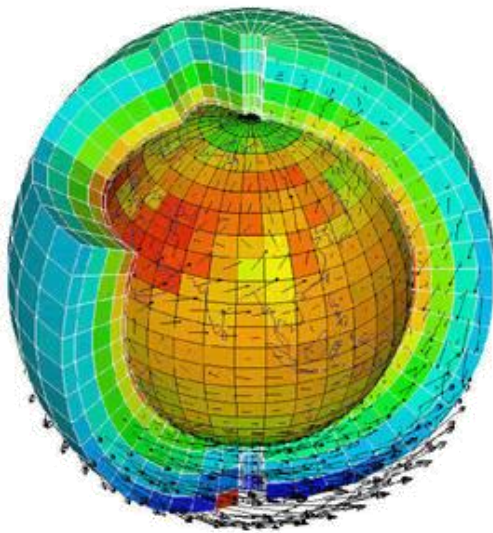


Intertropical ocean-atmosphere coupling in a state of the art Earth System Model: Evaluating the representation of turbulent air-sea fluxes in IPSL-CM5A



VS.



Alina Găinușă-Bogdan, Pascale Braconnot

Laboratoire des Sciences du Climat et de l'Environnement, Saclay, France

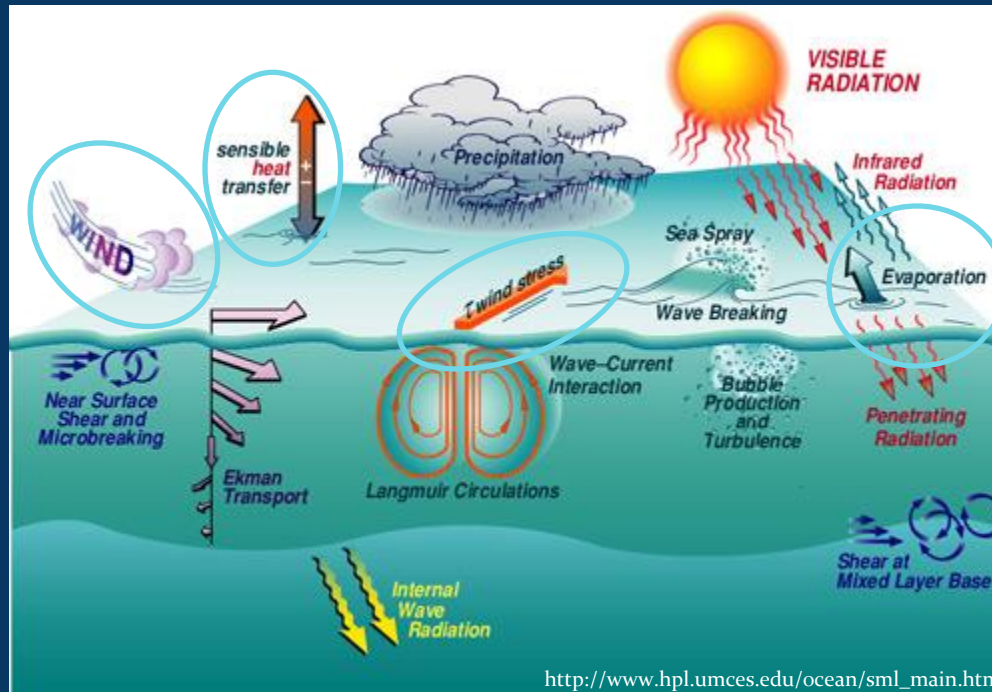
Turbulent fluxes

Sensible heat flux

$$\rho C_p C_H (U - U_s) (T_s - T_a)$$

Momentum flux
= Wind stress

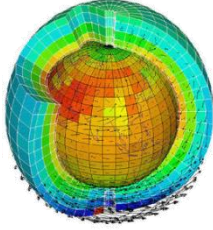
$$\rho C_D (U - U_s)^2$$



Latent heat flux
 $\rho L_v C_E (U - U_s) (Q_s - Q_a)$

Approach

IPSL-CM5A



vs.

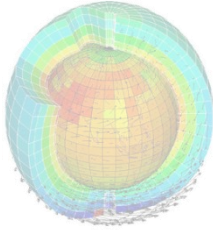
OBS



Direct evaluation of
the model of interest

Approach

IPSL-CM5A



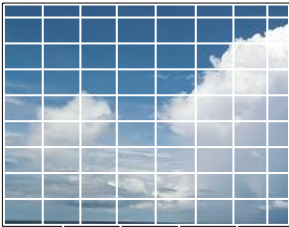
VS.

OBS



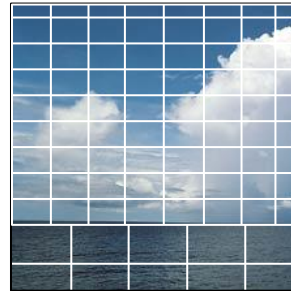
Direct evaluation of
the model of interest

LMDZ5A AMIP



VS.

IPSL-CM5A



VS.

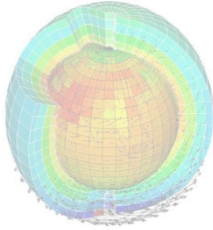
OBS



Atmospheric
processes
vs.
Ocean-
atmosphere
feedbacks

Approach

IPSL-CM5A



VS.

OBS



Direct evaluation of
the model of interest

LMDZ5A AMIP



VS.

IPSL-CM5A



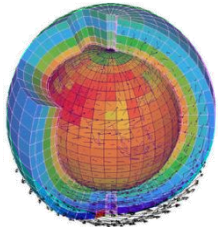
VS.

OBS



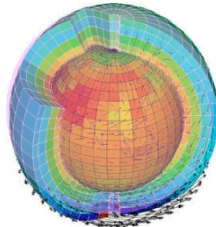
Atmospheric
processes
vs.
Ocean-
atmosphere
feedbacks

IPSL-CM5A



VS.

IPSL-CM4



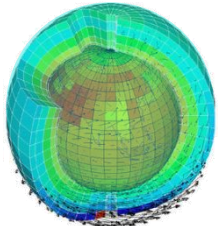
VS.

OBS

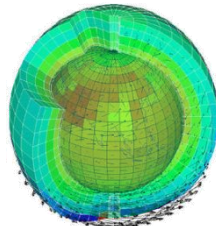


Model
development
perspective

IPSL-CM5AMR

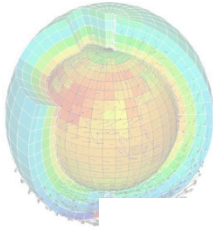


IPSL-CM5B



Approach

IPSL-CM5A



VS.

OBS



Direct evaluation of
the model of interest

❖ climatologies

LMDZ5A AMII

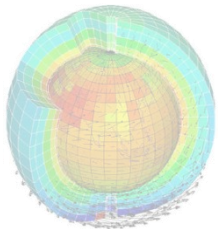


❖ annual mean large-scale patterns

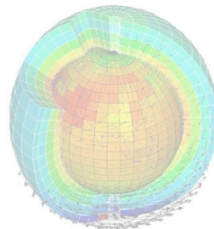
Atmospheric
processes
vs.
Ocean-
atmosphere
feedbacks

❖ seasonality in selected regions

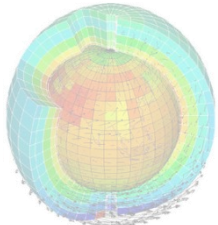
IPSL-CM5A



IPSL-CM4

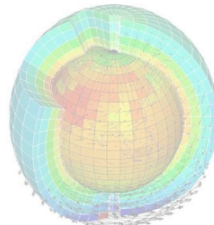


IPSL-CM5AMR



VS.

IPSL-CM5B



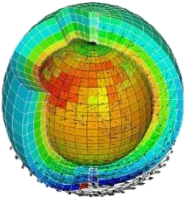
VS.

OBS



Model
development
perspective

Data

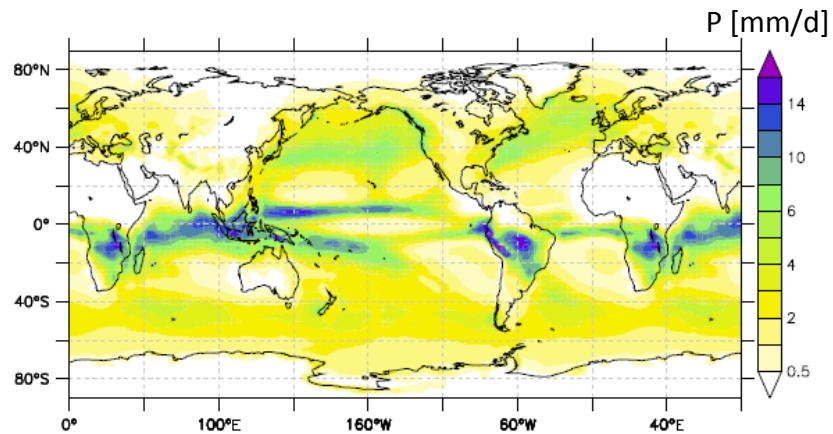


Models	“Validation” data sets
IPSL-CM5A	3 <i>in situ</i>
LMDZ5A → “AMIP”	3 satellite-based
IPSL-CM5AMR	3 hybrid
IPSL-CM4	3 reanalyses
IPSL-CM5B	2 ocean model forcing

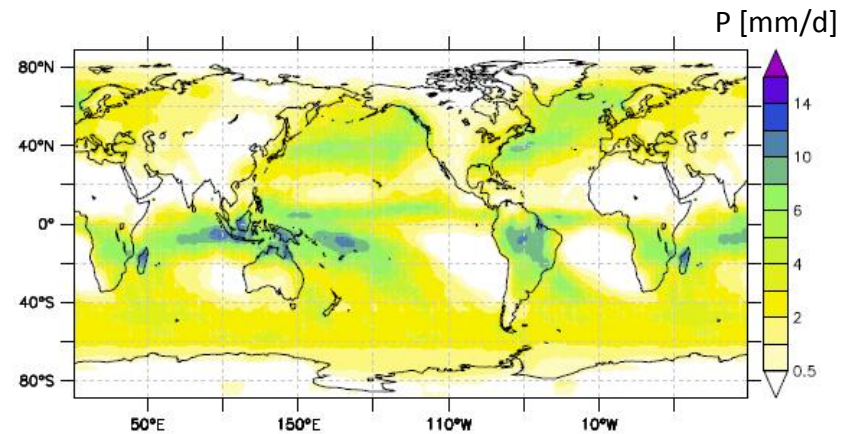
Period of reference: 1979-2005

Important model biases

IPSL-CM5A

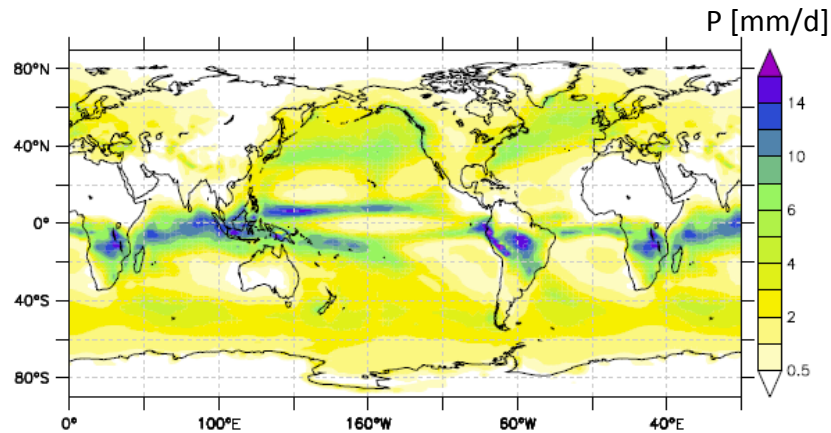


GPCP

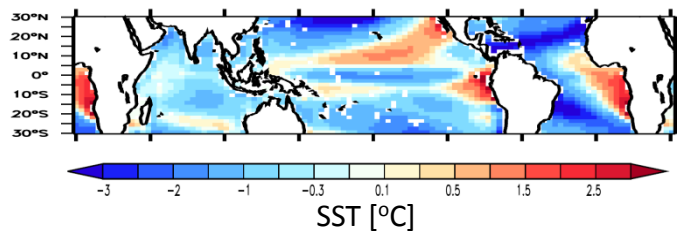
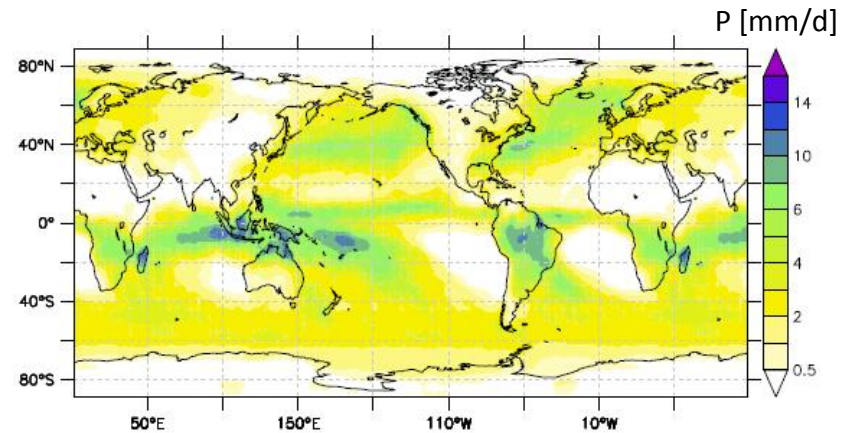


