Developing an improved wildland fire emissions inventory

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Nancy Martinez, Harvard; Pete Lahm, USFS WO

EPA Emissions Inventory Conference
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San Antonio, TX

bluesky framework

SEMIP Smoke and Emissions Model Intercomparison Project

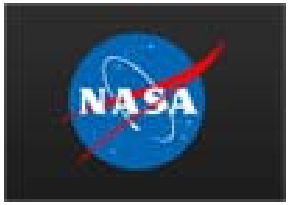
AIRFIRE

Sonoma Technology, Inc.

Towards an improved EI

3 Projects Working Together

Analysis	Fire Information	Emissions
• Where are the biggest sources of uncertainty? • What can be easily changed / constrained?	• How best to utilize all available fire info? Local and satellite? Real-time and retro-spective?	• How to utilize satellite information on fuel moistures, plumes, & more?
➢ SEMIP	➢ SMARTFIRE 2	➢ BlueSky Framework



Increasing Demand for Fire EI

Many groups, not just EPA:

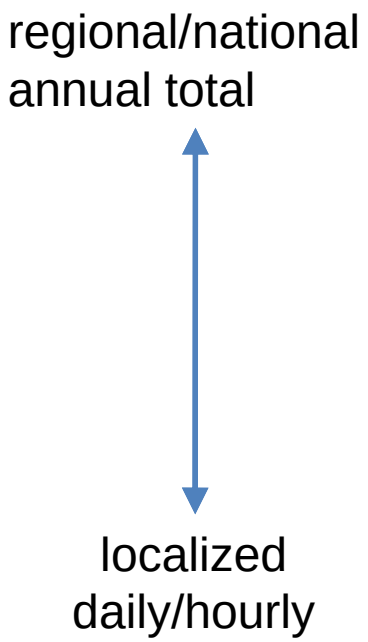
- land agencies, states, first nations

Faster EI development:

- yearly reporting

Multiple purposes:

- GHG/Carbon reporting
- Short lived climate forcers
- Air quality



Current Fire EIs

- Many Fire EIs done for many purposes
- Methodologies differ
  - Different Fire Detects
  - Different Fuel Loadings
  - Different Consumption Models
  - Different Emissions Factors
  - databases and models change over time
- Resulting differences can be large
  - reasons not generally clear

Current Fire EIs

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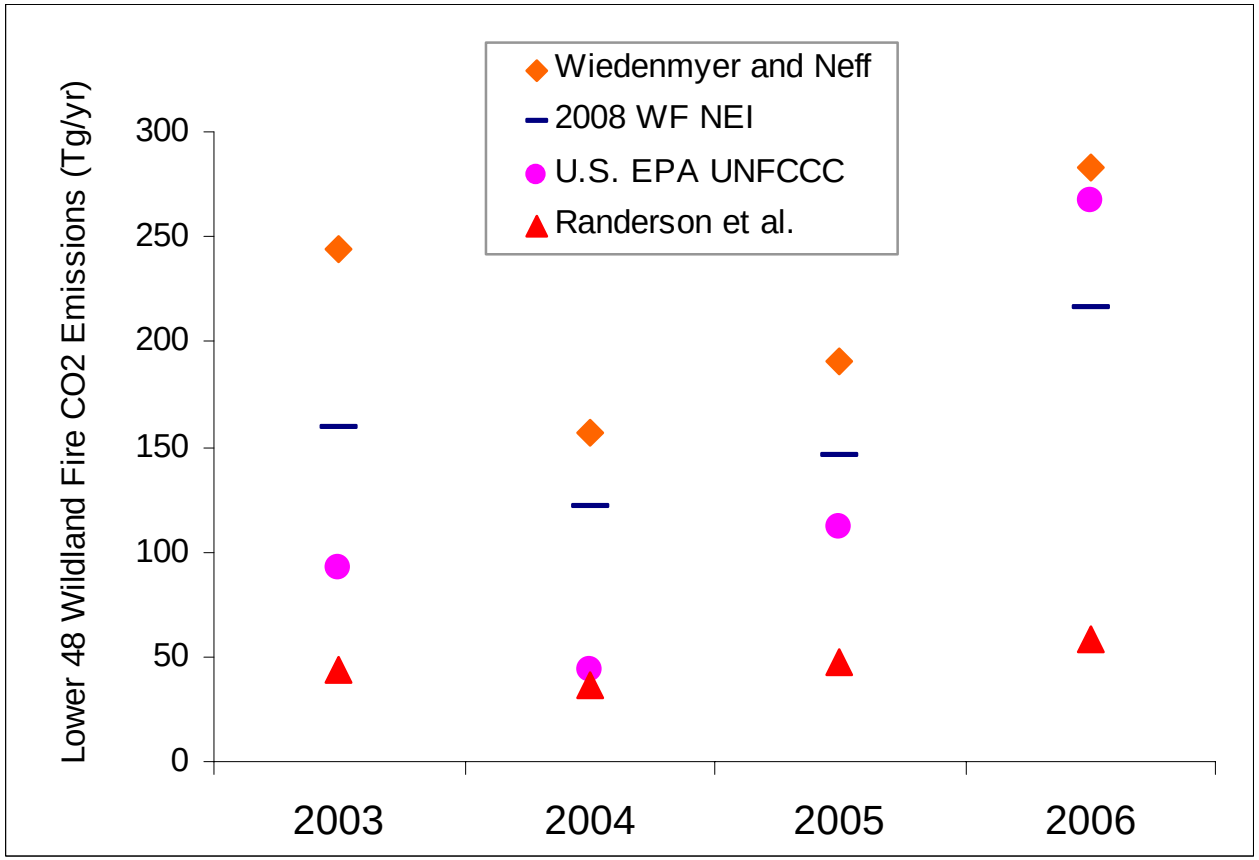


SEMIP Smoke and Emissions Model Intercomparison Project

Cross-cutting model intercomparison project

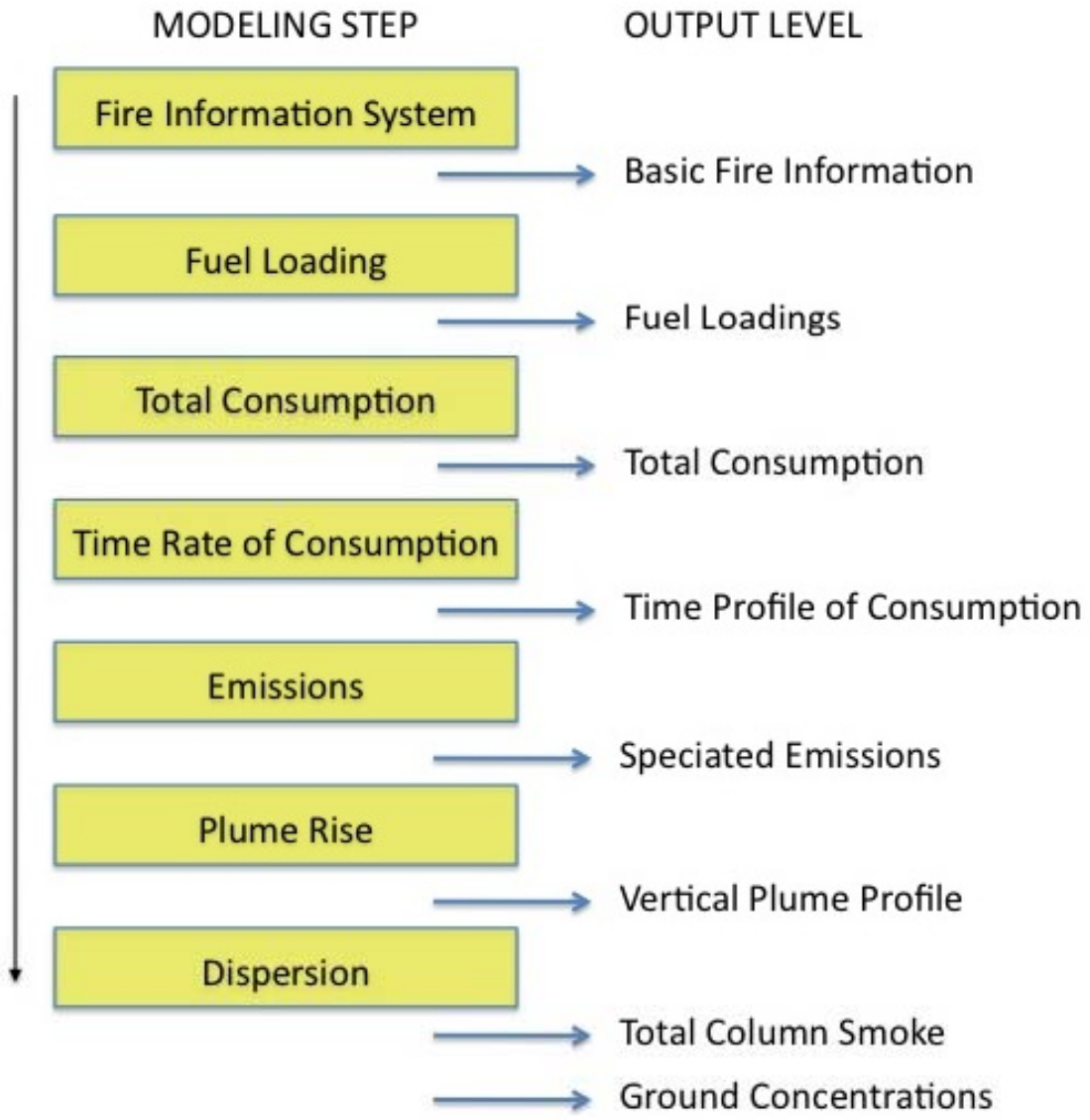
Evaluations at many different output levels

Anyone can add data/model output

Standard test cases

Standard comparison metrics

All documented on web: http://semip.org



SEMIP Smoke and Emissions Model Intercomparison Project

Test Cases

SEMIP utilizes a series of test cases to analyze to serve as a starting point for SEMIP's analysis. These case have been selected to try to represent a wide array of conditions, fire types, regions, vegetation, weather, and use cases. It is expected that additional test cases will be added over time.

National Cases

1. Fires Everywhere 2. National Emissions Inventory 2008

Regional Wildfire Case

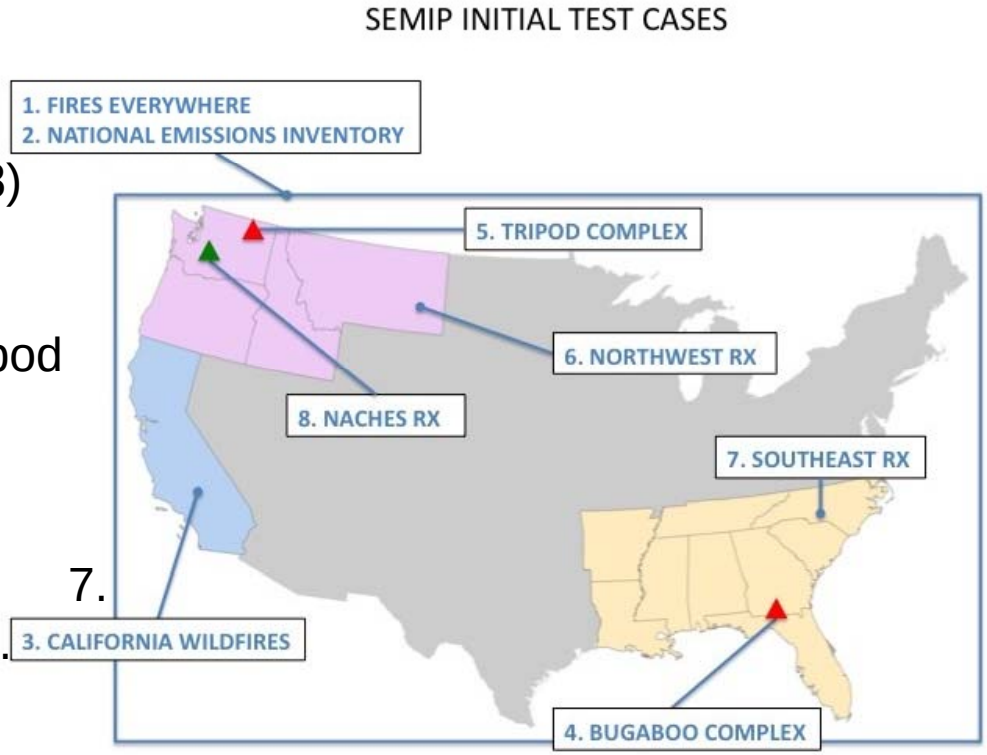
3. California Wildfires (2007 & 2008)

Individual Wildfire Cases

4. Bugaboo Complex 2007 5. Tripod Complex 2006

Prescribed Fire Cases

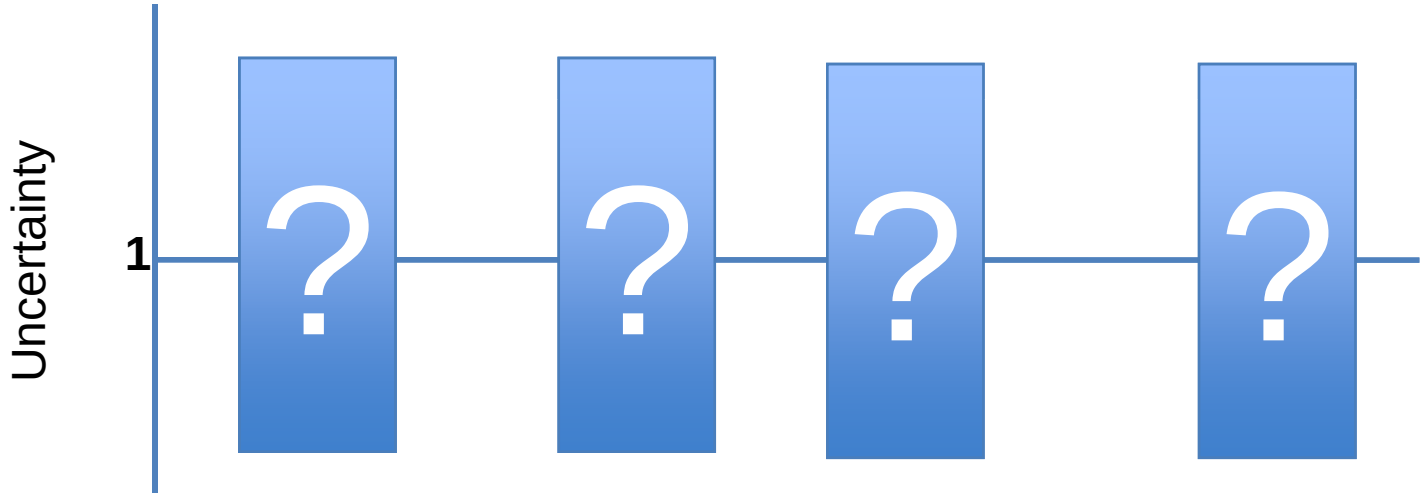
6. Northwest Regional Rx Season 7. Southeast Regional Rx Season 8. Naches, WA Rx Fire



