Wildland Fire Emission Modeling: Integrating BlueSky and SMOKE

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Outline of Presentation

- Why Link BlueSky with SMOKE?
- What is BlueSky and SMOKE?
- How the programs were linked
- Test case with model results
- Summary

US Forest Service (USFS) & US Environmental Protection Agency (US EPA)

Signed an interagency agreement to improve the **episodic modeling of fires**

using

- Improved fuel loading data
- Improved fire location information
- Improved fire behavior modeling (including plume behavior), using meteorological inputs

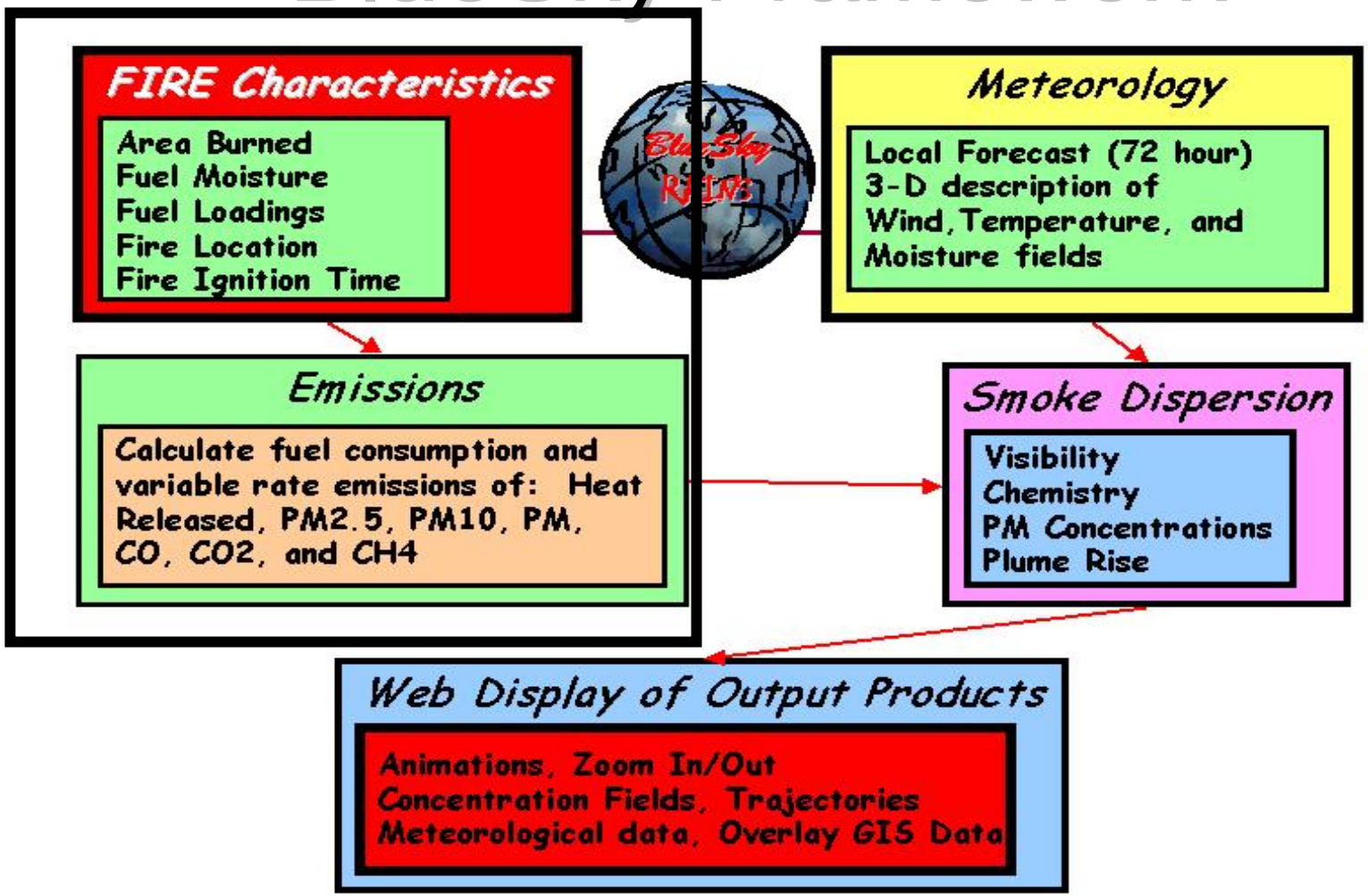
Why Link BlueSky and SMOKE?

