# Uncertainties in prescribed fire emissions and their impact on smoke dispersion predictions

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Ninth Symposium on Fire and Forest Meteorology
20 October, 2011

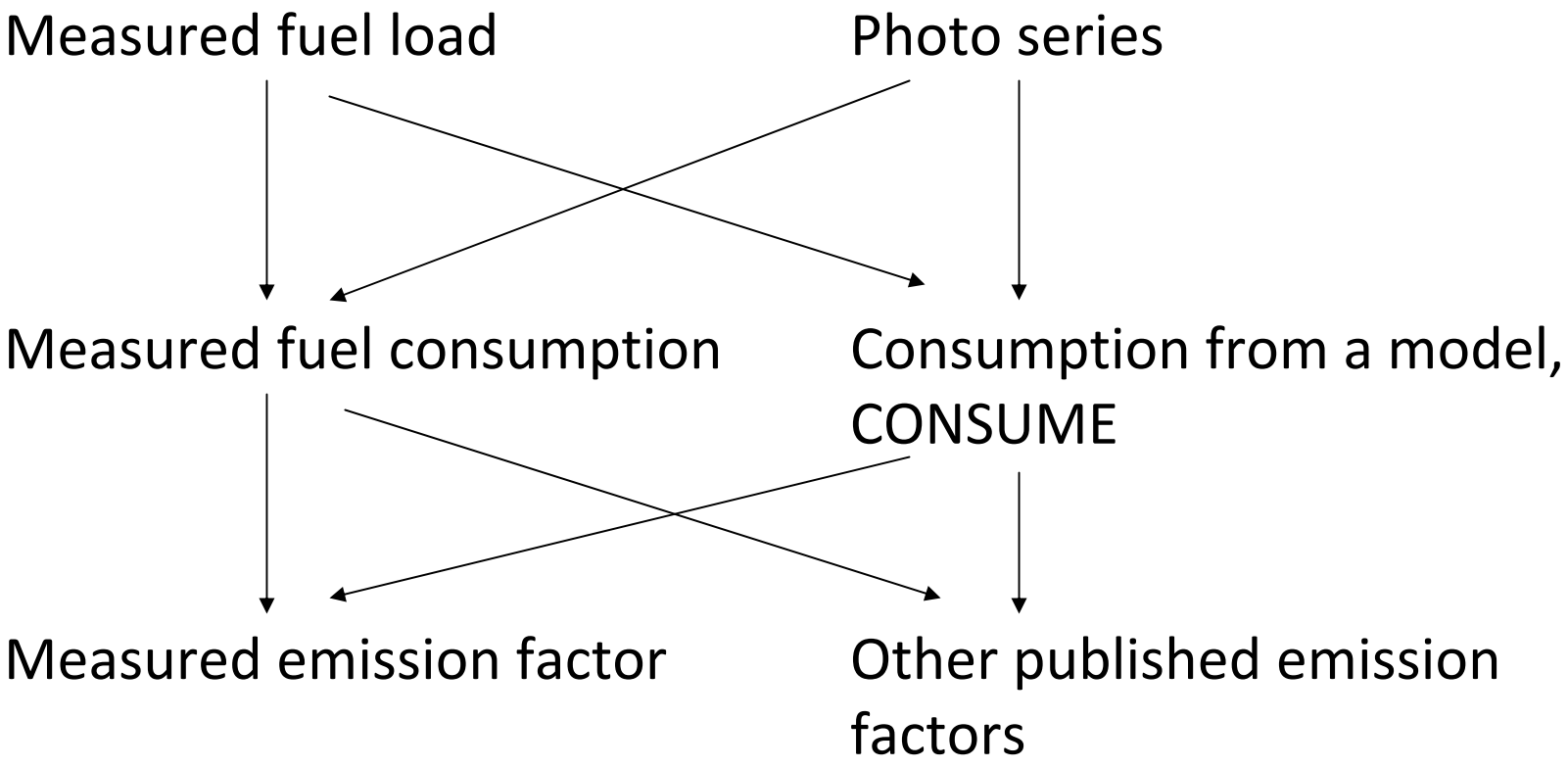
# Motivation

- U.S. EPA lists Prescribed burning as the 3rd largest source of fine particulate matter.
- Knowing the uncertainties associated to smoke impact prediction is critical for decision making
- Accurate predictions of the smoke and air quality impacts require several modeling tools. Each model introduces uncertainties and uncertainties propagated from model to model.

