

Supplemental Materials

Impact of heatwaves on sources and transformations of ambient volatile organic compounds

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Table S1. Summary of heatwave definitions used in previous studies around the world.

Country	Study city/region	Heatwave	Temperature threshold	Duration	References
Europe	—	Not specified	—	—	Aas et al., 2026
Iran	Tehran	Not specified	—	—	Alisoltani et al., 2024
Germany	Garmisch-Partenkirchen, Bavaria,	Not specified	—	—	Bamberger et al., 2017
Global	—	Relative threshold	$T_{max} \geq P98$	≥ 2 d	Ban et al., 2022
China and USA	—	Absolute threshold	$T_{max} \geq 30$ °C	—	Bao et al., 2025
Greece	Attica	Absolute threshold	$T_{max} > 37$ °C	≥ 3 d	Begou et al., 2026
Germany	Garmisch-Partenkirchen	Not specified	—	—	Birami et al., 2021
SBrazil	São Paulo Megacity	Relative threshold	$T_{max} \geq P90$	≥ 6 d	Carvalho et al., 2025
France	Grenoble	Not specified	—	—	Chaxel and Chollet, 2009
China	Central Eastern China	Relative threshold	$T_{max} \geq P90$	≥ 3 d	Chen et al., 2024

Country	Study city/region	Heatwave	Temperature threshold	Duration	References
Germany	Berlin	Relative threshold	Tmax > 5 °C above the 1961–1990 climatological mean	≥5 d	Churkina et al., 2017
China	—	Relative threshold	Tmean ≥P98	≥2 d	Du et al., 2024
UK	Wytham Woods	Not specified	—	—	Ferracci et al., 2020
UK	London	Absolute threshold	Tmax ≥28 °C	≥2 d	Gao et al., 2024
South Korea	Seoul	Absolute threshold	Tmax >33 °C	—	Gil et al., 2026
Europe	—	Relative threshold	Tmax >P75	≥3 d	Guion et al., 2023
China	Chongqing	Absolute threshold	Tmax >35 °C	≥3 d	Hao et al., 2025
China	the Greater Bay Area	Relative threshold	Tmax ≥P80	—	Huang et al., 2023
Spain	Catalonia	Relative threshold	Tmax ≥P98	≥3 d	Jaén et al., 2021
Rwanda	Kigali	Relative threshold	Tmax ≥ average Tmax (1961–1990) +5 °C	≥3 d	Kalisa and Sudmant, 2025
UK	Birmingham	Relative threshold	Tmax > 6 °C above the 1961–1990 climatological mean	≥5 d	Kalisa et al., 2018

Country	Study city/region	Heatwave	Temperature threshold	Duration	References
Morocco	Casablanca and Marrakech	Relative threshold	$T_{\max} \geq P95$	≥ 3 d	Khomsî et al., 2018
Germany	Jülich	Not specified	—	—	Kleist et al., 2012
China	—	Absolute threshold	$T_{\max} \geq 35$ °C	≥ 3 d	Kong et al., 2025
UK	London	Not specified	—	—	Lee et al., 2006
China	—	Relative threshold	$T_{\max} > P90$	≥ 3 d	Li et al., 2024
China	Sichuan Basin	Relative threshold	$T_{\max}/T_{\min} > P90$	≥ 3 d	Liu et al., 2025
Germany	—	Not specified	—	—	Lupaşcu et al., 2022
China	North China Plain	Relative threshold	$T_{\max} > P95$ (1987–2016)	≥ 3 d	Ma et al., 2019
France	Paris	Not specified	—	—	Maison et al., 2024
China	—	Relative threshold	$T_{\max} \geq P97.5$	≥ 3 d	Meng et al., 2023
Egypt	Greater Cairo	Absolute threshold	$T_{\max} \geq 37$ °C, $T_{\text{mean}} \geq 31$ °C	—	Mostafa et al., 2024

