

EXPLOITING THE DIGITAL FORECAST DATABASE FOR ENHANCED CUSTOMER SERVICE

Pat Murphy

NOAA/National Weather Service, Rapid City, South Dakota

1. Introduction

The modernization of the National Weather Service has been culminated with the implementation of the Interactive Forecast Preparation System (IFPS). IFPS has changed the way NWS forecasts are created, presented, and disseminated (Mass 2003).

The foundation of IFPS is the Digital Forecast Database (DFD). The power of the DFD is that a forecast can be changed or modified “on the fly”, and this change can be simultaneously passed to all NWS forecast “products”. For example, if the wind forecast for this afternoon is changed in the DFD, the change can be made to all NWS issued text products such as the Zone Forecast, the Fire Weather Forecast, Marine Forecasts, etc. Additionally, the DFDs of each NWS Forecast office are combined to create the National Digital Forecast Database (NDFD), creating a seamless digital forecast across the contiguous United States.

This NDFD allows for a forecast of each weather element every 5 km (Mass 2003). This is a considerably higher spatial resolution than previous NWS forecasts that had a resolution of roughly the size of a county. This high-resolution forecast possesses hourly grid point forecasts rather than one value for a several hour “block” of time—significantly increasing the temporal resolution of the forecast as well.

Use of the NDFD results in higher quality representations of the official NWS forecast in a wide variety of useful formats. An example of this is seen in the Digital Zone Forecast. Instead of the traditional text-based zone forecast shown in Fig. 1, a digital forecast for the same area is shown in Fig. 2. While each of these forecasts have different amounts of detail and information, both were produced simultaneously from the same DFD. Of course this same forecast information can be represented graphically (e.g., Fig. 3).

The primary benefit of IFPS (and specifically, the NDFD) is in the digital forecast data themselves. Through the dissemination of NWS forecasts in a form providing high resolution and greater flexibility, the usefulness of the forecasts will be increased (Ruth 2002). Further exploitation of the NDFD for user-defined applications and criteria will allow NWS offices to create a suite of different representations of the forecast (e.g., text, web-based, visual, digital, etc.) to enhance the official NWS forecast. In other words, the same NWS forecast can be displayed differently, to different customer groups, so that each group may extract the most useful forecast information pertinent to their particular uses. A windmill operator may only want the NWS wind forecast; a rancher may want the temperature and relative humidity forecasts; and a baseball player may only be concerned with the chance of rain; yet all must use the same forecast representation to find what they need. User-defined exploitation of the NDFD will

make this a problem of the past. Ideally, individual customers would create their own “products” both in text and visual form from the NWS’s NDFD.

```

WESTERN SOUTH DAKOTA AND NORTHEASTERN WYOMING ZONE FORECAST
NATIONAL WEATHER SERVICE RAPID CITY SD
330 PM MST WED FEB 19 2003

WYZ054-056-201130-
NORTHERN CAMPBELL-WESTERN CROOK-
INCLUDING THE CITIES OF...GILLETTE...MOORCROFT
330 PM MST WED FEB 19 2003

.TONIGHT...PARTLY CLOUDY. LOWS IN THE LOWER 20S. SOUTHWEST WINDS
AROUND 10 MPH.
.THURSDAY...MOSTLY CLOUDY. HIGHS IN THE UPPER 40S. WEST WINDS AROUND
15 MPH.
.THURSDAY NIGHT...MOSTLY CLOUDY WITH A CHANCE OF SNOW. LOWS IN THE
UPPER TEENS. WEST WINDS 10 TO 15 MPH. CHANCE OF SNOW 30 PERCENT.
.FRIDAY...CLOUDY WITH A CHANCE OF SNOW. BRISK. HIGHS IN THE UPPER
30S. CHANCE OF SNOW 40 PERCENT.
.FRIDAY NIGHT...SNOW LIKELY. LOWS IN THE LOWER TEENS. CHANCE OF SNOW
60 PERCENT.
.SATURDAY...SNOW LIKELY. COLDER. HIGHS NEAR 20. CHANCE OF SNOW 70
PERCENT.
.SATURDAY NIGHT...SNOW LIKELY. LOWS ZERO TO 5 ABOVE. CHANCE OF SNOW
60 PERCENT.
.SUNDAY...MOSTLY CLOUDY WITH A CHANCE OF SNOW. HIGHS IN THE MID
TEENS.
.MONDAY...MOSTLY CLOUDY WITH A CHANCE OF SNOW. LOWS ZERO TO 5 ABOVE
AND HIGHS IN THE LOWER 20S.
.TUESDAY...PARTLY CLOUDY. LOWS IN THE LOWER TEENS AND HIGHS IN THE
MID 30S.
.WEDNESDAY...PARTLY CLOUDY. LOWS IN THE LOWER 20S AND HIGHS NEAR 40.

$$

