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*Supplement of*

## **Recommendations on benchmarks for numerical air quality model applications in China – Part 1: PM<sub>2.5</sub> and chemical species**

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## References

**Table S1: List of peer-reviewed journals included in this study**

<b>No.</b>	<b>Journal name</b>	<b>No. of journal articles included in this study</b>
1	Advances in Atmospheric Sciences	6
2	Aerosol and Air Quality Research	17
3	Asian Journal of Atmospheric Environment	1
4	Atmosphere	2
5	Atmospheric Chemistry and Physics	92
6	Atmospheric Environment	100
7	Atmospheric Research	10
8	Environmental Pollution	18
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**Table S2: Summary of studies complied in this work (see Figure 1 for region definition)**

Reference	Models applied	Pollutants evaluated	Seasons evaluated	Regions evaluated
An et al. (2007)	CMAQ	PM <sub>10</sub> , SO <sub>2</sub>	Spring	BTH
J. An et al. (2013)	WRF-Chem	HONO	Summer	BTH
X. An et al. (2013)	CMAQ	SO <sub>2</sub> , NO <sub>x</sub> , CO, O <sub>3</sub>	Annual	BTH, Northeast, YRD
Ansari et al. (2019)	WRF-Chem	PM <sub>2.5</sub> , PM <sub>10</sub> , CO, NO <sub>2</sub> , SO <sub>2</sub> , O <sub>3</sub>	Fall	BTH, NCP
Archer-Nicholls et al. (2016)	WRF-Chem	PM <sub>2.5</sub>	Annual	Entire China
Bei et al. (2016)	WRF-Chem	PM <sub>2.5</sub> , O <sub>3</sub> , NO <sub>2</sub> , SO <sub>2</sub> , CO	Winter	PRD
Bei et al. (2018)	WRF-Chem	PM <sub>2.5</sub> , O <sub>3</sub> , NO <sub>2</sub> , CO	Summer	BTH
Bo et al. (2019)	CAMx	NO <sub>x</sub> , SO <sub>2</sub> , PM <sub>2.5</sub> , nitrate, sulfate	Annual	China
Bouarar et al. (2019)	WRF-Chem	NO <sub>x</sub> , O <sub>3</sub> , SO <sub>2</sub> , PM <sub>2.5</sub> , PM <sub>10</sub> , NO <sub>2</sub>	Summer, winter	Beijing (NCP), Guangzhou (PRD), Shanghai (YRD)
Campbell et al. (2017)	WRF-Chem	PM <sub>10</sub> , PM <sub>2.5</sub> , CO, NO, NO <sub>2</sub> , NO <sub>x</sub> , O <sub>3</sub> , SO <sub>2</sub>	Spring	Southeast, Entire china, PRD
Chang et al. (2018)	CMAQ	PM <sub>2.5</sub> , EC, OC, nitrate, sulfate, ammonium	Summer, winter	BTH
Che et al. (2011)	CMAQ	SO <sub>2</sub> , NO <sub>2</sub> , PM <sub>10</sub> , O <sub>3</sub>	Fall	PRD
Chen et al. (2007)	CMAQ	PM <sub>10</sub>	Spring, summer, fall, winter	BTH
Chen et al. (2014)	CMAQ	PM <sub>10</sub>	Annual, spring, summer, winter	BTH
Chen et al. (2015)	WRF-Chem	PM <sub>10</sub>	Spring, summer, fall, winter	BTH, YRD, Central China, PRD
Chen et al. (2016)	WRF-Chem	PM <sub>2.5</sub> , PM <sub>10</sub> , NO <sub>2</sub> , O <sub>3</sub> , SO <sub>2</sub> , CO, BC, SO <sub>4</sub> , NO <sub>3</sub> , NH <sub>4</sub>	Fall	BTH
D. Chen et al. (2017a)	CMAQ	PM <sub>2.5</sub> , OC/EC, sulfate, nitrate, ammonium	Fall	NCP
D. Chen et al. (2017b)	WRF-Chem	PM <sub>2.5</sub>	Spring, summer, fall, winter	NCP
L. Chen et al. (2017a)	WRF-Chem	SO <sub>2</sub> , NO <sub>2</sub> , PM <sub>2.5</sub> , PM <sub>10</sub>	Spring	Northwest, BTH
L. Chen et al. (2017b)	CMAQ	PM <sub>10</sub>	Winter, summer, spring, fall	NCP
Chen et al. (2018)	WRF-Chem	PM <sub>2.5</sub>	Spring, summer, fall, winter	BTH
D. Chen et al. (2019a)	WRF-Chem	SO <sub>2</sub>	Annual	NCP, Northeast, Northwest, Sichuan Basin, Central China, YRD, PRD
D. Chen et al. (2019b)	CMAQ	PM <sub>2.5</sub>	Spring, summer, fall, winter	YRD
D. Chen et al. (2019c)	WRF-Chem	NO <sub>2</sub> , SO <sub>2</sub> , PM <sub>2.5</sub>	Spring, summer, fall, winter	PRD
L. Chen et al. (2019a)	CMAQ	PM <sub>2.5</sub> , EC, nitrate, ammonium, PM <sub>10</sub> , sulfate, AOD, NO <sub>2</sub> , SO <sub>2</sub>	Annual	Entire China
L. Chen et al. (2019b)	WRF-Chem	PM <sub>2.5</sub>	Fall	Northeast, BTH, Central china
T. Chen et al. (2019)	CMAQ	PM <sub>2.5</sub> , SO <sub>2</sub> , NO <sub>2</sub>	Winter	Southeast
X. Chen et al. (2019)	WRF-Chem	NO <sub>2</sub> , O <sub>3</sub>	Fall	PRD
Cheng et al. (2013)	CAMx	PM <sub>10</sub>	Fall	PRD
Cheng et al. (2014)	CMAQ	PM <sub>2.5</sub>	Summer	YRD
Cheng et al. (2017)	CMAQ	PM <sub>10</sub> , PM <sub>2.5</sub>	Winter	Entire China
Cheng et al. (2019)	CMAQ	PM <sub>2.5</sub> , SO <sub>2</sub> , NO <sub>2</sub> , CO, PM <sub>10</sub> , O <sub>3</sub>	Annual, spring, summer, fall,	BTH

Cui et al. (2015)	WRF-Chem	SO <sub>2</sub> , NO <sub>2</sub> , PM <sub>2.5</sub> , O <sub>3</sub>	winter Spring + fall + winter, spring + summer + fall	PRD
Ding et al. (2019)	WRF-Chem	PM <sub>2.5</sub>	Winter	Entire China
Dong et al. (2013)	CMAQ	O <sub>3</sub> , SO <sub>2</sub> , NO <sub>2</sub> , PM <sub>2.5</sub> , PM <sub>10</sub>	Annual	YRD
Dong et al. (2014)	CMAQ	PM <sub>2.5</sub> , sulfate, ammonium, nitrate	Annual	YRD
Du et al. (2019)	NAQPMS	PM <sub>2.5</sub>	Fall, winter	BTH
Fan et al. (2015)	CMAQ	PM <sub>2.5</sub> , SO <sub>2</sub> , NO <sub>2</sub> , O <sub>3</sub>	Spring	PRD
T. Feng et al. (2016a)	WRF-Chem	O <sub>3</sub> , NO <sub>2</sub> , PM <sub>2.5</sub>	Summer	Northwest
T. Feng et al. (2016b)	WRF-Chem	PM <sub>2.5</sub> , O <sub>3</sub> , EC	Spring	Northwest
S. Feng et al. (2018)	CMAQ	PM <sub>2.5</sub>	Winter	Entire China, NCP, YRD, Sichuan Basin
T. Feng et al. (2018a)	WRF-Chem	O <sub>3</sub> , NO <sub>2</sub> , PM <sub>2.5</sub> , sulfate, nitrate, ammonium, HONO	Winter	Northwest
T. Feng et al. (2018b)	WRF-Chem	CO <sub>2</sub>	Summer	Northwest
J. Feng et al. (2019)	CMAQ	SO <sub>2</sub> , PM <sub>2.5</sub>	Summer, winter	YRD
T. Feng et al. (2019)	WRF-Chem	PM <sub>2.5</sub> , OM, O <sub>3</sub> , NO <sub>2</sub> , EC	Fall	BTH
X. Feng et al. (2019)	WRF-Chem	PM <sub>2.5</sub>	Winter	PRD
Fu et al. (2008)	CMAQ	SO <sub>2</sub> , NO <sub>2</sub> , O <sub>3</sub>	Summer	Entire China, PRD + Southeast
Fu et al. (2014)	CMAQ	PM <sub>10</sub>	Spring	Entire China, BTH, YRD, PRD, NCP, Northwest, Southwest, Central China, Southeast
Fu et al. (2015)	CMAQ	nitrate	Fall, summer	YRD
X. Fu et al. (2016)	CMAQ	PM <sub>2.5</sub>	Winter	YRD
Y. Fu et al. (2016)	GEOS-Chem	OM, OC	Summer + fall, winter, spring, summer, fall	Entire China
Fu et al. (2019)	CMAQ	O <sub>3</sub> (8-hr max), PM <sub>2.5</sub>	Fall	PRD
Gao et al. (2011)	WRF-Chem	PM <sub>2.5</sub>	Summer	BTH
Gao et al. (2012)	CMAQ	O <sub>3</sub> , NO <sub>x</sub>	Summer	BTH
Gao et al. (2014)	CMAQ	PM <sub>2.5</sub>	Winter	YRD
J. Gao et al. (2016)	WRF-Chem	O <sub>3</sub>	Spring	YRD
M. Gao et al. (2016a)	WRF-Chem	PM <sub>2.5</sub>	Winter	BTH
M. Gao et al. (2016b)	WRF-Chem	PM <sub>2.5</sub>	Winter	BTH
J. Gao et al. (2017)	WRF-Chem	O <sub>3</sub>	Summer	YRD
M. Gao et al. (2017a)	WRF-Chem	PM <sub>2.5</sub>	Fall	BTH
M. Gao et al. (2017b)	WRF-Chem	PM <sub>2.5</sub> , PM <sub>10</sub>	Winter	BTH
Gao et al. (2018)	WRF-Chem	PM <sub>2.5</sub>	Annual	Entire China
Gbaguidi et al. (2018)	NAQPMS	SO <sub>2</sub> , NO <sub>2</sub> , sulfate, nitrate, ammonium, Ca	Summer	Northeast
Ge et al. (2014)	NAQPMS	SO <sub>2</sub> , NO <sub>x</sub> , ammonia, sulfate, nitrate, ammonium	Spring, summer, fall, winter	PRD

