NEXT GENERATION FIRE MODELING FOR ADVANCED WILDLAND FIRE TRAINING

OVERVIEW

The Air Force Wildland Fire Center (AFWFC) at Eglin AFB, in collaboration with Los Alamos National Lab (LANL), have initiated a project to demonstrate and validate the capabilities of a physics-based, fluid dynamics wildland fire spread model, FIRETEC, to simulate fire behavior from prescribed fires in southeastern fuels. Funded by the Department of Defense (DoD) Environmental Security Technology Certification Program (ESTCP), this project proposes to (a) validate the FIRETEC model by comparing model simulations to measured values of fire-induced wind velocities and heat release from experimental prescribed fires, (b) demonstrate the ability of FIRETEC to predict realistic fire phenomenological response to heterogeneous forest structure, wind speed, and firing pattern scenarios, and (c) disseminate modeling results and lessons learned to fire managers and practitioners.

WHAT IS FIRETEC?

Current fire spread models are inadequate for predicting the complex influences of atmosphere, forest structure, and self-generating fire processes on wildland fire behavior. FIRETEC is a physics-based, three-dimensional computer code, developed by LANL, designed to capture what is a constantly changing, interactive relationship between wildland fire and its environment. To accurately represent such interactive fire processes, FIRETEC combines physics models that represent combustion, heat transfer, aerodynamic drag, and turbulence with a computational fluid-dynamics model that represents airflow and its adjustments to terrain, vegetative obstructions, and the fire itself.

WHY EGLIN AFB?

- ESTCP is DoD’s environmental technology demonstration and validation program whose goal is to identify and demonstrate the most promising innovative and cost-effective technologies that address DoD’s high-priority environmental requirements.
- The AF Wildland Fire Center at Eglin AFB possesses an extremely active and successful wildland fire program, annually managing over 250 wildland fire incidents either prescribed or wildfire, as well as an extensive fuels monitoring program.
- The Prescribed Fire Combustion and Atmospheric Dynamics Research Experiment (RxCADRE) took place at Eglin AFB in 2008, 2011, and 2012 and will provide invaluable validation datasets for FIRETEC model runs.

FIRETEC SIMULATIONS TO ADDRESS “BURNING” QUESTIONS

Figure 1 illustrates the baseline series of numerical simulations that will be used to illustrate fundamental sensitivities associated with vegetation structure, ignition type, wind speed, and number of ignition lines on fire behavior. In this figure, each of the 18 small black boxes at the bottom represents a simulation that will have the conditions indicated by the number of ignition lines shown in the black boxes and the wind speeds, ignition type, and vegetation structure shown in blue boxes above the black boxes in the tree. To explore and demonstrate the impacts of vegetation structure on fire behavior, three different vegetation conditions will be simulated: grass, canopy, and canopy with midstory. For each of these vegetation conditions, fire will be simulated with a single strip ignition under both moderate (12 mph) and low (5 mph) wind speeds. A much more extensive series of simulations will be performed to explore basic prescribed fire sensitivities in the canopy w/midstory fuel type, shown within dashed lines in Figure 1. For the canopy w/midstory simulations, both aerial/spot and strip ignitions will be simulated and a variety of ignition lines will be simulated: 5, 10 and 15 lines for aerial/spot and 2, 4, and 6 lines for strip ignition. These patterns were chosen as representative of actual ignition patterns based on inputs from Eglin AFB fire managers.
Following the baseline simulations, additional simulations will be performed to identify key phenomenology that should be considered when making decisions about prescribed fire ignition strategies and techniques. Some of the simulations associated with these studies are illustrated in Figure 2, in which the grey boxes indicate simulations that will be leveraged from the baseline scenarios in Figure 1. Black boxes in Figure 2 represent additional simulations. With these simulations specifically focused on prescribed fire techniques and their implications, the project will answer such questions as:

- What is the effect of distance between ignition points on fire intensity and plume lofting?
- How does spot ignition moderate fire intensity as compared to “dash” or “line” ignition patterns?
- How does lighting unit boundaries affect fire behavior/effects in the burn unit?
- What is the effect of ignition point orientation (in-line vs. staggered) with regard to wind direction?
- How does forest structure affect wind fields and resulting fire behavior with various ignition patterns?
- How do the effects of the above ignition patterns change under varying wind conditions?

**EXPECTED OUTCOMES**

FIRETEC will produce short “video clips” of fire behavior for modeled simulations. These will be utilized to develop video and training materials for fire managers which will be shared via:

- Facilitated workshops at DoD installations in southeastern U.S. and other locations upon request
- Interagency Prescribed Fire Training Center
- DoD and other “pyro-tourists” training at Air Force Wildland Fire Center
- Rx-510 Advanced Fire Effects Course hosted at National Advanced Fire and Research Institute (NAFRI) (Upon Invitation)
- Wildland Fire Lessons Learned Center (www.wildfirelessons.net)
- Joint Fire Science Program Knowledge Exchange Regional Consortia (e.g., Southern Fire Exchange)
- Coalition of Prescribed Fire Councils, Inc.
- Fire Research and Management Exchange System (FRAMES) (www.frames.gov)
- Additionally, scientific papers will be produced and shared with the fire science community

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