How to assess CMIP5 and Cordex projections of climate change in west Africa ?

Frédéric Hourdin, Françoise Guichard, Abdoul Khadre Traore, Benjamin Sultan, Bertrand Muller, Salack Seyni, Dominique Bougniol, Florence Favot, Catherine Rio, Fleur Couvreux, Jean-Yves Grandpeix, Remy Roca, Marine Bonazola, Youssouph Sane, Philippe Roudier and Lidia Mellul
(LMD/IPSL, CNRM, Locean, Cirad, Isra)

1. Global Climate Modeling and the CMIP5 exercise
2. Representation of the present-day mean climate
3. Assessment in terms of decadal variability
4. Scale issues
5. Conclusionss

Main conclusion

- CMIP5 models have not reached yet a degree of maturity which makes it possible to rely on them directly to anticipate climate changes and their impact, especially for rainfall over West Africa
- There is no reason to "believe" regional models (Cordex) more than global (CMIP5).
- Any use of climate model results needs a specific phase of assessment and understanding of climate modeling
- For "impacts", specific methodologies much be developed which start from robust elements of the climate simulations, when they exist

Illustrations based on

- CMIP5 multi-model simulations
- Ensemble simulations with the IPSL-CM model
- Regional simulations from the AMMA-Ensemble european project
- Impact oriented assessment with Sarrah

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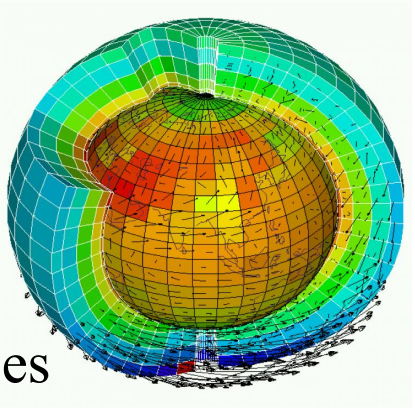


Global Climate Models (or ESM) characteristics

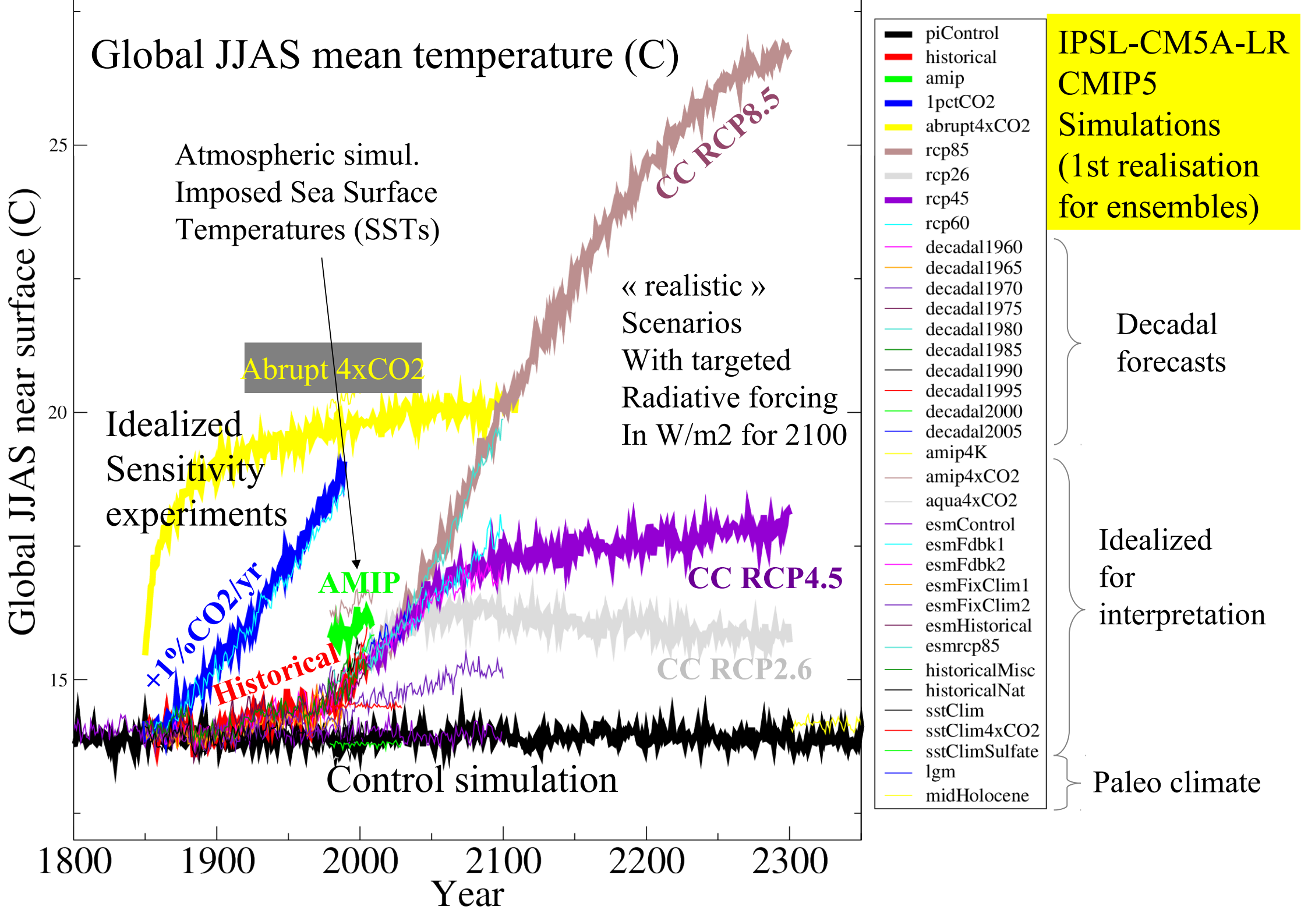
- Based on conservation laws of physics
- Self-consistent
- Global but coarse grid (grid cells of 30 – 250 km)
- Approximate : numerical issues, parameterization of subgrid-scale processes
- Partially tuned with respect to present-day observations (radiative balance)

Use for CMIP

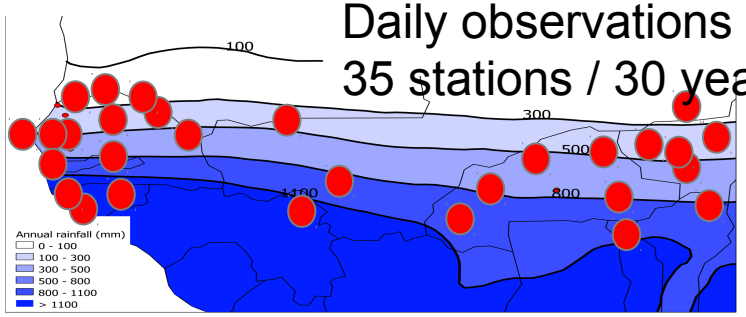
- Atmosphere coupled to ocean or forced by sea surface temperature
- Composition (greenhouse gases, aerosols, ozone) :
  * imposed (issued from other simulation) or interactive
  * present-day or evolving
- Initial state : issued from long control experiments or initialized for decadal forecasts

CMIP5 core experiments

- “amip”: 1979-> 2009, Forced by sea temperature (SSTs), CO2, aerosols, ozone
- “control” : coupled with ocean, constant forcing
- “historical” : 1850->2009, with varying forcing as observed
- “1pctCO2” : idealized scenario +1% CO2/year
- “rcpX” : scenario for future, imposed concentrations, effective forcing X W/m2 in 2100


Global JJAS mean temperature (C)
Global JJAS near surface (C)
Year
1800
1900
2000
2100
2200
2300
15
20
25
Atmospheric simul.
Imposed Sea Surface
Temperatures (SSTs)
Abrupt 4xCO2
Idealized
Sensitivity
experiments
+1%CO2/yr
AMIP
Historical
Control simulation
CC RCP8.5
« realistic »
Scenarios
With targeted
Radiative forcing
In W/m2 for 2100
CC RCP4.5
CC RCP2.6
piControl
historical
amip
1pctCO2
abrupt4xCO2
rcp85
rcp26
rcp45
rcp60
decadal1960
decadal1965
decadal1970
decadal1975
decadal1980
decadal1985
decadal1990
decadal1995
decadal2000
decadal2005
amip4K
amip4xCO2
aqua4xCO2
esmControl
esmFdbk1
esmFdbk2
esmFixClim1
esmFixClim2
esmHistorical
esmrcp85
historicalMisc
historicalNat
sstClim
sstClim4xCO2
sstClimSulfate
lgm
midHolocene
IPSL-CM5A-LR
CMIP5
Simulations
(1st realisation
for ensembles)
Decadal
forecasts
Idealized
for
interpretation
Paleo climate

From climate change to impacts : an example of use of CMIP results

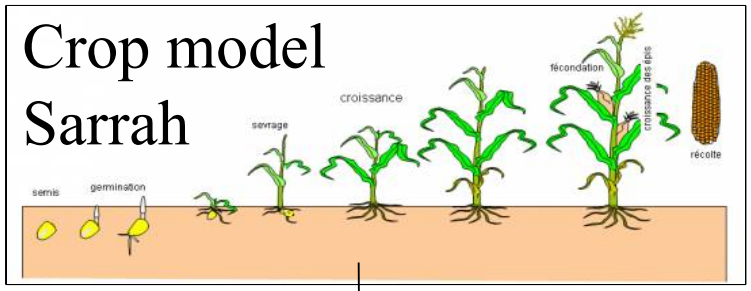


Climate change : Delta method

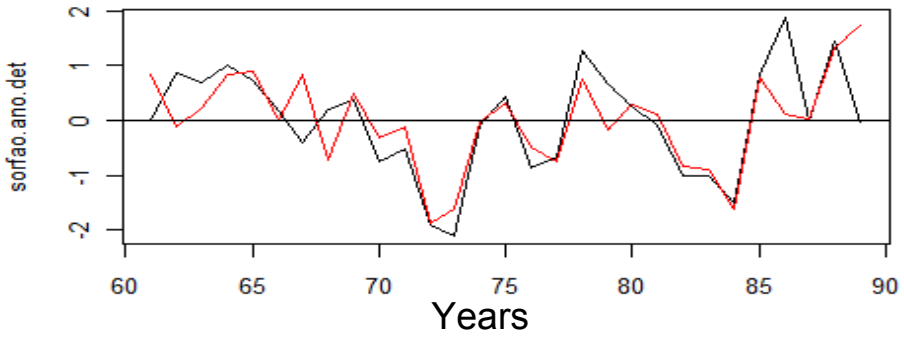
Δ+ T2m (observed 2m temperature)

(1+Λ) x P (Precipitation)

P, T2m(av/min/max), RH2m, SW

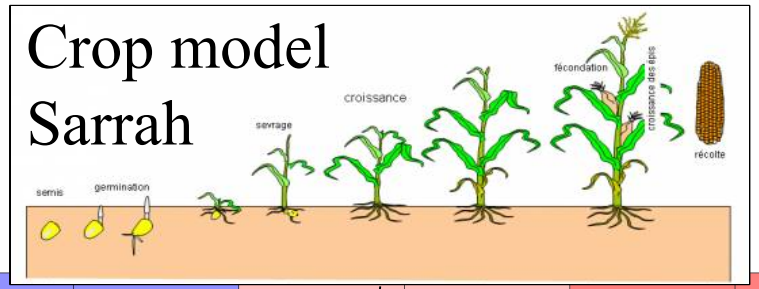


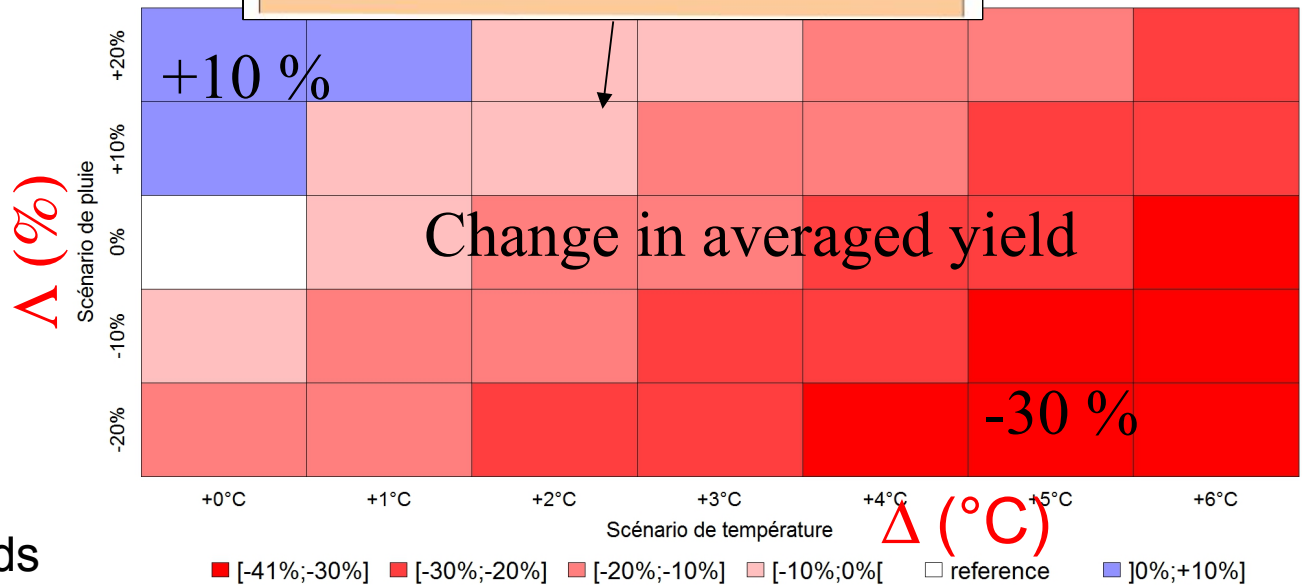
SORGHO (R=0.71)



Correlations of Sarrah results vs FAO yields

(1+Λ)xP, Δ+T2m(av/min/max)+, RH2m, SW



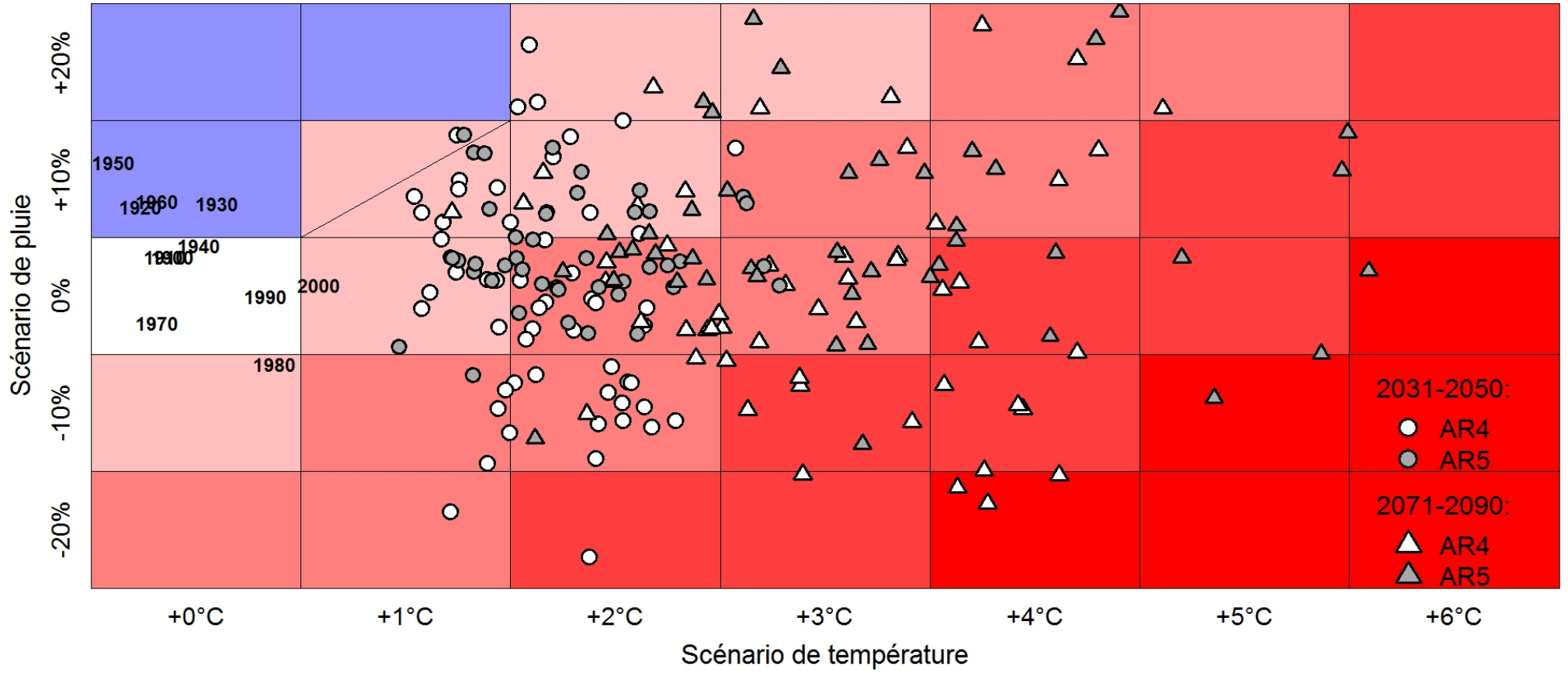


➢ Average over: 6 varieties, 35 stations, 30 years

Traoré, S. B., Alhassane, A., Muller, B., Kouressy, M., Somé, L., Sultan, B., Oettli, P., Siéné L., Ambroise C., Sangaré, S., Vaksmann, M., Diop, M. Dingkhun, M., Baron, C. (2010)

From climate change to impacts : an example of use of CMIP results

Change of crops potential yields over Sahel



- Change in rainfall very uncertain within +/- 20%
- Warming in all the simulations. Sign is “robust”, amplitude uncertain (factor 2).
- Dispersion quite similar in CMIP3 (AR4) and CMIP5 (AR5) simulations

Which confidence to those results ? Assessment of CMIP5 simulations.

P. Roudier, B. Sultan et al. (2010)

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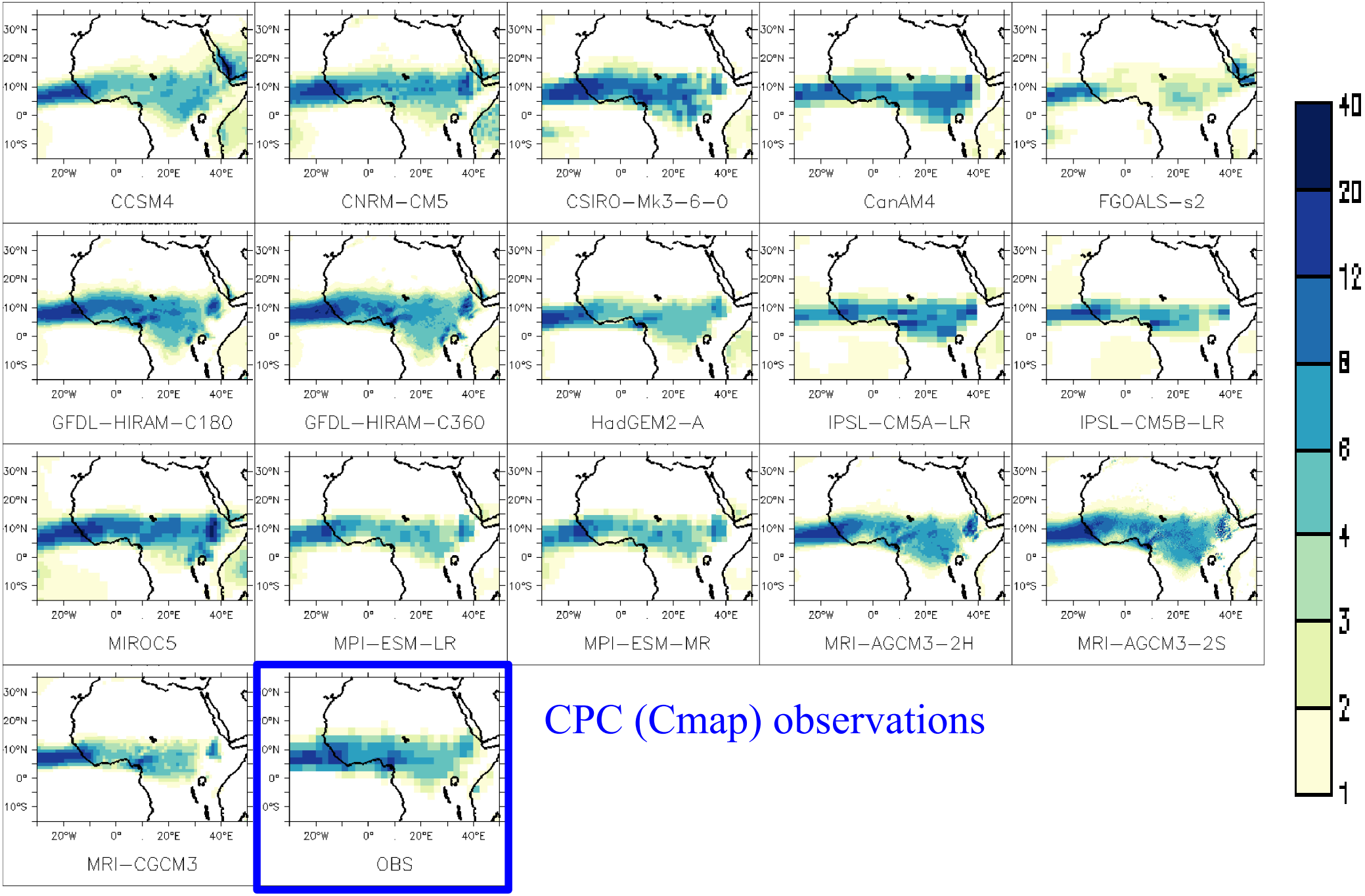
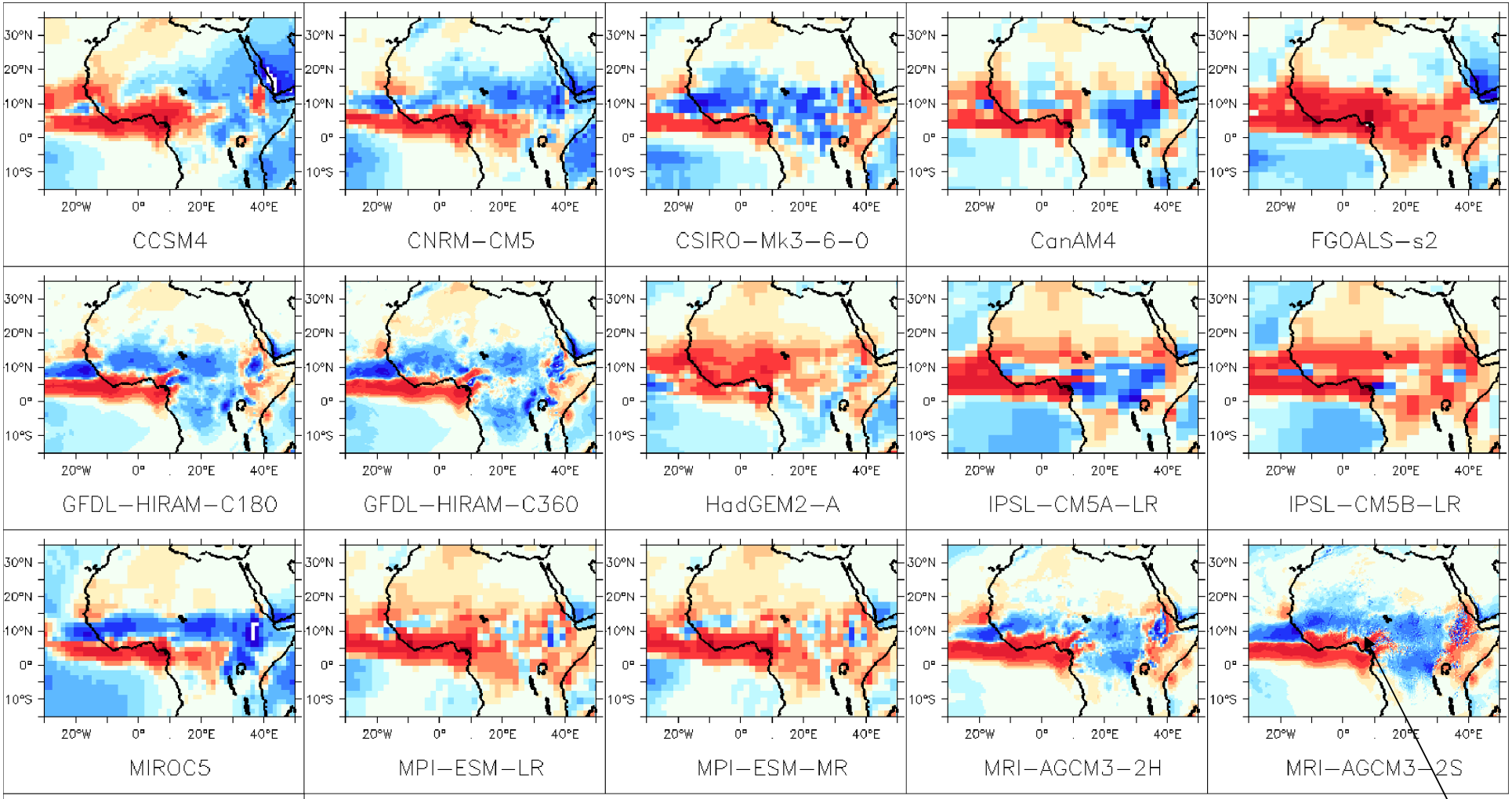
JJAS mean precipitation 1980-1999 (mm/day)
Imposed-SST (amip) simulations



CPC (Cmap) observations

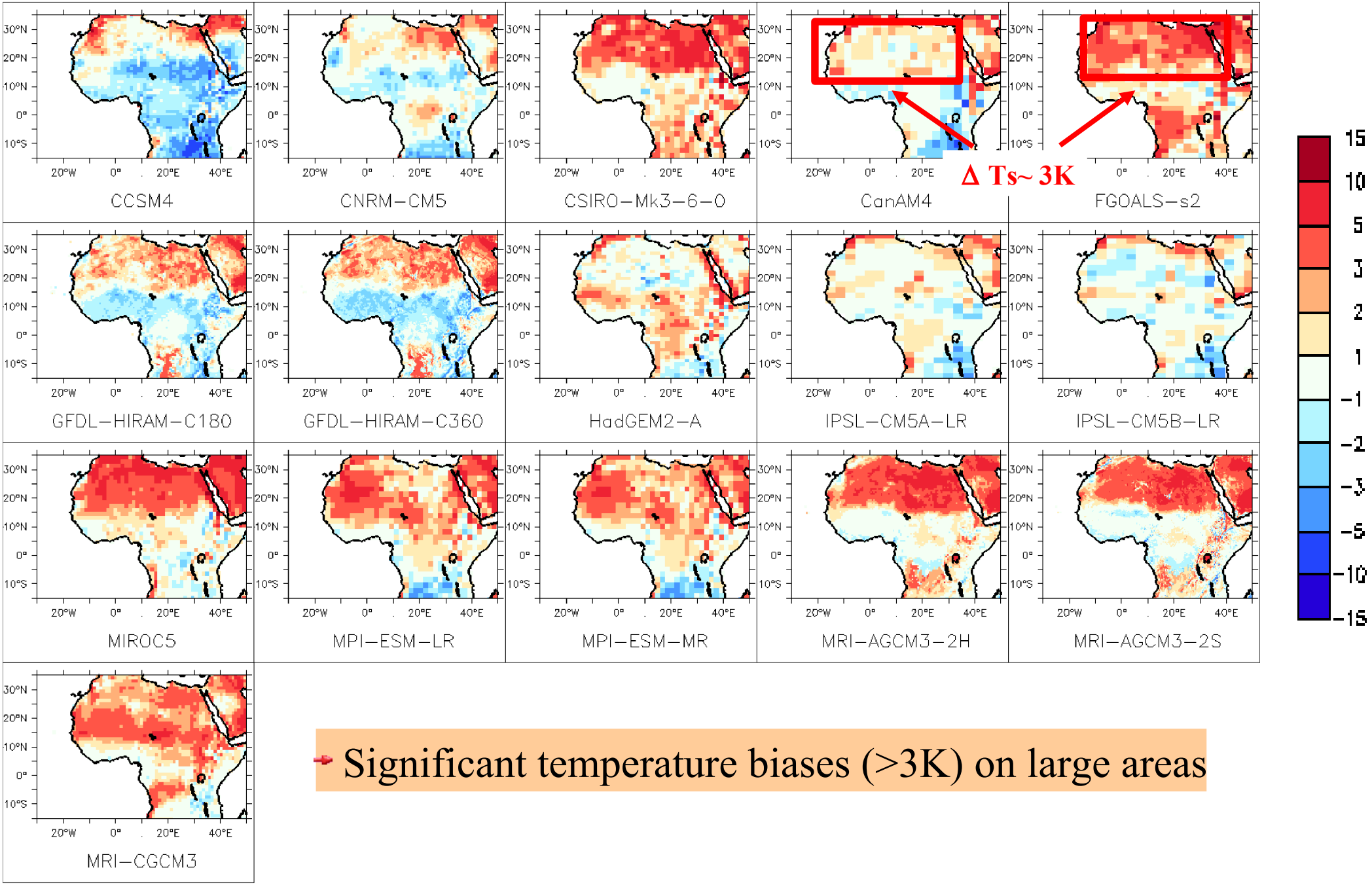
JJAS mean precipitation bias (versus CPC) 1980-1999 (mm/day)
Imposed-SST (amip) simulations



