

# Expanding BlueSkyRAINS to Support Emission Inventory Preparation

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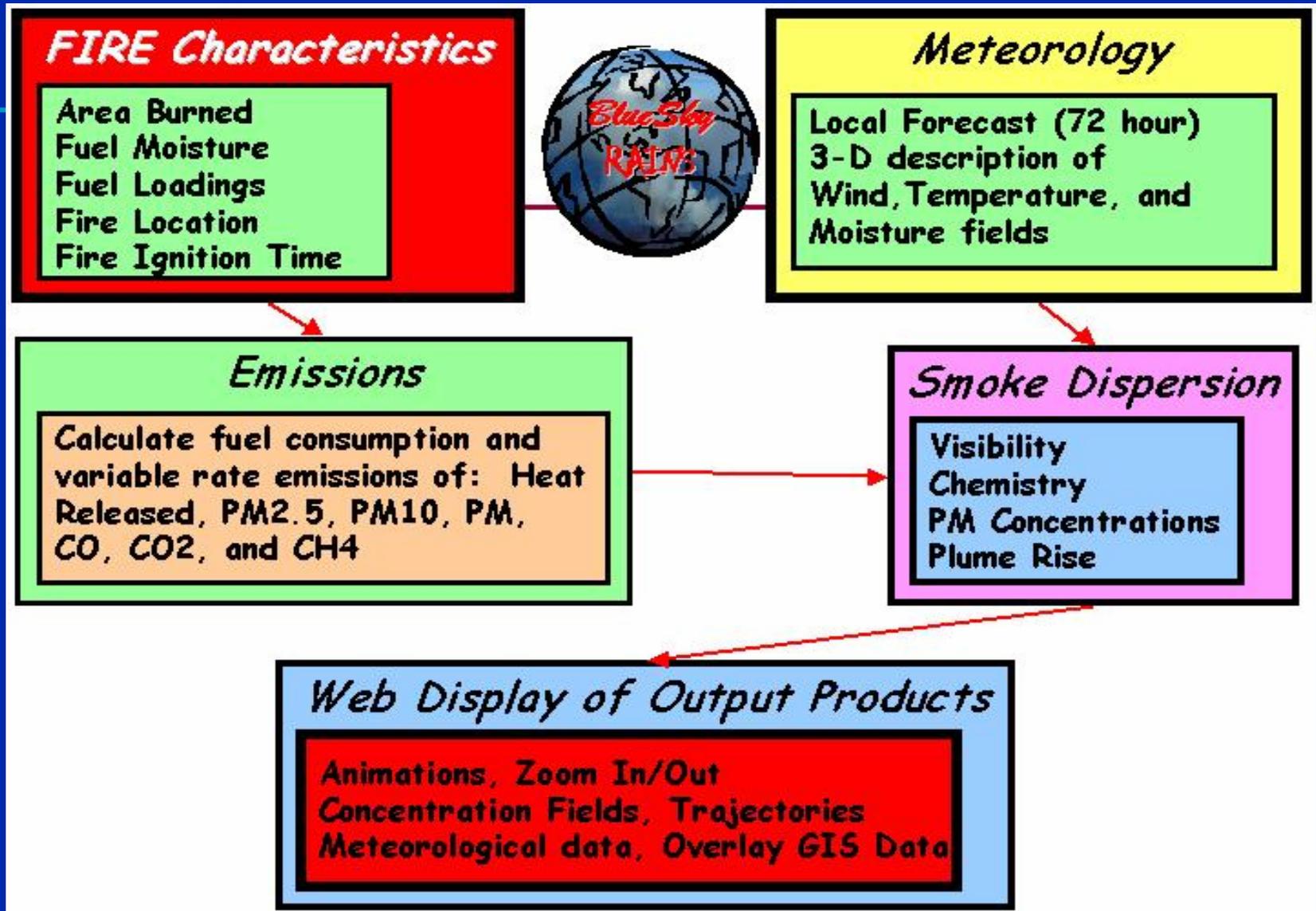
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May 17, 2006

# BlueSkyRAINS

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- BlueSky is a modeling framework that predicts the cumulative impact of wildfires and prescribed and agricultural burns on ground-level PM<sub>2.5</sub> concentrations.
- RAINS is a Web-based geographical information system (GIS) display for exploring BlueSky output.
- BlueSkyRAINS (BSR) assists smoke managers in making “go/no go” decisions for planned burns.

# BlueSkyRAINS Modeling Framework



Source: <http://www.fs.fed.us/bluesky/>

Display Data For:

Apr 3 Noon

2006 PDT

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

Auto Refresh

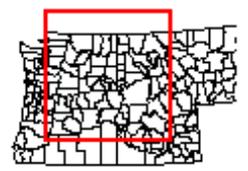
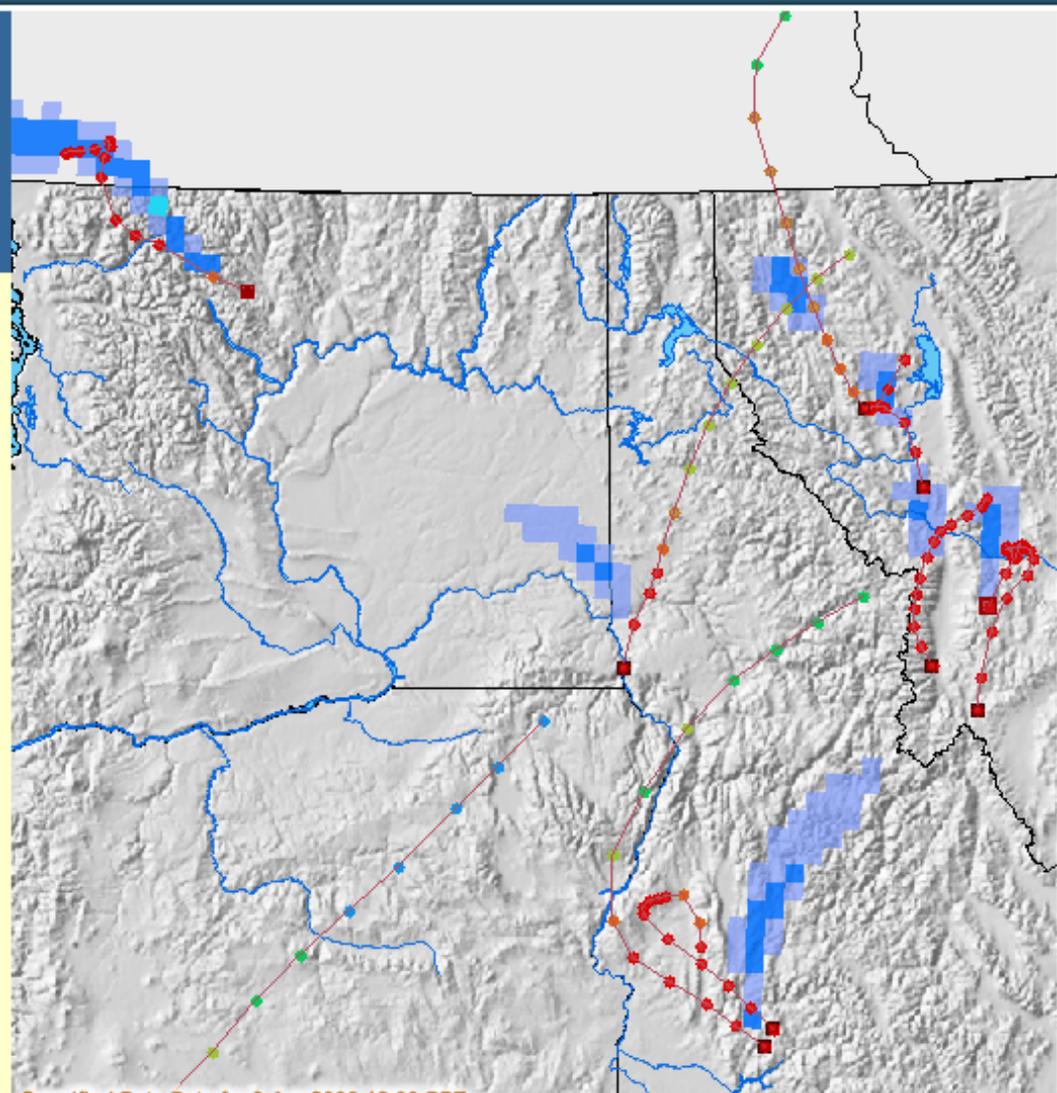
Data Layers

Data Status

- Burn Information
- 4km Predictions
- 12km Predictions
- Other Pollution Sources
- Observed Air Quality
- Receptors
- Base Map Data
- Canada Base Map Data

Layer Help

- A closed group, click to open.
- An open group, click to close.
- A hidden group/layer, click to make visible.
- A visible group/layer, click to hide.
- A visible layer, but not at this scale.
- A partially visible group, click to make visible.
- 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

- 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
  - ~ Rivers

Specified Date, Data for 3 Apr 2006 12:00 PDT  
**CAUTION: Burn Information Planned, Not actual, Accuracy Unknown**

