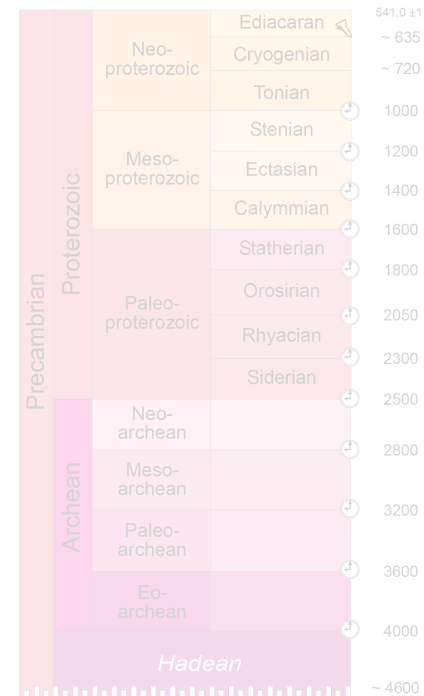
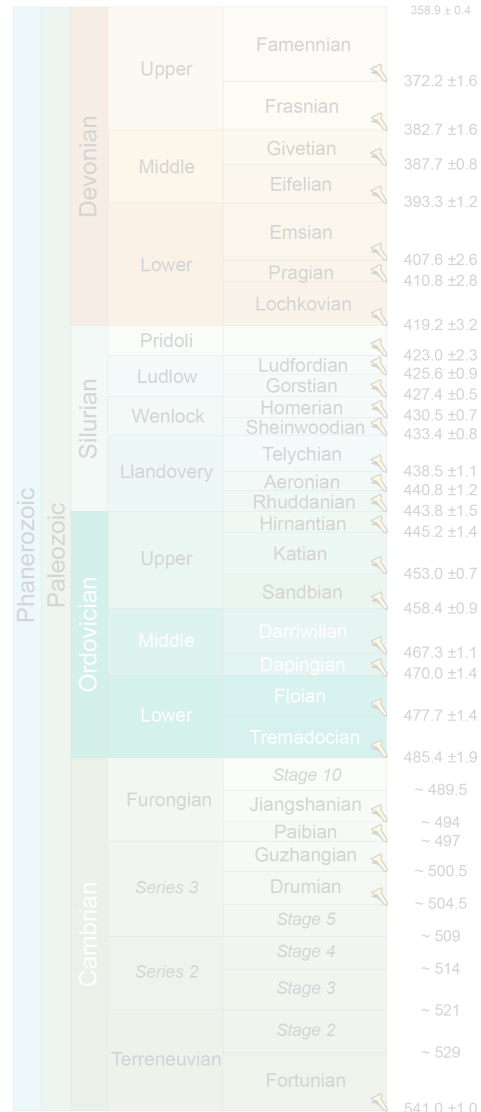
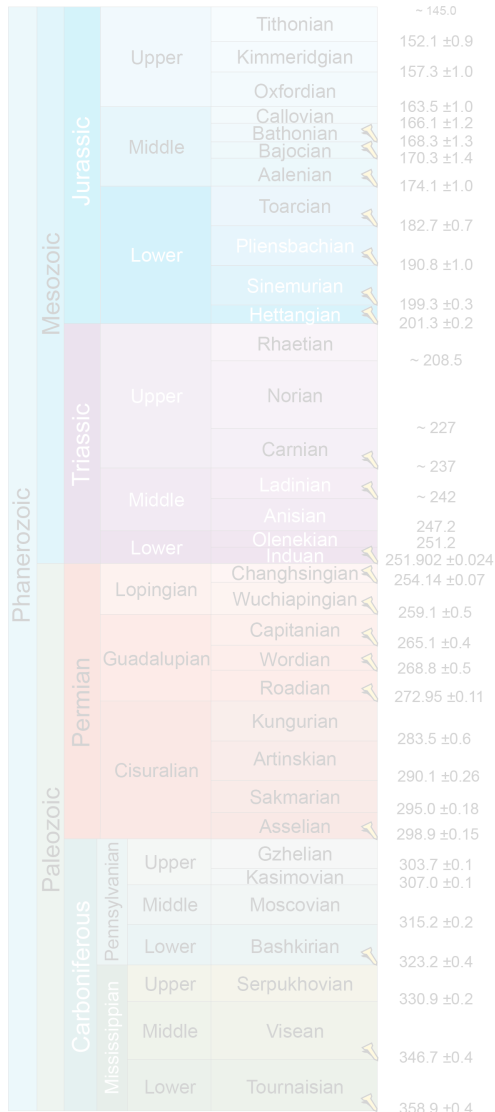
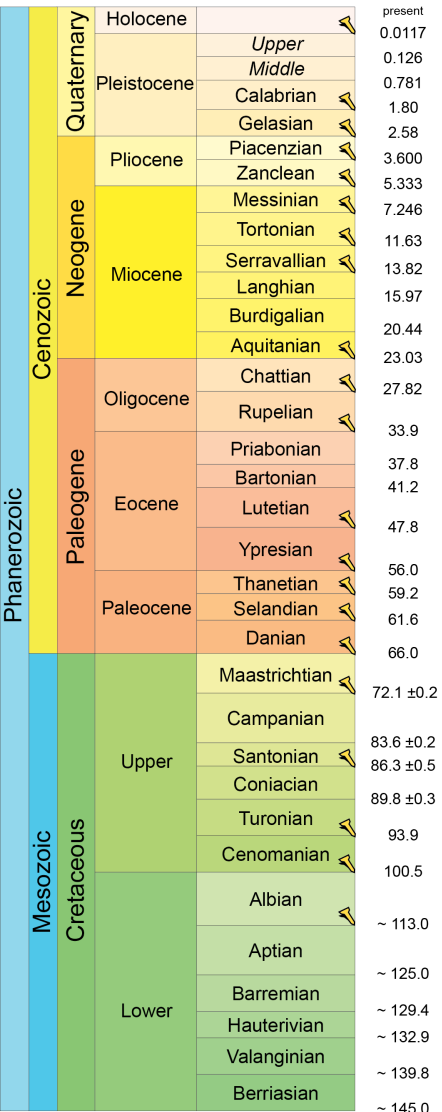


IPSL ESM et paléoclimats

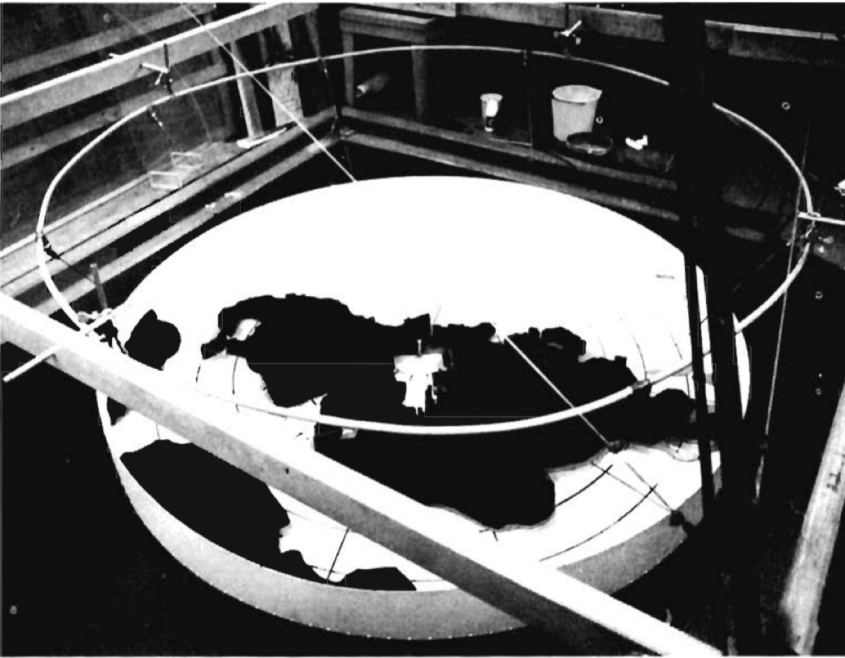
Etudes en cours, limites, et questions pour l'avenir

P. Sepulchre, réunion PEDALONS, 4 juin 2020.

Les longues échelles de temps



Historique rapido

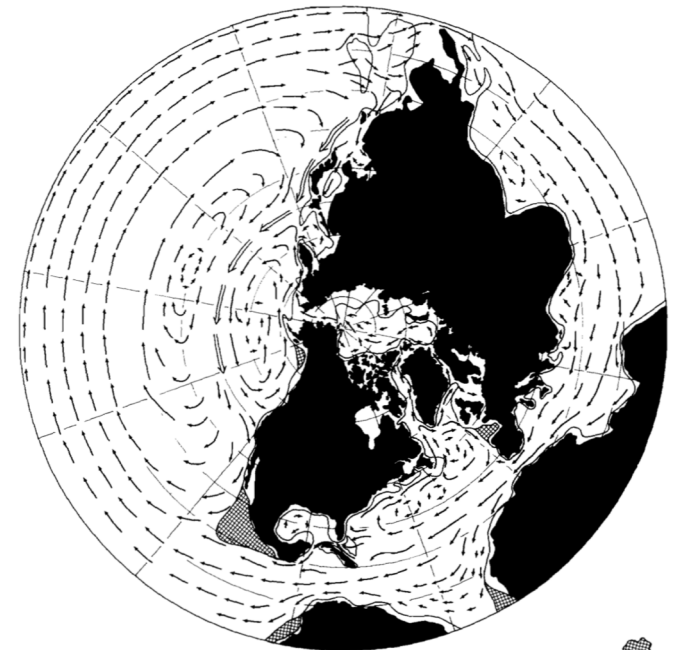
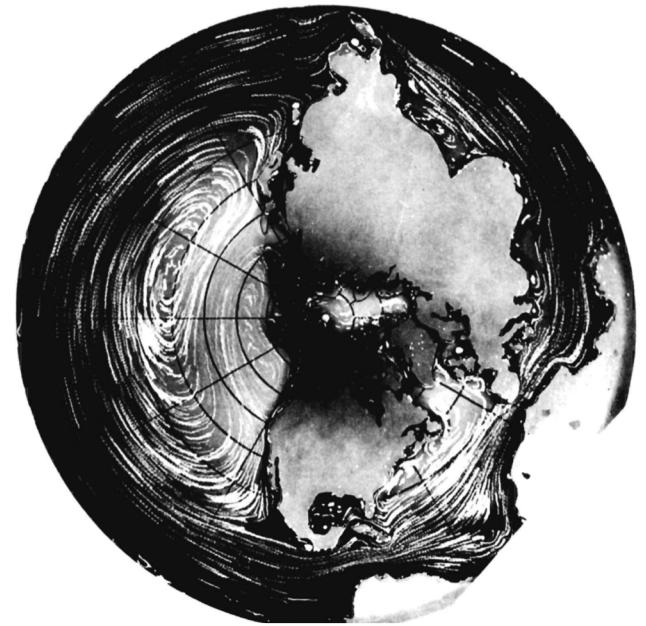


BRUCE P. LUYENDYK
DONALD FORSYTH
J. D. PHILLIPS

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543

Experimental Approach to the Paleocirculation of the Oceanic Surface Waters

Geological Society of America Bulletin, v. 83, p. 2649-2664, 6 figs., September 1972



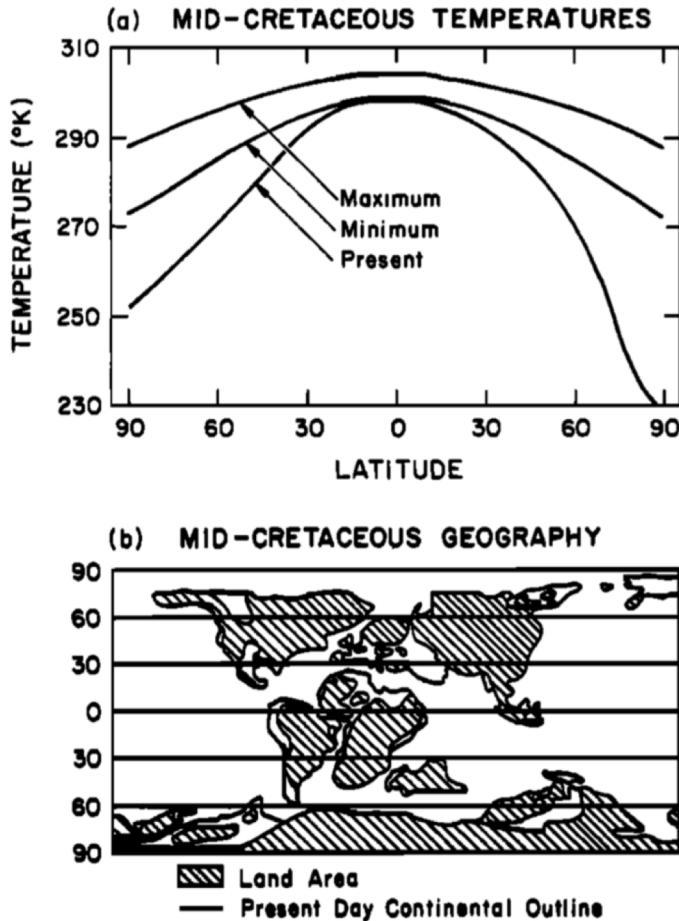
> 6 kn
 2-4 kn
 1-2 kn
 < 1 kn
 upwelling

Figure 5. Vector interpretation of the "nonglacial" experiment shown in Figure 3. The vector scale is the same as in Figure 4, except for double arrows which are currents greater than 6 kn. Upwelling regions are indicated by cross-hatching.

