Exposure and Health Assessment of Agricultural Burning Smoke

L.-J. Sally Liu,J. Sullivan, C. Trenga, T. Gould, C. Marquist, University of Washington

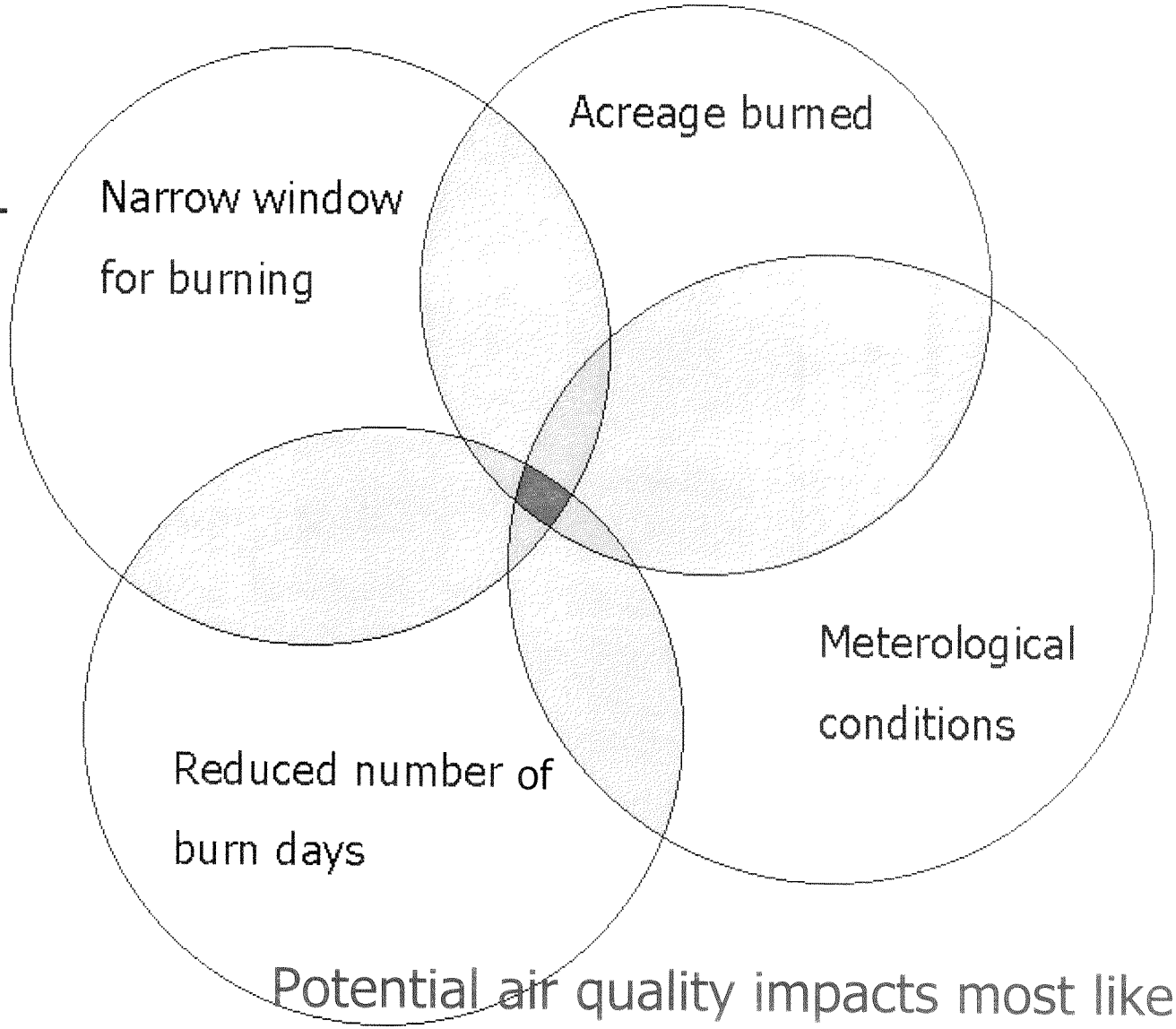
R. Dhammapala, J. Jimenez, Candis Claiborn
Washington State University

For presentation at the WA Department of Ecology, March 13, 2003

What are the Impacts of Field Burning in Washington State?

It has been difficult to quantify the air quality impact in the rural areas of Eastern WA

- Spatial variability
- Short-term PM spikes (both PM_{10} and $PM_{2.5}$)
- Paucity of continuous monitors
- Small populations



Potential air quality impacts most likely occur at the confluence of these conditions!

Issues

- Community Exposure
- Health Effects of peak exposures
- Regulations
- Air monitoring

A Burning Question

Are episodes of increased particulate matter air pollution from agricultural burning associated with health effects in asthmatics, as measured by:

- Decrement in forced expiratory volume in one second (FEV_1)?
- Increase in exhaled nitric oxide (eNO)?
- Increase in asthmatic symptoms and/or use of rescue medications?

