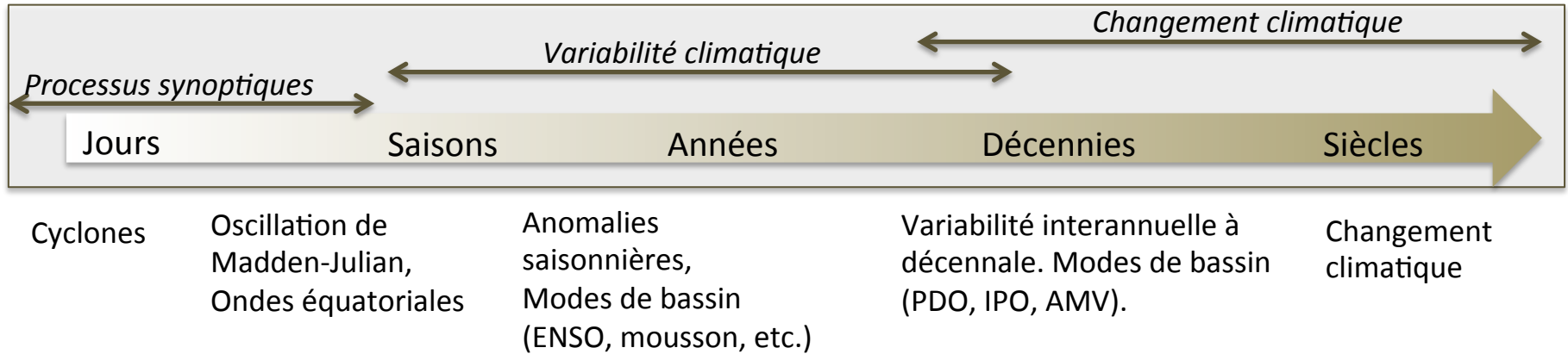


Comprendre et reconstruire la variabilité tropicale passée à différentes échelles de temps: études en cours, biais et limitations

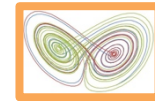
Myriam Khodri



Comprendre et reconstruire la variabilité climatique tropicale passée à différentes échelles de temps



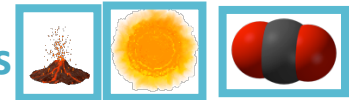
Comprendre la variabilité interne du système climatique



Processus de variabilité

Interactions entre les modes de variabilité climatique

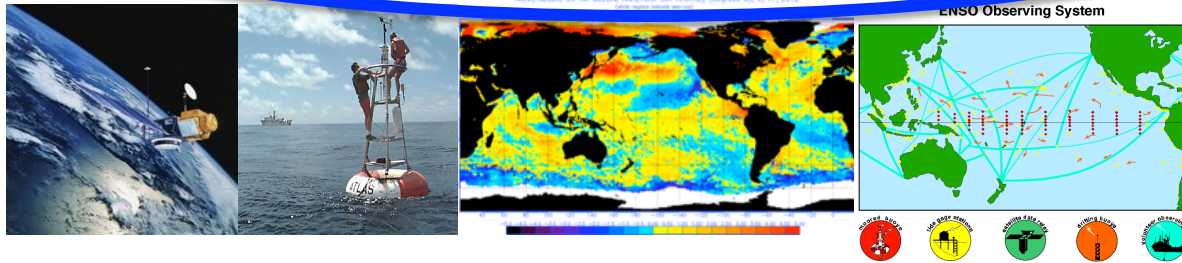
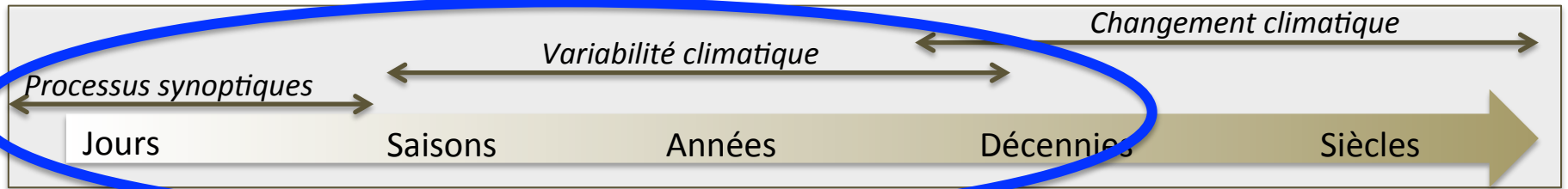
Comprendre le rôle et l'impact des forçages externes



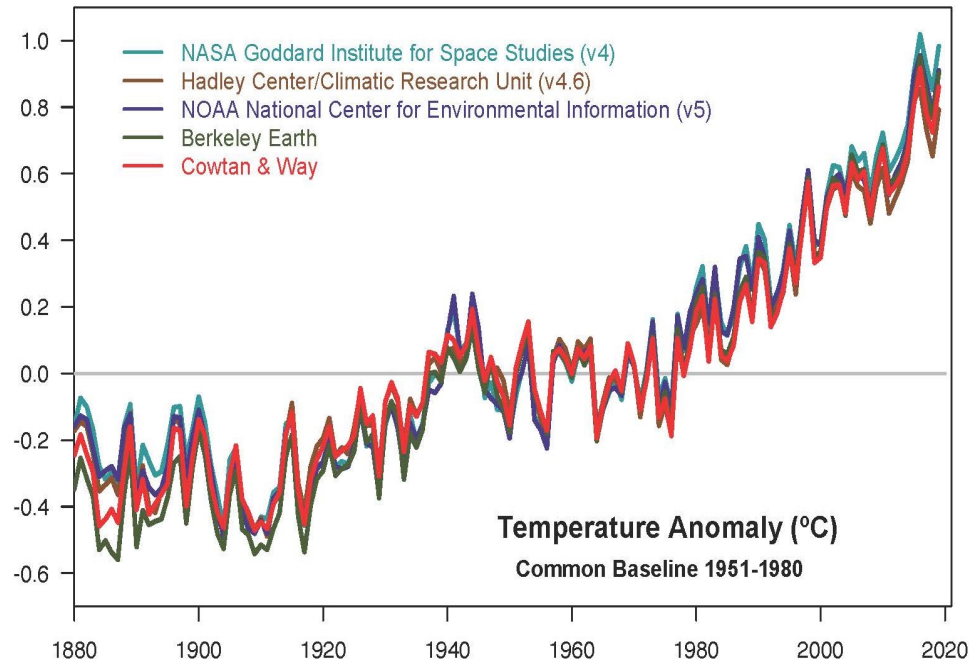
Volcanisme, irradiance solaire (naturel)

Gaz à effet de serre, aérosols, etc. (anthropique)

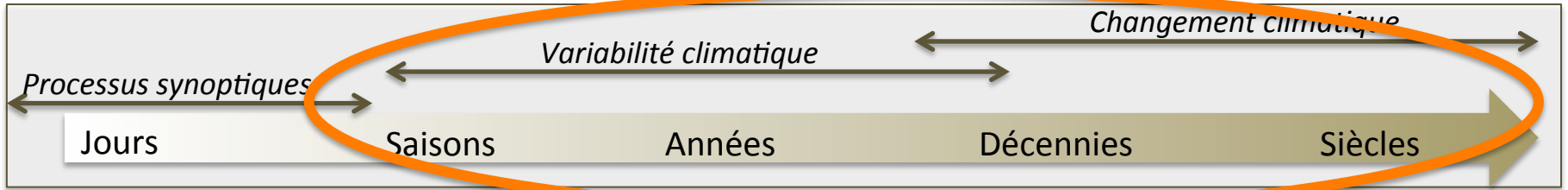
Comprendre et reconstruire la variabilité climatique tropicale passée à différentes échelles de temps