0 88mi

Zoom/Back Pan/Move Select/Show/Clear Data Print/Download/Bookmark

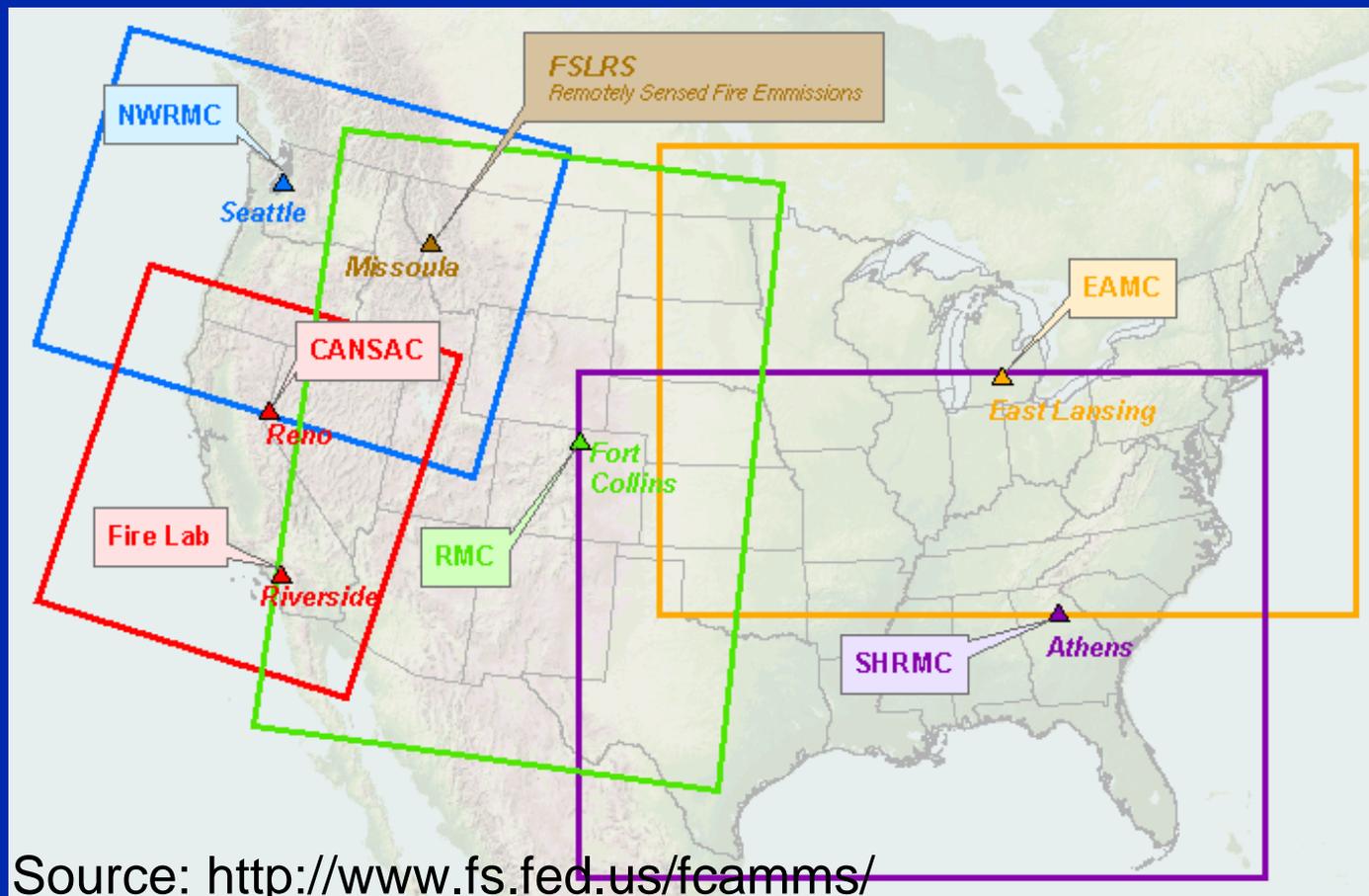
# BSR and Emission Inventories

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- BSR is a potentially powerful tool for the preparation of fire emission inventories.
- The outputs from BSR are not yet directly useful or available for emission inventory preparation.
- Emission inventory information from BSR is not widely utilized.
- A number of planned improvements will address issues hindering the use of BSR for emission inventories.

# Issue 1 – Input Activity Data (1 of 3)

- Currently, BSR runs routinely only in the Pacific Northwest
- BlueSky models (without the RAINS interface) operate independently in other regions



# Issue 1 – Input Activity Data (2 of 3)

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- For each region, BlueSky relies on fire reports from many agencies.
  - USDA Forest Service
  - Bureau of Land Management
  - States
  - Tribes
  - Regional consortia
- Each agency employs different reporting criteria.

# Issue 1 – Input Activity Data (3 of 3)

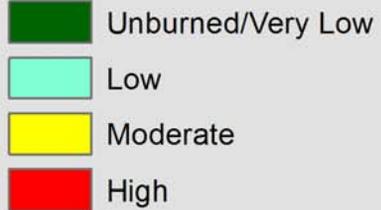
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- To facilitate BSR expansion to the national scale, a more streamlined and uniform method for determining fires will be helpful.
- Fires detected by satellite-based sensors will be incorporated into the BSR system.
  - Moderate Resolution Imaging Spectroradiometer (MODIS)
  - Geostationary Environmental Satellites (GOES)
- Satellite-detected fires could improve input:
  - Consistency
  - Coverage
  - Positional accuracy
  - Large fire size estimation

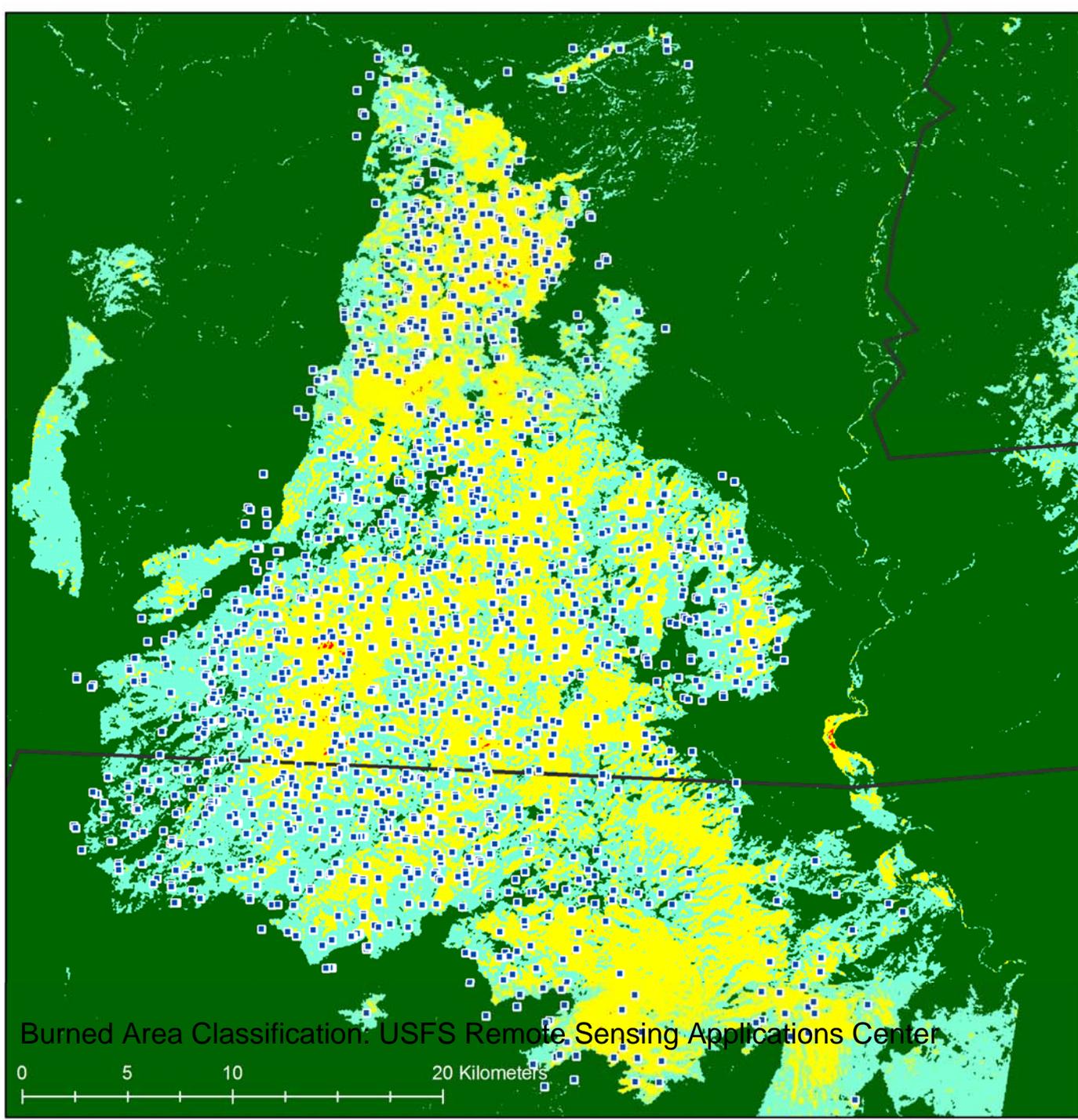
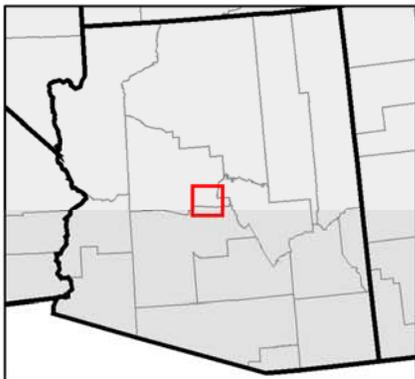
## Cave Creek Fire 6/21-7/6 2005

