

# Satellite Data Driven Modeling System for Predicting Air Quality and Visibility during Wildfire and Prescribed Burn Events

Udaysankar Nair <sup>1</sup>, Ken Keiser<sup>2</sup>, Yuling Wu<sup>3</sup>, Manil Maskey<sup>2</sup>,  
Sundar Christopher<sup>1</sup>, Denise Berendes<sup>3</sup>, Patrick Glass<sup>4</sup>,  
Dan Jackson<sup>4</sup> and Abhi Dhakal<sup>4</sup>

<sup>1</sup>Department of Atmospheric Science

<sup>2</sup>Information Technology System Center

<sup>3</sup>Earth System Science Center

University of Alabama in Huntsville

<sup>4</sup>Alabama Forestry Commission

# Overview

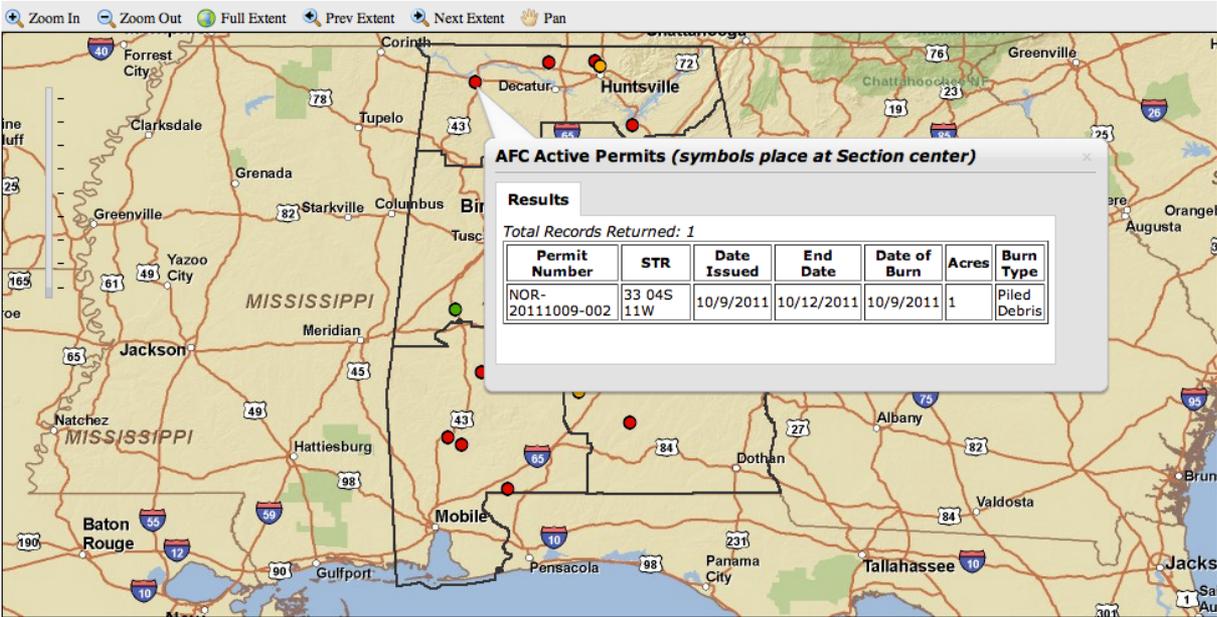
- Development of satellite data driven modeling system for wild fires and prescribed burns
- End users: Alabama Forestry Commission (AFC), National Weather Service, Huntsville regional office
- Decision making: Visibility and health alerts, Smoke management
- Decision support systems: Virtual Alabama, AWIPS
- Two year project, received one year NCE, 7/31/2013

# End user

- Alabama Forestry Commission (AFC) : *“Established as a state agency in 1924, the mission of the Alabama Forestry Commission is three-fold: to Protect the Forests from all harmful agents; to Service and Help Landowners to carry out responsible forest management on their property, using professional technical assistance so as to benefit themselves, their land and society; and to Educate the General Public about the value of our forests in insuring both a healthy economy and environment.”*
- As a part of this mandate, AFC is responsible for wildfire control and also for management of prescribed burning.

# Prescribed burning in Alabama

- AFC issues burn permits for executing prescribed burning.



**AFC Active Permits (symbols place at Section center)**

**Results**

Total Records Returned: 1

Permit Number	STR	Date Issued	End Date	Date of Burn	Acres	Burn Type
NOR-20111009-002	33 04S 11W	10/9/2011	10/12/2011	10/9/2011	1	Piled Debris

Click map icons for more information  
To zoom: Select zoom tool icon and drag a box over area of interest

Icon illustrations are approximate locations  
To request a Burn Permit contact your local Alabama Forestry Commission Office.  
Certified Burn Managers can obtain a permit on-line.

25 Active Permits as of 10/10/2011 10:30:45 AM  
(refresh screen to update data)  
● 3-day ● 2-day ● 1-day

If data does not display contact the [mike.kysar](#) - Map Service provided by [ISD Geospatial Office](#)

[Download KMZ file](#) (required to view in [Google Earth](#) or [Virtual Alabama](#))

Disclaimer

The information presented on the maps have been compiled from many sources and are considered reliable. The Alabama Forestry Commission (AFC) makes no warranties either expressed or implied, concerning the location, accuracy, completeness, reliability, or suitability of this data for any use other than display. The maps and information contained on the maps may periodically change and may or may not be incorporated in any new version. AFC assumes no liability for the use or misuse of the information contained in these maps. Please contact the AFC GIS Manager if you discover any discrepancies with the online maps.

# Prescribed burning in Alabama

- Prescribed burning is maximum during mid Jan-March. Average of 200 permits are issued per day during this time period. Maximum number of permits issued are in excess of 800.
- Two thirds of the burns occur in the southern third to half of the state
- When conducting prescribed burning, problems associated with smoke create friction between users of fire as a management tool and public. Smoke management needs to be a part of the burn plan

# Smoke Management Considerations

- Smoke-sensitive areas that could be potentially impacted by smoke from the prescribed burn event need to be identified and considered in the burn plan
- Burning under wet conditions can lead to smog which hug close to ground and is transported by drainage flows into settling in low lying roads, bridges etc.
- Two important considerations from smoke management aspects are: Adverse health impact and reduced visibility

Source: Alabama Cooperative Extension System fact sheet on control burns

# Smoke Management Considerations

- Smoke-sensitive areas that could be potentially impacted by smoke from the prescribed burn event need to be identified and considered in the burn plan
- Burning under wet conditions can lead to smog which hug close to ground and is transported by drainage flows into settling in low lying roads, bridges etc.
- Two important considerations from smoke management aspects are: Adverse health impact and reduced visibility

