Supplementary Materials:

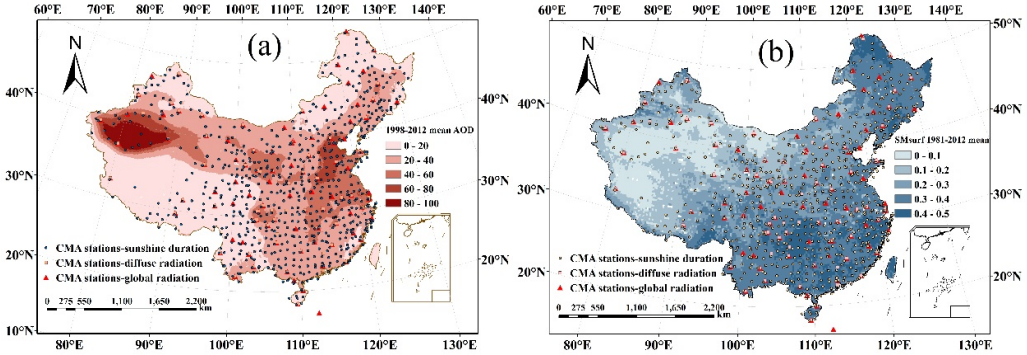
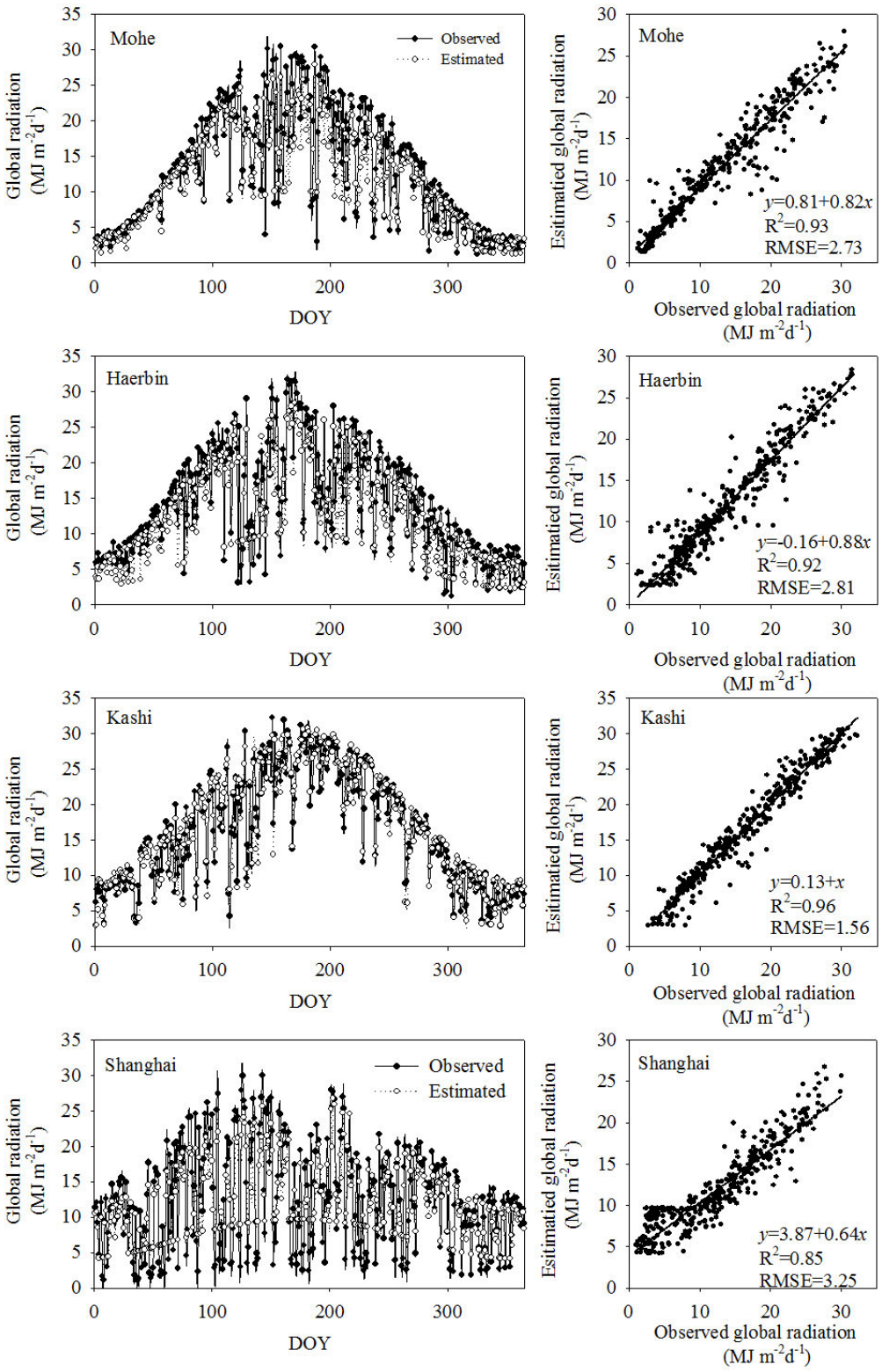
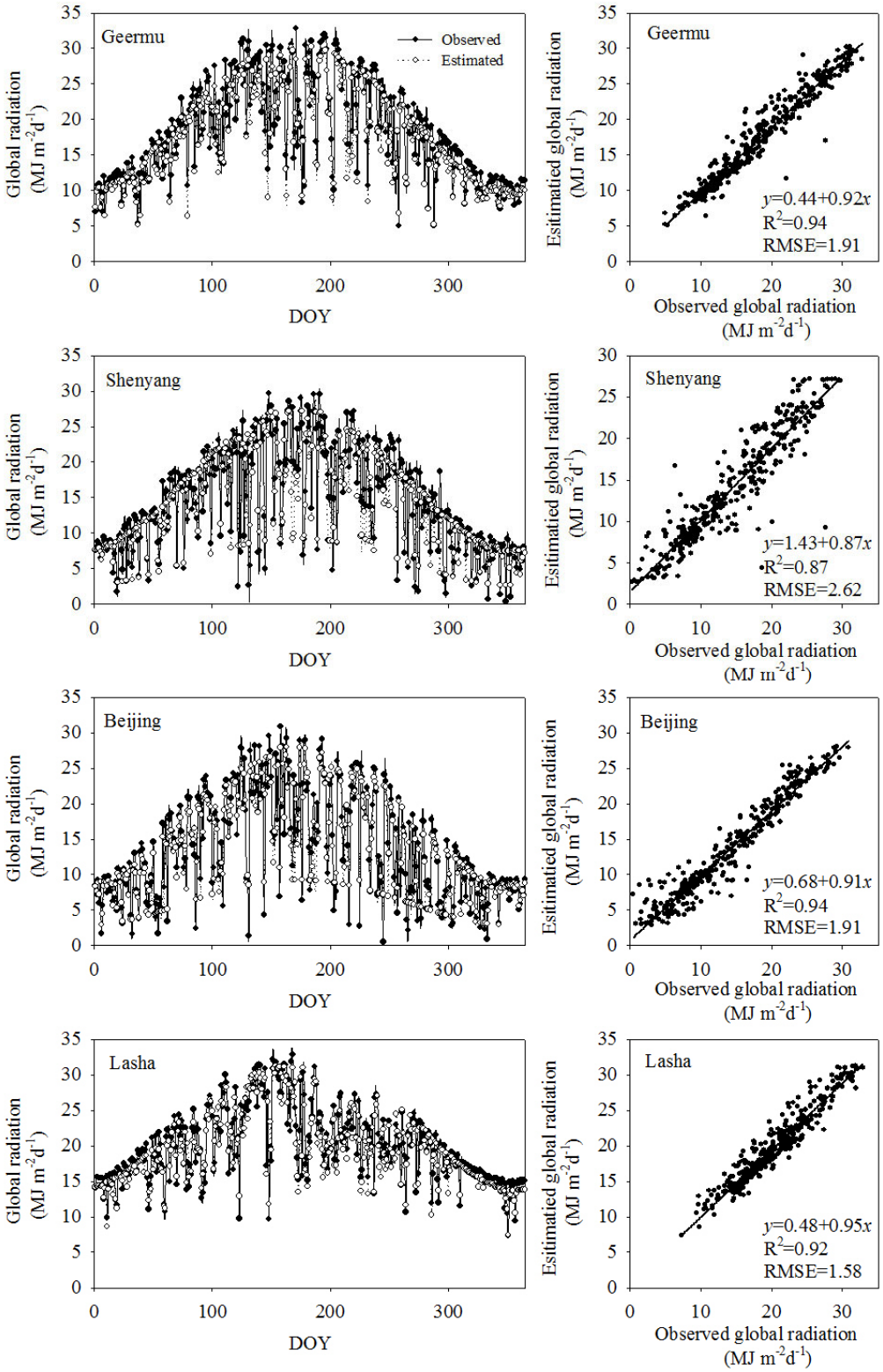


