Considerations In The Development of Dose-Response Functions For Particulate Matter

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EPRI

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McLean, VA

PM and Health

- Widely studied
- Many epidemiological studies find association but not all (some find more evidence for gases)
- Mechanisms unknown, but plausible biological mechanisms have been identified
- Different study designs
  - Acute
  - Chronic

Which Study?

Acute vs. chronic

Do they measure same thing?

Does chronic capture acute?

Do we have equal confidence in acute and chronic studies?

Variability of Results

Chronic Studies

ACS cohort (Pope et al)

- reanalyzed by HEI (Krewski et al)
- updated in 2001

Harvard 6 Cities Study

- reanalysis by HEI (Krewski)

ASMOG

Veterans Study

Hoek et al Dutch Study

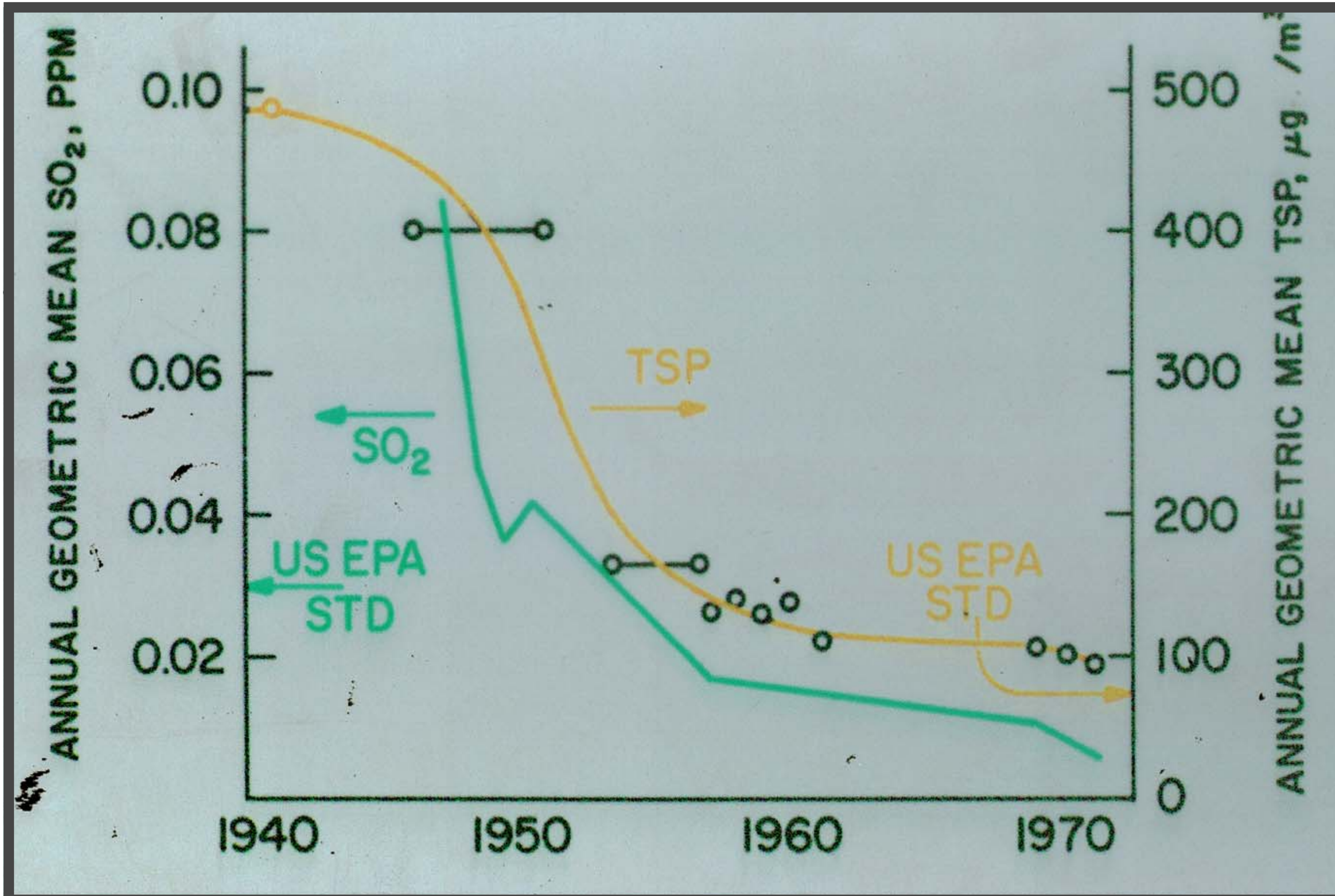
Results vary

EPA CD

EPRI – Washington University Veterans Study

- 90,000 veterans treated at VA hospitals
- Diagnosed as hypertensive
- Enrolled 1974-1976
- 52% died by 1996
- Average age at enrollment: 51

