La mousson afro-asiatique et l'ENSO dans les simulations paleoclimatiques et 1%CO2 avec le modèle de l'IPSL

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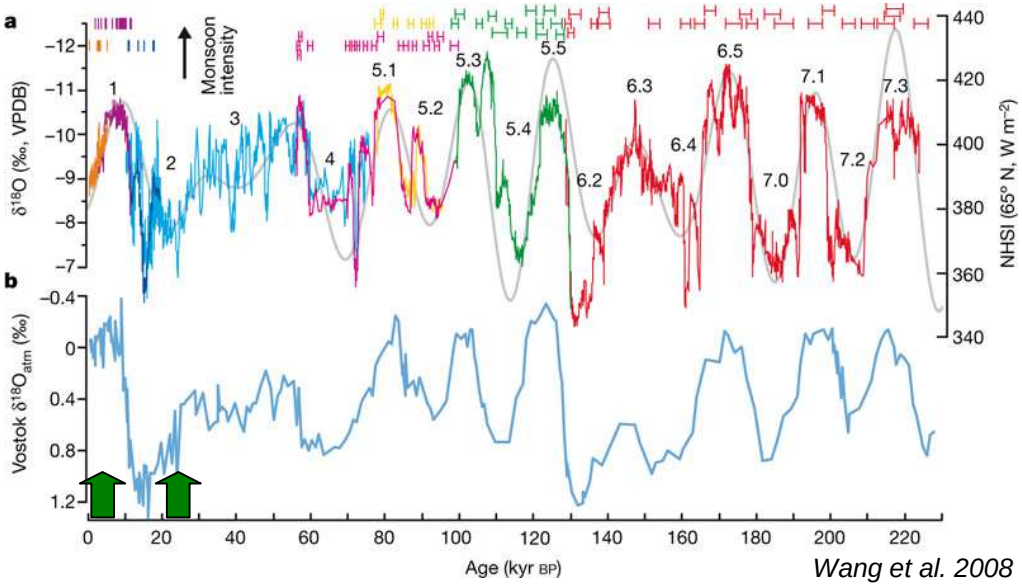
J-Y. Peterchmitt, M-A. Foujols, A. Caubel

Monsoon and ENSO in the past

Sanbao cave, China : monsoon record

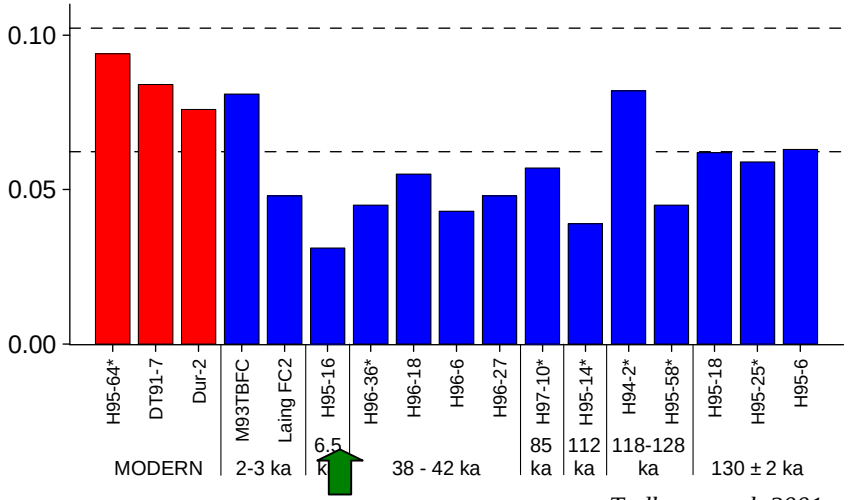


Wang et al. 2008

- Fluctuations at the orbital time scales:
  - Eccentricity (100 kyrs) , obliquity (41 kyrs), precession (19 and 23 kyr)
- Lots of publications with model results
  - (see Liu and Braconnot, in press for a review)
- Some rapid events are correlated with perturbations in the North Atlantic (not shown)

- Large variations in ENSO variability
- Model Evidences for a link with precession
  - i.e Clement et al. (1999)
  - + about 12 publications with model results

Coral records : ENSO



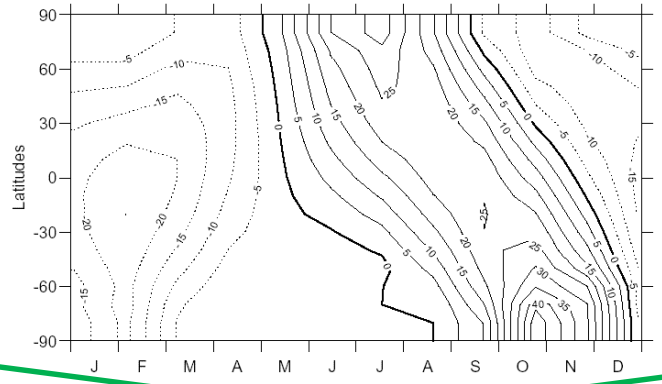
Tudhope et al, 2001

Periods considered in this talk

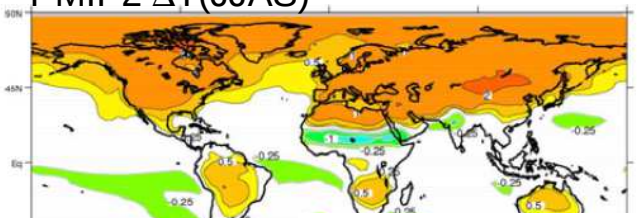
Mid- Holocene and Last Glacial Maximum

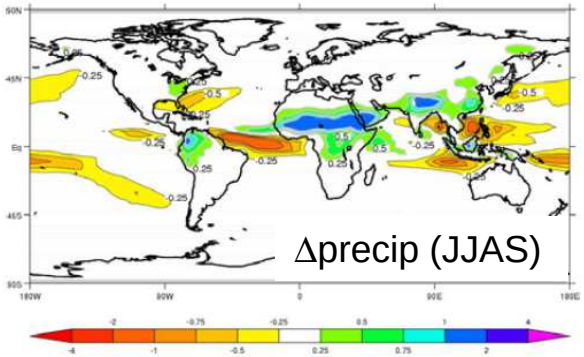
Mid Holocene, 6000 years ago

Change in insolation forcing



PMIP2 ΔT(JJAS)



