Multi-model estimates of premature human mortality due to intercontinental transport of air pollution – Supplemental Material

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Table S1 –Models that reported O_3 and $PM_{2.5}$ (mmrpm2p5) concentrations for TF-HTAP2, with type of O_3 (h – hourly, d– daily and m – monthly) and monthly $PM_{2.5}$ output with the function used by models to calculate $PM_{2.5}$ from species concentrations. (Data are available upon request from http://aerocom.met.no).

Model	Emission perturbation experiment	Institution	Contact	Model resolution (lonxlat)	O_3	$PM_{2.5}$	Reference
CAM-Chem	-20% regions	NCAR	Louisa Emmons	$2.5^0x1.9^0$	m		Tilmes et al. (2016)
CHASER_T42	-20% regions -20% sectors	NAGOYA,JAMSTEC,NIES	Kengo Sudo Takashi Sekiya	$2.8^0x2.8^0$	h	SO_4+OC+NO_3+NH_4+ BC+ Dust(fine)+SS(fine)	Sudo et al. (2002)
CHASER_T106	-20% regions	as above	as above	$1.1^0x1.1^0$	m	SO_4+OC+NO_3+NH_4+ BC+ Dust(fine)+SS(fine)	as above
#C-IFS	-20% regions	ECMWF	Johannes Flemming	$0.7^0x0.7^0$	m	SS1 + 0.5*SS2 + Dust1 + Dust2 + 0.7*(OM1 + OM2 + SO4)	Flemming et al. (2015)
EMEPrv48	-20% regions	Met No	Jan Eiof Jonson	$0.5^0x0.5^0$	m	SO_4+OA+NO_3+NH_4+Dust+BC+SS	Simpson et al. (2012)
GEOS5	-20% regions	NASA GSFC	Huisheng Bian, Mian Chin Xiaohua Pan	$1.3^0x1.0^0$	-	1.375* SO_4+OA+0.15*Dust+BC+SS	Rienecker et al. (2008) Colarco et al. (2010)
$GEOSCHEMA DJOINT	-20% regions -20% sectors	Univ.Col. Boulder	Daven Henze	$2.5^0x2.0^0$	m	1.33*(SO_4+NO_3+NH_4)+BCpi+BCpo +1.4*(1.16*OCpi+OCpo)+1.16*SOA+Dust1+0.38*Dust2+1.86SS	Henze et al. (2007)
GEOS-Chem	-20% regions	SNU	Rokjin Park	$2.5^0x2.0^0$	d	-	Bey et al. (2001a)
GFDL_AM3	-20% regions	NOAA	Meiyun Lin	$1.2^0x1.0^0$	h	-	Lin et al. (2012) Lin et al. (2017)
GOCART	-20% regions -20% sectors	NASA GSFC	Tom Kucsera	$1.3^0x1.0^0$	-	1.375*SO_4+OA+0.15*Dust+BC	Chin et al. (2002)
HadGEM2-ES	-20% regions -20% sectors	UK Met Office	Gerd Folberth	$2.5^0x3.75^0$	h	-	Collins et al. (2011) Jones et al. (2011)
OsloCTM3.v2	-20% regions -20% sectors	CICERO	Marianne Tronstad Lund	$2.8^0x2.8^0$	m	-	Søvde et al. (2012)
RAQMS	-20% regions	NOAA/NESDIS	Bradket Pierce Allen Lenzen	$1.0^0x1.0^0$	m	-	Pierce et al. (2007)
SPRINTARS	-20% regions -20% sectors	RIAM	Toshihiko Takemura	$1.1^0x1.1^0$	-	SO_4+OA+Dust+BC+SS	Watanabe et al. (2010) Takemura et al. (2005)

#The C-IFS SS1 and SS2, dust 1 and dust 2 refer to two modes of aerosol size distribution.

$The GEOSCHEMADJOINT pi and po of BC and OC refer to hydrophilic and hydrophobic components, and dust 1 and dust 2 refer to two modes of aerosol size distribution.

Table S2. Statistical model evaluation for the maximum 3-month average of daily 1-hour maximum ozone, comparing TOAR observations with individual model simulations and the ensemble average, in TF-HTAP2 regions (Figure. S2).

		Ensemble	CAMchem	CHASER_T42	CHASER_T106	C-IFS_v2	EMEP_rv48	GEOSCHEMA DJOINT	GEOS-Chem	GFDL_AM3	HadGEM2-ES	OsloCTM3.v2	RAQMS
NAM (1,417 sites)	NMB(%)	14.1%	21.9%	21.1%	30.8%	-8.9%	20.1%	31.6%	32.3%	25.1%	5.4%	-18.1%	-6.3%
	NME(%)	17.6%	22.7%	25.9%	32.3%	16.6%	24.9%	32.5%	33.5%	26.4%	13.8%	21.0%	12.5%
	R	0.52	0.63	0.38	0.44	0.29	0.42	0.51	0.47	0.49	0.6	0.35	0.46
EUR (1,887 sites)	NMB(%)	4.3%	9.0%	7.0%	21.3%	-23.0%	15.8%	14.9%	10.1%	14.0%	11.7%	-24.1%	-10.1%
	NME(%)	9.8%	12.5%	13.2%	22.7%	24.5%	17.8%	16.5%	13.3%	15.4%	17.7%	27.1%	15.1%
	R	0.55	0.55	0.41	0.48	0.28	0.47	0.48	0.49	0.61	0.31	0.37	0.48
SAS (4 sites)	NMB(%)	25.3%	37.9%	16.1%	29.1%	-2.4%	40.0%	42.0%	40.6%	45.0%	31.1%	-24.5%	23.9%
	NME(%)	25.3%	37.9%	16.1%	29.1%	15.6%	40.0%	42.0%	40.6%	45.0%	41.6%	24.5%	23.9%
	R	0.30	0.41	0.67	0.31	0.14	0.28	0.52	0.40	0.03	-0.29	-0.22	0.45
EAS (1,156 sites)	NMB(%)	5.2%	10.8%	1.2%	19.8%	-26.4%	-3.1%	24.5%	13.0%	18.7%	10.9%	4.0%	-16.5%
	NME(%)	13.2%	16.1%	16.5%	22.6%	28.3%	17.0%	26.1%	18.4%	19.9%	16.9%	14.8%	22.3%
	R	0.08	0.12	0.05	0.14	-0.15	-0.06	0.07	0.06	0.25	0.03	0.12	-0.09
MDE (13 sites)	NMB(%)	4.9%	20.8%	4.3%	7.9%	-30.5%	6.7%	21.2%	16.0%	0.1%	20.3%	10.4%	-22.9%
	NME(%)	12.2%	22.1%	14.1%	13.7%	30.5%	18.7%	22.0%	17.6%	15.0%	20.7%	16.9%	27.2%
	R	-0.09	-0.05	-0.49	-0.2	-0.09	-0.21	0.26	0.17	-0.1	0.54	0.18	-0.21
RBU (4 sites)	NMB(%)	-11.2%	-12.2%	-9.7%	-6.9%	-27.7%	5.4%	2.4%	0.1%	1.4%	-23.1%	-35.3%	-17.9%
	NME(%)	11.2%	12.2%	14.3%	7.3%	27.7%	6.4%	2.4%	1.0%	9.1%	23.1%	35.3%	17.9%
	R	0.98	1.00	0.71	0.97	0.26	0.94	1.00	1.00	0.92	0.97	0.67	0.93
World (4,655 sites)	NMB(%)	7.3%	13.1%	9.2%	23.0%	-19.4%	11.7%	22.5%	17.6%	19.0%	9.5%	-14.9%	-10.8%
	NME(%)	13.2%	16.6%	18.0%	25.3%	23.0%	19.8%	23.9%	20.8%	20.4%	16.5%	21.9%	16.4%
	R	0.53	0.56	0.36	0.47	0.24	0.30	0.51	0.45	0.55	0.48	0.47	0.38

Table S3. Statistical model evaluation for the annual average $PM_{2.5}$, comparing GBD2013 observations with individual model simulations and the ensemble average in each TF-HTAP2 region (Figure. S2).

		Ensemble	CHASER	CHASER_t106	C-IFS_v2	EMEP_rv48	GEOSCHEMA DJOINT	GEOS5	GOCARTv5	SPRINTARS
NAM (757 sites)	NMB(%)	-10.5%	7.4%	13.9%	-28.1%	-10.1%	11.6%	-7.5%	-24.9%	-46.6%
	NME(%)	27.6%	39.2%	39.5%	45.8%	29.0%	48.5%	30.2%	35.5%	47.8%
	R	0.50	0.42	0.43	0.13	0.56	0.45	0.36	0.44	0.47
EUR (1,580 sites)	NMB(%)	-36.0%	-27.6%	-29.6%	-52.3%	-45.6%	31.9%	-34.0%	-55.1%	-76.0%
	NME(%)	39.7%	35.5%	37.2%	58.6%	47.3%	56.4%	41.1%	56.8%	76.0%
	R	0.73	0.49	0.46	0.47	0.55	0.25	0.65	0.67	0.64
SAS (189 sites)	NMB(%)	19.4%	32.3%	49.7%	8.6%	26.1%	39.5%	36.6%	-2.5%	-35.0%
	NME(%)	40.4%	48.8%	61.4%	39.5%	48.1%	55.5%	54.6%	33.6%	50.2%
	R	0.60	0.55	0.57	0.49	0.52	0.60	0.45	0.56	-0.09
EAS (390 sites)	NMB(%)	-10.9%	2.6%	21.0%	-50.4%	-12.1%	29.5%	-9.1%	-21.8%	-46.5%
	NME(%)	28.7%	31.7%	40.5%	51.8%	37.2%	59.9%	35.0%	32.0%	49.9%
	R	0.65	0.57	0.56	0.61	0.63	0.56	0.61	0.63	0.48
MDE (29 sites)	NMB(%)	-11.1%	-30.2%	-42.6%	22.8%	31.5%	-52.6%	12.3%	20.8%	-50.5%
	NME(%)	21.2%	37.9%	44.4%	34.1%	46.1%	52.6%	22.8%	27.6%	50.5%
	R	0.84	0.33	0.74	0.81	0.43	0.54	0.91	0.91	0.67
RBU (2 sites)	NMB(%)	-49.7%	-42.7%	-37.4%	-58.8%	-64.6%	-19.8%	-45.4%	-55.0%	-74.1%
	NME(%)	49.7%	42.7%	37.4%	58.8%	64.6%	38.2%	45.4%	55.0%	74.1%
	R	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
World (3,157 sites)	NMB(%)	-23.1%	-12.7%	-7.4%	-39.7%	-26.3%	20.3%	-18.7%	-39.4%	-60.9%
	NME(%)	35.4%	37.4%	40.0%	52.2%	41.8%	55.1%	38.6%	46.6%	62.9%
	R	0.77	0.71	0.71	0.66	0.71	0.65	0.74	0.77	0.63

Table S4 - Regional and global population (for age 25 and older) and average cause-specific baseline mortality rates (also for age 25 and older): chronic respiratory mortality (RESP), ischemic heart disease (IHD), cerebrovascular disease (STROKE), chronic obstructive pulmonary disease (COPD) and lung cancer (LC).

Regions	Population (million people)	Mortality (deaths per year per 1,000 people).				
		RESP	IHD	COPD	STROKE	LC
NAM	231.7	0.88	2.71	0.73	0.84	0.80
EUU	433.3	0.72	2.84	0.53	1.77	0.70
SAS	730.9	1.73	1.68	1.33	0.94	0.14
EAS	1,047.3	1.18	1.18	1.05	2.07	0.63
MDE	102.4	0.34	2.11	0.16	1.05	0.13
RBU	194.4	0.54	6.80	0.42	3.64	0.47
World	3,838.8	0.97	1.86	0.76	1.57	0.41

Sources: Population - Oak Ridge National Laboratory's Landscan 2011 Global Population Dataset (Bright et al. 2012). Baseline mortality rates - Cause-specific baseline mortality rates for 187 countries (IHME, 2013)

Table S5 – Difference in global population-weighted anthropogenic O_3 concentrations (ppb) for 20% emission reduction scenarios relative to the baseline for the year 2010. O_3 is seasonal average of 1-hr. daily maximum O_3 for consecutive 6 months, a metric commonly used in health impact evaluations. All numbers are rounded to the nearest hundredth.

Models		20% emission reduction scenarios									
	BASE	GLO	NAM	EUR	SAS	EAS	MDE	RBU	PIN	TRN	RES
CAM-Chem	56.49	-2.29	-0.10	-0.05	-0.58	-0.23	-0.02	0.06	---	---	---
CHASER_T42	56.27	-3.64	-0.26	-0.22	-1.06	-1.04	-0.11	-0.08	-1.51	-1.35	-0.53
CHASER_T106	56.38	-3.30	-0.23	-0.19	-1.03	-0.91	---	---	---	---	---
C-IFS	38.73	-1.95	-0.11	-0.04	-0.75	-0.28	---	---	---	---	---
EMEPrv48	59.41	-3.13	-0.24	-0.18	-0.93	-0.77	-0.09	-0.13	---	---	---
GEOSCHEMADJOINT	58.97	-2.36	-0.18	-0.08	-0.69	-0.41	-0.09	-0.03	-0.83	-0.92	-0.46
GEOS-Chem	57.59	-2.45	-0.21	---	---	-0.62	---	---	---	---	---
GFDL_AM3	63.75	-3.15	-0.22	-0.20	---	-0.49	---	---	---	---	---
HadGEM2-ES	58.03	-3.18	-0.23	-0.20	-1.30	-0.51	-0.07	-0.09	-1.02	-1.29	-0.81
OsloCTM3.v2	38.95	-2.79	-0.16	-0.12	-0.87	-0.63	-0.14	-0.03	-1.09	-0.97	-0.47
RAQMS	46.62	---	---	---	---	-0.45	---	---	---	---	---
Multi-model mean	53.74±8.03	-2.82±0.53	-0.19±0.07	-0.14±0.07	-0.90±0.22	-0.58±0.25	-0.09±0.04	-0.05±0.06	-1.11±0.25	-1.13±0.19	-0.57±0.14

Table S6 – Difference in global population-weighted anthropogenic $PM_{2.5}$ concentrations ($\mu g/m^3$) for 20% emission reduction scenarios relative to the baseline for the year 2010. $PM_{2.5}$ is the annual average. All numbers are rounded to the nearest hundredth.

Models	BASE	20% emission reduction scenarios									
		GLO	NAM	EUR	SAS	EAS	MDE	RBU	PIN	TRN	RES
CHASER_T42	27.02	-4.09	-0.12	-0.18	-1.31	-1.77	-0.12	-0.05	-1.94	-0.47	-1.28
CHASER_T106	30.49	-4.64	-0.11	-0.18	-1.48	-2.00	---	---	---	---	---
C-IFS	23.67	-1.42	-0.03	-0.03	-0.47	-0.56	---	---	---	---	---
EMEPrv48	26.55	-4.23	-0.08	-0.14	-1.30	-1.54	-0.08	-0.07	---	---	---
GEOS5	30.85	-3.64	-0.05	-0.08	-1.39	-1.42	-0.05	-0.03	---	---	---
GEOSCHEMADJOINT	30.36	-6.02	-0.15	-0.34	-2.05	-2.79	-0.12	-0.09	-2.07	-0.99	-1.54
GOCART	24.42	-2.34	-0.04	-0.07	-0.81	-0.96	-0.05	-0.03	-1.06	-0.10	-1.18
SPRINTARS	14.50	-1.51	-0.03	-0.06	-0.45	-0.59	-0.04	-0.01	-0.76	-0.06	-0.68
Multi-model mean	25.98±5.05	-3.49±1.51	-0.08±0.04	-0.13±0.09	-1.16±0.51	-1.45±0.71	-0.08±0.03	-0.05±0.03	-1.46±0.56	-0.40±0.37	-1.17±0.31

Table S7 – Global O_3-related respiratory mortality for the year 2010 baseline, showing the deterministic mean. All numbers are rounded to three significant figures or the nearest 100 deaths.

