U.S. AMOC Science Team

http://www.usclivar.org/amoc

A U.S. interagency program with a focus on AMOC monitoring and prediction capability

NASA Earth Science Division

Satellite data analyses, modeling and space-based observations

NOAA Climate Program Office

Observing systems, monitoring, climate modeling

NSF Geosciences program

Process studies, models, and observations

U.S. Department of Energy

Climate and process modeling, climate impacts

U.S. AMOC Program History

- January 2007: AMOC identified as near-term priority by JSOST
- October 2007: U.S. AMOC Implementation Plan released
- March 2008: U.S. AMOC Science Team formed
- May 2009: 1st Annual PI meeting (Annapolis, MD)
- June 2010: 2nd Annual PI meeting (Miami, FL)
- July 2011: Joint U.S./U.K. AMOC Science Conference (Bristol, UK)
- August 2012: 3rd U.S. AMOC meeting (Boulder, CO)
- July 2013: Joint U.S./U.K. International AMOC Science Meeting (Baltimore, MD)

Recent Developments:

- Over 50 funded projects supported by 4 agencies; New 2013 awards by NOAA, NSF and NASA
- 5-year period as SOST priority completed; Science Team continues as U.S. CLIVAR priority
- 5th Annual Progress Report published June 2013
- External Review Committee Report issued June 2013

U.S. AMOC Scientific Objectives

- AMOC observing system implementation and evaluation
- Assessment of AMOC state, variability, and change
- Assessment of AMOC variability mechanisms and predictability
- Assessment of the AMOC's role in global climate and ecosystems

Program Organization:

Science Team Chair: Gokhan Danabosoglu (previously Bill Johns)

Task Teams:

1. *AMOC Observing System Implementation and Evaluation*
   (Chair: Susan Lozier; Vice-chair: Patrick Heimbach)
2. *AMOC State, Variability, and Change*
   (Chair: Josh Willis; Vice-chair: Rong Zhang)
3. *AMOC Mechanisms and Predictability*
   (Chair: Gokhan Danabasoglu; Vice-chair: Young-Oh Kwon)
4. *Climate Sensitivity to AMOC: Climate/Ecosystem Impacts*
   (Chair: Ping Chang; Vice-chair: Yochanon Kushnir)

Executive Committee:

Science Chair + Task Team chairs/vice-chairs

2012 U.S. AMOC PI Meeting
August 15-17, 2012, Boulder

Mini-Workshops

1. **AMOC Fingerprinting from Historic and Proxy Records**
   Speakers: Ben Horton, Casey Saenger

2. **AMOC's Impact on the Carbon Cycle**
   Speakers: Galen McKinley, Scott Doney

3. **AMOC Observing System**
   Speakers: Johanna Baehr, Rui Ponte

4. **AMOC Mechanisms and Predictability**
   Speakers: Tom Delworth, Grant Branstator

Research Priorities

1. Enhance observing system to provide estimates of overturning variability in the subpolar North Atlantic as well as in the South Atlantic.
2. Assess importance of deep temperature and salinity measurements (i.e., deep Argo) in monitoring AMOC variability.
3. Synthesize observations from existing elements of the observing system, including comparing the transport and transport variability of the flow field at Line W, RAPID-MOCHA and the MOVE array in the broader context of satellite and Argo float observations across the North Atlantic.
4. Develop fingerprinting techniques to better characterize AMOC variability by combining model simulations with observations should be further encouraged and supported.
5. Develop a set of metrics for the AMOC, in both depth and density spaces, in order to understand how AMOC variability relates to, is impacted by, and impacts oceanic and atmospheric processes and properties.

Research Priorities (cont.)

6. Coordinate assimilation modeling efforts to reach a consensus on the variability of the AMOC over the past few decades, and on placing realistic uncertainty bounds on these estimates.
7. Explore AMOC and MHT relationships in various models (forward, assimilation, non-eddy-resolving, eddy-resolving) in comparison with observational data to understand the reasons for differences, or biases, in the relationship between model AMOC intensity and Meridional Heat Transport in available models.
8. Contribute to ongoing near-term AMOC prediction and predictability efforts through coordinated and focused analysis and inter-comparison of the CMIP5 decadal prediction simulations, including verification of notable AMOC-related climate events.
9. Understand the connections between AMOC/North Atlantic SST and climate variability elsewhere, the physical mechanisms of these teleconnections, and the related impacts on humans and ecosystems. Explore the impact of AMOC variability on sea ice, ocean ecosystems, sea level changes around the Atlantic Basin, and the exchange of carbon between the atmosphere and ocean.

