# Mid-Holocene and Last Glacial Maximum climate simulations with the IPSL model:
new features with the IPSL_CM5 version

Masa Kageyama, Pascale Braconnot, Laurent Bopp, Eric Guilyardi, James Lloyd, Fabien Lombard, Véronique Mariotti, Tilla Roy, Marie-Nöelle Woillez

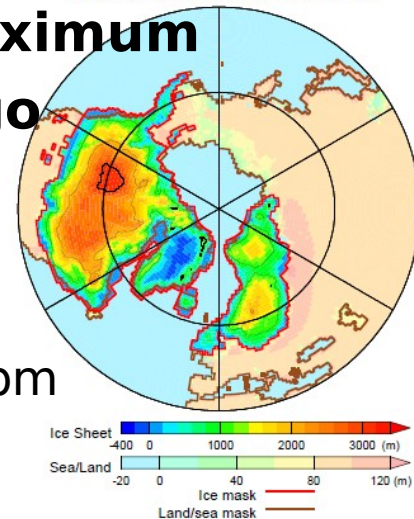# The mid Holocene and Last Glacial Maximum in brief

Mid Holocene, 6000 years ago

Change in insolation forcing
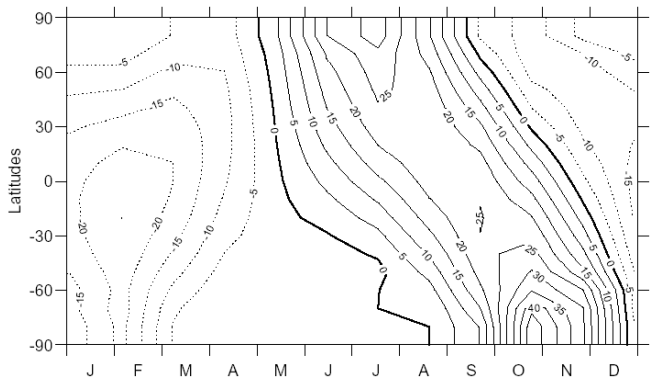
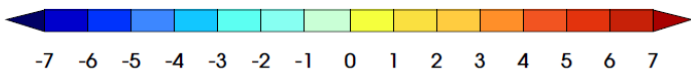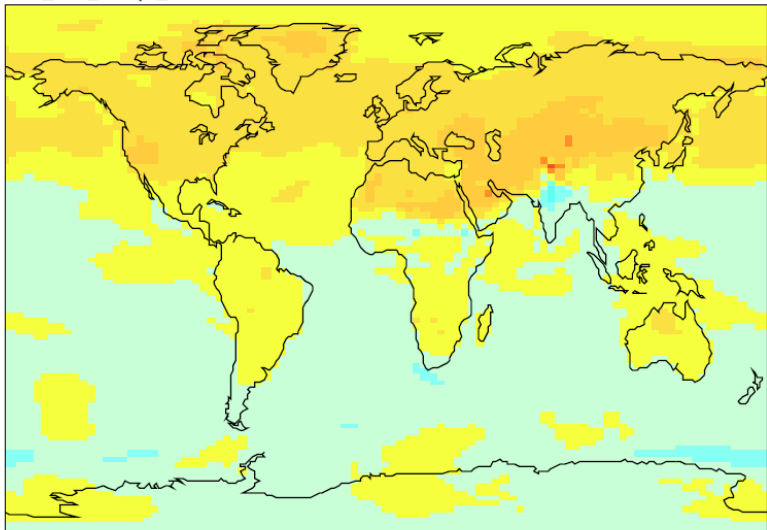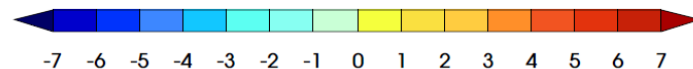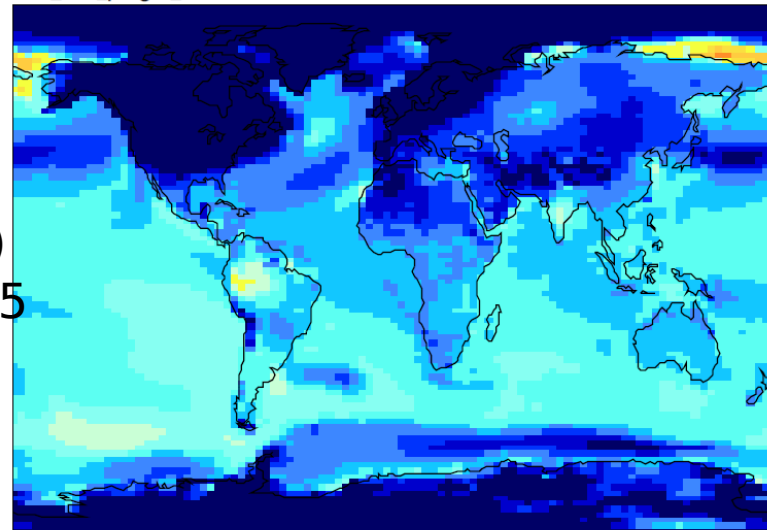## Last Glacial Maximum 21000 years ago