- Strong biases in the mean rainfall (mm/day)
- Not systematic
- Not much improvement with respect to CMIP3
- No systematic improvement from grid refinement

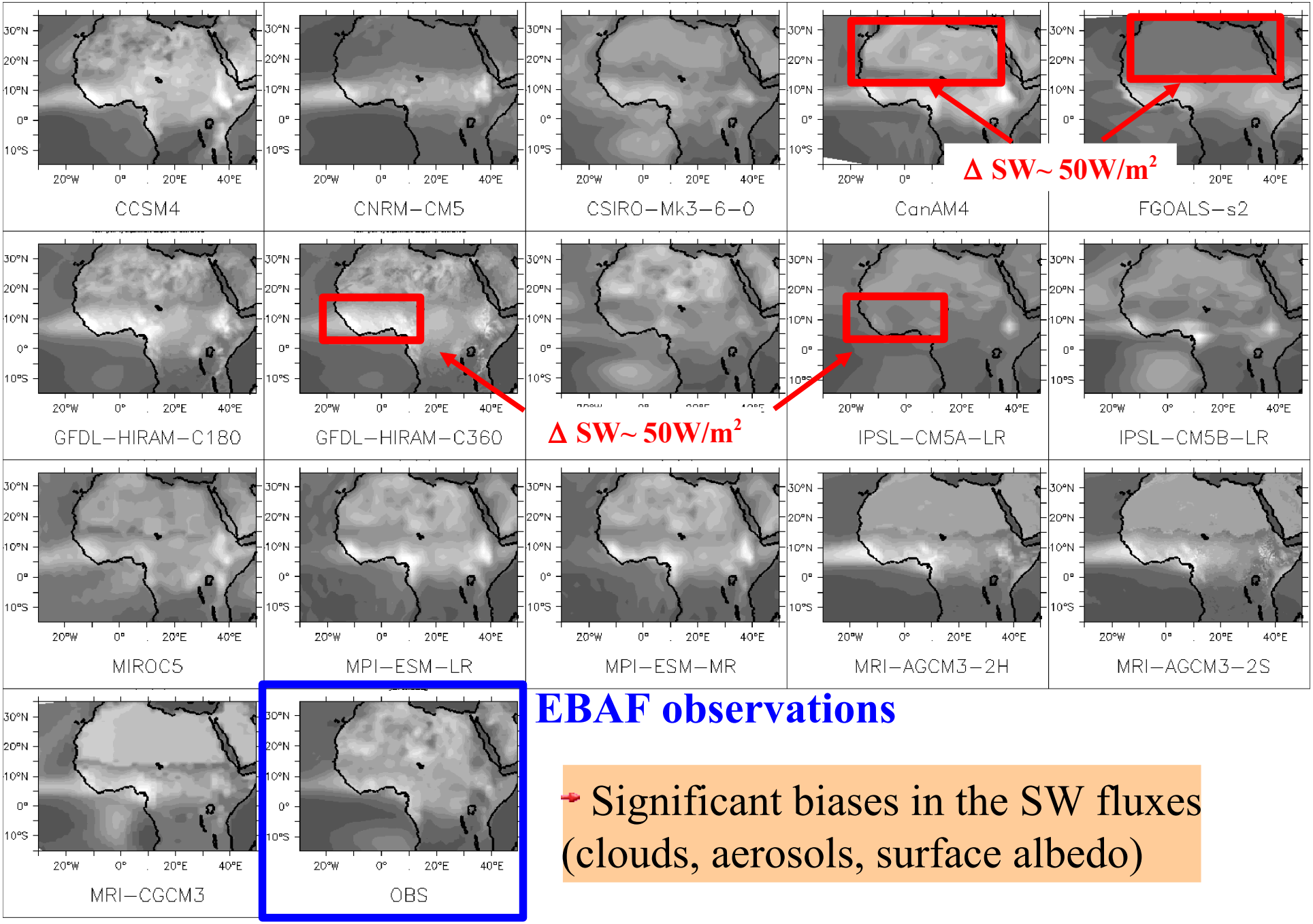
Grid cell
20 km

JJAS mean biases in JJAS mean T2m (/CRU) 1980-1999 (K)
Imposed-SST (amip) simulations



- Significant temperature biases (>3K) on large areas

JJAS mean outgoing (reflected) SW radiation top-of-atmosphere 1980-1999 (W/m^2)



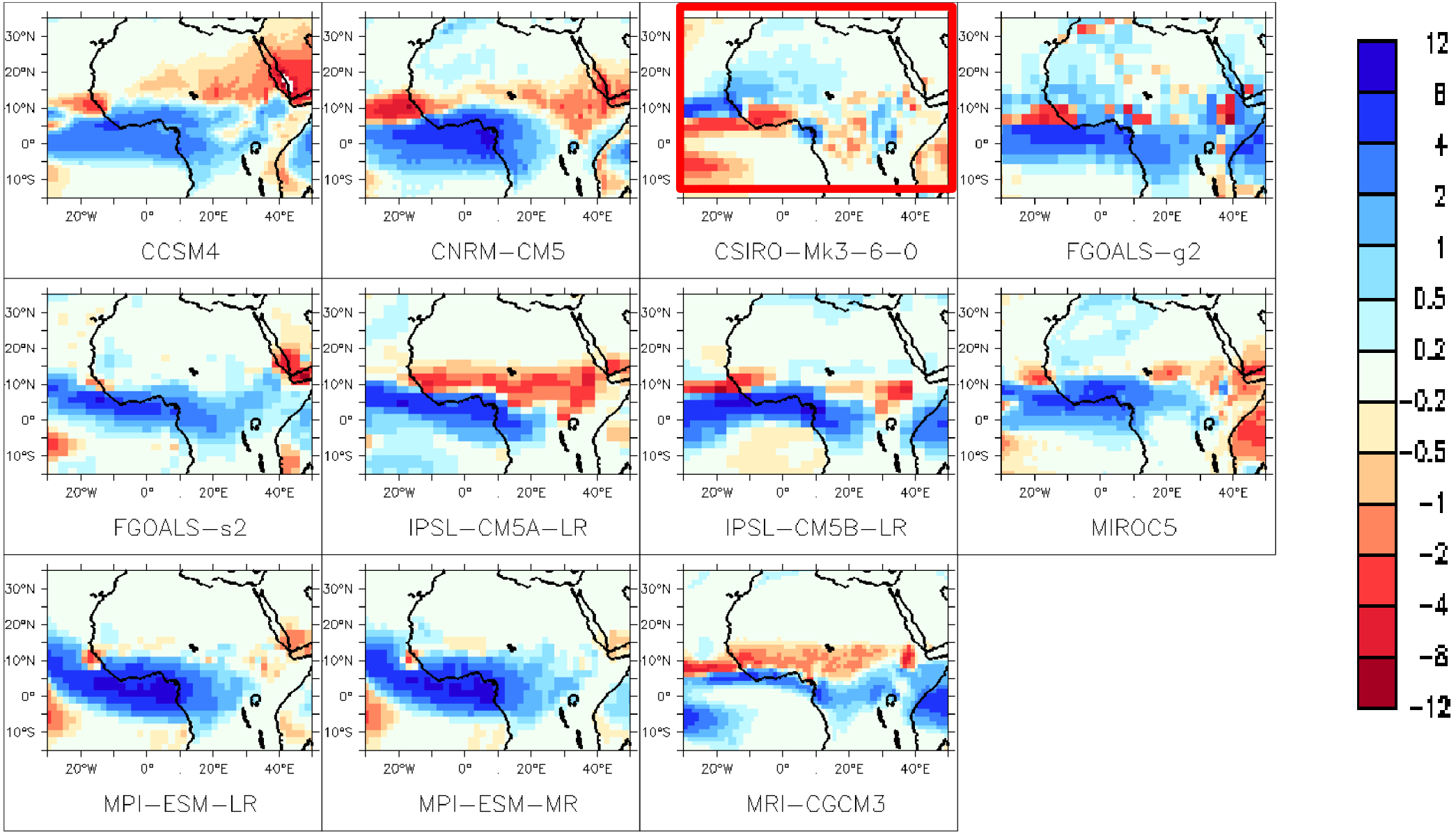
EBAF observations

- Significant biases in the SW fluxes (clouds, aerosols, surface albedo)

Impact of coupling with the ocean on the JJAS mean precipitation (mm/day)

Difference : **(coupled ocean-atmosphere) – (imposed SSTs)**

"historical" - amip

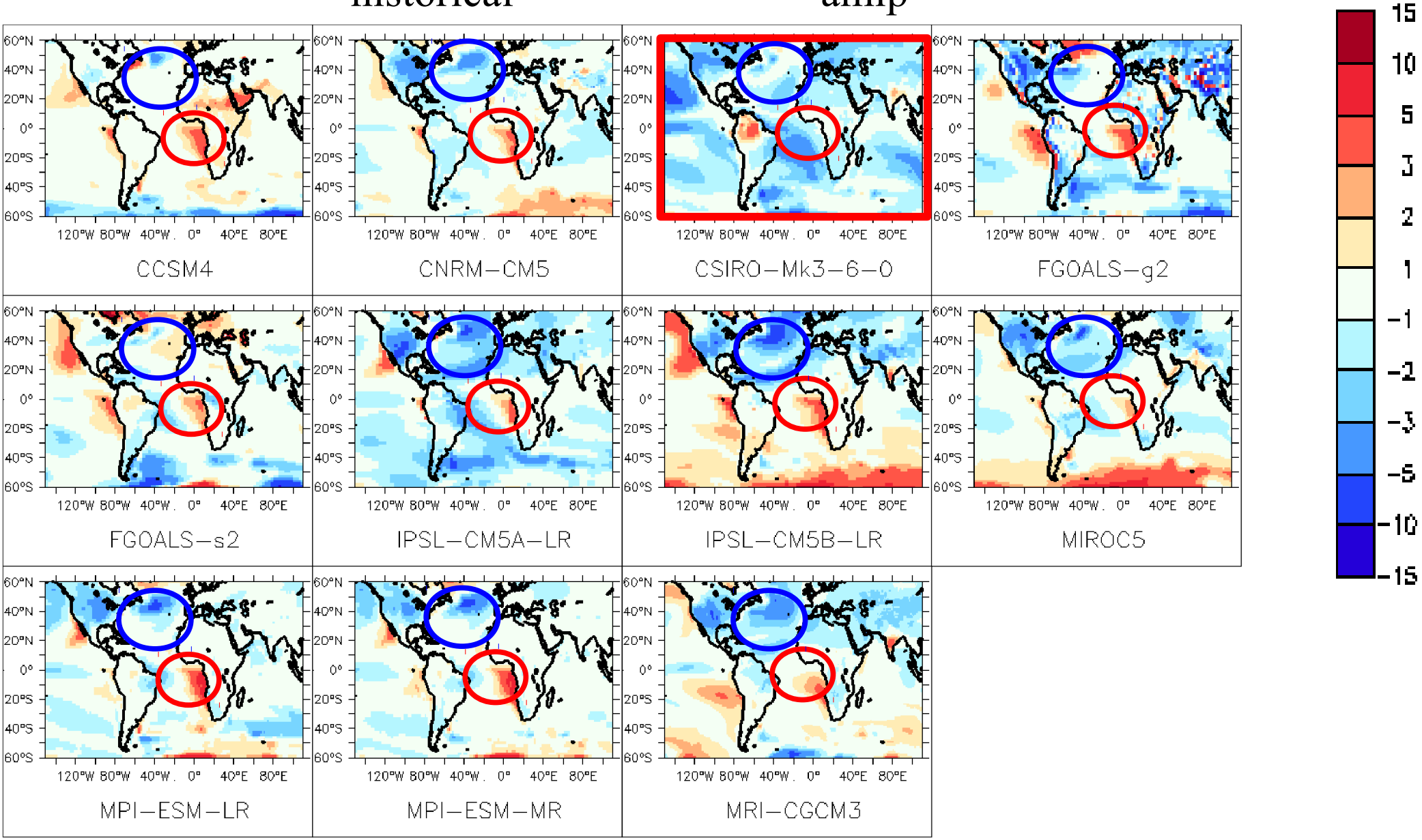


- Coupling with ocean is at the origin of large biases on the regional rainfall

Impact of coupling with the ocean on the JJAS mean 2m temperature (K)

Difference : **(coupled ocean-atmosphere) – (imposed SSTs)**

"historical" - amip



- Large and robust biases in Sea Surface Temperature (SST) at the origin of rainfall biases

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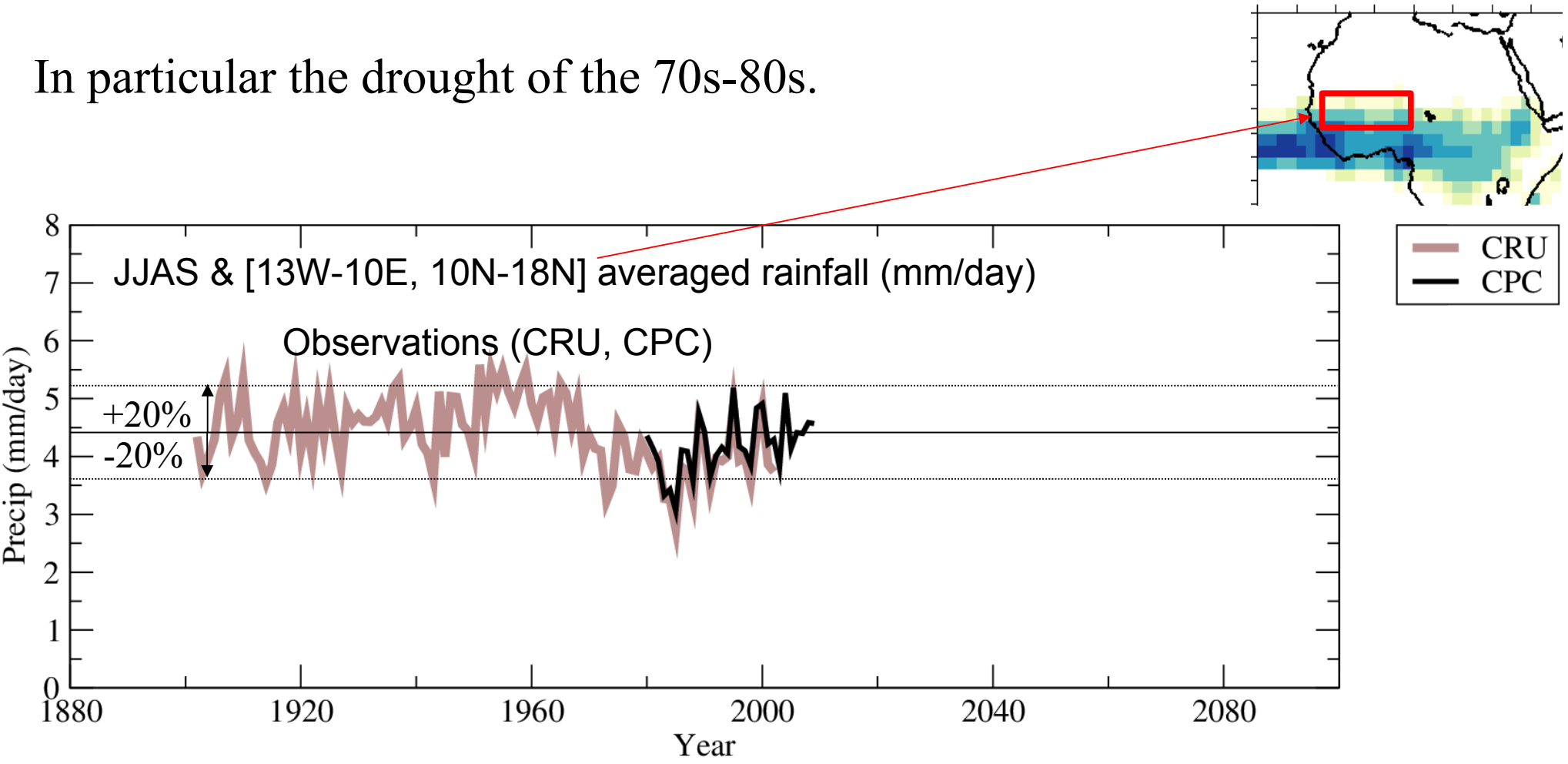
Are the model able to represent the climate variability of the past decades ?

In particular the drought of the 70s-80s.



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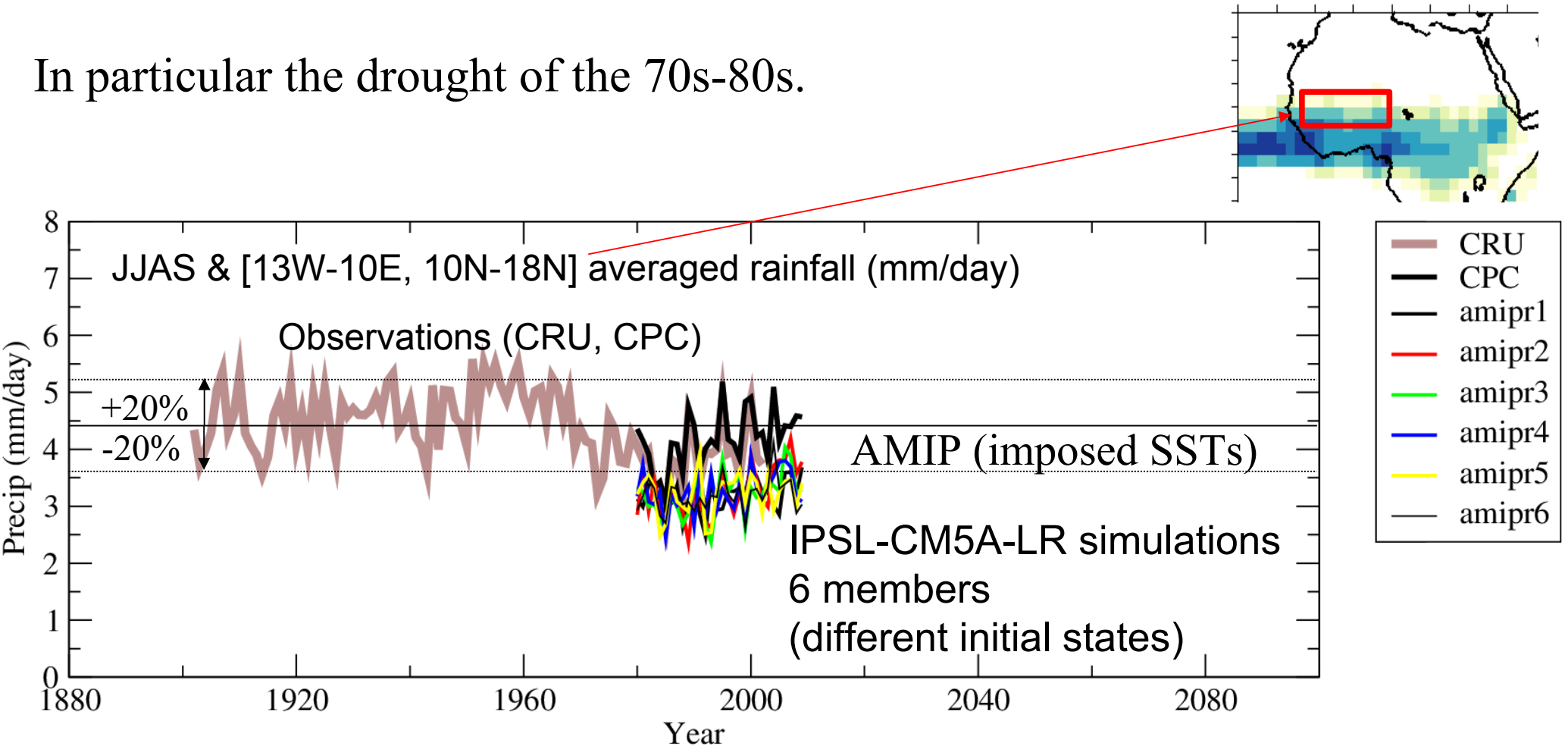

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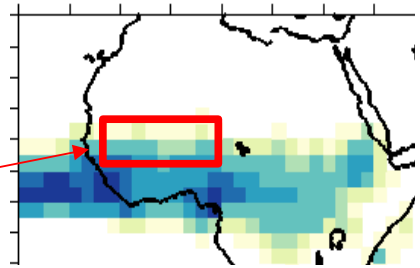
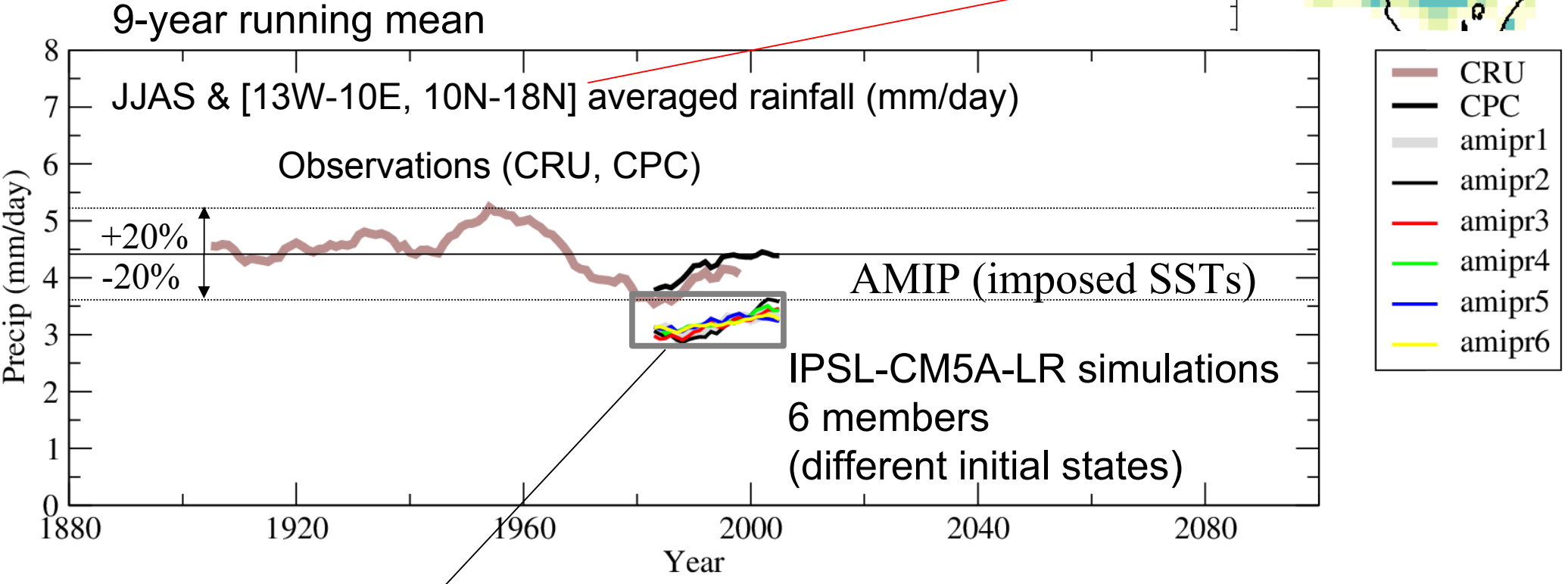
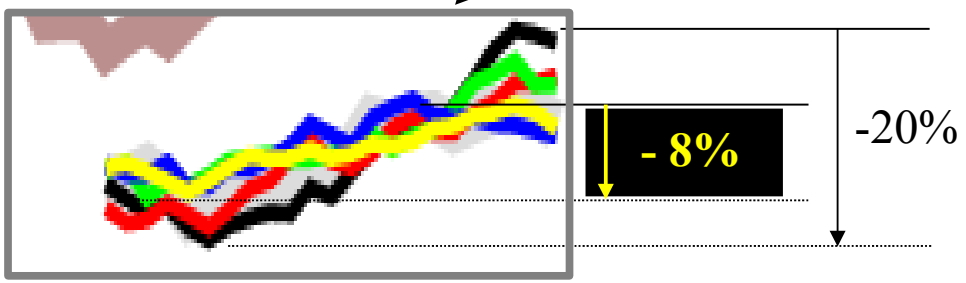
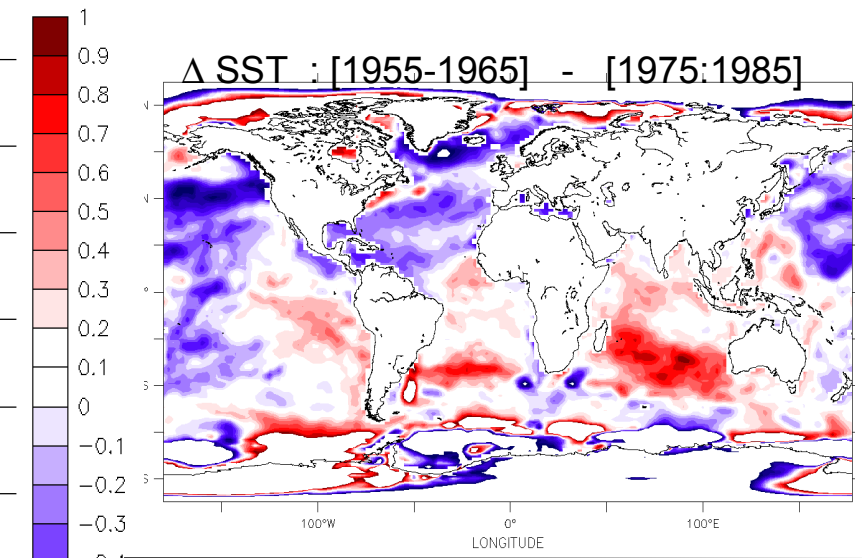


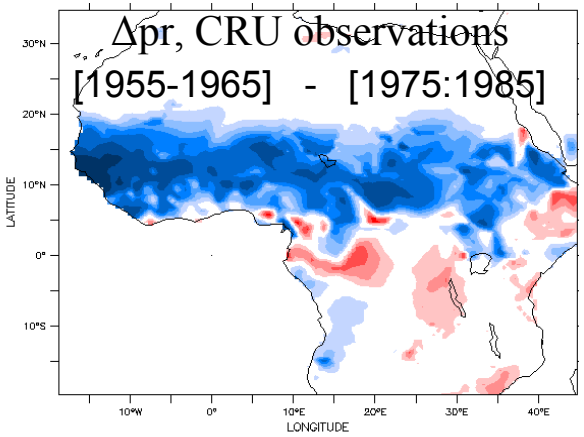




- IPSL ensemble simulations show some tendency to recovery from 1979 to 2009
- Amplitude depends on the particular member
- Interest for 1950-2009 simulations



