The BlueSkyRAINS Smoke Modeling System

Sim Larkin
AirFIRE Team, Pacific Wildland Fire Sciences Laboratory
Emissions Conference, New Orleans
May 17, 2006

Outline

- What is BlueSkyRAINS?
- Making BlueSkyRAINS useful for EIs
- Problems with Fire
- Ongoing Work

AIRFIRE
ATMOSPHERE & FIRE INTERACTIONS RESEARCH & ENGINEERING

Acknowledgements

Sue Ferguson
Susan O'Neill

AirFIRE Team
Robert Solomon
Dylan Myers
Miriam Rorig
Jeanne Hoadley
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Rob Wilson
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BlueSky Smoke
Modeling Consortium

FCAMMS centers
- Scott Goodrick

BlueSky-EM Project
EPA NERL / NOAA ARL
Tom Pierce
George Pouliot
UNC
CMAS

NASA Grant
Sonoma Tech
Sean Raffuse
Lyle Chinkin
Dana Sullivan

Tom Pace, EPA
Charlene Spells, EPA

+ many others

BlueSkyRAINS

BLUESKY

A Framework of Models

+

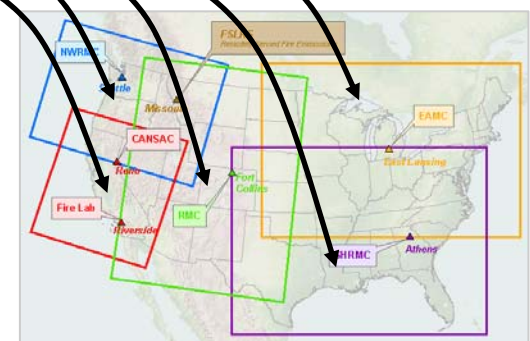
RAINS

Visualization Tools

Cumulative Smoke Impact Calculations from Rx, Wildland, and/or Ag fires

User Interface

Applied to Various Inputs, Domains



Smoke Predictions

AIRFIRE
ATMOSPHERE & FIRE INTERACTIONS RESEARCH & ENGINEERING

BlueSkyRAINS

BLUESKY

A Framework of Models

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RAINS

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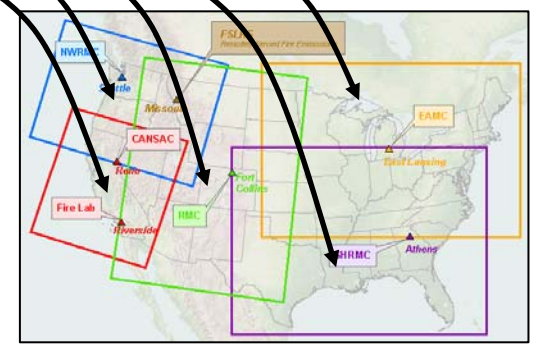
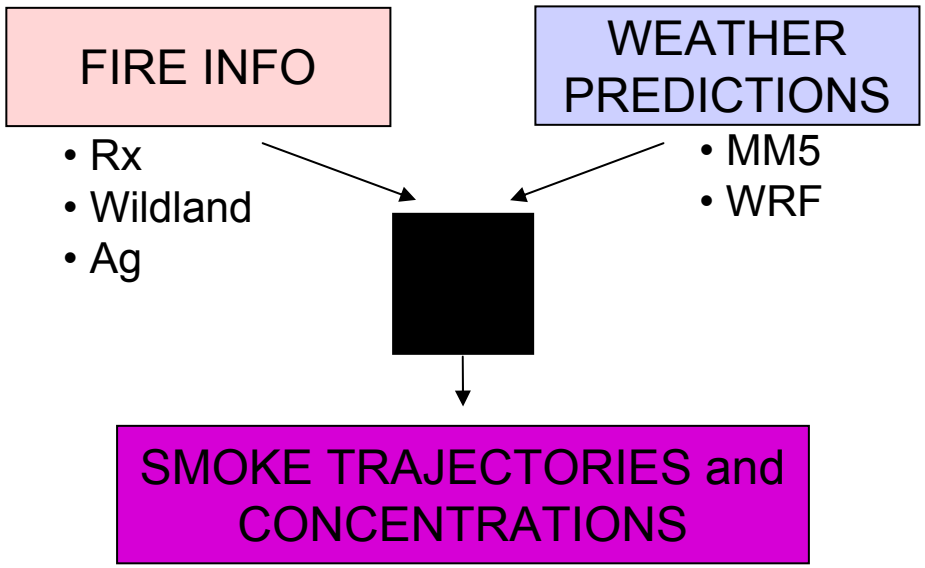
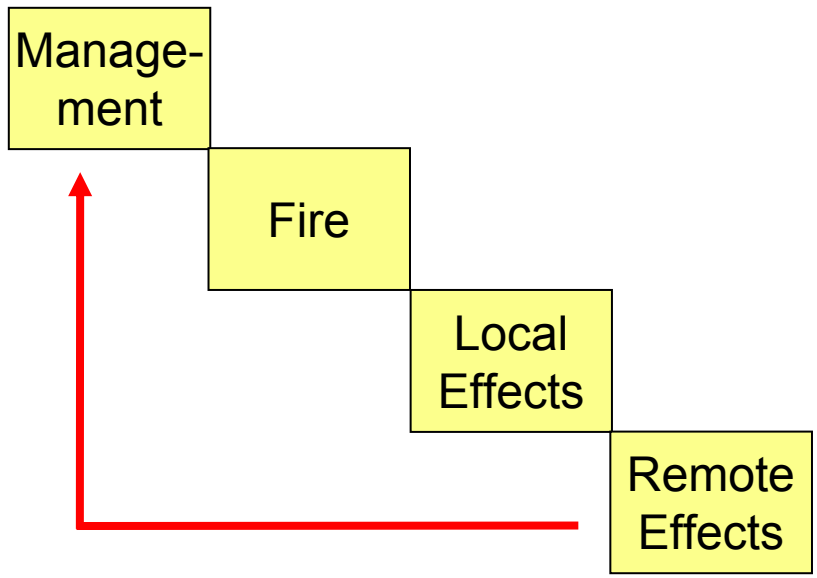


