Catch the big picture of the Mediterranean Sea with the end-to-end

NEMOMED12-Eco3M-S – OSMOSE model

Fabien Moullec
MARBEC Lab, Montpellier

Laure Velez, Philippe Verley, Nicolas Barrier, François Guilhaumon, Clara Péron, Caroline Ulses, Yunne-Jai Shin *et al*.

International Mistrals Workshop – Climate Change impacts in the Mediterranean region - 16-18 Oct 2017 Montpellier (France)

A hot-spot of biodiversity

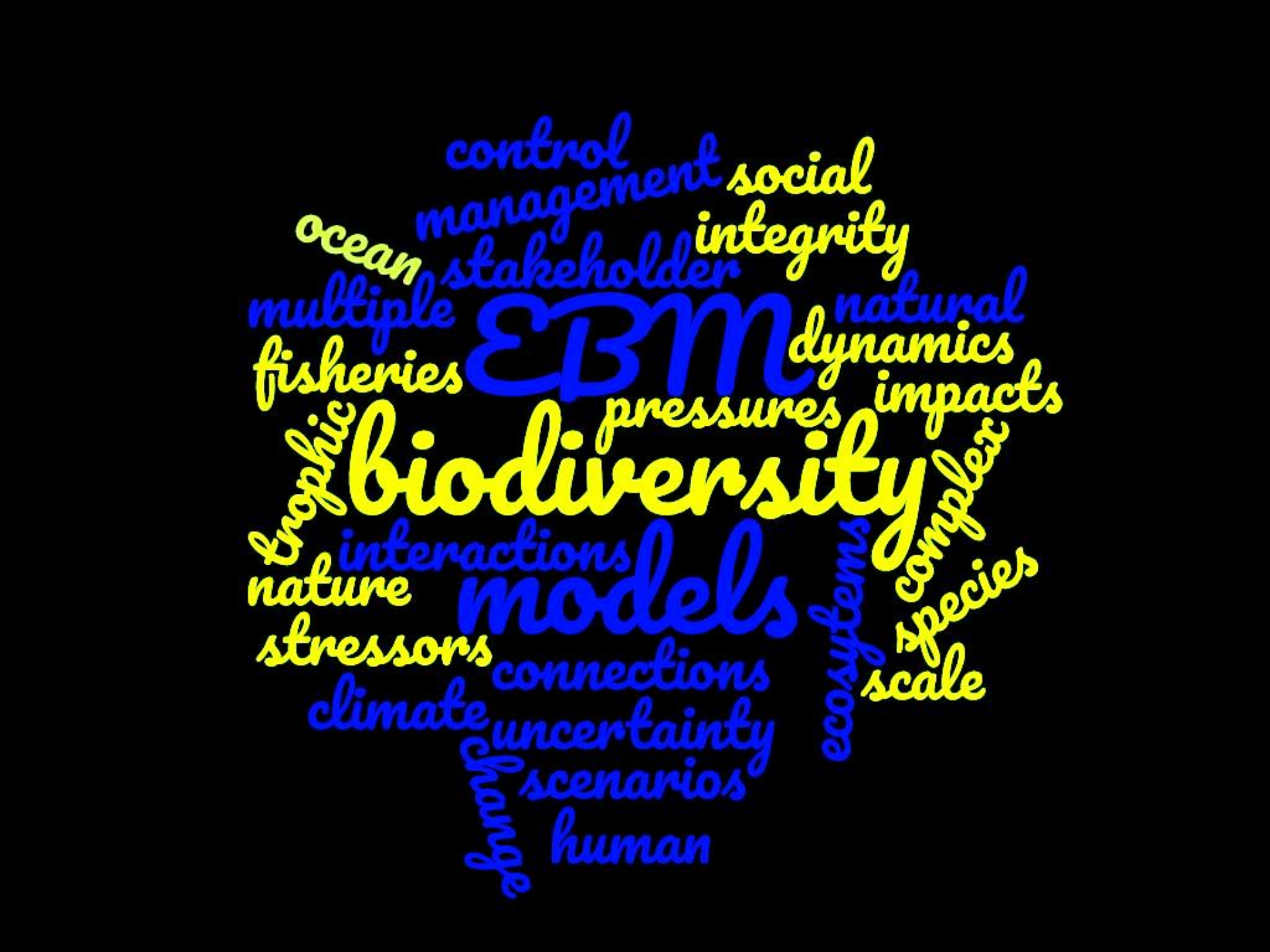


Coll *et al.* (2010, 2012)

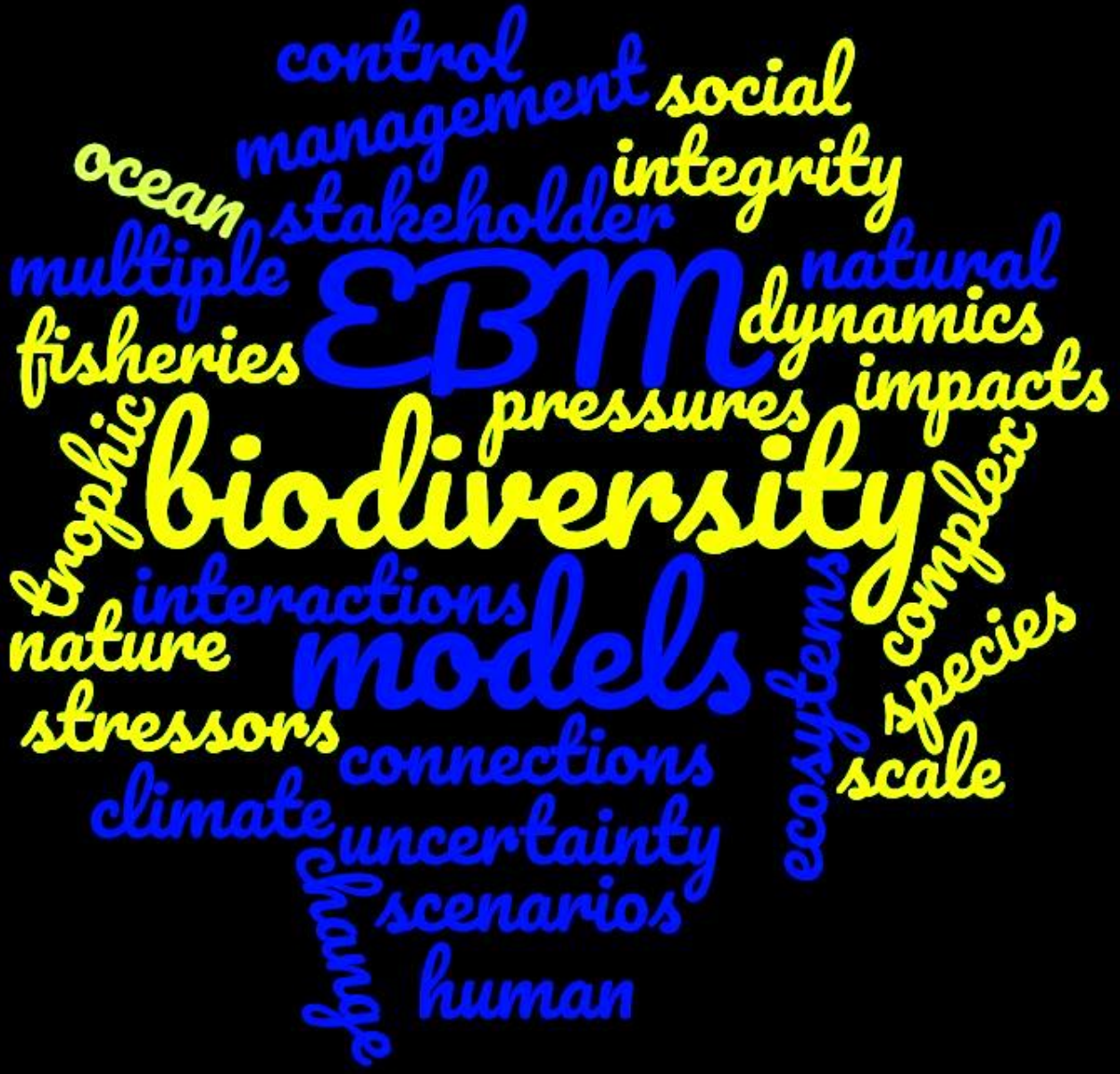
A hot-spot of global changes



Coll *et al.* (2012)
Micheli *et al.* (2013)
Halpern *et al.* (2015)

