WP1 : Global 20th century analysis

Development of the ocean carbon component

[MERCO] *Aurélie Albert*, Coralie Perruche
[UVSQ] Marion Gehlen

ERA-CLIM2 General Assembly Meeting 19-21 november 2014, ECMWF

Objectives :

- set up of the coupling of Ocean Biogeochemistry with CERA-20C
- run 10 20th century reanalysis of ocean biogeochemistry

3 strategies for the coupling :

- offline coupling, CERA-20C ocean & atmospheric outputs as forcings
- offline NEMO-PISCES, CERA-20C atmospheric outputs as forcings w/o selective damping to CERA-20C oceanic component
- online coupling, we provide code, namelists & biogeochemical inputs and ECMWF integrates PISCES in CERA-20C

Set up :

- choose strategy

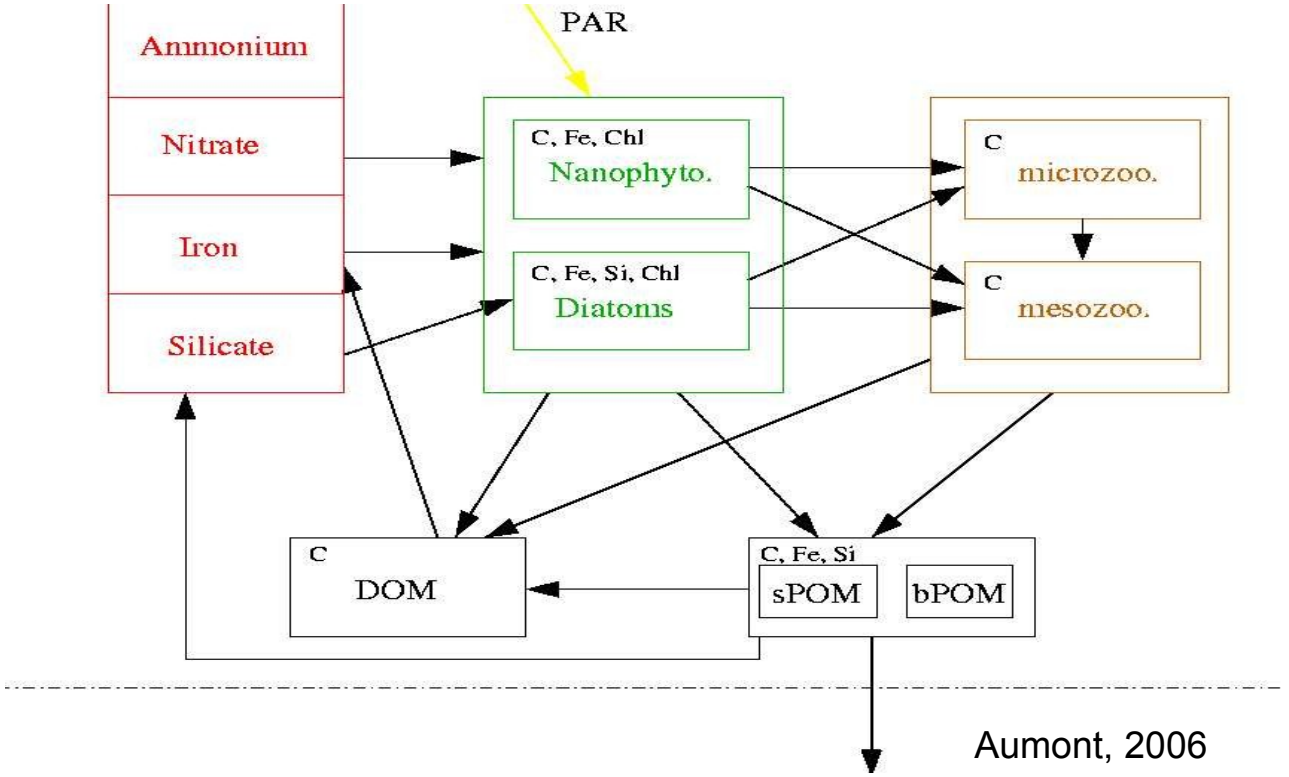
then given the strategy

- tuning of biogeochemical parameters
- choose biological & coupling parameterization
- choose initialization strategy

Tool : PISCES biogeochemical model :

ecosystem, carbon and oxygen cycles, 2 phytos, 2 zoos, detritus, nutrient limitations (including silicate & iron)

24 prognostic variables + online diagnostics (carbon fluxes, primary production, export ...)