Emissions Bulk Formula

EMISSIONS = AREA x FUEL LOAD x BURNING EFFICIENCY x EMISSIONS FACTOR

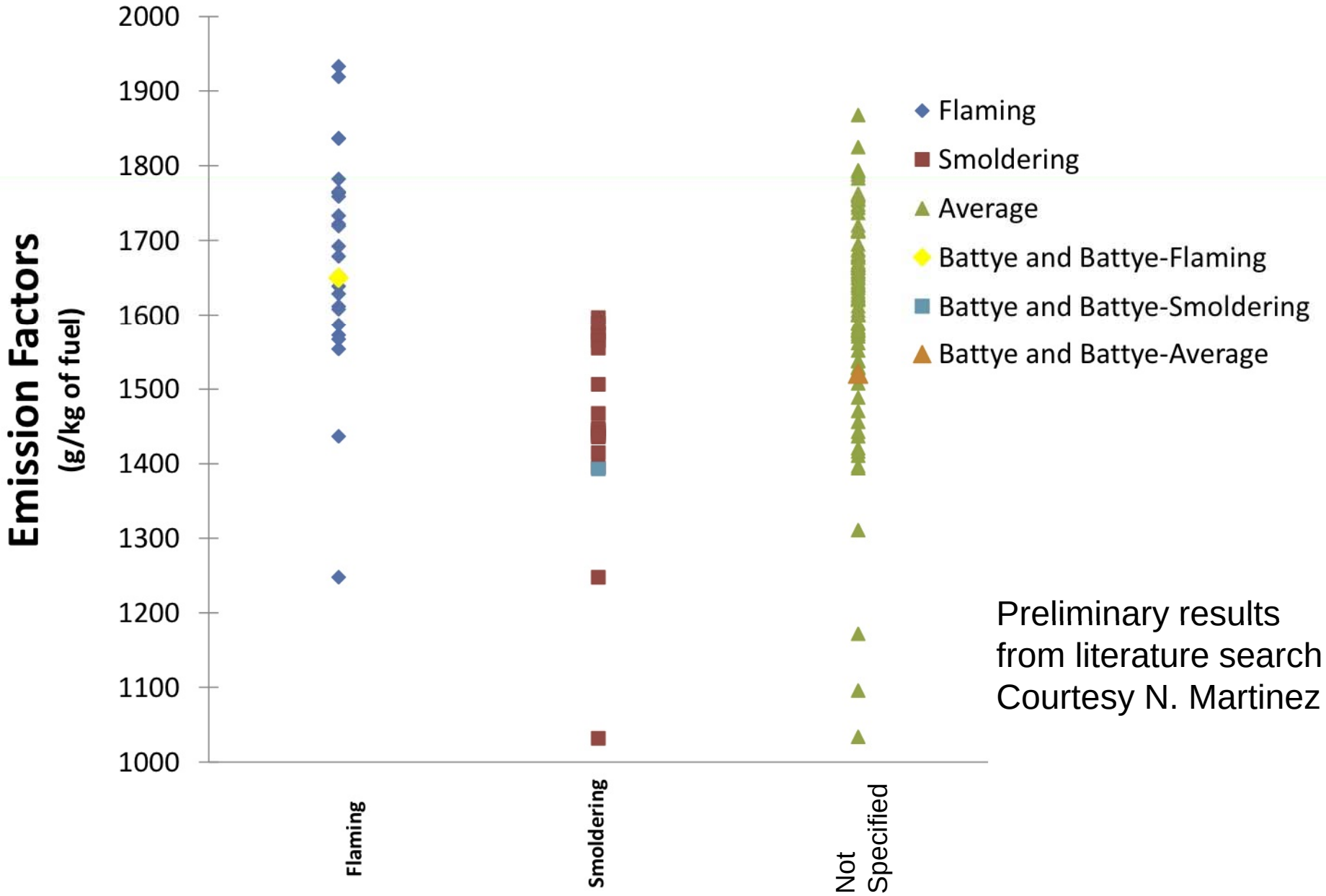
CONSUMPTION



A priori, might expect uncertainties to rank as:

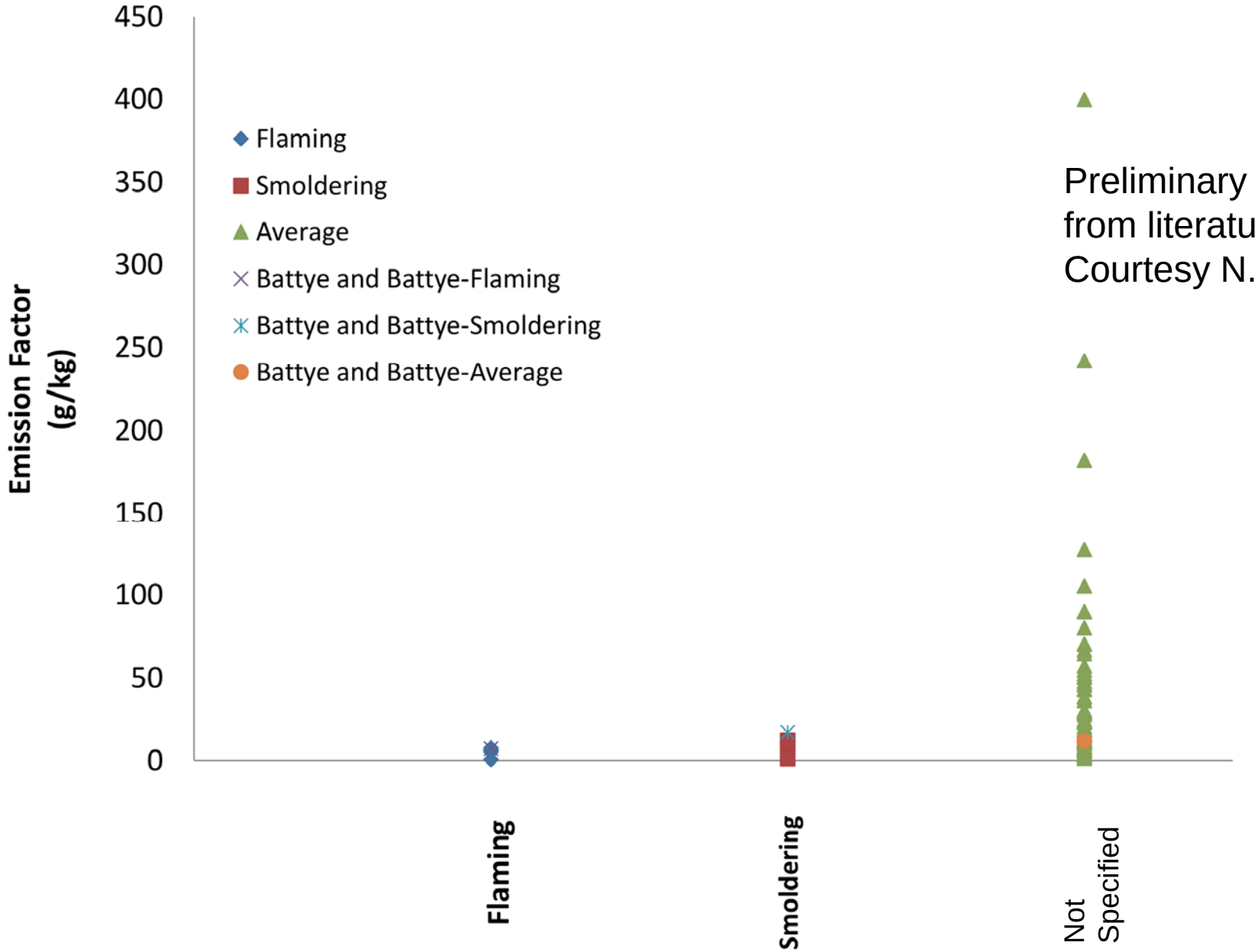
Area < Consumption < EF

CO_2 Emission Factors



Preliminary results
from literature search
Courtesy N. Martinez

PM (2.5) Emission Factors



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Fuels and Consumption

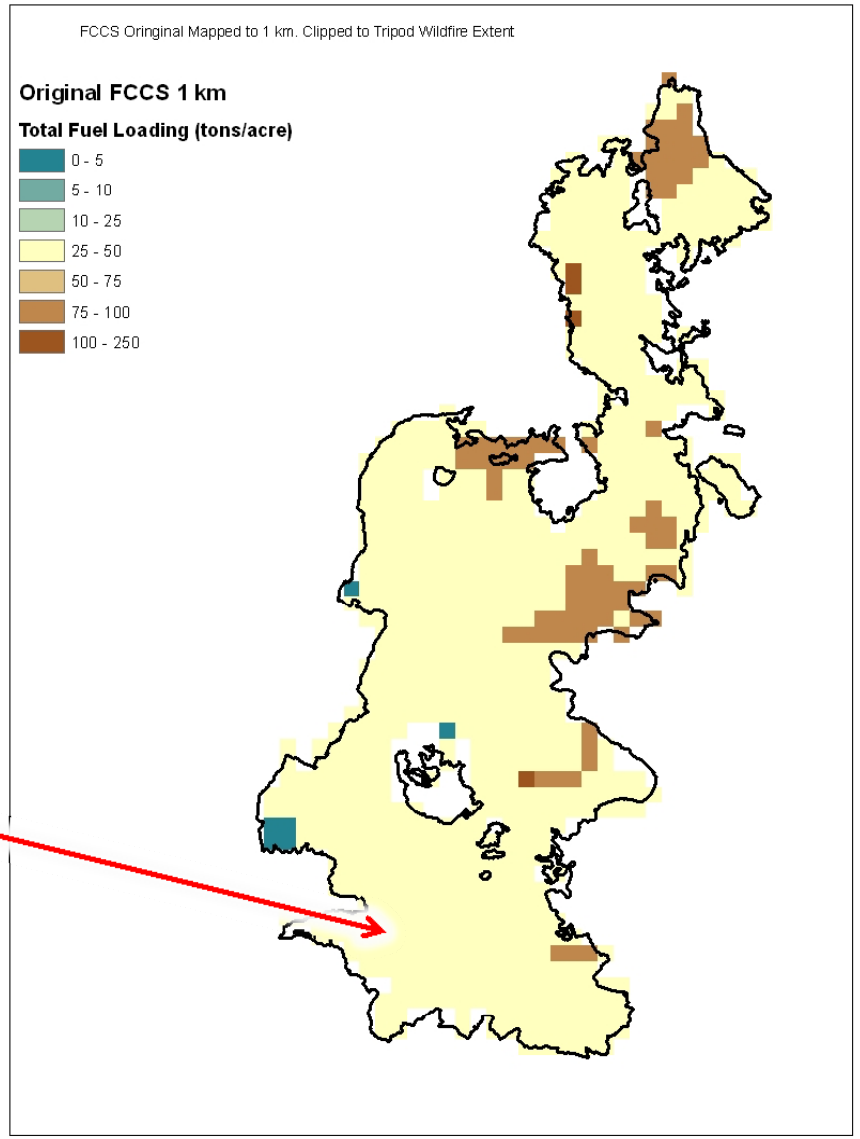
Example: Tripod Fire 2006

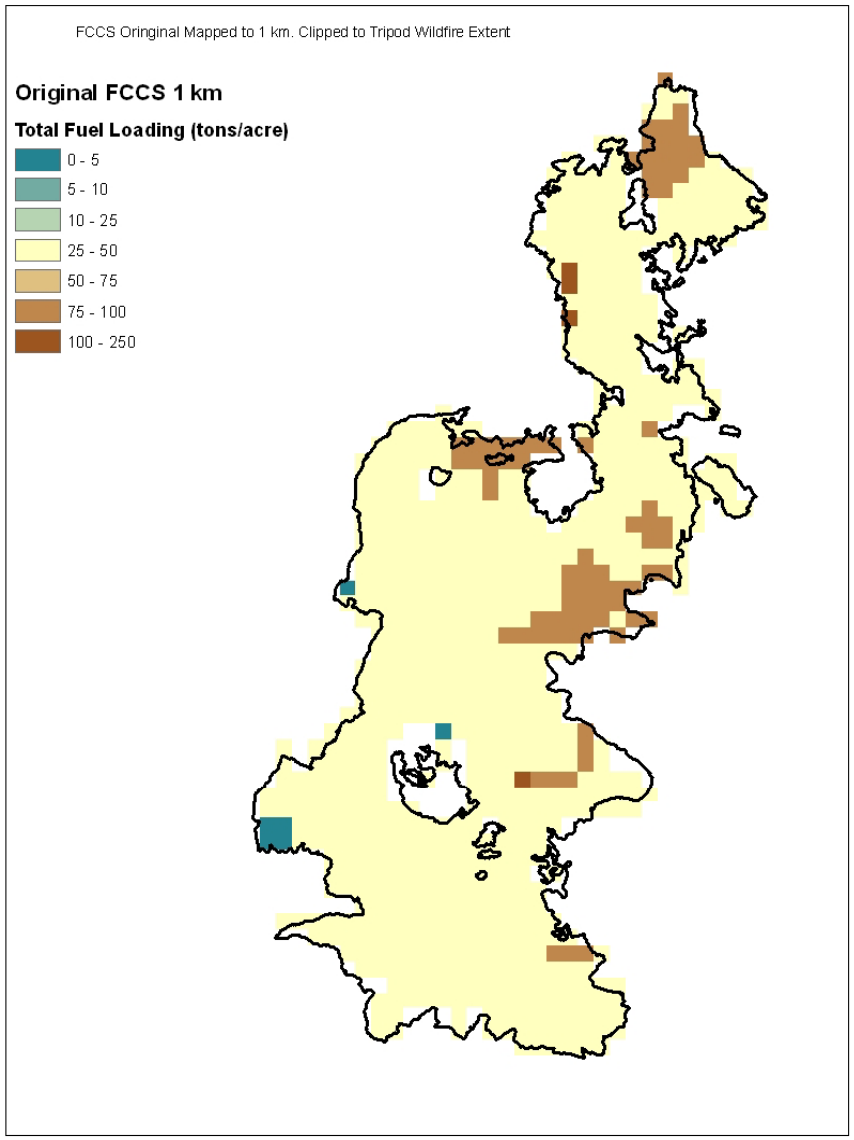
175,000+ acres
(71,000 hectares)