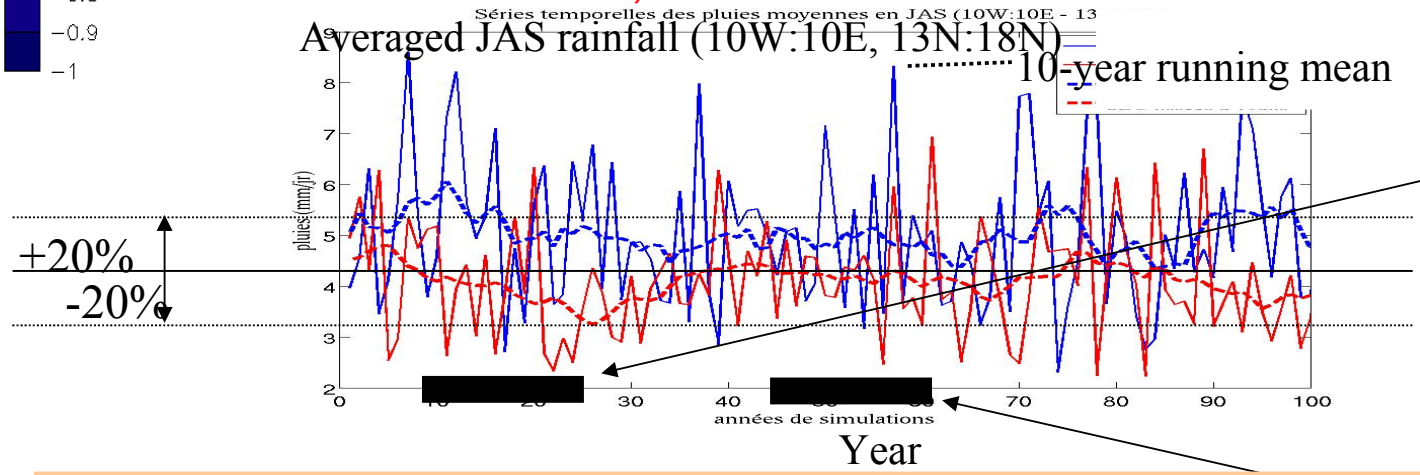
1975-1985 :
Warm SSTs in the south
Drought over Sahel

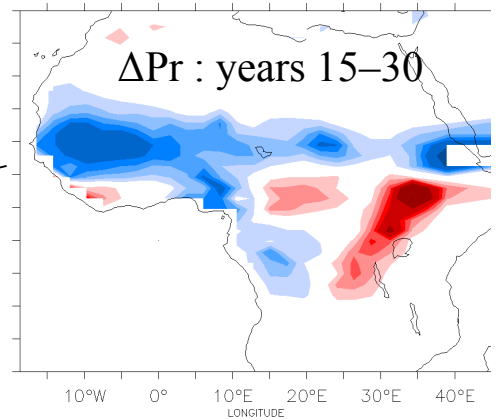


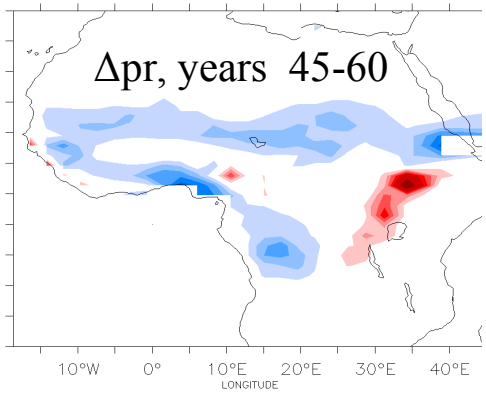
Idealized experiments with IPSL-CM5A-MR, Imposed SSTs, mean seasonal cycle

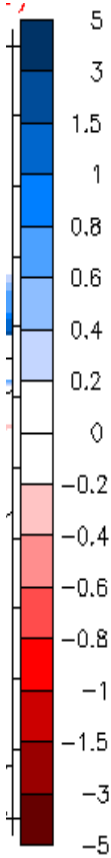
— « MOIST » simulation, SST 1955-1965

— « DRY » simulation, SST 1975-1985



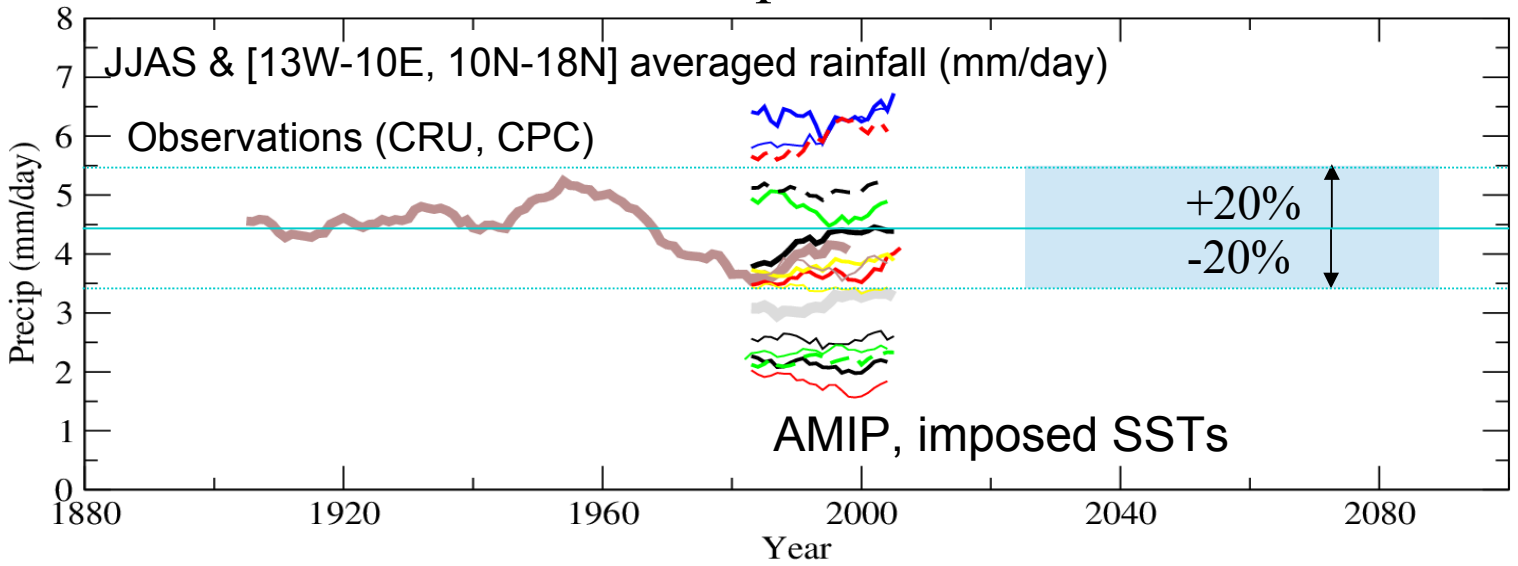


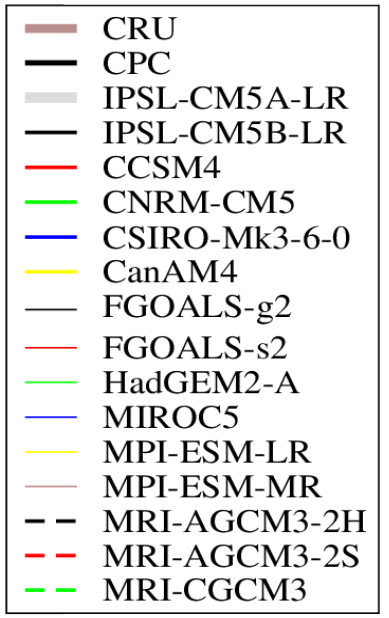


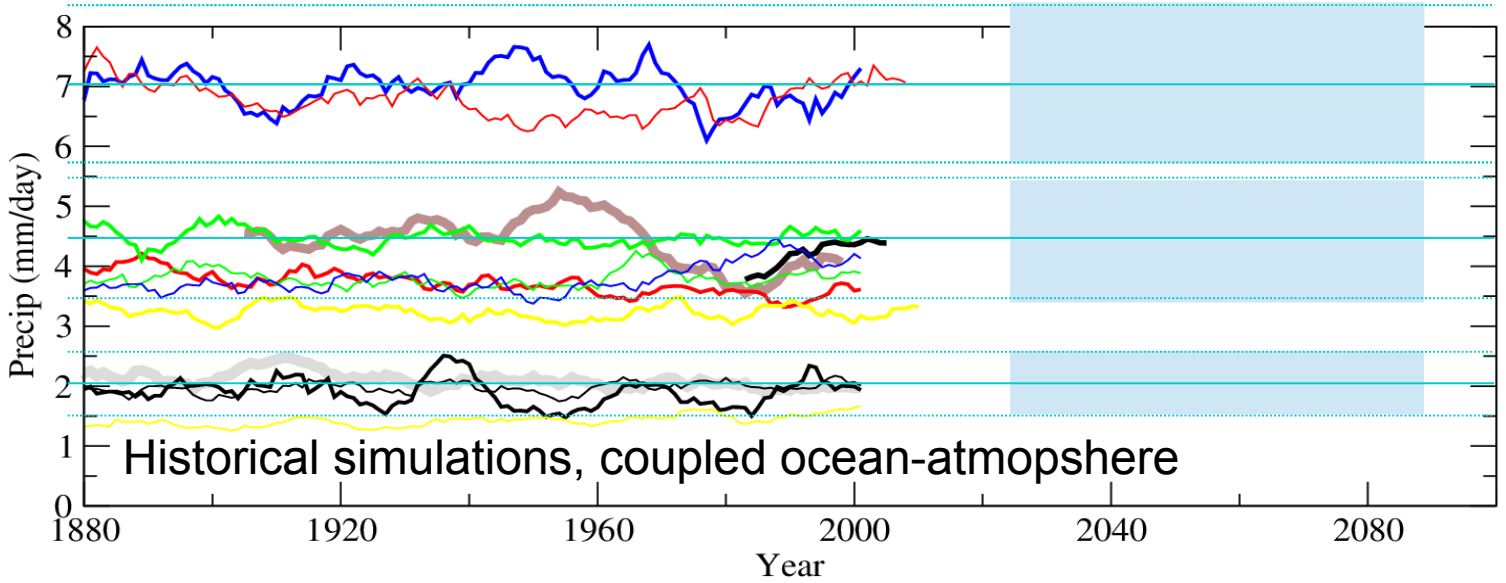


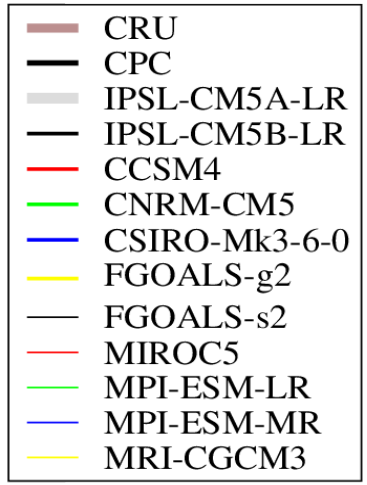
- Confirms the role of SSTs on decadal rainfall (Gianini et al., Cook et al., Zeng et al., ...)
- Strong year-to-year variability (obs and models)
- Strong signature at decadal scale (20%)
- Historical records to short to assess decadal rainfall amplitude to less than a factor 2

Mutli-model simulation of the past decades









- Simulations with imposed SSTs do not all show the late 1979-2009 recovery
- Coupled ocean-atmosphere simulations often underestimate the decadal variability
- Oscillations not in phase with observations (coupled ocean-atmosphere variability)
- **Need to assess the part of the decadal variations due to greenhouse gases increase**

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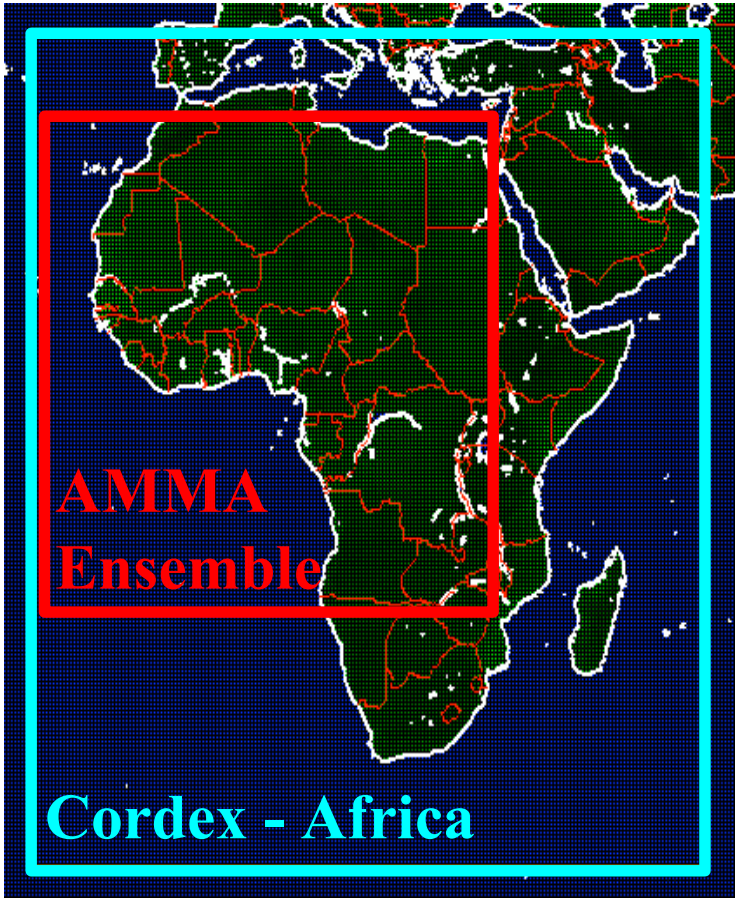
Scale issues : contribution from regional climate models ?



Regional Climate Model
Limited area model forced at boundaries
Horizontal grid resolution 5-50 km
Assessment with forcing from reanalysis
Climate change : snapshot forced by global models

AMMA-Ensemble
Downscaling experiments designed in the
frame of the Ensemble EU project

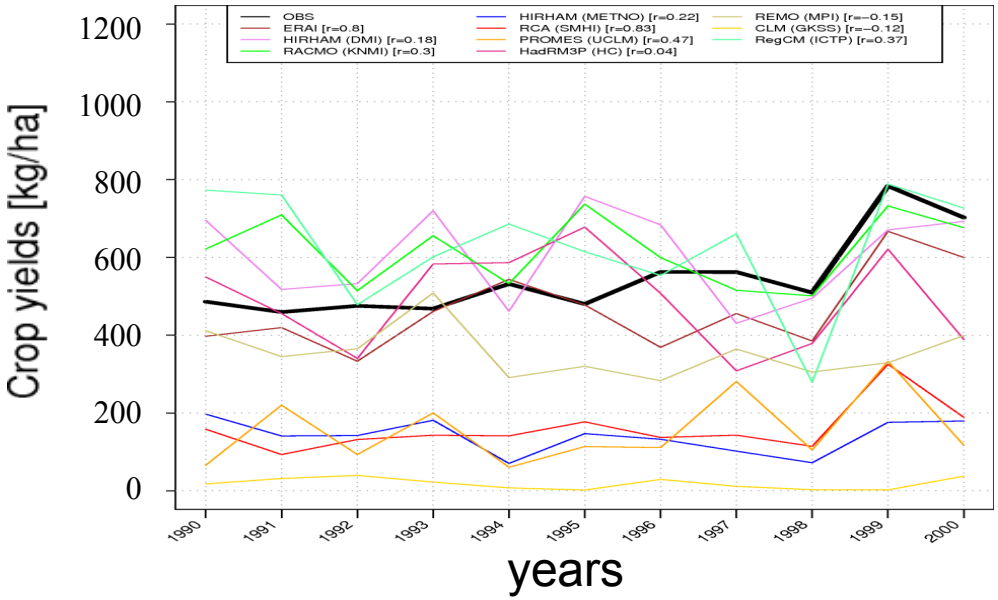
Cordex
International inter-comparison exercise
Resolution <50km
Parallel to CMIP5 but for regional models

Goal : answer scientific questions
Added value due to the better representation of surface heterogeneities ?
Added value from better representation of local couplings (rainfall/soil moisture , Taylor et al.) ?
Additional source of uncertainties and biases due to inconsistency with large scale forcing ?

Convection and clouds are parameterized as in global models
Explicit convection (simulation of MCS, convection life cycle) requires much finer grids

Assessment of Ensemble/AMMA simulations

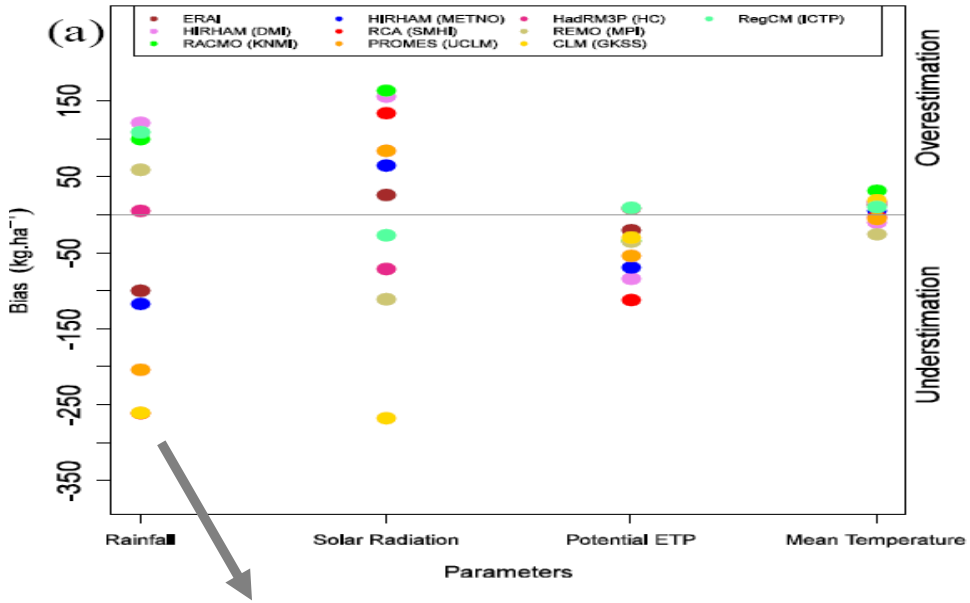
Computation of yields from meteorological variables taken directly from Ensemble/AMMA simulations with the Sarrah crop model (Milet Souna III)

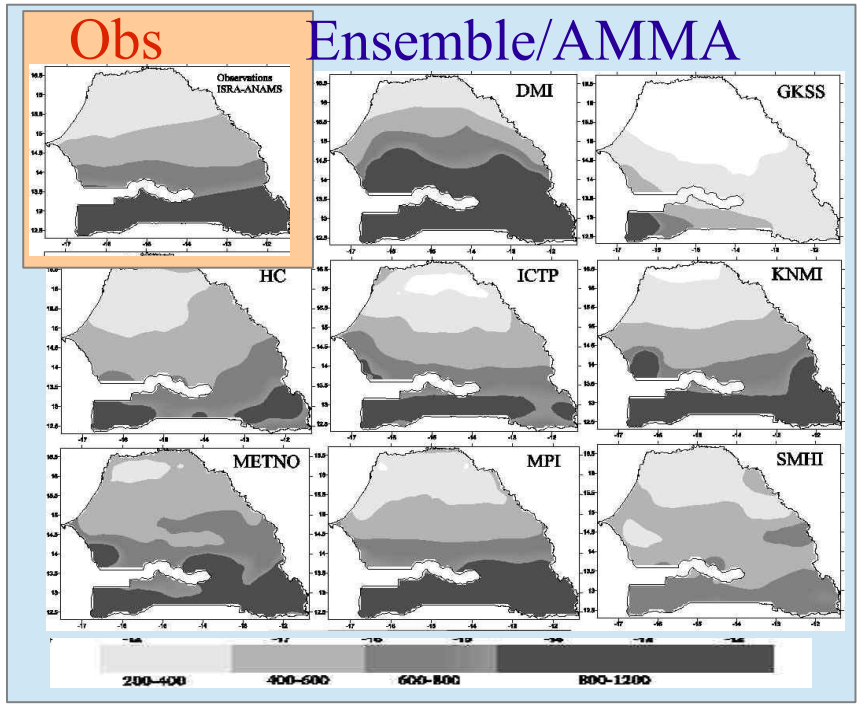


Meteorological variables from observation

Except one taken from Ensemble/AMMA simulations

Oettli P., Sultan B., Baron C. and Vrac M. (2011)





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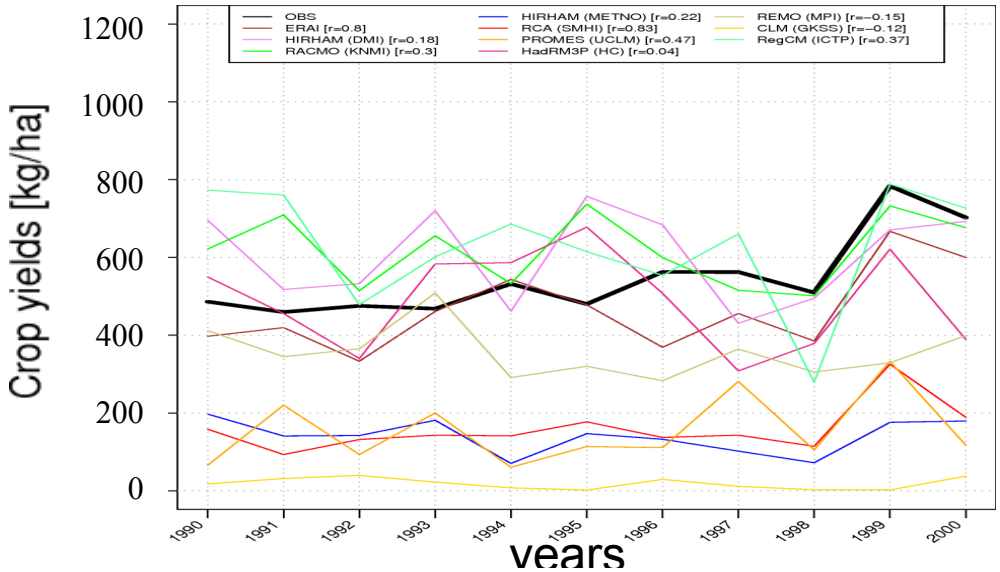

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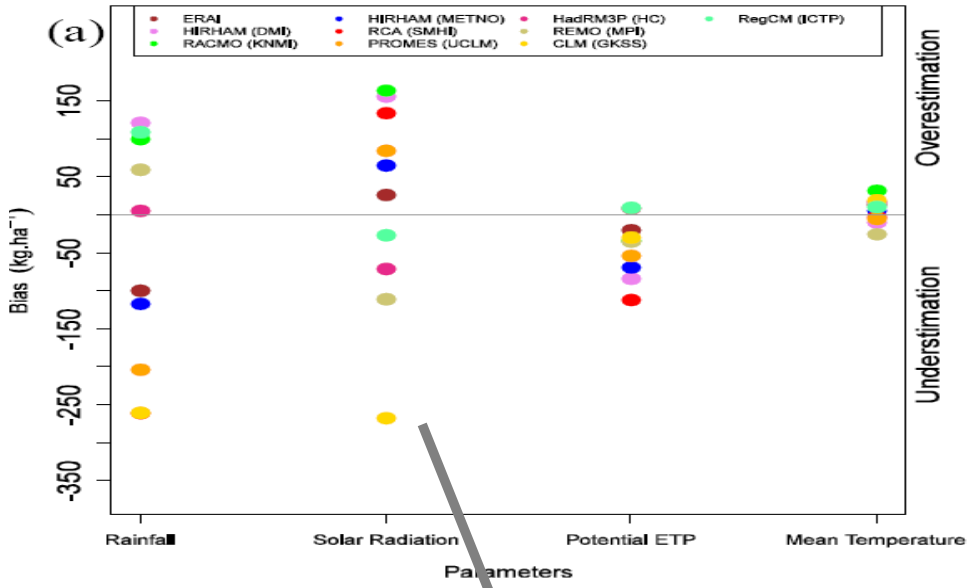
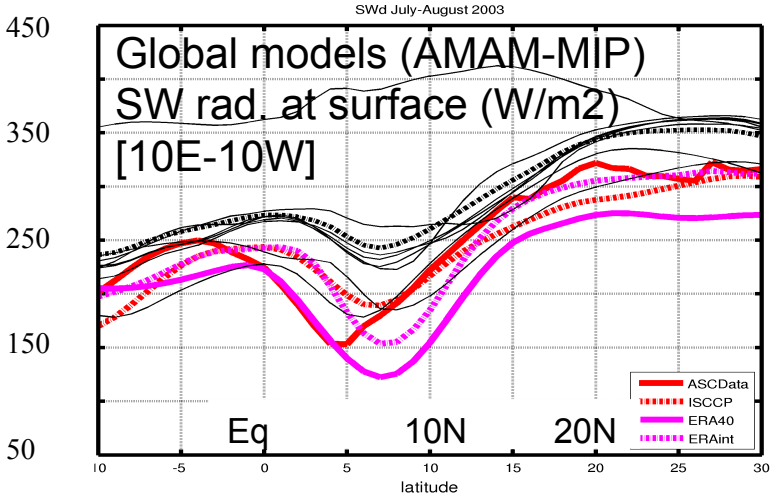
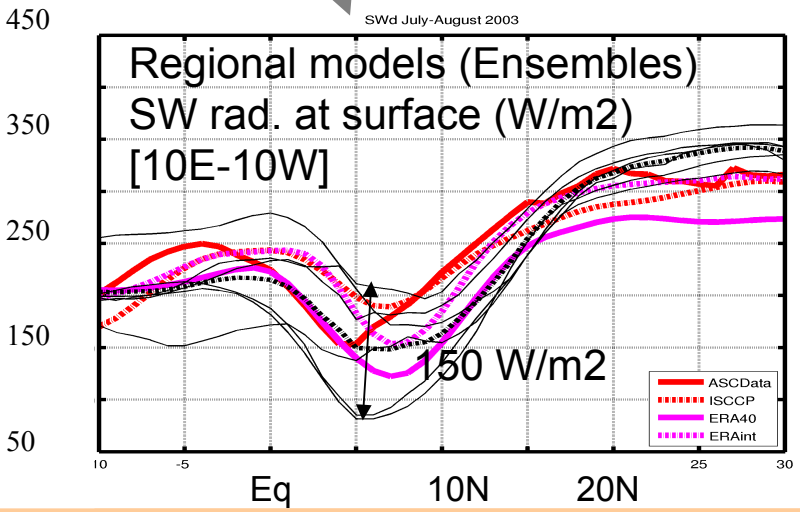