```

Fig. 1. Traditional Zone Forecast.

```

DIGITAL ZONE FORECAST
NATIONAL WEATHER SERVICE RAPID CITY SD
330 PM MST WED FEB 19 2003

WYZ054-056-201140-
NORTHERN CAMPBELL-WESTERN CROOK-
INCLUDING THE CITIES OF...GILLETTE...MOORCROFT
330 PM MST WED FEB 19 2003

          \   THU 02/20/03   \   FRI 02/21/03   \
MST      15 18 21 00 03 06 09 12 15 18 21 00 03 06 09 12 15 18 21 00 03 06
MN/MX           23           48           18           38           13
TEMP          33 28 25 23 24 36 46 45 31 24 21 19 20 31 37 30
DEWPT         24 22 20 19 19 22 20 18 17 16 16 17 18 21 23 24
RH            70 78 82 85 81 57 36 34 56 72 81 92 92 67 57 79
WIND DIR       SW SW SW SW  W  W  W  W  W  W  SW SW SW  W  W  W
WIND SPD       10 10 10 10 15 15 15 15 15 15 15 10 15 10 20 25 15 15 20 20
WIND CHILL     25 19 15 13 11 27           20 11  7  8  6 22 27 16
CLOUDS         SC SC B1 B1 B2 B2 B2 B2 B2 B2 B2 B2 OV OV OV OV OV OV
POP 12HR              0              0              30              40              60
SNOW                               C  C  C  C  C  C  C  C  L  L  L  L

$$

```

Fig. 2. Digital Zone Forecast.

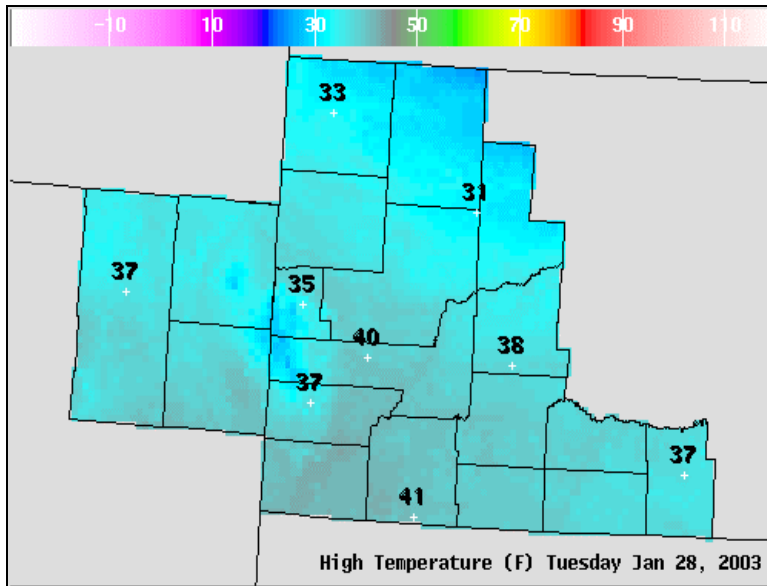


Fig. 3. Graphical representation of the high temperature forecast.

2. DFD Exploitation

The real power of the digital database is that it opens the door for providing much more forecast information and in more useful forms (Glahn and Ruth 2003). By exploiting the NDFD with user-defined and user-initiated representations of the forecast, the NWS will be able to better communicate its forecast message and serve its customers. It will also allow private sector meteorologists to access the official NWS forecast, and easily repackage or add value to it for their customer uses. At WFO Rapid City, such an application has been developed to more clearly represent the fire weather forecasts that are used to plan for Prescribed Burns.

A “Prescribed Burn” is a controlled, intentionally ignited fire used by federal, state, and local land management agencies to reduce dead or extremely dry vegetative “fuels”. Planning such a burn requires advanced ignition and fire suppression strategies, as well as organizing massive resources and providing for safety. For these burns to take place, certain meteorological conditions and parameters must exist. These conditions change for each prescribed burn. If one or more of the conditions are not met, the burn cannot occur.

