

# AMMA-2050 bias-corrected CMIP5 datasets over Africa

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## 1. Introduction

We present in this document two versions of bias-corrected CMIP5 data carried out over Africa by using the CDF-t method associated to two versions of reference data. This is a contribution to AMMA-2050 project whose goals are to significantly improve scientific understanding of climate variability and change across Africa and the impact of climate change on specific development decisions, to introduce flexible methods for integrating improved climate information and tools in specific decision-making contexts and to improve medium to long-term (5-40 year) decision-making, policies, planning and investment by African stakeholders and donors. For more information about AMMA-2050 project, please visit <http://www.amma2050.org/>.

This document is organized as follows: we first describe the bias-corrected data using WFDEI (Section 2) and EWEMBI (Section 3) as reference dataset. Then we give some information about the data structure and location (Section 4). Finally, we list the general terms of use of AMMA-2050 (Section 5).

## 2. The bias-corrected CMIP5 data using WFDEI as reference dataset

For the first version, we applied bias-corrections to daily data of seven variables (precipitation, mean near-surface air temperature, air maximum and minimum temperature, surface down-welling shortwave radiation, near-surface wind speed and near-surface specific humidity<sup>1</sup>) extracted from the CMIP5 database over the period from 1 January 1950 to 31 December 2099 for Africa (20°W-55°E; 40°N-40°S). Based on data availability, it includes 29 GCMs for historical simulations (1950-2005) and RCP8.5 (2006-2099), 27 GCMs for RCP4.5 (2006-2099) and 20 GCMs for RCP2.6 (2006-2099). Bilinear interpolation has been applied on the 0.5°x0.5° grid for mean near-surface air temperature (tas), maximum air temperature (tasmax), minimum air temperature (tasmin), surface down-welling shortwave radiation (rsds), near-surface wind speed (sfcWind) and specific humidity (huss); and the nearest neighbour method for precipitation (pr). To adjust the GCMs data, we used the WFDEI data from the European WATCH project (Weedon et al., 2014). The CDF-t method developed by Michelangeli et al. (2009) has been used to correct 6 variables out of 7 (huss, tas, tasmax, tasmin, rsds, sfcWind) and the updated version of CDF-t for precipitation (see Vrac 2016, for more details). Some metrics have been computed to evaluate these bias-corrected data and the results are presented in

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<sup>1</sup> Near-surface specific humidity is only available for 24 GCMs (for historical and RCP8.5 simulations), 23 GCMs (for RCP4.5 simulations) and 18 GCMs (for RCP2.6 simulations)

Famien et al. (2018). A more complete set of diagnostics can also be found at <http://www.amma2050.org/content/climate-metrics>.

### **3. The bias-corrected CMIP5 data using EWEMBI as reference dataset**

For the second version, the same CDF-t bias-correction method has been applied on the same data but using EWEMBI as reference dataset (Frieler et al., 2017). All the data have been interpolated to the  $0.5^{\circ} \times 0.5^{\circ}$  grid using bilinear interpolation method except for precipitation where conservative remapping method was used. EWEMBI dataset is identical to the WFDEI dataset except for surface down-welling shortwave radiation whose data have been improved (Frieler et al., 2017; Lange 2017b).

### **4. Data archive**

The AMMA-2050 bias-corrected data are located at [http://amma2050.ipsl.upmc.fr/CMIP5\\_AFRICA/](http://amma2050.ipsl.upmc.fr/CMIP5_AFRICA/). Data are organized into 6 directories:

- ✓ mdlgrid: for raw GCMs data extracted over Africa on their native grid;
- ✓  $0.5^{\circ} \times 0.5^{\circ}$ : for raw GCMs data interpolated on the  $0.5^{\circ} \times 0.5^{\circ}$  grid;
- ✓ BC\_WFDEI: for bias-corrected data using WFDEI as reference dataset and interpolated on the  $0.5^{\circ} \times 0.5^{\circ}$  grid;
- ✓ BC\_EWEMBI: for bias-corrected data using EWEMBI as reference dataset and interpolated on the  $0.5^{\circ} \times 0.5^{\circ}$  grid;
- ✓ WFDEI: the reference dataset extracted over Africa on the  $0.5^{\circ} \times 0.5^{\circ}$  grid;
- ✓ EWEMBI: the reference dataset extracted over Africa on the  $0.5^{\circ} \times 0.5^{\circ}$  grid.

Data can be access and download using Linux wget, rsync or scp command. Login and password are needed:

Login: amma2050

Password: @Amma2050!

Example using wget:

```
wget -r -A.nc --http-user =amma2050 --http-passwd=@Amma2050!
```

[http://amma2050.ipsl.upmc.fr/CMIP5\\_AFRICA/](http://amma2050.ipsl.upmc.fr/CMIP5_AFRICA/)

### **5. Terms of use of AMMA-2050 the bias-corrected CMIP5 datasets**

To ensure that you are using the most up-to-date version of the simulation data, you should check the readme file in data folder. You are responsible for ensuring that the data you are using is up to date before submitting publications.

1. For data limited to non-commercial research and educational purposes:

- a) I agree to restrict my use of AMMA-2050 bias-corrected model output to **non-commercial research and educational purposes only**.

For research to be considered non-commercial, its end products (in the form of data sets, reports, and other publications) must not be considered proprietary, and they must be made generally available through open publication or by equally accessible means. Materials prepared for educational purposes cannot be sold. These restrictions may only be relaxed by permission of the individual modelling groups responsible for the simulations.

2. For unrestricted data:

- a) I understand that the subset of AMMA-2050 bias-corrected model output that will be made accessible to this group has been designated for **"unrestricted" use**.

For both groups of users, the terms of use include these additional statements:

- b) I will hold no individual(s), organization(s), or group(s) responsible for any errors in the models or in their output data.
- c) In publications that rely on the AMMA-2050 bias-corrected model output, I will appropriately credit the data providers by an acknowledgment similar to the following:

*"This work received funding from the UK's National Environment Research Council (NERC)/Department for International Development (DFID) Future Climate For Africa programme, under the AMMA-2050 project (grant numbers NE/M020428/1, NE/M019969/1, NE/M019950/1, NE/M020126/1 and NE/M019934/1). To process the CMIP5 data, this study benefited from the IPSL mesocenter facility which is supported by CNRS, UPMC, Labex L-IPSL which is funded by the ANR (Grant #ANR-10-LABX-0018) and by the European FP7 IS-ENES2 project (Grant #312979)."*

I will also quote the following article:

*Famien, A. M., Janicot, S., Ochou, A. D., Vrac, M., Defrance, D., Sultan, B., and Noël, T.: A bias-corrected CMIP5 dataset for Africa using CDF-t method. A contribution to agricultural impact studies, Earth Systems Dynamics, Discussion, <https://doi.org/10.5194/esd-2017-111>, 2018.*

- d) I acknowledge the potential limitations of the data obtained from this archive. These may include (but are not necessarily limited to) errors in the models, shortcomings in the experiment designs, the conjectural quality of the forcing scenarios used to drive the models, and so on.
- e) I understand that although the model output has been subjected to a quality control procedure, unrecognized errors almost certainly remain.
- f) To aid participating modelling groups in understanding and improving their models, I will respond to reasonable requests from AMMA-2050 team for feedback about my AMMA-2050 research results (e.g. reporting

model deficiencies). As soon as my AMMA-2050 based paper is published I will provide the associated reference to the AMMA-2050 bias-corrected data.

- g) These data are freely and publicly available. Sale of the data is strictly forbidden.

## References

Famien, A. M., Janicot, S., Ochou, A. D., Vrac, M., Defrance, D., Sultan, B., and Noël, T.: A bias-corrected CMIP5 dataset for Africa using CDF-t method. A contribution to agricultural impact studies. *Earth Syst. Dynam. Discuss.*, <https://doi.org/10.5194/esd-2017-111>, 2018.

Frieler, K., Lange, S., Piontek, F., Reyer, C. P., Schewe, J., Warszawski, L., Zhao, F., Chini, L., Denvil, S., Emanuel, K., et al.: Assessing the impacts of 1.5°C global warming—simulation protocol of the Inter-Sectorial Impact Model Intercomparison Project (ISIMIP2b), *Geoscientific Model Development*, 10, 4321, 2017.

Lange, S.: Bias correction of surface downwelling longwave and shortwave radiation for the EWEMBI dataset, *Earth Syst. Dynam., Discuss.*, 2017, 1–30, <https://doi.org/10.5194/esd-2017-81>, <https://www.earth-syst-dynam-discuss.net/esd-2017-81/>, 2017.