The Role of Geographic Variables in Explaining Paleoclimates: Results From Cretaceous Climate Model Sensitivity Studies

ERIC J. BARRON AND WARREN M. WASHINGTON

National Center for Atmospheric Research



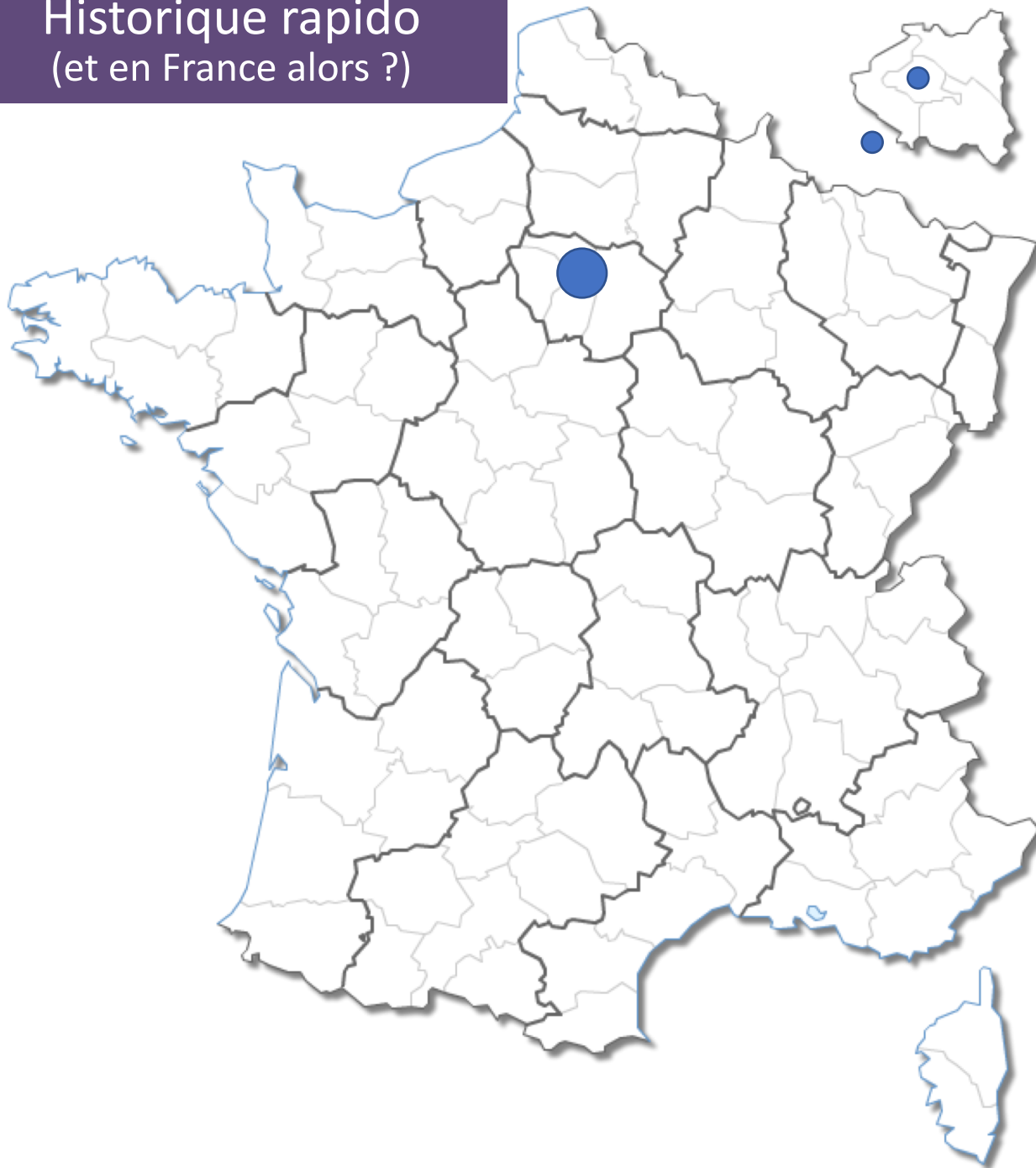
Changes in geography (topography, continental positions and sea level) are one of the most frequently cited mechanisms of climatic change on geologic time scales. The role of geographic variables in paleoclimatology is investigated through a series of climate model sensitivity studies using a version of the National Center for Atmospheric Research spectral GCM and specified Cretaceous (≈ 100 million years ago) geography. The Cretaceous is investigated because it was both a large geographic and climatic contrast from the present day. The model simulations demonstrate that paleogeography was a substantial climatic forcing factor (4.8°K increase in globally averaged surface temperature compared with a present-day control). However, the warming is insufficient to explain fully the paleoclimatic data. In addition, the model is insensitive to global sea level variations (related to tectonics and not ice volume) which are well correlated with paleoclimatic data. Additional climatic forcing factors, such as increased atmospheric CO_2 correlated with these sea level variations, may be required to explain the Cretaceous climate.



E. Barron et al., 1982, 1983, 1984

Fig. 1. (a) Zonally averaged mean annual surface temperature limits for the mid-Cretaceous compared with present-day values; (b) Cretaceous paleogeography [after Barron et al., 1981b]. Shaded regions indicate area of land above sea level.

Historique rapido (et en France alors ?)



● LMCE/LMD &
IPGP



G. Ramstein · Y. Serafini-Le Treut · H. Le Treut
M. Forichon · S. Joussaume

Cloud processes associated with past and future climate

Existence of an ice cap during the mid-Cretaceous period (120–90 Ma): an AGCM investigation

G. RAMSTEIN,¹ F. FLUTEAU,^{1,2} V. MASSON¹

¹Laboratoire de Modélisation du Climat et de l'Environnement, CE Saclay, Bâtiment 709, 91121 Gif-sur-Yvette Cedex, France

²Laboratoire de Paléomagnétisme, Institut de Physique du Globe de Paris, 4 place Jussieu, 75252 Paris Cedex 05, France

articles

Effect of orogeny, plate motion and land–sea distribution on Eurasian climate change over the past 30 million years

Gilles Ramstein*, Frédéric Fluteau*†, Jean Besse† & Sylvie Joussaume*‡

* Laboratoire de Modélisation du Climat et de l'Environnement, DSM CEN Saclay, Bât. 709, 91191 Gif-sur-Yvette cedex, France

† Laboratoire de Paléomagnétisme, Institut de Physique du Globe de Paris, ‡ Laboratoire d'Océanographie Dynamique et de Climatologie, CNRS/ORSTOM/Université P. M. Curie, 4 place Jussieu, 75252 Paris cedex 05, France

GEOPHYSICAL RESEARCH LETTERS, VOL. 29, NO. 23, 2127, doi:10.1029/2002GL015902, 2002

Is high obliquity a plausible cause for Neoproterozoic glaciations?

Yannick Donnadieu, and Gilles Ramstein

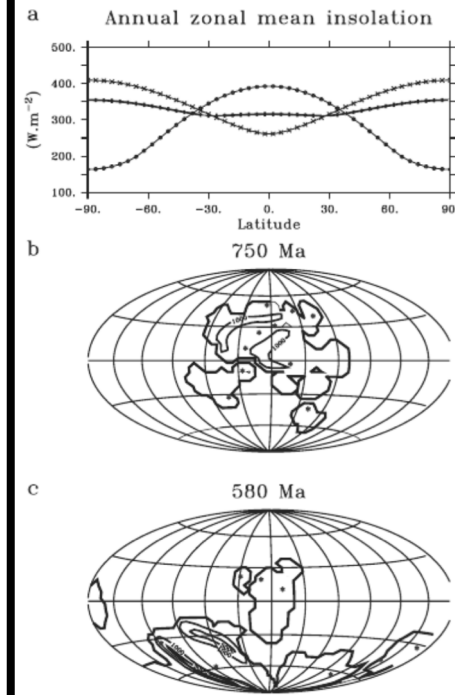
LSCE, CE-Saclay, Gif sur Yvette, France

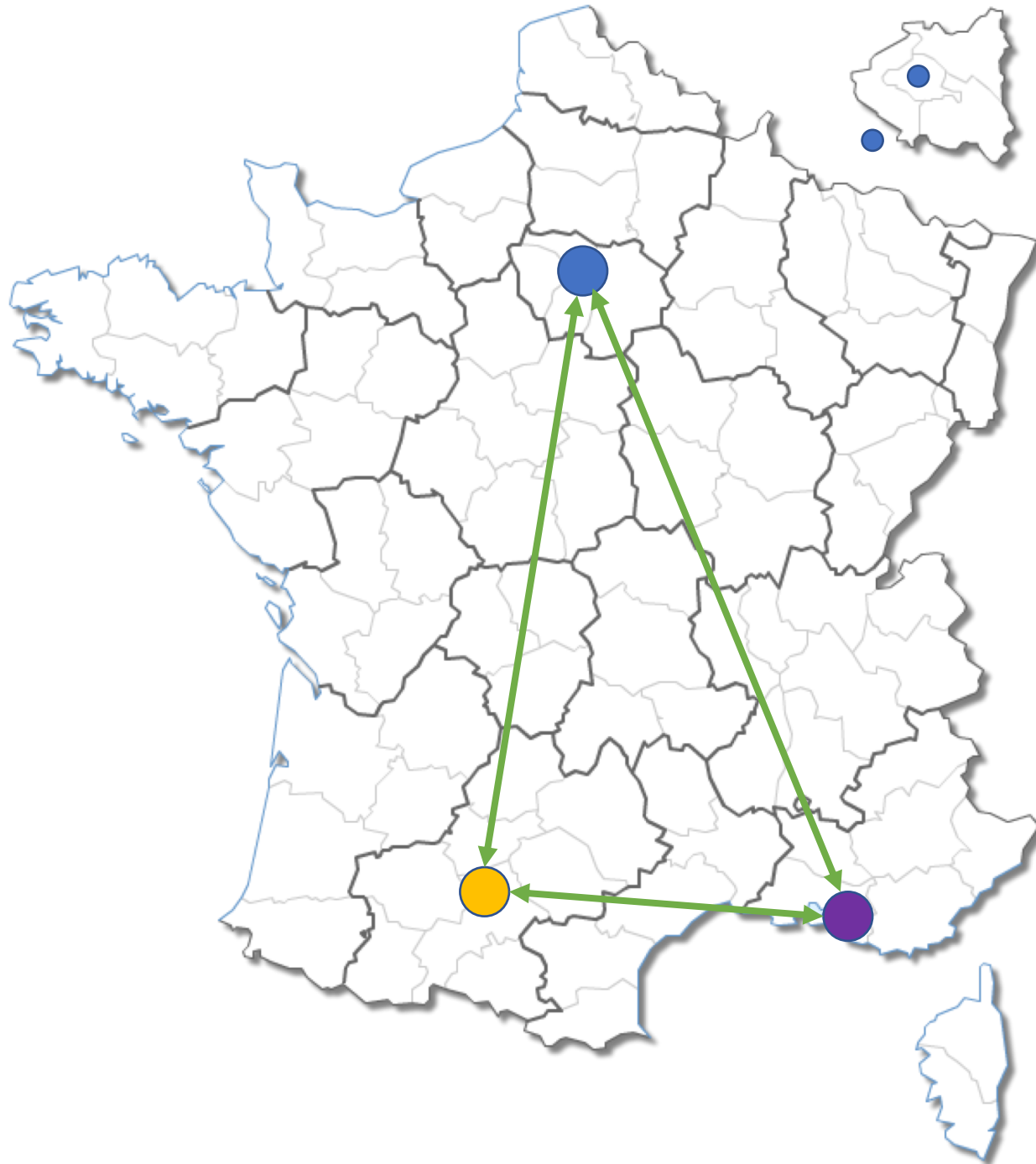
Frederic Fluteau and Jean Besse

Université Paris 7 - IPGP, Paris cedex 05, France

Joseph Meert

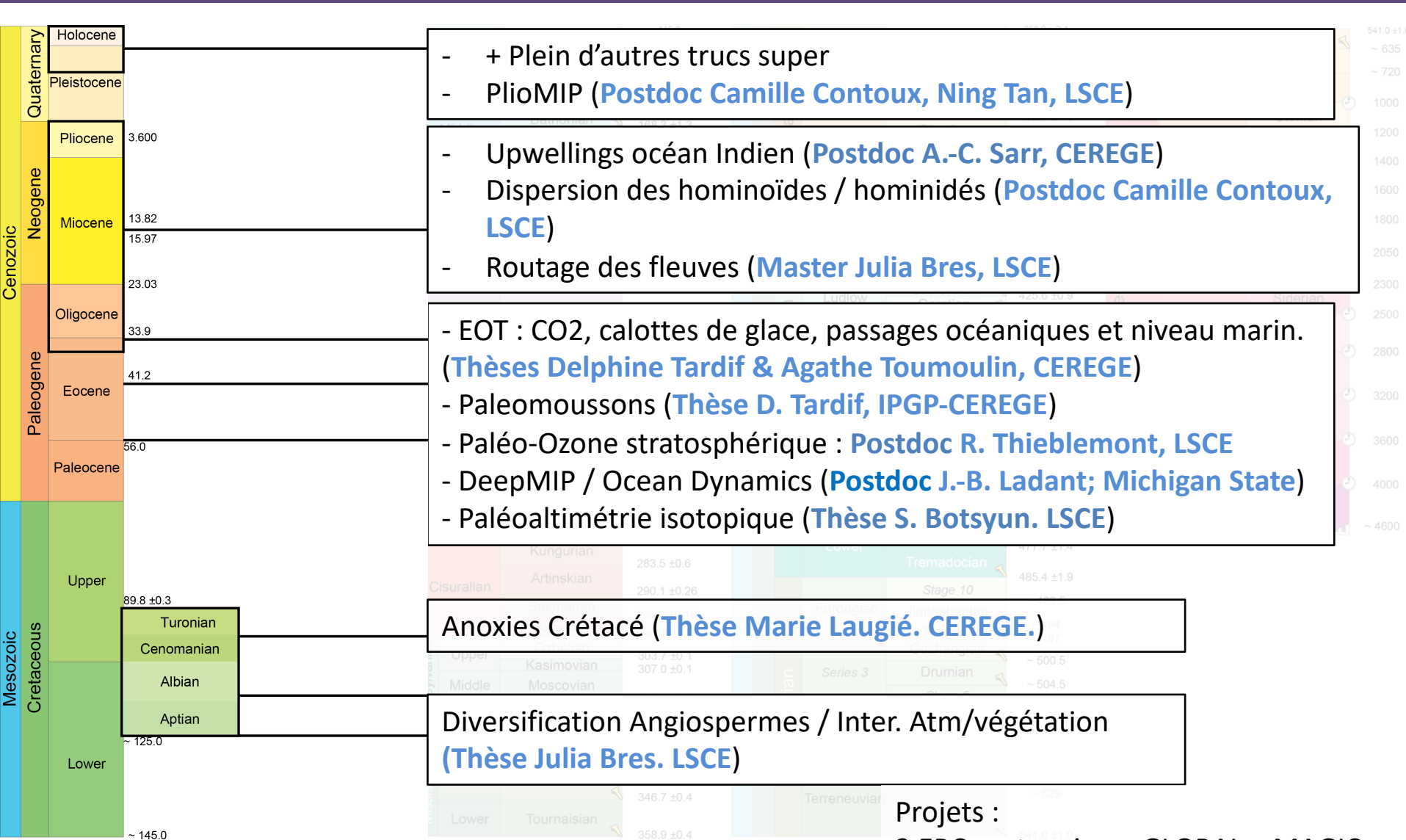
Department of Geological Sciences, University of Florida, Gainesville, Florida, USA





