanced level of knowledge of applied meteorology equivalent to several years of forecasting	Provides hydrologic forecasts, warnings, and related products to customers and partners for its local area of responsibility. As part of an integrated mode of operations, the entire WFO operational	Provides routine and special weather and hydrologic information to the general public and to warn the public

User Class	Responsibilities	Skill Level	Work Activities	Mode of interaction
	(public, fire, weather and hydrology, aviation, etc.)	experience o Knowledge of the principles and theories of hydrology and the hydrologic characteristics of rivers, streams, and drainage basins in the forecast area	staff participates in hydrologic activities, including issuing routine hydrologic products and collecting and quality controlling the hydrologic/ hydrometeorologic data	and "action agencies" of the imminent threat of natural disasters of a meteorological or hydrological nature
NWS Scientists and Engineers	Maintain and enhance technology and science	o Same as RFC above o Ability in communications techniques, including effective writing and speaking	Provides scientific services and support hydrologic/ hydrometeorologic training and professional development	Contacts are made to provide hydrometeorological assistance to forecasters
NCEP Forecasters	Use grid information to support forecasts, watches and warnings, guidance and outlook products	o Same as RFC above o Ability in communications techniques, including effective writing and speaking	Encourage operational interactions between operational staffs while recognizing the uniqueness of each entities' operations Provide hydrologic modeling and hydrometeorologic data technologies developed by the OHD Integrating interrelated aspects of hydrologic and meteorologic science into WFO, RFC, and NCEP operations Encouraging hydrometeorological collaboration activities between WFOs, RFCs, NCEP, and the OHD Support integrated operations, where appropriate, within field offices	Contacts are made to provide hydrometeorological assistance to forecasters
Hydrologist-In-Charge (HIC)	Direction and evaluation to maintain and continuously improve operational and technical support for the hydrologic program at each WFO. Also, provide technical oversight for the content of hydrologic services provided to the public in the RFC area of responsibility	o Knowledge of management principles and practices necessary to manage a highly technical program and to supervise a professional, highly educated staff in an operational NWS field office o Management training o Knowledge of theoretical and applied hydrologic/hydraulic sciences, especially as they apply to operational hydrologic forecasting o A basic knowledge of applied meteorology o A thorough knowledge of the RFC mission, operations, and external requirements for products and services (necessary in order to oversee the staff effort to maintain or improve the quality of the numerous hydrologic/hydrometeorologic services provided by the RFC) o A thorough knowledge of the NWSRFS primary components	The incumbent provides oversight for all RFC activities and the technical aspects of hydrologic services in his/her area of responsibility. He/she is involved in the many cooperative efforts with other NWS offices as well as water management and hydrologic-oriented agencies outside the NWS. The incumbent manages the RFC involvement in these areas and provides overall direction of the staff effort given to maintaining and improving a variety of RFC services to WFOs and outside authorities and agencies. The incumbent provides supervision for the entire RFC staff and is the most knowledgeable person on overall operations of the center	Contacts involve management level interactions with the Regional Headquarters and OHD. Contacts also involve MICs, other HICs, and other field office personnel. Interagency contacts include high level interactions with various Federal water management agencies, the Federal Emergency Management Agency, senior state and local government officials, state and local water management agencies, and civil defense interests

4.4 Support Environment:

a. The tool shall operate continuously (24 hours per day / seven days per week) to support the NWS mission and Digital Services Program.

b. The support environment will also include the following:

1. Problem reporting and resolution support
2. Communications links
3. NWS releases of new AWIPS builds
4. Backup capacity
5. Documentation for implementation, setup, and user functions

5. Operational Scenarios:

a. Set descriptions of how the proposed system should operate:

1. The system must be available 24 hours per day, 7 days per week, and 365 days per year.
2. The system will initiate the gridded forecast preparation process by initializing the database with forecasts derived from at least one numerical model, WFO ISC grids, or guidance grids.
    a. Using the editing capabilities in the system, derived grids are copied into the forecast
    b. The valid time of grids are adjusted and interpolated from one grid to another
3. The next step is interactively modifying weather elements.
    a. Once the set of gridded forecast elements are defined and saved, products can be generated
4. Adjust the appearance of the display by varying the color enhancement curves, set of displayed weather elements, and contour intervals.
    a. Zoom, pan, overlay, and animation capabilities should be provided
    b. The forecaster will use the system to provide a view of weather elements in a time-series representation. This will allow the forecaster to quickly view and edit changes to a weather element over time intervals
5. Prior to completion of the forecast, define all times in the forecast period.
    a. Edit the forecast using a series of Drawing Tools
    b. Define an area on the system and then apply an editing action to that area
    c. Use Smart Tools to add meteorological concepts, model, terrain data, and quality assurance into the system
    d. Use the contour-editing tool to make small corrections to existing grids by redrawing portions of contours, or to generate a completely new grid by drawing a series of contours

b. How the various parts of the proposed system should function: The proposed system should function in much the same way as the GFE Tool used by the WFOs:

1. The system must include a graphical editing tool and a collection of software that permits forecasters to define the weather elements numerically or digitally.
2. Forecasters should be able to use an interactive editor within the system to manipulate gridded representations of the forecast.

