Electronic Supplementary Material to:
Description and Evaluation of the Emission and Atmospheric Processes Integrated and Coupled Community (EPICC) Model Version 1.0*

EPICC Model Working Group

ESM to: EPICC Model Working Group, 2026: Description and evaluation of the Emission and atmospheric Processes Integrated and Coupled Community (EPICC) Model version 1.0. *Adv. Atmos. Sci.*, **43**(4), 671−694, https://doi.org/10.1007/s00376-025-4384-y.

Contributors to EPICC Model v1.0
(Sorted alphabetically by name, as of November 7, 2025)

Junling AN, Institute of Atmospheric Physics, Chinese Academy of Sciences
Junji CAO, Institute of Atmospheric Physics, Chinese Academy of Sciences
Huansheng CHEN, Institute of Atmospheric Physics, Chinese Academy of Sciences
Xueshun CHEN, Institute of Atmospheric Physics, Chinese Academy of Sciences
Yafei CHEN, 3Clear Technology Co., Ltd.
Huiyun DU, Institute of Atmospheric Physics, Chinese Academy of Sciences
Xiaohan FAN, 3Clear Technology Co., Ltd.
Baozhu GE, Institute of Atmospheric Physics, Chinese Academy of Sciences
Zhiwei HAN , Institute of Atmospheric Physics, Chinese Academy of Sciences
Hong HE, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences
Jianlin HU, Nanjing University of Information Science & Technology
Jianping HUANG, Lanzhou University
Zhijiong HUANG, Jinan University
Zijian JIANG, Institute of Atmospheric Physics, Chinese Academy of Sciences
Lei KONG, Institute of Atmospheric Physics, Chinese Academy of Sciences
Jiawei LI, Institute of Atmospheric Physics, Chinese Academy of Sciences
Jie LI, Institute of Atmospheric Physics, Chinese Academy of Sciences
Jingyi LI, Nanjing University of Information Science & Technology
Xinwei LI, Institute of Atmospheric Physics, Chinese Academy of Sciences
Run LIU, Jinan University
Shaw Chen LIU, Jinan University
Yanhui LIU, Peking University
Keding LU, Peking University
Wen LU , Nanjing University of Information Science & Technology
Dongming Qin, 3Clear Technology Co., Ltd.
Yu QU, Institute of Atmospheric Physics, Chinese Academy of Sciences
Yu SONG, Peking University
Xiao TANG, Institute of Atmospheric Physics, Chinese Academy of Sciences
Huijun WANG, Nanjing University of Information Science & Technology
Jiandong WANG, Nanjing University of Information Science & Technology
Shuxiao WANG, Tsinghua University
Tao WANG, Institute of Atmospheric Physics, Chinese Academy of Sciences
Tiantian WANG, Peking University
Wending WANG, Institute of Atmospheric Physics, Chinese Academy of Sciences
Zhe WANG, Institute of Atmospheric Physics, Chinese Academy of Sciences
Zifa WANG, Institute of Atmospheric Physics, Chinese Academy of Sciences

*The online version of this article can be found at https://doi.org/10.1007/s00376-025-4384-y.

Lianfang WEI, Chinese Research Academy of Environmental Sciences
Huangjian WU, Institute of Atmospheric Physics, Chinese Academy of Sciences
Jianbin WU, 3Clear Technology Co., Ltd.
Qizhong WU, BeiJing Normal University
Zichen WU, Institute of Atmospheric Physics, Chinese Academy of Sciences
Linhong XIAO, 3Clear Technology Co., Ltd.
Wei XIAO, 3Clear Technology Co., Ltd.
Shuqi YAN, Nanjing University of Information Science & Technology
Ting YANG, Institute of Atmospheric Physics, Chinese Academy of Sciences
Wenyi YANG, Chinese Academy of Environmental Planning
Fenfen YU, 3Clear Technology Co., Ltd.
Chaolin ZHANG, Chinese Academy of Meteorological Sciences
Jinlong ZHANG, Jinan University
Wending ZHANG, 3Clear Technology Co., Ltd.
Xiaoye ZHANG, Chinese Academy of Meteorological Sciences
Bin ZHAO, Tsinghua University
Junyu ZHENG, The Hong Kong University of Science and Technology (Guangzhou)
Fangqian ZHONG, 3Clear Technology Co., Ltd.
Houhua ZHOU, Peking University
Bin ZHU, Nanjing University of Information Science & Technology
Tong ZHU, Peking University

Table S1. Vertical layer definition for EPICC simulations.

