RC2: 'Comment on essd-2021-361', Anonymous Referee #2, 18 Nov 2021

Thank the authors and editor for bringing me to this work, the bias-correction method based dynamical downscaling is a totally new technique for me and very interesting. Base on this method, the authors created high resolution historical and projected gridded climate datasets in Central Asia (CA), which are very important and useful to the target region. The manuscript is generally well written and I have only some minor points as following.

(1) I suggest to also provide the key geostatic variables from the WRF downscaling for data archive, e.g. topography, soil type, land cover type.

Reply: We have uploaded four geostatic variables from the simulation to the data repository. They are terrain height (HGT, m), land use category (LU_INDEX, 21 categories), land mask (LANDMASK, 1 for land and 0 for water), and soil category (ISLTYP, 16 categories). Accordingly, we revised the MS and updated the information about the dataset on the website of the data repository (https://doi.org/10.11888/Meteoro.tpdc.271759).

"…the HCPD-CA (High-resolution Climate Projection Dataset in CA) dataset is derived from the 9-km resolution downscaled results, which includes four geostatic (time-invariant) variables and ten meteorological elements (Table 1) that are widely used to drive ecological and hydrological models. The geostatic variables are terrain height (HGT, m), land use category (LU_INDEX, 21 categories), land mask (LANDMASK, 1 for land and 0 for water), and soil category (ISLTYP, 16 categories)." (L59-64 in the revised MS)

"The geogrid program in the WRF model is to define the simulation domains, and interpolate various terrestrial datasets to the model grids (Wang et al., 2007). First, geogrid computes the latitude, longitude, and map scale factors at every grid point. Then, it interpolates terrain height, land use category, soil category and other time-invariant data to the model grides. Global datasets of each of these fields are provided through the WRF download page (https://www2.mmm.ucar.edu/wrf/users/download/get_sources_wps_geog.html). The HCPD-CA dataset contains four of the geostatic variables. In them, the terrain height (HGT) data (Fig. S1) is from the United States Geological Survey (USGS) GTOPO30 elevation dataset, the land use category (LU_INDEX) data (Table S1 and Fig. S2) is from the Moderate Resolution Imaging Spectroradiometer (MODIS) 21 category land dataset, the soil category (ISLTYP) data (Table S2 and Fig. S3) is from the global 5-minute United Nation FAO soil category dataset, and the land mask (LANDMASK) data (Fig. S4) is calculated based on LU_INDEX with the condition that the value of a grid cell is set as 1 (0) if land (water) area at least accounts for 50%." (L86-97 in the revised MS)

"The names of the files containing the static variables follow the order: [dataset name]_[variable name].nc. For example, the file name, HCPD-CA_ISLTYP.nc, represents the soil category in the HCPD-CA dataset." (L275-277 in the revised MS)

Table S1 Land use categories in the HCPD-CA dataset

Land use category	**Land use description**
1	Evergreen needleleaf forest
2	Evergreen broadleaf forest
3	Deciduous needleleaf forest
4	Deciduous broadleaf forest

5	Mixed forest
6	Closed shrublands
7	Open shrublands
8	Woody savannas
9	Savannas
10	Grasslands
11	Permanent wetland
12	Croplands
13	Urban and build-up
14	Cropland/natural vegetation mosaic
15	Snow and ice
16	Barren or sparsely vegetated
17	Water
18	Wooded tundra
19	Mixed Tundra
20	Barren Tundra
21	Lakes

Table S2 Soil categories in the HCPD-CA dataset

Soil category	**Soil description**
1	Sand
2	Loamy sand
3	Sandy loam
4	Silt loam
5	Silt
6	Loam
7	Sandy clay loam
8	Silty clay loam
9	Clay loam
10	Sandy clay
11	Silty clay
12	Clay
13	Organic material
14	Water
15	Bedrock
16	Other (land-ice)