3. The system should house tools that can modify the gridded forecast in hydro-meteorologically useful ways.
4. Separate editors should be available within the system to provide different views of the forecast database.
    a. A Spatial Editor that presents an areal perspective of the grids so that forecasters can edit the gridded data over a particular area
    b. A Temporal Editor that displays a time series view of the data over any selected area. This editor lets the forecaster modify the grids for the selected area as a function of time
    c. A Grid Manager that displays an inventory view of the gridded elements that forecasters can inject or replace based on numerical model output, change the time period over which grids are valid, or add new grids by interpolating based on existing grids
5. The system should also contain nationally accepted Smart Tools, which can be used by forecasters to perform value added operations. The Smart Tools should have access to an array of data sources including numerical model output, surface observations, climatology, and topography.

6. Summary of Impacts:

6.1 Operational Impacts:

The key operational impacts related to the implementation of this tool are:

1. **Software:** The prototype system must be based on current NWS operational software. The software must be managed such that all modifications can be merged back into the AWIPS baseline.

2. **Maintenance:** The NWS will provide long-term hardware and software operations and maintenance support for the tool.

3. **Process improvements:** The time that forecasters previously spent typing text products can now be better spent improving the quality of the gridded forecast.

4. **Training:** The introduction of a new tool into RFC operations is a substantial change for NWS Hydrologists. It fundamentally changes how forecasters do their jobs. Therefore, the establishment of a training program prior to implementation is necessary.

5. **Coordination:** RFC offices will be able to coordinate routine forecasts from WFOs within their domain, as well as NWS national centers, to improve forecast efficiency and dissemination. Coordination tasks associated with the use of a common grid editing tool will ensure the NWS mission is fulfilled.

6. **Dissemination:** The tool must be able to provide forecast grids in multiple formats.

7. **Performance:** Forecast generation must be timely. Therefore, forecast generation should only be related to the forecaster analysis period.

6.2 Organizational Impacts:

Products and service changes:

1. Improved water and weather services
2. Improved numerical and hydrologic model forecasts
3. Improved production efficiency and dissemination
4. Increased interaction with the media
5. Improved support to other agencies and the private weather sector
6. Training materials will be provided

National and regional product and service policies:

1. NWS Directives System documents will be reviewed and updated, as necessary
2. Regional Supplements may also be provided

Staffing changes:

1. Increased staff time for outreach
2. Increased staff time to provide training

6.3 Impacts during Development*:*

Prioritization of development and testing resources rests within the NWS Office of Science and Technology (Programs and Plans Division, Systems Engineering Center), Forecast Systems Laboratory, and (possibly) OHD. Impacts will be assessed by both of these entities.

6.4 Impacts during Transition to Proposed System:

1. **System performance:** Use of a grid editing tool at the RFCs will require additional disk space. The impact on system performance will have to be closely monitored to prevent system degradation or slow down.
2. **Training:** The use of a tool must be supported by an increase in training at the RFCs. Performance assessments should be used to ensure that new concepts and ideas are implemented.
3. **Process improvement:** Although additional workload is possible during the transition, the use of a new tool at the RFCs will provide an opportunity to significantly enhance the forecast process. New business practices and procedures will be enacted to improve efficiency and effectiveness of the system.

7. Analysis of the Proposed System:

7.1 Summary of Improvements:

The benefits derived from possessing a grid editing tool at the RFCs include:

1. Improved gridded forecast collaboration
2. Availability of additional forecast variables for input into the hydrologic models
3. Generation of more accurate and timely QPF products, River Forecast products, and Flash Flood Guidance products (as well as others)
4. Value added data increases NWS customer and partner satisfaction
5. Improved products and services through distinct formats
6. Streamlined product dissemination (both internally and externally)
7. Speedy communication of essential information to decision makers

7.2 Disadvantages and Limitations:

Items such as software, hardware, disk space, system maintenance, processing requirements, and performance needs should be evaluated for the RFCs. In addition, the skill in precipitation and temperature forecasting, training, verification, and collaboration will need to be addressed.

