

Supplementary

Tables

Table S1: CV results of the reanalysis (outside bracket) and base simulation (in bracket) for PM_{2.5} concentrations in different regions of China at different temporal scales

PM _{2.5} ($\mu\text{g}/\text{m}^3$)	NCP				NE			
	R ²	MBE	NMB(%)	RMSE	R ²	MBE	NMB (%)	RMSE
Hourly	0.85 (0.33)	-3.3 (22.4)	-4.8 (32.8)	25.1 (62.6)	0.77 (0.25)	-2.6 (2.8)	-5.8 (6.5)	22.6 (44.5)
Daily	0.90 (0.44)	-3.4 (22.3)	-4.9 (32.4)	17.5 (51.2)	0.86 (0.32)	-2.6 (2.6)	-5.9 (6.0)	14.7 (35.1)
Monthly	0.92 (0.56)	-3.4 (22.2)	-4.9 (32.4)	11.4 (34.1)	0.86 (0.38)	-2.6 (2.7)	-5.9 (6.0)	9.7 (21.4)
Yearly	0.92 (0.56)	-3.6 (20.8)	-5.0 (29.2)	8.7 (27.3)	0.79 (0.35)	-3.1 (0.4)	-6.6 (0.8)	8.8 (16.7)
<hr/>								
SE				SW				
	R ²	MBE	NMB(%)	RMSE	R ²	MBE	NMB (%)	RMSE
	0.85 (0.25)	-1.8 (22.2)	-3.8 (47.6)	14.9 (51.5)	0.79 (0.22)	-1.4 (30.3)	-3.4 (74.7)	16.5 (57.4)
Daily	0.90 (0.31)	-1.8 (22.2)	-3.8 (47.4)	10.6 (45.4)	0.86 (0.29)	-1.4 (30.0)	-3.4 (74.2)	12.1 (51.6)
Monthly	0.92 (0.45)	-1.8 (22.1)	-3.8 (47.2)	7.4 (33.7)	0.86 (0.49)	-1.5 (29.8)	-3.7 (73.3)	9.7 (42.8)
Yearly	0.90 (0.37)	-2.0 (20.5)	-4.0 (42.0)	6.1 (29.3)	0.79 (0.47)	-2.2 (27.2)	-5.0 (63.2)	9.5 (38.8)
<hr/>								
NW				Central				
	R ²	MBE	NMB(%)	RMSE	R ²	MBE	NMB (%)	RMSE
	0.52 (0.11)	-7.3 (-28.7)	-13.1 (-51.1)	52.1 (73.0)	0.72 (0.23)	-4.1 (0.8)	-8.2 (1.6)	26.6 (47.5)
Daily	0.66 (0.15)	-7.5 (-29.0)	-13.2 (-51.3)	39.4 (66.0)	0.83 (0.30)	-4.2 (0.7)	-8.3 (1.4)	19.1 (39.9)
Monthly	0.72 (0.28)	-7.4 (-28.9)	-13.1 (-51.3)	26.9 (50.3)	0.85 (0.42)	-4.2 (0.7)	-8.2 (1.4)	13.1 (26.1)
Yearly	0.64 (0.40)	-9.8 (-33.5)	-16.1 (-54.9)	23.5 (43.1)	0.77 (0.31)	-5.4 (-3.6)	-10.1 (-6.7)	12.5 (24.3)

Table S2: CV results of the reanalysis (outside bracket) and base simulation (in bracket) for PM₁₀ concentrations in different regions of China at different temporal scales

PM ₁₀ ($\mu\text{g}/\text{m}^3$)	NCP				NE			
	R ²	MBE	NMB(%)	RMSE	R ²	MBE	NMB (%)	RMSE
Hourly	0.79 (0.23)	-7.7 (-14.6)	-6.4 (-12.1)	43.7 (88.3)	0.71 (0.18)	-7.6 (-23.6)	-9.6 (-29.8)	39.8 (70.8)
Daily	0.86 (0.31)	-7.6 (-14.2)	-6.3 (-11.7)	30.9 (71.8)	0.79 (0.25)	-7.6 (-23.6)	-9.7 (-30.0)	27.1 (56.8)
Monthly	0.86 (0.38)	-7.6 (-14.2)	-6.3 (-11.8)	21.4 (44.9)	0.76 (0.29)	-7.7 (-23.6)	-9.8 (-30.0)	19.4 (39.6)
Yearly	0.85 (0.46)	-7.6 (-15.8)	-6.2 (-12.8)	17.6 (33.0)	0.67 (0.31)	-8.3 (-26.5)	-10.3 (-32.6)	18.4 (36.2)
SE								
	R ²	MBE	NMB(%)	RMSE	R ²	MBE	NMB (%)	RMSE
	0.77 (0.18)	-4.4 (6.9)	-5.9 (9.4)	26.0 (61.2)	0.69 (0.15)	-5.1 (13.0)	-7.5 (19.1)	30.2 (66.2)
Hourly	0.85 (0.23)	-4.1 (8.1)	-5.6 (11.1)	18.6 (52.0)	0.77 (0.21)	-5.0 (13.1)	-7.4 (19.6)	22.4 (56.5)
Daily	0.85 (0.38)	-4.2 (7.5)	-5.7 (10.2)	13.7 (33.3)	0.76 (0.38)	-5.2 (12.5)	-7.8 (18.5)	18.7 (41.4)
Monthly	0.81 (0.36)	-4.7 (4.9)	-6.1 (6.5)	12.3 (26.3)	0.62 (0.38)	-6.8 (8.7)	-9.6 (12.2)	19.3 (35.7)
NW								
	R ²	MBE	NMB(%)	RMSE	R ²	MBE	NMB (%)	RMSE
	0.46 (0.08)	-21.5 (-88.5)	-18.0 (-74.1)	105.5 (150.2)	0.61 (0.11)	-14.6 (-45.6)	-14.1 (-43.9)	57.3 (96.4)
Hourly	0.56 (0.11)	-21.5 (-89.3)	-17.9 (-74.1)	85.5 (141.6)	0.72 (0.14)	-14.6 (-45.5)	-14.1 (-43.8)	42.1 (84.6)
Daily	0.59 (0.17)	-20.8 (-89.5)	-17.2 (-74.0)	64.0 (118.9)	0.74 (0.28)	-14.6 (-45.3)	-14.1 (-43.8)	30.2 (62.5)
Monthly	0.58 (0.23)	-23.8 (-92.3)	-19.3 (-74.7)	55.8 (110.2)	0.67 (0.25)	-16.4 (-50.1)	-15.4 (-46.8)	28.0 (60.4)
Central								

