Recent Advancement of Atmospheric PM Research in Southern Thailand

PRINCE OF SONGKLA UNIVERSITY

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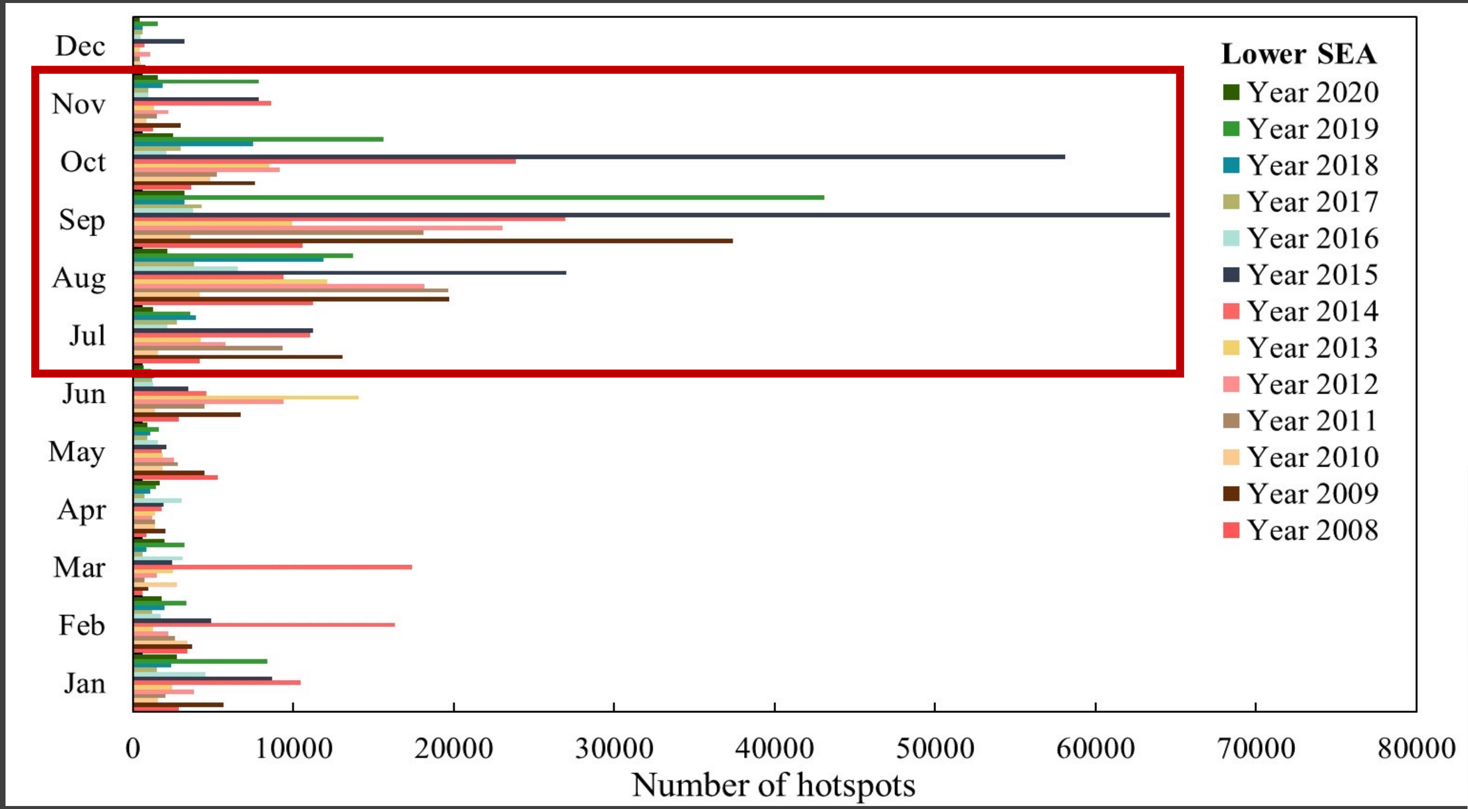
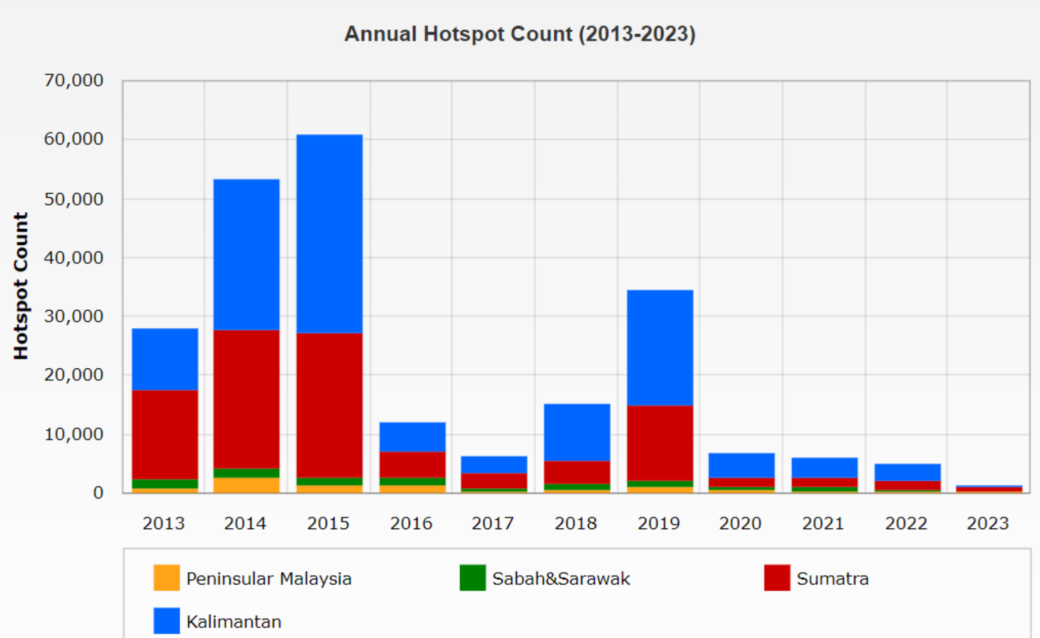
(Regional Specialized Meteorological Centre, 2022)

