Predictability in the California Current Coastal Ecosystem

Mer Pozo Buil

mercedes.pozo@ucsc.edu

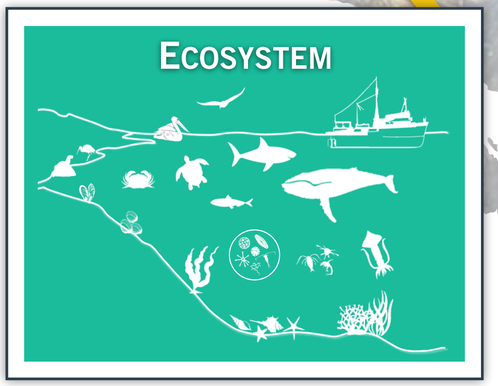
Ocean Predict SYMPOSIUM OP'24

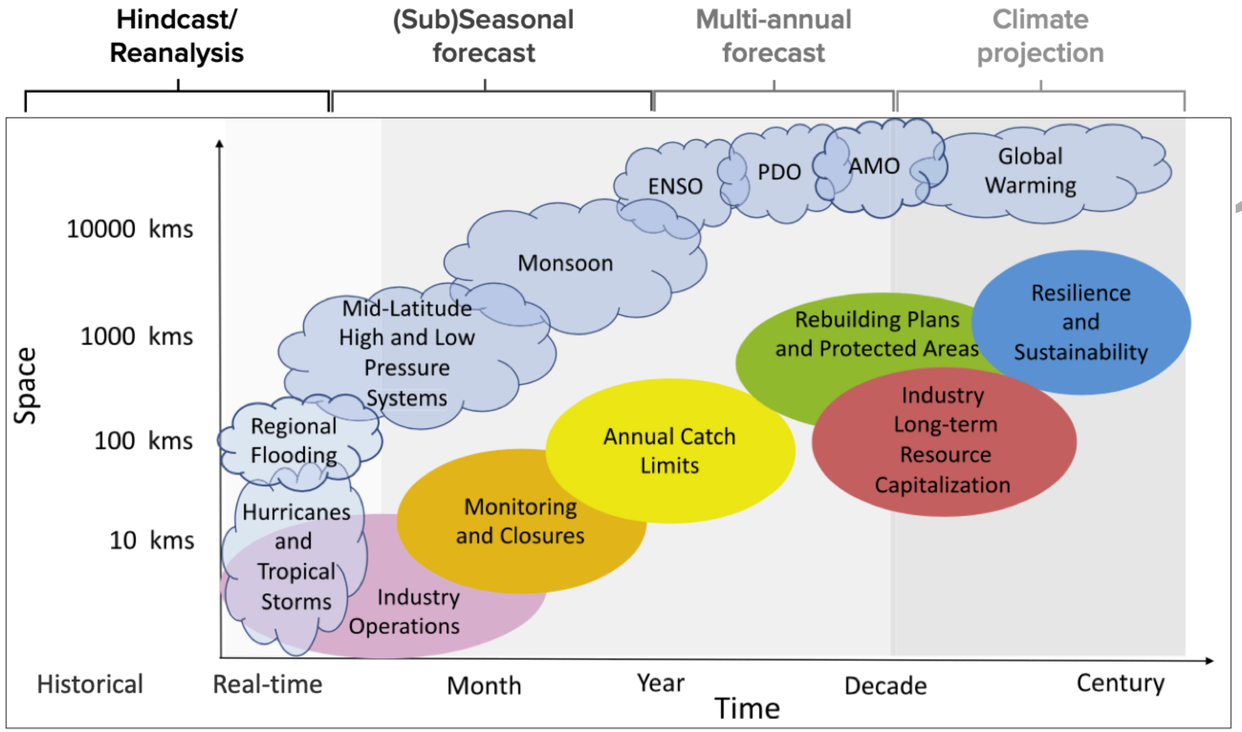
In partnership with unesco Intergovernmental Oceanographic Commission

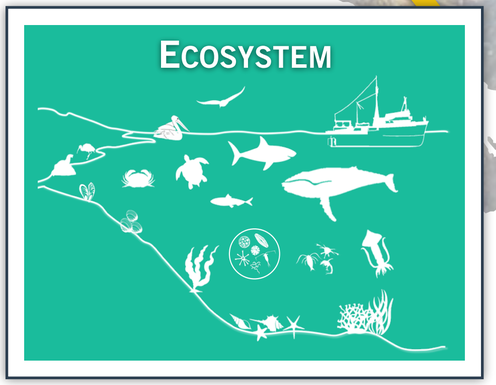
2021 2030 United Nations Decade of Ocean Science for Sustainable Development

MOTIVATION:

Skillful predictions of the ecosystem provide **decision-makers** with information needed to develop effective long-term **ecosystem management strategies**







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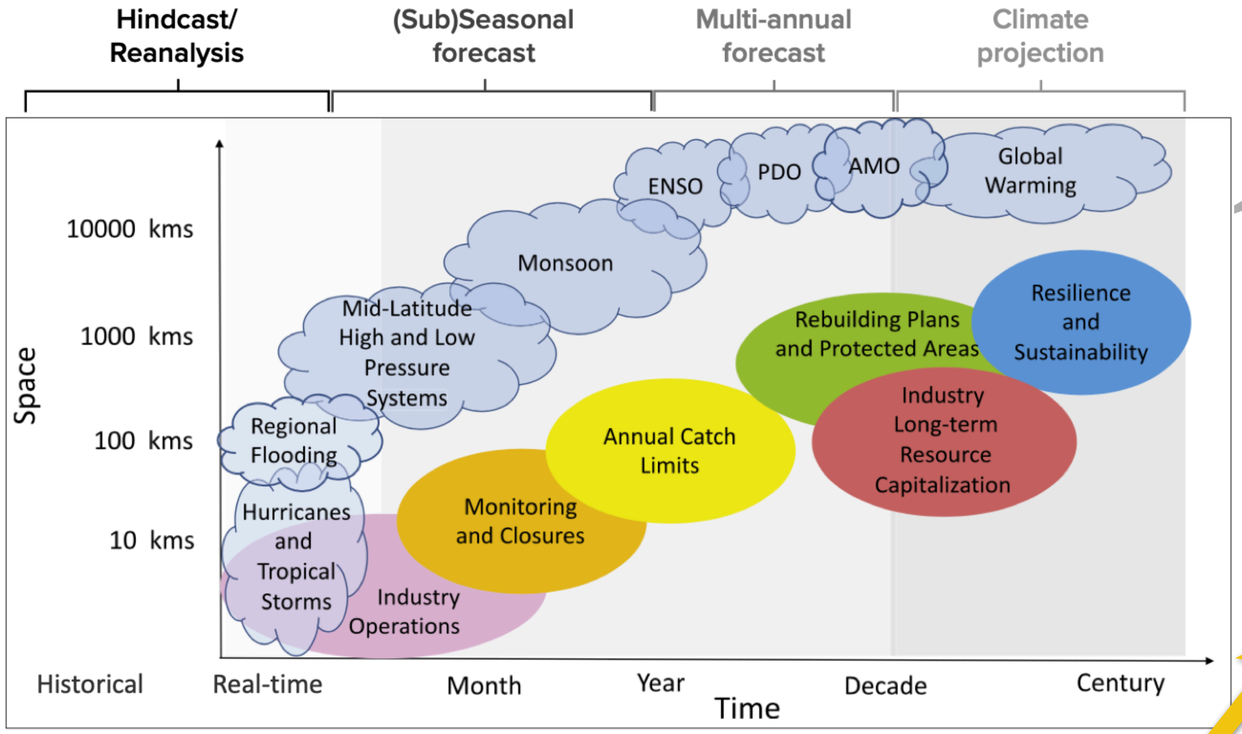
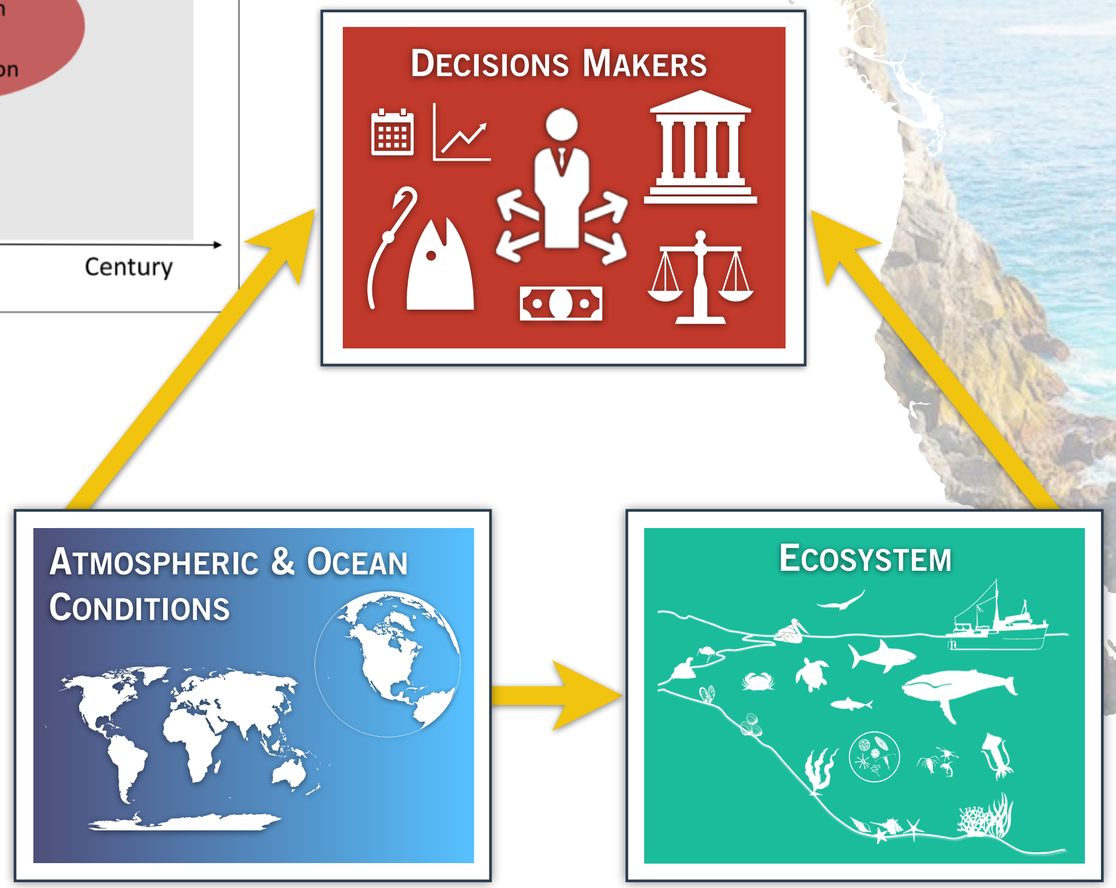
Tomassi et al., 2017



Start from **skillful physical climate predictions,** which are then connected by statistical or mechanistic models to ecological targets of interest