Table S3: CV results of the reanalysis (outside bracket) and base simulation (in bracket) for SO₂ concentrations in different regions of China at different temporal scales

SO ₂ ($\mu\text{g}/\text{m}^3$)	NCP				NE			
	R ²	MBE	NMB(%)	RMSE	R ²	MBE	NMB (%)	RMSE
Hourly	0.62 (0.10)	-3.6 (26.4)	-9.4 (69.4)	31.5 (63.1)	0.46 (0.08)	-2.0 (5.1)	-6.9 (17.5)	34.8 (53.2)
Daily	0.74 (0.16)	-3.6 (26.4)	-9.4 (69.6)	22.8 (52.7)	0.62 (0.13)	-2.0 (5.1)	-7.0 (17.6)	23.8 (42.2)
Monthly	0.79 (0.19)	-3.7 (26.2)	-9.6 (68.4)	17.1 (43.6)	0.71 (0.14)	-2.0 (5.0)	-6.9 (17.3)	17.9 (34.9)
Yearly	0.81 (0.18)	-4.2 (23.7)	-10.2 (56.9)	13.3 (36.1)	0.56 (0.14)	-2.4 (2.7)	-7.6 (8.7)	15.9 (27.7)
SE								SW
	R ²	MBE	NMB(%)	RMSE	R ²	MBE	NMB (%)	RMSE
	0.42 (0.01)	-1.0 (29.8)	-5.7 (169.6)	14.6 (69.3)	0.27 (0.01)	-1.9 (44.2)	-12.1 (277.2)	16.7 (88.1)
Daily	0.55 (0.01)	-1.0 (29.9)	-5.7 (170.2)	10.5 (63.3)	0.38 (0.01)	-1.9 (44.1)	-12.2 (276.5)	11.8 (80.3)
Monthly	0.61 (0.01)	-1.0 (29.7)	-5.7 (168.6)	7.8 (55.8)	0.46 (0.02)	-2.0 (43.9)	-12.4 (273.7)	9.1 (73.7)
Yearly	0.66 (0.01)	-1.4 (28.0)	-7.1 (144.5)	7.9 (52.7)	0.53 (0.01)	-2.7 (41.2)	-15.2 (231.3)	9.5 (68.3)
NW								Central
	R ²	MBE	NMB(%)	RMSE	R ²	MBE	NMB (%)	RMSE
	0.31 (0.01)	-0.3 (9.4)	-2.3 (61.6)	22.7 (40.4)	0.30 (0.02)	-4.4 (13.2)	-17.0 (51.3)	36.0 (58.9)
Daily	0.42 (0.01)	-0.3 (9.4)	-1.8 (62.2)	17.8 (36.2)	0.49 (0.03)	-4.4 (13.2)	-17.0 (51.5)	23.6 (49.1)
Monthly	0.48 (0.03)	-0.3 (9.3)	-2.2 (61.1)	13.4 (30.3)	0.59 (0.03)	-4.4 (13.1)	-17.0 (51.0)	18.2 (43.2)
Yearly	0.29 (0.00)	-1.9 (6.6)	-10.5 (35.9)	15.8 (28.0)	0.50 (0.00)	-5.6 (8.6)	-19.0 (29.3)	18.6 (40.2)

Table S4: CV results of the reanalysis (outside bracket) and base simulation (in bracket) for NO₂ concentrations in different regions of China at different temporal scales