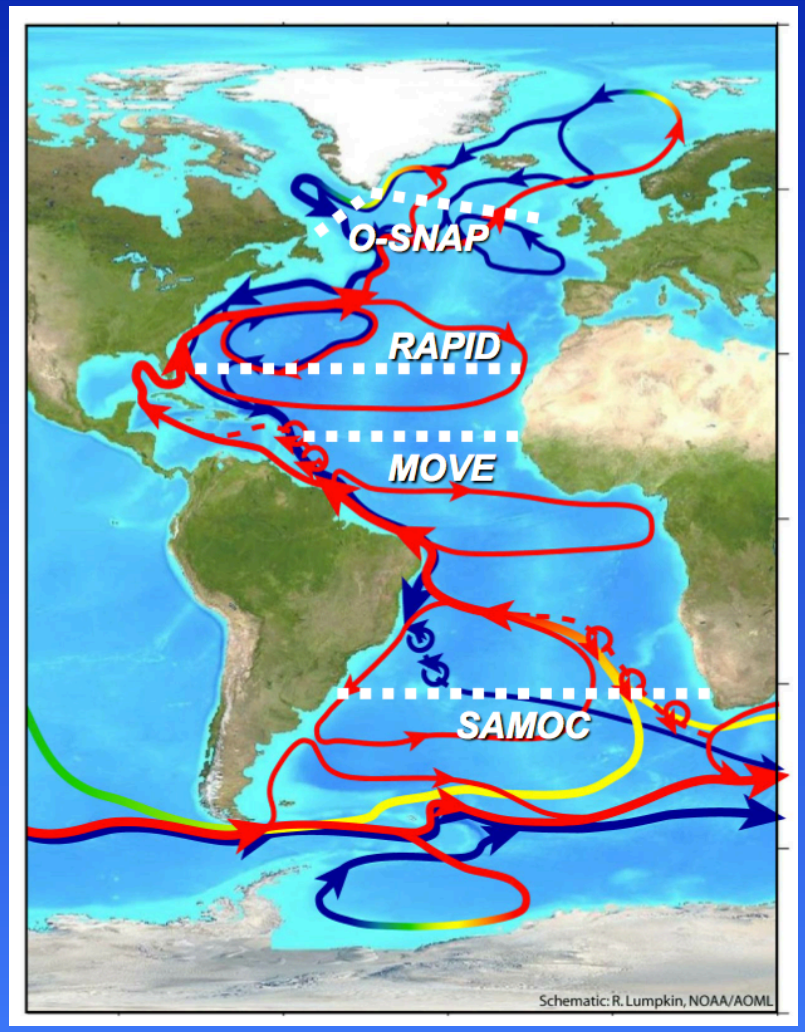
AMOC Observing System

Strategy:

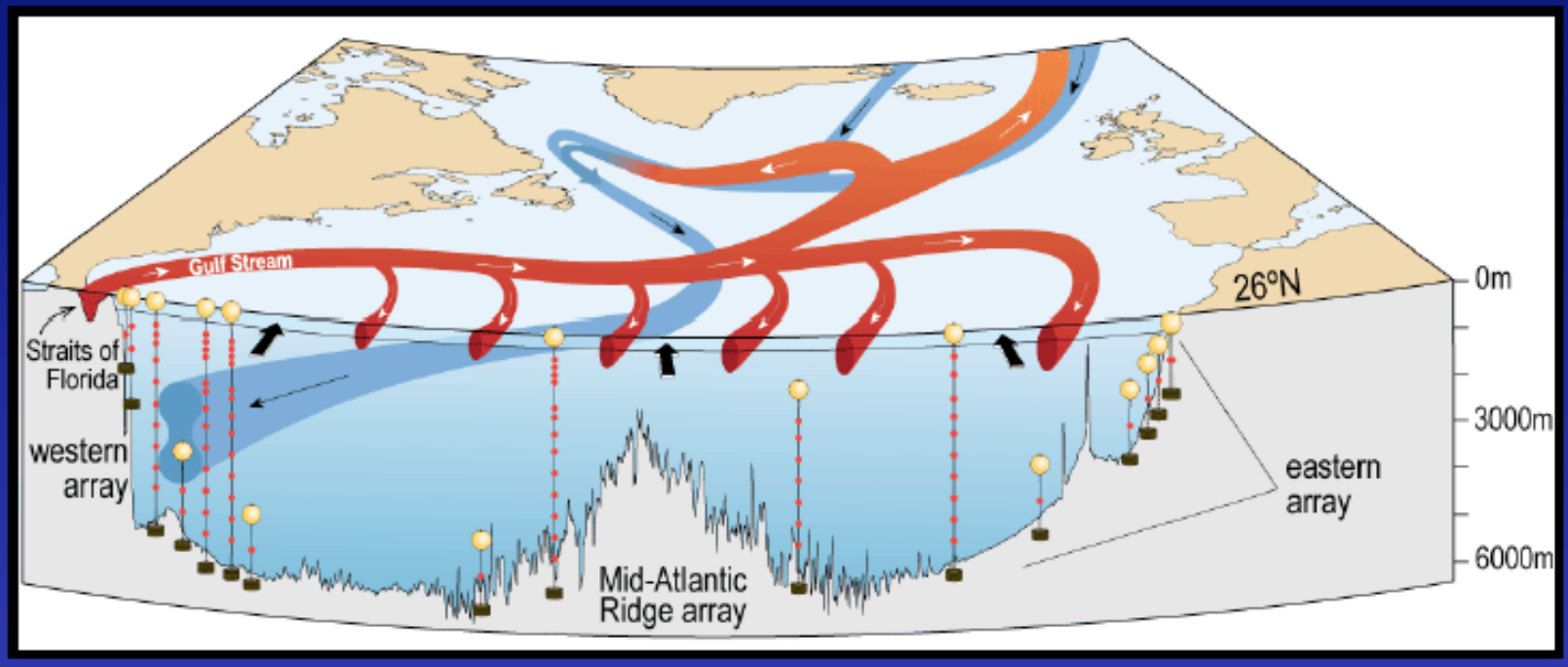
Establish discrete set of trans-basin arrays (moorings + autonomous profiling) for continuous AMOC estimates

Value:

- ***Accurate*** multi-year mean AMOC estimates, for comparison with future (and past) AMOC states
- ***Understanding*** of processes underlying short-term (intraseasonal to annual) variability
- ***Benchmarks*** for evaluation of modeled AMOC variability (GCMs, data synthesis models)



The RAPID / MOCHA* Array



How it works:

- Gulf Stream : telephone cable
- Ekman : scatterometer
- Mid-ocean : density, current meters

Why 26.5°N?

