

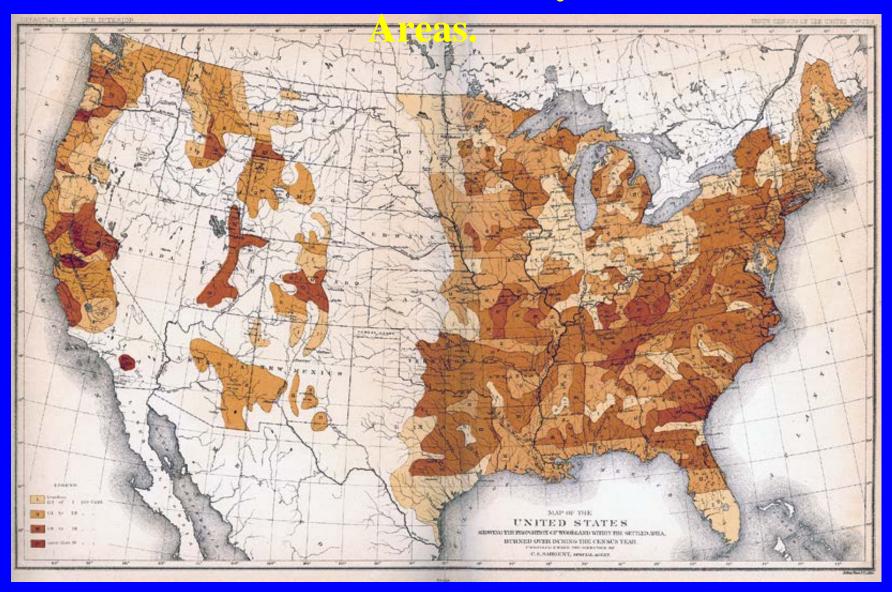
#### Objectives

• Help prescribed burners better manage smoke from a burn and to learn new tools to help do that job.

