

## MESOSCALE SIMULATIONS DURING THE DOUBLE TROUBLE STATE PARK WILDFIRE IN EAST-CENTRAL NEW JERSEY ON JUNE 2, 2002

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### 1. INTRODUCTION

The 2000 fire season brought to the forefront the issue of severe wildland fires in the United States. To address the need for new research and for the development of predictive tools for the management of wildland fires, Congress allocated funding under the National Fire Plan (NFP) to better equip government agencies to fight and study forest fires. As part of the NFP research agenda, the Eastern Area Modeling Consortium (EAMC: <http://www.ncrs.fs.fed.us/eamc/>) was established as one of five Fire Consortia for the Advanced Modeling of Meteorology and Smoke (FCAMMS: <http://www.fs.fed.us/fcamms/>). The centerpiece of the EAMC is a PSU/NCAR MM5-based modeling system designed to improve understanding of interactions between mesoscale weather processes and fires, and to develop better smoke transport assessments and predictions.

### 2. MODEL AND FIRE CHARACTERISTICS

The MM5 modeling system is run twice daily in real time, initialized from observations at 0000 and 1200 UTC, on a 32-processor PC cluster located in East Lansing, MI. Results for the entire north-central and northeast USA are available on a 12km grid, with 4km data available for the Great Lakes region and for New England. Shortly after the system was initiated, on June 2, 2002, a wildfire occurred in the Double Trouble State Park in east-central New Jersey (Fig. 1). The fire burned 1300 acres, destroyed or damaged 10 homes, and forced the closure of the Garden State Parkway for several hours due to dense smoke. The EAMC modeling system captured the weather associated with this event in real time on both the 12km and the 4km (New England) grid.

### 3. SIMULATION RESULTS

Results from the real-time simulation were analyzed to assess what role, if any, weather conditions played in the rapid growth of this fire. Meteorological observations from the event generally compared favorably with the model results. Specifically, National Weather Service (NWS)



Figure 1: Aerial photograph of the burned area in the Double Trouble State Park. Photo courtesy of the New Jersey Forest Fire Service.

forecasters in Mount Holly, NJ observed that anomalously low surface relative humidity (RH) values were observed near Philadelphia and across south-central New Jersey. Additionally, observations at the time and location of the fire from the New Jersey Forest Fire Service (NJFFS) suggested that a pronounced increase in the magnitude of surface winds coincided with the arrival of the dry air. The unusually dry surface conditions coupled with the increase in surface wind speeds on the morning of the fire appeared to contribute to the observed rapid fire growth and ensuing damage. Fig. 2 shows the simulated surface RH from the model on the

Surface RH in % valid at 1700UTC on JUN 02, 2002

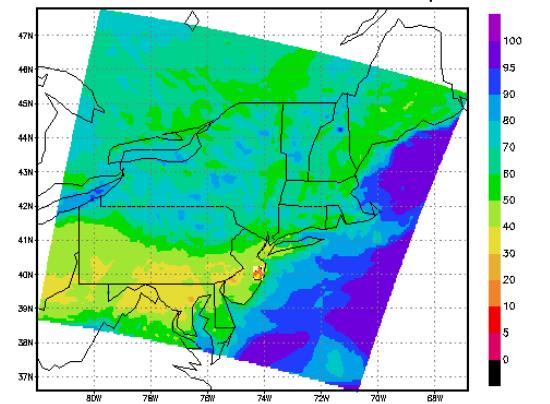


Figure 2: Simulated surface relative humidity corresponding to 1700UTC on June 2, 2002. The location of the fire is indicated by an orange flame icon.

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afternoon of the fire. The model was able to reproduce the observed distribution of RH with some degree of accuracy. The simulation also captured the increase in wind speed leading up to the period of rapid fire growth.

Additional simulations of this event were produced to compare against the observed weather conditions on the day following the initial rapid growth of the fire (during which fire fighting activities continued) and to better resolve the specific planetary boundary layer (PBL) processes associated with the observed fire behavior. Fig. 3 shows simulated surface winds valid during the evening of June 3, the day after the initial rapid spread of the fire. Both NWS spot forecasts and NJFFS observations indicated that a coastal front entered the fire area during the late afternoon, leading to a substantial wind shift and a corresponding change in RH due to onshore moisture advection. Fig. 3 indicates that the simulated coastal front was moving into the area late in the evening on June 3rd, in general agreement with the observations.

