# Climate Change Risks for Regional Marine Ecosystems & Fisheries

Tyler Eddy

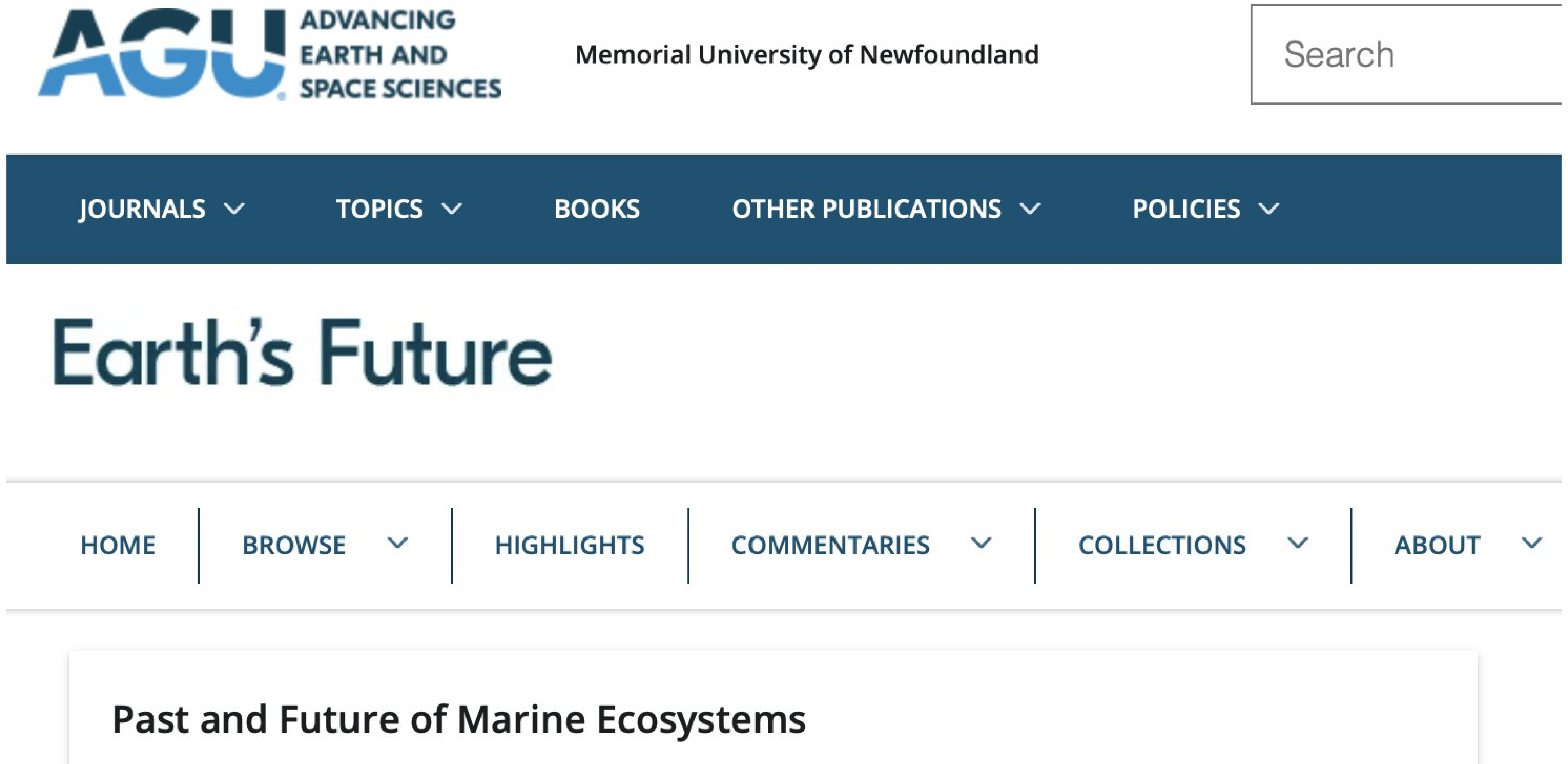
ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

FishMIP
Fisheries & Marine Ecosystem Model Intercomparison Project

MARINE INSTITUTE

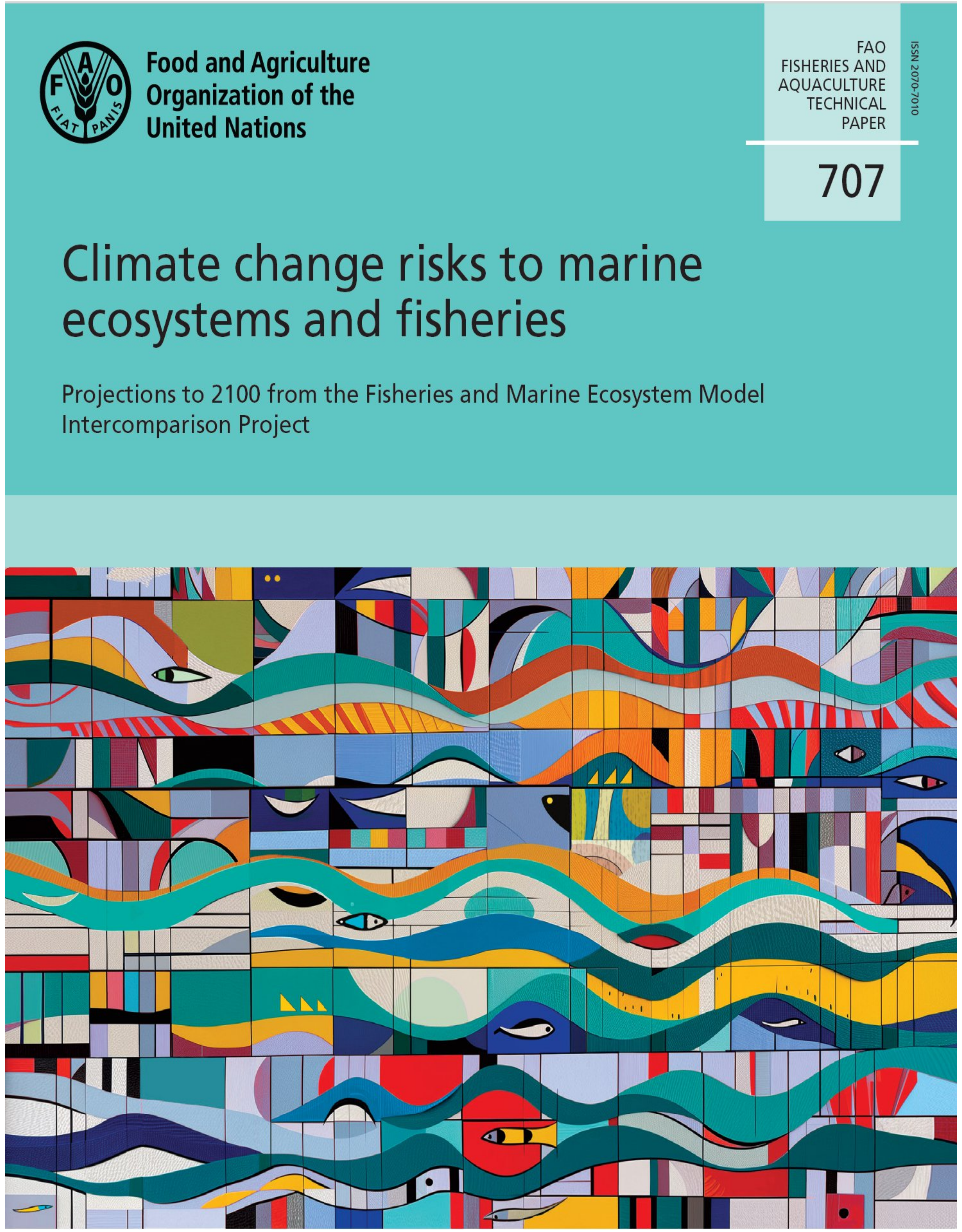
THE LIFE AQUATIC

MEMORIAL UNIVERSITY



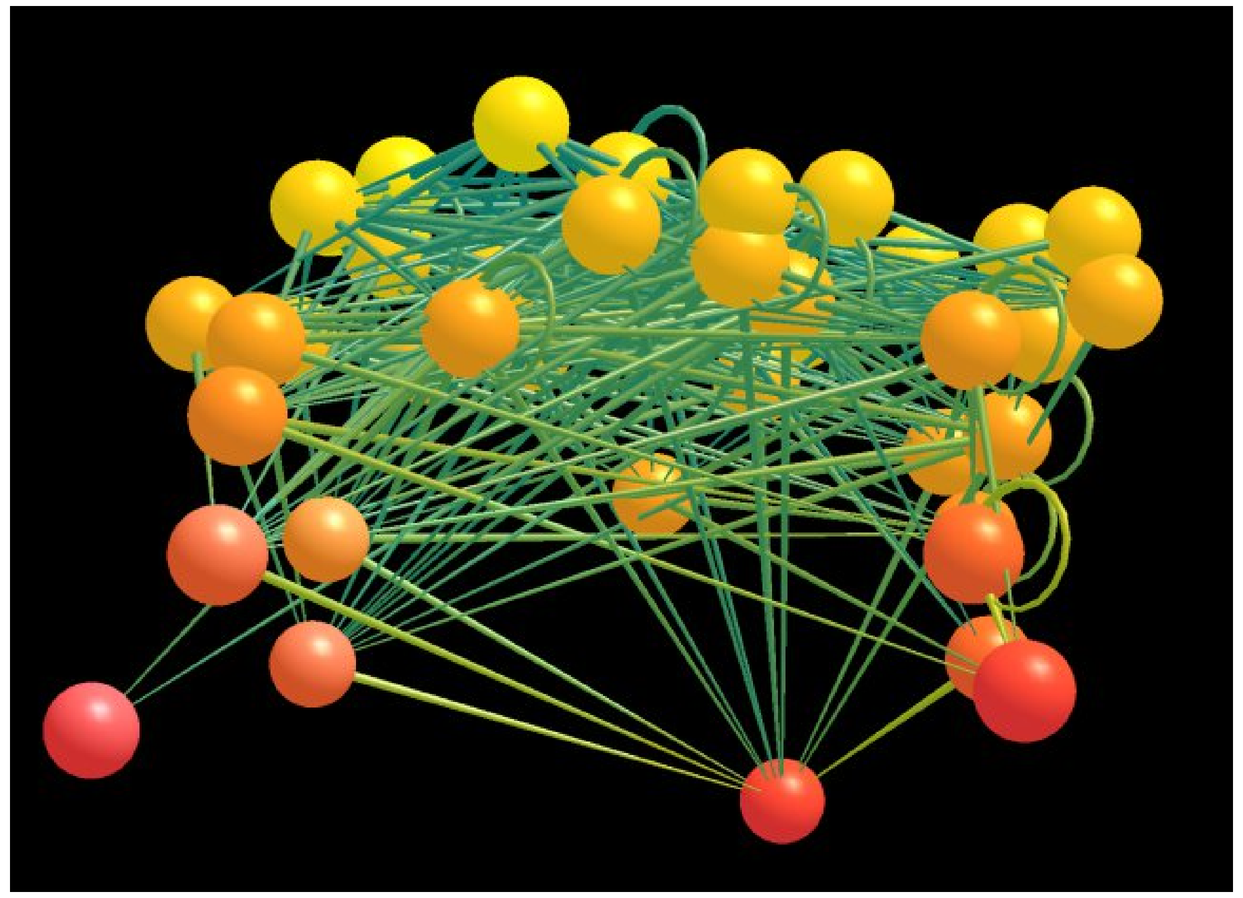

Special issue with 16 articles

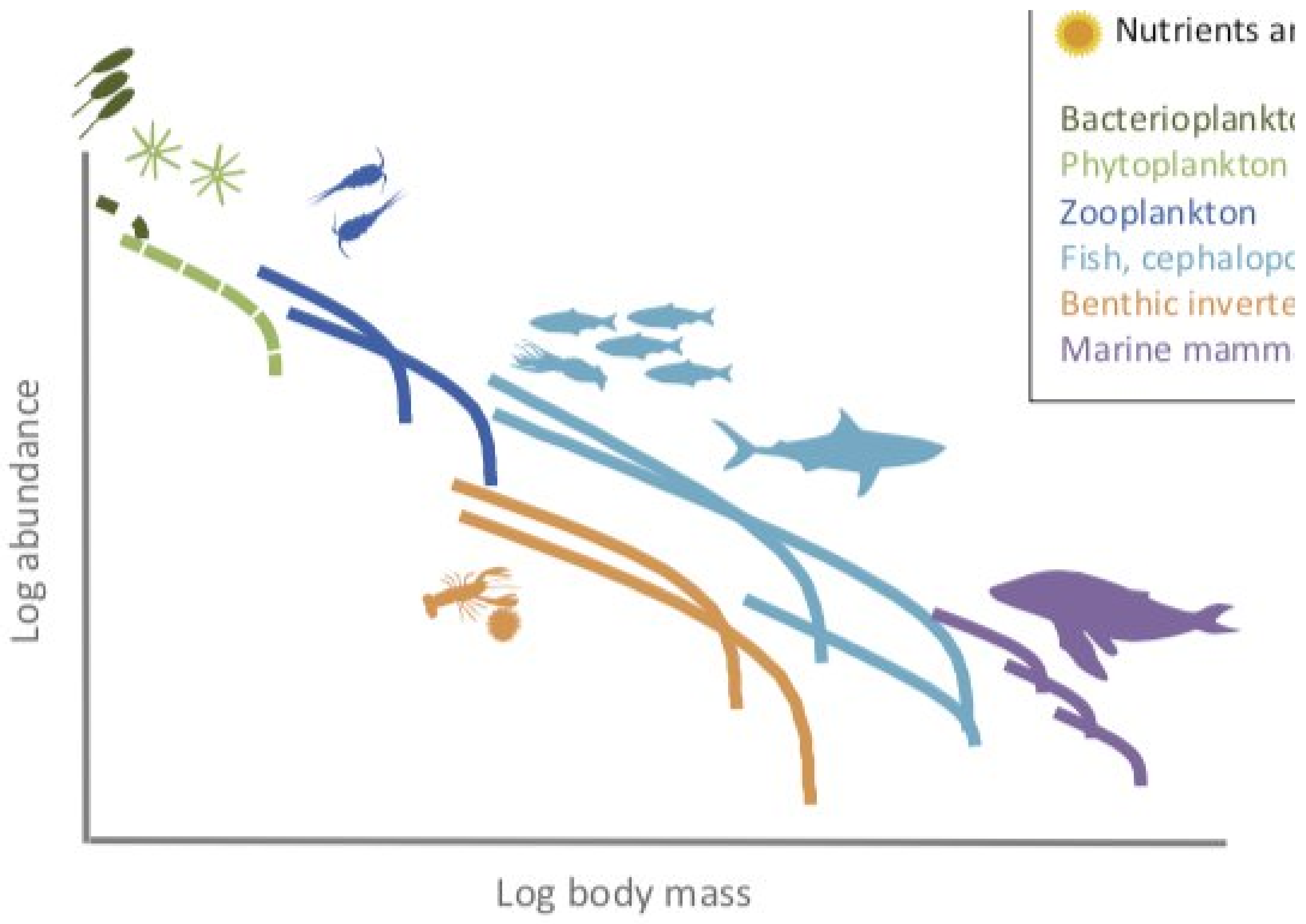
FishMIP
Fisheries & Marine Ecosystem Model Intercomparison Project

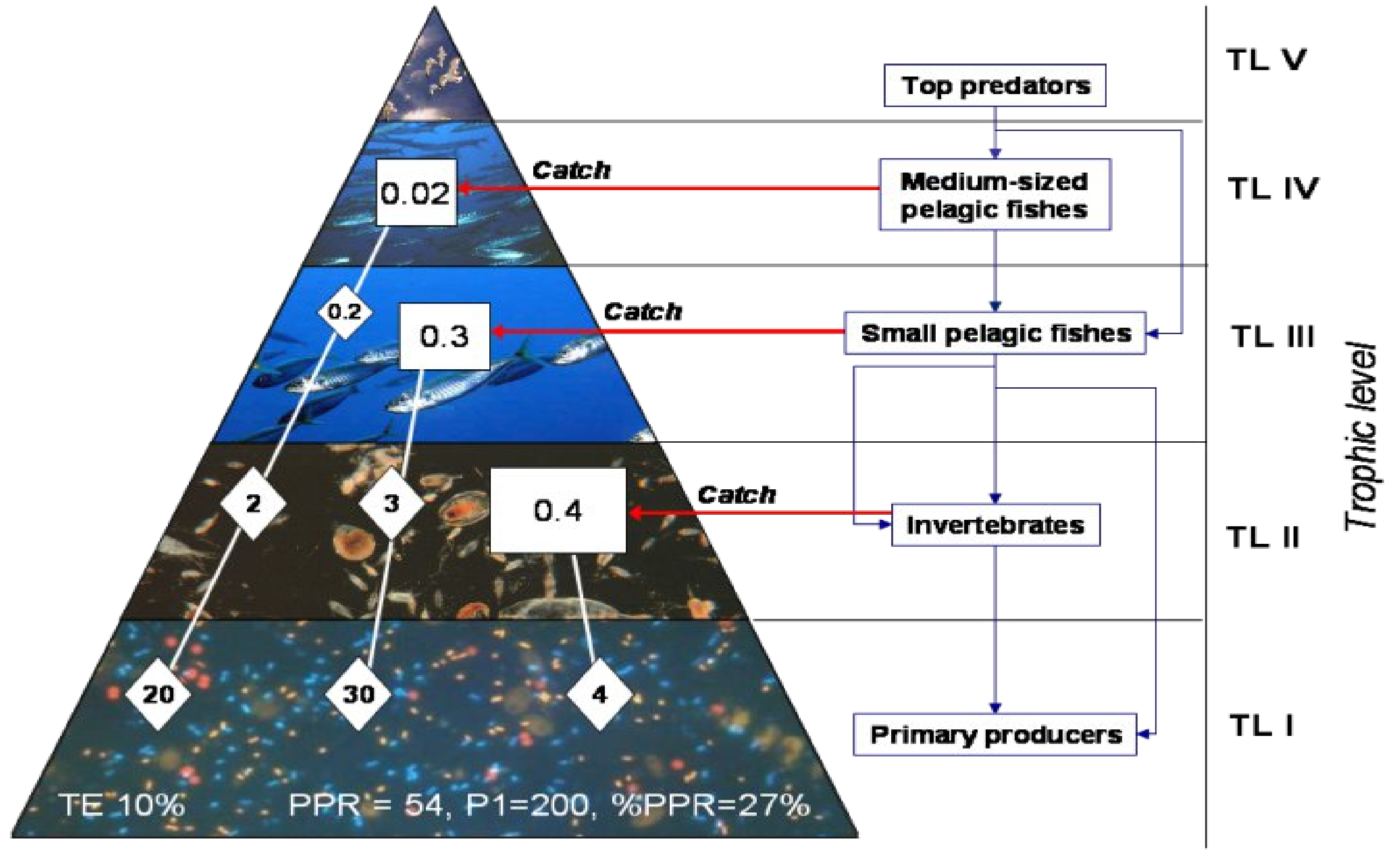


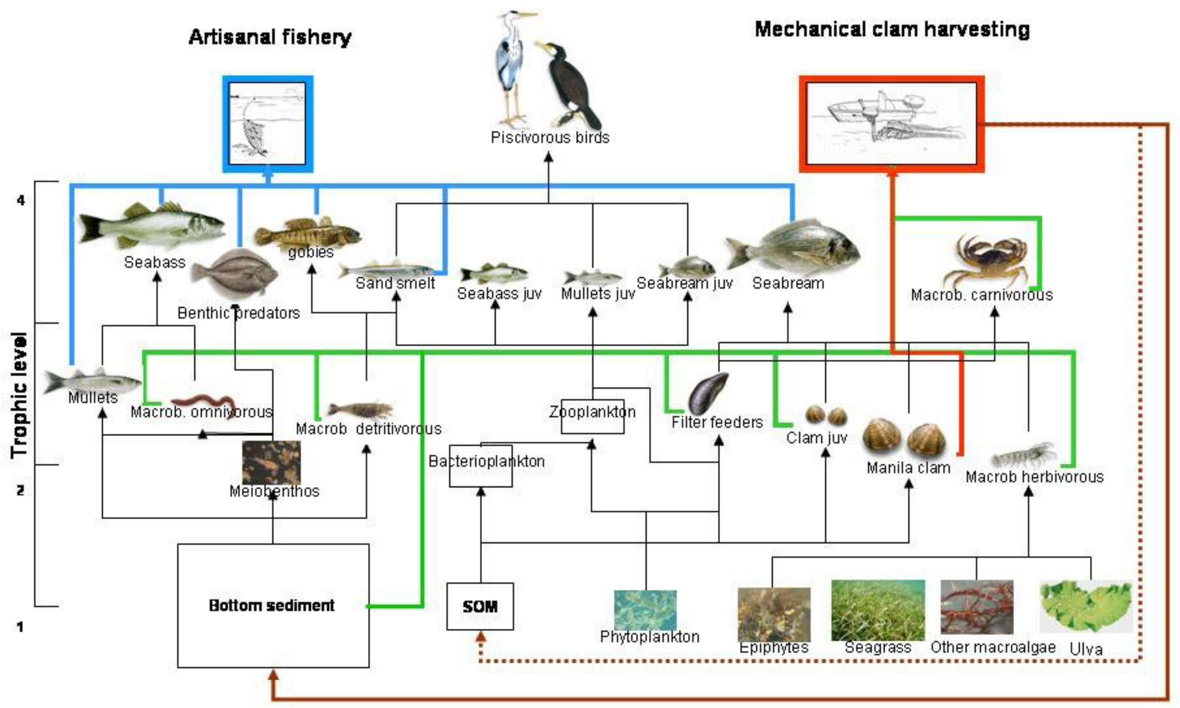

Blanchard and Novaglio 2024 (eds)

