Ocean biogeochemical response to Climate Change: a multi-stressor approach in CMIP5

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Novembre 2012 - MISSTERRE

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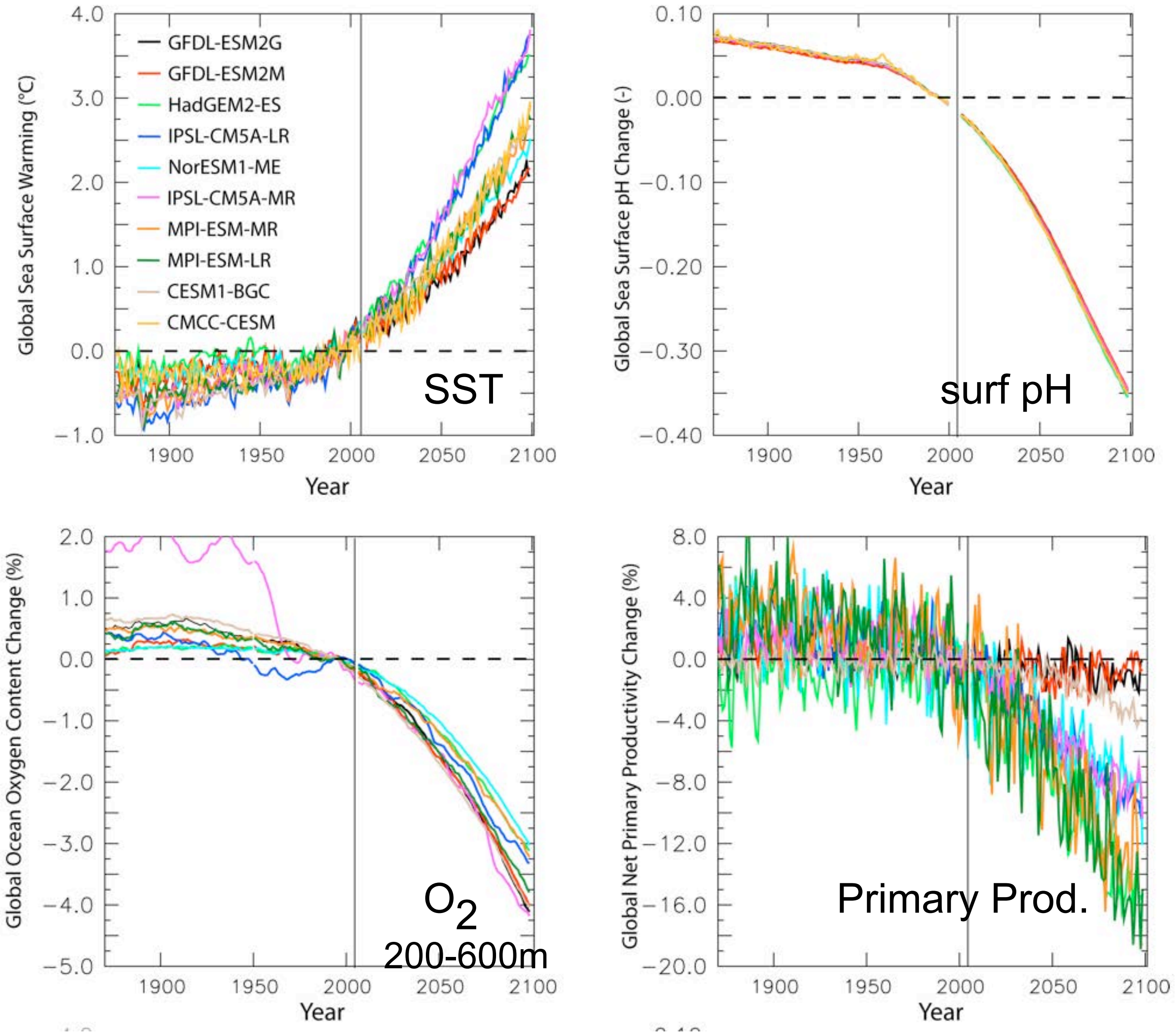
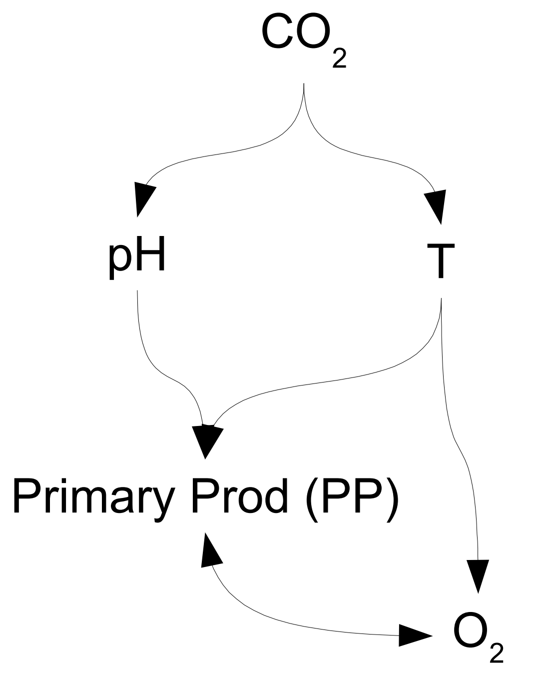
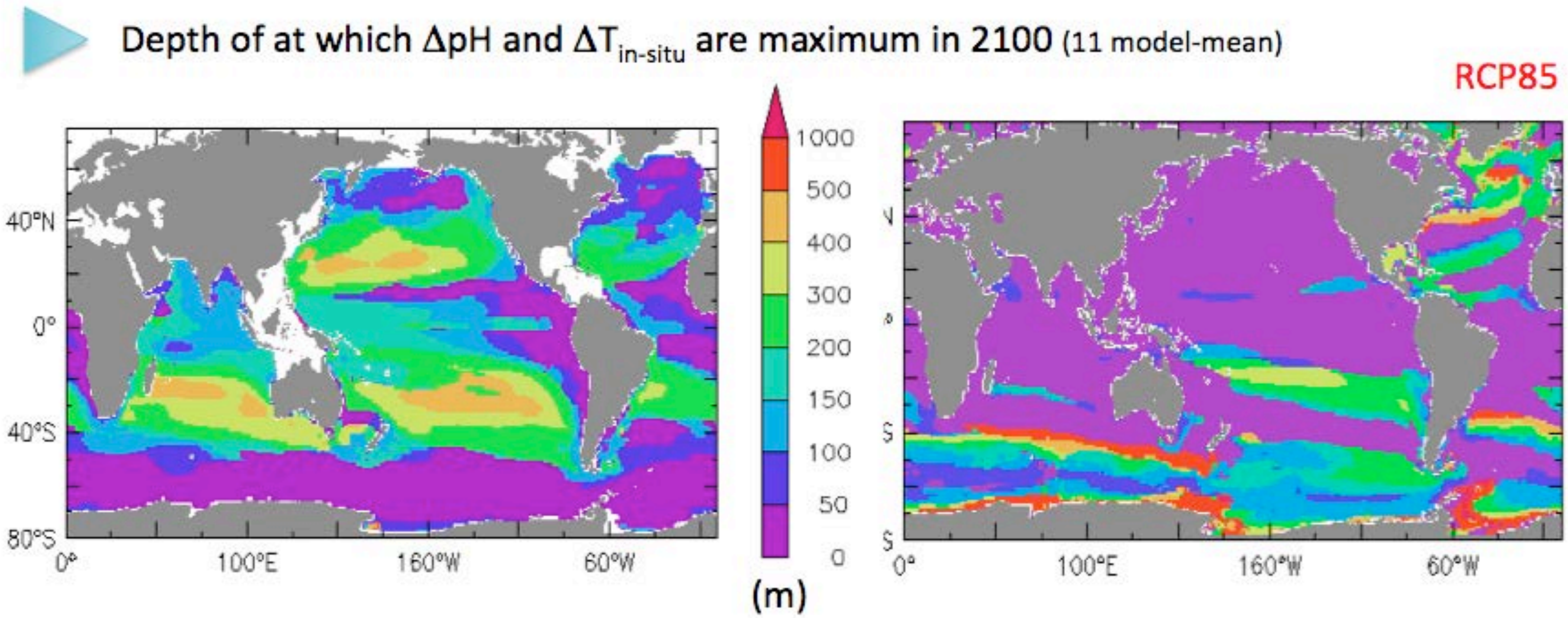
Oceanic biogeochemical response:

