U.S. AMOC Program

www.atlanticmoc.org

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 in JSOST ORPP
- October 2007: US AMOC Implementation Plan released
- March 2008: US AMOC Science Team formed
- May 2009: 1st Annual meeting (Annapolis, MD)
- June 2010: 2nd Annual meeting (Miami, FL)
- July 2011: Joint US/UK AMOC Science Conference (Bristol, UK)
- August 2012: 3rd Annual meeting (Boulder, CO)
- Summer 2013: Joint US/UK AMOC Science Conference (US host)

Recent Developments

- DOE added as sponsoring agency in 2012 (11 new projects added)
- Over 50 funded projects now linked to the program
- 4th Annual Progress Report published March 2012
- External program review planned for fall 2012

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: B. Johns (prev. S. Lozier)

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

Research Priorities

1. Complete the basin-wide observing system for the AMOC, including measurement systems in the South Atlantic and subpolar North Atlantic.

2. Evaluate the AMOC observing system using OSSE's in high-resolution ocean models and sensitivity studies in adjoint models.

3. Synthesize available results from present *in-situ* observing system and data-assimilation models to understand AMOC changes that are currently taking place and that have taken place in the recent past.

4. Develop "fingerprinting" techniques to extend the AMOC record back in time using the historical instrumental record and high-resolution paleo proxy data.

5. Evaluate AMOC variability mechanisms using diverse approaches (theoretical/simplified modeling, climate/earth system modeling, adjoint modeling, state estimation).

Research Priorities (con't)

6. Improve the representation of the AMOC in present generation climate models (e.g., overflows, model representation of ocean meridional heat transport) through validation studies with available in-situ data.

7. Assess AMOC predictability and the robustness/model dependency of AMOC predictions, through focused intercomparisons of the IPCC AR5 decadal prediction experiments.

8. Understand the physical linkages between AMOC variability and SST variability over the Atlantic, especially the connection between the AMOC and AMV, and its linkages to global climate and precipitation variability.

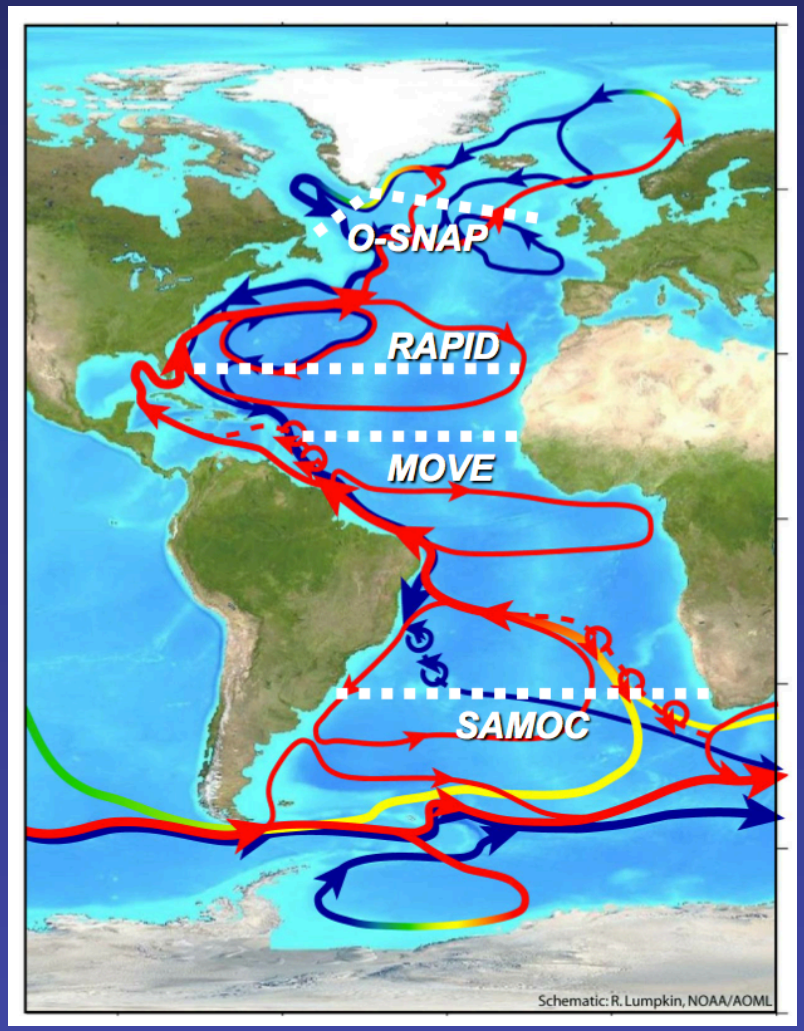
AMOC Observing System

Strategy:

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

Value:

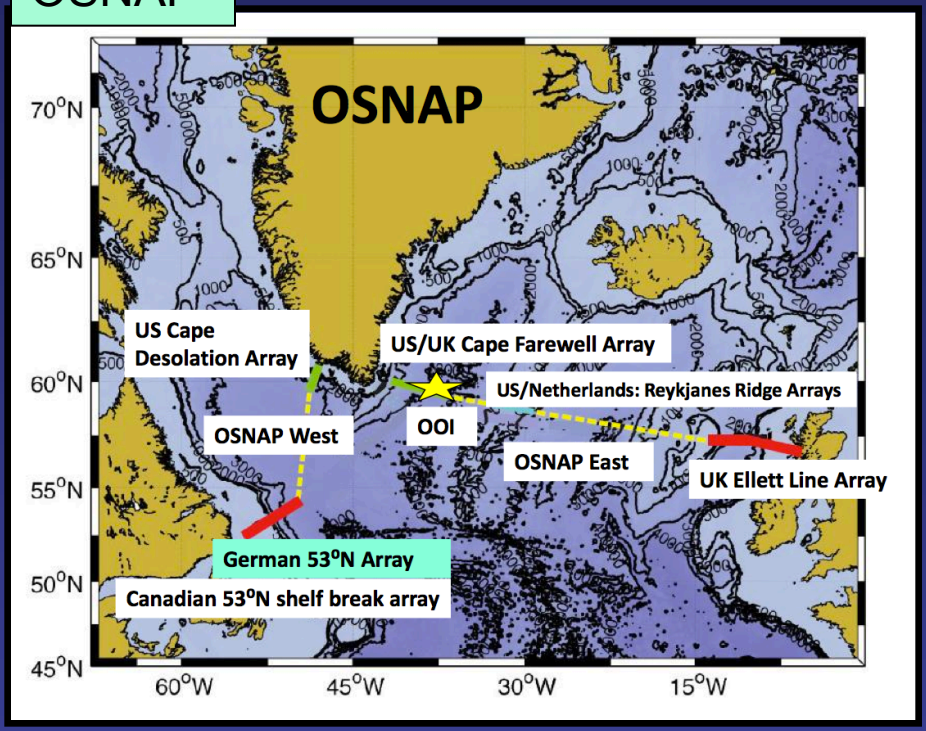
- ***Accurate*** multi-year mean AMOC estimates, for comparison with future (and past) AMOC states
- ***Understanding*** of processes underlying short-term (intraseasonal to annual) variability
- ***Benchmarks*** for evaluation of modeled AMOC variability (GCMs, data synthesis models)



