Science for an uncertain future

evaluating climate impacts and management approaches using a coupled modeling framework

June 2018, 4th ECCWO

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Jonathan Reum, UW
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William Stockhausen, NOAA
Cody Szuwalski, NOAA
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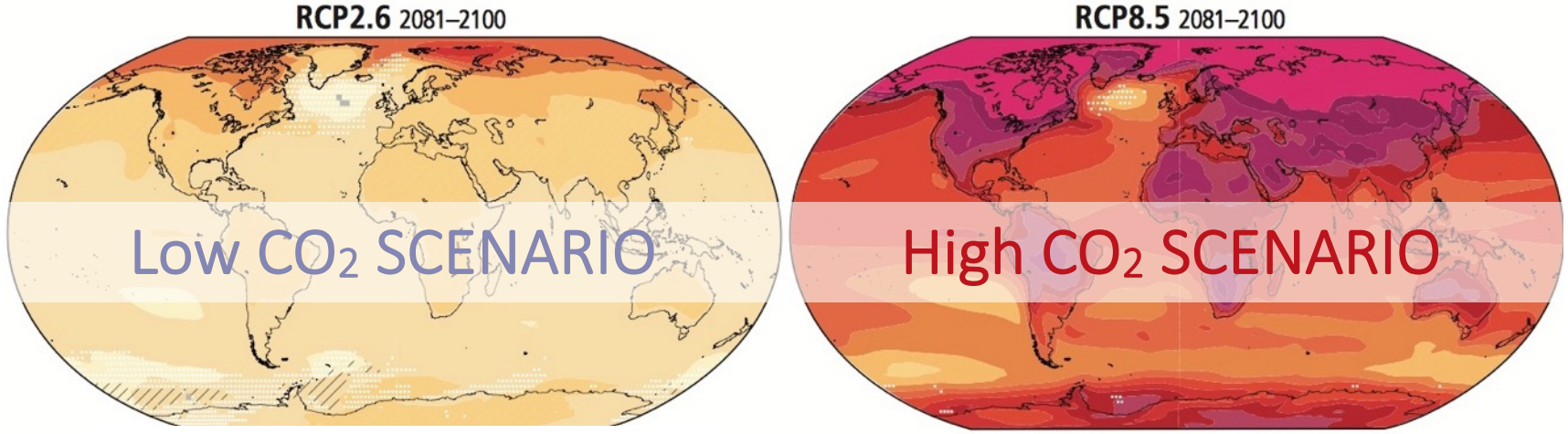
Trond Kristiansen, NOR

https://www.ipcc.ch/report/ar5

Intergovernmental Panel on Climate Change (IPCC)
5th Assessment Report (2013, 2014)

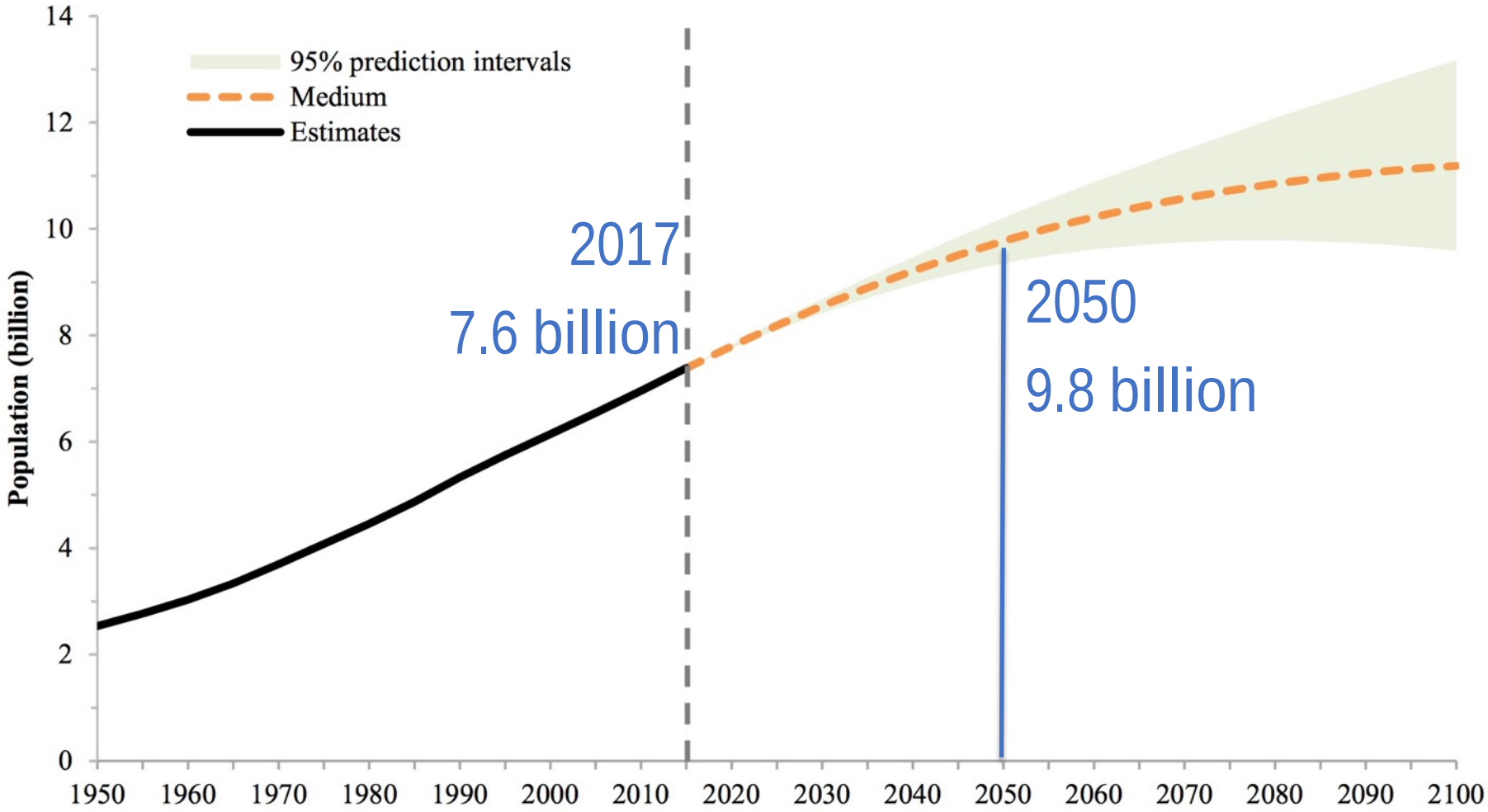


"Paris COP21 agreement"

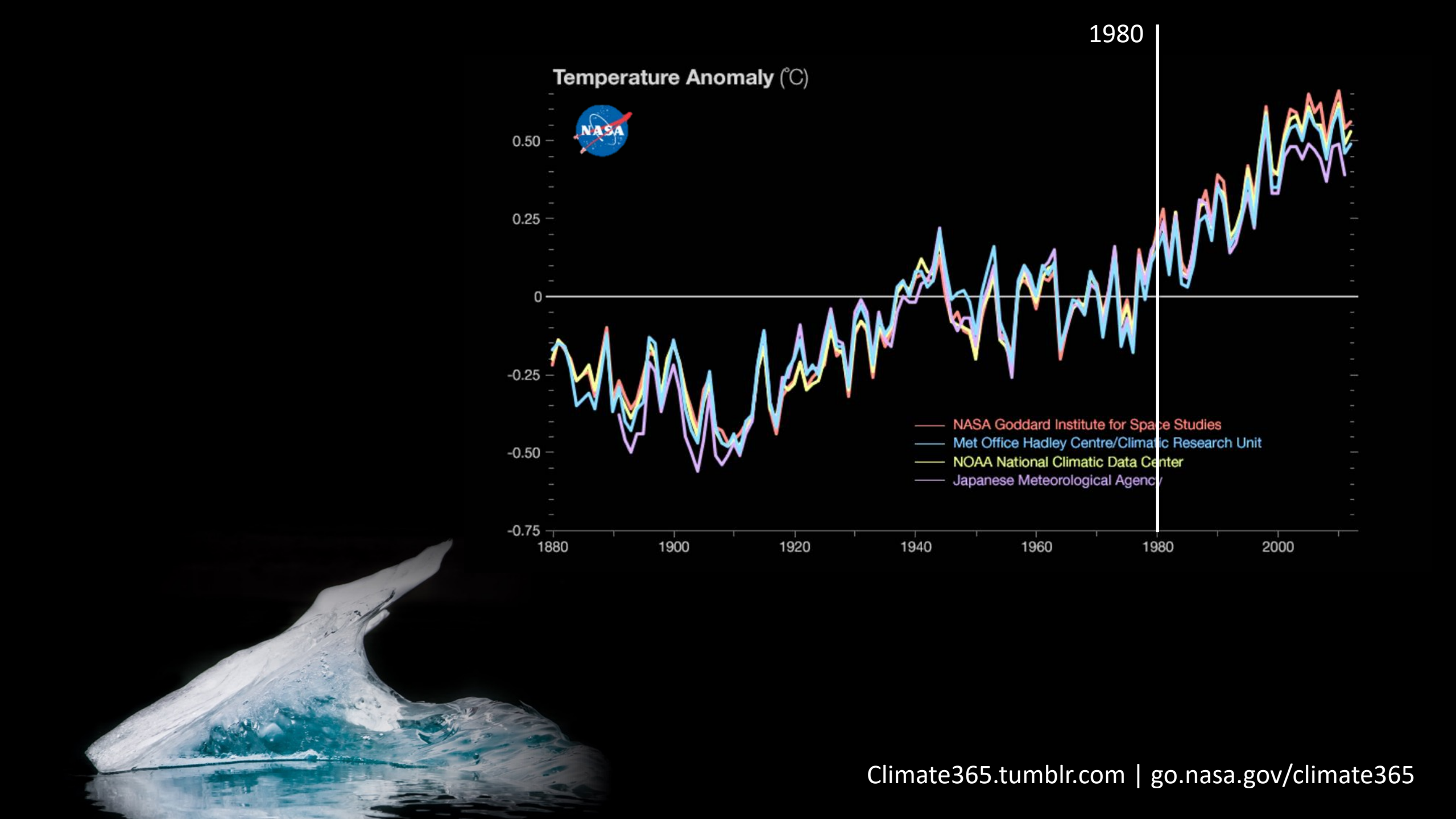
"Business as usual"

Global Population

"The health of our planet as well as our own health and future food security all hinge on how we treat the blue world,"
FAO Director-General José Graziano da Silva, 2014