Michelangeli, P.-A., Vrac, M., and Loukos, H.: Probabilistic downscaling approaches: Application to wind cumulative distribution functions. *Geophysical Research Letters*, 36, 2009.

Vrac, M., Noël, T., and Vautard, R.: Bias correction of precipitation through Singularity Stochastic Removal: Because occurrences matter. *Journal of Geophysical Research: Atmospheres*, 2016.

Weedon, G. P., Balsamo, G., Bellouin, N., Gomes, S., Best, M. J., and Viterbo, P.: The WFDEI meteorological forcing data set: WATCH Forcing Data methodology applied to ERA-Interim reanalysis data, *Water Resources Research*, 50, 7505–7514, 2014.

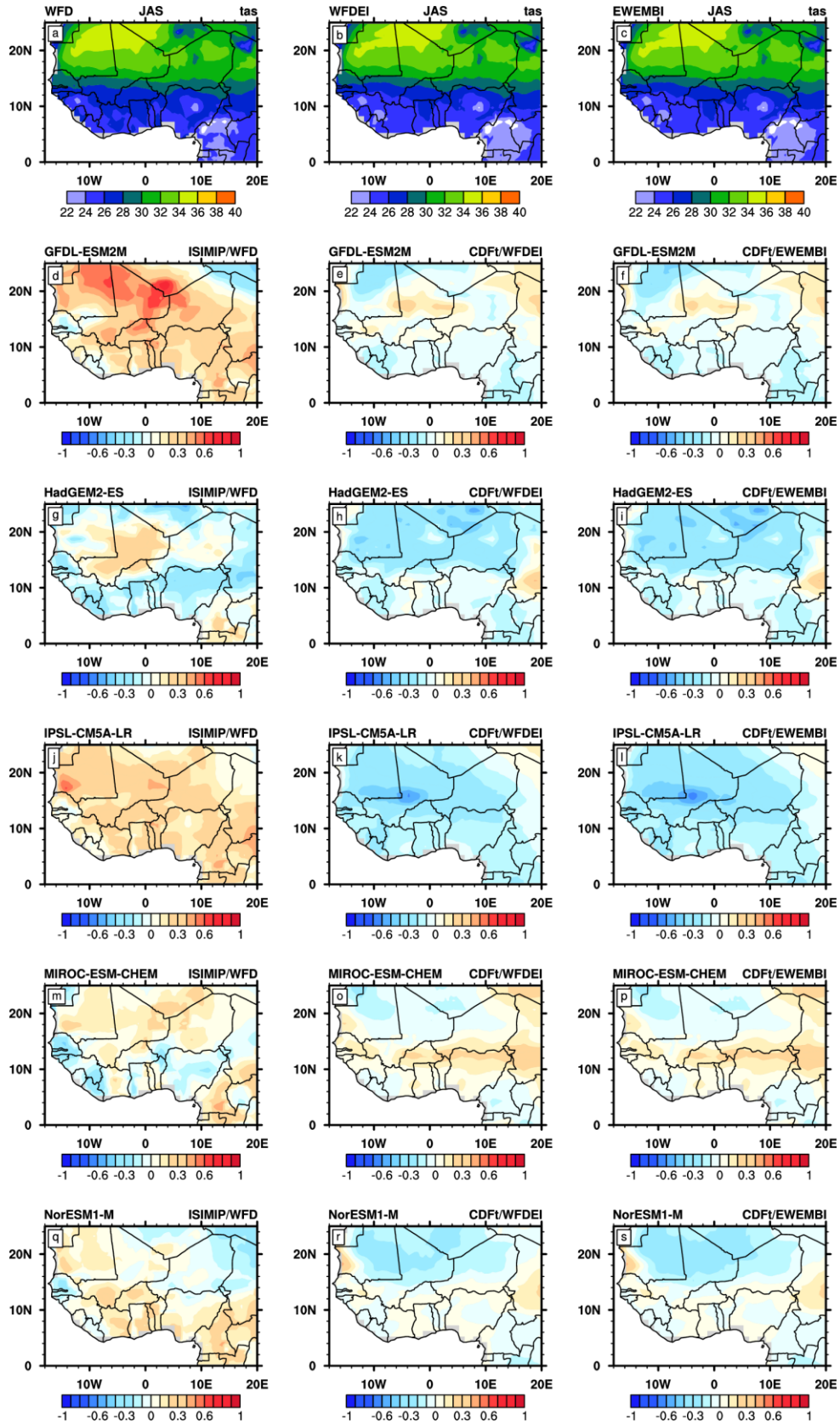


Figure 1 : Summer climatology from different observations datasets (WFD, WFDEI and EWEMBI) for near-surface air temperature ( $^{\circ}\text{C}$ ) over JAS 1979-2001 and difference between five bias-corrected GCMs and their respective reference dataset for ISIMIP (first column), WFDEI (second column) and EWEMBI (third column).

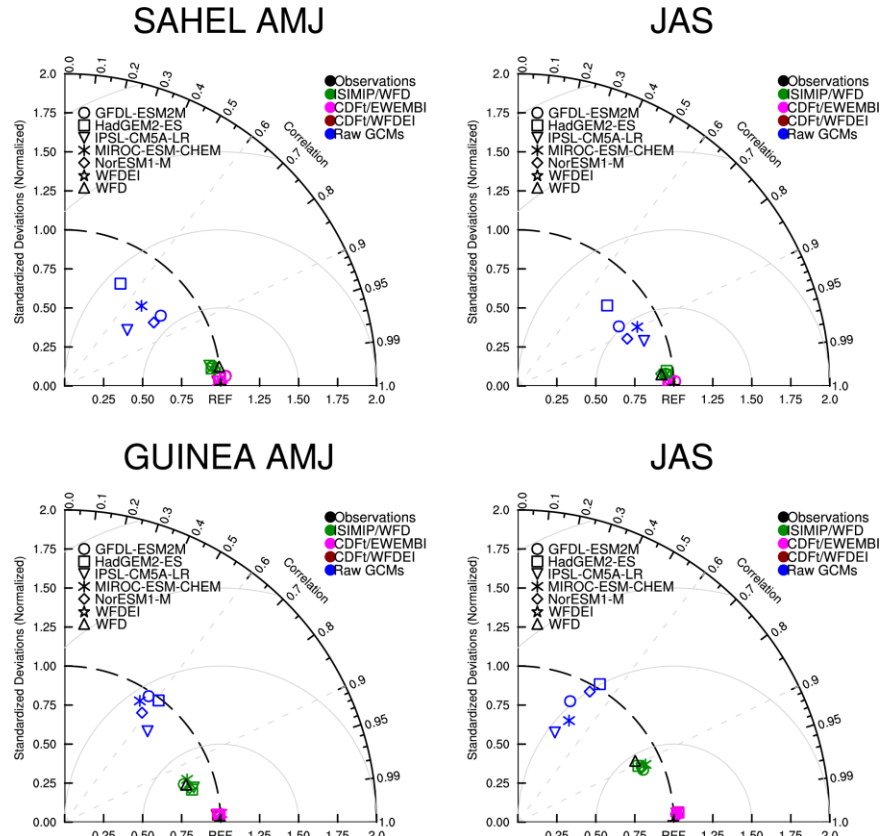


Figure 2 : Taylor diagrams relative to the mean near-surface air temperature over AMJ and JAS 1979-2001 from 5 CMIP5 GCMs used in ISIMIP. Two areas are considered: Sahel box (18°W-10°E ; 10°N-20°N) and Guinea box (18°W-10°E ; 3°N-10°N). Data are compared to EWEMBI data. « Observations » label represents WFD and WFDEI (in black), raw GCMs data are in blue, CDF-t bias-corrected data using WFDEI as reference dataset are in red, CDF-t bias-corrected data using EWEMBI as reference dataset are in pink and ISIMIP bias-corrected GCMs data are in green.



