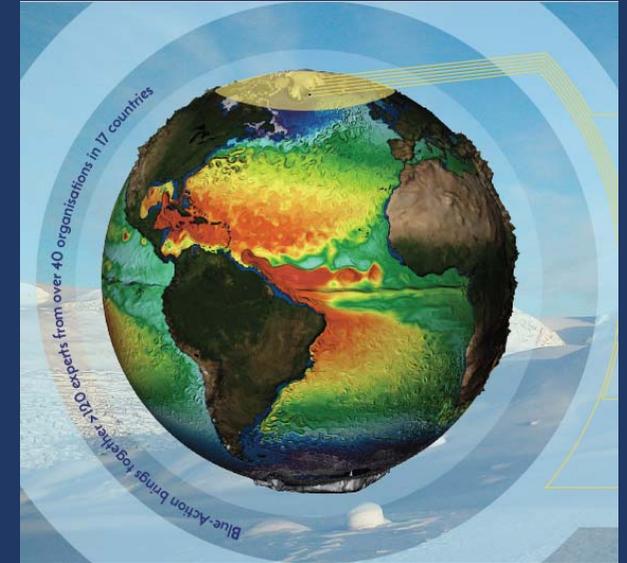


# AMOC and its regional components - *at the gateways to the Arctic*



*With contributions from Karin Margretha H. Larsen (FAMRI), Gerard McCarthy (NUIM), Didier Swingedouw (EPOC), Helene R. Langehaug (NERSC) and Blue-Action team members*

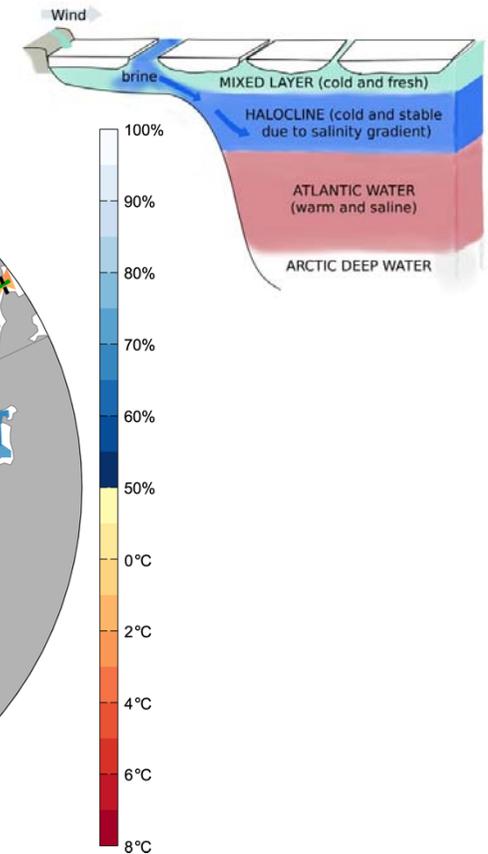
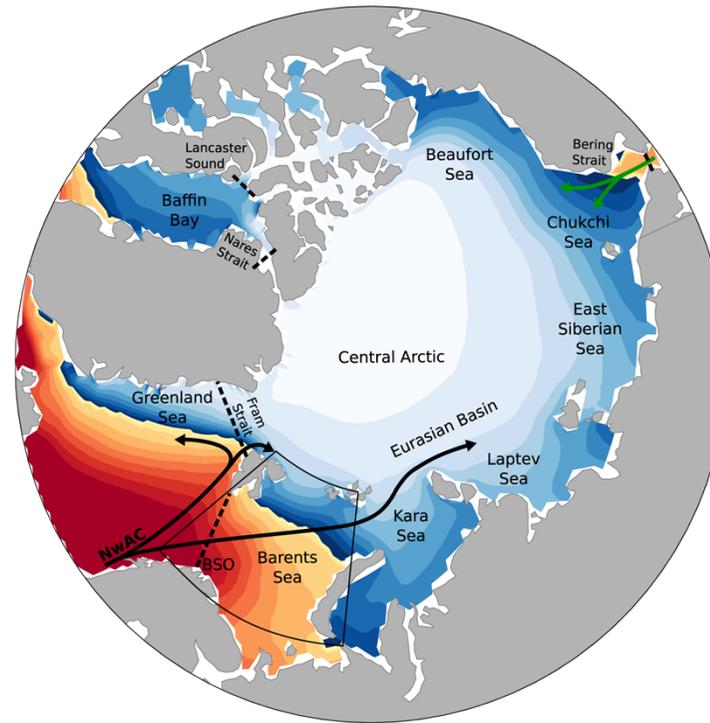
*Presented by **Steffen M. Olsen** (DMI), Coordinator [www.blue-action.eu](http://www.blue-action.eu) @BG10Blueaction*

