Smoke Management for Prescribed Burning

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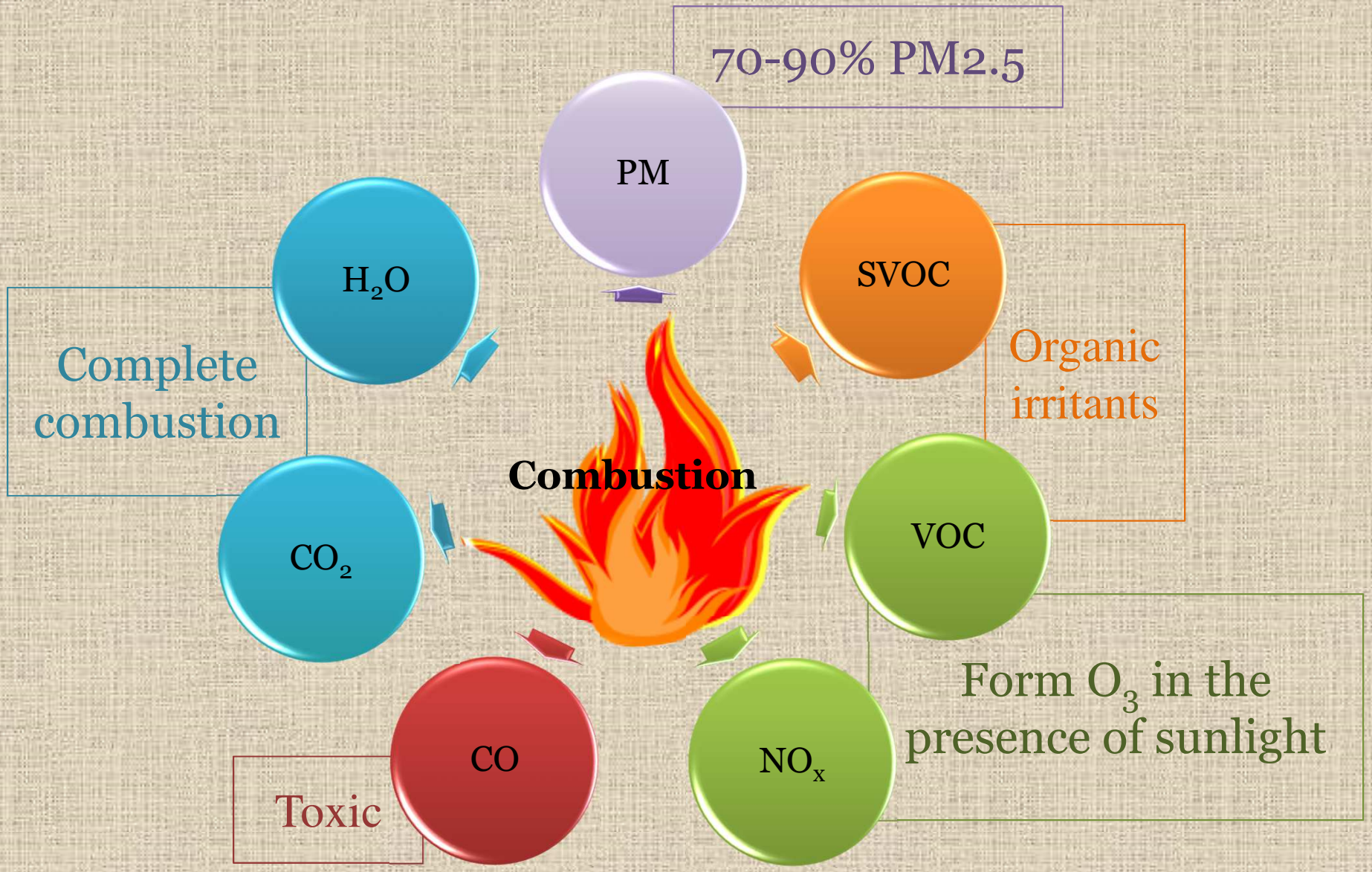
