WeeklyNote

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ORIGINAL PAPER

Projected temperature and precipitation changes on the Tibetan Plateau: results from dynamical downscaling and CCSM4

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Introduction

青藏高原由于有广泛的冰覆盖面积以及巨大的淡水储库，因此被世人称为世界的“第三极”，其250万平方公里以及平均海拔4000m的平均高度是世界上最大、海拔最高的高原。

青藏高原对于大气循环和局地气候都扮演着重要的作用，青藏高原近十几年的气候变化已经导致冰川削减、雪覆盖率的降低以及多年冻土的减少。

Method

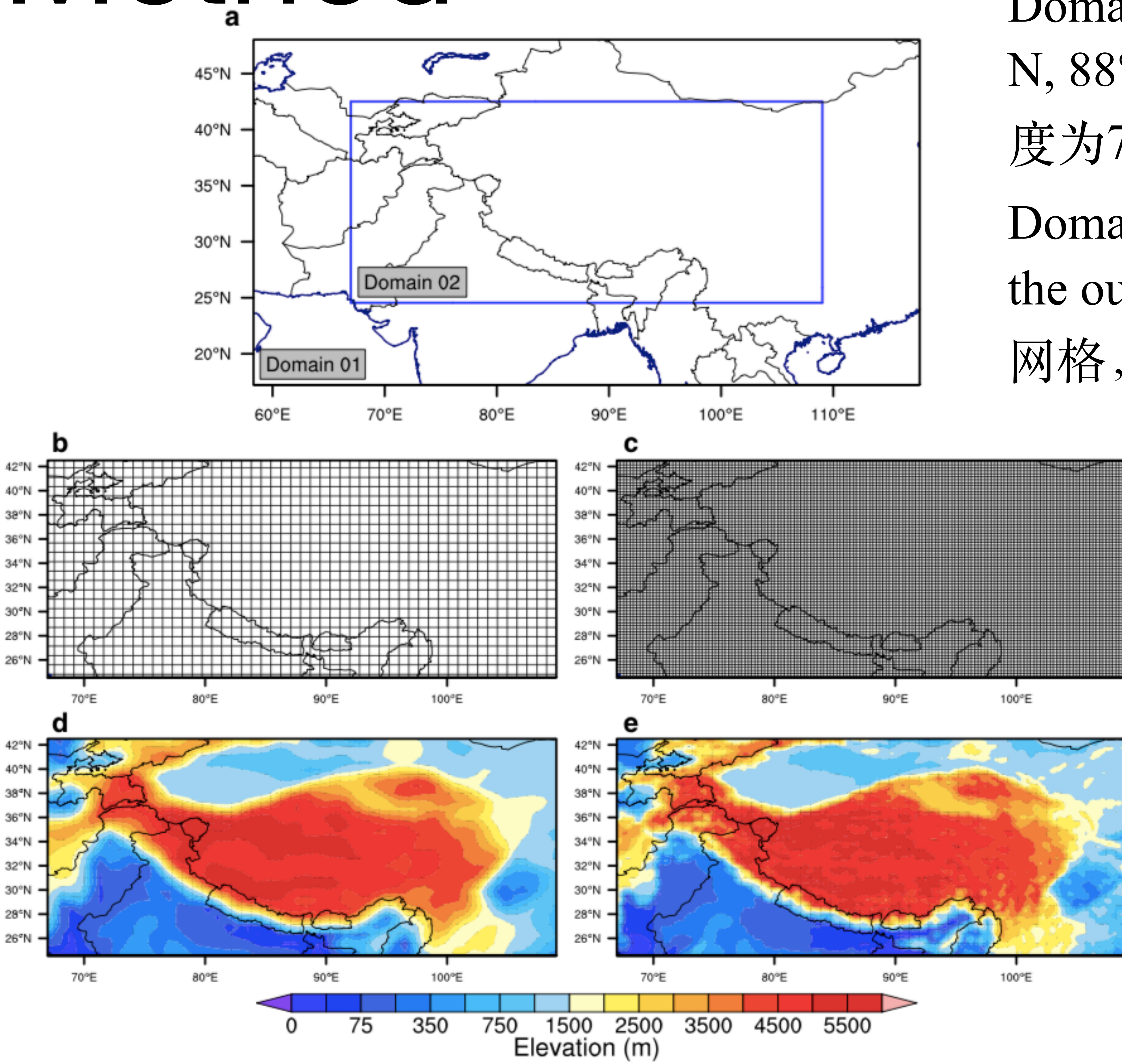


Fig. 1 Locations of the WRF domains (a). The horizontal resolutions of domains 01 and 02 are 75 (b) and 25 km (c), respectively, and elevation resolutions are shown in (d) and (e), respectively

Domain 01: centered at 34° N, 88° E, 75*48个网格，精度为75km；

Domain 02: centered within the outer domain, 157*82个网格，精度为25km。

Method

Data

WRF version 3.7.1;

时间:

1979-2005(conducted using ERA-Interim reanalysis and CCSM4 GCM initial and Iateral boundary conditions)、

2020-2060(used CCSM4 and explored high and low emission scenarios using the representative concentration pathways(RCP) 8.5 and 4.5, respectively)

