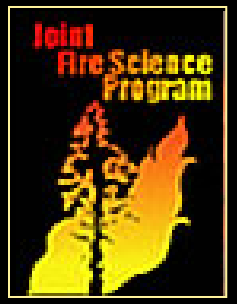


NRS-06 Research and Product Development to Support the Joint Fire Science Program and the National Fire Plan

SMOKE TRANSPORT MODELING AND MONITORING

Presentations

- Development of modeling tools for predicting smoke dispersion from low intensity fires – Overview of JFSP project - Warren Heilman
- Field design for smoke modeling validation - John Hom
- Scalar and particulate fluxes from prescribed fires in the New Jersey Pine Barrens - Ken Clark
- Numerical modeling tools for simulating smoke dispersion and emissions from low-intensity fires - Ryan Shadbolt

Development of Modeling Tools for Predicting Smoke Dispersion From Low-Intensity Fires

Warren Heilman[1], Sharon Zhong[2], John Hom[3], Ken Clark[4], Joseph Charney[1], Gil Bohrer[5], Nicholas Showronski[4] ,Xindi Bian[1], Michael Kiefer[2], and Ryan Shadbolt[2]

[1]USDA Forest Service, East Lansing, MI

[2]Michigan State University, East Lansing, MI

[3]USDA Forest Service, Newtown Square, PA

[4]USDA Forest Service, Silas Little Experimental Forest, NJ

[5]Ohio State University, Columbus, OH

Project Goal

Adapt three existing numerical models for predicting short-range smoke transport and diffusion from low intensity fires and evaluate their performance using observational data from prescribed burn experiments.

Project Hypotheses

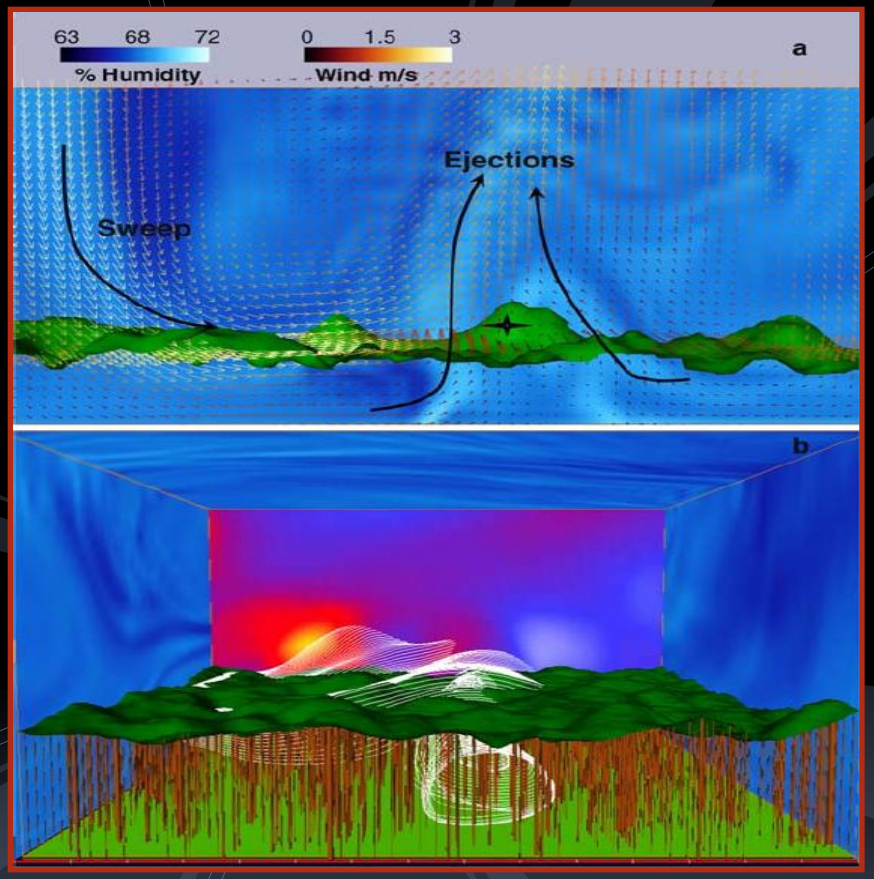
1. Land-surface characteristics, such as terrain and forest vegetation, and near-surface atmospheric processes induced by variations in terrain and vegetation can have significant impacts on smoke transport and diffusion from low-intensity fires.

2. Improved understanding of these impacts will lead to better predictions of smoke transport and dispersion over areas of complex terrain and forest vegetation.

Model Adaptation and Evaluation

RAFLES

The RAMS-based Forest Large Eddy Simulation (RAFLES) model, which has been used to simulate biological dispersal in forest canopies (Bohrer 2007), is being adapted to simulate smoke dispersion from prescribed/wildland fires and the effects of canopy structure on the dispersion.