Guo et al. (2016)	WRF-Chem	SO <sub>2</sub> , NO <sub>2</sub> , O <sub>3</sub> , CO, PM <sub>2.5</sub> , PM <sub>10</sub>	Fall	BTH
Han et al. (2009)	CMAQ	NO <sub>2</sub> column	Spring, summer, fall, winter	BTH+YRD
Han et al. (2011)	CMAQ	AOD, sulfate, PM <sub>2.5</sub> , PM <sub>10</sub>	Annual	BTH
Han et al. (2012)	CMAQ	PM <sub>10</sub>	Spring	NCP, Central China, BTH, Northwest, Southeast, YRD, PRD
X. Han et al. (2013)	CMAQ	SO <sub>2</sub> , NO <sub>2</sub> , PM <sub>2.5</sub> , PM <sub>10</sub> , O <sub>3</sub>	Winter	BTH, NCP
K. Han et al. (2013)	CMAQ	HCHO column	Summer, winter	YRD+Central China, Northeast+Southeast, PRD+Southwest+Southeast
Han et al. (2014)	CMAQ	PM <sub>2.5</sub> , O <sub>3</sub> , NO <sub>2</sub>	Summer, winter	BTH
Han et al. (2015)	CMAQ	NO <sub>2</sub>	Spring, summer, fall, winter	BTH+NCP+Central China, YRD+Central China, PRD+Southwest+Central China+Southeast, Sichuan Basin+Northwest+Southwest
Han et al. (2018)	CMAQ	O <sub>3</sub> , NO <sub>2</sub>	Summer, winter	BTH
Hu et al. (2015)	CMAQ	PM <sub>2.5</sub>	Spring	BTH, Northeast, Central China, Sichuan Basin, Southwest, PRD, YRD, NCP, Northwest
Hu et al. (2016)	CMAQ	O <sub>3</sub> (1-hr max), O <sub>3</sub> (8-hr max), PM <sub>2.5</sub> , PM <sub>10</sub> , CO, NO <sub>2</sub> , SO <sub>2</sub>	Spring, summer, fall, winter	Entire China
J. Hu et al. (2017a)	CMAQ	O <sub>3</sub> , CO, NO <sub>2</sub> , SO <sub>2</sub> , PM <sub>2.5</sub> , PM <sub>10</sub> , O <sub>3</sub> (1-hr max)	Annual	Entire China, Northeast, NCP, Northwest, YRD, Central China, Sichuan Basin, PRD + Southwest, Southwest + PRD
J. Hu et al. (2017b)	CMAQ	VOC, isoprene, EC, OC	Spring, summer, winter	YRD, BTH, PRD
Hu et al. (2018)	WRF-Chem	O <sub>3</sub>	Summer	YRD
Hu et al. (2019)	WRF-Chem	PM <sub>2.5</sub> , PM <sub>10</sub>	Winter	Sichuan Basin, Southwest
Huang et al. (2014)	CMAQ	Visibility	Annual	YRD
X. Huang et al. (2016)	WRF-Chem	alkene, aromatic, isoprene	Summer	YRD
Z. Huang et al. (2016)	CAMx	O <sub>3</sub> , NO <sub>2</sub> , NO <sub>x</sub> , SO <sub>2</sub> , PM <sub>10</sub> , PM <sub>2.5</sub>	Spring, fall	PRD
Huang et al. (2019)	CAMx	PM <sub>2.5</sub> , PM <sub>10</sub>	Winter	YRD
Itahashi et al. (2012)	CMAQ	PM <sub>2.5</sub>	Summer	Entire China
S. Itahashi et al. (2015a)	CAMx	O <sub>3</sub>	Fall	Entire China
S. Itahashi et al. (2015b)	CMAQ	nitrate	Annual	Entire China
Jeong et al. (2013)	GEOS-Chem	O <sub>3</sub> , sulfate, nitrate, ammonium	Annual, spring, summer, fall, winter	Entire China
Jia et al. (2017)	CAMx	PM <sub>2.5</sub>	Winter	BTH
Jia et al. (2018)	CMAQ	sulfate, nitrate	Spring, summer, fall, winter	BTH
Jiang et al. (2008)	WRF-Chem	O <sub>3</sub> , NO <sub>x</sub>	Fall	PRD
Jiang et al. (2013)	GEOS-Chem	sulfate, nitrate, EC	Annual	Entire China
Kang et al. (2019)	CMAQ	OM, EC, nitrate, ammonium, sulfate, PM <sub>2.5</sub>	Spring	YRD + Southeast, YRD, Southeast
Kim et al. (2017)	CAMx	PM <sub>2.5</sub>	Fall	Sichuan Basin, PRD, Northeast, YRD, BTH
Kong et al. (2019)	GEOS-Chem	NO <sub>2</sub> column	Summer	YRD
Koo et al. (2015)	CAMx	PM <sub>10</sub>	Summer, winter	Entire China
Kuhlmann et al. (2015)	CMAQ	NO <sub>2</sub> column	Fall + winter	PRD

Kwok et al. (2010)	CMAQ	sulfate, OC, EC, ammonium, nitrate, CI, Na	Spring, summer, fall, winter	PRD
Lai et al. (2019)	CMAQ	PM <sub>2.5</sub>	Spring, winter	Southeast
Lang et al. (2013)	CMAQ	PM <sub>2.5</sub>	Spring, summer, fall, winter	BTH
Lang et al. (2017)	CMAQ	SO <sub>2</sub> , NO <sub>2</sub>	Spring, summer, fall, winter	BTH
Li et al. (2007)	NAQPMS	O <sub>3</sub>	Spring, summer, fall, winter	NCP, YRD, Northwest
Li et al. (2008)	NAQPMS	O <sub>3</sub> , CO, NO <sub>x</sub> , EC	Summer	NCP
L. Li et al. (2011)	CMAQ	SO <sub>2</sub> , NO <sub>2</sub> , PM <sub>10</sub>	Summer, winter	YRD
J. Li et al. (2011)	NAQPMS	O <sub>3</sub>	Summer	NCP
Y. Li et al. (2011)	WRF-Chem	HONO, O <sub>3</sub> , NO <sub>2</sub> , NO	Summer	BTH
J. Li et al. (2012)	NAQPMS	SO <sub>2</sub> , NO <sub>2</sub> , PM <sub>10</sub>	Spring	YRD, BTH, NCP, Southwest, Central China
L. Li et al. (2012)	CMAQ	NO <sub>2</sub> , NO <sub>x</sub> , NO <sub>y</sub> , O <sub>3</sub>	Summer	YRD
N. Li et al. (2013)	CMAQ	OM	Fall	PRD
Y. Li et al. (2013)	CAMx	NO <sub>2</sub> , NO <sub>x</sub> , O <sub>3</sub> , Ox	Winter	PRD
L. Li et al. (2014)	CMAQ	PM <sub>2.5</sub> , nitrate, sulfate, ammonium, OM, EC	Fall	YRD
Y. Li et al. (2014)	WRF-Chem	HONO	Summer	BTH
L. Li et al. (2015)	CAMx	PM <sub>2.5</sub> , sulfate, nitrate, ammonium, OC, EC	Fall	YRD
X. Li et al. (2015)	CAMx	PM <sub>2.5</sub>	Spring, summer, fall, winter	BTH
K. Li et al. (2016)	GEOS-Chem	PM <sub>2.5</sub> , sulfate, nitrate, ammonium, EC, OC	Annual, spring, summer, fall, winter	Entire China
L. Li et al. (2016)	CAMx	O <sub>3</sub> , NO <sub>2</sub>	Fall	YRD
M. Li et al. (2016)	WRF-Chem	O <sub>3</sub> , NO <sub>2</sub>	Spring	PRD
N. Li et al. (2016a)	CMAQ	SO <sub>2</sub> , NO <sub>x</sub> , O <sub>3</sub> , CO, VOC, PM <sub>2.5</sub>	Annual	Southeast
N. Li et al. (2016b)	WRF-Chem	EC	Annual, spring, summer, fall, winter	Northwest
Q. Li et al. (2016)	WRF-Chem	PM <sub>2.5</sub> , NO <sub>2</sub> , O <sub>3</sub> , O <sub>3</sub> (1-hr max)	Winter	PRD
G. Li et al. (2017)	WRF-Chem	O <sub>3</sub>	Spring	NCP, Northeast, Central China, BTH, NCP, YRD, Southwest, Southeast, PRD
J. Li et al. (2017a)	NAQPMS	PM <sub>2.5</sub>	Fall, winter	BTH
J. Li et al. (2017b)	CMAQ	PM <sub>2.5</sub> , OM	Fall	Entire China
J. Li et al. (2017c)	NAQPMS	PM <sub>2.5</sub>	Spring	Southwest, PRD, YRD
M. Li et al. (2017)	WRF-Chem	PM <sub>10</sub> , O <sub>3</sub> , NO <sub>2</sub>	Spring	YRD
J. Li et al. (2018)	CMAQ	PM <sub>2.5</sub>	Summer, winter	Entire China
L. Li et al. (2018)	CAMx	sulfate, nitrate, ammonia, EC, OM	Fall	YRD
M. Li et al. (2018)	GEOS-Chem	NO <sub>2</sub> , NO <sub>x</sub> , SO <sub>2</sub>	Summer	Entire China, BTH+YRD+PRD+Northwest+Southwest
N. Li et al. (2018)	WRF-Chem	NO <sub>x</sub> , PM <sub>2.5</sub> , O <sub>3</sub>	Summer	Northwest
X. Li et al. (2018)	WRF-Chem	PM <sub>2.5</sub> , O <sub>3</sub> , OM, sulfate, nitrate, ammonium	Winter	BTH

