2 Climate Change Projections in the Twenty-First Century

Wenxiang Wu, Chenchen Xu and Xingcai Liu

2.1 Background

Climate change will inevitably continue in the next few decades. The Fifth Assessment Reports (AR5) of the Intergovernmental Panel on Climate Change (IPCC) proposed that global mean temperature, relative to preindustrial, is likely to increase by 1.5–4.0 °C by the end of the twenty-first century, accompanied with changes in rainfall patterns and an increase in climate variability (IPCC 2013). Accordingly, extreme climate events, especially extreme high temperature and precipitation, have been showing an increasing trend (He et al. 2015; IPCC 2013; Dong et al. 2015). Natural disasters such as drought and flood caused by climate change are now occurring more frequently and widely, leading to the instability of eco-environment system and restricting the socioeconomic development (Min et al. 2011).

China is one of the countries severely affected by climate change and meteorological disasters. Losses of meteorological disasters is about 70% of those caused by natural disasters, and have led to about 3–6% of Gross National Product (GNP) of direct economic loss in China (Yin et al. 2016). It is thus necessary to analyze the general features of future climate change.

The primary goal of this chapter was to present the up-to-date projected changes of climate variables, including the daily maximum, minimum, and average temperature and annual precipitation across China. In addition, we provided maps of the temperature and precipitation geographical distributions and their changing features in the twenty-first century.

2.2 Data and Method

Future climate data across China are originated from five Global Climate Models (GFDL-ESM2M, HadGEM2-ES, IPSL-CM5A-LR, MIROC-ESM-CHEM, and NorESM1-M). The model outputs were bias-corrected and downscaled to a grid with 0.5° × 0.5° resolution by the Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP) (Stefan et al. 2011; Hempel et al. 2013; Piani et al. 2010; Warszawski et al. 2014). All representative concentration pathways (RCPs), namely RCP2.6, RCP4.5, RCP6.0, and RCP8.5, representing the low, middle, and high pathways for energy and industry CO_2 emissions were adopted.

To investigate the multi-decadal variability and trends of climate changes, consecutive 30-year periods throughout the twenty-first century were adopted with 1981–2010 period as baseline. Values of climate variable for each grid in 2011–2040, 2041–2070, and 2071–2010, which were the mean of five climate model outputs, were compared with those of baseline. Temperature change was evaluated by its absolute variations in daily rate and precipitation was compared with relative precipitation change in yearly rate. The standard deviation of simulated changes in climate variables from the five general circulation models (GCMs) was calculated to quantify inter-model variability (Lobell et al. 2007).

W. Wu (✉) · C. Xu
Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing, 100101, China
e-mail: wuwx@igsnrr.ac.cn

C. Xu
University of Chinese Academy of Sciences, Beijing, 100049, China

X. Liu
Key Laboratory of Water Cycle and Related Land Surface Processes, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing, 100101, China

Q. Tang and Q. Ge (eds.), *Atlas of Environmental Risks Facing China Under Climate Change*,
IHDP/Future Earth-Integrated Risk Governance Project Series, DOI 10.1007/978-981-10-4199-0_2

2.3 Results

2.3.1 Climate Change

(1) Daily maximum temperature

The daily maximum temperature is increasing across China in future periods under all RCPs scenarios. Temperature increase is greater in the areas with higher latitude or altitude, and changes in the daily maximum temperature are higher in inland regions than that of coastal areas. The area with highest increase of maximum temperature distributes near the Tibetan Plateau within ranges of 1.8–2.5, 1.8–4.0, 1.4–5.0, and 1.8–6.9 °C under RCP2.6, RCP4.5, RCP6.0, and RCP8.5 scenarios, respectively.

The slightest increase in daily maximum temperature is for 2011–2040, while the largest increase is for 2071–2100 under RCP4.5, RCP6.0, and RCP8.5 scenarios. The largest increase in temperature under RCP2.6 scenario occurs in 2041–2070.

(2) Daily minimum and mean temperatures

The daily minimum and mean temperatures change similarly in future periods under all RCPs with a greater increase in areas located in higher latitude or altitude, as well as inland areas far away from coastline. The northern Xinjiang and Heilongjiang provinces are the areas with the highest change in daily minimum and mean temperatures. Increase of the daily minimum temperature is 1.8–2.5, 1.8–4.0, 1.4–5.0, and 1.4–6.8 °C and increase of the daily mean temperature is 2.0–3.0, 2.0–4.0, 1.2–5.0, and 1.7–6.6 °C under RCP2.6, RCP4.5, RCP6.0, and RCP8.5 scenarios, respectively.

The daily minimum and mean temperatures rise by the smallest amount in 2011–2040, and the largest amount in 2071–2100 under RCP4.5, RCP6.0, and RCP8.5 scenarios. The highest change in daily minimum and mean temperatures occurs in 2041–2070 under RCP2.6 scenario.

(3) Annual precipitation

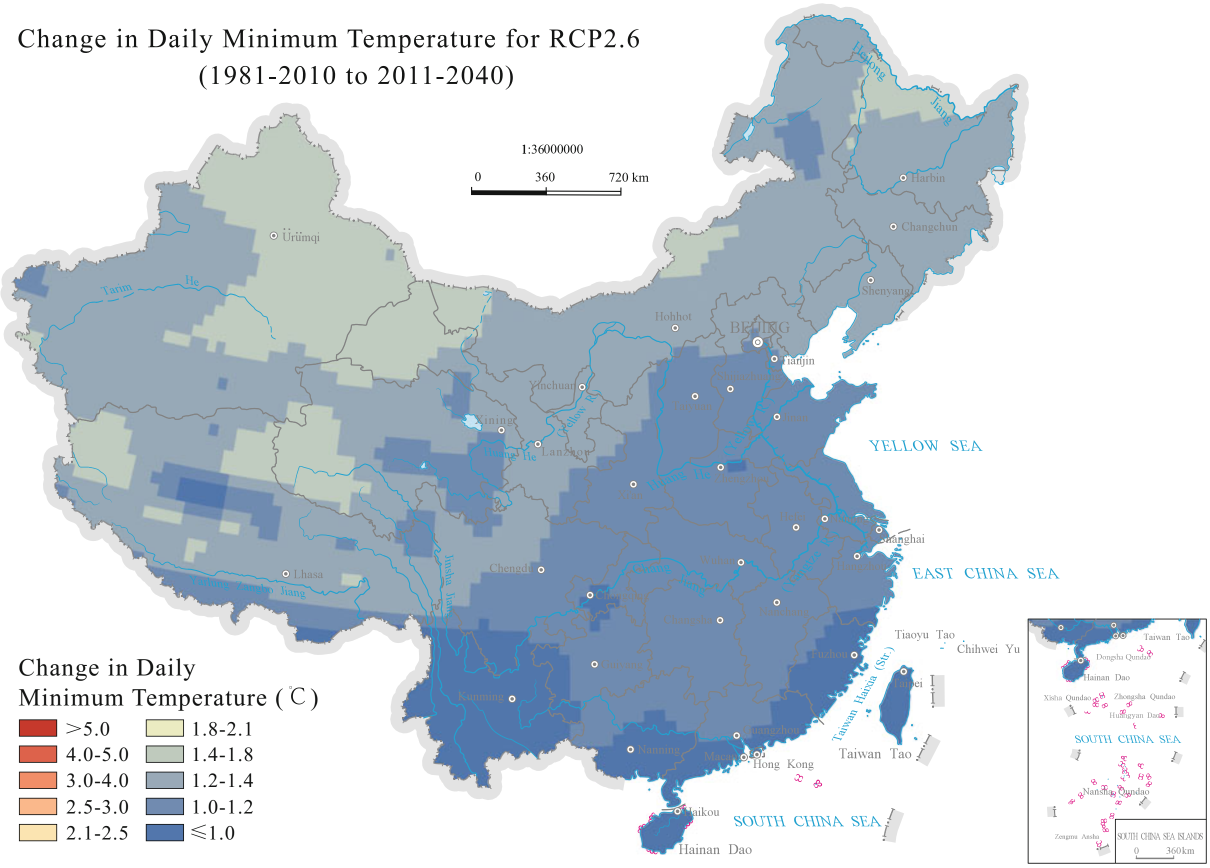
The annual precipitation exhibits a general increasing trend across China during future periods under all RCPs scenarios. Precipitation rising tends to be greater in areas having higher latitude or altitude or areas close to the coastline. The area with highest change in annual precipitation distributes near the Tibetan Plateau, the Qaidam Basin, and northern Gansu province. Under most of the RCP scenarios, minimal increase of annual precipitation is for 2011–2040 and maximal increase is for 2071–2010.

2.3.2 Intermodel Spread in Climate Changes

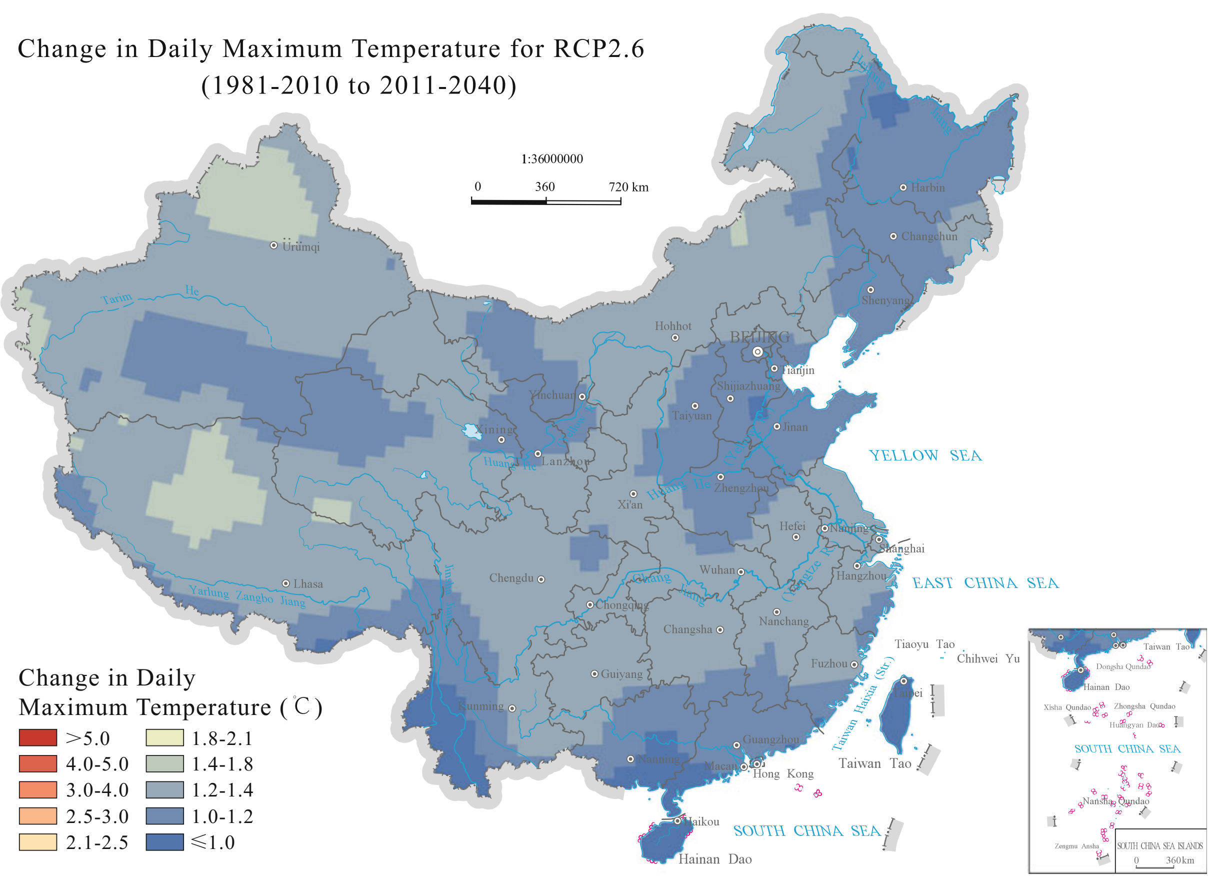
The standard deviations of climate variables in 2071–2010 under RCP8.5 scenarios were calculated. The spread arising from climate models for daily temperatures (maximum, minimum, and mean temperature) was generally less than 20%, indicating that their values generated from multiple climate models were in good consistency. However, the spread for annual precipitation across China showed greater regionally differences, with relative changes being less than 20% for most regions but more than 20% for eastern China.

2.4 Maps

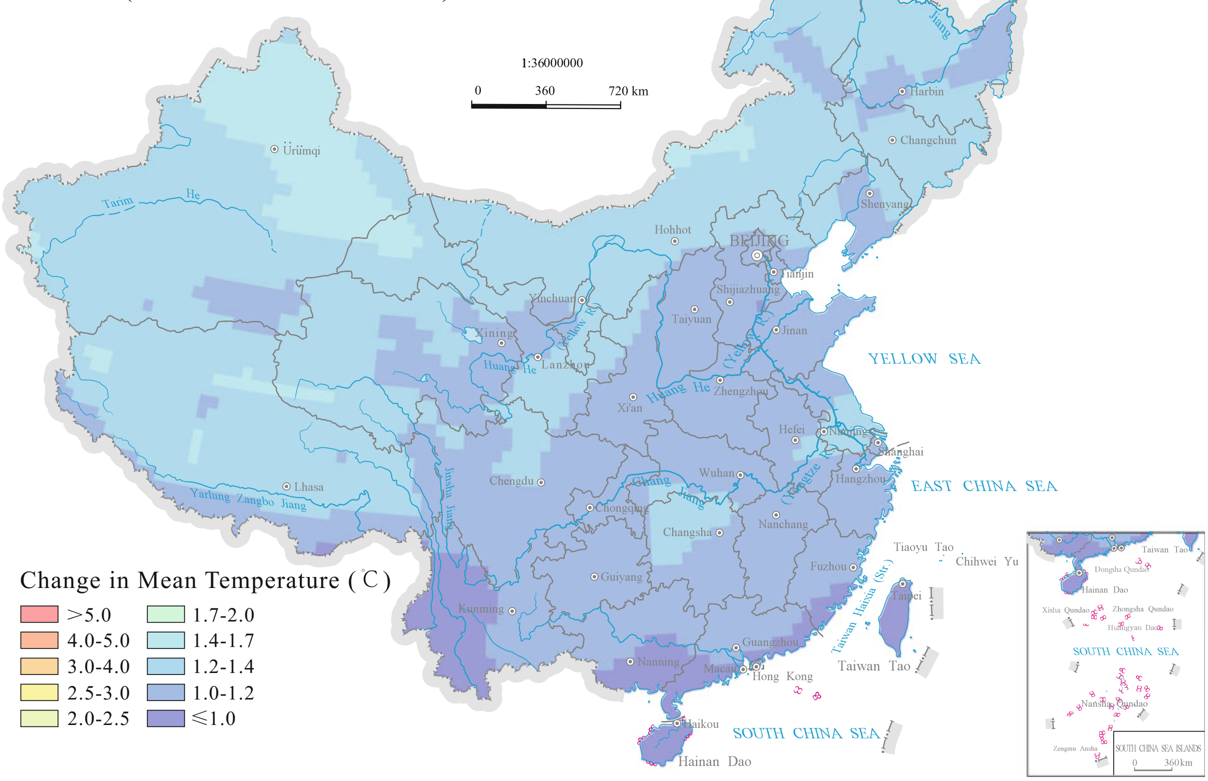
Change in Daily Minimum Temperature for RCP2.6
(1981-2010 to 2011-2040)



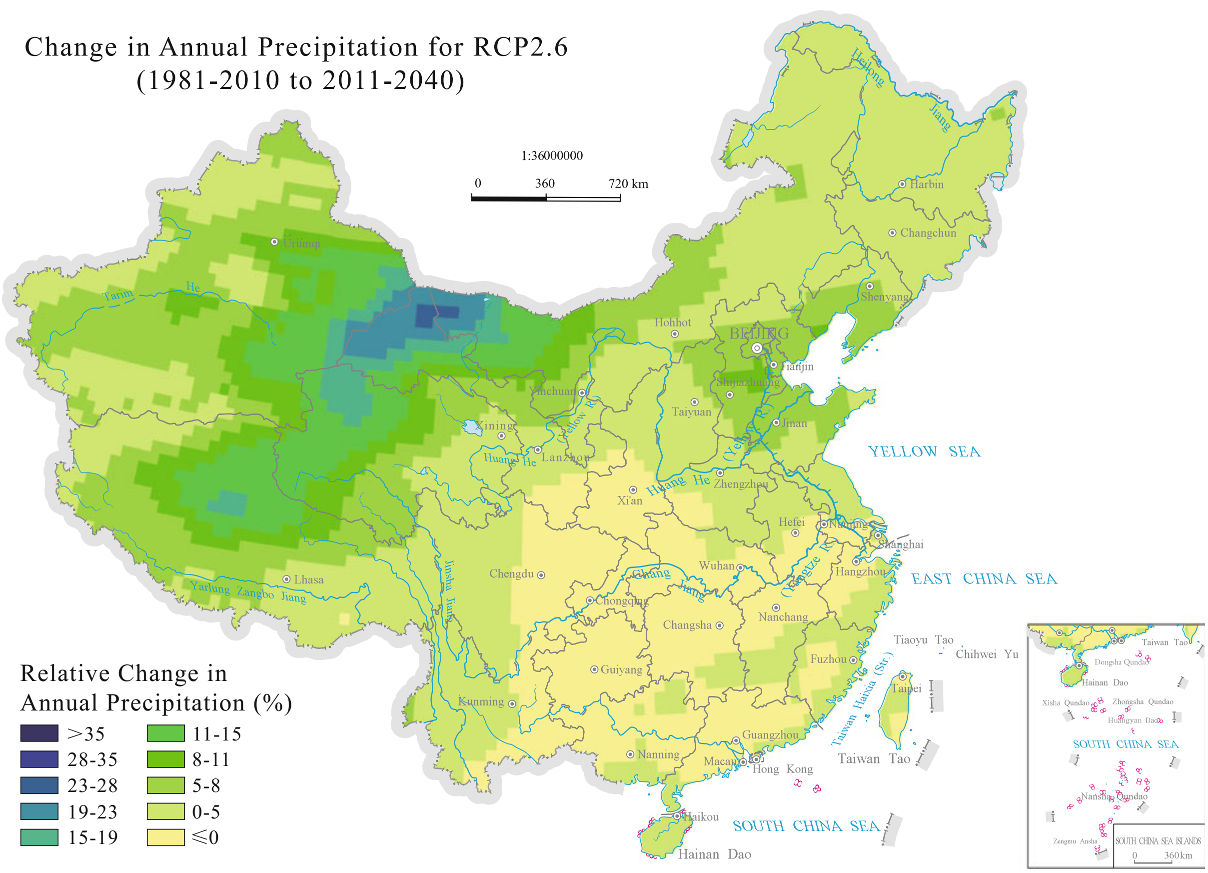
Change in Daily Maximum Temperature for RCP2.6
(1981-2010 to 2011-2040)

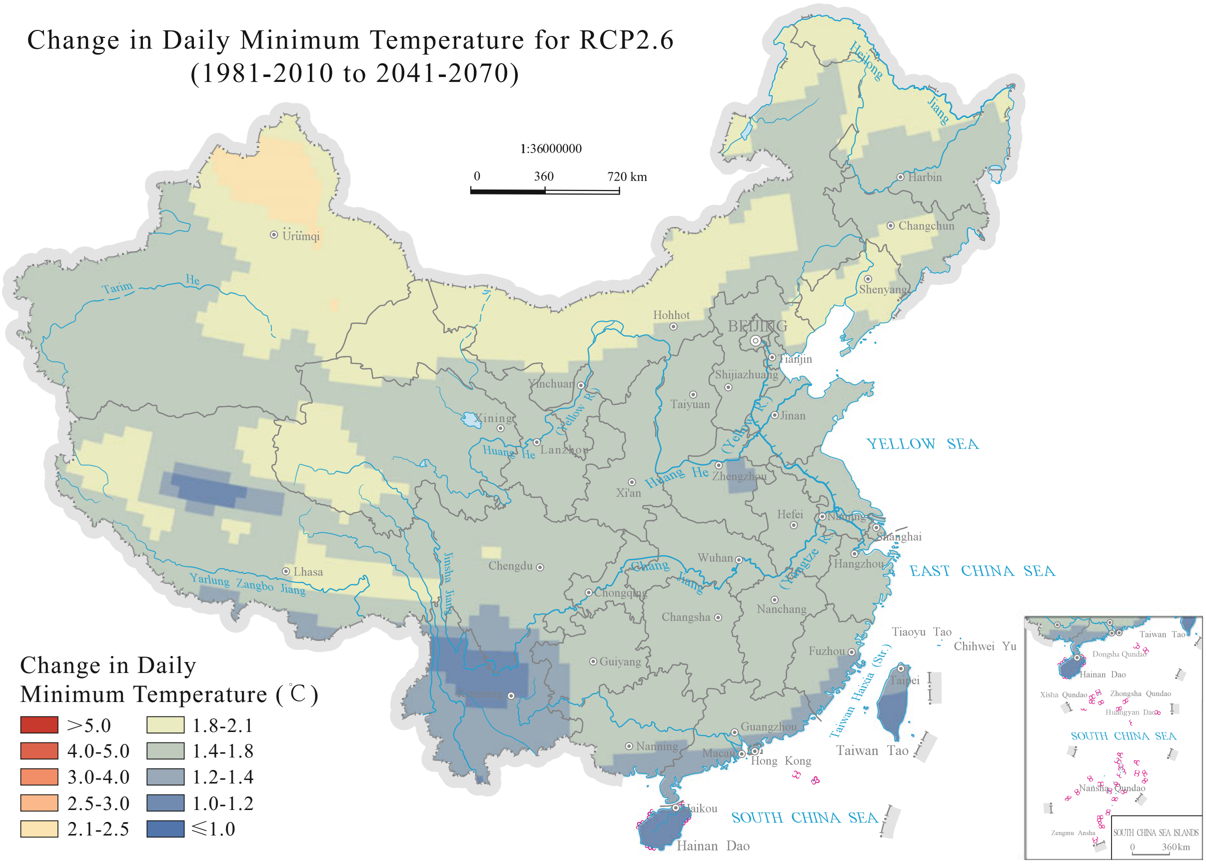


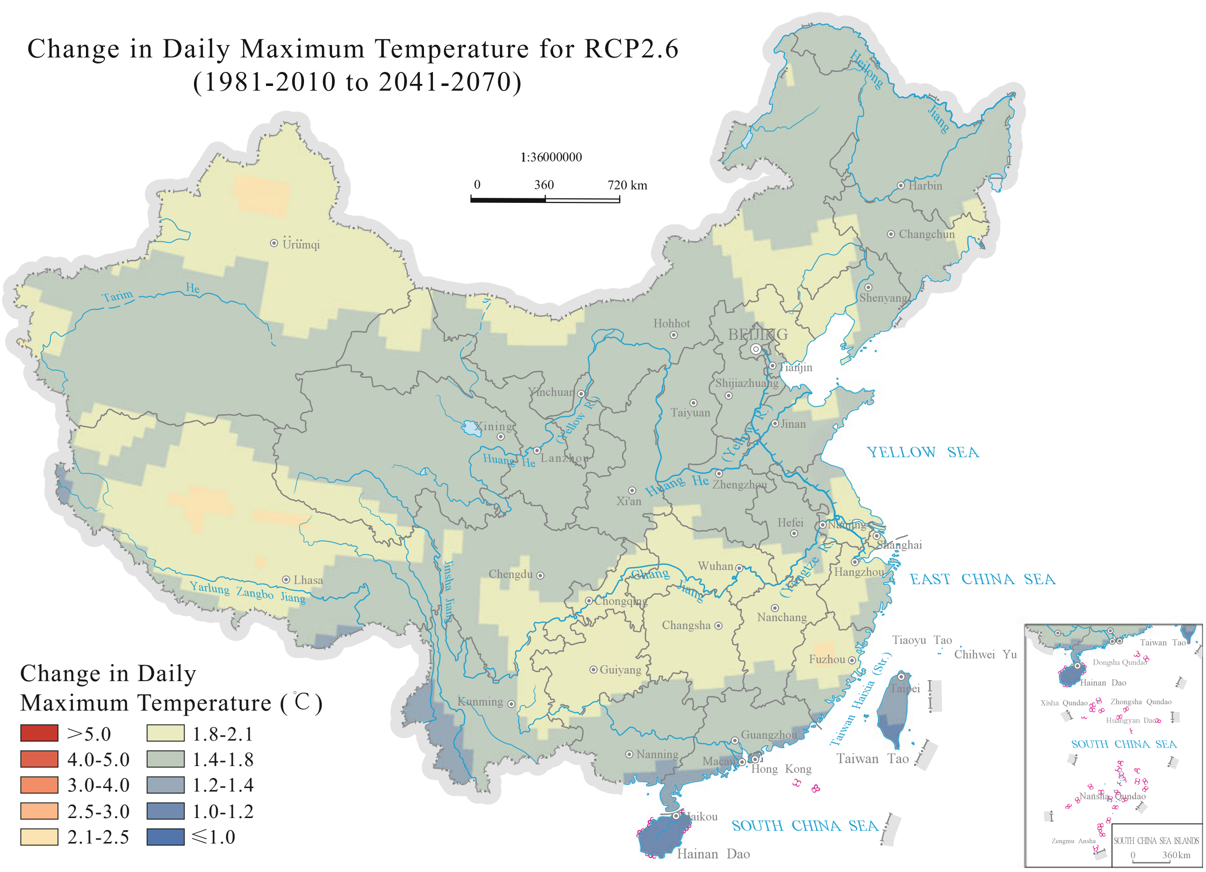
Change in Mean Temperature for RCP2.6
(1981-2010 to 2011-2040)