common drivers & interactions with Climate Change





Response reflects physical circulation and water masses



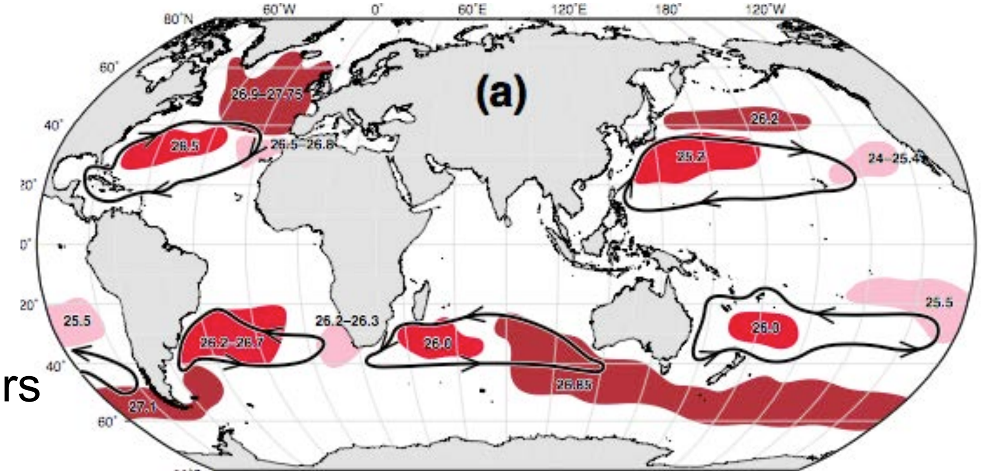
ΔT max at surface apart from high-lat/deep MLD

ΔpH max at sub-surface i.e. mode and intermediate waters
(observed at BATS station, Bates 2012)

Physical context to study the changes in ocean interior: water masses

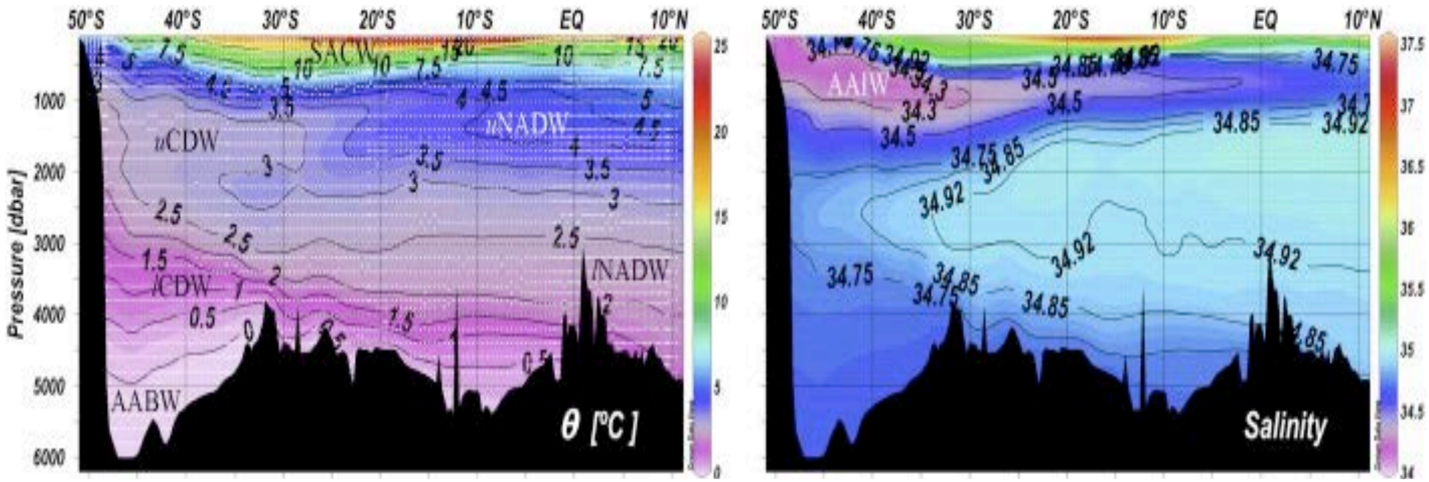
Water-mass framework

- global ocean
- multi-model approach
    different physics
- multi-tracers (or stressor) approach



