WP2 : Future coupling methods

Development of the carbon component coupled earth system reanalysis of the 20th century : the ocean carbon

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Objective :

- develop and assess options for including ocean biogeochemistry in a future coupled 20th century reanalysis

3 strategies for coupling :

- **online coupling** : MO&UVSQ/LSCE: provide code, namelists, external fluxes and initial conditions for biogeochemical code (PISCES)
  ECMWF integrates PISCES in CERA-20C

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- **"offline" NEMO-PISCES** : atmospheric forcing fields from CERA-20C

⇒ *the only workable option ! We focus on this one ...*

The “offline” NEMO-PISCES strategy :

- NEMO-PISCES configuration based on ECMWF settings, forced by ERA-20C atmospheric reanalysis

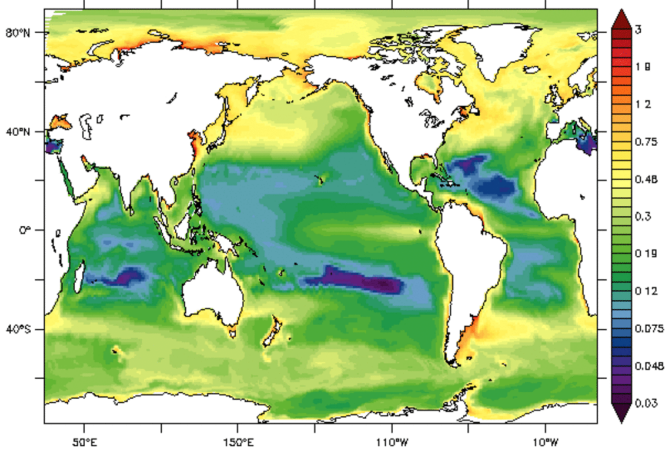
- biogeochemical initial state, 1900, from coupled ORCA05-LIM-PISCES simulation (DFS4.2) covering the historical period provided by UVDSQ/ LSCE (ORCA05-LJS18)

- 10 year spin-up (1891-1900) forced by 1900 ERA-20C in loop

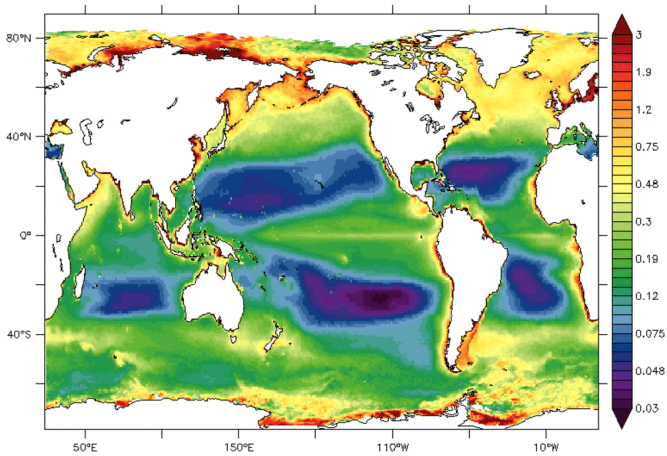
=> T106

The “offline” NEMO-PISCES strategy : results in 1900

Surface chlorophyll in mg CHL / m^3 (log scale)