# The ocean is key to predicting the Arctic

Increased heat fluxes act as a trigger for sea-ice retreat  
- *Atlantification and Pacification*

Warm and saline pulses from the south give rise to predictability

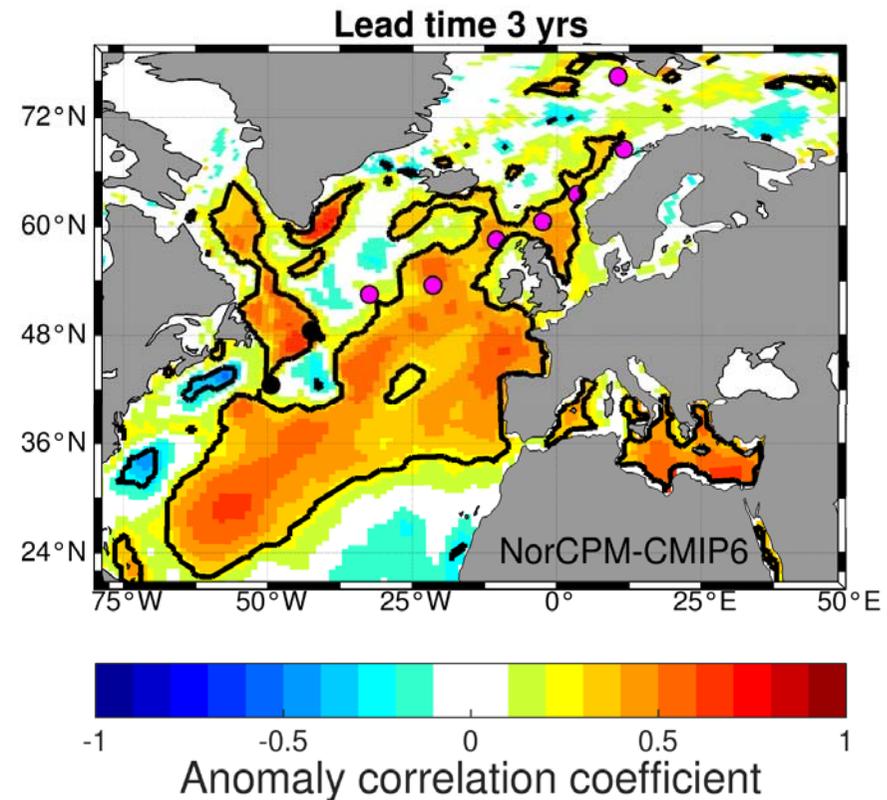
Observations suggest that there is potential to predict heat and sea ice variability on seasonal to interannual time scales.