NO ₂ ($\mu\text{g}/\text{m}^3$)	NCP				NE			
	R ²	MBE	NMB(%)	RMSE	R ²	MBE	NMB (%)	RMSE
Hourly	0.67 (0.20)	-1.4 (-3.0)	-3.5 (-7.1)	16.8 (26.5)	0.61 (0.27)	-1.6 (-5.9)	-5.0 (-19.1)	15.8 (22.4)
Daily	0.72 (0.22)	-1.4 (-2.9)	-3.3 (-7.1)	12.4 (20.8)	0.66 (0.34)	-1.5 (-5.9)	-4.9 (-19.0)	11.7 (17.2)
Monthly	0.72 (0.24)	-1.4 (-2.9)	-3.3 (-7.1)	9.3 (15.5)	0.64 (0.37)	-1.5 (-5.9)	-5.0 (-19.1)	9.3 (13.7)
Yearly	0.67 (0.36)	-1.4 (-3.8)	-3.3 (-9.0)	7.5 (11.0)	0.64 (0.45)	-1.5 (-6.4)	-4.8 (-20.3)	7.8 (11.7)
SE				SW				
	R ²	MBE	NMB(%)	RMSE	R ²	MBE	NMB (%)	RMSE
	0.64 (0.23)	-1.9 (-1.3)	-5.9 (-4.0)	14.9 (24.1)	0.49 (0.19)	-3.9 (-9.9)	-14.0 (-35.7)	16.4 (23.2)
Hourly	0.71 (0.28)	-1.8 (-1.3)	-5.8 (-4.0)	11.2 (19.2)	0.55 (0.28)	-3.9 (-9.9)	-14.0 (-35.7)	12.8 (18.7)
Daily	0.72 (0.36)	-1.8 (-1.2)	-5.8 (-3.9)	8.8 (14.7)	0.48 (0.32)	-4.0 (-10.0)	-14.4 (-36.0)	12.6 (17.2)
Monthly	0.66 (0.49)	-1.9 (-2.2)	-6.0 (-6.6)	7.8 (11.7)	0.46 (0.37)	-4.6 (-11.0)	-16.1 (-38.7)	11.8 (16.4)
NW				Central				
	R ²	MBE	NMB(%)	RMSE	R ²	MBE	NMB (%)	RMSE
	0.46 (0.20)	-4.3 (-18.0)	-12.9 (-54.4)	24.3 (31.5)	0.50 (0.20)	-5.2 (-16.7)	-15.1 (-48.3)	20.5 (29.2)
Hourly	0.55 (0.27)	-4.1 (-18.0)	-12.5 (-54.4)	18.3 (27.0)	0.58 (0.28)	-5.2 (-16.7)	-15.0 (-48.3)	15.4 (24.7)
Daily	0.59 (0.40)	-4.2 (-18.0)	-12.7 (-54.3)	15.3 (23.8)	0.61 (0.40)	-5.2 (-16.6)	-15.1 (-48.3)	12.8 (21.6)
Monthly	0.40 (0.36)	-6.0 (-19.7)	-17.3 (-56.3)	16.5 (23.8)	0.55 (0.36)	-5.6 (-17.6)	-16.0 (-50.1)	12.2 (21.4)

Table S5: CV results of the reanalysis (outside bracket) and base simulation (in bracket) for CO concentrations in different regions of China at different temporal scales

CO (mg/m ³)	NCP				NE			
	R ²	MBE	NMB(%)	RMSE	R ²	MBE	NMB (%)	RMSE
Hourly	0.67 (0.25)	-0.03 (-0.59)	-2.49 (-43.4)	0.64 (1.13)	0.50 (0.20)	-0.05 (-0.51)	-5.3 (-51.9)	0.59 (0.88)
Daily	0.72 (0.31)	-0.03 (-0.59)	-2.15 (-43.3)	0.50 (0.99)	0.56 (0.25)	-0.05 (-0.51)	-4.9 (-51.7)	0.46 (0.78)
Monthly	0.74 (0.34)	-0.03 (-0.59)	-2.24 (-43.5)	0.38 (0.85)	0.59 (0.25)	-0.05 (-0.51)	-5.2 (-52.0)	0.37 (0.70)
Yearly	0.71 (0.14)	-0.04 (-0.64)	-2.75 (-45.1)	0.32 (0.85)	0.55 (0.14)	-0.06 (-0.56)	-5.9 (-54.0)	0.35 (0.74)
SE				SW				
	R ²	MBE	NMB(%)	RMSE	R ²	MBE	NMB (%)	RMSE
	0.42 (0.13)	-0.06 (-0.36)	-6.4 (-38.2)	0.39 (0.62)	0.36 (0.07)	-0.08 (-0.32)	-9.4 (-36.4)	0.46 (0.65)
Hourly	0.45 (0.15)	-0.06 (-0.36)	-6.1 (-38.0)	0.34 (0.57)	0.40 (0.08)	-0.08 (-0.31)	-9.1 (-36.3)	0.39 (0.59)
Daily	0.44 (0.14)	-0.06 (-0.36)	-6.2 (-38.1)	0.28 (0.51)	0.40 (0.08)	-0.08 (-0.32)	-9.4 (-36.7)	0.34 (0.54)
Monthly	0.38 (0.05)	-0.06 (-0.38)	-6.5 (-39.3)	0.25 (0.50)	0.36 (0.01)	-0.09 (-0.36)	-10.1 (-39.1)	0.36 (0.57)
NW				Central				
	R ²	MBE	NMB(%)	RMSE	R ²	MBE	NMB (%)	RMSE
	0.38 (0.12)	-0.19 (-1.02)	-15.0 (-79.3)	1.13 (1.55)	0.44 (0.22)	-0.13 (-0.76)	-11.2 (-65.2)	0.73 (1.11)
Hourly	0.45 (0.18)	-0.19 (-1.01)	-14.6 (-79.2)	0.92 (1.43)	0.49 (0.27)	-0.13 (-0.76)	-10.8 (-65.1)	0.62 (1.04)
Daily	0.50 (0.29)	-0.19 (-1.02)	-15.1 (-79.3)	0.75 (1.32)	0.53 (0.32)	-0.13 (-0.76)	-11.1 (-65.2)	0.52 (0.97)
Monthly	0.13 (0.12)	-0.31 (-1.18)	-21.1 (-80.8)	0.85 (1.35)	0.19 (0.08)	-0.17 (-0.84)	-13.3 (-67.3)	0.69 (1.08)

