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2 *Supplement of*

3 **The Regional Climate-Chemistry-Ecology**
4 **Coupling Model RegCM-Chem (v4.6)-YIBs (v1.0):**
5 **Development and Application**

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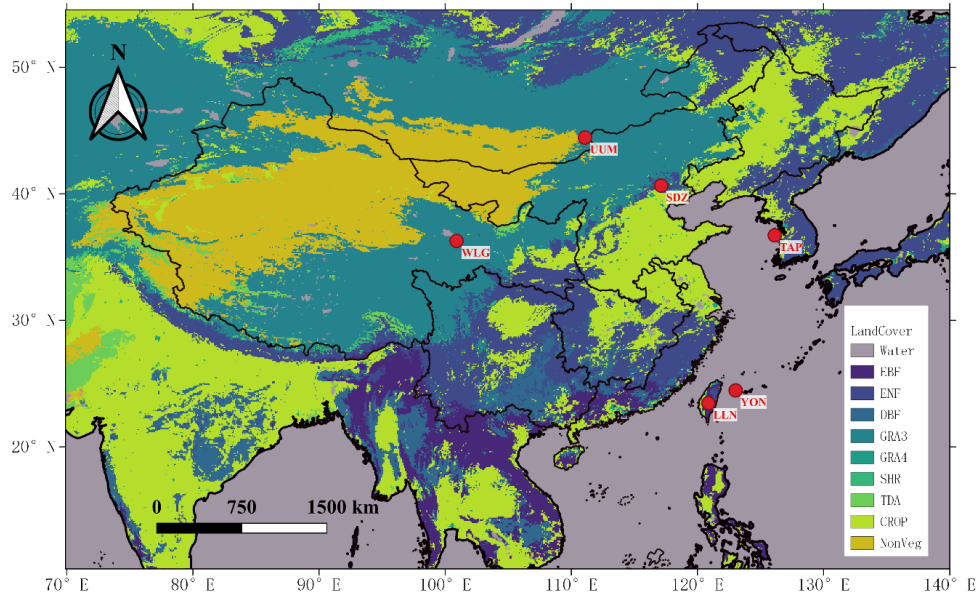
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30 **Figure S1.** Distribution map of surface vegetation types in the simulated area. Evergreen broad-
 31 leaved forest (EBF), evergreen coniferous forest (ENF), deciduous broad-leaved forest (DBF), C3
 32 grassland (GRA3), C4 grassland (GRA4), shrub forest (SHR), tundra (TDA), crops (CROP). The
 33 red circles indicate the locations of CO₂ observation sites.

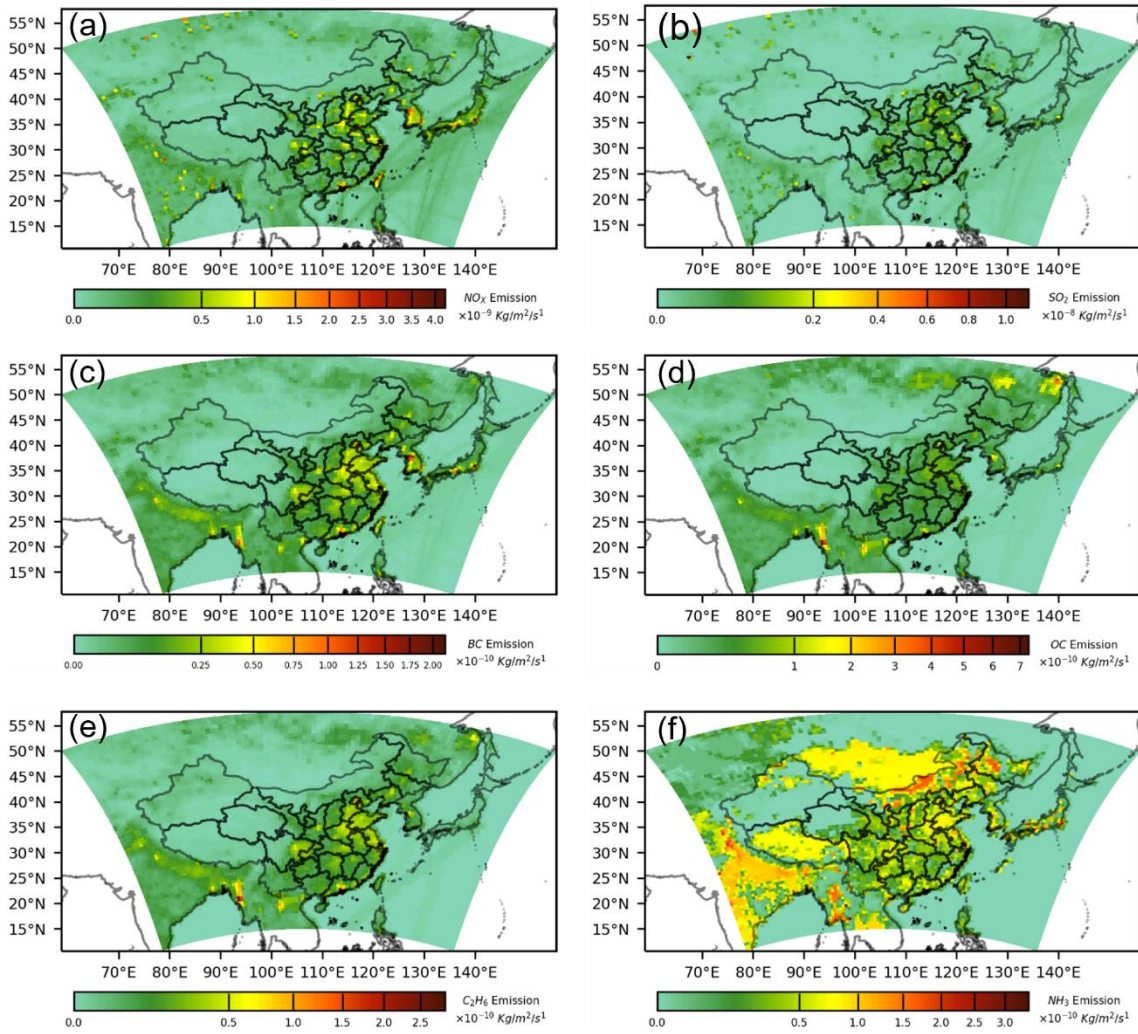
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40 **Figure S2.** Emission fluxes of main pollutants (NO_x (a), SO_2 (b), BC(c), OC(d), C_2H_6 (e), NH_3 (f))
 41 in the simulation area. Units: $\text{Kg m}^{-2} \text{s}^{-1}$.