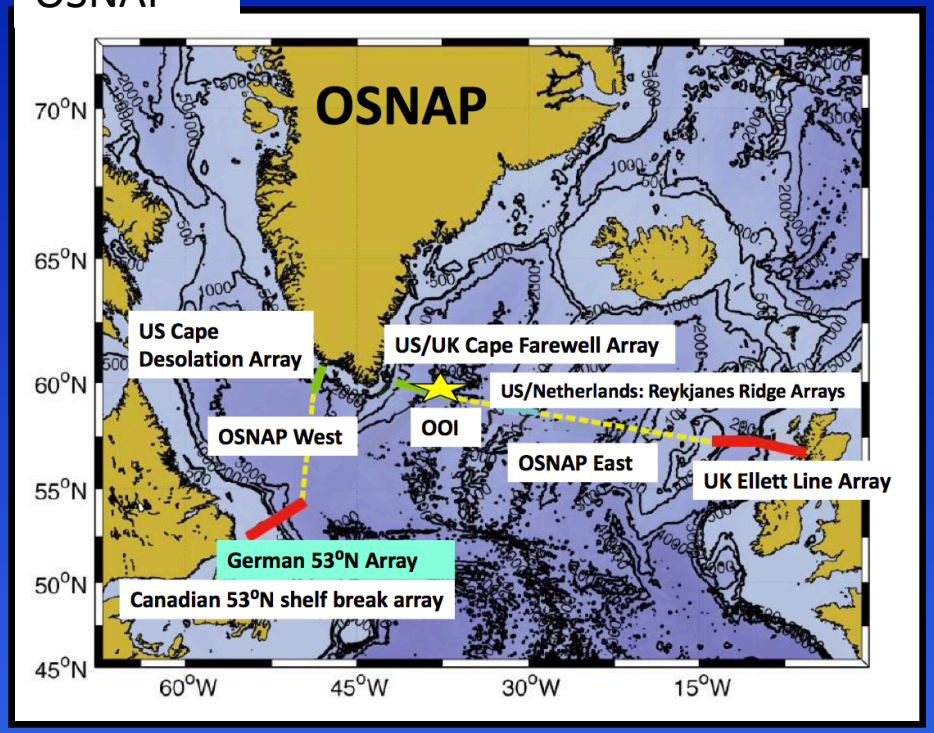
- Maximum heat transport
- History of measurements:
  - Florida Current
  - repeat hydro-sections

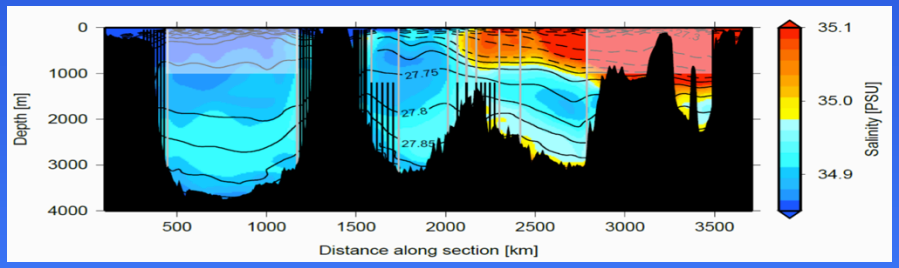
→ **Funded through 2014 - will provide a 10 year time series (2004-2014)**

* NERC / UK RAPID Climate Change Programme
NSF / US Meridional Overturning Circulation and HeatFlux Array

Subpolar North Atlantic

OSNAP

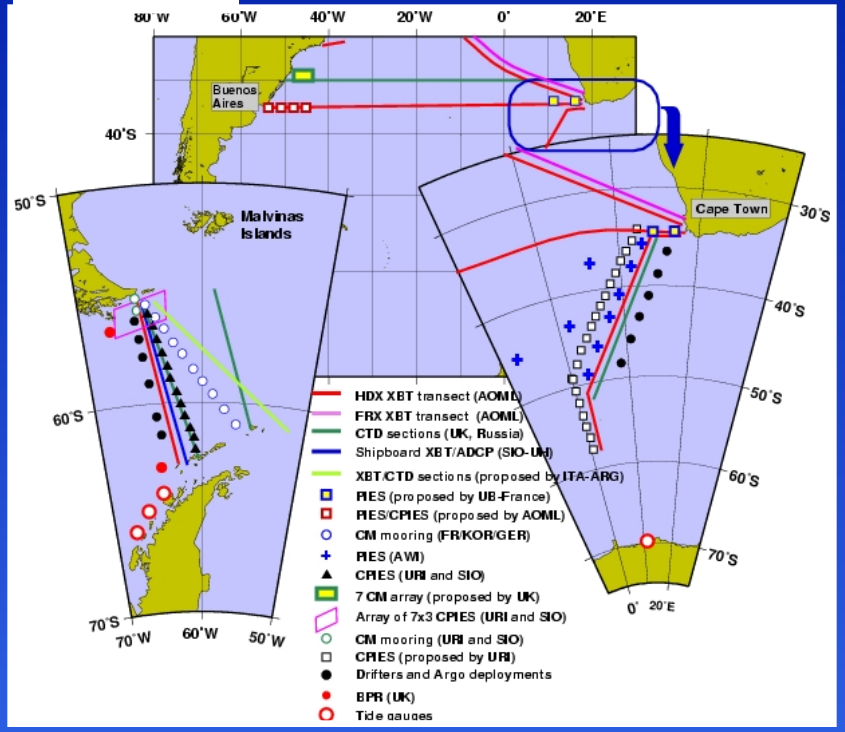


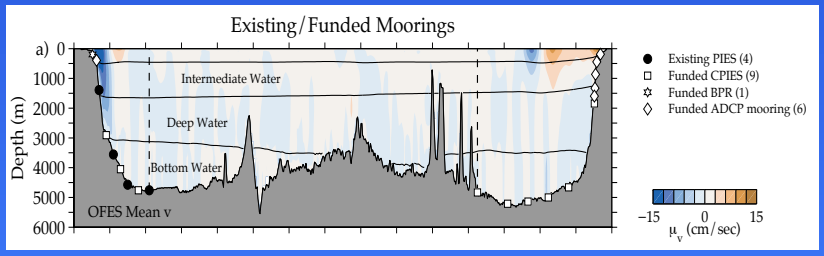


(U.S., U.K., Germany, Netherlands, Canada)