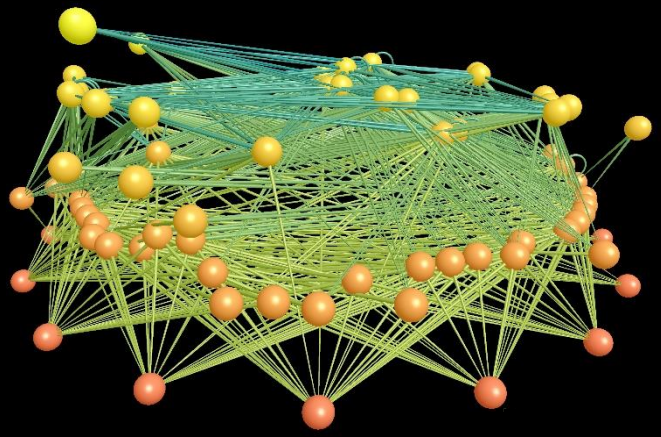

control
management
social
integrity
ocean
stakeholder
multiple
EBM
natural
dynamics
fisheries
pressures
impacts
trophic
biodiversity
complex
interactions
models
nature
species
stressors
connections
scale
climate
uncertainty
ecosystems
change
scenarios
human

Ecosystem-based management



Which tools and methods are involved?

End-to-End models



Travers *et al.* (2007)

What are the emerging conditions of marine communities ?

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Impact of CC on species distributions ?
(considering trophic interactions !)

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Impact of CC on species distributions ?
(considering trophic interactions !)

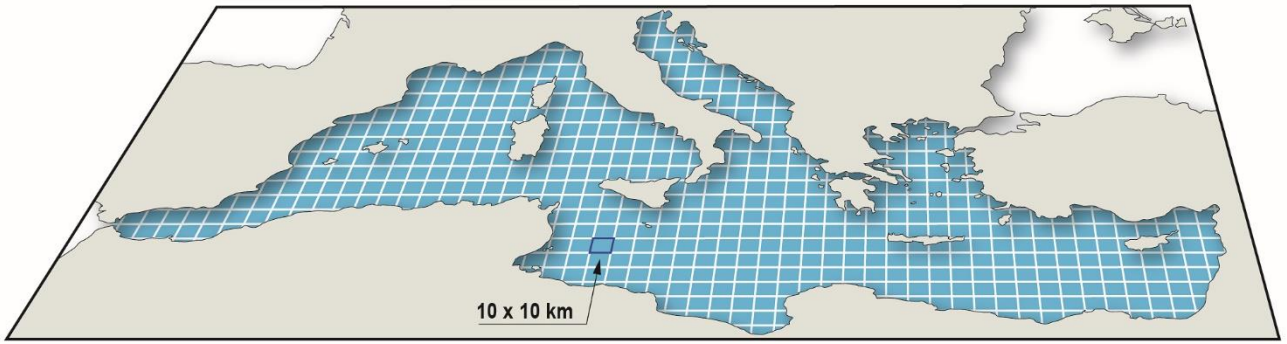
How fishing and climate may affect marine food webs ?

How ?

How ?

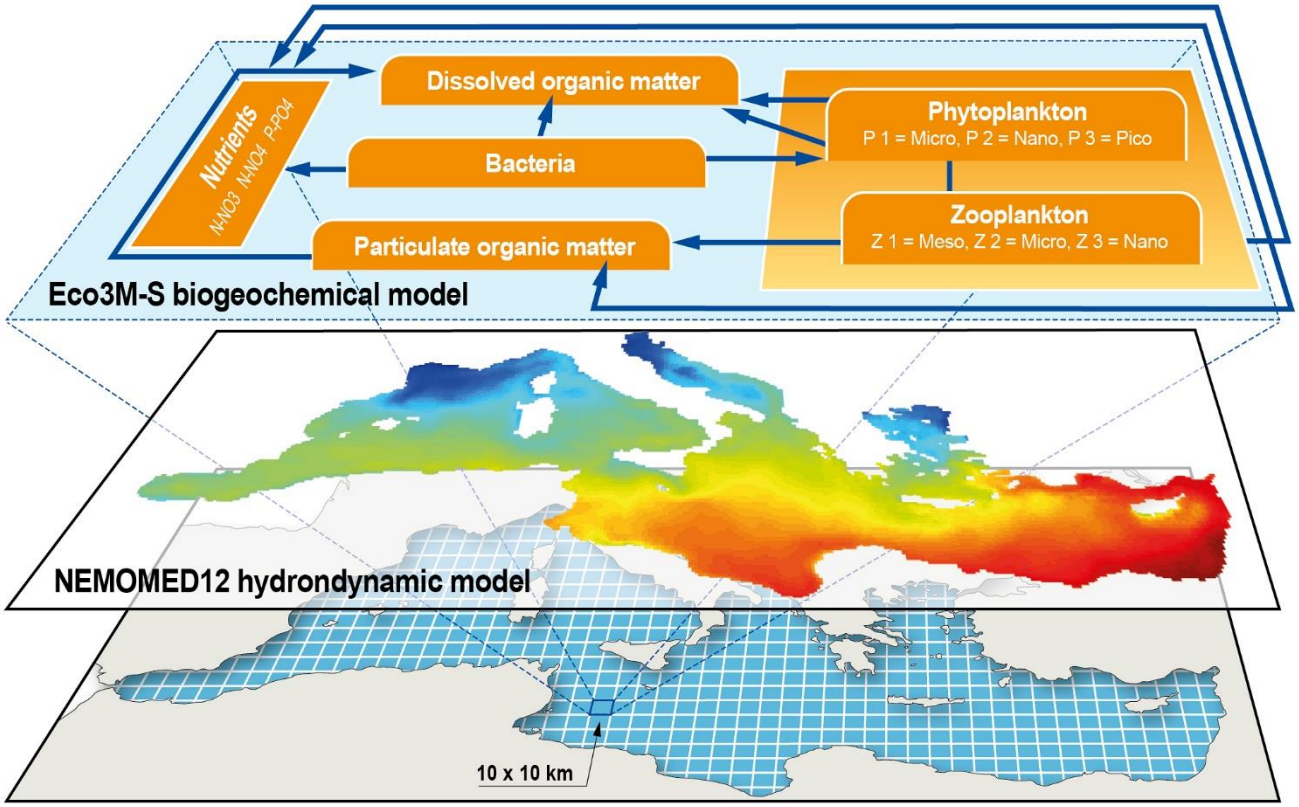
By coupling physical – biogeochemical and fish community models

Spatial grid of 100 km²
≈ 25 000 cells



Coupled model
Physical-biogeochemical
NEMOMED12 – Eco3M-S
(offline)