Country	Study city/region	Heatwave	Temperature threshold	Duration	References
China	Yangtze River Delta	Relative threshold	Tmax > P85 (2014–2023 climatology, ± 15 d window)	>3 d	Pan et al., 2026
USA	Phoenix and Tucson, Arizona	Absolute threshold	Phoenix Tmax ≥ 44 °C; Tucson Tmax ≥ 40 °C	≥ 4 d	Parakkat et al., 2025
China	Yangtze River Delta	Absolute threshold	Tmax ≥ 35 °C	—	Pu et al., 201
Cyprus	Nicosia	Absolute threshold	Tmax >39 °C	≥ 4 d	Pyrgou et al., 2018
China	Shanghai	Absolute threshold	Tmax >35 °C	≥ 3 d	Qin et al., 2025
South Korea	—	Relative threshold	Tmax >P90	—	Qiu et al., 2024
UK	London	Absolute threshold	Tmax >28 °C	≥ 3 d	Ryan et al., 2023
USA	Missouri	Absolute threshold	Hourly mean temperature >32 °C	—	Salvador et al., 2025
USA	—	Relative threshold	Tmax $\geq$ P95	—	Schnell and Prather, 2017
South America	Bogotá、Quito、Santiago、 São Paulo	Not specified	—	—	Seguel et al., 2024

Country	Study city/region	Heatwave	Temperature threshold	Duration	References
UK	Southeast England	Not specified	—	—	Strong et al., 2013
China	—	Absolute threshold	Tmax >35 °C	—	Su et al., 2025
China	Yangtze River Basin	Relative threshold	Tmax >P90	—	Sun et al., 2026
Global	—	Relative threshold	Tmax >P95	≥3 d	Tao et al., 2024
China	Pearl River Delta	Absolute threshold	Tmax ≥305 K	≥3 d	Wang et al., 2021
China	—	Relative threshold	Tmax ≥P90 (May–September, 2014–2019)	—	Wang et al., 2022
China	Eastern China	Relative threshold	Tmax ≥P90 (1980–2022)	>3 d	Wang et al., 2023
USA	Alaska	Relative threshold	Tmax >P95 (2020–2023 climatology)	—	Wang et al., 2024a
Global	—	Not specified	—	—	Wang et al., 2024b
China	Chengdu and Chongqing	Not specified	—	—	Wang et al., 2024c
China	Beijing	Relative threshold	Tmax/Tmin ≥P90 (1998–2018)	>3 d	Wang et al., 2025a

Country	Study city/region	Heatwave	Temperature threshold	Duration	References
USA		Not specified	—	—	Wang et al., 2025c
China	Zaozhuang	Relative threshold	Tmax >P90 (2007–2021 climatology, 15-day sliding window)	—	Wang et al., 2026a
China	Beijing	Relative threshold	Tmax >P90 (1990–2018 climatology)	≥3 d	Wang et al., 2026b
China	Yangtze River Basin	Not specified	—	—	Wang et al., 2026d
China	—	Not specified	—	—	Wang et al., 2026e
Germany	—	Absolute threshold	Tmax ≥38 °C	—	Werner et al., 2020
China	Shanghai over Yangtze River	Absolute threshold	Tmax >35 °C	≥3 d	Wu et al., 2017
China	Sichuan Basin	Relative threshold	Tmax >P90	—	Xian et al., 2026
China	Pearl River Delta	Not specified	—	—	Xiang et al., 2025
China	Beijing-Tianjin-Hebei and	Absolute threshold	Tmax >35 °C	—	Xie et al., 2026

Country	Study city/region	Heatwave	Temperature threshold	Duration	References
South Korea	Busan and Ulsan	Absolute threshold	Tmax >33 °C	≥2 d	Yang et al., 2020
China	Sichuan basin	Not specified	—	—	Yang et al., 2025
Slovenia	—	Not specified	—	—	Žabkar et al., 2013
China	Jiangmen	Absolute threshold	Tmax ≥35 °C	≥3 d	Zeng et al., 2025
China	Jiangmen	Not specified	—	—	Zeng et al., 2026
USA	New York	Absolute threshold	Tmax >32.2 °C	≥3 d	Zhang et al., 2021
China	Xuzhou	Absolute threshold	Tmax >35 °C	—	Zhang et al., 2024a
USA	New York	Absolute threshold	Tmax ≥32 °C	≥3 d	Zhao et al., 2019
China	Nanjing	Relative threshold	Tmax ≥P90	—	Zhou et al., 2025
China	Hefei	Absolute threshold	Tmax >34 °C	—	Zhou et al., 2026

Notes: P75-P98 means the 75th-98th percentile thresholds of daily maximum temperature (Tmax) during the baseline period.

