Enhanced warming of the U.S. NES under climate change: Implications for fisheries

Vincent S. Saba, Stephen M. Griffies, Whit G. Anderson, Michael Winton, Michael A. Alexander, Thomas L. Delworth, Michael Fogarty, Jonathan A. Hare, Matthew J. Harrison, Kristin Kleisner, Anthony Rosati, Gabriel A. Vecchi, Rong Zhang

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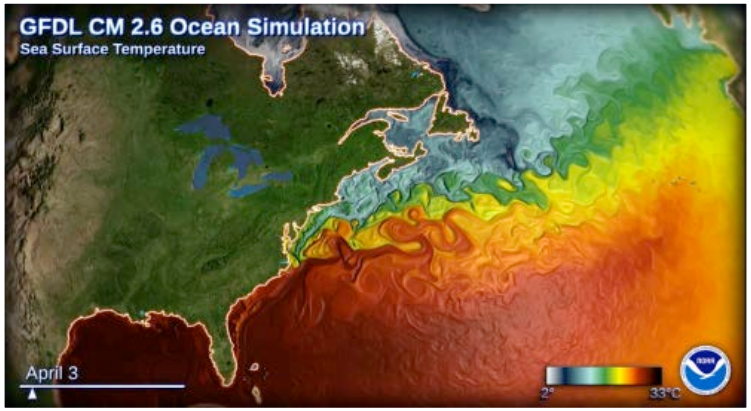
Geophysical Fluid Dynamics Laboratory GFDL NOAA

Earth System Research Laboratory
Physical Sciences Division



NEFSC Ecosystem and Climate Science Program Review

Climate Research Session

June 6, 2016

AGU PUBLICATIONS

JGR

Journal of Geophysical Research: Oceans

RESEARCH ARTICLE

10.1002/2015JC011346

Key Points:

- Northwest Atlantic circulation bias is reduced in a high-resolution global climate model
- Atmospheric CO_2 doubling over 70–80 years results in an enhanced warming of the Northwest Atlantic
- The enhanced warming is associated with a weakening AMOC and regional circulation change

Supporting Information:

- Supporting Information S1
- Movie S1

Enhanced warming of the Northwest Atlantic Ocean under climate change

Vincent S. Saba[1], Stephen M. Griffies[2], Whit G. Anderson[2], Michael Winton[2], Michael A. Alexander[3], Thomas L. Delworth[2], Jonathan A. Hare[4], Matthew J. Harrison[2], Anthony Rosati[2], Gabriel A. Vecchi[2], and Rong Zhang[2]

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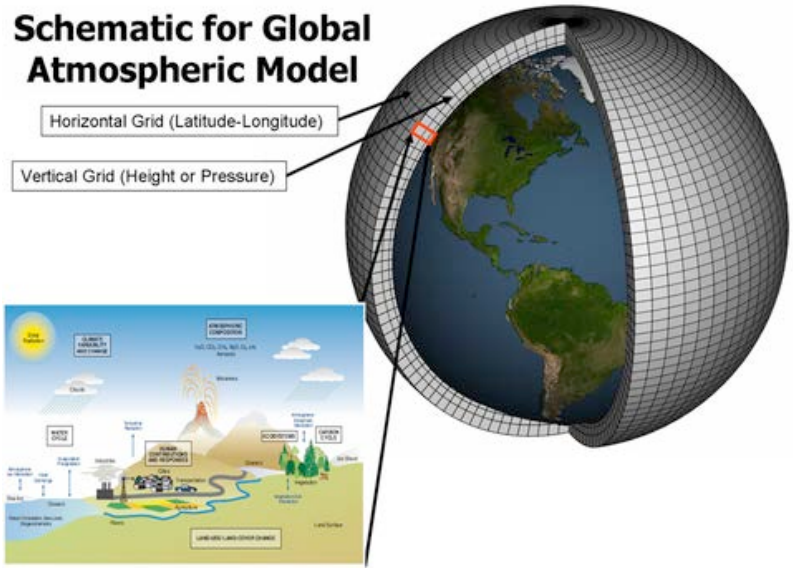
Themes