Models	Receptors						
	World	NAM	EUR	SAS	EAS	MDE	RBU
CAM-Chem	396,000	22,600	16,600	167,000	168,000	3,700	3,400
CHASER_ T42	355,000	23,200	24,000	150,000	125,000	5,700	5,200
CHASER_ T106	394,000	22,500	20,300	157,000	172,000	3,600	4,400
C-IFS	96,700	6,000	1,400	64,400	18,700	800	200
EMEPrv48	418,000	15,400	17,600	195,000	146,000	3,300	5,200
GEOSCHEMADJOINT	391,000	22,400	17,700	178,000	132,000	5,000	4,900
GEOS-Chem	381,000	22,600	15,200	178,000	130,000	4,500	4,400
GFDL_AM3	494,000	22,200	23,400	224,000	170,000	3,800	5,000
HadGEM2-ES	390,000	14,200	19,700	211,000	108,000	4,700	2,500
OsloCTM3.v2	73,900	3,200	2,300	36,800	23,600	2,300	100
RAQMS	202,000	5,700	5,500	118,900	56,300	1,200	1,400
Multi-model mean	326,000±131,000	16,400±7,600	14,900±7,700	153,000±55,700	114,000 ±53,700	3,500±1,500	3,300±1,900

Table S8 – Global $PM_{2.5}$-related mortality (IHD+Stroke+COPD+LC) for the year 2010 baseline, showing the deterministic mean. All numbers are rounded to three significant figures or the nearest 100 deaths.

Models	Receptors						
	World	NAM	EUR	SAS	EAS	MDE	RBU
CHASER_T42	3,070,000	98,700	230,000	797,000	1,320,000	67,000	158,000
CHASER_T106	3,270,000	109,000	229,000	845,000	1,400,000	63,700	157,000
C-IFS	2,420,000	16,800	144,000	713,000	781,000	106,000	200,000
EMEPrv48	2,780,000	80,600	150,000	778,000	1,170,000	100,000	128,000
GEOS5	3,190,000	67,600	213,000	825,000	1,220,000	101,000	244,000
GEOSCHEMADJOINT	3,230,000	114,000	381,000	797,000	1,430,000	41,000	281,000
GOCART	2,710,000	39,400	127,000	718,000	1,120,000	106,000	201,000
SPRINTARS	1,720,000	27,400	25,600	477,000	812,000	59,000	9,000
Multi-model mean	2,840,000±494,000	77,400±35,300	180,000±96,700	743,000±110,000	1,190,000±231,000	75,000±24,000	172,000±77,100

Table S9–Global avoided O_3-related respiratory mortality in 20% emission reduction scenarios for the year 2010, showing the deterministic mean. All numbers are rounded to three significant figures or the nearest 100 deaths.

Models	20% emission reduction scenarios									
	GLO	NAM	EUR	SAS	EAS	MDE	RBU	PIN	TRN	RES
CAM-Chem	34,000	800	0	12,400	3,600	-700	-1,300	---	---	---
CHASER_ T42	64,900	4,000	2,800	23,800	22,000	900	1,100	27,800	23,400	9,600
CHASER_ T106	58,700	3,500	2,500	23,000	19,300	---	---	---	---	---
C-IFS	32,100	1,600	400	16,400	5,200	---	---	---	---	---
EMEPrv48	52,600	3,500	2,300	20,400	14,200	1,200	2,100	---	---	---
GEOSCHEMADJ OINT	37,600	2,600	900	15,100	7,800	1,000	500	13,200	14,400	8,500
GEOS-Chem	40,600	3,100	---	---	12,100	---	---	---	---	---
GFDL_AM3	50,300	3,200	2,600	---	9,200	---	---	---	---	---
HadGEM2-ES	54,700	3,300	2,600	28,600	9,700	1,100	1,200	17,000	21,002	15,100
OsloCTM3.v2	46,700	2,200	1,400	19,100	12,100	1,600	400	18,600	16,000	8,300
RAQMS	---	---	---	---	8,600	---	---	---	---	---
Multi-model mean	47,200±10,400	2,800±900	1,700±1,000	19,800±4,900	11,200±5,300	800±700	600±1,000	19,200±5,300	18,800±3,600	10,400±2,800

Table S10 –Global avoided $PM_{2.5}$-related mortality (IHD+Stroke+COPD+LC) in 20% emission reduction scenarios for the year 2010, showing the deterministic mean. All numbers are rounded to three significant figures or the nearest 100 deaths.

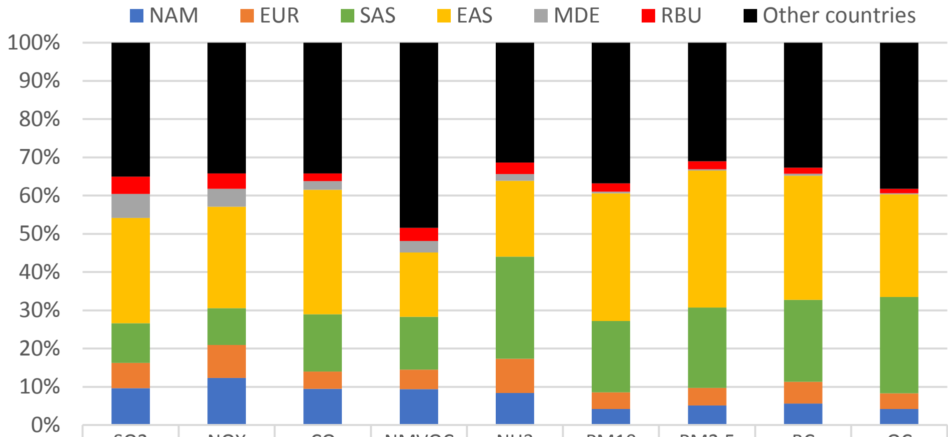
Models	20% emission reduction scenarios									
	GLO	NAM	EUR	SAS	EAS	MDE	RBU	PIN	TRN	RES
CHASER_T42	375,000	27,100	57,500	57,800	116,000	11,500	25,800	179,000	44,000	86,500
CHASER_T106	375,000	26,200	60,500	54,900	111,000	---	---	---	---	---
C-IFS	172,000	5,900	8,100	27,500	86,300	---	---	---	---	---
EMEPrv48	375,000	21,200	55,900	57,800	113,000	3,500	33,400	---	---	---
GEOS5	266,000	18,000	27,100	52,900	94,700	2,300	14,000	---	---	---
GEOSCHEMADJOINT	435,000	29,000	71,000	84,300	126,000	16,100	39,000	140,000	66,000	78,900
GOCART	231,000	15,200	19,600	46,000	89,600	2,500	15,000	114,000	10,300	98,100
SPRINTARS	225,000	10,900	13,200	50,000	95,600	4,500	5,600	122,000	7,800	89,500
Multi-model mean	307,000±88,500	20,600±7,700	40,500±23,000	57,000±14,800	106,000±13,400	6,700±5,200	22,100±11,700	139,000±25,100	32,000±24,200	88,200±6,900

Table S11 O_3-related deaths in regional reduction scenarios, including the deterministic means, results from the Monte Carlo analysis, and analysis of uncertainty showing the standard deviation and coefficient of variation (%) due to uncertainties from the spread of individual model results, the relative risks (RRs), and baseline mortality rates.

		Spread of model			**RRs**			**Baseline rates**			**Monte-Carlo analysis**		
source	Receptor	mean	stdev	CV	mean	stdev	CV	mean	stdev	CV	mean	2.5%	97.5%
NAM	**NAM**	**1,516**	**699**	**46%**	**1,516**	**510**	**34%**	**1,516**	**154**	**10%**	**1,529**	**-169**	**4,037**
	ERU	325	98	30%	325	108	33%	325	38	12%	327	-11	-797
	SAS	165	701	425%	165	55	34%	165	27	17%	172	-246	-685
	EAS	509	262	52%	509	170	33%	509	45	9%	527	-910	2,209
	MDE	32	10	31%	32	11	33%	32	6	18%	33	2	82
	RBU	66	20	31%	66	22	33%	66	8	12%	66	-2	168
EUR	NAM	61	36	58%	61	20	33%	61	6	10%	63	-81	239
	ERU	**919**	**727**	**79%**	**919**	**308**	**34%**	**919**	**111**	**12%**	**929**	**-73**	**2,440**
	SAS	-68	728	1065%	-68	-23	33%	-68	-10	14%	-80	-875	668
	EAS	471	309	66%	471	157	33%	471	40	9%	492	-1,052	2,260
	MDE	45	11	25%	45	15	33%	45	8	18%	45	6	107
	RBU	107	31	29%	107	36	33%	107	13	12%	108	7	253
SAS	NAM	36	18	49%	36	12	33%	36	4	10%	37	-39	133
	ERU	50	28	56%	50	17	33%	50	6	12%	51	-31	157
	SAS	**18,864**	**5,202**	**28%**	**18,864**	**6,378**	**34%**	**18,864**	**2,968**	**16%**	**19,013**	**4,000**	**42,201**
	EAS	408	215	53%	408	136	33%	408	34	8%	416	-339	1,373
	MDE	15	6	39%	15	5	33%	15	3	19%	15	0	41
	RBU	13	9	68%	13	4	33%	13	2	12%	13	-7	40
EAS	NAM	228	121	53%	228	76	33%	228	23	10%	230	-51	629
	ERU	311	163	52%	311	104	33%	311	36	12%	314	-54	848
	SAS	423	828	196%	423	141	33%	423	68	16%	449	-1,249	2,381
	EAS	**9,609**	**5,254**	**55%**	**9,609**	**3,241**	**34%**	**9,609**	**813**	**8%**	**9,696**	**-2,015**	**26,364**
	MDE	33	15	45%	33	11	33%	33	6	18%	34	-3	95
	RBU	84	38	46%	84	28	33%	84	10	12%	84	-10	225
MDE	NAM	34	19	56%	34	11	33%	34	3	10%	34	-33	121
	ERU	55	17	31%	55	18	33%	55	7	13%	57	-45	187
	SAS	304	845	278%	304	102	33%	304	50	16%	310	-89	911
	EAS	158	70	45%	158	53	33%	158	14	9%	160	-117	520
	MDE	**172**	**97**	**57%**	**172**	**58**	**34%**	**172**	**31**	**18%**	**176**	**-6**	**479**
	RBU	30	4	13%	30	10	33%	30	4	13%	30	1	74
RBU	NAM	41	34	82%	41	14	33%	41	4	10%	42	-60	166
	ERU	152	69	46%	152	51	33%	152	19	12%	154	-45	440
	SAS	-178	850	478%	-178	-59	33%	-178	-28	16%	-199	-1,707	1,175
	EAS	407	332	82%	407	136	33%	407	35	9%	420	-622	1,660
	MDE	16	12	73%	16	5	33%	16	3	17%	17	-12	56
	RBU	**139**	**129**	**93%**	**139**	**47**	**34%**	**139**	**17**	**12%**	**141**	**-63**	**422**

Table S12 $PM_{2.5}$-related deaths in regional reduction scenarios, including the deterministic means, results from the Monte Carlo analysis, and analysis of uncertainty showing the standard deviation and coefficient of variation (%) due to uncertainties from the spread of individual model results, the relative risks (RRs), and baseline mortality rates.

		Spread of model			**RRs**			**Baseline Mortaltiy**			**Monte-Carlo analysis**		
source	Receptor	mean	stdev	Cv	mean	stdev	CV	mean	stdev	CV	mean	2.5%	97.5%
NAM	**NAM**	**17,686**	**7,015**	**40%**	**17,686**	**3,071**	**17%**	**17,686**	**1,819**	**10%**	**17,988**	**630**	**28,310**
	ERU	629	711	113%	629	68	11%	629	60	9%	640	82	1,076
	SAS	-11	193	1682%	-11	5	46%	-11	-1	6%	11	-207	82
	EAS	214	250	117%	214	-2	1%	214	21	10%	196	-296	365
	MDE	9	52	579%	9	2	21%	9	1	16%	8	-5	28
	RBU	298	387	130%	298	32	11%	298	16	5%	250	89	420
EUR	NAM	62	34	55%	62	18	30%	62	6	10%	62	6	108
	ERU	**31,072**	**19,747**	**64%**	**31,072**	**4,560**	**15%**	**31,072**	**2,785**	**9%**	**31,924**	**4,521**	**53,853**
	SAS	123	140	113%	123	19	15%	123	22	18%	117	-57	188
	EAS	412	182	44%	412	20	5%	412	40	10%	389	-23	550
	MDE	537	448	83%	537	-16	3%	537	68	13%	401	27	1,363
	RBU	5,826	3,940	68%	5,826	476	8%	5,826	317	5%	5,743	681	8,033
SAS	NAM	46	65	142%	46	15	32%	46	5	10%	46	-14	88
	ERU	109	111	102%	109	2	2%	109	10	10%	113	14	196
	SAS	**50,435**	**14,936**	**30%**	**50,435**	**5,748**	**11%**	**50,435**	**7,484**	**15%**	**47,923**	**30,035**	**68,484**
	EAS	1,415	1,196	85%	1,415	147	10%	1,415	124	9%	1,394	-71	2,045
	MDE	58	78	135%	58	9	15%	58	11	20%	38	2	148
	RBU	50	95	190%	50	-8	15%	50	2	5%	42	8	108
EAS	NAM	338	179	53%	338	93	28%	338	35	10%	335	35	505
	ERU	395	324	82%	395	46	12%	395	37	9%	394	24	694
	SAS	903	870	96%	903	152	17%	903	136	15%	897	589	1,355
	EAS	**98,495**	**13,602**	**14%**	**98,495**	**6,963**	**7%**	**98,495**	**8,770**	**9%**	**91,114**	**436**	**128,649**
	MDE	11	28	260%	11	-1	7%	11	1	12%	5	-1	25
	RBU	813	534	66%	813	135	17%	813	46	6%	803	14	1,298
MDE	NAM	36	24	66%	36	12	34%	36	4	10%	34	-1	57
	ERU	481	360	75%	481	6	1%	481	48	10%	419	93	854
	SAS	1,400	709	51%	1,400	295	21%	1,400	234	17%	1,346	744	2,371
	EAS	169	646	383%	169	-10	6%	169	16	10%	177	-612	455
	MDE	**2,538**	**2,800**	**110%**	**2,538**	**22**	**1%**	**2,538**	**336**	**13%**	**1,599**	**238**	**4,535**
	RBU	813	842	104%	813	53	6%	813	53	7%	644	31	1,605
RBU	NAM	46	39	86%	46	8	17%	46	5	10%	41	12	64
	ERU	2,196	1,099	50%	2,196	241	11%	2,196	174	8%	2,204	299	3,695
	SAS	13	507	3974%	13	31	247%	13	8	66%	93	-216	192
	EAS	859	376	44%	859	61	7%	859	82	10%	814	334	1,086
	MDE	106	111	104%	106	1	1%	106	13	12%	75	9	222
	RBU	**18,001**	**10,178**	**57%**	**18,001**	**2,625**	**15%**	**18,001**	**985**	**5%**	**17,640**	**386**	**25,674**



	SO2	NOX	CO	NMVOC	NH3	PM10	PM2.5	BC	OC
Other countries	37	39	187	71	15	19	11	2	5
RBU	5	5	11	5	1	1	1	0	0
MDE	7	5	12	4	1	0	0	0	0
EAS	29	30	177	25	10	17	12	2	3
SAS	11	11	82	20	13	9	7	1	3
EUR	7	10	24	8	4	2	2	0	1
NAM	10	14	52	14	4	2	2	0	1

	BC	CO	NH3	NMVOC	NOx	OC	PM10	PM2.5	SO2
AGRICULTURE	0	0	42	0	0	0	0	0	0
SHIPS	0	1	0	1	14	0	1	1	8
AIR	0	1	0	0	2	0	0	0	0
RESIDENTIAL	3	239	5	43	7	10	22	17	8
TRANSPORT	1	160	0	35	42	1	3	3	2
INDUSTRY	1	135	1	67	22	2	18	10	41
ENERGY	0	9	0	1	28	0	6	3	45

Figure S1. Regional (upper panel) and sectoral (lower panel) percent of total anthropogenic emissions of gaseous pollutants and particulate matter for the year 2010. Global absolute emissions are reported on bottom table in Tg species per year (Adapted from Janssens-Maenhout et al (2015)).

