J2.5 COMPARISON OF 2-D WIND FIELDS AND SIMULATED WILDLAND FIRE GROWTH

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1. INTRODUCTION

The paper discusses wildfire growth simulated by the *FARSITE* model using high-resolution wind fields over complex terrain extracted from operational runs of the MM5 weather forecast model supported by the USDA FS Rocky Mountain Center (RMC: http://www.fs.fed.us/rmc/). The original 12-km resolution wind field (simulated by MM5) has been scaled down to 100 m using diagnostic scaling routines from the Local Analysis and Prediction System (LAPS). This approach provides the opportunity to better model conditions sensed by real fires. We use the August – September 2003 Snow-Talon fire in Montana to illustrate this new capability.

2. METHOD

2. 1 MM5 and LAPS

The 4-km and 12-km resolution domains for fire weather analysis supported by RMC provide excellent regional area forecast coverage. However, they do not offer sufficient details of the wind flow in complex terrain that is necessary for wildland fire support. For these applications, grid spacing of 100 meters or less are required. A technique to "downscale" the LAPS wind analyses and MM5 forecasts to such a high resolution has been implemented. LAPS uses a two stage approach to generate analyses (McGinley and Smart 2001): 1) data from various platforms are combined to satisfy basic geometric constraints, and 2) a dynamic adjustment is implemented that forces the fundamental equations of mass, momentum, and continuity to be satisfied (McGinley 1987). It is this second adjustment step that, when applied with appropriate constraints, generates the downscaled wind forecast.

The dynamical adjustment takes advantage of a technique, which applies a variational operator to minimize a penalty function. The penalty function includes contributions from mass continuity and dynamical constraints between mass and momentum. User-defined weights are specified to control the relative importance of each constraint. The solution fields are solved using a discretized form of integral constraints as described by Sasaki (1970). For this application, the weights were set to force an exact solution of the mass continuity fields. The weights of the dynamical balance between mass and continuity were set such that the wind field is adjusted much more than the mass field to satisfy this dynamic constraint. In this manner, the downscaled low-level wind field adjusts to the mass field as defined by the complex topography and the thermodynamic characteristics. And conversely, little adjustment is made to the downscaled temperature field. The desired result is a low-level wind field that is more consistent with the terrain resolution.

2. 2 The FARSITE model

The Fire Area Simulator (FARSITE) is a fire growth model (see http://farsite.org/). It uses spatial information on topography, fuels, weather and wind fields. It integrates simulation modules of surface fire, crown fire, spotting, post-frontal combustion, and fire acceleration into a 2-dimensional fire growth model. FARSITE is used here to simulate the Snow-Talon fire that occurred in Montana towards the end of August and beginning of September 2003.

3. RESULTS

3. 1 Downscaled high resolution wind fields

An example focusing on the Snow Talon fire in Montana illustrates the procedure. Figures 1 and 2 show results of downscaled winds derived from the operational 12-km LAPS-MM5 domain of RMC. This example is only one hour during the FARSITE model run period presented below. This downscaled high-resolution domain is defined as a 417 east-west x 442 north-south grid point area with horizontal grid spacing of 100 meters (~41.6 x 44.1 km^2) centered on the fire area at ca. 47° 00' N Lat. and 112° 33' W Lon. Topography is derived from a 3-sec (~90 m) Digital Elevation Model dataset provided by USGS. LAPS typically uses vertical grid spacing of 50 mb, but for reasons that will become apparent, the vertical grid spacing between 900 and 600 mb has been increased to 10mb. Operational LAPS analysis and MM5 forecast data from the northern part of the 12-km domain were then horizontally interpolated, using a piecewise bi-cubic spline technique, and vertically interpolated (linearly in ln-p) to the high-resolution domain. The interpolated fields combined with the high-resolution topography are ingested into the variational scheme to resolve new dynamically balanced fields of temperature and wind.

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Since the variational scheme only operates on the LAPS three-dimensional isobaric grid, a surface wind field is not generated directly. Surface winds are extracted by using the lowest aboveground wind at each grid point. The increased vertical grid resolution ensures that the lowest LAPS level is no more than 10 mb (~90 m) above the terrain. Results from 2100 UTC on 26 August 2003 are shown in Figures 1 and 2. Figure 1 is the LAPS analysis of actual data and Figure 2 is the 12-hour MM5 forecast that was initialized at 0900 UTC. Both analysis (Fig. 1) and forecast (Fig. 2) are run through the LAPS high-resolution process. Note the similarity in wind fields between the observational analysis (Fig. 1), and the model forecast (Fig. 2), which demonstrates the validity of this approach.