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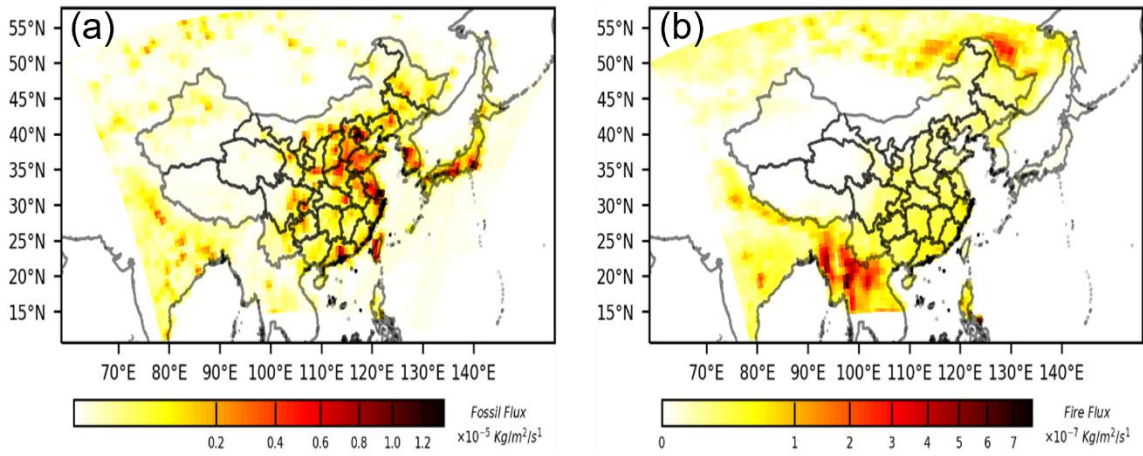
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61 **Figure S3.** Modeling regional CO₂ emission fluxes from fossil fuel(a) and biomass
62 combustion(b). Units: Kg m⁻² s⁻¹.

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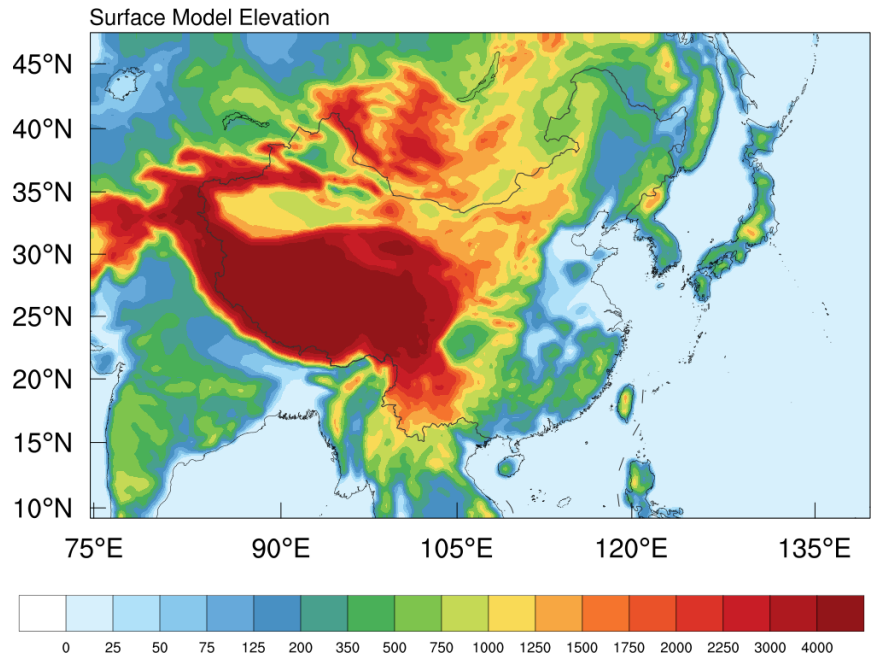
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87 **Figure S4.** The modelling domain applied and Topographic Elevation (Units: m) in this study.