Changes in
- ice-sheets
- GHG forcings:
    $CO_2 = 185ppm$
- coastlines

t2m_JJA_mh-pi IPSLCM5

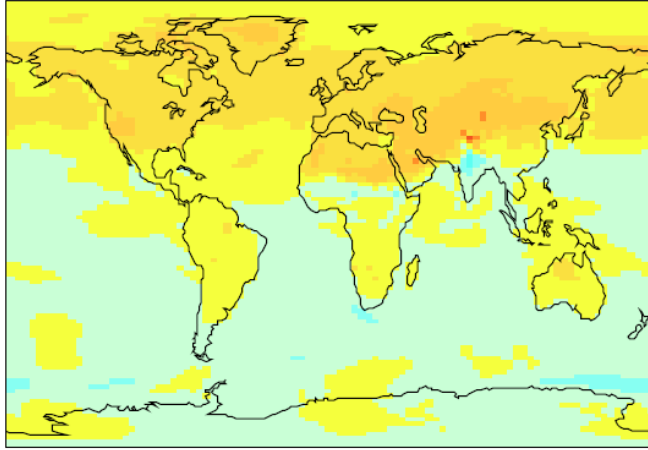ΔT(JJA)
IPSLCM5

t2m_JJA_pi-lgm_IPSLCM5
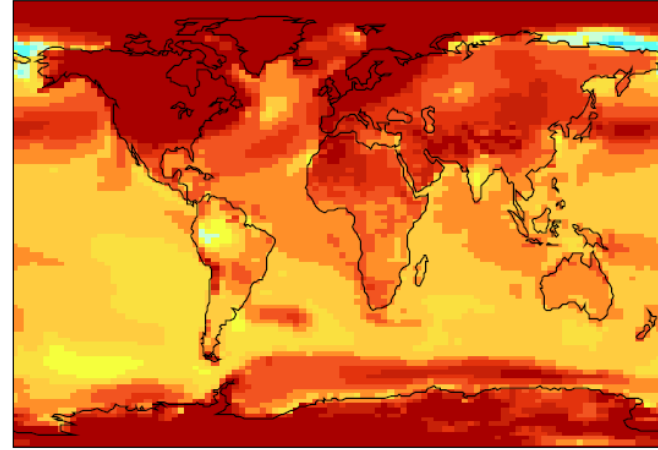
IPSL_CM5 vs IPSL_CM4: T_JJA