7.3 Alternatives and Trade-offs Considered:

As an alternative, a possible remedy to grid viewing and manipulation would be the use of Geographic Information Systems (GIS). RFCs are using GIS software, and the application of a GIS for NDFD grid viewing and manipulation could possibly merge into a mode of operation that NWS field offices desire. However, the goal is to support one editor for editing all gridded data, and GIS alone would not likely meet all of the functional and data requirements needed to support this initiative.

8. Appendices:

GLOSSARY & ORGANIZATIONAL ABBREVIATIONS

AHPS Advanced Hydrological Prediction Service
AWIPS Advanced Weather Interactive Processor
DCP Data Collection Platform
DMIP Distributed Model Intercomparison Project
EPA Environmental Protection Agency
ESPADP Ensemble Streamflow Prediction Analysis and Display Program
FEMA Federal Emergency Management Administration
FLDVIEW Flood View
FLDWAV Flood Wave
GFE Graphical Forecast Editor
GIS Geographical Information System
GOES Geophysical Operational Environmental Satellite
HADS Hydrometeorological Automated Data System
HAS Hydrometeorological Analysis and Support

HDPT HADS Data Product Timeliness
HL Hydrologic Laboratory
ISC Intersite Coordination
IT Information Technology
LDAS Land Data Assimilation System
MOPEX Model Parameter Estimating Experiment
MPE Multi-sensor Precipitation Estimator
NASA National Aeronautic and Space Administration
NCDC National Climatic Data Center
NCEP National Centers for Environmental Prediction
MDL Meteorological Development Laboratory
NDFD National Digital Forecast Database
NESDIS National Environmental Satellite Data & Information Service
NHDS National Hydrologic Data System
NOAA National Oceanic and Atmospheric Administration
NOS National Oceanic Service
NWRFC Northwest River Forecast Center
NWS National Weather Service
NWSRFS National Weather Service River Forecast System
OCWWS Office of Climate, Water, and Weather Services
OHD Office of Hydrologic Development
OOS Office of Operational Services
OS&T Office of Science & Technology
PE Potential Evaporation
PE Precipitation Estimator
QPF Quantitative Precipitation Forecast
RFC River Forecast Center
Snow MIP Snow Model Intercomparison Project
USACE United States Army Corps of Engineers
USBR United States Bureau of Reclamation
VAR Variational Assimilator
VCP Volume Coverage Pattern
WFO Weather Forecast Office
WHFS WFO Hydrologic Forecast System
WSR-88D Weather Service Radar - 1988 Doppler

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[i] Quantitative Precipitation Forecast (QPF), also known as the Precipitation Amount, represents the total amount of liquid precipitation (in hundredths of inches) at a grid point, when the 12-hr Probability of Precipitation (PoP12) is at least 15%.

[ii] Grid editors enable forecasters to draw and manipulate fields of sensible weather on a map.

[iii] Advanced Hydrologic Prediction Services (AHPS) provides longer term hydrologic outlooks to the various users of hydrologic information, such as local emergency management officials, reservoir operators, and other water resources managers. The core of the AHPS system is the Ensemble Streamflow Prediction program, which is part of NWSRFS. The format of the products tends to be graphical in nature, as opposed to the text-based products generally issued for current forecast products. The data in the products tend to be probabilistic in nature, based on analysis of historic precipitation, temperature and streamflow, current river and basin conditions, and short-term meteorological outlooks.

[iv] NMAP is a product generator, encompassing many of the display features of GEMPAK programs, as well as interactive data selection and manipulation (GEMPAK is a general meteorological software package that was originally developed by the National Weather Service's National Centers for Environmental Prediction (NCEP). GEMPAK is included as part of the NCEP Advanced Weather Interactive Processing System (N-AWIPS). NMAP provides a means for selecting which maps will be used with a displayed product system. Mountain Mapper is an evaluation technique currently used by the NWS River Forecast System to analyze precipitation in mountainous areas. NMAP is also deployed at RFCs to support the Quantitative Precipitation Forecast (QPF) Program requirements.

[v] The HPC is one of several Service Centers under the umbrella of NCEP. The HPC serves as a center of excellence in Q PF, Medium Range Forecasting (three to seven days) and the interpretation of numerical weather prediction models.

[vi] HL supports the delivery of flood and streamflow forecasting services by 13 RFCs and 120 WFOs throughout the country by developing, implementing and maintaining state-of-the-art hydrologic models and systems. HL provides training and operational support for NWS field offices, conducts necessary hydrologic research and studies, provides hydrologic expertise and supports a variety of other users both nationally and internationally. Also, as appropriate, HL participates in scientific gatherings and publish in professional journals.