Large Marine Environment
Biogeochemical evolution within the next century

Julien Palmié; 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.

Atmospheric forcing
HadGEM2-ES -- RCP8.5 scenario

High resolution:
ORCA 1°

Low resolution:
ORCA 1°

Dynamic: NEMO
Biogeoch: MEDUSA

耦合

Does the higher resolution improve the LMEs biogeochemistry??

LME Ecological evolution with Climate change??

BUT

Same configuration
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??

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

ORCA025 closest to observation
ORCA025 further to observation
Definition of an Improvement Index (ID)

Are ORCA025 results more realistic than ORCA1's ??

**Improvement Index (ID)**

\[
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Adapt ID
Improvement/degradation
At the same scale
Definition of an Improvement Index (ID)

Are ORCA025 results more realistic than ORCA1's??

**Improvement Index (ID)**

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\text{ID} = \frac{||\text{ORCA025} - \text{Obs}||}{||\text{ORCA1} - \text{Obs}||}
\]

**Adapt ID**

Improvement/degradation
At the same scale

\[\text{ID} < 1 \rightarrow \text{ID} = -\frac{1}{ID}\]

\[\text{ID} \geq 1 \rightarrow \text{No Changes}\]
Biogeochemistry in LME is closer to Obs in ORCA205

Improvement = \frac{\|\text{ORCA 025} - \text{Obs}\|}{\|\text{ORCA 1} - \text{Obs}\|}
Biogeochemistry in LME is closer to Obs in ORCA205

\[
\text{Improvement } = \frac{||\text{ORCA}025 - \text{Obs}||}{||\text{ORCA}1 - \text{Obs}||}
\]
Biogeochemistry in LME is closer to Obs in ORCA205

- Biogeochemistry is closest to Obs at finer resolution
  
  Continue with ORCA025
Evaluation of NEMO-MEDUSA (ORCA025)

δSSS – obs-ORCA025

δSST – obs-ORCA025 (°C)

δDIN – obs-ORCA025 (µmol l⁻¹)

δChl – obs-ORCA025 (µg-C l⁻¹)
Physical changes between 2000 and 2090 decades.

- SSS change following E-P
- SST increase everywhere up to 6°C
- Decrease of MLD – Deep Water Formation zone
Biogeochemical changes between 2000 and 2090 decades.

- Decrease in DIN up to 65% in N-Atl
- Chl genal decrease except around S-Ocean
- Increase of Arctic subsurface PP
- Decrease in N-Atl ~50%
Changes in time of seasonal Maximum

- 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 accruts 1 to 2 month earlier in N-Hemisphere.

¡¡¡ Obrigado !!!

julien.palmieri@noc.soton.ac.uk