# Using NOAA's high-resolution global climate model to assess climate change impacts in the Northwest Atlantic

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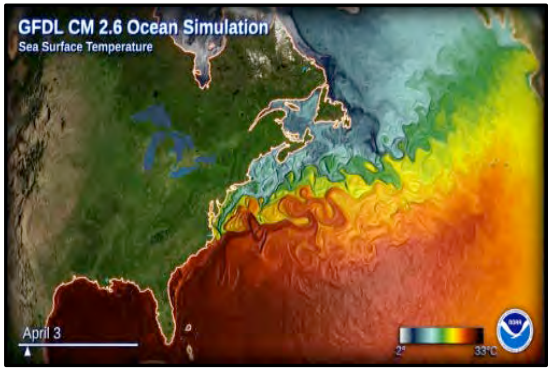
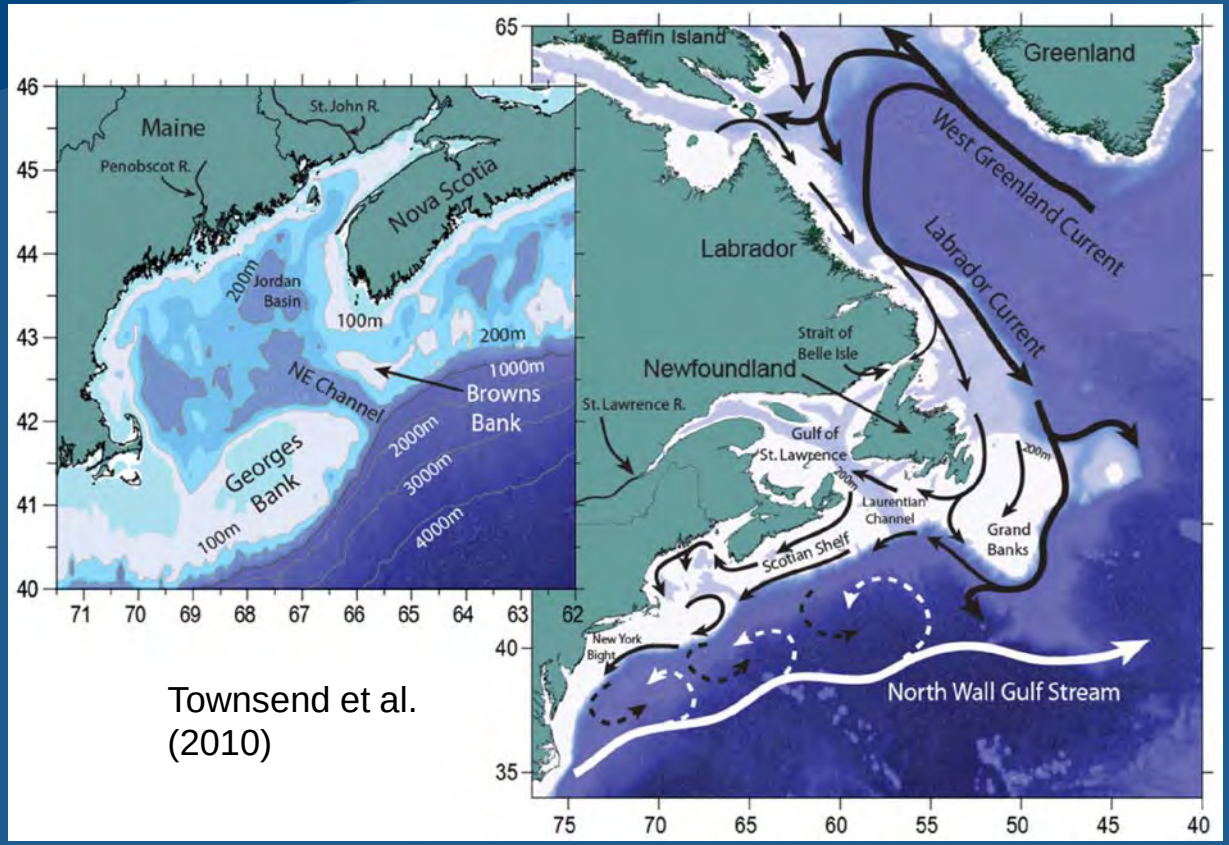
NOAA FISHERIES