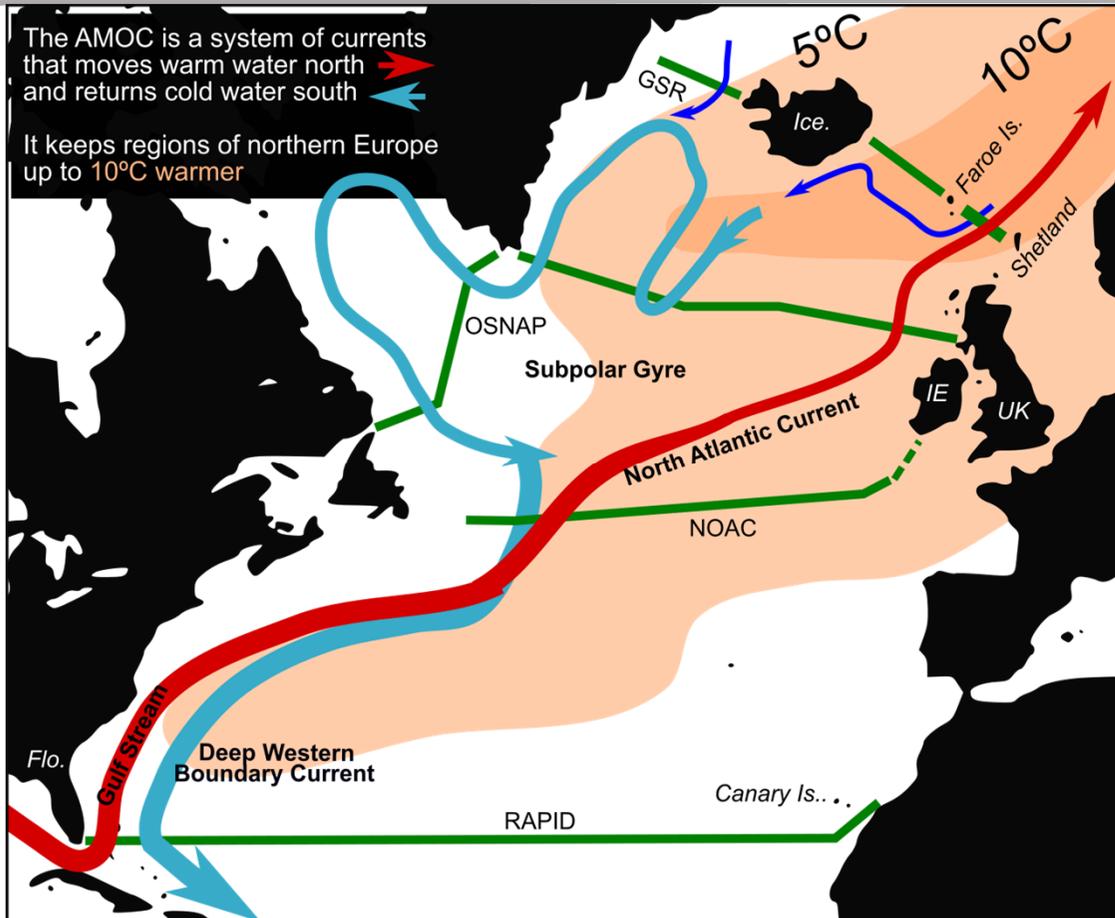
Årthun et al. 2017, 2019; Dai et al., 2020

# Predictive skill reduces towards the Arctic

- In the subpolar North Atlantic, most prediction systems can predict SST several years ahead
- Yet challenging for prediction systems to predict the oceanic pathway to the Arctic on decadal time scales



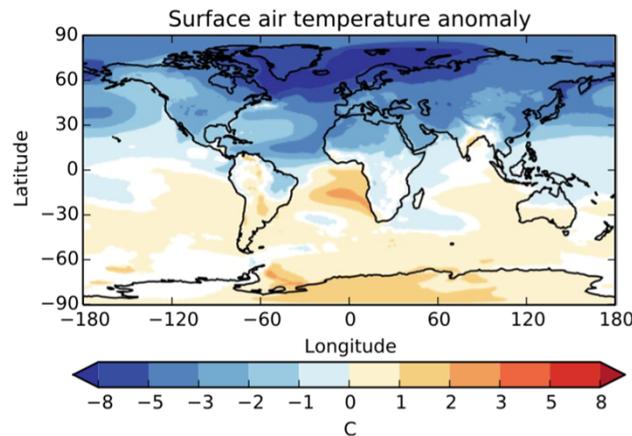
# Components of the AMOC



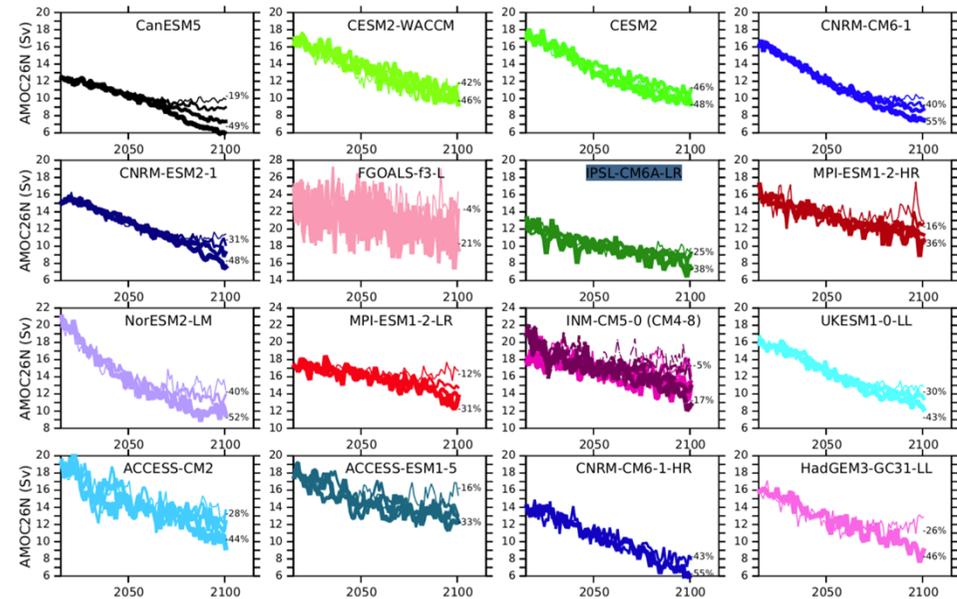
- AMOC observing systems (green) cover an observational gap and chart the vital signs of this complex set of ocean currents and provide emerging constraints for Earth System Models.
- Emerging technology and sensors are changing how scientists make these measurements, leading to optimization of long-term funded infrastructure.