Layer	Height above ground (m)
1	36
2	72
3	110
4	150
5	190
6	240
7	300
8	360
9	420
10	500
11	600
12	700
13	800
14	1000
15	1200
16	1500
17	1900
18	2300
19	2800
20	3300
21	3840
22	4710
23	5760
24	7030
25	8540
26	10 350
27	12 530
28	14 710
29	17 180
30	20 000

Table S2. Parameterized HONO source mechanisms to be coupled in the model.

Source	Reaction rate constant	Parameterization	Uncertainty	First-order sensitivity	Second-order sensitivity	Distribution type
$E^{**}_{traffic}$	$E_{traffic} = f_1\left(E_{NO_x}, f_{HONO/NO_x}\right)$	$f_{HONO/NO} = 1.7\%$	$0.3\% \leqslant f_{HONO/NO_x} \leqslant 1.7\%$	0.12	0.58	Log-normal
$E^{**}_{biomass}$	$E_{bb} = f_4\left(E_{CO}, f_{HONO/CO}\right)$	$f_{HONO/CO} = 1.18\times10^{-3}$ (mol/mol)	$9.5\times10^{-4} \leqslant f_{HONO/CO} \leqslant 1.4\times10^{-3}$(mol/mol)	—	—	Log-normal
E^{**}_{soil}	$E_{soil} = f_2\left(F_{N,opt(HONO)}, E_a, T_s, SWC\right)$	$0.31 \leqslant F_{N,opt(HONO)} \leqslant 257.50\left(ng\cdot m^{-2}\cdot s^{-1}\right)$	(−86%, 261%)	0.0005	0.0004	Log-normal
E^{**}_{indoor}	$E_{indoor} = f_3\left(K_{AER}, C_{indoor}, C_{outdoor}, N, H\right)$	$C_{indoor} = 4.7(ppb), K_{AER} = 0.65$	(−61%, 36%)	0.01	−0.01	Log-normal
$NO+OH$	k_{NO+OH}	k_{NO+OH}	(−28.61%, 27.59%)	0.09	0.03	Log-normal
$Het^{**}_{aerosol}$	$Het_{aerosol} = \frac{1}{4}v_{NO_2}\left(\frac{S}{V}\right)\gamma_a$	$\gamma_a = 5.0\times10^{-6}$	γ_α: (−43%, 51%)	0.3	0.01	Normal
$Het^{**}_{aerosol\_hv}$	$Het_{aerasol} = \frac{1}{4}v_{NO_2}\left(\frac{S}{V}\right)\gamma_a\frac{\text{light intensity}}{300}$	$\gamma_a = 5.0\times10^{-6}$ light intensity (dynamic)	γ_α: (−43%, 51%) $k_{\text{light-aerosol}}$: (−60%, 60%)	γ_α: 0.3 $k_{\text{light-aerosol}}$: 0.07	γ_α: 0.01 $k_{\text{light-aerosol}}$: 0.13	Log-normal
Het^{**}_{ground}	$Het_{ground} = f\times\frac{v_d}{h}$	$f = 0.5, v_d$ (dynamic)	f: (−33%, 566%) v_d: (−50%, 100%)	f: 0.2 v_d: 0.17	f: 0.19 v_d: 0.42	Log-normal
$Het^{**}_{ground\_hv}$	$H_{gromd} = f\times\frac{v_d}{h}\times\left(1+\frac{\text{light intensity}}{300}\right)$	$f = 0.5, v_d$ (dynamic) light intensity (dynamic)	f: (−33%, 566%) v_d: (−50%, 100%) $k_{\text{light-ground}}$: (−60%, 60%)	f: 0.2 v_d: 0.17 $k_{\text{light-ground}}$: 0.4	f: 0.19 v_d: 0.42 $k_{\text{light-ground}}$: 0.09	Log-normal
$Phot^{**}_{nitrate}$	$Phot = f_5\left(V_{dHNO_3}, V_{dPNO_3}, J_{nitrate}/J_{HNO_3}\right)$	$J_{nitrate}/J_{HNO_3} = 30$	$10 \leqslant k_{nitrate-phot} \leqslant 650$	0.03	0.02	Log-normal