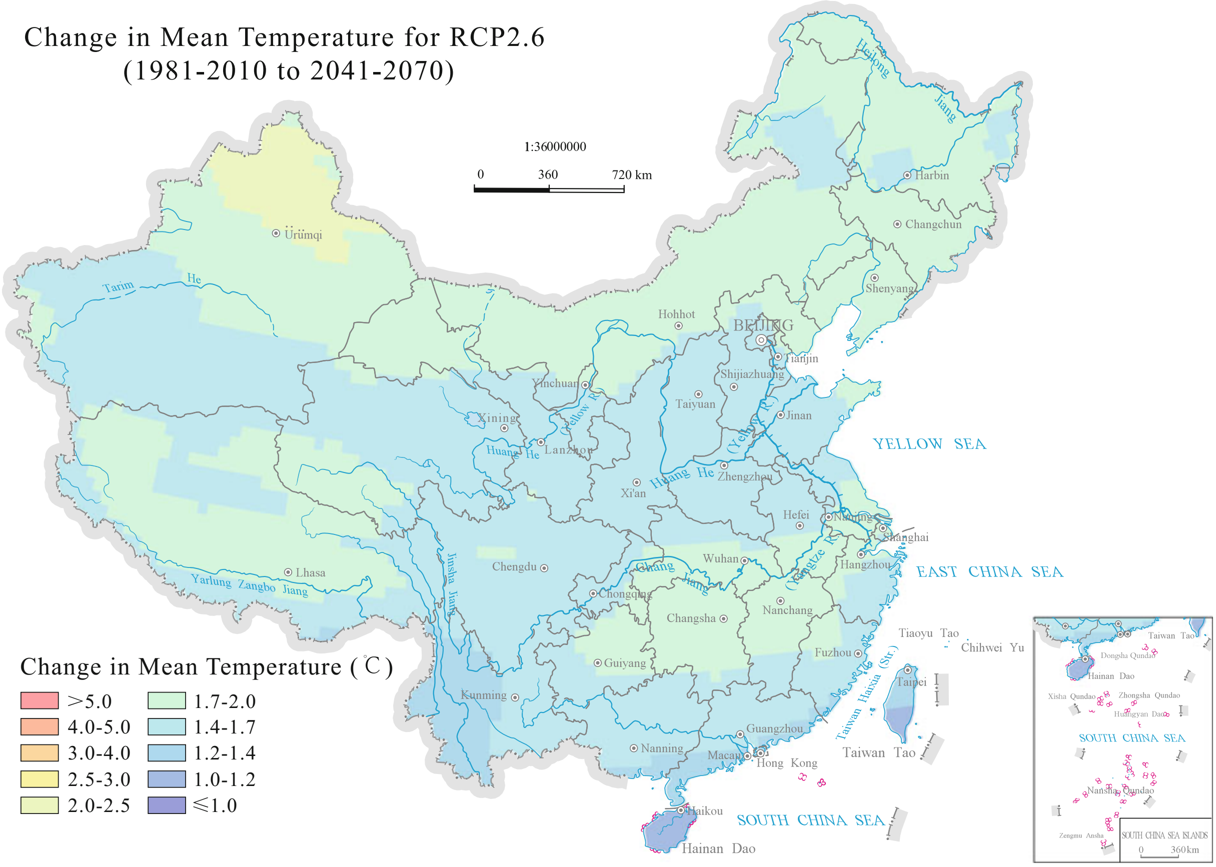
Change in Annual Precipitation for RCP2.6
(1981-2010 to 2011-2040)



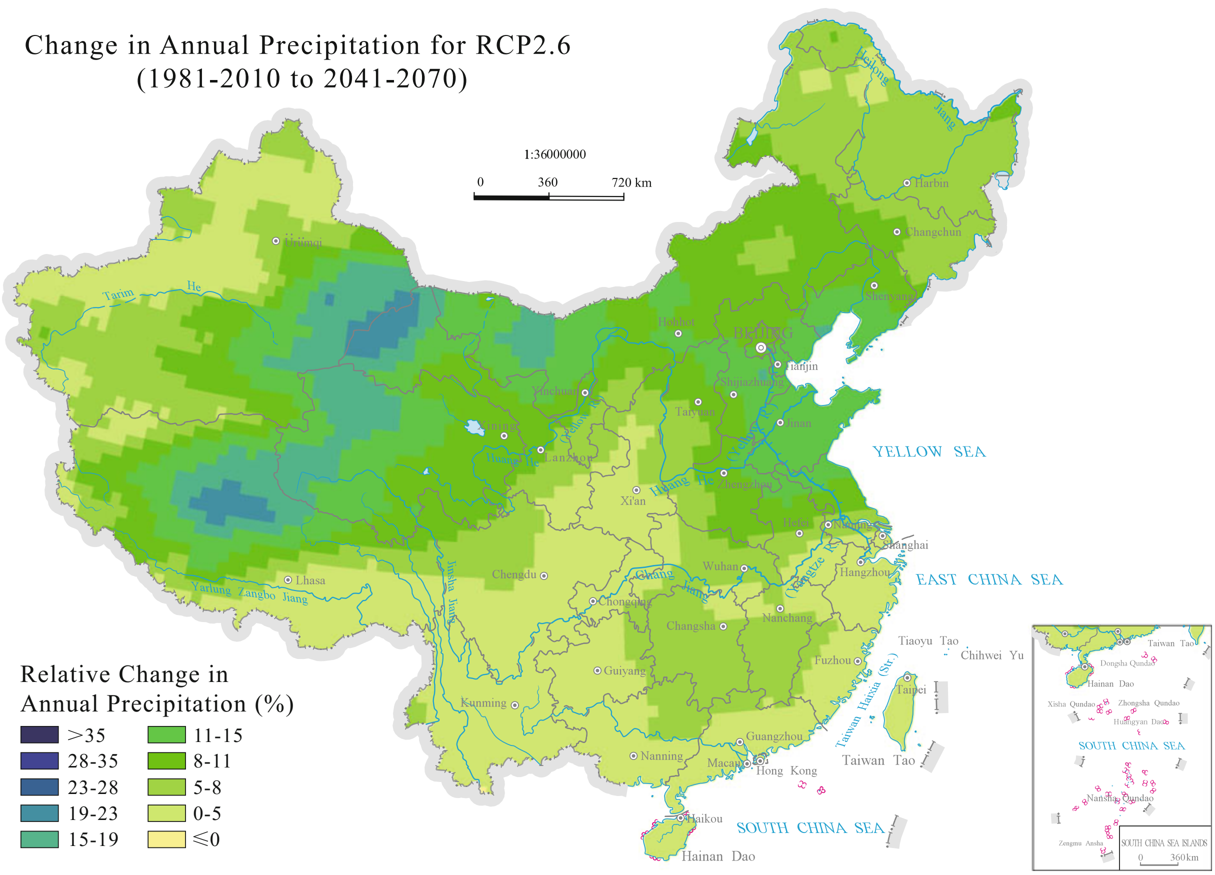

Change in Daily Minimum Temperature for RCP2.6
(1981-2010 to 2041-2070)
1:36000000
0 360 720 km
Change in Daily
Minimum Temperature (℃)
>5.0
4.0-5.0
3.0-4.0
2.5-3.0
2.1-2.5
1.8-2.1
1.4-1.8
1.2-1.4
1.0-1.2
≤1.0
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA
Harbin
Changchun
Shenyang
Ürümqi
Hohhot
BEIJING
Tianjin
Shijiazhuang
Taiyuan
Jinan
Yinchuan
Xining
Lanzhou
Xi'an
Zhengzhou
Hefei
Nanjing
Shanghai
Hangzhou
Wuhan
Chengdu
Chongqing
Changsha
Nanchang
Fuzhou
Guiyang
Lhasa
Nanning
Guangzhou
Macao
Hong Kong
Haikou
Hainan Dao
Taipei
Taiwan Tao
Tiaoyu Tao
Chihwei Yu
Tarim He
Yarlung Zangbo Jiang
Heilong Jiang
Huang He
Jinsha Jiang
Taiwan Haixia (Str.)
SOUTH CHINA SEA


Change in Daily Maximum Temperature for RCP2.6
(1981-2010 to 2041-2070)
1:36000000
0 360 720 km
Change in Daily
Maximum Temperature (℃)
>5.0
4.0-5.0
3.0-4.0
2.5-3.0
2.1-2.5
1.8-2.1
1.4-1.8
1.2-1.4
1.0-1.2
≤1.0
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA
Harbin
Changchun
Shenyang
Ürümqi
Hohhot
BEIJING
Tianjin
Shijiazhuang
Taiyuan
Jinan
Yinchuan
Xining
Lanzhou
Xi'an
Zhengzhou
Hefei
Nanjing
Shanghai
Hangzhou
Wuhan
Chengdu
Chongqing
Changsha
Nanchang
Fuzhou
Guiyang
Kunming
Lhasa
Nanning
Guangzhou
Macao
Hong Kong
Haikou
Hainan Dao
Taipei
Taiwan Tao
Tiaoyu Tao
Chihwei Yu
Tarim He
Yarlung Zangbo Jiang
Heilong Jiang
Huang He
Jinsha Jiang
Taiwan Haixia (Str.)
SOUTH CHINA SEA

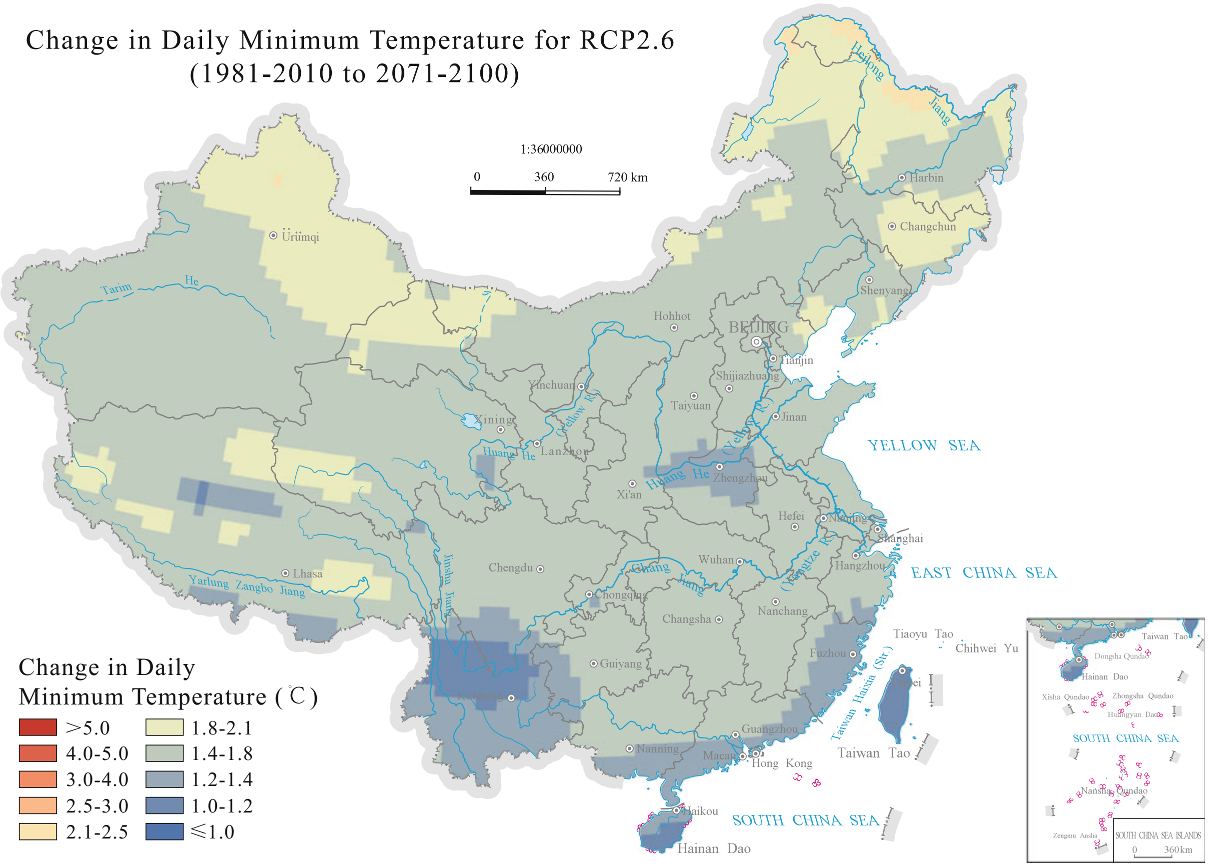
Change in Mean Temperature for RCP2.6
(1981-2010 to 2041-2070)



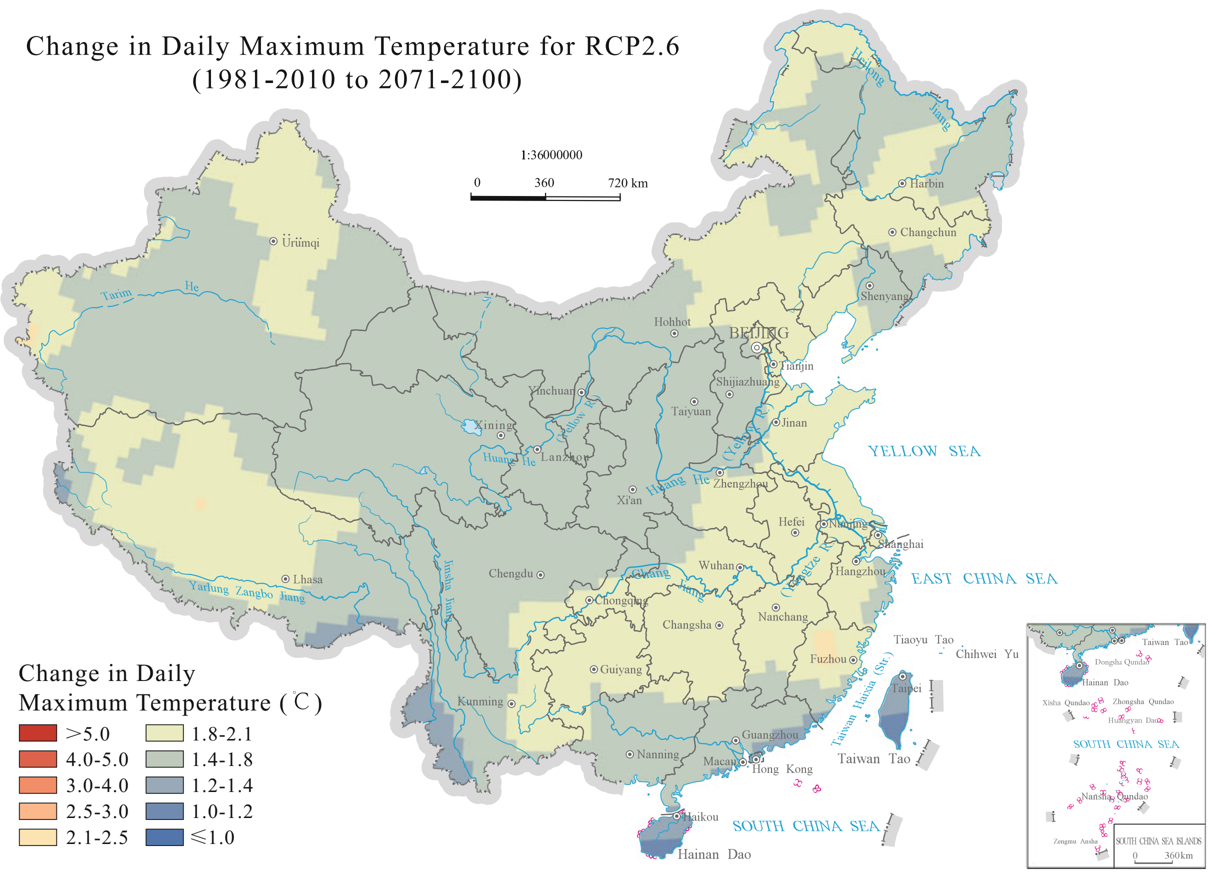
Change in Annual Precipitation for RCP2.6
(1981-2010 to 2041-2070)



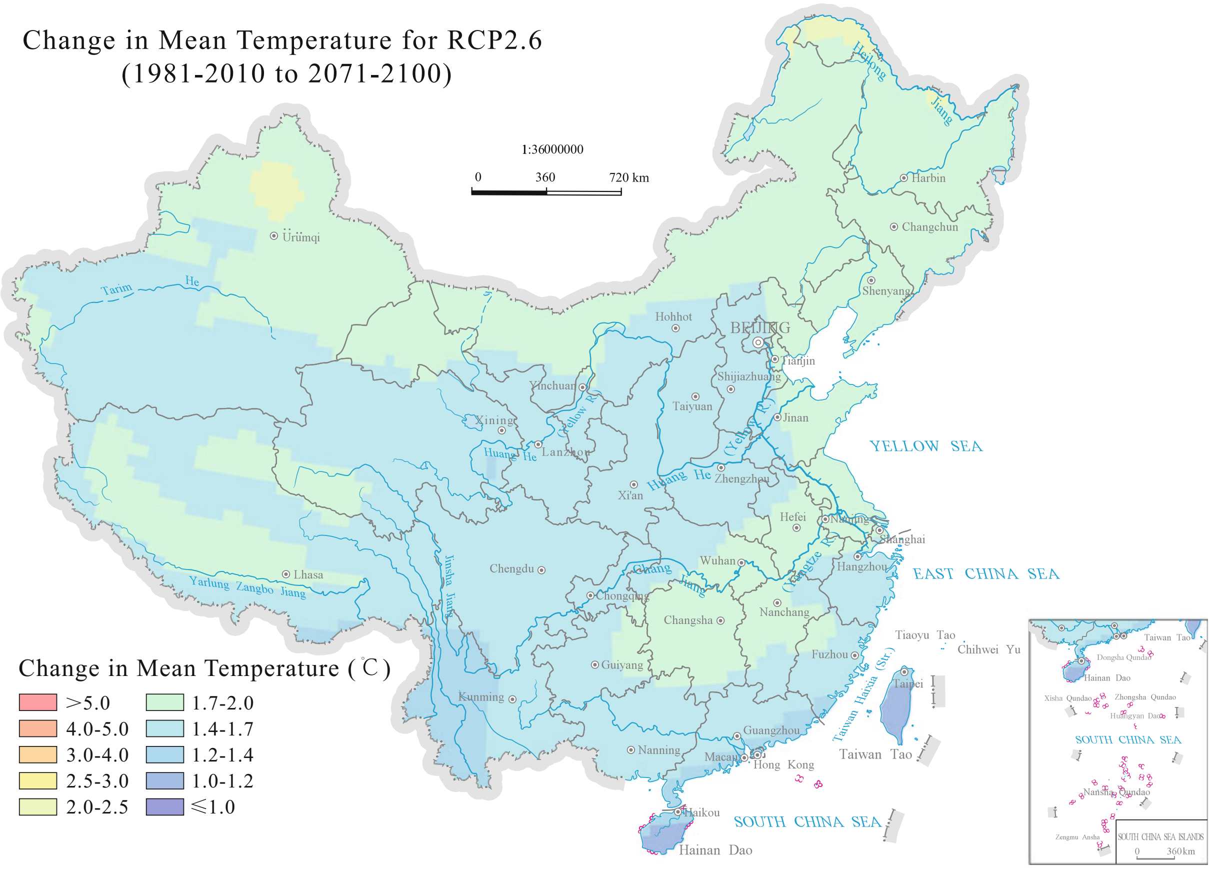
Change in Daily Minimum Temperature for RCP2.6
(1981-2010 to 2071-2100)



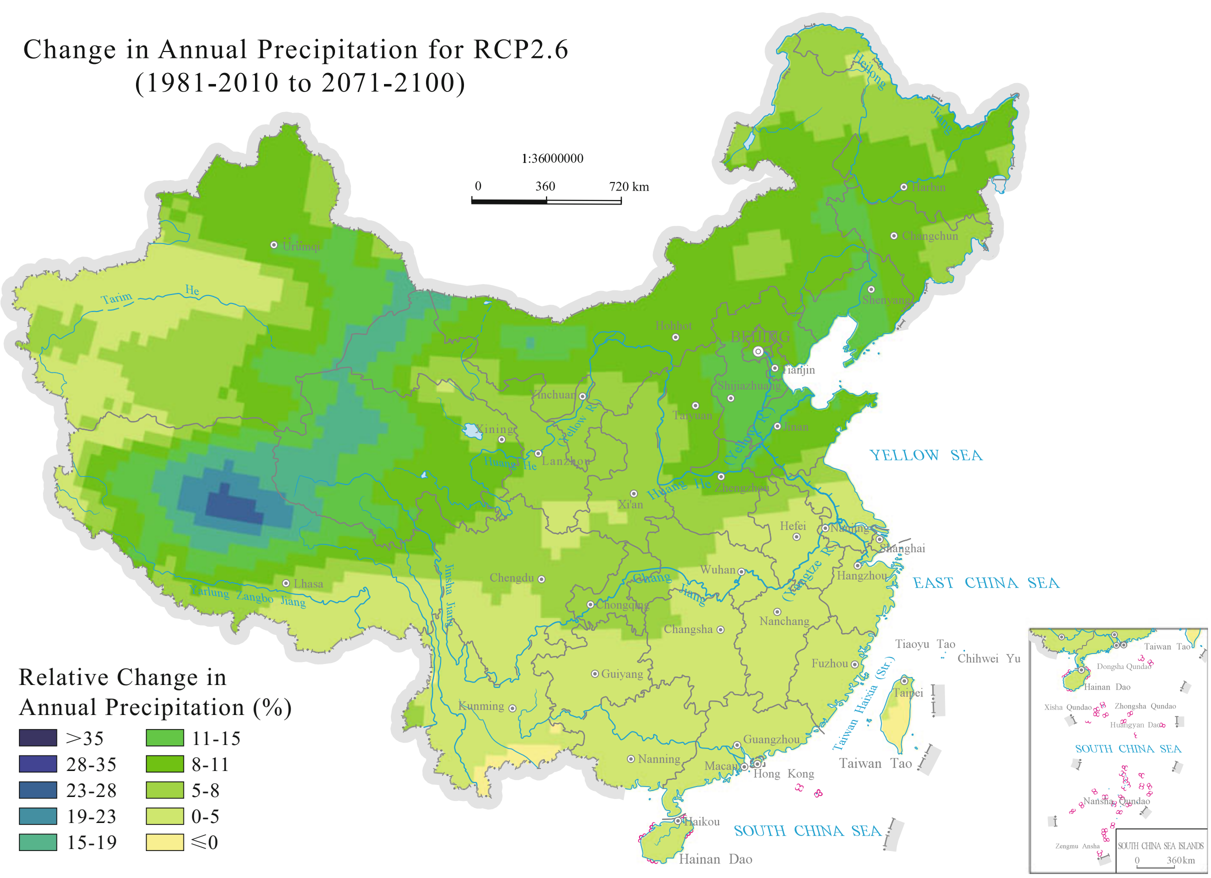
Change in Daily Maximum Temperature for RCP2.6
(1981-2010 to 2071-2100)