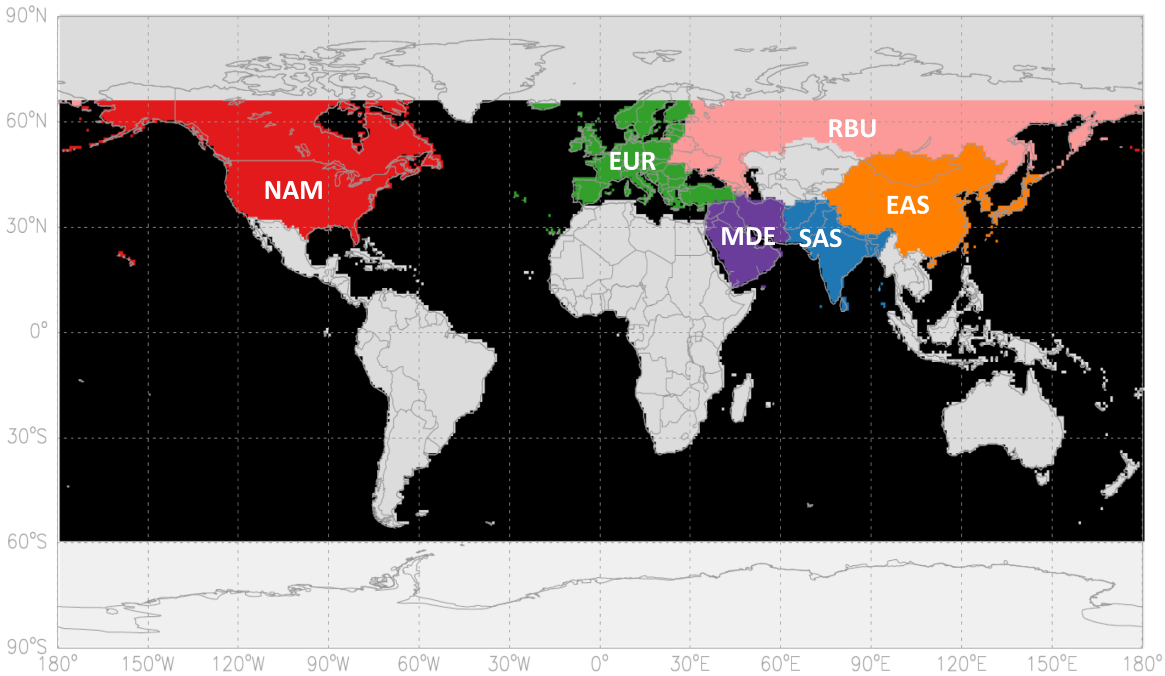


Figure S2. Six priority regions defined by TF-HTAP2 – NAM: North America, EUR: Europe, EAS: East Asia, SAS: South Asia, RBU; Russia/Belarus/Ukraine and MDE: Middle East.

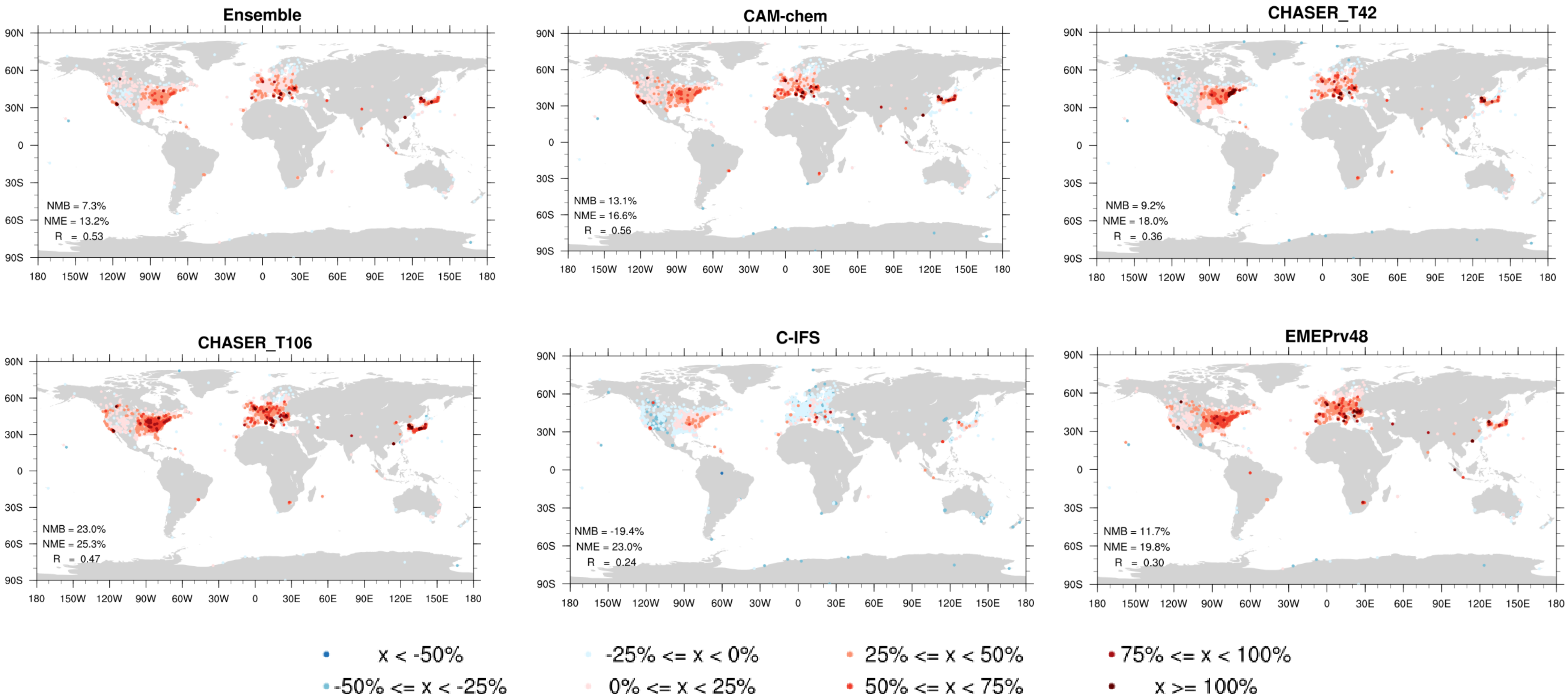


Figure S3. Spatial distributions of model performance for the maximum 3-month average of daily 1-hour maximum O_3 comparing TOAR observations with individual model simulations and the ensemble mean. The overall statistical parameters for each model are in the bottom left of each plot.

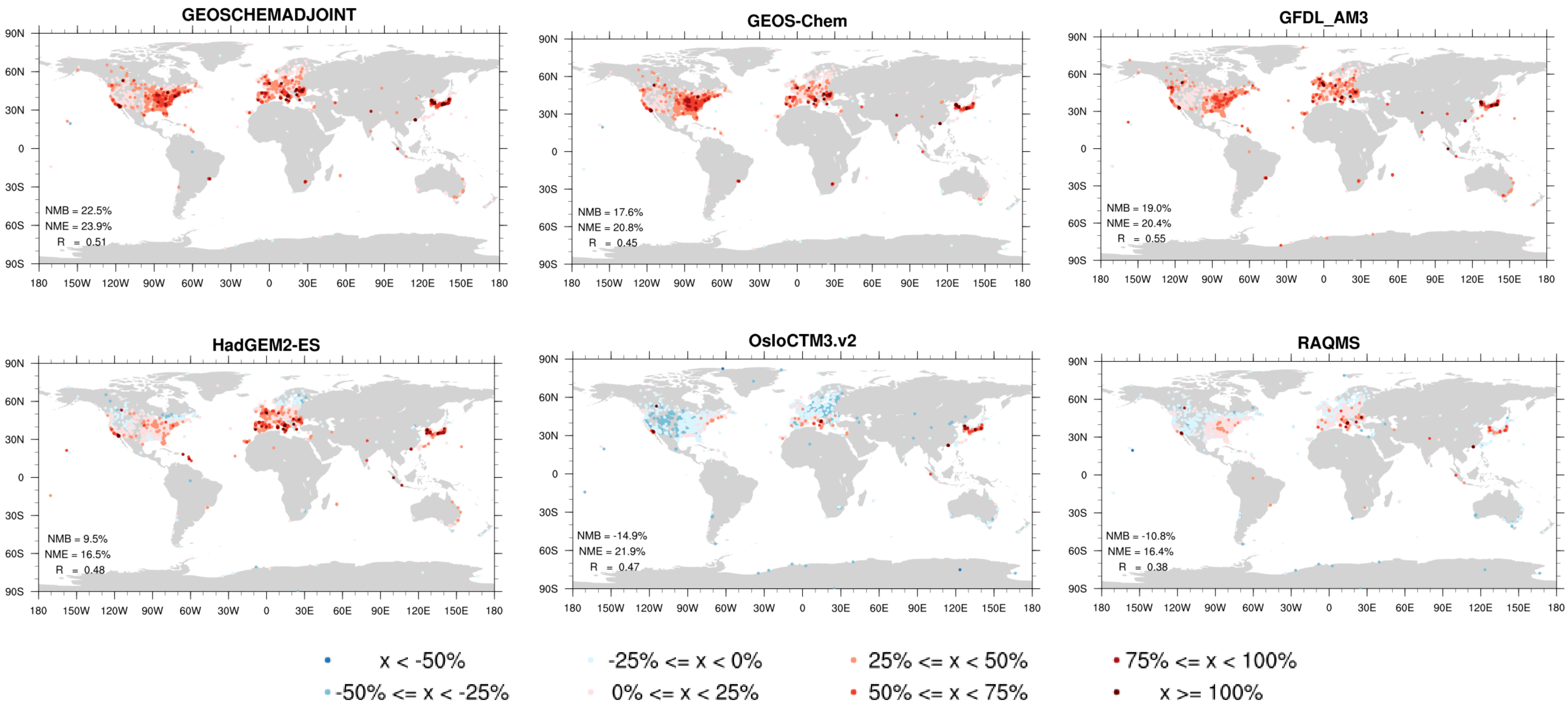


Figure S3. Continued.

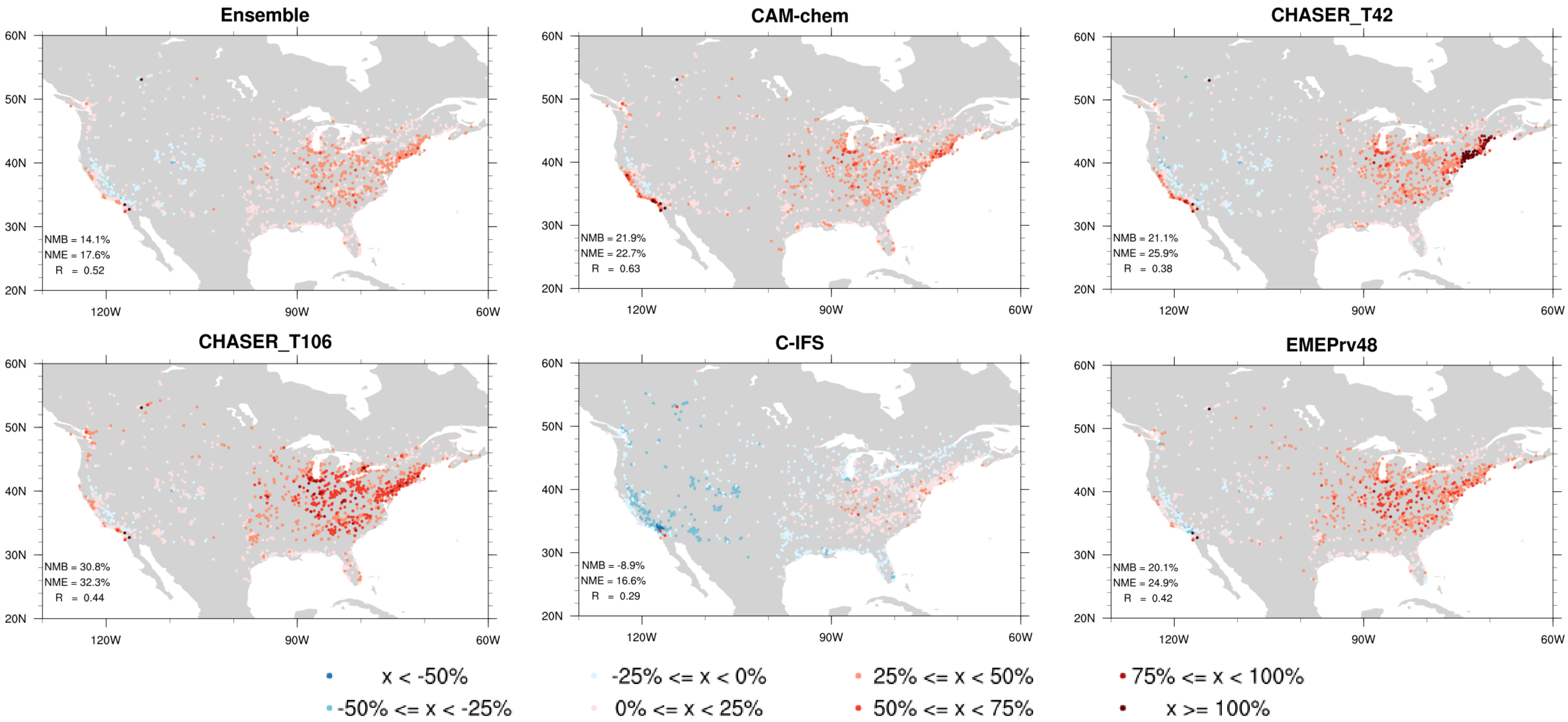


Figure S4. As Figure S3, but for North America.

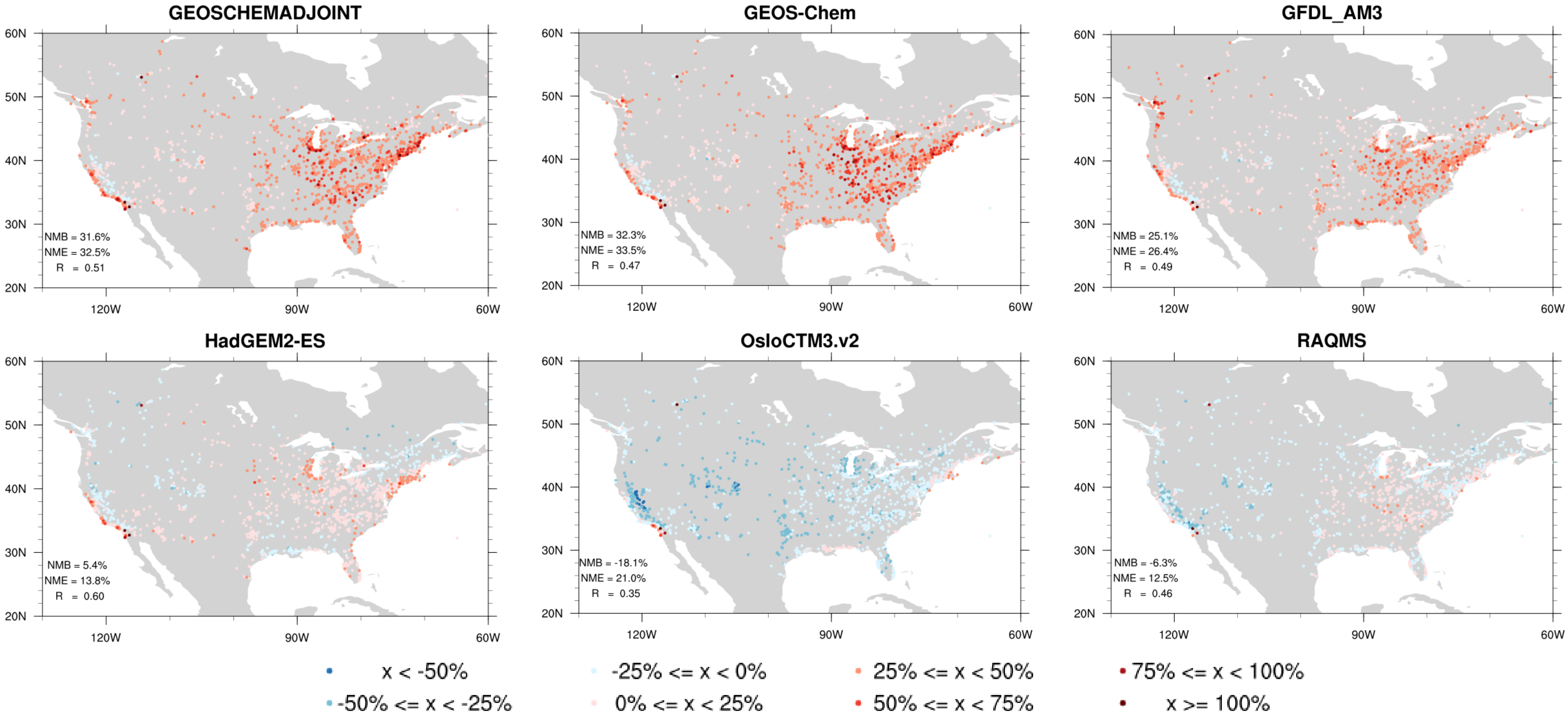


Figure S4. Continued.

