Technical Methods for Wild and Prescribed Fires - 2011

Sean Raffuse, ShihMing Huang
Sonoma Technology, Inc.
Petaluma, CA

for

EPA Fire Emissions Summit
Raleigh, NC

November 3, 2014

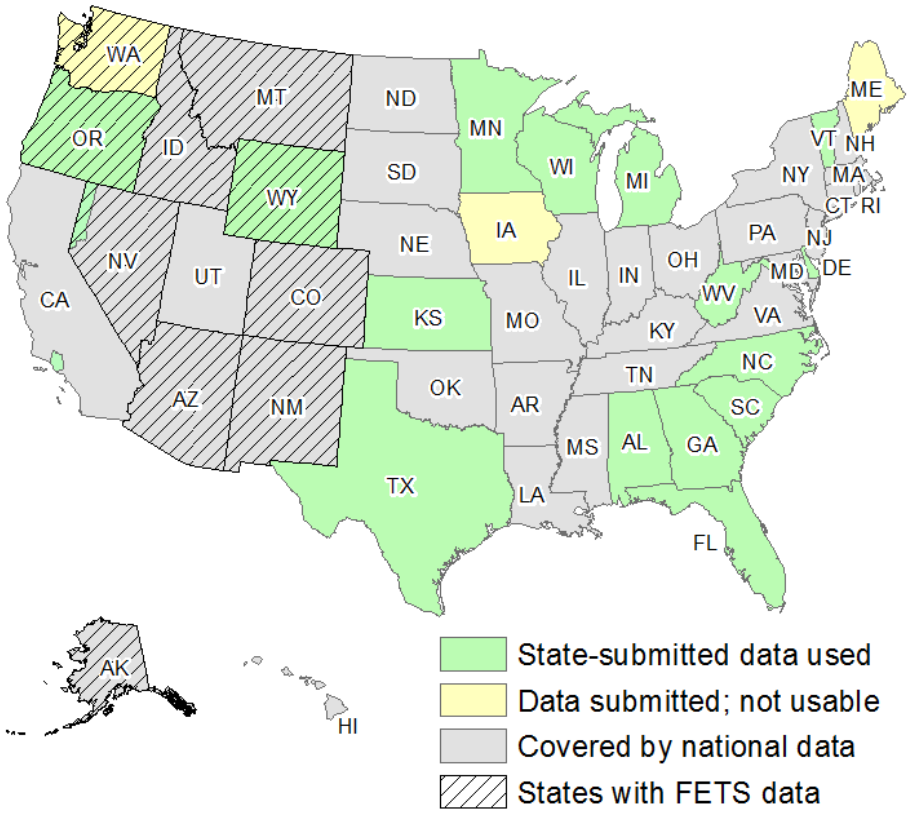
STi
Sonoma Technology, Inc.

Methods – Big Picture

1. Gather as much information on fire occurrence as possible from all sources
2. Reconcile sources of fire into a single data set for area burned
3. Estimate and calculate emissions
   - Emissions = Area Burned * Available Fuel * Fraction Consumed * Emission Factor

Gather State Data

- Through funding from the USFS, we put out a call for state fire activity data
- State-provided data covered 23 states
- Thank You!
- Each data set was reviewed for the basic information needed