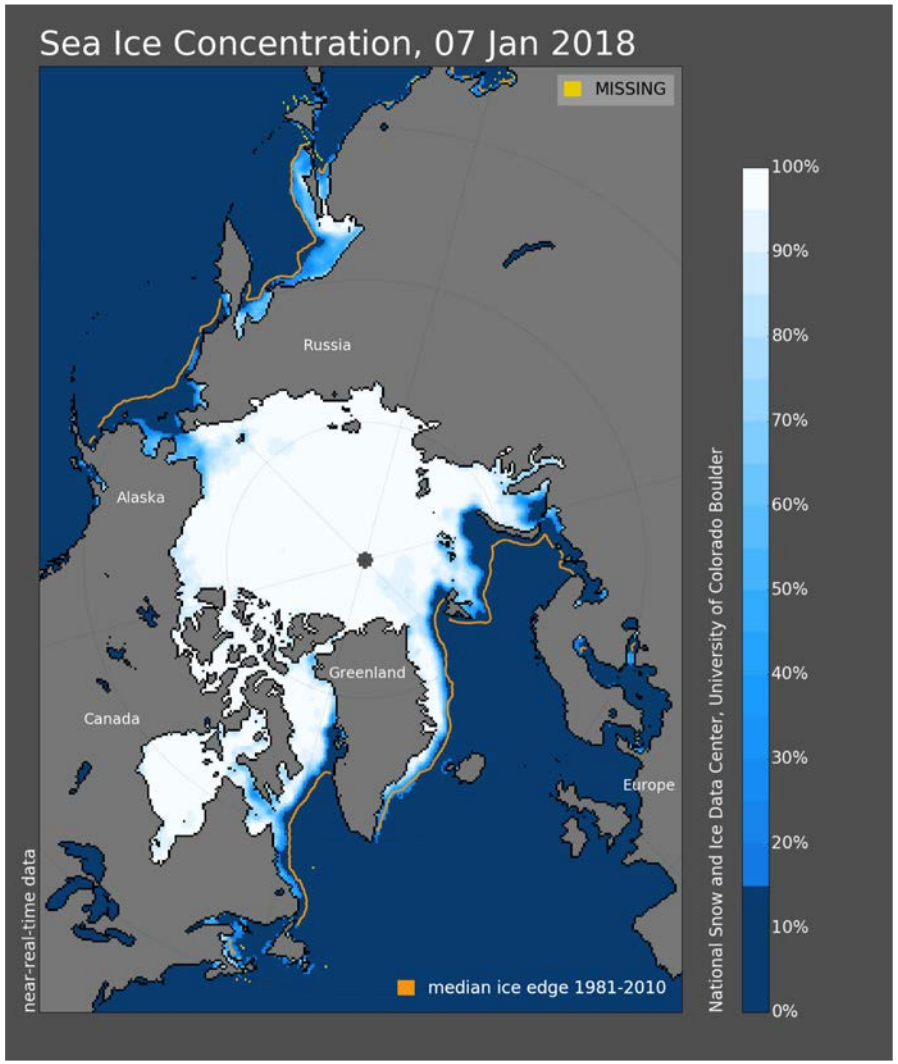


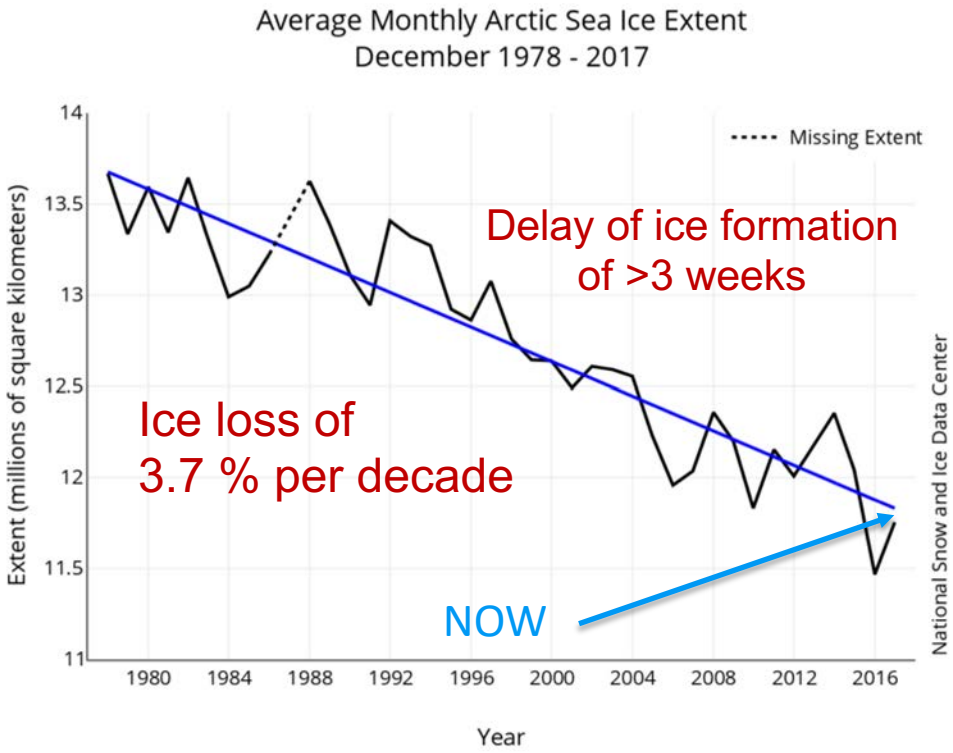
Source: United Nations, Department of Economic and Social Affairs, Population Division (2017). *World Population Prospects: The 2017 Revision*. New York: United Nations.



Climate365.tumblr.com | go.nasa.gov/climate365

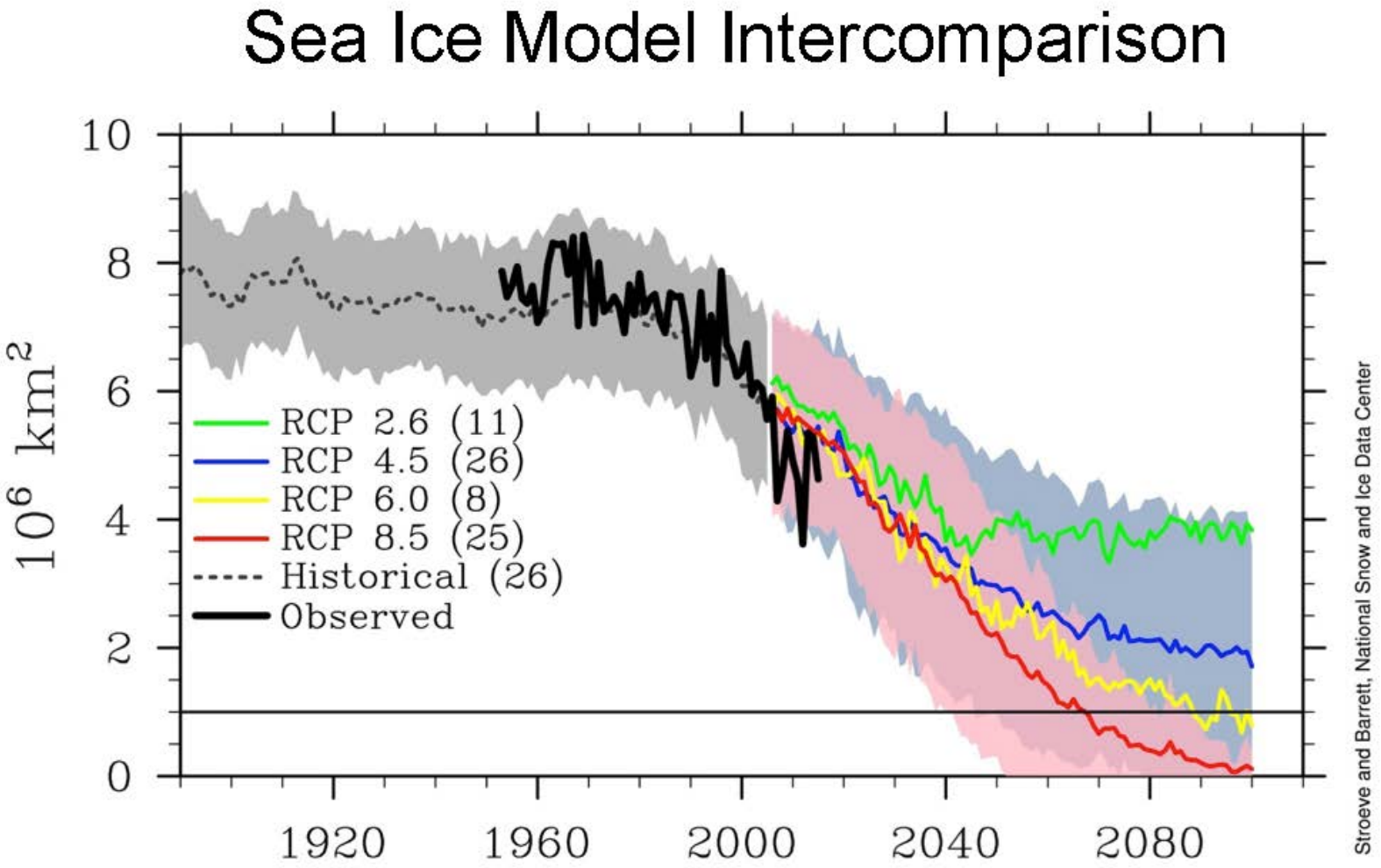
National Sea Ice Data Center





http://nsidc.org/arcticseaicenews/

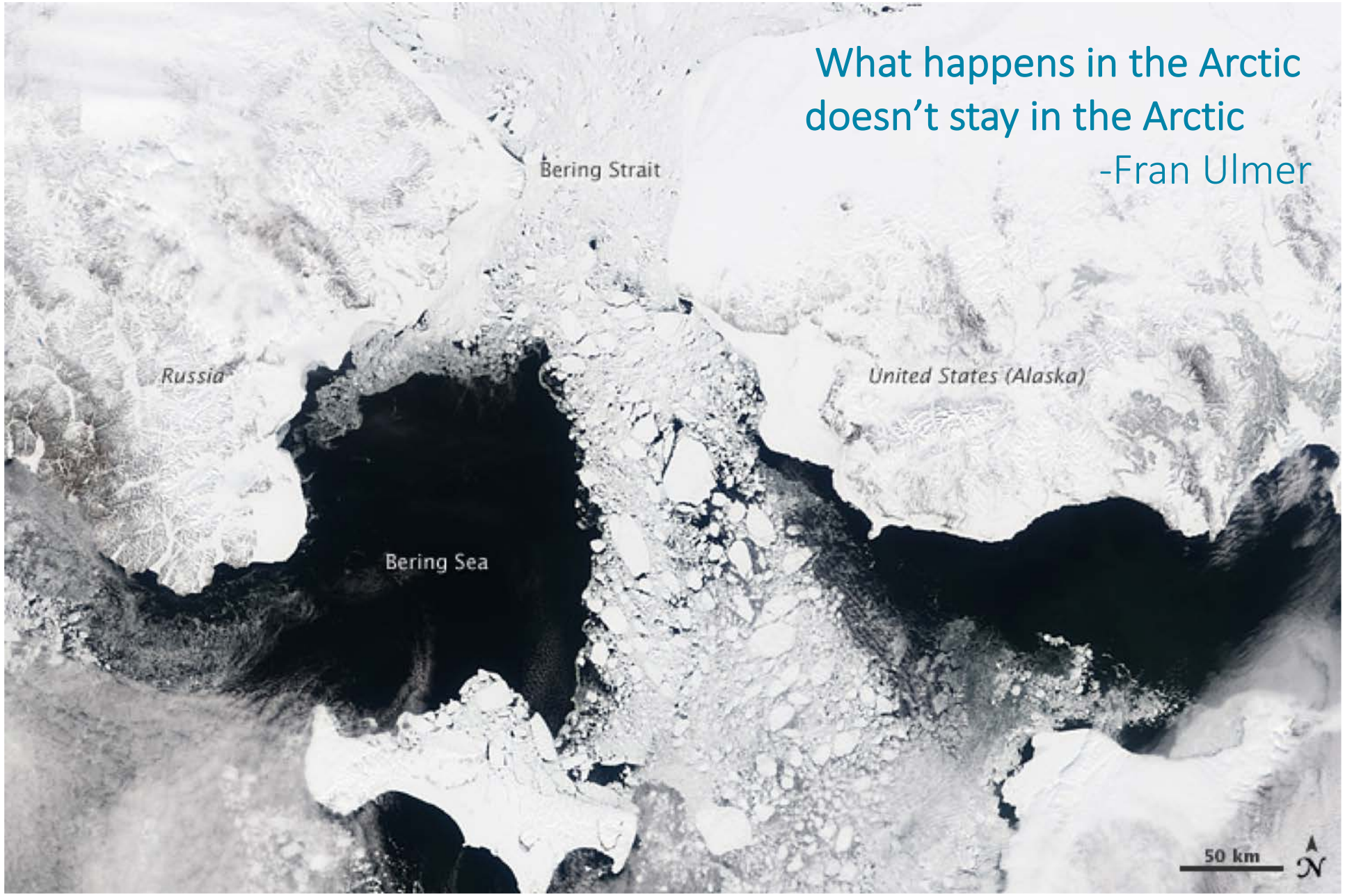
National Snow and Ice Data Center: nsidc.org