# The future AMOC

- The AMOC is 'very likely' to weaken
- Ensemble mean AMOC decline in future scenarios is stronger in CMIP6 than CMIP5 models.
- Were the overturning to collapse, cooler temperatures can be expected for the whole Northern Hemisphere.
- An abrupt AMOC collapse would be an environmental disaster for Europe.



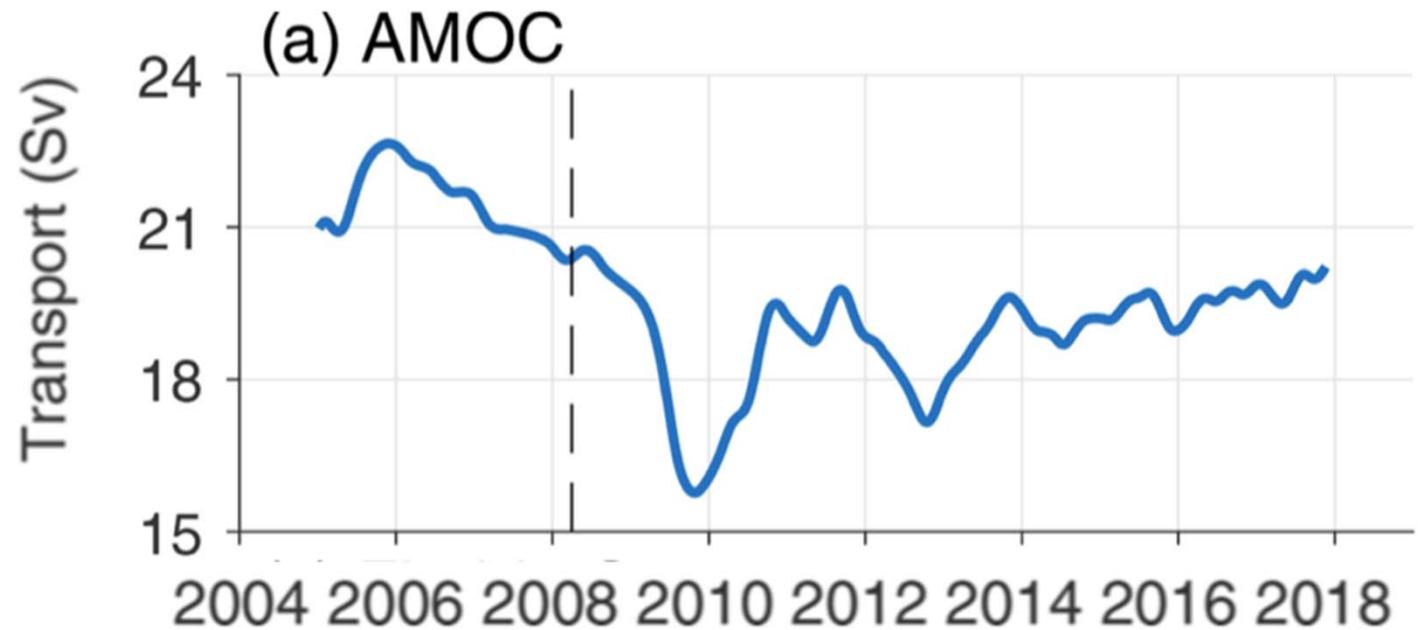
Jackson et al. (2015)



Weijer, W., Cheng, W., Garuba, O. A., Hu, A., & Nadiga, B. T. (2020). CMIP6 models predict significant 21st century decline of the Atlantic Meridional Overturning Circulation. *Geophysical Research Letters*, 47(12), e2019GL086075.