The HONO sources include the gas-phase homogeneous reaction of NO and OH (NO+OH), vehicle emissions ($E^{**}_{traffic}$), soil emissions (E^{**}_{soil}), indoor emissions (E^{**}_{indoor}), the heterogeneous reaction of NO_2 on ground surfaces (Het^{**}_{ground}), the lighting-enhanced heterogeneous reaction of NO_2 on ground surfaces ($Het^{**}_{ground\_hv}$), the heterogeneous reaction of NO_2 on aerosol surfaces ($Het^{**}_{aerosol}$), the lighting-enhanced heterogeneous reaction of NO_2 on aerosol surfaces ($Het^{**}_{aerosol\_hv}$), and the photolysis of particulate nitrate ($Phot^{**}_{nitrate}$).

Table S3. Chemical mechanisms, parameterization schemes, and emission inventory inputs configured for the baseline (S0) simulation.

Model component	Description and reference(s)
Advection	Walcek and Aleksic (1998)
Convection	Emanuel (1991)
Turbulent mixing	"K-theory" approach
Photolysis	Tropospheric Ultraviolet–Visible radiative transfer model version 4.5 (TUV4.5) (Emery et al., 2010)
Gas-phase chemistry	Carbon Bond 06 Mechanism revision 5 (CB06r5) (Yarwood et al., 2020)
Inorganic aerosol thermodynamic process	ISORROPIA (Nenes et al., 1998)
Secondary organic aerosol	1.5D Volatility Basis Set (VBS) module (Yang et al., 2018)
Aqueous chemistry	Regional Acid Deposition Model mechanism
Heterogeneous chemistry	A dynamic, heterogeneous chemistry module (Li et al., 2018)
Aerosol microphysics	Advanced Particle Microphysics module (Yu and Luo, 2009)
Dry deposition	Zhang et al. (2001, 2003)
Wet deposition	Regional Acid Deposition Model mechanism
Meteorological initial conditions/boundary conditions	FNL data
Emission	Anthropogenic: MEIC (China), EDGAR (outside China); Biomass burning: FINN; Biogenic: MEGAN

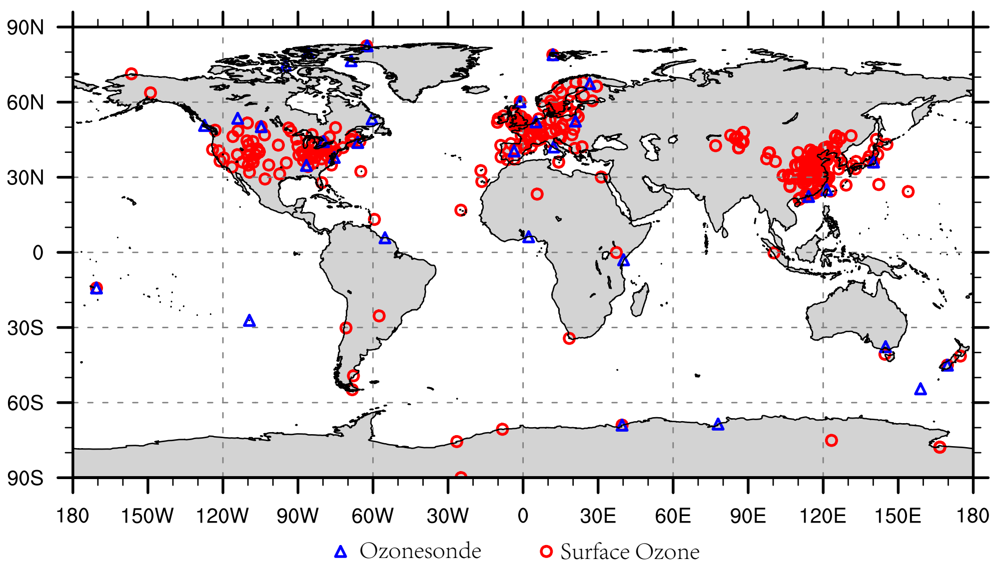

Fig. S1. Observation stations used for the global evaluation in this study.