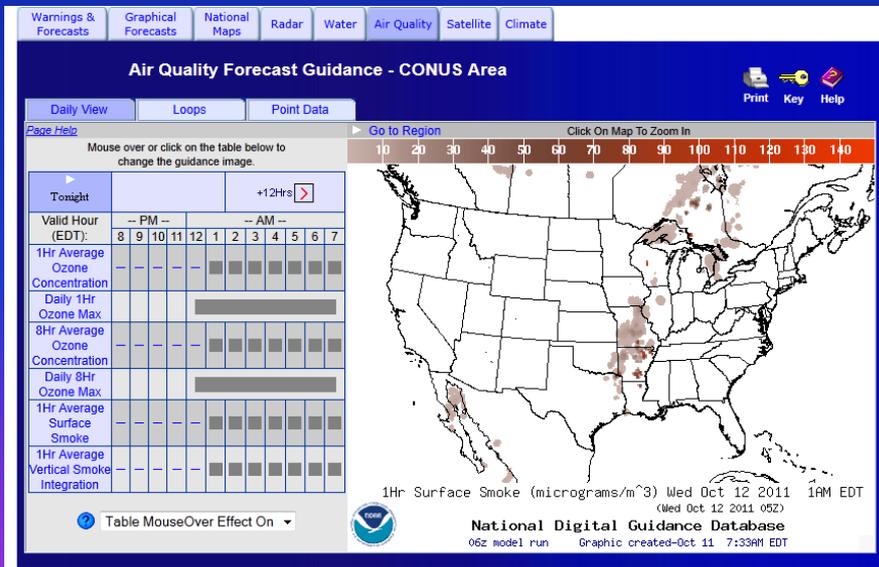
Source: Alabama Cooperative Extension System fact sheet on control burns

# Smoke Management Considerations

- During the large wildfire events of 2007 that occurred in Georgia and Florida, particulate matter air quality (PM<sub>2.5</sub>) jumped from background values of 20  $\mu\text{g m}^{-3}$  (good) to 150  $\mu\text{g m}^{-3}$  (extremely dangerous conditions)
- Super fog events, where combined emissions of smoke and water vapor from smoldering fuel causes extreme reduction in visibility, causing highway accidents such as the event in 2000 along the Alabama-Mississippi border that resulted in 5 deaths and 26 injuries

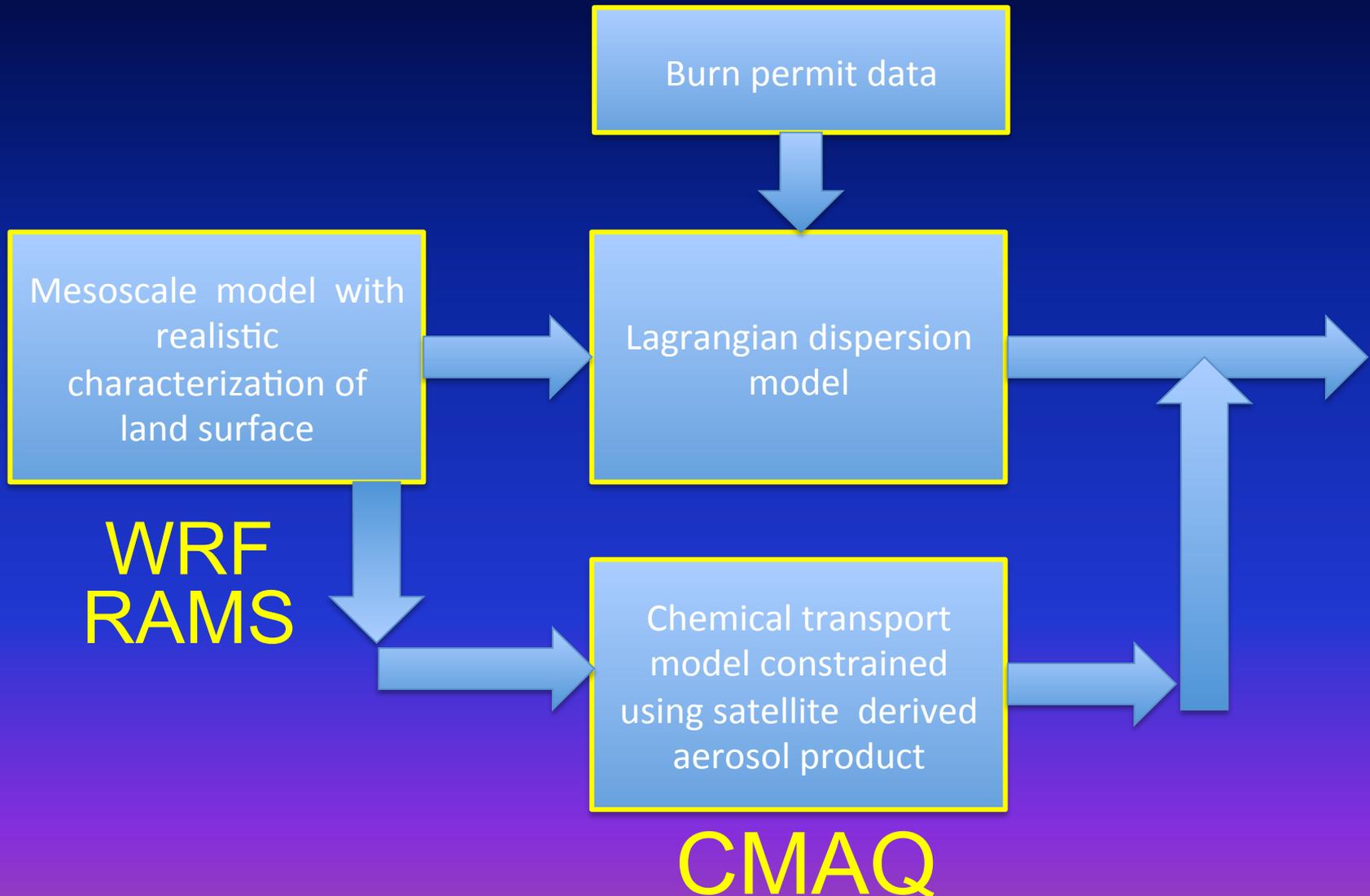
# Tools currently available to AFC

- Smoke transport model for wild fires, dispersion index from NWS, modeling systems such as BlueSky
- Difficult to model several sources, does not account for background air quality and also does not provide contextual information of relevance to smoke management