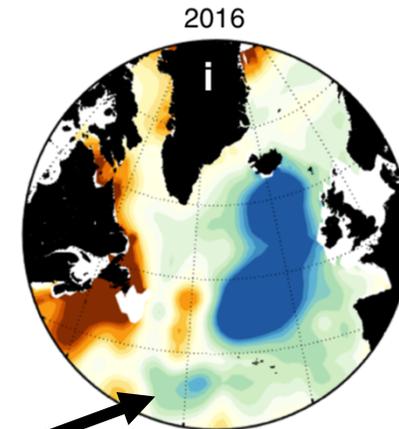
# The current AMOC @26N

... but RAPID shows a strengthening since ~2010

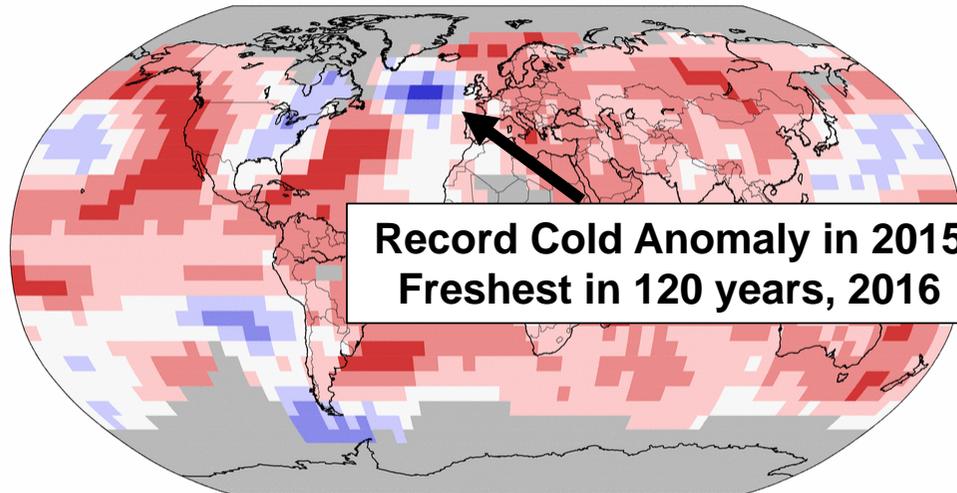


Moat, Ben I., et al. "Pending recovery in the strength of the meridional overturning circulation at 26° N." *Ocean Science* 16.4 (2020): 863-874.

# Recent changes in the SPG

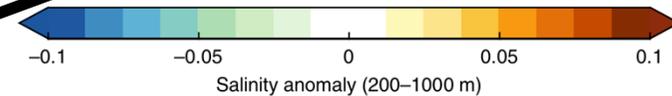


Land & Ocean Temperature Percentiles Dec 2014–Feb 2015  
NOAA's National Climatic Data Center  
Data Source: GHCN–M version 3.2.2 & ERSST version 3b