# FishMIP Models






Large Model Diversity:

- Size or age-based
- Food-web
- Species distribution
- Hybrid models

FISHERIES & MARINE ECOSYSTEM
FISH-MIP
MODEL INTERCOMPARISON PROJECT

# Do regional and global models agree on climate change projections?

AGU ADVANCING EARTH AND SPACE SCIENCES

Earth's Future

RESEARCH ARTICLE
10.1029/2024EF005537

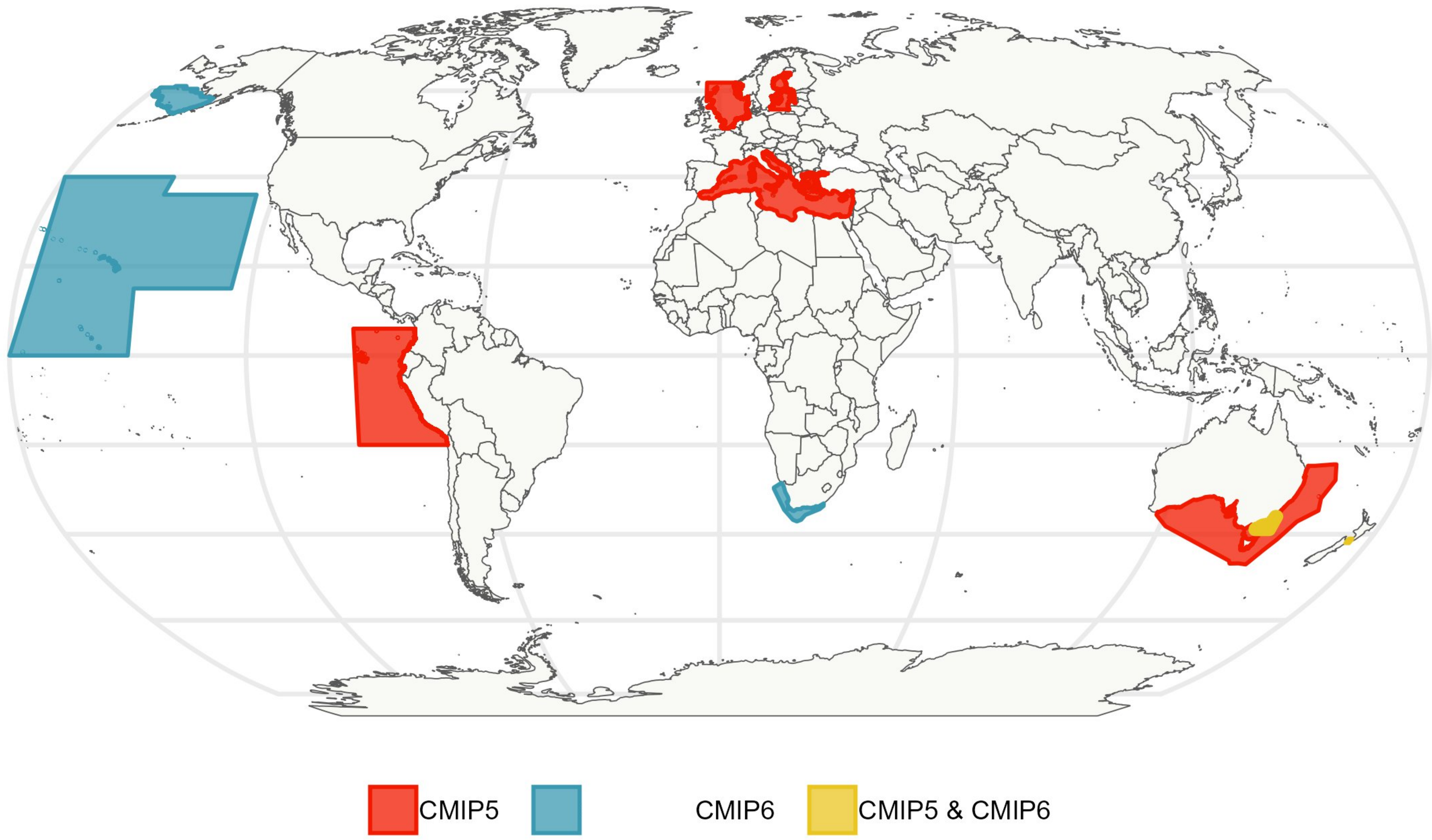
Special Collection:
Past and Future of Marine Ecosystems

## Global and Regional Marine Ecosystem Models Reveal Key Uncertainties in Climate Change Projections

Tyler D. Eddy[1], Ryan F. Heneghan[2], Andrea Bryndum-Buchholz[1], Elizabeth A. Fulton[3,4], Cheryl S. Harrison[5], Derek P. Tittensor[6], Heike K. Lotze[6], Kelly Ortega-Cisneros[7,8], Camilla Novaglio[4,9], Daniele Bianchi[10], Matthias Büchner[11], Catherine Bulman[3], William W. L. Cheung[12], Villy Christensen[12,13], Marta Coll[13,14], Jason D. Everett[15,16,17], Denisse Fierro-Arcos[9], Eric D. Galbraith[18], Didier Gascuel[19], Jerome Guiet[10], Steve Mackinson[20], Olivier Maury[21], Susa Niiranen[22], Ricardo Oliveros-Ramos[23], Juliano Palacios-Abrantes[12], Chiara Piroddi[24], Hubert du Pontavice[25], Jonathan Reum[26], Anthony J. Richardson[15,16], Jacob Schewe[11], Lynne Shannon[8], Yunne-Jai Shin[23], Jeroen Steenbeek[13], Jan Volkholz[11], Nicola D. Walker[27], Phoebe Woodworth-Jefcoats[28], and Julia L. Blanchard[4,9]

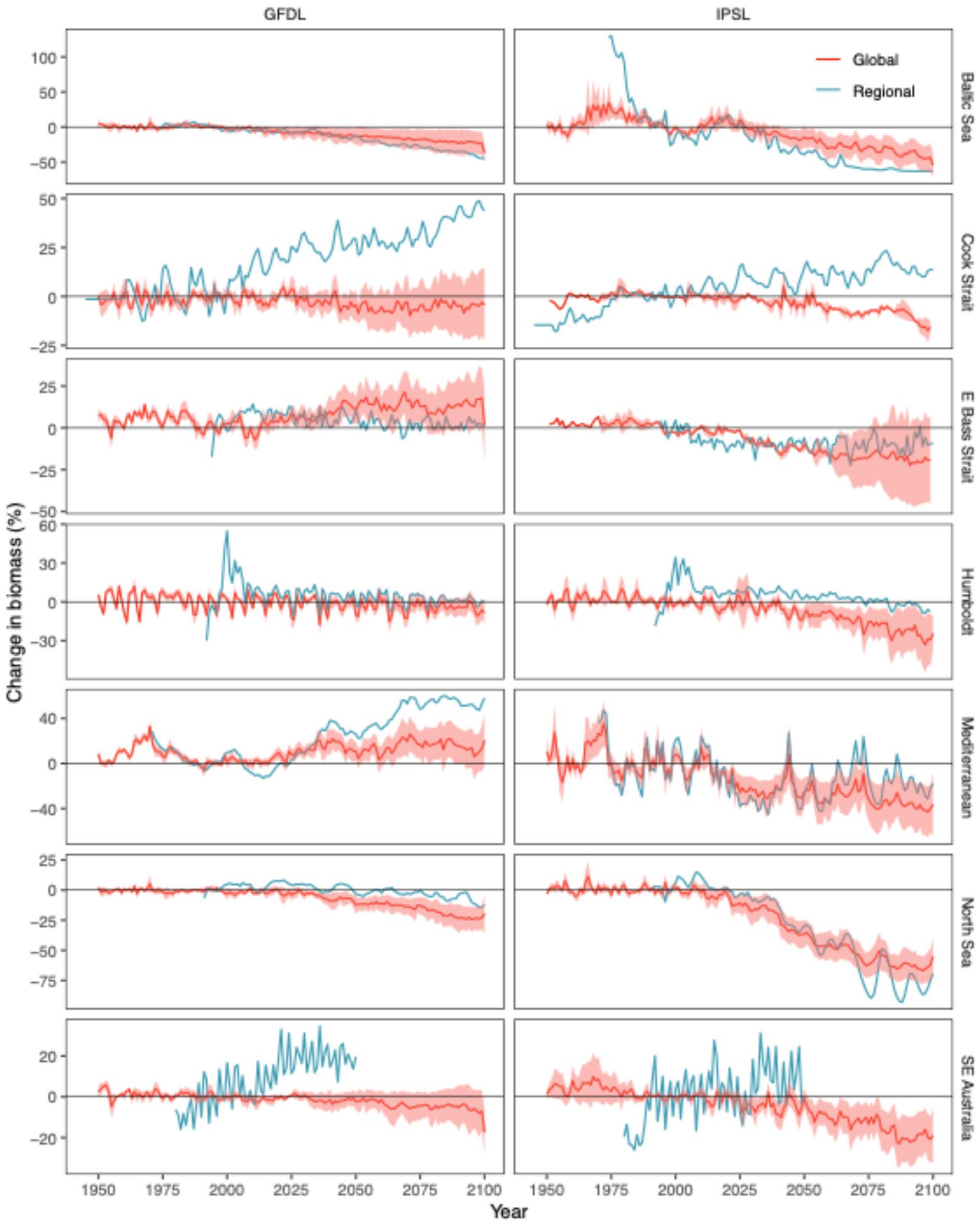
**Key Points:**

- Global marine ecosystem models projected greater biomass declines with climate change than regional marine ecosystem models for many regions
- For both global and regional models, greater biomass declines were




Eddy et al. 2025 Earth's Future

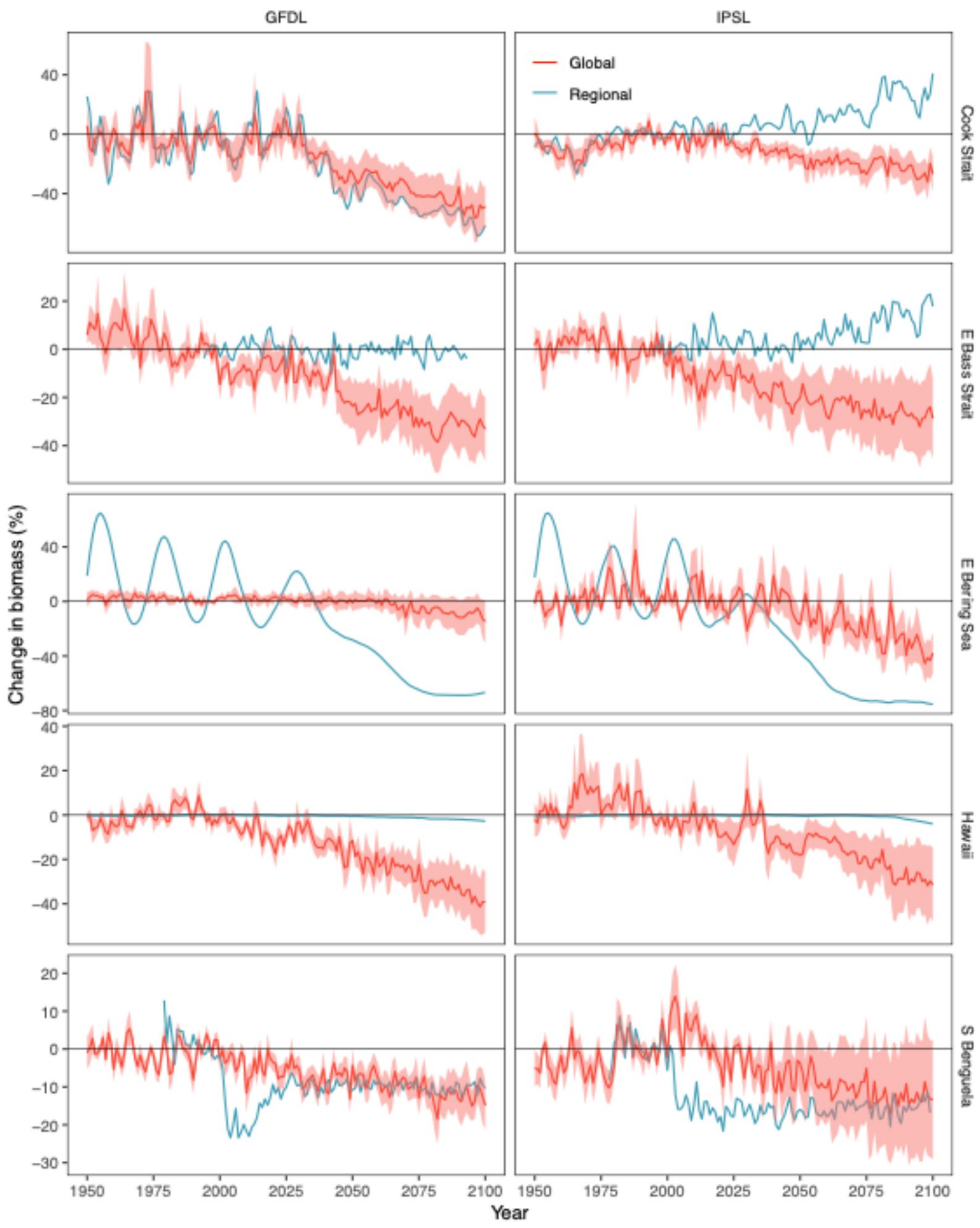
# Do regional and global models agree on climate change projections?




- For CMIP5, average biomass decline at the end of the century was 6% for regional models vs. 18% for global
- Global models projected biomass declines in 86% of CMIP5 simulations for ocean regions compared to 50% for regional models in the same ocean regions
- Regional model biomass change projections were within the range of the global model ensemble on average for 43% of the time series in CMIP5

Eddy et al. 2025 Earth’s Future

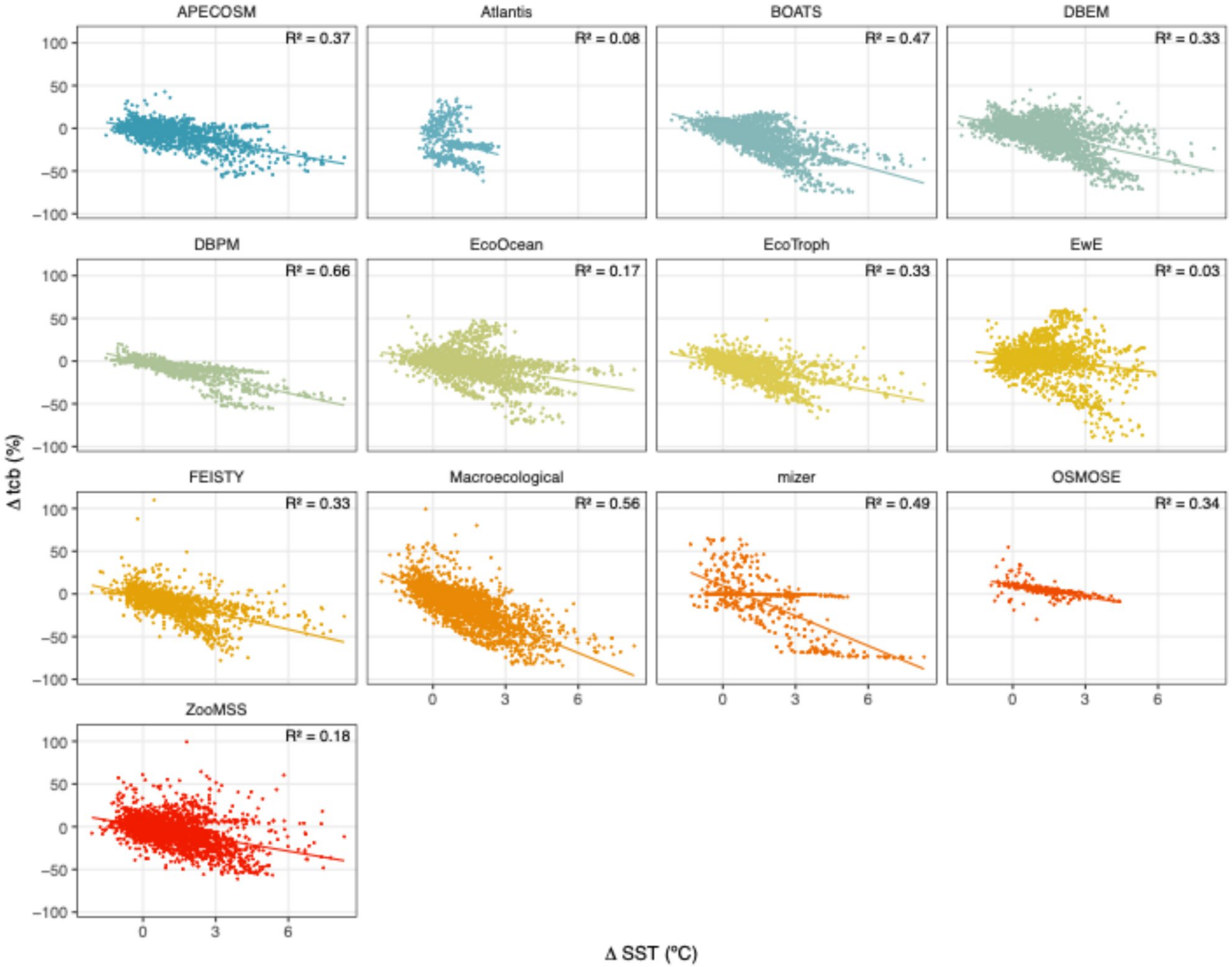
# Do regional and global models agree on climate change projections?




- For CMIP6, regional models projected a decline of 18% by 2100, vs. 27% for global
- For CMIP6, all global model simulations projected biomass declines in ocean regions by 2100, vs. 67% for regional
- Regional model biomass change projections were within the range of the global model ensemble on average for 36% of the time series in CMIP6
- For both global and regional models, greater biomass declines were projected using CMIP6 than CMIP5 and IPSL vs. GFDL simulations

Eddy et al. 2025 Earth's Future

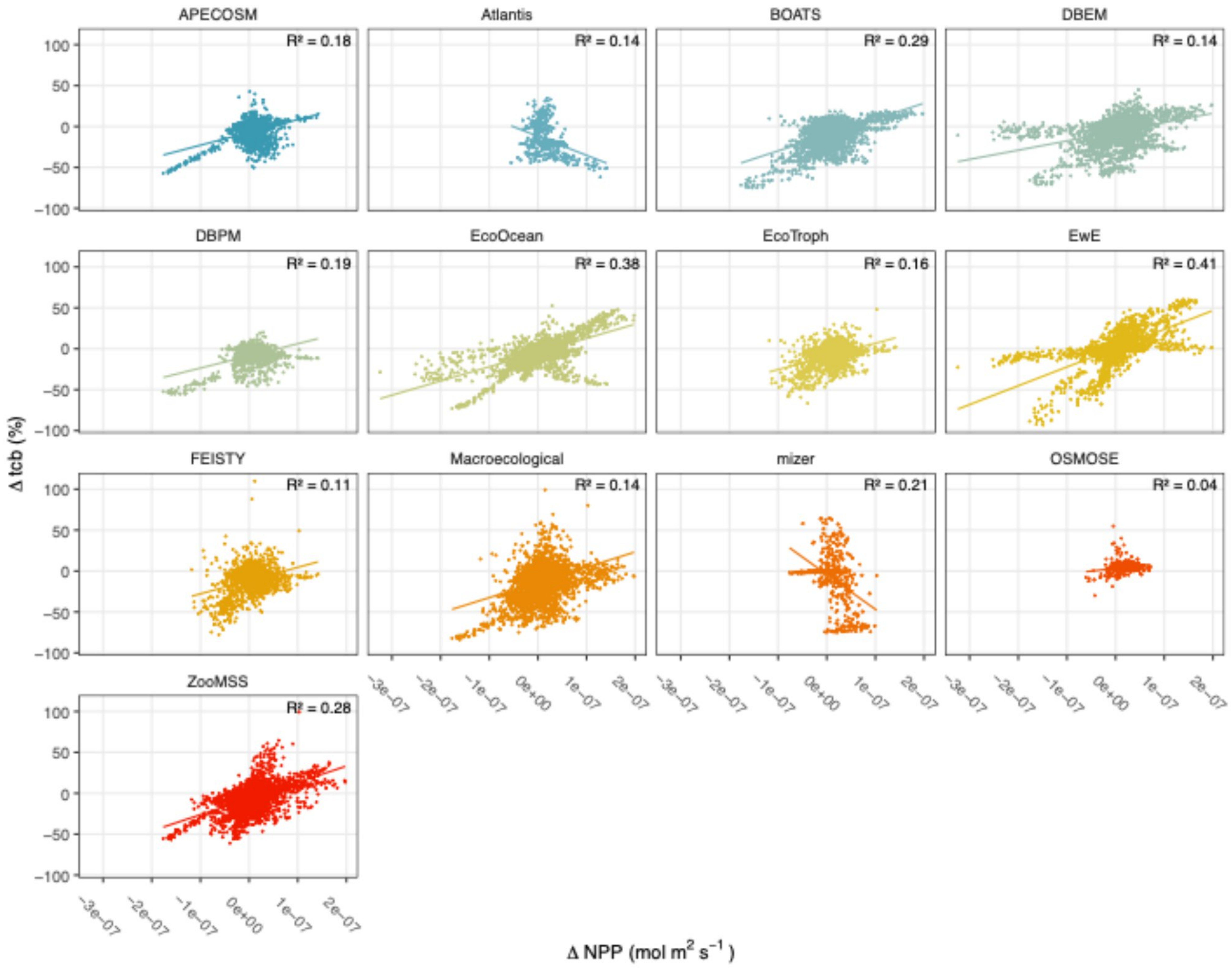
# Global and regional model relationships with temperature