# Areas of study

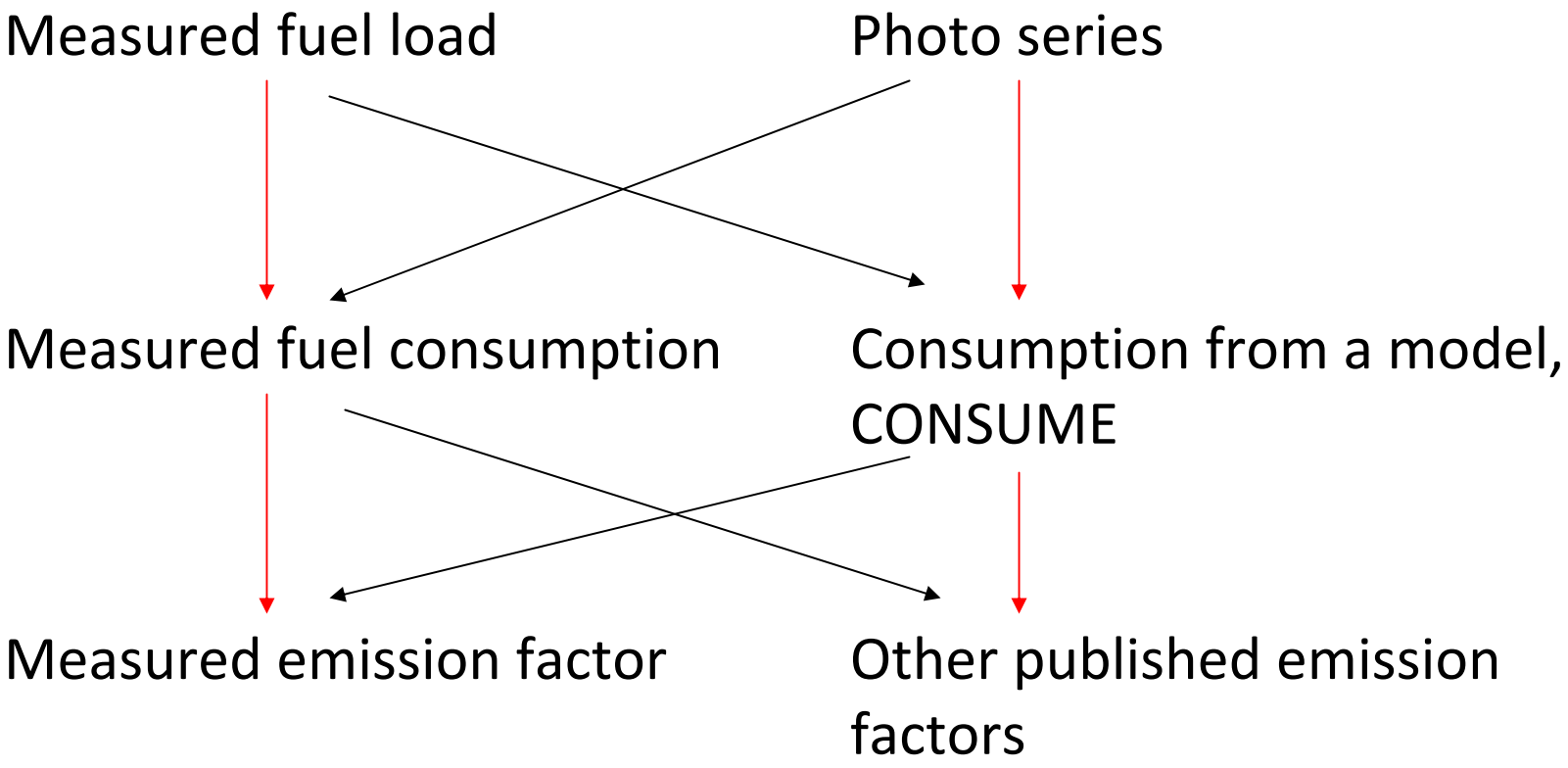
1. Fuel load
   - Lab results from fuel samples vs. estimates based on photo series
2. Consumption
   - Lab results from fuel samples vs. model (CONSUME) estimates
3. Emission Factor
   - Derivation based on emissions measured near the fire vs. other emission factors from literature

