

Development and Applications of Systems for Modeling Emissions and Smoke from Fires: The BlueSky Smoke Modeling Framework and SMARTFIRE

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Outline

The status of smoke and fire tools

The status of BlueSky systems

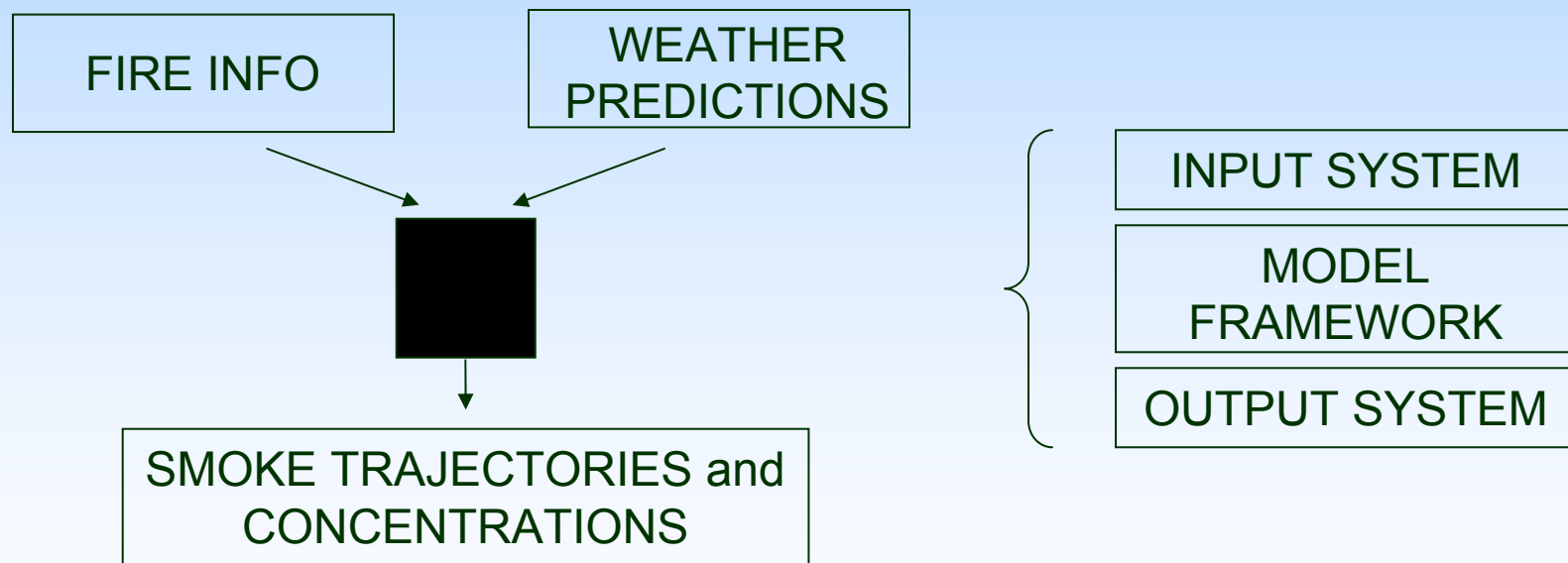
- SMARTFIRE
- BlueSky Framework

Applications

Next steps, the future

Availability

Basics of Smoke Application



Lots of Different Uses

Strategic planning for prescribed burning

long-range, need to compare options (what if)

Lighting or managing a fire

real-time (right now!), need to compare options (what if)

Strategic planning for air quality

long-range, need to compare options (what if)

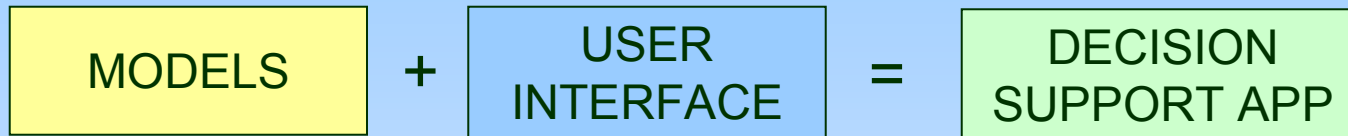
Breathing the air

real-time (right now!), best guess of what will happen

Diagnosing what happened

historical, best guess of what will happen

The State of Smoke Tools



Current State: HAPHAZARD



April 2008

June 2008

2009?

Promising Developments

1. Model Inter-operability

- BlueSky Framework

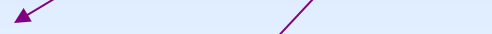
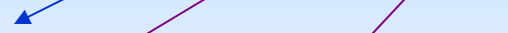
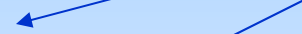
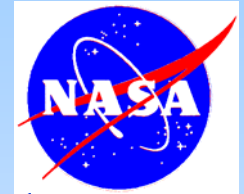
2. Nationally Consistent Products

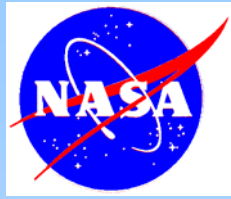
3. New, Advanced Tools

- for Fire Info (SMARTFIRE)
- for Planning (AQUIPT)

4. Inter- and intra-agency alliances strengthened and/or established

- EPA Emission Inventory
- Canadian Forest Service
- Clearsky/AIRPACT



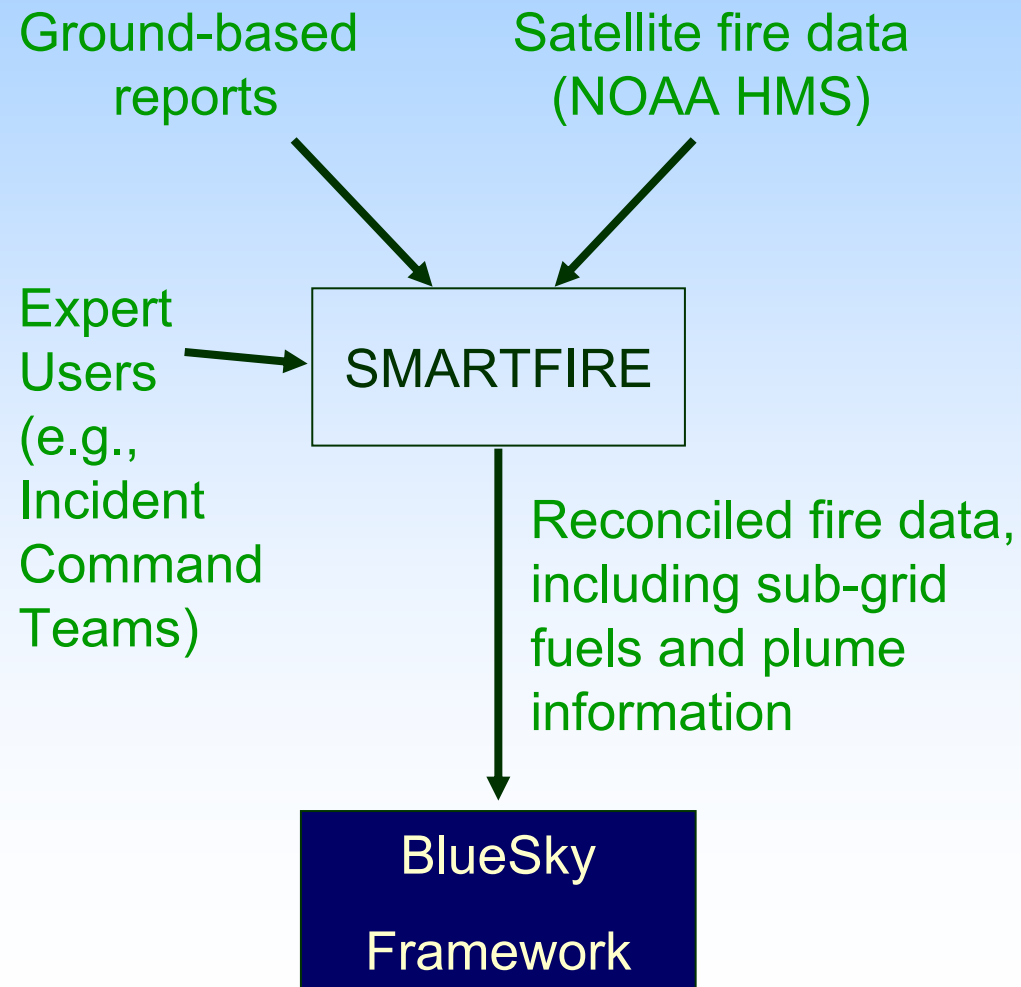


NASA Cooperative Research Agreement

Objective: Facilitate sustained operational support with BlueSky systems (with satellite data)

- Engineer improved maintainability, portability, expandability, scalability, ease of use
- Broaden geographic scope (U.S. or N. America)
- Increase relevance of BlueSky-enabled products
 - Completeness, timeliness
 - Scientific basis, reliability, accuracy
 - System capabilities, tools
- Promote inter- and intra-agency alliances and adoption of BlueSky systems

SMARTFIRE: Reconciled Fire Data



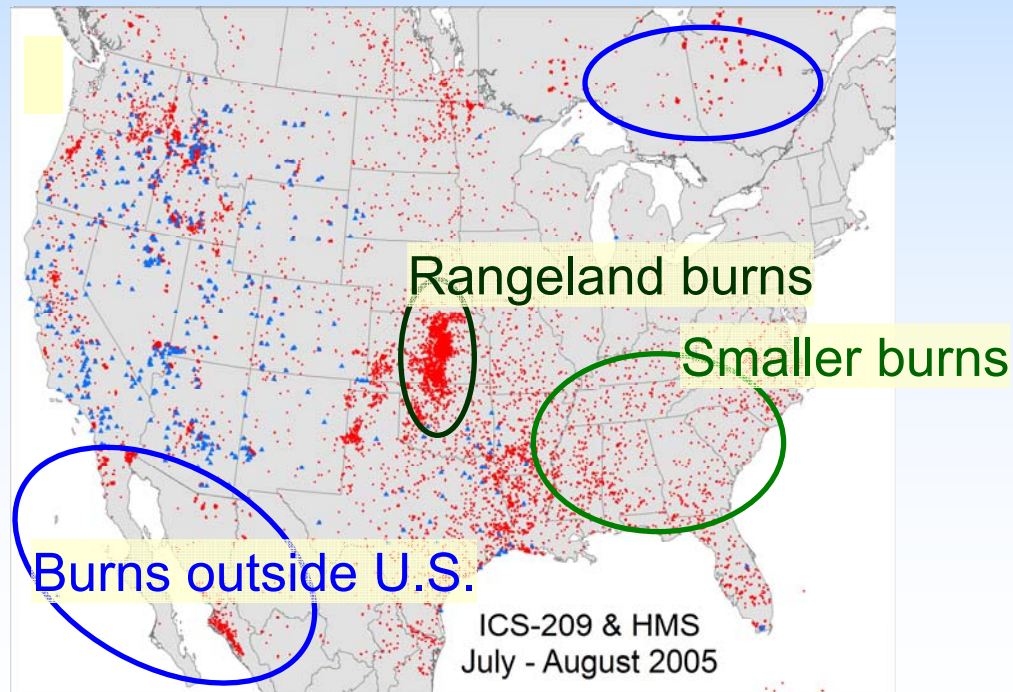
SMARTFIRE: Reconciled Fire Data

One year ago...