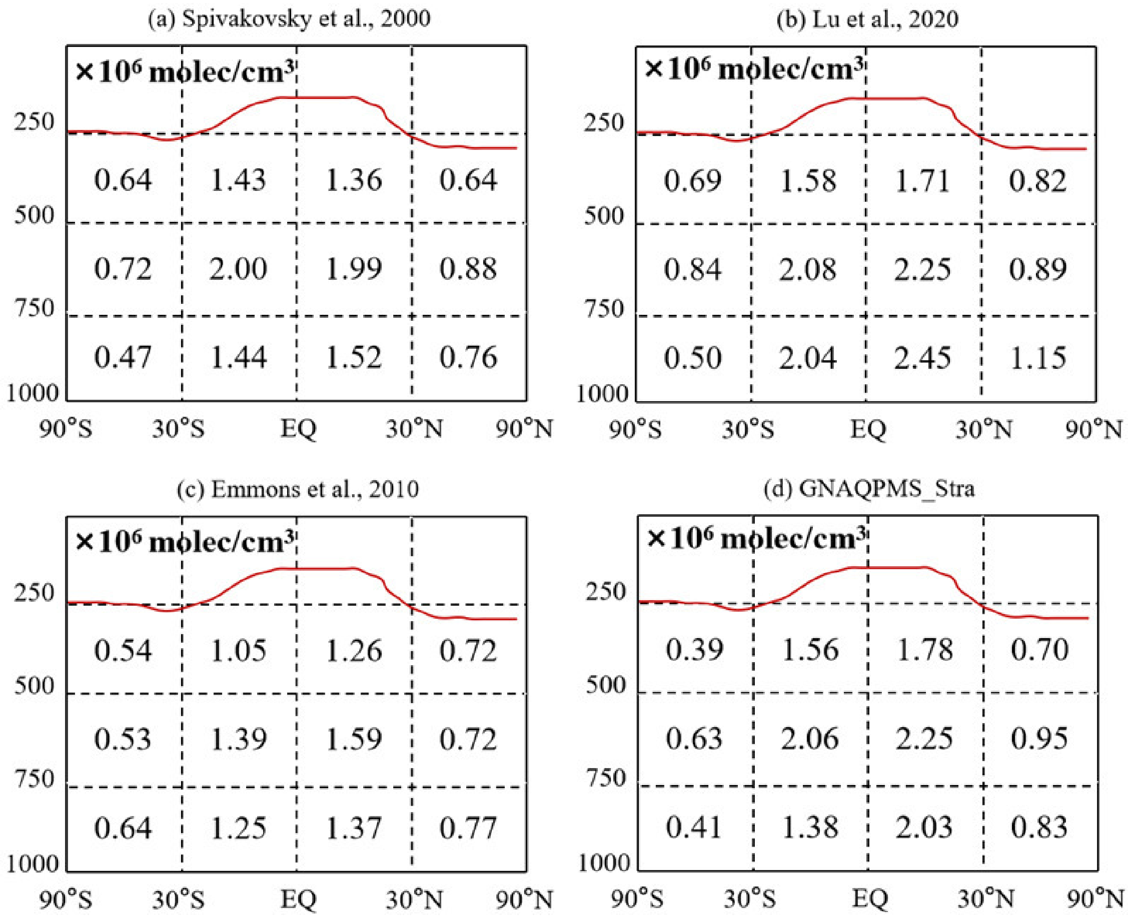

Fig. S2. The OH burden from the (d) EPICC model compared with the climatology of (a) Spivakovsky et al. (2000) and other simulations [(b) GEOS-Chem (Lu et al., 2020); (c) MOZART-4 (Emmons et al., 2010)]. Red lines are the simulated tropopause height.

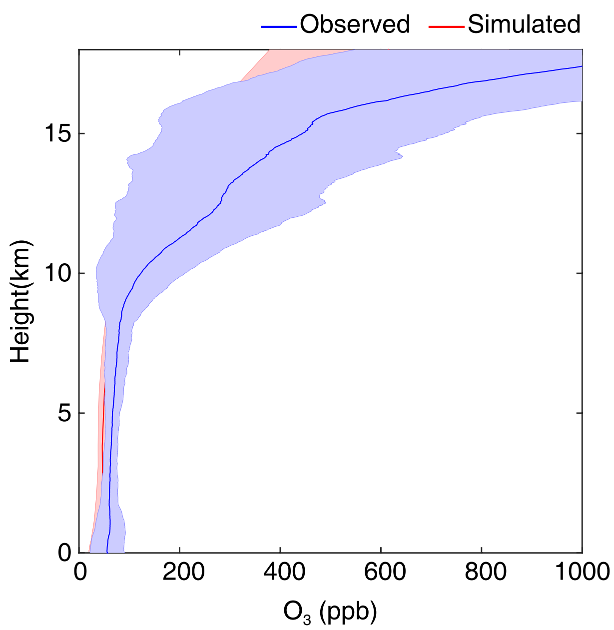

Fig. S3. Observed (blue) and simulated (red) vertical profiles of the annual O_3 mixing ratio (1400 LST) for Beijing, China.