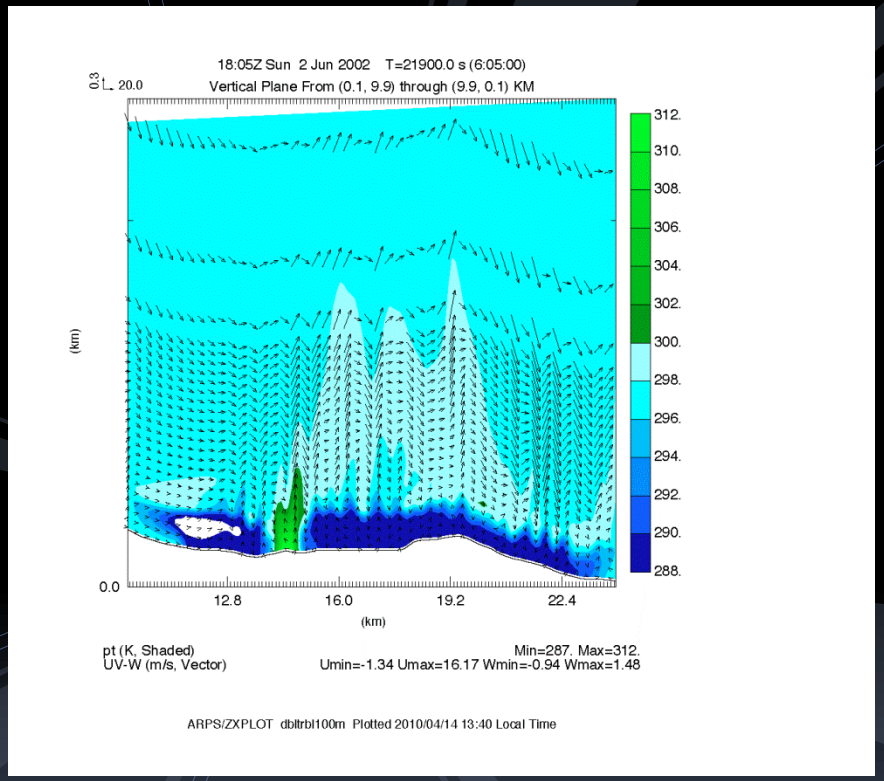


Example RAFLES simulations of circulations (ejection-sweep dynamics) and humidity within and above a forest vegetation layer. Green surface in figures represents the canopy top; tree stems are represented by brown; temperature on the back "wall" (From Gil Bohrer)

Model Adaptation and Evaluation

ARPS-FLEXPART

The Advanced Regional Prediction System (ARPS), originally developed at the Univ. Oklahoma, has been modified to include canopy effects on boundary-layer dynamics and is being used to simulate the atmospheric response to "fires" in forested environments. Meteorological output from ARPS simulations will be used to drive a particle transport model (FLEXPART).