Important model biases

IPSL-CM5A



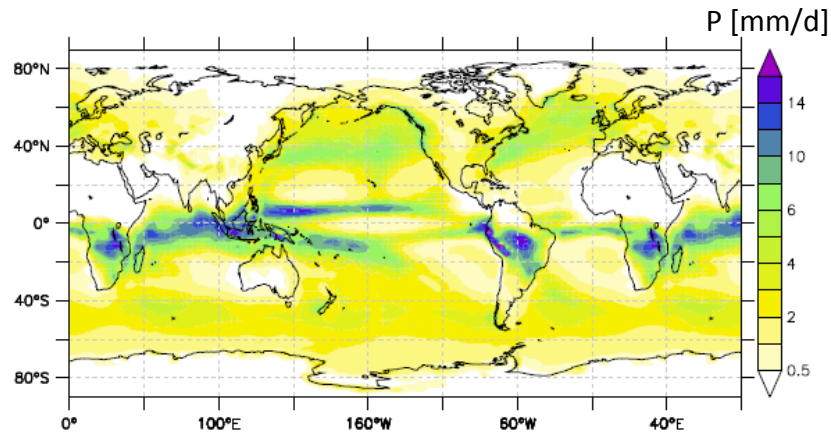
GPCP



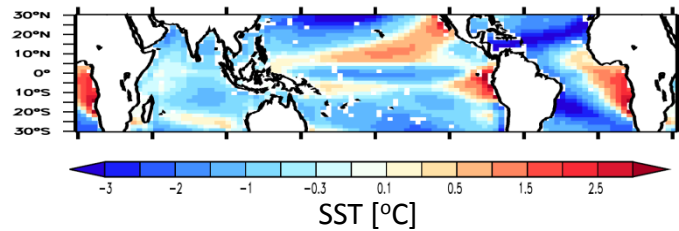
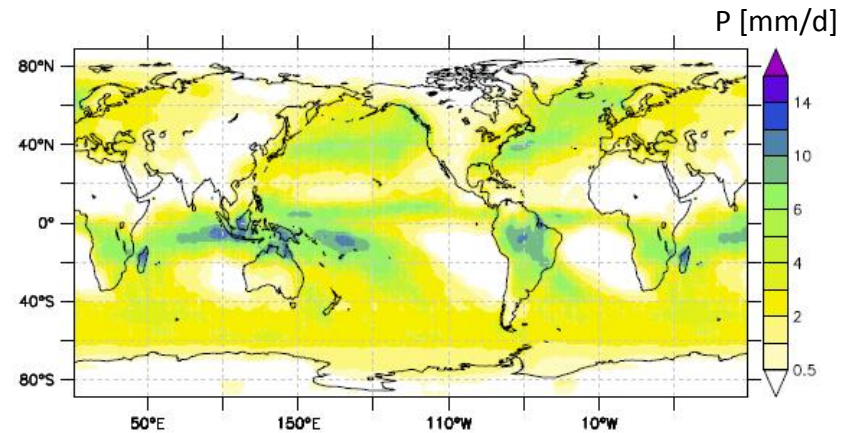
Δ : IPSL-CM5A - OBS

Important model biases

IPSL-CM5A

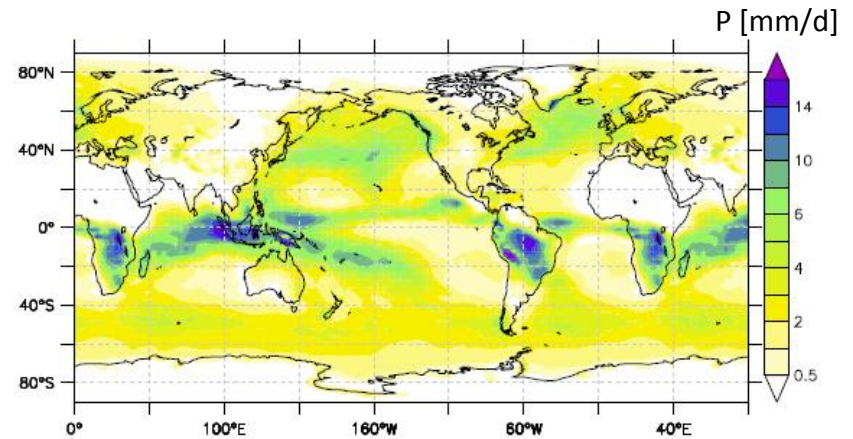


GPCP

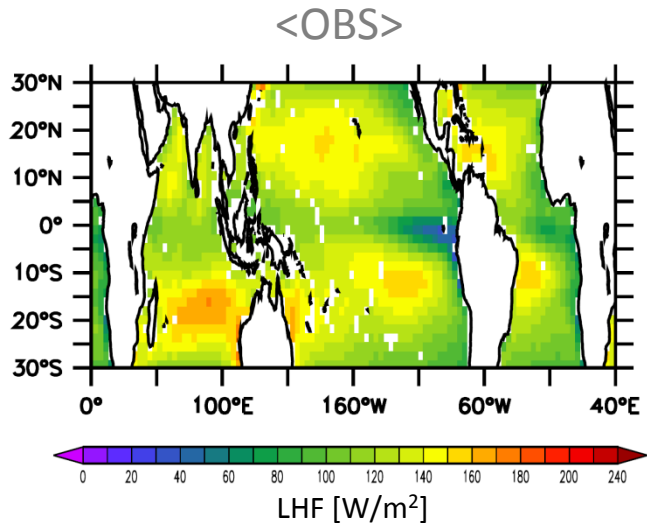


Δ: IPSL-CM5A - OBS

AMIP

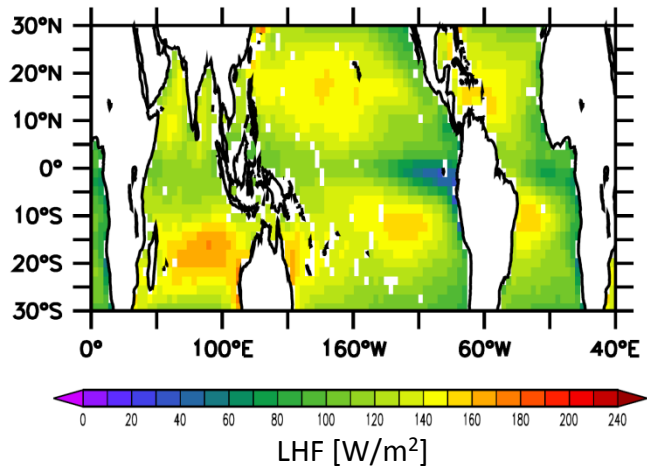


What about the fluxes?

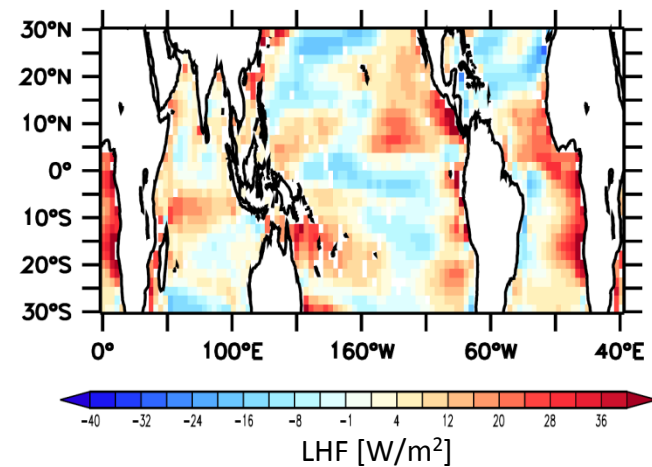


What about the fluxes?

<OBS>

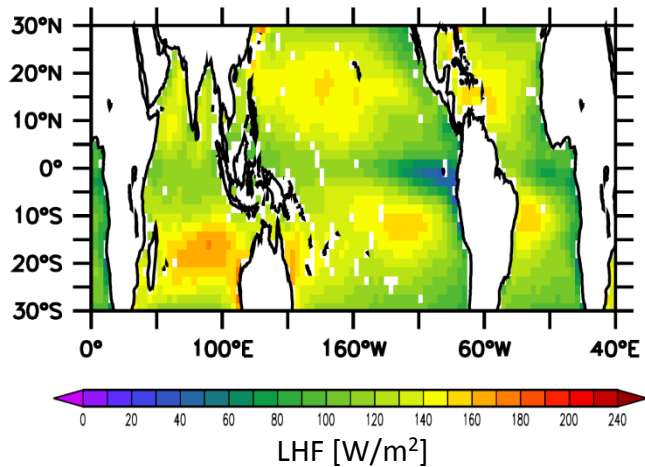


Δ : IPSL-CM5A - <OBS>

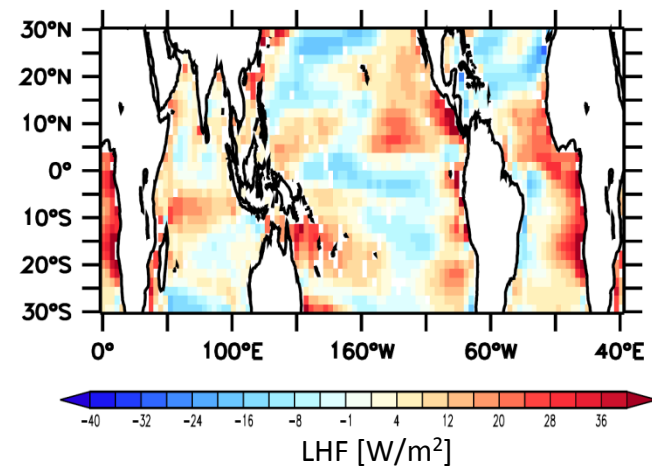


What about the fluxes?

