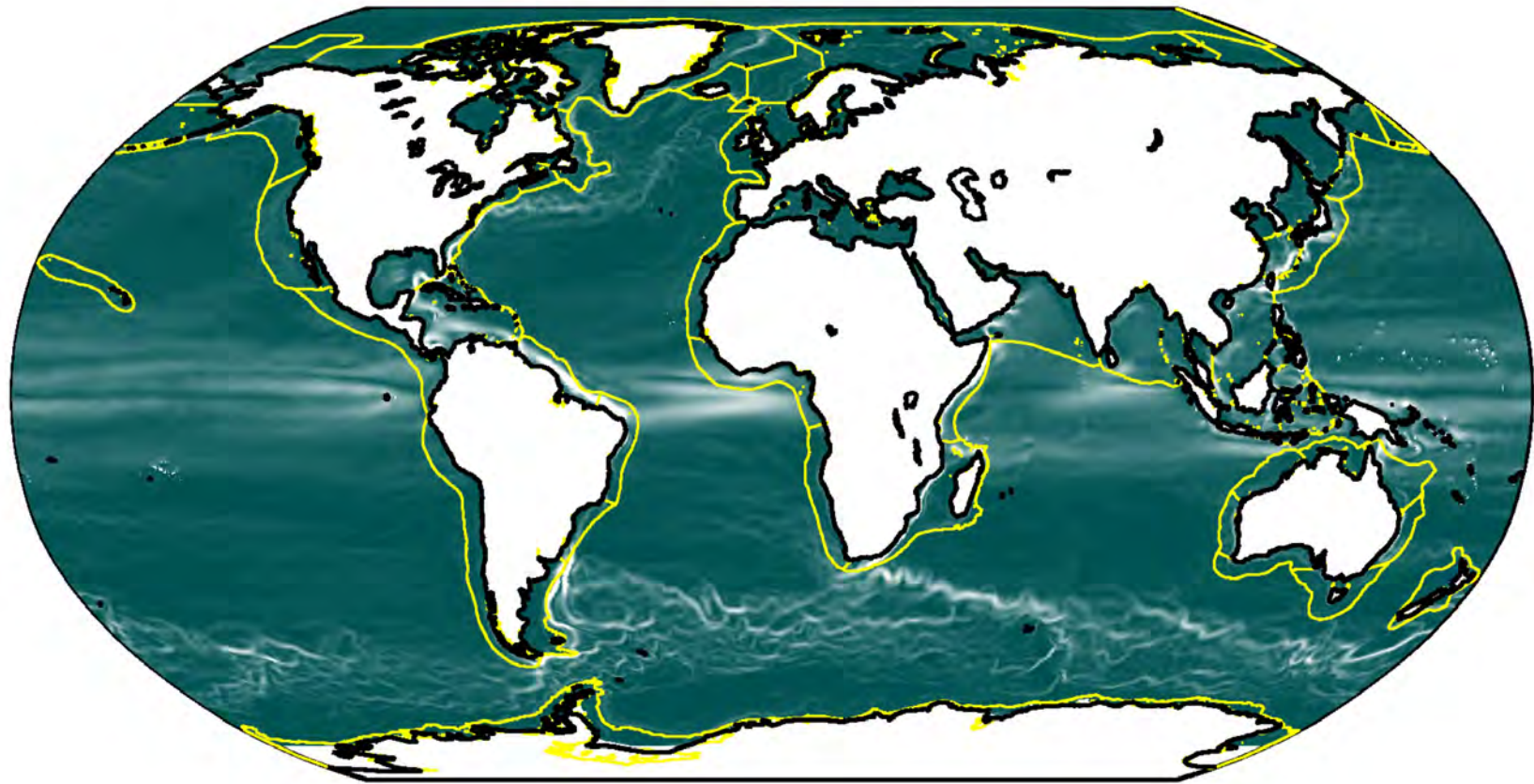




*Large Marine Environment
Biogeochemical evolution within the next century*

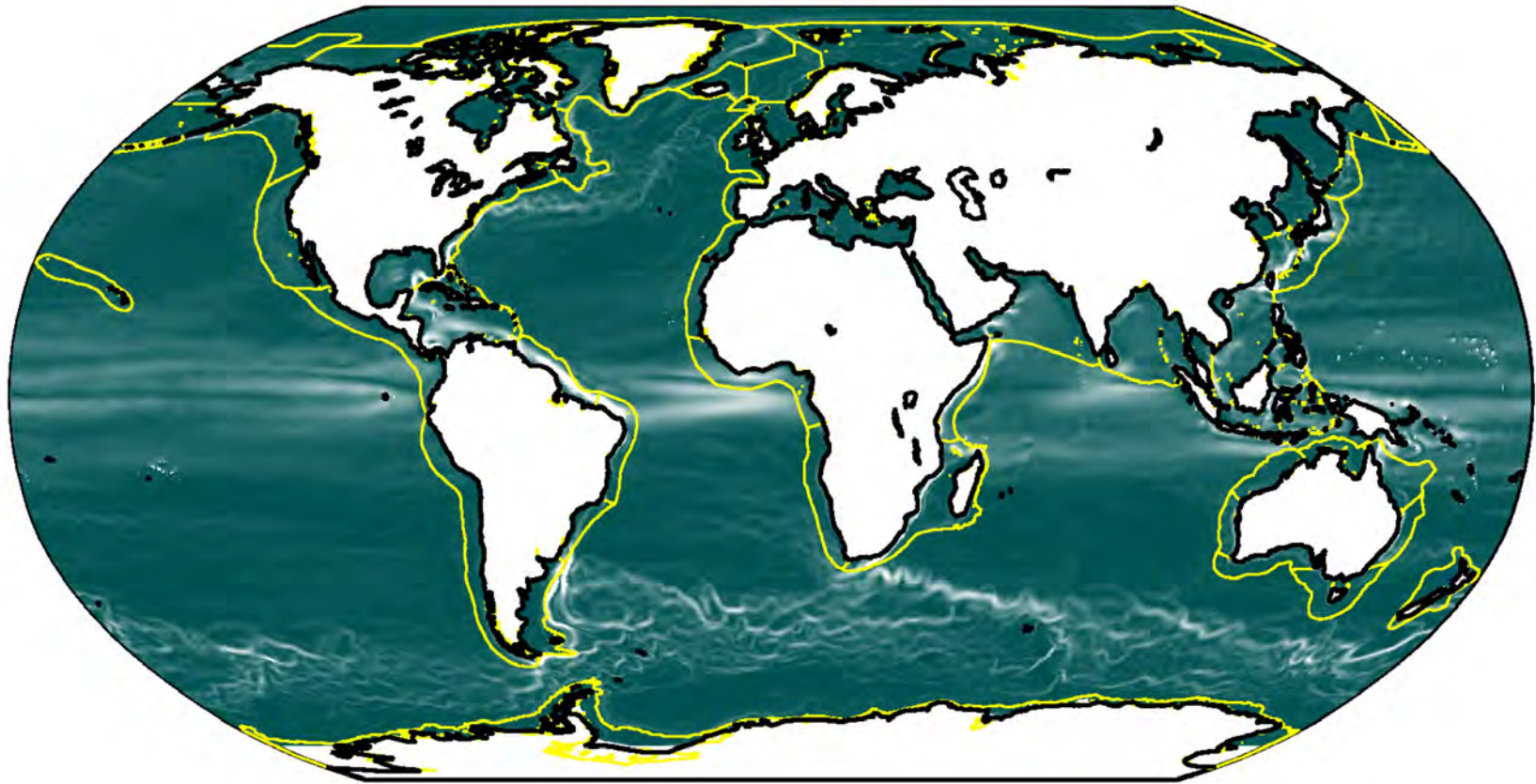
Julien Palmiéri; Andrew Yool, Katya Popova

Large Marine Ecosystems (LME) – Presentation



- 65 large regions.
- ~200,000 km² - from coastal to outer boundary margin.
- Characterized by 1 – bathymetry, 2 – hydrography, 3 – productivity ,
4 – trophically dependant population