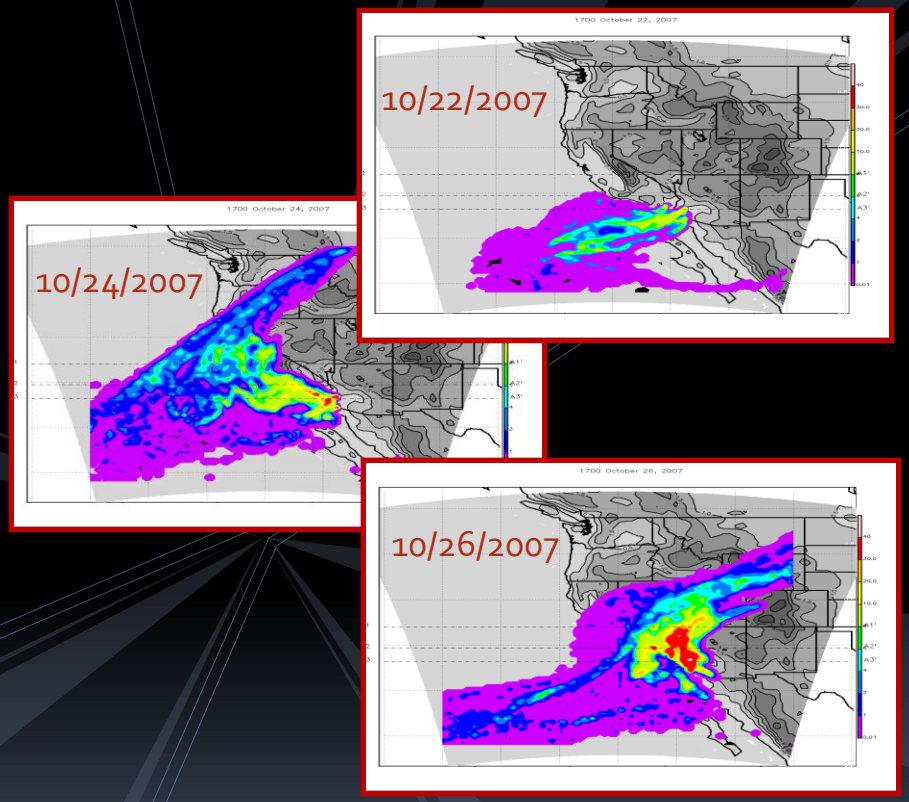


Example ARPS simulation of circulations and potential temperatures resulting from an imposed 800 W m^{-2} heat source at the surface in a forest vegetation layer. (From Mike Kiefer – MSU)

Model Adaptation and Evaluation

WRF-FLEXPART

The Weather Research and Forecasting (WRF) system has been coupled to the FLEXPART particle transport model (Fast and Easter 2006) and will be modified to include canopy effects on boundary-layer dynamics . It will be used to simulate the atmospheric response to "fires" and the associated transport of smoke particles from "fires" in forested environments.



Example WRF-FLEXPART simulated surface CO concentrations during the October 2007 southern California wildfires (From Lu et al. 2009)

Meteorological and Smoke Monitoring

Prescribed burn experiments are being conducted in the New Jersey Pine Barrens with *in situ* ground- and tower-based meteorological and air quality instrumentation. Data from these experiments will be used to evaluate the meteorological and air quality simulations from RAFLES, ARPS-FLEXPART, and WRF-FLEXPART, as well as improve our understanding of forest vegetation impacts on the atmospheric environment during wildland and prescribed fires.


Burn Site
The experimental site for the monitoring component of this study is located in the New Jersey Pine Barrens Administrative Area and National Reserve. The Pine Barrens have some of the most volatile fire cycle vegetation in the East (Pitch Pine, scrub oaks and shrubs). Smoke emissions and air quality are major concerns here.
New Jersey
New Lisbon, Pemberton, NJ 08015
Philadelphia
Pennsylvania Turnpike
Atlantic City Expy
Garden State Pkwy
287
1
29
276
295
195
18
33
138
422
309
63
13
90
676
476
76
322
130
42
495
40
55
9
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Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2010 Europa Technologies
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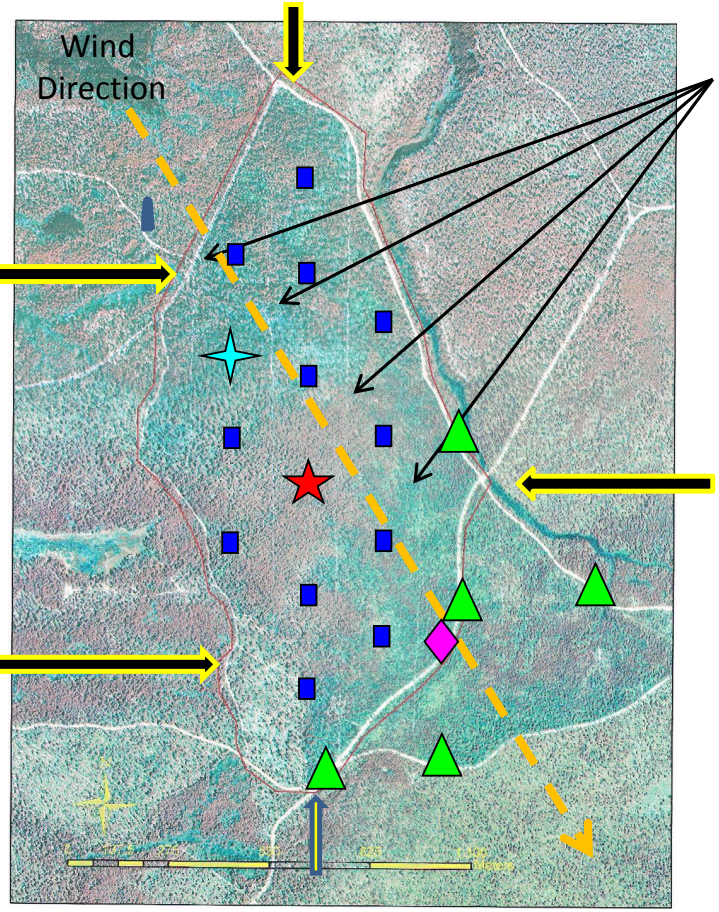
Experimental Design
NJ Pine Barrens

