Supplementary material for

Three-Dimensional Biomass Burning Emission Inventory for Southeast and East Asia Based on Multi-Source Data and Machine Learning

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Table S 1 The ERA5 reanalysis data

Variable	Abbreviation	unit
10m u-component of wind	u10	m/s
10m v-component of wind	v10	m/s
2m temperature	t2m	°C
Surface latent heat flux	slhf	W/m²
Surface net solar radiation	ssr	W/m²
Surface sensible heat flux	sshf	W/m²
Total cloud cover	tcc	%
Vertical integral of temperature	p54.162	K·m
Boundary layer height	blh	m
Convective available potential energy	cape	J/kg
Friction velocity	zust	m/s
Geopotential	z	m²/s²
2m dewpoint temperature	d2m	°C
Evaporation	e	mm/day
Leaf area index, high vegetation	lai_hv	m²/m²
Leaf area index, low vegetation	lai_lv	m²/m²
Mean sea level pressure	msl	Pa
Soil temperature level 1	stl1	°C
Volumetric soil water layer 1	vswl1	m³/m³
Total precipitation	tp	mm

Table S 2 Five BB emission inventories

Inventory	Spatial & Temporal Resolution	Time Coverage	Data Source	Emitted Species
FINN v1.5 & v2.5	1 km² Daily	2002–Present	MODIS C6.1	VOCs Gases/Aerosols
GFAS v1.2	0.1° × 0.1° Daily	2003–Present	MODIS C6.1	VOCs Gases/Aerosols
FEER v1.0-G1.2	0.1° × 0.1° Daily	2003–Present	GFAS v1.2 FRP	VOCs Gases/Aerosols
QFED v2.6	0.1° × 0.1° Daily	2000–Present	MODIS C6.1	VOCs Gases/Aerosols
IS4FIRES v2.0	0.1° × 0.1° 3-hourly	2000–Present	MODIS C6.1	$PM_{2.5}$

Table S 3 Alternative calibration factors

	Forests	Shrublands	Grasslands	Croplands	Peatlands
Jan	-0.004	0.045	-0.057	0.018	-0.099
Feb	-0.136	-0.069	-0.091	-0.139	-0.515
Mar	0.065	0.010	-0.035	-0.202	0.476
Apr	0.125	0.136	0.039	-0.182	-0.177
May	0.177	-0.002	0.097	0.049	-0.083
Jun	-0.028	-0.371	-0.174	-0.159	-0.557
Jul	-0.299	-0.305	-0.288	-0.345	-0.494
Aug	-0.384	-0.227	-0.337	-0.281	-0.157
Sep	-0.437	-0.460	-0.298	-0.136	-0.306
Oct	-0.219	-0.154	0.051	-0.083	-0.478
Nov	-0.124	-0.280	0.440	-0.031	-0.435
Dec	-0.040	0.026	0.054	-0.018	-0.206

