

# Tropical variability and biases in IPSLCM-6A-LR Futur challenges

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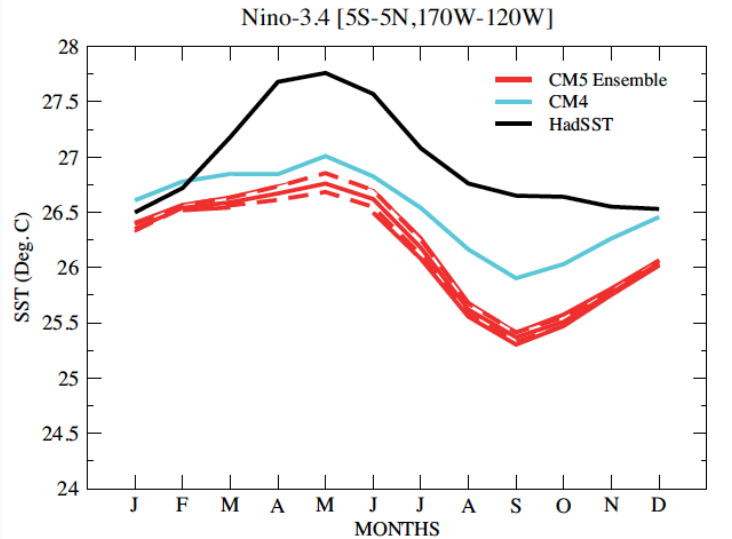
# Plan

- From CMIP4, CMIP5 to CMIP6: significant progresses, but .....
- Aerosols, tropical variability and biases in IPSLCM\_6A\_LR: a new paradigm and problem
- Ocean-atmosphere coupling and ENSO in IPSLCM\_6A\_LR: a long-standing challenge and a way forward

**A bonus:** Some parallel evaluation of IPSLCM\_6A\_LR and CNRM-CM6-1!

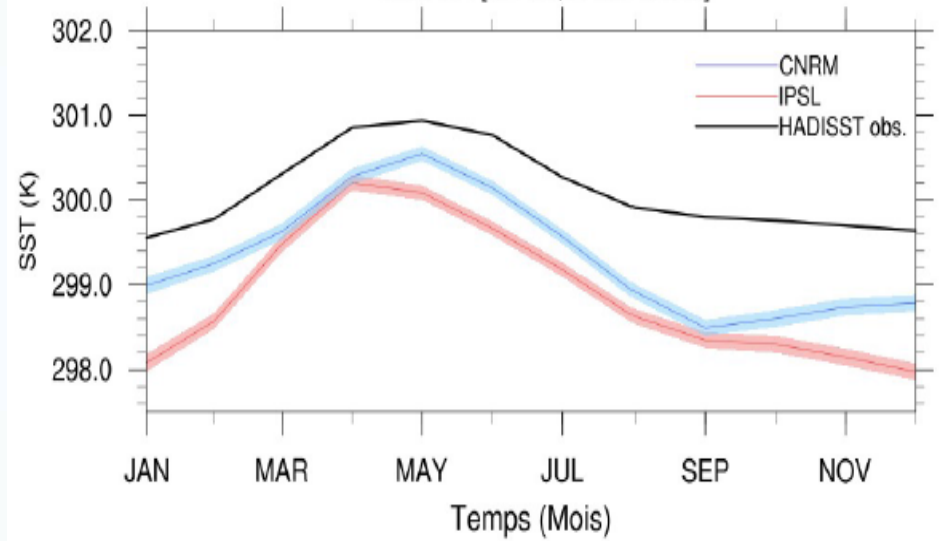
# **From CMIP4, CMIP5 to CMIP6**

## Annual Cycle of SST - IPSL-CM5

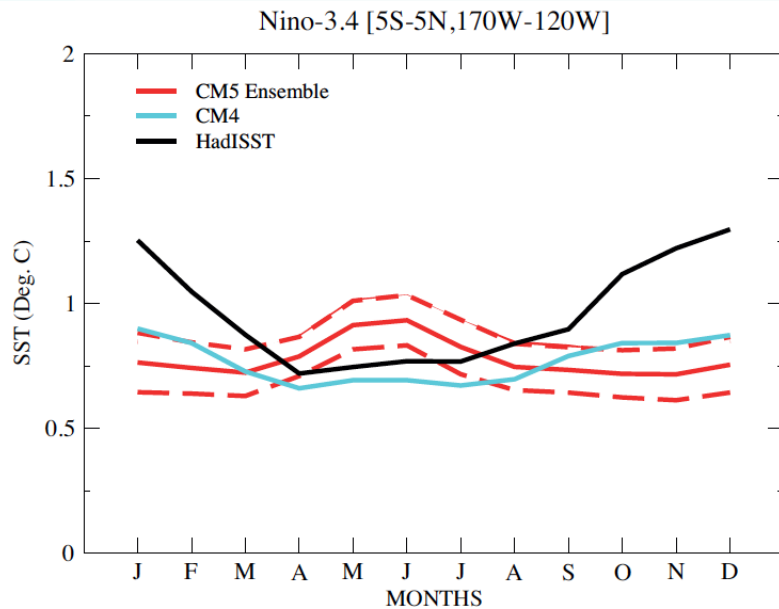


## Cycle annuel de SST (variabilite interne)

Niño 3.4 [5S-5N,170W-120W]



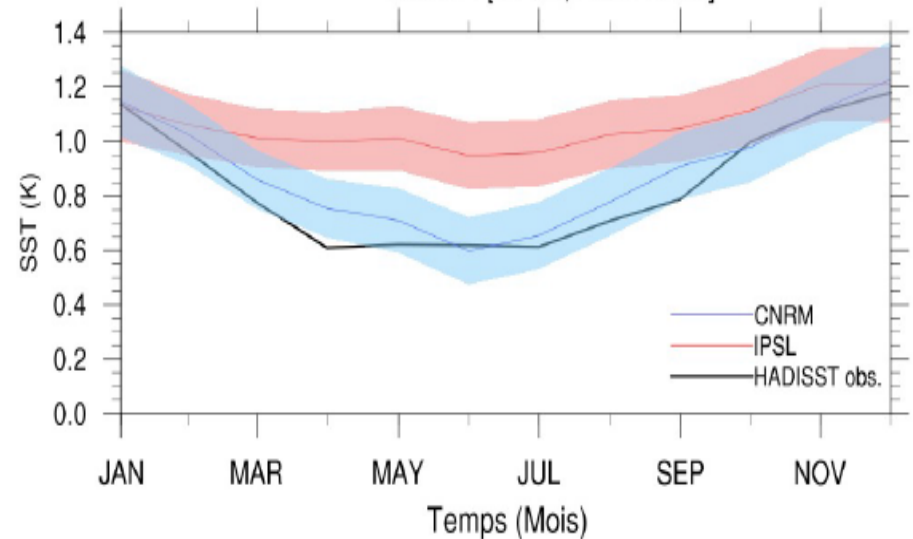
## Annual Cycle of SST Stdev during 1971-2000 - IPSL-CM5



