The BlueSky smoke modeling framework and SMARTFIRE

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Background

- AirFire Team / Sue Ferguson
- Northwest Regional Modeling Consortium
  - Early 90s
  - Many interested groups
  - Headed by U W (Cliff Mass)
  - Weather forecasts + value added
- Prescribed burning for forest ecology and fuels reduction
- Lawsuits
  - Save our Summers (WA State)
- Initial system for prescribed “go/no-go” decision support
- NW Prescribed fire reporting systems
  - FASTRACS, OR DOF, MT/ID Airshed Group

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ATMOSPHERE & FIRE INTERACTIONS RESEARCH & ENGINEERING

History

- 2001 National Fire Plan
- 2002 Forecasts begin (NW)
  - BlueSky Consortium
  - Links to NW databases
- 2004 Request for BlueSky
  - Implemented for wildfire
  - EPA Director Mike Leavitt
- 2004 BlueSky-EM project
  - BlueSky part of SMOKE/CMAQ
- 2005 BlueSkyRAINS-West
  - EPA, Dept of Interior, US Forest Service
- 2006 National Weather Service (NWS) Experimental Forecasts
- 2006 NASA ROSES DSS Grant w/ Sonoma Technologies

Smoke in Denver from 2002 Hayman Fire

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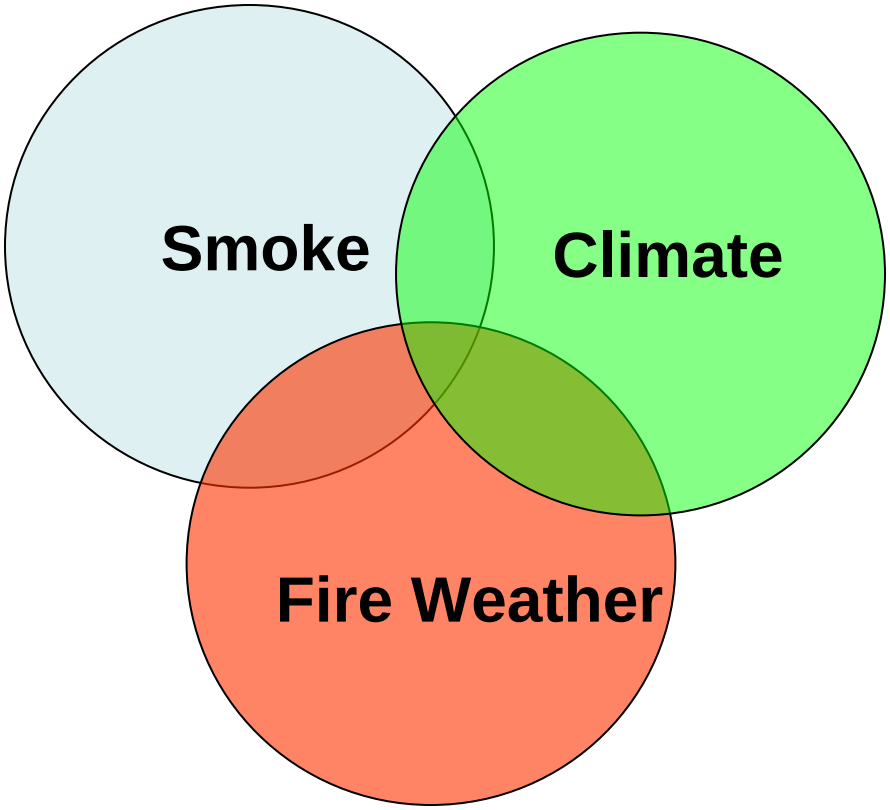
AirFire Research Areas

- US Forest Service atmospheric science research group
- Modeling & field studies, mostly related to fire
- Tools for decision support for smoke management



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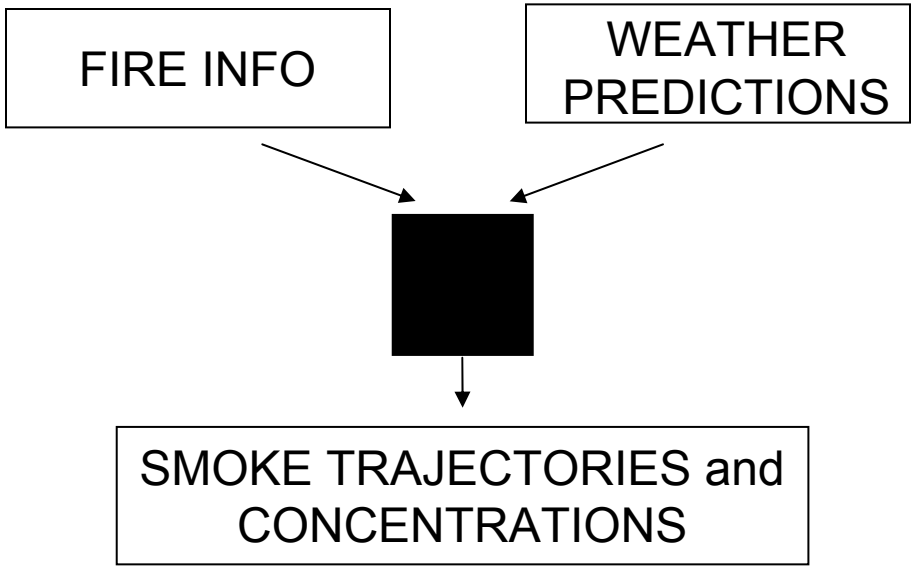
What is BlueSky?



- INPUT SYSTEM
- MODEL FRAMEWORK
- OUTPUT SYSTEM

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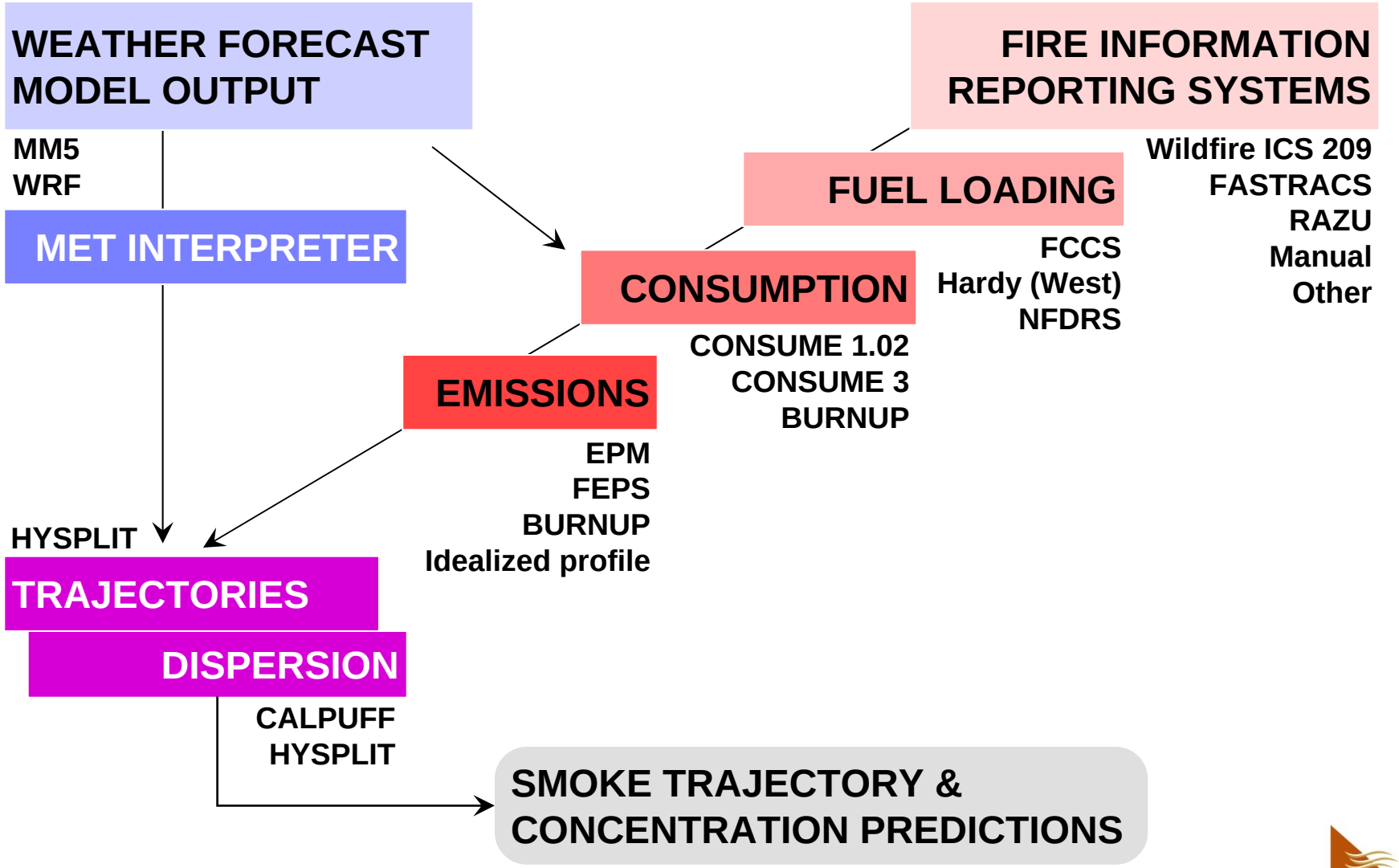
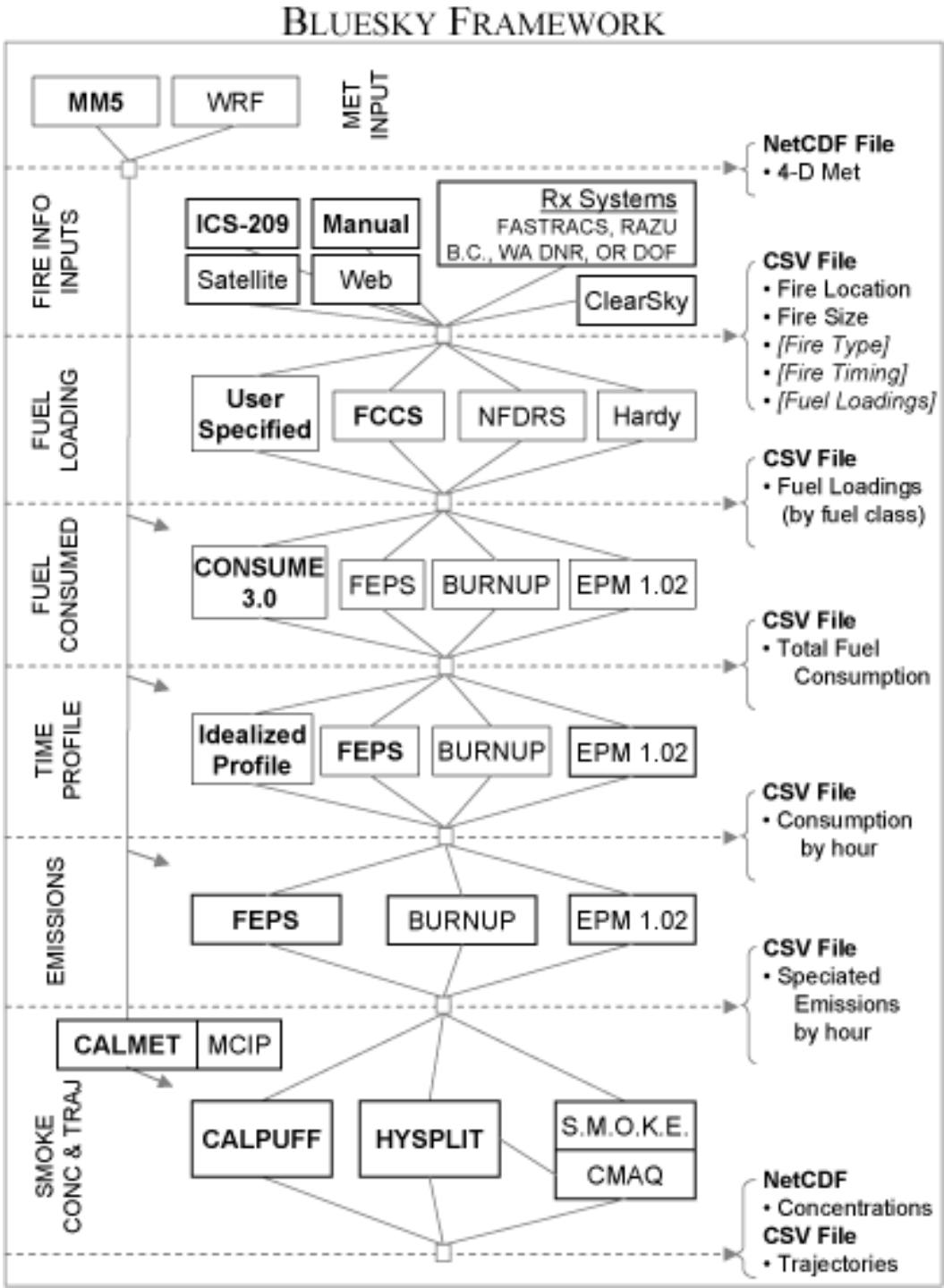
BlueSky Framework