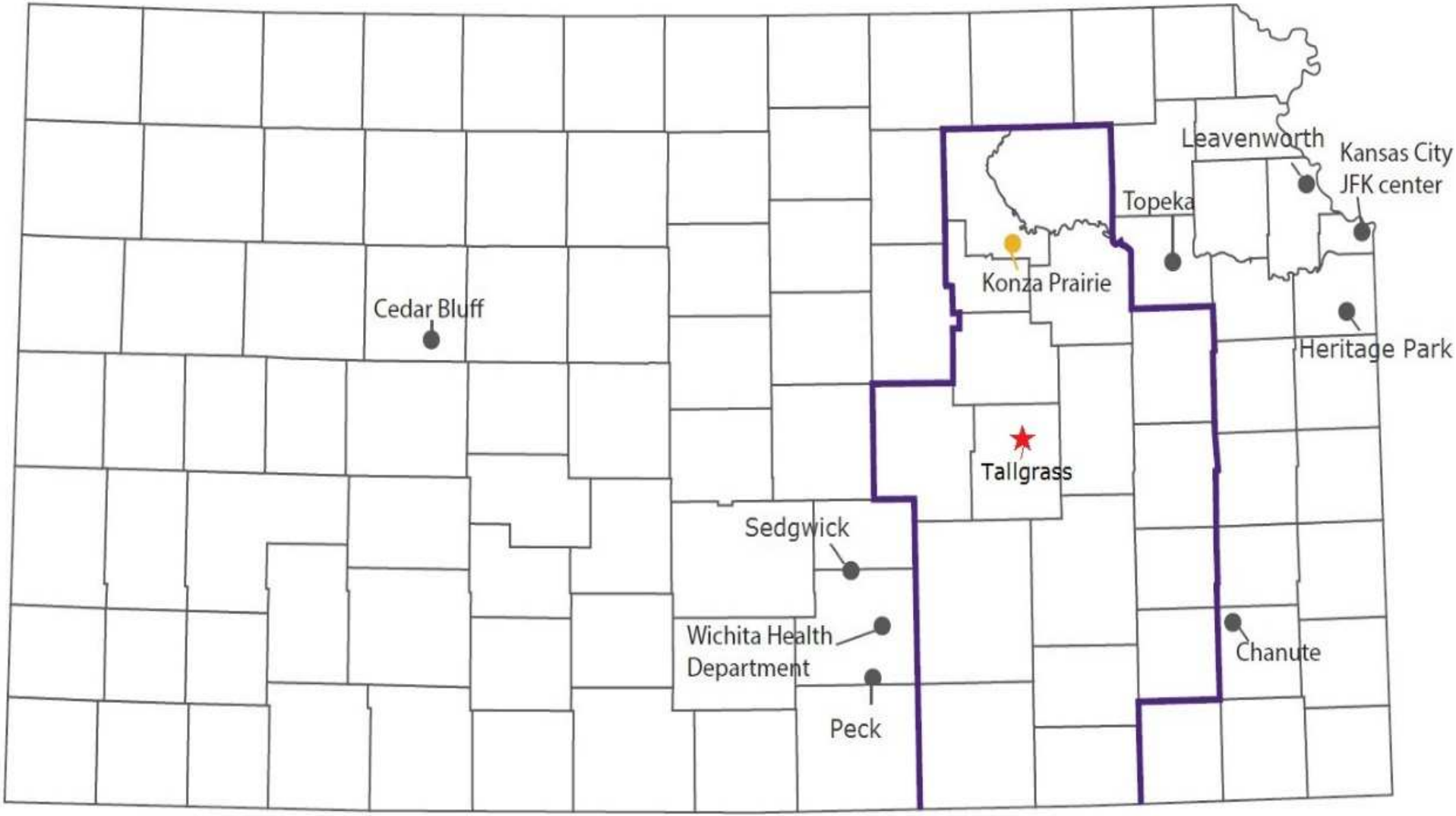
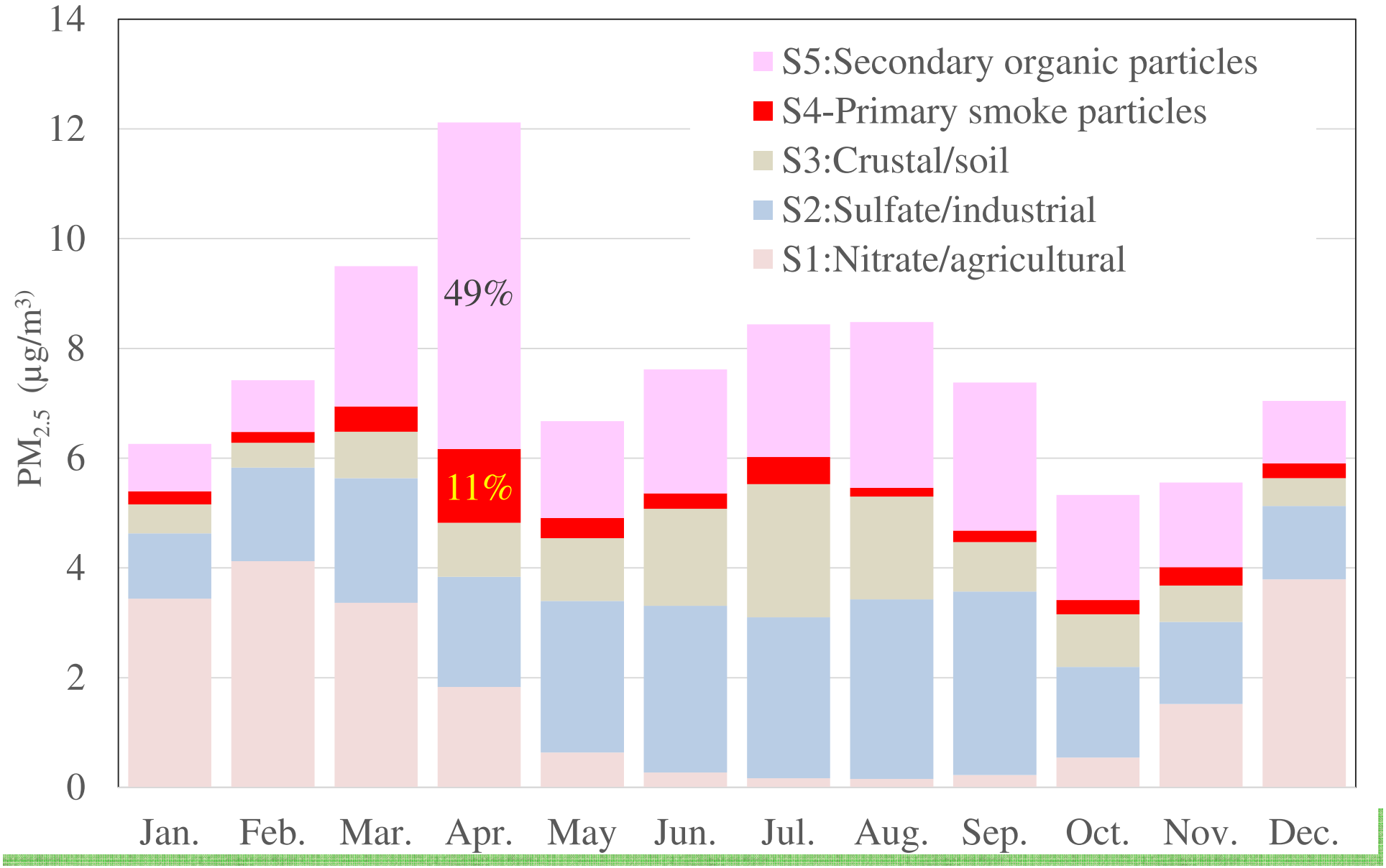
Smoke and air quality