Biomass Burning in Lower SEA



The hotspots in lower SEA occurred from **July to November**, mostly in the islands of Kalimantan and Sumatra of Indonesia

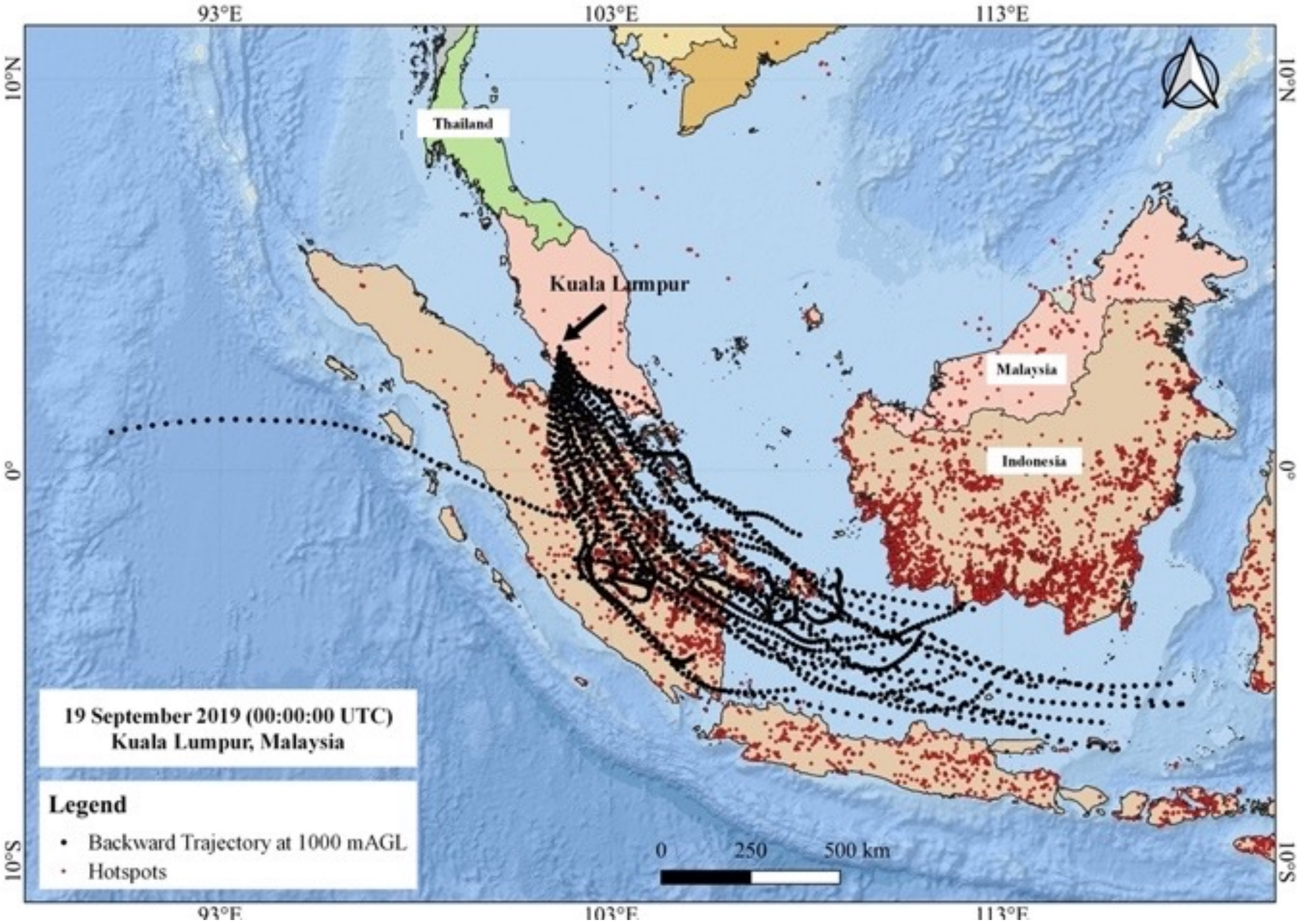


Monthly and annual hotspot count from NOAA-18 and NOAA-19 satellites: 2013-2023

Transboundary Haze

Two important factors that determine how strong the transboundary haze affects the air quality of various locations include:

- **Meteorological factors** that influence transport of the pollutants, i.e. fine and ultrafine particles to destination. These are the **wind speed and direction**, which determine location and distance the pollutants can travel, as well as **precipitation**, which determines how much the pollutants can arrive at the destinations or encounter wet deposition.
- **Local meteorological condition** - **temperature and relative humidity and geography of the destination**, that controls accumulation of the pollutants.