Table S6: CV results of the reanalysis (outside bracket) and base simulation (in bracket) for O₃ concentrations in different regions of China at different temporal scales

O ₃ ($\mu\text{g}/\text{m}^3$)	NCP				NE			
	R ²	MBE	NMB(%)	RMSE	R ²	MBE	NMB (%)	RMSE
Hourly	0.83 (0.50)	-3.9 (-24.5)	-6.1 (-39.1)	22.1 (44.3)	0.76 (0.38)	-3.6 (-15.4)	-6.0 (-25.6)	21.0 (36.7)
Daily	0.83 (0.48)	-3.8 (-24.5)	-6.0 (-39.1)	16.3 (37.0)	0.76 (0.34)	-3.6 (-15.3)	-5.9 (-25.5)	16.4 (30.8)
Monthly	0.85 (0.62)	-3.8 (-24.4)	-6.1 (-39.1)	12.6 (31.6)	0.76 (0.42)	-3.6 (-15.2)	-5.9 (-25.4)	13.1 (25.2)
Yearly	0.72 (0.29)	-3.7 (-23.1)	-6.2 (-38.6)	9.2 (26.8)	0.62 (0.18)	-3.5 (-14.4)	-6.1 (-25.0)	10.0 (20.4)
SE								SW
	R ²	MBE	NMB(%)	RMSE	R ²	MBE	NMB (%)	RMSE
	0.77 (0.57)	-2.3 (-10.0)	-3.9 (-17.4)	21.1 (38.2)	0.69 (0.40)	0.8 (9.6)	1.4 (18.0)	22.2 (33.6)
Hourly	0.69 (0.44)	-2.2 (-10.0)	-3.8 (-17.3)	15.8 (31.0)	0.64 (0.34)	0.8 (9.7)	1.5 (18.1)	17.4 (26.7)
Daily	0.69 (0.43)	-2.2 (-10.0)	-3.9 (-17.3)	12.4 (24.2)	0.64 (0.44)	0.8 (9.7)	1.6 (18.1)	14.4 (21.1)
Monthly	0.45 (0.07)	-2.4 (-10.1)	-4.2 (-17.7)	10.0 (20.7)	0.42 (0.28)	1.3 (10.0)	2.6 (19.4)	12.0 (17.7)
NW								Central
	R ²	MBE	NMB(%)	RMSE	R ²	MBE	NMB (%)	RMSE
	0.52 (0.31)	-2.7 (-2.2)	-4.6 (-3.8)	28.3 (33.2)	0.71 (0.45)	-1.5 (-0.8)	-2.5 (-1.3)	23.9 (32.5)
Hourly	0.50 (0.31)	-2.6 (-2.1)	-4.5 (-3.6)	22.9 (26.6)	0.67 (0.42)	-1.4 (-0.7)	-2.4 (-1.1)	17.8 (23.9)
Daily	0.58 (0.42)	-2.6 (-2.1)	-4.5 (-3.6)	19.1 (22.1)	0.72 (0.56)	-1.4 (-0.7)	-2.4 (-1.2)	13.9 (17.6)
Monthly	0.37 (0.24)	-1.6 (-0.6)	-2.9 (-1.1)	15.7 (17.1)	0.53 (0.30)	-0.8 (0.2)	-1.4 (0.4)	11.6 (14.1)