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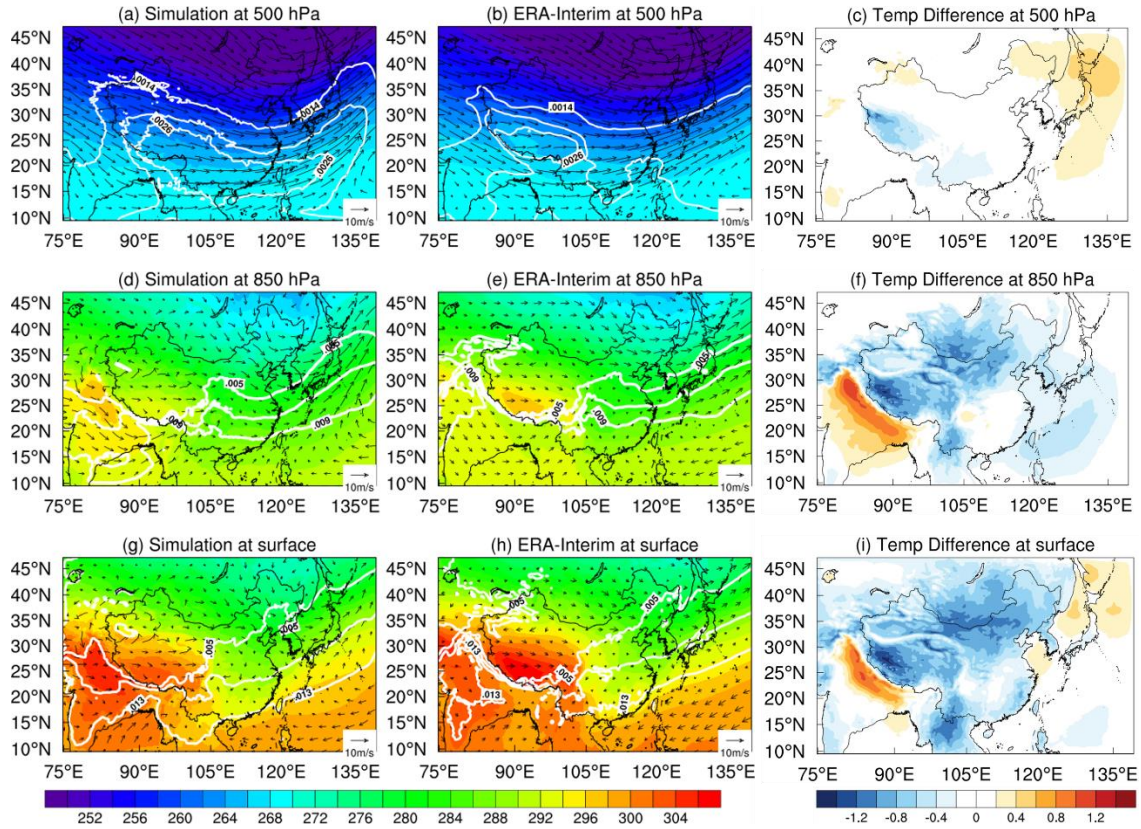
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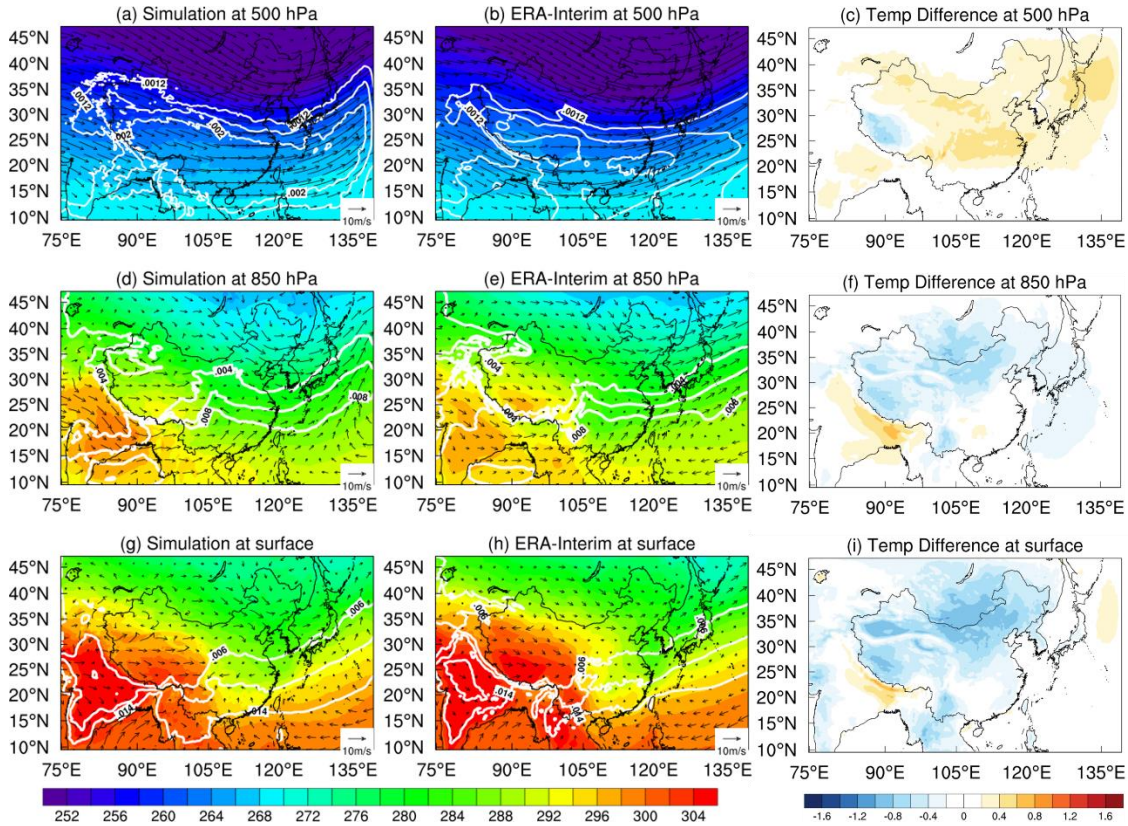
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115 **Figure S5.** Temperature (color-filled; units: K), specific humidity (contours; units: kg kg^{-1}) and wind
 116 field (streamlines; units: m s^{-1}) in 2016 at 500 hPa (a, b), 850 hPa (d, e) and near surface (g, h) for the
 117 model simulation (a, d, g) and ERA-Interim data (b, e, h). The column on the far right shows the
 118 differences between simulated and observed temperature at 500hPa (c), 850hPa (f), and surface (i).
 119 The differences are simulation minus observation.

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128 **Figure S6.** Spring average temperature (color-filled; units: K), specific humidity (contours; units: kg
 129 kg^{-1}) and wind field (streamlines; units: m s^{-1}) in 2016 at 500 hPa (a, b), 850 hPa (d, e) and near
 130 surface (g, h) for the model simulation (a, d, g) and ERA-Interim data (b, e, h). The column on the far
 131 right shows the differences between simulated and observed temperature at 500hPa (c), 850hPa (f),
 132 and surface (i). The differences are simulation minus observation. The months we defined as spring
 133 include March, April and May.