Aumont, 2006

The offline strategy : coupling with CERA-20C ocean component

The PISCES model needs a set of daily mean forcing fields:

Description	Variable name	Grid	Remark
Ocean temperature	votemper	3D field, T grid	
Ocean salinity	vosaline	3D field, T grid	
Net upward water flux	sowaflup	2D field, T grid	This is the net fresh water budget into ocean (i.e. evaporation minus precipitation)
Sea-ice fraction	soicecov	2D field, T grid	This variable is named ileadfra at MERCATOR
Net downward shortwave flux	soshfldo	2D field, T grid	This variable is named soceshwf at MERCATOR
Mixed layer depth	somixhgt	2D field, T grid	This variable is named somxlavt at MERCATOR
Wind speed at 10m	sowindsp	2D field, T grid	This variable is named sowinmod at MERCATOR
Zonal velocity	vozocrtx	3D field, U grid	
Meridional velocity	vozocrty	3D field, V grid	
Vertical velocity	vozocrtz	3D field, W grid	
Vertical diffusion coefficient	votkeavt	3D field, W grid	Two fields are archived: avt_k (initial vertical diffusion coefficient) and avt (avt_k with enhanced convection and tide effects).

The PISCES model needs a set of daily mean forcing fields:

Description	Filename	Grid	Remark
River runoff climatology	runoff_1m_nomask.nc	2D field, T grid	Contain 12 monthly means. Retrieve from ec:/ocx/NEMO/SETUP/V34/ORCA1_Z42_v3/PARAMETERS/runoff_1m_nomask.nc
Mesh and mask data	mesh_mask.nc	/	Retrieve from /perm/rd/ocx/data/nemo/V34/ORCA1_Z42_v3/mesh_mask.nc (HPC directory)
Bathymetry	bathy_meter.nc	2D field, T grid	Retrieve from ec:/ocx/NEMO/SETUP/V34/ORCA1_Z42_v3/PARAMETERS/bathy_meter.nc

The offline strategy : coupling with CERA-20C ocean component

The PISCES model needs a set of daily mean forcing fields:

Description	Variable name	Grid	Remark
Ocean temperature	votemper	3D field, T grid	
Ocean salinity	vosaline	3D field, T grid	
Net upward water flux	sowaflup	2D field, T grid	
Sea-ice fraction	soicecov	2D field, T grid	This variable is named ileadfra at MERCATOR
Net downward shortwave flux	soshfldo	2D field, T grid	This variable is named soceshwf at MERCATOR
Mixed layer depth	somixhgt	2D field, T grid	This variable is named somxlavt at MERCATOR
Wind speed at 10m	sowindsp	2D field, T grid	This variable is named sowinmod at MERCATOR
Zonal velocity	vozocrtx	3D field, U grid	
Meridional velocity	vozocrty	3D field, V grid	
Vertical velocity	vozocrtz	3D field, W grid	
Vertical diffusion coefficient	votkeavt	3D field, W grid	Two fields are archived: avt_k (initial vertical diffusion coefficient) and avt (avt_k with enhanced convection and tide effects).

different convention, in PISCES we need water flux into the ocean
=> we multiply by -1

first sensitivity test

The PISCES model needs a set of daily mean forcing fields:

Description	Filename	Grid	Remark
River runoff climatology	runoff_1m_nomask.nc	2D field, T grid	Contain 12 monthly means. Retrieve from ec:/ocx/NEMO/SETUP/V34/ORCA1_Z42_v3/PARAMETERS/runoff_1m_nomask.nc
Mesh and mask data	mesh_mask.nc	/	Retrieve from /perm/rd/ocx/data/nemo/V34/ORCA1_Z42_v3/mesh_mask.nc (HPC directory)
Bathymetry	bathy_meter.nc	2D field, T grid	Retrieve from ec:/ocx/NEMO/SETUP/V34/ORCA1_Z42_v3/PARAMETERS/bathy_meter.nc

+ initial conditions & external biogeochemical forcings (dust, rivers, sediments)

Workplan with 2009-2010 CERA-20C :

Loop on forcings to get 10 years (⇨ drift, stabilisation ?)