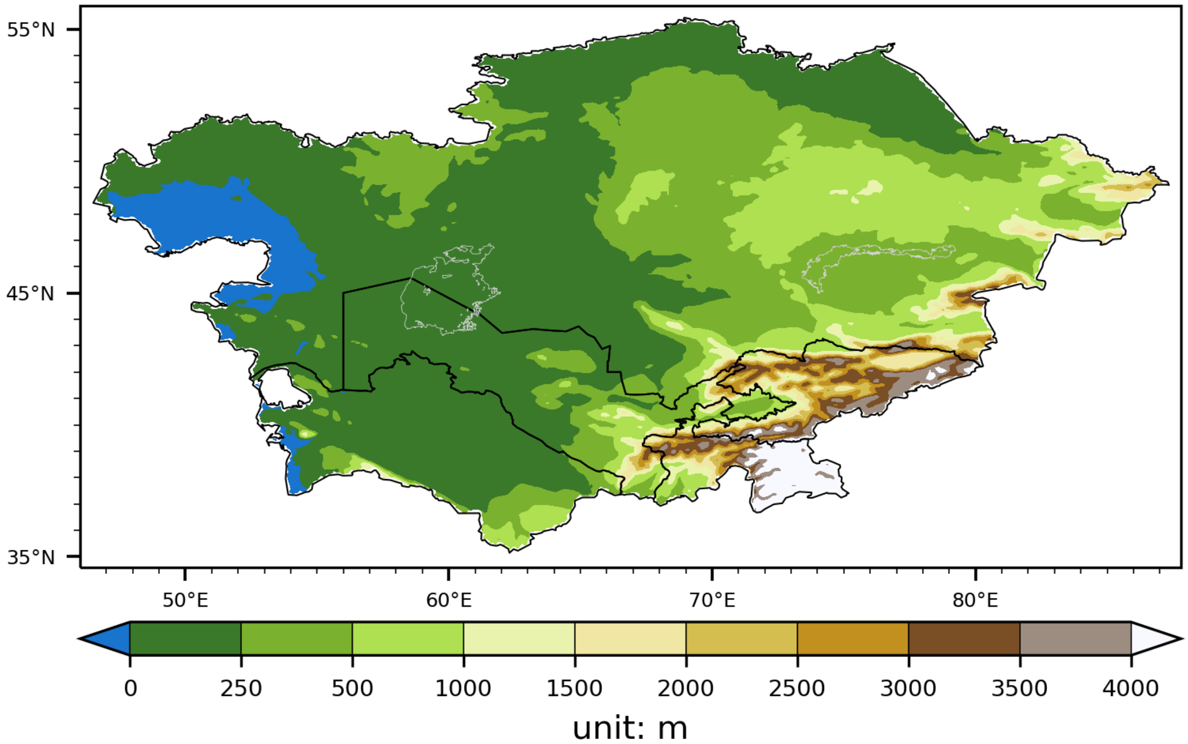

Fig. S1 The terrain height in the WRF model.

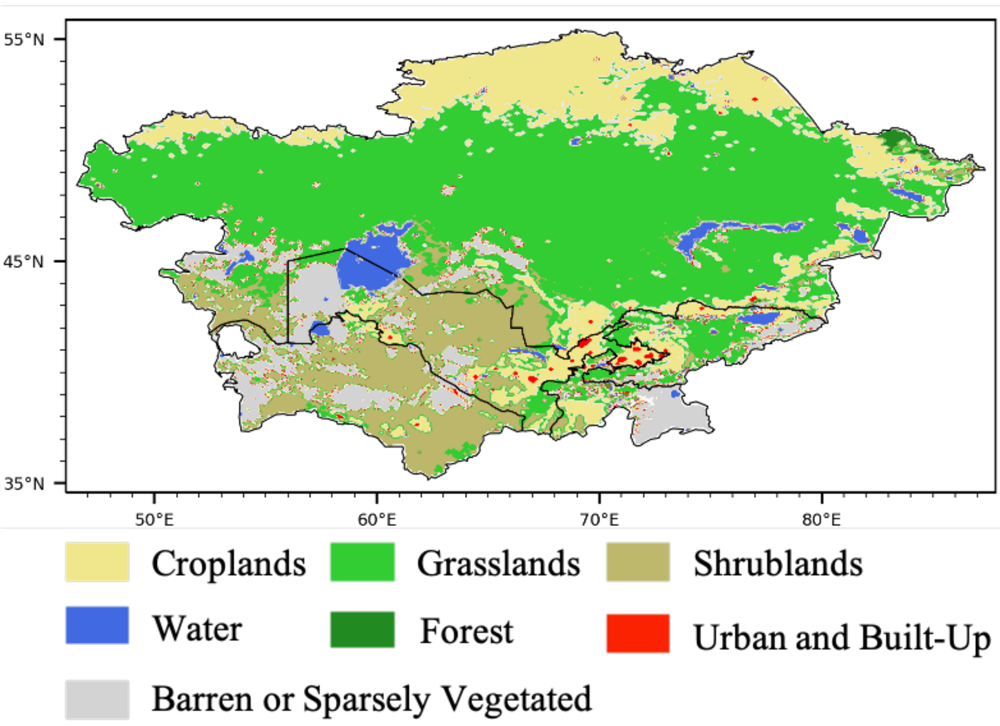

Fig. 2S The main land use categories in the WRF model.