■ MODIS\_fires

### Burned Area Classification



MODIS does an excellent job of capturing the size and shape of large wildfires

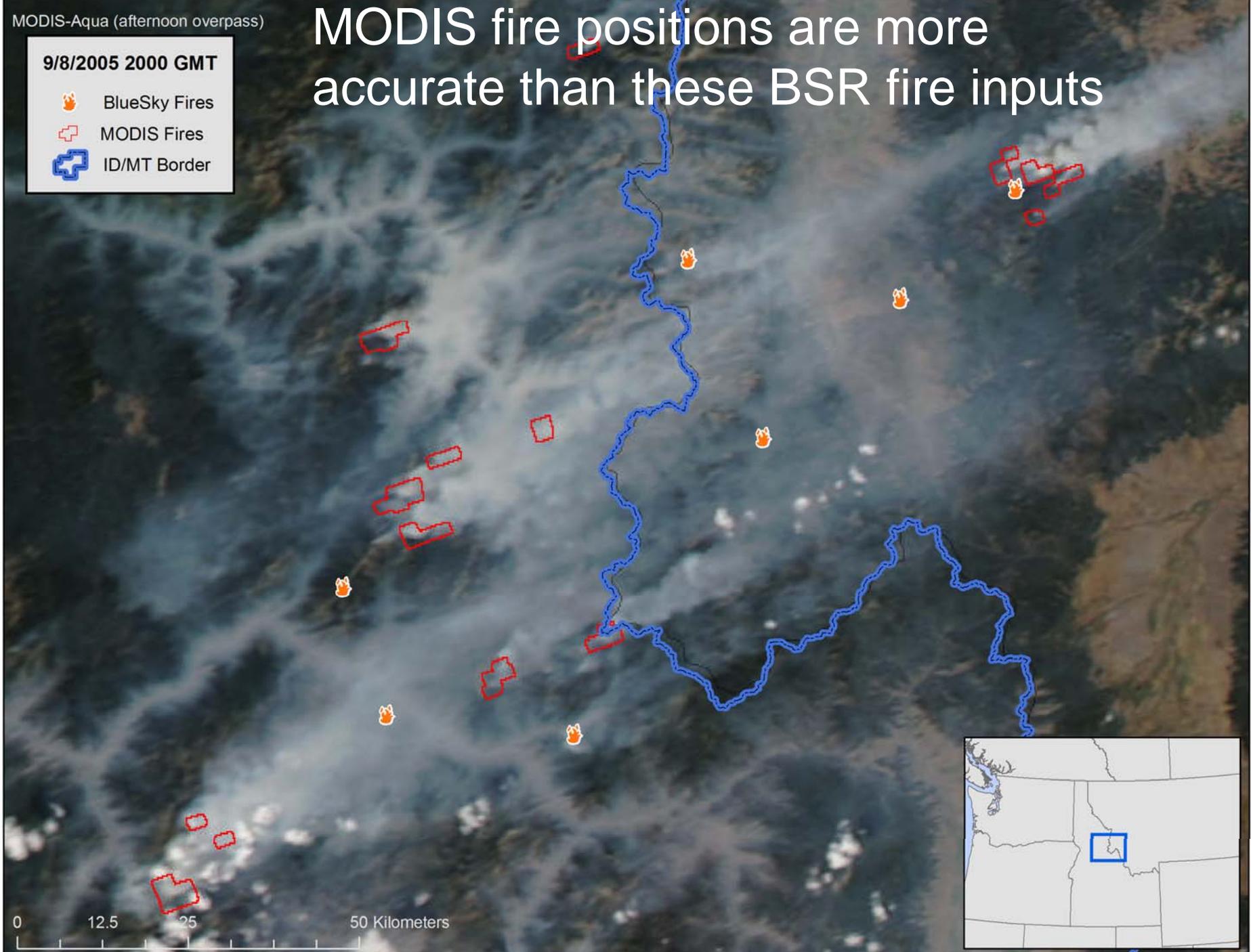


MODIS-Aqua (afternoon overpass)