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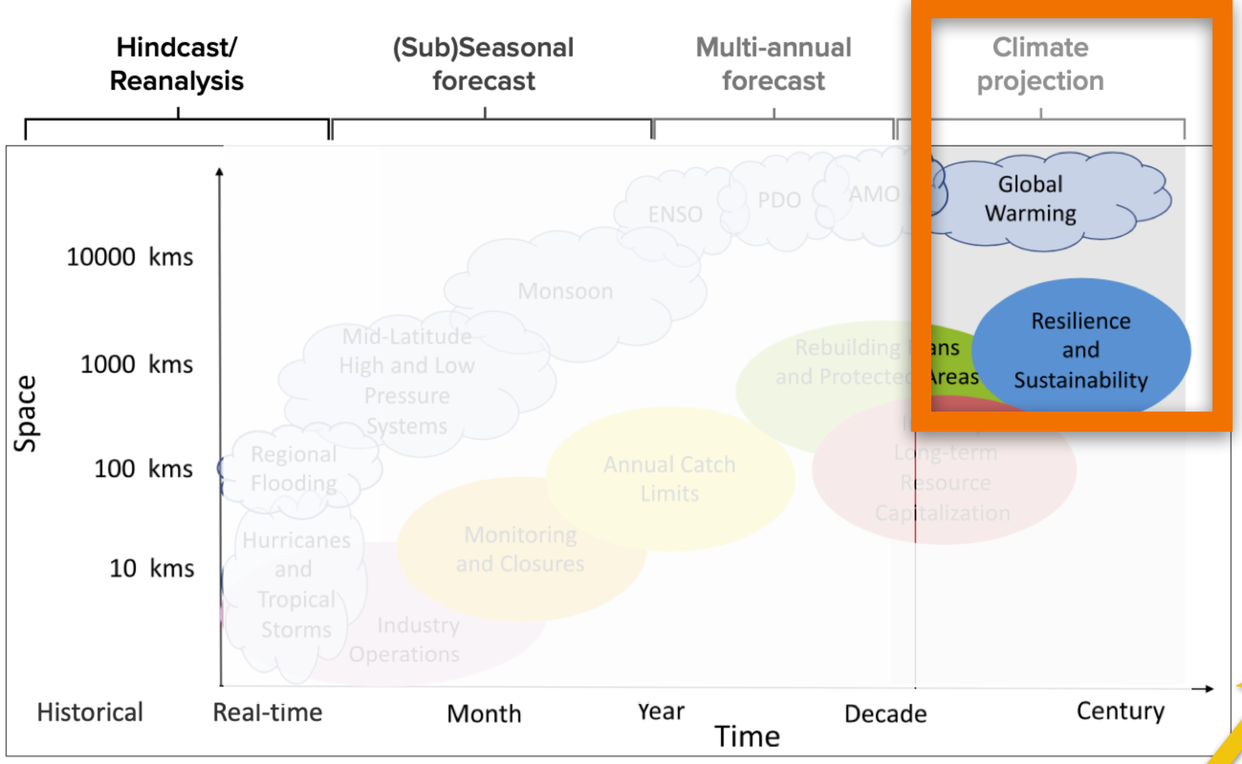

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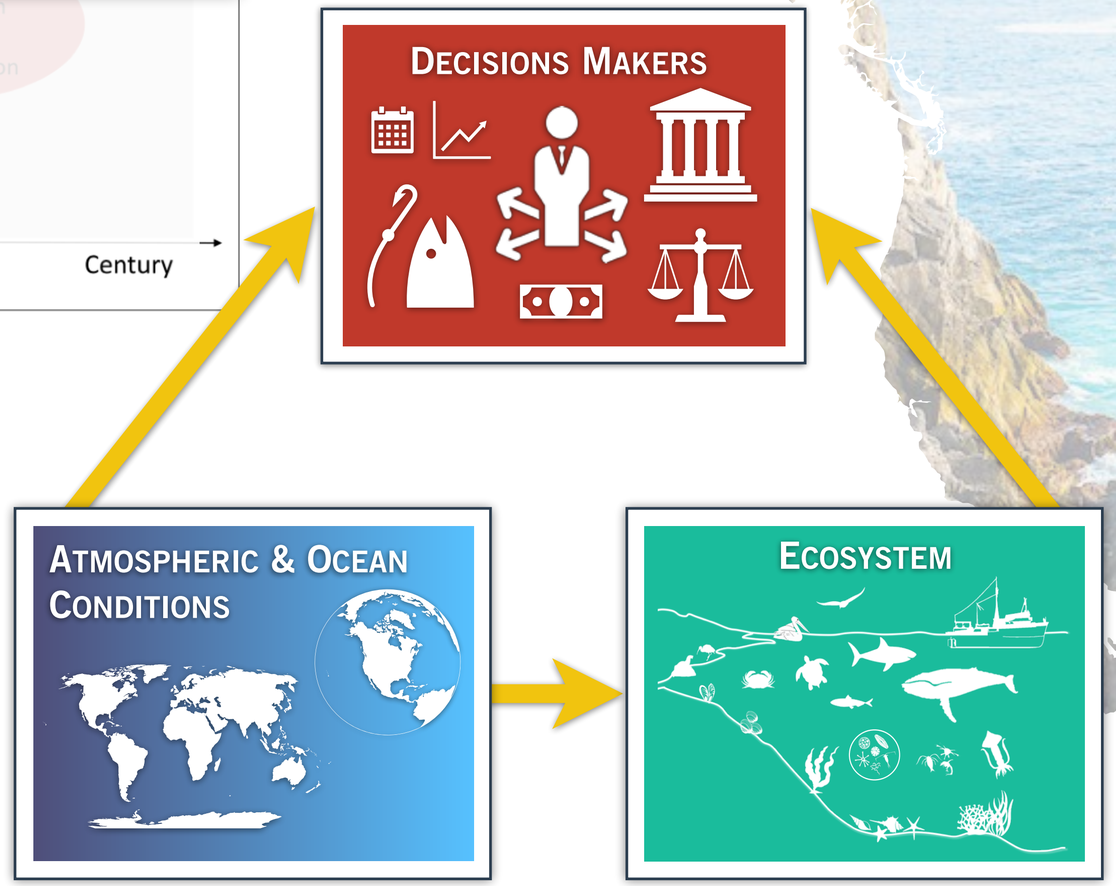

Tomassi et al., 2017

GOAL

Build a **downscaling framework** to produce high-resolution regional **climate projections** of ecosystem variables for the California Current System (CCS)

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Coupled dynamics
Radiative forcing

Better resolution of
fine-scale processes

Exploit physical/biological
relationships

Century Projections — Downscaling Methodology

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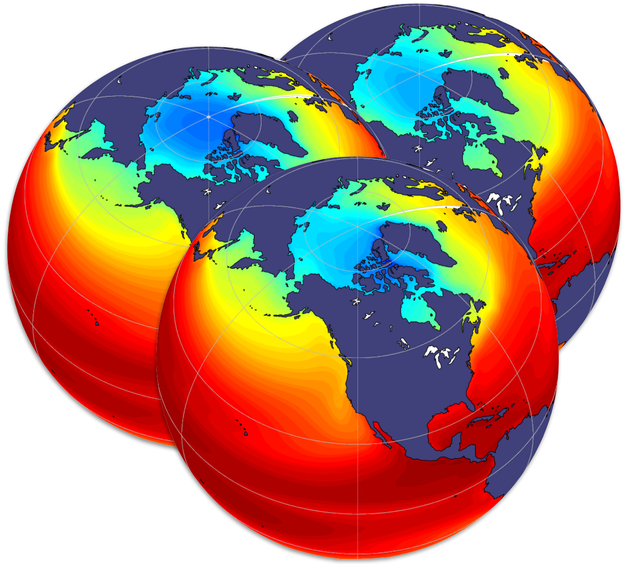
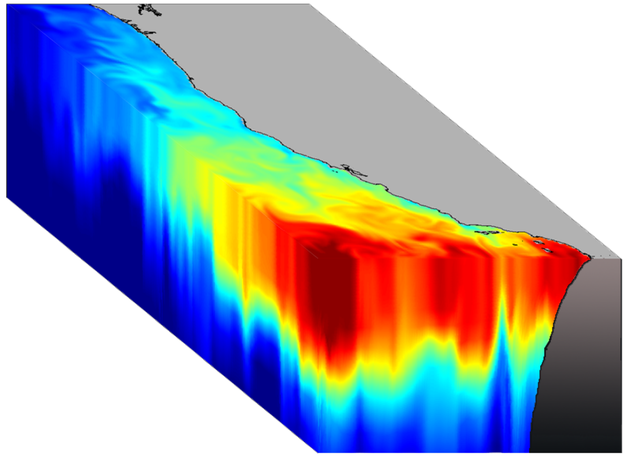
Global Earth System Models



High Emission Scenario (rcp8.5)

HADGEM2-ES
GFDL-ESM2M
IPSL-CM5A-MR

Regional Physical & Biochemical Coupled models

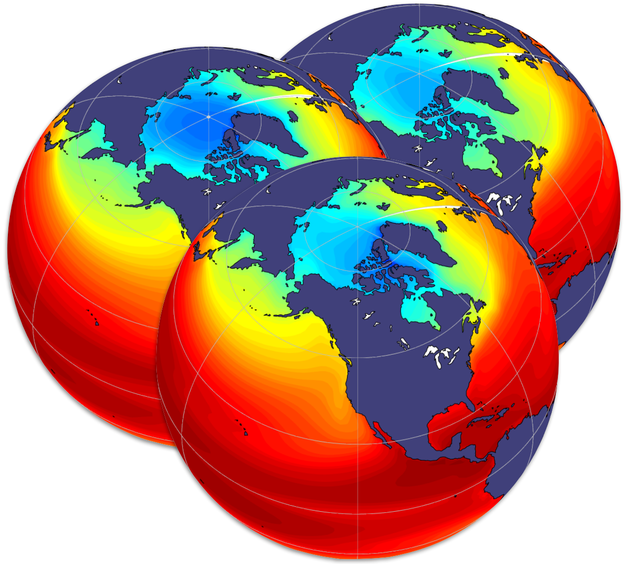


ROMS + NEMURO
10km

https://oceanmodeling.ucsc.edu

Century Projections — Downscaling Methodology

Global Earth System Models



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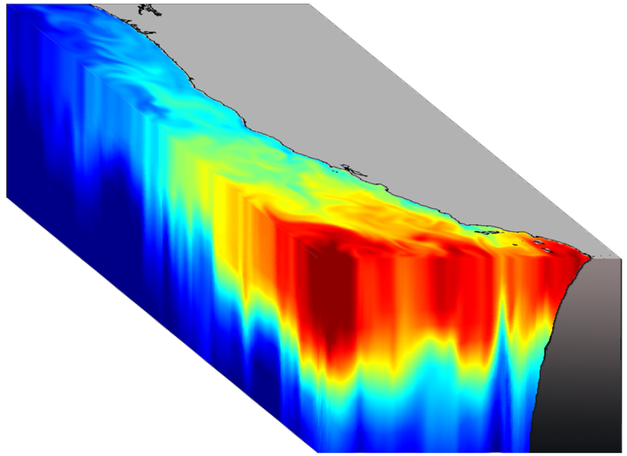

