

**Supplement of “Influence of Chemical Boundary Conditions on
Simulating Summer Ozone in China using a regional chemical
transport model”**

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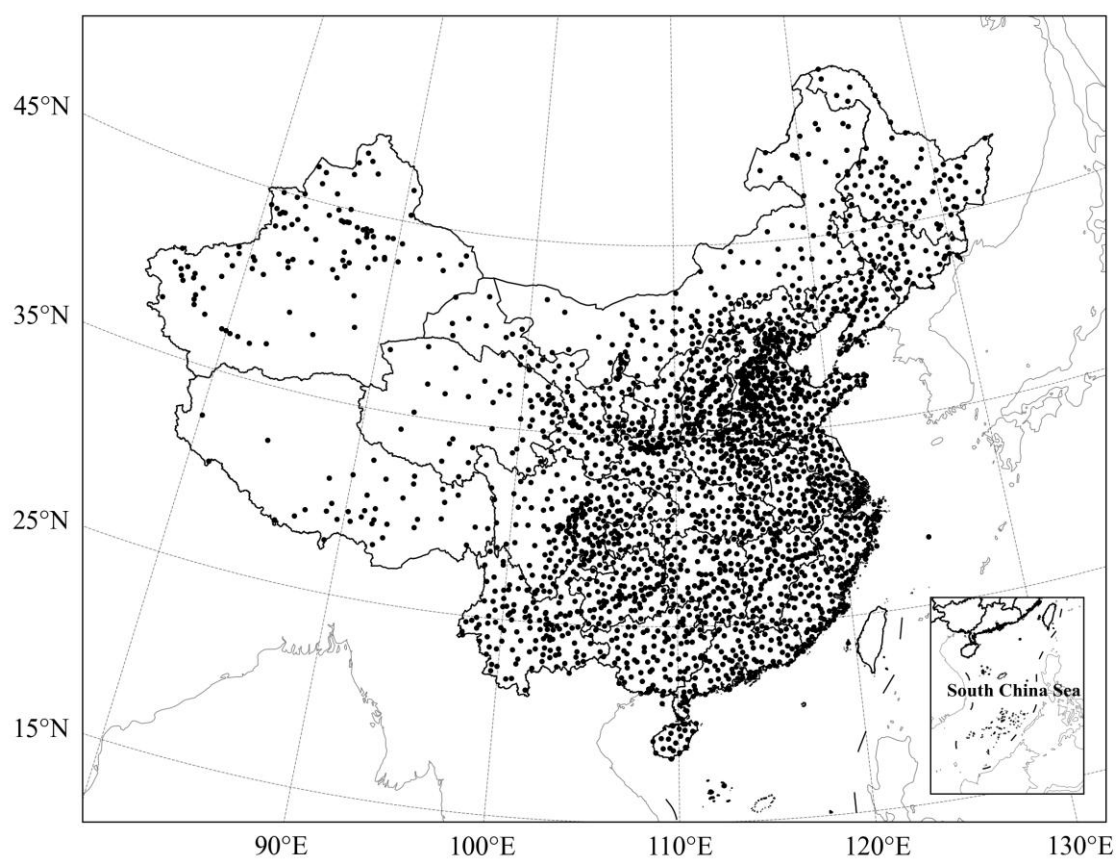


Fig. S1. Surface meteorological observation station location.