The Tallgrass monitoring site



Five $PM_{2.5}$ source categories at the Tallgrass site



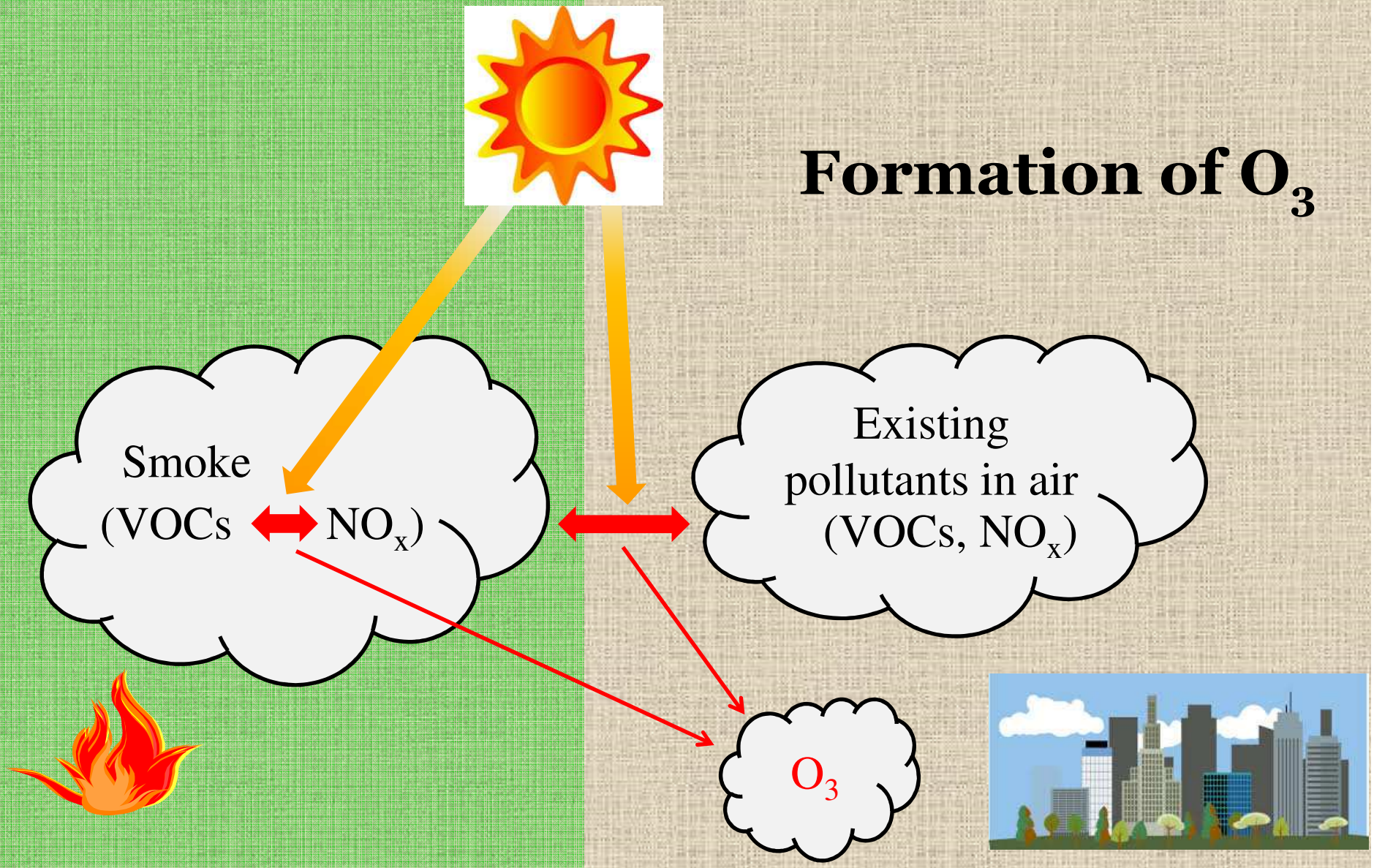
National Ambient Air Quality Standards (NAAQS)