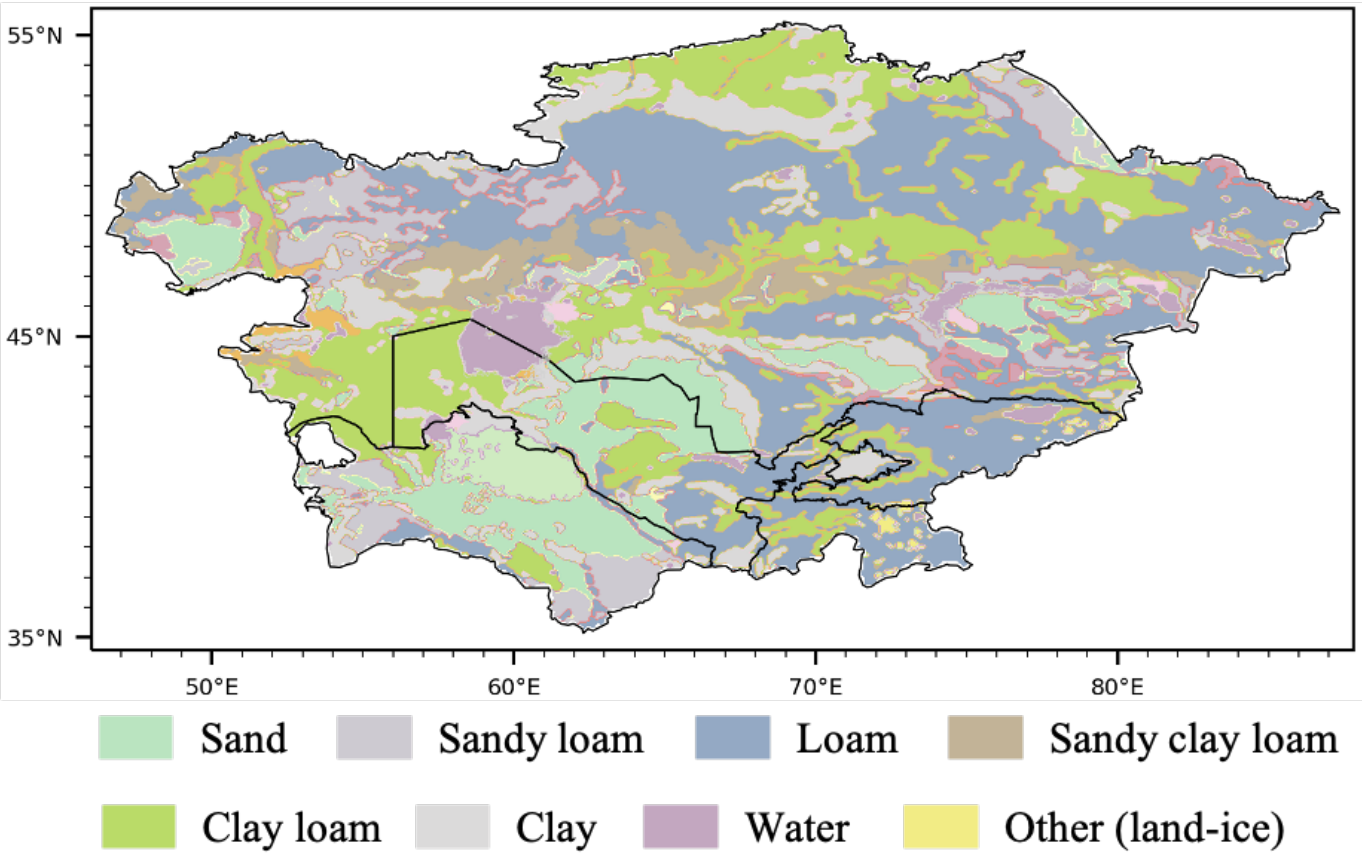

Fig. 3S The main soil categories in the WRF model.