- All models showed a negative relationship between change in SST and change in total consumer biomass
- The greatest slopes were observed for mizer and Macroecological
- The smallest slope was observed for Ecopath with Ecosim (EwE)

Eddy et al. 2025 Earth's Future

# Global and regional model relationships with primary production

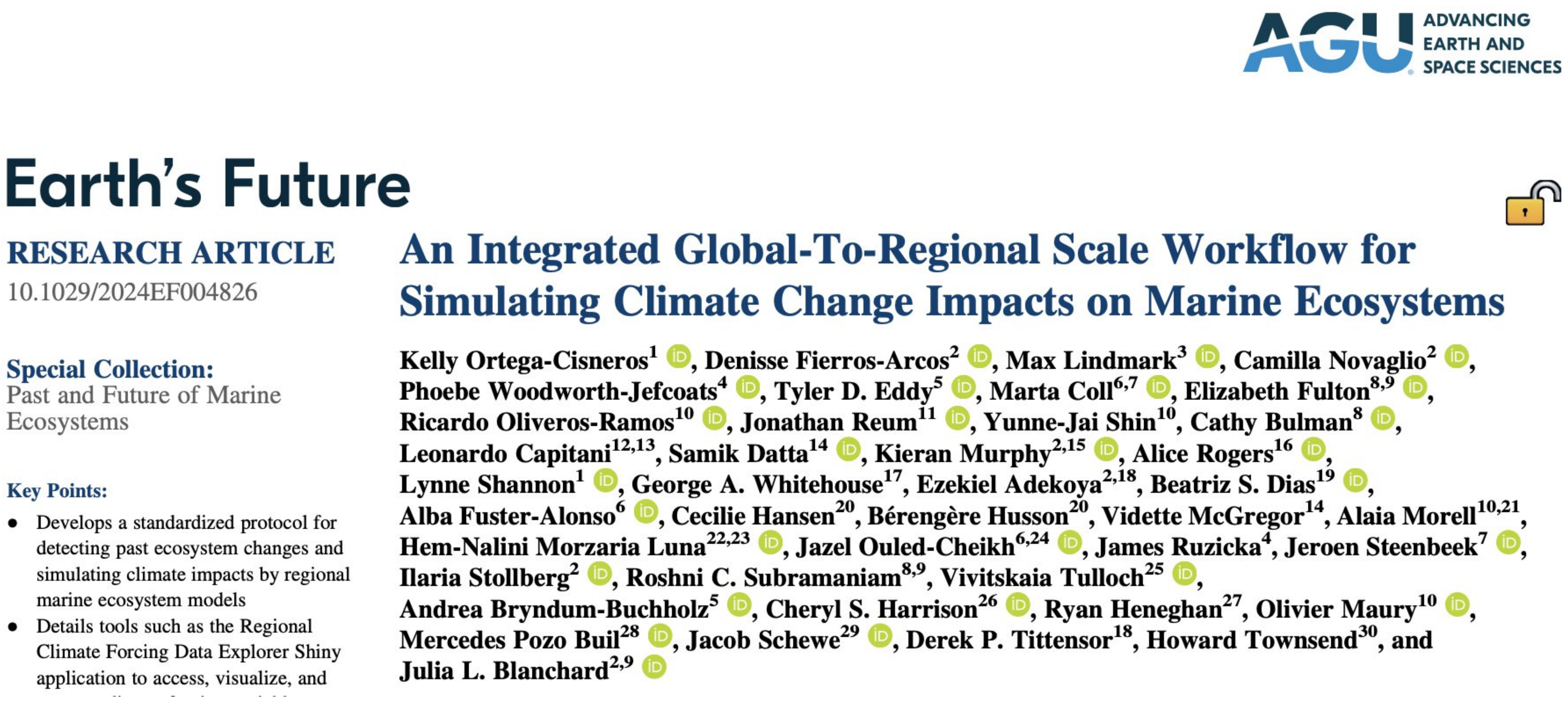



- Most models had a positive relationship between change in NPP and total consumer biomass, except Atlantis and mizer (both regional)
- The model that had the greatest positive slope was EwE, while the greatest negative slope was observed for mizer (both regional)

Eddy et al. 2025 Earth's Future

# Potential reasons for mismatches between regional and global models

- Regional models often have greater functional diversity and ecological or taxonomic resolution – greater resilience
- Regional models generally include more processes and resolve predator-prey interactions more explicitly than global models
- Coarse spatial resolution of coastal regions in global Earth System Models while regional models are developed at finer scales


ADVANCING EARTH AND SPACE SCIENCES

Earth's Future

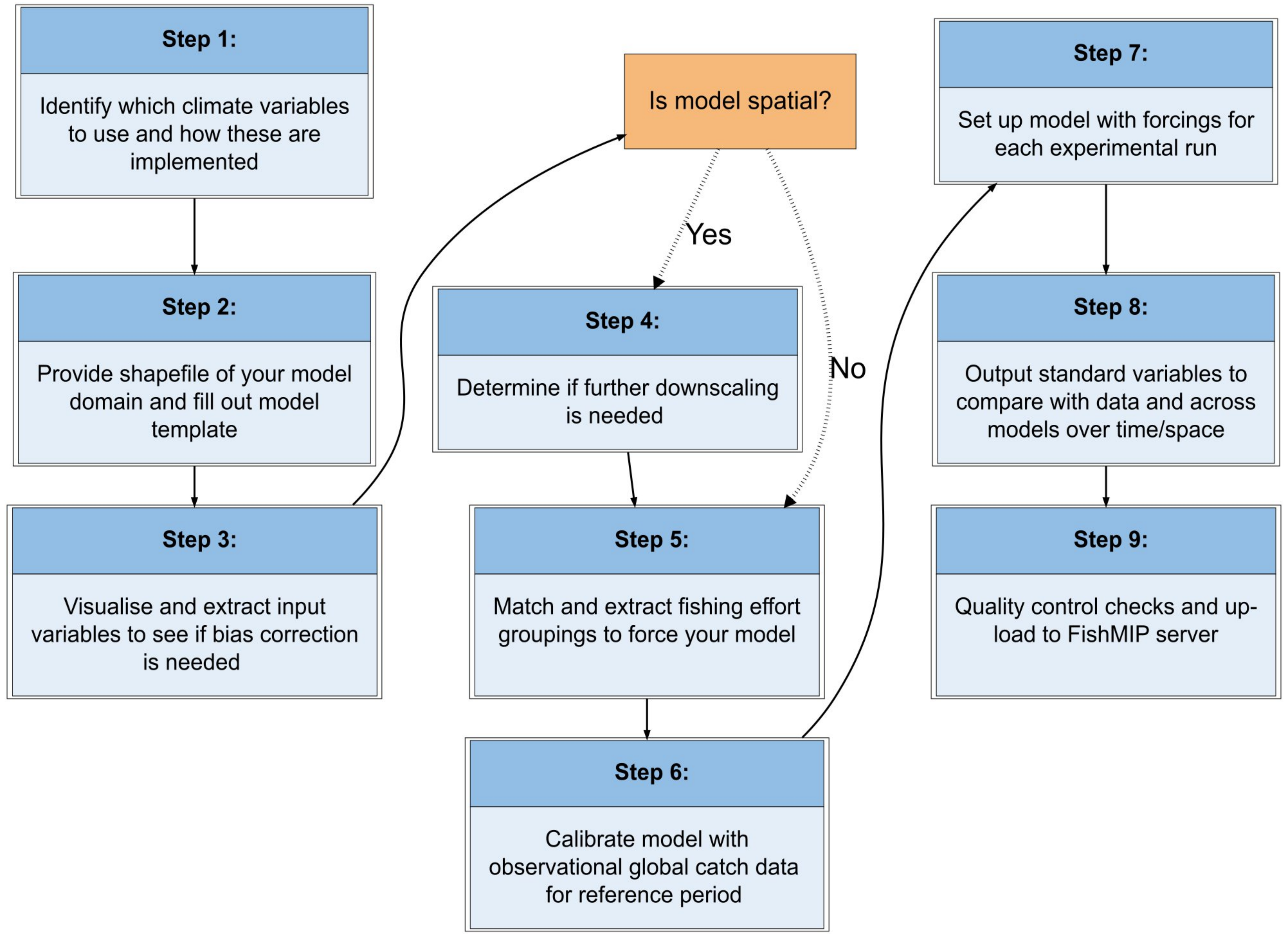
RESEARCH ARTICLE
10.1029/2024EF004826

Special Collection:
Past and Future of Marine Ecosystems

Key Points:
- Develops a standardized protocol for detecting past ecosystem changes and simulating climate impacts by regional marine ecosystem models
- Details tools such as the Regional Climate Forcing Data Explorer Shiny application to access, visualize, and

# An Integrated Global-To-Regional Scale Workflow for Simulating Climate Change Impacts on Marine Ecosystems

Kelly Ortega-Cisneros[1], Denisse Fierros-Arcos[2], Max Lindmark[3], Camilla Novaglio[2], Phoebe Woodworth-Jefcoats[4], Tyler D. Eddy[5], Marta Coll[6,7], Elizabeth Fulton[8,9], Ricardo Oliveros-Ramos[10], Jonathan Reum[11], Yunne-Jai Shin[10], Cathy Bulman[8], Leonardo Capitani[12,13], Samik Datta[14], Kieran Murphy[2,15], Alice Rogers[16], Lynne Shannon[1], George A. Whitehouse[17], Ezekiel Adekoya[2,18], Beatriz S. Dias[19], Alba Fuster-Alonso[6], Cecilie Hansen[20], Bérengère Husson[20], Vidette McGregor[14], Alaia Morell[10,21], Hem-Nalini Morzaria Luna[22,23], Jazel Ouled-Cheikh[6,24], James Ruzicka[4], Jeroen Steenbeek[7], Ilaria Stollberg[2], Roshni C. Subramaniam[8,9], Vivitskaia Tulloch[25], Andrea Bryndum-Buchholz[5], Cheryl S. Harrison[26], Ryan Heneghan[27], Olivier Maury[10], Mercedes Pozo Buil[28], Jacob Schewe[29], Derek P. Tittensor[18], Howard Townsend[30], and Julia L. Blanchard[2,9]




Ortega-Cisneros et al. 2025 Earth's Future

# THANK-YOU!

fishmip.org

Tyler Eddy
tyler.eddy@mi.mun.ca
thelifeaquatic.xyz
@tyzissou

MARINE INSTITUTE

MEMORIAL UNIVERSITY

FishMIP
Fisheries & Marine Ecosystem Model Intercomparison Project

ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

THE LIFE AQUATIC

# Conclusions

- Variation in model projections is a good thing! It can teach us things about our models
- Spatial resolution is an important factor to consider for climate change projections using marine ecosystem models
- The present FishMIP simulation round is poised to tease out contribution of spatial scale to variation in regional and global model projections

AGU ADVANCING EARTH AND SPACE SCIENCES

Earth's Future

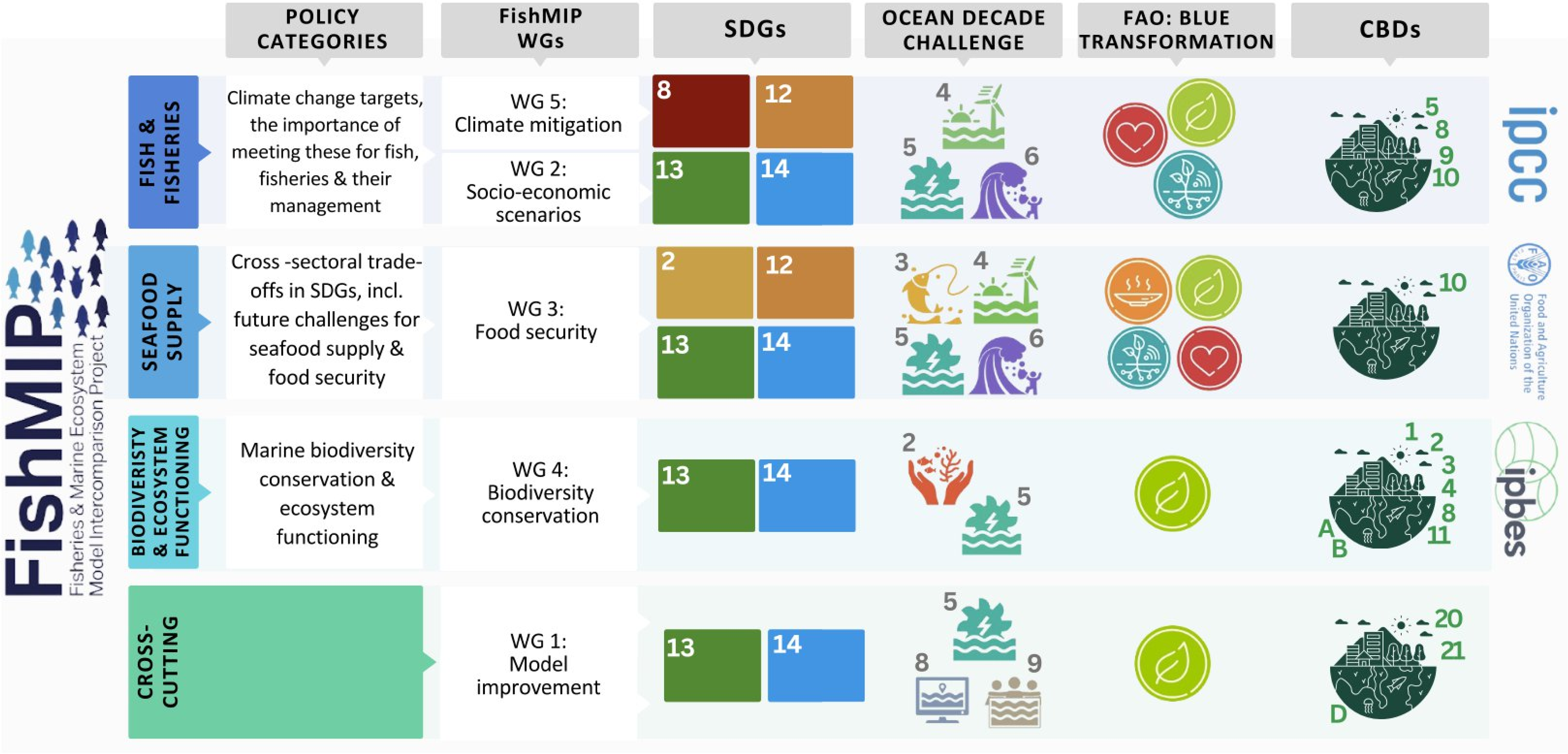
REVIEW ARTICLE

10.1029/2023EF004398

Special Collection:
Past and Future of Marine Ecosystems

# The Past and Future of the Fisheries and Marine Ecosystem Model Intercomparison Project

**Camilla Novaglio[1,2], Andrea Bryndum-Buchholz[3], Derek P. Tittensor[4], Tyler D. Eddy[3], Heike K. Lotze[4], Cheryl S. Harrison[5], Ryan F. Heneghan[6], Olivier Maury[7], Kelly Ortega-Cisneros[8], Colleen M. Petrik[9], Kelsey E. Roberts[5], and Julia L. Blanchard[1,2]**




Novaglio et al. 2024 Earth's Future

AGU ADVANCING EARTH AND SPACE SCIENCES

Earth's Future

COMMENTARY
10.1029/2023EF004402

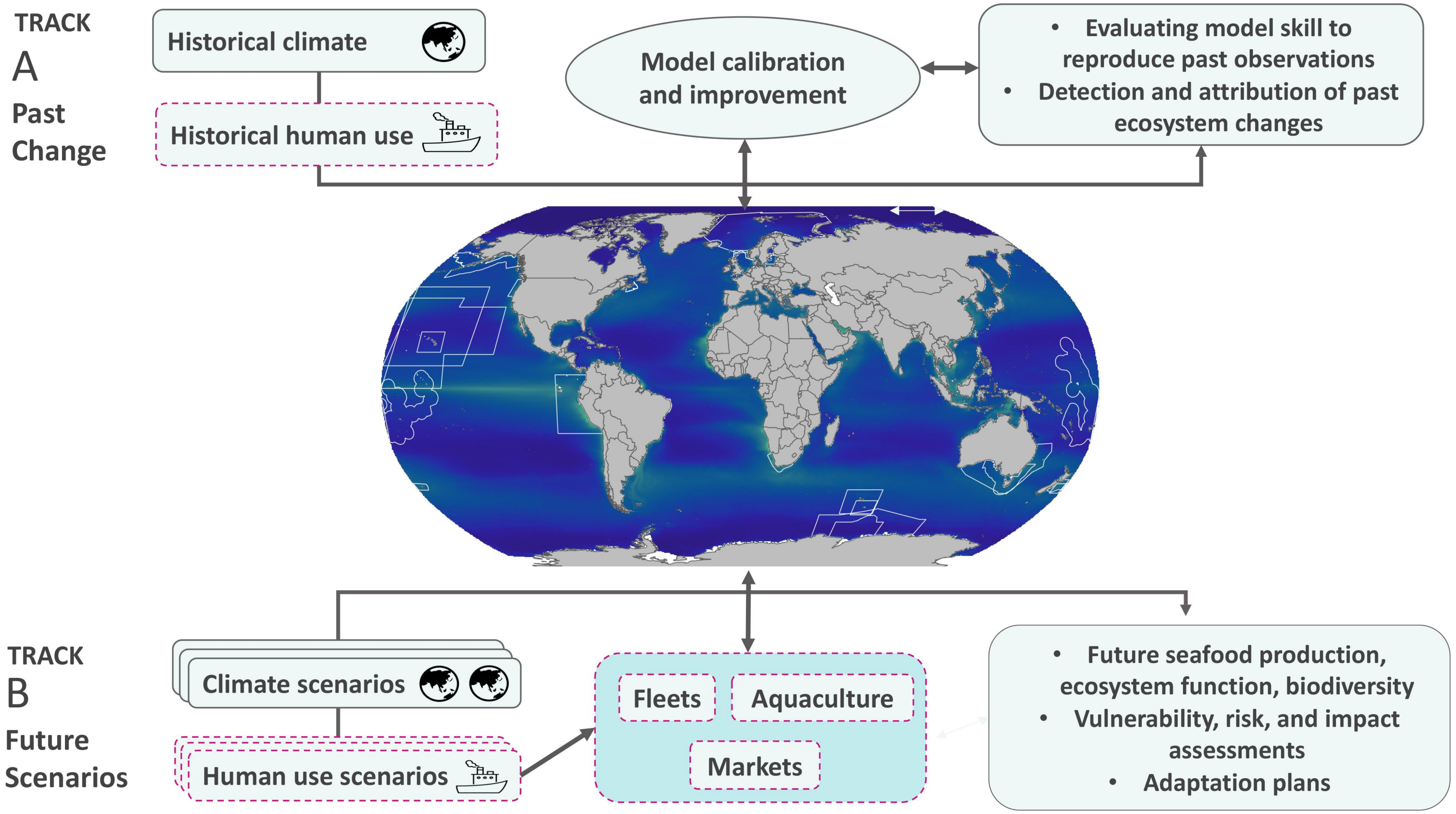
Special Collection:
Past and Future of Marine Ecosystems

# Detecting, Attributing, and Projecting Global Marine Ecosystem and Fisheries Change: FishMIP 2.0

Julia L. Blanchard[1,2,3], Camilla Novaglio[1,2], Olivier Maury[4], Cheryl S. Harrison[5], Colleen M. Petrik[6], Denisse Fierro-Arcos[1], Kelly Ortega-Cisneros[7], Andrea Bryndum-Buchholz[8], Tyler D. Eddy[8], Ryan Heneghan[9], Kelsey Roberts[5], Jacob Schewe[10], Daniele Bianchi[11], Jerome Guiet[11], P. Daniel van Denderen[12], Juliano Palacios-Abrantes[13], Xiao Liu[14], Charles A. Stock[14], Yannick Rousseau[1], Matthias Büchner[10], Ezekiel O. Adekoya[1,15], Cathy Bulman[16], William Cheung[13], Villy Christensen[13,17], Marta Coll[17,18], Leonardo Capitani[19], Samik Datta[20], Elizabeth A. Fulton[2,16], Alba Fuster[18], Victoria Garza[5], Matthieu Lengaigne[4], Max Lindmark[21], Kieran Murphy[1,3], Jazel Ouled-Cheikh[18], Sowdamini S. Prasad[1], Ricardo Oliveros-Ramos[3], Jonathan C. Reum[22], Nina Rynne[1,23], Kim J. N. Scherrer[24], Yunne-Jai Shin[4], Jeroen Steenbeek[17], Phoebe Woodworth-Jefcoats[25], Yan-Lun Wu[1], and Derek P. Tittensor[15]

Key Points:

- Detecting, attributing, and projecting climate change risks on marine ecosystems and fisheries requires models with realistic dynamics
- FishMIP 2.0 incorporates fishing and climate impact trajectories to assess models and detect past ecosystem