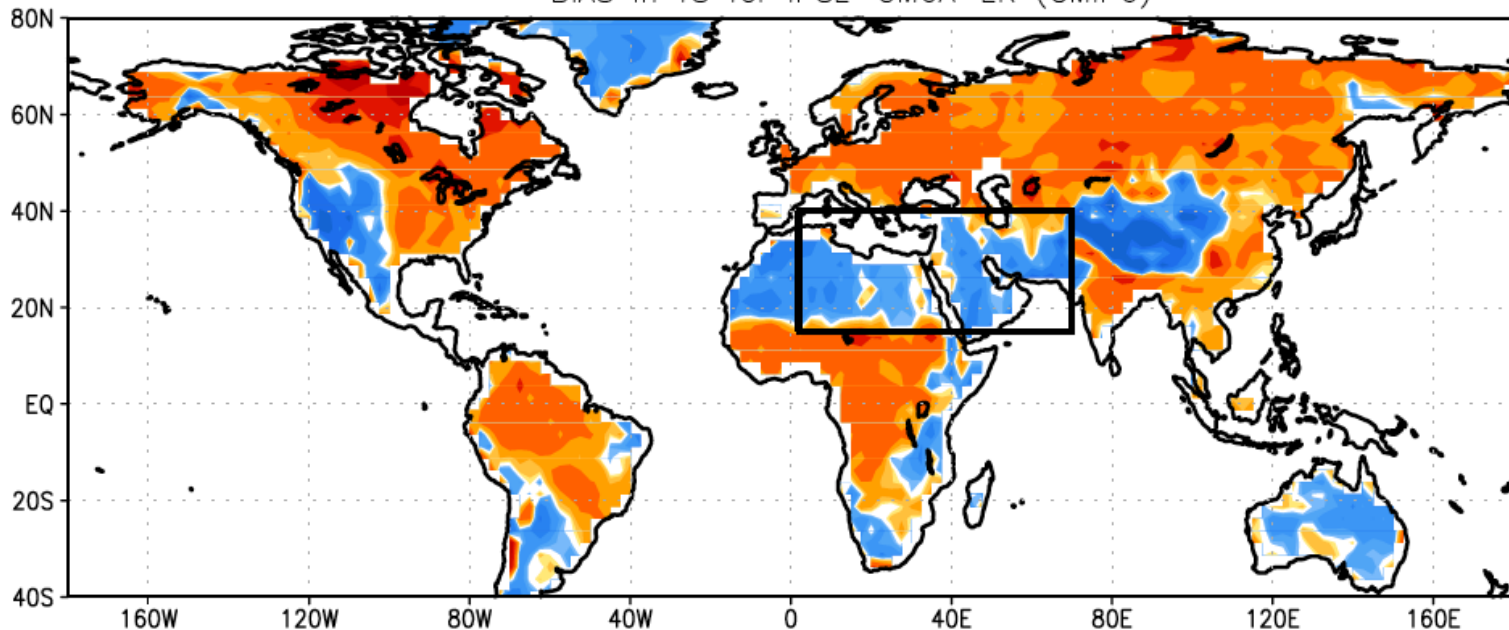
Periode: 1979-2014

## Variabilite Inter-Annuelle (variabilite interne)

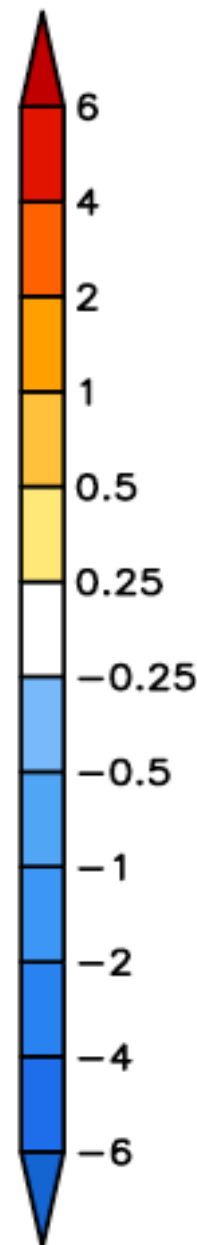
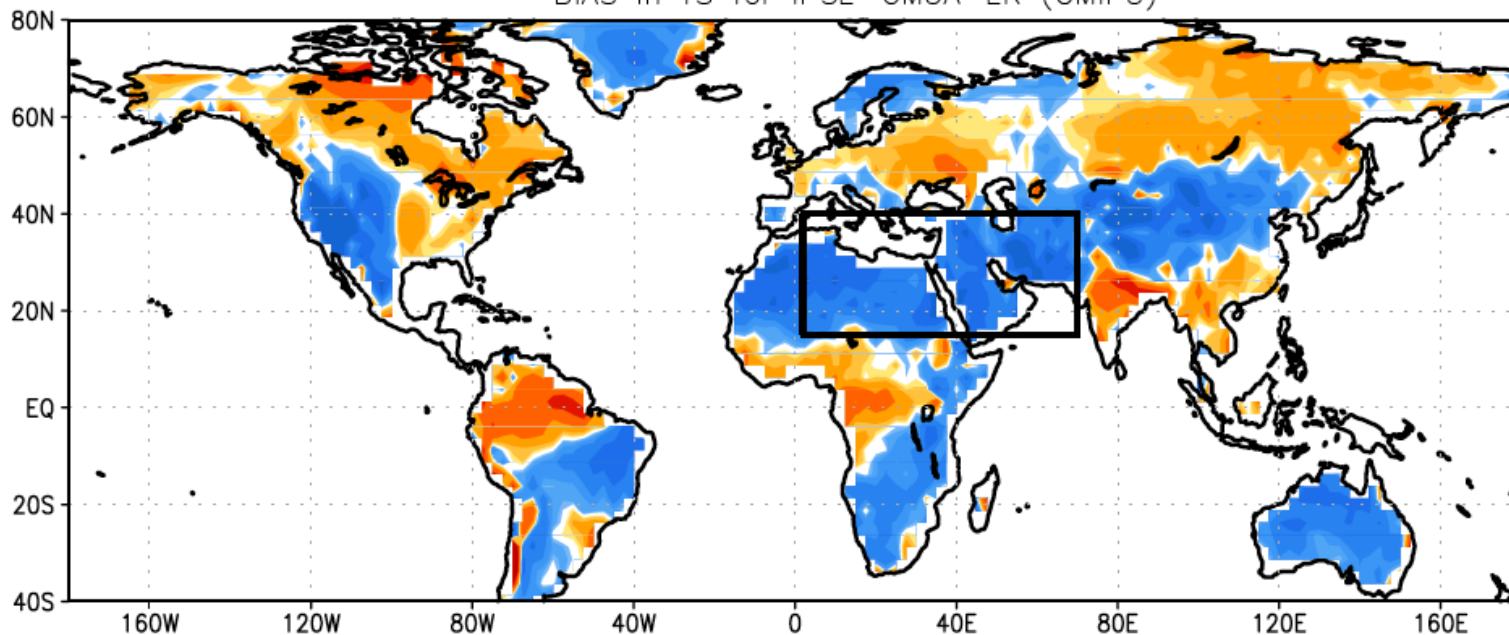
Niño 3.4 [5S-5N,170W-120W]



BIAS in TS for IPSL-CM6A-LR (CMIP6)



BIAS in TS for IPSL-CM5A-LR (CMIP5)



**NH subtropical deserts:  
Sahara, Arabia, Middle-East  
(Land : 15°–40°N, 20°W–75°E)**

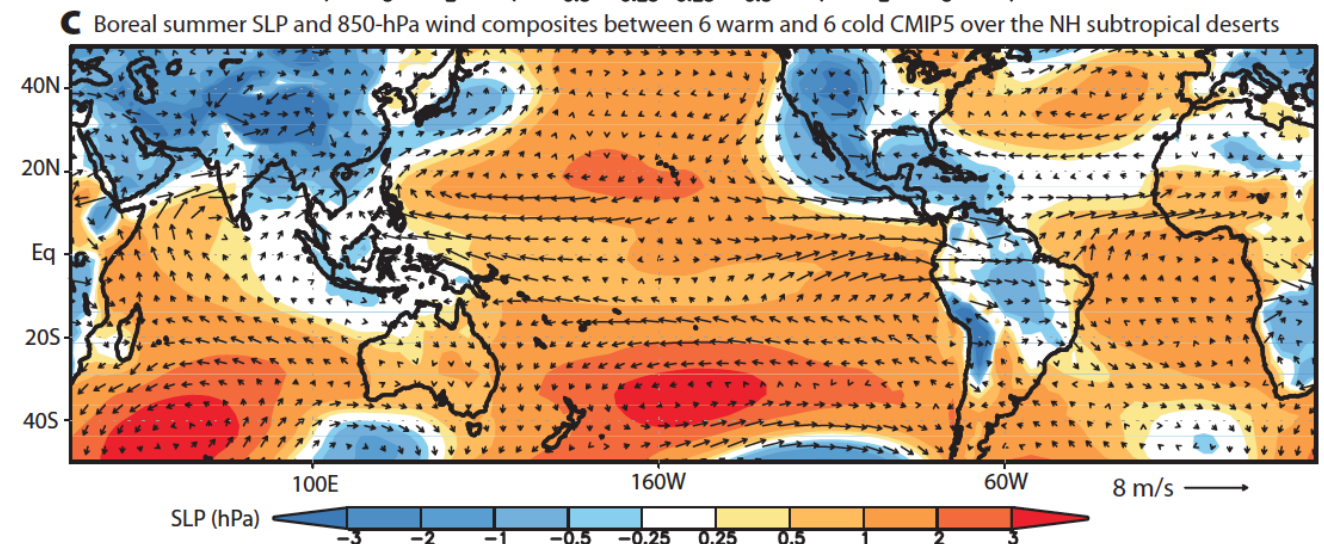
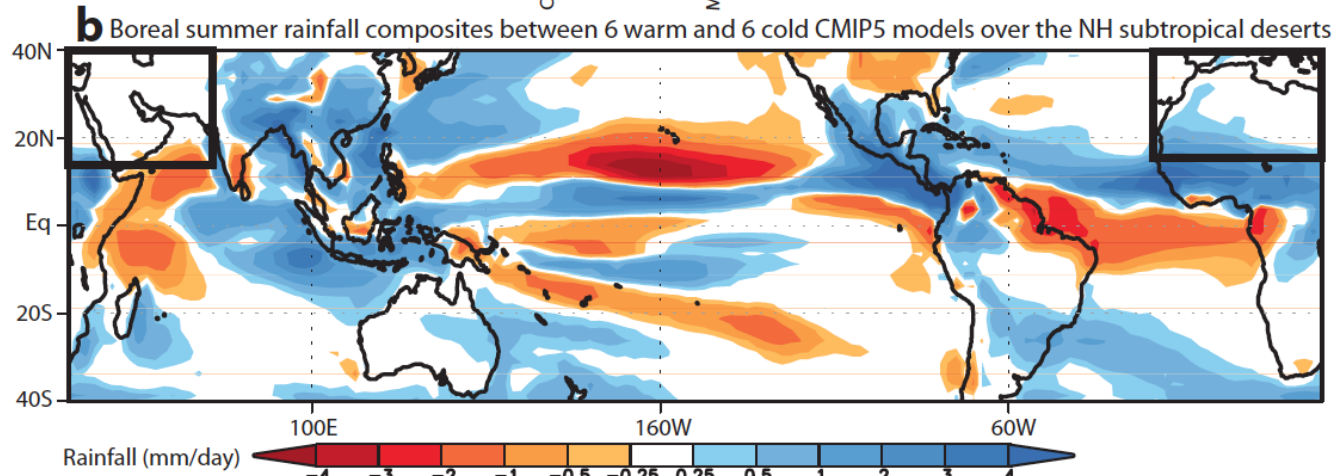
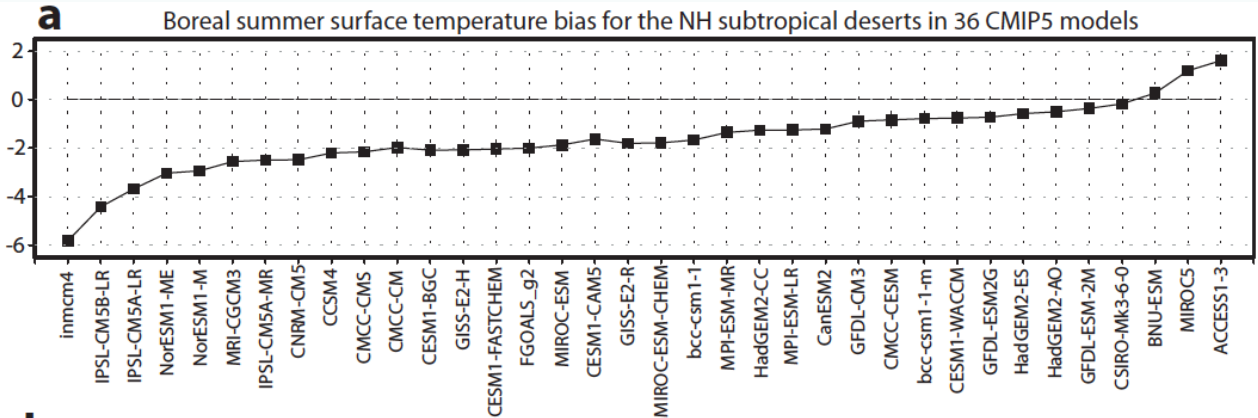
→ Suggest a possible role of the temperature and radiative flux errors over the NH subtropical deserts on the tropical rainfall biases!

