

Enhancements to the BlueSkyRAINS (BSR) Emissions Assessment and Air Quality Prediction System

Project Overview

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Project Team

- National Aeronautics and Space Administration (NASA) through its Cooperative Agreement Notice (CAN) grant program
- The AirFire Team of the Pacific Northwest Research Station (Seattle, WA) of the Forest Service of the U.S. Department of Agriculture (USDA-FS)
- Sonoma Technology, Inc. (STI)
- Collaborators
 - U.S. Environmental Protection Agency (EPA)
 - National Oceanic and Atmospheric Administration (NOAA)
 - Regional Planning Organizations (RPOs)
 - Central Regional Air Planning Association (CENRAP)
 - Western Regional Air Partnership (WRAP)
 - National Institute of Standards and Technology (NIST)
 - BSR users and potential users

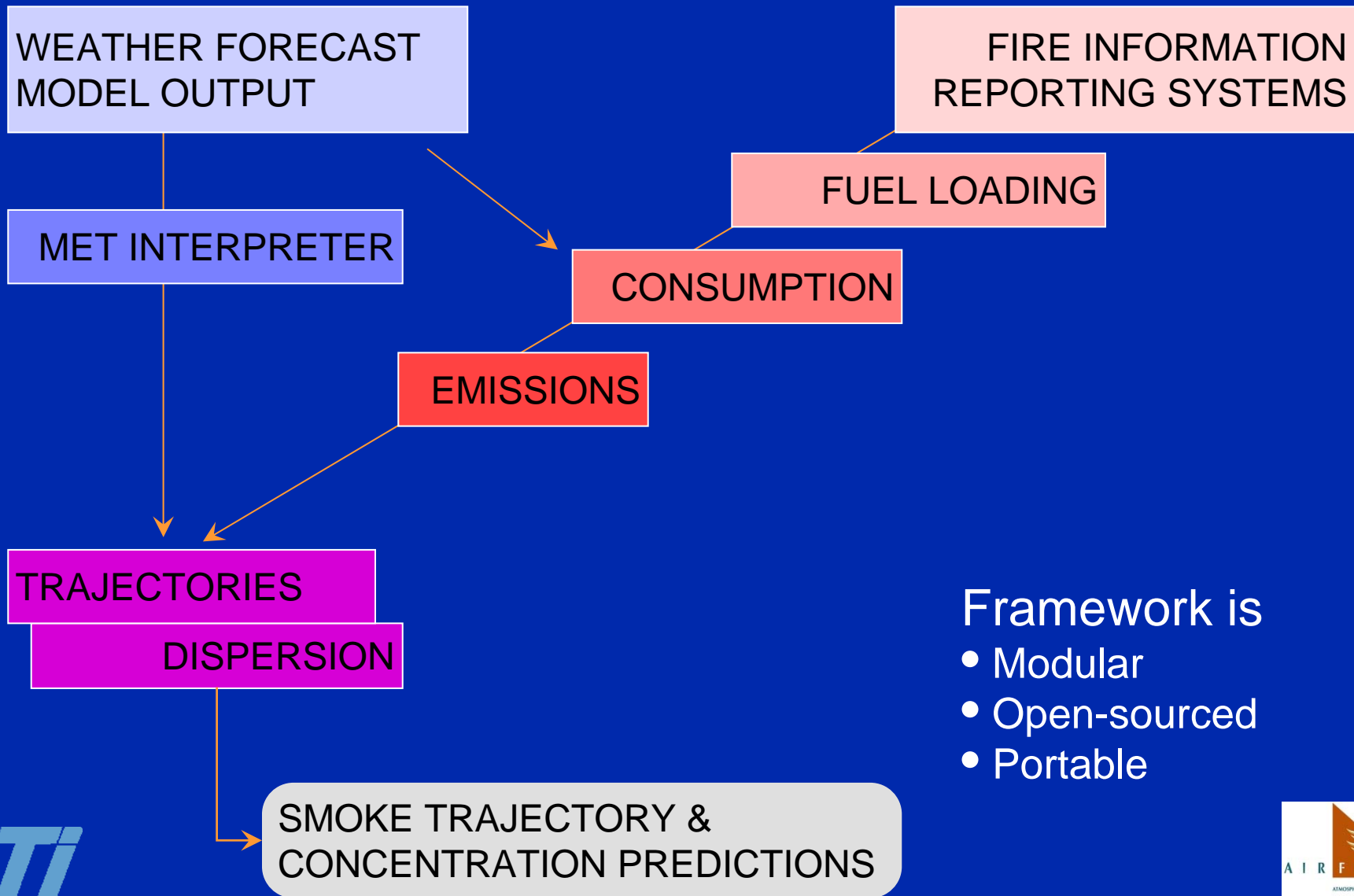
Project Purpose

- Aid managers of wildland and prescribed fires and air quality agencies in their efforts to mitigate adverse air quality impacts.
- NASA's goals and objectives relevant to this project
 - Harness NASA's satellite-derived Earth Science products to benefit decision-support tools related to issues of national priority, such as air quality.
 - Facilitate nationwide adoption of the decision-support tools.
 - Demonstrate the effectiveness and capacity for assimilation of the tools.
 - Facilitate continued availability of the tools beyond the project period of performance.

What is BlueSkyRAINS?

- A decision-support system that predicts the air quality impacts from prescribed and wildland fires
- BlueSkyRAINS = BlueSky + RAINS
 - BlueSky: A framework that allows individual models (emissions, fuel consumption, fire behavior, meteorology, dispersion) to behave and communicate with one another as modules within a larger structure
 - RAINS: A visualization system for publishing, querying, and analyzing BlueSky results across the Internet
- Originated and maintained by the AirFire Team of the Pacific Northwest Research Station (Seattle, WA) of the USDA-FS