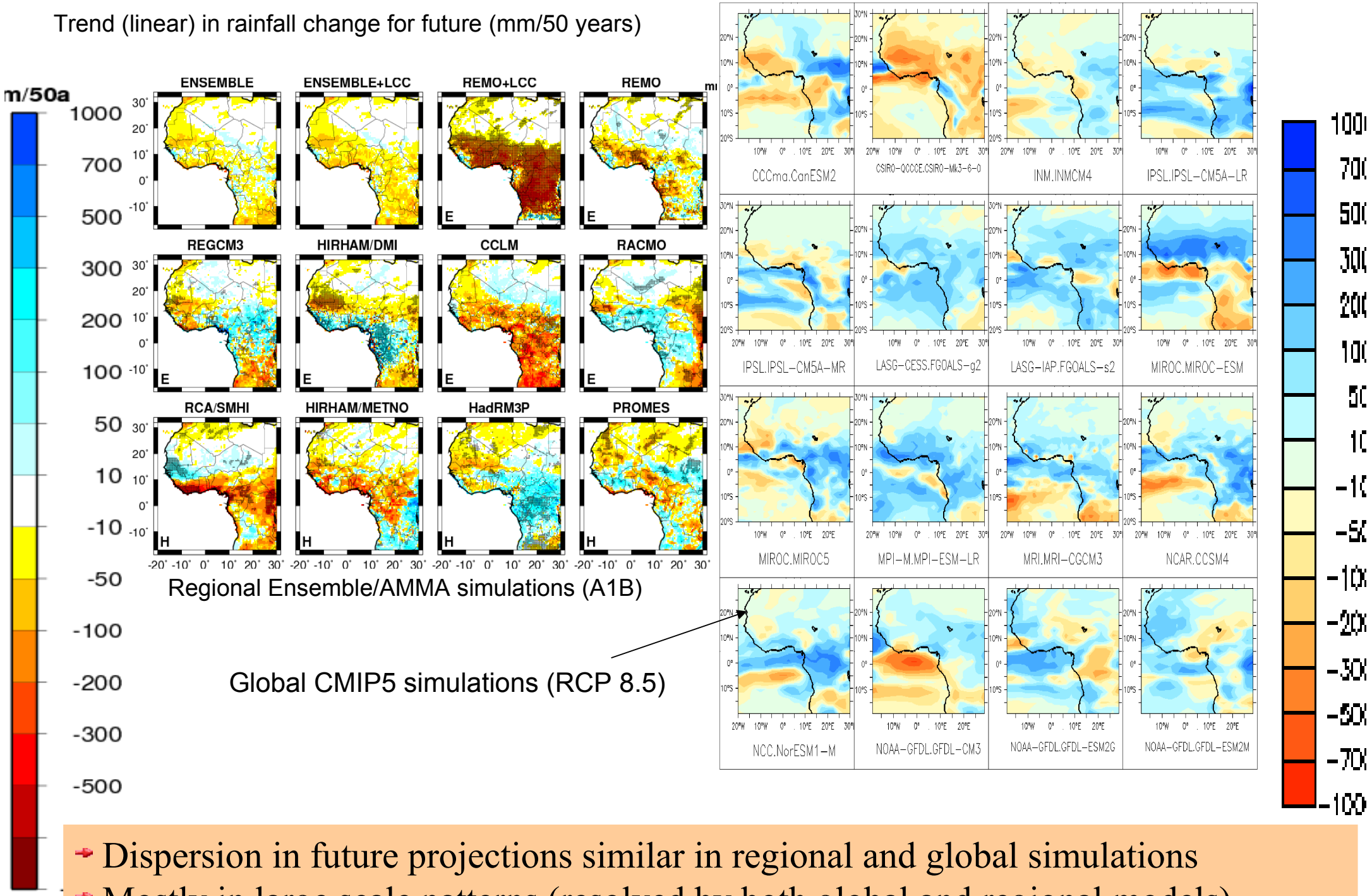


Ruti et al (2010)
ASL AMMA Special issue



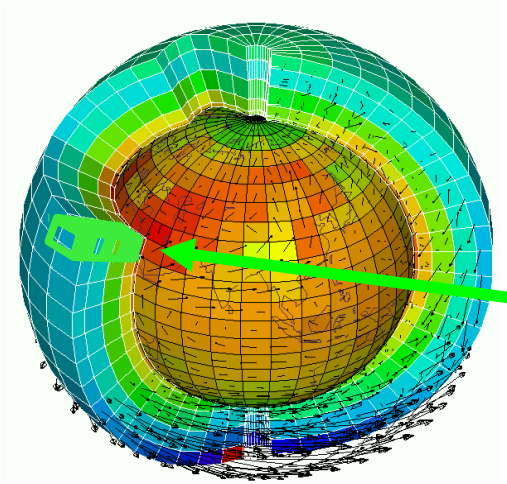
- Huge dispersion in rainfall and SW fluxes
- Both are important for yield computations
- Not better represented in regional than in global models

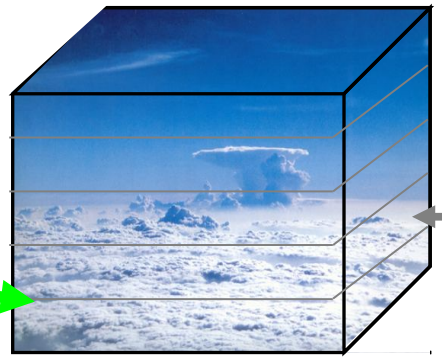
Trend (linear) in rainfall change for future (mm/50 years)



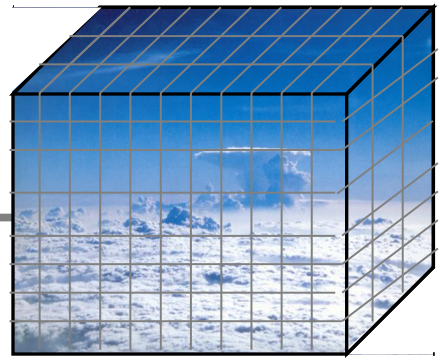
- Dispersion in future projections similar in regional and global simulations
- Mostly in large scale patterns (resolved by both global and regional models)
- Not only due to the large scale forcing (additional internal feedbaks / consistency ?)

Scale issues : explicit versus parameterized convection





Large-
Scale
forcing



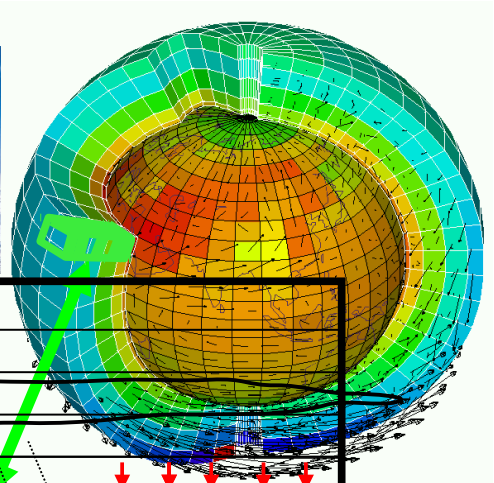
Large-
Scale
forcing

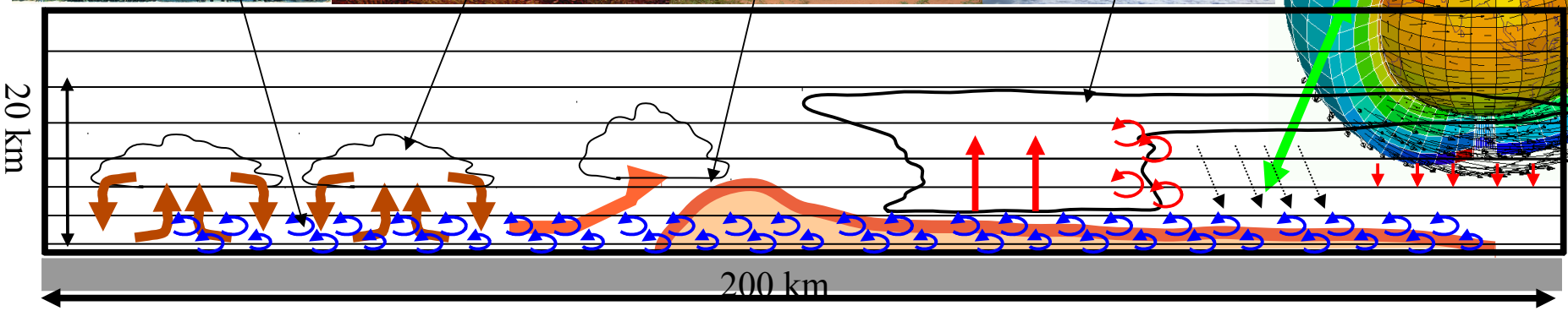
Parameterized physics
Single column model

3D explicit simulations of convection
LES (dx~100m), CRM (dx~1km)

Use of explicit modeling for development/evaluation of parameterizations

LMDZ « New Physics »



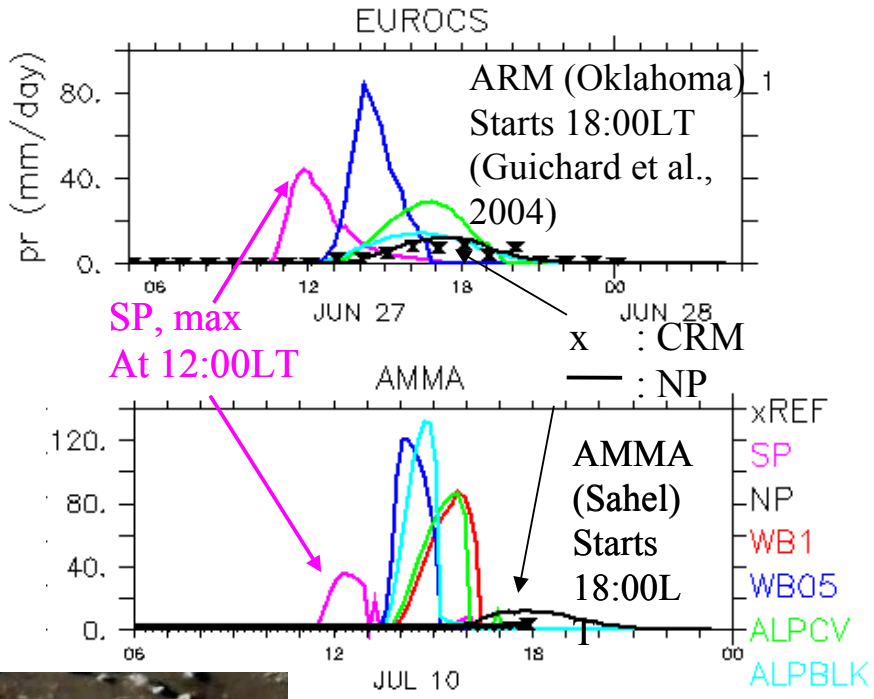


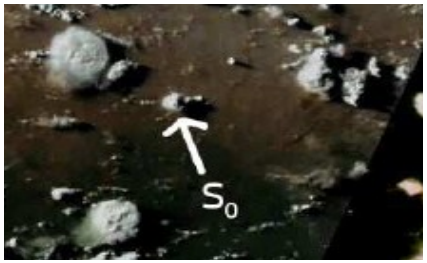
New Physics = **Mellor & Yamada + thermal plume model + new closure for convection + cold pools or wakes + cloud scheme coupled to thermal plumes and convection**

Rio et al., 2008, 2009, 2010, Grandpeix, Lafore et al., 2010a,b

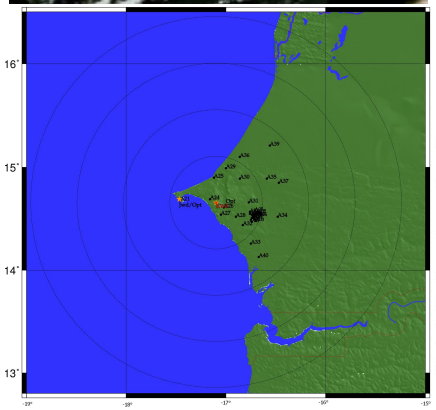
Shifting the diurnal cycle of convective rainfall : possible with parameterized convection

1D test cases/ comparison with explicit simulations (MesoNH)

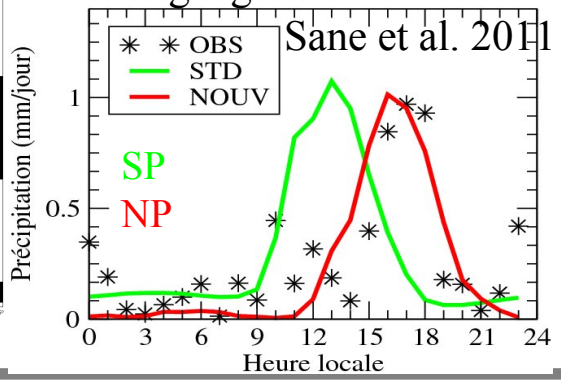




AMMA 10 July case, convection initiation, Niamey
Couvreux et al., 2012
Rio et al., 2012



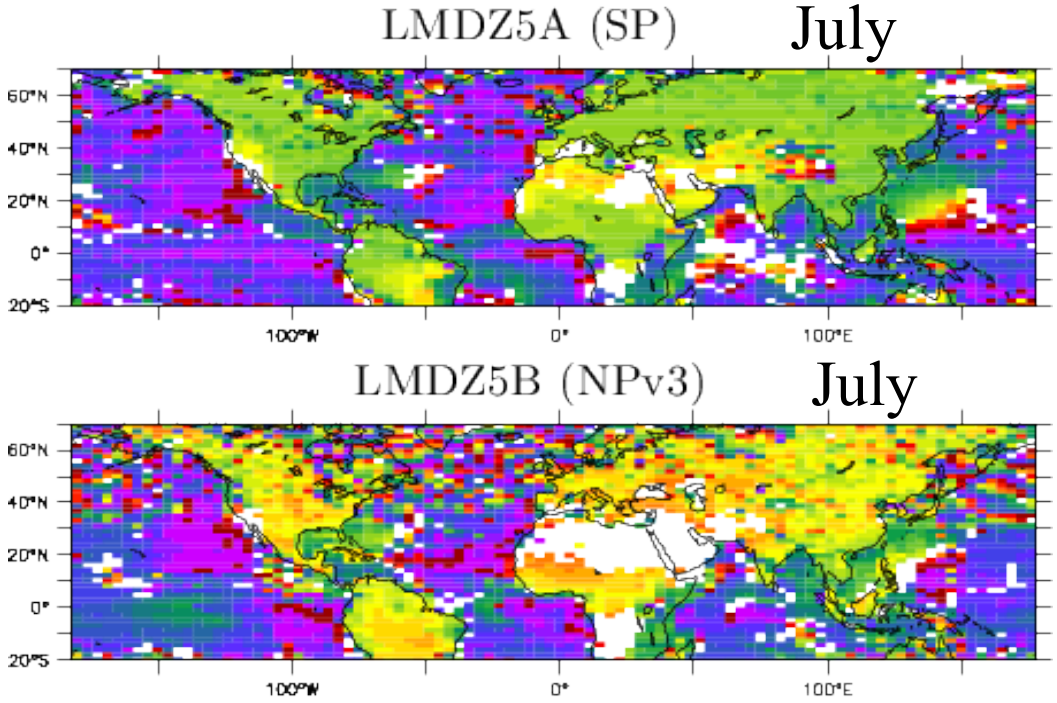
Dakar LPAOSF/NASA raingauges network



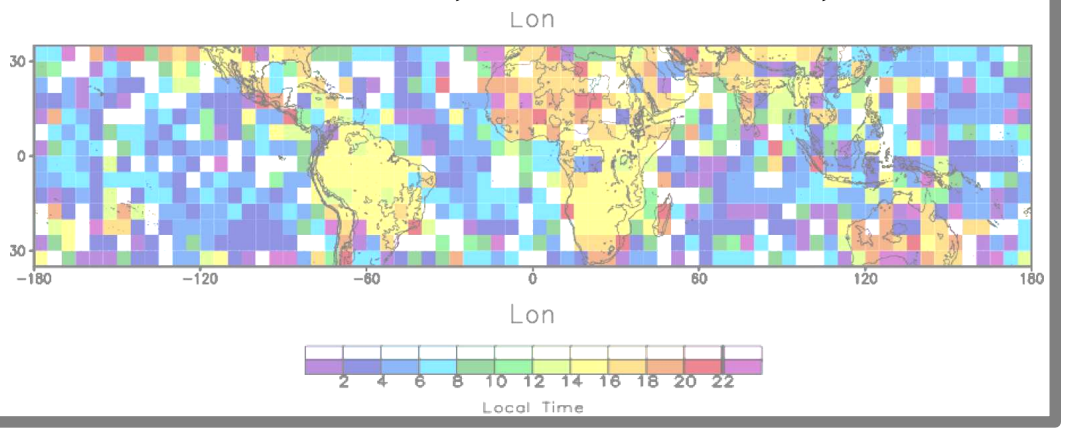
Sane et al. 2011

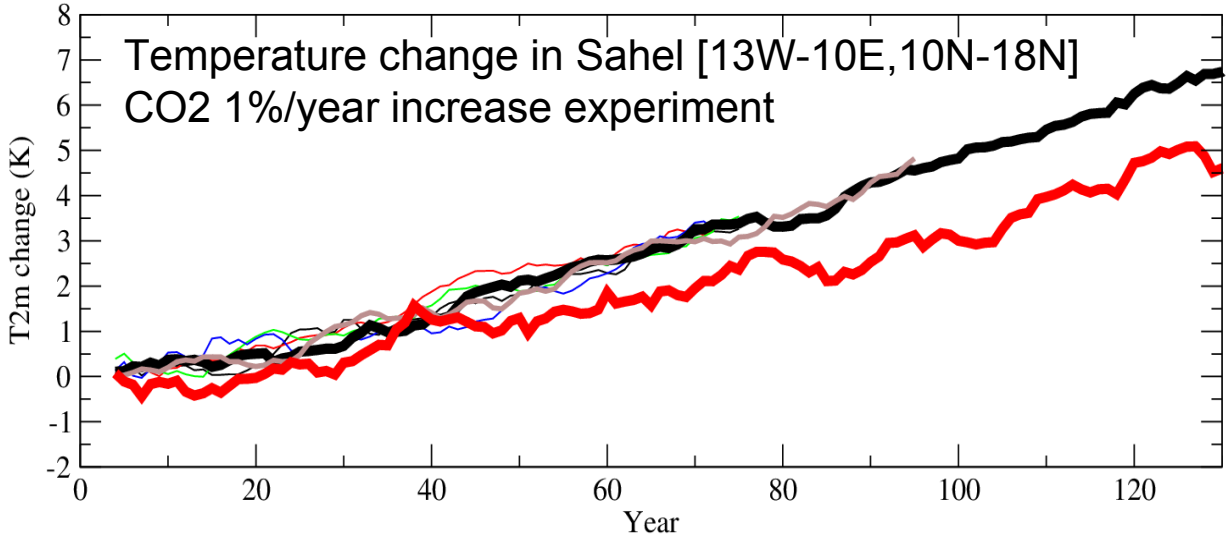
3D simulations

Local time of maximum rainfall



TRMM satellite obs., Hirose et al. 2008, annual

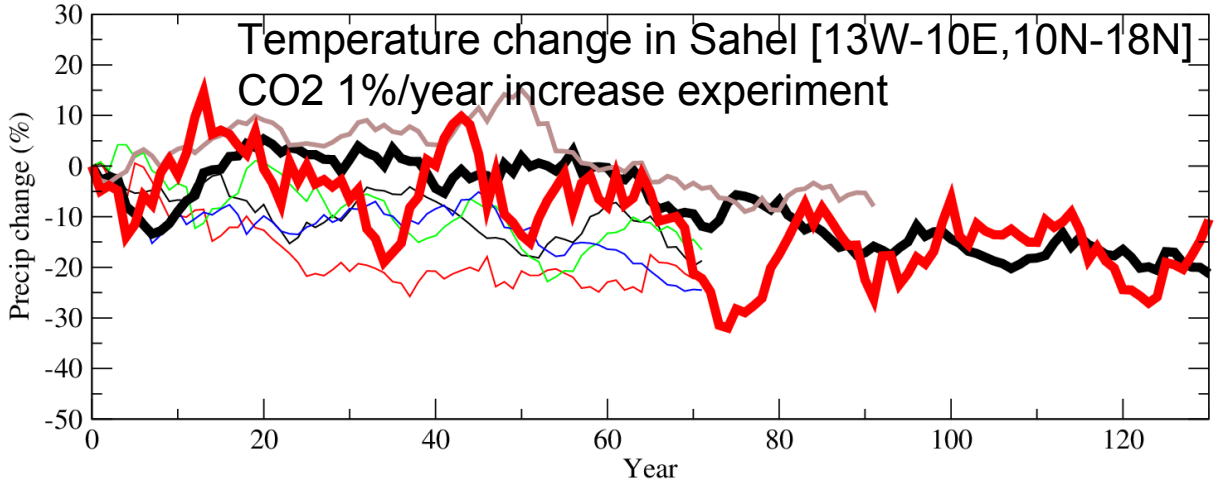




CM4-144x142
CM4-96x71
CM4-96x71B
CM4-96x95
CM5A-LR
CM5A-MR
CM5B-LR

Same physics
Change in resolution
Vertical grid (ext. Stratosph)
tuning

« New physics »

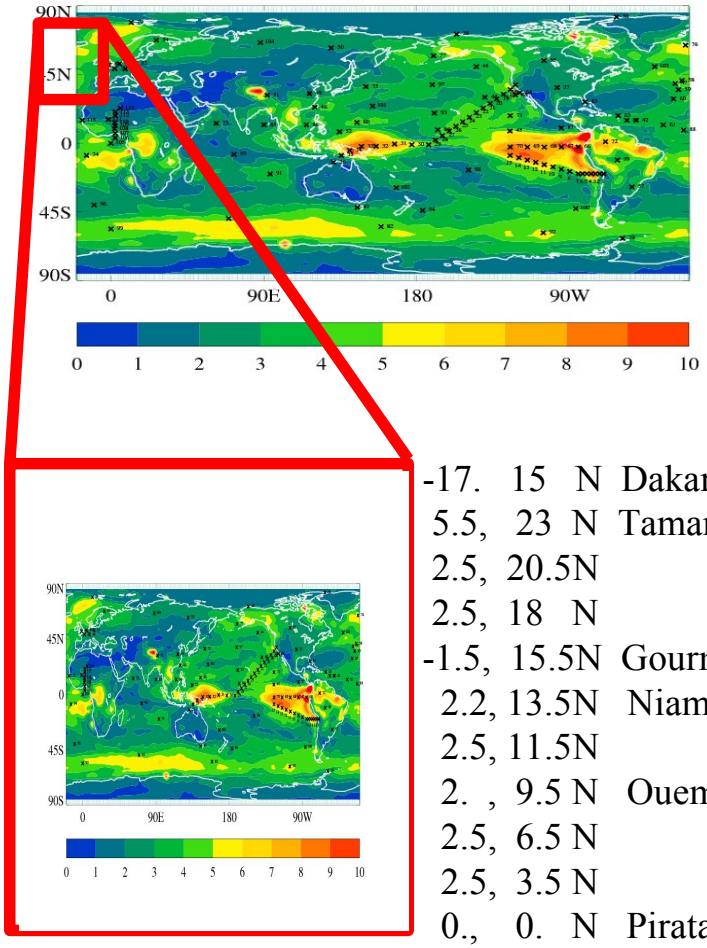


CM4-144x142
CM4-96x71
CM4-96x71B
CM4-96x95
CM5A-LR
CM5A-MR
CM5B-LR

- Strong effect of parameterized physics on the amplitude of global warming
- Significant effect on the decadal variations of rainfall

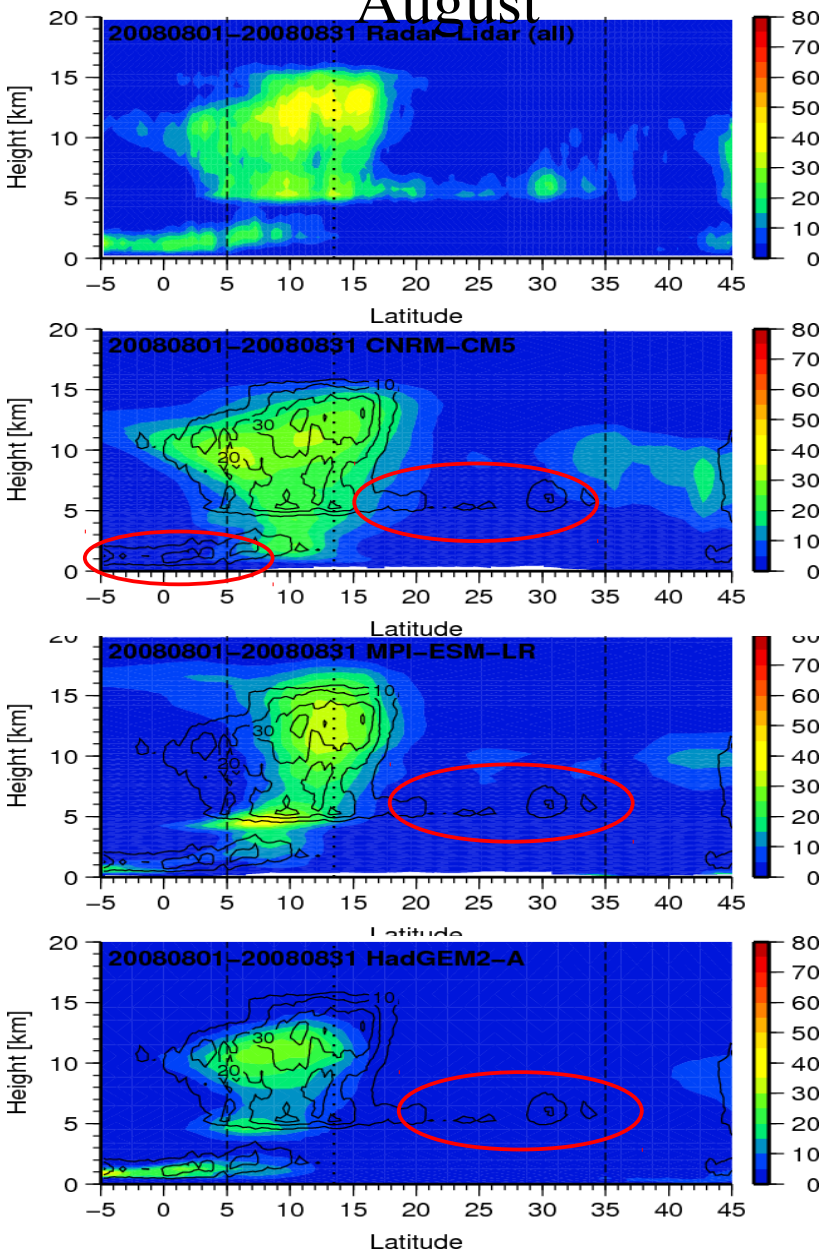
Need to assess the representation of those cloud/convective processes

Promote the AMMA/ AMMA-MIP framework
Evaluation on the 10W-10E transect of CMIP5 and Cordex simulations
11 « stations » selected for CMIP5 outputs which include AMMA super-sites



-17. 15 N Dakar
5.5, 23 N Tamanrasset
2.5, 20.5N
2.5, 18 N
-1.5, 15.5N Gourma
2.2, 13.5N Niamey ARM
2.5, 11.5N
2. , 9.5 N Oueme
2.5, 6.5 N
2.5, 3.5 N
0., 0. N Pirata Buoy

August



Preliminary results :
Cross section of cloud cover for calipso/cloudsat A-train data and 3 CMIP5 models
Bougniol et al., this conference

1. Global Climate Modeling and the CMIP5 exercise

2. Representation of the present-day mean climate

3. Assessment in terms of decadal variability

4. Scale issues

5. Conclusions

Preliminary results on CMIP5 simulations

Skill of global models for present-day climate

- Problably not much improved with respect to CMIP3
- Huge biases in the Sahelian rainfall, a large fraction coming from SSTs biases
- SST « robust » biases (in particular warm biases in the upwelling regions)

Climate change projection

- Robust elements : global warming (and regional over Sahel)
- Dispersion in sensitivity similar to CMIP3 (factor 2 on global temperature)
- Drying in the tropical subsiding regions
- Sign of rainfall change uncertain over Sahel (-/+ 30 % for next century)

Regional modeling

- Regional and global models show similar biases
- Not only rainfall but also radiative fluxes and clouds
- The changes in rainfall are uncertain but rather large scale (resolved by global models)
- There is no reason to "believe" regional models (Cordex) more than global (CMIP5)
  - Global : coarser grid but consistency between global and continental scales
  - Regional : local feedbacks, surface heterogeneities but inconsistency with forcing

Challenges and questions for our community

Improve models

- Not only evaluate and inter-compare
- Requires more work on processes, improve their representation + process oriented evaluation
- There is hope for model with parameterized physics
- Global LES not for tomorrow

Understand and gain confidence as for the response of the monsoon system

- Changes in SSTs : regional changes (north/south, Atlantic and global)
- Response of the atmosphere
- Response to CO2, SSTs, coupling with surface …
- Use the passed decades to decompose and assess the various contributions to the climate trends

... knowing that we will be limited by the internal year-to-year variability Of the monsoon rainfall (some hope in multi-variate analysis).

