Test Cases

1. FIRES EVERYWHERE
2. NATIONAL EMISSIONS INVENTORY

+ 9. MULTI-YEAR SATELLITE PLUME RISE CASE

5. TRIPOD COMPLEX

6. NORTHWEST RX

8. NACHES RX

7. SOUTHEAST RX

3. CALIFORNIA WILDFIRES

4. BUGABOO COMPLEX

AIRFIRE
ATMOSPHERE & FIRE INTERACTIONS
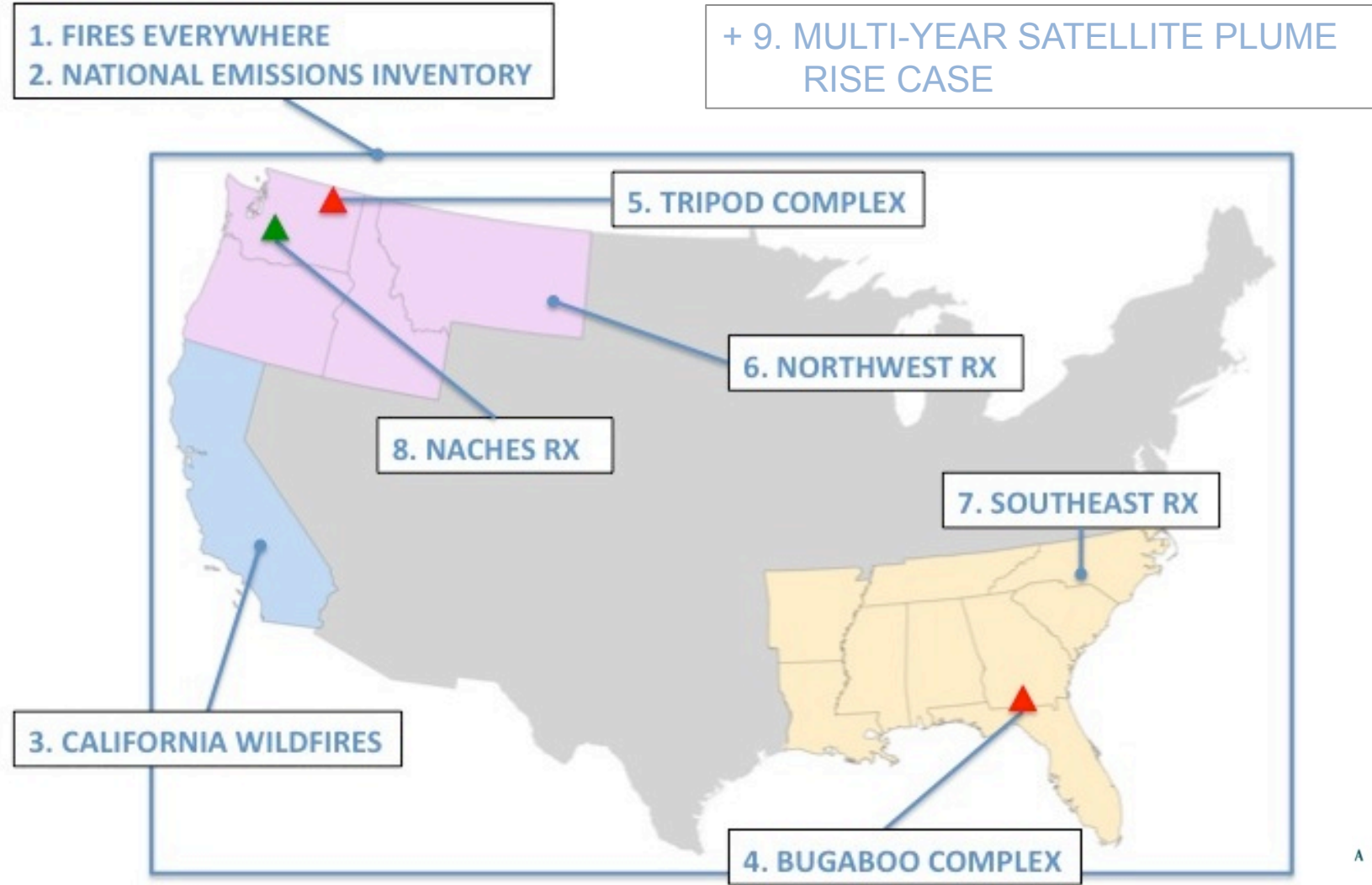RESEARCH & ENGINEERING

SEMIP — Smoke and Emissions Model Intercomparison Project

- Model intercomparison

- Quantification of uncertainties

MODELING STEP | OUTPUT LEVEL

Fire Information System → Basic Fire Information

Fuel Loading → Fuel Loadings

Total Consumption → Total Consumption

Time Rate of Consumption → Time Profile of Consumption

Emissions → Speciated Emissions

Plume Rise → Vertical Plume Profile

Dispersion → Total Column Smoke

→ Ground Concentrations

Reality

Fire
Info

Fuels

Total
Consumption

Time
Rate

Emissions

Plume
Rise

Dispersion /
Trajectories

right answer, wrong reasons

Reality

Fire
Info

Fuels

Total
Consumption

Time
Rate

Emissions

Plume
Rise

Dispersion /
Trajectories
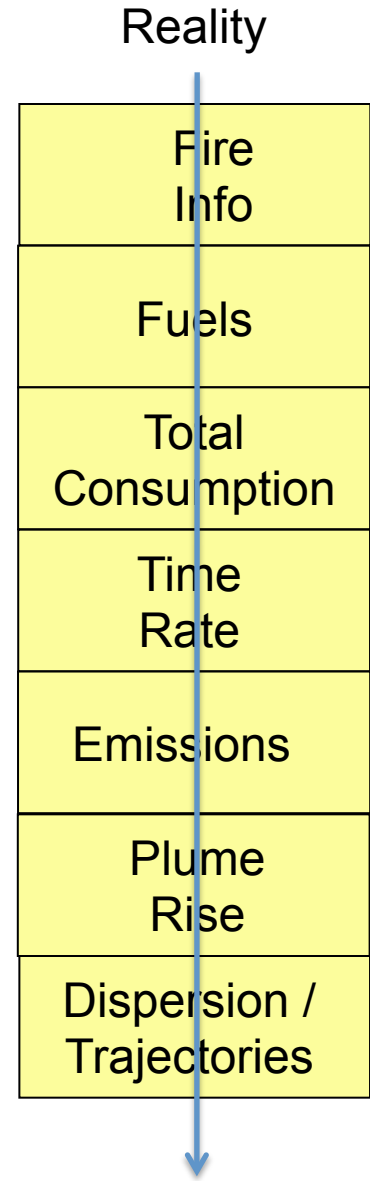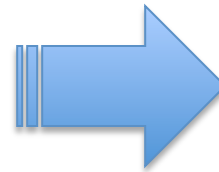
right answer, right reasons

SEMIP · Smoke and Emissions Model Intercomparison Project

Where are the issues?