Historical Air Quality Trends for Cincinnati
(Annual Geometric Means)



Mortality Data
All Causes by Time Period

Regression Relationship Matrix

	Mortality		
Air Quality	1976-81	1982-88	1989-96
Up to 1975	Chronic	Chronic	Chronic
1975-81	Acute	Chronic	Chronic
1982-88		Acute	Chronic
1989-96			Acute

Inhalable Particulate Incremental Risks

Mortality	1976-81	1982-88	1989-96
$PM_{2.5}$			
1979-81	-0.090	-0.171*	-0.261*
1982-84		-0.092*	-0.183*

*= $p < 0.05$

Similar Results for PM_{15}; SO_4^{2-}

Ozone Incremental Risks

Single Pollutant Model

	Mortality		
Air Quality	1976-81	1982-88	1989-96
Up to 1975	0.088	-0.033	-0.039
1975-81	0.102*	0.100*	-0.010
1982-88		0.146*	0.060
1989-96			0.035

* = $p<0.05$

Which model?

Relative Risks – Mortality All-Cause

	Independent	With Regional Adjustment
Fine particles alone	1.18 (1.03, 1.35)	1.16 (0.99-1.37)
Fine Particles relative humidity	1.18 (1.08, 1.30)	1.10 (0.91-1.34)
Fine particles & altitude	1.14 (1.05, 1.24)	1.09 (0.91-1.31)

From Krewski et al

Is Nature of Pollution Changing?

ACS	(1982-1989)	6.9% ↑ in mortality per 10µg/m^3 in $PM_{2.5}$
ACS	(1990-1998)	2.5% ↑ in mortality peer 10µg/m3 in $PM_{2.5}$

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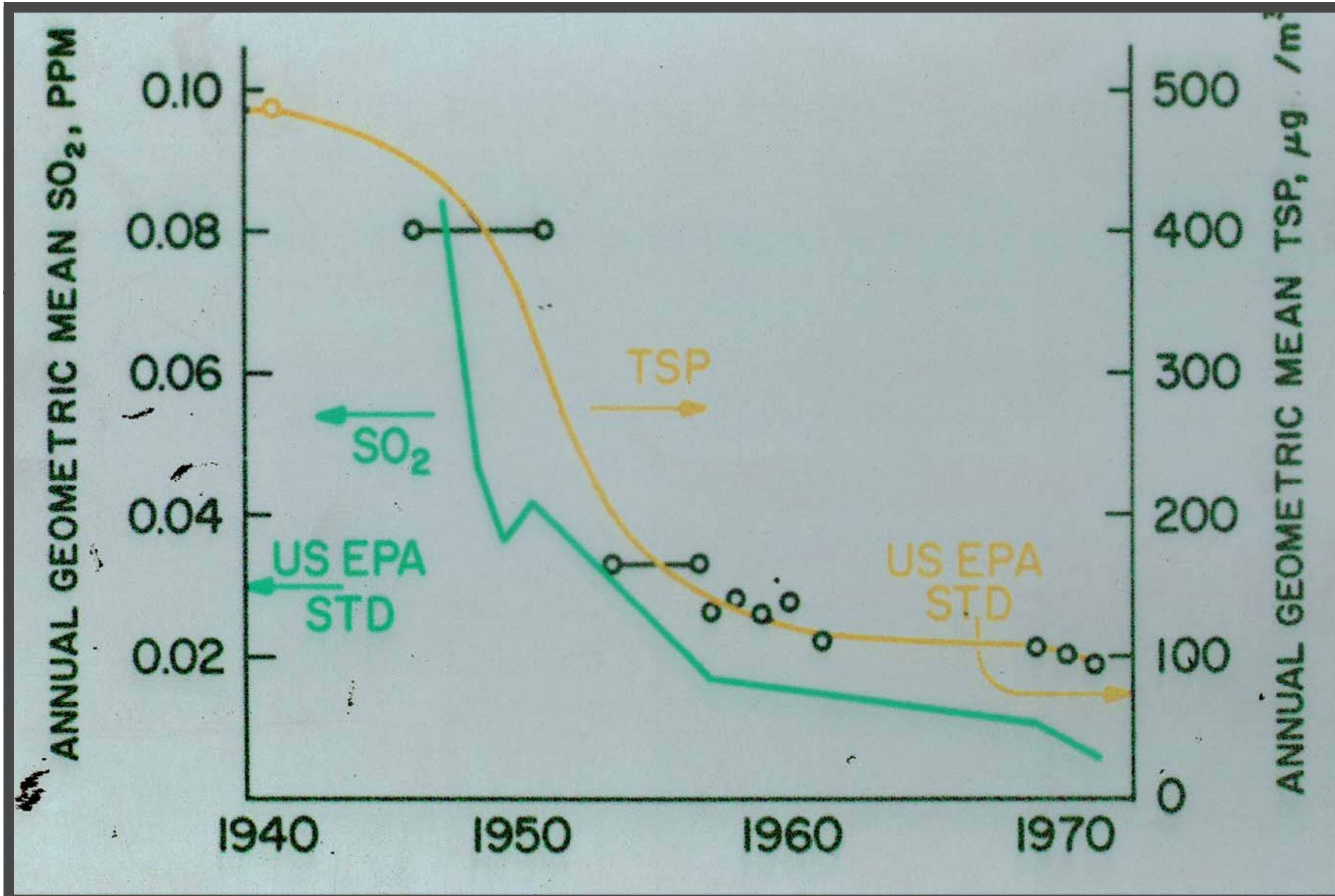