Table S2. The concentrations of ambient VOC species under heatwave (HW) conditions in different cities of the world (unit: ppbv).

VOC groups	VOC species	Chengdu ^a China 2021	Chengdu ^a China 2022	Seoul ^b South Korea	Chengdu ^c China	Chongqing ^c China	Zaozhuang ^d C hina Dry HW	Zaozhuang ^d China Wet HW	Essex ^e UK Day HW	Essex ^e UK Night HW	Nantong ^f China
Alkanes	Ethane	3.5	4.06	7.048	4.1	1.6	—	—	3.038	4.344	3.4
Alkanes	Propane	2.35	2.78	6.599	2.8	0.6	—	—	1.736	3.00	3.5
Alkanes	Isobutane	1.08	0.96	1.796	1.0	0.3	—	—	0.602	0.774	—
Alkanes	n-Butane	1.57	1.51	3.071	1.5	0.7	—	—	1.095	1.413	1.5
Alkanes	i-Pentane	1.74	1.32	1.897	1.3	1.0	—	—	0.962	1.273	1.5
Alkanes	n-Pentane	0.52	0.31	1.013	0.3	0.3	—	—	0.388	0.561	—
Alkanes	Cyclopentane	0.14	0.16	0.296	—	—	—	—	0.045	0.057	—
Alkanes	2,2-Dimethylbutane	0.15	0.08	0.22	0.1	0.0	—	—	—	—	—
Alkanes	2,3-Dimethylbutane	0.11	0.05	0.191	0.0	0.3	—	—	—	—	—
Alkanes	2-Methylpentane	0.27	0.55	0.465	0.6	0.2	—	—	—	—	—

VOC groups	VOC species	Chengdu ^a China 2021	Chengdu ^a China 2022	Seoul ^b South Korea	Chengdu ^c China	Chongqing ^c China	Zaozhuang ^d C hina Dry HW	Zaozhuang ^d China Wet HW	Essex ^e UK Day HW	Essex ^e UK Night HW	Nantong ^f China
Alkanes	3-Methylpentane	0.27	0.20	0.289	0.2	0.1	—	—	—	—	—
Alkanes	2,4-Dimethylpentane	0.03	0.02	0.073	—	—	—	—	—	—	—
Alkanes	2,3-Dimethylpentane	0.03	0.01	0.277	—	—	—	—	—	—	—
Alkanes	2,2,4-Trimethylpentane	0.02	0.05	0.187	—	—	—	—	—	—	—
Alkanes	2,3,4-Trimethylpentane	0.09	0.11	0.088	—	—	—	—	—	—	—
Alkanes	n-Hexane	0.43	0.56	0.992	0.6	0.1	—	—	0.113	0.157	—
Alkanes	2-Methylhexane	—	—	0.178	—	0.0	—	—	—	—	—
Alkanes	3-Methylhexane	0.07	0.07	0.225	0.1	0.1	—	—	—	—	—

VOC groups	VOC species	Chengdu ^a China 2021	Chengdu ^a China 2022	Seoul ^b South Korea	Chengdu ^c China	Chongqing ^c China	Zaozhuang ^d C hina Dry HW	Zaozhuang ^d China Wet HW	Essex ^e UK Day HW	Essex ^e UK Night HW	Nantong ^f China
Alkanes	Heptane	0.08	0.06	0.221	0.1	0.1	—	—	0.057	0.065	—
Alkanes	2-Methylheptane	0.01	0.00	0.076	—	—	—	—	—	—	—
Alkanes	3-Methylheptane	0.02	0.02	0.091	—	—	—	—	—	—	—
Alkanes	Octane	0.12	0.24	0.151	0.2	0.0	—	—	0.070	0.095	—
Alkanes	n-Nonane	0.01	0.00	0.164	0.0	0.1	—	—	—	—	—
Alkanes	n-Decane	—	—	0.299	—	0.0	—	—	—	—	—
Alkanes	n-Undecane	0.01	0.01	0.228	0.0	0.0	—	—	—	—	—
Alkanes	n-Dodecane	—	—	—	—	0.0	—	—	—	—	—
Alkanes	Cyclohexane	—	—	0.261	—	0.1	—	—	0.050	0.065	—
Alkanes	Cyclohexylmethane	0.01	0.01	—	—	—	—	—	—	—	—
Alkanes	Methylcyclopentane	0.02	0.18	0.458	—	—	—	—	—	—	—
Alkenes	Ethylene	1.66	0.92	3.411	0.9	0.4	1.09	0.85	0.865	0.999	1.6