Blanchard et al. 2024 Earth's Future

AGU ADVANCING EARTH AND SPACE SCIENCES

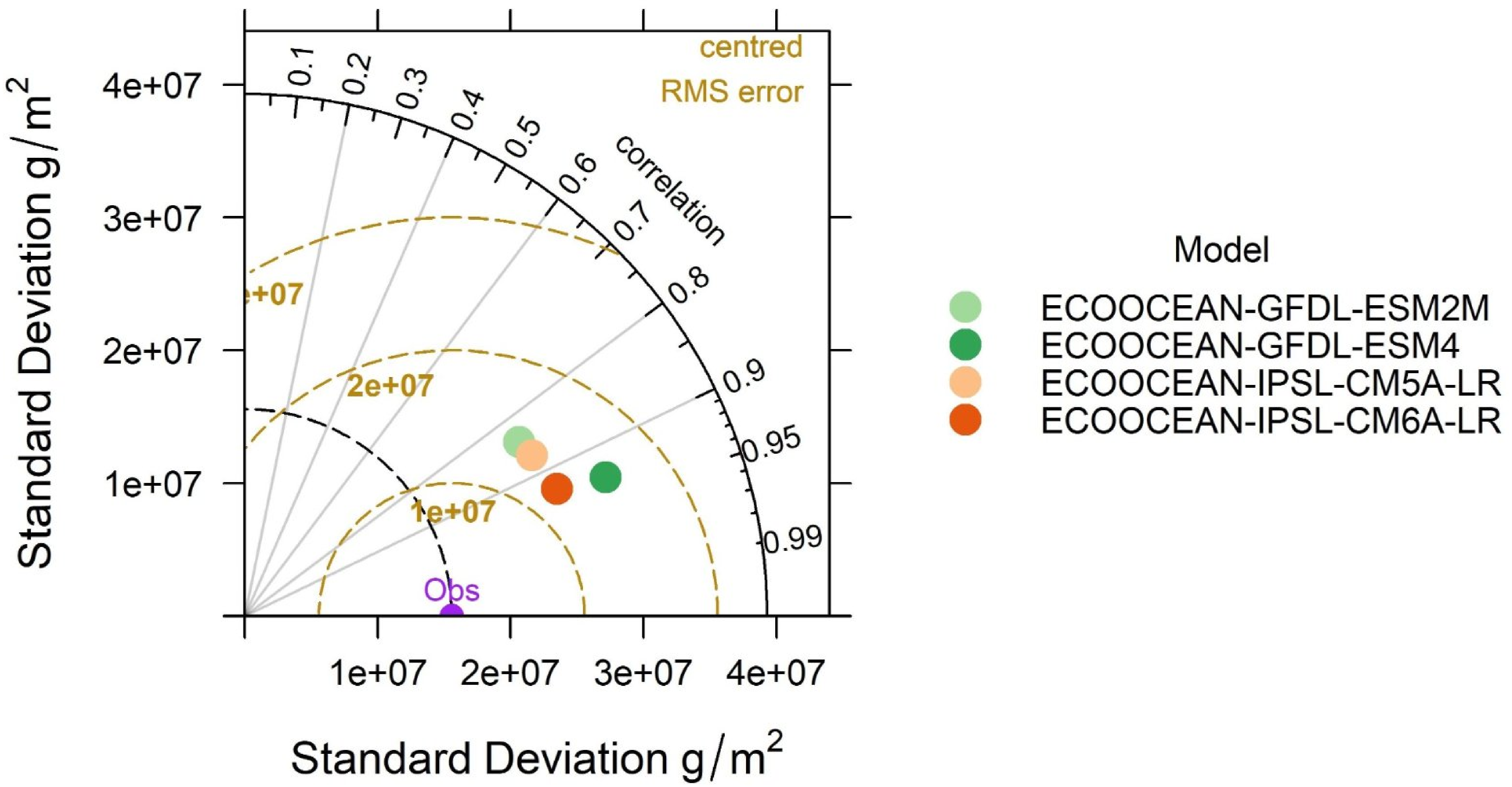
Earth's Future

RESEARCH ARTICLE
10.1029/2024EF004868

Special Collection:
Past and Future of Marine Ecosystems

# A Skill Assessment Framework for the Fisheries and Marine Ecosystem Model Intercomparison Project

Nina Rynne[1,2], Camilla Novaglio[2,3], Julia Blanchard[2,3], Daniele Bianchi[4], Villy Christensen[5,6], Marta Coll[6,7], Jerome Guiet[4], Jeroen Steenbeek[6], Andrea Bryndum-Buchholz[8], Tyler D. Eddy[8], Cheryl Harrison[9], Olivier Maury[10], Kelly Ortega-Cisneros[11], Colleen M. Petrik[12], Derek P. Tittensor[13], and Ryan F. Heneghan[1,14,15]




Rynne et al. 2025 Earth's Future

AGU ADVANCING EARTH AND SPACE SCIENCES

Earth's Future

RESEARCH ARTICLE
10.1029/2024EF004851

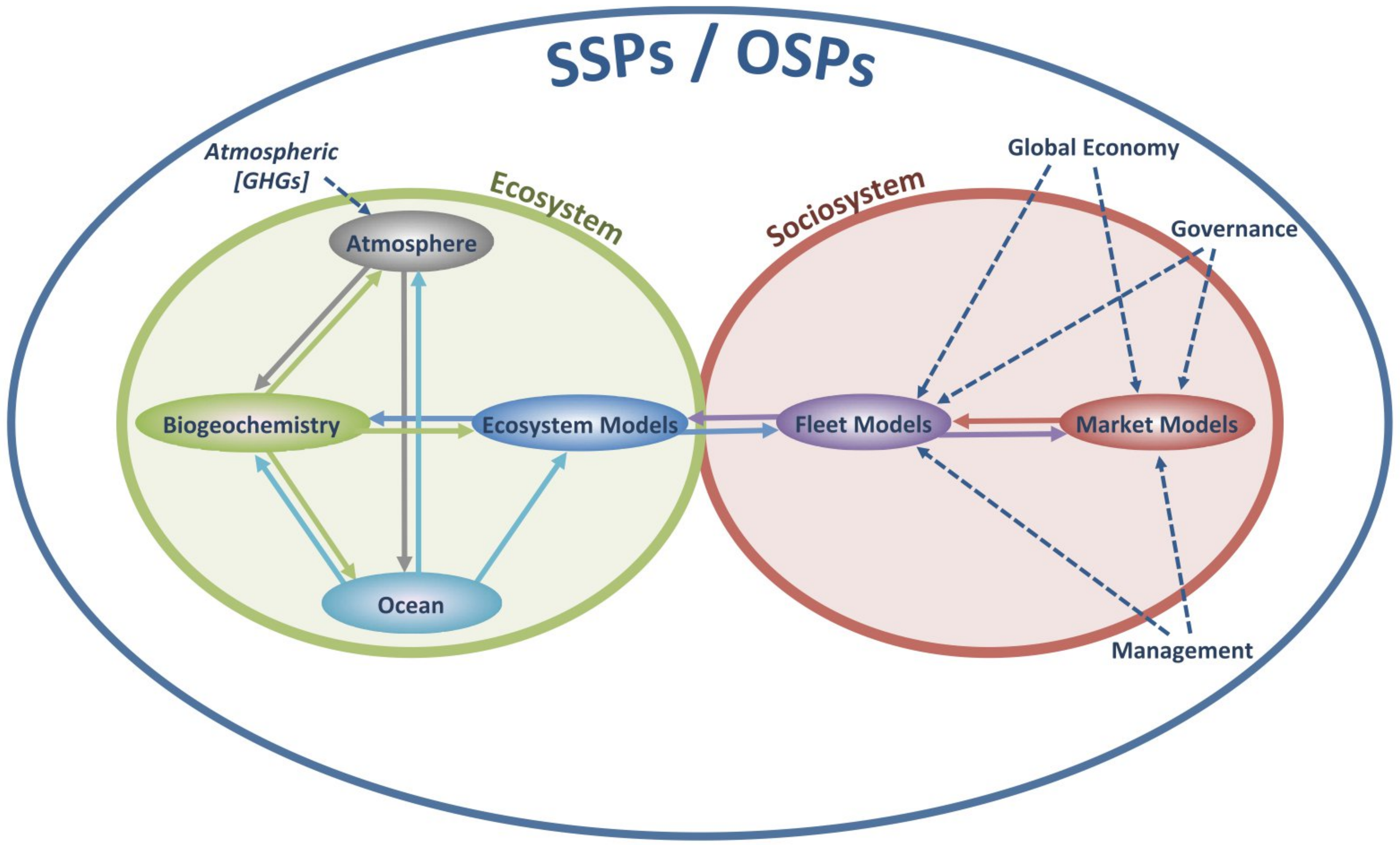
**Special Collection:**
Past and Future of Marine Ecosystems

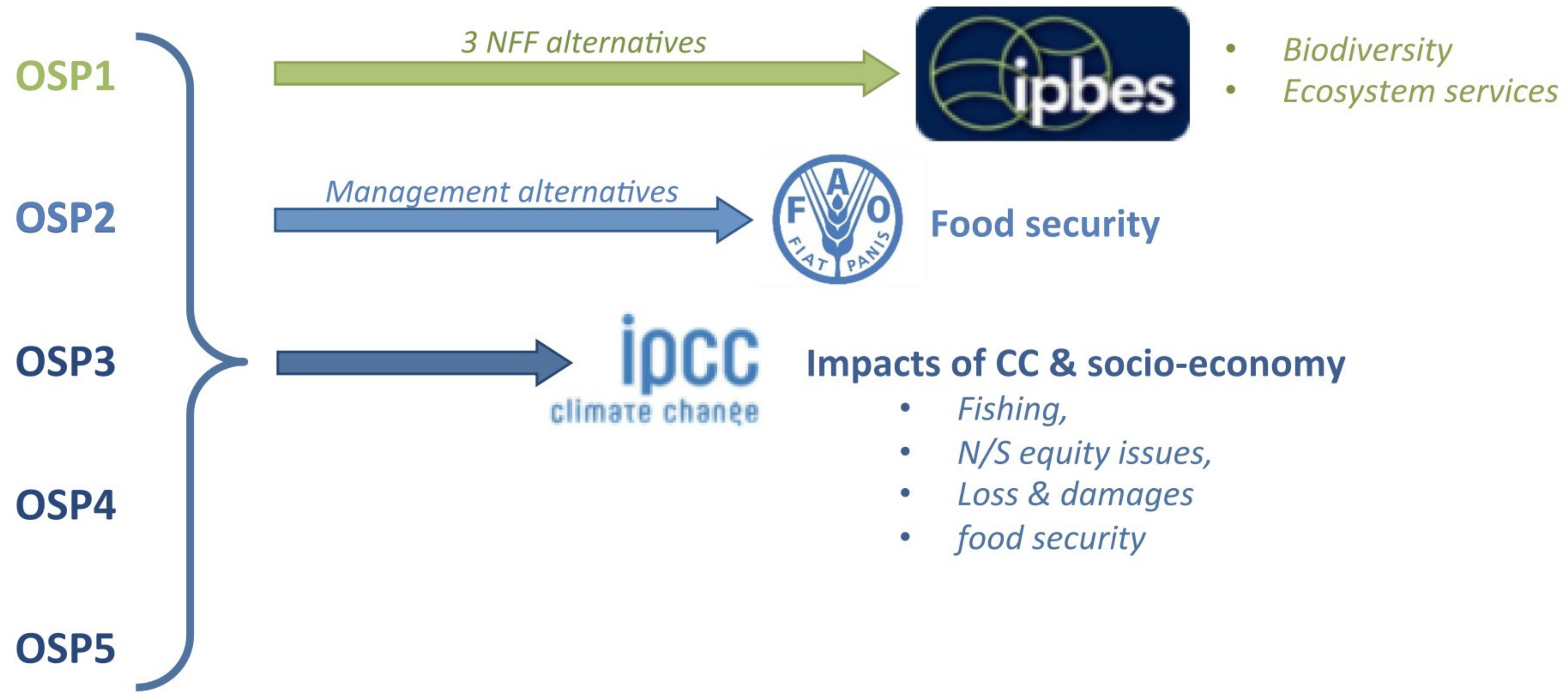
# The Ocean System Pathways (OSPs): A New Scenario and Simulation Framework to Investigate the Future of the World Fisheries

**O. Maury[1], D. P. Tittensor[2], T. D. Eddy[3], E. H. Allison[4,5], T. Bahri[6], N. Barrier[1], L. Campling[7], W. W. L. Cheung[8], K. Frieler[9], E. A. Fulton[10,11], P. Guillotreau[1], R. F. Heneghan[12,13], V. W. Y. Lam[8], D. Leclère[14], M. Lengaigne[1], H. Lotze-Campen[9,15], C. Novaglio[6,16], K. Ortega-Cisneros[17], J. Rault[18], J. Schewe[9], Y.-J. Shin[1], H. Sloterdijk[19], D. Squires[20], U. R. Sumaila[8,21], A. N. Tidd[1], B. van Ruijven[14], and J. Blanchard[16]**

**Key Points:**

- We present new scenarios and models for simulating fisheries and marine




Maury et al. 2025 Earth's Future

# Conclusions

- Be hard on your models but be nice to your fellow modellers :)

FISHERIES & MARINE ECOSYSTEM
FISH-MIP
MODEL INTERCOMPARISON PROJECT

FishMIP

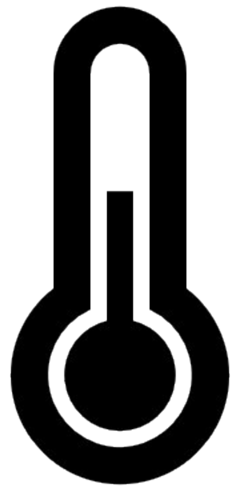
Fisheries & Marine Ecosystem Model Intercomparison Project

fishmip.org

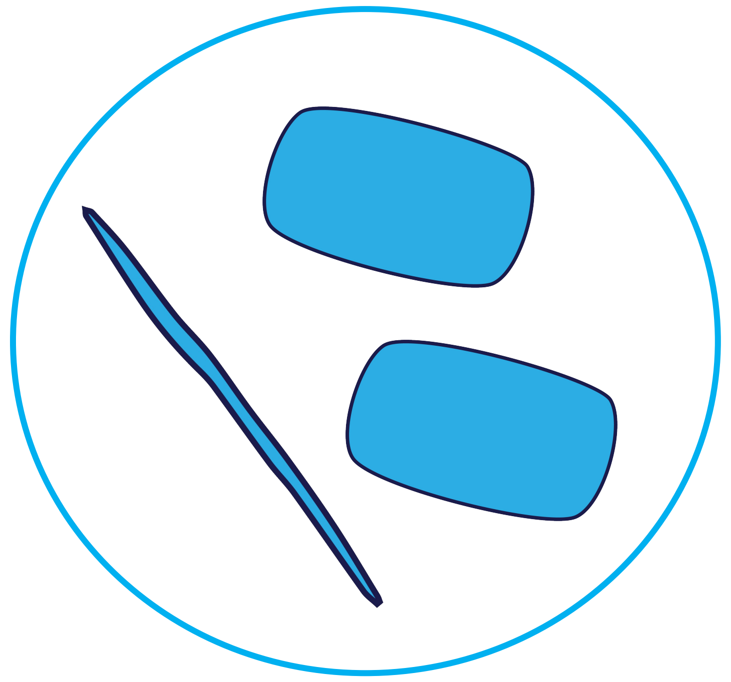
fishmip.coordinators@gmail.com

## Step 1: Identify which climate model variables to use and how these are implemented

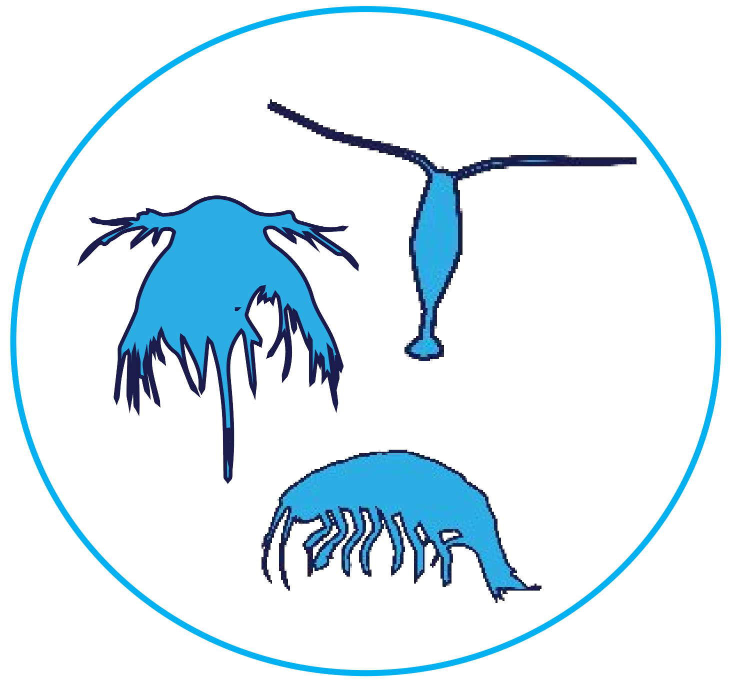
- Oceanic forcing data derived from the coupled physical and biogeochemical ocean models Geophysical Fluid Dynamics Laboratory (GFDL), Modular Ocean Model (MOM6) and Carbon, Ocean Biogeochemistry and Lower Trophics (COBALTv2) for 1961-2010.



**Sea**
**Temperature**
**Oxygen**



**Primary production**
**Phytoplankton biomass**



**Zooplankton biomass**

Ortega-Cisneros et al. 2025 Earth’s Future

# Step 2: Provide shapefile of your model domain and complete model templates

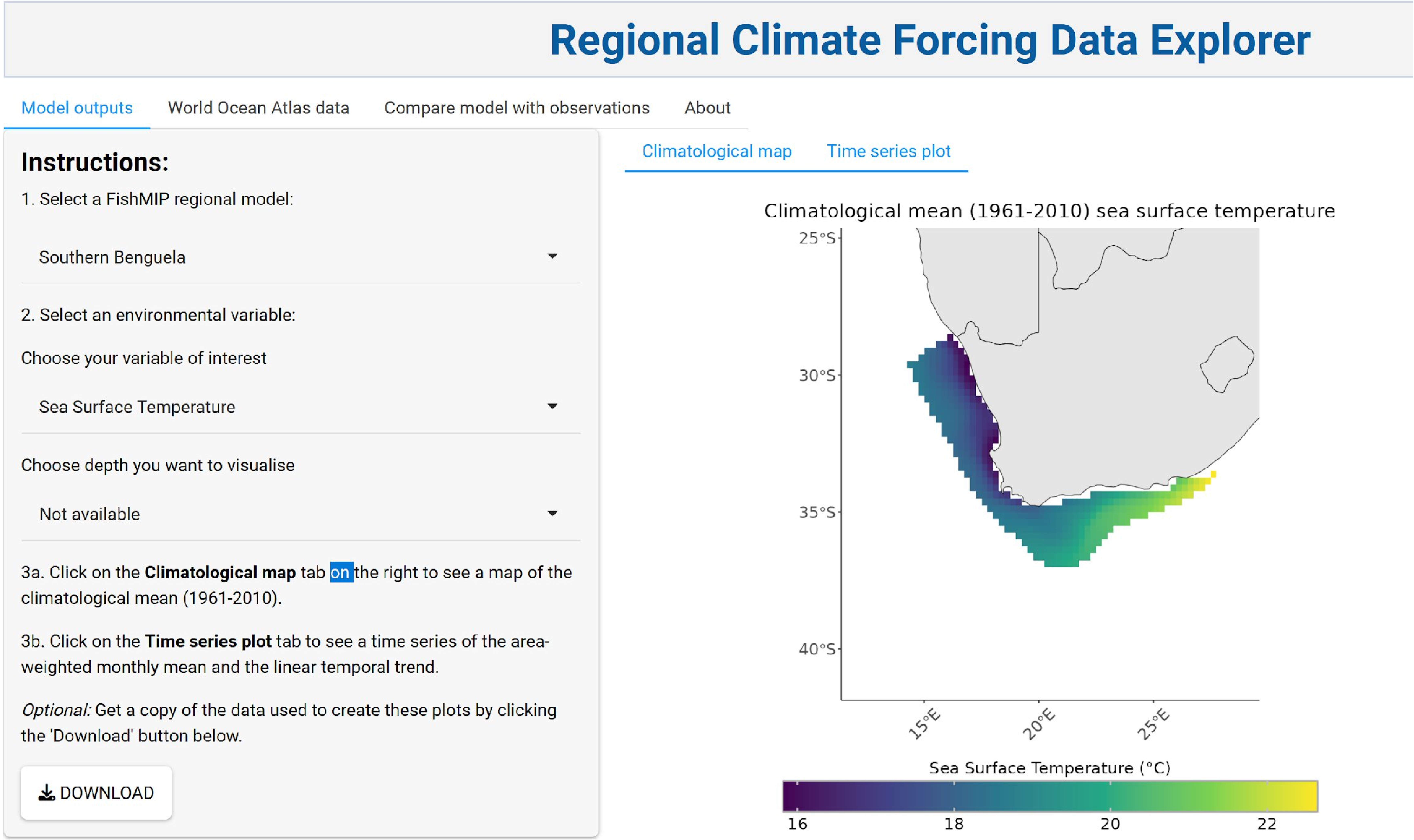
- Model spatial boundaries to extract all climate variables available in GFDL-MOM6-COBALTv2.
- Tools available at FishMIP GitHub repositories.
- Model templates requesting information about model set-up and calibration.

https://github.com/Fish-MIP/FishMIP2.0_TrackA_ISIMIP3a

Table 6. Climate forcing variables and units for FishMIP 3a simulations. All variables are available on a 0.25 and 1 degree horizontal grid, monthly and annual resolutions. Note: Some variables are available as specific layers extracted from vertically resolved data. Their variable names have been suffixed with -bot (ocean bottom, e.g. o2-bot), -surf (surface values, e.g. pH-surf) or -vint (vertically integrated, e.g. phyc-vint), respectively, or prefixed with int (vertically integrated, e.g. intpp). Temperature is suffixed with b or s for bottom (e.g. tob) or surface (e.g. tos) layers, respectively.

