Getting the big picture in focus

Assessing climate and human factors with global human-ocean models

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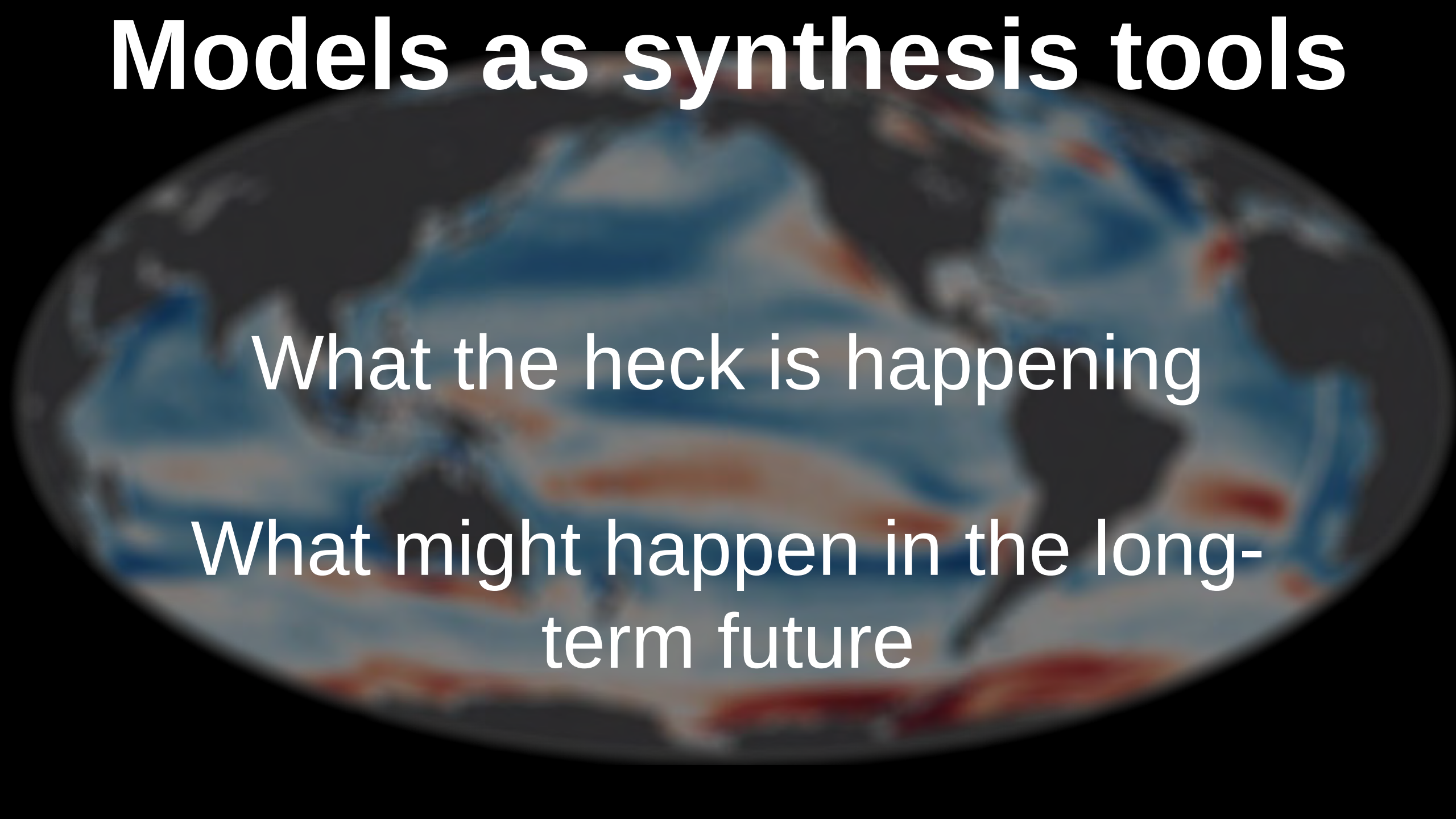
BIGSEA

erc European Research Council


Nutrient supply
Primary production
Deoxygenation
Deep Sea Mining
Plastics
Warming
Ocean currents
Coastal Pollution
Acidification
Food web structure
Fisheries
Invasive Species

Models as synthesis tools

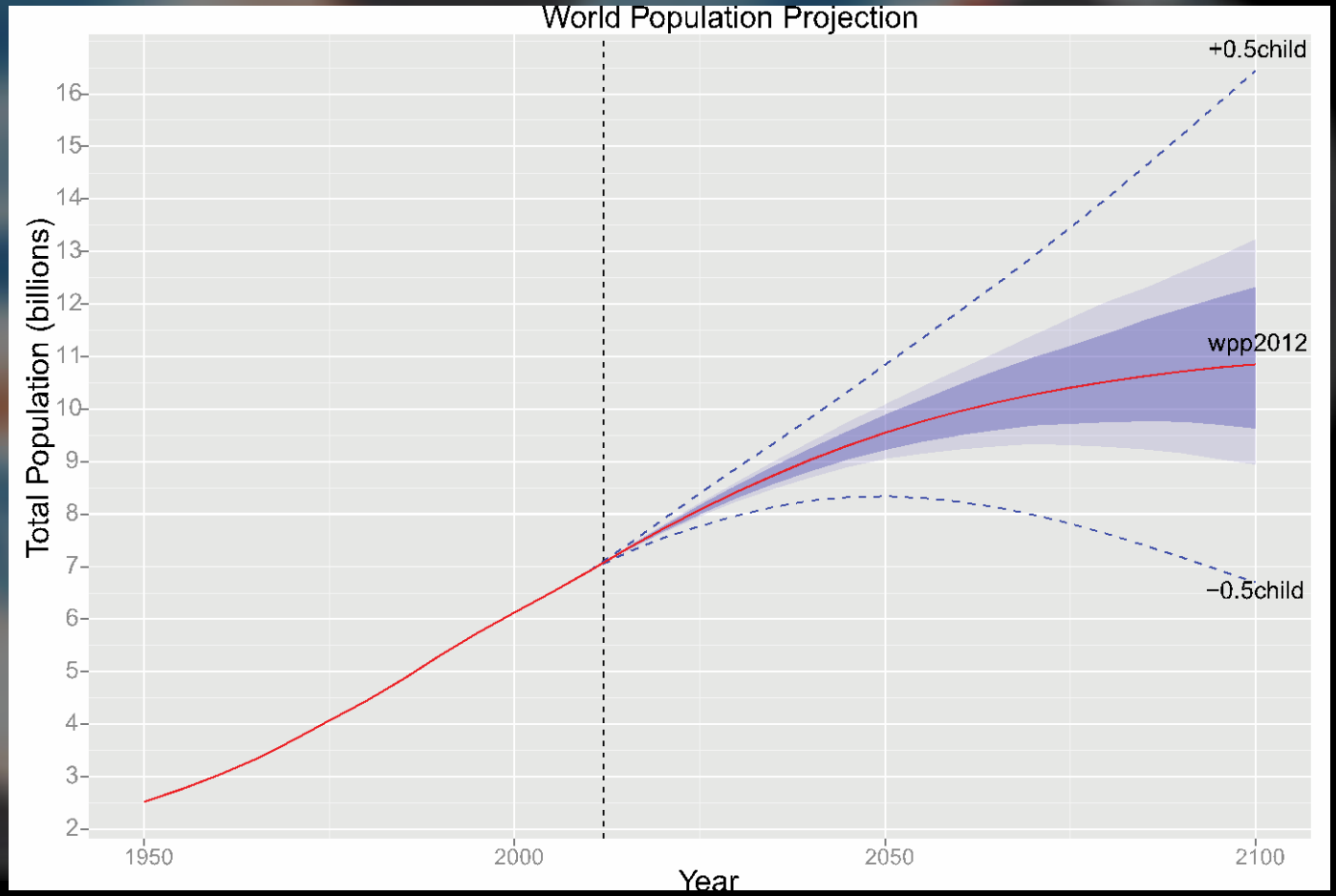


What the heck is happening

What might happen in the long-term future

Why a global perspectives is necessary

- We are throwing a global party and 10 billion people are invited
- Will we all have enough to eat? How can we maintain healthy ecosystems and prevent widespread extinctions?