Multiple fuel types

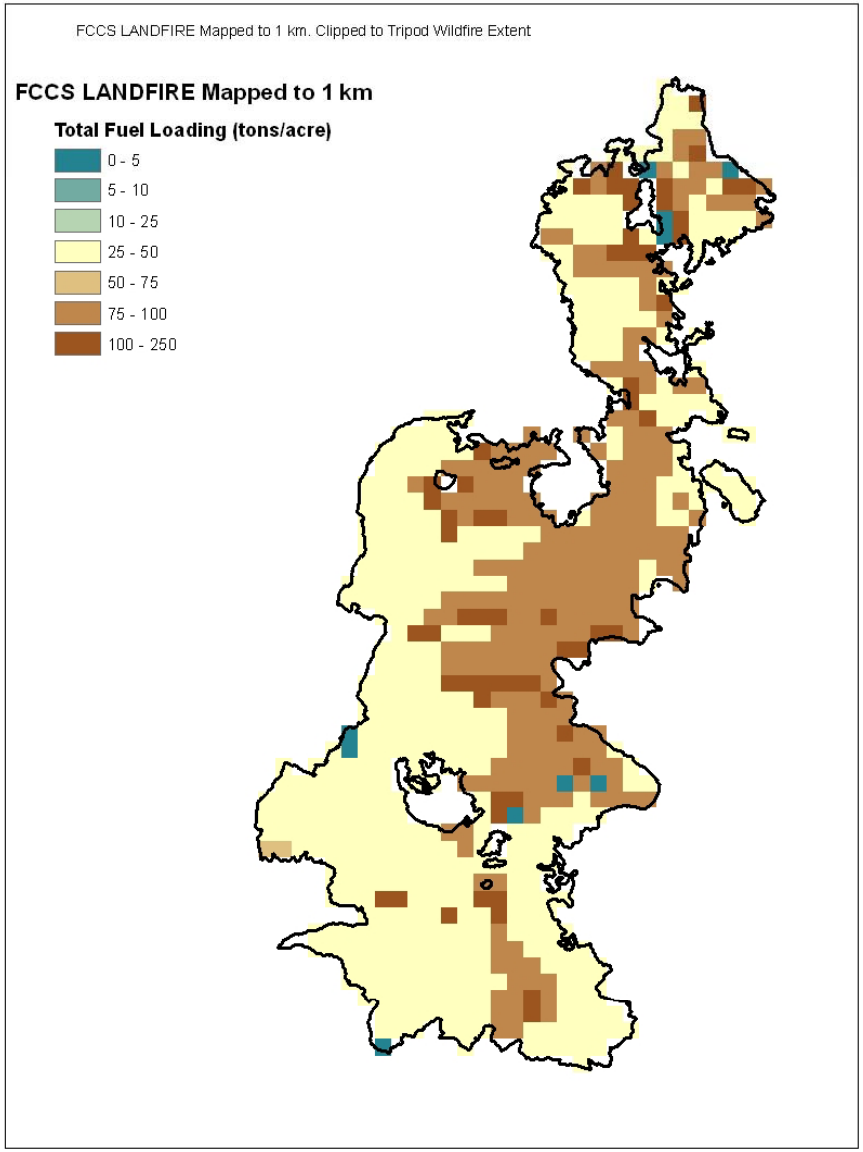
ICS Report location in corner of area burned

How does point variability scale to a large fire area?

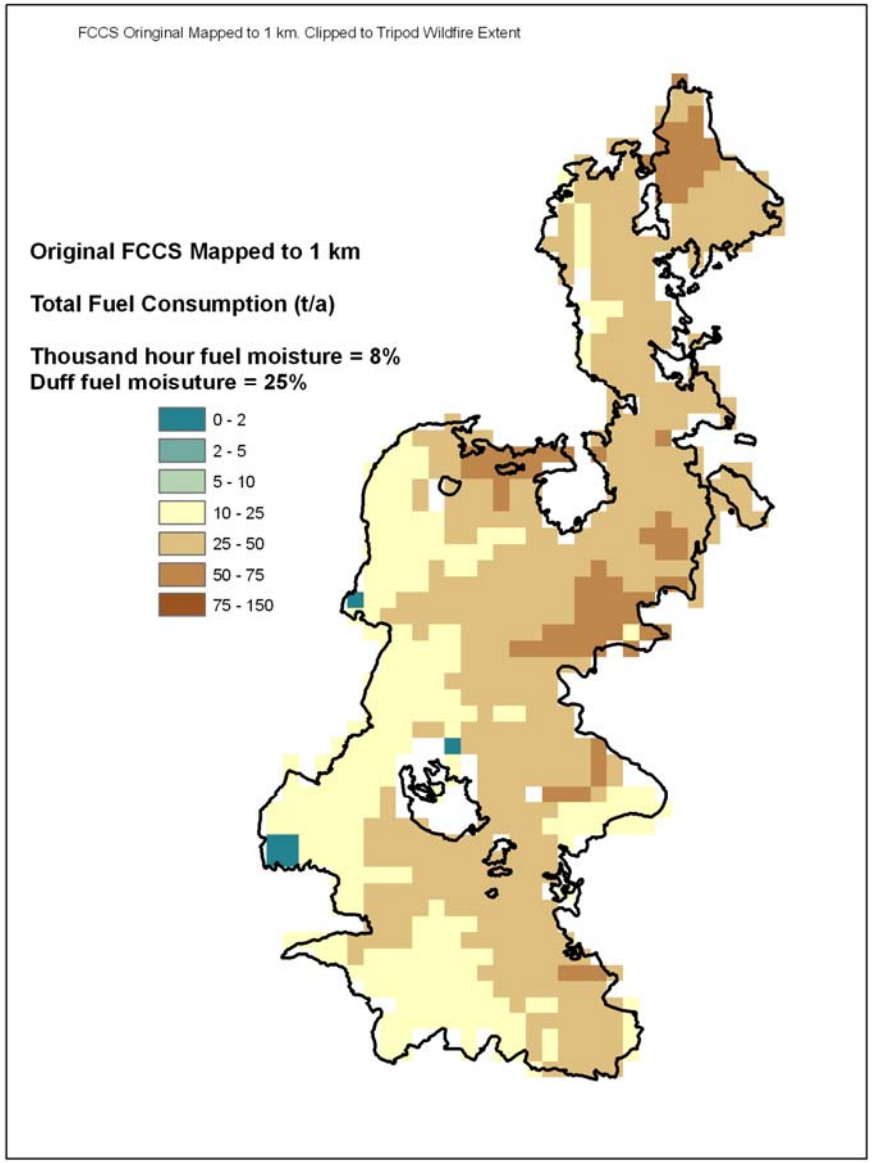



FCCS Oringinal Mapped to 1 km. Clipped to Tripod Wildfire Extent
Original FCCS 1 km
Total Fuel Loading (tons/acre)
0 - 5
5 - 10
10 - 25
25 - 50
50 - 75
75 - 100
100 - 250

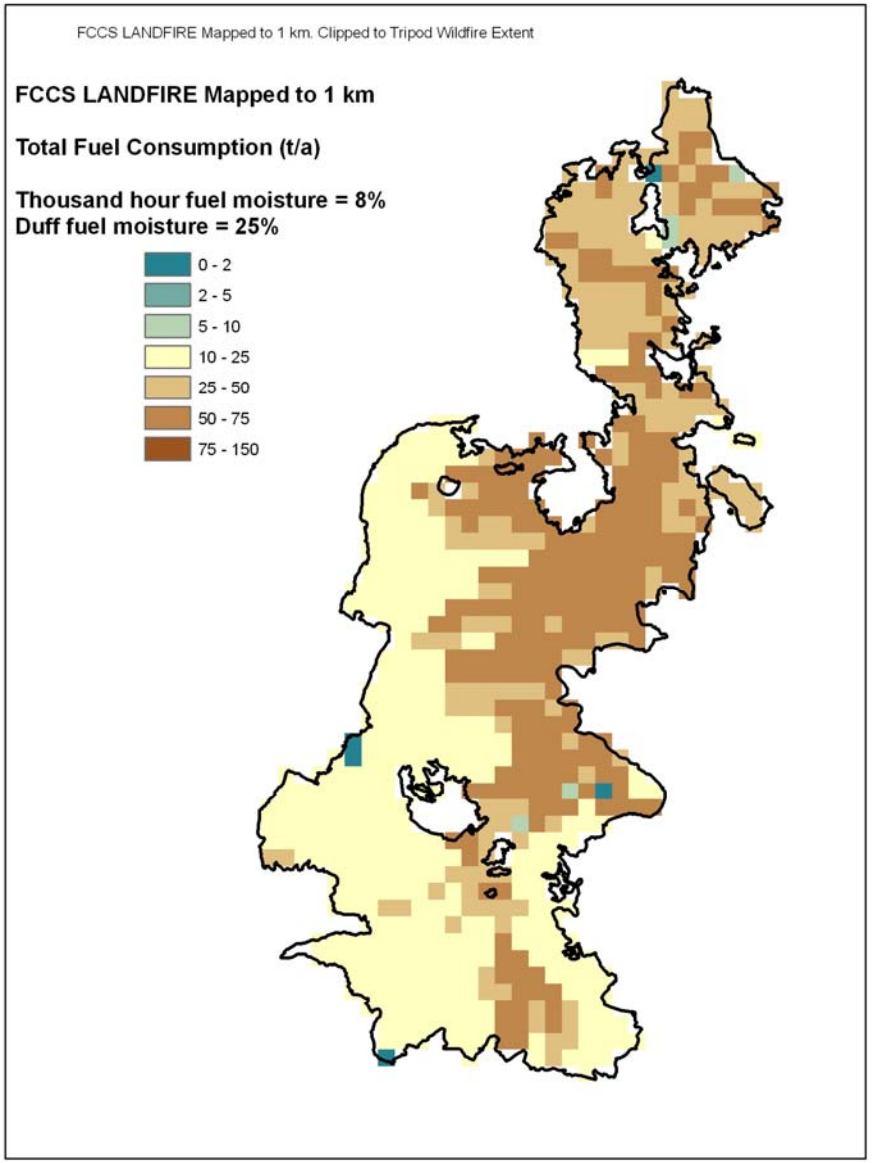
old


FCCS LANDFIRE Mapped to 1 km. Clipped to Tripod Wildfire Extent
FCCS LANDFIRE Mapped to 1 km
Total Fuel Loading (tons/acre)
0 - 5
5 - 10
10 - 25
25 - 50
50 - 75
75 - 100
100 - 250

new


FCCS Oringinal Mapped to 1 km. Clipped to Tripod Wildfire Extent
Original FCCS Mapped to 1 km
Total Fuel Consumption (t/a)
Thousand hour fuel moisture = 8%
Duff fuel moisuture = 25%
0 - 2
2 - 5
5 - 10
10 - 25
25 - 50
50 - 75
75 - 150