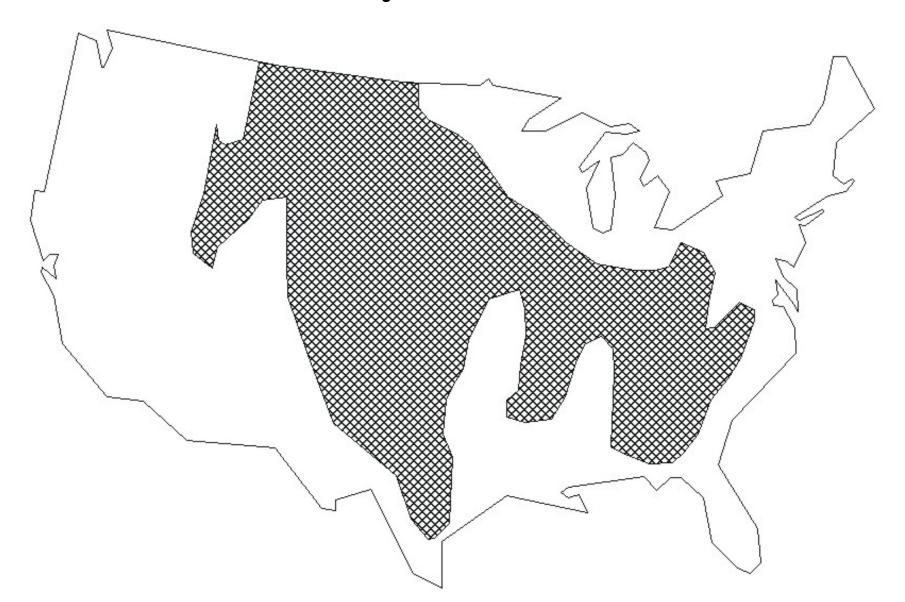
#### Risk, Threat, and Vulnerability

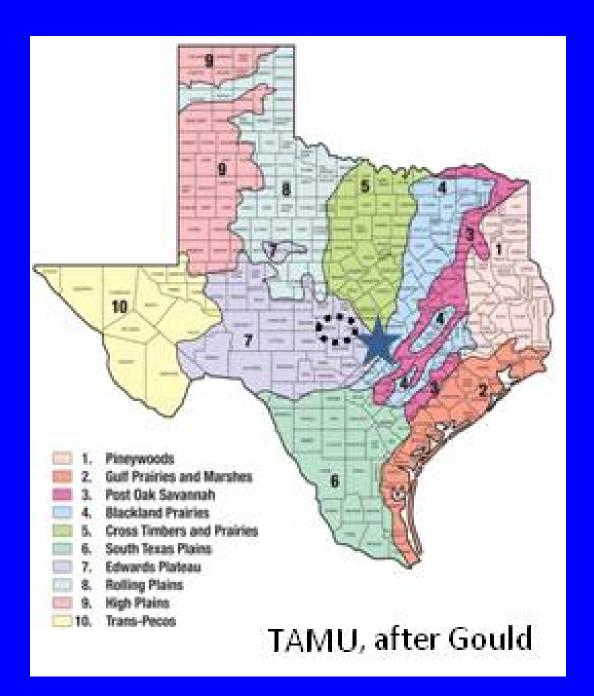
- Risk: The probability of the smoke causing a wreck, polluting a home or business, or just being a nuisance.
- Threat: Refers to the source and means by which we could be sued.
- Vulnerability: What sources in our smoke management plan have failed, or what decisions did we make that would allow the suit to be successful?

# 1880 Survey Map. Darkest Color Represents 10% of "Woodlands Burned Annually Within Settled



# Range of the Modern Buffalo Herd Approximately 400 years B.P.





#### Smoke

- Can be detrimental to YOUR health.
- Can cause major visibility problems
  - on highways
  - in vista areas
- Pollution problems could be costly
- Might be an important factor in maintaining our right to burn.

## Nuisance Smoke

- Smoke may cause problems without violating air quality standards.
  - May interfere with public's activities
  - Many burn programs
     are more severely
     restricted by these
     impacts than from
     air quality regulations.
- Even the *perception* of a problem can result in restrictions on a burn program.



### Why is smoke so important?

- Endangered Species Act
- Restore ecological integrity and maintain air quality and visibility
- NAAQS -National Ambient Air Quality Std
- PM 2.5 and Non-attainment areas
- Visibility and Regional Haze
- Safety and Liability from nuisance smoke.

### Smoke Regulations

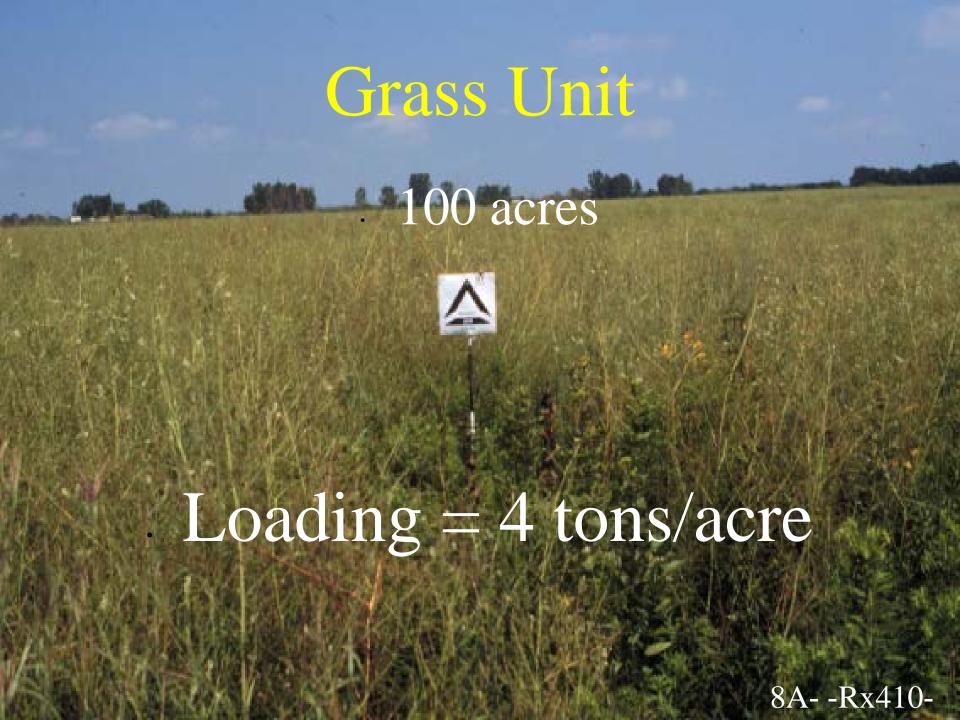
- U.S. EPA Clean Air Act
  - Updated and measured frequently
  - PM 2.5 is new standard
- Texas Commission on Environmental Quality
  - All outdoor burning rules apply mostly to smoke