South Atlantic

SAMOC

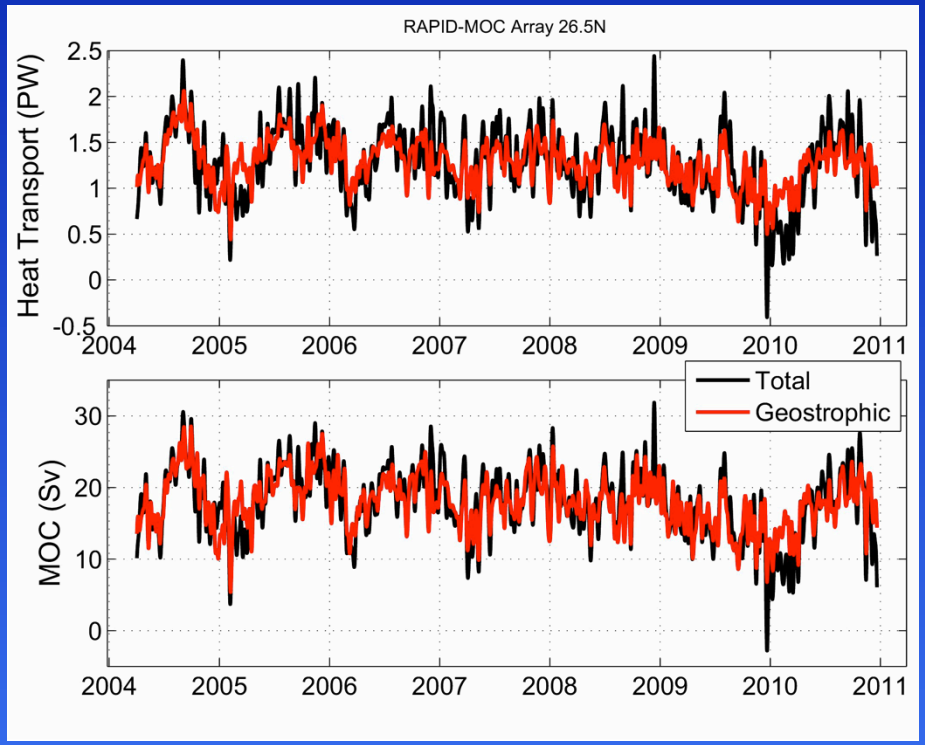




(U.S., Brazil, Argentina, France, S. Africa)

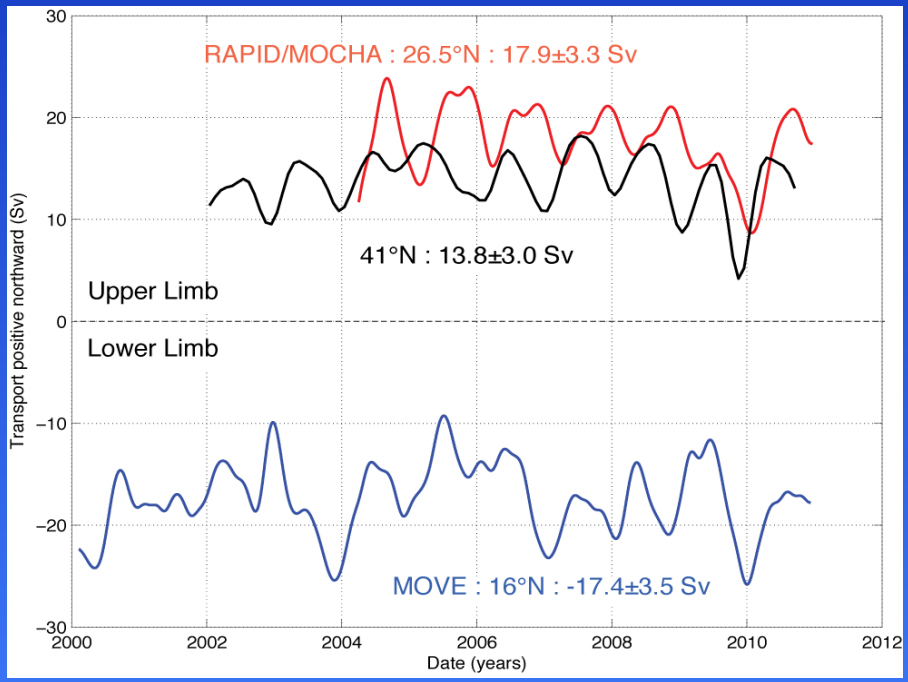
AMOC Variability from Observations

RAPID-MOCHA Array (26.5°N)



McCarthy et al. (2012)