t2m_JJA_mh-pi_IPSLCM5

t2m_JJA_pi-lgm_IPSLCM5

CM 5

Mid Holocene – PI
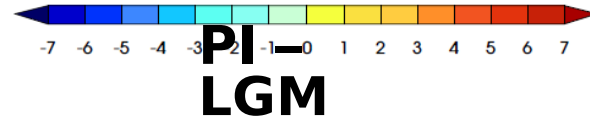
PI – LGM

t2m_JJA_mh-pi_IPSLCM4
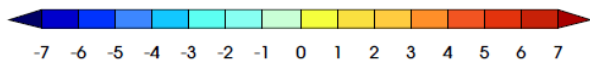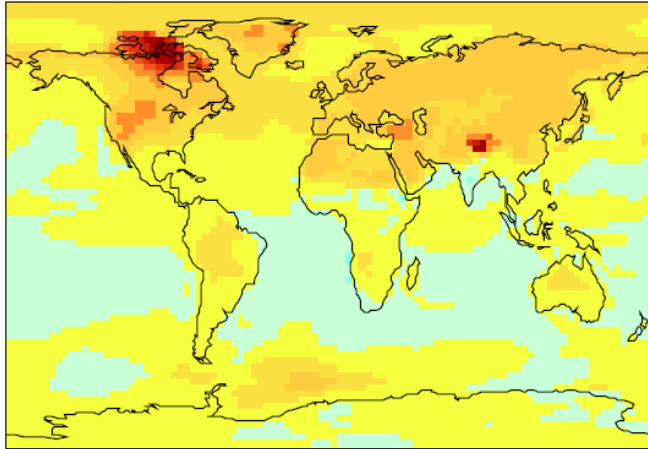
t2m_JJA_pi-lgm_IPSLCM4
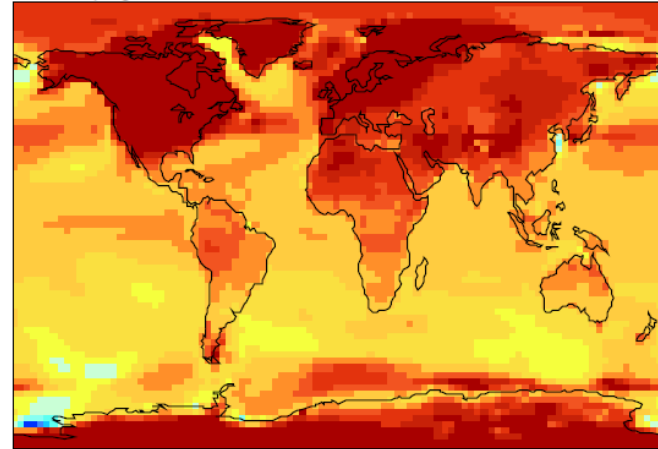
CM 4

Analyses of the forcings (following Taylor et al. 2007)

$$\hat{Q}_s^{\downarrow} = \frac{Q_s^{\downarrow}}{S}$$

$$\alpha = Q_s^{\uparrow} / Q_s^{\downarrow}$$

$$A = 1 - Q/S$$

$$\mu = A + \hat{Q}_s^{\downarrow}(1 - \alpha).$$

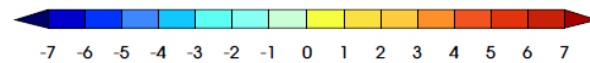$$\gamma = \frac{\mu - \hat{Q}_s^{\downarrow}}{\mu - \alpha \hat{Q}_s^{\downarrow}}.$$