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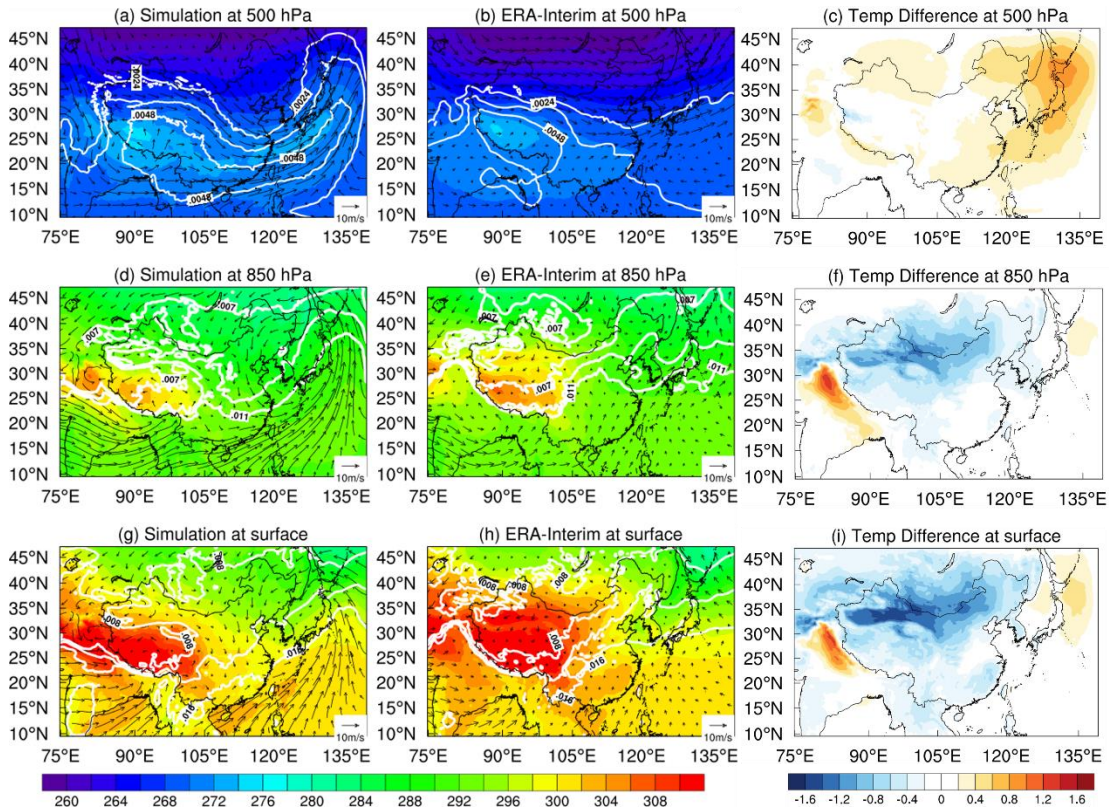
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144 **Figure S7.** Summer average temperature (color-filled; units: K), specific humidity (contours; units:
 145 kg kg^{-1}) and wind field (streamlines; units: m s^{-1}) in 2016 at 500 hPa (a, b), 850 hPa (d, e) and near
 146 surface (g, h) for the model simulation (a, d, g) and ERA-Interim data (b, e, h). The column on the far
 147 right shows the differences between simulated and observed temperature at 500hPa (c), 850hPa (f),
 148 and surface (i). The differences are simulation minus observation. The months we define as summer
 149 include June, July and August.

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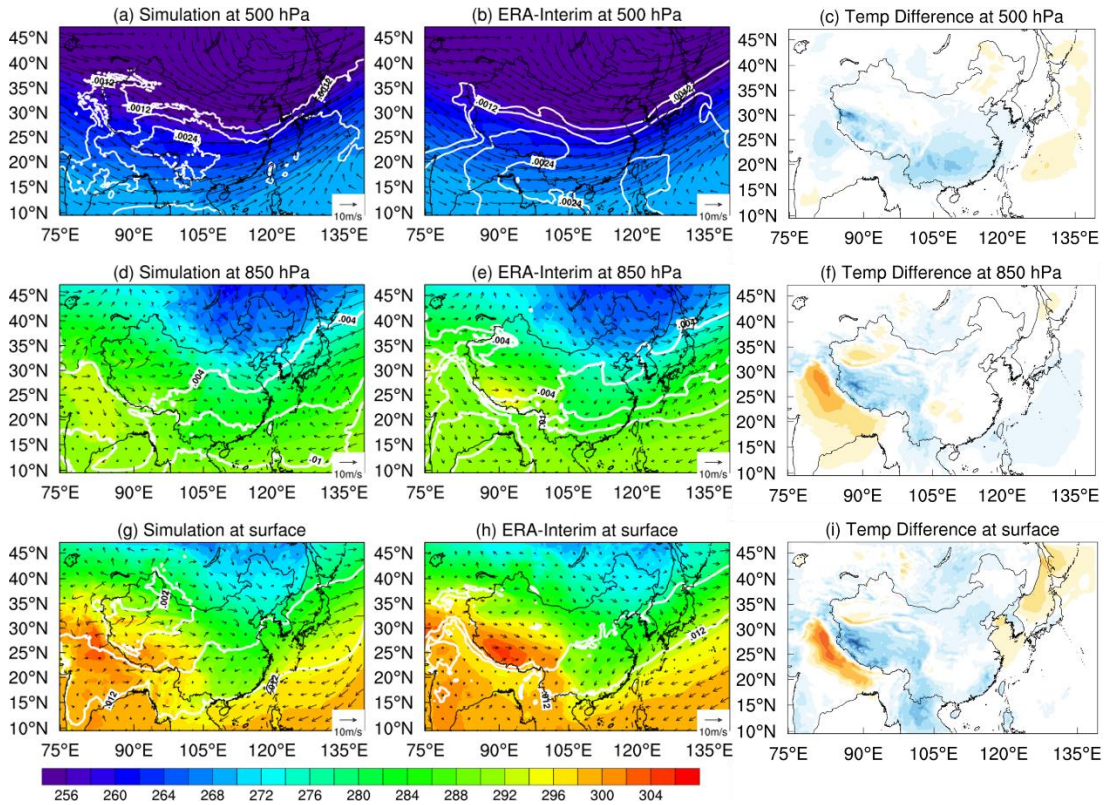
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161 **Figure S8.** Autumn average temperature (color-filled; units: K), specific humidity (contours; units: kg
 162 kg^{-1}) and wind field (streamlines; units: m s^{-1}) in 2016 at 500 hPa (a, b), 850 hPa (d, e) and near
 163 surface (g, h) for the model simulation (a, d, g) and ERA-Interim data (b, e, h). The column on the far
 164 right shows the differences between simulated and observed temperature at 500hPa (c), 850hPa (f),
 165 and surface (i). The differences are simulation minus observation. The months we define as autumn
 166 include September, October and November.