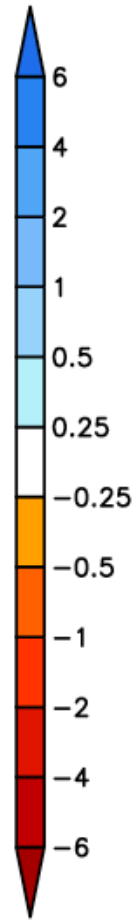
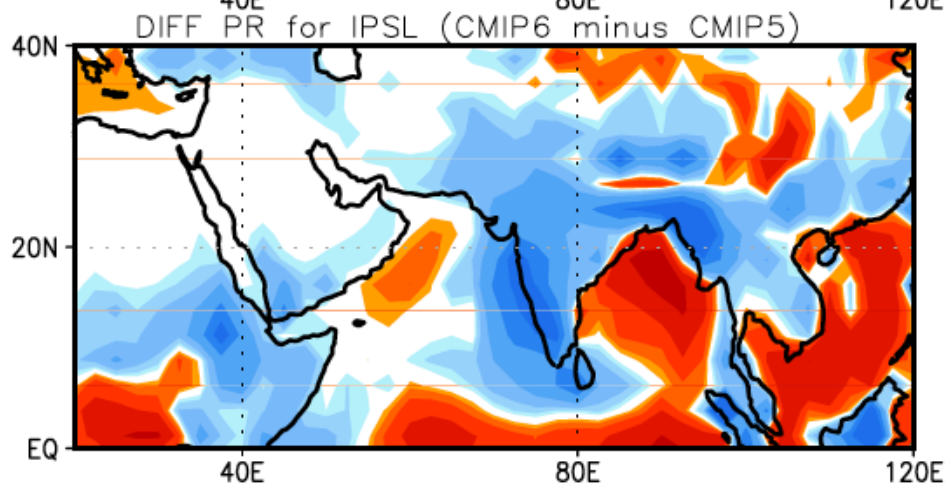
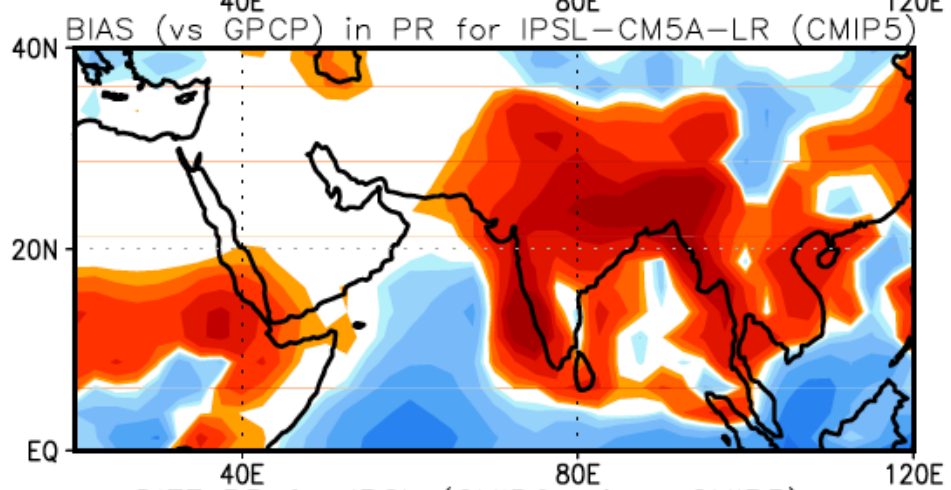
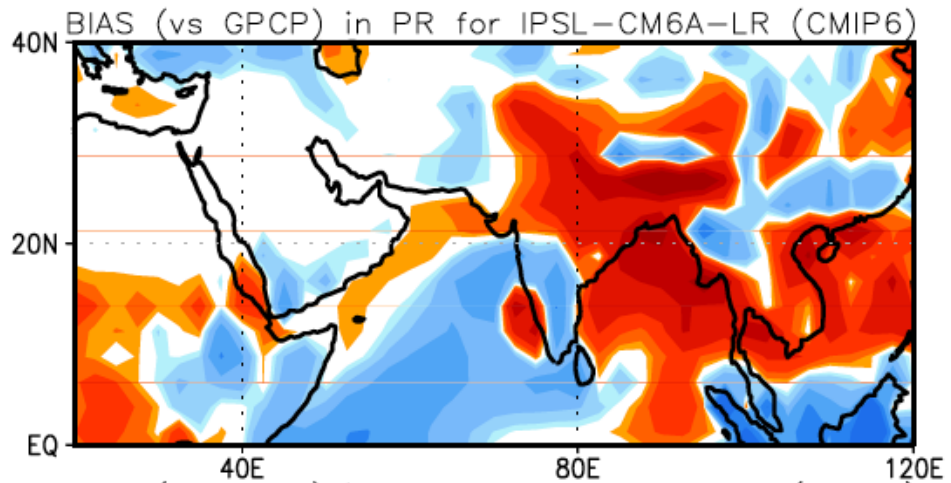
**Terray et al. (2018)**

doi:[10.1007/s00382-017-3956-7](https://doi.org/10.1007/s00382-017-3956-7)

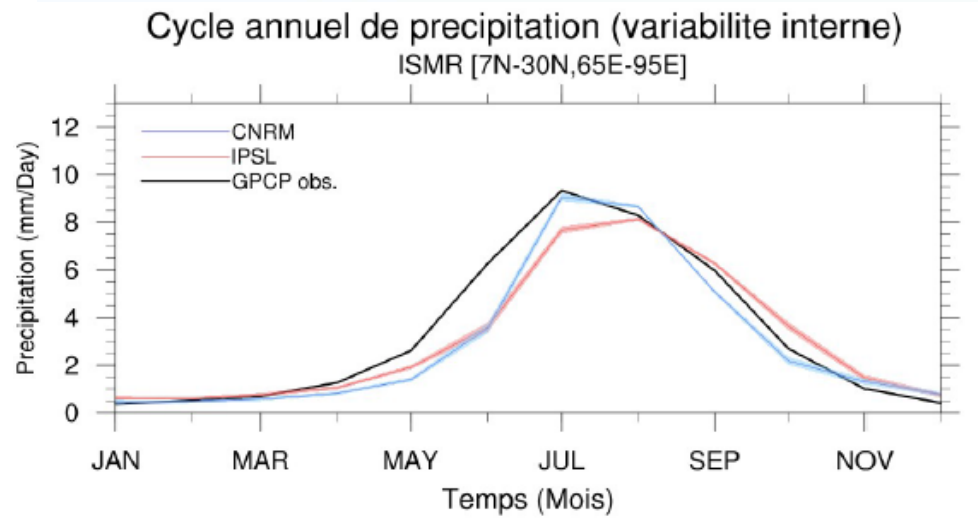
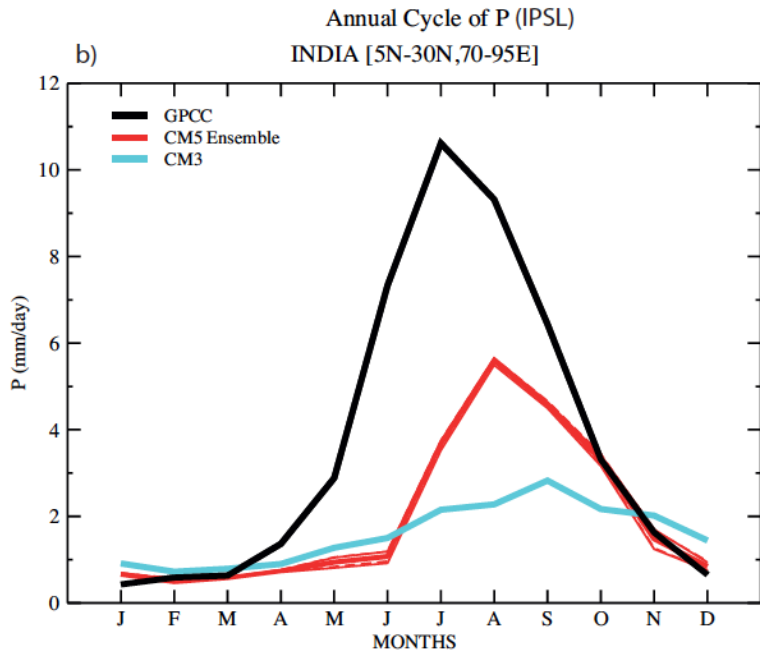
**Sooraj et al. (2019)**

doi:[10.1007/s00382-018-4396-8](https://doi.org/10.1007/s00382-018-4396-8)





## Indian monsoon annual cycle (ISMR index)

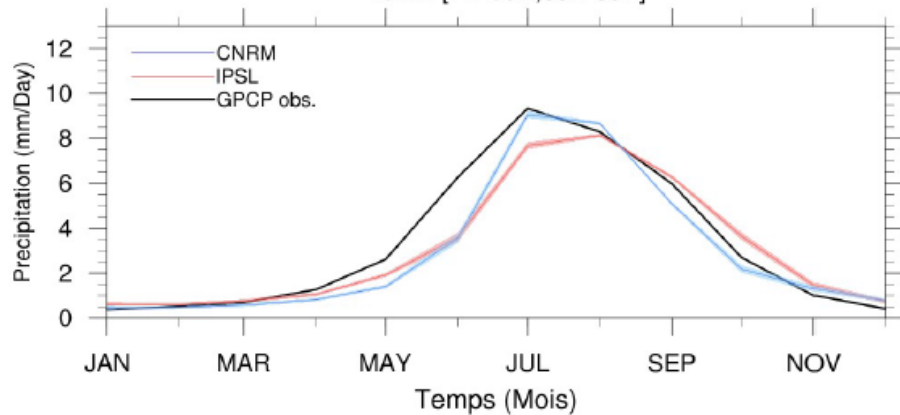




# **Aerosols, tropical variability and biases**

### Cycle annuel de precipitation (variabilite interne)

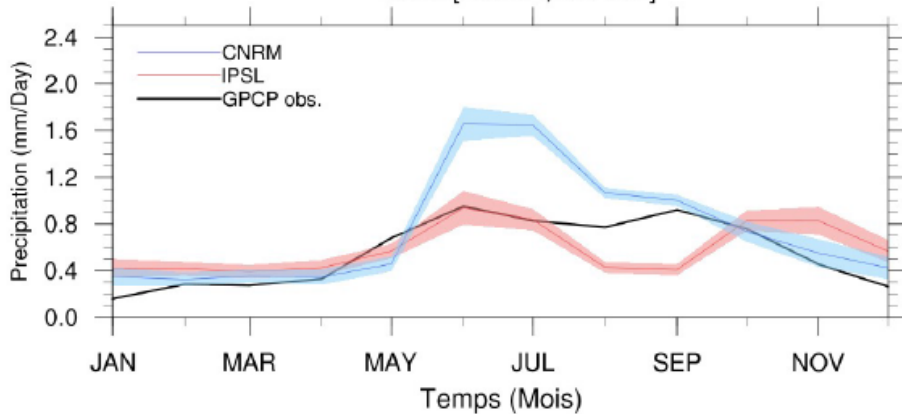
ISMR [7N-30N,65E-95E]