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ROMS-NEMUCSC

10Km CCS from UCSC

Control HINDCAST 1980-2010

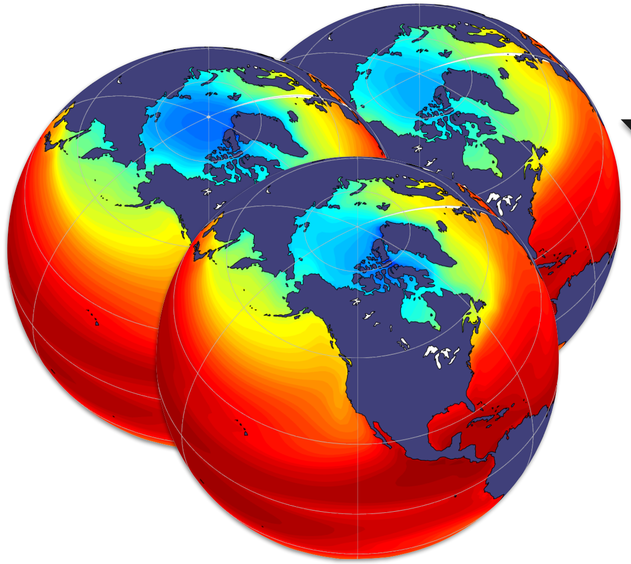
- Atmospheric forcing:
  ERA-5 1h,
  ERA-5 6h & CCMP1 6h, winds
- Open boundaries:
  SODA month & WOA

Pozo Buil et al., 2021

“Time-varying” Delta

Downscaling Method

Global Earth System Models



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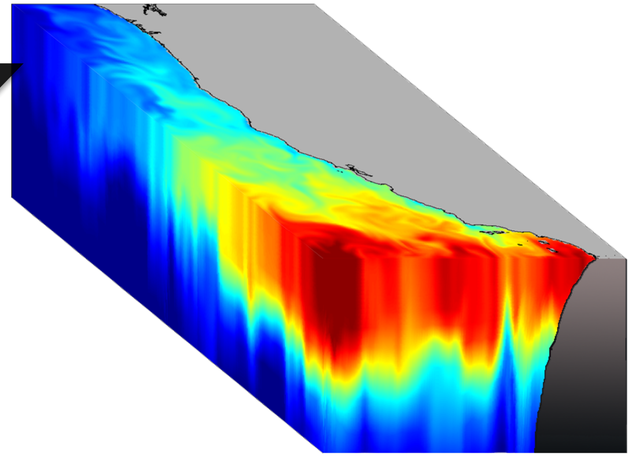

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- Changes in **INTER-ANNUAL** variability are captured
- **Transient** period (2006-2100) is resolved
- **Corrects ESM mean bias** with respect to observations

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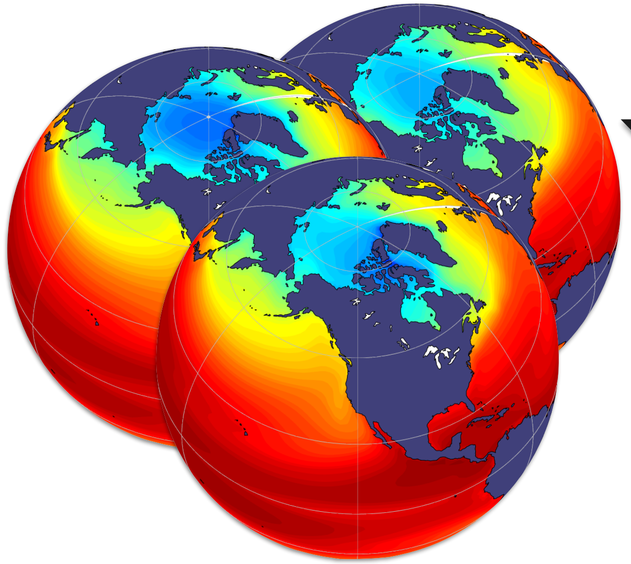

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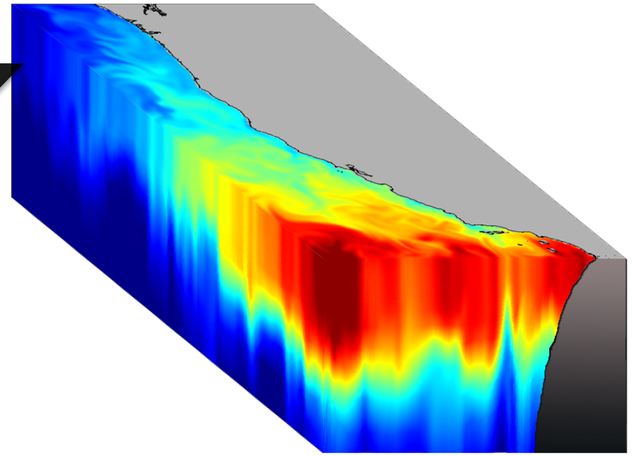

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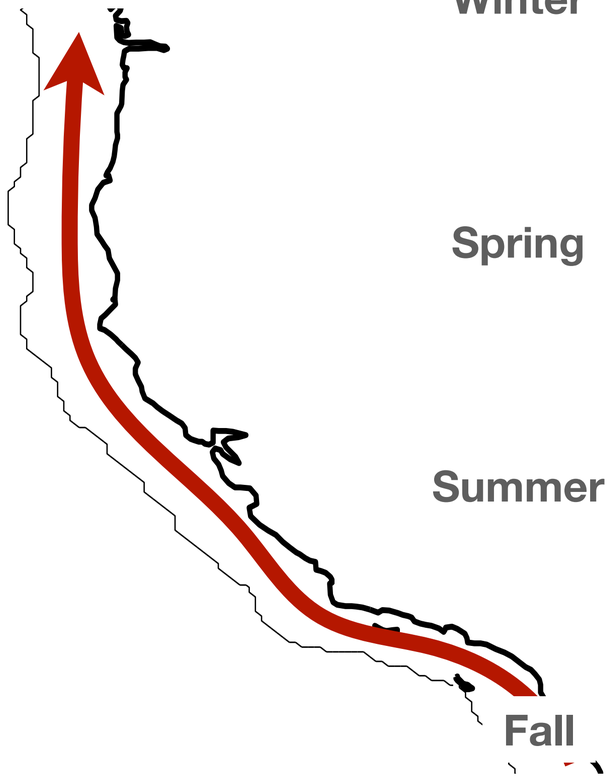
3 Downscaled Projections:

ROMS GFDL **ROMS IPSL** **ROMS HAD**

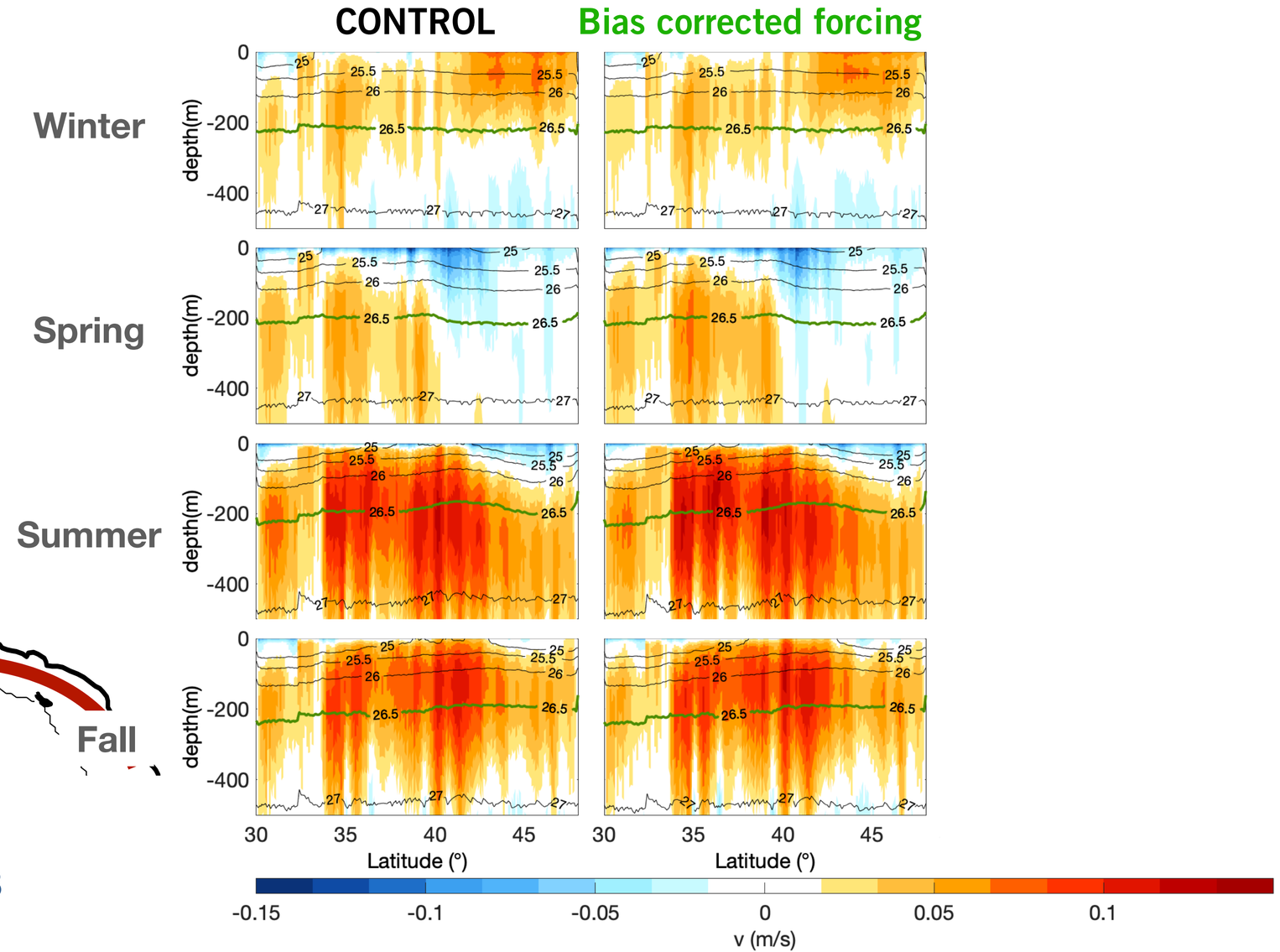
Pozo Buil et al., 2021

Century Projections — Impact of Bias Correcting Forcing

Representation of the California Undercurrent



Pozo Buil et al., 2023



Mean Historical
1980-2010

Meridional Velocity & Potential Density

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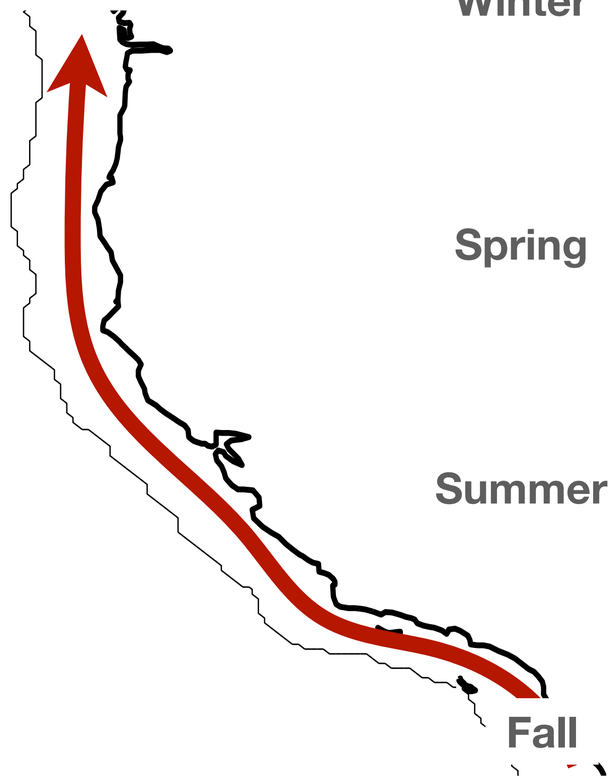