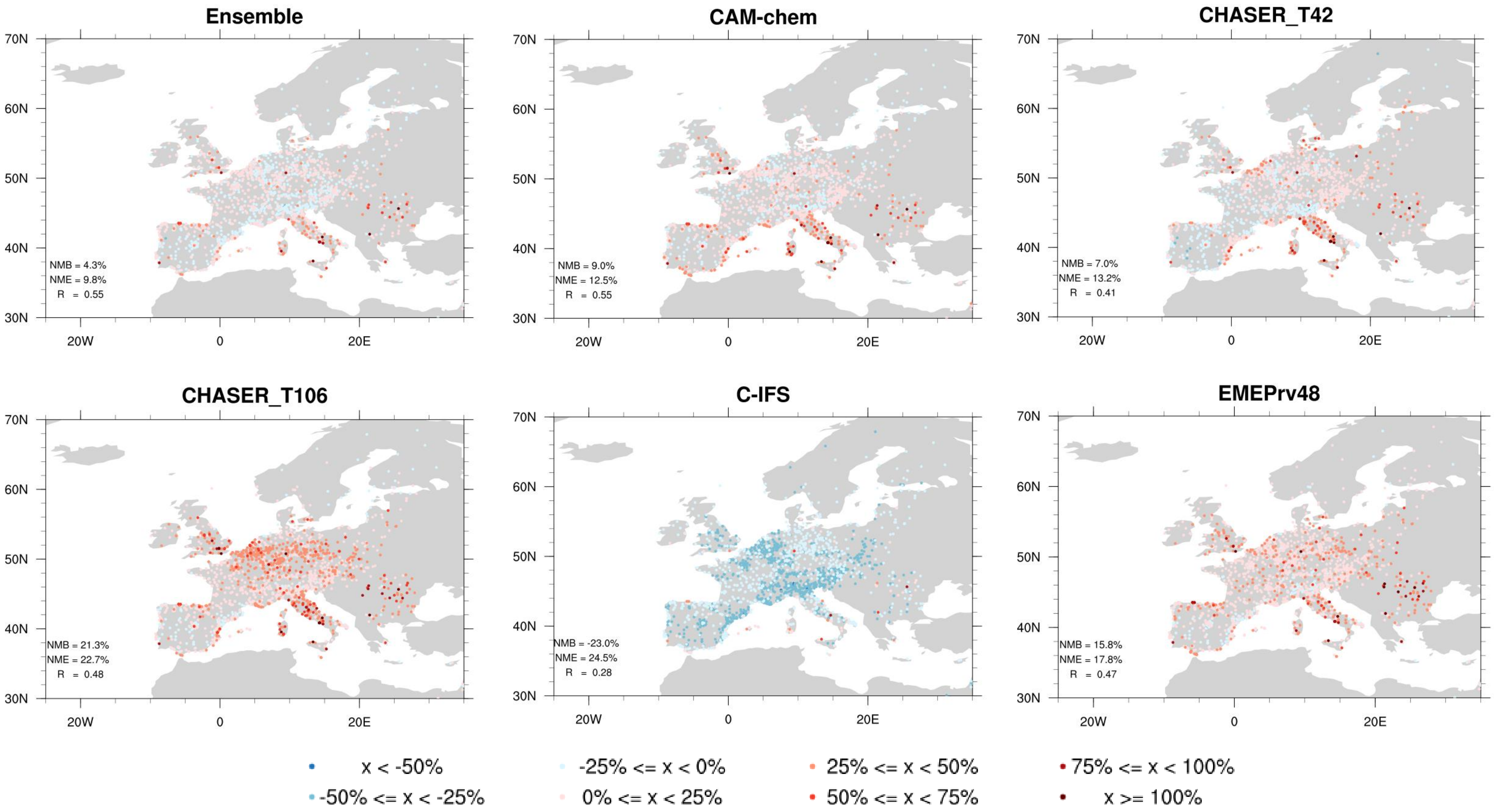


Figure S5. As Figure S3, but for Europe.

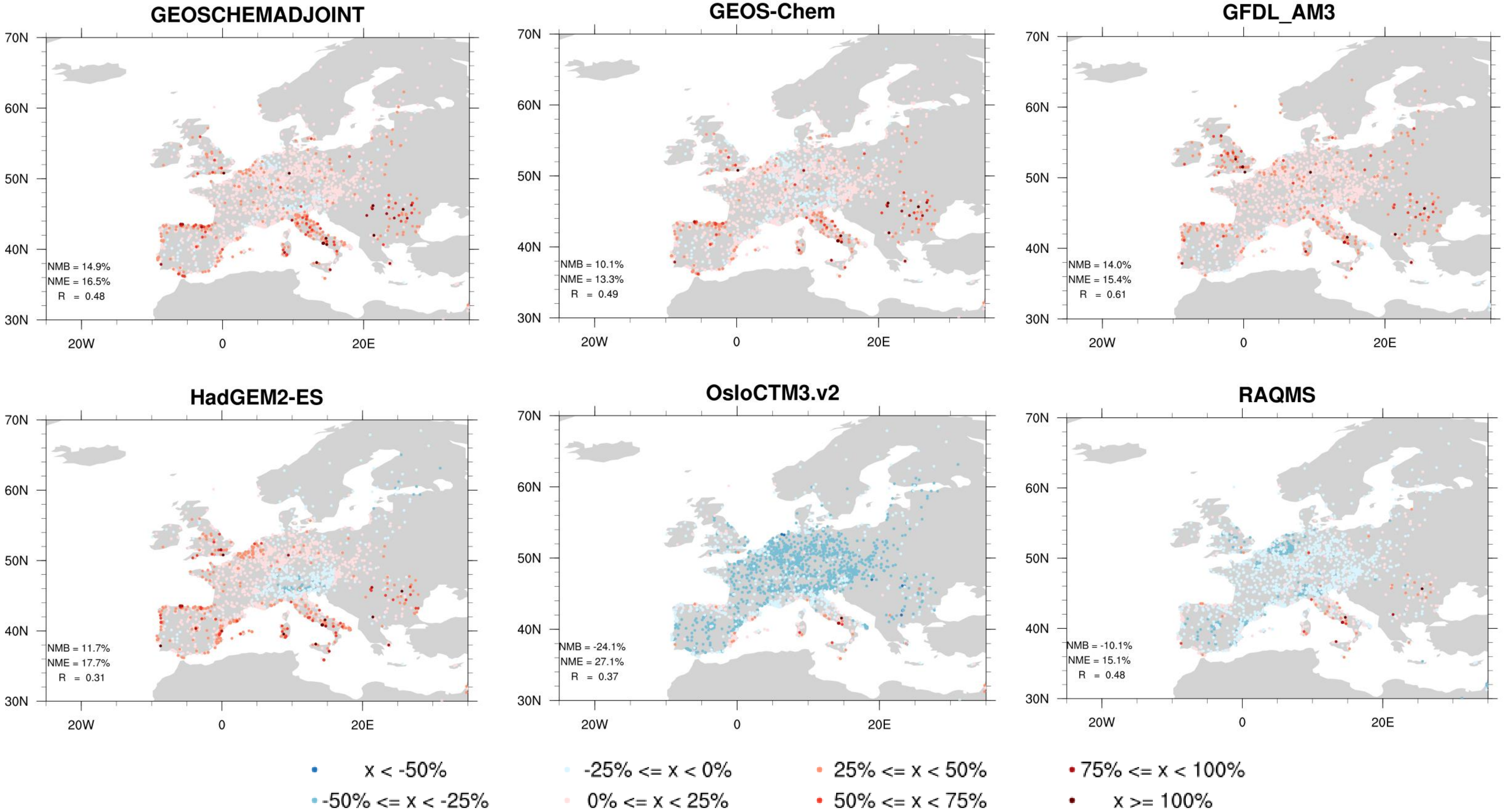


Figure S5. Continued.

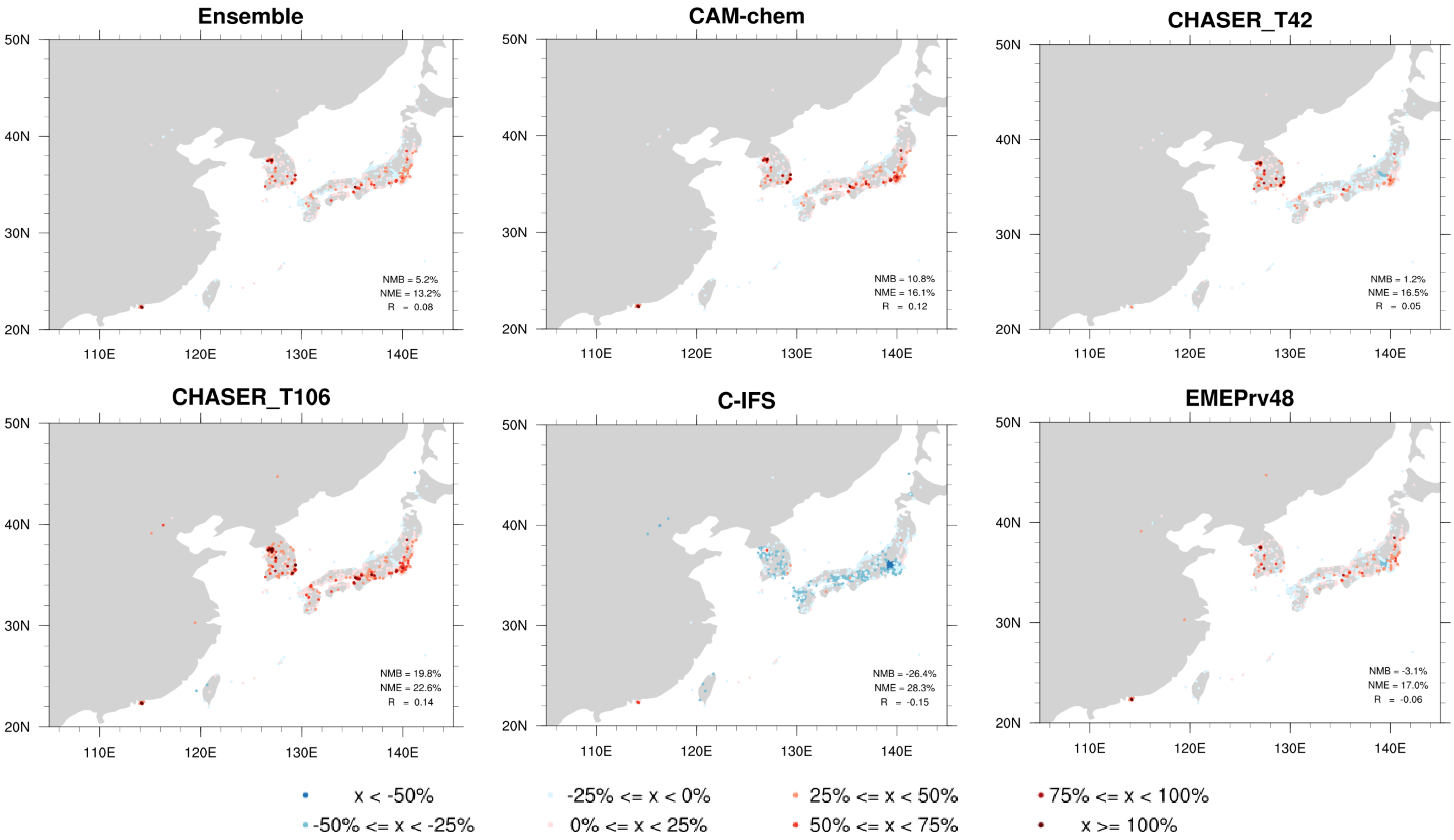


Figure S6. As Figure S3, but for East Asia.

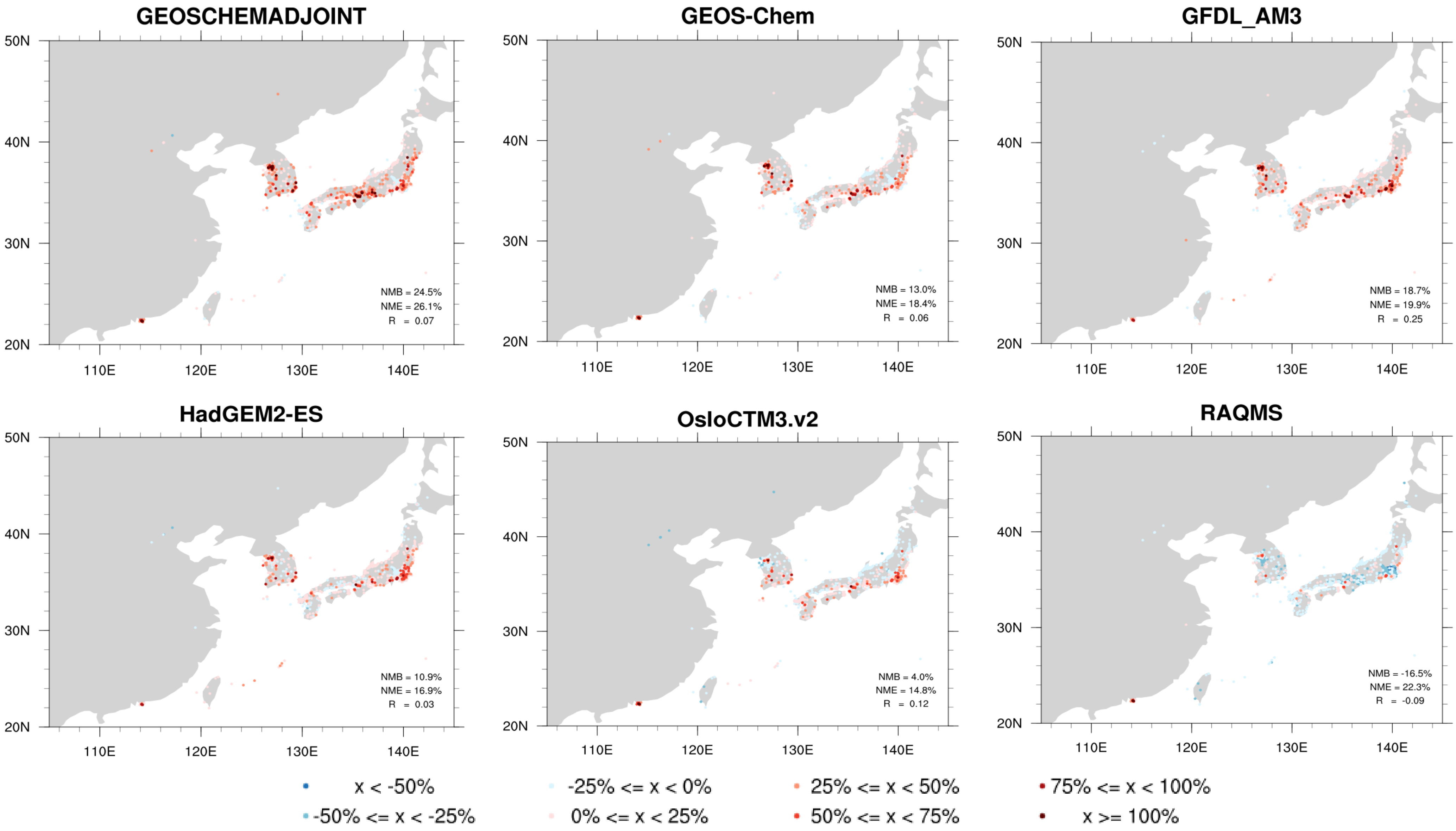


Figure S6. Continued.