Pine overstory, Vaccinium with Oak understory 265 Acres

N

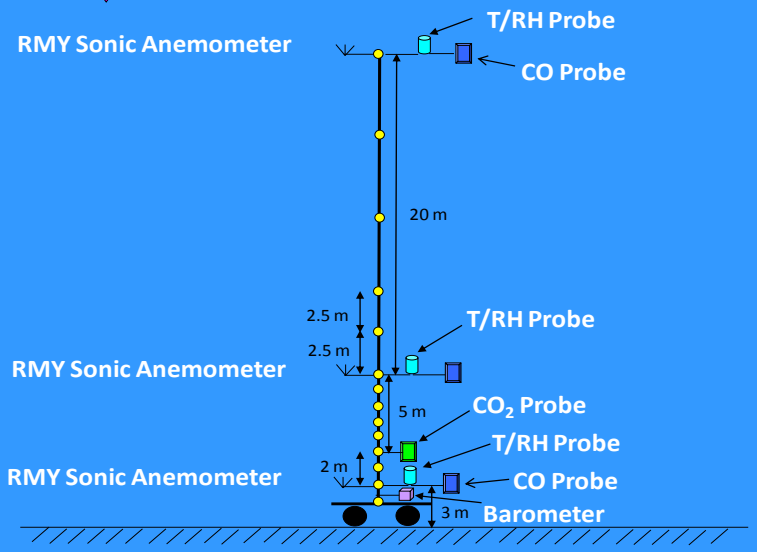
Ambient measurements
1 km NW of burn site



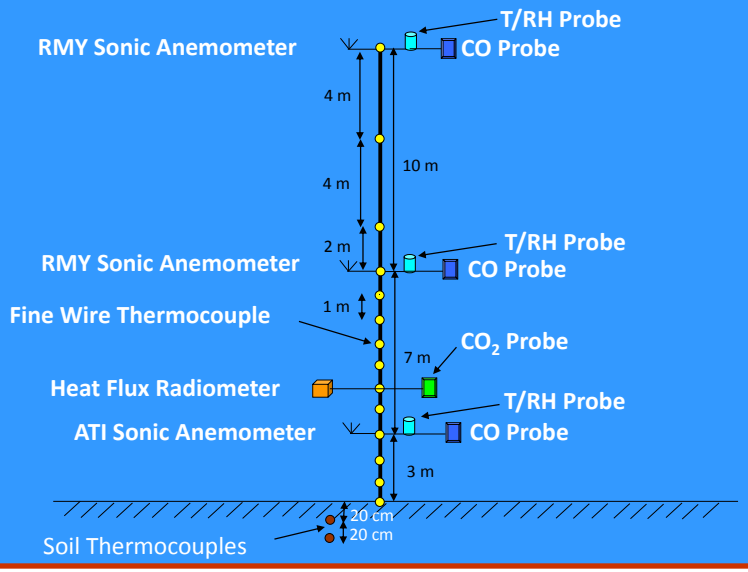
Plow lines (Ignitions along lines from south to north)

30 m Tower
20 m Tower
10 m Tower
3 m Tower
$PM_{2.5}$ Monitor
SODAR

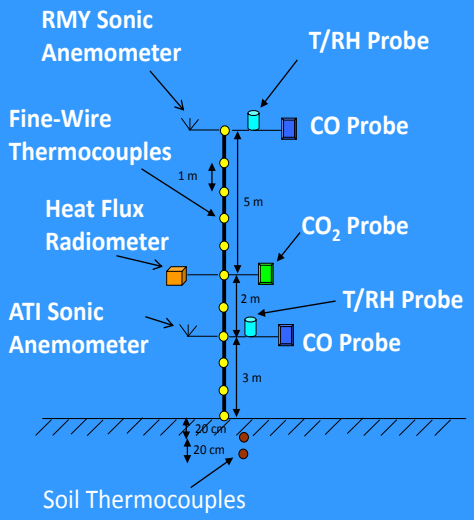
30 m Mobile Tower



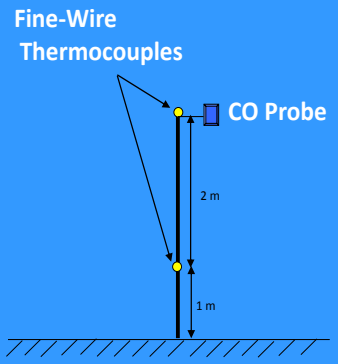
20 m Tower



10 m Tower



3 m Towers



Meteorological and Smoke Monitoring

- Prescribed burning was severely limited in NJ this year because of snow/precipitation.
- First prescribed burn experiment started on the morning of March 26, 2010.
- NJFFS halted all prescribed burns in NJ shortly after 1200 LT on 3/26 due to adverse fire-weather conditions and wind concerns associated with a sea breeze front.
- Wait till next year!!!!!

Discussion

- Smoke/air-quality research in NRS-06
- Participation in field campaigns (e.g. RxCADRE, FireFlux) in other locations
- ????