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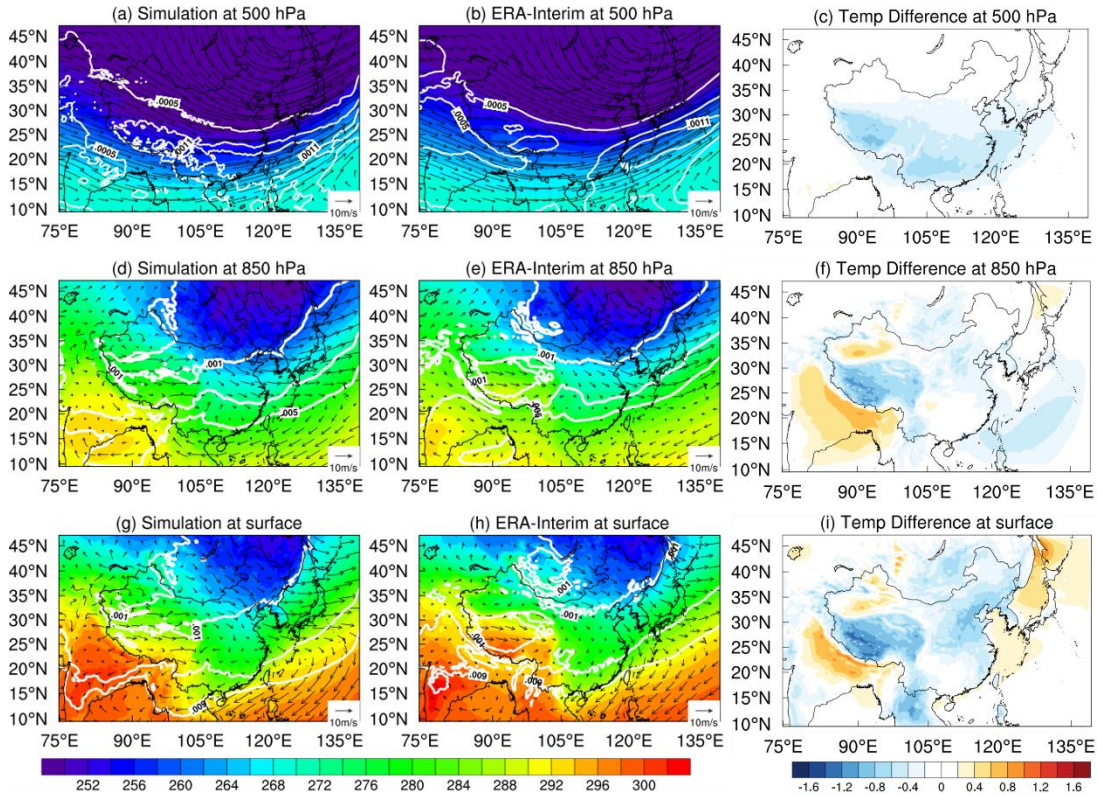
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178 **Figure S9.** Winter average temperature (color-filled; units: K), specific humidity (contours; units: kg
 179 kg^{-1}) and wind field (streamlines; units: m s^{-1}) in 2016 at 500 hPa (a, b), 850 hPa (d, e) and near
 180 surface (g, h) for the model simulation (a, d, g) and ERA-Interim data (b, e, h). The column on the far
 181 right shows the differences between simulated and observed temperature at 500hPa (c), 850hPa (f) and
 182 surface (i). The differences are simulation minus observation. The months we define as winter include
 183 January, February and December.

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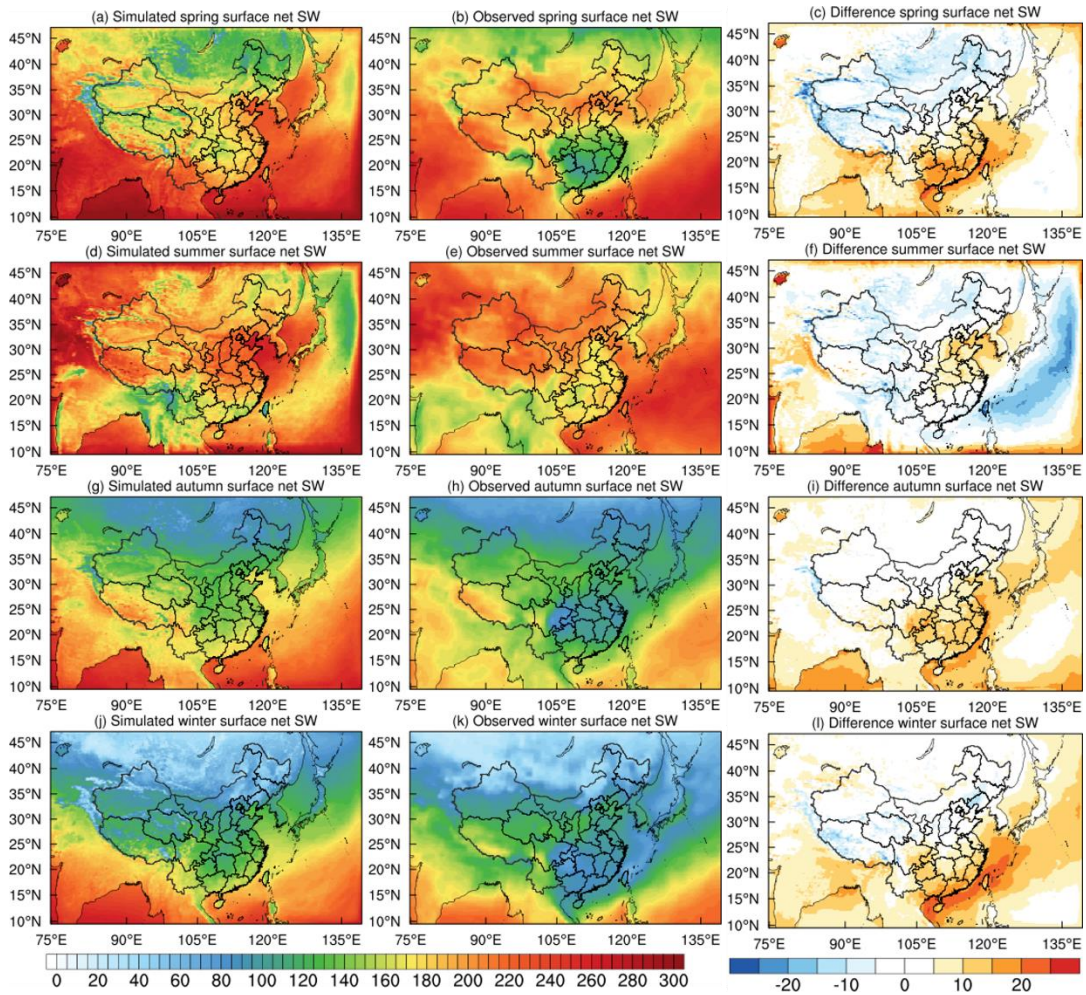
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195 **Figure S10.** Spring (a, b), summer (d, e), autumn (g, h), winter (j, k) four season model simulations (a,
 196 d, g, j) and satellite retrieval (b, e, h, k) in 2016 surface net shortwave radiation flux. The column on
 197 the far right shows the difference between simulations and observations for spring(c), summer(f),
 198 autumn(i), and winter(l). The differences are simulation minus observation. Units: $W m^{-2}$.