J. Li et al. (2019)	CMAQ	PM <sub>2.5</sub>	Fall, summer	Entire China
L. Li et al. (2019)	CAMx	O <sub>3</sub> , NO <sub>2</sub>	Spring, summer, fall	YRD, BTH
R. Li et al. (2019)	CMAQ	PM <sub>2.5</sub>	Spring, summer, fall, winter	BTH, NCP, Northwest, Central China, YRD, PRD, Sichuan Basin
Liao et al. (2014)	WRF-Chem	O <sub>3</sub> , PM <sub>10</sub>	Summer, winter	YRD
Liao et al. (2015)	WRF-Chem	O <sub>3</sub> , PM <sub>10</sub>	Summer, winter	YRD
Lin et al. (2009)	CMAQ	O <sub>3</sub>	Spring + summer	Northwest, NCP, YRD, BTH
Lin et al. (2012)	GEOS-Chem	NO <sub>2</sub> column	Summer, winter	BTH+NCP+Central China+YRD+PBD+Southeast
Lin et al. (2016)	CAMx	NO <sub>x</sub> , O <sub>3</sub> , OM	Fall	BTH
Liu et al. (2010)	CMAQ	SO <sub>2</sub> , NO <sub>2</sub> , O <sub>3</sub> (1-hr max), PM <sub>10</sub> , CO, TRO, AOD	Spring, summer, fall, winter	Entire China
Liu et al. (2017)	WRF-Chem	PM <sub>2.5</sub>	Winter	PRD
H. Liu et al. (2018)	CMAQ	O <sub>3</sub> (1-hr max), O <sub>3</sub> (8-hr max)	Annual, spring, summer, fall, winter	Entire China
S. Liu et al. (2018)	WRF-Chem	NO <sub>2</sub> , SO <sub>2</sub> , PM <sub>10</sub>	Annual	Central China
Y. Liu et al. (2018)	CMAQ	O <sub>3</sub> , NO <sub>2</sub>	Summer	YRD
H. Liu et al. (2019)	CMAQ	O <sub>3</sub> , NO <sub>2</sub>	Fall	BTH, part of NCP
L. Liu et al. (2019a)	WRF-Chem	PM <sub>2.5</sub> , O <sub>3</sub> , NO <sub>2</sub> , SO <sub>2</sub> , nitrate, ammonium, OM	Summer	BTH
L. Liu et al. (2019b)	WRF-Chem	PM <sub>2.5</sub> , O <sub>3</sub> , NO <sub>2</sub> , SO <sub>2</sub> , CO, OM, sulfate, ammonium, nitrate	Winter	BTH
L. Liu et al. (2019c)	GEOS-Chem	ammonia	Winter	Entire china
S. Liu et al. (2019)	CMAQ	PM <sub>2.5</sub> , As, Se, Pb, Cd, Cr, Ni, Sb, Mn, CO, Cu, Zn	Fall, summer	BTH
Long et al. (2016)	WRF-Chem	PM <sub>2.5</sub> , O <sub>3</sub> , NO <sub>2</sub>	Fall	BTH, NCP
Long et al. (2019)	WRF-Chem	PM <sub>2.5</sub> , NO <sub>2</sub> , SO <sub>2</sub> , CO	Winter	NCP
X. Lu et al. (2016a)	CAMx	PM <sub>2.5</sub> , sulfate, nitrate	Summer, winter	PRD
X. Lu et al. (2016b)	CAMx	NO <sub>x</sub> , NO <sub>2</sub> , O <sub>3</sub>	Spring, summer, fall, winter	PRD
Lu et al. (2017)	NAQPMS	PM <sub>2.5</sub>	Fall	BTH, NCP, Central China, YRD
X. Lu et al. (2019a)	CAMx	PM <sub>2.5</sub>	Spring, winter	PRD
X. Lu et al. (2019b)	CAMx	PM <sub>2.5</sub> , NO <sub>2</sub> , O <sub>3</sub> , SO <sub>2</sub> , sulfate, nitrate, ammonium	Annual	PRD
X. Lu et al. (2019c)	GEOS-Chem	O <sub>3</sub> (8-hr max)	Annual	BTH, Central China, NCP, YRD, Northwest, Sichuan Basin, PRD, Central China, Southwest
Lv et al. (2018)	CMAQ	PM <sub>2.5</sub>	Annual, spring, summer, fall, winter	Entire China
Lyu et al. (2019)	CMAQ	PM <sub>2.5</sub>	Annual	Entire China
Ma et al. (2017)	GEOS-Chem	PM <sub>2.5</sub>	Annual	Northeast, NCP, YRD, Sichuan Basin, PRD
C. Ma et al. (2018)	WRF-Chem	SO <sub>2</sub> , NO <sub>2</sub> , PM <sub>10</sub> , O <sub>3</sub> , PM <sub>2.5</sub>	Fall	BTH
X. Ma et al. (2018)	WRF-Chem	PM <sub>2.5</sub>	Spring, summer, fall, winter	BTH
Mao et al. (2018)	WRF-Chem	methylamine	Summer	YRD
Matsui et al. (2009)	CMAQ	CO, NO <sub>x</sub> , SO <sub>2</sub> , alkane, alkene, aromatic, sulfate, ammonium,	Summer	BTH



		nitrate, EC, OC, PM <sub>2.5</sub> , O <sub>3</sub>		
Meng et al. (2019)	WRF-Chem	PM <sub>10</sub>	Spring	Northwest
Ni et al. (2018)	WRF-Chem	PM <sub>2.5</sub> , SO <sub>2</sub>	Winter	YRD
Pang et al. (2018)	WRF-Chem	PM <sub>2.5</sub>	Winter	Entire China, BTH+YRD+PRD+NCP+Northeast+Central China+Southeast, BTH, YRD
Peng et al. (2011)	CAMx	O <sub>3</sub>	Spring, summer, fall, winter	Southeast (Taiwan)
W. Peng et al. (2017)	WRF-Chem	PM <sub>2.5</sub>	Spring, summer, fall, winter	BTH
Z. Peng et al. (2017)	WRF-Chem	PM <sub>2.5</sub>	Fall	YRD, BTH
Peng et al. (2018)	WRF-Chem	PM <sub>2.5</sub> , PM <sub>10</sub> , SO <sub>2</sub> , NO <sub>2</sub> , CO, O <sub>3</sub>	Fall	BTH
Qiao et al. (2015)	CMAQ	sulfate, nitrate, ammonium	Summer	Sichuan Basin
Qiao et al. (2019)	CMAQ	O <sub>3</sub>	Annual	Entire China
Qiao et al. (2019)	CMAQ	PM <sub>2.5</sub> , O <sub>3</sub>	Summer, winter	Sichuan Basin
Qin et al. (2015)	CMAQ	NO <sub>2</sub> , SO <sub>2</sub> , PM <sub>10</sub> , PM <sub>2.5</sub> , sulfate, ammonium, nitrate, OC, EC, O <sub>3</sub> (8-hr max)	Spring, summer, fall, winter	PRD
X. Qiu et al. (2017)	CMAQ	SO <sub>2</sub> , NO <sub>2</sub>	Spring, summer, winter	NCP
Y. Qiu et al. (2017)	WRF-Chem	PM <sub>2.5</sub> , SO <sub>2</sub> , NO <sub>2</sub> , O <sub>3</sub>	Winter	BTH+NCP
X. Qiu et al. (2019)	CMAQ	NO <sub>2</sub> , PM <sub>2.5</sub> , O <sub>3</sub>	Summer	BTH
Y. Qiu et al. (2019)	WRF-Chem	PM <sub>2.5</sub> , NO <sub>2</sub> , PAN, O <sub>3</sub>	Winter	BTH
Qu et al. (2014)	CAMx	O <sub>3</sub>	Fall	BTH
Qu et al. (2019)	WRF-Chem	PM <sub>2.5</sub> , NO <sub>2</sub>	Annual	BTH
Quan et al. (2008)	CMAQ	SO <sub>2</sub> , sulfate, NH <sub>3</sub> , ammonium	Annual	Entire China
Reddington et al. (2019)	WRF-Chem	PM <sub>2.5</sub>	Annual	Southeast
Sekiguchi et al. (2018)	CMAQ	PM <sub>2.5</sub>	Spring + winter	Entire china, BTH
T. Sha et al. (2019a)	WRF-Chem	SO <sub>2</sub> , NO <sub>2</sub> , PM <sub>2.5</sub> , sulfate, nitrate	Winter	YRD
T. Sha et al. (2019b)	WRF-Chem	SO <sub>2</sub> , NO <sub>2</sub> , ammonia, sulfate, nitrate, ammonium, PM <sub>2.5</sub>	Spring	YRD
Shi et al. (2008)	CMAQ	NO <sub>2</sub> column	Summer	BTH
Shi et al. (2017)	CMAQ	sulfate, nitrate, ammonium	Annual	Entire China
Shimadera et al. (2014)	CMAQ	PM <sub>2.5</sub>	Winter	East Asia
Shu et al. (2016)	CMAQ	O <sub>3</sub> , NO <sub>2</sub>	Summer	YRD
Song et al. (2008)	CMAQ	AOD	Spring, summer, fall, winter	NCP, BTH, Central China, YRD, Sichuan Basin
Sun et al. (2017)	CAMx	PM <sub>2.5</sub>	Spring, summer, fall, winter	BTH
Sun et al. (2018)	CAMx	PM <sub>2.5</sub>	Spring, summer, fall, winter	YRD + Central China
Sun et al. (2019)	GEOS-Chem	O <sub>3</sub>	Summer	NCP, BTH + YRD + Sichuan Basin + NCP + Northwest + Southwest + Central China
Tang et al. (2013)	NAQPMS	CO	Summer	BTH
Tang et al. (2014)	WRF-Chem	HONO	Summer	BTH