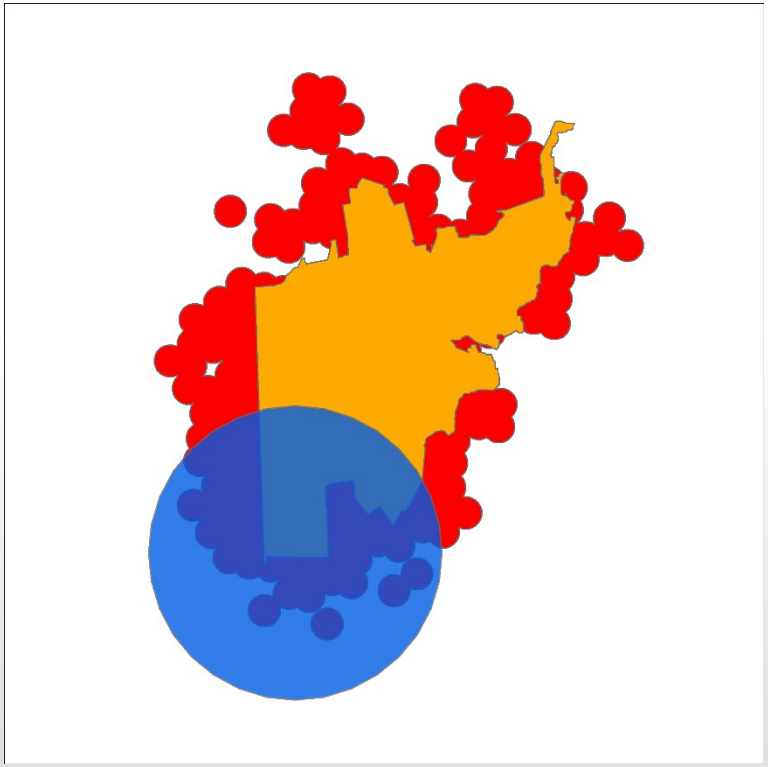


Gather National Data

- Incident Command Reports – many WFs
- GeoMac Perimeters – large WFs
- US Fish & Wildlife – Rx burns on FWS land
- US Forest Service – Rx burns and some WFs on USFS land
- National Association of State Foresters – database of WFs and some Rx burns on state jurisdiction
- NOAA Hazard Mapping System – Detection from seven satellites plus human analysts

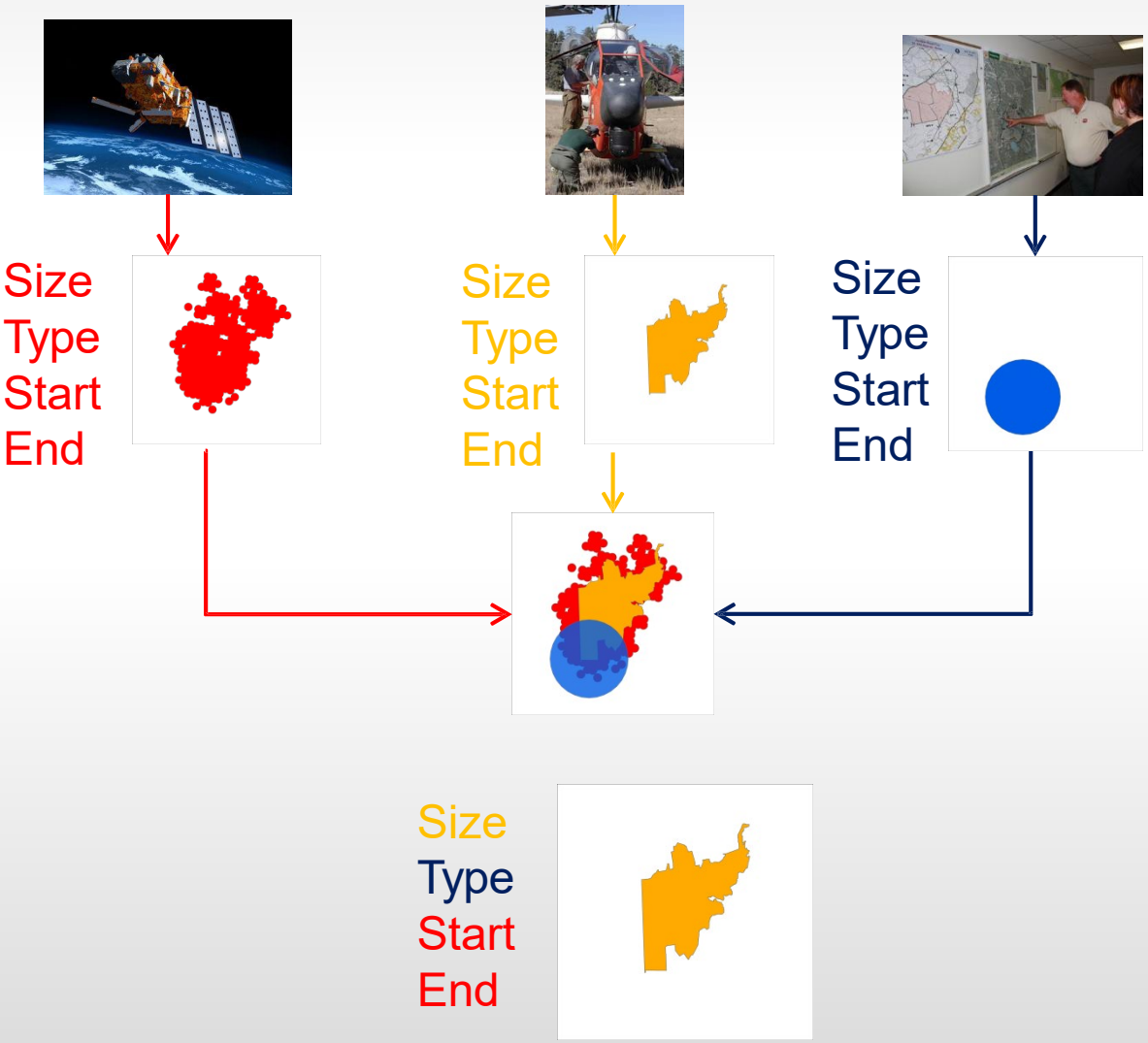
Reconciliation – Overview (1)