Backward trajectory simulations for Hat Yai during strong haze periods

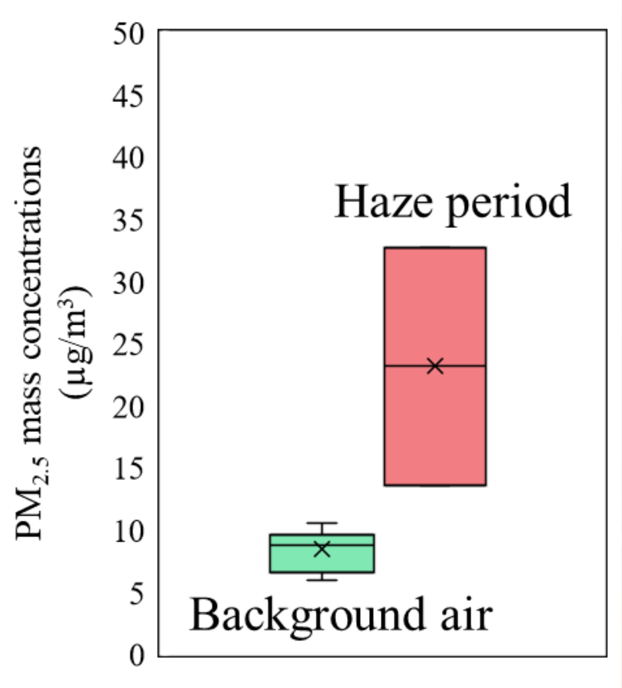
Reference: Dejchanchaiwong, R., Tekasakul, P., Morris, J., Ingviya, T., et al. (2023) "Biomass Burning in Southeast Asia and Influences on Atmospheric Nanoparticles", in Szpunar, J and Jimenez-Lamana, J. Environmental Nanopollutants: Sources, Occurrence, Analysis and Fate. Royal Society of Chemistry: 49-81.

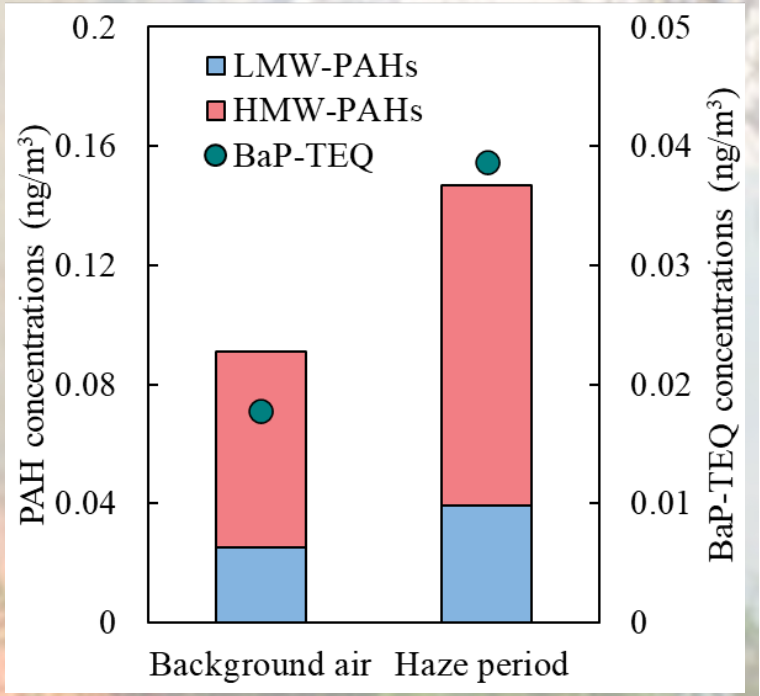
Sources of $PM_{2.5}$ in Southern Thailand