Six criteria air pollutants

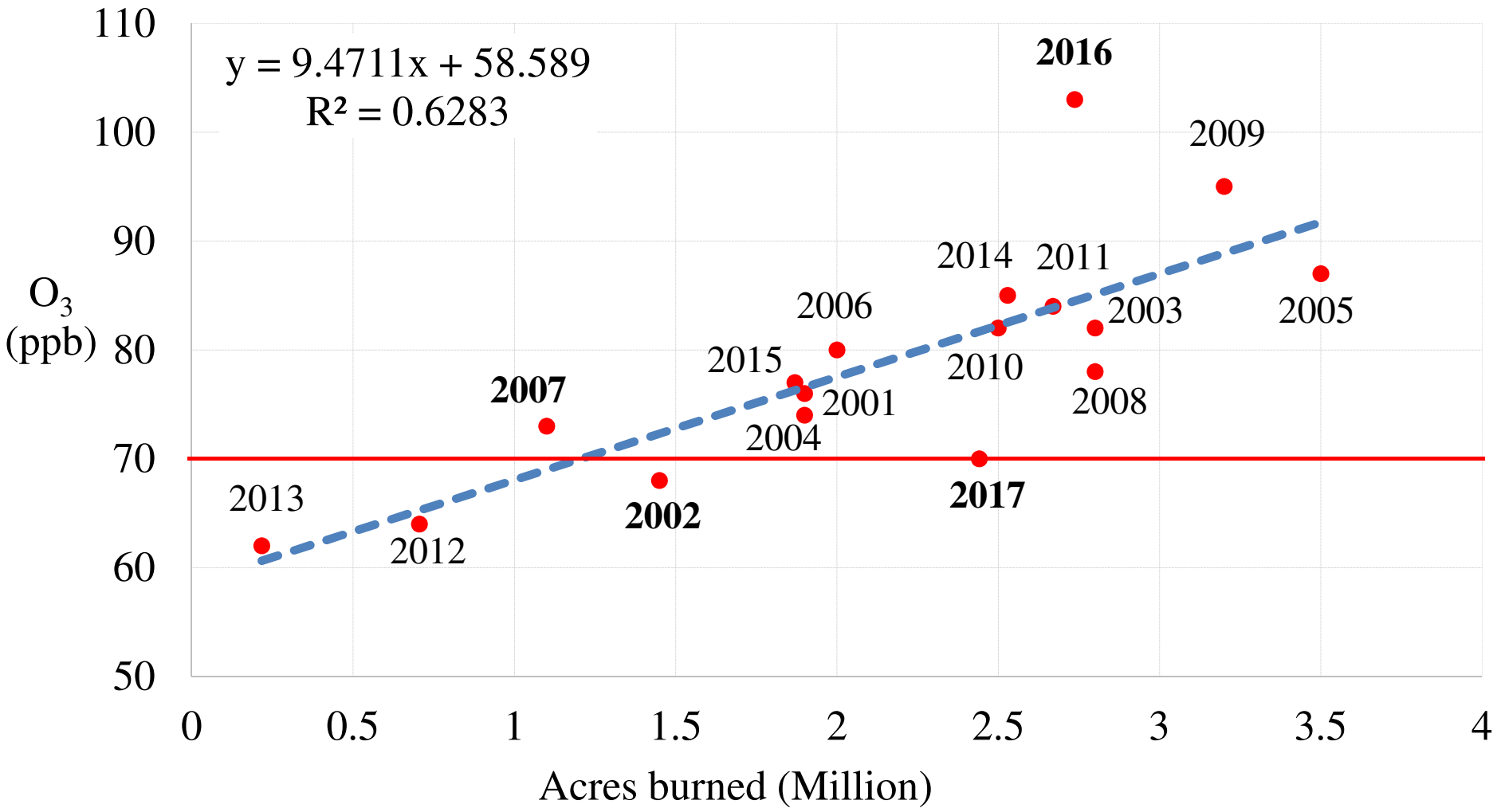
- PM
- O_3
- NO_2
- SO_2
- CO
- Pb

http://www.epa.gov/ttn/naaqs/

Formation of O_3

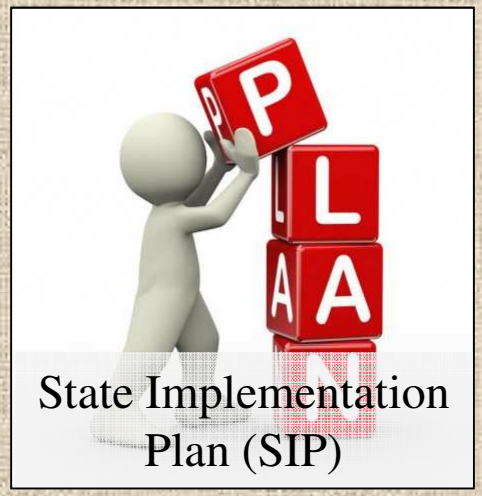


Acres burned vs. highest 8hr O_3 in April



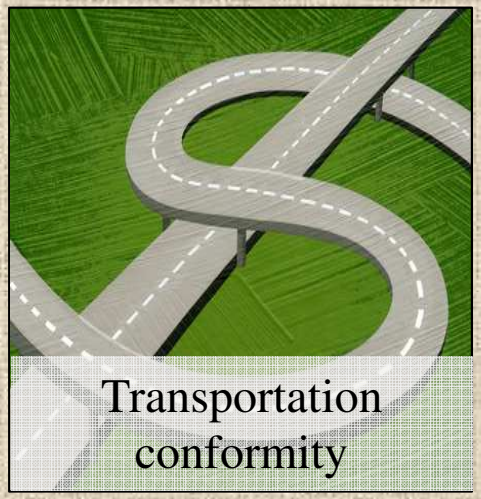
For every one million increase of burn acres, the highest 8-hour O_3 mixing ratios increased around 9 ppb.

Consequences of nonattainment



State Implementation Plan (SIP)

- Enhanced emissions inventory
- Photochemical modeling
- Economic development curtailed



Transportation conformity

- Potential for loss of highway funds and restrictions on how highway funds can be spent.