Figure S1 Distribution of sunshine duration, diffuse and global radiation station in China. The background was Aerosol Optical Depth (AOD, unit: ug m^{-3}) (**a**) and soil moisture (**b**). AOD data was from satellite-derived Geographically Weighted Regression (GWR) adjusted PM2.5 concentrations at 0.1° × 0.1° (V4.GL.02) for the period of 1998–2012, which were provided by the Atmospheric Composition Analysis Group via: http://fizz.phys.dal.ca/~atmos/martin/?page_id=140. Soil moisture data were from satellite-derived soil moisture at 0.25° × 0.25° for the period of 1981–2012 from GLEAM V3.3.


Mohe
Observed
Estimated
Global radiation (MJ m-2d-1)
DOY
Mohe
Estimatied global radiation (MJ m-2d-1)
Observed global radiation (MJ m-2d-1)
y=0.81+0.82x
R2=0.93
RMSE=2.73
Haerbin
Global radiation (MJ m-2d-1)
DOY
Haerbin
Estimatied global radiation (MJ m-2d-1)
Observed global radiation (MJ m-2d-1)
y=-0.16+0.88x
R2=0.92
RMSE=2.81
Kashi
Global radiation (MJ m-2d-1)
DOY
Kashi
Estimatied global radiation (MJ m-2d-1)
Observed global radiation (MJ m-2d-1)
y=0.13+x
R2=0.96
RMSE=1.56
Shanghai
Observed
Estimated
Global radiation (MJ m-2d-1)
DOY
Shanghai
Estimatied global radiation (MJ m-2d-1)
Observed global radiation (MJ m-2d-1)
y=3.87+0.64x
R2=0.85
RMSE=3.25


Geermu
Observed
Estimated
Global radiation (MJ m-2d-1)
DOY
Esitimatied global radiation (MJ m-2d-1)
Observed global radiation (MJ m-2d-1)
y=0.44+0.92x
R2=0.94
RMSE=1.91
Shenyang
y=1.43+0.87x
R2=0.87
RMSE=2.62
Beijing
y=0.68+0.91x
R2=0.94
RMSE=1.91
Lasha
y=0.48+0.95x
R2=0.92
RMSE=1.58