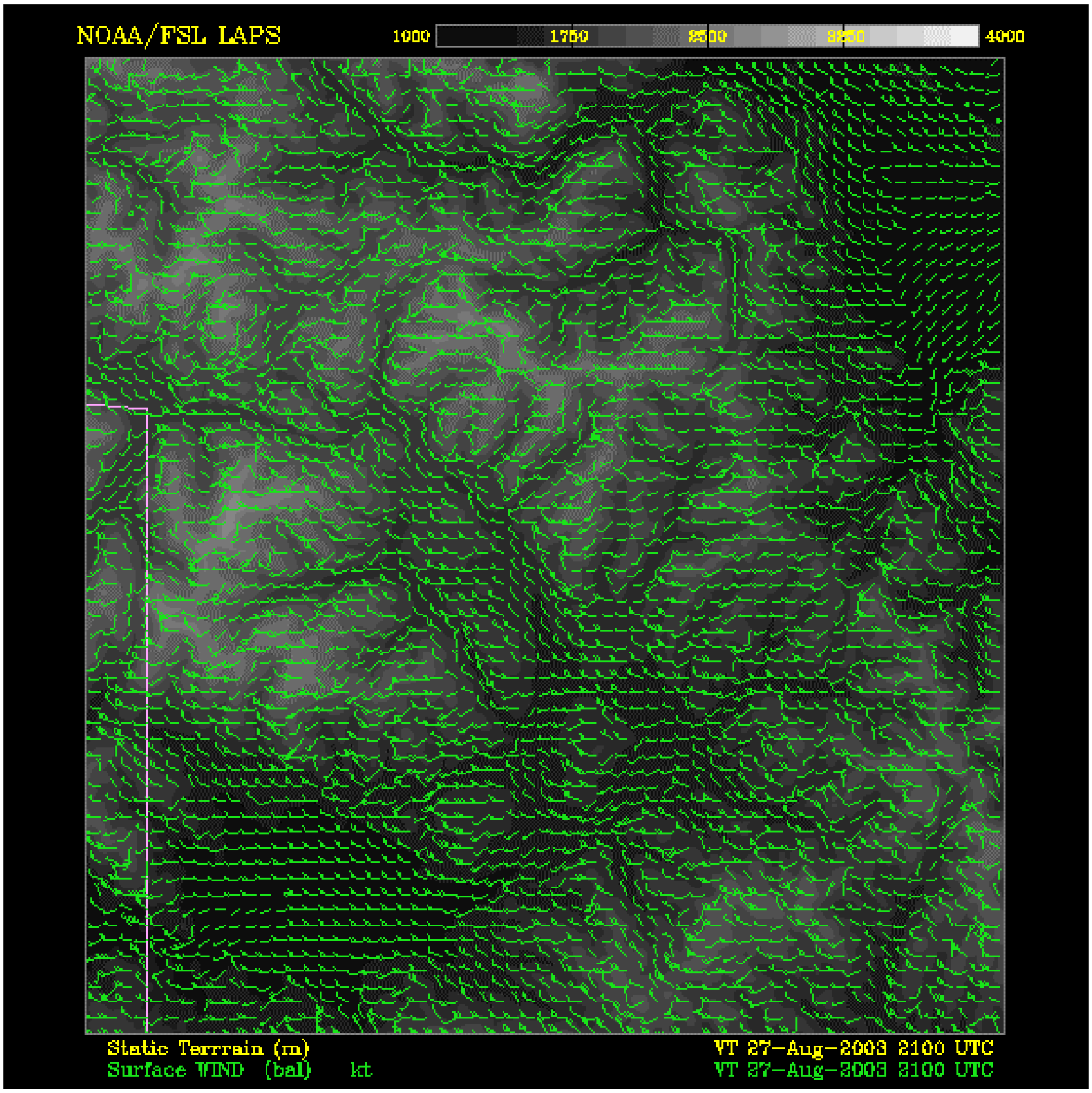

Figure 1. Map of 100-m resolution surface winds produced by LAPS analysis of actual observations at 2100 UTC on August 26, 2003.