# Methods of calculating fire emissions




$$Emission_{PM2.5} = EF_{PM2.5} \times consumption$$

# Methods of calculating fire emissions

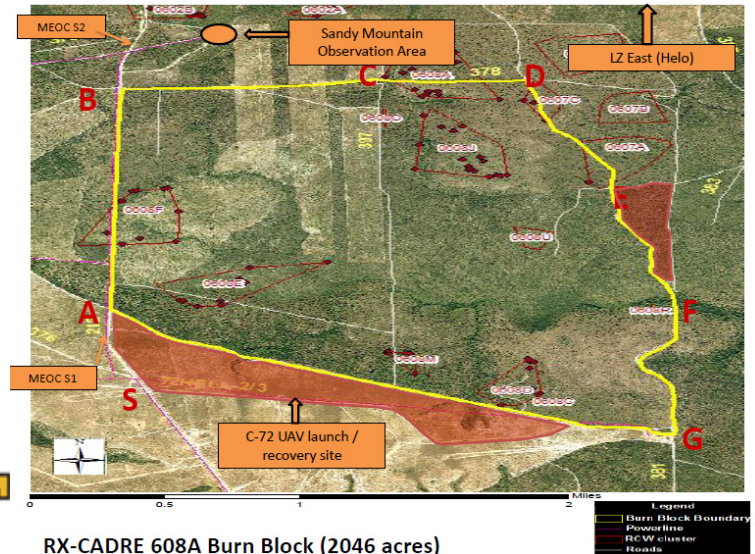



$$\Delta\, Emission_{PM2.5} = \Delta EF_{PM2.5} \times \Delta consumption$$

# Case study: Feb 8, 2011 RxCADRE 608A in Eglin, FL.

- Burn lot: 2054 acres with 2 yr old fuel
- helicopter starts firing at 11:59am local time
- helicopter completes firing at 1:56pm
- majority of burnout