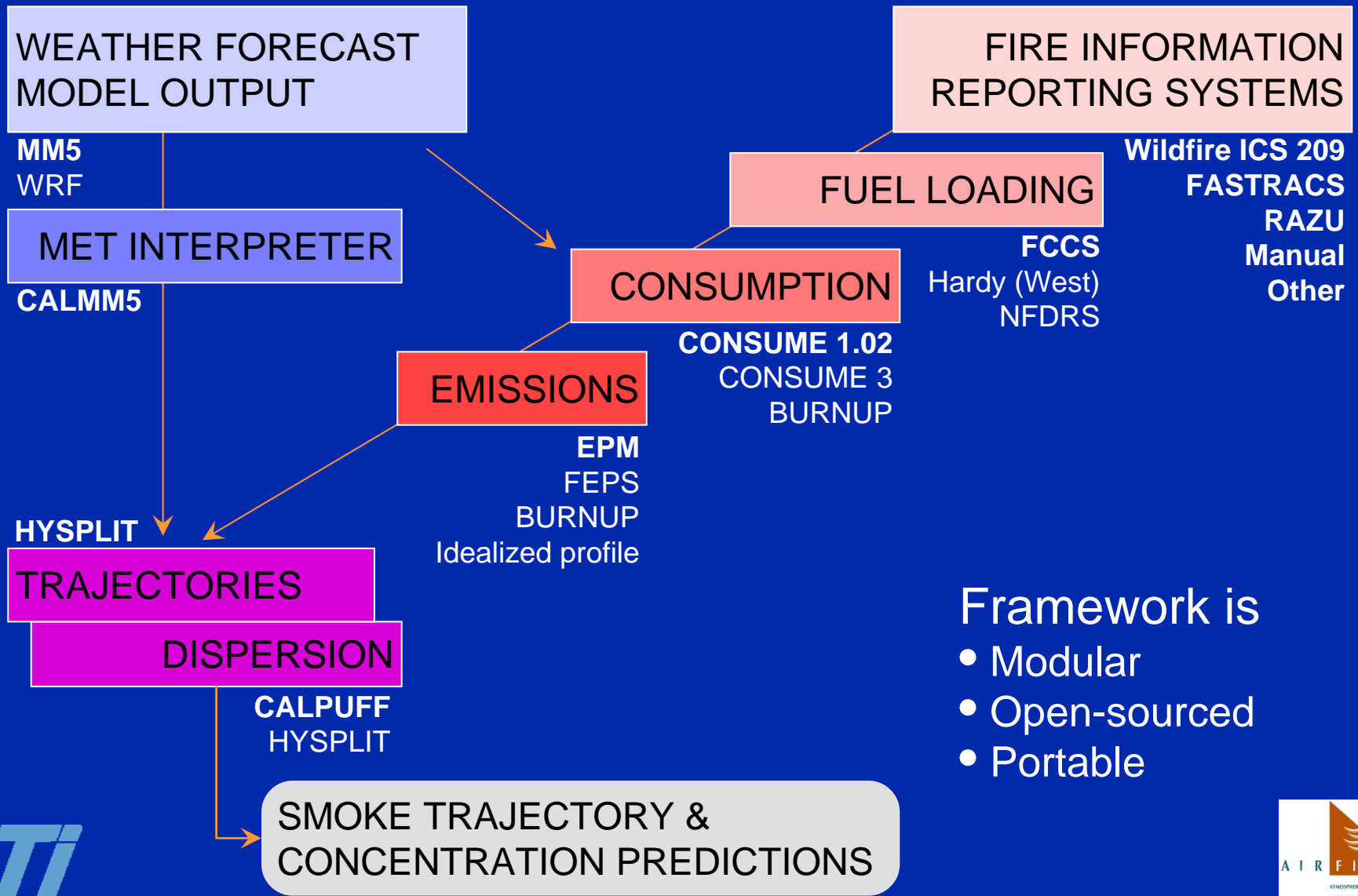
BlueSky Framework (1 of 2)



Framework is

- Modular
- Open-sourced
- Portable

BlueSky Framework (2 of 2)



Framework is

- Modular
- Open-sourced
- Portable

Who Uses BlueSkyRAINS and Why?

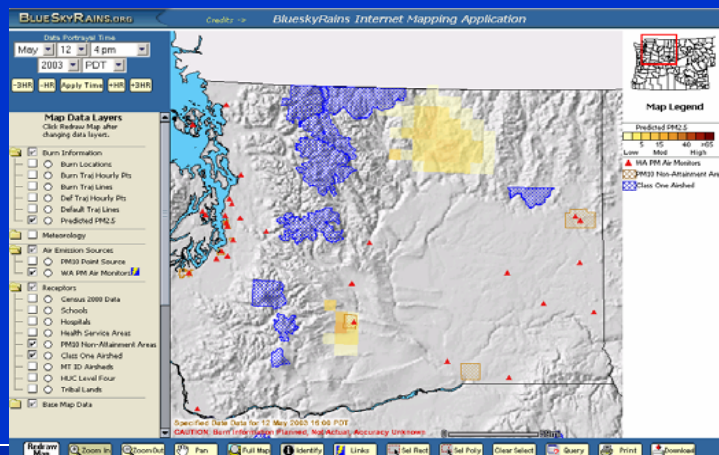
- Managers of prescribed and wildland fires
 - Daily go/no-go decisions
 - Potential use for longer-range resource management of staff and equipment
- Air quality agencies
 - Daily health advisory decisions (e.g., Spare the Air)
 - Potential use for emission inventories (e.g., State Implementation Plans, EPA's National Emission Inventory)
- Air quality and fire behavior researchers
 - Potential use for ensemble modeling

Real-time Products Using BlueSky

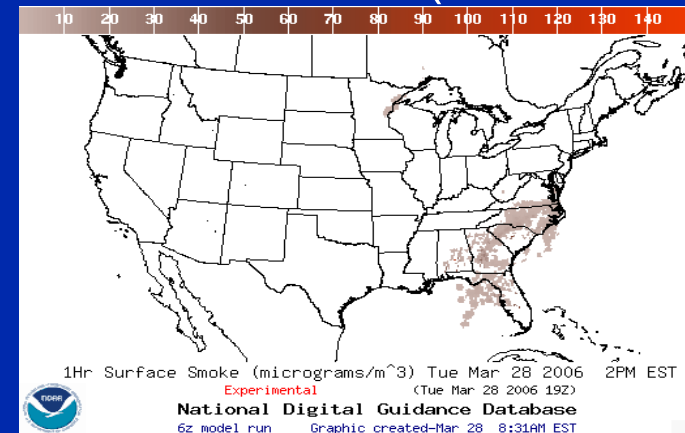
FCAMMS

(5 regional centers,
covering lower 48)

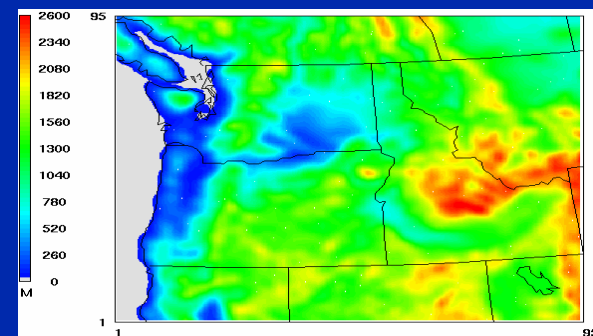
BlueSky + RAINS = BlueSkyRAINS



NWS Smoke Forecast Product (lower 48)