old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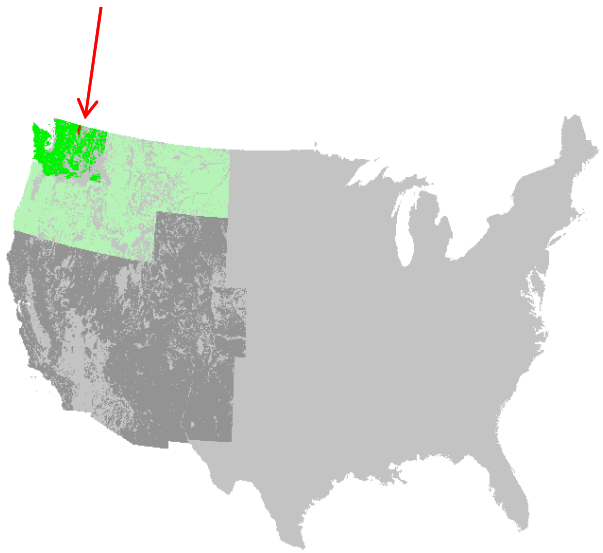
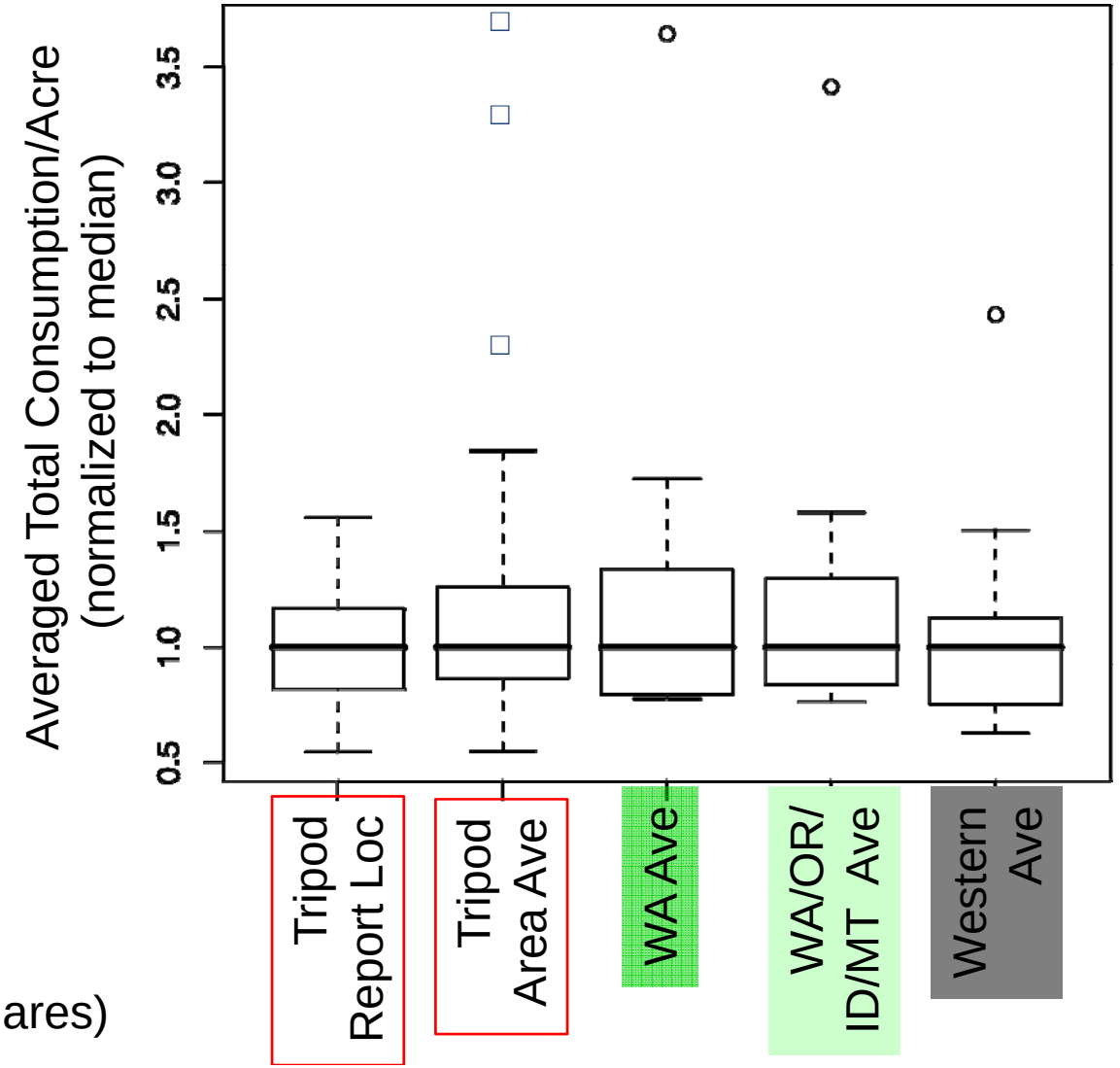
new

Scaling from a point to westwide

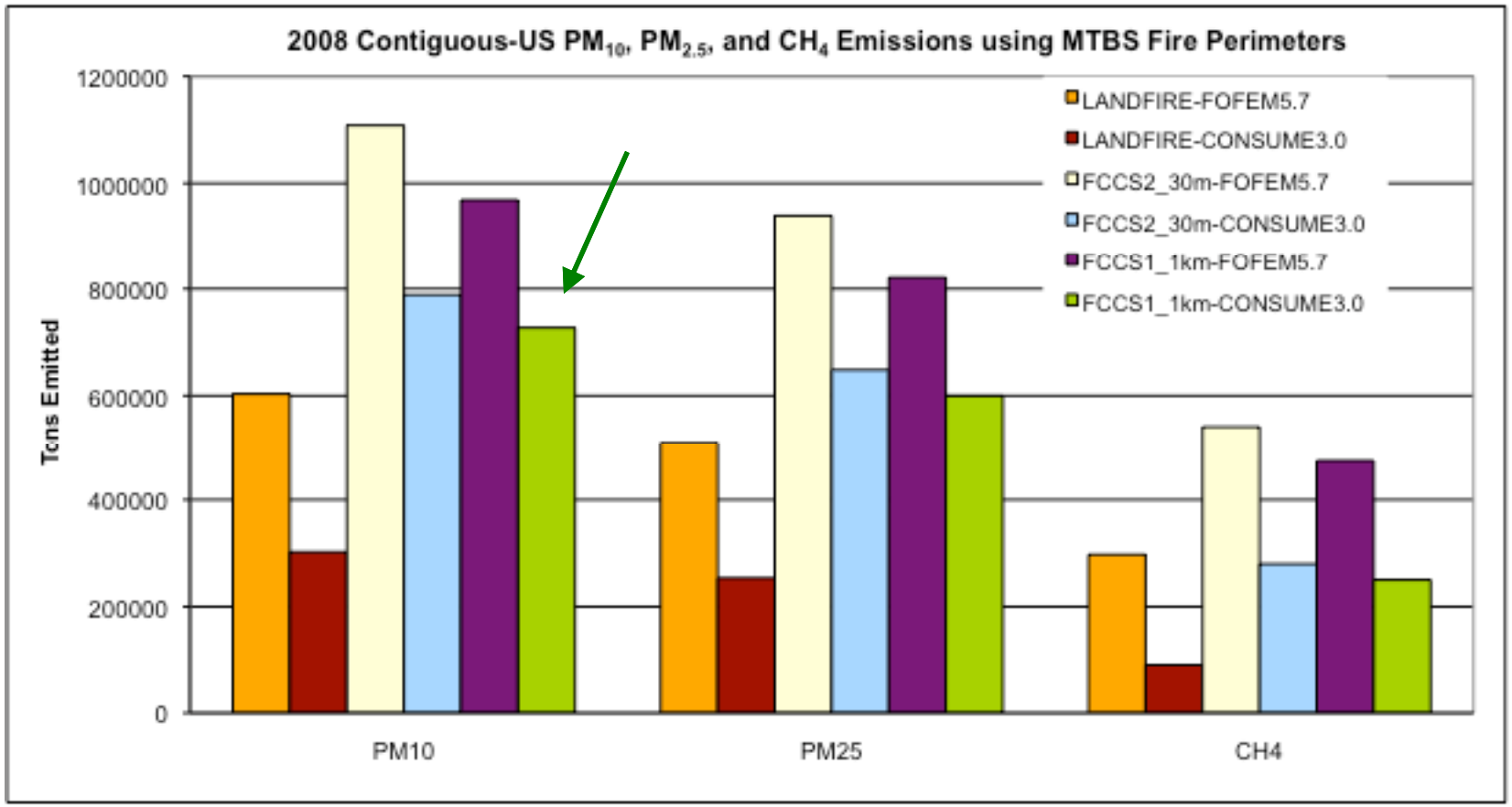




Based on 12 model pathways
Tripod Average also includes
high-res fuels -> CONSUME (squares)

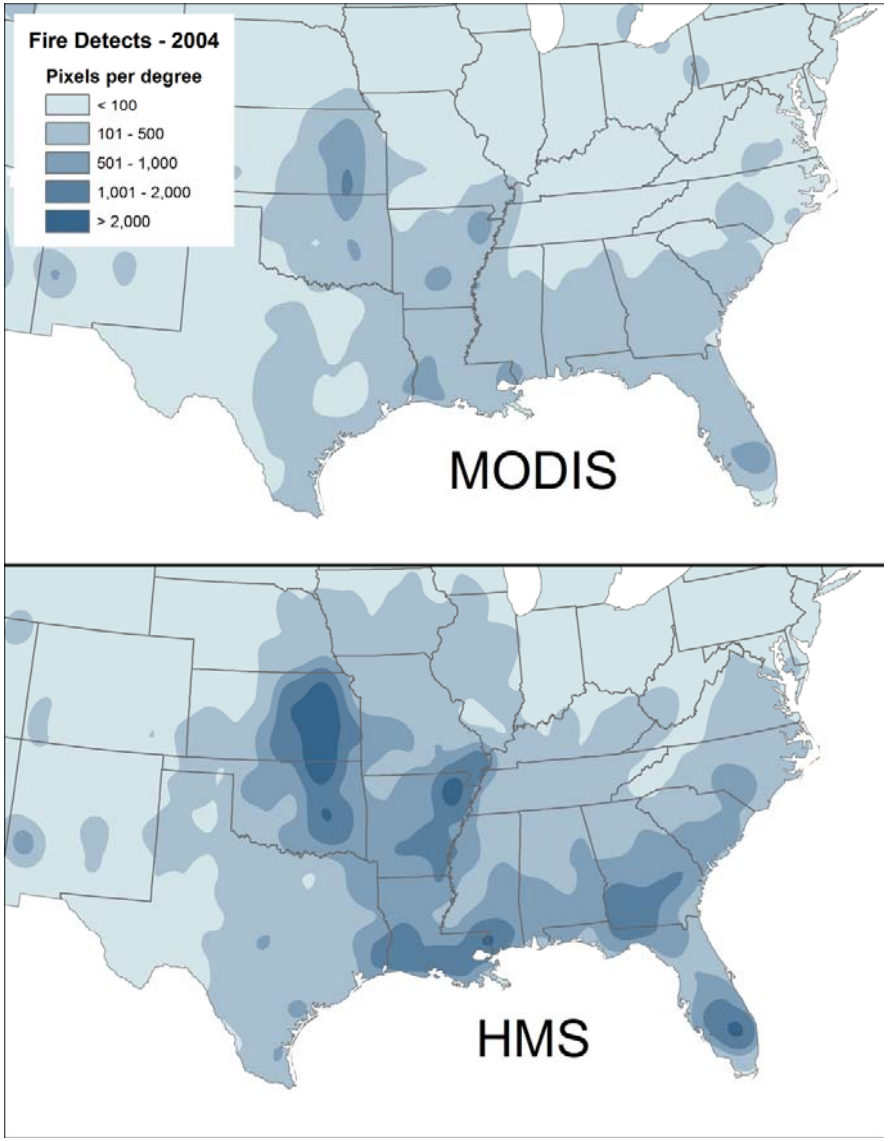
Changes in 2008 Due to Path

- Only large fires (from MTBS)
- Fuel maps: FCCS1-1km, FCCS2-30m, LANDFIRE-30m fuels
- Consumption & Emissions: CONSUME3.0 & FOFEM5.7



Fire Information

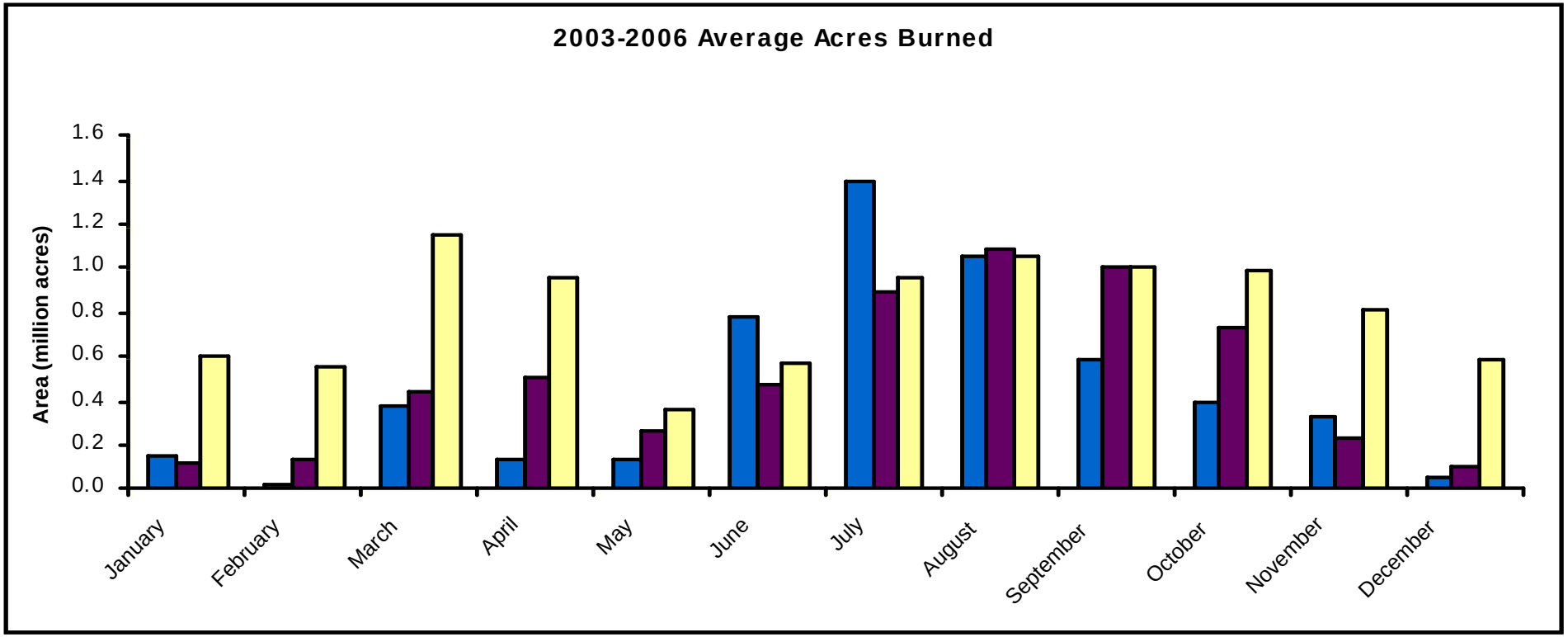
- Emissions inventory depends explicitly on fire area, location, and timing
- Major regional differences in reporting systems, fire size, fire types, and fire detection