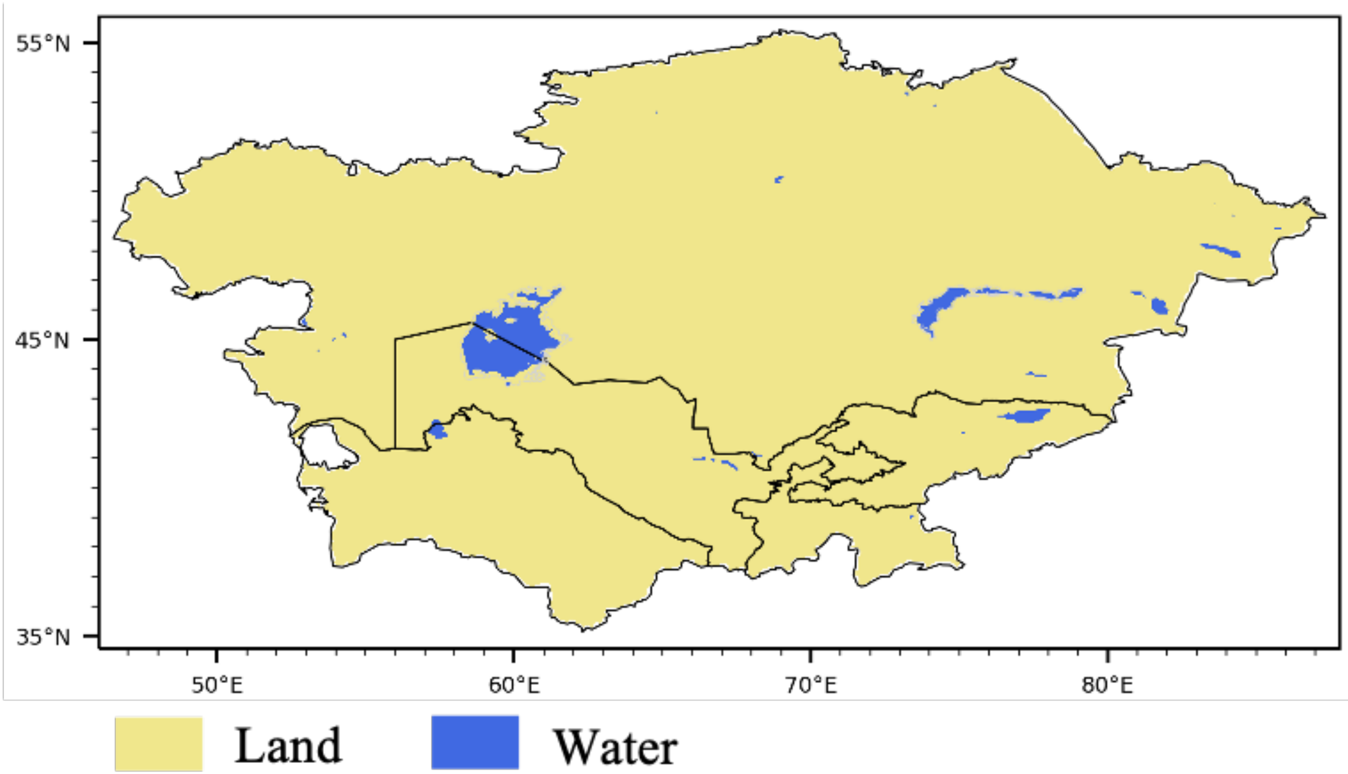

Fig. 4S The land mask in the WRF model.

(2) Addressing the data quality is very important, especially for a data journal. As a potential user, I expect to see the spacial distribution of biases (those versus CRU, ERA5 and stations), so I can have a basic impression on the accuracy of the data when applied to any sub-region or basin for ecological and hydrological studies.

Thus, I recommend to add related figures, but you do not need to deliver in-depth scientific discussions. I also suggest to provide similar figures as figure 8 for other variables instead of only give precipitation as an example. So the readers can directly know the quality of each variable when compared with station observation.

You can add such figures as main content or even as an appendix is acceptable.

Additionally, I suggest to consider topographic elevation difference between WRF simulation and observation (CRU, ERA5, station) during comparison/evaluation, for these three variables: pressure, temperature, relative humidity. Because base on my own experience, this is very important over mountainous/complex-terrain regions.

Reply: The figures (Fig. 5S-7S) about the spatial distribution of biases have been added in the supplementary information, to help the readers have a basic impression on the accuracy of the data. To let the readers directly know the quality of each simulated variables, we made a table (Table S3) which summarizes their statistic metrics [spatial correlation coefficient (SCC), mean error (ME), and root mean square error (RMSE)] over CA and its climate subregions [northern CA (NCA), middle CA (MCA), southern CA (SCA), and the mountainous areas (MT), see their scopes in Fig. 1c]. We agree that elevation differences between the model and the observations should be taken into account when evaluating the model, to give a fairer assessment. In sect. 4.1 "Uncertainties of the evaluation", we adjusted the model simulated T2MEAN to the elevation of the station observations and then compare the adjusted model data with the observations. Results show that after adjusting the SCCs of the annual and seasonal T2MEAN over CA increases and the RMSEs decreases. This proves that the regional model's skills may be underestimated if the elevation differences between the observations and the model grids is not considered. This study is to describe the HCPD-CA dataset to the scientific community and thus we did not analyze other variables (surface pressure and relative humidity) before and after adjusting.

"The simulated annual mean T2MEAN over the very north of Kazakhstan and the Pamirs has cold bias and that over other areas generally has warm bias (Fig. 5Sa-c). However, the bias over most of CA is within -2~2°C. The annual mean RH2MEAN is generally underestimated over CA except some areas in the northern part and the Aral Sea. The RCM simulations commonly overestimate the annual mean WS10MEAN (Fig. 6Sd-f) over the mountainous areas. Stronger annual mean SWD prevails in CA in each simulation (Fig. 7Sa-c), with the mean errors (MEs) over the whole region in a range of 27.72-31.43 W/m^2. Meanwhile, the regional model slightly underestimates annual mean LWD (Fig. 7Sd-f). The bias in annual mean PSFC is minor over the majority of CA (Fig. 7Sg-i). Table S3 summarizes the statistic metrics [SCCs, RMSEs, and mean errors (MEs)] of all the annual mean variables over both CA and its climate subregions [northern CA (NCA), middle CA (MCA), southern CA (SCA), and the mountainous areas (MT), see their scopes in Fig. 1c], to help the readers easily check the quality of this data product in the areas they are interested." (L170-182 in the revised MS)

"To prove if considering the elevation differences between the observations and the model grids during the evaluation will give a fairer assessment of the model's skills, we take T2MEAN as an example and adjusted the simulated T2MEAN to the elevation of the observations and then compared the adjusted T2MEAN with the observations. Here, we use the records of T2MEAN on 58 stations across CA (see the stars in Fig. 1a) as observations, which as well as the records of PREC on 52 stations (which is used in sect. 4.2, see the circles in Fig. 1a) are from Global Historical Climatology Network (GHCN) of NOAA National Climatic Data Center and have been quality controlled (Qiu et al., 2021). Note that a station is compared with the model grid on which it is located. Fig. 8S shows the SCCs and RMSEs of the simulated annual and seasonal T2MEAN over CA before and after adjusting based on the elevation differences. It is seen that the simulated T2MEAN is more consistent with the observations after vertically interpolating the model data to the elevation of the stations by the standard moist lapse rate of 6.5 °C/km (Qiu et al., 2017). For instance, after adjusting the SCC of the annual T2MEAN increases from 0.93 to 0.96 and its RMSE decreases from 2.52 to 2.25°C. This proves that the regional model's skills can be underestimated if the elevation differences between the model and the observation is not considered." (L219-231 in the revised MS)

Table S3 Statistic metrics [spatial correlation coefficients (SCCs), mean errors (MEs), and root mean square errors (RMSEs)] of the annual mean variables in the RCM simulations over Central Asia and its climate subregions [northern CA (NCA), middle CA (MCA), southern CA (SCA), and the mountainous areas (MT), see their scopes in Fig. 1c]. The ensemble mean (first number) and the minimum and maximum member (in parentheses) are listed. The metrics are calculated based on the gridded observations (CRU TS v4 and ERA5-Land).