VOC groups	VOC species	Chengdu ^a China 2021	Chengdu ^a China 2022	Seoul ^b South Korea	Chengdu ^c China	Chongqing ^c China	Zaozhuang ^d C hina Dry HW	Zaozhuang ^d China Wet HW	Essex ^e UK Day HW	Essex ^e UK Night HW	Nantong ^f China
Alkenes	Propylene	0.13	0.13	1.333	0.1	0.2	0.14	0.11	0.237	0.285	—
Alkenes	Propadiene	—	—	—	—	—	—	—	0.011	0.017	—
Alkenes	1-Butene	0.08	0.05	0.456	0.1	0.1	—	—	0.062	0.064	—
Alkenes	trans-2-Butene	0.18	0.15	0.274	0.1	0.1	—	—	0.013	0.017	—
Alkenes	cis-2-Butene	0.07	0.09	0.756	0.1	0.1	—	—	0.009	0.012	—
Alkenes	Isobutene	—	—	—	—	—	—	—	0.063	0.080	—
Alkenes	1,3-Butadiene	—	—	—	—	0.0	—	—	0.017	0.032	—
Alkenes	1,2-Butadiene	—	—	—	—	—	—	—	0.045	0.050	—
Alkenes	Isoprene	0.41	0.31	0.734	0.3	0.6	0.25	0.77	0.380	0.034	—
Alkenes	trans-2-Pentene	0.08	0.01	0.332	0.0	0.0	—	—	0.008	0.012	—
Alkenes	1-Pentene	0.16	0.05	0.263	0.1	0.1	—	—	0.016	0.016	—
Alkenes	cis-2-Pentene	0.10	0.01	0.256	0.0	0.0	—	—	0.007	0.009	—

VOC groups	VOC species	Chengdu ^a China 2021	Chengdu ^a China 2022	Seoul ^b South Korea	Chengdu ^c China	Chongqing ^c China	Zaozhuang ^d C hina Dry HW	Zaozhuang ^d China Wet HW	Essex ^e UK Day HW	Essex ^e UK Night HW	Nantong ^f China
Alkenes	2-Methyl-1-butene	—	—	—	—	—	—	—	0.024	0.032	—
Alkenes	2-Methyl-2-butene	—	—	—	—	—	—	—	0.010	0.014	—
Alkenes	1-Hexene	0.00	0.12	0.325	0.1	0.0	—	—	—	—	—
Alkenes	Cyclopentene	—	—	—	—	—	—	—	0.005	0.213	—
Alkynes	Ethyne	—	—	1.567	—	1.2	—	—	0.699	0.893	—
Alkynes	Propyne	—	—	—	—	—	—	—	0.016	0.228	—
Aromatics	Benzene	0.36	0.38	0.352	0.4	0.3	—	—	0.336	0.524	—
Aromatics	Toluene	0.87	0.10	6.006	1.0	0.5	0.34	0.38	0.510	0.723	—
Aromatics	Ethylbenzene	0.33	0.29	1.623	0.3	0.1	—	—	0.068	0.095	—
Aromatics	m,p-Xylene	1.04	0.10	2.481	—	—	0.15	0.18	0.160	0.252	—
Aromatics	o-Xylene	0.37	0.36	1.285	0.4	0.2	—	—	0.063	0.099	—
Aromatics	Styrene	0.10	0.08	0.13	0.1	0.0	—	—	0.010	0.014	—