Credit: J. Stroeve and A. Barrett, National Snow and Ice Data Center

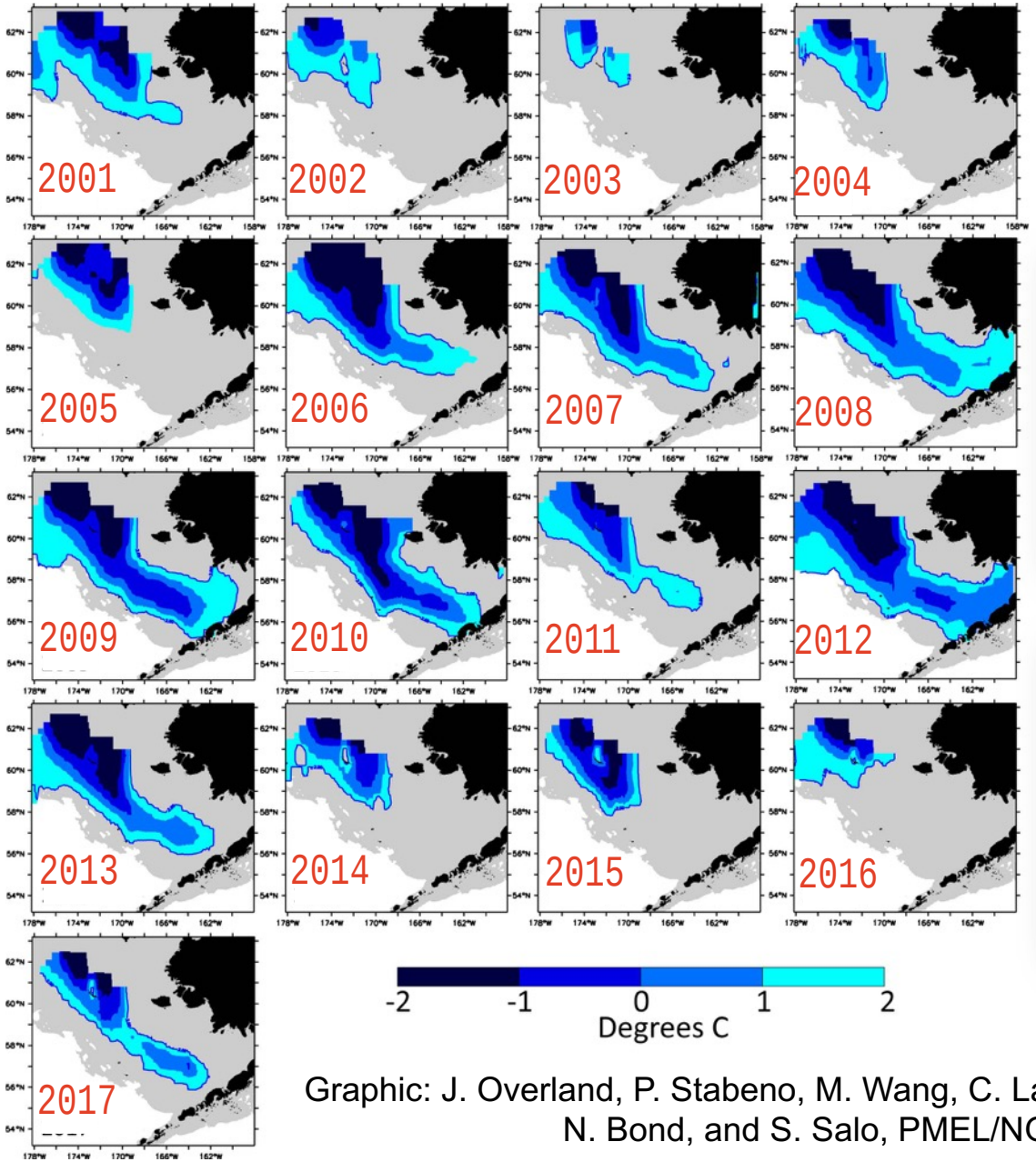
What happens in the Arctic doesn't stay in the Arctic

-Fran Ulmer

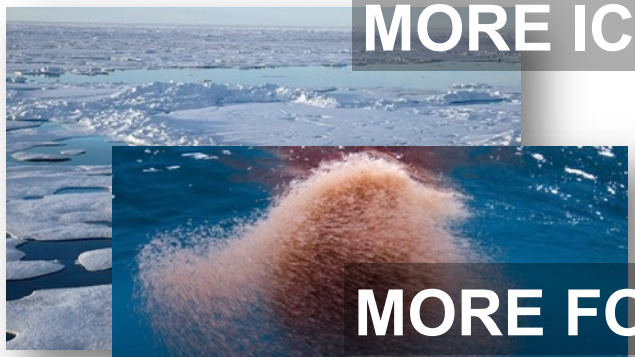


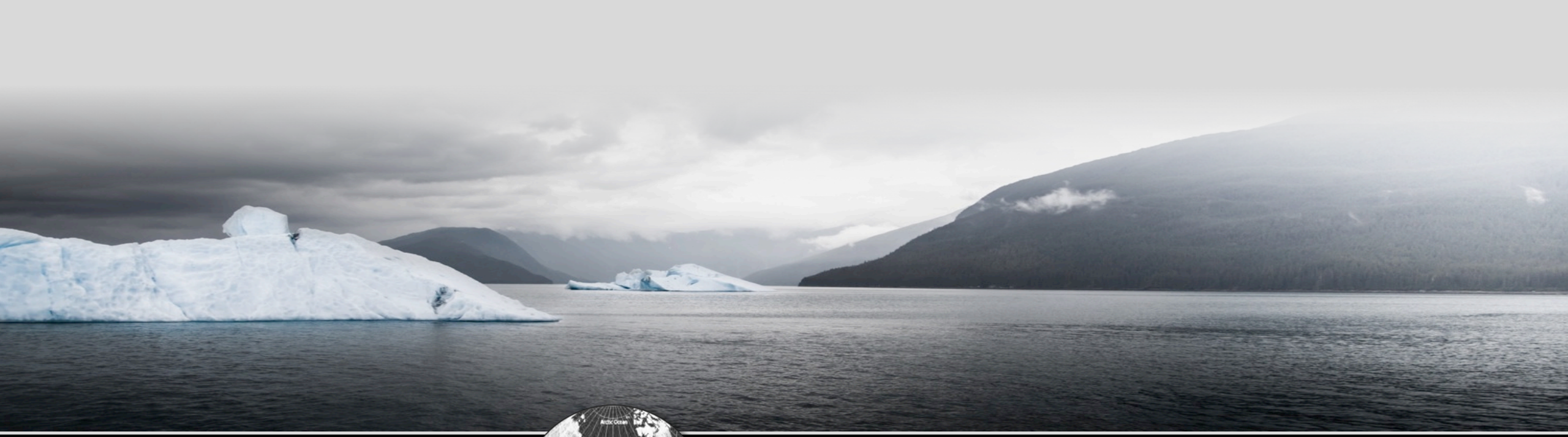
NASA MODIS image by Jesse Allen

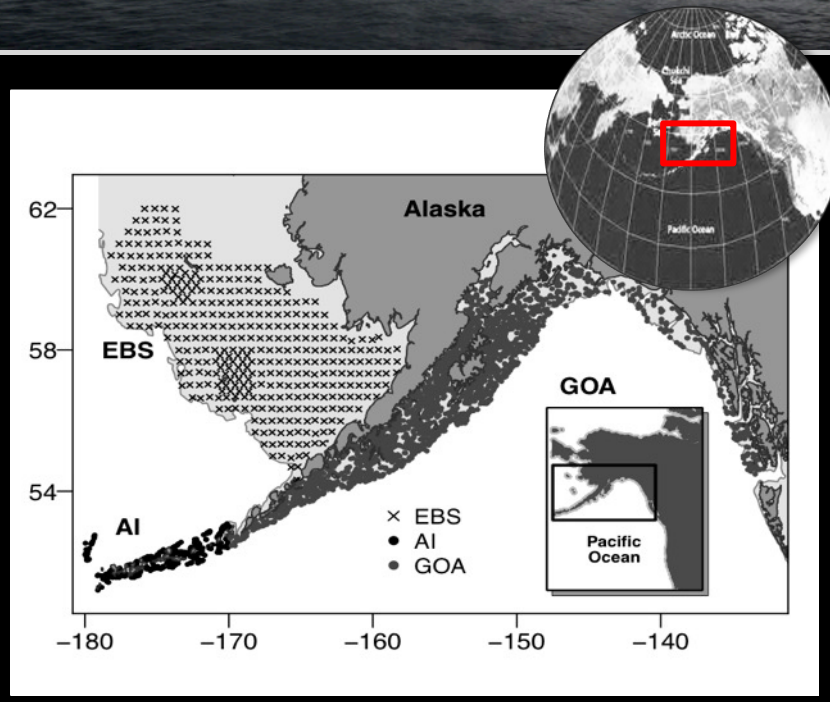
Bering Sea “Cold Pool” 2001-2017



Graphic: J. Overland, P. Stabeno, M. Wang, C. Ladd, N. Bond, and S. Salo, PMEL/NOAA






Arctic Ocean
Chukchi Sea
Pacific Ocean
Alaska
62
58
54
EBS
AI
GOA
Pacific Ocean
× EBS
• AI
• GOA
−180
−170
−160
−150
−140

Management advice on the scale of 100 years?

Inaction is maladaption

- Manuel Barange

Improve management **foresight** in a changing climate

Protect **adaptive capacity** in fish and fisheries

Project changes in Bering Sea ocean conditions and fish populations

Physical, biological, & socioeconomic change; now - 2100

Evaluate how management can adapt to minimize negative impacts of future changes

gradual change & sudden shocks; test existing & new tools; estimate risk

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
UNITED STATES DEPARTMENT OF COMMERCE

ACLIM
Alaska Climate Integrated Modeling Project

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FATE: Fisheries & the Environment
SAAM: Stock Assessment Analytical Methods
S&T: Climate Regimes & Ecosystem Productivity

Global Climate Models (x 7)
- ECHO-G
- MIROC3.2 med res.
- CGCM3-t47
- CCSM4-NCAR- PO
- MIROCESM-C- PO
- GFDL-ESM2M*- PO
- GFDL-ESM2M*- PON

Projection Scenarios (x3)
- AR4 A1B
- AR5 RCP 4.5
- AR5 RCP 8.5

Physical downscaling

ROMS

Biological downscaling

NPZ

Bering Sea 10K Model

Socio-economic / harvest scenarios (x 5+)
- No fishing
- Status quo
- By-catch changes
- CE-reference points
- MEY

Climate Enhanced Biological models (x 5+)
- CE- single species assessment models
- CE- multispecies model (CEATTLE)
- CE - Size spectrum model
- CE- Ecopath with Ecosim
- End-to-End model (FEAST)