Results

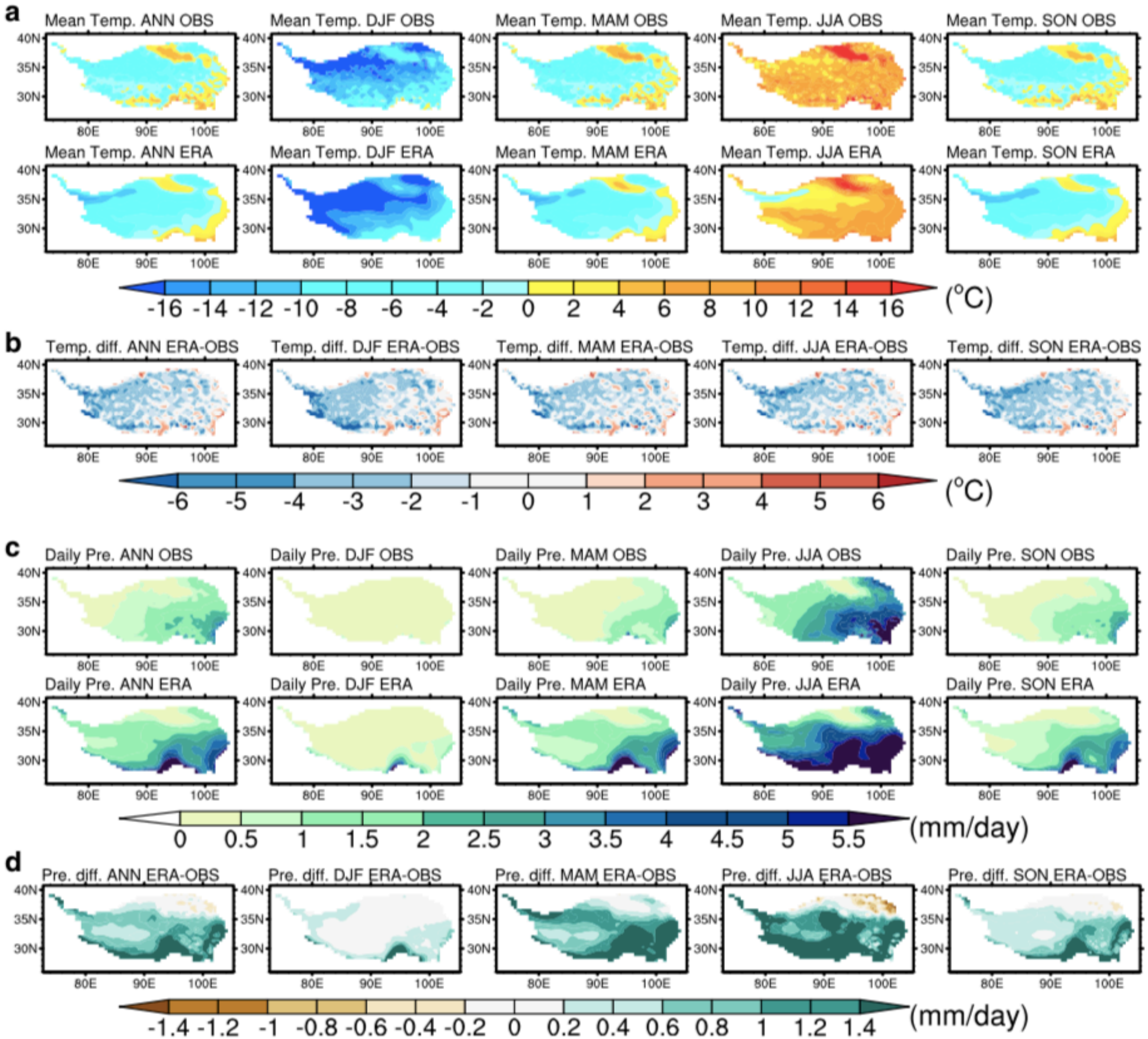


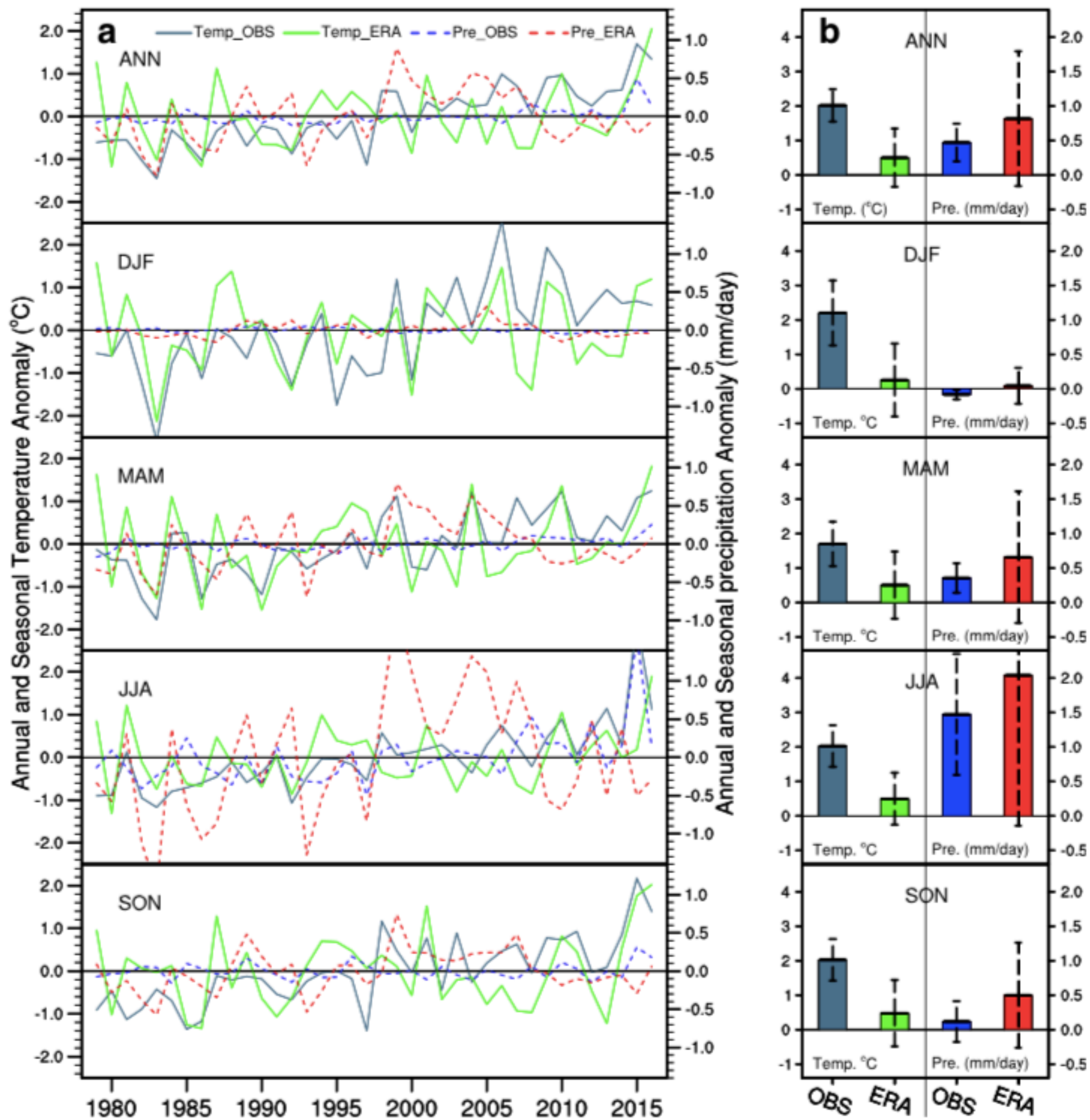
Fig. 2 Spatial distribution of annual and seasonal mean temperature (**a**) and precipitation (**c**) over the Tibetan Plateau (1979–2016) determined from observations and ERA-Interim reanalysis data. Difference between the observation and reanalysis data: **b** temperature, unit: °C; **d** precipitation, unit: mm day^{-1}