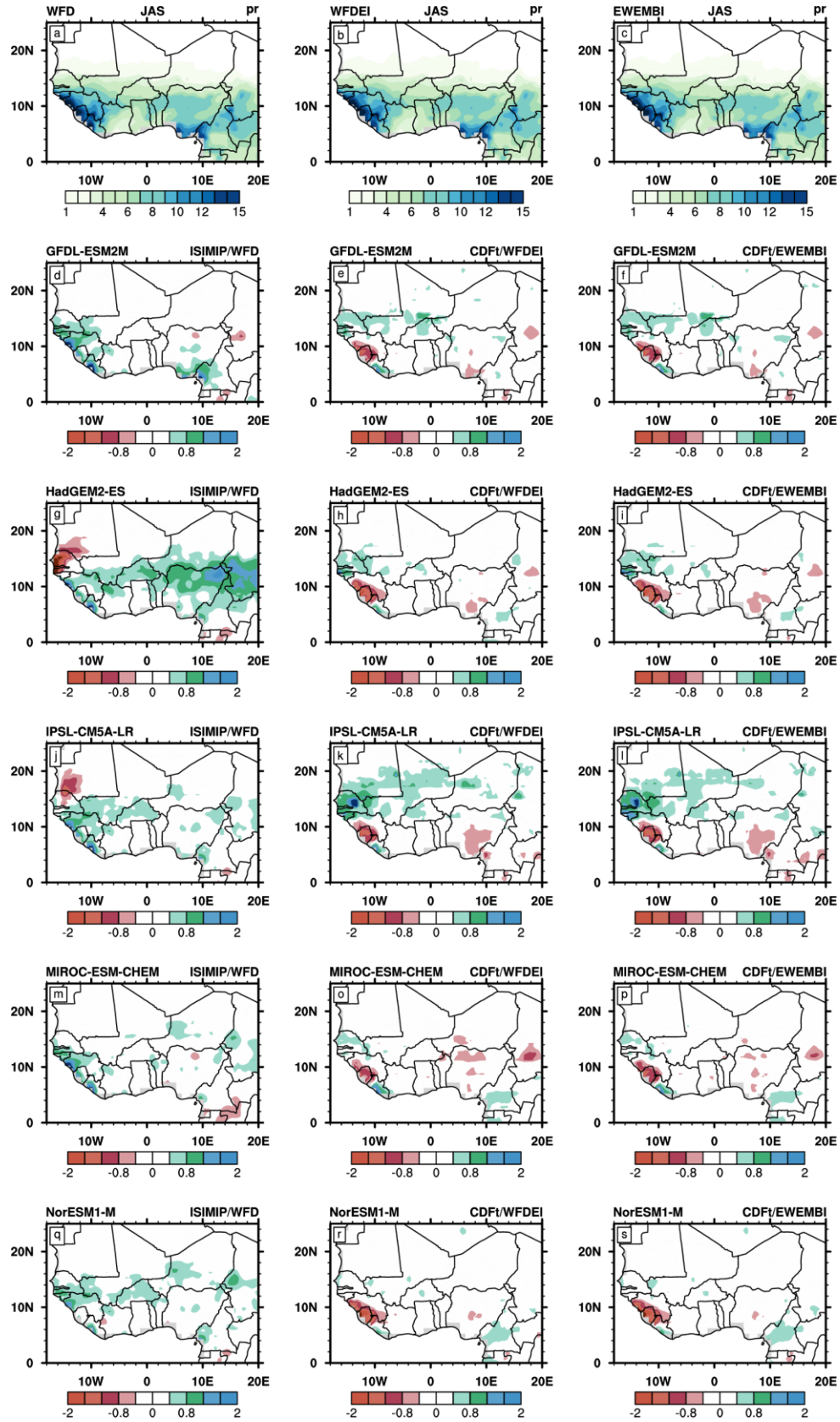


Figure 3 : Same as Figure 1 but for precipitation rate (mm/day).

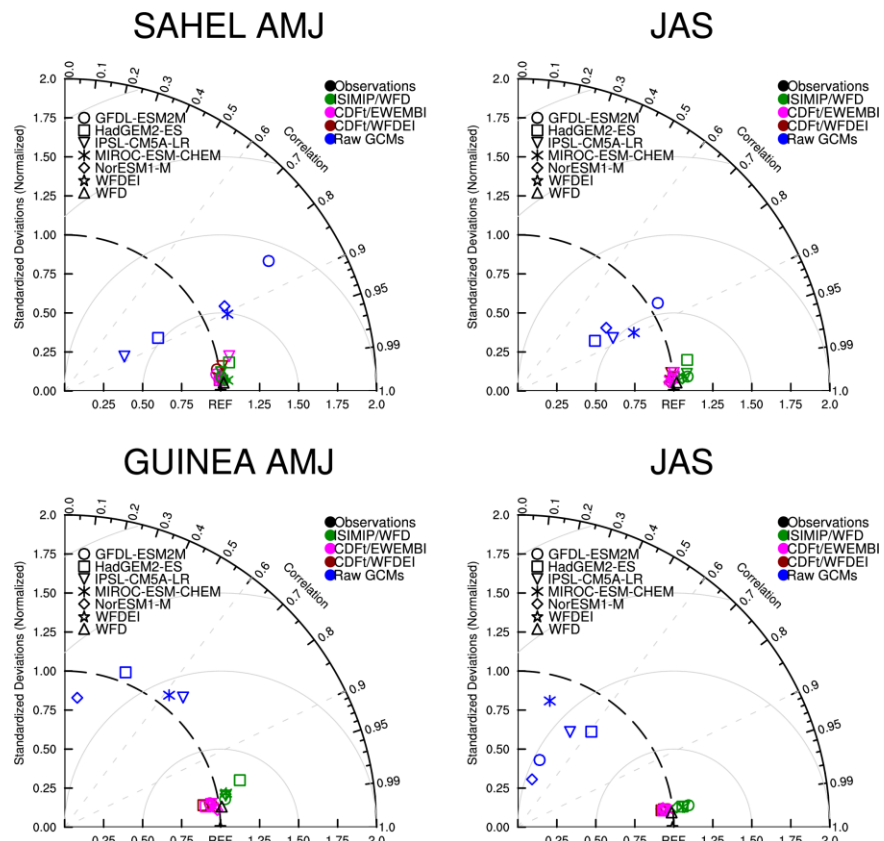


Figure 4 : Same as Figure 2 but for precipitation rate.



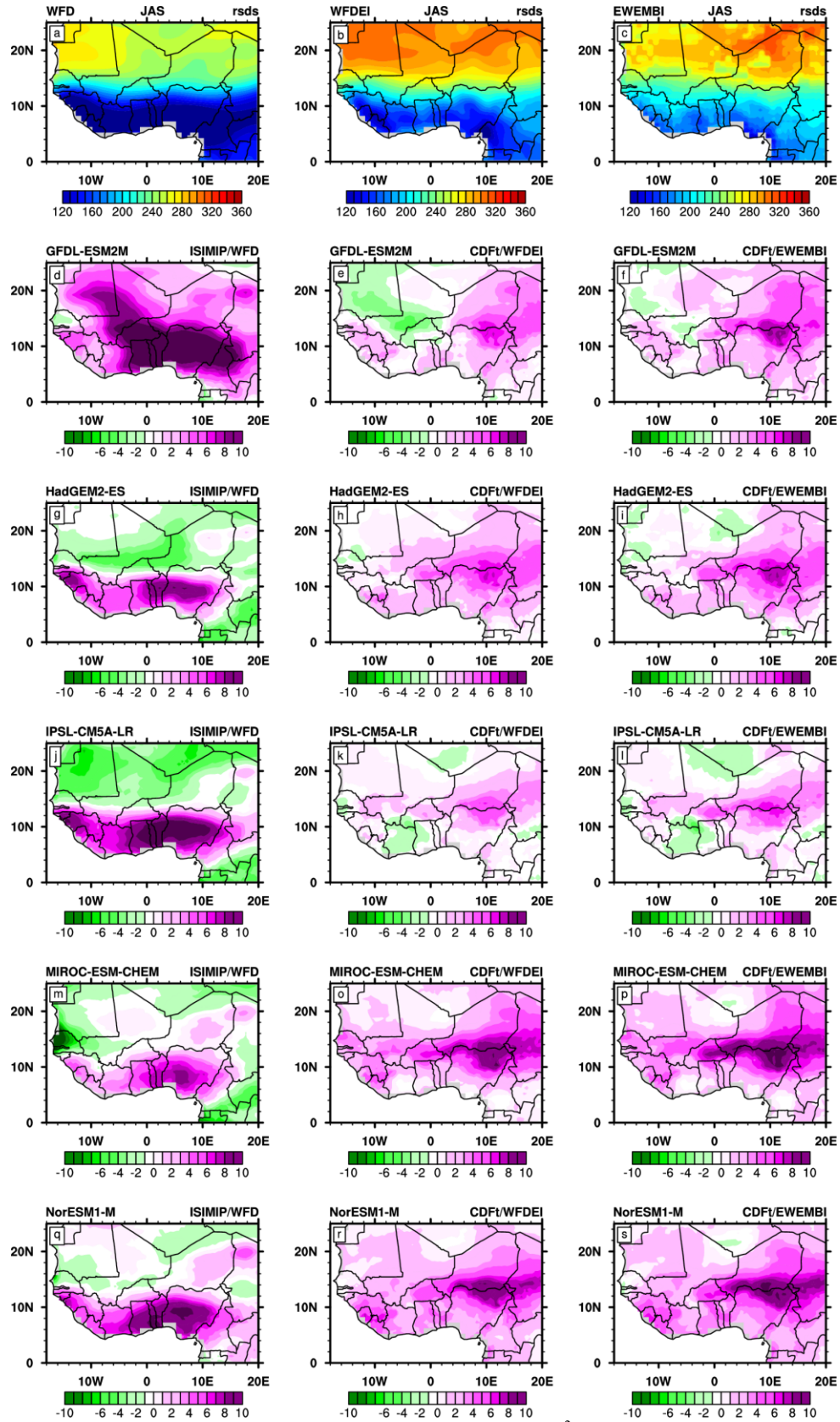


Figure 5 : Same as Figure 1 but for surface down-welling solar radiation in W/m<sup>2</sup>.