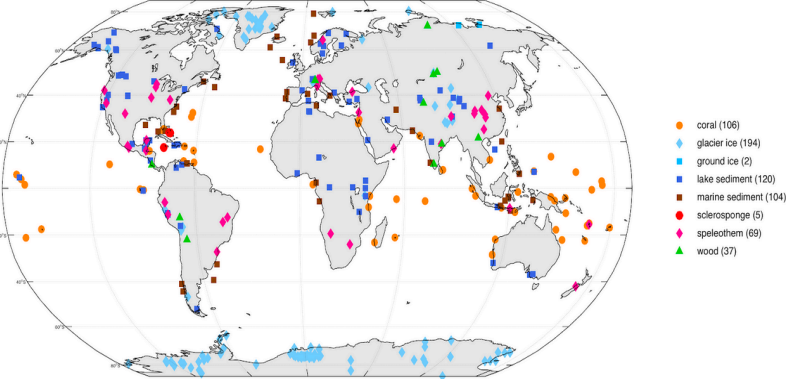
Anomalies des températures globales



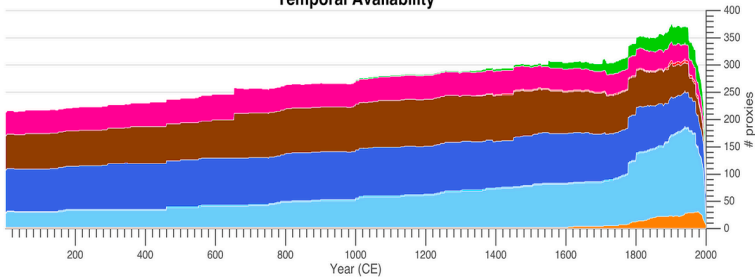
Les enregistrements paleoclimatiques



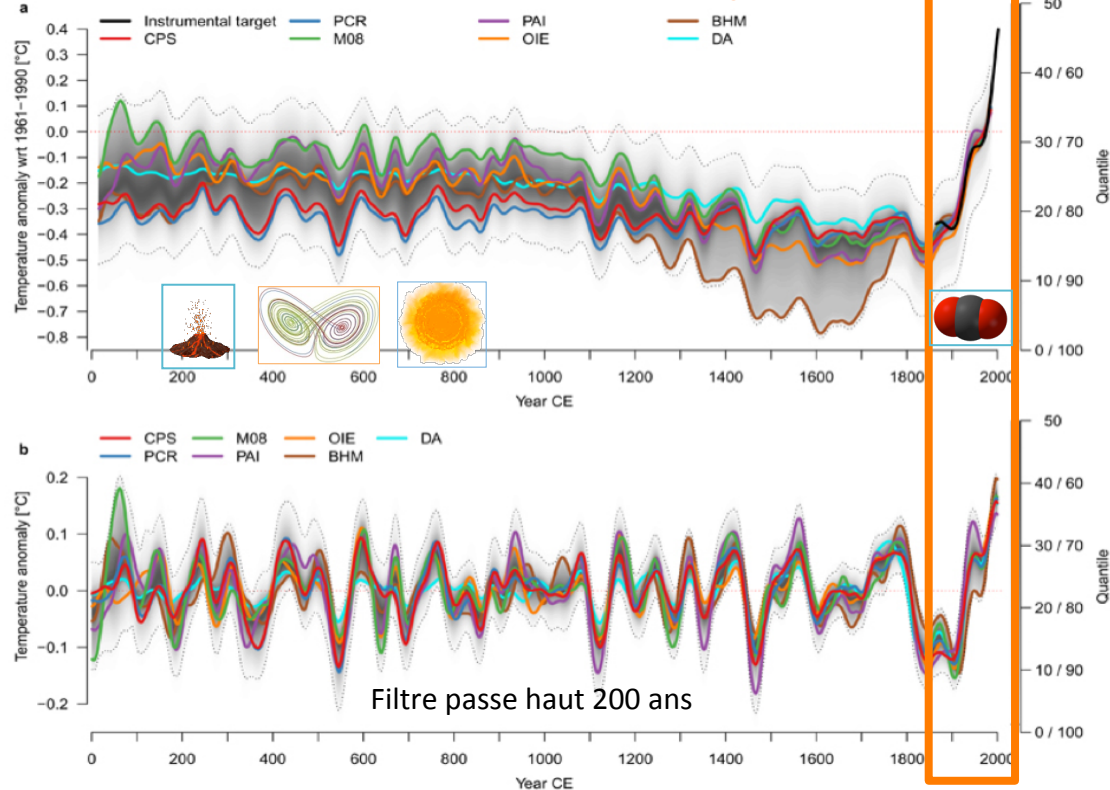
Iso2k network version 0.7 (637 records from 436 sites)