BlueSky Framework

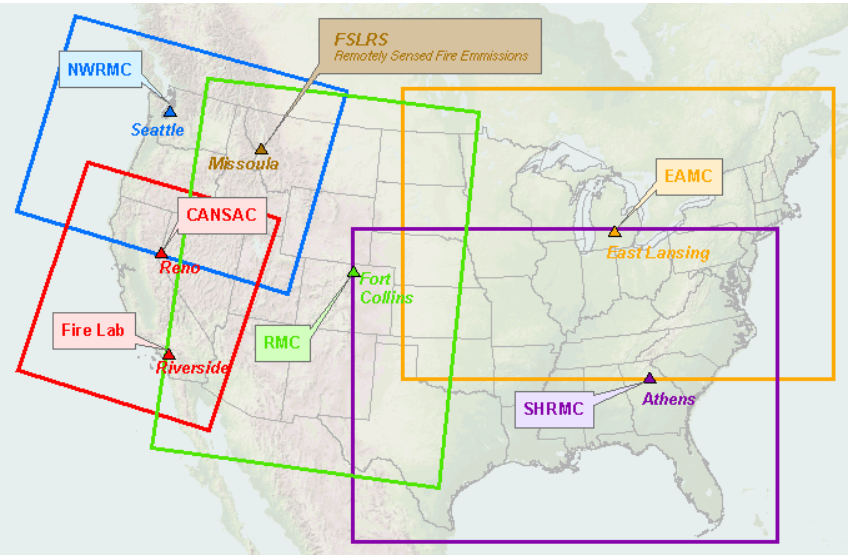
- Revamped code-base (Professional)
- More models
- More modular
- More reliable

⇒ A Community Model

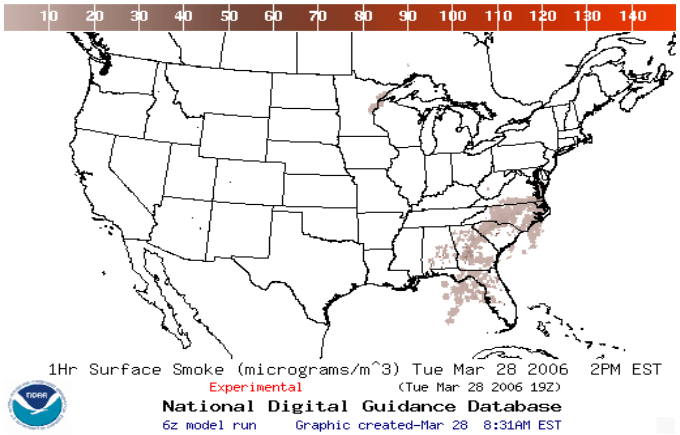


Real-time predictions w/BlueSky

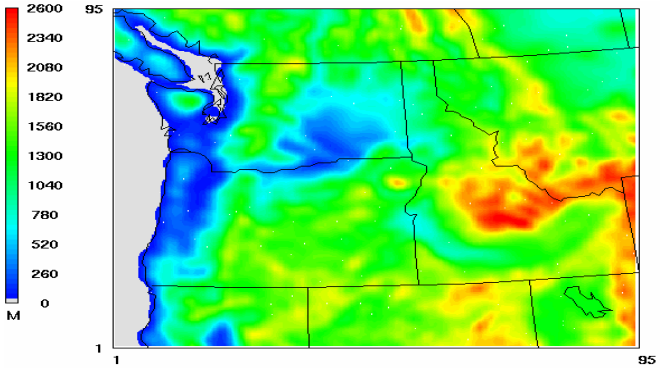
FCAMMS
(5 regional centers covering lower 48)



US NWS Smoke Forecast Product
(lower 48)



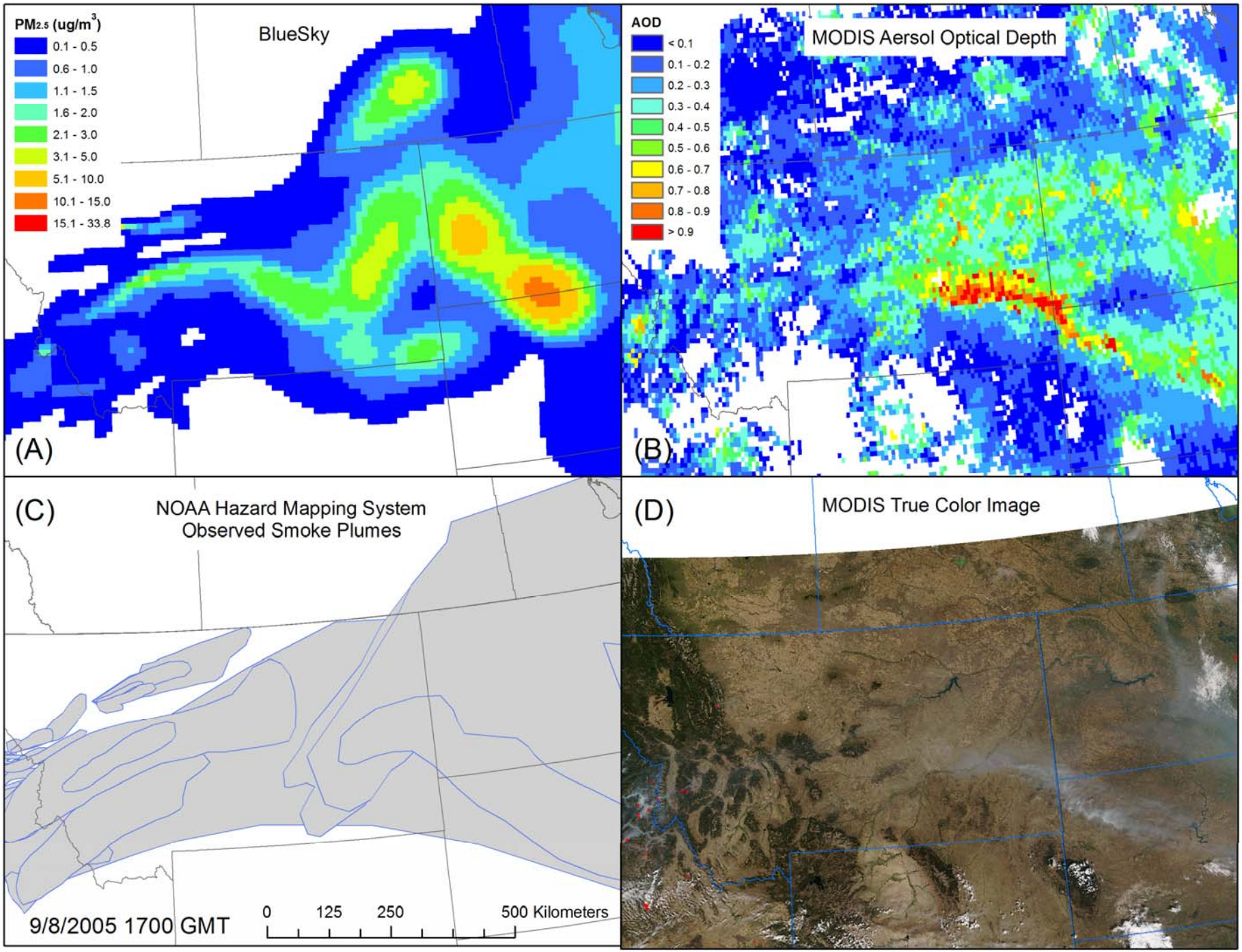
AirPACT3 & ClearSky
(PNW, Lamb & Vaughan, WSU)



Qualitative Evaluation / Lessons

Overall: Plume shape (horizontal) looks good but we are under-predicting concentrations