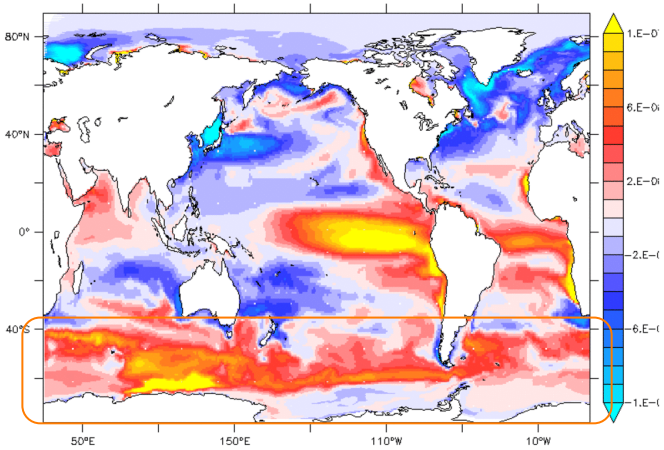


T106 1900



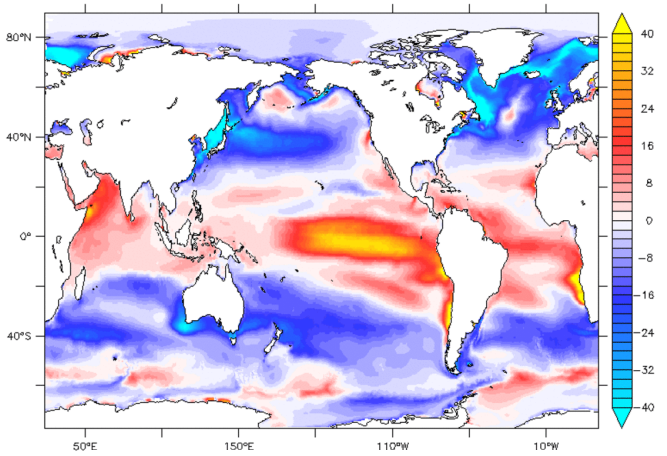
data : globcolor (1998-2011)

Sea-to-air CO_2 flux in g C / m^2



T106 1900

Important biais in Southern Ocean



ORCA05-LJS18 1900

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=> T106 = not satisfying !

Modifications of parameters since results presented at WP2 meeting in May (T106) :

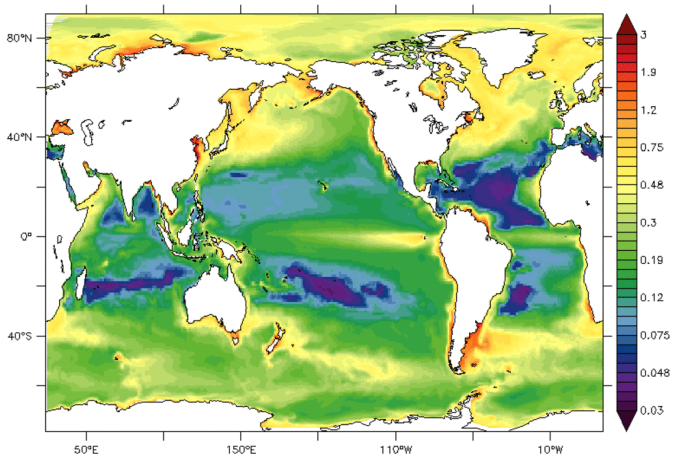
- low-frequency relaxation of global nutrient to a mean value activated
- lateral diffusion of all passive tracer activated
- iron supply from sediments enhanced

=> T113

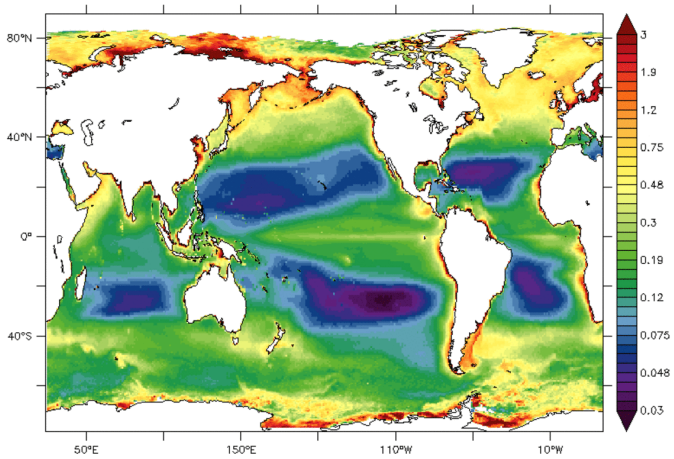
at present 50 yrs of simulation (1900-1950): ORCA1_LIM_PISCES-T113

The “offline” NEMO-PISCES strategy : results in 1950

Surface chlorophyll
in mg CHL / m^3
(log scale)



T113 1950



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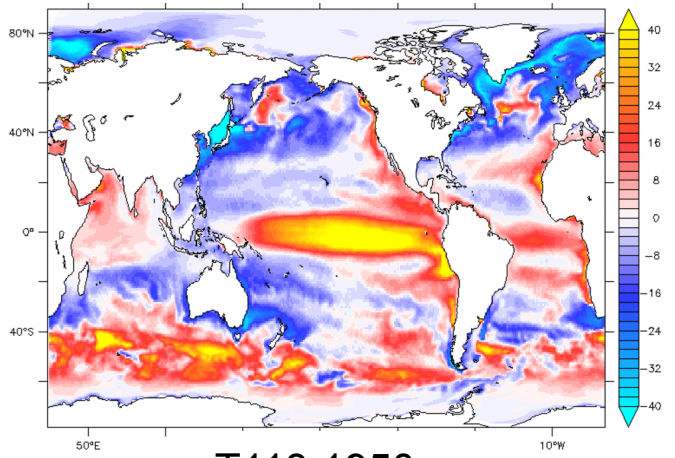
Sea-to-air CO_2 Flux
in g C / m^2