- BlueSky used by Forest Service to forecast fires (wildfires and prescribed) (good temporal and spatial resolution)
- SMOKE creates emission estimates for chemical transport models
- Wild land fire inventory emissions known only at state level (spatially) and at monthly time resolution (temporally)

Linking BlueSky & SMOKE

- BlueSky Framework
  - Estimates emissions, incorporates meteorology, and uses dispersion models to forecast smoke impacts from fires.
- Sparse Matrix Operator Kernel Emission Processor (SMOKE)
  - Creates “model ready” inputs for chemical transport models

BlueSky Framework



Source: http://www.fs.fed.us/bluesky/about/

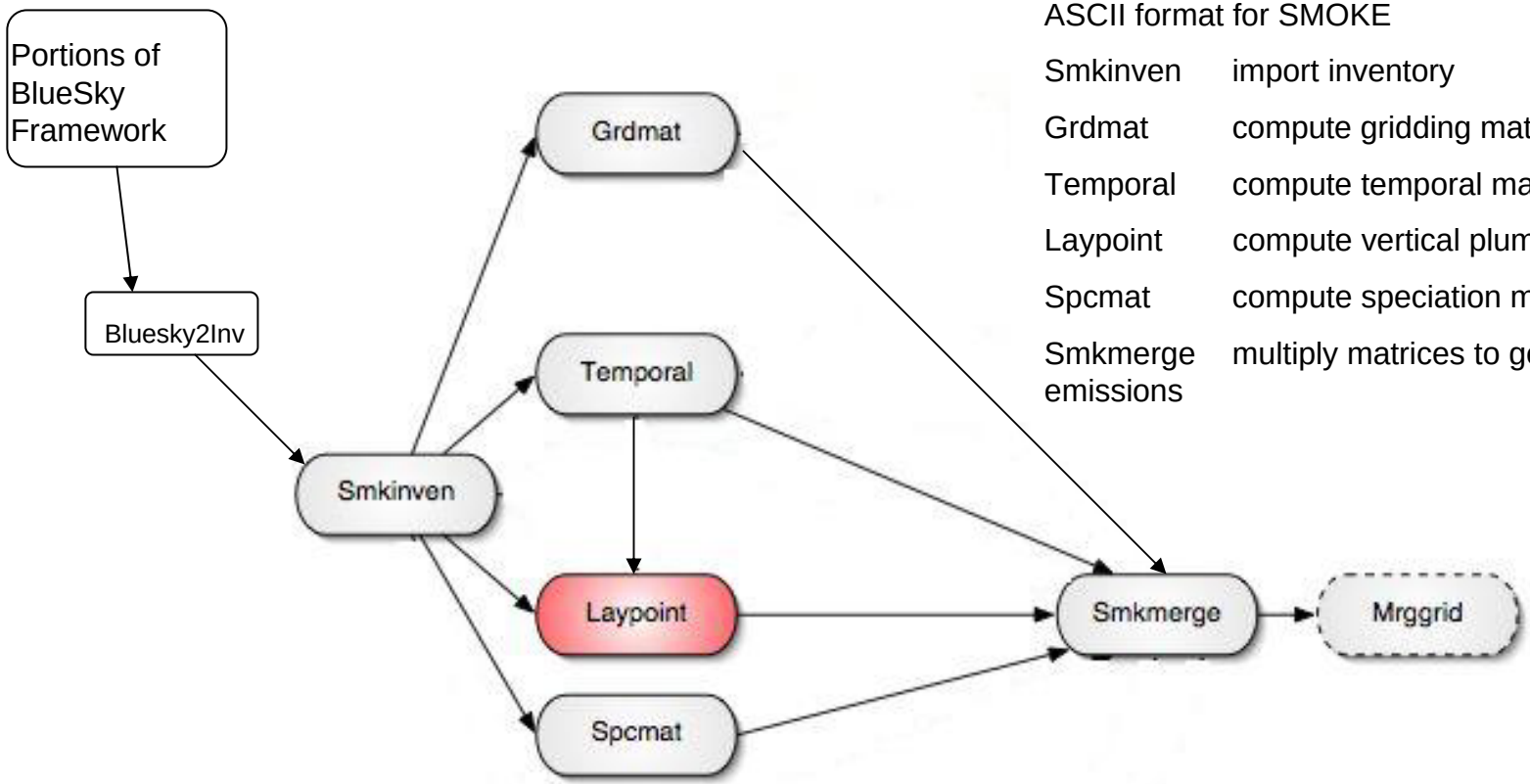
Linking BlueSky & SMOKE

- BlueSky computes Q, Plume Rise in SMOKE needs F, buoyancy flux (m^4/s^3)
- F=Q*0.00000258 (from Fire Emission Production Simulator or FEPS documentation)
- Q=heat flux (BTU/hr)