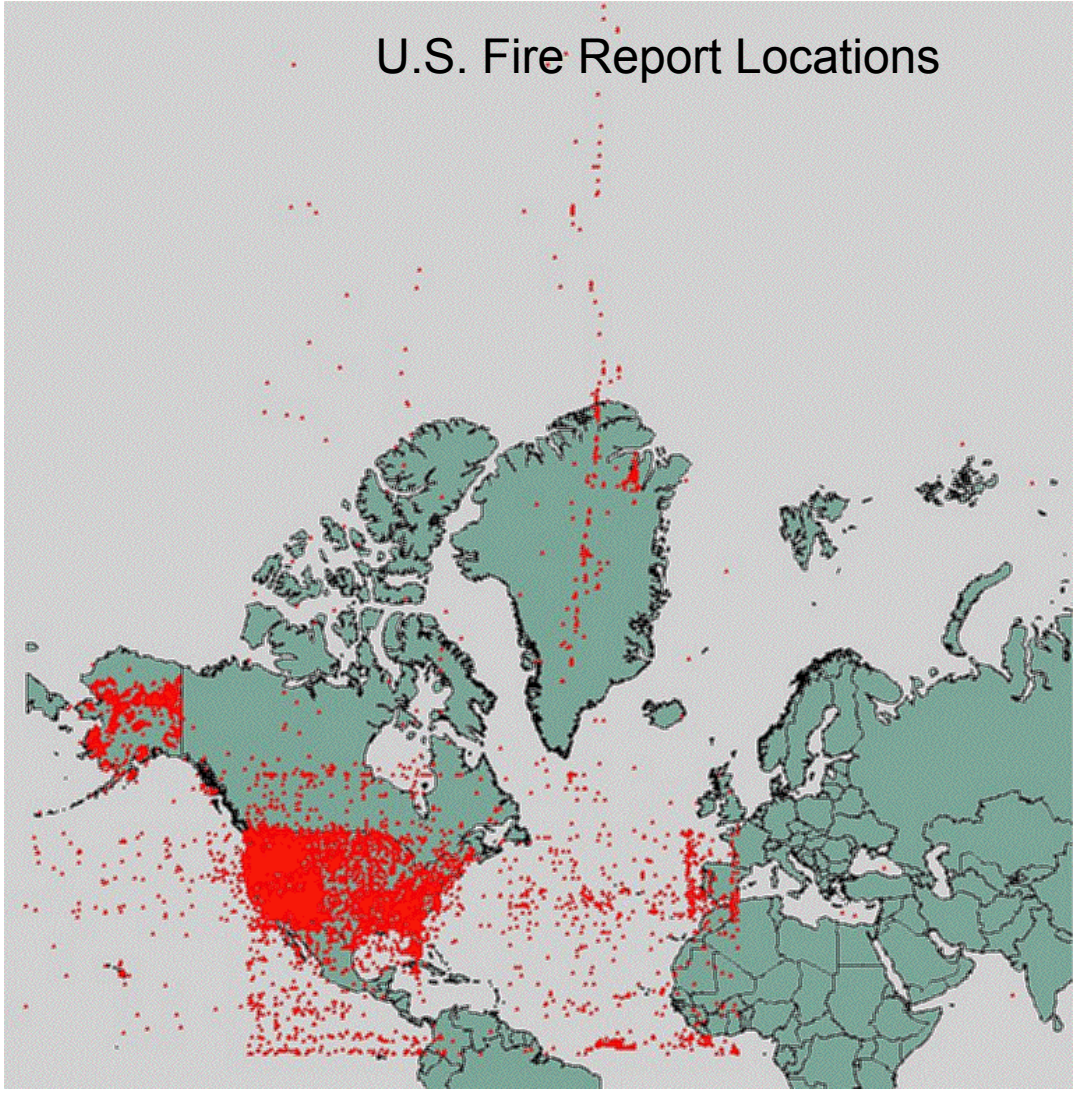
- Fire information can be of poor quality
- Which model to choose?
- Plume rise critical (possible for 1 fire to have many effective plumes)


PM2.5 (ug/m3)
0.1 - 0.5
0.6 - 1.0
1.1 - 1.5
1.6 - 2.0
2.1 - 3.0
3.1 - 5.0
5.1 - 10.0
10.1 - 15.0
15.1 - 33.8
BlueSky
(A)
AOD
< 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5
0.5 - 0.6
0.6 - 0.7
0.7 - 0.8
0.8 - 0.9
> 0.9
MODIS Aersol Optical Depth
(B)
(C)
NOAA Hazard Mapping System
Observed Smoke Plumes
9/8/2005 1700 GMT
0
125
250
500 Kilometers
(D)
MODIS True Color Image

Fire Information Issues

Fire information can be of poor quality

Smoke predictions depend on the fire information

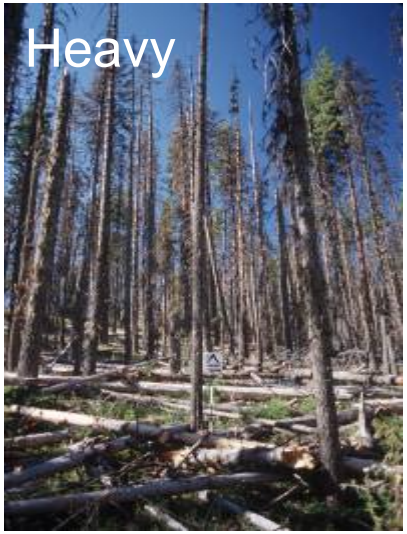


Courtesy Tim Brown, DRI

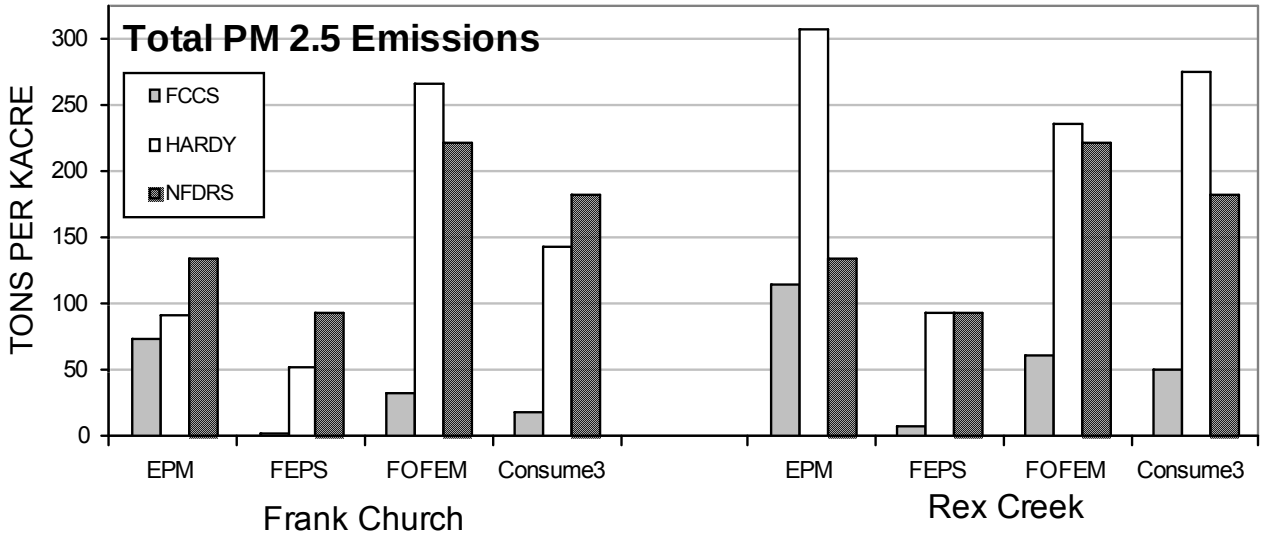
Which model is best?

Fuel Loadings

Even in the same vegetation type can vary



Photos courtesy Ottmar et al.

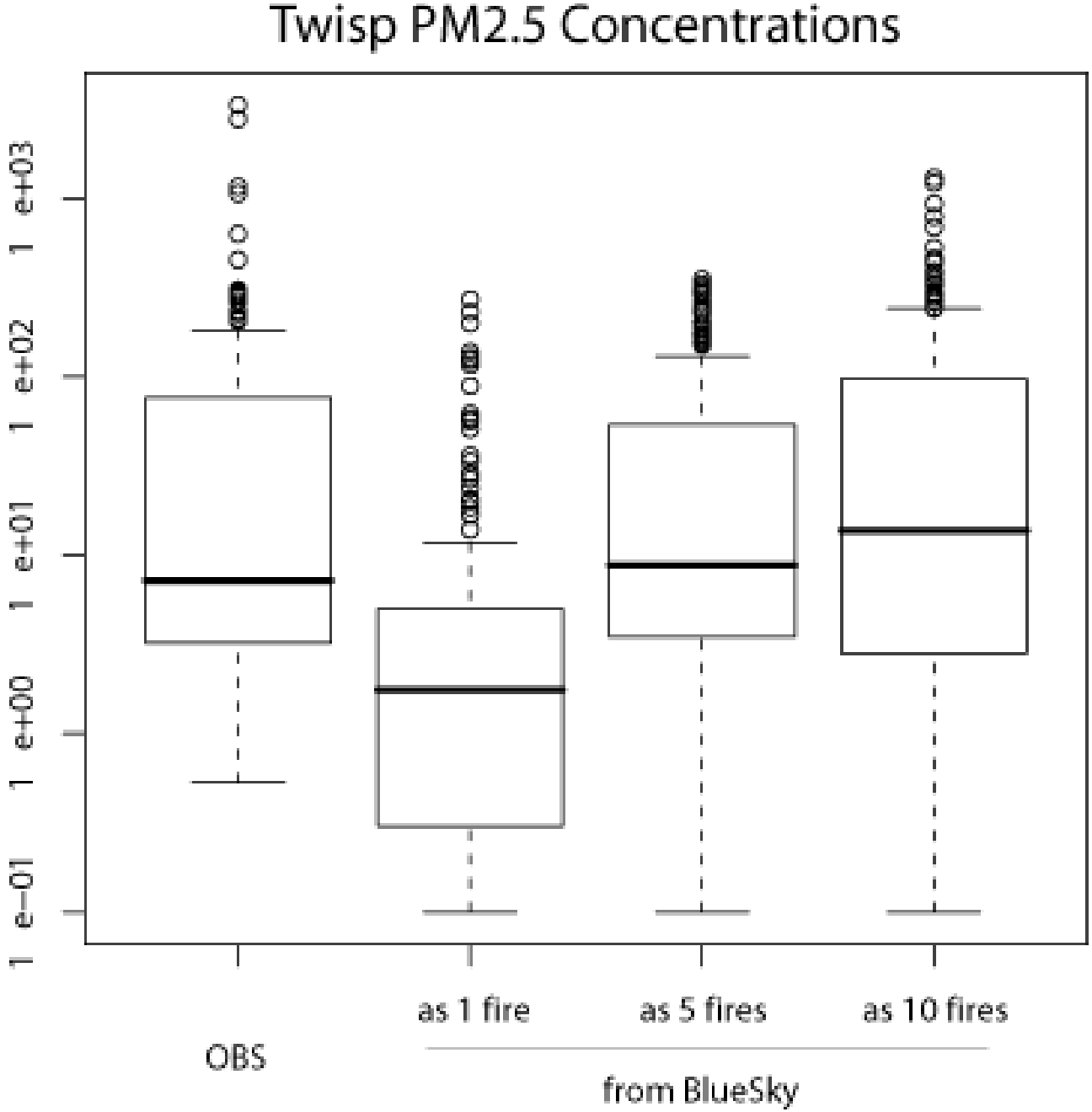


Emissions based on Fuel Load and Fuel Consumption Model Choices

Plume Rise

- Fires are currently modeled as single plumes
  - Lofting smoke
  - Unrealistically high
  - Lowering ground impacts
- Reality fires, many burning areas
  - Many plumes
  - Lofting smoke
  - Various heights