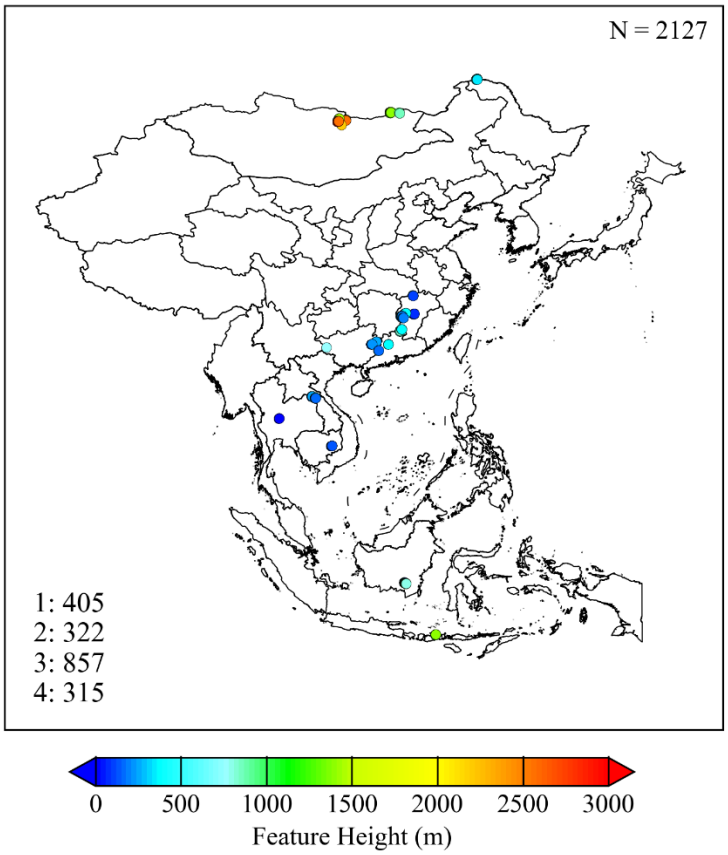

Figure S 1. The spatial distribution of plume height data for 2,127 sampled fire points from the 2017-2018 MISR Plume Height Project 2.

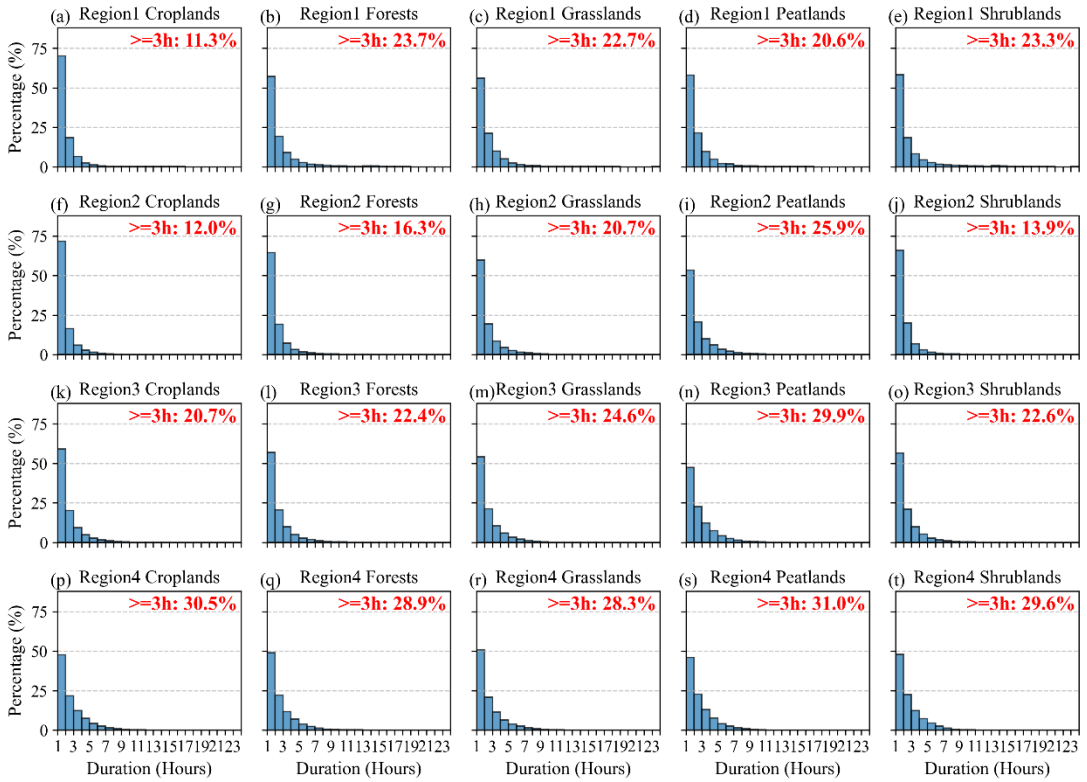

Figure S 2. The probability statistics of continuous fire burning occurrences from 2016 to 2023 based on Himawari-8/9 satellite FRP data across four climate regions and five vegetation types. The red font highlights the percentage of occurrences where the burning duration is greater than or equal to 3 hours.