Northeast Fisheries Science Center

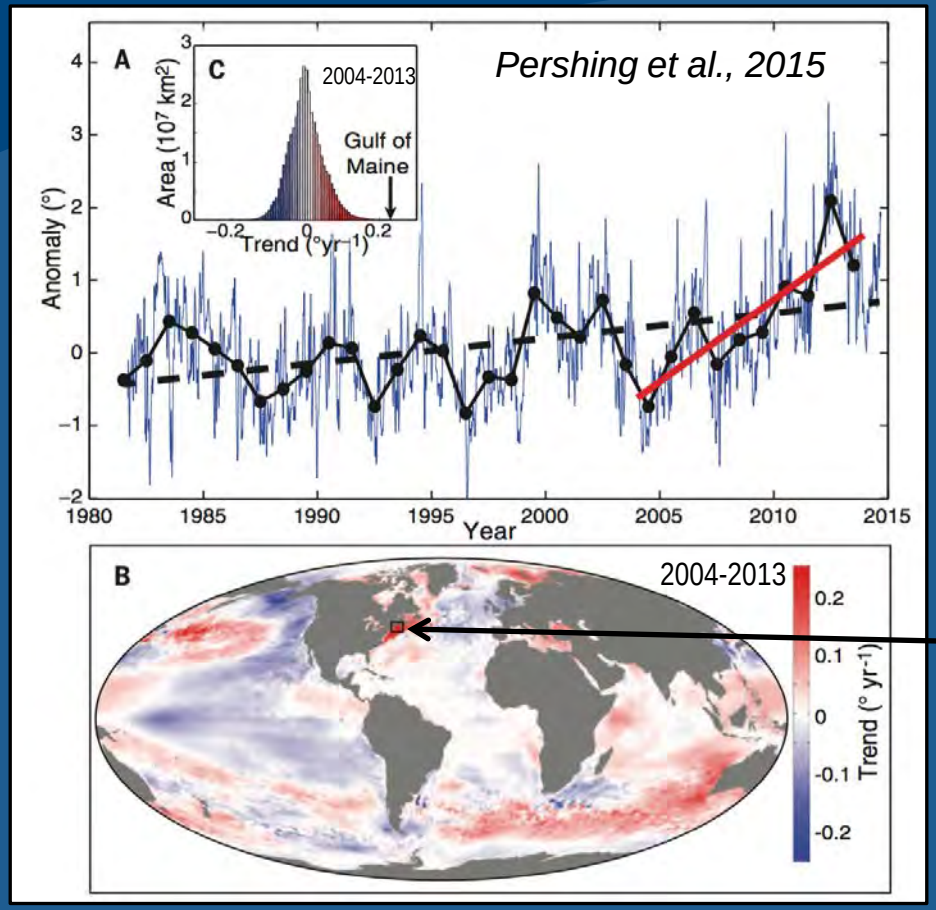



# Northwest Atlantic Oceanography



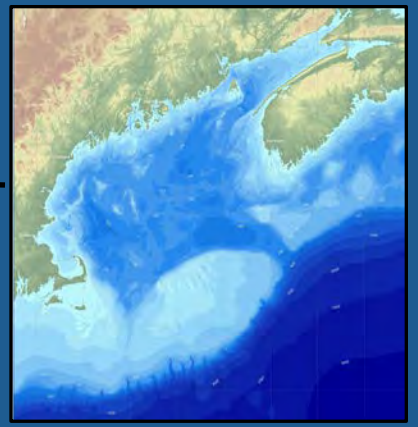

Townsend et al. (2010)

# U.S. Northeast Shelf - Warming




## Gulf of Maine

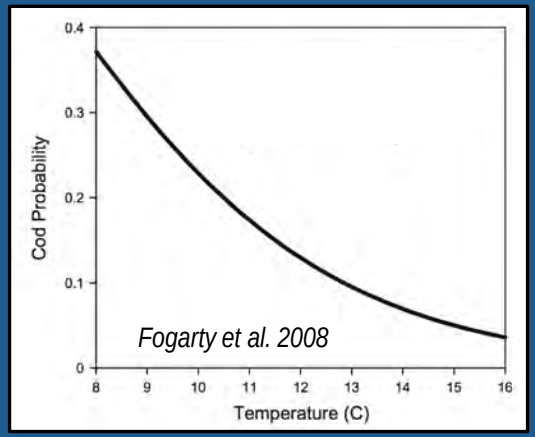
Ocean surface temperature has warmed faster than 99% of the global ocean (*Pershing et al. 2015*).