# MODIS fire positions are more accurate than these BSR fire inputs

9/8/2005 2000 GMT

-  BlueSky Fires
-  MODIS Fires
-  ID/MT Border

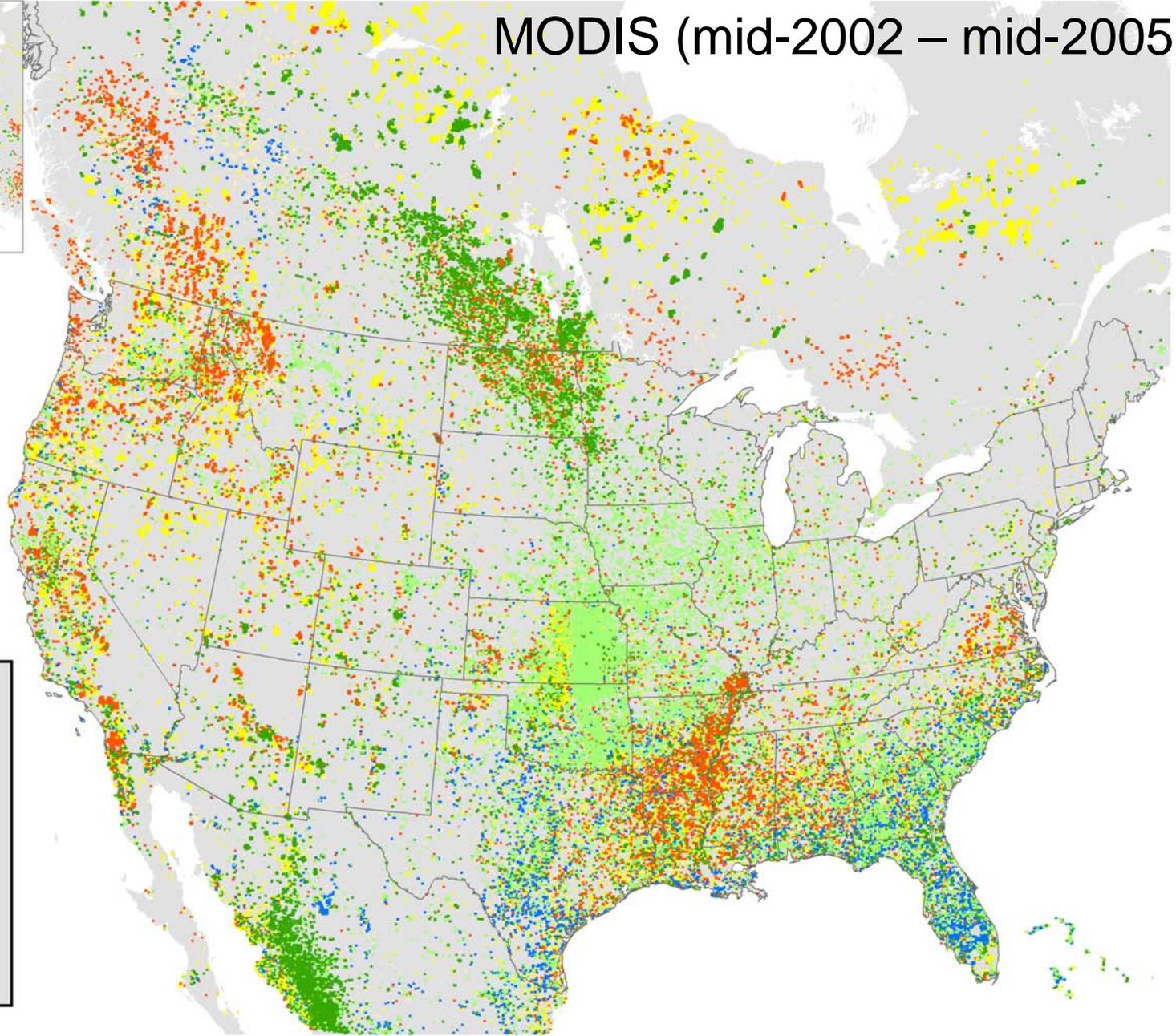
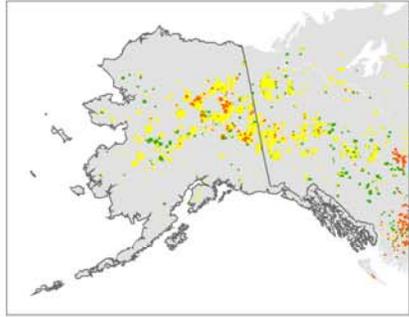


0 12.5 25 50 Kilometers



# Satellite Detected Fire Seasonality

MODIS (mid-2002 – mid-2005)



Satellite fires  
have national  
coverage

## Detected Hot Spots Month

- Jan, Feb
- Mar, Apr
- May, June
- Jul, Aug
- Sep, Oct
- Nov, Dec

# Satellite Fire Challenges

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- Despite the promise of satellite-detected fire data, several challenges remain.
  - Small fires cannot be detected.
  - Estimating fire size is difficult.
  - Estimating fire growth is difficult.
  - Clouds and heavy smoke preclude fire detection.
- The best fire data will come from a combination of field-reported and satellite-detected fires.

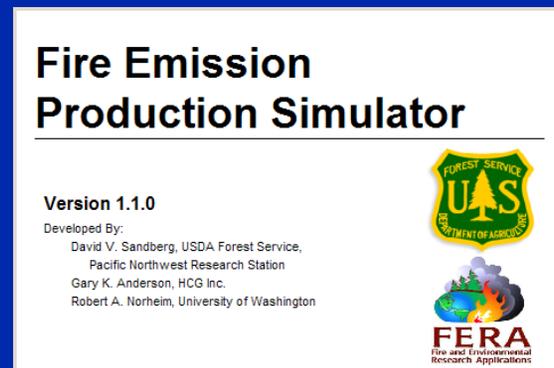
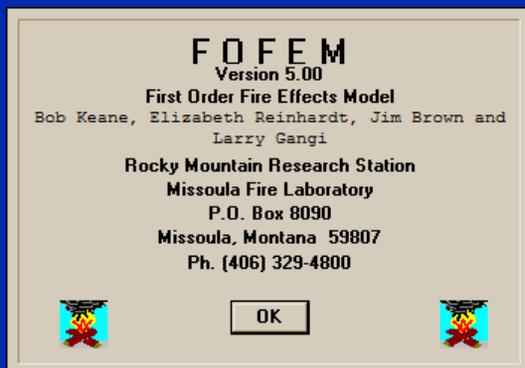
# Issue 2 – Flexibility