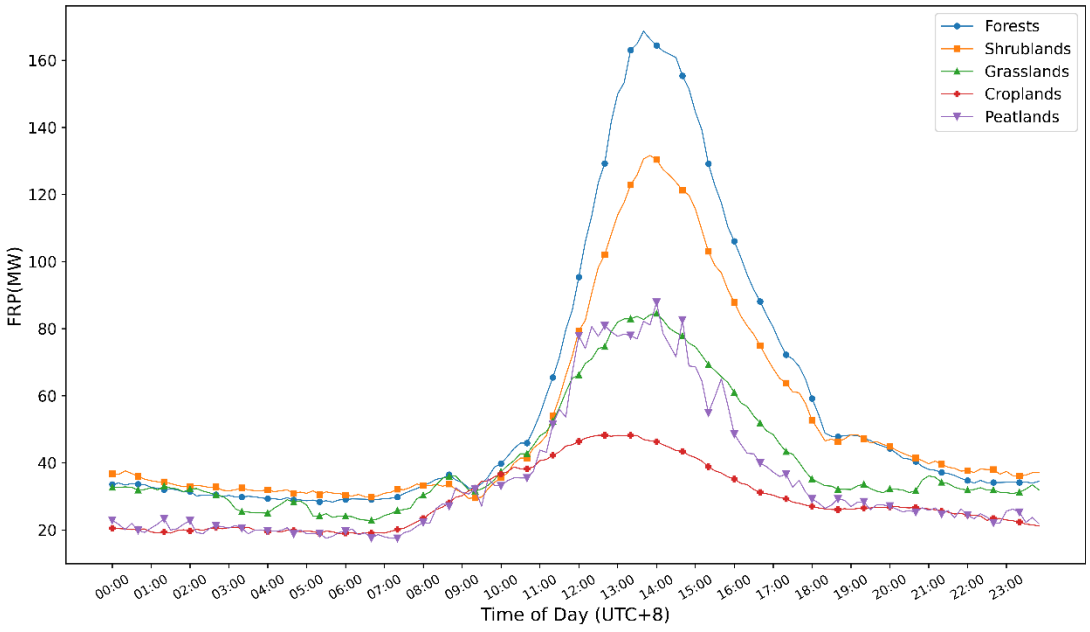

Figure S 3. Diurnal cycle statistics of FRP in different land types over Southeast and East Asia.