Spatial grid of 100 km²



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Physical-biogeochemical
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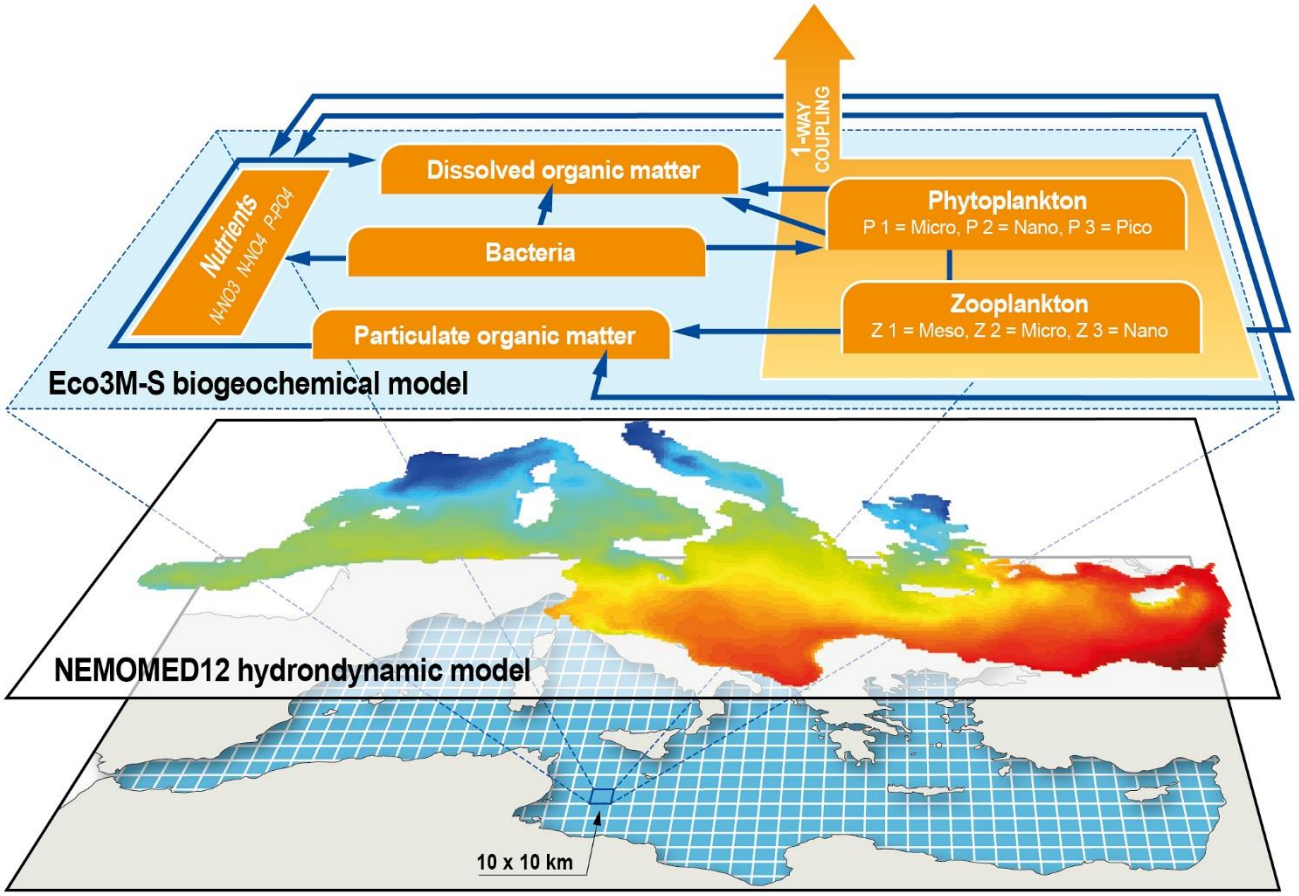
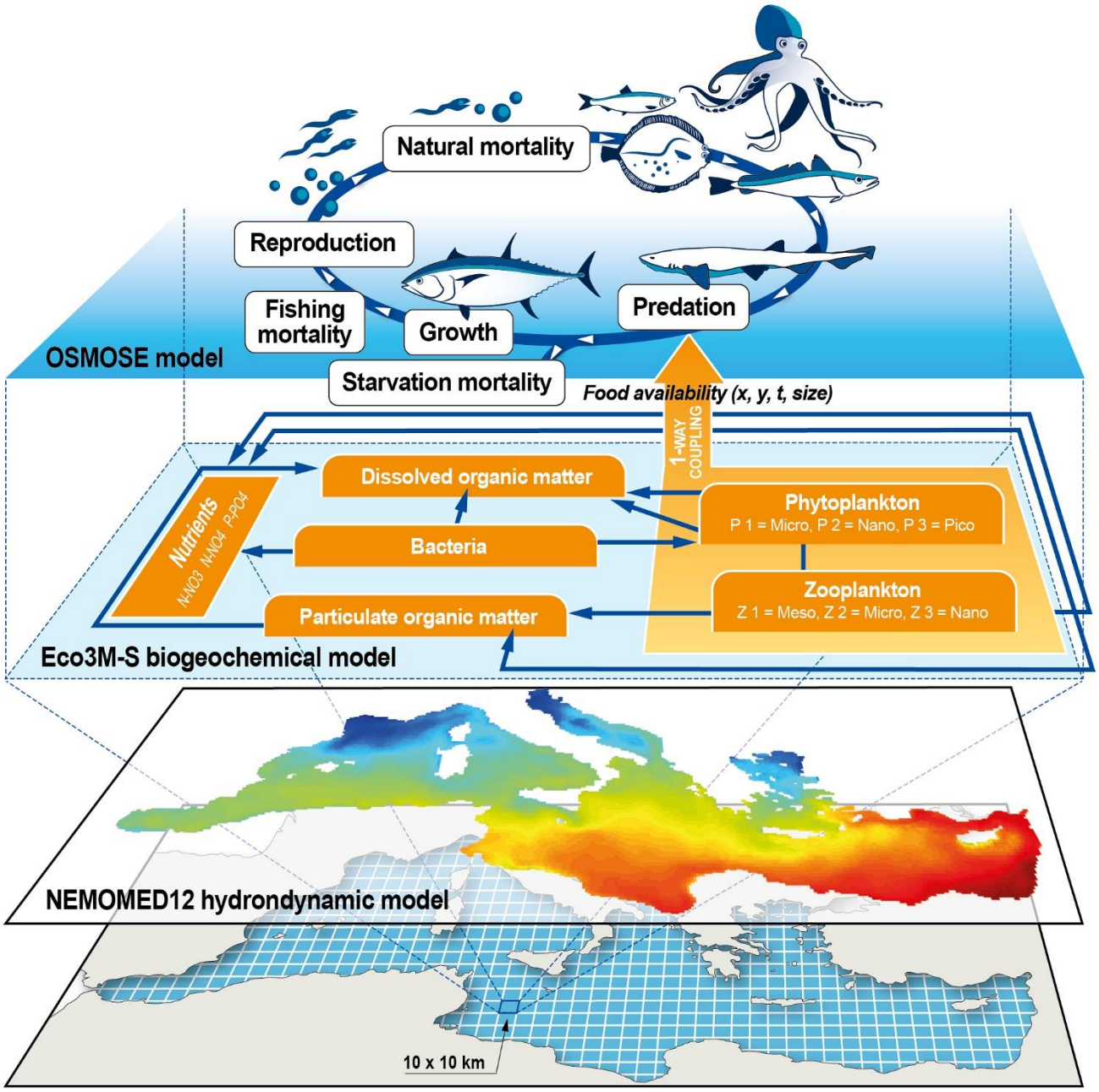