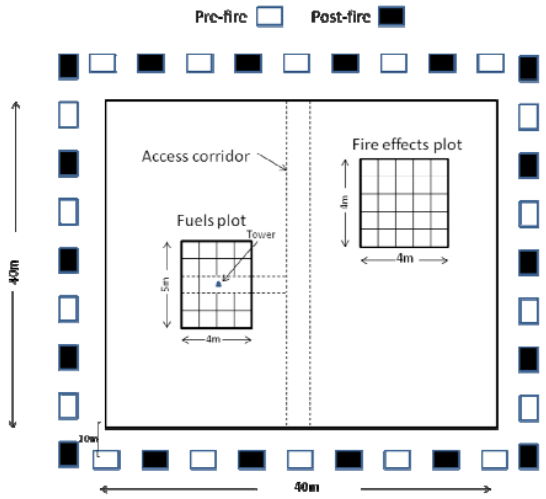
continued until 2:20pm

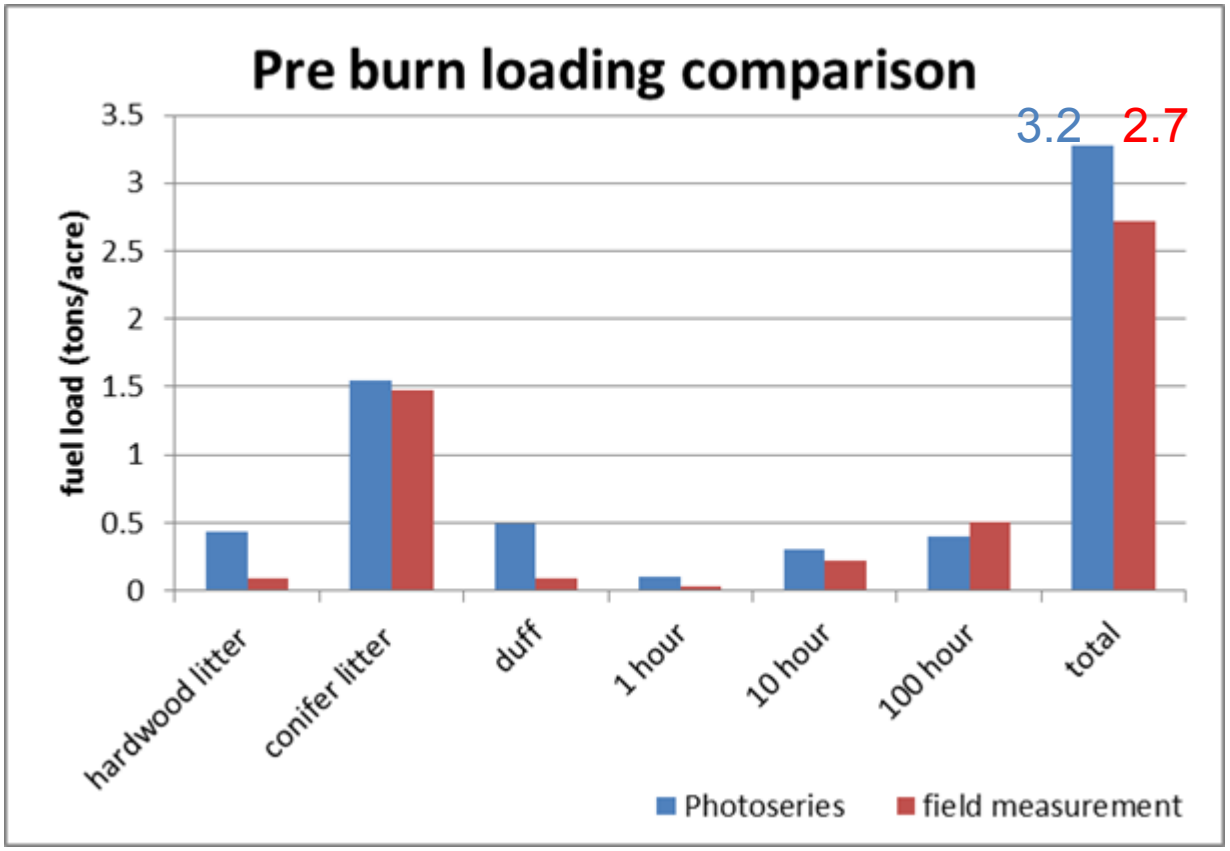



RX-CADRE 608A Burn Block (2046 acres)