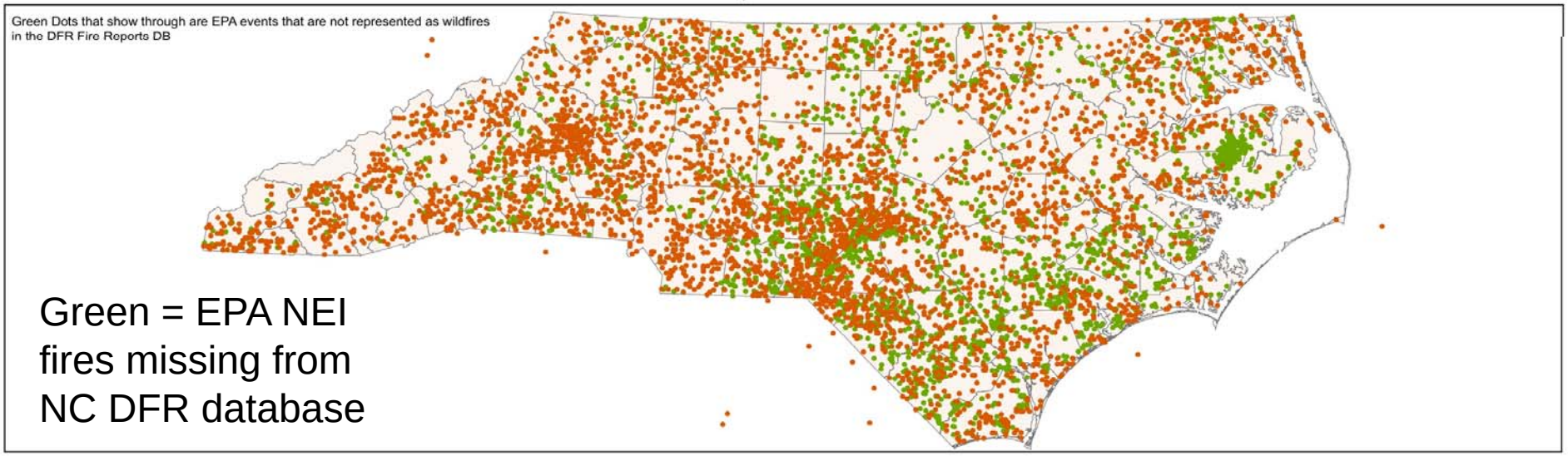
Quantity and Timing

Choice of fire information system affects timing

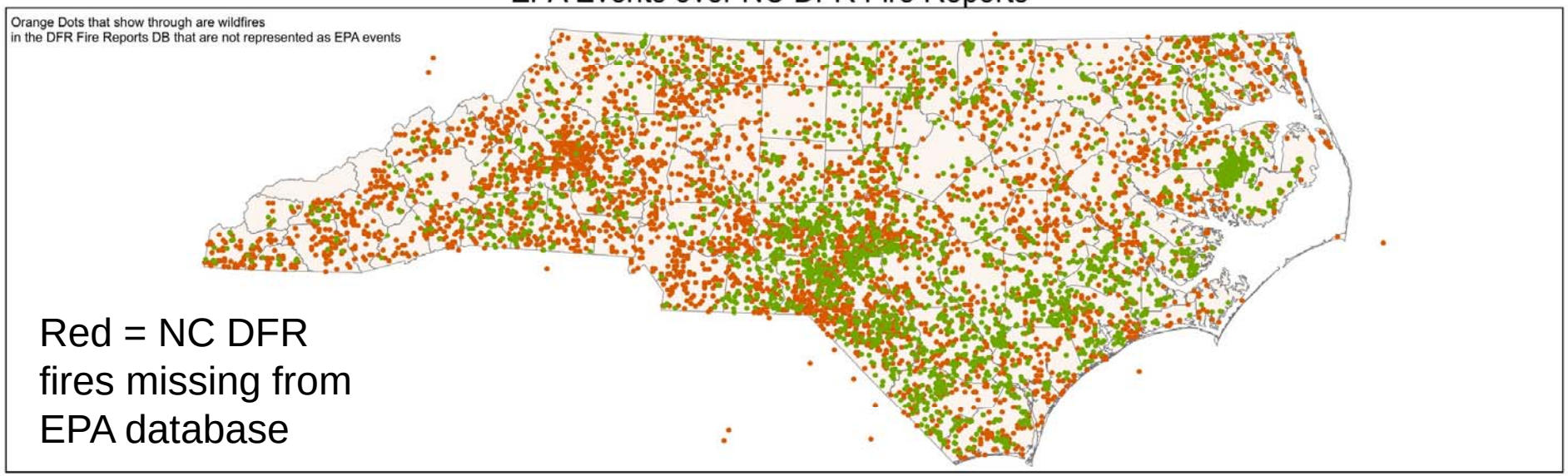
Blue = ICS209 Wildfire Reports
Red = MODIS Fire Detects
Yellow = HMS Fire Detects



NC DFR Fire Reports over EPA Events



EPA Events over NC DFR Fire Reports



Courtesy G. Curcio

The West

- WRAP states 2002 inventory compared with various fire reporting systems (both ground and satellite-based).
- Most systems only reported a fraction of the WRAP EI acres.
- SMARTFIRE overall detected only 52% of WRAP EI acres.
- But, SMARTFIRE does not include Ag burns (~1/3 of total).

Soja et al, 2009

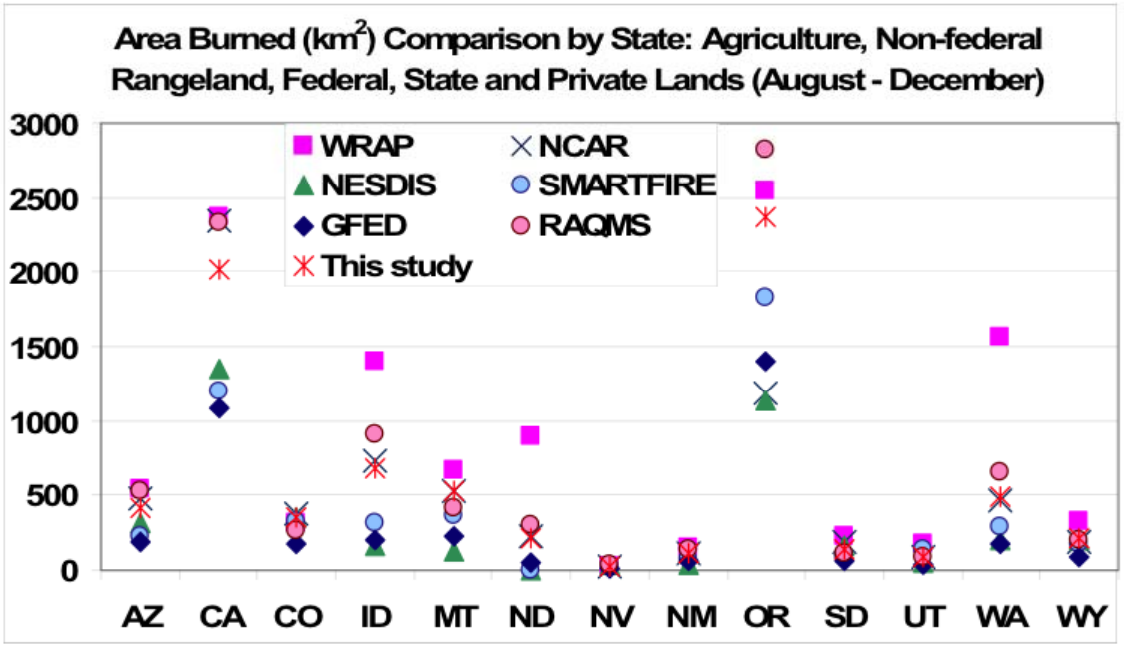


Fig. 11 Area burned from August through December of 2002 in 13 WRAP states. With the exception of August, these months are outside of the primary natural fire season, however several additional products are available after July 2002 following Aqua's data availability.

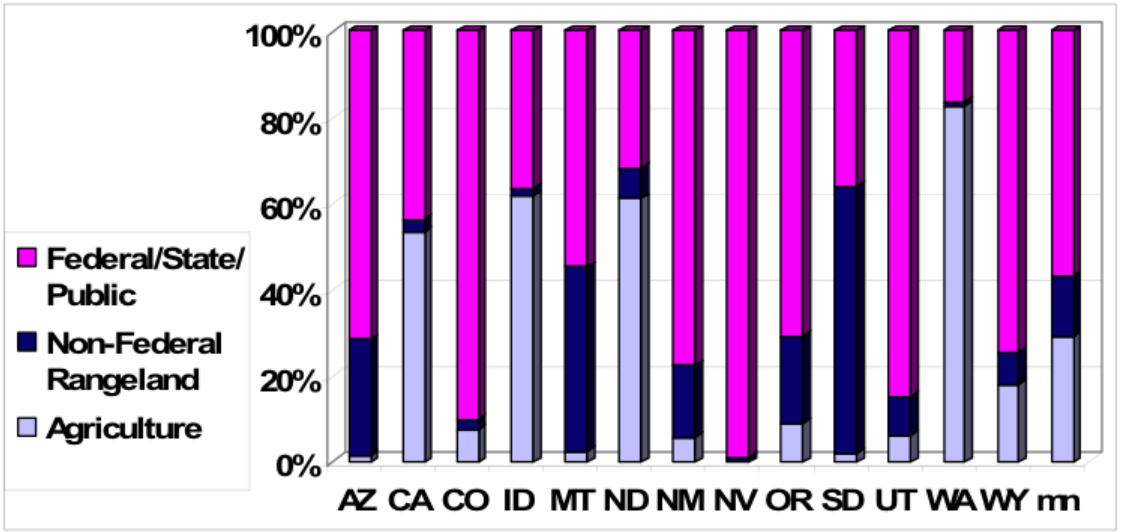


Fig. 12 Percent area burned from each category in individual WRAP states for 2002. One might expect

Some Preliminary Conclusions

Relative weight of uncertainties:

Area ≈ Consumption ≈ best known EFs

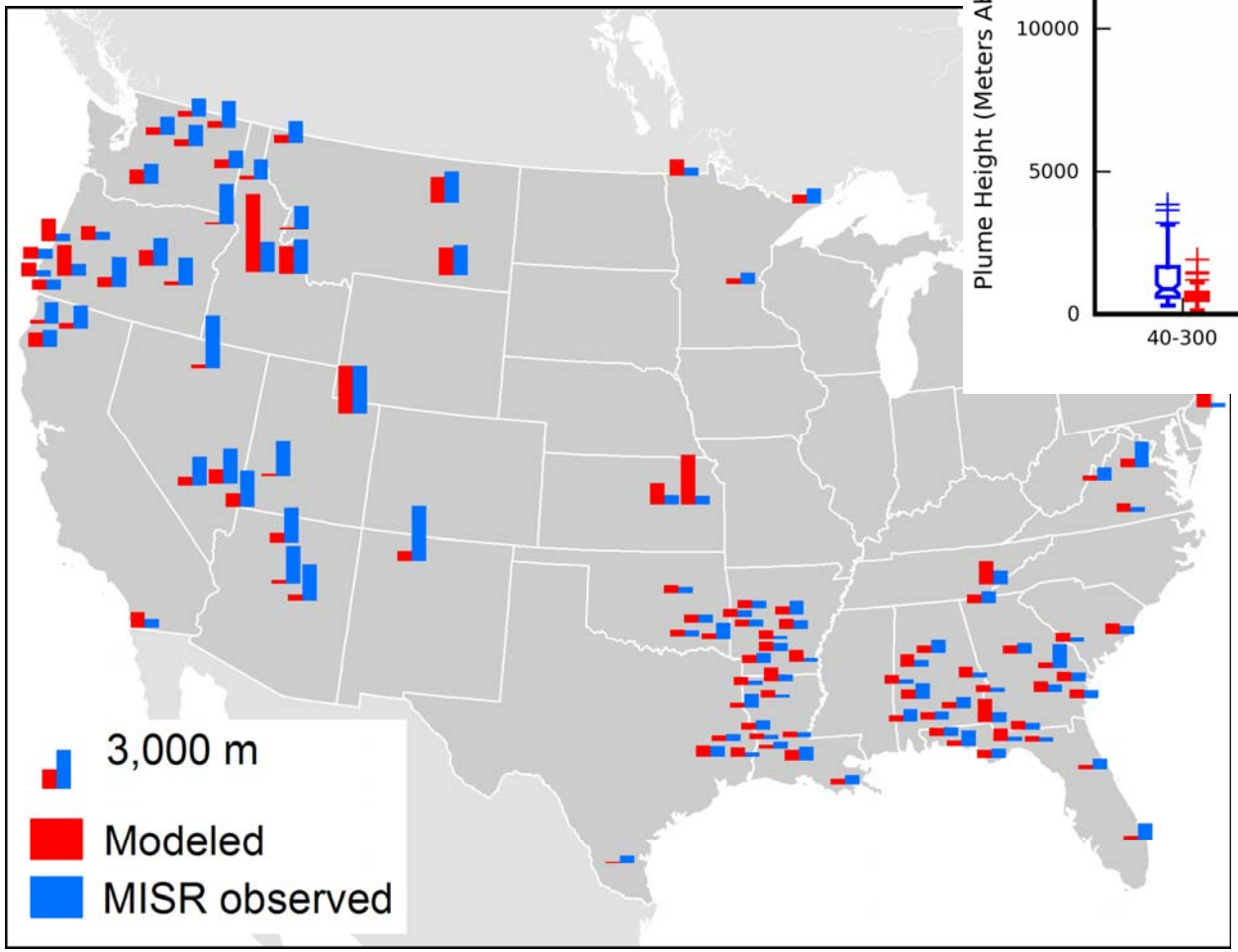
for regional summaries.

