Reduction of CMIP5 models bias using Cumulative Distribution Function transform and impact on crops yields simulations across West Africa

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Objectives

- **We make this work in the framework of AMMA 2050 which is part of Future Climate for Africa (FCFA) program.**

- **One of the aims is to analyse climate projection of Africa around 2050 and impacts on agriculture and hydrology.**
  This is based on GCMs simulations that still have large biases.

- **So bias correction is necessary for Agronomical and hydrological use.**
  This has been done over Africa with:

GCMs: 29 CMIP5 GCMs
- Interpolate to WFDEI grid;
- Period of covering:
  Present period: 1950-2005
  Future period: 2006-2099
- Historical, RCP2.6, RCP4.5 and RCP8.5

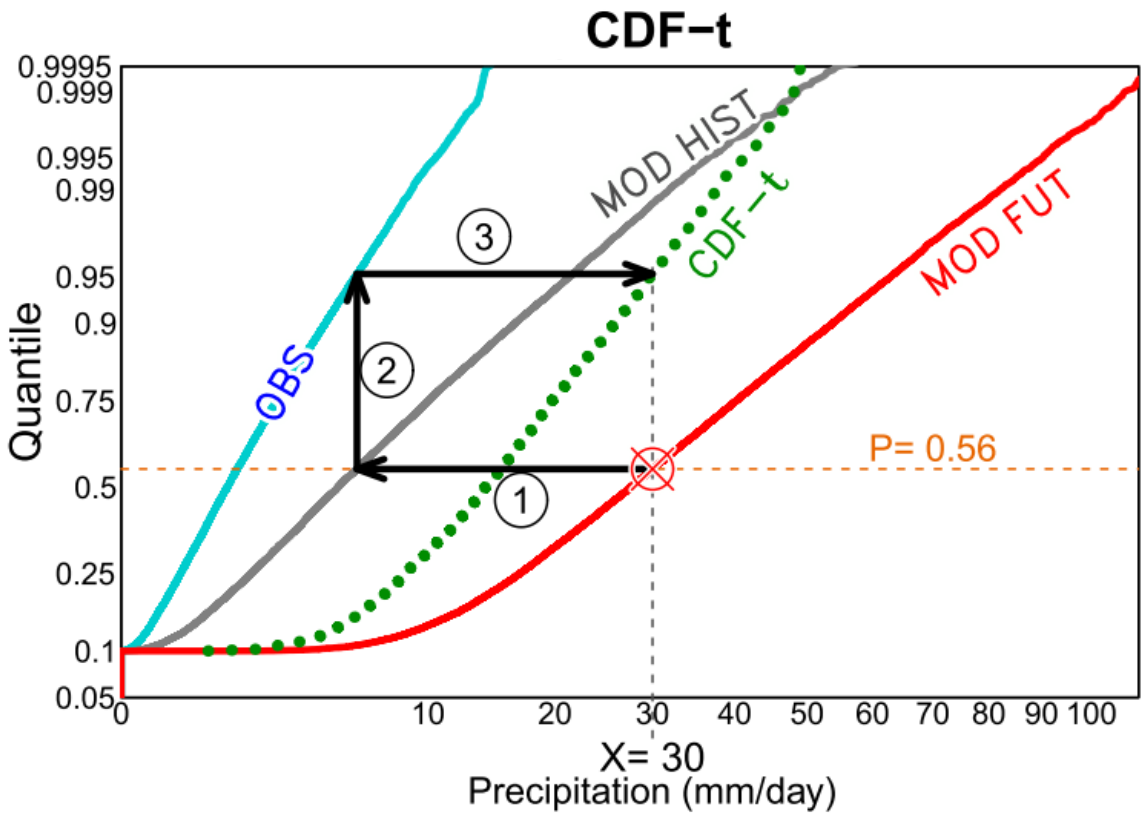
Reference data: WFDEI (new version of WFD)
- Grid: 0.5°x0.5°
- Period of covering: 1979-2013
- Variables: tas, tasmin, tasmax, pr, rsds and wind

- **Use of this bias correction on one GCM to predict crops yields over West Africa.**

  - ✓ **Validation of bias correction method using IPSL-CM5A-LR;**
  - ✓ **Impact on crops yields using Sarra-H.**

Cumulative Distribution Function-transform (CDF-t)

❑CDFt is developped by Michelangeli et al. (2009)



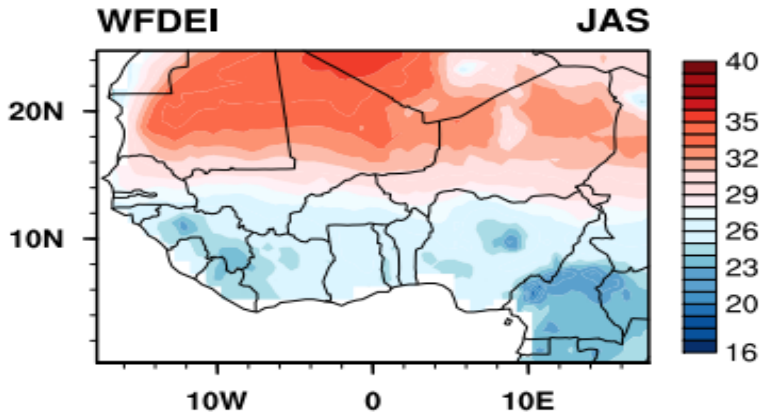
Schematic description of CDF-t (Fig.1.c, Pierce et al. 2015)