Are Components Important?

Which Time Average is Important

Range of air pollution in 1960's is 4 times greater than that in 1980's.

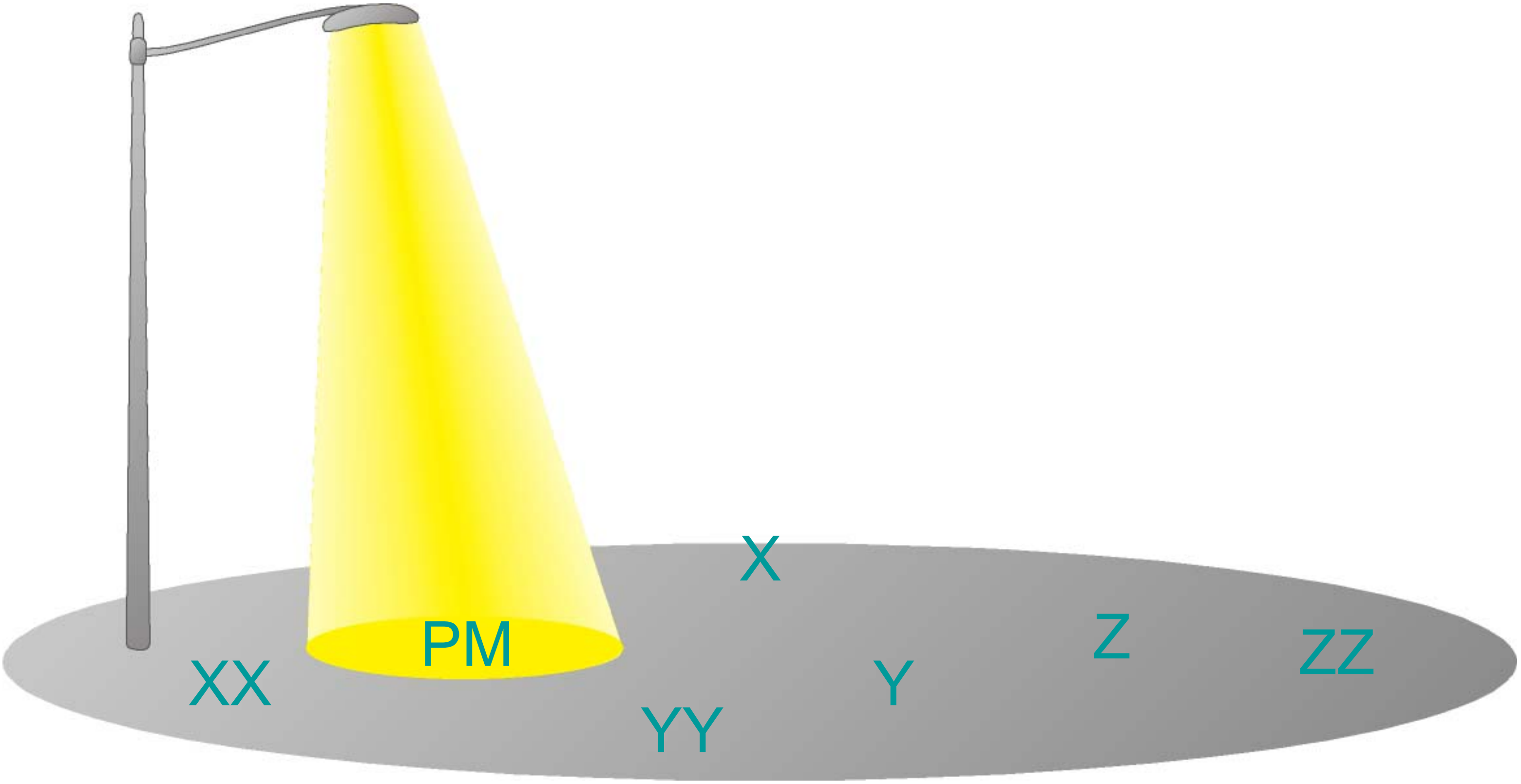
Hence (using ACS 1982-89 result)