Objectives

- Characterize the air quality impacts from agricultural field burning in Eastern WA
- Characterize community exposure to Ag burning smoke
- Determine the relationship(s), if any, between particulate air pollution from Ag burning and acute adverse health outcomes in asthmatic adults

Study Location

- Washington State University community, Pullman
- Population density
- Impacted by wheat burning in WA and grass burnings in Idaho
- Historical data
- Infrastructure

Study Population

- 32 Adults, male or female, aged 18-65, in the WSU community, Pullman, WA.
- Physician-diagnosed mild to moderate asthma
- With or without inhaled corticosteroid use, but prefer those without
- Sample size was determined based on power simulations
- Many concerns for not to use children subjects

Study Period

- ~60-day period, between Sept 4, 2002 and Oct 31, 2002
- 2 monitoring sessions, each session consisting of 32 subjects and 30 days of monitoring period.
- 32 subjects: 16 Active and 16 on-call
  - Those 16 subjects who are active in session 1 become on-call in session 2.
  - Vice versa

Health Effect Assessment

Active subjects – 3 lab visits/week

- Pulmonary function (Micro DL)
- Breath samples for CO, eNO
- PFT: 4 X/day, 7d/wk: upon awakening, before lunch, before dinner, before retiring
- Symptom/medication and time-activity diaries

On-call subjects – 3 lab visits/episode

- 3 consecutive-day lab visits (eNO, CO, PFT, urine samples) during an episode
- Daily self-administered PFT, sym/med, and TAD

Exposure Assessment

Central Site Monitoring on WSU campus (rooftop)

- 12-hr PM_{10}, $PM_{2.5}$ samples on quartz, Teflon filters with HI; 24-hr aldehydes with DNPH coated Sep-Paks
- Real-time B_{sp} via nephelometer; $PM_{2.5}$ and PM_{10} via TEOM; CO, CO_2, NO_x, temperature, and RH

Outdoor Monitoring

- Topologic considerations: 2 neph sites (including DOE site) and six 24-h HPEMs during episodes

Exposure Assessment - continued

- Indoor Monitoring
  - Real-time T, RH, and PM_1, 1 nephelometer or pDR at (nearly) each home
  - Recursive modeling for outdoor contribution to indoor PM

Exposure Assessment - continued

- Indoor Monitoring
  - Real-time PM, 1 nephelometer or pDR at (nearly) each home
  - Recursive modeling for outdoor contribution to indoor PM
- Time-activity diary
  - From every subject everyday, 10-min resolution
  - For estimating exposures to ambient originated PM
- Personal sampling:
  - 2/d, 2 HPEMs/subject (Teflon for XRF, quartz for EC/OC)
- Urine Sample Collection and smoked food diary
  - 2 urine samples per day from all subjects during episodes
  - Daily urine samples from the 2 intensive monitoring subj
- House ventilation logs
  - from intensive subjects

Exposure Assessment - continued

- Indoor Monitoring
  - Real-time PM, 1 nephelometer or pDR at (nearly) each home
  - Recursive modeling for outdoor contribution to indoor PM
- Time-activity diary
  - From every subject everyday, 10-min resolution
  - For estimating exposures to ambient originated PM
- Personal sampling:
  - 2/d, 2 HPEMs/subject (Teflon for XRF, quartz for EC/OC)
- Urine Sample Collection and smoked food diary
  - 2 urine samples per day from all subjects during episodes
  - Daily urine samples from the 2 intensive monitoring subj
- House ventilation logs
  - from intensive subjects

Exposure Assessment - continued

- Indoor Monitoring
  - Real-time PM, 1 nephelometer or pDR at (nearly) each home
  - Recursive modeling for outdoor contribution to indoor PM
- Time-activity diary
  - From every subject everyday, 10-min resolution
  - For estimating exposures to ambient originated PM
- Personal Sampling:
  - 2/d, 2 HPEMs/subject (Teflon for XRF, quartz for EC/OC)
- Urine Sample Collection and smoked food diary
  - Daily urine samples from the 2 intensive monitoring subj
  - 2 urine samples per day from all subjects during episodes
- House ventilation logs
  - from intensive subjects