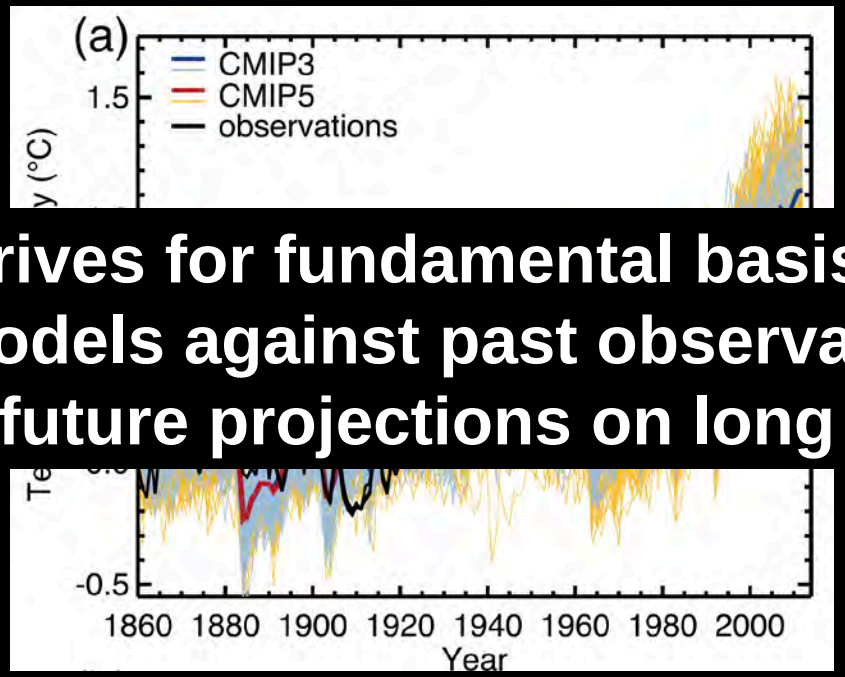


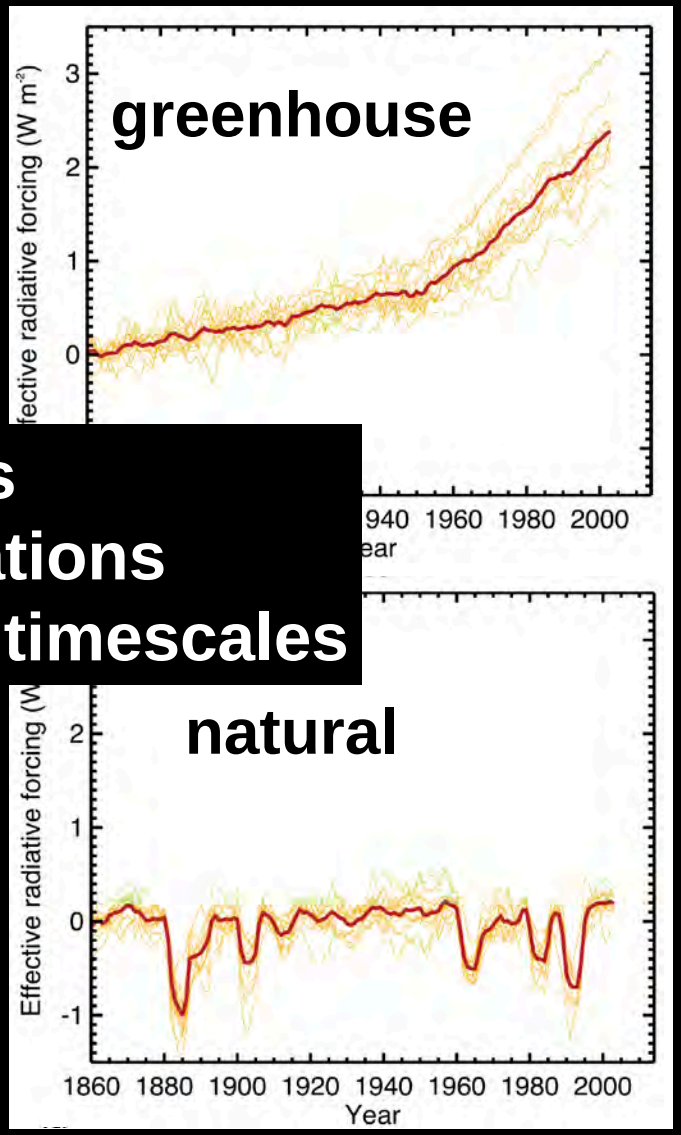
Gerland et al., Science 2014

Why a global perspectives is necessary

- Addresses possible location-bias of local changes
- Provides context for local changes
- Can help to illuminate universal processes
- Climate and the oceans both require global policy

Climate model approach



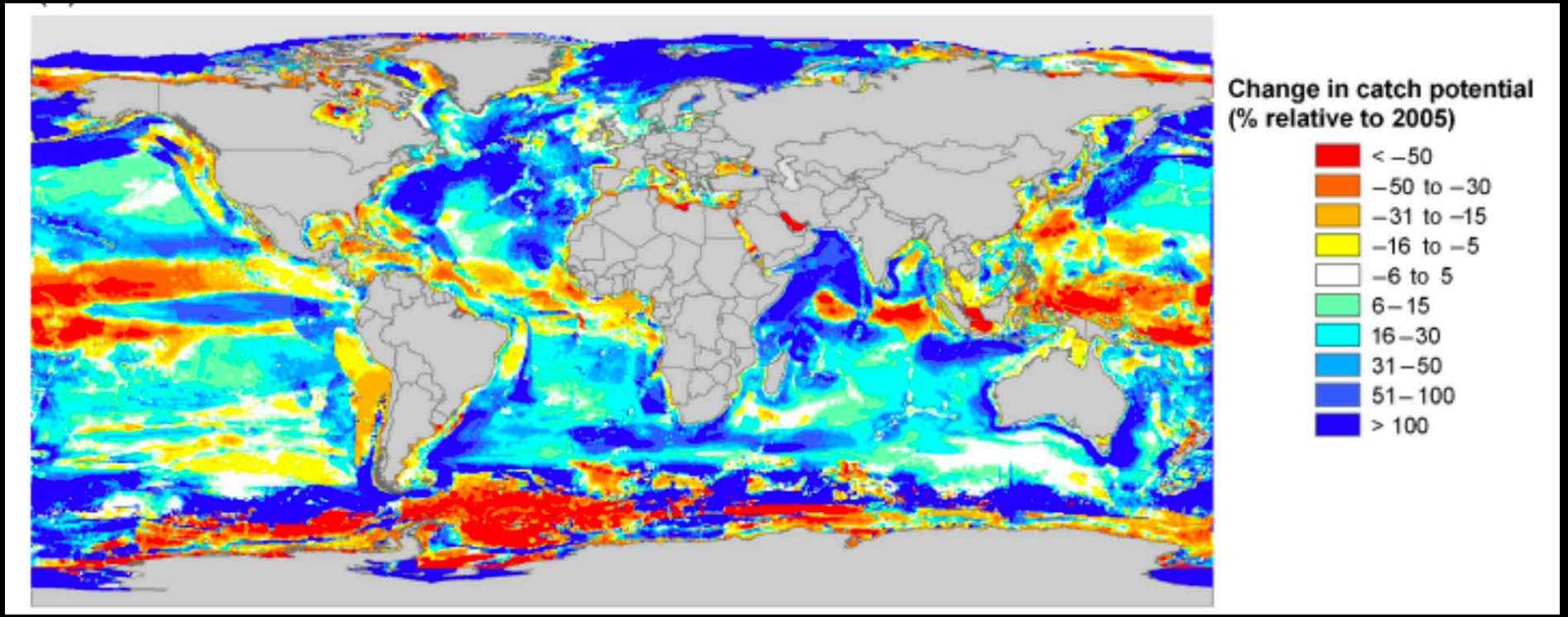


- **Strives for fundamental basis**
- **Test models against past observations**
- **Can provide future projections on long timescales**