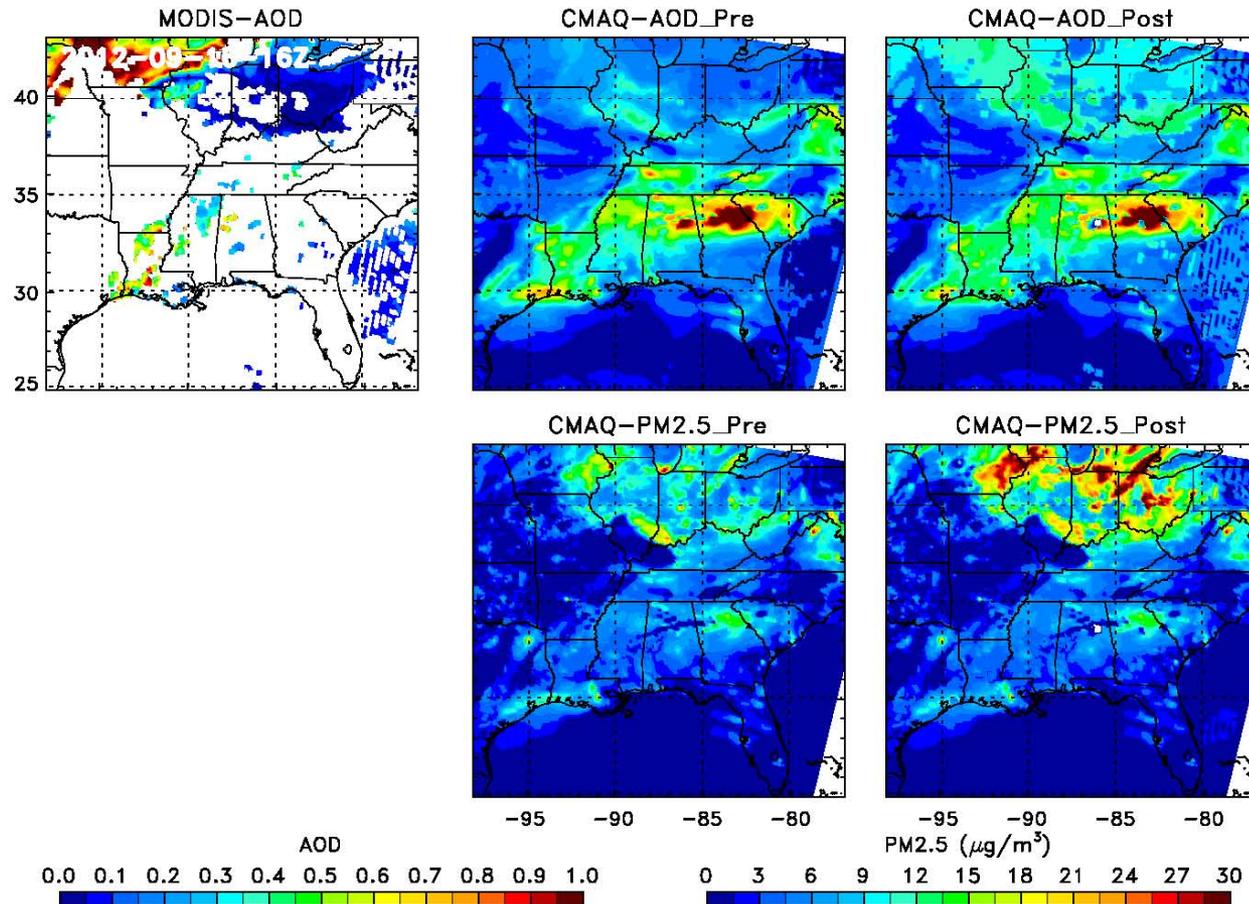


Category Day	Dispersion Index	
•	1 – 6	very poor dispersion
• I	7 – 12	poor dispersion
• II	13-20	generally poor dispersion
• III	21-40	fair dispersion
• IV	41-60	generally good dispersion
• V	61-100	good dispersion
• VI	100+	excellent dispersion

# Modeling system



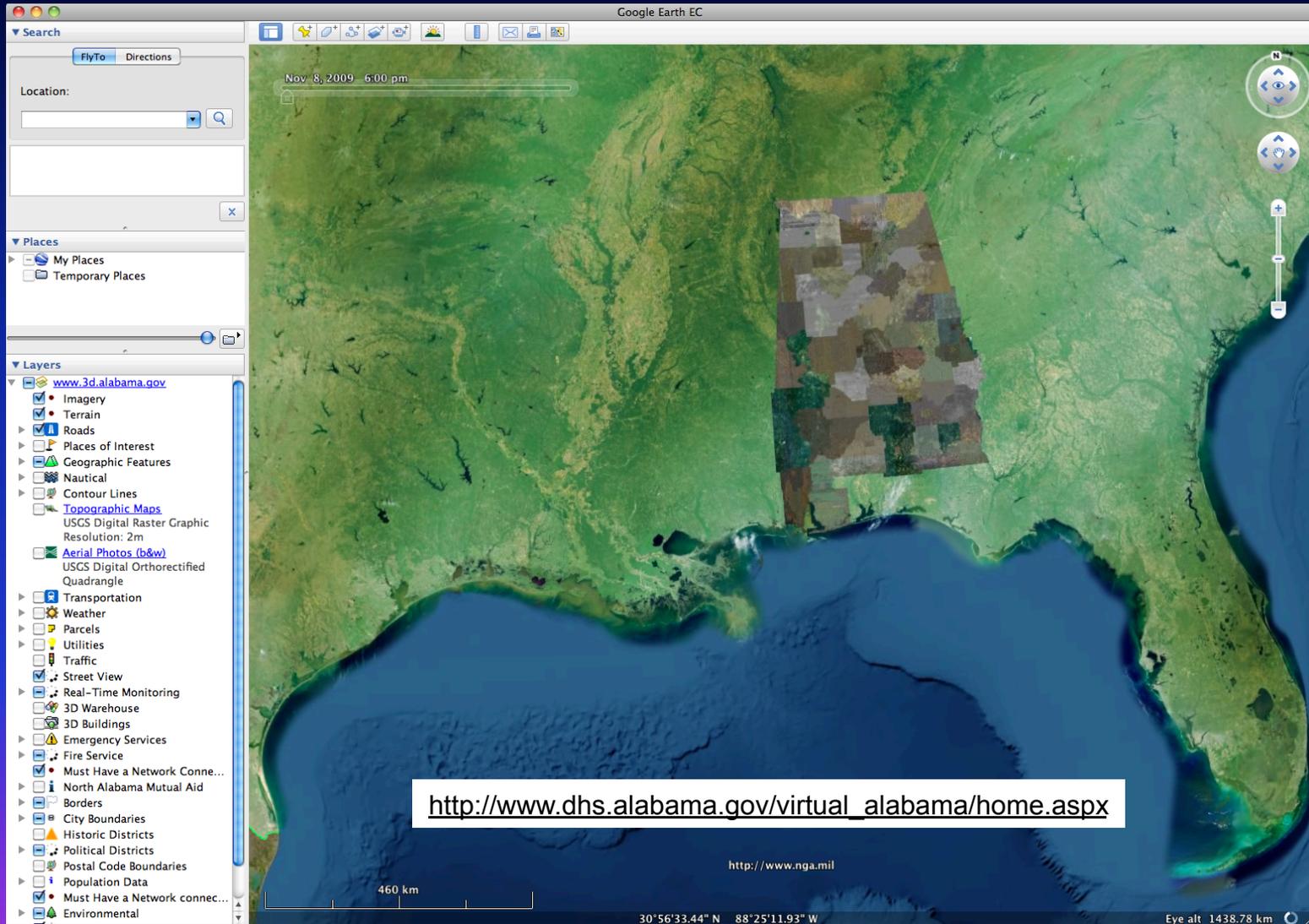
# Use of satellite observations to constrain CMAQ model