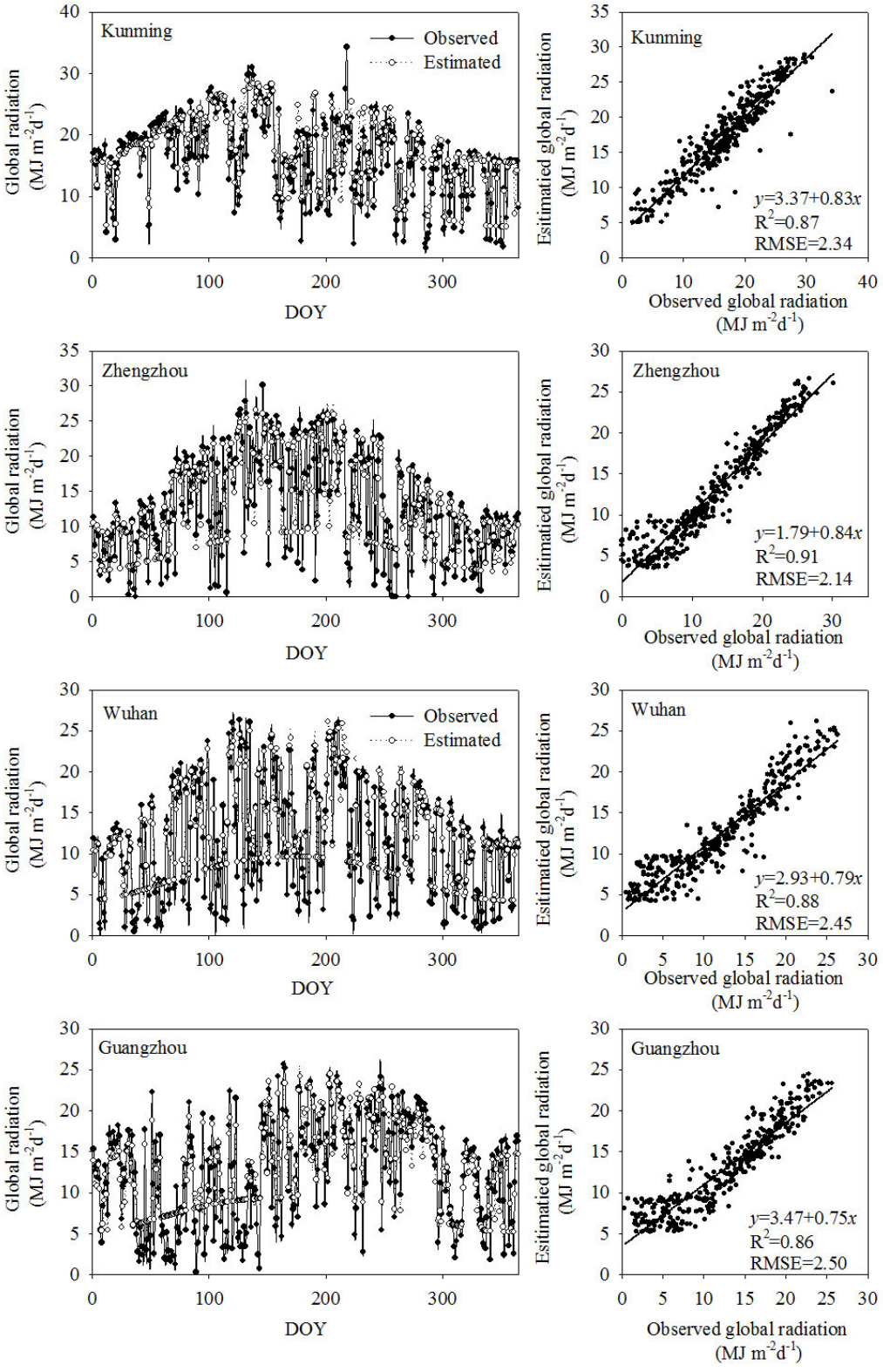