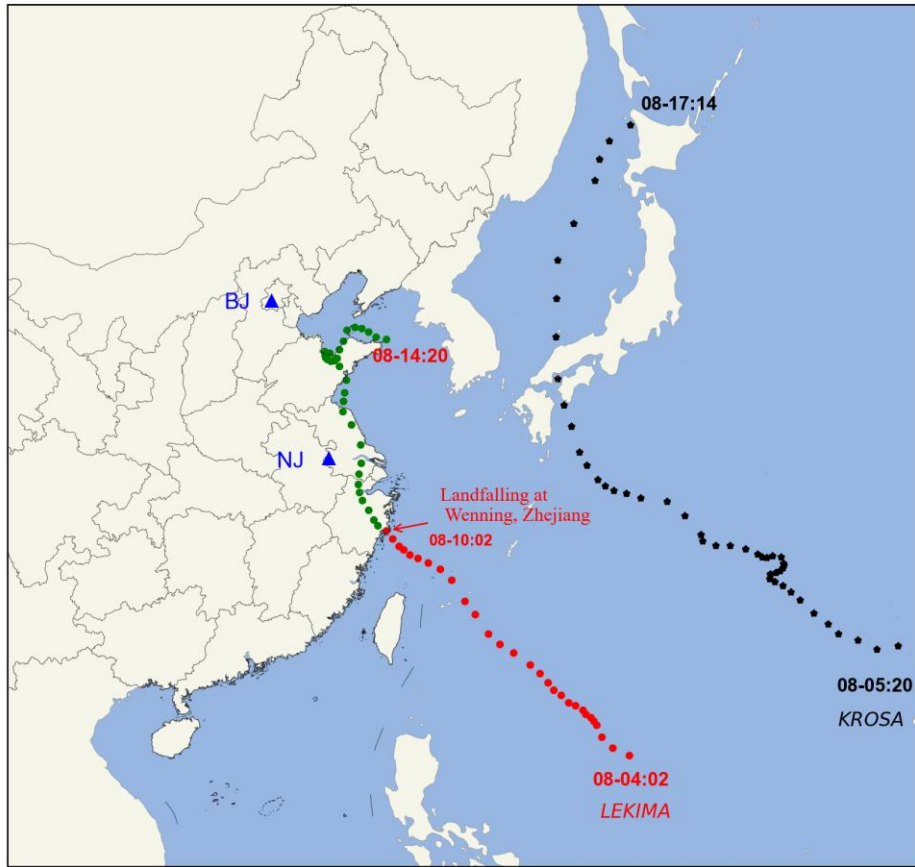


Fig. S2. Trajectories of Typhoons Lekima and Krosa. Green dots mark Lekima's path after landfall. Blue triangles indicate the locations of Beijing (BJ) and Nanjing (NJ). All times are shown in local time.

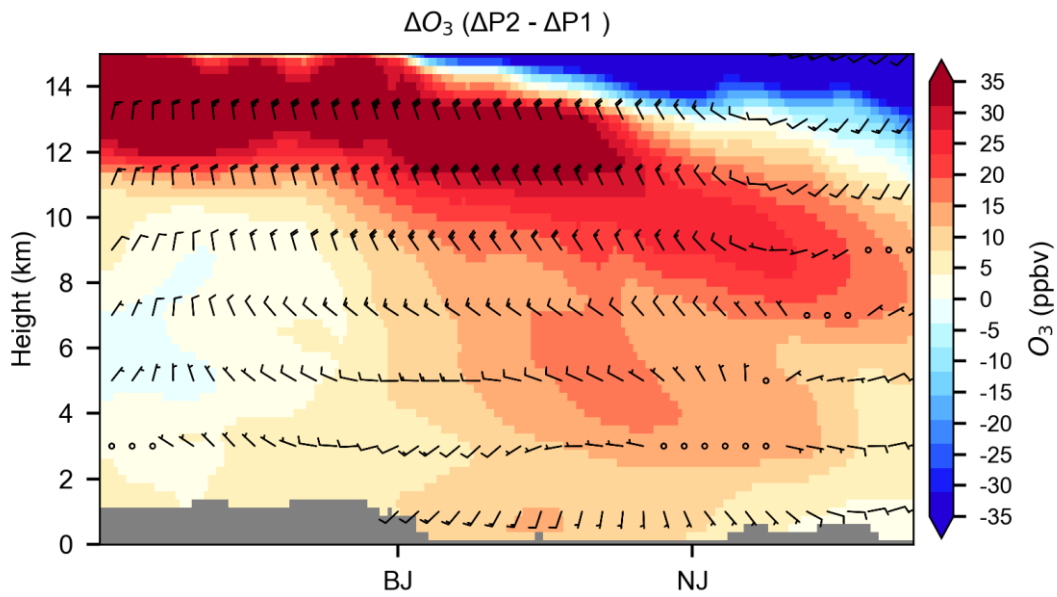


Fig. S3. Vertical cross-sectional analysis of the O_3 and wind difference between P2 (Fig. 9c) and P1 (Fig. 9a).