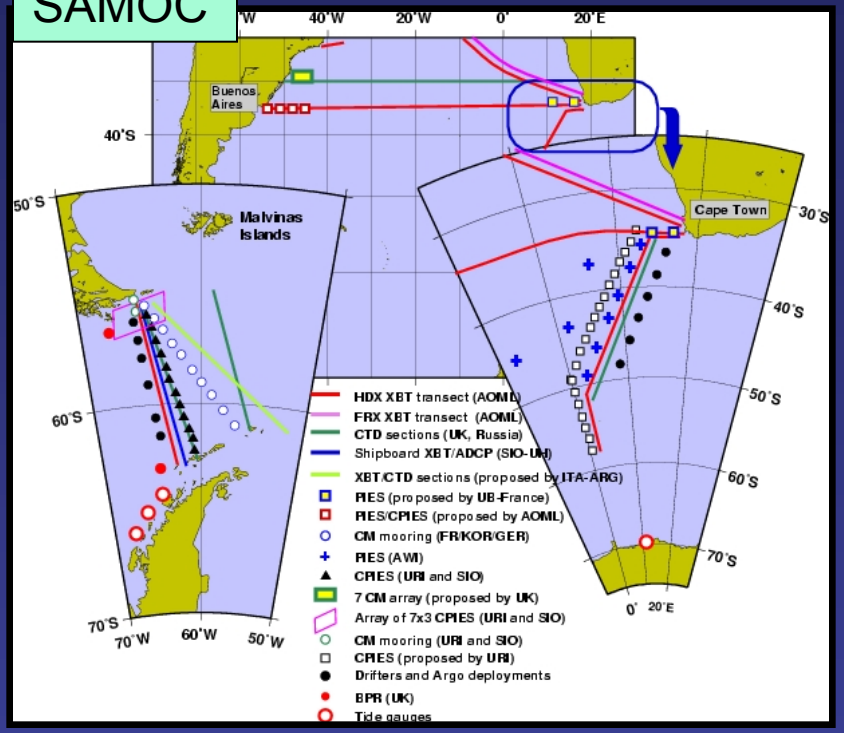
Subpolar North Atlantic

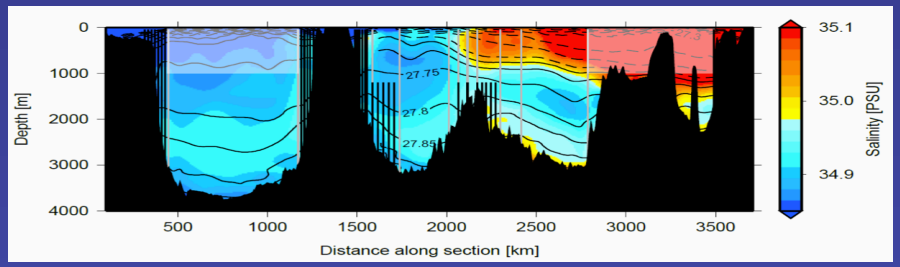
South Atlantic

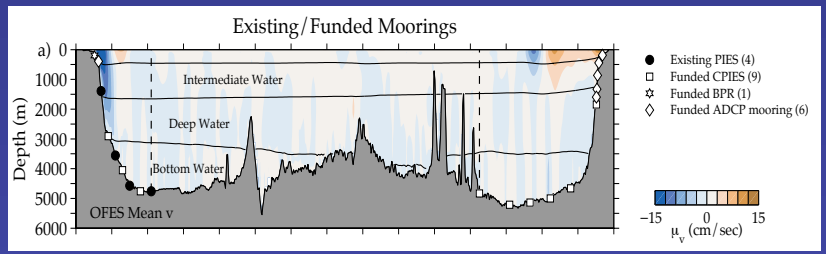
OSNAP



SAMOC





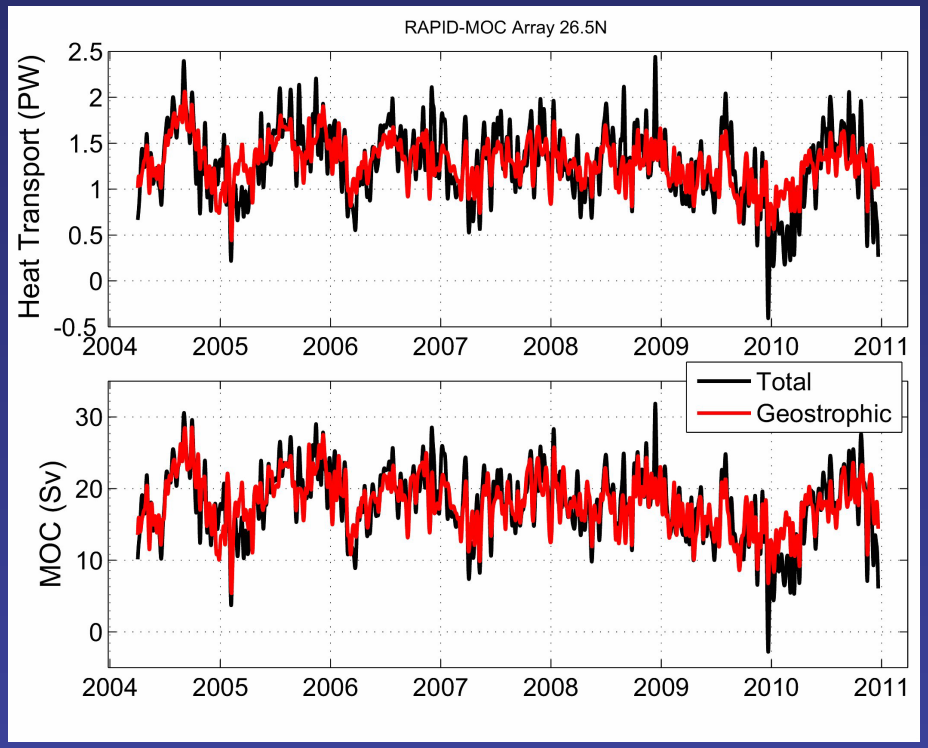


(U.S., U.K., Germany, Netherlands, Canada)