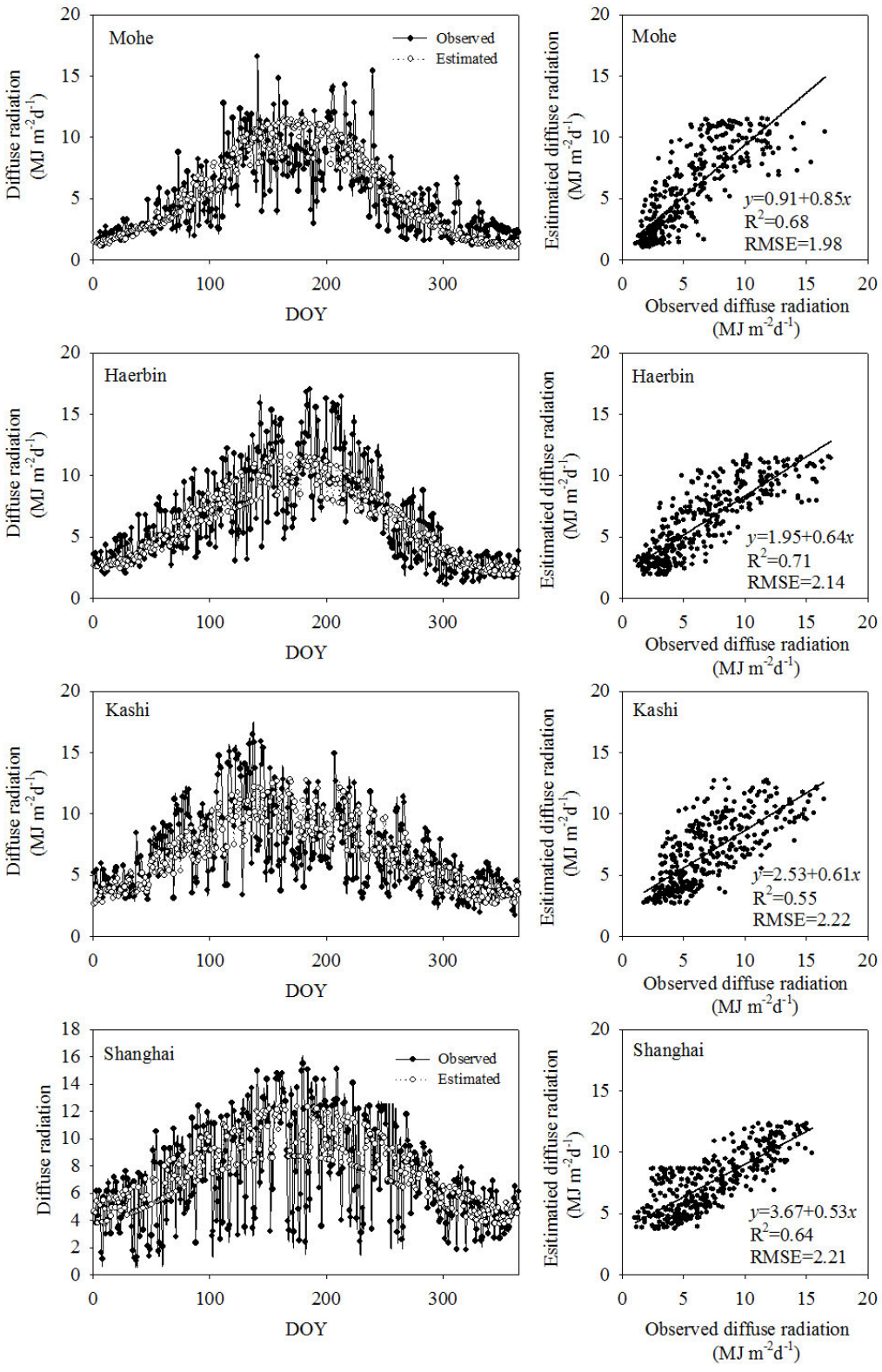