Subject Characteristics

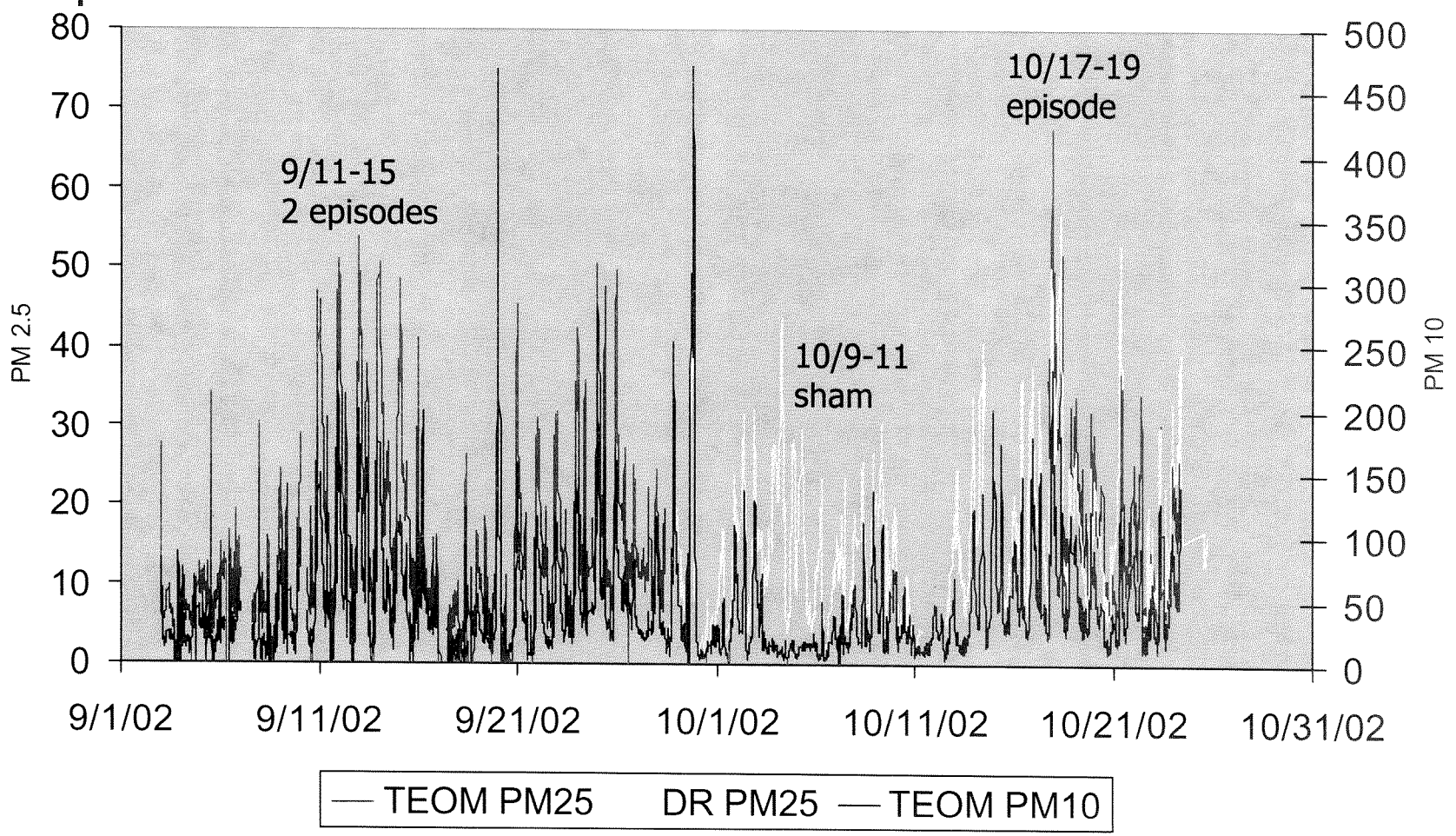
Age and drop-out rate

Age Group	18-19	20-29	30-39	40-49	50-52	Total
Start	9	17	5	3	2	36
dropped out	3	1	0	0	0	4
total	6	16	5	3	2	32

Asthma Severity

Asthma Severity	Male	Female	18-19	20-29	30-39	40-49	50-52	Total
Mild	7	8	4	6	3	1	1	15
Moderate	3	6	1	5	1	2	0	9
Mod-severe	1	3	1	4	0	0	0	4
Severe	1	3	0	1	1	0	1	4
Very Severe	0	0	0	0	0	0	0	0
Total	12	20	6	16	5	3	2	32

$PM_{2.5}$ and PM_{10} concentrations at the central site during the study



Summary

- Smoke episodes resulted in $PM_{2.5}$ concentrations approaching 40-50 $\mu g/m^3$ for short durations
- Sampling scheme allows for estimating of ambient contribution to indoor and personal PM
- Exposure and health effects will be analyzed against PM of ambient, indoor, and personal activity origins.

Data Analysis Plan

- Data entry and QC: End of March
- Preliminary data analysis: April-May
- Ag burning smoke characterization: June
- Exposure characterization and modeling: June-July
- Health effects assessment: July-Sep

Acknowledgement

- Study subjects
- EPA/Northwest Research Center for Particulate Air Pollution and Health Effects
- WA Department of Ecology
- U.S. EPA, Region 10