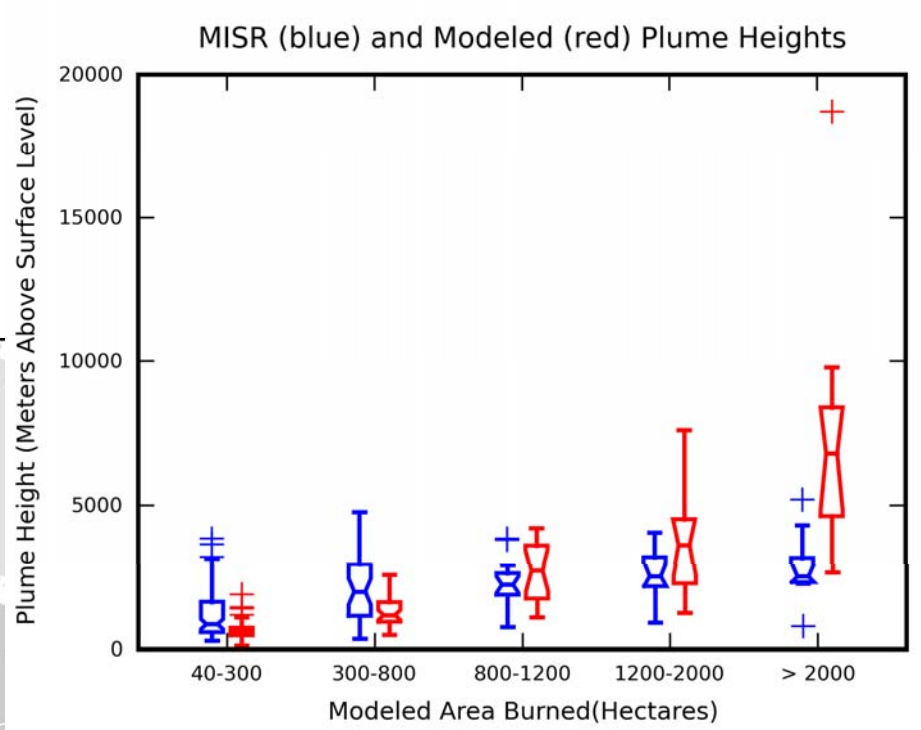
But, for *air quality* uses, the uncertainty in area becomes even more important.

Caveat: in much of this, we don't know what we don't know. This is especially true for EFs.

Plume Rise

We matched 163 plumes.





- MISR dynamic range less than modeled
- Model underpredicting small fires, overpredicting large fires
- Clear regime difference in MISR data between West and Southeast
- Poor performance throughout the West

Changes Underway

Focus on:

- Plume height constraints
- Additional emission calculation schemes
- Better treatment of fuel moisture
- Spatially explicit fuels (all fuels in perimeter)
- More recent fuel map (FCCS2 30m national)
- Incorporating more local data
  - Fire information, e.g. from states
  - Local fuel surveys

Needed

More local data:

- fuels
- fire perimeters
- management information
- ancillary data

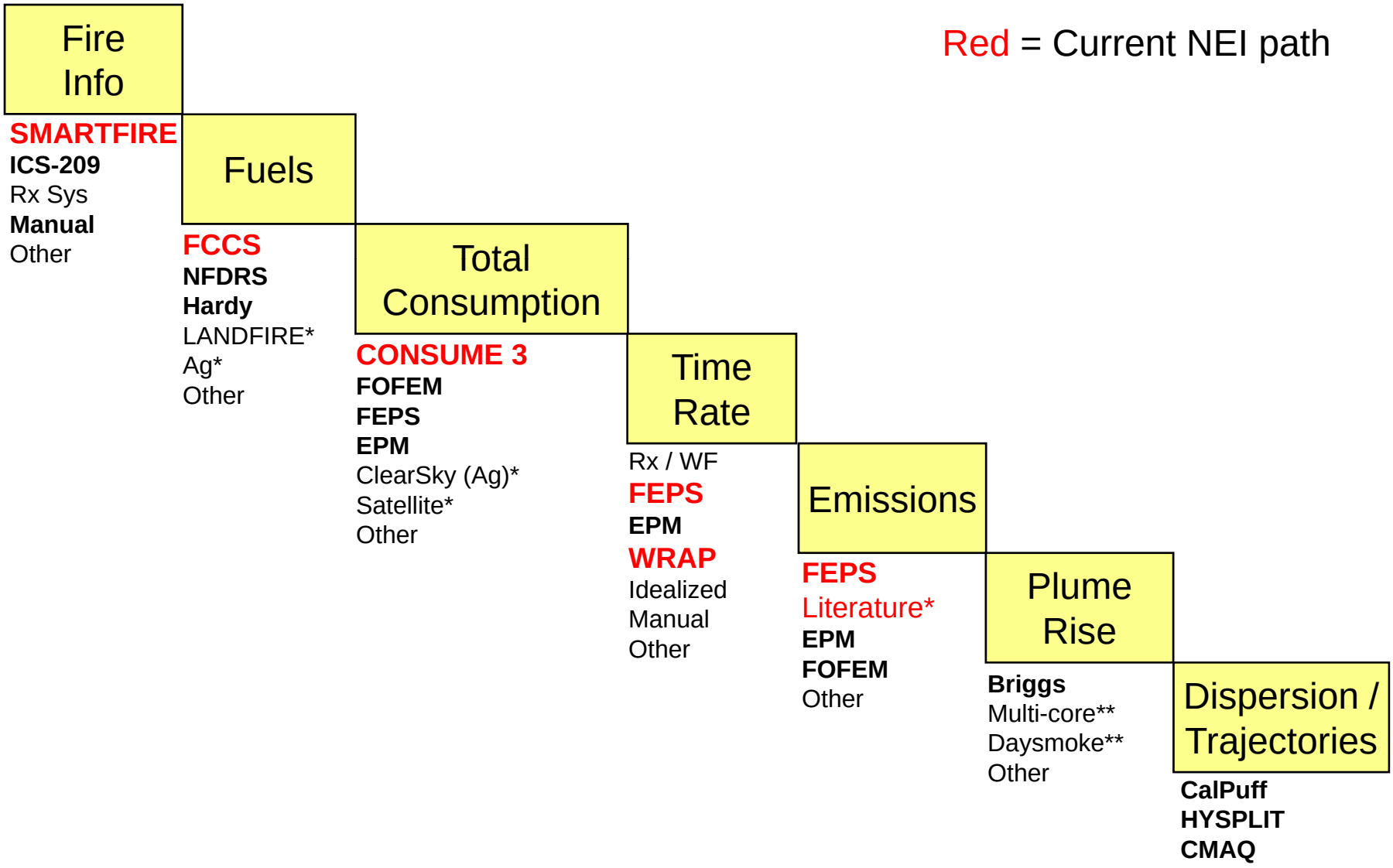
More types of information:

- cross comparison of various types of data may be able to constrain uncertainties

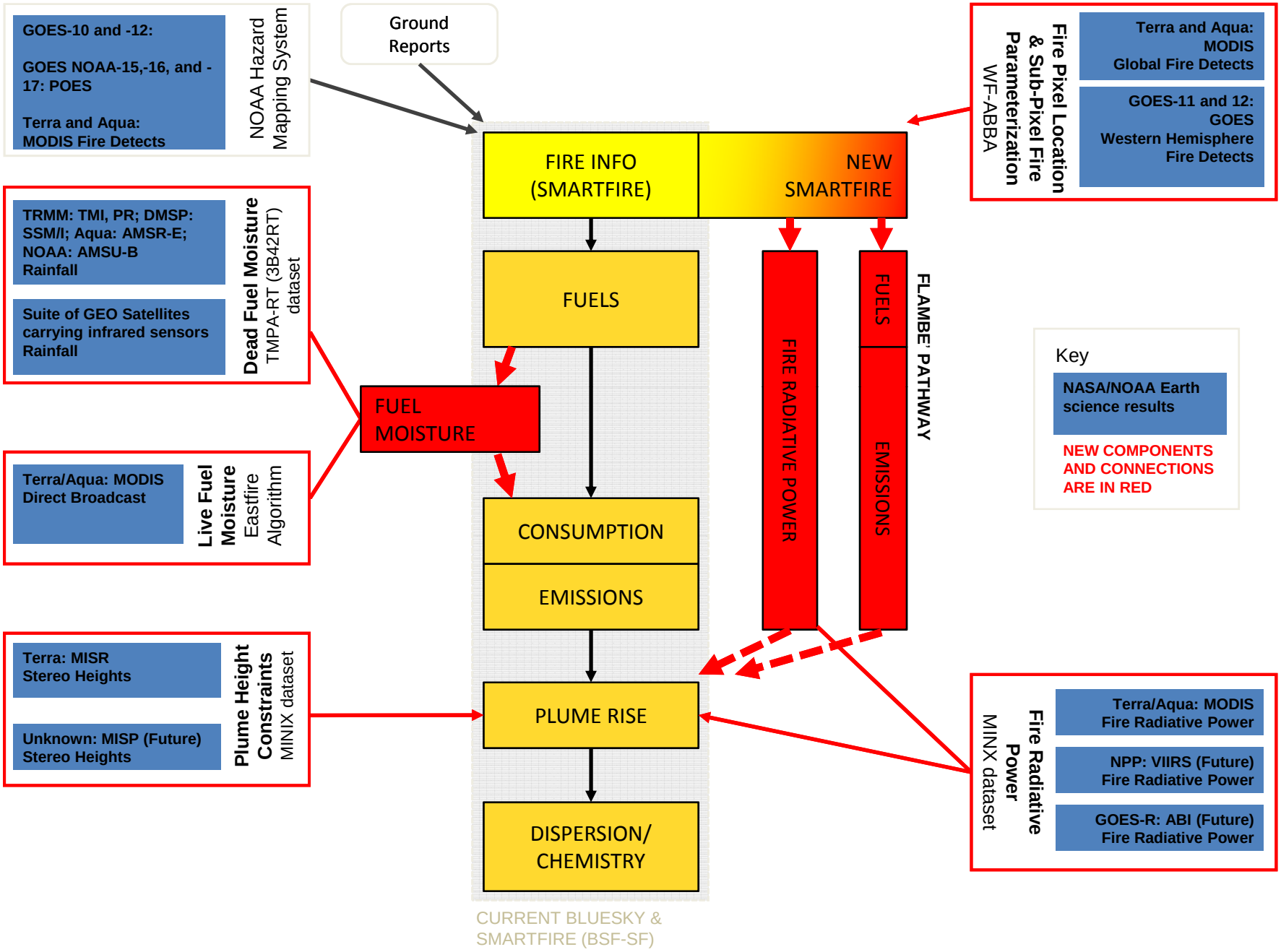
More explicit treatment of uncertainty

Aggregation databases (gathering information in one spot)

BlueSky Framework

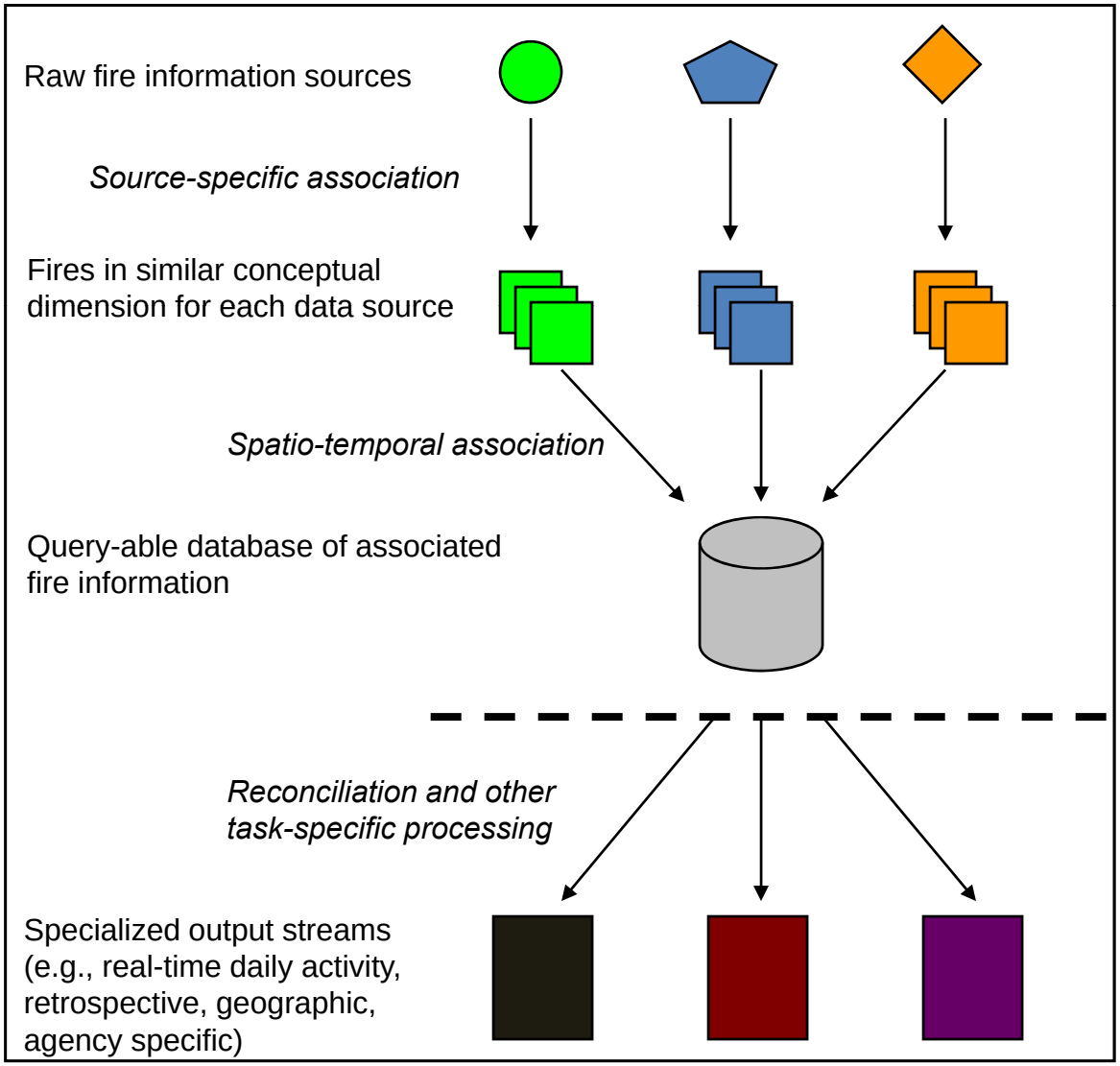


BlueSky Improvements Underway



Tackling the Fire Information Problem

SMARTFIRE 2



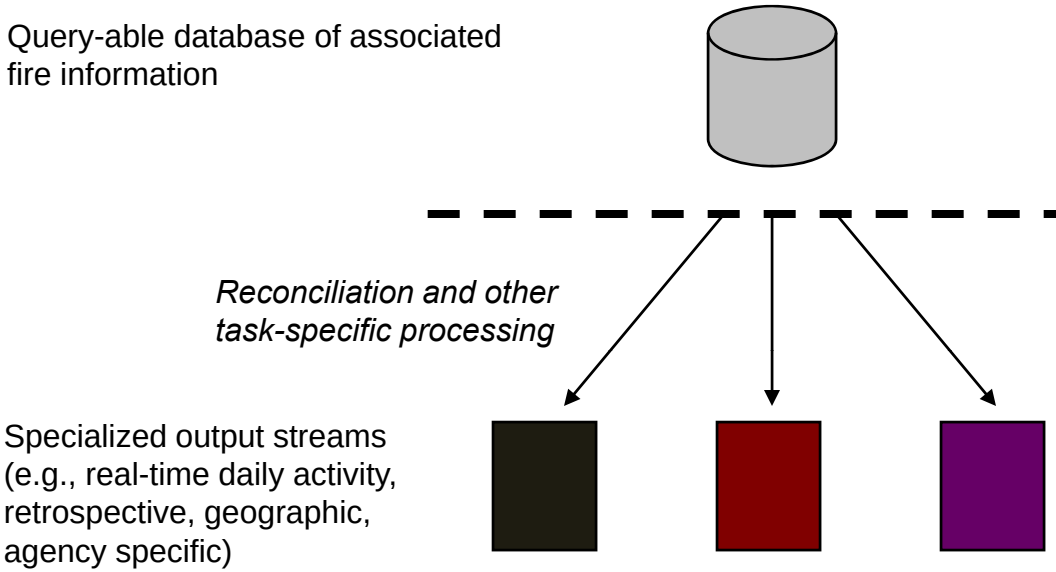
Any number of input databases

- ICS-209
- NOAA HMS
- MBTS (burn scar)
- Helicopter perimeters
- FETS
- State Rx DBs
- Annual reports
- Local forest databases, e.g. fuels