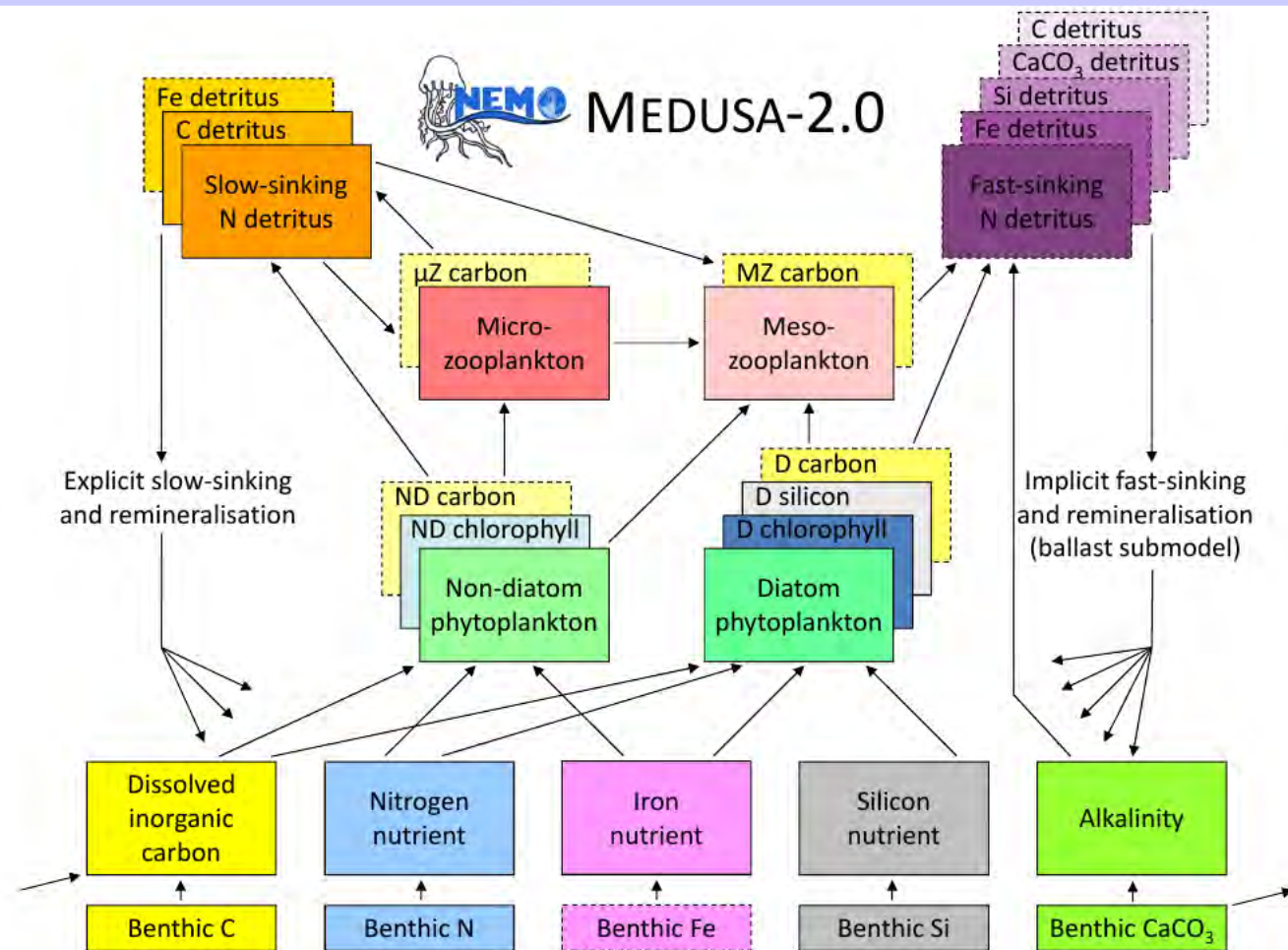
Large Marine Ecosystems (LME) – Presentation



- Developed by NOAA for conservative purpose
- 95% of fisheries ;
- Objective : enabling Ecosystem-based Management

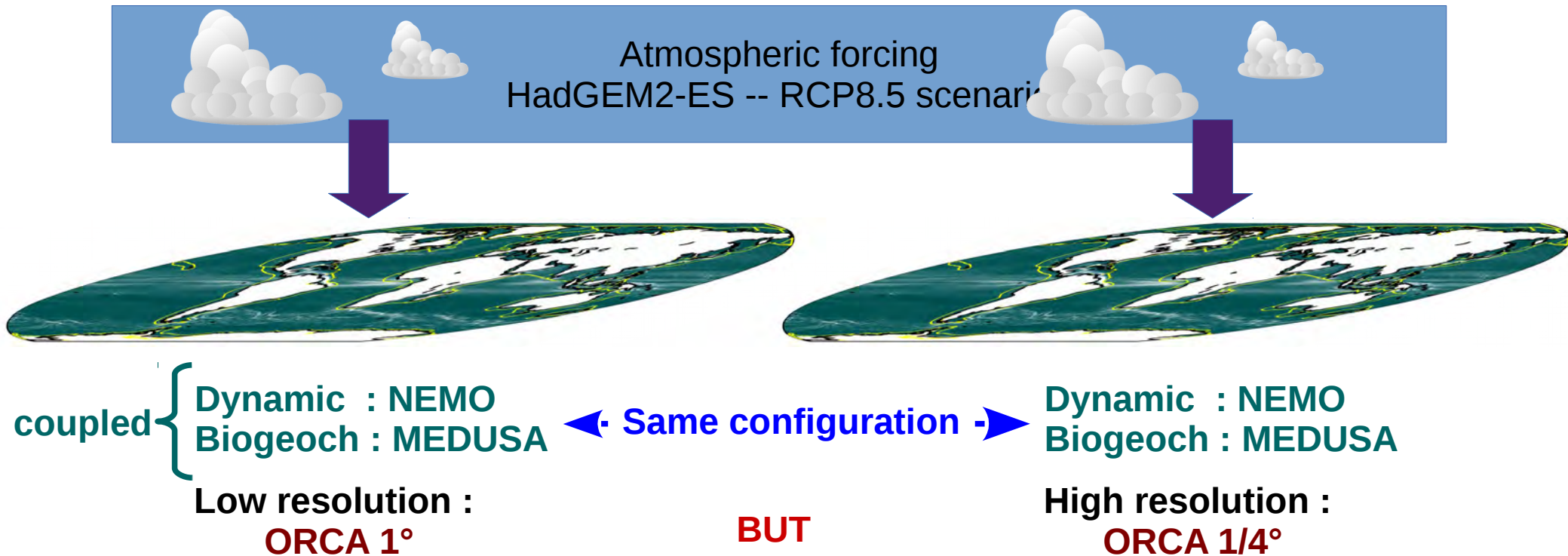
Modelling approach : NEMO-MEDUSA

- 2 Phytoplanktons
- 2 Zooplanktons
- Total : 15 tracers



- “Intermediate complexity” plankton ecosystem model.
- Variable C : N in exported organic matter.

Two simulations available – 2 Ocean grid resolutions.

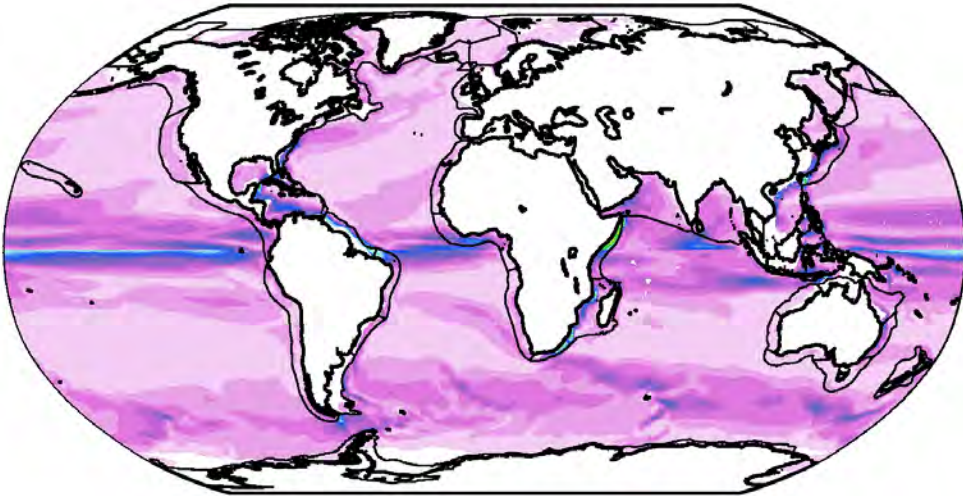


→ Does the higher resolution improves the LMEs biogeochemistry ??