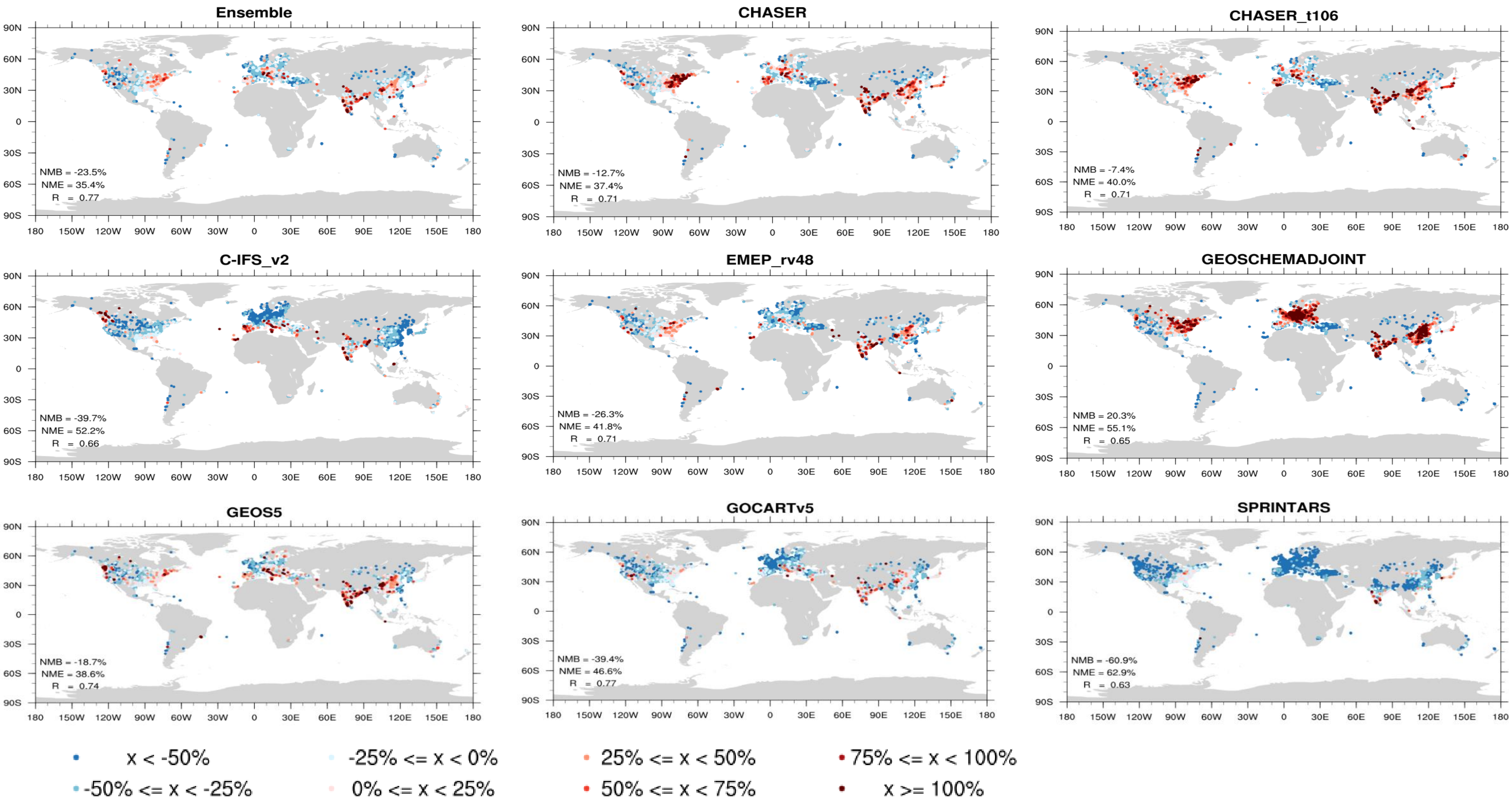


Figure S7. Spatial distributions of model performance for the annual average $PM_{2.5}$, comparing GBD2015 observations with individual model simulations and the ensemble mean. The overall statistical parameters for each model are in the bottom left of the plot.

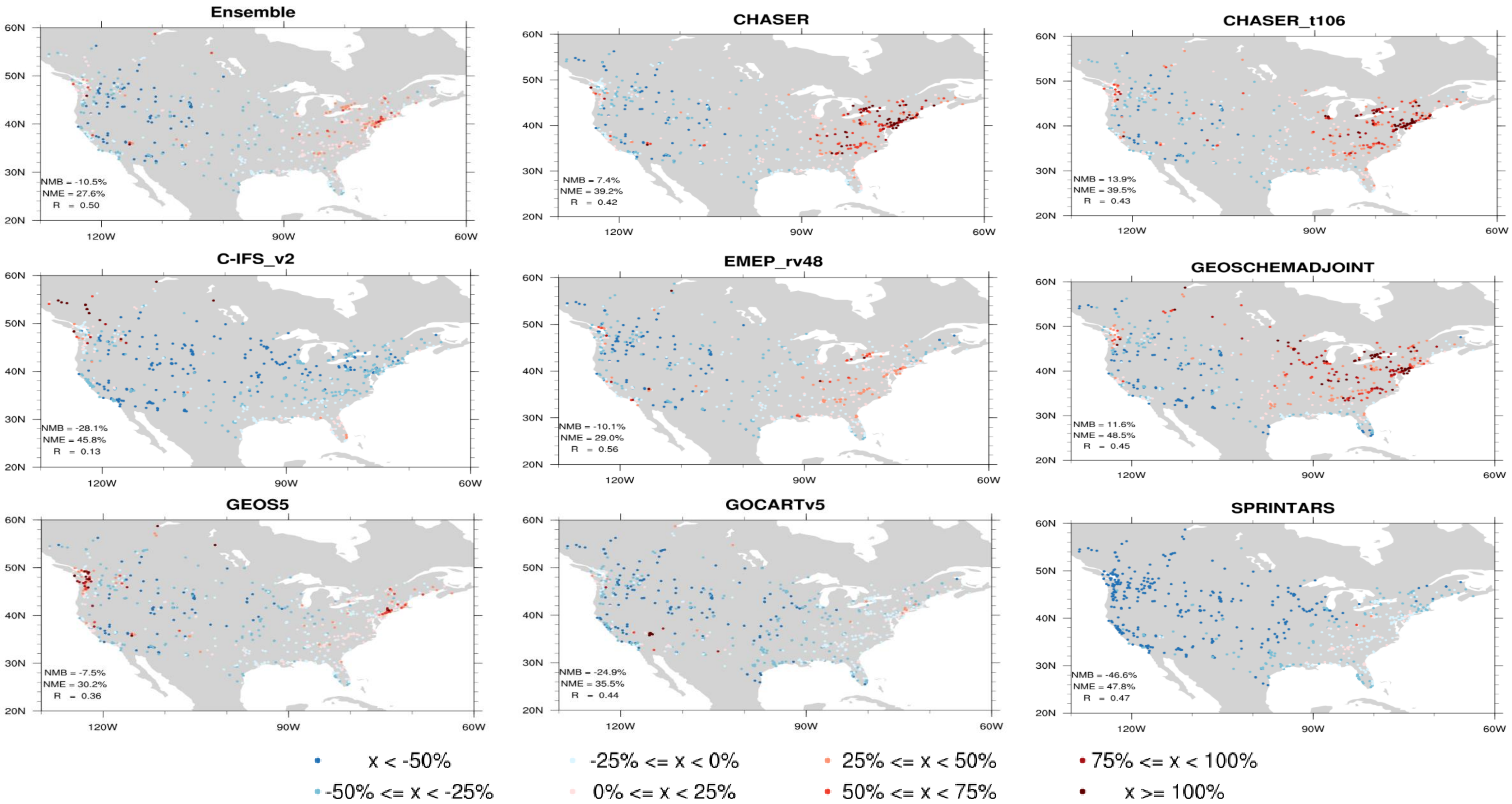


Figure S8. As Figure S7 but for NAM.

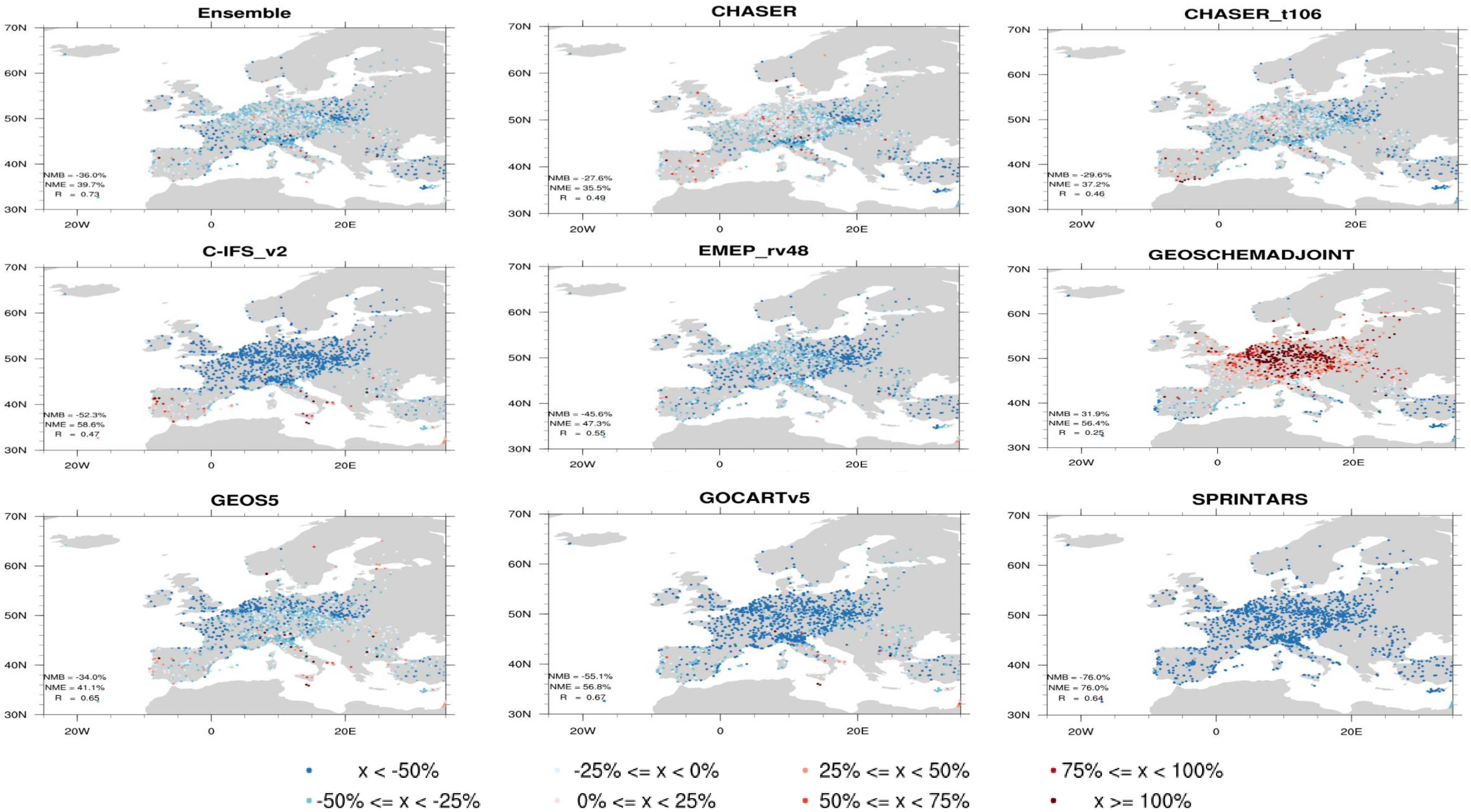


Figure S9. As figure S7, but for Europe.

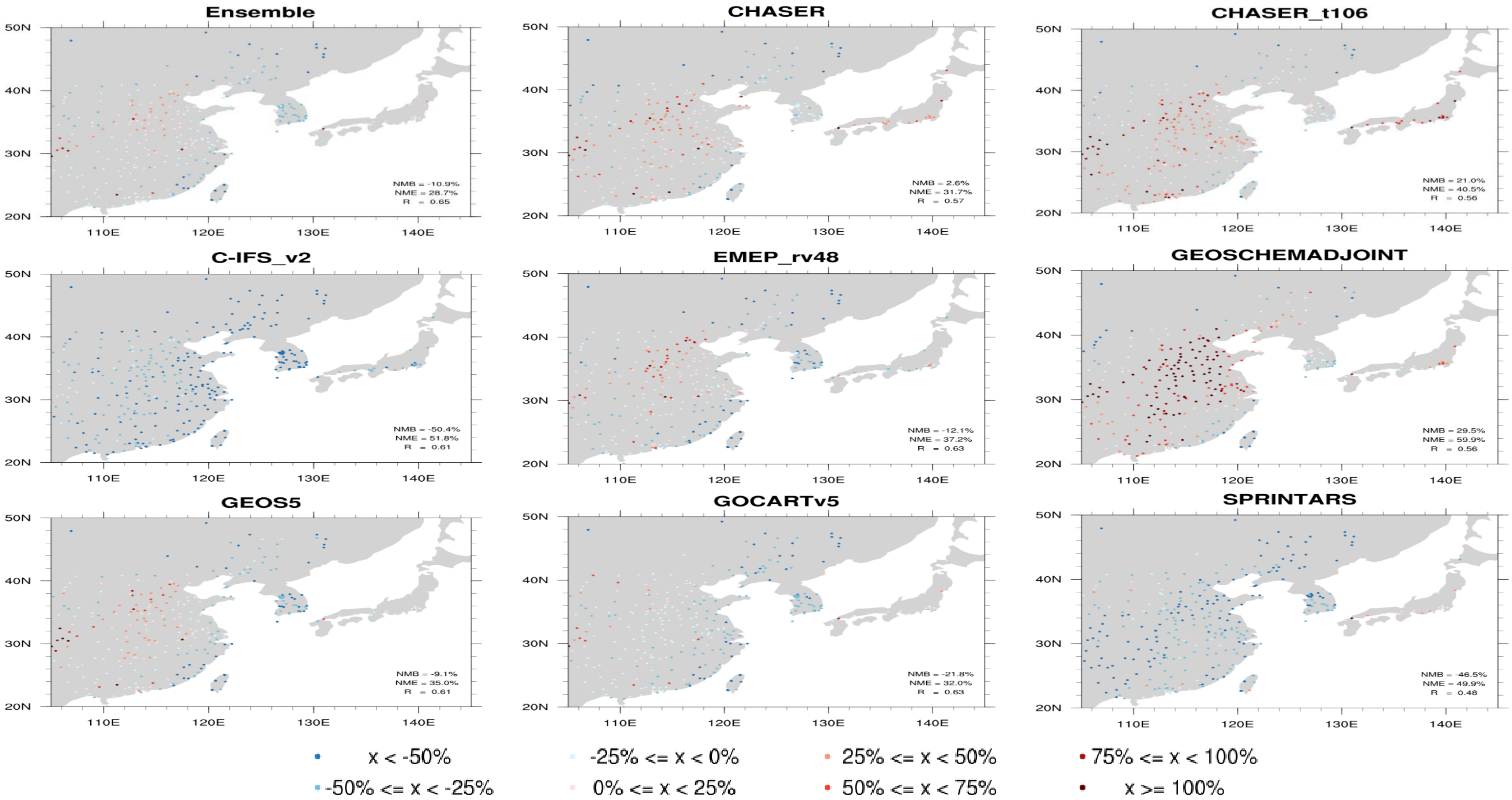


Figure S10. As Figure S7, but for East Asia.

