Using an Operational MM5 in the Fire Weather Forecast Process for West Texas and Southeastern New Mexico

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1. INTRODUCTION

Forecasting meteorological conditions critical to fire spread has gained public attention due to a number of recent fire disasters. Over $2.1 billion was associated with wildfire damage in 2000 (sto, 2001). Accurate fire weather forecasts are critical for managing prescribed burns and wild fires and have a direct impact on the safety of the public and fire control staff along with resource allocations of staff, equipment, and ultimately money.

The National Weather Service Office in Midland, Texas has employed a local version of the NCAR/PSU MM5 (Grell et al., 1994; Cotton et al., 1994), in part, to enhance the fire weather forecast products. This paper will focus on the products created with the Midland MM5 and how they are integrated into the fire weather forecast process with routine and non-routine fire weather forecasts serving as examples. Some ideas for future work will also be discussed.

2. CONFIGURATION AND INTERFACE

Using initial and boundary conditions from the NCEP Eta, the Midland MM5 produces 3-hourly output to 36 hours in nested 45 km and 15 km grids centered on western Texas and eastern New Mexico. The 15 km grid is governed by the Goddard microphysics moisture scheme, the Kain-Fritcsh cumulus scheme, and a Blackadar boundary layer, along with a time step in the outer grid of 135 seconds. The model is run on a dual-800MHz Pentium III Linux computer and takes about 3 hours to integrate.

Forecasters examine GEMPAK images and loops along with station text time-series created with the 15 km resolution data through a fire weather intranet web page (Fig. 1). Typically these data are available in time for the routine fire weather forecasts issued in the mid-morning and late-afternoon.

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3. ROUTINE FIRE WEATHER FORECAST

The products created for the Midland-MM5 fire weather data page echo the information contained within the routine fire weather forecast (Fig. 2). Surface relative humidity and 10 meter winds, along with mid and high level Haines Indices, can be obtained through horizontal planar maps of each region output every three hours. Trends in the relative humidity, wind speed, and Haines Index are displayed for forecast points through graphical traces (Fig. 3) and time series text interpolations (Fig. 4). Trends are paramount in fire weather forecasts since fire managers are most concerned about changes in fire behavior from the observed current state.

Planetary boundary layer (PBL) depth and transport winds are displayed on a single map (Fig. 5) for each region due to their intimate relationship to smoke dispersal and ventilation, which are included in the routine fire weather forecast. Another product (Fig. 6) is created to give forecasters a quick indication of the possibility of "red flag" conditions. This product highlights near surface winds greater than 20 knots and surface relative humidities of less than 15%, which are conducive to rapid fire spread. The 15 km MM5 fire weather products mentioned above give an overview of conditions that will impact fire behavior on the meso-β scale through 36 hours after initialization time.

4. QUEEN, NEW MEXICO PRESCRIBED BURN EVENT

Figure 1: The NWS-Midland MM5 Fire Weather Data Page. The tables of available graphics are divided into the two main fire weather regions within the Midland area of responsibility. Haines Indices and a locally derived index (LRH) are shown here. The LRH is the layer average relative humidity multiplied by the lapse rate (K km^{-1}). Mid-level is defined as the 850-700 hPa layer, while high-level is the 700-500 hPa layer.

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FIRE WEATHER FORECAST FOR SE NEW MEXICO AND SW TEXAS
NATIONAL WEATHER SERVICE MIDLAND/ODESSA TX
338 PM CDT WED MAY 16 2001

...DRY LIGHTNING/GUSTY WINDS IN PECOS/TERRELL COUNTIES THIS EVENING...
...CONTINUED DRY WITH HAINES INDICES OF 5 ALL AREAS ON THURSDAY...

...SYNOPSIS...
THROUGH EARLY EVENING DRY LIGHTNING AND GUSTY WINDS WILL POSSIBLE IN
PECOS AND TERRELL COUNTIES OF WEST TEXAS. CONTINUED WEST TO SOUTHWEST
WINDS TONIGHT WILL FAVOR POOR RH RECOVERY...ESPECIALLY IN THE MOUNTAINS.
WITH TEMPERATURES SOARING AGAIN ON THURSDAY RH'S WILL FALL BELOW 15
PERCENT WITH LOCAL GUSTY WINDS FAVORED IN PASSES AND ON RIDGE TOPS.
OTHERWISE A COLD FRONT WILL MOVE INTO THE AREA FRIDAY EVENING BRINGING
A SLIGHT CHANCE OF SHOWERS AND STORMS THROUGH THE WEEKEND...ESPECIALLY
FOR THE PLAINS OF EASTERN NEW MEXICO AND THE PERMIAN BASIN.