# 1) Fuel Load: fuel measurement vs. photo series

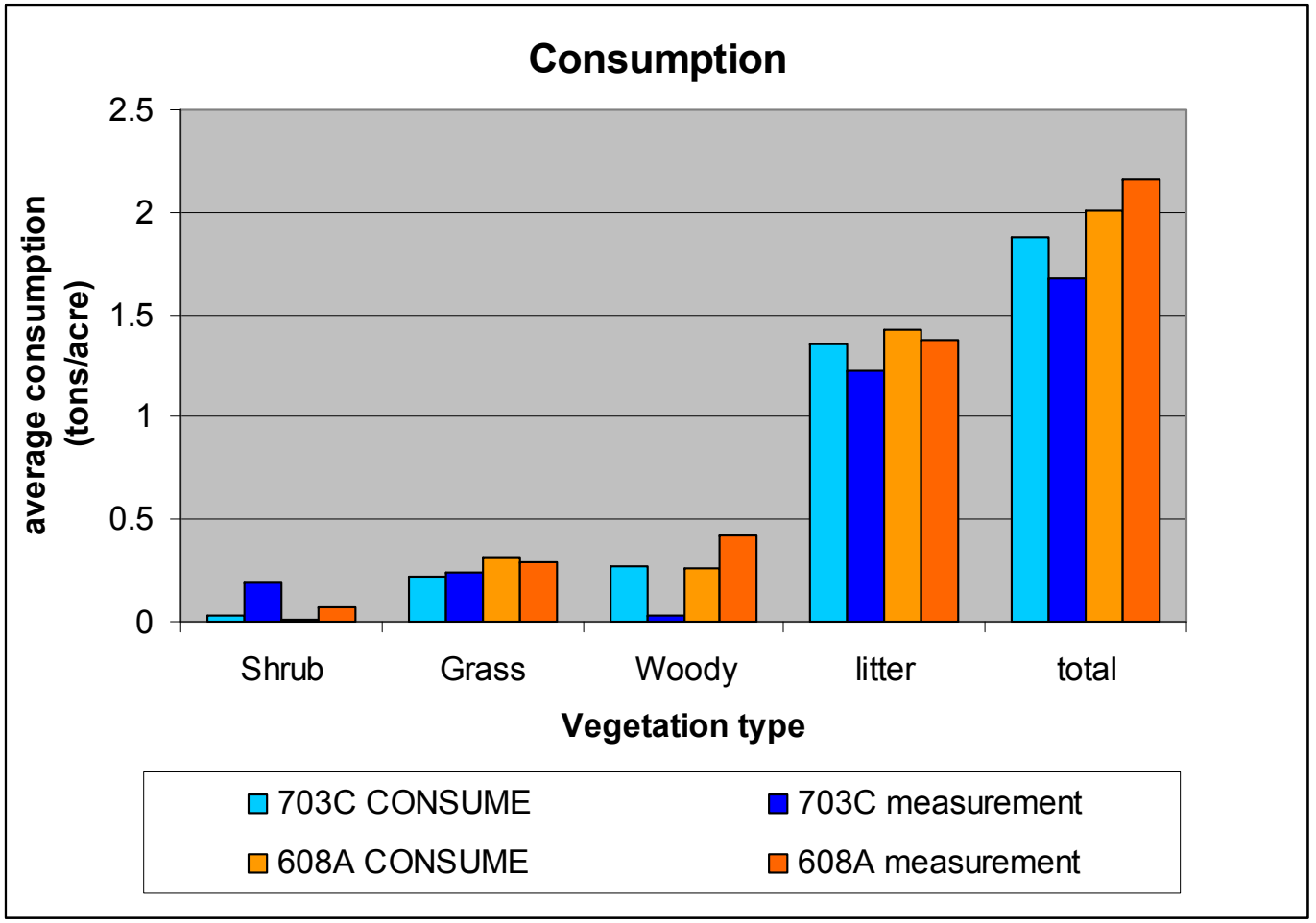
18 4mX5m




Total fuel estimate difference of 0.5 tons/acre, 20% overestimated

# 2) Fuel Consumption: measured vs. model CONSUME 3.0

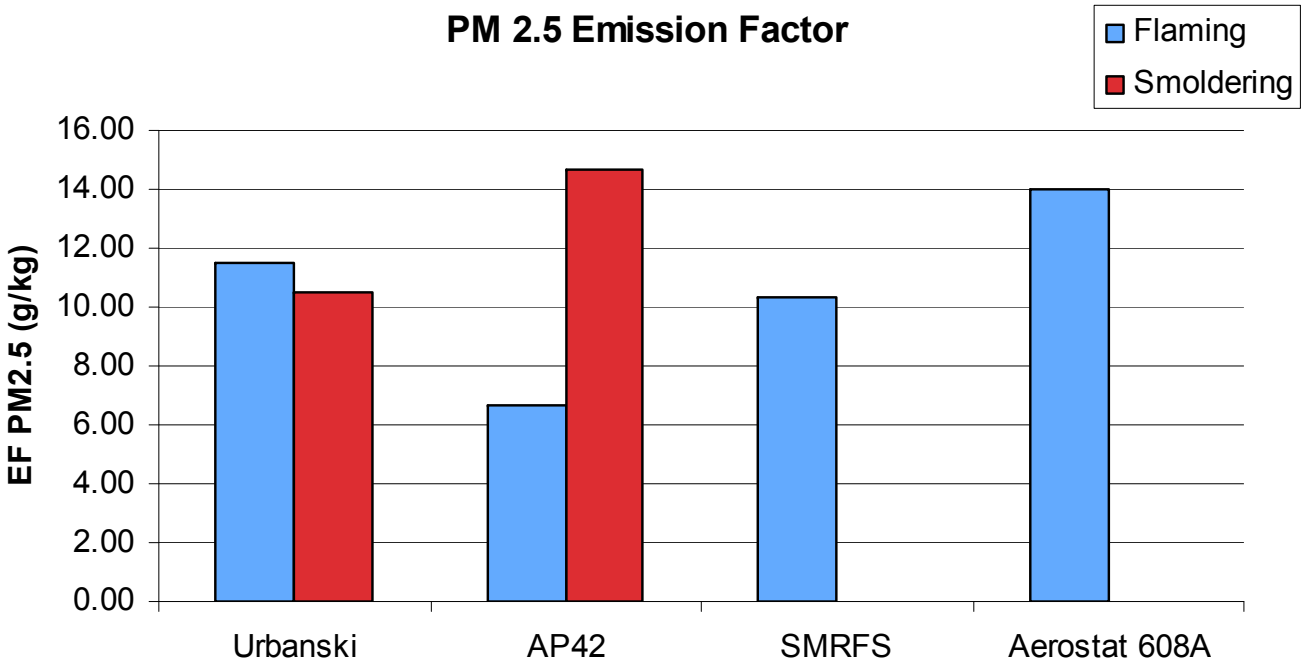