IPCC AR5, 2013


Natural-Social Science Gap
Physics
Chemistry
Biology
Well-being
Values
Behaviour

Fish Models



Climate Physics → Fish

Cheung et al., Global Change Biology 2010

Diverse modeling approaches

Ecopath/Ecosim

Atlantis

OSMOSE

APECOSM

Madingly

EcoOcean

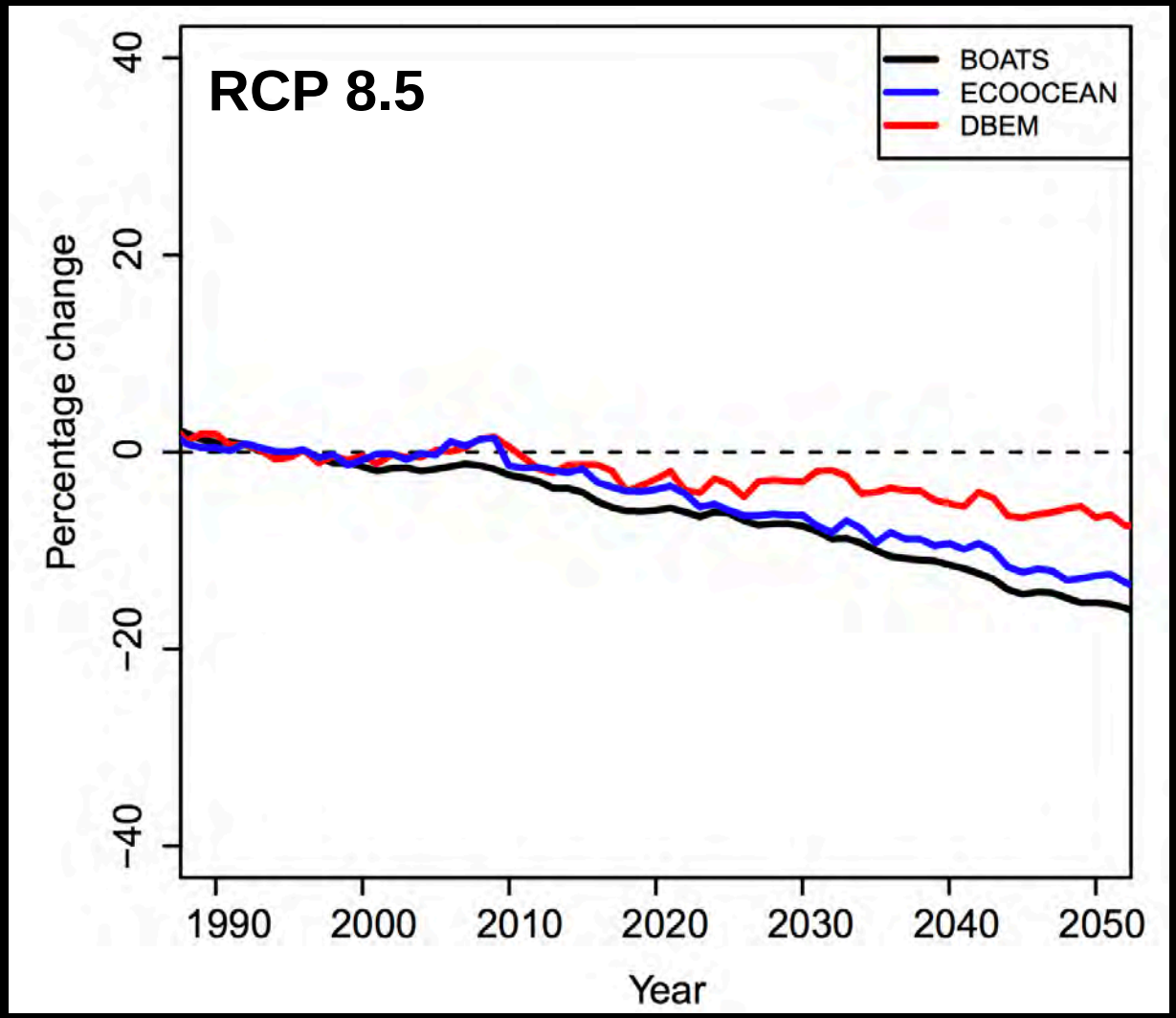
DBEM

Macroecological

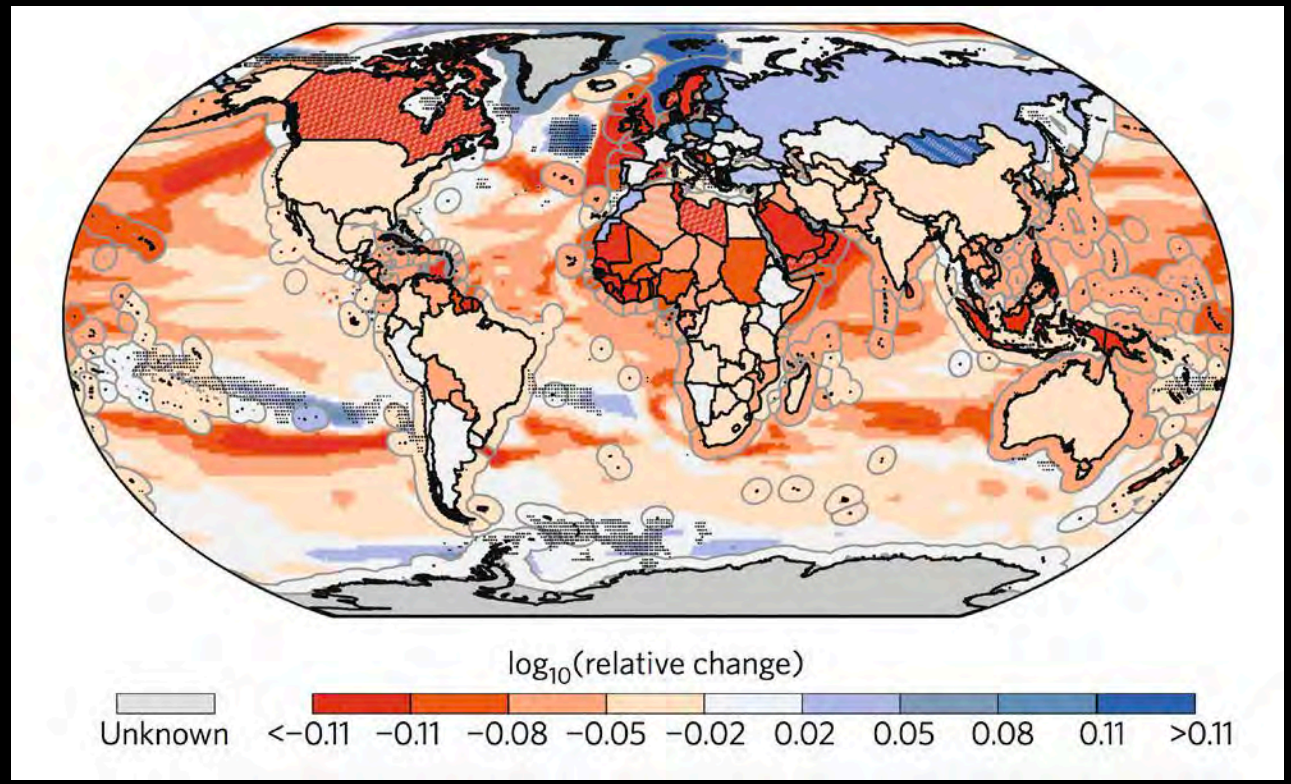
POEM

BOATS

Projected fish biomass



Tittensor et al., GMD 2018

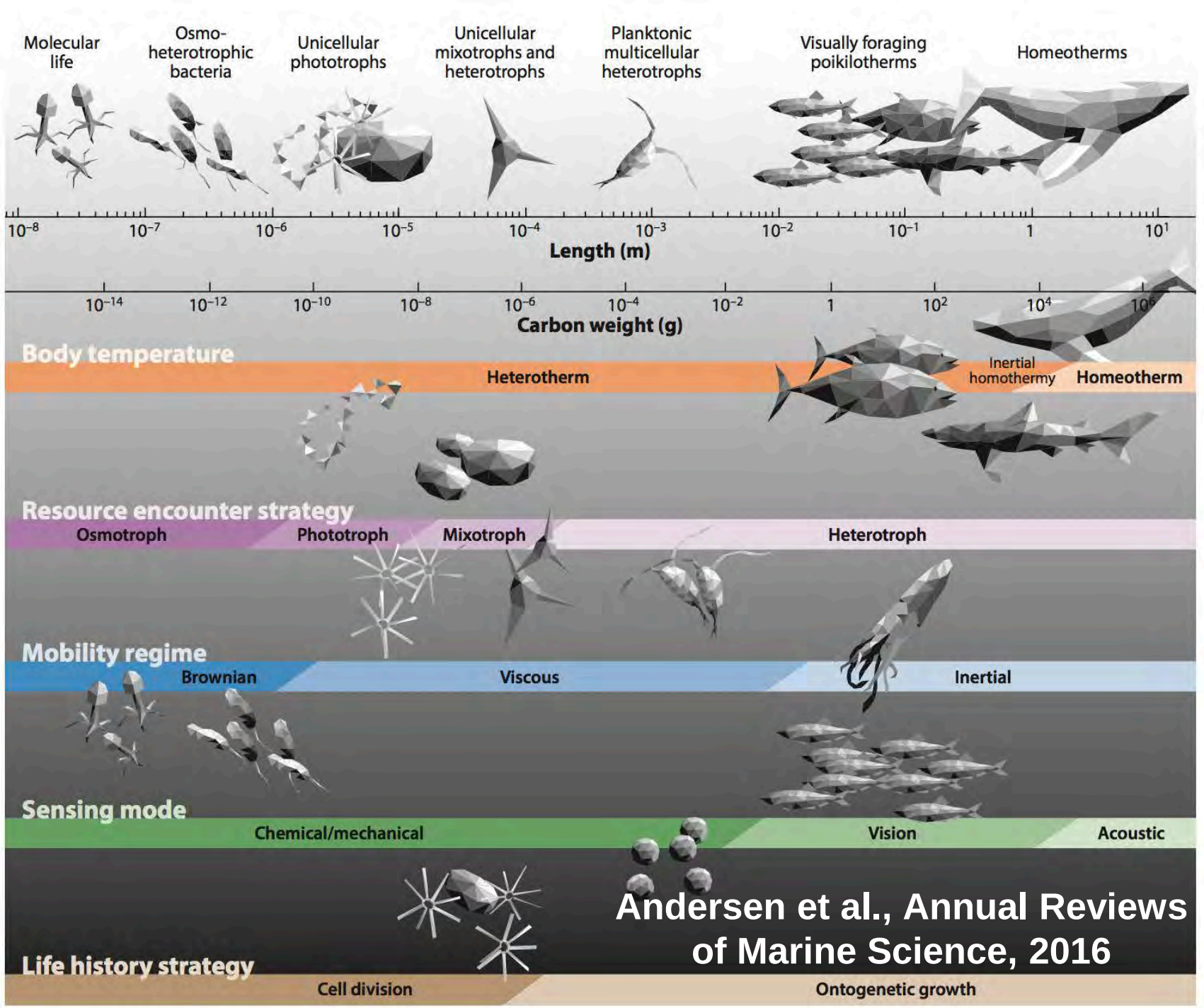


Blanchard et al., Nature Ecology and Evolution 2017

FISHERIES & MARINE ECOSYSTEM
FISH-MIP
MODEL INTERCOMPARISON PROJECT

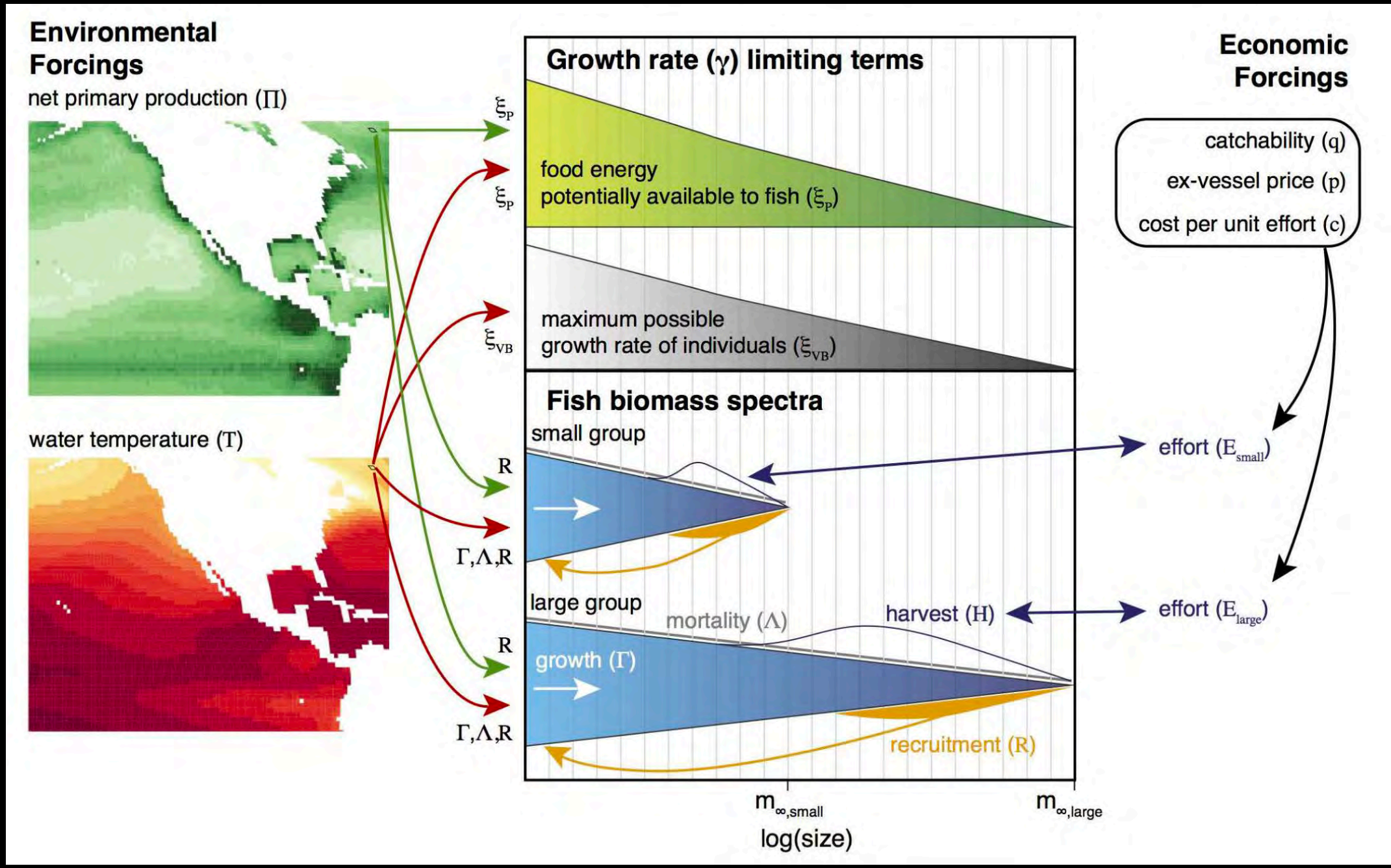
Why do the global models predict that climate change reduces fish biomass?