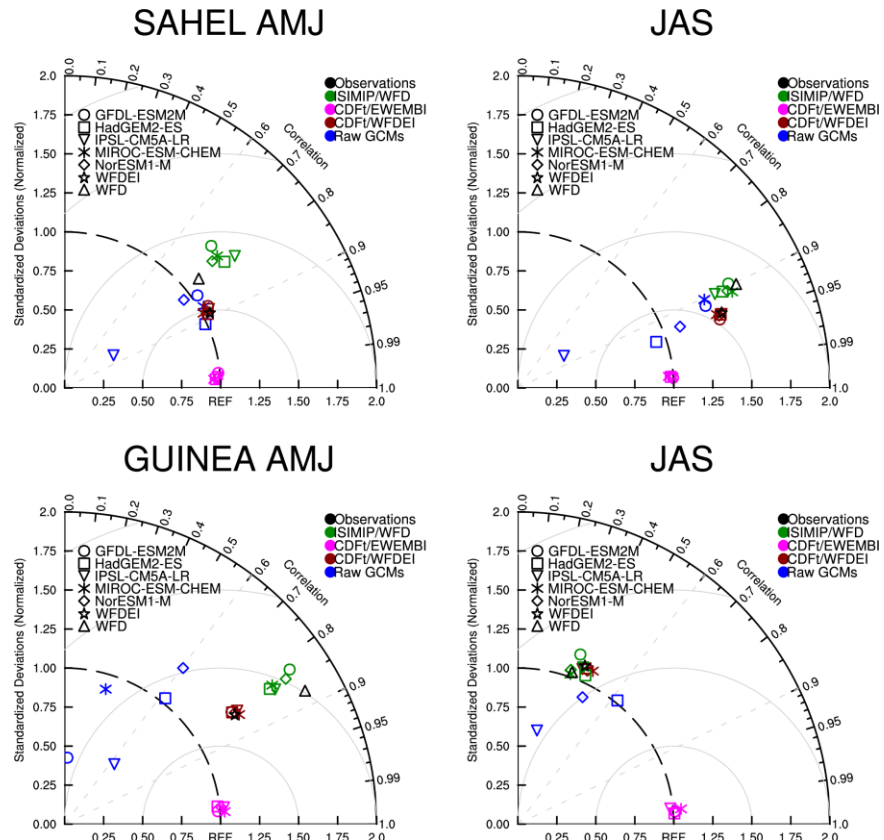


Figure 6 : Same as Figure 2 but for surface down-welling solar radiation.

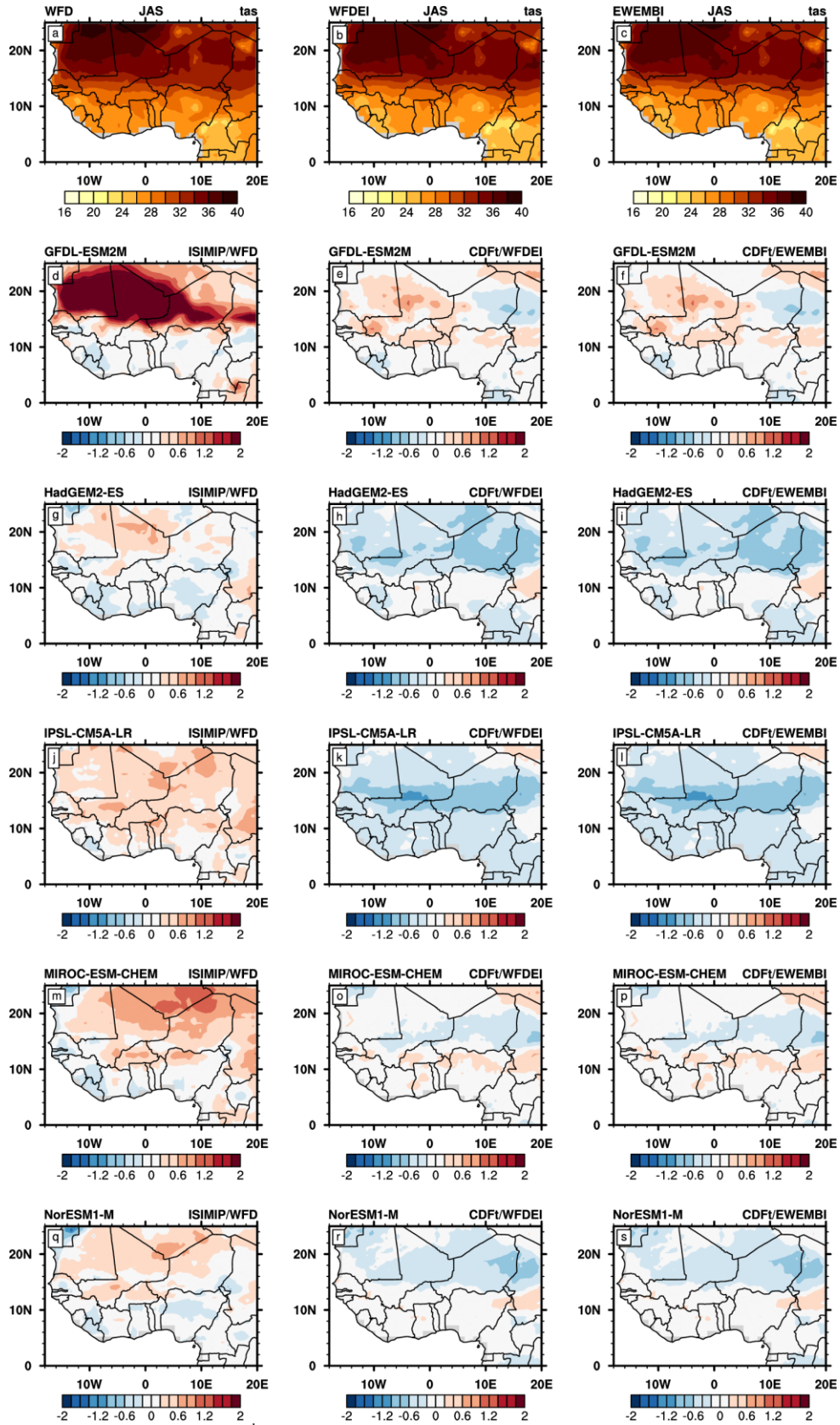


Figure 7 : Same as Figure 1 but for the 95<sup>th</sup> percentile of daily values of temperature in °C.