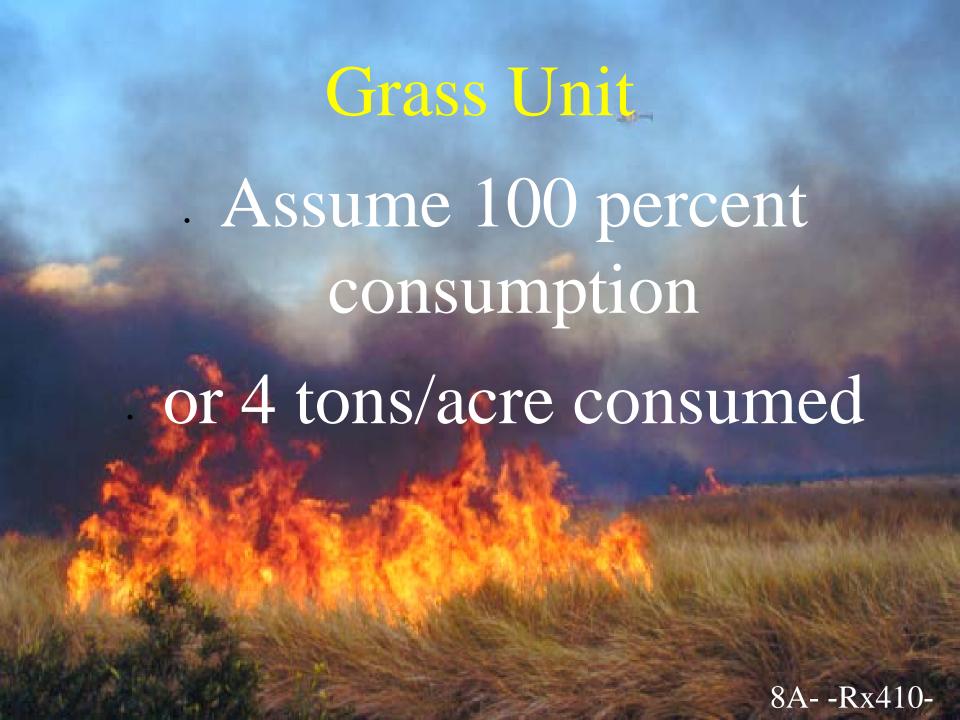
#### What is Smoke?

- CO2 90% of smoke consists of
- H2O Carbon Dioxide and Water
- CO
- PM, PM 10, PM 2.5
- Ozone
- Air Toxins acrolein, formaldehyde

## Particulate Matter

- Smoke particles from wildland fires are relatively small
  - 10% by mass are greater than 10 microns (fly ash)
  - 20% by mass are between 2.5 and 10 microns (dust)
  - 70% by mass are smaller than 2.5 microns (pollen)





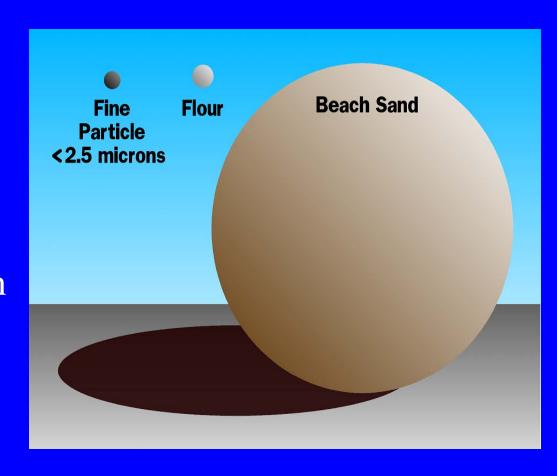
# Emissions (PM<sub>2.5</sub>)