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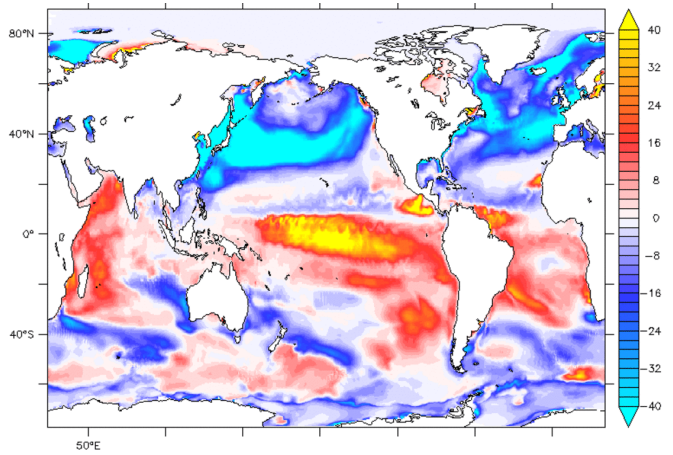
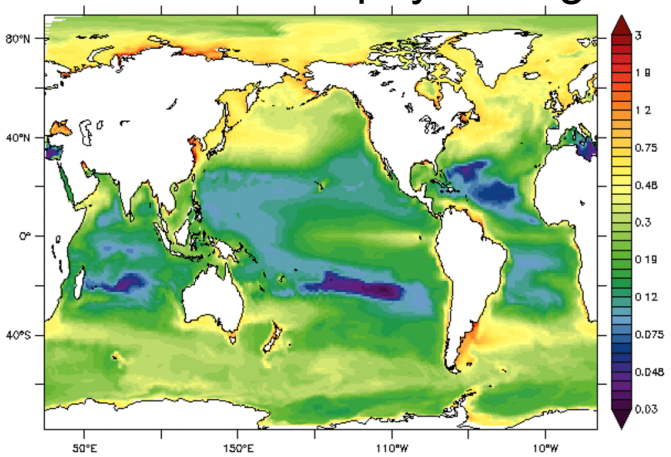


ORCA05-LJS18 1950

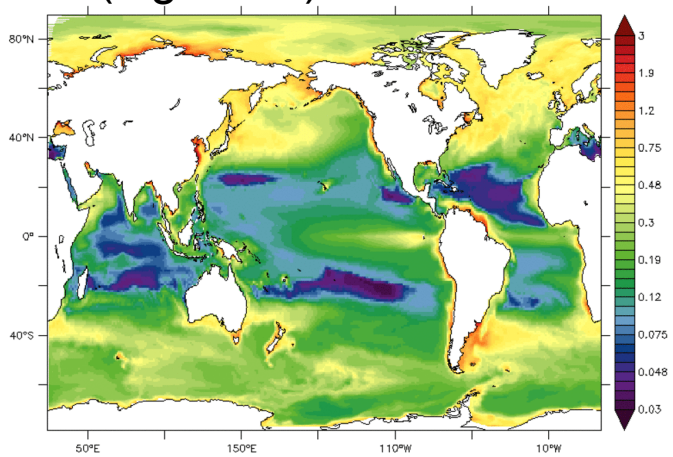
=> Chl: Loss of Pacific and S Atl oligotrophic gyres, not productive enough at high latitudes;
FCO_2: spurious outgassing in S Ocean (particular Indian sector), NW Pacific sink missing