Figures

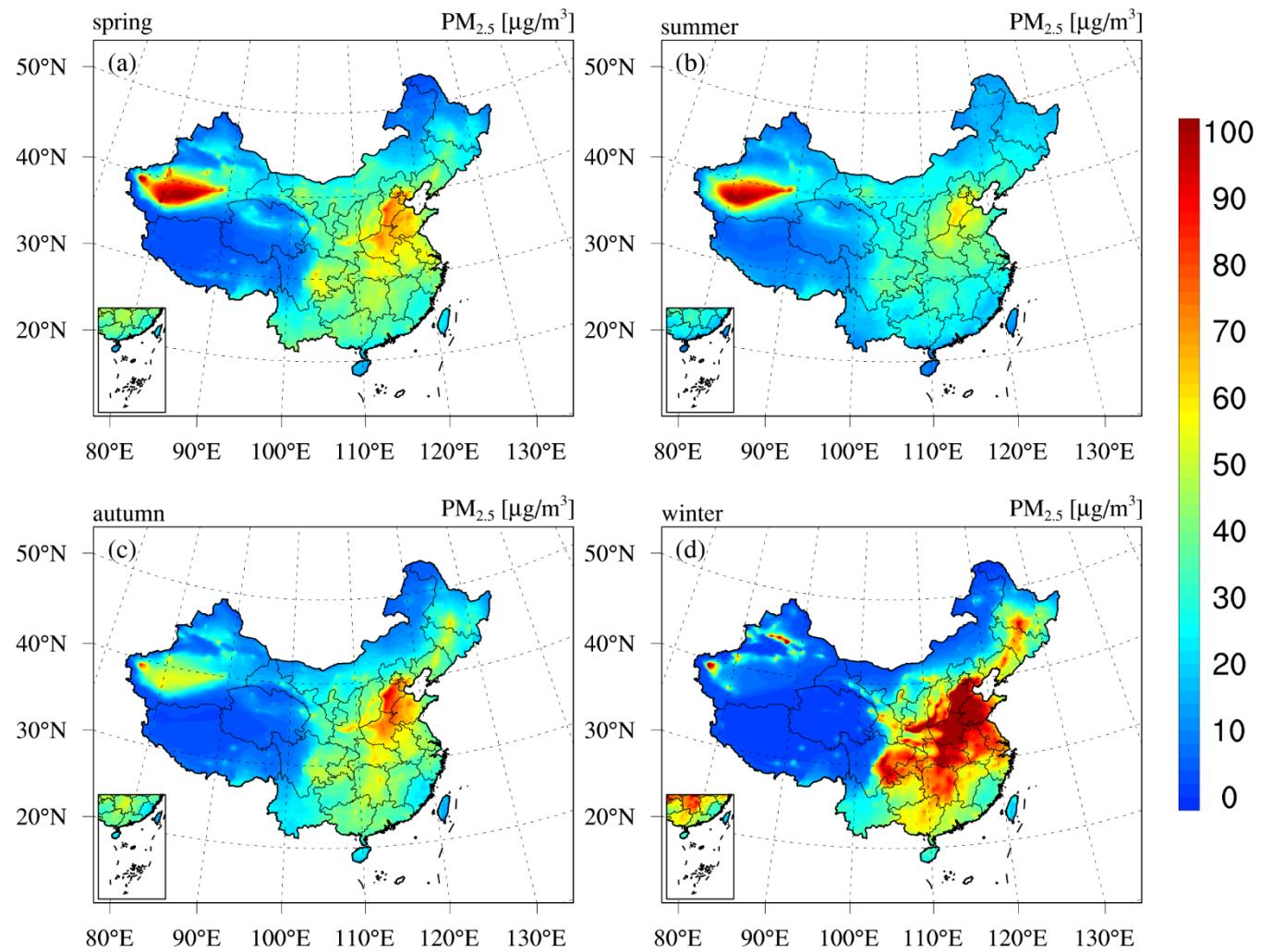


Figure S1: Spatial distributions of the $\text{PM}_{2.5}$ concentrations in China during (a) spring, (b) summer, (c) autumn and (d) winter averaged from 2013 to 2018.

5

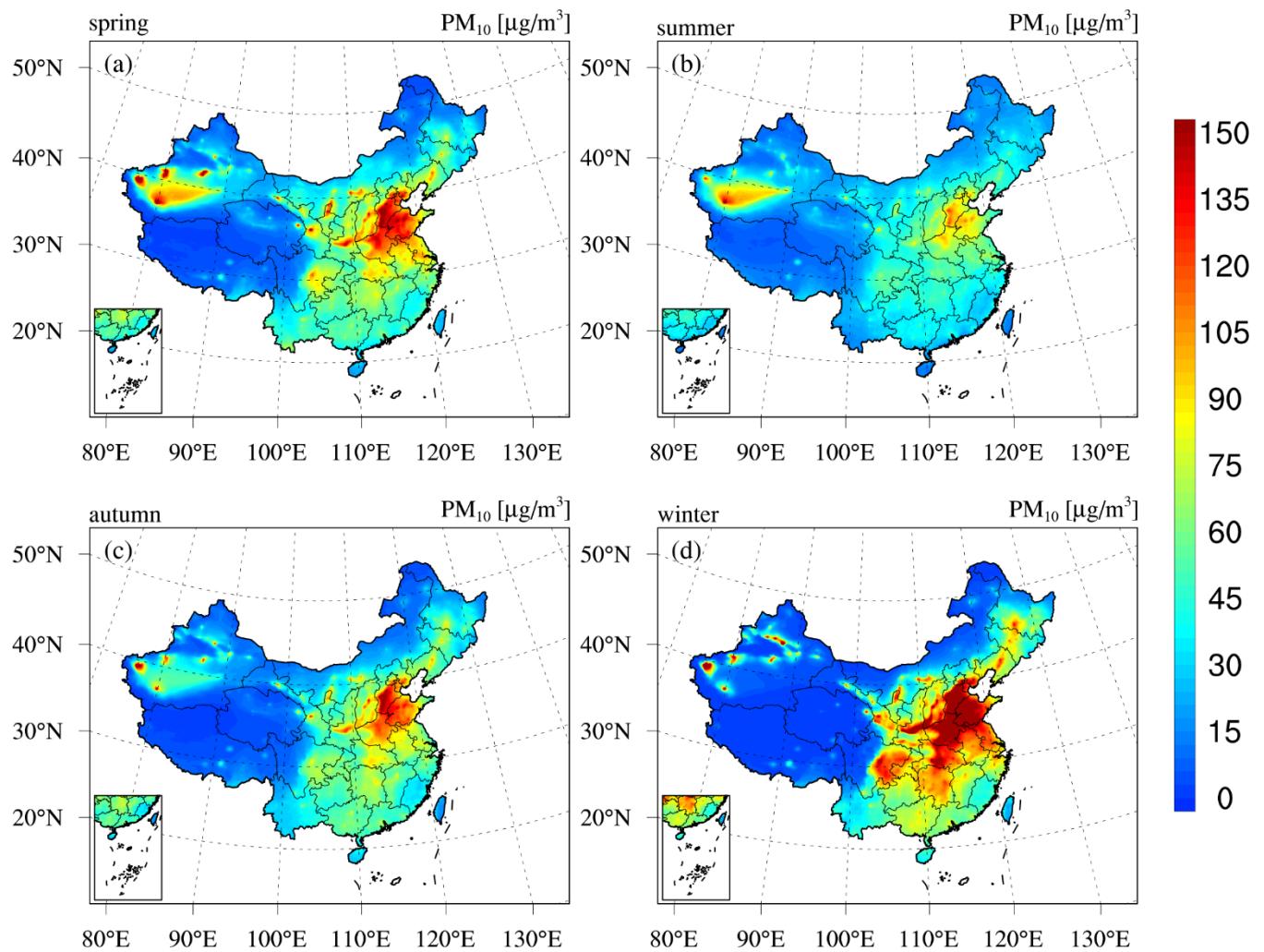


Figure S2: Same as Fig. S1 but for PM₁₀ concentrations.