ERA-Interim 的温度通常较冷，特别是在西边界上偏差最大（5 ° C）；

EAR-Interim的偏差在春季，夏季和秋季最大，而在冬季可以忽略不计。

Results

Fig. 3 Time series of temperature and precipitation anomalies (**a**) and changes in annual and seasonal mean temperature and precipitation (**b**) over the Tibetan Plateau (1979–2016) determined from observations and ERA-Interim reanalysis data, units: °C and mm day^{-1}



冬季（春季）温度升高最大（最小）；

降水最多（最少）的季节为夏季（冬季）；

ERA-Interim在分析资料的时空特征和观测相对一致；但是，温度（降水）的增加往往被低估（高估）。

Results

由ERA-Interim驱动的历史模拟称为’WRFE’；

由CCSM驱动的历史模拟称为’WRFC’。

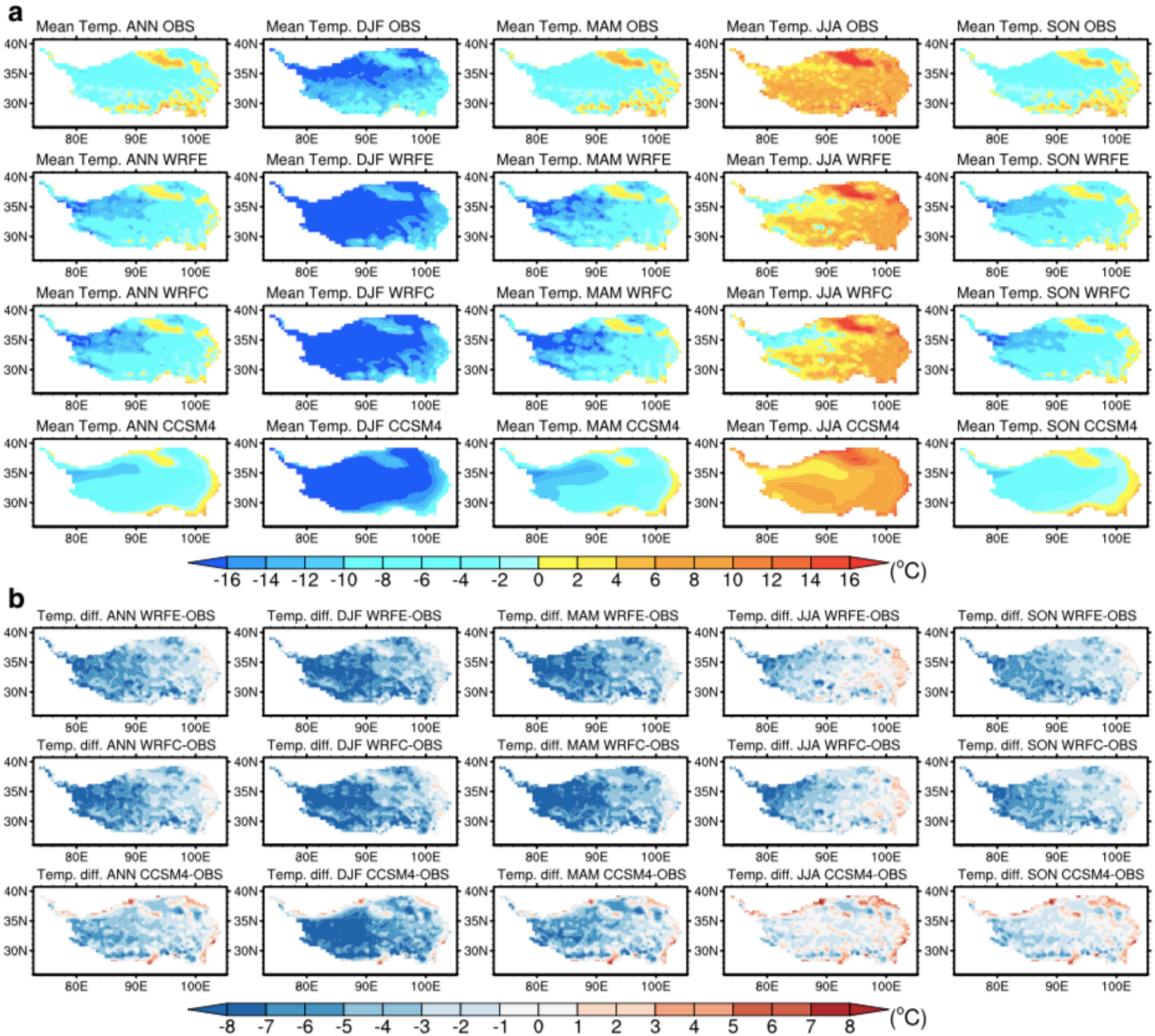


Fig. 4 Observed and simulated (WRFE, WRFC, and CCSM4) spatial distribution of annual and seasonal mean temperatures **a** over the Tibetan Plateau (1980–2005) and **b** their associated difference plots, unit: °C