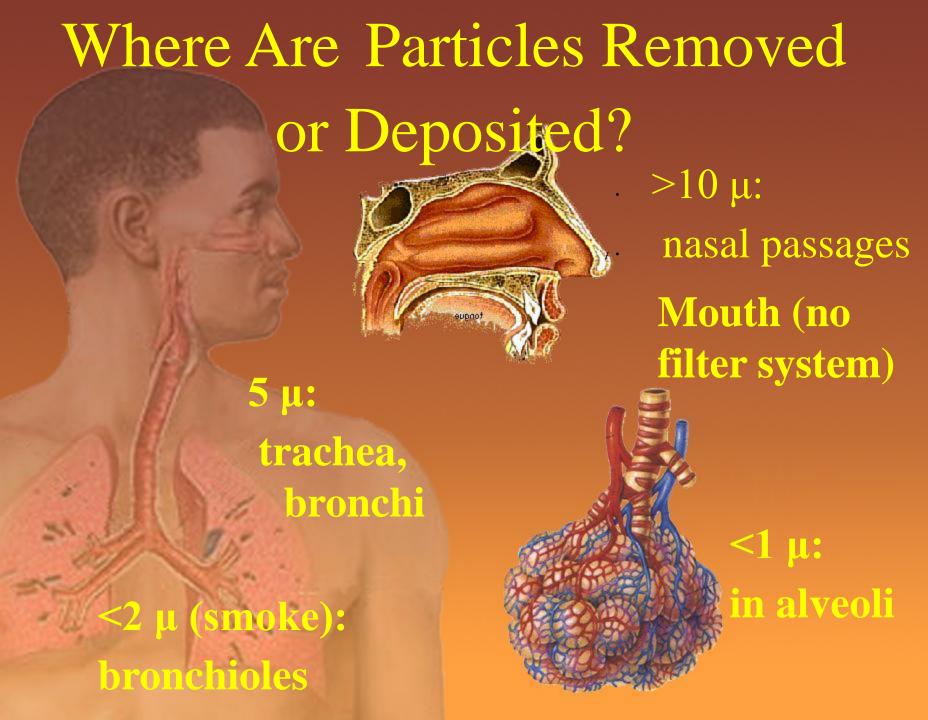
Fuel consumed PM<sub>2.5</sub> EF Emissions production 4 tons/acre X 15 lbs/ton = 60 lbs/acre

area emission production total emissions 100 acrés X 60 lbs/acré = 6,000 lbs or 3 tons

#### Personal safety

- The big particles from smoke can be effectively filtered by a mask or handkerchief.
- The small <2.5 micron particles are with us forever.





#### Toxins in Smoke

- Acrolein
- Formaldehyde
- Respirable Particulates
- Carbon Monoxide
- Benzene

## Acrolein

- Aldehyde with piercing, choking odor
- Irritates eyes, upper respiratory tract, causes nausea
- Severe exposure results in edema, abnormal lung function
- Long term exposure—chronic respiratory disease
- Workshift Peak Exposure Level: 0.1 ppm

# Formaldehyde

- Low-level: irritates eyes, nose, throat
- Higher level: irritates respiratory tract
- Long-term exposure associated with cancer
- Workshift Peak Exposure Level: 0.75
   ppm