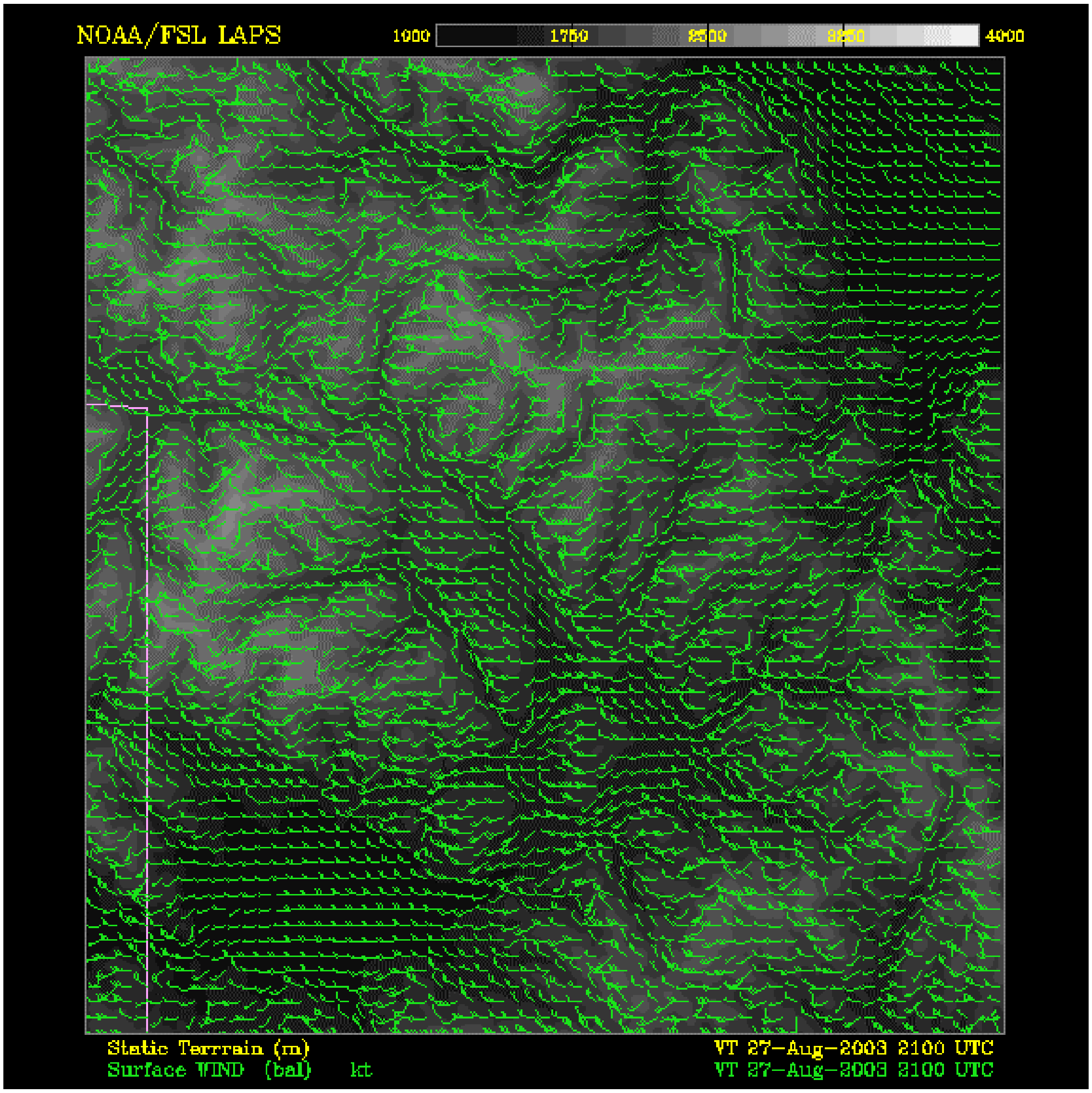

Figure 2. Map of 100-m resolution surface winds from a 12-hour MM5 forecast valid at 2100 UTC on August 26, 2003.