WFO Rapid City issues a Fire Weather Zone Forecast (FWF) product twice a day during the fire season (Fig. 4). This is a text product that gives forecast weather conditions pertinent to fire behavior. It is used mainly by land management agencies for planning when a Prescribed Burn can or will occur. Since it is in a narrative format, specific information is limited. For example, the forecast for today might say “Maximum Temperature...60 degrees. Minimum Relative Humidity...35 percent.” While the quality of the forecast is good and indeed the forecast may verify perfectly, the usefulness of the forecast is limited. Will the temperature reach 60 degrees at noon and remain there until 5 pm? Or, will the temperature slowly rise all day, finally reaching 60 degrees at 5 pm? The same sort of questions can be asked of each forecast parameter. In fact, the WFO receives numerous calls each day from fire weather customers

asking these very types of questions. It has become apparent that for someone planning a prescribed burn, this forecast is not as useful as it could be. Additionally, this text product has rigid transmission times and format, and contains standard zone-averaged information. In contrast, the NDFD should always contain the most current forecast thinking and can be accessed anytime, at the customer's initiation.

```

FIRE WEATHER FORECAST
NATIONAL WEATHER SERVICE RAPID CITY SD
225 PM MST THU OCT 01 2002

.DISCUSSION... A COLD FRONT WILL MOVE ACROSS THE REGION TONIGHT BRINGING GOOD CHANCES OF
WETTING RAIN TONIGHT AND MUCH COOLER TEMPERATURES THE NEXT SEVERAL DAYS. A SHARP WIND
SHIFT WILL OCCUR WITH THE FRONTAL PASSAGE AND WINDS WILL REMAIN QUITE CUSTY THROUGH THE
NIGHT. WINDS WILL BECOME LIGHT AND VARIABLE WITH TERRAIN EFFECTS DOMINATING AS HIGH
PRESSURE BUILDS OVER THE AREA.

*****
225 PM MST THU OCT 01 2002
FIRE WEATHER ZONES... 299 260 262 WYOMING BLACK HILLS NORTHERN BLACK
HILLS CENTRAL AND SOUTHERN BLACK HILLS

.TONIGHT
SKY/WEATHER...CLOUDY WITH RAIN SHOWERS LIKELY
TEMPERATURE...LOWS 35 TO 40
RELATIVE HUMIDITY...MAXIMUMS 69 TO 95
WIND 20 FOOT...SOUTHEAST 5 TO 10 MPH UNTIL 11 PM THEN SHIFTING TO THE NORTHWEST AND
INCREASING TO 20 TO 30 MPH WITH GUSTS TO 40 MPH.
LAL...1
QFF...0.75

TRANSPORT WIND...WEST 10 MPH
MIXING HEIGHT...<500 FEET
SMOKE DISPERSAL...POOR
HAINES INDEX REMAINING AT 2

.TOMORROW
SKY/WEATHER...BECOMING PARTLY CLOUDY
TEMPERATURE...HIGHS 55 TO 60
RELATIVE HUMIDITY...MINIMUMS 47 TO 63
WIND 20 FOOT...NORTHWEST 4 TO 8 MPH
LAL...1
QFF...0.00

TRANSPORT WIND...WEST 10 MPH
MIXING HEIGHT...1500 FEET
SMOKE DISPERSAL...POOR
HAINES INDEX 2

.TOMORROW NIGHT
SKY/WEATHER...MOSTLY CLEAR
TEMPERATURE...LOWS 25 TO 35
RELATIVE HUMIDITY...MAXIMUMS 59 TO 80
WIND 20 FOOT...VARIABLE LESS THAN 5 MPH DOWNVALLEY AFTER MIDNIGHT.
LAL...1
QFF...0.00

.EXTENDED FORECAST...
...WINDS INCLUDED THROUGH DAY 5 WHEN EXPECTED TO EXCEED 20 MPH...
.SATURDAY...SUNNY. HIGHS IN THE MID 50S.
.SATURDAY NIGHT...MOSTLY CLOUDY WITH A CHANCE OF RAIN. LOWS IN THE
30S. CHANCE OF RAIN 30 PERCENT.
.SUNDAY...CLOUDY. A CHANCE OF RAIN IN THE MORNING. HIGHS IN THE MID
50S. CHANCE OF RAIN 30 PERCENT.
.SUNDAY NIGHT...CLOUDY. LOWS IN THE 30S.
.MONDAY...PARTLY CLOUDY. HIGHS IN THE 50S.
.ELECTION DAY...CLOUDY WITH A CHANCE OF RAIN. LOWS IN THE 30S
AND HIGHS IN THE 50S.
.WEDNESDAY...PARTLY CLOUDY AND WINDY. NORTHWEST WINDS 30 TO 40 MPH. LOWS IN THE 20S AND
HIGHS 45 TO 55.
.THURSDAY...MOSTLY CLEAR AND WINDY. NORTHWEST WINDS 30 TO 40 MPH. LOWS 20 TO 25. AND
HIGHS IN THE 40S.