Multiple plumes make it look better



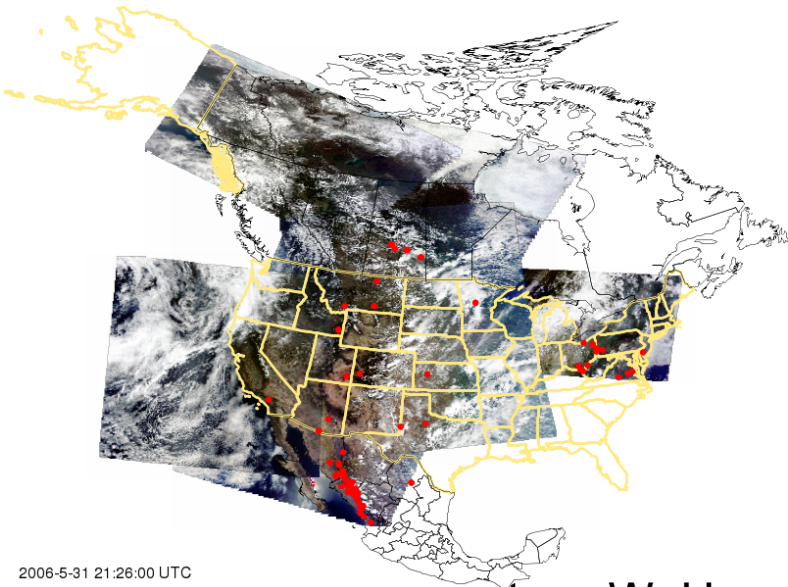
The Next Generation BlueSky

Sonoma Technologies + AirFire
NASA ROSES grant

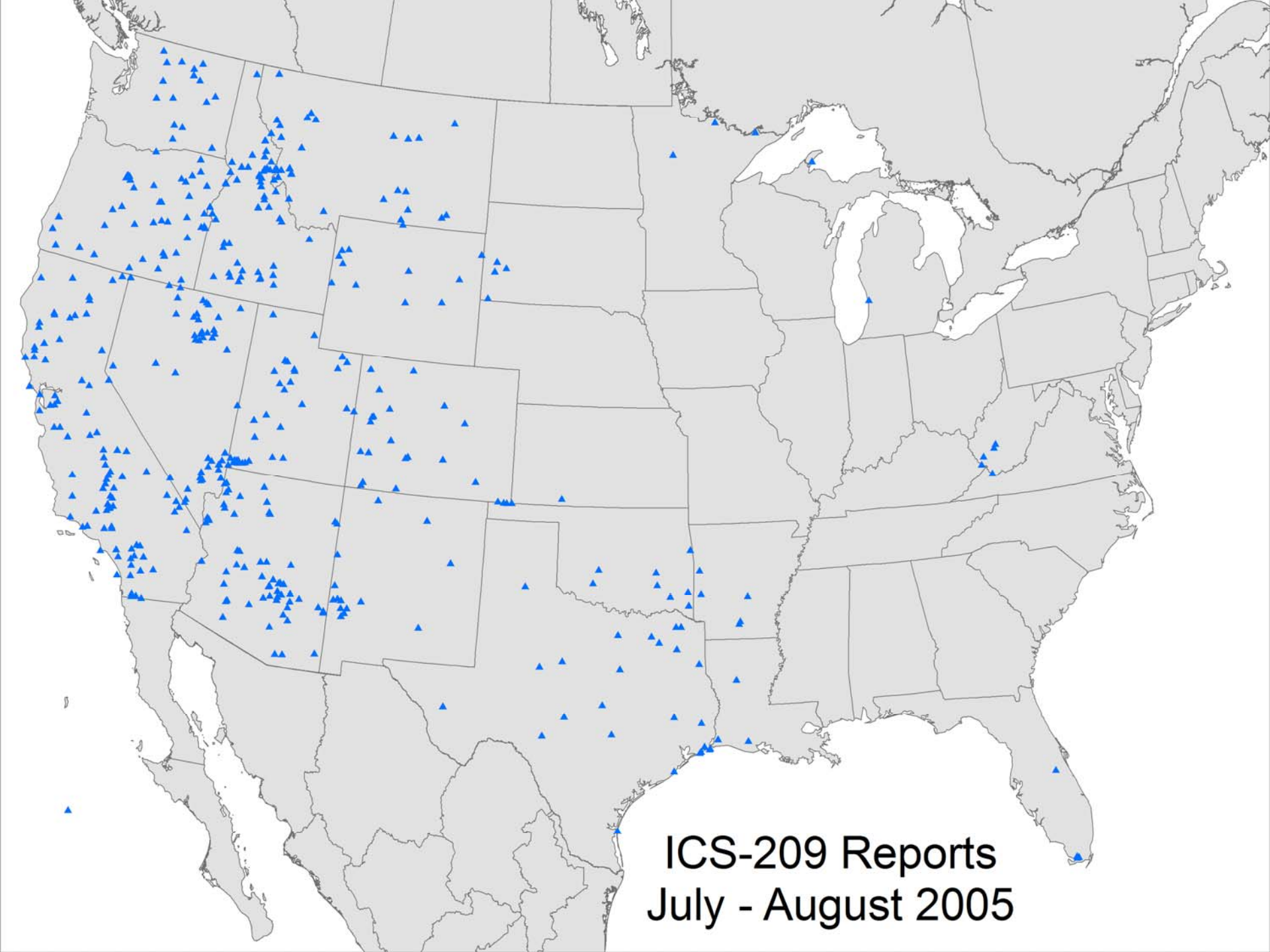
- New Input System:
  SMARTFIRE

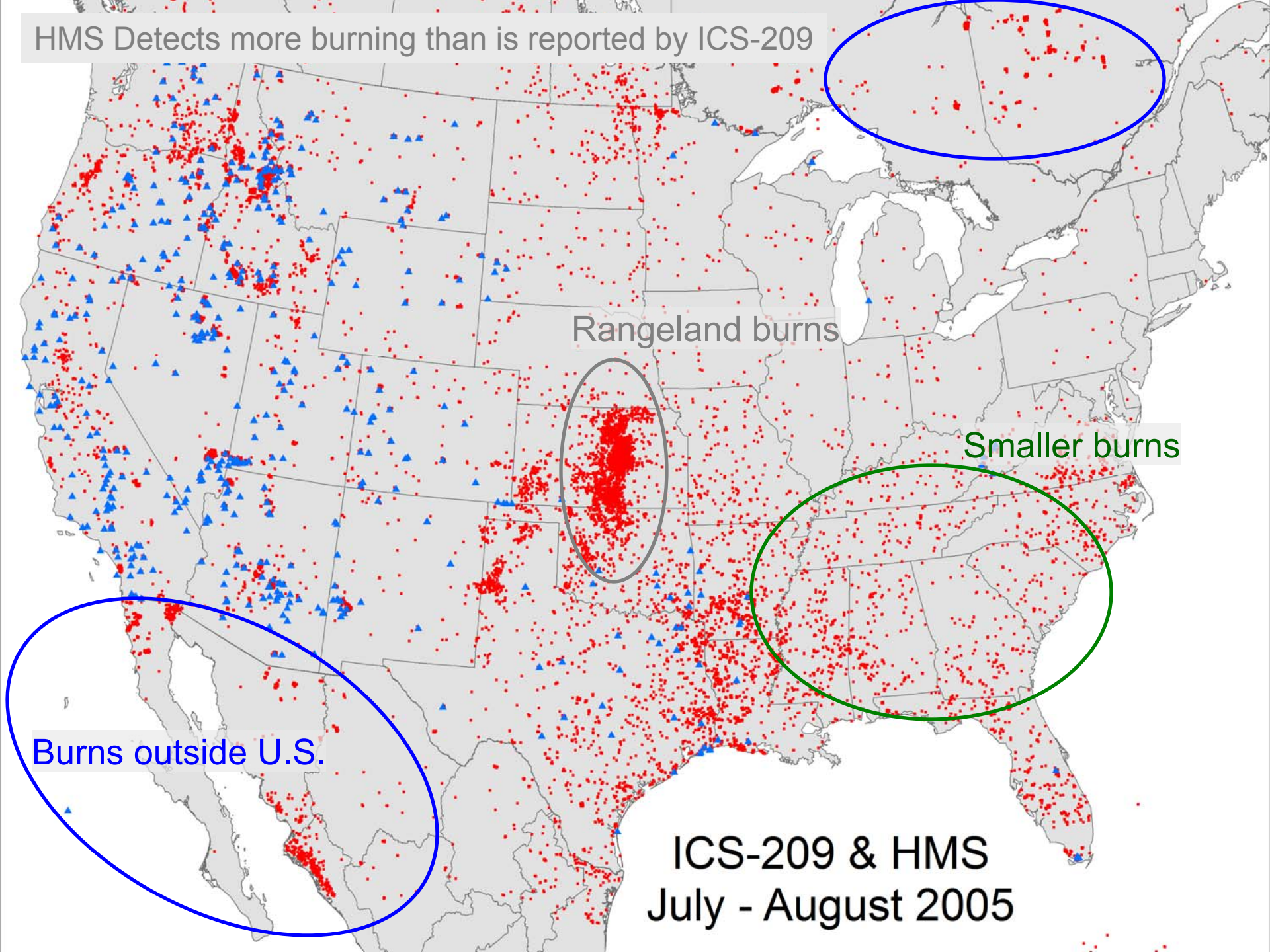
- Revamped Framework
  truly modular / open source

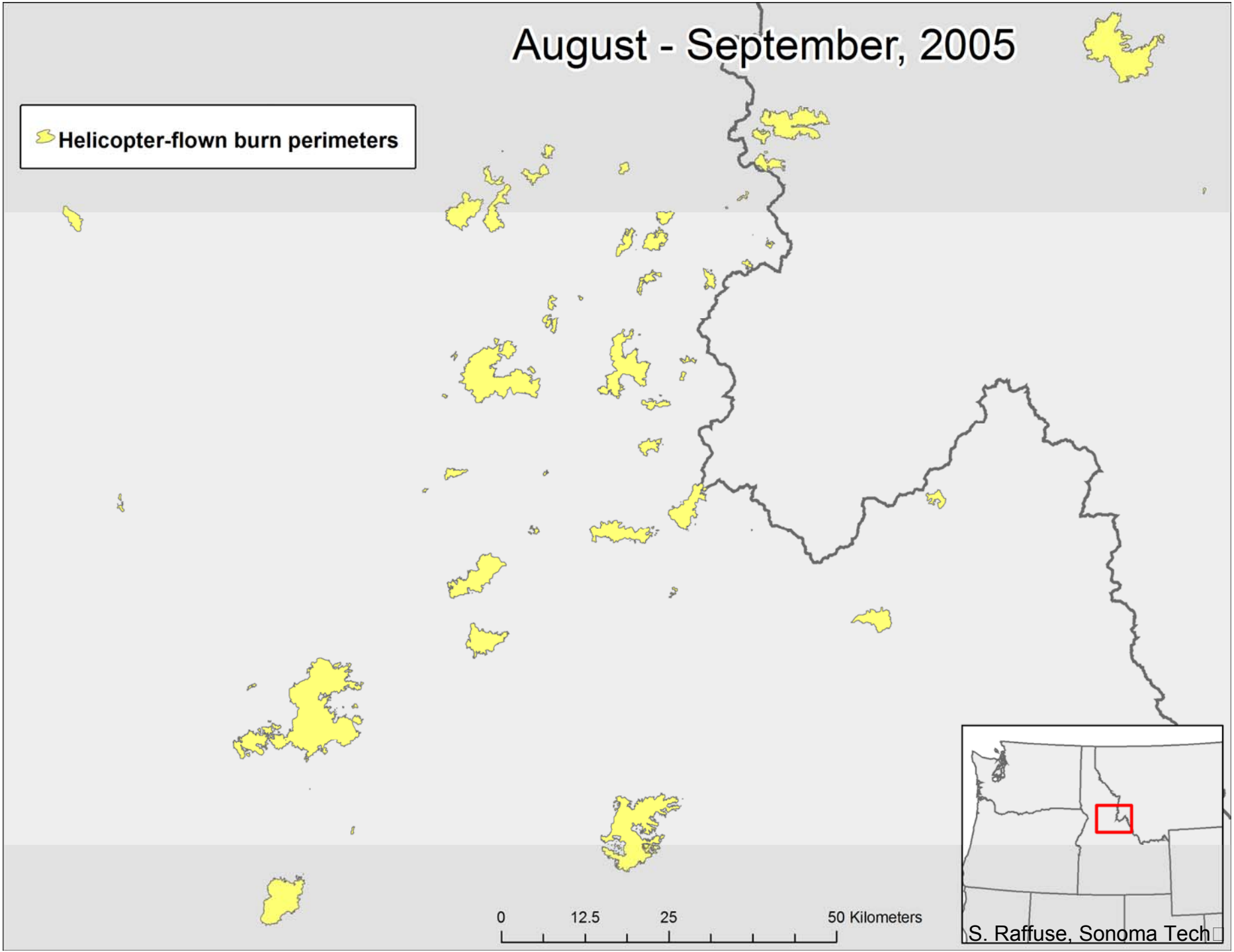
- New User Interface for
  Smoke Management “what-if” game playing