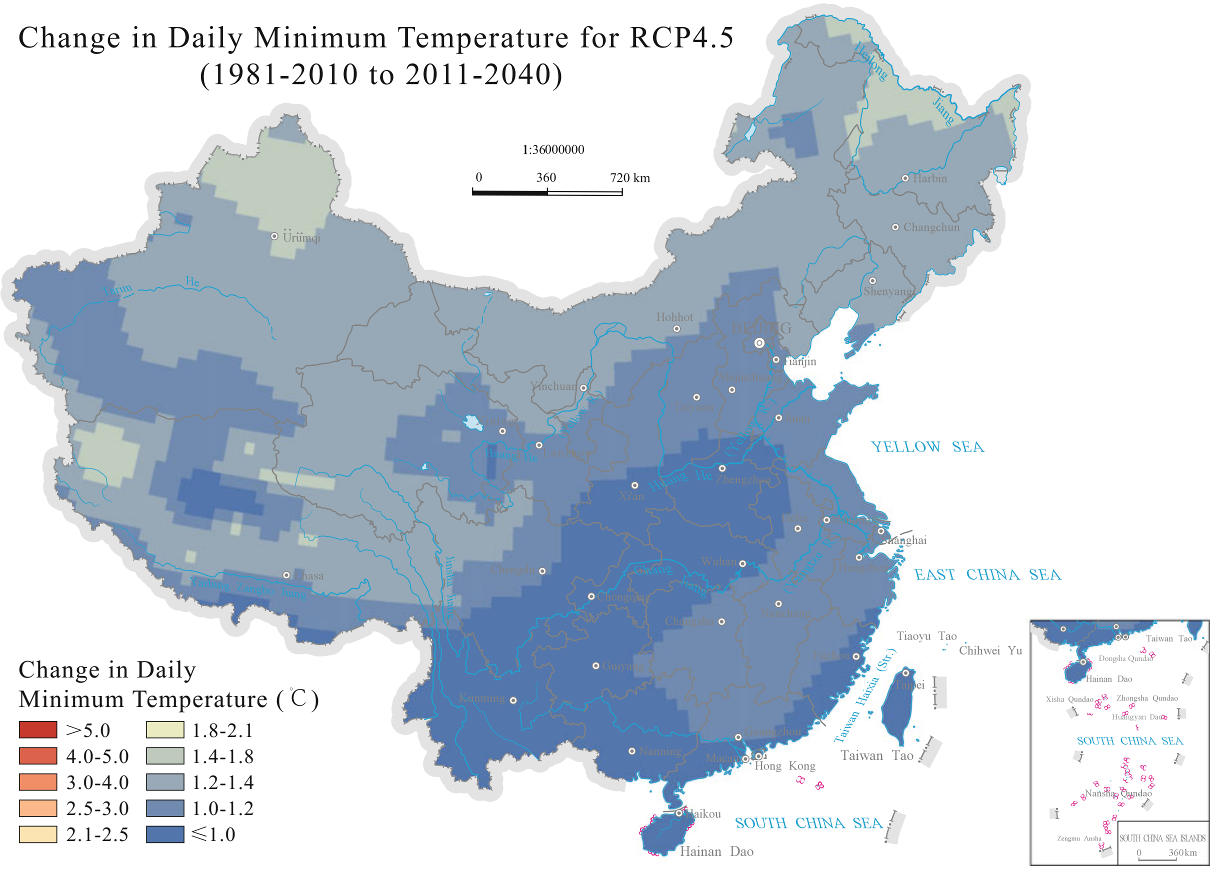


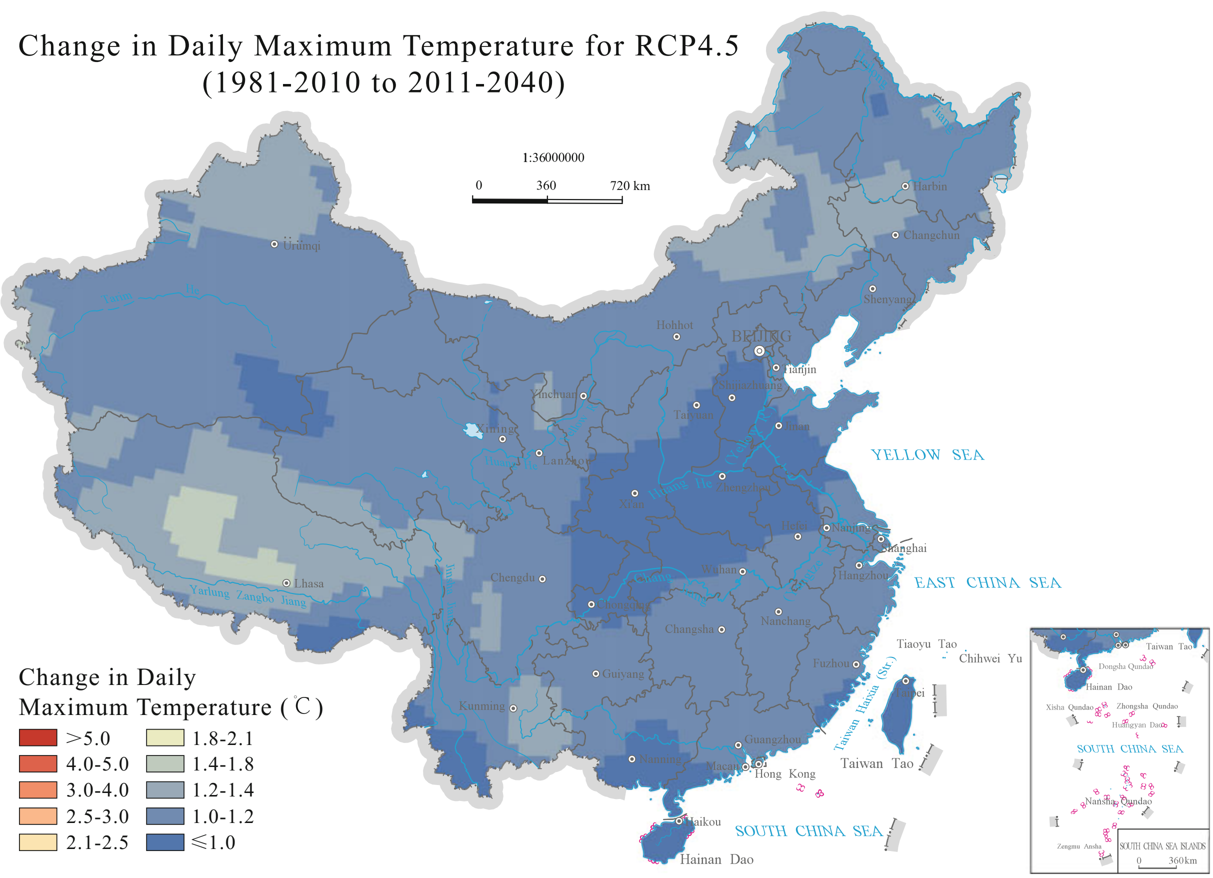
Change in Mean Temperature for RCP2.6
(1981-2010 to 2071-2100)



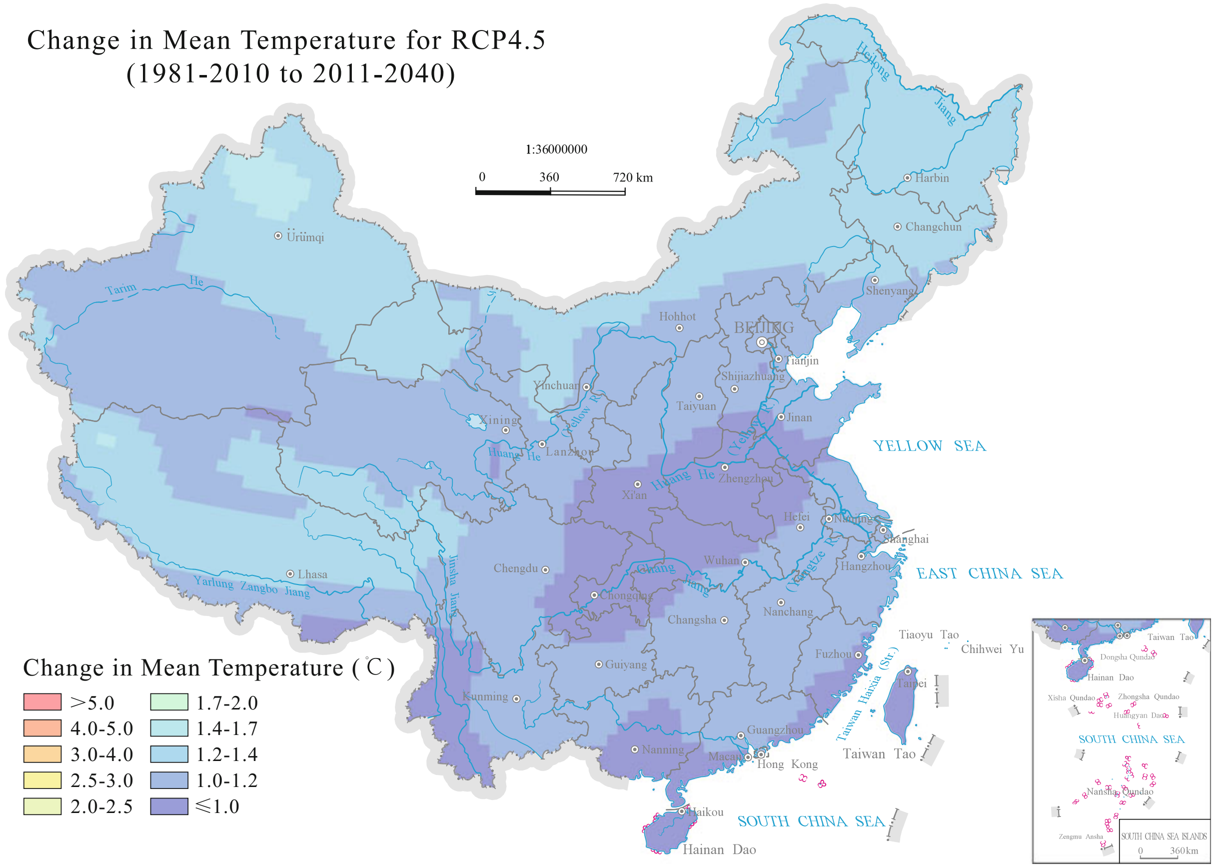
Change in Annual Precipitation for RCP2.6
(1981-2010 to 2071-2100)



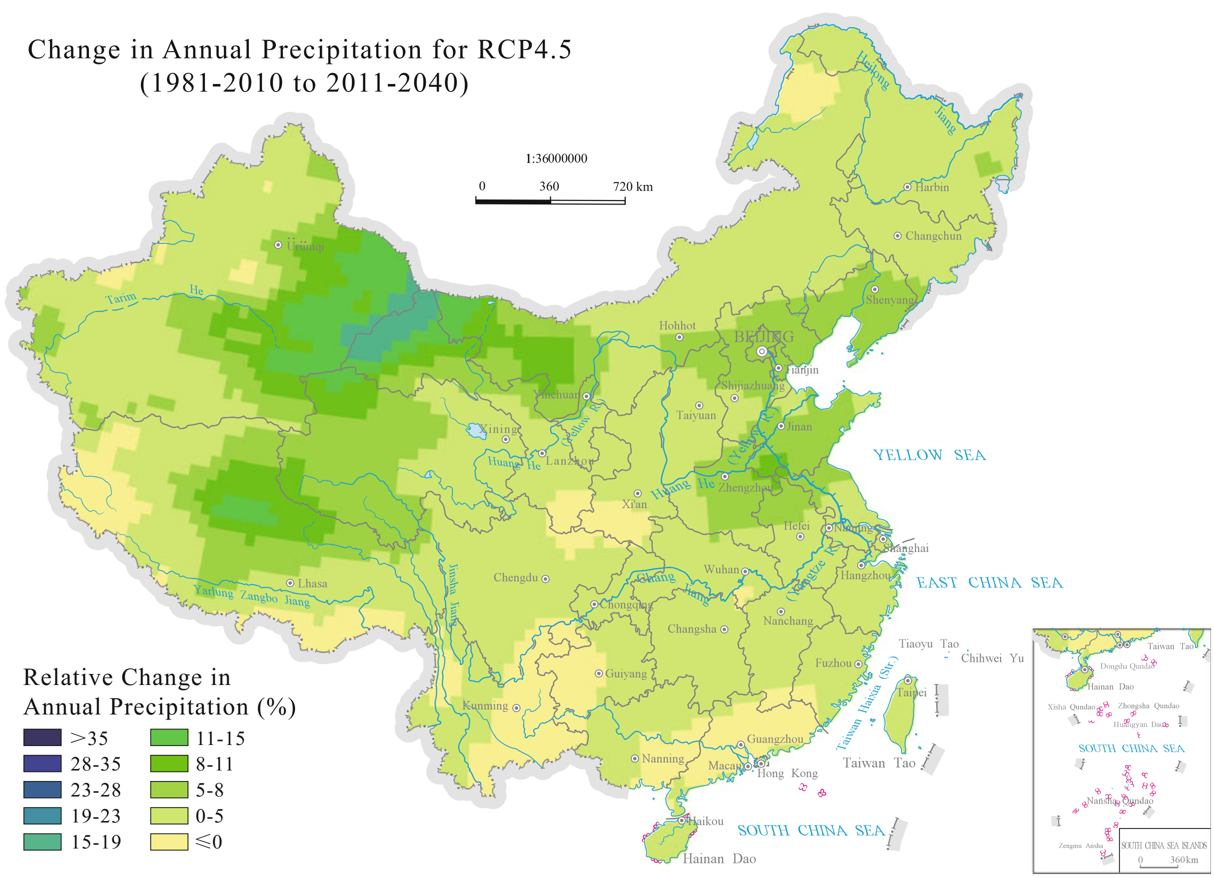

Change in Daily Minimum Temperature for RCP4.5
(1981-2010 to 2011-2040)
1:36000000
0 360 720 km
Harbin
Changchun
Shenyang
Ürümqi
Hohhot
BEIJING
Tianjin
Yinchuan
Zhengzhou
Xi'an
Wuhan
Shanghai
Lhasa
Chongqing
Guiyang
Kunming
Nanning
Hong Kong
Haikou
Hainan Dao
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA
Tiaoyu Tao
Chihwei Yu
Taiwan Tao
Change in Daily
Minimum Temperature (℃)
>5.0
4.0-5.0
3.0-4.0
2.5-3.0
2.1-2.5
1.8-2.1
1.4-1.8
1.2-1.4
1.0-1.2
≤1.0


Change in Daily Maximum Temperature for RCP4.5
(1981-2010 to 2011-2040)
1:36000000
0 360 720 km
Harbin
Changchun
Shenyang
Ürümqi
Hohhot
BEIJING
Tianjin
Yinchuan
Lanzhou
Xi'an
Zhengzhou
Nanjing
Shanghai
Hangzhou
Wuhan
Lhasa
Yarlung Zangbo Jiang
Chengdu
Changsha
Nanchang
Fuzhou
Guiyang
Kunming
Guangzhou
Hong Kong
Haikou
Hainan Dao
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA
Tiaoyu Tao
Chihwei Yu
Taiwan Tao
Change in Daily
Maximum Temperature (℃)
>5.0
4.0-5.0
3.0-4.0
2.5-3.0
2.1-2.5
1.8-2.1
1.4-1.8
1.2-1.4
1.0-1.2
≤1.0

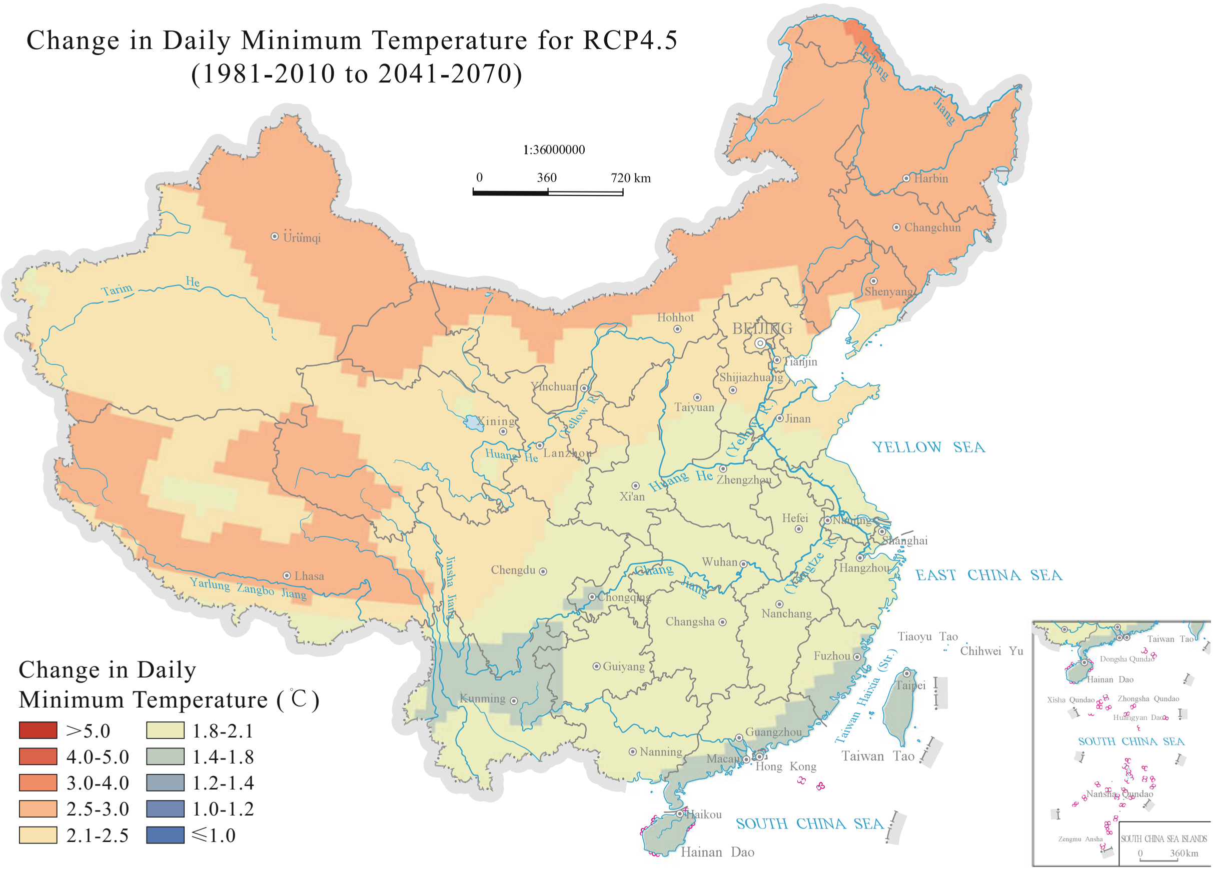
Change in Mean Temperature for RCP4.5
(1981-2010 to 2011-2040)



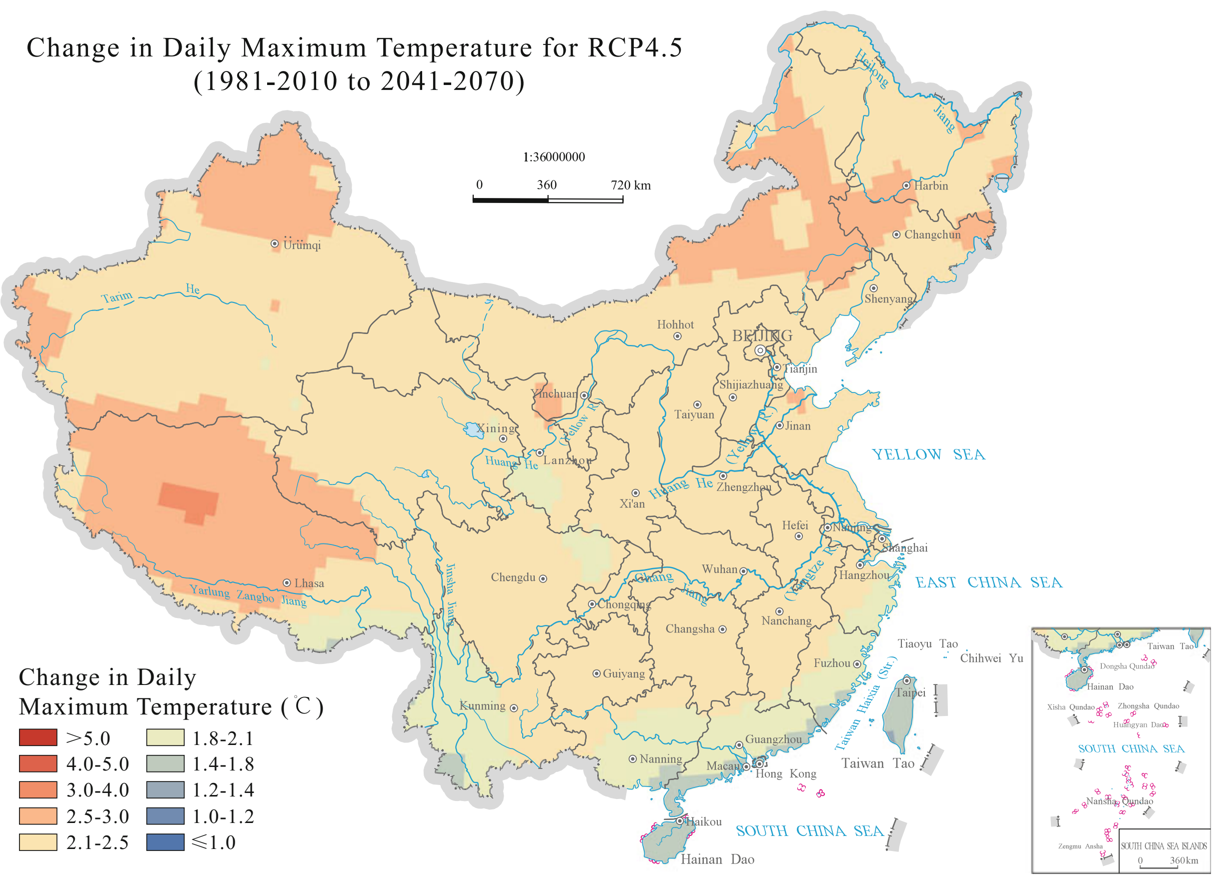
Change in Annual Precipitation for RCP4.5
(1981-2010 to 2011-2040)

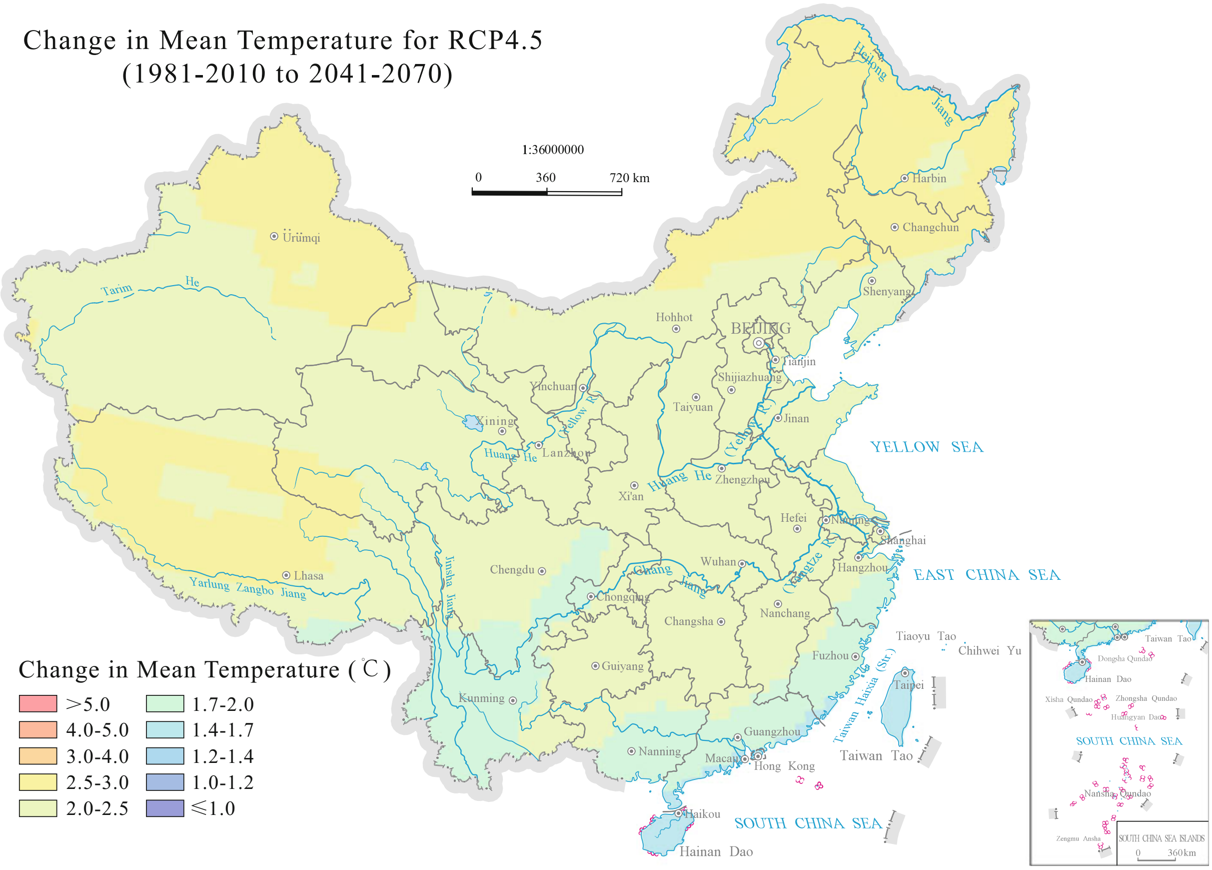


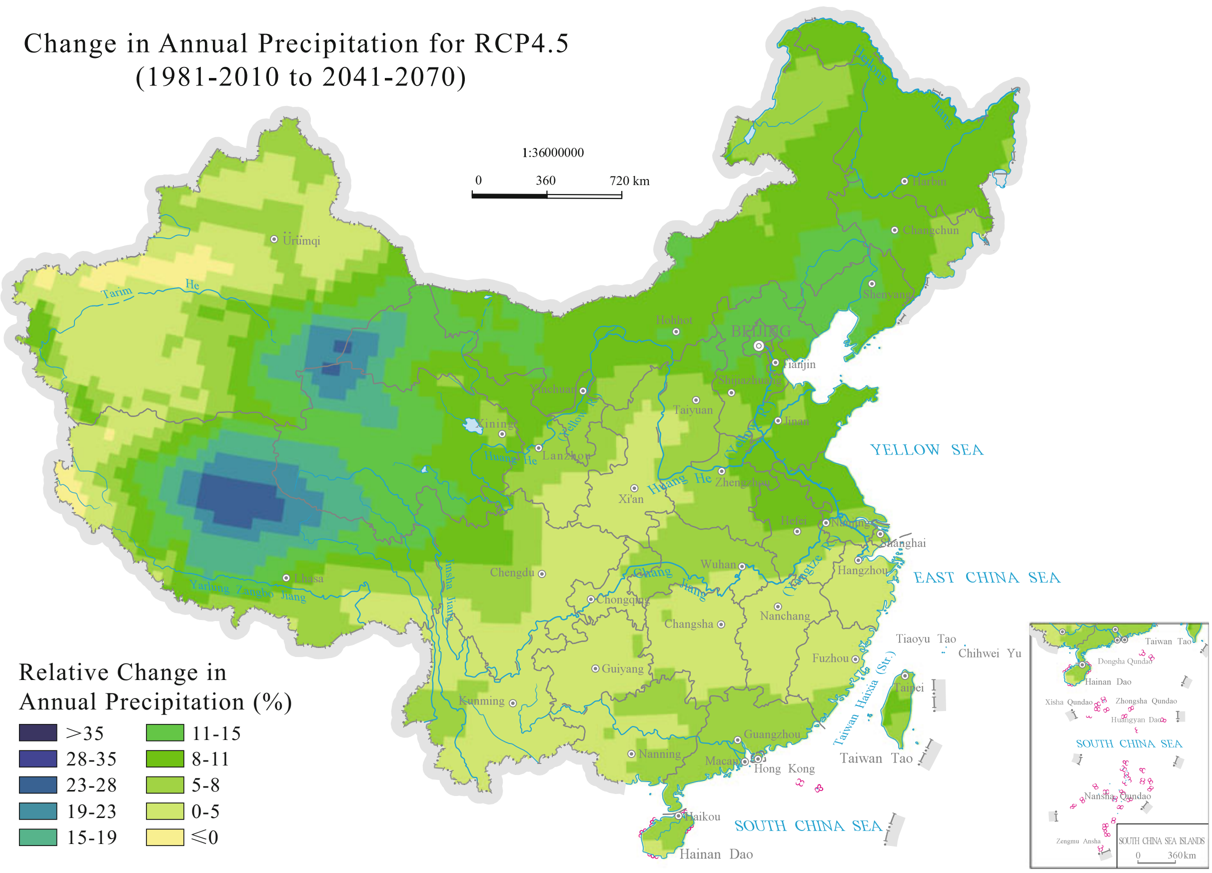
Change in Daily Minimum Temperature for RCP4.5
(1981-2010 to 2041-2070)