LGM case vs. PI

Shortwave forcing

Albedo feedback
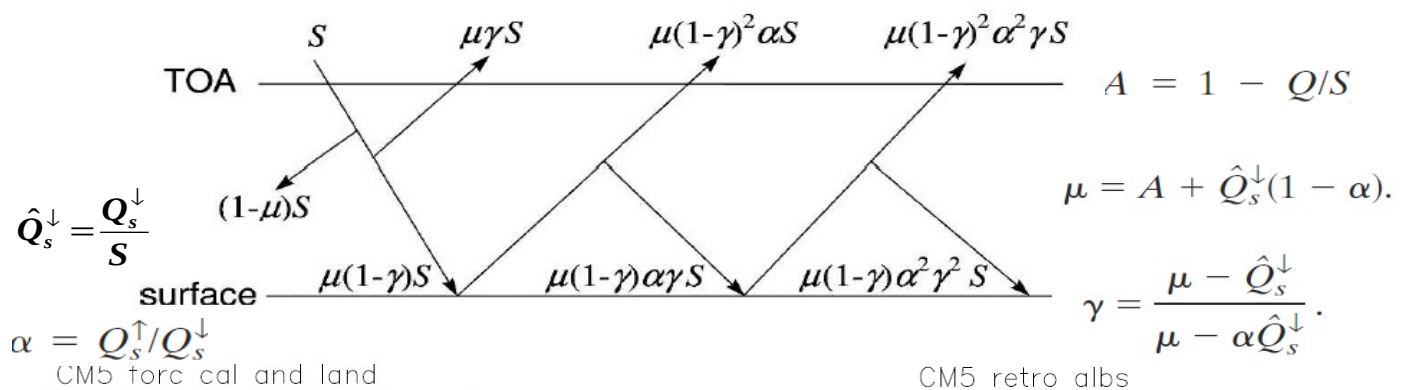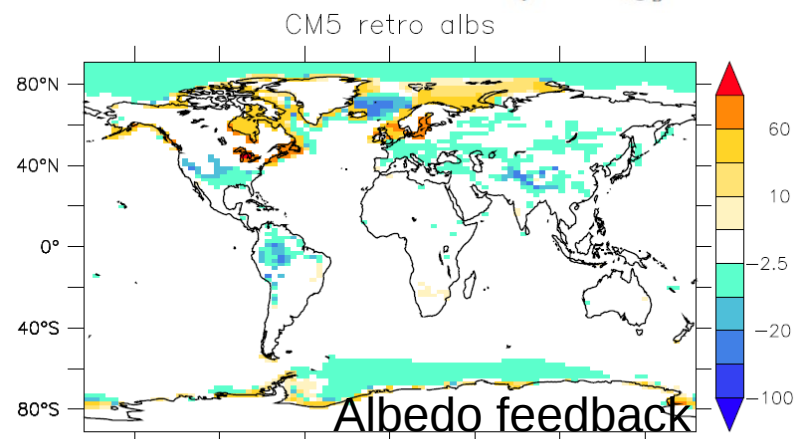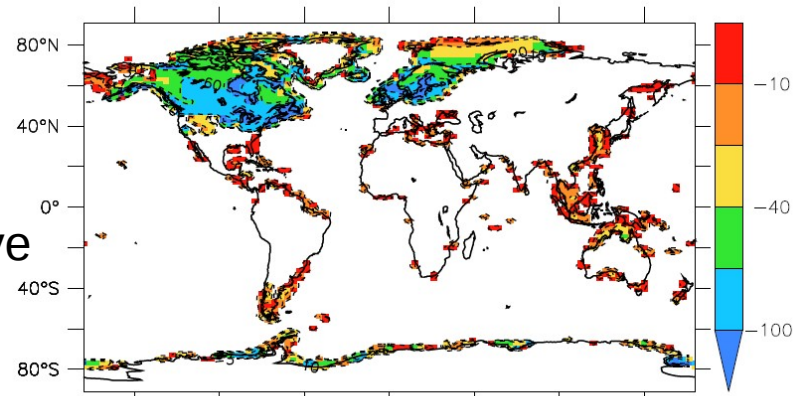
SW scattering (including clouds)