- If multiple data sources have information on a fire that overlaps in time and space, we must choose what is correct.
- Elements we need:
  - Name
  - Location/Shape
  - Size (total area burned)
  - Type (WF, Rx, Ag)
  - Start and End Dates
  - Daily fraction of area burned



Reconciliation – Overview (2)

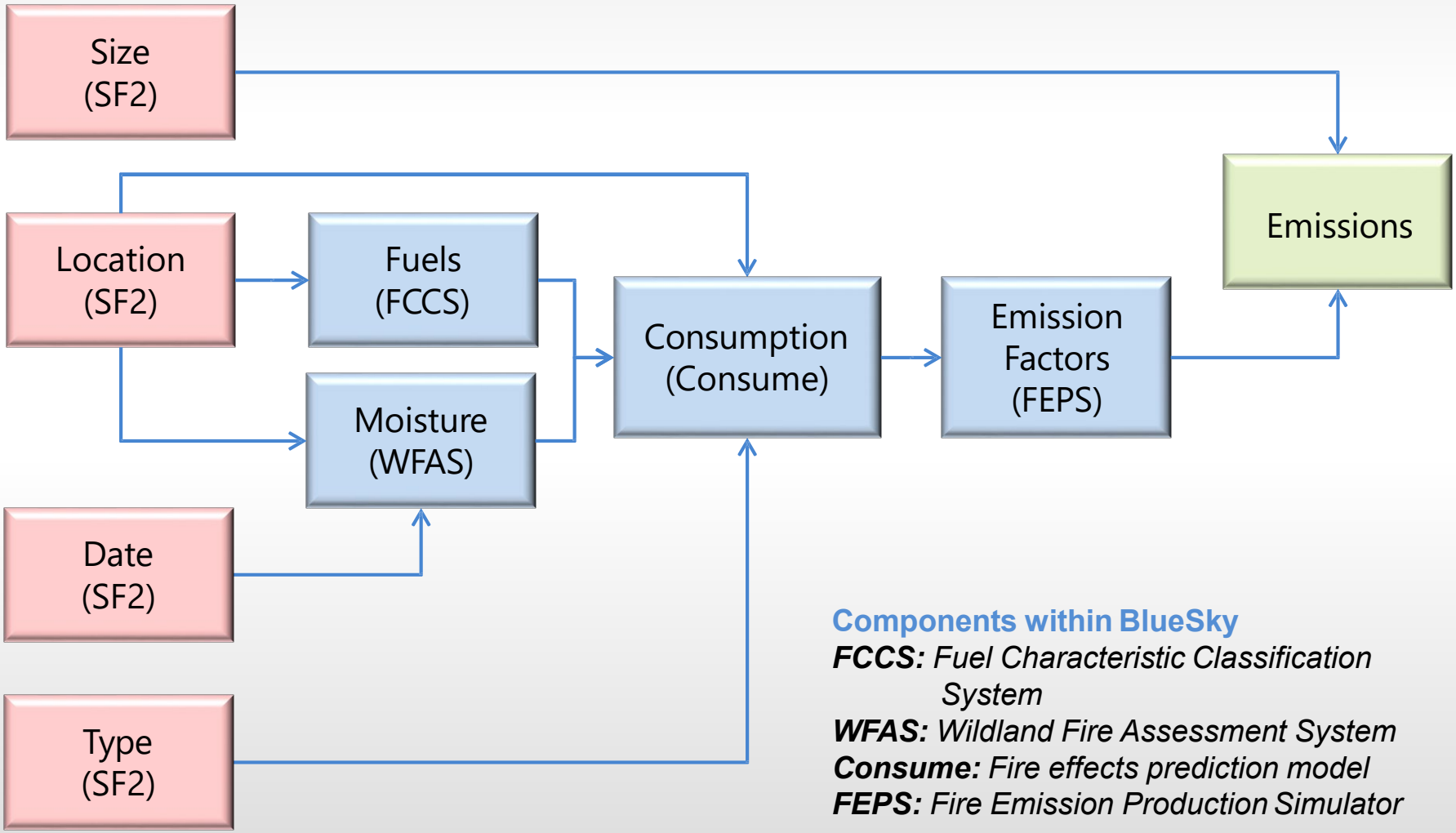
- We ranked each data source for reliability of each element
- Then, for each fire, a final composite fire was created using the highest ranking data to build the fire