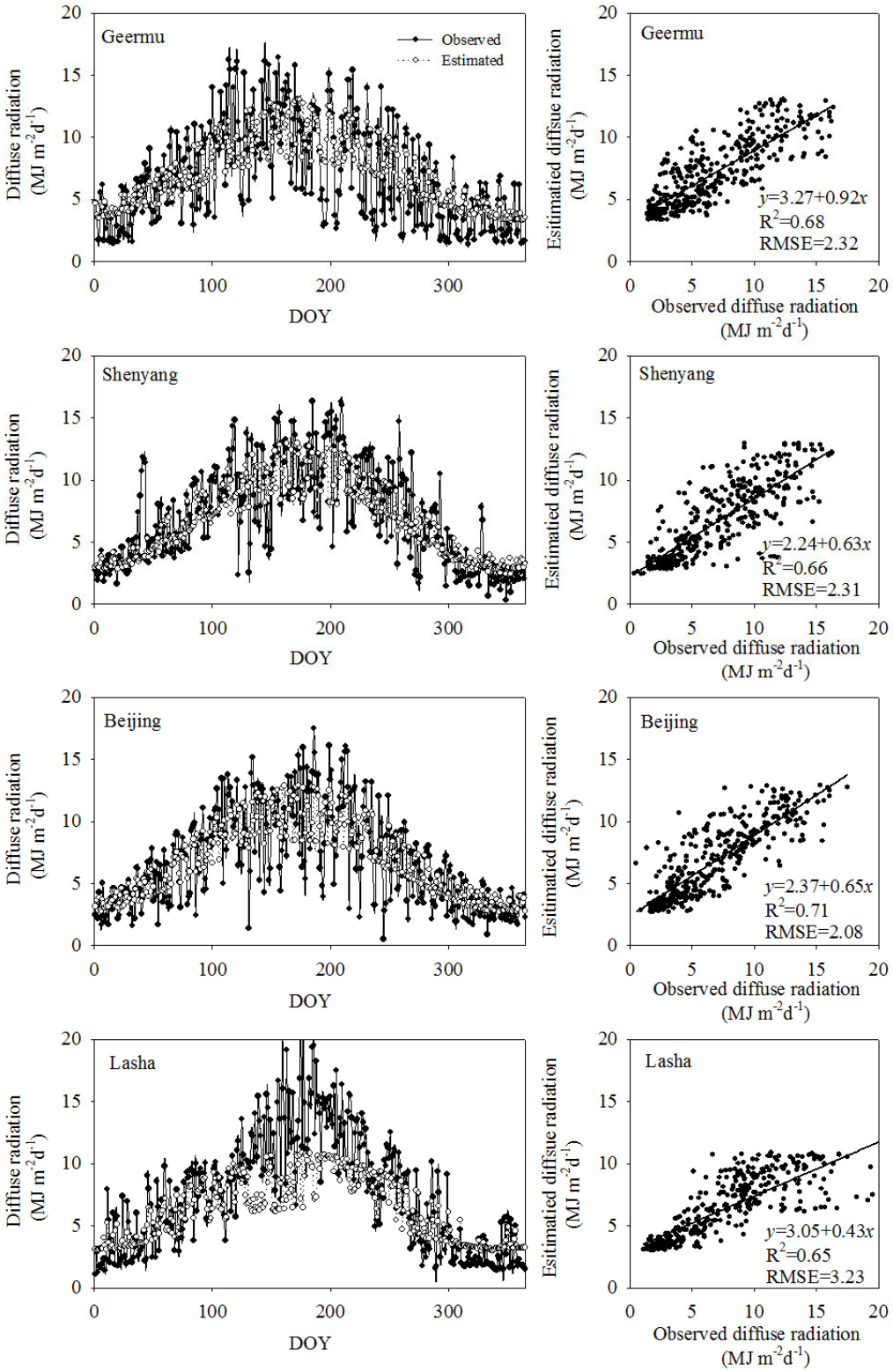