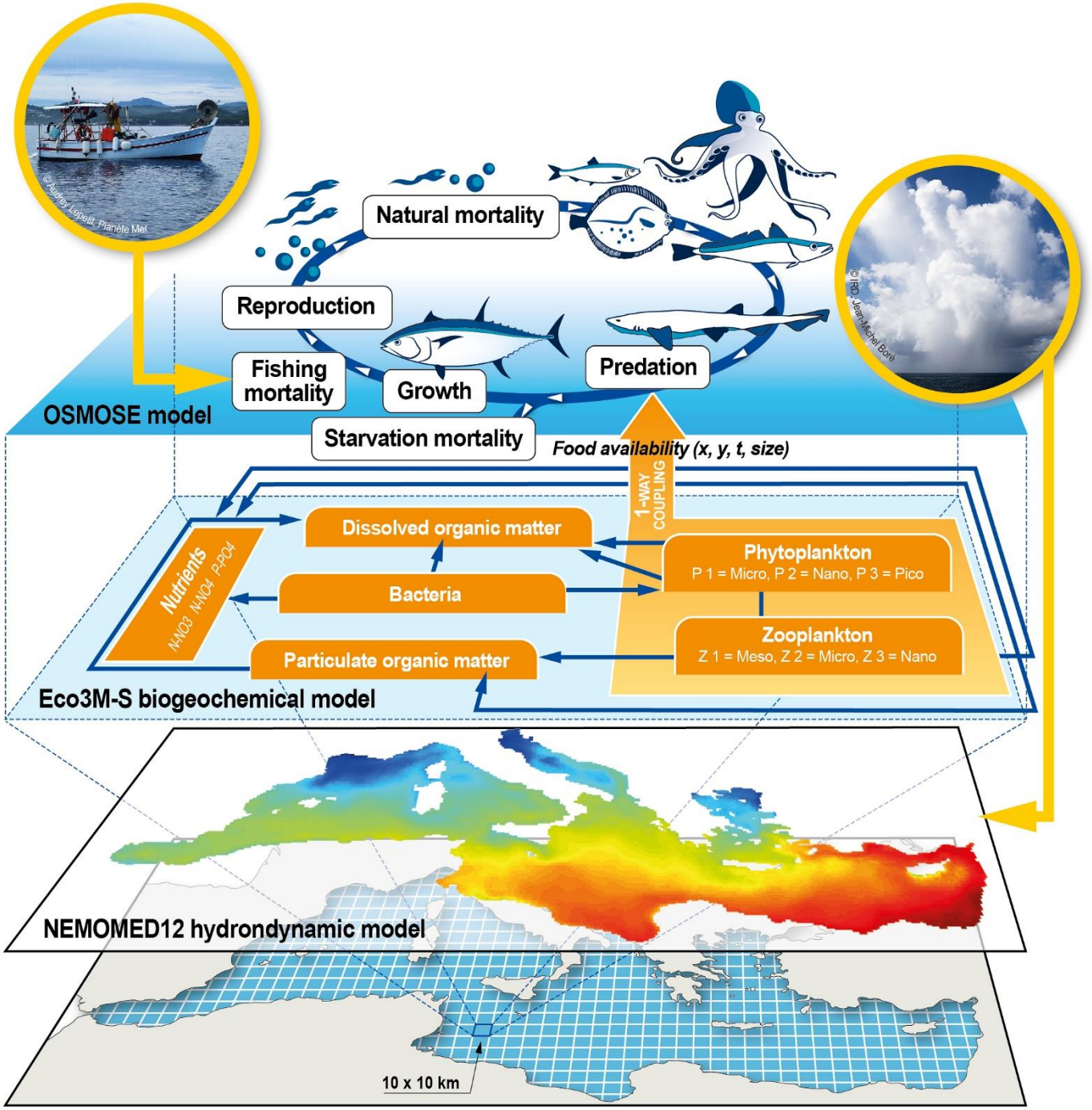
Community model
OSMOSE

Coupled model
Physical-biogeochemical
NEMOMED12 – Eco3M-S
(offline)

Spatial grid of 100 km²



OSMOSE - MED


© Audrey Lepelit, Planète Mer
Natural mortality
Reproduction
Fishing mortality
Growth
Predation
Starvation mortality
OSMOSE model
Food availability (x, y, t, size)
1-WAY COUPLING
© IRD, Jean-Michel Boré
Dissolved organic matter
Nutrients
N-NO3 N-NO4 P-PO4
Bacteria
Phytoplankton
P 1 = Micro, P 2 = Nano, P 3 = Pico
Zooplankton
Z 1 = Meso, Z 2 = Micro, Z 3 = Nano
Particulate organic matter
Eco3M-S biogeochemical model
NEMOMED12 hydrondynamic model
10 x 10 km

Multispecies and individual-based model

OSMOSE - MED

Shin & Cury (2001, 2004)
Travers *et al.* (2009)

Multispecies and individual-based model
Opportunistic predation based on size

OSMOSE - MED

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Entire life cycle of species

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OSMOSE - MED

Multispecies and individual-based model
Opportunistic predation based on size
Entire life cycle of species

Predation
Growth
Reproduction
Mortalities
Migration

Shin & Cury (2001, 2004)
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Multispecies and individual-based model
Opportunistic predation based on size
Entire life cycle of species
Spatially explicit

OSMOSE - MED

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FishMed database
635 fish species
Albouy *et al* (2015)

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More than 140 sources !

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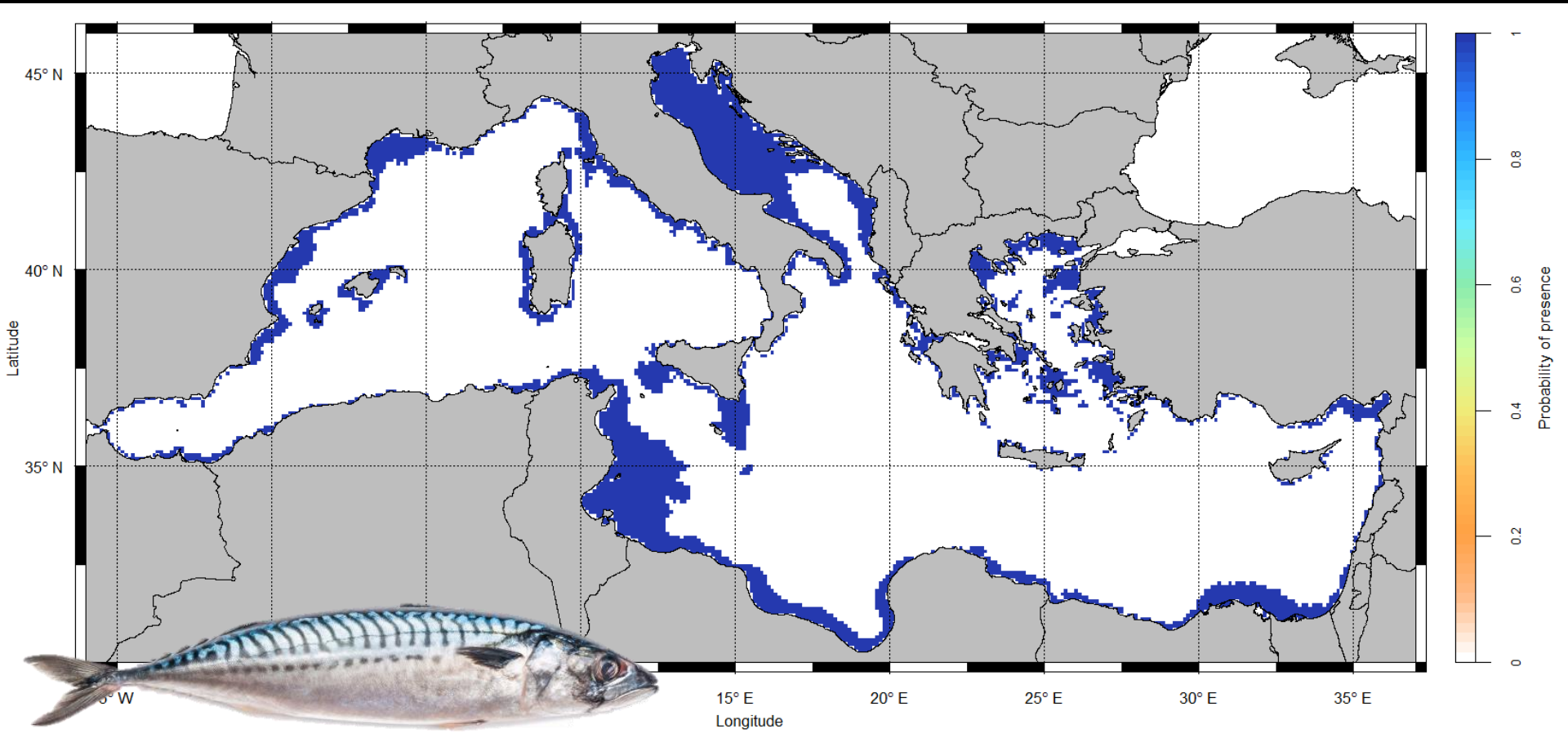
Search for spatial distribution data

FishMed (Albouy *et al*. (2015), MediSeH project (Giannoulaki *et al*. (2013), Druon *et al*. (2016), FAO Geonetwork, AquaMaps