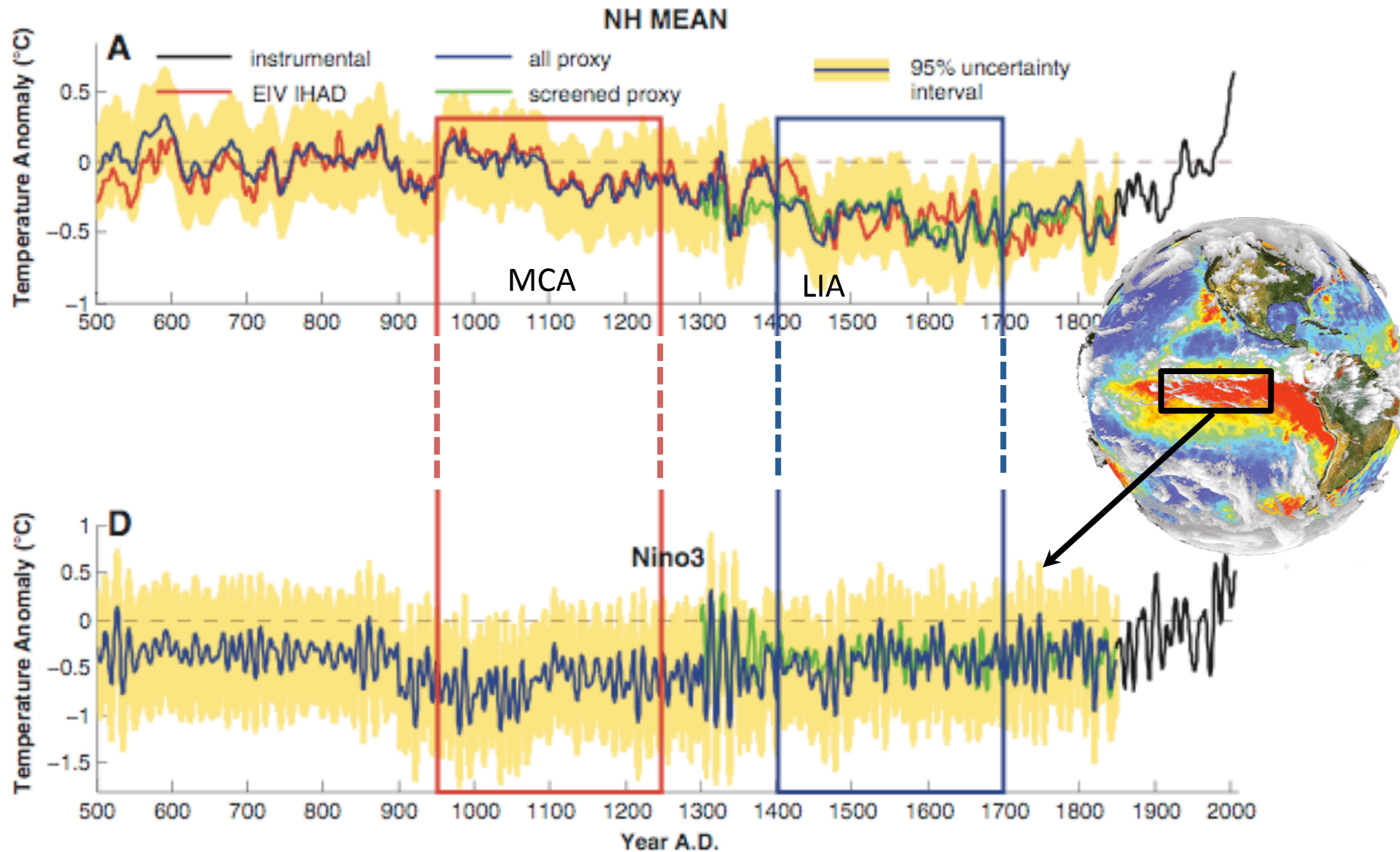
Temporal Availability



Anomalies des températures globales

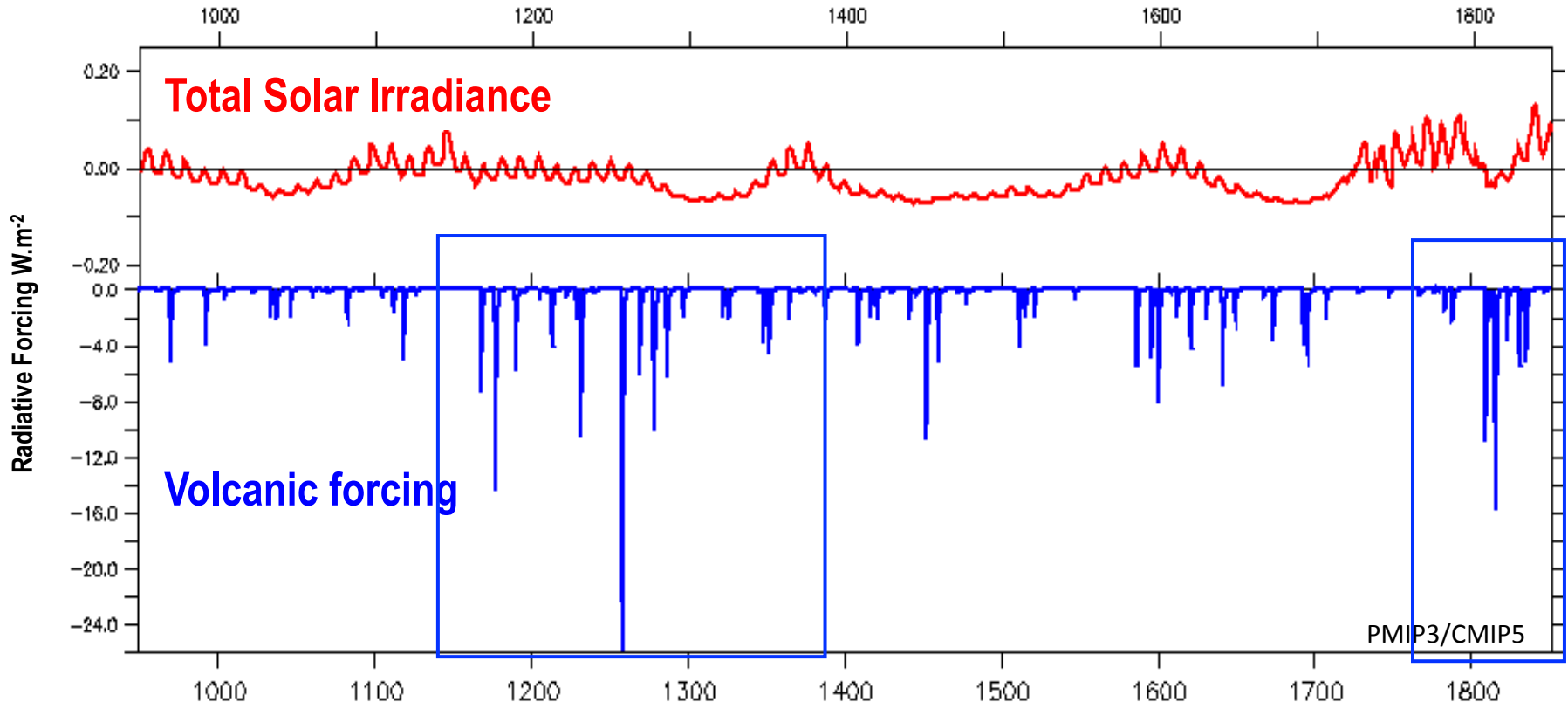


Modulation passée de l'ENSO dans les observations historiques et les archives naturelles

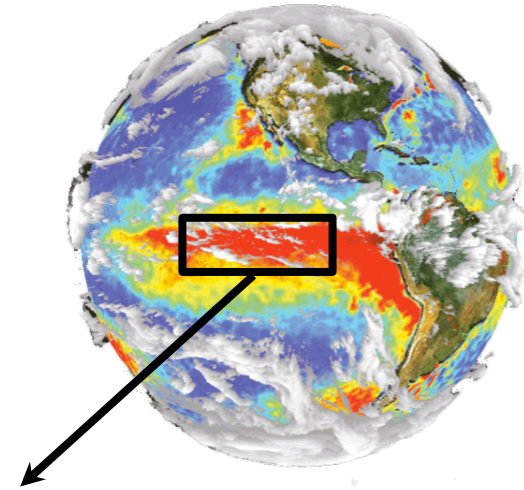


Variabilité interne ou variabilité forcée?

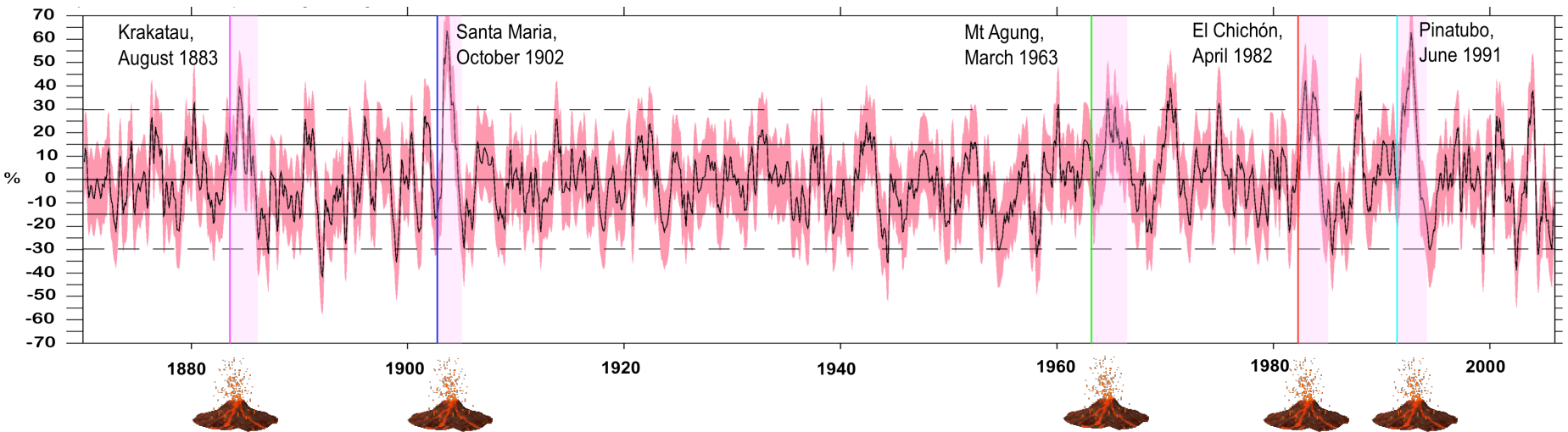
Pour la période précédant le XIXe siècle, les forçages naturels liés **aux variations solaires** et **aux éruptions volcaniques** sont prépondérants par rapport **aux forçages anthropiques**.