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

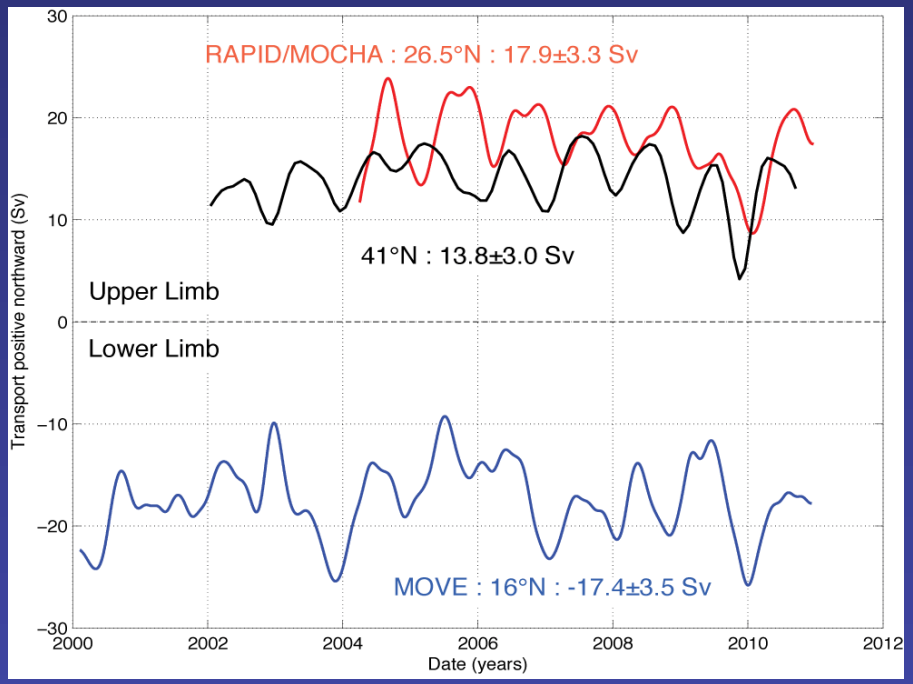
AMOC Variability from Observations

RAPID-MOCHA Array (26.5°N)



McCarthy et al. (2012)

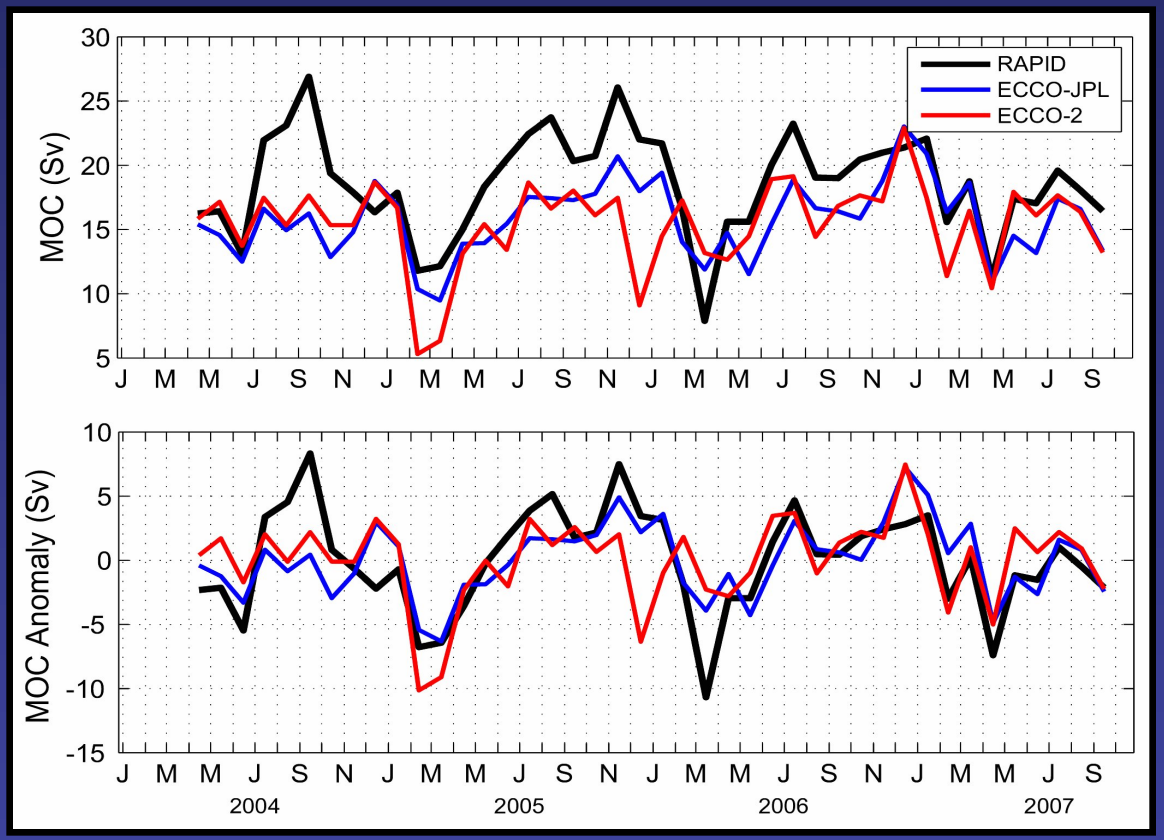
RAPID, MOVE, and 41°N (Willis)