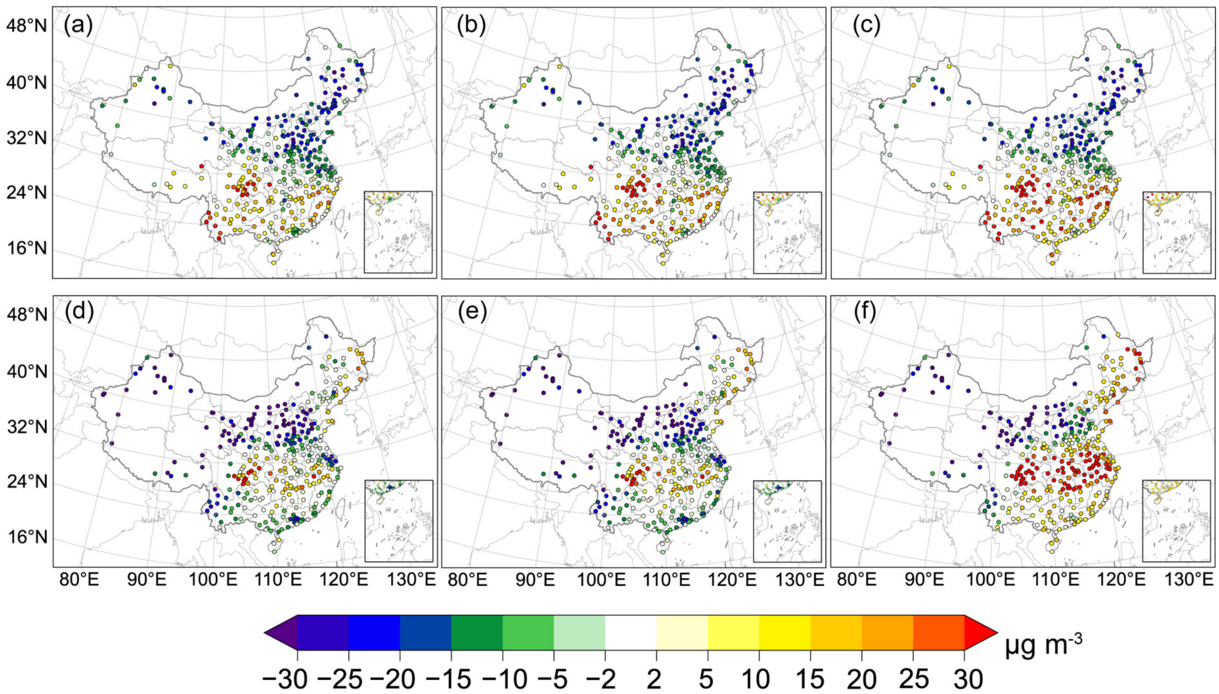

Fig. S4. Simulated mean biases of MDA8 O_3 over China under the (a, d) S0, (b, e) S3, and (c, f) S4 scenarios during (a–c) January and (d–f) July 2021.

REFERENCES

Emmons, L. K., and Coauthors, 2010: Description and evaluation of the Model for Ozone and Related chemical Tracers, version 4 (MOZART-4). *Geoscientific Model Development*, **3**, 43−67, https://doi.org/10.5194/gmd-3-43-2010.

Lu, X., and Coauthors, 2020: Development of the global atmospheric chemistry general circulation model BCC-GEOS-Chem v1.0: Model description and evaluation. *Geoscientific Model Development*, **13**(9), 3817−3838, https://doi.org/10.5194/gmd-13-3817-2020.

Spivakovsky, C. M., and Coauthors, 2000: Three-dimensional climatological distribution of tropospheric OH: Update and evaluation. *J. Geophys. Res.*, **105**, 8931−8980, https://doi.org/10.1029/1999JD901006.