Periode: 1979-2014

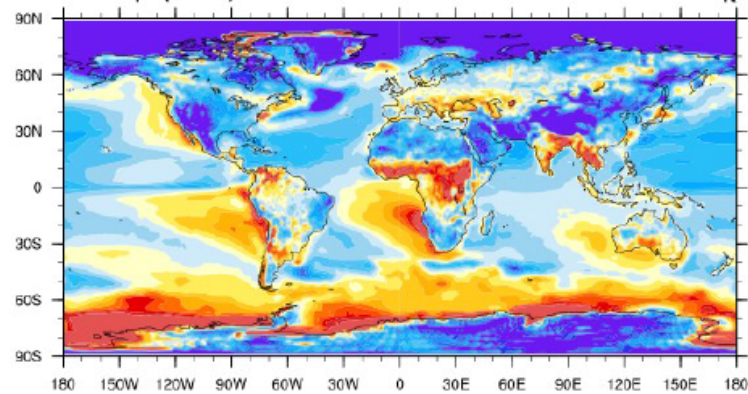
### Variabilite Inter-Annuelle (variabilite interne)

ISMR [7N-30N,65E-95E]



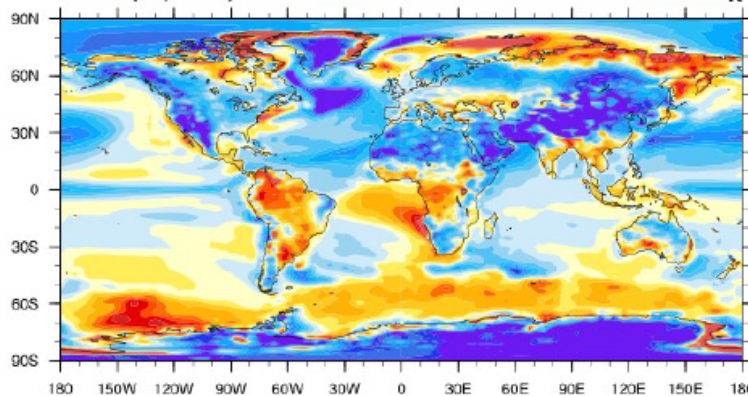
### Biais de Skin Temperature (1979-2014) [CNRM-ERAi]

Printemps (FMAM)



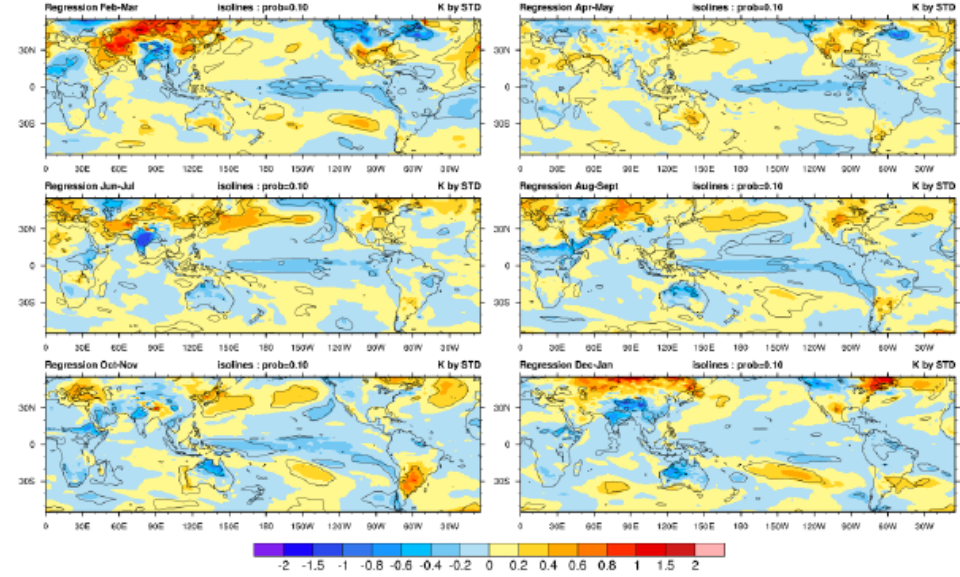
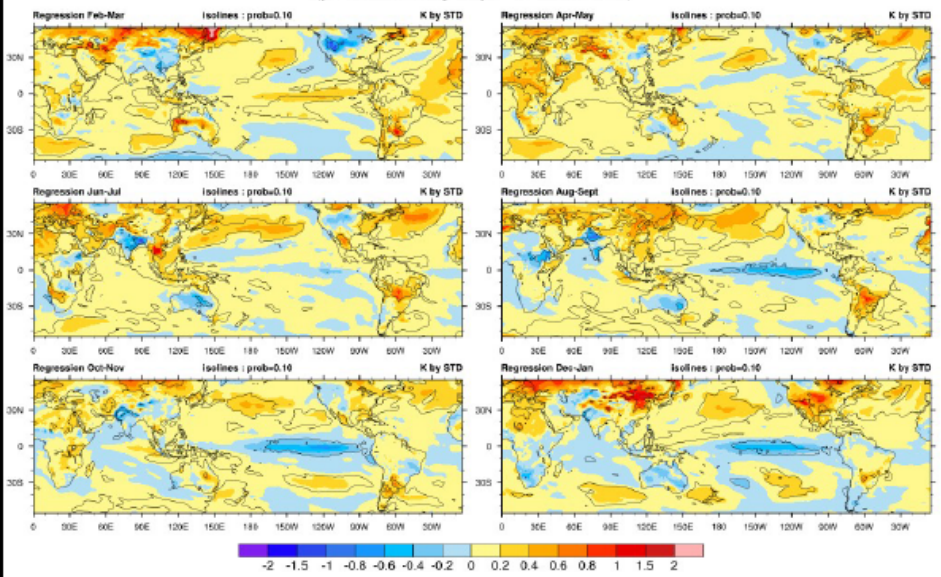
### Biais de Skin Temperature (1979-2014) [IPSL-ERAi]

Printemps (FMAM)

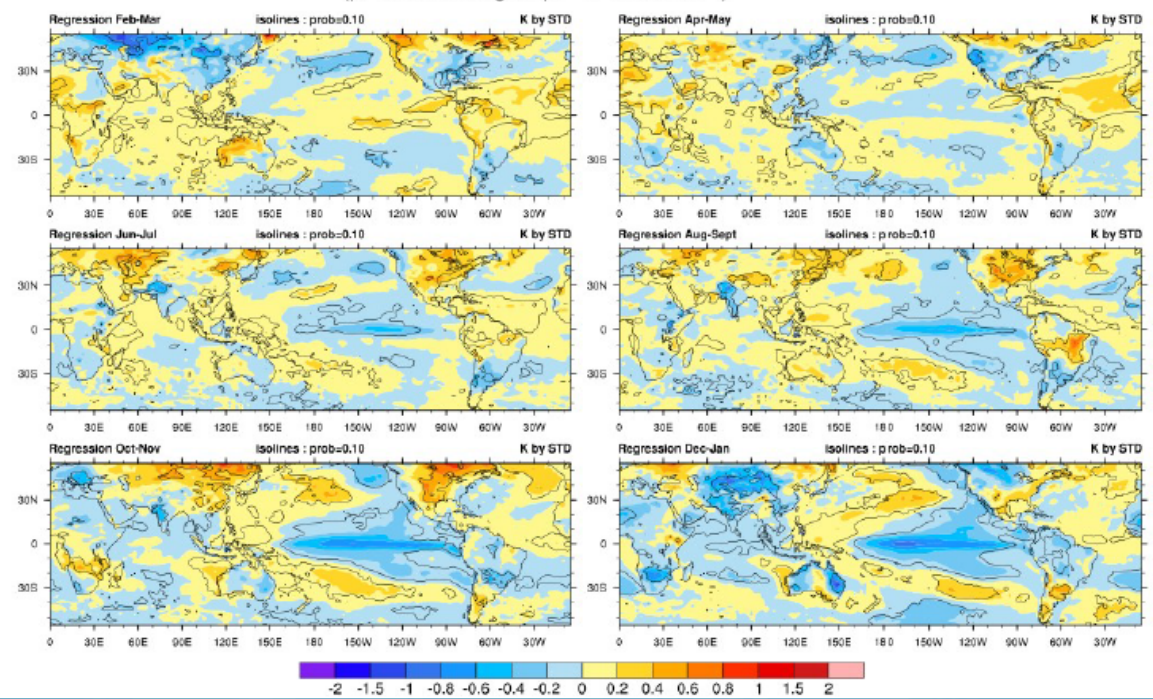


Skin temperature : [CNRM] regressed on the ISMR index  
(pi=Jun-Jul-Aug-Sept t=1979-2014)

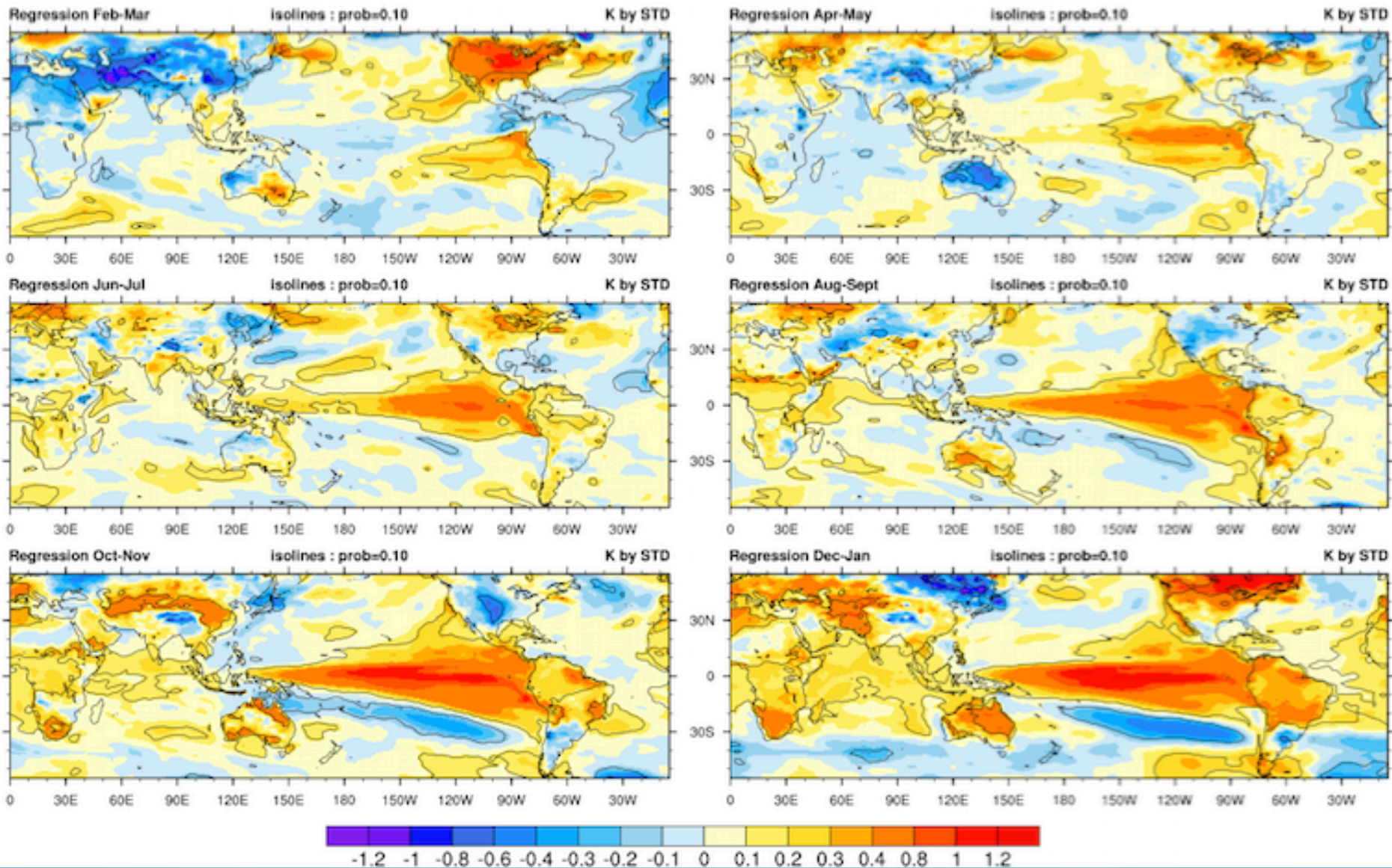
Skin temperature : [IPSL] regressed on the ISMR index  
(pi=Jun-Jul-Aug-Sept t=1979-2014)



