

# Impacts of Peat-Forest Smoke on Urban Atmosphere in Maritime Continent

## What is new?

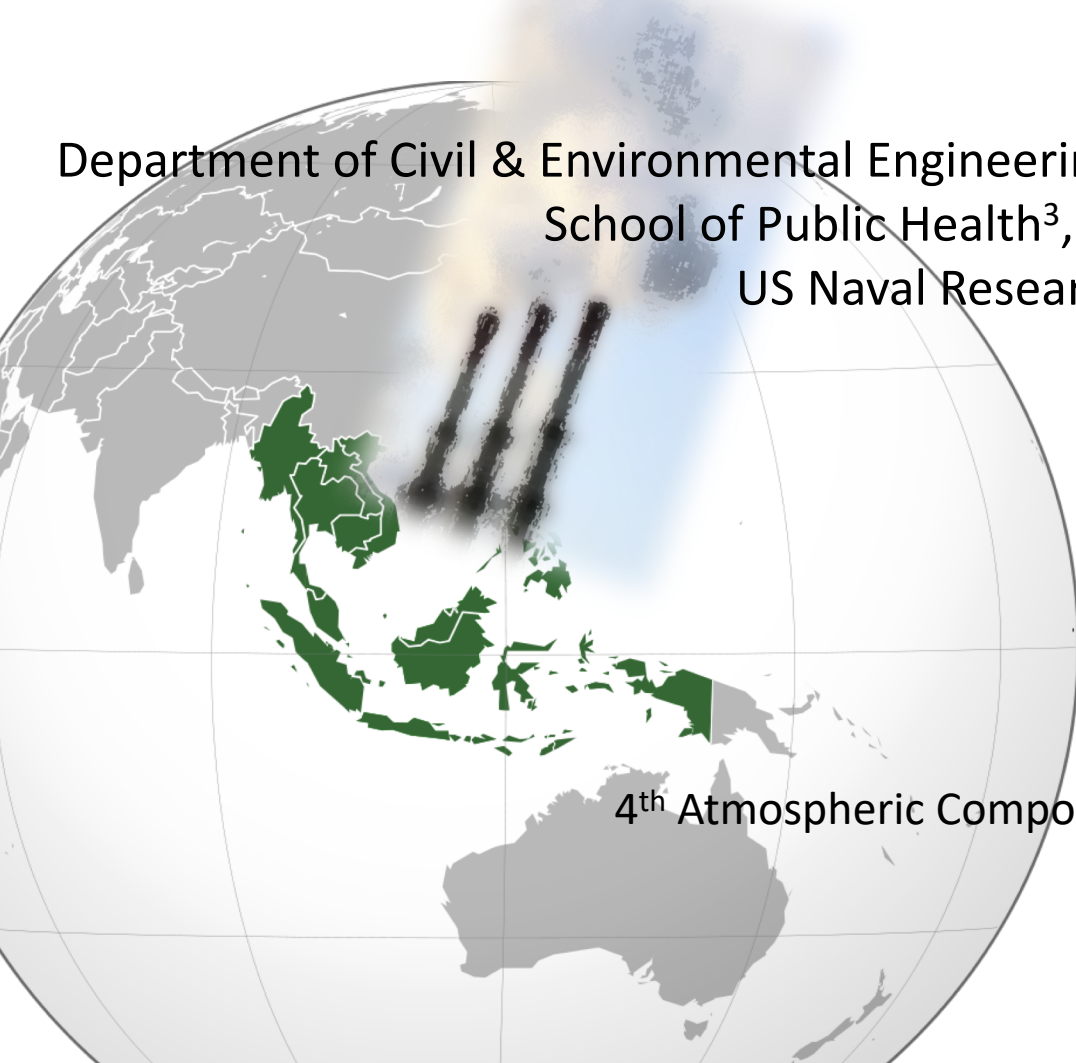
Liya E. Yu<sup>1,2</sup>, Yang Lang<sup>2</sup>, Jackson Tham<sup>2</sup>, Xiaorui Wu<sup>2</sup>, Sayantan Sarkar<sup>1</sup>, Shiguo Jia<sup>1,2</sup>, Jeffery S. Reid<sup>4</sup>, Choon Nam Ong<sup>2,3</sup>

Department of Civil & Environmental Engineering<sup>1</sup>, NUS Environmental Research Institute (NERI)<sup>2</sup>, Saw Swee Hock  
School of Public Health<sup>3</sup>, National University of Singapore, Singapore  
US Naval Research Laboratory, Monterey, CA, USA<sup>4</sup>

For

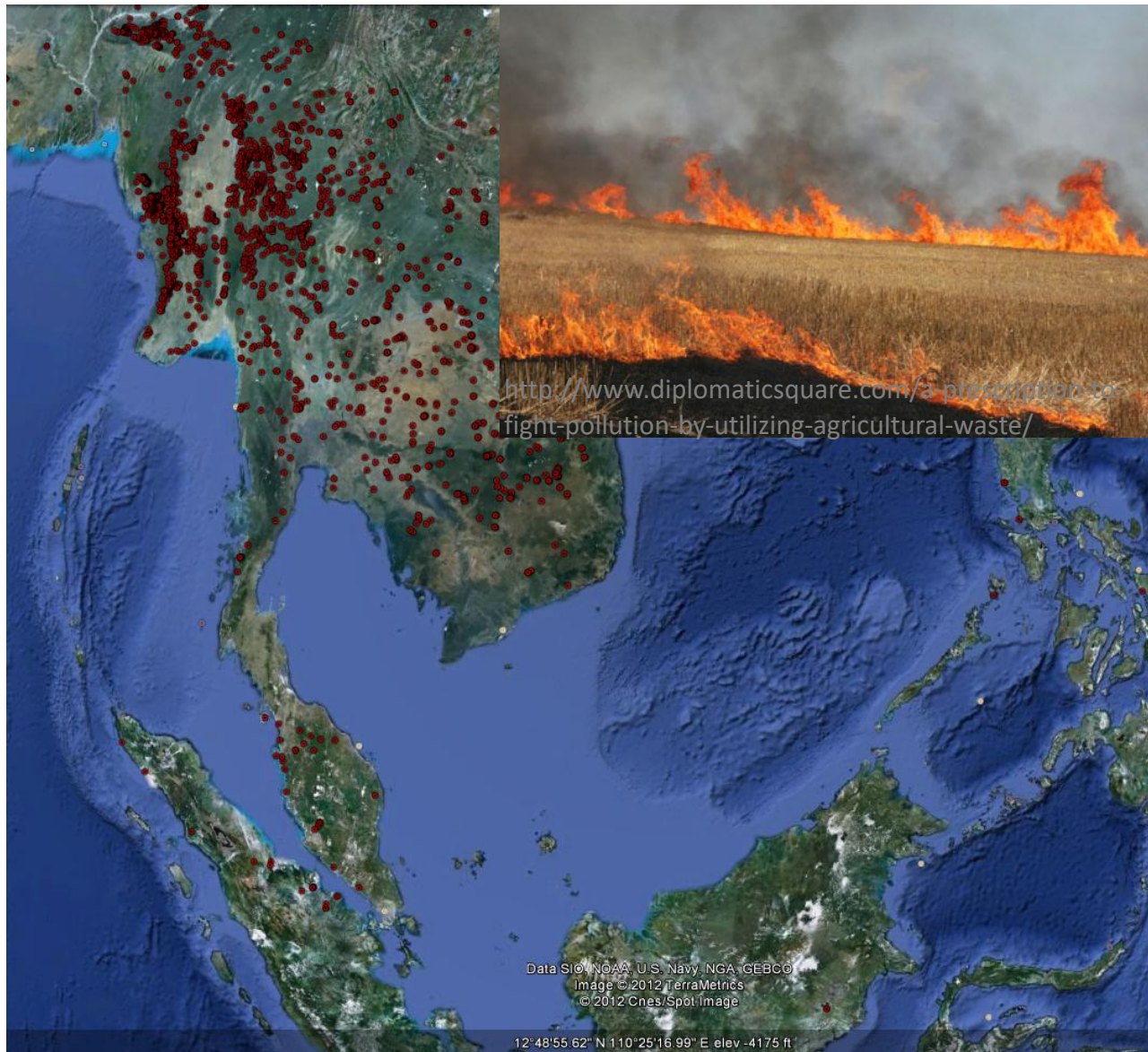
4<sup>th</sup> Atmospheric Composition and Asian Monsoon (ACAM) Workshop