NMZ019-027>029-033-034-TXZ057-258-171630-
NEW MEXICO FIRE WEATHER ZONE 12
SOUTHEAST PLAINS-GUADALUPE MOUNTAINS/ROSWELL BLM-LINCOLN NF/LNO-
238 PM MDT WED MAY 16 2001

.TONIGHT...CLEAR.  LOWS IN THE 50S AND 60S. WEST TO SOUTHWEST WIND
10 TO 20 MPH.
.THURSDAY...MOSTLY SUNNY AND CONTINUED HOT.  HIGHS FROM THE 80S
MOUNTAINS TO THE UPPER 90S WESTERN PLAINS. WEST WIND 10 TO 20 MPH...
15 TO 25 MPH AND GUSTY THROUGH PASSES AND ON EXPOSED RIDGES.
.<                              TEMPERATURE        /  CHC WETTING RN
CARLSBAD 13200 FT)              M40E U90S          /    0    0
ROSWELL  13500 FT)              N60  M90S          /    0    0
THE BOWL 17500 FT)              M50S L80S          /    0    0

REGIONAL DATA...
SOUTHEAST PLAINS
  RELATIVE HUMIDITY......... 45    12
  LAL....................... 1     1
  HAINES INDEX.............. 4     5
  10000FT WINDS............. NW10  W10
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Figure 2: Sample routine Fire Weather Forecast. This product consists of a synopsis, zone forecast, and site specific data. The forecast is split into two separate zones: 1. southeast New Mexico (shown) and 2. southwest Texas (not shown). The 10,000 ft MSL winds are referred to as the transport level winds. Brevity is stressed in fire weather forecasts since these are usually read over a radio to fire fighters in the field with only a basic knowledge of meteorology.

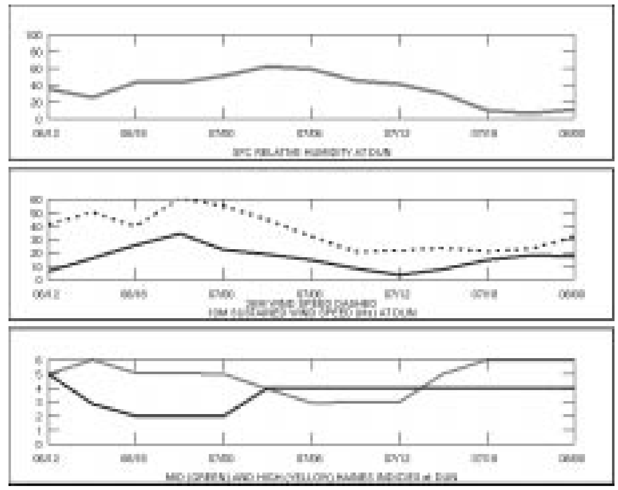


Figure 3: Forecast trace for Dunken, New Mexico. Displayed are surface relative humidity, 3 km and 10 meter winds (kts), and Haines Indices from the 15 km MM5 output.

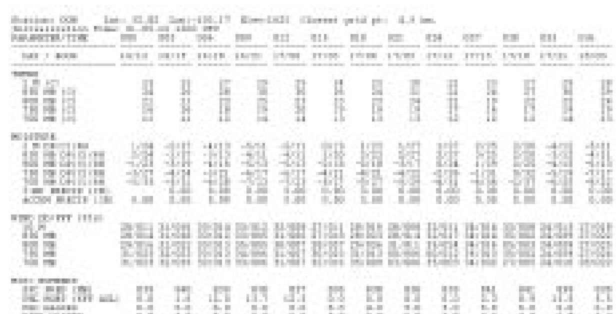


Figure 4: Station text time-series for Dunken, New Mexico interpolated from the 15 km MM5 output. Categories are grouped according to key fire behavior factors (i.e. winds, moisture, temperature, and stability).

Figure 5: Ventilation plot for southeastern New Mexico. Black lines denote boundary layer height (kft AGL), barbs are 3 km transport winds (kts), and thin gray lines are the terrain (meters MSL).