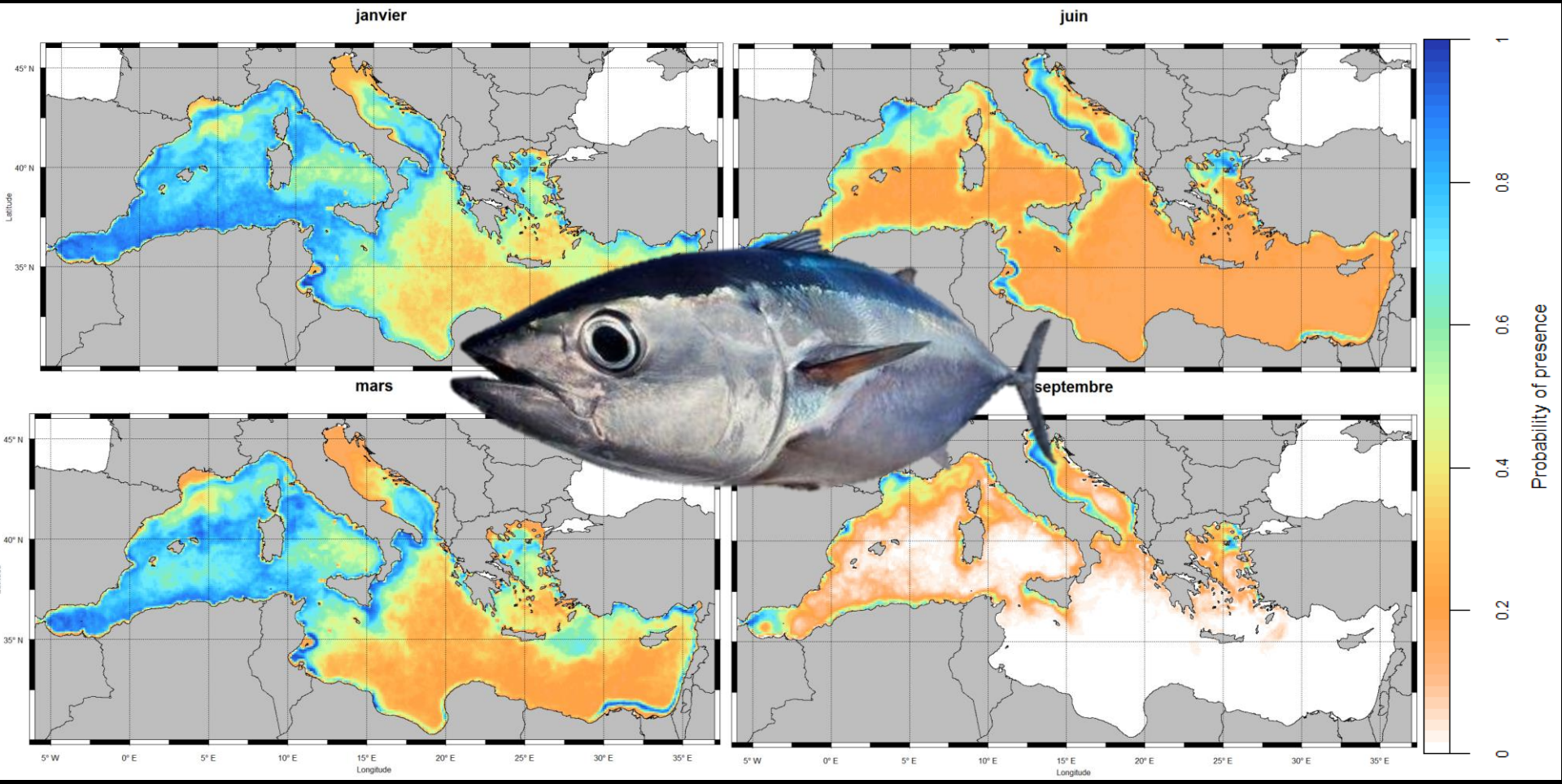
A Spatially explicit model

e.g. Atlantic mackerel (only one map from FAO geonetwork)



A Spatially explicit model

e.g. juvenile bluefin tuna (distribution by age or size and season)



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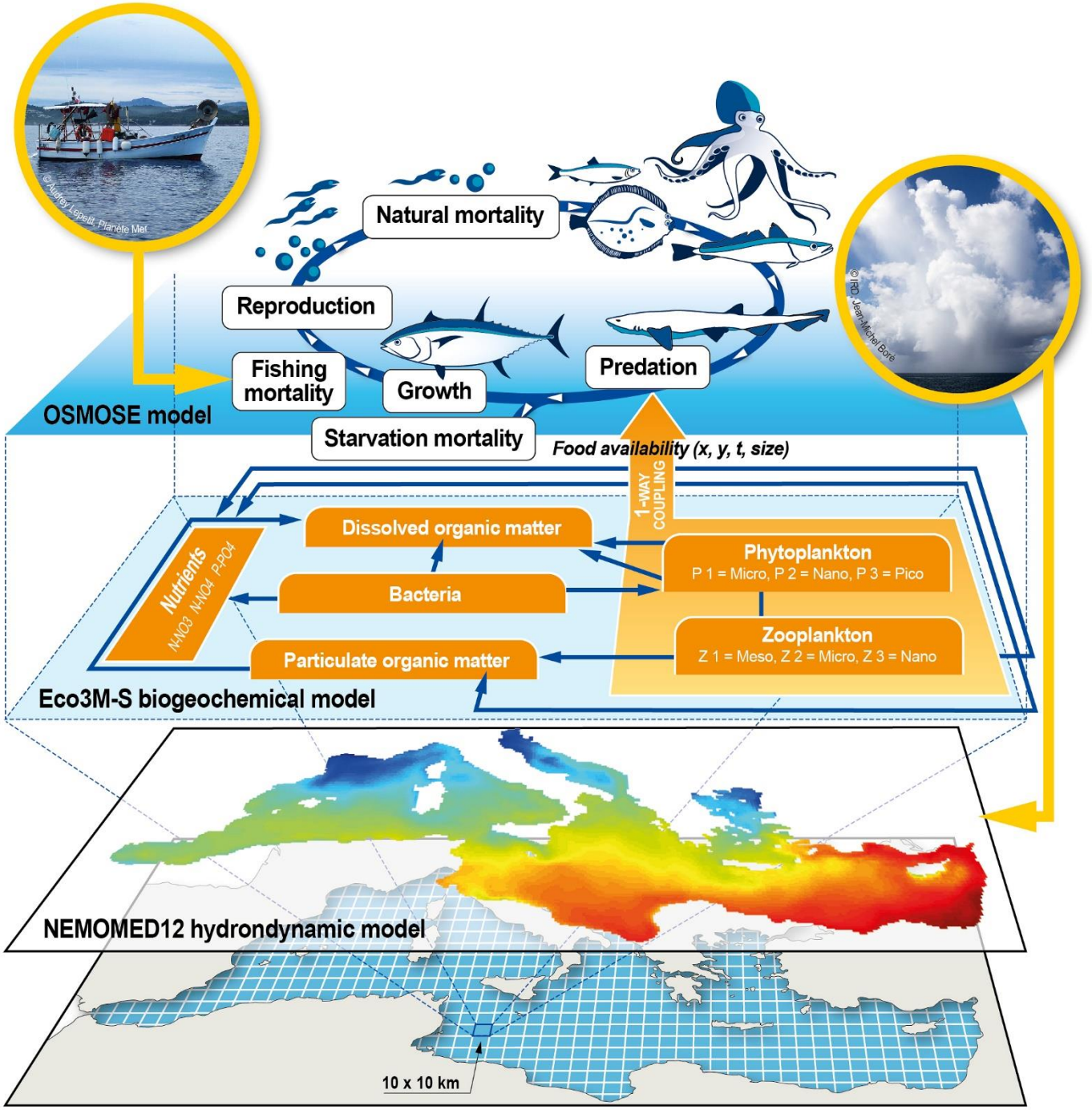
Integration of mediterranean best ecological knowledge

114 species

99 fish
5 cephalopods
10 crustaceans

Representing
95 % of total catches



Ecosytem models need to be confronted with data

How to calibrate the model to fit on observed values ?

How to calibrate the model to fit on observed values ?