Mode waters

Atlantic section WOCE



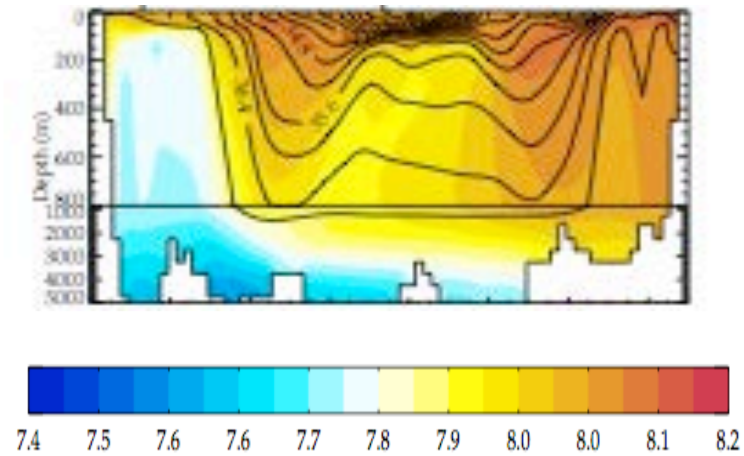
Sigma-2 criteria defined for each basin and merged into global framework:

- **Tropical Waters (TW)**: stratification
- **Mode waters & Intermediate (MW and IW)**: salinity minimum (North Atlantic: + meridional velocity)
- **Deep waters (DW) and Bottom waters (BW)**: meridional velocity

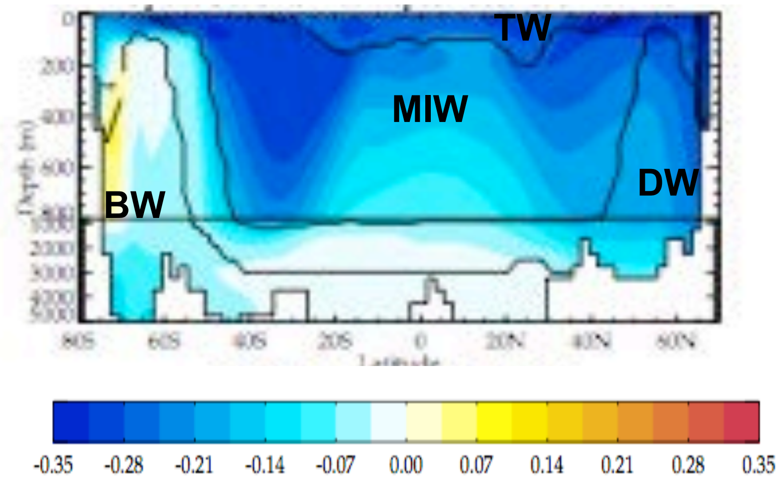
Water-mass framework

IPSL-CM5A-LR
Atlantic Section

pH
2006



ΔpH
2100-2006



TW: Thermocline waters
MIW :Modal / intermediate
DW :Deep waters
BW : Bottom waters

CMIP5 Models with oxygen

GFDL-ESM2G
GFDL-ESM2M
HadGEM2-ES
IPSL-CM5A-LR
IPSL-CM5A-MR
IPSL-CM5B-LR
MPI-ESM-LR
MPI-ESM-MR
NorESM1
CESM1-BGC
(BNU-ESM)
(CMCC-CESM)