Wildland Fire Plume Rise

- Brigg's layer by layer approach (see CMAQ Science Algorithms document)
- Smoldering Fraction
- $S_{fract}=1-BE_{size}$
- $BE_{size}=0.0703*\ln(acres)+0.3$
  - derived from a "best fit" of WRAP tables)

Wildland Fire Emission Processing



Bluesky2Inv	convert Bluesky output to ASCII format for SMOKE
Smkinven	import inventory
Grdmat	compute gridding matrix
Temporal	compute temporal matrix
Laypoint	compute vertical plume rise
Spcmat	compute speciation matrix
Smkmerge	multiply matrices to get emissions

SMOKE Updates

- Create Bluesky2Inv Tool
  - Converts emission estimates into format for SMOKE (ASCII)
- Include plume rise for fires in LAYPOINT
  - Uses Briggs approach and heat release info from BlueSky
- Updated SMKINVEN for Fire Event Inventory

Test Case of BlueSky-EM

- Meteorological data for 2001 already available
- Detailed Fire Inventory available for Florida
- Focus on large fire event in Florida during May 2001

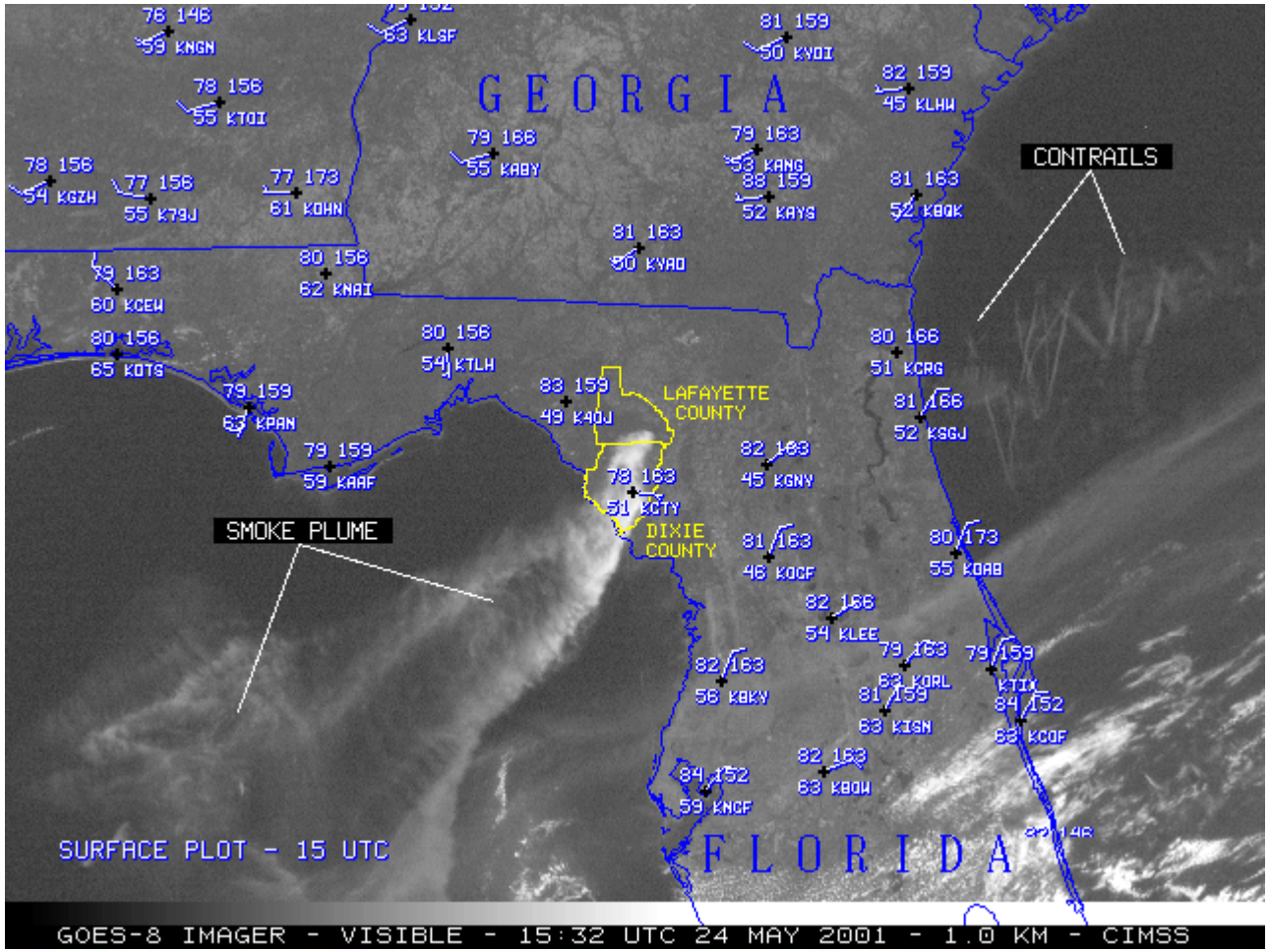
Mallory Swamp Fire

- 57,200 Acres Burned Total; 34,000 acres in one day (May 25, 2001)
- Started by lightning
- Florida's Biggest Fire In 15 Years