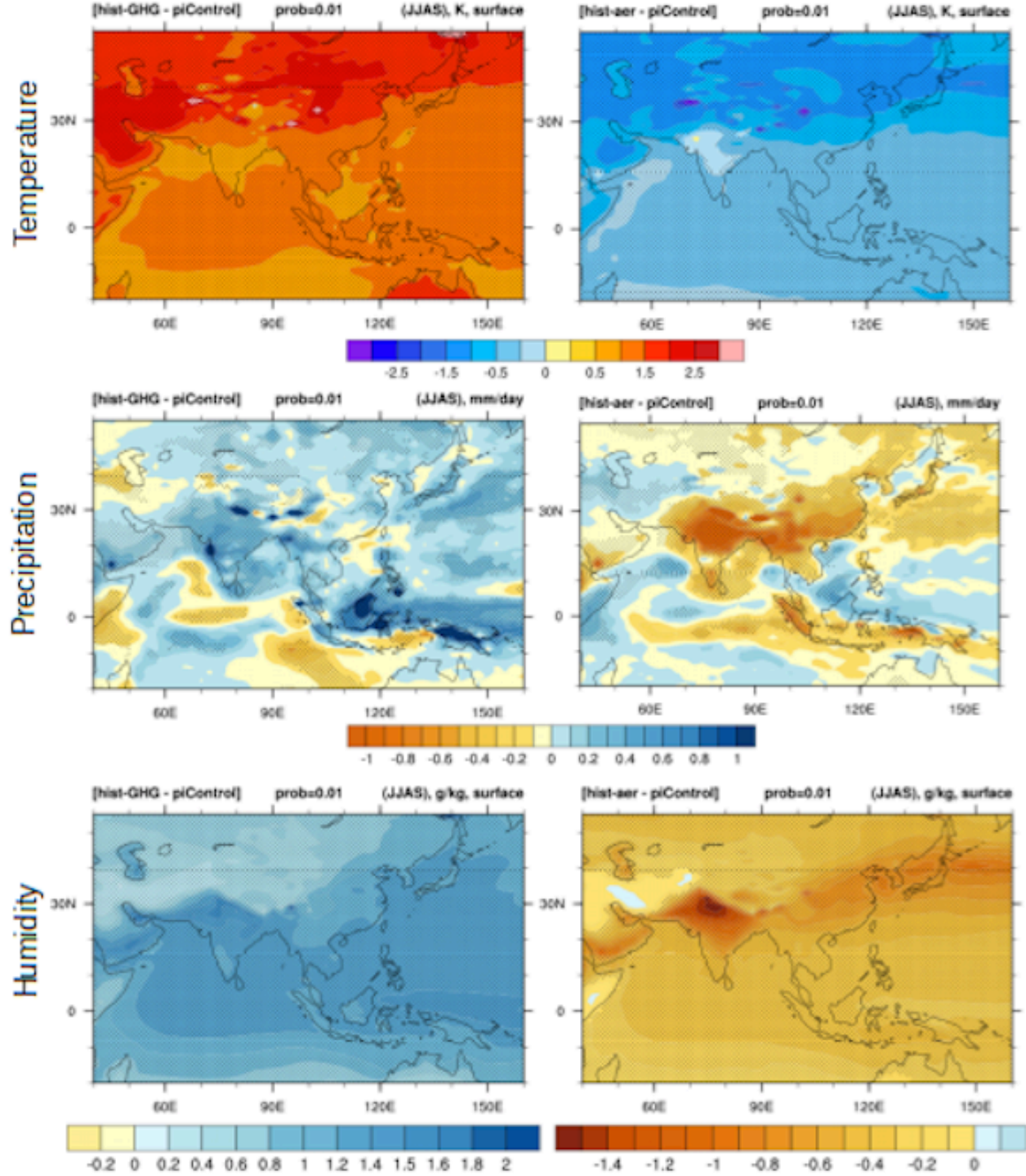
Skin Temperature : [ERAi] regressed on the ISMR index  
(pi=Jun-Jul-Aug-Sept t=1979-2014)



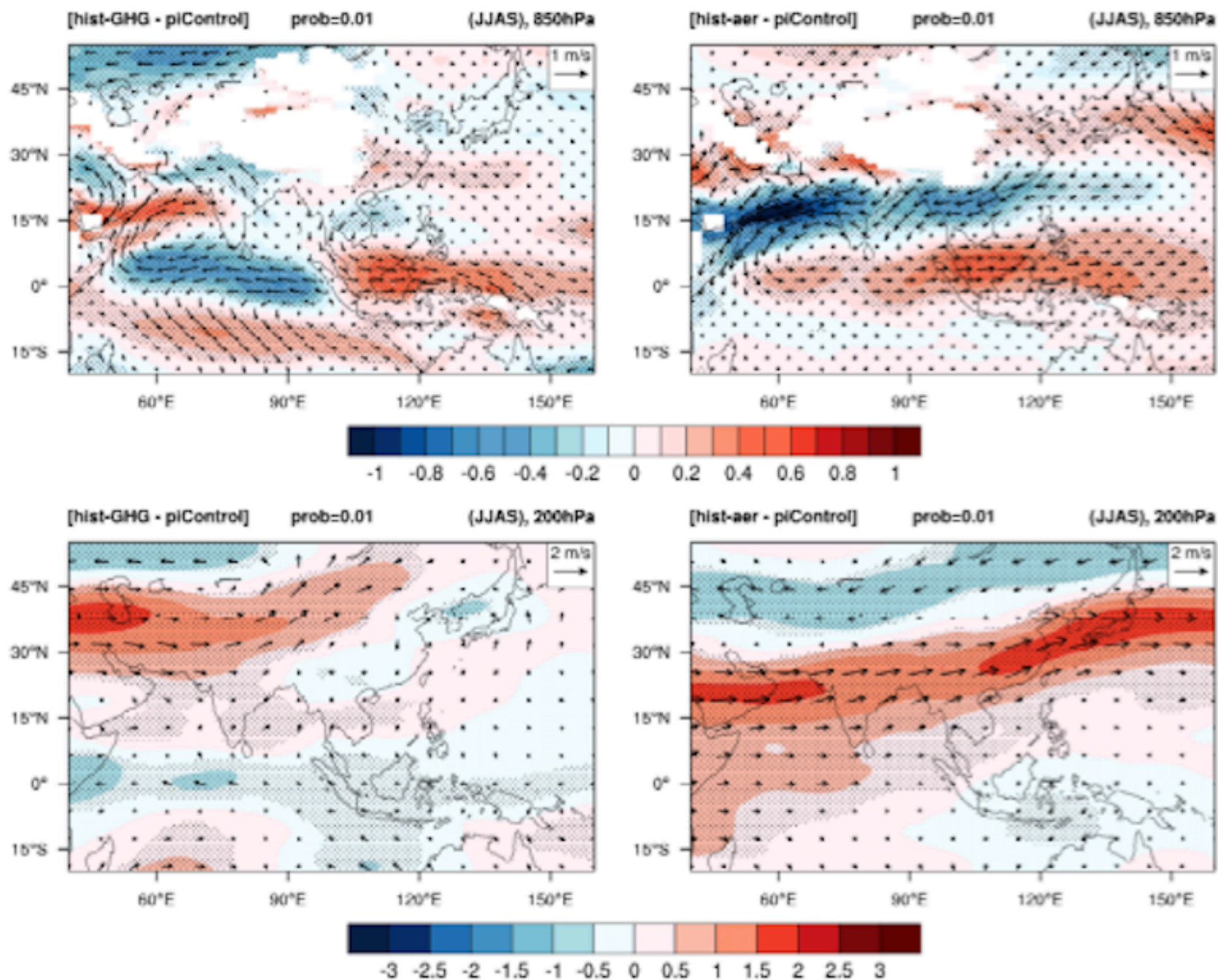
# Skin temperature : [IPSL] regressed on the Niño 3.4 index (pi=Dec-Jan t=1979-2014)