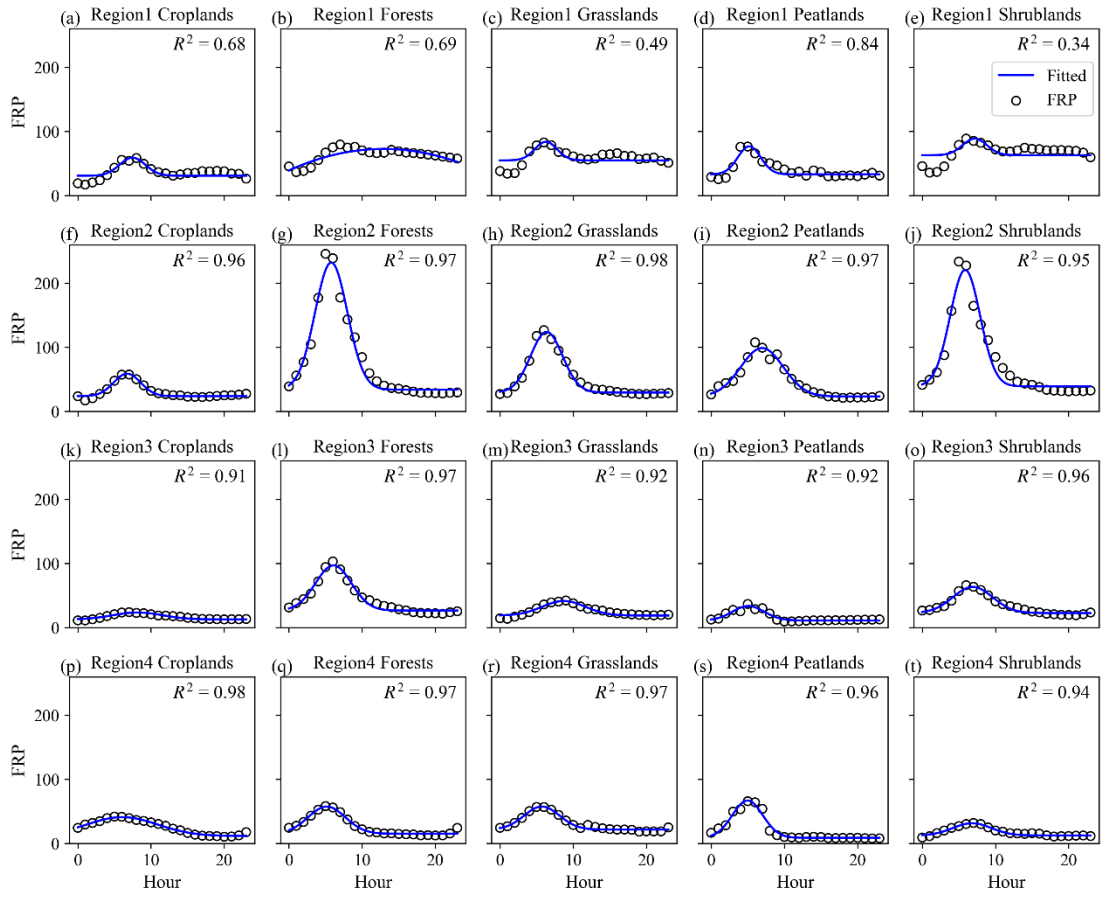

Figure S 4. Gaussian fitting curves based on hourly FRP (MW) retrieved from AHI for 2016–2023 across four climatic regions and five vegetation types, with the fitting correlations.

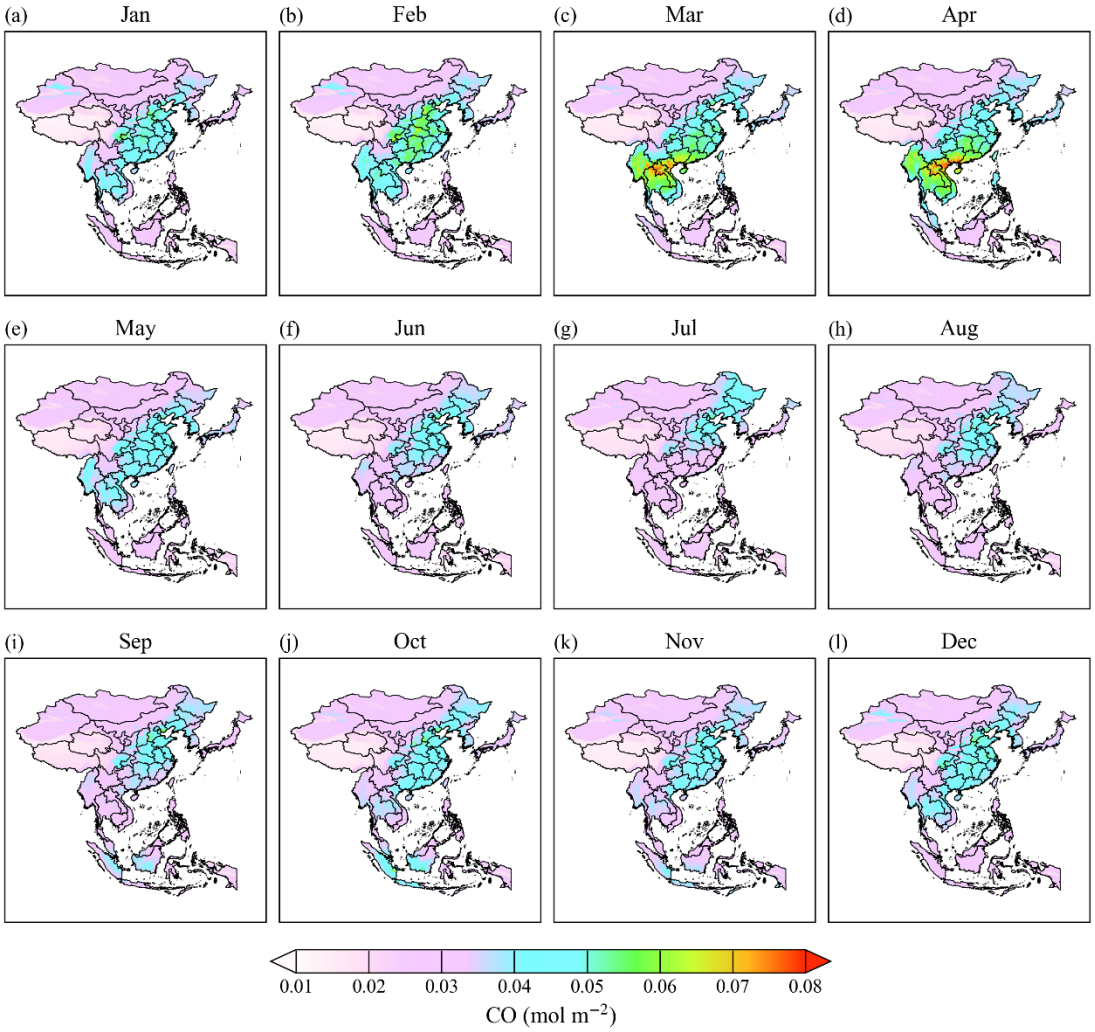

Figure S 5 Spatial distribution of monthly CO averages in the SEA region from TROPOMI in 2023