Figure S2 Observed and interpolated daily global radiation at 12 sites in 2014.


Mohe
Observed
Estimated
Diffuse radiation (MJ m-2d-1)
DOY
Esitimatied diffuse radiation (MJ m-2d-1)
Observed diffuse radiation (MJ m-2d-1)
y=0.91+0.85x
R2=0.68
RMSE=1.98
Haerbin
y=1.95+0.64x
R2=0.71
RMSE=2.14
Kashi
y=2.53+0.61x
R2=0.55
RMSE=2.22
Shanghai
y=3.67+0.53x
R2=0.64
RMSE=2.21


Geermu
Observed
Estimated
Diffuse radiation (MJ m-2d-1)
DOY
Esitimatied diffuse radiation (MJ m-2d-1)
Observed diffuse radiation (MJ m-2d-1)
y=3.27+0.92x
R2=0.68
RMSE=2.32
Shenyang
y=2.24+0.63x
R2=0.66
RMSE=2.31
Beijing
y=2.37+0.65x
R2=0.71
RMSE=2.08
Lasha
y=3.05+0.43x
R2=0.65
RMSE=3.23

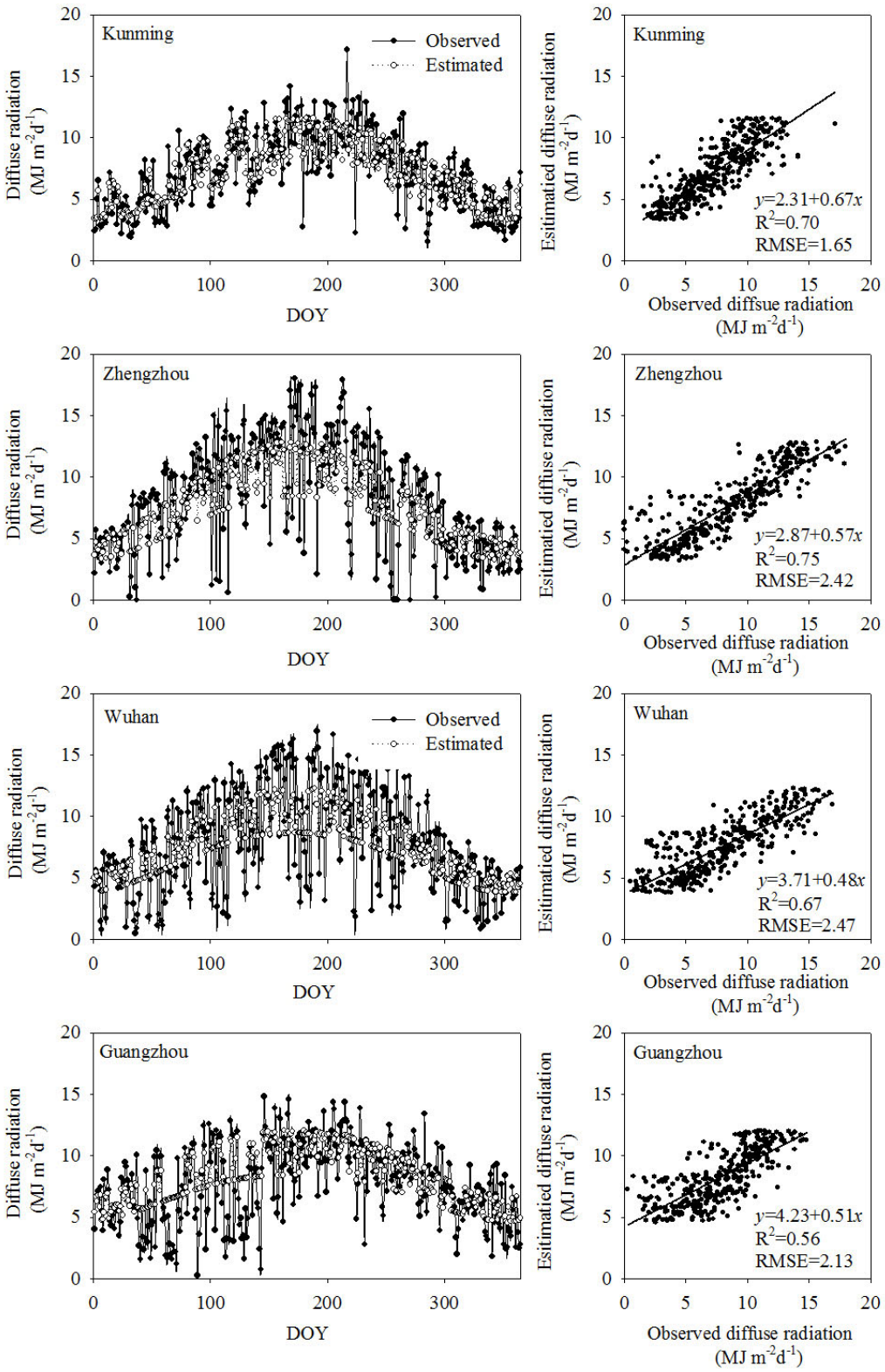


Figure S3 Observed and interpolated daily diffuse radiation at 12 sites in 2014.