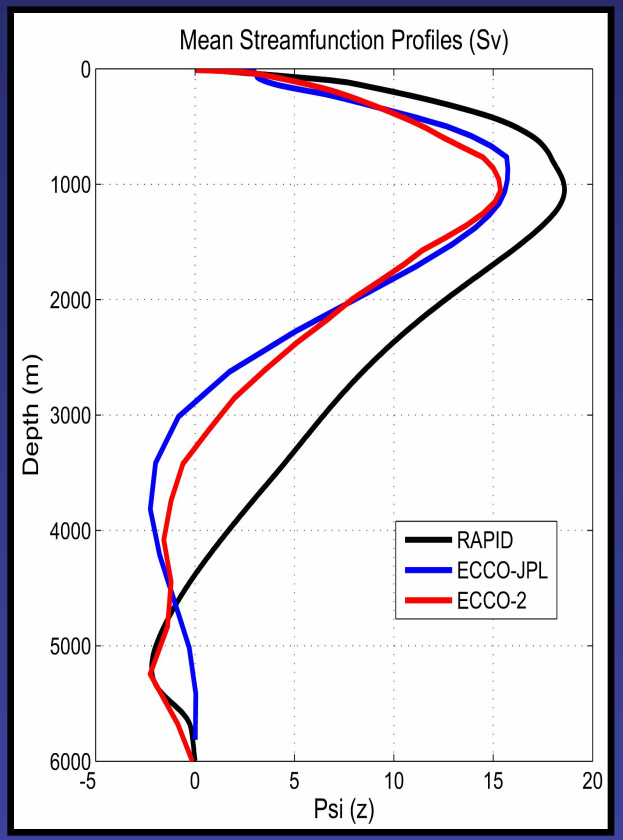


Baringer et al. (2012)
State of the Climate in 2011 (BAMS Suppl.)