Smoke Predictions

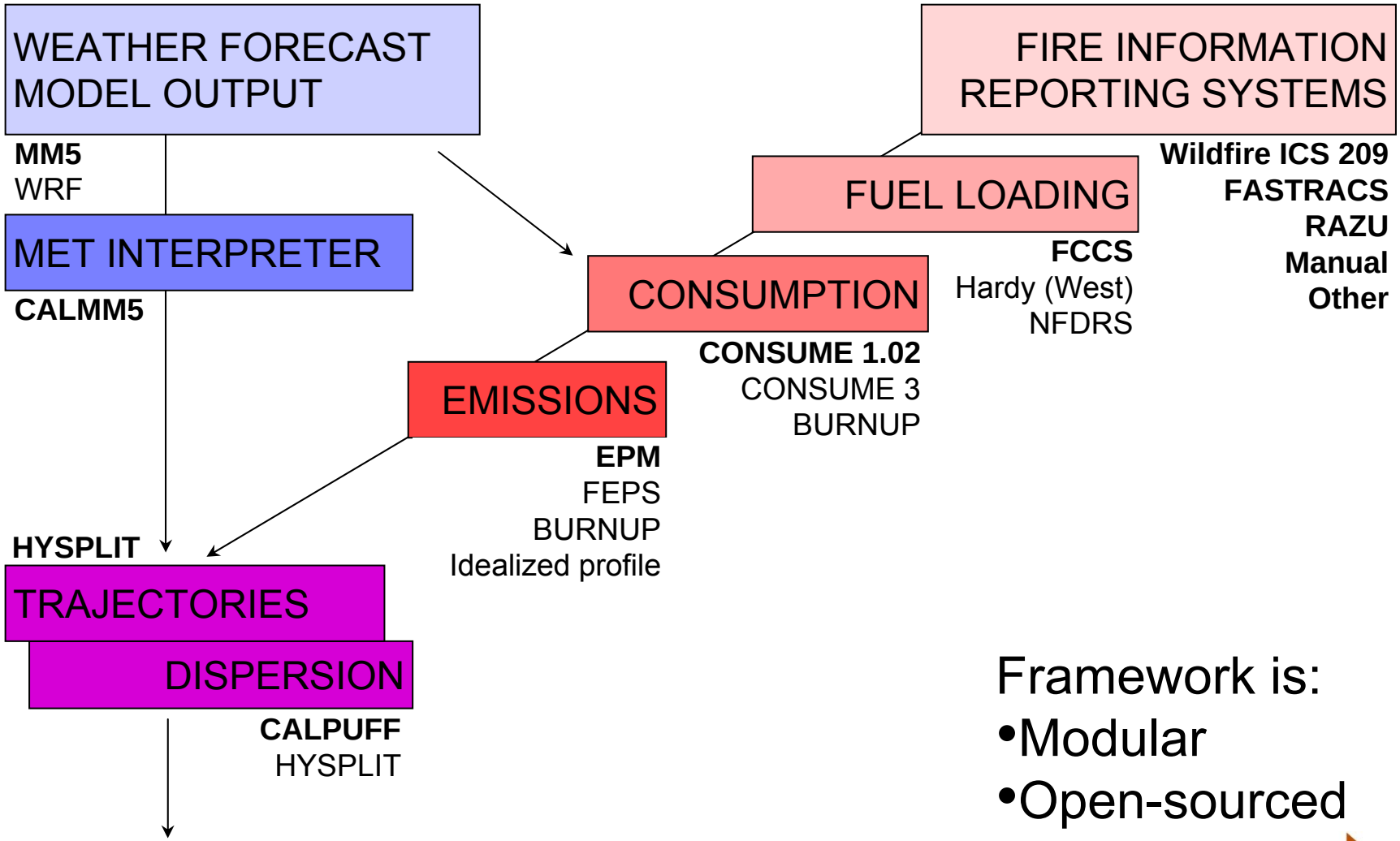
The Idea

Calculations of Cumulative Smoke Impacts from Fires





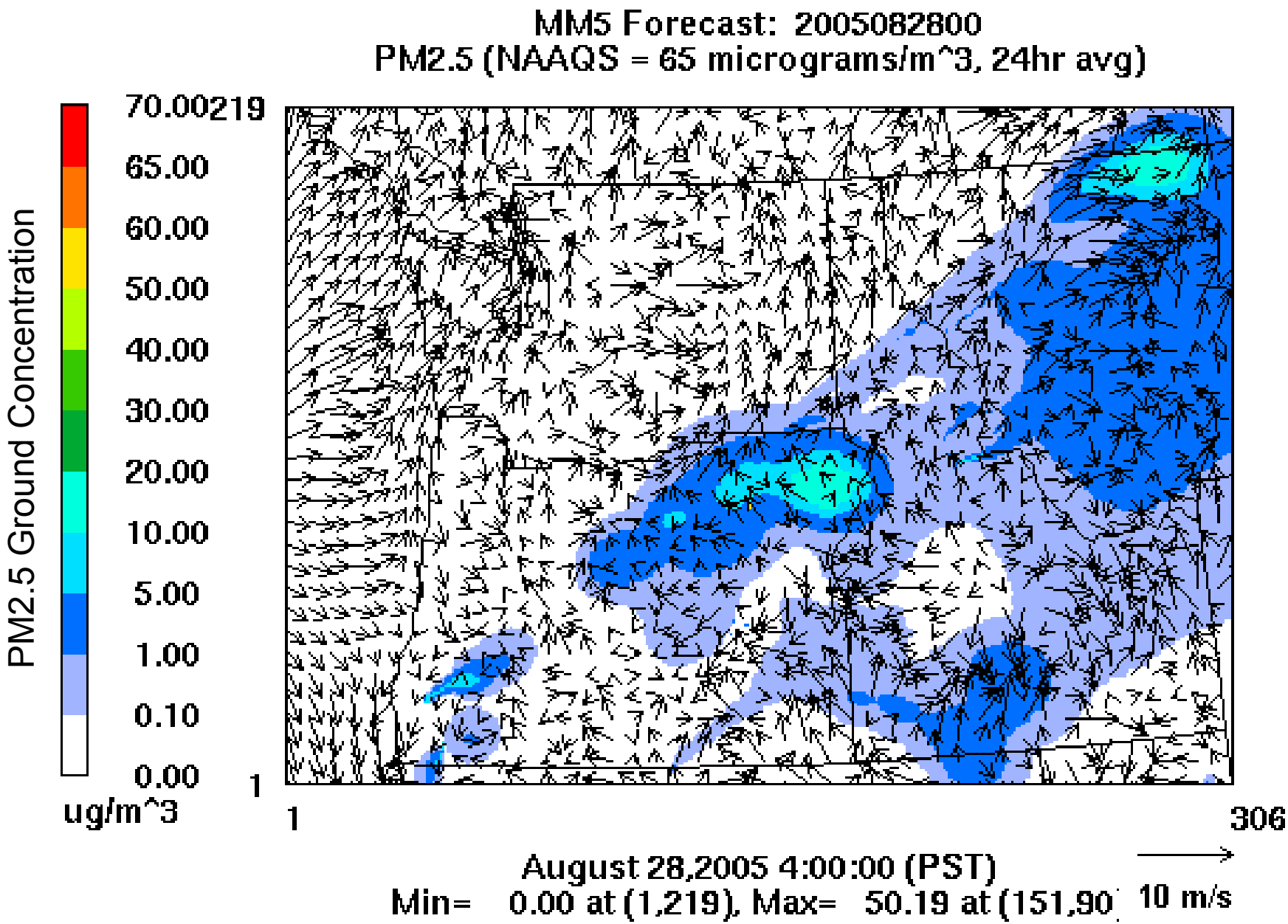
BlueSky Framework



Framework is:

- Modular
- Open-sourced

Prescribed Fire & Wildfire Simulation



What is BlueSky?