- Ground-based reports (e.g., ICS-209)

Now...

- Satellite data (NOAA HMS) reconciled with ground-based reports

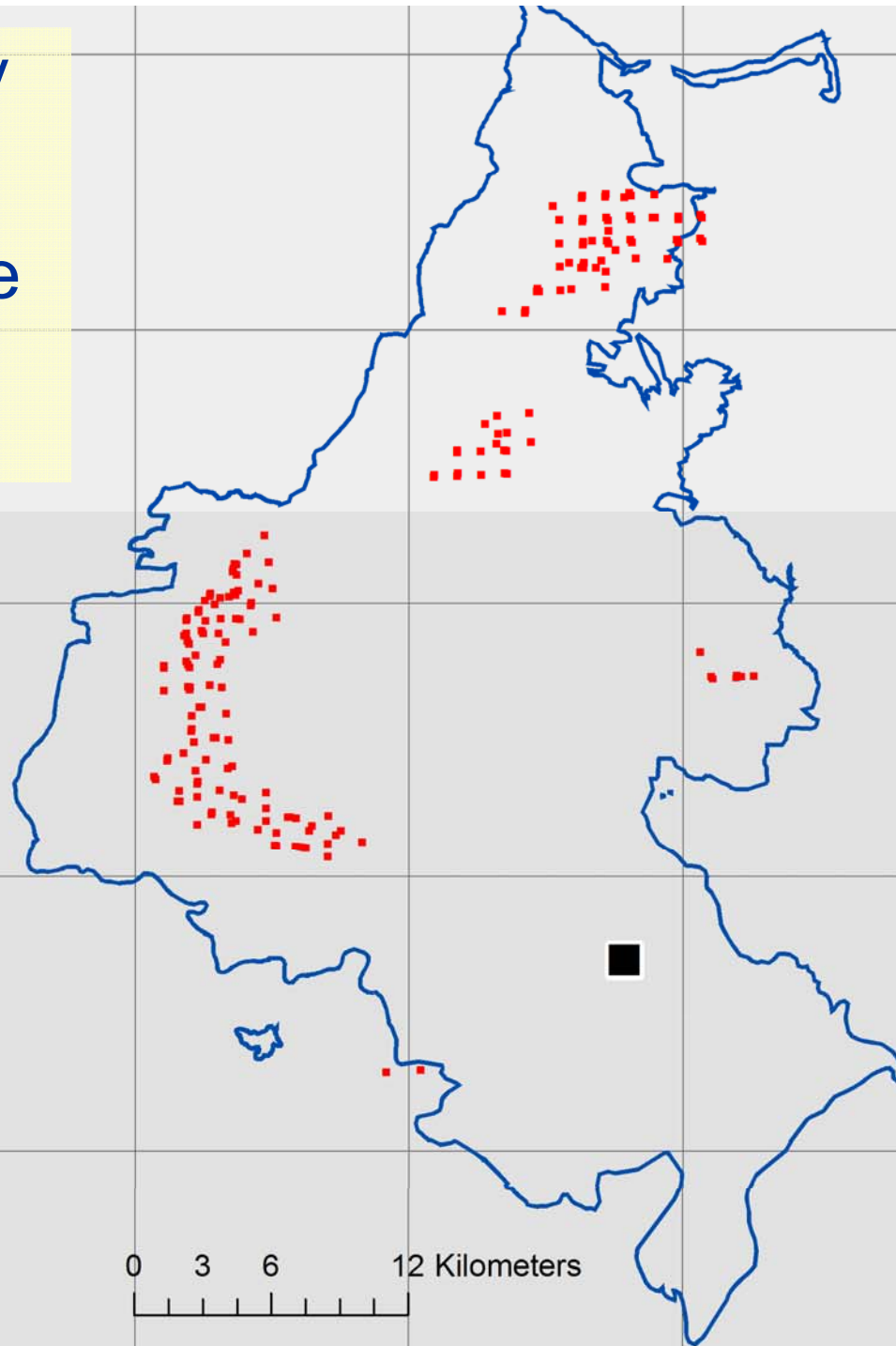


ICS-209s report only the ignition point.

Satellite data provide a daily snapshot of burning locations.

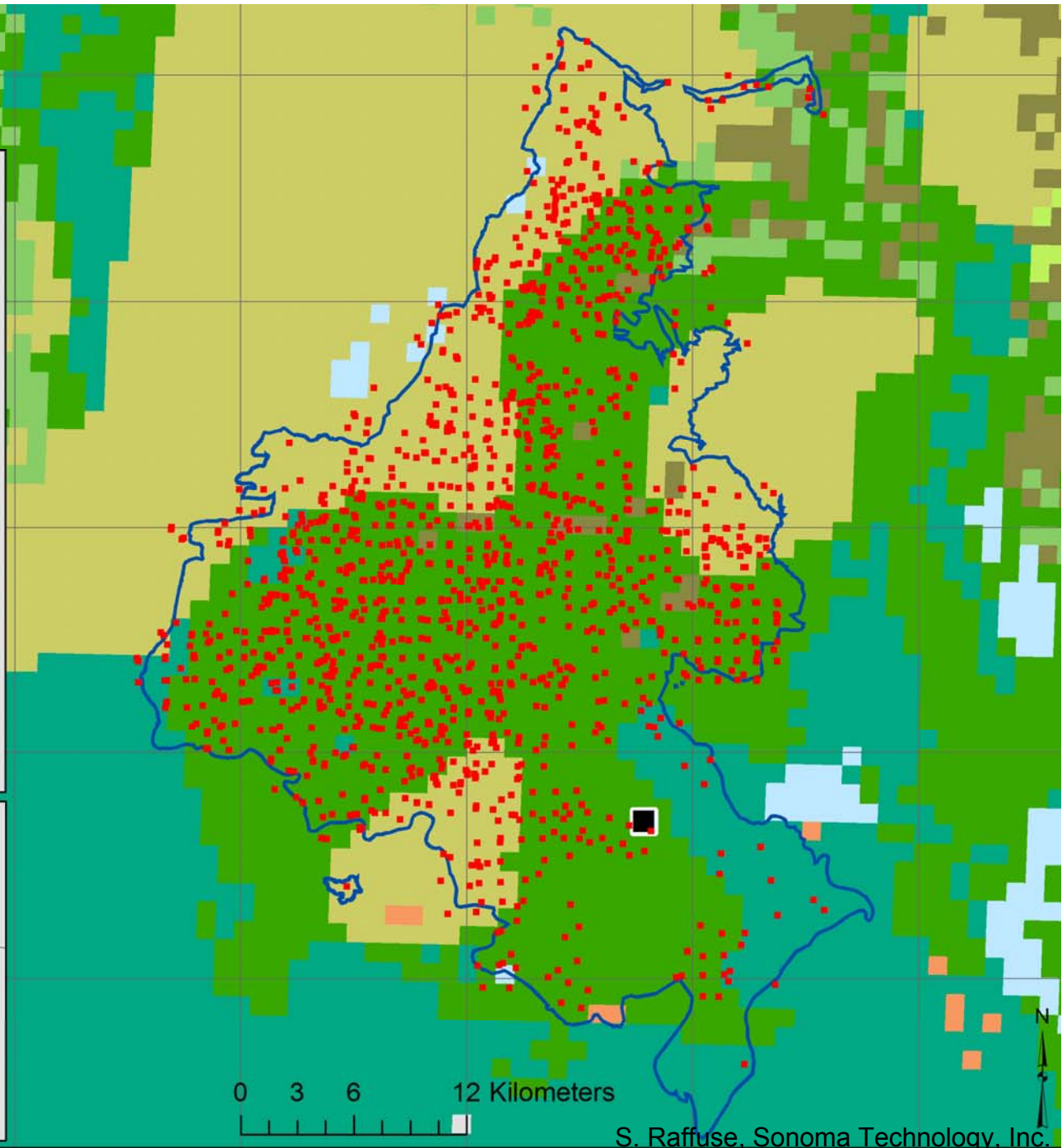
Cave Creek Fire 6/30/2005

- Satellite fire detects
- ICS-209 Location
- 🌀 Cave Creek - final perimeter
- 12-km Modeling Grid