# Respirable Particles (PM<sub>2.5</sub>)

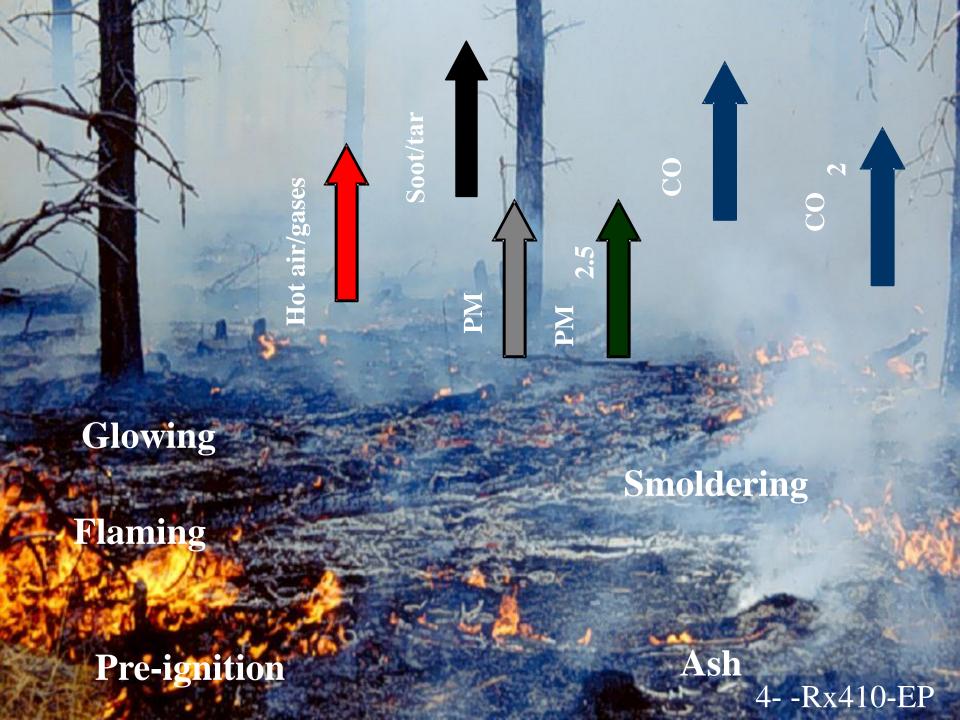
- Irritation of mucous membranes
- Deposition in respiratory tract (alveoli)
- Transports carcinogenic policyclic Aromatic Hydrocarbons (PAHs)
- Defenses: cilia, macrophages
- Workshift Peak Exposure Level: 5,000 μg/m³ (5 milligrams/m³)

# Carbon Monoxide (CO)

- Colorless and odorless
- Reduces oxygen transport in the blood
- Causes severe headaches
- Loss of mental acuity, motor skills, and time awareness
- Stresses heart
- May cause angina, coma, death
- Workshift Peak Exposure Level: 50ppm

#### Protect yourself from smoke

- Limit your exposure time
- Rotate crew members if possible
- Reduce mop up time
- Meetings and lunch in smoke free zones



# Pre-Ignition Phase

- Fuels are heated
- Fuel moisture is driven off and water vapor is released
- Pyrolysis begins:
   thermal
   decomposition
   of cellulose to combustible vapors



# Flaming Phase

 Combustible vapors reach 600° F and mix with sufficient oxygen

- Accelerates pyrolysis
- Rapid oxidation
- Produces primarily
   CO<sub>2</sub> and H<sub>2</sub>O
- Partial oxidation causes a variety of emissions



# Consumption and Smoldering Phase

- Occurs at fuel surface or internally
- Can occur with limited oxygen
- Slower rate of combustion
- Long duration
- Lower combustion efficiency, high emission factor
- Consumption rate variable

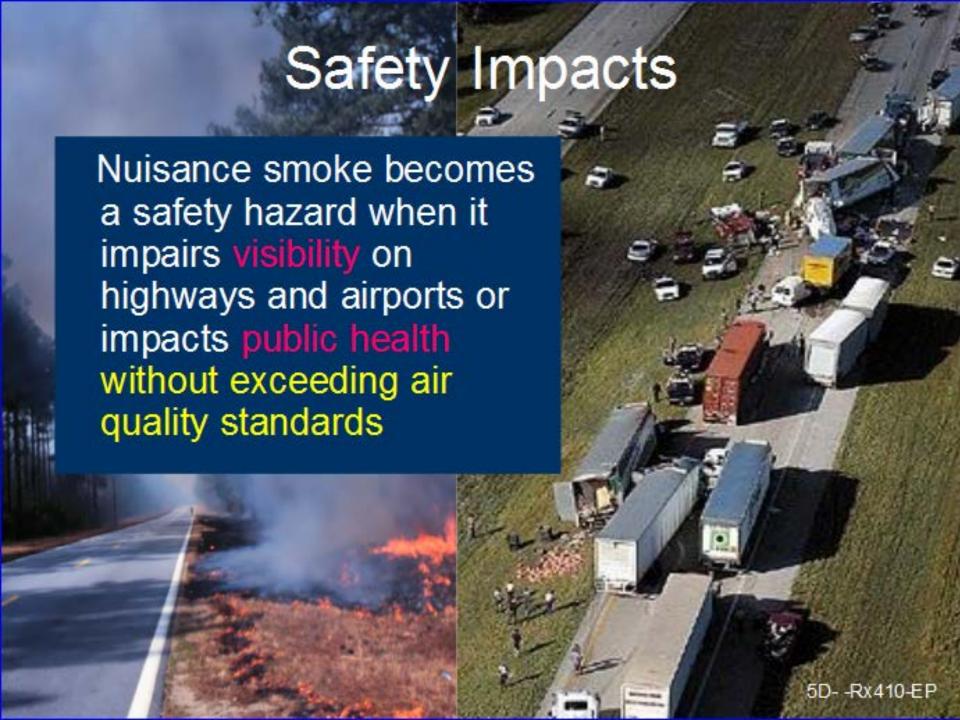
# Why are we concerned about visibility?