# Warming ocean, fish on the move

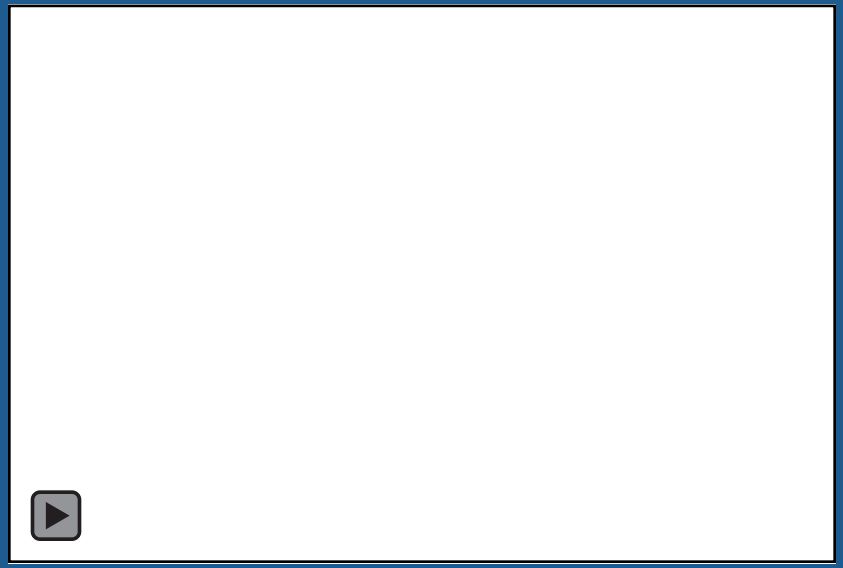
Atlantic cod

NOAA Survey Data



# Warming ocean, fish on the move

Black sea bass



NOAA Survey Data

# Earth System and Global Climate Models: SST bias

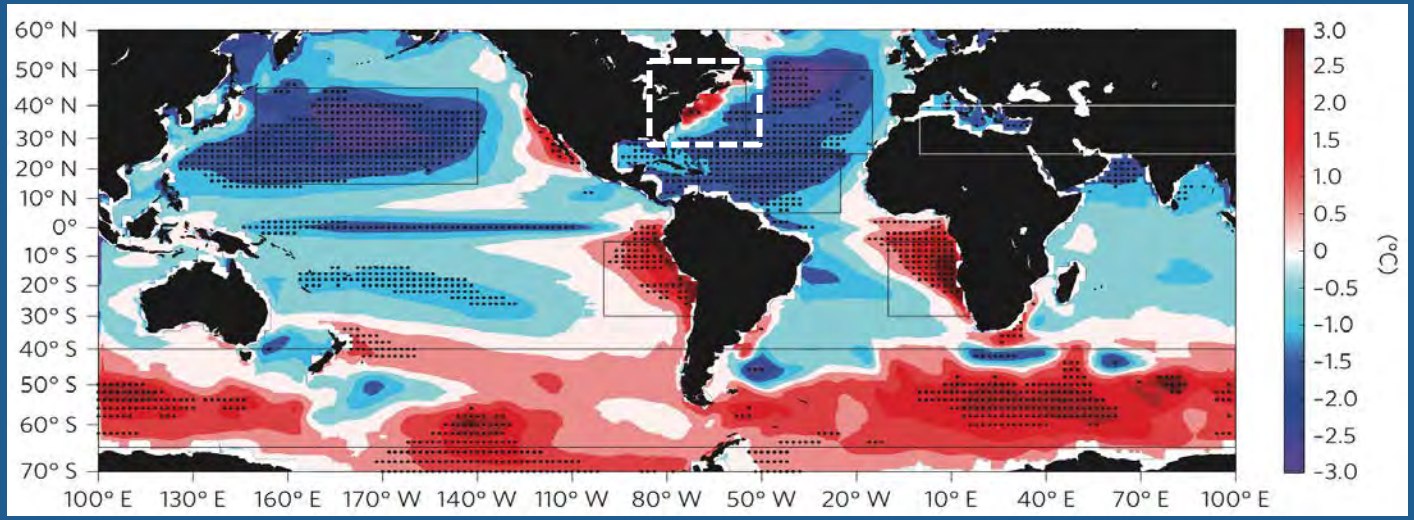
nature climate change

LETTERS

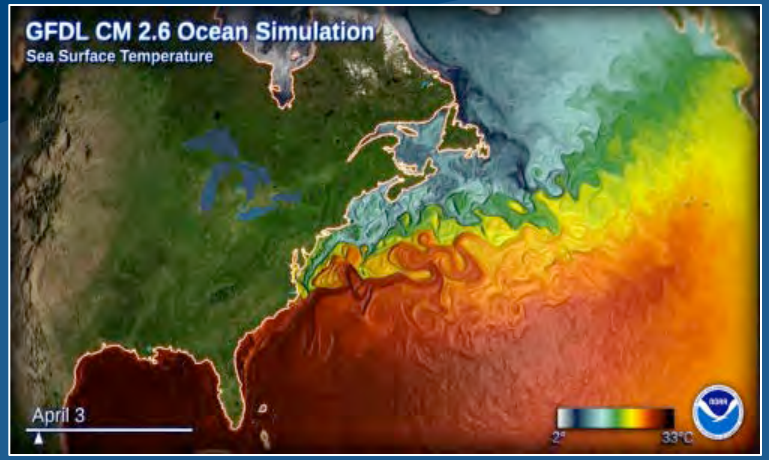
PUBLISHED ONLINE: 23 FEBRUARY 2014 | DOI: 10.1038/NCLIMATE2118