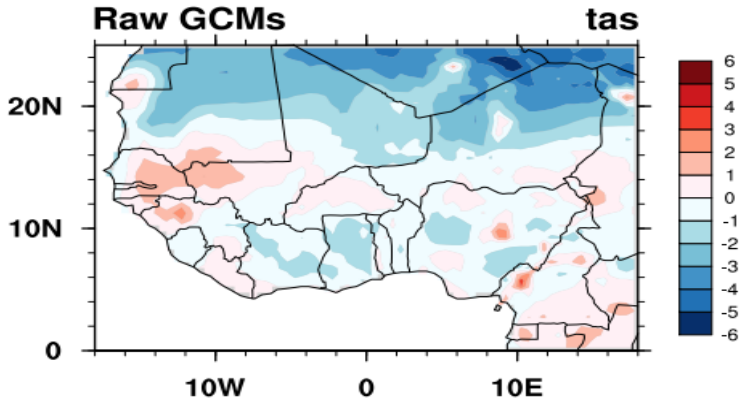
❑CDFt aims to relate the CDF of climate variable at large scale to the CDF of this variable at locale scale.

❑ CDFt has been widely used in many studies over differents regions (Vrac et al.,2012, Vrac et al.,2016; Oettli et al. 2011; Kallache et al., 2011).

Biases GCM-IPSL / WFDEI JAS

tas





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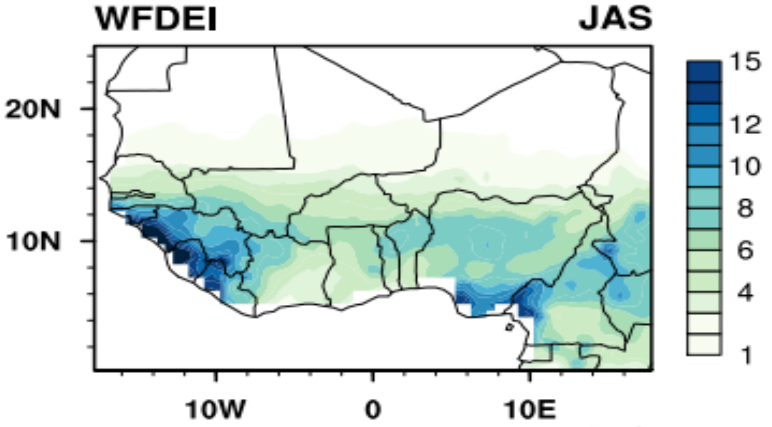
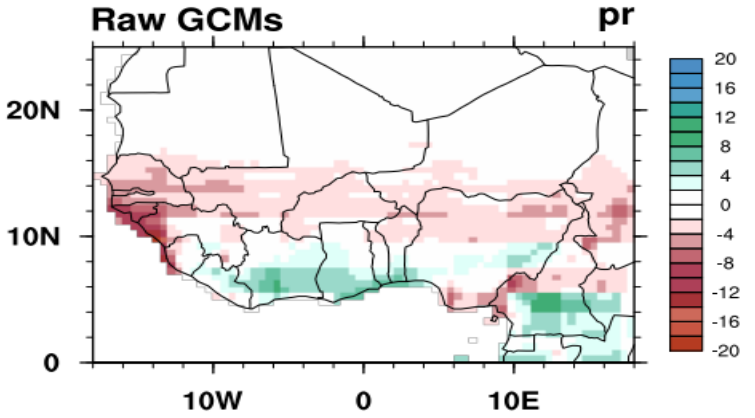
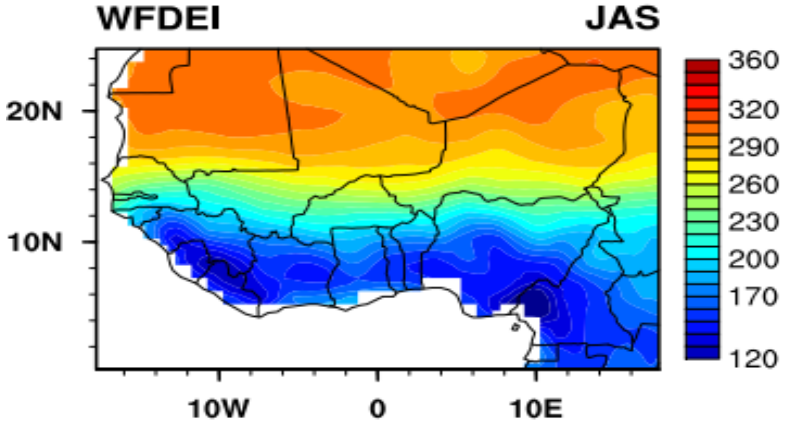
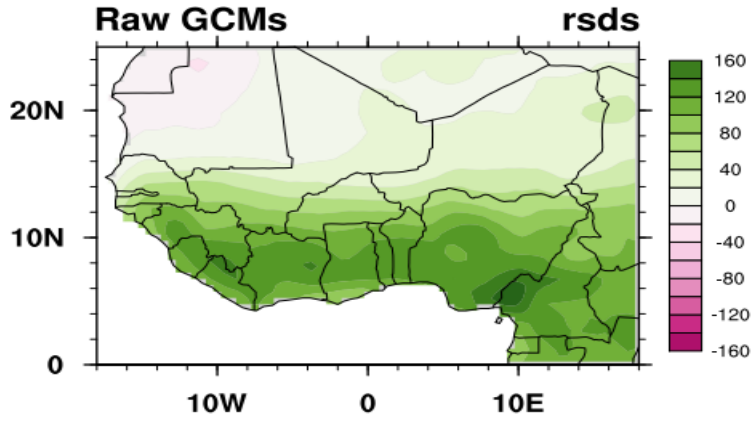