For impact studies :

Climate → impact

- Do consider CMIP5 and Cordex as scientific exercises. Not operational forecasts (nor decadal simulations)
- Use multi-model : no particular model more reliable.
- Do not consider Cordex as « a more realistic simulation of climate change »; complementary source of information to CMIP5
- Must be consider in terms of added value and possible new source of errors
- Develop methodologies that rely on robust elements of the climate models
- For each specific questions, a different methodology should probably be developed.

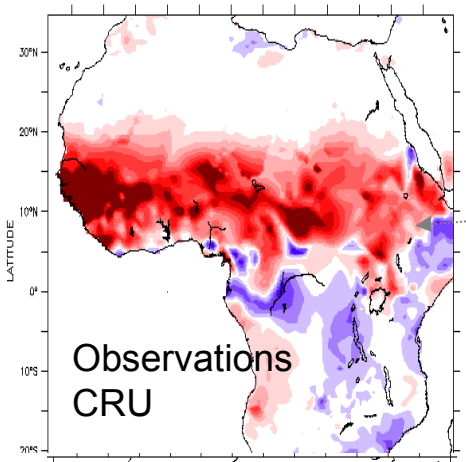
Impact → climate

- Promote “impact studies” and indicators as a way to assess the simulations
- Learn what is important in the climate for given questions

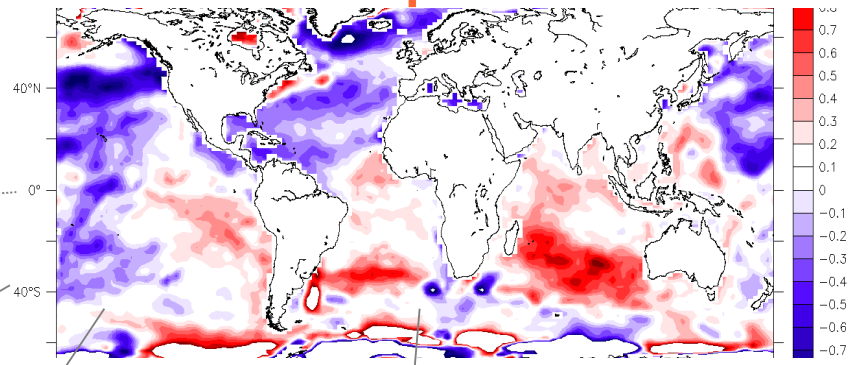
Main conclusion

- CMIP5 models have not reached yet a degree of maturity which makes it possible to rely on them directly to anticipate climate changes and their impact, especially for rainfall over West Africa
- There is no reason to "believe" regional models (Cordex) more than global (CMIP5).
- Any use of climate model results needs a specific phase of assessment and understanding of climate modeling
- For "impacts", specific methodologies much be developed which start from robust elements of the climate simulations, when they exist

I. Reconstructions de variations climatiques des décennies passées

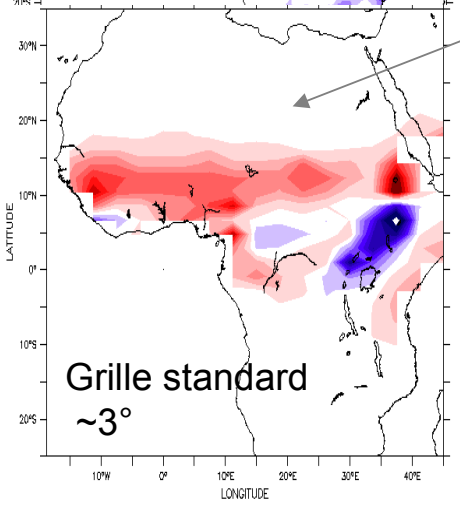


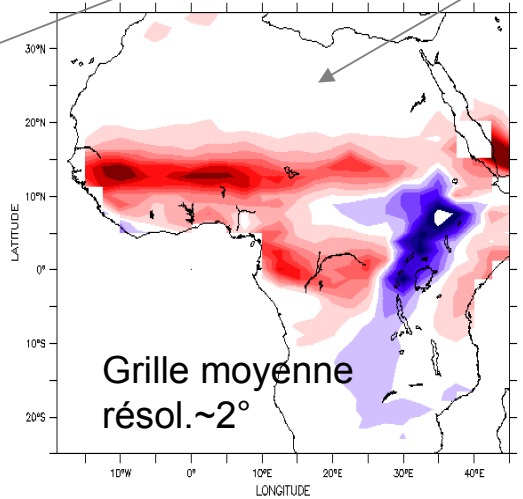
?

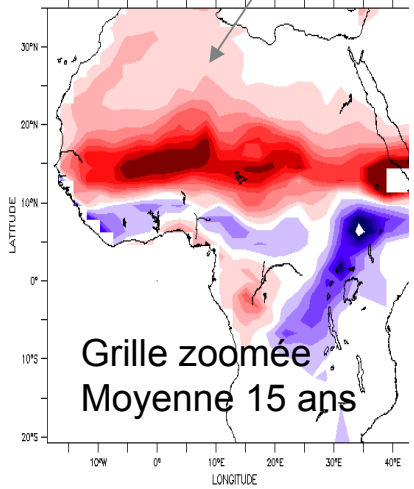


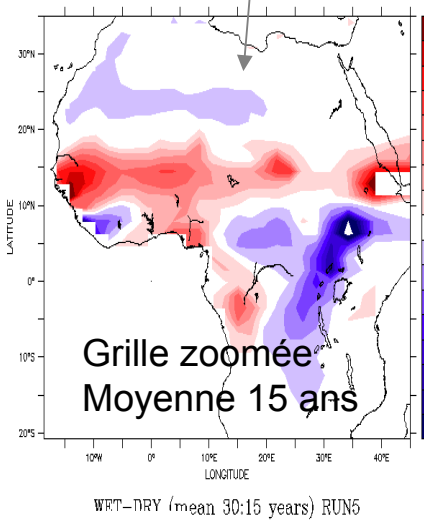
Δ SST (K) : [1975-1985] - [1955:1965]

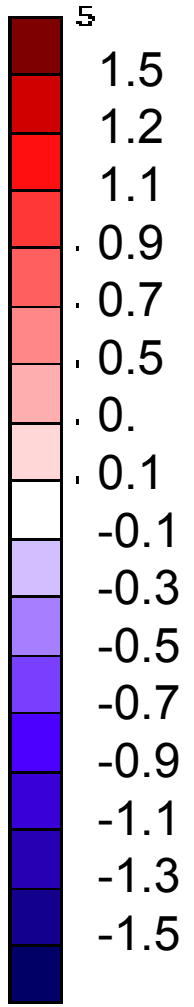
Δ precip (mm/jour) : [1975-1985] - [1955:1965]

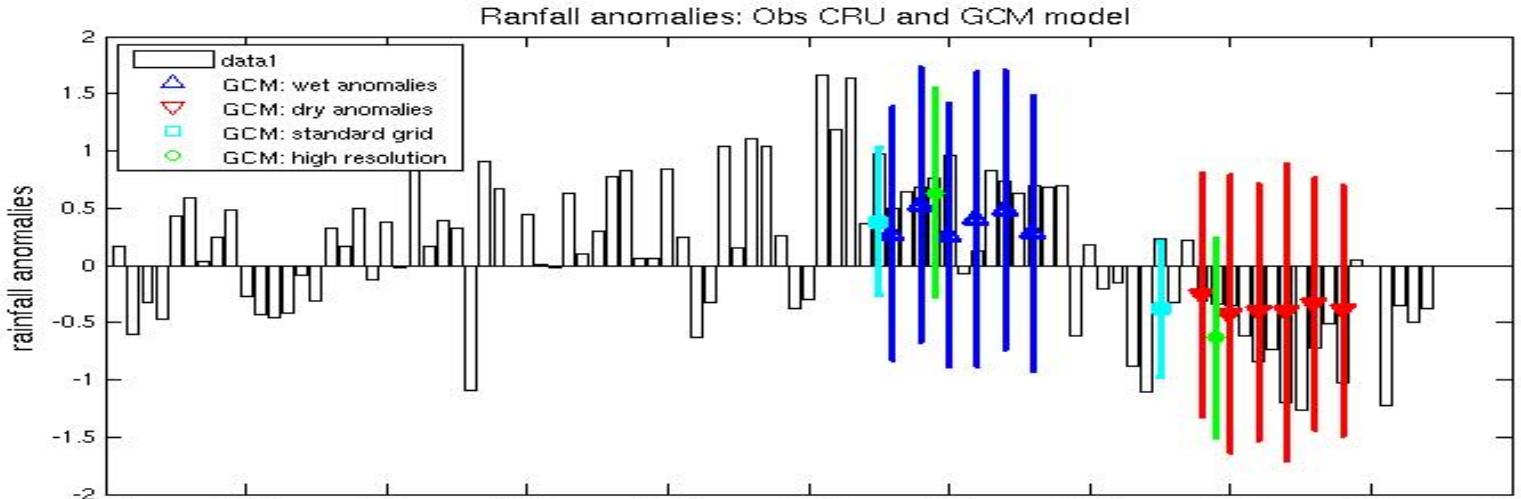


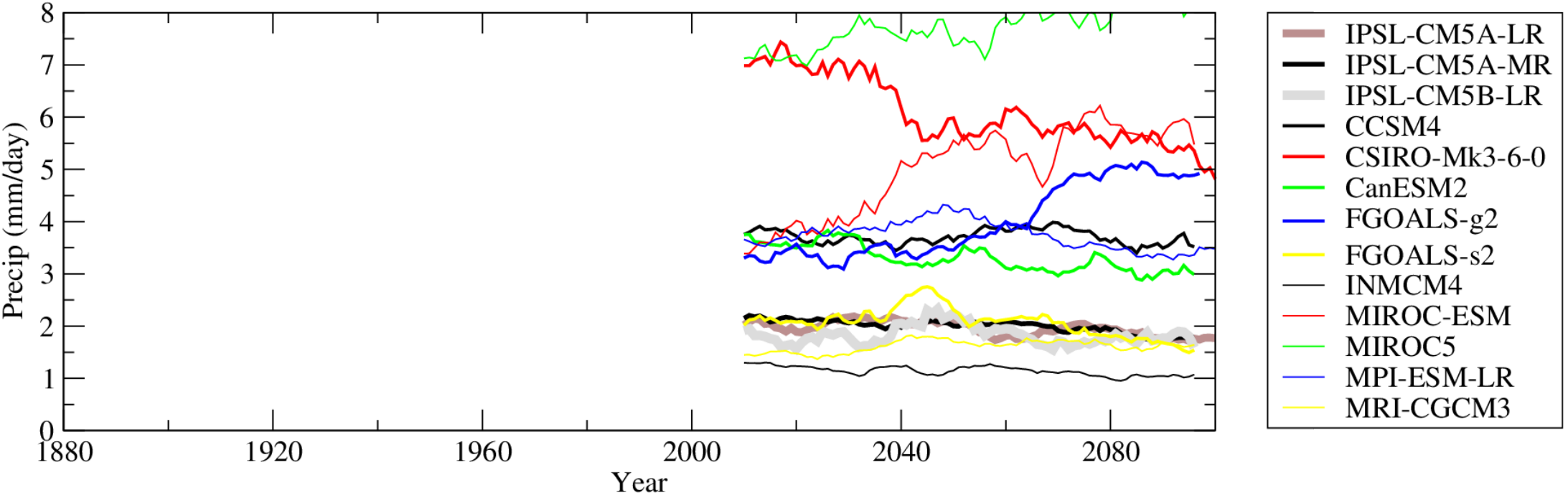


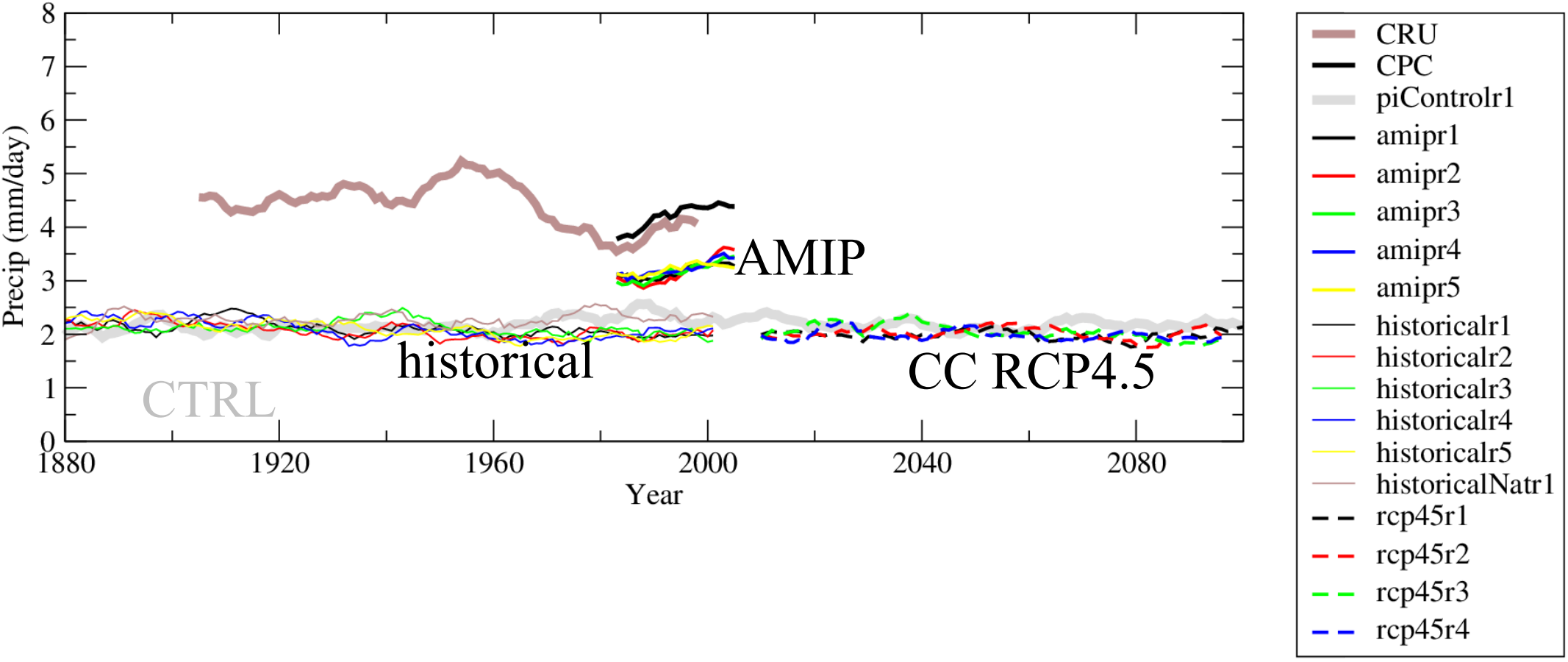









Precip (mm/day)
0
1
2
3
4
5
6
7
8
1880
1920
1960
2000
2040
2080
Year
IPSL-CM5A-LR
IPSL-CM5A-MR
IPSL-CM5B-LR
CCSM4
CSIRO-Mk3-6-0
CanESM2
FGOALS-g2
FGOALS-s2
INMCM4
MIROC-ESM
MIROC5
MPI-ESM-LR
MRI-CGCM3


Precip (mm/day)
8
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6
5
4
3
2
1
0
1880
1920
1960
2000
2040
2080
Year
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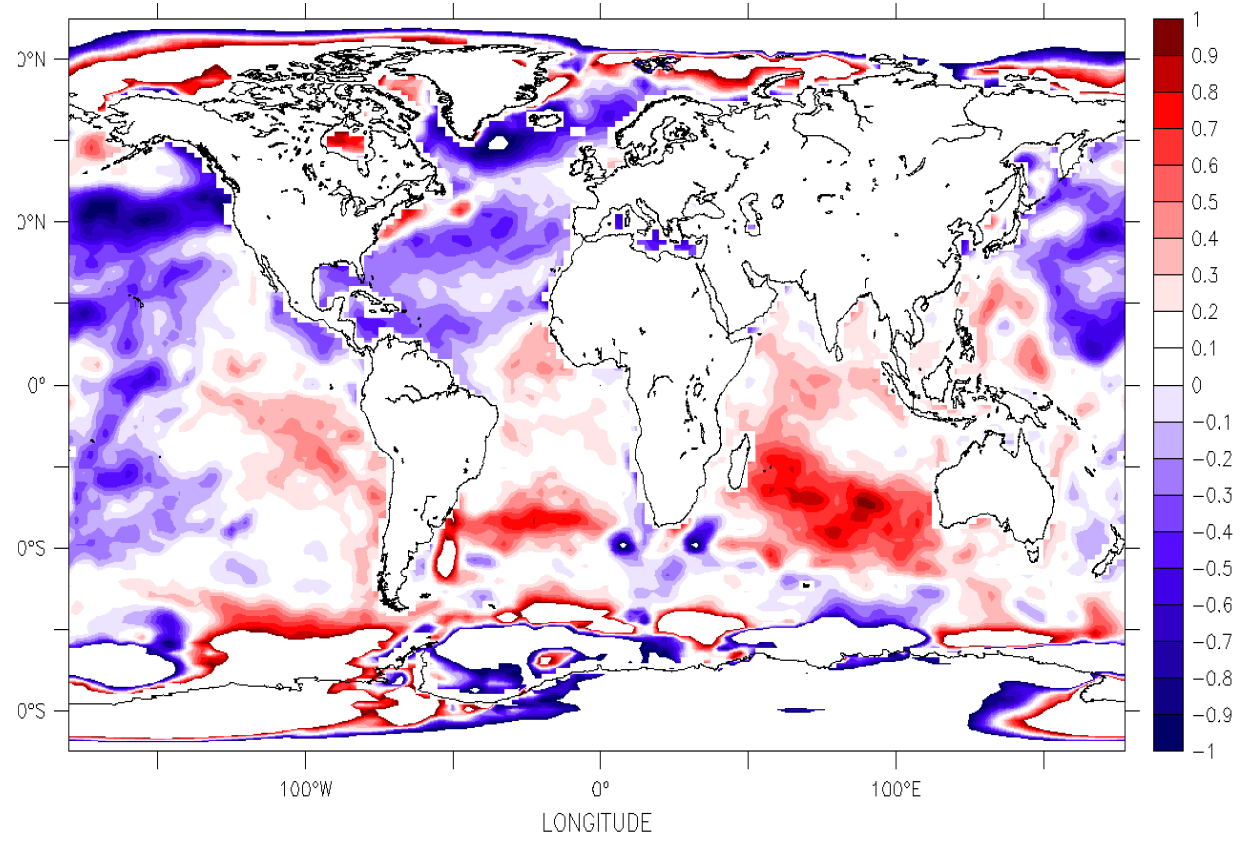
historical
CC RCP4.5
CTRL
CRU
CPC
piControlr1
amipr1
amipr2
amipr3
amipr4
amipr5
historicalr1
historicalr2
historicalr3
historicalr4
historicalr5
historicalNatr1
rcp45r1
rcp45r2
rcp45r3
rcp45r4

I. Reconstructions de variations climatiques des décennies passées

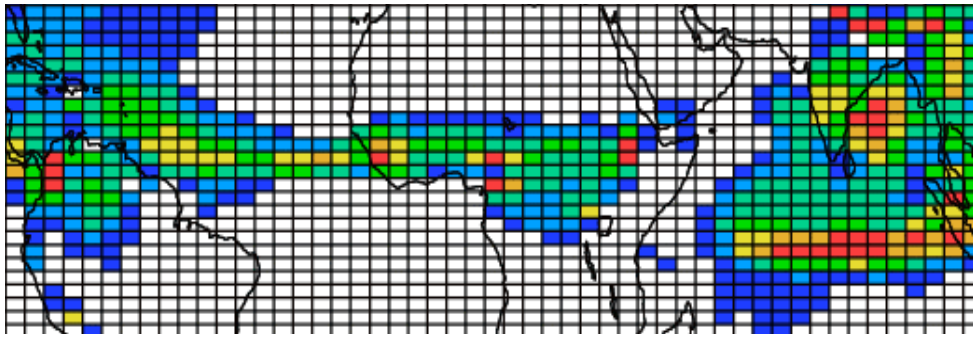
La sécheresse des années 70-80 :
Quelle part peut être expliquée par le forçage par les températures de surface de l'océan (SSTs) ?

→ Série de simulations de sensibilité
→ Forcées par le cycle saisonnier moyen d'une décennie : [1975-1985] - [1955:1965]
→ Ensemble de simulations de plusieurs 100aines d'années

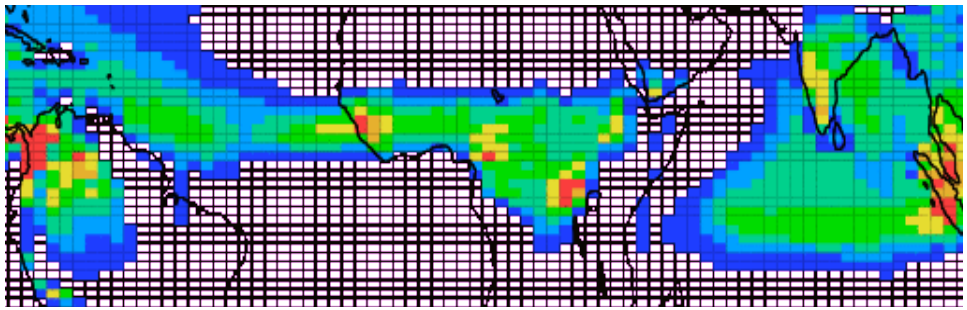
Δ SST : [1975-1985] - [1955:1965]



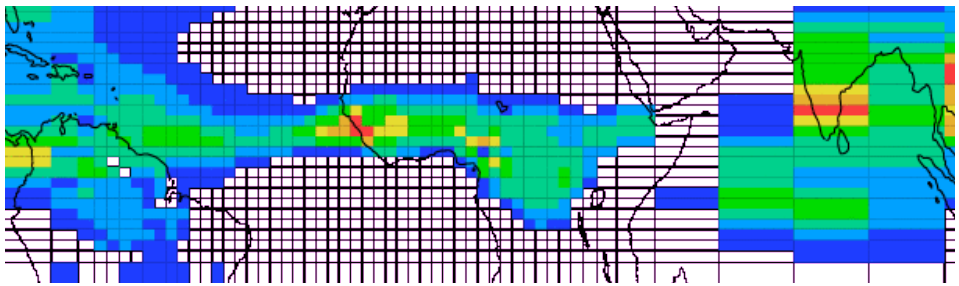
3 Grilles
Grille standard (LR, 96x95x39)



Grille régulière moyenne (MR, 144x142x39)



Grille zoomée légère (LPAOSF, 64x48x19)

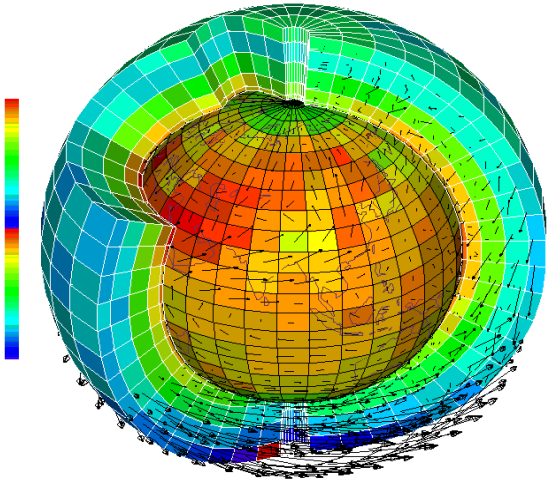


Comment modéliser les rendements futurs?