Tang et al. (2015)	WRF-Chem	O <sub>3</sub> , NO <sub>2</sub> , HONO, OH, radical	Summer	BTH+PRD, BTH, PRD
Tao et al. (2015)	WRF-Chem	O <sub>3</sub> , CO, PM <sub>2.5</sub>	Spring + summer + fall, summer + fall	YRD
Tao et al. (2018)	CMAQ	PM <sub>2.5</sub> , O <sub>3</sub>	Summer, winter	BTH
Tie et al. (2013)	WRF-Chem	CO, O <sub>3</sub> , PM <sub>2.5</sub> , NO <sub>x</sub> , NO <sub>y</sub> , HONO, alkane, alkene, aromatic, OVOCs, VOC	Fall	YRD
L. Wang et al. (2010)	CMAQ	PM <sub>10</sub> , NO <sub>2</sub> column, AOD	Spring, summer, fall, winter	Entire China
S. Wang et al. (2010)	CMAQ	PM <sub>10</sub> , NO <sub>2</sub> column, PM <sub>2.5</sub>	Summer	BTH
X. Wang et al. (2010a)	WRF-Chem	SO <sub>2</sub> , NO <sub>2</sub>	Summer	Entire China
X. Wang et al. (2010b)	CMAQ	O <sub>3</sub> , NO, NO <sub>2</sub> , NMHC	Fall	PRD
S. Wang et al. (2011a)	CMAQ	NO <sub>2</sub> column, SO <sub>2</sub> column, AOD, PM <sub>10</sub> , NO <sub>2</sub> , SO <sub>2</sub> , PM <sub>2.5</sub> , sulfate, nitrate, ammonium, OC, EC	Annual, spring, summer, fall, winter	NCP, YRD, PRD, NCP+YRD+PRD, BTH
S. Wang et al. (2011b)	CMAQ	O <sub>3</sub>	Fall	PRD
X. Wang et al. (2011)	CMAQ	O <sub>3</sub>	Fall	PRD
L. Wang et al. (2012)	CMAQ	PM <sub>10</sub> , SO <sub>2</sub>	Annual	BTH + NCP + Central China
T. Wang et al. (2012)	WRF-Chem	PM <sub>10</sub> , SO <sub>2</sub> , NO <sub>2</sub> , API	Fall	YRD
D. Wang et al. (2014)	CMAQ	NO <sub>2</sub> , SO <sub>2</sub> , PM <sub>2.5</sub> , PM <sub>10</sub>	Winter	Northwest
F. Wang et al. (2014)	WRF-Chem	O <sub>3</sub> , NO <sub>2</sub>	Summer	BTH
L. Wang et al. (2014)	CMAQ	PM <sub>2.5</sub> , PM <sub>10</sub>	Winter	Entire china, BTH + NCP + Central China
Y. Wang et al. (2014)	GEOS-Chem	PM <sub>2.5</sub>	Spring	Entire China
L. Wang et al. (2015)	CMAQ	PM <sub>2.5</sub> , PM <sub>10</sub>	Summer, winter	BTH
N. Wang et al. (2015)	CMAQ	O <sub>3</sub> , NO <sub>x</sub>	Fall	PRD
Z. Wang et al. (2015)	CMAQ	SO <sub>2</sub> , NO <sub>2</sub> , PM <sub>10</sub>	Spring, summer, fall, winter	Entire China
J. Wang et al. (2016a)	WRF-Chem	O <sub>3</sub> , NO <sub>x</sub> , NO, CO, SO <sub>2</sub>	Spring	Entire China
J. Wang et al. (2016b)	CAMx	sulfate, nitrate	Annual	Entire China
L. Wang et al. (2016)	WRF-Chem	SO <sub>2</sub> , NO <sub>2</sub> , CO, PM <sub>2.5</sub> , PM <sub>10</sub>	Winter	Entire China
N. Wang et al. (2016)	CMAQ	O <sub>3</sub> , NO <sub>x</sub> , PM <sub>2.5</sub>	Annual, spring, summer, fall, winter	PRD
Z. Wang et al. (2016)	CAMx	PM <sub>2.5</sub>	Fall	BTH
G. Wang et al. (2017)	CMAQ	PM <sub>2.5</sub> , nitrate, sulfate, ammonium	Fall, summer	BTH
J. Wang et al. (2017)	WRF-Chem	SO <sub>2</sub>	Winter	Northwest
Y. Wang et al. (2017)	CAMx	PM <sub>2.5</sub>	Fall	BTH, NCP
Z. Wang et al. (2017)	NAQPMS/CMAQ	PM <sub>2.5</sub> , PMC	Winter	NCP+BTH+YRD, BTH
X. Wang et al. (2018a)	CMAQ	Hg	Annual	Entire China
X. Wang et al. (2018b)	CAMx	PM <sub>2.5</sub>	Fall	BTH
Z. Wang et al. (2018)	NAQPMS	PM <sub>2.5</sub> , PM <sub>10</sub>	Spring	BTH, NCP, YRD

H. Wang et al. (2019)	NAQPMS	PM <sub>2.5</sub> , O <sub>3</sub>	Summer	NCP, BTH, Central China
P. Wang et al. (2019)	CMAQ	O <sub>3</sub>	Summer	BTH, YRD, PRD, Sichuan Basin
Q. Wang et al. (2019a)	WRF-Chem	PM <sub>2.5</sub>	Fall	BTH
Q. Wang et al. (2019b)	CMAQ	PM <sub>2.5</sub>	Summer, winter	Entire China
X. Wang et al. (2019a)	CAMx	PM <sub>2.5</sub> , sulfate, nitrate	Fall	PRD
X. Wang et al. (2019b)	CAMx	PM <sub>2.5</sub>	Summer, winter	BTH
W. Wei et al. (2018a)	WRF-Chem	VOC	Summer, winter	BTH
W. Wei et al. (2018b)	WRF-Chem	O <sub>3</sub> (8-hr max), NO <sub>x</sub> , CO	Summer	BTH
Wei et al. (2019)	WRF-Chem	O <sub>3</sub> , NO <sub>x</sub> , CO	Summer	BTH
Wu et al. (2011)	NAQPMS	SO <sub>2</sub> , PM <sub>10</sub> , NO <sub>2</sub> , O <sub>3</sub>	Summer	BTH
Wu et al. (2013)	CAMx	PM <sub>10</sub> , PM <sub>2.5</sub>	Spring, winter	PRD
J. Wu et al. (2017a)	WRF-Chem	PM <sub>2.5</sub> , O <sub>3</sub> , NO <sub>2</sub> , OM, sulfate, nitrate, ammonium	Summer	BTH
J. Wu et al. (2017b)	NAQPMS	PM <sub>2.5</sub> , SO <sub>2</sub> , NO <sub>2</sub>	Winter	YRD
Wu et al. (2018)	WRF-Chem	PM <sub>2.5</sub> , O <sub>3</sub> , NO <sub>3</sub> , OM, sulfate, nitrate, ammonium	Summer	BTH, NCP
M. Xie et al. (2016a)	WRF-Chem	O <sub>3</sub> , PM <sub>10</sub>	Summer, winter	YRD
M. Xie et al. (2016b)	WRF-Chem	O <sub>3</sub> , PM <sub>10</sub>	Summer, winter	PRD, Southwest
J. Xing et al. (2011a)	CMAQ	O <sub>3</sub>	Summer	BTH, YRD, PRD, Entire China
J. Xing et al. (2011b)	CMAQ	NO <sub>2</sub> , SO <sub>2</sub> , PM <sub>10</sub> , PM <sub>2.5</sub> , O <sub>3</sub> , sulfate, nitrate, ammonium, EC, OC, NO <sub>2</sub> column, SO <sub>2</sub> column, CO column, TOR, AOD	Summer	BTH
Xing et al. (2015)	CMAQ	SO <sub>2</sub> , NO <sub>2</sub>	Annual	Entire China
Xing et al. (2017)	CMAQ	O <sub>3</sub>	Summer, winter	BTH, YRD, PRD, Central China, Sichuan Basin, Entire China
Xing et al. (2019)	WRF-Chem	OM, HONO	Winter	BTH
Xu et al. (2015)	GEOS-Chem	PM <sub>2.5</sub>	Annual, spring, summer, fall, winter	Entire China, BTH, NCP, YRD, Southeast
Xu et al. (2016)	WRF-Chem	PM <sub>2.5</sub>	Annual	YRD
Xu et al. (2018)	CMAQ	PM <sub>2.5</sub>	Winter	Entire China
J. Xu et al. (2019)	WRF-Chem	O <sub>3</sub> , NO <sub>x</sub>	Summer	YRD
Z. Xu et al. (2019)	WRF-Chem	nitrate, ammonia, HNO <sub>3</sub>	Winter	Northeast
Xue et al. (2013)	CMAQ	SO <sub>2</sub> , NO <sub>2</sub> , AOD	Annual	Entire China, BTH, YRD, PRD
Xue et al. (2016)	CMAQ	PM <sub>10</sub> , PM <sub>2.5</sub> , SO <sub>2</sub> , NO <sub>2</sub>	Annual	BTH
Yamaji et al. (2010)	CMAQ	CO, EC, OC, O <sub>3</sub>	Summer	NCP
Yang et al. (2015)	GEOS-Chem	sulfate, nitrate, ammonium, EC, PM <sub>2.5</sub>	Annual	Entire China
X. Yang et al. (2018a)	CMAQ	PM <sub>2.5</sub>	Spring, summer, fall, winter	BTH
X. Yang et al. (2018b)	CMAQ	O <sub>3</sub>	Summer	BTH
J. Yang et al. (2019)	WRF-Chem	EC	Annual	Southwest