In modeling the biggest uncertainties depend on use:

- For emissions from a given fire: **fuels**
  (emissions factors for lesser species)

- For smoke from a given fire: **plume rise/fire timing**

- For regional emissions inventory: **fire info & fuels**
  (emissions factors for lesser species)
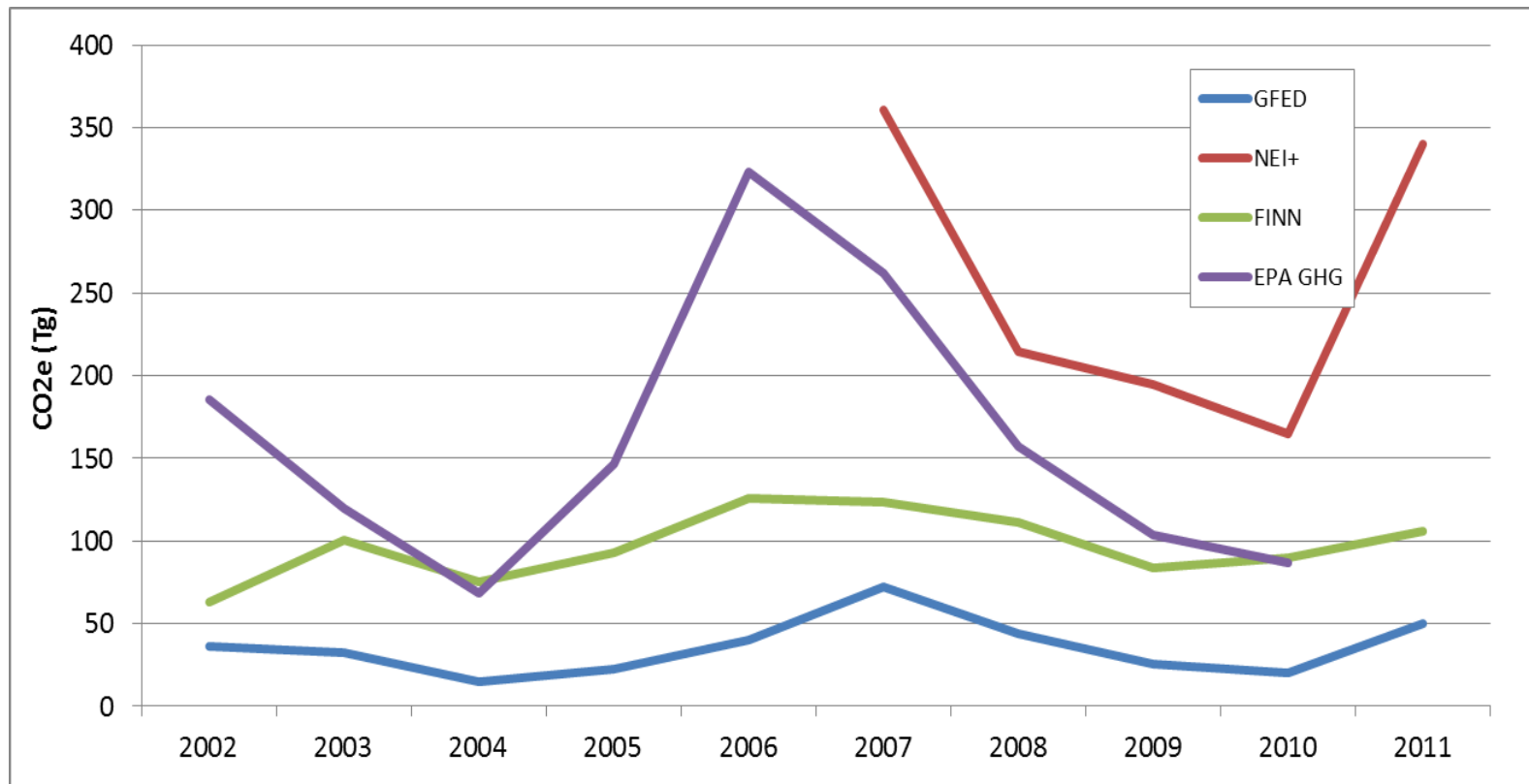
- For regional air quality: **fire info & plume rise**

Caveats:

o *Generalized answers; specific cases can vary*
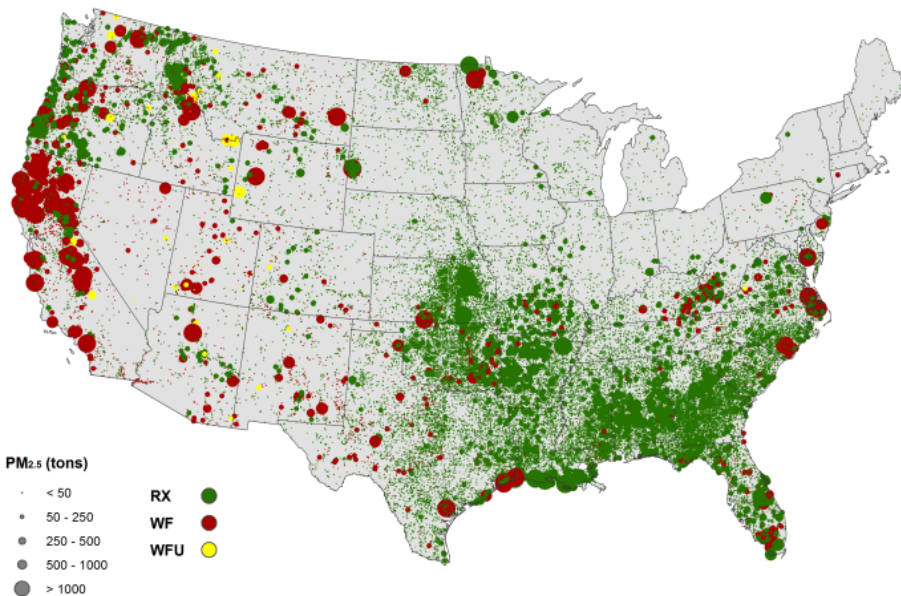
Even annual emissions totals differ
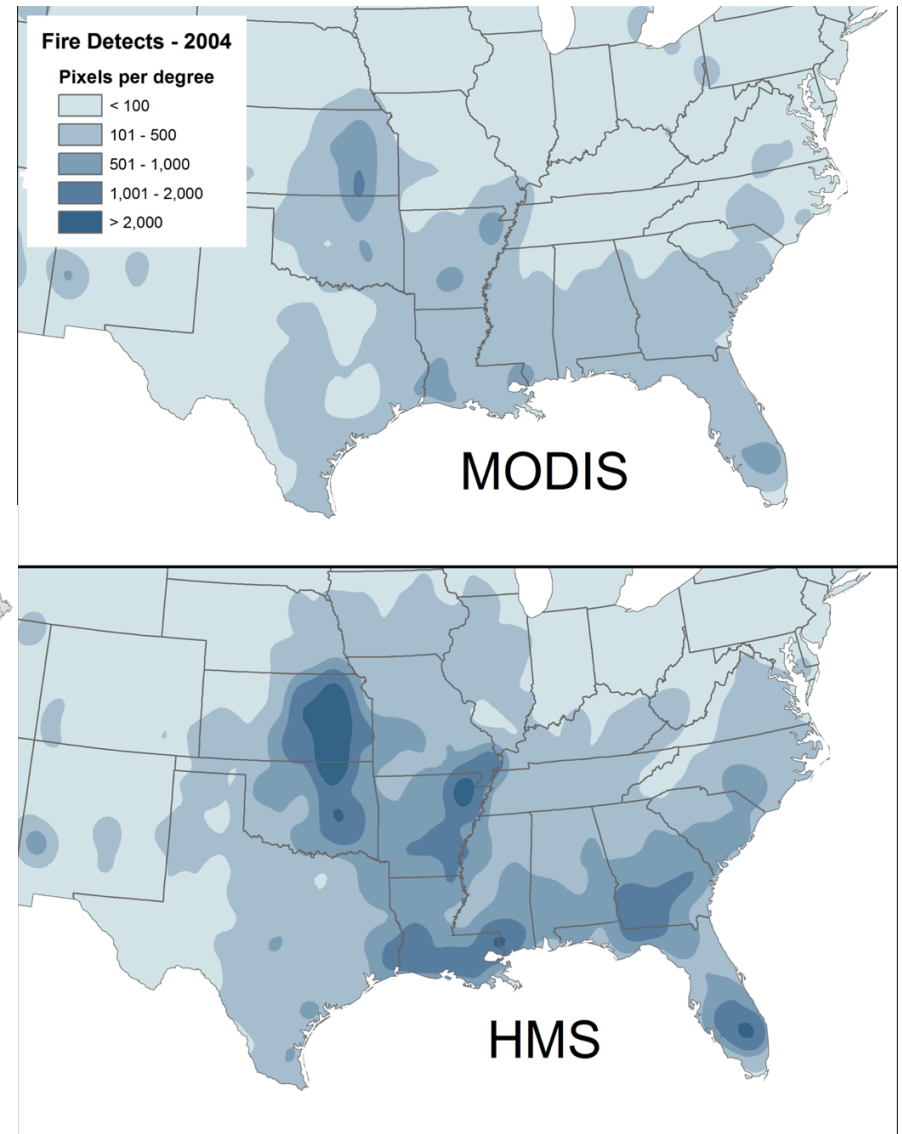
U.S. CONUS Annual Total Emissions by year

Larkin et al, 2014, FEM
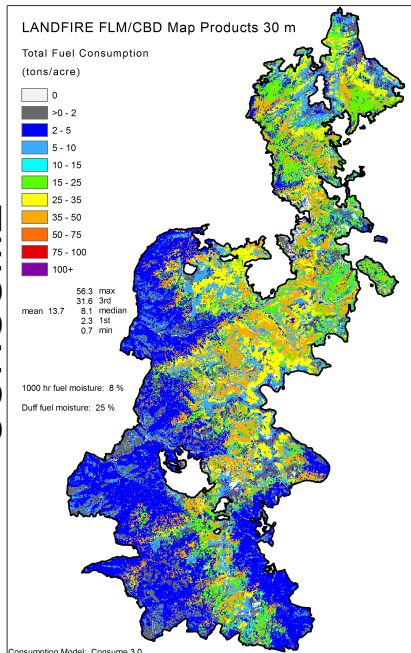
Fire Information

- Major regional differences in reporting systems, fire size, fire types, and fire detection

PM₂.₅ (tons)
- < 50
- 50 - 250
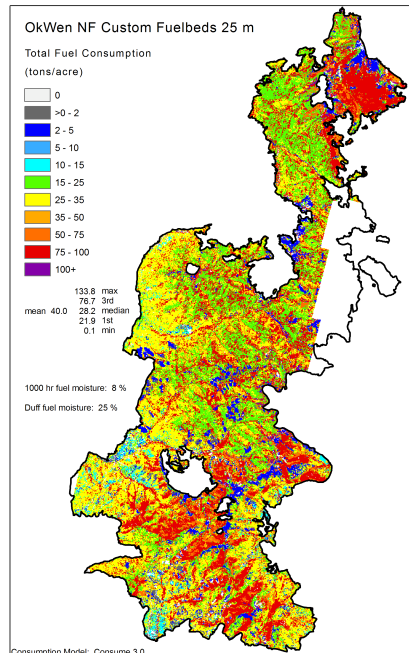- 250 - 500
- 500 - 1000
- > 1000

RX ● (green)
WF ● (red)
WFU ● (yellow)

2011 NEI

Fire Detects - 2004
Pixels per degree
- < 100
- 101 - 500
- 501 - 1,000
- 1,001 - 2,000
- > 2,000

MODIS

HMS

CONSUME

LANDFIRE FLM/CBD Map Products 30 m

Total Fuel Consumption
(tons/acre)
- 0
- >0 - 2
- 2 - 5
- 5 - 10
- 10 - 15
- 15 - 25
- 25 - 35
- 35 - 50
- 50 - 75
- 75 - 100
- 100+

	56.3	max
	31.6	3rd
mean 13.7	8.1	median
	2.3	1st
	0.7	min

1000 hr fuel moisture: 8 %
Duff fuel moisture: 25 %

Consumption Model: Consume 3.0

LANDFIRE

OkWen NF Custom Fuelbeds 25 m

Total Fuel Consumption
(tons/acre)
- 0
- >0 - 2
- 2 - 5
- 5 - 10
- 10 - 15
- 15 - 25
- 25 - 35
- 35 - 50
- 50 - 75
- 75 - 100
- 100+

	133.8	max
	76.7	3rd
mean 40.0	28.2	median
	21.9	1st
	0.1	min

1000 hr fuel moisture: 8 %
Duff fuel moisture: 25 %

Consumption Model: Consume 3.0

OK-WEN FOREST

FCCS2 30 m

Total Fuel Consumption
(tons/acre)
- 0
- >0 - 2
- 2 - 5
- 5 - 10
- 10 - 15
- 15 - 25
- 25 - 35
- 35 - 50
- 50 - 75
- 75 - 100
- 100+