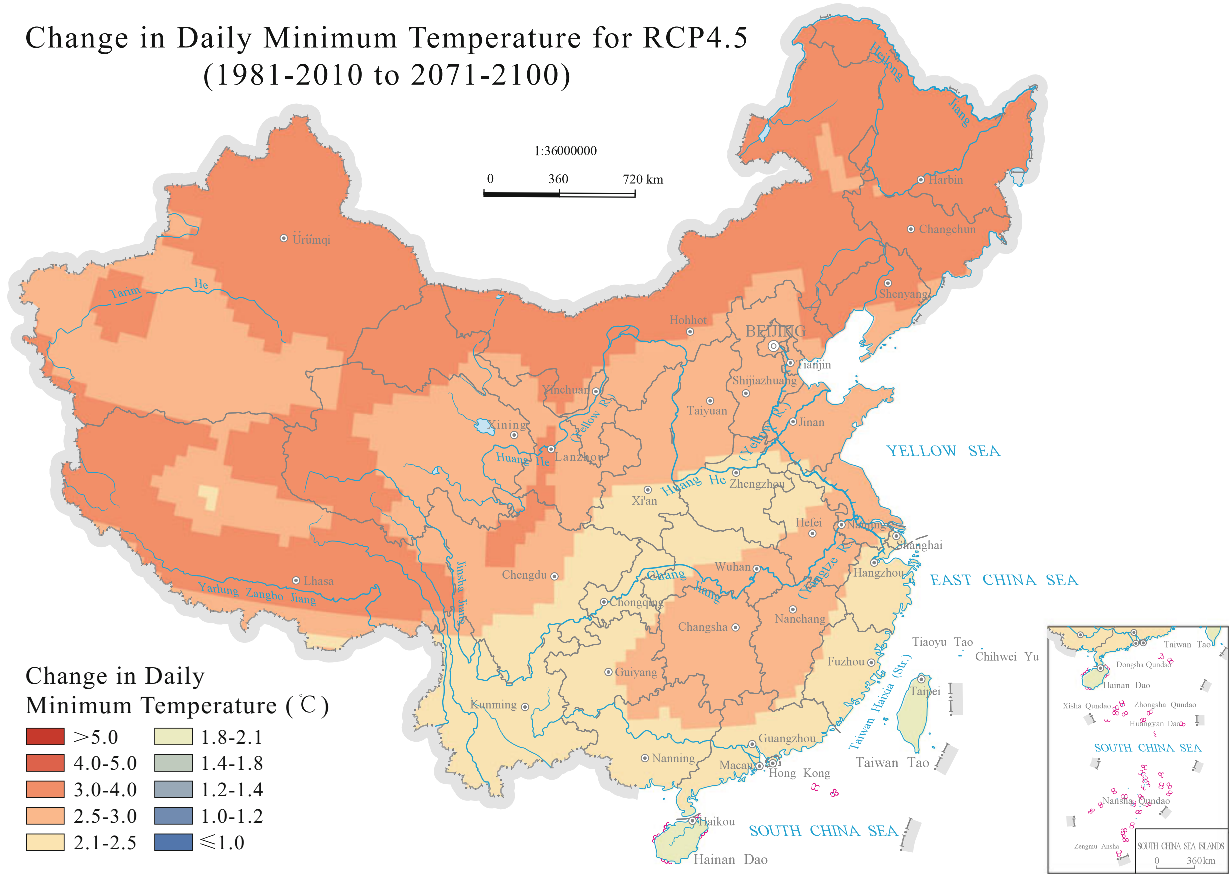
Change in Daily Maximum Temperature for RCP4.5
(1981-2010 to 2041-2070)



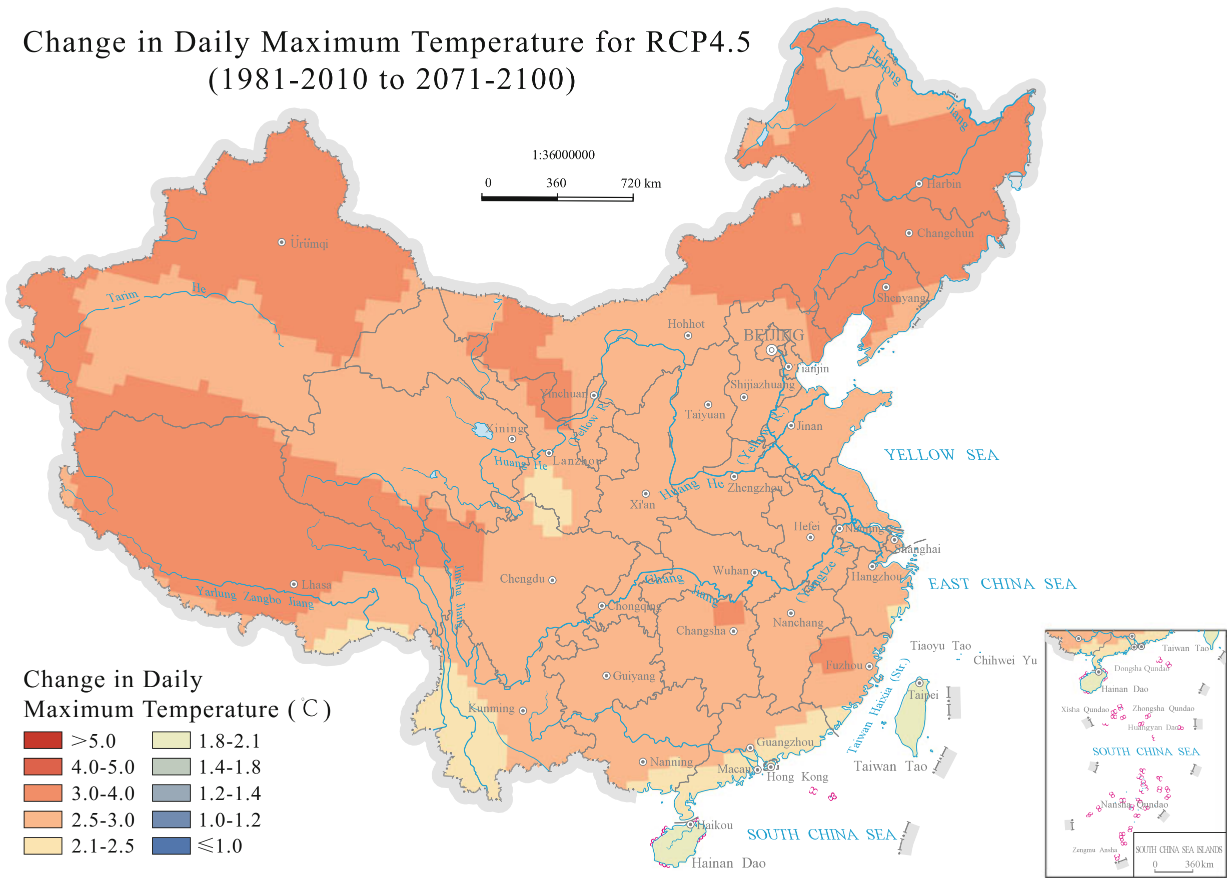

Change in Mean Temperature for RCP4.5
(1981-2010 to 2041-2070)
1:36000000
0 360 720 km
Change in Mean Temperature (℃)
>5.0
4.0-5.0
3.0-4.0
2.5-3.0
2.0-2.5
1.7-2.0
1.4-1.7
1.2-1.4
1.0-1.2
≤1.0
Ürümqi
Tarim He
Lhasa
Yarlung Zangbo Jiang
Harbin
Changchun
Shenyang
Hohhot
BEIJING
Tianjin
Shijiazhuang
Yinchuan
Taiyuan
Jinan
Xining
Lanzhou
Huang He
Xi'an
Zhengzhou
Hefei
Nanjing
Shanghai
Hangzhou
Wuhan
Chengdu
Chongqing
Changsha
Nanchang
Fuzhou
Guiyang
Kunming
Nanning
Guangzhou
Macao
Hong Kong
Haikou
Hainan Dao
Taipei
Taiwan Dao
Tiaoyu Tao
Chihwei Yu
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA

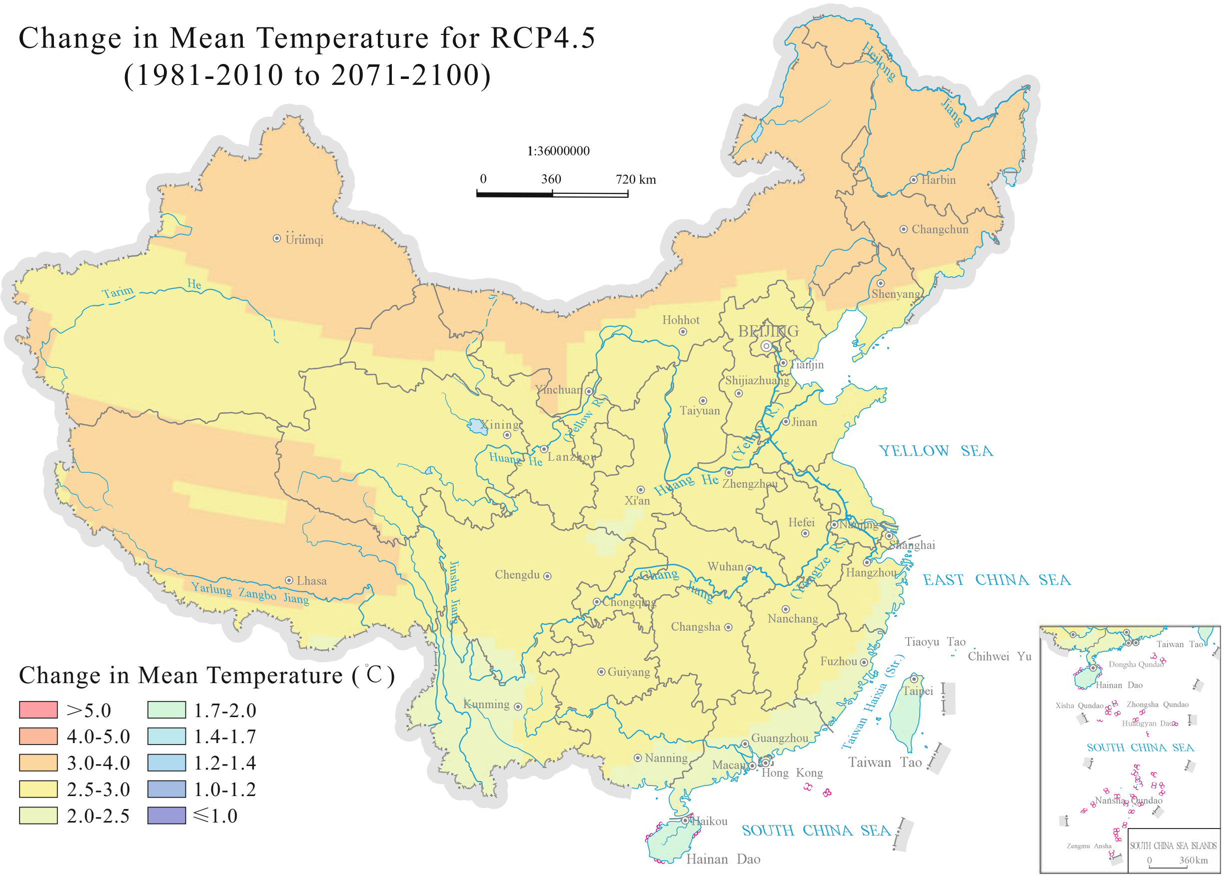

Change in Annual Precipitation for RCP4.5
(1981-2010 to 2041-2070)
1:36000000
0 360 720 km
Relative Change in
Annual Precipitation (%)
>35
28-35
23-28
19-23
15-19
11-15
8-11
5-8
0-5
≤0
Ürümqi
Tarim He
Harbin
Changchun
Shenyang
Hohhot
BEIJING
Tianjin
Taiyuan
Jinan
Xining
Lanzhou
Xi'an
Zhengzhou
Hefei
Nanjing
Shanghai
Hangzhou
Wuhan
Chengdu
Chongqing
Changsha
Nanchang
Fuzhou
Guiyang
Kunming
Nanning
Guangzhou
Macao
Hong Kong
Haikou
Hainan Dao
Taipei
Taiwan Dao
Tiaoyu Tao
Chihwei Yu
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA

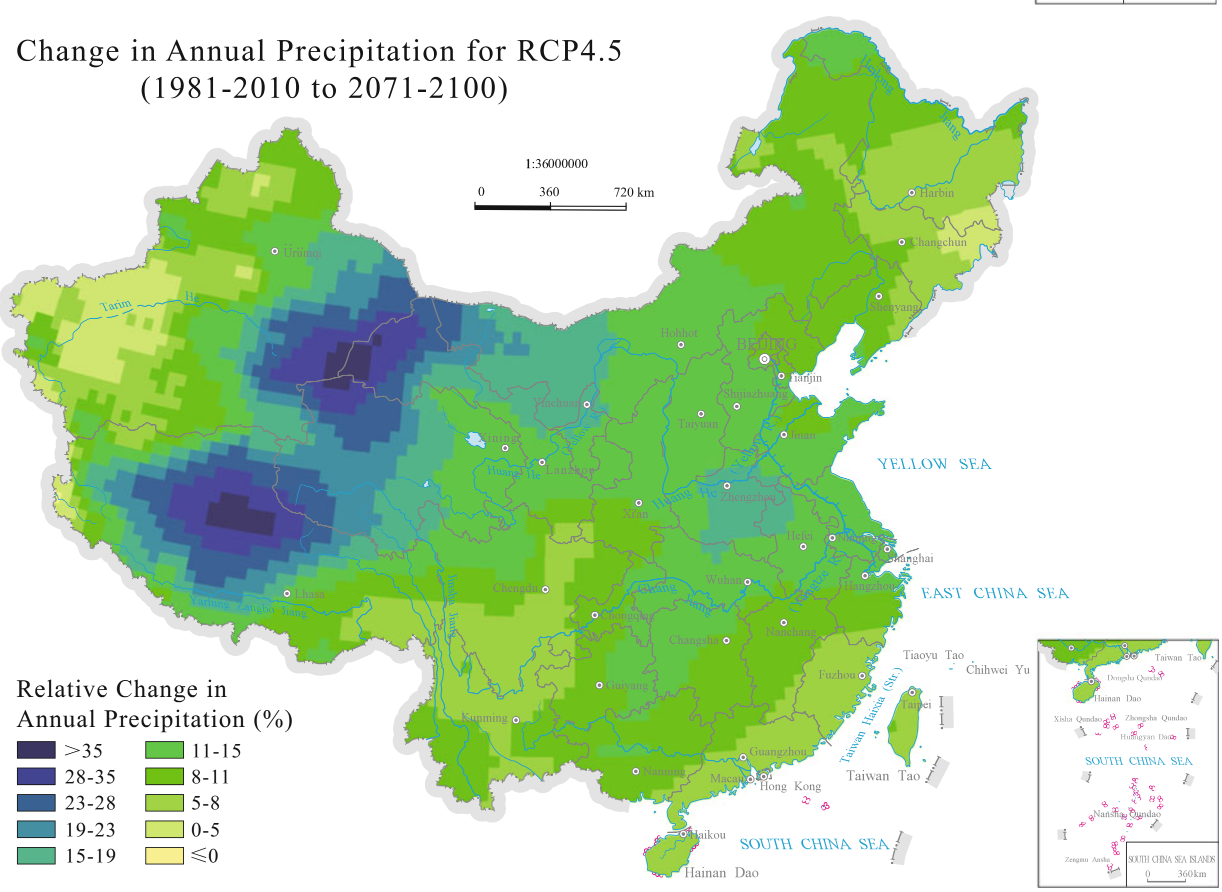
Change in Daily Minimum Temperature for RCP4.5
(1981-2010 to 2071-2100)

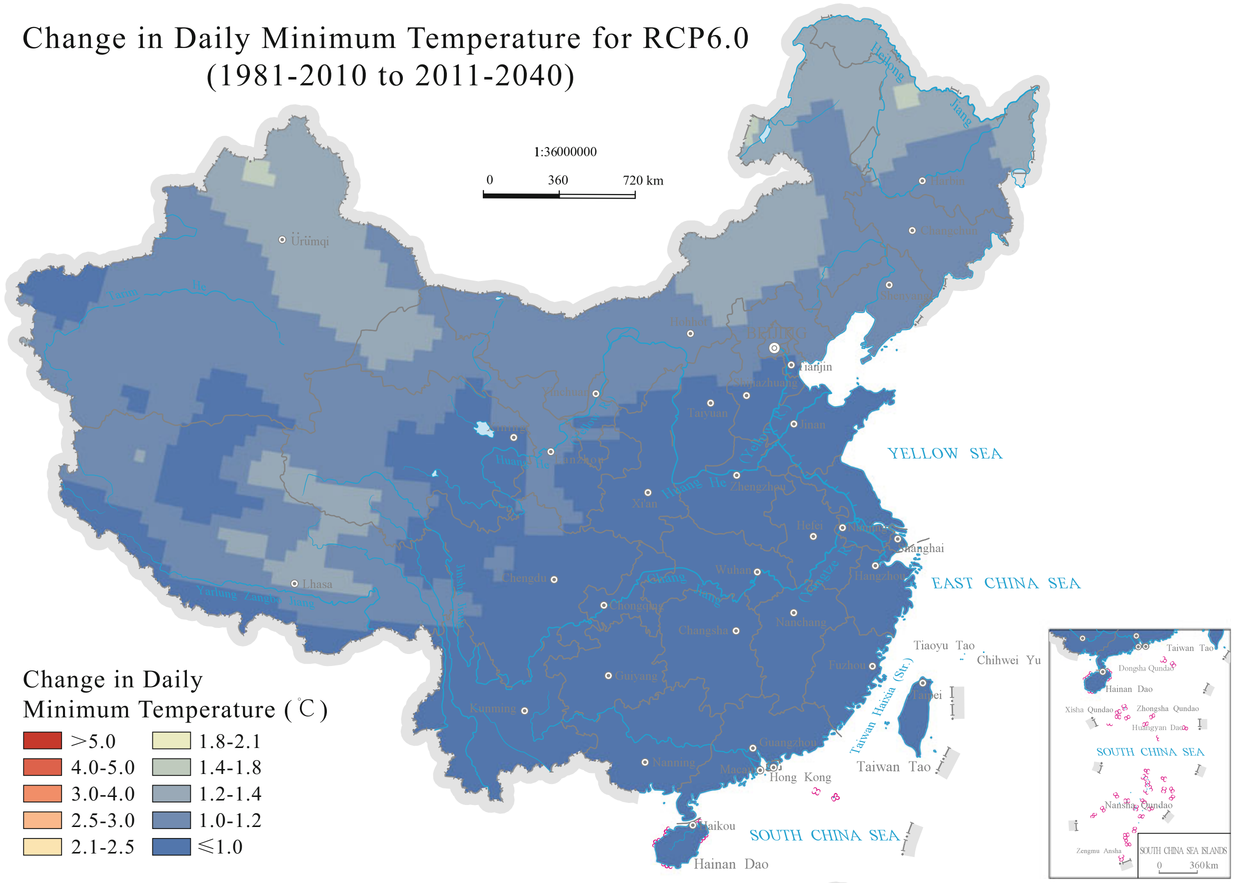


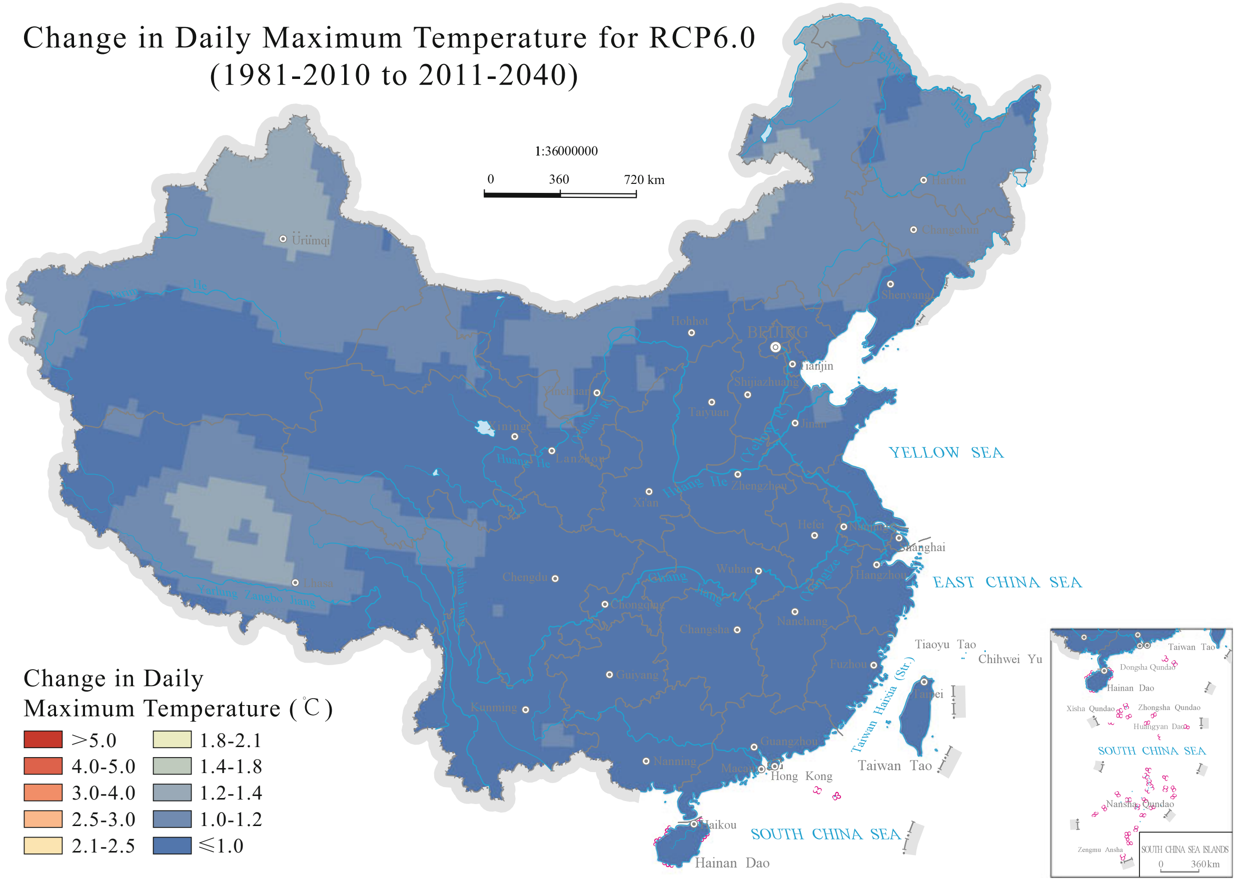
Change in Daily Maximum Temperature for RCP4.5
(1981-2010 to 2071-2100)