W. Yang et al. (2019a)	NAQPMS	O <sub>3</sub>	Spring, summer, fall, winter	PRD, YRD
W. Yang et al. (2019b)	NAQPMS	PM <sub>2.5</sub>	Annual	BTH, NCP, Northeast, Northwest, Central China, YRD
X. Yang et al. (2019)	CMAQ	PM <sub>10</sub> , PM <sub>2.5</sub>	Annual	Northwest
Yao et al. (2014)	CAMx	ammonium, sulfate, nitrate	Winter	PRD
Yao et al. (2017)	WRF-Chem	EC, OC	Summer	YRD
Ye et al. (2019)	CMAQ	PM <sub>2.5</sub> , sulfate, nitrate, ammonium	Annual, spring, summer, fall, winter	BTH
Yin et al. (2017)	CAMx	PM <sub>10</sub>	Spring, summer, fall, winter	PRD
Yin et al. (2018)	CAMx	O <sub>3</sub> , NO <sub>2</sub> , SO <sub>2</sub> , PM <sub>10</sub> , PM <sub>2.5</sub>	Spring, fall	PRD
Ying et al. (2014)	CMAQ	PM <sub>2.5</sub> , nitrate, sulfate	Summer, winter	Entire China, BTH, PRD
Ying et al. (2018)	CMAQ	OC, EC, Na, Al, Si, Cl, K, Ca, Ti, Cr, Mn, Fe, Cu, Zn, As, Ba, Pb	Annual	Entire China
Yu et al. (2012)	WRF-Chem	O <sub>3</sub>	Spring	BTH, YRD
Yu et al. (2014)	WRF-Chem	O <sub>3</sub>	Summer	BTH
Yu et al. (2018)	WRF-Chem	PM <sub>1</sub>	Summer + fall	YRD
Zeren et al. (2019)	WRF-Chem	O <sub>3</sub> , NO <sub>2</sub>	Fall	PRD
Zhai et al. (2016)	CMAQ	PM <sub>2.5</sub>	Fall	BTH
Zhang et al. (2013)	CMAQ	O <sub>3</sub> , NO <sub>x</sub> , PM <sub>10</sub>	Fall	PRD
B. Zhang et al. (2015)	WRF-Chem	PM <sub>2.5</sub>	Winter	Northeast
L. Zhang et al. (2015a)	WRF-Chem	O <sub>3</sub>	Summer	YRD
L. Zhang et al. (2015b)	WRF-Chem	PM <sub>2.5</sub>	Winter	BTH
L. Zhang et al. (2016)	GEOS-Chem	PM <sub>2.5</sub>	Fall	BTH
Y. Zhang et al. (2016)	WRF-Chem/CMAQ	SO <sub>2</sub> , PM <sub>10</sub> , CO, NO, NO <sub>2</sub> , PM <sub>2.5</sub> , O <sub>3</sub>	Spring, summer, fall, winter	Entire China, PRD, Southeast
L. Zhang et al. (2017a)	WRF-Chem	O <sub>3</sub>	Summer	Entire China
L. Zhang et al. (2017b)	WRF-Chem	O <sub>3</sub>	Spring	YRD
Z. Zhang et al. (2017a)	WRF-Chem	PM <sub>2.5</sub>	Fall + winter	BTH
Z. Zhang et al. (2017b)	CMAQ	PM <sub>2.5</sub>	Winter	BTH
H. Zhang et al. (2018)	CAMx	PM <sub>2.5</sub> , sulfate, nitrate, ammonium, OM	Fall	BTH
L. Zhang et al. (2018)	WRF-Chem	PM <sub>2.5</sub> , CO, NO <sub>2</sub> , O <sub>3</sub> , SO <sub>2</sub> , sulfate, nitrate, ammonium	Winter	YRD
X. Zhang et al. (2018)	WRF-Chem	PM <sub>2.5</sub>	Annual	Entire China
Y. Zhang et al. (2018)	GEOS-Chem	OM	Annual	Northwest, BTH, YRD, Central China, Southwest, Northeast, Entire China
G. Zhang et al. (2019)	CMAQ	PM <sub>2.5</sub>	Winter	Entire China
H. Zhang et al. (2019a)	CAMx	PM <sub>2.5</sub> , ammonium, sulfate, nitrate, OM	Spring, summer, fall, winter	BTH
H. Zhang et al. (2019b)	CAMx	PM <sub>2.5</sub>	Summer, winter	BTH
J. Zhang et al. (2019)	WRF-Chem	HONO, OM	Summer	BTH

L. Zhang et al. (2019)	WRF-Chem	PM <sub>2.5</sub>	Fall	Sichuan Basin
Q. Zhang et al. (2019a)	GEOS-Chem	ammonia	Summer, winter	NCP, BTH
Q. Zhang et al. (2019b)	CMAQ	PM <sub>2.5</sub>	Winter	Southeast
S. Zhang et al. (2019)	CMAQ	SO <sub>2</sub> , NO <sub>2</sub> , PM <sub>2.5</sub>	Winter	BTH
Zhao et al. (2013)	CMAQ	NO <sub>2</sub> column, AOD, PM <sub>10</sub>	Spring, summer, fall, winter	Entire ChinaNCP+YRD+PRD
Zhao et al. (2015)	WRF-Chem	EC	Winter	Northwest
Y. Zhao et al. (2017a)	CMAQ	O <sub>3</sub>	Spring, summer, fall, winter	YRD
Y. Zhao et al. (2017b)	GEOS-Chem	ammonium, nitrate, ammonia	Annual	Entire China
Zhao et al. (2019)	CMAQ	EC	Spring, summer, fall, winter	YRD
Zheng et al. (2019)	CMAQ	O <sub>3</sub> (1-hr max), O <sub>3</sub> (8-hr max), NO <sub>2</sub> , PM <sub>2.5</sub>	Summer, winter	BTH
G. Zhou et al. (2017)	WRF-Chem	PM <sub>2.5</sub> , O <sub>3</sub> (8-hr max)	Annual	BTH + NCP + YRD+Central China+Southeast
Y. Zhou et al. (2017)	CMAQ	SO <sub>2</sub> , NO <sub>2</sub> , O <sub>3</sub> , PM <sub>2.5</sub>	Fall	YRD
Zhu et al. (2015)	GEOS-Chem	ammonia, ammonium	Spring, summer, fall	Entire China
Zhu et al. (2016)	GEOS-Chem	O <sub>3</sub>	Annual	BTH, Northwest, YRD, PRD, Sichuan Basin, Southwest, Northeast
Zhu et al. (2017)	WRF-Chem	PM <sub>10</sub> , O <sub>3</sub>	Summer, winter	PRD

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**Table S3: Definition of regions**

No.	Region	Provinces included
1	Beijing-Tianjin-Hebei (BTH)	Beijing, Tianjin, Hebei
2	Central China	Shanxi, Henan, Hubei, Hunan, Jiangxi
3	North China Plain (NCP)	Inner Mongolia, Shandong
4	Northeast	Liaoning, Heilongjiang, Jilin
5	Northwest	Xinjiang, Qinghai, Gansu, Ningxia, Shaanxi
6	Pearl River Delta (PRD)	Guangdong, Hong Kong, Macau
7	Sichuan Basin	Sichuan, Chongqing
8	Southeast	Fujian, Taiwan
9	Southwest	Tibet, Yunnan, Guizhou, Hainan, Guangxi
10	Yangtze River Delta (YRD)	Jiangsu, Zhejiang, Shanghai, Anhui

**Table S4: List of statistical metrics used in studies compiled in this work**

No.	Abbreviation	Metric	No. of studies used
1	R (R <sup>2</sup> )	Correlation coefficient (coefficient of determination)	221
2	NMB	Normalized mean bias	170
3	MB	Mean bias	132
4	RMSE	Root mean square error	118
5	NME	Normalized mean error	111
6	FB	Fractional bias	66
7	FE	Fractional error	62
8	IOA	Index of agreement	57
9	ME	Mean error	27
10	MNB	Mean normalized bias	15
11	MNE	Mean normalized error	10
12	FAC2	Fraction of predictions within a factor of two of the observations	9
13	NMBF	Normalized mean bias factor	2
14	Std. dev.	Standard deviation	2
15	Bias Factor	No definition given	1
16	CRMSE	Centered pattern root-mean-square	1
17	MAD	Mean absolute deviation	1