	128.5	max
	71.0	3rd
mean 32.6	26.2	median
	13.1	1st
	0.7	min

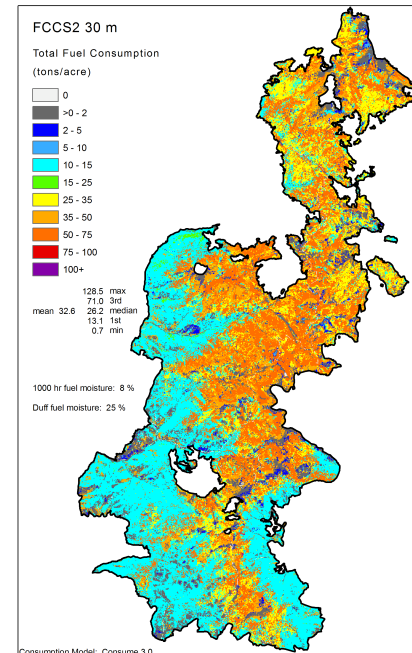1000 hr fuel moisture: 8 %
Duff fuel moisture: 25 %

Consumption Model: Consume 3.0
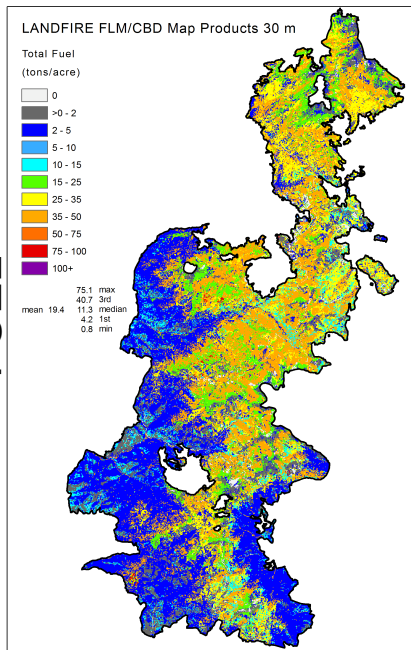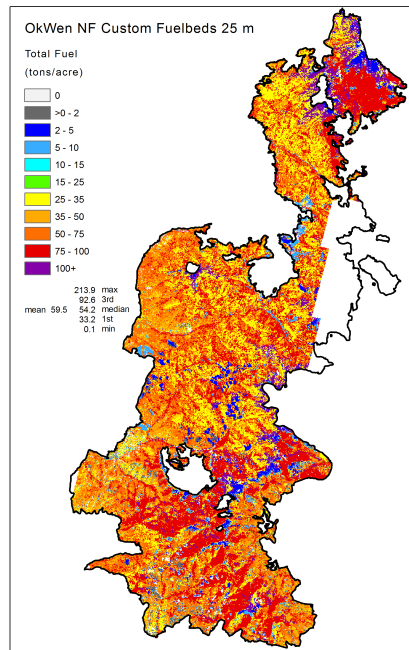
FCCS-LF

SEMIP   Smoke and Emissions Model
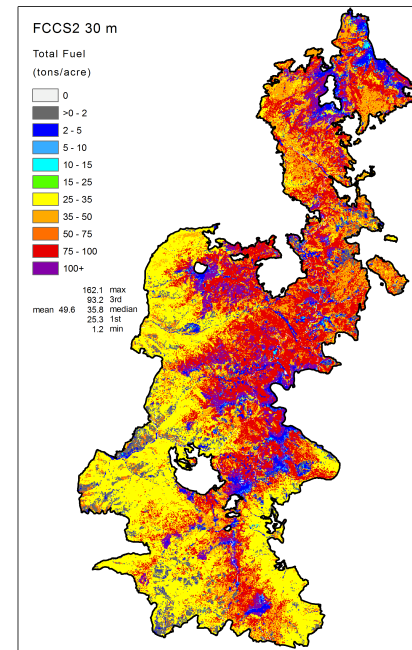   Intercomparison Project

TRIPOD FIRE CASE
TOTAL FUEL &
CONSUMPTION

Drury et al 2014

FUEL

LANDFIRE FLM/CBD Map Products 30 m

Total Fuel
(tons/acre)
- 0
- >0 - 2
- 2 - 5
- 5 - 10
- 10 - 15
- 15 - 25
- 25 - 35
- 35 - 50
- 50 - 75
- 75 - 100
- 100+

	75.1	max
	40.7	3rd
mean 19.4	11.3	median
	4.2	1st
	0.8	min

LANDFIRE

OkWen NF Custom Fuelbeds 25 m

Total Fuel
(tons/acre)
- 0
- >0 - 2
- 2 - 5
- 5 - 10
- 10 - 15
- 15 - 25
- 25 - 35
- 35 - 50
- 50 - 75
- 75 - 100
- 100+

	213.9	max
	92.6	3rd
mean 59.5	54.2	median
	33.2	1st
	0.1	min

OK-WEN FOREST

FCCS2 30 m

Total Fuel
(tons/acre)
- 0
- >0 - 2
- 2 - 5
- 5 - 10
- 10 - 15
- 15 - 25
- 25 - 35
- 35 - 50
- 50 - 75
- 75 - 100
- 100+

