Ocean Predict

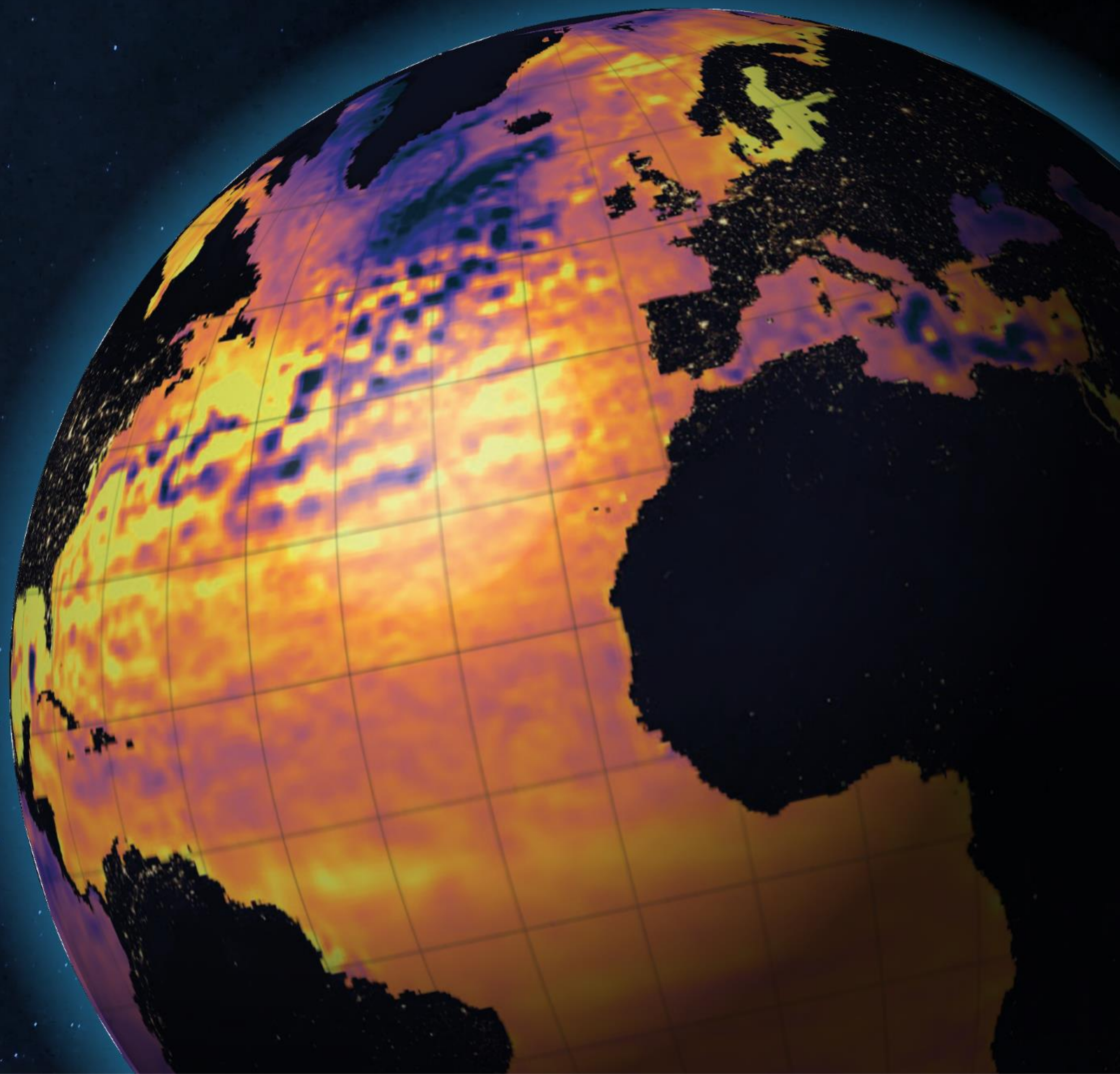
SYMPOSIUM OP'24

In partnership with unesco Intergovernmental Oceanographic Commission

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Low and mid-trophic levels reanalysis in the European Copernicus Marine Service catalogue:

State of the current product, and development plan
Applications to sciences and society



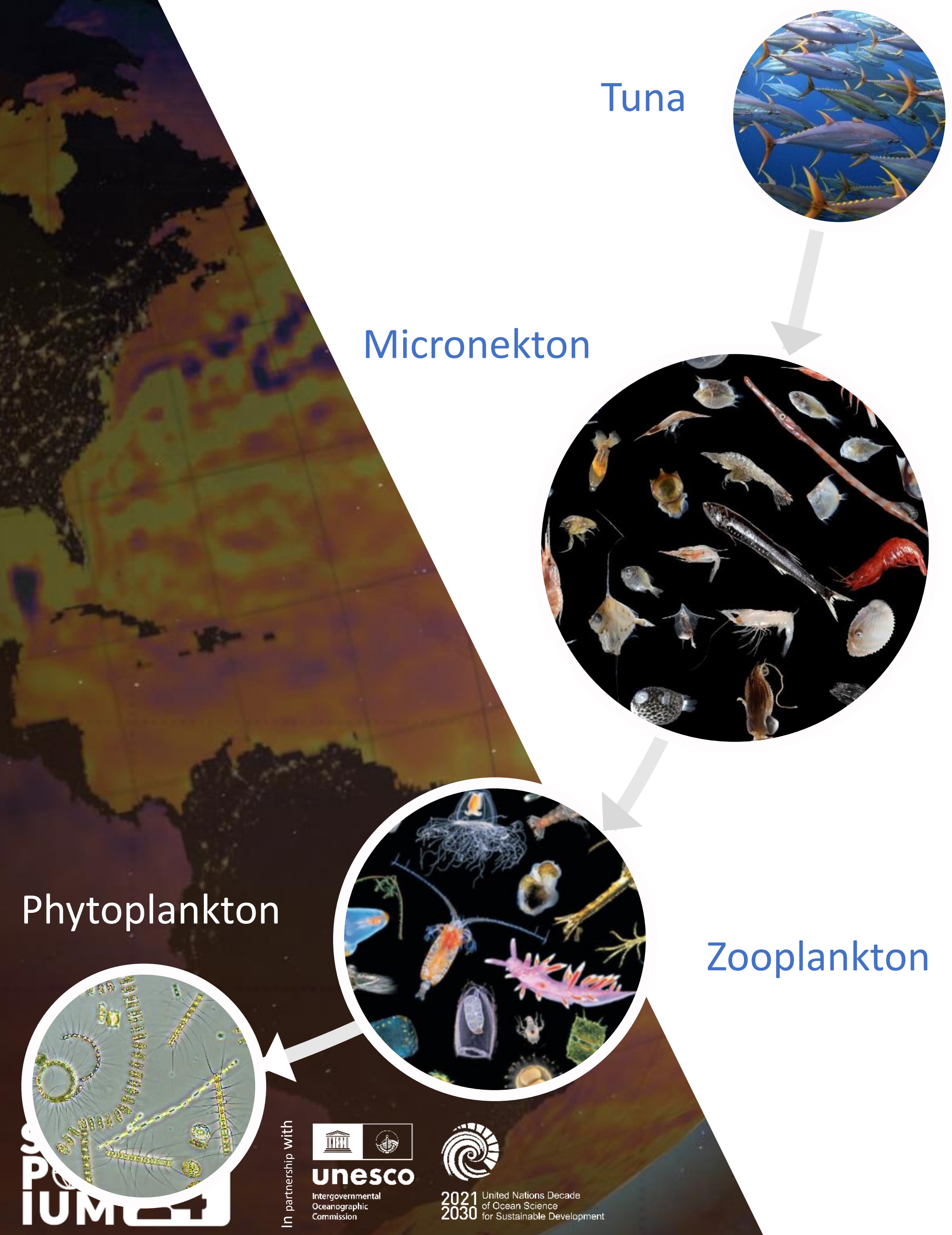
Olivier Titaud, Héloïse Magliano, Laurène Mérillet, Sarah Albernhe, <u>Anna Conchon</u>