Sensitivity tests planned in offline mode :

- filtered Kz or not
- advection & diffusion scheme
- biogeochemical parameterization (ln_newprod,...)
- initial conditions

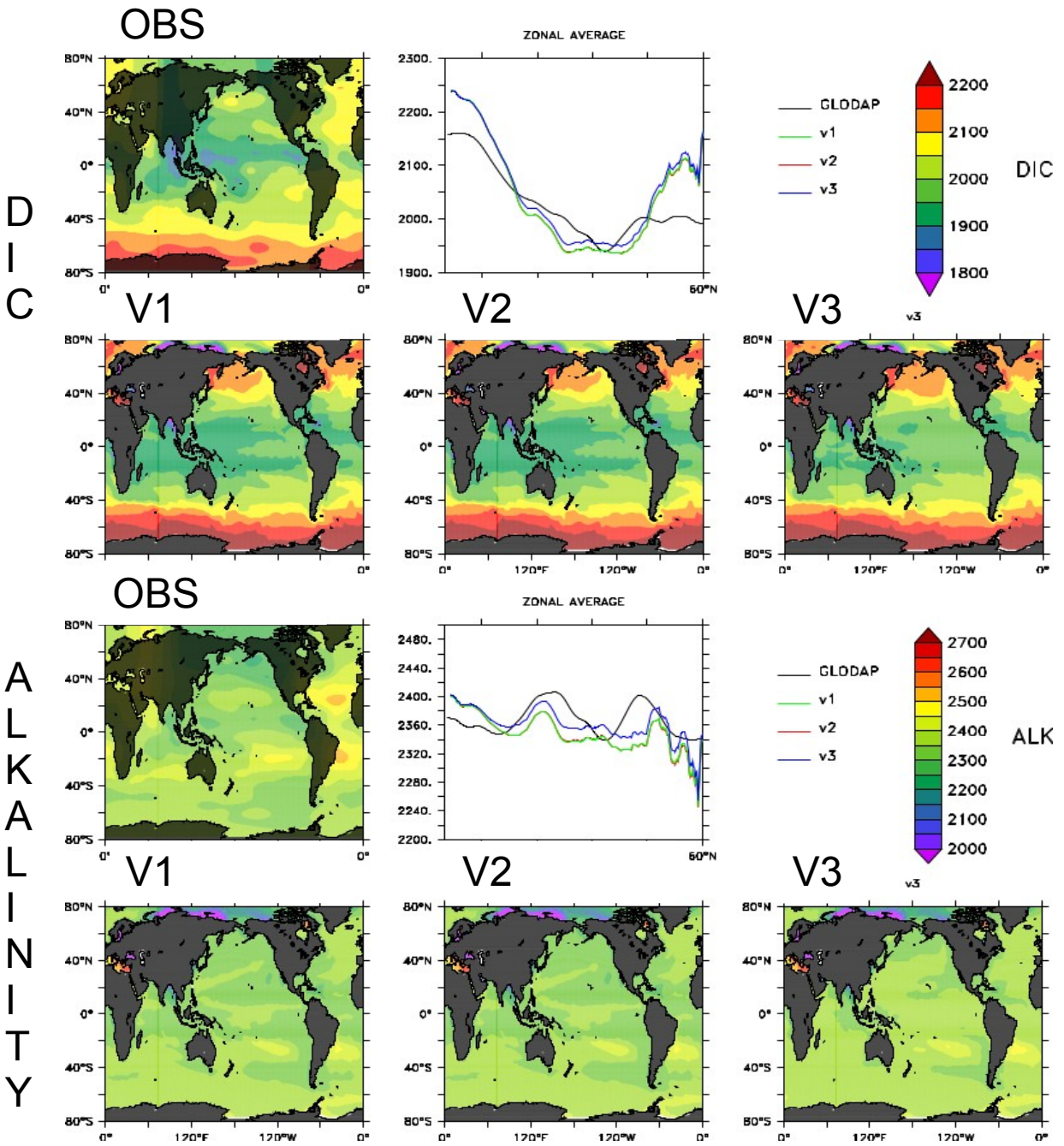
Initialization strategy :

CNRM R. Seferian 3 initial states output of +3000 years simulation

- OBS : GLODAP
- V1 : CORE forcing + default PISCES
- V2 : DFS forcing + PISCES1
- V3 : DFS forcing + PISCES2
- also plan for ERA-interim + PISCES without newprod…