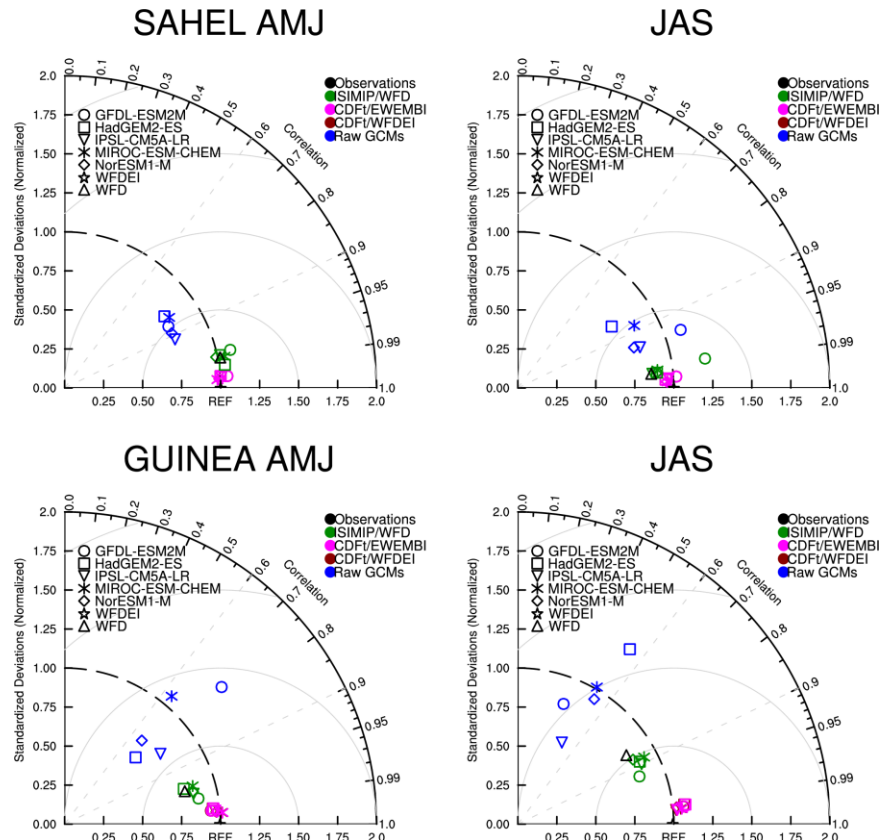


Figure 8 : Same as Figure 2 but for the 95<sup>th</sup> percentile of daily values of temperature.



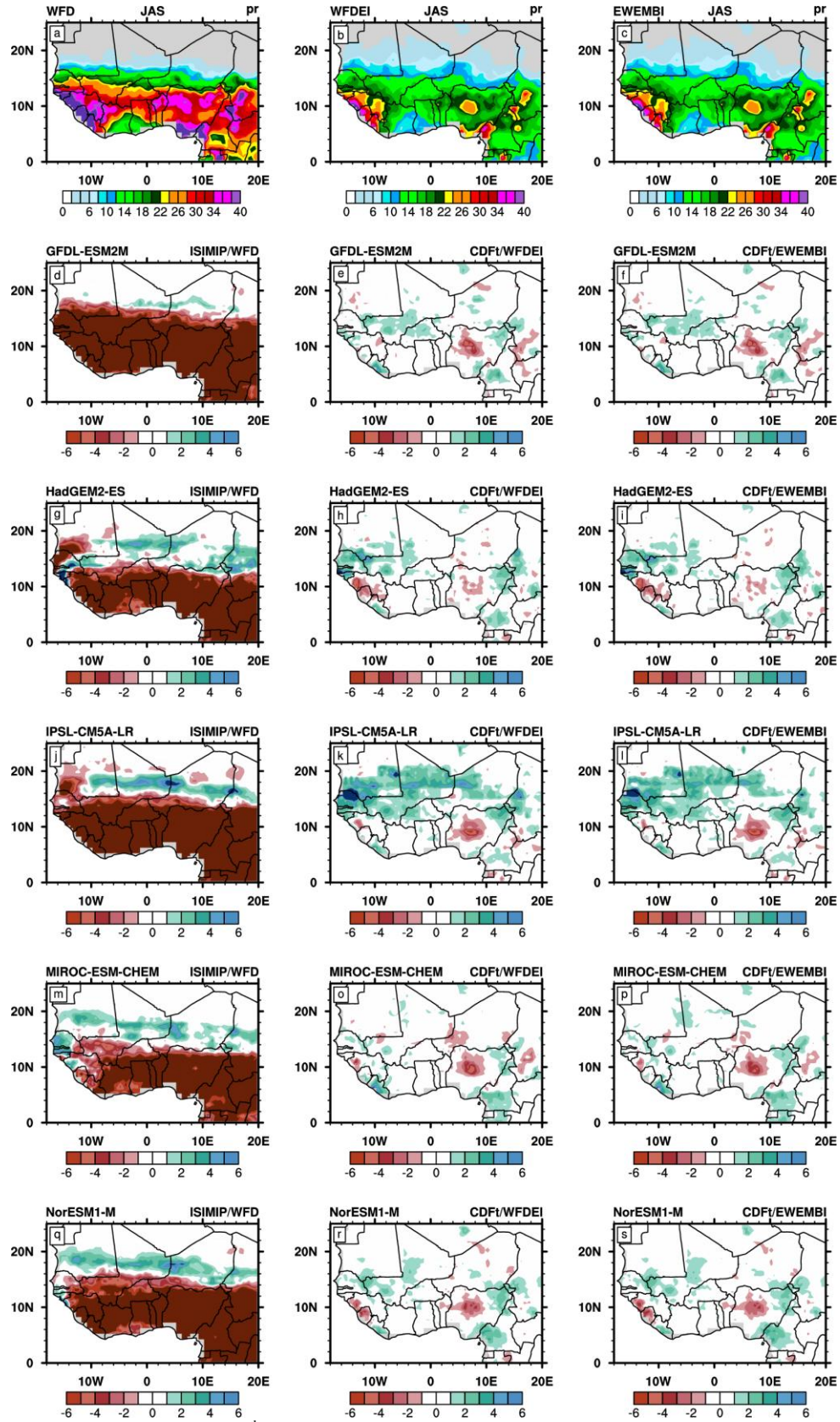


Figure 9 : Same as Figure 1 but for the 95<sup>th</sup> percentile of daily precipitation rate in mm/day.

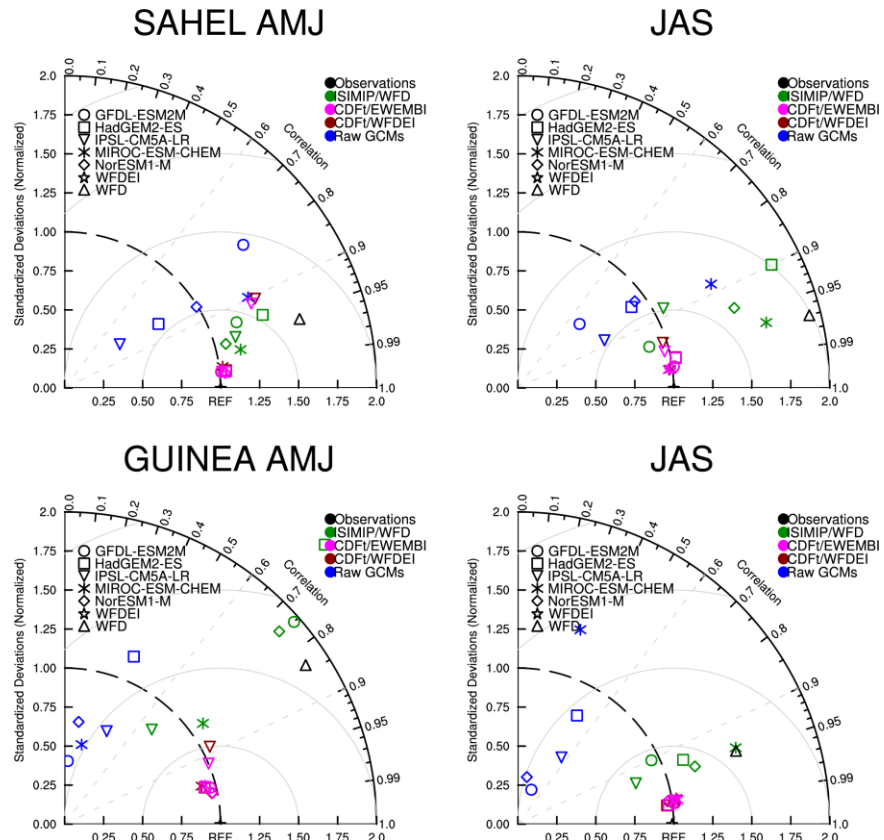


Figure 10 : Same as Figure 2 but for the 95<sup>th</sup> percentile of daily precipitation rate.