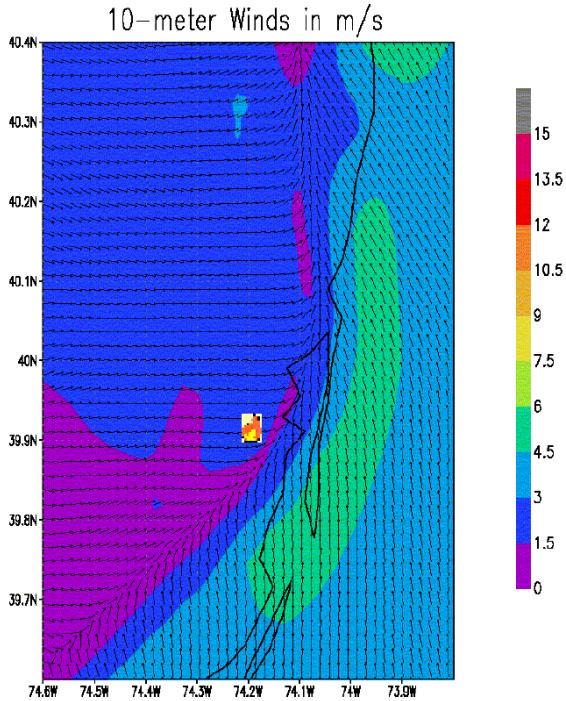


Figure 3: Simulated surface wind valid at 2300UTC June 3, 2002. The location of the fire is indicated by an orange flame icon.

#### 4. ANALYSIS AND DISCUSSION

The overall agreement between the simulation results and observations suggests that the model captured the weather conditions sufficiently well that the role of mesoscale processes in the event can be

assessed. In order to begin addressing fire-weather interactions in the PBL, analyses of the mixed layer height, mixed-layer average winds, and the ventilation index (Hardy et al., 2002, and others) were performed (Fig. 4). Interestingly, these analyses indicate that while mixed layer heights and mixed layer average winds were not substantially larger in the fire area compared to other locations in New Jersey, the ventilation index was larger in south-central New Jersey than in other locations. While the ventilation index is usually employed to assess the ability of the atmosphere to disperse smoke and other atmospheric constituents, this event suggests that high values of the ventilation index could also indicate the potential for rapid wind-driven fire spread.

Fig. 5 shows a 48-hour time-height cross section of wind speed and direction at the location of the fire. On the afternoon of June 2nd, high momentum air from the upper levels begins to mix down into the PBL, apparently associated with an upstream stratospheric intrusion (Fast et al., 1999). This downward mixing of high-momentum air could be associated with the observed surface wind surge and the initial rapid growth of the fire. Additionally, the localized, unusually dry surface air could be associated with this same stratospheric intrusion event.

Using the results from these simulations, the EAMC is working to develop and test new fire-weather interaction indices that will help predict when these conditions are going to occur. Additionally, the EAMC is working with fire fighters and fire-weather forecasters across the region to provide timely weather data and products that are tailored for fire fighting operations. In this particular case, the ability to anticipate the evolution of the coastal front 24-48 hours in advance could prove to be a particularly valuable tool for fighting fires in south-central New Jersey. Since the area is prone to producing multiple fires on any given day during periods of even moderate drought, access to more precise predictions of this particular mesoscale feature would be very useful for allocating fire suppression resources for potentially dangerous fires.

#### 5. REFERENCES

Fast, J. D., X. Bian, and C. M. Berkowitz, 1999: Regional-scale simulations of stratospheric intrusions of ozone over eastern North America during the summer of 1991. *Preprints, Symposium on Interdisciplinary Issues in Atmospheric Chemistry*, Dallas, Texas, American Meteorological Society, pp. 16-23.

Hardy, C., R. D. Ottmar, J. Peterson, and J. Core, 2002. Smoke management guide for prescribed and wildland fire -- 2000 edition. Boise, ID: National Wildfire Coordinating Group. [in press]