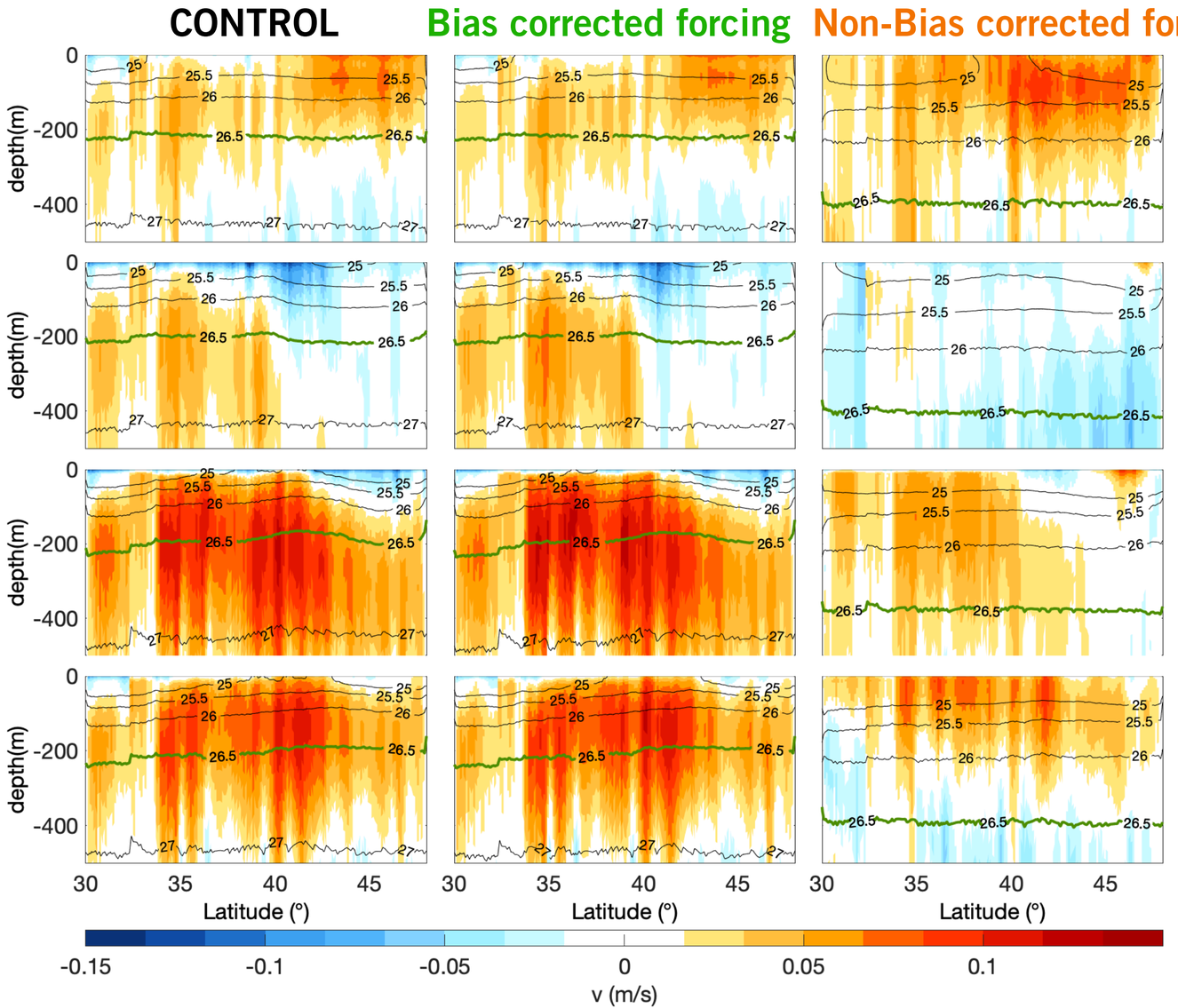

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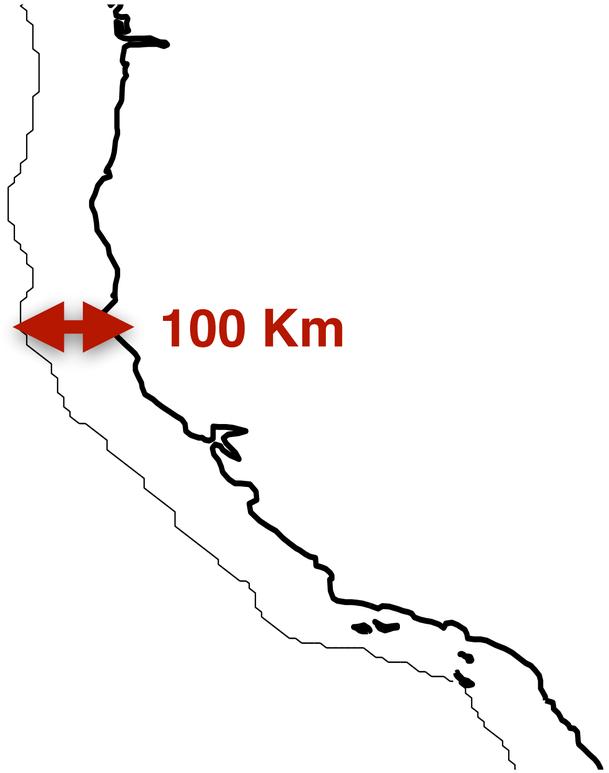
Pozo Buil et al., 2023

Temporal variability

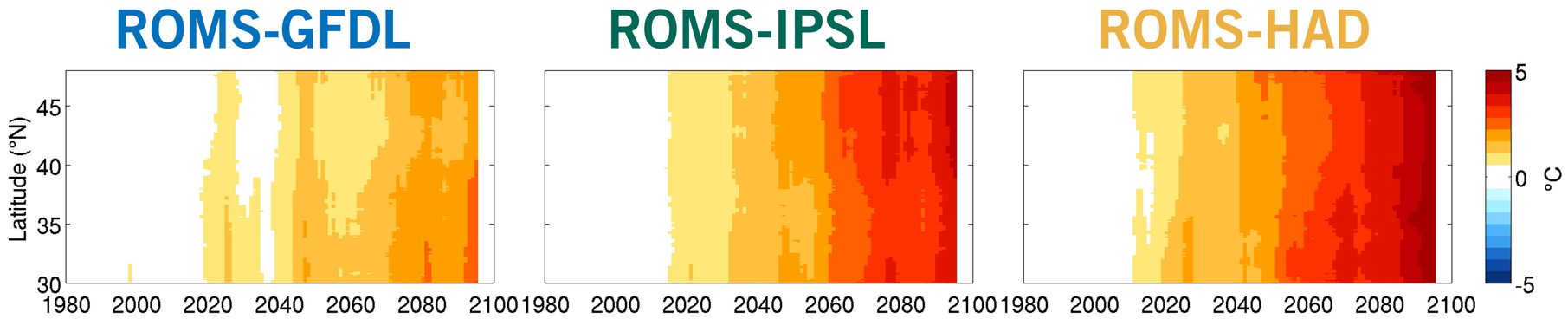


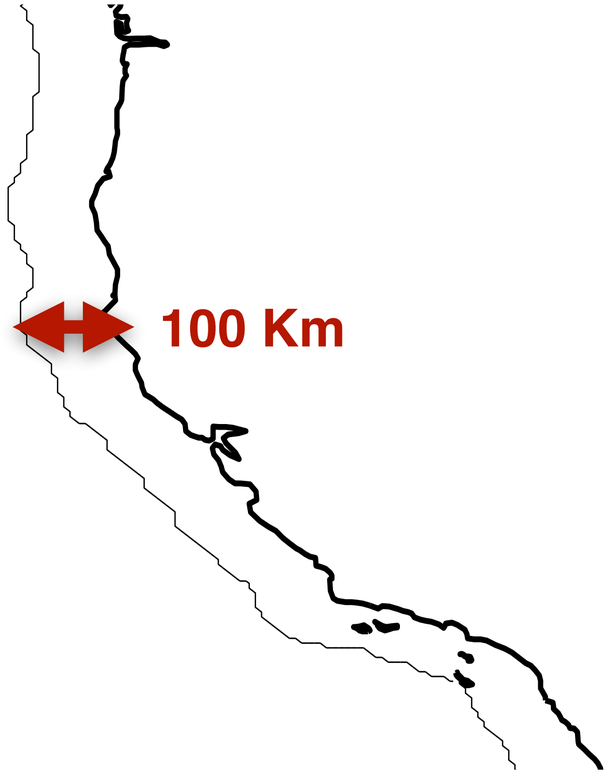
Pozo Buil et al., 2021

Temporal variability

Changes with respect to the historical period (1980-2010)