## 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]



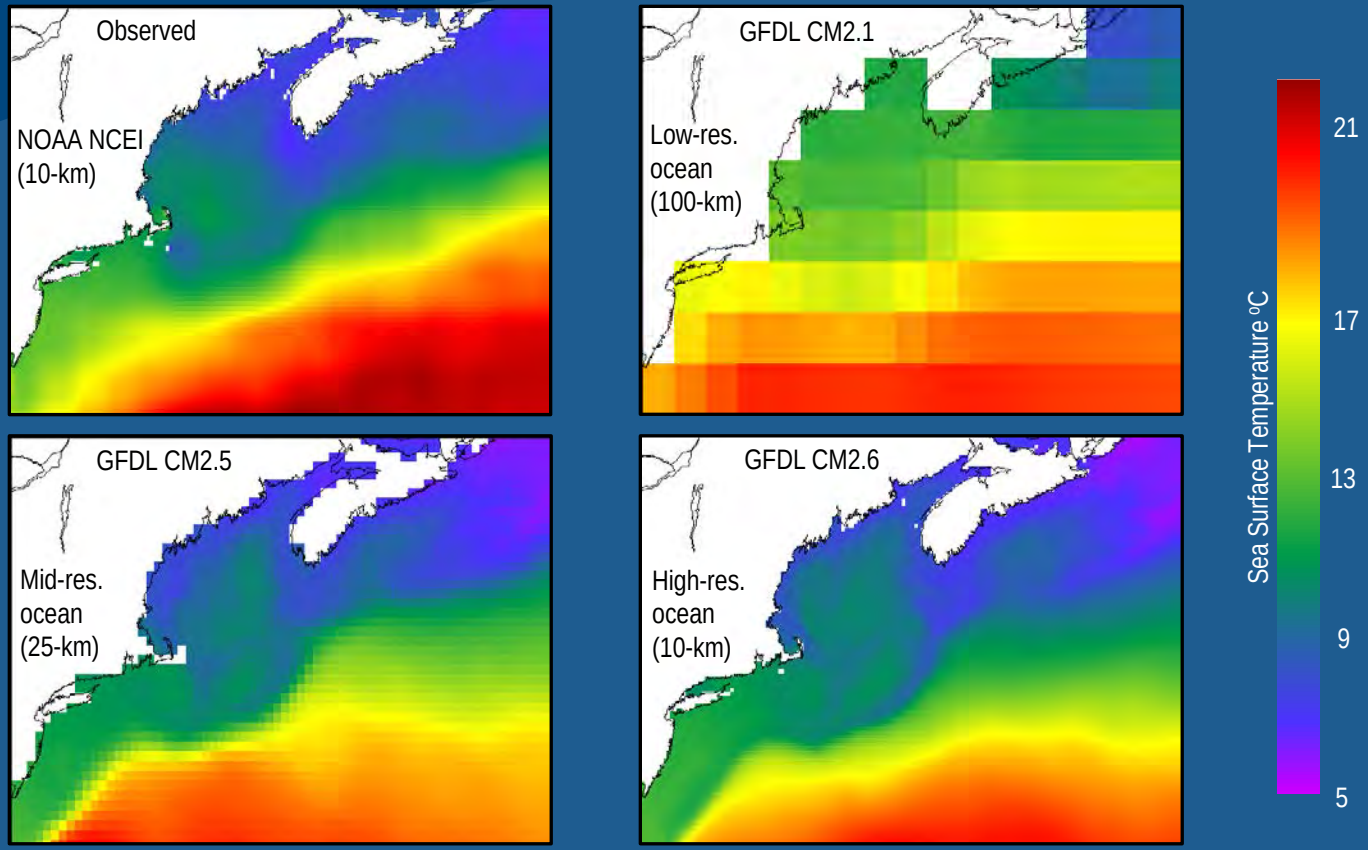
# NOAA GFDL Global Climate Models




Experiments:
1860 control run
1990 control run
2x$CO_2$ run (80 years)

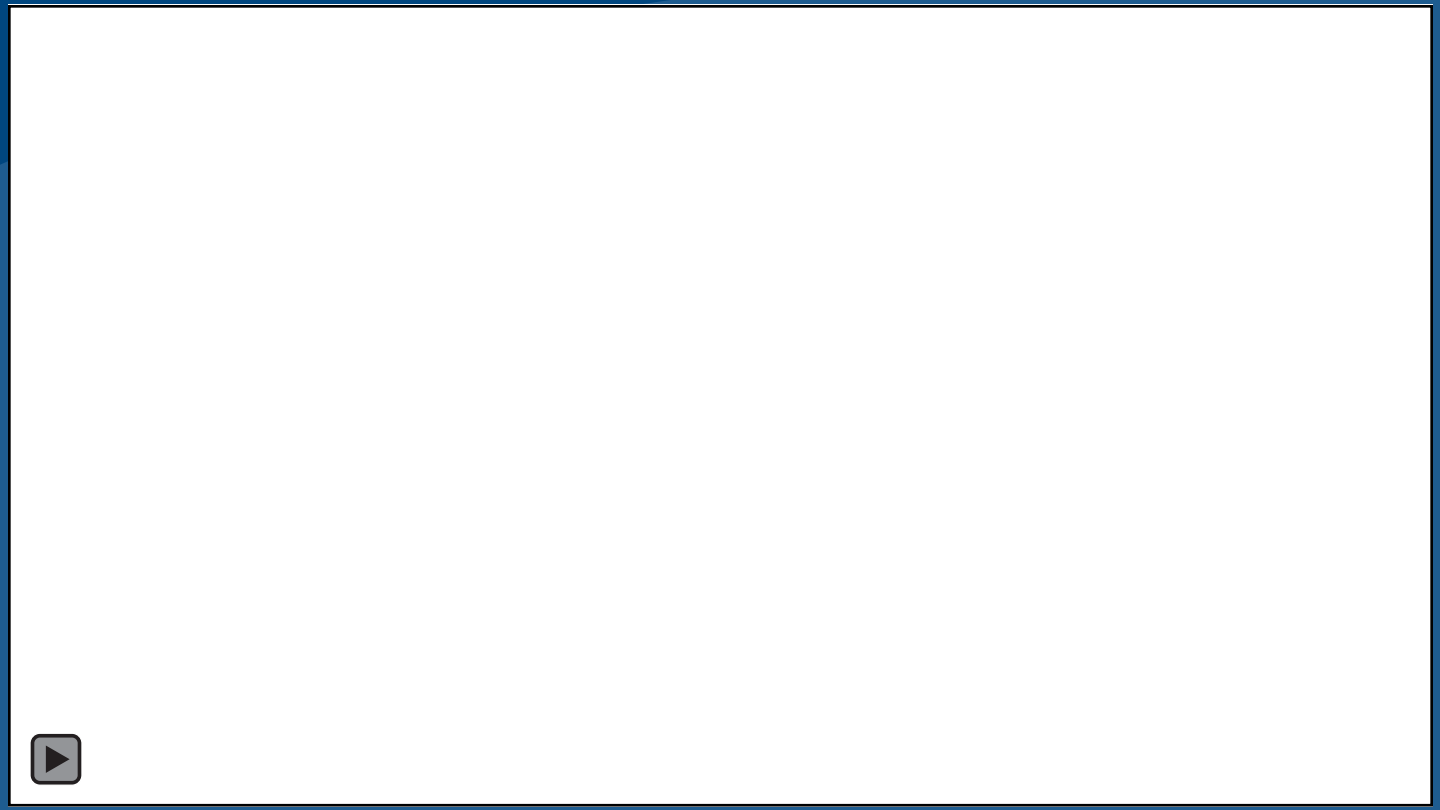
| Model | Ocean resolution (vertical layers) | Atmosphere resolution (vertical layers) | Land Model | Sea Ice Model (snow & sea ice max. albedos) |
|---|---|---|---|---|
| CM2.1 | 1° (50) | 2° (24) | LaD | SIS (0.80 & 0.58) |
| CM2.5 FLOR | 1° (50) | 0.5° (32) | LM3 | SIS (0.85 & 0.68) |
| CM2.5 | 0.25°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