LW gain
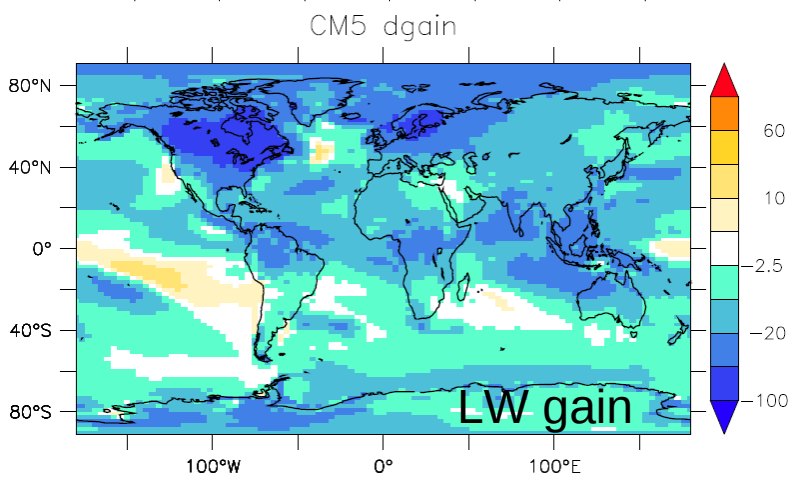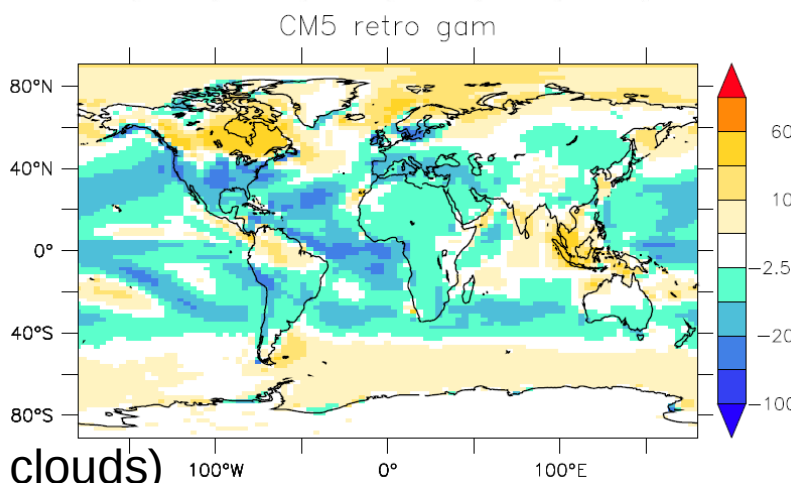
Model data comparisons and land-ocean relationships

PMIP2 data base, LGM data, Mean Annual Temperature

Land vs ocean mean annual temperature changes

North Atlantic /Europe

Tropics

East Antarctica
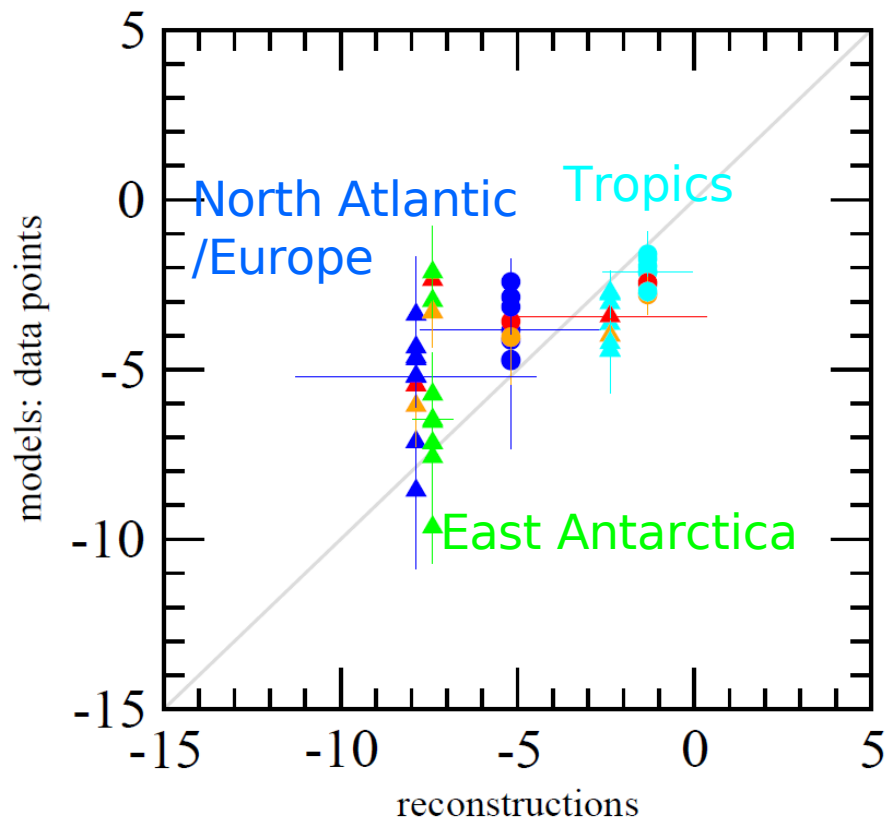
Circles = ocean -
Triangles= land

