P4.2

IMPROVING PRESCRIBED BURN PLANNING WITH NWS DIGITAL FORECAST DATABASE TOOLS

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1. INTRODUCTION

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”, as well as to manage vegetation density and overall forest health. Planning such a burn occurs months in advance and involves detailed ignition and fire suppression strategies, as well as organizing massive resources. For these burns to take place, certain meteorological conditions and parameters must exist. Conditions of temperature, relative humidity, wind, and atmospheric stability affect fire behavior and growth considerably. The necessary weather conditions change for each prescribed burn depending upon the types and quantity of fuels, local terrain, season of the year, and etc. Once the burn is planned, the land manager must then wait for the prescribed weather and fuel conditions to be present. To amass the necessary people, tools, and equipment needed for the burn takes weeks or even months, and accurate forecast information is demanded several days in advance. If one or more of the conditions are not met, the burn cannot occur, at a considerable cost to the land management agency.

National Weather Service (NWS) offices with fire weather forecasting responsibility issue a Fire Weather Zone Forecast (FWF) product twice a day during the fire season. 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, and to maintain forecast information during wildfires. This text format is restrictive in several ways. Since it is in a narrative format, specific information cannot be adequately communicated. 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 [see Murphy, A. (1993), for further discussion on what is a good forecast]. 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 weather parameter. Also this textual forecast is generalized over geo-political zones, which vary in size, and to some extent, topography, and fuels. To accommodate for the size of the “zone”, forecast weather conditions are given in ranges. Five to ten degree temperature ranges are not unusual in mountainous regions. The text forecast is prepared at predetermined issue times, and may not be updated for *minor* meteorological changes, which may in fact, have dramatic affects on local fire behavior. It has become apparent that for someone planning a prescribed burn, this product is not as useful as it could be. NWS offices receive numerous calls each day from fire weather customers asking for more information than is contained in the text FWF products. What will the winds be like at specific latitude and longitude coordinates next Tuesday? When in the next week will the relative humidity be below 40 percent for at least 7 hours during the day? Dozens of such questions could be asked. By exploiting the high resolution Digital Forecast Database (DFD) of individual WFOs and the National DFD (NDFD), fire weather customers can easily have these, and dozens of other questions answered in just seconds. Also, the DFD contains the most current forecast thinking and can be accessed anytime, at the customer’s initiation.

2. NWS DIGITAL FORECAST DATABASE

The modernization of the NWS 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 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 Public Zone Forecast, the FWF, Marine Forecasts, etc. Rather than spending time typing the words of the forecast, the forecaster can concentrate on the “meteorology” of the forecast at hand. In essence the forecaster “paints” the forecast on a digital backdrop. By drawing isopleths of various weather parameters and interpolating between them, the forecast is applied to each individual grid point. Areas to be edited can be highlighted by drawing lines freehand, selecting certain elevations, or along geologic boundaries such as valleys, bodies of water, etc. For example, edits to winds can be made to make them upslope on the windward side of a mountain, and downslope on the leeward side, with the ensuing affects to temperatures and cloud cover applied as

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well. The forecast is then stored as a digital database. Text products, maps, and graphics are generated from this database. This is an improvement over the old method of a forecaster imagining these changes and affects in her head, and then typing the end result out several times in a text forecast.

Additionally, the DFDs of each NWS Forecast office are combined to create the 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. You can stand at any point within the contiguous United States, and you are never more than 2-3 km from an official NWS forecast grid point. This high-resolution forecast also 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.

The primary benefit of IFPS (and specifically, the DFD) 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 DFD for user-defined applications and criteria will allow NWS offices, and others outside the NWS, 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 pilot 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 text to find what they need. User-defined exploitation of the DFD is making this a problem of the past.

Use of the DFD 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). More compelling than just being able to differently *represent* the forecast is the fact that the customer can directly access the DFD itself. By directly accessing the digital forecast data themselves, customers can receive or search for only the forecast weather information important to them, and "display" it or apply it as they wish, or in their own applications. 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 DFD with user-defined and user-initiated representations of the forecast, the NWS will be able to better communicate its forecast message and to 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 customers' uses. Trucking companies could create forecasts along a route, or GPS units could access the forecast for the precise grid point of the user's location (NWS 2003). The applications for exploiting the DFD can be developed and customized by the private weather industry and other weather customers.