interacting pressures

lower trophic

biogeochemical habitats

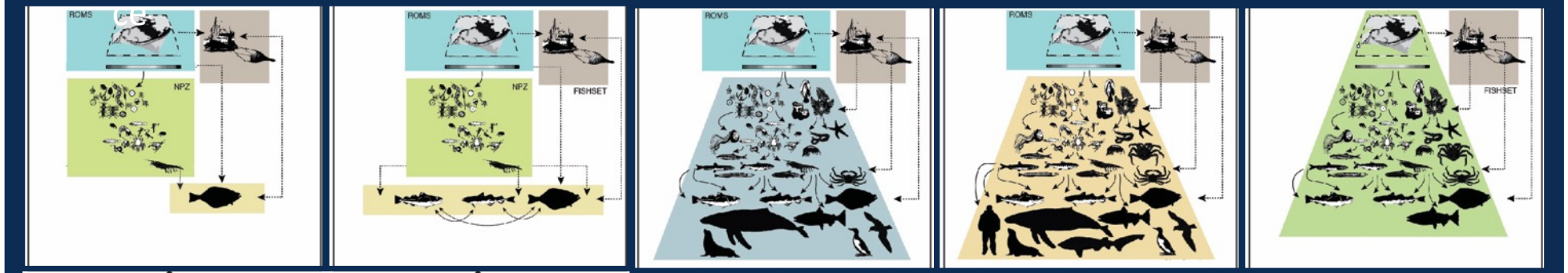
Coupled Socio-ecological System

communities of practice

communities of place

upper trophic

CE-SSM | CE-MSM | CE-EwE | CE-MIZER | FEAST



Fast
Statistical
Implicit ecosystem noise

Slow
High resolution
Explicit ecosystem interactions

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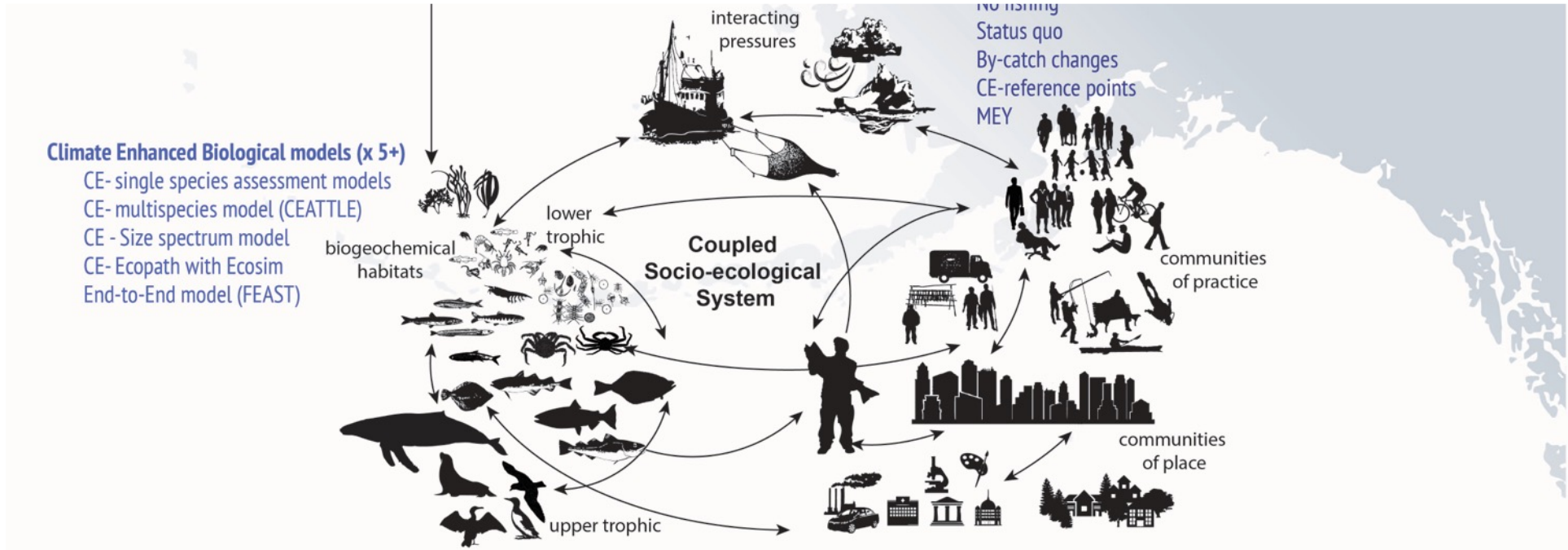

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interacting pressures

lower trophic

biogeochemical habitats

Coupled Socio-ecological System

communities of practice

communities of place

upper trophic

Sustainable tools ≠ climate change tools

PNAS

Income diversification and risk for fishermen

Stephen Kasperski[a,1] and Daniel S. Holland[b,1]

[a]Alaska Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Seattle, WA 98115; and [b]Northwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Seattle, WA 98112

Edited by Stephen Polasky, University of Minnesota, St. Paul, MN, and approved December 12, 2012 (received for review July 17, 2012)

Catches and prices from many fisheries exhibit high interannual variability, leading to variability in the income derived by fishery participants. The economic risk posed by this may be mitigated in some cases if individuals participate in several different fisheries, particularly if revenues from those fisheries are uncorrelated or

to them beyond adopting less-risky farming strategies. They often have access to subsidized crop insurance, price supports, and futures markets (19–22), none of which are available to fishermen. Extending crop insurance-like programs to commercial fisheries harvesters has been suggested (23–26), but a feasibility

Fisherman don't always follow the fish

ICES Journal of Marine Science Advance Access published June 8, 2012

ICES Journal of Marine Science

ICES International Council for the Exploration of the Sea
CIEM Conseil International pour l'Exploration de la Mer

ICES Journal of Marine Science; doi:10.1093/icesjms/fss097

The effect of decreasing seasonal sea-ice cover on the winter Bering Sea pollock fishery

Lisa Pfeiffer and Alan C. Haynie*

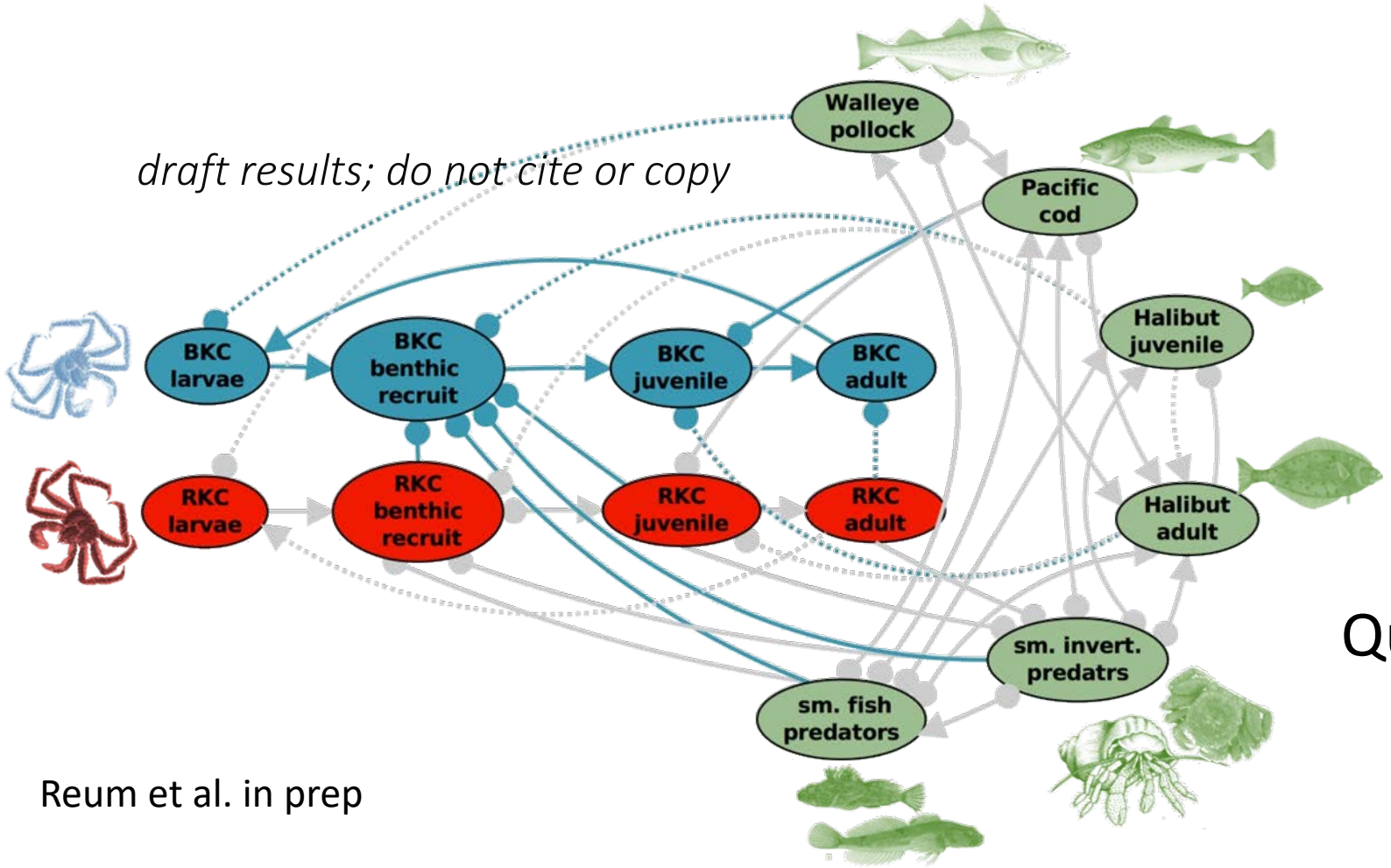
REFM Division, Alaska Fisheries Science Center, Economics and Social Sciences Research Program, NOAA National Marine Fisheries Service, 7600 Sand Point Way NE, Seattle, WA 98115, USA

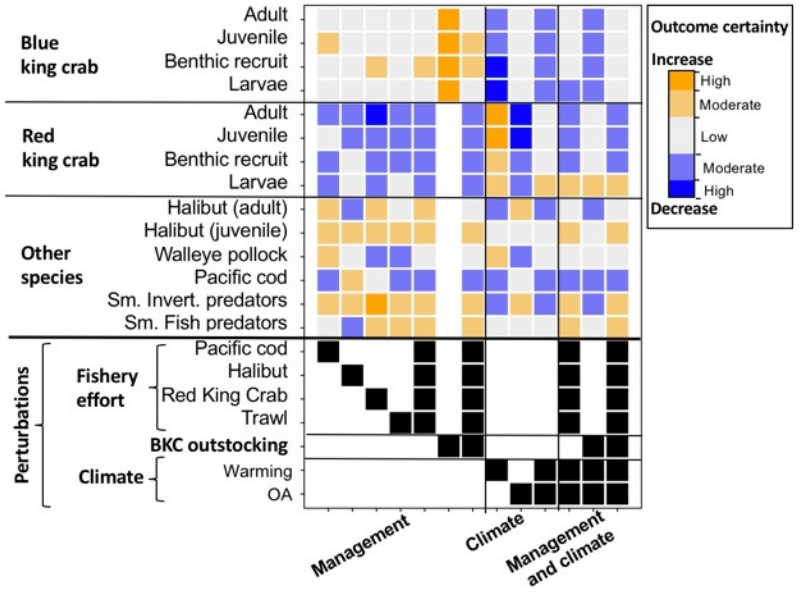
**Corresponding author: tel: +1 206 5264253; fax +1 206 5266723; e-mail: alan.haynie@noaa.gov.*

Pfeiffer, L., and Haynie, A. C. The effect of decreasing seasonal sea-ice cover on the winter Bering Sea pollock fishery. – ICES Journal of Marine Science, doi:10.1093/icesjms/fss097.

Received 15 September 2011; accepted 8 April 2012.