The “offline” NEMO-PISCES strategy : results in 1900

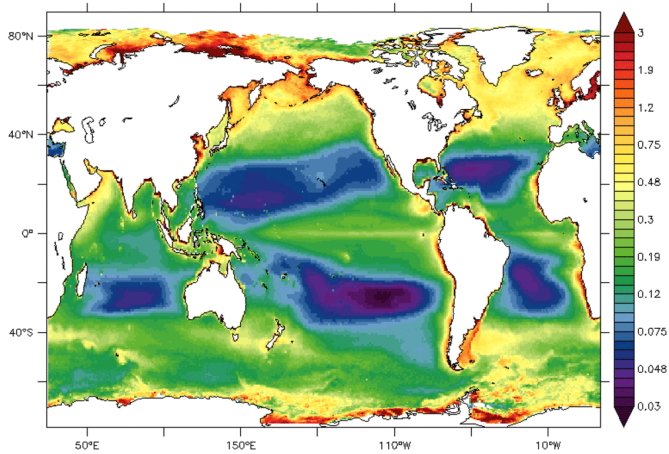
Surface chlorophyll in mg CHL / m^3 (log scale)



T106 1900

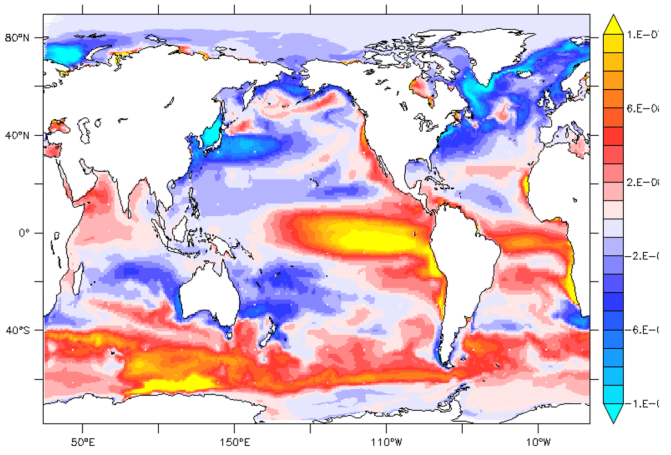


T113 1900



data : globcolor (1998-2011)

Carbon flux ocean to atm in g C / m^2



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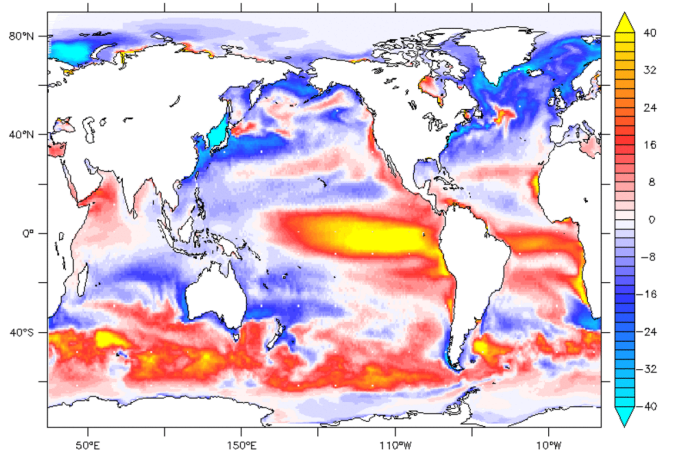

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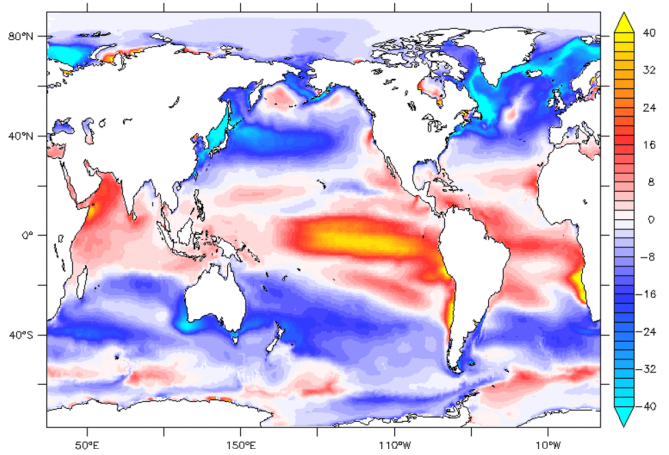

ORCA05-LJS18 1900

The “offline” NEMO-PISCES strategy :

- new set-up based on orca1 NEMO-PISCES configuration developed at IPSL (OR1L3PIS-V1) :
  - latest NEMO 3.6, LIM3 for ice
  - 75 vertical levels, vvl option (water column volume variable)
- initial state from OR1L3PIS-V1 (100 yr climatological spin-up)
- start year 1870, corresponding atmospheric CO2
- 1870-1900: climatological ERA-20C atmospheric forcing + increasing atmospheric CO_2
- external input fluxes: river nutrient input, sediment Fe supply + Fe from sea ice, atmospheric Fe, Si, N and P deposition
- forced by ERA-20C 1900-2000