VOC groups	VOC species	Chengdu ^a China 2021	Chengdu ^a China 2022	Seoul ^b South Korea	Chengdu ^c China	Chongqing ^c China	Zaozhuang ^d C hina Dry HW	Zaozhuang ^d China Wet HW	Essex ^e UK Day HW	Essex ^e UK Night HW	Nantong ^f China
Aromatics	Cumene	0.00	0.00	0.072	0.0	0.0	—	—	—	—	—
Aromatics	n-Propylbenzene	0.01	0.00	0.048	0.0	0.0	—	—	—	—	—
Aromatics	m-Ethyltoluene	0.01	0.00	0.159	0.0	0.0	—	—	—	—	—
Aromatics	p-Ethyltoluene	0.00	0.00	0.101	0.0	0.0	—	—	—	—	—
Aromatics	o-Ethyltoluene	0.01	0.00	0.094	0.0	0.0	—	—	—	—	—
Aromatics	1,3,5- Trimethylbenzene	0.00	0.00	0.076	0.0	0.0	—	—	0.010	0.018	—
Aromatics	1,2,4- Trimethylbenzene	0.04	0.06	0.291	0.1	0.1	0.07	0.07	—	—	—
Aromatics	1,2,3- Trimethylbenzene	0.01	0.05	0.205	0.0	0.0	—	—	0.024	0.036	—
Aromatics	m-Diethylbenzene	0.00	0.00	0.060	—	—	—	—	—	—	—
Aromatics	p-Diethylbenzene	0.00	0.00	0.048	—	—	—	—	—	—	—

VOC groups	VOC species	Chengdu ^a China 2021	Chengdu ^a China 2022	Seoul ^b South Korea	Chengdu ^c China	Chongqing ^c China	Zaozhuang ^d C hina Dry HW	Zaozhuang ^d China Wet HW	Essex ^e UK Day HW	Essex ^e UK Night HW	Nantong ^f China
OVOCs	Acetaldehyde	—	—	—	—	—	1.75	1.63	3.059	3.934	—
OVOCs	Acetone	—	—	—	—	—	3.78	2.97	5.174	4.973	3.8
OVOCs	Propanal	—	—	—	—	—	0.36	0.35	—	—	—
OVOCs	n-Butyraldehyde	—	—	—	—	—	0.15	0.16	0.055	0.044	—
OVOCs	2-Methylpropanal	—	—	—	—	—	—	—	0.012	0.015	—
OVOCs	Pentanal	—	—	—	—	—	—	—	0.066	0.052	—
OVOCs	Hexanal	—	—	—	—	—	—	—	0.051	0.081	—
OVOCs	2-Pentanone	—	—	—	—	—	—	—	0.003	0.001	—
OVOCs	Butanone	—	—	—	—	—	—	—	0.135	0.108	—
OVOCs	Methanol	—	—	—	—	—	—	—	5.135	5.168	—
OVOCs	Propanol	—	—	—	—	—	—	—	0.215	0.205	—
OVOCs	Methacrolein	—	—	—	—	—	—	—	0.076	0.059	—

VOC groups	VOC species	Chengdu ^a China 2021	Chengdu ^a China 2022	Seoul ^b South Korea	Chengdu ^c China	Chongqing ^c China	Zaozhuang ^d C hina Dry HW	Zaozhuang ^d China Wet HW	Essex ^e UK Day HW	Essex ^e UK Night HW	Nantong ^f China
Halohydrocarbon	Bromomethane	—	—	—	—	—	—	—	—	—	2.5
Halohydrocarbon	Dichloromethane	—	—	—	—	—	—	—	—	—	2.3
Halohydrocarbon	Chloroethane	—	—	—	—	—	—	—	—	—	2.1
Halohydrocarbon	Vinyl chloride	—	—	—	—	—	—	—	—	—	2.1

Notes: ^a is cited from Kong et al., (2025), ^b is cited from Gil et al., (2026), ^c is cited from Wang et al., (2024c); ^d is cited from Wang et al., (2026a), ^e is cited from Lee et al., (2006), and ^f is cited from Chu et al. (2022).

Table S3. Representative temperature-dependent parameterizations of VOC emissions from biogenic and anthropogenic sources.

