Abstract: Recent individual field programs, including FireFlux, In-canopy Plume Dynamics, Rapid Response, and Fuel Analyses, were combined in a comprehensive field study to measure in-canopy fire meteorological and thermodynamic parameters, determine smoke plume transport and dispersion near the active front, and to quantify emissions from the smoldering portions of the burn. Those data were used to evaluate a simple puff-dispersion model developed for in-canopy plume transport and to integrate the model into the BlueSky Smoke Modeling Framework. The end products are an extensive data base of emissions and smoke behavior from low-intensity/smolder fires and a new ability to simulate sub-canopy smoke concentrations. Results provided to the fire and air quality communities include a unique, replicated, in-situ observation dataset of smoke plume emissions, transport, and dispersion collected in a longleaf pine forest canopy of uniform age, stand structure. Data have been used to evaluate an existing In-canopy, near-source puff dispersion model and three BlueSky pathways. The project has four major objectives: 1. Investigate sub-canopy meteorology and smoke plume dynamics as the flaming front moves through the burn unit; 2. Employ fuels, smoke, and tracer data to develop emission factors for PM and other pollutants from the smoldering phase of the burn and incorporate these into BlueSky; 3. Evaluate the in-canopy puff dispersion model for simulation of near source (≤10 km) smoke transport and dispersion and b) integration as a new module into BlueSky, and 4. Translate the model evaluations into a usable guide for decision makers.

The Site:
TNC Calloway Forest/
Sandhills Preserve
- Long-leaf pine (Pinus palustris Mill.) — natural regeneration in the areas burned
- Average age is 50 years
- Fire encourages
- Long-leaf height
- Windbreak (Aristida stricta) reproduction
- Shrubification of shrub species
- Keeping turkey cove back

Flux tower instrumentation
2 flux towers (20 m) instrumented to measure winds, heat, and H2O fluxes at a fine time-scale
A “Super tower” (26 m) was outfitted with additional instruments to measure tracer gas fluxes: CO, CO2, CH4, NOx, NH3, N2O and a tracer

Concentrations
Concentrations: Black carbon in the source

PM2.5 and CO (Near-Source)

Introduction —what we do
Smoke: fire-atmosphere interactions

Vertical profiles of winds and temperature to characterize turbulence and heat flux

Sub-Canopy Smoke Dispersion: Measurements of fire-behavior, fuels, consumption, emissions, plume rise and dispersion near and in a prescribed fire-source
Authors: Robert A. Mickler, Tara Strand, Miriam Rorig, Craig Clements, and Brian Lamb
Affiliations: Alion Science and Technology Corporation, USDA Forest Service, San Jose State University, and Washington State University

Dispersion Results
Real -Time
Using observed consumed values

Adding observations decreased concentrations and plume width

Tracer Gas
Tracer concentrations (ppt)

Verification of plume source
Understanding dilution
Model evaluation and testing of theory

Fire Behavior-Temperature
- 2011 Calloway Rx Burn 1
CO Monitors and Small Tower
240 F Mean
250 F Min.
1,200 F Max.

Tracers
L2Z F Mean
250 F Min.
1,300 F Max.

- 2011 Calloway Rx Burn 2
CO Monitors and Small Tower
650 F Mean
240 F Min.
1,200 F Max.

Tracers
L2Z F Mean
250 F Min.
1,300 F Max.