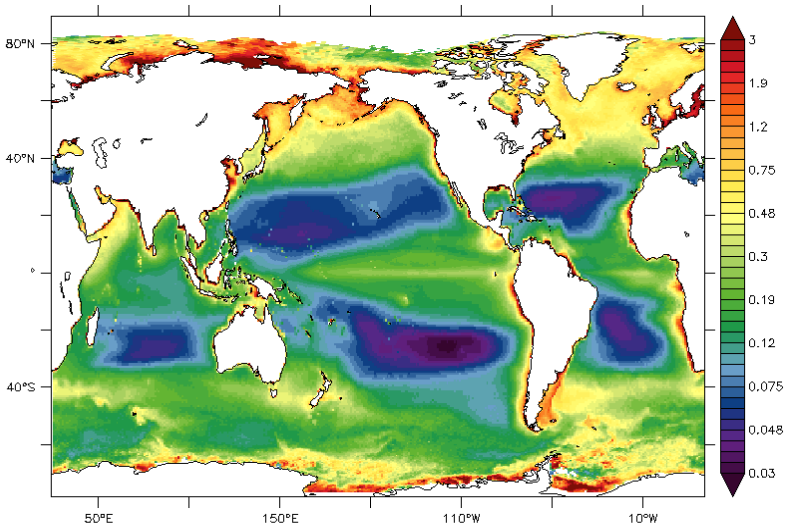
preindustrial atmospheric carbon

What strategy for the 20th century ? Spin-up ? How long ?



Preliminary results for first runs : influence of vertical mixing coefficient

OBS



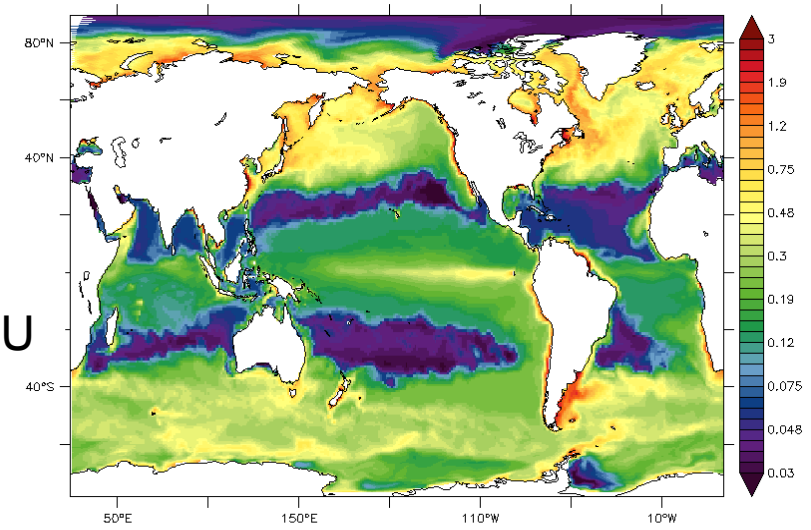
Surf Chl Globcolor 1998–2011

Annual mean of surface **chlorophyll** (mg CHL/m^3)
- Observation (Globcolour)
- Simulation with filtered Kz
- Diff (total – filtered) Kz

Simulation vs Obs :
- good patterns and magnitude
- poor subtropical gyres with width too thin
- equatorial bias

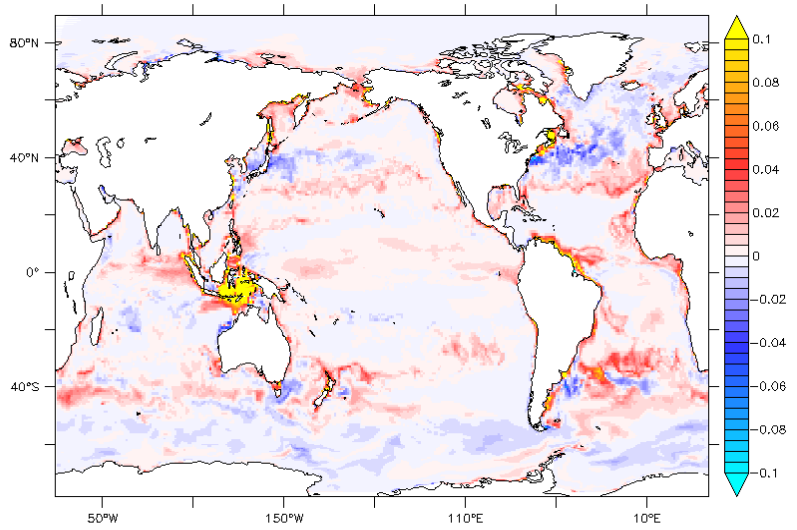
Total Kz vs Filtered :
- more production except in strong currents
- stronger differences in Indonesian region, upwelling better represented