Body size as a master organizing variable



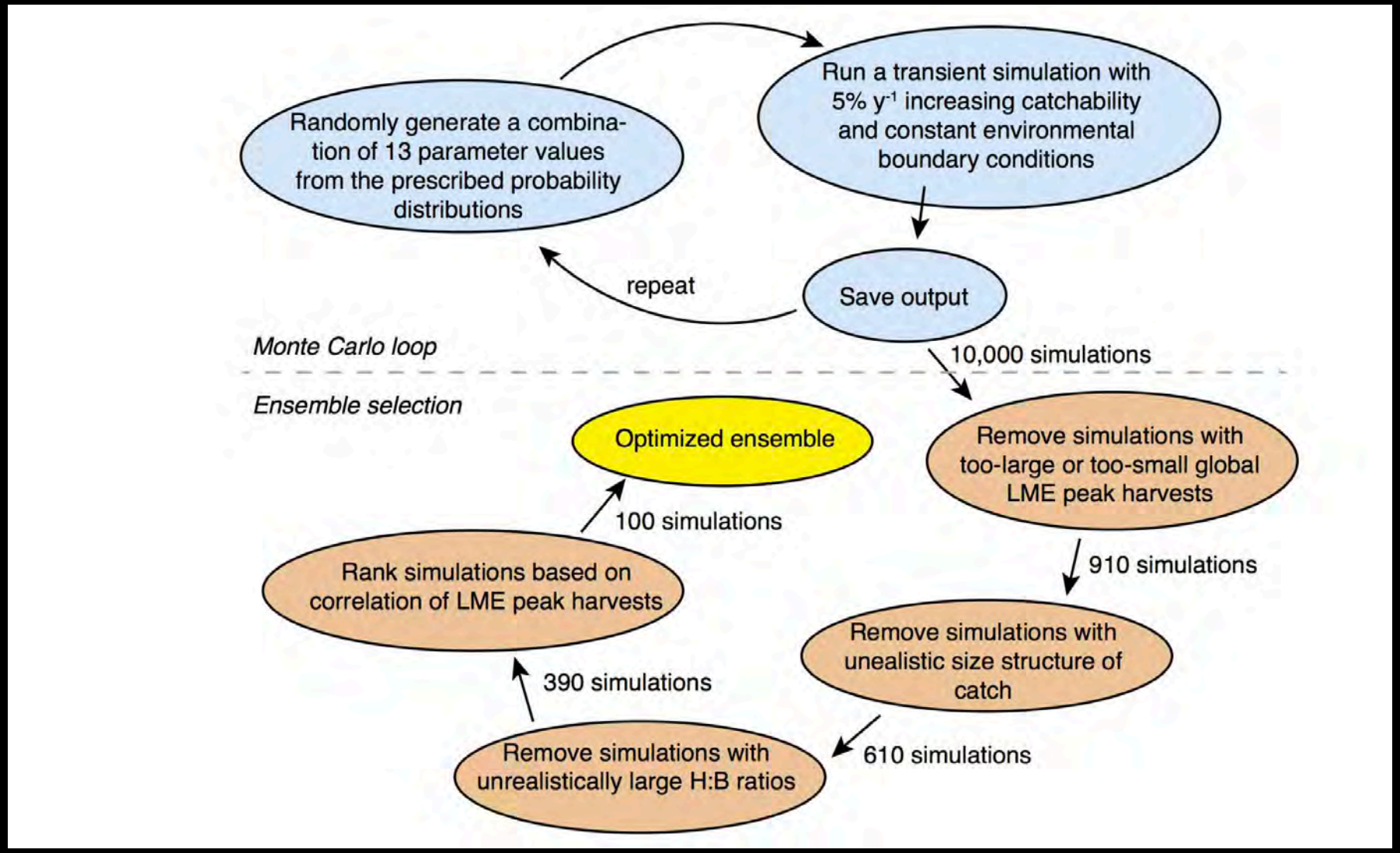
Andersen et al., Annual Reviews of Marine Science, 2016