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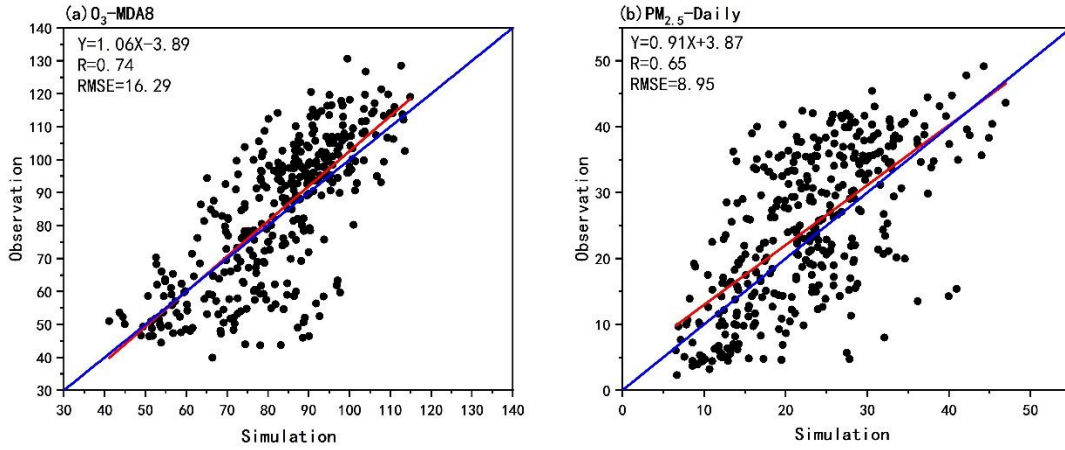
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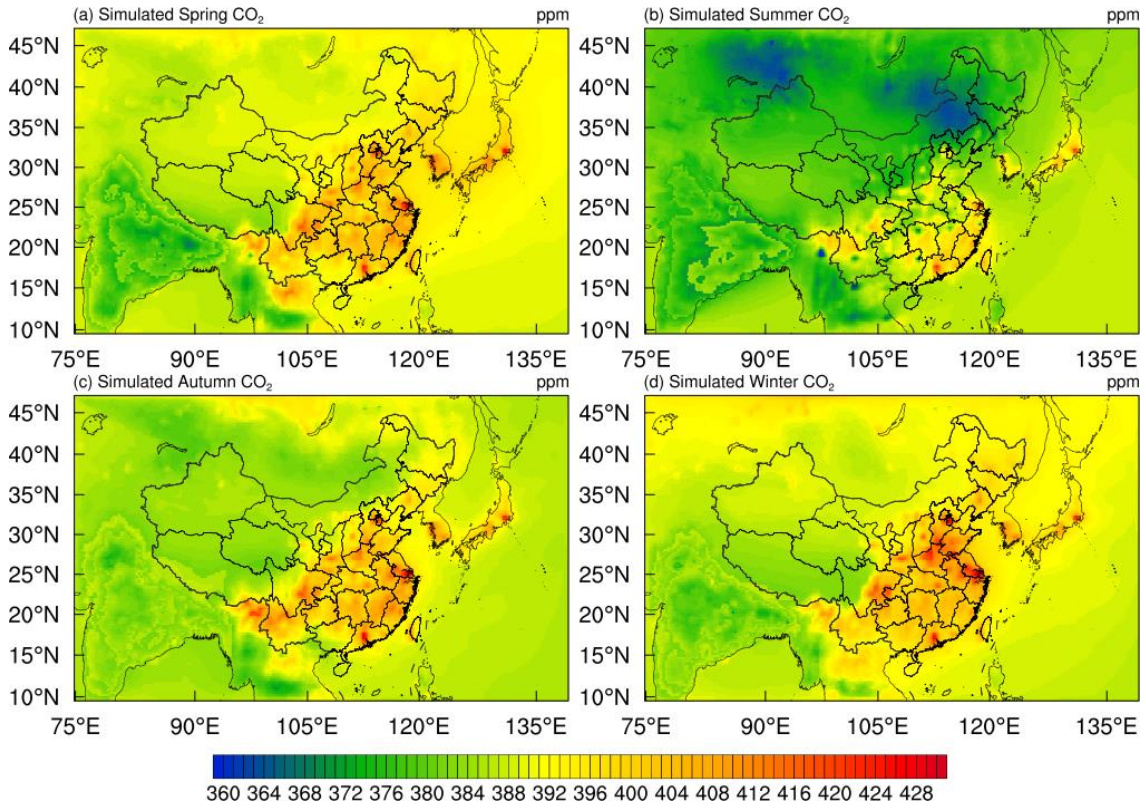
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209 **Figure S11.** Scatter plot of simulated and observed for O_3 (a) and $PM_{2.5}$ (b) Units: $\mu g m^{-3}$

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239 **Figure S12.** Spatial distribution of CO₂ simulated by model of spring(a), summer(b), autumn(c) and
 240 winter(d) in 2016. Units: ppm