Filt SIMU



Surf Chl T08 2018

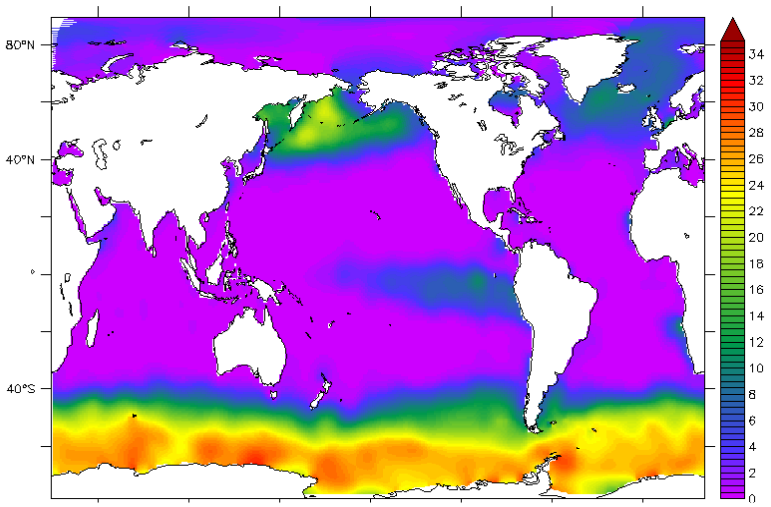
Diff Total-Filt



Surf Chl T09–T08 2018

Preliminary results for first runs : influence of vertical mixing coefficient

OBS



Annual mean of surface **nitrates** (mmol N /m^3)

- Observation (WOA05)
- Simulation with filtered Kz
- Diff (total – filtered) Kz

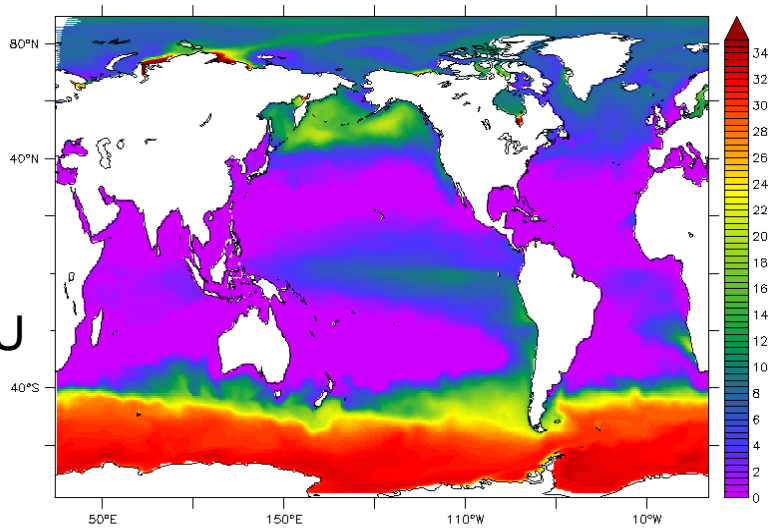
Simulation vs Obs :

- good patterns and magnitude
- equatorial bias

Total Kz vs Filtered :

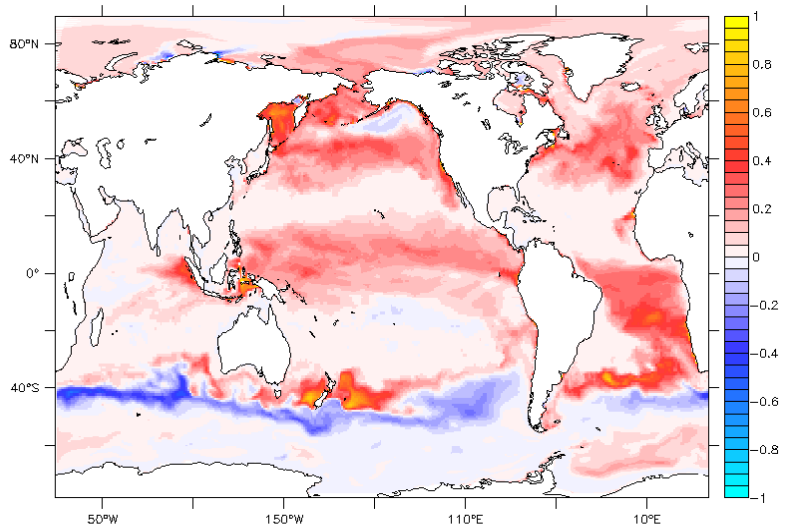
- more nutrient except in circumpolar current
- weak differences (less than 1 mmol N /m$^{3)}$