Reconciliation – General Notes

- State data trump other sources
- Satellite data are generally low rank, as they provide the least specific information
- Agricultural burns were removed prior to emissions processing
  - Fires from any data source that were designated Agricultural
  - Satellite detected fires within crop land cover

The SmartFire-BlueSky Process



Components within BlueSky

FCCS: *Fuel Characteristic Classification System*

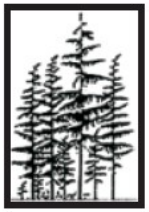
WFAS: *Wildland Fire Assessment System*

Consume: *Fire effects prediction model*

FEPS: *Fire Emission Production Simulator*

Fuel Loading

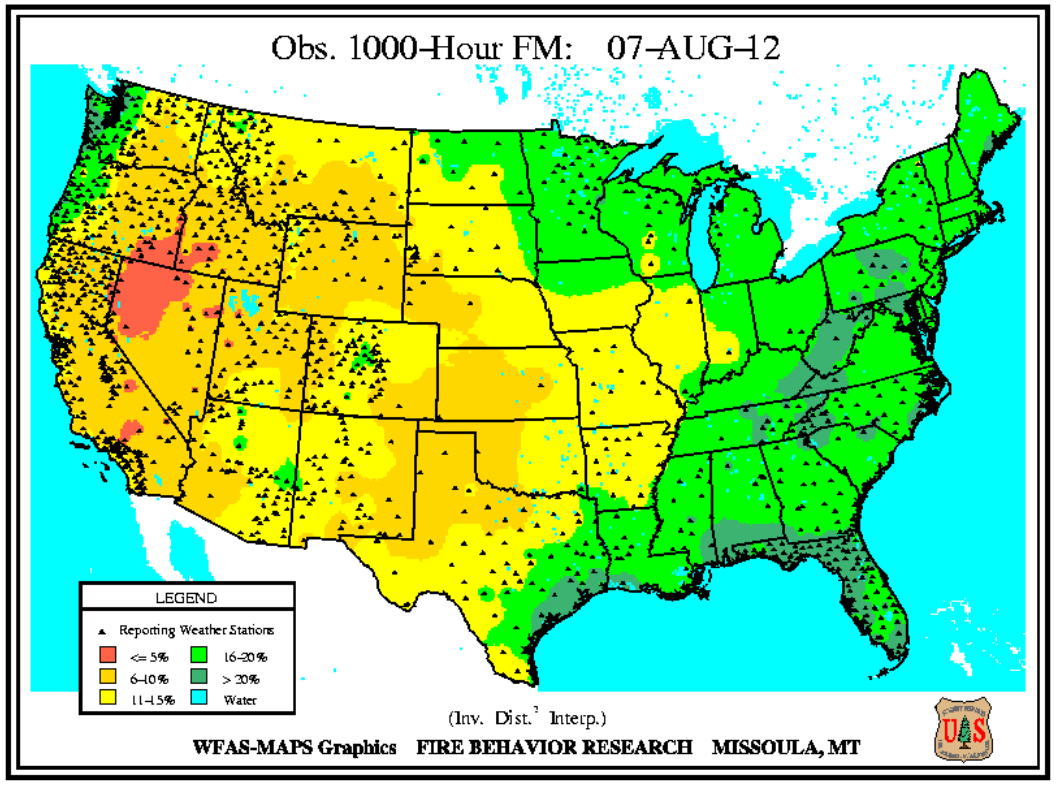
- What is available to burn?
- Fuel loadings from the Fuel Characteristic Classification System (FCCS)
  - 1-km resolution map assigns fires to one of several hundred "fuelbeds"
  - A fuelbed describes the live and dead vegetation structure of a region for use in fire effects models