- LSCE/IPSL & IPGP
- CEREGE (Aix-en-Provence)
- GET (Toulouse)

Modélisation du climat à toutes les échelles de temps avec IPSL-CM

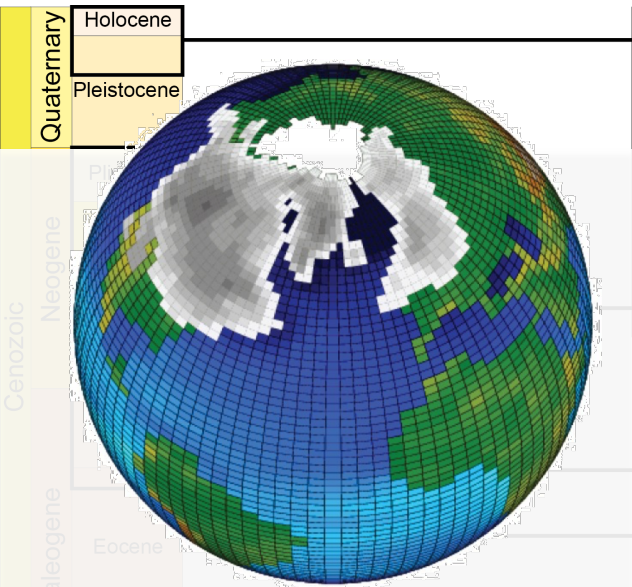


Projets :

2 ERC partenaires : GLOBAL + MAGIC

ANR : HadoC, ANOXIE, AMOR, PaleOX

Modélisation du climat à toutes les échelles de temps

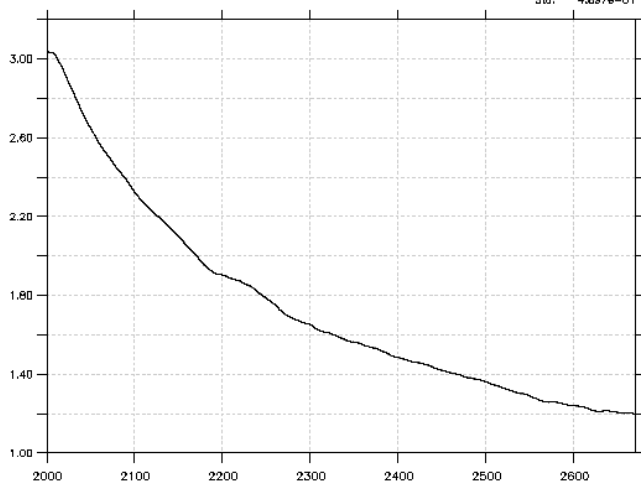


- PMIP4 / LGM / Interglaciaires: [Thèse Marie Sicard \(IPSL-CM6\)](#)
- Transitoires Holocène (TROHL)
- Climate- ice sheets interactions

OCE_temp_1000m_global_ava.nc

Temperature at 1000m (GLOBAL) (degC)

Min: 1.195e+00
Max: 3.038e+00
Mean: 1.745e+00
Std: 4.887e-01



- Mêmes conditions aux limites que le run PMIP3 d'IPSLCM5A
- Démarrage de Levitus (pas réussi à démarrer à partir de la simulation PMIP3)
- Après 700 ans, la température océanique commence à s'ajuster.
- Run en cours (1700 ans... mais désolée, le monitoring n'a pas suivi)
- La suite: runs de sensibilité aux forçages

<https://doi.org/10.5194/gmd-2019-332>
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the Creative Commons Attribution 4.0 License.



Abstract

Assets

Discussion

Metrics

Submitted as: model description paper

09 Dec 2019

IPSL-CM5A2. An Earth System Model designed for multi-millennial climate simulations

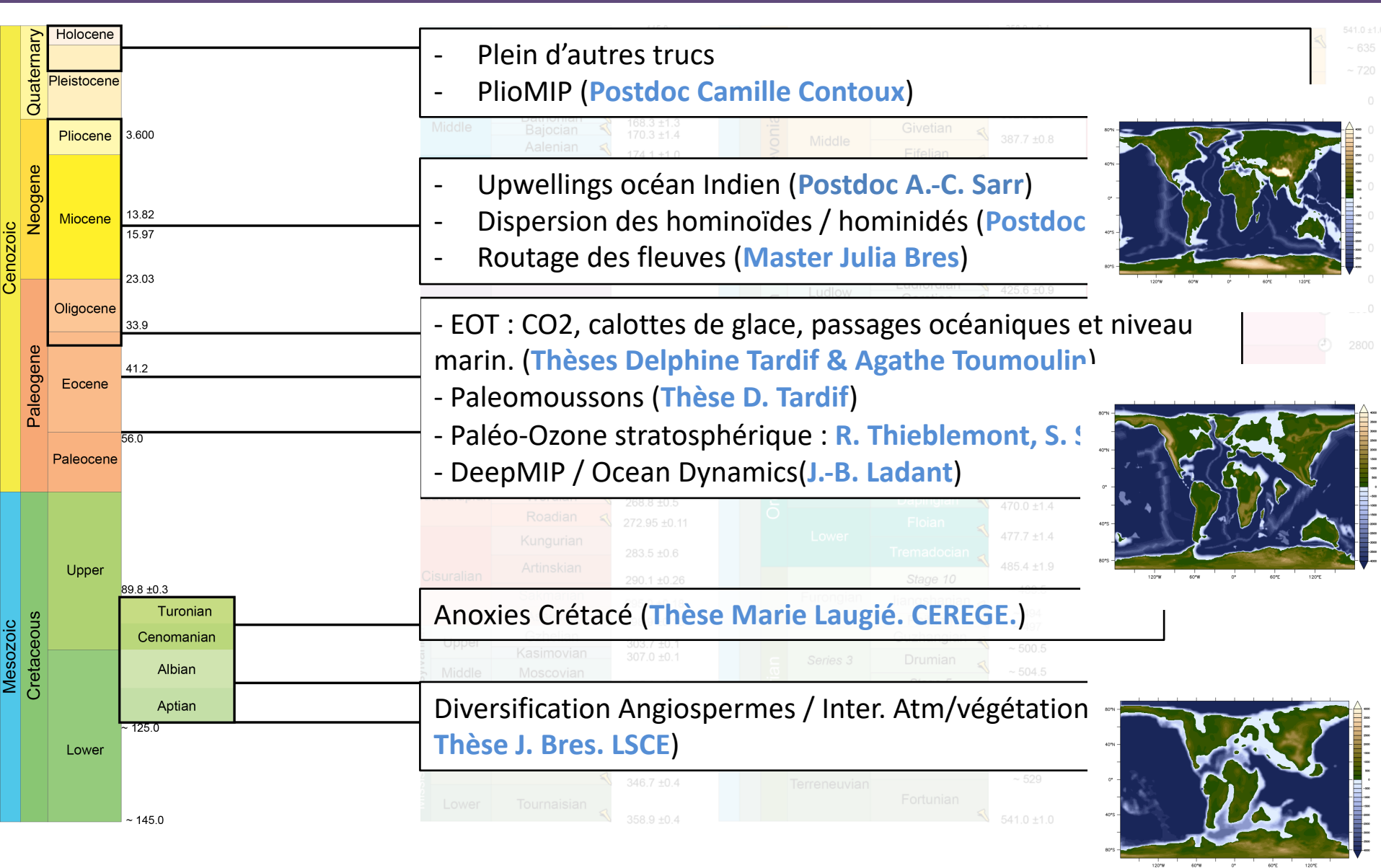
Review status

A revised version of this preprint was accepted for the journal GMD and is expected to appear here in due course.

Pierre Sepulchre^{ID}¹, Arnaud Caubel¹, Jean-Baptiste Ladant^{ID}^{1,2}, Laurent Bopp³,
Olivier Boucher^{ID}⁴, Pascale Braconnot¹, Patrick Brockmann¹, Anne Cozic¹,
Yannick Donnadieu^{ID}⁵, Victor Estella-Perez⁶, Christian Ethé⁸, Frédéric Fluteau^{ID}⁷,
Marie-Alice Foujols^{ID}⁸, Guillaume Gastineau^{ID}⁶, Josefine Ghattas⁸, Didier Hauglustaine¹, Frédéric Hourdin⁴, Masa Kageyama¹,
Myriam Khodri^{ID}⁶, Olivier Marti^{ID}¹, Yann Meurdesoif¹, Juliette Mignot⁶, Anta-Clarisse Sarr^{ID}⁵, Jérôme Servonnat¹,
Didier Swingedouw^{ID}⁹, Sophie Szopa^{ID}¹, and Delphine Tardif^{ID}⁷

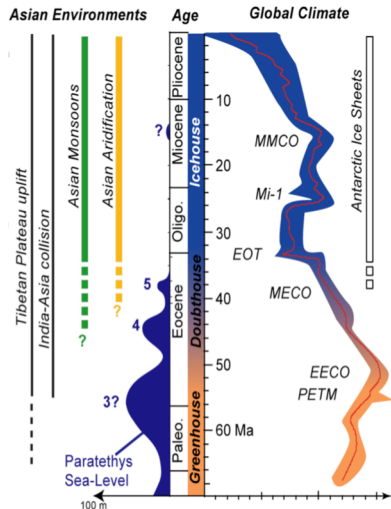
<https://www.geosci-model-dev-discuss.net/gmd-2019-332/gmd-2019-332.pdf>

Modélisation du climat à toutes les échelles de temps



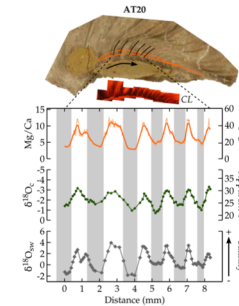
Les paléoclimats chauds (exemples)

Eocène supérieur (40 Ma) : D. Tardif; F. Fluteau et al.

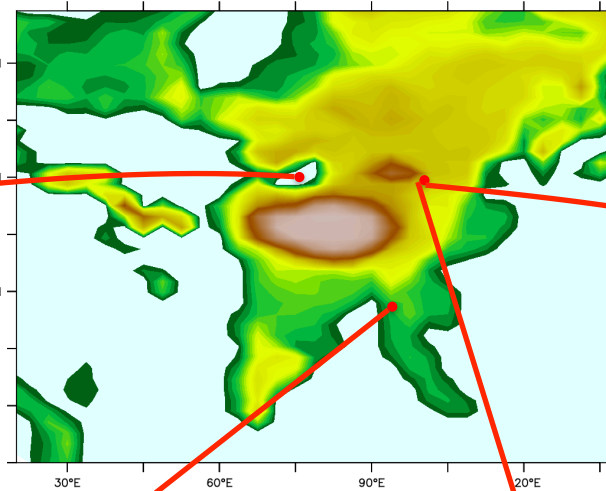


Modified from Dupont-Nivet (pers. com.) and Zachos et al., 2008

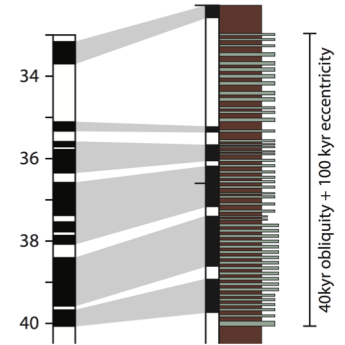
$\delta^{18}\text{O}$ sur fossiles marins, une mesure des SST



Bougeois et al., 2018

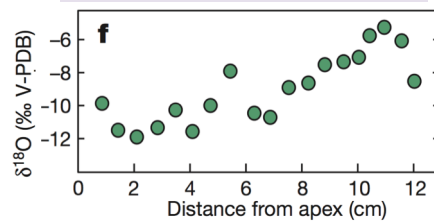


Les archives sédimentaires, une information sur le climat

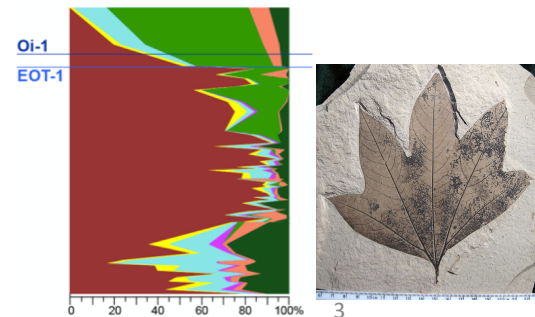


Meijer et al., 2019

$\delta^{18}\text{O}$ sur gastérides, une estimation de la saisonnalité

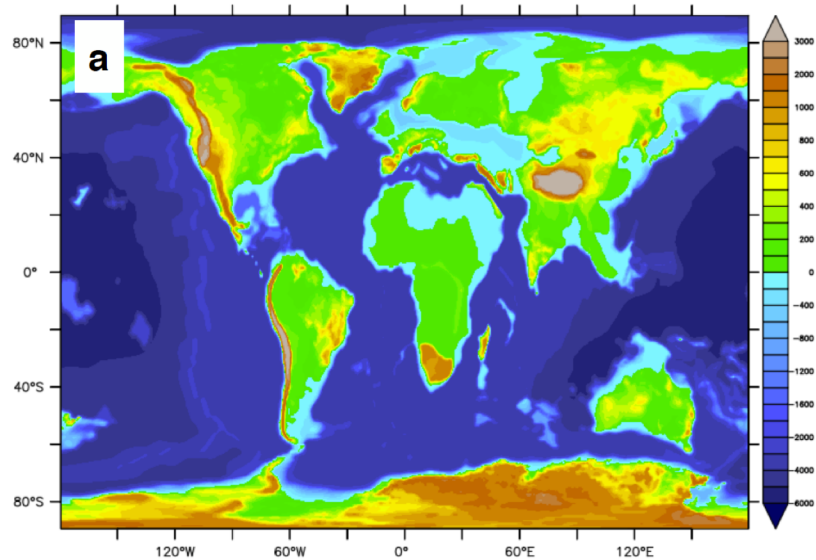


Licht et al., 2014



Flore et pollen, une information sur le climat

Eocène supérieur (40 Ma) : D. Tardif; F. Fluteau et al.