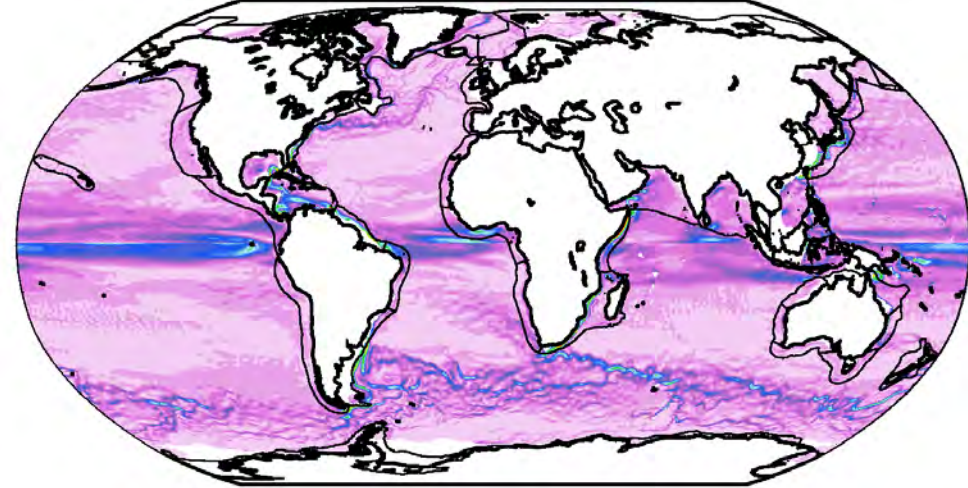
→ LME Ecological evolution with Climate change ??

Finer grid resolution improve the dynamic...

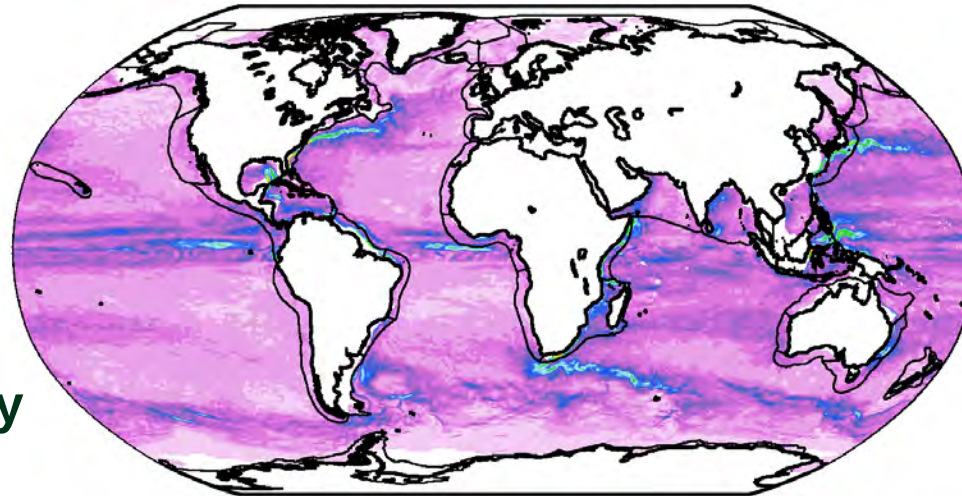
Current – NEMO-ORCA1



Current – NEMO-ORCA025



Current – Obs – AVISO

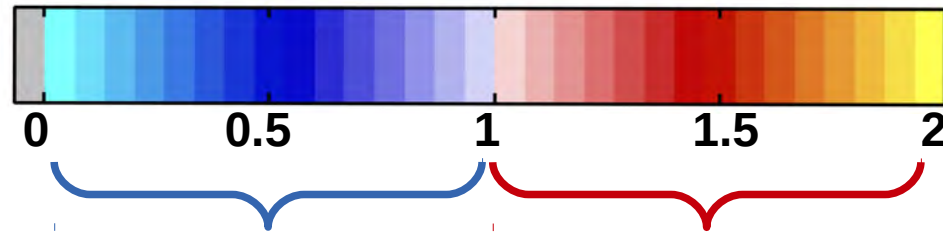


... But,
is the biogeochemistry
also improved
with the grid resolution
in the LME ??

Definition of an Improvement Index (ID)

Are ORCA025 results more realistic than ORCA1's ??

$$\text{Improvement Index (ID)} = \frac{\|ORCA025 - Obs\|}{\|ORCA1 - Obs\|}$$



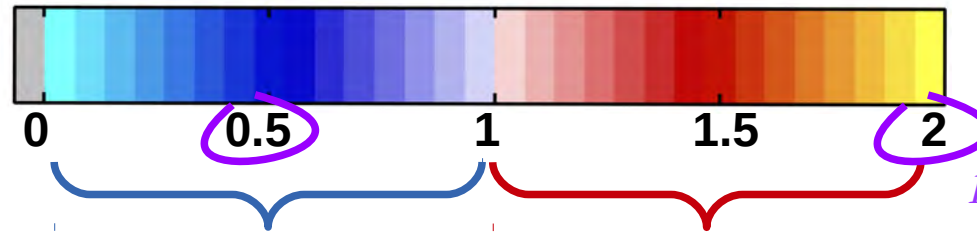
ORCA025 closest
to observation

ORCA025 further
to observation

Definition of an Improvement Index (ID)

Are ORCA025 results more realistic than ORCA1's ??

$$\text{Improvement Index (ID)} = \frac{\|ORCA025 - Obs\|}{\|ORCA1 - Obs\|}$$



**ORCA025 closest
to observation**

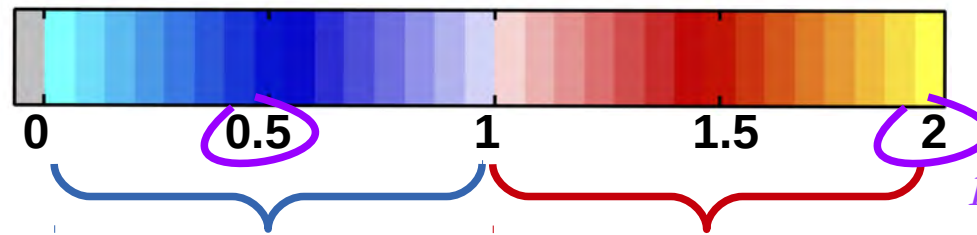
**ORCA025 further
to observation**

*Adapt ID
Improvement/degradation
At the same scale*

Definition of an Improvement Index (ID)

Are ORCA025 results more realistic than ORCA1's ??