温度普遍为偏冷的偏差，偏差在冬季和春季最为显着，而在夏秋季节则不明显；这有可能由于对积雪的高估导致地表反照率更强以及地表吸收短波辐射减少；季节性温度差异更明显。

Results

Fig. 5 Time series of temperature anomalies (**a**) and changes in annual and seasonal mean temperature (**b**) over the Tibetan Plateau (1980–2005) for observations, WRFE, WRFC, and CCSM4, unit: °C

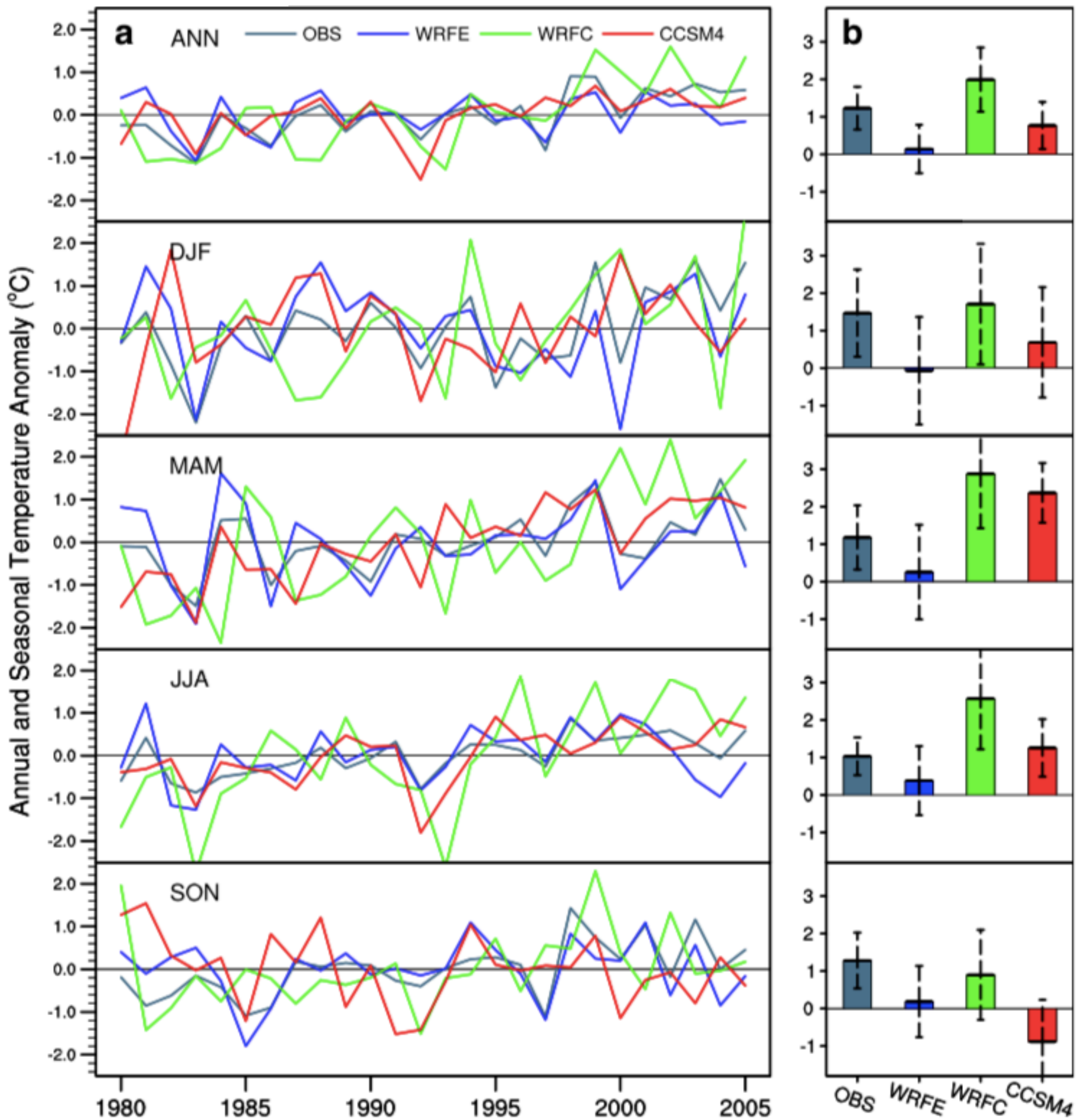
TP温度明显呈现上升趋势，在1980 – 2006年期间，年平均温度升高超过1.0° C，高于全球变暖的平均温度，该现象与最近的研究一致。