Contingency measures

- Expanded burning restrictions

The goal

- Keep prescribed burning, but burn in a manner that minimize adverse environmental and social effects.

Objectives

- To avoid exceedances of the NAAQS.
- To receive an exemption/flag in the event of an exceedance of the NAAQS (Exceptional Event).

NAAQS: National Ambient Air Quality Standards

Flint Hills smoke management plan (SMP) since 2011

Kansas Flint Hills SMOKE MANAGEMENT

www.ksfire.org

Smoke Management

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Kansas Flint Hills Smoke Management

Welcome to the Kansas Flint Hills Smoke Management Website. This site provides a single location for land managers conducting prescribed burns in the Flint Hills to obtain information and access tools to assist them in making burn decisions.

This website supports the Flint Hills Smoke Management Plan, which was developed in an attempt to balance the need for prescribed fire in the Flint Hills with the need for clean air in downwind communities.

At A Glance

- 2016 Air Quality Health Advisory Alert
- 2015 Flint Hills Acres Burned
- April Burning Restrictions (Regulations)
- April Burning Restrictions (FAQ)
- Kansas Smoke Management Plan - KDHE
- Fire Management Practices to Improve Air Quality (PDF)
- County Burn Permit Information
- Current Burn Bans- Contact your local Emergency Manager
- Fire Management Practices to Reduce the Impacts of Smoke (PDF)

Two strategies to reduce smoke impact

Reduce smoke production

- Frequency of burns
- Managing fuel load and fuel moistures
- Ignition and burn technique
- Reduce smoldering

Optimize timing of burns

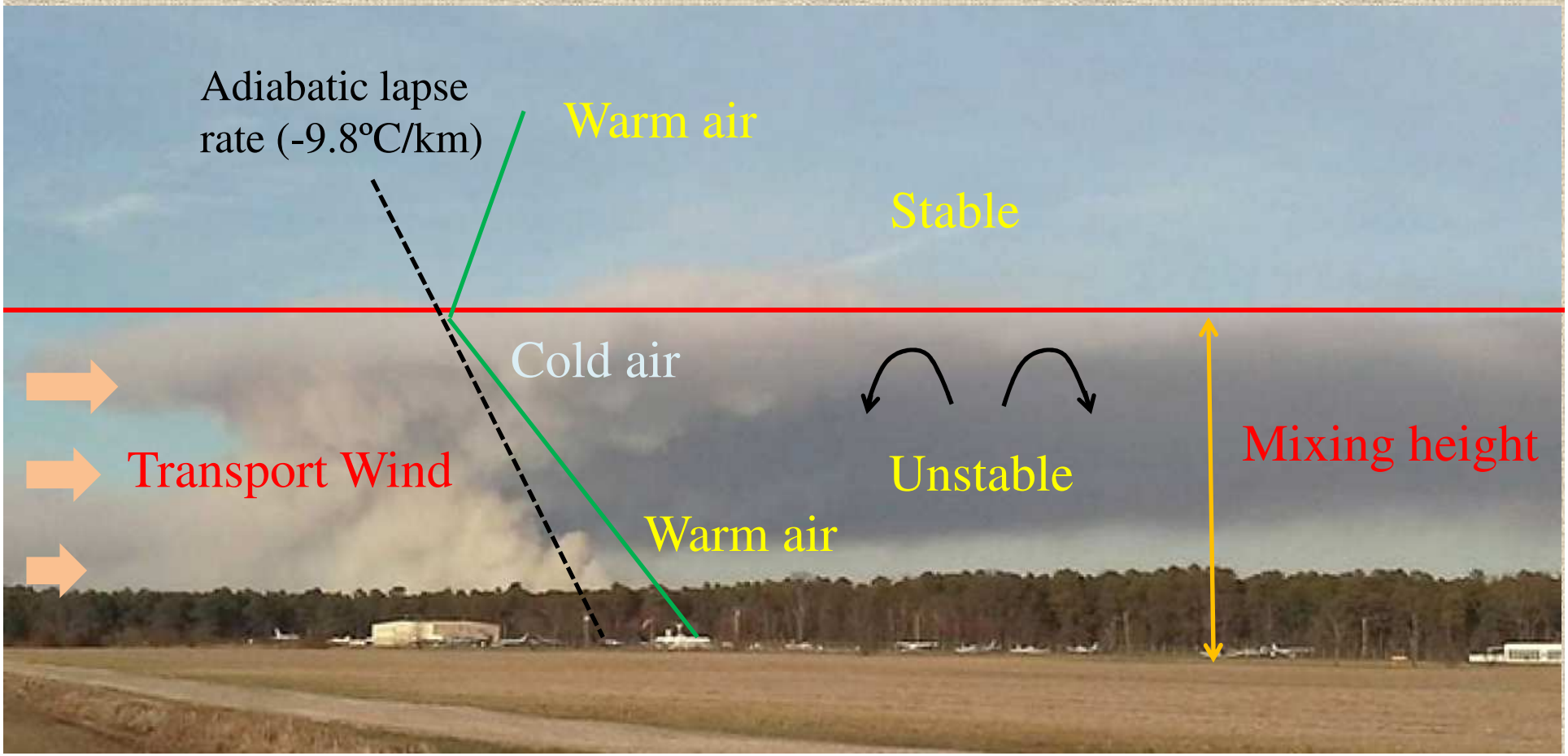
- Allow for adequate smoke dispersion
- Minimize exposure of sensitive populations
- Avoid high O_3 day