$$\text{Improvement Index (ID)} = \frac{\|ORCA025 - Obs\|}{\|ORCA1 - Obs\|}$$



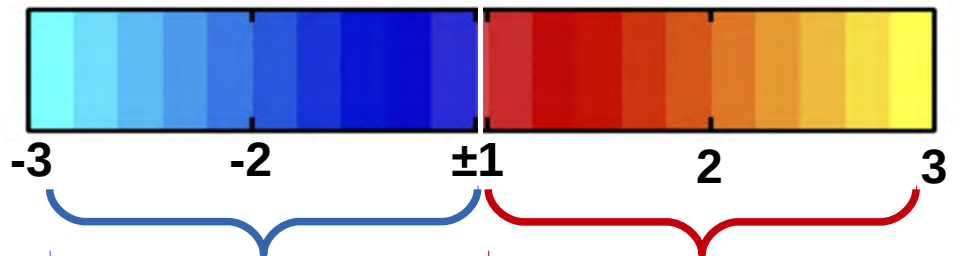
ORCA025 closest to observation

ORCA025 further to observation

*Adapt ID
Improvement/degradation
At the same scale*

$$ID < 1 \rightarrow ID = \frac{-1}{ID}$$

$ID \geq 1 \rightarrow$ No Changes

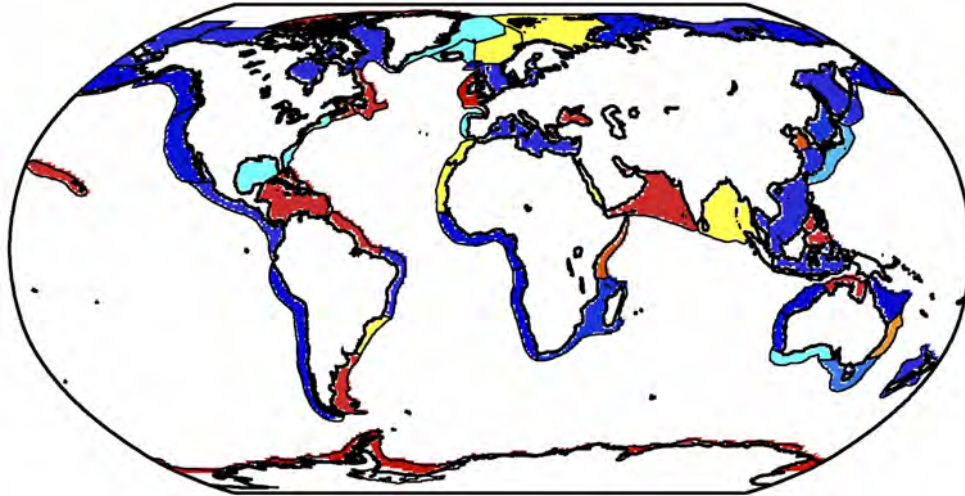


ORCA025 closest to observation

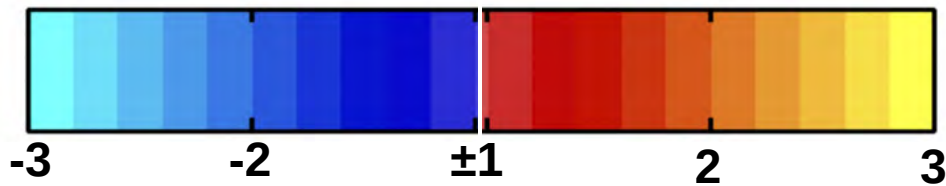
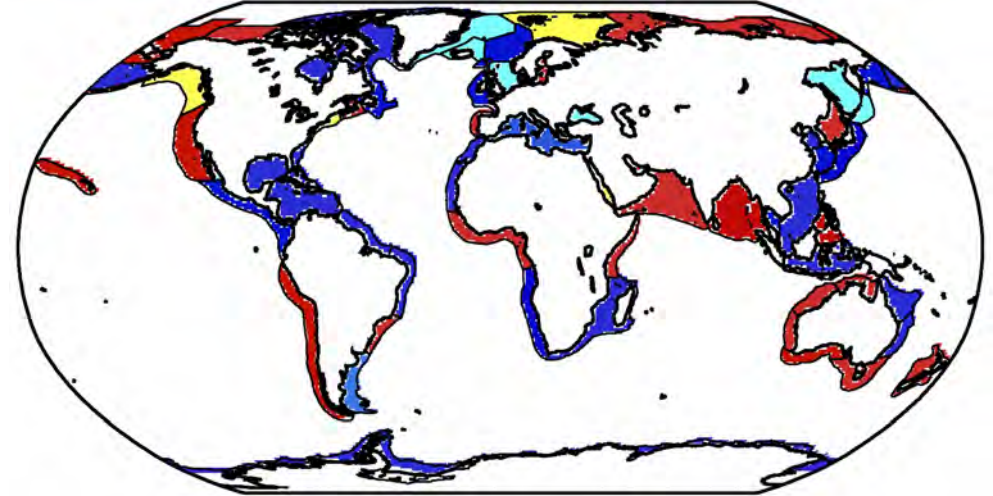
ORCA025 further to observation

Biogeochemistry in LME is closer to Obs in ORCA205

SST



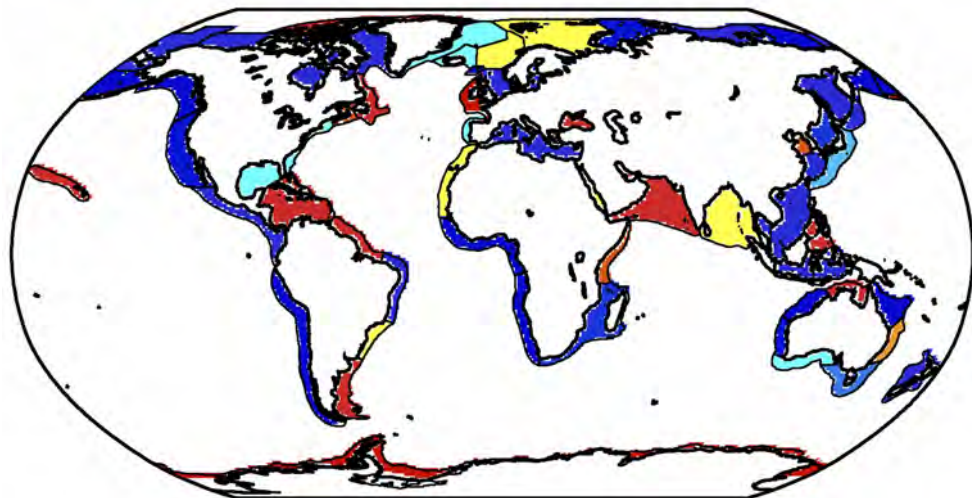
SSS



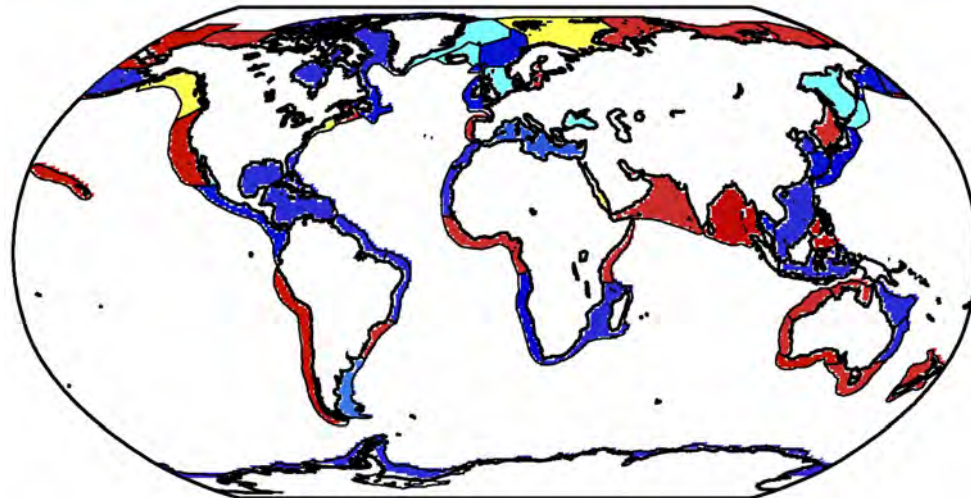
$$\text{Improvement} = \frac{\|ORCA\ 025 - Obs\|}{\|ORCA\ 1 - Obs\|}$$