相对于观测，WRFE在年平均温度和季节平均温度方面表现出更强的变暖趋势；

WRFC显示年，夏季和春季的温度升高趋势较强，而秋季的趋势较弱，其中冬季趋势接近观测值；

与观测值相比，CCSM4在冬季表现出较弱的趋势，在春季和夏季表现出较强的趋势，与观测值相反，秋季表现出下降趋势；

因此，WRFC是预测TP未来温度变化的更可靠方法。



Results

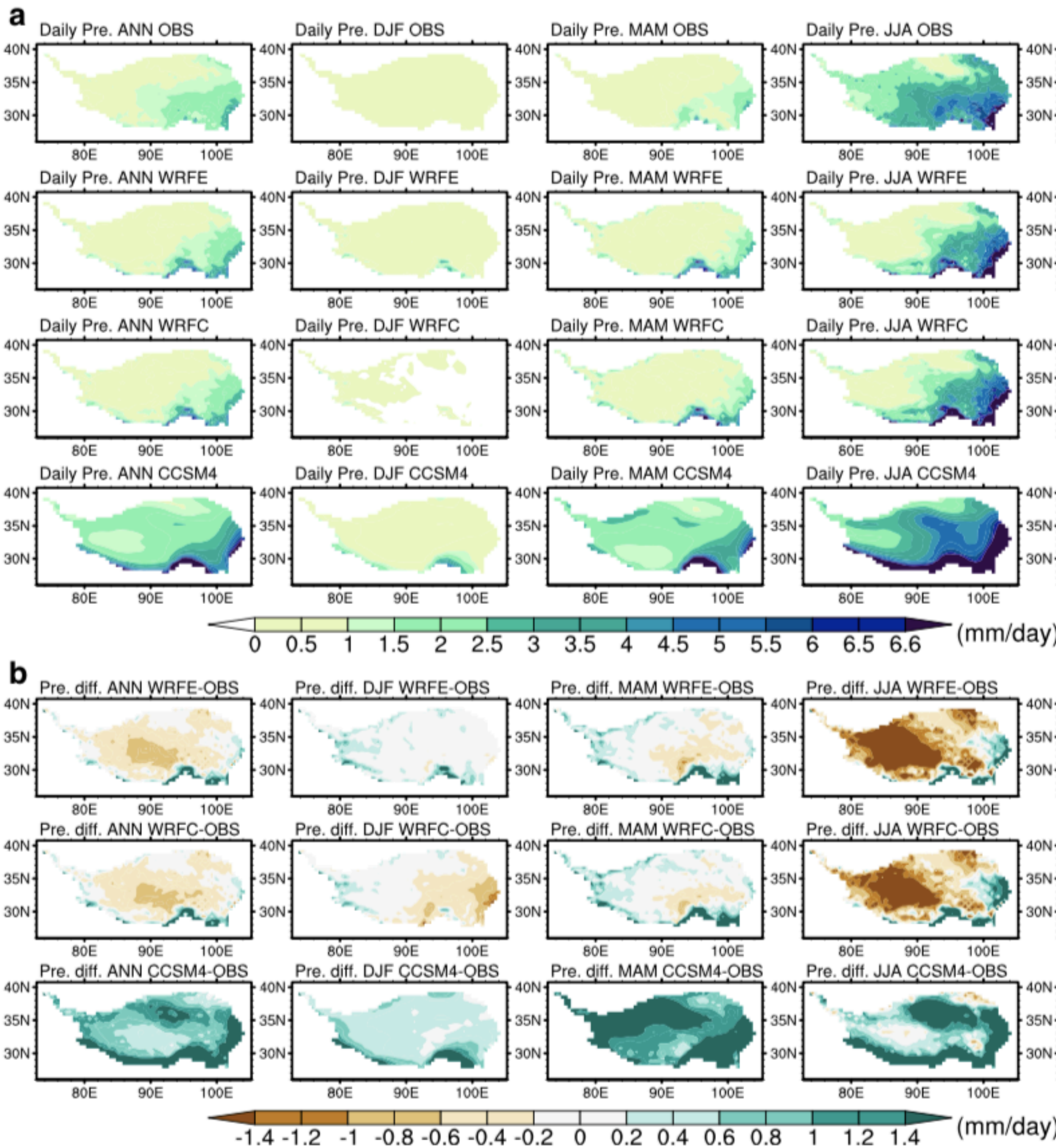