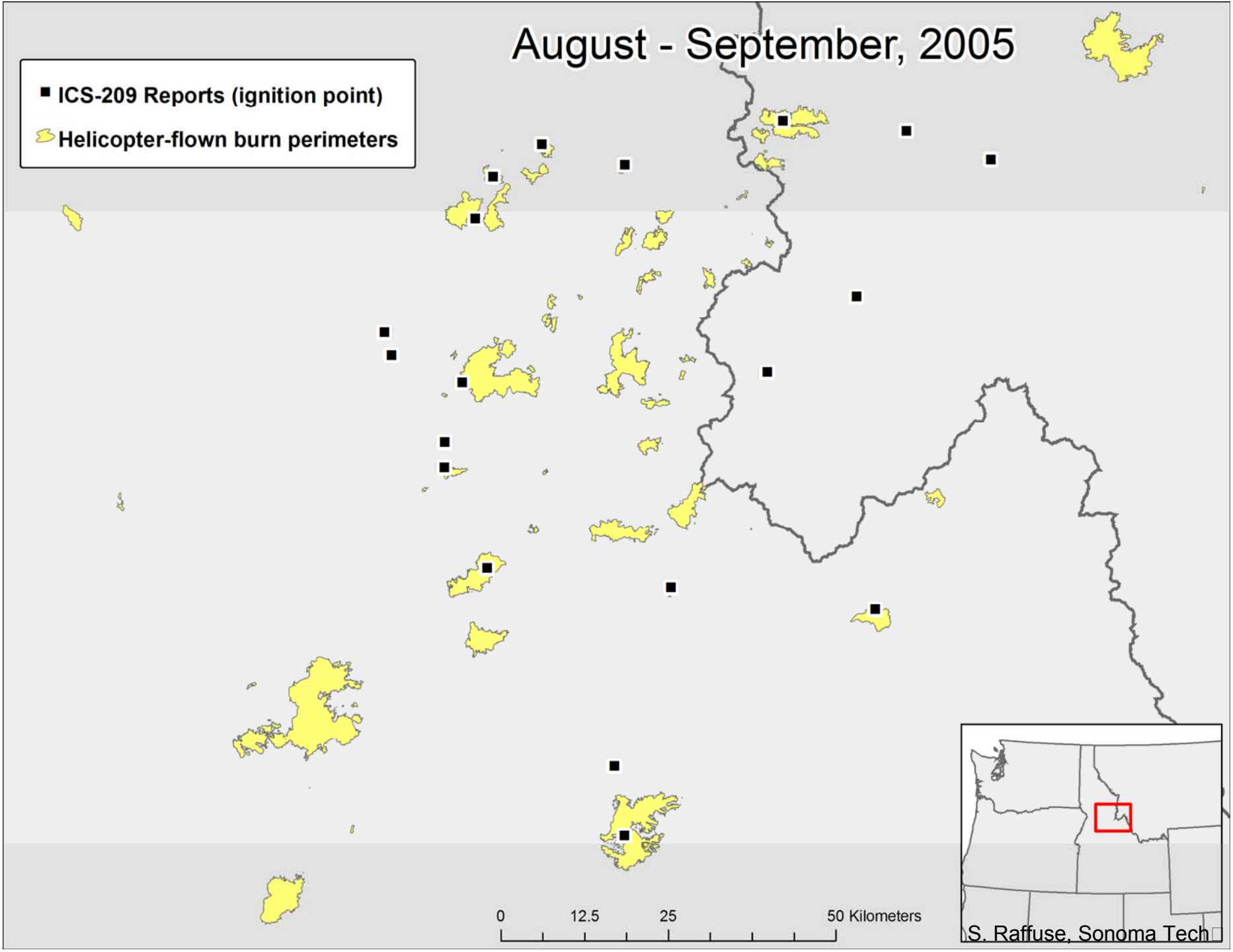


courtesy W. Hao


ICS-209 Reports
July - August 2005


HMS Detects more burning than is reported by ICS-209
Rangeland burns
Smaller burns
Burns outside U.S.
ICS-209 & HMS
July - August 2005


August - September, 2005
Helicopter-flown burn perimeters
0
12.5
25
50 Kilometers
S. Raffuse, Sonoma Tech