	162.1	max
	93.2	3rd
mean 49.6	35.8	median
	25.3	1st
	1.2	min

FCCS-LF
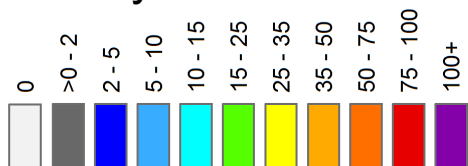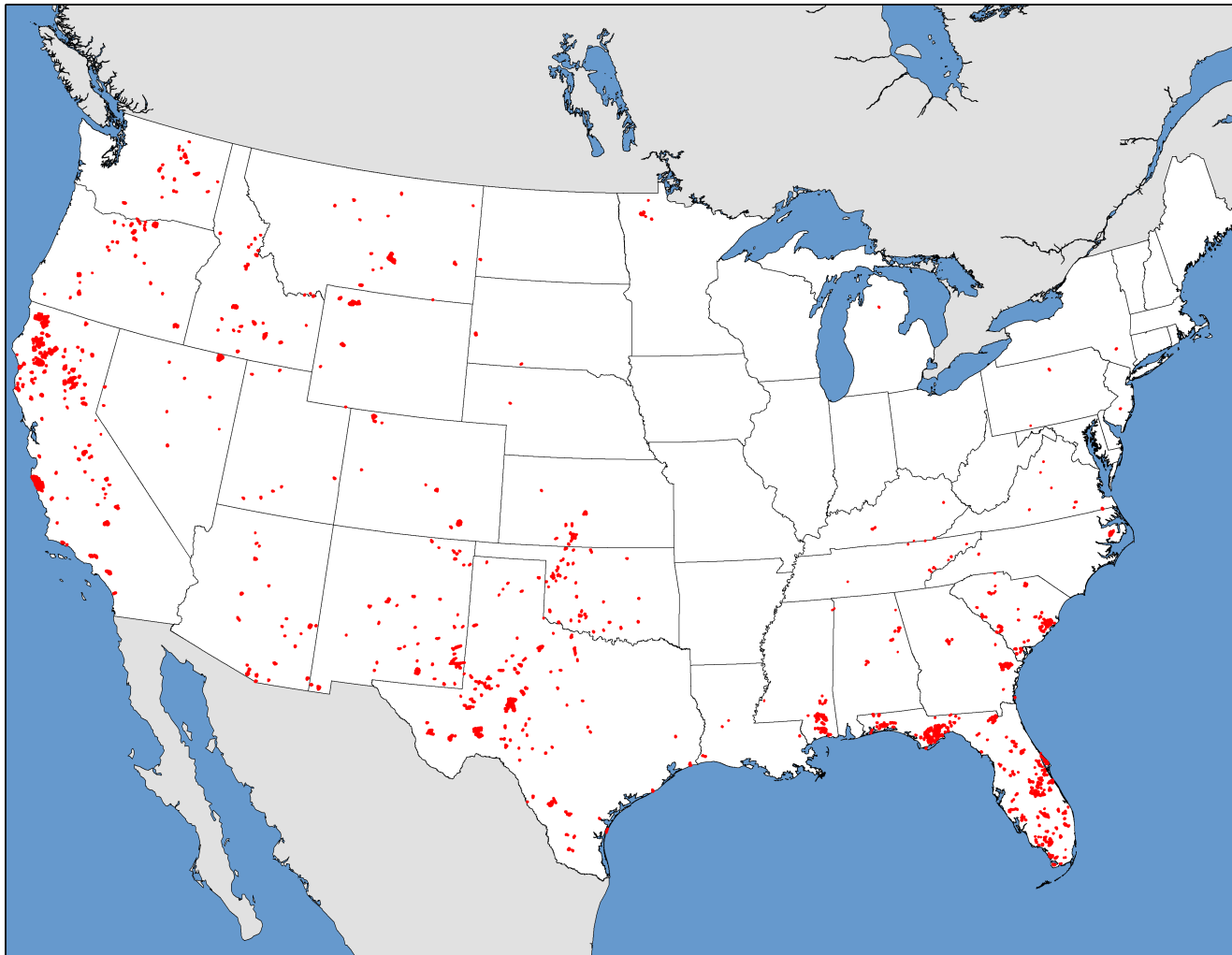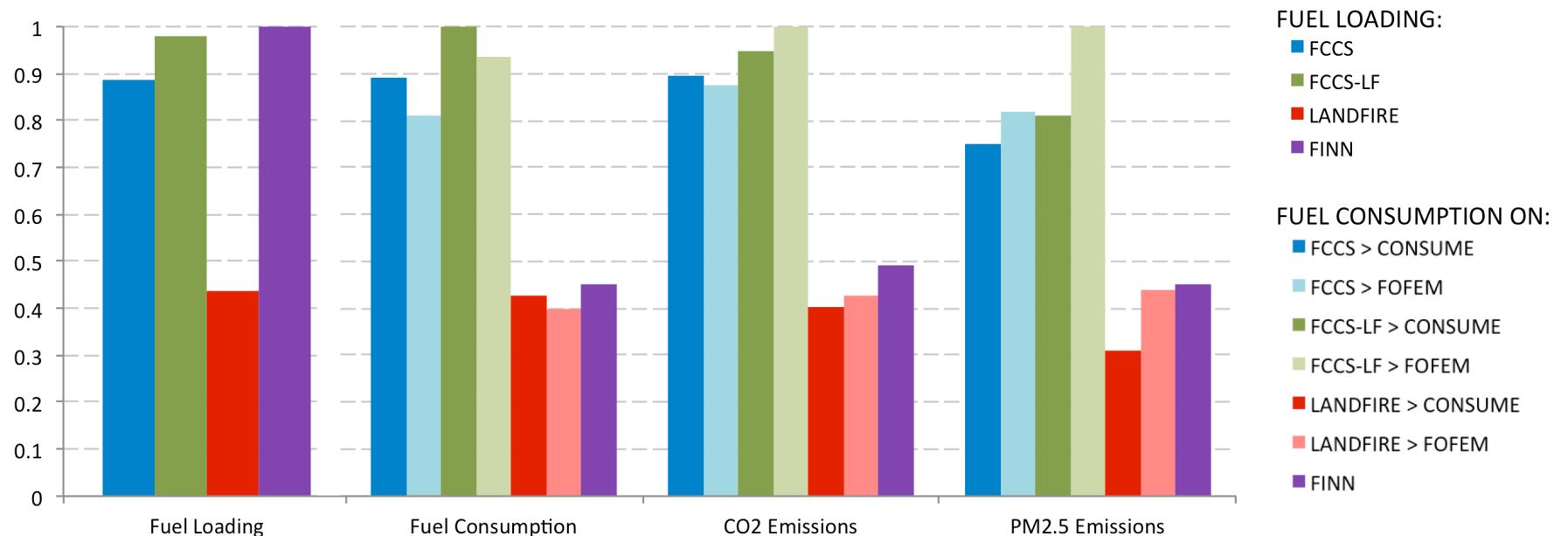
2008 CONUS Fires

- Only large fires (from MTBS)

Emissions Models

Models vary considerably in fuels, less in consumption and emissions factors (for major species)

Total fuels, consumption, and PM2.5 for all large 2008 fires, normalized:

FUEL LOADING:
- FCCS
- FCCS-LF
- LANDFIRE
- FINN

FUEL CONSUMPTION ON:
- FCCS > CONSUME
- FCCS > FOFEM
- FCCS-LF > CONSUME
- FCCS-LF > FOFEM
- LANDFIRE > CONSUME
- LANDFIRE > FOFEM
- FINN