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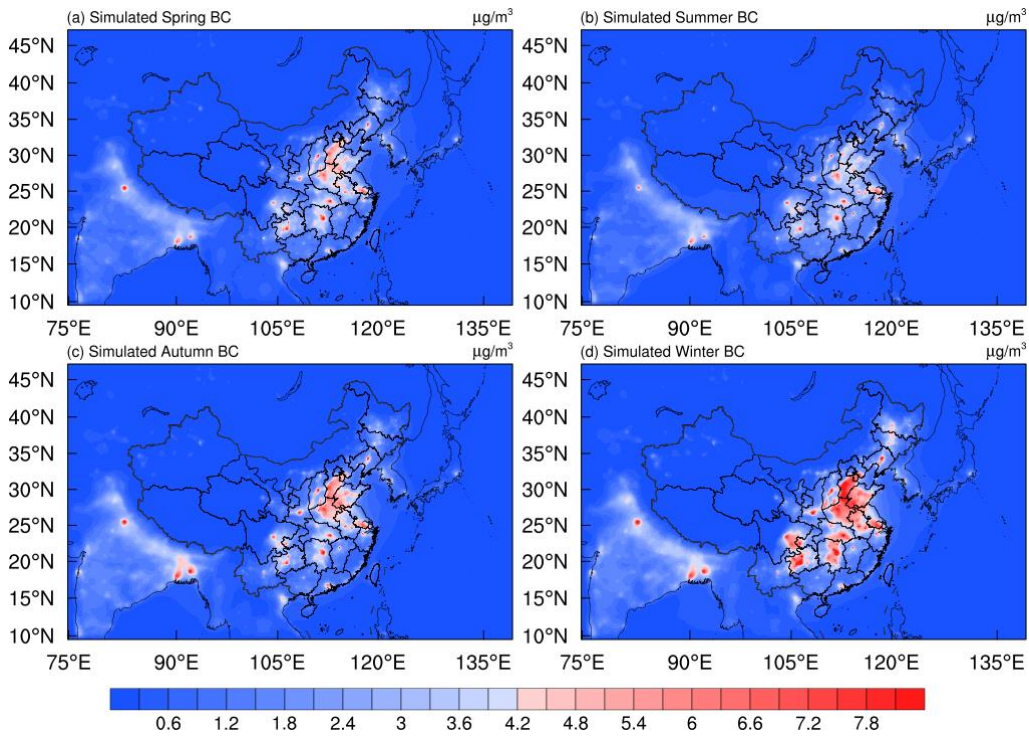
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265 **Figure S13.** Spatial distribution of BC simulated by four season models of spring(a), summer(b),
 266 autumn(c) and winter(d) in 2016. Units: $\mu\text{g m}^{-3}$

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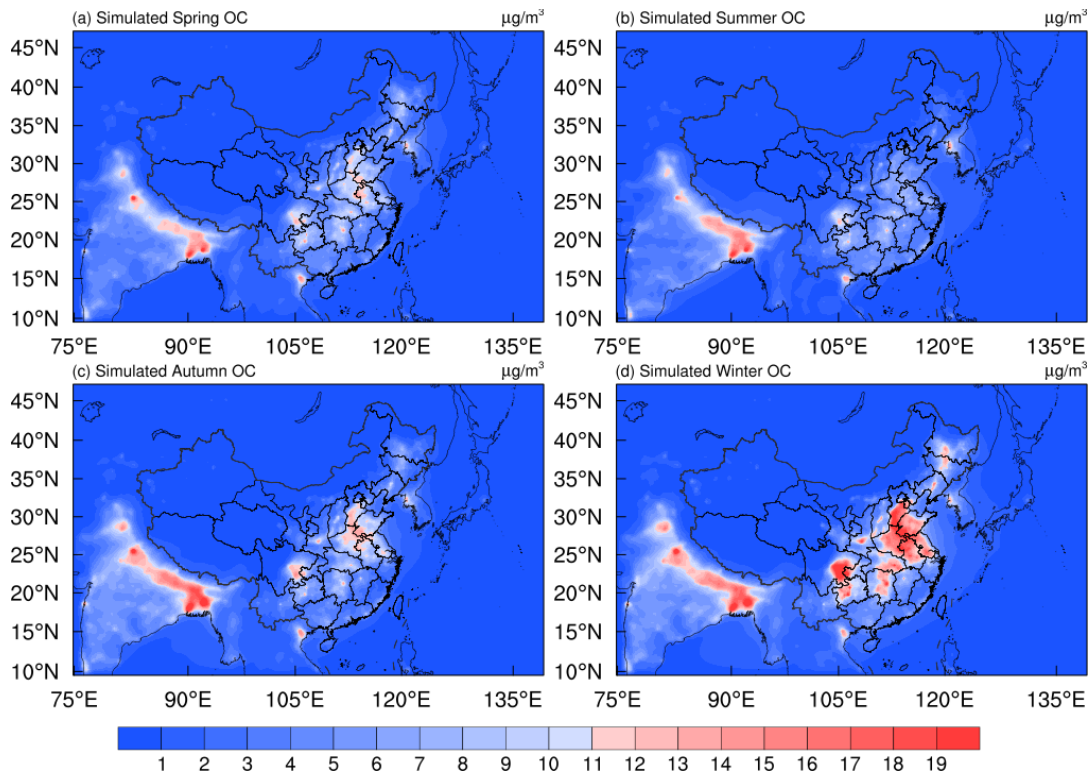
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291 **Figure S14.** Spatial distribution of OC simulated by four season models of spring(a), summer(b),
 292 autumn(c) and winter(d) in 2016. Units: $\mu\text{g m}^{-3}$