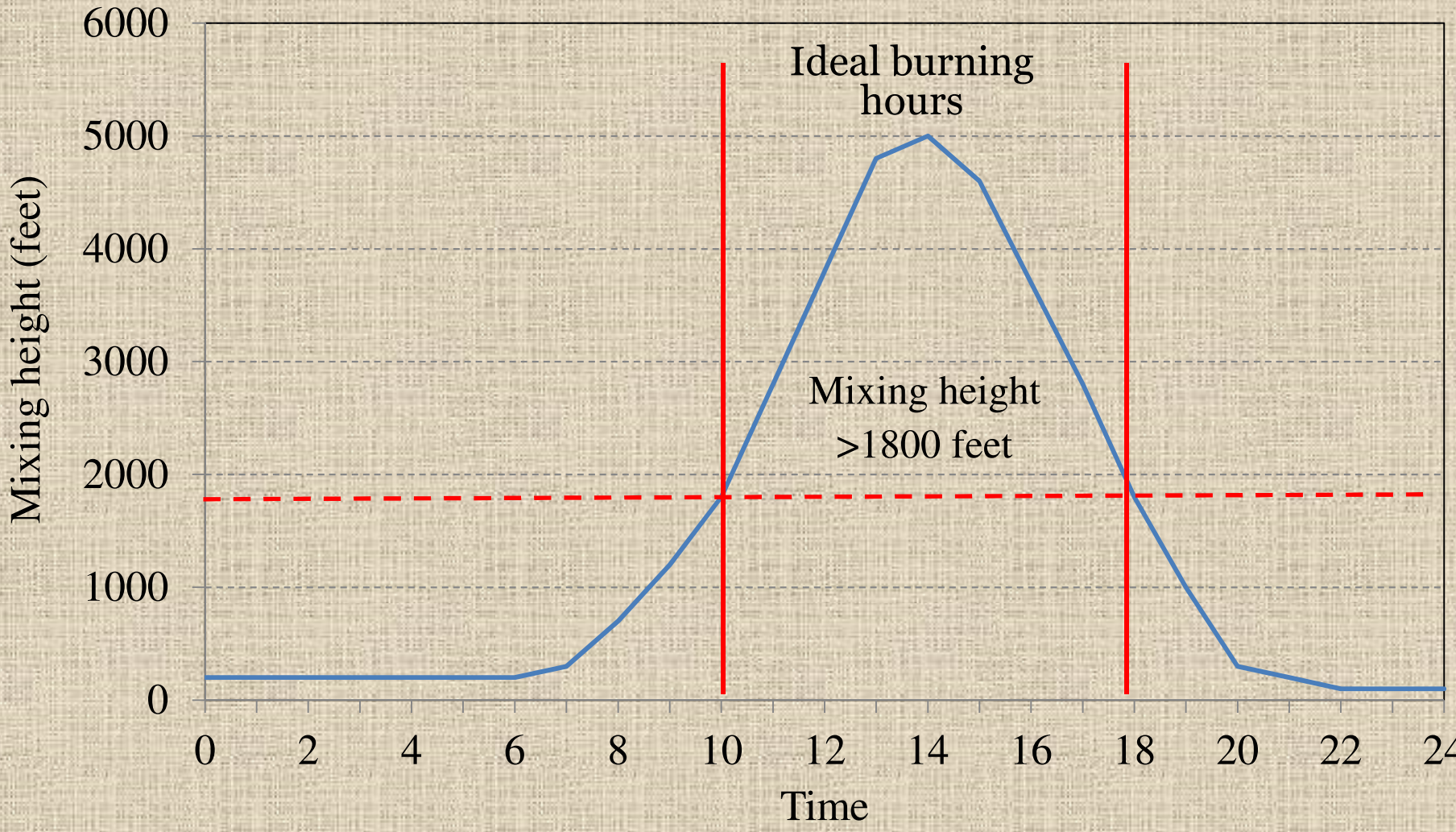
Mixing height

The height above the ground through which the air is under turbulent mixing. The height at which smoke stops rising.

Transport Wind

The average wind speed throughout the depth of the mixed layer.




Ideal burning hours
Mixing height >1800 feet
Mixing height (feet)
6000
5000
4000
3000
2000
1000
0
0
2
4
6
8
10
12
14
16
18
20
22
24
Time

Recommended weather conditions for burning in the SMP

Relative humidity: 30-50%	Reduced smoke production
Mixing height: >1,800 feet (548m)	Adequate smoke dispersion
Transport winds: 8-20 mph (3.6-8.9m/s)	
Preferred start/stop times: 10 am to 6 pm	
Cloud cover: 30 to 50%	Reduced ozone production

When is the best time to burn?