Synthesis Models

RAPID vs. ECCO products

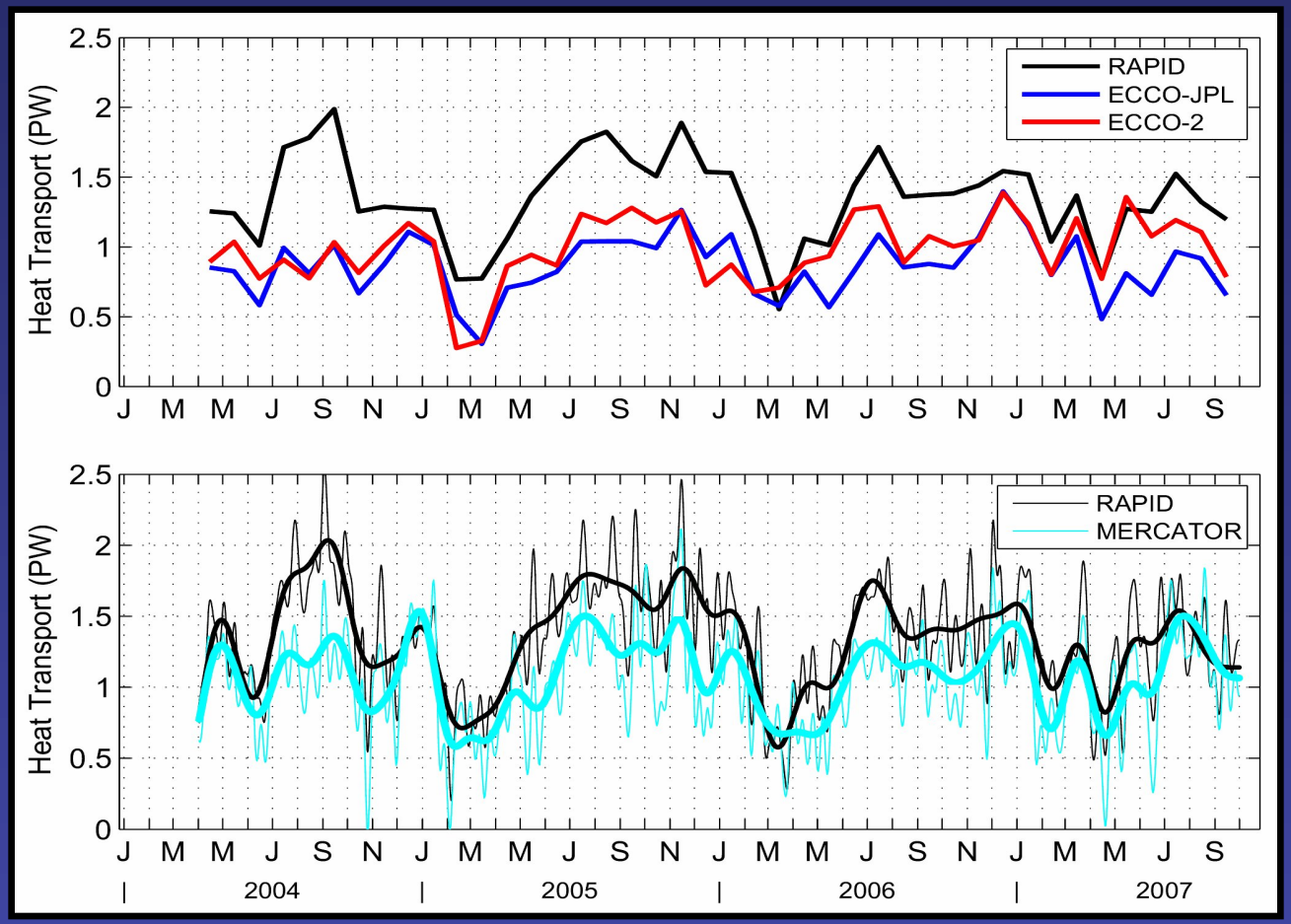




➔ *Anomaly agreement is encouraging; biases still exist*

Synthesis Models: Heat Transport

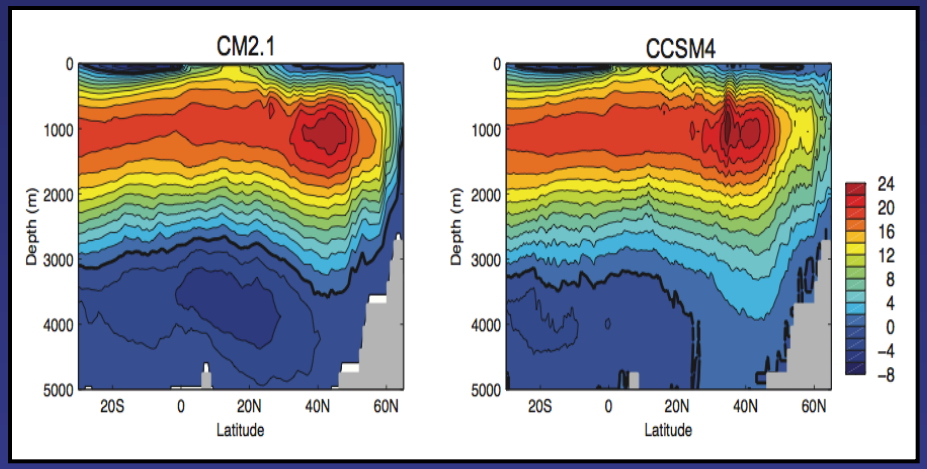
RAPID vs. ECCO products

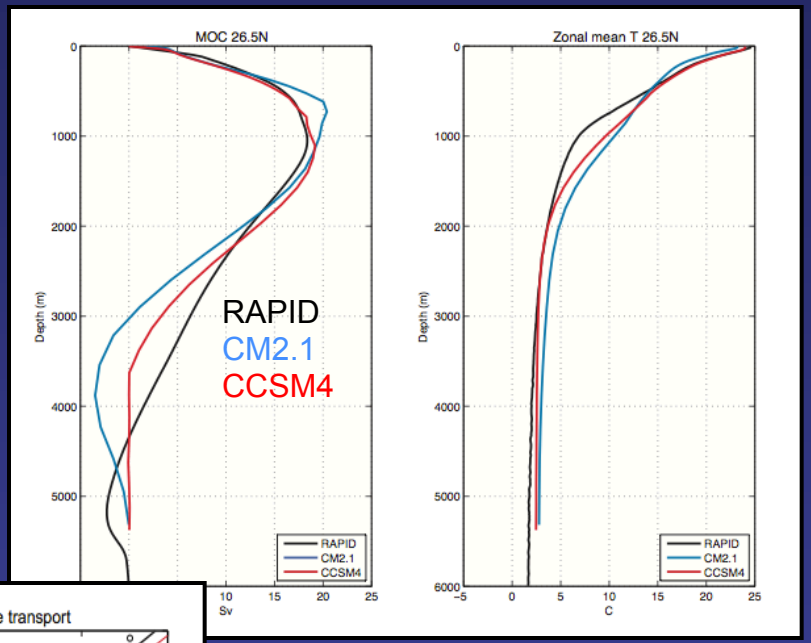


➔ *Heat transport tends to be biased to a greater degree than MOC strength*

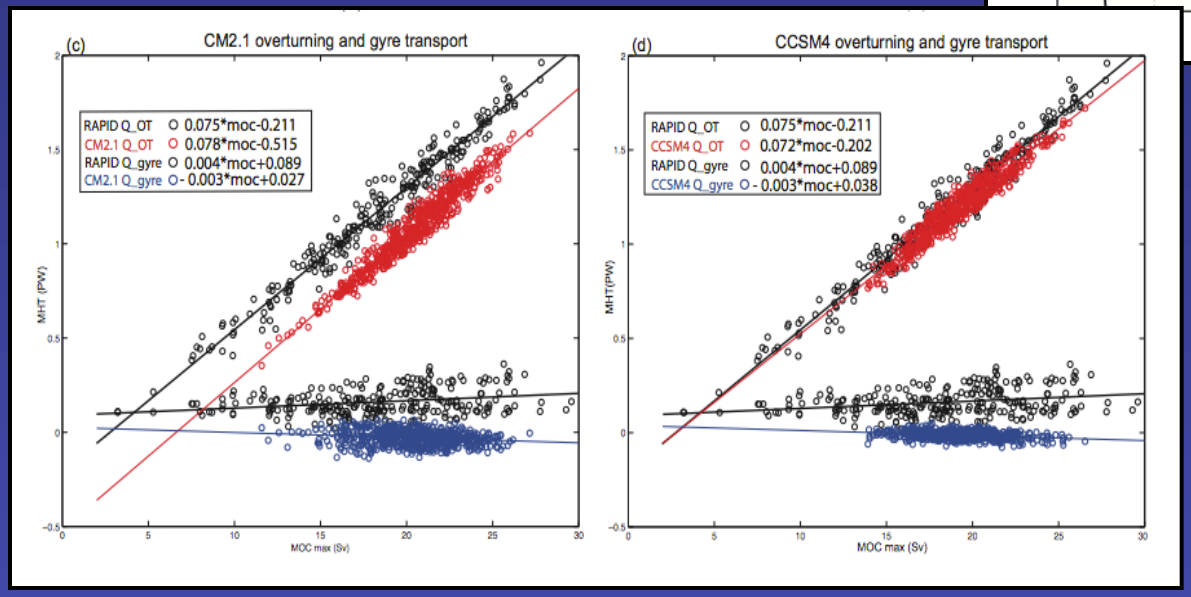
AMOC Representation in Coupled Models

Model Overturning Streamfunctions





MOC profiles at 26.5°N vs. RAPID