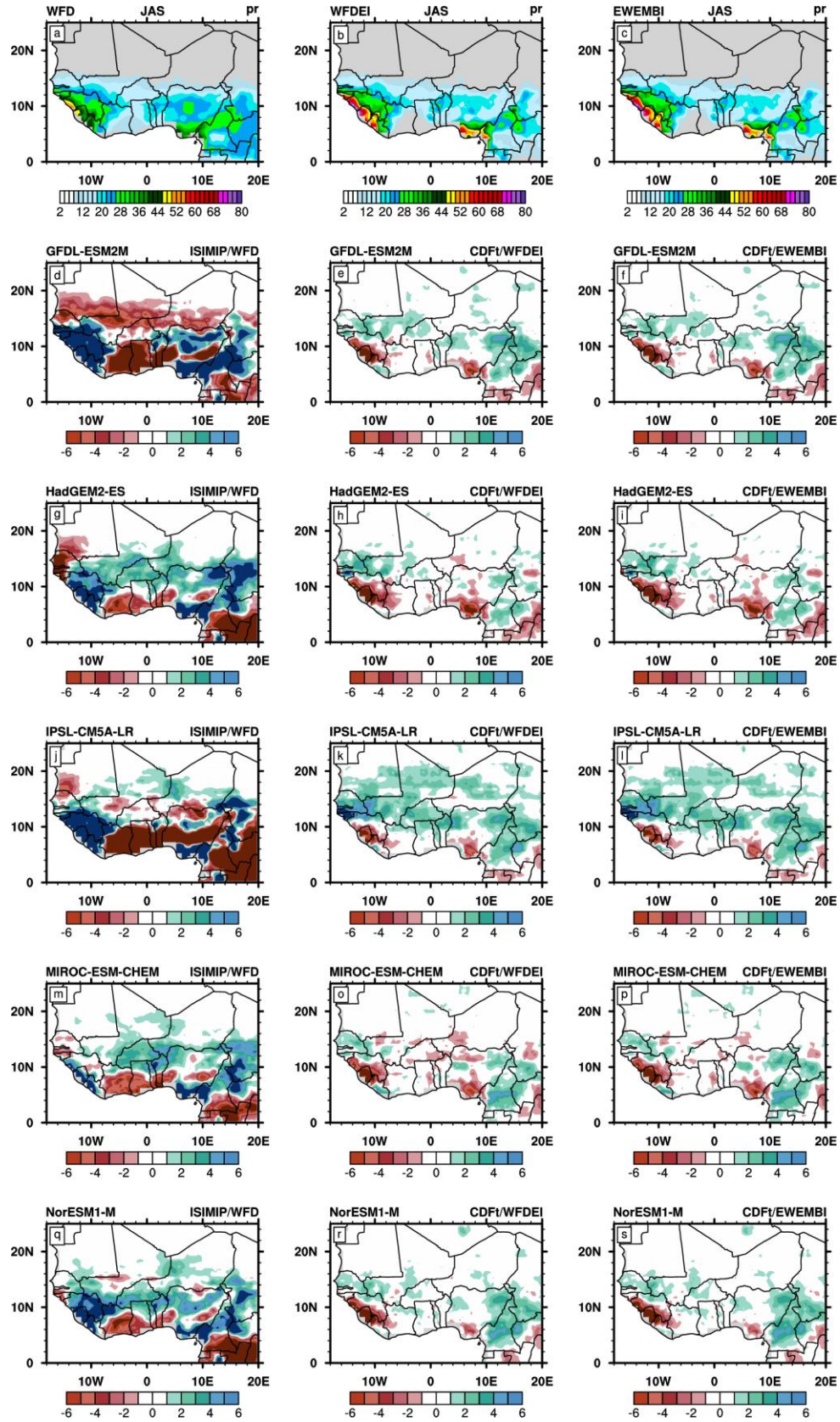


Figure 11 : Same as Figure 1 but for number of day where precipitation is greater or equal to 10 mm/day.

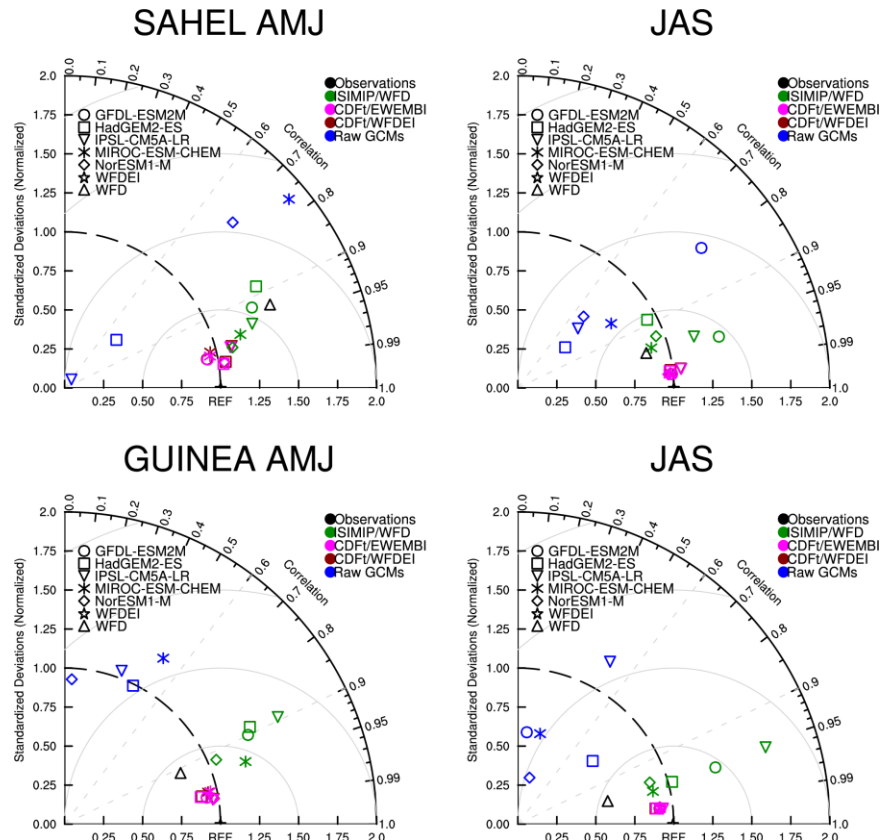


Figure 12 : Same as Figure 2 but for number of day where precipitation is greater or equal to 10 mm/day .