Glossary

- SEAPODYM: a Low and Mid Trophic Levels biomass density model
- Validation of key variables of SEAPODYM
- Application to science and society
- What’s new ? The YYOGA framework
- MICRORYS : the LMTL reanalysis of Copernicus Marine Service

Ocean Low
& Mid-Trophic Levels

Ocean Predict



Credit: Elodie Vourey SPC 2019

A very large diversity of species in the ocean **constitute the low-trophic** (zooplankton) **and mid-trophic** (micronekton) **levels** of the food web.

They are the prey of larger size animals -> they play a key role in the marine ecosystem

Micronekton (~1-20 cm), including larvae and juveniles of large fish species, as some **other very large animals** (whale shark or baleen whales) **feed on zooplankton**

Large fish, cephalopods, seabirds and many marine mammals feed on micronekton.

Yet **micronekton it is not studied / observed enough**

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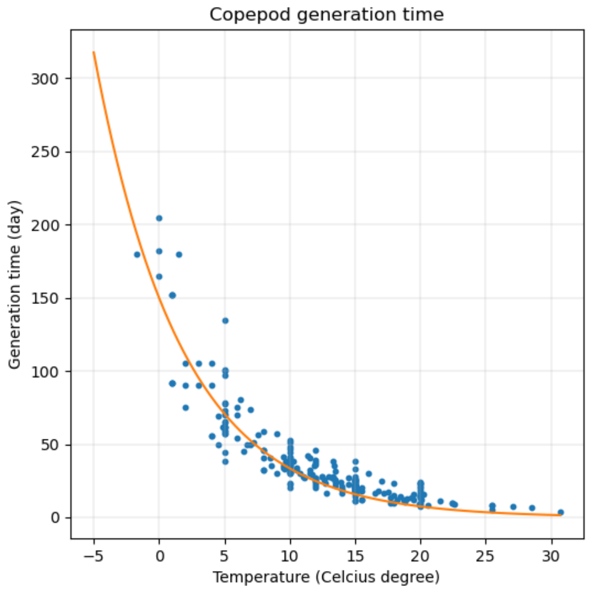
SEAPODYM is based on advection-diffusion-reaction equations



Example of time of development until maturity w.r.t temperature of copepods

Model parameters are estimated from available data

Huntley and Lopez, 1992; Conchon, 2016

NPP

Equation for the production

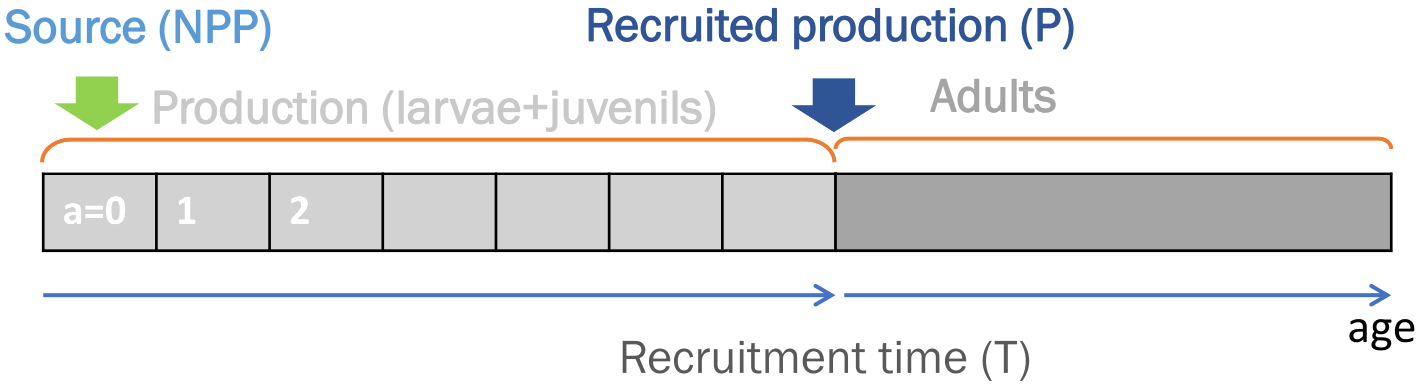
$$\partial_t N + \partial_a N = -\mathrm{div}(\mathbf{v}N) + \nabla(D\nabla N) + S$$

$$N(a, t_0) = N_0(a)$$

Equation for the adults

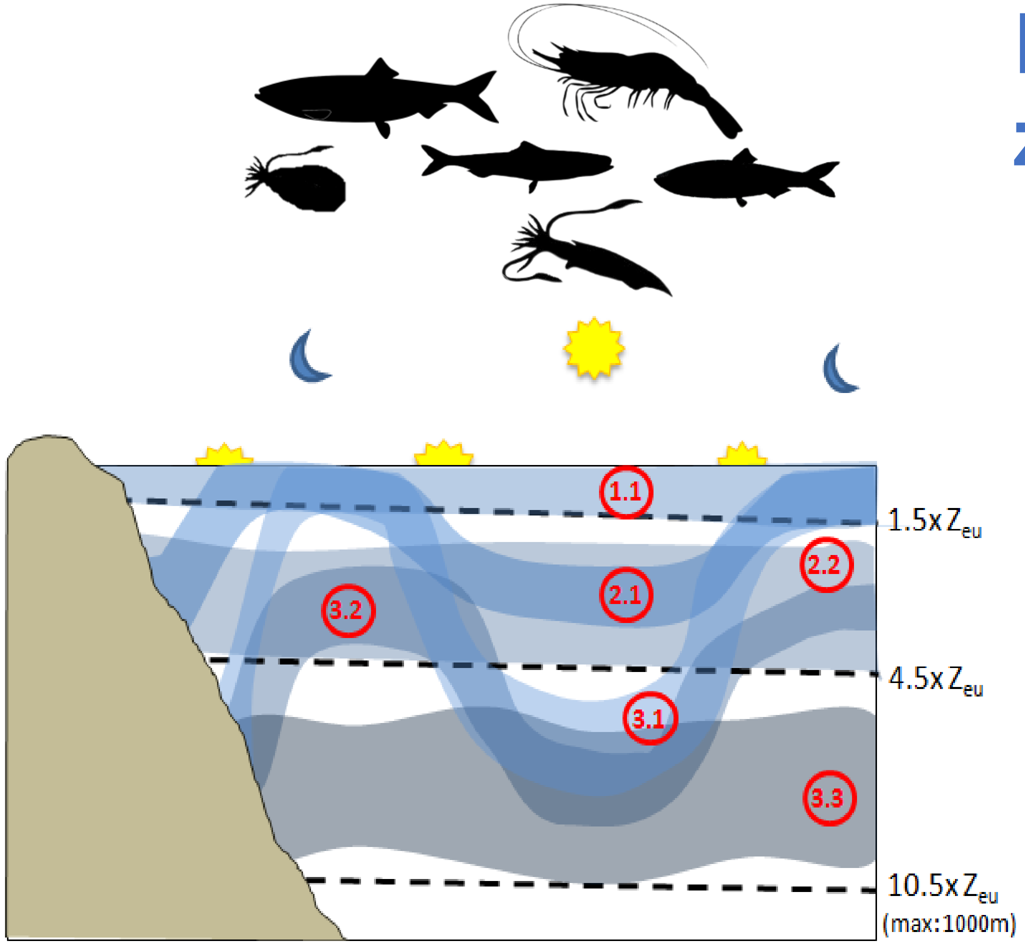
$$\partial_t N = -\mathrm{div}(\mathbf{v}N) + \nabla(D\nabla N) - MN + P(\mathbf{T})$$