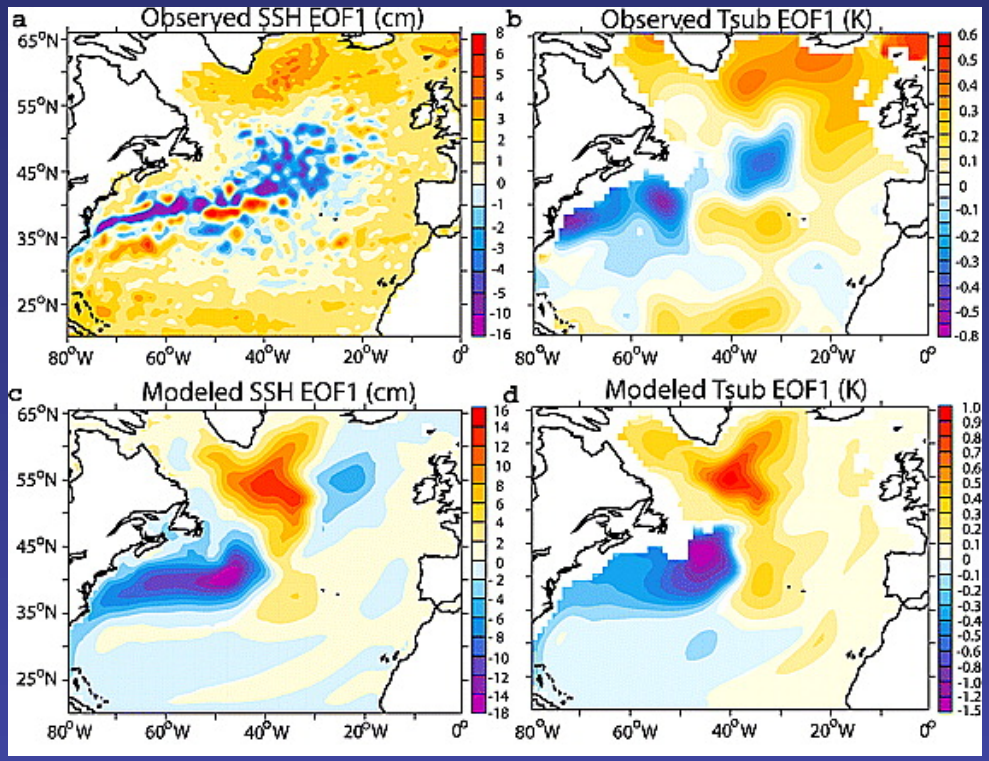


Overturning and gyre heat transport regressed against the MOC strength

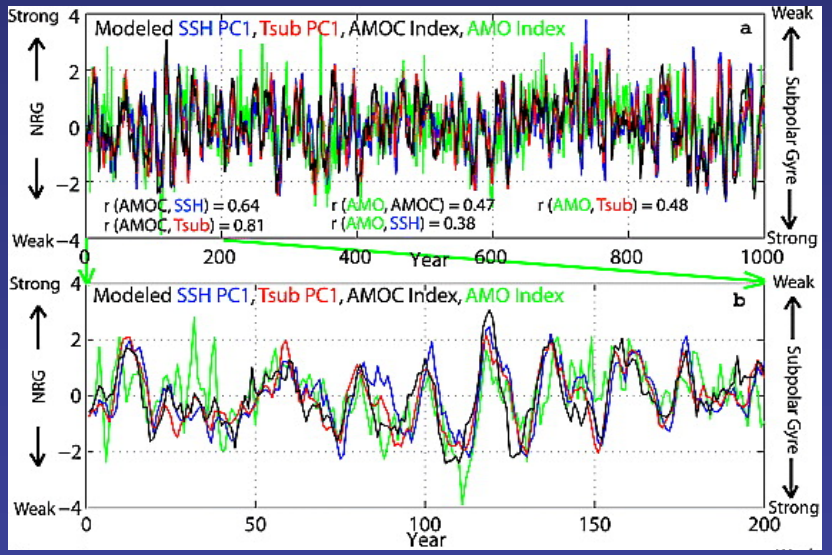
Msadek et al. (2012)

AMOC "Fingerprinting"

Observed and modeled 1st EOFs of sea surface height (SSH) and subsurface temperature (Tsub)



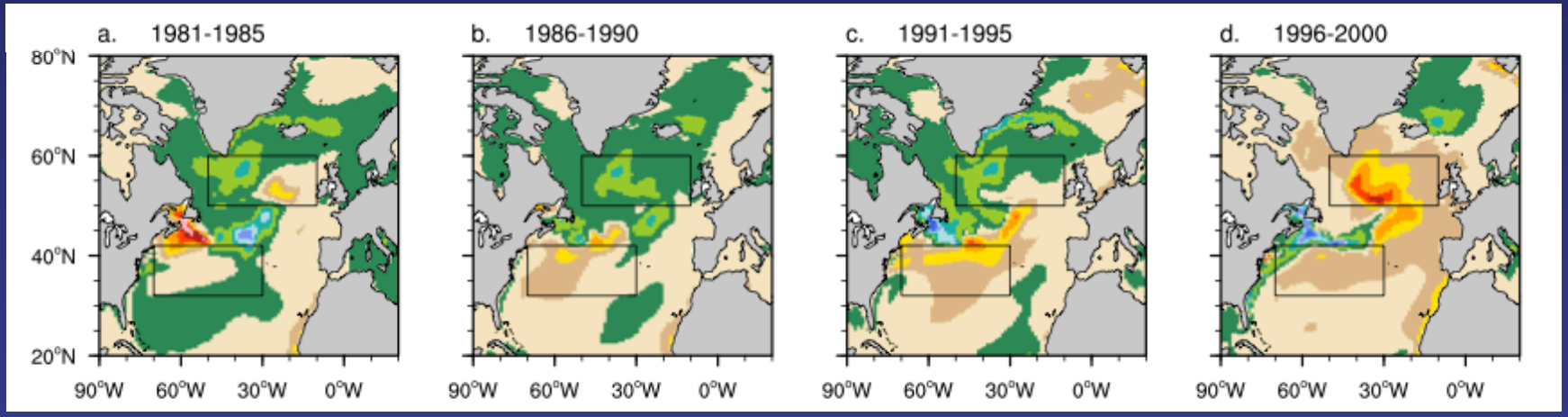
Time series of SSH, Tsub, and AMO index vs. AMOC strength



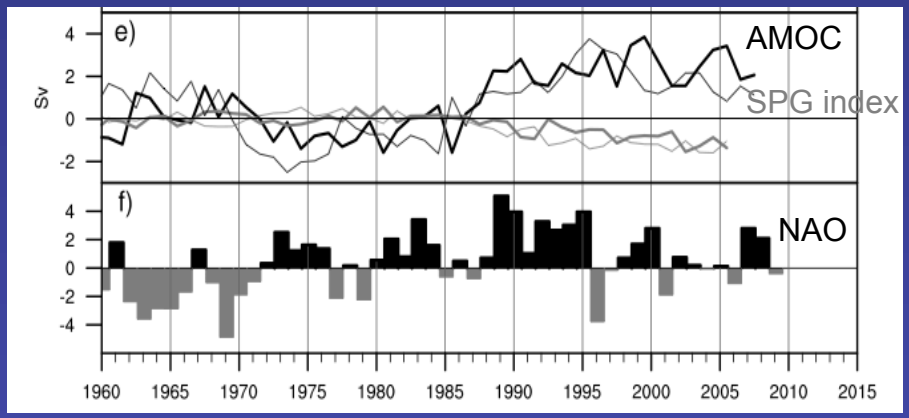
Zhang et al. (2008), Mahajan et al. (2011)
GFDL CM2.1