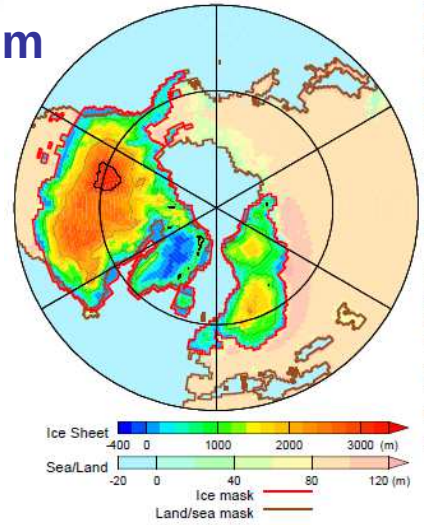


Warmer NH summers,stronger monsoons

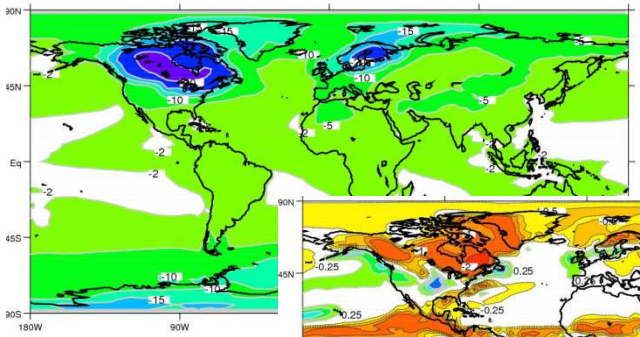
Last Glacial Maximum 21000 years ago

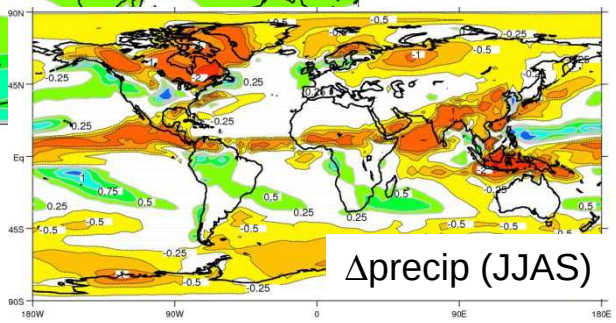
Changes in :

- ice-sheets
  (topo, albedo)
- coastlines
- GHG forcings:
  CO_2 = 185ppm
  CH_4, N_2O



PMIP2 ΔT(JJASl)



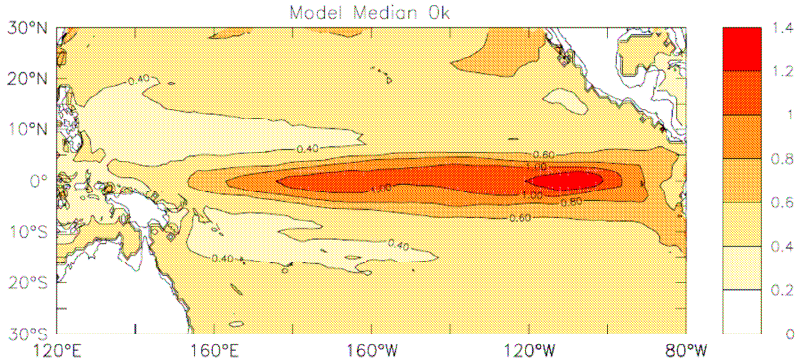


Colder, drier

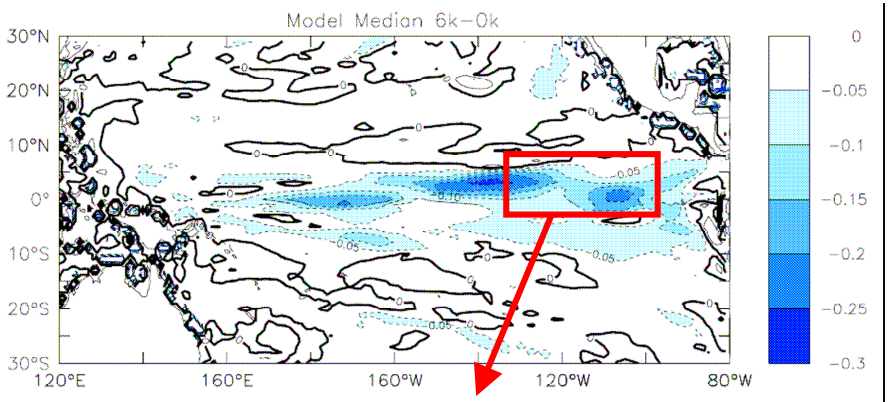
PMIP2 results, Braconnot et al 2007

ENSO in PMIP2 mid-Holocene simulations

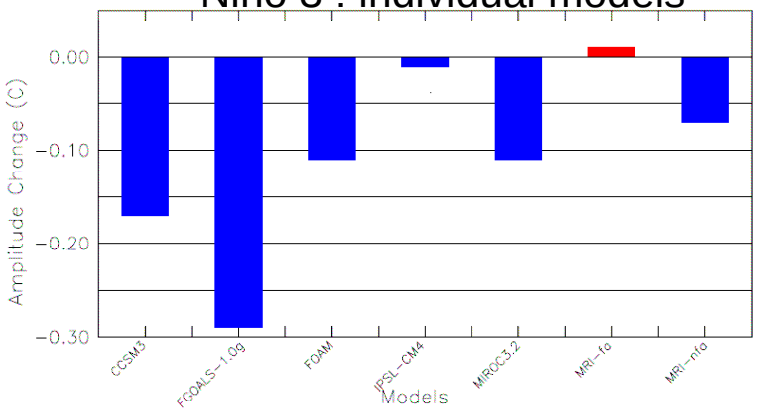
Interannual variability (model median)



MH change in Interannual variability (model median)