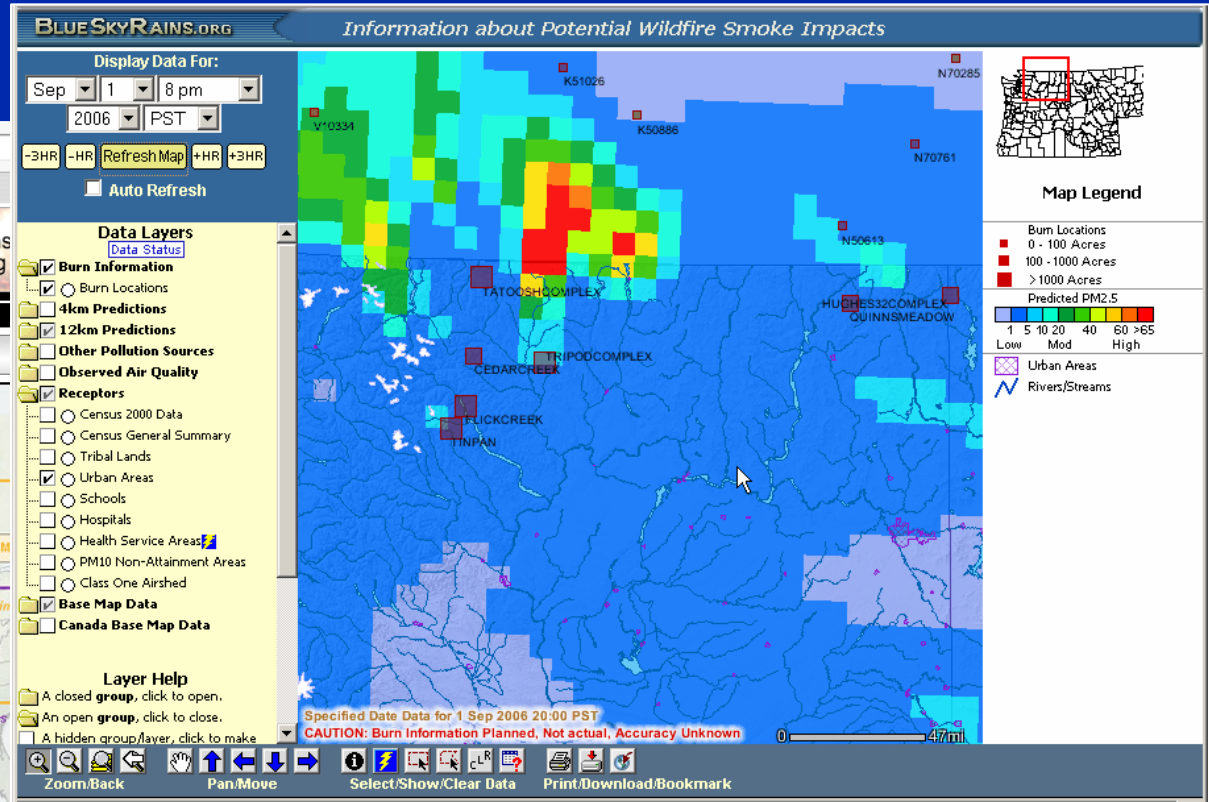
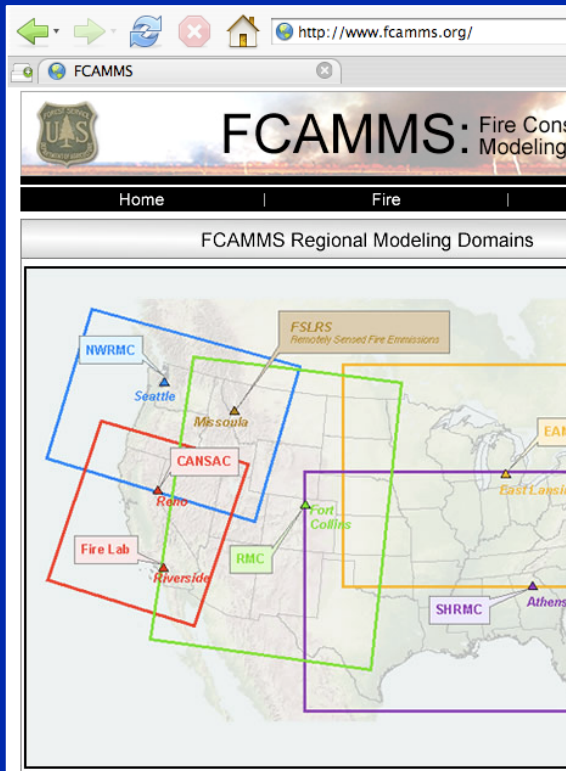


AirPACT3 & ClearSky
(PNW, Lamb & Vaughan, WSU)



FCAMMS: National BlueSkyRAINS

<http://fcamms.org>



The FCAMMS study the atmospheric component of the fire environment across space and time scales, and its interaction with other components, using a balance of basic and applied science to provide tools to the field now, and to create a basis for future science applications. They bring scientists and land managers together to create a focused research program and promote science delivery. The regional structure of the FCAMMS allows better coordination with land management needs and locally unique fire problems, but the science developed by the FCAMMS is globally relevant and shared among the regions as needed and appropriate.

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Major Accomplishments

- BlueSky Consortium
 - Users and scientists together?! Oh, my!
 - Tailored visualizations (RAINS)
 - Creating a dialog
- Modular/Flexible (therefore it's being used)
 - Adopted by National Weather Service
 - SMOKE preprocessor (like MOBILE, etc...)
 - Enables inter-model comparisons
- National Forecasts
 - NWS (“experimental” transitioning to “operational”)
 - FCAMMS (consistent national product now available)
- Inter-agency cooperation
 - USDA, USDOJ, USEPA, NOAA, and now NASA
 - BlueSkyRAINS West 2005 demonstration project