608A consumption difference of 0.15 tons/acre, 7% underestimated

# 3) Emission Factor: literature vs. calculated from aerostat measurement

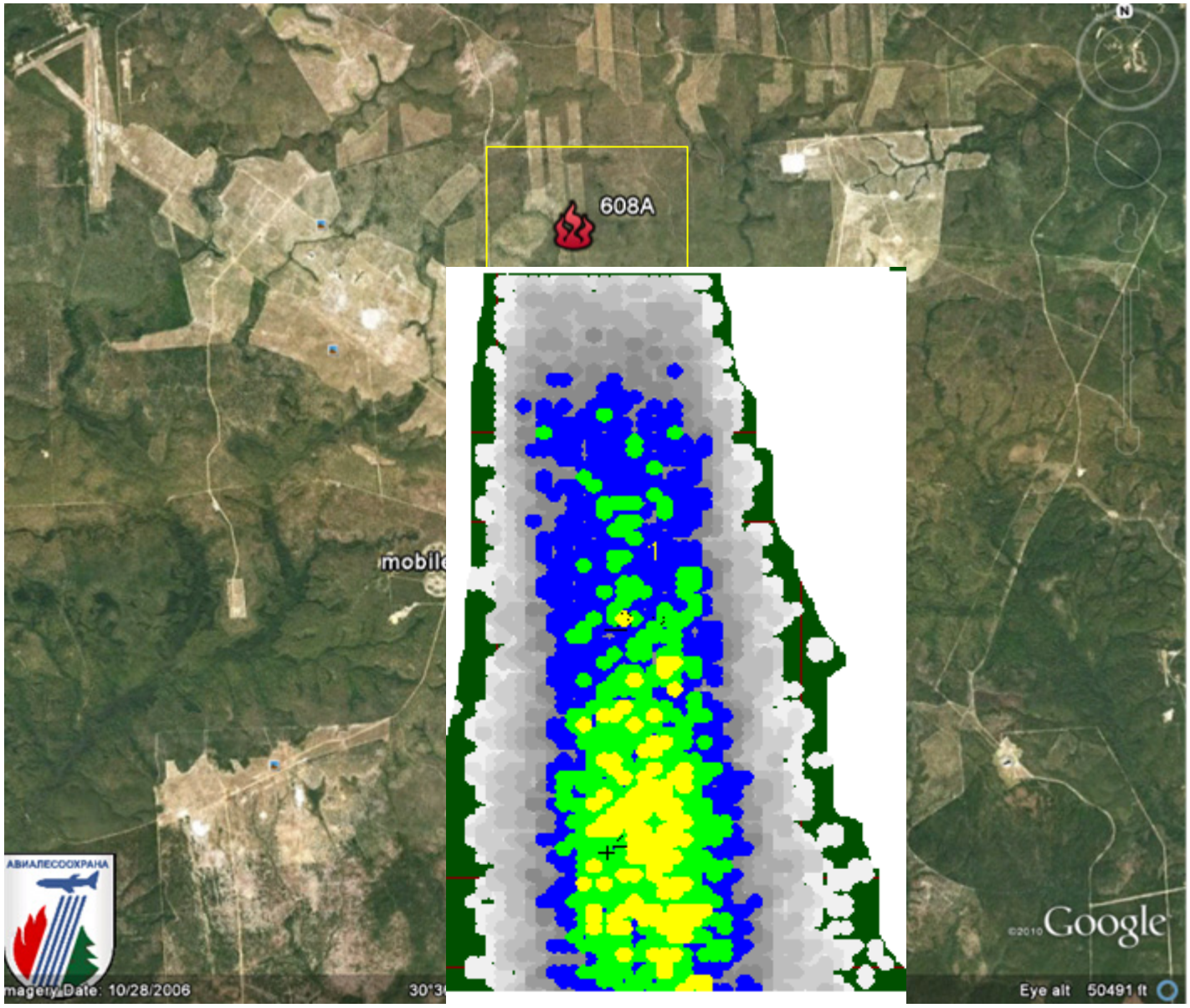
Event based EF compared to published PM2.5 emission factors (Urbanski et. al.(2008), AP42) and emission factors measured in a laboratory (SMRFS).