$$N(t_0) = N_0$$



Lehodey et al. 1998; *Fish. Oceanog.*; 2010, *Progr. Oceanog.*; 2015, *ICES J Mar Sci*;

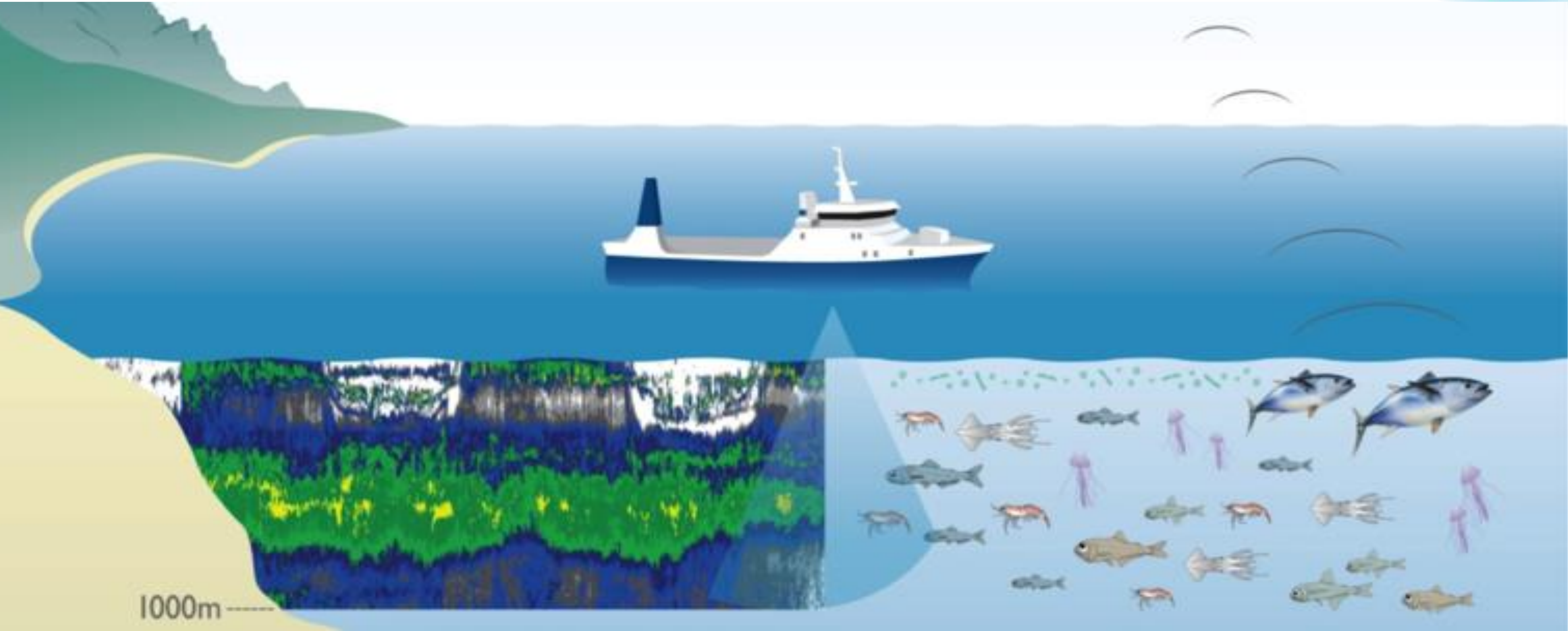
Modeling framework for zooplankton and micronekton



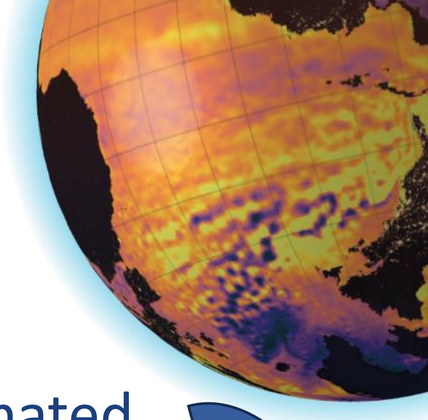
Pelagic vertical layers are dynamically defined from euphotic depth (Zeu)

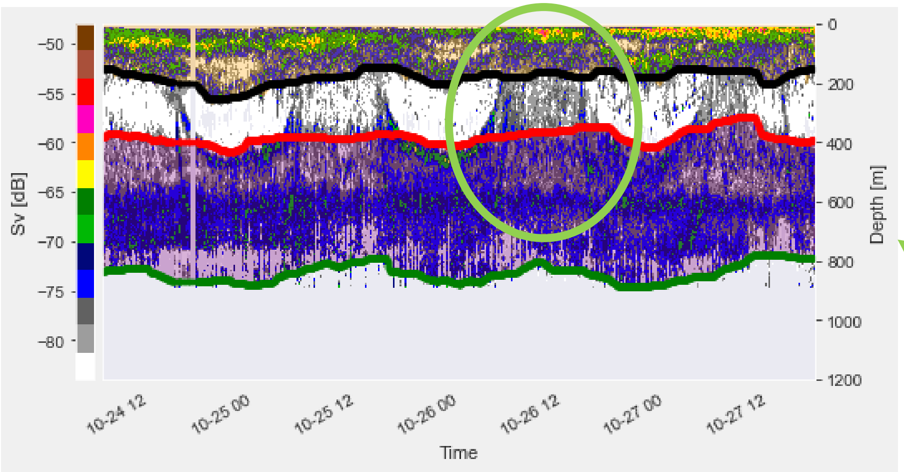
- Water column is simplified into 3 pelagic layers over which forcings (current, temperature) are averaged
- Micronekton is described by six functional groups according to their diel vertical migration behaviour
- Zooplankton is described by a single functional group inhabiting the epipelagic layer
- By their dial migration, micronekton participates to the carbon export