The Next-Generation BlueSky

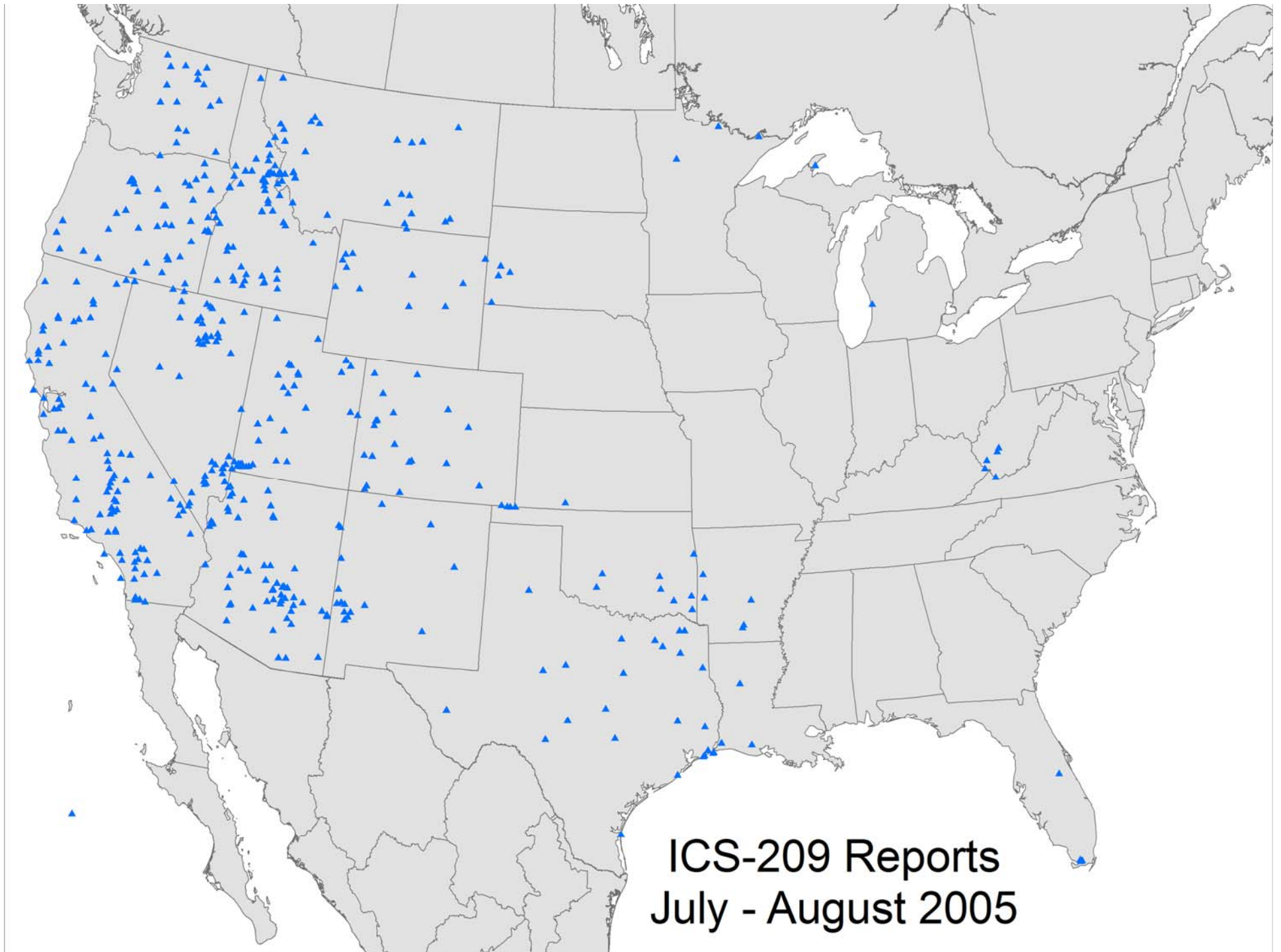
- AirFire and Sonoma Technology, Inc. with NASA ROSES Grant funding
- Objectives
 1. Improve predictive accuracy
 2. Facilitate sustained operations
 3. Outreach to new and existing users

1. Improve Predictive Accuracy

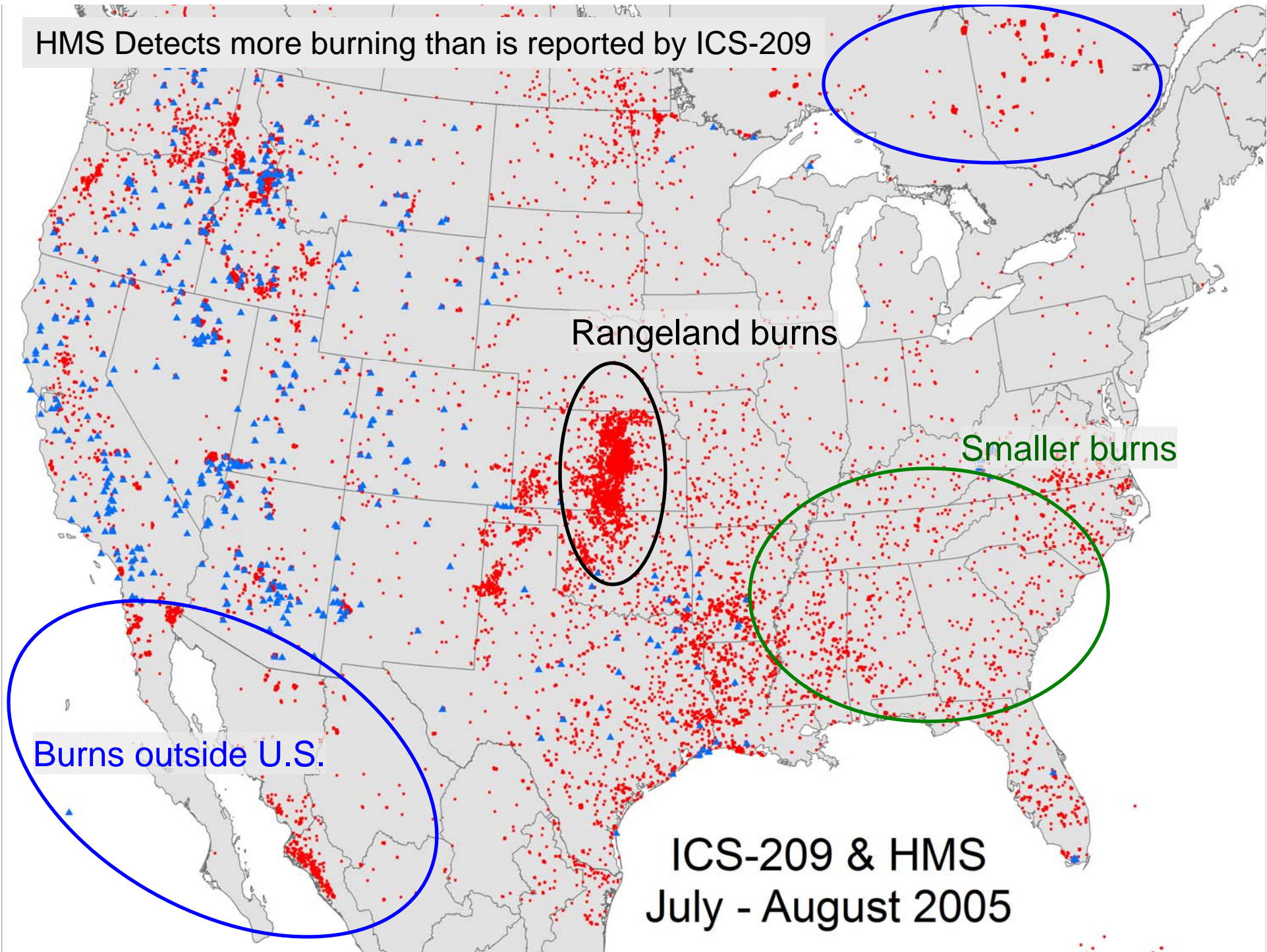
- Improve completeness, timeliness, and accuracy of emissions
 - Include more, timelier, and consistently geo-located fire data (satellite-derived fire data)
 - Retain value of ground-based fire reports
 - Deal with known plume rise and fuels issues
 - Enable manual reporting of fire information
 - Include non-fire emissions (industrial point sources, on-road motor vehicles, etc.)
- Treat photochemistry (CMAQ)

Satellite-derived Fire Data

- NOAA's Hazard Mapping System (HMS) includes fires detected by 3 instruments onboard 7 NASA and NOAA satellites:
 - Moderate Resolution Imaging Spectroradiometer (MODIS)
 - Geostationary Operational Environmental Satellites (GOES)
 - Advanced Very High Resolution Radiometer (AVHRR)