AMOC Mechanisms and Predictability

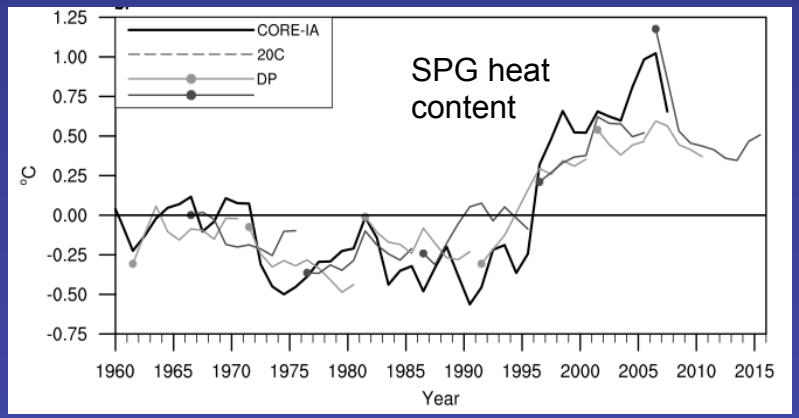
Predictability of the subpolar gyre warming in the late 1990's:



CCSM4 hindcast with CORE-IA forcing

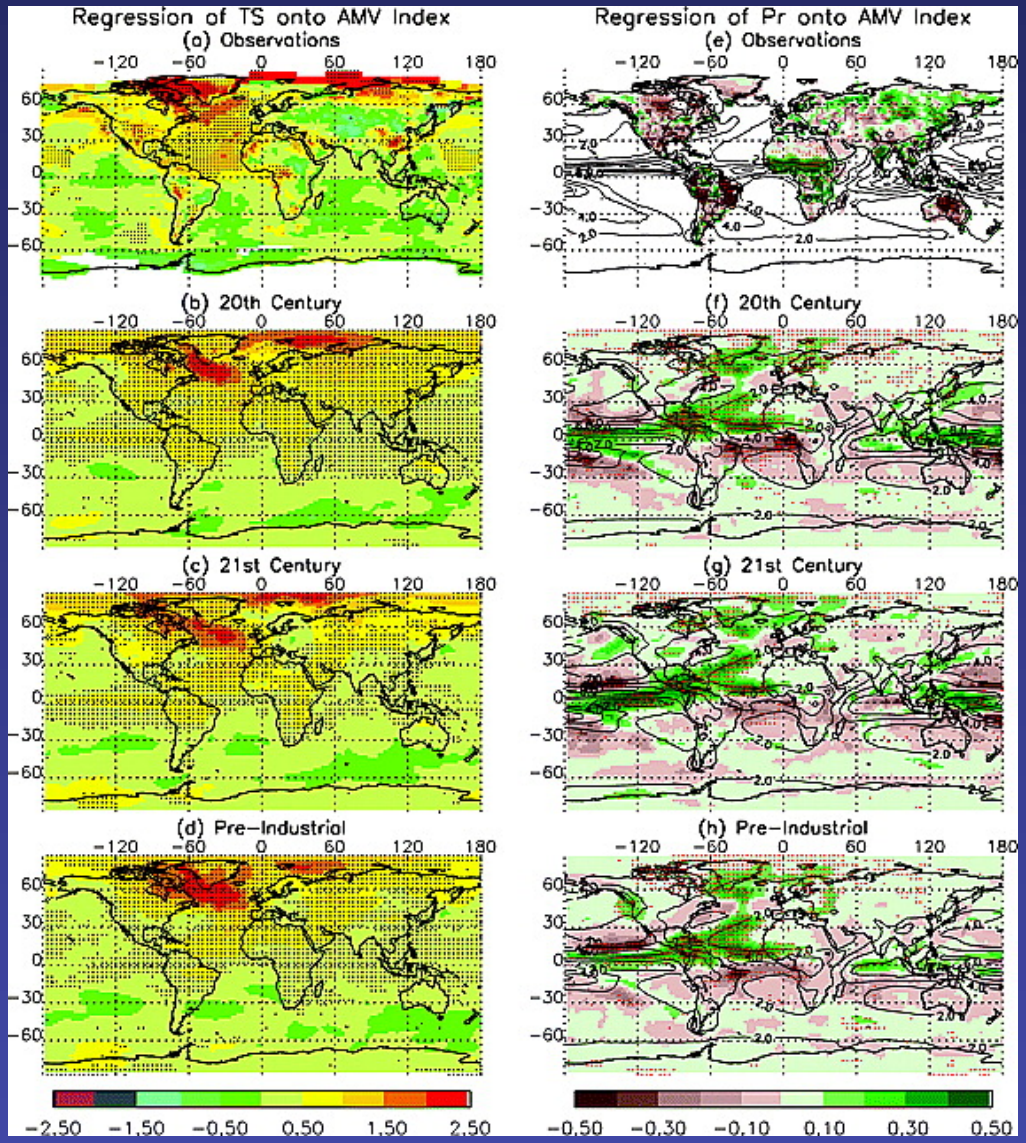


Decadal predictions init. w/ hindcast

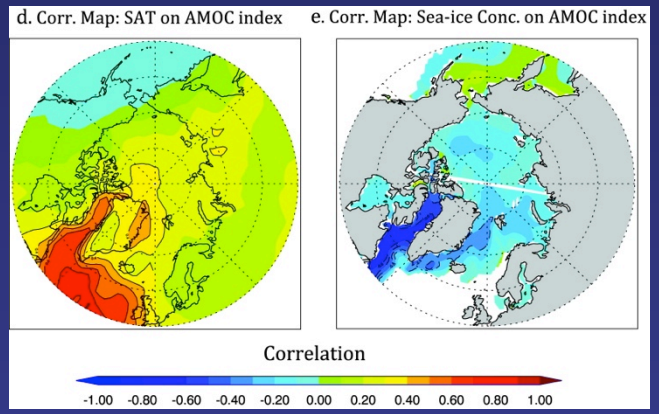


Yeager et al. (2012)