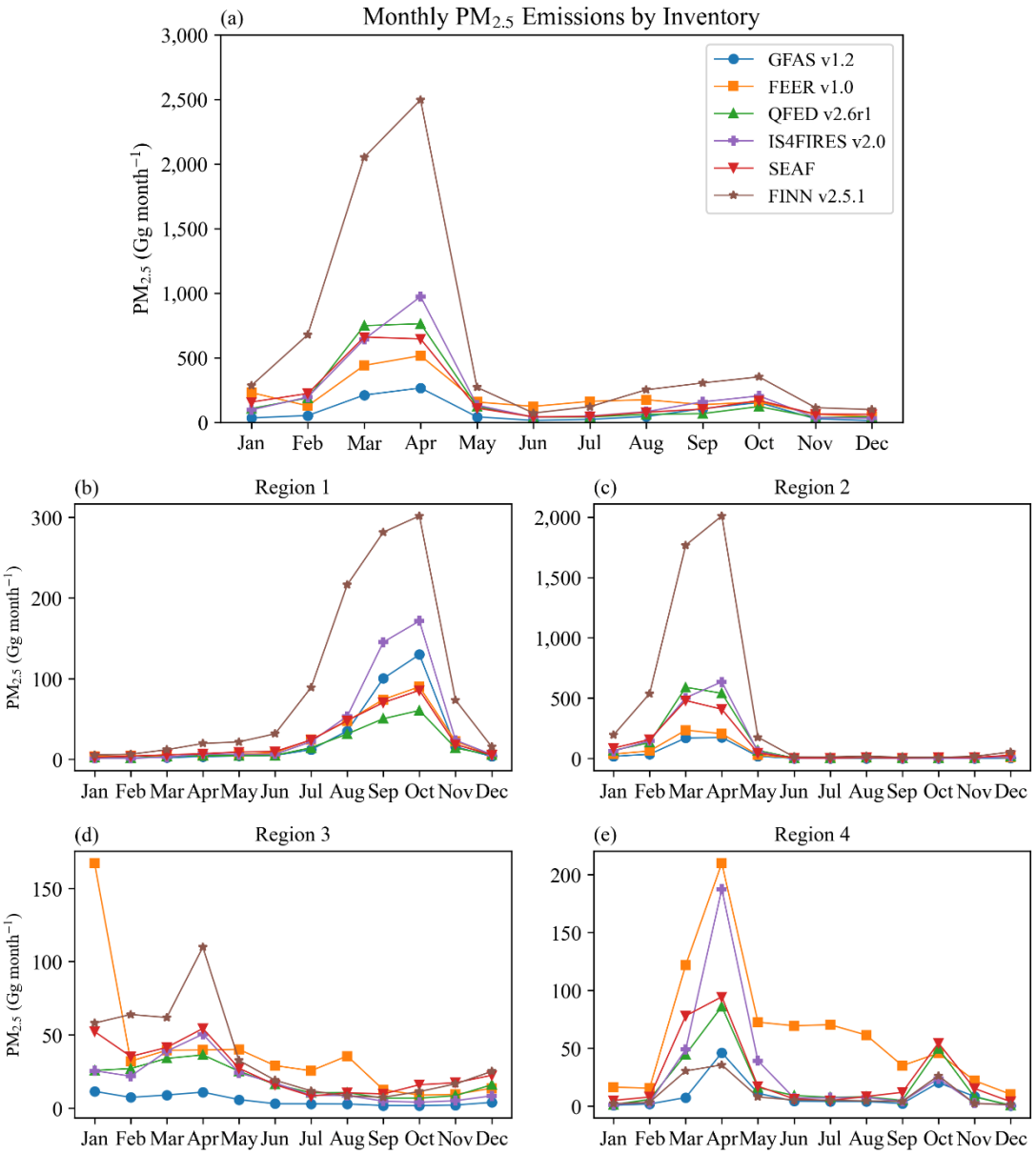

Figure S 6 Comparison of SEAF monthly $PM_{2.5}$ emissions with five emission inventories.