HMS Detects more burning than is reported by ICS-209



Rangeland burns

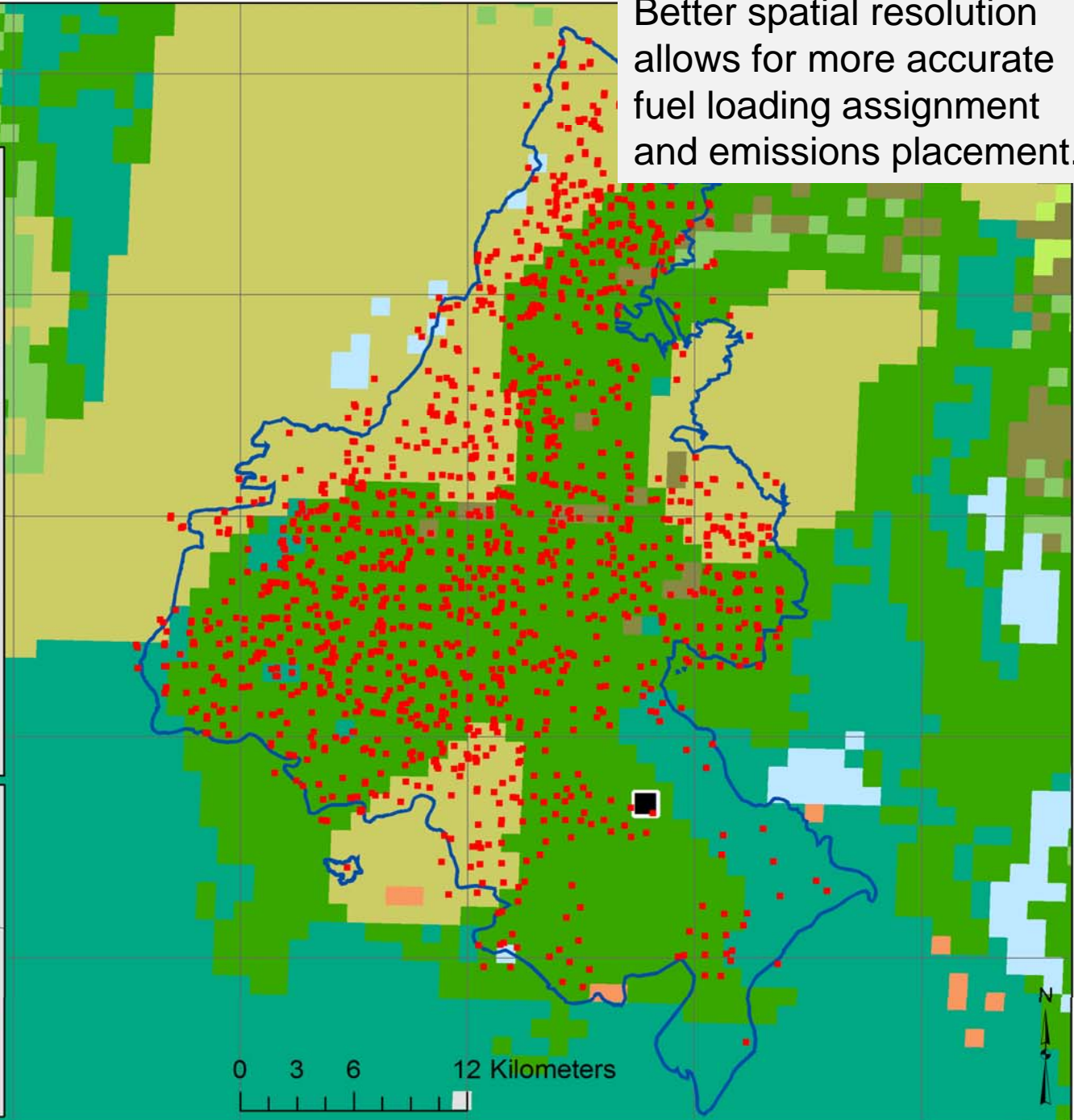
Smaller burns

Burns outside U.S.

ICS-209 & HMS
July - August 2005

Cave Creek Fire 6/22 - 7/4 2005

Better spatial resolution allows for more accurate fuel loading assignment and emissions placement.



Retain Value of Ground-Based Reports

- Satellite data make up for some ICS-209 weaknesses.
- But, we do not want to abandon ICS-209 data.
 - Satellites miss fires too!
 - Too small (less than a few hundred acres)
 - Clouds
 - ICS-209 contains useful metadata:
 - Fuels
 - Growth potential
 - Name of the fire or complex
- Goal: Use the HMS and ICS-209s for BlueSky inputs.
- Challenge: Avoid double counting of fires reported in the ICS-209s and also detected by satellites.
- Solution: Develop an algorithm to reconcile the two information sources.