Links between ENSO and tropical volcanism over the historical period 1870-1999 in CMIP5 climate model simulations (106 simulations)

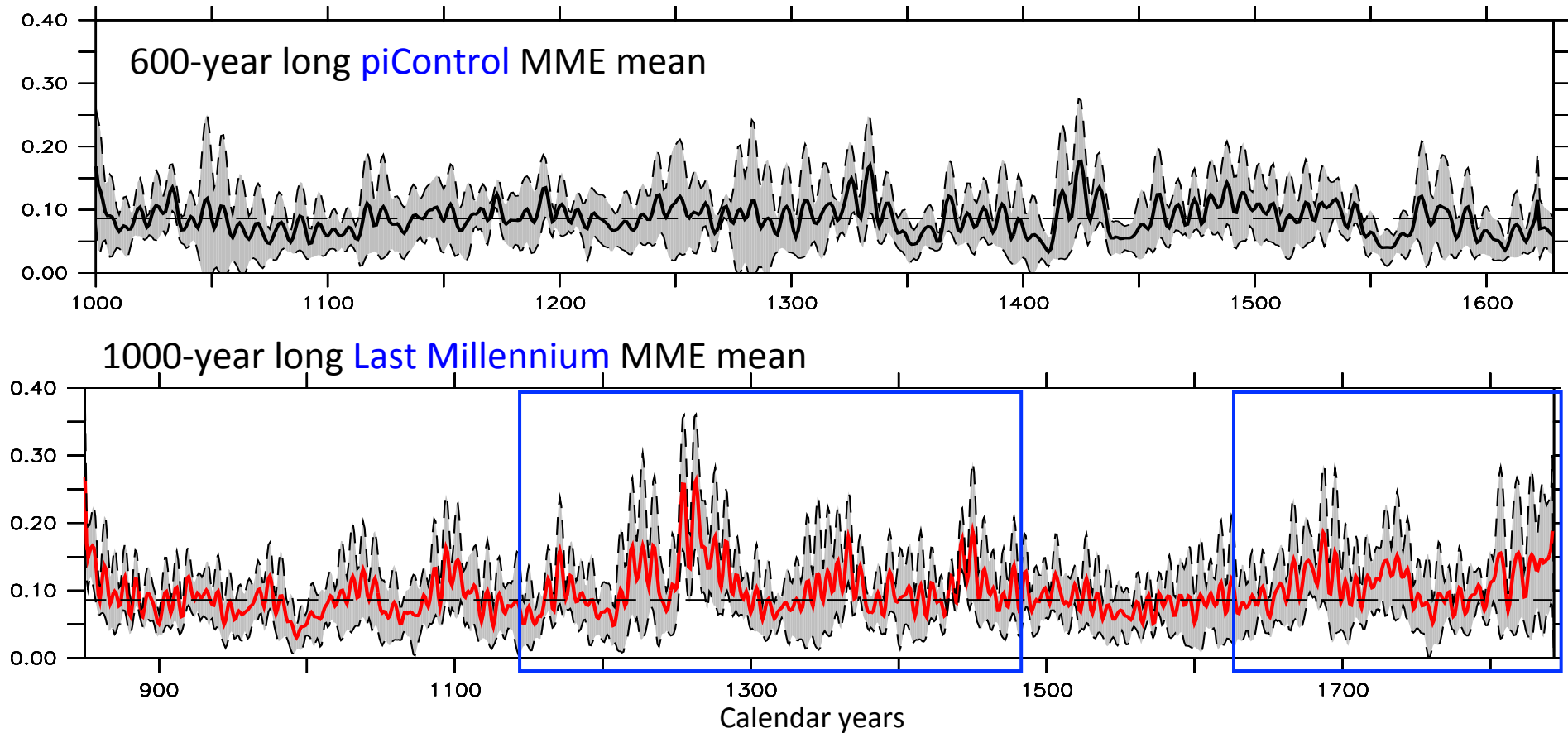


Percentage of CMIP5 Simulations with an El Niño event in their historical simulations using relative SST anomalies



Links between ENSO and tropical volcanism over the Last Millennium (850-1850) in PMIP4/CMIP5 climate model simulations (6 simulations)

Niño3 SSTs 8-years running Standard deviation across
Multi-Model Ensemble (MME) mean



Ensemble simulations for the Pinatubo eruption (Philippines, June 1991)

IPSL-CM5B-LR coupled model

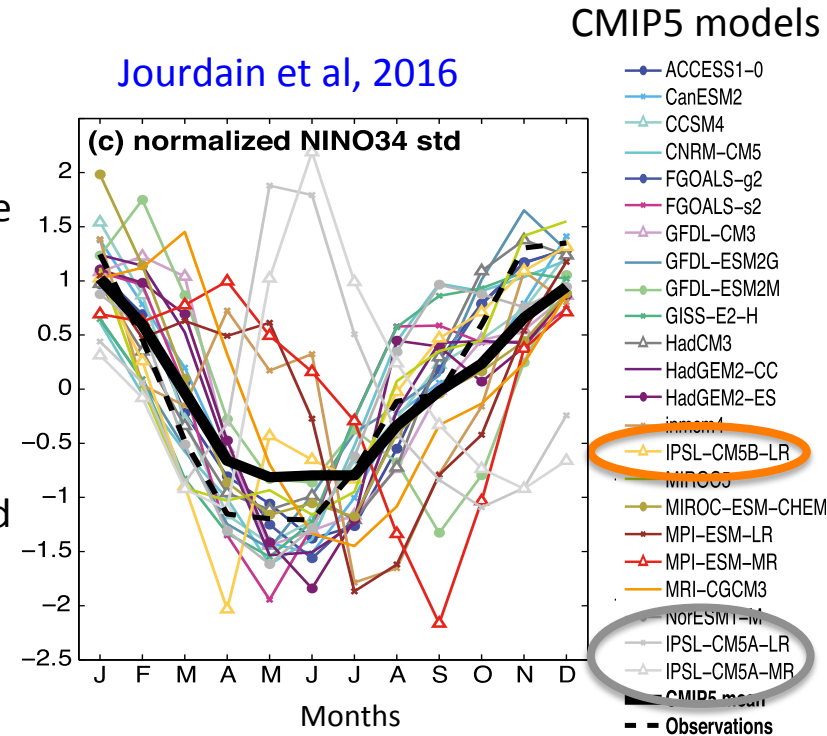
(Dufresne, et al, 2013)

LMDz Atmospheric model : 1.87° in latitude, 3.75° in longitude and 31 vertical levels (17 in the stratosphere).

NEMO3.2 model using ORCA2 : 2° resolution (0.5° at equator)

This model reproduces ENSO variability with two spectral peaks around 3-3.5 years and beyond 4 years, which is in good agreement with observations.

Correct seasonal phase of ENSO cycle (peak mostly in NDJ).



Proposed mechanism

Gill-type response

Volcanic eruption in June -> reduced African monsoon -> Kelvin Waves -> west Pacific westerly