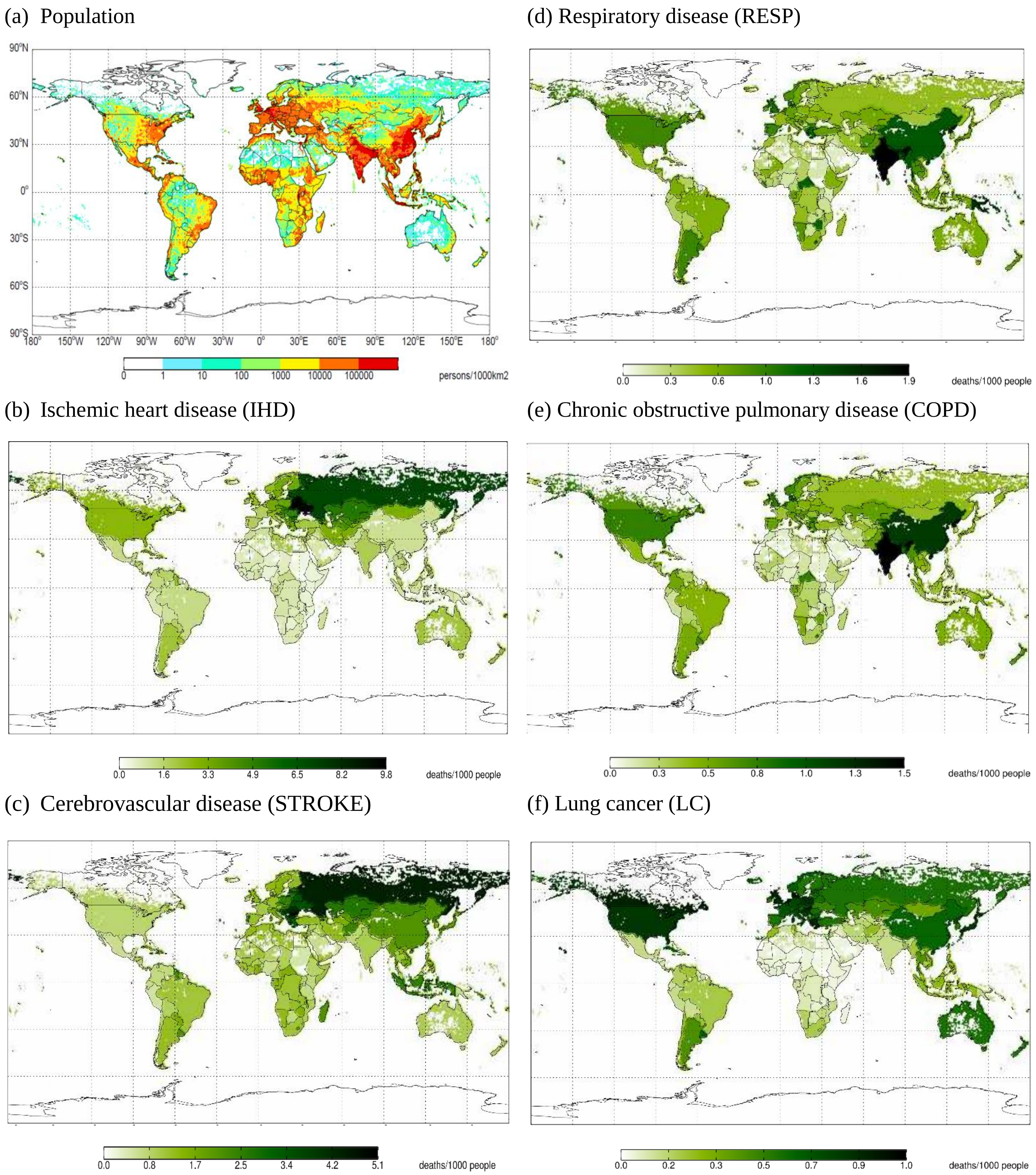


Figure S11– Spatial distribution of exposed population (people per 1,000 square kilometers) and the baseline mortality rates (deaths per year per 1,000 people) for adults aged 25 and above for specific mortality causes, at 0.5°× 0.5° resolution in 2011. The cause-specific baseline mortality rates for 187 countries are from the GBD 2010 mortality dataset (IHME, 2013)

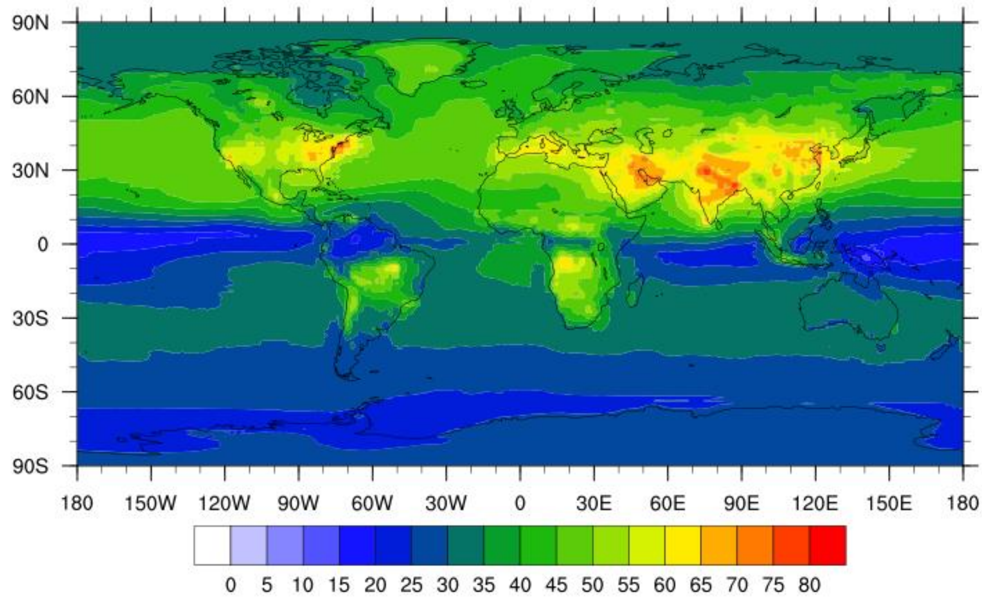


Figure S12 – Spatial distribution of O_3 concentrations for the year 2010 (ppb), showing the multi-model mean (11 models) in each grid cell for the baseline.

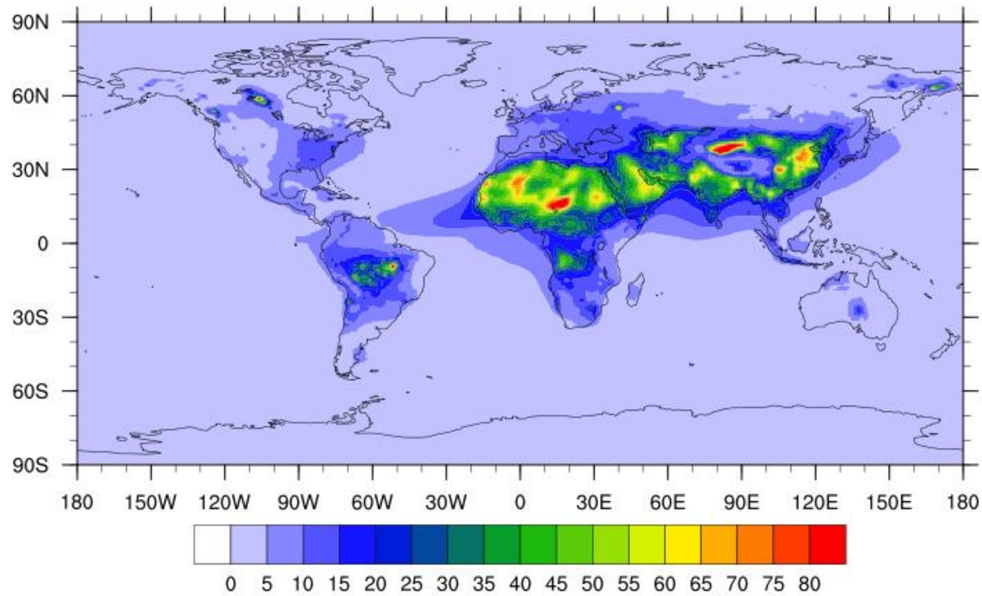
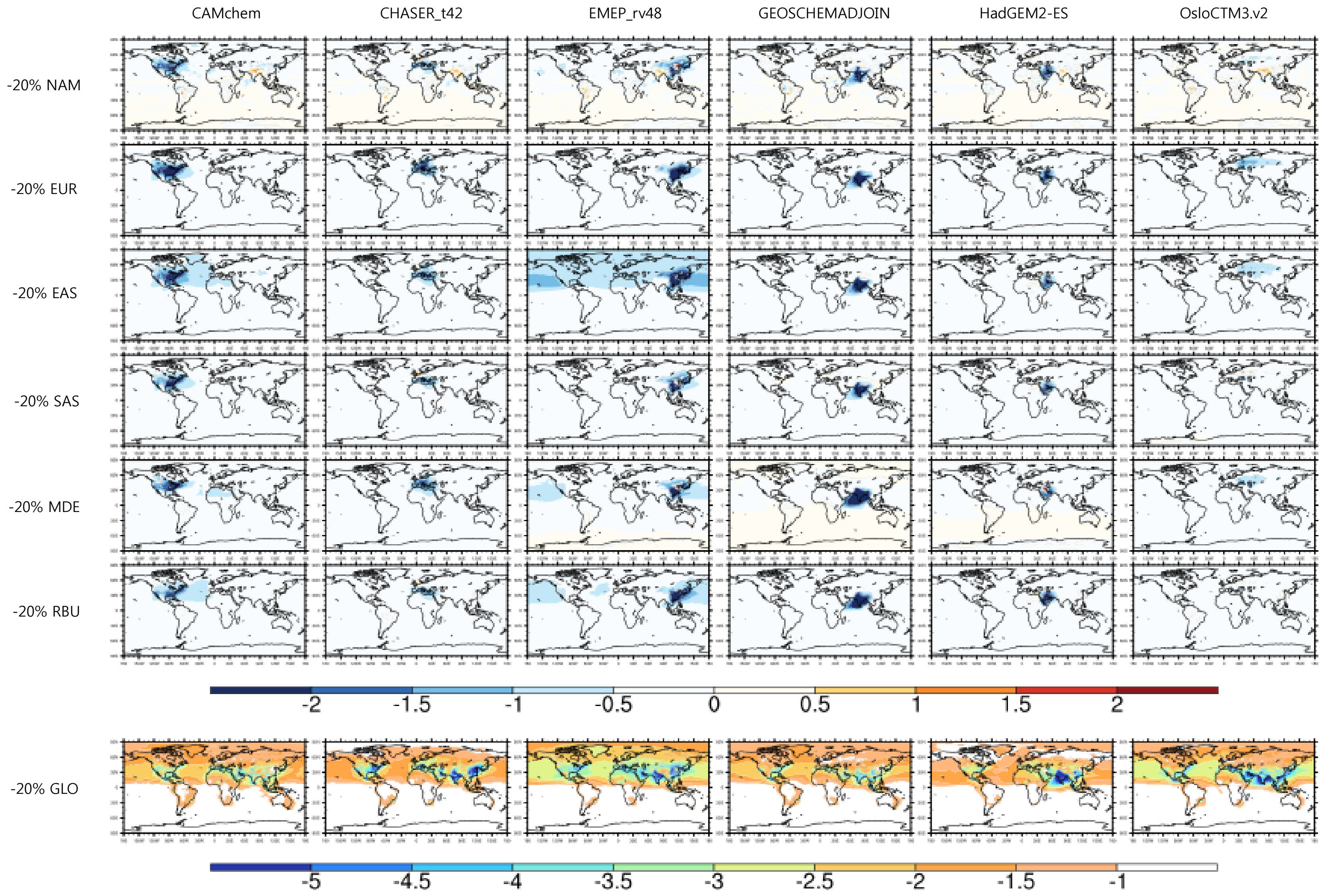


Figure S13 – Spatial distribution of $PM_{2.5}$ concentrations for the year 2010 (μg/m^3), showing the multi-model mean (8 models) in each grid cell for the baseline.



CAMchem
CHASER_t42
EMEP_rv48
GEOSCHEMADJOIN
HadGEM2-ES
OsloCTM3.v2
-20% NAM
-20% EUR
-20% EAS
-20% SAS
-20% MDE
-20% RBU
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
-20% GLO
-5
-4.5
-4
-3.5
-3
-2.5
-2
-1.5
-1

Figure S14 – The spatial distribution of the global difference in individual model O_3 concentrations (ppb) in 20% emission reduction scenarios relative to the baseline for year 2010, for the 6-month O_3 season average of 1-hr. daily maximums.

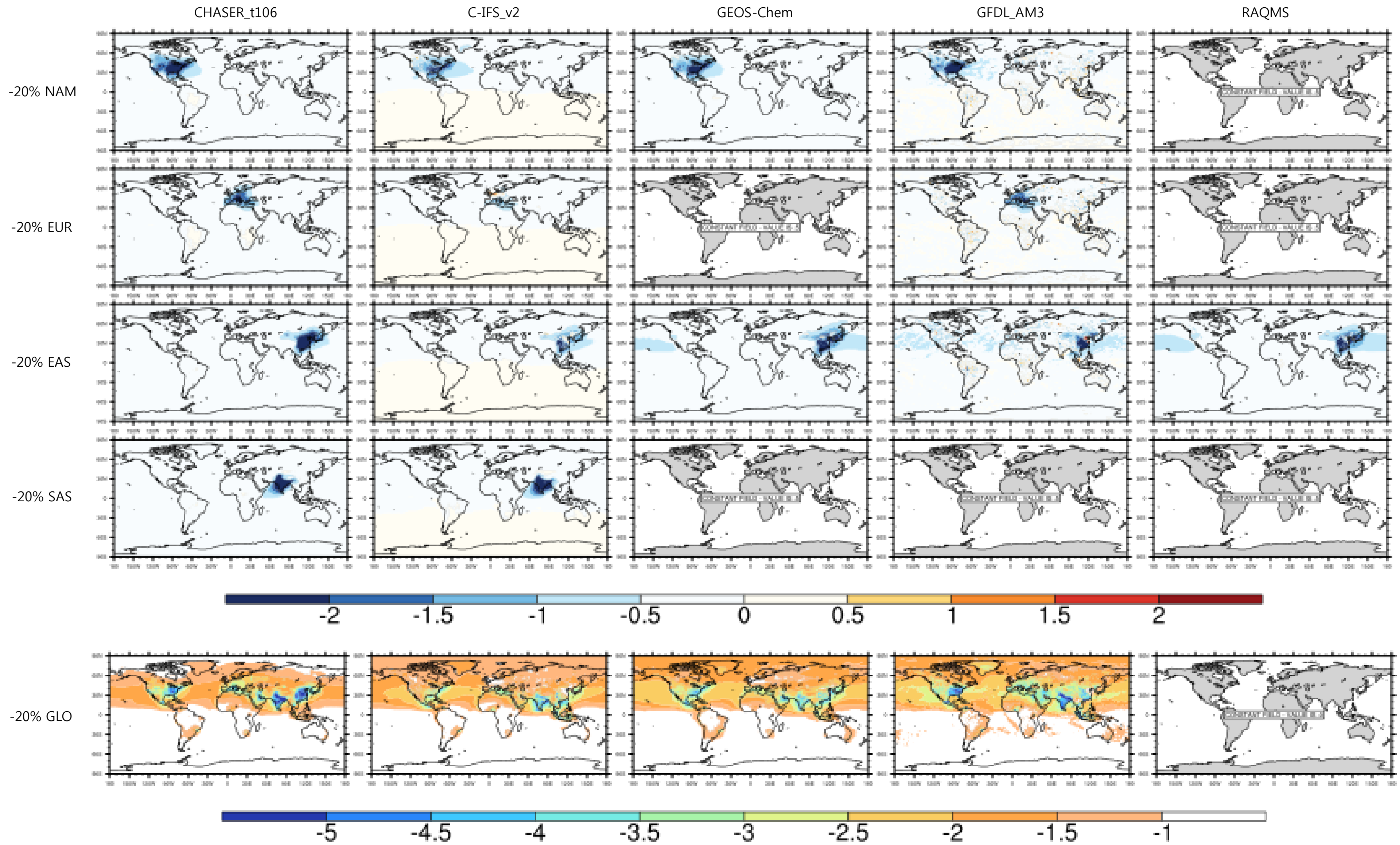


Figure S14 – Continued.