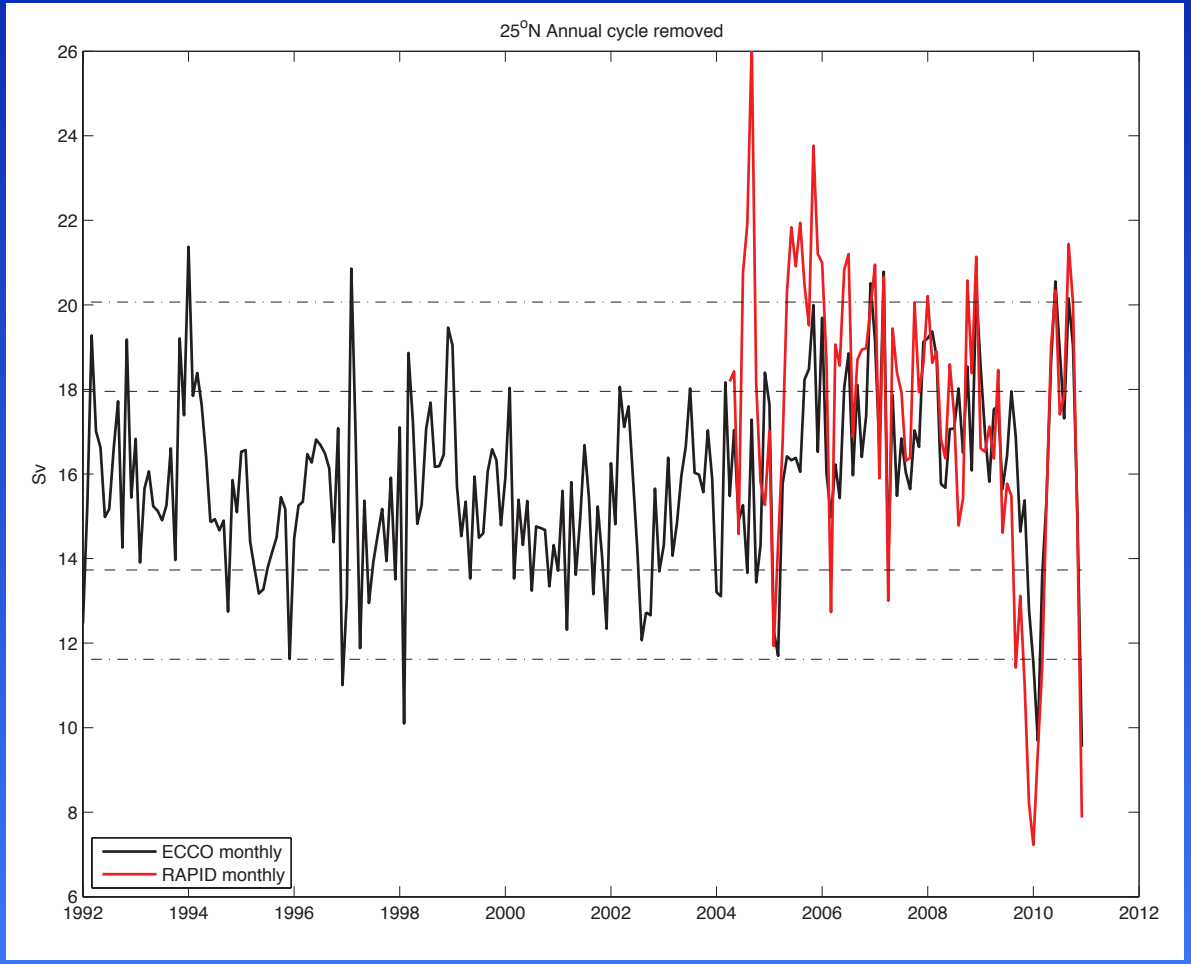
RAPID, MOVE, and 41°N (Willis)



Baringer et al. (2012)
State of the Climate in 2011 (BAMS Suppl.)