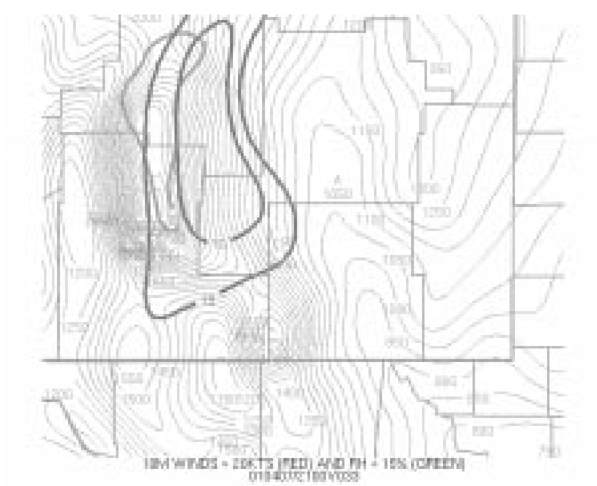
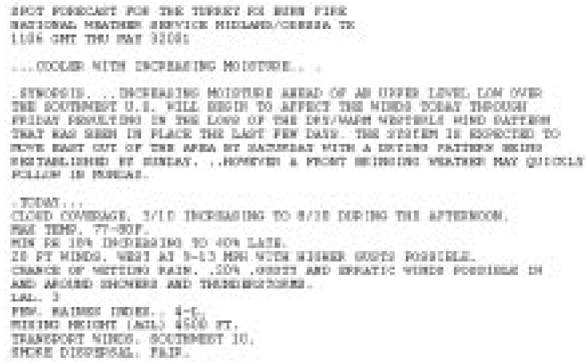


Figure 6: Red flag condition plot for southeastern New Mexico. Solid black lines represent surface relative humidity values below 15% while the lighter thick line represents sustained 10 meter winds above 20 knots. Terrain (meters MSL) is denoted by the thin gray lines.



SPOT FORECAST FOR THE TURKEY RX BURN FIRE
NATIONAL WEATHER SERVICE MIDLAND/ODESSA TX
1106 GMT THU MAY 32001

...COOLER WITH INCREASING MOISTURE...

.SYNOPSIS...INCREASING MOISTURE AHEAD OF AN UPPER LEVEL LOW OVER THE SOUTHWEST U.S. WILL BEGIN TO AFFECT THE WINDS TODAY THROUGH FRIDAY RESULTING IN THE LOSS OF THE DRY/WARM WESTERLY WIND PATTERN THAT HAS BEEN IN PLACE THE LAST FEW DAYS. THE SYSTEM IS EXPECTED TO MOVE EAST OUT OF THE AREA BY SATURDAY WITH A DRYING PATTERN BEING REESTABLISHED BY SUNDAY...HOWEVER A FRONT BRINGING WEATHER MAY QUICKLY FOLLOW IN MONDAY.

.TODAY...
CLOUD COVERAGE. 3/10 INCREASING TO 8/10 DURING THE AFTERNOON.
MAX TEMP. 77-80F.
MIN RH 10% INCREASING TO 40% LATE.
20 FT WINDS. WEST AT 9-13 MPH WITH HIGHER GUSTS POSSIBLE.
CHANCE OF WETTING RAIN. .20% .GUSTY AND ERRATIC WINDS POSSIBLE IN AND AROUND SHOWERS AND THUNDERSTORMS.
LAL. 3
FWX. HAINES INDEX. 4-5.
MIXING HEIGHT (AGL) 4500 FT.
TRANSPORT WINDS. SOUTHWEST 10.
SMOKE DISPERSAL. FAIR.

Figure 7: Part of a spot fire weather forecast issued for the Queen, New Mexico prescribed burns on May 3, 2001. A typical spot forecast from NWS-Midland will include a synopsis along with site specific data for the next three forecast periods (i.e. today, tonight, and tomorrow).

In addition to routine forecasts, the Midland-MM5 fire weather data can be used to create spot fire weather forecasts (Fig. 7) for specific sites in support of prescribed or wild fire control (meso-γ scale). In one case, a 20,000 acre prescribed burn was planned by the Bureau of Land Management near Queen, New Mexico in early May 2001. NWS-Midland was given enough advance notice of the prescribed burn so that a 5 km resolution grid was inserted around the burn area and run with the operational 45/15 km MM5. The data for this grid were incorporated into a separate prescribed burn intranet web page (Fig. 8).