Tropics

North Atlantic /Europe
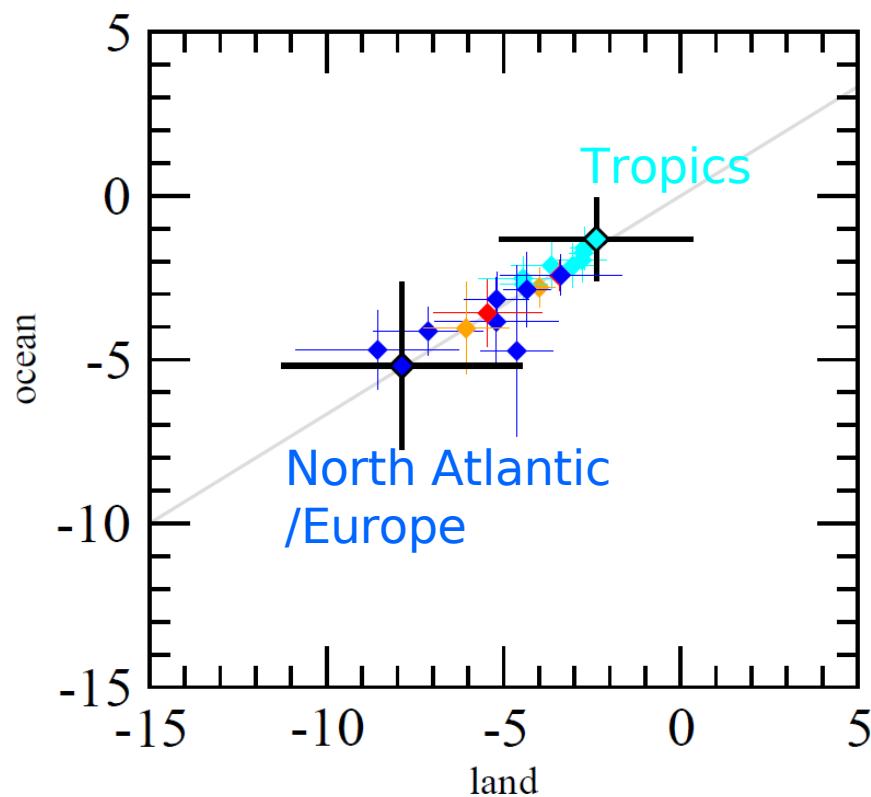
Black error bars = data