| Variable | Specifier | Unit | Resolution | Datasets |
|---|---|---|---|---|
| Mass Concentration of Total Phytoplankton Expressed as Chlorophyll | **chl** | kg m-3 | 0.25° , 1° grid | GFDL-MOM6-COBALT2 |
| Sea Floor Depth | **deptho** | m | 0.25° , 1° grid | GFDL-MOM6-COBALT2 |
| Downward Flux of Particulate Organic Carbon | **expc-bot** | mol m-2 s-1 | 0.25° , 1° grid | GFDL-MOM6-COBALT2 |
| Particulate Organic Carbon Content | **intpoc** | kg m-2 | 0.25° , 1° grid | GFDL-MOM6-COBALT2 |
| Primary Organic Carbon Production by All Types of Phytoplankton | **intpp** | mol m-2 s-1 | 0.25° , 1° grid | GFDL-MOM6-COBALT2 |
| Net Primary Organic Carbon Production by Diatoms | **intppdiat** | mol m-2 s-1 | 0.25° , 1° grid | GFDL-MOM6-COBALT2 |
| Net Primary Mole Productivity of Carbon by Diazotrophs | **intppdiaz** | mol m-2 s-1 | 0.25° , 1° grid | GFDL-MOM6-COBALT2 |
| Net Primary Mole Productivity of Carbon by Picophytoplankton | **intpppico** | mol m-2 s-1 | 0.25° , 1° grid | GFDL-MOM6-COBALT2 |

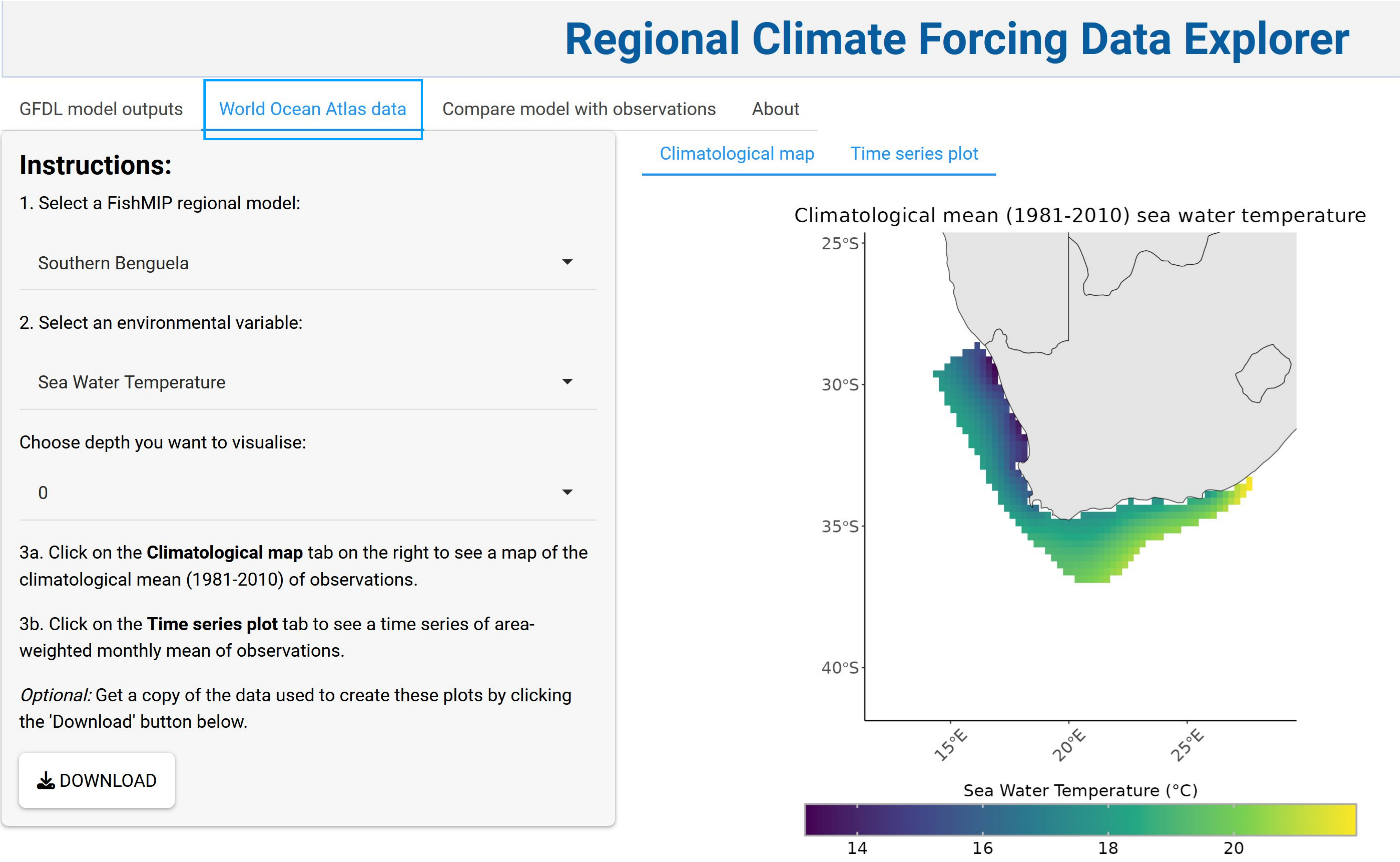
# Step 3: Visualize and extract input variables to see if bias correction is needed




https://rstudio.global-ecosystem-model.cloud.edu.au/shiny/FishMIP_Input_Explorer/

# Step 3: Visualize and extract input variables to see if bias correction is needed

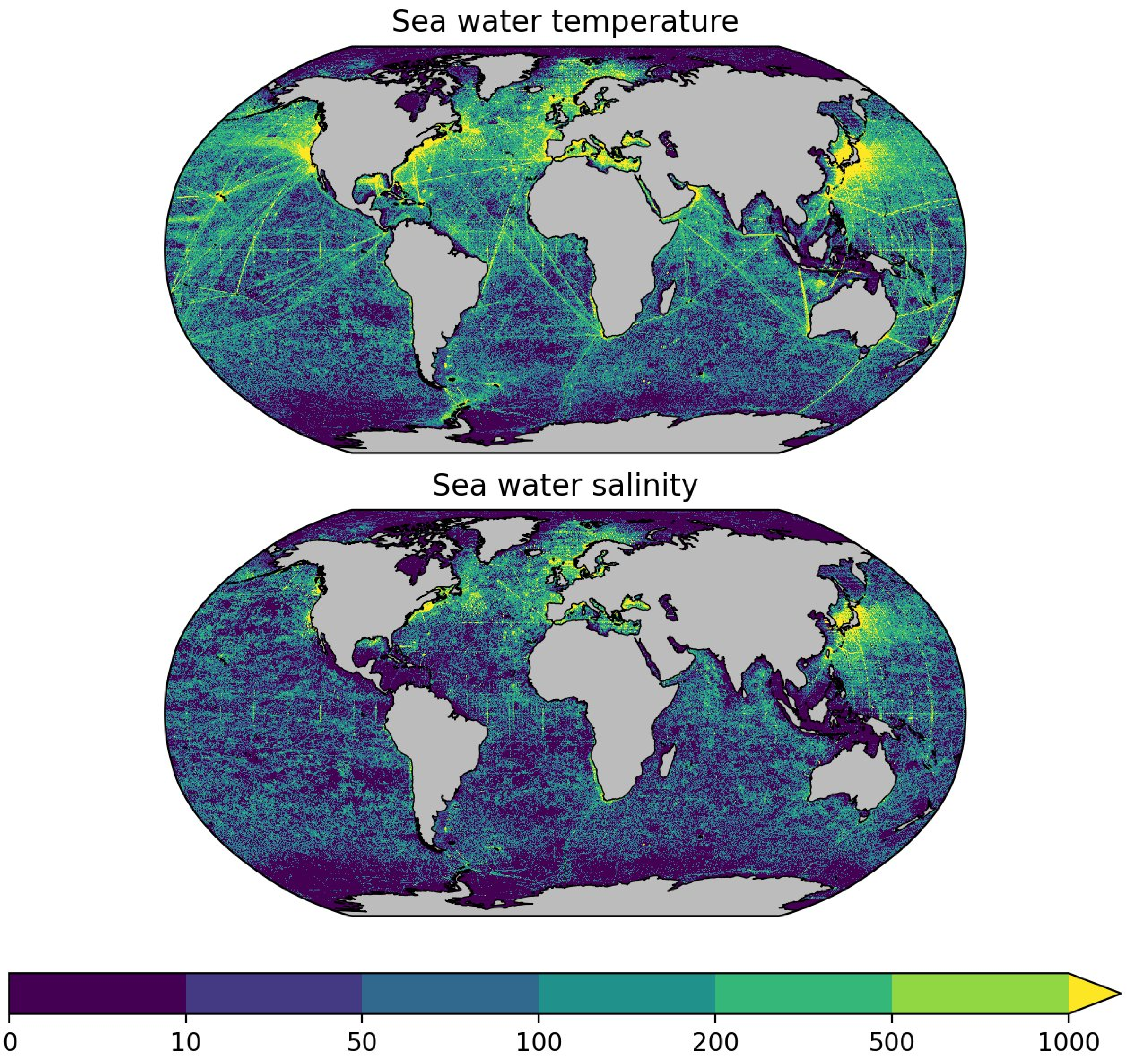
- WOA 2023
- Delta method




https://rstudio.global-ecosystem-model.cloud.edu.au/shiny/FishMIP_Input_Explorer/

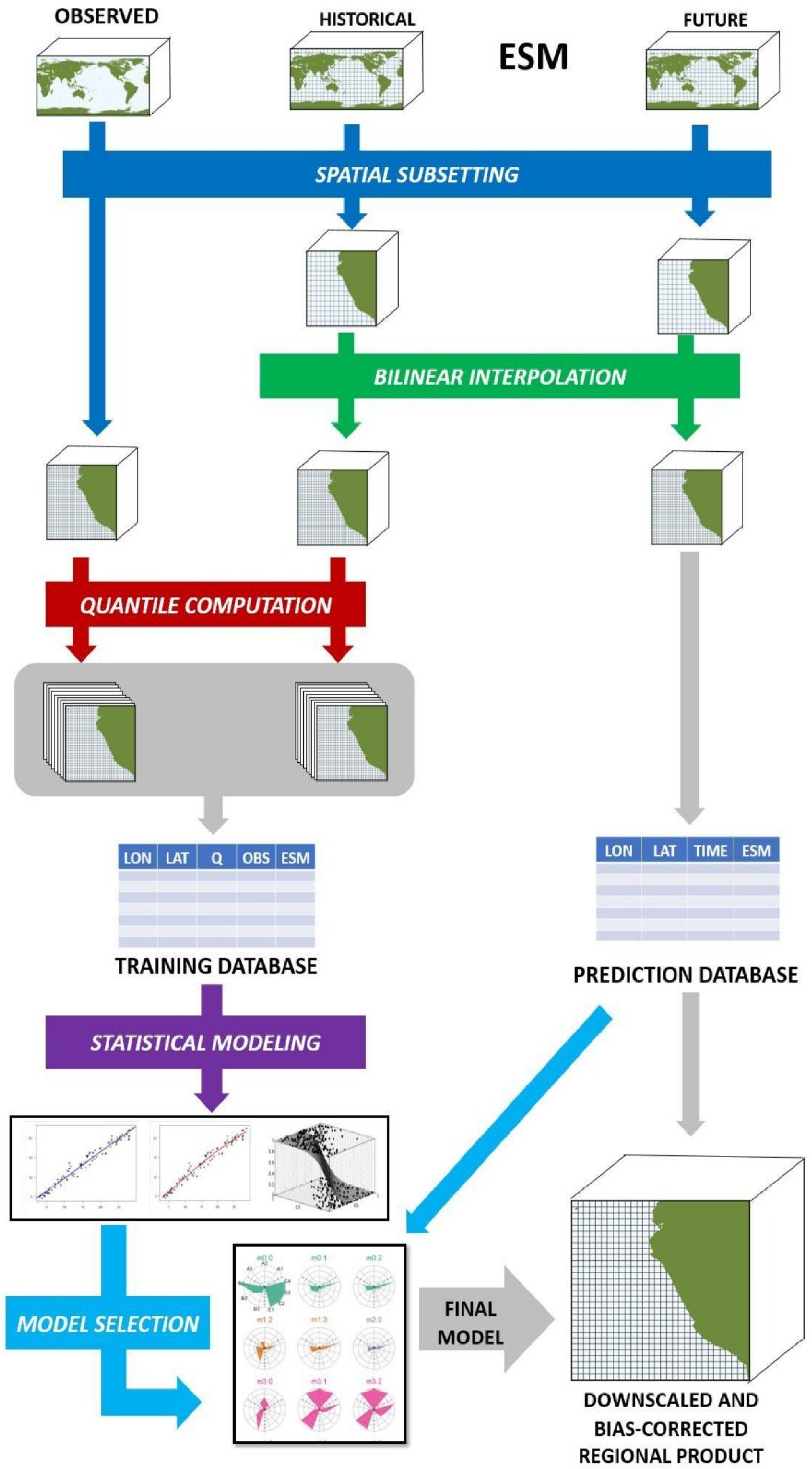
## Step 3: Visualize and extract input variables to see if bias correction is needed

- Total number of observations per grid cell (1981-2010) over the water column from the WOA 2023



## Step 4: If spatial: determine if further downscaling is needed

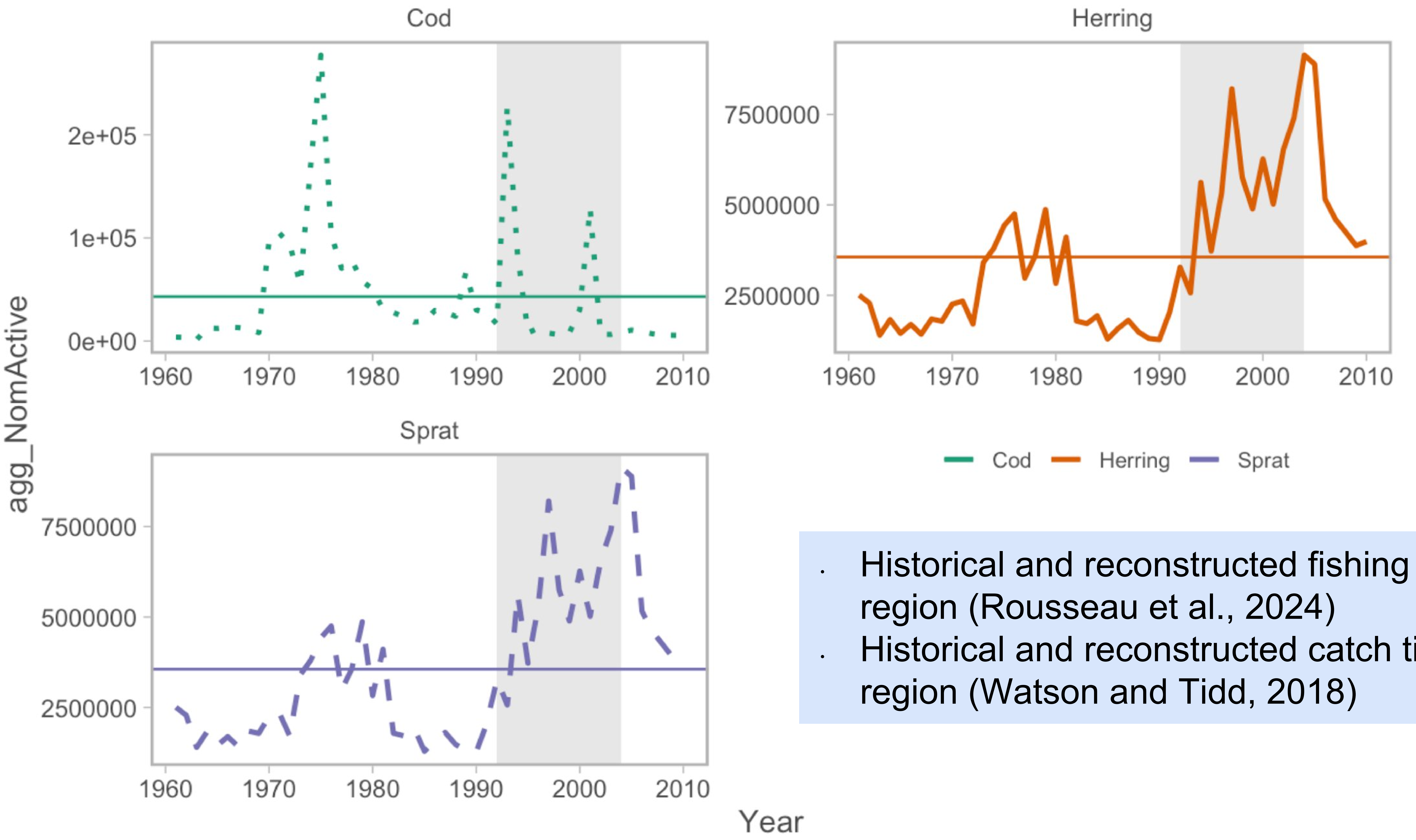
- OSMOSE-Northern Humboldt.
- Oliveros-Ramos et al. (2023) evaluated 19 nested statistical downscaling models and found that model performance varied across regions.
- Gridded time series analysis R package ([https://github.com/roliveros-ramos/gts)](https://github.com/roliveros-ramos/gts).
- Statistical downscaling approach to be used as part of this protocol has not yet been standardized.




Oliveros-Ramos et al. 2023

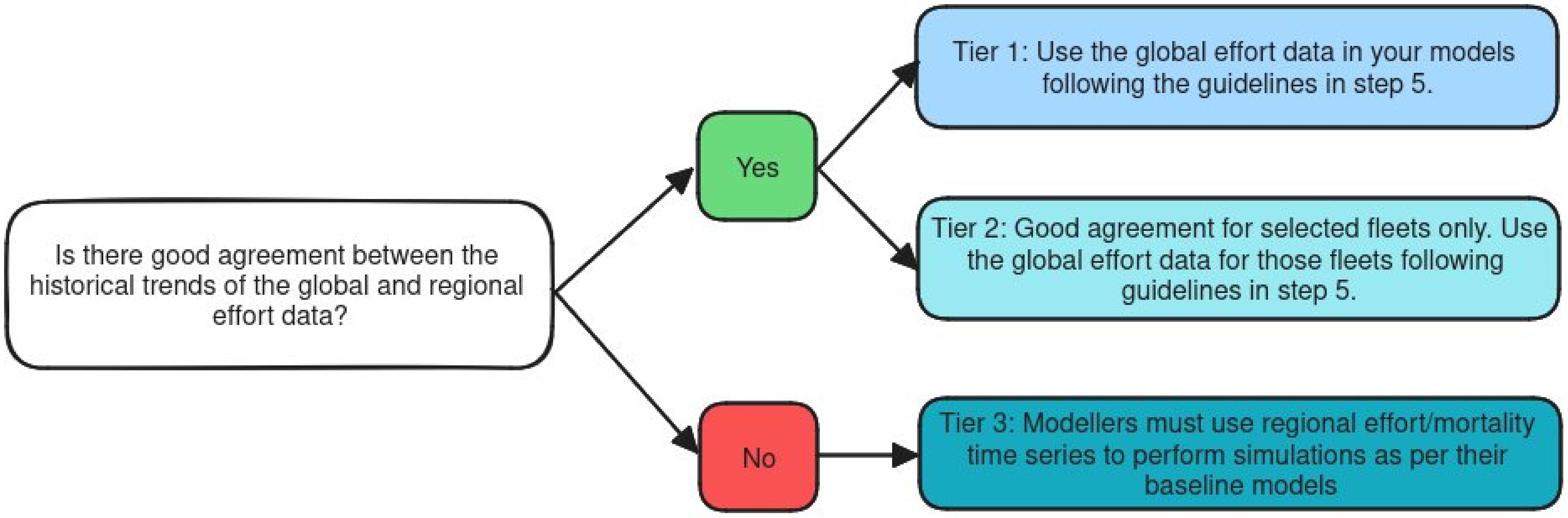
## Step 5: Match and extract fishing effort groupings to force your model

- Assumptions on how to split the global effort by fleet and catch to account for the taxonomic resolution required by some regional models.