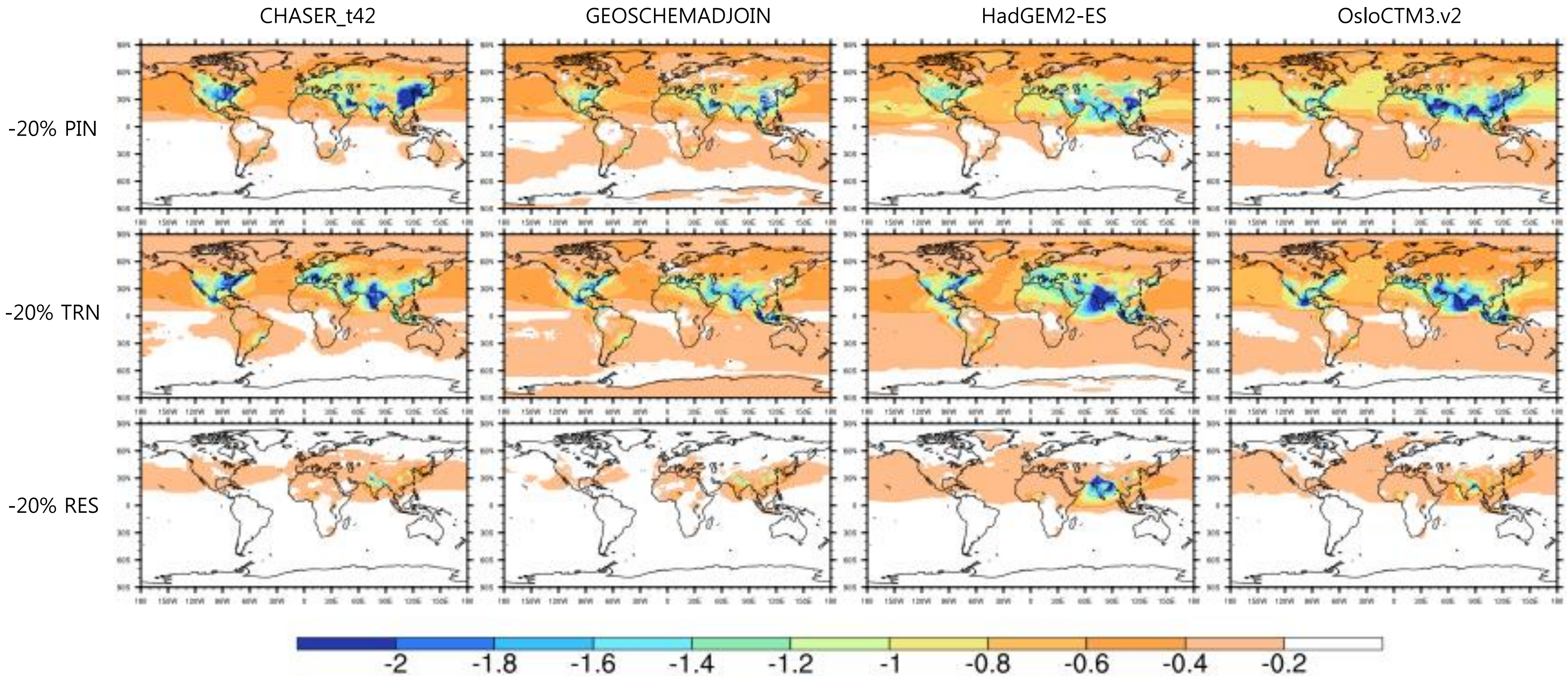


Figure S15 – As Figure S14, but for 20% sectoral emission reductions.

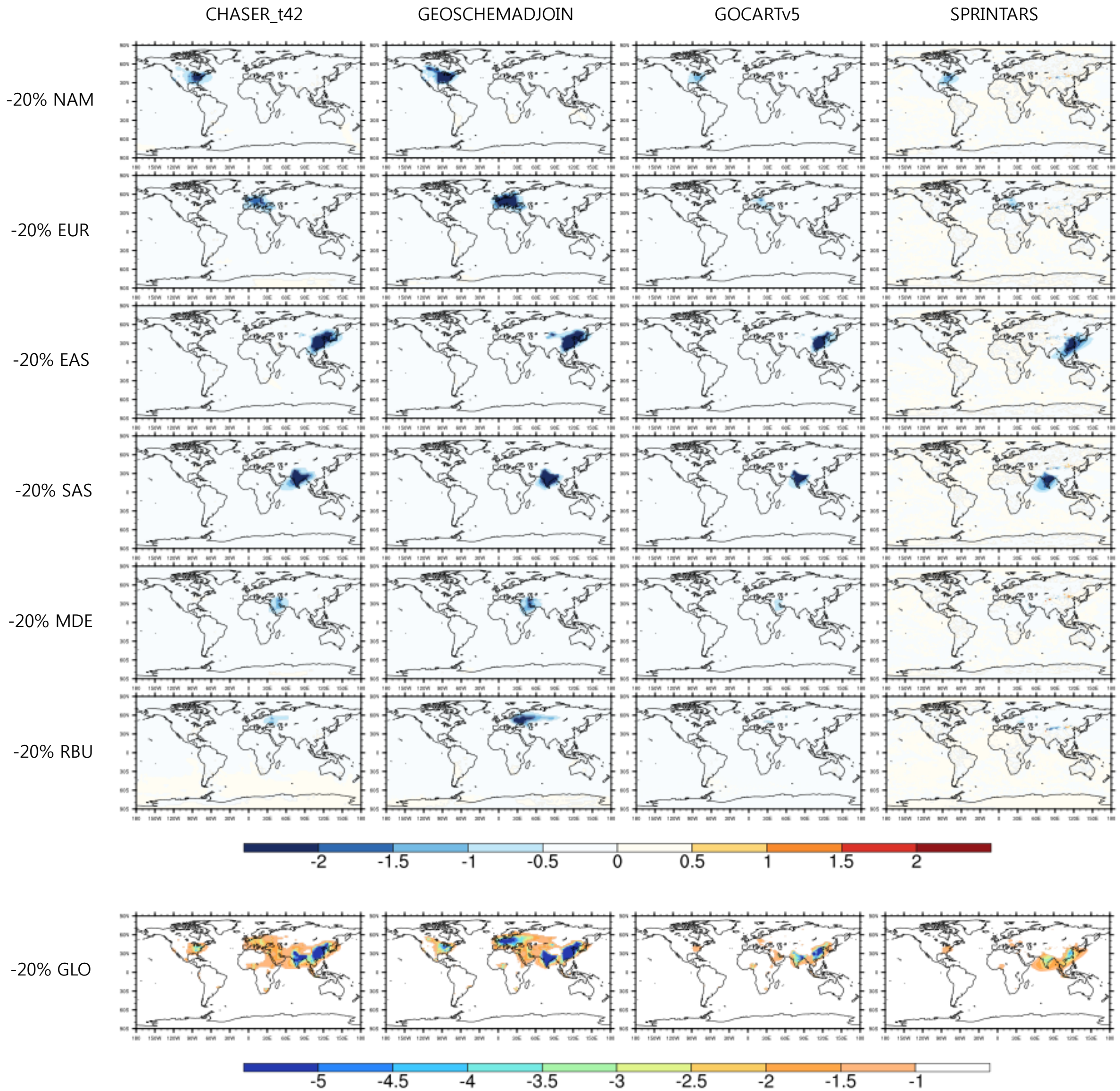


Figure S16 – The spatial distribution of the global difference in individual model annual average $PM_{2.5}$ concentrations ($\mu g/m^3$) in 20% emission reduction scenarios relative to the baseline for year 2010.

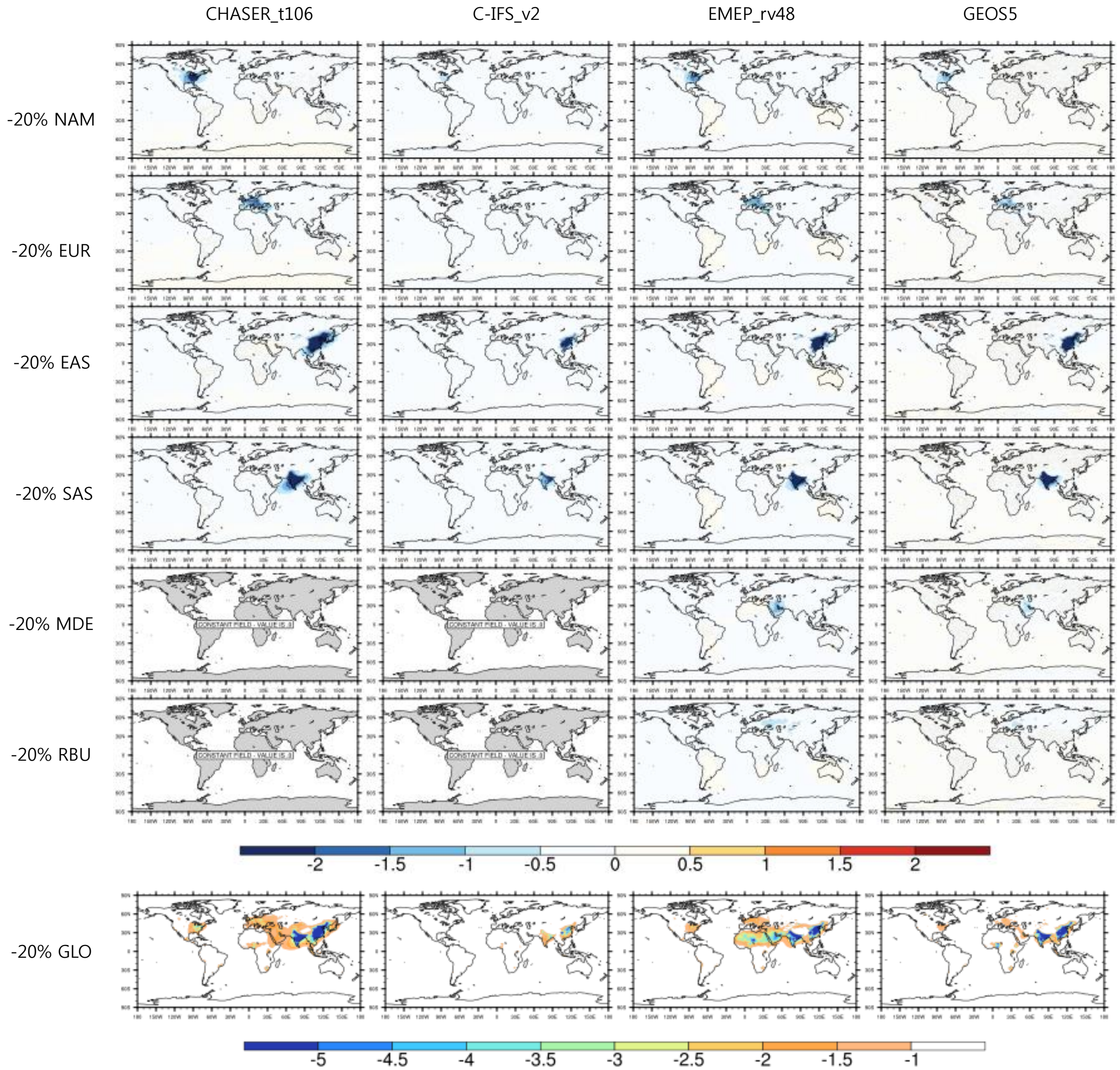


Figure S16 – Continued.

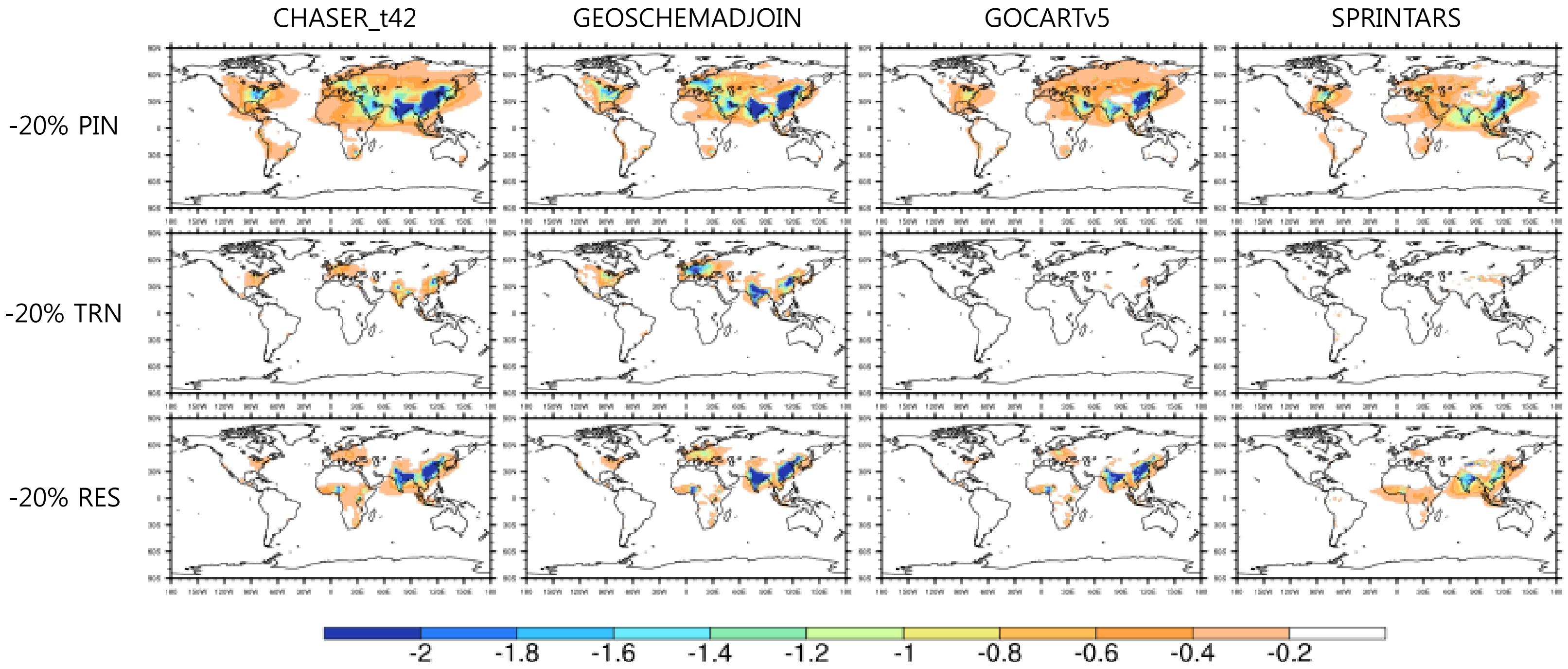


Figure S17 – As Figure S16, but for 20% sectoral emission reductions.