# NOAA GFDL Climate Models: U.S. Northeast Shelf




*Saba et al. 2016*

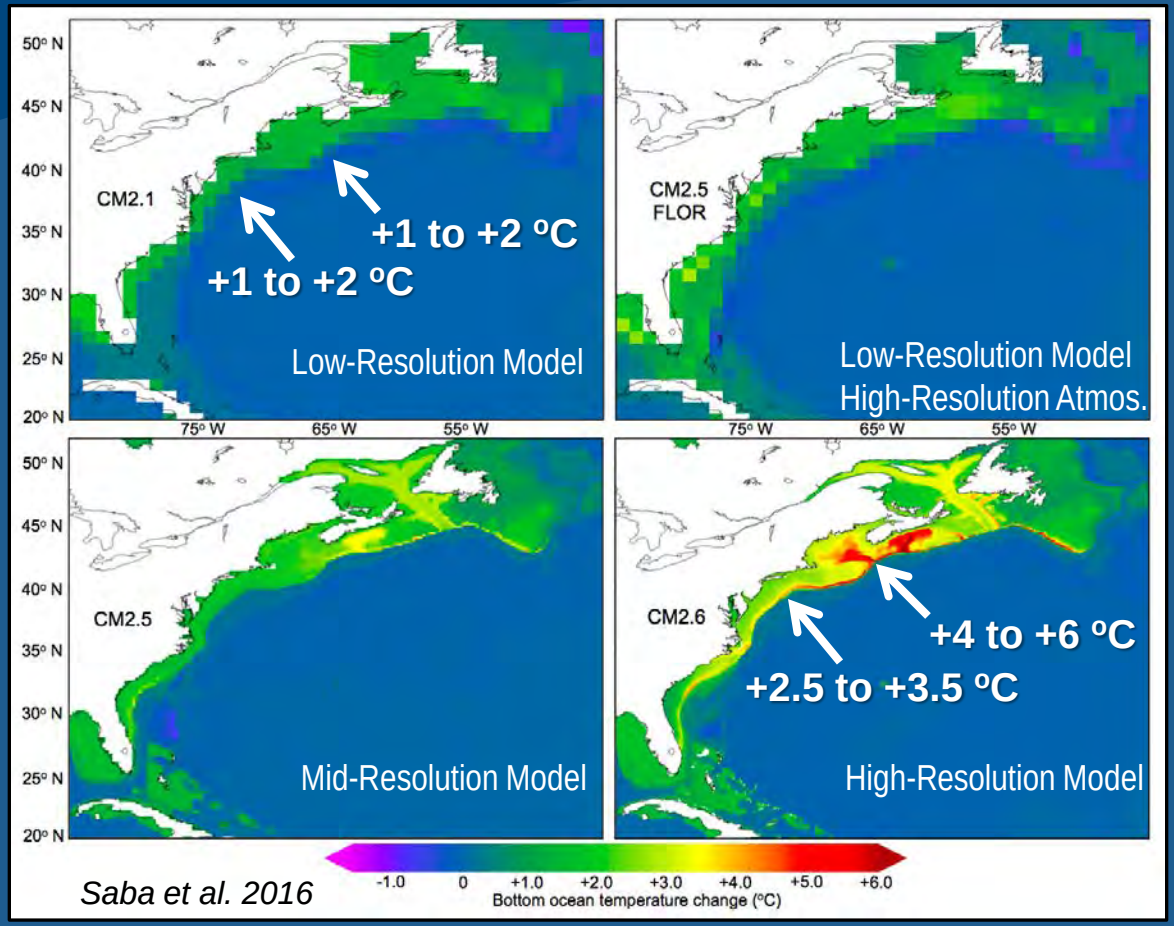
# Global Climate Models: Resolution



High-Resolution Ocean (10-km)

Low-Resolution Ocean (100-km)