Preserves all input data

Customizable Metrics

SMARTFIRE 2



Specific outputs

- probability of existence
- lat, lon point location
- spatial extent
- final size
- time resolved growth
- fuels
- emissions
- more

Multiple processing streams

Each processing stream based on a customizable set of “trust” metrics for each input db

Thank you

In particular: JFSP, NASA, DOI/USFS

Also: NFP, USFS, EPA and others

More information:

- SEMIP: http://semip.org
- BlueSky & SMARTFIRE: http://blueskyframework.org

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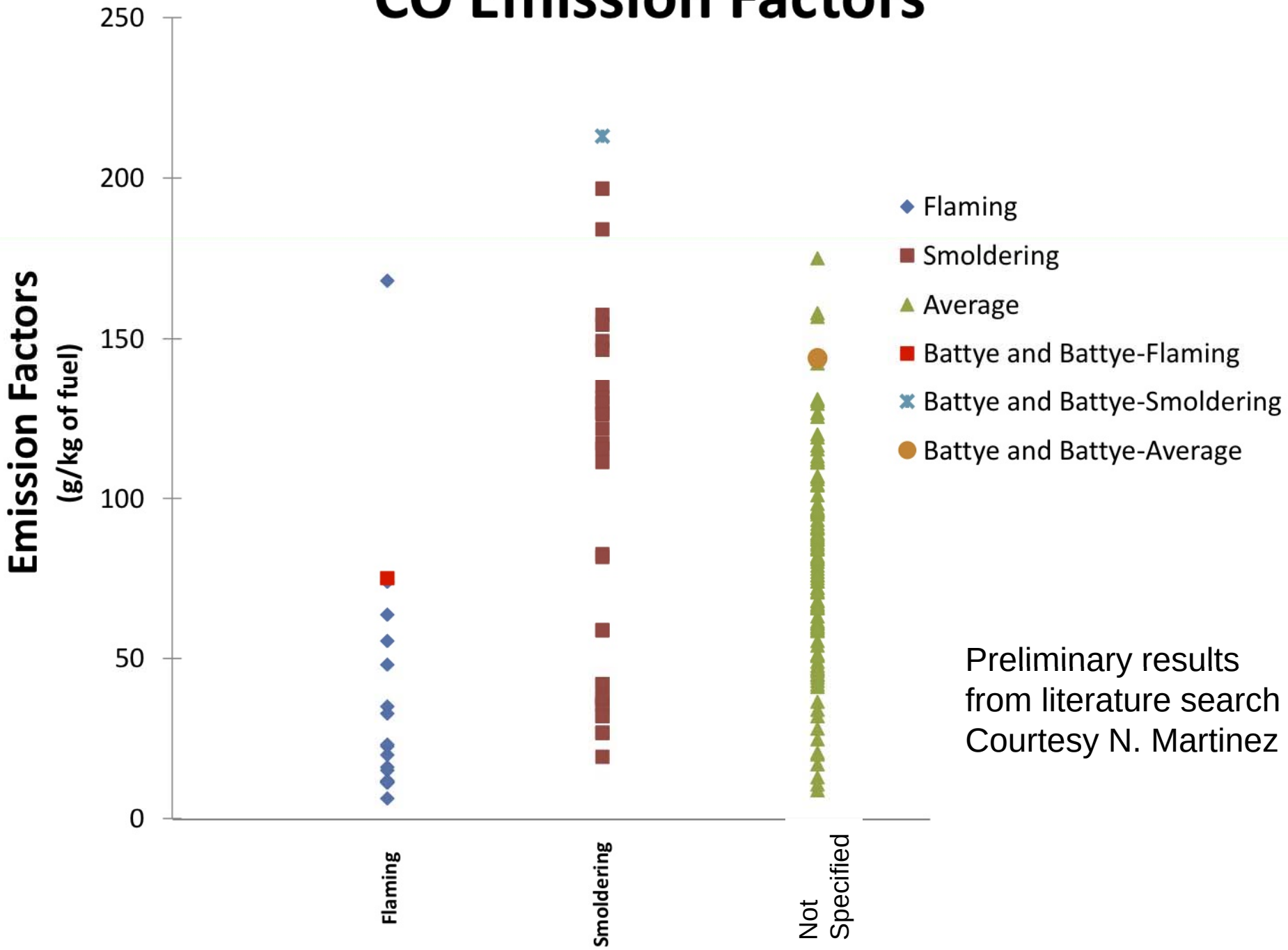
206-732-7849

End of Presentation

Thank you.

CO Emission Factors



Preliminary results
from literature search
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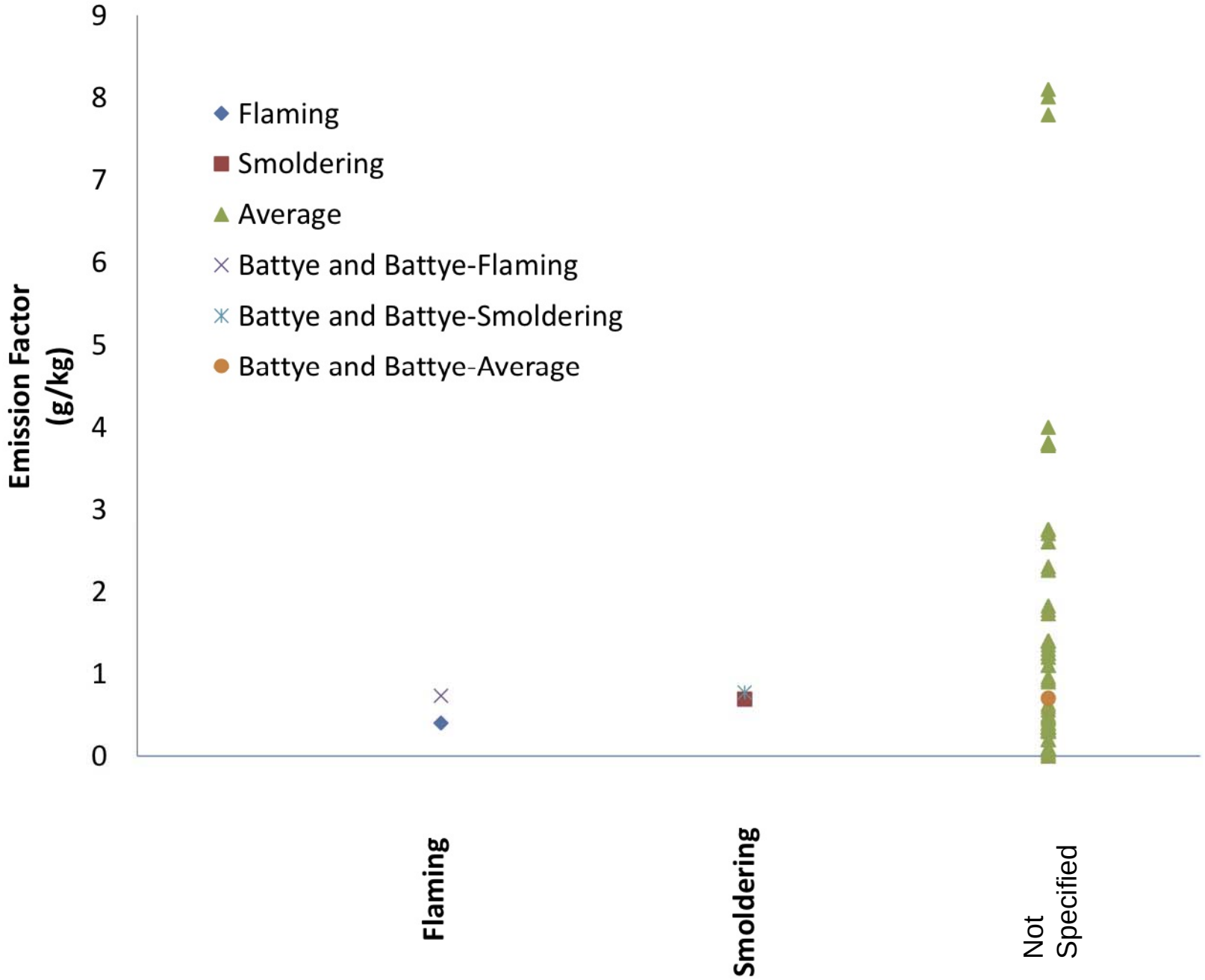
EC Emission Factors