6.9% ↗ in mortality

→ 1.7% ↗ in mortality per $10\mu/m^3$ $PM_{2.5}$

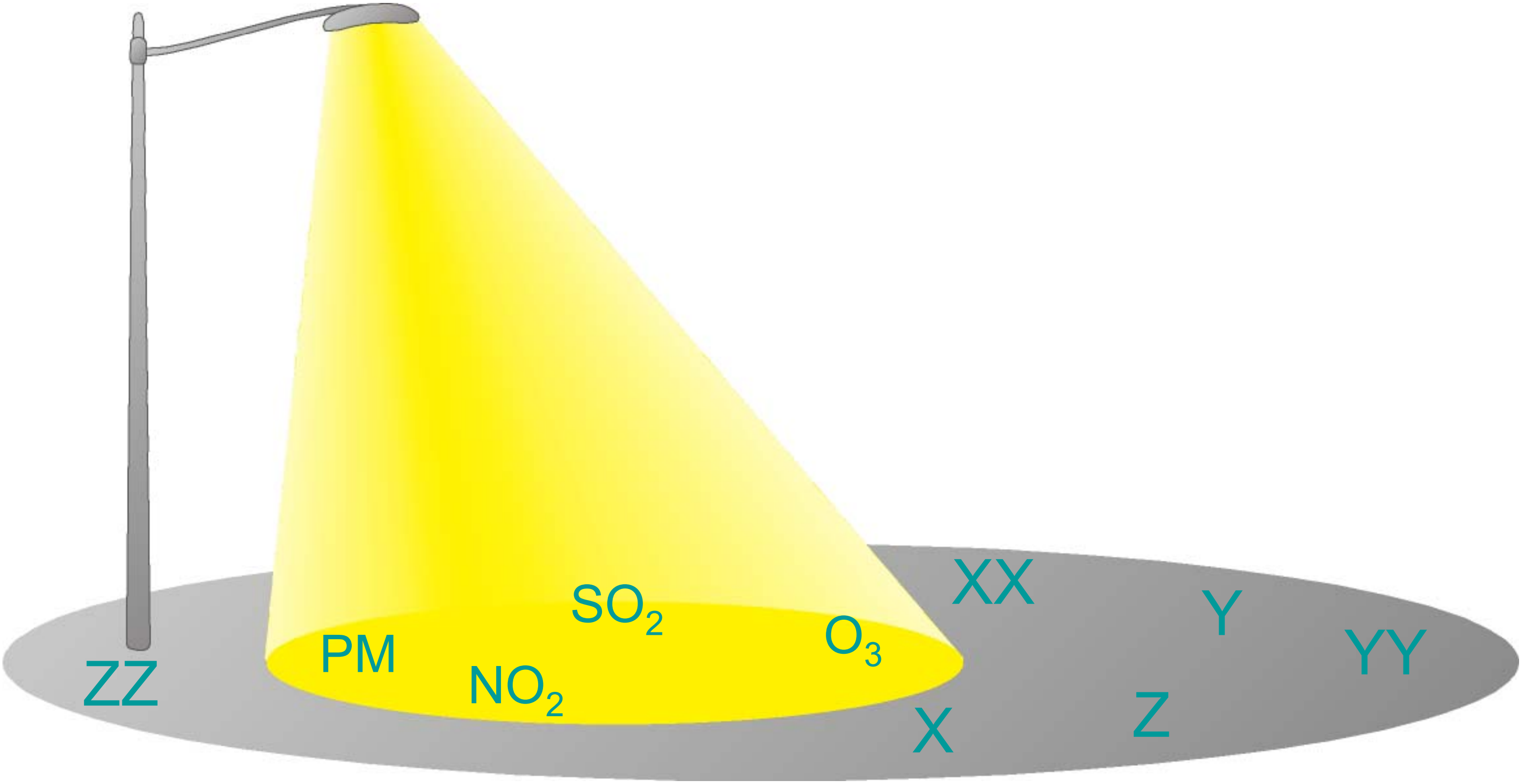
AIR POLLUTION HEALTH STUDIES

Many Studies



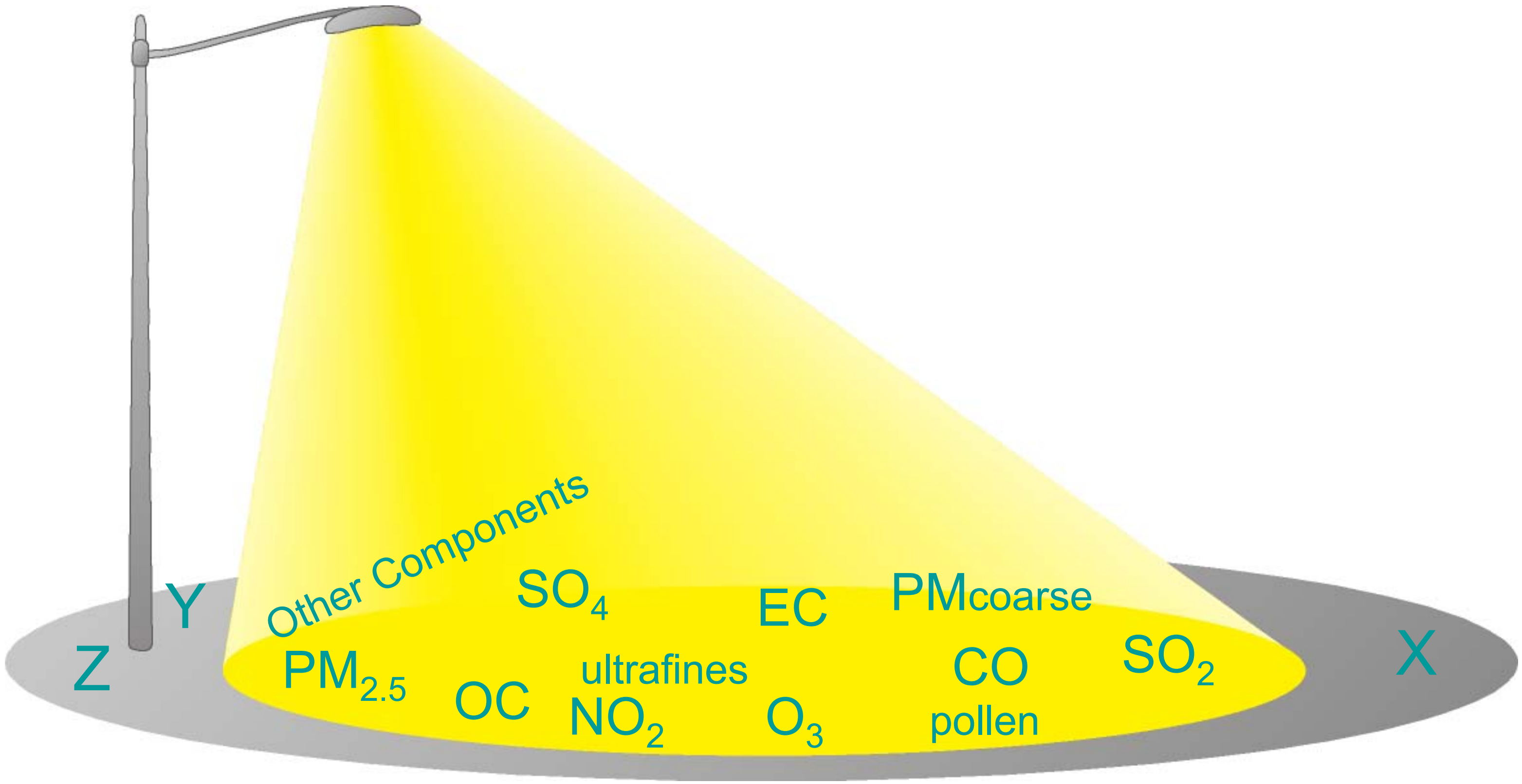