### 3-Panel Plot valid at 2000UTC JUN 02, 2002

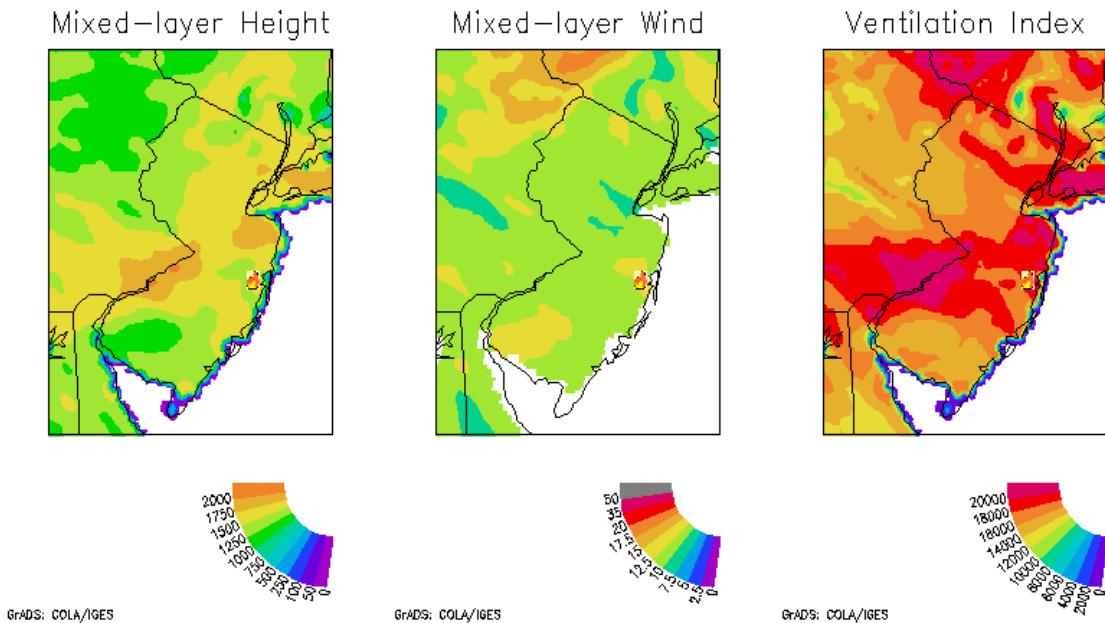


Figure 4: Three-panel plot of simulated mixed-layer height (in meters), mixed-layer-average wind speed (in m/s), and ventilation index (in  $\text{m}^2/\text{s}^2$ ) valid for 2000UTC June 2, 2002.

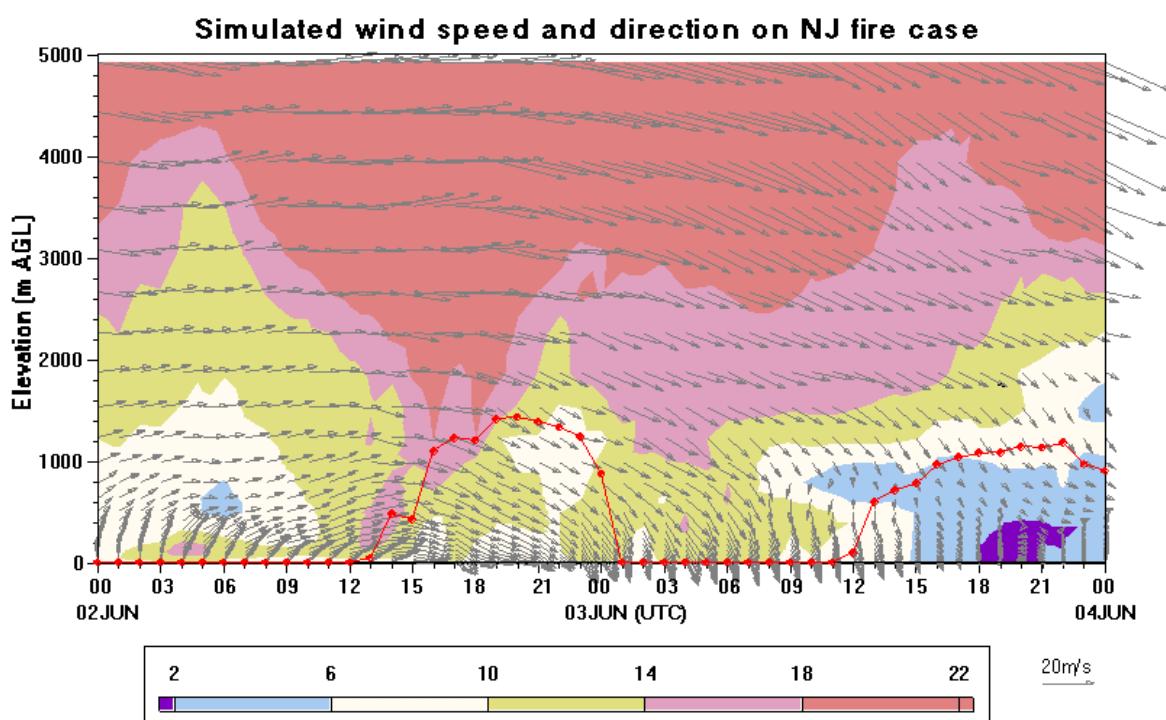


Figure 5: Time-height cross section of simulated wind speed (in m/s), horizontal (x-y plane) direction (vector arrows), and mixed-layer height (red line) valid from 0000UTC June 2, 2002 through 0000UTC June 4, 2002.