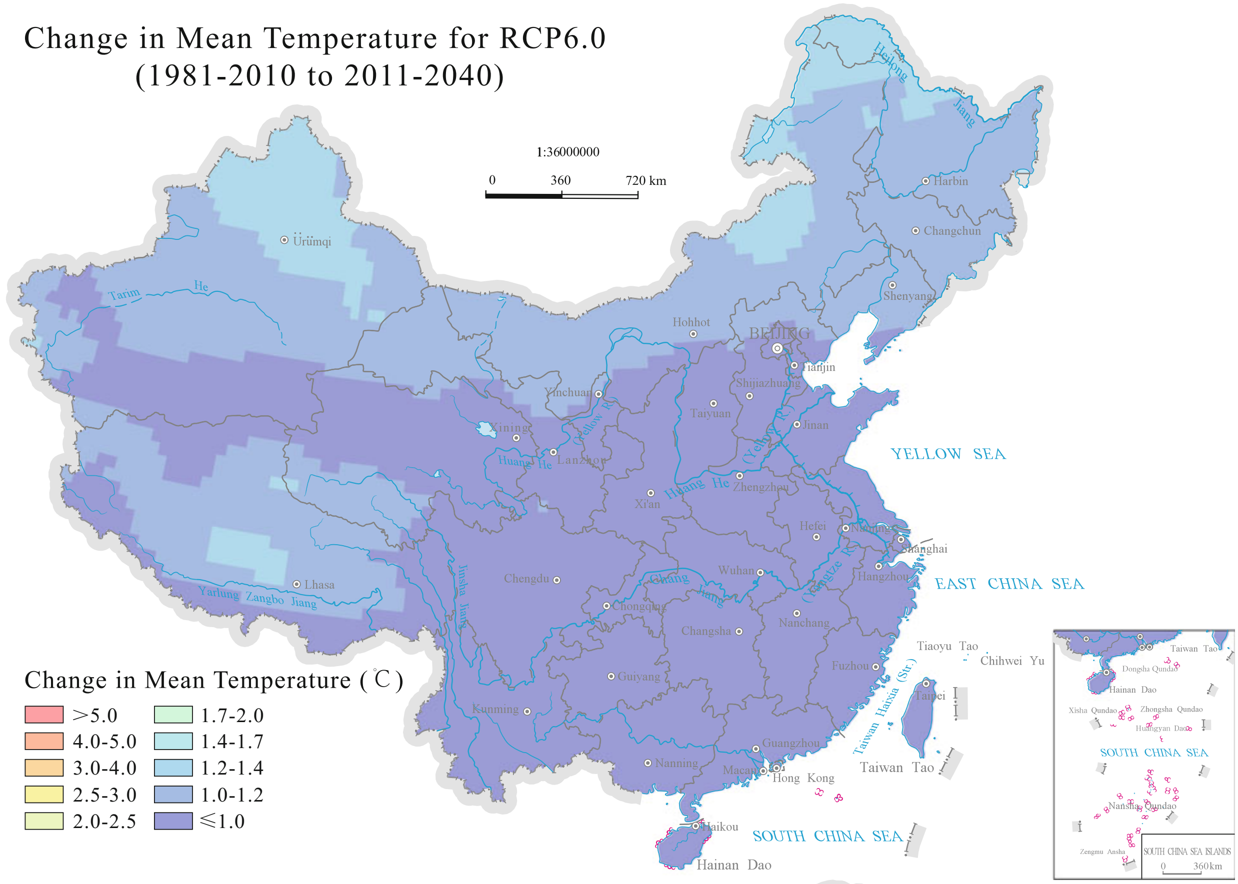

Change in Mean Temperature for RCP4.5
(1981-2010 to 2071-2100)
1:36000000
0 360 720 km
Change in Mean Temperature (℃)
>5.0
4.0-5.0
3.0-4.0
2.5-3.0
2.0-2.5
1.7-2.0
1.4-1.7
1.2-1.4
1.0-1.2
≤1.0
Harbin
Changchun
Shenyang
Ürümqi
Tarim He
Hohhot
BEIJING
Tianjin
Shijiazhuang
Taiyuan
Jinan
Yinchuan
Xining
Lanzhou
Huang He
Xi'an
Zhengzhou
Hefei
Nanjing
Shanghai
Hangzhou
Wuhan
Chengdu
Chongqing
Changsha
Nanchang
Lhasa
Yarlung Zangbo Jiang
Guiyang
Kunming
Fuzhou
Taipei
Guangzhou
Nanning
Macau
Hong Kong
Haikou
Hainan Dao
Taiwan Tao
Tiaoyu Tao
Chihwei Yu
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA


Change in Annual Precipitation for RCP4.5
(1981-2010 to 2071-2100)
1:36000000
0 360 720 km
Relative Change in
Annual Precipitation (%)
>35
28-35
23-28
19-23
15-19
11-15
8-11
5-8
0-5
≤0
Harbin
Changchun
Shenyang
Ürümqi
Tarim He
Hohhot
BEIJING
Tianjin
Taiyuan
Yinchuan
Xining
Lanzhou
Xi'an
Wuhan
Chengdu
Changsha
Lhasa
Kunming
Fuzhou
Taipei
Guangzhou
Macau
Hong Kong
Haikou
Hainan Dao
Taiwan Tao
Tiaoyu Tao
Chihwei Yu
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA

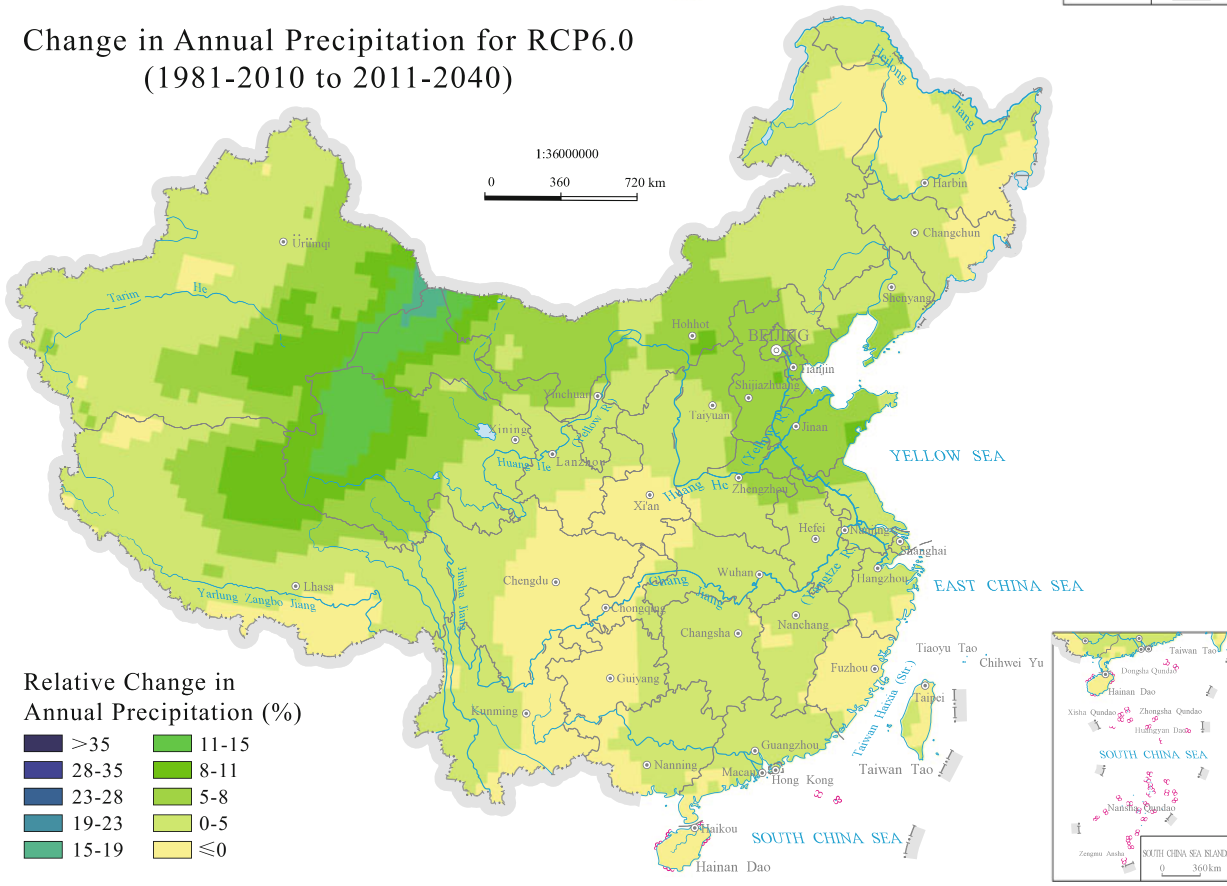

Change in Daily Minimum Temperature for RCP6.0
(1981-2010 to 2011-2040)
1:36000000
0 360 720 km
Change in Daily
Minimum Temperature (℃)
>5.0
4.0-5.0
3.0-4.0
2.5-3.0
2.1-2.5
1.8-2.1
1.4-1.8
1.2-1.4
1.0-1.2
≤1.0
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA
Hainan Dao
Taiwan Tao
Hong Kong
Shanghai
Tianjin
Tiaoyu Tao
Chihwei Yu
SOUTH CHINA SEA ISLANDS

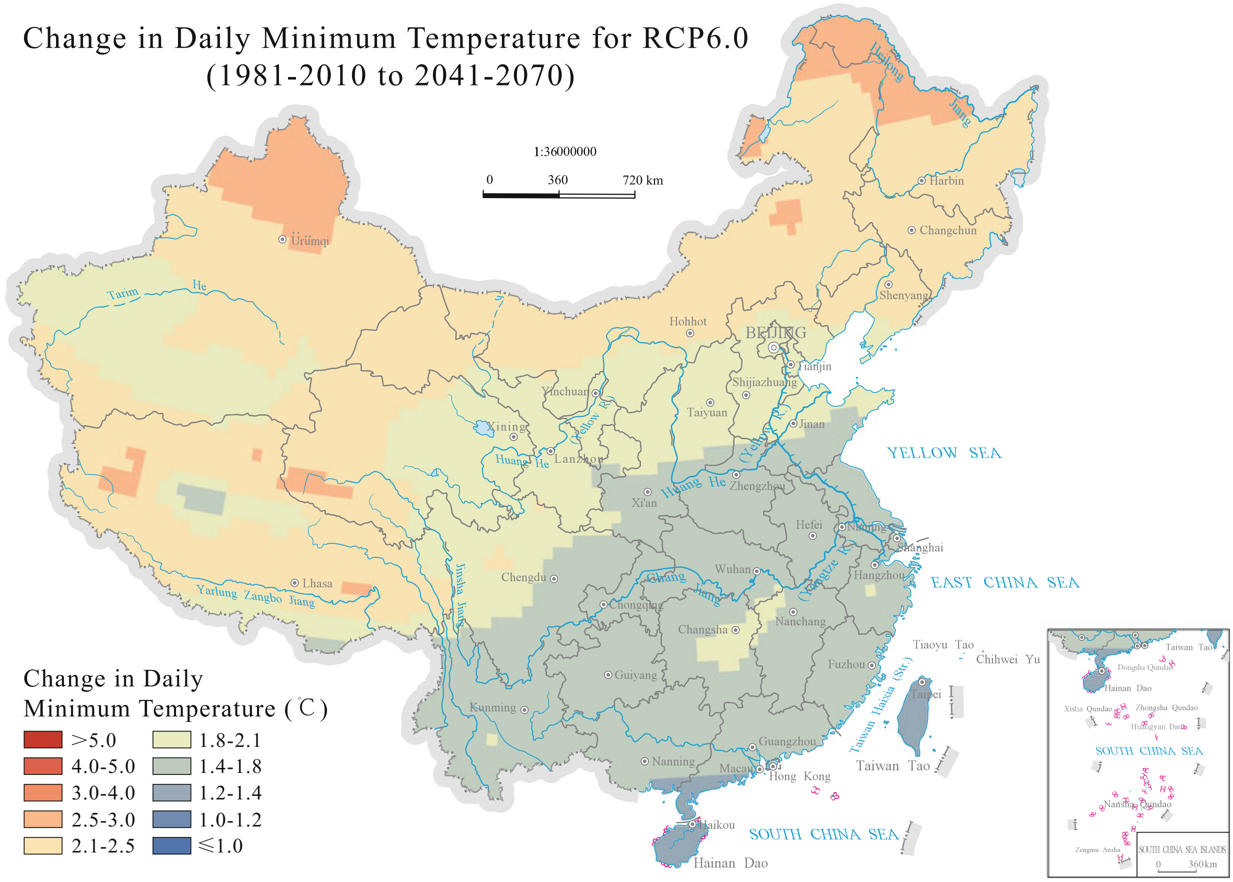

Change in Daily Maximum Temperature for RCP6.0
(1981-2010 to 2011-2040)
1:36000000
0 360 720 km
Change in Daily
Maximum Temperature (℃)
>5.0
4.0-5.0
3.0-4.0
2.5-3.0
2.1-2.5
1.8-2.1
1.4-1.8
1.2-1.4
1.0-1.2
≤1.0
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA
Hainan Dao
Taiwan Tao
Hong Kong
Shanghai
Tianjin
Tiaoyu Tao
Chihwei Yu
SOUTH CHINA SEA ISLANDS

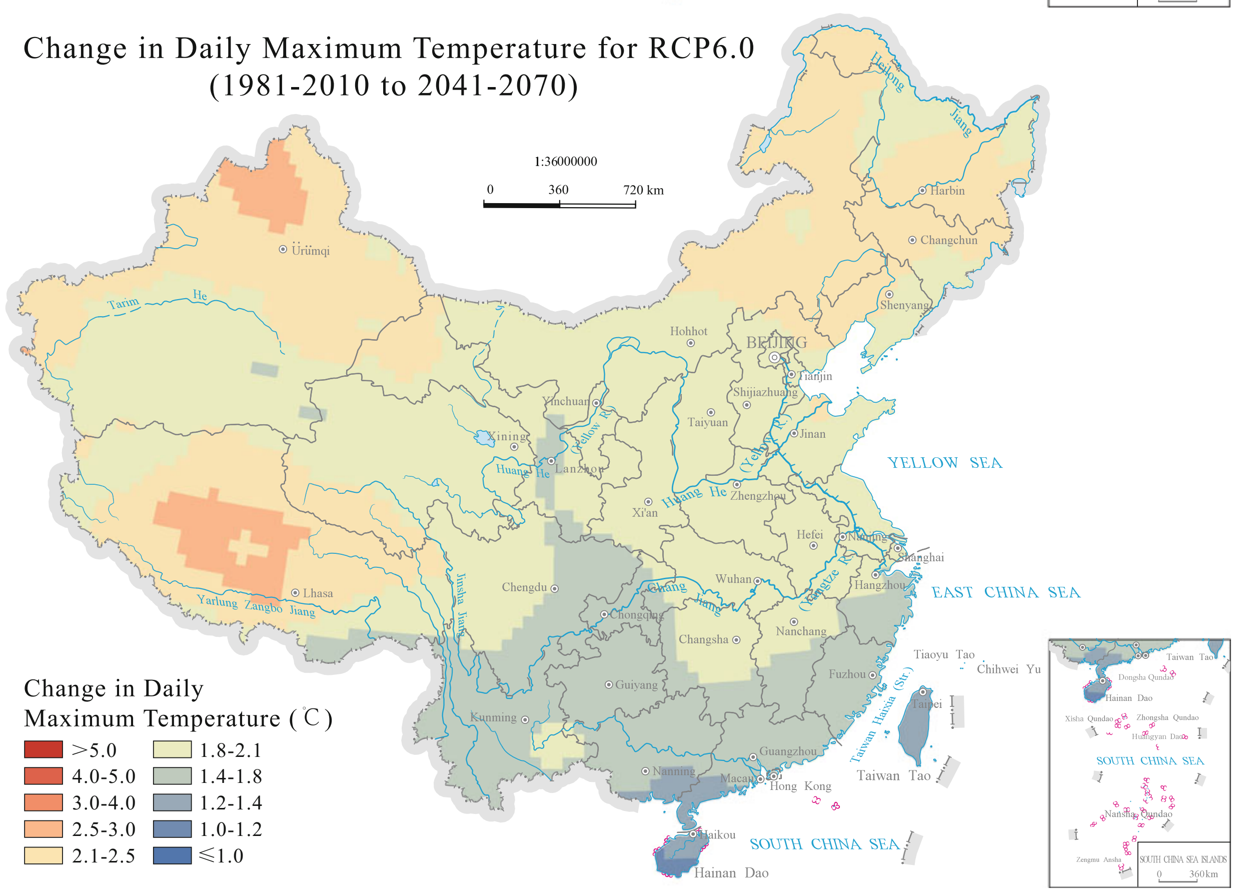
Change in Mean Temperature for RCP6.0
(1981-2010 to 2011-2040)



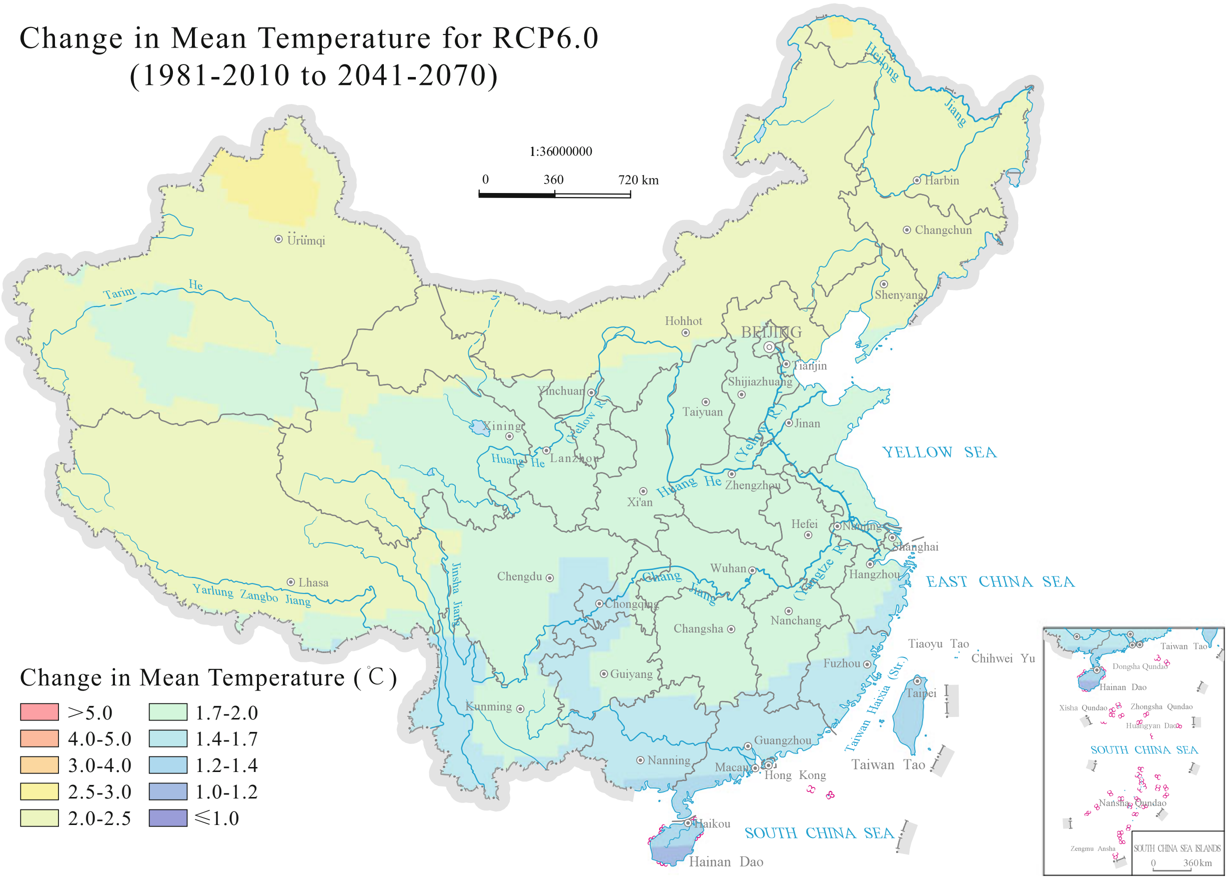
Change in Annual Precipitation for RCP6.0
(1981-2010 to 2011-2040)



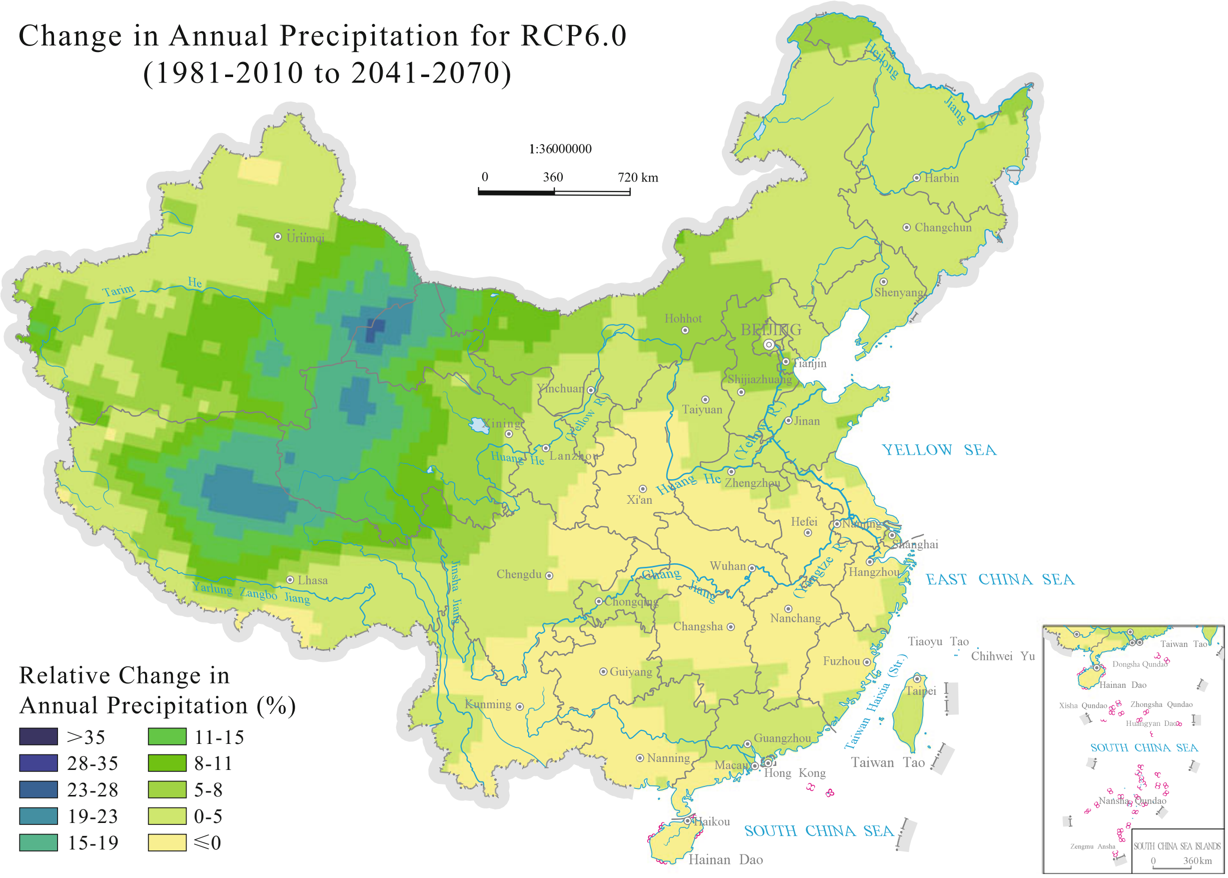

Change in Daily Minimum Temperature for RCP6.0
(1981-2010 to 2041-2070)
1:36000000
0 360 720 km
Change in Daily
Minimum Temperature (℃)
>5.0
4.0-5.0
3.0-4.0
2.5-3.0
2.1-2.5
1.8-2.1
1.4-1.8
1.2-1.4
1.0-1.2
≤1.0
BEIJING
Harbin
Changchun
Shenyang
Tianjin
Hohhot
Shijiazhuang
Taiyuan
Jinan
Yinchuan
Xining
Lanzhou
Zhengzhou
Xi'an
Hefei
Nanjing
Shanghai
Wuhan
Hangzhou
Chengdu
Chongqing
Changsha
Nanchang
Fuzhou
Guiyang
Kunming
Nanning
Guangzhou
Macao
Hong Kong
Haikou
Taipei
Ürümqi
Lhasa
Tarim He
Yarlung Zangbo Jiang
Huang He
Heilong Jiang
Jinsha Jiang
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA
Taiwan Tao
Taiwan Haixia
Hainan Dao
Tiaoyu Tao
Chihwei Yu
SOUTH CHINA SEA ISLANDS


Change in Daily Maximum Temperature for RCP6.0
(1981-2010 to 2041-2070)
1:36000000
0 360 720 km
Change in Daily
Maximum Temperature (℃)
>5.0
4.0-5.0
3.0-4.0
2.5-3.0
2.1-2.5
1.8-2.1
1.4-1.8
1.2-1.4
1.0-1.2
≤1.0
BEIJING
Harbin
Changchun
Shenyang
Tianjin
Hohhot
Shijiazhuang
Taiyuan
Jinan
Yinchuan
Xining
Lanzhou
Zhengzhou
Xi'an
Hefei
Nanjing
Shanghai
Wuhan
Hangzhou
Chengdu
Chongqing
Changsha
Nanchang
Fuzhou
Guiyang
Kunming
Nanning
Guangzhou
Macao
Hong Kong
Haikou
Taipei
Ürümqi
Lhasa
Tarim He
Yarlung Zangbo Jiang
Huang He
Heilong Jiang
Jinsha Jiang
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA
Taiwan Tao
Taiwan Haixia
Hainan Dao
Tiaoyu Tao
Chihwei Yu
SOUTH CHINA SEA ISLANDS