Stratum		Category
CANOPY		Trees, snags, ladder fuels
SHRUBS		Primary and secondary layers
NONWOODY VEGETATION		Primary and secondary layers
WOODY FUELS		All wood, sound wood, rotten wood, stumps, and woody fuel accumulations
LITTER-LICHEN-MOSS		Litter, lichen, and moss layers
GROUND FUELS		Duff, basal accumulations, and squirrel middens

Source: FCCS Users Guide

Fuel Moisture

- Consumption depends on moisture in the fuels
- Nearby moisture values are retrieved from the Wildland Fire Assessment System (WFAS)
- Daily observed 1000-hr fuel moisture values at fire weather stations

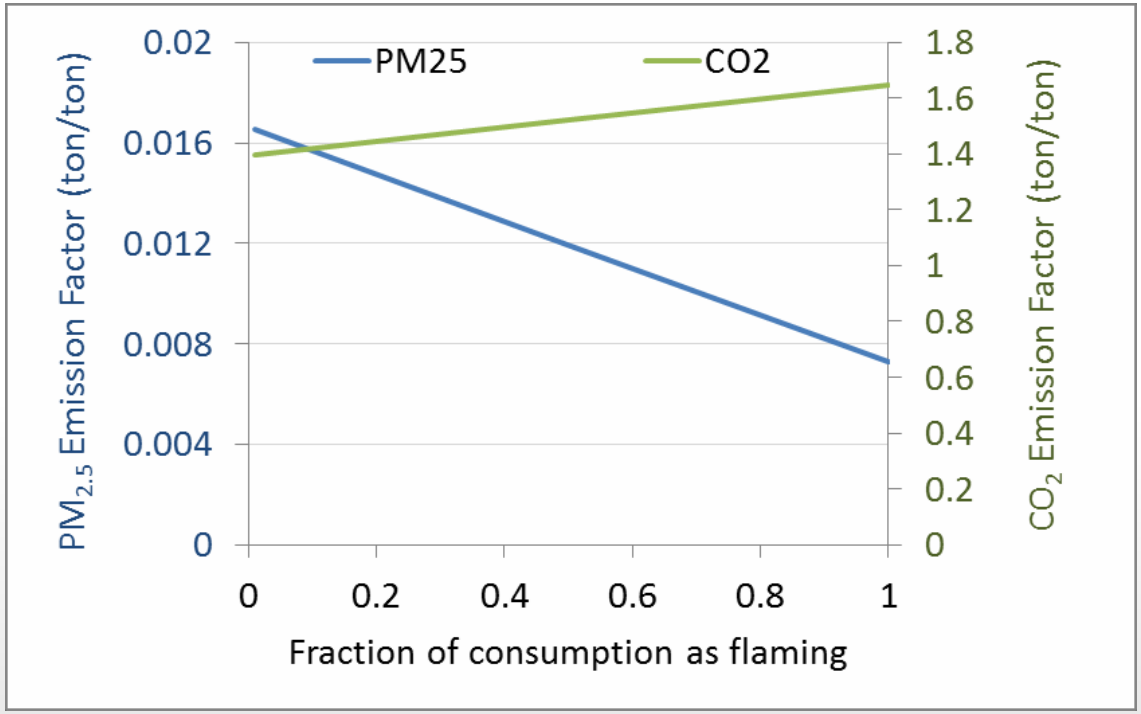


Consumption

- What fraction of the available fuel is consumed?
- USFS FERA Consume 4.1 Fire Effects Model
- Inputs include available fuel loadings and fuel moisture
- Outputs include consumption by combustion phase
- Ground fuels consumption was capped for Rx burns