Fig. 6 Same as Fig. 4 but for precipitation, unit: mm day^{-1}

WRFE和WRFC均可再现TP降水的空间分布，特别是在东南TP区域高降水方面。相比之下，CCSM4表现较差；

与WRFE相比，WRFC和CCSM4的相关性明显较低。

Results

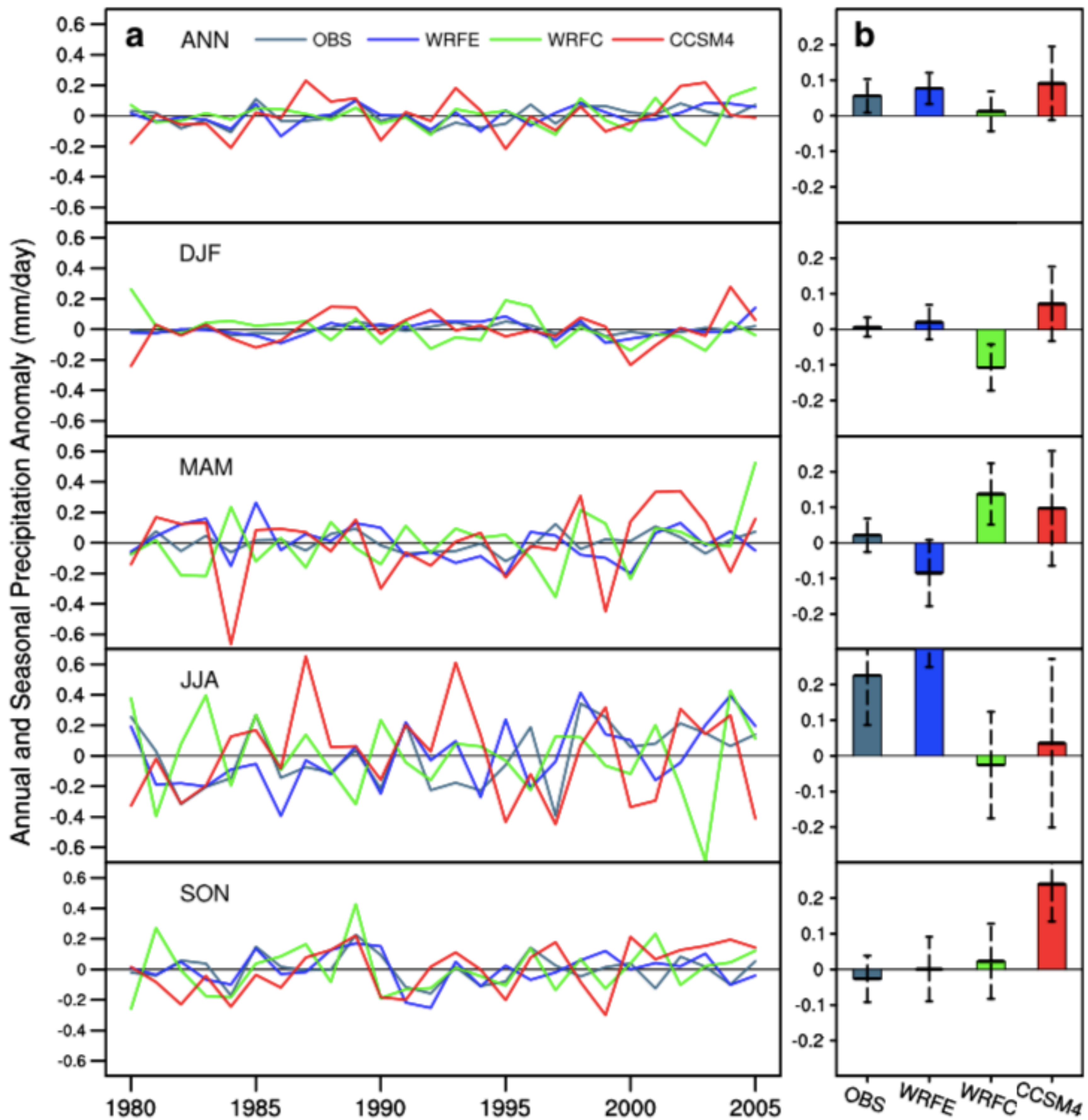


Fig. 7 Same as Fig. 5 but for precipitation, unit: mm day^{-1}