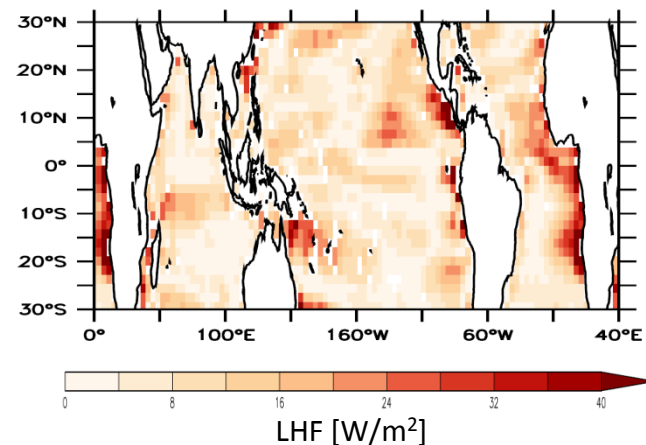
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Δ : IPSL-CM5A - <OBS>

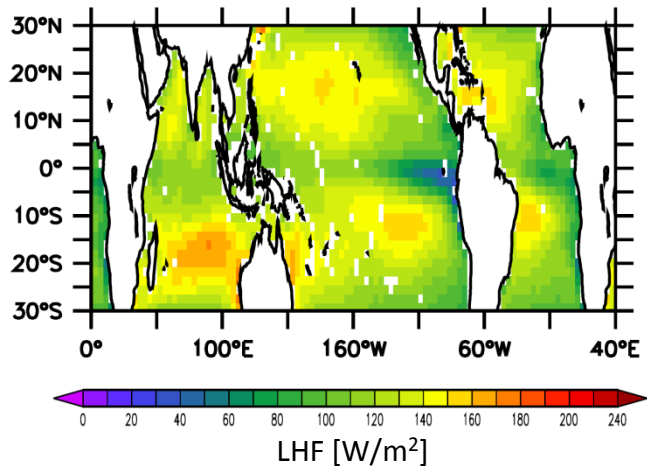


MAX | IPSL-CM5A - <OBS> |

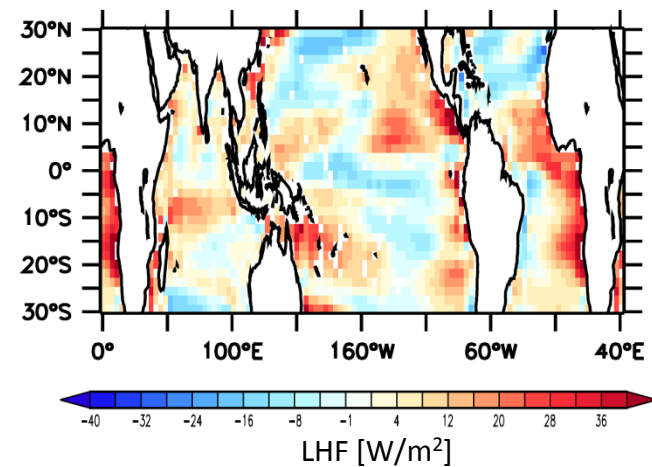


What about the fluxes?

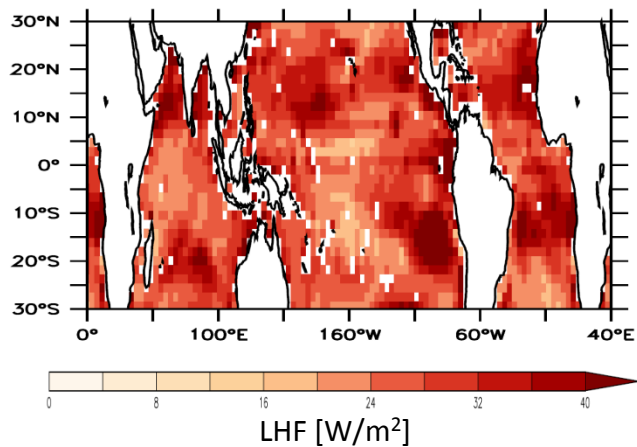
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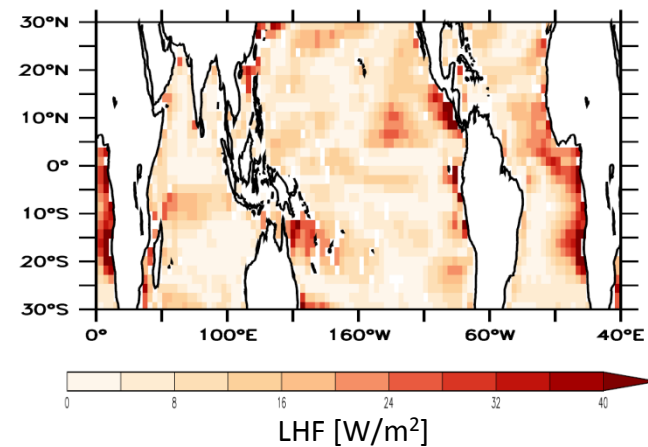
Δ : IPSL-CM5A - <OBS>



MAX |OBS - <OBS>|

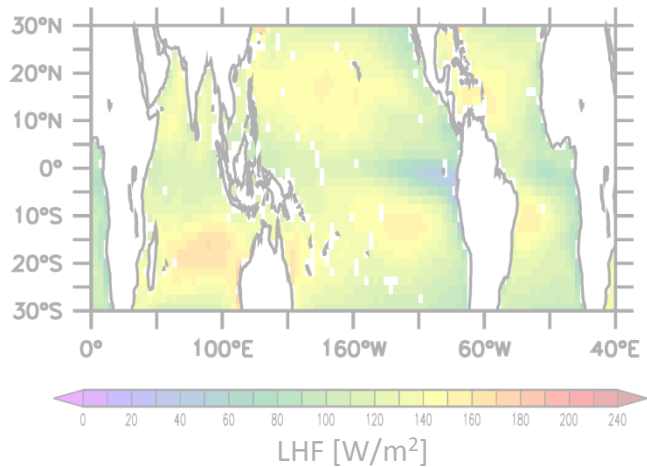


MAX |IPSL-CM5A - <OBS>|

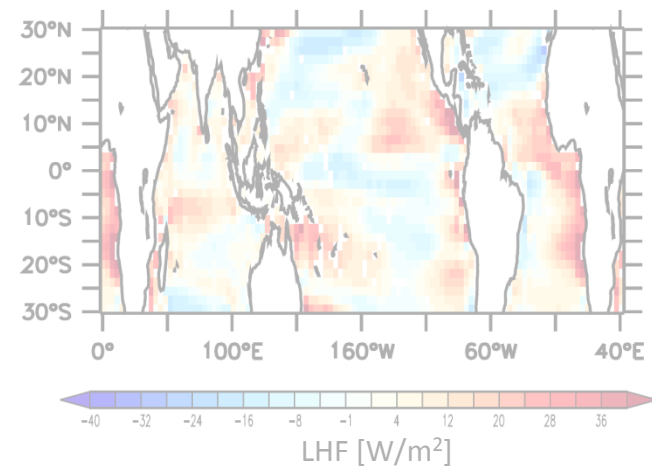


What about the fluxes?

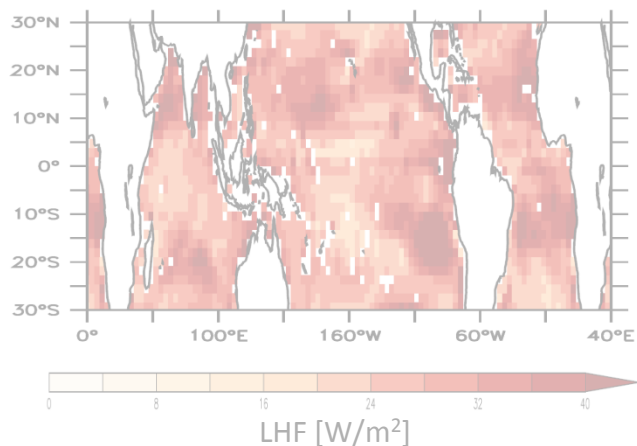
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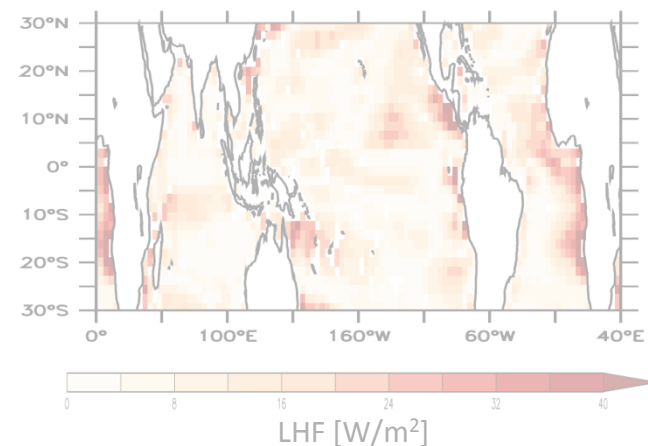
Δ : IPSL-CM5A - <OBS>