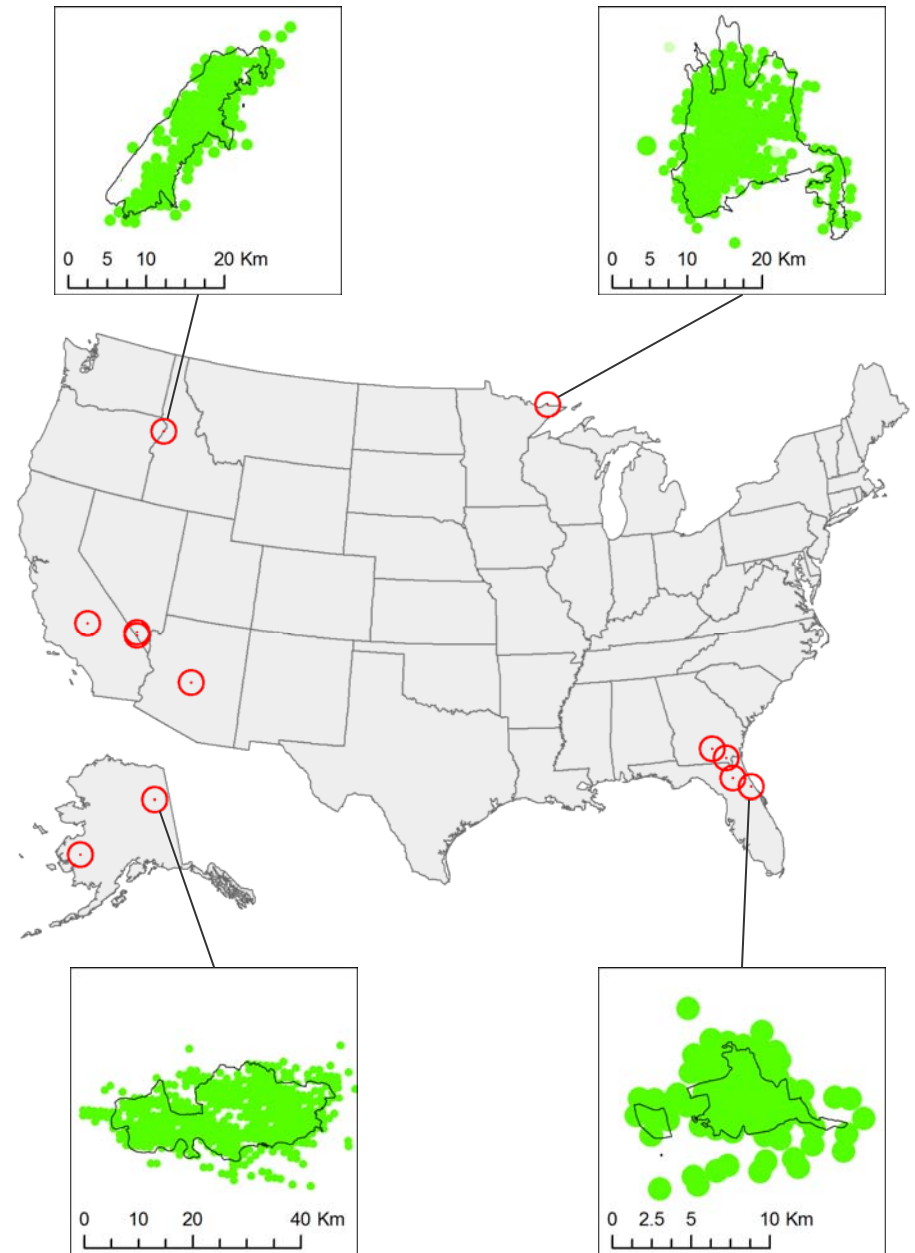
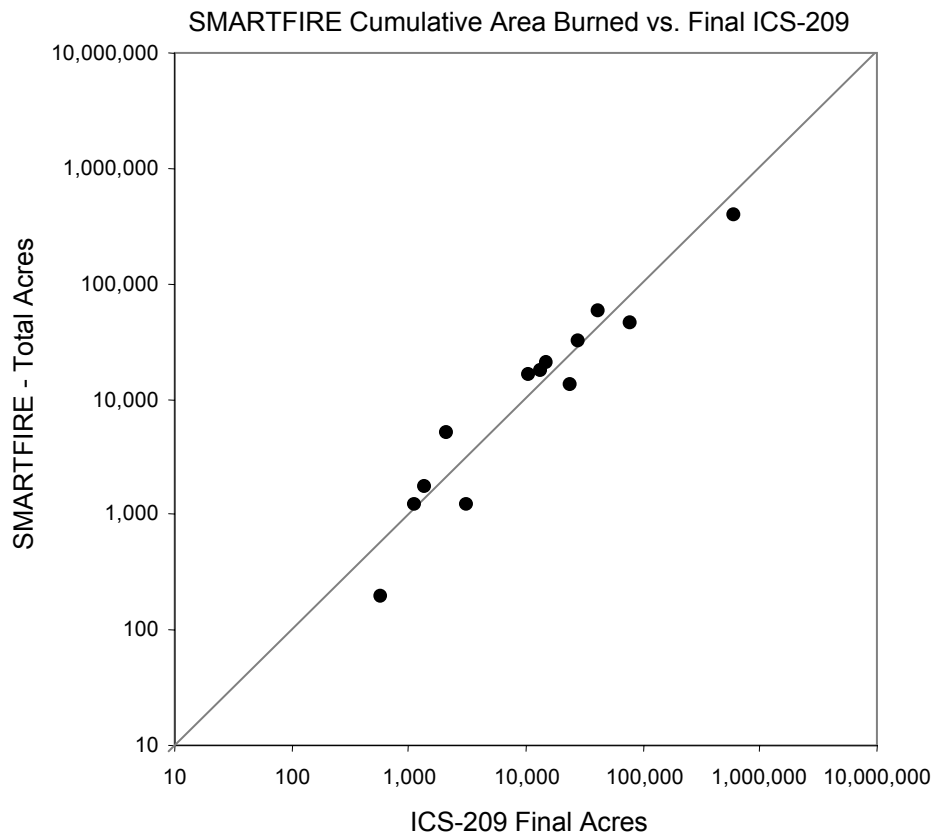
Cave Creek Fire

6/22 - 7/4 2005



SMARTFIRE Algorithm Tuning

Sample Wildfire Test Locations



SMARTFIRE Small Fire Comparison

Georgia Silviculture (2002)

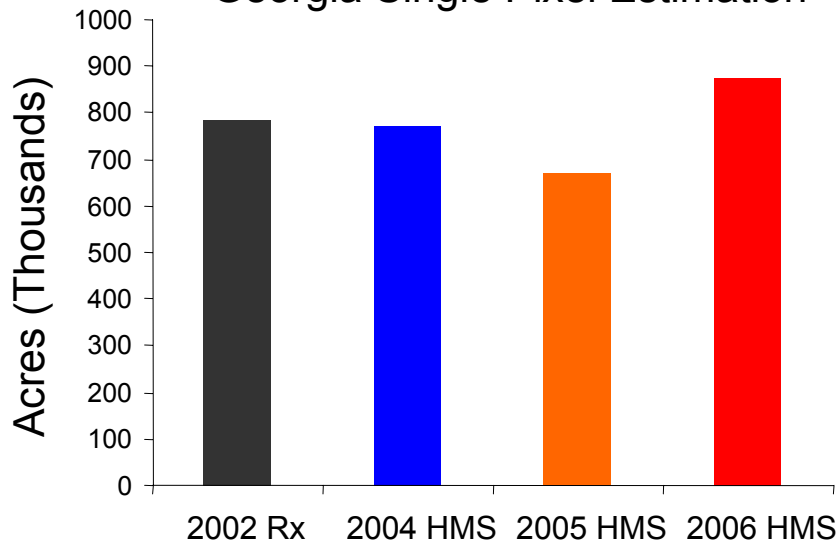
Fires 19,818
 Acres 783,262
 Acres per fire 39.5

HMS Pixel Counts

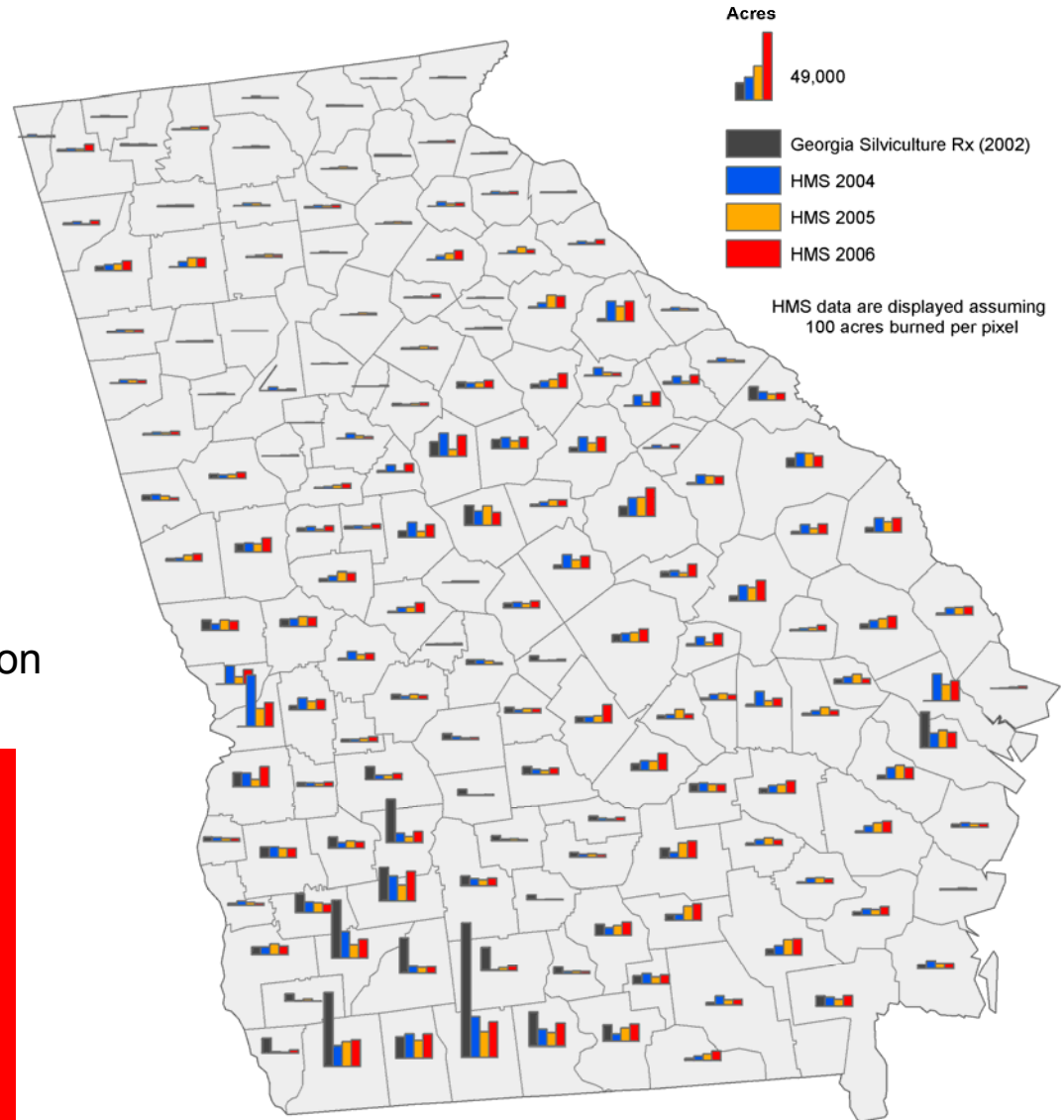
2004 7,725
 2005 6,704
 2006 8,741
 3-yr avg 7,723