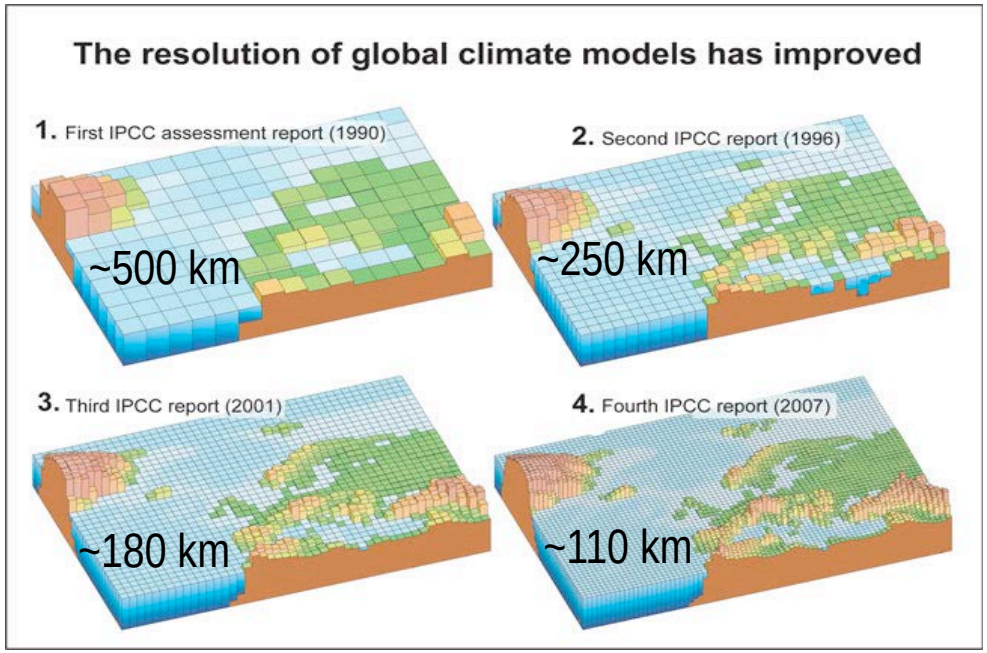
2) Ecosystem Data

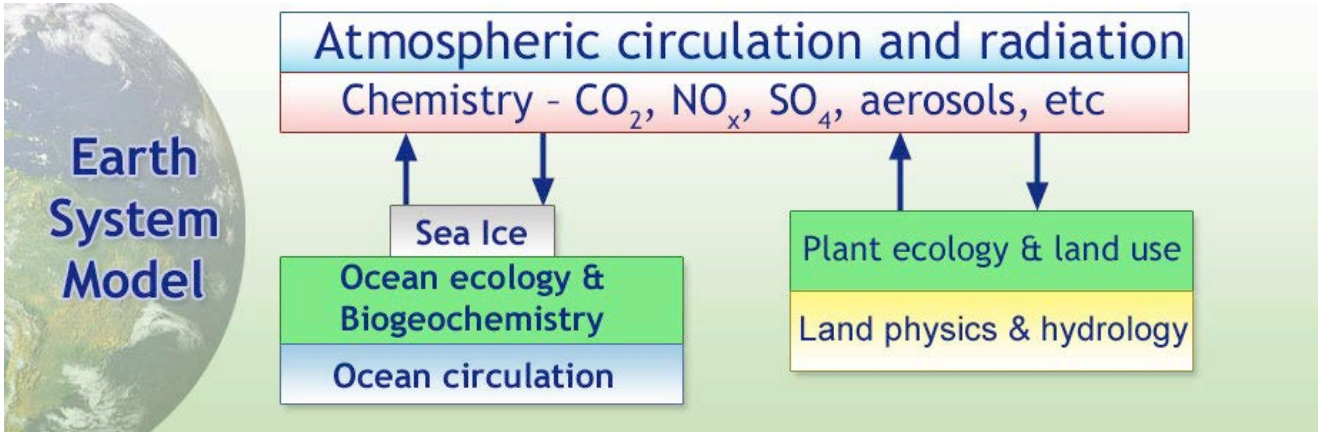
3) Modeling/Analysis

5) Communication/Peer-Review

Earth System and Global Climate Models







Earth System and Global Climate Models

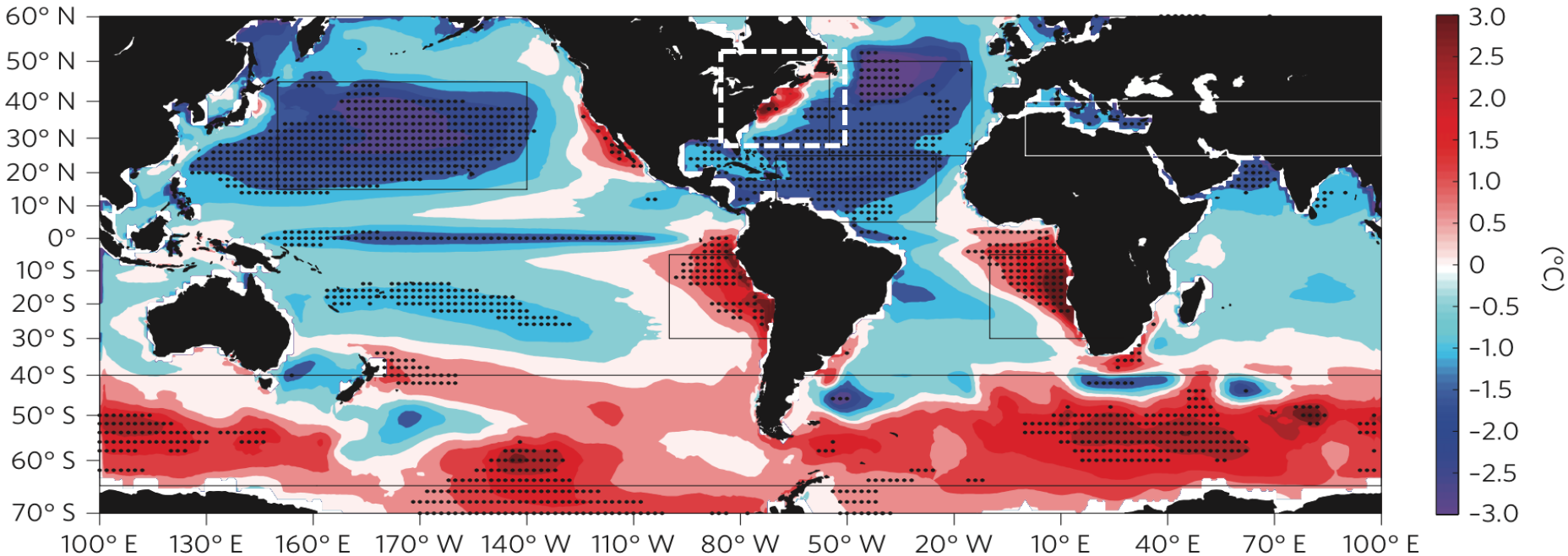
nature climate change

LETTERS

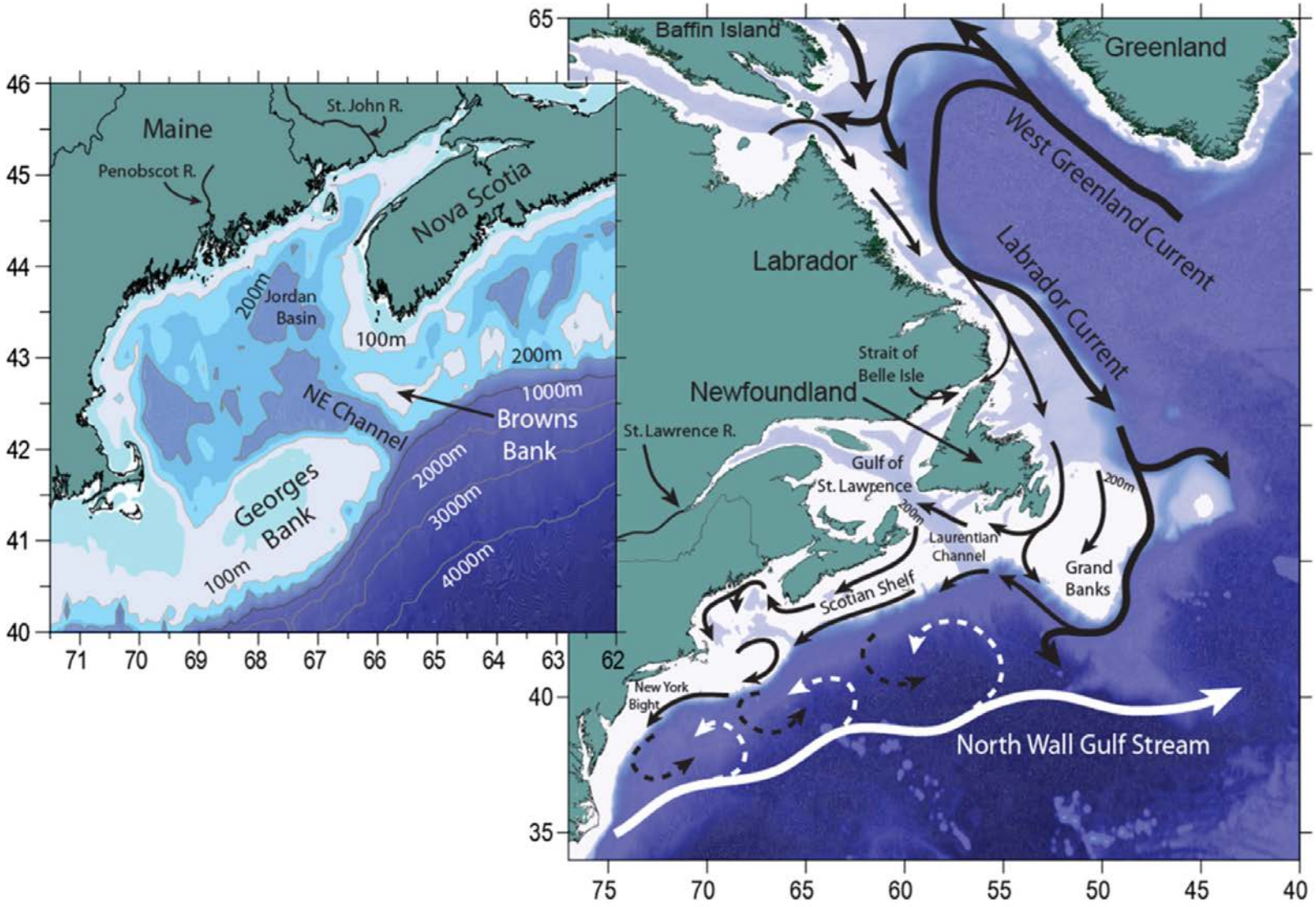
PUBLISHED ONLINE: 23 FEBRUARY 2014 | DOI: 10.1038/NCLIMATE2118