IPSL-CM5B + LMDZ5B

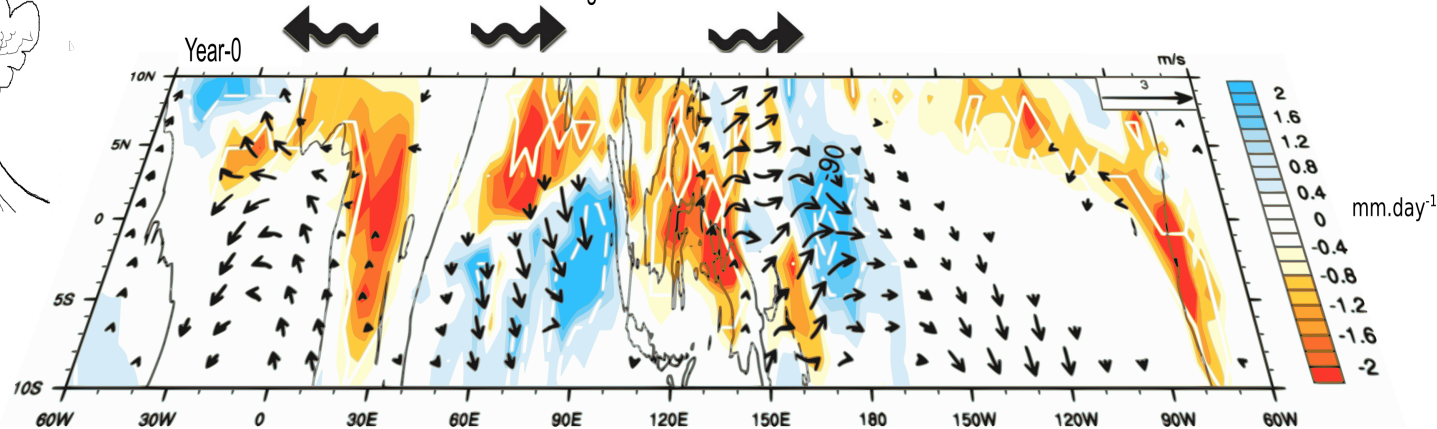
June eruption



Year-0

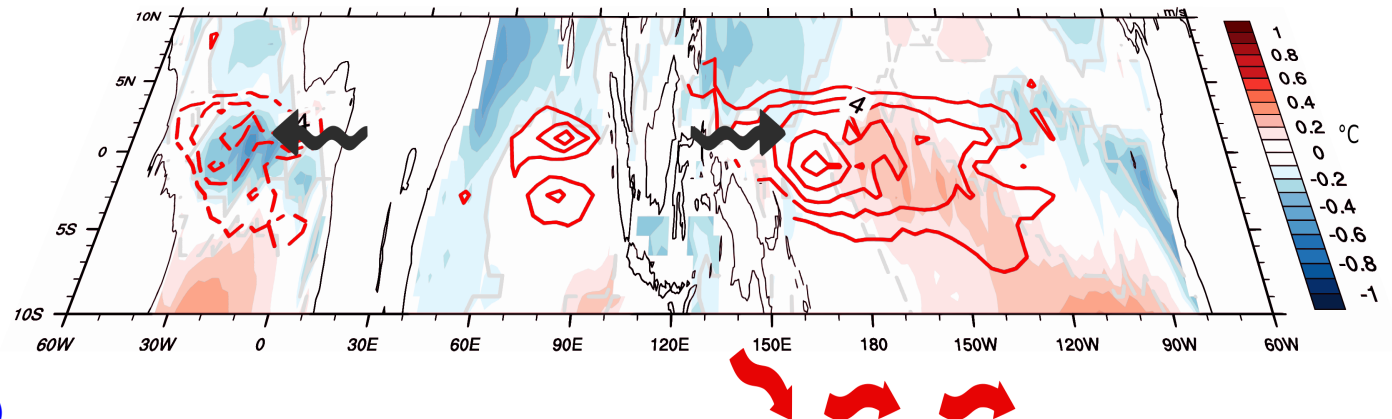
Reduced tropical precipitation in particular over West Africa favors anomalous atmospheric Rossby and Kelvin waves in August-November

SON Precip and wind Anom



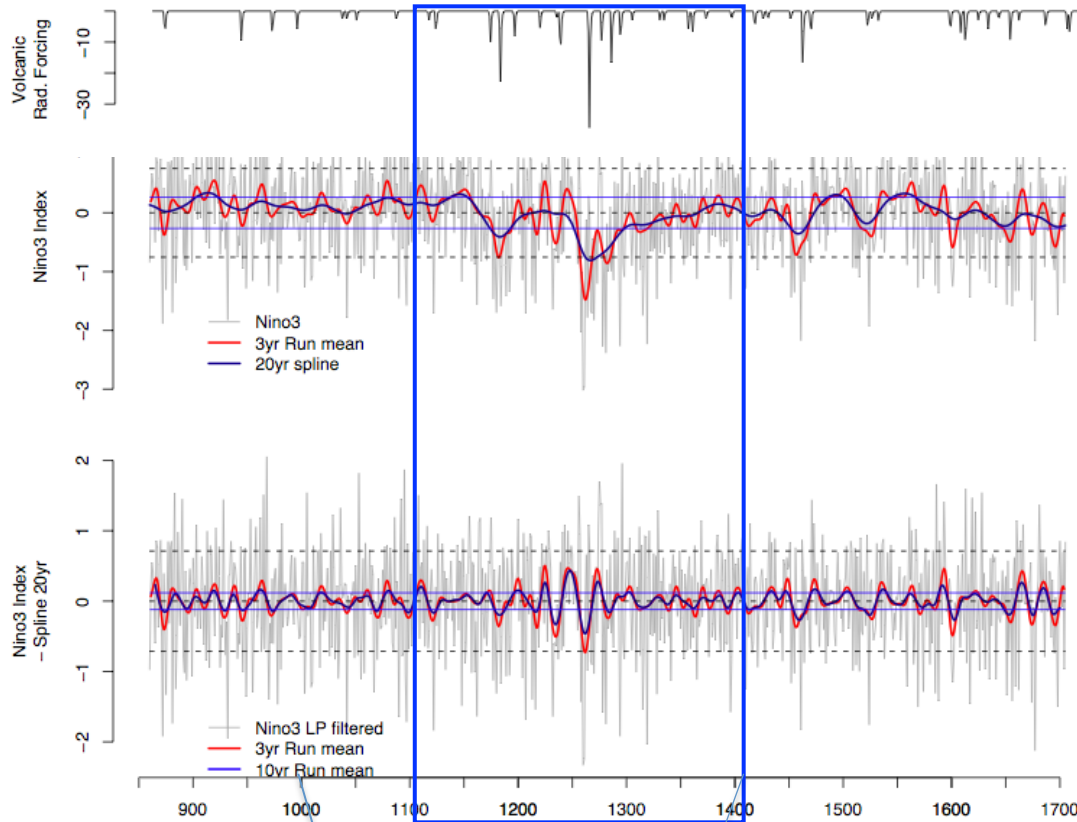
Which shallow the Atlantic Ocean thermocline and initiate anomalous westward oceanic downwelling Kelvin waves reaching central Pacific in December of the eruption year

SON RSSTA & zonal current

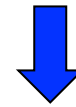


From intraseasonal to decadal timescales

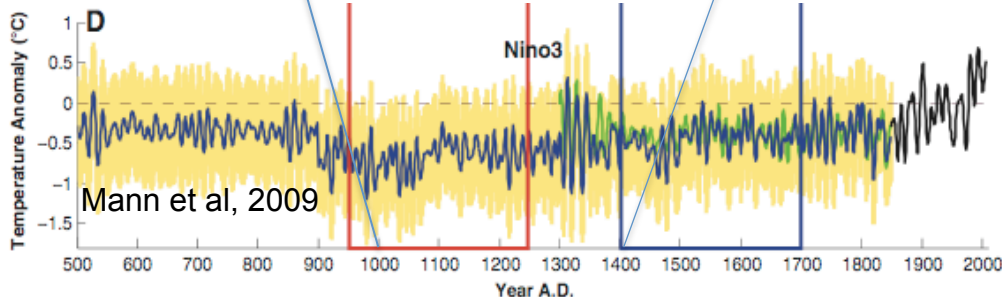
IPSL model Niño3 SSTs



Large volcanic eruptions can alter trade winds and modulate ENSO at decadal scale,