BLUESKY RAINS

A Framework of Models

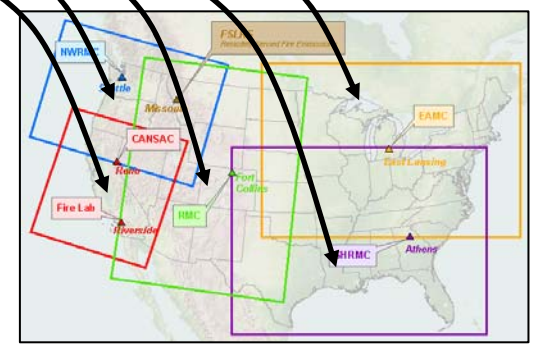
+

Visualization Tools

Cumulative Smoke Impact Calculations from Rx, Wildland, and/or Ag fires

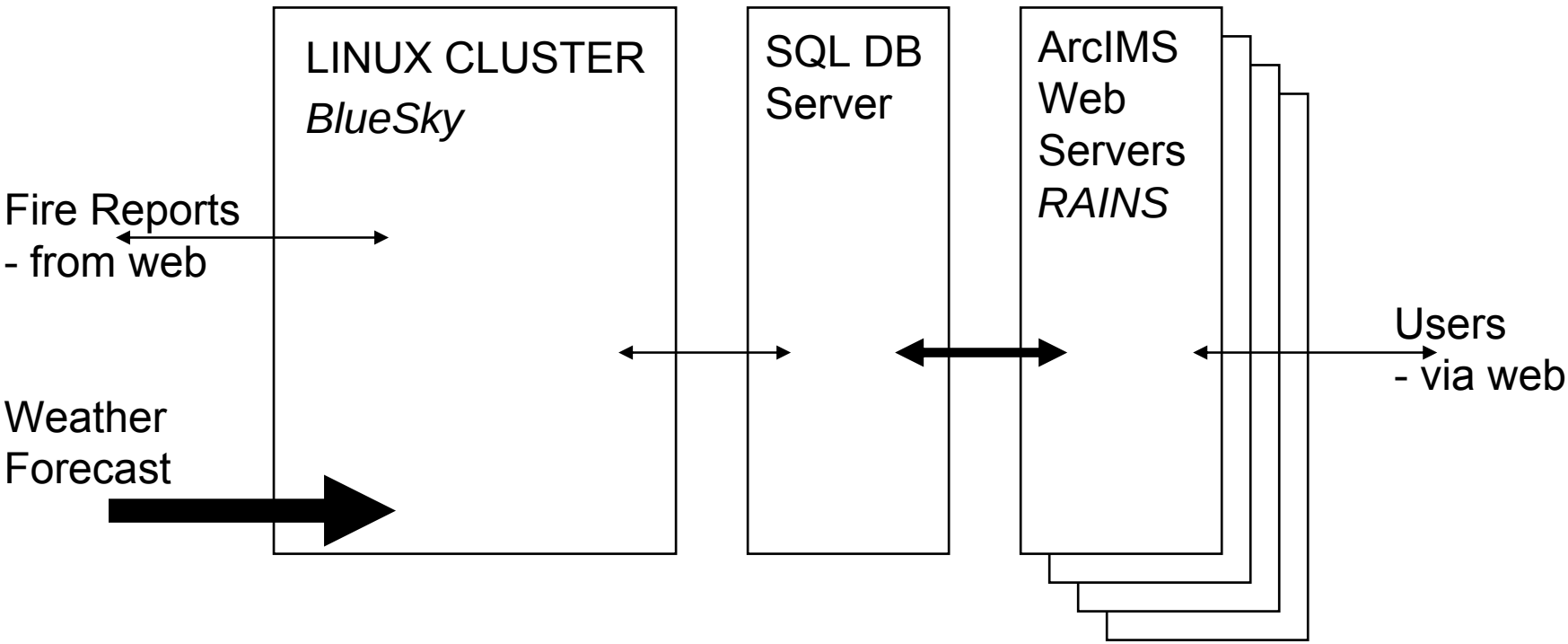
User Interface

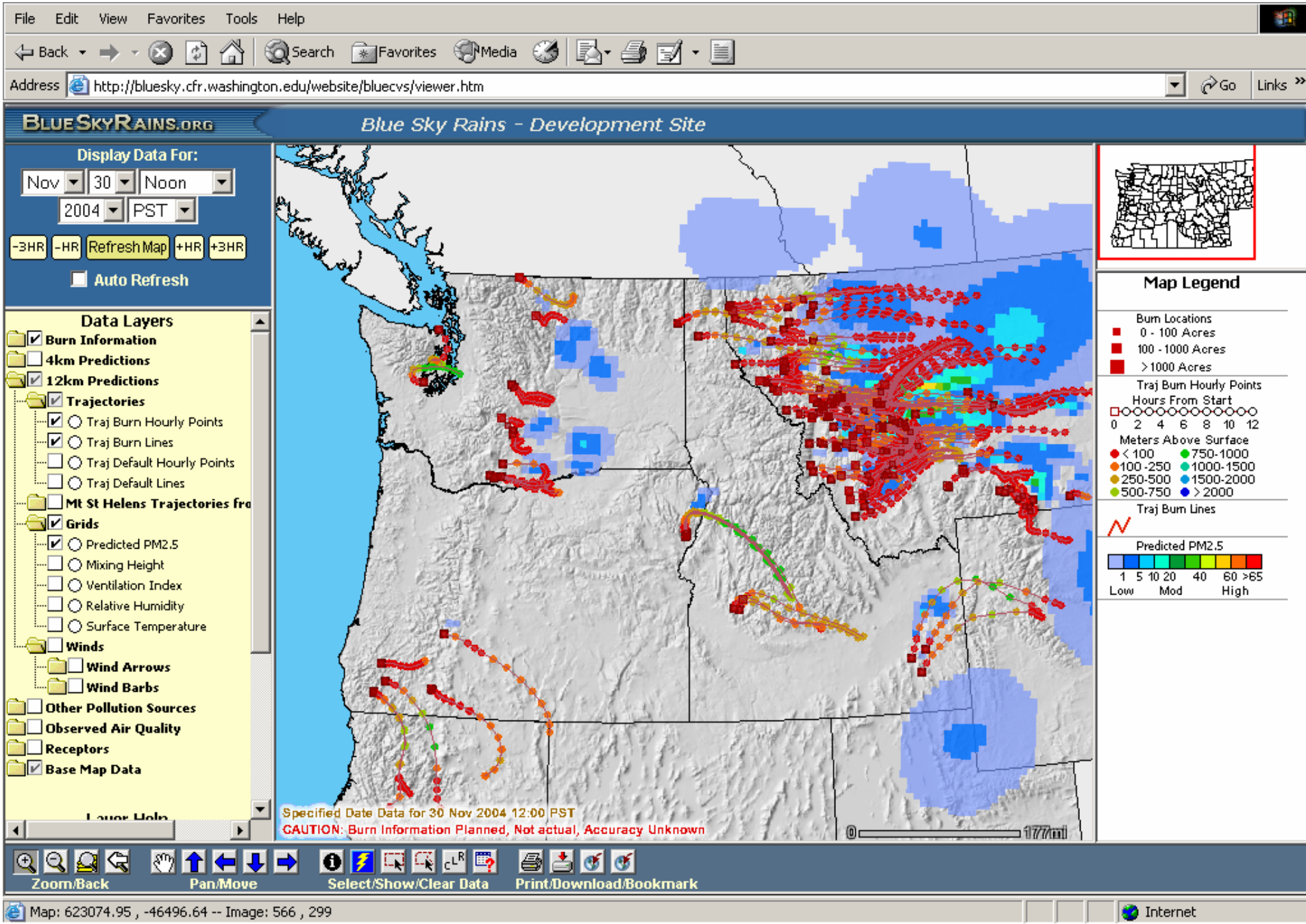
Applied to Various Inputs, Domains



Smoke Predictions

Technology


LINUX CLUSTER
BlueSky
SQL DB
Server
ArcIMS
Web
Servers
RAINS
Fire Reports
- from web
Weather
Forecast
Users
- via web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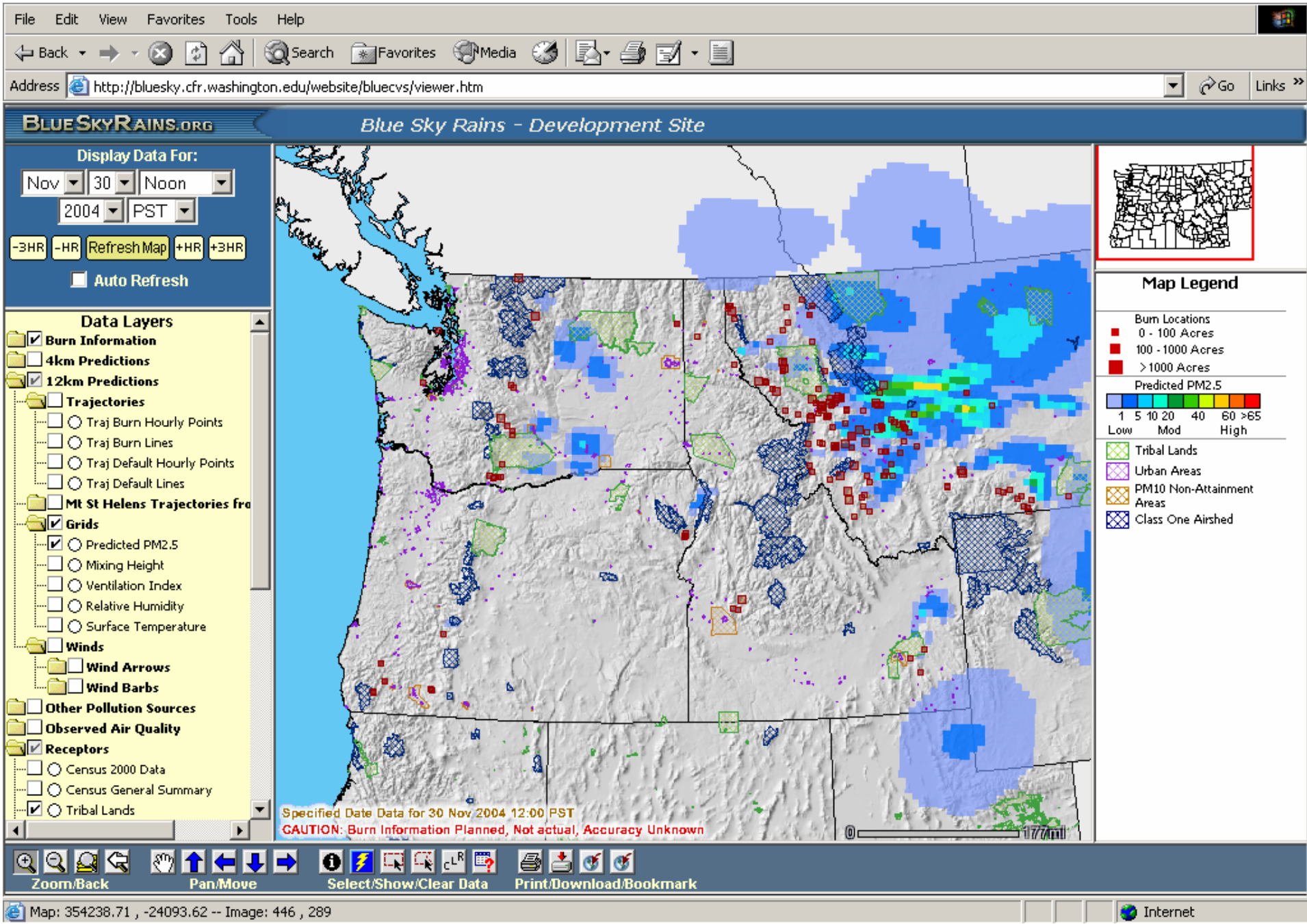
Address http://bluesky.cfr.washington.edu/website/bluecvs/viewer.htm
Go Links
BLUESKYRAINS.ORG
Blue Sky Rains - Development Site
Display Data For:
Nov 30 Noon
2004 PST
-3HR -HR Refresh Map +HR +3HR
Auto Refresh
Data Layers
Burn Information
4km Predictions
12km Predictions
Trajectories
Traj Burn Hourly Points
Traj Burn Lines
Traj Default Hourly Points
Traj Default Lines
Mt St Helens Trajectories fro
Grids
Predicted PM2.5
Mixing Height
Ventilation Index
Relative Humidity
Surface Temperature
Winds
Wind Arrows
Wind Barbs
Other Pollution Sources
Observed Air Quality
Receptors
Base Map Data
Layer Help
Map Legend
Burn Locations
0 - 100 Acres
100 - 1000 Acres
>1000 Acres
Traj Burn Hourly Points
Hours From Start
0 2 4 6 8 10 12
Meters Above Surface
< 100
100 -250
250-500
500-750
750-1000
1000-1500
1500-2000
> 2000
Traj Burn Lines
Predicted PM2.5
1 5 10 20 40 60 >65
Low Mod High
Specified Date Data for 30 Nov 2004 12:00 PST
CAUTION: Burn Information Planned, Not actual, Accuracy Unknown
0 177mi
Zoom/Back
Pan/Move
Select/Show/Clear Data
Print/Download/Bookmark
Map: 623074.95 , -46496.64 -- Image: 566 , 299
Internet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Blue Sky Rains - Development Site
Display Data For:
Nov 30 Noon
2004 PST
-3HR -HR Refresh Map +HR +3HR
Auto Refresh
Data Layers
Burn Information
4km Predictions
12km Predictions
Trajectories
Traj Burn Hourly Points
Traj Burn Lines
Traj Default Hourly Points
Traj Default Lines
Mt St Helens Trajectories fro