Location	Period	Method	Potential Sources	Ref.
Hat Yai, Songkhla	Jan-Dec 2018	OC/EC and Char-EC/Soot-EC ratios	**Vehicle**, biomass	Phairuang et al. (2020)
Hat Yai, Songkhla	Aug-Oct 2017 (Normal)	PAHs	**Vehicle**, biomass	Chomanee et al. (2020)
	Sep-Oct 2015 (Strong haze)		**Biomass**, vehicle	
Phuket	March 2017 to February 2018	PCA	**Vehicular exhausts** **Biomass burning** Sea salt aerosols and Industrial emissions	Choochuay et al. (2020)
Tepha, Songkhla	Jan-May 2019 & Oct 2019-Jan 2020 (Normal)	Chemical mass balance (CMB)	**Local biomass burning (72%)** Vehicular exhausts (16%)	Mahasakpan et al. (2022)
	Sep 2019 (Strong haze)		**Peatland fire (52%)** Vehicular exhausts (20%) & Local biomass burning (16%)	
Hat Yai, Songkhla	Sep 2019 (Strong haze)	Chemical mass balance (CMB)	**Peatland fire (45%)** diesel (14%) rubber wood (12%) and rice straw (8%)	Promsiri et al. (2023)
	Jun 2019 – May 2020 (Normal)		**Vehicle (52%)** Rubber wood burning (18%)	
Tepha, Songkhla	May 2019 - Feb 2020 (Normal)	PCA	**Vehicle emission,** Local biomass burning and SIA	Chaisongkaew et al. (2023)
	Sep 2019 (Strong haze)		**Biomass burning,** Vehicular exhausts, Sea salt and SIA	
Kuan Kreng Peat Swamp Forest , Sourthern, Thailand	August 2019 (Forest fire)	CMB	- M. cajuputi or white samet (69.3%) - Local biomass burning i.e., Rubber & oil Palm (6.7%) - grey sedge (4.5%) & Vehicle (2.4%)	Nim et al. (2023)
	March–October 2021		- Vehicle (63.9%) & Grey sedge (44.5%) - Rice straw (5.4%)	

PM2.5-bound Polycyclic Aromatic Hydrocarbons (PAHs) in Southern Thailand: Characteristics, Risk Assessment and Sources

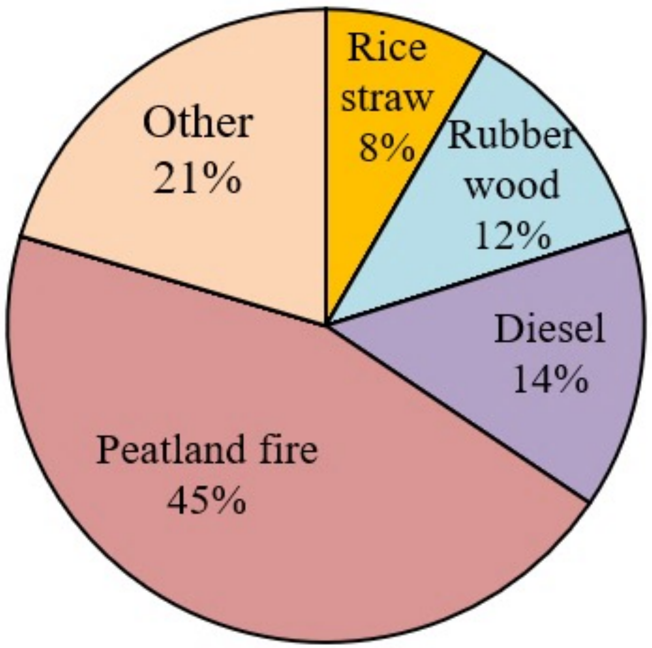
- This was influenced by transboundary haze in September 2019, when the 14-day average $PM_{2.5}$ concentration reached 32.7 µg/m³ (Sep#2) or **~4 times higher than** background concentrations for the rest of the year (8.4±1.7 µg/m³).
- Total concentrations of 16 PAHs ranged from 0.058 to 0.161 ng/m³ during the entire sampling period.
- Monthly PAH concentrations during transboundary haze period were 0.15±0.02 ng/m³ or **~2 times** as high as those in background air (0.09±0.03 ng/m³) counterparts.
- HMW-PAHs during the transboundary haze period contributed 67.8-80.0% of total PAH.
- The increase of PM level during the haze period was an regional effect, as no significant change of local sources occurred..



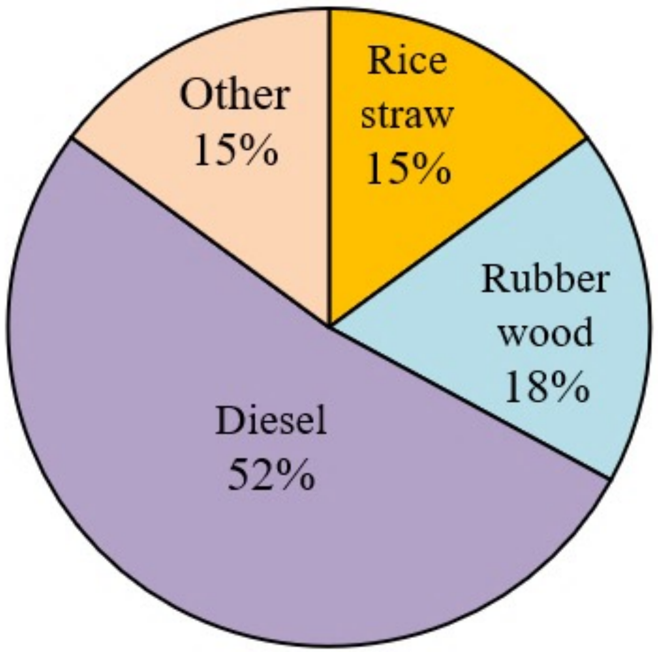


2019 Haze in Southern Thailand
(Promsiri et al., 2023)

Source apportionment: CMB Model



(a) Transboundary haze



(b) background air

- The CMB source apportionment indicated that the dominant sources of $PM_{2.5}$ during the transboundary haze were **peatland fire (45%), followed by diesel (14%), rubber wood (12%), rice straw (8%) and unidentified sources (21%).**
- In contrast, in the background air, diesel combustion (52%) and rubber wood burning (18%) were the major influences on $PM_{2.5}$ in Hat Yai.
- **Air quality in Hat Yai city was directly influenced by not only transboundary haze caused by regional sources but also are in fact intensified by local emissions, i.e., diesel combustion and biomass burning i.e., rubber wood and rice straw burning as well as secondary aerosol formation, SOA and SIA, in other unidentified sources.**