Source category	Temperature-dependent parameterization	Key parameters and their interpretation	References
Monoterpenes	$E = E_s[\exp(\beta(T - T_s))]$	E is monoterpene emission rate at temperature $T(K)$, E_s is monoterpene emission rate at a standard temperature $T_s(K)$, $\beta(K^{-1})$ is an empirical coefficient.	Guenther et al., 1995, 1993
Isoprene	$I = I_s \cdot C_L \cdot C_T$ $C_T = \frac{\exp\left[\frac{c_{T_1}(T-T_s)}{RT_sT}\right]}{1 + \exp\left[\frac{c_{T_2}(T-T_M)}{RT_sT}\right]}$	I is isoprene emission rate at a temperature $T(K)$; I_s is isoprene emission rate at a standard temperature $T_s(K)$, C_L is light-response factor, C_T is temperature-response factor, T_M is empirical temperature associated with maximum emission and onset of high temperature inhibition(K), R is a constant ($8.314 J \cdot K^{-1} \cdot mol^{-1}$), c_{T_1} and c_{T_2} : empirical temperature parameters ($J \cdot mol^{-1}$).	Guenther et al., 1995, 1993
Vehicle evaporative emissions	$EF_{c,y,v,f, \text{evap}} = Stock_{c,y,f,v} \times \sum_{m=1}^{m=12} EF_evap_{y,m,v,f,temp} \times Day_{y,m}/Fuel_{c,y,v,f}$	m represents month; $Stock$, Day , and $Fuel$ represent vehicle ownership, number of the days in month m of year y , and fuel consumption, respectively; $temp$ represents temperature interval. EF_{evap} represents the daily NMVOC emissions per vehicle in different temperature intervals.	Xu et al., 2025

Source category	Temperature-dependent parameterization	Key parameters and their interpretation	References
Vehicle evaporative emissions	$E = \frac{A}{T} \exp\left(\frac{-B}{T}\right)$	E is the evaporative VOC emission flux from transportation (kg m ⁻² s ⁻¹), T is the ambient temperature(K), A (kg m ⁻² s ⁻¹ K) and B(K) are empirical temperature-dependency parameters.	Huang et al., 2022; Wu et al., 2024
Gasoline evaporation	$E = 0.003 \times T^2 - 0.10T + 3.6$	E is expressed as a function of temperature T.	Qin et al., 2025
Fuel storage and distribution	$L_s = 365V_vW_vK_EK_S$	L _s is annual standing-storage loss (kg a ⁻¹); V _v is vapor-space volume (m ³); W _v is vapor density (kg m ³); K _E is vapor-space expansion factor; K _S is saturation factor.	EPA, 2024
Solvent use	$EF_{domestic\ solvent\ use} = 0.08 \times GDP^{0.39} \times Temp^{3.62}$	EF _{domestic solvent use} is NMVOC emission factor for residential solvent use, GDP is per-capita GDP, Temp is annual mean temperature. coefficients obtained from empirical fitting.	Xu et al., 2025
Solvent use	$E = \frac{A}{\sqrt{T}} \exp\left(\frac{-B}{T}\right)$	E is the evaporative VOC flux associated with solvent use (kg m ⁻² s ⁻¹). A (kg m ⁻² s ⁻¹ K ^{1/2}) and B (K) are the temperature-dependency parameters.	Huang et al., 2015
Solvent use	$E = \frac{1.3 \times 10^{12} \times e^{\frac{-4689}{T}}}{T}$	E is the fitted emission rate from paints (in units of µg m ⁻³ h ⁻¹) and T is the ambient temperature (K).	Qin et al., 2025

Table S4. Representative quantitative responses of anthropogenic VOCs (AVOCs) emissions to temperature.