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Predicted PM2.5
Mixing Height
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Other Pollution Sources
Observed Air Quality
Receptors
Census 2000 Data
Census General Summary
Tribal Lands
Map Legend
Burn Locations
0 - 100 Acres
100 - 1000 Acres
>1000 Acres
Predicted PM2.5
1 5 10 20 40 60 >65
Low Mod High
Tribal Lands
Urban Areas
PM10 Non-Attainment Areas
Class One Airshed
Specified Date Data for 30 Nov 2004 12:00 PST
CAUTION: Burn Information Planned, Not actual, Accuracy Unknown
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Zoom/Back
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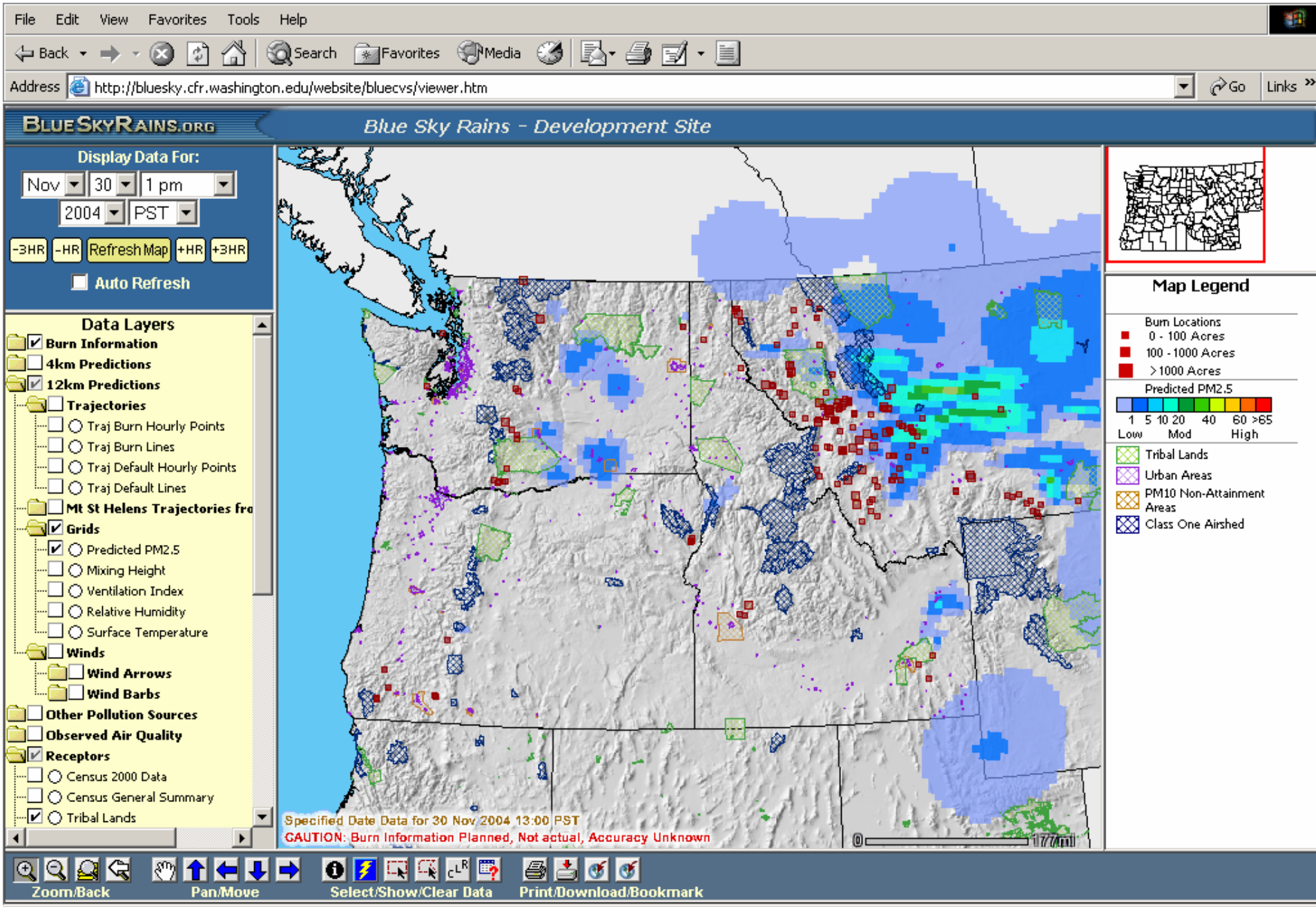
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Display Data For:
Nov 30 1 pm
2004 PST
-3HR -HR Refresh Map +HR +3HR
Auto Refresh
Data Layers
Burn Information
4km Predictions
12km Predictions
Trajectories
Traj Burn Hourly Points
Traj Burn Lines
Traj Default Hourly Points
Traj Default Lines
Mt St Helens Trajectories fro
Grids
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Ventilation Index
Relative Humidity
Surface Temperature
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Wind Arrows
Wind Barbs
Other Pollution Sources
Observed Air Quality
Receptors
Census 2000 Data
Census General Summary
Tribal Lands
Specified Date Data for 30 Nov 2004 13:00 PST
CAUTION: Burn Information Planned, Not actual, Accuracy Unknown
Map Legend
Burn Locations
0 - 100 Acres
100 - 1000 Acres
>1000 Acres
Predicted PM2.5
1 5 10 20 40 60 >65
Low Mod High
Tribal Lands
Urban Areas
PM10 Non-Attainment Areas
Class One Airshed
Zoom/Back
Pan/Move
Select/Show/Clear Data
Print/Download/Bookmark
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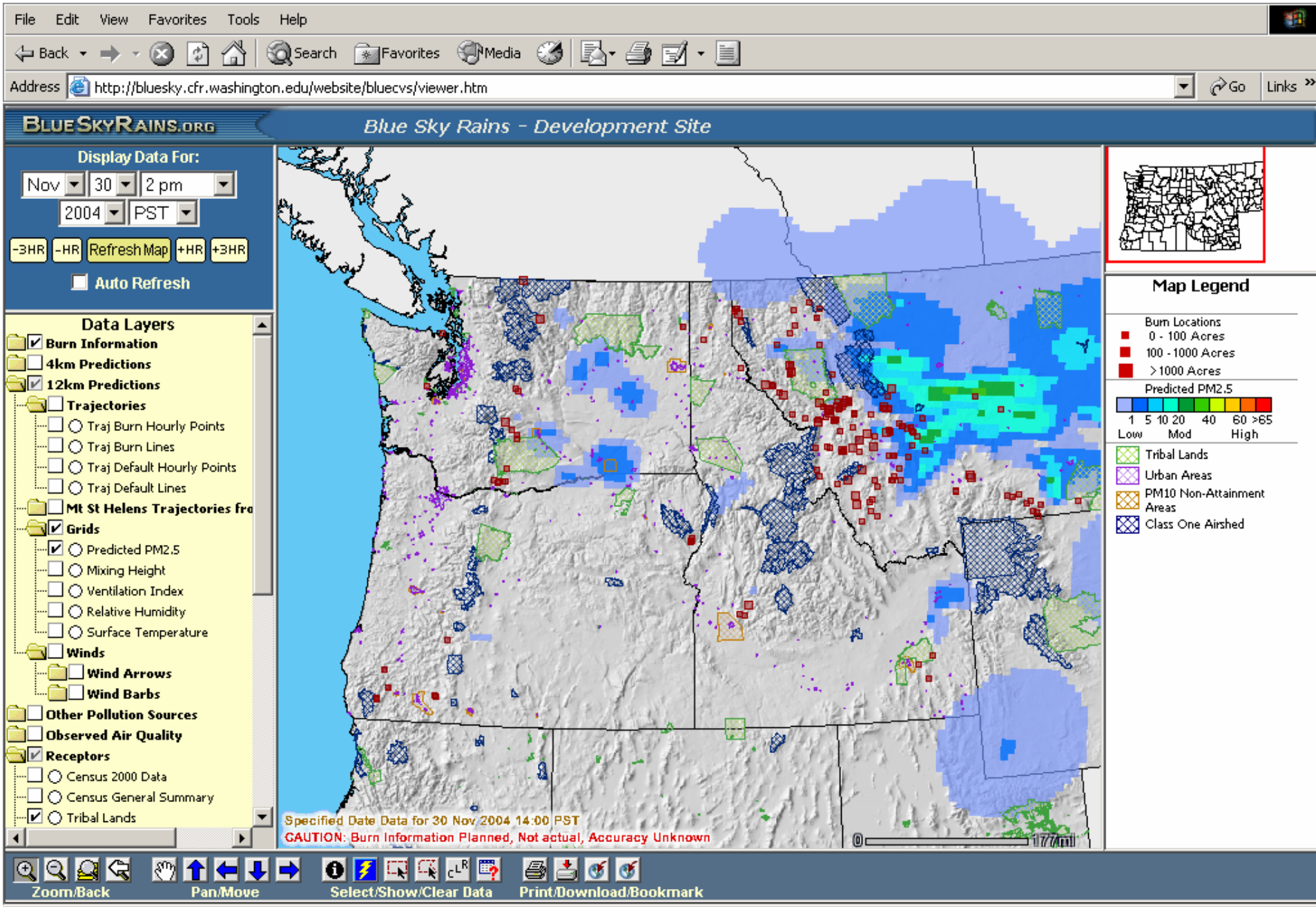
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Zoom/Back
Pan/Move
Select/Show/Clear Data
Print/Download/Bookmark
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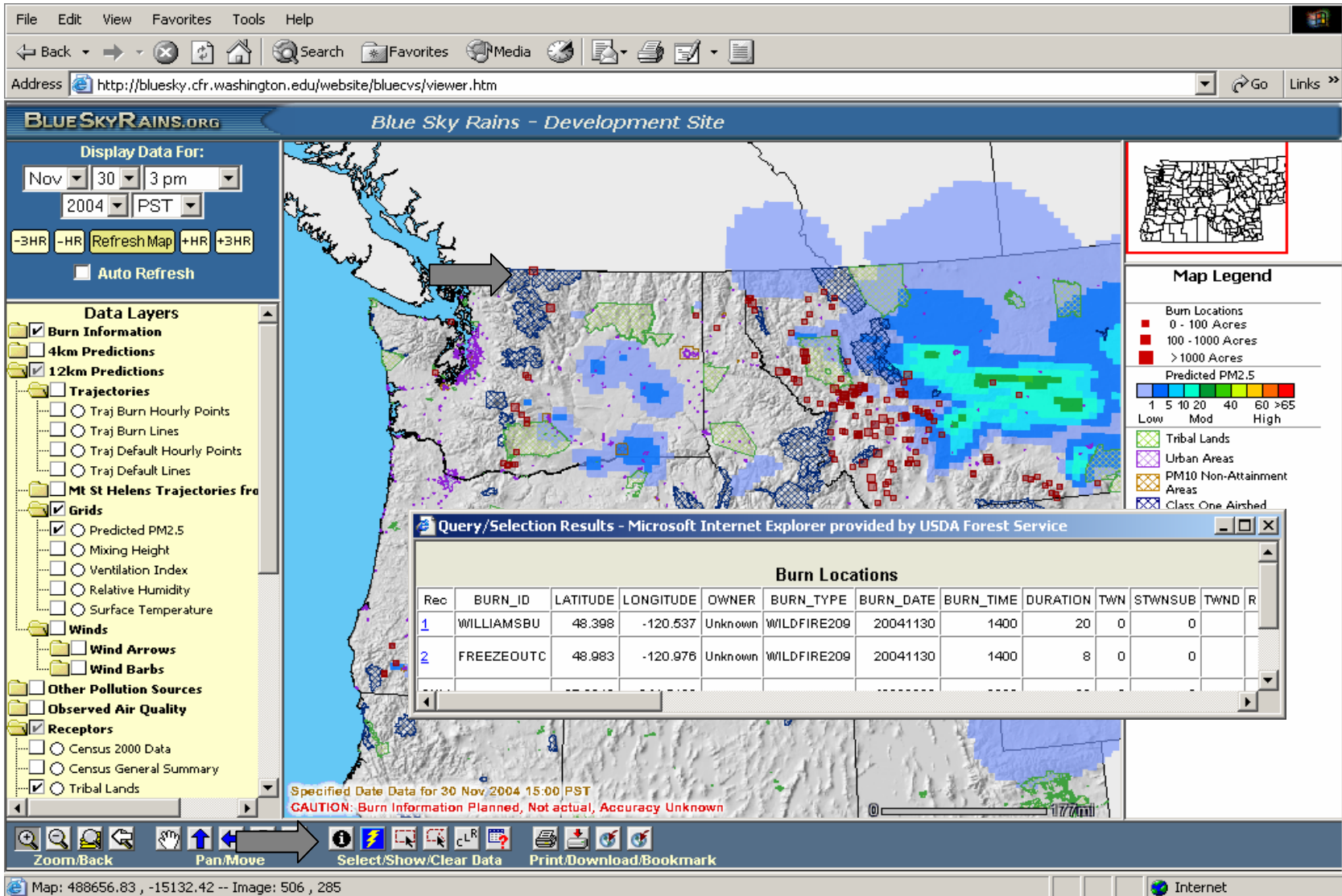
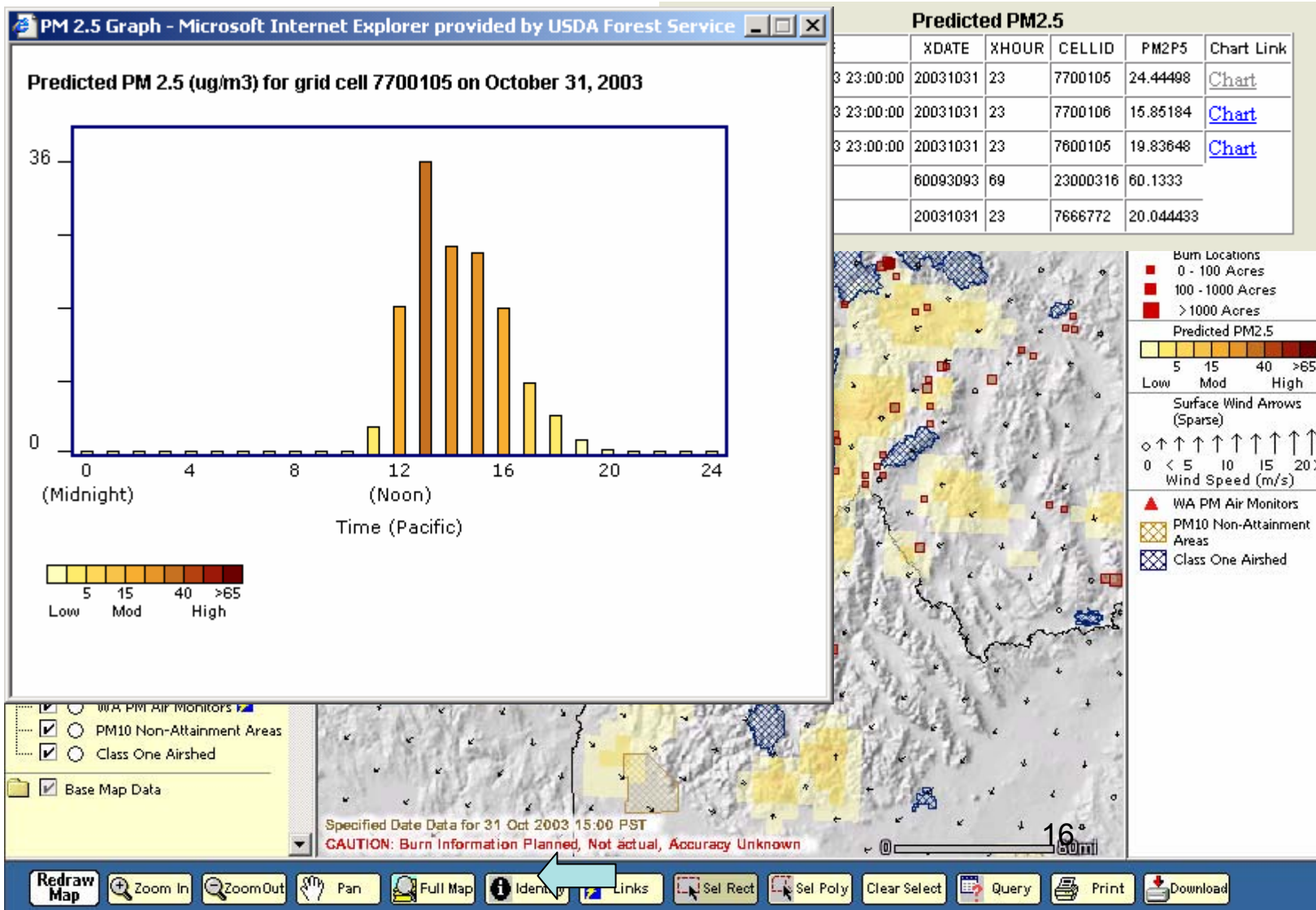
Internet