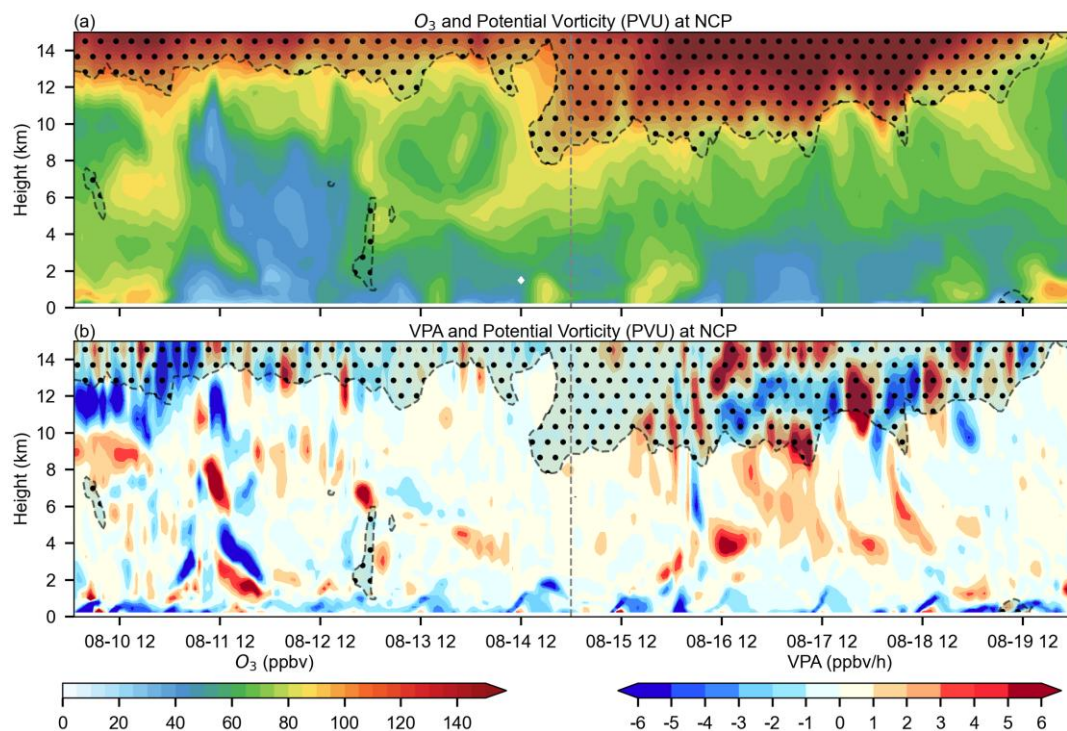


Fig. S4. The Vertical time cross-sectional analysis of the O_3 and VPA (calculated by CMAQ process analysis as the sum of vertical diffusion and vertical advection) during P1 and P2 processes in the North China Plain (NCP) region. The black dots areas represent regions where $PVU > 2$, and the black contour lines represent $PVU = 2$.

39 **Table S1.** Subregions and the provinces included in each subregion.

region	Provinces included
South China	Fujian, Guangdong, Guangxi, Hainan, Jiangxi
East China	Anhui, Jiangsu, Shanghai, Shandong, Zhejiang
North China	Beijing, Hebei, Neimenggu, Shanxi, Tianjin
Central China	Henan, Hubei, Hunan
Northeast China	Heilongjiang, Jilin, Liaoning
Northwest China	Gansu, Ningxia, Qinghai, shannxi, Xinjiang

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41 **Table S2.** Surface and vertical observation data.