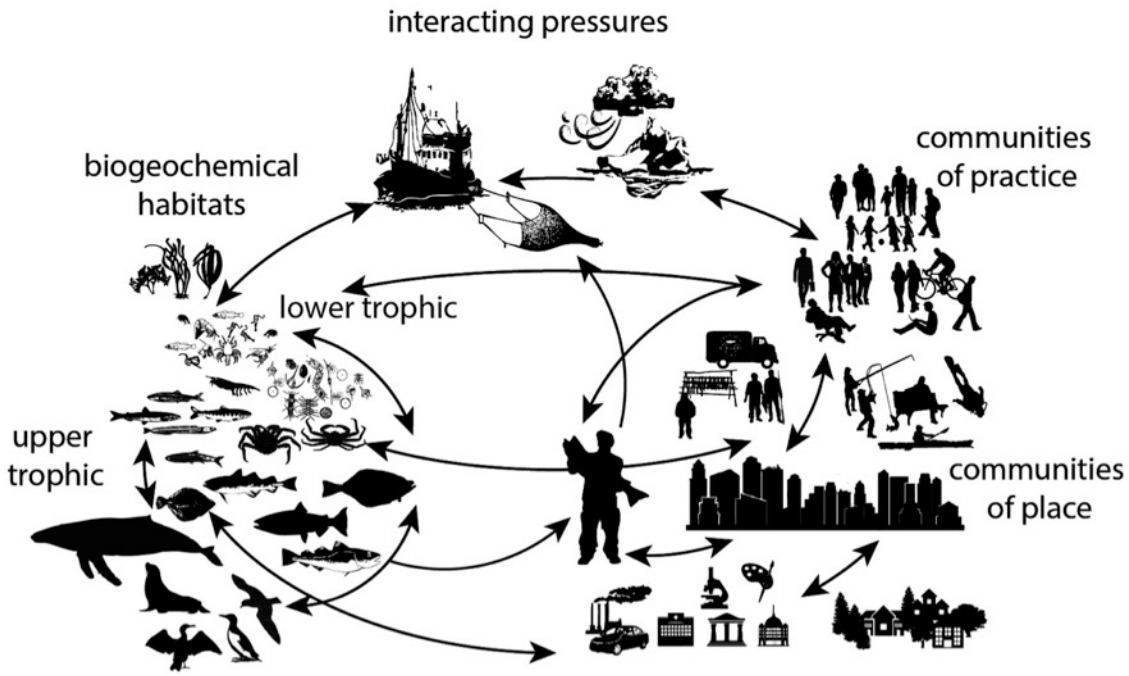
draft results; do not cite or copy





Qualitative Network Modeling

Reum et al. in prep

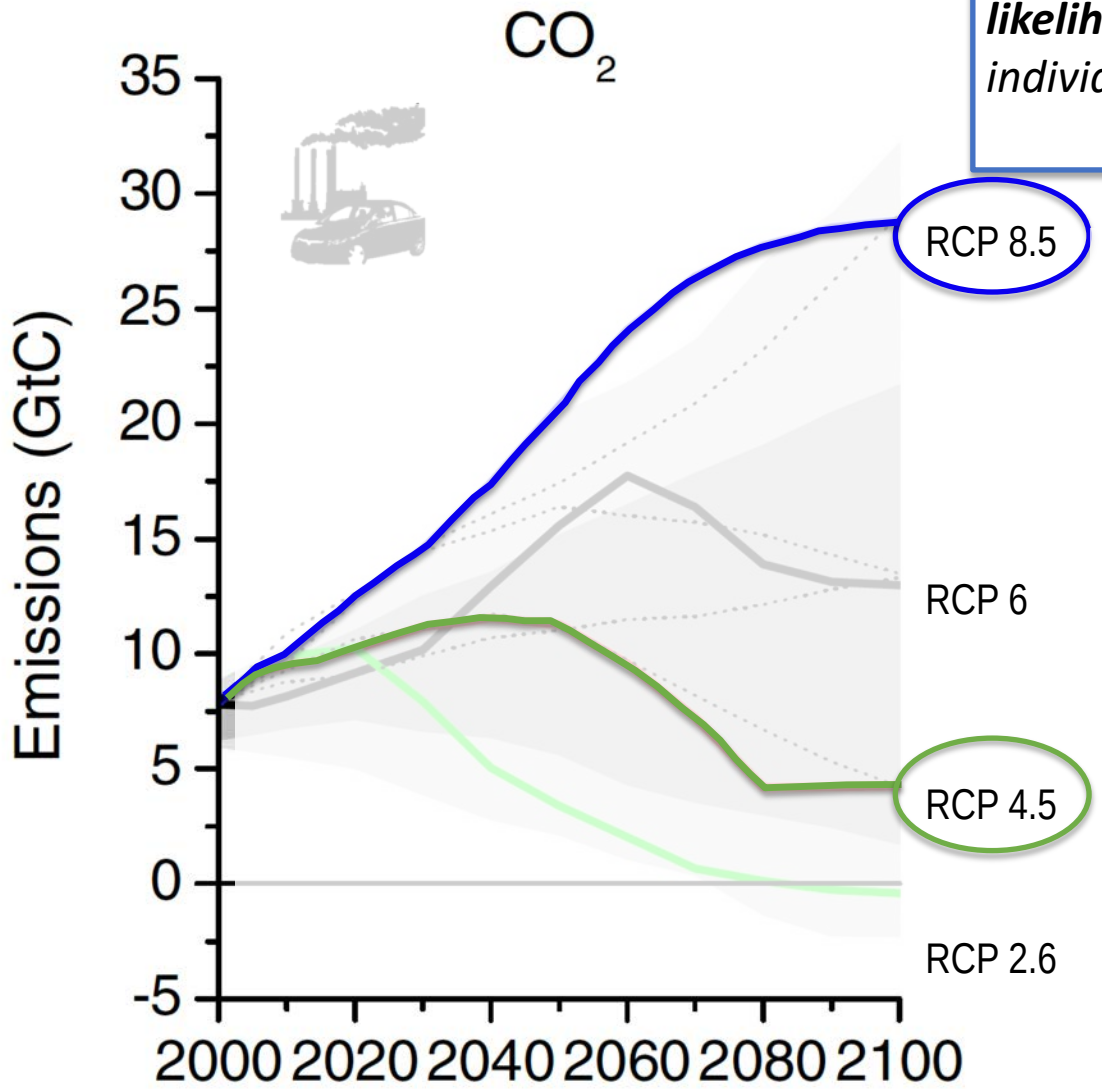


Integrated Approach

- Evaluate projection error
- Understand future risk
- Characterize adaptive capacity
- Identify key unknowns
- Build capacity for response

Carbon Emission Scenarios

> *"**plausible descriptions** of how the future may evolve with respect to a range of variables…they are not meant to be policy prescriptive, (i.e. **no likelihood or preference is attached** to any of the individual scenarios of the set)"*
>
> *van Vuuren et al. 2011*

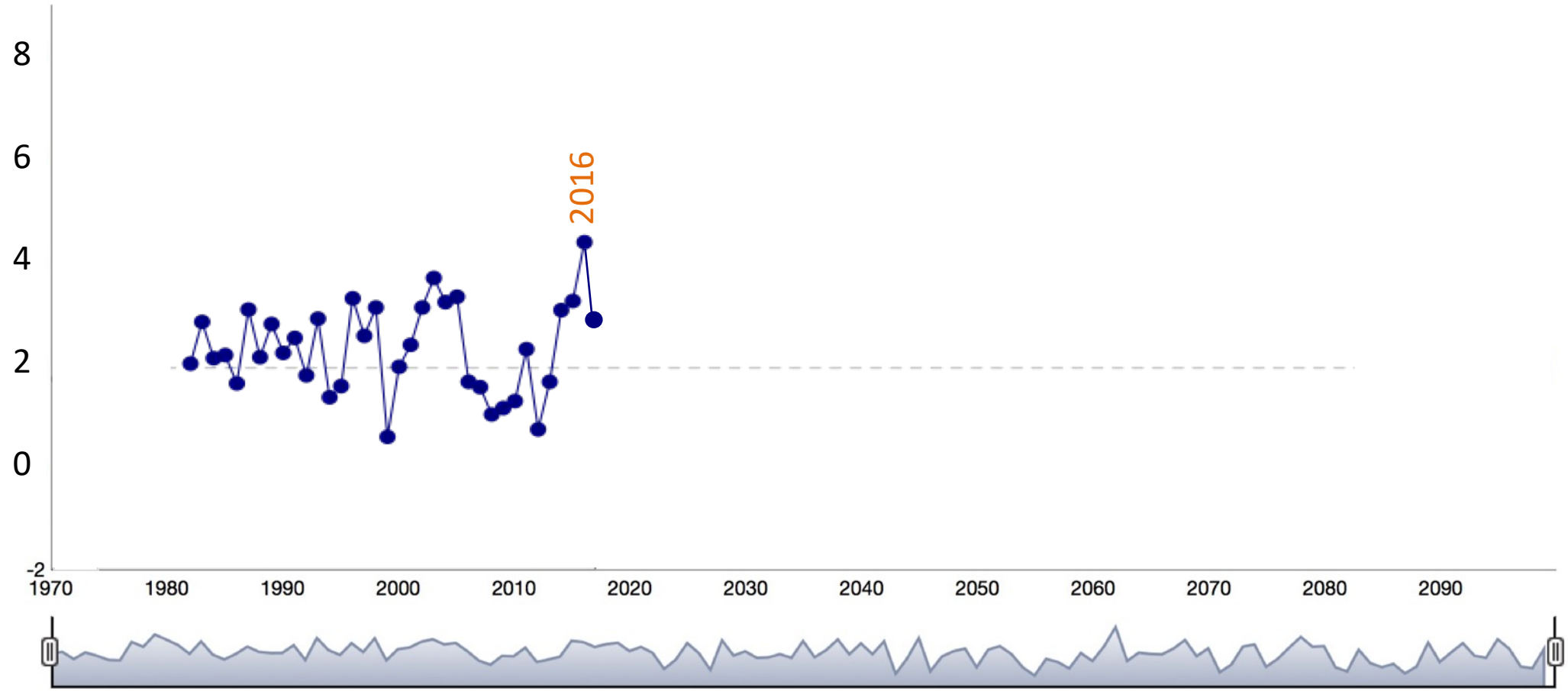


High-Baseline
"Business as usual"

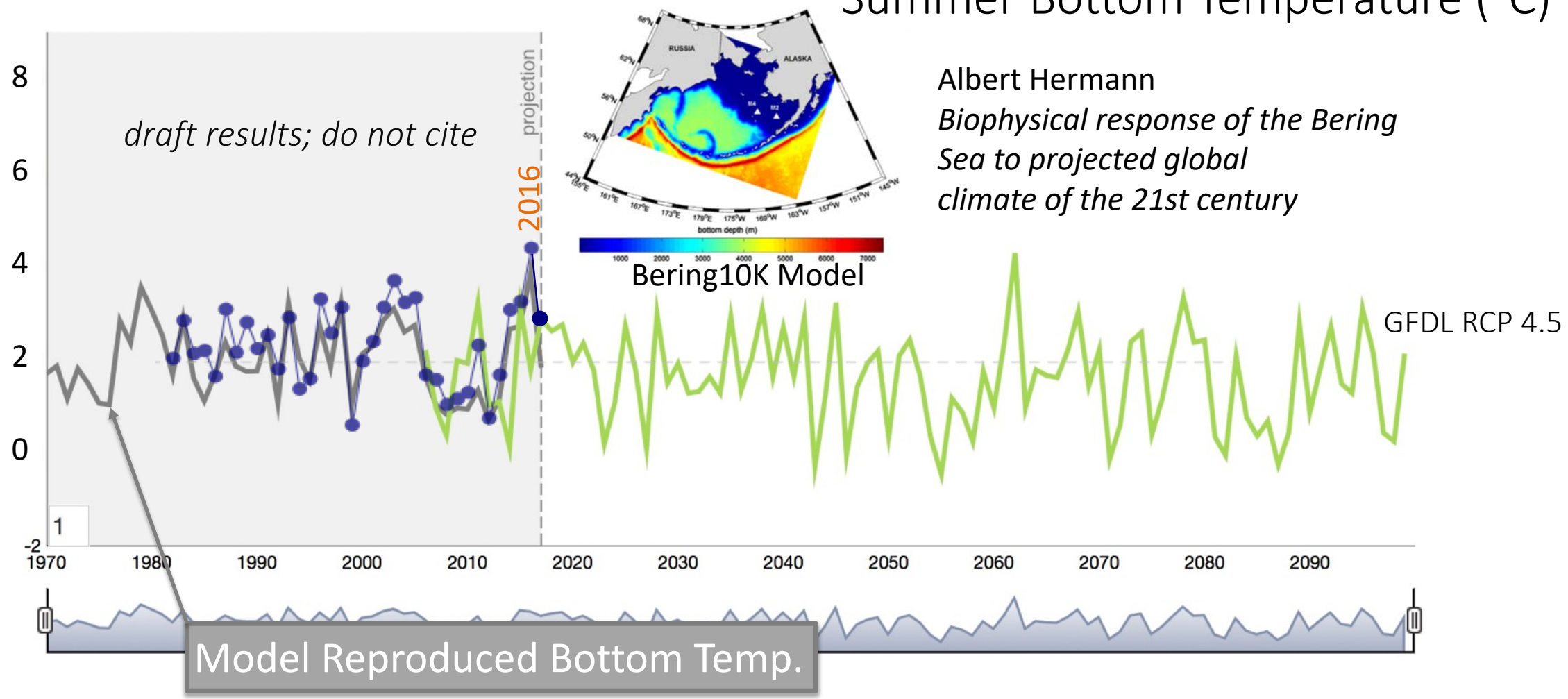
Medium-low

Preliminary Results

Summer Bottom Temperature (°C)