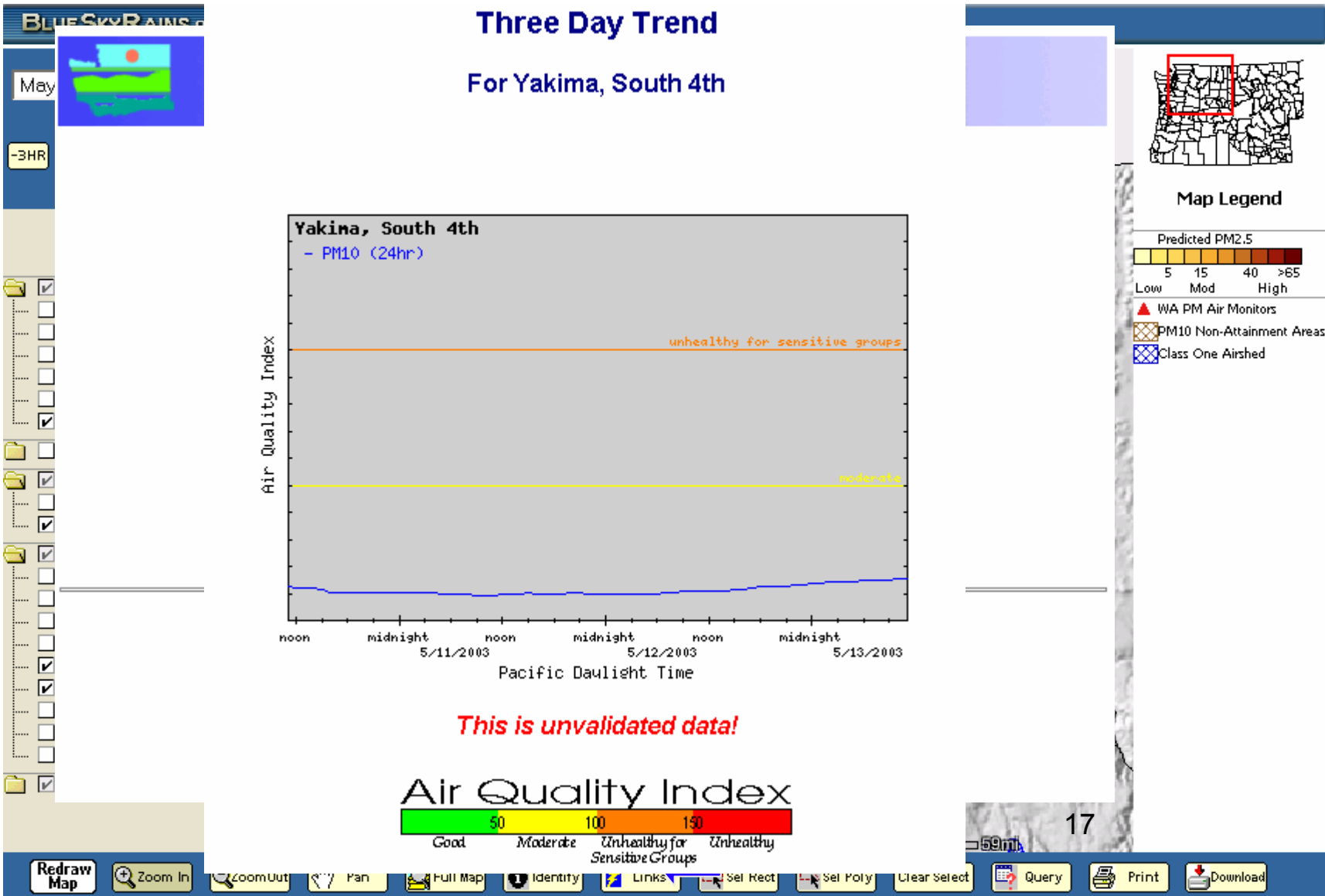
Quantitative Information



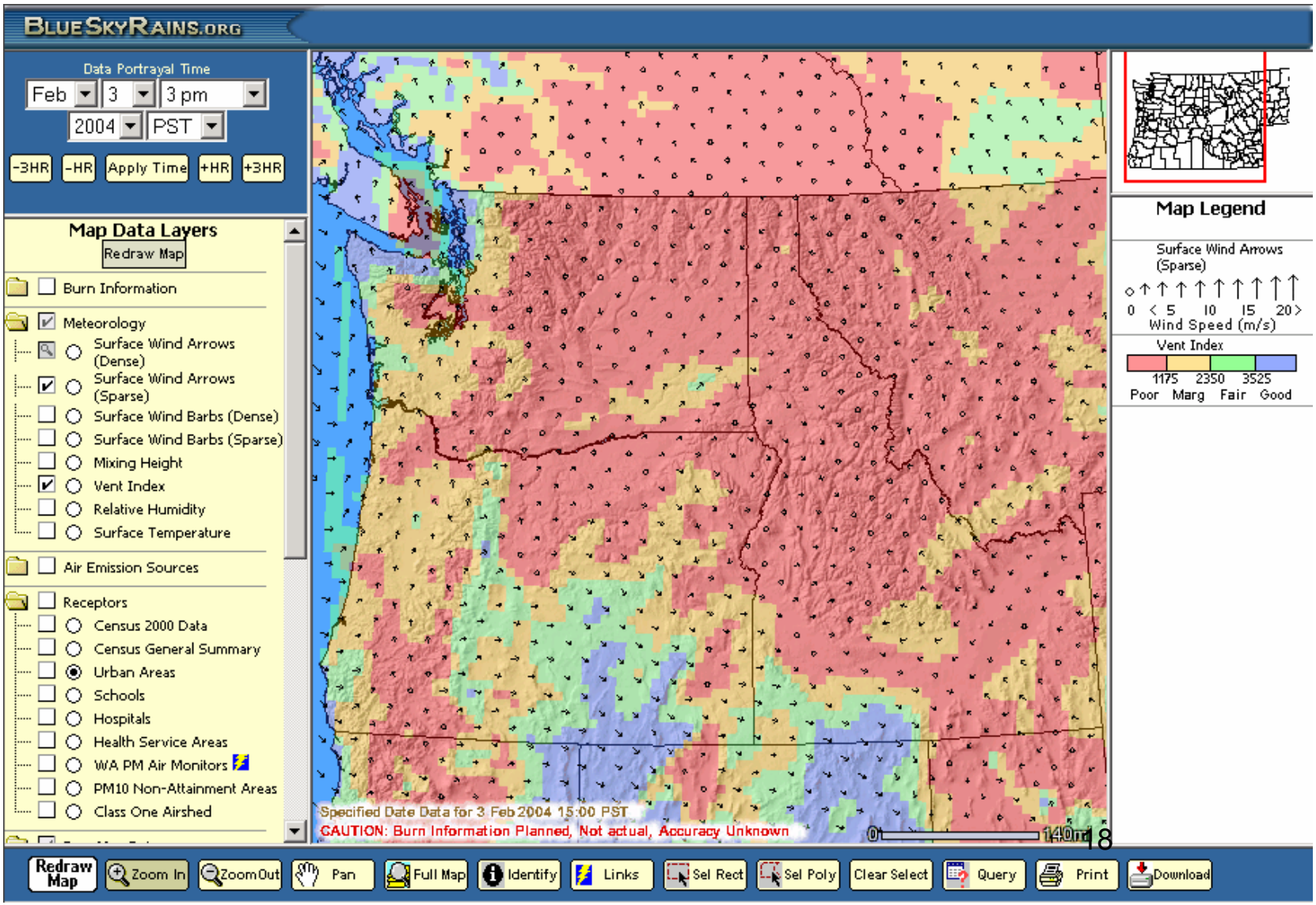
Quantitative Information



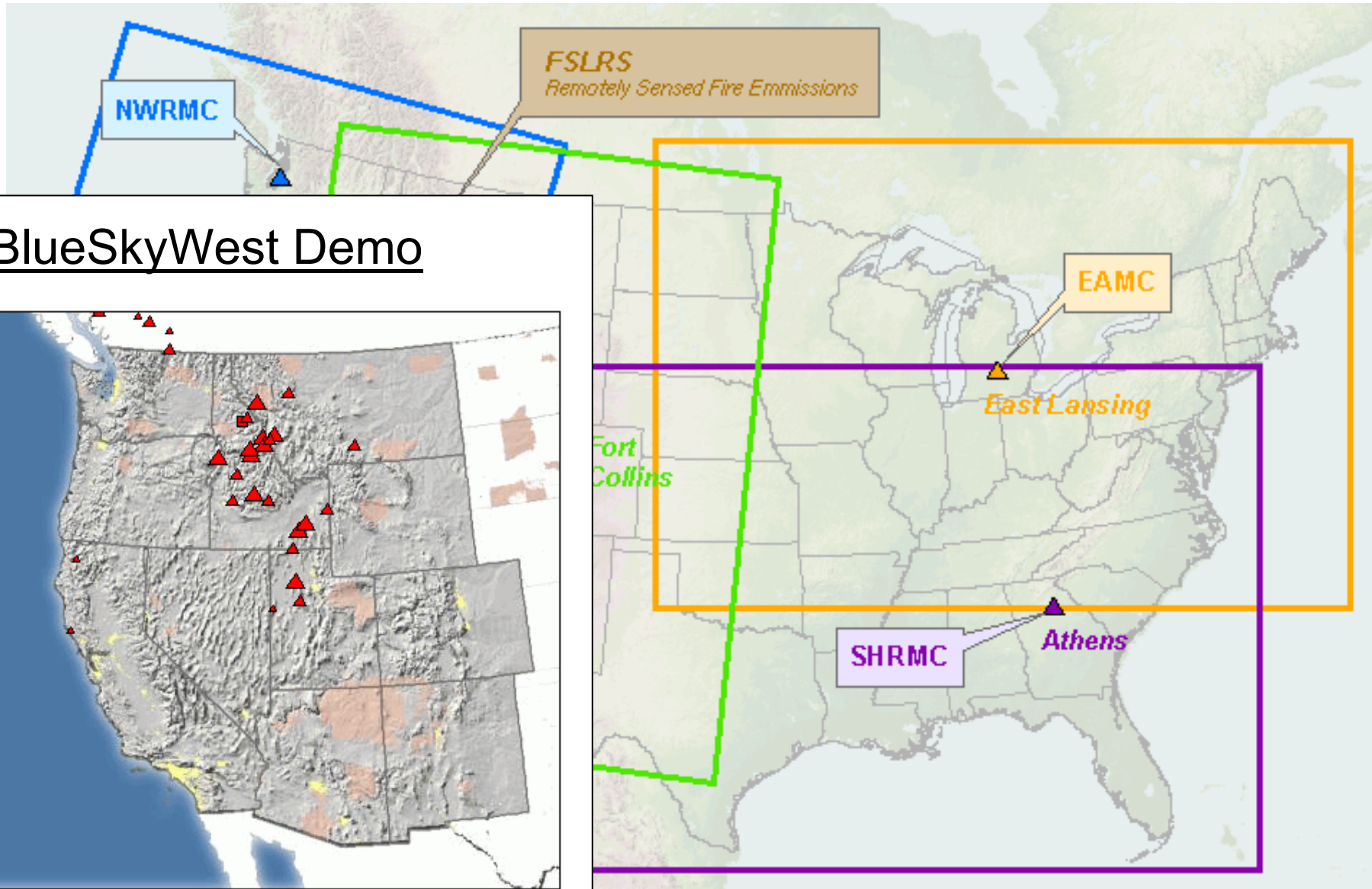
Monitoring Data



Meteorological Forecast Info



Implementation (FCAMMS centers)