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- BSR currently does not give the end-user choices beyond displaying results.
- Three upgrades will give users flexibility useful for emission inventory preparation.
  - Fire emission model choices
  - Ad hoc model runs
  - Output data products

# Fire Emission Models

- Currently used: Emission Production Model (EPM)
- Being added:
  - First-Order Fire Effects Model (FOFEM)
  - Fire Emission Production Simulator (FEPS; an improvement to EPM)



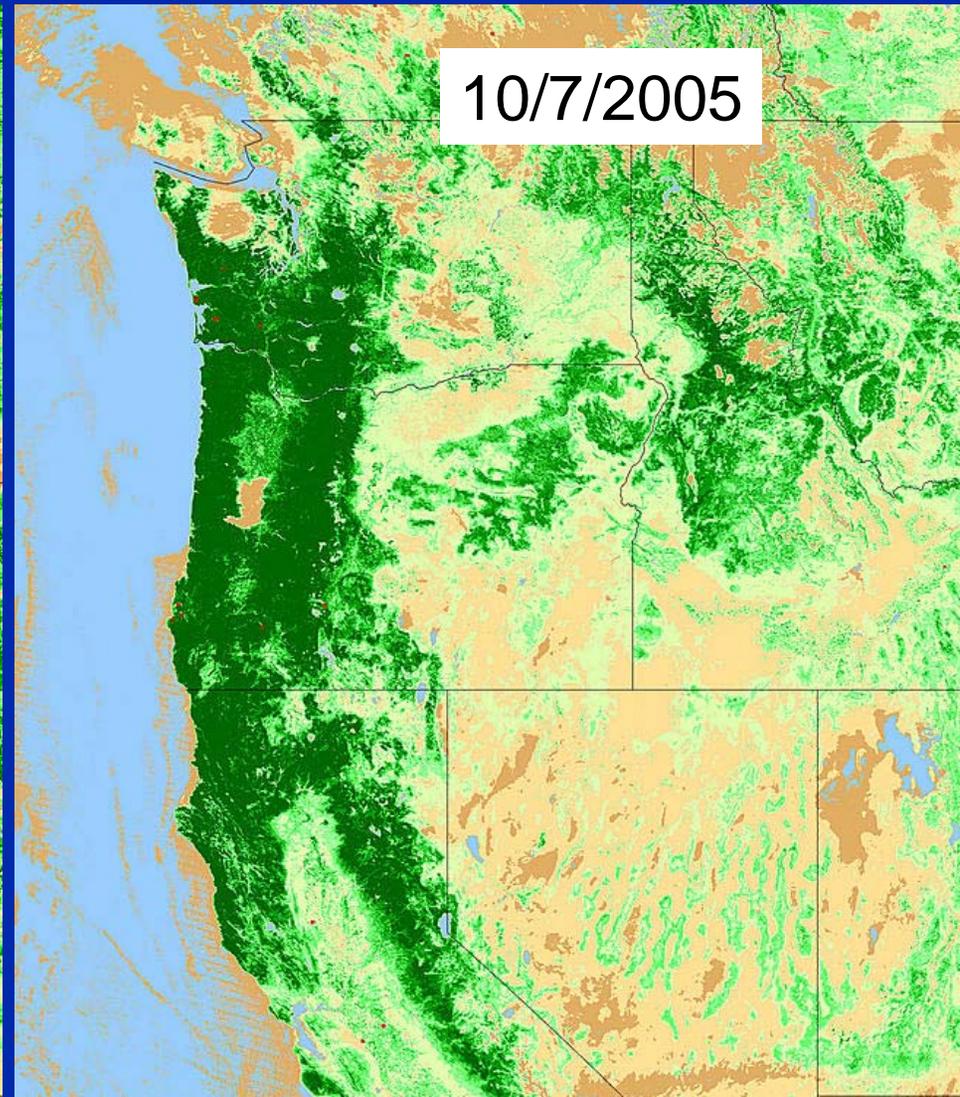
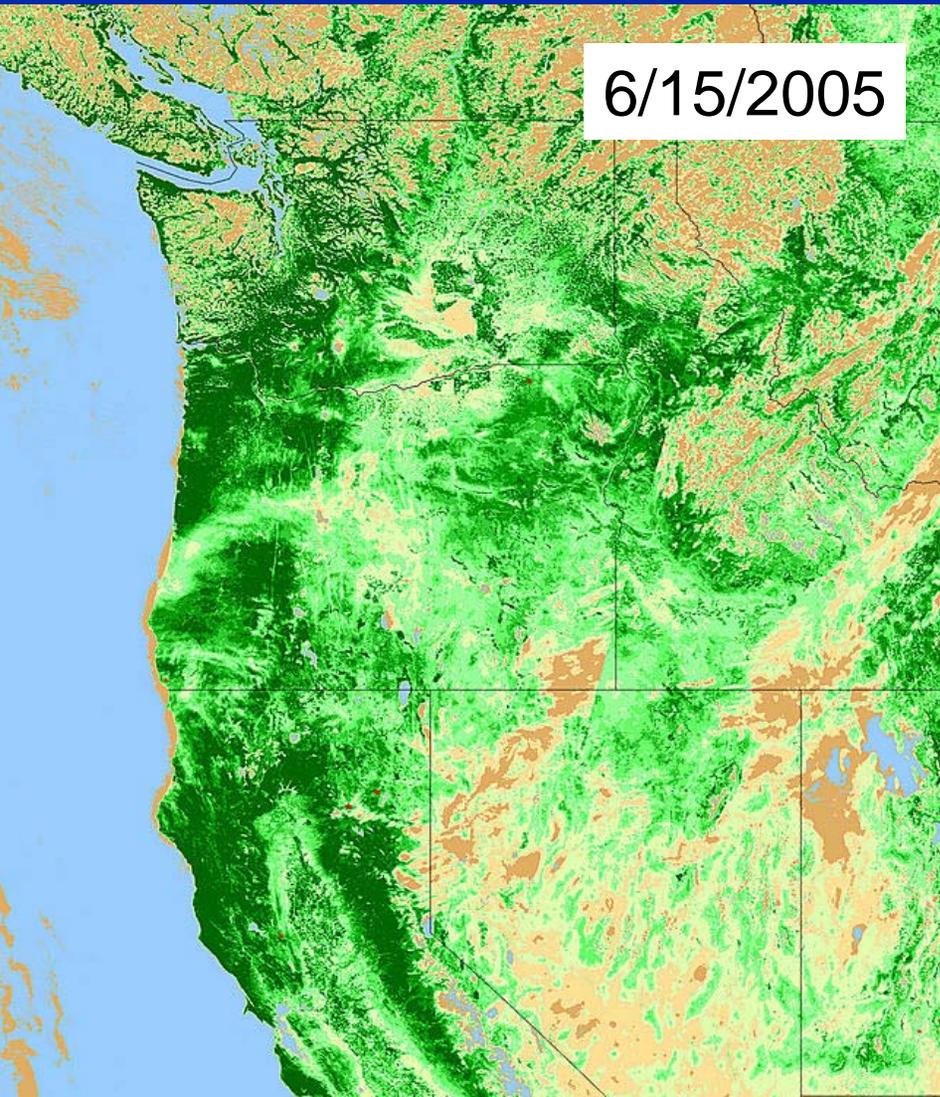
# Improved Emission Factors