Choix du scénario futur

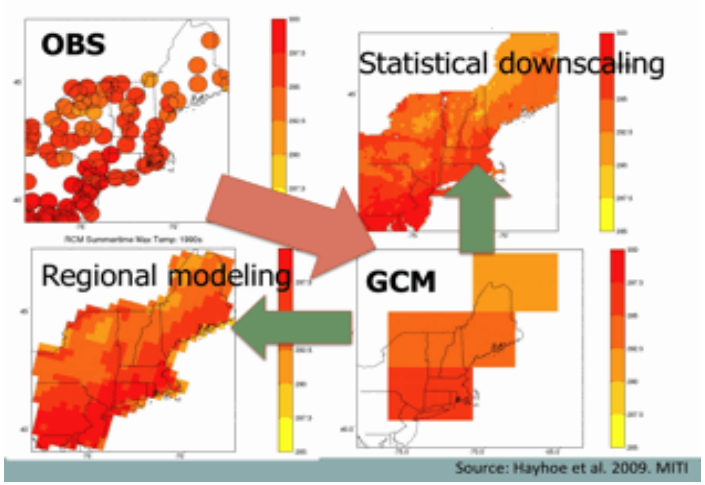
Scénarii SRES, RCP…

Modélisation du climat



GCMs

Descente d'échelle (downscaling)



Rendement

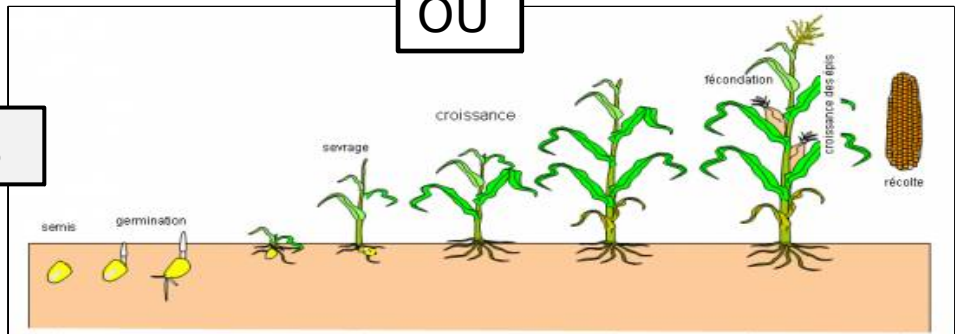
Modélisation des rendements

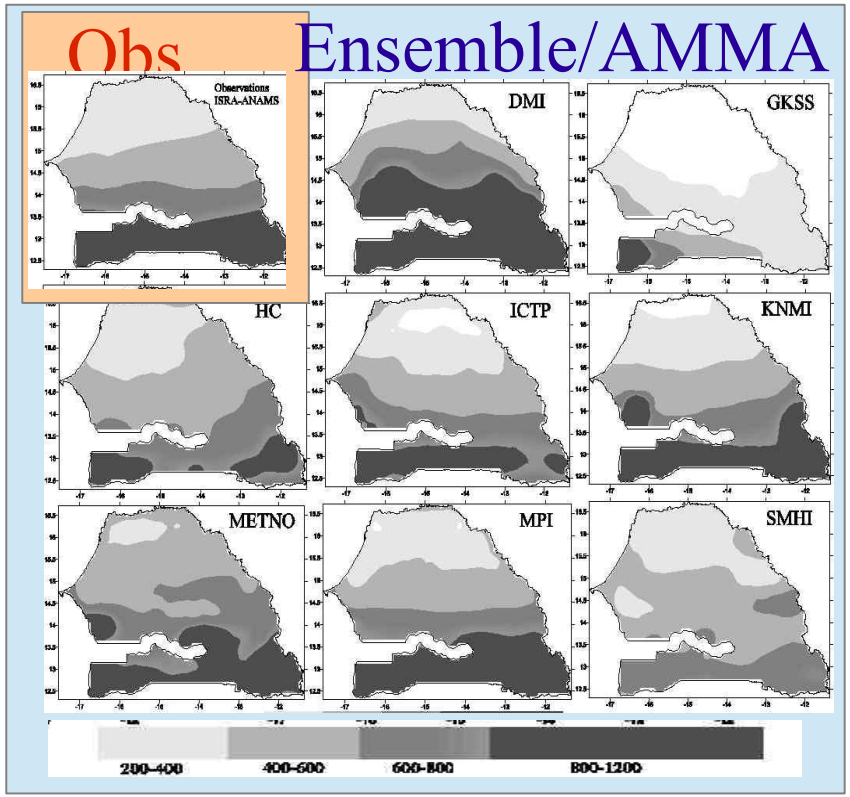
Modèles empiriques

$$y_{it} = f(w_{it}) + \gamma_1 t + \gamma_2 t^2 + c_i + \varepsilon_{it}.$$

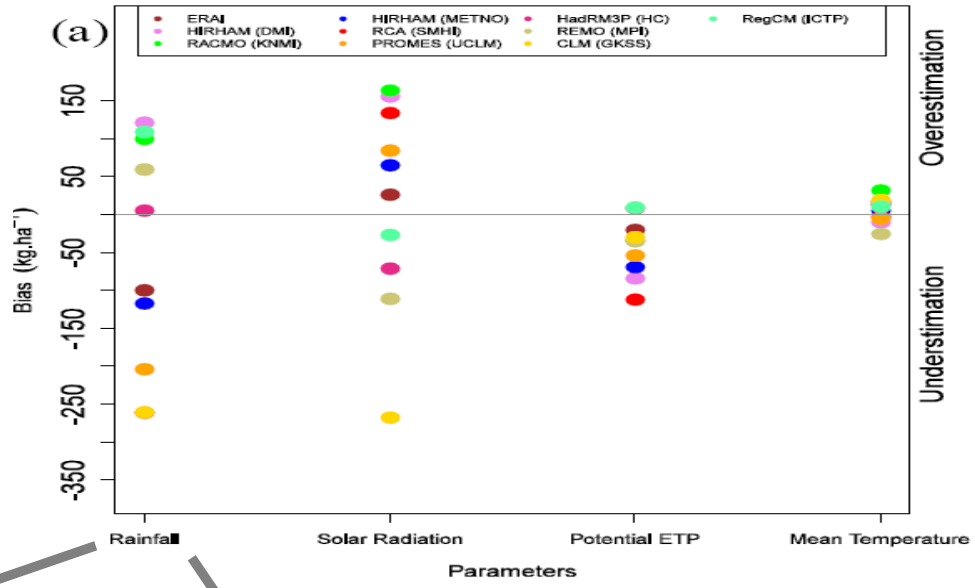
OU

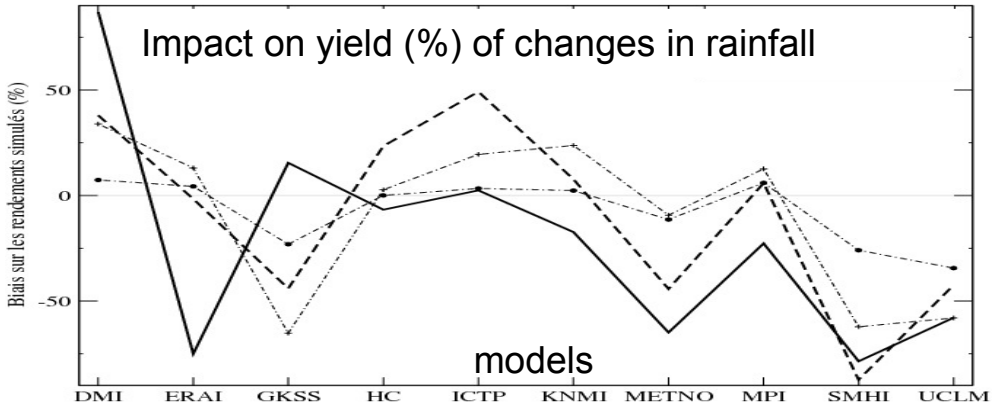
Modèles mécanistes

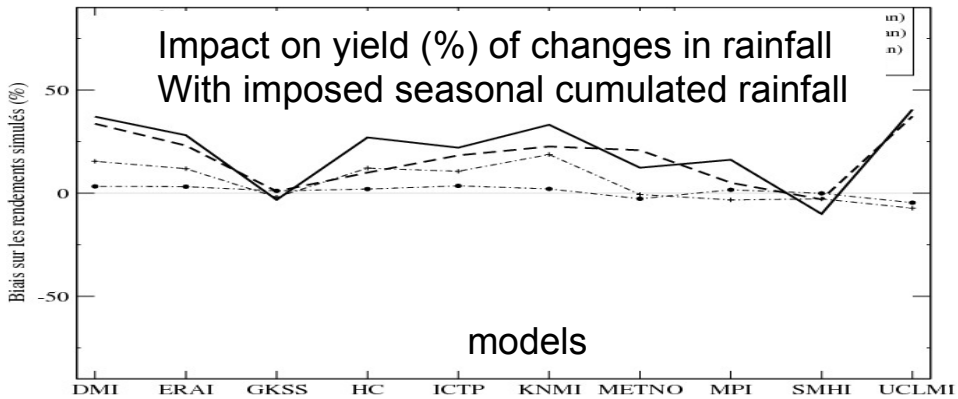




Meteorological variables from observation
Except one taken from Ensemble/AMMA simulations
Oettli P., Sultan B., Baron C. and Vrac M. (2011)







Salack Seyni, Benjamin Sultan, Pascal Oettli, Bertrand Muller, Amadou T. Gaye1, Frédéric Hourdin, Sécheresse (2012)

- Dispersion in regional model rainfall similar to global simulations
- Intra-seasonal variation of rainfall secondary in the

Récupération de jeux de « données » (CNRM) :

1. Récupération des réanalyses MERRA et NCEP-CFSR
   (ces 2 la couvrent la periode 1979-2010)

2. Réananalyse XXeme sciècle 1870-2010 (Compo et al., 2011)
   Assimilation de la pression de surface seule.
   Ensemble de simulations (56 membres)
   Variabilité interne décevante (sic)
   Biais comme des Rnet trop forts au printemps

3. Récupération des données synop 1980-1995

Conclusion intermédiaires

1. Sensibilité des rendements en contexte de changement climatique
   T > cumul de precipitations

2. Sensibilité des rendements aux biais des modèles de climat
   Flux solaires (← nuages) ~ cumul pr > inta-saisonnier

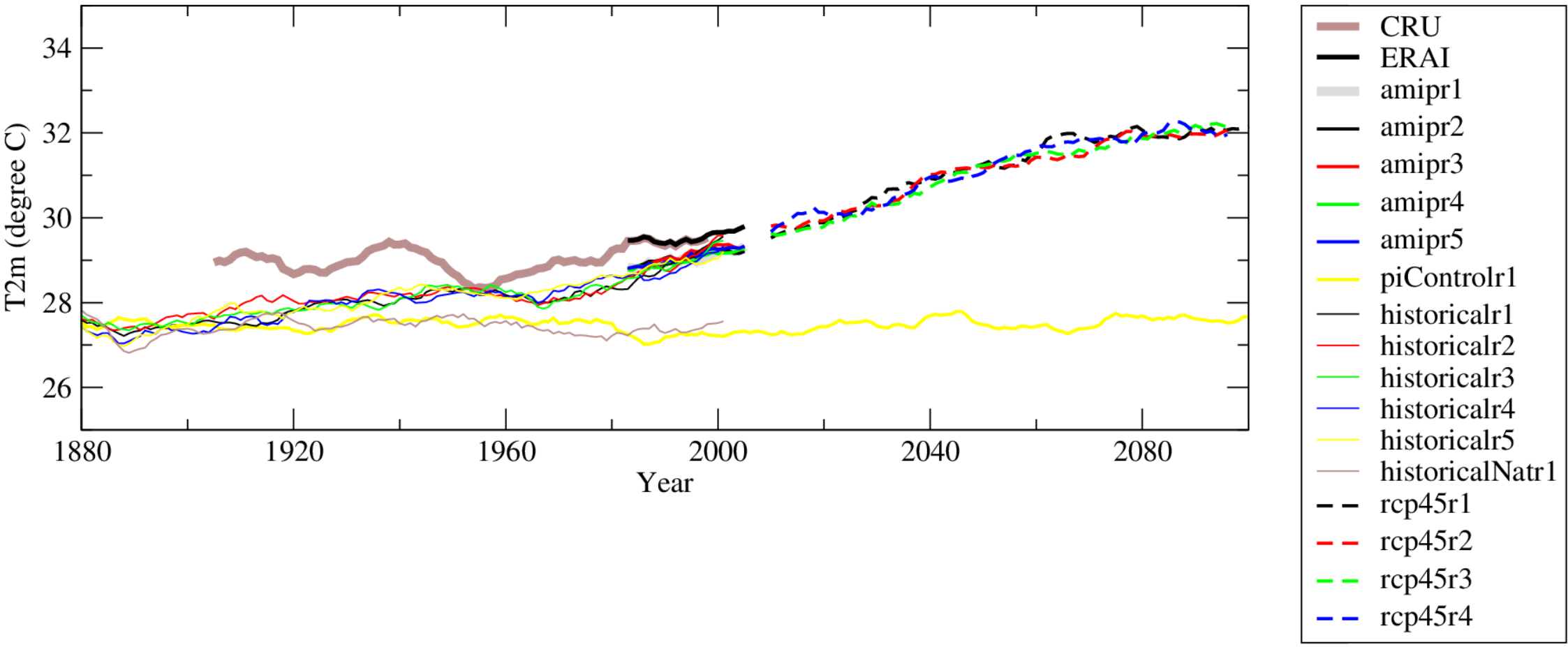
3. Simulation des cumul des précipitations en climat actuel.
   Très peu sensible à la résolution. Assez peu sensible à la physique (???)

4. En changement climatique
   Changements de T plus robustes que ceux de précipitation.
   Changement de précipitation très peu sensibles à la résolution mais très sensible à la physique.

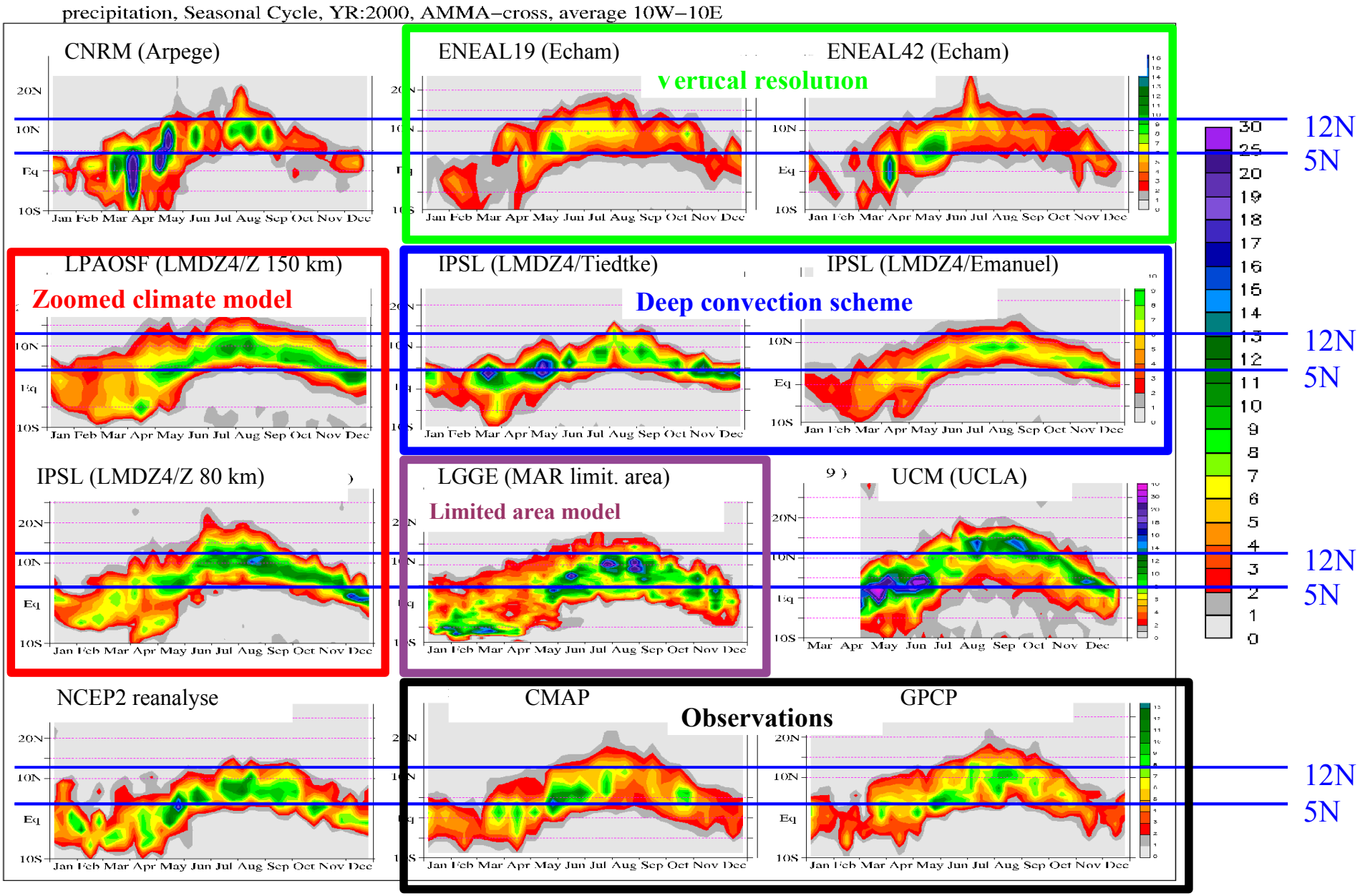
En pratique :
Beaucoup de simulations disponibles au format CMIP sur ciclad
Les simulations CMIP multi-modèles commencent aussi à être accessible.

Deliverables à venir :
M12 : Simulations multi-configurations
M18 : attribution des changements sur les dernières décennies (modèle)
M24 : attribution / évaluation des reconstructions du climat des dernières décennies (modèle/obs)

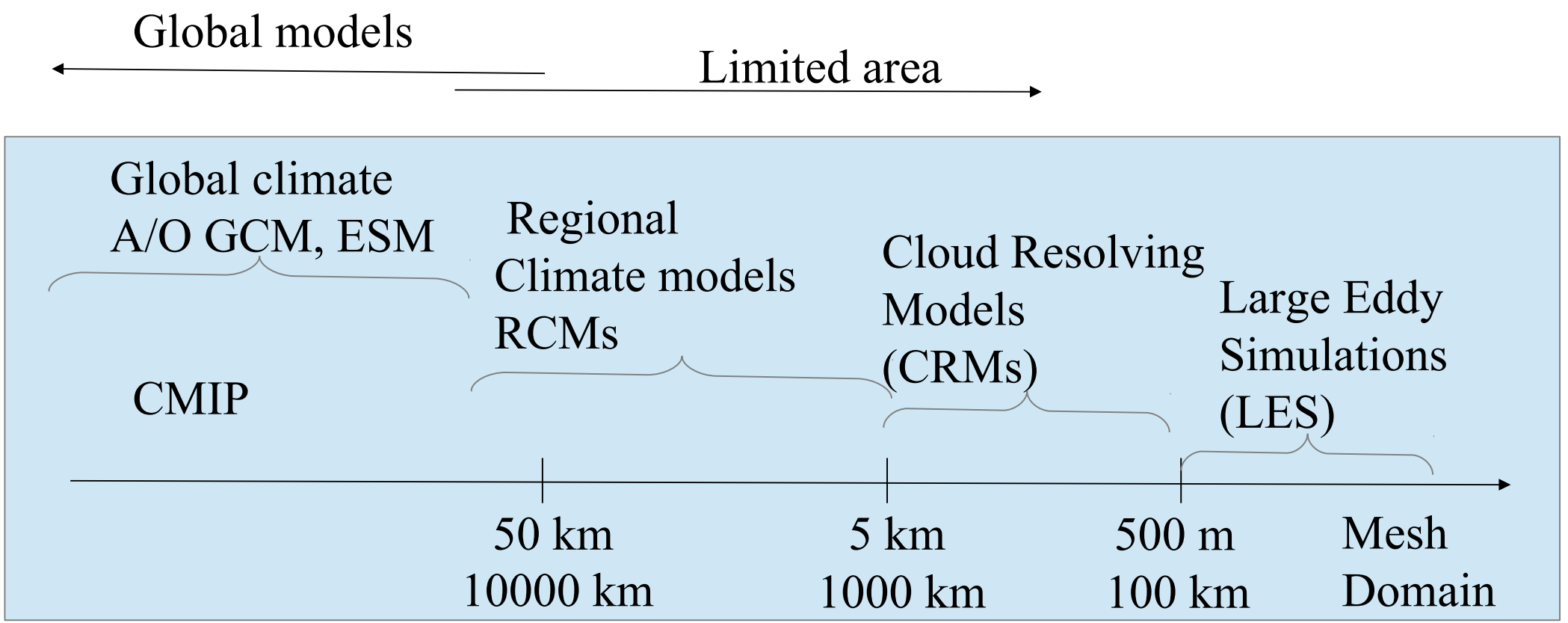
Priorités pour la suite ouvertes à discussions.


T2m (degree C)
34
32
30
28
26
1880
1920
1960
2000
2040
2080
Year
CRU
ERAI
amipr1
amipr2
amipr3
amipr4
amipr5
piControlr1
historicalr1
historicalr2
historicalr3
historicalr4
historicalr5
historicalNatr1
rcp45r1
rcp45r2
rcp45r3
rcp45r4

III. Evaluation des scenarios futurs



Déplacement latitudinal de la pluie sur l'Afrique de l'Ouest au cours des saisons
Moyenne 10E-10W d'une moyenne glissante sur 10 jours de la pluie (mm/day) pour l'année 2000



Characteristics

→ Self consistent
→ Coupled
→ **Parameterized convetion and clouds**

→ Depends on large scale forcing
→ Consistency issue
→ **Parameterized convection and clouds**

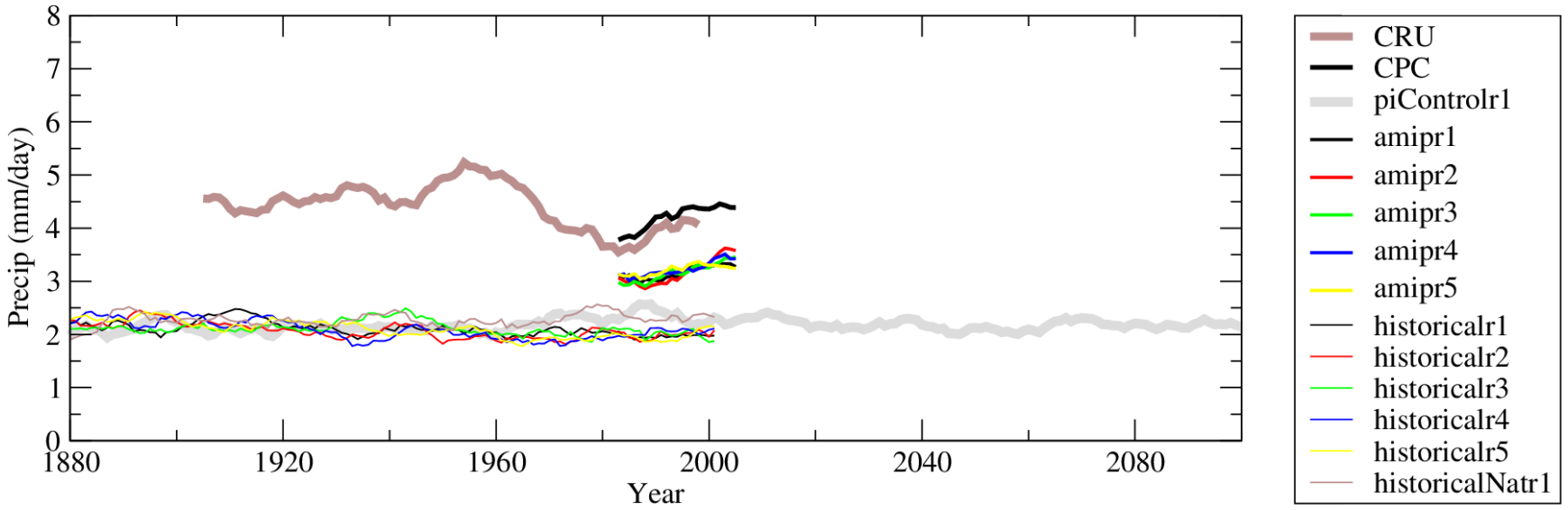
→ **Explicit convection turbulence and clouds**

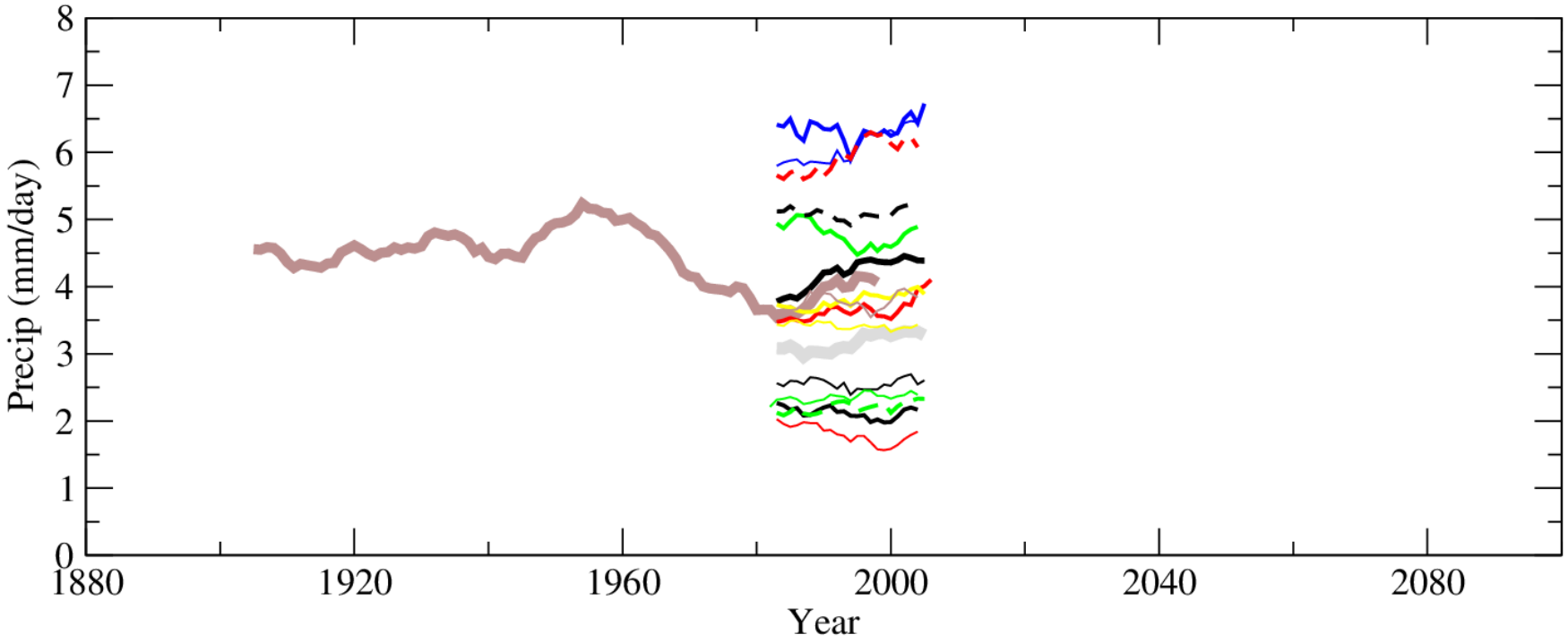
What for

→ Climate change
→ global and regional feedbacks

→ Downscaling
→ Better account for surface heterogeneities
→ Local feedbacks (eg : hydro, Taylor et al.)