Biogeochemistry in LME is closer to Obs in ORCA205

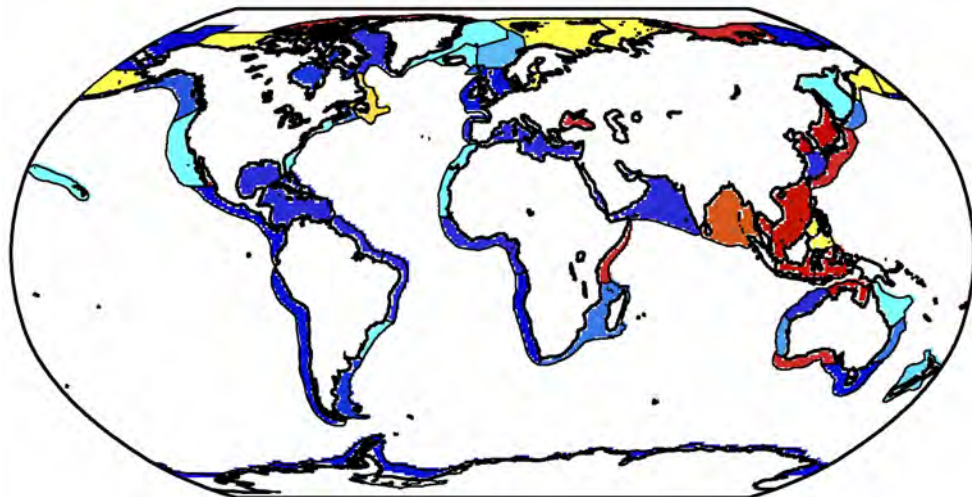
SST



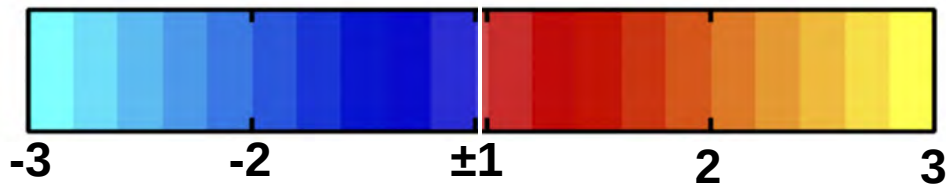
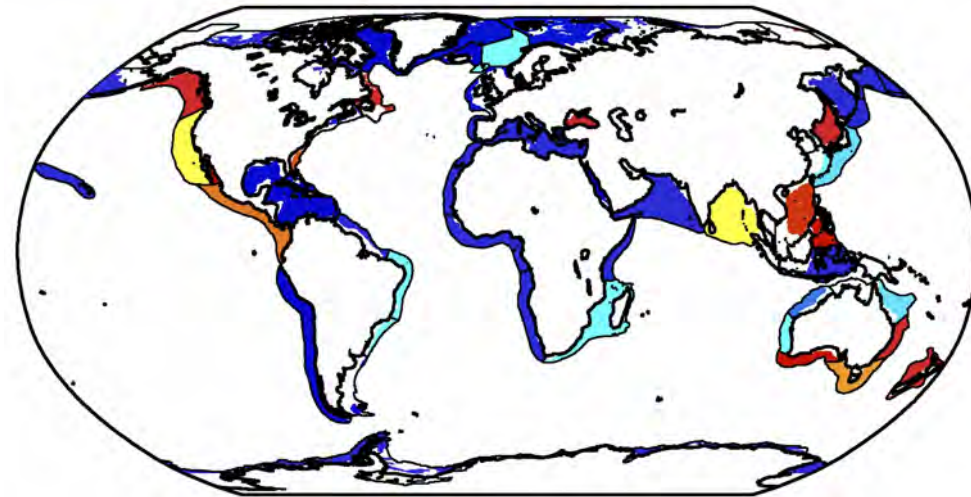
SSS



DIN



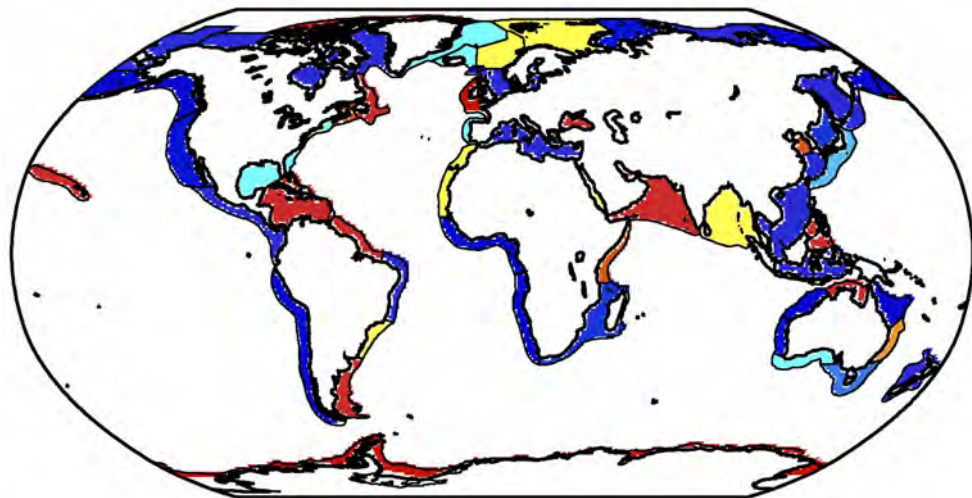
Chl



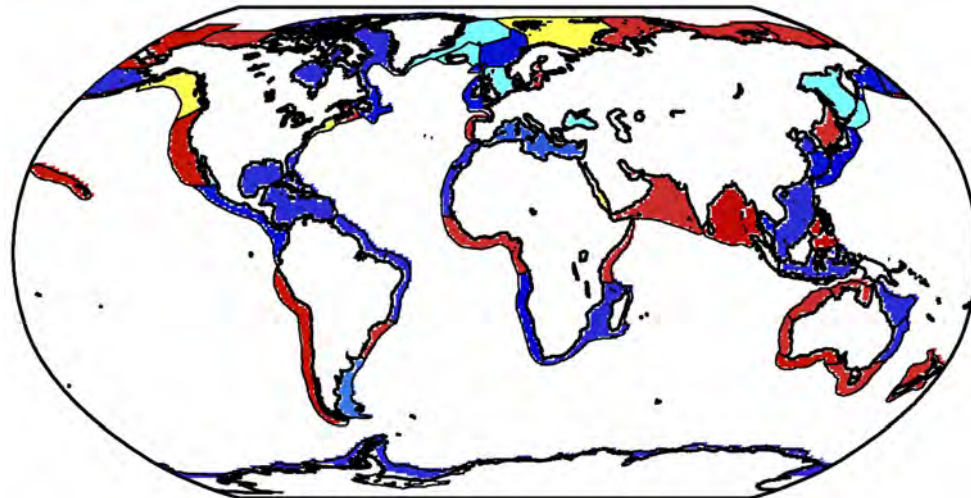
$$\text{Improvement} = \frac{\|ORCA\ 025 - Obs\|}{\|ORCA\ 1 - Obs\|}$$