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- In addition to updated fire emission models, satellite data will be applied to improve fire emission estimates.
- Normalized Difference Vegetation Index (NDVI) is a measure of “greenness.”
- Biweekly NDVI from MODIS will be used to improve fuel moisture inputs to the fire emission models.

# NDVI Comparison

Darker greens indicate increased green vegetation (and fuel moisture)



# Ad Hoc Model Runs

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- Interactive modeling will allow users to model emissions and concentrations based on their own input data.
- For example, a state may want to use its own agricultural burn activity data to develop a source category-specific emission inventory.

# Output Data Products

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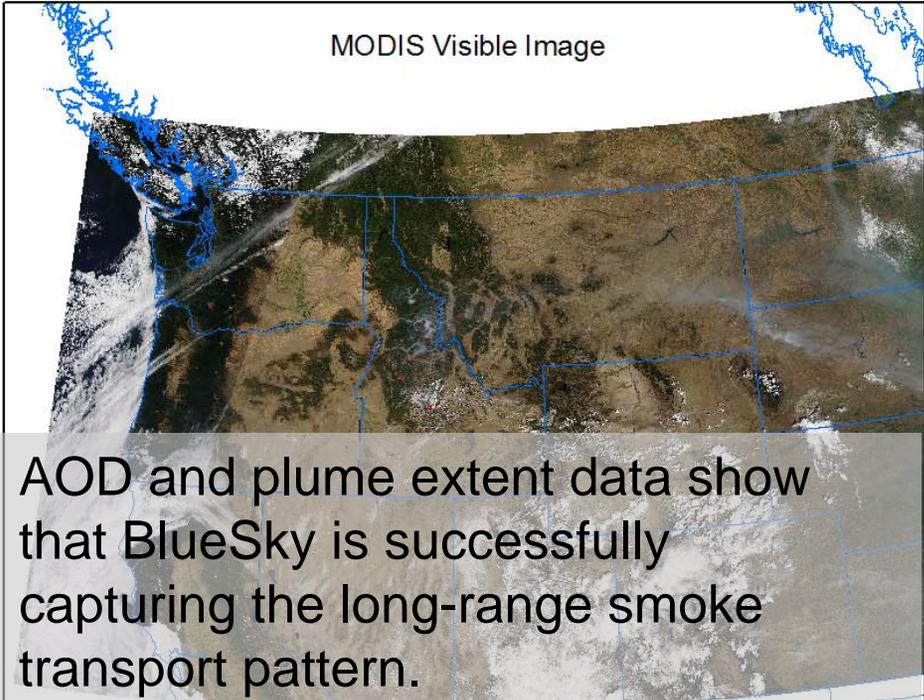
- Currently available products
  - Modeled meteorological fields
  - Modeled PM<sub>2.5</sub> surface concentrations
  - Modeled air mass trajectories
  - Visualization products (GIS, animations)
- Upcoming products
  - Activity data (fire inputs) in a more accessible form
  - Calculated emissions in emission inventory-friendly format

# Issue 3 – Validation and Accuracy

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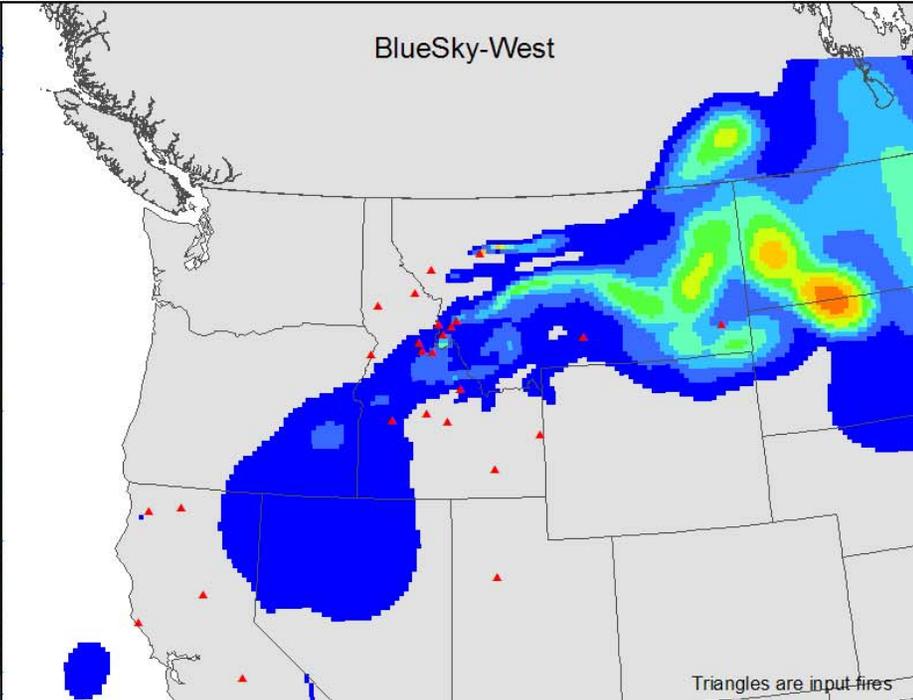
- BSR validation and refinement is ongoing.
- Validation is assisted by the ingest and comparison of routine data sets.
  - PM<sub>2.5</sub> monitors (current)
  - Satellite aerosol optical depth (in progress)
  - Analyzed smoke plume extents from the National Oceanic and Atmospheric Administration (NOAA) Hazard Mapping System (in progress)