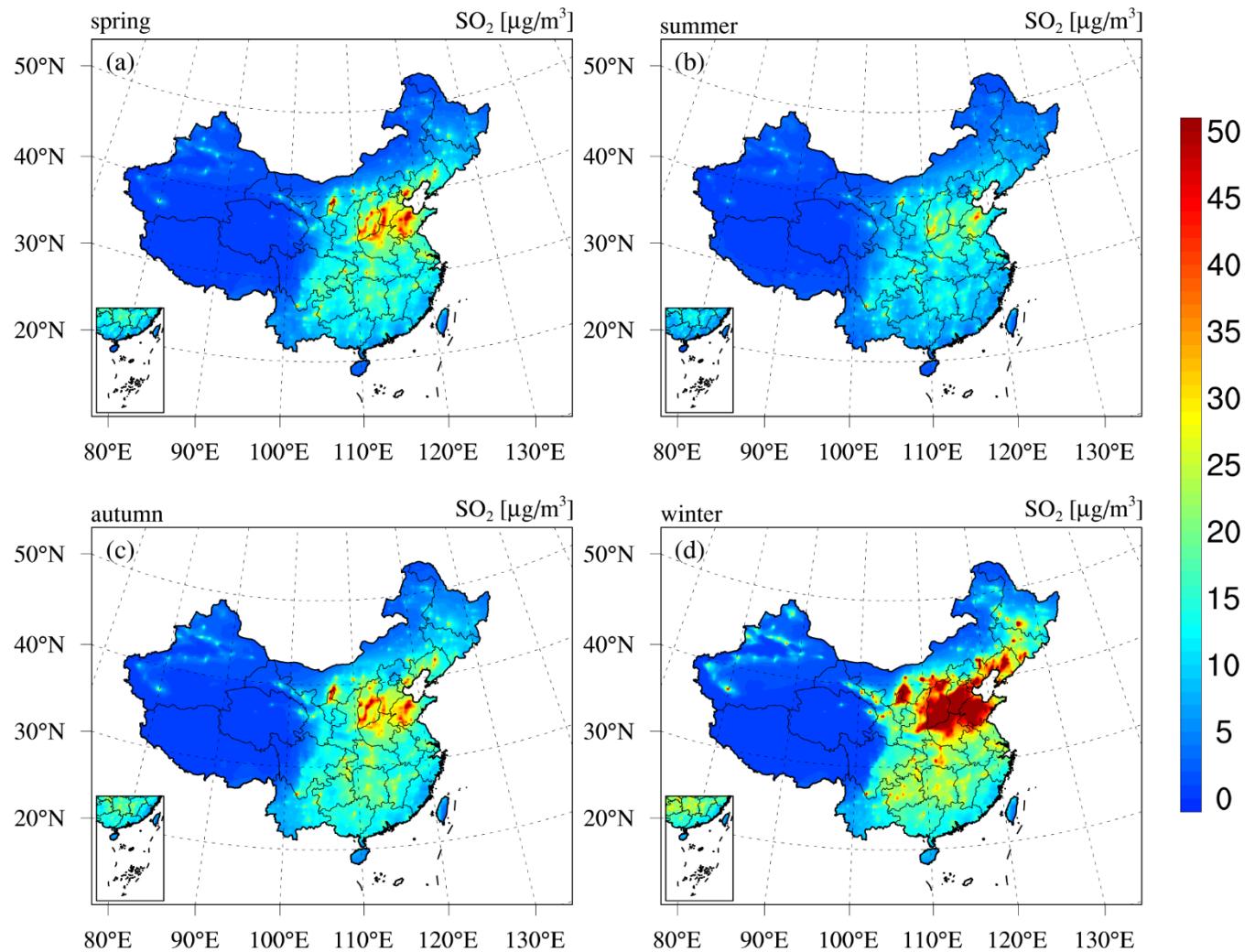


Figure S3: Same as Fig. S1 but for SO_2 concentrations.