Automated Reconciliation: SMARTFIRE

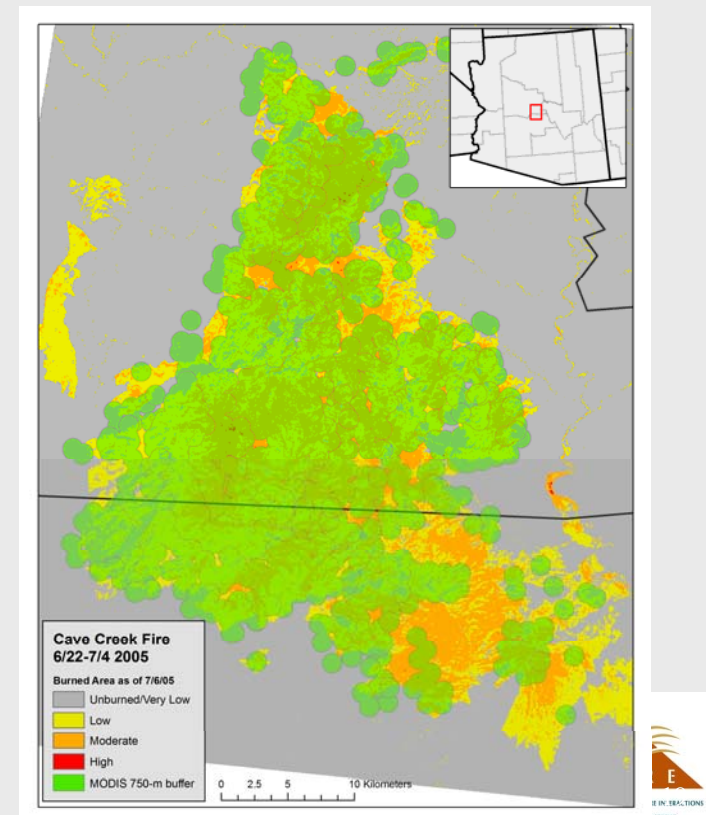
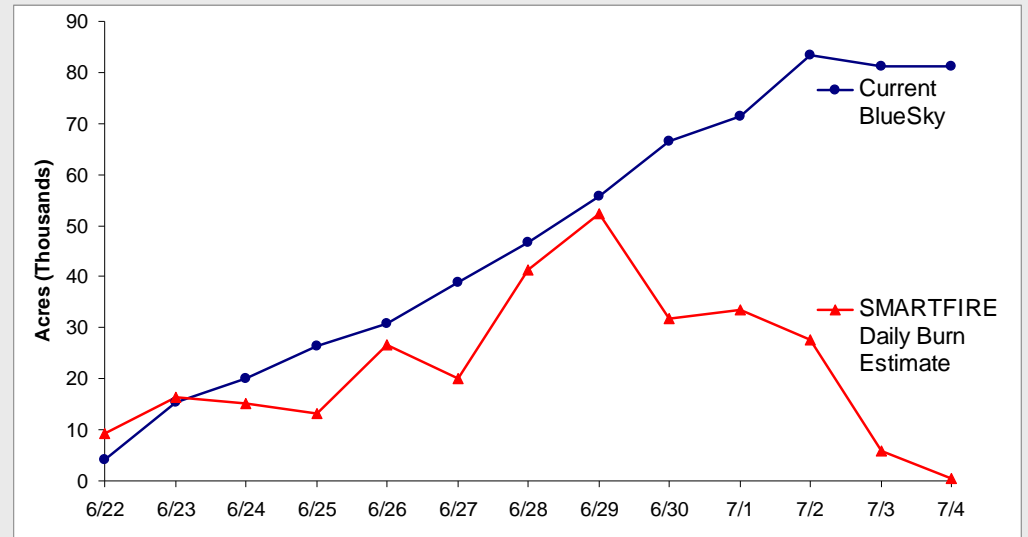
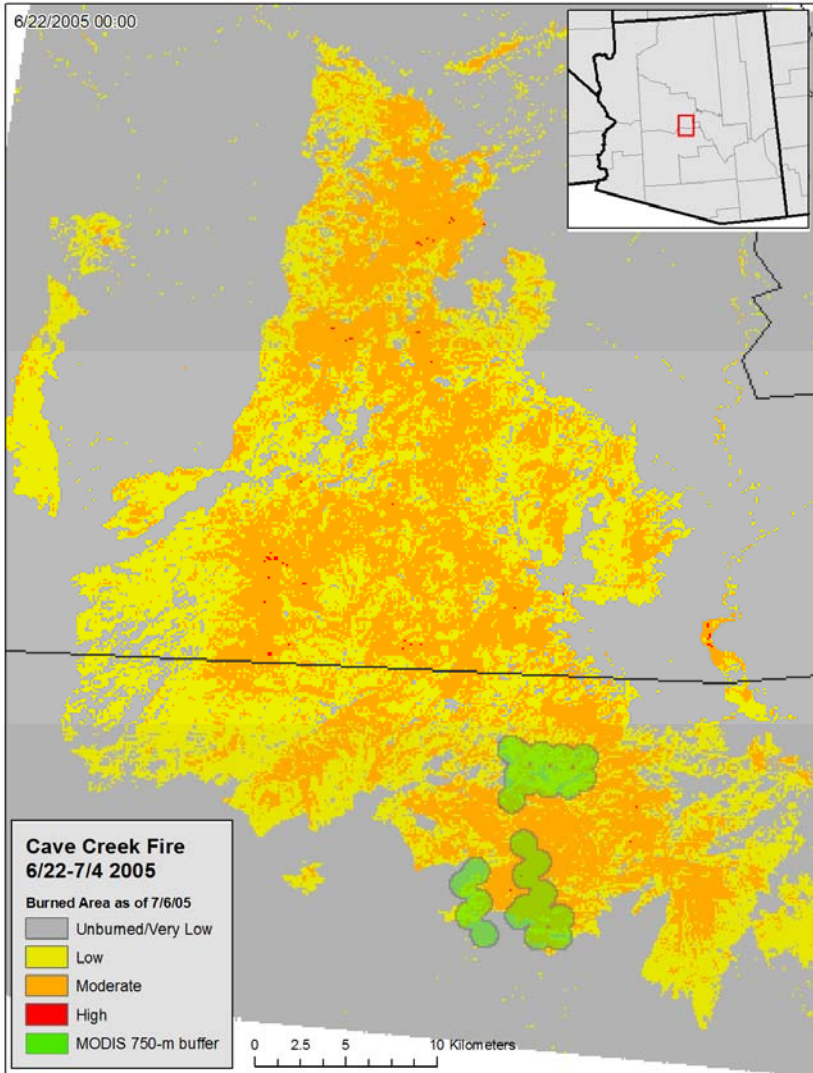
- SMARTFIRE is a computational system for the operational reconciliation of ICS-209-reported, satellite-detected, and user-defined wildfires.
- SMARTFIRE serves two purposes:
 - Provide daily burn areas to BlueSky on a national scale.
 - Compile a database of fire progression information that can be mined to improve next-day burn predictions.
- SMARTFIRE uses geospatial methods to compile data into fire “events” as they move across the landscape over time.



SMARTFIRE = Satellite Mapping Automatic Reanalysis Tool for Fire Incident Reconciliation