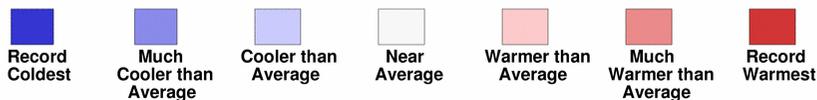


**Record Cold Anomaly in 2015  
Freshest in 120 years, 2016**

From Holliday et al., 2020

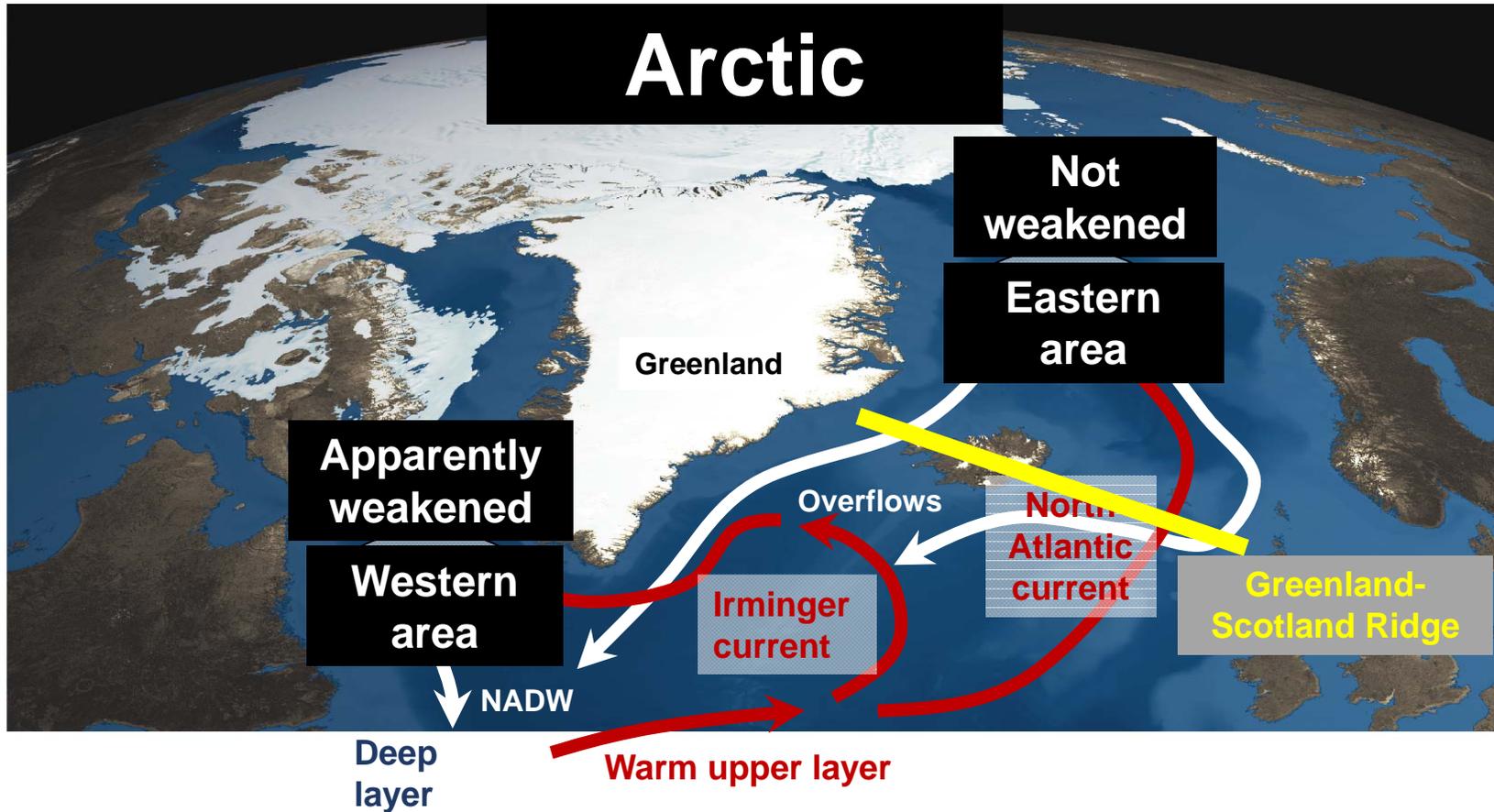


- Unprecedented changes are ongoing
- We suspect the AMOC has weakened
- Could we be approaching a tipping point?