AIR POLLUTION HEALTH STUDIES

Chronic Studies

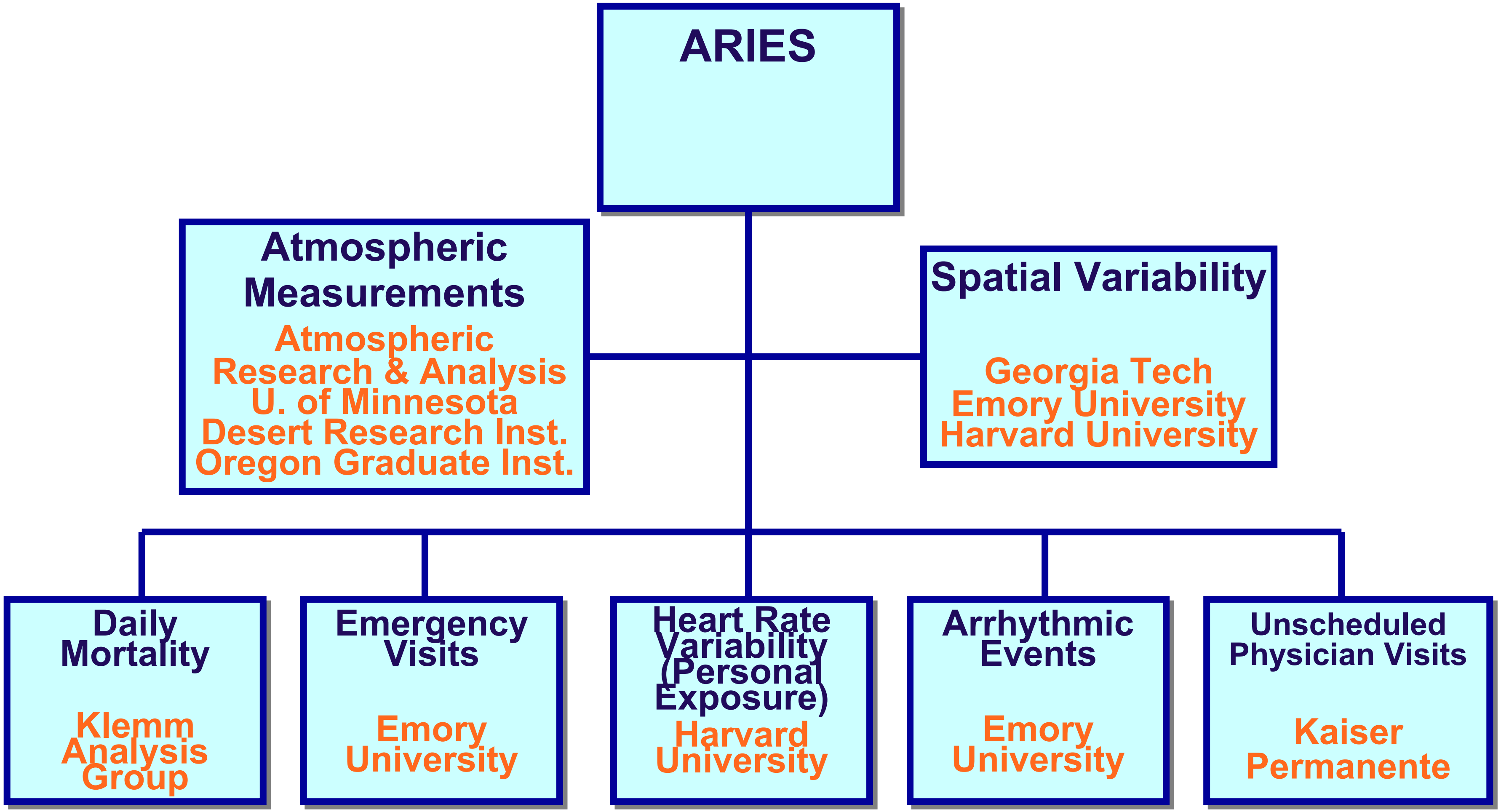


AIR POLLUTION HEALTH STUDIES

ARIES Model



ARIES Design and Scientific Team



ARIES Air Quality Data

- PM_{10}
- $PM_{2.5}$
- $PM_{10-2.5}$
- $PM_{2.5}$ components
  - Sulfates
  - Water-sol metals
  - Acidity
  - Organic matter
  - Elemental carbon
- Ultrafine PM
- O_3
- NO_2
- CO
- SO_2
- Polar VOCs