3. 1 FARSITE model run

Figure 3 depicts an example of a FARSITE model simulation that predicts the growth of the Snow-Talon fire perimeter for five days into the future starting on August 26, 2003.

4. CONCLUSION

Employing mesoscale wind forecasting and high-resolution wind field analysis will greatly improve our ability to predict the spread of wild fires in the future. Current research at the FS RMRS addresses the feasibility of combining MM5 and FARSITE for use as operational tools in the near future.

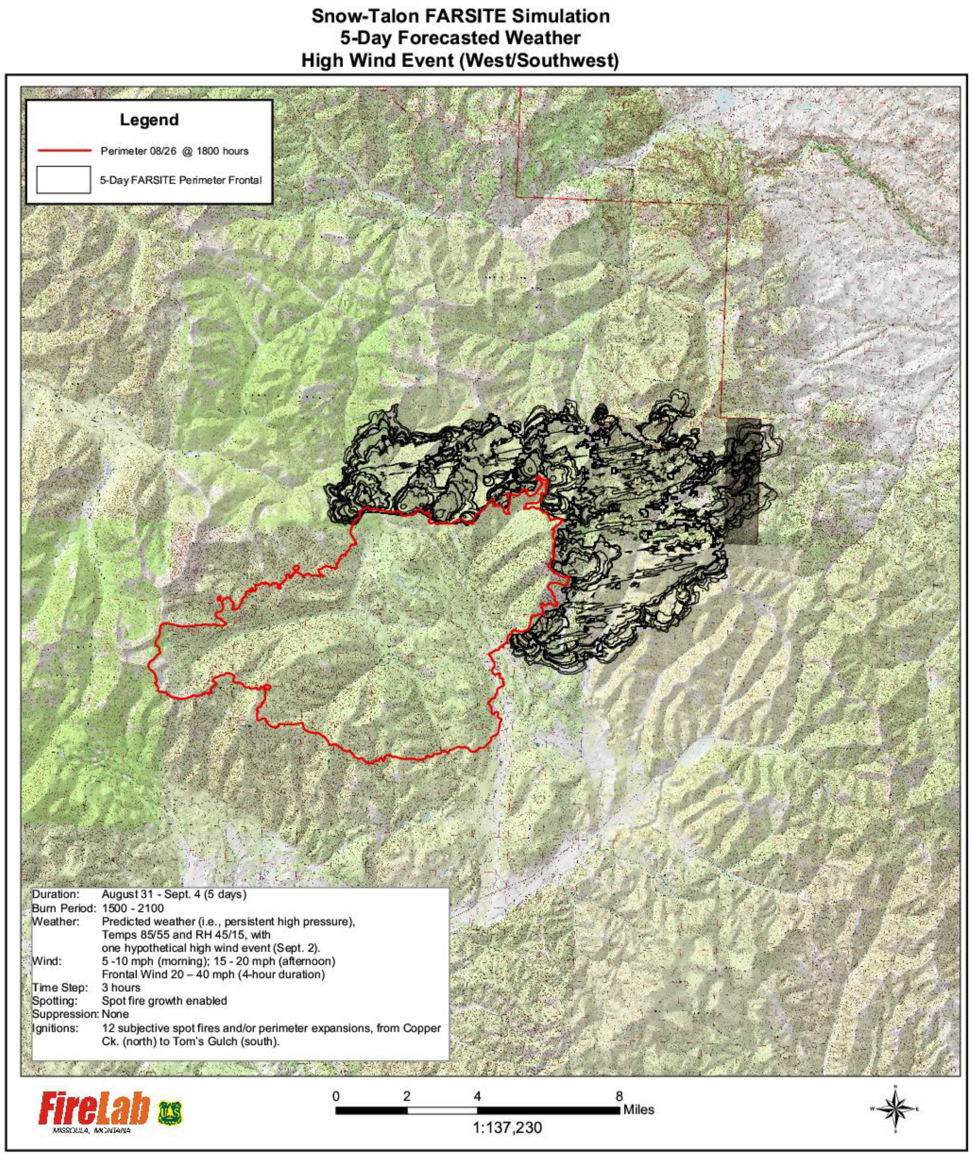

Figure 3. Results from FARSITE simulation of the Snow-Talon fire using a high-wind scenario.

5. REFERENCES

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