→ process studies
→ Convection life cycle Organisation, MCS ...
→ local climate feedbacks


Precip (mm/day)
Year
1880
1920
1960
2000
2040
2080
0
1
2
3
4
5
6
7
8
CRU
CPC
piControlr1
amipr1
amipr2
amipr3
amipr4
amipr5
historicalr1
historicalr2
historicalr3
historicalr4
historicalr5
historicalNatr1


Precip (mm/day)
Year
1880
1920
1960
2000
2040
2080
0
1
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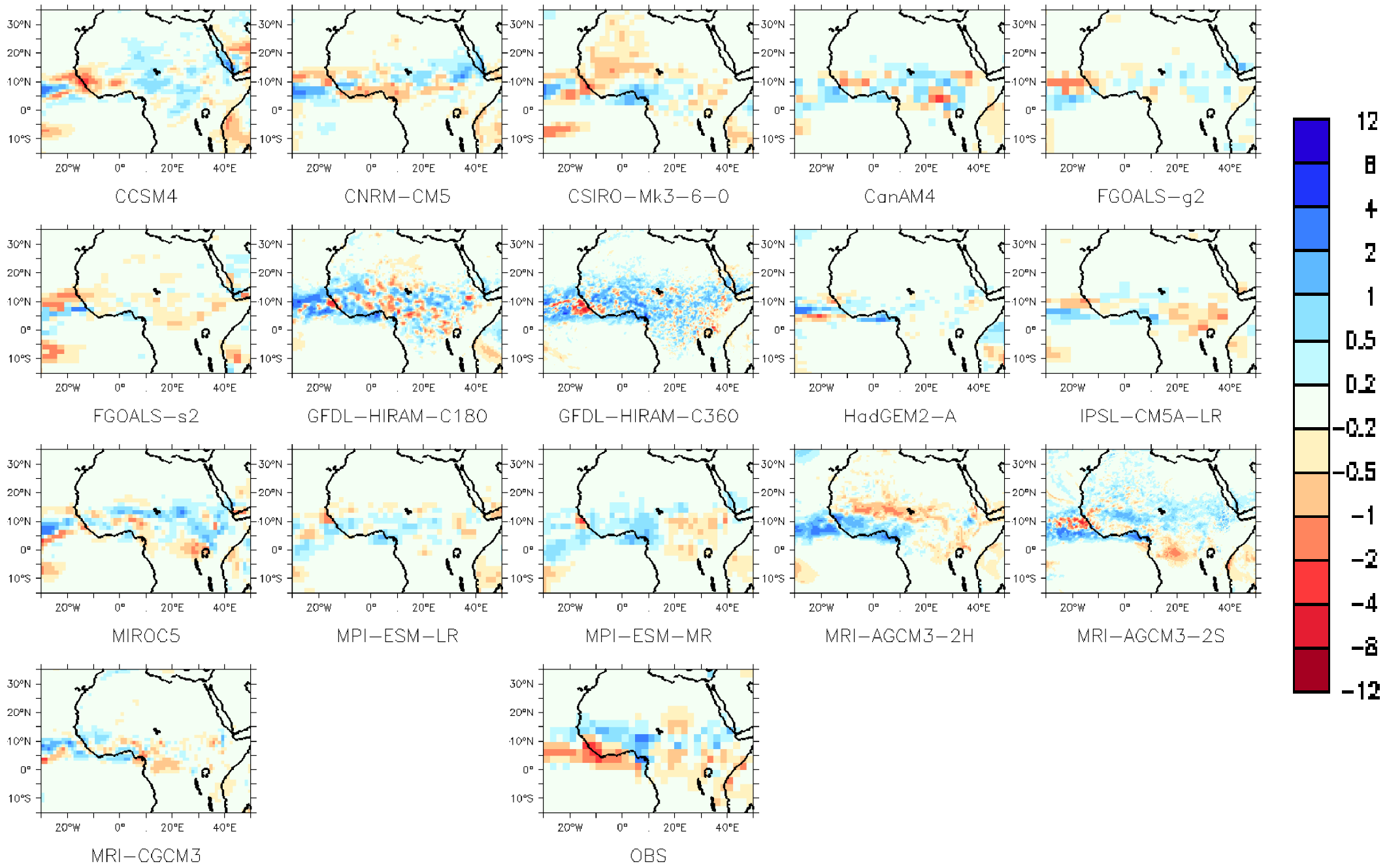
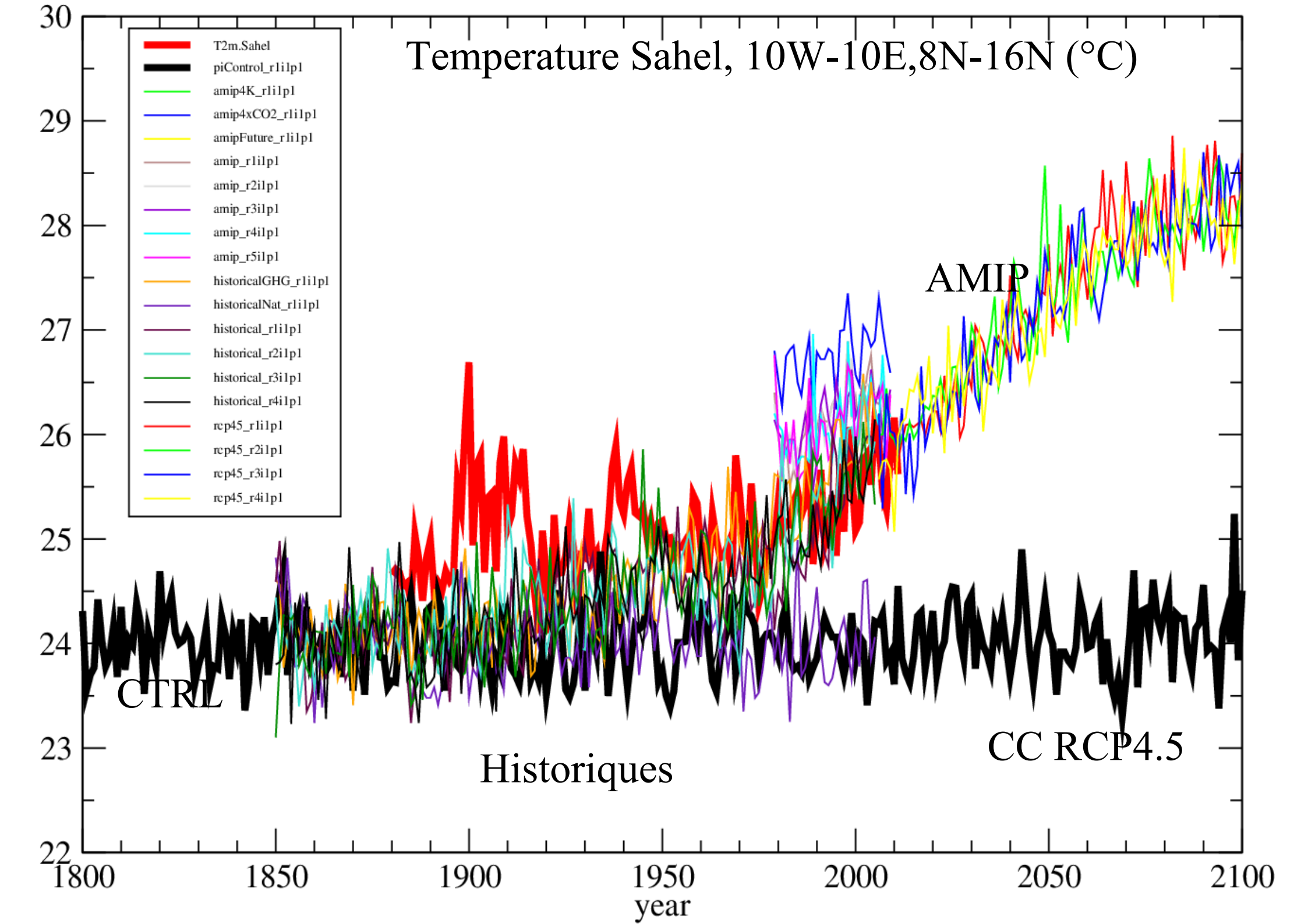
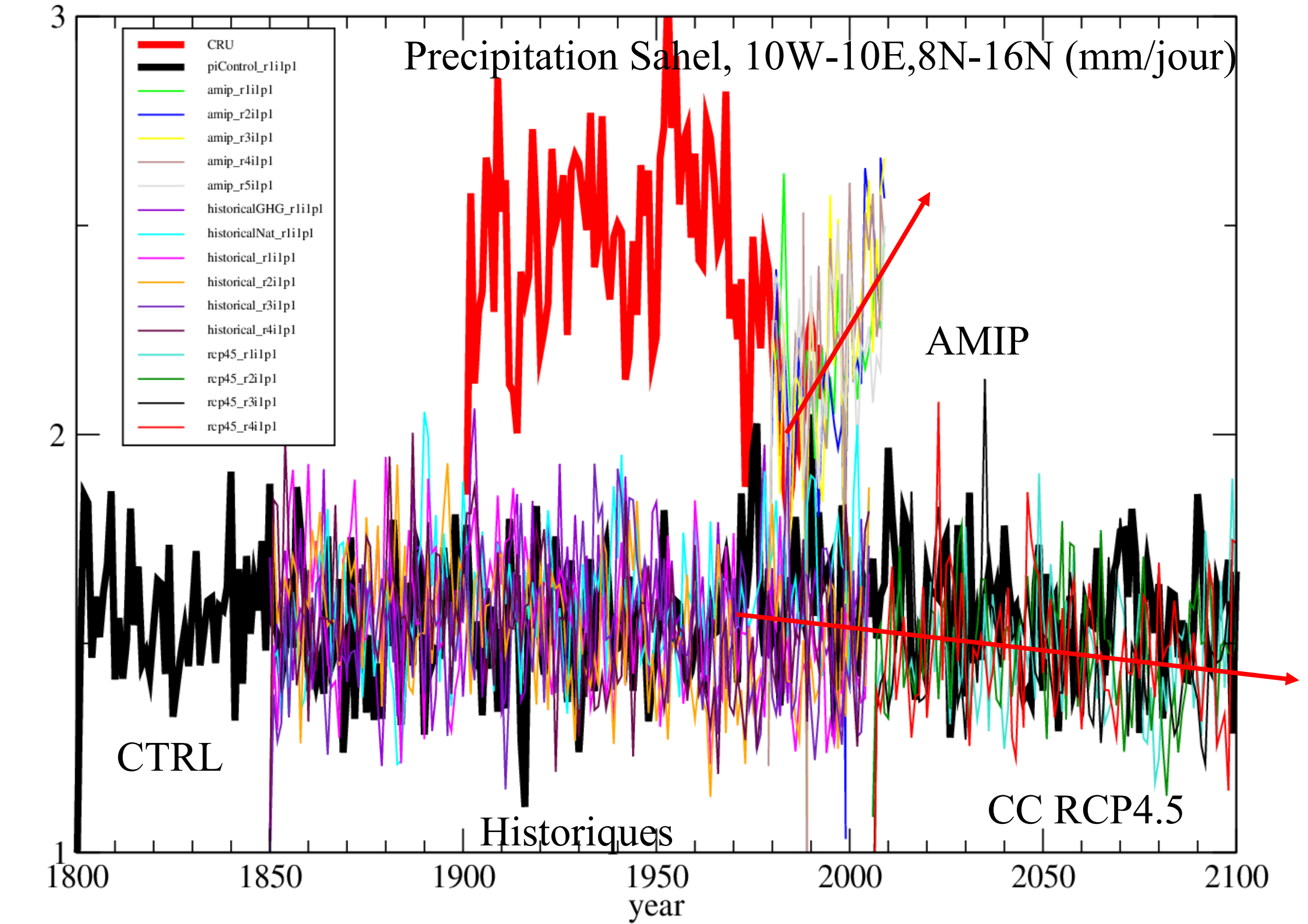
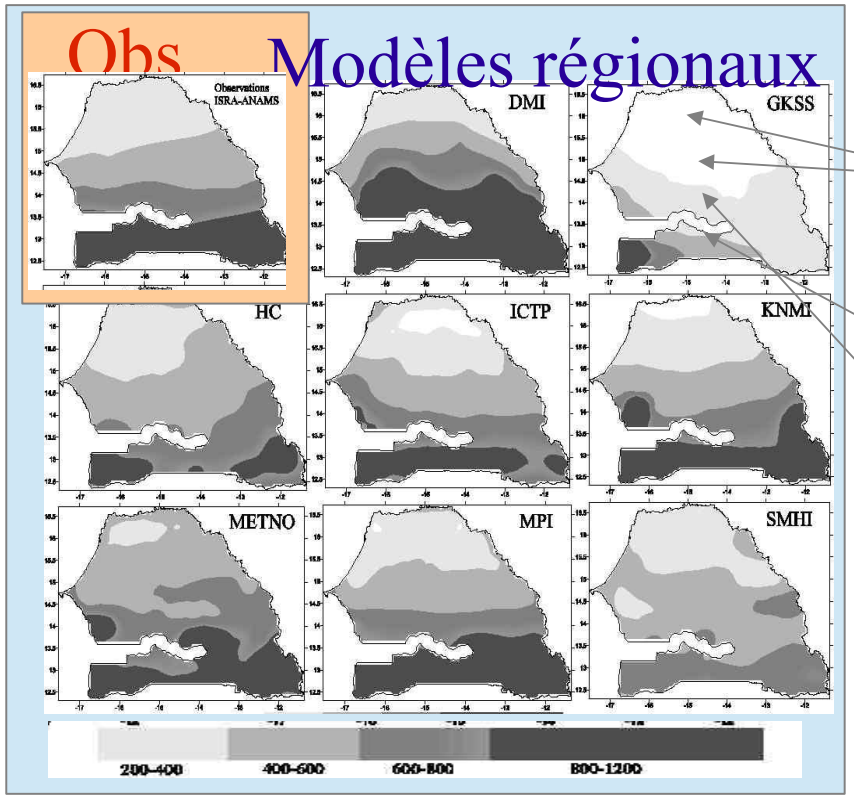
4
5
6
7
8
CRU
CPC
IPSL-CM5A-L
IPSL-CM5B-L
CCSM4
CNRM-CM5
CSIRO-Mk3-6
CanAM4
FGOALS-g2
FGOALS-s2
HadGEM2-A
MIROC5
MPI-ESM-LR
MPI-ESM-MR
MRI-AGCM3-
MRI-AGCM3-
MRI-CGCM3

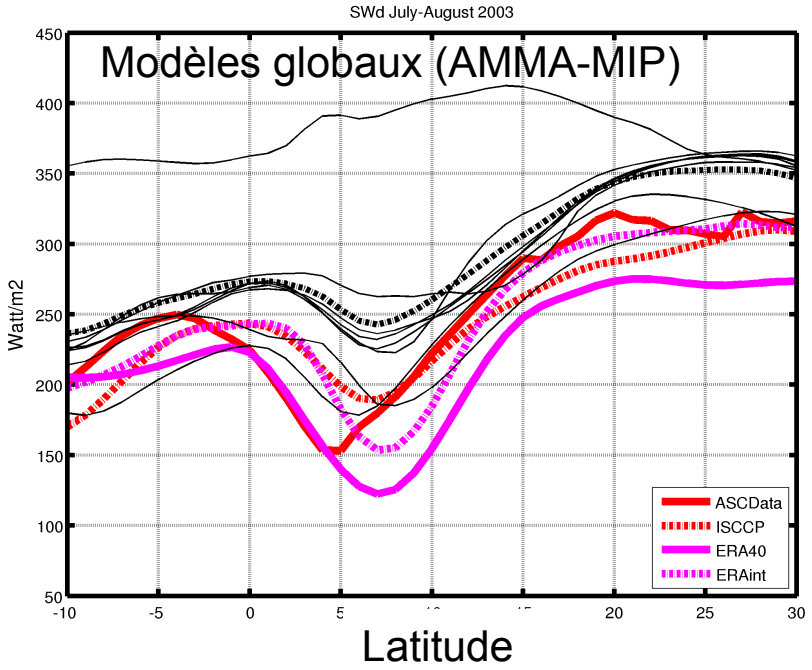

CCSM4
CNRM−CM5
CSIRO−Mk3−6−0
CanAM4
FGOALS−g2
FGOALS−s2
GFDL−HIRAM−C180
GFDL−HIRAM−C360
HadGEM2−A
IPSL−CM5A−LR
MIROC5
MPI−ESM−LR
MPI−ESM−MR
MRI−AGCM3−2H
MRI−AGCM3−2S
MRI−CGCM3
OBS
30°N
20°N
10°N
0°
10°S
20°W
0°
20°E
40°E
12
8
4
2
1
0.5
0.2
−0.2
−0.5
−1
−2
−4
−8
−12

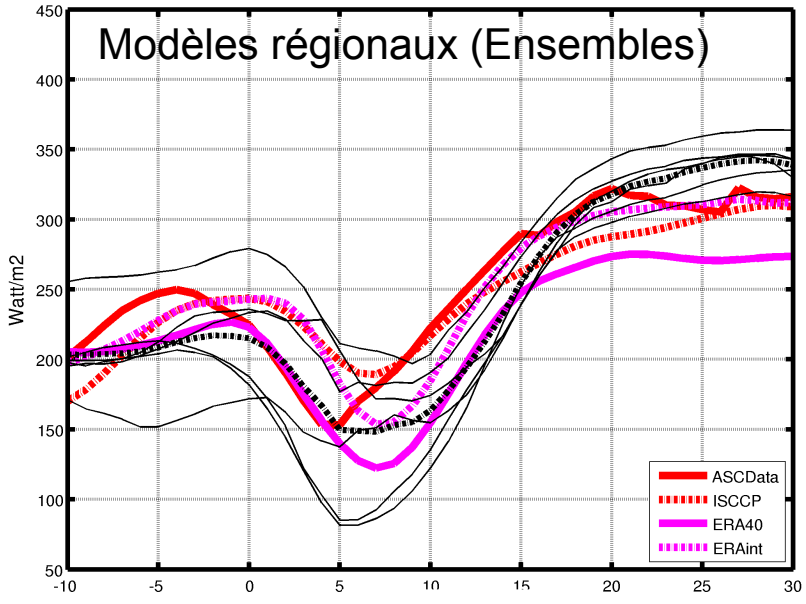

Temperature Sahel, 10W-10E,8N-16N (°C)
T2m.Sahel
piControl_r1i1p1
amip4K_r1i1p1
amip4xCO2_r1i1p1
amipFuture_r1i1p1
amip_r1i1p1
amip_r2i1p1
amip_r3i1p1
amip_r4i1p1
amip_r5i1p1
historicalGHG_r1i1p1
historicalNat_r1i1p1
historical_r1i1p1
historical_r2i1p1
historical_r3i1p1
historical_r4i1p1
rcp45_r1i1p1
rcp45_r2i1p1
rcp45_r3i1p1
rcp45_r4i1p1
AMIP
CTRL
Historiques
CC RCP4.5
30
29
28
27
26
25
24
23
22
1800
1850
1900
1950
2000
2050
2100
year


Precipitation Sahel, 10W-10E,8N-16N (mm/jour)
CRU
piControl_r1i1p1
amip_r1i1p1
amip_r2i1p1
amip_r3i1p1
amip_r4i1p1
amip_r5i1p1
historicalGHG_r1i1p1
historicalNat_r1i1p1
historical_r1i1p1
historical_r2i1p1
historical_r3i1p1
historical_r4i1p1
rcp45_r1i1p1
rcp45_r2i1p1
rcp45_r3i1p1
rcp45_r4i1p1
AMIP
CTRL
Historiques
CC RCP4.5
3
2
1
1800
1850
1900
1950
2000
2050
2100
year

Impact des pauses pluviométriques sur les rendements (plus généralement de la distribution intra-saisonnière de la pluie)

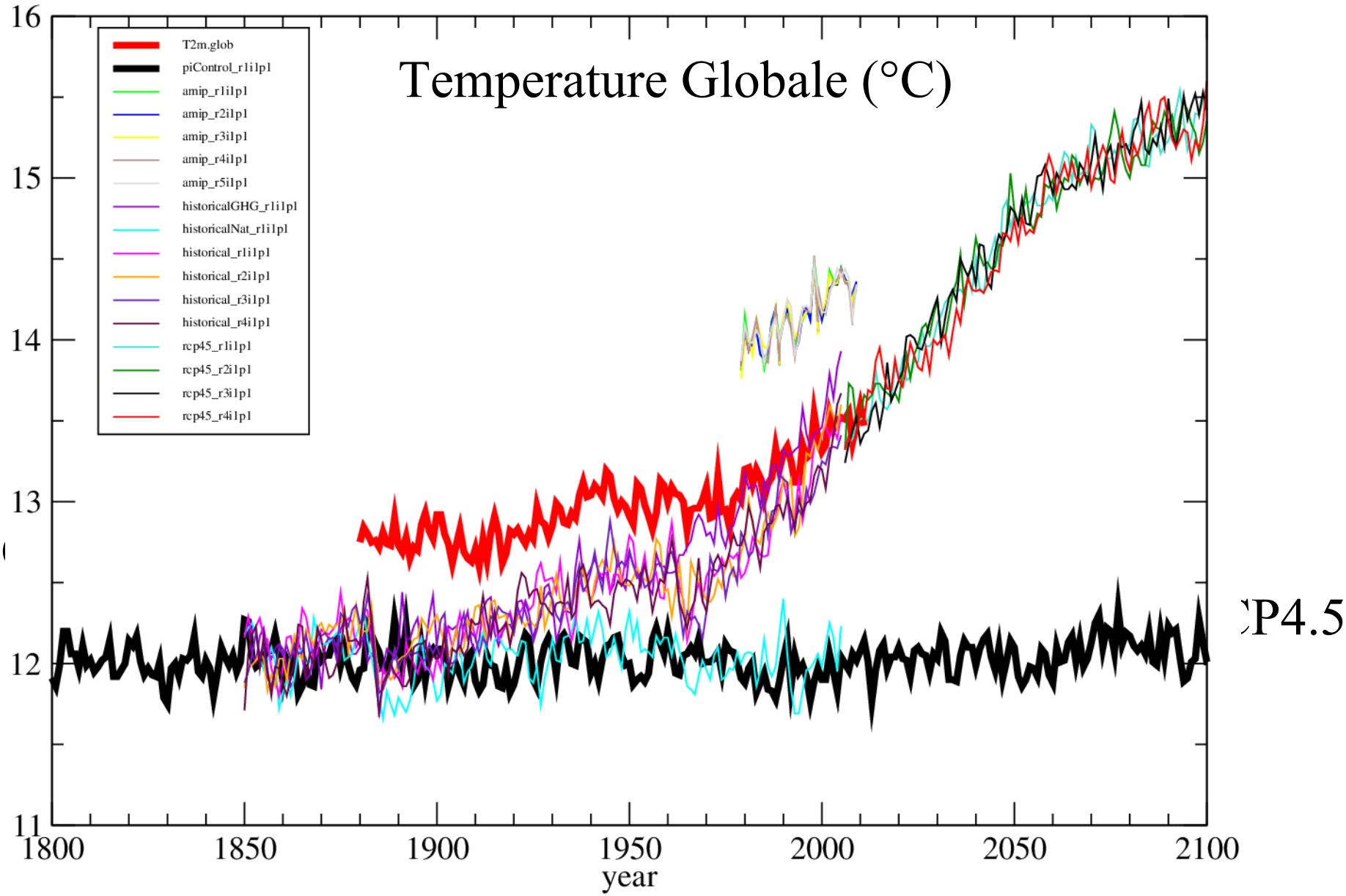






es au nord

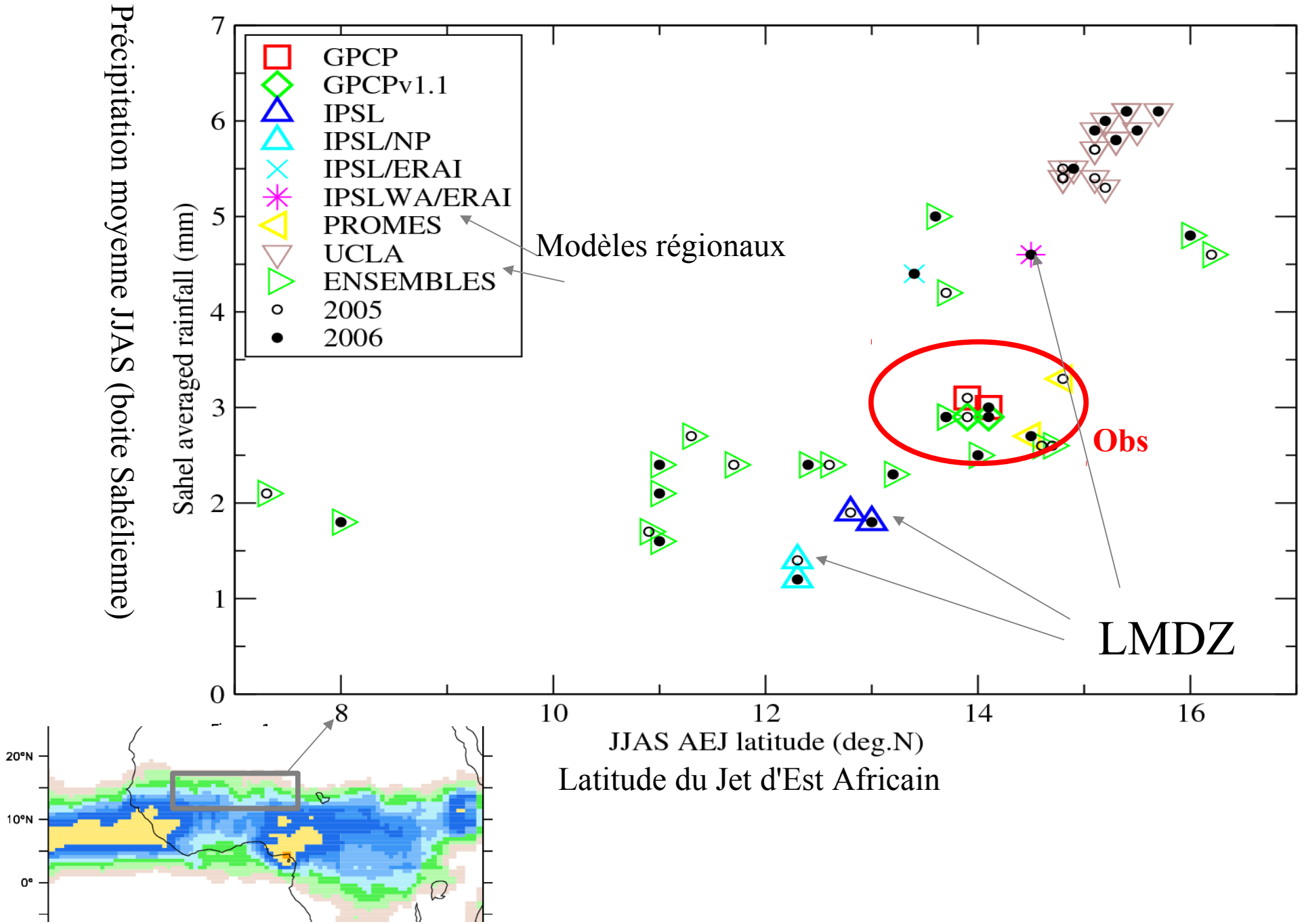
Salack Seyni, Benjamin Sultan, Pascal Oettli, Bertrand Muller,


Temperature Globale (°C)
T2m.glob
piControl_r1i1p1
amip_r1i1p1
amip_r2i1p1
amip_r3i1p1
amip_r4i1p1
amip_r5i1p1
historicalGHG_r1i1p1
historicalNat_r1i1p1
historical_r1i1p1
historical_r2i1p1
historical_r3i1p1
historical_r4i1p1
rcp45_r1i1p1
rcp45_r2i1p1
rcp45_r3i1p1
rcp45_r4i1p1
16
15
14
13
12
11
1800
1850
1900
1950
2000
2050
2100
year

CP4.5

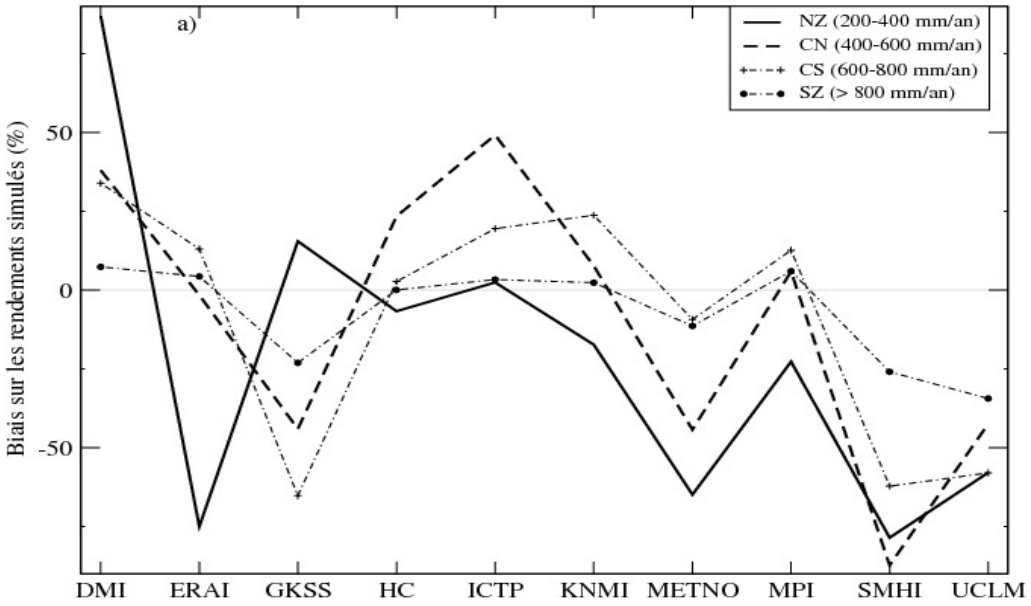
III. Evaluation des scenarios futurs

Global runs from AMMA-MIP and regional runs from ENSEMBLES

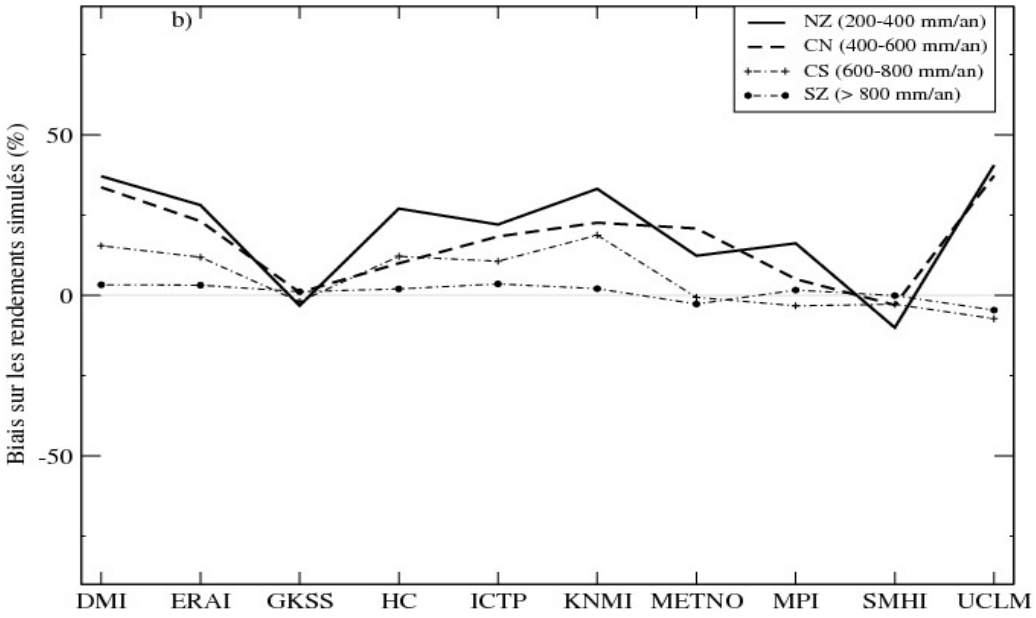


Latitude du Jet d'Est Africain

III. Etudes d'impact



Impact sur le rendement du changement de la pluie seule (pluies RCM Ensemble)