BOATS



Carozza et al., PLoS One 2017

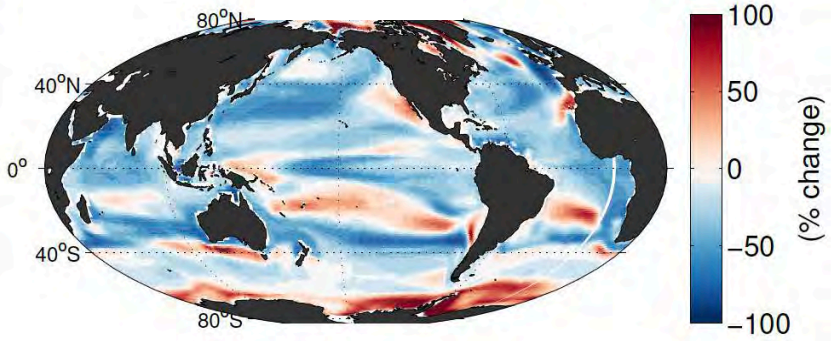
Parameter optimization



Carozza et al., PLoS One 2017

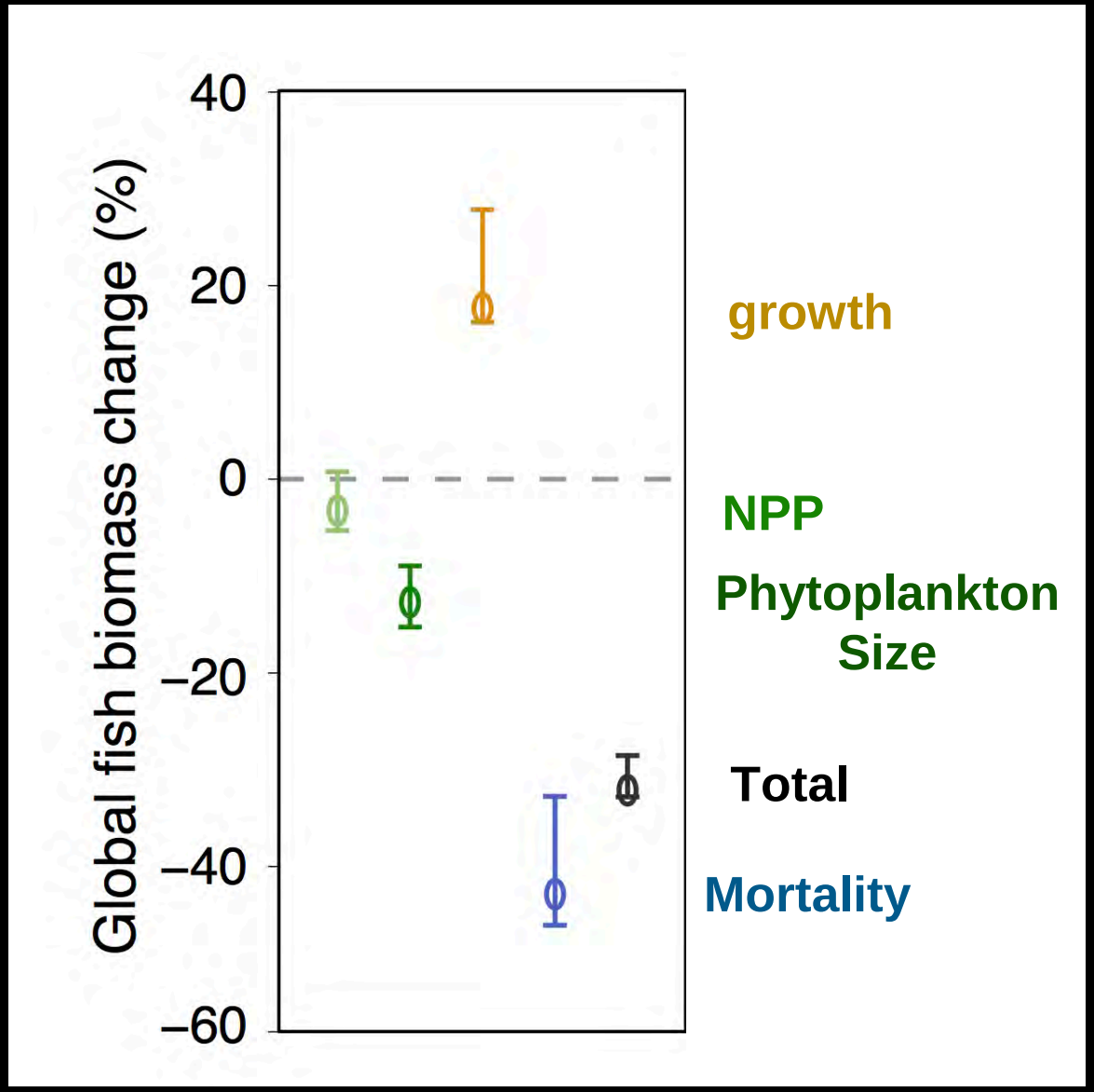
RCP8.5
2100

Total change



Carozza et al., *Global Ecology and Biogeography*, in review

Integrated global impact in BOATS



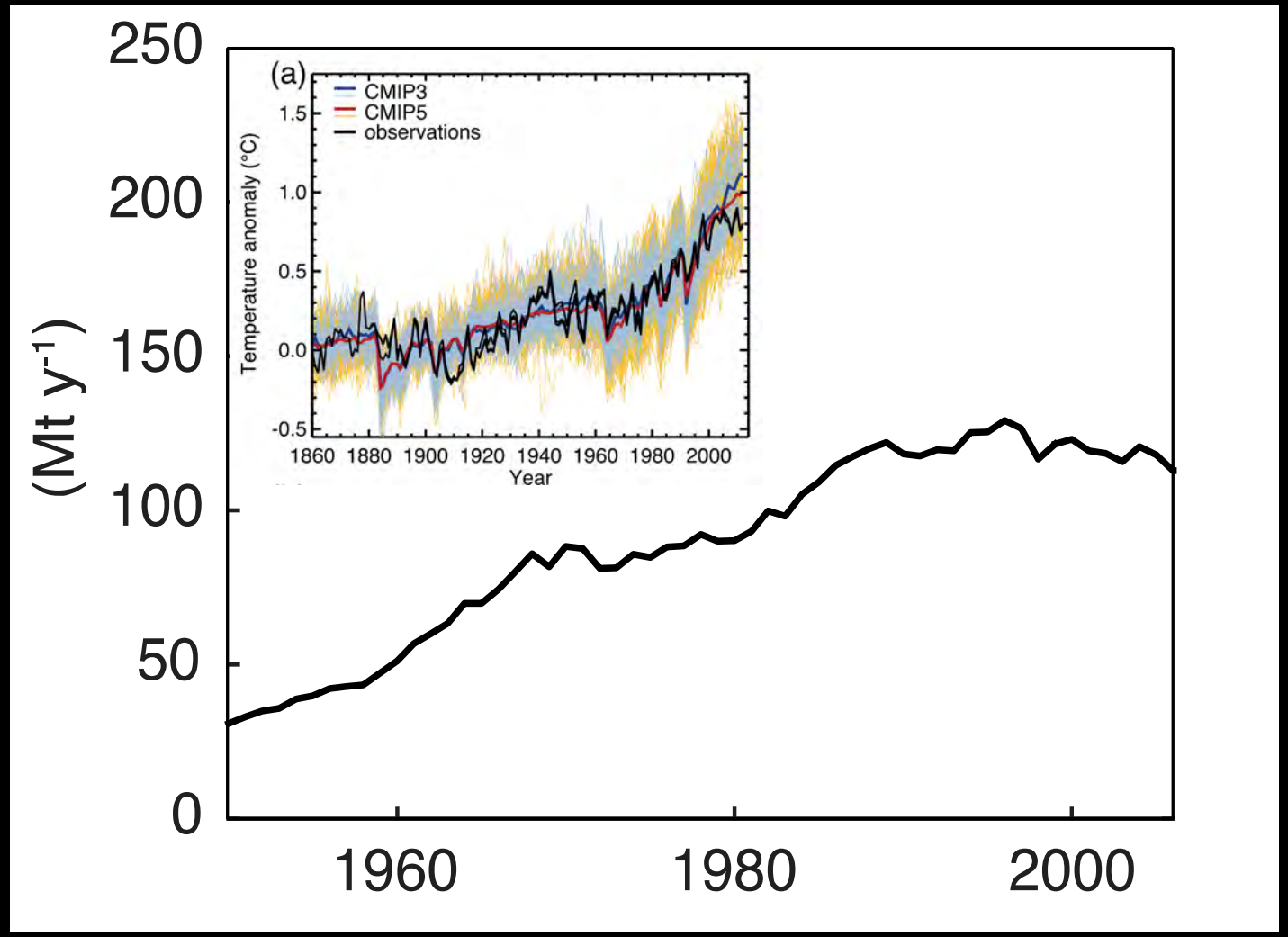
Carozza et al., *Global Ecology and Biogeography*, in review

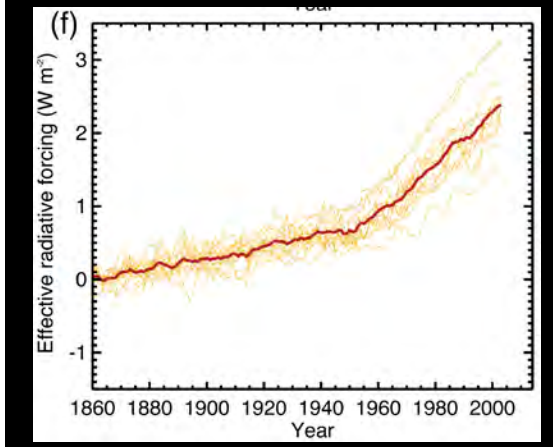
Large model uncertainties

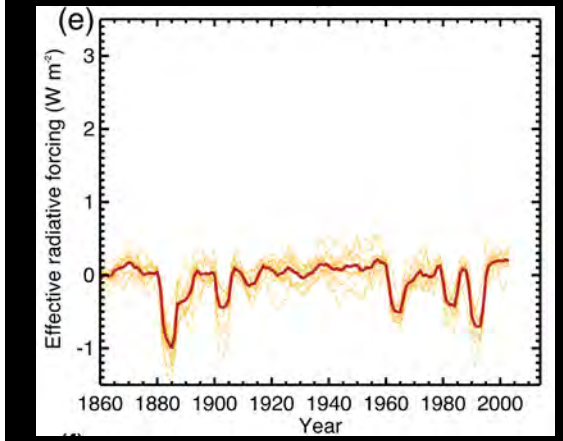
- Simple, mostly linear behaviour
- No tipping points
- Missing many processes
- Need more close collaboration between modelers and observationalists

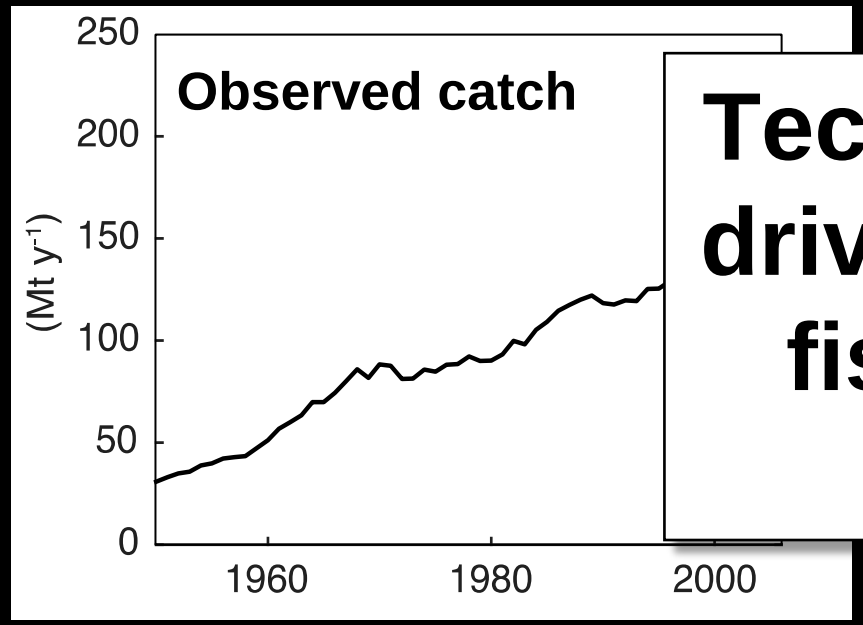
Hindcasts: can we predict the past?