Filt SIMU



Surf NO3 T08 2018

Diff Total-Filt



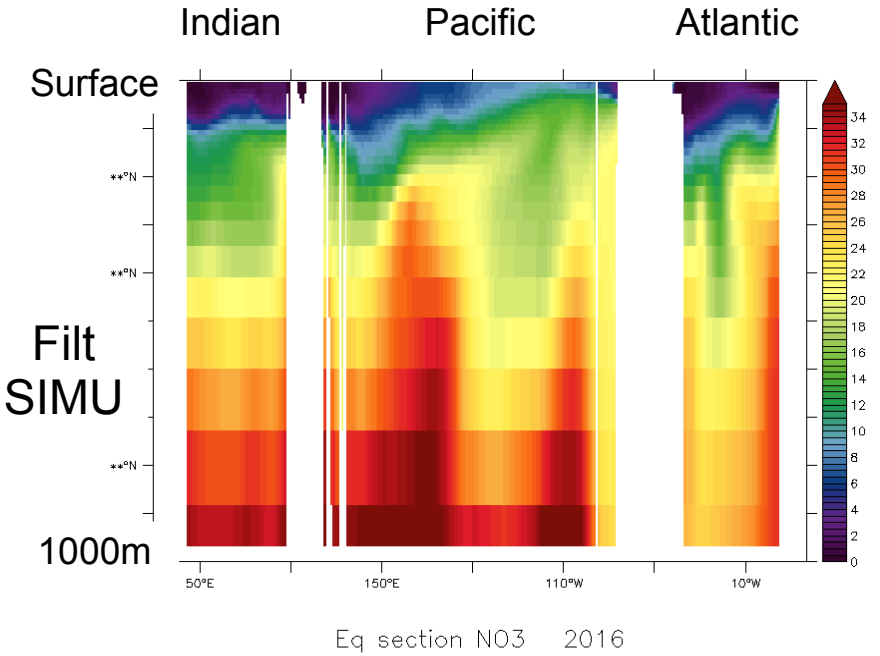
Surf NO3 T09−T08 2018

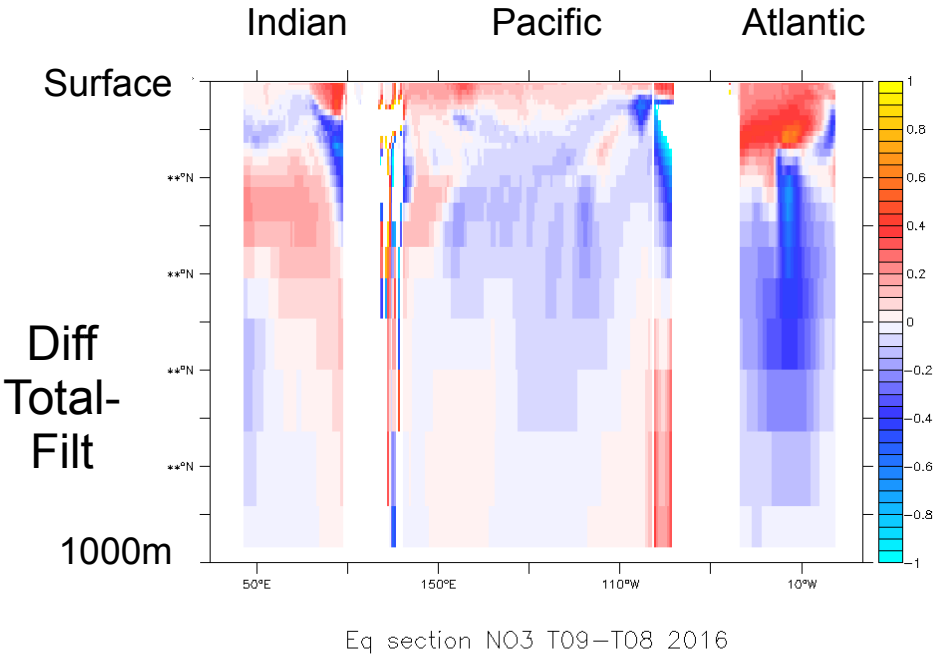
Preliminary results for first runs : influence of vertical mixing coefficient