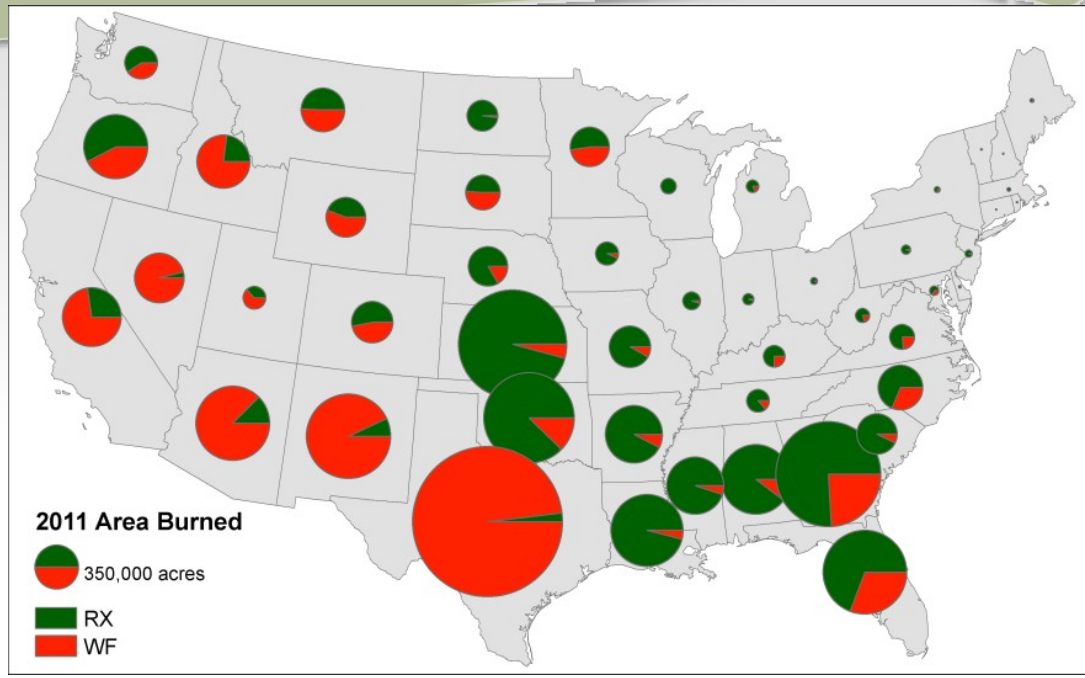
Emission Factors

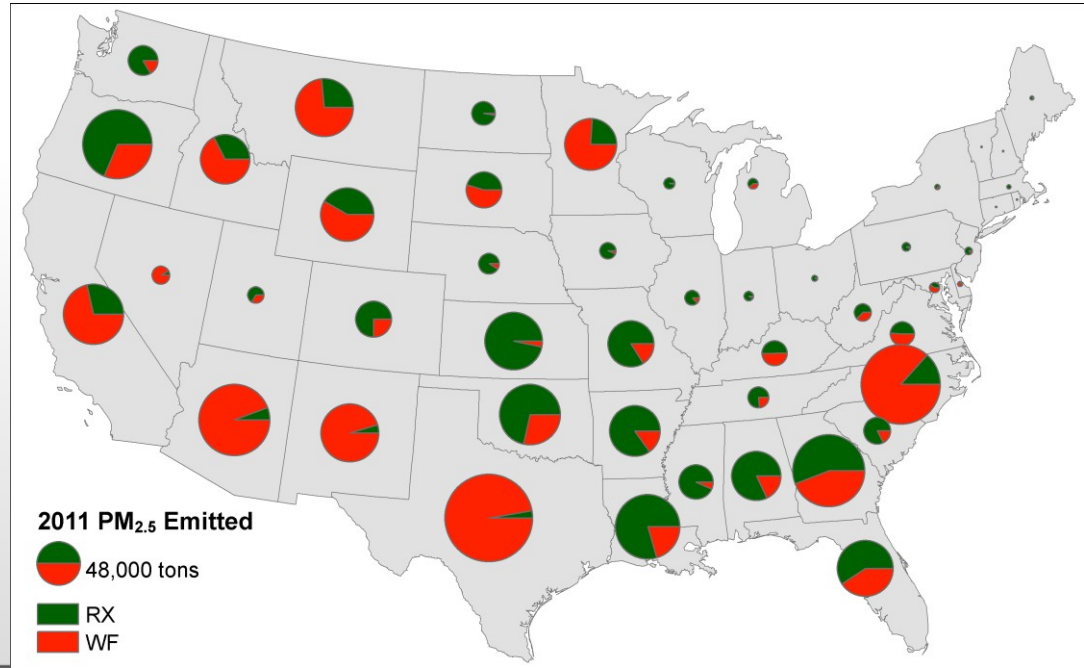
- How many tons of pollutant released per ton of fuel consumed?
- Emission Factors from the USFS FERA Fire Emissions Production Simulator (FEPS)
- Emission Factors depend on the ratio of flaming to smoldering fire



Results

- Large WF area in southwest, especially Texas
- Rx burns dominate area burned in southeast and central plains
- High $PM_{2.5}$ from peat fires (NC, MN)





Issues and Improvements

- Some states have complete fire data – we should use it directly
- Consumption is the largest source of uncertainty, especially in deep organics
- Emission factors should be updated
- Incorporate more time for feedback and revision

Contact

Sean Raffuse

Manager, Fire & Fuels

707.665.9900

Sonoma Technology, Inc.

Environmental Science and Innovative Solutions

sonomatech.com @sonoma_tech

Ground Fuels Reduction

- Some areas have a deep layer of ground fuels that may burn