Biogeochemistry in LME is closer to Obs in ORCA205

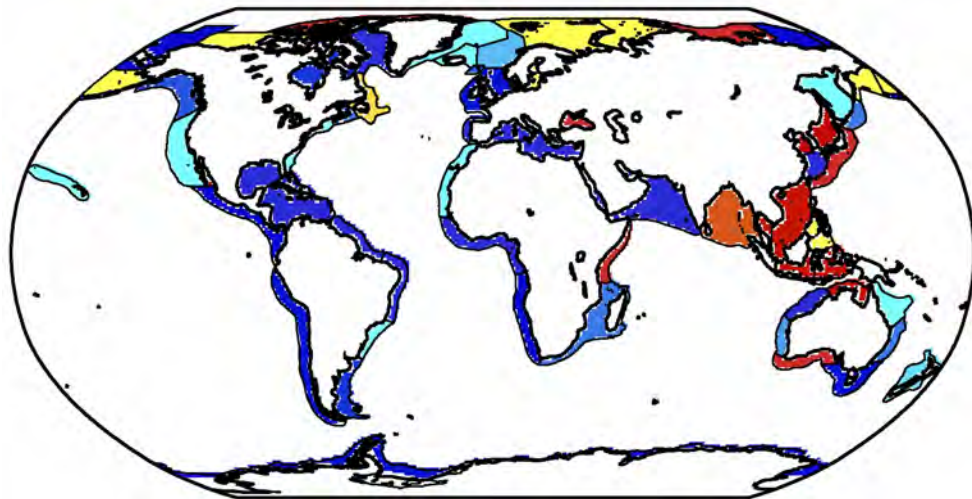
SST



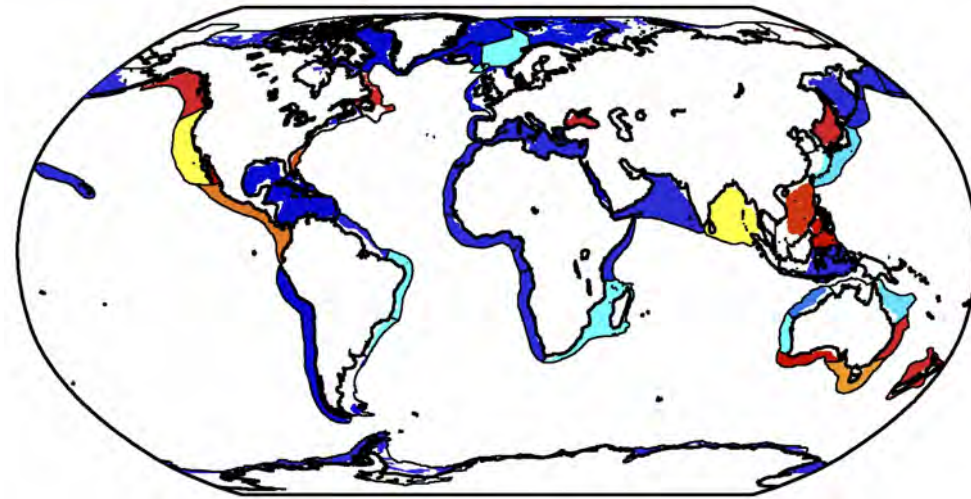
SSS



DIN



Chl

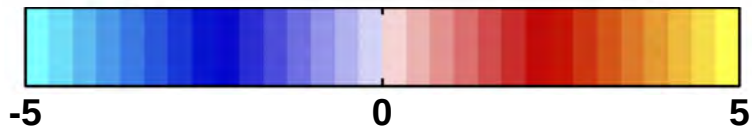
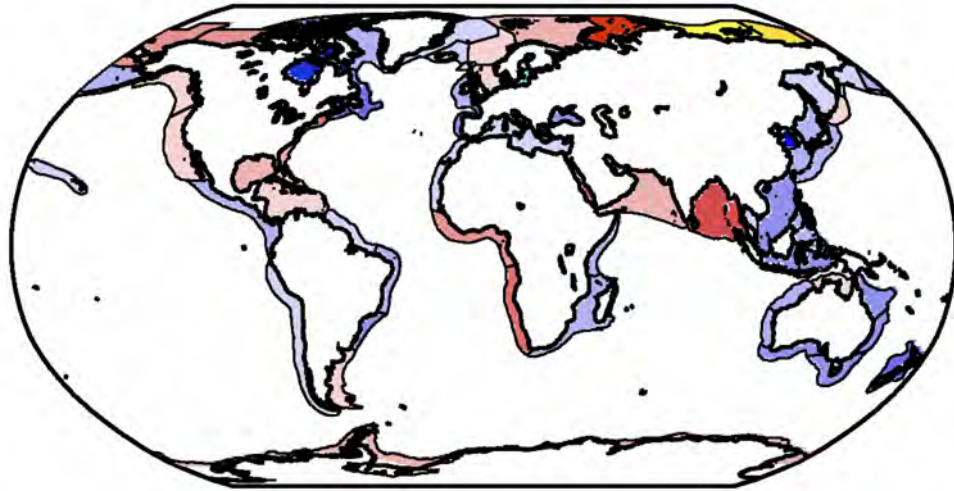


- Biogeochemistry is closest to Obs at finer resolution

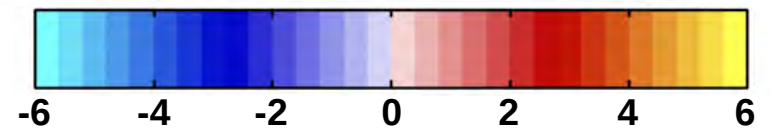
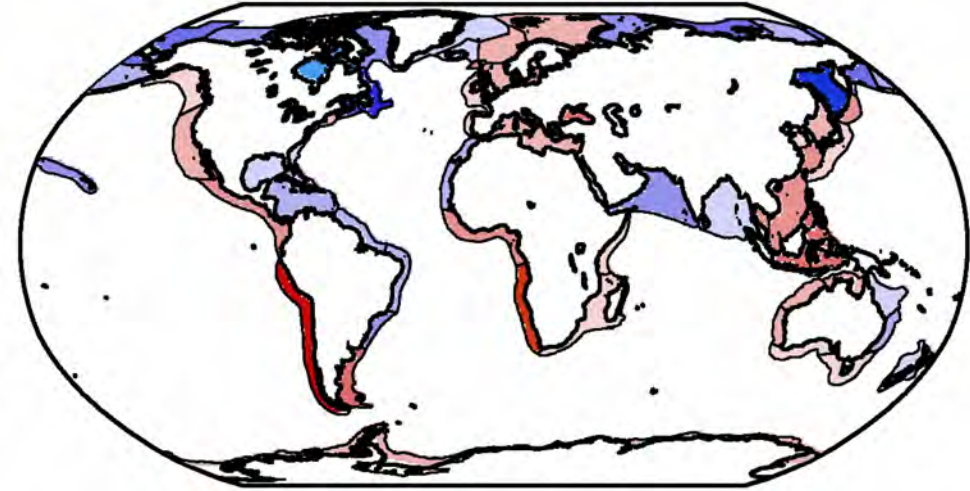
➔ Continue with ORCA025

Evaluation of NEMO-MEDUSA (ORCA025)

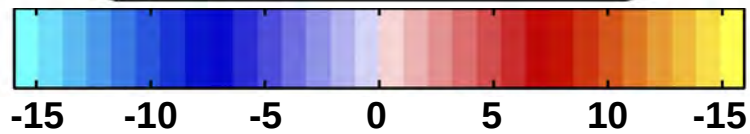
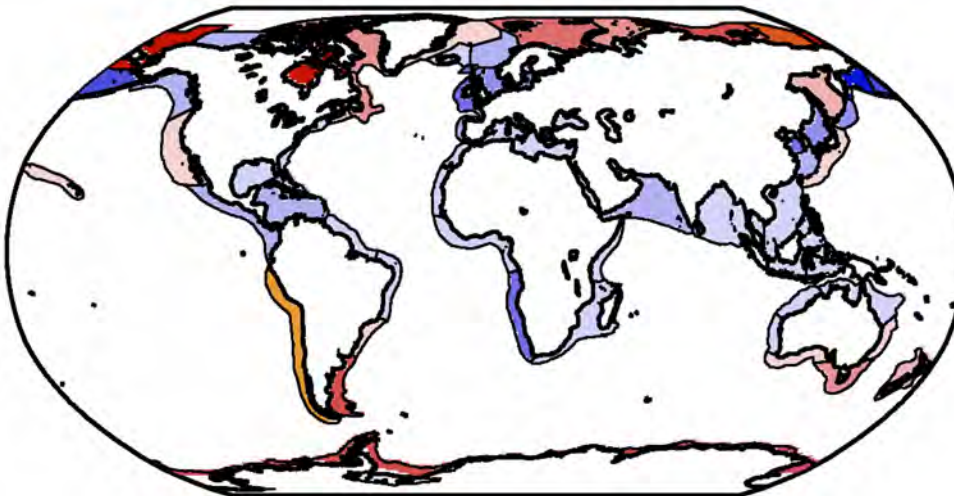
$\delta SSS - \text{obs-ORCA025}$



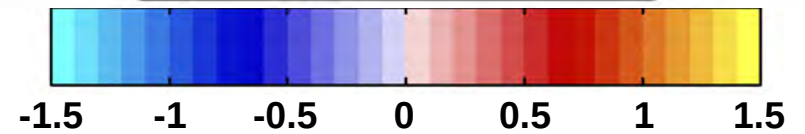
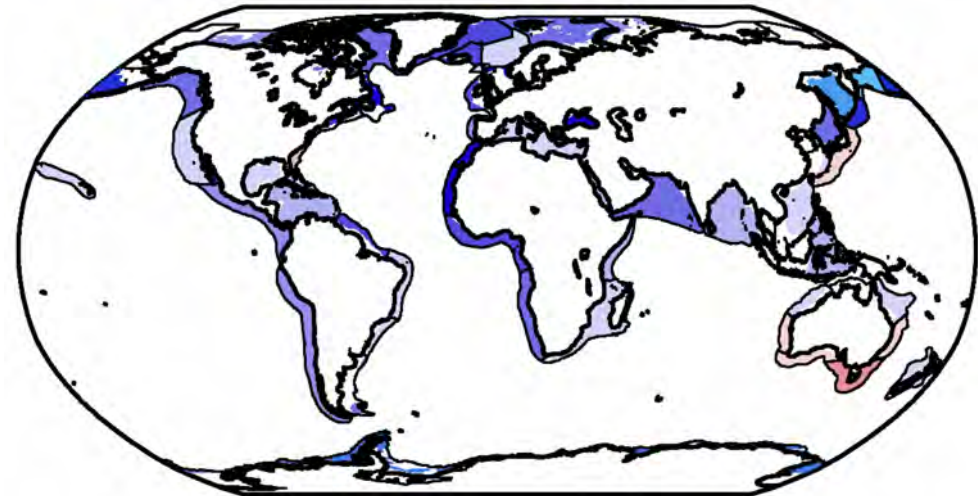
$\delta SST - \text{obs-ORCA025} (^{\circ}C)$