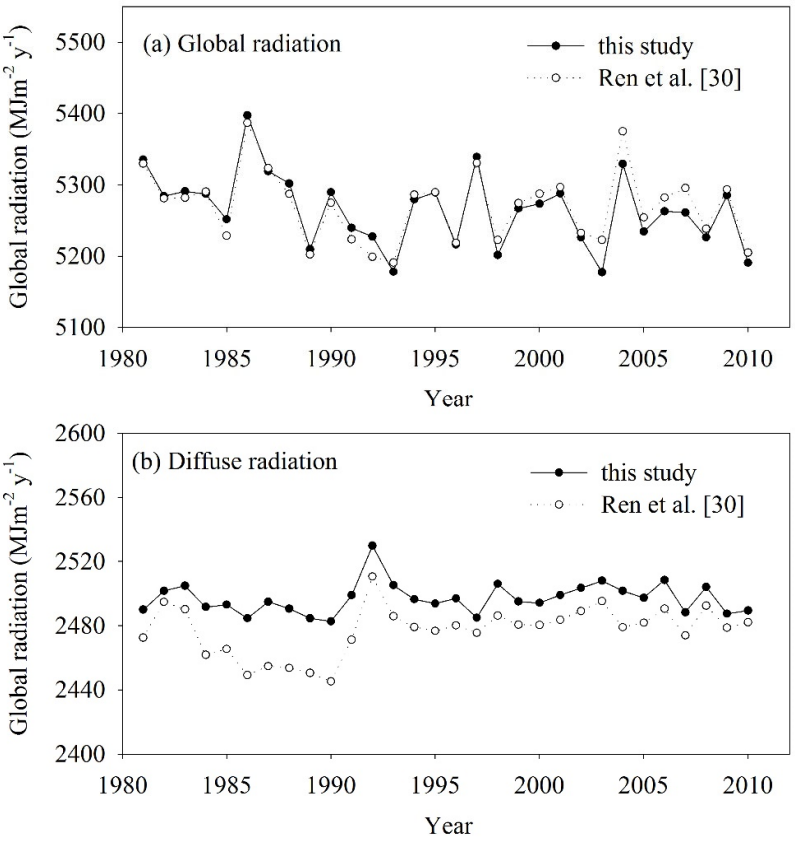


Figure S4 Comparisons of estimated global and diffuse radiation between this study and that of Ren et al. [30].

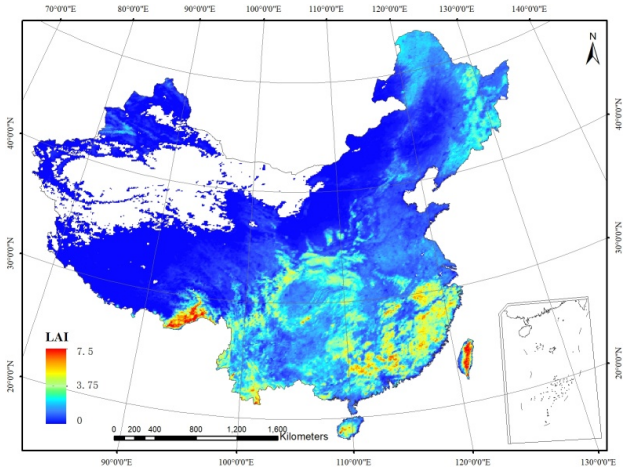


Figure S5 Spatial distribution of mean annual LAI in China during 1981 to 2012.

Table S1 Proportions of sites distributed in different AOD levels. AOD data was from satellite-derived Geographically Weighted Regression (GWR) adjusted PM2.5 concentrations at 0.1° × 0.1° (V4.GL.02) for the period of 1998–2012, which were provided by the Atmospheric Composition Analysis Group via: http://fizz.phys.dal.ca/~atmos/martin/?page_id=140.

AOD (ug m^{-3})	Sunshine Duration (%)	Diffuse Radiation (%)	Global Radiation (%)

0<SM<=20	26.16	14.29	19.59
20<SM<=40	47.82	36.36	36.08
40<SM<=60	20.2	37.66	34.02
60<SM<=80	4.8	10.39	8.25
80<SM<=100	1.02	1.3	2.06

Table S2 Proportions of sites distributed in different Soil moisture (SM) levels. SM data were from satellite-derived soil moisture at 0.25° × 0.25°for the period of 1981–2012 from GLEAM V3.3.

SM.	Sunshine Duration (%)	Diffuse Radiation (%)	Global Radiation (%)
0<SM< = 0.1	3.25	3.95	3.19
0.1<SM< = 0.2	15.09	17.1	17.02
0.2<SM< = 0.3	22.78	21.05	24.47
0.3<SM< = 0.4	44.38	53.95	50
0.4<SM< = 0.5	14.5	3.95	5.32

Table S3 Scenario simulations of the impact of radiation change on GPP.

Scenarios	Global Radiation	Diffuse Radiation	LAI, VPD, Ta
Scenario	1981–2012 daily global radiation	1981–2012 daily diffuse radiation	historical data with temporal variations
Scenario_R_g	based on the assumption that the annual global radiation per year remained unchanged from 1981 to 2012, and variation tendency of daily global radiation variation to global radiation values in 1981 was consistent, daily radiation for the period 1981–2012 was calibrated using the equation (9)	1981–2012 daily diffuse radiation	historical data with temporal variations
Scenario_R_d	1981–2012 daily global radiation	based on the assumption that the annual diffuse radiation fraction remained constant per year from 1981 to 2012, and variation tendency of daily diffuse radiation variation to diffuse radiation values in 1981 was consistent, daily diffuse radiation fraction for the period 1982–2012 was calibrated using the equation (10)	historical data with temporal variations