A global perspective on CMIP5 climate model biases

Chunzai Wang[1*], Liping Zhang [1,2], Sang-Ki Lee[1,2], Lixin Wu[3] and Carlos R. Mechoso[4]



Northwest Atlantic Circulation



Gulf of Maine Circulation

Contents lists available at SciVerse ScienceDirect

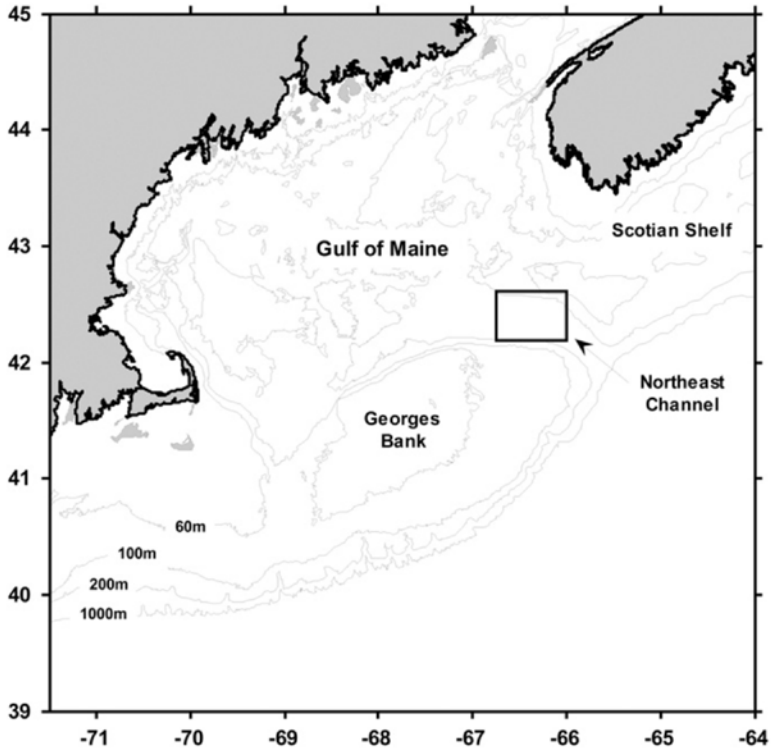
Continental Shelf Research

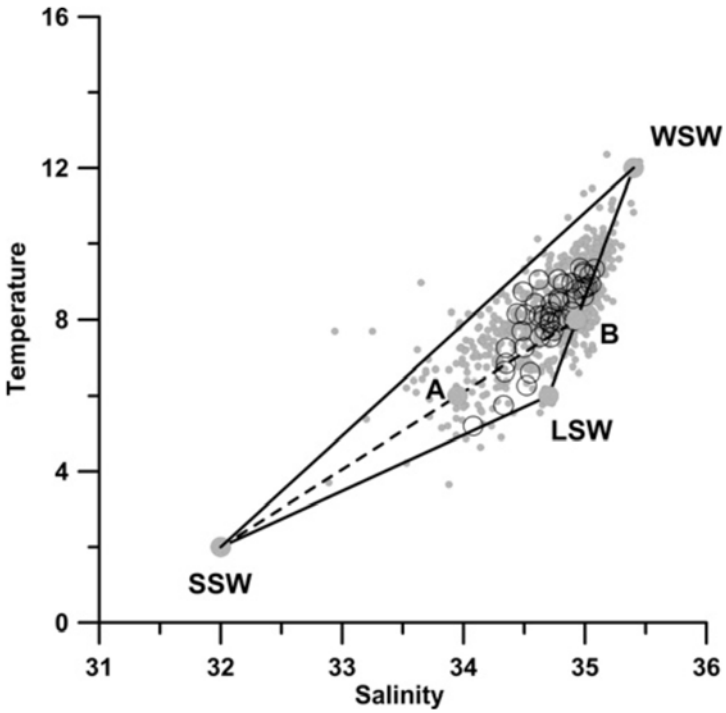
journal homepage: www.elsevier.com/locate/csr

Research papers

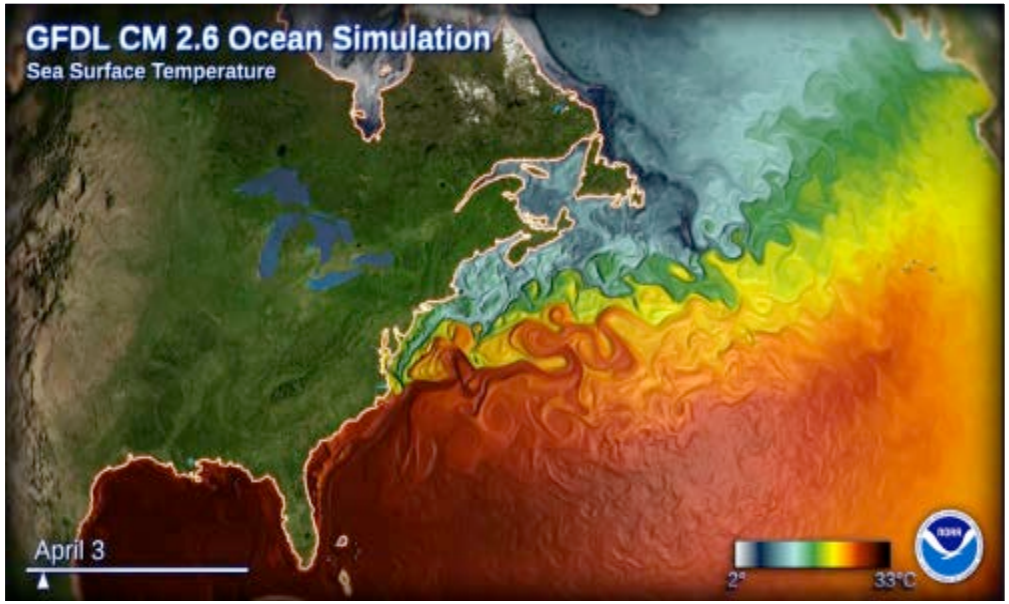
Labrador slope water entering the Gulf of Maine—response to the North Atlantic Oscillation