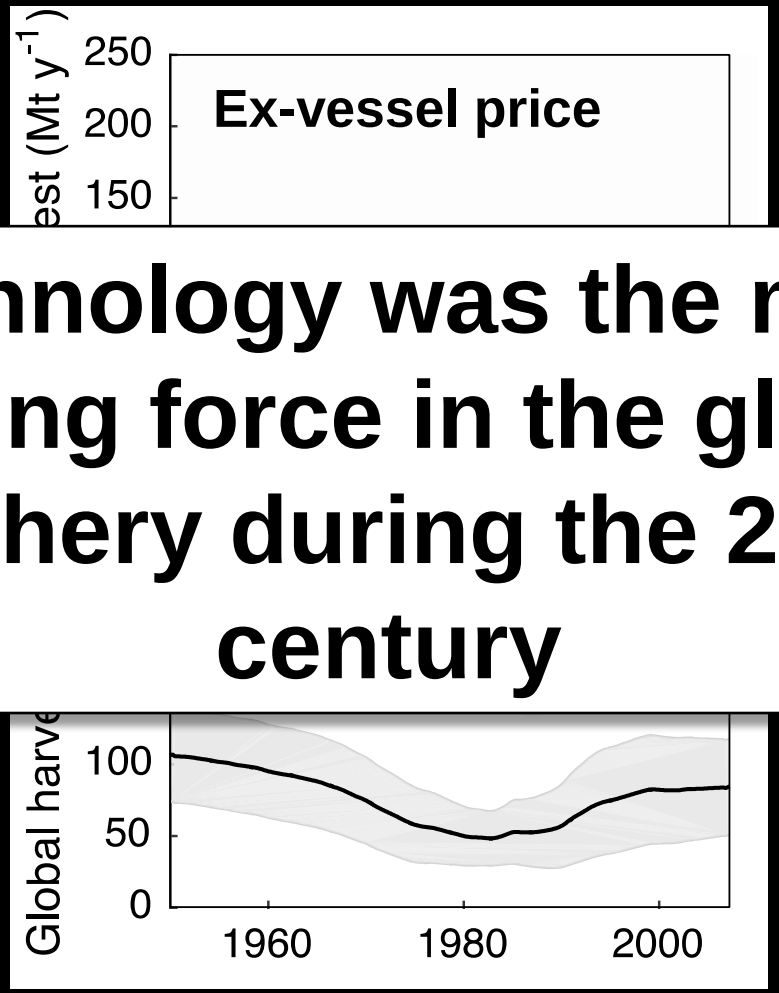
World fish catch



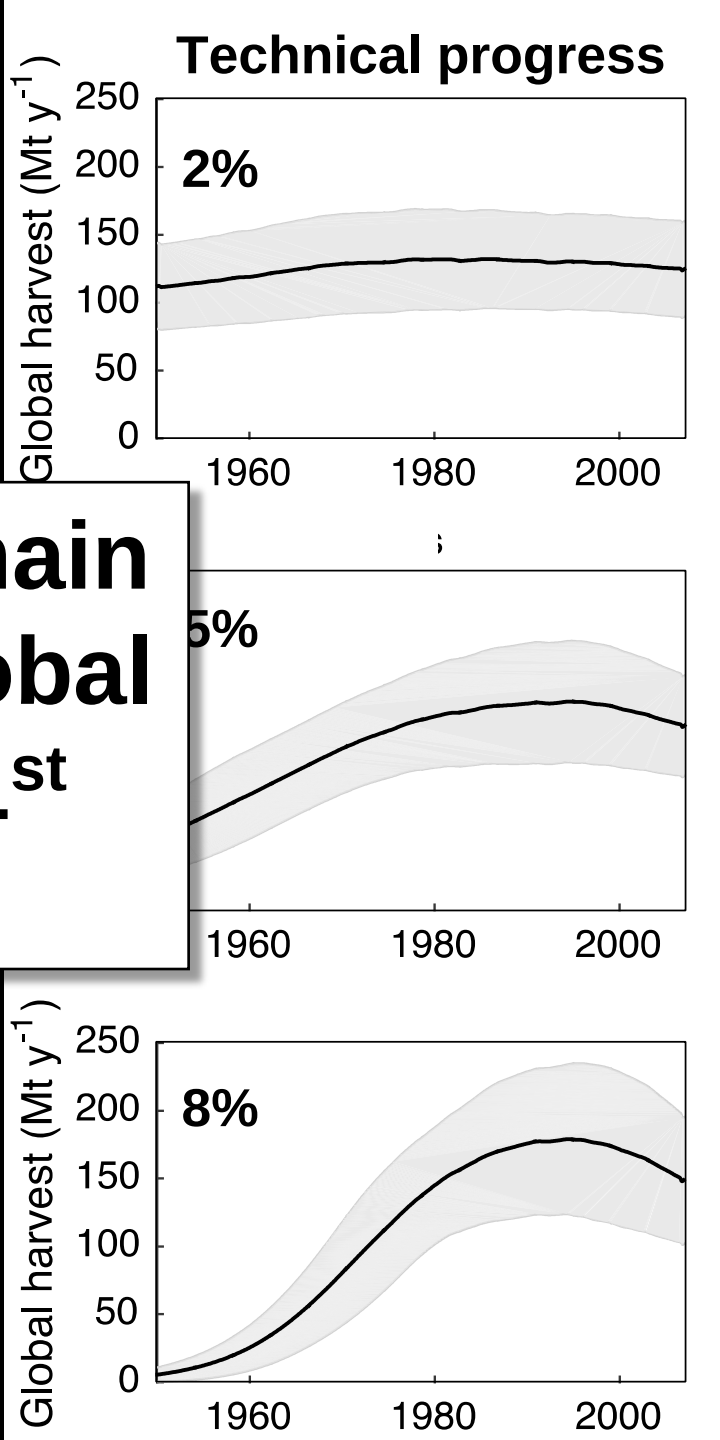








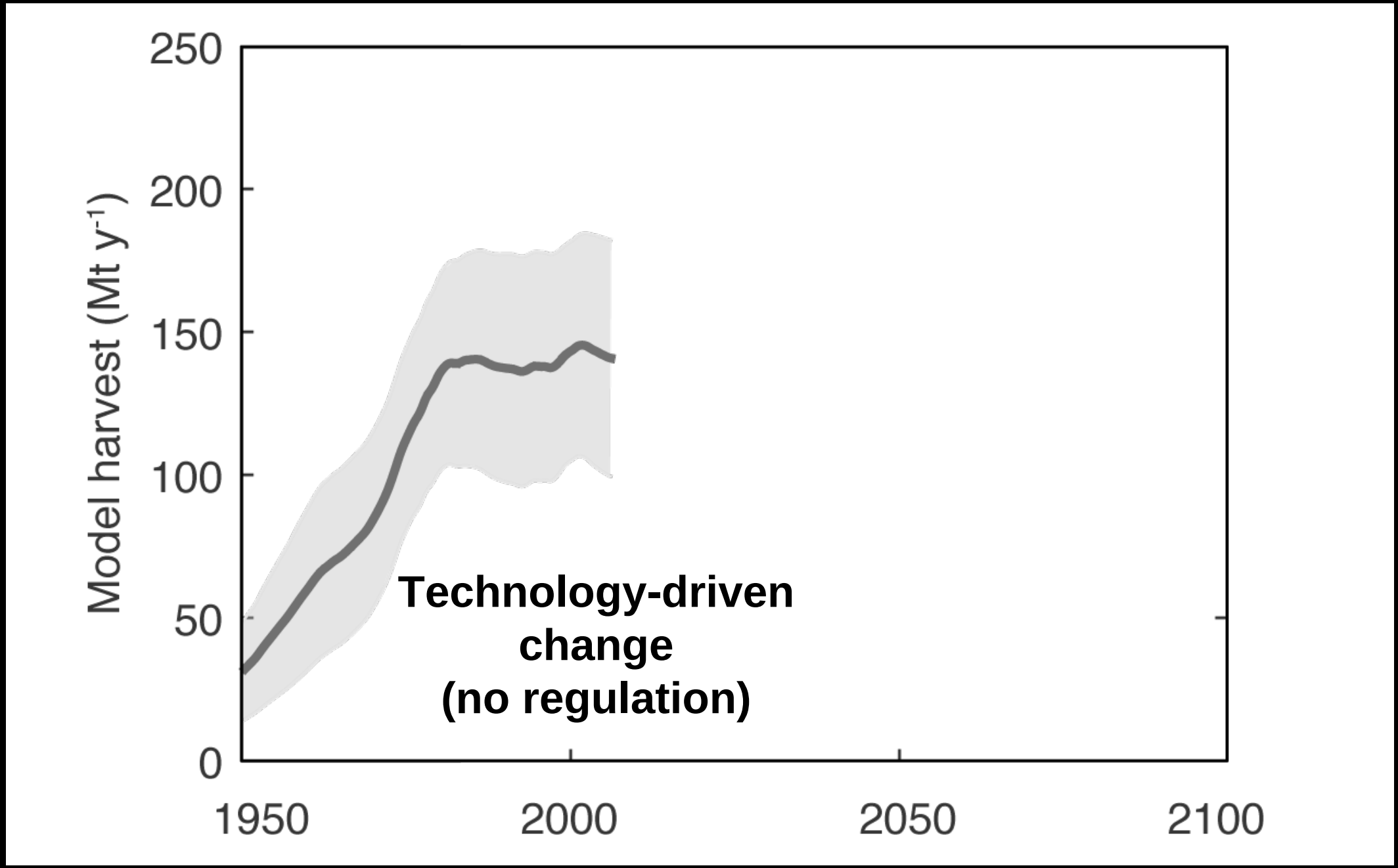
Technology was the main driving force in the global fishery during the 21st century



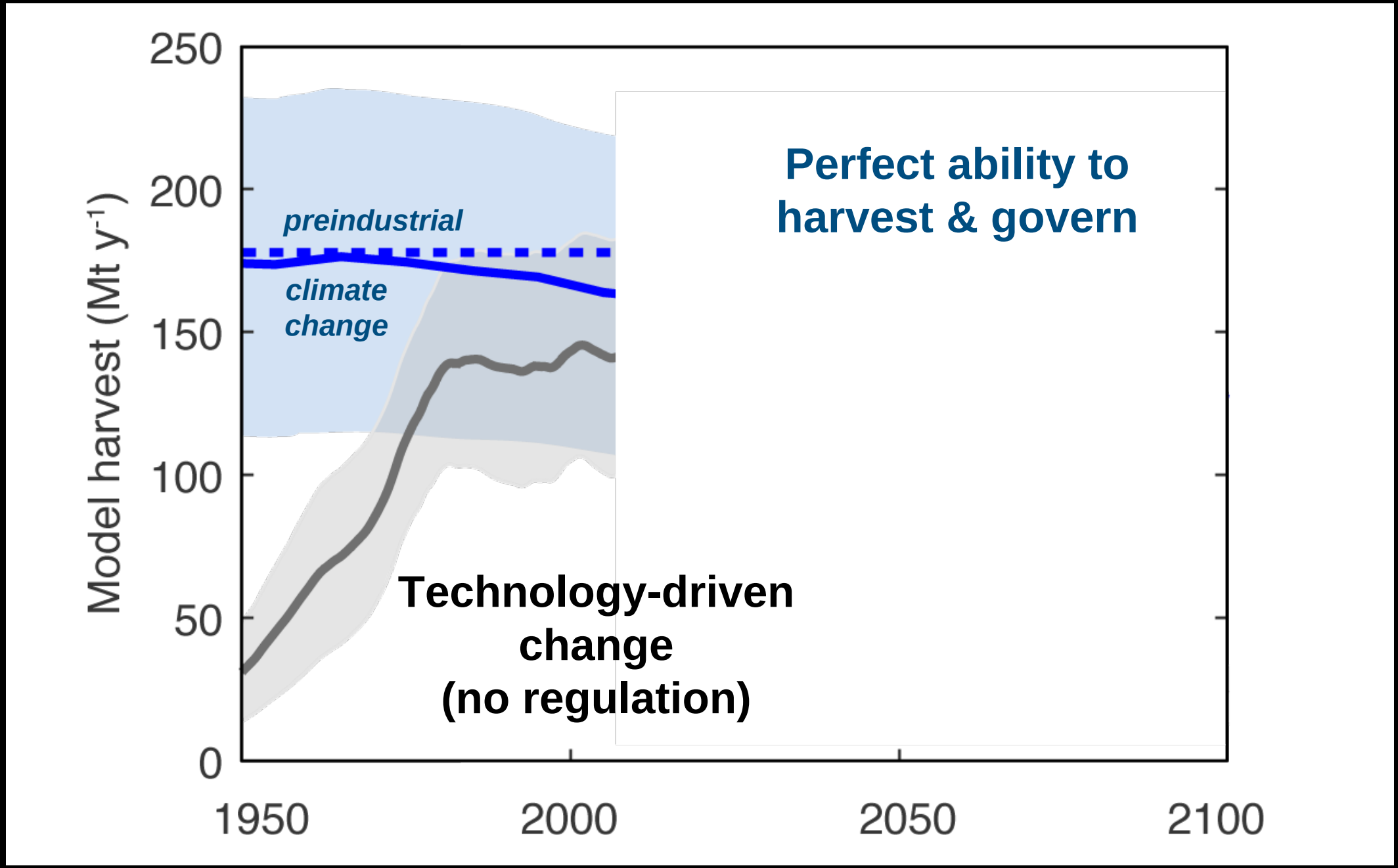
Galbraith et al., Nature Communications, 2017