- Historical and reconstructed fishing effort data by region (Rousseau et al., 2024)
- Historical and reconstructed catch time series by region (Watson and Tidd, 2018)

## Step 5: Match and extract fishing effort groupings to force your model




**Options to implement the global historical and reconstructed fishing effort data into regional MEMs**

Ortega-Cisneros et al. 2025 Earth's Future

# FishMIP 3a protocol

https://github.com/Fish-MIP/FishMIP2.0_TrackA_ISIMIP3a

README

# FishMIP_2022_3a_Protocol

## Contents

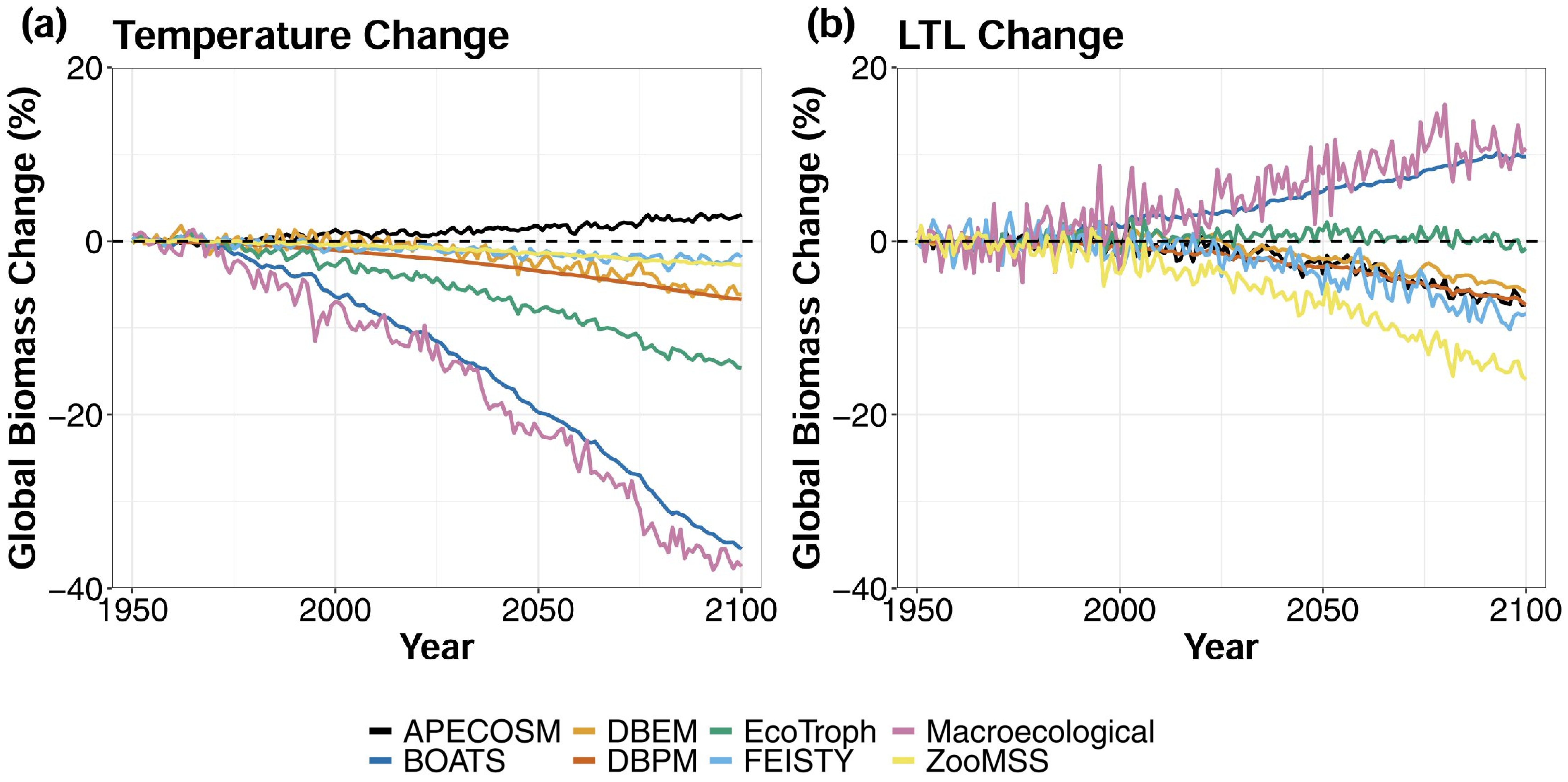


## Goal

The goal of the FishMIP Model Evaluation Protocol is to understand and reduce uncertainty associated with FishMIP models through model evaluation under historical climate and fishing effort forcings.

This information will allow FishMIP to better target policy initiatives such as IPCC and IPBES by providing more robust uncertainty assessment, as well as advancing the state of FishMIP models for informing vulnerability, impact, and adaptation plans of coastal sea ecosystems and fisheries (requested by the FAO). It will also help move towards a detection and attribution framework.

# Global models:
# Temperature & low trophic level drivers




Heneghan et al. 2021 Progress in Oceanography

FISHERIES & MARINE ECOSYSTEM
# FISH-MIP
MODEL INTERCOMPARISON PROJECT


- Network of >100 climate & marine ecosystem modellers

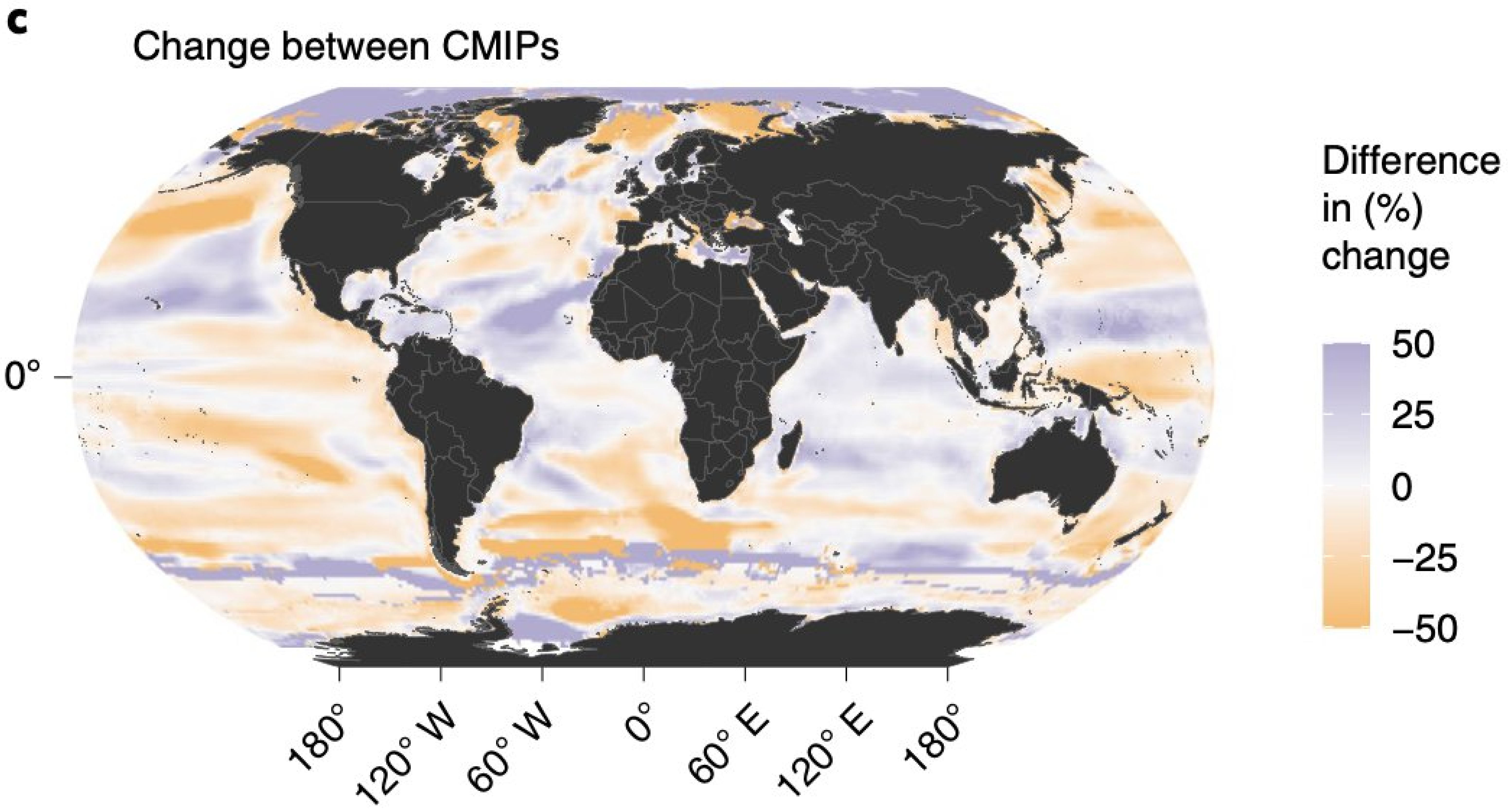

# Spatial resolution

- Global models often do not represent waters <50 m depth, and at the 1° grid size scale (~100 km by 100 km at the equator) fail to capture key fine-scale coastal processes such as eddies and upwelling – important for nutrient supply, primary production, higher trophic level production, and fisheries production

- Two approaches to achieving increased resolution of drivers are
  (i) through statistical downscaling to a higher resolution grid (this will be influenced by the ESM that it was downscaled from)
  (ii) through use of a regional biogeochemical model or a regional ocean modelling system (ROMS)

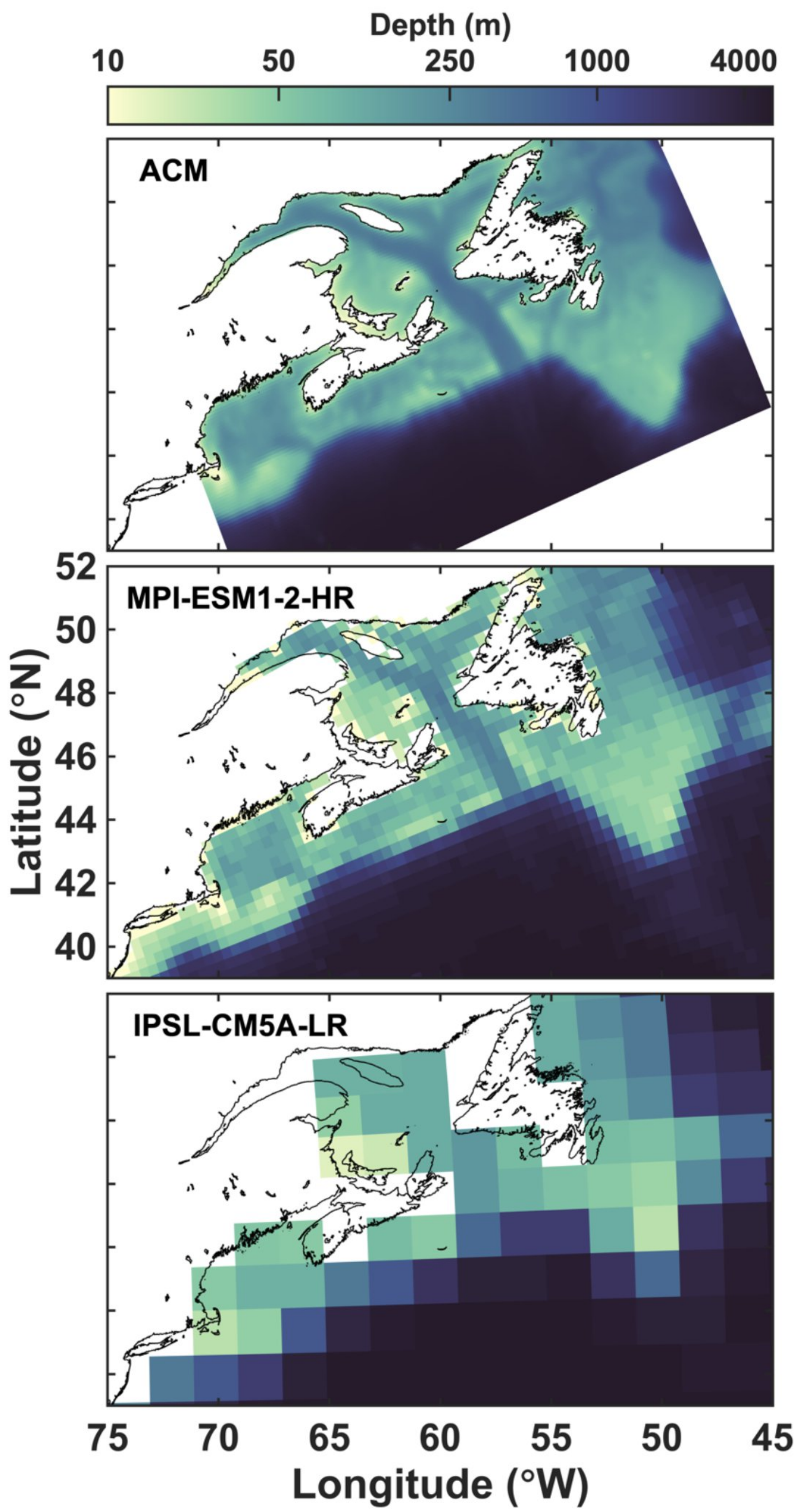
# Changes in total consumer biomass

Regional shifts in the direction of biomass changes highlight the continued and urgent need to reduce uncertainty in the projected responses of marine ecosystems to climate change to help support adaptation planning




Tittensor et al. 2021 Nature Climate Change

# ROMS vs. Earth System Model Coastal Resolution



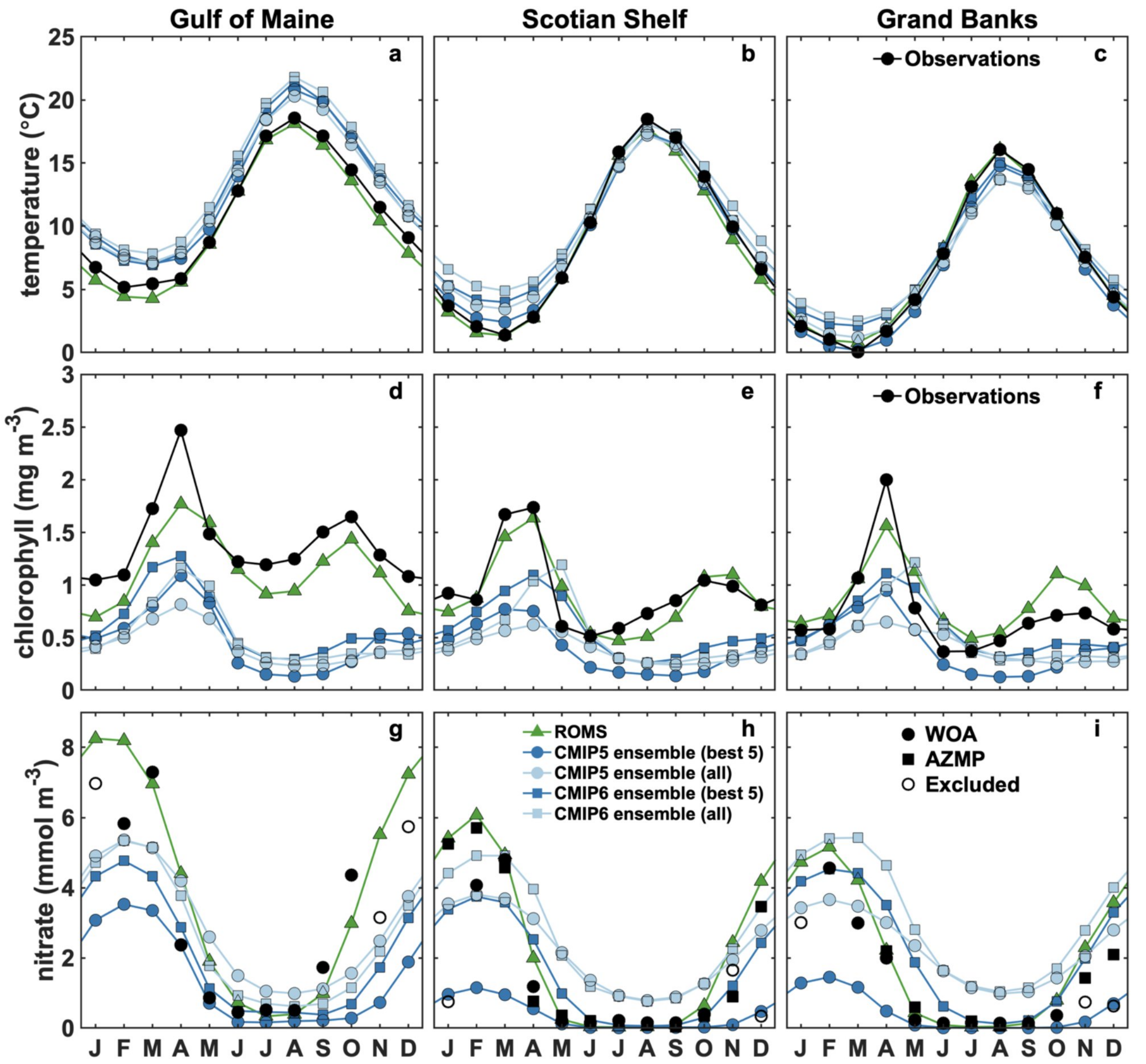

3729 grid cells for Grand Banks

193 grid cells for Grand Banks

13 grid cells for Grand Banks

Laurent et al. 2021 Biogeosciences

Mean 1999–2010




655 **Figure 4. Observed, ROMS and ensemble means area averaged surface chlorophyll (a-c), nitrate (d-f) and temperature (g-i) in the 3 NWA shelf regions.**

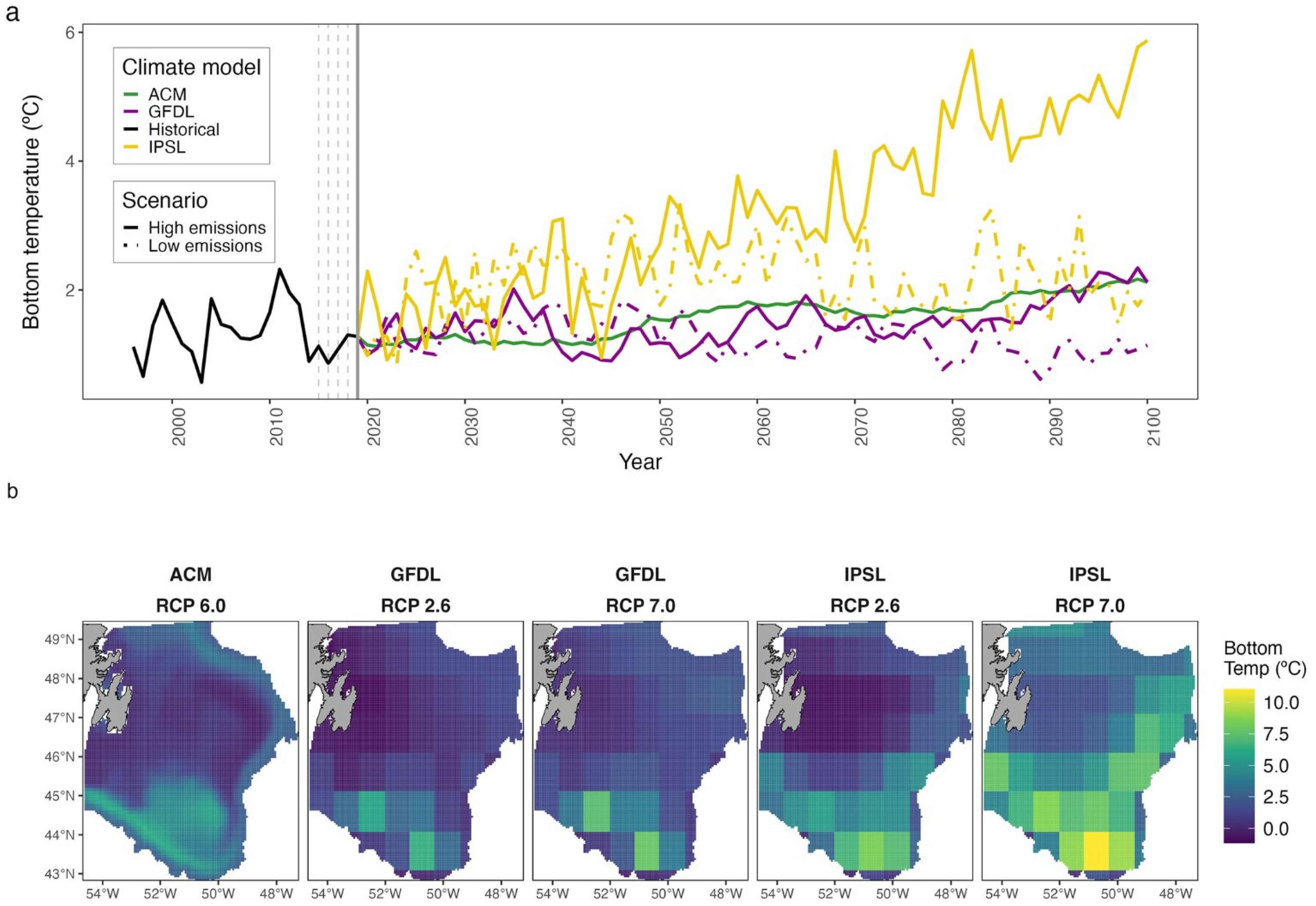
Laurent et al. 2021 Biogeosciences

PLOS CLIMATE

RESEARCH ARTICLE

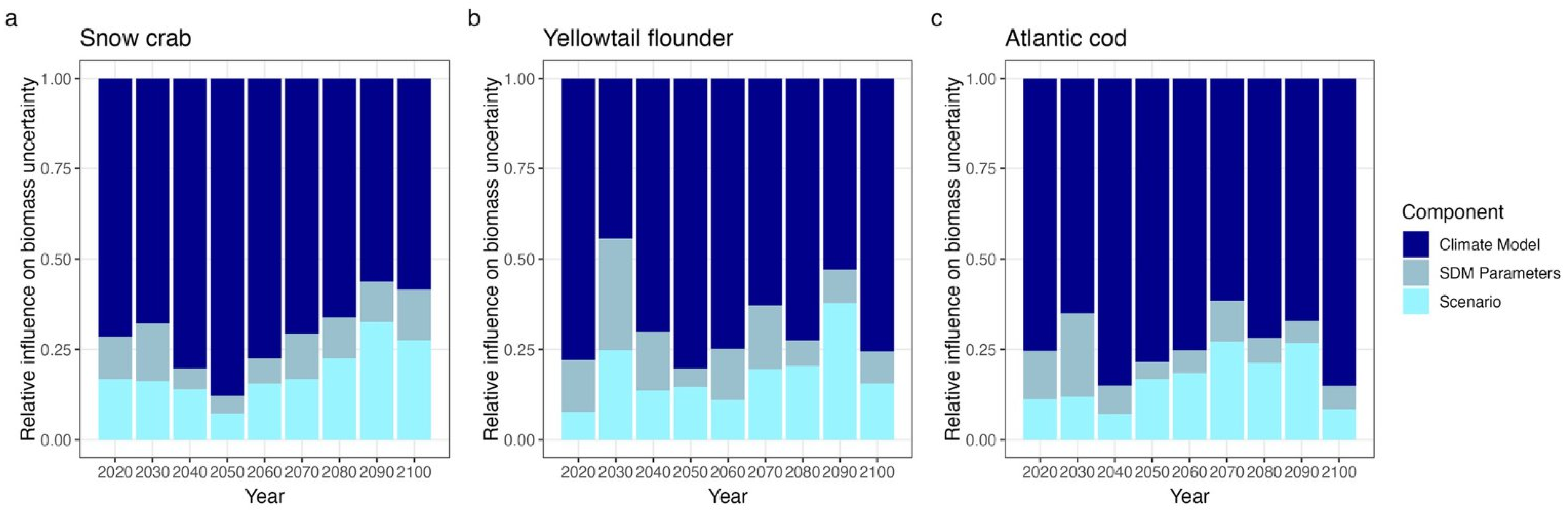
# Climate models drive variation in projections of species distribution on the Grand Banks of Newfoundland