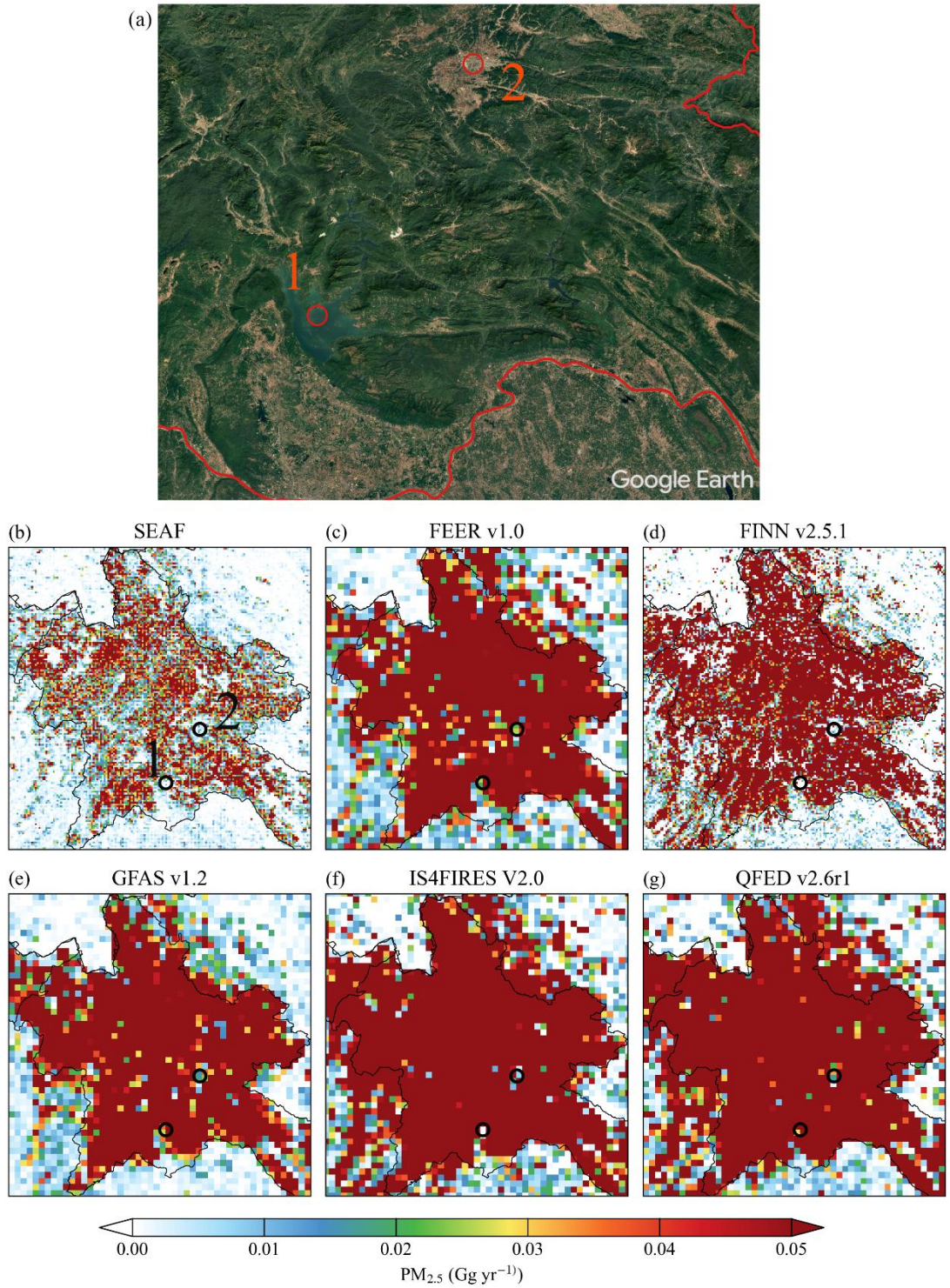

Figure S 7 (a) Google Earth satellite image (© Google Earth). Point 1 (102.6°E, 18.6°N) corresponds to the Nam Ngum Reservoir, while point 2 (103.2°E, 19.5°N) represents the Phonsavan region, which is characterized by predominantly bare land surface. (b–g) compare the annual BB $PM_{2.5}$ emissions over northern Laos (100-105°E, 17.5-22.5°N) from different emission inventories.