August - September, 2005
ICS-209 Reports (ignition point)
Helicopter-flown burn perimeters
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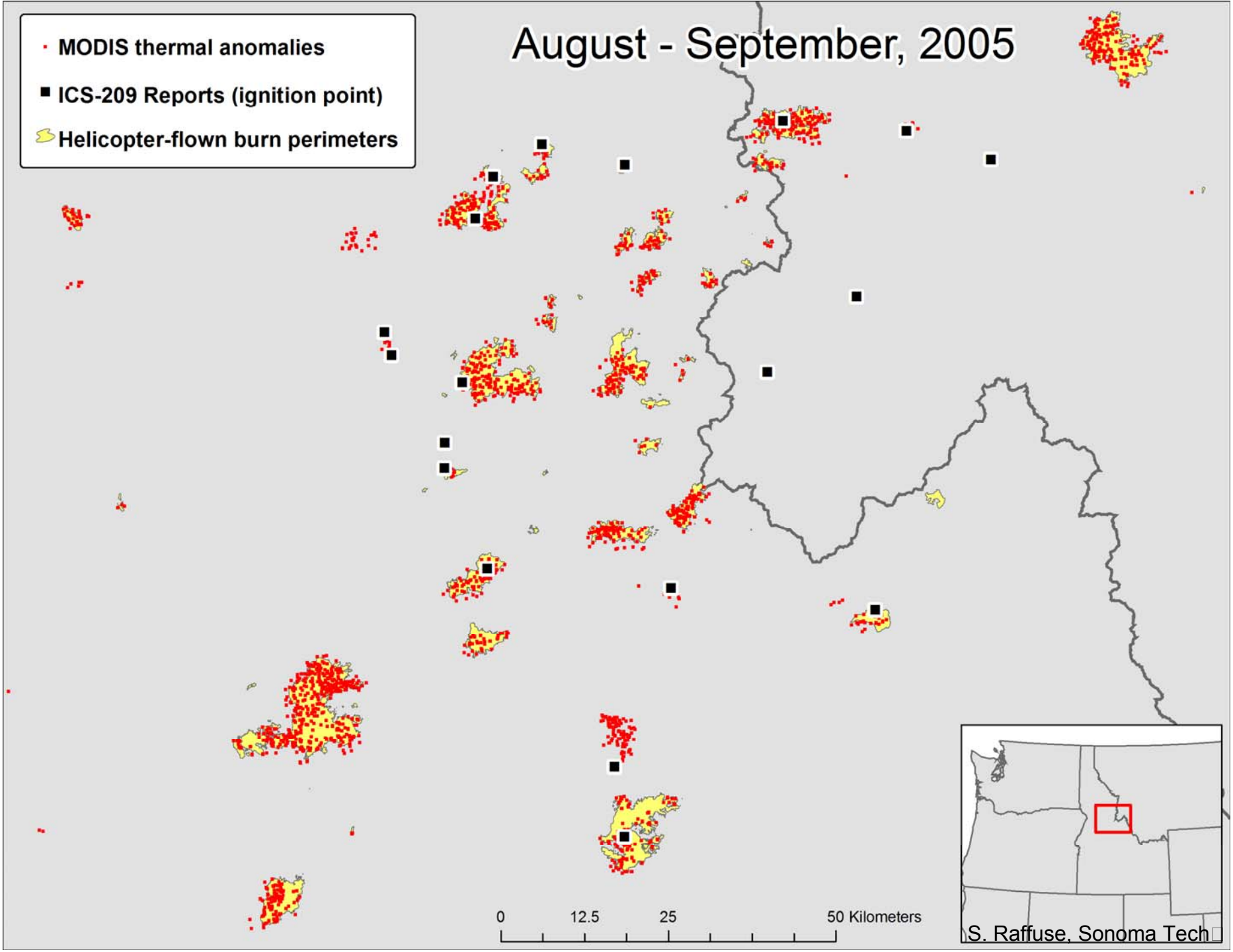
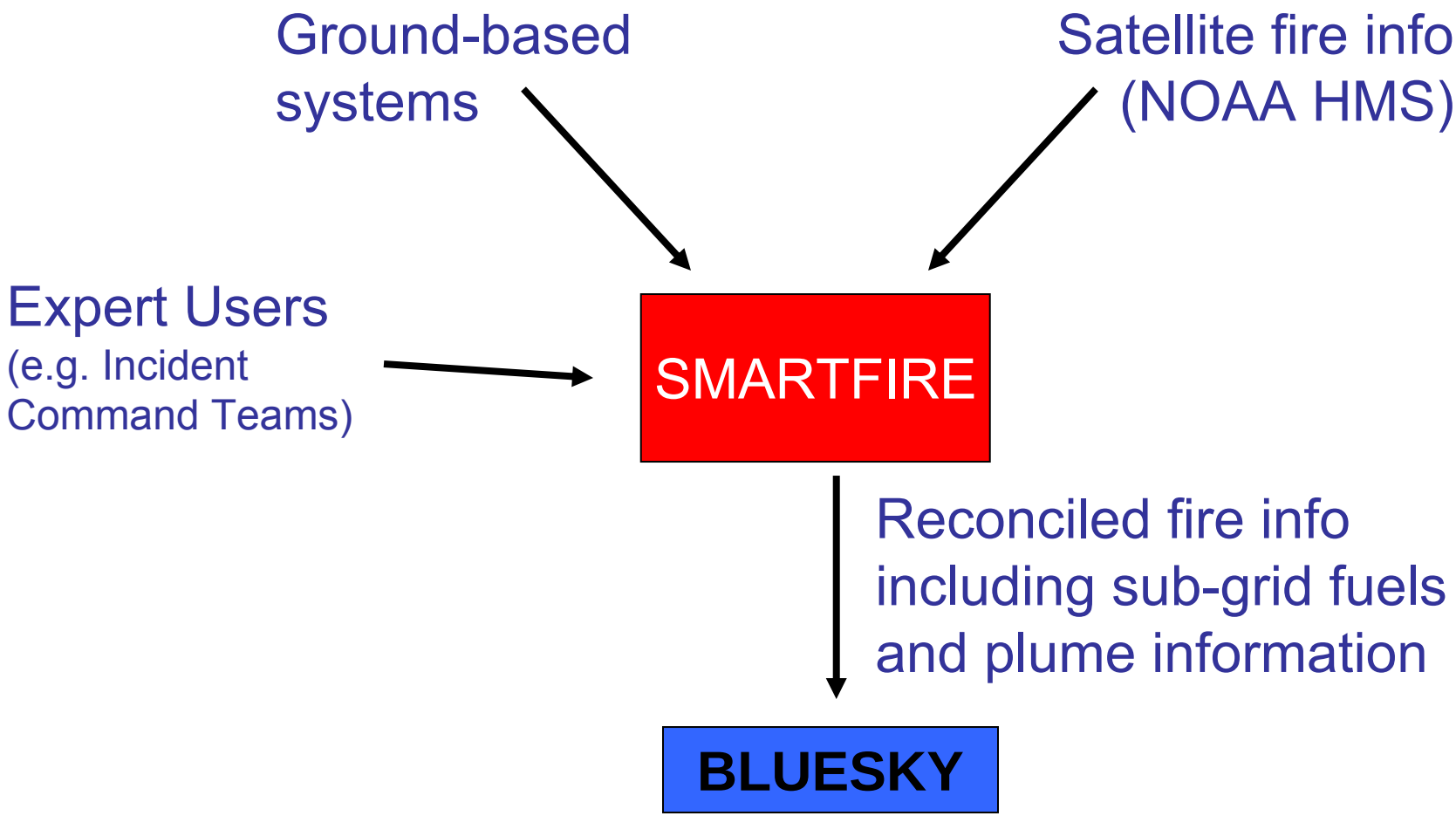
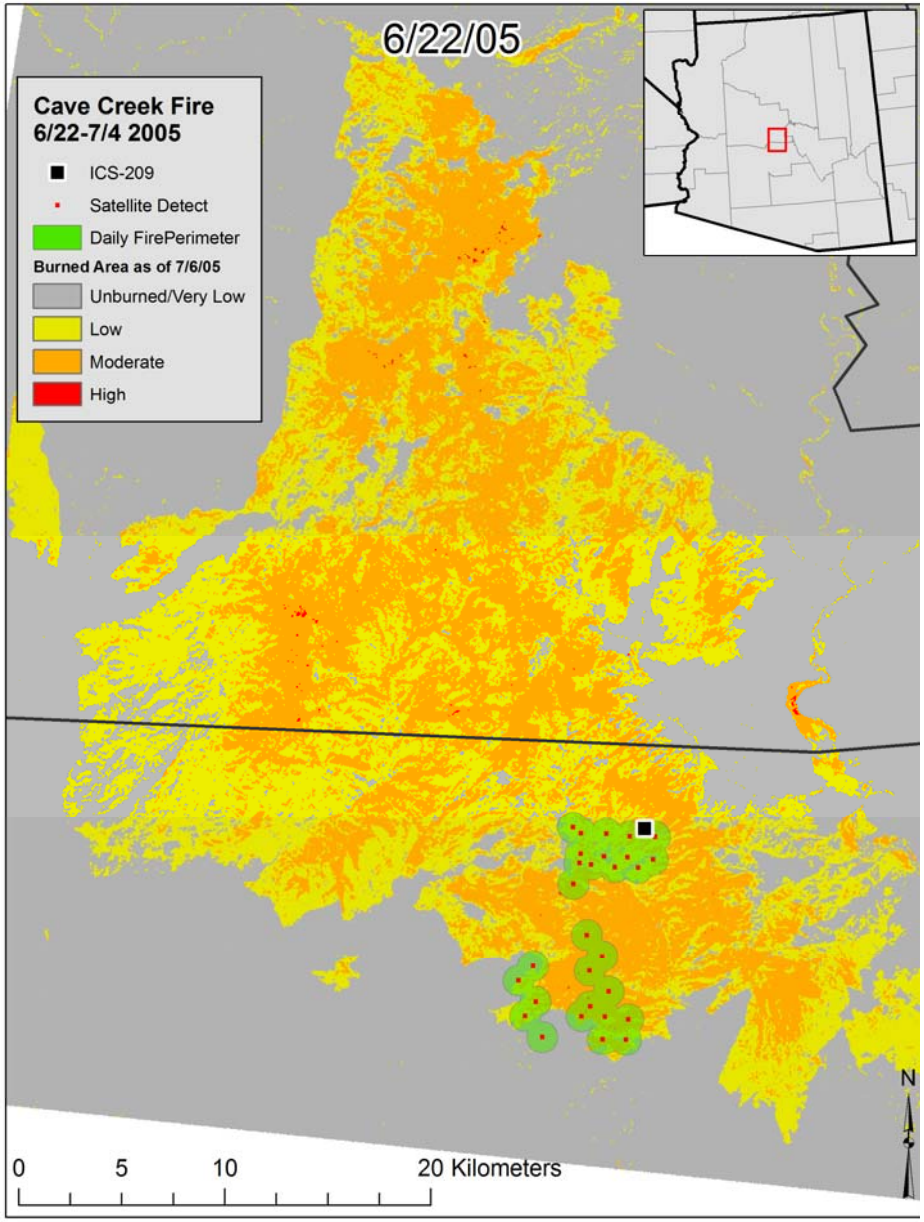
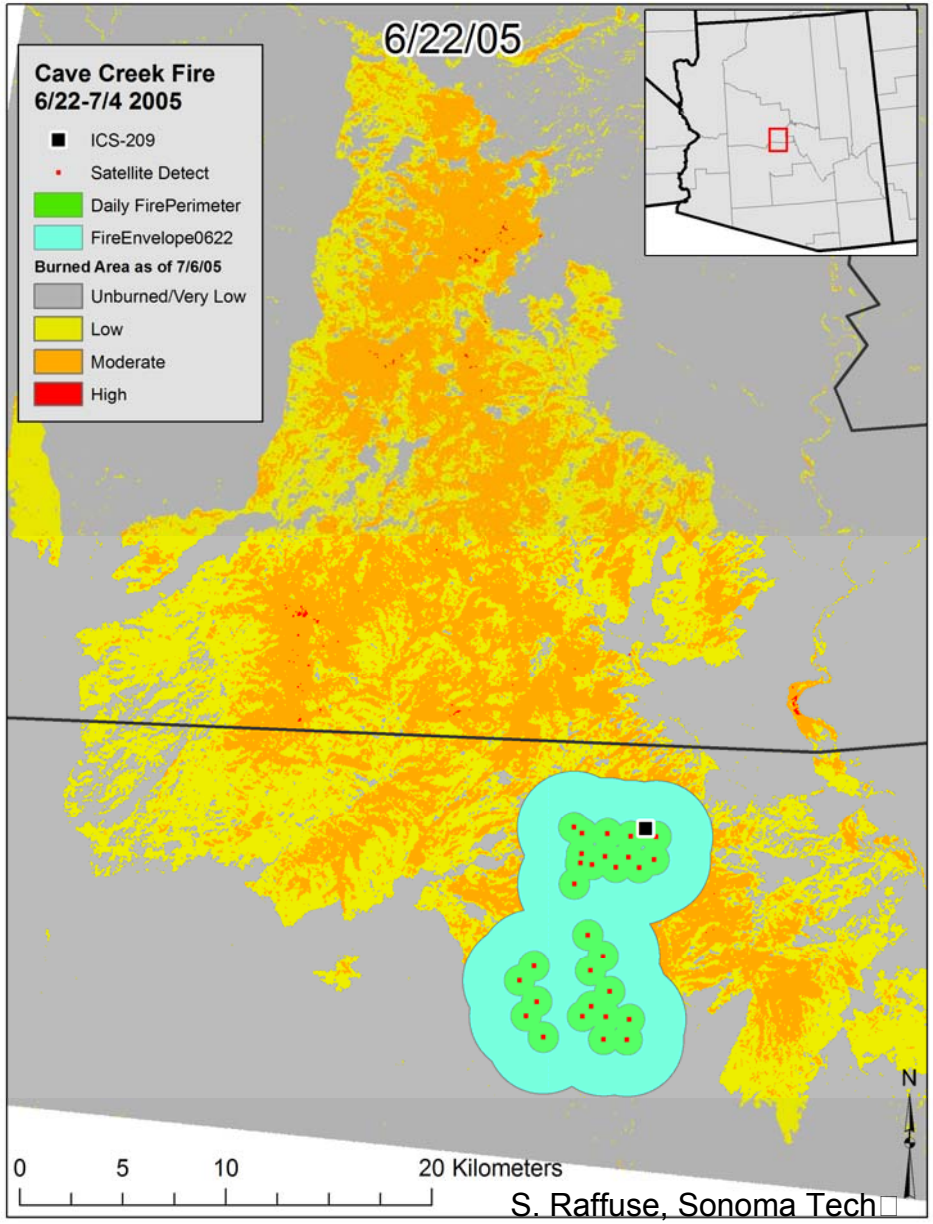

MODIS thermal anomalies
ICS-209 Reports (ignition point)
Helicopter-flown burn perimeters
August - September, 2005
0
12.5
25
50 Kilometers
S. Raffuse, Sonoma Tech