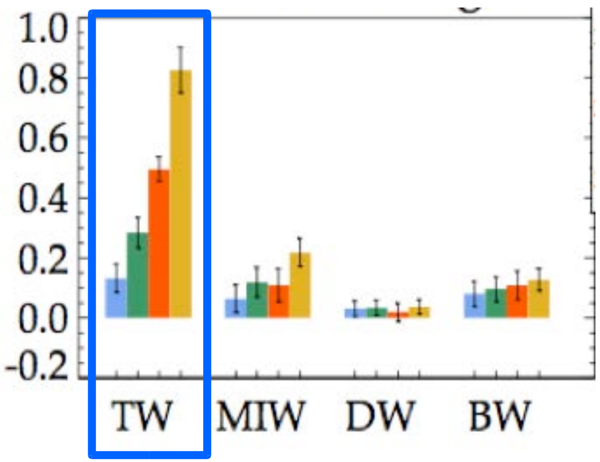
Rcps, esmFixClim2, esmFdbk2, historical

First results: distinct processes in water masses

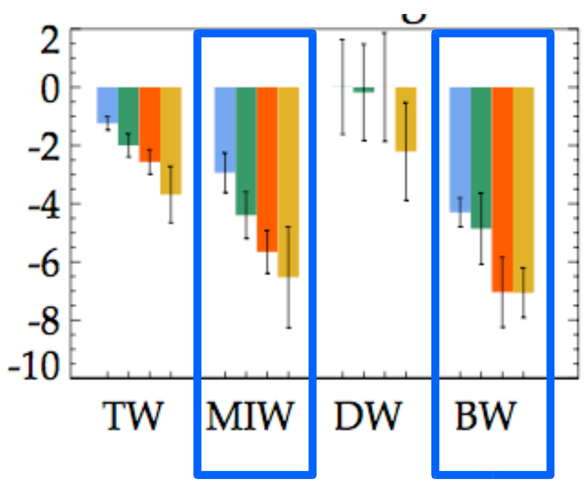
Change 2100-2006

10 models mean +/- std

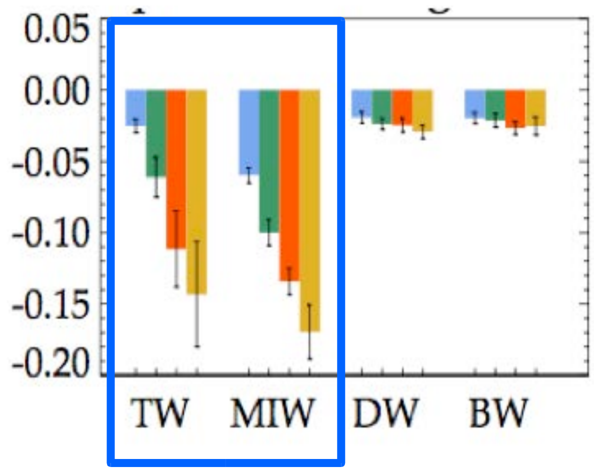
ΔT



ΔO_2



ΔpH



TW: Thermocline waters
MIW :Modal / intermediate
DW :Deep waters
BW : Bottom waters