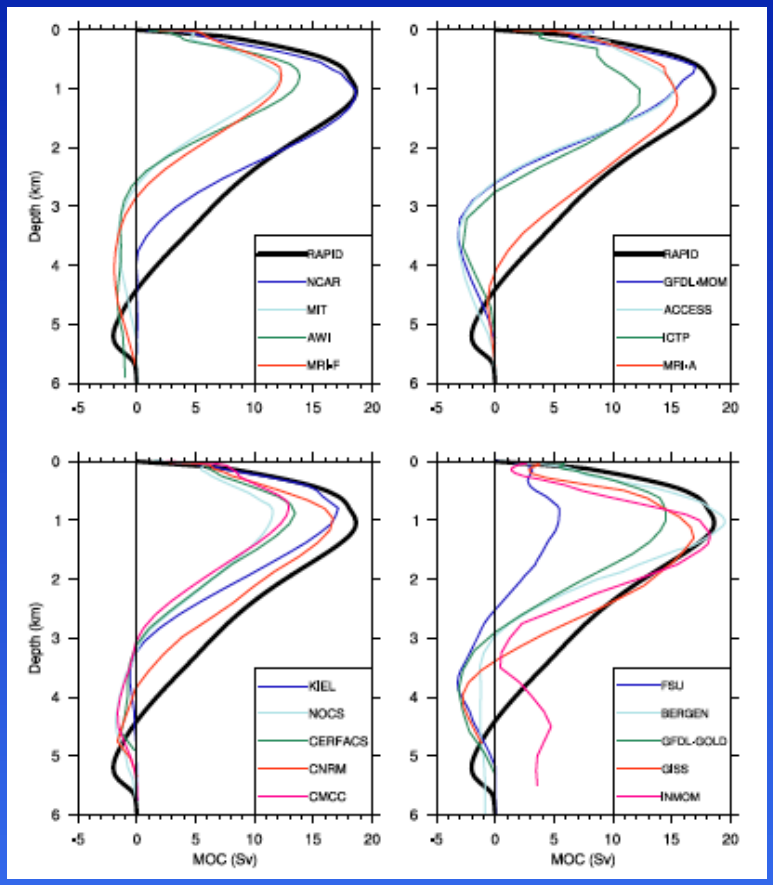
Synthesis/reanalysis Models

RAPID vs. ECCO products



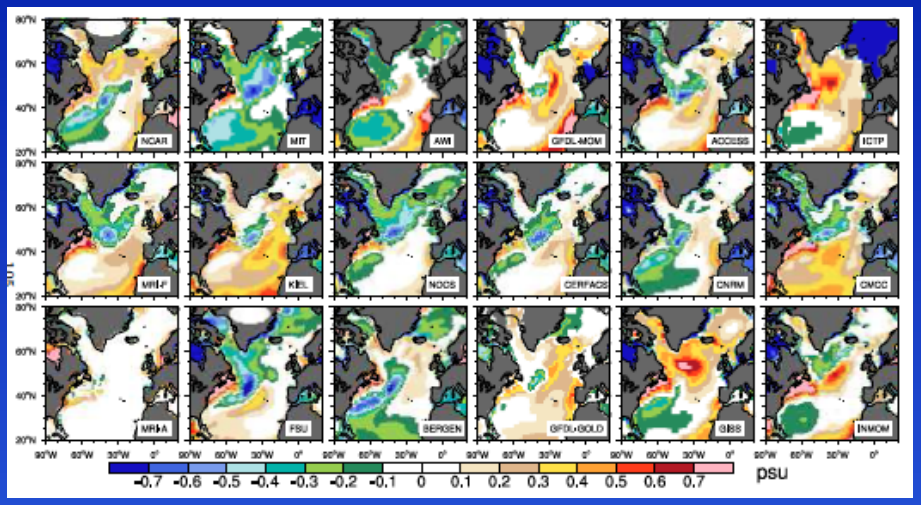
Courtesy of Patrick Heimbach

AMOC Representation in CORE-II Simulations

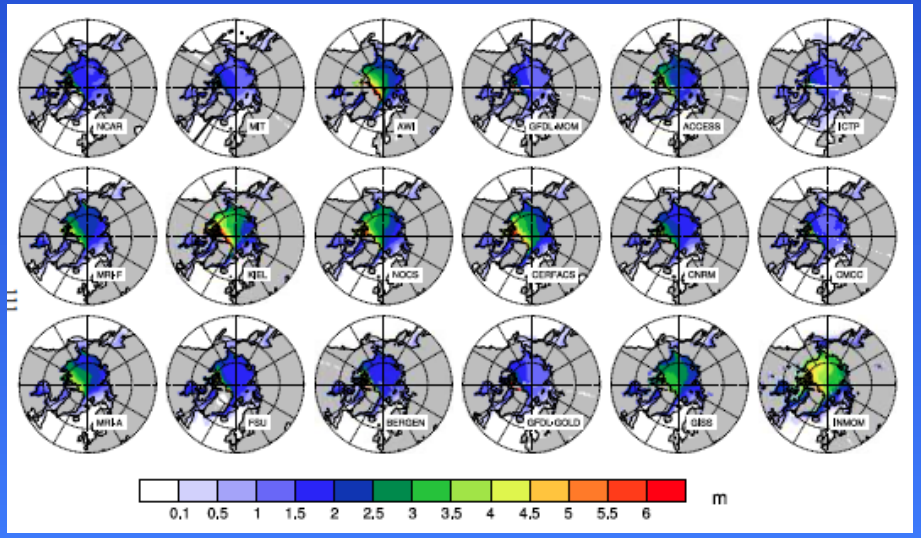


2004-2007 mean MOC profiles at 26.5°N for 18 global ocean- sea ice models vs RAPID

Danabasoglu et al. (2013)



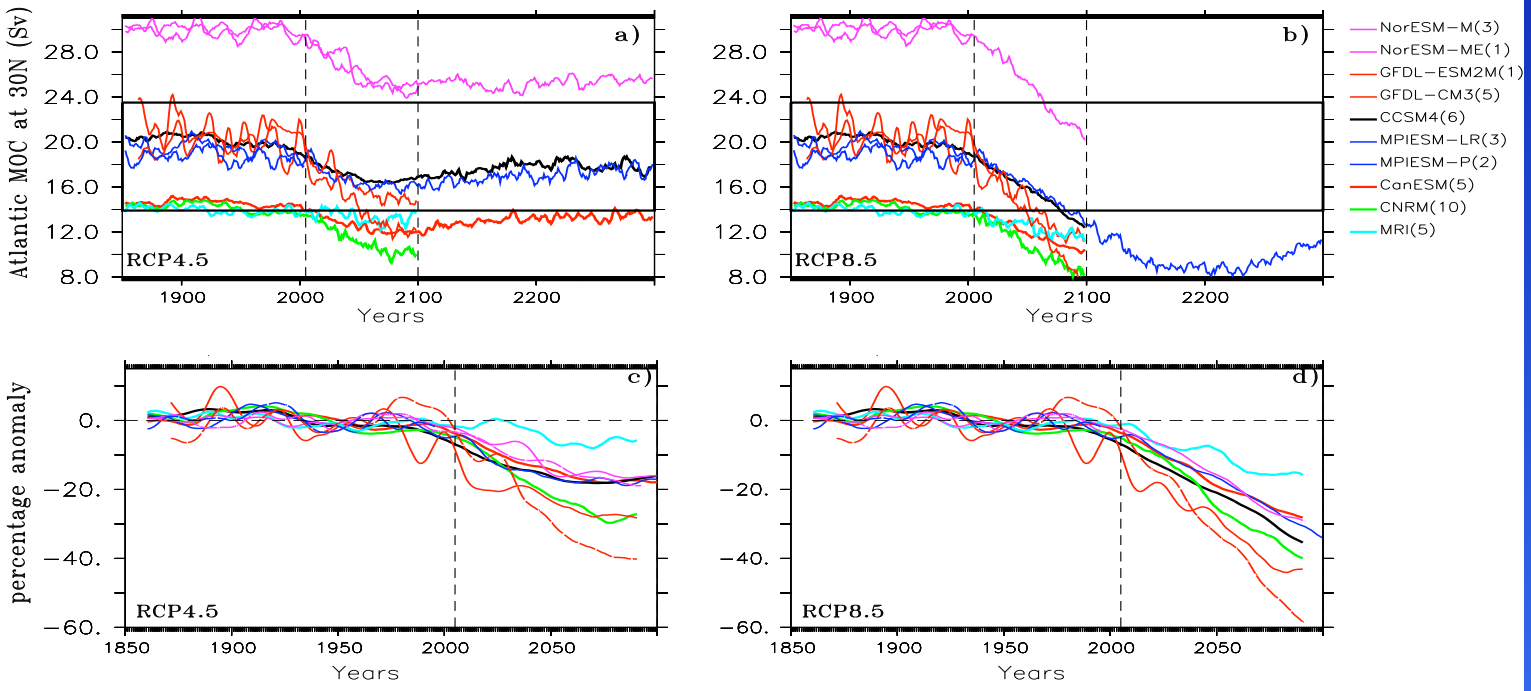
0-700 m average salinity model minus observations