Source category	Study region	Temperature response of AVOC emissions	References
Vehicle evaporation	USA	A 1 °C increase in daily maximum temperature increased evaporative VOC emissions by $6.5 \pm 2.5\%$	Rubin et al., 2006
Vehicle evaporation	China	Between 25 and 38 °C, hot-soak VOC emission factors increased by 36.0-533.9%, while diurnal-loss emission factors increased by 16.7–106.2%	Yue et al., 202
Vehicle evaporation	China	At 313 K, total hydrocarbon emissions were 12.3–26.7 times those at 298 K.	Huang et al., 2022
Vehicle evaporation	China	Contribution of evaporative NMVOCs increased by $7.55\% \text{ }^{\circ}\text{C}^{-1}$	Song et al., 2018
Building materials	China	Formaldehyde emissions increased by approximately 14-fold from 25 to 80 °C	Huang et al., 2015
AVOCs	China	A 3 °C increase in temperature enhanced transportation-related evaporative and solvent-use AVOC emissions by 26.7% and 21.9%, respectively	Xian et al., 2026
AVOCs	China	The temperature sensitivities of VOC emissions from vehicle sources, NG/LPG/combustion, solvent use, other industrial processes were 5.0%, 0%, 1.0%, $14.5\% \text{ }^{\circ}\text{C}^{-1}$, respectively	Song et al., 2019
AVOCs	China	The regional mean temperature sensitivity of AVOC emissions was $6.25\% \text{ K}^{-1}$, with sensitivities of 9.7, 5.8, and $3.4\% \text{ K}^{-1}$ for traffic, solvent use, and non-solvent industry, respectively	Wu et al., 2024

Source category	Study region	Temperature response of AVOC emissions	References
AVOCs	China	The temperature sensitivities of AVOC emissions from solvent use and traffic (gasoline evaporation) were 6.7% K ⁻¹ and 3.1% K ⁻¹ , respectively	Qin et al., 2025

Table S5. Representative quantitative responses of biogenic VOCs (BVOCs) emissions to temperature.

Source category	Study region	Temperature response of BVOC emissions	References
Isoprene	Arctic tundra	A 2 and 4 °C warming increased isoprene emissions by approximately 41% and 87%, respectively	Seco et al., 2022
Isoprene	Arctic tundra	A 3–4 °C temperature increase enhanced isoprene emissions by approximately 180–215%	Angot et al., 2020
Isoprene	Germany	Heatwave and heatwave–drought conditions increased isoprene emissions by approximately 6–8-fold, despite reduced photosynthetic activity	Bamberger et al., 2017
Isoprene	China	Isoprene emission rates increased by approximately 130% under a ~2 °C increase in mean temperature	Wang et al., 2026d
Isoprene	UK	During a heatwave–drought event, peak isoprene concentrations reached approximately 4 times the levels observed before and after the heatwave	Ferracci et al., 2020
Monoterpenes	Global	Mean temperature-response coefficient was approximately 0.13 °C ⁻¹ , with substantial variability among forest types	Bourtsoukidis et al., 2024
Monoterpenes	Europe	Monoterpene emissions increased exponentially with temperature, with β values of approximately 0.08–0.13 K ⁻¹ among individual compounds	Komenda and Koppmann, 2002
Monoterpenes	USA	A 13–15 °C temperature increase enhanced monoterpene emissions by 22–5900-fold, depending on plant species	Nagalingam et al., 2023
Monoterpenes	USA	Heat stress produced very strong responses, with Q ₁₀ values of 7.6–22	Nagalingam et al., 2024

Source category	Study region	Temperature response of BVOC emissions	References
Monoterpenes	Amazon	Leaf warming during the 2015 El Niño event increased β -ocimene emissions by $\sim 4.4\%$ °C ⁻¹ , while α -pinene emissions decreased by $\sim 0.8\%$ °C ⁻¹	Jardine et al., 2017
Sesquiterpenes	Europe	Temperature-response coefficients ranged from approximately 0.09–0.12 K ⁻¹ across seasons	Bourtsoukidis et al., 2012
Sesquiterpenes	Germany	Sesquiterpene emissions increased exponentially under heat stress at 37–43 °C	Birami et al., 2021
Sesquiterpenes	Global	The environmental change can substantially modify sesquiterpene temperature sensitivity, with significant differences among plant functional types and a long-term decline in reported temperature responses	Bourtsoukidis et al., 2025
Methanol	Canadian	Methanol emissions increased with air temperature from approximately 3–35 °C, but excessive temperatures could suppress emissions because of reduced enzyme activity or thermal damage	Cai et al., 2021
Total BVOCs	China	A 3 °C increase in temperature enhanced BVOC emissions by 53.6%	Xian et al., 2026
Total BVOCs	Global	Warming increased global isoprene and monoterpene emissions by approximately 107% and 60%, respectively, whereas sesquiterpenes showed a weaker response	Chen et al., 2026

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