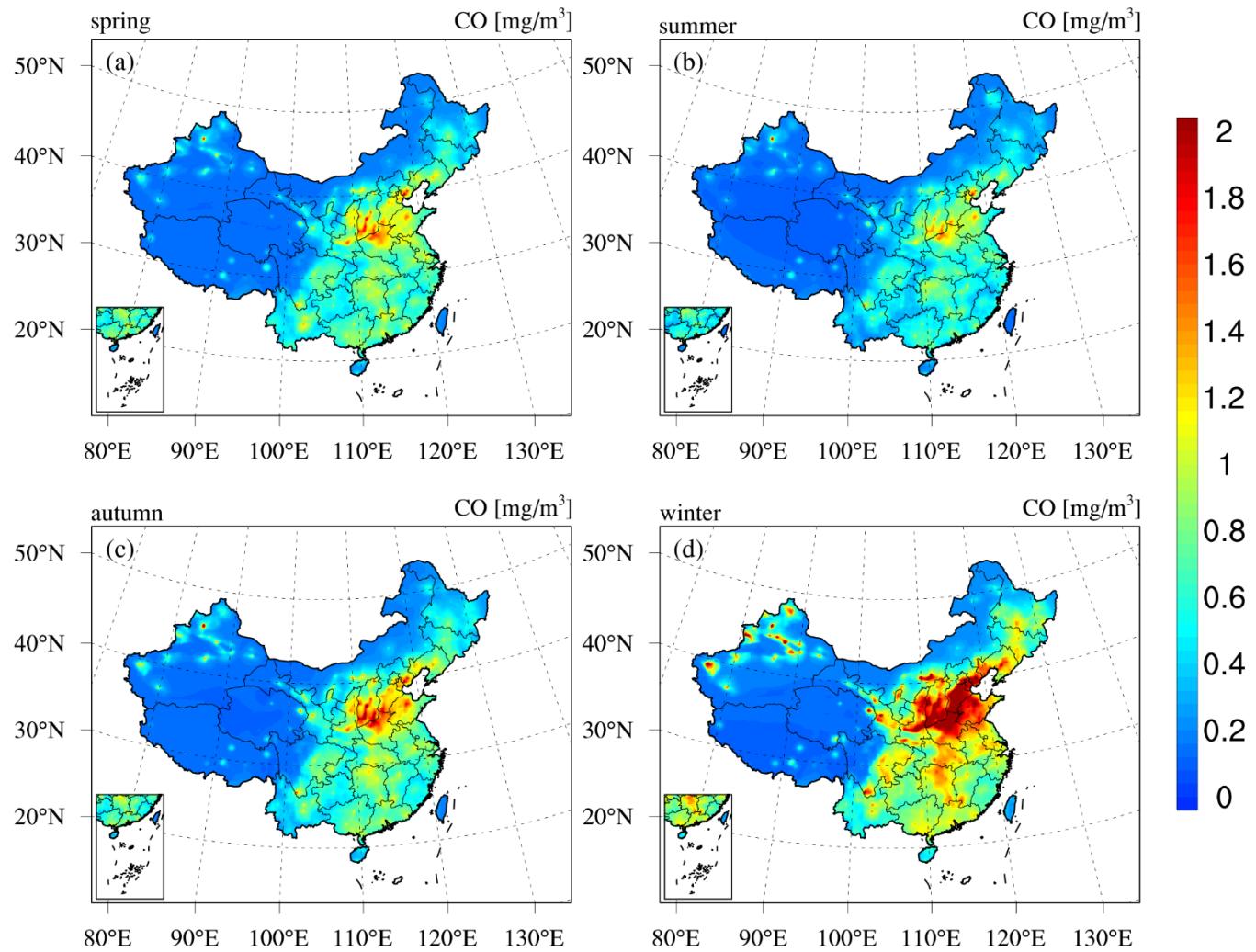


Figure S4: Same as Fig. S1 but for CO concentrations.