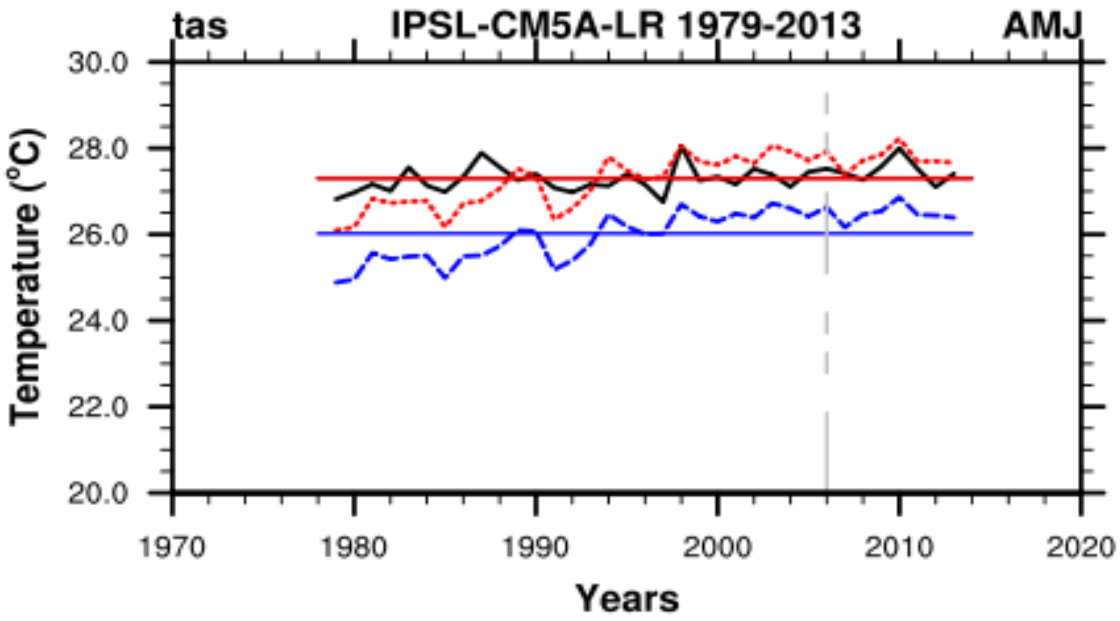
rsds





Raw vs BC IPSL data AMJ: Temperature

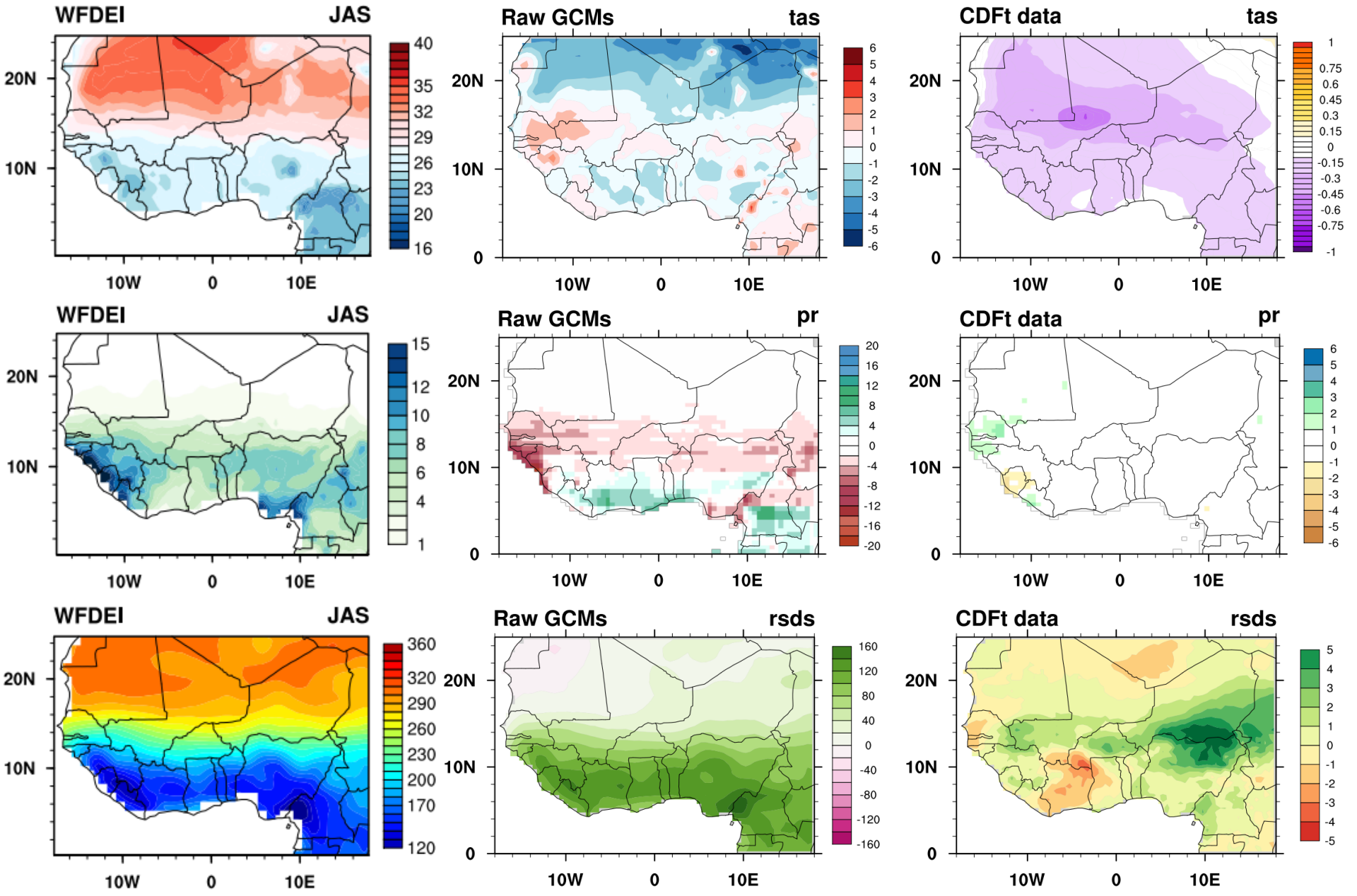
Guinean coast AMJ



Mean bias