Validation

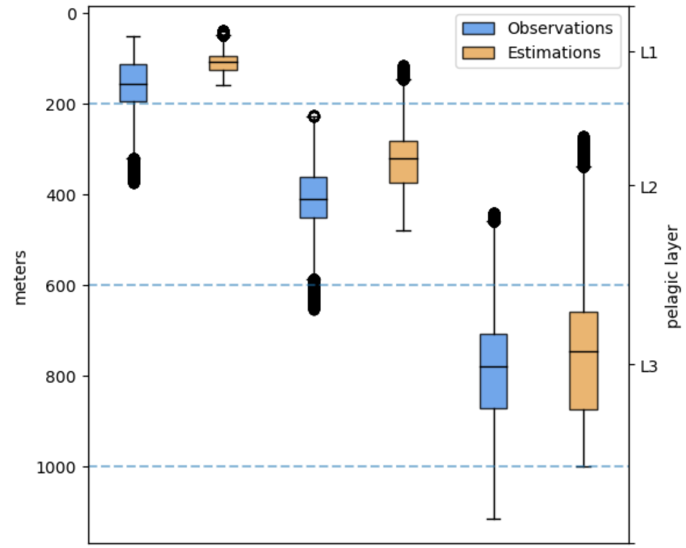


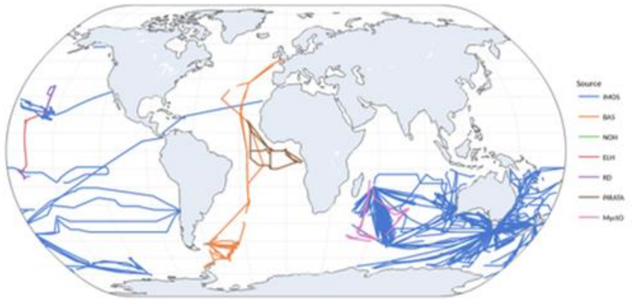
Validation: pelagic layers estimation

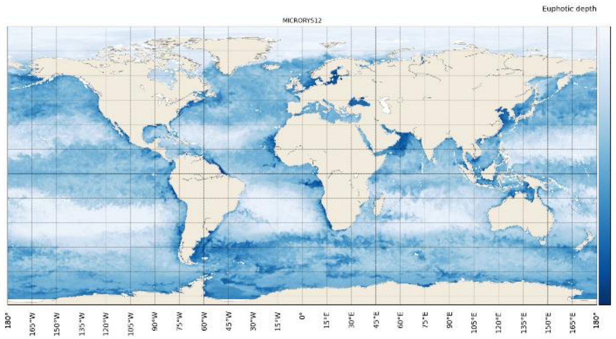




- Pelagic layers bottom depth estimated from euphotic depth
- Compared to those estimated from acoustic transects

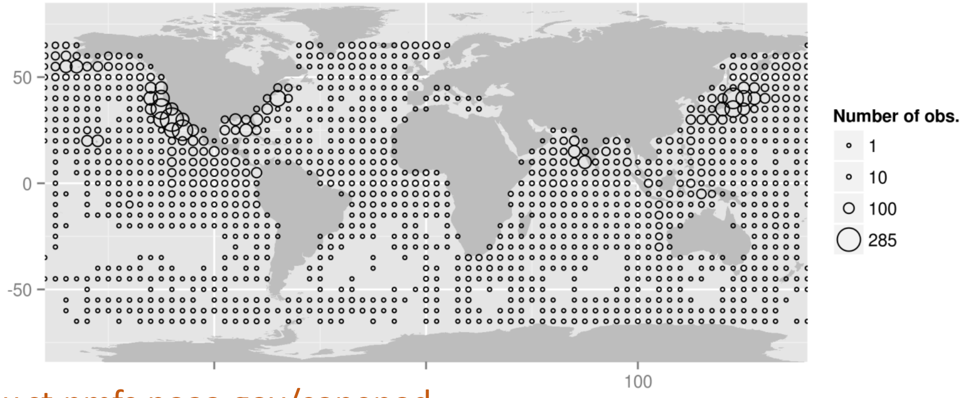




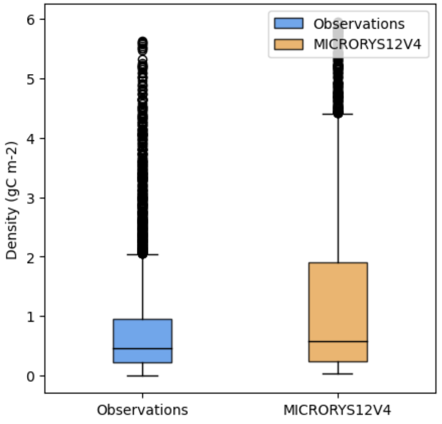


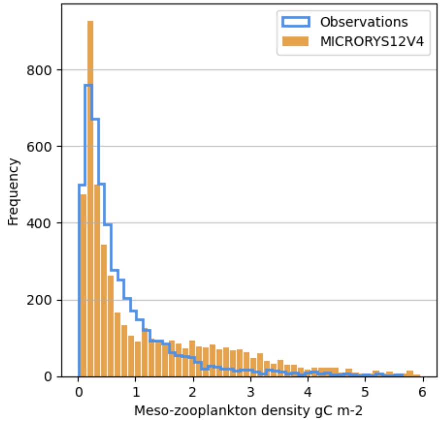
Validation ZOOPLANKTON

We use the COPEPOD database to compare modelled and observed zooplankton distribution

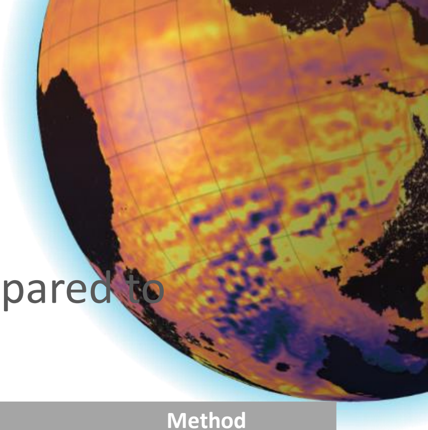


www.st.nmfs.noaa.gov/copepod





Validation MICRONEKTON



Total biomass of micronekton is compared to estimation found in literature

Estimate	Reference	Method
0.8 Gt	Gjøsæter and Kawaguchi (1980)	Ocean trawl data
11 to 15 Gt (40°N-40°S)	Irigoien et al. (2014)	Acoustics
< 1.4 Gt	Jennings and Collingridge (2015)	Macroecological model
2.4 Gt (40°N-40°S)	Anderson et al. (2019)	Food-web model
1.8 to 16.0 Gt (70°N -70°S)	Proud et. al. (2018)	Acoustics
[2.23;2.54] with mean 2.44 Gt (70°N – 70°S)	MICRORYS12V5	Macroecological model

Sparse observations also exist at regional level

Table 7: Estimates of local mesopelagic fish biomass.