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Fine and ultrafine particle- and gas-polycyclic aromatic hydrocarbons affecting southern Thailand air quality during transboundary haze and potential health effects

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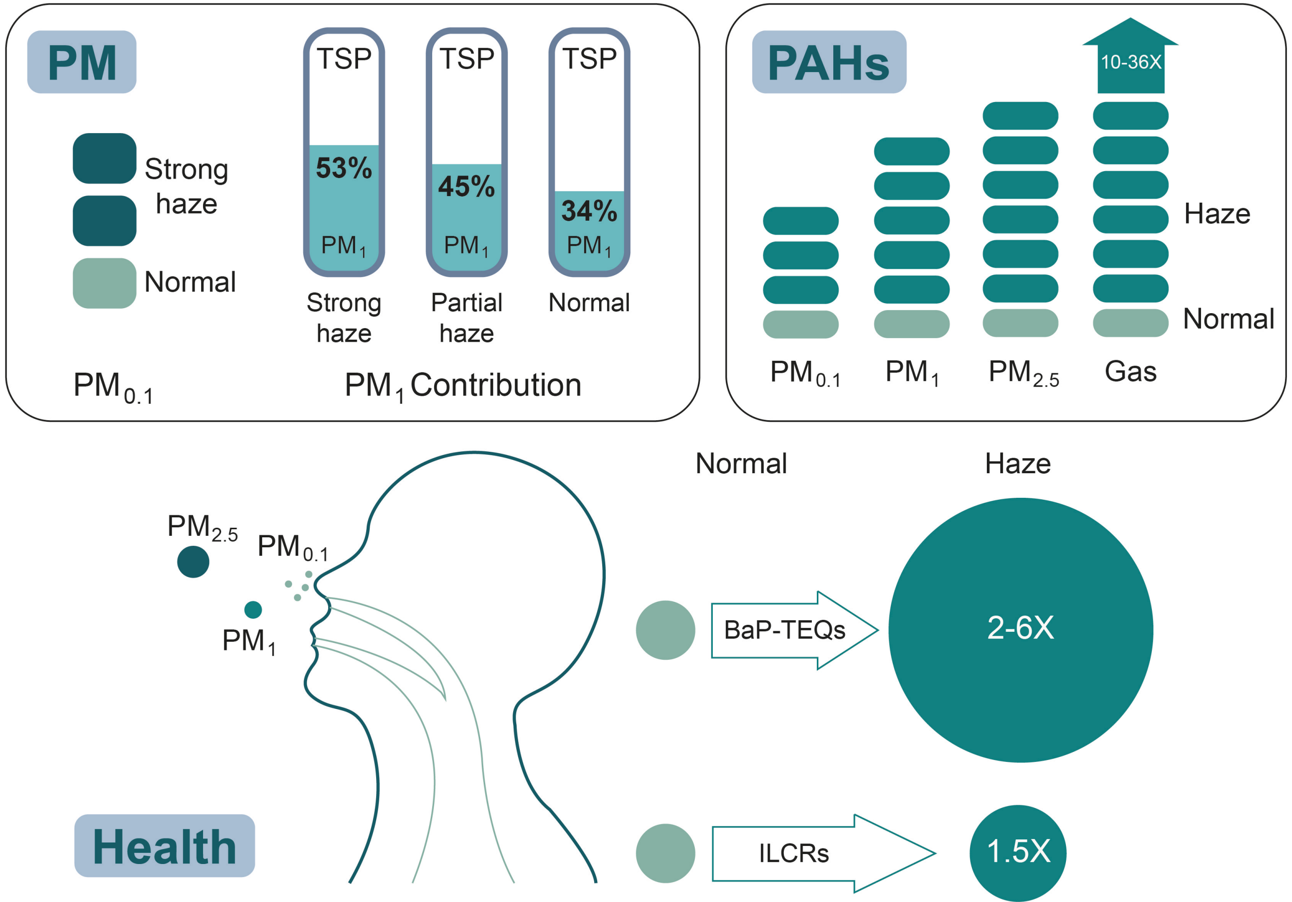
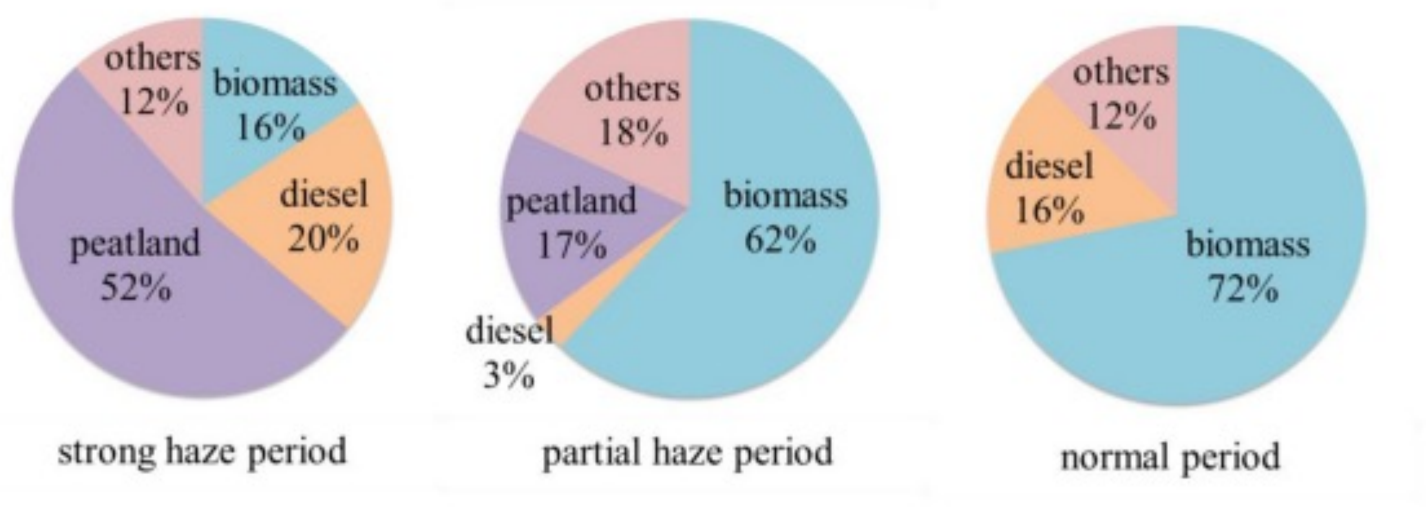