June 24–28, 2019

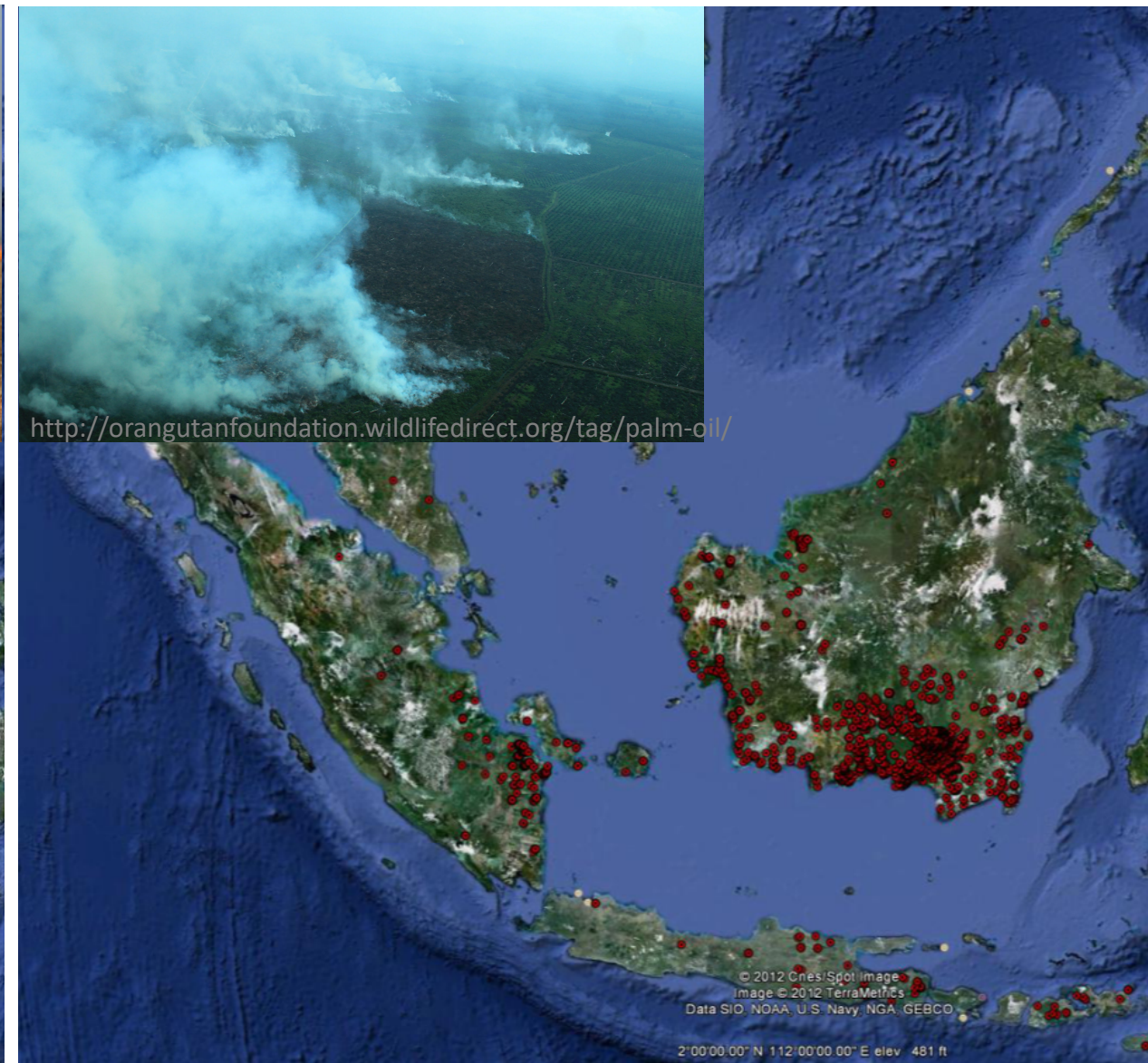




# Recurrent Biomass Burning in Southeast Asia



06 March (JD 65) 2011

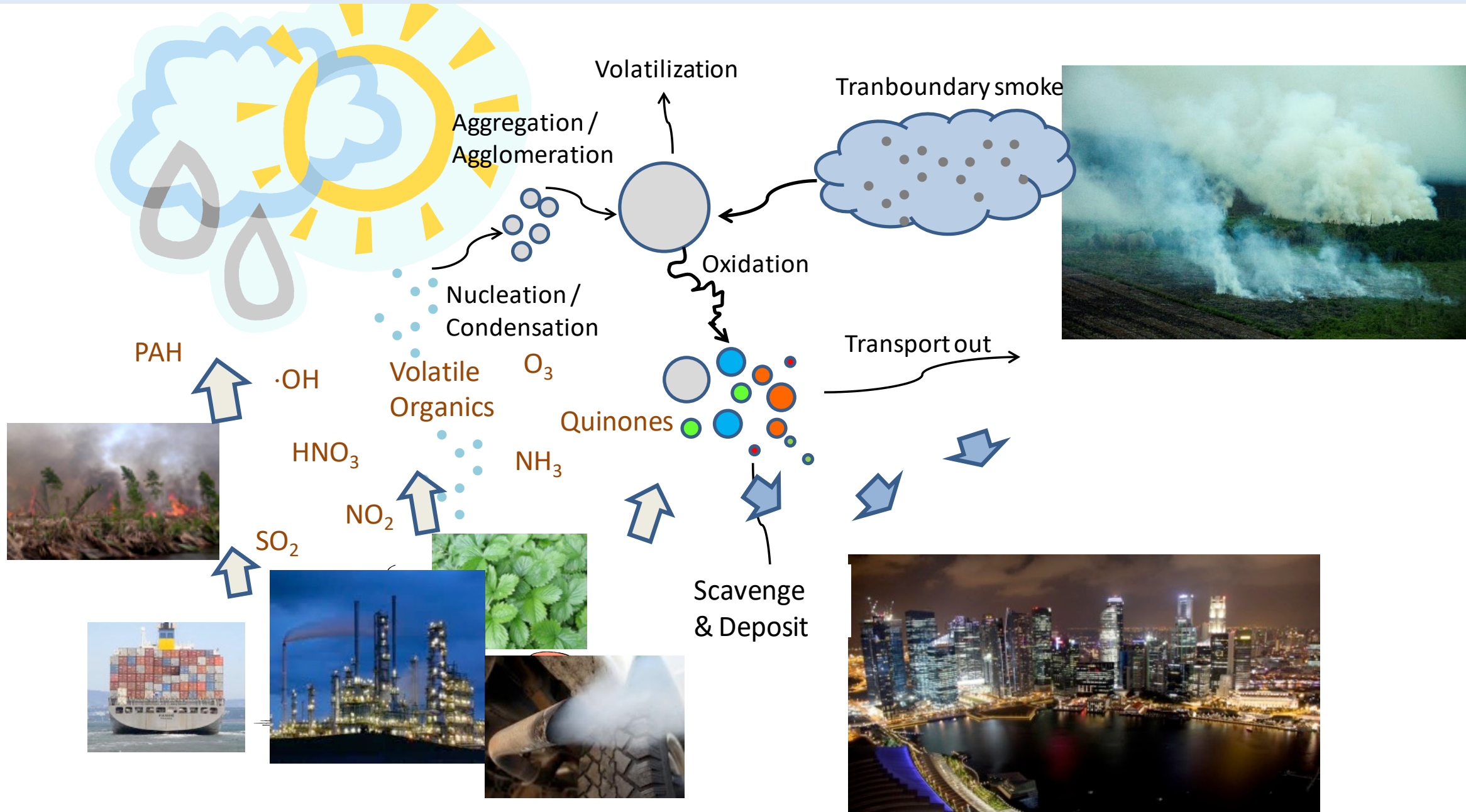


25 September (JD 268) 2009

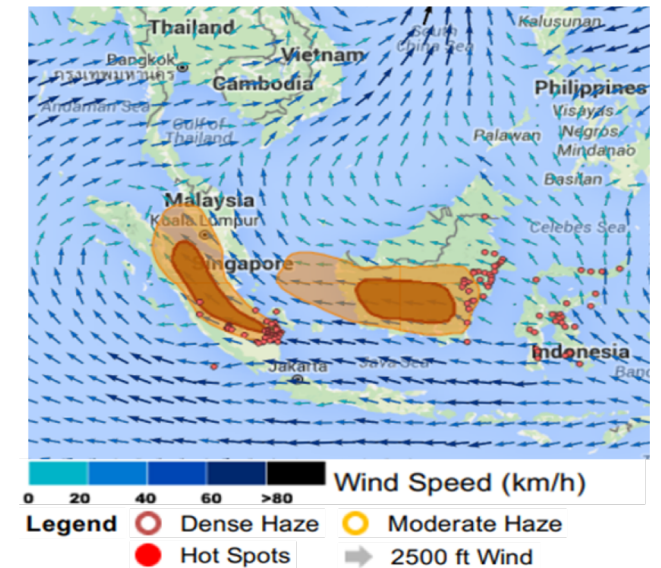