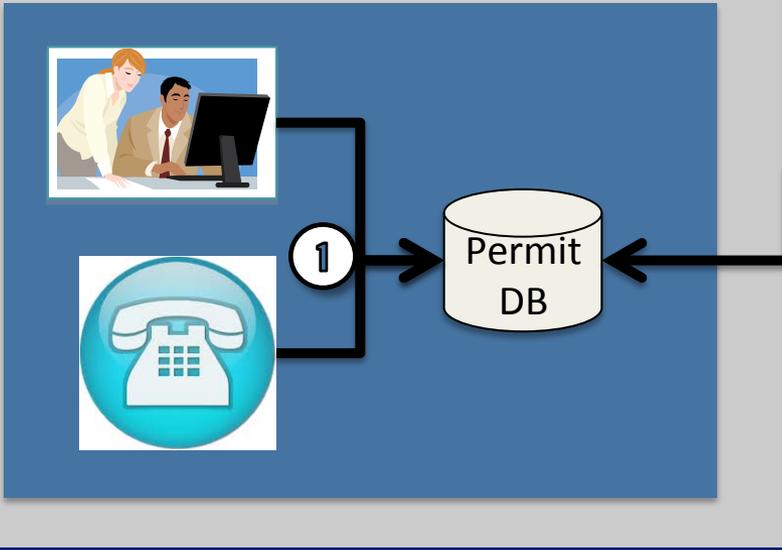
# Decision Support System: Virtual Alabama

- Virtual Alabama (VA): Developed by Alabama Department of Homeland Security
- Leverages existing state asset imagery and infrastructure data into a web-based decision support tool
- VA has over 1800 online users and incorporates variety of information from state and federal agencies

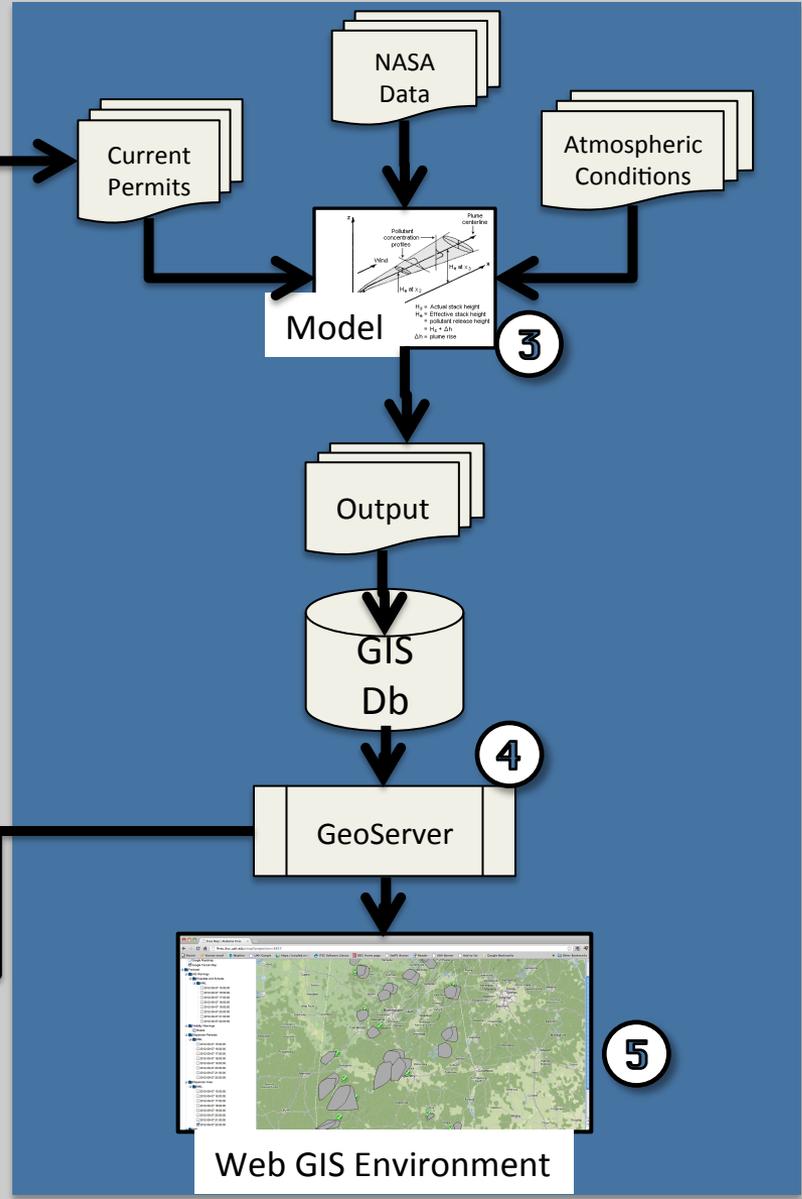
# Decision Support System: Virtual Alabama