David G. Mountain *





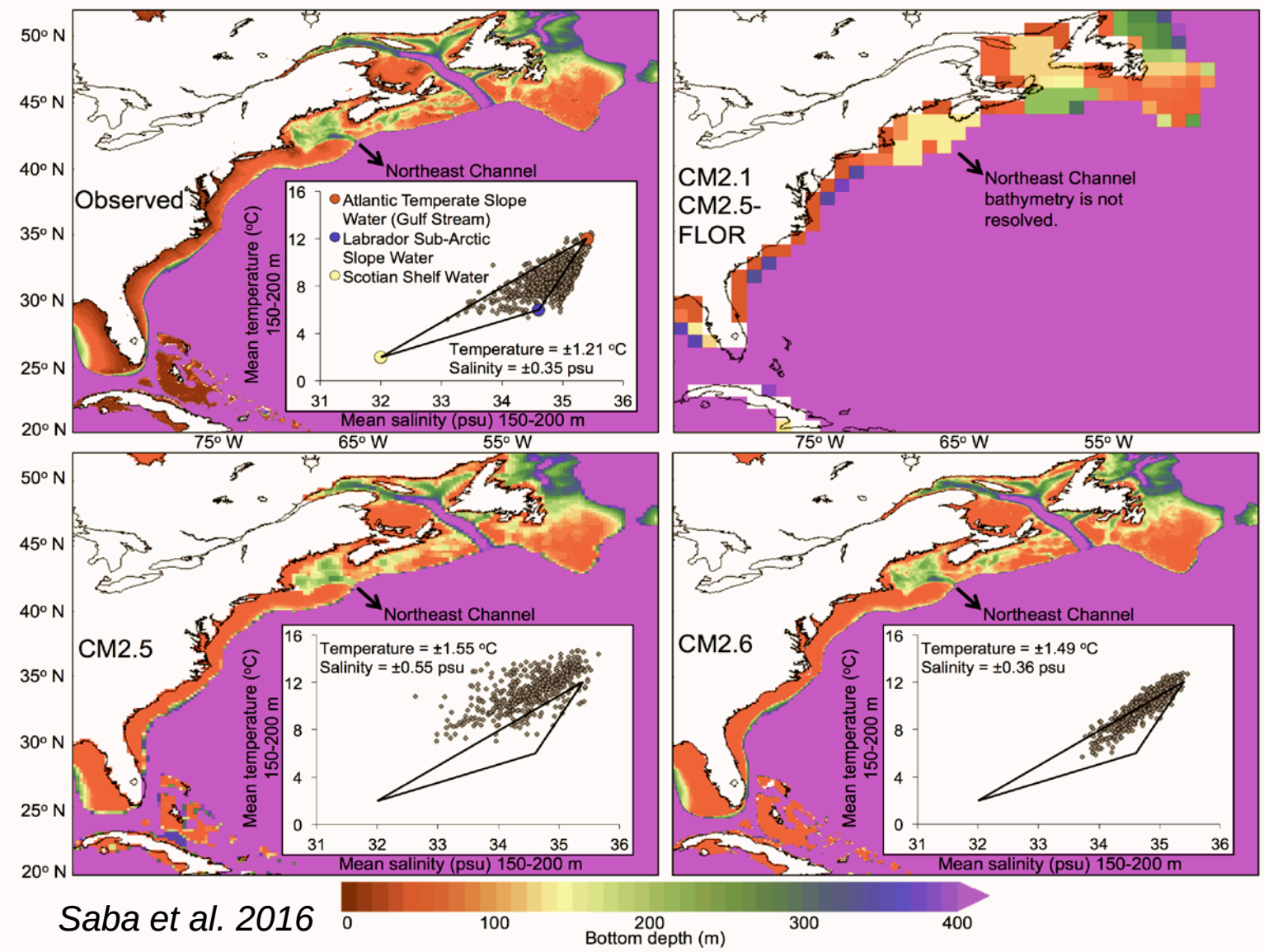
NOAA GFDL Global Climate Models



- Experiments:
- 1860 control run (140 y)
- 1990 control run (140 y)
- 2xCO2 run (80 y)

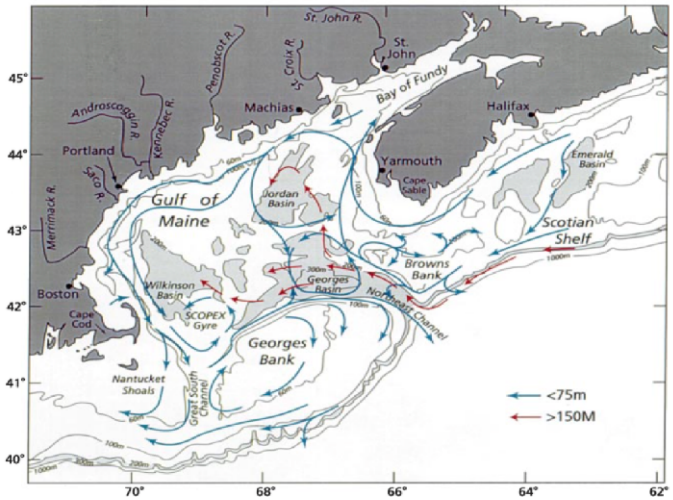
Model	Ocean resolution (vertical layers)	Atmosphere resolution (vertical layers)	Land Model	Sea Ice Model (snow & sea ice max. albedos)
CM2.1	1° (50)	2° (24)	LaD	SIS (0.80 & 0.58)
CM2.5 FLOR	1° (50)	0.5° (32)	LM3	SIS (0.85 & 0.68)
CM2.5	0.25° (50)	0.5° (32)	LM3	SIS (0.85 & 0.68)
CM2.6	0.1° (50)	0.5° (32)	LM3	SIS (0.85 & 0.68)

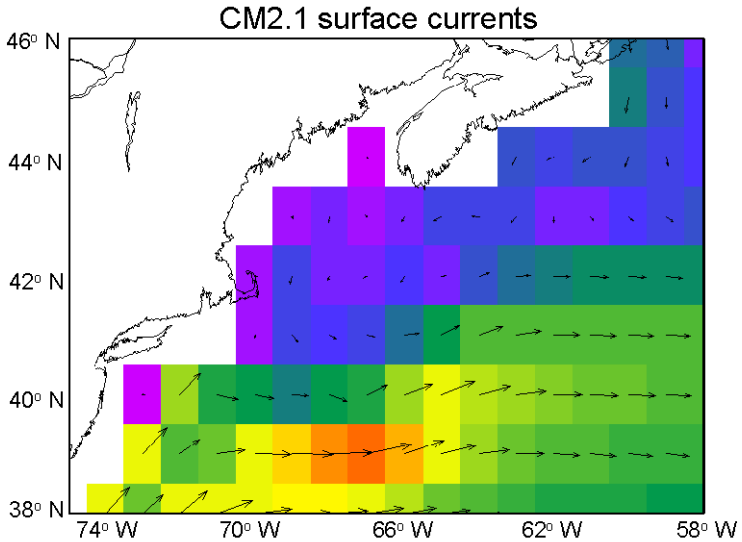
Model Assessment for the U.S. Northeast Shelf

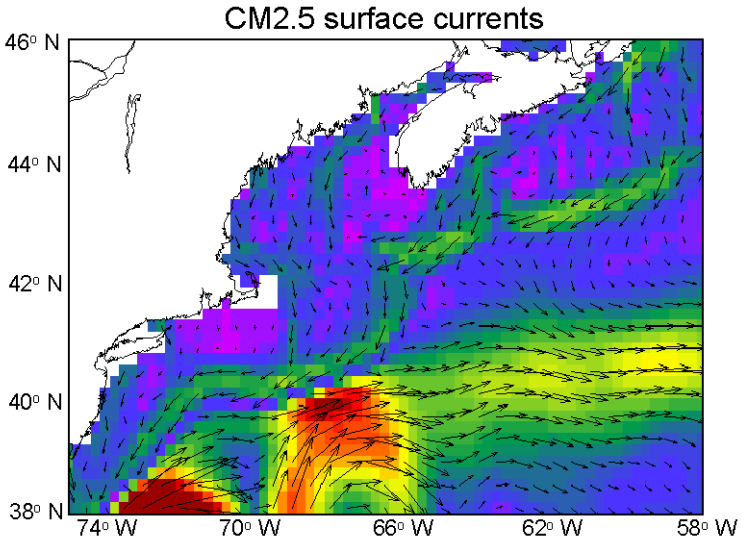


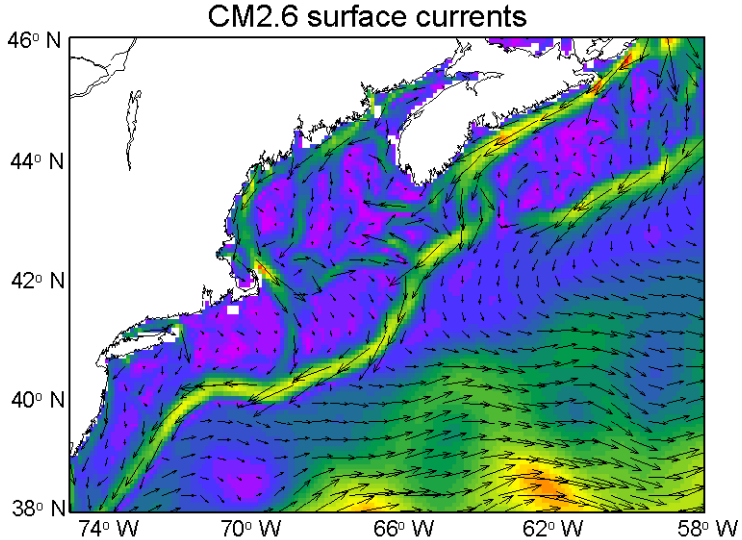
Saba et al. 2016

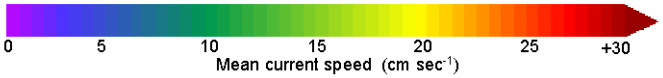
Model Assessment for the U.S. Northeast Shelf