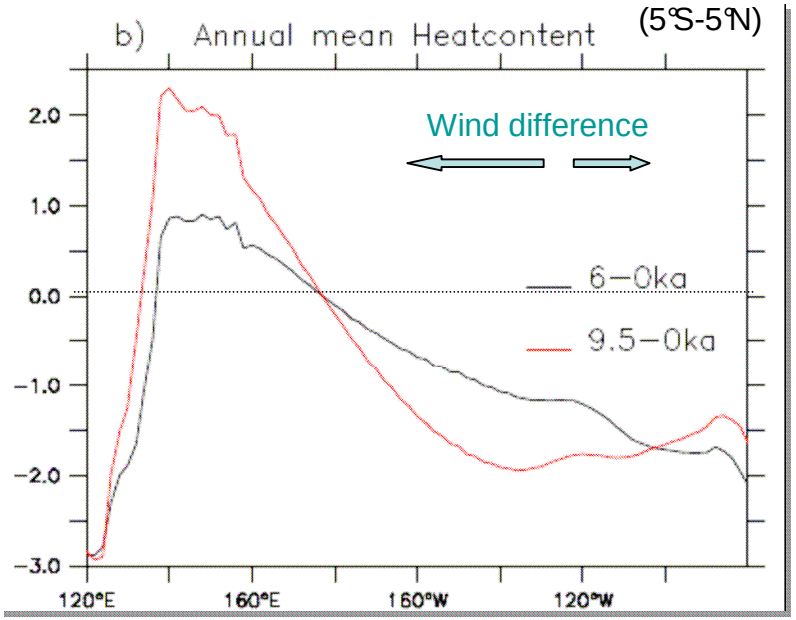
Niño 3 : individual models



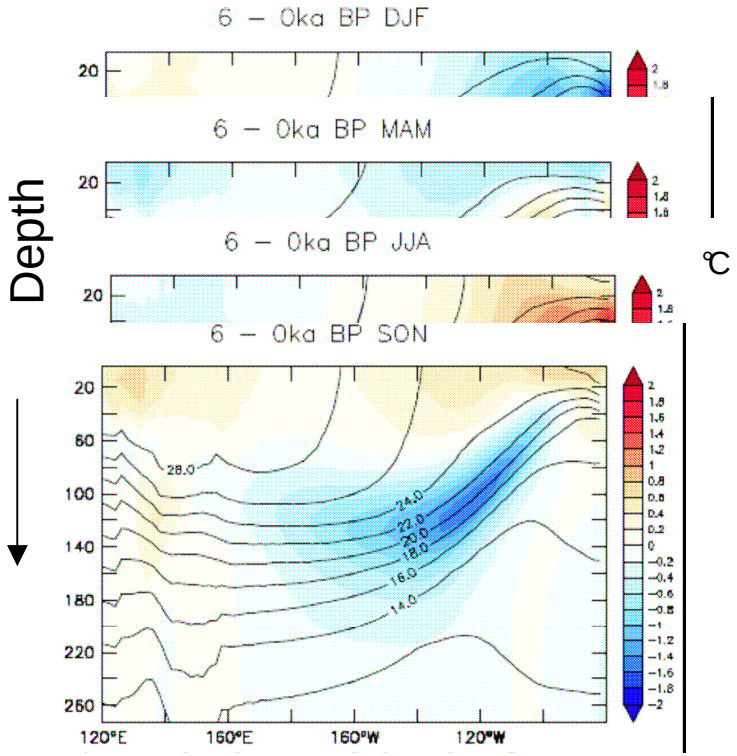
Zheng et al 2008

- Almost all simulations show reduced ENSO
- Consistent with several records (corals, shells, giant bivalves…) , but smaller magnitude
- The changes in large scale dynamic (interhemispheric gradient, enhanced monsoon) have a strong constraint on the mean annual cycle
- Large spread in model results for the LGM

Relationship with changes in ocean mean state in the IPSL 6k simulation



5°S-5°N equatorial section : Pacific 6k-0k



➢ Annual mean :
Strengthening E/W wind and heat content gradient (no direct link SST/wind)

➢In Autumn (SON) :
Upwelling (thermocline) + warmer surface water in the east counteract downwelling El-Niño anomaly
El-Nino development is damped

Luan et al. submitted

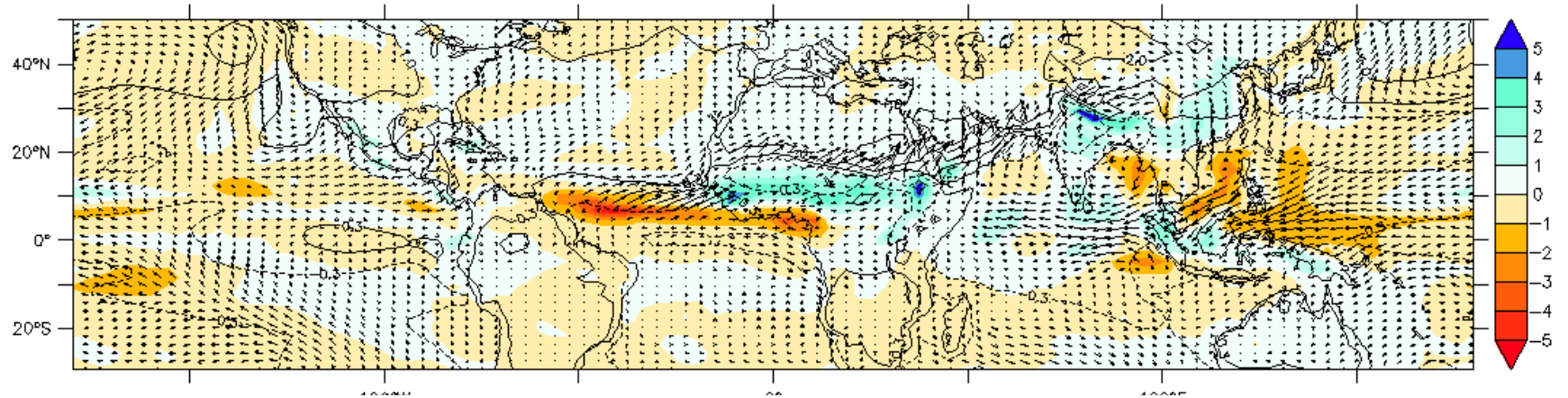
Questions

- État moyen /
  - Caractéristiques saisonnalité (mousson)
  - Caractéristiques variabilité (ENSO)
- Identification lien avec les biais des modèles
  - Comparaison CM4 et CM5
  - Extension à PMIP3
- Passé/futur : critères d'évaluation
  - Pas traité dans cet exposé