To account for all acres using HMS
 $783,262 / 7,723 \sim 100$ acres per count

Georgia Single Pixel Estimation



HMS Detects and Georgia Prescribed Burn Database Comparison



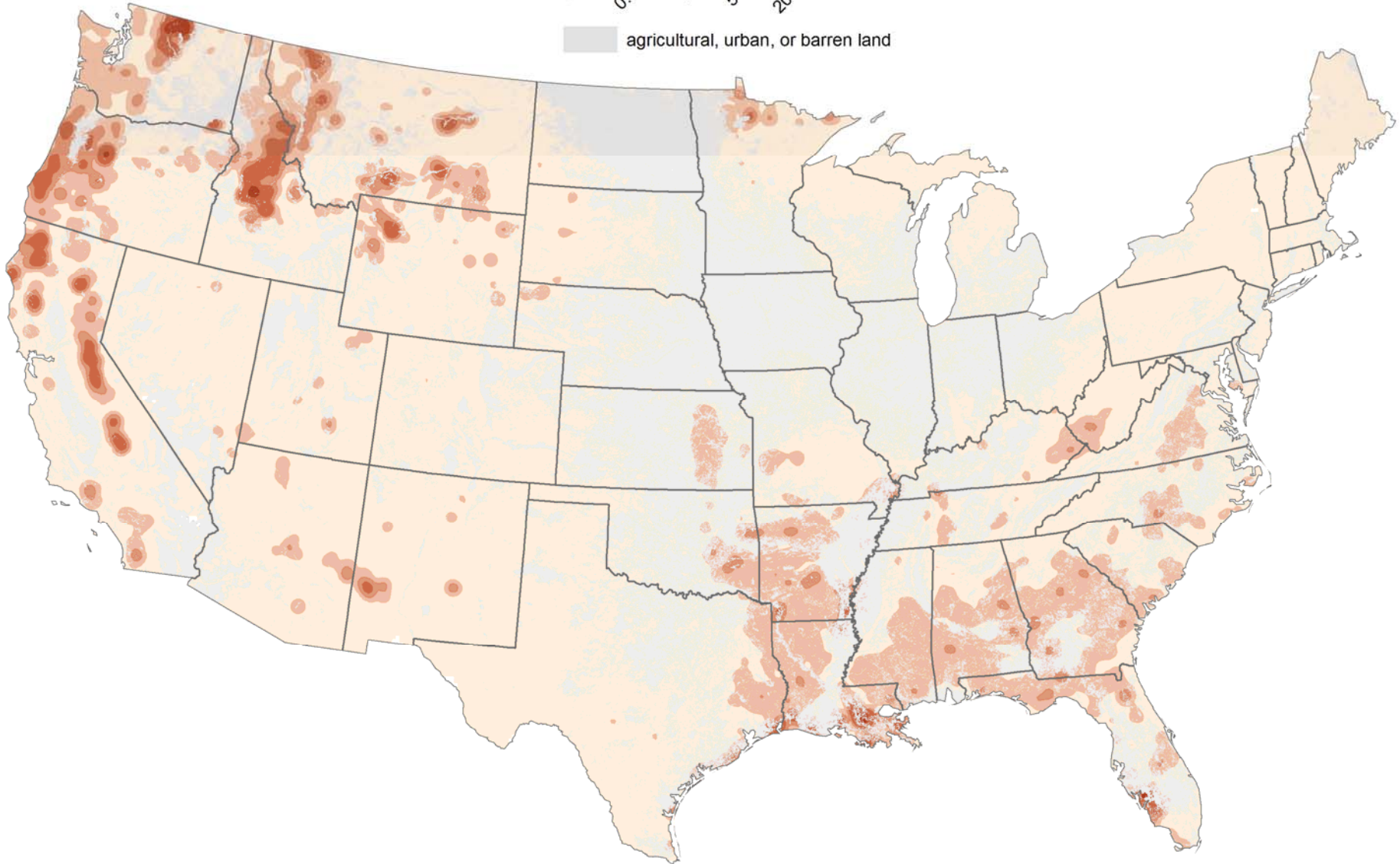
Annual Average PM_{2.5} Wildland Fire Emission Density (2003 - 2006)

tons per square mile



<0.5 0.5-2 2-5 5-20 20-50

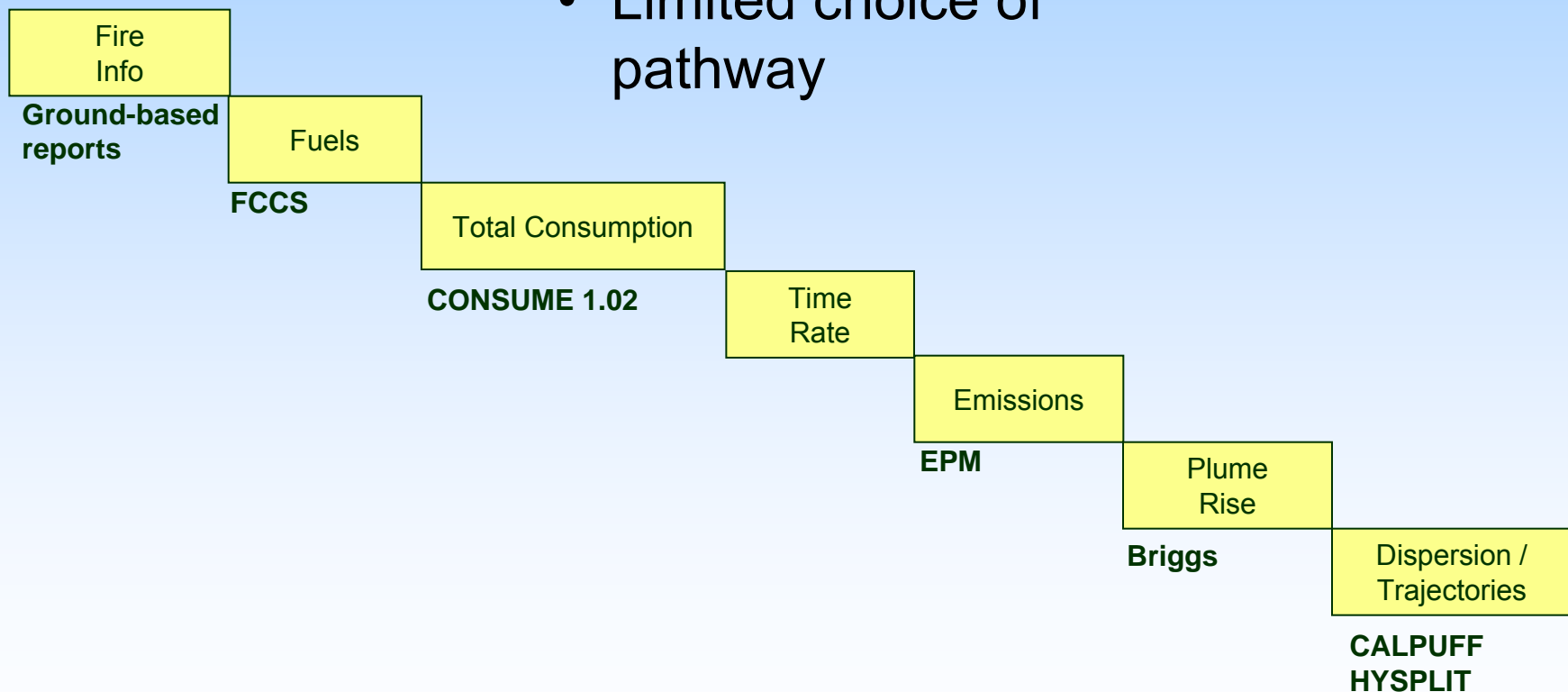
agricultural, urban, or barren land



BlueSky Framework 3 (1 of 4)

One year ago...