SMARTFIRE: Incorporating satellite fire data



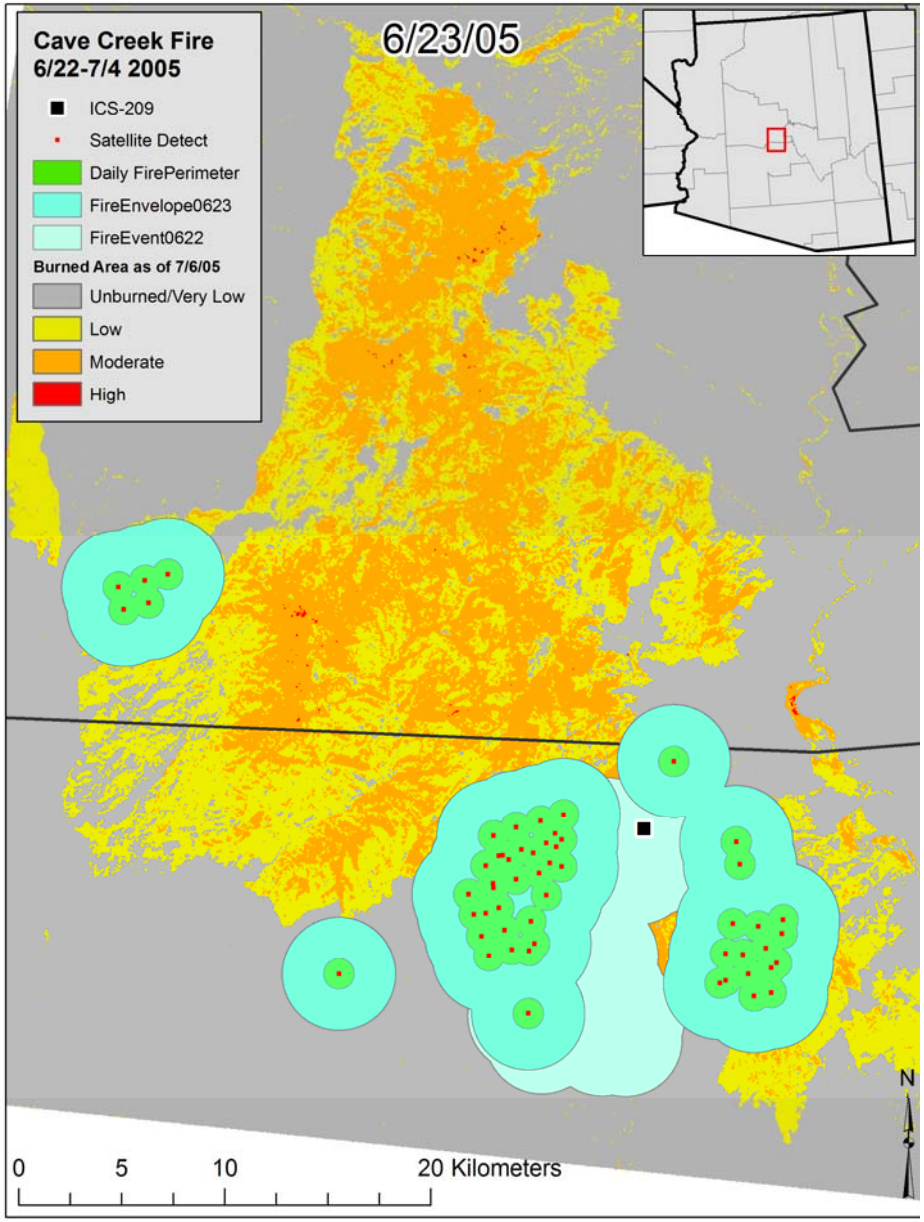
SMARTFIRE Fire Event Development (1 of 2)

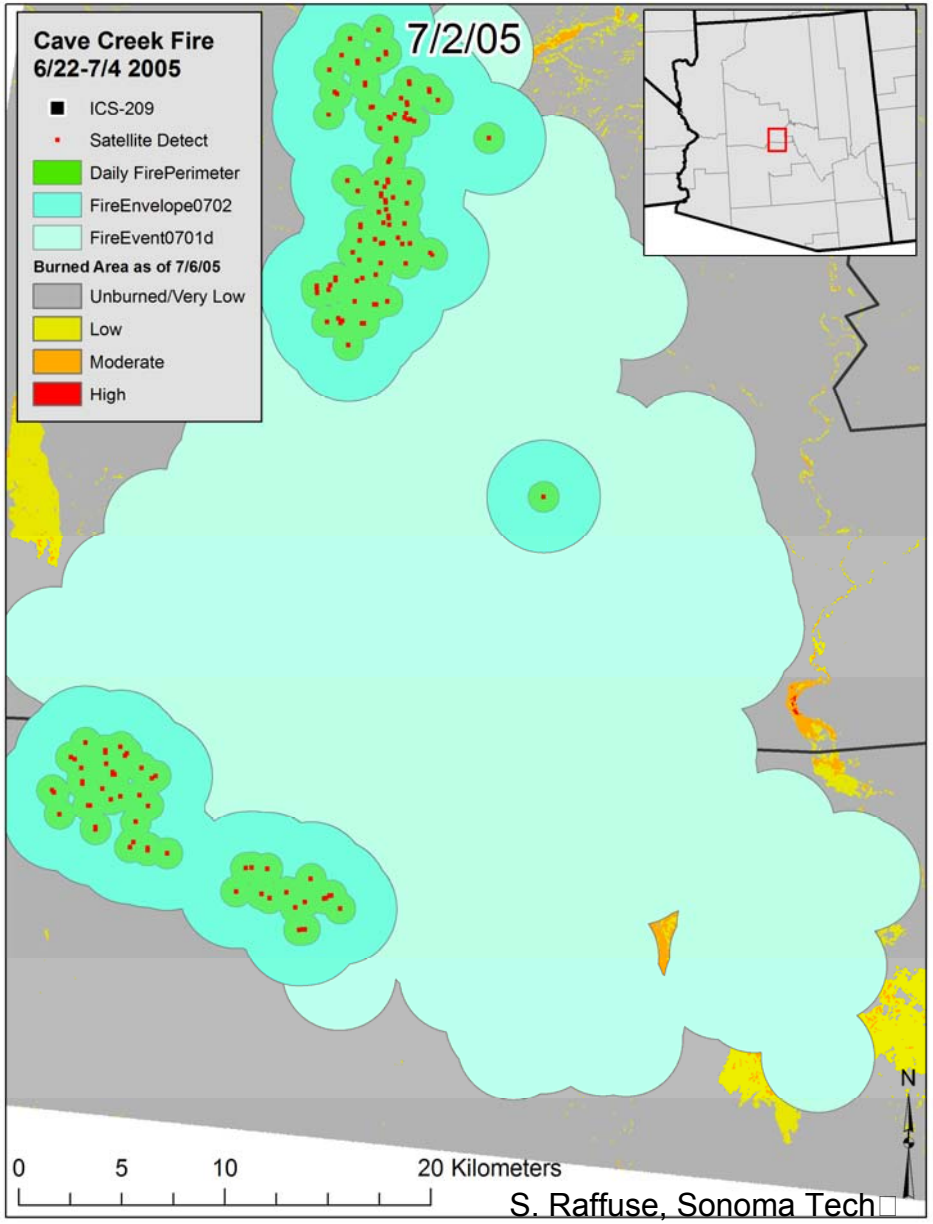




S. Raffuse, Sonoma Tech

SMARTFIRE Fire Event Development (2 of 2)





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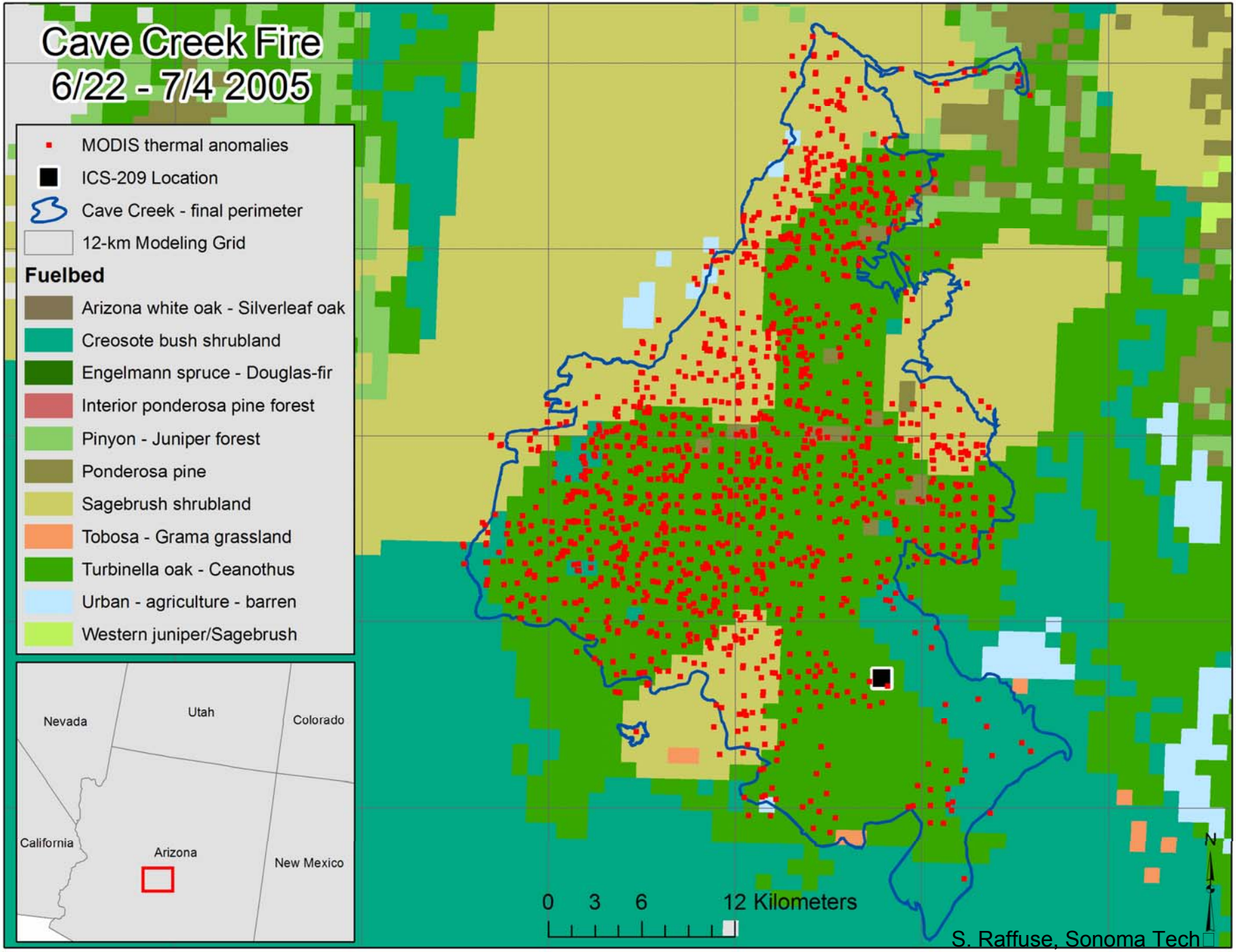
Cave Creek Fire
6/22 - 7/4 2005
MODIS thermal anomalies
ICS-209 Location
Cave Creek - final perimeter
12-km Modeling Grid
Fuelbed
Arizona white oak - Silverleaf oak
Creosote bush shrubland
Engelmann spruce - Douglas-fir
Interior ponderosa pine forest
Pinyon - Juniper forest
Ponderosa pine
Sagebrush shrubland
Tobosa - Grama grassland
Turbinella oak - Ceanothus
Urban - agriculture - barren
Western juniper/Sagebrush
Nevada
Utah
Colorado
California
Arizona
New Mexico
0 3 6 12 Kilometers
N
S. Raffuse, Sonoma Tech

Conclusions

Now(ish) available:

- Reconciled satellite data (SMARTFIRE) (in testing)
- Initial BlueSky Framework rewrite available (1 month)
- FCAMMS - consistent BlueSky predictions

Later this year:

- Revised interface (AirNowTech? RAINS2?)
- Incorporation into AirNow

Next year:

- Ability to ‘game-play’ prescribed burns
- On-the-fly trajectories, single burn impacts
- Ability to ensemble forecasts

AIRFIRE
ATMOSPHERE & FIRE INTERACTIONS RESEARCH & ENGINEERING

Summary of Goals

- Community model:
  - NWS, Environment Canada, WSU, etc…
  - More models (WRF-Chem, etc…)
- New output types:
  - New RAINS
  - Google Earth
  - Alternate measures: AQI, total daily, etc…
  - Ensembles (met, fuel loadings, etc…)
  - Scenarios
  - On-the-fly: dispersion, trajectories
- Evaluate:
  - Field observation campaigns (ground + airborne)
  - Cross-model comparisons
  - Satellites (plume height: CALYPSO, etc…)

AIR FIRE
ATMOSPHERE & FIRE INTERACTIONS
RESEARCH & ENGINEERING

Summary of Goals

- Add sources:
  - Satellites (SMARTFIRE)
  - Ag burning (ClearSky, WSU)
  - ICTs / Expert info
  - National Rx Input (FETS + National Manual Sys?)
- Expand domains:
  - National grid (lower 48, FCAMMS)
  - Canada
  - Alaska (FCAMMS)
- Update the Weather Service
  - New BS Framework
  - SMARTFIRE ??