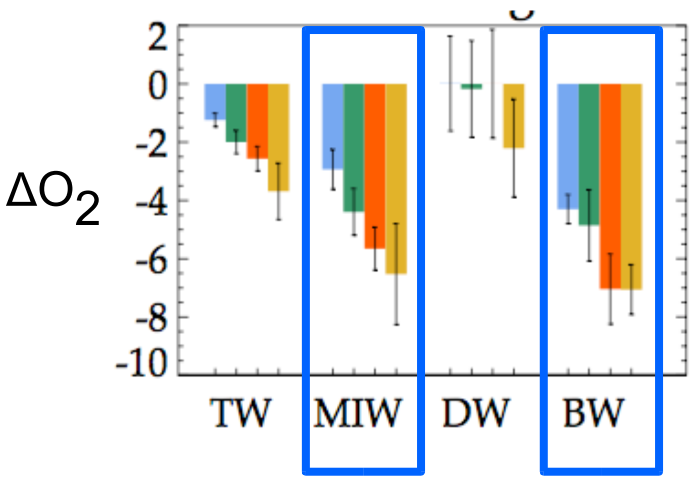
rcp26
rcp45
rcp60
rcp85

Ventilation

- decreased solubility
- increased stratification
- decreased outcrop surface

=> decreased ventilation of Mode-Intermediate and Bottom waters

Change 2100-2006



rcp26
rcp45
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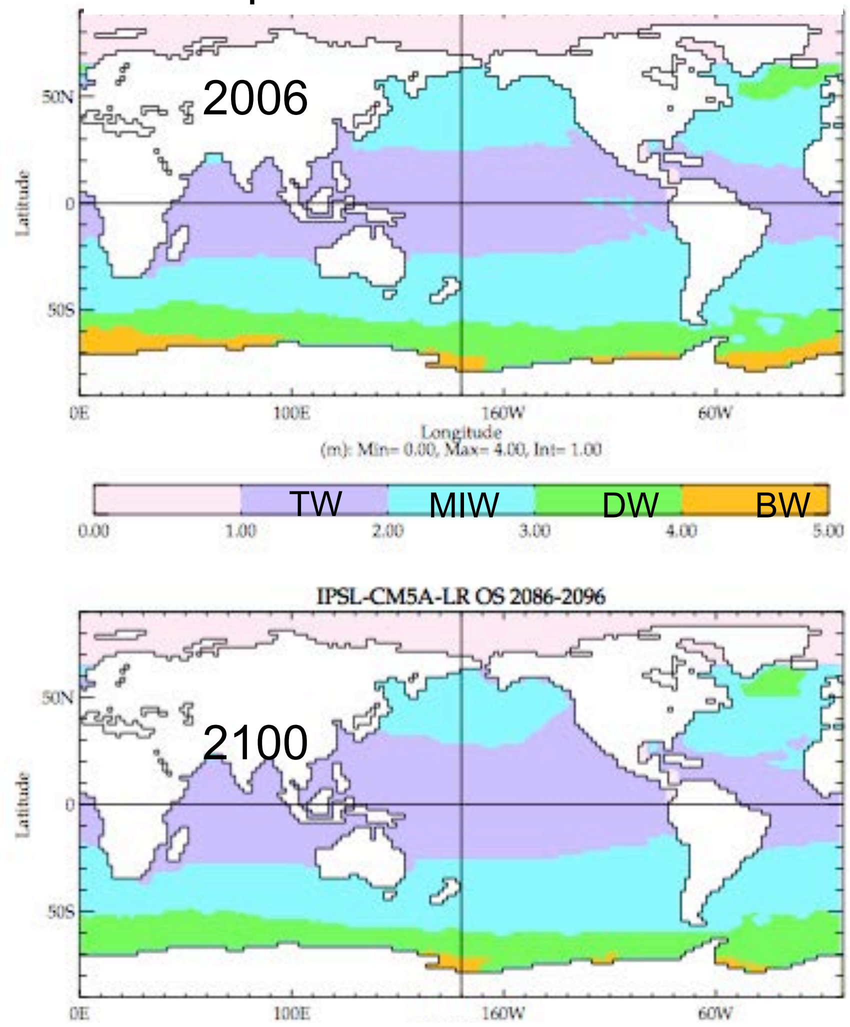
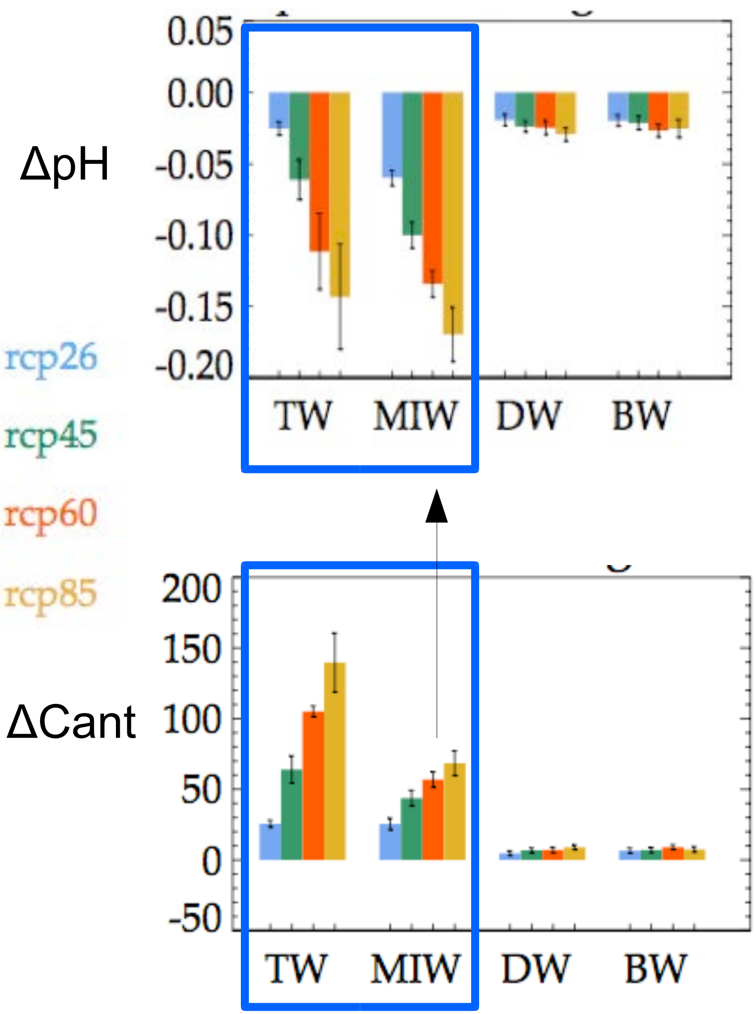
Outcrop Surface of Water masses



