The State of Smoke Tools

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May 13, 2008
Salt Lake City, Utah
Lots of different applications

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

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

Breathing the air
  real-time (right now!), best guess (just what is going to happen)

Diagnosing what happened
  historical, best guess (just what happened)
The State of Smoke Tools

Current State: HAPHAZARD

Technology Development Progression

Emergent

- few, ‘silos’, confusing
- April 2008

Mature

- user choices, inter-operability, ease of use
- June 2008

Transition from April 2008 to June 2008?
Promising Developments

1. Model Inter-operability
   • BlueSky Framework

2. Nationally Consistent Products

3. New, Advanced Tools
   • for Fire Info (SMARTFIRE)
   • for Planning (AQUIPT)

4. Community Organizing
   • for Scientists (Modeling Intercomparison Project)
   • for Users (this, among others)
Basics of Smoke Application

- **FIRE INFO**
- **WEATHER PREDICTIONS**
- **SMOKE TRAJECTORIES and CONCENTRATIONS**

**INPUT SYSTEM**
- **MODEL FRAMEWORK**
- **OUTPUT SYSTEM**
The New BlueSky Framework:

enabling interoperability

Currently 1296 different paths!
Modularity = Flexibility leads to user choice

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

JFSP funded project
## Real-Time Smoke-Related Systems

### Fire Detection
- Smoke Only
- All Pollutants

### Locations / Emissions
- Transport

### Domain
- **Global**
  - GEOS-Chem
  - FLAMBE / NAAPS
- **National**
  - NWS Smoke
  - WRF-Chem
  - STI-CMAQ
  - ICS
- **Regional**
  - AIRPACT
  - OK-FIRE
  - FCAMMS
  - ClearSky (Ag)
  - Australian
  - Rx
  - Florida SST

### Resolution
- 1°
- 36km
- 12km
- 4km
- 1km

### More Desirable

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The diagram illustrates various real-time smoke-related systems, categorized by domain and resolution, along with fire detection and emission transport functionalities.
National Smoke Products

National Weather Service
• smoke only (12-km) & aq (36-km)

FCAMMS
• smoke only
• regional hi-res (4-km)
• national 12-km 3-day
  (based on NWS NAM)
• national 36-km 7-day
  (based on NWS GFS)

STI CMAQ
• national emissions inventory + fire
• national 36-km
Lessons Learned

Fire information can be of poor quality

Models differ substantially

Plume rise needs fixing

U.S. Fire Report Locations

Courtesy Tim Brown, DRI
SMARTFIRE: Reconciled fire data

- Ground-based systems
- Satellite fire info (NOAA HMS)
- Expert Users (e.g. Incident Command Teams)

SMARTFIRE

Reconciled fire info including sub-grid fuels and plume information

BLUESKY
HMS detects more burning than is reported by ICS-209

- Rangeland burns
- Smaller burns
- Burns outside U.S.

ICS-209 & HMS
July - August 2005
NEI / SMARTFIRE

comparisons based on 2000-2003
NOAA HMS’s use of GOES
picks up smaller burns in the SE
AQUIPT: Longer-range planning

Example: planning fire this August
Can’t say what impacts will be
But can use history as a guide

![Diagram showing the process of AQUIPT]

- Past Weather + Emissions Modeling + Dispersion Modeling = Probabilistic Future Impacts

Web Interface
Example: Fire this August

*air quality impacts planning tool*

Can’t say what impacts **will be**
But can use **history as a guide**

\[
\text{Aug 2005} + \text{Emissions Modeling} + \text{Dispersion Modeling} = \text{Impacts for Aug 2005}
\]
Example: Fire this August

air quality impacts planning tool

Can’t say what impacts will be
But can use history as a guide
Example: Fire this August

*air quality impacts planning tool*

Can’t say what impacts will be
But can use **history as a guide**
AQUIPT: Accessible through web

air quality impacts planning tool
AQUIPT: Summary

Provide basic source info, 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
Smoke and Emissions Model Inter-comparison Project (SEMIP)

Just funded

Large-scale, Inclusive

Based on other “MIPs”
getBlueSky.org portal

Model Evaluation & Field Observations
- field observations (available in real-time, USFS)
- New! 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)
  - New! real-time scenario game-playing (soon, USFS)
  - more being added

Longer-Range Planning Tools
- New! probable impacts based on climatology (AQUIPT)
- New! National Emissions Inventory (NEI) assessments

Fire Info
- New! SMARTFIRE reconciled fire info
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

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Our many collaborators and partners, including Ray Knighton. Susan O’Neill.

BlueSky Meeting: May 20-22, Boise.

http://getBlueSky.org

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The big picture: not so bad

Bluesky models long-range transport very well, but historically has generally under-predicted.
Which model is best?

Emissions based on using different combinations of fuel loading maps and fuel consumption models

Larkin et al 2008
Plume Rise

• Fires are currently modeled as single plumes, lofting smoke unrealistically high and lowering ground impacts.

• In reality, fires are made of many burning areas lofting smoke to various heights.
Multiple plumes make it look better

Twisp PM2.5 Concentrations
SMARTFIRE FireEvent Development (1 of 2)

Cave Creek Fire
6/22-7/4 2005

- ICS-209
- Satellite Detect
- Daily FirePerimeter
- Burned Area as of 7/6/05
  - Unburned/Very Low
  - Low
  - Moderate
  - High

6/22/05

S. Raffuse, Sonoma Tech
Wildfire Area Burned Estimates

For the largest fires examined, SMARTFIRE final footprints match very well with final ICS-209 area estimates.

SMARTFIRE tends to overestimate area burned for smaller wildfires.

This relationship appears independent of ecosystem or fuel type.

\[ y = 16.9x^{0.77} \]

\[ R^2 = 0.937 \]
Smaller Fires

ICS-209 report information is not available for many small fires.
- Agricultural burns
- Prescribed fires
- Rangeland fires
- Small wildfires

For these fires, available data sets will be used to validate SMARTFIRE.

The large-scale pattern of satellite detects matches fairly well with this single day of fires from a Florida fire database.

Mismatches may be due to satellite false detects, satellite non-detects, or database errors.
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