# Alabama Forestry Commission

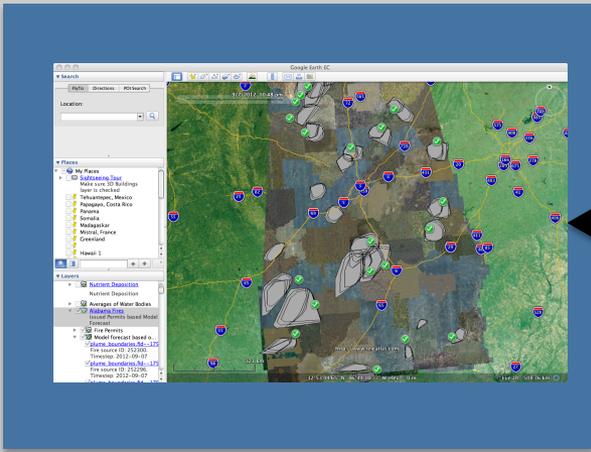


# University of Alabama In Huntsville



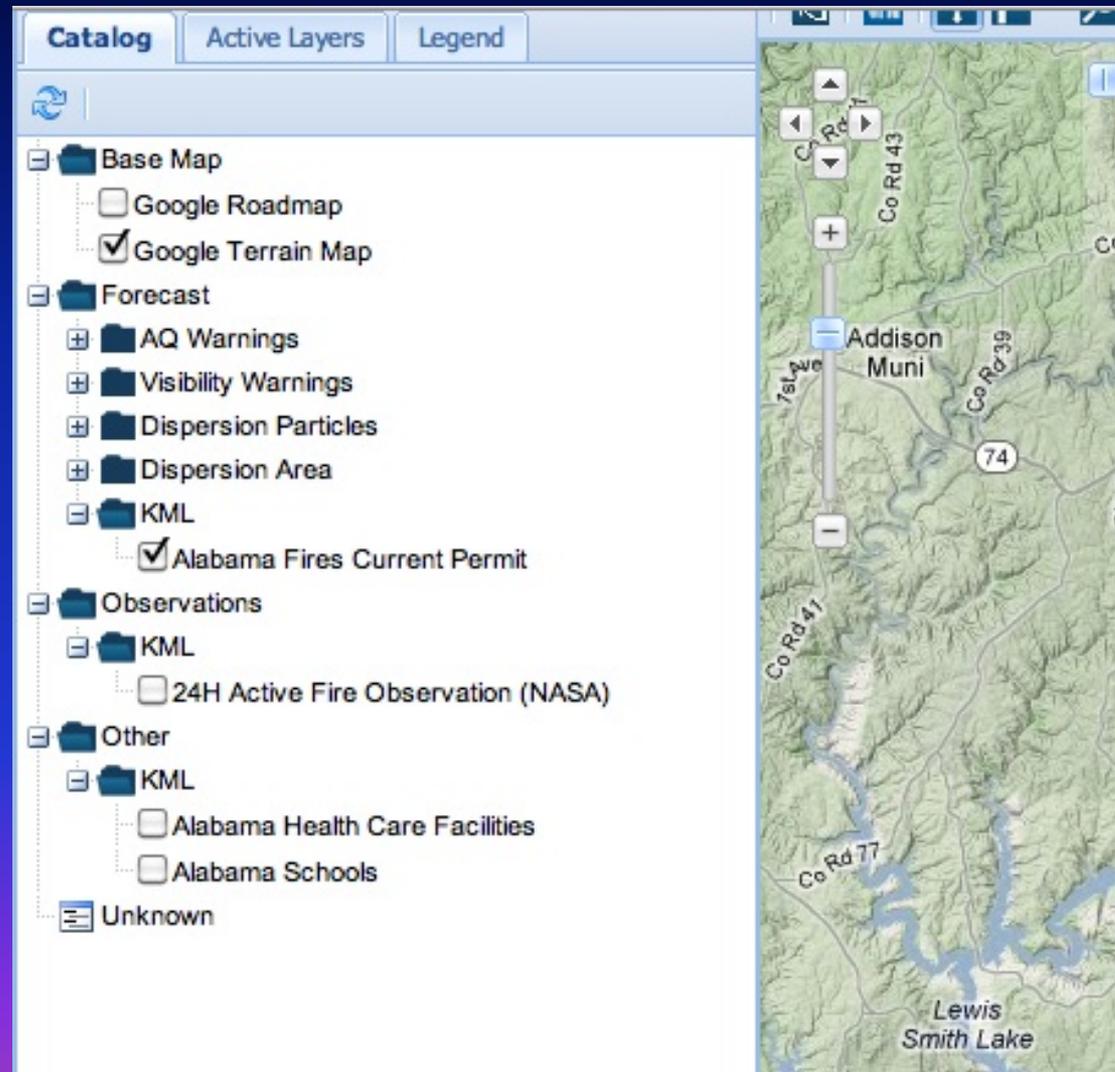
## High-Level Architecture

### Virtual Alabama

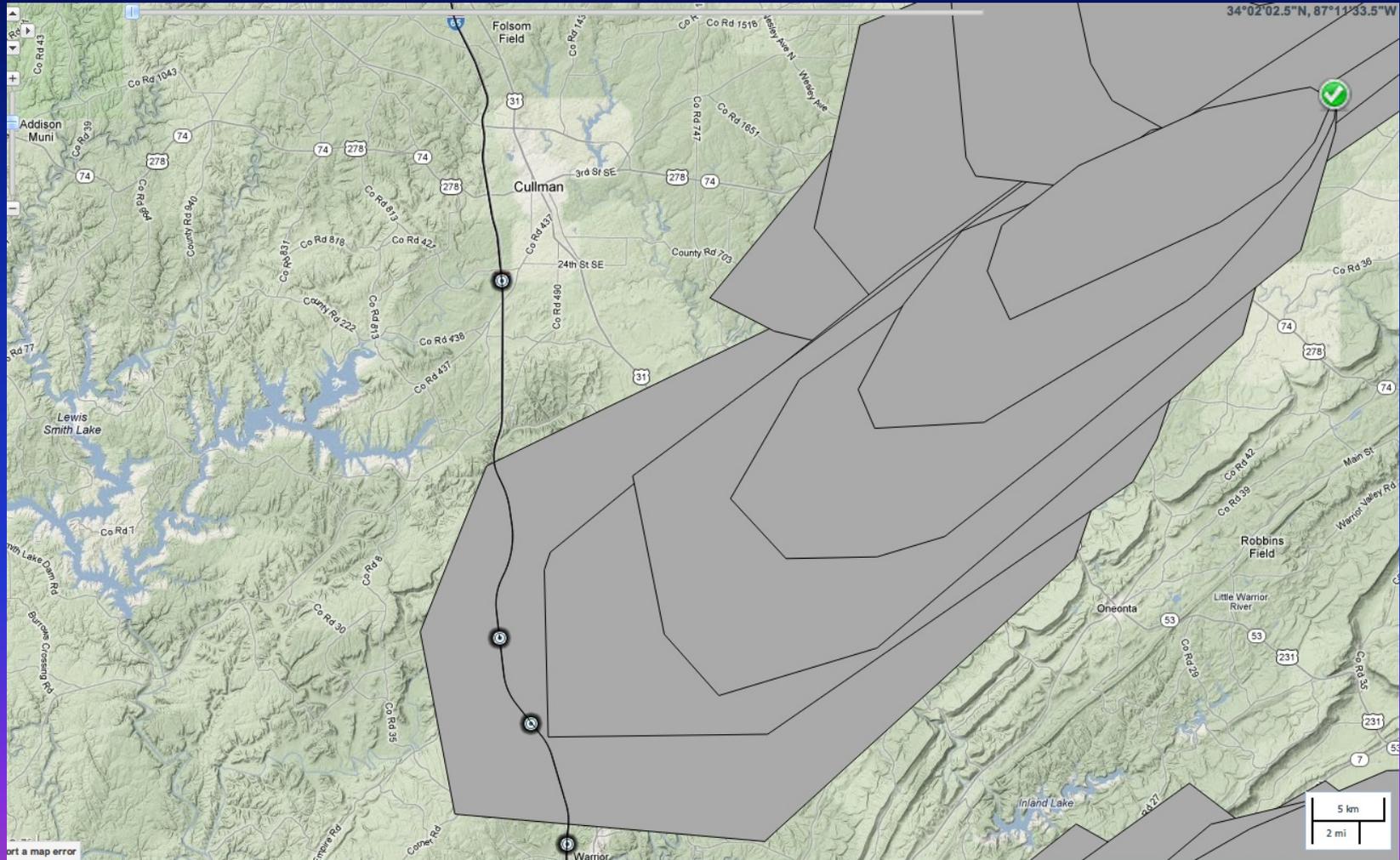


Web GIS Environment

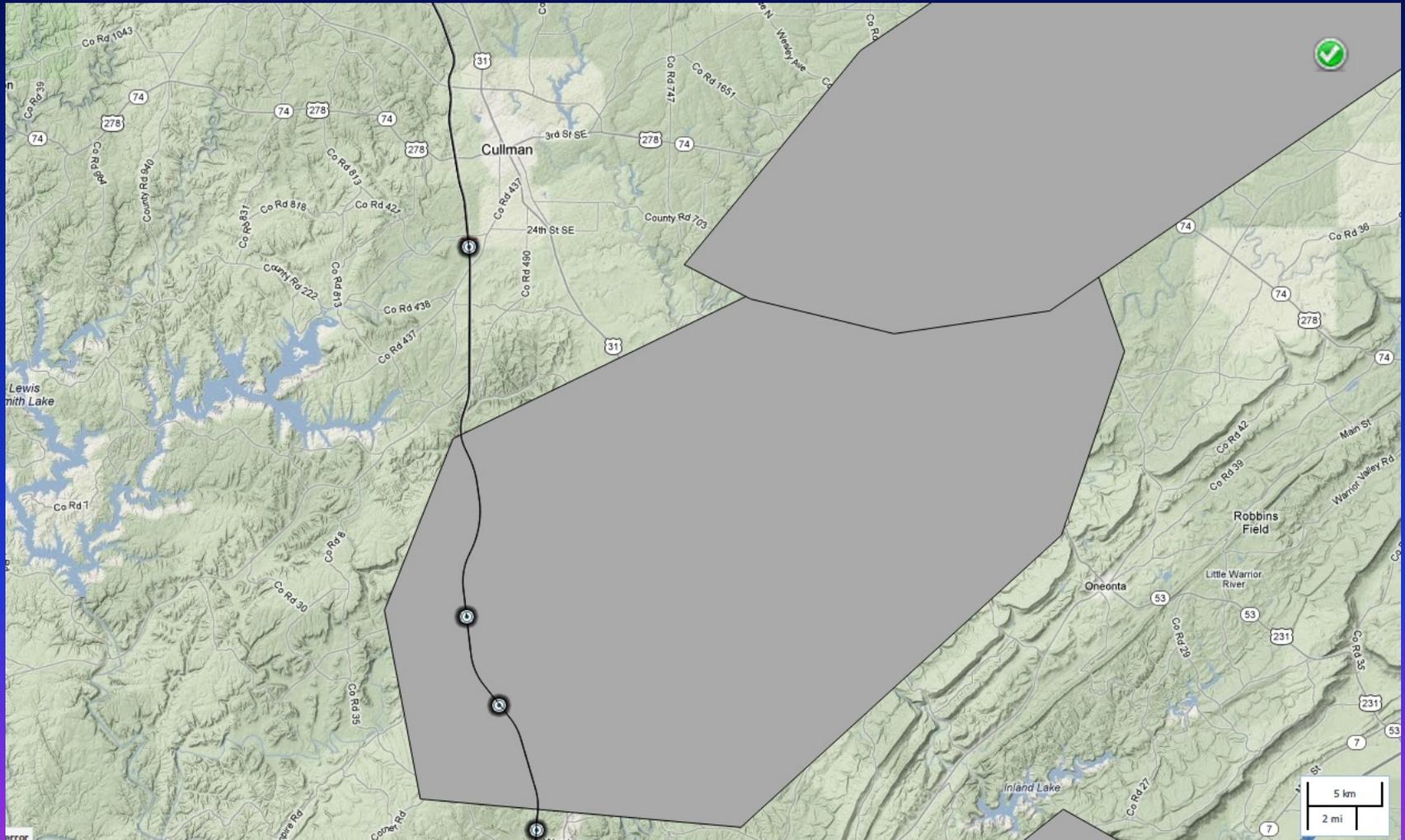
# Features/layers within the web map



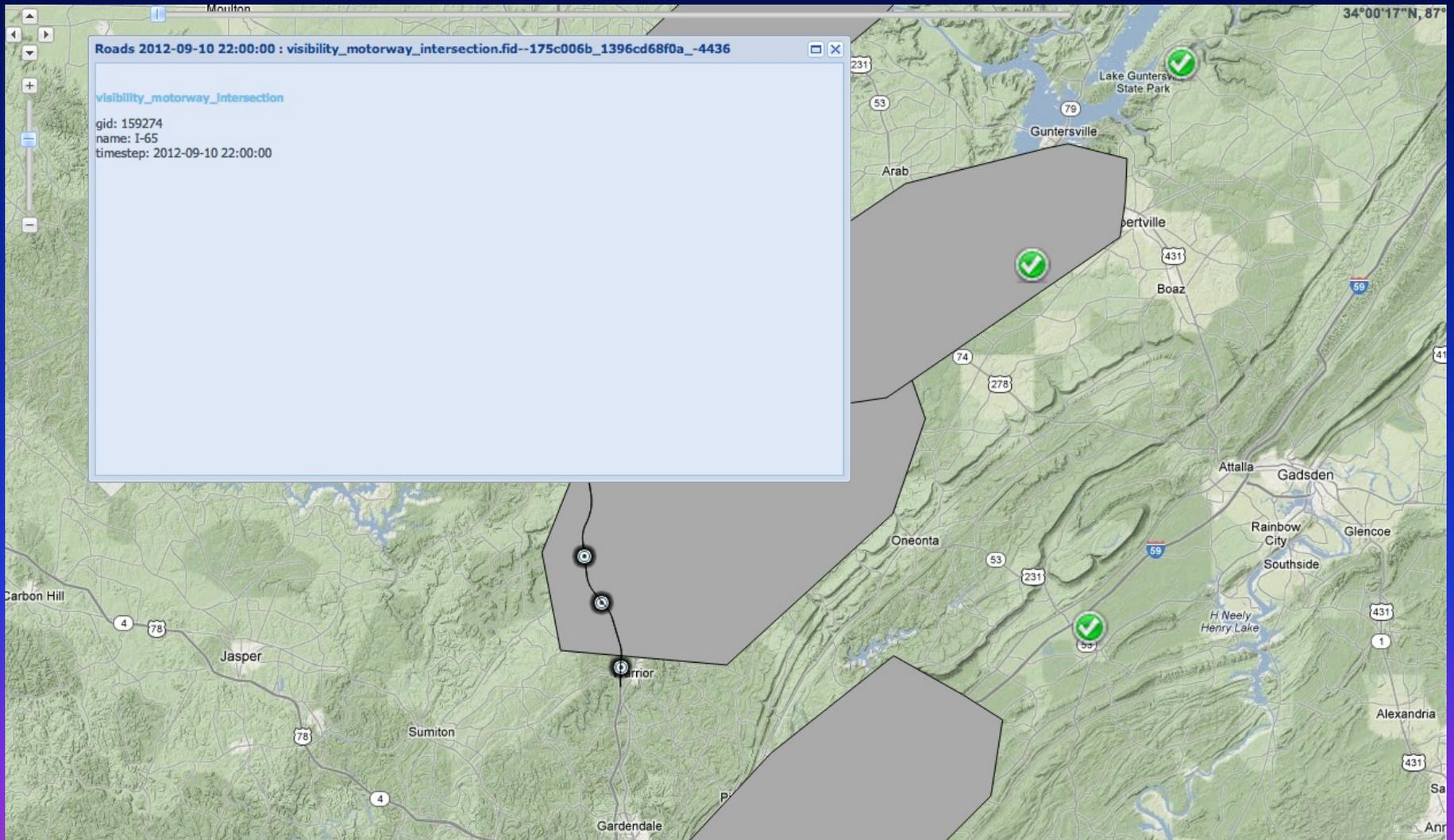
# Permit location and plume boundaries



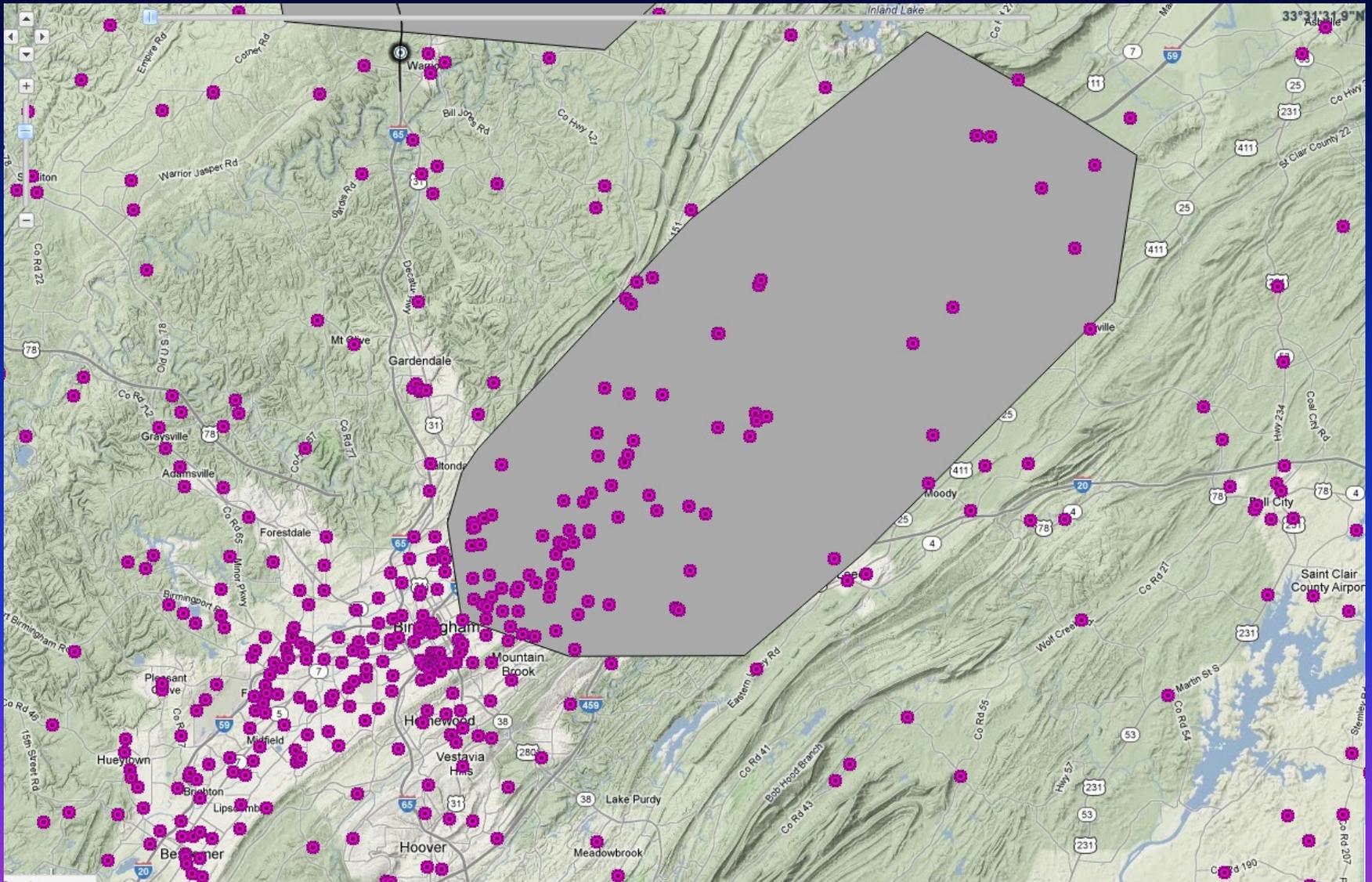
# Intersection with roads



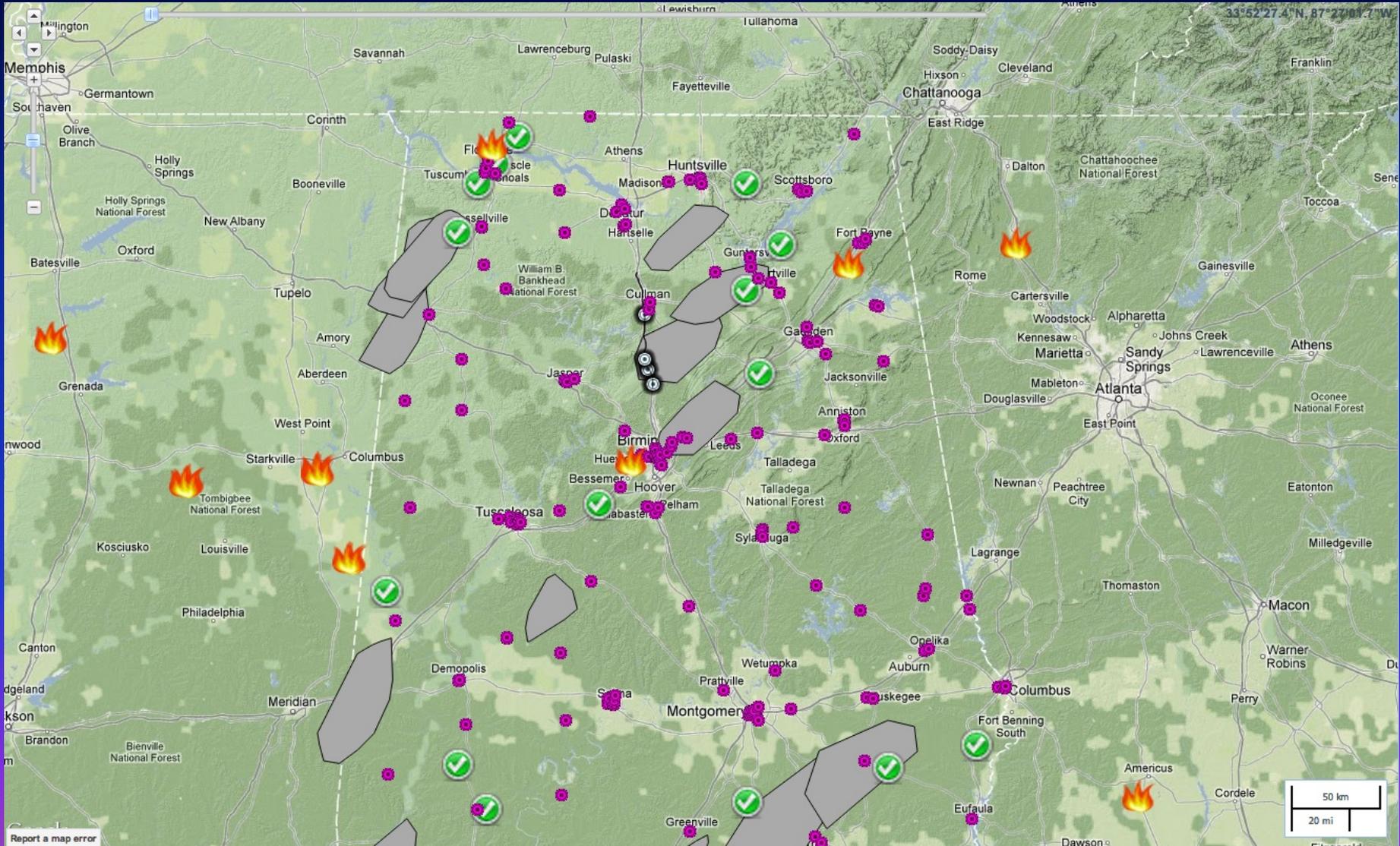
# Details of the intersection



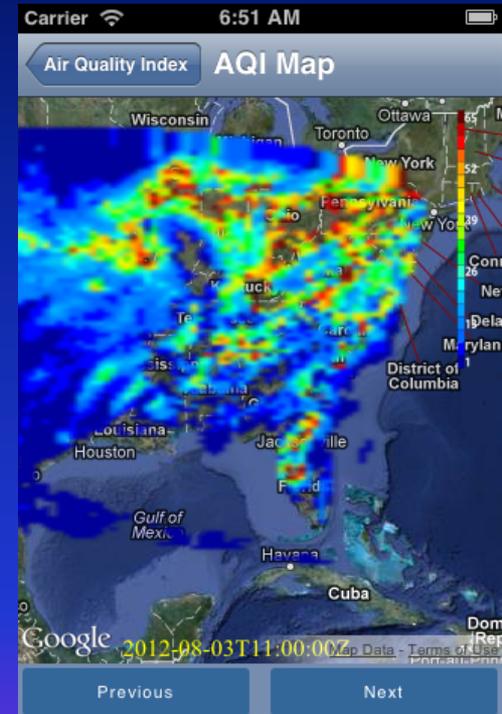
# Intersection with hospitals and schools



# Overlay of NASA fire data



# Smartphone Application



# Task Schedule

Tasks (Leads: 1=Nair, 2=Christopher, 3=Keiser)	Months from Project Start							