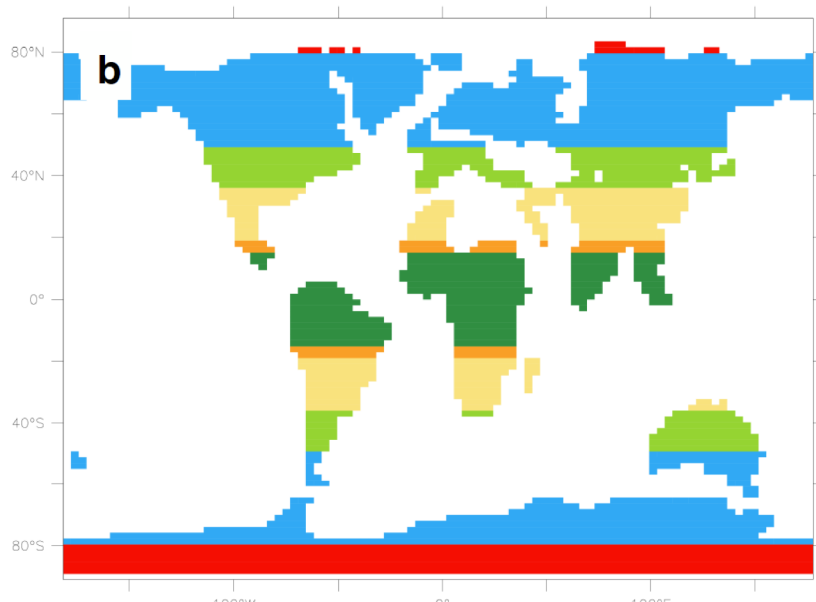
Constante solaire = $1360,19 \text{ W.m}^{-2}$

CO₂

Eocène 1120 ppm (4x) => Oligocène 560 ppm (2x)

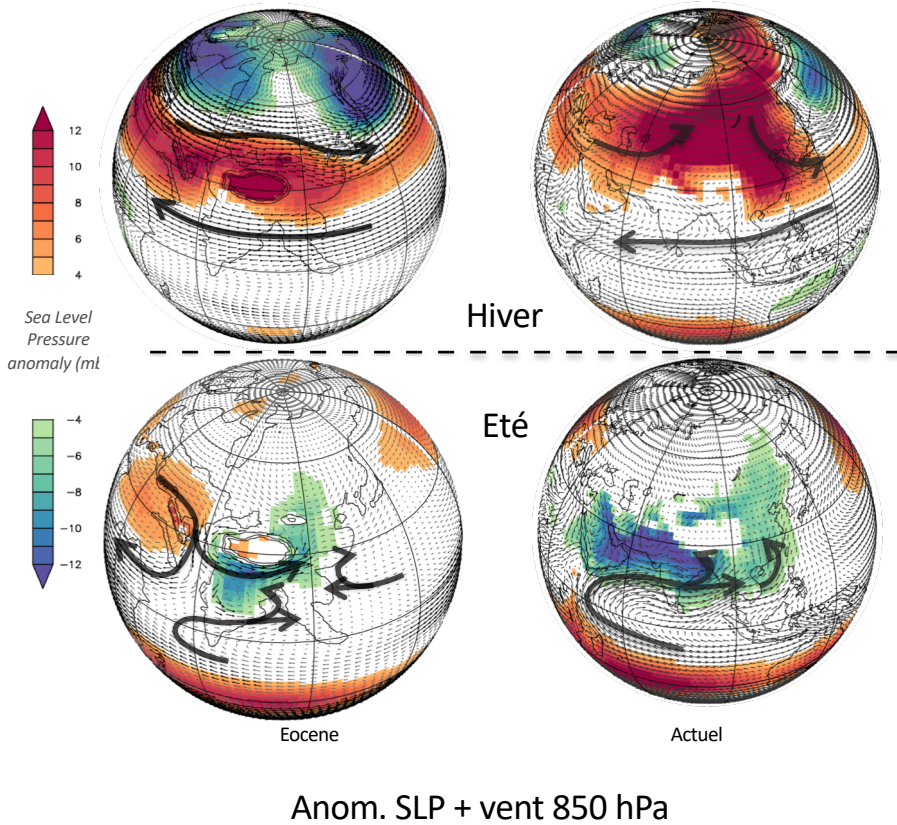
Paramètres orbitaux actuels

(Simulations avec config. Orbitales différentes)

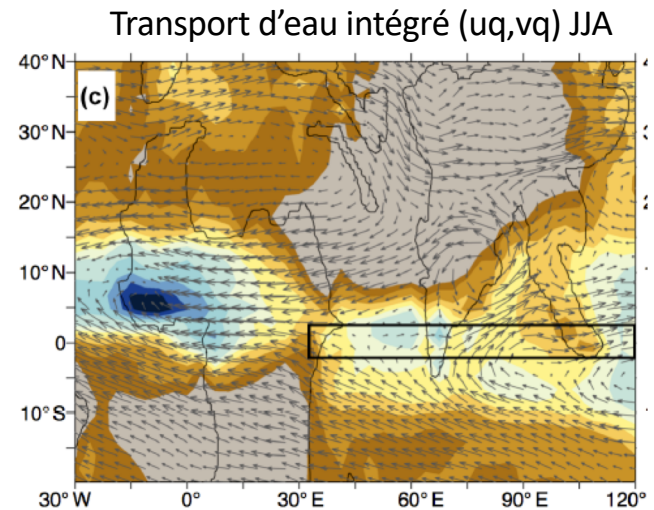


La végétation simplifiée
à 40 Ma
(forêt boréale / forêt
tempérée / forêt
tropicale/désert)

Eocène supérieur (40 Ma) : mousson asiatique ?

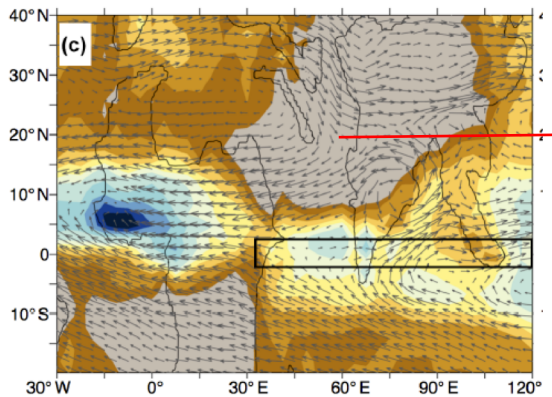


- Pas de Haute pression de Sibérie en hiver, vents zonaux
- Faible remontée de l'ITCZ sur le sud de l'Inde et le sud-est asiatique
- Apport d'humidité sur la côte est de la Chine en provenance du Pacifique



Eocène supérieur (40 Ma) : une mousson asiatique ?

Transport d'eau intégré (uq,vq) JJA



Simulation
contrôle
PI

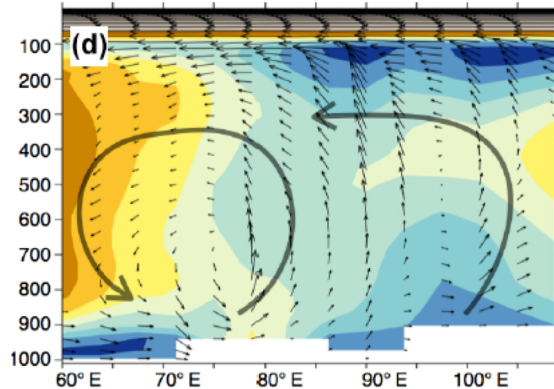
L' Afrique : point de convergence du transport d'eau

Forte réduction du transport d'eau vers l'Asie

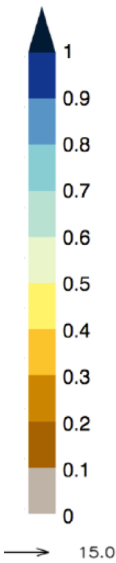
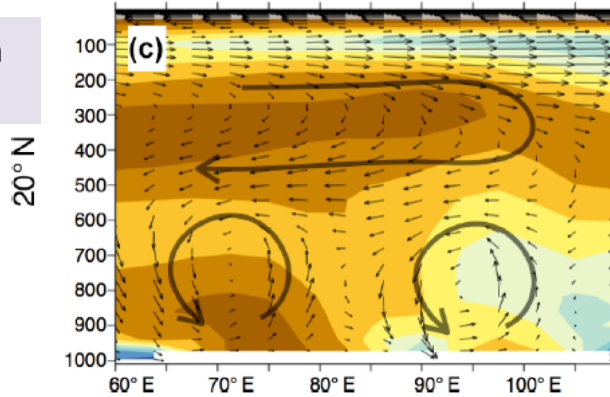
Convection limitée sur l'Inde (sauf ITCZ)

Niveau de condensation élevé

Profil Humidité relative + circulation à 20°N

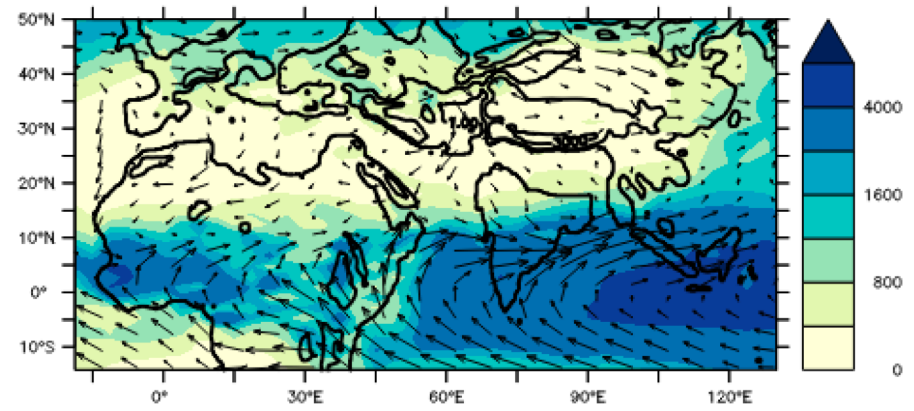


Simulation
40 Ma

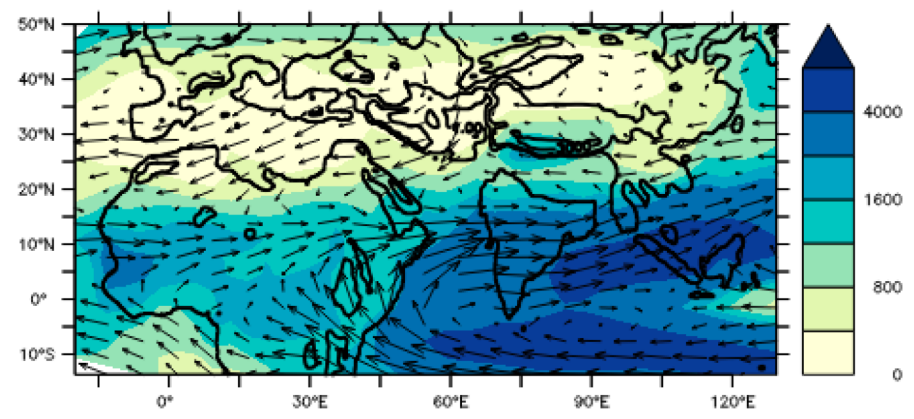


1/ IPSL-CM5A2 : Sec en climat très chaud ?

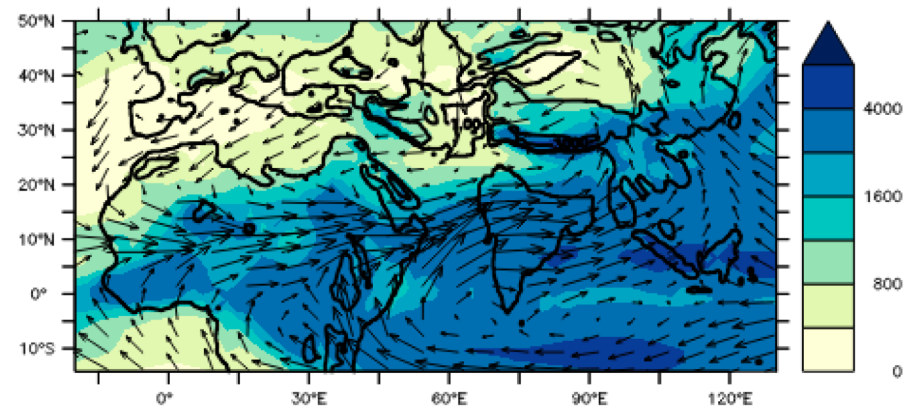
IPSL-CM5A2



GFDL-CM2.1

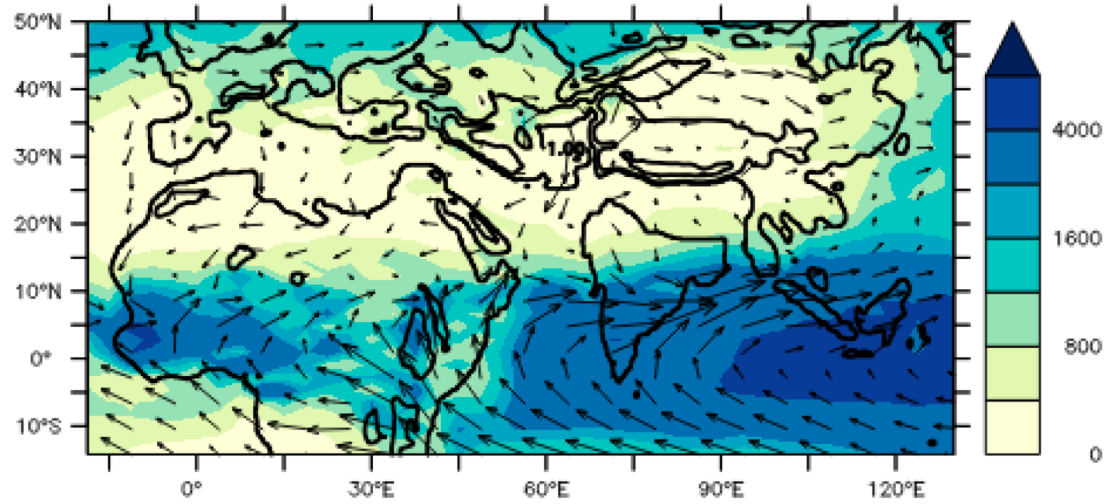


CESM1.05



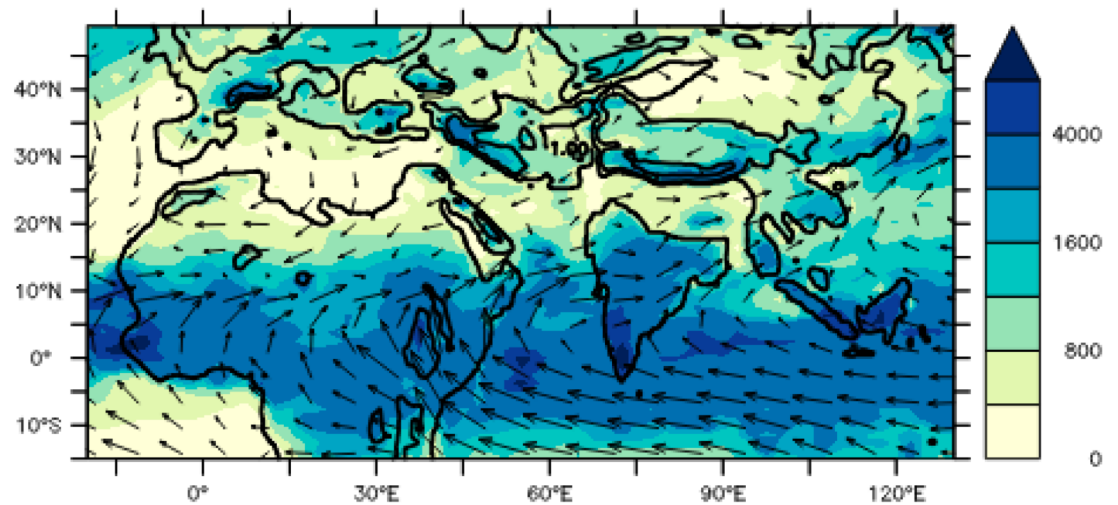
1/ IPSL-CM5A2 : Sec en climat très chaud ?