Sea Surface Temperature





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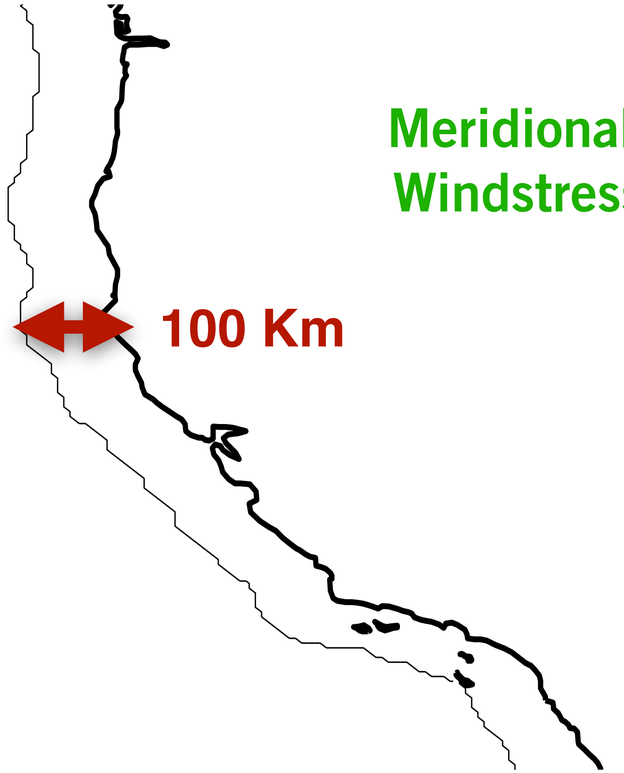
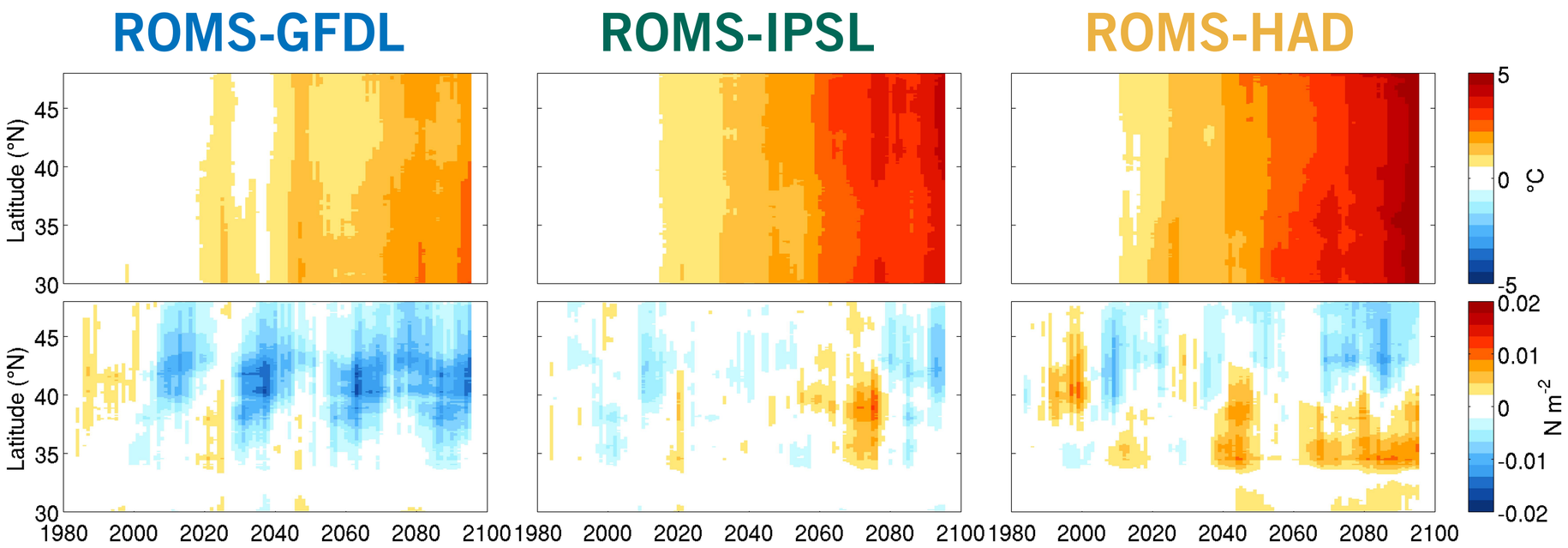


Sea Surface Temperature

Meridional Windstress



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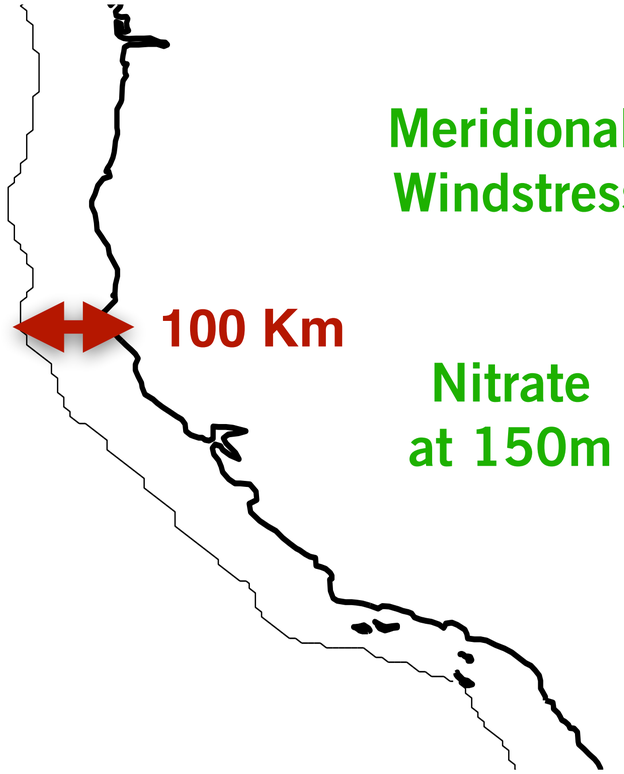

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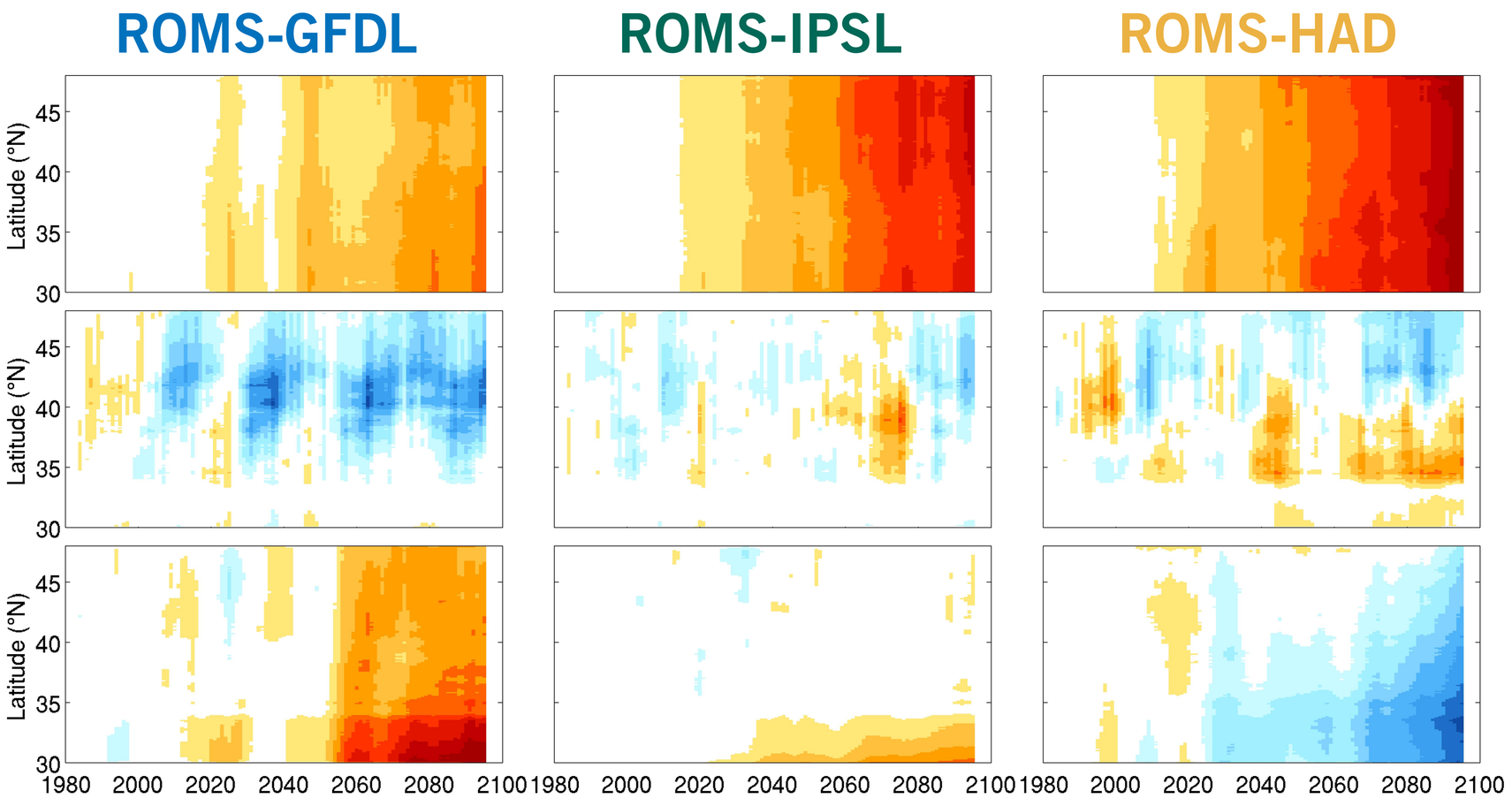
Meridional Windstress

Nitrate at 150m



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Temporal variability

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Sea Surface Temperature

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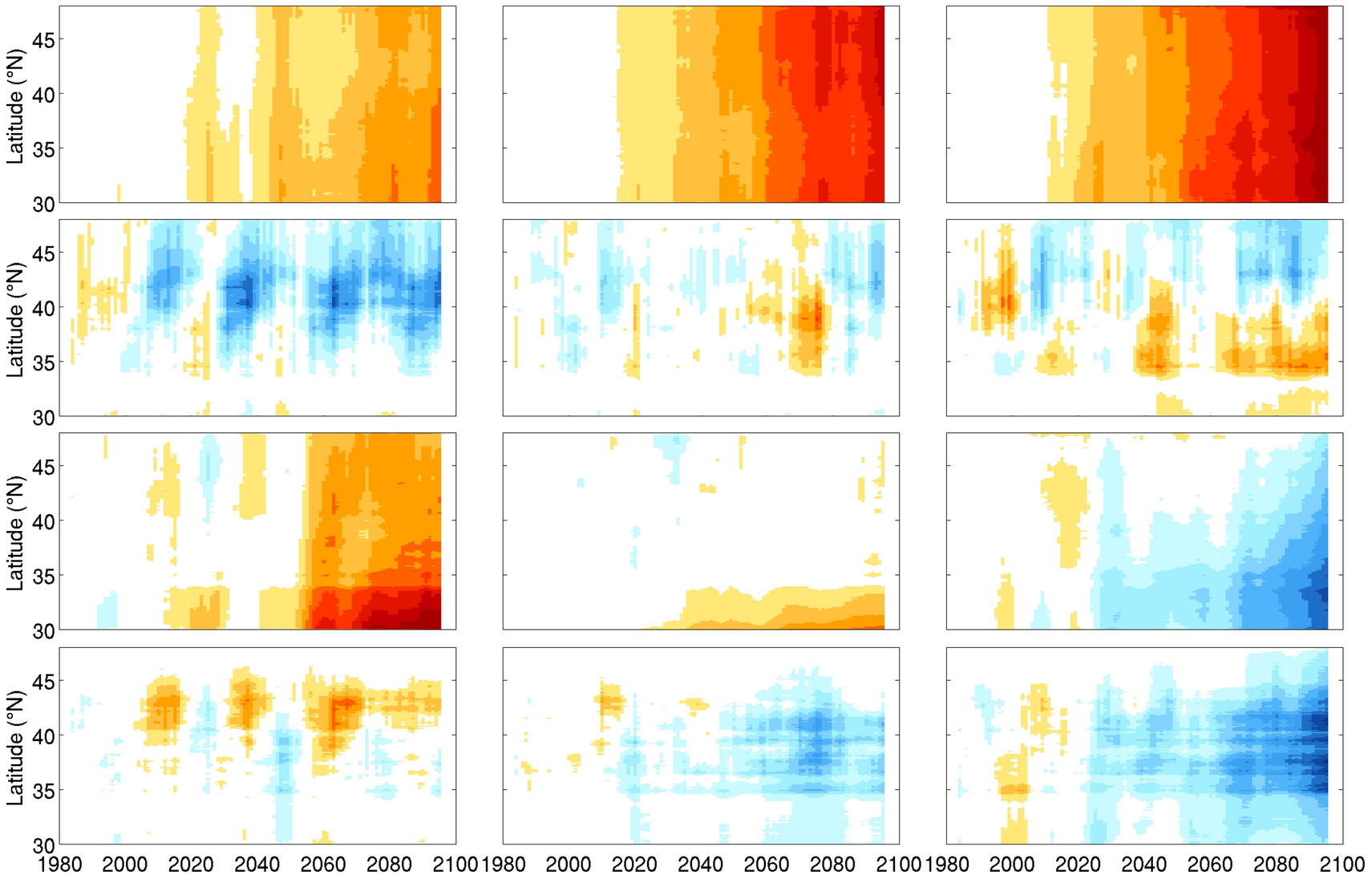
Nitrate at 150m