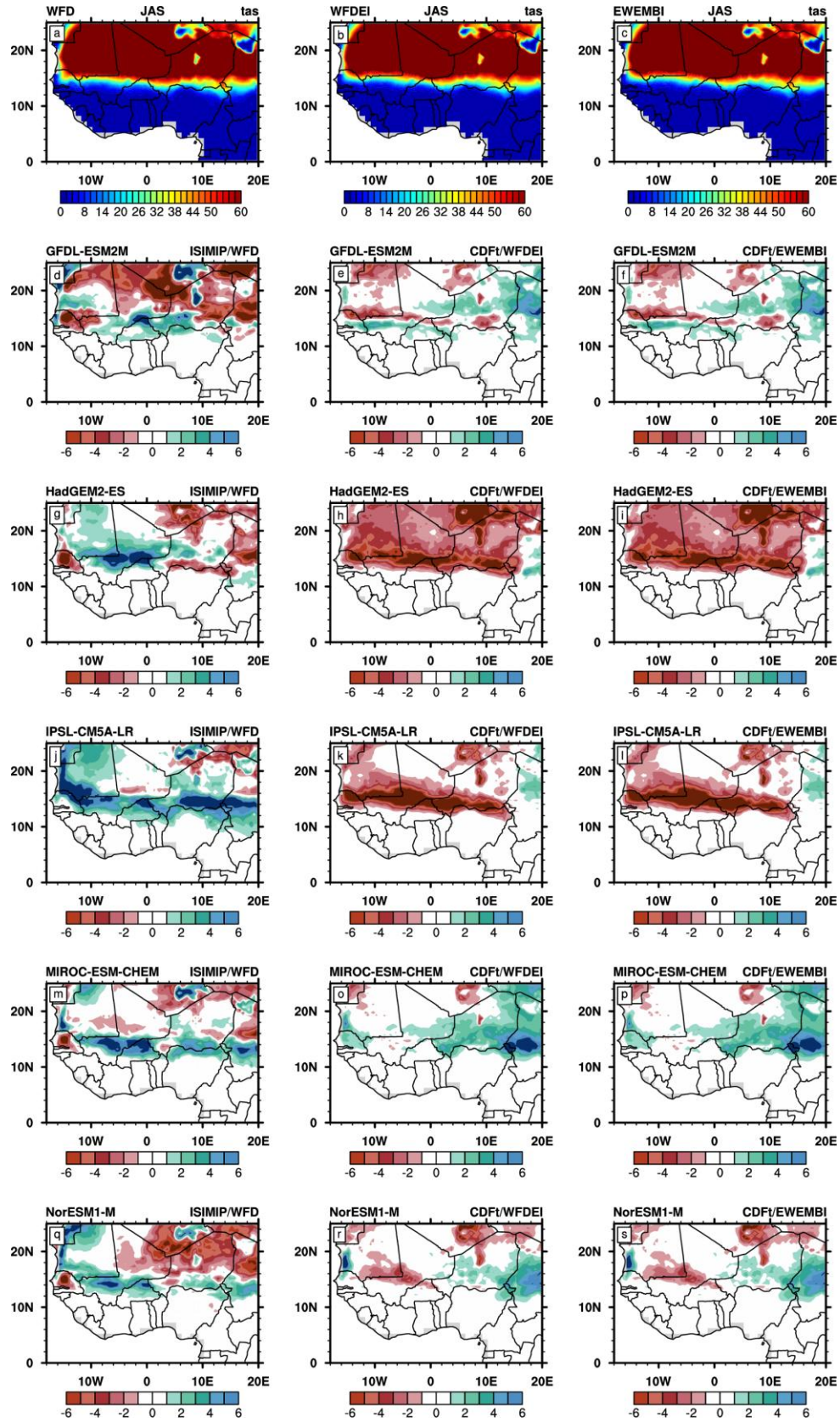


Figure 13 : Same as Figure 1 but for number of days where near-surface air temperature is greater or equal to 30°C.



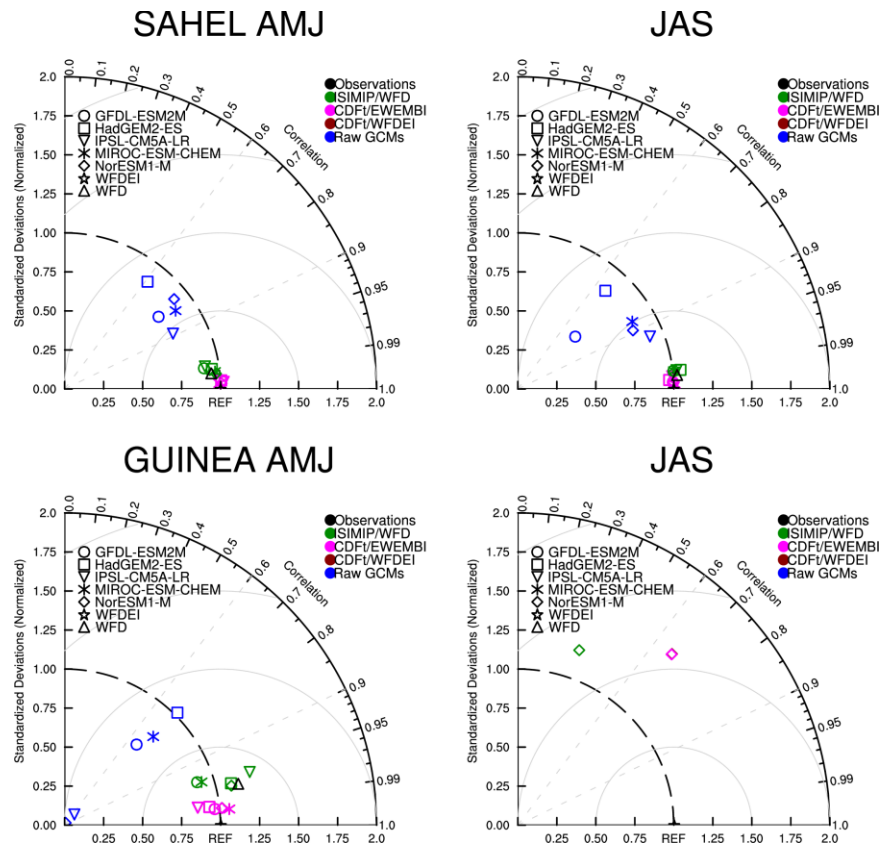


Figure 14 : Same as Figure 2 but for number of days where near-surface air temperature is greater or equal to 30°C.

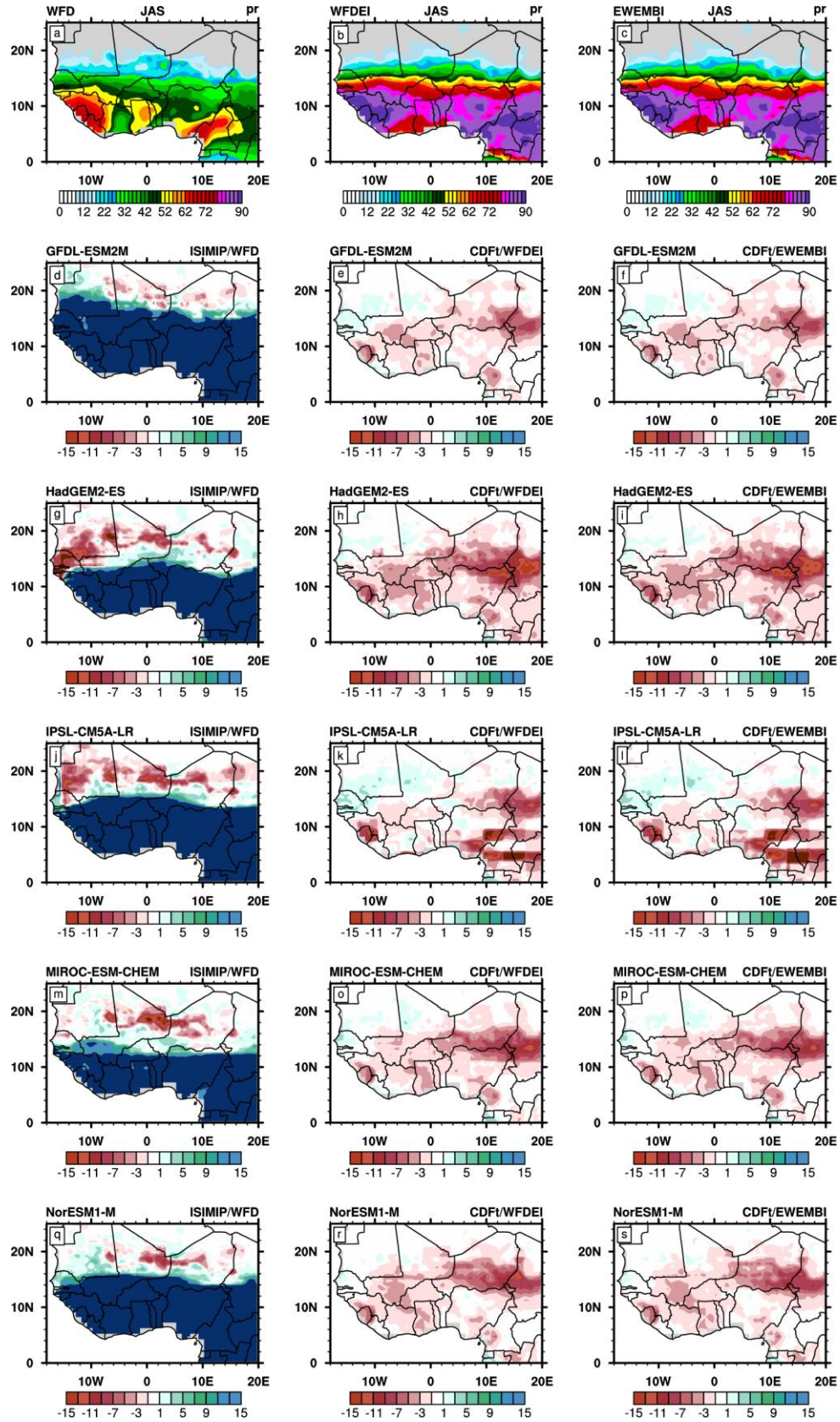


Figure 15 : Same as Figure 1 but for the number of wet days ( $pr > 1 \text{ mm/day}$ ).