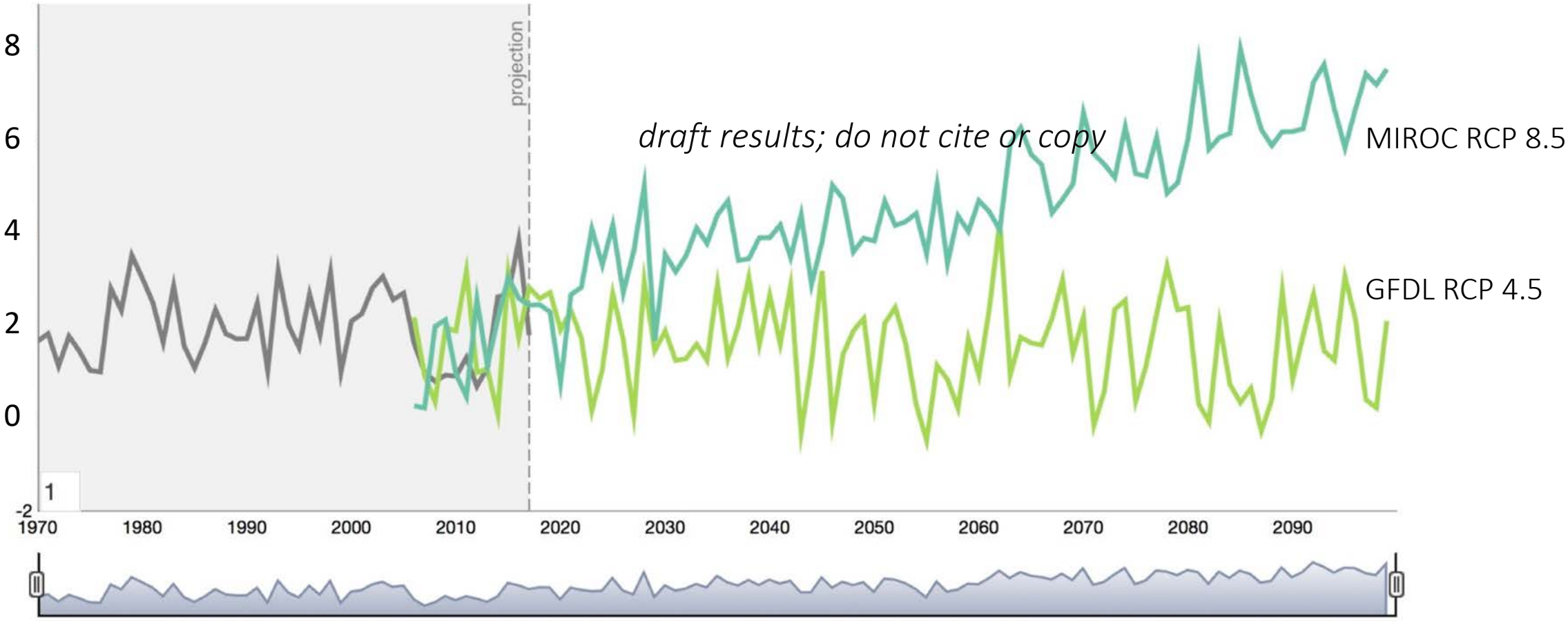
Summer Bottom Temperature (°C)



Albert Hermann

Biophysical response of the Bering Sea to projected global climate of the 21st century

Summer Bottom Temperature (°C)



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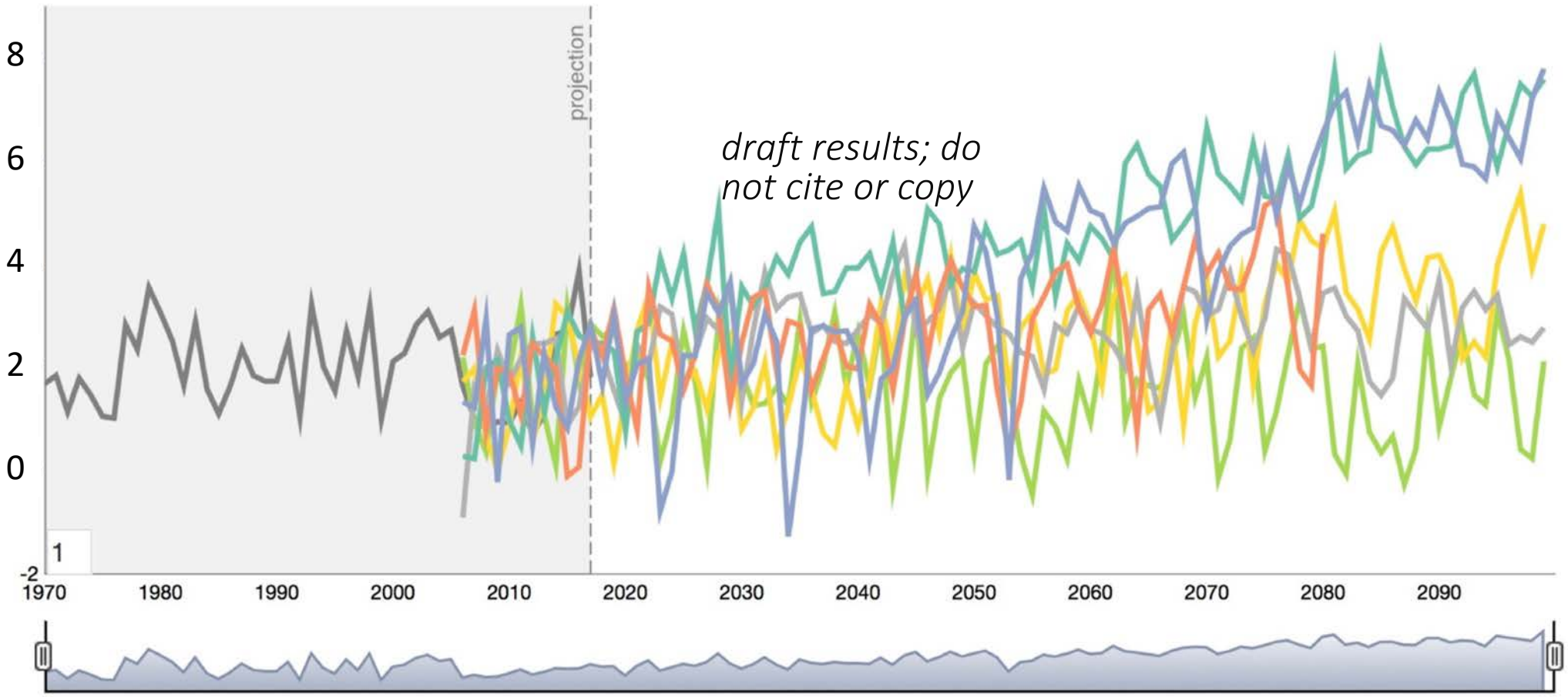

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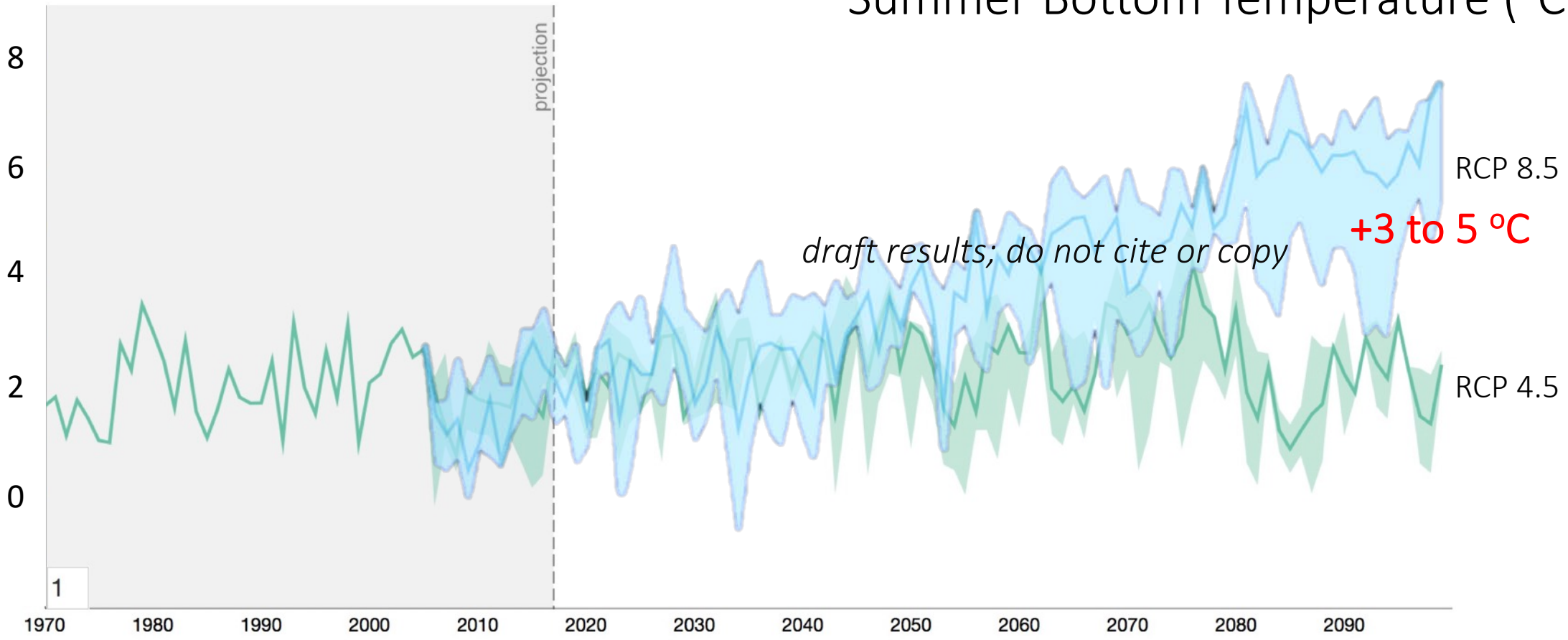
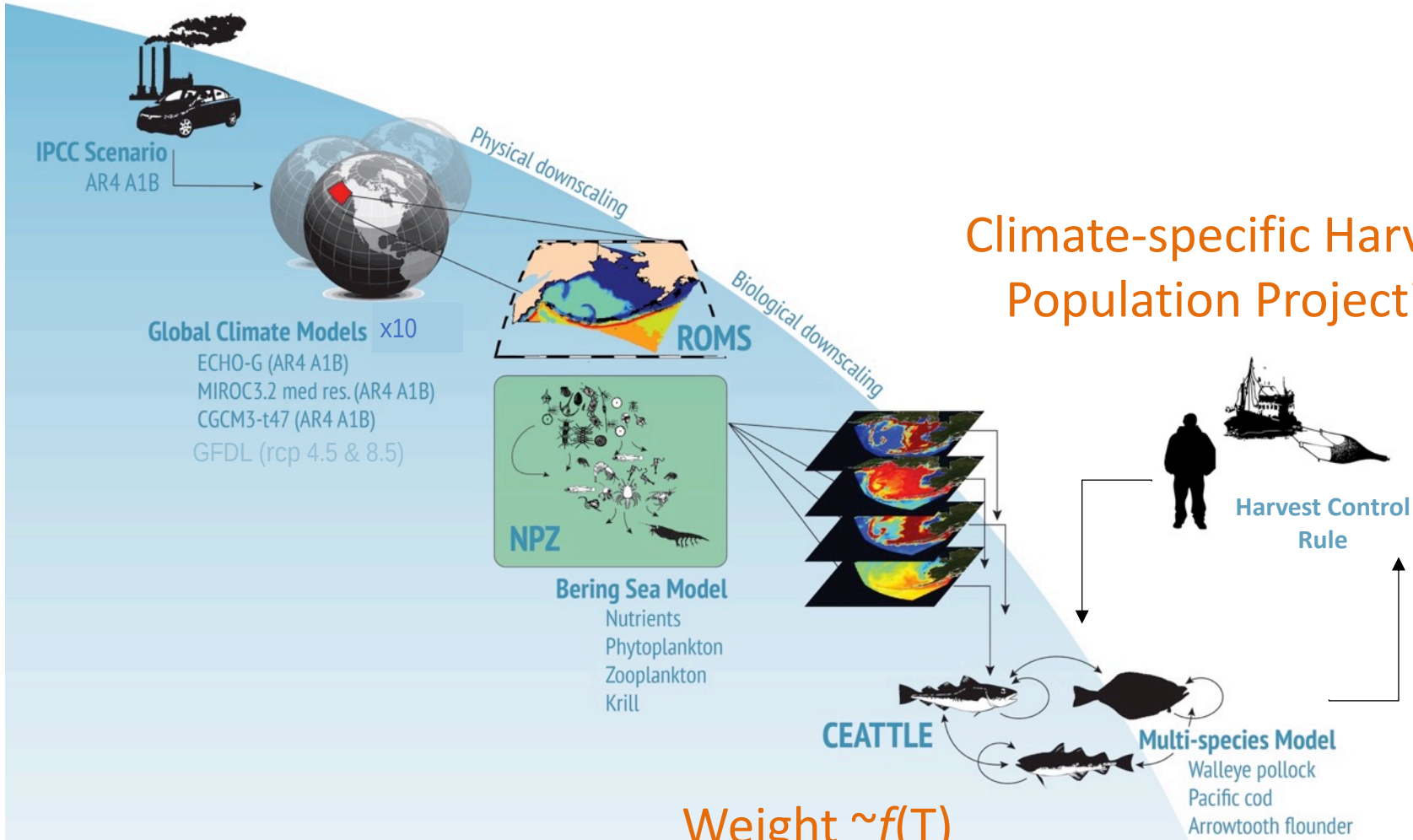