	Calibration
IPSL (Raw)	- 1.29
IPSL (CDFt)	-0.01

Raw vs BC IPSL data JAS



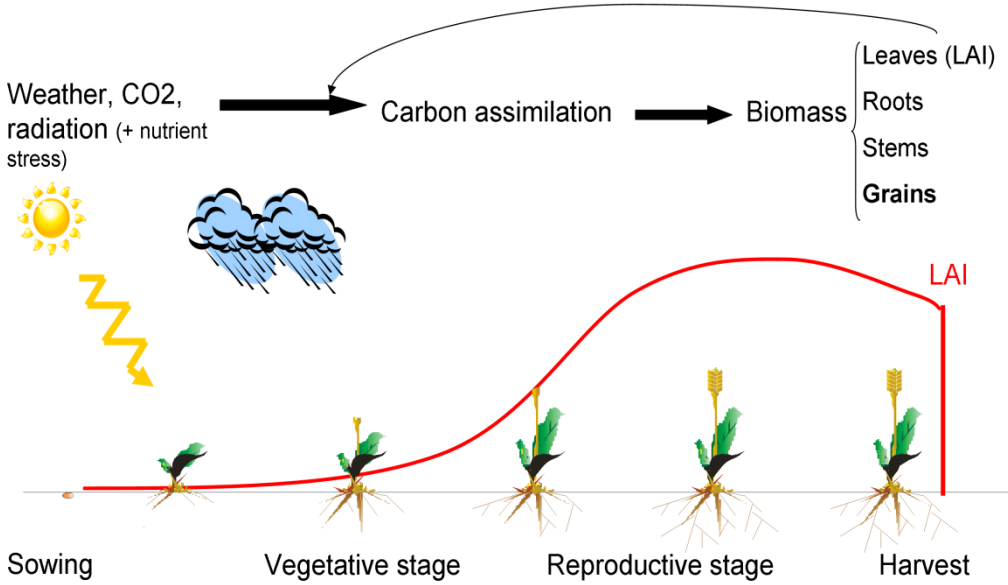
The Crop model Sarra-H

SarraH

Dingkuhn et al. (2003)