AIRFIRE
ATMOSPHERE & FIRE INTERACTIONS RESEARCH & ENGINEERING

Thank you

Funding from National Fire Plan, USFS, Joint Fire Science Program, EPA, DOI, and NASA ROSES DSS.

Our many collaborators and partners.

BlueSky
http://airfire.org/bluesky

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end

Other Applications

- "Climate" version for Rx planning (AQUIPT)
  What is the likely impact of … ?

- Carbon cycling (the Matrix)
  What are the uncertainties in C fluxes ?

- Future AQ (EPA STAR : WSU/UW/FERA/AirFire)
  What does the future hold for AQ ?

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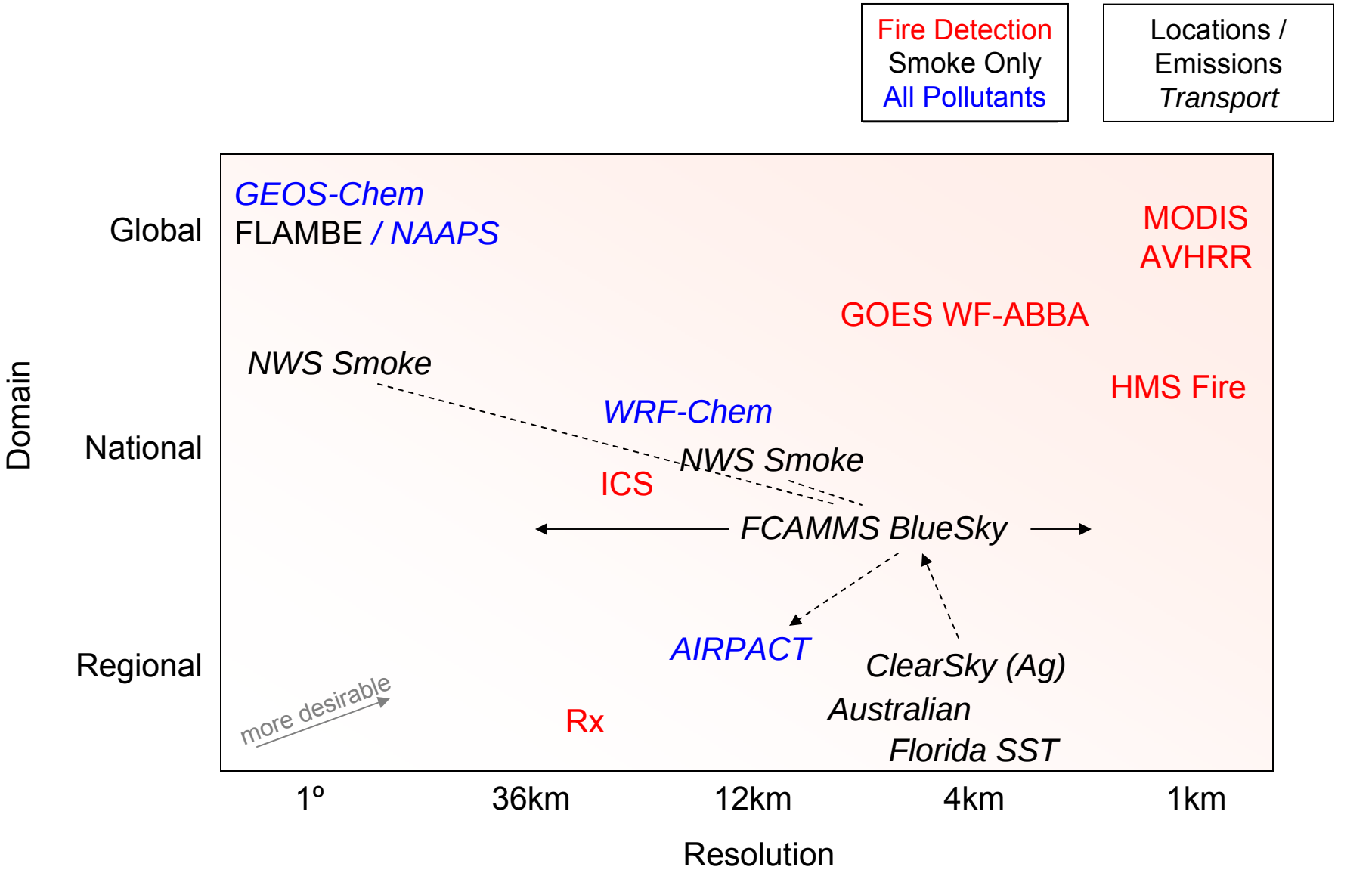
ATMOSPHERE & FIRE INTERACTIONS
RESEARCH & ENGINEERING

Real-Time Smoke Systems

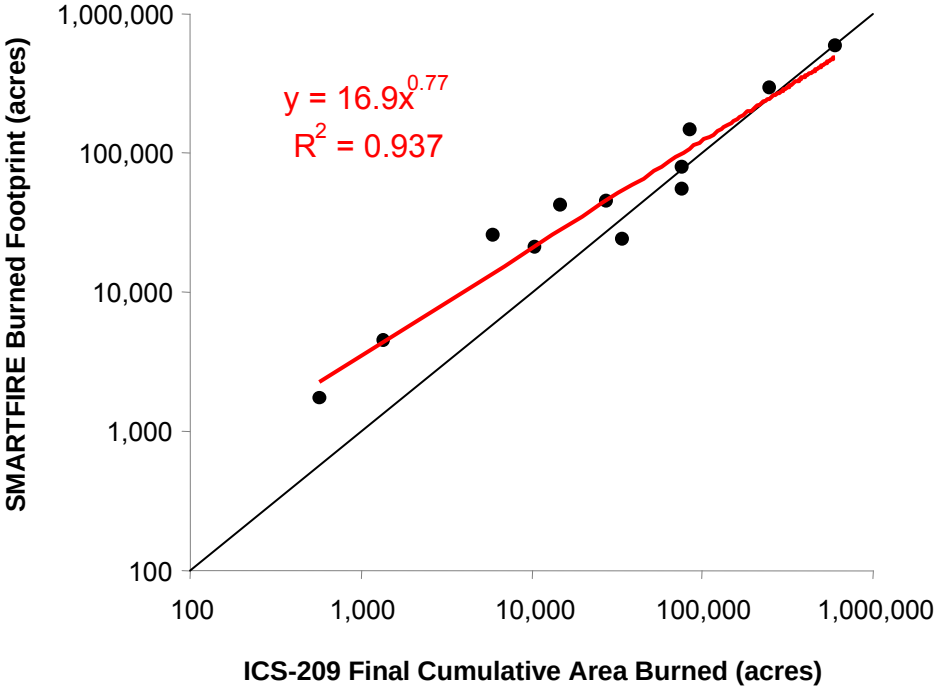
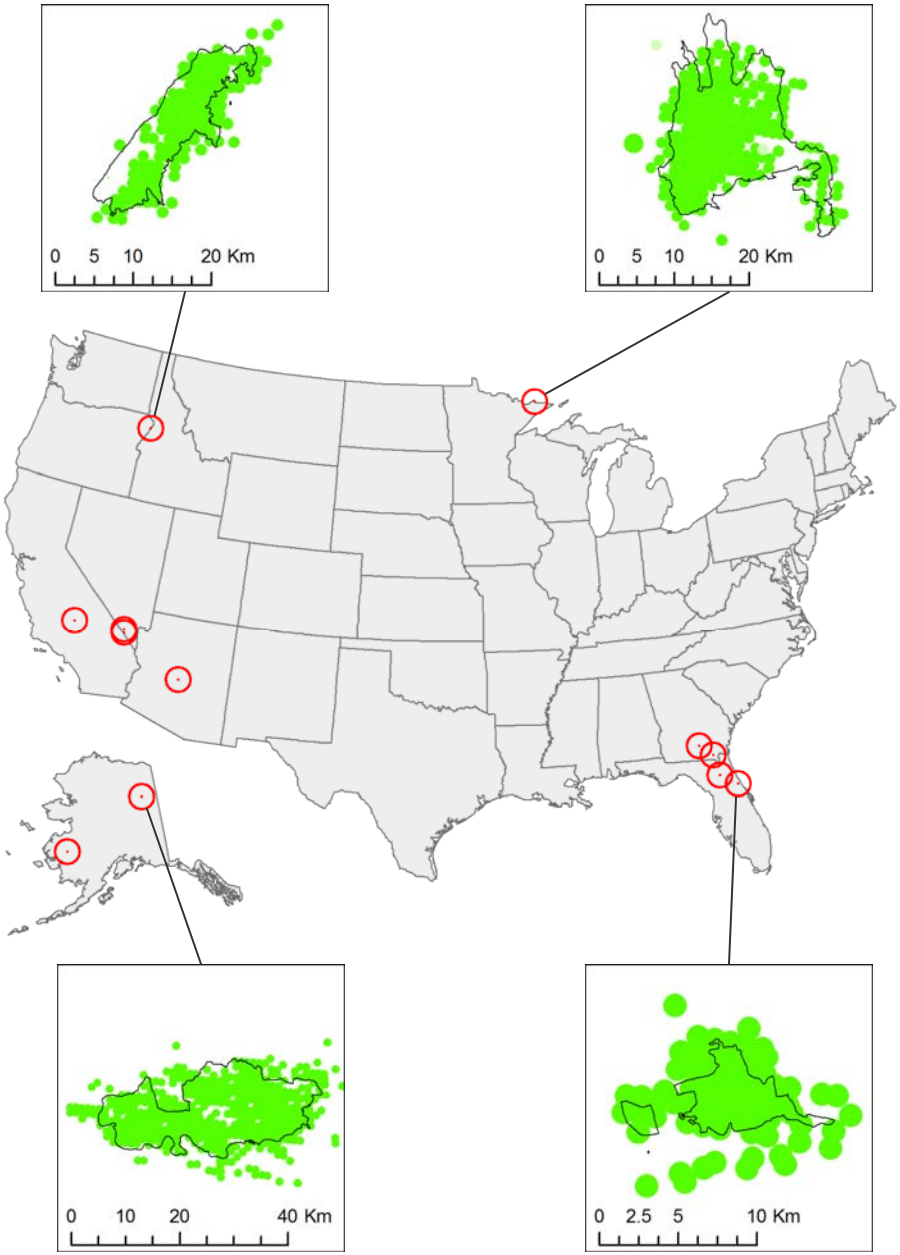


Wildfire Area Burned Estimates

For the largest fires examined, SMARTFIRE final footprints match very well with final ICS-209 area estimates.

SMARTFIRE tends to overestimate area burned for smaller wildfires.

This relationship appears independent of ecosystem or fuel type.



Wildfire Test Locations