Difference (SMRFS vs field) of 4g/kg in emission factor causes 30% difference in total mass of PM2.5 emitted from the burn.

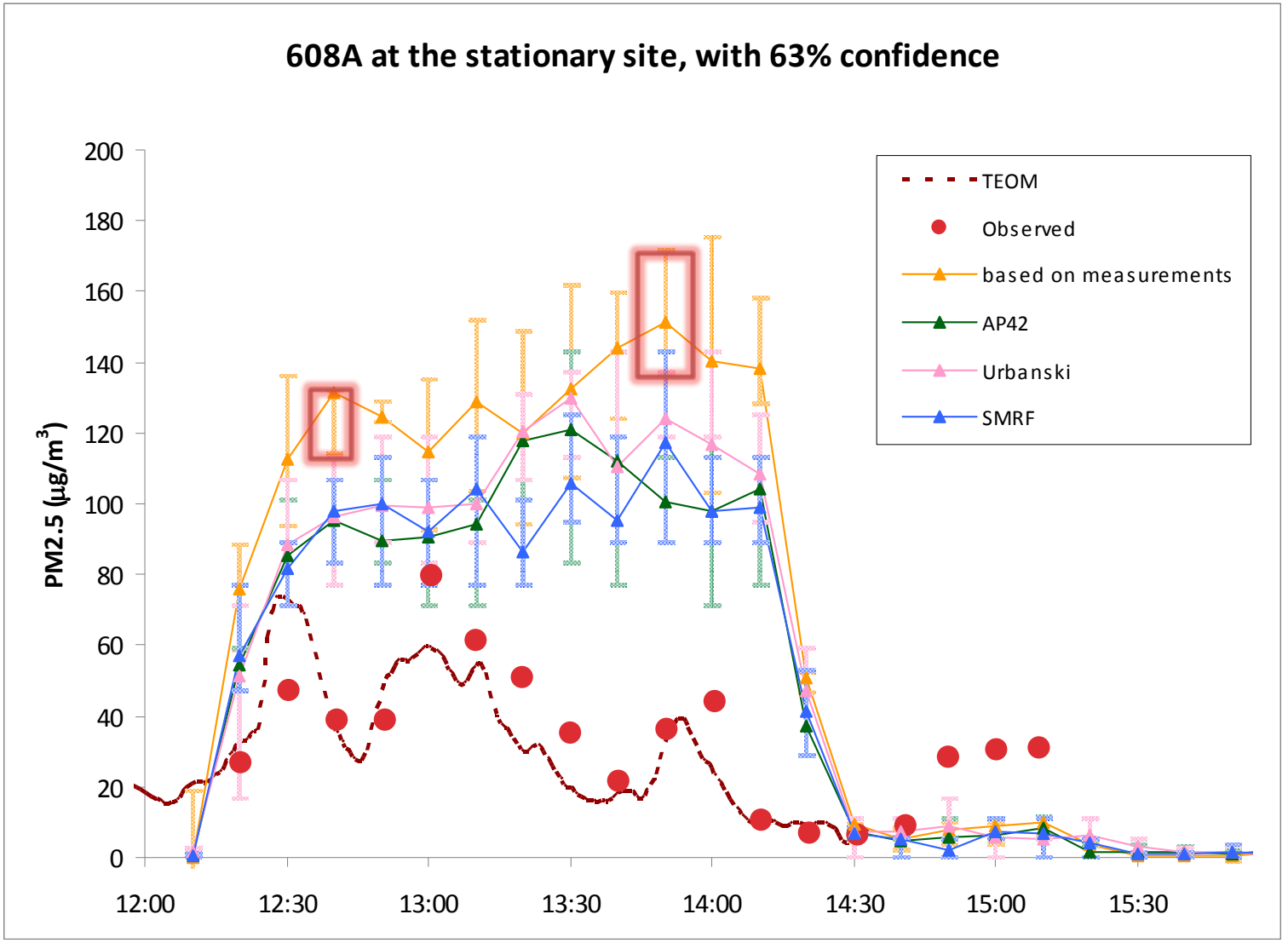


# Calculate concentration with Daysmoke

Stationary site
4km (2.5 mi) away from the center of 608A block



# PM2.5 concentration measured vs. modeled with different emission factors



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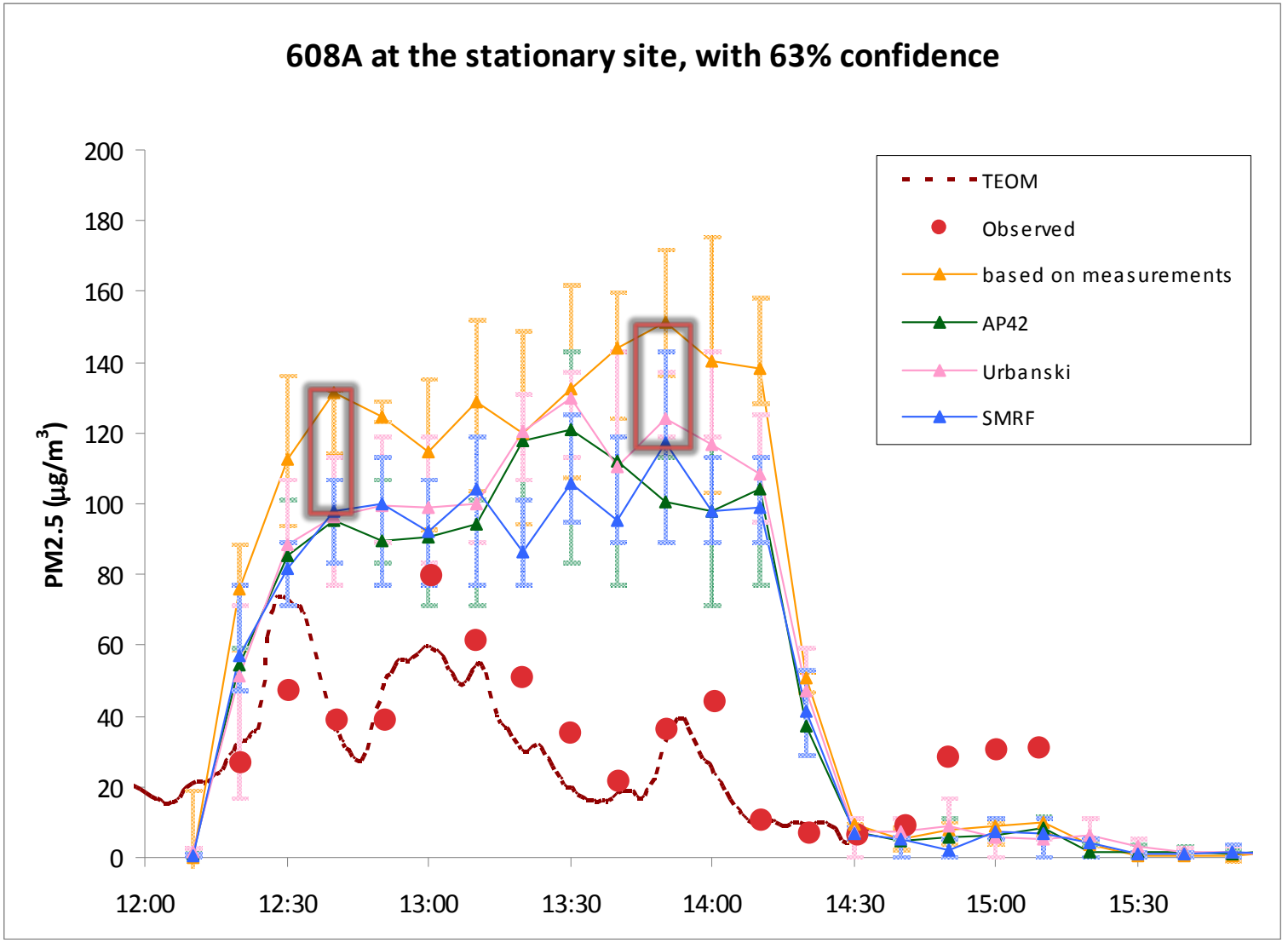

# Summary

- For this case study, fuel load has 20% uncertainty, fuel consumption  has 7% uncertainty, and emission factor has 30% uncertainty.
- Uncertainty created by fuel load, consumption, and emission factor is just as big as the variance of the smoke dispersion model, therefore improvements in these three inputs will make model improvements.
- Uncertainties of other input variables must be studied as well in order to reduce the difference between model and observations.

# Acknowledgements


- Strategic Environmental Research and Development Program
- Joint Fire Science Program
- Georgia Department of Natural Resources, Environmental Protection Division
- US Forest Service, Southern Research Station