Region	CA	NCA	MCA	SCA	MT
T2MEAN (°C)					
SCC	0.98(0.98, 0.98)	0.73(0.71,0.77)	0.95(0.95,0.95)	0.94(0.94,0.95)	0.93(0.93,0.93)
ME	0.50(0.10,0.82)	-0.02(-0.39,0.21)	0.62(0.19,1.00)	1.21(0.76,1.57)	-0.73(-0.97,-0.59)
RMSE	1.34(1.16,1.52)	1.01(0.93,1.07)	1.06(0.81,1.29)	1.42(1.08,1.73)	2.64(2.55,2.69)
PREC (mm/day)					
SCC	0.85(0.84,0.86)	0.90(0.89,0.91)	0.82(0.82,0.83)	0.88(0.87,0.88)	0.44(0.41,0.46)
ME	-0.09(-0.18,0.02)	-0.05(-0.18,0.08)	-0.09(-0.16,0.02)	-0.08(-0.15,-0.01)	-0.22(-0.39,-0.04)
RMSE	0.39(0.37,0.41)	0.22(0.20,0.25)	0.23(0.20,0.26)	0.25(0.22,0.28)	1.16(1.14,1.18)
RH2MEAN (%)					
SCC	0.88(0.88,0.89)	0.87(0.87,0.88)	0.85(0.84,0.87)	0.71(0.70,0.73)	0.37(0.36,0.37)
ME	-2.19(-3.78,-0.48)	1.73(-0.27,3.32)	-1.38(-2.93,0.63)	-5.83(-7.21,-4.37)	-7.13(-8.31,-5.88)
RMSE	5.81(5.16,6.39)	3.92(3.13,4.47)	3.99(3.38,4.59)	7.57(6.30,8.78)	10.63(9.61,11.52)
WS10MEAN (m/s)					
SCC	0.60(0.54,0.64)	0.67(0.65,0.69)	0.80(0.74,0.83)	0.56(0.48,0.60)	0.03(0.03,0.03)
ME	0.02(-0.02,0.05)	0.04(-0.03,0.15)	-0.03(-0.11,0.04)	-0.14(-0.26,-0.06)	0.77(0.76,0.78)
RMSE	0.46(0.45,0.49)	0.33(0.32,0.35)	0.27(0.25,0.30)	0.50(0.47,0.56)	1.11(1.10,1.12)
SWD (W/m^2)					
SCC	0.97(0.97,0.97)	0.97(0.97,0.97)	0.89(0.88,0.90)	0.94(0.93,0.94)	0.89(0.89,0.90)
ME	29.65(27.72,31.43)	28.32(26.52,30.21)	29.77(27.54,31.61)	30.09(28.28,31.93)	31.60(30.58,32.55)
RMSE	30.11(28.20,31.86)	28.52(26.73,30.39)	30.40(28.19,32.18)	30.28(28.49,32.10)	32.67(31.61,33.64)
LWD (W/m^2)					
SCC	0.98(0.97,0.98)	0.92(0.91,0.94)	0.94(0.93,0.95)	0.92(0.92,0.93)	0.90(0.90,0.90)
ME	-5.38(-8.60,-3.46)	-6.87(-10.35,-4.74)	-4.62(-7.91,-2.65)	-3.42(-6.63,-1.82)	-11.54(-13.65,-9.57)
RMSE	7.73(6.36,10.04)	7.58(5.75,10.71)	6.06(4.69,8.61)	5.40(4.20,7.72)	17.09(15.68,18.64)

PSFC (hPa)					
SCC	1.00(1.00,1.00)	1.00(1.00,1.00)	1.00(1.00,1.00)	0.99(0.99,0.99)	0.99(0.99,0.99)
ME	-0.39(-0.54,-0.16)	-0.33(-0.65,0.10)	-0.49(-0.64,-0.23)	-0.02(-0.28,0.14)	-1.18(-1.41,-0.98)
RMSE	4.59(4.58,4.60)	3.12(3.10,3.15)	2.99(2.94,3.02)	4.00(3.98,4.01)	11.97(11.95,12.01)