- Limited choice of pathway



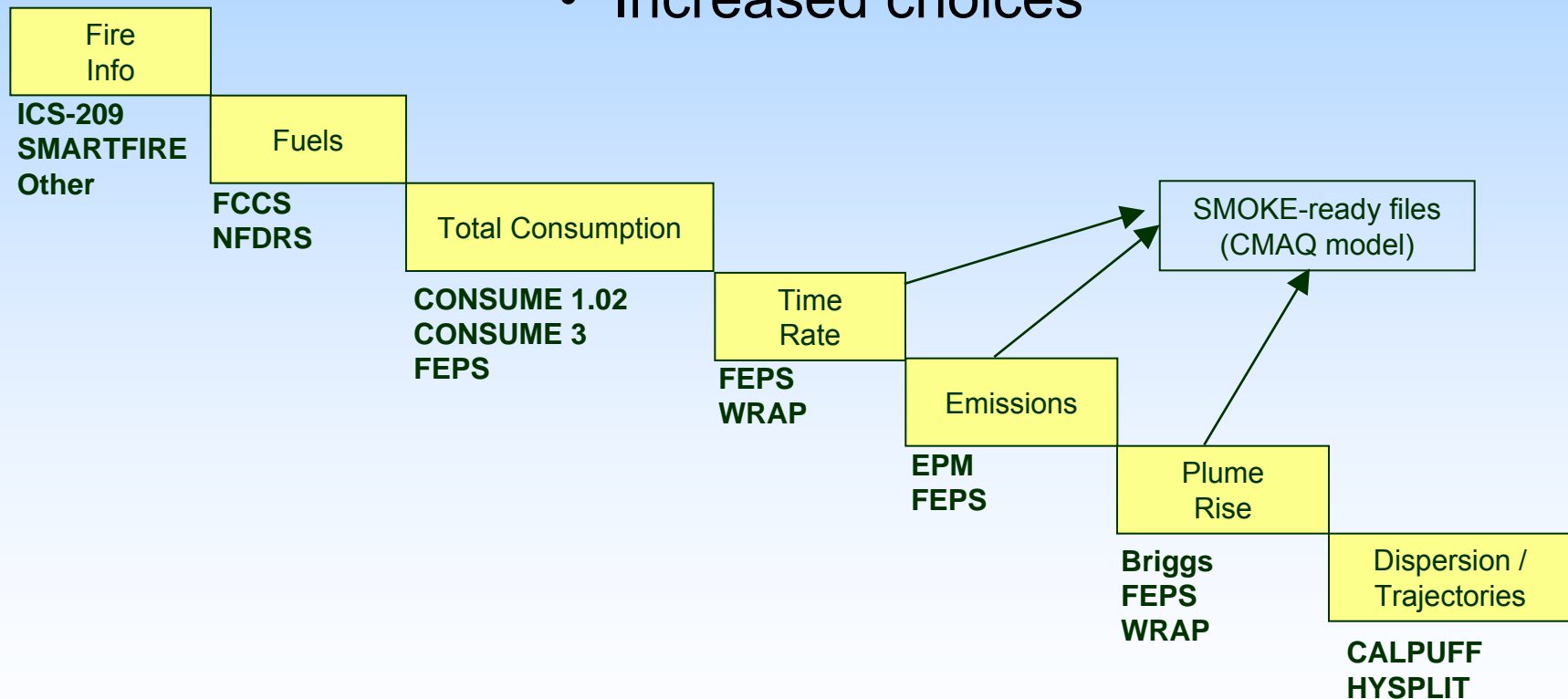
BlueSky Framework 3 (2 of 4)

- Written in Python, open source
- Improved modularity
- Offers new choices built-in
- Can use different paths for different types of fires
- Easier to install, configure, and run
- Easier to extend
- Emissions spin-up and multi-day modeling are built in

BlueSky Framework 3 (3 of 4)

Now...

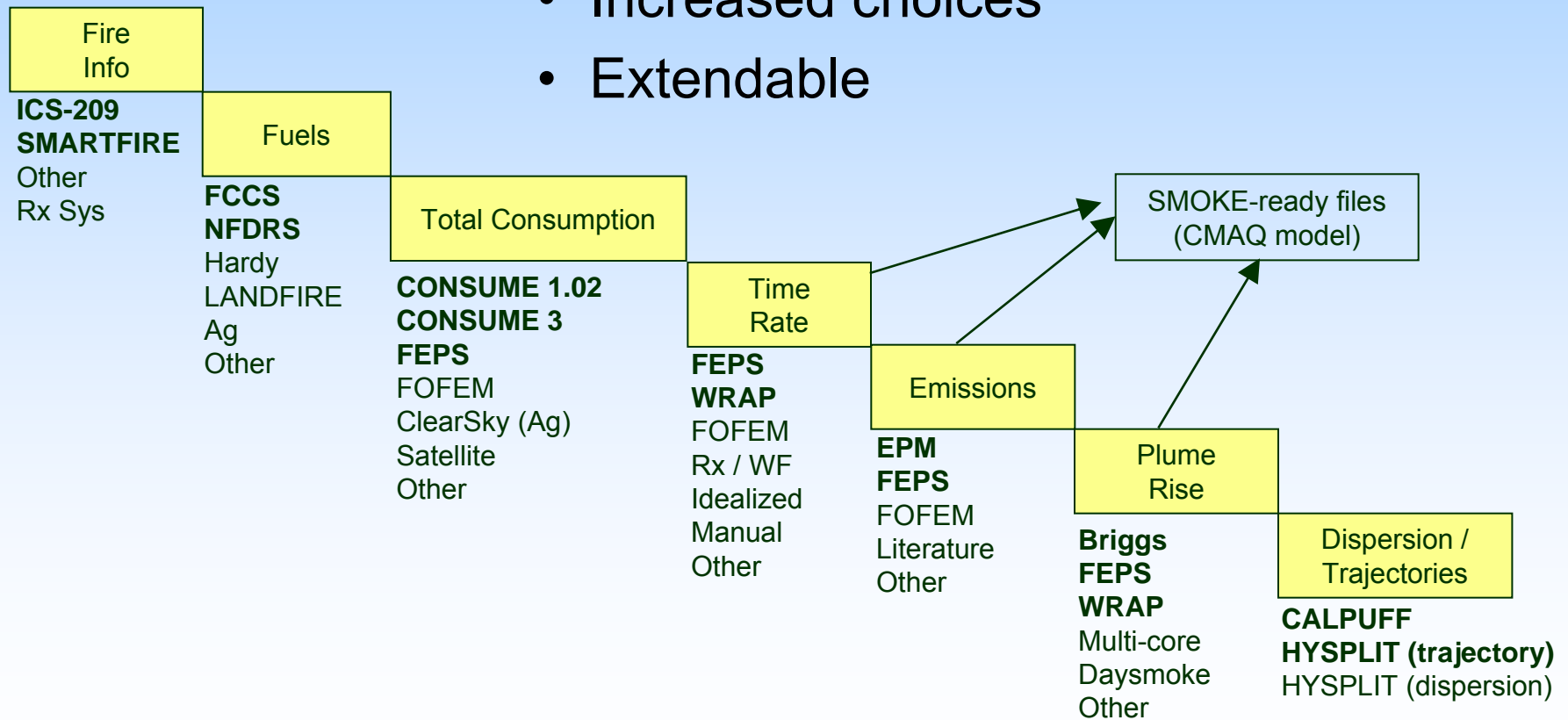
- Increased choices



BlueSky Framework 3 (4 of 4)

Now...

- Increased choices
- Extendable



Installing and Running BlueSky V3.0.0

BlueSky Framework found at

www.getbluesky.org

→Downloads

→The BlueSky Framework

–<http://www.getbluesky.org>

Automatically installs with libraries, ready to run
on any Unix system

To Run:

```
C:\> bluesky -d 20080520 example
```

where 'example' is the configuration file name

Specify output targets

- **Targets** = OutputEmissions OutputSmokeFiles
OUTPUT_\$DISPERSION OUTPUT_\$TRAJECTORY

Enter analysis time range

- **DATE** = 2008050100Z
DISPERSION_OFFSET = 0
HOURS_TO_RUN = 48
HOURS_TO_RUN_TRAJECTORY = 12
SPIN_UP_EMISSIONS = true

Enter the models you want to run

- **FUEL_LOAD** = FCCS
WILDFIRE_CONSUMPTION = CONSUME
PRESCRIBED_CONSUMPTION = CONSUME
OTHER_CONSUMPTION = CONSUME
TIME_PROFILE = WRAPTimeProfile
EMISSIONS = FEPSEmissions
PLUME_RISE = WRAPPlumeRise
DISPERSION = CALPUFF
TRAJECTORY = HYSPLIT

New Initiatives

BlueSky Framework 3 and SMARTFIRE have led to new and improved tools.

- Real-time smoke predictions (illustration)

In addition to existing NWS, Northwest FCAMMS, ClearSky/AIRPACT, we are now adding:

- Experimental CMAQ predictions on BlueSky Gateway
 - FCAMMS HYSPLIT predictions for continental U.S. out 3 to 7 days
 - Canadian Forest Service predictions for British Columbia and Alberta
- Air Quality Impacts Planning Tool (AQUIPT)
 - Wildland Fire DSS-Smoke
 - Game-playing web services application

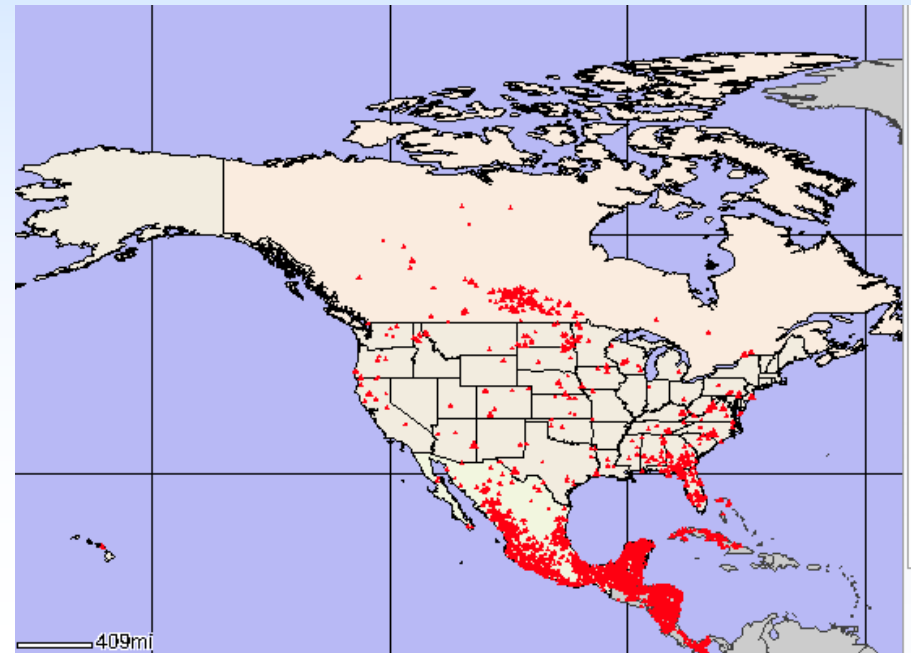
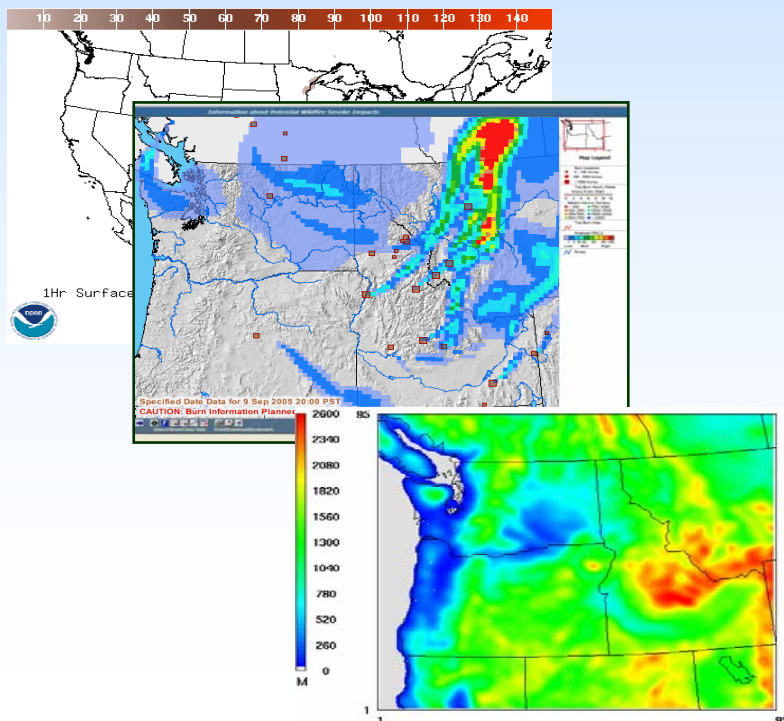
Real-time Smoke Predictions