Scaling

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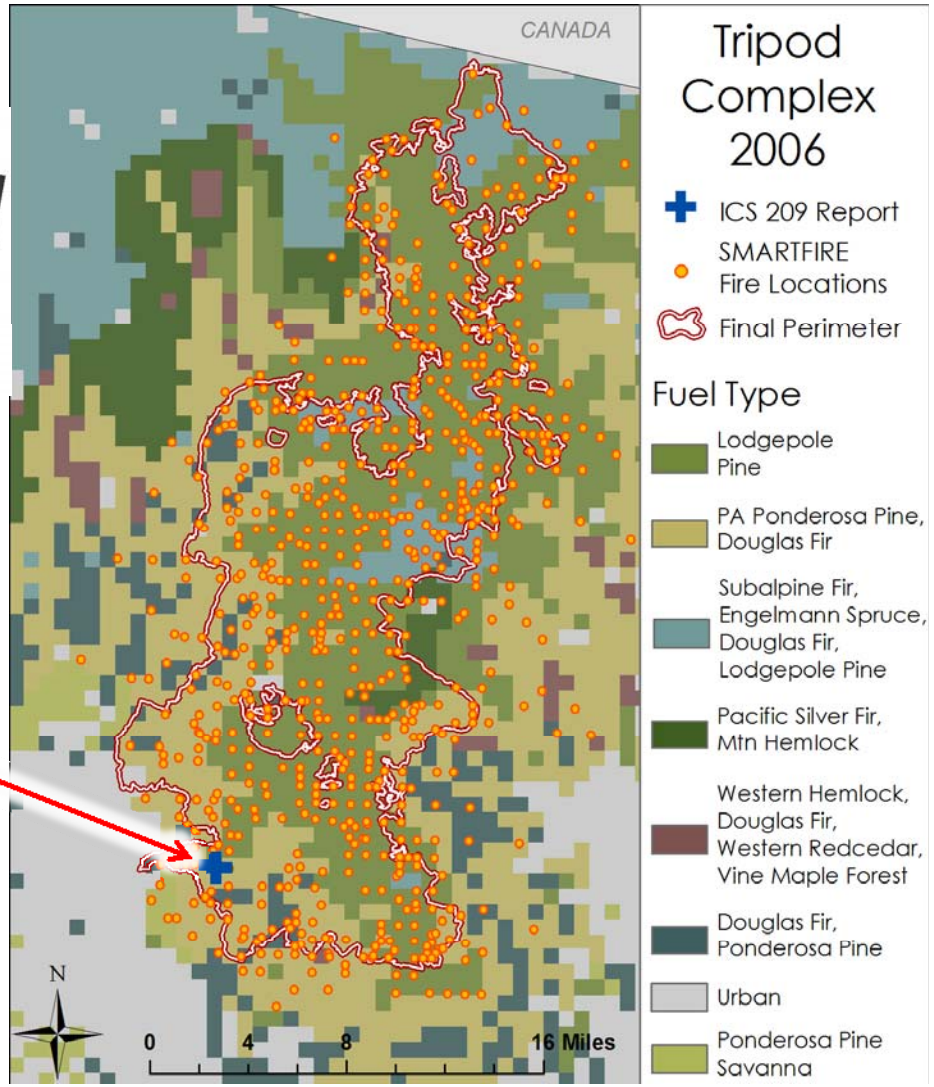
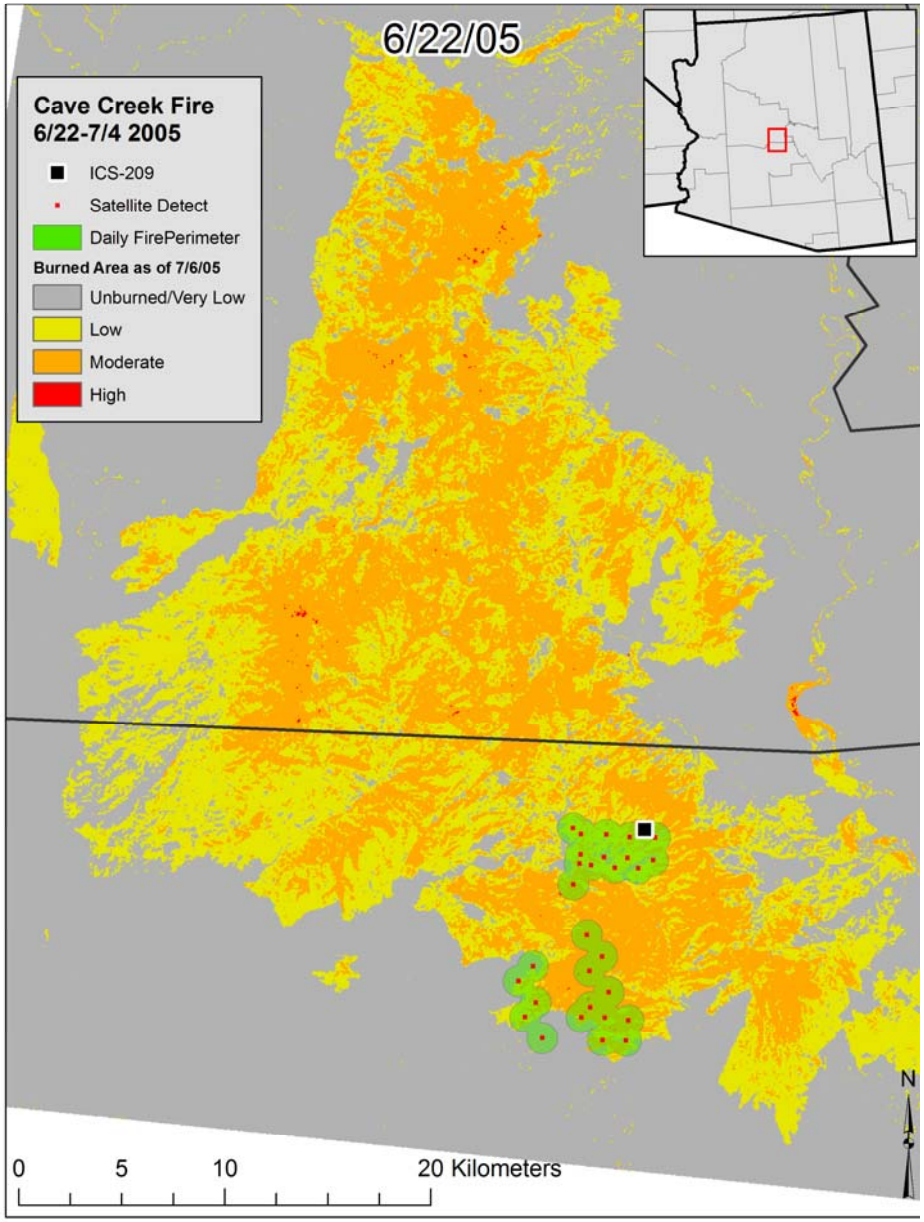
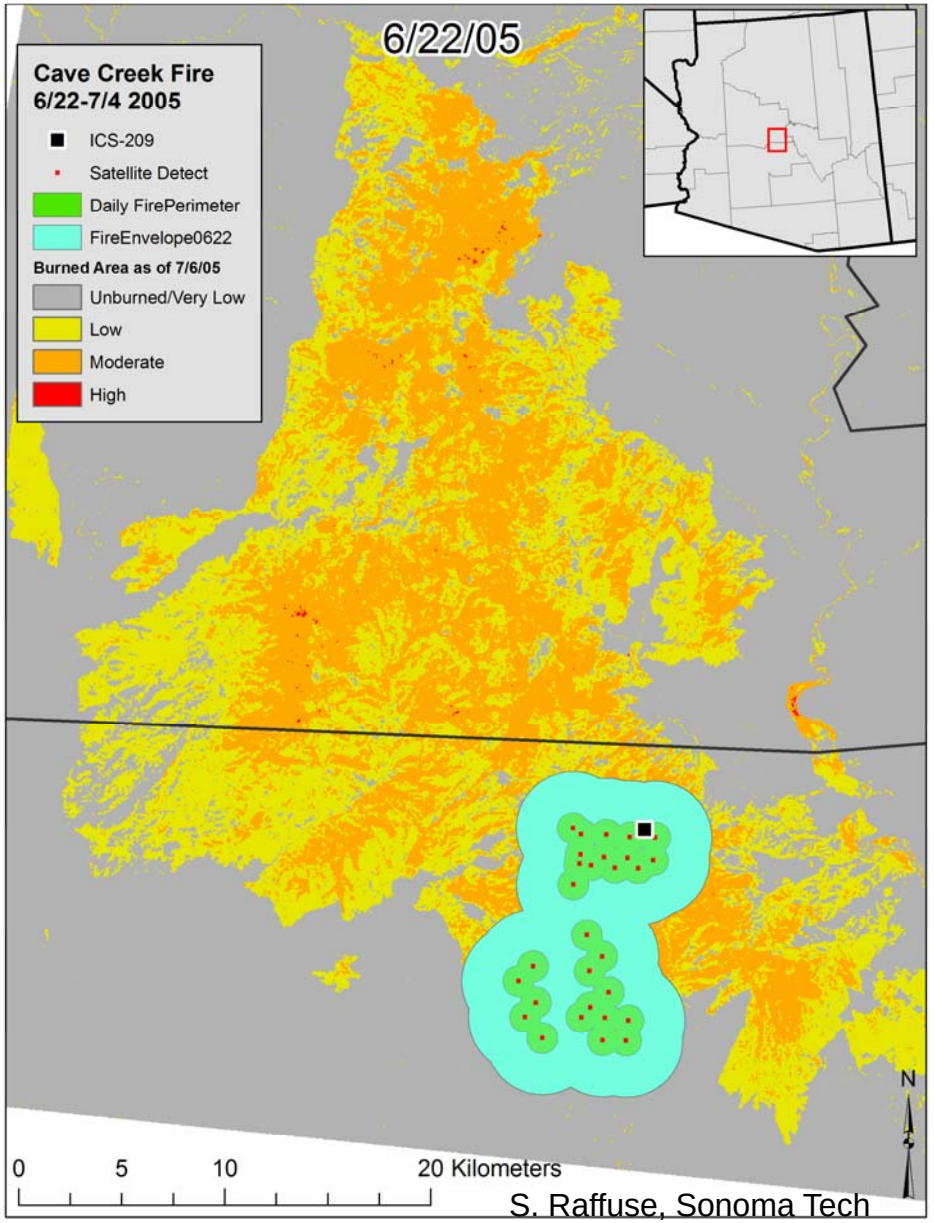


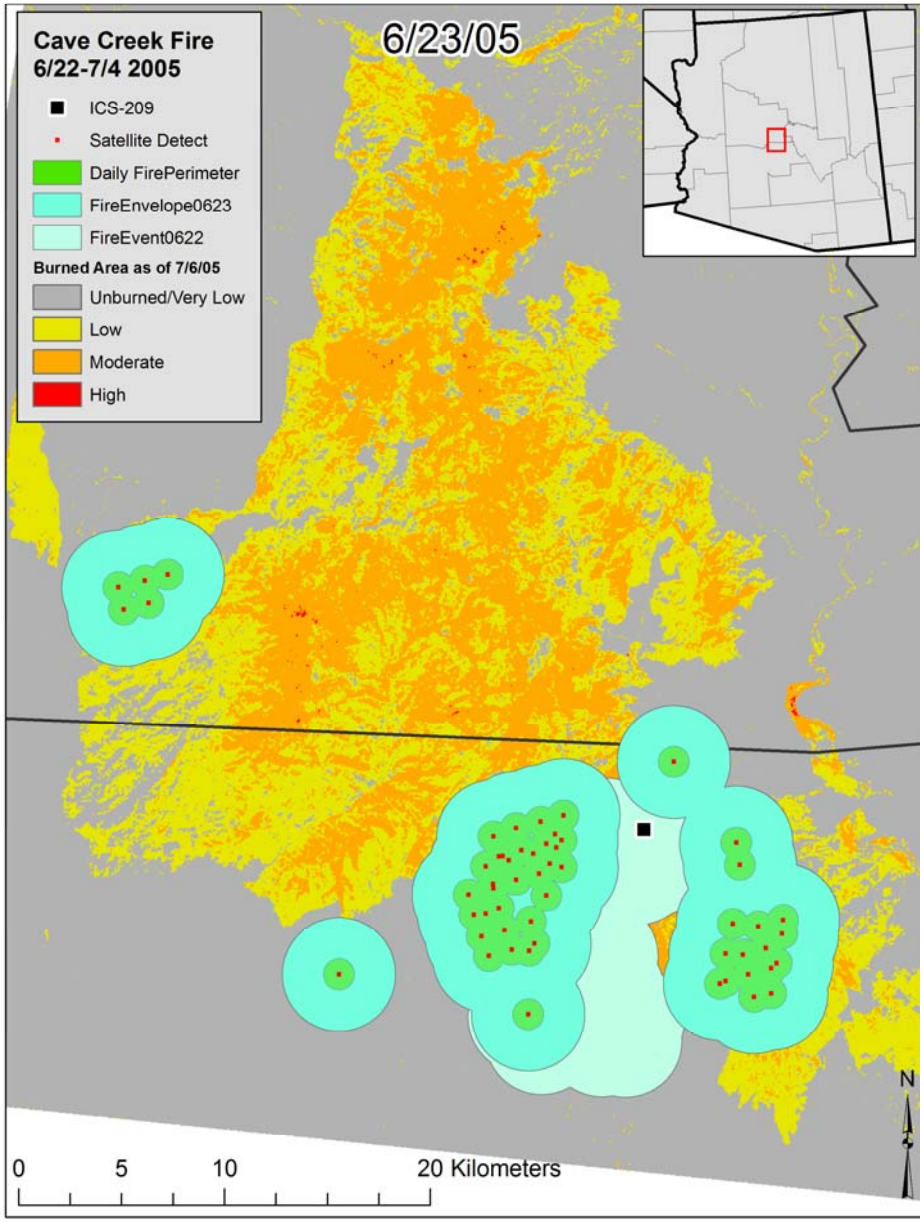
SMARTFIRE FireEvent Development (1 of 2)

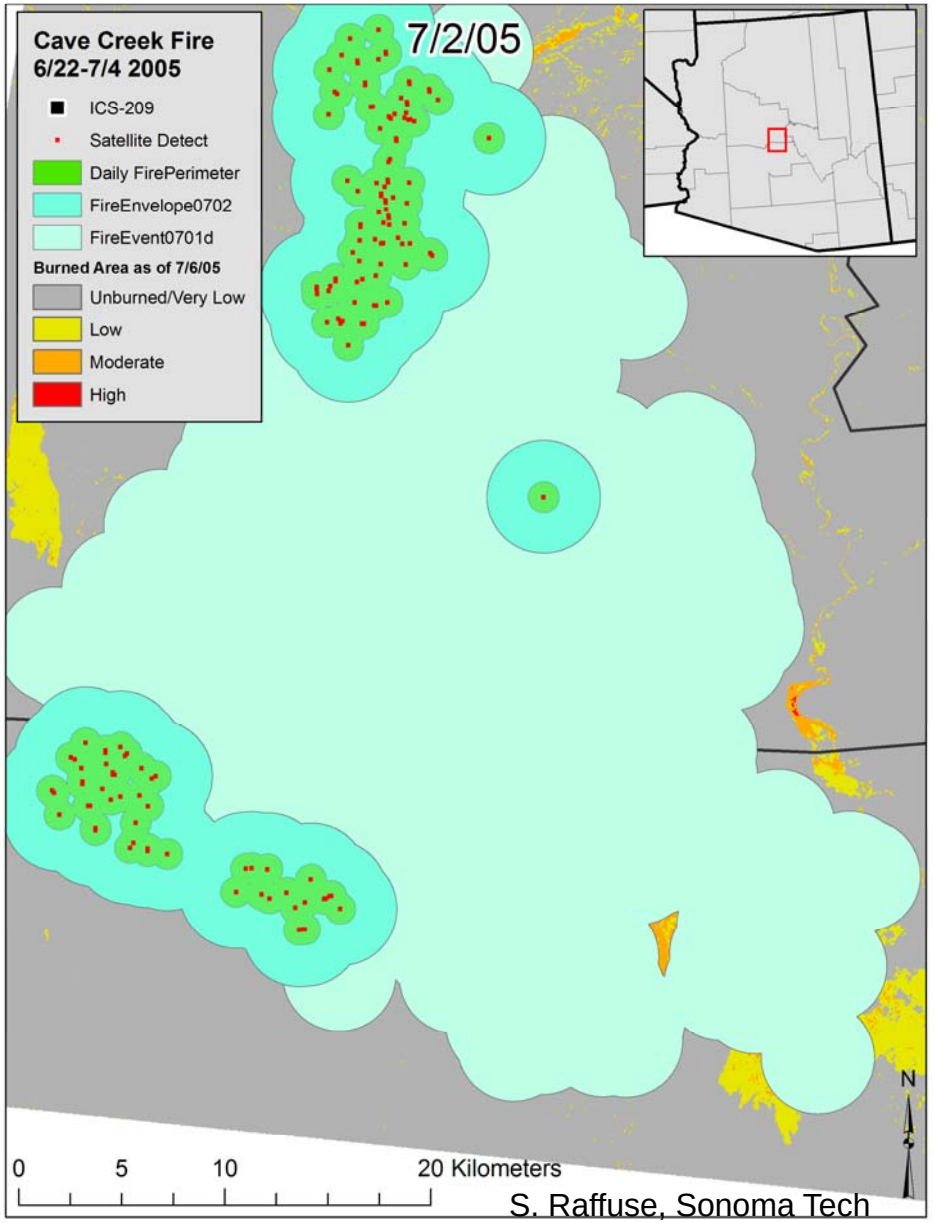




S. Raffuse, Sonoma Tech

SMARTFIRE FireEvent Development (2 of 2)





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