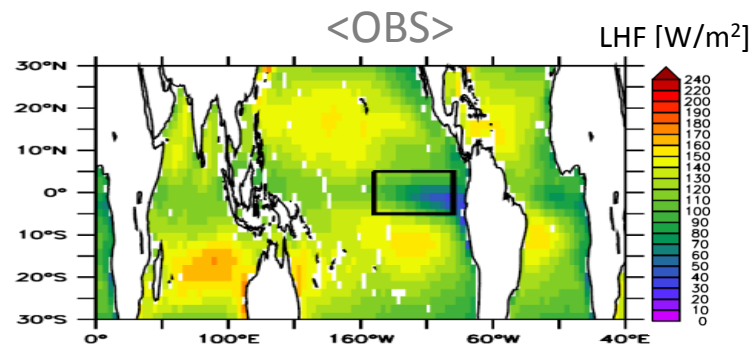


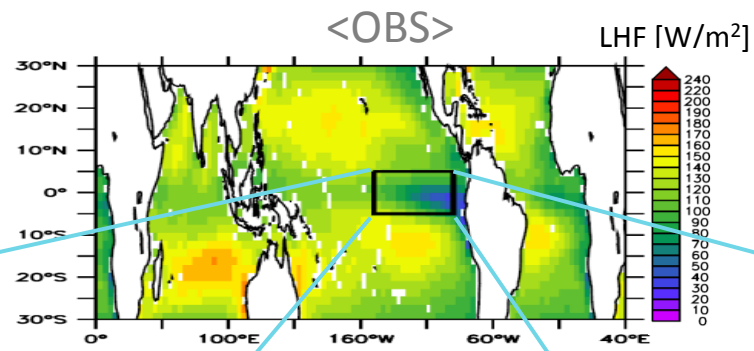
MAX|OBS - <OBS>|



MAX|IPSL-CM5A - <OBS>|

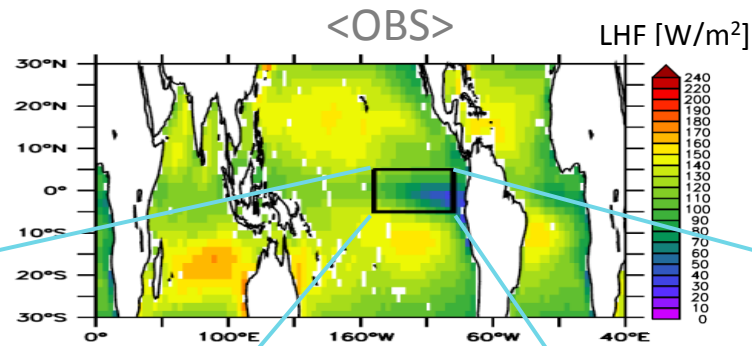






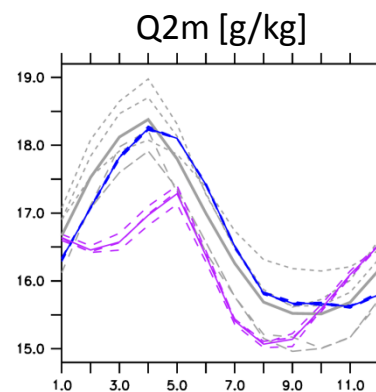
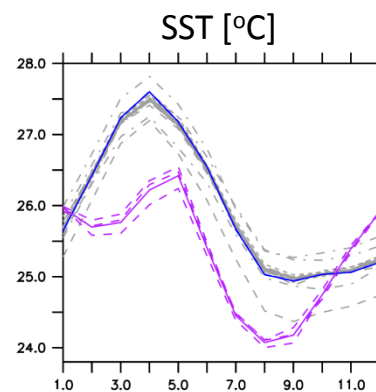
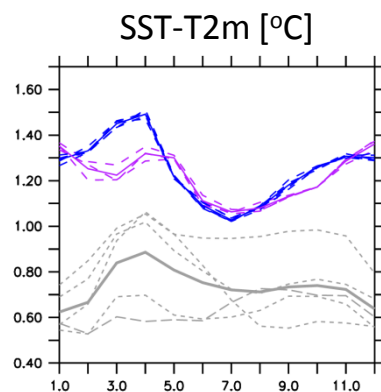
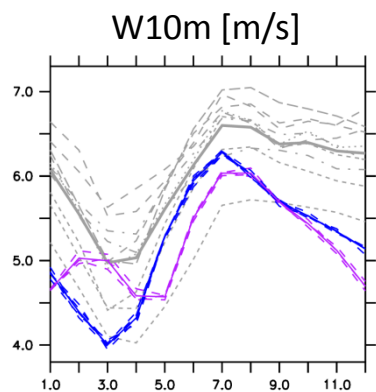
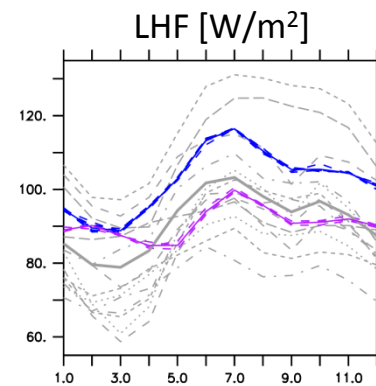
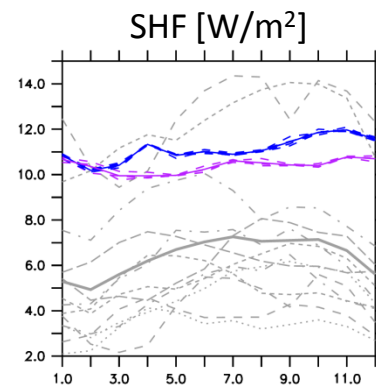
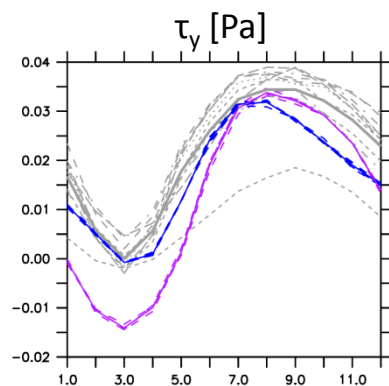
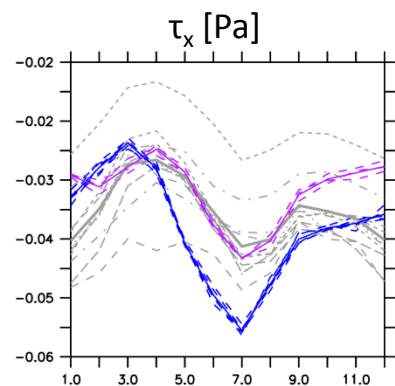
NINO3 (150°W - 90°W ; 5°S - 5°N)

IPSLCM5A123(1979–2005)
AMIP12345(1979–2005)

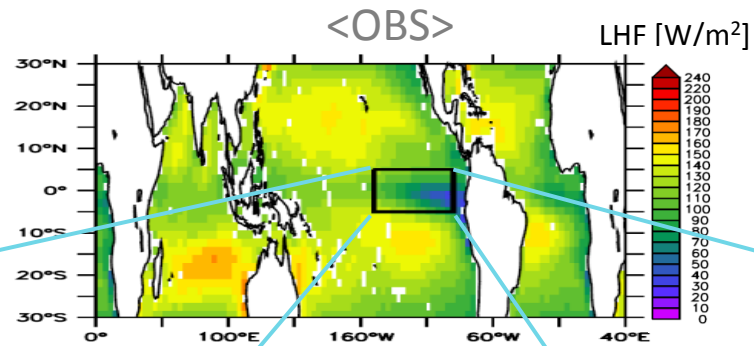


— 'OBS'
--- Satellite
--- *In situ*
--- Reanalysis
--- Hybrid
--- Ocean model
surface forcing

NINO3 (150°W-90°W; 5°S-5°N)

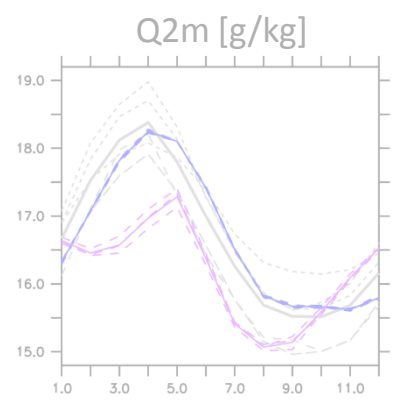
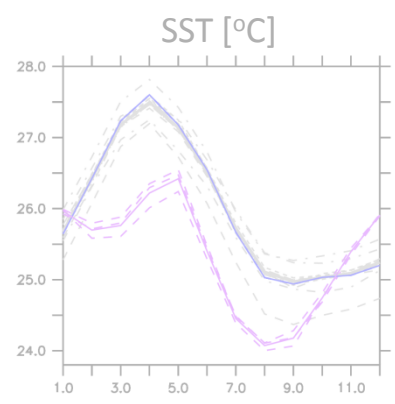
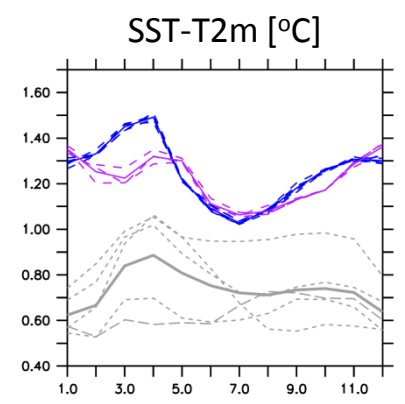
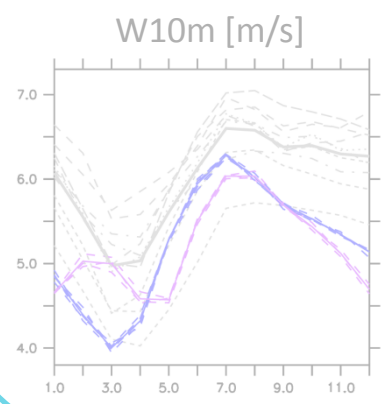
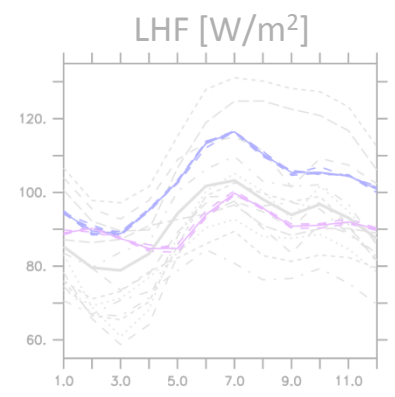
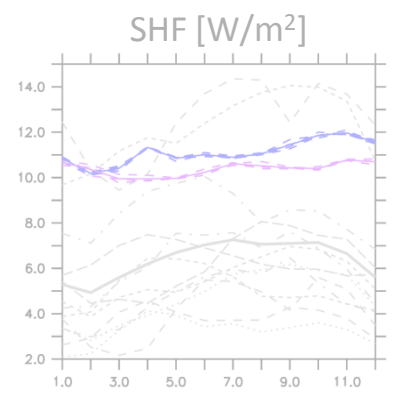
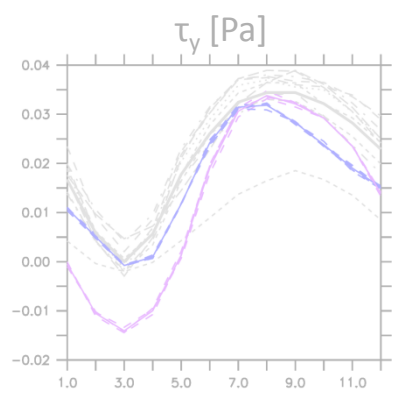
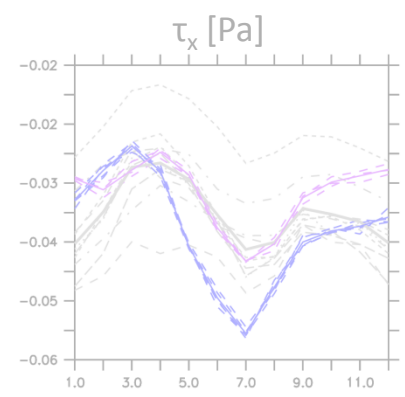


IPSLCM5A123(1979-2005)
AMIP12345(1979-2005)

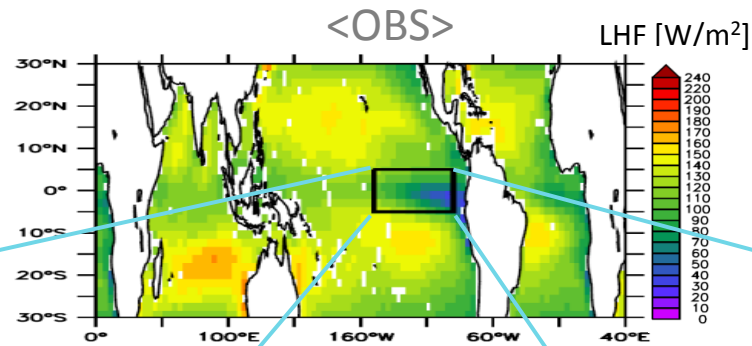


— 'OBS'
- - Satellite
- - *In situ*
- - Reanalysis
... Hybrid
- - Ocean model
surface forcing

NINO3 (150°W-90°W; 5°S-5°N)

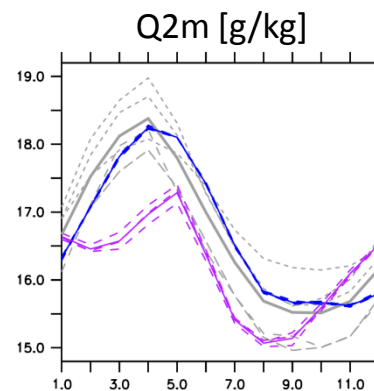
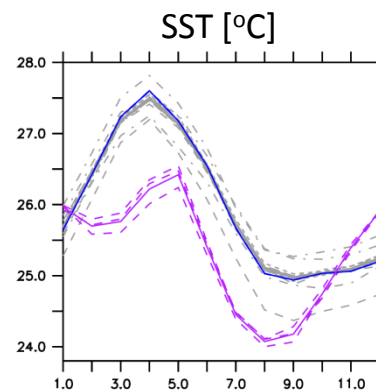
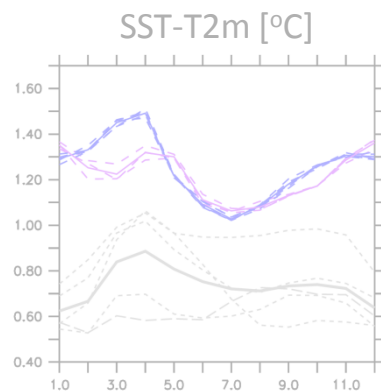
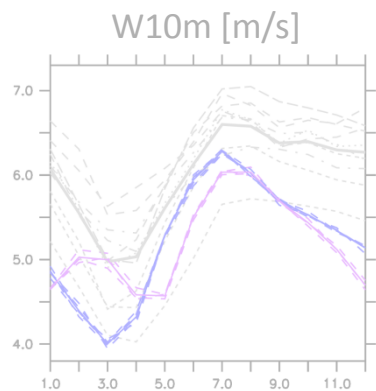
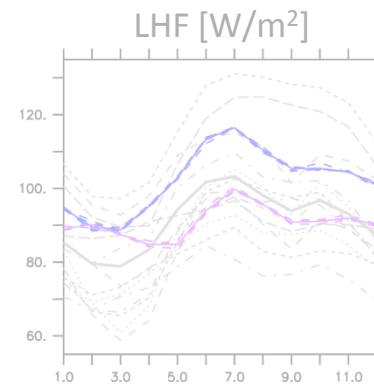
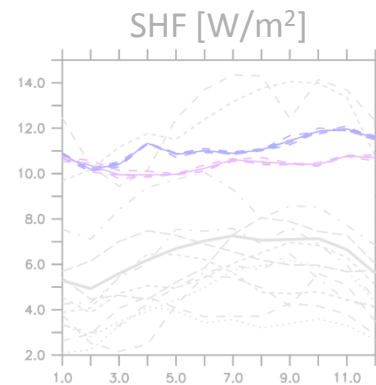
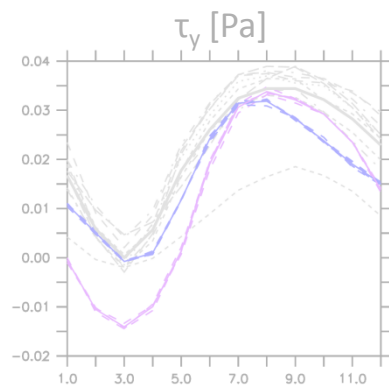
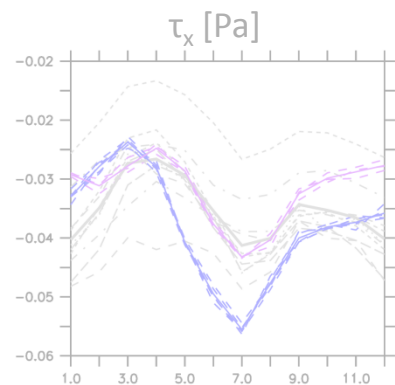