```

Fig. 4. Fire Weather Zone Forecast.

3. Prescribed Burn Planner

NWS personnel at WFO Rapid City, and also at WFO Pleasant Hill, have worked together to develop the **Prescribed Burn Planner**. Input from fire weather customers has guided this effort. This planner allows land management customers considering a prescribed burn to access the DFD of the local WFO whenever they need forecast information, freeing them from the strict transmission times and formats of standard text products. They are able to extract the precise

forecast conditions they need, at the specific point of the burn, and display their data in an easy to understand format.

It is important to point out that the NWS forecast office is not creating a new product here, but rather is simply representing differently, the forecast already in existence. Also, while the DFD is accessed at the customers' initiation, there is no means for the customer to modify the DFD or otherwise alter the contents of the forecast.

Through an interface on the NWS web page, the fire management customer begins the process. He or she can enter a range of values for each of the weather parameters that will influence the planning of the prescribed burn (Fig. 5). A script will take these parameters and query the NDFD, searching for the occurrence of matching forecast weather conditions. Output is sent back to the web page in the form of a graphic (Fig. 6), illustrating when the conditions are met for each prescribed parameter.

The screenshot shows the National Weather Service Forecast Office website for Rapid City, SD. The page has a blue header with the text "National Weather Service Forecast Office" and "Rapid City, SD". Below the header is a navigation bar with links for "Home", "Site Map", "News", "Organization", and "Search" (with a text input field "Enter Search Here"). The main content area is titled "Fire Weather" and contains several input fields for weather parameters. The parameters and their ranges are: Temperature (°F) from 40 to 50, Rel. Humidity (%) from 30 to 45, Prob. Popn (%) from 0 to 25, Wind Speed (mph) from 5 to 10, Wind Direction (clockwise-compass) from sw to ne, and Sky Cover (%) from 0 to 50. There are also input fields for Latitude (43.07) and Longitude (-103.22), and a "Submit" button. Below the input fields is a map of South Dakota with a pink highlight over the Rapid City area. The map is titled "Click Map for Forecast or Enter Lat/Lon Above". To the right of the map is a text box with instructions: "Click on map for forecasts, warnings, and observations for a specific location. Click here for a summary of all warnings and advisories." Below the map is a "Flood Statement" section with a pink highlight. At the bottom of the page, there is a footer with the text "National Weather Service Rapid City Weather Forecast Office", "Disclaimer", and "Privacy Notice".

Fig. 5. The “Prescribed Burn Planner” website interface. Desired ranges of weather parameters are entered here.