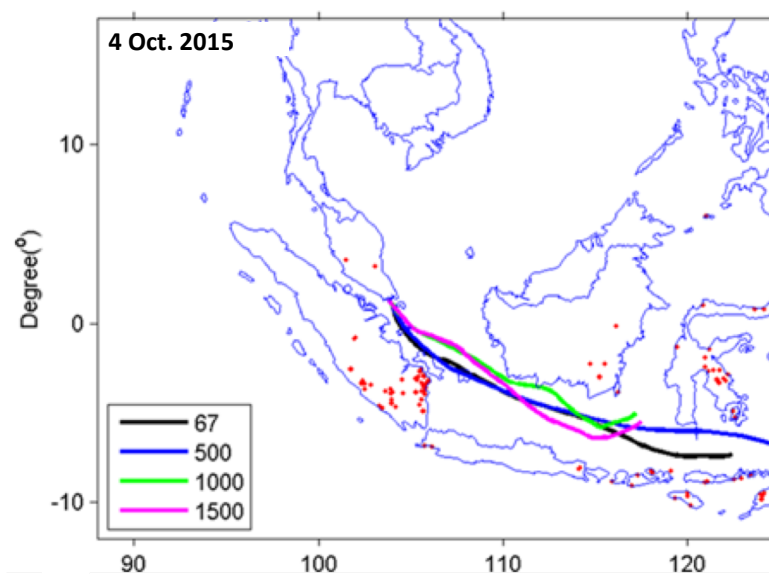
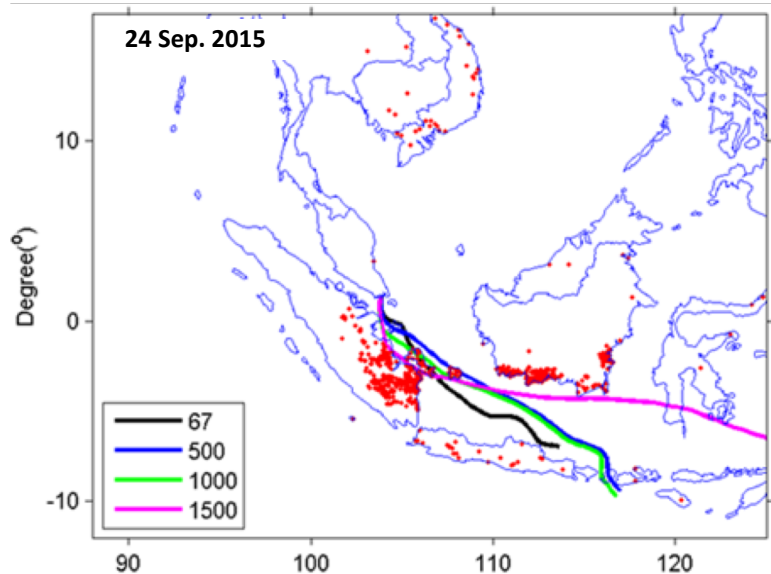
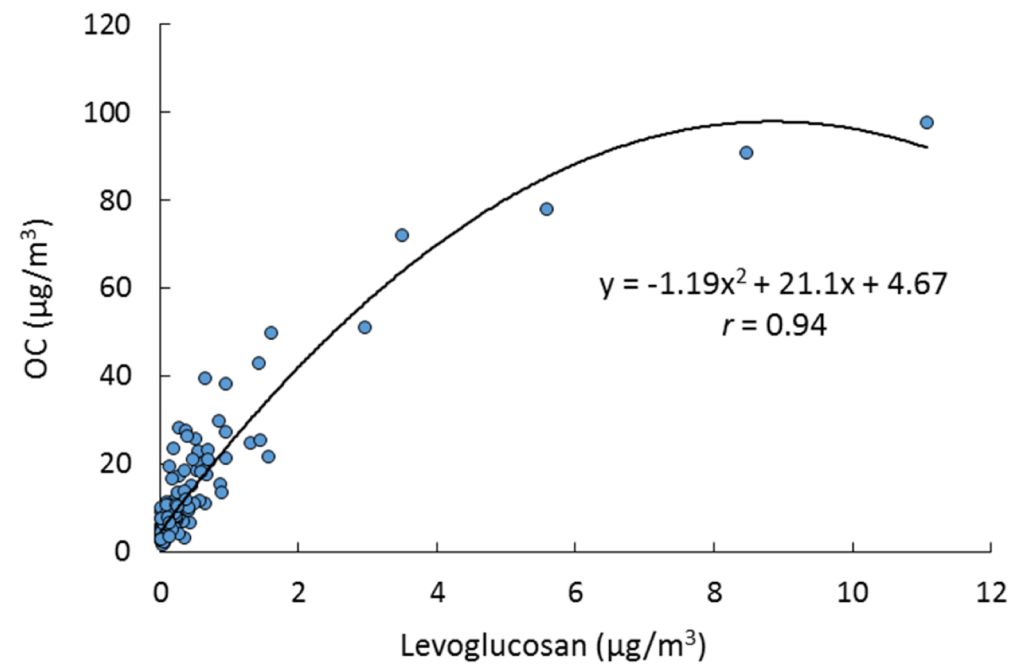
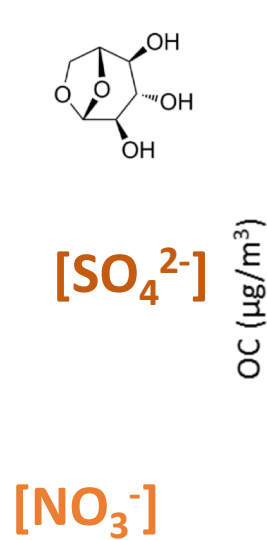
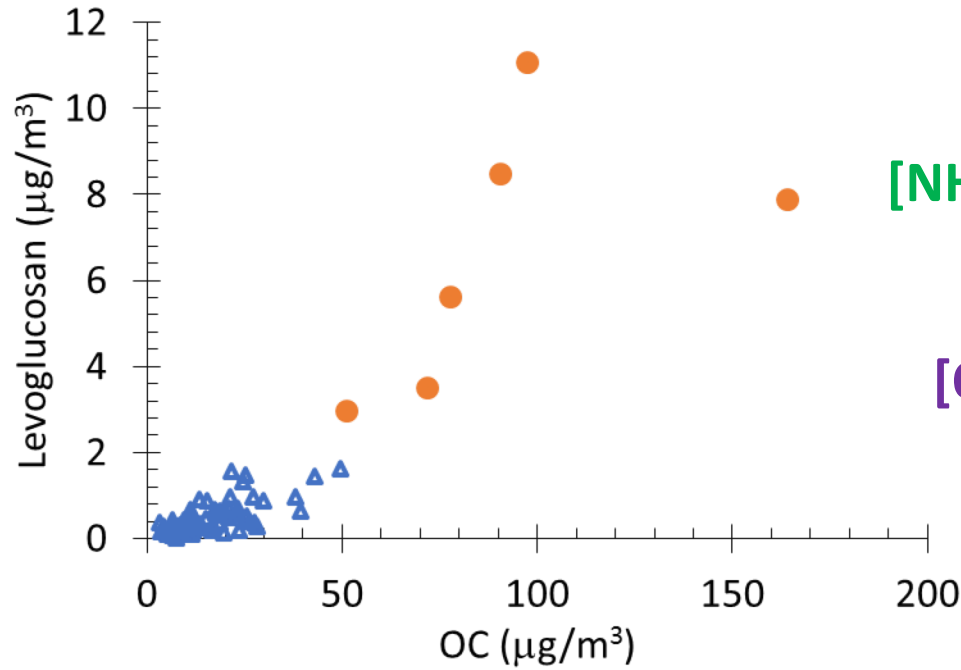
Source: 7SEAS FLAMBE (<http://www.nrlmry.navy.mil/flambe/7seas/7seas.htm>)