Critical parameters including surface relative humidity and winds were used to predict the spread of any fire, along with the low-level stability and transport winds to predict smoke dispersal patterns. In the Queen area, relative humidities and winds should be near 10-20% and 10-20 knots, respectively, for the widely spaced fuels to burn efficiently. In addition, smoke pollution is a concern near controlled fires therefore the ventilation should be excellent (i.e. low stabilities/high mixing depth and brisk transport-level winds).

Products from the 5 km resolution data highlighted these meteorological conditions in proximity to the Queen burn area. A west to east cross section (not shown) through the 5 km grid was produced to visualize the stability, moisture, and wind fields in the vertical across the burn area. Horizontal planar maps were also created for surface RH and 10 meter winds along with PBL height and transport-level winds (Fig. 9). There are also traces and text time series similar to Figures 3 and 4 available for points within the 5 km grid. The implementation of a 5 km grid added value to the spot forecasts issued through better terrain representation and the associated relative humidity and wind fields compared to

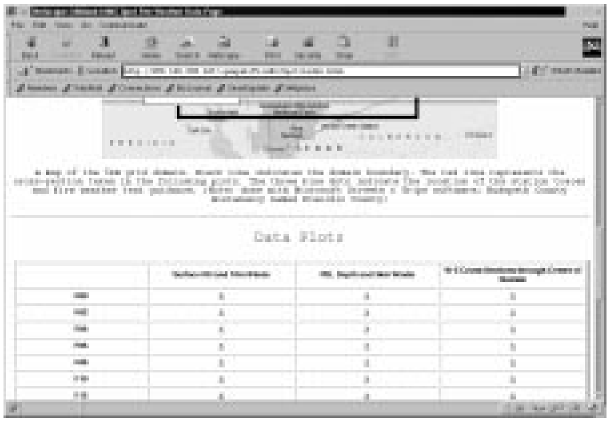


Figure 8: Screen capture of the NWS-Midland Prescribed Burn MM5 Data Page. A portion of the map designating the 5 km grid focus region is located near the top with tables of graphics below. The plots are available in two hour intervals out to 36 hours.

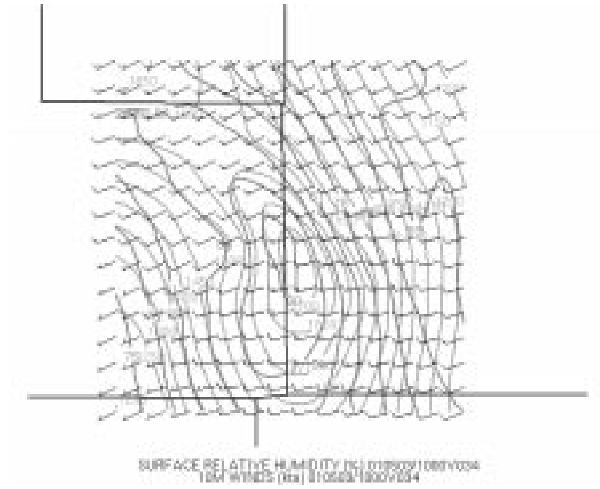


Figure 9: 10m winds (kts), surface relative humidity (black lines), and terrain (meters MSL in thin gray lines) from the 5km grid around Queen, New Mexico.

the courser 15 km MM5 data and the near 20 km resolution NCEP data available on AWIPS.

5. FUTURE WORK AND IDEAS

In concert with fire weather forecasters in the field, several ideas have emerged for future work integrating the MM5 into fire weather forecast operations. Given the probable rapid increase in the speed of laptop computers over the next few years, one possibility is a “Mobile MM5”. Powerful Linux laptops would be equipped with the MM5 model on a near 5 km resolution. The on-site forecaster would download the appropriate Eta GRIB files and run a single high-resolution grid around the area of interest (i.e. prescribed burn). GEMPAK scripts or GARP could then be used to view the data.

In the more immediate future, use of 5 km or higher resolution grids to support large prescribed or wild fires will continue in the NWS-Midland fire weather area. Research will simultaneously continue into evaluating the effectiveness and accuracy of high-resolution MM5 data to support fire weather operations across the southeast New Mexico and southwest Texas region (Cox et al., 1998).

6. ACKNOWLEDGMENTS

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