Ocean acidification: major role of mode and intermediate waters

Lower ΔCant but large ΔpH
... difference in carbonate chemistry



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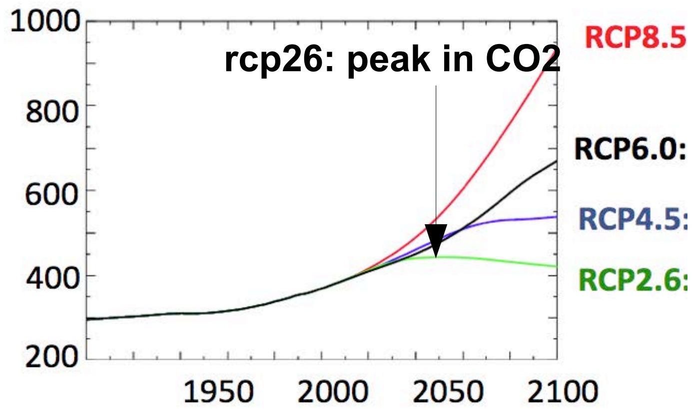
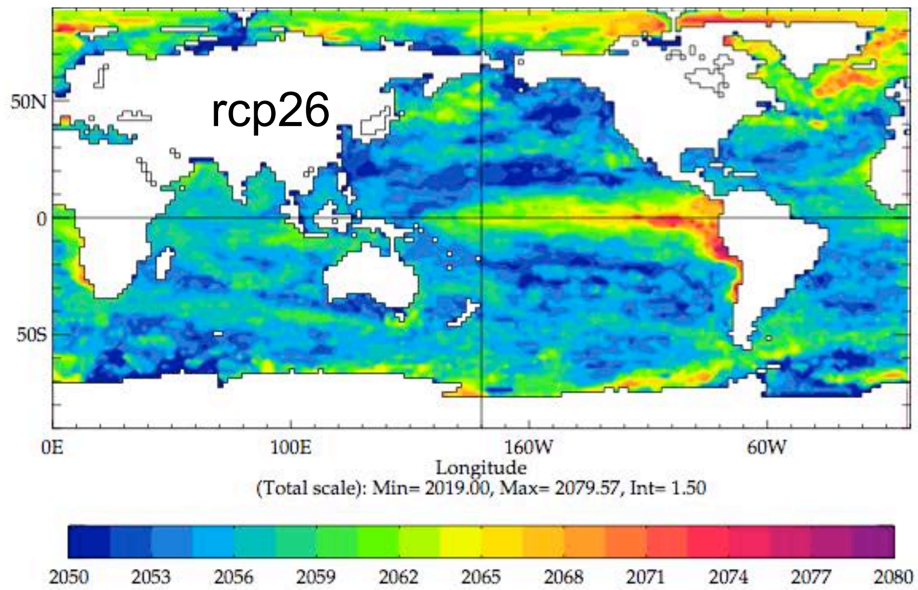
Main pathway for acidification
into ocean interior



Year of minimum pH at surface (models mean)



Conclusions and perspectives

- Global water mass framework
- Early results show contrasted changes in pH/T/O2/PP
- Different dynamical and biogeochemical processes
  (equilibration time, mixing, buffer factor...)
- Scenarios offer the opportunity to identify dynamical/biogeochemical processes
  (rcp26, esmFixClim2, esmFdbk2)