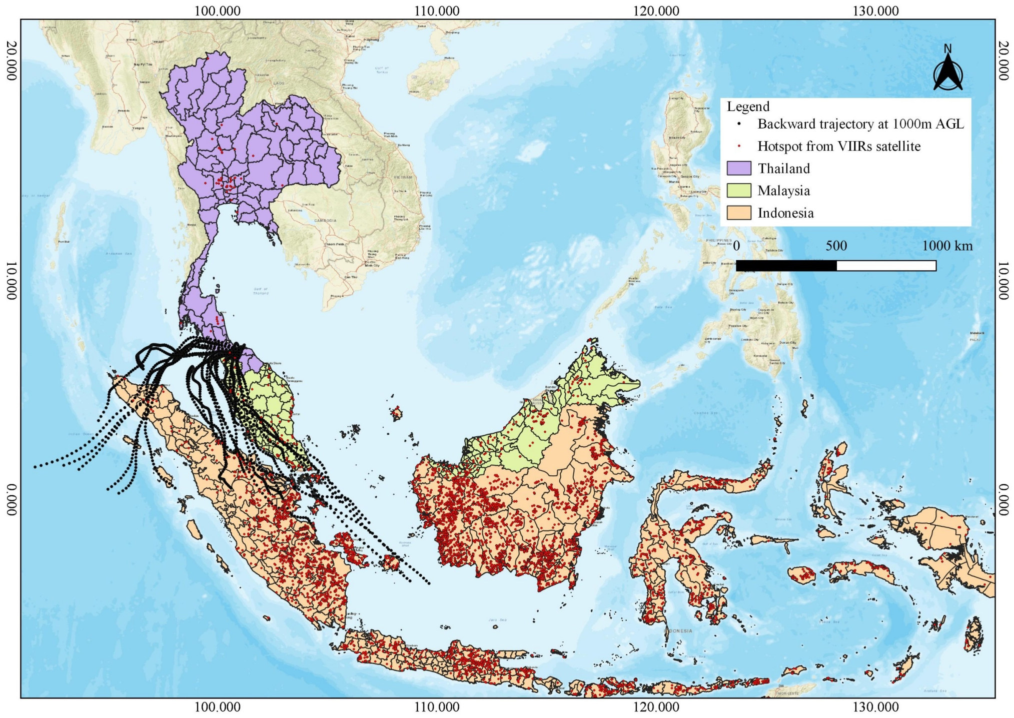
- **PM_1 was the predominant component, during partial and strong haze periods,** accounting for 45.1% and 52.9% of total suspended particulate matter, respectively, while during normal period the contribution was only 34.0%.
- **$PM_{0.1}$ concentrations, during the strong haze period, were approximately 2 times** higher than those during the normal period.
- Levels of PAHs during the strong haze period for fine and ultrafine particles were significantly higher than those during the normal period.
- Substantially increased levels of particle-PAHs for $PM_{0.1}$, PM_1 and $PM_{2.5}$ were observed during strong haze period, about 3, 5 and 6 times higher than those during normal period.
- Toxic Equivalency Quotients (BaP-TEQ) in $PM_{0.1}$, PM_1 and $PM_{2.5}$ during haze periods were about 2-6 times higher than in the normal period.
- **PM_1 played a major role in toxicity in $PM_{2.5}$, measured by BaP-TEQ concentrations, accounting for 68.7-91.3%, whereas $PM_{0.1}$ contributed to 10.5-28.9% of the BaP-TEQ in $PM_{2.5}$.**
- **This indicated that smaller particles, <1 μm, were a more significant source of carcinogenic aerosols and caused more health detriments than larger particles.**