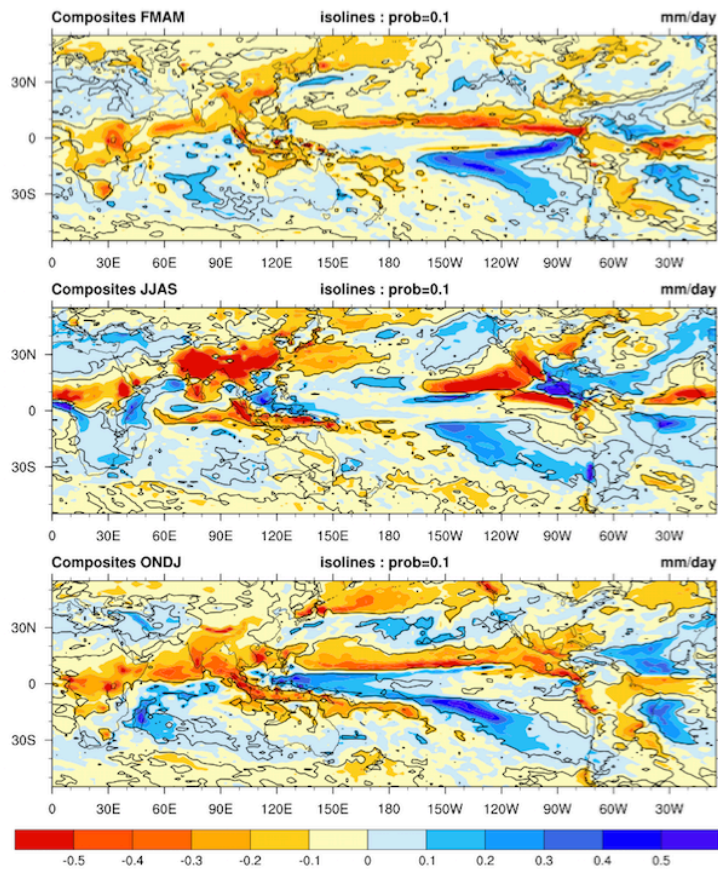
IPSL-CM6A-LR [dampip-piControl]



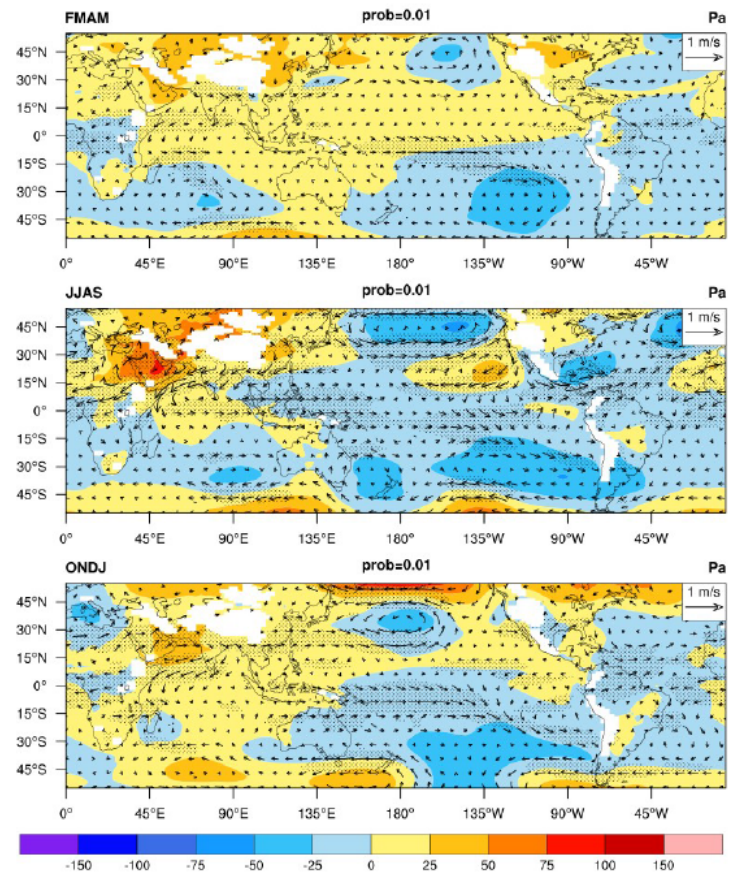
# Wind composites IPSL-CM6A-LR [damp-piControl]



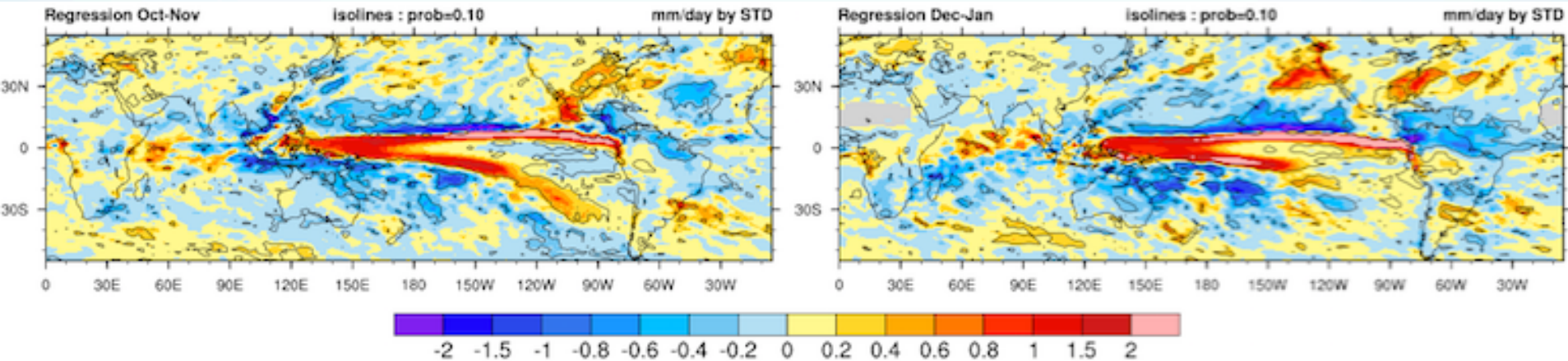
Precipitation composite [IPSL] : Damip hist-aer - piControl



Wind (ua850,va850) et psl composites [IPSL] : Damip hist-aer - piControl



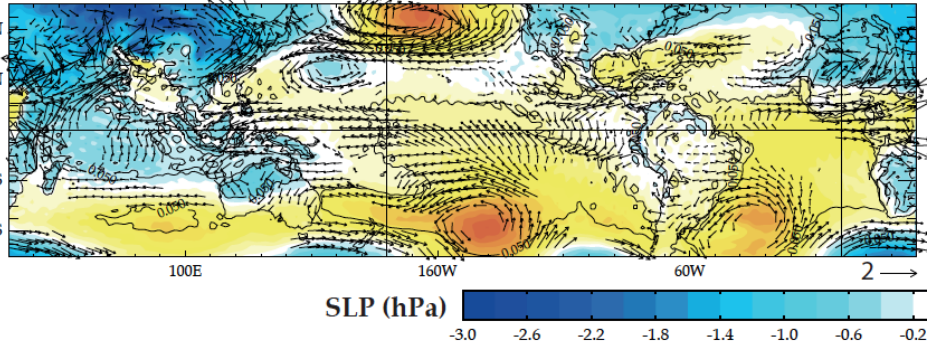
Rainfall regressed on the Nino3.4 index(Dec-Jan) 1974-2014



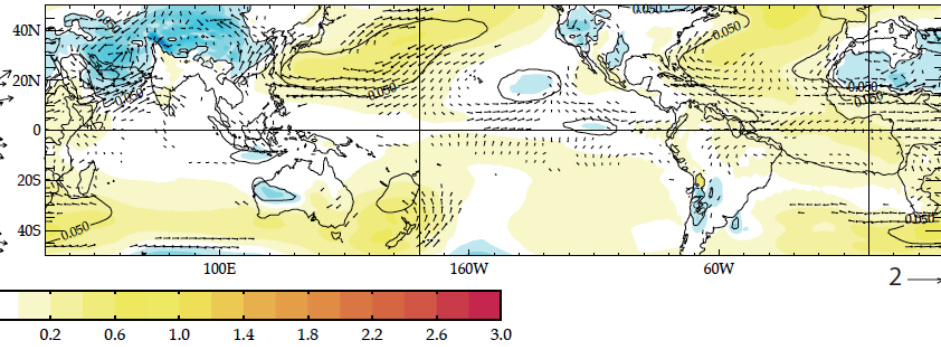
# Mechanisms:

Enhanced easterly vertical zonal wind shear in the African-Asian domain  
Modulation of the South Pacific anticyclone and Pacific equatorial surface wind

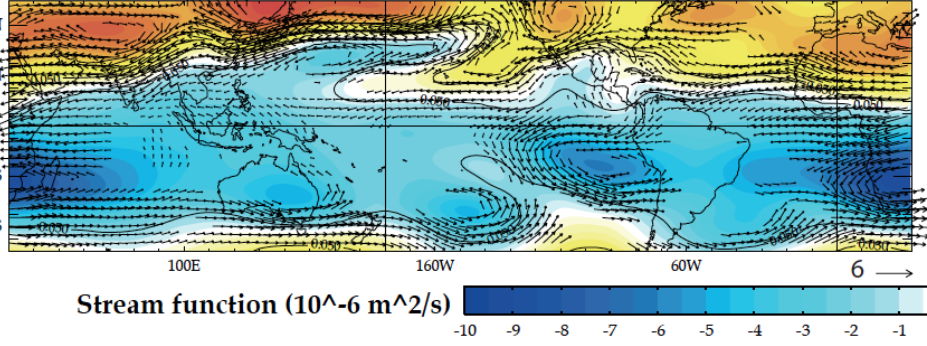
**a** 850 hPa wind and SLP differences - MODIS\_CFS - CFS



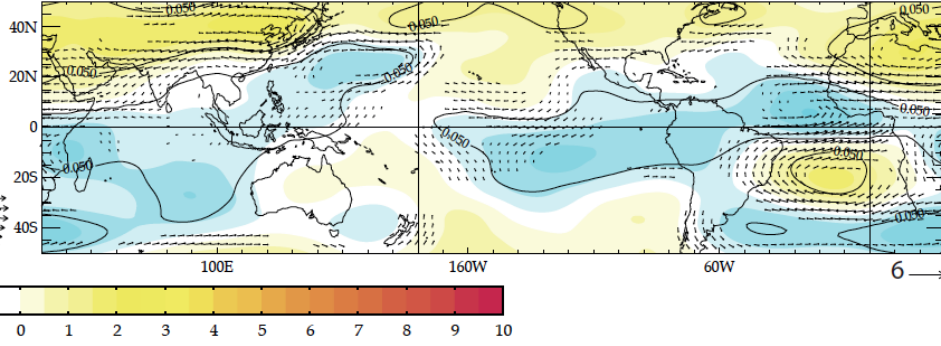
**d** 850 hPa wind and SLP differences - MODIS\_SINTEX - SINTEX