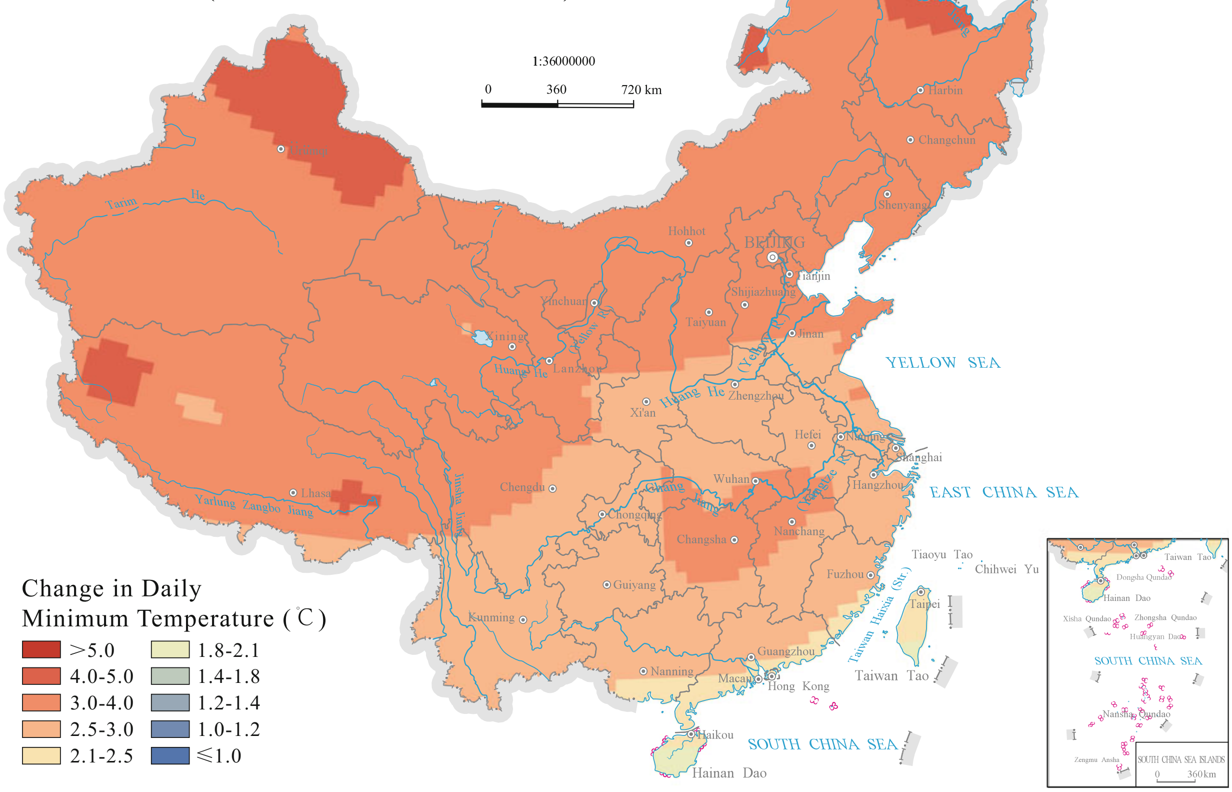
Change in Mean Temperature for RCP6.0
(1981-2010 to 2041-2070)



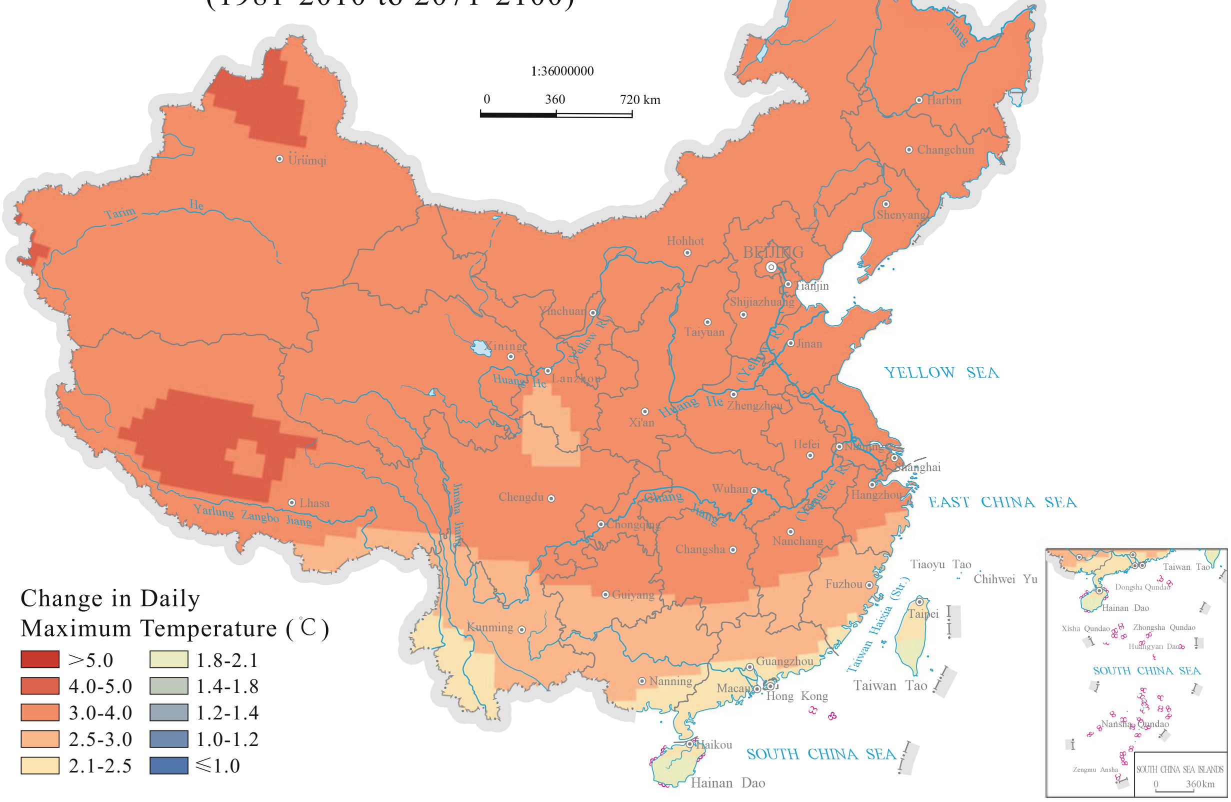
Change in Annual Precipitation for RCP6.0
(1981-2010 to 2041-2070)

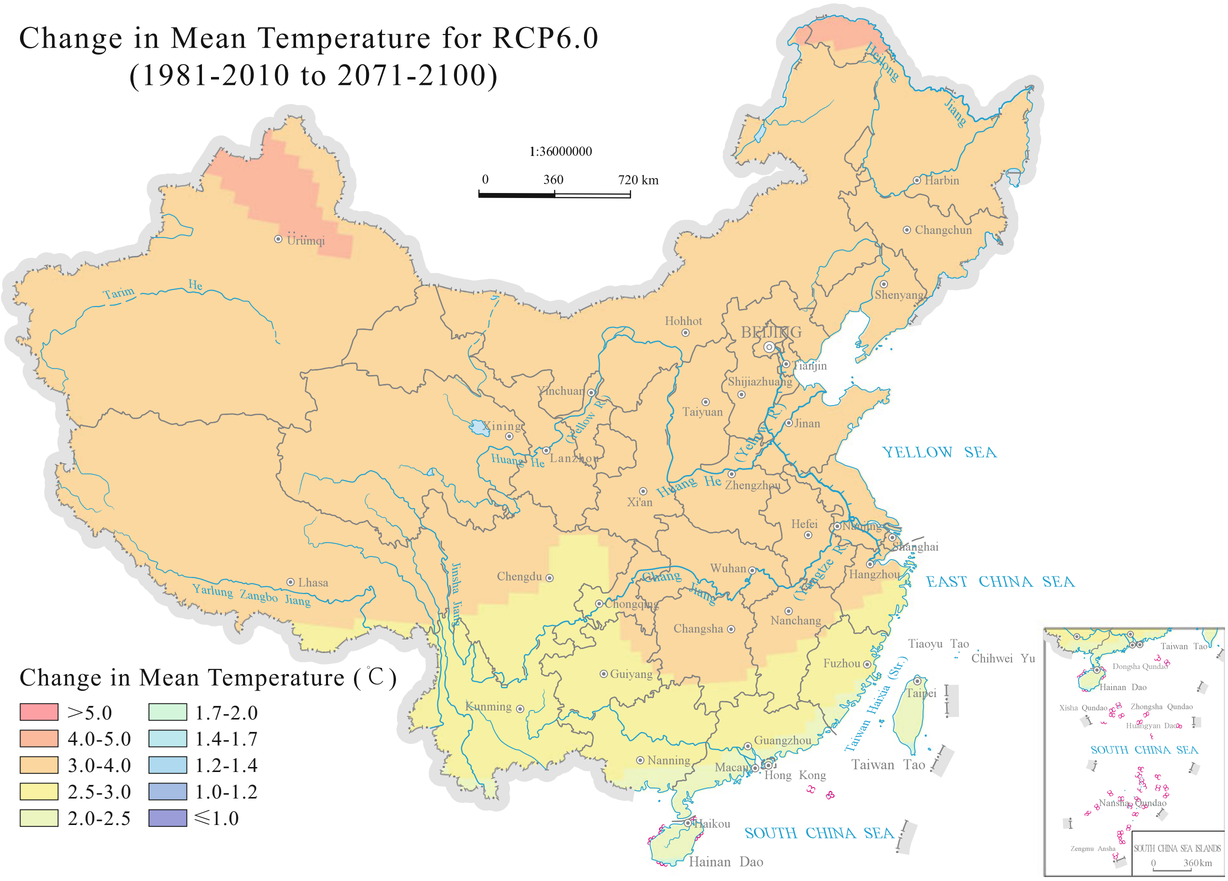


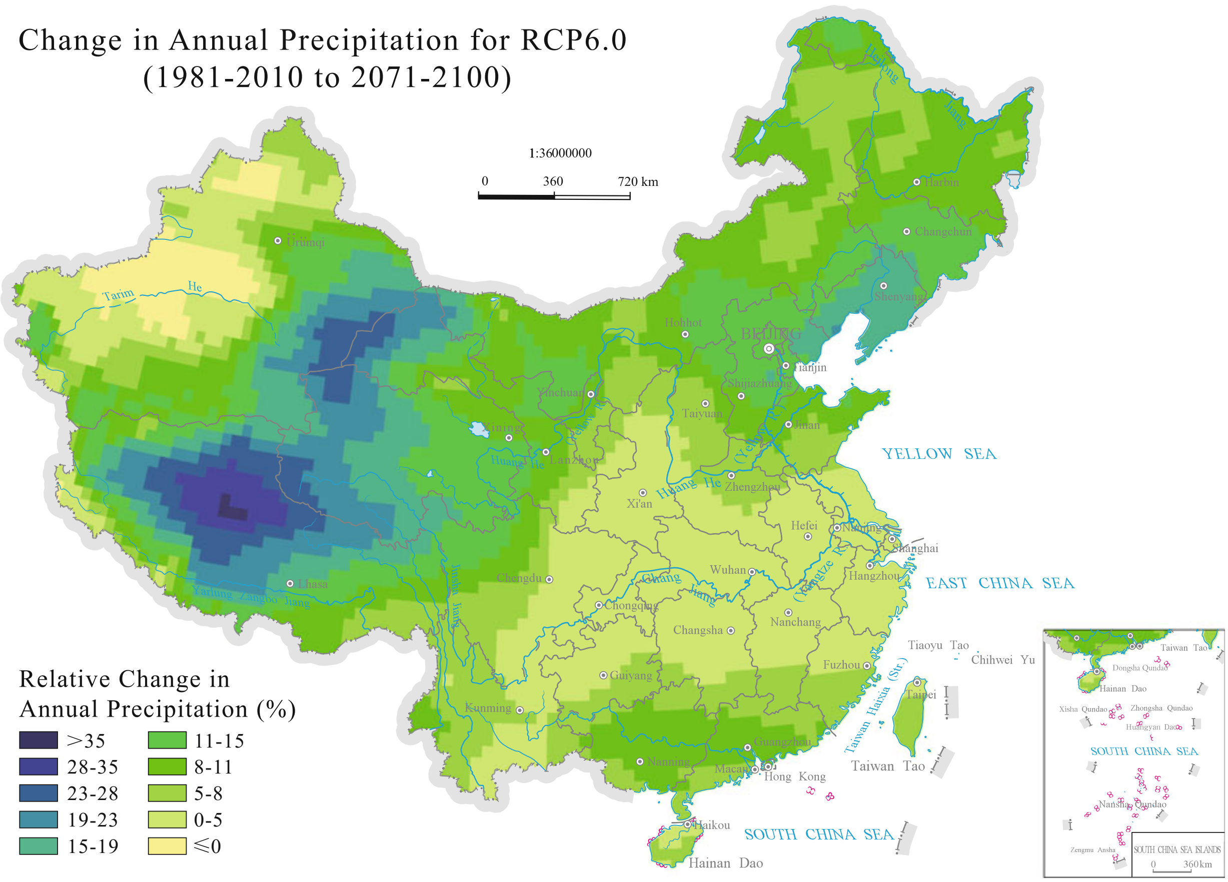
Change in Daily Minimum Temperature for RCP6.0 (1981-2010 to 2071-2100)



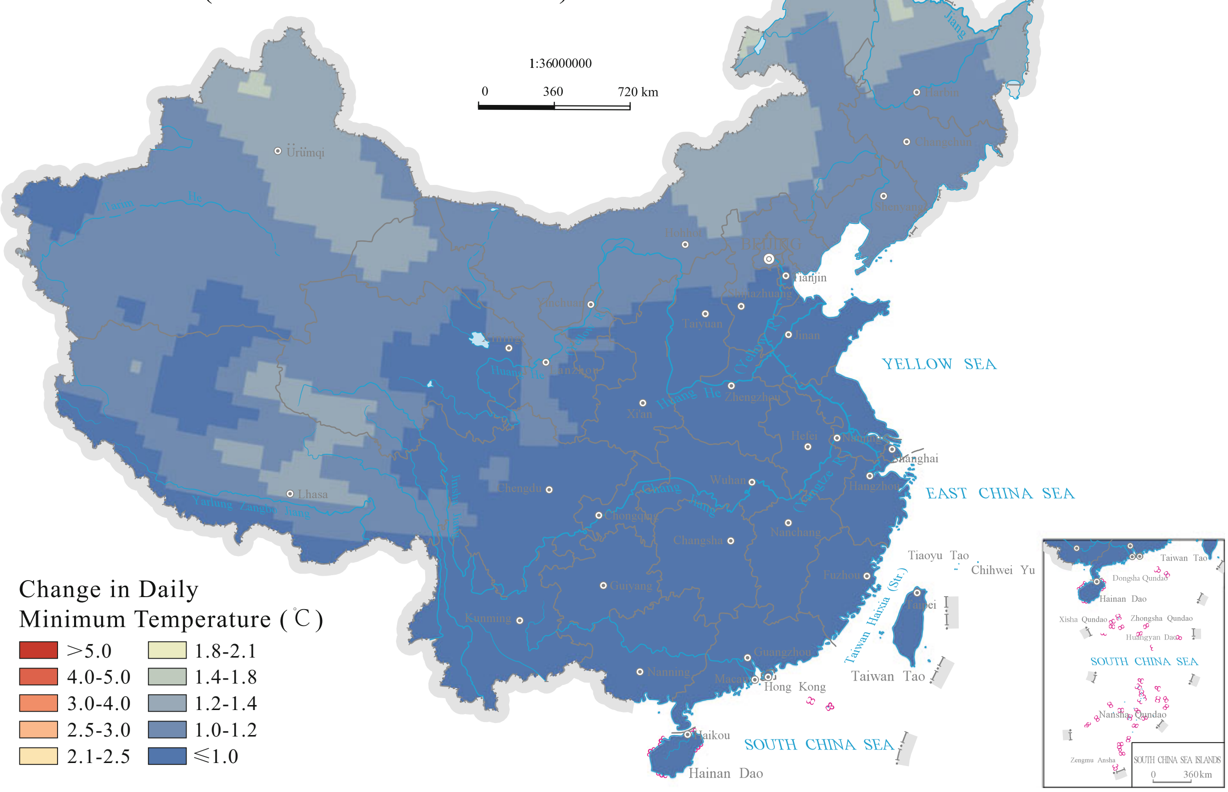
Change in Daily Maximum Temperature for RCP6.0 (1981-2010 to 2071-2100)



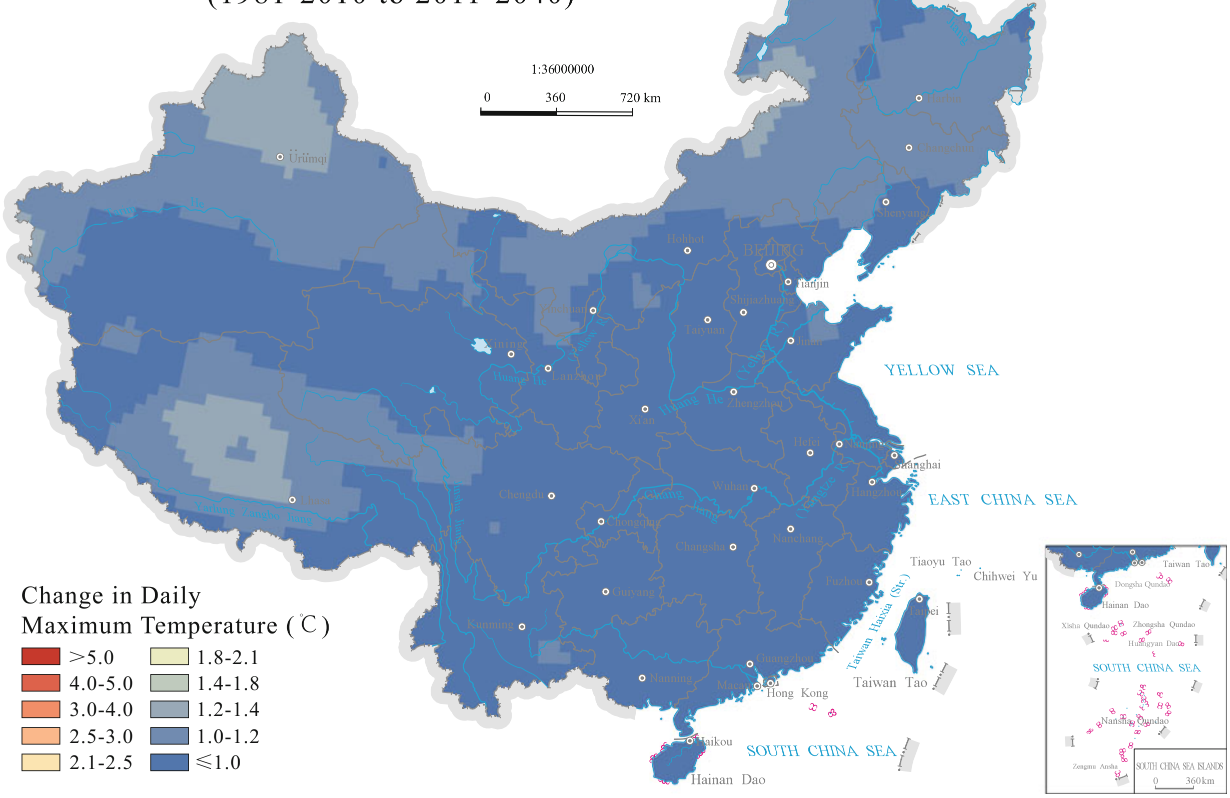

Change in Mean Temperature for RCP6.0
(1981-2010 to 2071-2100)
1:36000000
0 360 720 km
Change in Mean Temperature (℃)
>5.0
4.0-5.0
3.0-4.0
2.5-3.0
2.0-2.5
1.7-2.0
1.4-1.7
1.2-1.4
1.0-1.2
⩽1.0
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA
Hainan Dao
Taiwan Tao
Tiaoyu Tao
Chihwei Yu
Harbin
Changchun
Shenyang
BEIJING
Tianjin
Shijiazhuang
Taiyuan
Hohhot
Jinan
Yinchuan
Xining
Lanzhou
Urümqi
Lhasa
Chengdu
Chongqing
Xi'an
Zhengzhou
Hefei
Nanjing
Shanghai
Hangzhou
Wuhan
Changsha
Nanchang
Fuzhou
Taipei
Guiyang
Kunming
Nanning
Guangzhou
Macao
Hong Kong
Haikou
SOUTH CHINA SEA ISLANDS


Change in Annual Precipitation for RCP6.0
(1981-2010 to 2071-2100)
1:36000000
0 360 720 km
Relative Change in
Annual Precipitation (%)
>35
28-35
23-28
19-23
15-19
11-15
8-11
5-8
0-5
⩽0
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA
Hainan Dao
Taiwan Tao
Tiaoyu Tao
Chihwei Yu
BEIJING
SOUTH CHINA SEA ISLANDS

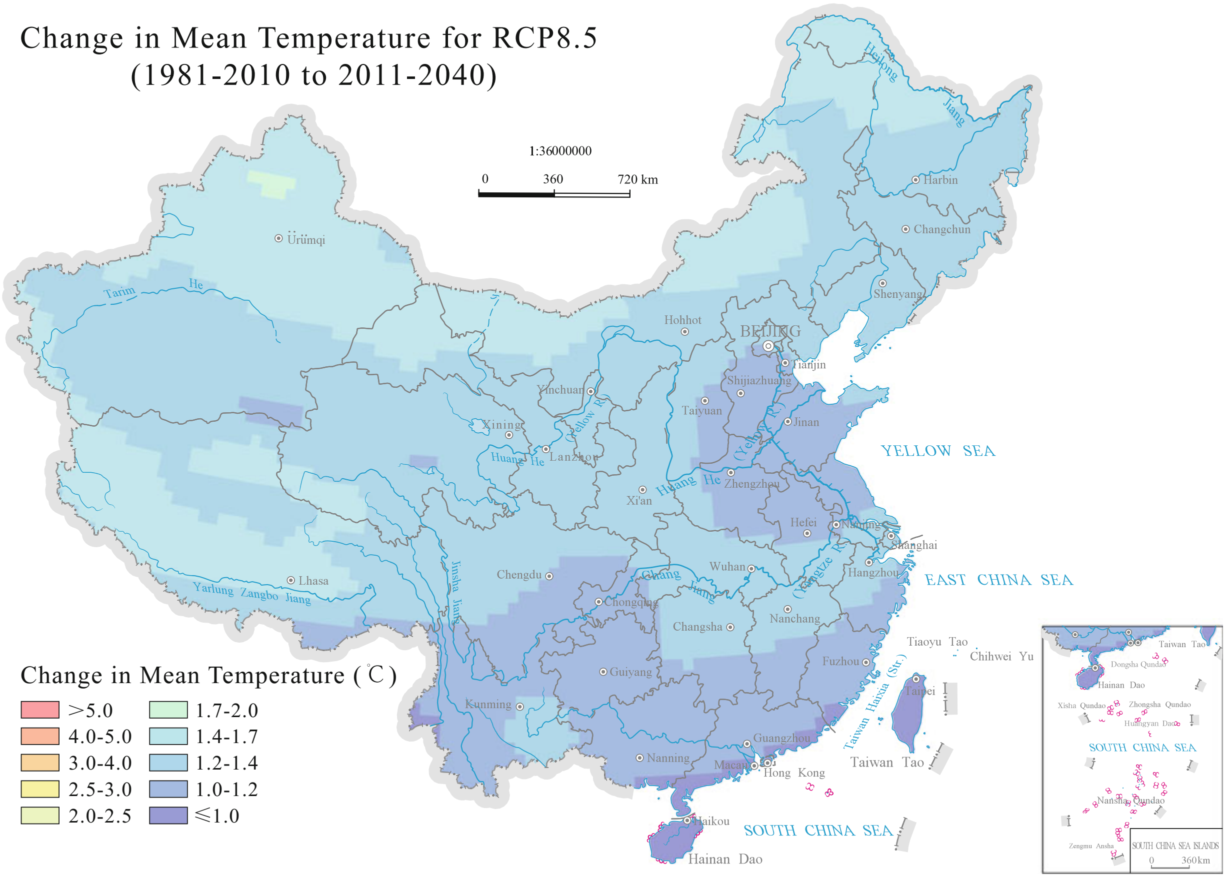
Change in Daily Minimum Temperature for RCP8.5
(1981-2010 to 2011-2040)



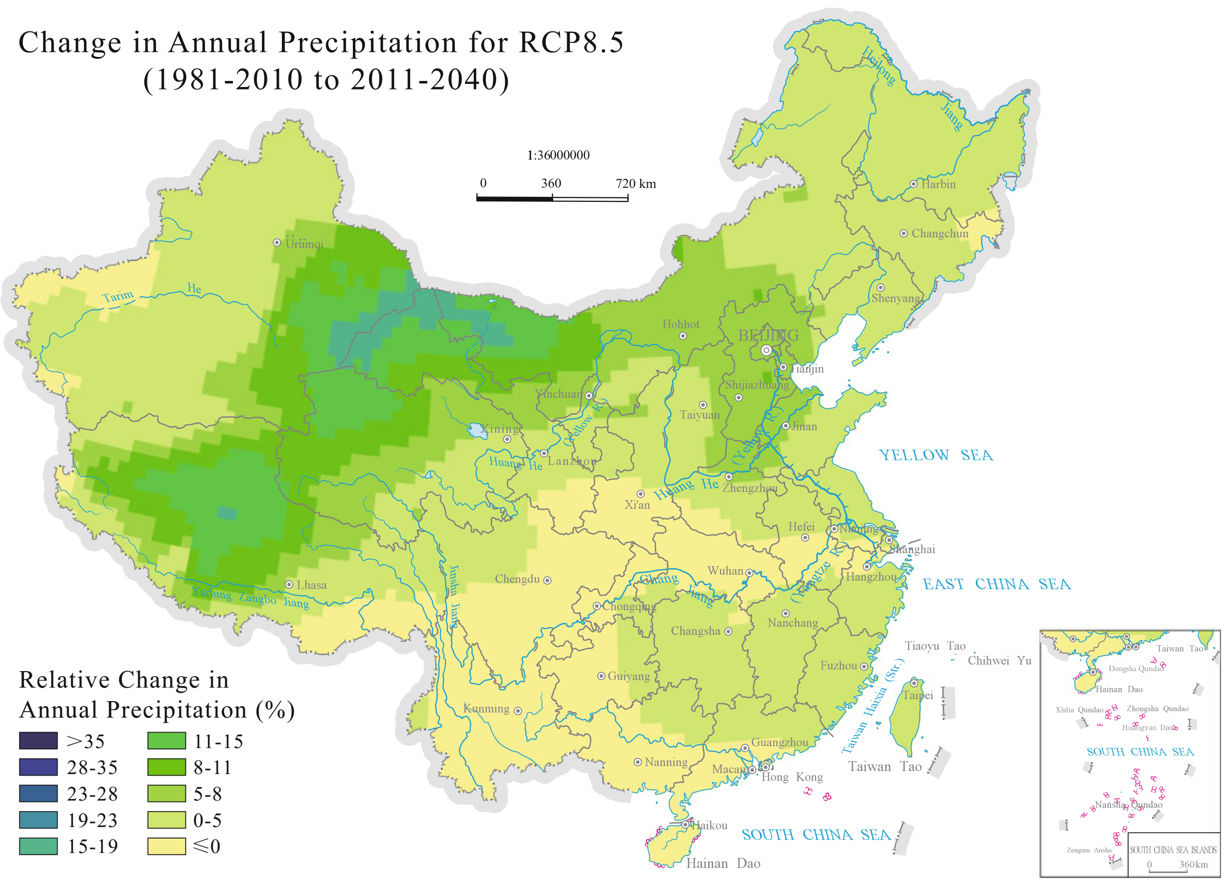
Change in Daily Maximum Temperature for RCP8.5
(1981-2010 to 2011-2040)