Annual mean of equatorial **nitrates** (mmol N /m^3) from surface to 1000m :
- Simulation with filtered Kz
- Diff (total – filtered) Kz

Simulation :
- strong values at depth
- eastern boundary upwelling

Total vs Kz :
- dipole of positive/negative differences surface/subsurface due to enhanced vertical mixing





Preliminary results for first runs : influence of vertical mixing coefficient

Annual mean of **carbon flux** (gC/m^2/yr) from ocean to atmosphere :

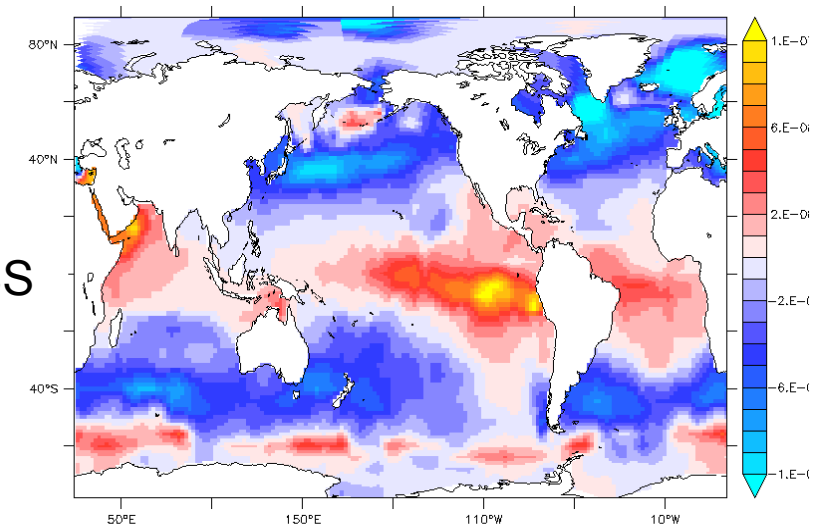
- Observation (Takahashi)
- Simulation with filtered Kz

Simu vs Obs :

- general good direction of the flux
- carbon sources to atmosphere too big
- very small carbon sink in North Atlantic & Austral Ocean

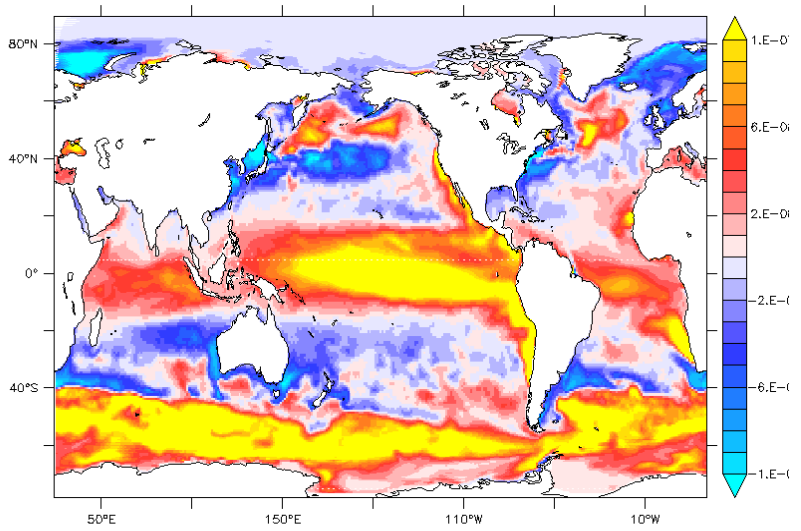
⇨ A lot of work to do !