IPSLCM5A123(1979-2005)
AMIP12345(1979-2005)

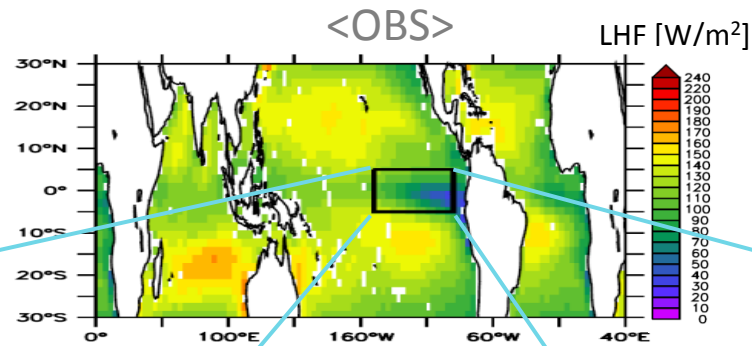


— 'OBS'
- - Satellite
- - *In situ*
- - Reanalysis
... Hybrid
- - Ocean model
surface forcing

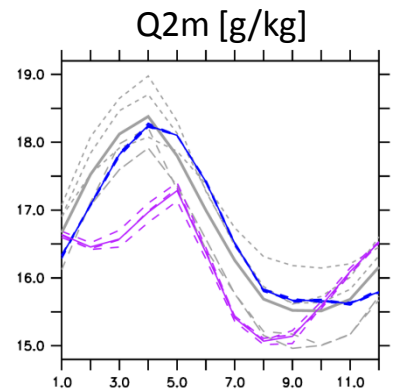
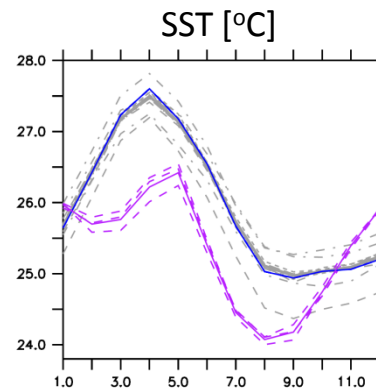
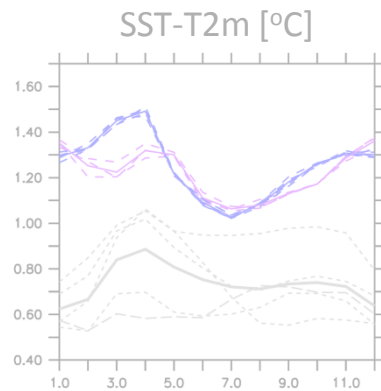
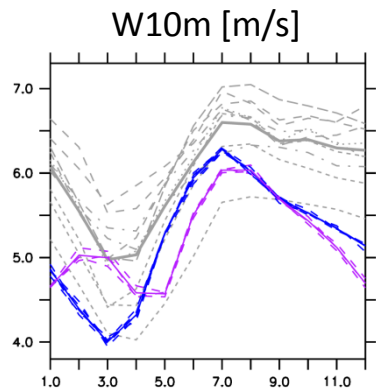
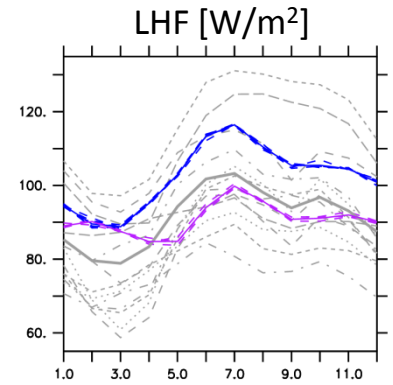
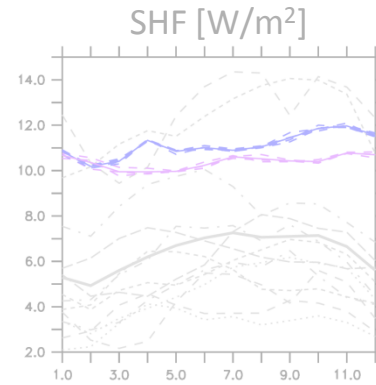
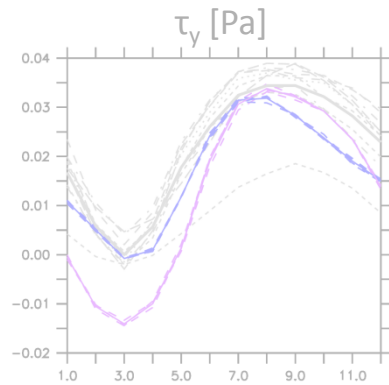
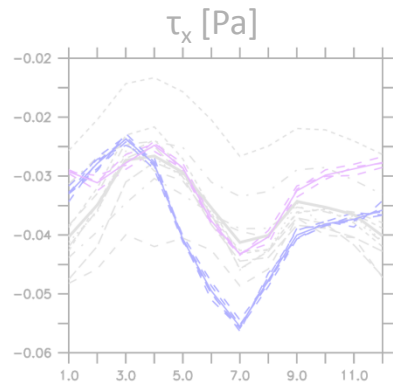
NINO3 (150°W-90°W; 5°S-5°N)



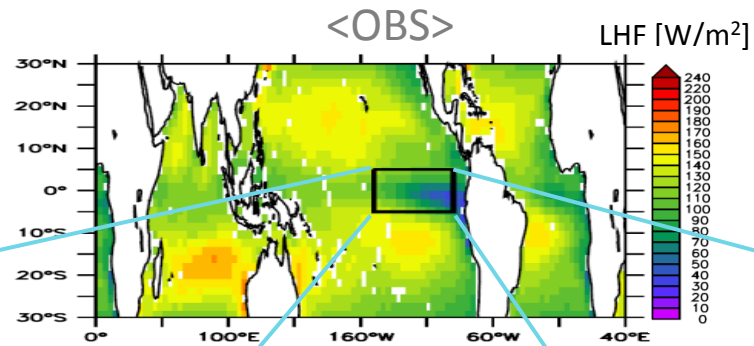
IPSLCM5A123(1979–2005)
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NINO3 (150°W-90°W; 5°S-5°N)

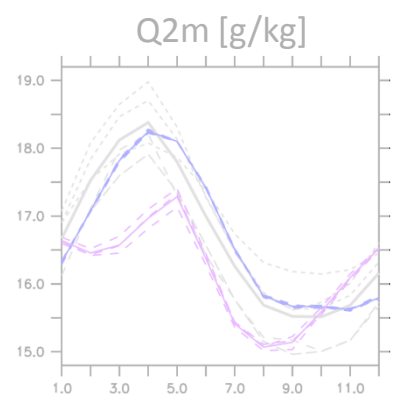
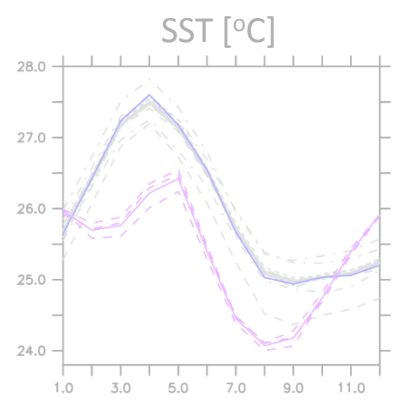
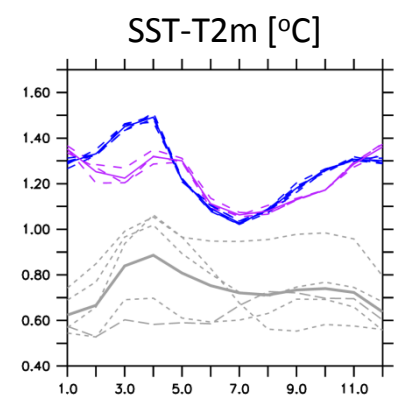
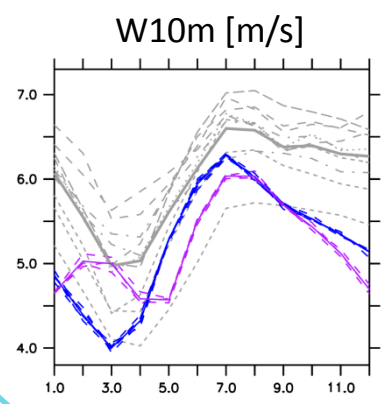
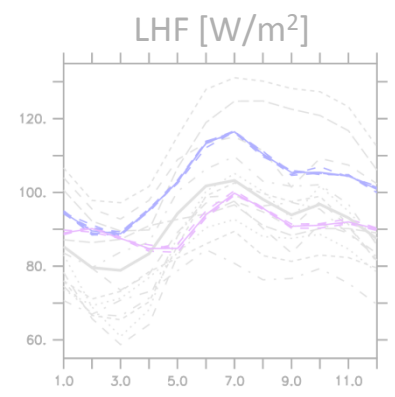
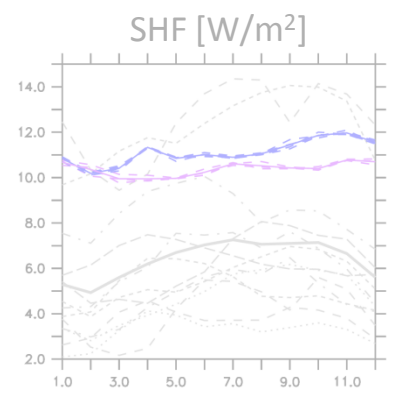
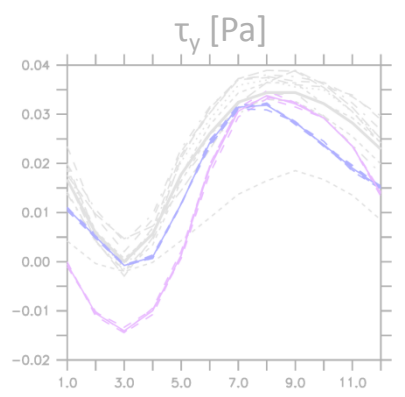
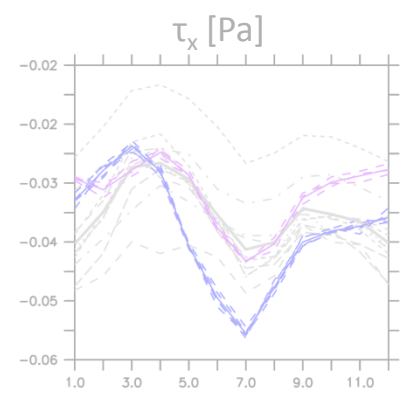