One year ago...

- NWS air quality forecasts
- FCAMMS overlapping regions, but inconsistent
- Pacific Northwest products
- BlueSky West inter-agency demonstration (one-time)

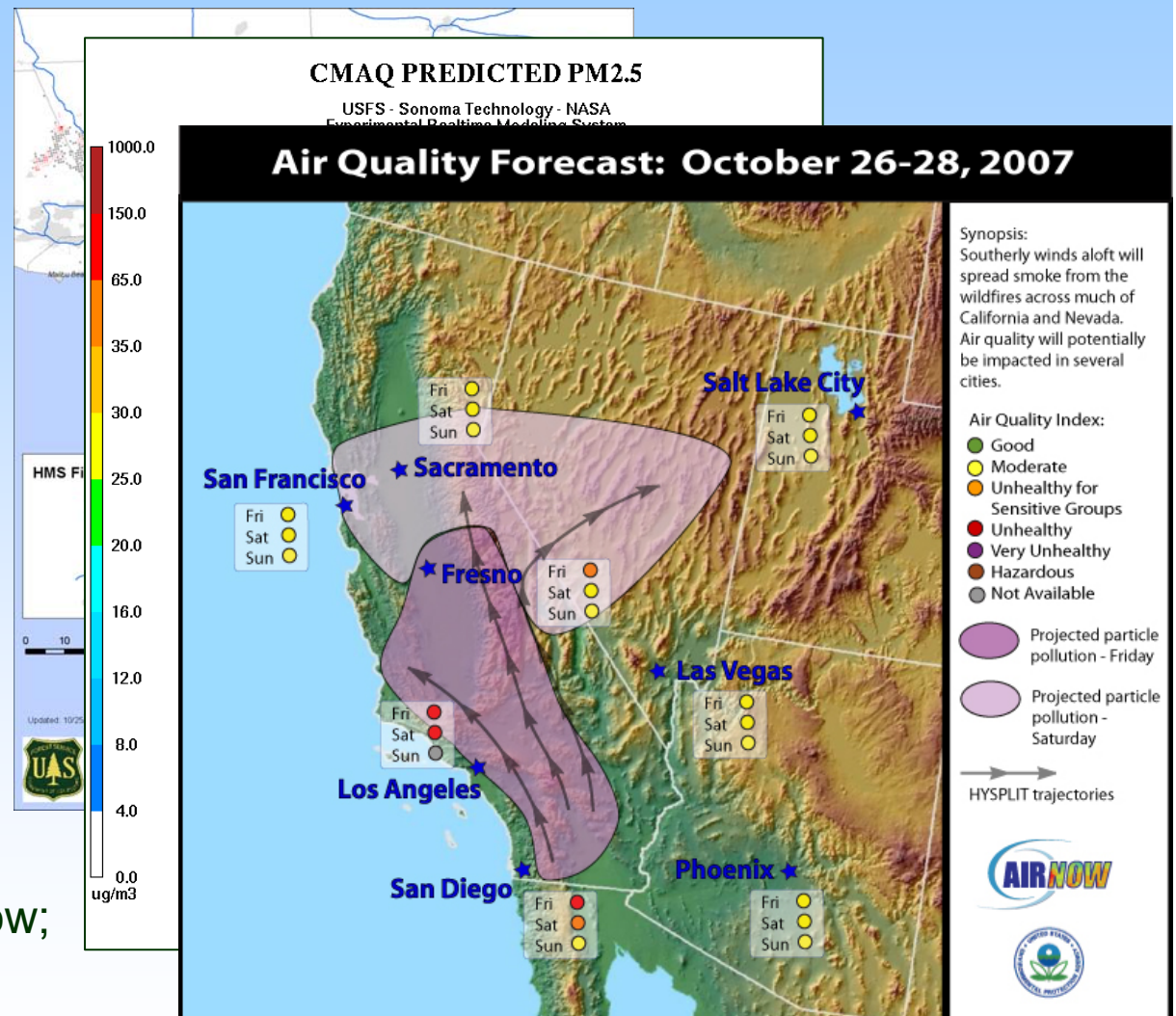
Now add...

- U.S. coverage including non-fire emissions, photochemistry, and carryover (experimental)
- Consistent FCAMMS overlapping regions, including carryover from CMAQ
- Comprehensive U.S. coverage at finer scale (FCAMMS)
- Groundwork laid for N. America



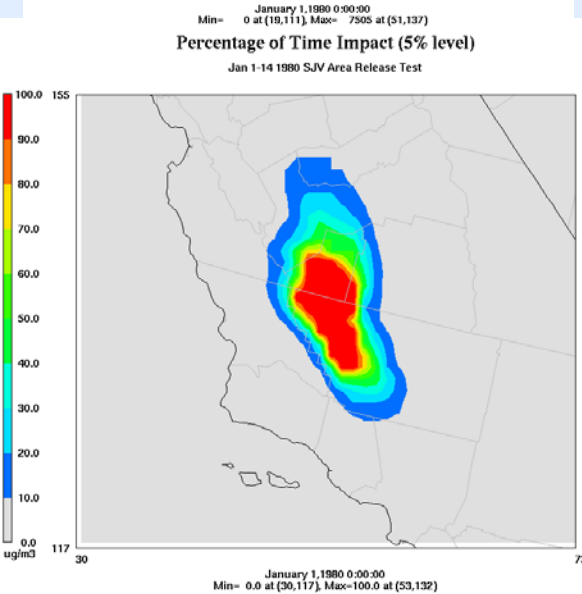
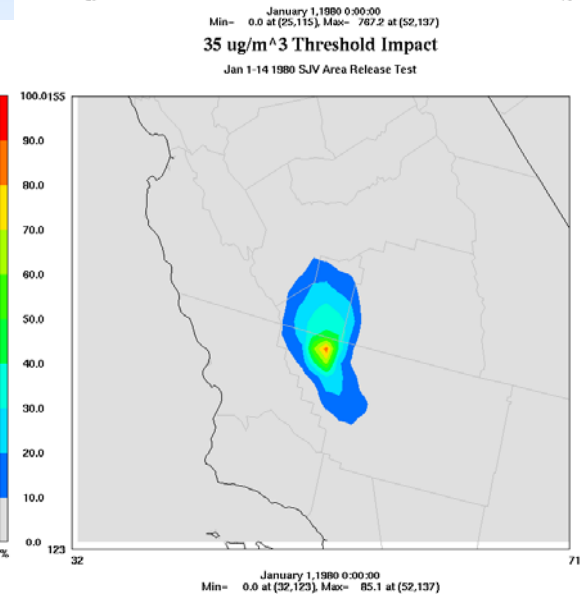
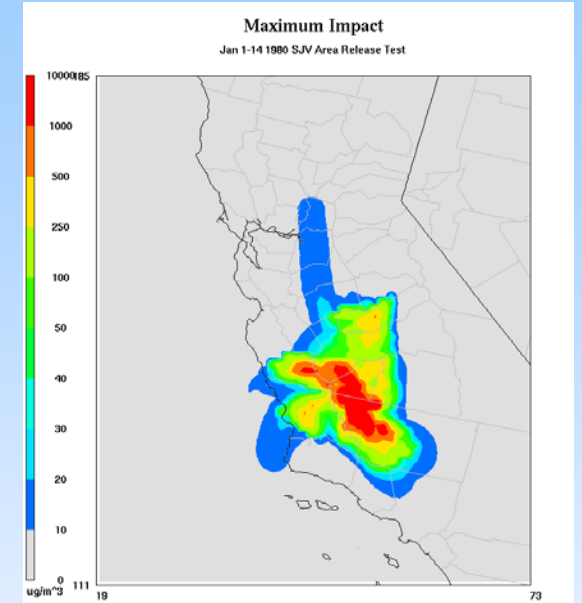
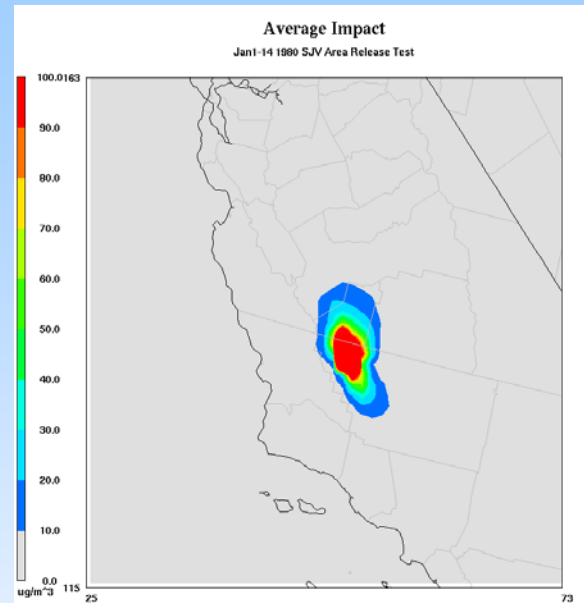
Southern California Fires