What's really new: biogeochemistry

Example: NPP computed by PISCES
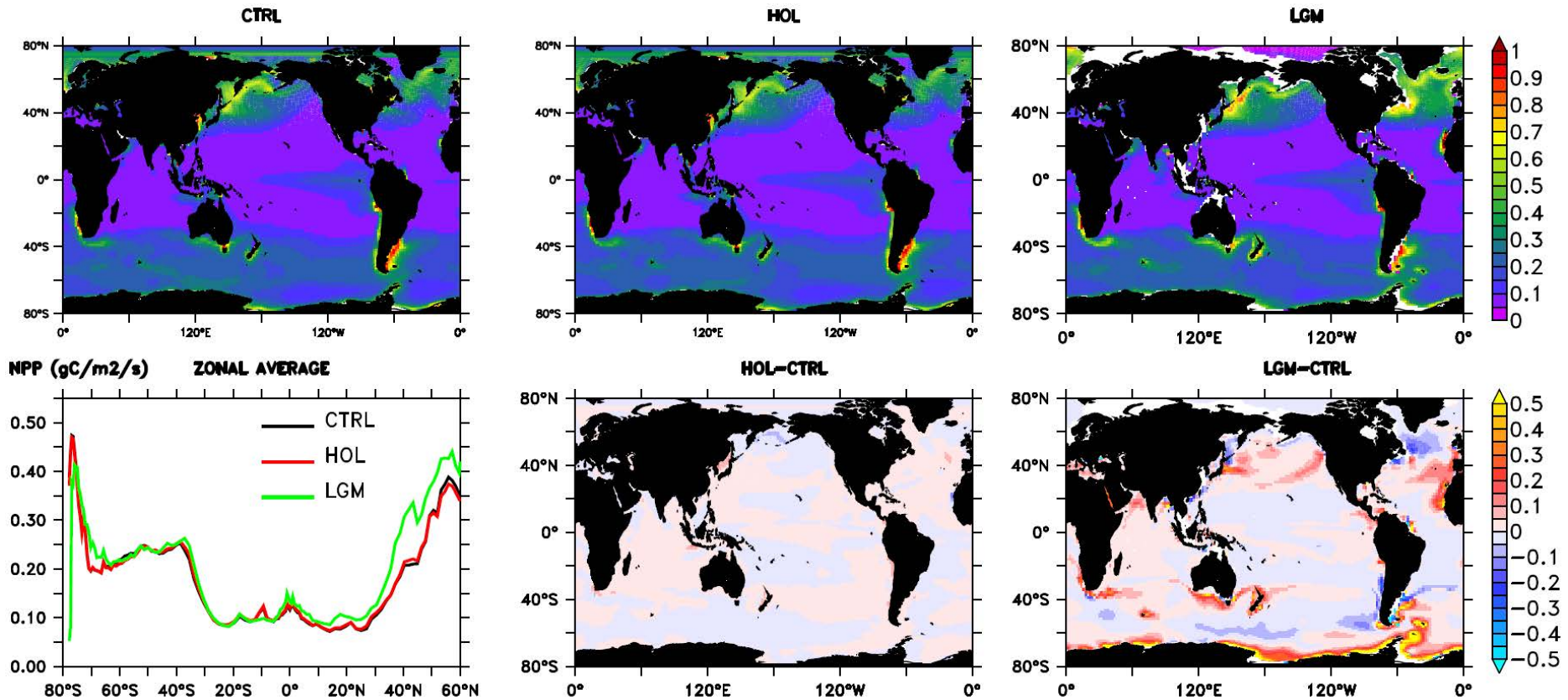
→ Plan to compute distribution of foraminifera to compare with marine data

Relationship with tropical variability?

IPSLCM5oCTL   monthly   Surface Temp. Std Dev Annual [0101-20012] (C)
(C [region mean/rms=0.495120/0.495120]): Min= 0.00, Max= 1.16

CM5H6KO2   monthly   Surface Temp. Std Dev Annual [200001-259912] (C)
(C [region mean/rms=0.458575/0.458575]): Min= 0.00, Max= 1.11

LGM8   monthly   Surface Temp. Std Dev Annual [185001-235912] (C)
(C [region mean/rms=0.670022/0.670022]): Min= 0.00, Max= 1.51

Merci!

$$S \qquad \mu\gamma S \qquad \mu(1-\gamma)^2\alpha S \qquad \mu(1-\gamma)^2\alpha^2\gamma S$$

TOA

$$A = 1 - Q/S$$

$$(1-\mu)S$$

$$\hat{Q}_s^{\downarrow} = \frac{Q_s^{\downarrow}}{S}$$

$$\mu = A + \hat{Q}_s^{\downarrow}(1-\alpha).$$

surface

$$\mu(1-\gamma)S \qquad \mu(1-\gamma)\alpha\gamma S \qquad \mu(1-\gamma)\alpha^2\gamma^2 S$$

$$\alpha = Q_s^{\uparrow}/Q_s^{\downarrow}$$

$$\gamma = \frac{\mu - \hat{Q}_s^{\downarrow}}{\mu - \alpha\hat{Q}_s^{\downarrow}}.$$

Taylor et al. 2007