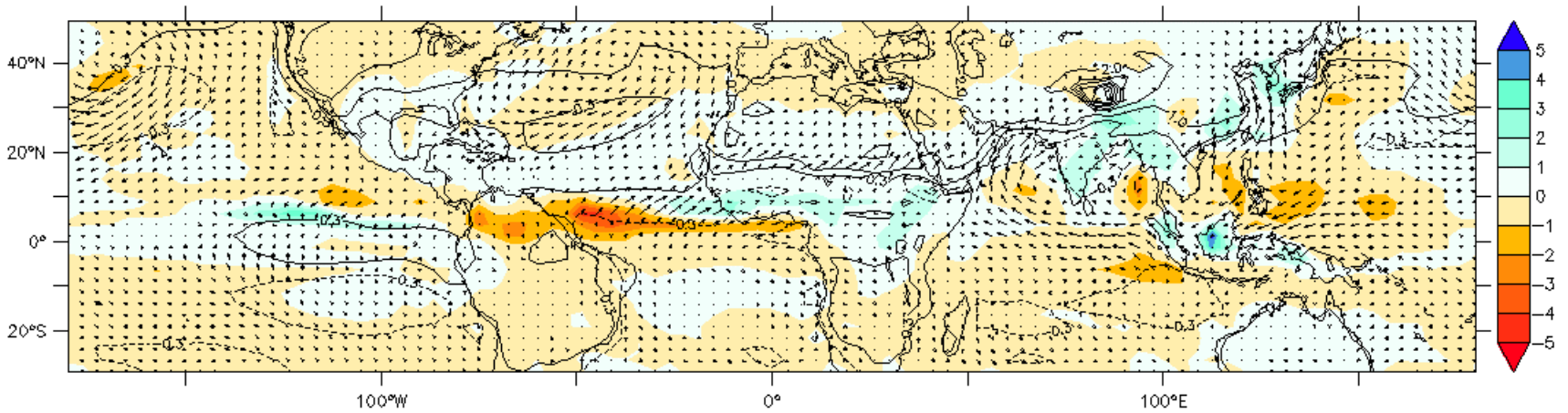
Mid-Holocene IPSL CM5 and CM4

Paleoclimate Modelling PMIP3 Intercomparison Project

IPSL CM5 6ka – 0ka JAAS ⟶ 5 m/s

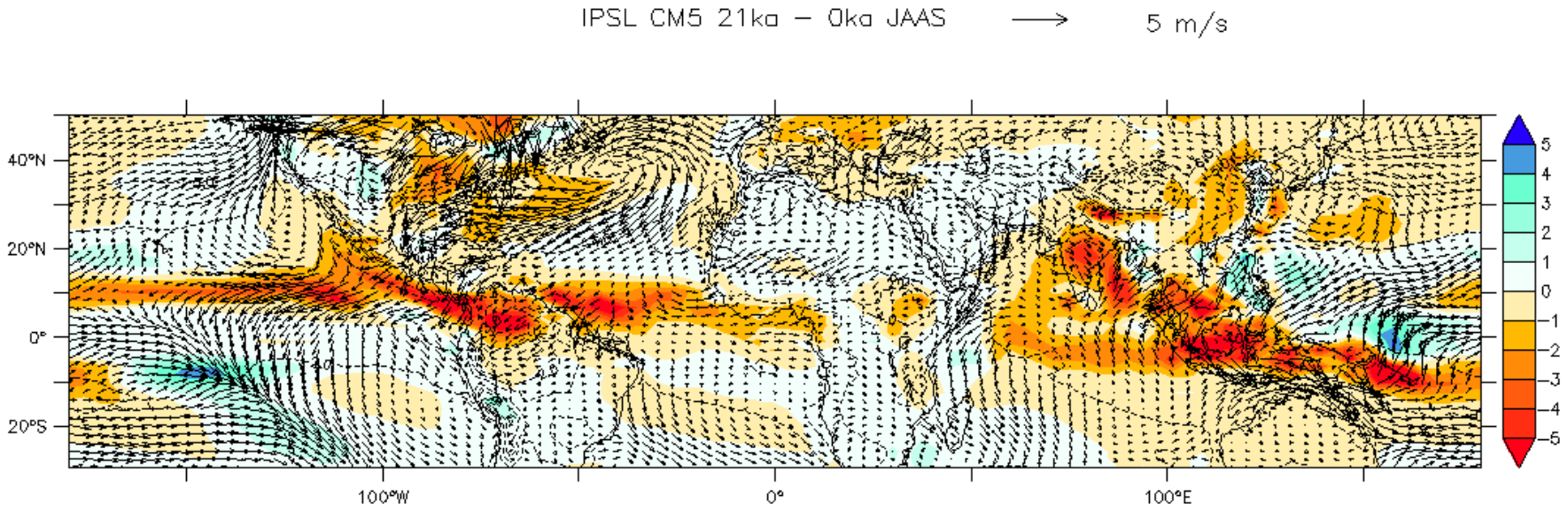


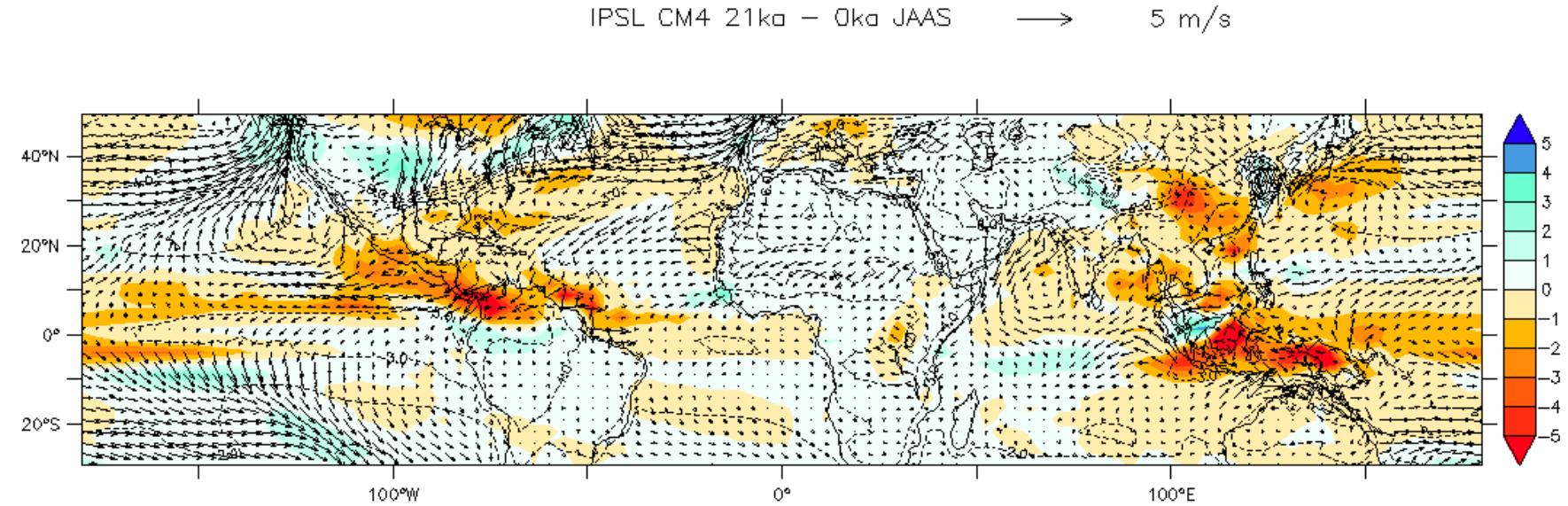
IPSL CM4 6ka – 0ka JAAS ⟶ 5 m/s



mm/day

LGM CM4 and CM5



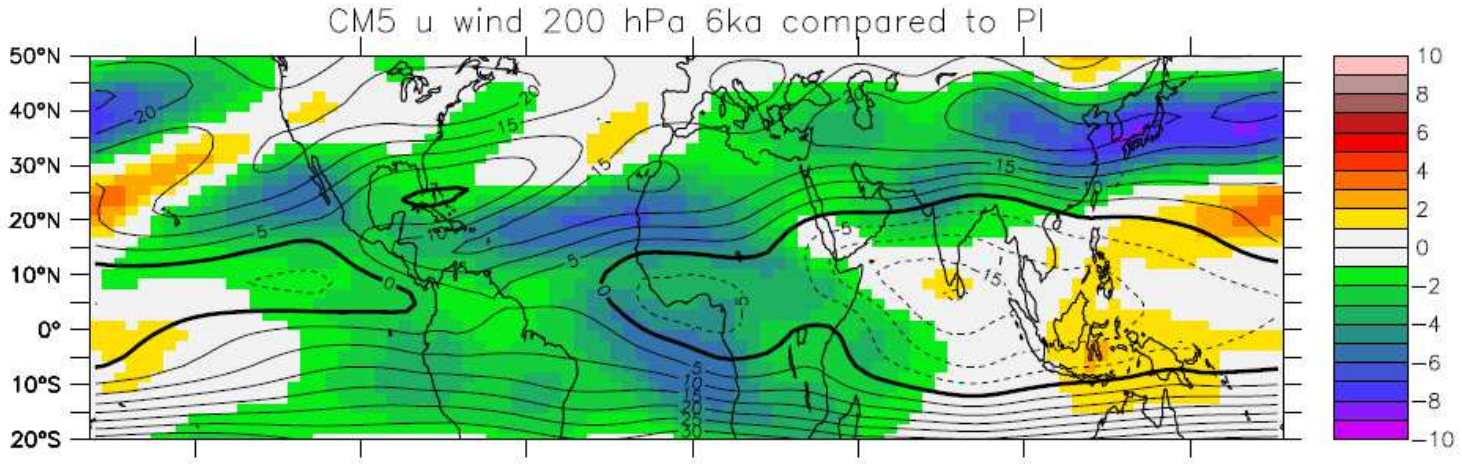


AM/

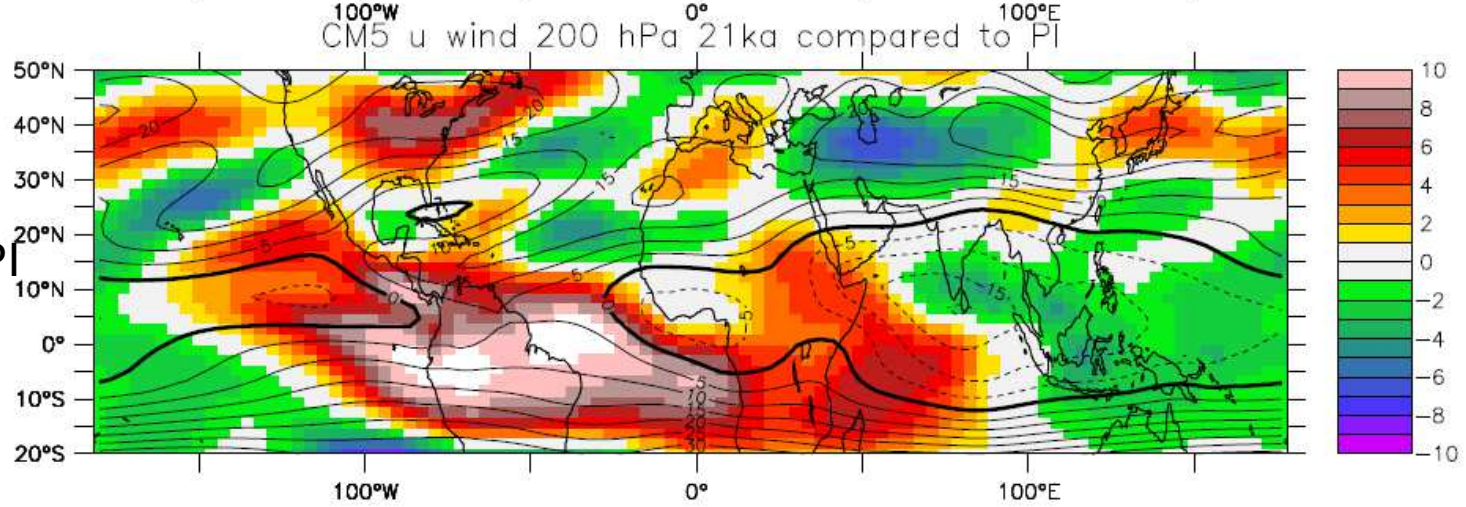
mm/day

200 hPa zonal wind

6ka - PI

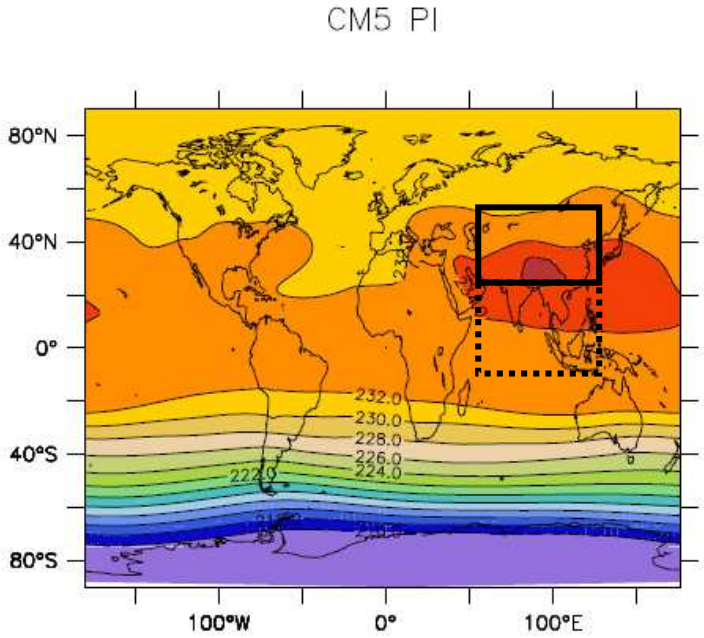