Estimate unknown parameters (e.g. larval mortalities) to fit on observed biomass

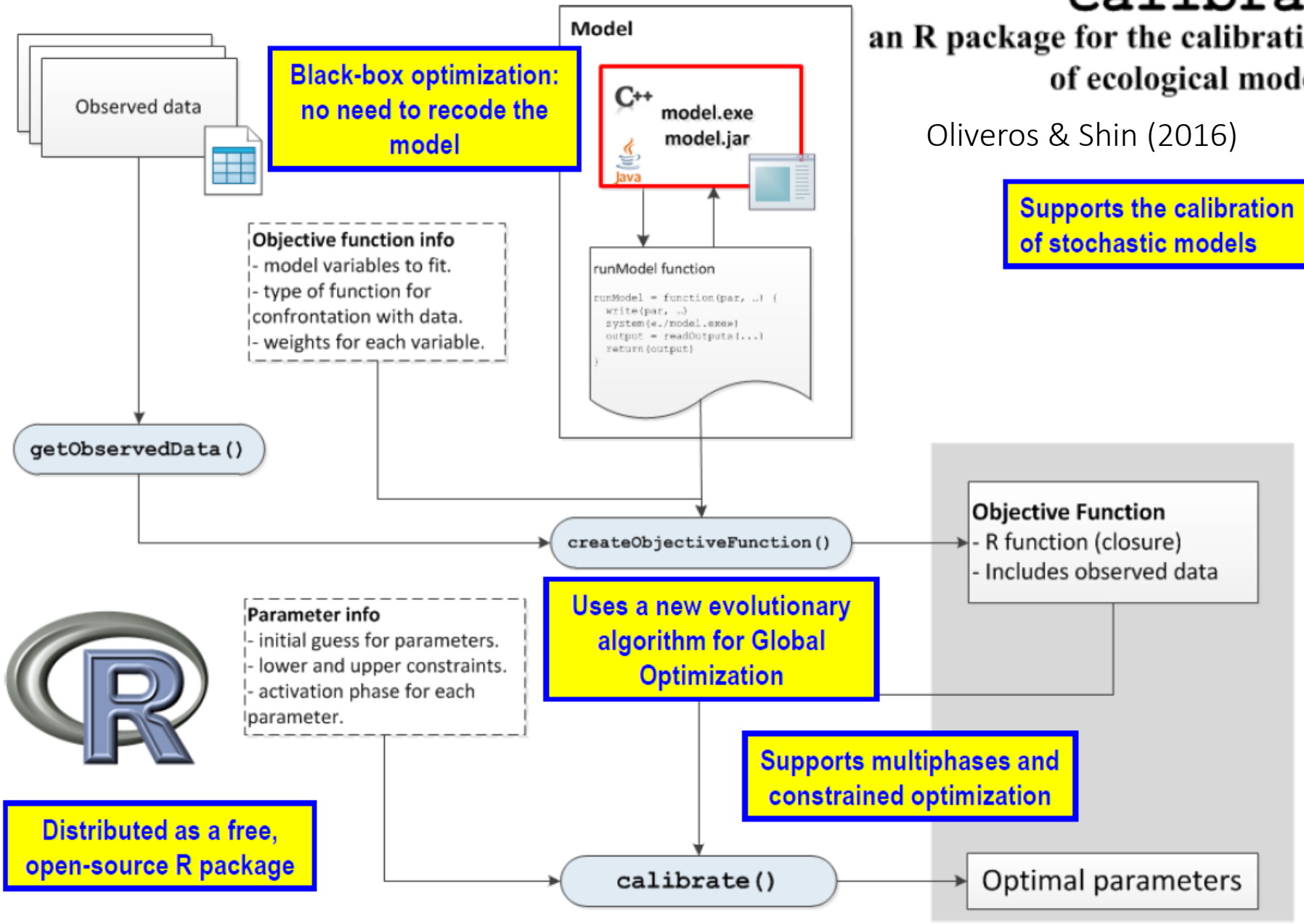
→ MEDITS survey on the 2006 – 2013 period

OSMOSE is a complex stochastic model

calibraR

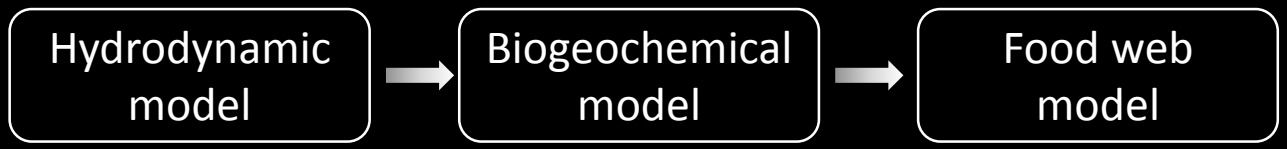
an R package for the calibration of ecological models

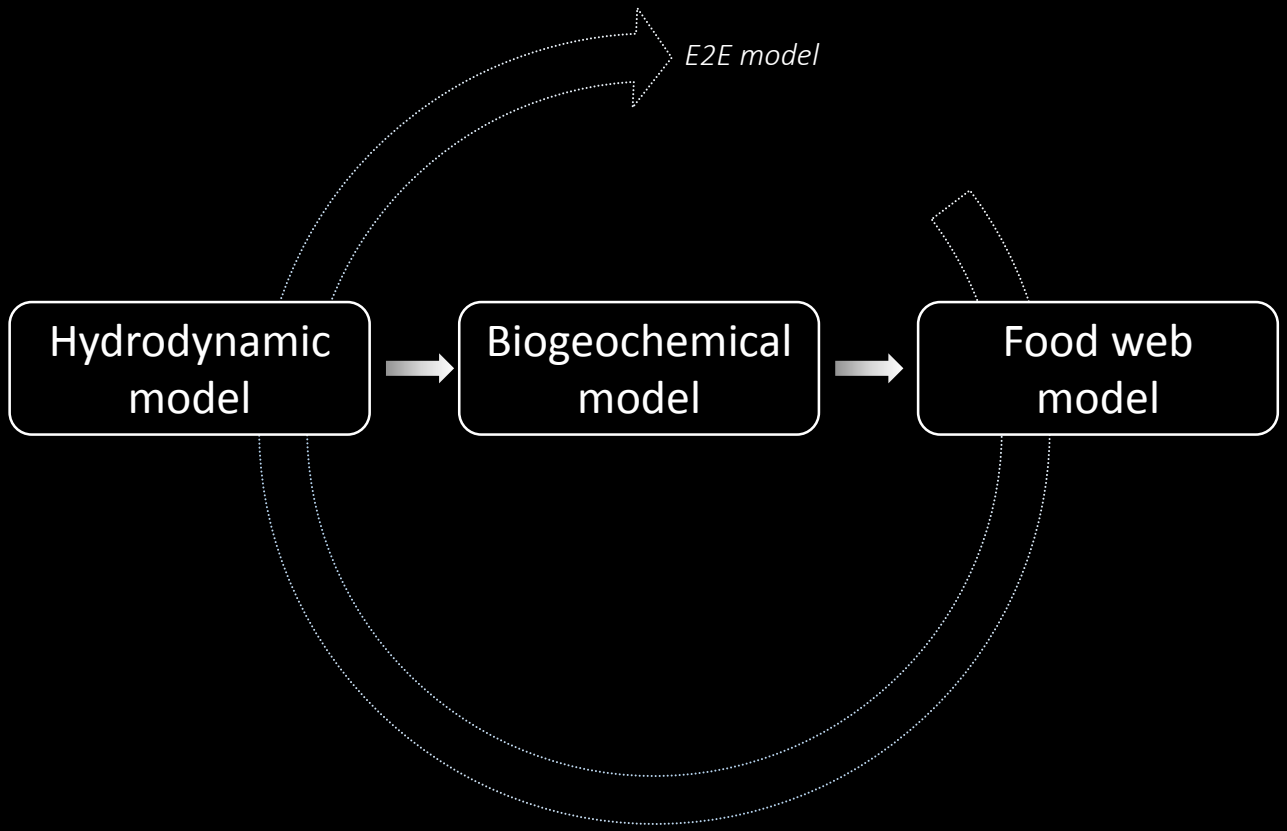
Oliveros & Shin (2016)