- Asked by USDA for data
- Supplemented other sources (e.g. NWS)
- SMARTFIRE (HMS&ICS) fire info
- CMAQ and CALPUFF model outputs (+NWS HYSPLIT)
- Used:
 - internally by USFS fire resource managers;
 - in Smog Stories and press releases by USDA & AirNow;
 - on White House conf call



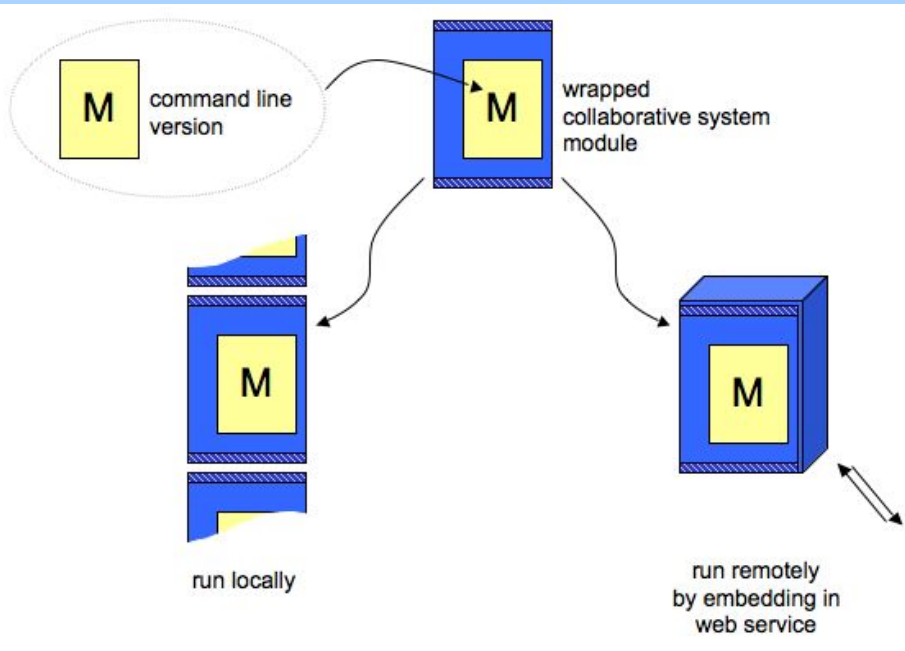
AQUIPT: Summary

- You provide basic source info and it does the rest
- Not just fire
- Uses 1979-2006 climatology
- Provides statistical answer to “what would have happened?”
- 24-hr turnaround
- Working on better graphics



Modularity = Flexibility

leads to user choice



Models can be run locally or remotely (as web-services)

JFSP-funded project

Smoke Modeling Game-Playing Application

Click to edit any information – changes propagate automatically

FIRE INFO

Fire Information (User Input):

Lat: Size:
 Lon:

FUEL LOADING MAPS

NFDRS (selected)	Hardy <i>click to select</i>	FCCS <i>click to select</i>
1-hr: 3	1-hr: 3	1-hr: 5
10-hr: 7	10-hr: 8	10-hr: 6
100-hr: 20	100-hr: 15	100-hr: 19
1k-hr: 13	1k-hr: 21	1k-hr: 14
Duff: 2	Duff: 4	Duff: 3
Shrub: 4		
Canopy: 2		
Litter: 0.1		
...		

click to edit

[more info](#)

PATH

Fire Info (user)

↓

Fuels (current: NFDRS)

↓

Next: ↓

Consumption

GO

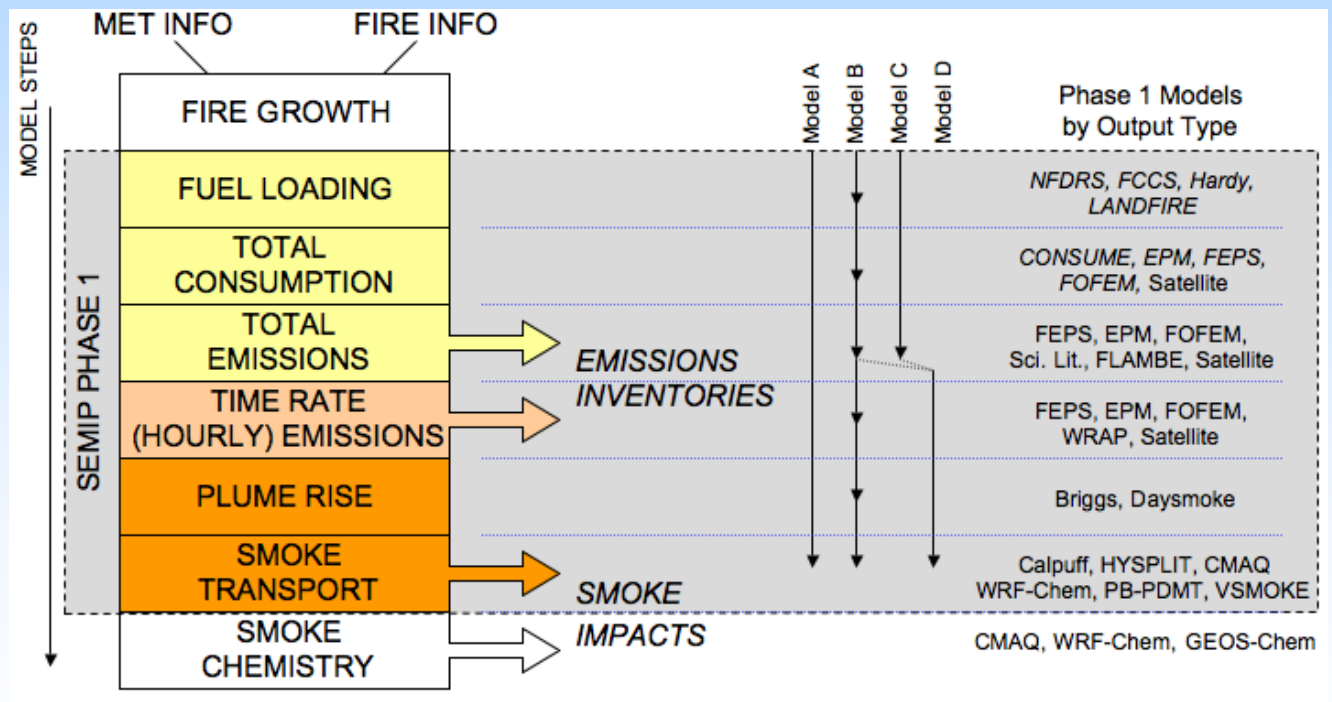
New Initiatives

BlueSky Framework 3 and SMARTFIRE have laid groundwork for the future:

- New research directions
e.g., re-structuring of fuels treatment research framework
- Accelerated research and development
e.g., model intercomparisons
- Expanded alliances
e.g., National Weather Service, EPA AIRNow

Smoke and Emissions Model Inter-comparison Project (SEMIP)

- Just funded
- Large-scale, inclusive
- Based on other “MIPs”



BlueSky Gateway (www.GetBlueSky.org)

- Model Evaluation and Field Observations
 - field observations (available in real-time, USFS)
 - **Soon!** Large-scale model inter-comparison project (SEMIP)
- Real-Time Smoke & AQ Forecasts
 - embedded in operational NWS Smoke Forecasts
 - experimental predictions:
 - regional high-resolution CALPUFF (USFS)
 - regional Northwest only CMAQ (WSU)
 - **New!** national CMAQ (STI)
 - **New!** Canada: British Columbia and Alberta (UBC)
 - **Soon!** real-time scenario game-playing (USFS)
- Longer-Range Planning Tools
 - **Soon!** probable impacts based on climatology (AQUIPT)
 - **New!** National Emissions Inventory (NEI) assessments
- Fire Info
 - **New!** SMARTFIRE reconciled fire info

BlueSky Gateway - Home - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.getbluesky.org/home.cfm

Getting Started Latest Headlines 511 740 KCBS PQS SB Y! Y!Map Y!YP Y!Grp G Fog BSG AN NWS-SF Sat

Secure Access SSL VPN - Home BlueSky Gateway - Home

BlueSky Gateway Beta Smoke Fire Downloads Framework FAQ [Logout](#)

What is BlueSky?

BlueSky Framework is a framework for model management. It facilitates the use of predictive models that simulate the cumulative impacts of smoke on air quality from forest, agricultural, and range fires. ([learn more](#))

BlueSky Gateway provides access to BlueSky-related information, data, and products.

<p>SMOKE Predictions</p>  <p>ENTER</p>	<p>FIRE Locations</p>  <p>ENTER</p>	<p>DOWNLOADS</p>  <p>ENTER</p>
<p>Browse BlueSky-enabled predictions of smoke impacts and air quality for today and tomorrow.</p>	<p>Interactively view or download real-time fire data.</p>	<p>Download the BlueSky Framework, BlueSky-enabled predictions, and fire data.</p>

 **STI**
Sonoma Technology, Inc.

[Contact Us](#) [Acknowledgments](#)

Done

BlueSky Gateway - Gateway Predictions - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.getbluesky.org/bluesky/sti/

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Secure Access SSL VPN - Home BlueSky Gateway - Gatew...