Safety

• It is the law (1977 Clean Air act Amendment)

Regional Haze

Scenic visibility protection



#### TCEQ rules

Commence or continue burning only when the wind direction and other weather conditions are such that the smoke and other pollutants will not present a hazard to any public road, landing strip, or navigable water (e.g. lake, river, stream, or bay) or have an adverse effect on any off site structure containing "sensitive receptors" (e.g. a residence, business, farm building, or greenhouse, see box, page 6). ... Post someone to flag traffic if at any time the burning causes or may tend to cause smoke to blow onto or across a road or highway.

# Safety Related Episodes

May result from direct plume impacts

May result from continued smoldering after the

burn, especially at night

Presence
 of smoke
 particles
 promotes fog
 formation at
 temperatures
 above the
 dew point.



## What Happens to Smoke Particles?

• It takes about 35 days for a particle between 0.1 and 1.0 µm to drop 1000 ft. (in still, dry air)

Most smoke particles = .1 to .7 μm
 Particles of this size form excellent cloud condensation nuclei and may assist in the formation of rain or fog droplets and can be removed

• from the atmosphere.

• It has been estimated that smoke particles have an average "life-span" of 2-3 weeks.



## **Assessing Air Quality**

Category	PM2.5 1-hr avg. concentration (µg/m³)	Visibility Range (miles)
Good	0-40	10 miles and up
Moderate	41-80	6 to 9 miles
Unhealthy for Sensitive Groups	81-175	3 to 5 miles
Unhealthy	176-300	1 1/2 to 2 1/2 miles
Very Unhealthy	301-500	1 to 1 1/4 mile
Hazardous	Over 500	3/4 mile or less

The procedure for using personal observations to determine the approximate PM 2.5 concentration for local areas without official monitors is:

- Face away from the sun.
- •Determine the limit of your visible range by looking for targets at known distance (miles). Visible range is that point at which even high contrast object totally disappear.

# Monitoring Smoke

When dealing with a smoke-sensitive site, it is important to monitor for nuisance and safety related smoke impacts, and document smoke observations.

- Set out stakes or flags on roadways at predetermined distances and monitor visibility
- Record number of nuisance complaints
- Use air quality monitors or cameras
- Patrol smoke-sensitive areas to monitor for impacts and reassure the public

# Practice Good Planning



Smoke management
should be considered
throughout all phases
of burn planning.

#### Plan Ahead

 Good decisions made early in the planning process will make it easier to attain smoke management objectives during burns.



• Use smoke management objectives as trigger points for assessing the severity of smoke impacts and whether to terminate the burn.



# Smoke Management Plan

- Plan the burn so that the smoke produced will be within the laws and rules.
- Obtain a prediction of the ventilation rate.
- Run the following models:
  - Simple Smoke Screen Model
  - Vsmoke Web
- Obtain a spot forecast to include HYSPLIT.

## Plan

- Should include the day of the burn and at least that night.
- Heavy smoke can move away during the day and then drop with the mixing height that night.
- Smoke from smoldering 1000 hr fuels can move with topography and literally flow down drainage areas.

### **Category Day**

Category Day	<b>Ventilation Rate</b>	<b>Burning Guidelines</b>
I	<14,500	No Burning!
П	14,500 - 29,000	No burning until surface inversion has lifted
III	29,000 - 58,000	Daytime burning only
IV	58,000 - 117,000	<b>Burning Anytime</b>
V	>117,000	<b>Excellent Smoke dispersal</b>

**Ventilation Rate** = (Afternoon mixing height in feet x transport wind speed mph)

If forecast is in metric units then you will need to convert to English system.

```
m/s (meters/second) *2.24 = mph
kts (Knots) * 1.15 = mph
meters * 3.28 = feet
```

# Category Day is useful

- Give you an idea of the dispersion of the smoke.
- Higher category days are more prevalent during the summer.
- Category Day is useful, but may not supply all the necessary information for a prescribed burn.