BlueSkyWest Demo

WESTERN BLUESKYRAINS

Information about Potential Wildfire Smoke Impacts

Display Data For:

Aug | 22 | 10 am

2005 | PDT

-3HR | -HR | Refresh Map | +HR | +3HR

☐ Auto Refresh

Data Layers

Data Status

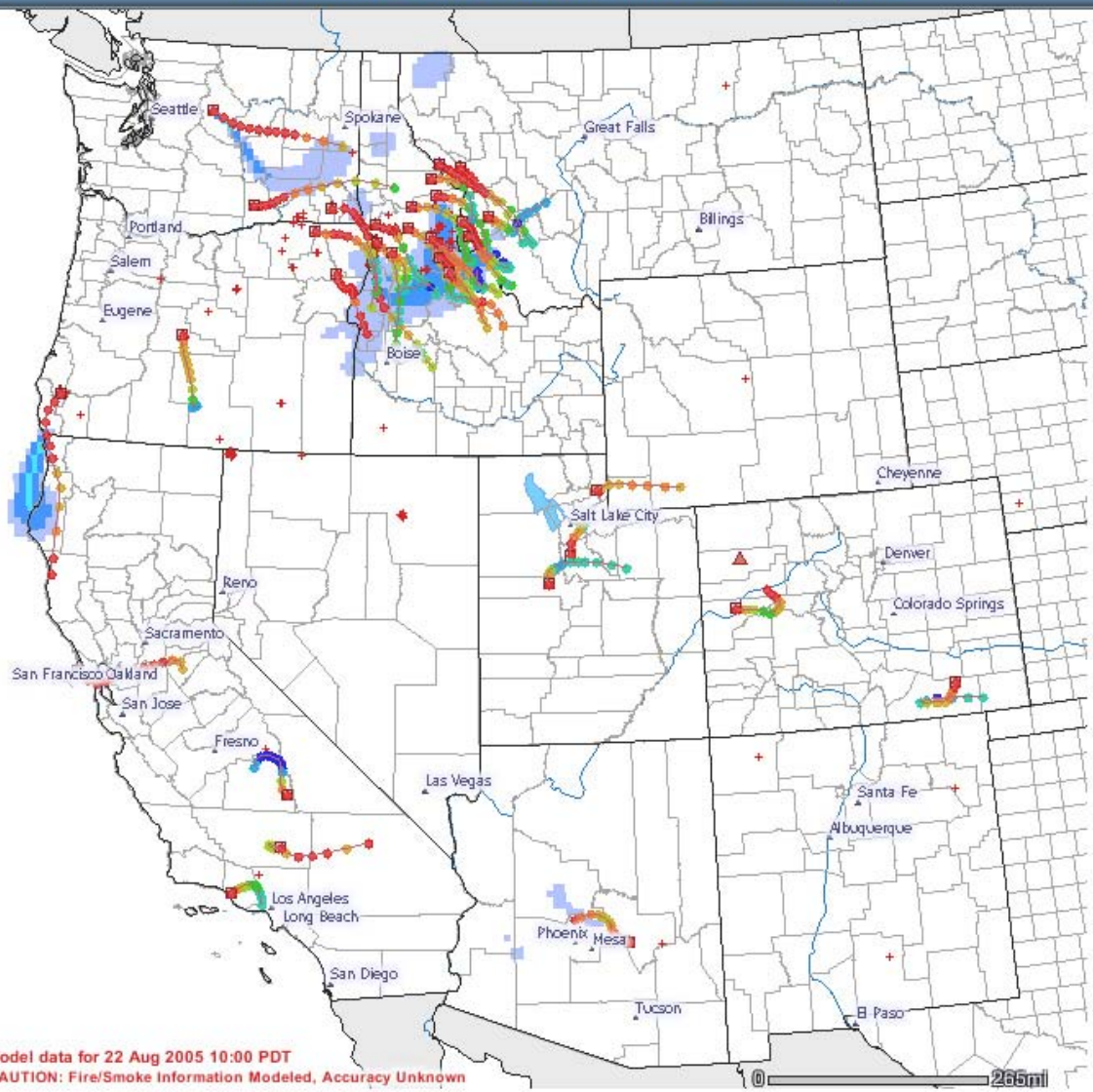
- ☑ **Burn Information**
- ☑ **12km Predictions**
- ☑ **NOAA Fire/Smoke Information**
- ☑ **Other Pollution Sources**
- ☐ **Observed Air Quality**
- ☐ **Receptors**
- ☑ **Base Map Data**

AIRNOW | Bluesky Animations

Bluesky Pacific NW | NOAA Animations

Layer Help

- A closed **group**, click to open.
- An open **group**, click to close.
- A hidden group/layer, click to make vi
- A visible group/layer, click to hide.
- A visible layer, but not at this scale.
- A partially visible group, click to make
- An inactive layer, click to make active.
- The active layer.
- Hyperlink toolbutton available.
- Meta Link to Metadata (click to view)
- A map layer.



Map Legend

Wildfire Locations
- 0 - 100 Acres
- 100 - 1000 Acres
- >1000 Acres

Burn Traj Hourly Pts

Hours From Start

0 2 4 6 8 10 12

Meters Above Surface

- < 100
- 100 -250
- 250-500
- 500-750
- 750-1000
- 1000-1500
- 1500-2000
- > 2000

Burn Traj Lines

Predicted PM2.5

1 5 10 20 40 60 >65

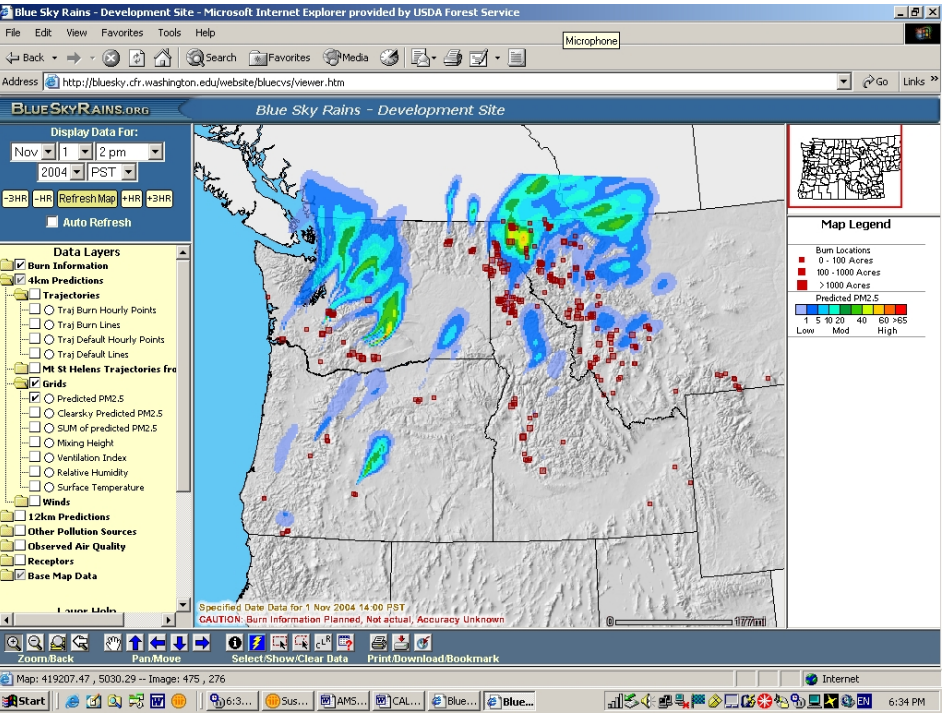
Low Mod High

NOAA Fire Detects

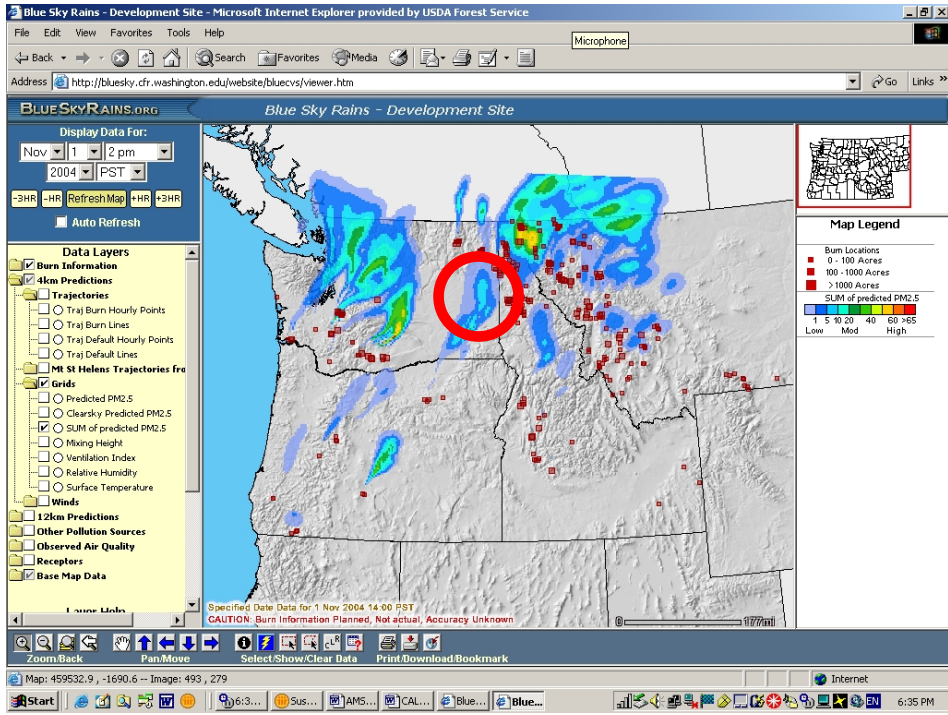
BlueSky/RAINS Applications

Domain	Resolution	FCAMMS	Station	Wildfire	Rx fire	Ag fire	RAINS	In Operation Since
Northwest	12 km	NWRMC	PNW			*		2002
	4 km							
N. California	4 km	CANSAC	PSW					2004
S. California	4 km	CANSAC	PSW					2004
Northeast	12 km	EAMC	NCRS		M			2004
Rocky Mountain	6 km	RMC	RMRC		M			2004
Southeast	12 km	SHRMC	SRS		M		*	2005
	4 km						*	
West (demo)	36 km	NWRMC / RMC	RMRC		M			2005
	12 km							