Larkin et al 2014, FEM

Emissions Factors

Updated emissions factors are needed in currently used models

Strand et al. in prep
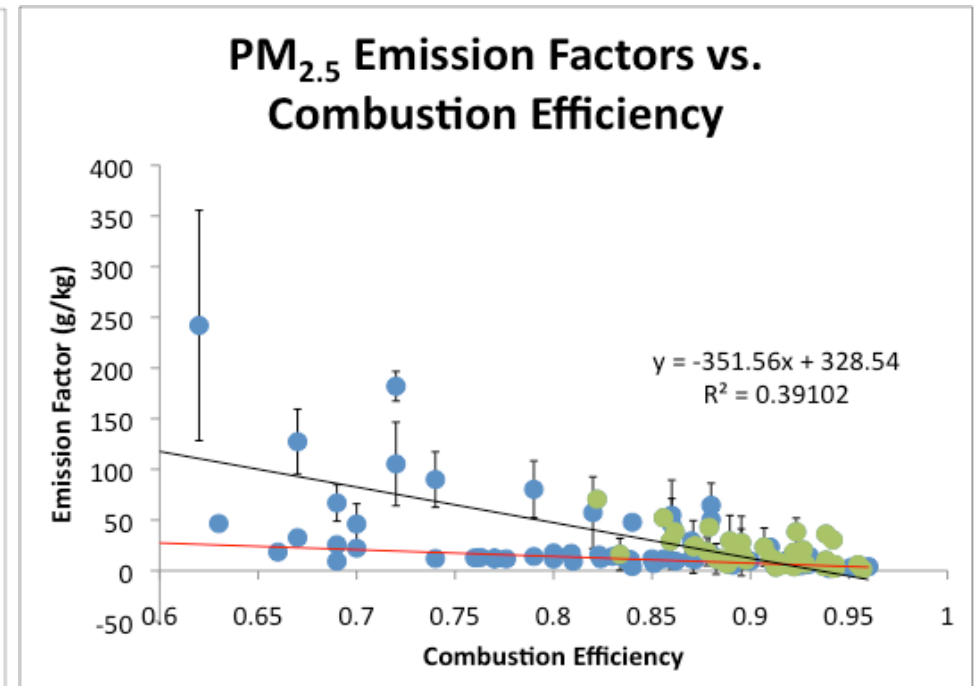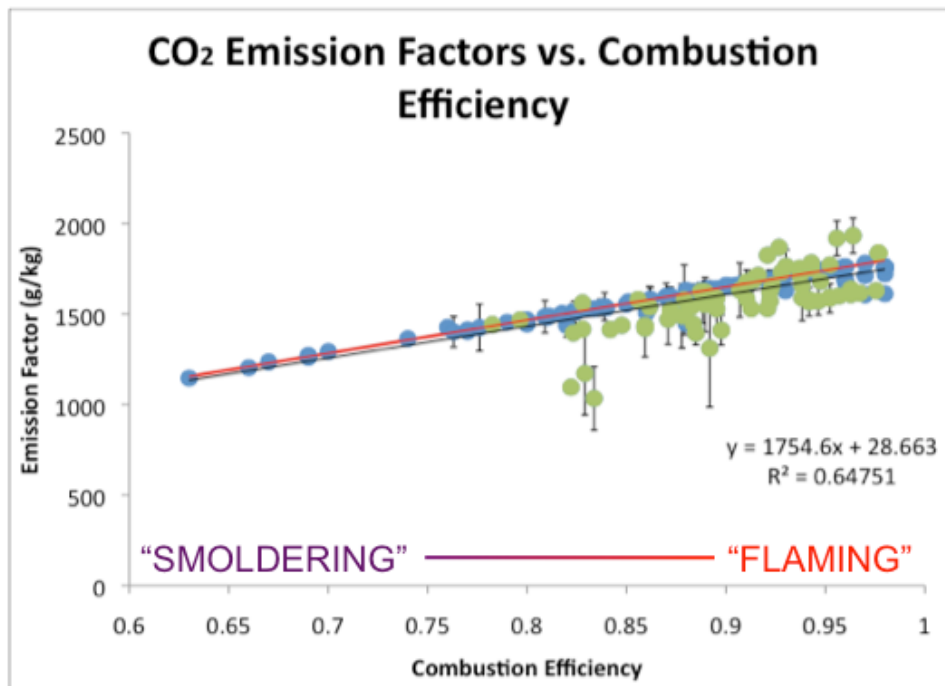
Plume Rise

How to better model the full complexity of wildland fire plumes?
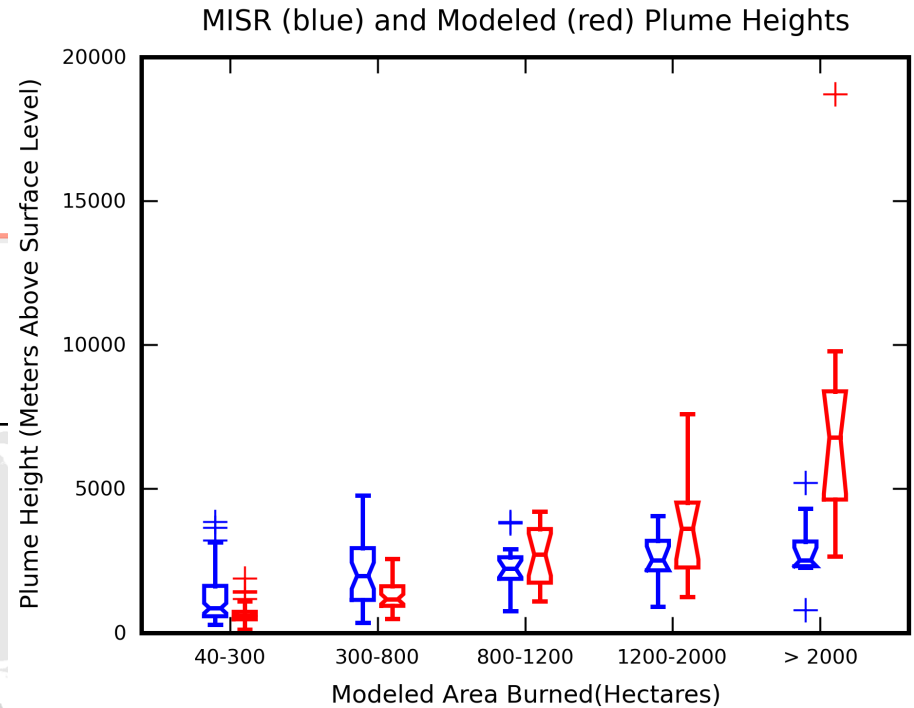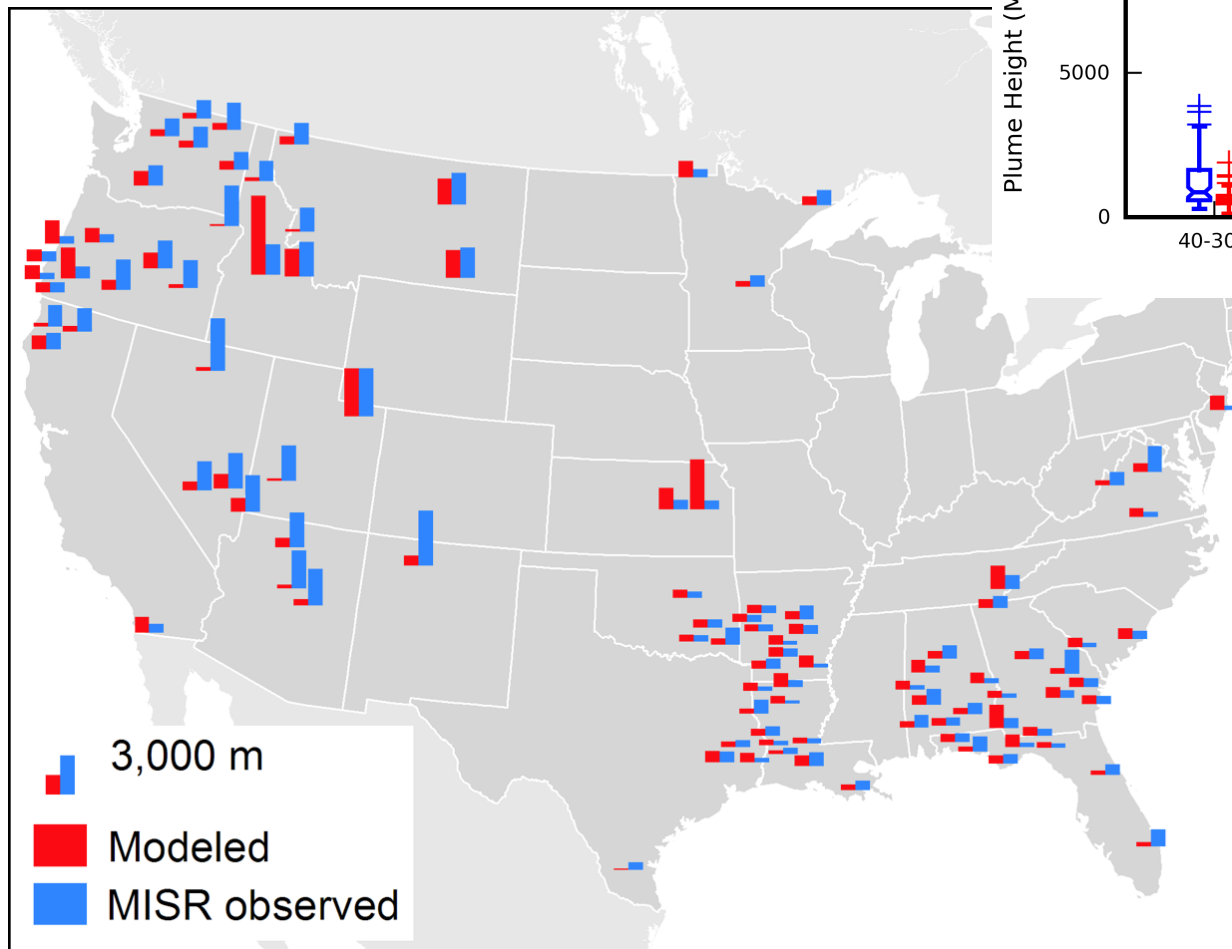
Plume Rise