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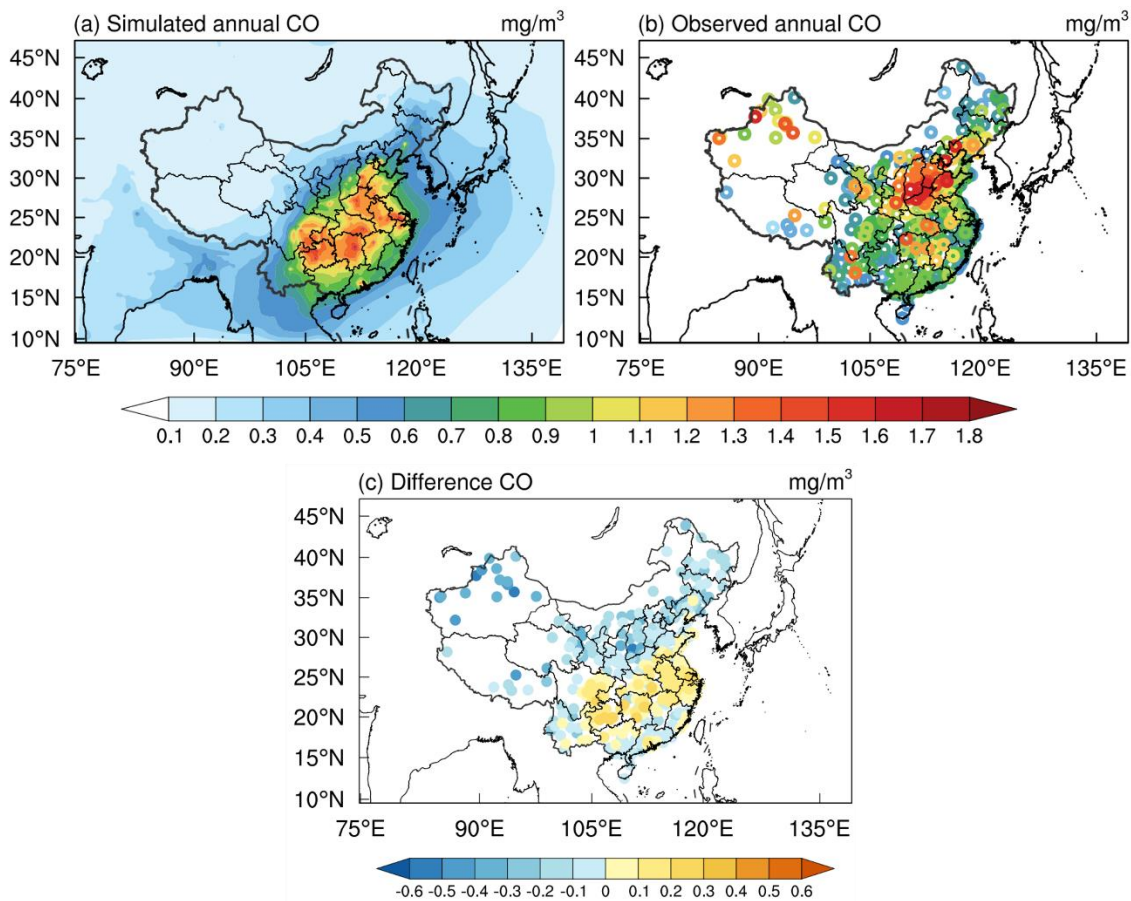
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314 **Figure S15.** Comparisons of simulations (a) and observations (b) and their differences (c) for CO
 315 across China. Colored circles show station observations. The differences are simulation minus
 316 observation. Units: mg m^{-3} .

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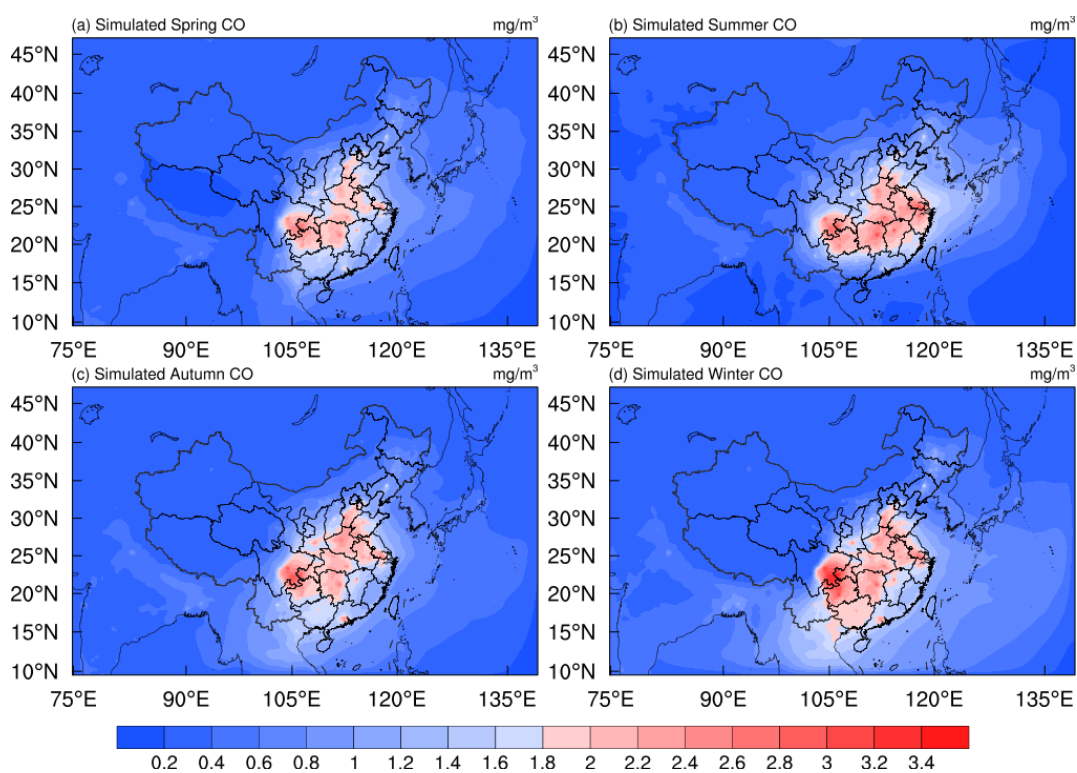
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342 **Figure S16.** Spatial distribution of CO simulated by four season models of spring(a), summer(b),
343 autumn(c) and winter(d) in 2016. Units: mg m⁻³

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366 **Table S1.** Statistical metrics for surface O₃ and PM_{2.5} concentration

Variables	R	MB	ME	NMB	NME	RMSE
O ₃ _MDA8	0.74	-1.47	11.61	0.0235	0.1577	16.29
PM _{2.5} _Daily	0.65	-1.80	7.21	0.1380	0.4211	8.95

367 (Abbreviated meaning: correlation coefficients (R), mean biases(MB), mean error (ME), normal mean
368 biases (NMB), normal mean error (NME), and root mean square error (RMSE). MB, ME and RMSE
369 units: $\mu\text{g m}^{-3}$)

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374 **Table S2.** Comparison between Observation and simulation carbon fluxes

Variables	R	MB	ME	RMSE
GPP	0.91	0.13	0.22	0.40
NPP	0.87	0.05	0.12	0.22

375 (The abbreviation definitions R, MB, ME, and RMSE are consistent with Table S1. MB, ME and
376 RMSE units: $\text{Kg C m}^{-2} \text{ year}^{-1}$)

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