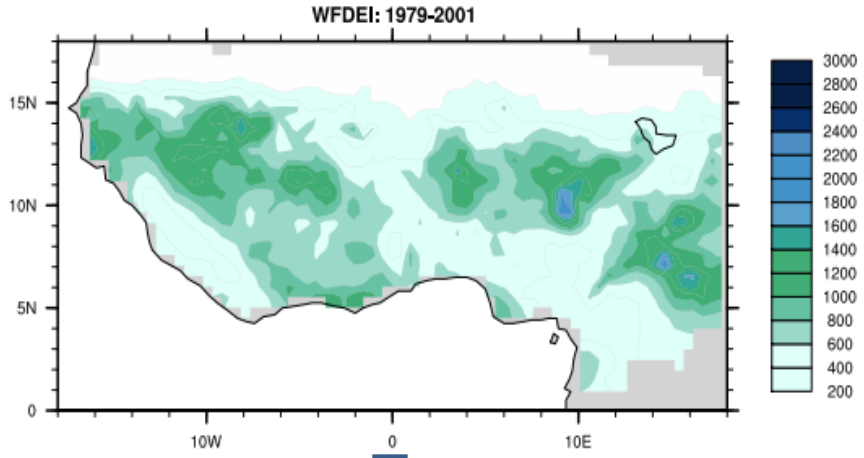
- **Water balance model** (water demand, soil water availibilty, stress index, critical phases)

- **Carbon assimilation and partionning** (radiation use efficiency, phenology, evolution of biomass and LAI)