March mean sea ice thickness

AMOC Representation in Coupled Models

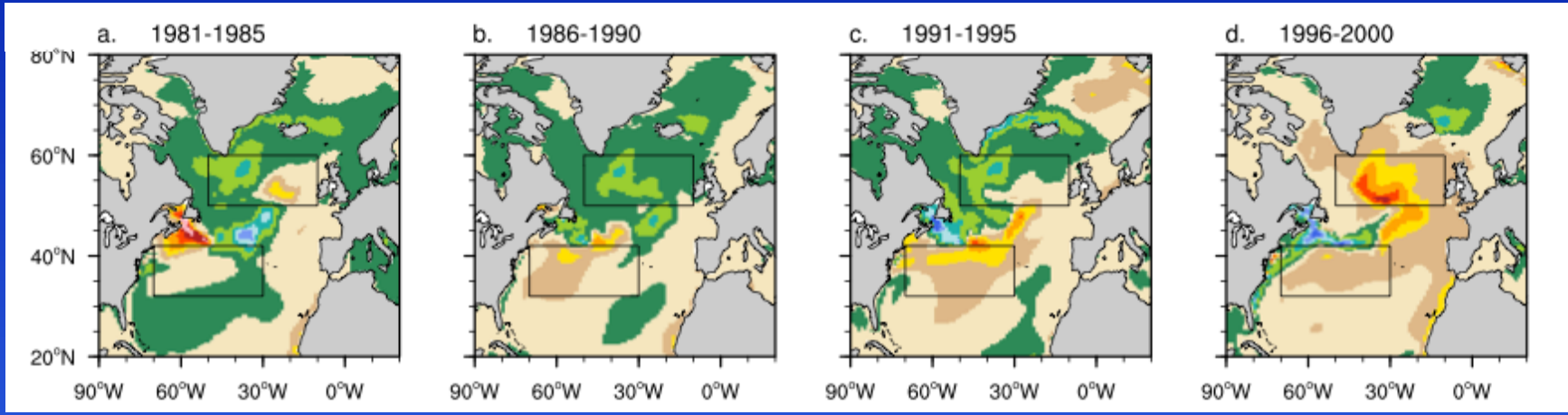
AMOC time series simulated by 10 CMIP5 models



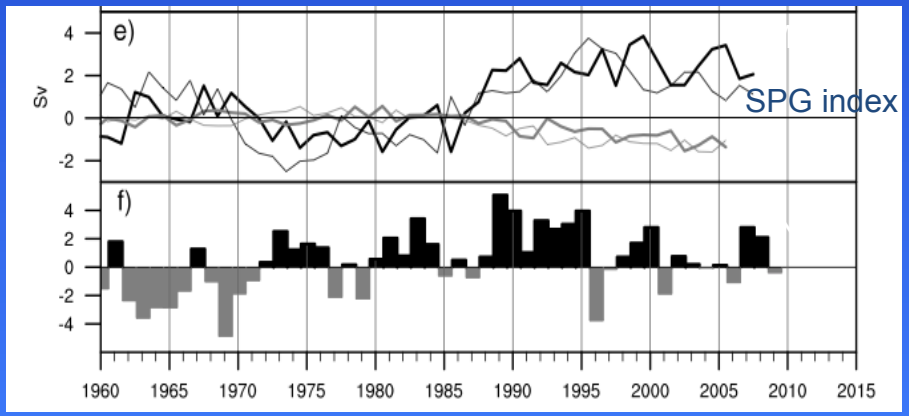
Cheng et al. (2013)

AMOC Mechanisms and Predictability

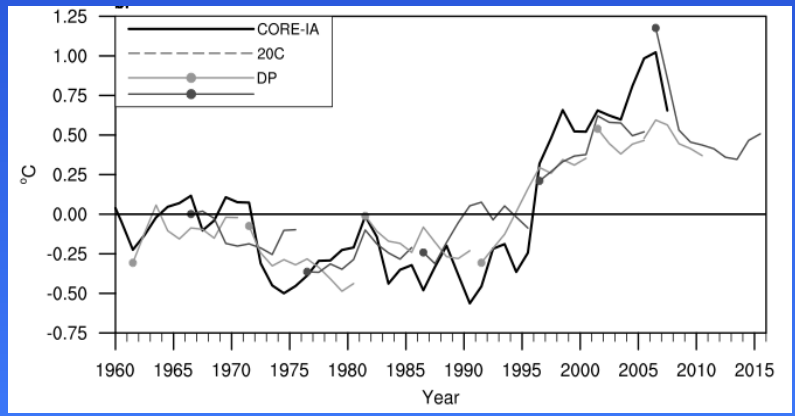
Predictability of the subpolar gyre warming in the late 1990's:



CCSM4 hindcast with CORE-IA forcing

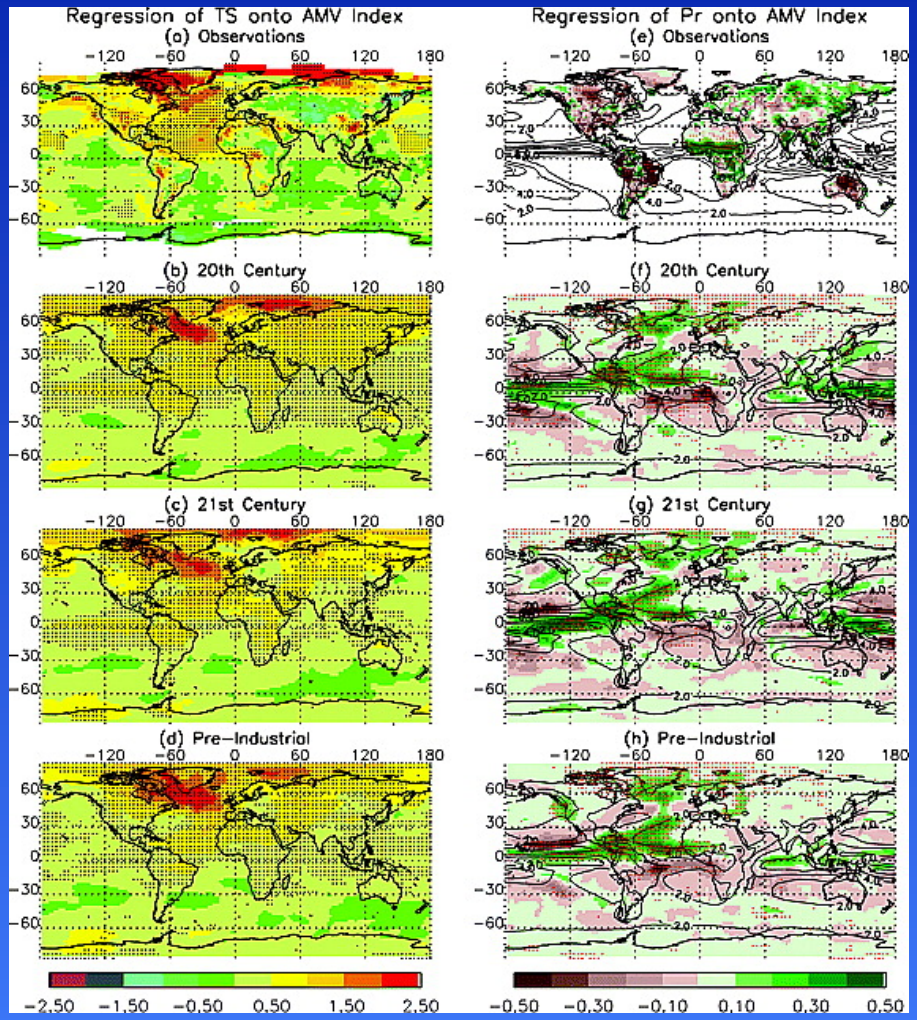


Decadal predictions init. w/ hindcast



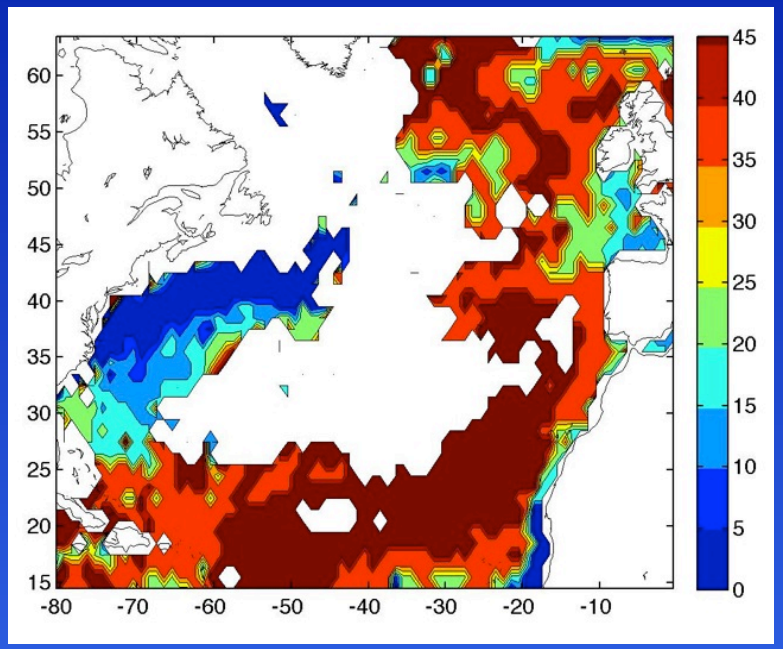
Yeager et al. (2012)

AMOC/AMV Climate Impacts



Ting et al (2011)

Global precipitation variability linked to AMV



Courtesy of Katherine Kelly

Locations where ocean processes are dominant contributor to SST anomalies

2013 International AMOC Science Meeting
July 16-19, 2013, Baltimore

"AMOC Variability: Dynamics and Impacts"

1. **Observations and dynamics of seasonal-to-interannual timescales** – results from recent instrument deployments and related observational studies, and results from regional high-resolution modeling
2. **Observations and dynamics of decadal to multi-centennial timescales** – results from proxy studies, and coupled climate model simulations
3. **Climate impacts, and what the future may hold** – studies focused on forecasts of societal impacts, including changes in key variables: SST, sea level, carbon/biogeochemistry, and ecosystems

~90 participants; 50% each from U.S./Europe; 54 talks; 48 posters