# Complex Urban Atmosphere: Smoke Dominant, Or Not?

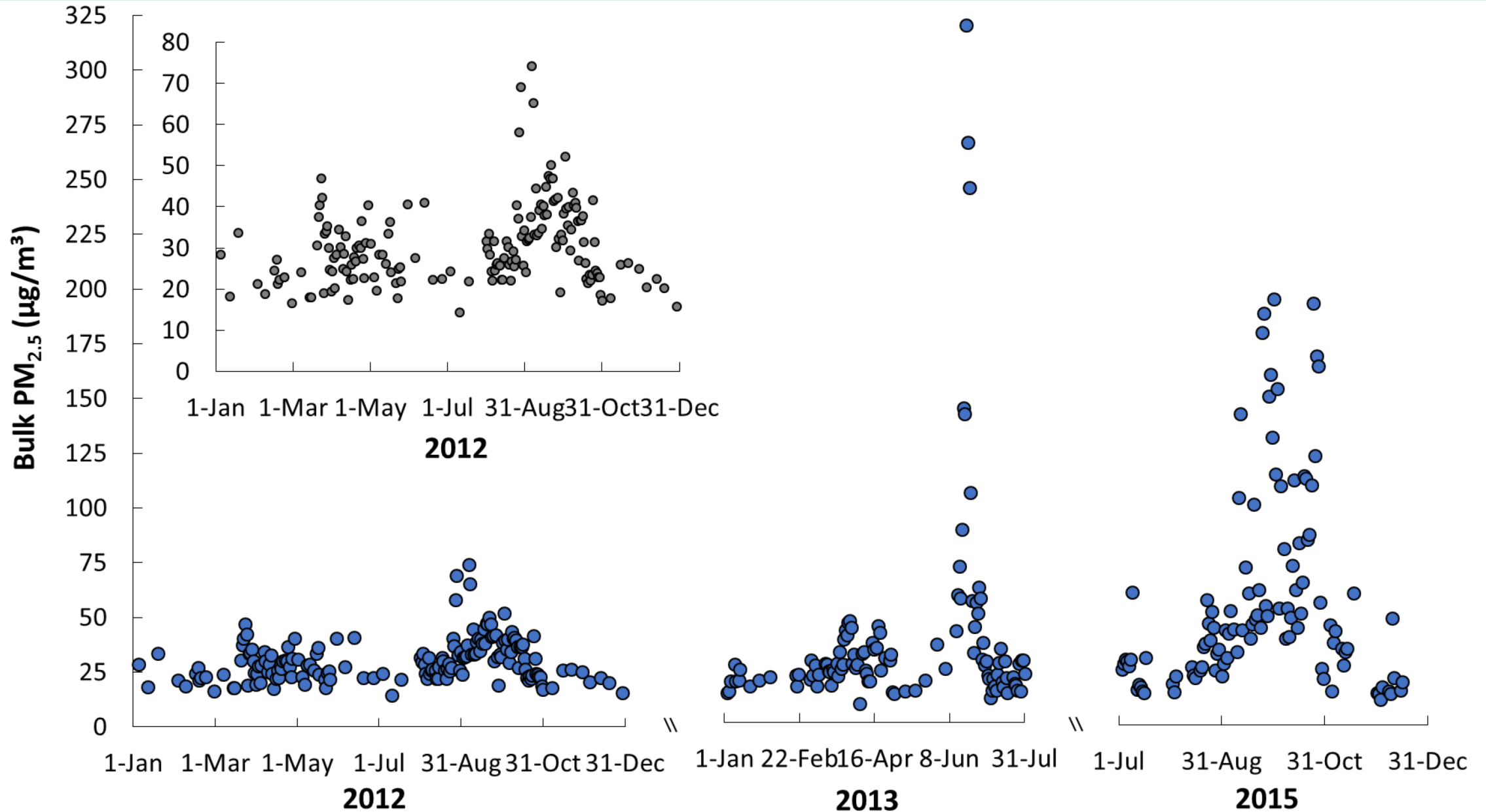


# Non-Smoke-Dominant (NSD) vs. Smoke-Dominant (SD) PM<sub>2.5</sub>





# 107 Non-Smoke-Dominant (NSD), 140 SD & Episodic PM<sub>2.5</sub>

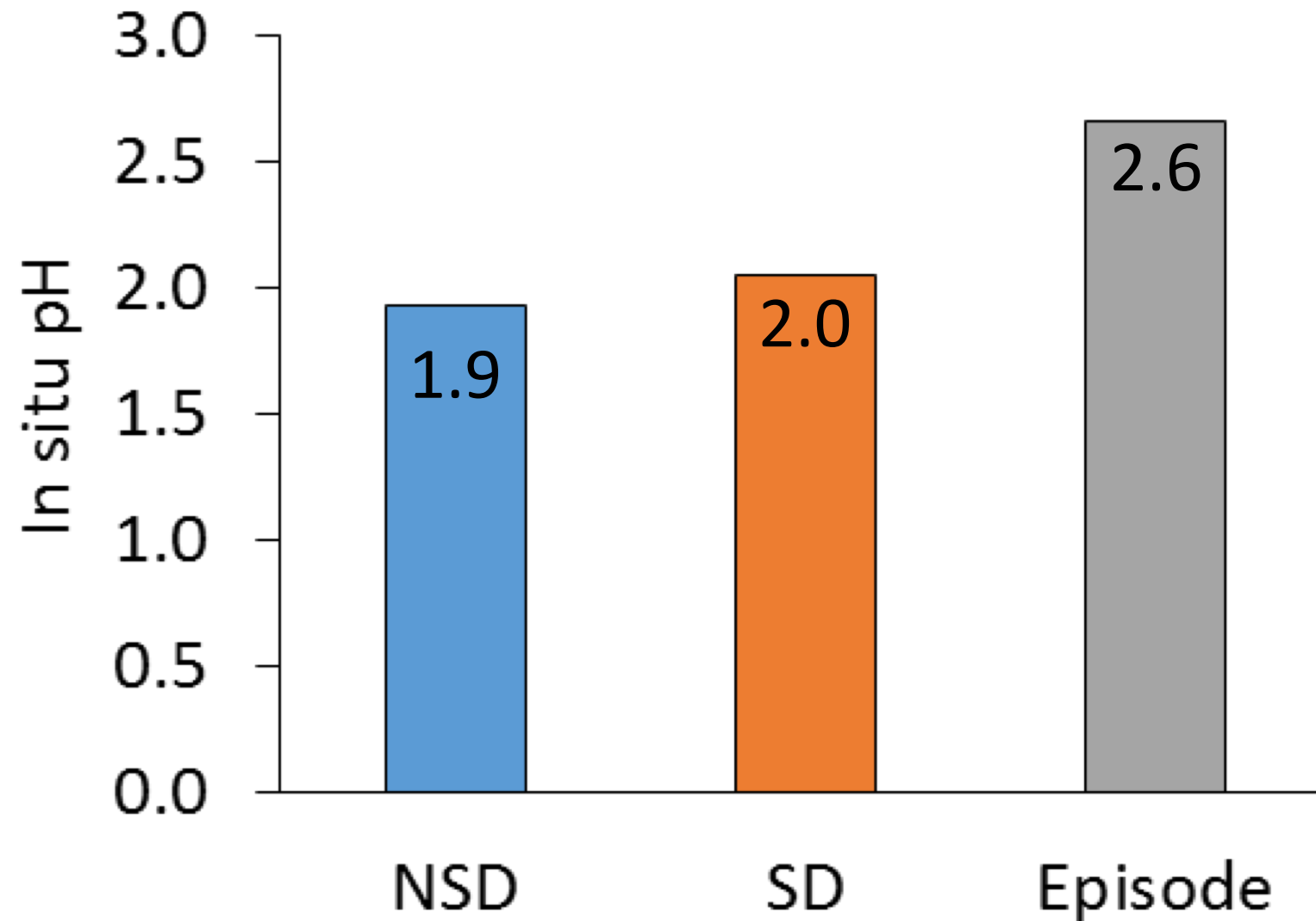