Sources of $PM_{0.1}$, PM_1 and $PM_{2.5}$ in Southern Thailand

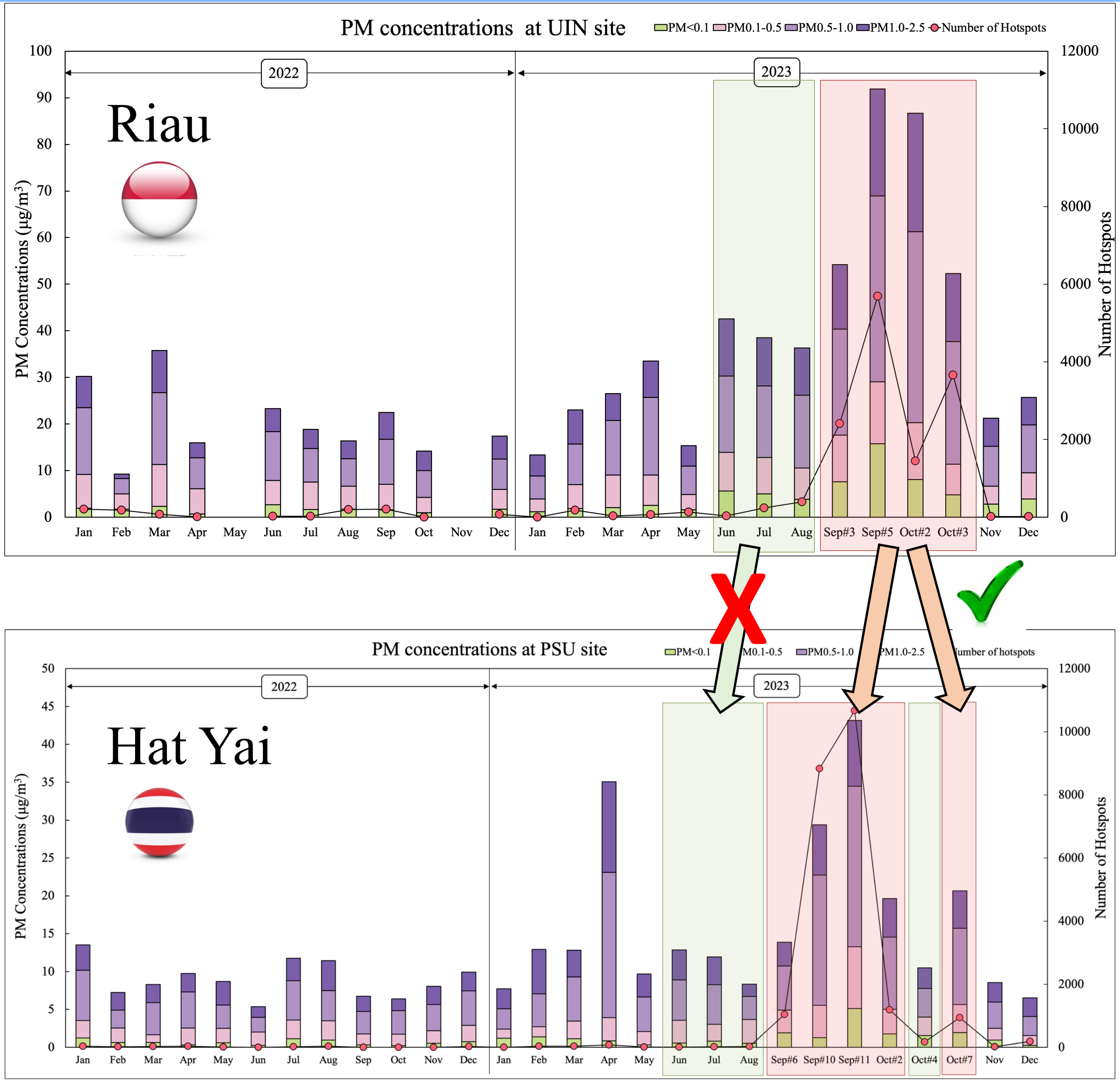
- The CMB analysis for $PM_{0.1}$, PM_1 and $PM_{2.5}$ indicated mixed sources of petroleum combustion and biomass burning
- The major source was peatland fires during the strong haze period.
- The contribution from local biomass burning was significant in $PM_{2.5}$ and PM_1 during the normal period, whereas diesel exhaust completely dominated $PM_{0.1}$.