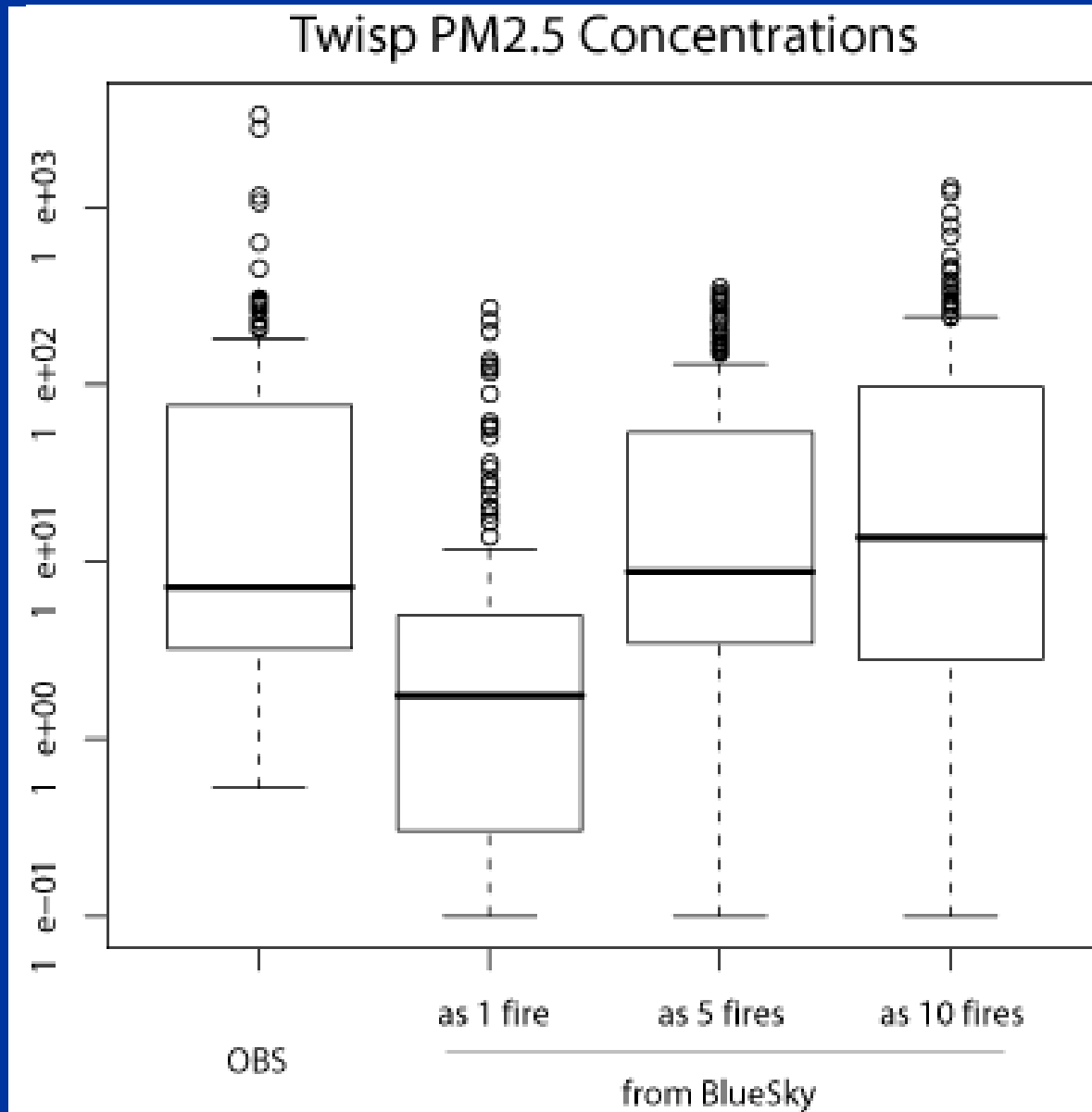
Sample results:
more accurate daily
area estimates.



Deal with Known Issues

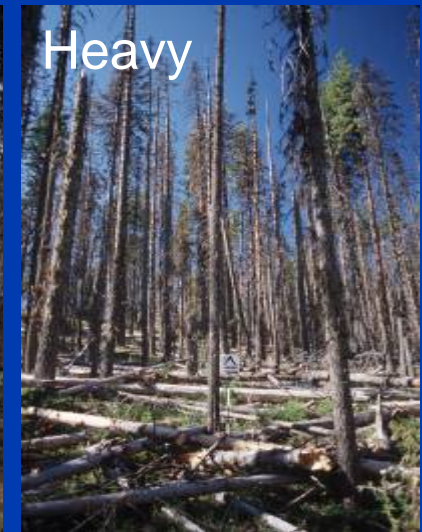
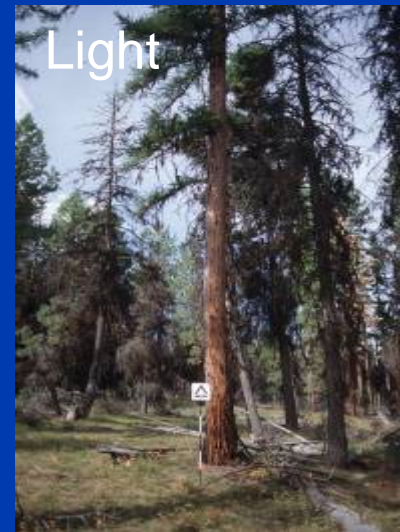
- Plume rise
 - Modules used within the BlueSky Framework are not handling buoyant plume rise well.
 - Little data are available on the vertical structure.
 - Data from two NASA instruments will be useful.
 - Time-height aerosol backscatter profiles from CALISPO
 - Stereo height from MISR (in collaboration with D. Diner's group at JPL)
 - Expected Outcome: Greatly improved plume rise estimates and near-field predictions of downwind concentrations.

Multiple Plumes Improve the Results

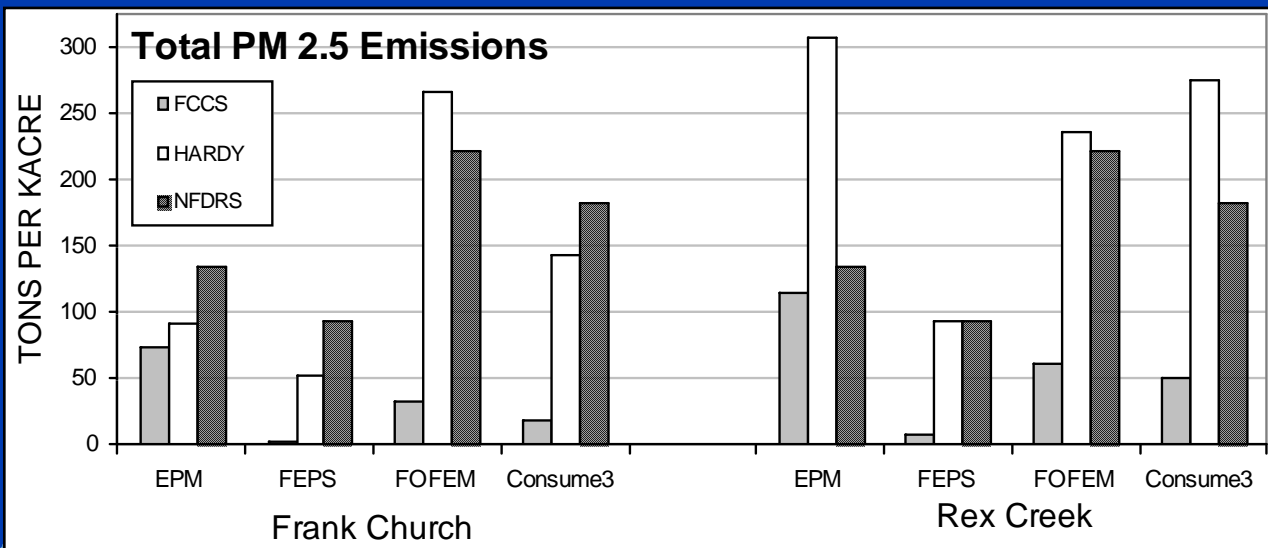


Deal with Known Issues

Fuel loadings can vary greatly even within the same vegetation type.