Region Period	Reference	Sampling	Method	Range of biomass (m-2)	Correction (gWW m-2)	Model average (gWW m-2)
California Current 2010-2012	Davison et al (2015)	35°N-30°N; 124°W-118°W	Acoustic model (18 and 38 kHz) with trawling Mesopelagic fish	25– 37 gWW	**12-28** (1)	**13.2** Average sum of all 5 mesopelagic groups
Northeast	Ariza et al	28°31'N;	Trawling	0.2 ±0.06		**2.74**

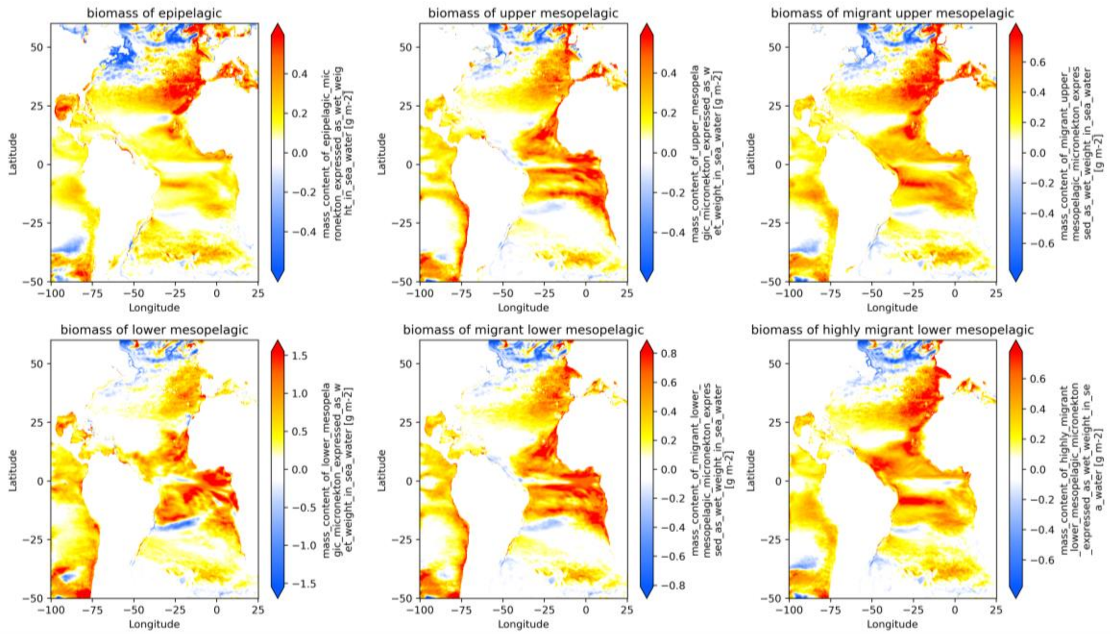
For more details see

https://catalogue.marine.copernicus.eu/documents/QUID/CMEMS-GLO-QUID-001-033.pdf

Applications to science and society

MISSION ATLANTIC – Studying the impact of climate change on distribution and biomass of micronekton

Micronekton biomass mean anomalies (historical – projected)



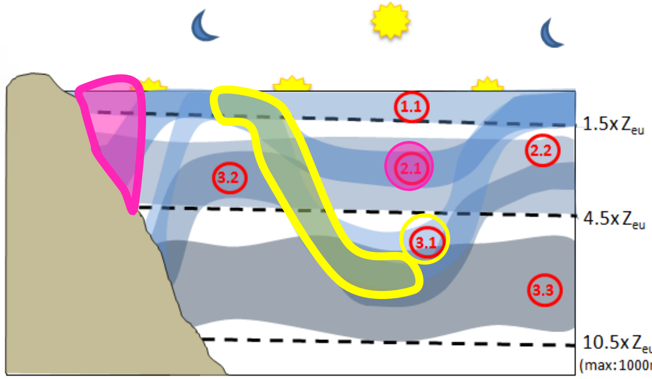
Red area: predicted decreasing biomass

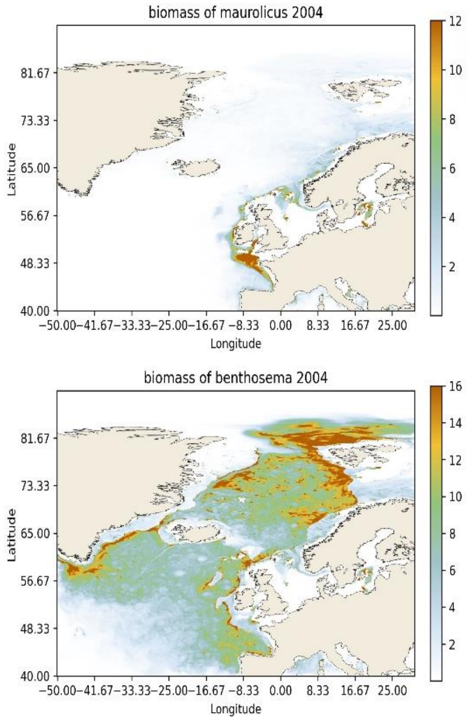
Blue area: predicted increasing biomass

MEESO – Could mesopelagic fisheries be sustainable ?

Two species of mesopelagic fish

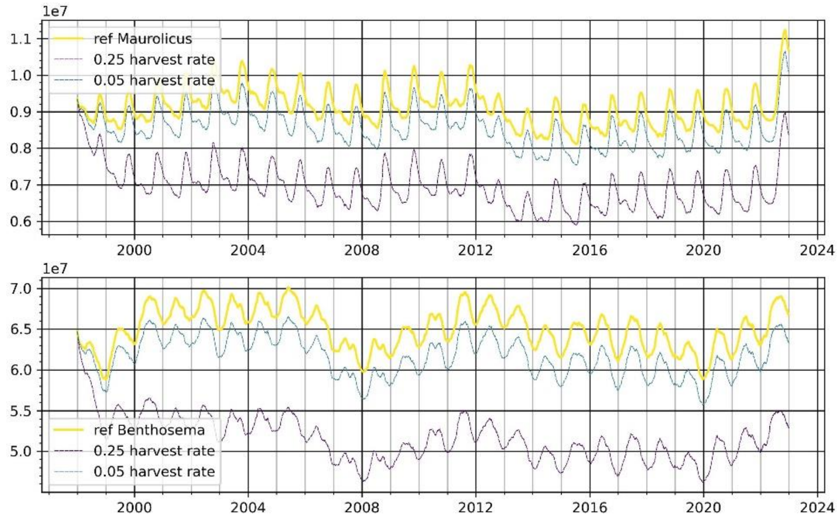
Credit: Svanhildur Egilsdóttir, Icelandic Marine and Freshwater Research Institute