(a) $PM_{2.5}$



2022-2023 Effects of Peatland Fires in Indonesia: PM concentrations

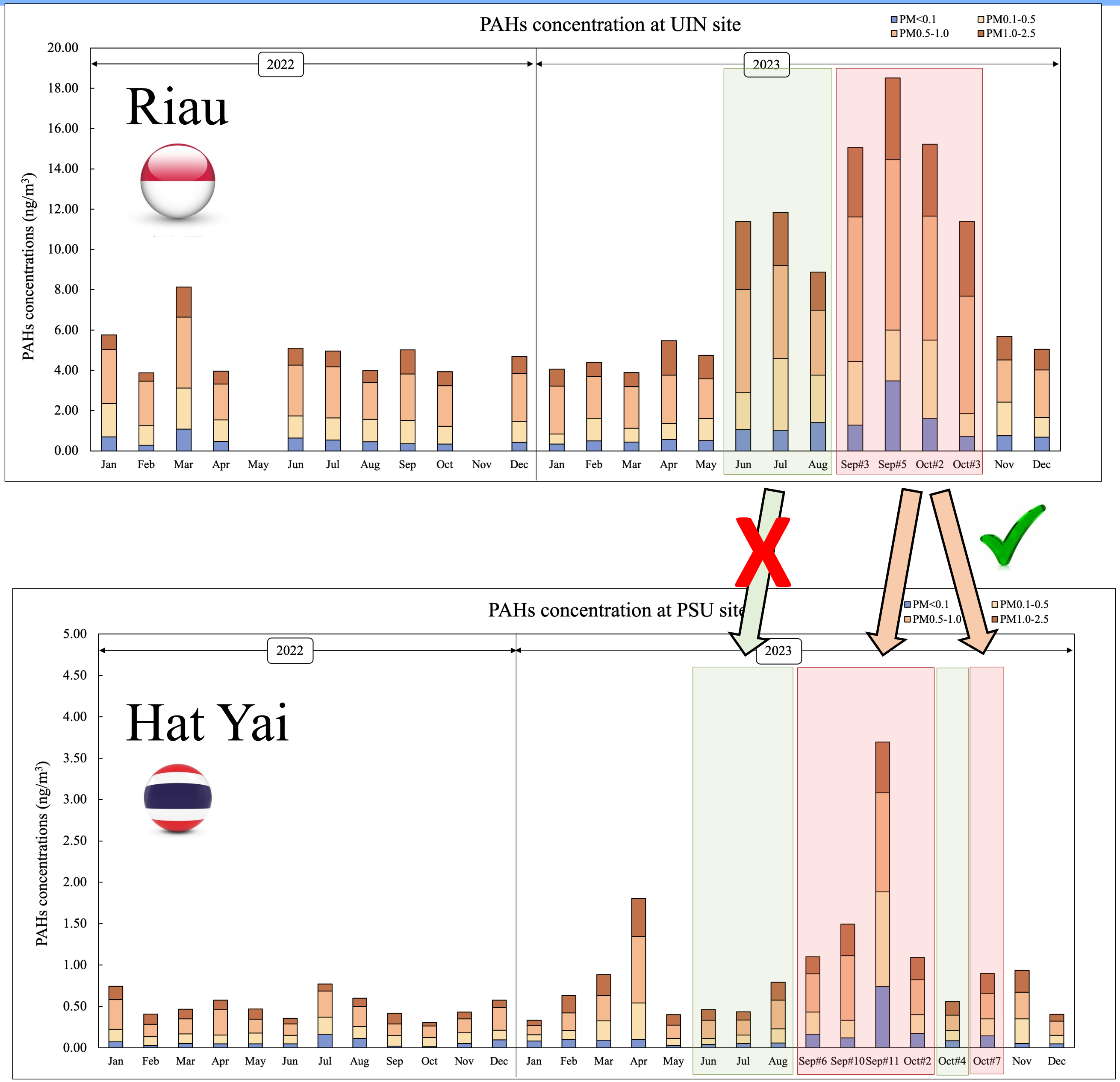


Site	Period	$PM_{0.1}$	PM_1	$PM_{2.5}$	Number of hotspots
UIN	Normal	1.94±0.77	16.07±5.69	21.32±7.33	85±78
	Haze non effect to Thailand	4.84±0.88	28.22±2.03	39.12±3.14	224±181
	Haze effect to Thailand	9.06±4.72	52.05±15.43	71.28±20.96	3303±1832

Site	Period	$PM_{0.1}$	PM_1	$PM_{2.5}$	Number of hotspots
PSU	Normal	0.71±0.38	7.26±4.21	10.55±6.40	30±43
	Non haze	0.86±0.46	7.91±0.92	10.91±1.96	56±77
	Haze	2.40±1.54	19.64±9.36	25.34±11.40	4535±4808

	UIN	PSU
(grey)	Haze non effect to Thailand	Non haze
(pink)	Haze effect to Thailand	Haze

2022-2023 Effects of Peatland Fires in Indonesia: PAHs concentrations



Site	Period	$PM_{0.1}$	PM_1	$PM_{2.5}$
UIN	Normal	0.53±0.19	3.95±0.86	4.86±1.06
	Haze no effect to Thailand	1.17±0.21	8.06±0.91	10.71±1.60
	Haze effect to Thailand	1.77±1.19	11.35±2.78	15.05±2.91

Site	Period	$PM_{0.1}$	PM_1	$PM_{2.5}$
PSU	Normal	0.07±0.04	0.46±0.26	0.61±0.34
	Non haze	0.06±0.02	0.41±0.11	0.56±0.16
	Haze	0.27±0.26	1.31±1.00	1.66±1.16

	UIN	PSU
(grey)	Haze non effect to Thailand	Non haze
(pink)	Haze effect to Thailand	Haze

Thank you

Computation & Aerosol Laboratory

Energy Technology Research Center
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