Smoke modeling tools

Management objectives

Smoke dispersion

Fire safety

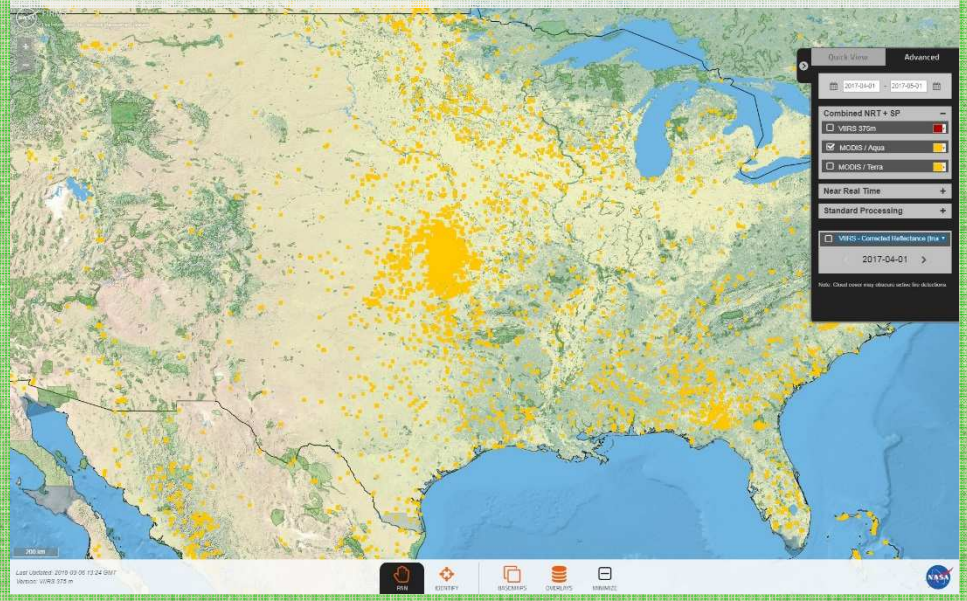
Sensitive populations

?

Avoid high O_3

New approaches for smoke management

Satellite Images



- National Aeronautics and Space Administration (NASA)
- Moderate Resolution Imaging Spectrometer (MODIS) fire products
- Fire Information for Resource Management System (FIRMS)

Unmanned aircraft systems (UAS)

Monitoring smoke using drones

Analysis of the daily burned area data from satellites

Landowners preferred to burn in warm and clear days with high solar radiation, and sometimes they burn at higher RH or lower wind speed than the recommended values.

	Wind speed (m/s)	Relative humidity (%)	Solar radiation (Langley)	Maximum temperature (°C)	Minimum temperature (°C)	Number of days per season
Preferred conditions for prescribed fires	1.9 ~ 7.5	34 ~ 82	536 ~ 633	8 ~ 31	-5 ~ 2	10
In the whole season	0.2 ~ 12.2	25 ~ 98	19 ~ 760	-6 ~ 38	-11 ~ 22	62
Conditions recommended by KDHE	2.2 ~ 6.7	30 ~ 50				

Preferred weather conditions for prescribed fires that were determined from all the heavy-fire days from 2003 to 2019.

When daily burned acres is between 0.25M to 0.5M

	Average of days with O_3>70ppb	Average of days with O_3<70ppb	April average
Daily maximum air temperature	24.4±5.4 ℃	19.2±4.1 ℃	20.7±5.5 ℃
Solar radiation	697±244 Langley	596±98 Langley	607±304 Langley
Relative humidity	54±10 %	54±12 %	67±14 %
Wind speed	2.4±1.1 m/s	2.9±1.2 m/s	4.1±2.0 m/s

UAS for pre-fire, active fire and post-fire multispectral sensing

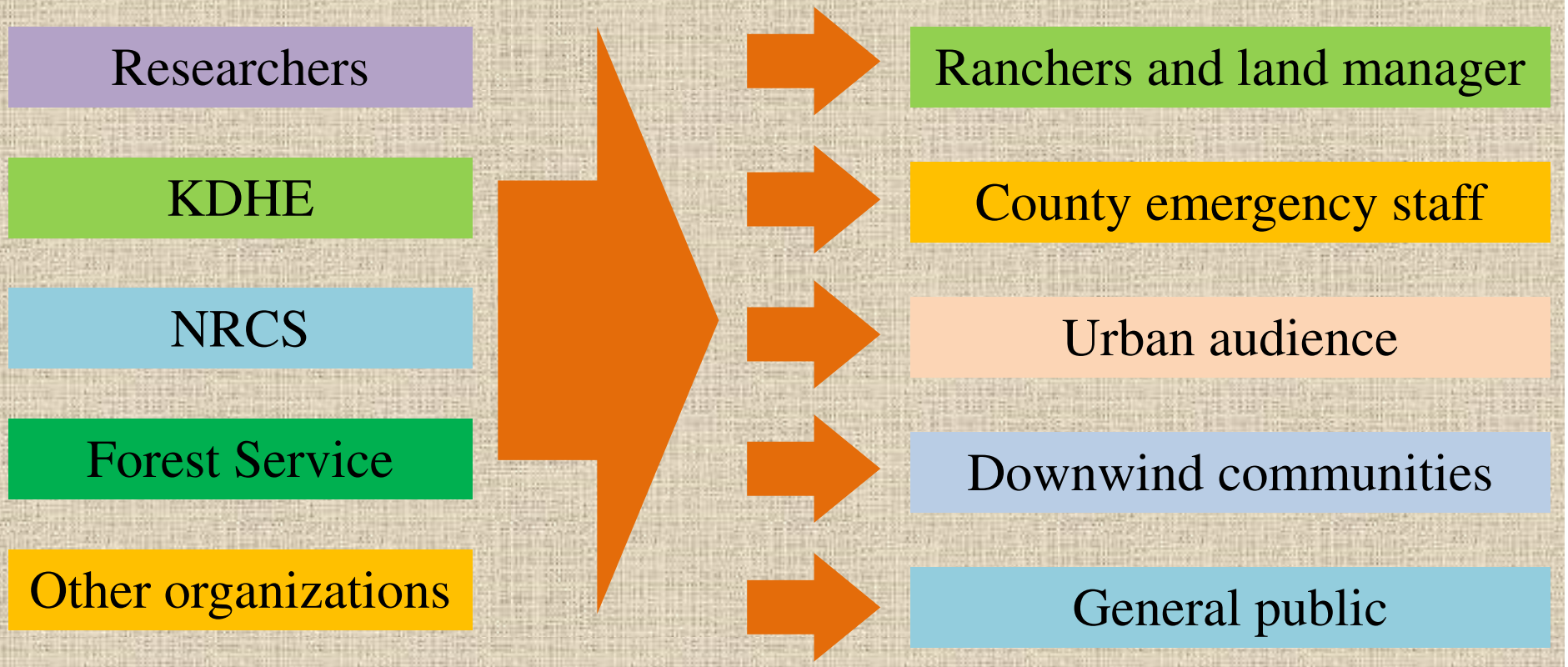
UAS sensing can help to establish relationships between burn conditions, fire spread rate, and smoke emissions, and to increase alignment of objectives and outcomes of prescribed fires