0-50m Chlorophyll



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Century Projections — Ecosystem Applications

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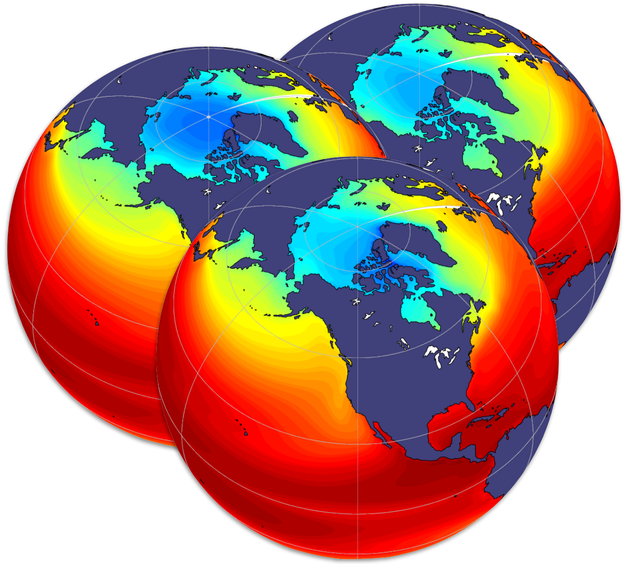

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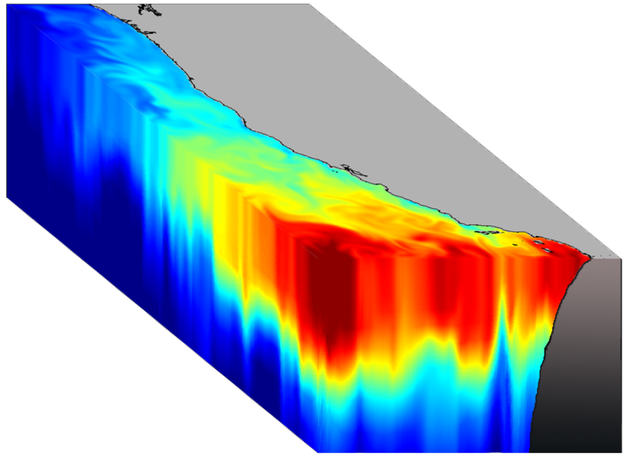

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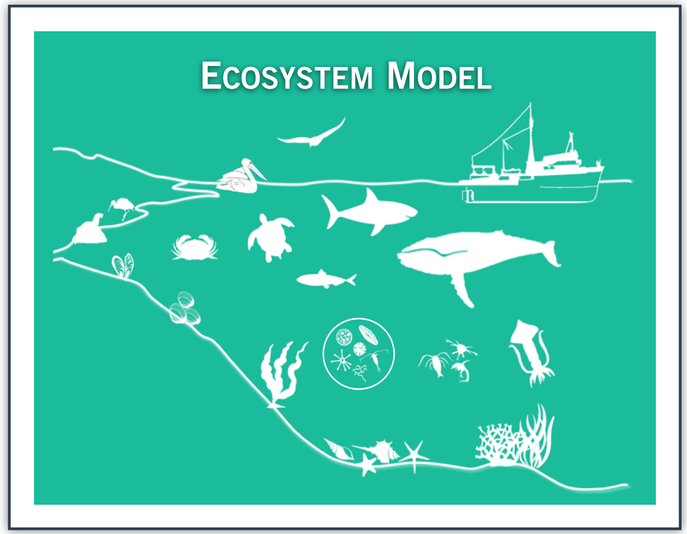

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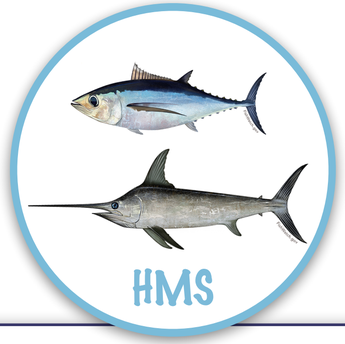

Fish Distribution and Populations

- Coastal pelagic species (Fiechter et al.)
- High-migratory (Lezama-Ochoa et al.)
- Groundfish (Samhouri, Harvey, et al.)

Aquaculture Production

- Mussels (Sainz et al.)

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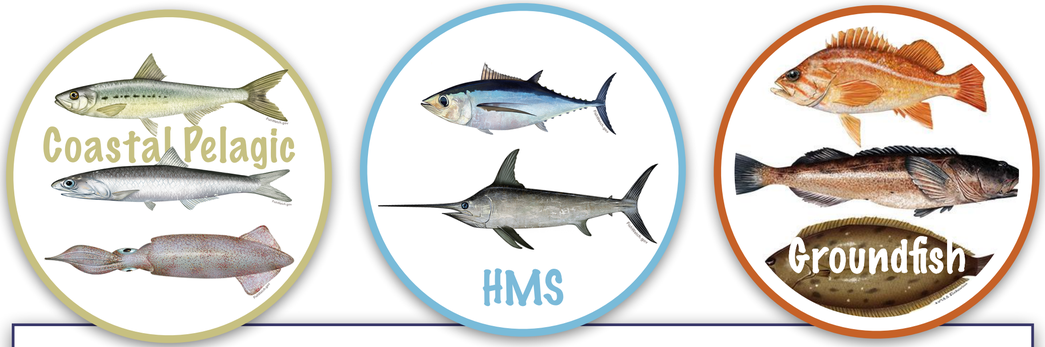

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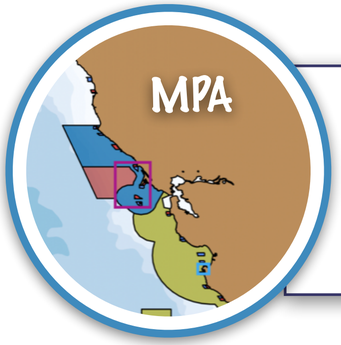
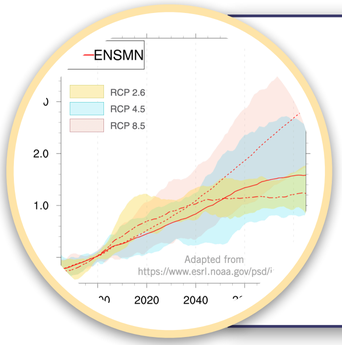


Marine Protected Areas

- CeNCOOS



Uncertainty & Ecological Decisions

- High-migratory, coastal pelagic, and groundfish (Brodie et al.,)

Aquaculture Production

- Mussels (Sainz et al.)

Social-Ecological Vulnerability Assessment

- Fishing dependent communities (Koehn et al.)

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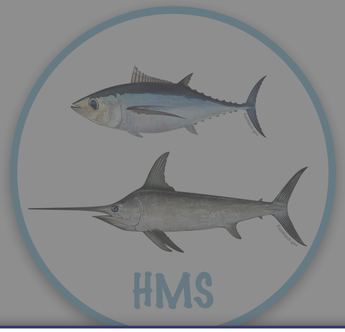

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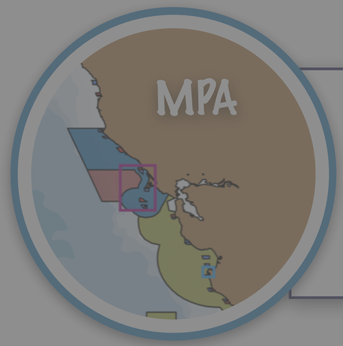

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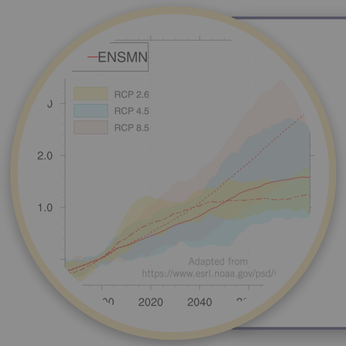

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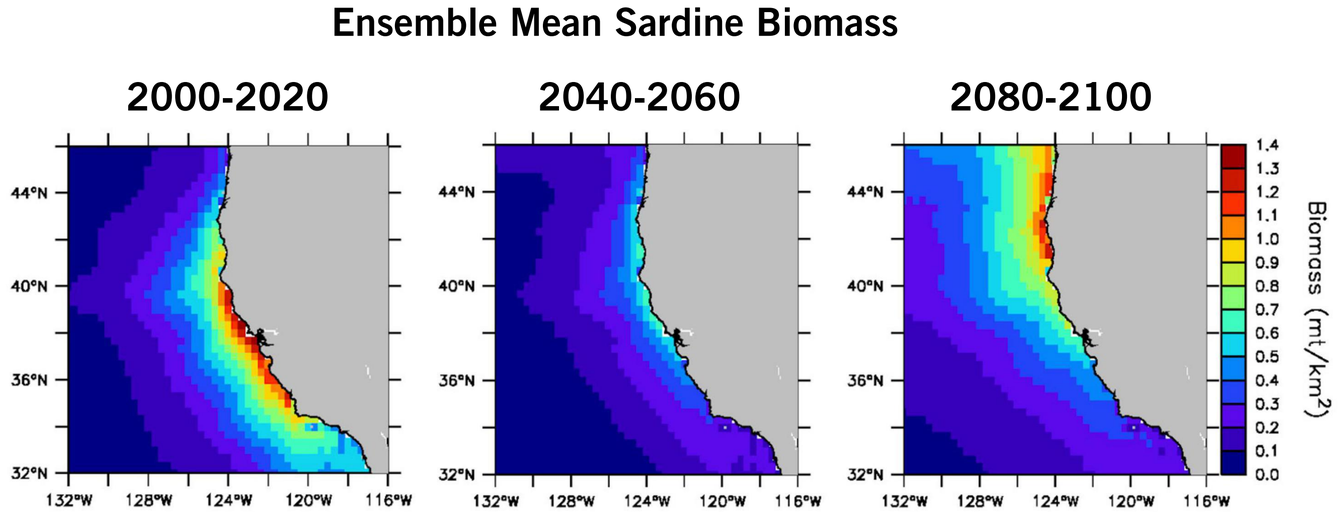
Future Sardine Distributions in the CCS