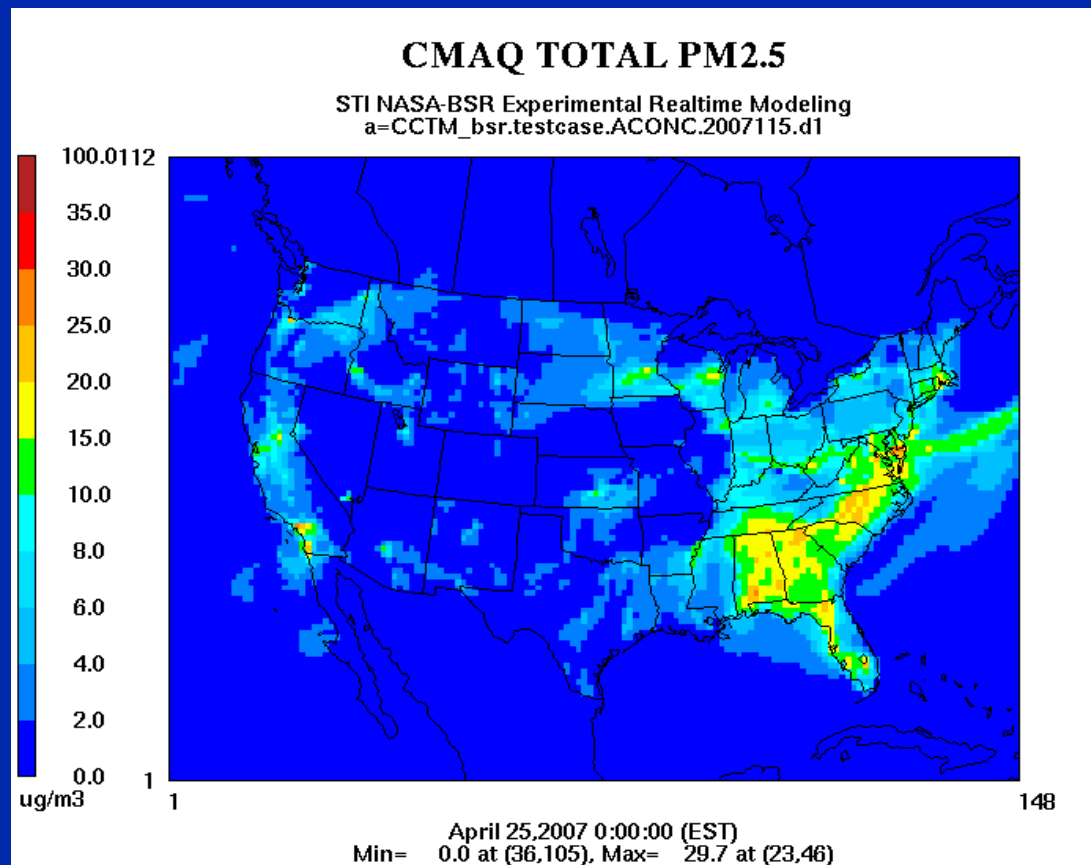
Photos courtesy Ottmar et al.



Emissions vary with fuel load and fuel consumption model selections.

Non-fire Emissions and Photochemistry

BlueSky National: Daily 36-km CMAQ Forecasts

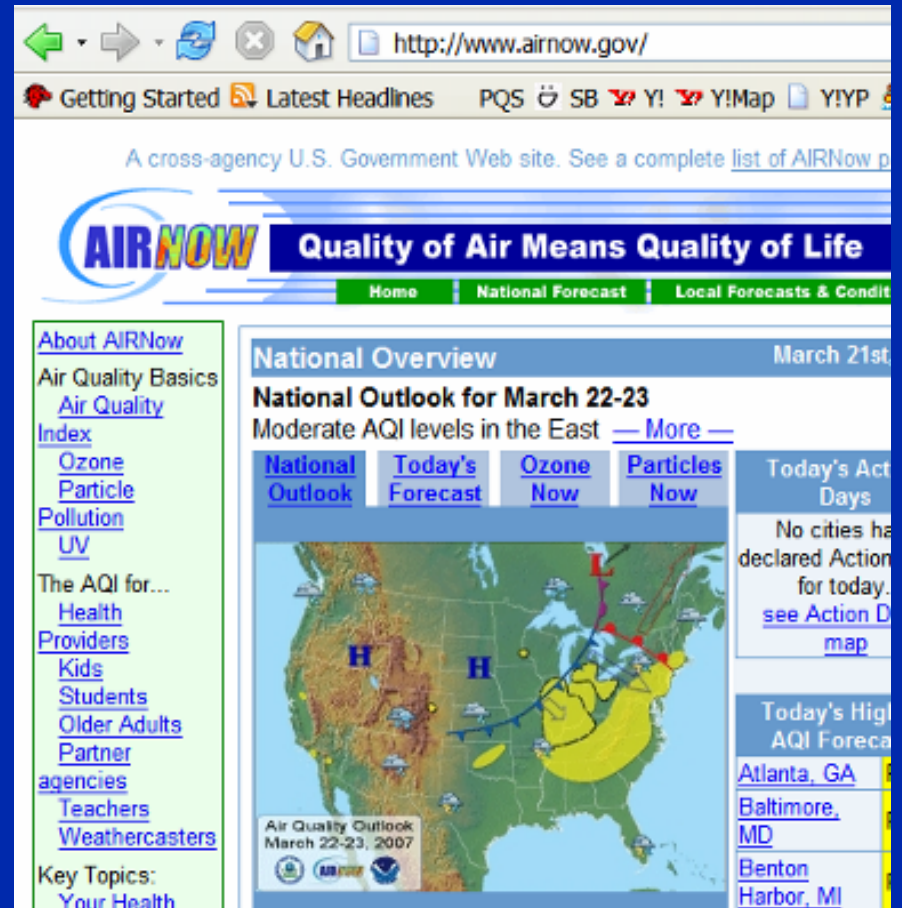


2. Facilitate Sustained Operations

- Re-architect the system to improve reliability, robustness, and ease of maintenance
 - Streamline modular design
 - Improve system automation
 - Design and build system security measures
 - Deploy version control

3. Outreach to Users (1 of 2)

- Broaden to national and international scopes
- Increase dialog with air quality community
 - Partner to AIRNow
 - Offer AQ-related features
- Re-design visualization system
 - Ease of use
 - Data exploration



3. Outreach to Users (2 of 2)

- Facilitate low-bandwidth service (while maintaining support for high-speed connections)
- Allow “what-if” analyses (activate/deactivate cached scenarios; view results)
- Allow data downloads (e.g., formatted emission inventories)
- Facilitate off-line runs (e.g., ensembling, altered model conditions, different model choice, etc.)
- Offer greater range of model choices and options

Project Status

- Now available:
 - Consistent BlueSky predictions across all FCAMMS + consistent visualization (RAINS)
- This summer:
 - Use of reconciled satellite data (SMARTFIRE)
 - BlueSky Framework Version 3 (initial version)
- Later this year:
 - N. American CMAQ modeling on 36-km grid integrated with FCAMMS hi-res regional models

Coming Soon

- By next year (?):
 - Revised visualization system and user interface
 - Partner to AIRNow
 - Ability to ‘what-if’ different scenarios
 - Ensembling capabilities
 - International scope (Canada)

Thank you

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