Model vs satellite

MISR (blue) and Modeled (red) Plume Heights

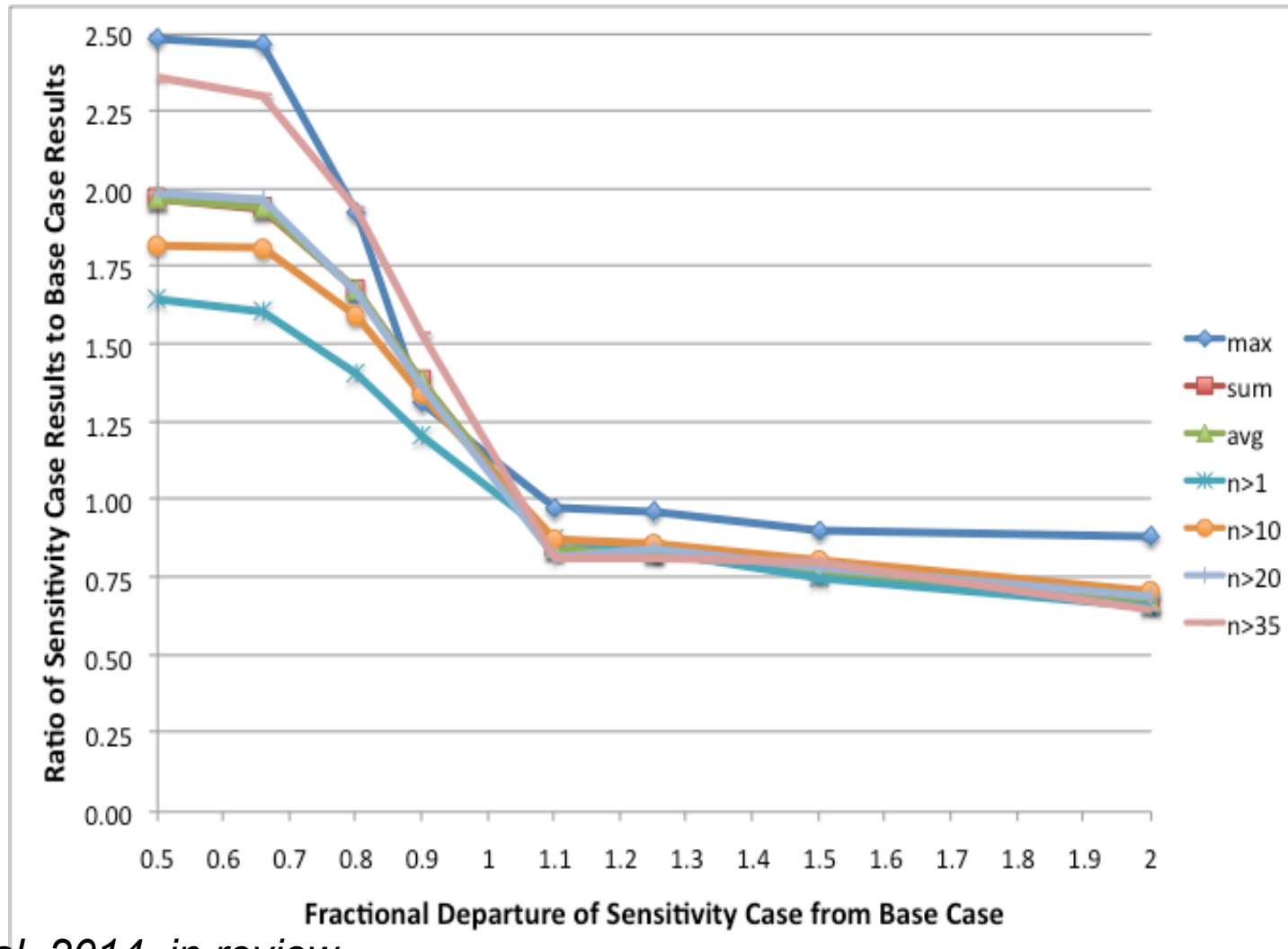MISR dynamic range less than modeled

Model underpredicting small fires, overpredicting large fires

Clear regime difference in MISR data between West and Southeast

Poor performance throughout the West

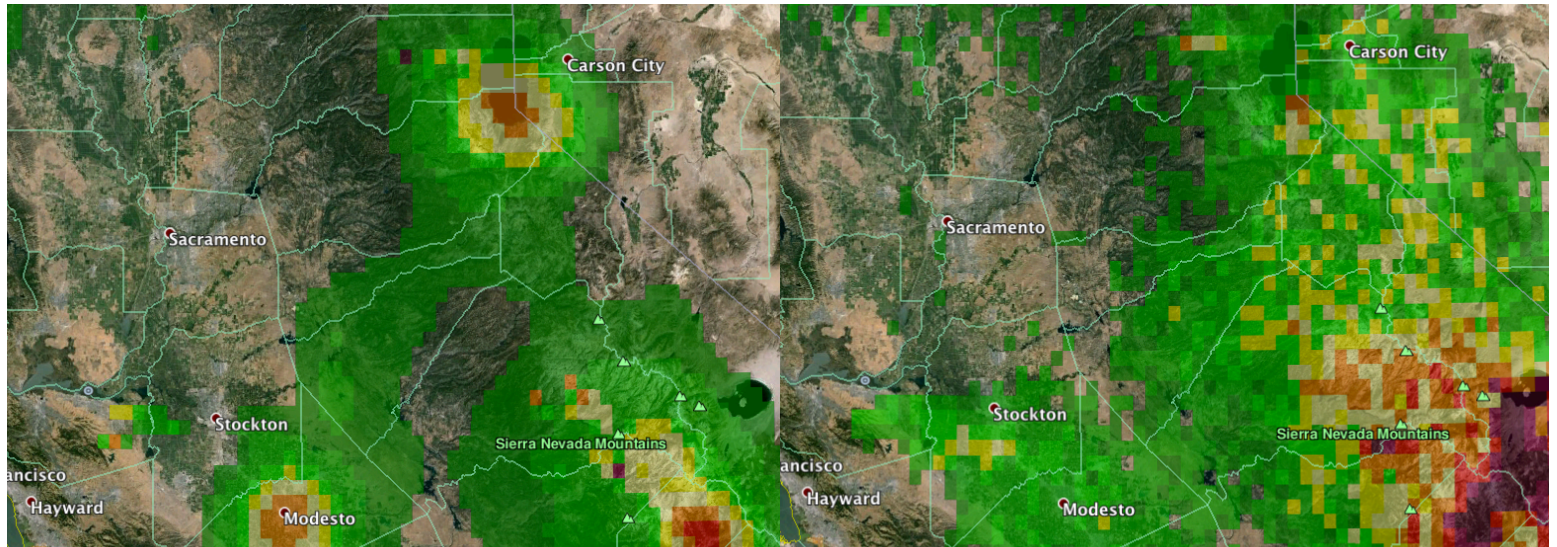*Raffuse et al. 2012.*

Sensitivity to Diurnal Profile

Larkin et al. 2014, in review

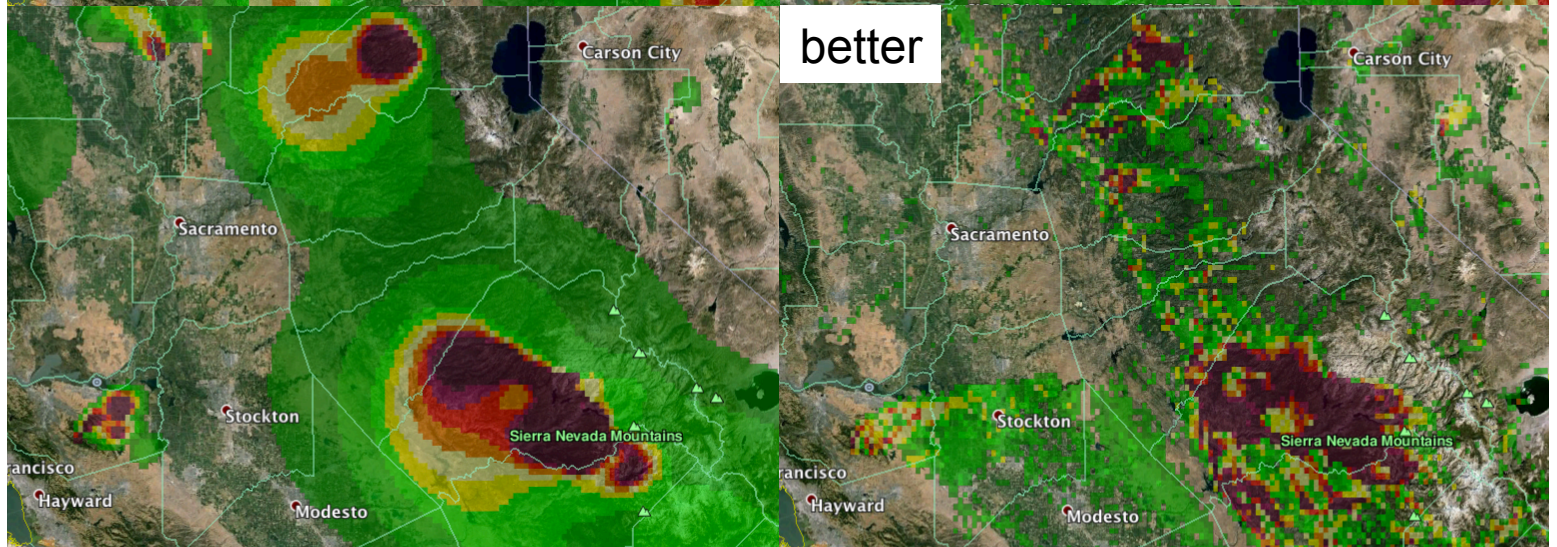# Rim Fire Forecast 9/11 5pm – Different configurations (HYSPLIT)

Some Conclusions

Source of biggest uncertainty depends on use:

- For emissions from a given fire: fuels
                                       (emissions factors for lesser species)

- For smoke from a given fire: plume rise/fire timing

- For regional emissions inventory: fire info & fuels
                                       (emissions factors for lesser species)

- For regional air quality: fire info & plume rise

Caveats:

o *Generalized answers; specific cases can vary*

Issues

Need to:

- Characterize fire emissions better.

Also:

- Better capture fire occurrence and fire growth
- Better resolve terrain
- Better diurnal profile models
- Better plume schemes
- Bring chemistry models into ensemble daily runs

Thank you

Special thanks to our funders in this work:

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http://airfire.org