IPSLCM5A123(1979-2005)
AMIP12345(1979-2005)

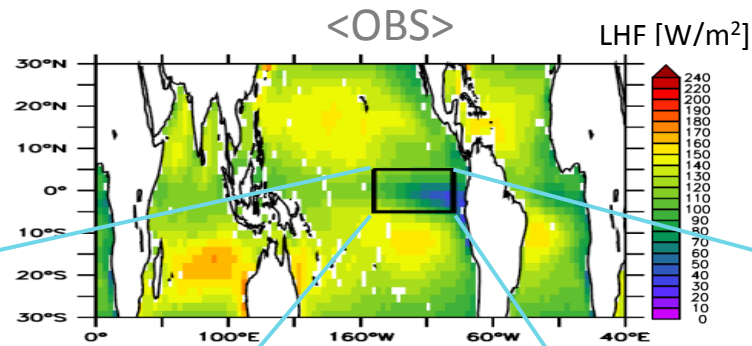


— 'OBS'
- - - Satellite
- - - *In situ*
- - - Reanalysis
... Hybrid
- - - Ocean model
surface forcing

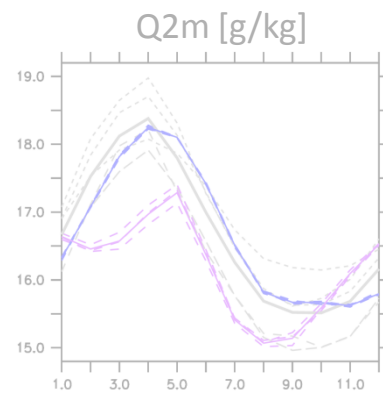
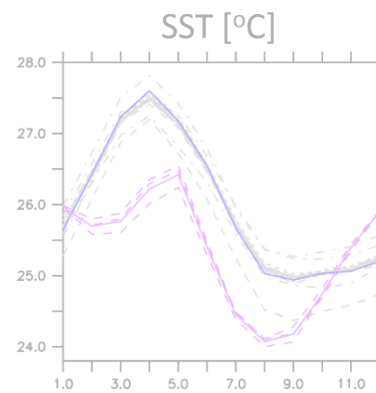
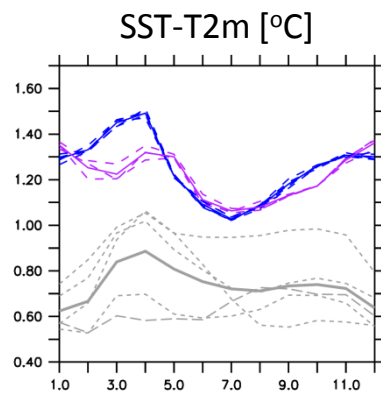
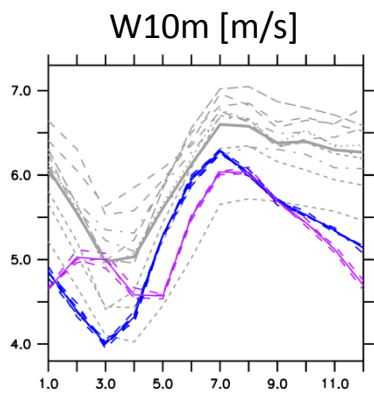
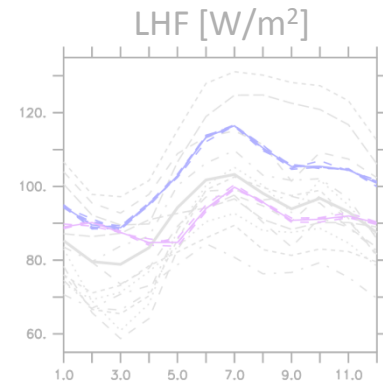
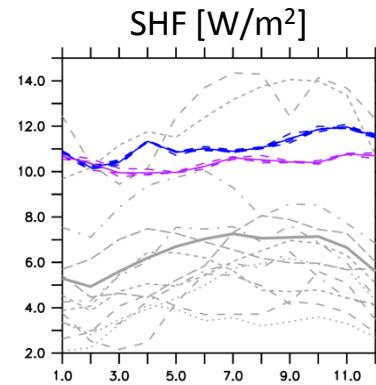
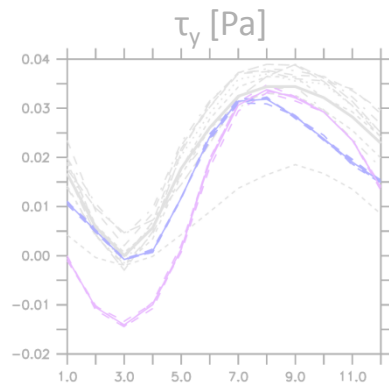
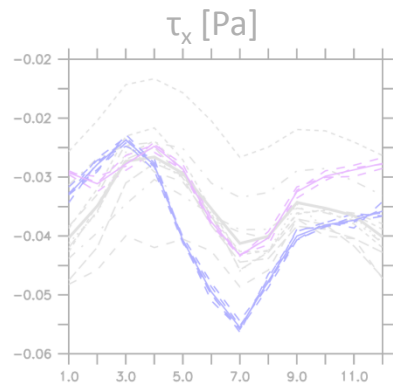
NINO3 (150°W-90°W; 5°S-5°N)



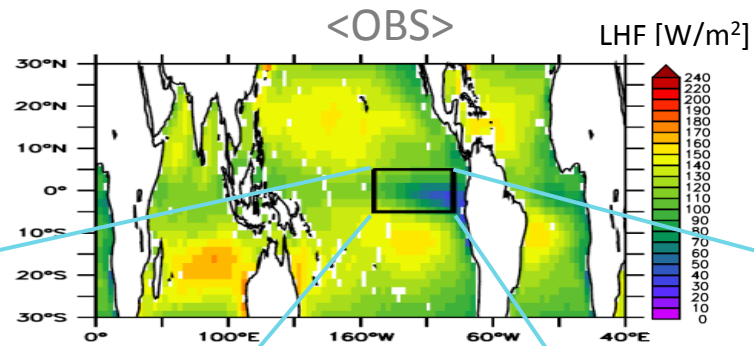
IPSLCM5A123(1979–2005)
AMIP12345(1979–2005)



NINO3 (150°W-90°W; 5°S-5°N)

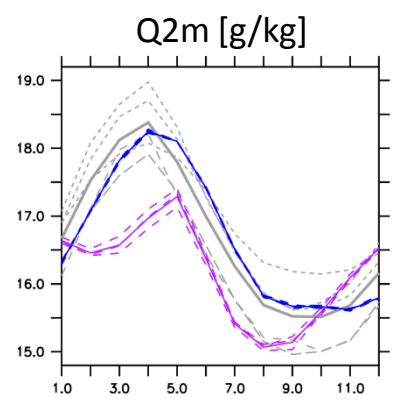
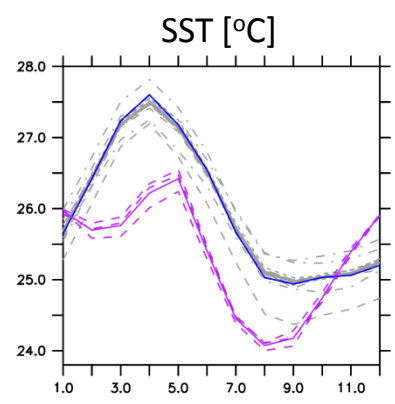
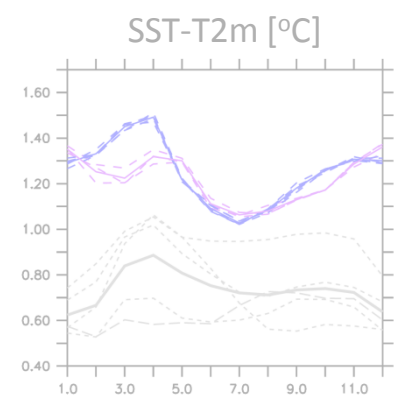
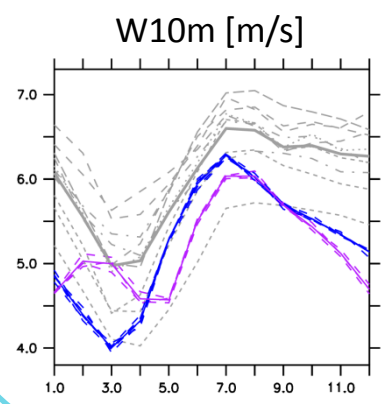
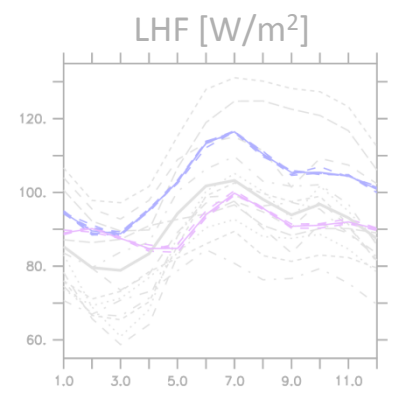
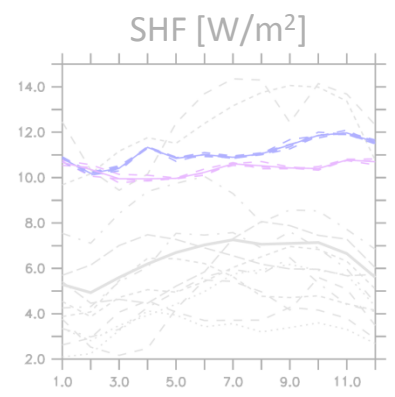
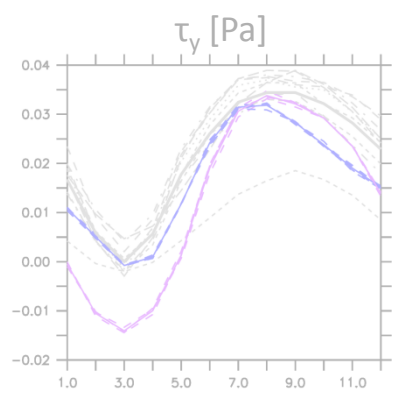
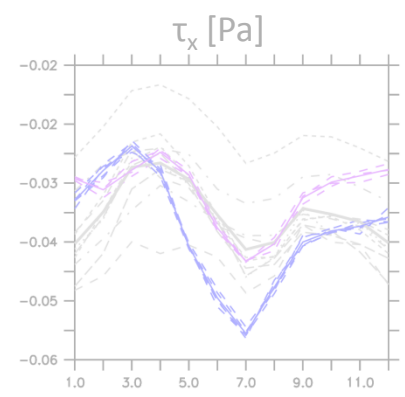


IPSLCM5A123(1979–2005)
AMIP12345(1979–2005)

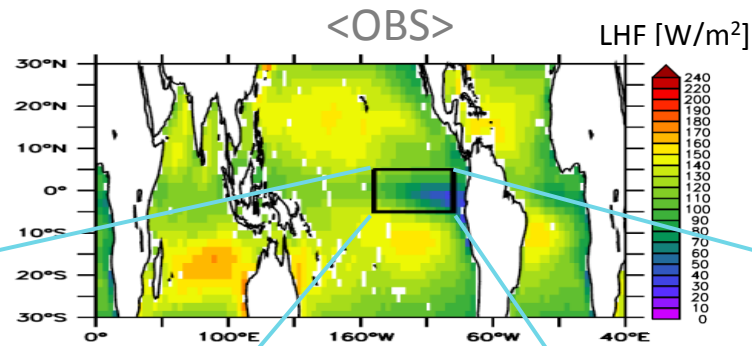


— 'OBS'
- - - Satellite
- - - *In situ*
- - - Reanalysis
... Hybrid
- - - Ocean model
surface forcing