# Transboundary Peat-Forest Burning Smoke, 2013

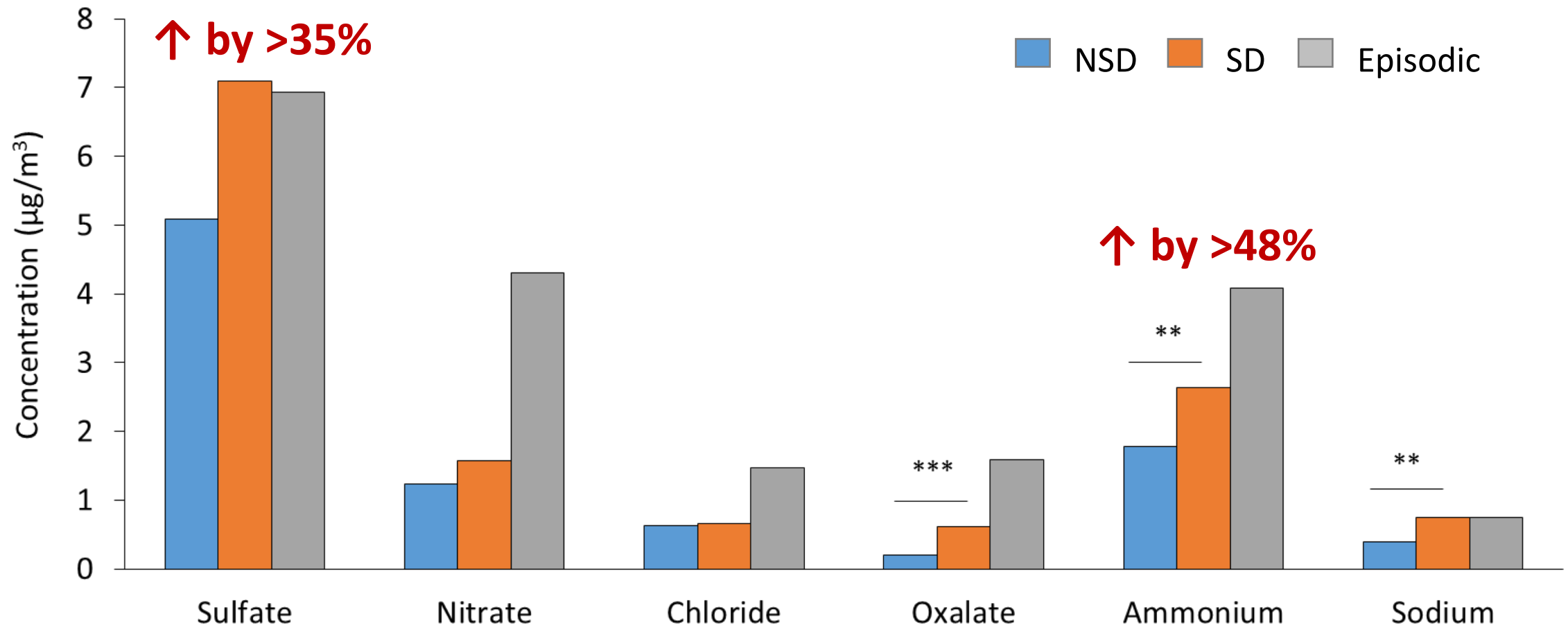




# Transboundary Smoke Neutralizes Receptor PM<sub>2.5</sub>



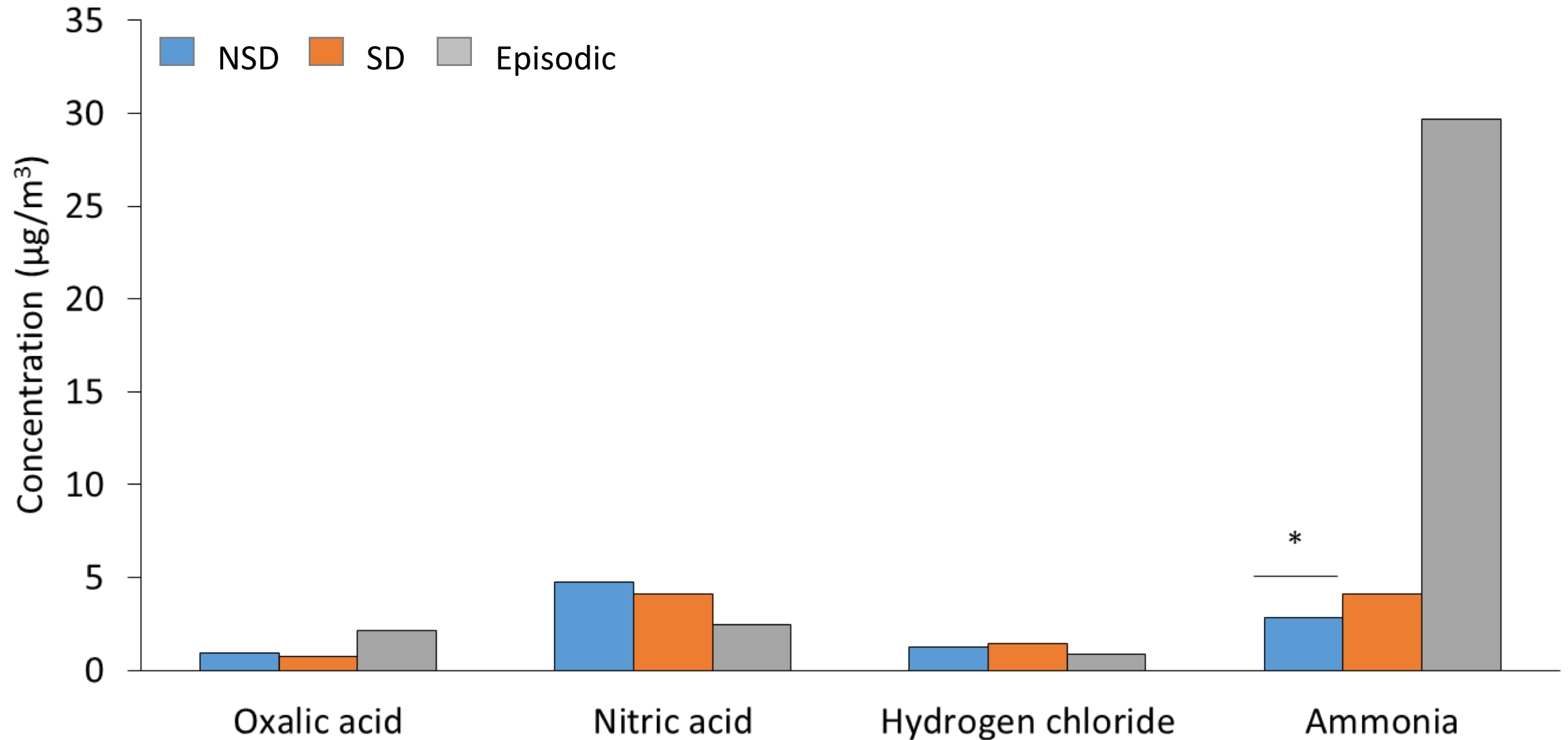
# Transboundary Smoke ↑ Alkaline Ionic Species