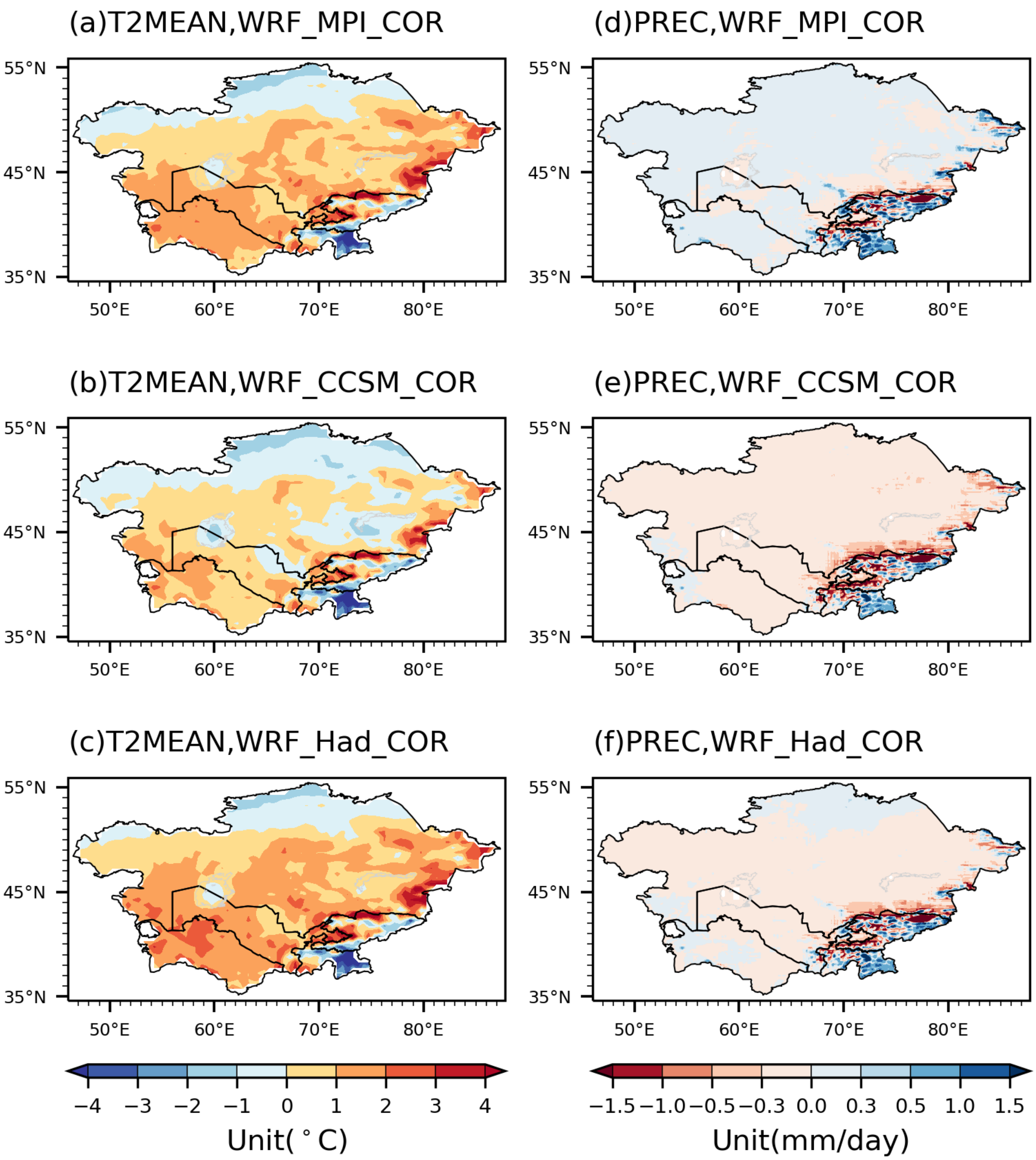

Fig. 5S The biases of the simulated annual mean T2MEAN and PREC in Central Asia during the reference period (1986-2005) relative to the observations.