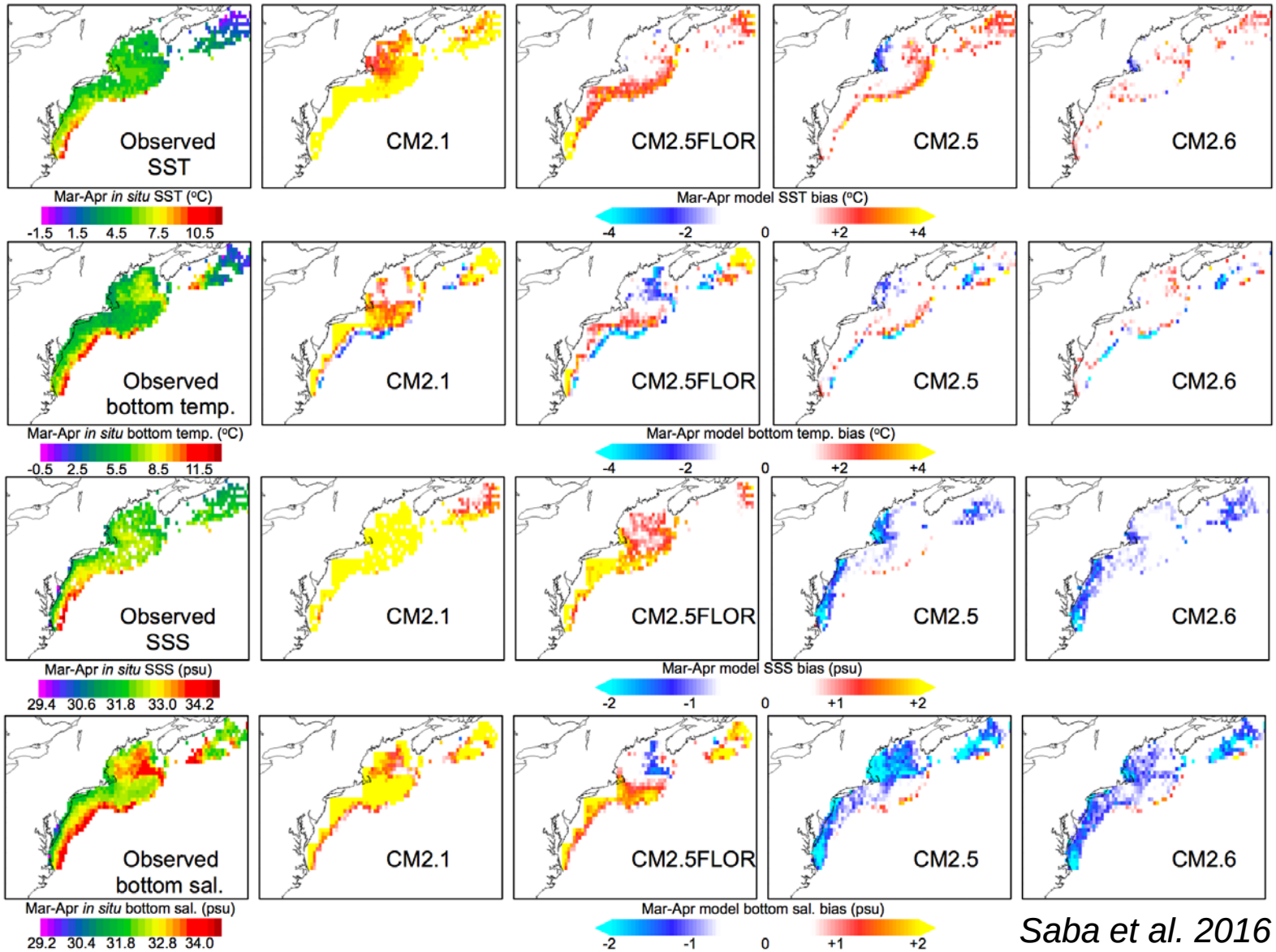








Model Bias U.S. Northeast Shelf



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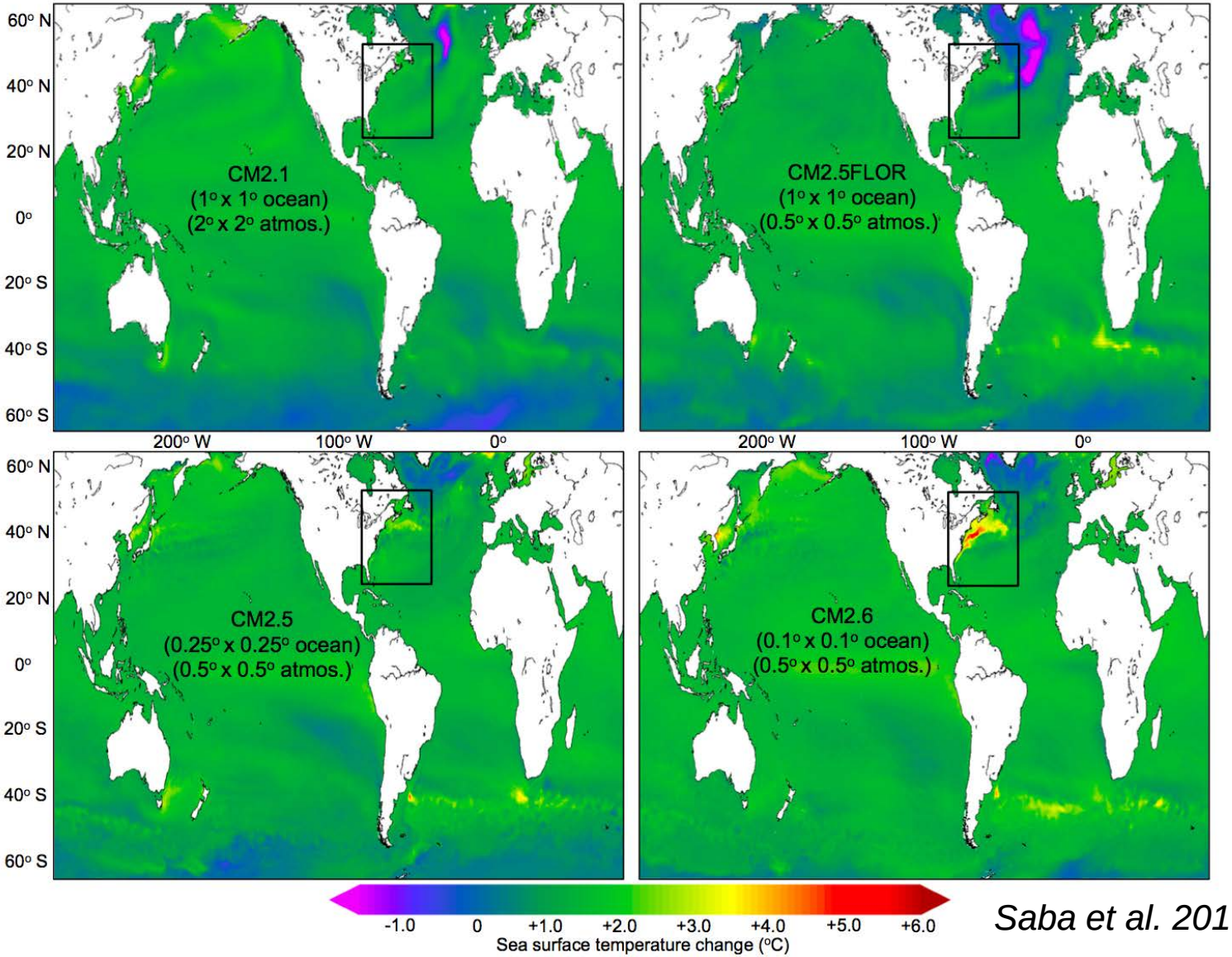
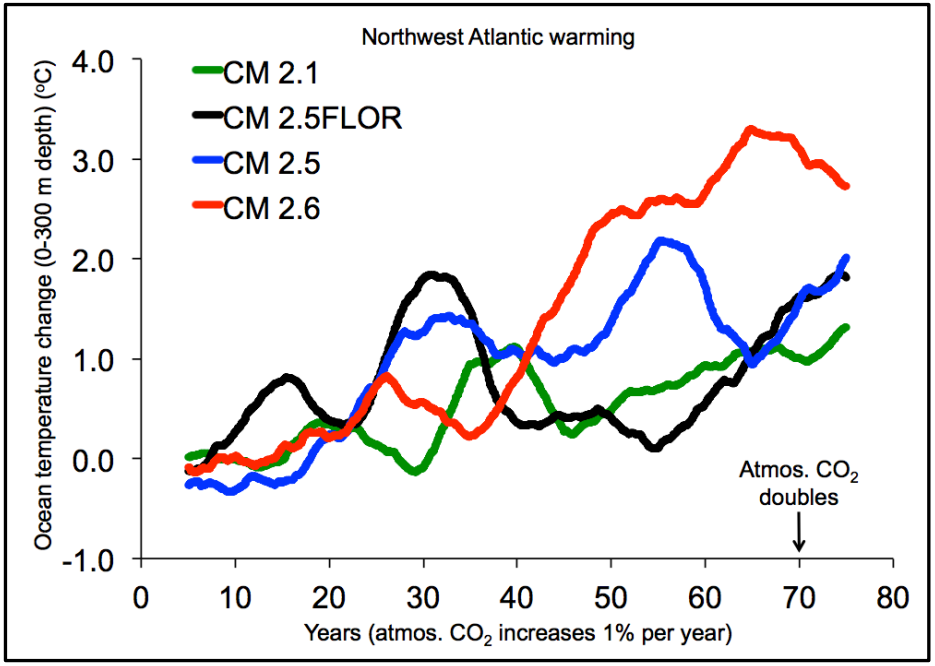