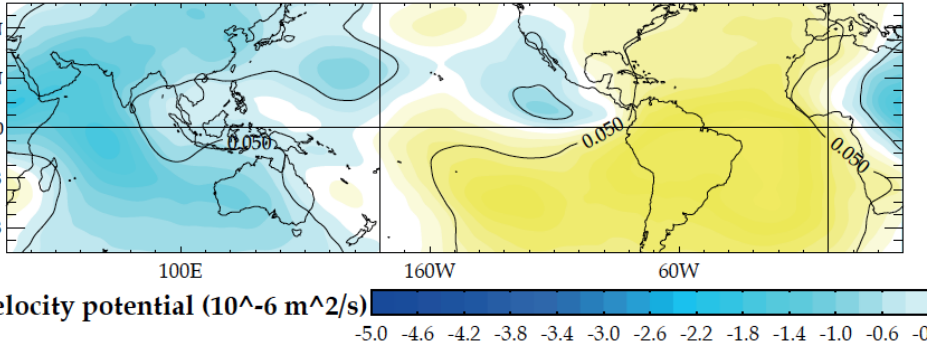
**b** 200 hPa wind and stream function differences - MODIS\_CFS - CFS



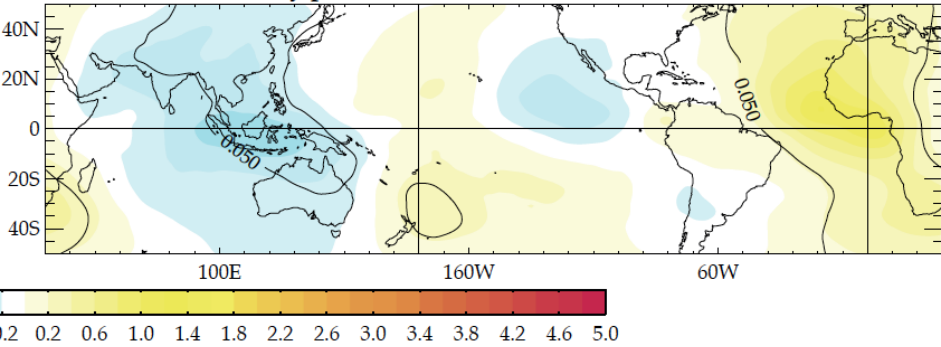
**e** 200 hPa wind and stream function differences - MODIS\_SINTEX - SINTEX



**c** 200 hPa velocity potential differences - MODIS\_CFS - CFS



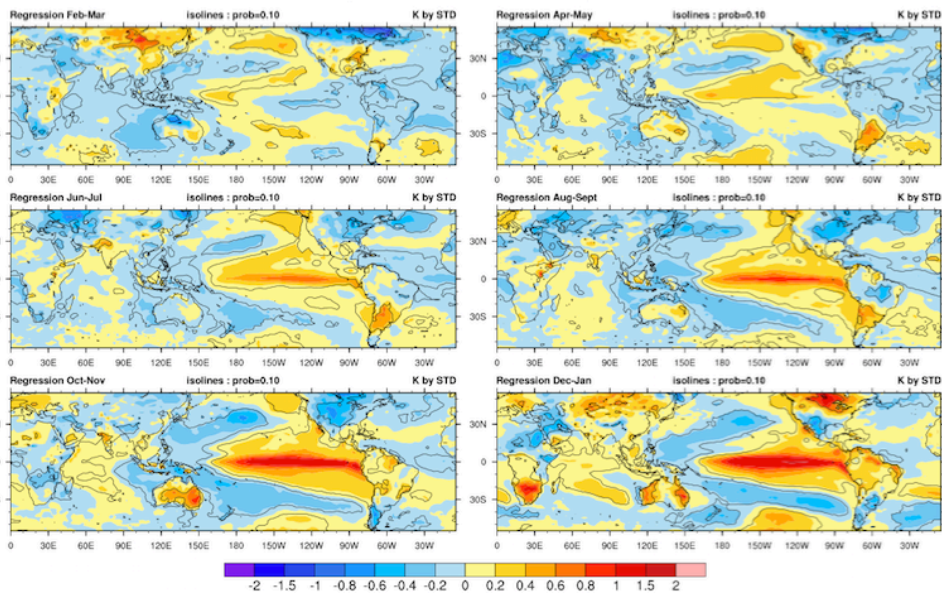
**f** 200 hPa velocity potential differences - MODIS\_SINTEX - SINTEX





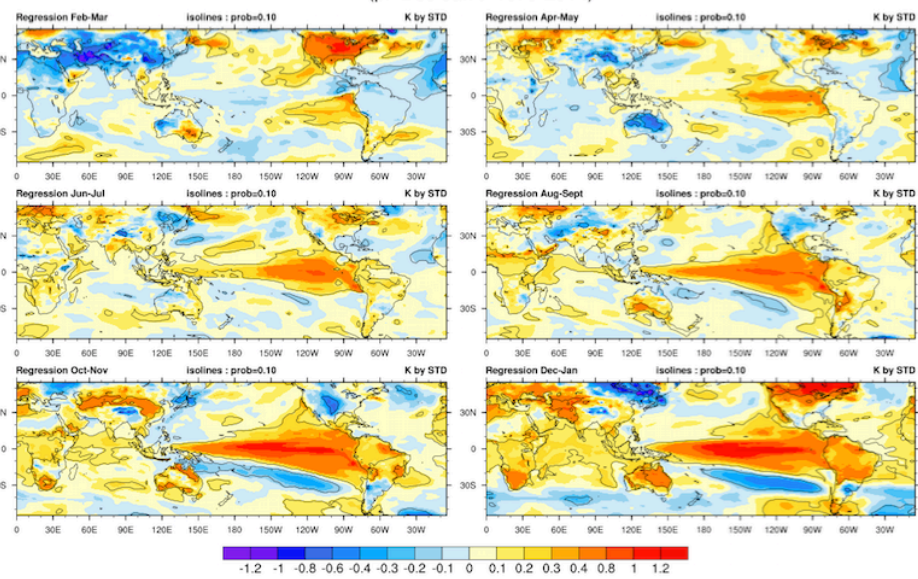
### Skin Temperature : [ERAi] regressed on the Niño 3.4 index

(pi=Dec-Jan t=1979-2014)



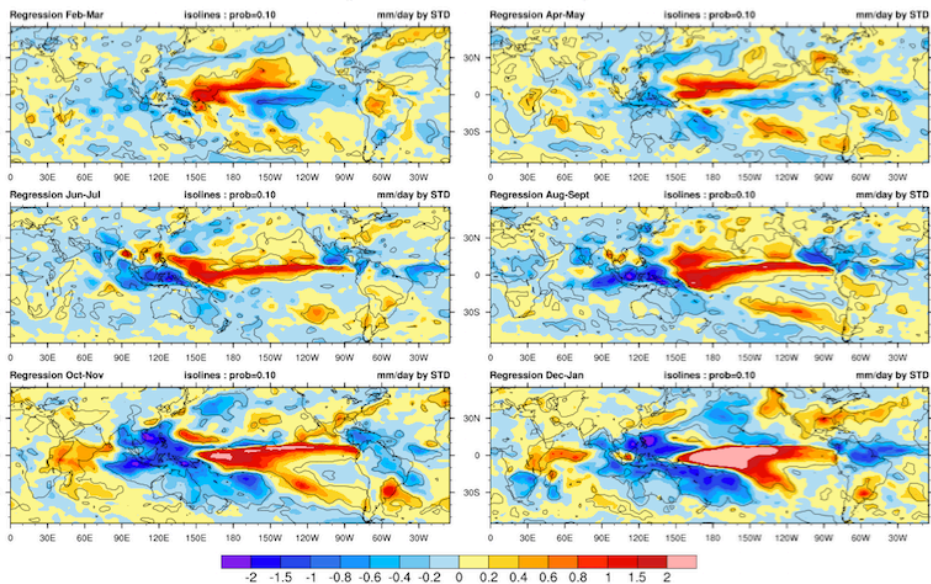
### Skin temperature : [IPSL] regressed on the Niño 3.4 index

(pi=Dec-Jan t=1979-2014)



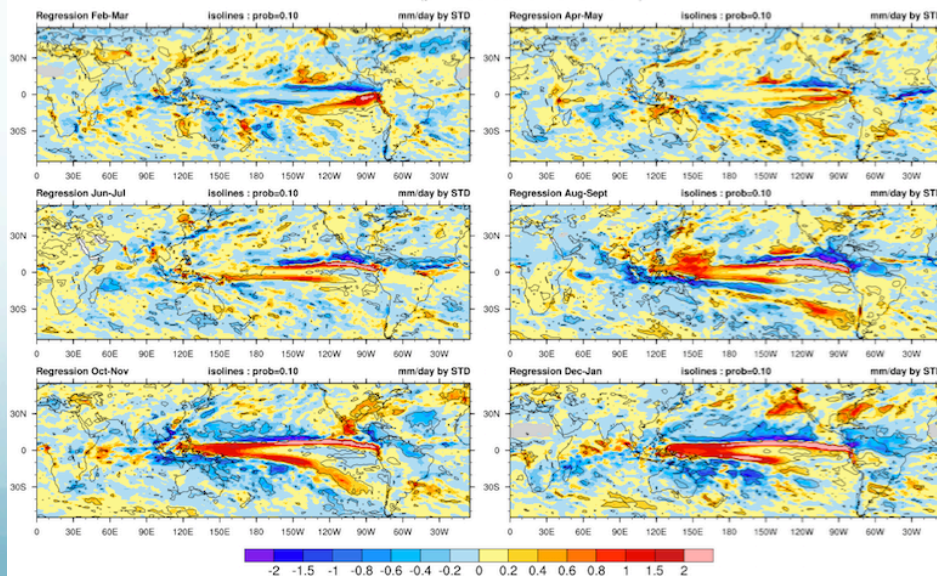
### Precipitation : [GPCP] regressed on the Niño 3.4 index

(pi=Dec-Jan t=1979-2014)



### Precipitation : [IPSL] regressed on the Niño 3.4 index

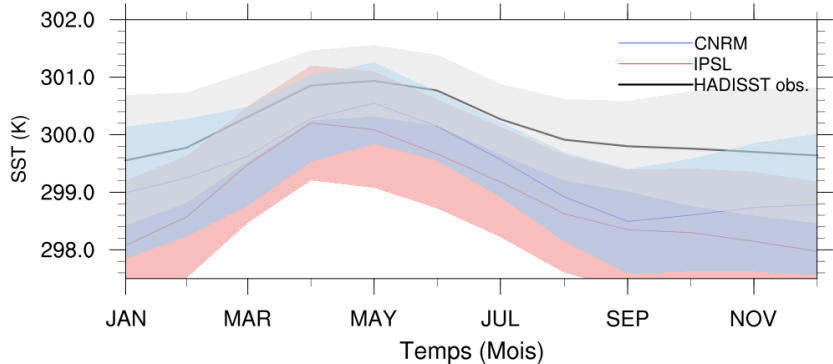
(pi=Dec-Jan t=1979-2014)