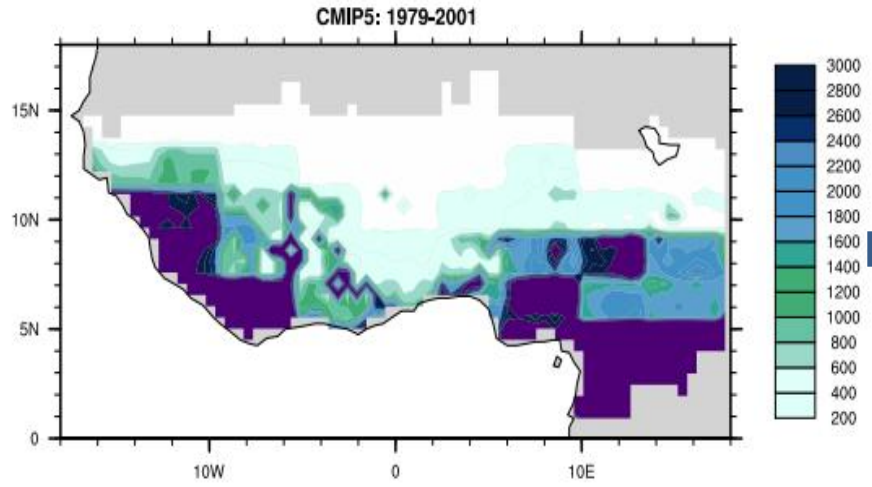


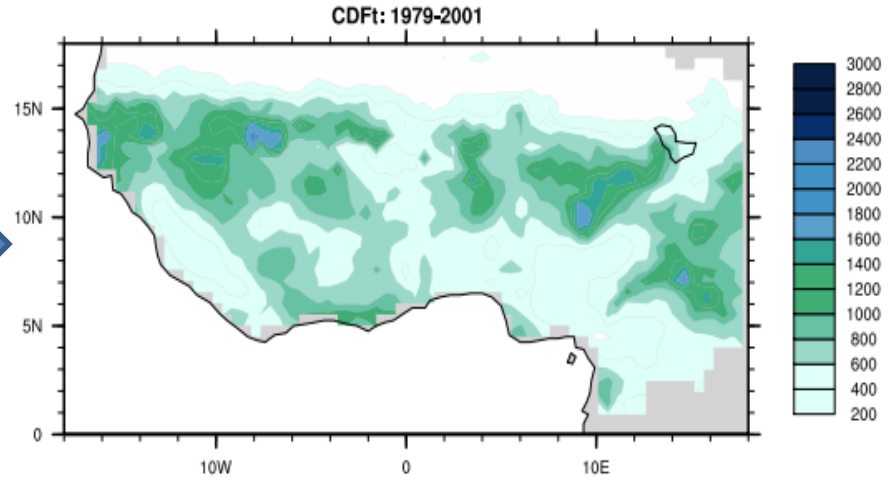
Crop yield mean: 1979-2001

CMIP5 MODELS → CDFt → CROP Model: SARRA-H



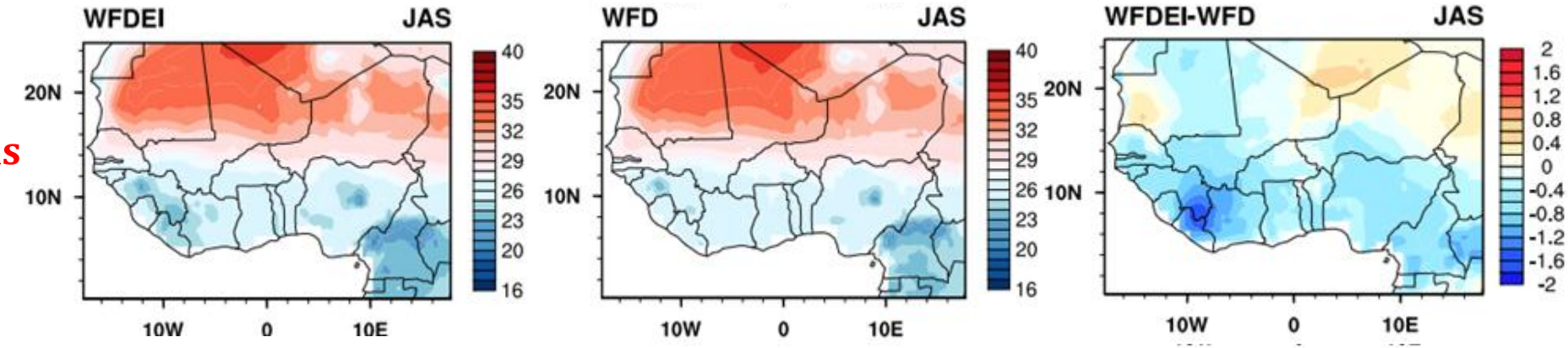
❑**Simulation driven by CDFt data produce better crop yield than those driven by raw GCMs data.**