BlueSky Wildland Fire+ ClearSky Agricultural Fire



BlueSky



BlueSky + ClearSky

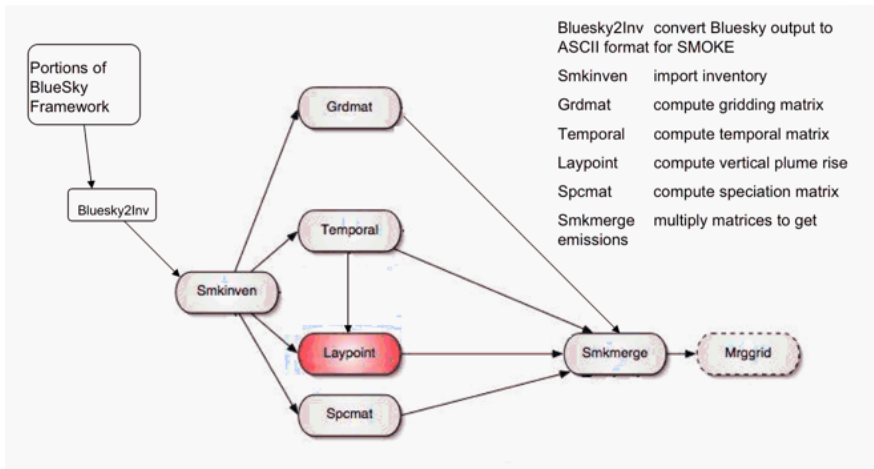
Using BlueSky for EIs

BlueSky Framework calculates hourly emissions from fire location information

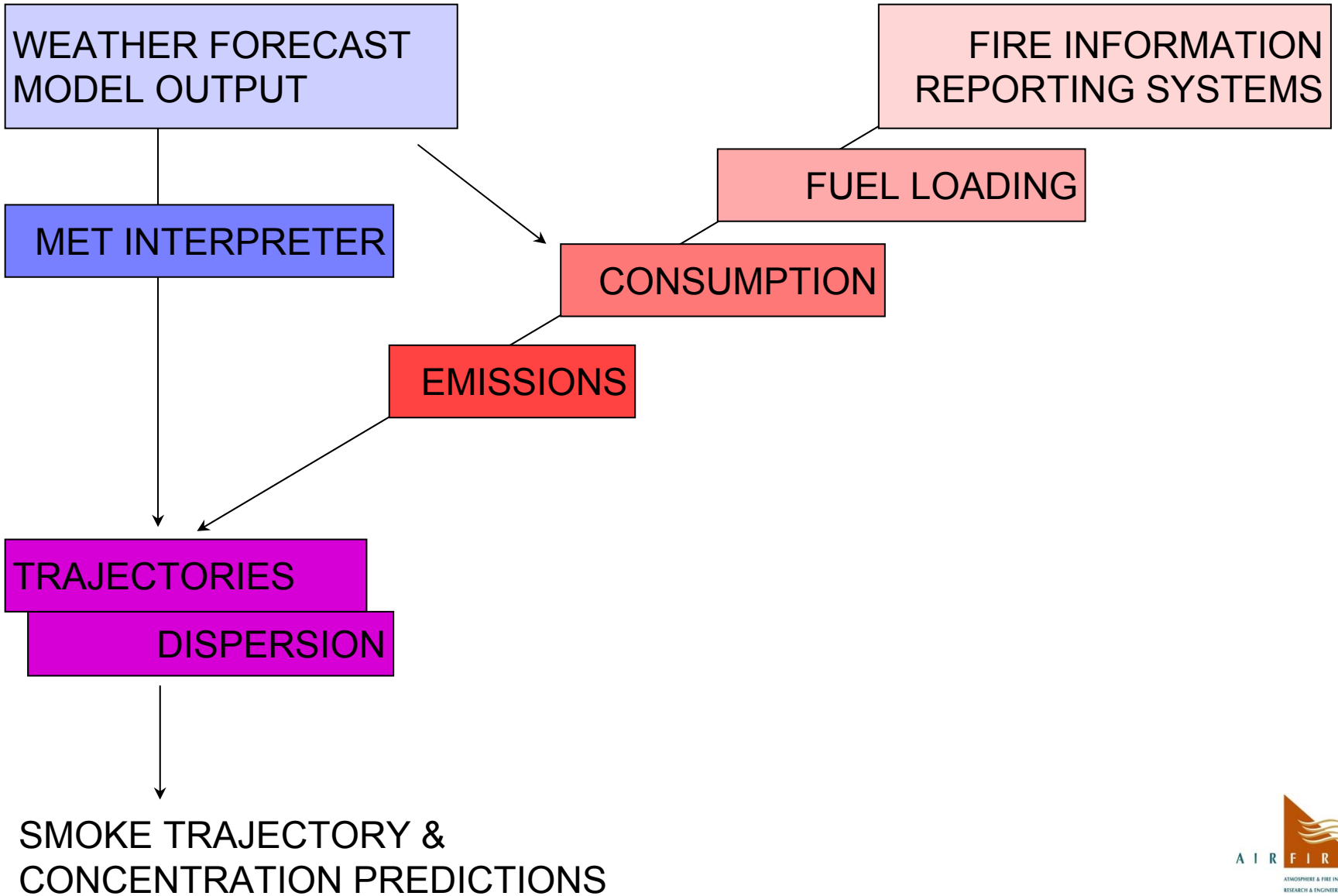
BlueSky EM project

BlueSky-EM Project
EPA NERL / NOAA ARL
Tom Pierce
George Pouliot
UNC
CMAS

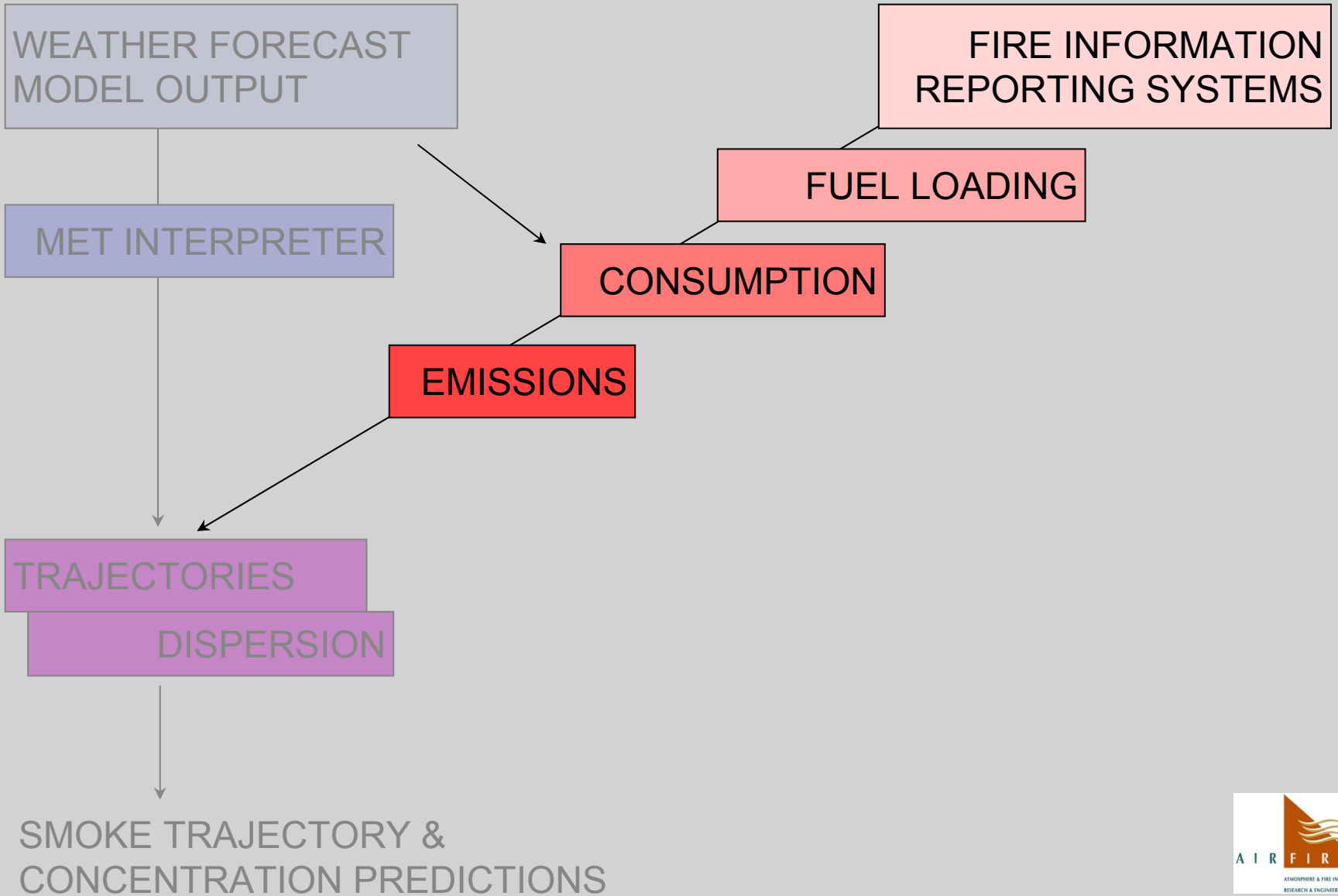
BlueSky as fire model for CMAQ
(make SMOKE ready files, like BEIS, MOBILE)



BlueSky Framework



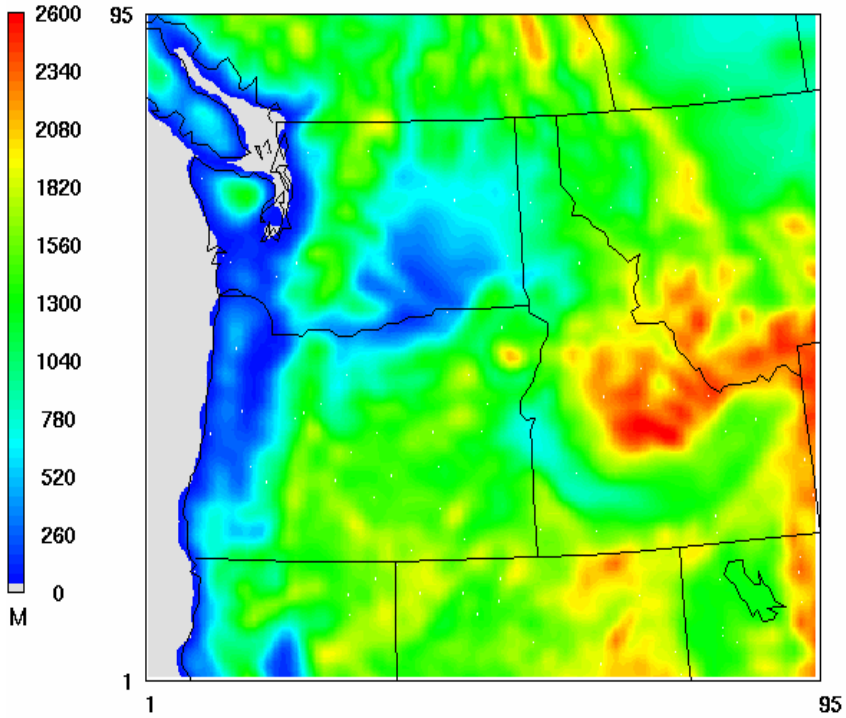
BlueSky Framework



Example: AIRPACT-3

- Washington State University
- Joe Vaughn & Brian Lamb

- Northwest Domain
- Daily AQ predictions
- CMAQ Model
- BlueSky fire emissions now incorporated
  - SMOKE ready file downloaded to AirPACT