NINO3 (150°W-90°W; 5°S-5°N)

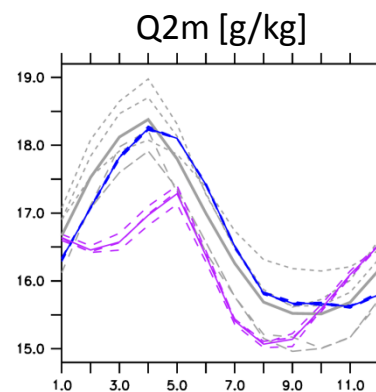
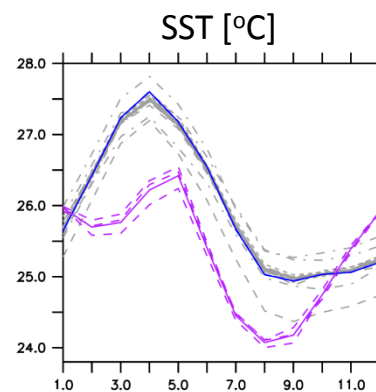
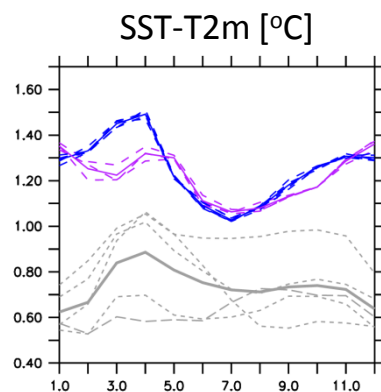
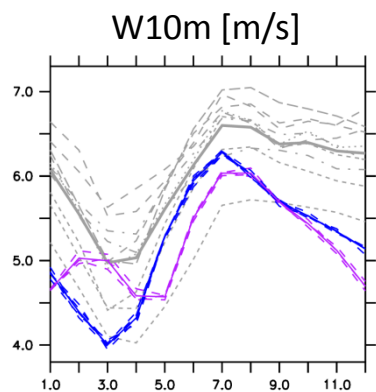
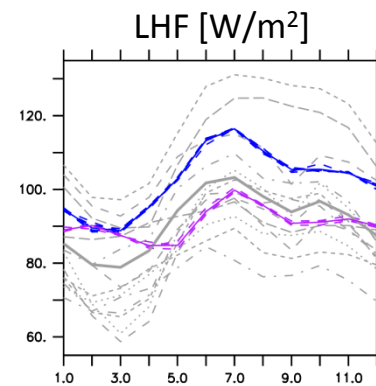
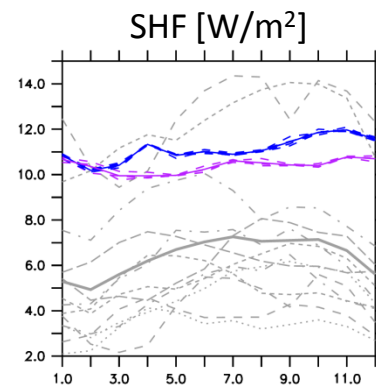
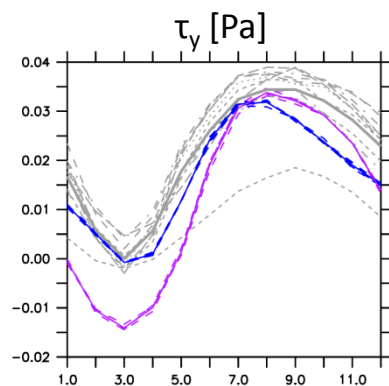
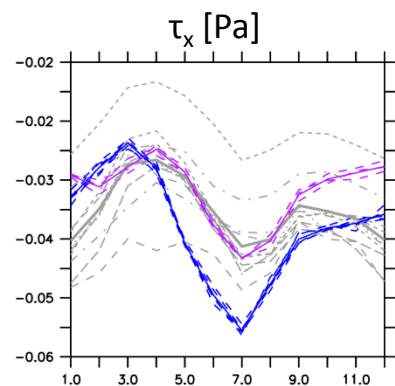


IPSLCM5A123(1979–2005)
AMIP12345(1979–2005)

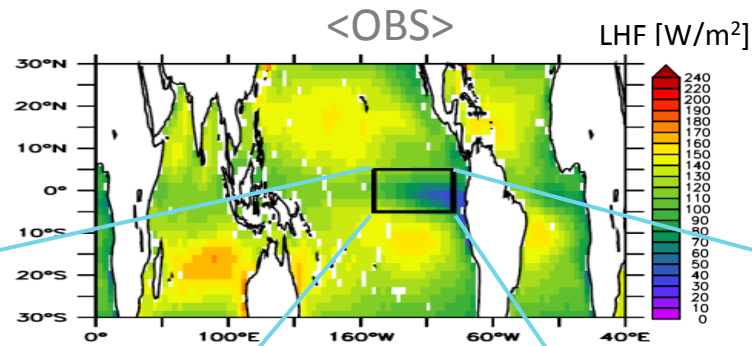


— 'OBS'
- - - Satellite
- - - *In situ*
- - - Reanalysis
- - - Hybrid
- - - Ocean model
surface forcing

NINO3 (150°W-90°W; 5°S-5°N)

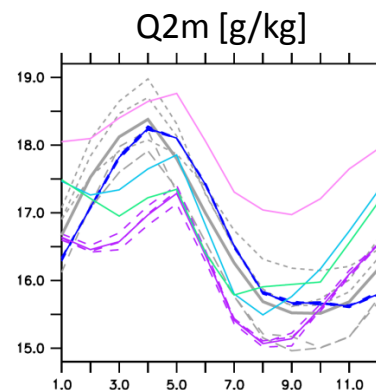
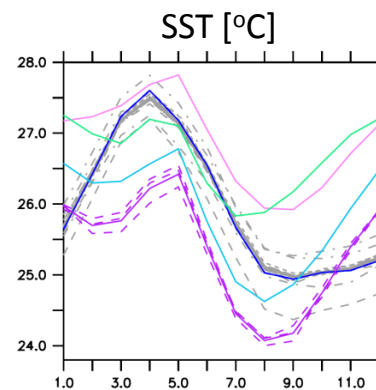
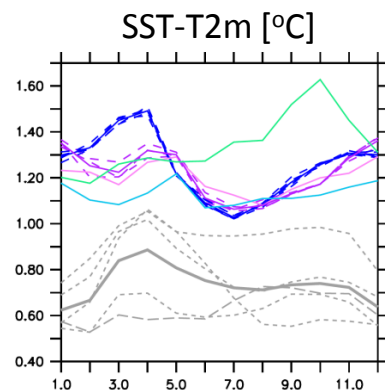
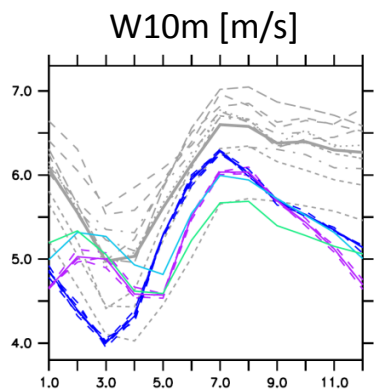
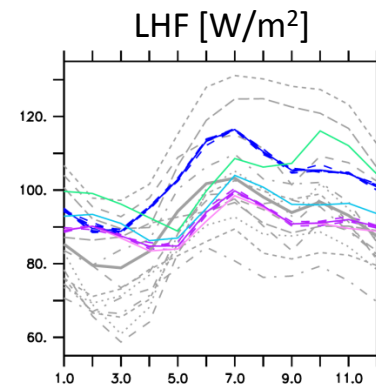
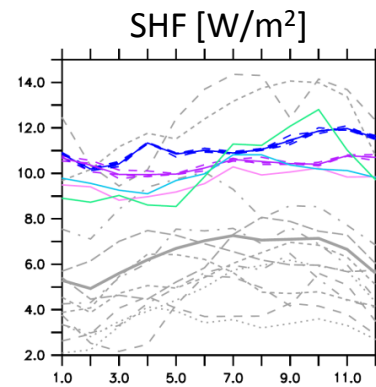
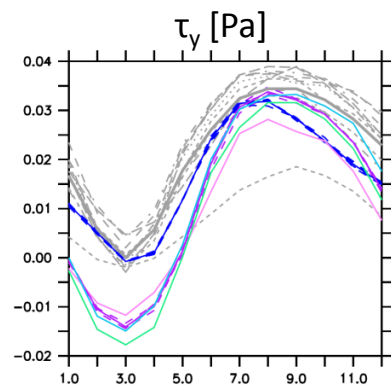
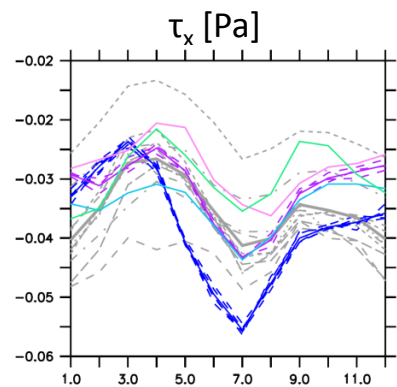


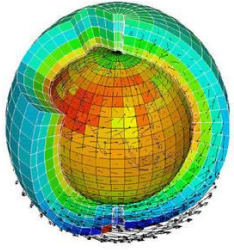
- IPSLCM4 (1979–2000)
- IPSLCM5A123(1979–2005)
- AMIP12345(1979–2005)
- IPSLCM5AMR (1979–2000)
- IPSLCM5B (1979–2000)



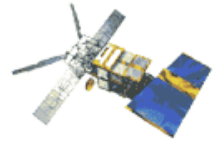
- 'OBS'
- - - Satellite
- - - *In situ*
- - - Reanalysis
- Hybrid
- - - Ocean model surface forcing

NINO3 (150°W-90°W; 5°S-5°N)





Conclusions



- ❑ Large observational uncertainties, especially in the surface heat fluxes
 - need to be addressed by the observational community
- ❑ When evaluating model results, we need to account for these uncertainties

- ❑ Systematic model biases (cold sea surface, weak winds) do not transfer to the surface fluxes, because of compensation of effects

- ❑ Except for mean value shifts, the largest differences are found between the old versions of the model and IPSL-CM5B



Extra slides...

“Validation” data

NOC2

(National Oceanography Center flux dataset)

FSU3

(Florida State University flux product)

Da Silva

(A. da Silva, A. C. Young, S. Levitus. Atlas of Surface Marine Data 1994, Volume 1: Algorithms and Procedures, number 6, 1994)



IFREMER

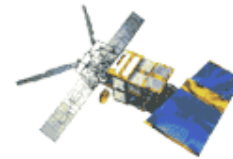
(Institut français de recherche pour l'exploitation de la mer)

J-OFURO

(Japanese Ocean Flux Data Sets with Use of Remote Sensing Observations)

HOAPS3

(Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data)



ECMWF – ERA-Interim(?)