**Raquel Ruiz-Diaz[1]*, Mariano Koen-Alonso[2], Frédéric Cyr[2], Jonathan A. D. Fisher[1], Sherrylynn Rowe[1], Katja Fennel[3], Lina Garcia-Suarez[3], Tyler D. Eddy[1]**

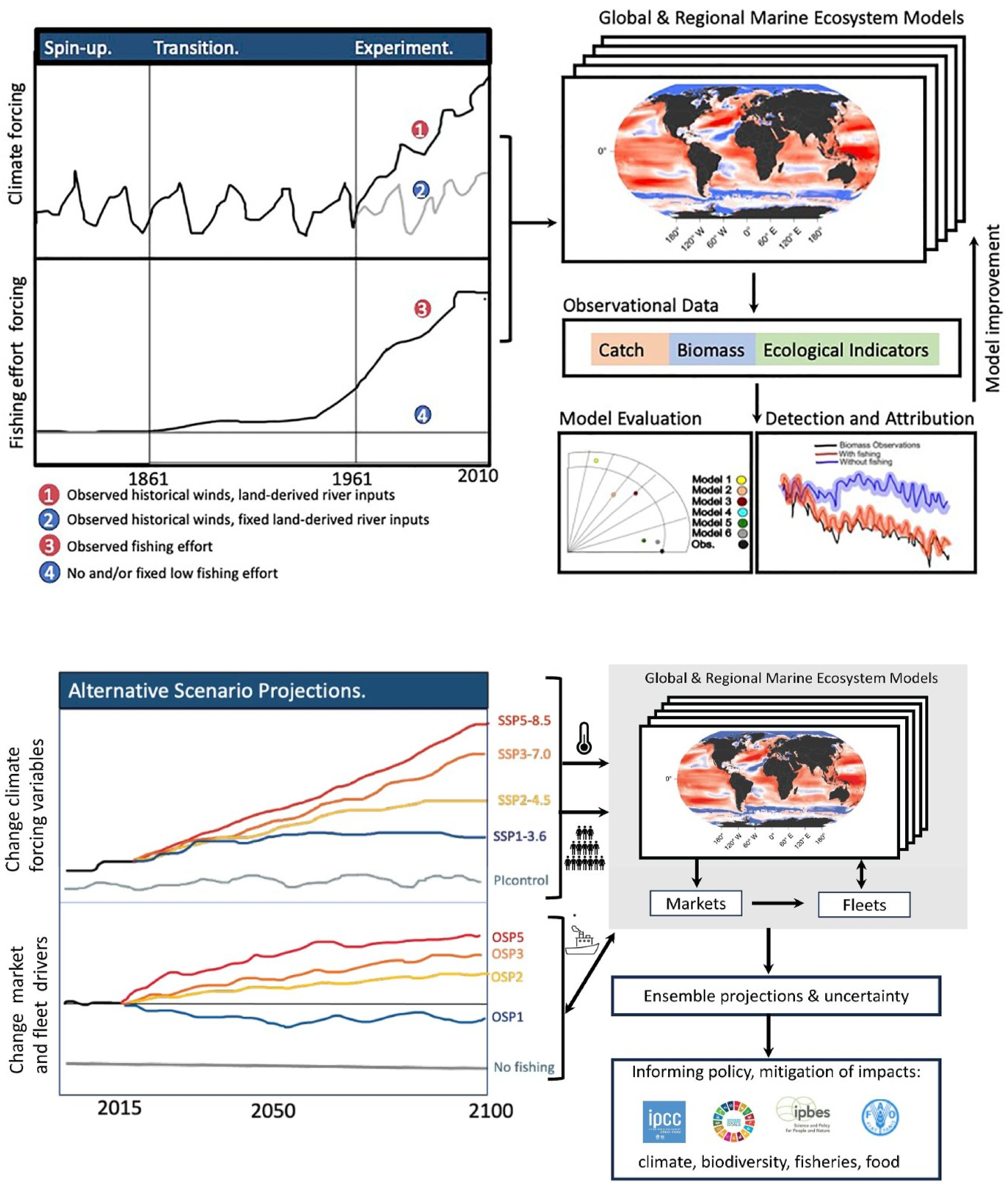



Ruiz-Díaz et al. 2024 PLOS Climate

# Sources of variation for climate change projections




Ruiz-Díaz et al. 2024 PLOS Climate



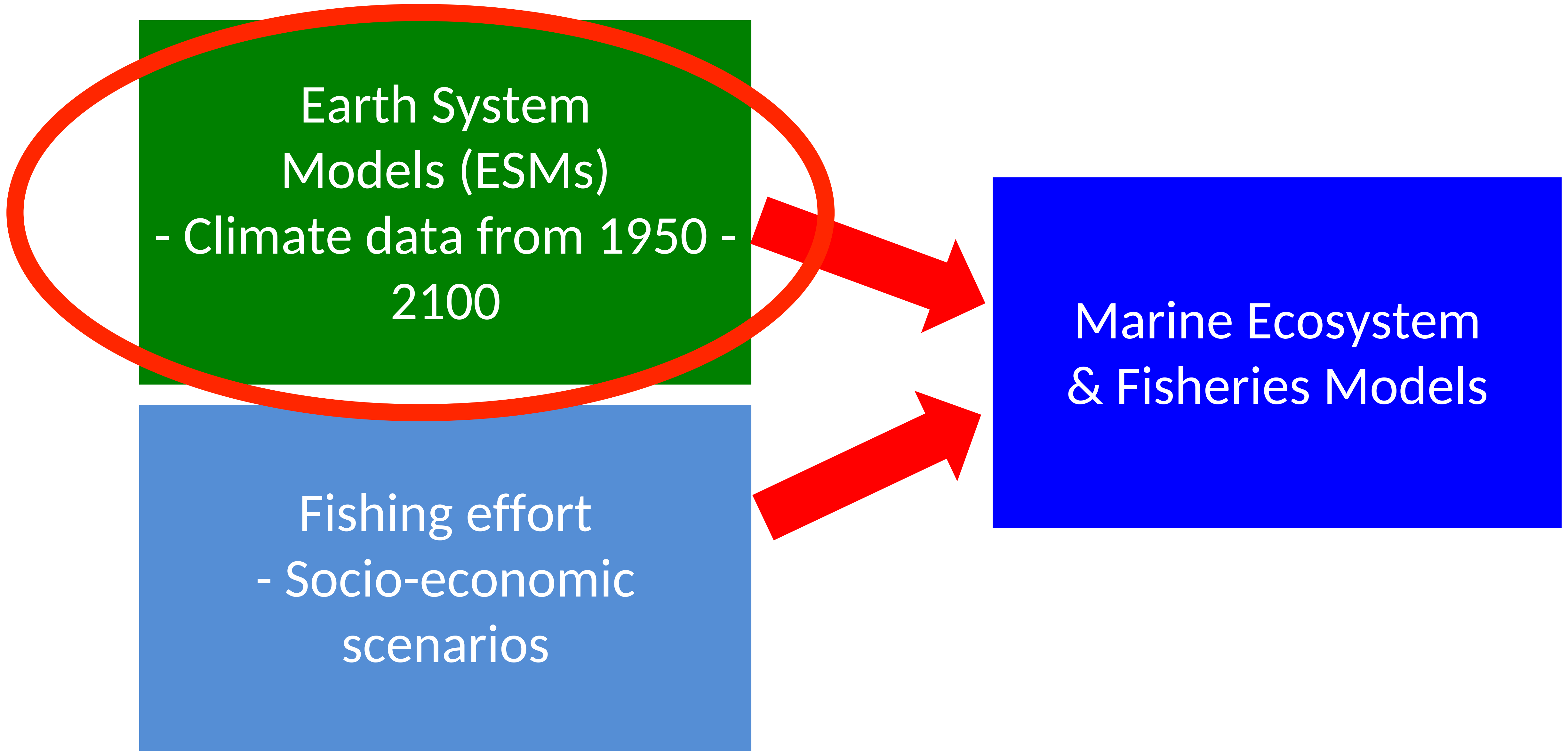

# FishMIP 2.0

Blanchard et al. 2024 Earth's Future

FISHERIES & MARINE ECOSYSTEM
FISH-MIP
MODEL INTERCOMPARISON PROJECT

Simulations to date have focussed on variability due to:

- CMIP5 vs. CMIP6
- Earth system model (GFDL vs. IPSL)
- Emissions scenario (high vs. low)

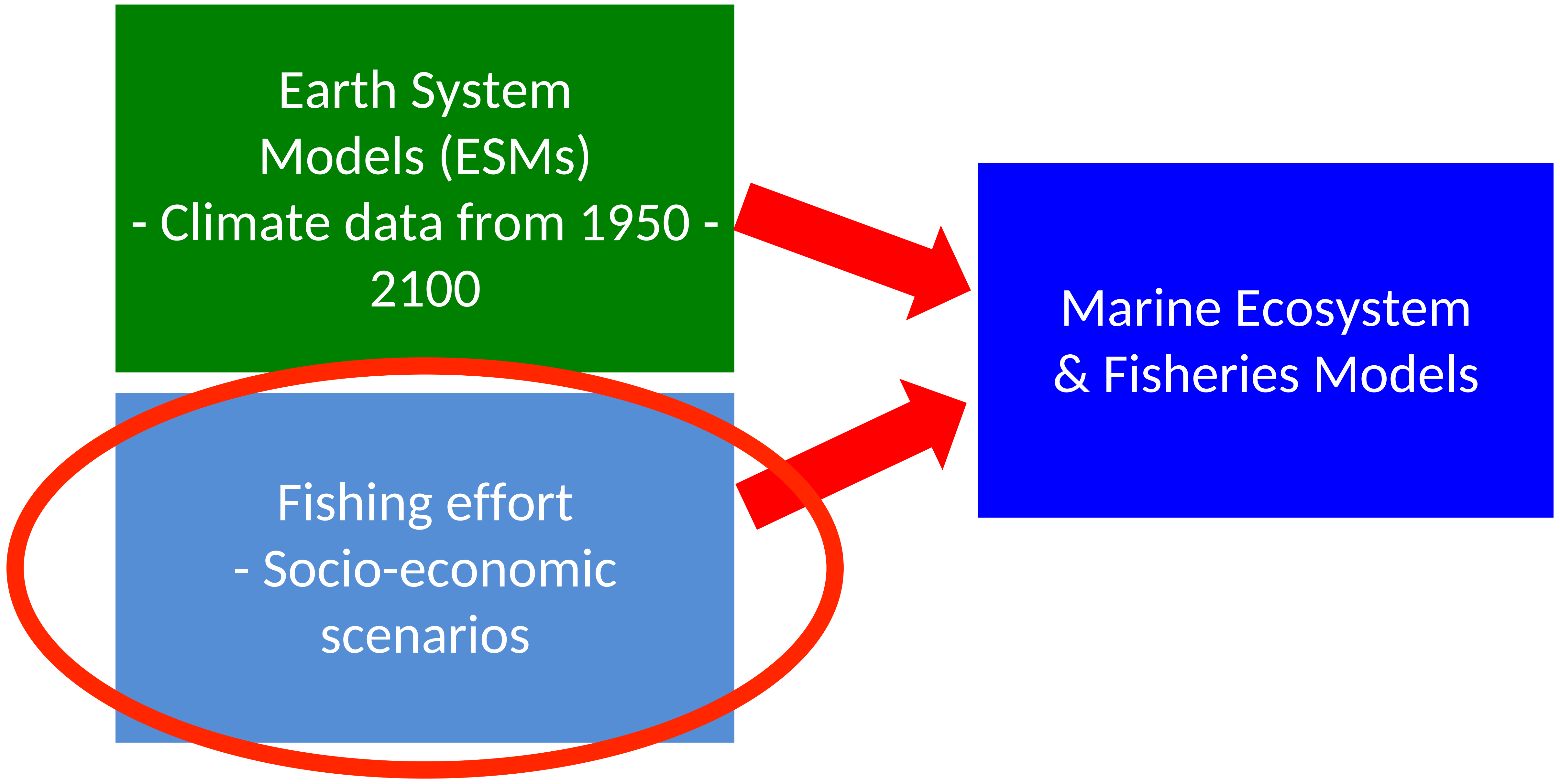


FISHERIES & MARINE ECOSYSTEM

# FISH-MIP

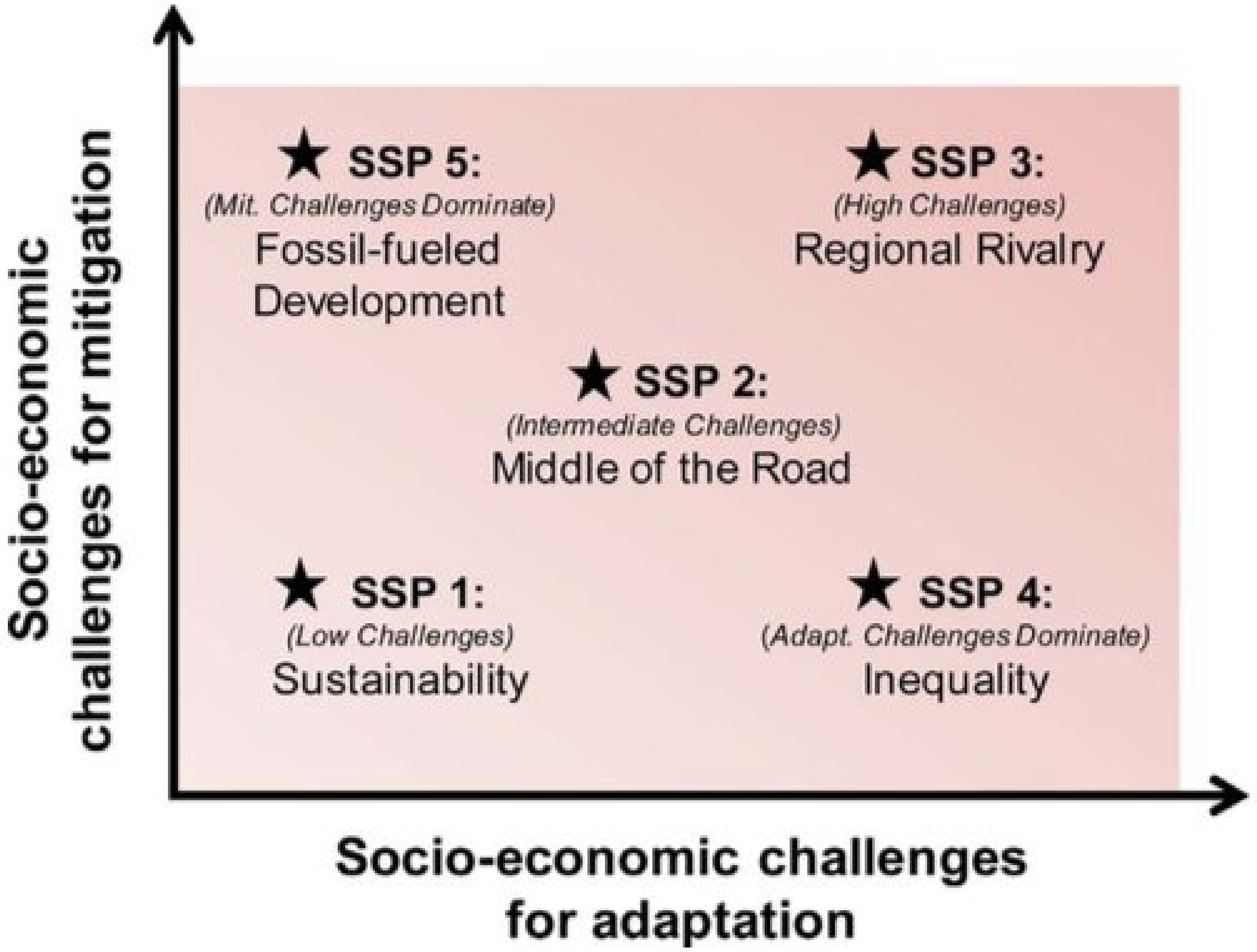
MODEL INTERCOMPARISON PROJECT

- Until now, future fishing scenarios were either:
  - No-fishing
  - Hold fishing constant at 2005 (CMIP5) or 2015 (CMIP6) levels

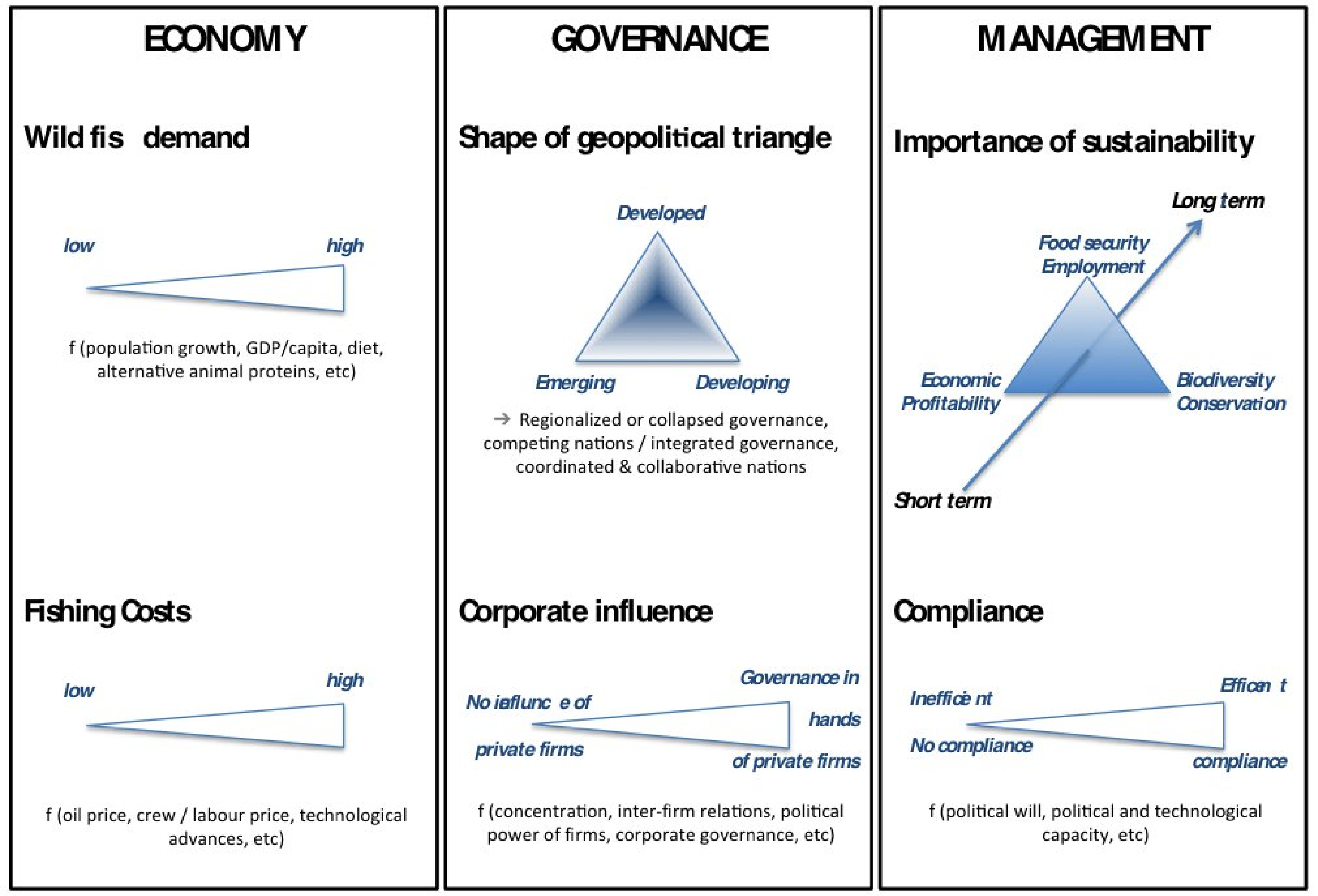


# Ocean System Pathways (OSPs)

- Development of time series of future fishing effort following the SSPs
- Ocean system pathways (OSPs), an extension of the oceanic system pathways
- Fishing fleets include: large pelagic fisheries (tuna and tuna-like species), demersal and benthic fisheries, small pelagic fisheries, emerging fisheries (mesopelagic fish, krill), and marine aquaculture
- Drivers available at IPBES regions (4), subregions (17) or country level