\*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$



# Transboundary Smoke ↑ Ammonia



\*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$

# Transboundary Smoke $\uparrow$ Ammonia

**10.8–12.4 g  $\text{NH}_3$  /kg**

$\sim 0.8 \text{ g } \text{NH}_3 / \text{kg}$

1.0–4.8 g  $\text{NH}_3$  /kg

(Akagi et al. 2011 & references therein)



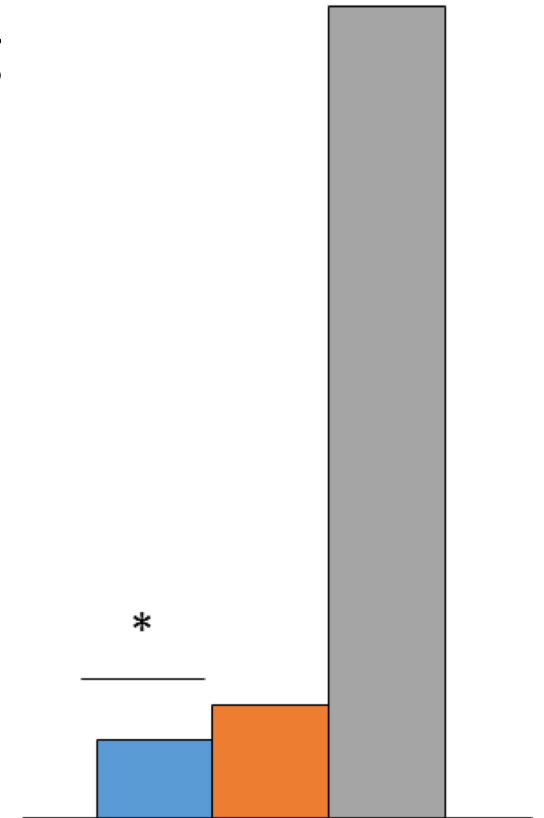
**Peat forest**



**Temperate forests**



**Animal dung**



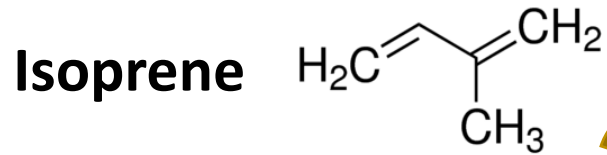
**Ammonia**



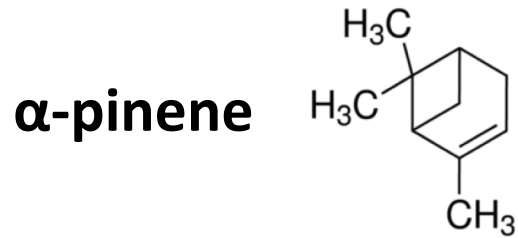
# Receptor vegetation stressed by transboundary smoke?

## Parent Biogenic VOC

## Parent Smoke Compounds

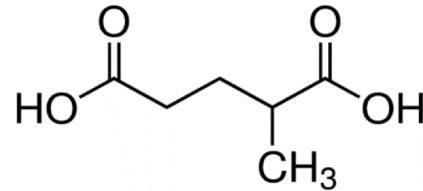


(Kourtchev et al. 2008)

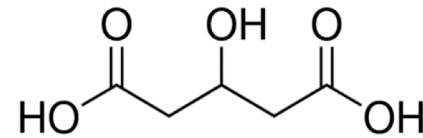


(Haddad et al. 2011)

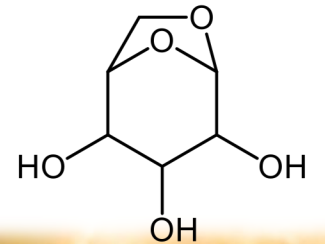
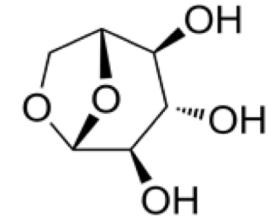
## Daughter compounds In PM<sub>2.5</sub>