Fishing boats in 1934

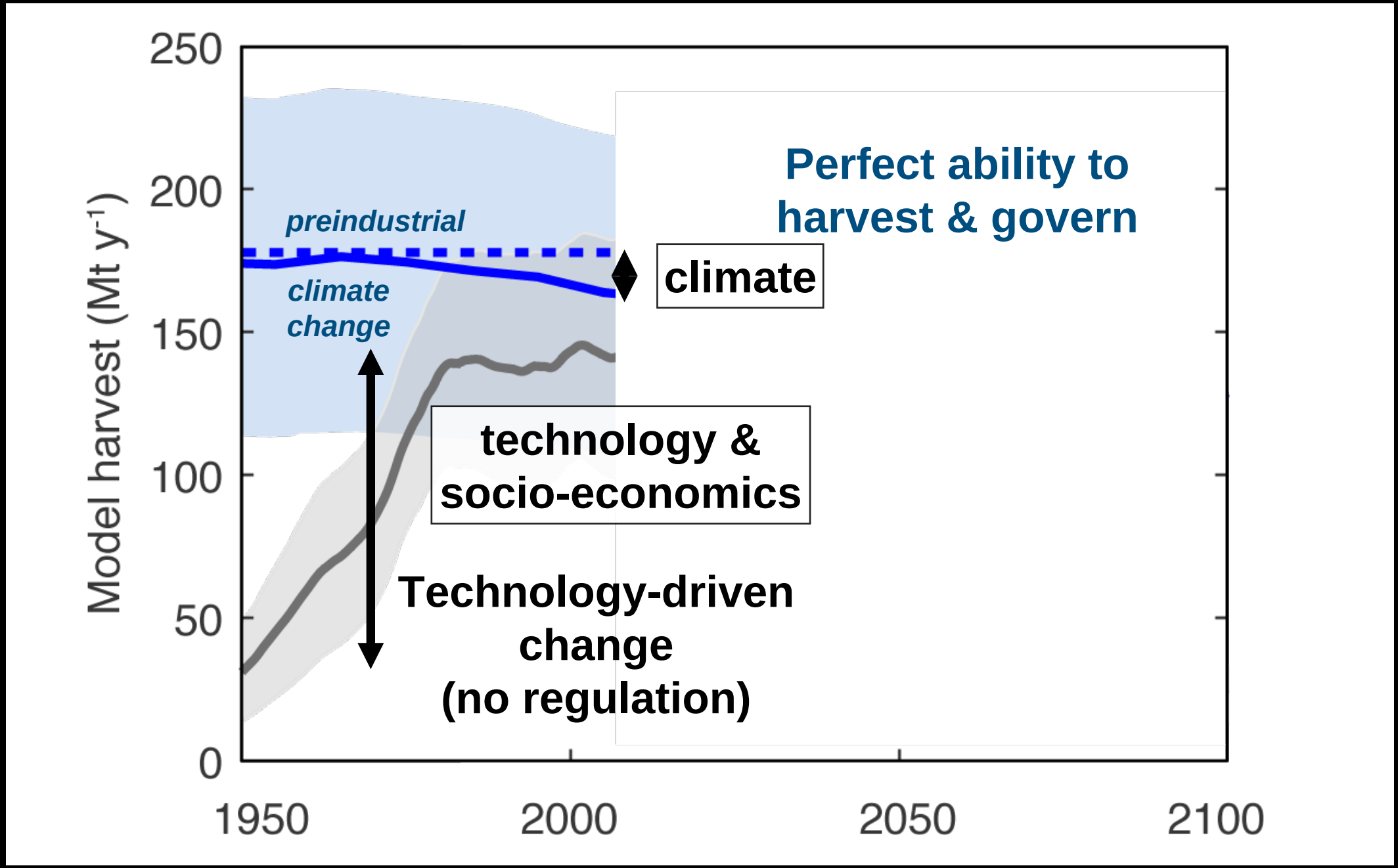
Fishing boats today



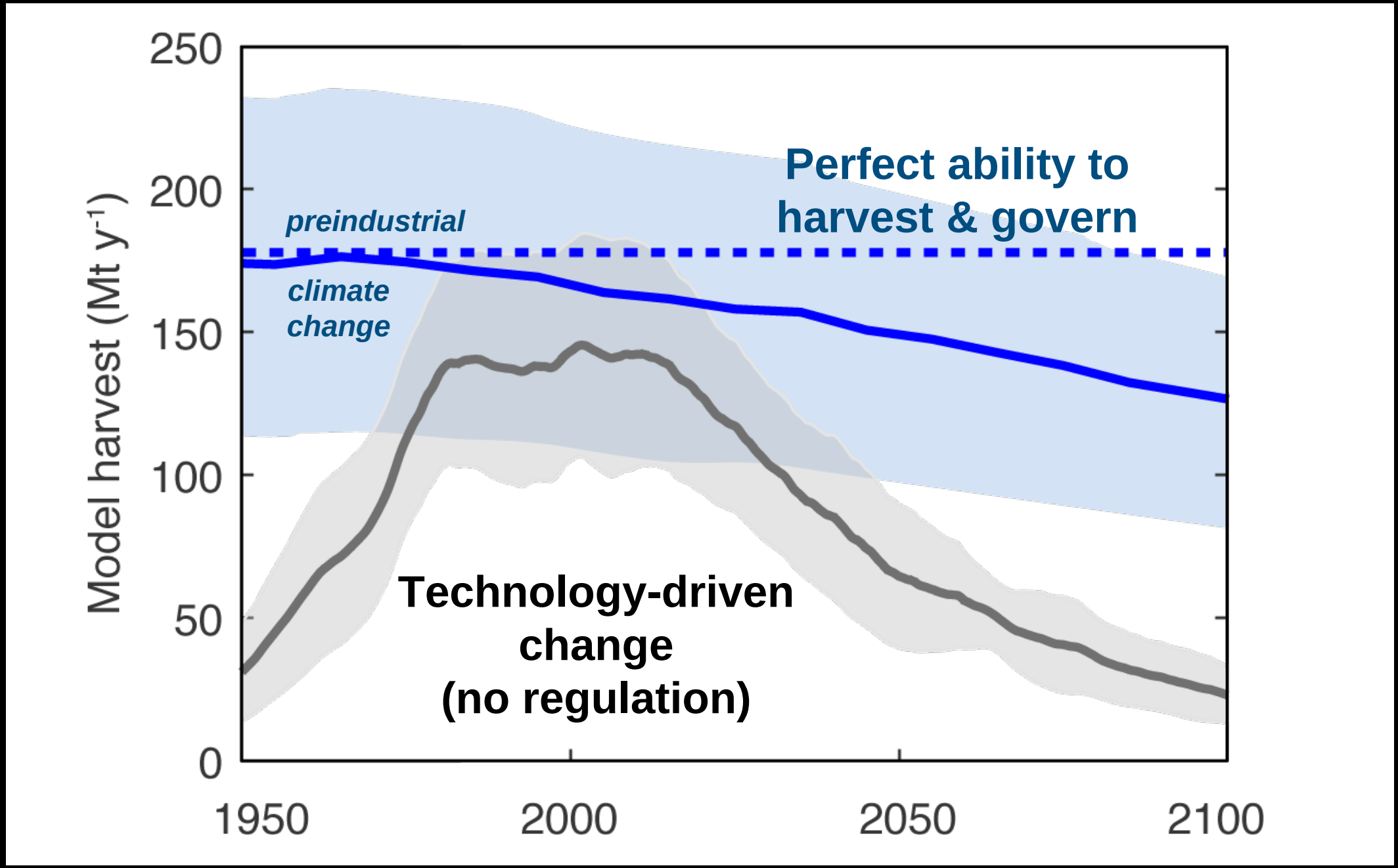
Galbraith et al., *Nature Communications*, 2017



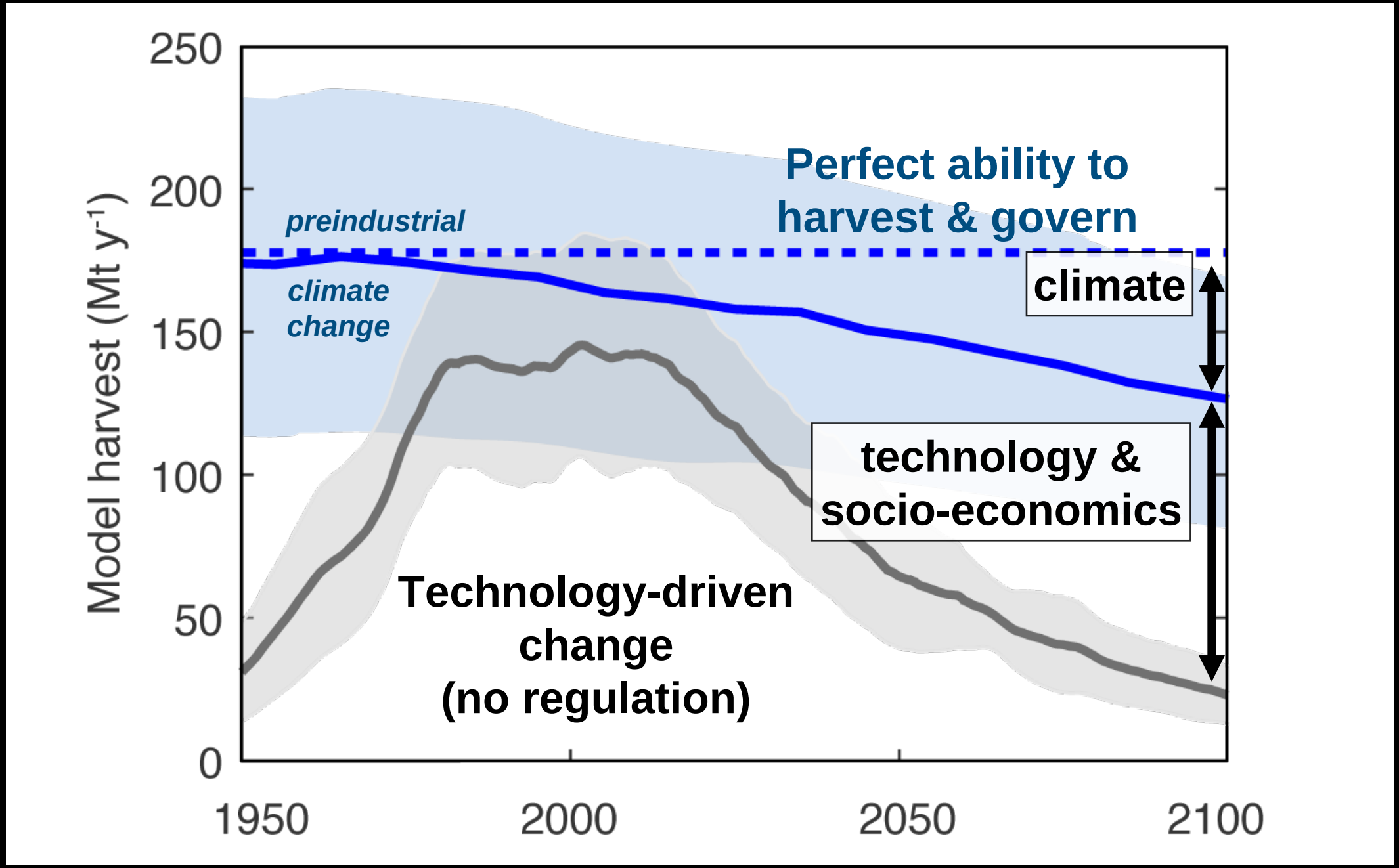
Galbraith et al., *Nature Communications*, 2017