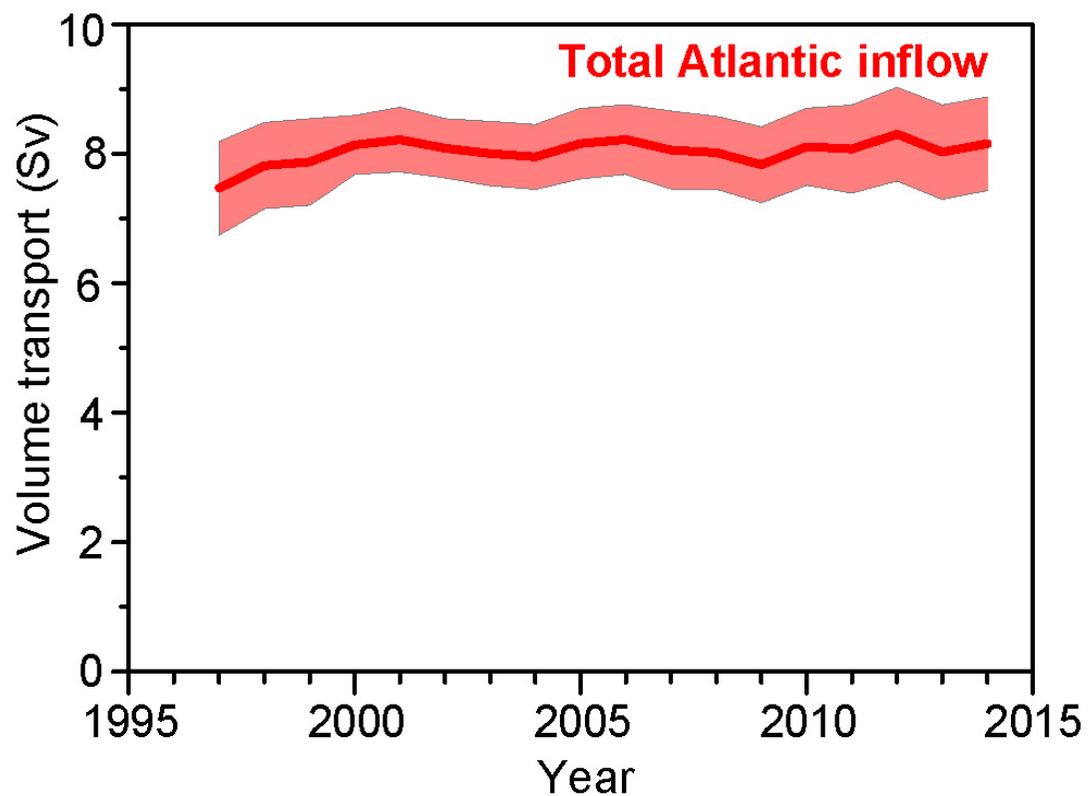


Mon Mar 16 19:53:13 EDT 2015

# Two ventilation areas for the AMOC



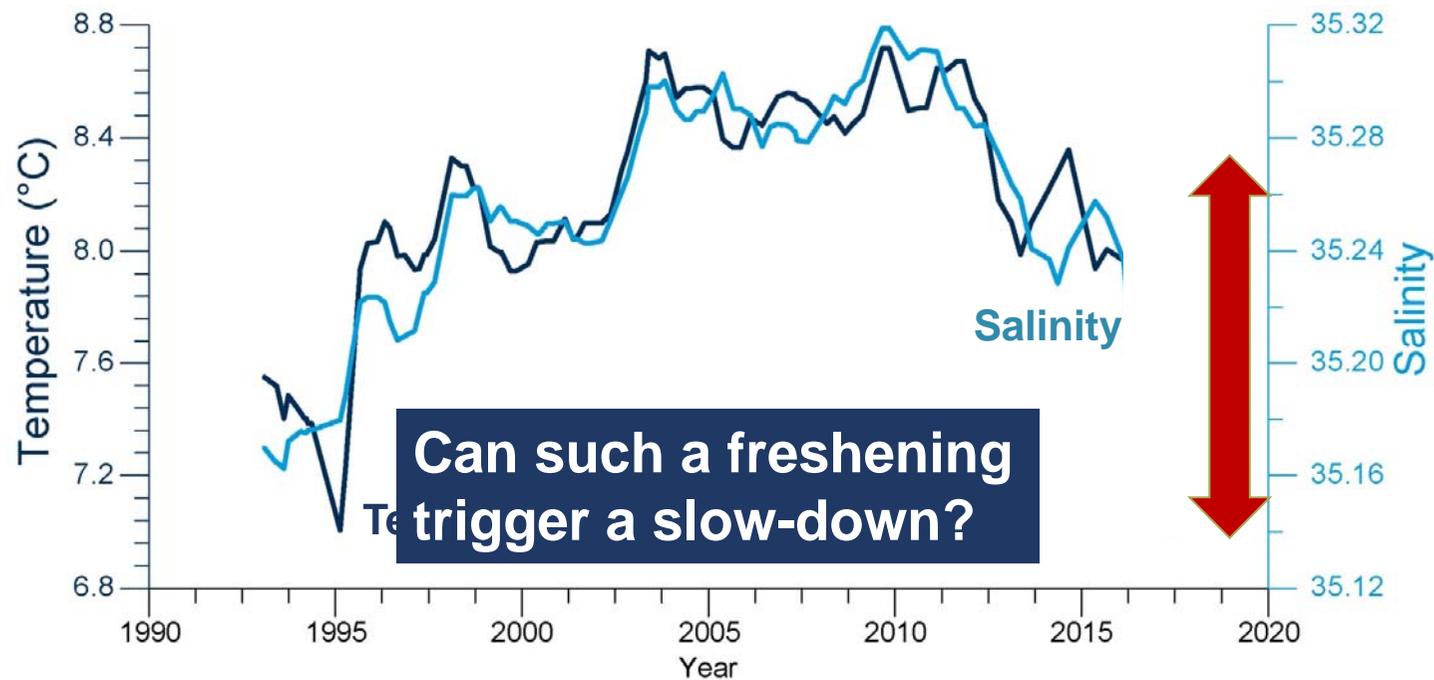
# Greenland-Scotland Ridge - Exchanges



Østerhus et al., 2019



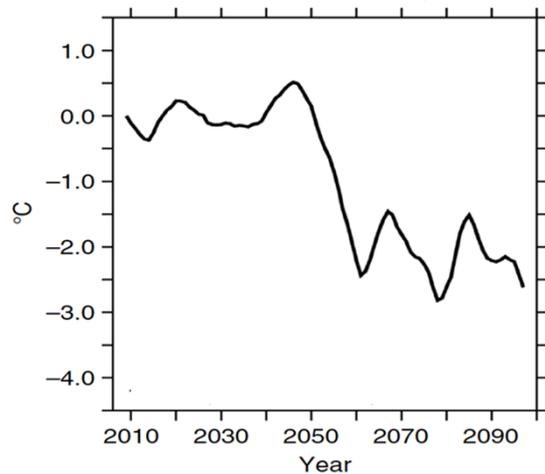
# Example from the Faroe Current



Are we approaching a tipping point?

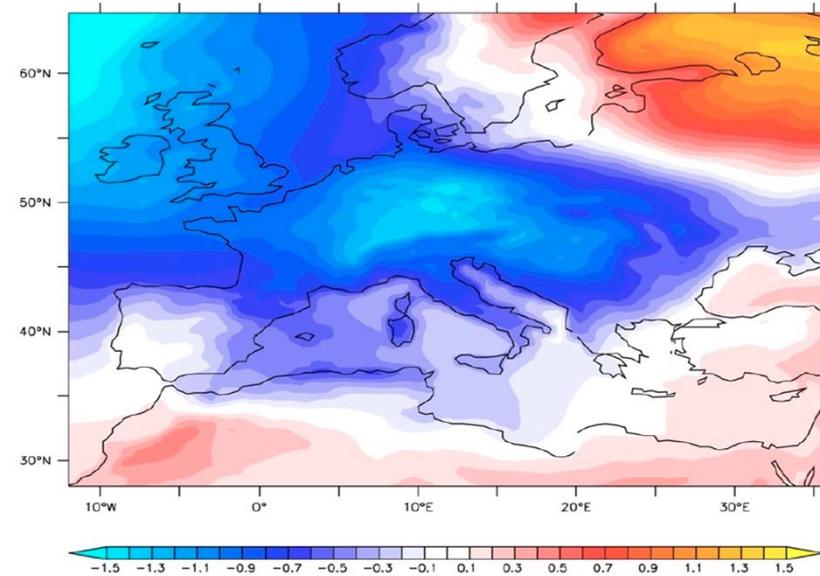
# Risk of subpolar convection collapse

- Some models do show abrupt (<10 years) cooling in the subpolar gyre
- The risk for such changes can be estimated between about 20 to 45%



Sgubin et al. 2017

Difference temperature after and before the shift



Sgubin et al. 2019

- The impact can be significant over Europe

# Recommendations

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- Long-term, sustained observations of the, North Atlantic and Arctic Ocean are required to inform climate predictions
  - Risks of AMOC collapse and associated impacts must be evaluated in a suite of models, using direct and indirect observations.
- Adapting to a risk-based approach is needed to bridge the science-to-policy gap that currently exists in Polar and ocean research.
  - Further work is needed to understand the independent dynamics of the subpolar gyre and its connection to the Arctic.
- We have evidence of teleconnections with the Arctic Ocean, and need a better understanding of these linkages to build a more climate-resilient society.
  - Improvements in the ability of climate models to represent processes related to Atlantification and Pacification are required in order to reduce uncertainty in future projections.



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