Quid de CM6 ?

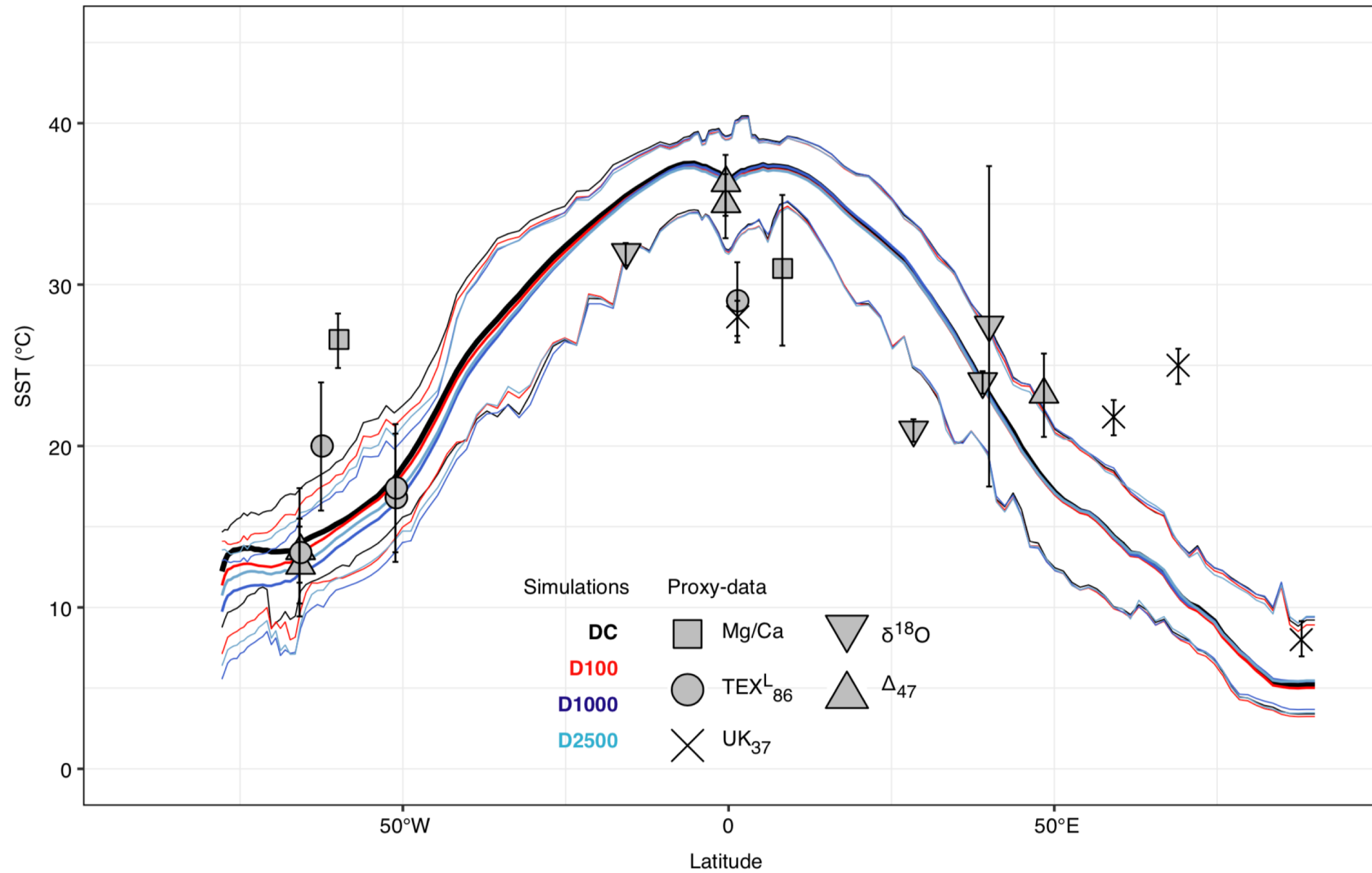


IPSL-CM5A2

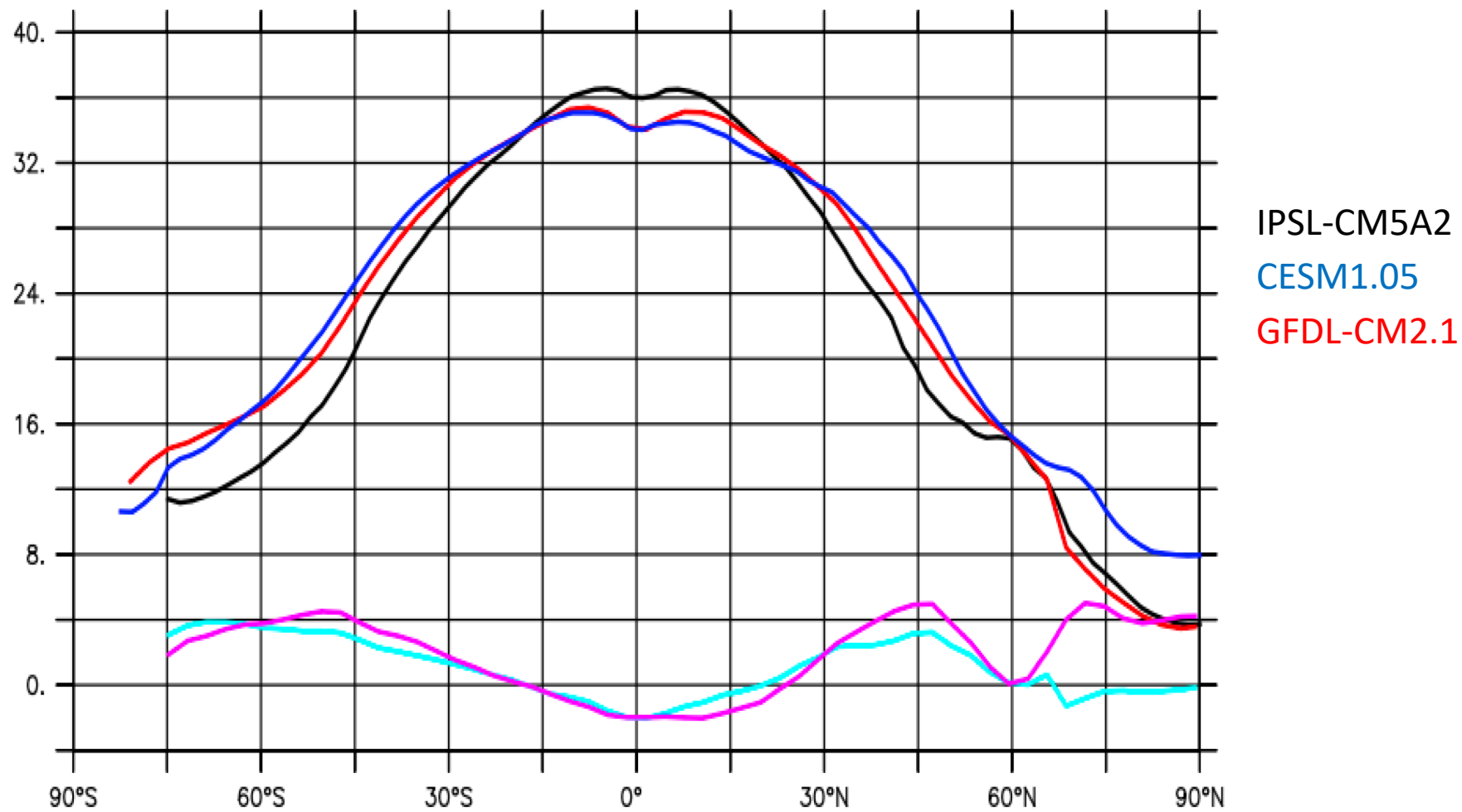
LMDZ6 144x148x79NP + SST CM5A2



2/ Equable climates ?

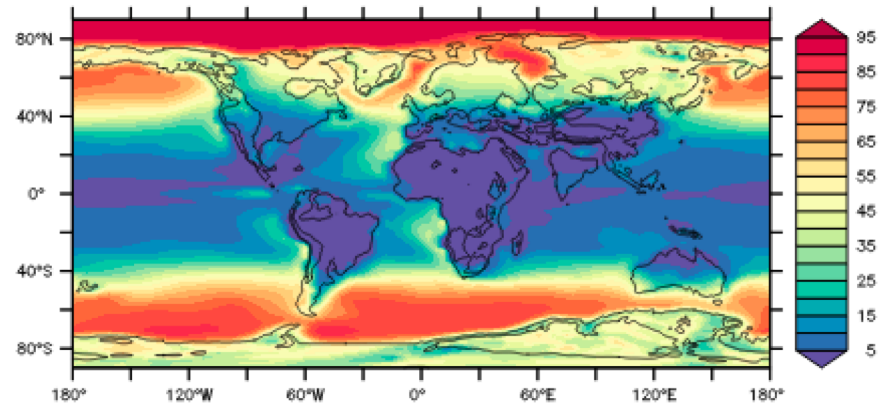


2/ Equable climates ?

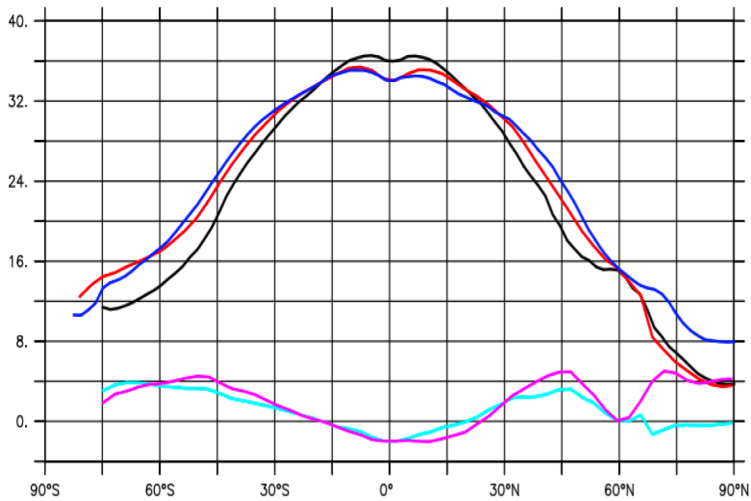


2/ Equable climates ?

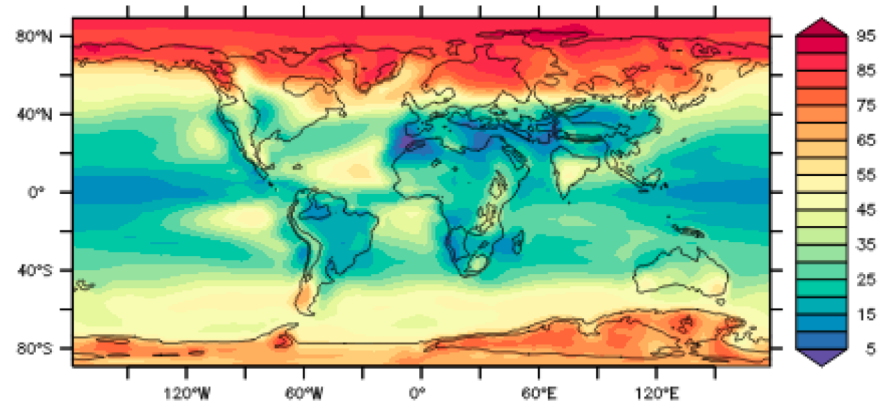
IPSL-CM5A2



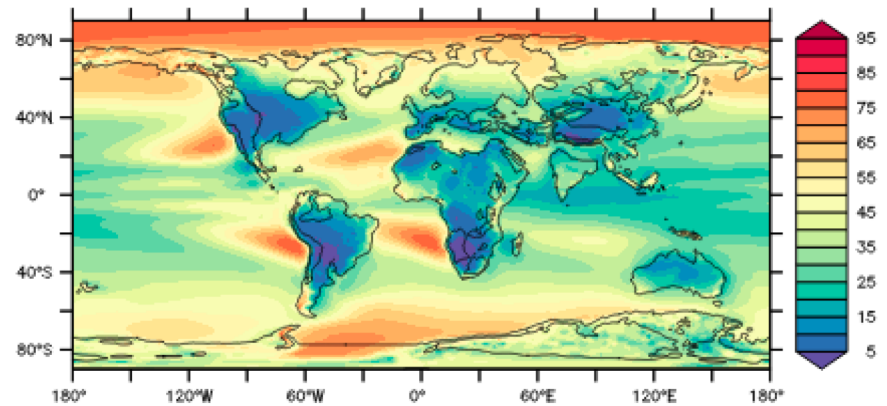
CLDL (%)