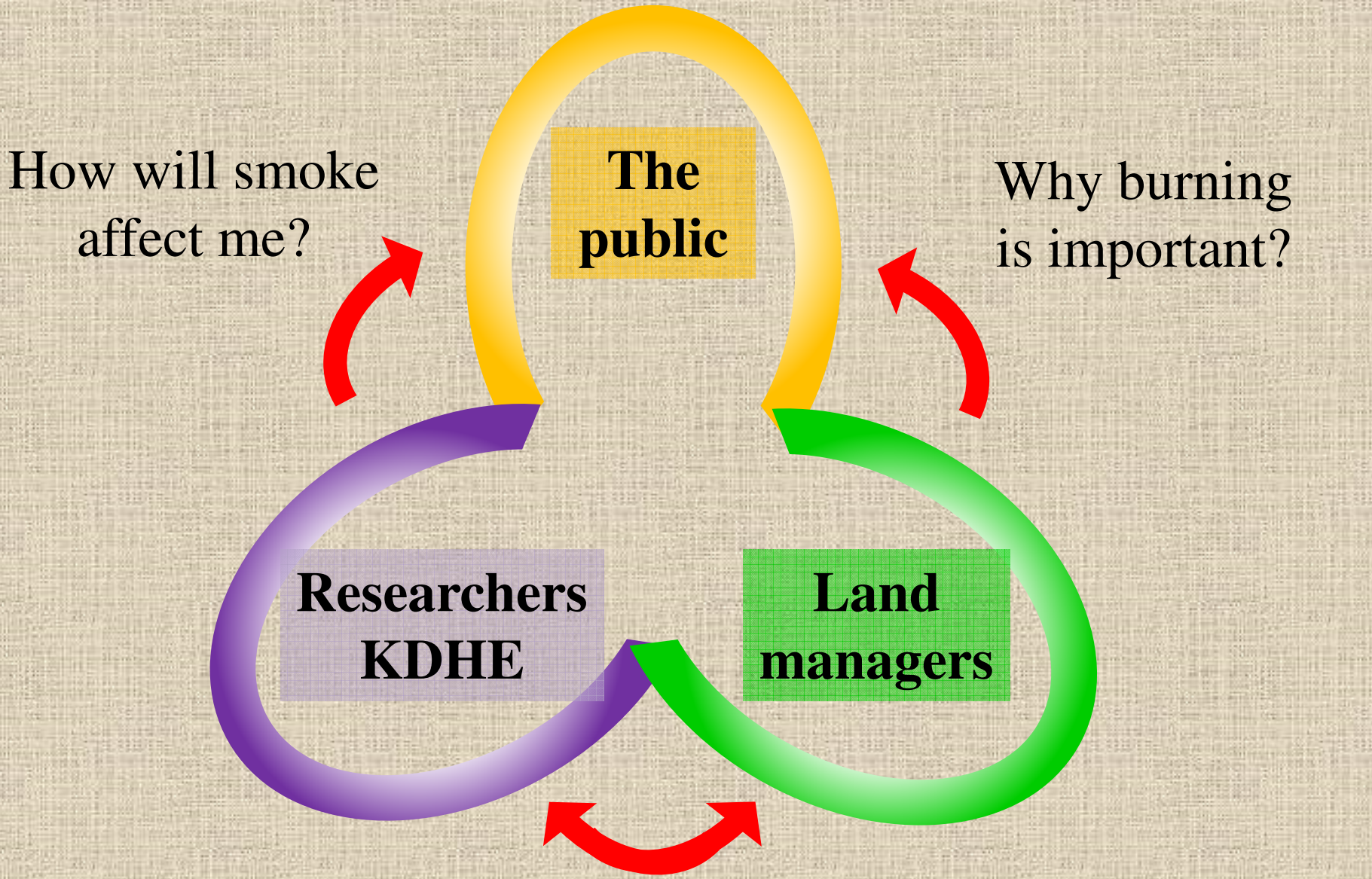
- Pre-fire: Fuel moisture can be retrieved from multispectral imagery
- Active fire: Fire temperatures, flaming and smoldering combustion, and smoke emission can be retrieved from the mid and short-wave infrared spectral region.
- Post-fire: Fire severity are commonly evaluated using normalized burn ratio (NBR) based on Landsat imagery.

Build a smart community

Coordinate and create one authoritative information source, providing easy access to information.

Identify target audiences and develop targeted messages, addressing specific information needs.




How will smoke affect me?
The public
Why burning is important?
Researchers KDHE
Land managers
How to reduce smoke impact?