2-methylglyceric acid

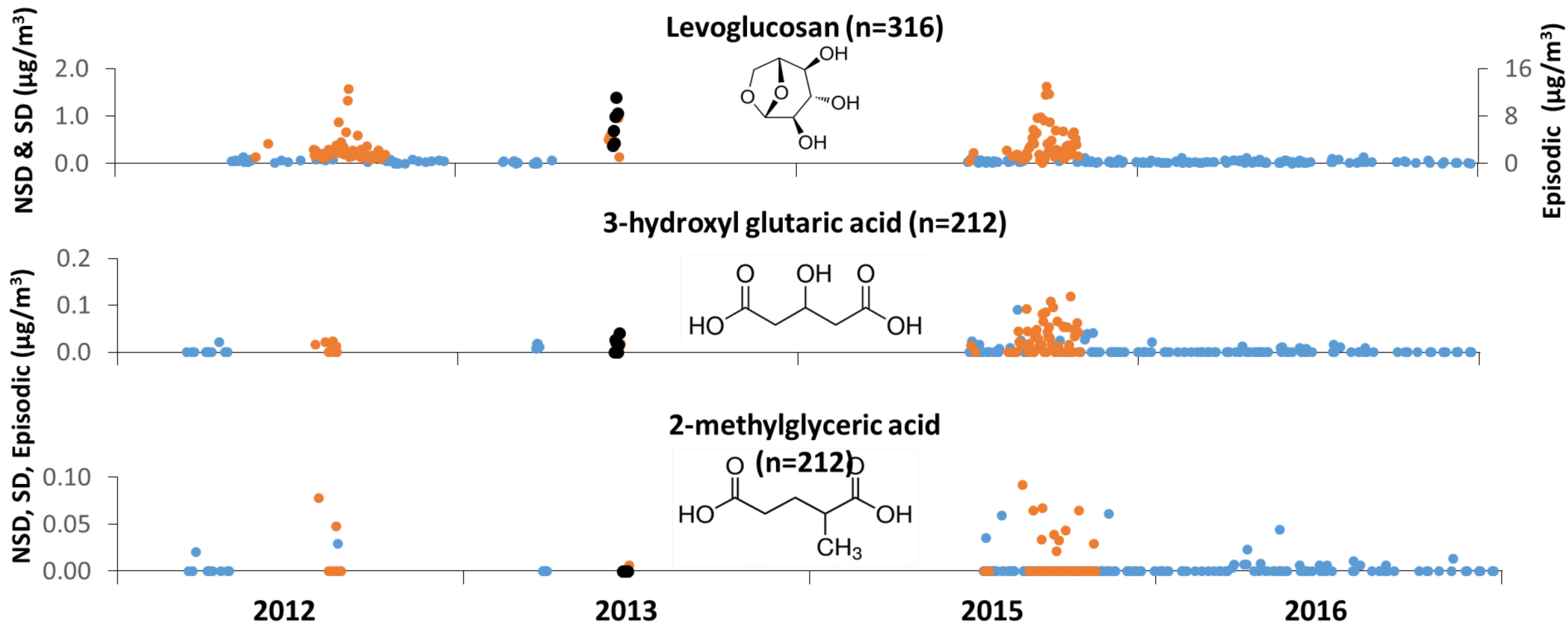


3-hydroxyglutaric acid



# Consistent Trend with Levoglucosan

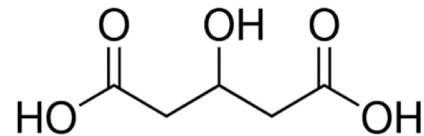
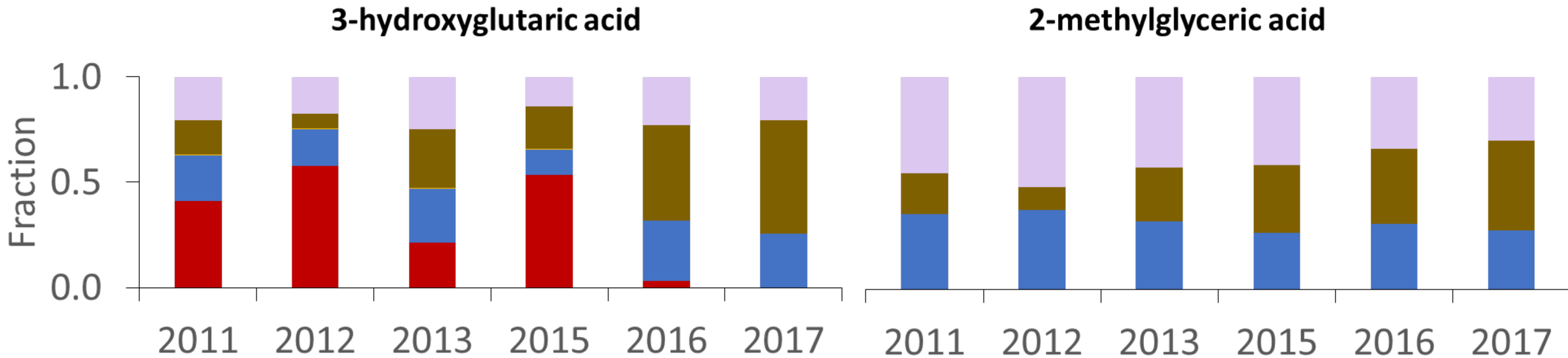
● Non-smoke dominant (NSD) PM<sub>2.5</sub> ● Smoke-dominant (SD) PM<sub>2.5</sub> ● Episodic PM<sub>2.5</sub>



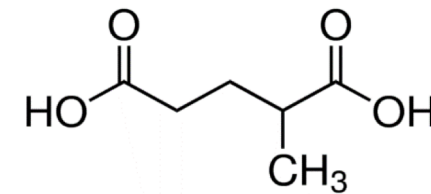


# 2-Methylglyceric Acid: A Potential Biomarker Indicating Stress

Oil refineries + shipping   Road dust + crustal   Secondary aerosols   Sea salt   Biomass burning   Traffic



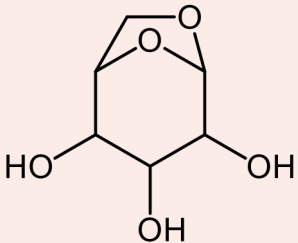


Associating with transboundary smoke



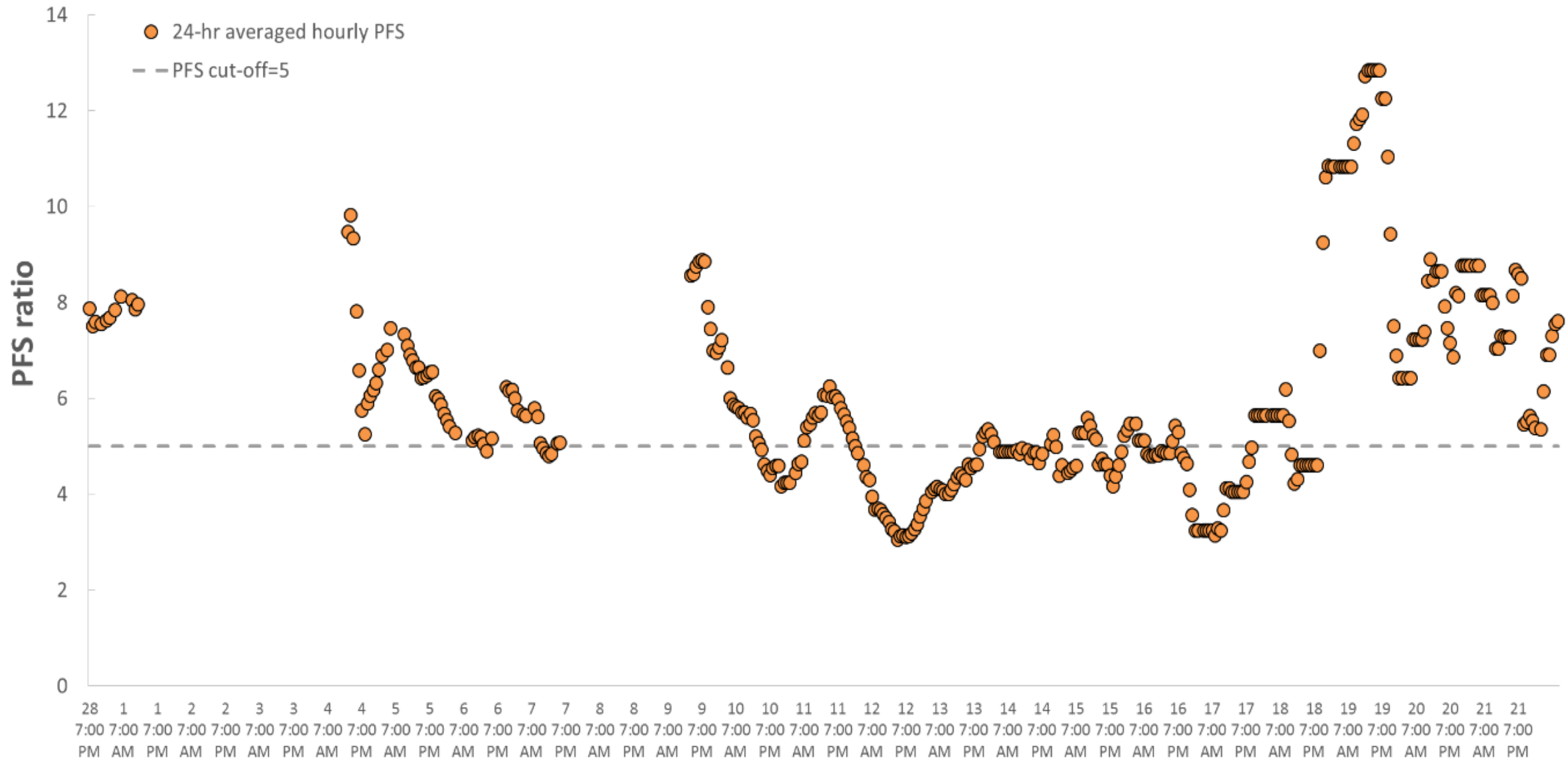
Mainly locally borne

# New Marker Assessing Transboundary Smoke @ Receptor Site

	Non-Smoke-Dominant	Smoke-Dominant	Detection Frequency	Processing Duration
				
New Marker $\left(\frac{OC2+OC3+PC}{Soot\ EC}\right)$	$< 5$	$\geq 5$	hourly	1.5 hours
Biomarker (Levoglucosan) 	$\leq 0.10\ \mu\text{g}/\text{m}^3$	$\geq 0.20\ \mu\text{g}/\text{m}^3$	Daily	> 20 hours