JAS Climatology WFDEI vs WFD: 1979-2001

tas



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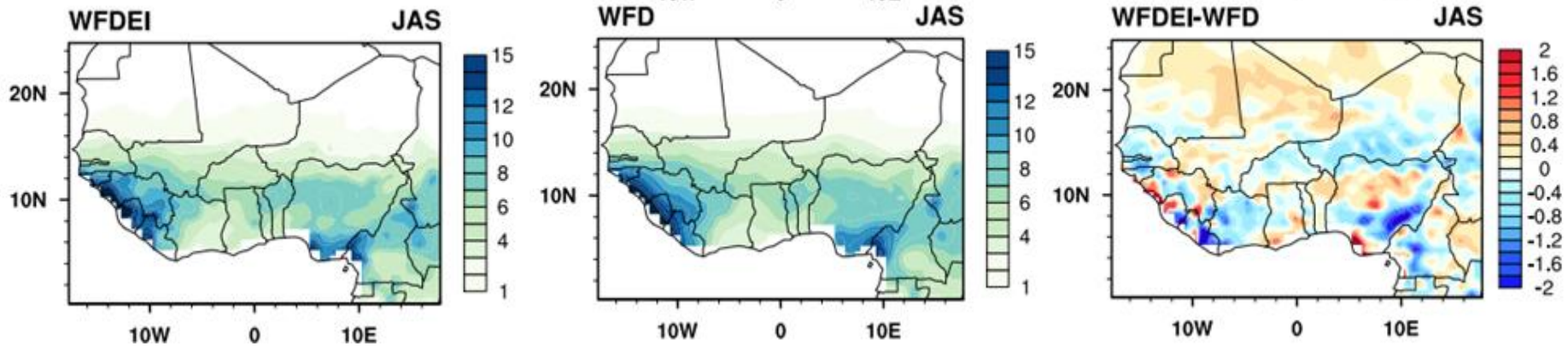
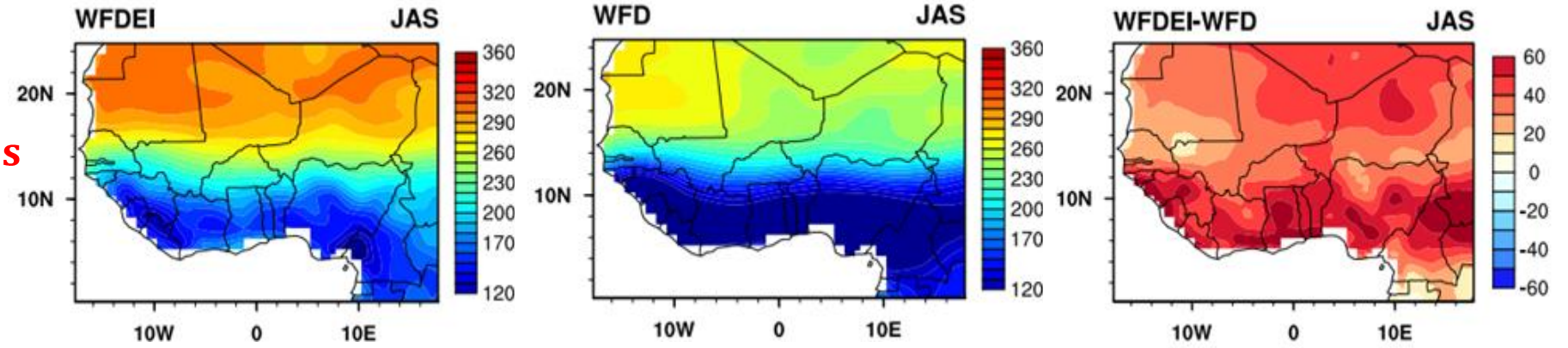
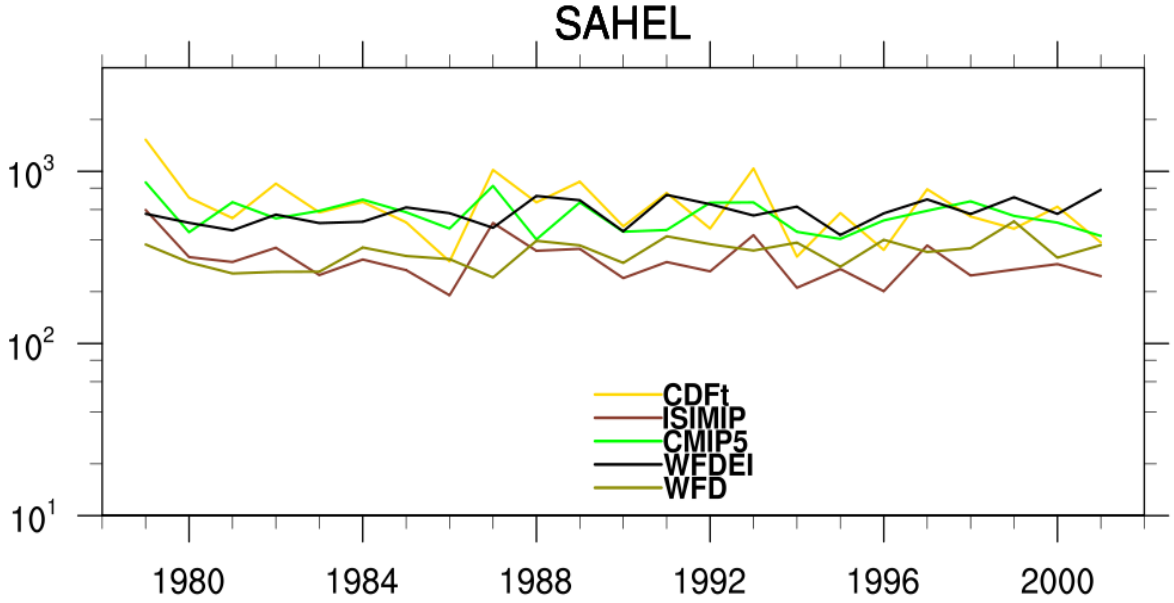