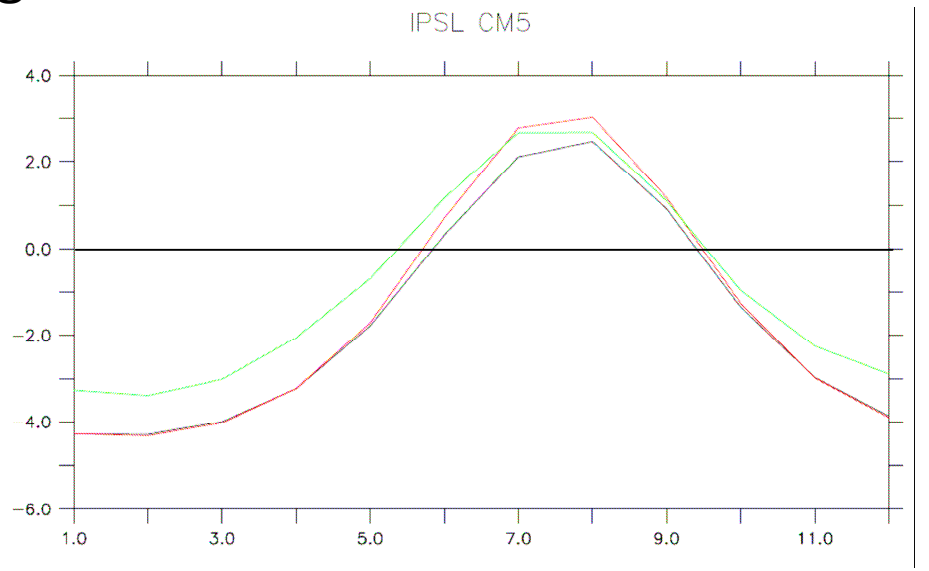
21ka - PI



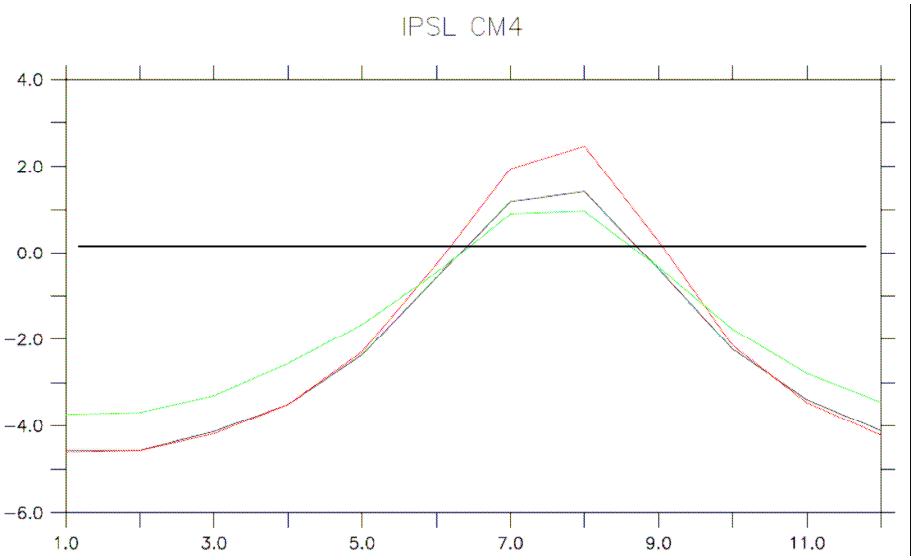
Atmospheric warming 500-200hPa

JJAS

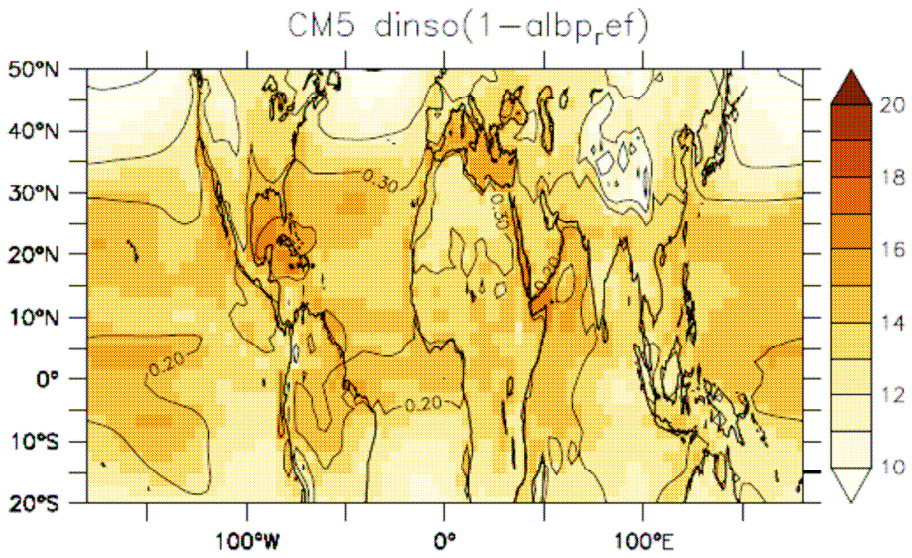


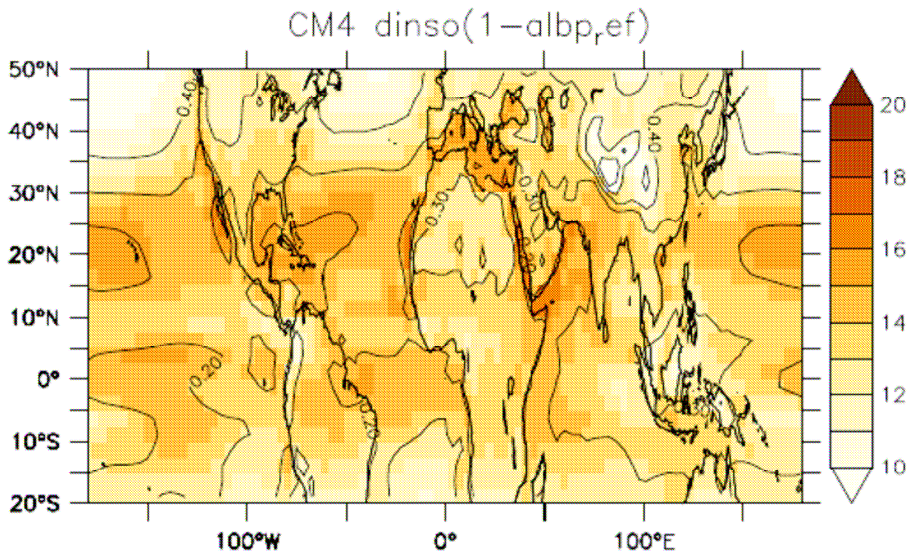


PI
6ka
21ka



6ka insolation forcing JJAS: role of PI albedo

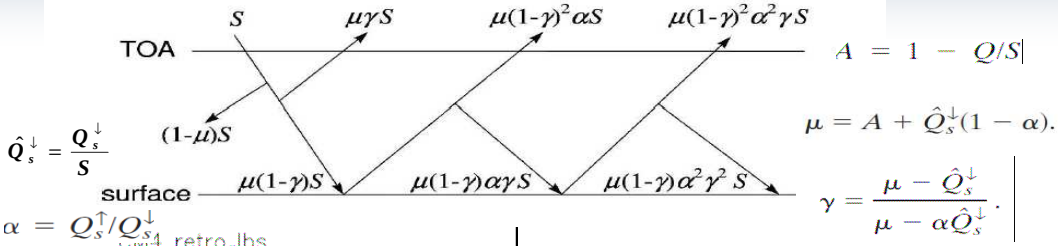




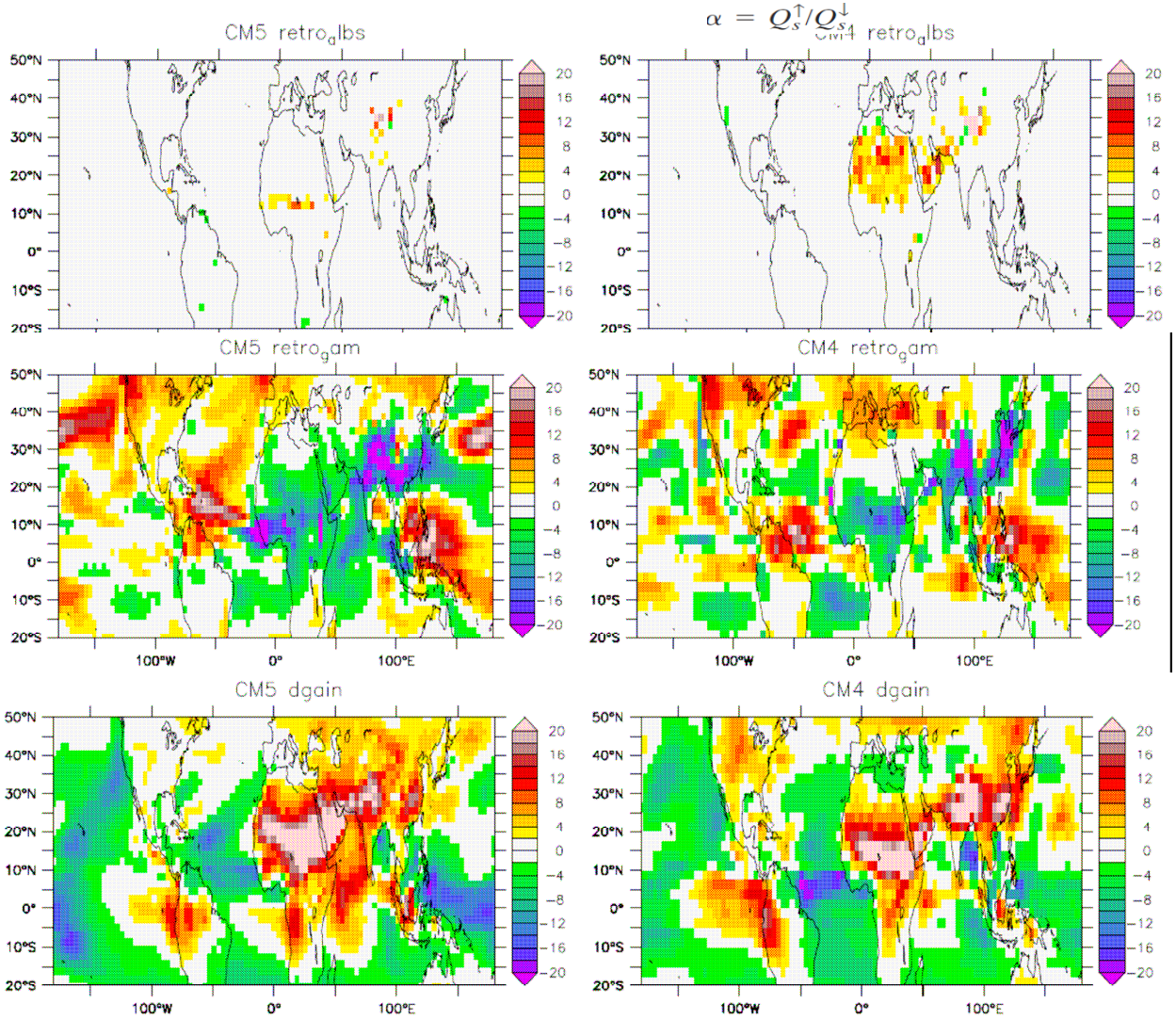
Couleur = *SWf*
Isoline = α_0

$$SWf = (1-\alpha_0)\Delta SW$$

SW Feedbacks and greenhouse effect