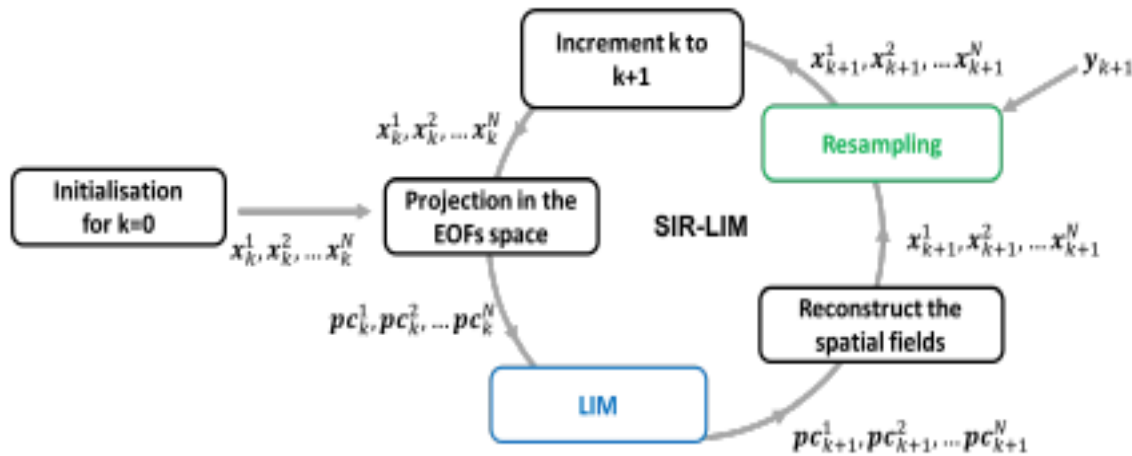
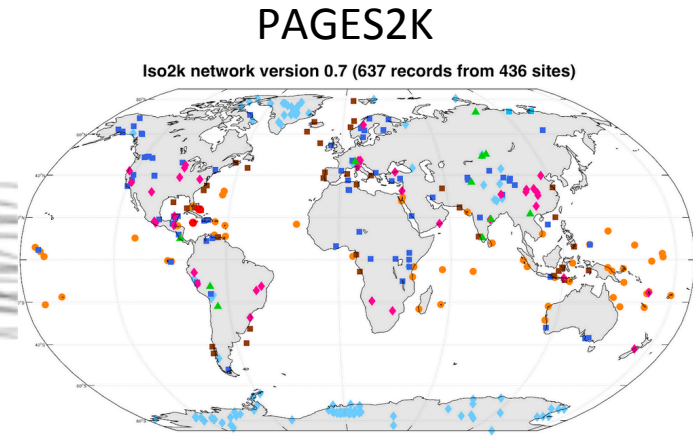
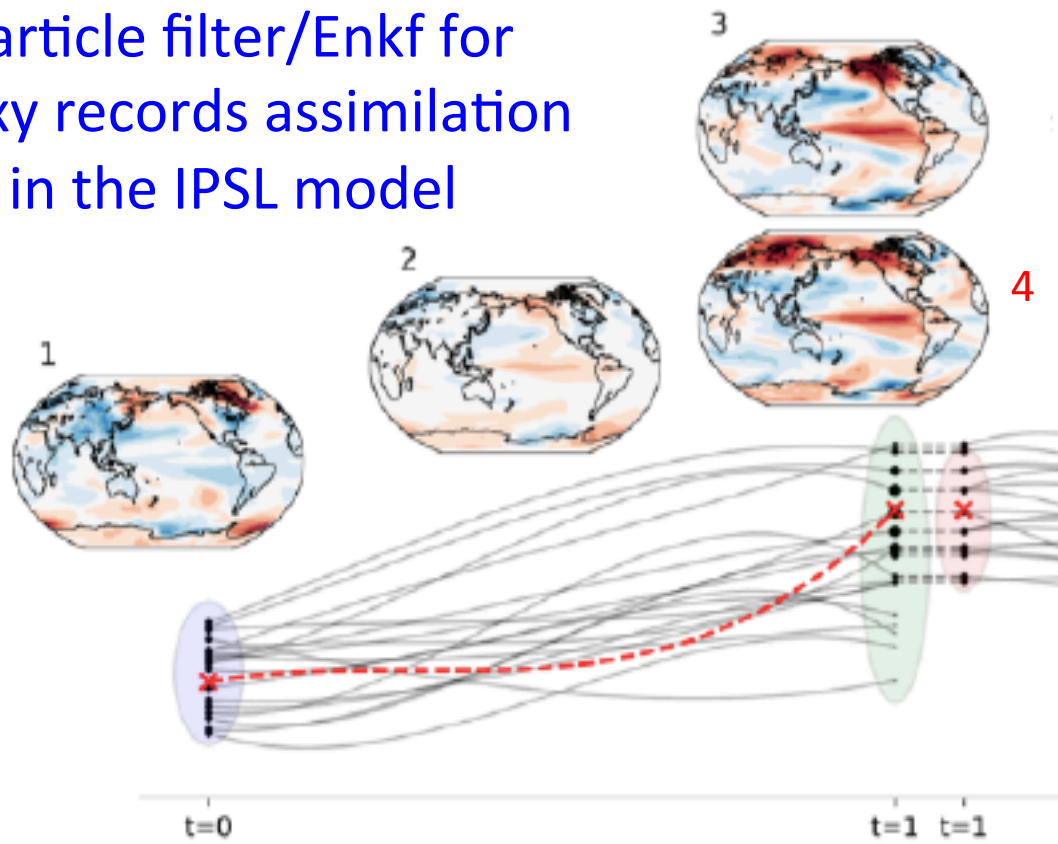


Higher Low Frequency (decadal) Variability



Convergence model-proxy

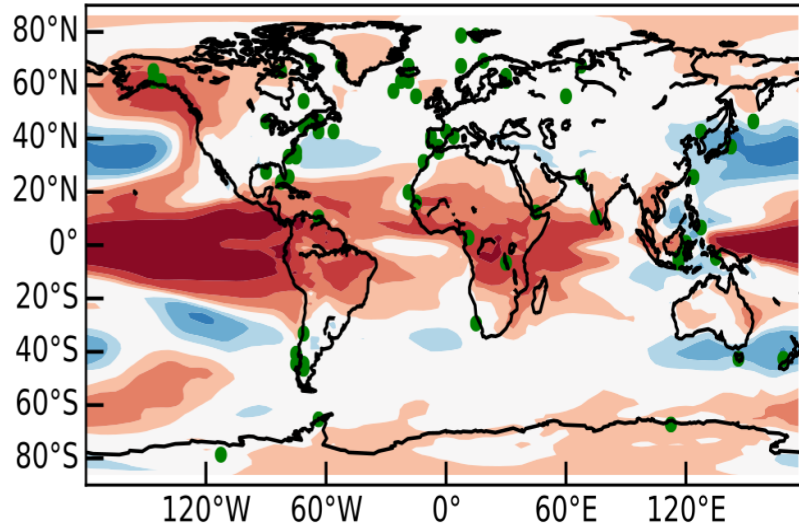
Particle filter/Enkf for proxy records assimilation in the IPSL model



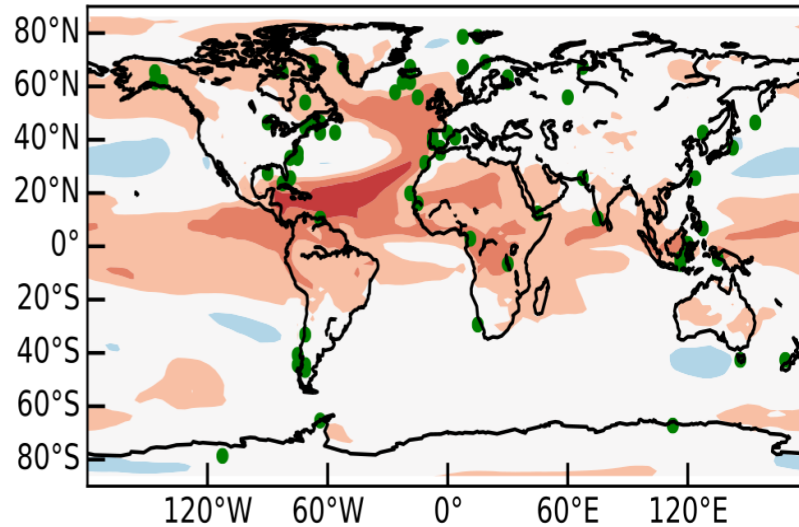
Jebri et al., (2020)

Past climates: a reference to better understand and constrain natural variability