Domains & drivers structuring the OSPs

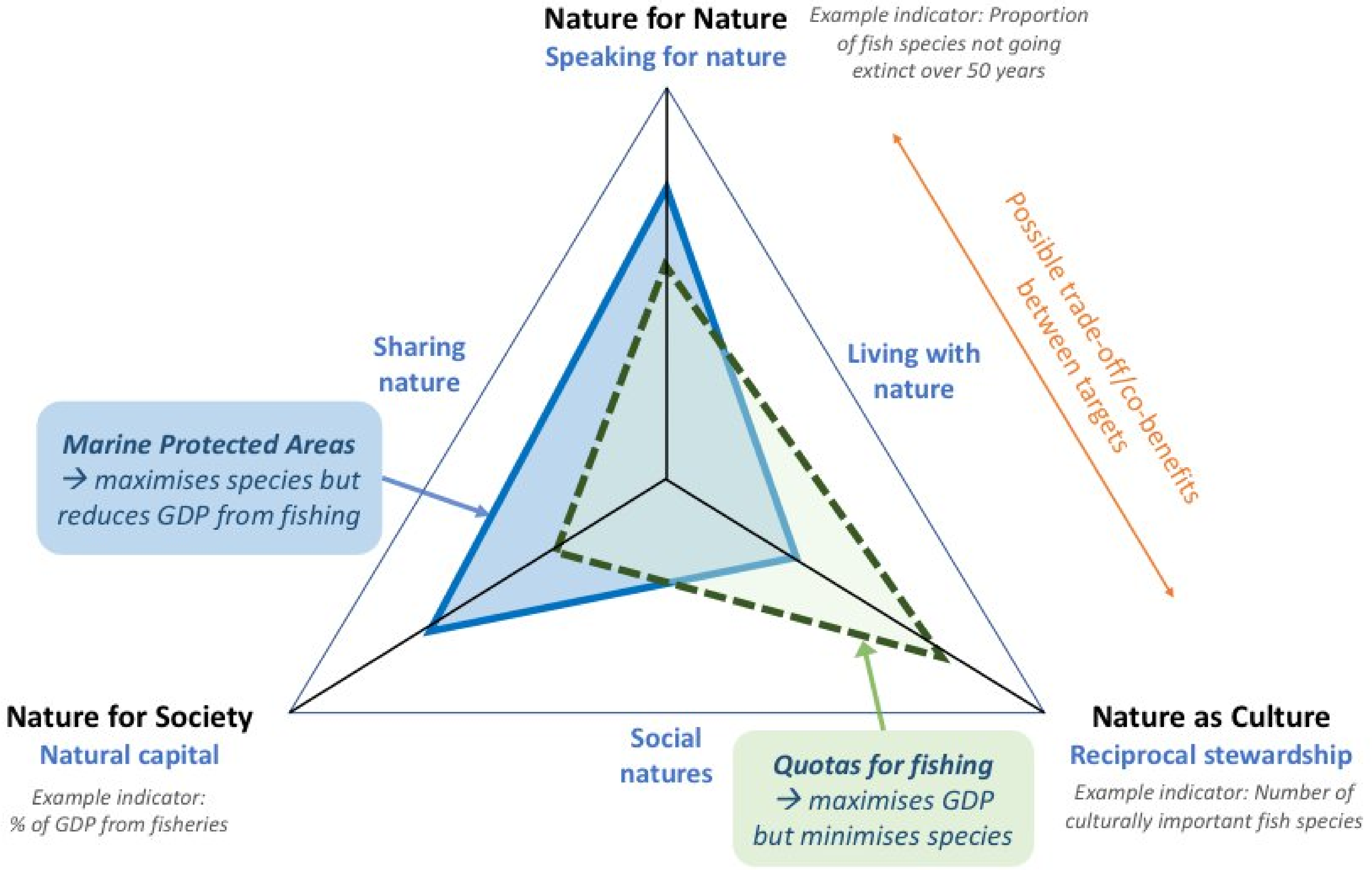



Maury et al. 2017 Global Environmental Change

# Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES) Nature Futures Scenarios

Three scenarios:

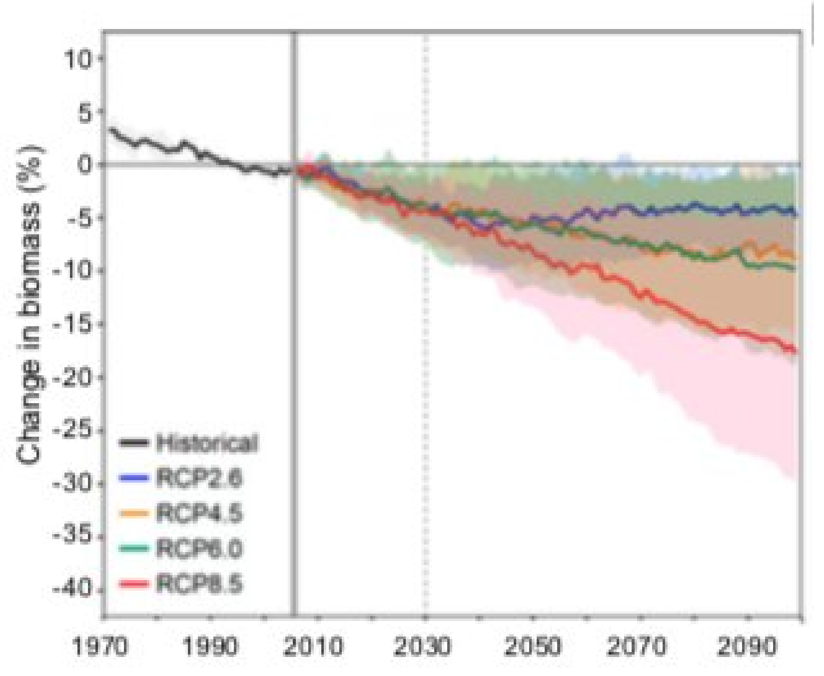
- Nature for nature - biodiversity priority
- Nature for society - ecosystem services priority
- Nature for culture - Indigenous and rural community priority

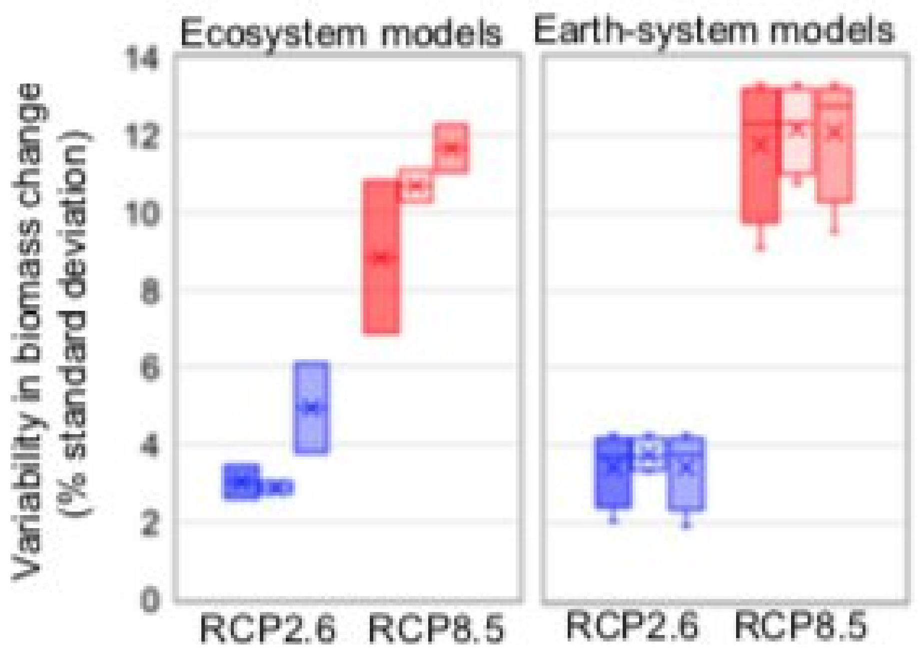


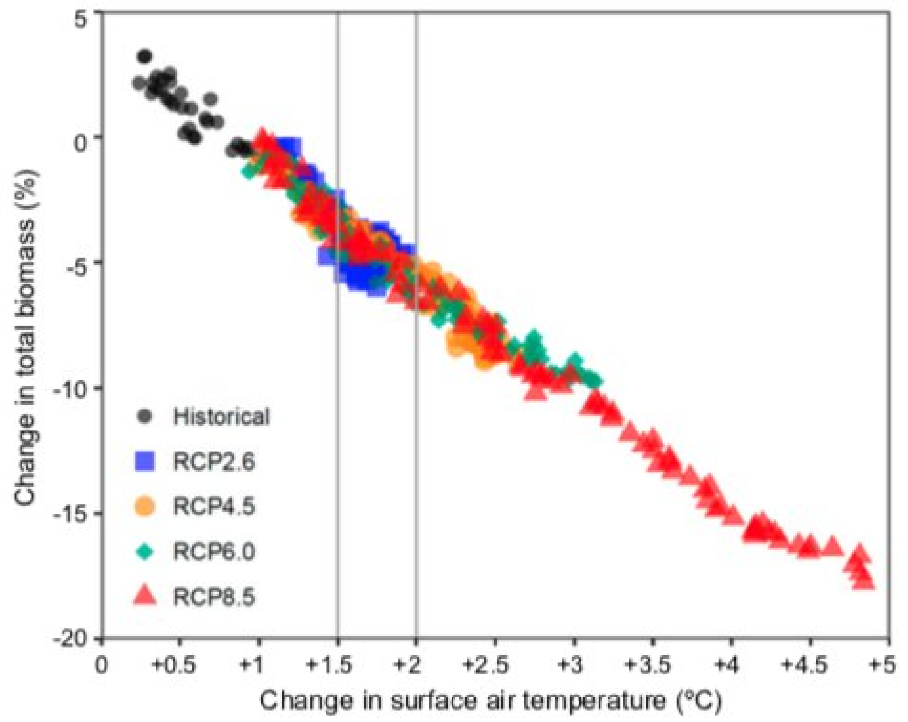

Kim et al. 2023 Global Environmental Change

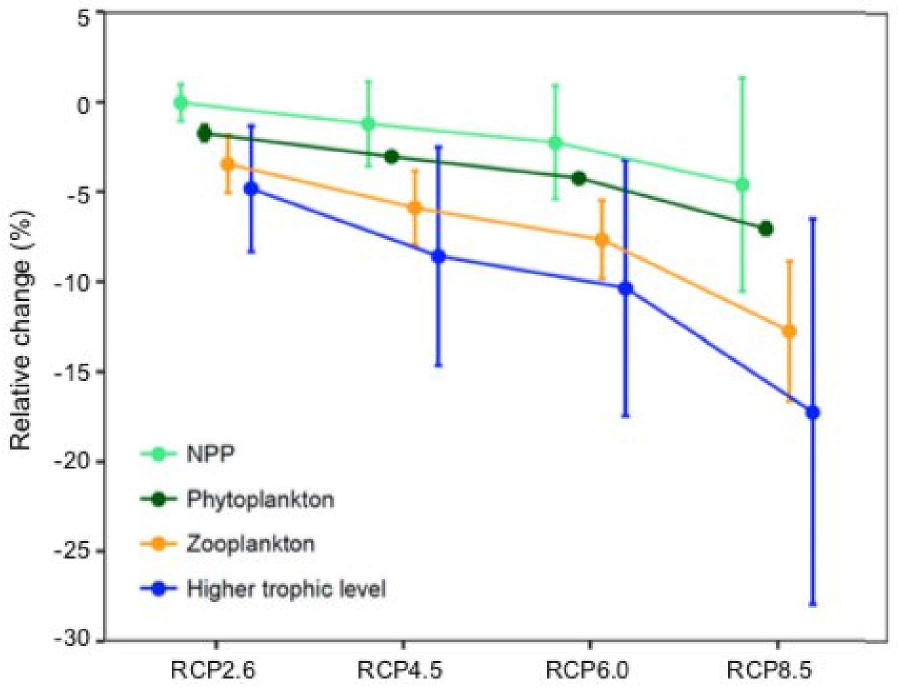
# Global ensemble projections reveal trophic amplification of ocean biomass declines with climate change

Heike K. Lotze[a,1], Derek P. Tittensor[a,b], Andrea Bryndum-Buchholz[a], Tyler D. Eddy[a,c], William W. L. Cheung[c], Eric D. Galbraith[d,e], Manuel Barange[f], Nicolas Barrier[g], Daniele Bianchi[h], Julia L. Blanchard[i,j], Laurent Bopp[k], Matthias Büchner[l], Catherine M. Bulman[m], David A. Carozza[n], Villy Christensen[o], Marta Coll[g,p], John P. Dunne[q], Elizabeth A. Fulton[j,m], Simon Jennings[r,s,t], Miranda C. Jones[c], Steve Mackinson[u], Olivier Maury[g,v], Susa Niiranen[w], Ricardo Oliveros-Ramos[x], Tilla Roy[i,y], José A. Fernandes[z,aa], Jacob Schewe[l], Yunne-Jai Shin[g,bb], Tiago A. M. Silva[r], Jeroen Steenbeek[p], Charles A. Stock[q], Philippe Verley[cc], Jan Volkholz[l], Nicola D. Walker[r], and Boris Worm[a]




- Large amount of variability in projected biomass declines among climate scenarios
- Similar amounts of variability in projections due to choice of Earth-system model & ecosystem model
- 5% loss of ocean biomass with every 1 °C of global warming
- Biggest losses at top of the food web (predators)

Lotze et al. 2019 PNAS

nature climate change

ARTICLES

https://doi.org/10.1038/s41558-021-01173-9

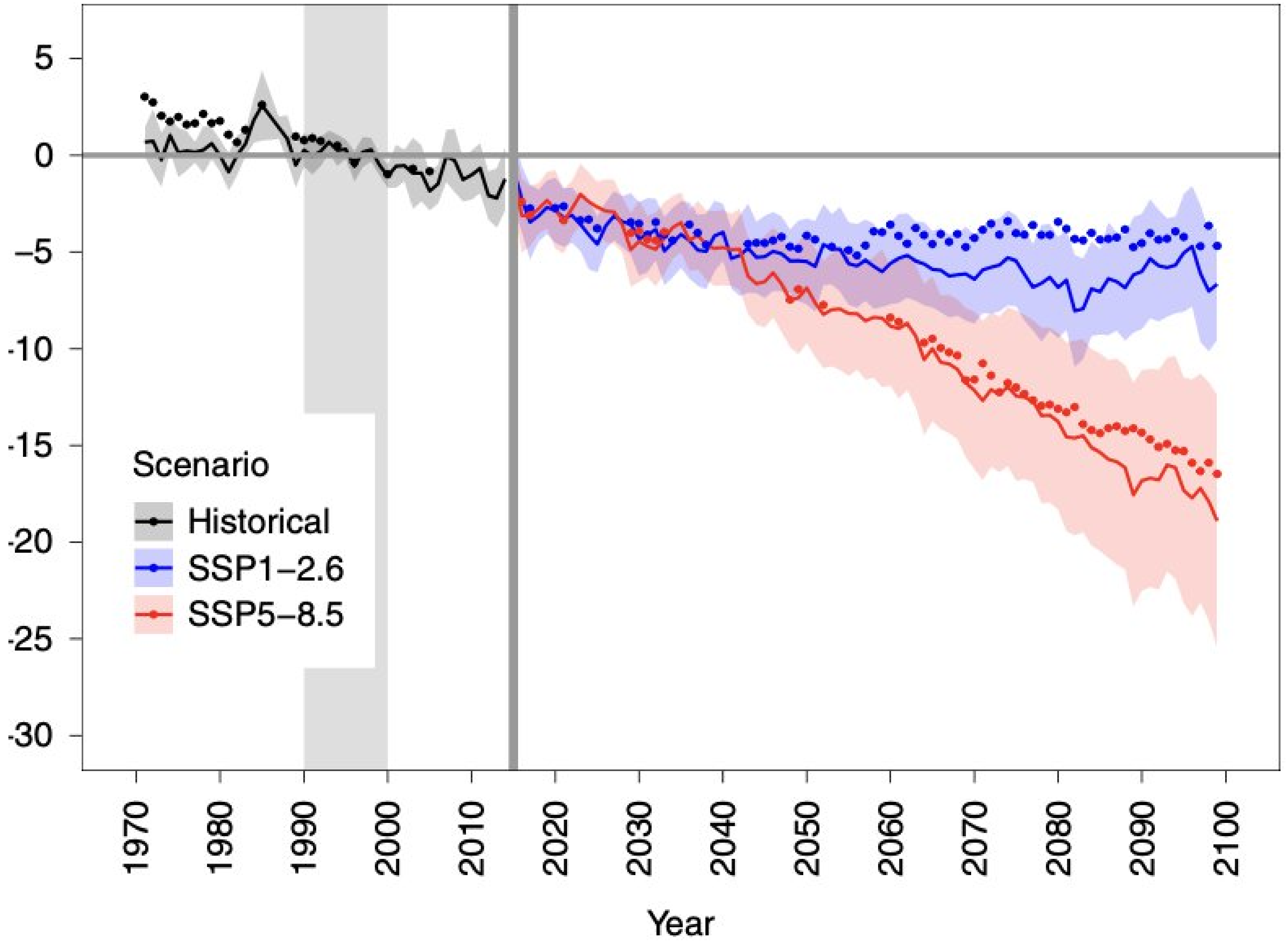
Check for updates

OPEN

# Next-generation ensemble projections reveal higher climate risks for marine ecosystems

Derek P. Tittensor[1,2]✉, Camilla Novaglio[3,4], Cheryl S. Harrison[5,6], Ryan F. Heneghan[7], Nicolas Barrier[8], Daniele Bianchi[9], Laurent Bopp[10], Andrea Bryndum-Buchholz[1], Gregory L. Britten[11], Matthias Büchner[12], William W. L. Cheung[13], Villy Christensen[13], Marta Coll[14,15], John P. Dunne[16], Tyler D. Eddy[17], Jason D. Everett[18,19,20], Jose A. Fernandes-Salvador[21], Elizabeth A. Fulton[4,22], Eric D. Galbraith[23], Didier Gascuel[24], Jerome Guiet[9], Jasmin G. John[16], Jason S. Link[25], Heike K. Lotze[1], Olivier Maury[8], Kelly Ortega-Cisneros[26], Juliano Palacios-Abrantes[13,27], Colleen M. Petrik[28], Hubert du Pontavice[24,29], Jonathan Rault[8], Anthony J. Richardson[18,19], Lynne Shannon[26], Yunne-Jai Shin[8], Jeroen Steenbeek[15], Charles A. Stock[16] and Julia L. Blanchard[3,4]

## CMIP5 vs. CMIP6




- Mean global decline of ~19% marine ecosystem biomass for CMIP6 by 2100 relative to 1990–1999 for high emissions scenario (~2.5% more than CMIP5)

Tittensor et al. 2021 Nature Climate Change

# Diversity of FishMIP models

- From a size-based model with three size classes to a species distribution model with more than 1000 species
- Challenge lies in coming up with climate and fishing scenarios and common outputs inclusive of all models
- Diversity is a challenge but it is also our strength!
- Additional challenge lies in aligning FishMIP simulations with ISIMIP simulations to compare among sectors

Tittensor, Eddy et al. 2018 Geoscientific Model Development

# The Model Intercomparison (MIP) Experience: Model Ensembles

CMIP
The World Climate Research Programme's Coupled Model Intercomparison Project

ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

FISHERIES & MARINE ECOSYSTEM
FISH-MIP
MODEL INTERCOMPARISON PROJECT

ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

Agreement →

| | | |
|---|---|---|
| *High agreement Limited evidence* | *High agreement Medium evidence* | *High agreement Robust evidence* |
| *Medium agreement Limited evidence* | *Medium agreement Medium evidence* | *Medium agreement Robust evidence* |
| *Low agreement Limited evidence* | *Low agreement Medium evidence* | *Low agreement Robust evidence* |

Evidence (type, amount, quality, consistency) →

Confidence Scale

IPCC 2014

ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

**climate projections**
RCP scenarios from CMIP & CORDEX archives

**Socio-economic input**
SSP scenarios

**Impact models** global & regional

| | |
|---|---|
| agriculture | water |
| biomes | Forests |
| coastal infrastructure | health |
| fisheries | energy |
| agro-economics | permafrost |

- Synthesis of impacts at different levels of global warming
- Quantification of uncertainties
- Model improvement
- Cross-sectoral interactions
- Cross-scale intercomparison
- Focus topics (e.g. extreme events, adaptation)

Agriculture Sector

Agro-economic Modelling

Terrestrial biodiversity

Permafrost

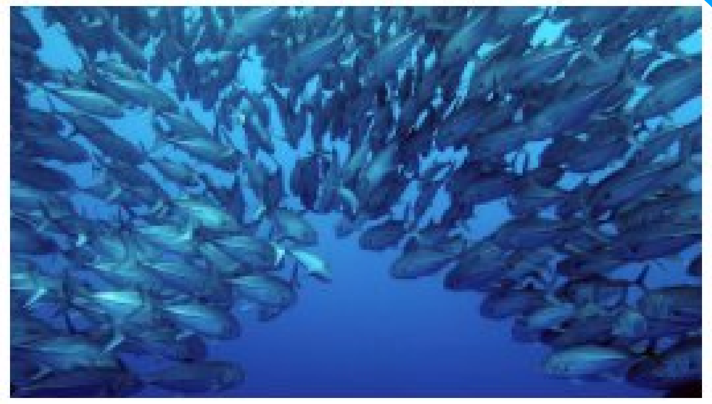
Coastal Infrastructure

Health

Lakes

Water (global)

Water (regional)



FishMIP
Fisheries & Marine Ecosystem Model Intercomparison Project

Energy Supply & Demand

Regional Forests

Global Biomes

# Fisheries & Marine Ecosystem Model Intercomparison Project (FishMIP)

- Primary production
- Temperature

CMIP
The World Climate Research Programme's Coupled Model Intercomparison Project


- Fishing effort
- Marine protected areas

Simulations with ensemble of Marine Ecosystem & Fisheries Models

ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

FISHERIES & MARINE ECOSYSTEM
FISH-MIP
MODEL INTERCOMPARISON PROJECT

PIK
Potsdam Institute for Climate Impact Research