JJAS

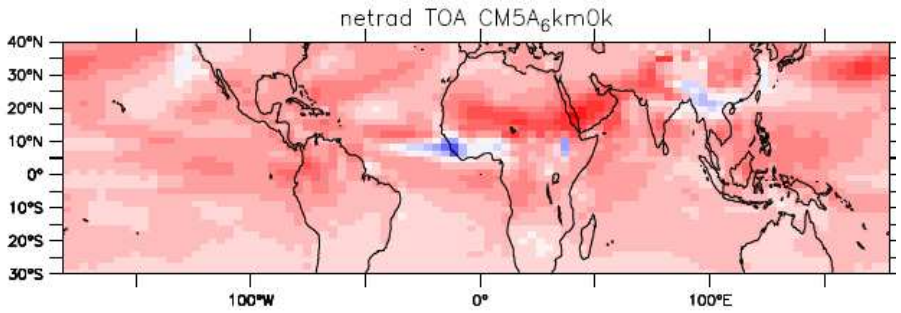


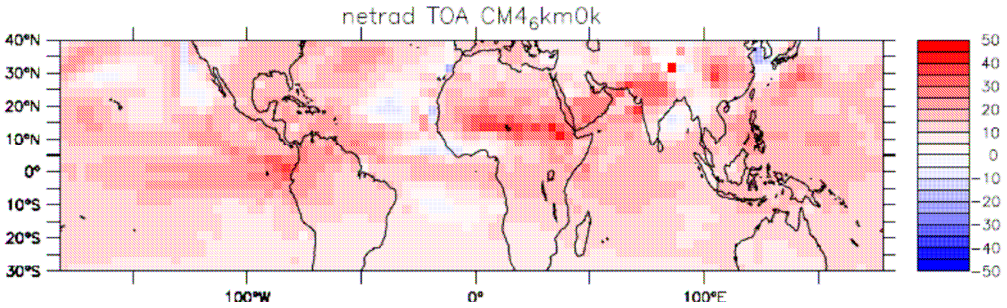
albedo

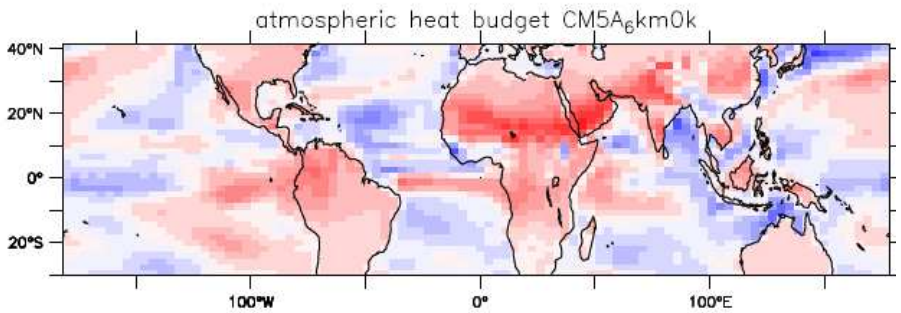
Diffusion + clouds

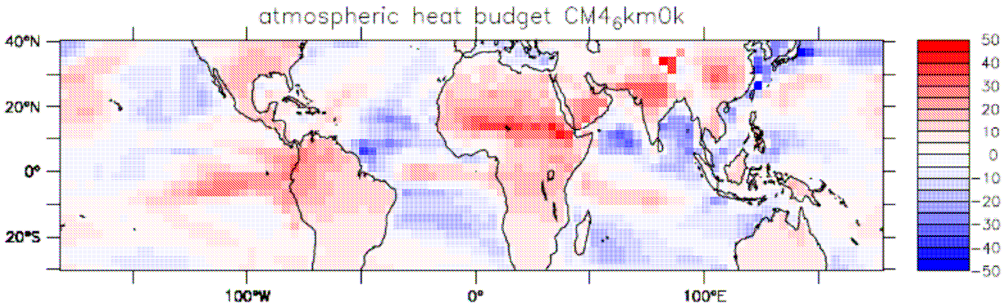
$\sigma T^4 - LW_{TOA}$

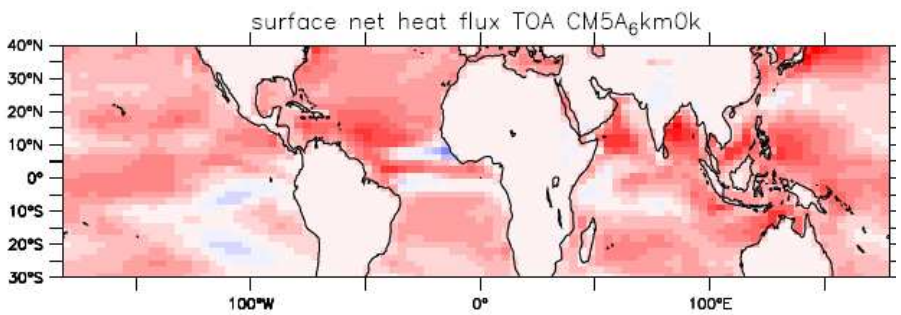
Heat budgets : JJAS 6ka - PI

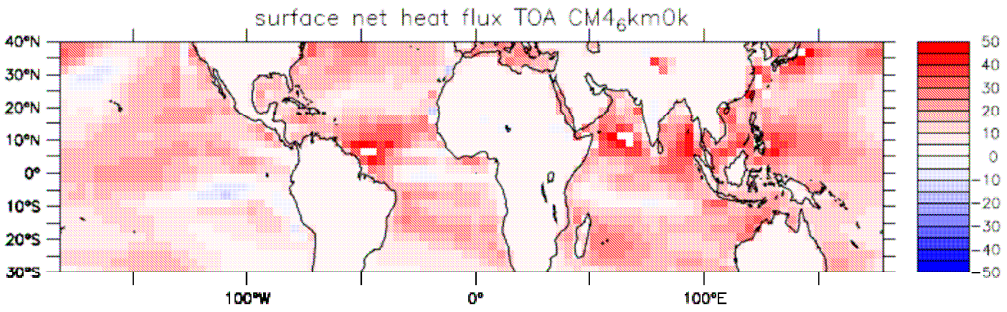












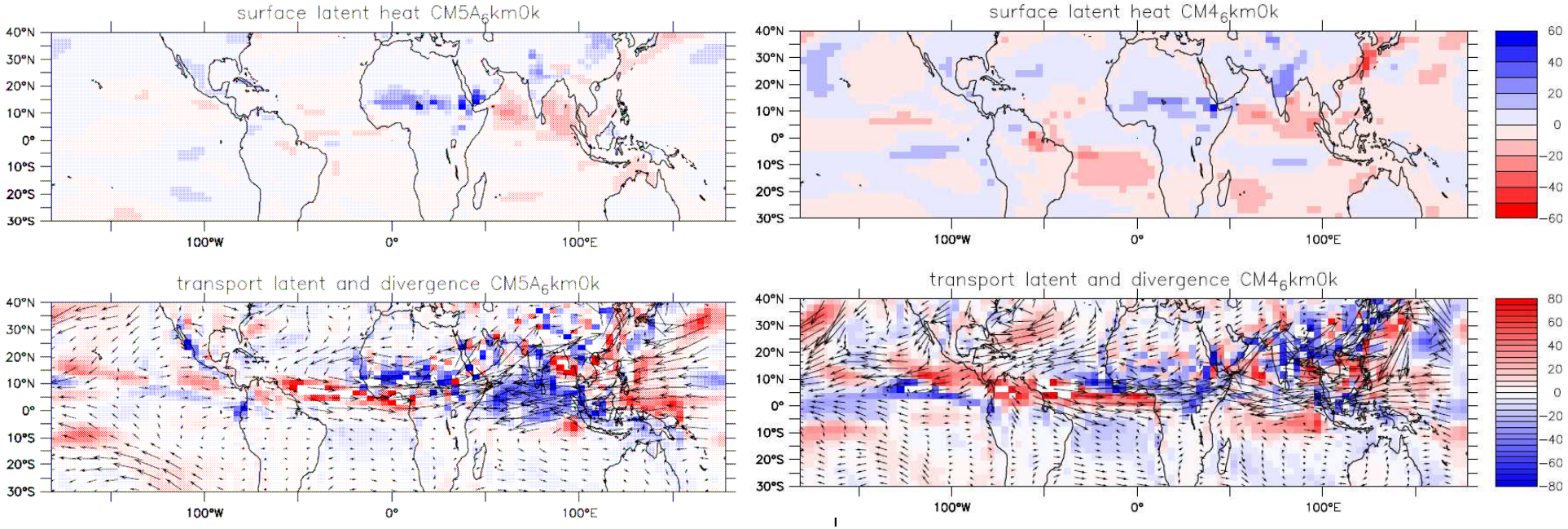
NetTOA = $SW_{Toa} – LW_{Toa}$

Bils = SWs – LWs –Latent – sensible