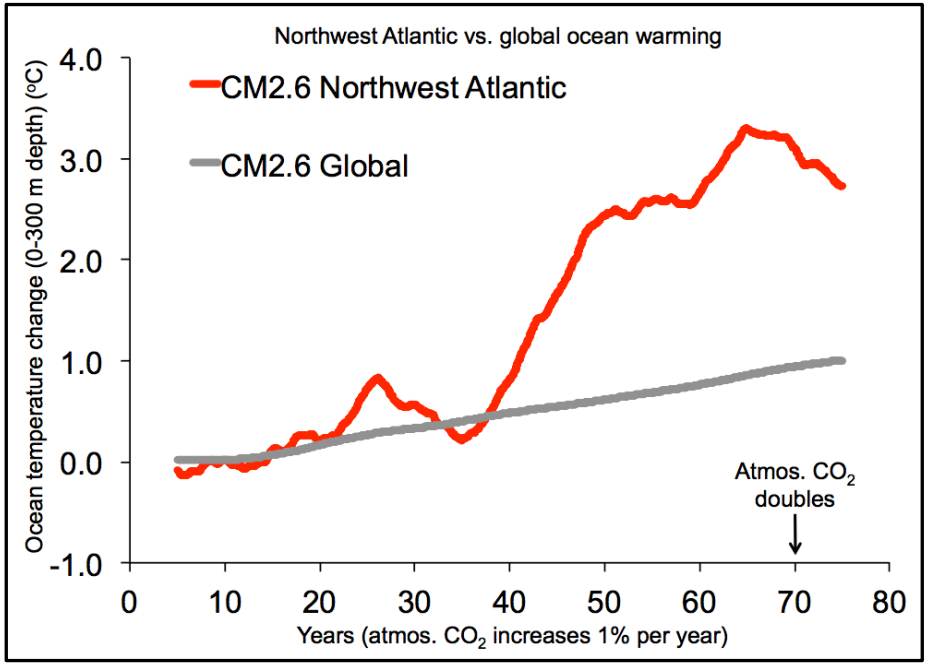
2xCO_2 Projection



Saba et al. 2016

Northwest Atlantic 2xCO_2 Projection





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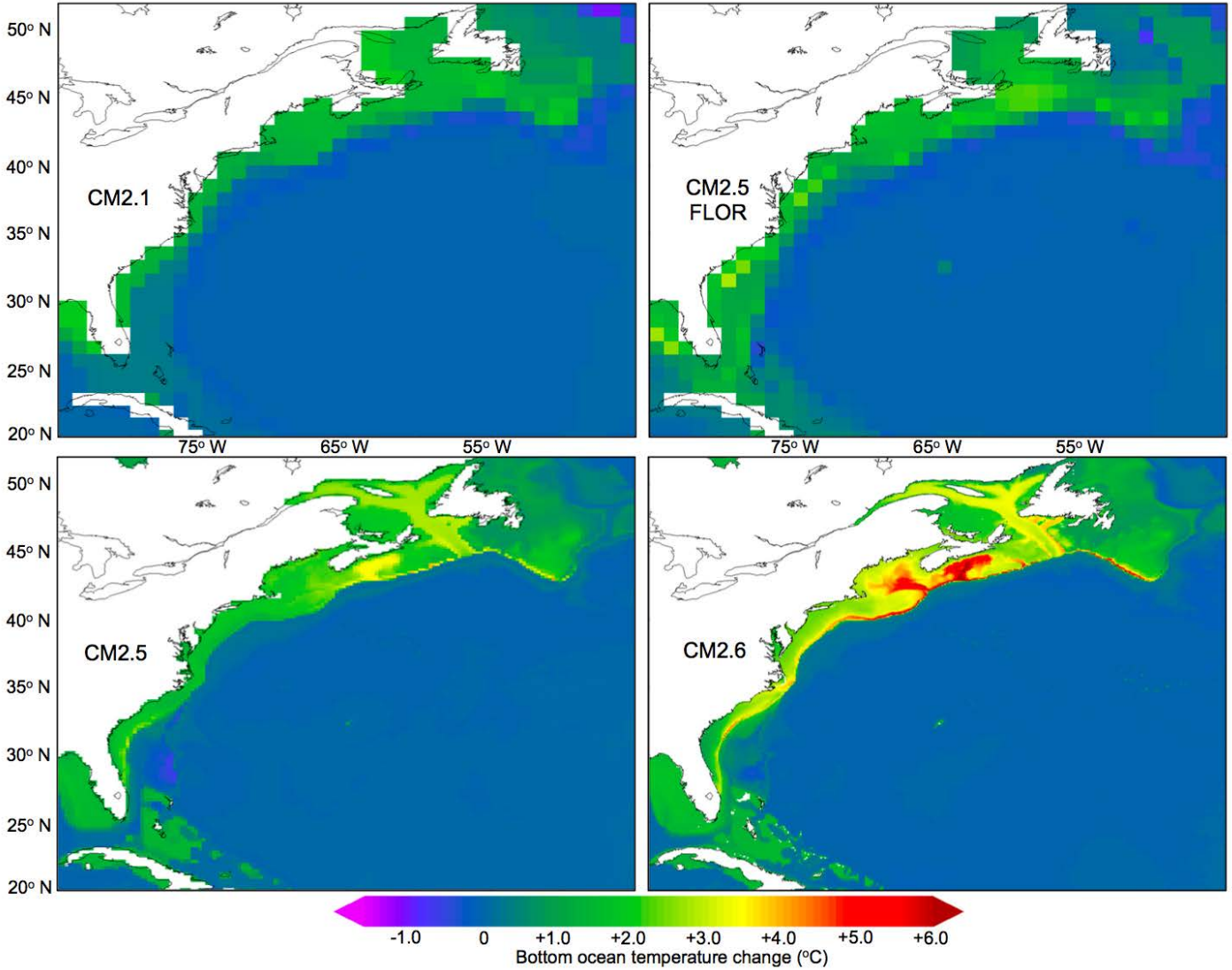
Northwest Atlantic 2xCO_2 Projection