18	MR	Mean ratio of observed to modelled	1
19	MRE	Mean relative error	1
20	NMAEF	Normalized mean absolute error factor	1
21	NMSE	Normalized mean square error	1
22	PE	Percent error	1
23	RB	Relative bias	1
24	RSMB	No definition given	1
25	UPPA	Unpaired peak prediction accuracy	1

**Table S5: Full name of species listed in Figure 3**

Abbreviation	Full name
AOD	Aerosol optical depth
API	Air Pollution Index
EC	Elemental carbon
NO <sub>x</sub>	NO + NO <sub>2</sub>
NO <sub>y</sub>	Sum of total nitrogen species
OC	Organic carbon
OM	Organic matter
OVOCs	Oxygenated VOCs
O <sub>x</sub>	Ozone + NO <sub>2</sub>
PAN	Peroxyacetyl nitrate
PM <sub>1</sub>	Particulate matter with an aerodynamic diameter of less than 1 μm
PM <sub>10</sub>	Particulate matter with an aerodynamic diameter of less than 10 μm
PM <sub>2.5</sub>	Particulate matter with an aerodynamic diameter of less than 2.5 μm
PMC	Coarse mode particulate matter
TOR	Tropospheric ozone residual
VOC	Volatile organic compounds

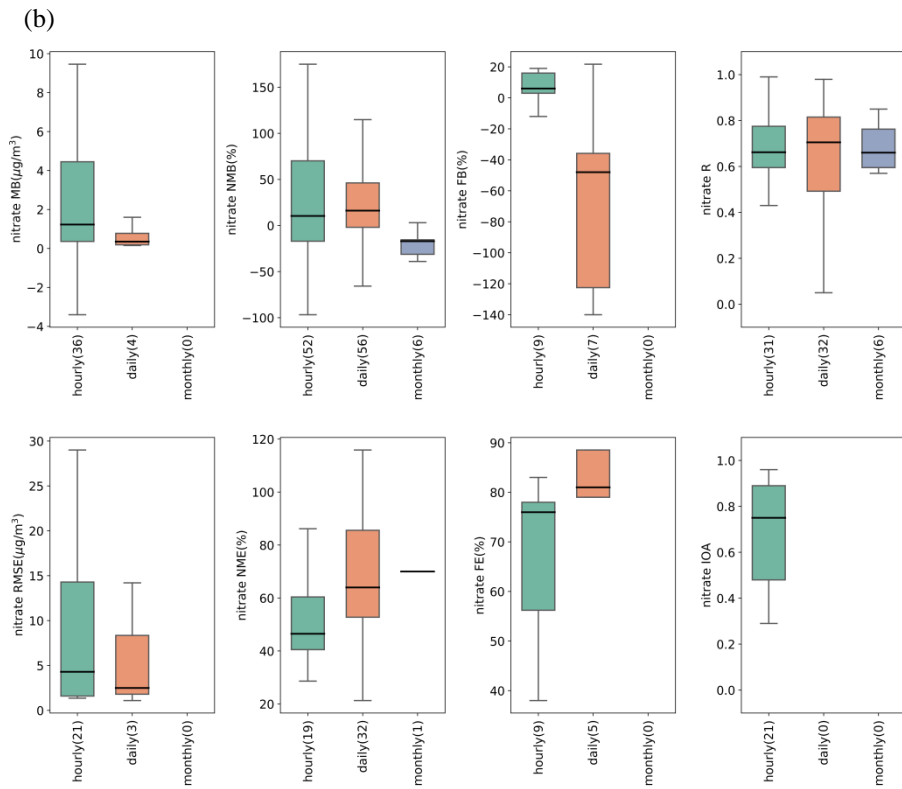
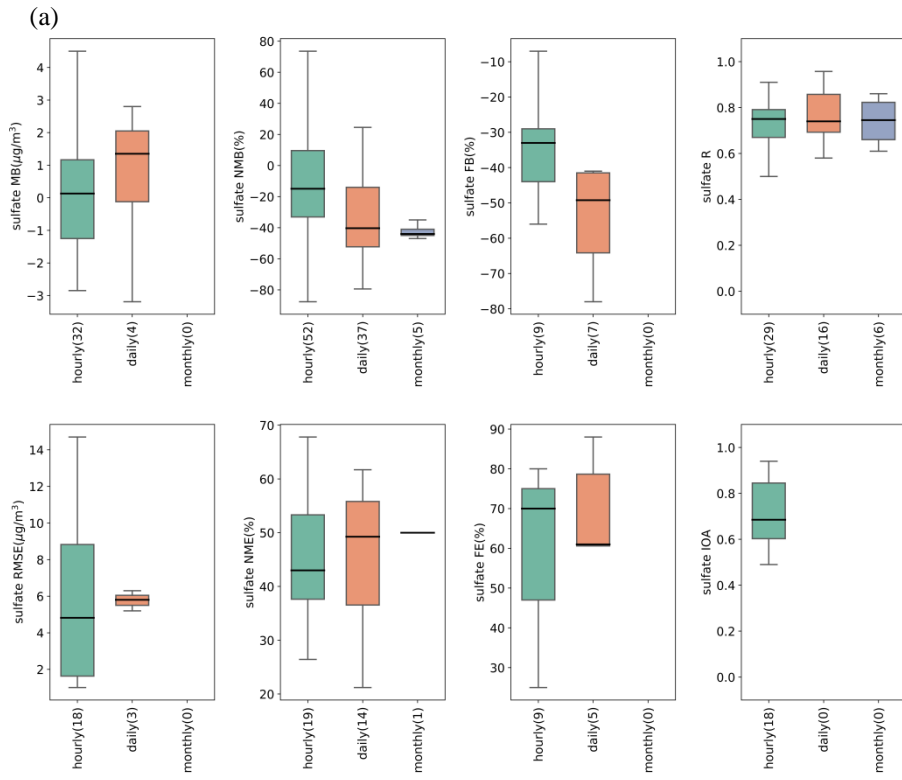
**Table S6: Quantile values of selected statistical metrics for total PM<sub>2.5</sub> and speciated components**

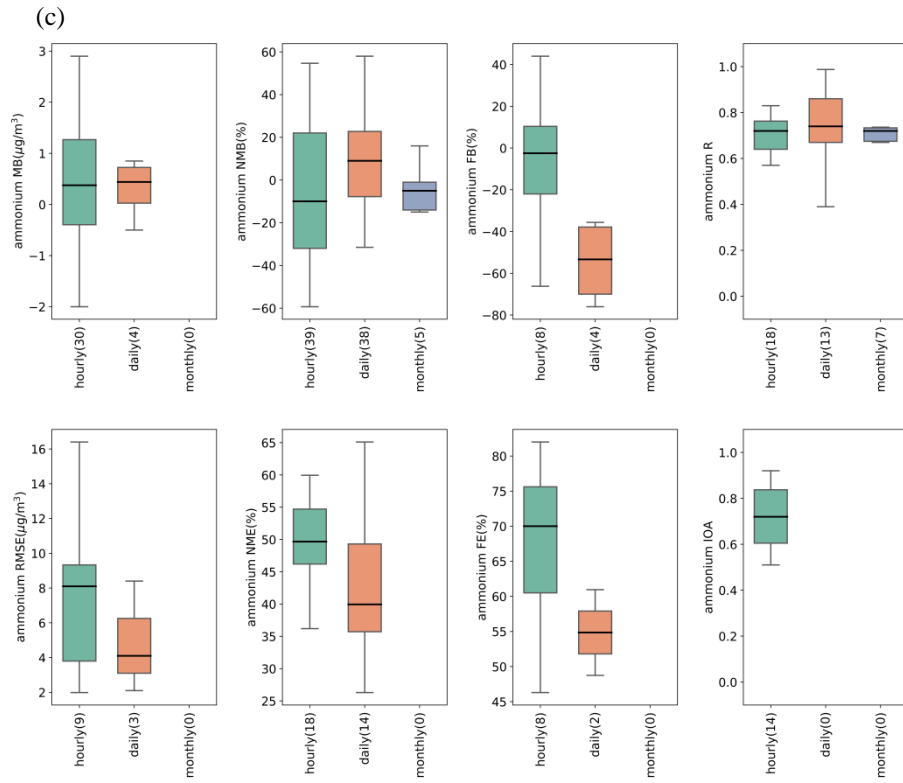
Pollutant	Metric	Unit	n	10%	25%	33%	50%	67%	75%	90%
PM <sub>2.5</sub>	R	-	761	0.87	0.8	0.77	0.70	0.61	0.58	0.46
PM <sub>2.5</sub>	IOA	-	124	0.95	0.92	0.85	0.76	0.72	0.69	0.62
PM <sub>2.5</sub>	MB	μg/m <sup>3</sup>	436	29.5	10.3	6.5	-2.5	-9.1	-13.1	-27.8
PM <sub>2.5</sub>	ME	μg/m <sup>3</sup>	179	96.9	43.0	36.5	30.1	23.3	20.5	13.2
PM <sub>2.5</sub>	NMB	%	600	26.0	8.4	2.0	-7.2	-13.14	-16.7	-28.3