AMOC/AMV Climate Impacts



AMOC impacts on sea ice



Mahajan et al (2011), CM2.1

Global precipitation variability linked to AMV

Ting et al (2011)

2012 USAMOC Annual Meeting

Aug. 15-17, NCAR, Boulder, CO

Agenda:

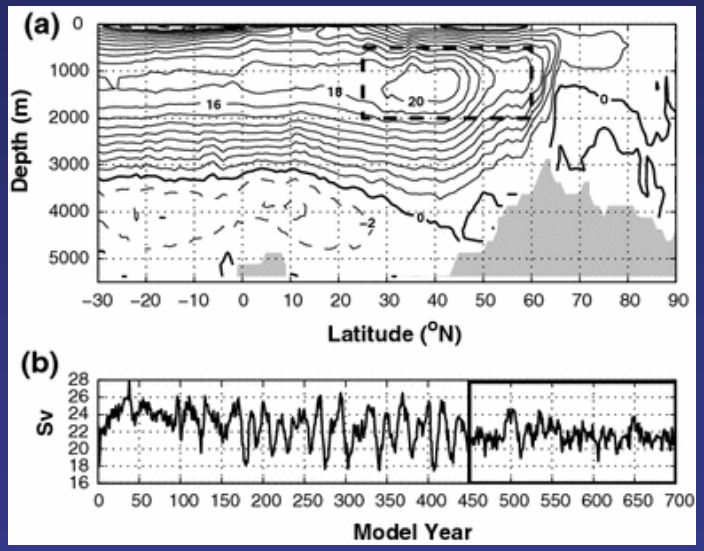
- **1 day for presentations**
- **1 day for "mini-workshops"**
- **½ day for mini-workshop reports and discussion on future directions/ priorities**

Mini-workshops:

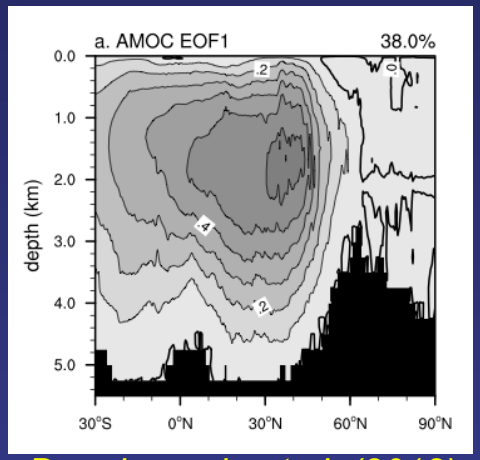
1. AMOC fingerprinting from historical and proxy data
   Speakers: Ben Horton, Casey Saenger
2. AMOC's impact on the carbon cycle
   Speakers: Galen McKinley, Scott Doney
3. The AMOC observing system
   Speakers: Johanna Baehr, Rui Ponte
4. AMOC Mechanisms and Predictability
   Speakers: Tom Delworth, Grant Branstator

AMOC Variability Mechanisms

AMOC variability in CCSM3 and CCSM4

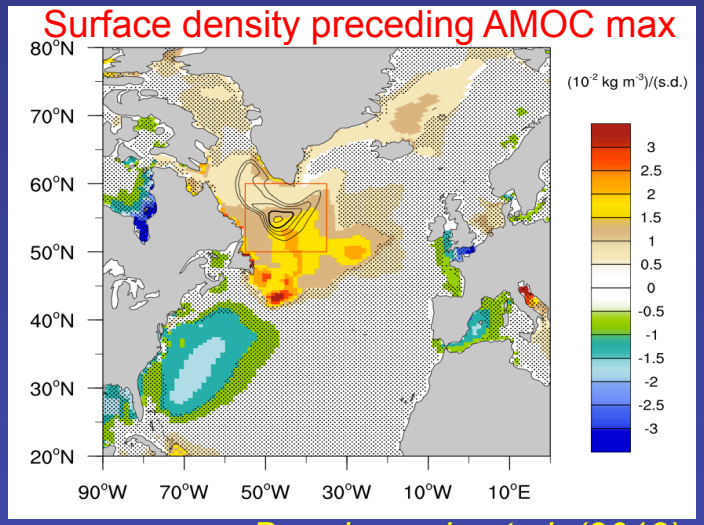


Kwon and Frankignoul (2012)

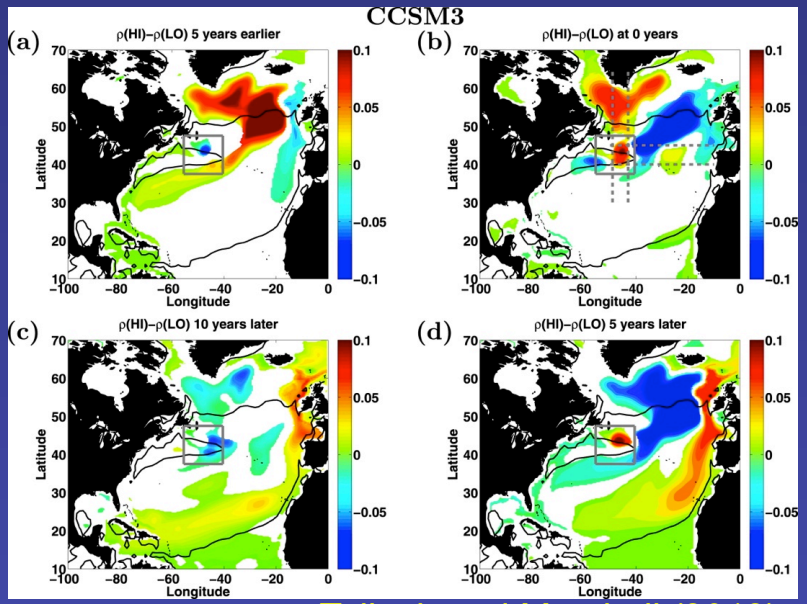


Danabasoglu et al. (2012)

Surface density preceding AMOC max



Danabasoglu et al. (2012)



Tulloch and Marshall (2012)