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WESTERN SOUTH DAKOTA AND NORTHEASTERN WYOMING ZONE FORECAST
NATIONAL WEATHER SERVICE RAPID CITY SD
129 PM MDT SUN JUL 20 2003

WYZ054>056-058-210929-
NORTHERN CAMPBELL-SOUTHERN CAMPBELL-WESTERN CROOK-WESTON-
INCLUDING THE CITIES OF...GILLETTE...MOORCROFT...NEWCASTLE...WRIGHT
129 PM MDT SUN JUL 20 2003

.TODAY...PARTLY CLOUDY. HIGHS IN THE MID TO UPPER 80S. EAST WINDS AROUND
10 MPH.
.TONIGHT...PARTLY CLOUDY. LOWS IN THE UPPER 50S. SOUTHEAST WINDS 10 TO
15 MPH.
.MONDAY...PARTLY CLOUDY. HIGHS AROUND 88. NORTHWEST WINDS 15 TO 25 MPH.
.MONDAY NIGHT...PARLTY CLOUDY. LOWS IN THE MID 50S.
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Figure 1. NWS Zone Forecast text product.

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WYZ054>056-058-210929-
NORTHERN CAMPBELL-SOUTHERN CAMPBELL-WESTERN CROOK-WESTON-
INCLUDING THE CITIES OF...GILLETTE...MOORCROFT...NEWCASTLE...
WRIGHT
129 PM MDT SUN JUL 20 2003

                   \     MON  07/21/03     \     TUE  07/22/03     \
MDT          15 18 21 00 03 06 09 12 15 18 21 00 03 06 09 12 15 18 21 00 03 06