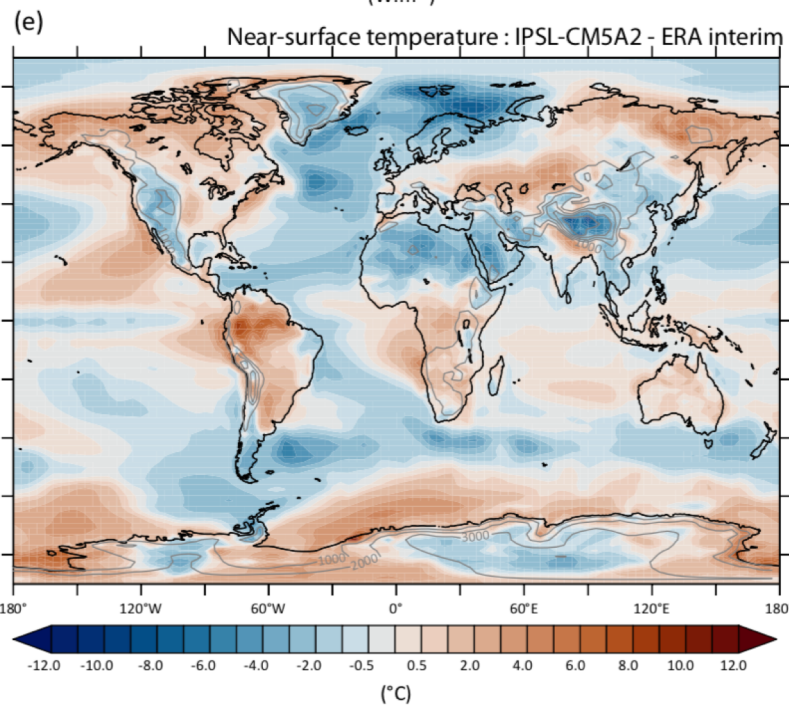
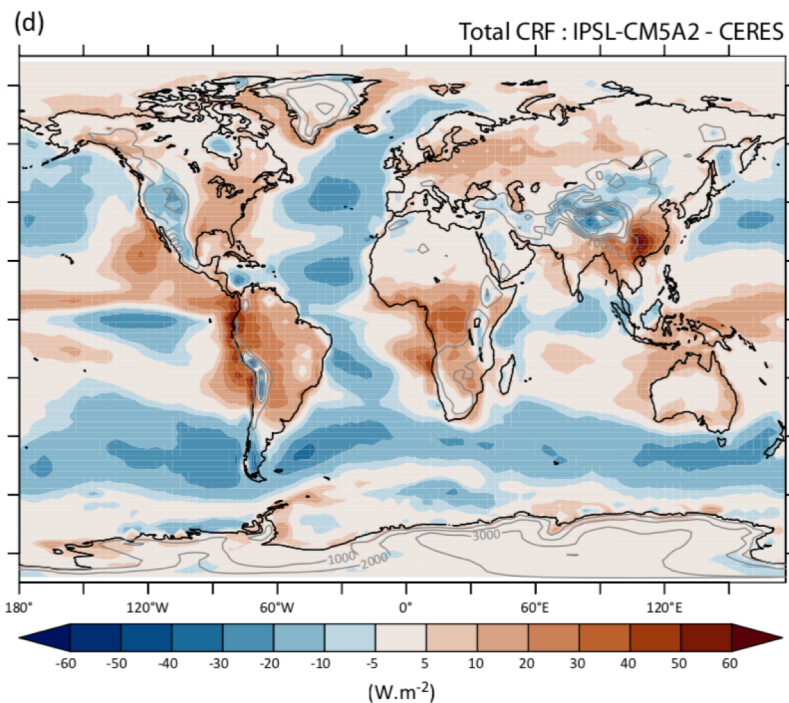
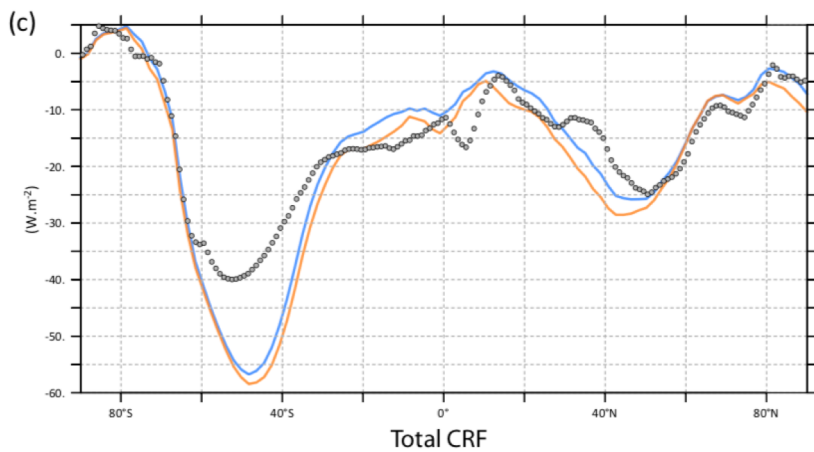
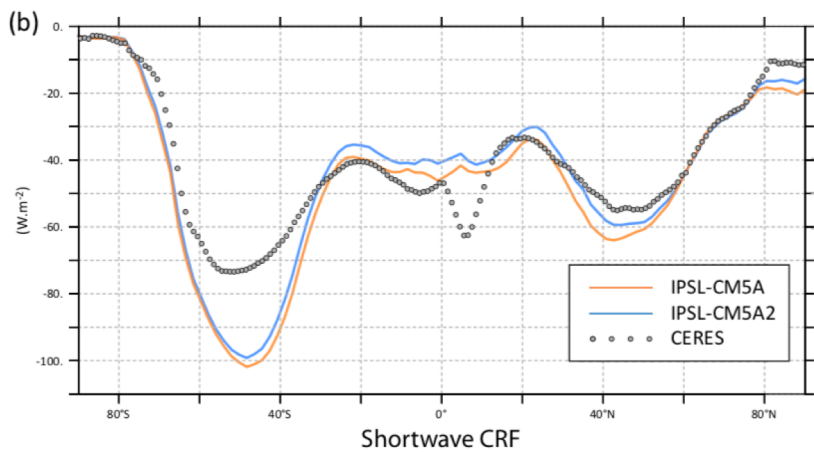
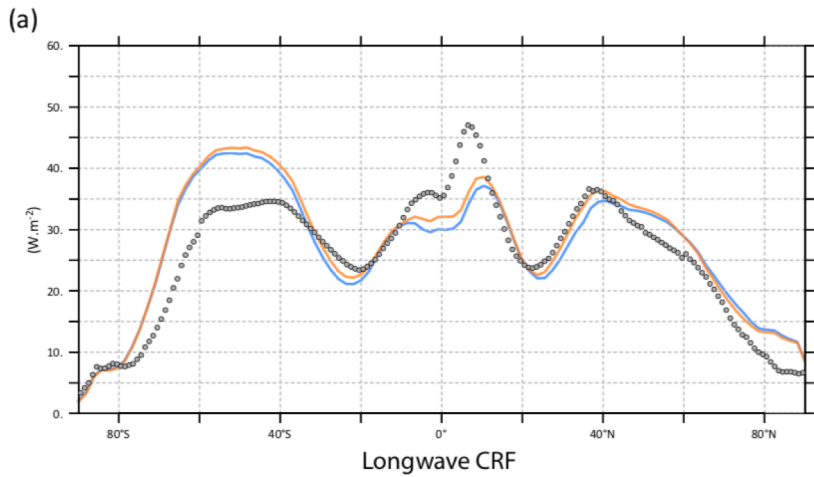


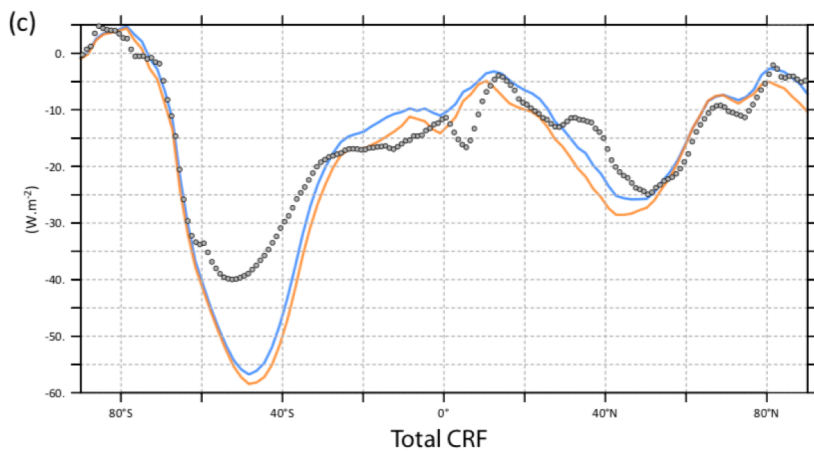
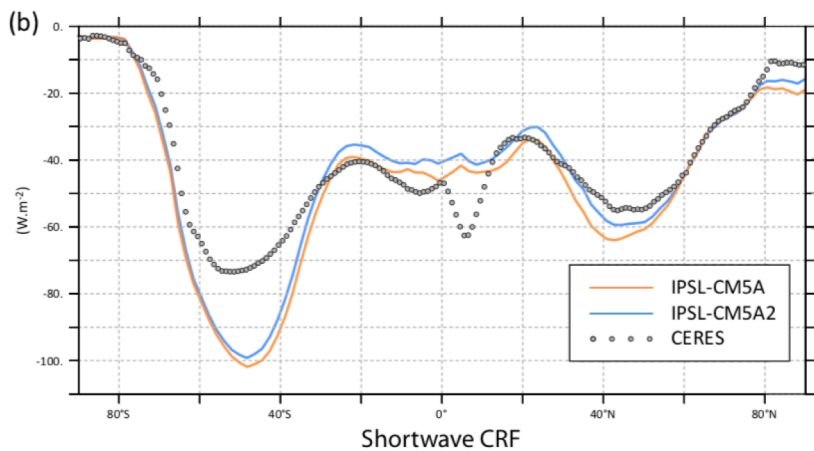
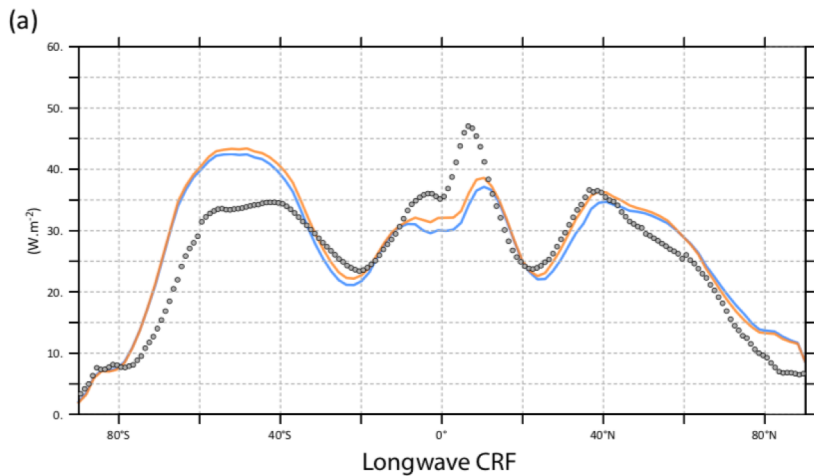
CESM1.05



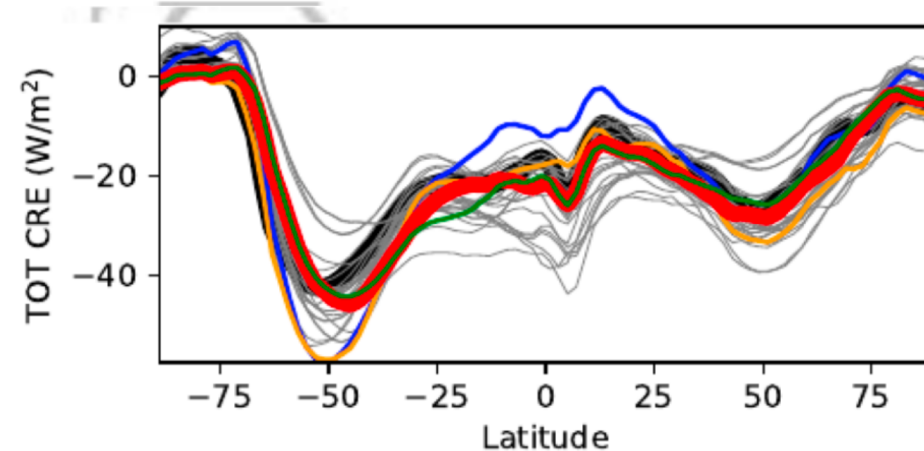
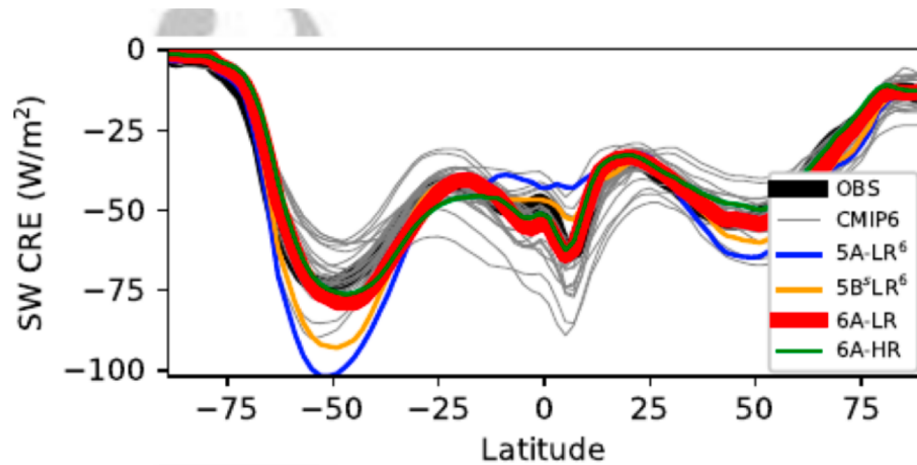
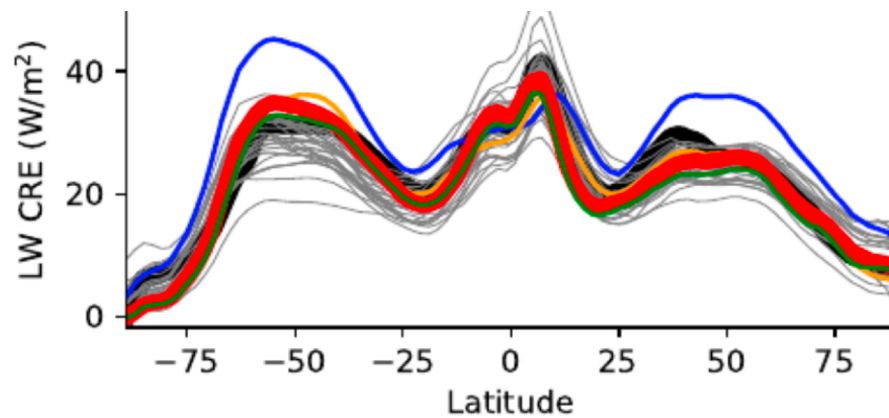
GFDL-CM2.1