Surface Observation Data						
Dataset Name	Stations number	Variables	Temporal Resolution	Source		Data Periods
Meteorological Observations	2394	T2, T2max, RH2, WS10, PRS,PRECIP	<u>hourly</u>	National Meteorological Information Center (http://data.cma.cn)		July–August 2019
O ₃ Observations	1480	O ₃	<u>hourly</u>	China National Environmental Monitoring Center (https://air.cnemc.cn:18007/)		
O ₃ Vertical Observation Data						
Site Name	Location	Altitude Above Sea Level (m)	Launching Time (LST)	number of profiles	Source	Data Periods
Hongkong	114.17E, 22.31N	66	13:00-14:00	9	World Ozone and Ultraviolet Radiation Data Centre (WOUDC, https://woudc.org/data.php)	03/07/2019 to 28/08/2022
Nanjing	118.90E, 31.93N	20	14:00	4	China Air Pollution Data Center (CAPDC, https://www.capdatabase.cn)	23/07/2019, 25/07/2019, 31/08/2020, 01/09/2020
Lhasa	91.14E, 29.66N	3650	23:00 to 02:00	12	National Tibetan Plateau Data Center (TPDC, https://data.tpdc.ac.cn/home, Bai, Z., 2022)	31/07/2019 to 21/08/2019, 04/08/2020 to 19/08/2020
Lijiang	100.22E, 26.85N	2389	23:00 to 02:00	5		02/07/2022 to 30/08/2022

Golmud	94.91E, 36.42N	2754	23:00 to 02:00	8		30/07/2020 to 30/08/2020, 27/06/2021 to 28/08/2021
Tropospheric Ozone Column (TOC) Data						
Satellite	Area	Variables	Spatial Resolution	Sensor	Source	Data Periods
Gaofen-5 satellite	China Mainland	Tropospheric Ozone (TOC) Column	1 km × 1 km	ultraviolet- visible hyperspectral spectrometer	University of Science and Technology of China (USTC), Zhao et al. (2024).	July–August 2019

44 **Table S3.** The average of observed and simulated avg-O3MDA8 and 90th-O3MDA8 for China and seven regions in July-August 2019. (Number
45 of monitoring sites in parentheses).

		China (1480)	E (319)	N (181)	S (256)	C (204)	NE (166)	NW (154)	SW (200)
Avg-O3MDA8 (ppbv)	OBS	59.4	64.7	73.5	46.9	66.7	49.5	64.1	51.0
	BASE	56.0	59.6	57.3	51.4	66.6	44.7	52.9	55.7
	H-CMAQ	58.7	60.4	62.9	51.7	68.0	47.5	60.6	59.3
	GEOS-Chem	59.2	61.5	64.3	51.2	68.8	48.5	60.8	58.7
	CESM2.2	62.3	63.0	68.4	52.9	70.7	50.7	68.7	63.4
90th-O3MDA8 (ppbv)	OBS	82.8	93.2	98.6	68.9	89.4	71.3	78.9	75.2
	BASE	75.0	85.4	79.1	71.9	83.8	62.9	63.4	68.6
	H-CMAQ	78.1	87.3	82.6	73.2	85.7	65.8	70.7	73.4
	GEOS-Chem	78.9	89.1	83.7	73.7	86.8	67.3	70.6	73.1
	CESM2.2	82.3	90.6	87.2	75.6	89.1	69.2	79.4	79.5

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48 **Table S4.** Evaluation of avg-O3MDA8 model performance in China and seven regions across four scenarios, using the metrics MB, and RMSE
49 (in ppbv), and IOA r and NMB (unitless).