ARIES Results

Cardiovascular Disease Hospital Emissions

Statistically significant pollutants

(1-pollutant models)

NO_2

CO

$PM_{2.5}$ { EC, OC }

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ARIES Results

Cardiovascular Disease

Two Pollutant Models

$CO > PM_{2.5}$

$CO^* > NO_2$

CO > EC+ OC

$PM_{2.5} > NO_2$

$EC + OC > PM_{2.5}$

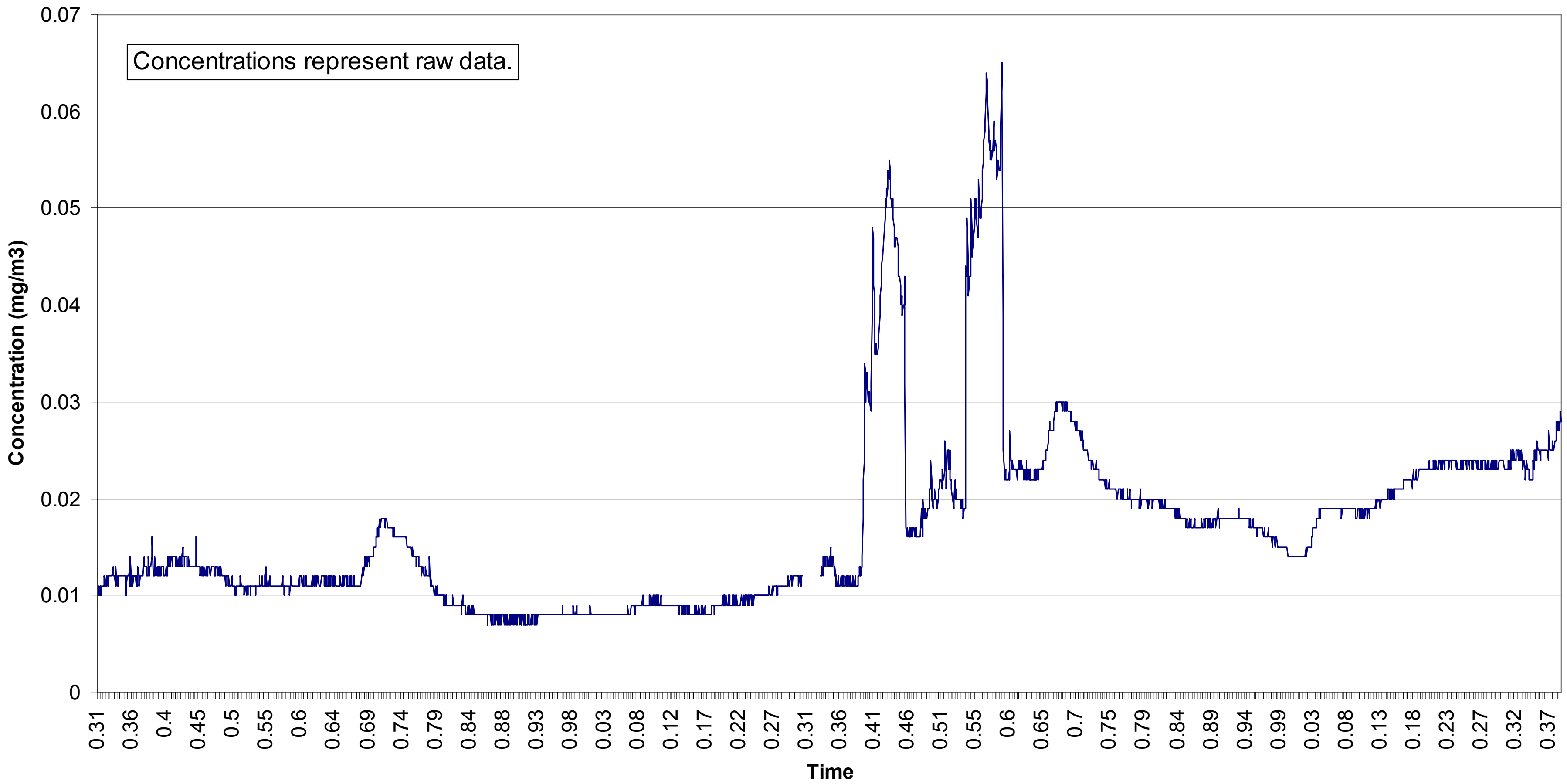
$EC + OC > NO_2$

Exposure Considerations

- role of peak exposures