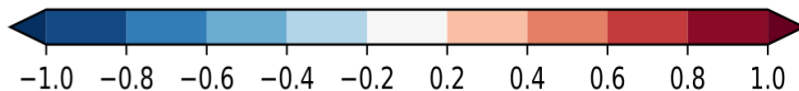
IPSL-CM5A2



IPO

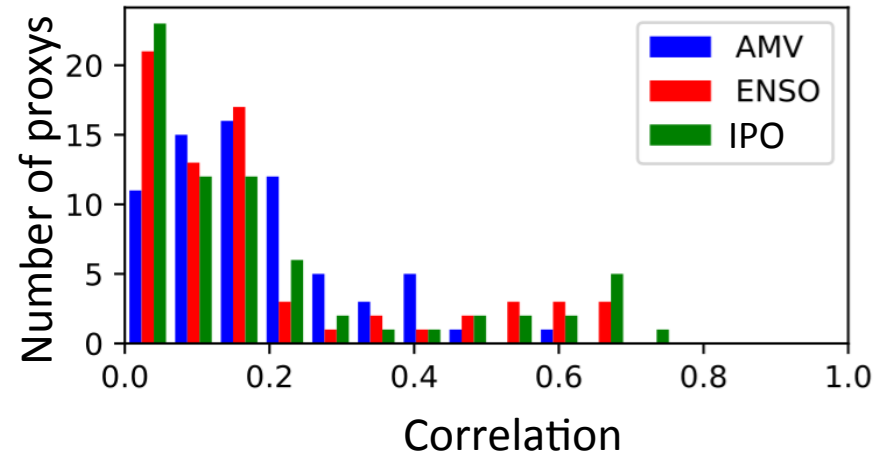


AMV



Correlation of Pages2k proxies with main modes of variability

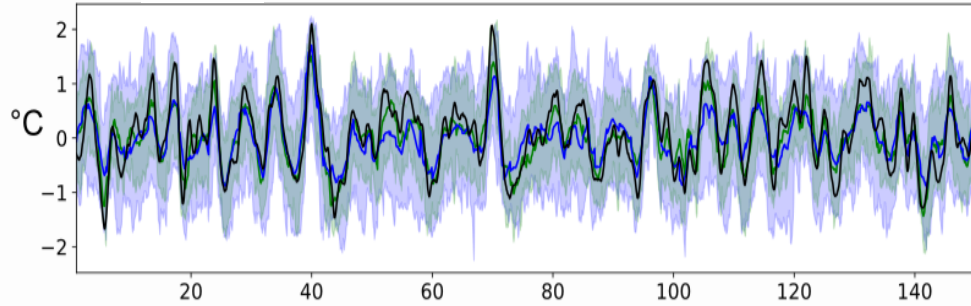
Year 1000AD



Jebri et al., (2020)

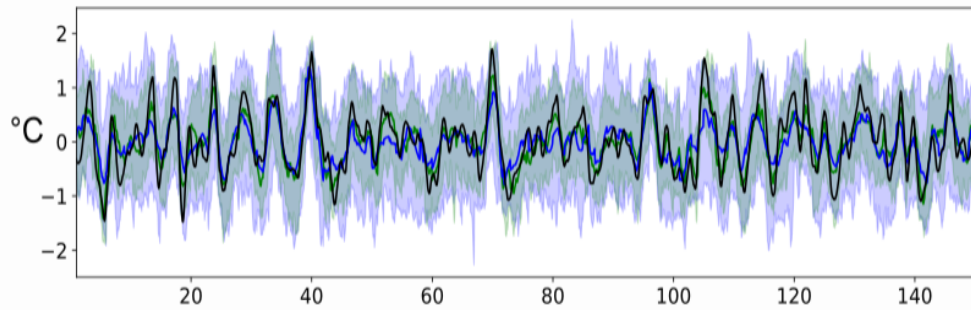
Past climates: a reference to better understand and constrain natural variability

(a) IPO **Reconstruction**



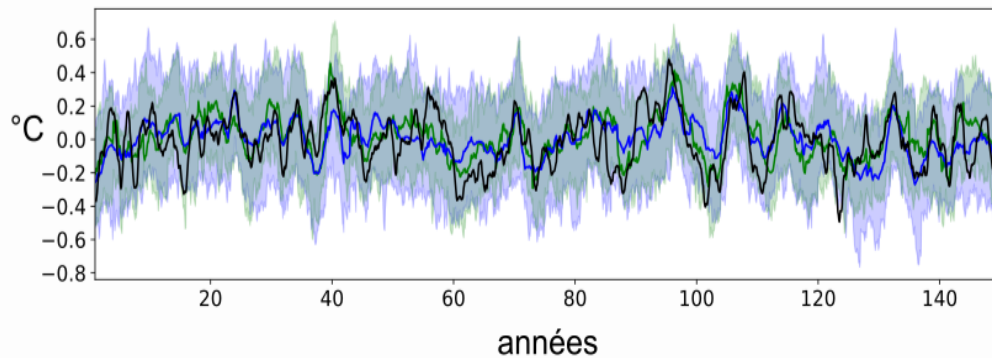
Pour 150 ans et ~100 particules

(b) Nino3.4



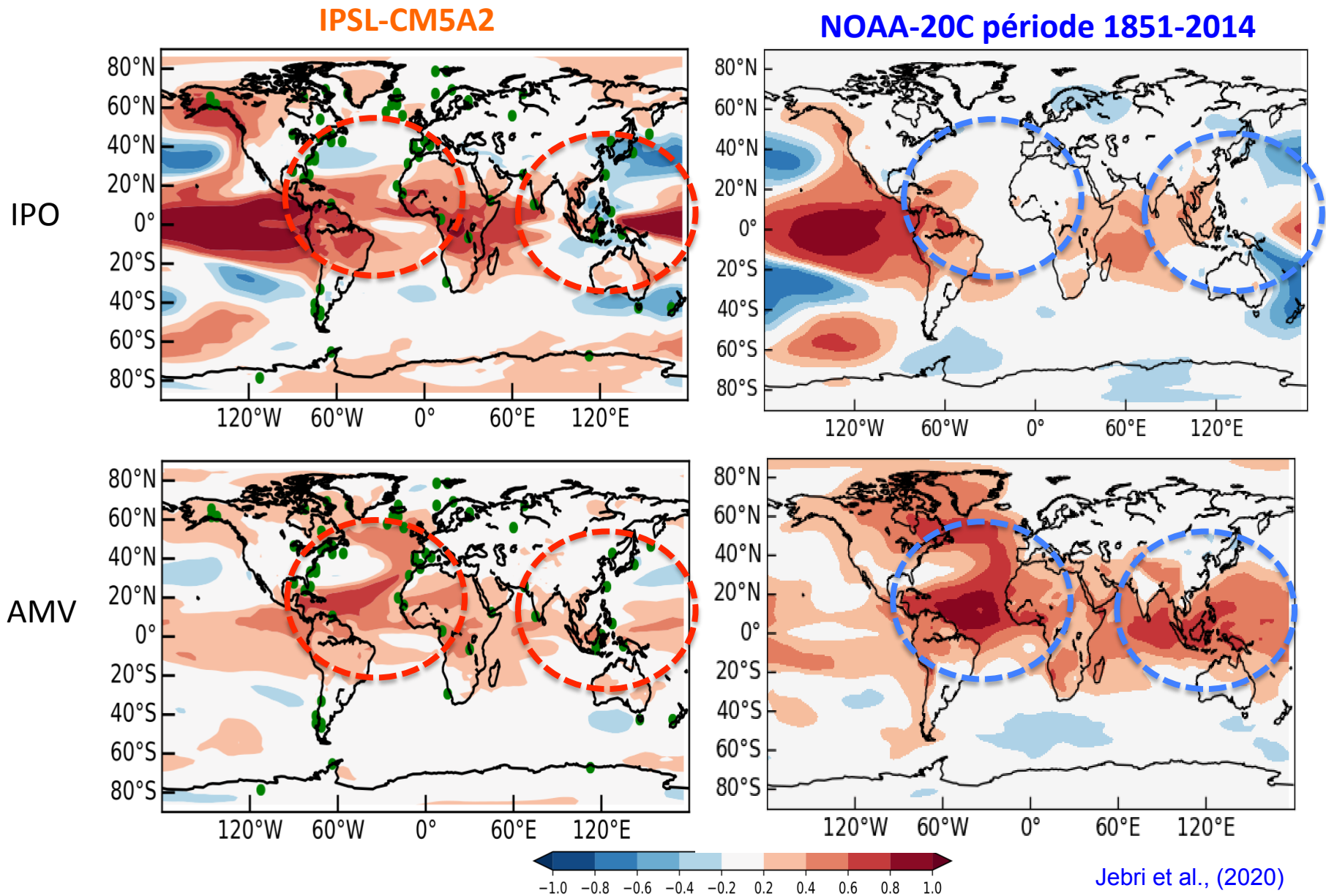
— Cible

(c) AMV



Jebri et al., (2020)

Influence of proxies location and model biases on climate model reconstruction skills !!!