Simulating fishing scenarios

Time serie of the biomass of Maurolicus (top) and Benthosema (bottom) in mt



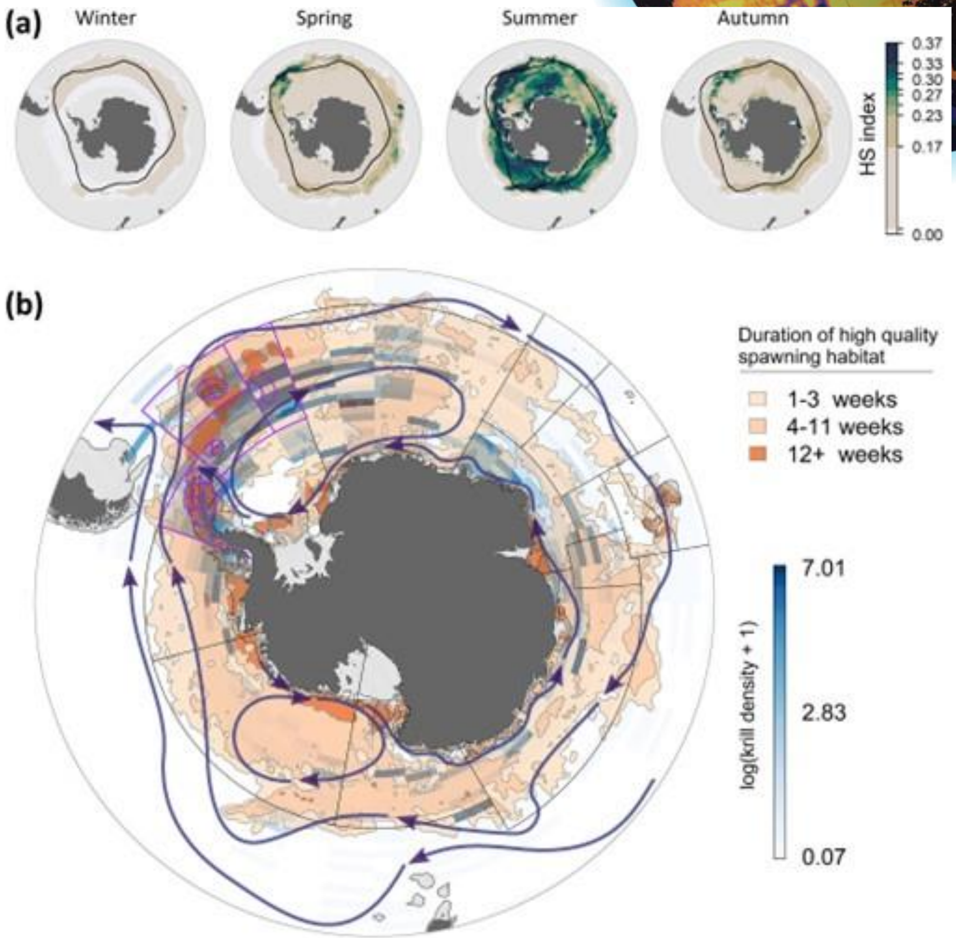
Spawning habitats of Antartic krill

Muséum national d'Histoire Naturelle (Paris)

Mechanistic model for Antarctic krill **spawning habitat uses** food constraints on **predation on egg survival by micronekton**

Seasonal distribution

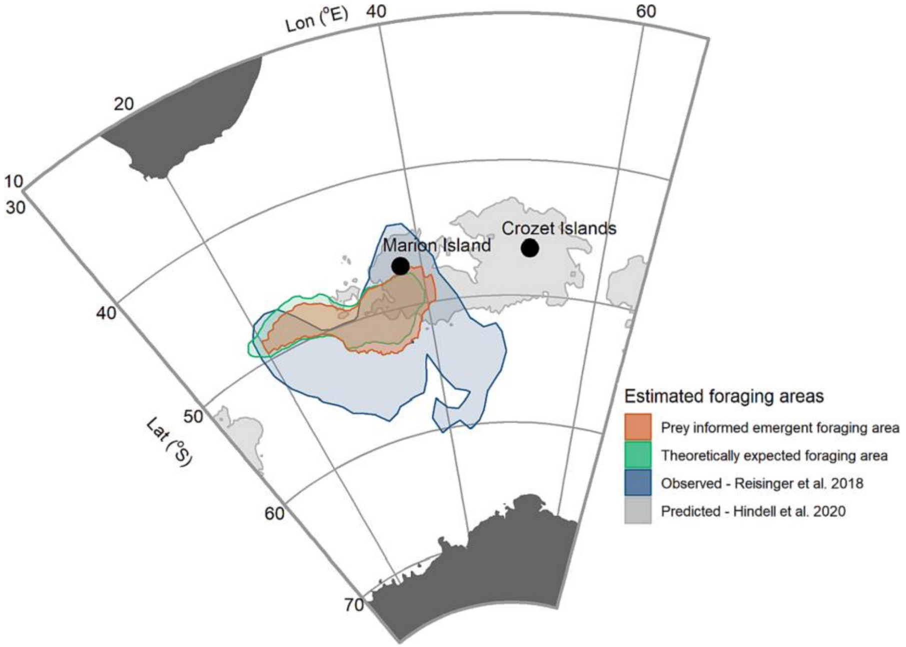
Mean annual duration of high quality spawning habitat



Green et al ; 2021. *Geophysical Research Letters*

Predator foraging success based on micronekton distribution

- Location of prey-informed emergent (orange) and theoretically expected (green) foraging areas



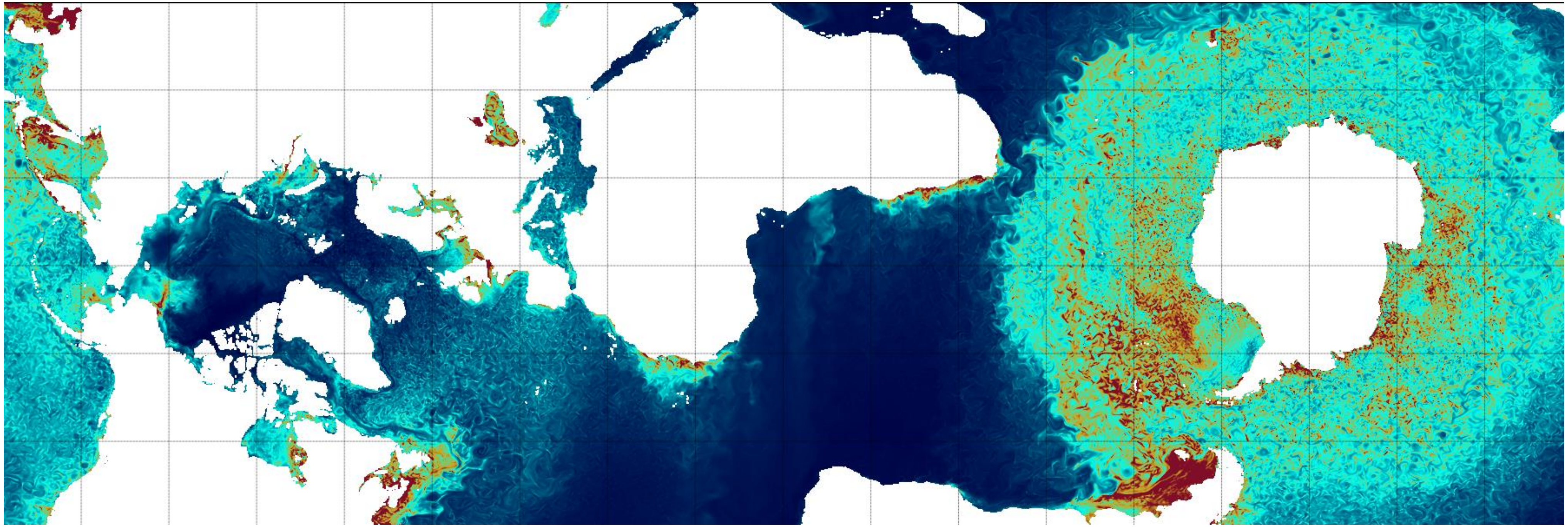
Green *et. al.* 2023, *Ecological Indicators*