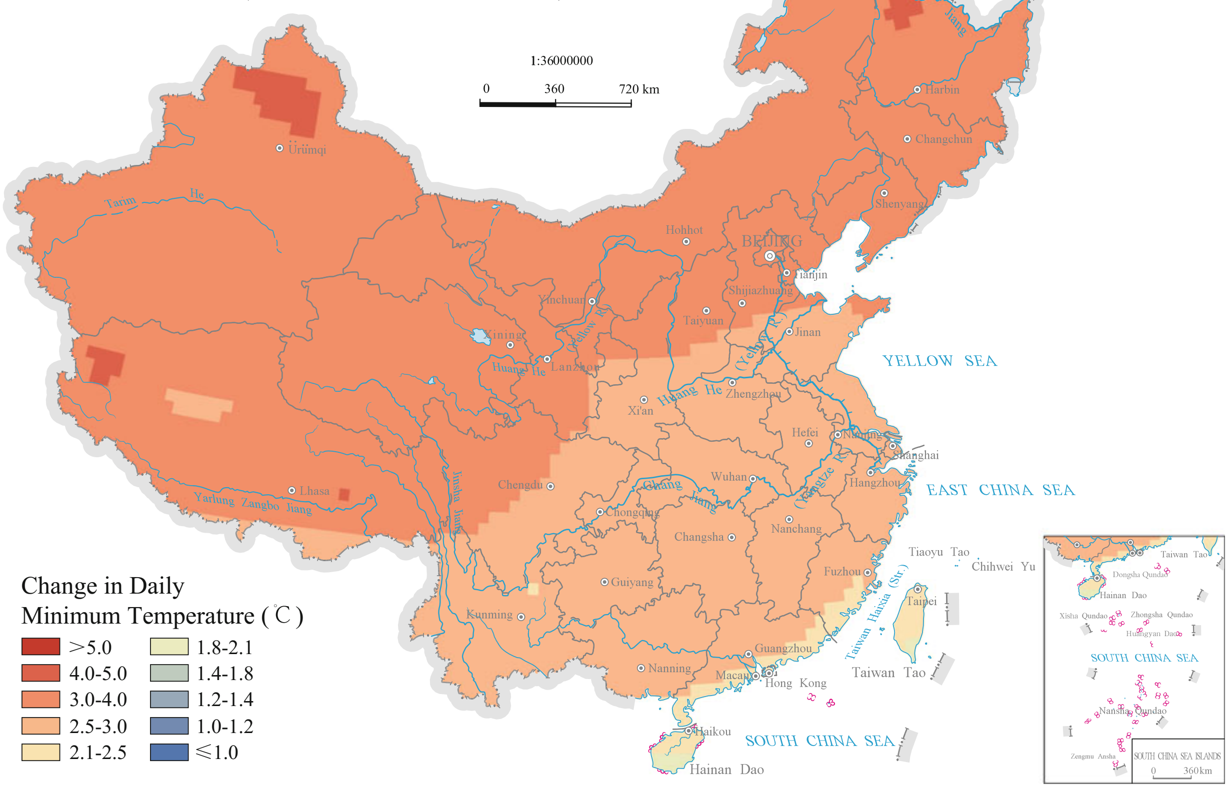
Change in Mean Temperature for RCP8.5 (1981-2010 to 2011-2040)



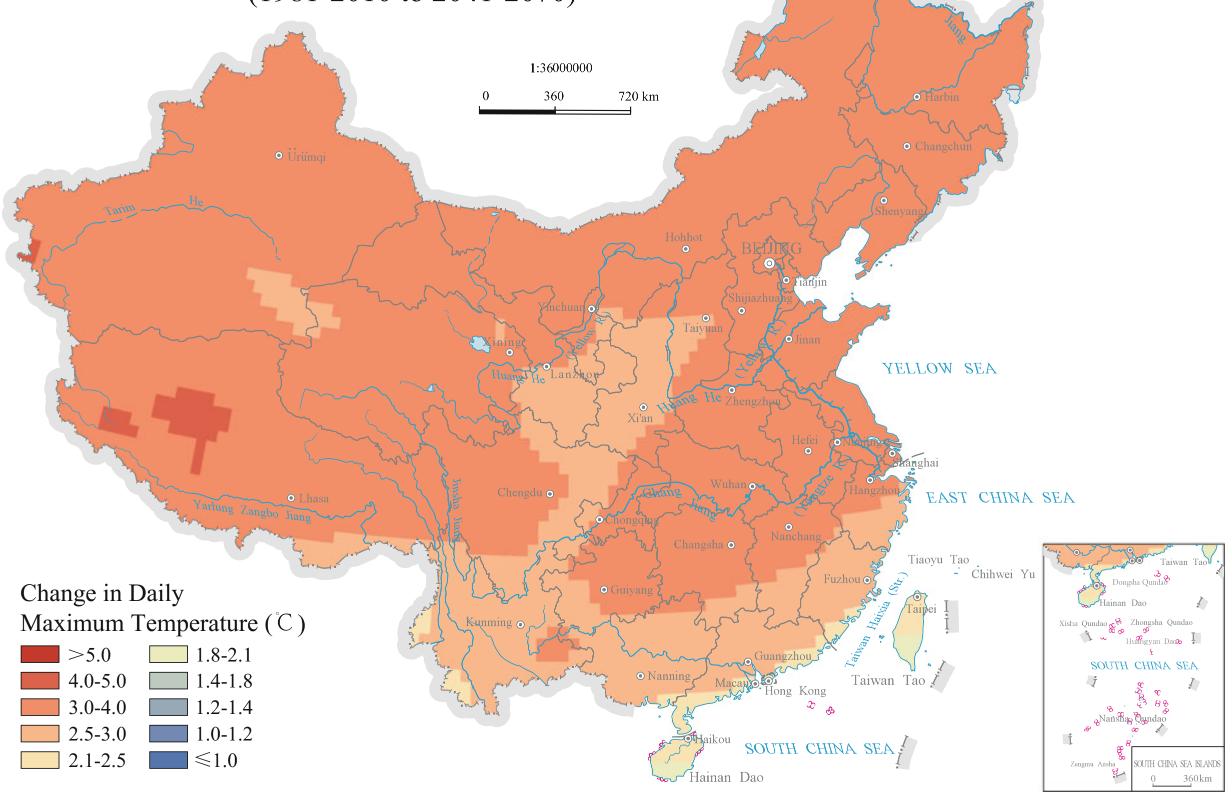
Change in Annual Precipitation for RCP8.5 (1981-2010 to 2011-2040)

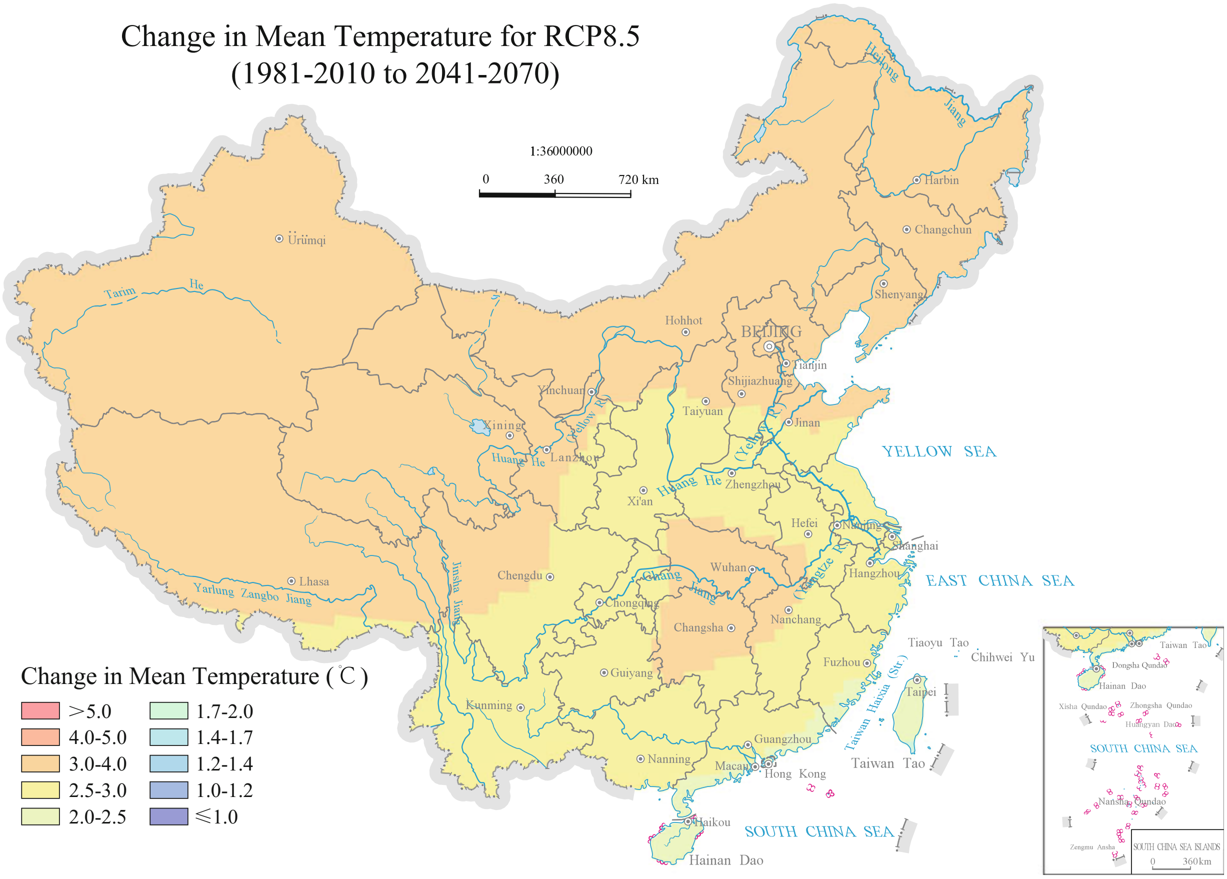


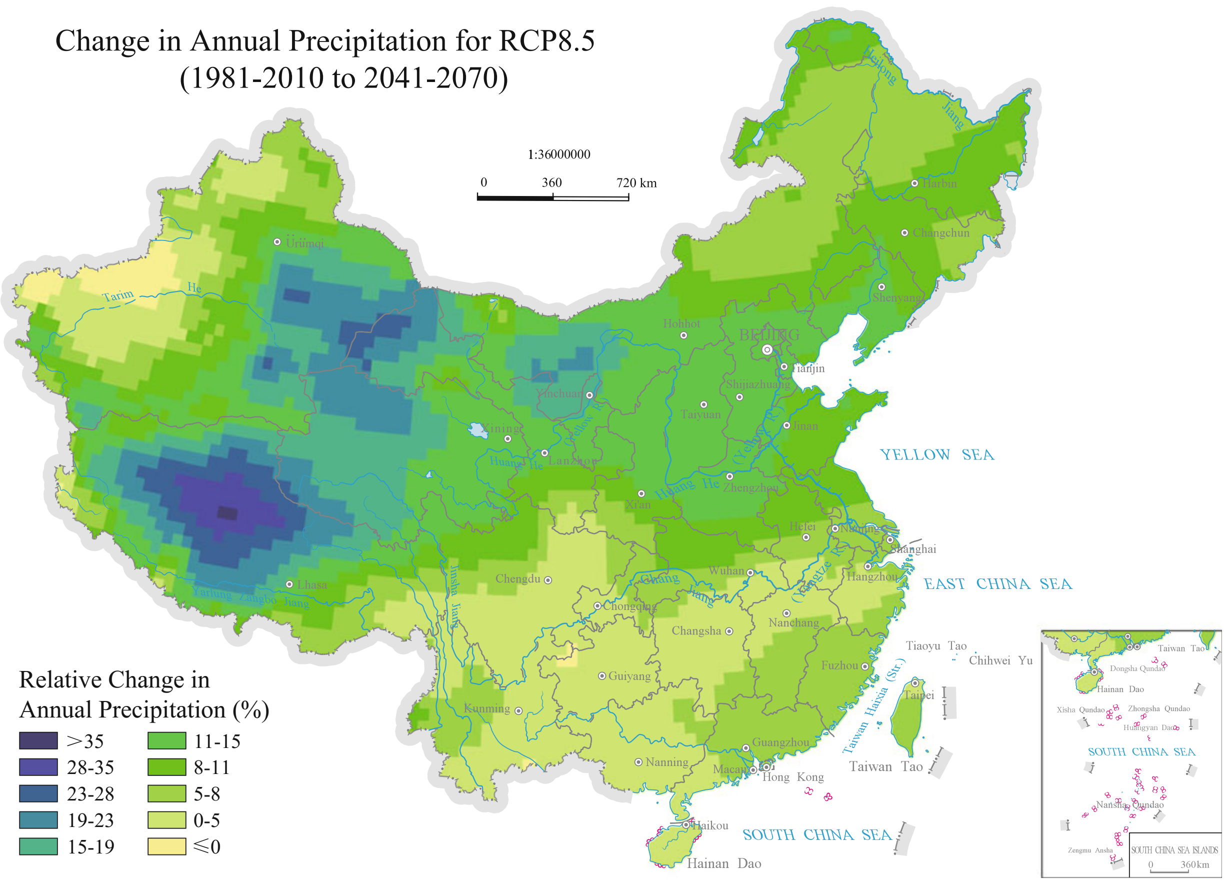
Change in Daily Minimum Temperature for RCP8.5
(1981-2010 to 2041-2070)

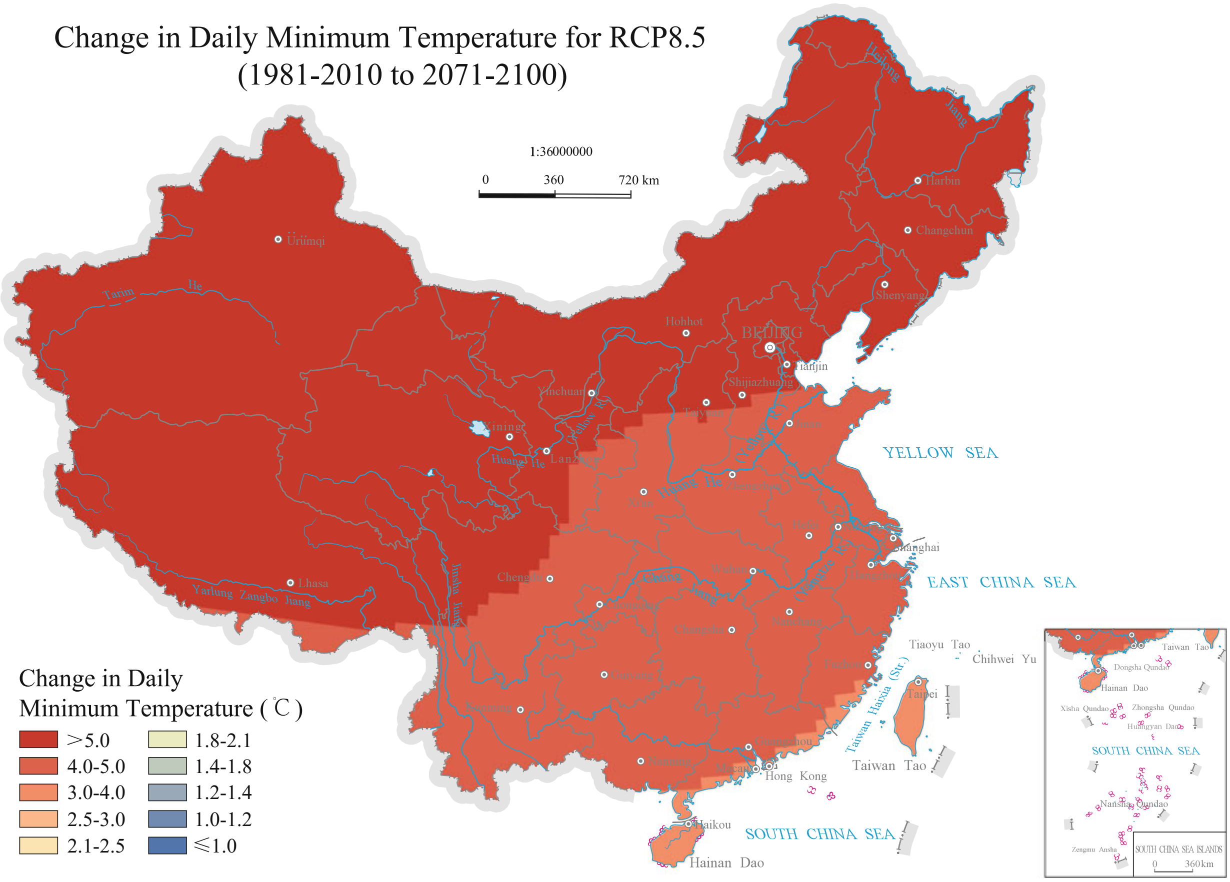


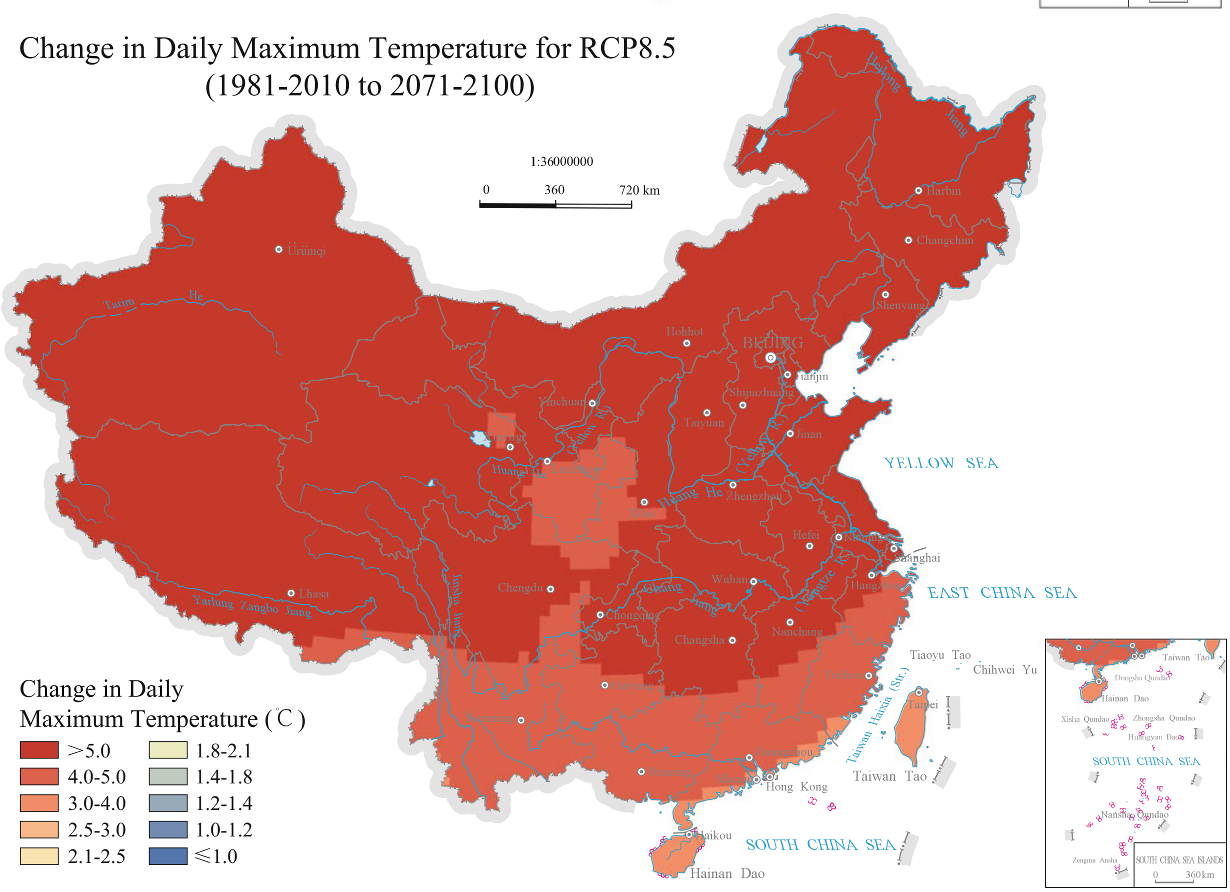
Change in Daily Maximum Temperature for RCP8.5
(1981-2010 to 2041-2070)



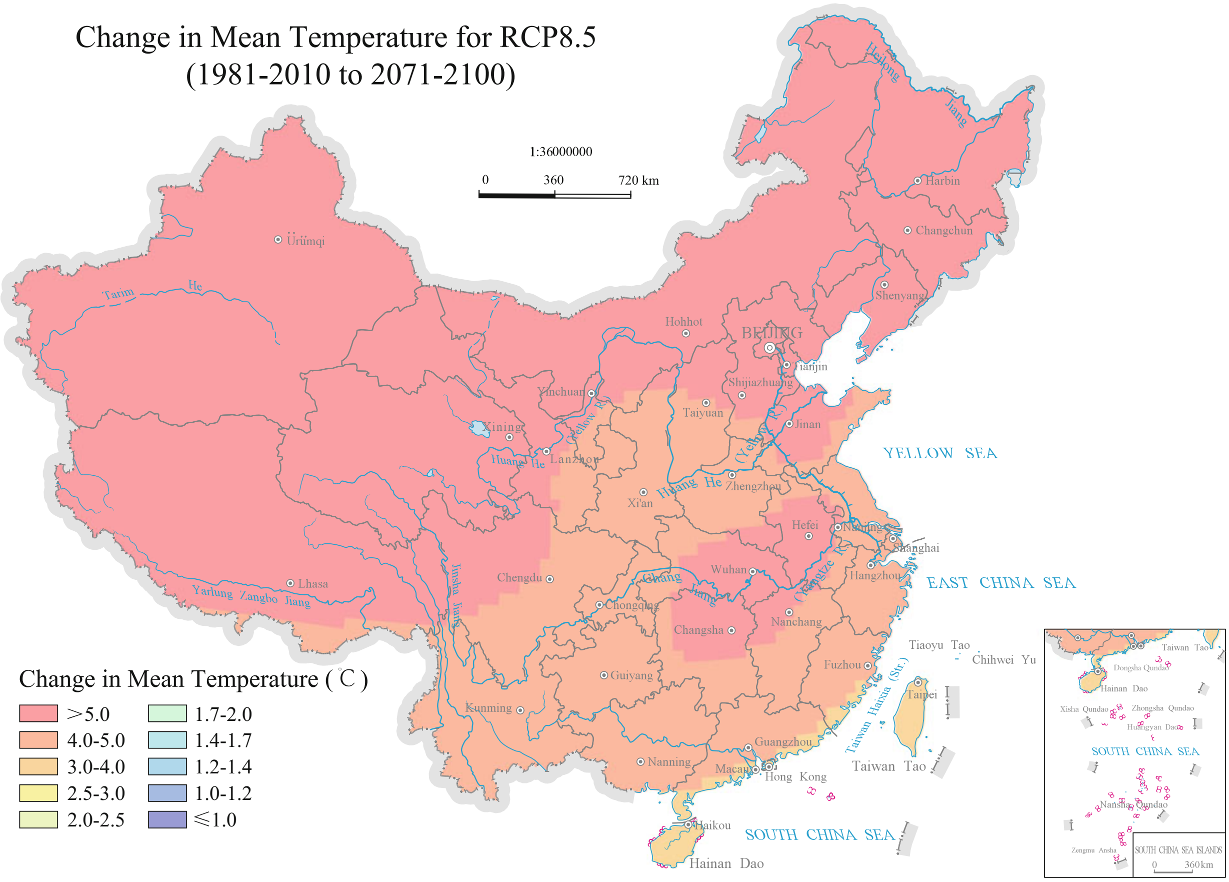

Change in Mean Temperature for RCP8.5
(1981-2010 to 2041-2070)
1:36000000
0 360 720 km
Change in Mean Temperature (℃)
>5.0
4.0-5.0
3.0-4.0
2.5-3.0
2.0-2.5
1.7-2.0
1.4-1.7
1.2-1.4
1.0-1.2
≤1.0
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA
Ürümqi
Harbin
Changchun
Shenyang
Hohhot
BEIJING
Tianjin
Shijiazhuang
Yinchuan
Taiyuan
Jinan
Xining
Lanzhou
Zhengzhou
Xi'an
Hefei
Nanjing
Shanghai
Wuhan
Hangzhou
Lhasa
Chengdu
Chongqing
Changsha
Nanchang
Fuzhou
Guiyang
Kunming
Taipei
Guangzhou
Nanning
Macao
Hong Kong
Haikou
Hainan Dao
Taiwan Tao
Tiaoyu Tao
Chihwei Yu
Tarim He
Yarlung Zangbo Jiang
Heilong Jiang
Huang He
Jinsha Jiang
SOUTH CHINA SEA ISLANDS