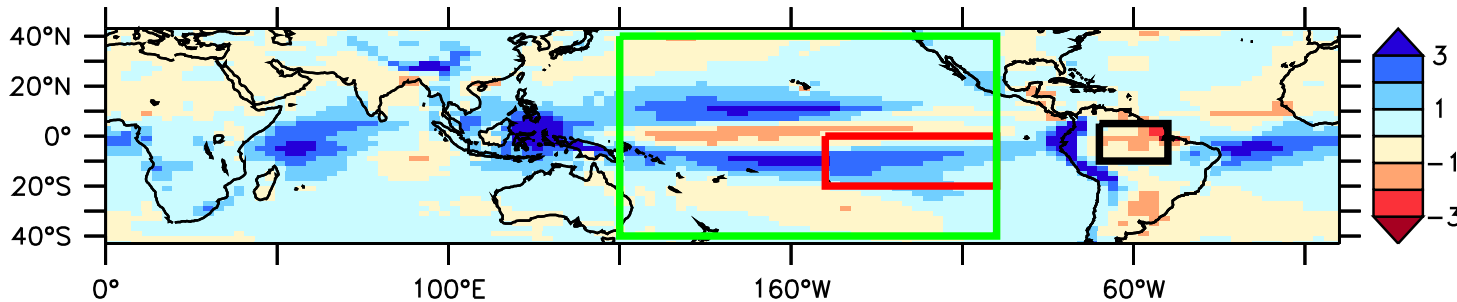


Mean climate and biases

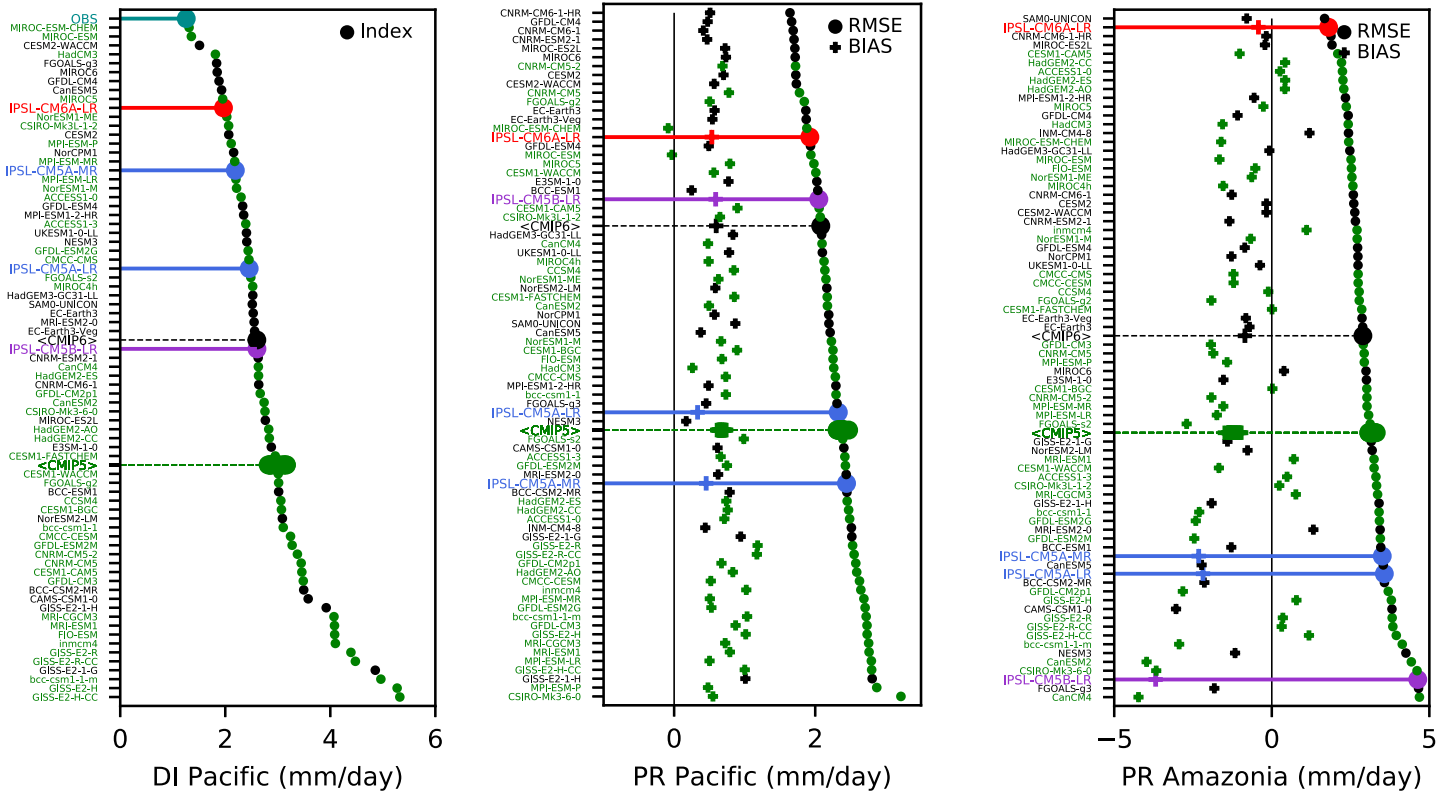
Classical CMIP-class model biases: cold tongue, double ITCZ, dry monsoons

Boucher et al, 2020

IPSLCM6A-LR



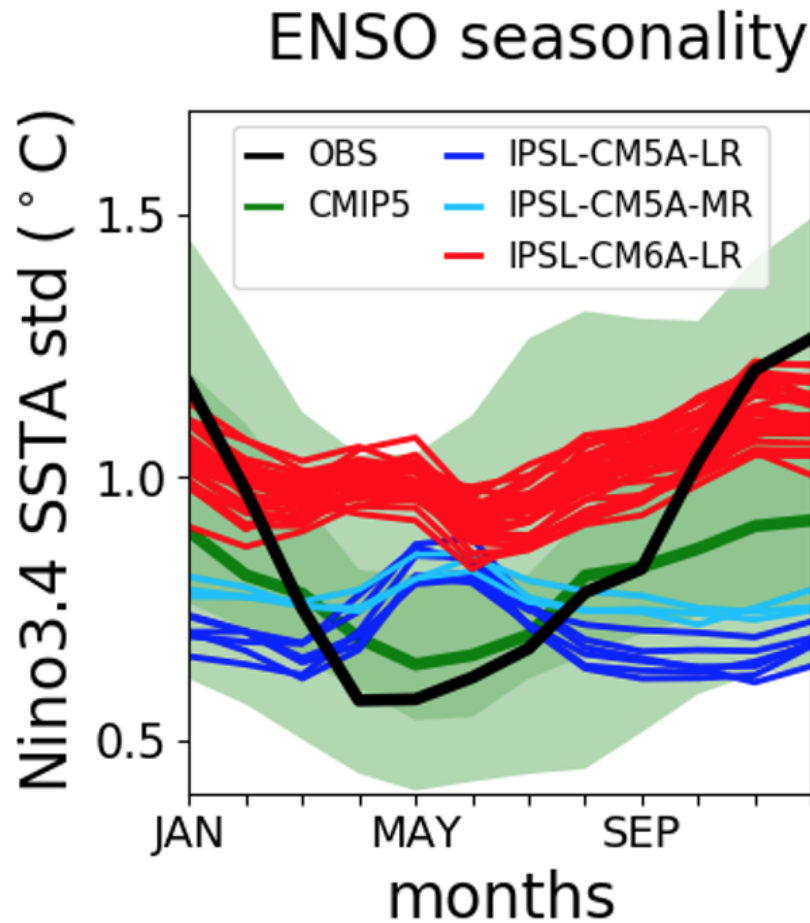
annual mean rainfall biases



Root mean square errors (RMSE, closed circles) against observations of double ITCZ index, Pacific and Amazonian rainfall

Mean climate and biases

Classical CMIP-class model biases: ENSO seasonality



- Les archives naturelles couvrant les siècles passés révèlent une variabilité naturelle importante du climat tropical.
- Les biais des modèles (moyenne et variabilité) limitent notre compréhension des mécanismes associés (variabilité interne vs. forçages externes).
- Des progrès significatifs dans la réduction des biais des modèles classiques (cold tongue/double ITCZ, etc.) dans la version CM6A-LR... mais certains biais persistent.
- Besoin d'une version du modèle IPSLCM6A compatible avec les longues échelles de temps paléo climatiques (plusieurs millénaires) avec une bonne représentation de la variabilité du climat tropical (biais moyens, var intra saisonnières à décennales).