Atm = NetTAO - bils

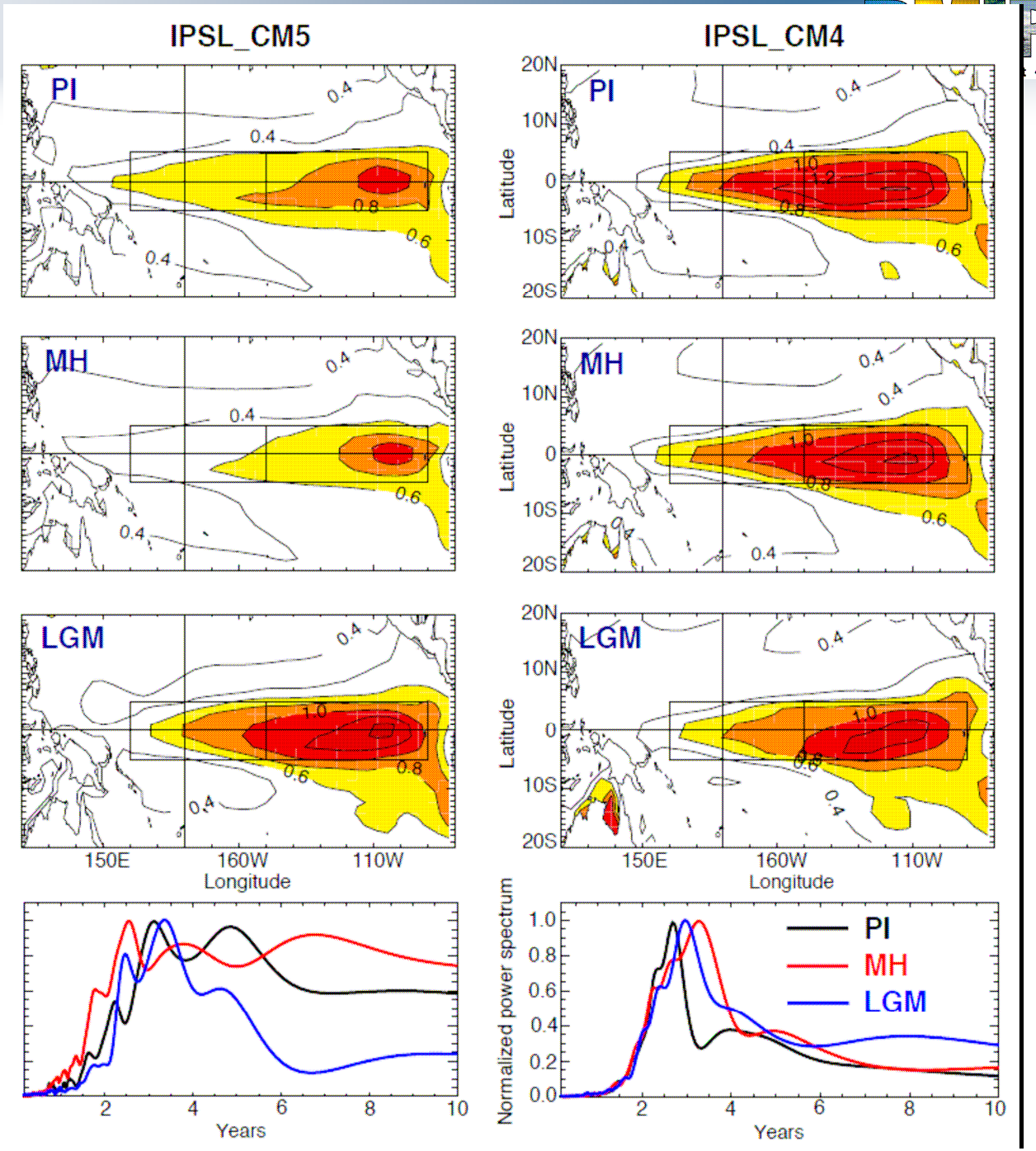
Latent heat and moisture transport

- JJAS: 6ka - PI



Less evaporation over the ocean
Evaporation / SST feedback : ex Subtropical N Atlantic
Larger evaporation in monsoon (Africa, N india) in CM5

ENSO


IPSL_CM5
IPSL_CM4
PI
MH
LGM
Latitude
20N
10N
0
10S
20S
150E
160W
110W
Longitude
Years
Normalized power spectrum
PI
MH
LGM

		ENSO (°C)	Mu	Alpha	Alpha_SW	Alpha_LH
Obs	OAFlux / ERA40	0.92	11.86	-18.60	-6.74	-10.89
Pre-industrial control run	IPSL CM4 Picntrl	1.02	4.80	-7.00	3.51	-6.62
	IPSL CM5A Picntrl	0.71	5.53	-5.01	6.85	-6.27
Mid-Holocene (6 ka)	IPSL CM4 HOL04D	1.01	4.32	-5.92	4.30	-6.32
	IPSL CM5A CM5H6KO2	0.63	5.02	-4.90	7.19	-6.26
Last Glacial Maximum	IPSL CM5A LGM8	1.01	3.75	-4.70	5.95	-5.33

Mu and alpha characterize the model behavior and are marginally affected by the climate change at least for 6ka, further exploration is needed for the LGM

From J. Lloyd