与测结果相比，WRFE，WRFC和CCSM4的趋势明显不同；

在WRFC中，温度和降水的偏差很明显，在降水方面，WRFC的性能比WRFE差。但是，WRFC通常能够在TP上再现温度的时空分布，并且明显优于CCSM4；

因此，使用WRFC预测TP上的未来温度和降水变化是可行的。

Results

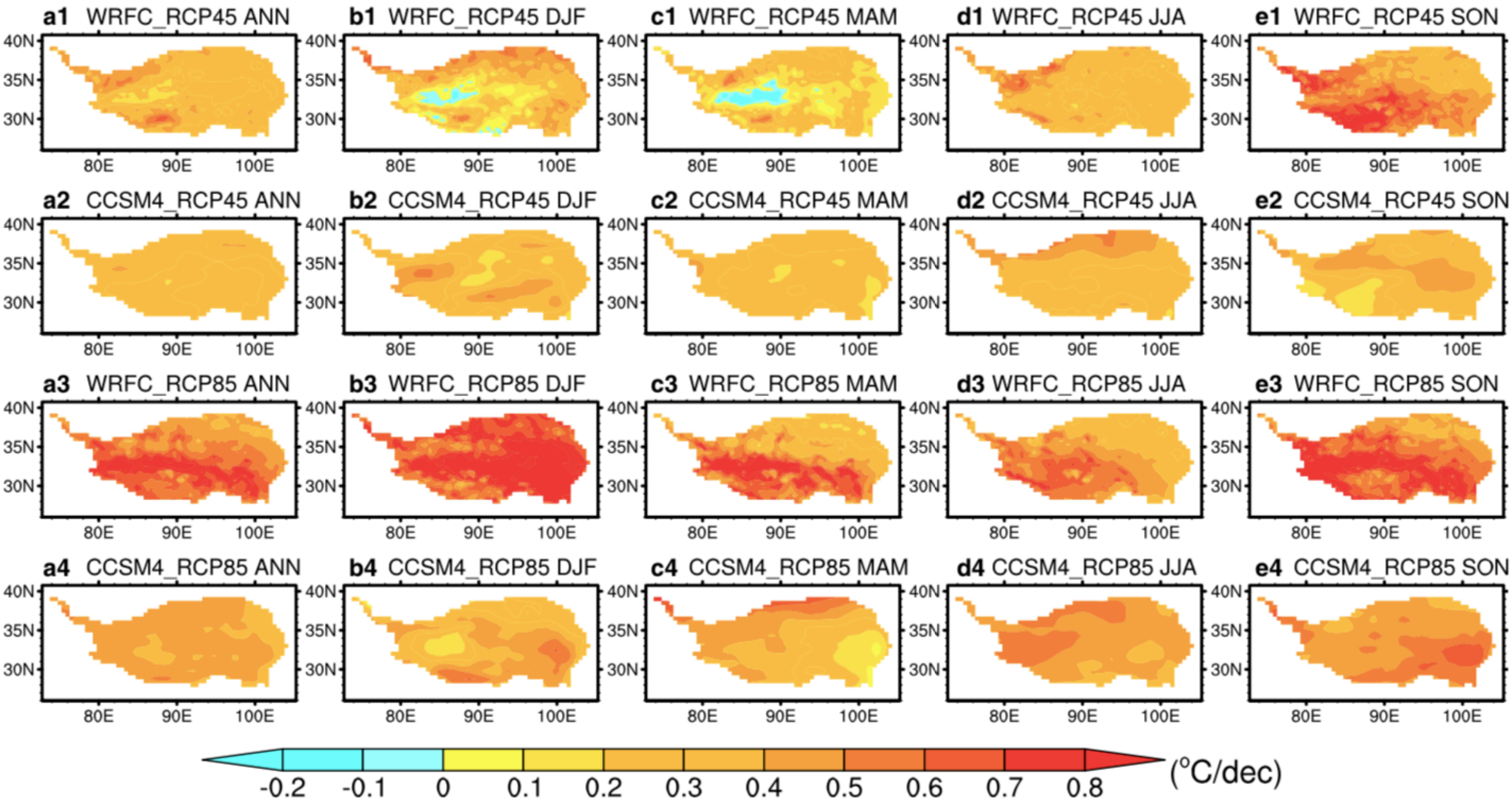
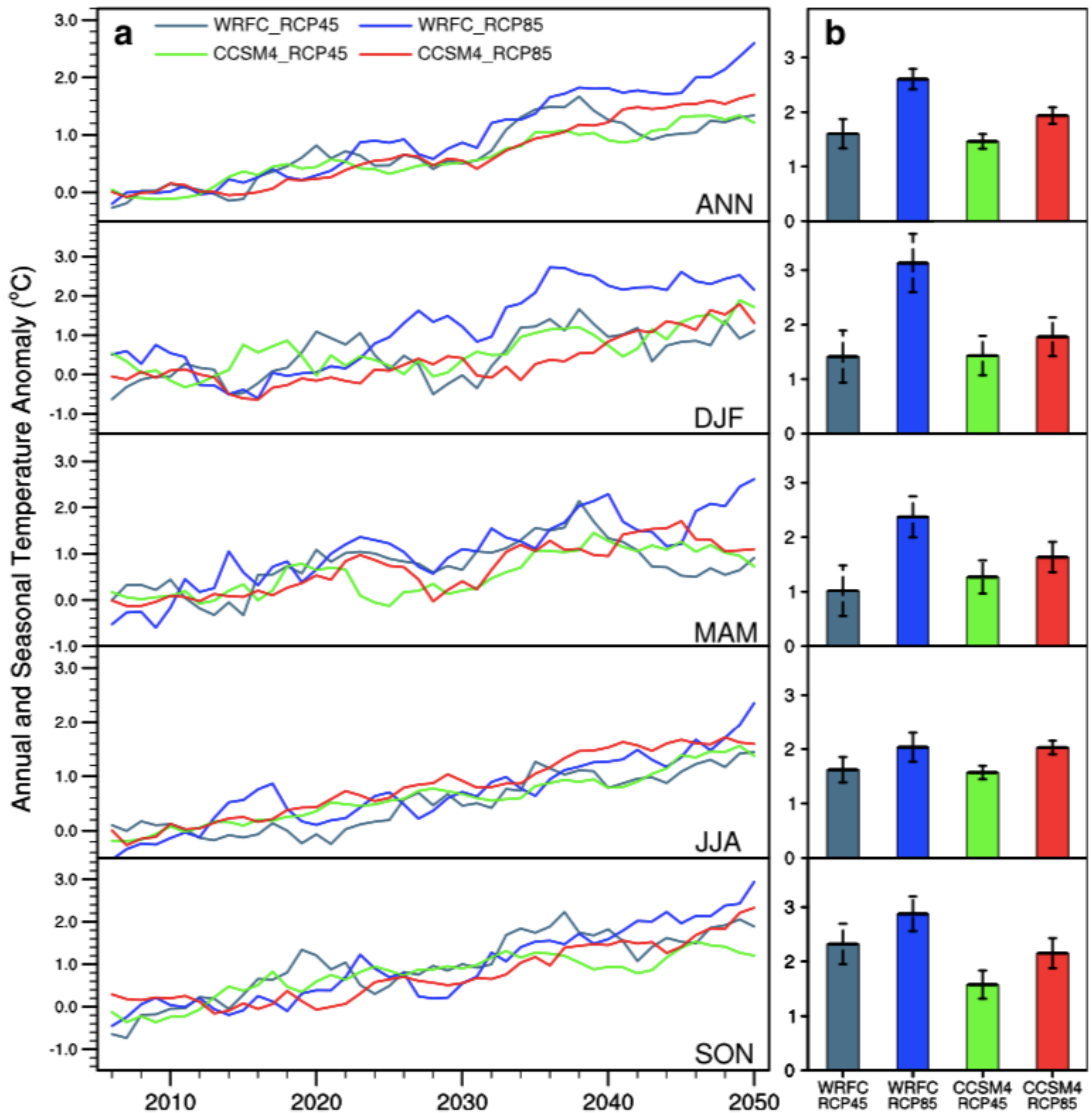