- personal exposure ≠ ambient monitored level

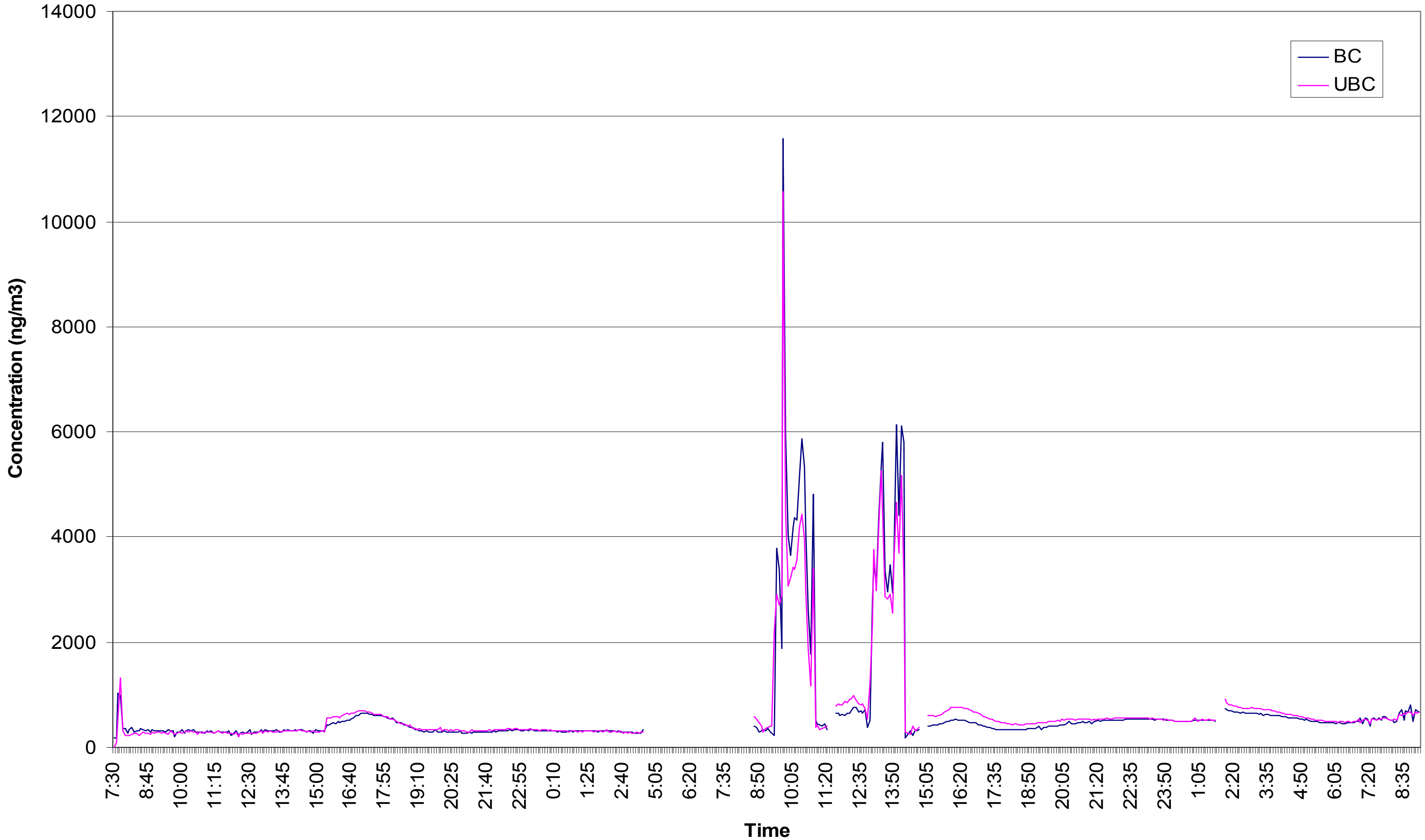
$PM_{2.5}$ Concentrations (Dust Trak)

Trip 1, March 11-13, 2002: St. Louis, MO



Black Carbon Concentrations

Trip 1, March 11-13, 2002: St. Louis, MO



Conclusions

Damage functions require many assumptions/choices

Uncertainty has many components: study design; study choice; model; confidence limits; etc., etc,

Uncertainty is large

Uncertainty need be expressed