# Northwest Atlantic – Projected ocean warming ($2xCO_2$)

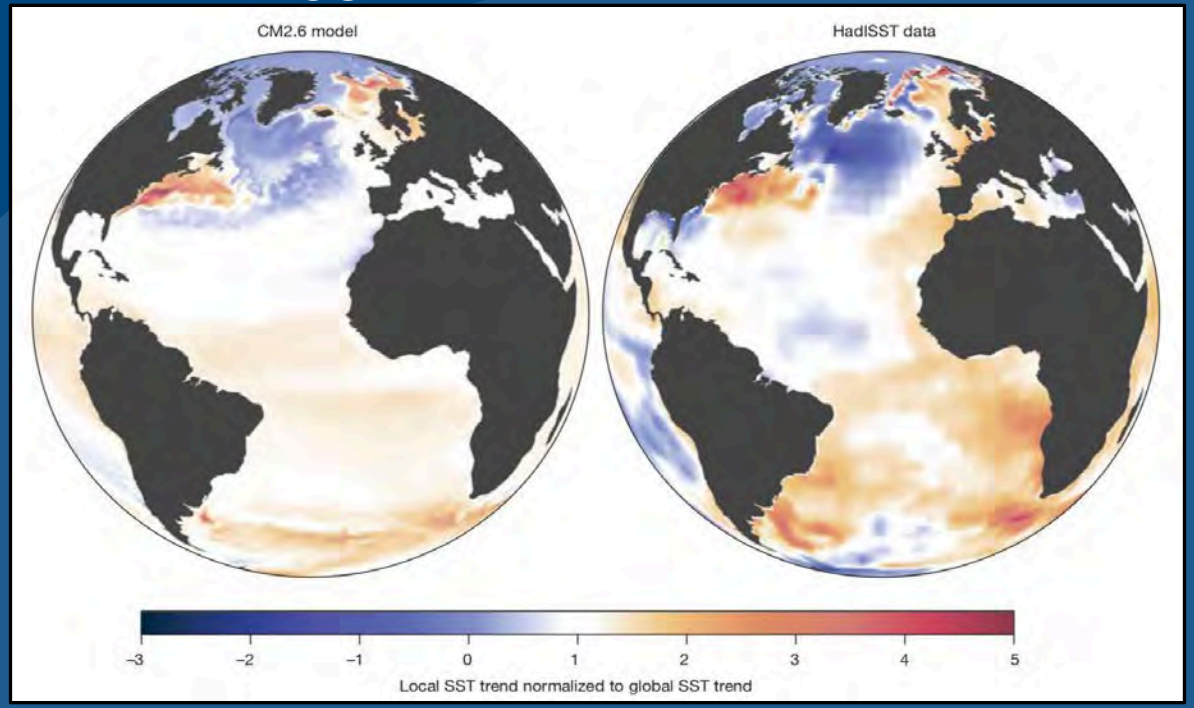



*Saba et al. 2016*

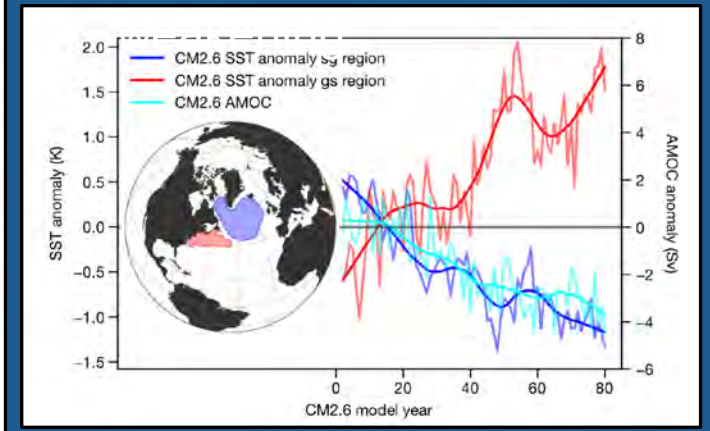
# Northwest Atlantic warming and AMOC

2xCO2

1870–2016 November–



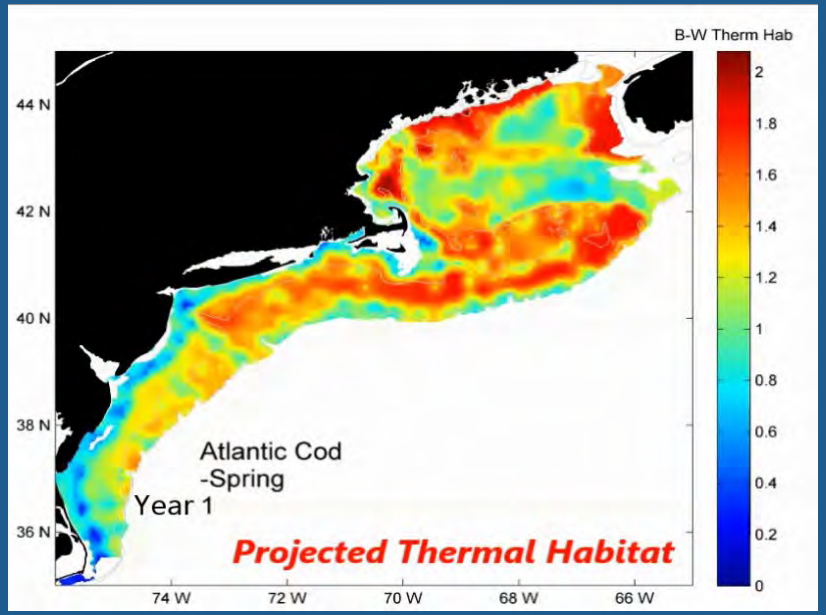

CM2.6 AMOC




*Caesar, Saba et al. 2018 Nature*

# Atlantic cod thermal habitat projection based on NOAA GFDL's high-res. climate model

## Atlantic cod



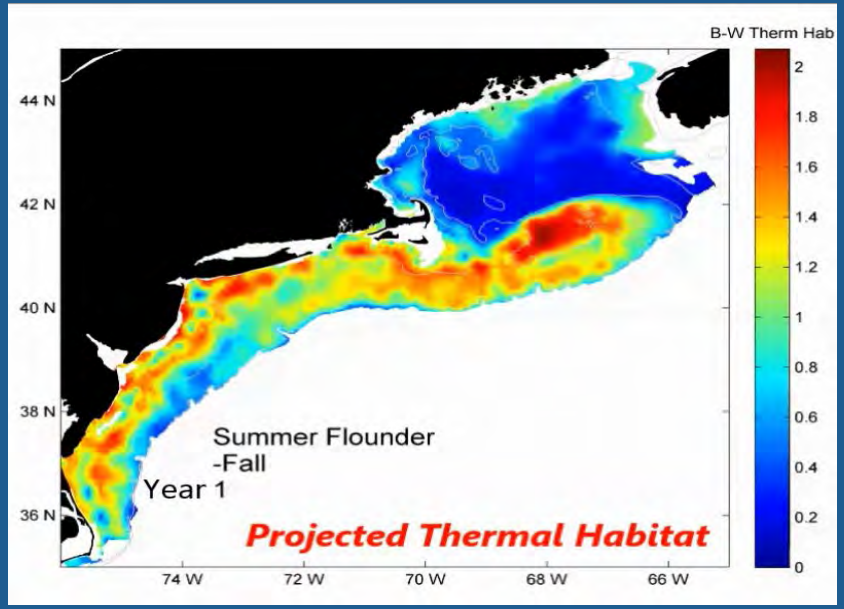

*Kleisner et al. 2017*

**Value of Landings**

| Rank | Species | Thousand Dollars |
|---|---|---|
| 1 | Lobsters | 679,214 |
| 2 | Crabs | 678,727 |
| 3 | Shrimp | 488,384 |
| 4 | Salmon | 460,166 |
| 5 | Pollock | 449,198 |
| 6 | Scallops | 440,496 |
| 7 | Cod | 264,191 |
| 8 | Flatfish | 263,615 |
| 9 | Oysters | 213,773 |
| 10 | Clams | 206,299 |