Sardine biomass distribution is shifting northward by the end of the century with significant decadal variations in total biomass

Individual-Based fish Model

Fiechter, Pozo Buil et al., 2021

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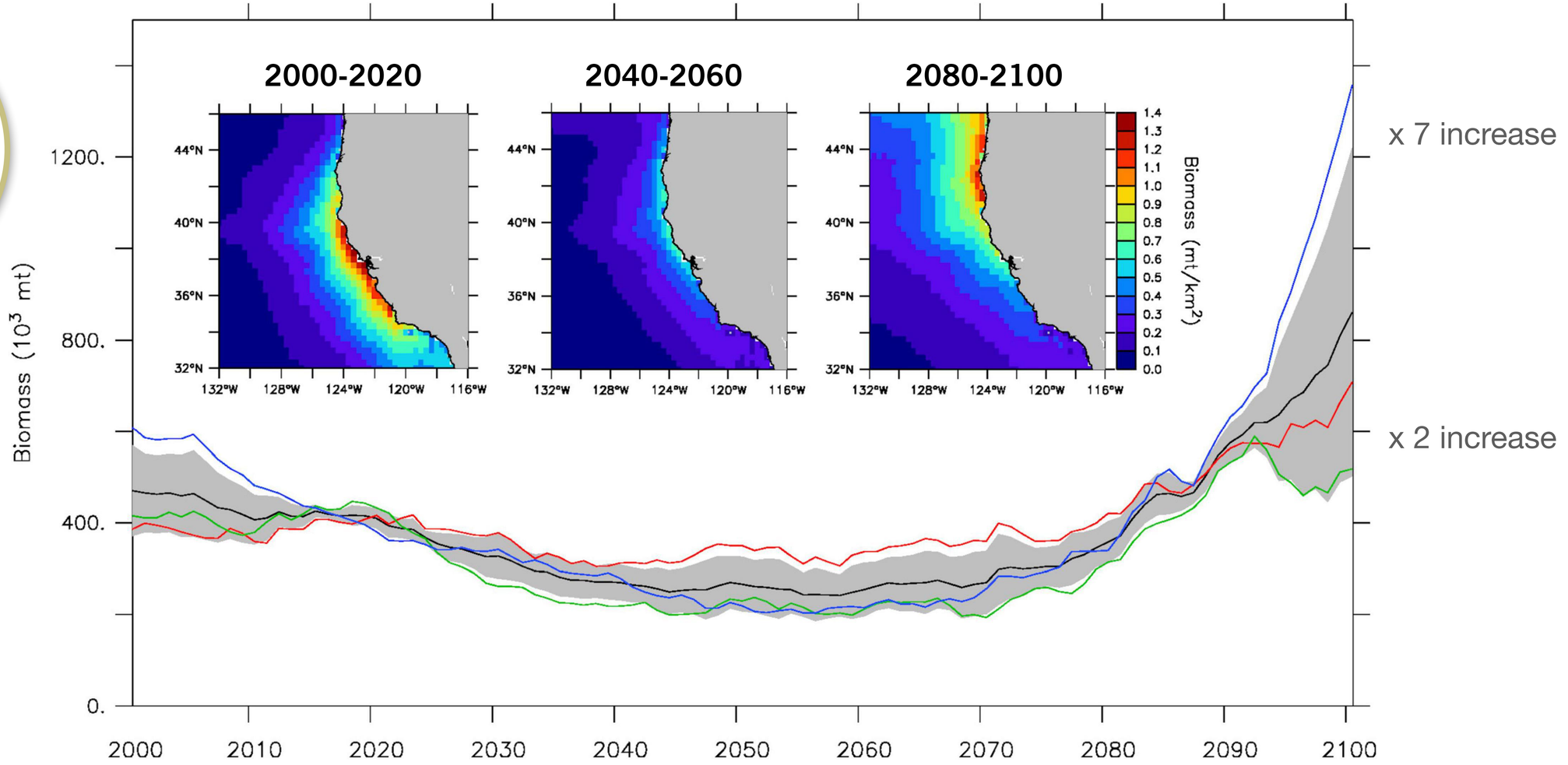

x 7 increase

x 2 increase

Ensemble Mean

ROMS-IPSL

ROMS-GFDL

ROMS-HAD

Fiechter, Pozo Buil et al., 2021

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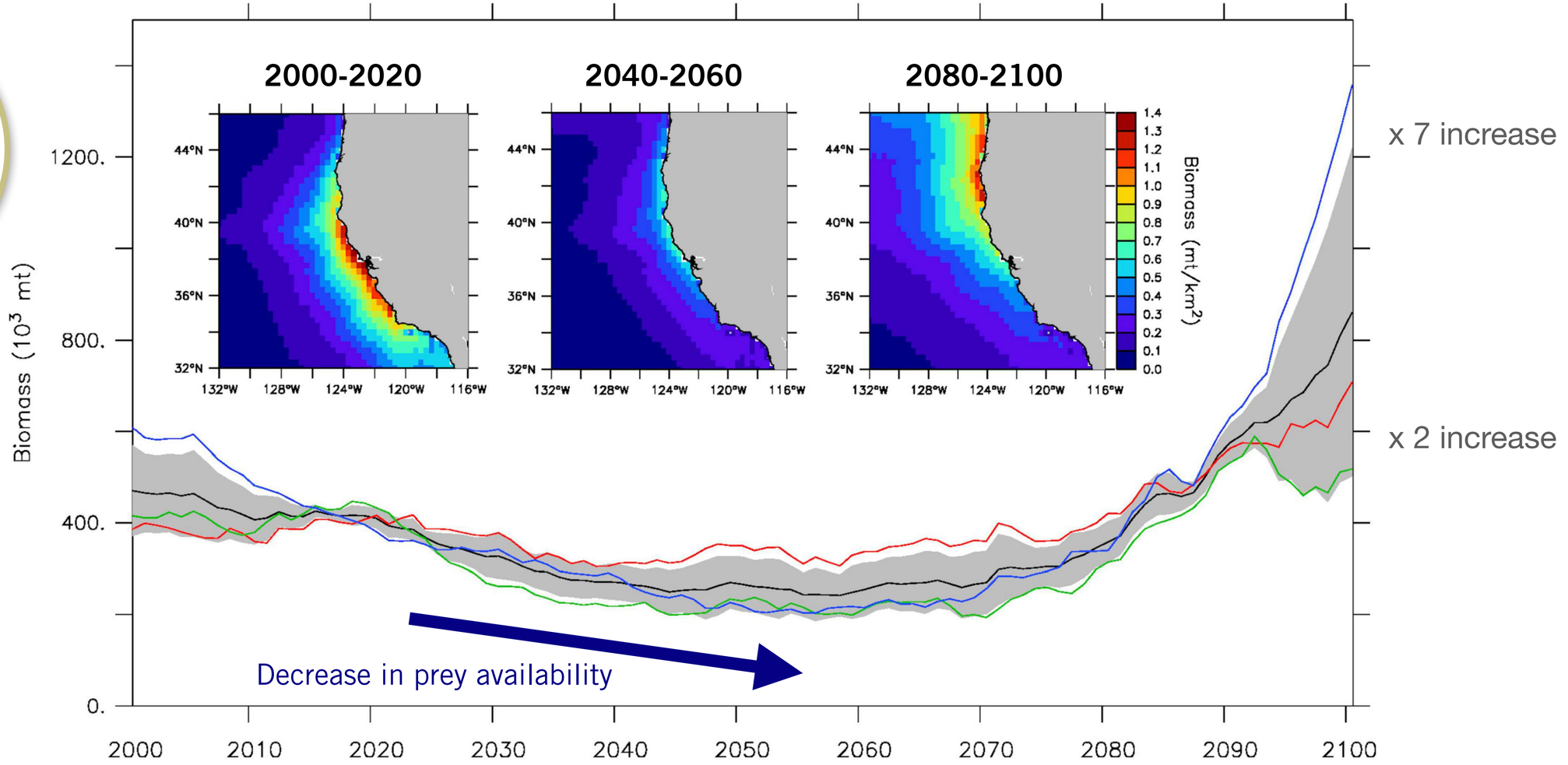

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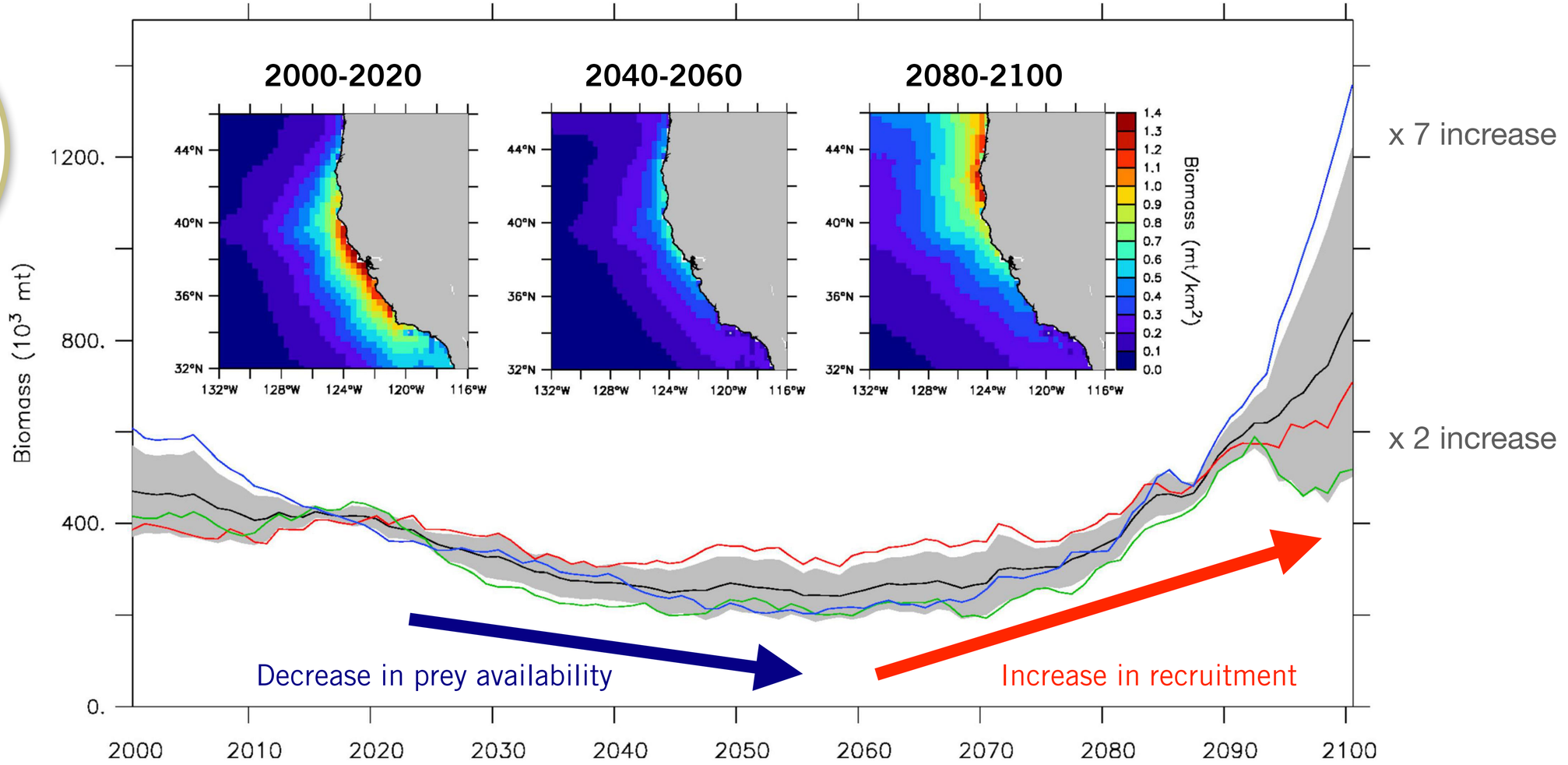