BlueSky Gateway Beta Smoke Fire Downloads Framework FAQ [Logout](#)

Operational: [National Weather Service](#) Experimental: [FCAMMS and Other Regions](#) | [Gateway Predictions](#)

Gateway Predictions

CMAQ DAILY AVERAGE TOTAL PM2.5

20090517 00z run
STI-NASA-USFS Experimental Realtime Modeling System

May 17, 2009 0:00:00
Min= 0.0 at (146,76), Max= 49.2 at (116,23)

[CMAQ Daily Average Total PM_{2.5} \(Today\)](#)

CMAQ DAILY AVERAGE TOTAL PM2.5

20090517 00z run
STI-NASA-USFS Experimental Realtime Modeling System

May 18, 2009 0:00:00
Min= 0.0 at (148,101), Max= 39.1 at (116,23)

[CMAQ Daily Average Total PM_{2.5} \(Tomorrow\)](#)

BlueSky Gateway air quality predictions are facilitated by the BlueSky Framework and represent the impacts of smoke from wildland fires, anthropogenic and biogenic sources from the EPA's National Emissions Inventory, and carryover smoke and emissions from the previous day. Sonoma Technology, Inc. uses the MM5 weather forecast model to drive the CMAQ model on a 26 kilometer grid. Predictions are currently

Gateway Predictions (Experimental)

- ◆ [Hourly Ozone \(pop up\)](#)
- ◆ [Hourly Fire PM_{2.5} \(pop up\)](#)
- ◆ [Hourly Non-fire PM_{2.5} \(pop up\)](#)
- ◆ [Hourly Total PM_{2.5} \(pop up\)](#)
- ◆ [Surface Peak 8 hr Average Ozone](#)



SMARTFIRE Resources on BlueSky Gateway

BlueSky Gateway - SMARTFIRE - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.getbluesky.org/smartfire/

Google

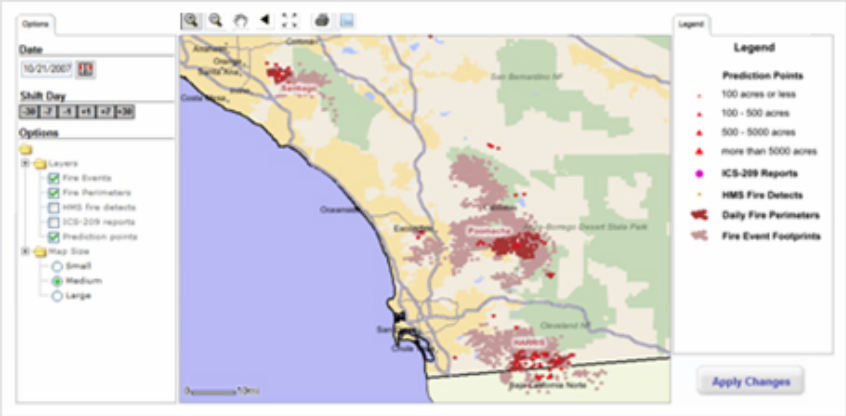
BlueSky Gateway Beta Smoke Fire Data Access Framework Other Tools Analysis FAQ [Login](#)

SMARTFIRE: [Fire Locations Map \(Interactive\)](#) | [Web Service](#) | [View Data](#) | [Documentation](#) | [Operational Status](#)

SMARTFIRE

The Satellite Mapping Automated Reanalysis Tool for Fire Incident Reconciliation (SMARTFIRE) is an algorithm and database system that operate within a geographic information system (GIS) framework. SMARTFIRE combines multiple sources of fire information and reconciles them into a unified GIS database. It reconciles fire data from space-borne sensors and ground-based reports, thus taking advantage of the strengths of both data types while avoiding double counting.

SMARTFIRE and its outputs were designed with the BlueSky Framework in mind, though the Framework can be (and often is) run without SMARTFIRE data. In addition, SMARTFIRE is useful for purposes beyond its original role of providing fire inputs to the Framework.



The screenshot shows the SMARTFIRE web application interface. It features a map of a coastal region with various fire locations and footprints. The interface includes a date selector set to 10/21/2007, a shift day selector, and several options for data layers and map size. A legend on the right side of the map identifies different data types: Prediction Points (100 acres or less, 100 - 500 acres, 500 - 5000 acres, more than 5000 acres), ICS-209 Reports, HMS Fire Detects, Daily Fire Perimeters, and Fire Event Footprints. An 'Apply Changes' button is located at the bottom right of the map area.

SMARTFIRE Resources

- ◆ [Fire Locations Map \(Interactive\)](#) (requires login)
- ◆ [View Data \(CSV format\)](#) (requires login)
- ◆ [Data Access \(Web Service\)](#)
- ◆ [Documentation and References](#)
- ◆ [Current Operational Status](#)

Done



Options

Date

8/14/2007

Shift Day

-30 -7 -1 +1 +7 +30

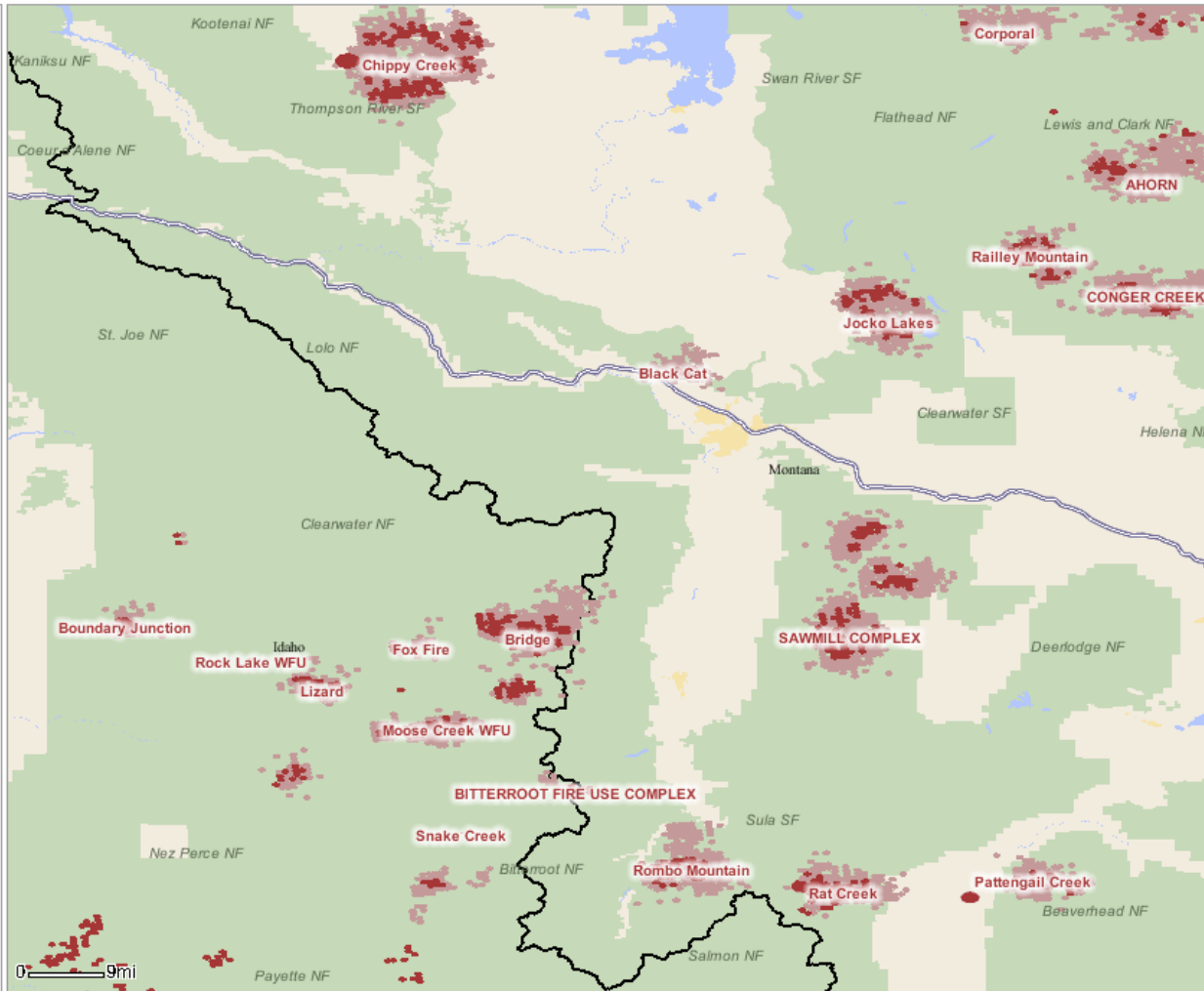
Options

Layers

- Fire Events
- Fire Perimeters
- HMS fire detects
- ICS-209 reports
- Prediction points

Map Size

- Small
- Medium
- Large



Legend

Prediction Points

- ▲ 100 acres or less
- ▲ 100 - 500 acres
- ▲ 500 - 5000 acres
- ▲ more than 5000 acres

ICS-209 Reports

-

HMS Fire Detects

-

Daily Fire Perimeters

-

Fire Event Footprints

-

[Apply Changes](#)

bsf_userguide.pdf (application/pdf Object) - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.getbluesky.org/docs/bsf_userguide.pdf


Getting Started Latest Headlines 511 740 KCBS PQS SB Y! Y!Map Y!YP Y!Grp G Fog BSG AN NWS-SF Sat

Secure Access SSL VPN - Home bsf_userguide.pdf (applica...)

Save a Copy Print Email Search Review & Comment Sign

Select Text 95%

STI
Sonoma Technology, Inc.
Air Quality Research and Innovative Solutions



**GETTING STARTED WITH THE
BLUESKY FRAMEWORK VERSION 3.0**

User's Guide
STI-905028.02-3356-UG

By
Daniel A. Pryden
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Petaluma, CA 94954-6503

Prepared for

8.5 x 11 in

1 of 20

Done

Next Steps

Linking Regional and National Forecasts

- High res local w/cross-boundary transport.
- Incident response super-res (300m) ?

Model Evaluation

- Model Inter-comparison Project
- Continuing field observations

Plume Rise Studies

- Multiple Cores is Largest Problem

Uncertainty Guides

- Ensembles and scenarios as proxy

Game-Playing (What-if?)

- Expose uncertainty / what-if in real-time

Fire Information Improvements

- Linking Rx, Ag fire w/SMARTFIRE

Thank You

Funding from National Fire Plan, USDA CSREES NRI, USFS, Joint Fire Science Program, EPA, DOI, and NASA.

Our many collaborators and partners, including Mark Ruminski (NOAA's HMS); Amber Soja (National Institute of Aerospace); Tom Pace (EPA); Pete Lahm (USFS); Susan O'Neill (Natural Resources Conservation Service); and Tweak Films.



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