Hourdin et al., JAMES, 2020





Geophysical Research Letters

RESEARCH LETTER

10.1029/2019GL085782

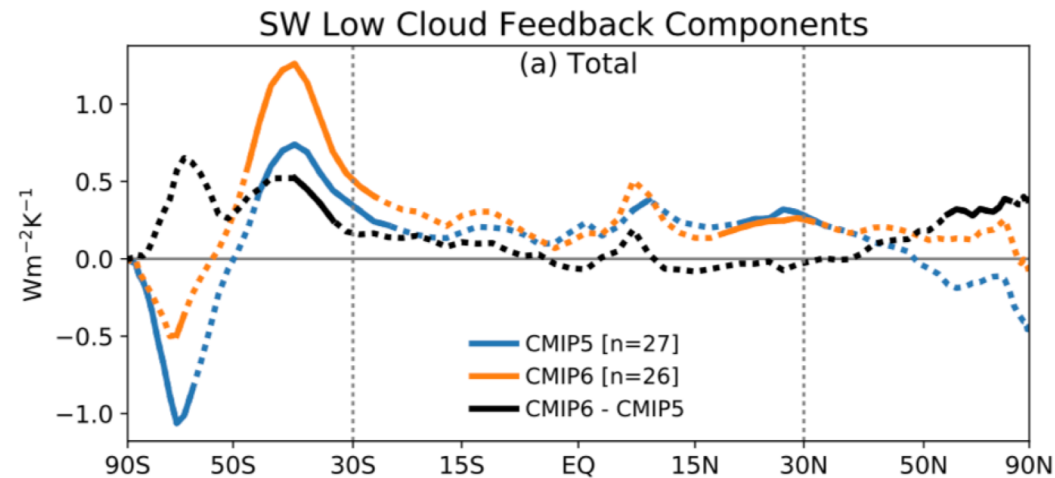
Key Points:

- Climate sensitivity is larger on average in CMIP6 than in CMIP5 due mostly to a stronger positive low cloud feedback

Causes of Higher Climate Sensitivity in CMIP6 Models

Mark D. Zelinka¹, Timothy A. Myers¹, Daniel T. McCoy², Stephen Po-Chedley¹, Peter M. Caldwell¹, Paulo Ceppi³, Stephen A. Klein¹, and Karl E. Taylor¹

¹Lawrence Livermore National Laboratory, Livermore, CA, USA, ²Institute of Climate and Atmospheric Sciences, University of Leeds, Leeds, UK, ³Grantham Institute, Imperial College London, London, UK



CMIP5 : 2.1-4.7°C

CMIP6 : 1.8-5.6°C

IPSL-CM5A : 4.1 °C

IPSL-CM6A : 4.8 °C

High climate sensitivity in CMIP6 model not supported by paleoclimate

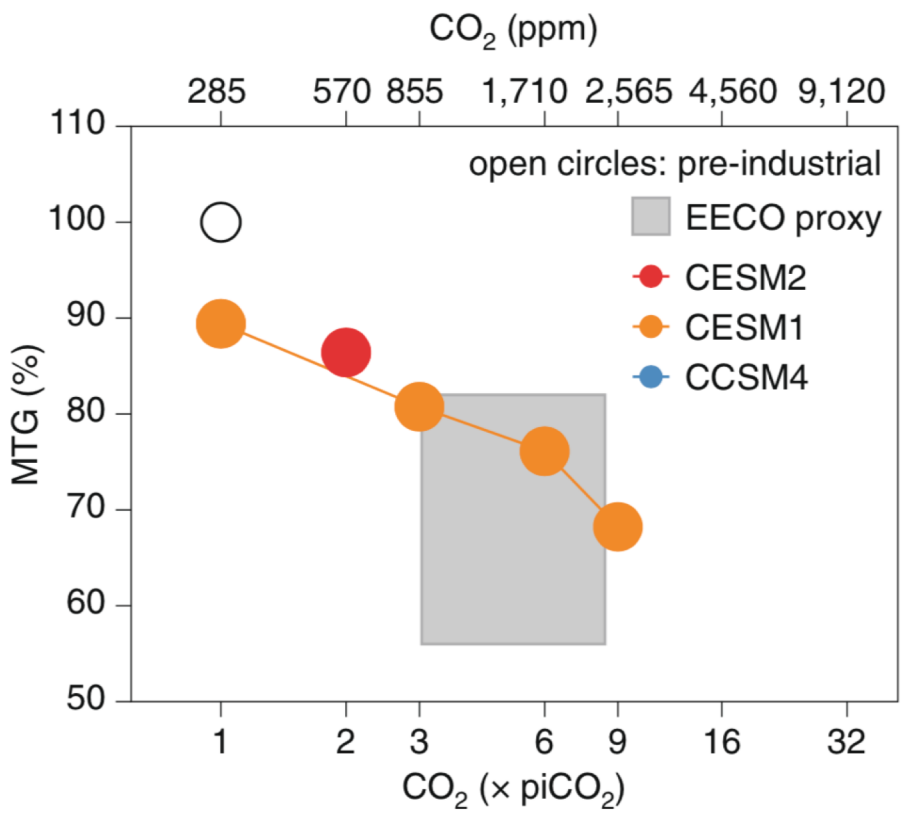
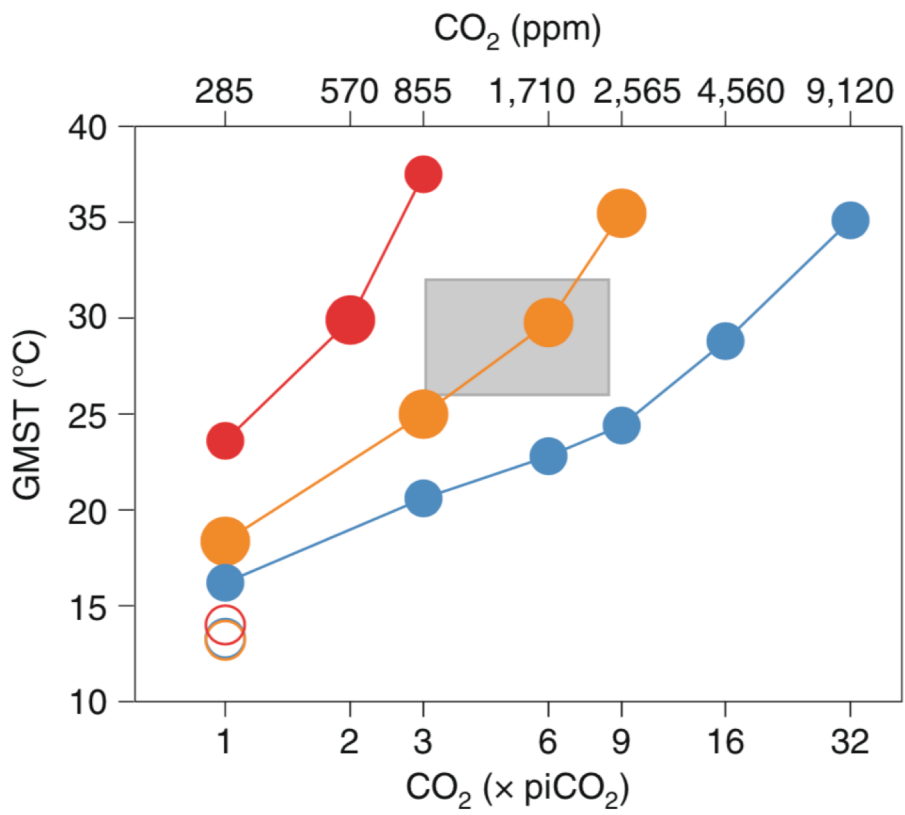
NATURE CLIMATE CHANGE | www.nature.com/natureclimatechange

Jiang Zhu¹, Christopher J. Poulsen¹ and Bette L. Otto-Bliesner²

¹Department of Earth and Environmental Sciences, University of Michigan, Ann Arbor, MI, USA.

²Climate and Global Dynamics Laboratory, National Center for Atmospheric Research, Boulder, CO, USA.

✉e-mail: jiazhu@umich.edu

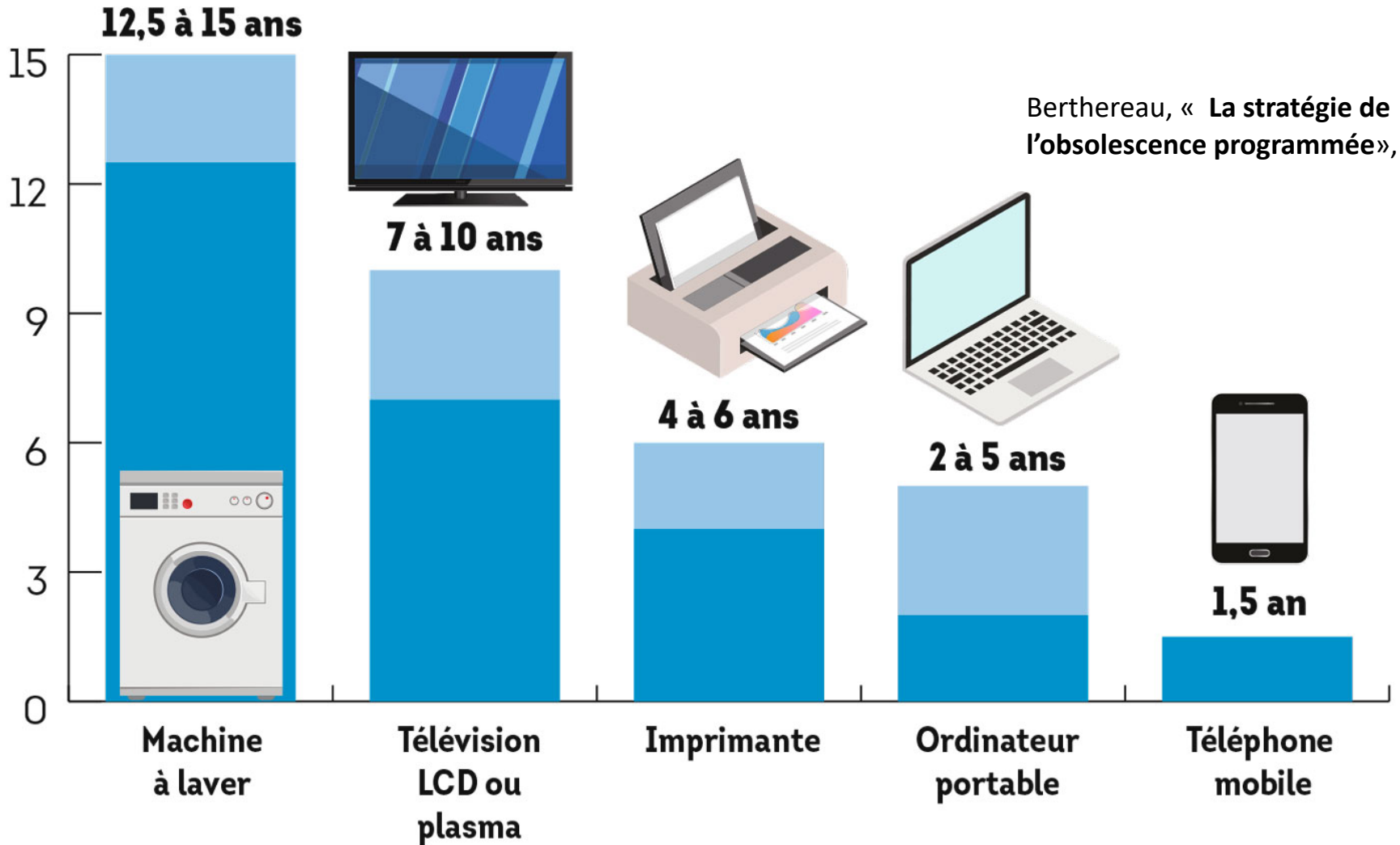


Questions en vrac & Perspectives

- Participation des IPSL-CM aux projets d'intercomparaison sur les climats chauds :
--> Voir Contoux et al., Ning et al., Ladant et al. (PlioMIP, deepMIP)
- Mettre en place des diags systématiques des forçages radiatifs dans les simulations paléo.
 - Quel comportement de LMDZ6 à très forts taux de CO₂ ? A comparer avec LMDZ5A.
 - Comment le choix du tuning d'un modèle sur l'actuel va altérer les résultats en paléo ? (ex. de la precip CM5A vs CM6A)
- Quel rôle pour la rétroaction de la végétation ? Et si nous réactivions la végétation dynamique ?
- Quel rôle pour la chimie atmosphérique (notamment pour les gradients plats voir Szopa et al., 2019) ?

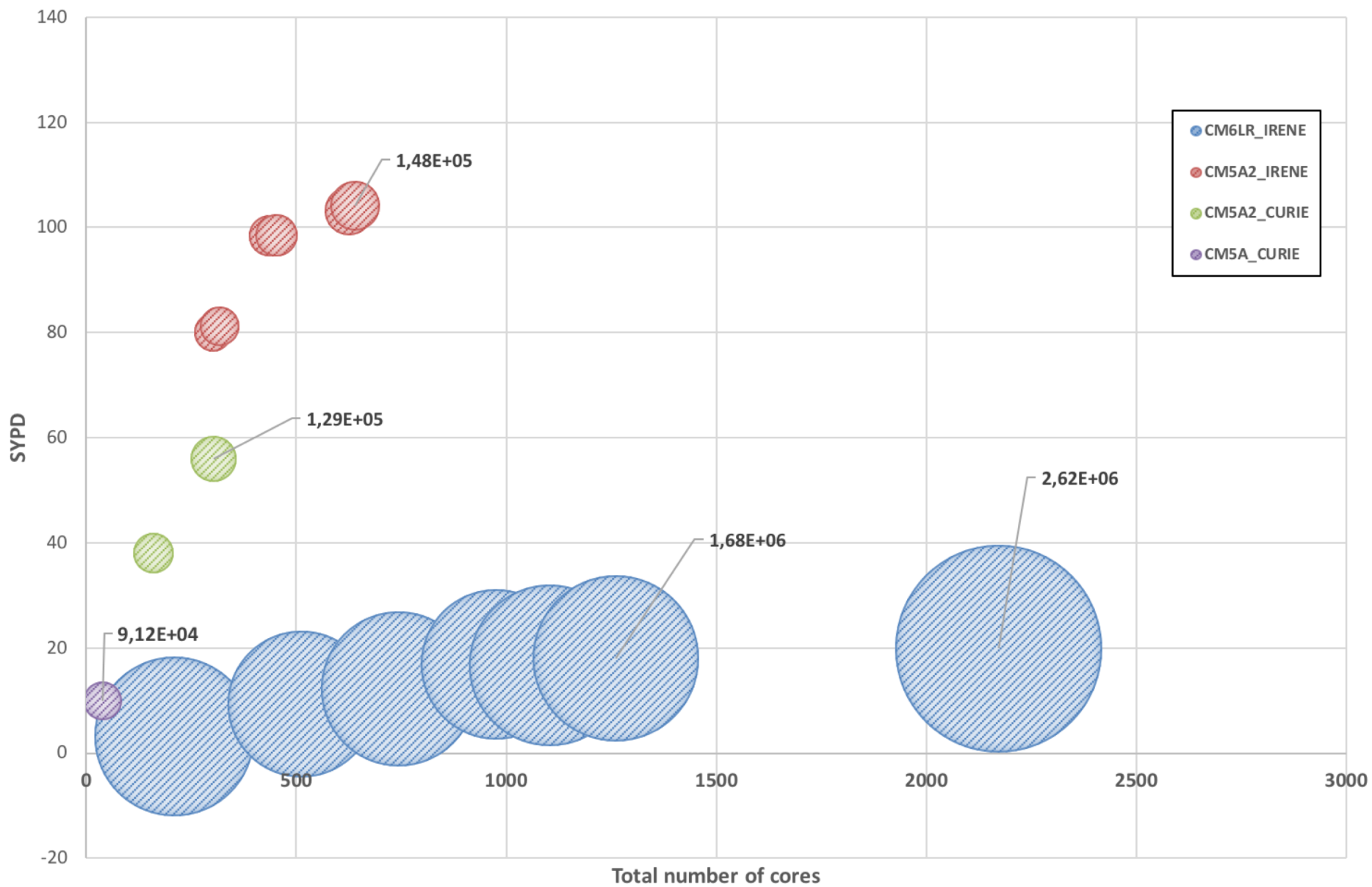
Perspectives et pistes...