## Ventilation Rate

- For a 1pm burn, the ventilation rate is excellent.
- Where will all that smoke be at 6am the next day?



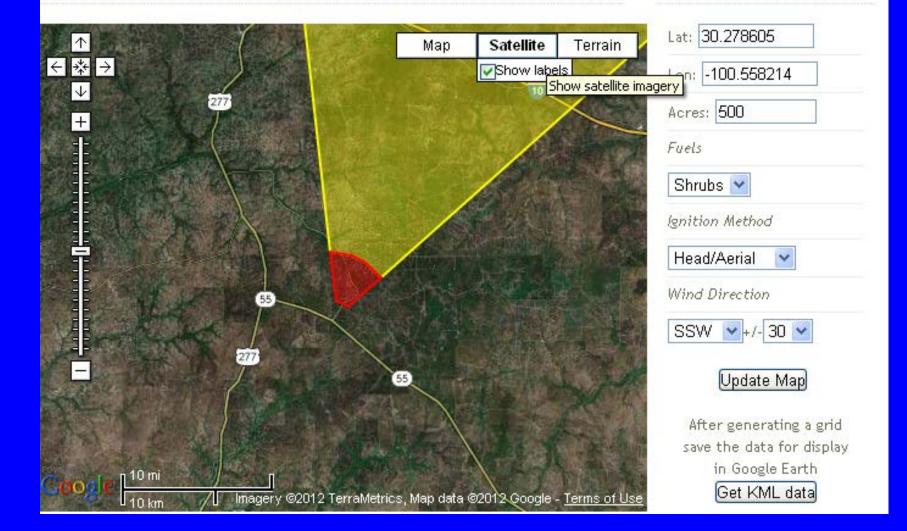
# Smoke planning

- Don't put up more smoke than can be released.
- Objective is to move the smoke away from the burn unit and disperse in the atmosphere away from problem areas.
- Strip headfires can be helpful to release the smoke in smaller units.

FCAMMS SHRMC Smoke Screening

#### Simple Smoke Screening

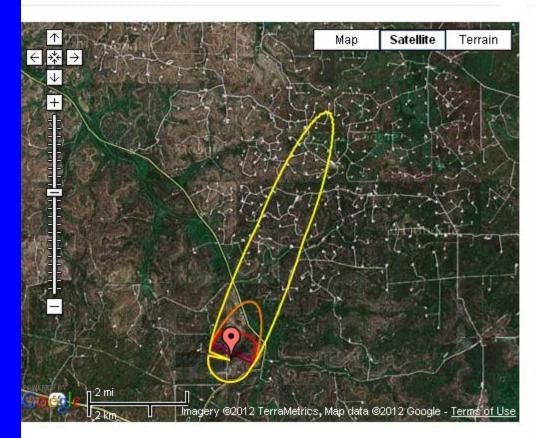
#### Fire & Fuel Info



## Vsmoke Web

- More inputs than the Simple Smoke model
- Use current meteorological data to manually input into the model.
  - Mixing height, transport wind speed, and wind direction
- Describe the fuels (coarsely)
- More levels of emissions.
- Outputs emission data for HYSPLIT

#### **Estimating Prescribed Fire Smoke Impacts**



Download KML File

About

#### Fire & Weather Info

1. Location

Lat: 30.28753158929

Lon: -100.552368164

2. Fire Size

Acres: 500

Duration: 5 hours

Ignition Method:

Head/Aerial 💌

3. Fuel Load

Fuel Type:

Shrub - Lght 💌

Tons/Acre: 4

4. Fuel Consumption

Fuel Moisture Scenario:

Dry

% consumed: 70

5. Emissions

PM 2.5 Emission Factor:

27 lbs/

## Vsmoke

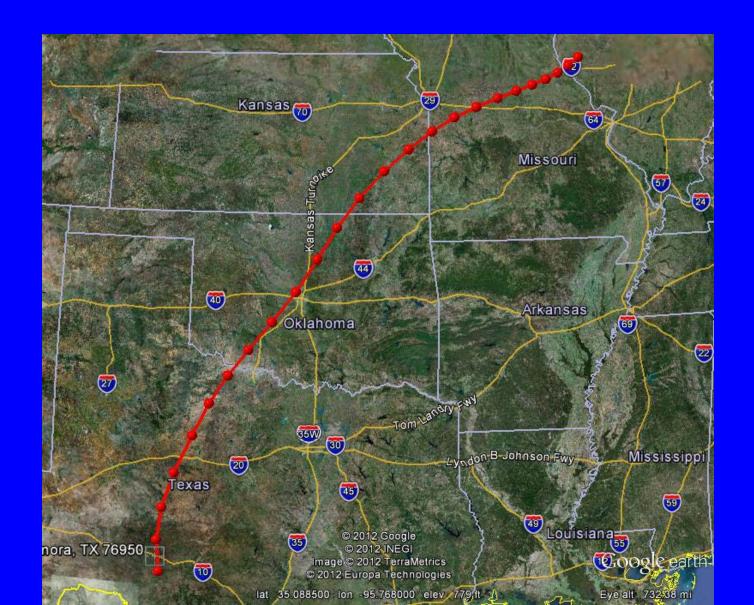
Levels of Health Concern	AQI Value	Hourly PM 2.5 Conc.	Meaning
Good	0 to 50	0 to 38	Air quality is considered satisfactory, and air pollution poses little or no risk
Moderate	51 to 100	39 to 88	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	101 to 150	89 to 138	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151 to 200	139 to 351	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201 to 300	352 to 526	Health alert: everyone may experience more serious health effects
Hazardous	301 to 500	> 526	Health warnings of emergency conditions. The entire population is more likely to be affected.

Stability Class: Moderately Unstable 💌 7. Update Map Run Model 8. Misc Options Background PM 2.5: 5 ug/m3 Plume Rise Fraction: 0.75 9. HYSPLIT Info Total Emissions: 5.498e+13 ug

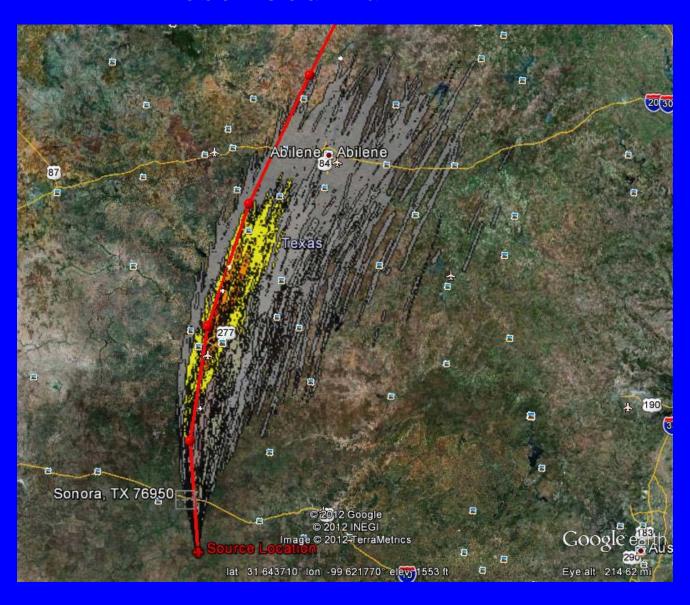
## HYSPLIT

- More complicated and you must be registered to get the emission run.
- Can get a HYSPLIT run if you request it with a spot forecast.
- Uses meteorological data from NOAA in real time.
- Can also do archived runs.

# HYSPLIT Trajectory Model



# HYSPLIT Emissions Model Prescribed Burn



## Other Models

- FEPS Estimates emissions and heat release. Data goes into HYSPLIT
- PB Piedmont night time model
- Blue Sky (used in HYSPLIT)

# Smoke Management

- Smoke planning is important
- Plan ahead for Safety and Liability Concerns.
- Run the Simple Smoke Screening or Vsmoke Web model for your plan.
- Get a copy of HYSPLIT with your spot forecast.