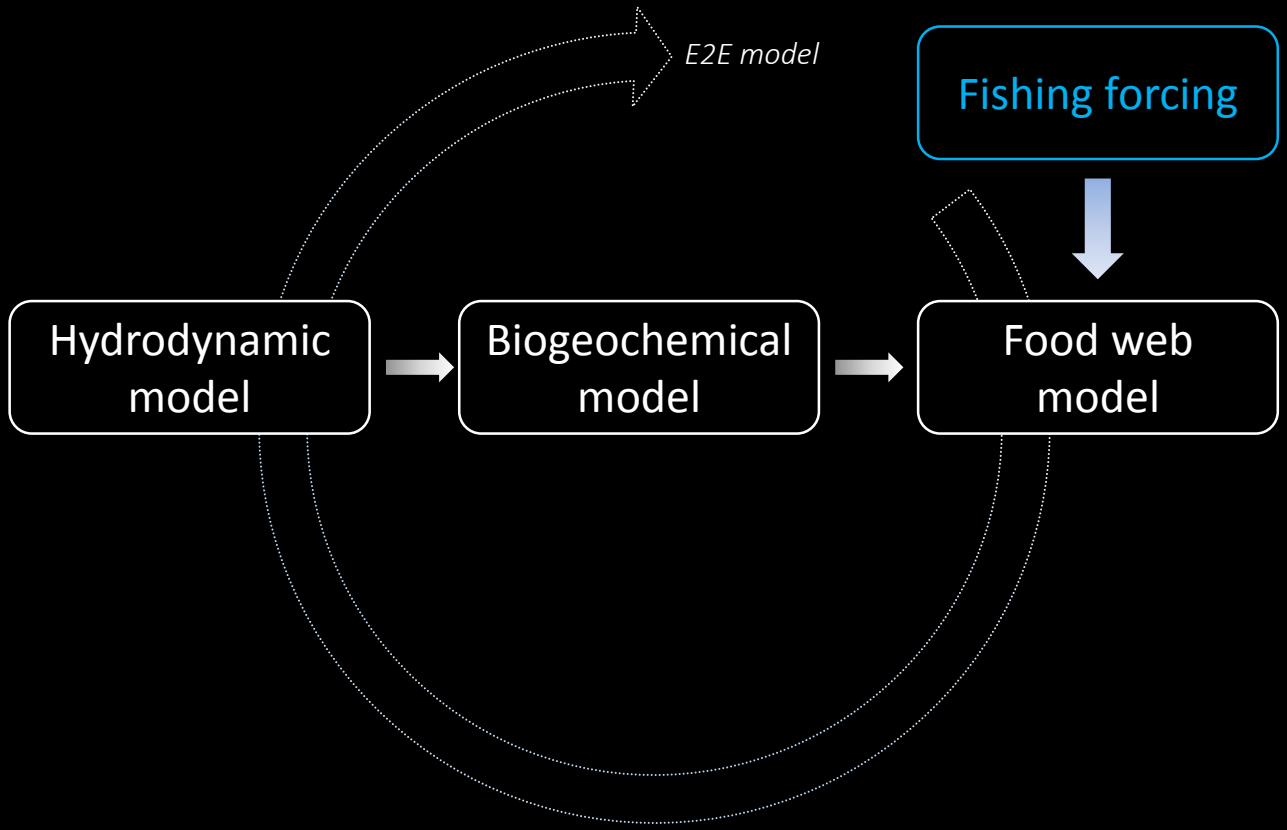


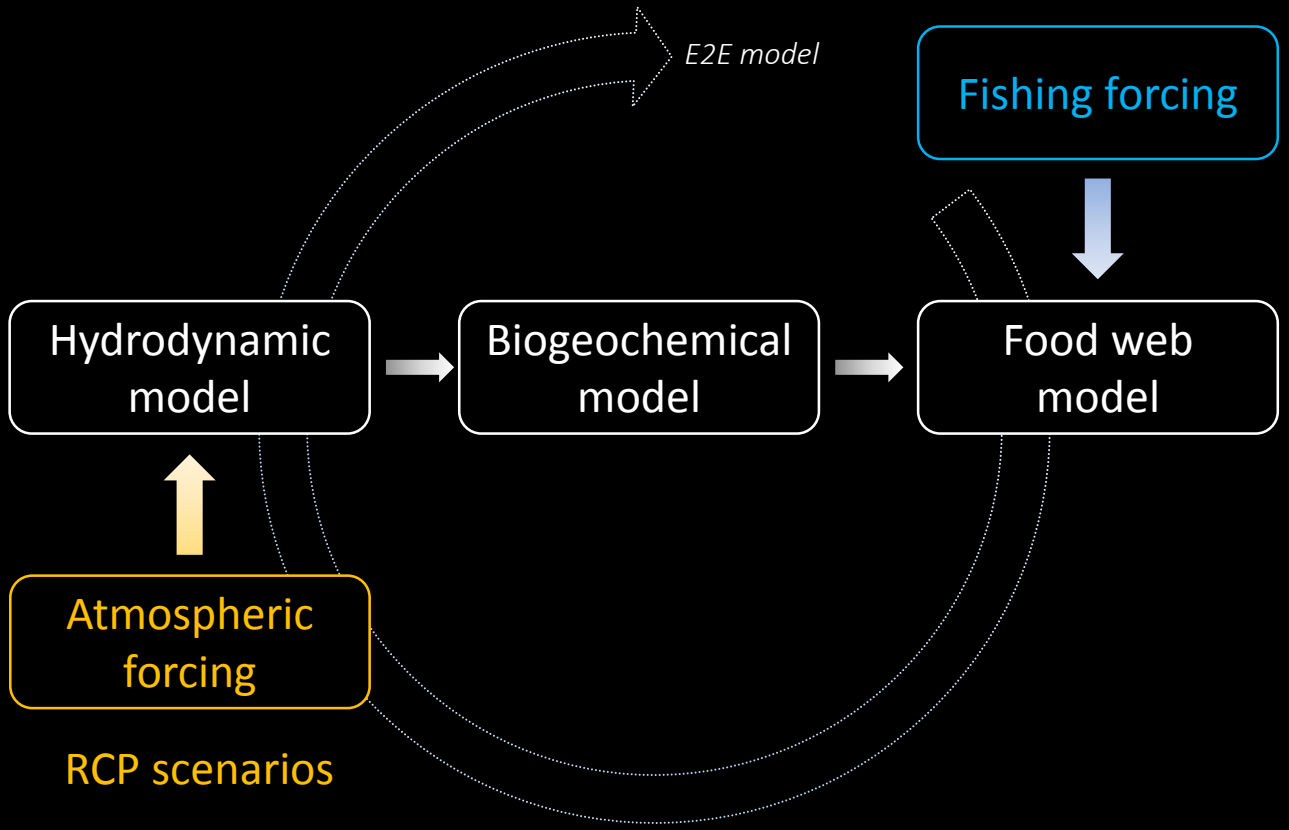
http://roliveros-ramos.github.io/calibrar/