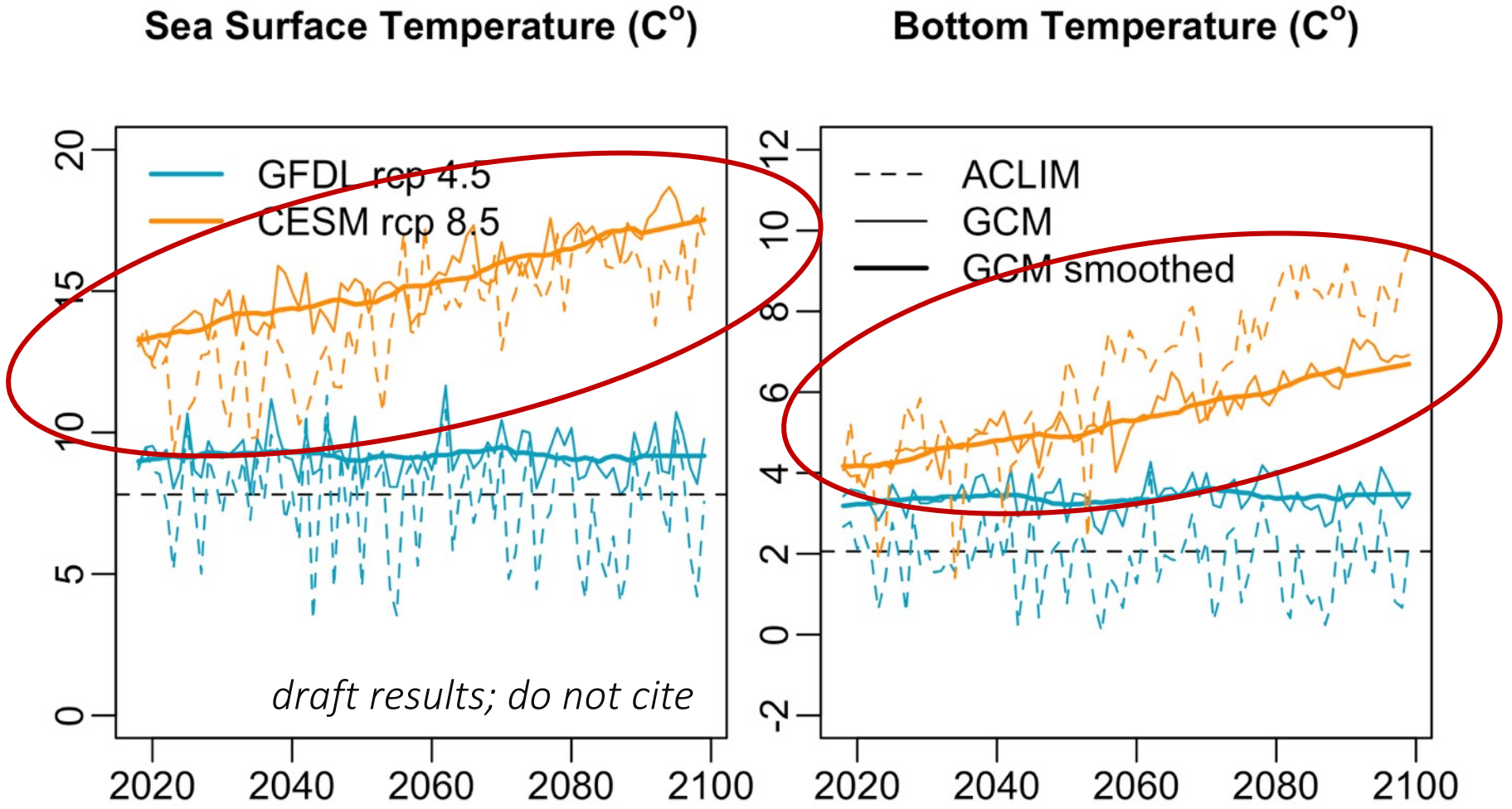
fish projections



Climate-specific Harvest & Population Projections

Weight ~*f*(T)
Predation ~*f*(T)
Recruitment ~*f*(climate)*

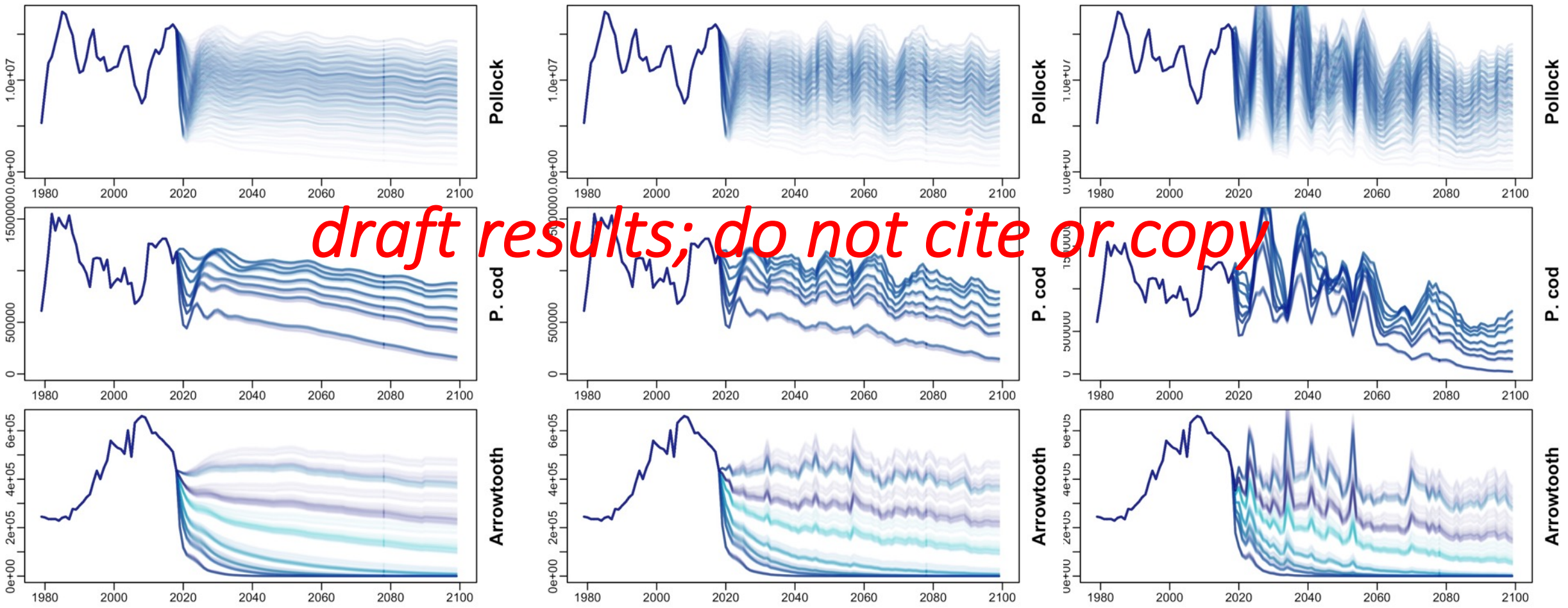
Holsman et al. in prep


Sea Surface Temperature (C°)
Bottom Temperature (C°)
GFDL rcp 4.5
CESM rcp 8.5
ACLIM
GCM
GCM smoothed
draft results; do not cite
0
5
10
15
20
-2
0
2
4
6
8
10
12
2020
2040
2060
2080
2100

GCM CESM RCP 8.5 (20 yr smooth)

GCM CESM RCP 8.5

Downscaled CESM RCP 8.5



Bering Sea Size-spectrum model

Scaling climate impacts from individual-level processes to populations and food webs using multispecies size spectrum models

Dr. Jonathan Reum

Tues 16:40

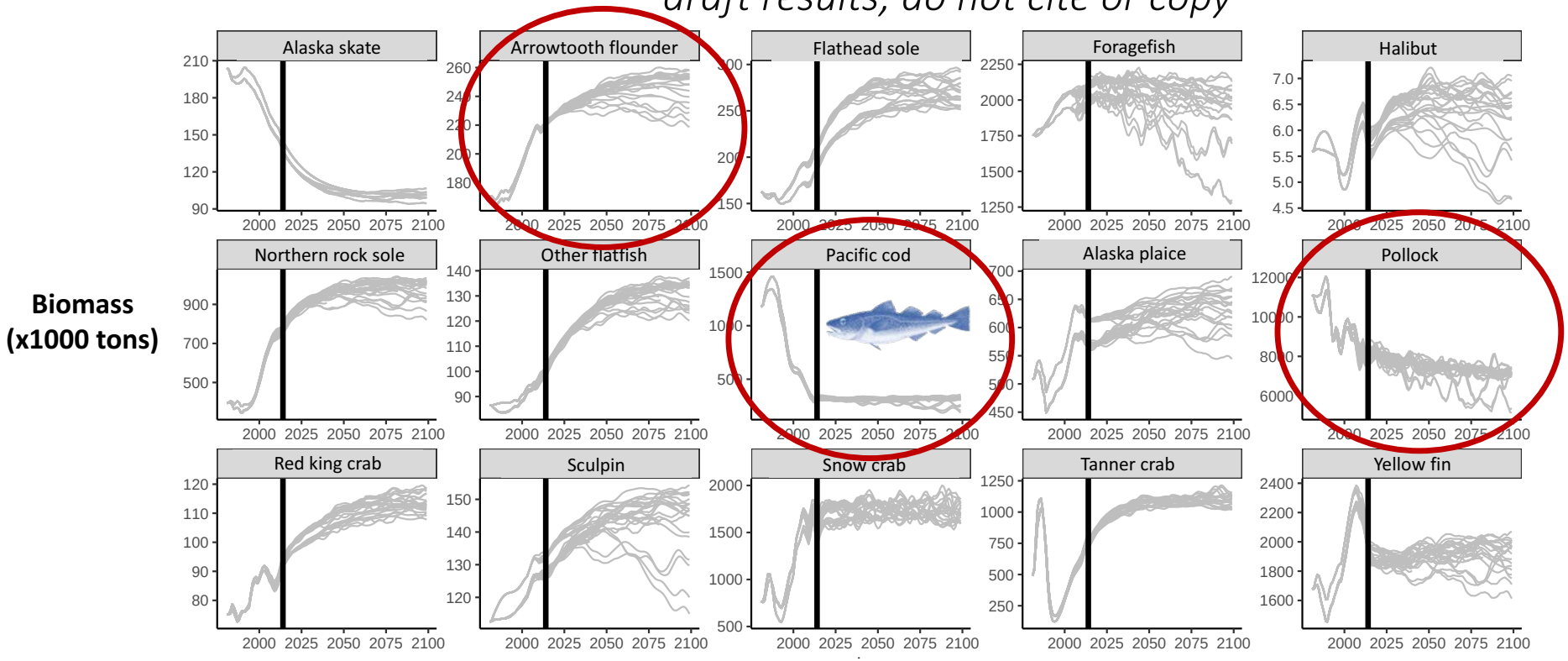
Session 13

(Columbia 1&2)

CO_2 scenario × GCM × Climate hypothesis

Fishing effort = recent historical mean

draft results; do not cite or copy



Downscaling is needed

GCMs may underestimate variance in projections

Adaptation through fisheries management

Changing harvest rates can lessen climate effects, to point; management measures forestalled declines

Account for predation

Accounting for predation changed the direction of projections from increases (single-sp model) to declines (multi-sp)

Mitigation is lower risk

Most pollock and cod scenarios crashed under business as usual (RCP8.5) by 2100; carbon mitigation (RCP 4.5) may lessen or prevent declines