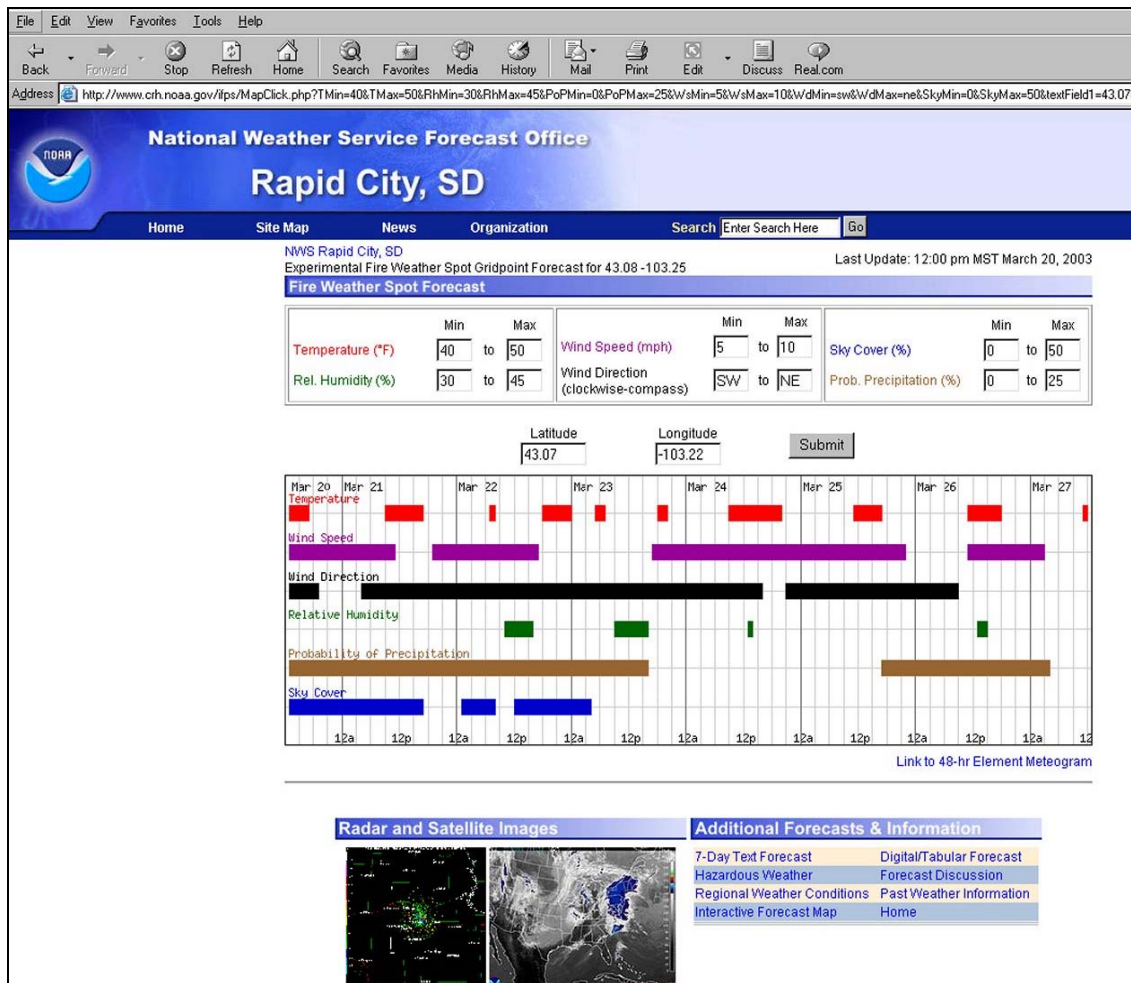


Fig. 6. Prescribed Burn Planner output table, bars indicate when each weather parameter is “in prescription”.

This output can quickly convey exactly when each parameter needed for the prescribed burn will be reached, and when they will coincide with the other weather requirements over the next seven days. Additionally, this simple output can convey the necessary information much quicker and easier than a forecaster could provide verbally. Imagine a forecaster trying to explain which hours of the next seven days the temperature will be such and such, while the relative humidity required will be met at the same time, and winds of a certain speed will also be occurring, etc. This would be an exhausting and time-consuming endeavor.

As a point of caution, with any forecast regime, there are limits to the predictability of the forecast elements as they become more detailed. Therefore, while hourly 5-km resolution forecasts are possible with IFPS (out to seven days), the accuracy of any single weather element at any given grid point decreases both with time and increasing spatial resolution due to the inherent limits of atmospheric predictability [see Mass (2003) for further discussion].

4. Summary and conclusions

This Prescribed Burn Planner will be tested at the Rapid City WFO during the 2003 fire season. Customers who have had input into its creation are excited about the potential of this application, as well as for other uses of the NDFD. This is one of the first customer-defined uses of the NDFD. While this ability to exploit the NDFD is a first step (and still constrains the customer to a specific format), in the future customers will be able to develop their own applications and display formats—only taking the forecast information from the NWS’s NDFD.

This modest application works to illustrate how customers can tailor the official NWS forecast to their specific needs. Such future “data mining” of the NWS digital forecast database by customers will give customers what they want, when they want it, and allow the NWS forecaster to focus on the “meteorology” of the forecast rather than the format and deadline of the “product”.

This Prescribed Burn Planner can be found at: <http://www.crh.noaa.gov/ifps/firewx.php?site=unr>

Acknowledgements. The software development work of Mark Mitchell of the Pleasant Hill NWS office, and Katy Fitzpatrick of the South Dakota School of Mines & Technology, is greatly appreciated. Brian Klimowski of the Flagstaff NWS office, David Carpenter and numerous staff from the NWS office in Rapid City, the South Dakota Wildfire Suppression Division, the U.S. Forest Service, and the Bureau of Land Management, also provided highly useful comments, suggestions, and guidance.

References

Glahn, H. R., and D. P. Ruth, 2003: The New Digital Forecast Database of the National Weather Service. *Bull. Amer. Meteor. Soc.*, **84**, 195-201.

Mass C, 2003: IFPS and the Future of the National Weather Service. *Wea. Forecasting*, **18**, 75-79.

Ruth, D. P., 2002: Interactive Forecast Preparation – the Future Has Come. Preprints, *Interactive Symp. On the Advanced Weather Interactive Processing System (AWIPS)*, Orlando, FL, Amer. Meteor. Soc., 20-22.