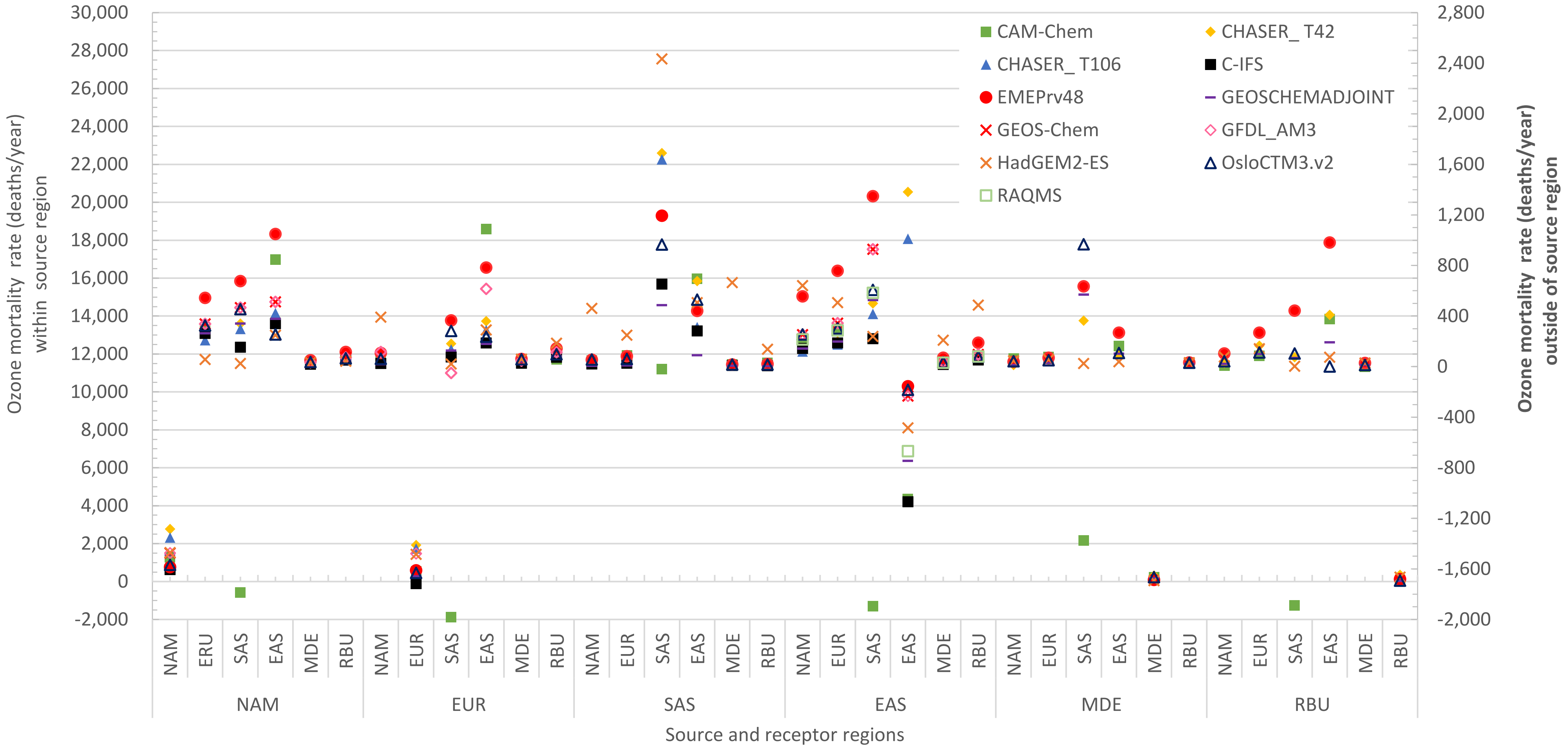


Figure S18 – Annual avoided O_3-related mortality in each 6 receptor region due to 20 % anthropogenic emission reductions in each 6 source region, as simulated by each of the 11 models. The left y axis shows the avoided deaths within source region itself, while the right represents the avoided deaths outside of the source region. The upper labels on x axis represent the receptor regions, while the six bottom labels represent the source region.

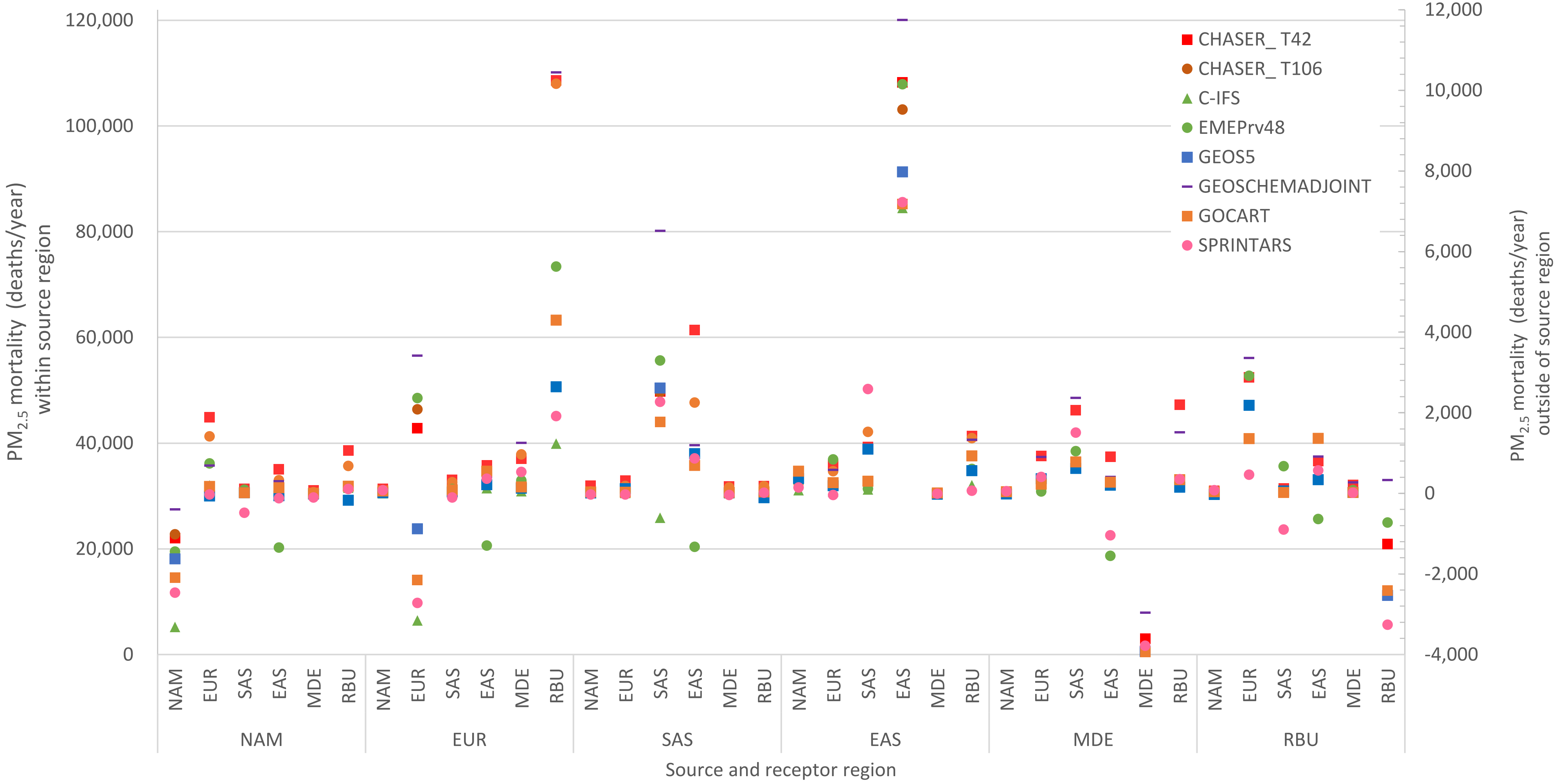
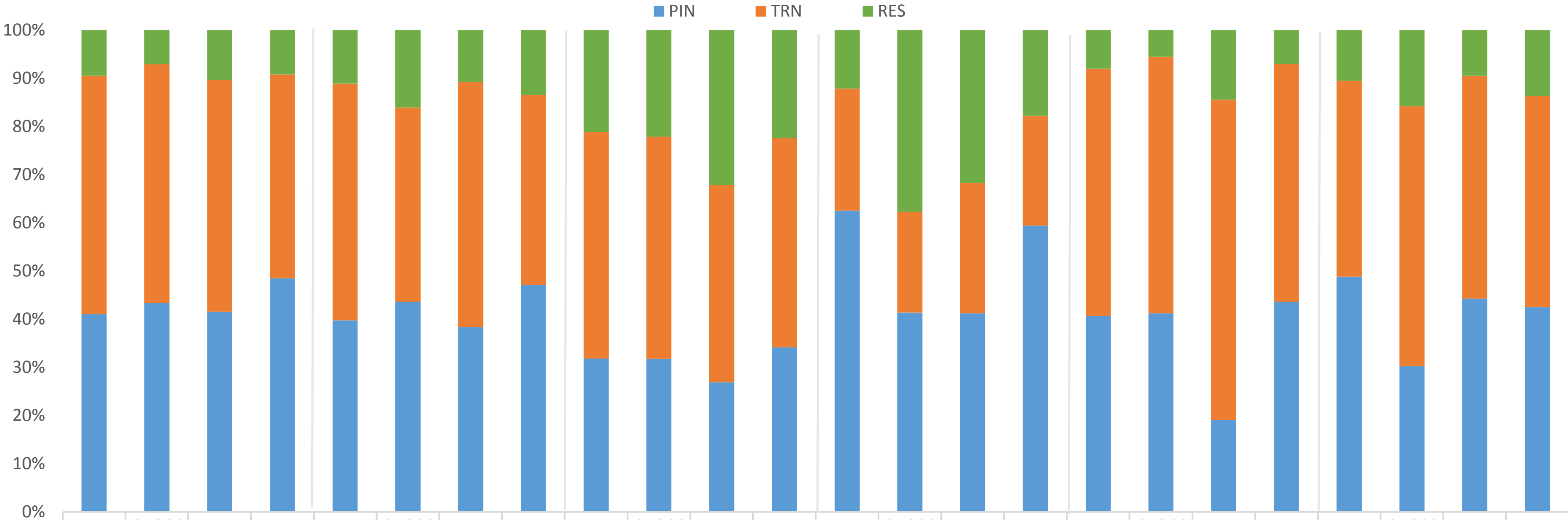
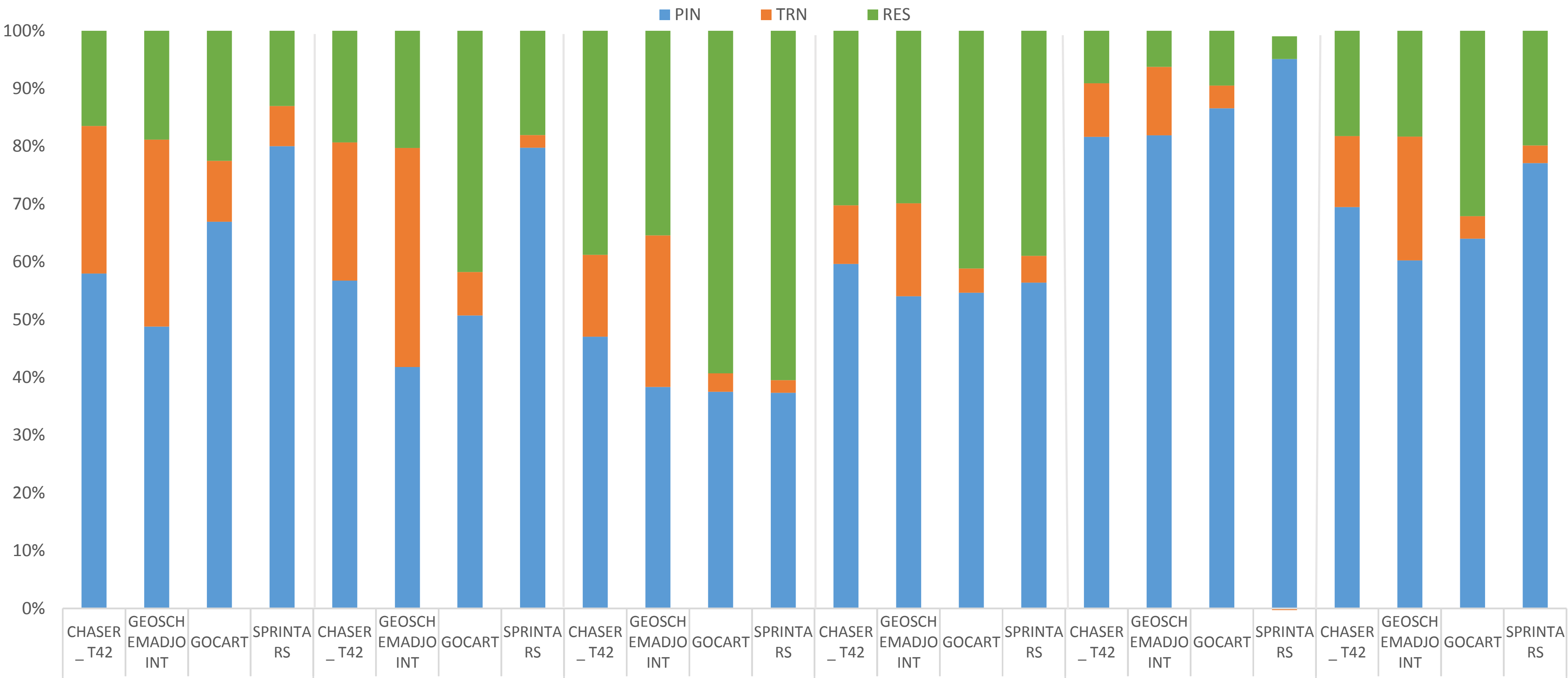


Figure S19 – Annual avoided $PM_{2.5}$-related mortality in each 6 receptor region due to 20 % anthropogenic emission reductions in each 6 source region, as simulated by each of the 8 models. The left y axis shows the avoided deaths within source region itself, while the right represents the avoided deaths outside of source region. The upper labels on x axis represent the receptor regions, while the six bottom labels represent the source region.



	NAM				EUR				SAS				EAS				MDE				RBU			
	CHASE R_ T42	GEOSC HEMAD JOINT	HadGE M2-ES	OsloCT M3.v2	CHASE R_ T42	GEOSC HEMAD JOINT	HadGE M2-ES	OsloCT M3.v2	CHASE R_ T42	GEOSC HEMAD JOINT	HadGE M2-ES	OsloCT M3.v2	CHASE R_ T42	GEOSC HEMAD JOINT	HadGE M2-ES	OsloCT M3.v2	CHASE R_ T42	GEOSC HEMAD JOINT	HadGE M2-ES	OsloCT M3.v2	CHASE R_ T42	GEOSC HEMAD JOINT	HadGE M2-ES	OsloCT M3.v2
RES	296	124	220	132	320	198	282	200	5,300	4,026	9,763	4,825	2,943	3,457	3,552	2,228	37	18	42	30	72	47	57	50
TRN	1,550	867	1,024	611	1,415	497	1,331	586	11,77	8,401	12,44	9,386	6,132	1,917	3,020	2,865	240	168	192	213	280	159	276	159
PIN	1,282	757	883	699	1,144	538	1,003	699	7,975	5,787	8,165	7,357	15,11	3,795	4,604	7,455	190	130	55	189	335	89	264	154

Figure S20 – Annual avoided O_3-related mortality in the 6 receptor regions due to 20 % anthropogenic emission reductions in 3 source sectors, as simulated by each of the 4 models. The value of y axis represents the percentage of total O_3-related mortality (sum of 3 sectors) of each sectoral emission reduction for individual models and receptor regions. The upper labels on x axis represent individual model while the bottom labels on x axis represent the receptor regions. The table shows the number of O_3-related avoided deaths from each sectoral emission reduction estimated by each model in each receptor region.



	NAM				EUR				SAS				EAS				MDE				RBU			
	CHASER_T42	GEOSCHEMADJOINT	GOCART	SPRINTARS	CHASER_T42	GEOSCHEMADJOINT	GOCART	SPRINTARS	CHASER_T42	GEOSCHEMADJOINT	GOCART	SPRINTARS	CHASER_T42	GEOSCHEMADJOINT	GOCART	SPRINTARS	CHASER_T42	GEOSCHEMADJOINT	GOCART	SPRINTARS	CHASER_T42	GEOSCHEMADJOINT	GOCART	SPRINTARS
RES	3,427	3,361	3,457	1,622	8,991	8,739	7,321	2,160	20,645	25,252	28,144	32,705	30,524	22,552	37,225	35,233	441	524	96	115	6,500	5,070	6,464	1,624
TRN	5,301	5,783	1,618	865	11,107	16,323	1,318	265	7,546	18,732	1,510	1,189	10,253	12,151	3,809	4,221	450	989	40	-27	4,366	5,938	776	250
PIN	12,045	8,712	10,275	9,963	26,382	18,012	8,897	9,550	25,030	27,345	17,801	20,191	60,257	40,820	49,471	51,005	3,958	6,847	870	2,750	24,752	16,693	12,890	6,308

Figure S21 –Annual avoided $PM_{2.5}$-related mortality in the 6 receptor regions due to 20 % anthropogenic emission reductions in 3 source sectors, as simulated by each of the 4 models. The value of y axis represents the percentage of total $PM_{2.5}$-related mortality (sum of 3 sectors) of each sectoral emission reduction for individual models and receptor regions. The upper labels on x axis represent individual models while the bottom labels on x axis represent the receptor region. The table shows the number of $PM_{2,5}$-related avoided deaths from each sectoral emission reduction estimated by each model in each receptor region.

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