Holsman et al. in prep

bridge the gap between social, marine, and ocean sciences

- Lynne Shannon

to be truly radical is to make hope possible, rather than despair convincing

-Raymond Williams

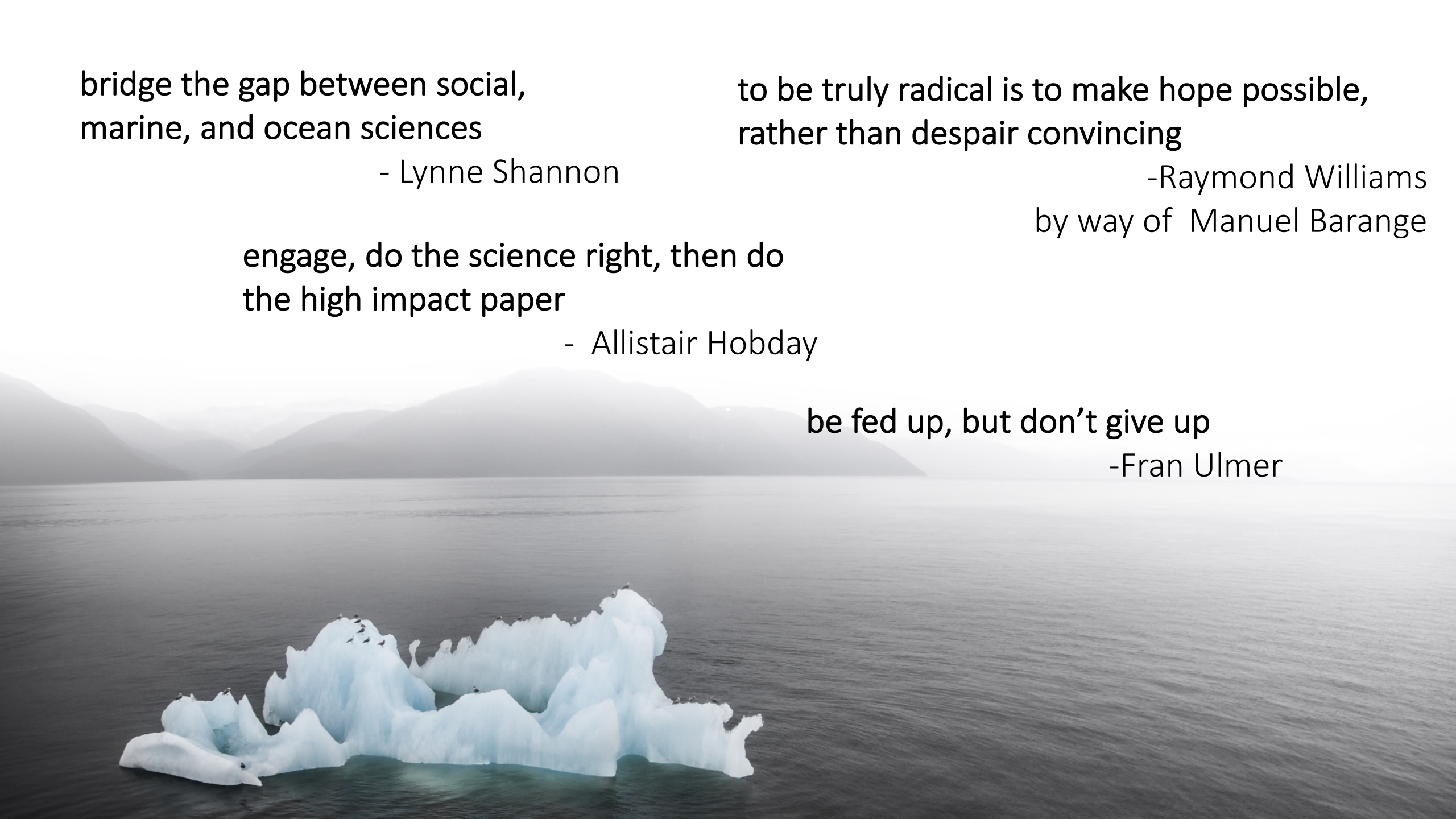
by way of Manuel Barange

engage, do the science right, then do the high impact paper

- Allistair Hobday

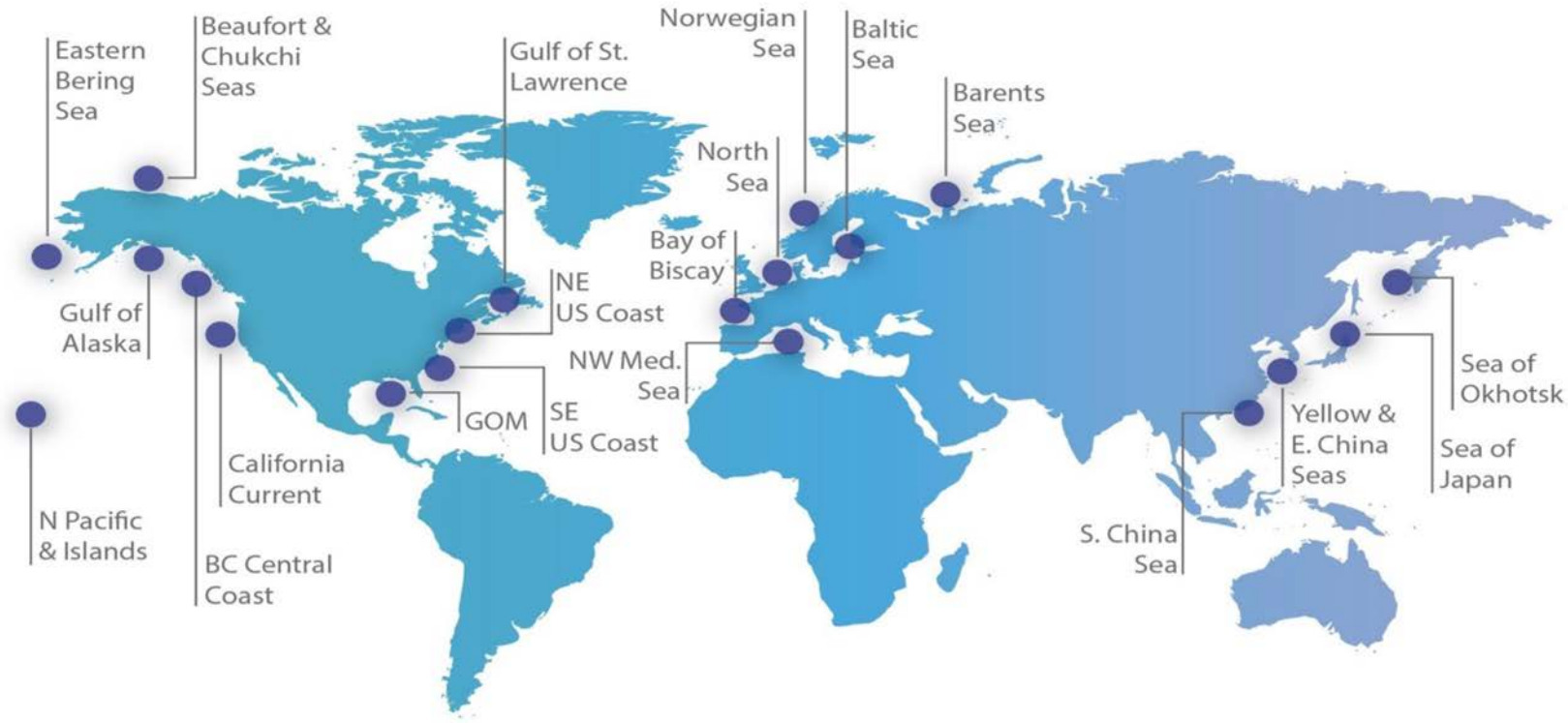
be fed up, but don't give up

-Fran Ulmer



SICCME/S-CCME

Regional Modeling Nodes



ICES-PICES Strategic Initiative on
Climate Change Effects on Marine Ecosystems

"Shared Socioeconomic Pathways (SSPs) for fisheries and aquaculture in Europe"

CERES

Climate change and European aquatic RESources

John K. Pinnegar, Katell Hamon & Myron Peck

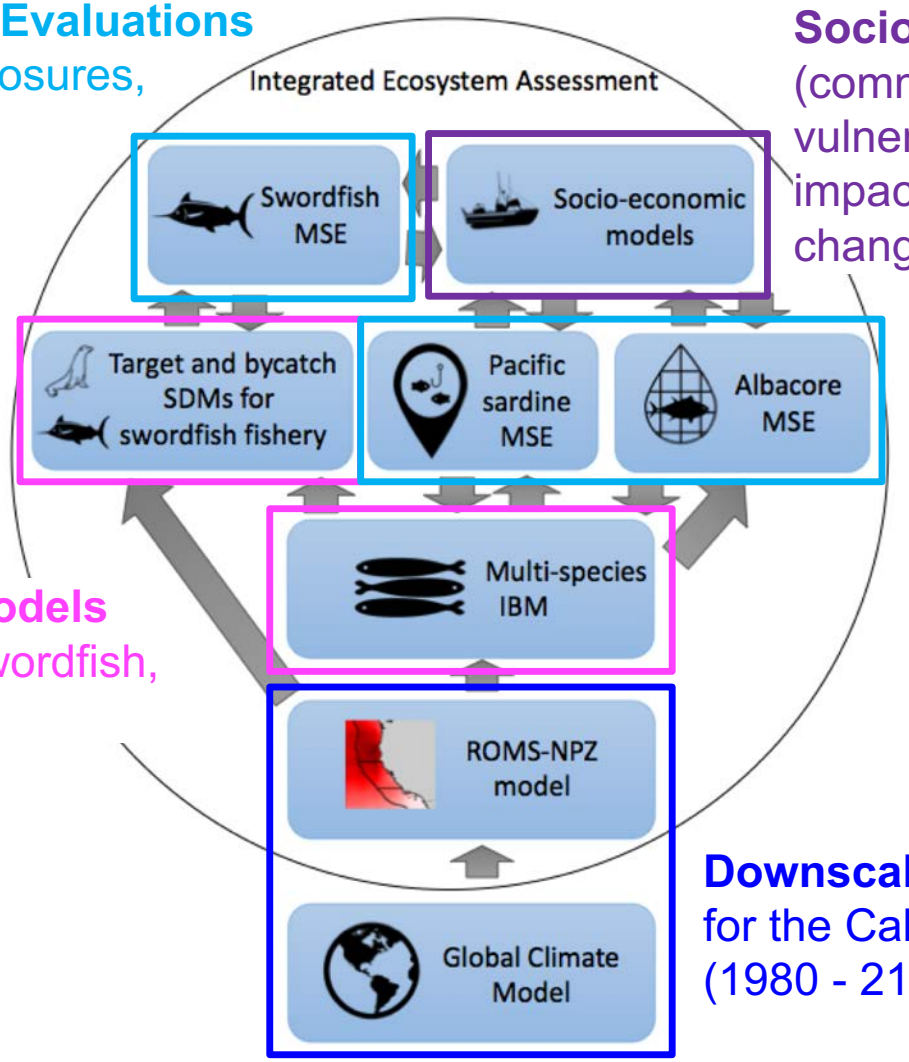
ceresproject.eu

This project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 678193.

Future Climate Change and the California Current (Future Seas)
A Physics to Fisheries Management Strategy Evaluation

Management Strategy Evaluations
(e.g., spatial/temporal closures, harvest guidelines)

Socio-economic Analyses
(community reliance and vulnerability, economic impacts of distributions shifts, changing abundance, etc.)



Multiple Ecosystem Models
for sardine, albacore, swordfish, and bycatch species

Downscaled Ocean Projections
for the California Current System (1980 - 2100)

The ACLIM team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Kirstin Holsman


Alan Haynie


Kerim Aydin


Albert Hermann


Wei Cheng


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Jim Ianelli


Andre Punt


Andy Whitehouse


Jonathan Reum


Amanda Faig

Christine Stawitz

Kelly Kearney


Paul Spencer


Michael Dalton


Darren Pilcher


Tom Wilderbuer


Cody Szuwalski

William Stockhausen

Ingrid Spies

Thanks!

NPRB & BSIERP Team
ACLIM Team
AFSC
Photos: Mark Holsman

Funding:
Fisheries & the Environment (FATE)
Stock Assessment Analytical Methods (SAAM)
Climate Regimes & Ecosystem Productivity (CREP)
Economics and Human Dimensions Program
NOAA Integrated Ecosystem Assessment Program (IEA)
NOAA Research Transition Acceleration Program (RTAP)