Acrolein
Benzene
1,3-Butadiene
Perchloroethylene
Formaldehyde
Acetaldehyde
Phenanthrene

PM species
Nitrates
Sulfates
Organic aerosols
Wind-Blown Dust
PM2.5 total mass

Problems w/ Fire Emissions

Depends on Type of Inventory Desired

- Real-time vs Retrospective
- Hourly vs Summary Statistics

Sticky Wickets

- Fire Reporting
- Fuel Loadings
- Emissions Models

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Fire Reporting: Timing & Availability

Better

Worse

Wildland Fire / Wildland Fire Use

- National Reporting
- ICS 209 reports
- ~ 1-2 day lag

Prescribed Fire

- varies regionally - some areas very good

e.g. WA/OR/ID/MT - planned burns reported

- ~ public lands okay, private less so

Agricultural Burning

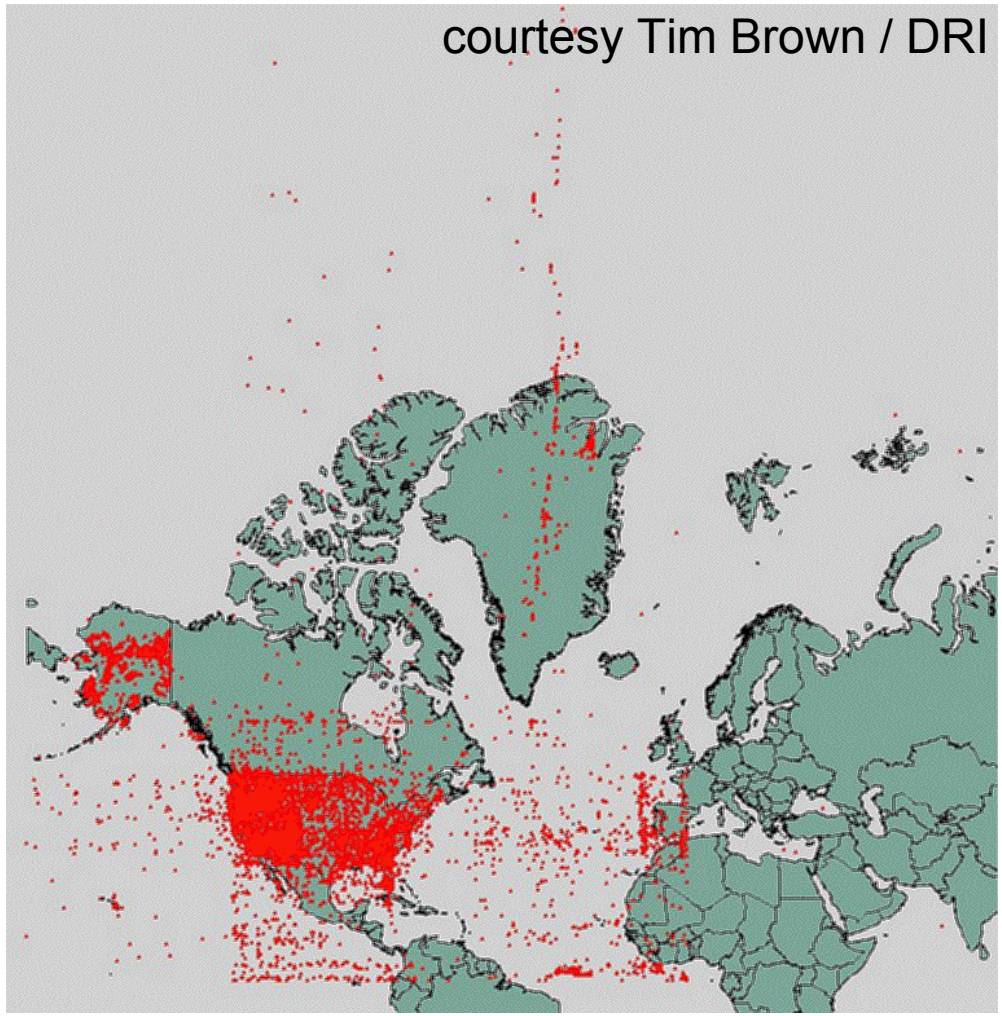
- much less

AIR FIRE
ATMOSPHERE & FIRE INTERACTIONS RESEARCH & ENGINEERING

Fire Reporting: QA / QC

Fire Locations

- not always accurate
- but satellites have problems too



Fire Growth

- can vary by person/ technique
- possible to get negative growth

Acres Burned ≠ Fuels Burned

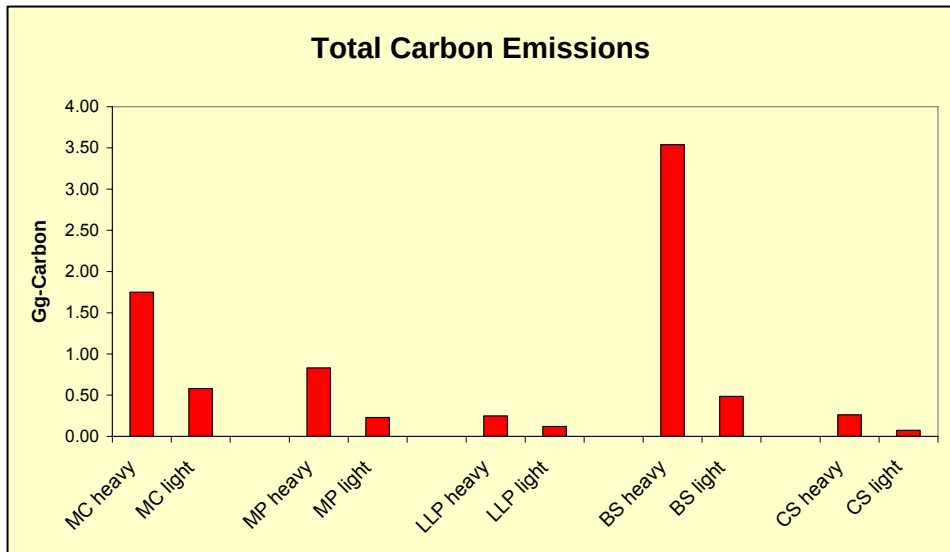
Fuel Loadings

Lack of Fuel Reporting

What Fuel Loading to use?

- Mapped fuels.

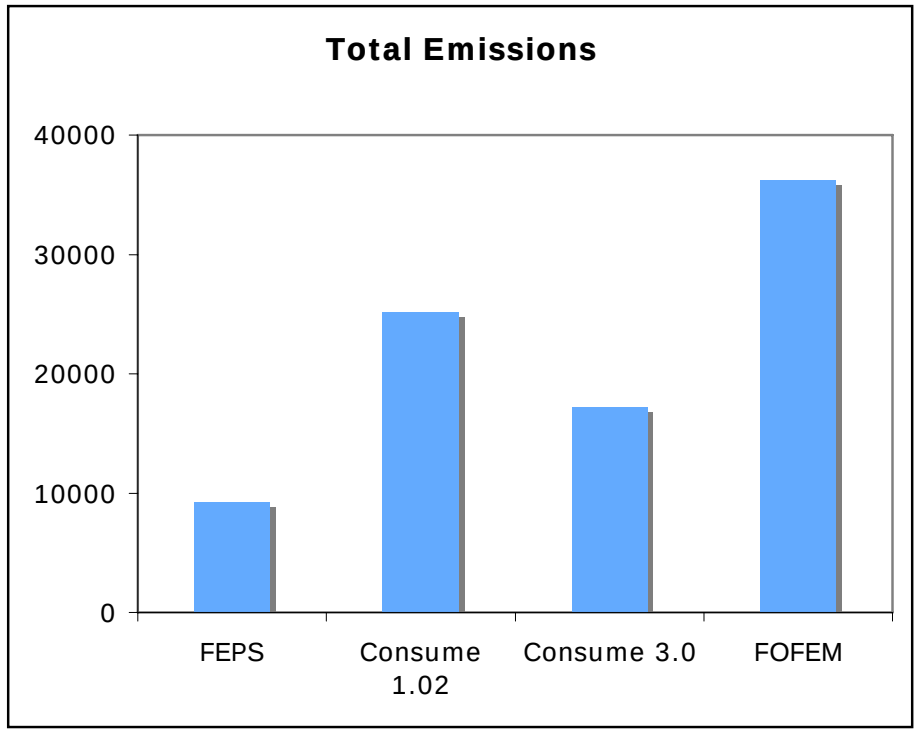
Observed variations can make a *big* difference (~2-8x).



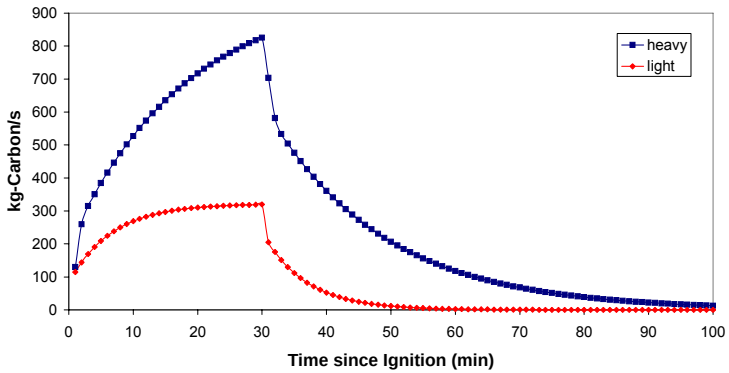
Emissions Models

Emissions Model choices matter, too. One example (~4x):

→ Bulk formulas may have large errors.



Time distribution typically simple:



Ongoing and Future Work

Model Evalution
- Verification Studies
- Sensitivity Experiments
- Model intercomparison

Ensembles
- of weather predictions
- of fire growth & fuels & emissions models

FCAMMS Integration
- National page to add your fire

Incorporating Satellite Information
- NASA grant / Sonoma Technologies
- (stay tuned for Lyle's talk up next)

Partners
BlueSky Consortium
FCAMMS
EPA
Sonoma Tech
UW / WSU
DOI

Funding
NFP
JFSP
EPA
DOI
NASA
R6/SORO
MT DEQ

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Thank you

Sally Dombrowski
the EPA
the Emissions Inventory Conference

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206-732-7849

http://airfire.org
http://blueskyrains.org