PM <sub>2.5</sub>	NME	%	479	60.3	47.5	43.5	37.2	32.4	30	23.0
PM <sub>2.5</sub>	FB	%	460	31.2	13.0	6.5	-4.7	-14.1	-20.2	-35.0
PM <sub>2.5</sub>	FE	%	440	66.9	57.7	51.9	44.7	37	33	24
PM <sub>2.5</sub>	RMSE	µg/m <sup>3</sup>	332	104.1	61.3	50.4	36.9	28.5	25.1	16.0
sulfate	R	-	62	0.91	0.82	0.79	0.74	0.69	0.67	0.56
sulfate	IOA	-	18	0.93	0.85	0.83	0.68	0.61	0.6	0.52
sulfate	MB	µg/m <sup>3</sup>	40	2.48	1.14	0.9	0.13	-0.97	-2.27	-3.19
sulfate	ME	µg/m <sup>3</sup>	1	5.3	5.3	5.3	5.3	5.3	5.3	5.3
sulfate	NMB	%	100	17.9	0.0	-13.4	-30.0	-40.6	-46.4	-60.0
sulfate	NME	%	36	67.8	55.0	53.6	44.4	40.4	37.0	26.42
sulfate	FB	%	20	-7.0	-33.0	-33.0	-42.0	-50.0	-57.0	-71.31
sulfate	FE	%	14	80.0	76.0	75.0	64.7	60.6	47.0	25.0
sulfate	RMSE	µg/m <sup>3</sup>	24	26.5	8.6	7.85	4.9	1.75	1.6	1.42
nitrate	R	-	79	0.88	0.79	0.75	0.68	0.61	0.55	0.24
nitrate	IOA	-	21	0.95	0.89	0.87	0.75	0.53	0.48	0.35
nitrate	MB	µg/m <sup>3</sup>	44	5.7	3.4	2.3	0.9	0.2	-0.2	-0.7
nitrate	ME	µg/m <sup>3</sup>	1	9.7	9.7	9.7	9.7	9.7	9.7	9.7
nitrate	NMB	%	121	76.2	47.0	40.2	10.2	-8.7	-17.0	-64.0
nitrate	NME	%	53	96.8	79.4	71.2	60.4	47.0	45.0	36.0
nitrate	FB	%	20	19.0	6.0	3.0	-34.5	-74.0	-115.0	-130.0
nitrate	FE	%	14	88.5	81.0	79.4	76.0	59.1	58.0	51.0
nitrate	RMSE	µg/m <sup>3</sup>	27	26.7	14.3	12.1	4.1	1.6	1.6	1.4
ammonium	R	-	48	0.87	0.81	0.78	0.73	0.67	0.64	0.38
ammonium	IOA	-	14	0.9	0.86	0.77	0.71	0.65	0.59	0.53
ammonium	MB	µg/m <sup>3</sup>	38	2.9	0.9	0.7	0.3	-0.04	-0.4	-0.9
ammonium	ME	µg/m <sup>3</sup>	1	4.8	4.8	4.8	4.8	4.8	4.8	4.8
ammonium	NMB	%	88	34.9	21.5	13	0.1	-14	-27.4	-47.7
ammonium	NME	%	32	59.9	53.5	52	47	41	38.6	35.5
ammonium	FB	%	16	44.0	10.0	-1.0	-18.0	-34	-38.6	-68.0

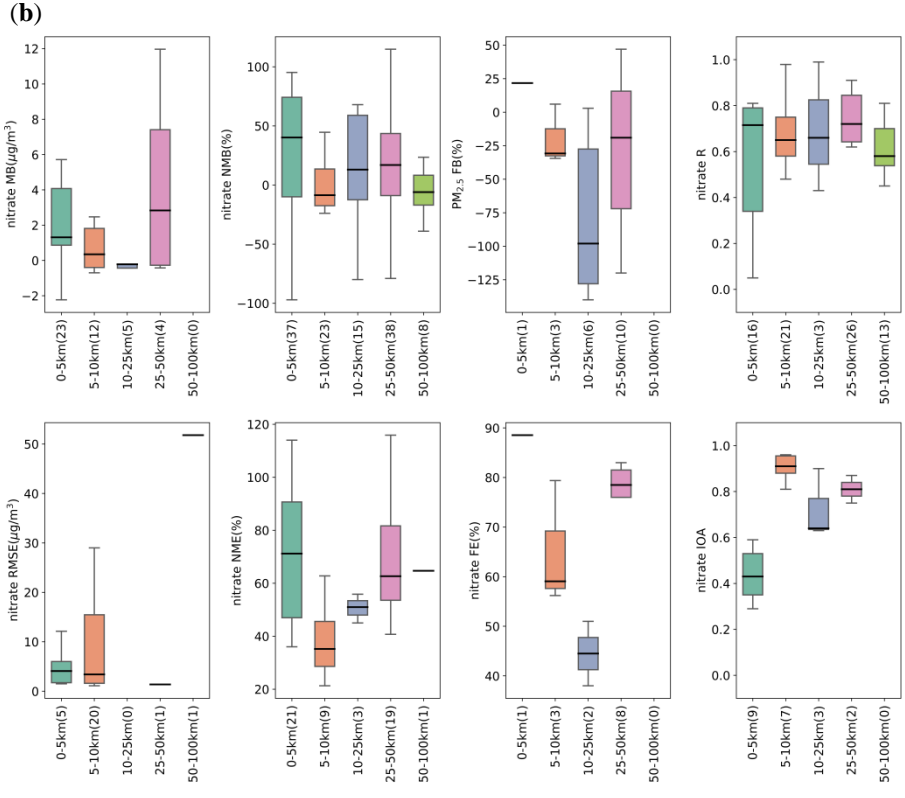
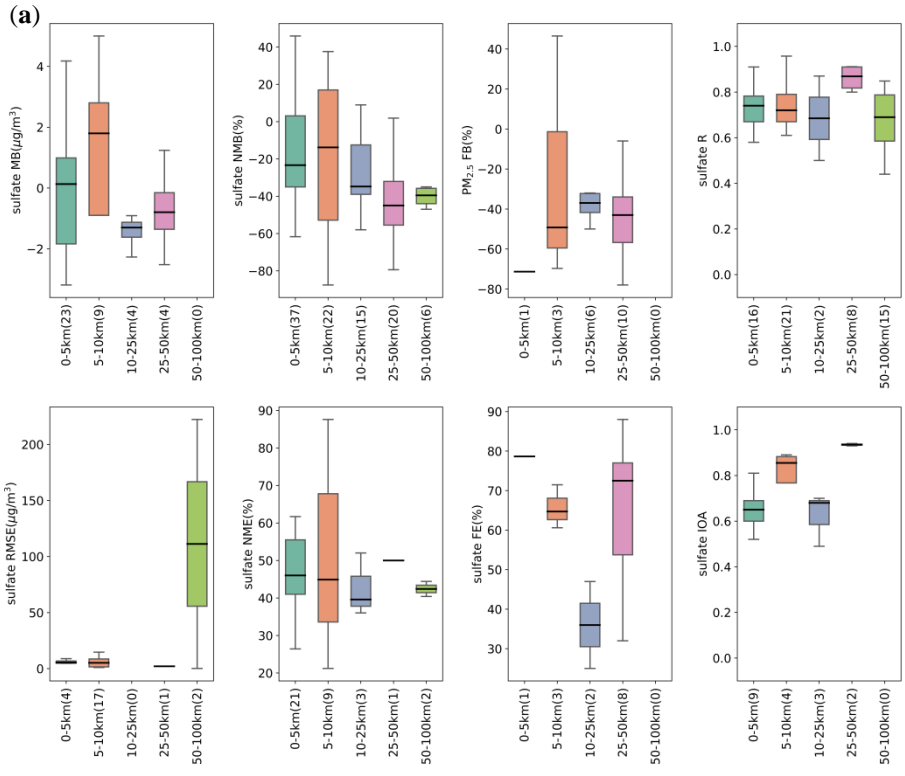