		China (1480)	E (319)	N (181)	S (256)	C (204)	NE (166)	NW (154)	SW (200)
MB	BASE	-3.39	-5.14	-16.16	4.46	-0.01	-4.84	-11.21	4.68
	H-CMAQ	-0.65	-4.26	-10.54	4.84	1.39	-2.08	-3.50	8.30
	GEOS-Chem	-0.19	-3.24	-9.13	4.31	2.16	-1.07	-3.34	7.73
	CESM2.2	2.90	-1.68	-5.10	5.99	4.09	1.15	4.59	12.40
NMB	BASE	-5.7%	-8.7%	-27.2%	7.5%	0.0%	-8.2%	-18.9%	7.9%
	H-CMAQ	-1.1%	-7.2%	-17.8%	8.2%	2.3%	-3.5%	-5.9%	14.0%
	GEOS-Chem	-0.3%	-5.5%	-15.4%	7.3%	3.6%	-1.8%	-5.6%	13.0%
	CESM2.2	4.9%	-2.8%	-8.6%	10.1%	6.9%	1.9%	7.7%	20.9%
RMSE	BASE	10.81	10.46	17.80	6.78	7.16	10.26	13.77	7.71
	H-CMAQ	9.34	9.76	13.17	7.08	6.98	9.55	7.34	10.24
	GEOS-Chem	8.75	9.09	11.86	6.78	6.83	9.10	7.17	9.62
	CESM2.2	9.49	8.67	9.66	7.99	7.64	9.40	7.67	14.22
IOA	BASE	0.77	0.59	0.58	0.79	0.77	0.71	0.48	0.86
	H-CMAQ	0.82	0.64	0.65	0.78	0.80	0.71	0.66	0.78
	GEOS-Chem	0.85	0.68	0.70	0.79	0.82	0.74	0.68	0.80
	CESM2.2	0.83	0.71	0.74	0.75	0.80	0.71	0.66	0.67
r	BASE	0.66	0.44	0.73	0.77	0.78	0.66	0.42	0.84
	H-CMAQ	0.73	0.49	0.69	0.77	0.79	0.63	0.54	0.85
	GEOS-Chem	0.77	0.53	0.72	0.76	0.81	0.65	0.56	0.86
	CESM2.2	0.75	0.54	0.66	0.76	0.81	0.63	0.57	0.78

51 **Table S5.** Evaluation of 90th-O3MDA8 model performance in China and seven regions across four scenarios, using the metrics MB, and RMSE
52 (in ppbv), and IOA ,r and NMB (unitless).

		China (1480)	E (319)	N (181)	S (256)	C (204)	NE (166)	NW (154)	SW (200)
MB	BASE	-7.75	-7.74	-19.50	3.03	-5.51	-8.41	-15.56	-6.65
	H-CMAQ	-4.70	-5.83	-16.03	4.31	-3.67	-5.51	-8.25	-1.85
	GEOS-Chem	-3.85	-4.11	-14.93	4.82	-2.56	-4.06	-8.37	-2.18
	CESM2.2	-0.43	-2.55	-11.44	6.73	-0.24	-2.11	0.43	4.28
NMB	BASE	-13.1%	-13.0%	-32.9%	5.1%	-9.3%	-14.2%	-26.2%	-11.2%
	H-CMAQ	-7.9%	-9.8%	-27.0%	7.3%	-6.2%	-9.3%	-13.9%	-3.1%
	GEOS-Chem	-6.5%	-6.9%	-25.2%	8.1%	-4.3%	-6.8%	-14.1%	-3.7%
	CESM2.2	-0.7%	-4.3%	-19.3%	11.3%	-0.4%	-3.6%	0.7%	7.2%
RMSE	BASE	14.57	15.48	22.16	10.25	10.11	13.41	17.29	11.23
	H-CMAQ	12.91	14.79	19.38	10.50	9.29	11.97	10.84	10.33
	GEOS-Chem	12.39	14.08	18.43	10.62	8.89	11.17	10.85	9.66
	CESM2.2	12.31	13.78	16.19	11.49	8.78	10.74	8.22	13.61
IOA	BASE	0.78	0.48	0.62	0.83	0.75	0.78	0.60	0.87
	H-CMAQ	0.81	0.48	0.64	0.83	0.76	0.80	0.73	0.86
	GEOS-Chem	0.83	0.49	0.66	0.83	0.77	0.82	0.73	0.89
	CESM2.2	0.82	0.50	0.67	0.81	0.76	0.83	0.78	0.77
r	BASE	0.73	0.25	0.74	0.75	0.68	0.80	0.77	0.88
	H-CMAQ	0.75	0.25	0.73	0.76	0.68	0.81	0.79	0.86
	GEOS-Chem	0.76	0.26	0.73	0.77	0.68	0.82	0.80	0.88
	CESM2.2	0.73	0.27	0.70	0.78	0.66	0.82	0.70	0.70

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