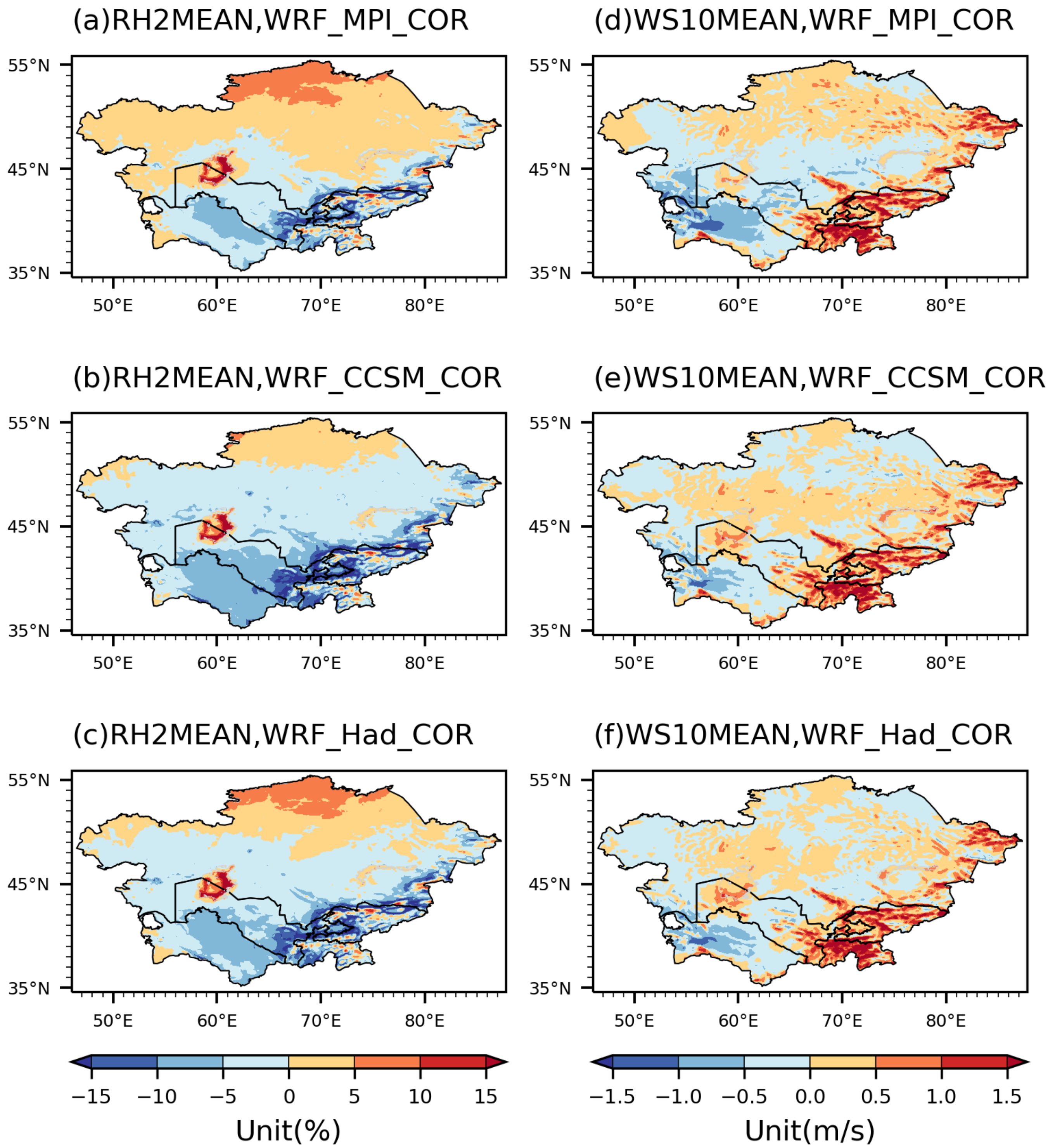

Fig. 6S Same as **Fig. 5S**, but for the annual mean RH2MEAN and WS10MEAN.