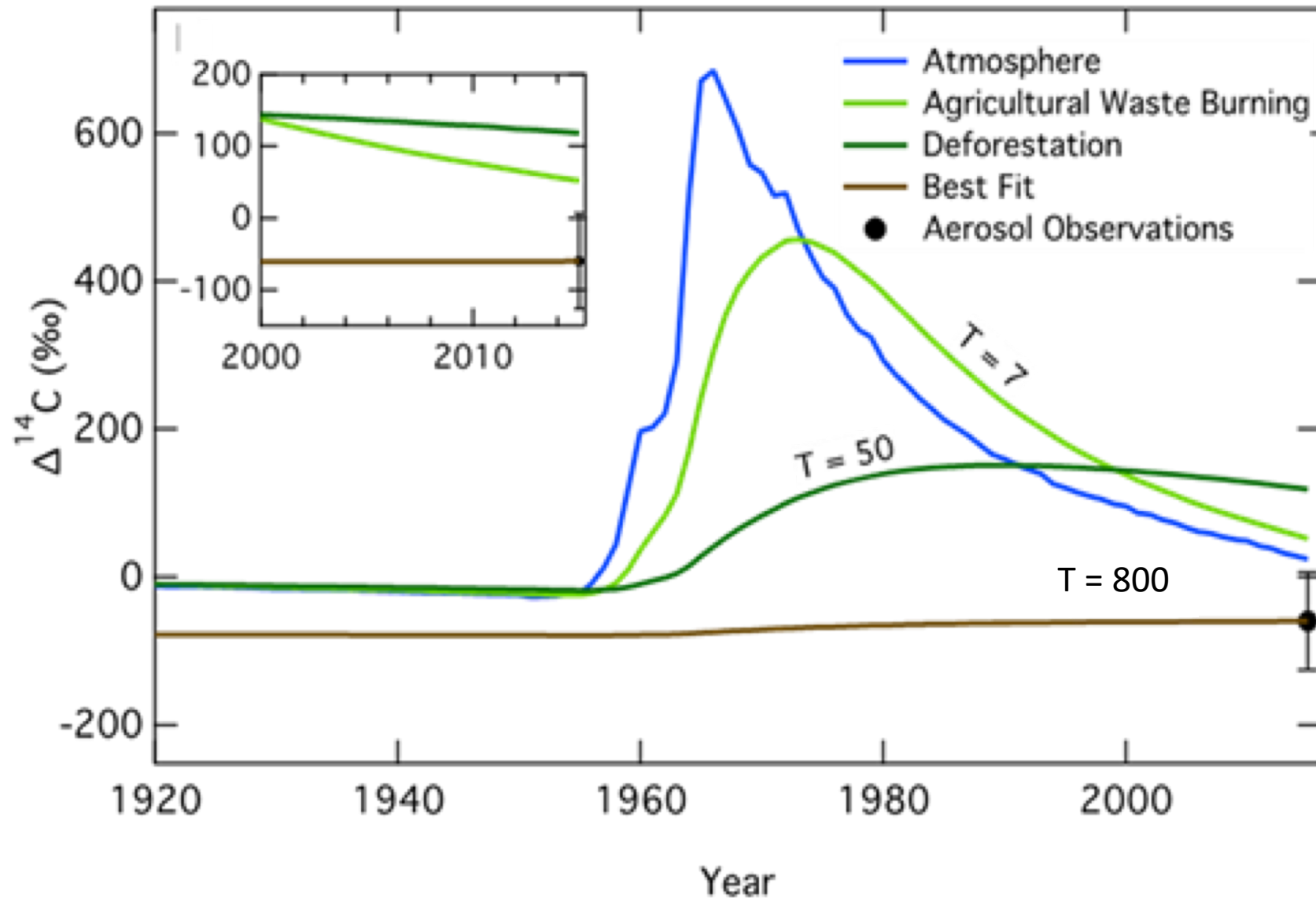
(PC: pyrolyzed carbon)

# Hourly Assessment of Transboundary Peat-Forest Smoke



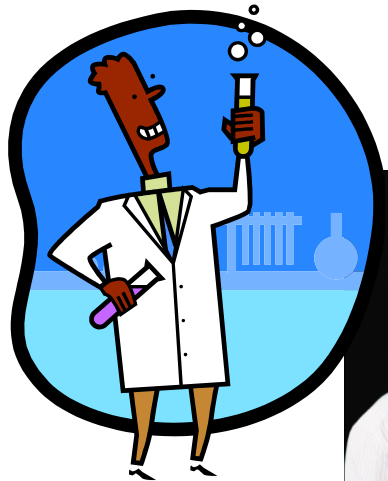


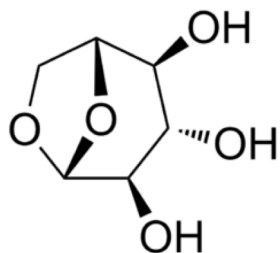
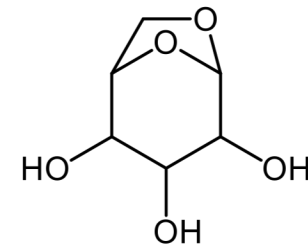
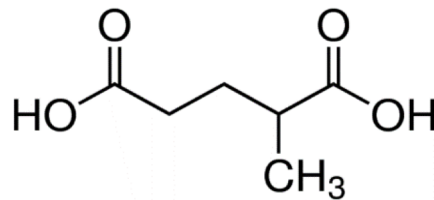
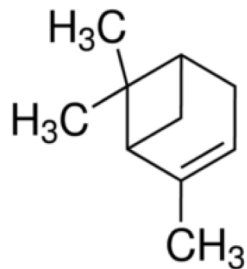
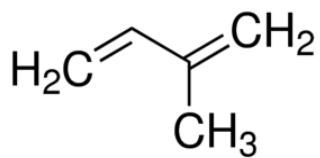
# Mean Age of 2015 Transboundary Peat-Forest Smoke: ~800 Years



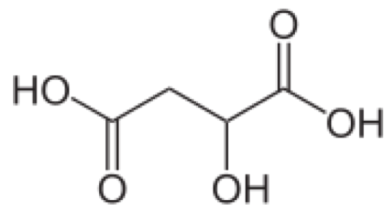
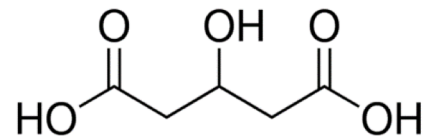
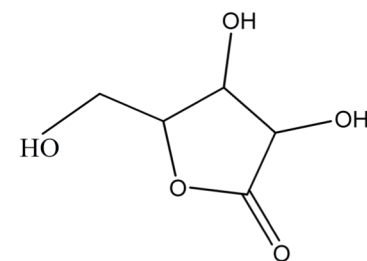
# Acknowledgement

- National Environment Agency, Singapore
- NASA, USA
- Student research assistants





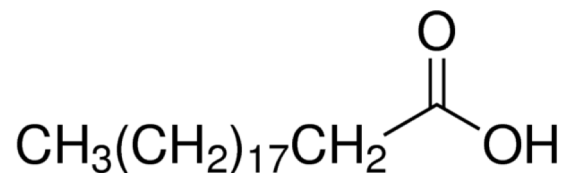
**Thank You!**



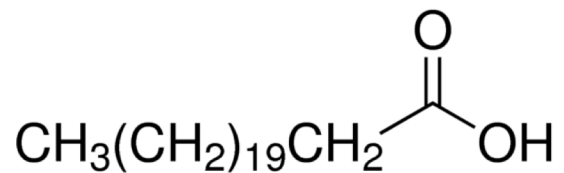


# Primary Biogenic Markers: Long-Chain Fatty Acids

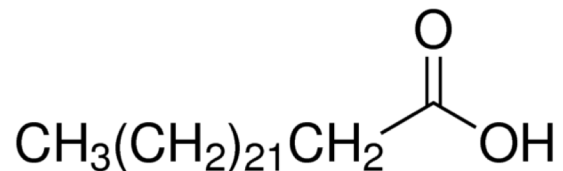
*High molecular weight (HMW) monocarboxylic acids (MCA)*



**Eicosanoic acid (C20)**



**Docosanoic acid (C22)**



**Tetracosanoic acid (C24)**

(Simoneit, 1986)



NPark, Singapore



# Transboundary Peat-Forest Smoke ↑ C20–C24 Fatty Acid Concentrations