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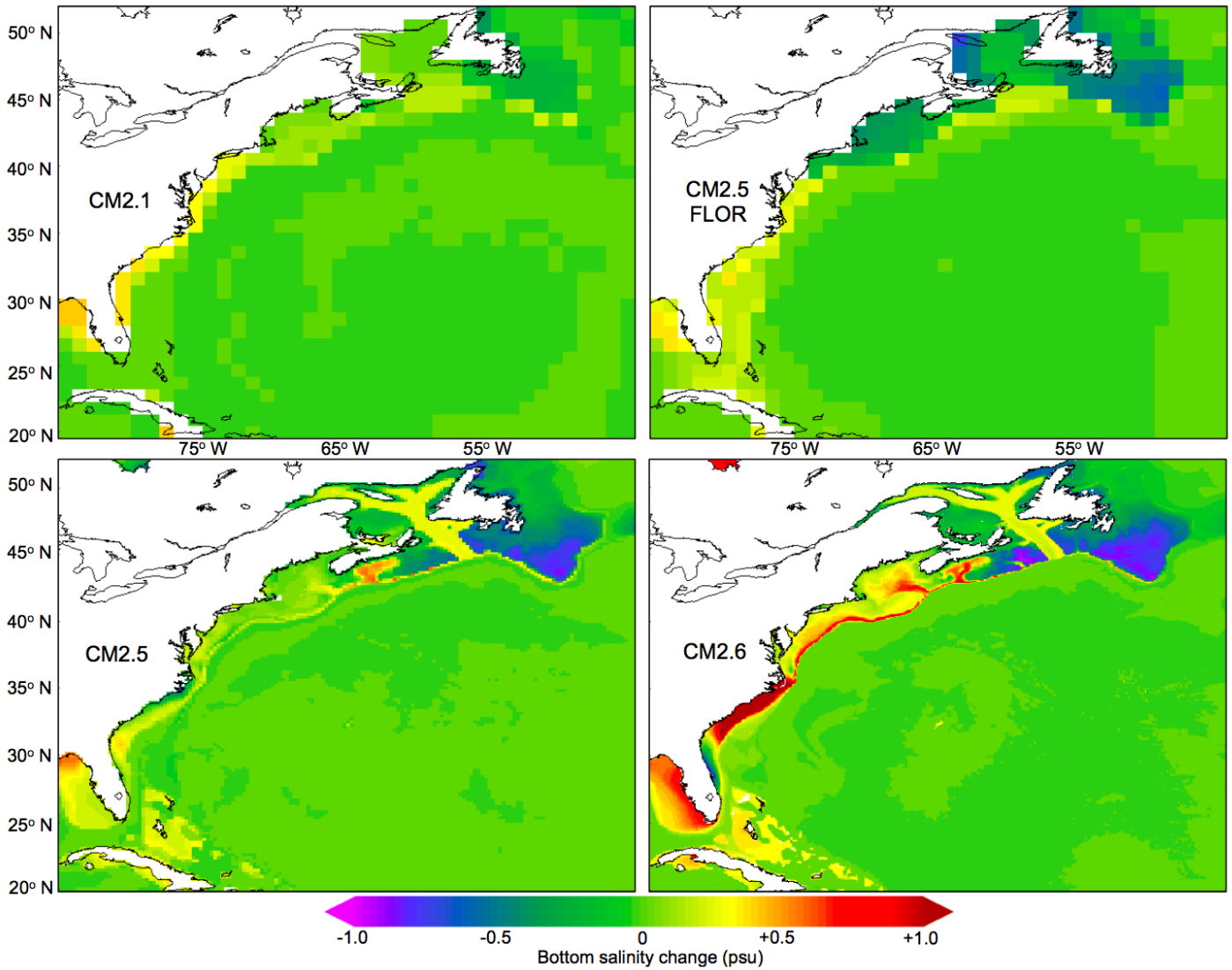
Northwest Atlantic 2xCO_2 Projection