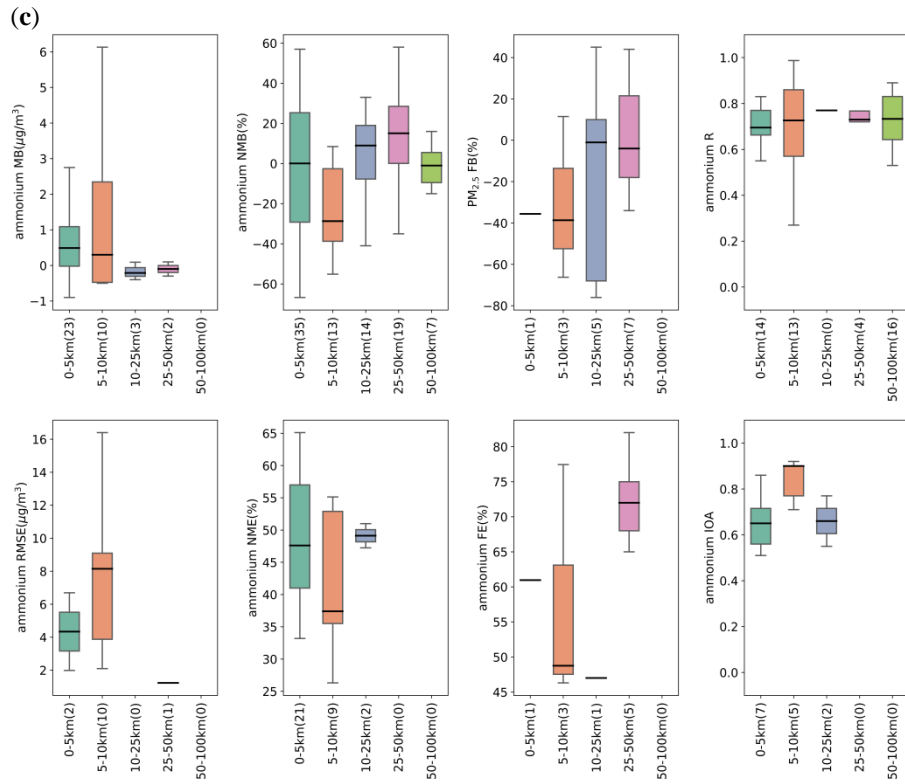
ammonium	FE	%	10	77.4	75.0	72.0	65.0	61.0	48.8	46.3
ammonium	RMSE	$\mu\text{g}/\text{m}^3$	13	16.3	8.4	8.2	6.7	3.8	3.5	2.0
OC	R	-	24	0.82	0.7	0.63	0.58	0.4	0.32	0.07
OC	IOA	-	5	0.86	0.79	0.79	0.63	0.62	0.62	0.54
OC	MB	$\mu\text{g}/\text{m}^3$	4	6.01	3.25	3.25	-1.55	-1.55	-3.51	-3.51
OC	NMB	%	38	8.49	-29	-38	-44.9	-52	-60	-68.6
OC	NME	%	14	68.6	55.7	47.2	45	39.4	33	31.3
OC	FB	%	9	27	7	7	-24	-41.6	-41.6	-59
OC	FE	%	9	62	53	53	46.8	39	39	33
OC	RMSE	$\mu\text{g}/\text{m}^3$	4	7.3	5.8	5.8	4.6	4.6	2.71	2.7
EC	R	-	51	0.8	0.7	0.65	0.55	0.48	0.41	0.37
EC	IOA	-	8	0.92	0.64	0.64	0.57	0.55	0.5	0.49
EC	MB	$\mu\text{g}/\text{m}^3$	25	2.64	1.02	0.71	-0.08	-1.85	-2.2	-3.4
EC	NMB	%	76	61.6	10.6	0	-16	-23.0	-29.2	-39.0
EC	NME	%	32	132.3	66.5	57.5	43.7	42.4	40.5	37
EC	FB	%	12	48	11	11	7.41	-52	-54	-55
EC	FE	%	10	56	52	48	43	42	34	29.1
EC	RMSE	$\mu\text{g}/\text{m}^3$	6	6.56	6.11	6.11	2.3	1.2	1.2	0.6
OM	R	-	22	0.82	0.74	0.7	0.64	0.58	0.57	0.48
OM	IOA	-	29	0.83	0.81	0.75	0.63	0.57	0.57	0.55
OM	MB	$\mu\text{g}/\text{m}^3$	49	5.1	0.07	-0.2	-1.3	-6.6	-7.67	-12.7
OM	NMB	%	35	14	1.2	-5.6	-39.1	-54.8	-59.6	-62.6
OM	NME	%	7	59.6	58	56.9	44.5	38.4	34.5	27.7
OM	FB	%	5	39	21.7	21.7	-40	-84	-84	-97
OM	FE	%	3	64.7	64.7	64.7	51.9	45	45	45
OM	RMSE	$\mu\text{g}/\text{m}^3$	34	23.5	21.4	18.4	13.8	8.9	8.8	6.9



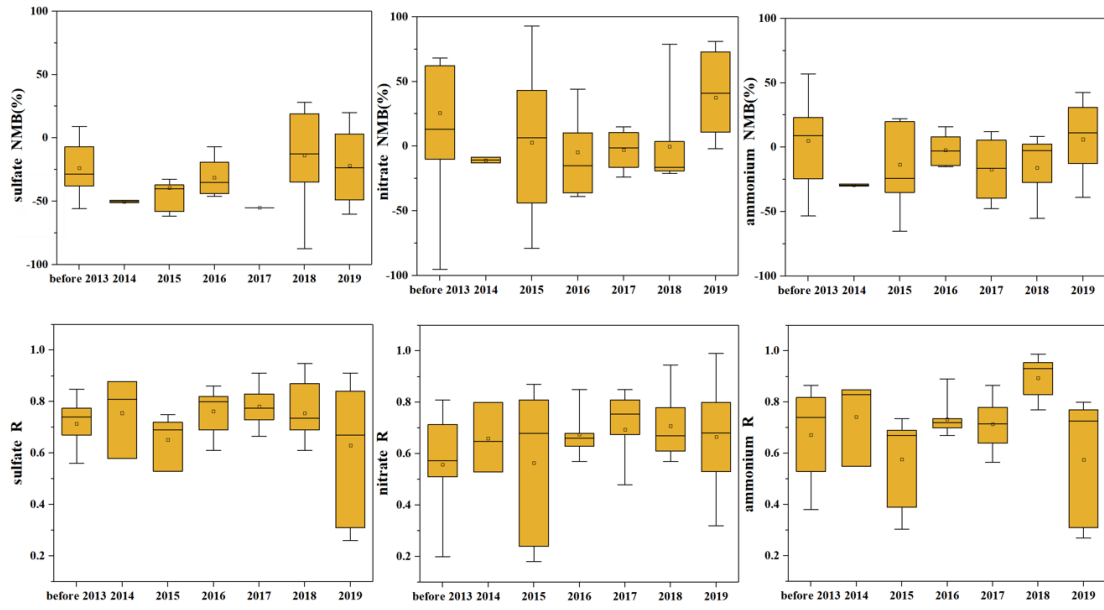


**Figure S1: Quantile distributions of MB, RMSE, NMB, NME, FB, FE, R and IOA of (a) sulfate, (b) nitrate, and (c) ammonium presented by temporal resolution for model validation**





**Figure S2: Quantile distributions of MB, RMSE, NMB, NME, FB, FE, R and IOA of (a) sulfate, (b) nitrate, and (c) ammonium presented by model grid resolution**



**Figure S3: Quantile distribution of R and NMB of sulfate, nitrate and ammonium presented by data published year**

**Table S7 List of model configurations collected from published studies (see full names below the table)**

Models	Emissions <sup>1</sup>	Gas phase chemistry <sup>2</sup>	Aerosol phase chemistry <sup>3</sup>	Boundary conditions <sup>4</sup>
CMAQ	MEIC	CB05	AERO3	Aircraft observation
CAMx	SOE	CB6	AERO4	CAMx default
WRF-Chem	EDGAR	CBIV	AERO4 + RADM	clean
NAQPMS	REAS	CBM-Z	AERO5	CMAQ default
GEOS-Chem	INTEX-B	CMAQ	AERO6	CMAQ modeling results
	MIX	GEOS-Chem default	CF+SOAP	Constant
	Self-developed	Modified but not specified	CMAQ default	FDDA
	Streets 2006 + REAS for NH3	modified CB05	CMAQ default + ISORROPIA + VBS	Forecast results
	REAS	modified SAPRC11	CMU_AQ + MOSAIC	GEOS-Chem
	MICS-Asia	MOZART	GEOS-Chem default	GEOS-Chem/CMAQ
	modified MEIC	Not specified	GOCART	MOZART
	modified INTEX-B	RACM	ISORROPIA	NALROM
	TRACE-P	RADM2	ISORROPIA + NAQPMS SOA	Not specified
	HTAP	SAPRC-07	ISORROPIA + RADM	WRF-Chem default
	MACCity	SAPRC-11	ISORROPIA + RADM + NAQPMS SOA	
	IIASA	SAPRC-99	ISORROPIA + RADM + VBS	
	Streets 2006		ISORROPIA + SOAP	
	modified Streets		ISORROPIA + VBS	
	RCP		ISORROPIA + CF	
			ISORROPIA + RADM + SOAP	
			ISORROPIA + SOAP	
			ISORROPIA+SOAP+CF	
			ISORROPIA+SOAP+RADM	

ISORROPIA+SORGAM

ISORROPIA+VBS

MADE+SORGAM

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<sup>1</sup>Emissions: MEIC - Multi-resolution Emission Inventory for China

SOE - Emission Inventory for China by School of Environment at Tsinghua University

EDGAR - Emissions Database for Global Atmospheric Research

REAS - Regional Emission inventory in Asia

INTEX-B - 2006 Asia Emission Inventory for the Intercontinental Chemical Transport Experiment

TRACE-P - Transport and Chemical Evolution over the Pacific

HTAP - Hemispheric Transport of Air Pollution global inventory

MACCity - MACC/CityZEN EU projects

IIASA - International Institute for Applied Systems Analysis

RCP - representative concentration pathway

<sup>2</sup>Gas phase chemistry

CB -Carbon Bond

CBIV - Carbon Bond-IV Mechanism

CBM-Z - Carbon Bond Mechanism version Z

SAPRC - Statewide Air Pollution Research Center

MOZART - Model for OZone and Related chemical Tracers

RACM - Regional Atmospheric Chemistry Mechanism

<sup>3</sup>Aerosol phase chemistry

AERO - aerosol mode

RADM - Regional Acid Deposition Model

VBS - volatility basis set

CMU\_AQ - Carnegie Mellon University aqueous-phase mechanism

MOSAIC - Model for Simulating Aerosol Interactions and Chemistry



GOCART - Goddard Chemistry Aerosol Radiation and Transport

NAQPMS - Nested Air Quality Prediction Model System

MADE - Modal Aerosol Dynamics Model for Europe

SORGAM - Secondary Organic Aerosol Model

<sup>4</sup>Boundary conditions

FDDA - four-dimensional data assimilation

NALROM - NOAA Aeronomy Lab Regional Oxidant Model

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