# **Pacific ocean- atmosphere coupling and ENSO**

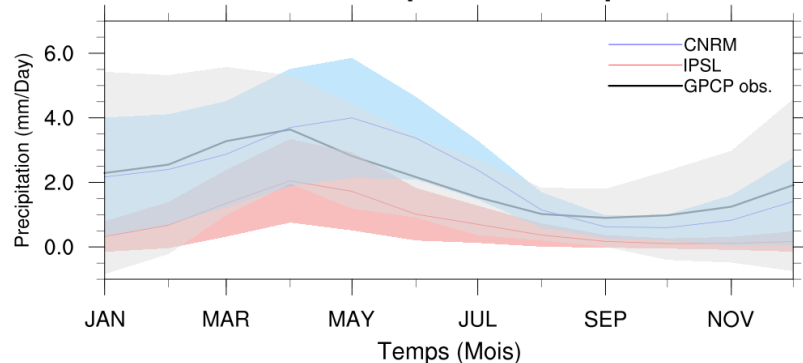
### Cycle annuel de SST (variabilite inter-annuelle)

Niño 3.4 [5S-5N,170W-120W]



### Cycle annuel de precipitation (variabilite inter-annuelle)

Niño 3.4 [5S-5N,170W-120W]



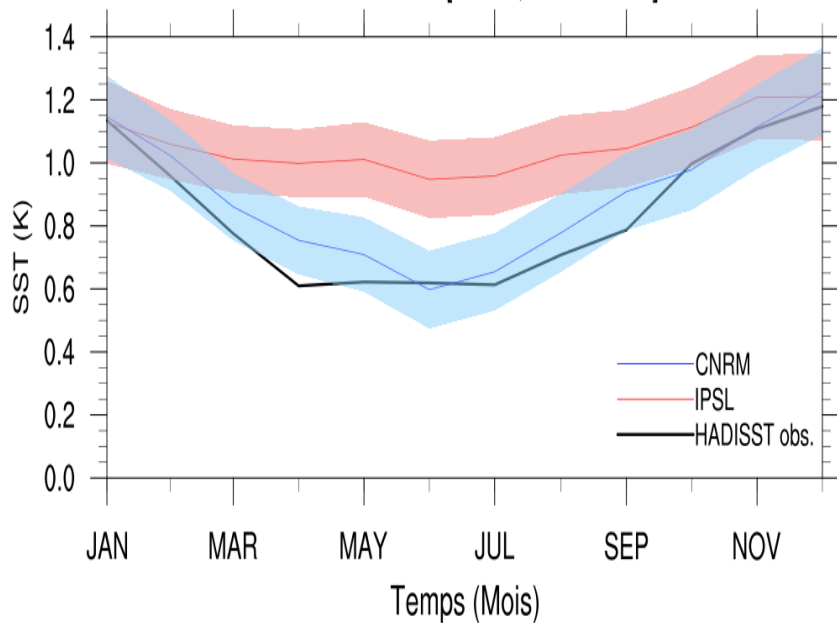
SST

Periode: 1979-2014

Rainfall

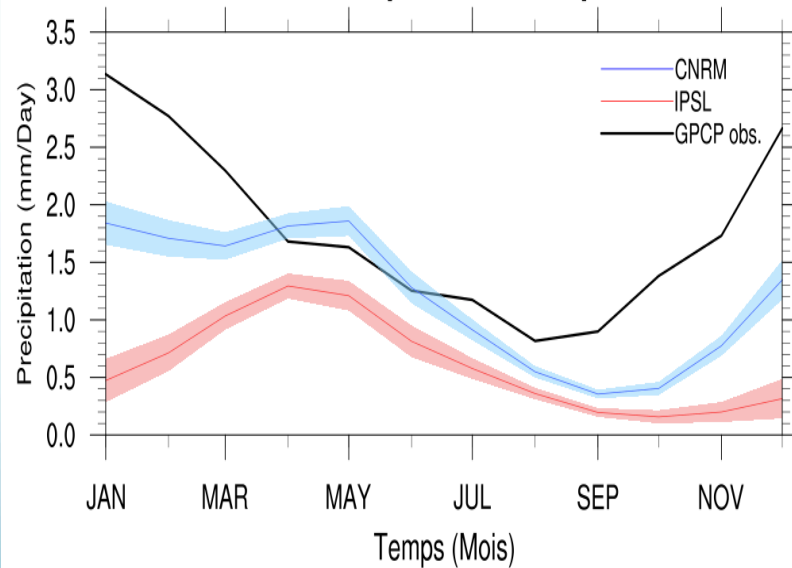
### Variabilite Inter-Annuelle (variabilite interne)

Niño 3.4 [5S-5N,170W-120W]

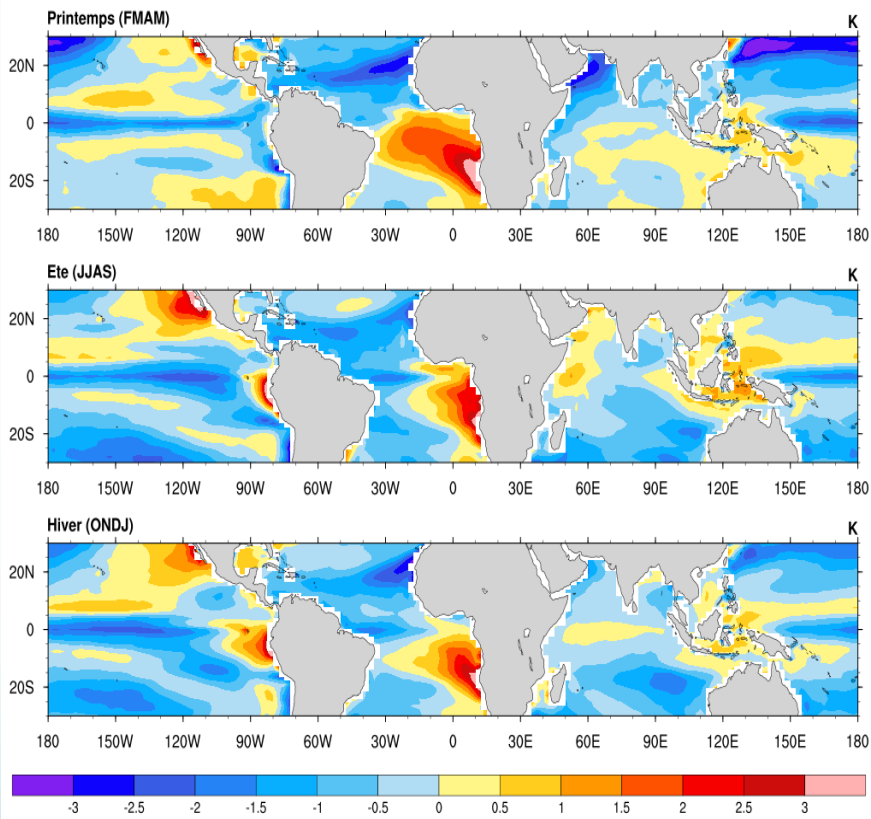


### Variabilite Inter-Annuelle (variabilite interne)

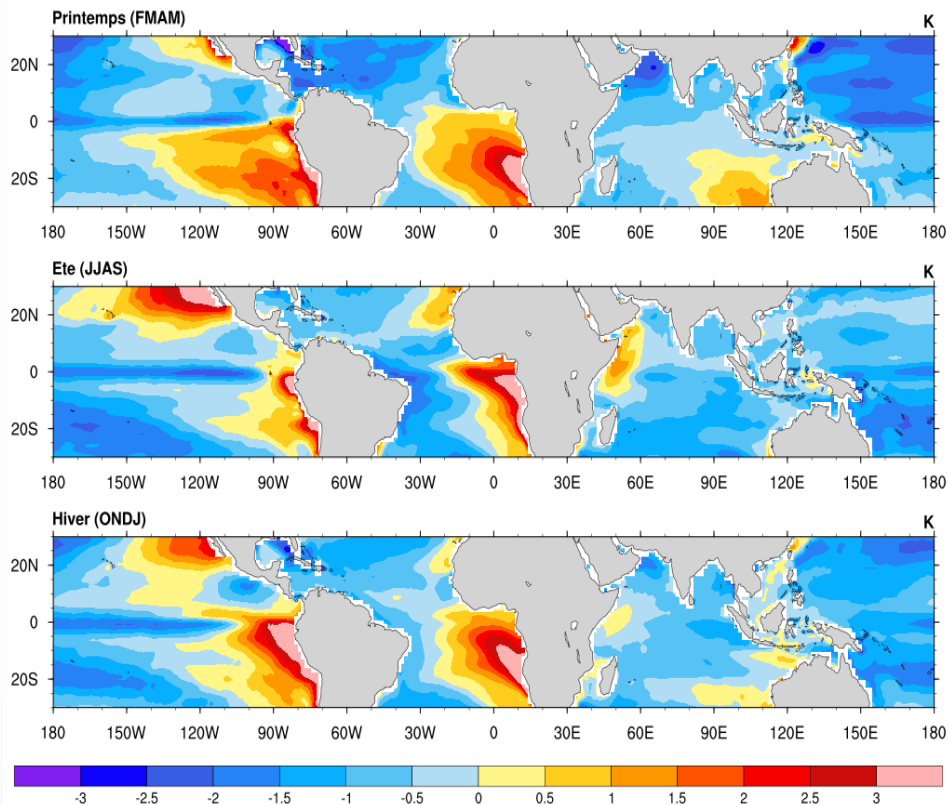
Niño 3.4 [5S-5N,170W-120W]



Biais de SST (1979-2014) [IPSL-HADISST]



Biais de SST (1979-2014) [CNRM-HADISST]



# Conclusions and perspectives

## Results, remarks and suggestions:

- Significant progresses in IPSLCM\_6A\_LR in tropical (interannual) variability from previous versions from simple diagnostics. Also, impressive results for reproducing observed temperature trends during the past 150 years, and, surprisingly, global rainfall trends (results not shown here).
- However, huge impacts of aerosols forcing on biases and tropical variability (monsoons, ENSO, ...) in both IPSLCM\_6A\_LR and CNRM\_CM6\_1. Is this realistic or (much) too strong?
- With the strong AMOC in the new versions of IPSLCM\_6A\_LR and CNRM\_CM6\_1, this implies a new paradigm to understand climate variability, trends and uncertainties in the new CMIP6 simulations done with these two models (probably true for most CMIP6 models).
- A clear need to revisit the role of surface wind variability, convection, tropical instability waves (in NEMO), diurnal variability and ocean-atmosphere coupling in the tropical Pacific in order to improve ENSO in the French coupled models (probably true also for other atmospheric models coupled to NEMO). .....