rsds

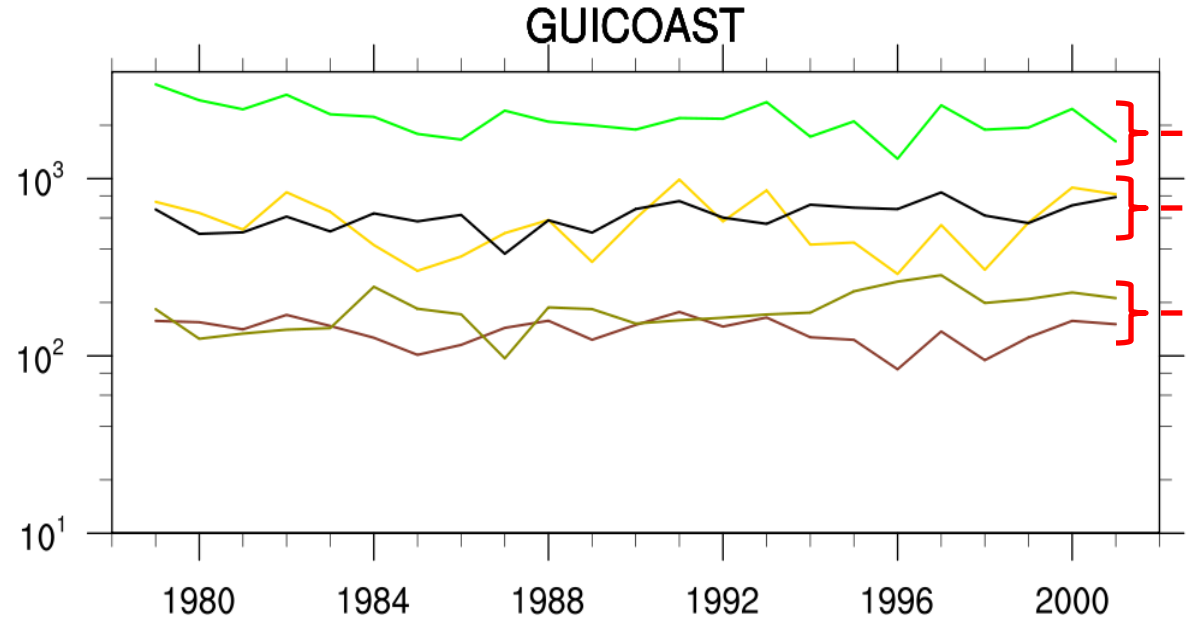


Crop yield Maize: Present day 1979-2001



Bias sensitivity experiments

	SAHEL	GUICOAST
WFDEIetp	21.06	23.75
WFDEIpr	29.23	-29.09
WFDEIrsds	48.61	40.74
WFDEItminmax	1.94	9.04
WFDEIWFDrsds	**-236.84**	**-462.17**
WFD	**-187.23**	**-425.42**

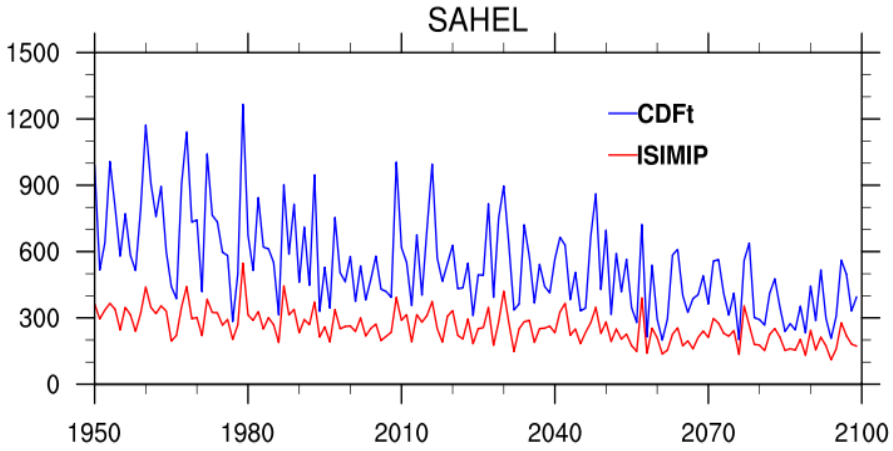


IPSL Raw data

IPSL CDFt data & WFDEI

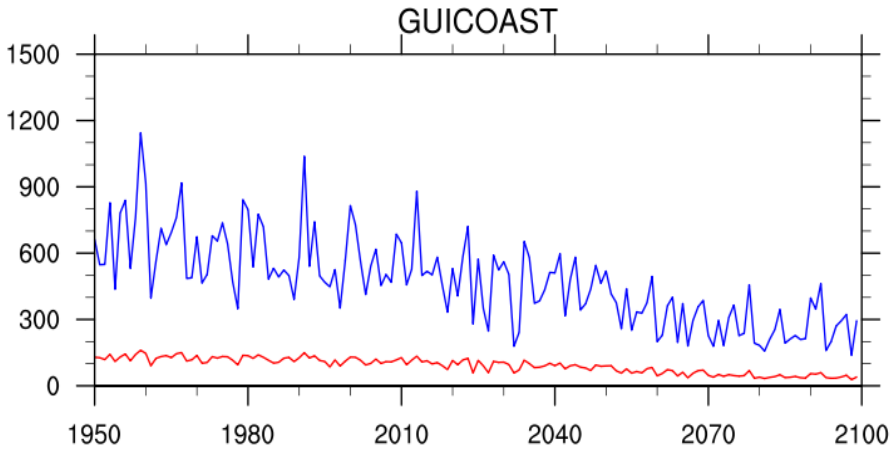
IPSL ISIMIP data & WFD

Crop yield Maize: Projections



Variance

	SAHEL		
	tas	**pr**	**rsds**
WFDEI	0.09	0.03	2.46
WFD	0.09	0.03	**3.30**
CMIP5	0.27	0.01	3.08
CDFt	0.29	0.06	**4.23**
ISIMIP	0.28	0.04	2.05



Variance

	GUINEAN COAST		
	tas	**pr**	**rsds**
WFDEI	0.05	0.06	5.35
WFD	0.05	0.08	**10.68**
CMIP5	0.15	0.03	3.15
CDFt	0.21	0.17	**12.02**
ISIMIP	0.18	0.05	0.77

CONCLUSION

Results

- Bias correction performed over Africa on 29 GCMs (1950-2099).
  - ✓ CDF-t corrects well mean state of variables ;
  - ✓ CDF-t preserves models trend;
  - ✓ CDF-t improves crop yield simulation;

- Crop model is sensitve to input data mainly to surface radiation;
- Crop model shows decreasing crop yields over West Africa (RCP8.5)

On going works

- Crop yield simulation with Sarra-H driven by 29 GCMs (historical,RCP2.6, RCP4.5 and RCP8.5)
- Explore the question of time of emergence with BC Data;
- ISIMIP2 project which use new version of data: EWEMBI (Lange et al., 2016)

Thank you!