$\delta DIN - \text{obs-ORCA025} (\mu\text{mol l}^{-1})$

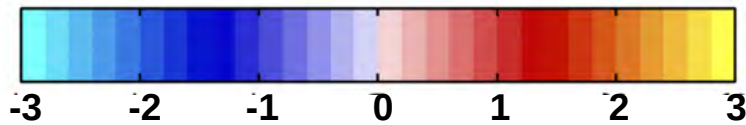
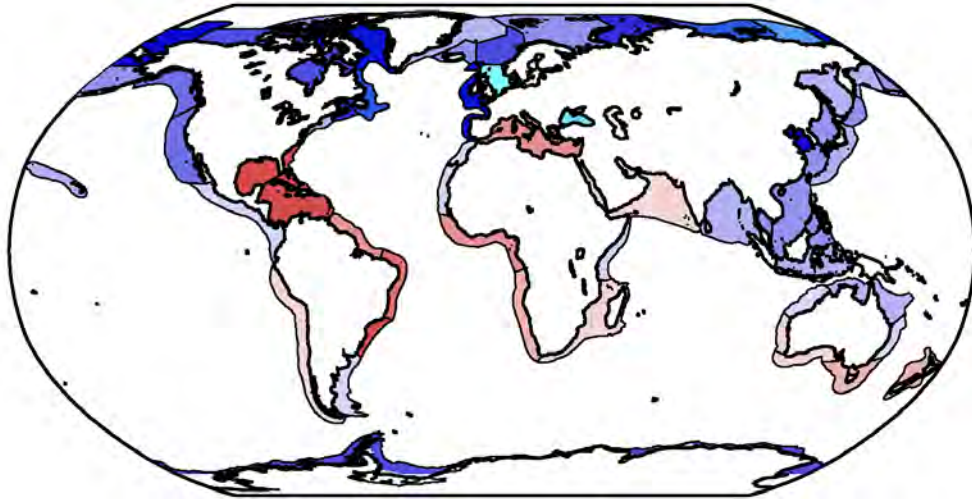


$\delta Chl - \text{obs-ORCA025} (\mu\text{g-C l}^{-1})$

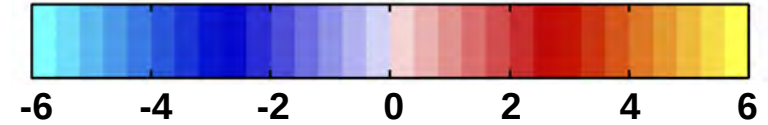
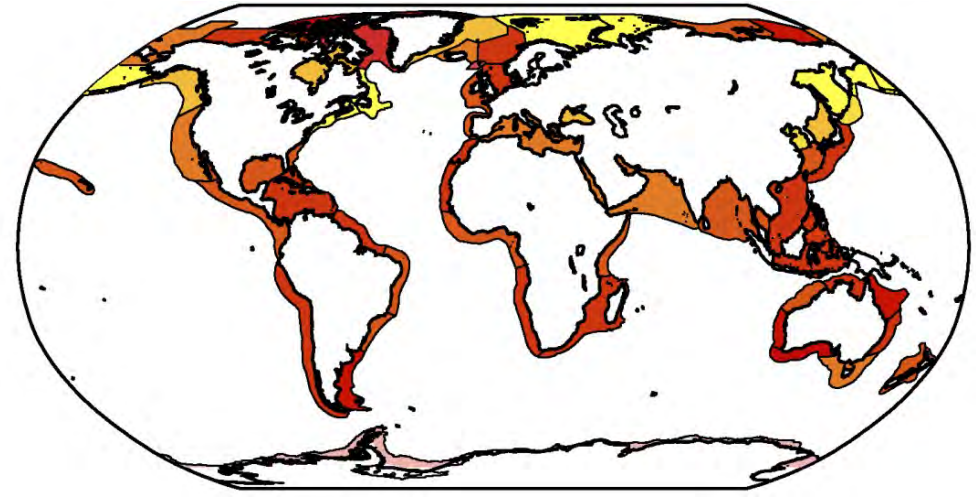


Physical changes between 2000 and 2090 decades.

δSSS -- 2090-2000

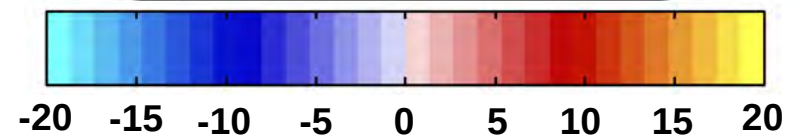


δSST -- 2090-2000 ($^{\circ}C$)



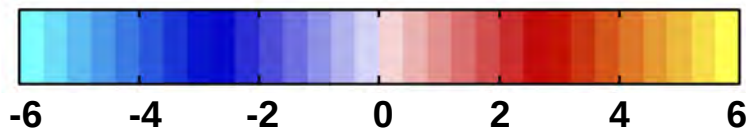
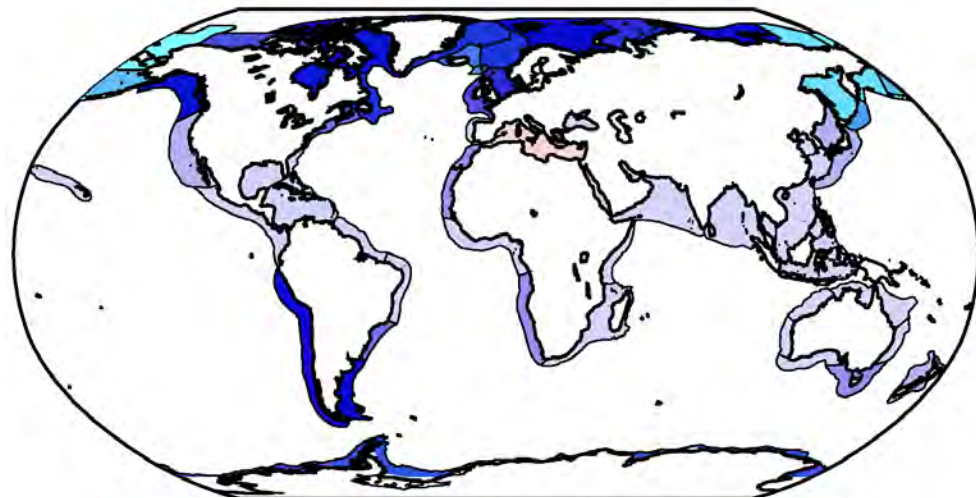
- SSS change following E-P
- SST increase everywhere up to $6^{\circ}C$
- Decrease of MLD – Deep Water Formation zone

δMLD -- 2090-2000 (m)

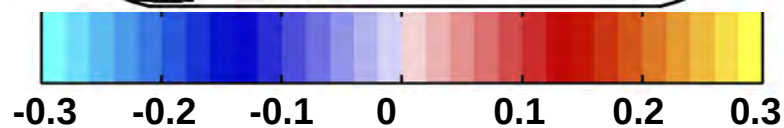
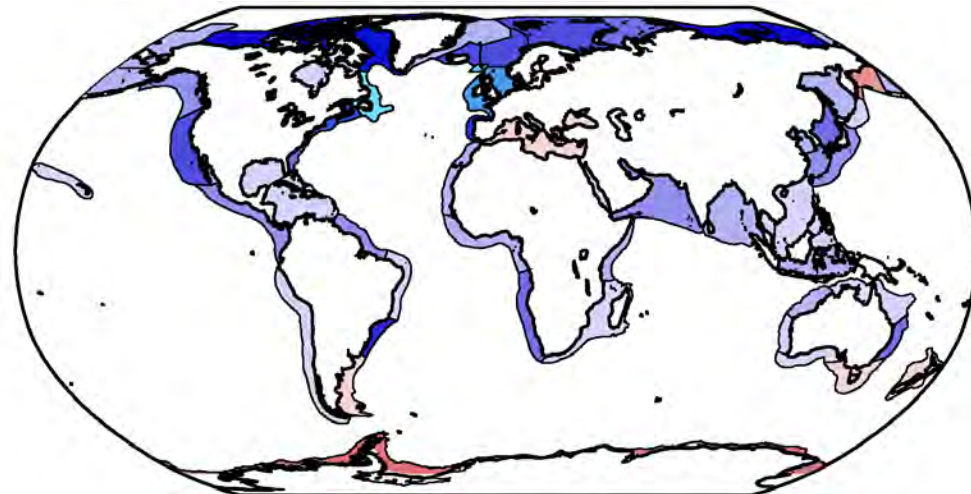


Biogeoch. changes between 2000 and 2090 decades.