Saba et al. 2016

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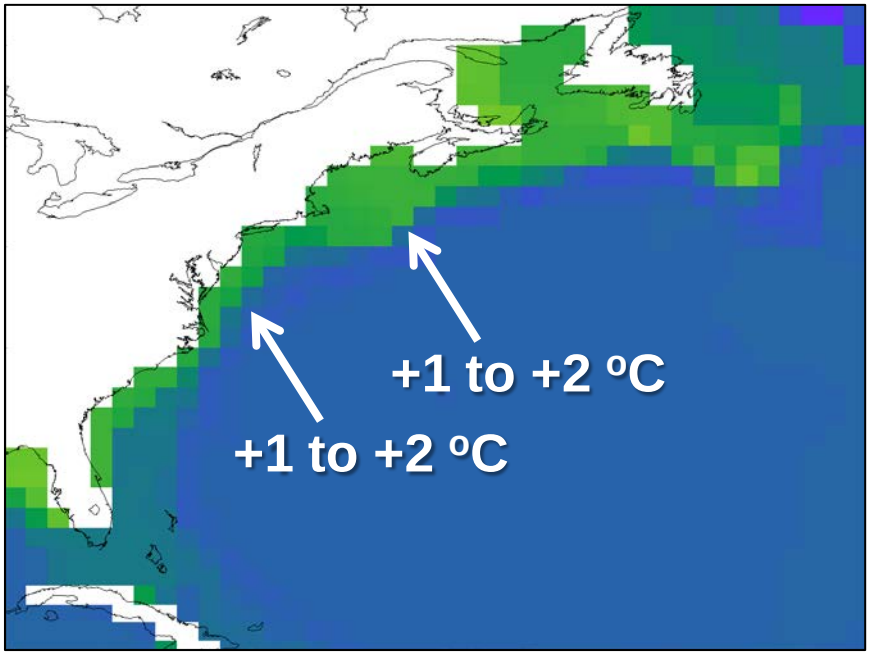
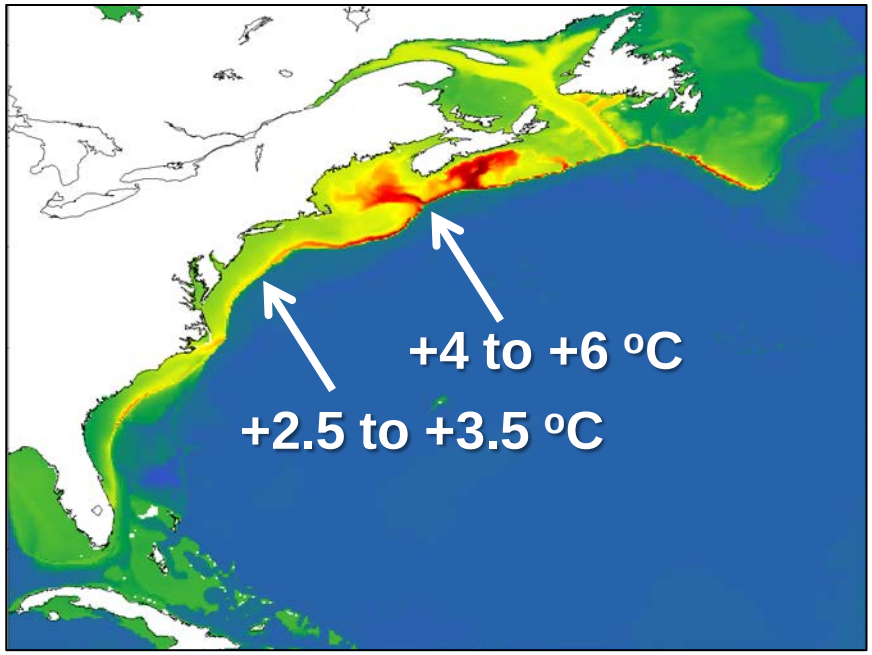
Saba et al. 2016

What are the mechanisms behind the enhanced warming of the NW Atlantic Shelf?

- Poleward expansion of the Gulf Stream. Poleward recession of the Labrador Current.
- Increased proportion of warm, salty Slope Water (ATSW) entering the NE Channel in the Gulf of Maine.
- Weakening AMOC.
- Synergy: Global Warming plus regional circulation change.



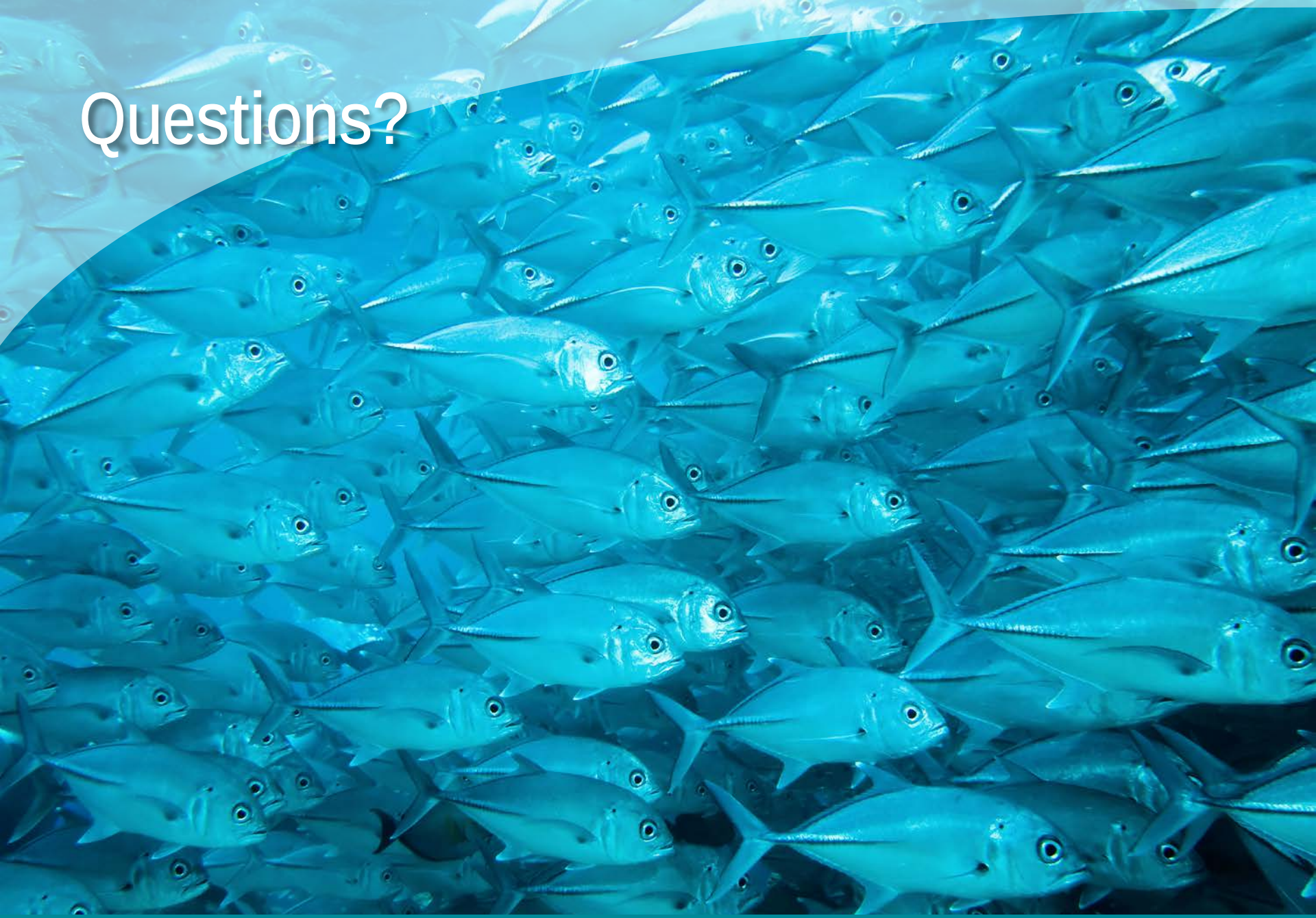
- Existing U.S. NES projections are based on low-res. models.
  - Cod
  - Cusk
  - River Herring
  - Croaker



Existing projects using GFDL CM2.6

- Project 1: Marine species distribution shifts in the U.S. NES under continued ocean warming. Kleisner et al. in prep.
- Project 2: Zooplankton/Icthyoplankton response to ocean warming.
- Project 3: Yellowtail flounder recruitment projections as a function of a changing Gulf Stream under continued ocean warming.
- Project 4: Climate change projections of overlap between predator and prey species.
- Project 5: Going beyond temperature - Projecting species presence/absence (~87 species) using SSH, salinity, and temperature.
- Project 6: Leatherback turtle habitat projections under continued ocean warming.
- Project 7: Projecting long fin squid, spiny dogfish, and black sea bass habitat based on process studies of metabolic scope.

Existing challenges with CM2.6

- No climate change projection (i.e. RCP), only a transient climate response (2xCO_2).
- Vertical mixing in ocean may not be shallow enough. Seasonal cold pool in Mid-Atlantic Bight not resolved.
- Winds were saved out monthly. Daily would have been ideal for regional model coupling (we think).
- No biogeochemistry (with all tracers and a projection).
- No ensemble.
- North Atlantic Drift Current too far south

Questions?