	3	6	9	12	15	18	21	24
Meet with partners from NWS, VA, and AFC and to determine communication protocols, data formats, exact schedules etc (1, 2, 3)	█							
Development of project web portal for project management, communication with end-users, documentation and dissemination of training material. (3)	█							
Development of scripts of automated execution of AERO-RAMS, including ingestion of near-real time satellite derived emissions (1)	█	█						
Develop interfaces for the interactive modeling system (3)	█	█						
Development of emissions database for prescribe burn categories. (1)		█	█					
End-to-end test of integration with AWIPS and VA, make changes based on user feedback (3)		█	█	█				
Add linkages to relevant databases in the VA system (3)			█	█				
Compile results from first year of the project into a journal manuscript (1, 2)			█	█				
Conduct first set of training and outreach meeting (1, 2, 3)			█					
Begin making the interfaces to AWIPS and VA operational (3)			█	█				
Communicate developments by meeting with program manager (1, 2)				█				
Finish transition to operational status (1, 2, 3)				█				
Refine functionalities and linkages based on feedback from end users (1, 3)					█			
Design and implement surveys for evaluating the utility of the decision support enhancements (2, 1, 3)					█	█		
Use surveys to collect the data necessary for quantifying the performance enhancement of the decision support systems (1, 2, 3)						█		
Quantify enhancements to decision making capabilities (1, 2)						█		
Transition of technology to appropriate state agencies through training (3, 1)							█	
Conduct second set of outreach and training meeting (1, 2, 3)							█	
Demonstrate capabilities to NASA program manager (1, 2)							█	█
Compile results from applications in a journal manuscript (1, 2)							█	█
Prepare final report to NASA (1, 2, 3)								█

1. Incorporate AFC feedback
2. Enable access control
3. Enable notification
4. Conduct training workshop (Nov 9<sup>th</sup>)
5. Submit publications

# ARL and Costing

Year1	Year2	Year3
3	4	8

- Total budget: \$400K
- Year 3 balance: \$156K