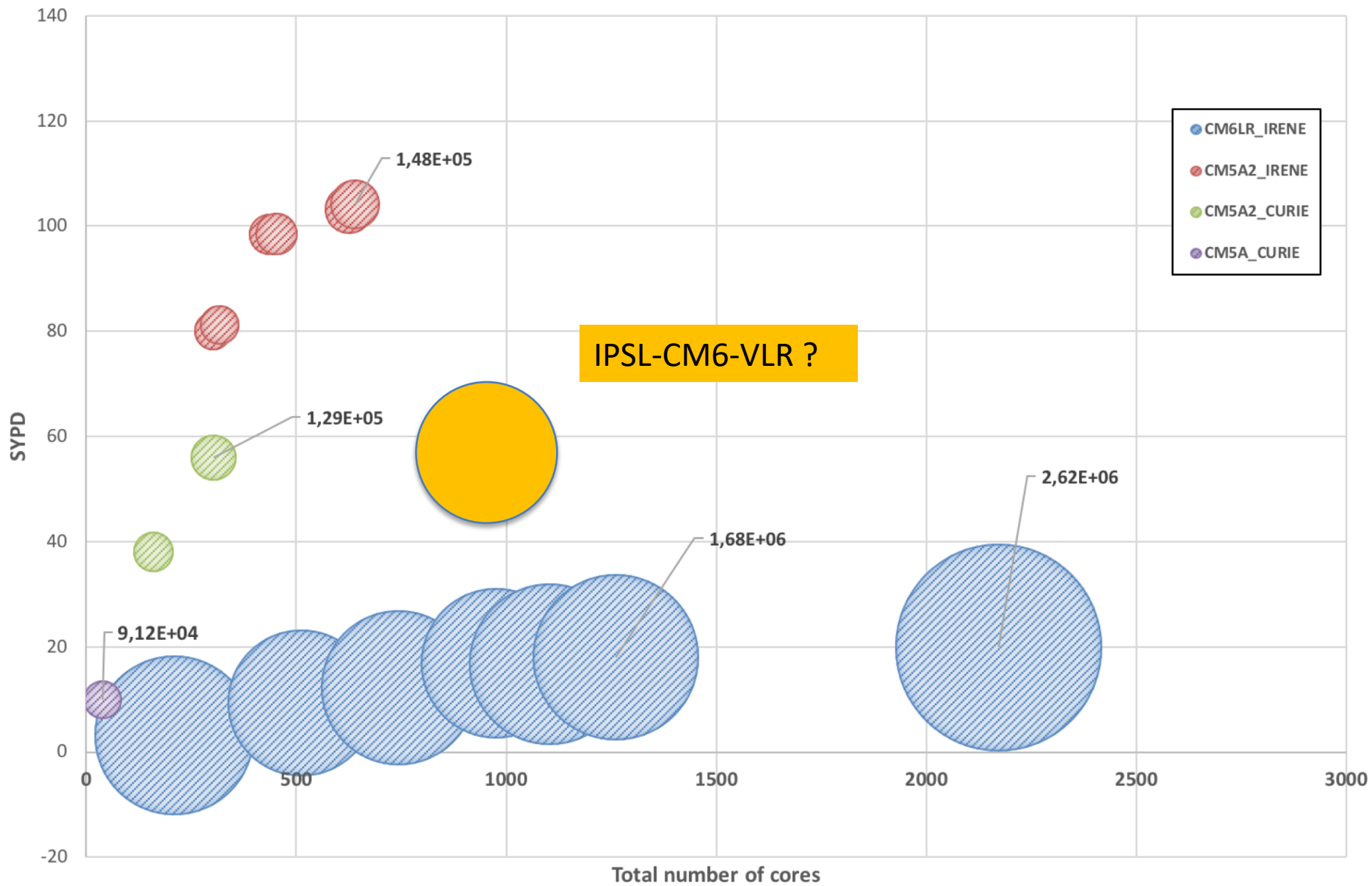
➤ Quelle durée de vie pour IPSL-CM5A2 ? Quelle bonne stratégie ?

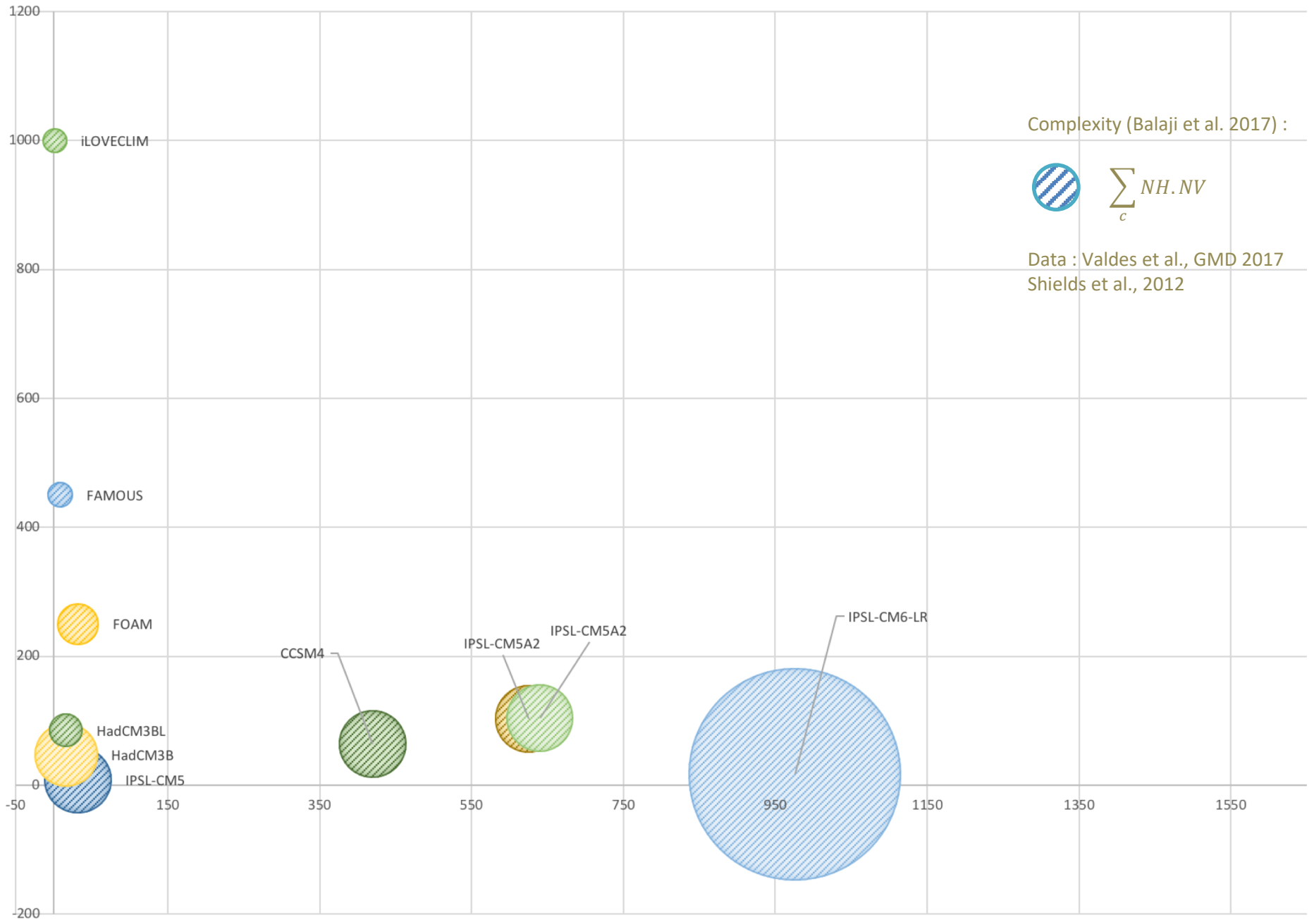


Perspectives et pistes...

- Quelle durée de vie pour IPSL-CM5A2 ?
- Et les isotopes dans tout ça ?
- Du temps pour les problèmes techniques (les p*%***** de plantage hgardfou !)







Complexity (Balaji et al. 2017) :

$$\sum_c NH.NV$$

Data : Valdes et al., GMD 2017
Shields et al., 2012

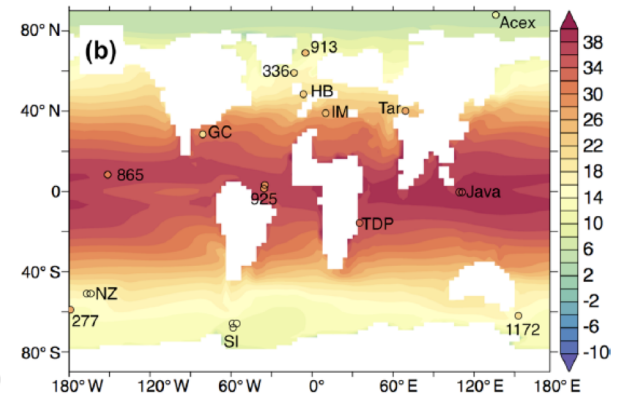
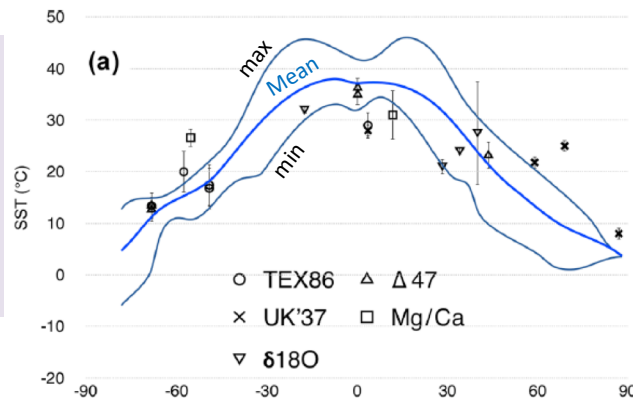
Autres trucs

SST et T2M par rapport aux données

Température de surface des océans (en moyenne annuelle)

⇒ Gradient assez plat dans les données, plus marqué dans la simulation

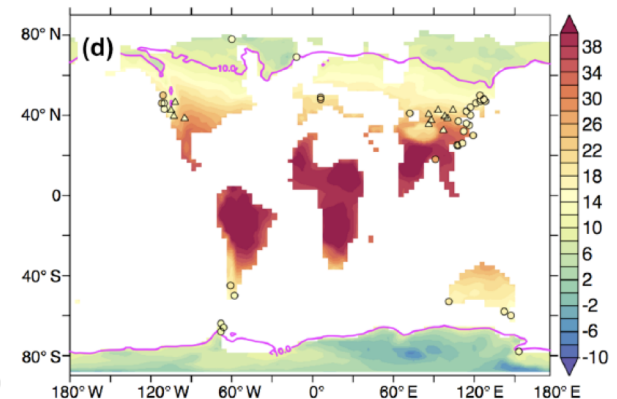
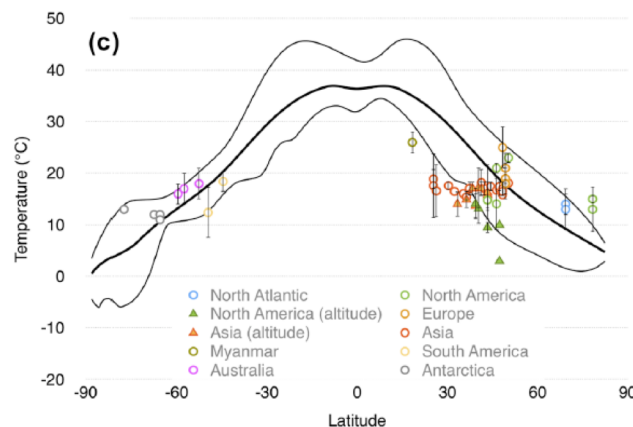
⇒ Biais saisonnier d'enregistrement



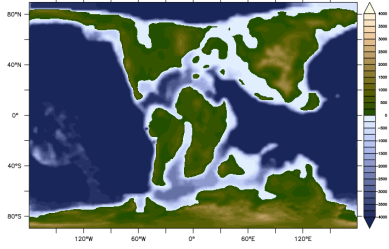
Température de surface continentale

⇒ Accord mais...

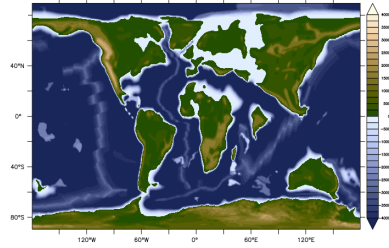
⇒ Biais d'enregistrement notamment sur les sites en altitude



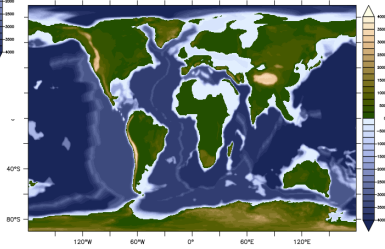
115Ma



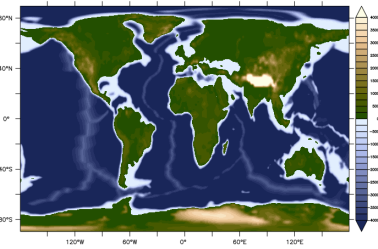
55Ma



40Ma



17Ma



14Ma