MN/MX                       59          88          56          91          58
TEMP            86 70 66 61 62 73 84 86 80 67 62 58 60 73 87 90
DEWPT           50 48 47 47 48 49 46 42 41 42 43 44 44 43 42 43
RH              29 46 51 60 61 43 27 22 25 41 50 60 56 35 21 20
WIND DIR         E SE SE  S NW  N  N NW  N  N  N NW NW NW  N  N
WIND SPD        10 10 15 10 15 20 25 20 15 10 10 10 10 10 10 10 15 15 15 15
CLOUDS          SC SC SC SC SC SC SC SC SC SC SC SC SC SC SC SC SC SC SC SC
POP 12HR                     0           0           0           0           0
```

Figure 2. NWS Digital Forecast text product. Same area and time as figure 1.

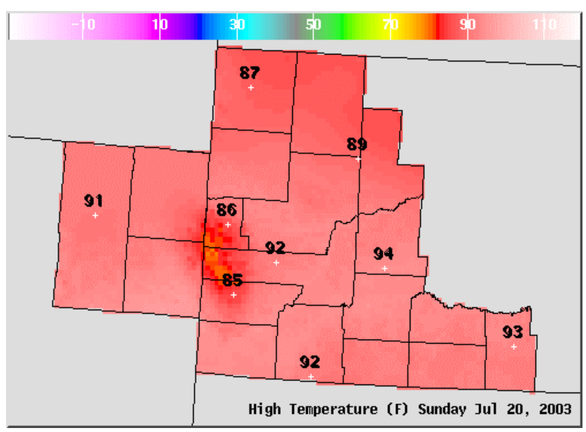

Figure 3. Graphical Forecast map.

It is also worth pointing out that no new text products are being created here. Weather customers are simply able to access the high-resolution forecast database that is used to create the traditional, low-resolution text products familiar to most NWS customers.

3. PRESCRIBED BURN PLANNER

NWS personnel at offices in Rapid City, SD, and Pleasant Hill, MO, worked together to develop the **Prescribed Burn Planner**, which is an experimental interface to the DFD. Input from fire weather customers guided this effort. This planner allows land management customers considering a prescribed burn to access the DFD of the local NWS offices whenever they need forecast information, freeing them from the strict transmission times and formats of standardized 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. The DFD contains the most current forecast thinking, often reflecting changes in the forecast that are still waiting to make it into an updated text product.

Through an interface on the local 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, which will influence the planning of the prescribed burn (Fig. 4). Once the needed parameters are entered, the customer clicks the approximate location on the map, or enters the precise latitude and longitude coordinates. A script will take these parameters and query the DFD, searching for the occurrence of matching forecast weather conditions. Output is sent back to the web page in the form of a graphic (Fig. 5), illustrating when the conditions are met for each prescribed parameter.

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.

Suppose, for example, that a fire behaviorist has written into her "prescription" for a particular burn a temperature range of 75 to 80 F with a relative humidity of 40 to 50 percent, and winds 5 to 8 mph from the southwest. If any of these conditions are not met, the burn cannot be safely completed, and personnel and resources amassed will have been wasted. By using the experimental Prescribed Burn

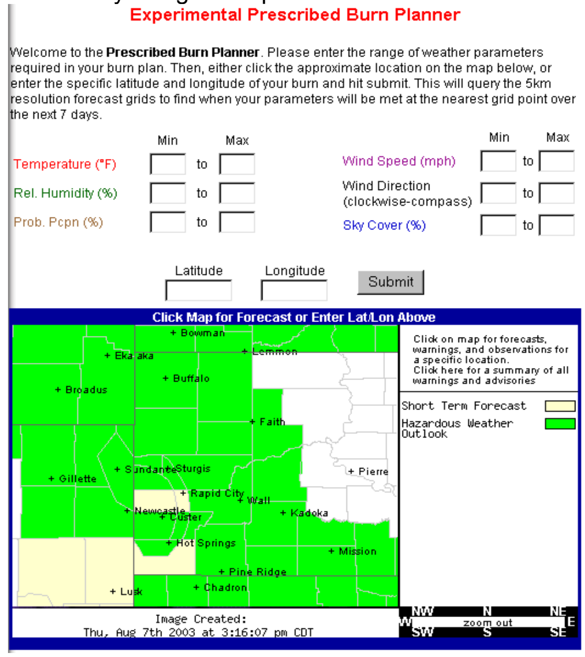

Figure 4.Input web page from the Prescribed Burn Planner DFD query.

Planner as in Figures 4 and 5, the required range of weather parameters could be entered and searched for. On the day that all the weather parameters are present in sufficient time and duration, the burn may proceed. Resources can now start to be amassed. Observations can be made at the burn site, and provided to the NWS forecast office, where a Spot Forecast will be prepared.

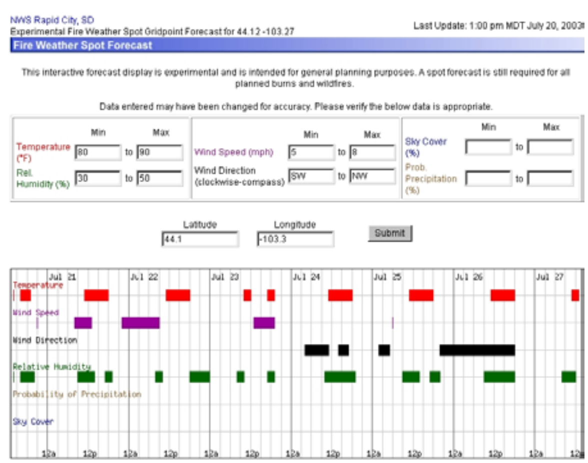

Figure 5. Output web page from the Prescribed Burn Planner DFD query.

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

Currently the NWS is using the IFPS to create the high-resolution DFDs. These databases are then used by IFPS to create the low-resolution NWS text products. By using the text products for general weather outlooks and trends, followed by accessing the high-resolution databases directly for detailed planning and resource allocation, and finally with a Spot Forecast for the day of the burn, finely tuned to the topography and fuels, a much safer prescribed burn can occur.

If, as the saying goes "information is power", then the **Prescribed Burn Planner** is a very powerful interface to the DFD. Previous applications of the DFD have been limited to static maps and graphics displaying the official NWS forecast. The **Prescribed Burn Planner** is unique in that it allows fire weather customers to interrogate the DFDs of local NWS forecast offices directly, searching for *only* the weather conditions needed at a specific time, and precise location. More forecast information is forecasted by the NWS than could ever be put into a text product. A typical FWF product is around 3 to 5 pages of printed text. To print out the DFD from just one office would consume over 10 reams of paper. Use of this planning tool is helping land managers to more efficiently plan for prescribed burns. They have been able access the DFD at their convenience to quickly answer all of their forecast questions.

The Prescribed Burn Planner was introduced in the spring at a few NWS offices for the 2003 fire season. Although it is experimental, it has quickly drawn praise from a spectrum of fire weather customers for its usefulness and efficiency.

This powerful tool 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 unique
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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

The views expressed are those of the author and do not necessarily represent those of the National Weather Service.

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