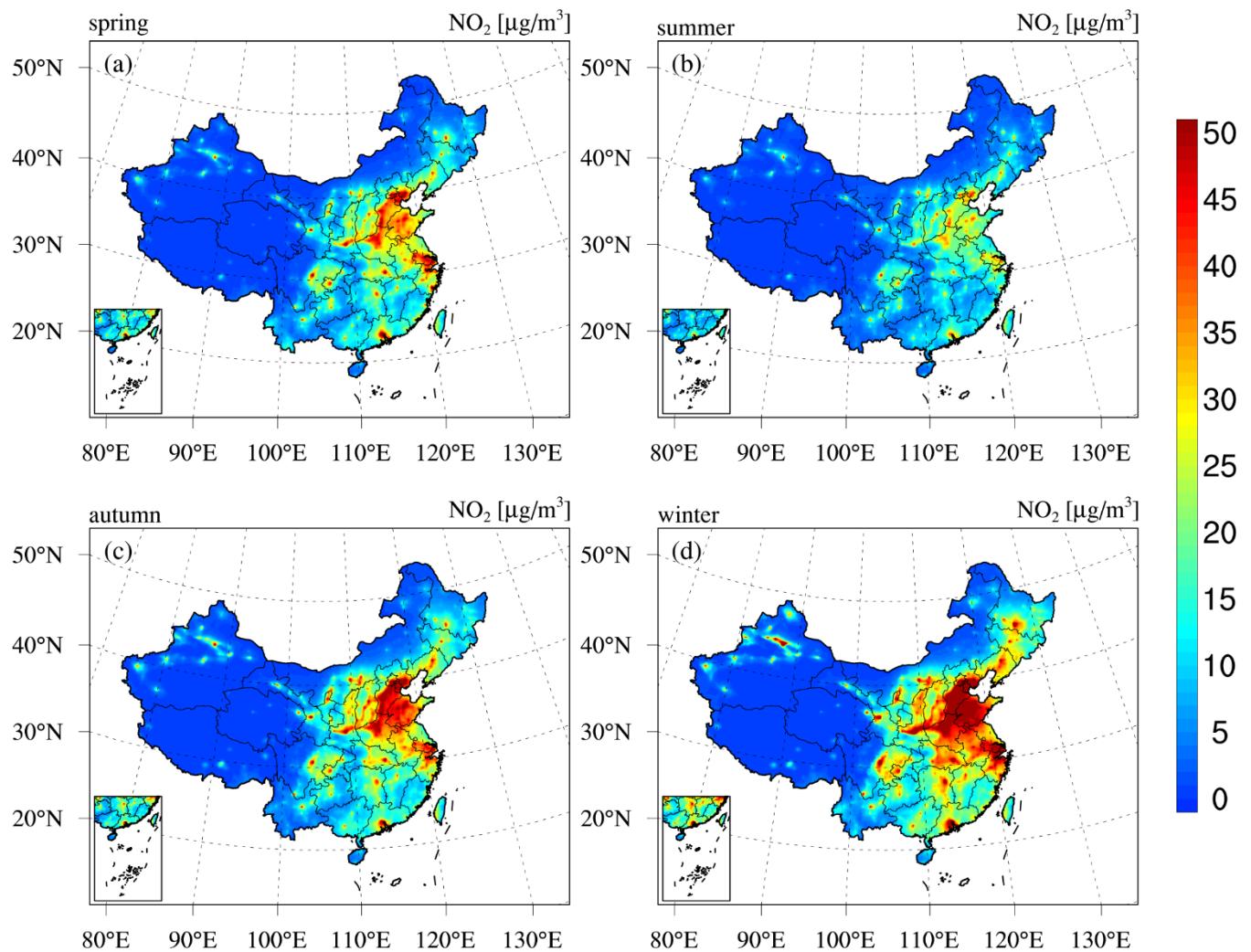


Figure S5: Same as Fig. S1 but for NO_2 concentrations.

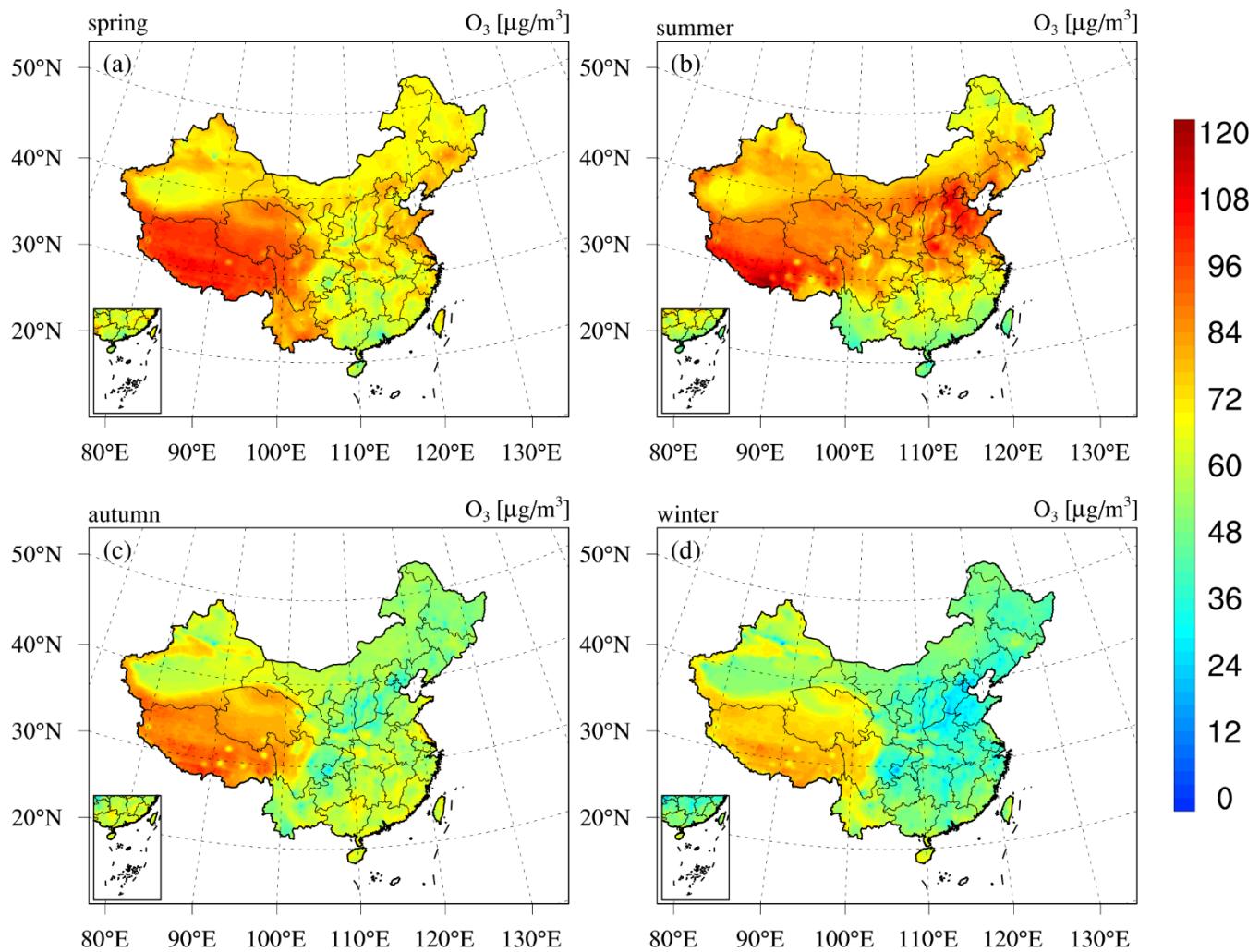


Figure S6: Same as Fig. S1 but for O₃ concentrations.