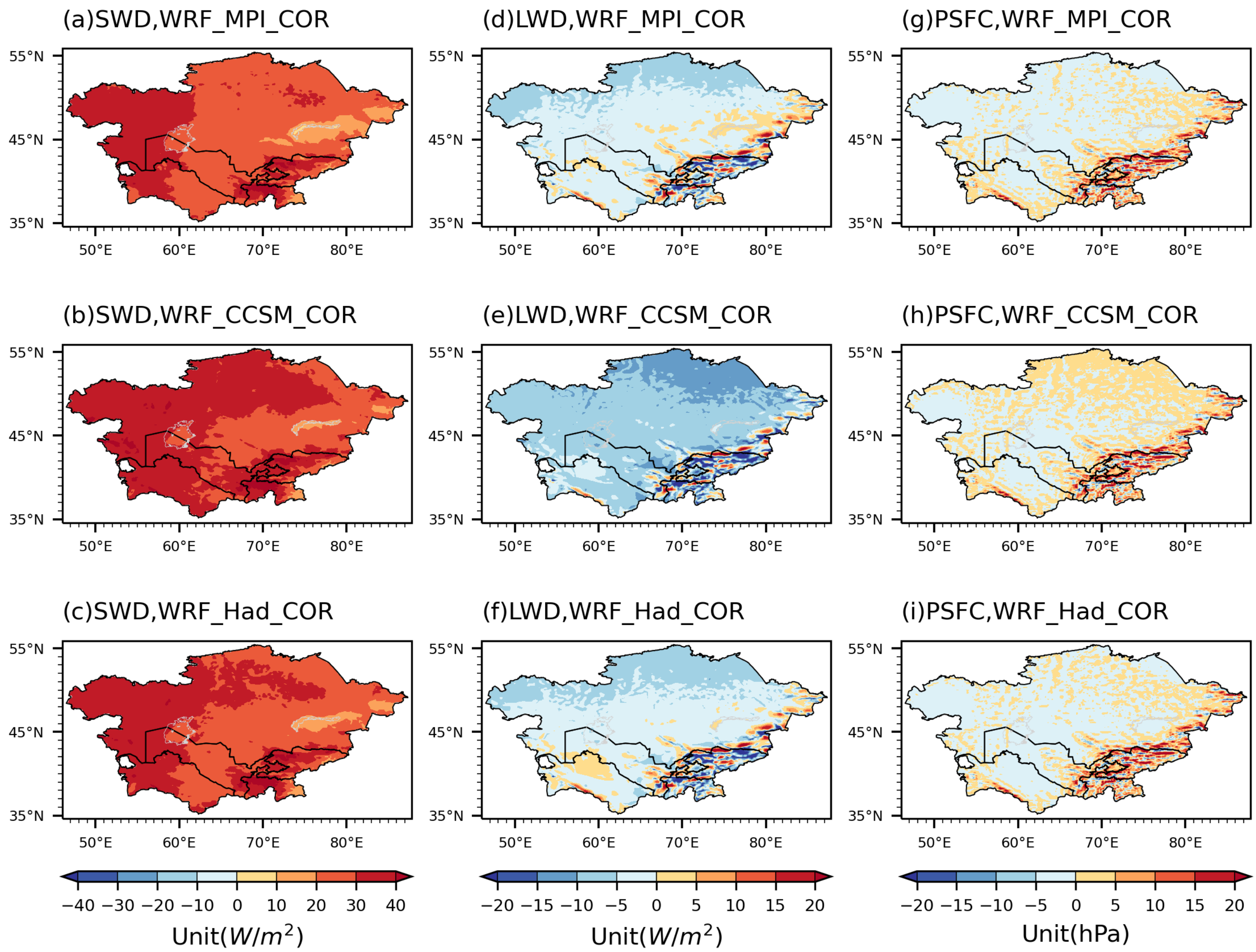

Fig. 7S Same as **Fig. 5S**, but for the annual mean SWD, LWD, and PSFC.

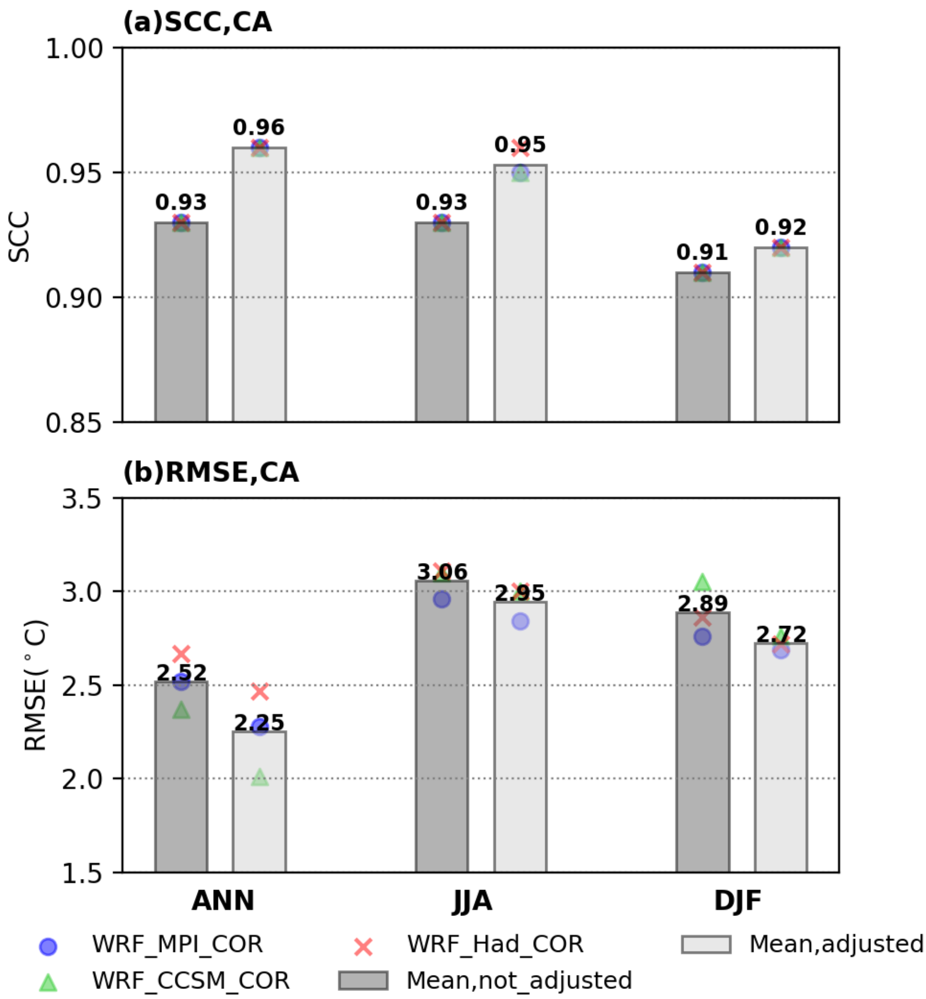

Fig. 8S Spatial correlation coefficients (SCCs) and root mean square errors (RMSEs) of the simulated annual (ANN), summer (JJA: June-July-August), and winter (DJF: December-January-February) mean T2MEAN over CA with and without adjusting based on the elevation differences between the observations and the model grids. The metrics are calculated based on 58 stations' data across CA.

(3) Please clarify the origin of the station data during evaluation.

Reply: The stations' data is from Global Historical Climatology Network (GHCN) of NOAA National Climatic Data Center.

"Here, we use the records of T2MEAN on 58 stations across CA (see the stars in Fig. 1a) as observations, which as well as the records of PREC on 52 stations (which is used in sect. 4.2, see the circles in Fig. 1a) are from Global Historical Climatology Network (GHCN) of NOAA National Climatic Data Center and have been quality controlled (Qiu et al., 2021)." (L222-225 in the revised MS)