- Clear Signature of Fire in Satellite Photos

Mallory Swamp Fire

Source: http://www.dca.state.fl.us/bpr/Preparedness/Logistics/mallory_swamp_fires.htm

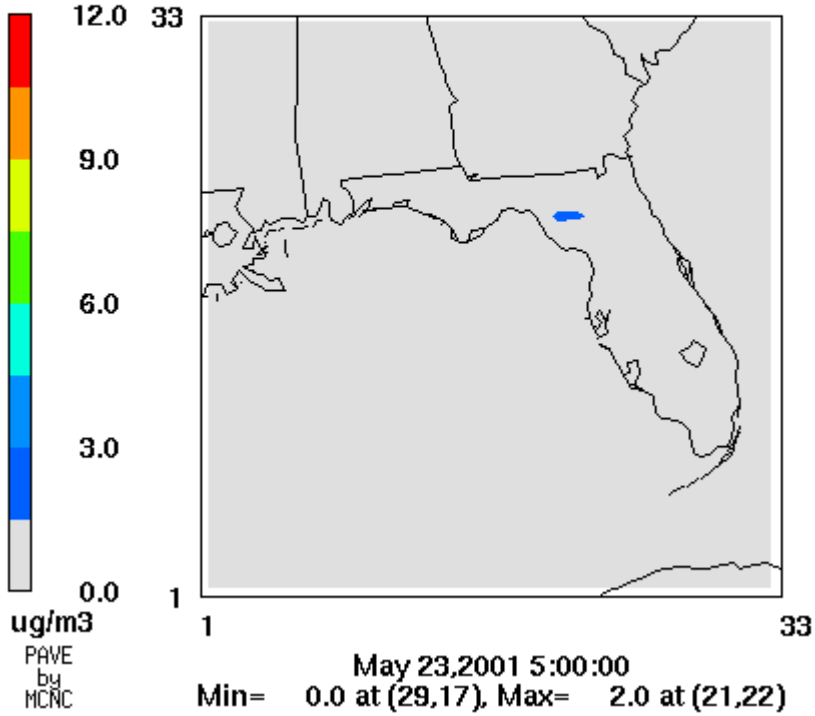
May 24, 2001 GOES Satellite



CMAQ results

- Used EPA's 2001 CMAQ Annual simulation with CB4 mechanism, MM5 met
- Simulation performed as part of Clean Air Interstate Rule (CAIR)
  http://www.epa.gov/air/interstateairquality/technical.html
- Replaced Florida Fire Emissions in the National Emissions Inventory (NEI) with BlueSky Emission Estimates during May 2001

Primary Organic Particulate Matter



BlueSky-EM documentation

- Documentation, code, test data sets Available online at
  - http://www.unc.edu/~cseppan/bluesky/
  - Not tested completely
  - No model evaluations with this tool yet

Summary

- BlueSky-EM: Creates wildfire emissions for use in chemical transport models
- Qualitatively reproduces plume from Mallory Swamp Fire in May 2001
- Evaluation of plume rise and emission estimates needed on a continental annual basis (aerosol monitoring network coverage)
- 2002 NEI will include wildfires on a national basis; BlueSky-EM will be evaluated with this dataset