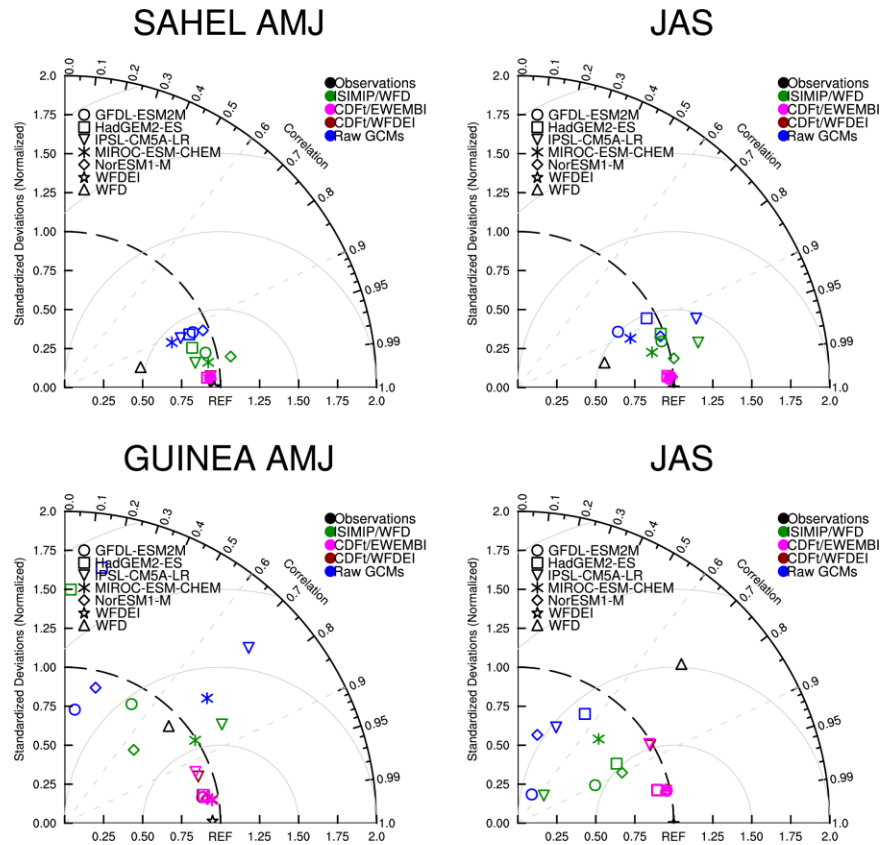


Figure 16 : Same as Figure 2 but for the number of wet days ( $pr > 1 \text{ mm/day}$ ).



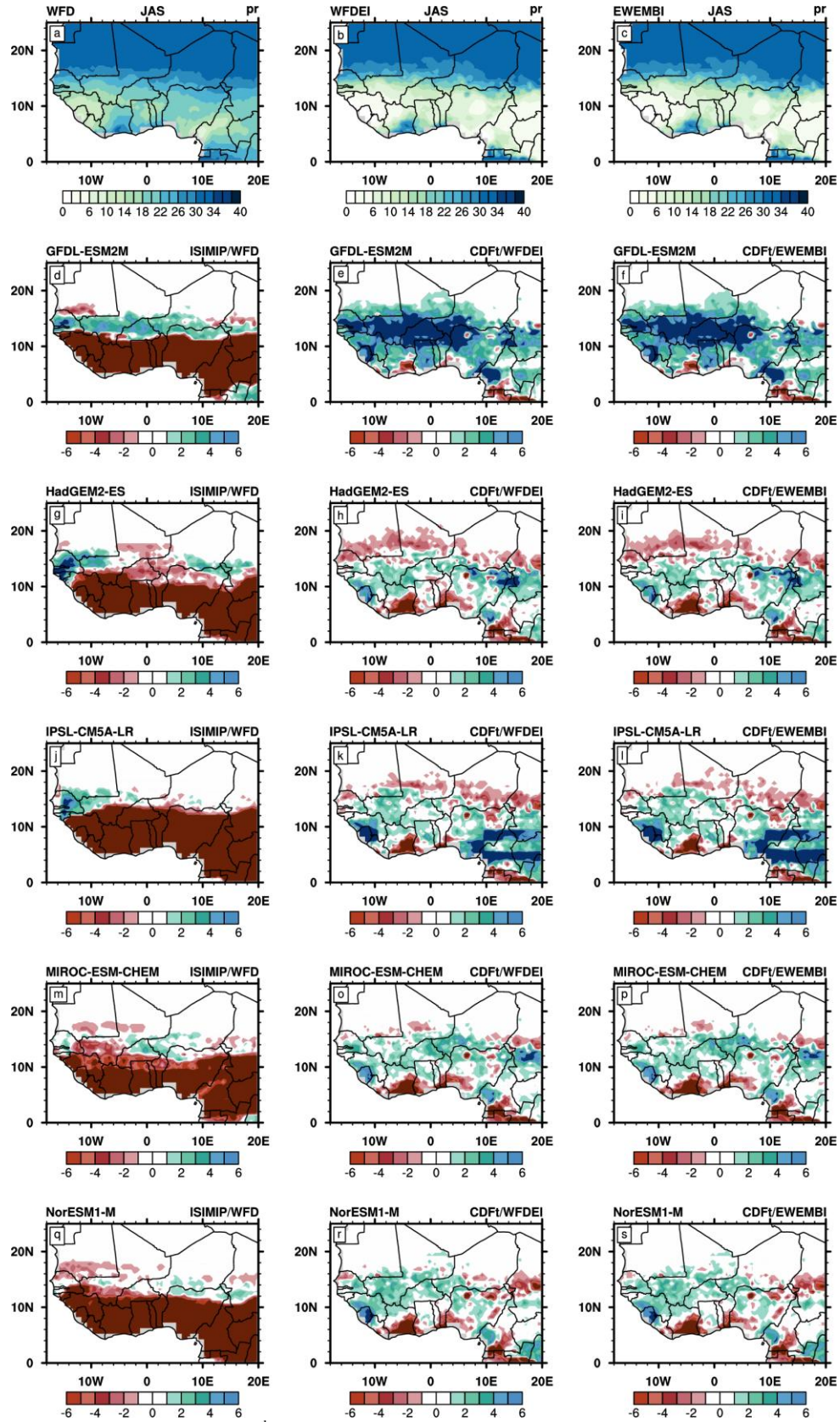


Figure 17 : Same as Figure 1 but for the 95<sup>th</sup> percentile of the number of consecutive dry days.

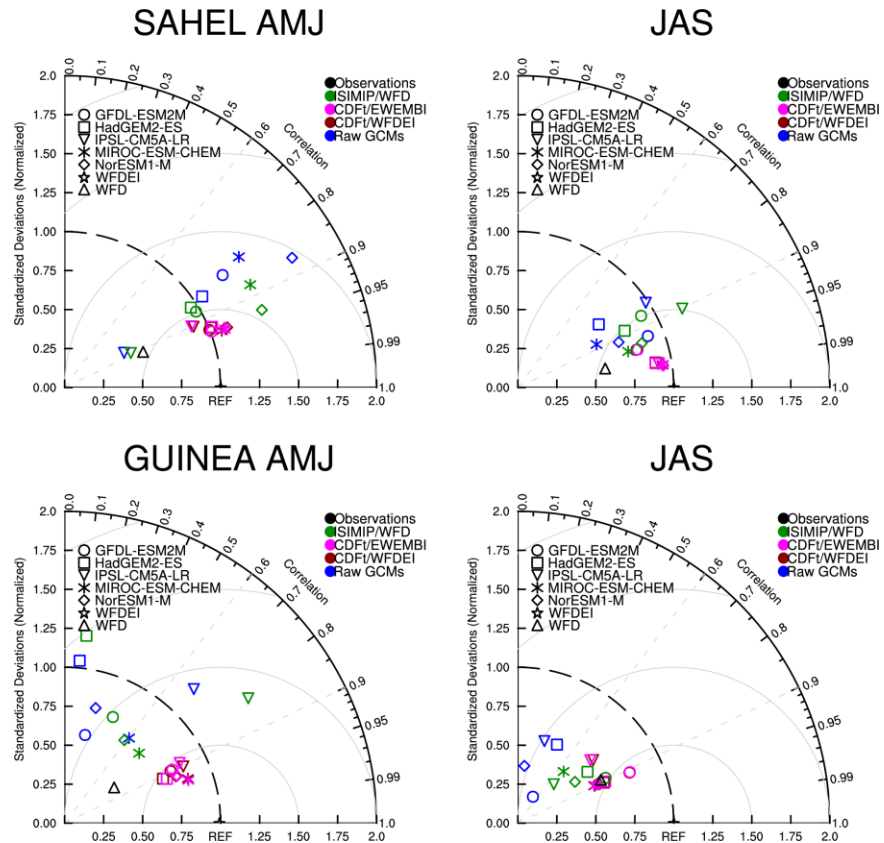


Figure 18 : Same as Figure 2 but for the 95<sup>th</sup> percentile of the number of consecutive dry days.