MODIS Visible Image

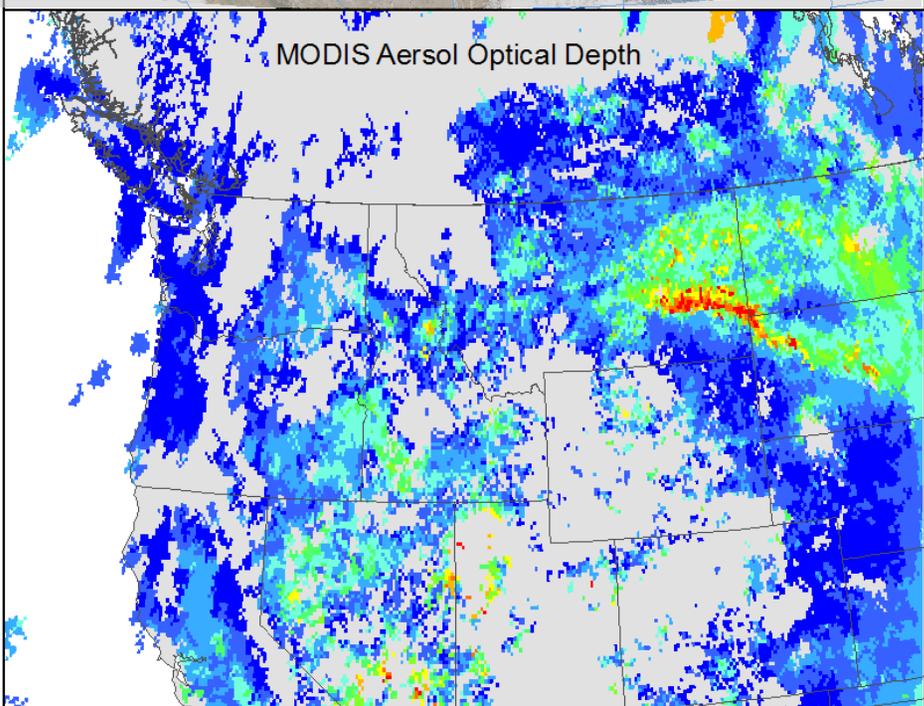


AOD and plume extent data show that BlueSky is successfully capturing the long-range smoke transport pattern.

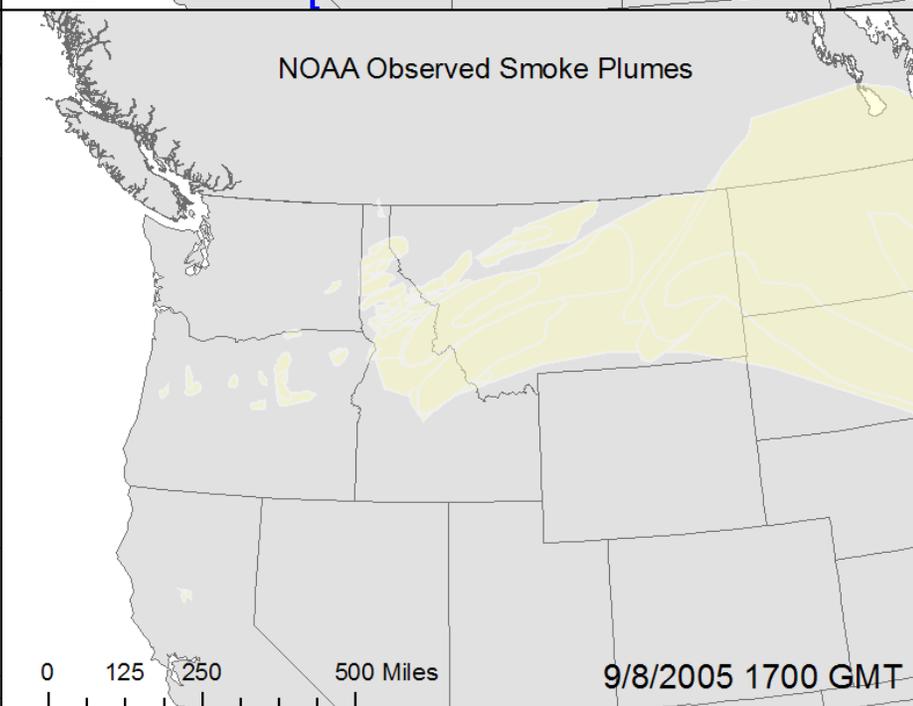
BlueSky-West



MODIS Aerosol Optical Depth



NOAA Observed Smoke Plumes



# Summary

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- BSR is already a useful tool for smoke managers.
- BSR shows great potential for assisting emission inventory preparation.
- Several issues are being addressed to harness that potential.
  - Input Activity Data
  - Flexibility
  - Validation/Accuracy
- This project has just begun. The timeframe for completion is 2-3 years.

# Acknowledgments

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- This project is funded by NASA.
- Work is being performed in collaboration with the USDA Forest Service AirFIRE Team and the U.S. EPA.