# Summer flounder thermal habitat projection based on NOAA GFDL's high-res. climate model

## Summer flounder




*Kleisner et al. 2017*

**Value of Landings**

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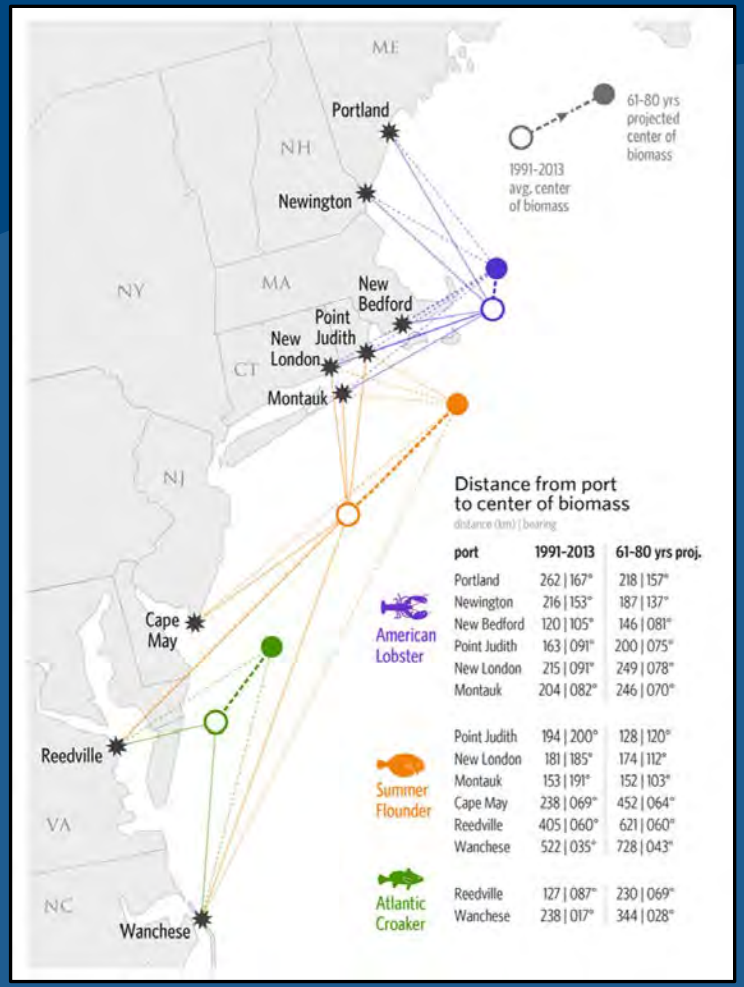
# Distance from port to fishing areas




Distance to port under continued ocean warming.

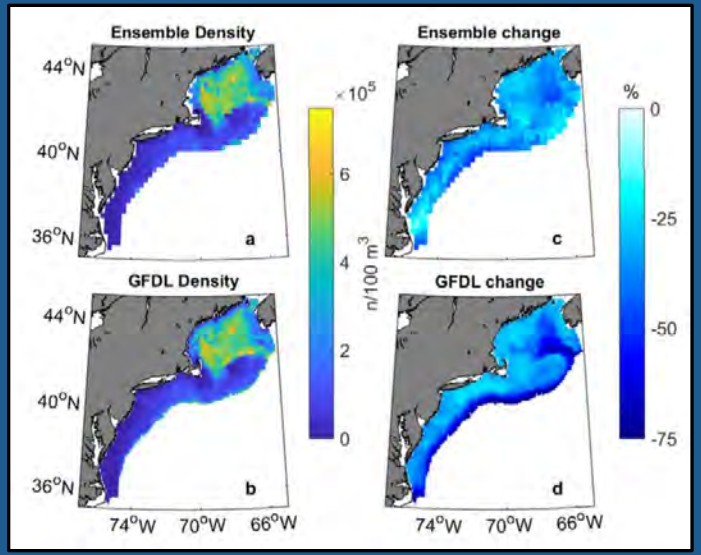
Does not account for:

- Fishing mortality change.
- Species interactions.