Modelled mid-trophic prey biomass may be useful to predict predator foraging success

Emergent foraging areas occur within observed foraging distributions of macaroni penguins

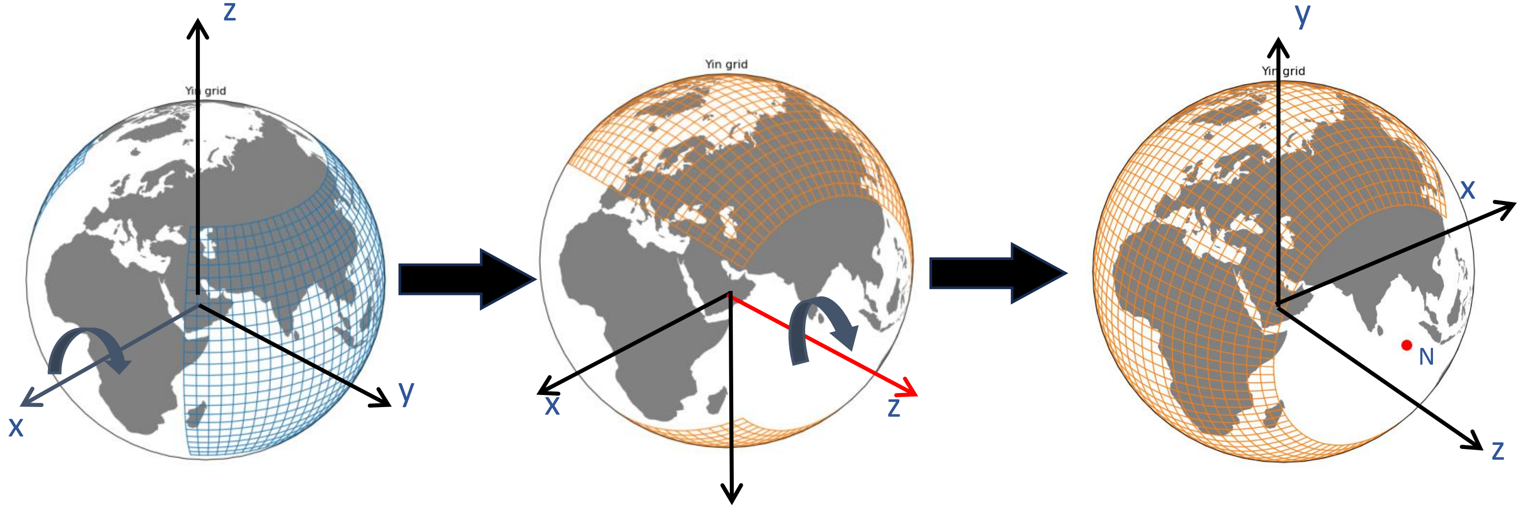
What's new ?

- The Yin-Yang Overset Grid Assembly framework

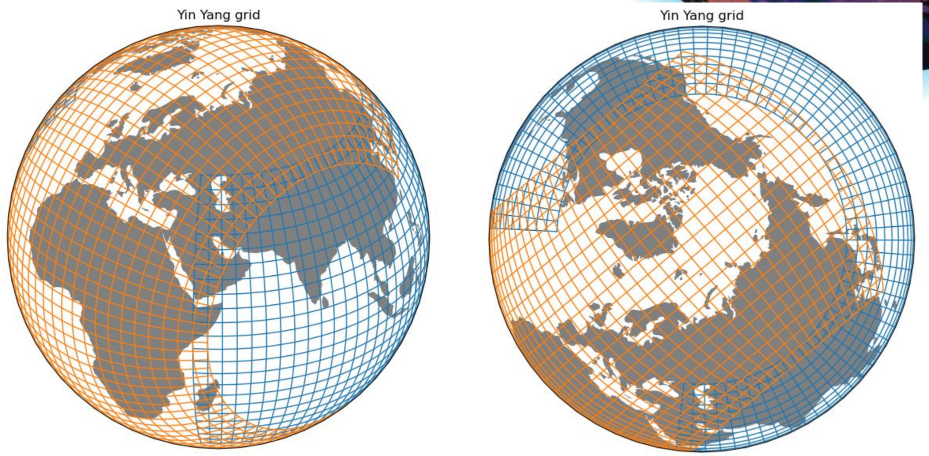


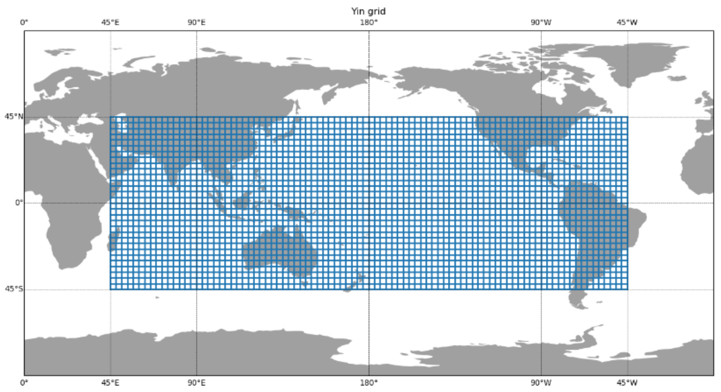
The Yin-Yang Overset Grid Assembly (YYOGA)