Fig. 8 Spatial distribution of projected trends (WRFC and CCSM4) in annual and seasonal mean temperatures over the Tibetan Plateau (2006–2050) under the RCP4.5 and RCP8.5 emission scenarios, unit: °C decade^{-1}

与WRFE相比，WRFC和CCSM4的相关性明显较低。

Results

Fig. 9 Time series of projected (WRFC and CCSM4) temperature anomalies (**a**) and warming patterns (**b**) for annual and seasonal mean temperatures over the Tibetan Plateau (2006–2050) under the RCP4.5 and RCP8.5 emission scenarios, unit: °C



Results

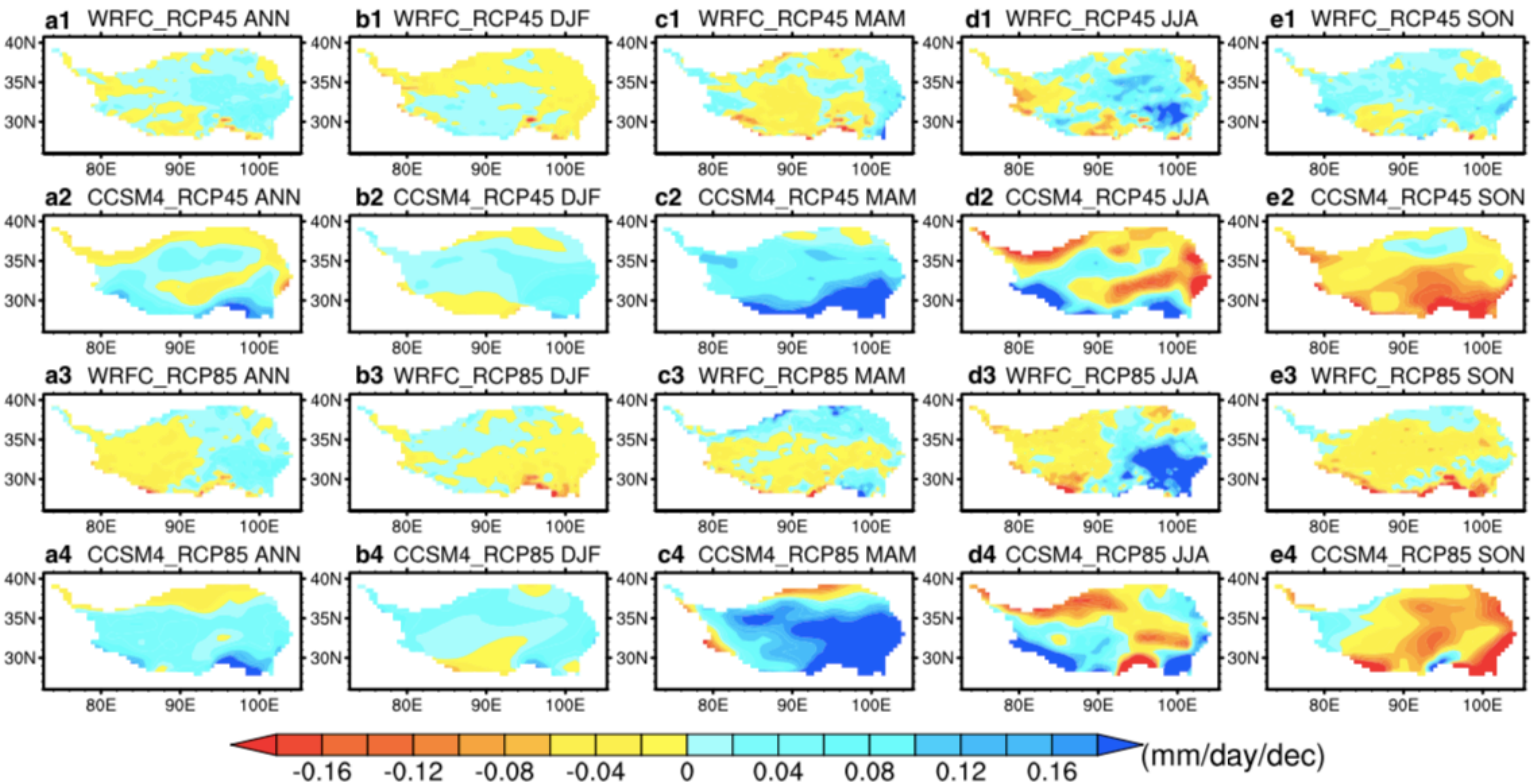
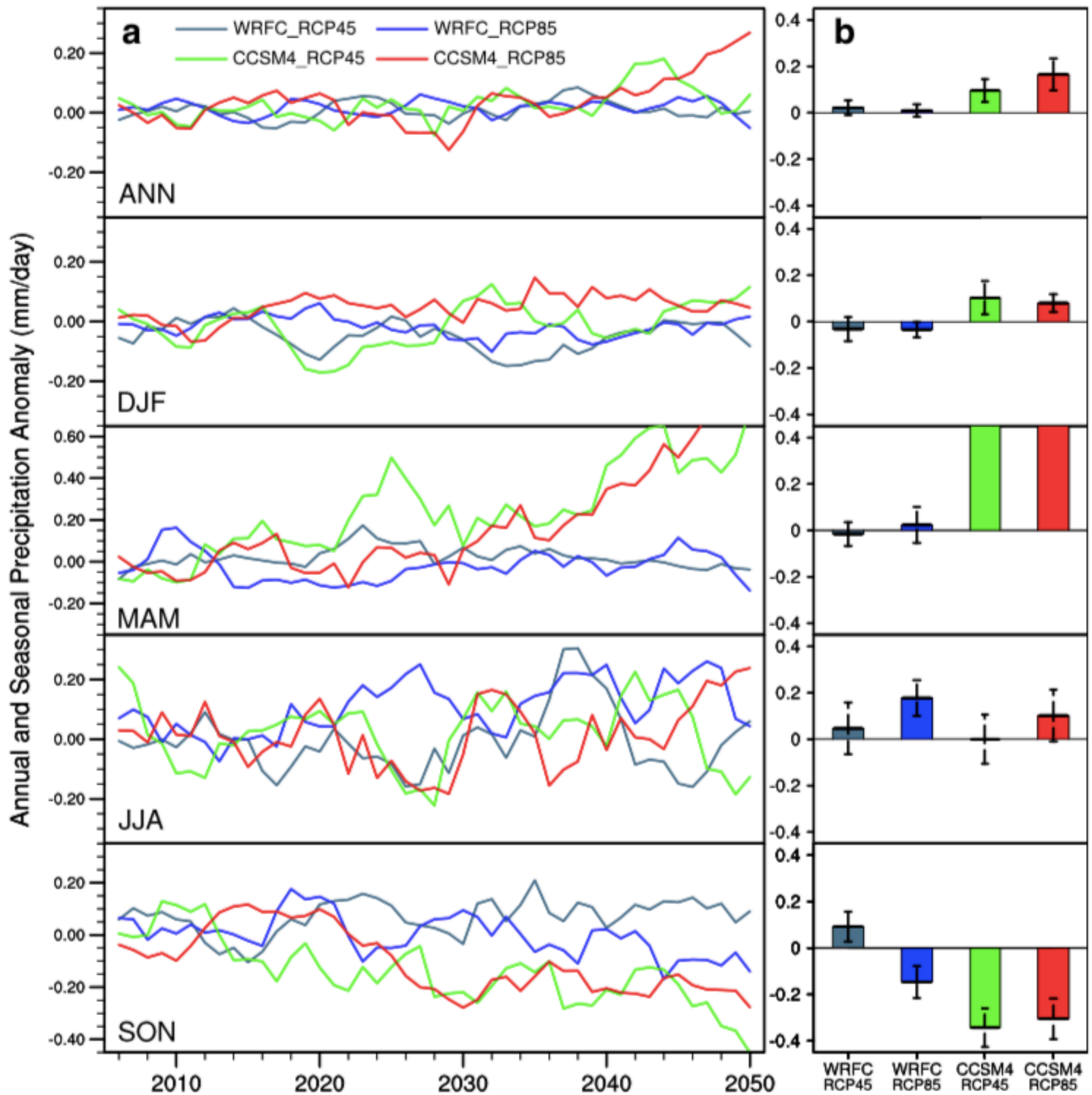


Fig. 10 Same as Fig. 8 but for precipitation, unit: mm day^{-1} decade^{-1}

Results

Fig. 11 Same as Fig. 9 but for precipitation, unit: mm day^{-1}



Conclusions

未完待续

谢谢