Impact de la variabilité intrasaisonnière de la pluie (avec le même cumul pour tous les modèles)

Contexte

→ Sahel zone sensible

→ Projections climatiques particulièrement incertaines

→ Modèles couplés pas fameux

→ Projet AMMA

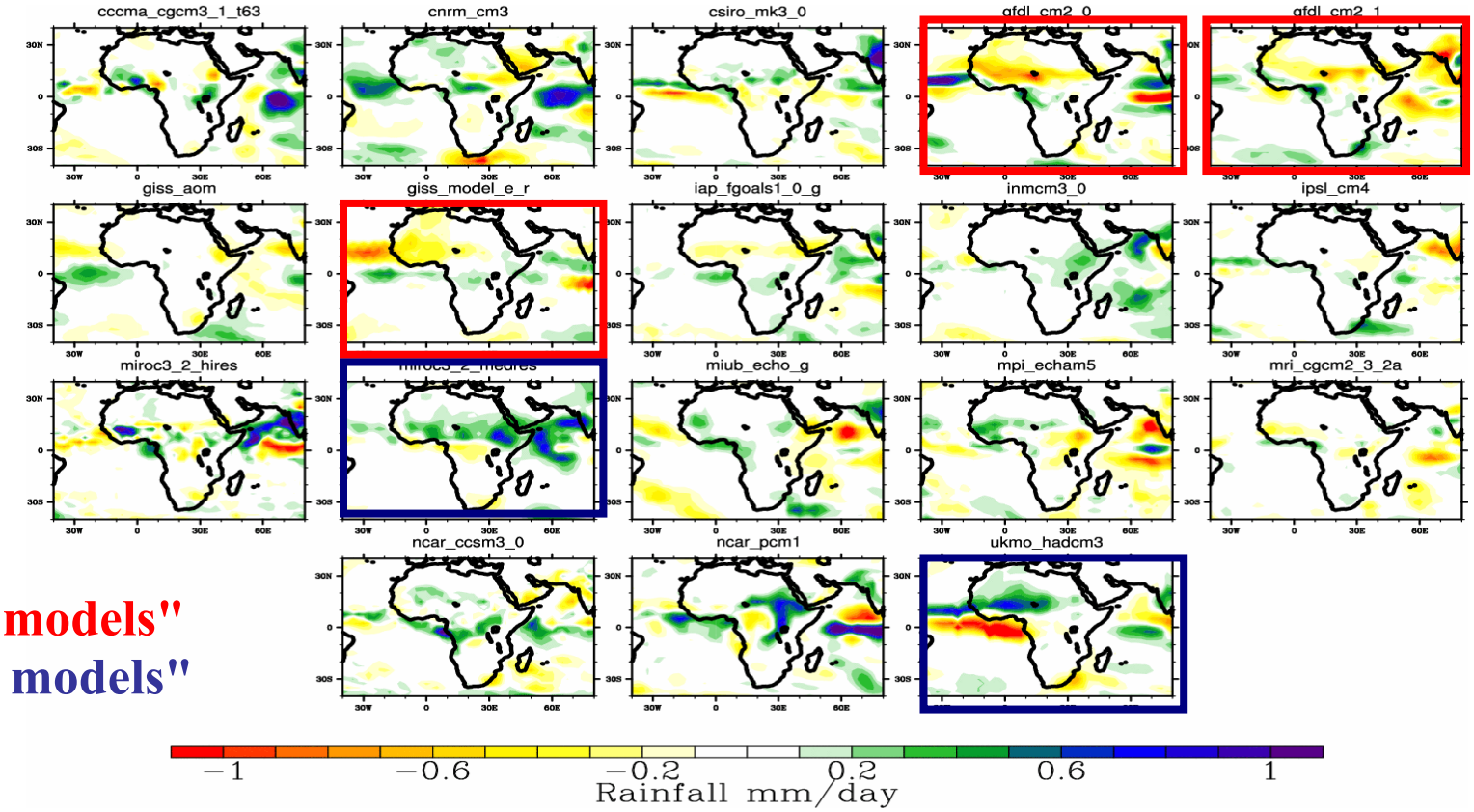
→ Collaboration LMD/LPAOSF

→ Projets CMIP et Cordex

→ Préparation IPCC AR5 I&II

Simulated rainfall trend (20th century):

XX1 (1970-99) – (1950-69) JAS.



Contexte

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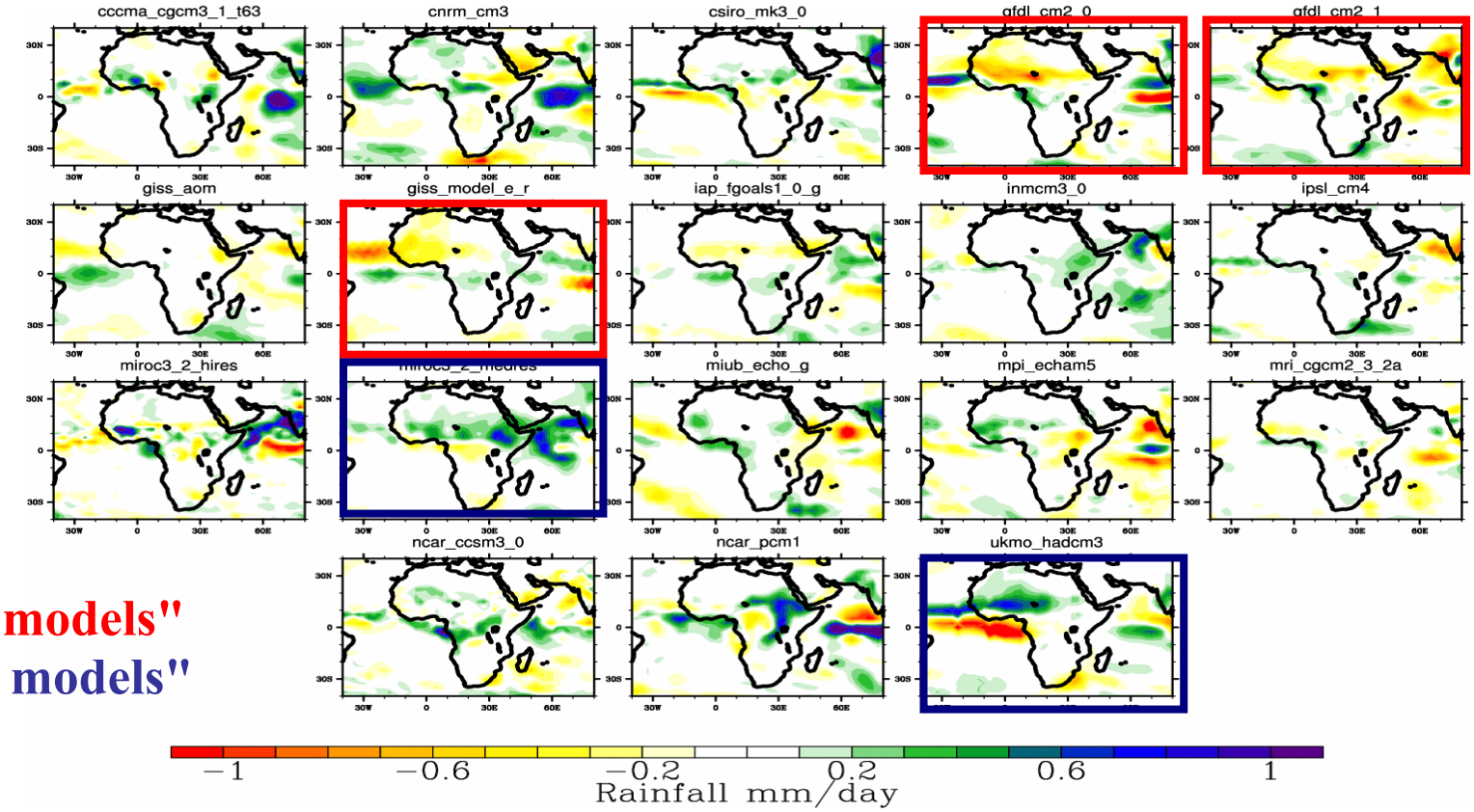
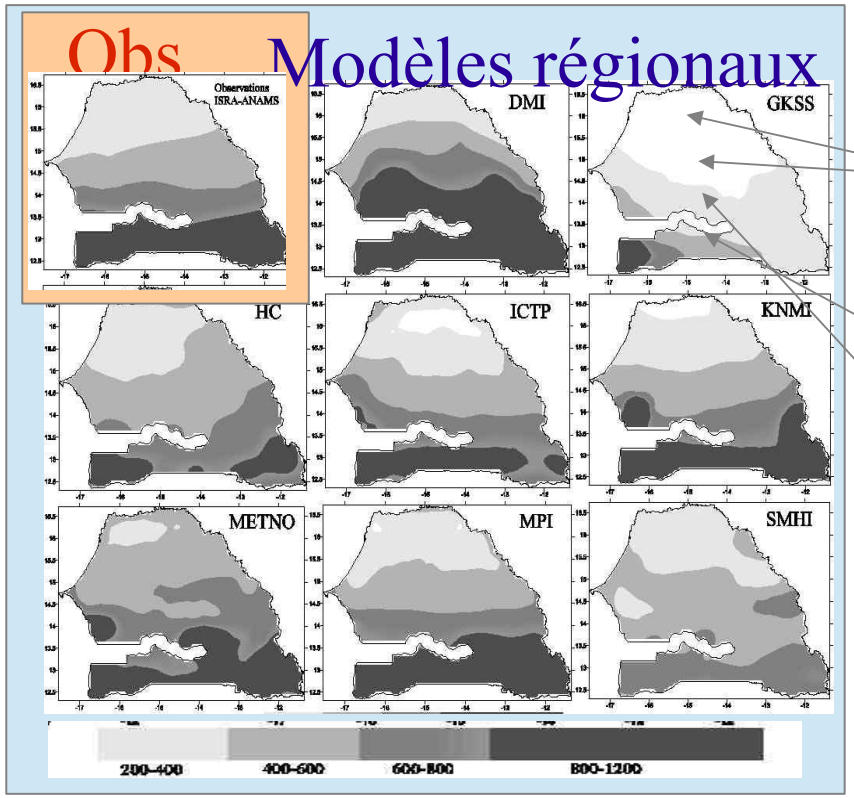
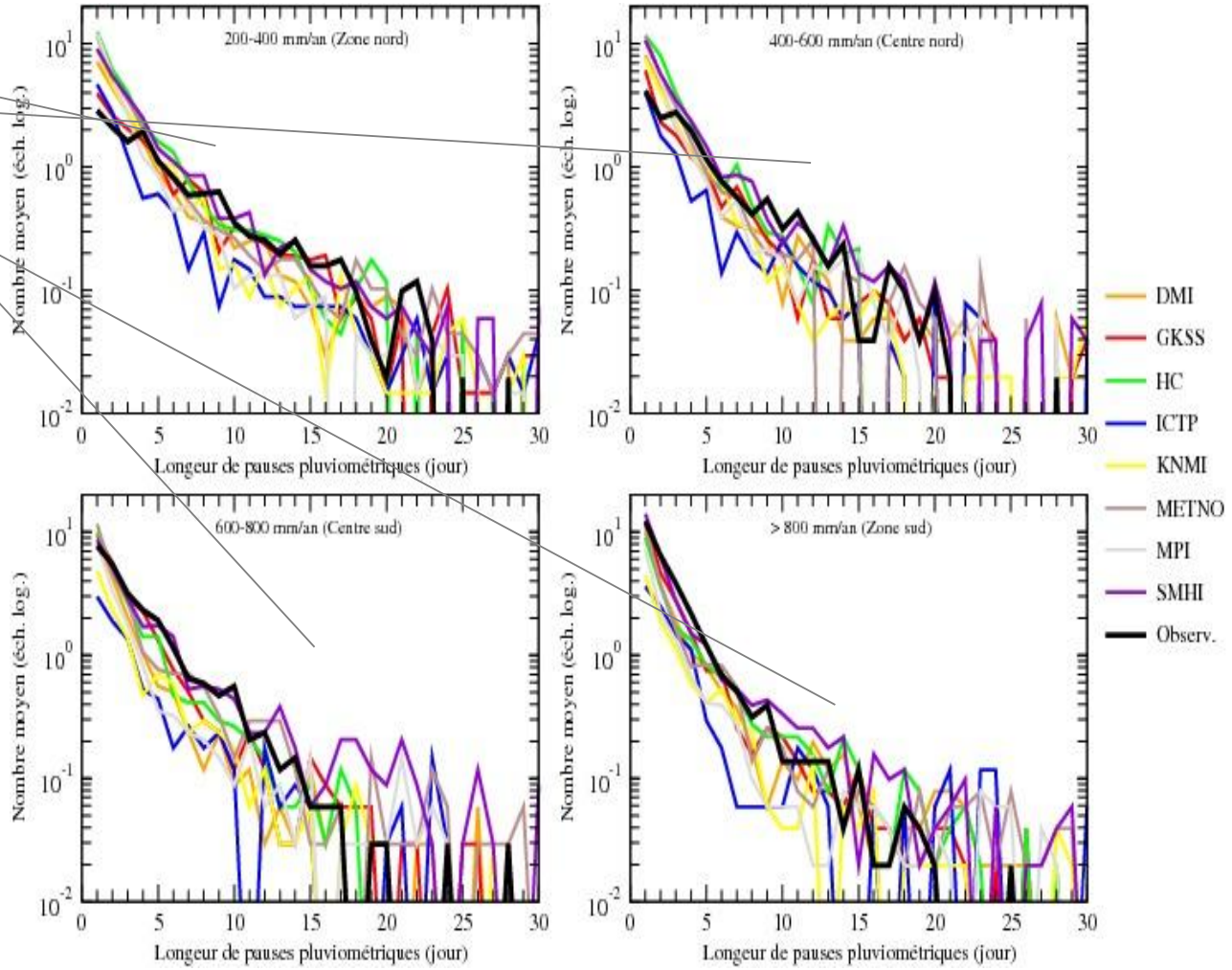


Impact des pauses pluviométriques sur les rendements (plus généralement de la distribution intra-saisonnière de la pluie)



Surestimation des pauses courtes au nord

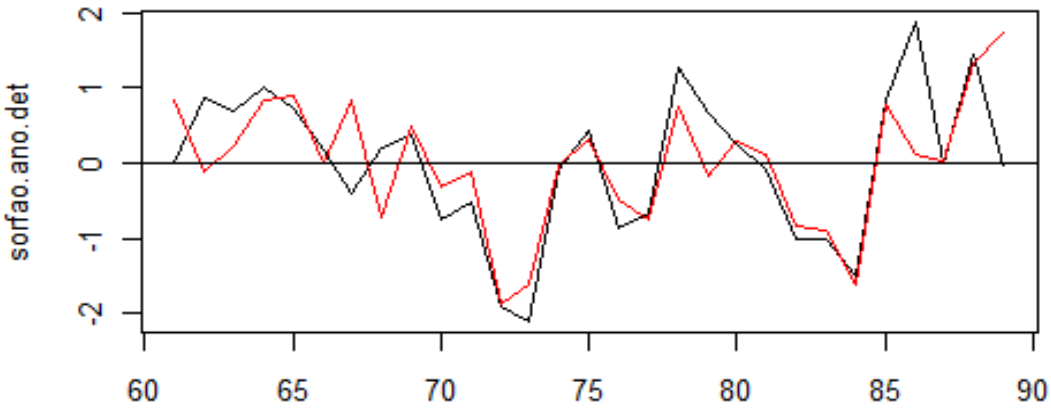


Salack Seyni, Benjamin Sultan, Pascal Oettli, Bertrand Muller, Amadou T. Gaye1, Frédéric Hourdin, soumis à Sécheresse

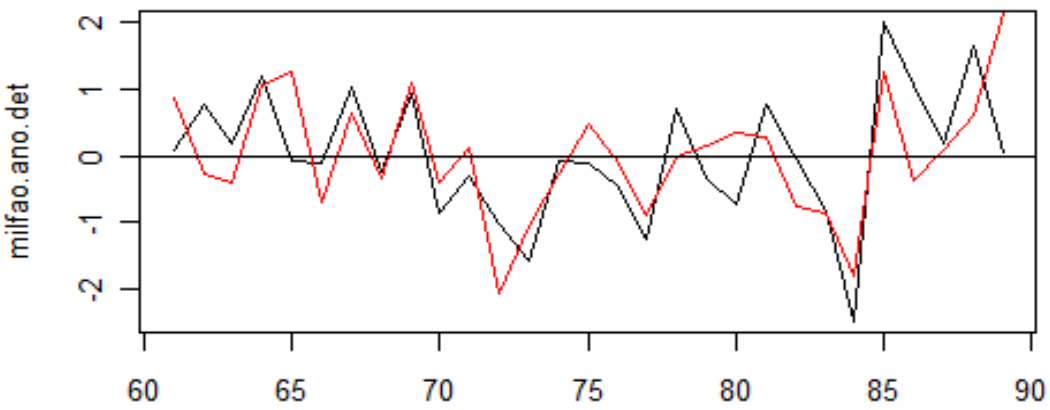
Rendement simulé vs Rendement FAO en moyenne sur toute l'Afrique de l'Ouest

Question : avez vous testé la méthodo de +dT +dPr en incast

SORGHO (R=0.71)



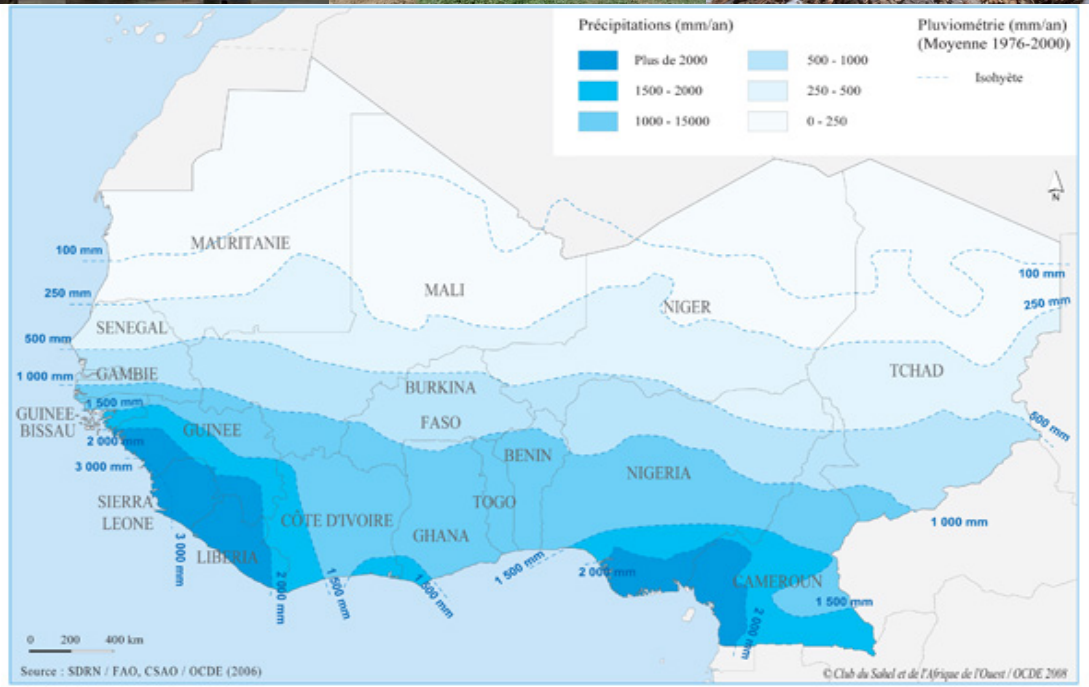
MIL (R=0.63)



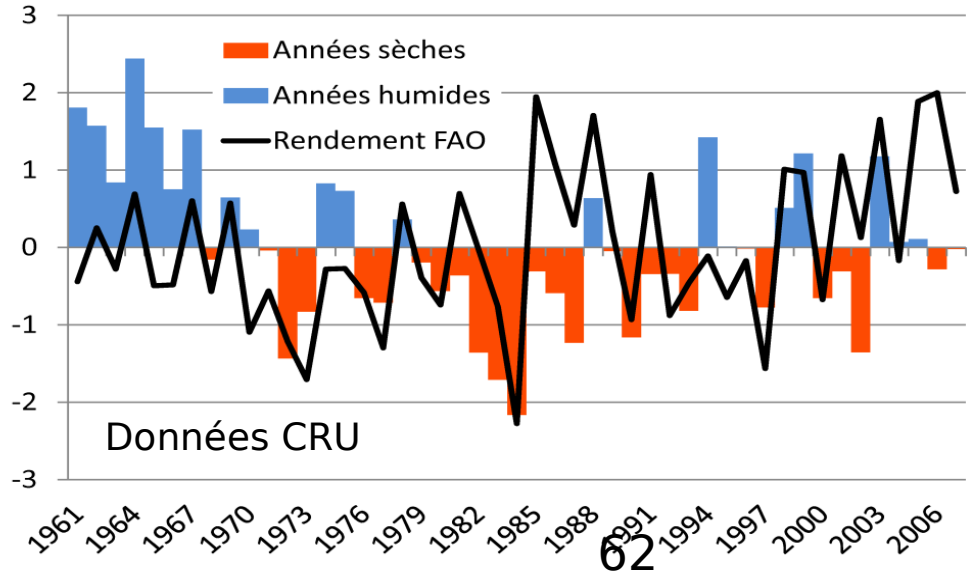
Le modèle SARRAH marche bien
(mais on a enlevé la trend et les séries sont standardisées)

Relations climat/agriculture

- Une agriculture pluviale
- Une forte variabilité pluviométrique interannuelle
- Déficit pluviométrique important dans les 70s, 80s, 90s
- Un lien important entre climat et rendement:
  - Observations
  - Perceptions

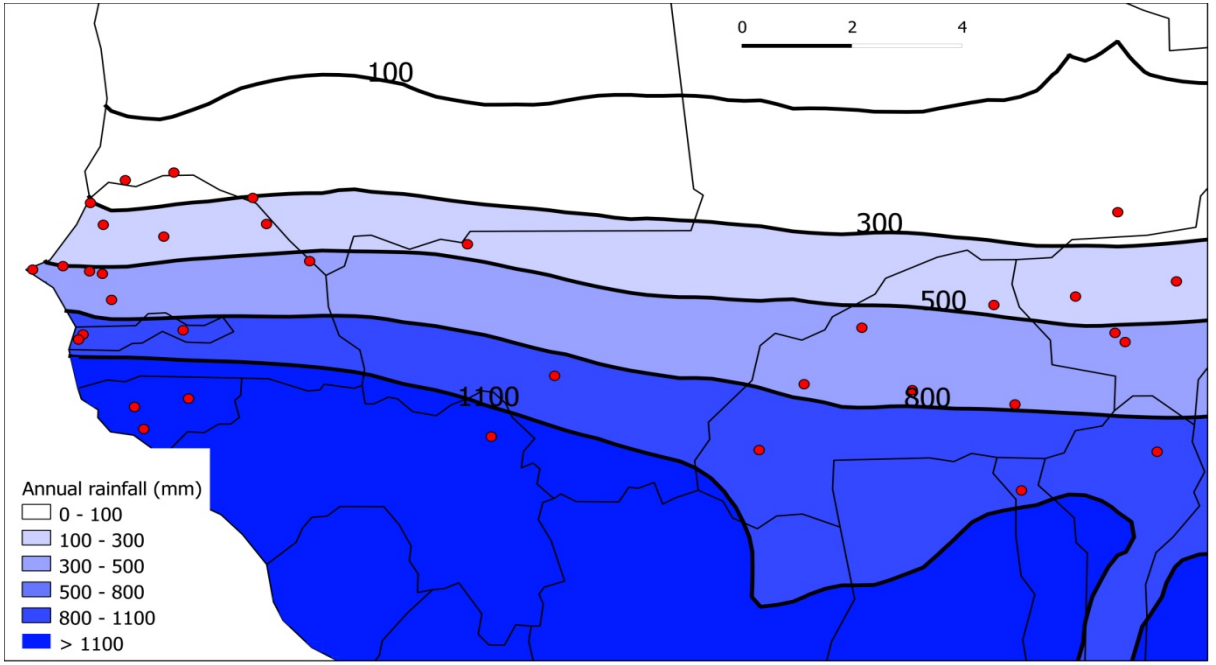


Indice standardisé



Méthodologie de l'étude d'impact

- 35 stations
- Période actuelle: 1961/1990
- 3 variétés de mil + 3 de sorgho



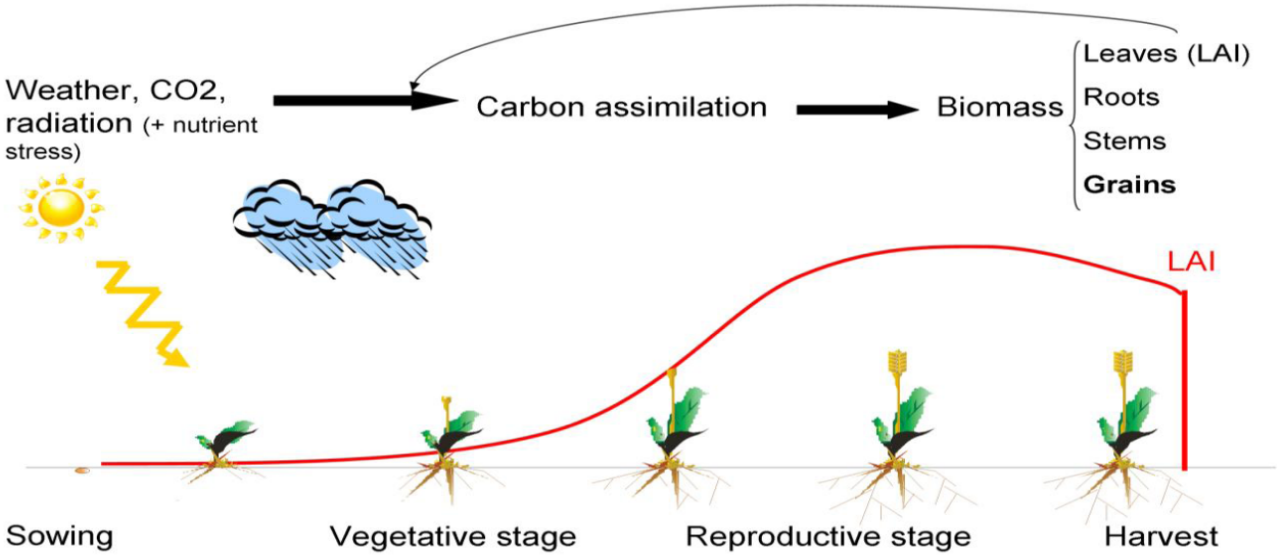
- Pluie : de -20% à +20%
- Température : de +0°C à +6°C
- Méthode des deltas
- 35 scénarii climatiques

SarraH

Dingkuhn et al. (2003)

Utilisation des scénarii comme données d'entrée pour le modèle agronomique SARRA-H

Le modèle agronomique SARRA-H



- Modèle conçu pour l'Afrique de l'Ouest
- 3 grands axes: (i) bilan hydrique, (ii) bilan carboné de la plante, (iii) phénologie de la plante

➔ Bonne représentation de l'influence du climat sur les rendements