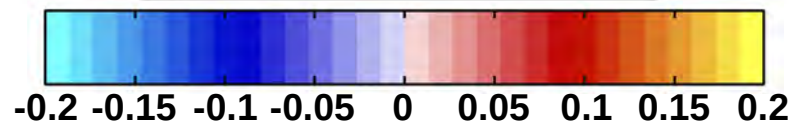
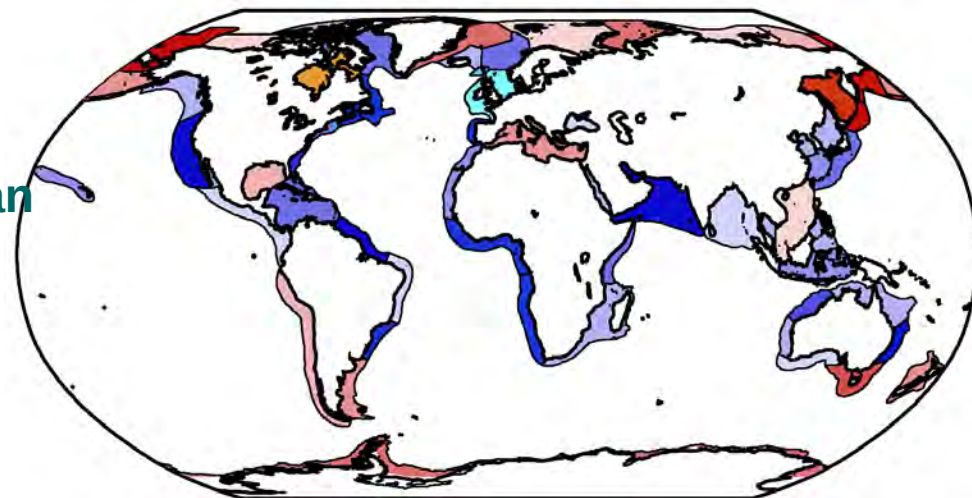
δ DIN -- 2090-2000 ($\mu\text{mol l}^{-1}$)



δ Chl -- 2090-2000 ($\mu\text{g-C l}^{-1}$)



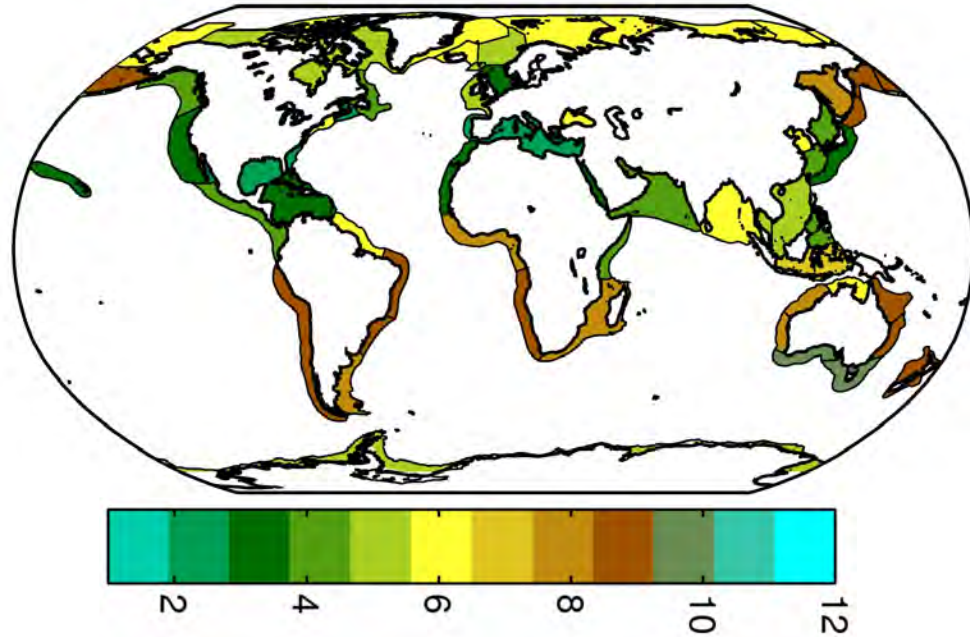
δ PP -- 2090-2000 ($\text{g-C m}^{-2} \text{d}^{-1}$)



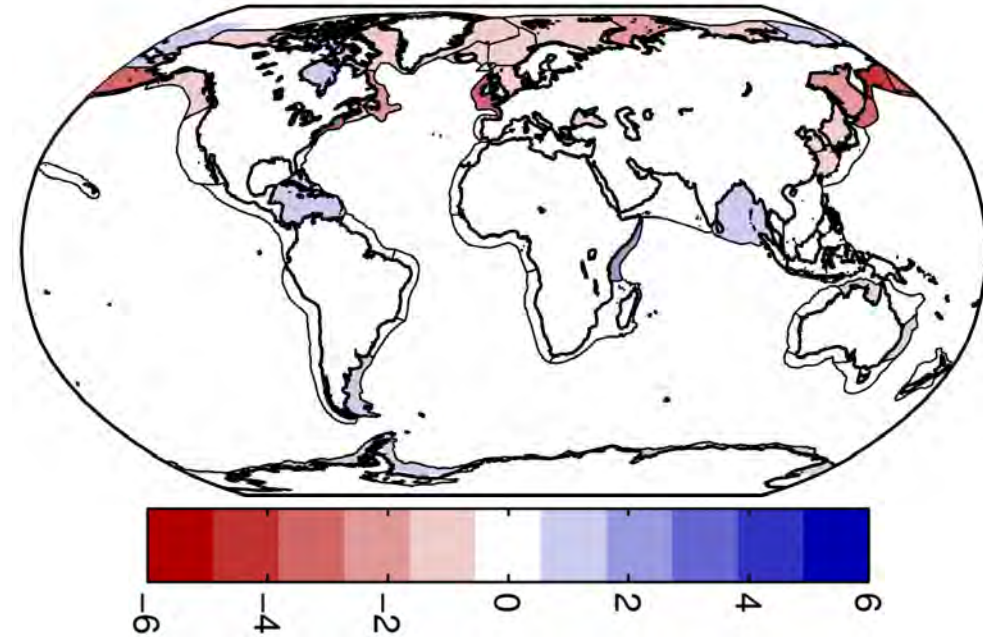
- Decrease in DIN up to 65% in N-Atl
- Chl gen^{al} decrease except around S-Ocean
- Increase of Arctic subsurface PP
Decrease in N-Atl ~50%

Changes in time of seasonal Maximum

Max Chl in 2000 (month)



Max Chl change - - 2090-2000 (month)



- Maximum Chl occurs 1-2 month earlier in N-Hemisphere
- No change to 1 month later in S-Hemisphere

Conclusion

- **Confirmed that increased resolution improve LME biogeochemistry results.**
- **MEDUSA's results in LME are realistic.**
 - But - slight nutrient underestimates in low-medium latitudes**
 - slight nutrient overestimates in high latitudes
 - Chl underestimates everywhere.
- **Evolution within Climate change shows**
 - General surface DIN decrease in all LME (~ 50%)
 - idem with surface Chl (up to 50%) except in Antarctic regions
 - subsurface PP increase in Arctic regions
 - Max Chl occurs 1 to 2 month earlier in N-Hemisphere.

!!! obrigado !!!