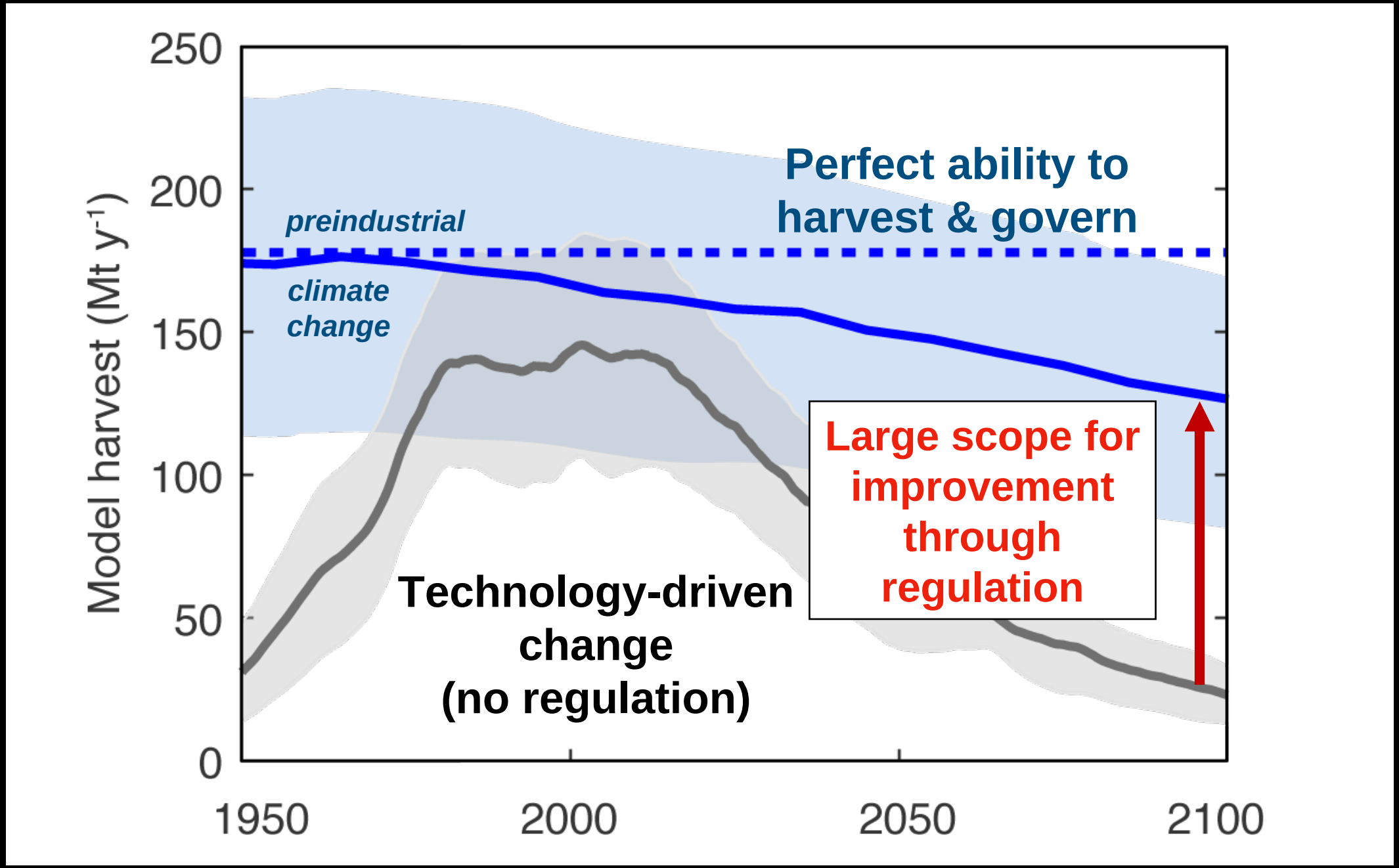
Galbraith et al., *Nature Communications*, 2017



Galbraith et al., *Nature Communications*, 2017

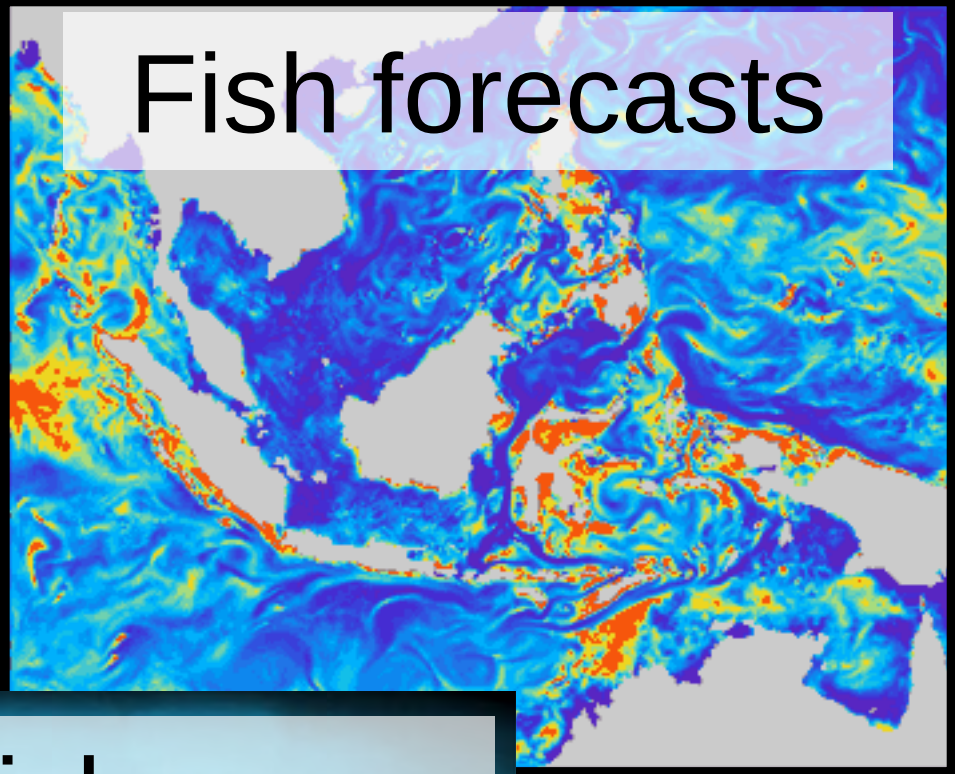


Galbraith et al., *Nature Communications*, 2017

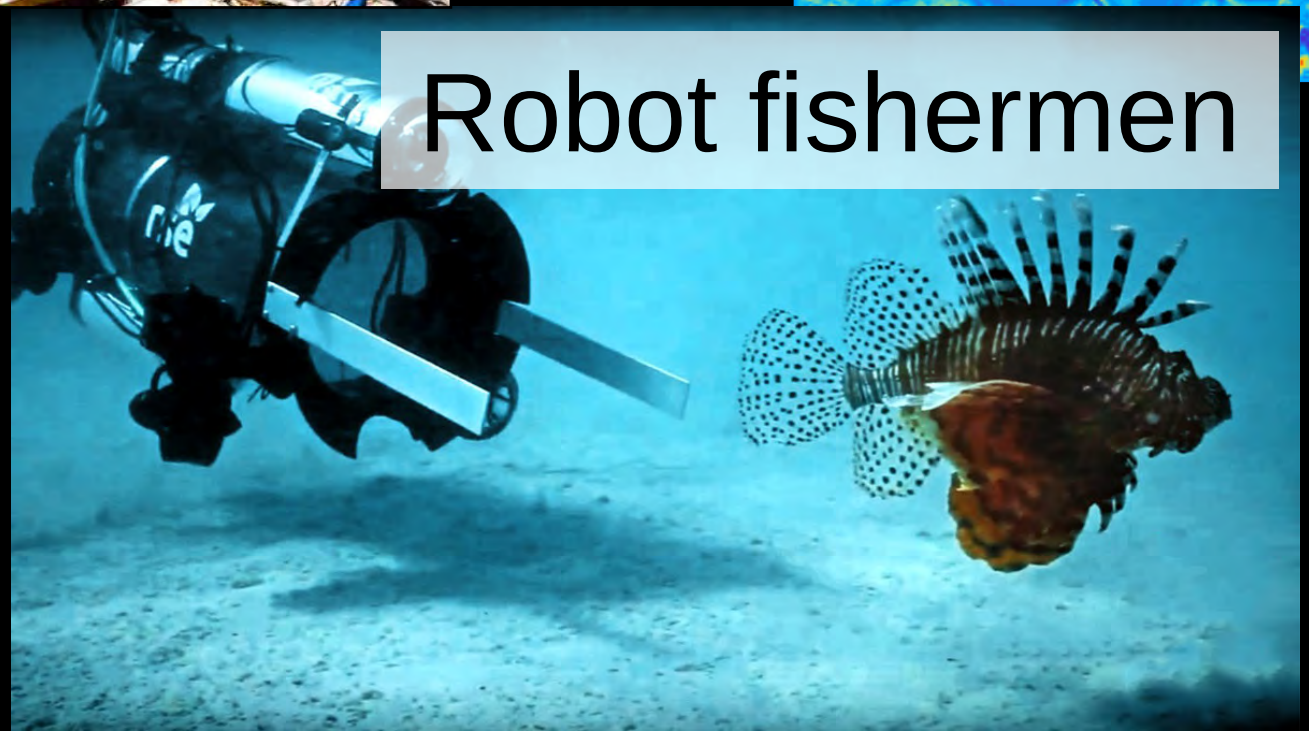


Galbraith et al., *Nature Communications*, 2017

Deployment of existing technology



Fish forecasts



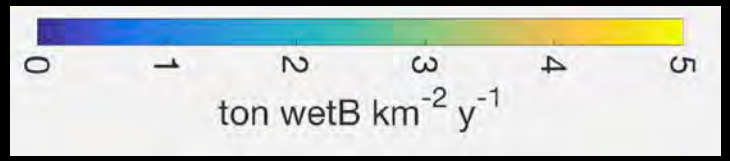
Robot fishermen

Dynamic regulation (constant climate)

No regulation

Some regulation

Perfect regulation



PhD student Kim Scherrer, in preparation

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Summary

- We need global predictive models to envision and quantify possible futures
- Existing global fish models unanimously predict a decrease of fish biomass due to climate change in 21st century, but processes remain highly uncertain, models lack tipping points
- Non-climate human factors are of comparable or potentially greater importance (e.g. technology)
- Can counter climate change impacts with improved fishery regulation
- Need more work on natural-social science integration

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