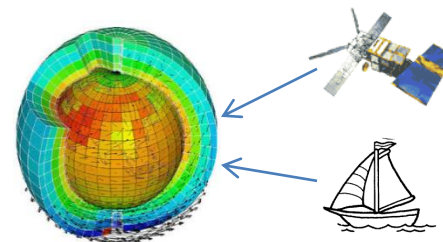
(European Center for Medium-Range Weather Forecasts)

NCEP/NCAR

(National Centers for Environmental Prediction/
National Centre for Atmospheric Research)

JRA25

(Japanese 25-year reanalysis)



“Validation” data

OAFlux

(Objectively-Analyzed air-sea Fluxes for the Global Oceans – WHOI)

GSSTF2

(Version 2 Goddard Satellite-Based Surface Turbulent Fluxes)

TropFlux

(National Institute of Oceanography, India & IPSL)

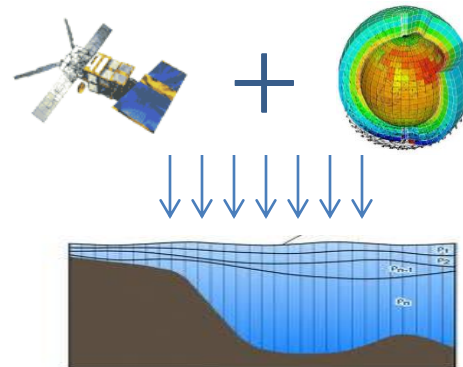


CORE2

(GFDL version 2 forcing for common ocean-ice reference experiments)

DFS4

(DRAKKAR Forcing Set v4.3 – MEOM, Grenoble)

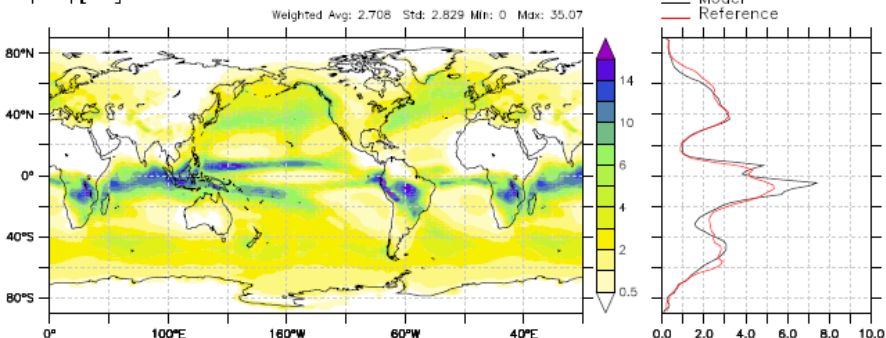


v3.historical1

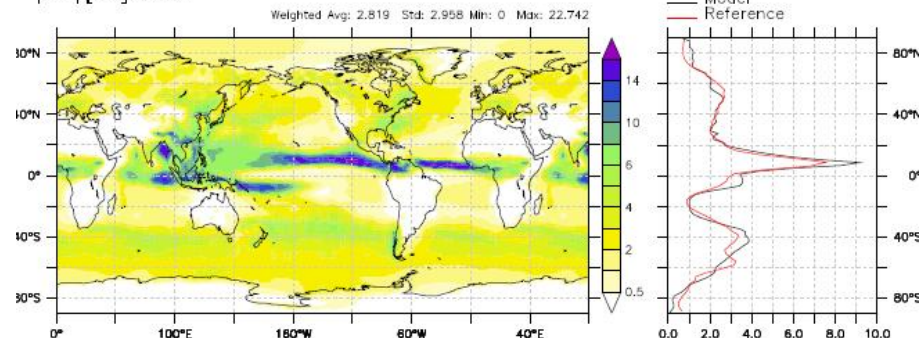
January

July

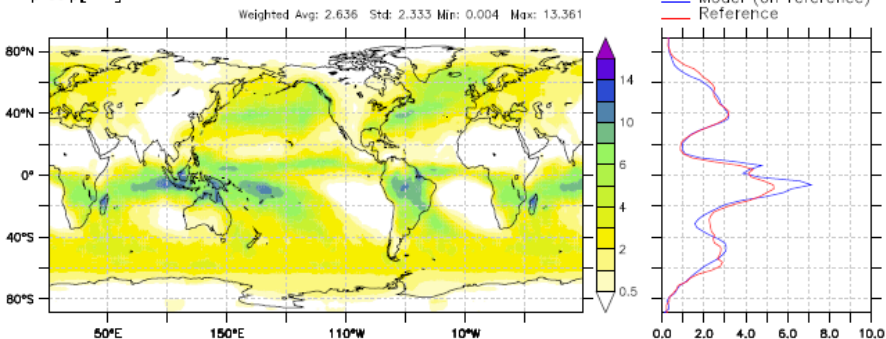
v3.historical1_SE_1990_1999_1M_histmth.nc
precip[l=1]+86400



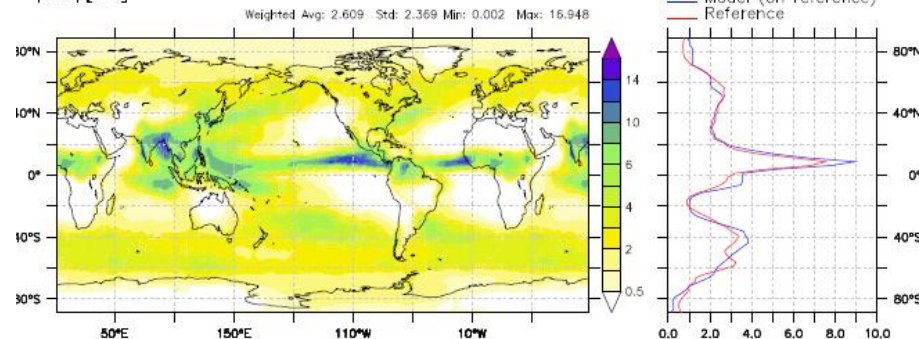
v3.historical1_SE_1990_1999_1M_histmth.nc
precip[l=7]+86400



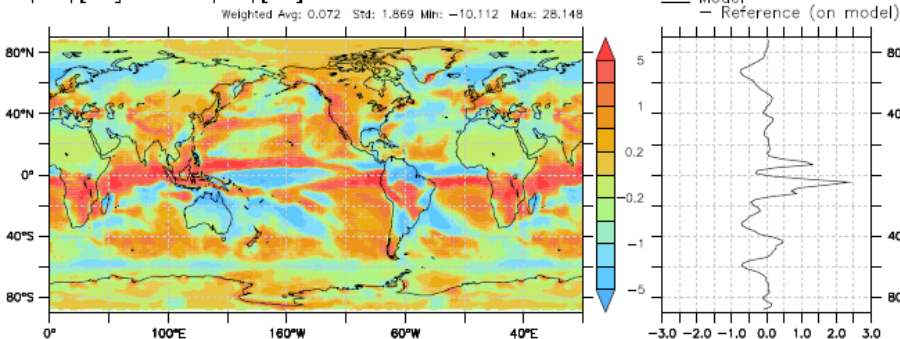
precip.mon.ltm.nc
precip[l=1]



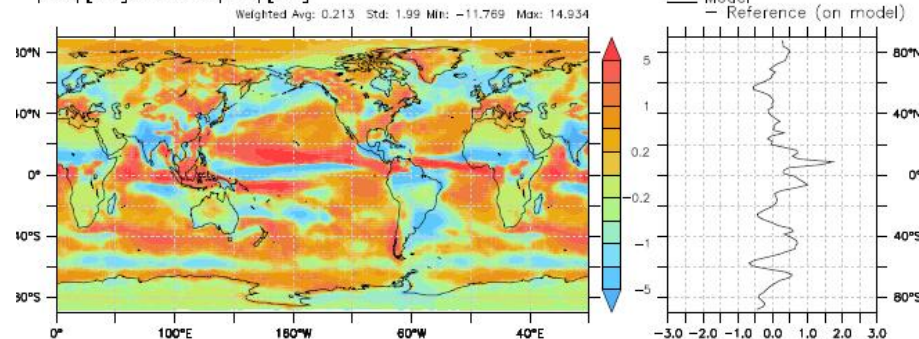
precip.mon.ltm.nc
precip[l=7]



Difference
precip[l=1]+86400 - precip[l=1]



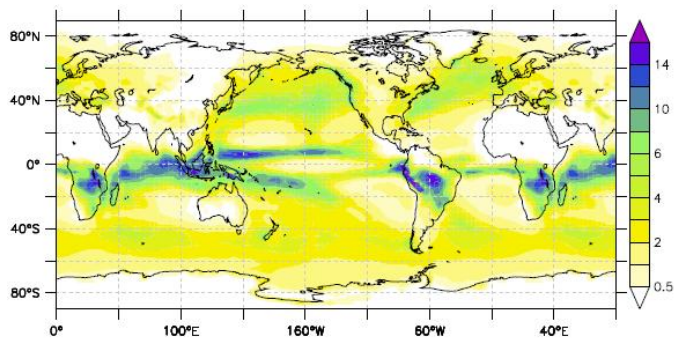
Difference
precip[l=7]+86400 - precip[l=7]



Important model biases

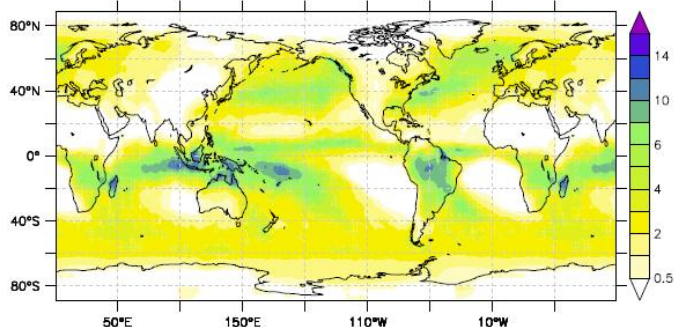
IPSL-CM5A

AMIP



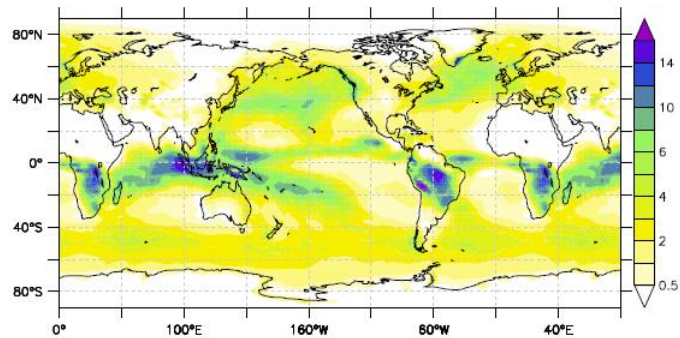
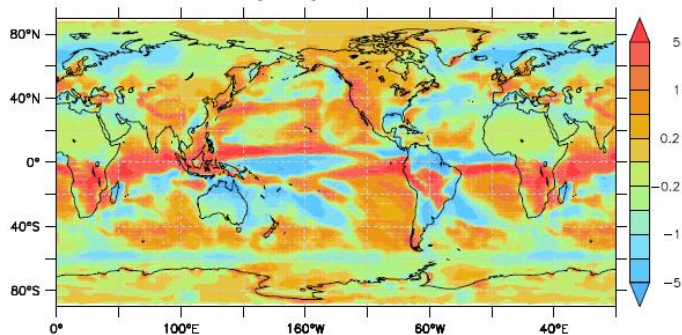
precip.mon.ltm.nc
precip[l=1]

Weighted Avg: 2.636 Std: 2.333 Min: 0.004 Max: 13.361



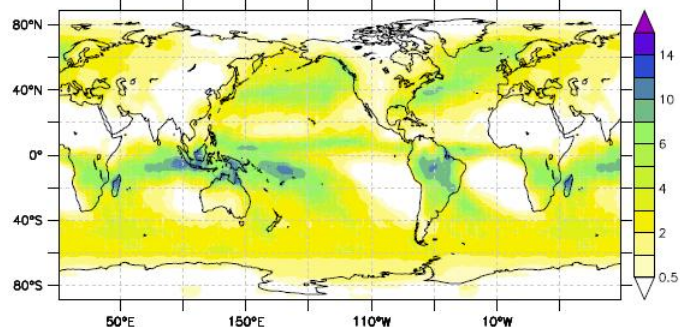
Difference
precip[l=1]*86400 - precip[l=1]

Weighted Avg: 0.072 Std: 1.869 Min: -10.112 Max: 28.148



precip.mon.ltm.nc
precip[l=1]

Weighted Avg: 2.636 Std: 2.333 Min: 0.004 Max: 13.361



Difference
precip[l=1]*86400 - precip[l=1]

Weighted Avg: 0.174 Std: 1.66 Min: -10.331 Max: 24.014