Change in Annual Precipitation for RCP8.5
(1981-2010 to 2041-2070)
1:36000000
0 360 720 km
Relative Change in
Annual Precipitation (%)
>35
28-35
23-28
19-23
15-19
11-15
8-11
5-8
0-5
≤0
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA
Hainan Dao
Taiwan Tao
SOUTH CHINA SEA ISLANDS

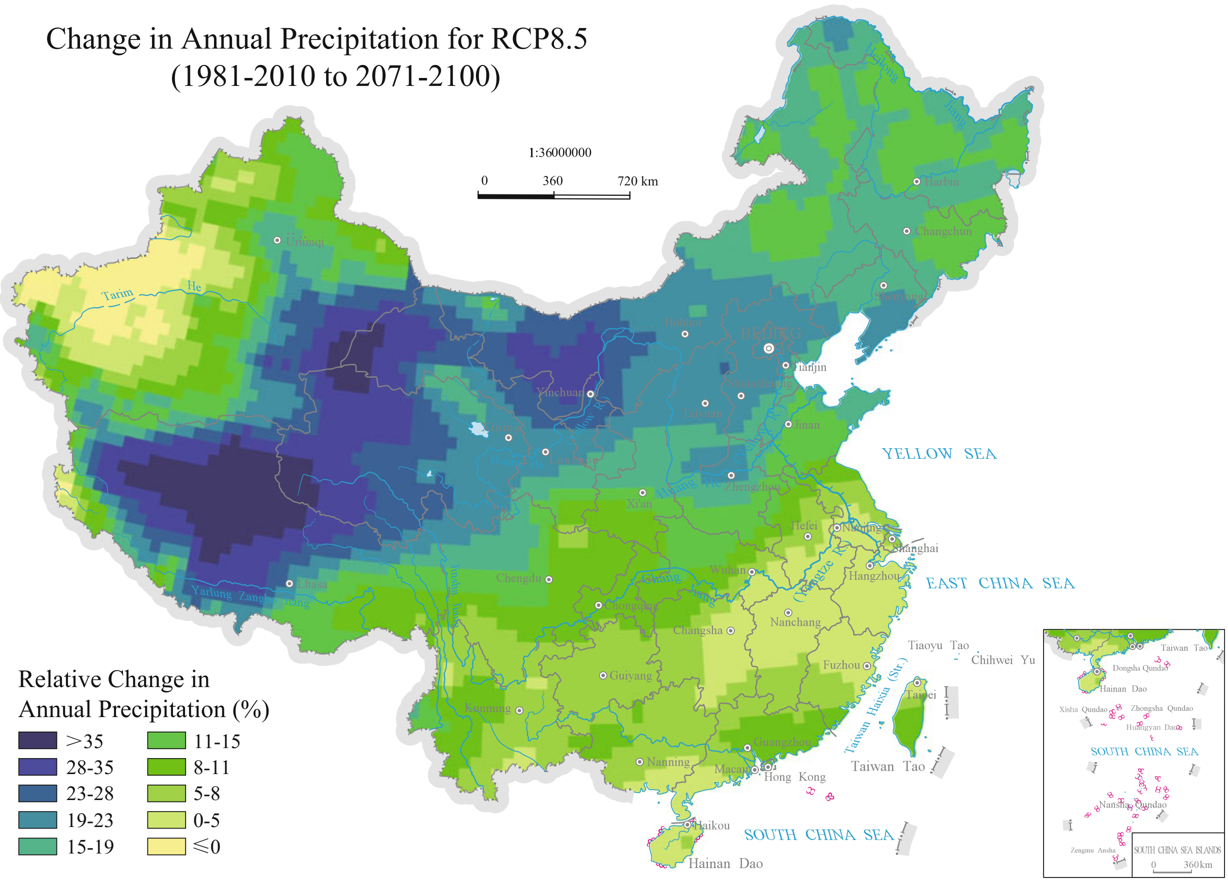

Change in Daily Minimum Temperature for RCP8.5
(1981-2010 to 2071-2100)
1:36000000
0 360 720 km
Change in Daily
Minimum Temperature (℃)
>5.0
4.0-5.0
3.0-4.0
2.5-3.0
2.1-2.5
1.8-2.1
1.4-1.8
1.2-1.4
1.0-1.2
≤1.0
Ürümqi
Harbin
Changchun
Shenyang
Hohhot
BEIJING
Tianjin
Lhasa
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA
Tiaoyu Tao
Chihwei Yu
Taiwan Tao
Hong Kong
Haikou
Hainan Dao

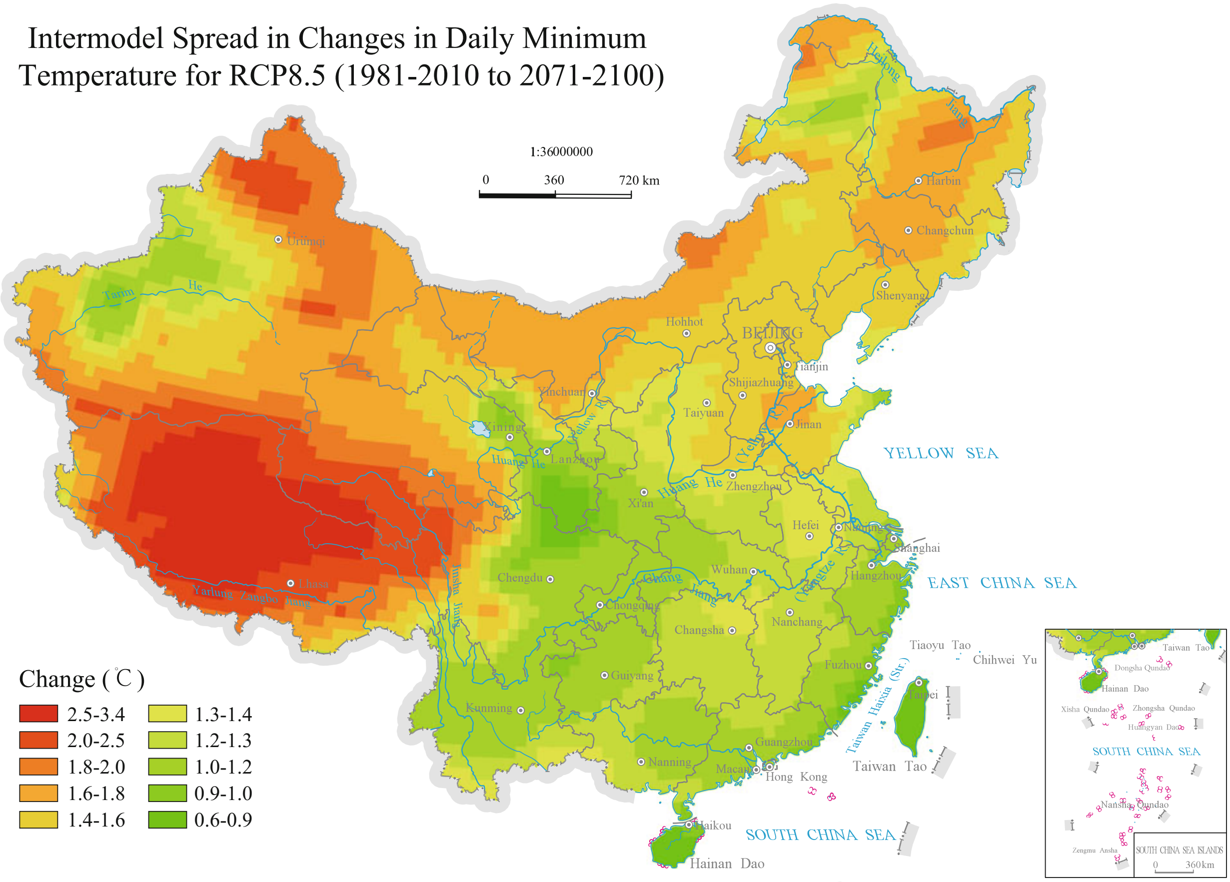

Change in Daily Maximum Temperature for RCP8.5
(1981-2010 to 2071-2100)
1:36000000
0 360 720 km
Change in Daily
Maximum Temperature (℃)
>5.0
4.0-5.0
3.0-4.0
2.5-3.0
2.1-2.5
1.8-2.1
1.4-1.8
1.2-1.4
1.0-1.2
≤1.0
Ürümqi
Harbin
Changchun
Shenyang
Hohhot
BEIJING
Tianjin
Shijiazhuang
Taiyuan
Jinan
Zhengzhou
Hefei
Shanghai
Wuhan
Chengdu
Chongqing
Changsha
Nanchang
Lhasa
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA
Tiaoyu Tao
Chihwei Yu
Taiwan Tao
Hong Kong
Haikou
Hainan Dao

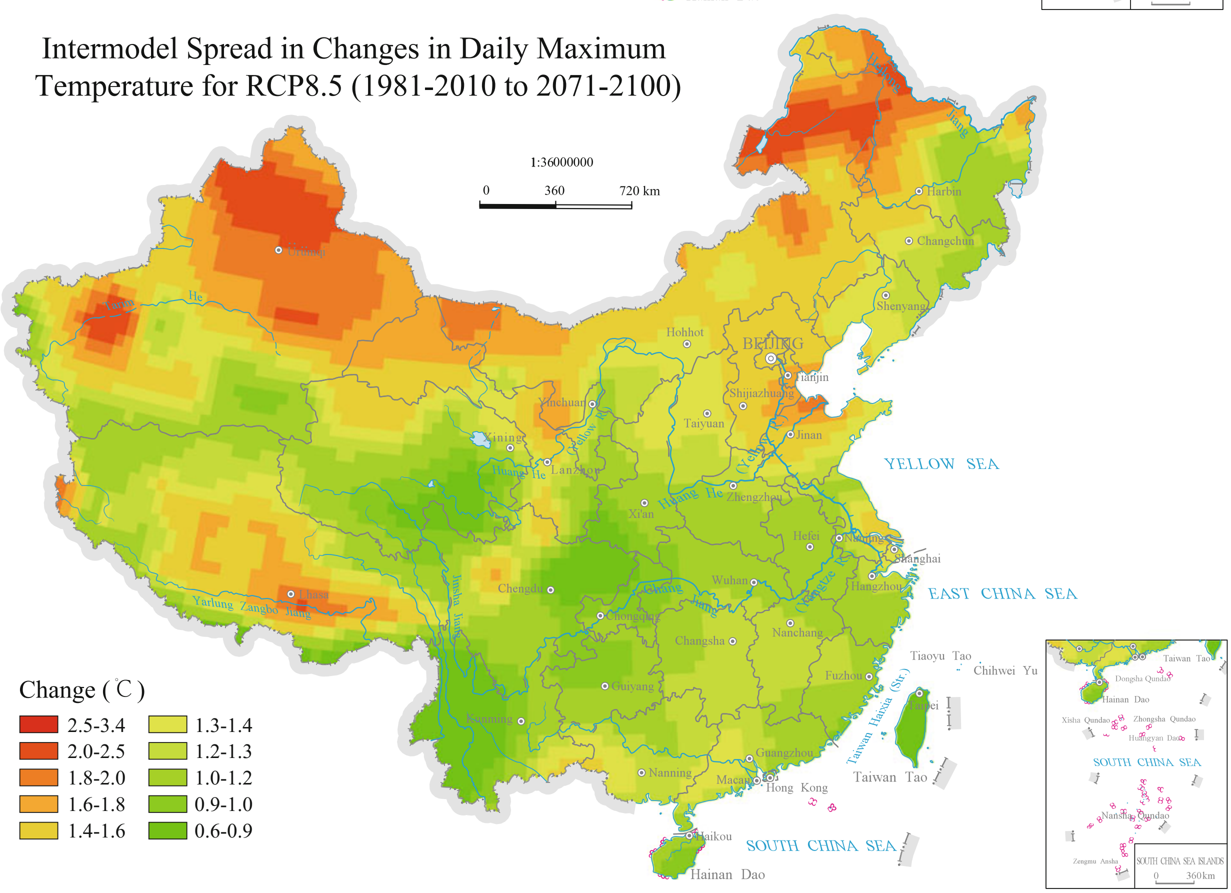
Change in Mean Temperature for RCP8.5
(1981-2010 to 2071-2100)

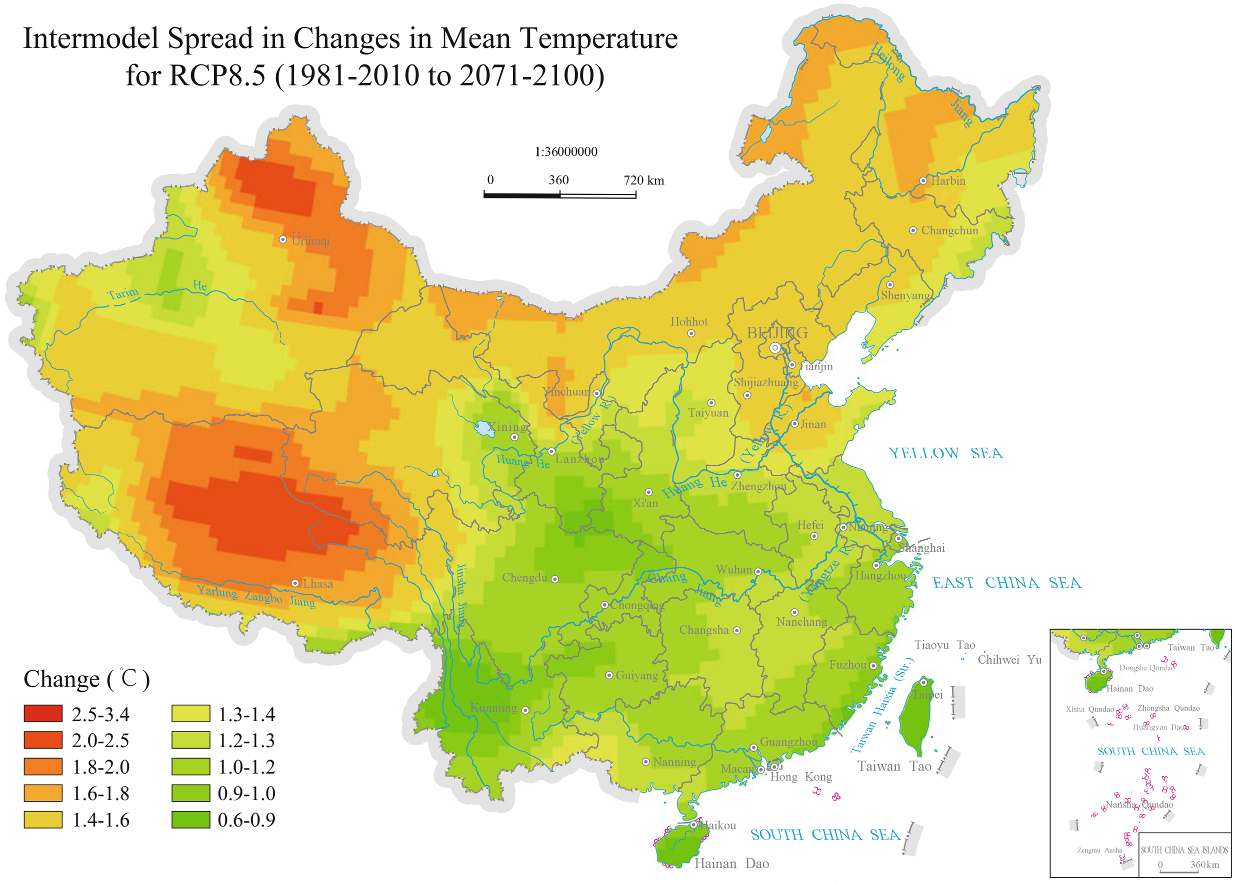


Change in Annual Precipitation for RCP8.5
(1981-2010 to 2071-2100)

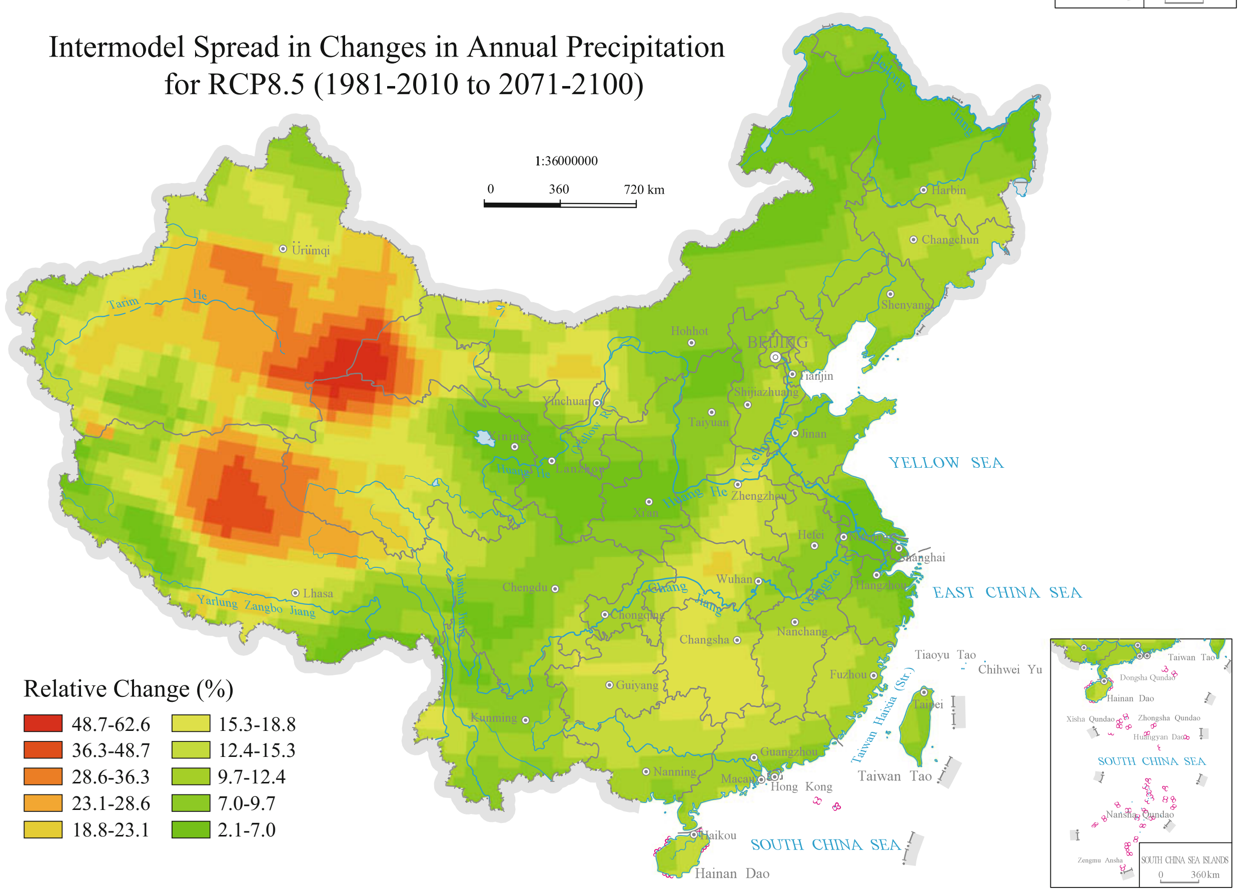



Intermodel Spread in Changes in Daily Minimum
Temperature for RCP8.5 (1981-2010 to 2071-2100)
1:36000000
0 360 720 km
Change (℃)
2.5-3.4
2.0-2.5
1.8-2.0
1.6-1.8
1.4-1.6
1.3-1.4
1.2-1.3
1.0-1.2
0.9-1.0
0.6-0.9
Harbin
Changchun
Shenyang
Hohhot
BEIJING
Tianjin
Shijiazhuang
Taiyuan
Jinan
Yinchuan
Xining
Lanzhou
Xi'an
Zhengzhou
Hefei
Nanjing
Shanghai
Hangzhou
Wuhan
Chengdu
Chongqing
Changsha
Nanchang
Fuzhou
Guiyang
Kunming
Nanning
Guangzhou
Macao
Hong Kong
Haikou
Taipei
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA
Taiwan Tao
Hainan Dao
Tiaoyu Tao
Chihwei Yu
Huang He
SOUTH CHINA SEA


Intermodel Spread in Changes in Daily Maximum
Temperature for RCP8.5 (1981-2010 to 2071-2100)
1:36000000
0 360 720 km
Change (℃)
2.5-3.4
2.0-2.5
1.8-2.0
1.6-1.8
1.4-1.6
1.3-1.4
1.2-1.3
1.0-1.2
0.9-1.0
0.6-0.9
Harbin
Changchun
Shenyang
Hohhot
BEIJING
Tianjin
Shijiazhuang
Taiyuan
Jinan
Yinchuan
Xining
Lanzhou
Xi'an
Zhengzhou
Hefei
Nanjing
Shanghai
Hangzhou
Wuhan
Chengdu
Chongqing
Changsha
Nanchang
Fuzhou
Guiyang
Kunming
Nanning
Guangzhou
Macao
Hong Kong
Haikou
Taipei
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA
Taiwan Tao
Hainan Dao
Tiaoyu Tao
Chihwei Yu
Huang He
SOUTH CHINA SEA



Intermodel Spread in Changes in Mean Temperature
for RCP8.5 (1981-2010 to 2071-2100)
1:36000000
0
360
720 km
Change (℃)
2.5-3.4
2.0-2.5
1.8-2.0
1.6-1.8
1.4-1.6
1.3-1.4
1.2-1.3
1.0-1.2
0.9-1.0
0.6-0.9
Harbin
Changchun
Shenyang
Ürümqi
Tarim He
Hohhot
BEIJING
Tianjin
Shijiazhuang
Taiyuan
Yinchuan
Jinan
Xining
Lanzhou
Huang He
Zhengzhou
Xi'an
YELLOW SEA
Hefei
Nanjing
Shanghai
Wuhan
Hangzhou
EAST CHINA SEA
Chengdu
Chongqing
Lhasa
Yarlung Zangbo Jiang
Changsha
Nanchang
Tiaoyu Tao
Chihwei Yu
Fuzhou
Taipei
Guiyang
Kunming
Guangzhou
Nanning
Macao
Hong Kong
Taiwan Tao
Haikou
SOUTH CHINA SEA
Hainan Dao



Intermodel Spread in Changes in Annual Precipitation
for RCP8.5 (1981-2010 to 2071-2100)
1:36000000
0
360
720 km
Relative Change (%)
48.7-62.6
36.3-48.7
28.6-36.3
23.1-28.6
18.8-23.1
15.3-18.8
12.4-15.3
9.7-12.4
7.0-9.7
2.1-7.0
Harbin
Changchun
Shenyang
Ürümqi
Tarim He
Hohhot
BEIJING
Tianjin
Shijiazhuang
Taiyuan
Yinchuan
Jinan
Xining
Lanzhou
Huang He
Zhengzhou
Xi'an
YELLOW SEA
Hefei
Shanghai
Wuhan
Hangzhou
EAST CHINA SEA
Chengdu
Chongqing
Lhasa
Yarlung Zangbo Jiang
Changsha
Nanchang
Tiaoyu Tao
Chihwei Yu
Fuzhou
Taipei
Guiyang
Kunming
Guangzhou
Nanning
Macao
Hong Kong
Taiwan Tao
Haikou
SOUTH CHINA SEA
Hainan Dao

References

Dong, W., Liu, Z., Liao, H., Tang, Q., & Li, X. (2015). New climate and socio-economic scenarios for assessing global human health challenges due to heat risk. *Climatic Change*, *130*(4), 505–518.

He, Y., Ye, J., & Yang, X. (2015). Analysis of the spatio-temporal patterns of dry and wet conditions in the Huai River Basin using the standardized precipitation index. *Atmospheric Research, 166,* 120–128.

Hempel, S., Frieler, K., Warszawski, L., Schewe, J., & Piontek, F. (2013). A trend-preserving bias correction: The ISI-MIP approach. *Earth System Dynamics, 4*(2), 219–236.

IPCC (Intergovernmental Panel on Climate Change). (2013). *Climate change 2013: The physical science basis*. Cambridge, England.

Lobell, D., Bonfils, C., & Duffy, P. (2007). Climate change uncertainty for daily minimum and maximum temperatures: A model inter-comparison. *Geophysical Research Letters, 34*(5), 1–5.

Min, S., Zhang, X., Zwiers, F., & Hegerl, G. (2011). Human contribution to more-intense precipitation extremes. *Nature, 470* (7334), 378–381.

Piani, C., Weedon, G., Best, M., Gomes, S., Viterbo, P., Hagemann, S., et al. (2010). Statistical bias correction of global simulated daily precipitation and temperature for the application of hydrological models. *Journal of Hydrology, 395*(3), 199–215.

Stefan, H., Cui, C., Jan, O. H., Jens, H., Dieter, G., & Claudio, P. (2011). Impact of a statistical bias correction on the projected hydrological changes obtained from three GCMs and two hydrology models. *Journal of Hydrometeorology, 12*(4), 556–578.

Warszawski, L., Frieler, K., Huber, V., Piontek, F., Serdeczny, O., & Schewe, J. (2014). The inter-sectoral impact model intercomparison projection (ISI-MIP): Project framework. *Proceedings of the National Academy of Sciences of the United States of America, 111,* 3228–3232.

Yin, J., Yan, D., Yang, Z., Yuan, Z., Yuan, Y., & Zhang, C. (2016). Projection of extreme precipitation in the context of climate change in Huang-Huai-Hai region, China. *Journal of Earth System Science, 125*(2), 417–429.