Symetric change of coordinate systems

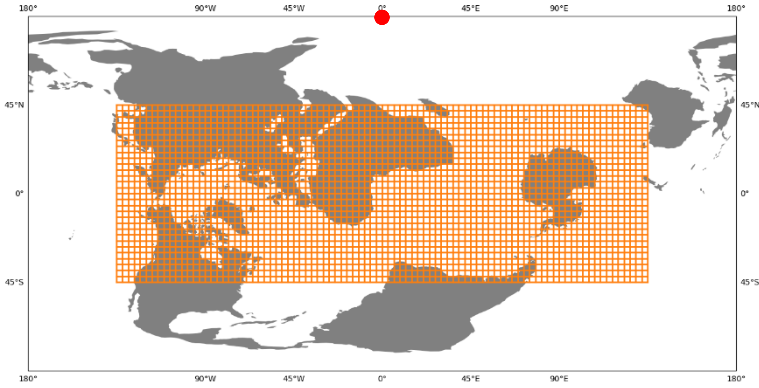


Kageyama and Sato, 2004

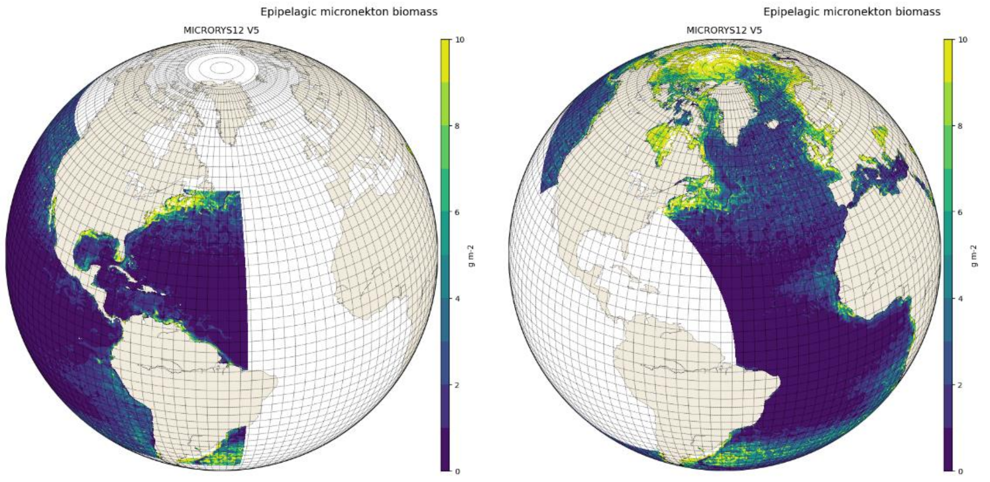




Lat/Lon classical coordinate system related to the regular Yin grid : the dark coordinate system

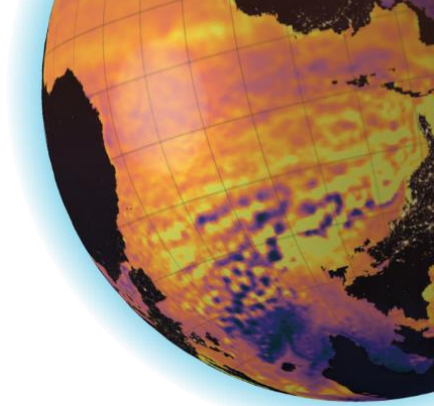


The sunny coordinate system related to the regular Yang grid in that system



Epipelagic micronekton 2003/03/03

How to get LMTL reanalysis ?
The Copernicus Marine Service Low and Mid Trophic product



MICRORYS

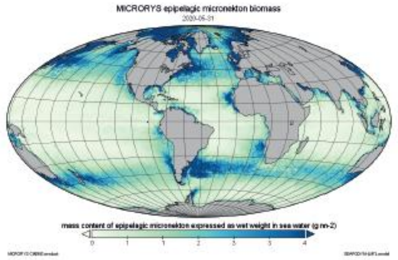
Zooplankton and micronekton reanalysis, a daily 1/12° CMEMS product

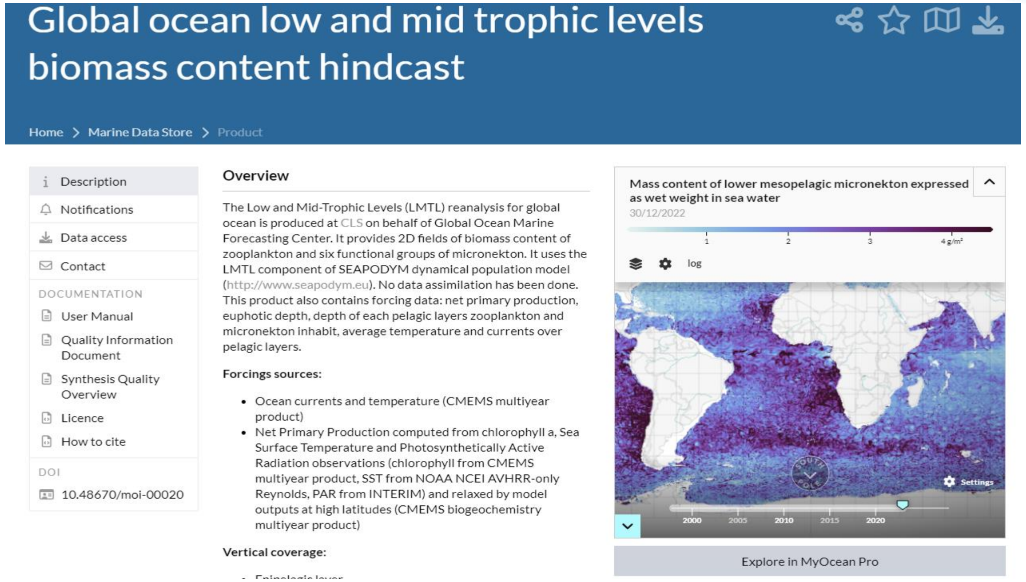
MICRORYS is produced at **Collecte Localisation Satellite** (CLS) for **Copernicus Marine Environment Monitoring Service**.

It is proposed for end users involved in marine resources and ocean ecosystem management and conservation. It is based on the Low and mid-trophic level module of the **Spatial Ecosystem And Population Dynamics Model** (SEAPODYM).

It contains time series of meso-zooplankton and 6 functional groups of micronekton biomass.

It can be downloaded from the **CMEMS** portfolio :





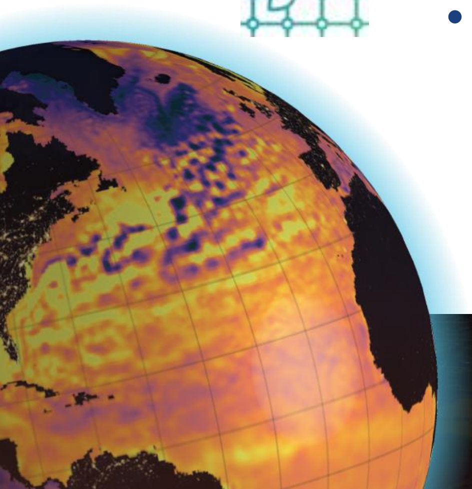
https://data.marine.copernicus.eu/product/GLOBAL_MULTIYEAR_BGC_001_033

MICRORYS development plan

- **Less diffusive numerical scheme**
- **Using regional products for Net Primary Productivity**

- **New estimation of pelagic layer depth**

- Improve **parametrisation**



References

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habitat quality to identify regions with potential to support high larval production. *Geophysical Research Letters*, *48*, e2020GL091206.
https://doi.org/10.1029/2020GL091206

David B. Green, Sophie Bestley, Stuart P. Corney, Rowan Trebilco, Azwianewi B. Makhado, Patrick Lehodey, Anna Conchon, Olivier Titaud, Mark A. Hindell, Modelled prey fields predict marine predator foraging success, Ecological Indicators, Volume 147,(2023), 109943, ISSN 1470-160X,
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Akira Kageyama and Tetsuya Sato, (2004), ‘‘Yin-Yang grid’’: An overset grid in spherical geometry, Geochemistry Geophysics Geosystems, Volume 5, Number 9,
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https://catalogue.marine.copernicus.eu/documents/QUID/CMEMS-GLO-QUID-001-033.pdf

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SYMPOSIUM OP'24

ADVANCING OCEAN PREDICTION SCIENCE FOR SOCIETAL BENEFITS

Thank you!

European Commission

Copernicus Marine Service

EU4OceanObs INTERNATIONAL OCEAN GOVERNANCE EU COMPONENT TO GLOBAL OCEAN OBSERVATIONS

MERCATOR OCEAN INTERNATIONAL

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