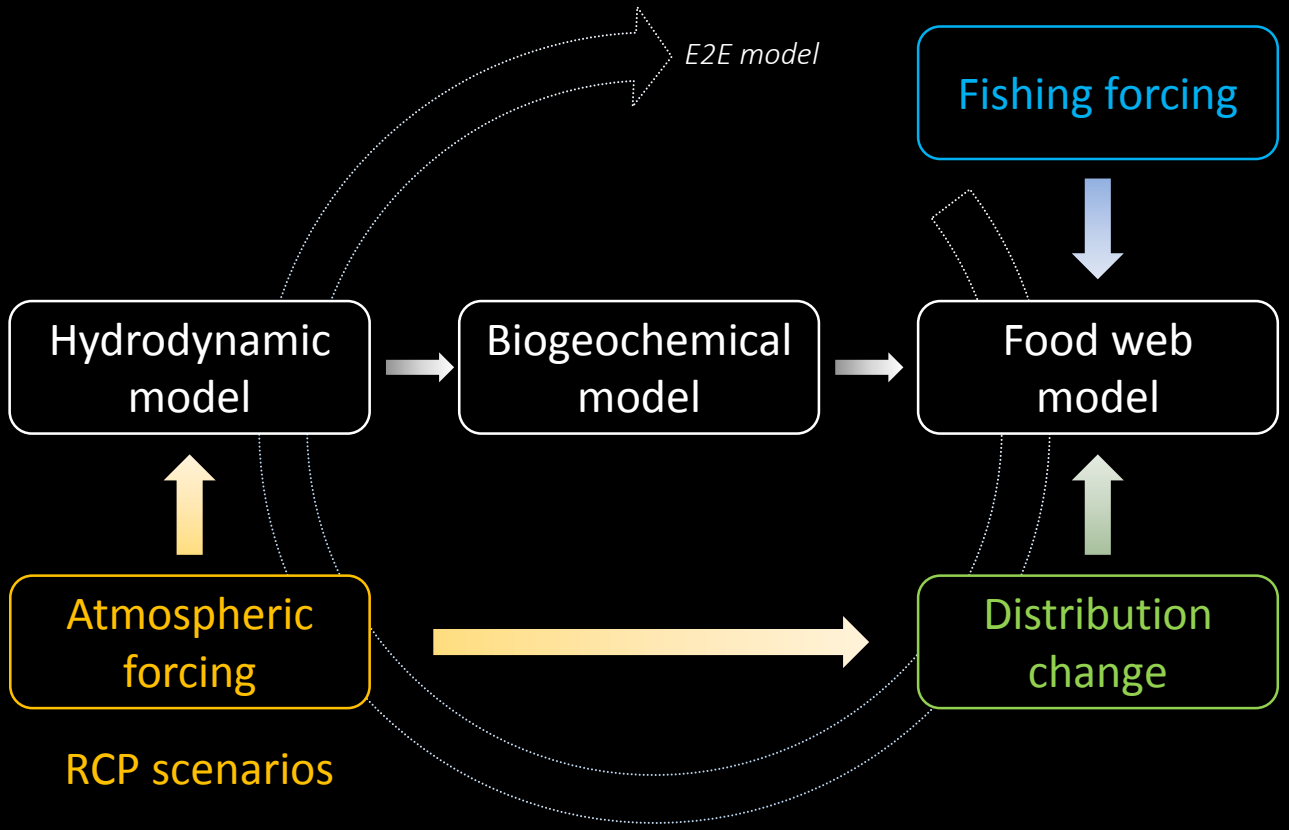
To conclude

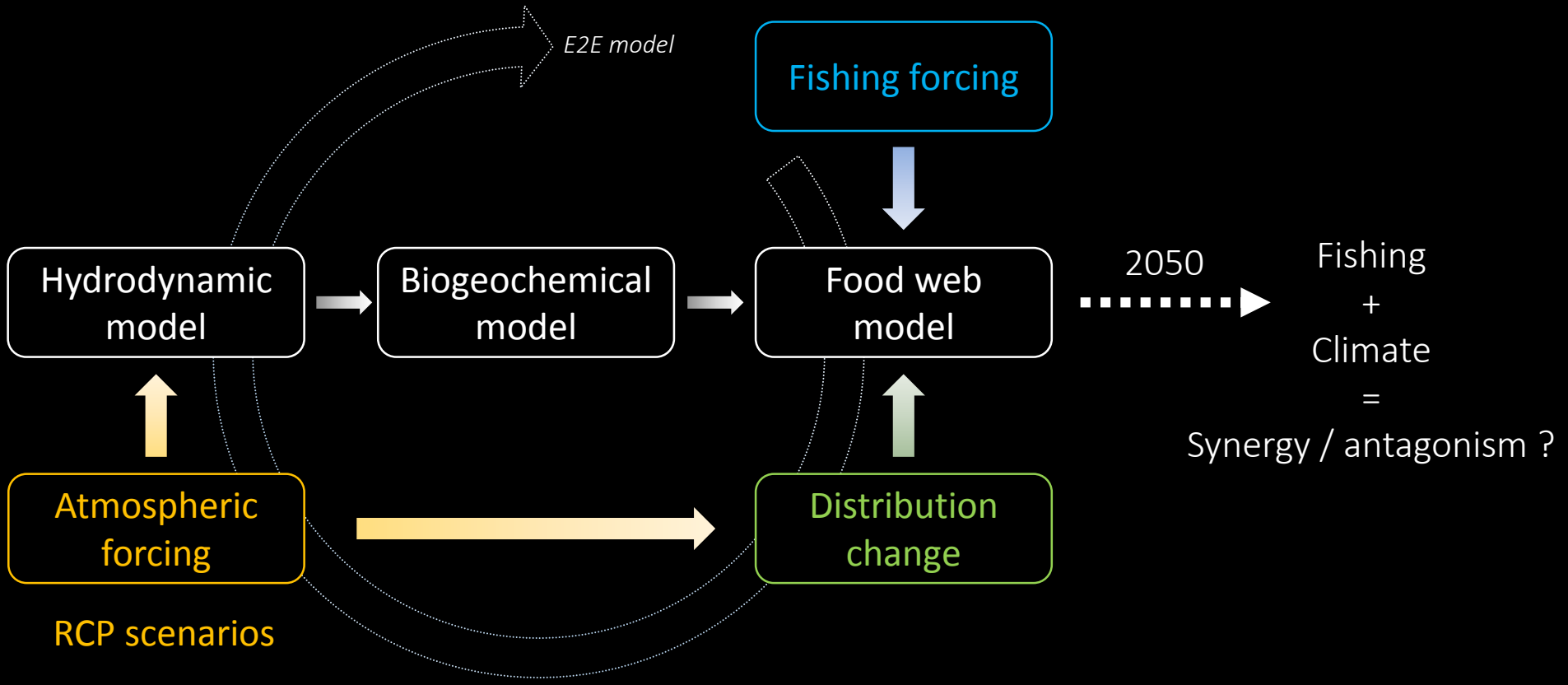

Hydrodynamic model
Biogeochemical model
Food web model


E2E model
Hydrodynamic model
Biogeochemical model
Food web model


E2E model
Fishing forcing
Hydrodynamic model
Biogeochemical model
Food web model


E2E model
Fishing forcing
Hydrodynamic model
Biogeochemical model
Food web model
Atmospheric forcing
RCP scenarios


E2E model
Fishing forcing
Hydrodynamic model
Biogeochemical model
Food web model
Atmospheric forcing
Distribution change
RCP scenarios


E2E model
Fishing forcing
Hydrodynamic model
Biogeochemical model
Food web model
2050
Fishing
+
Climate
=
Synergy / antagonism ?
Atmospheric forcing
Distribution change
RCP scenarios

OSMOSE - MED

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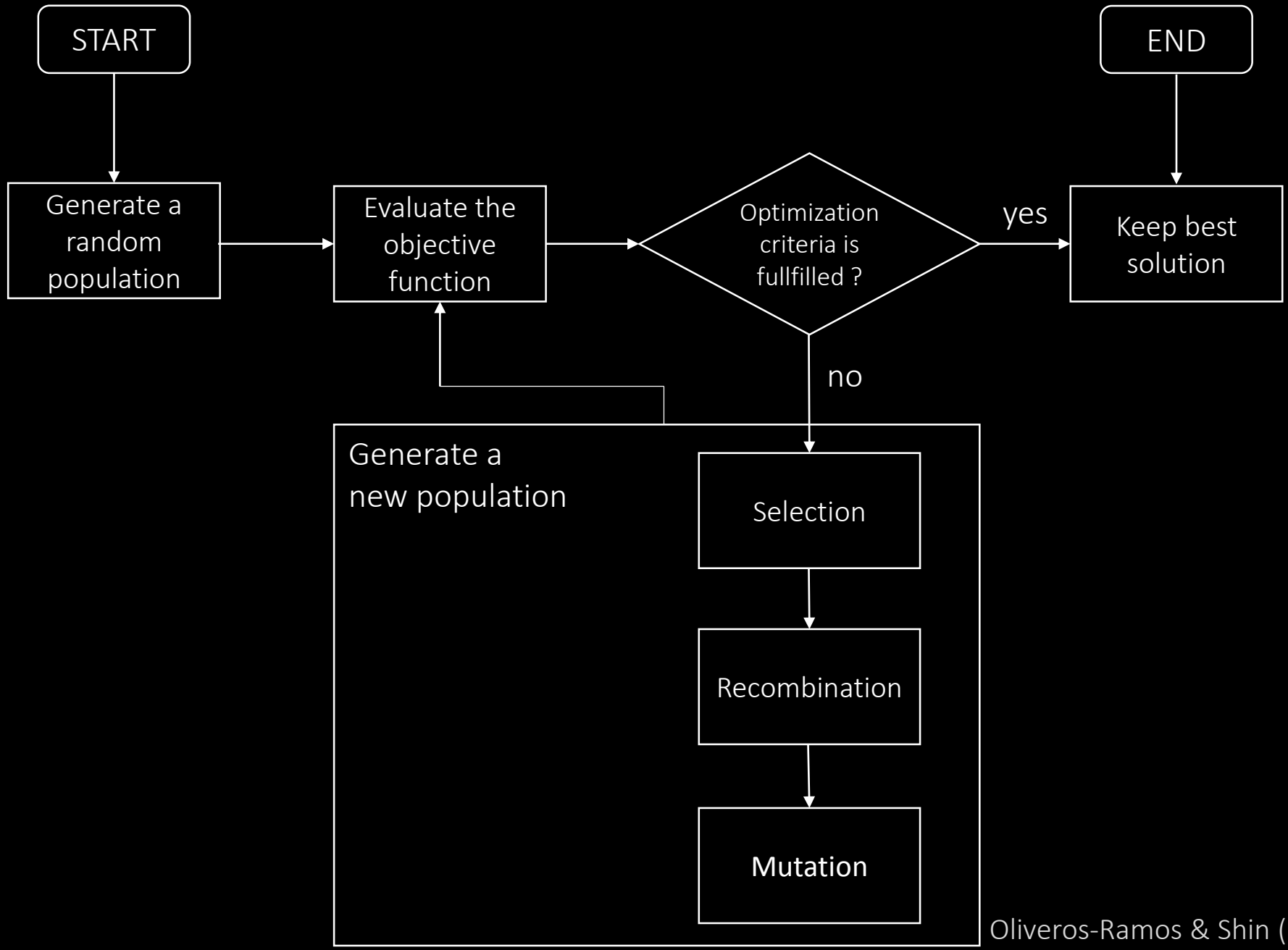
Outputs ?

size-based and species-based ecological indicators

at different levels of aggregation: species and community levels

Adaptative hierarchical recombination – Evolutionary strategies



Oliveros-Ramos & Shin (2016)