=> on-going simulation

The “offline” NEMO-PISCES strategy : after 100 yrs with constant atm CO2

Surface chlorophyll
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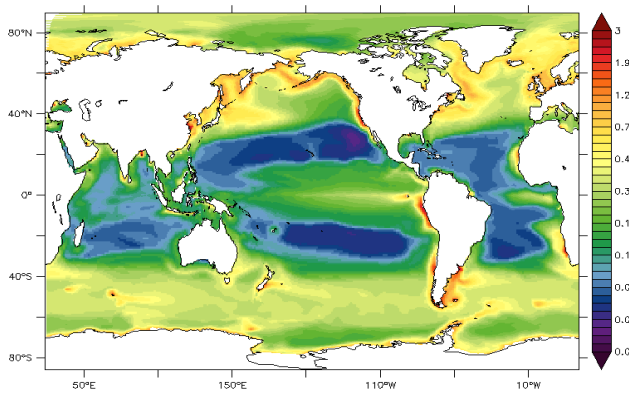
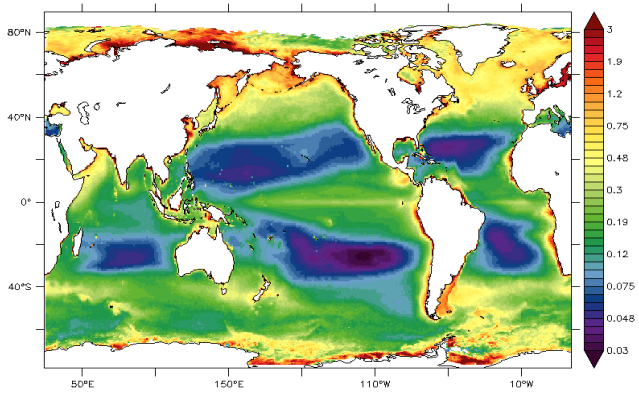
(log scale)



OR1L3PIS-V1 0100



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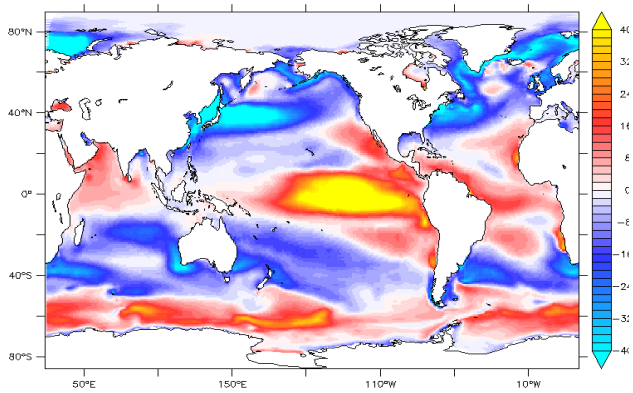

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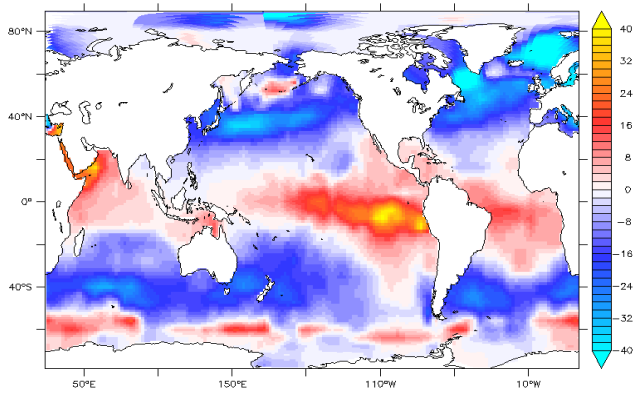

data : takahashi (1995)

pre-industrial atmospheric pCO_2

Conclusions :

By February 2016 (end of 18 month contract of Aurélie Albert), 2 biogeochemical ocean simulations covering the 20th century will be available :

- ECMWF setting (NEMO 3.4, 42 levels, start 1890)
- IPSL setting (NEMO 3.6, 75 levels, start 1870)

Need of observations for the beginning of 20th century to assess simulations

Outlook:

UVSQ/LSCE will run centennial simulation forced with CERA-20C aymospheric reanalysis