*Kleisner et al. 2017*

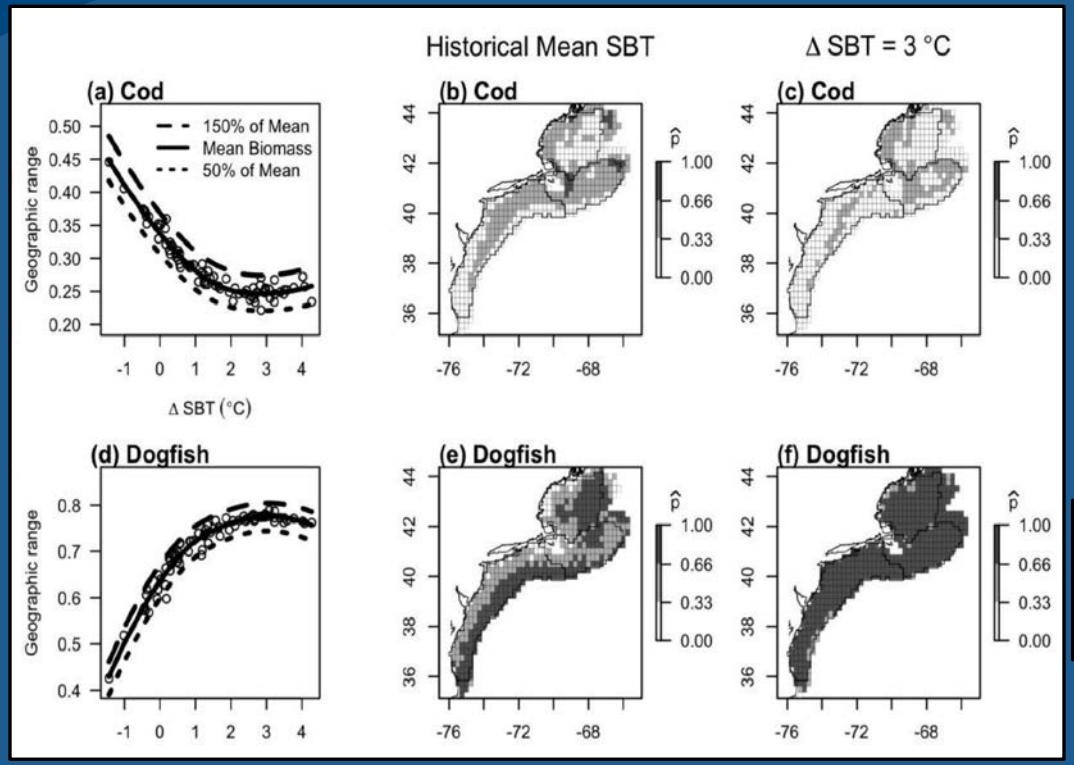
# *Calanus finmarchicus* projection based on NOAA GFDL's high-res. climate model

*Calanus finmarchicus* habitat climate change projection based on NOAA GFDL's high-res. CM2.6.



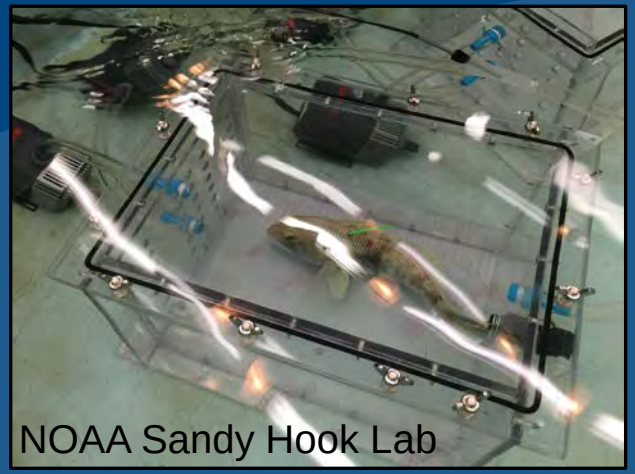

*Grieve, Hare, Saba 2017*

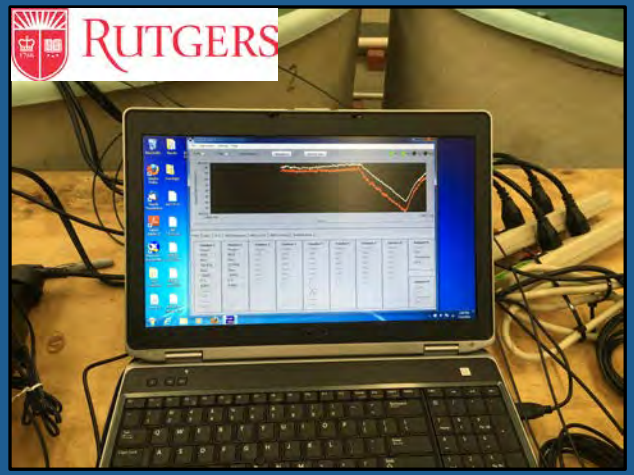
# Piscivore overlap projections based on NOAA GFDL's high-res. climate model



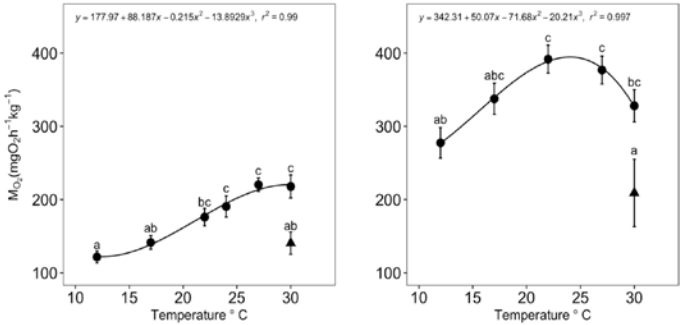

*Selden et al. 2017*

# Laboratory Studies




*Slesinger et al. unpublished*



# Summary

- Northwest Atlantic has warmed faster than most other coastal waters globally.
- NOAA GFDL's high-res. global climate model resolves the enhanced warming. This model is now being widely used to assess climate change impacts in the NW Atlantic.
- Enhanced warming of the NW Atlantic is associated with a weakening AMOC.
- Continued distribution shifts of valuable commercial species are highly likely under climate change.
- Need to move beyond temperature impacts. More laboratory process studies are needed.
- Climate impacts research – inform assessments and management.