OBS



C flux Takahashi 2007

Filt SIMU



C flux T08 2018

Technical aspects :

- wall-time of one 10 years run : ~43h ⇨ 100 years : ~18 days
- reconstruction of outputs takes 4 times more time than running (in parallel)

⇨ need for optimization (use of land processors in the multi-processors cut-out to debug)

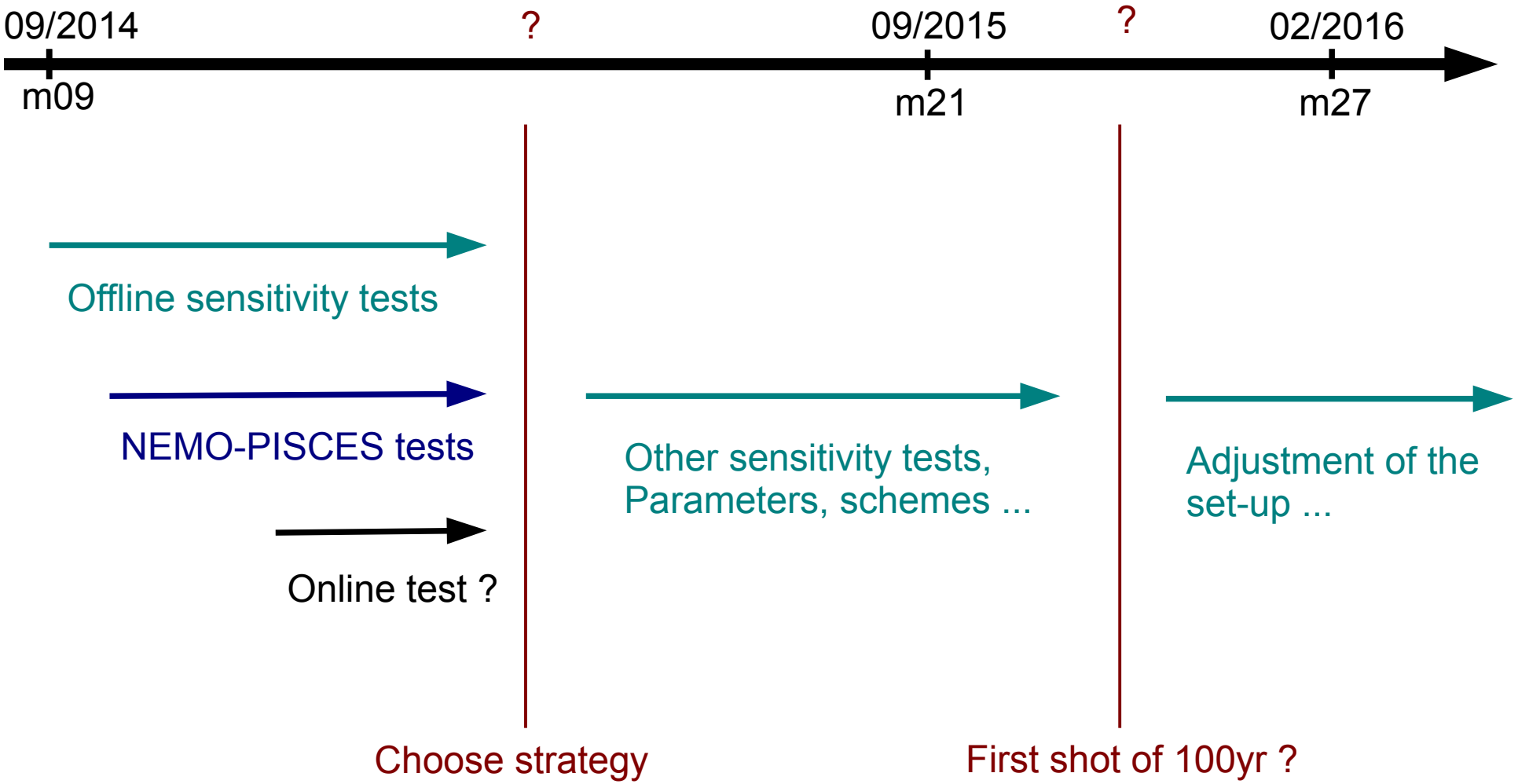
- storage for one 10 years run : 1.25T ⇨ 100 years : 12.5T (outputs only)
- storage for one 10 years run : 1.55T ⇨ 100 years : 15.5T (with annual mean)

⇨ distribution of the outputs : which variable to keep ?

- CMIP norms for name, units and aspect of the outputs ?

- management of the daily forcings : copy + unzip 100 years in a row not possible

Calendar :


09/2014
?
09/2015
?
02/2016
m09
m21
m27
Offline sensitivity tests
NEMO-PISCES tests
Online test ?
Other sensitivity tests,
Parameters, schemes ...
Adjustment of the
set-up ...
Choose strategy
First shot of 100yr ?