- During prescribed burn conditions, significant ground fuel reduction is uncommon
- Current consumption models predict too much ground fuel reduction for Rx burns in area with deep ground fuels
- For the NEI, Rx ground fuel consumption was capped at
  5 tons/acre in the East and
  20 tons/acre in the West

Pains Bay Fire (NC, 2011)

Source: NC Forest Service

Emission Factors

Comparison vs. Akagi et al, EFs (g/Kg)

	100% Flaming	Inventory Average	100% Smoldering	FINN Temperate Forest
CO_2	1650	1560	1390	1630
CO	72	120	210	100
CH4	3.8	6.0	9.9	5
$PM_{2.5}$	7.3	11	17	13
PM_{10}	8.6	13	20	-
NO_x	2.4	1.9	0.91	1.3
SO_2	0.98	0.98	0.98	1
NH_3	1.2	2.0	3.4	1.5
VOCs	17	29	49	-

Comparison to Other Efforts

	Area (million acres)	CO_2 (million tons)	$PM_{2.5}$ (million tons)	CO_2/area	$PM_{2.5}$/area	$PM_{2.5}/CO_2$
This study WF	10.7					
NIFC WF	8.7					
This study Forest Rx	7.5					
Survey Forestry Rx	7.9					
NEI total (CONUS)	22.8	280	2.0	12	0.088	0.0070
GFED	6.5	50	0.29	7.7	0.044	0.0058
FINN	9.7	110	0.64	10.9	0.066	0.0060
GFAS	-	170	0.85	-	-	0.0049