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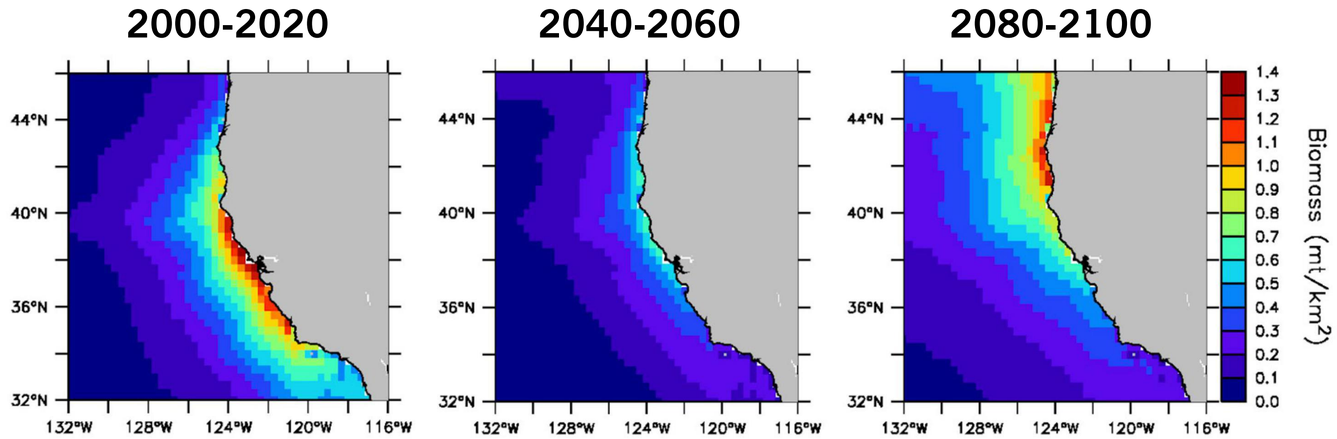
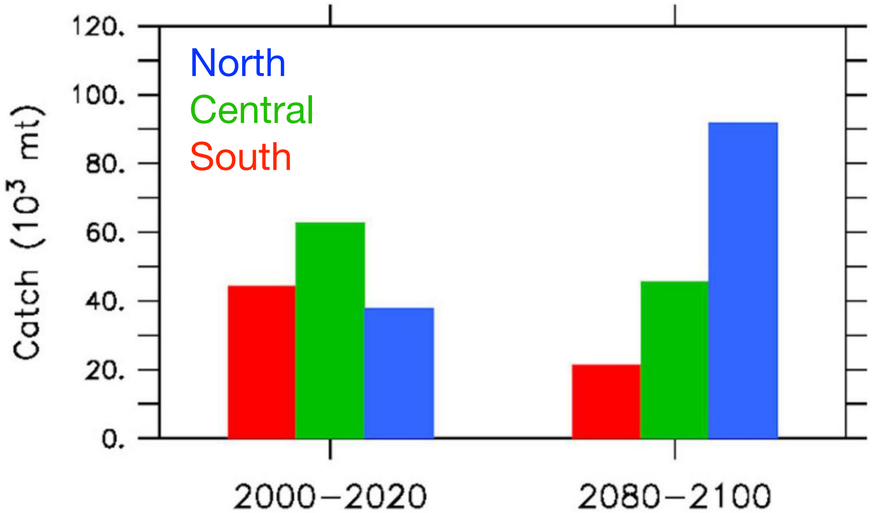


Change in Future Catch by the end of the century

- increase by 50–70% in the **northern** CCS
- decrease by 30–70% in the **southern** and **central** CCS



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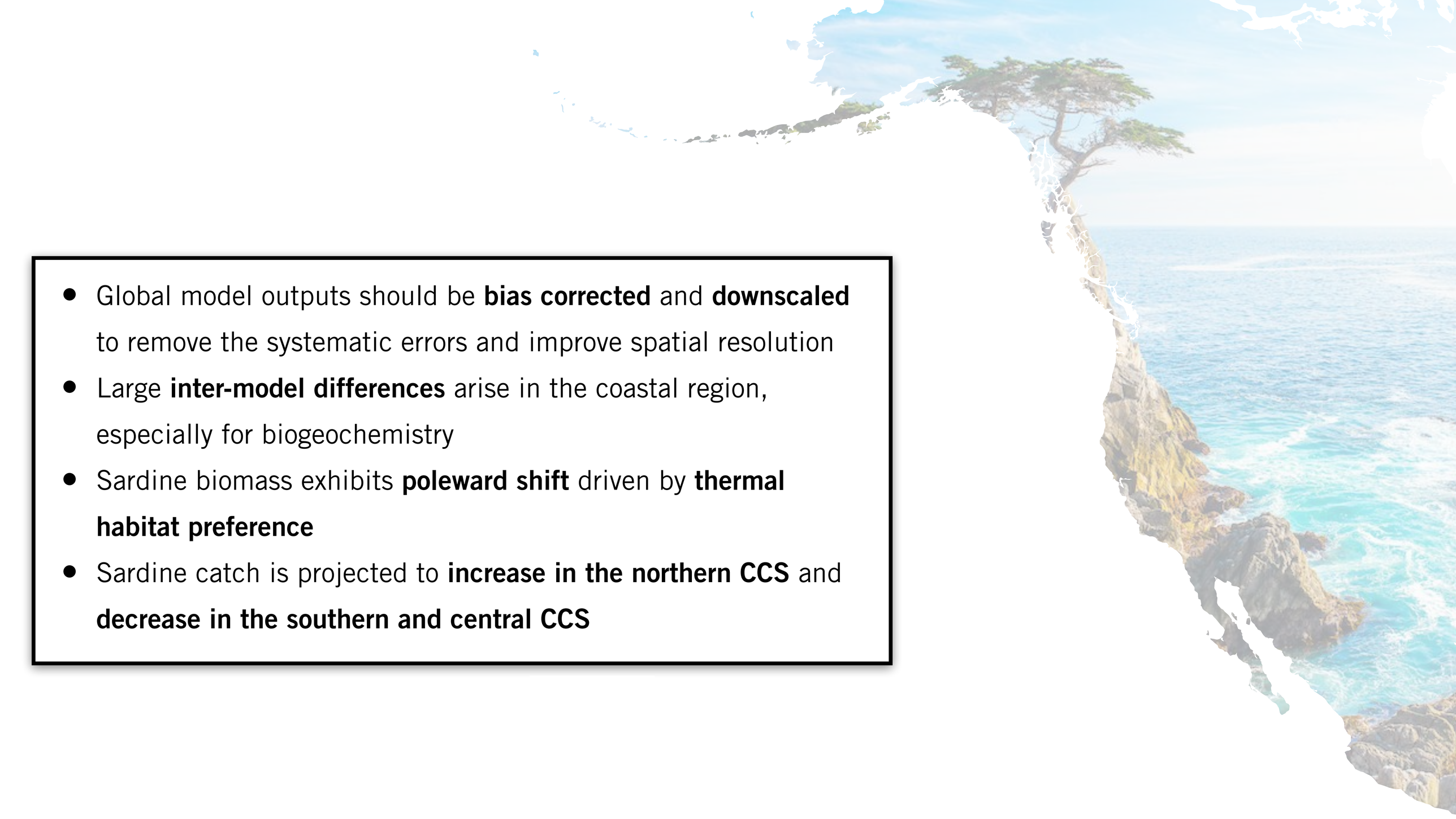

- Global model outputs should be **bias corrected** and **downscaled** to remove the systematic errors and improve spatial resolution
- Large **inter-model differences** arise in the coastal region, especially for biogeochemistry
- Sardine biomass exhibits **poleward shift** driven by **thermal habitat preference**
- Sardine catch is projected to **increase in the northern CCS** and **decrease in the southern and central CCS**

MAPP
Modeling, Analysis, Predictions, and Projections

CVP
Climate Variability and Predictability

UC SANTA CRUZ

FUTURE SEAS
A Physics-to-Fisheries Management Strategy Evaluation for the California Current System

SUPREME
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Steven Bograd,
Michael Jacox,
Jerome Fiechter,
Future Seas Team

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Ocean Predict

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Ensemble of high-resolution **future projections** for the California Current System

Impact of **bias correction** the forcing prior to downscaling

Climate change **impacts** in three California Current **fisheries**

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CVP
Climate Variability and Predictability

UC SANTA CRUZ

FUTURE SEAS
A Physics-to-Fisheries Management Strategy Evaluation for the California Current System

SUPREME
SUstainability, Predictability and REsilience of Marine Ecosystems

SUPREME - An Ocean Decade Endorsed Programme

- To support robust climate predictions to guide effective marine ecosystem management and adaptation strategies in a changing climate.
- To advance the modeling tools needed to reduce risks and increase resilience of marine/coastal resources and the people who depend on them.

Ensemble of high-resolution **future projections** for the California Current System

Impact of **bias correction** the forcing prior to downscaling

Climate change **impacts** in three California Current **fisheries**

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Ocean Predict

SYMPOSIUM OP'24

In partnership with unesco Intergovernmental Oceanographic Commission

2021 2030 United Nations Decade of Ocean Science for Sustainable Development