An Assessment of Atlantic Meridional Overturning Circulation (AMOC) in Coordinated Ocean-ice Reference Experiments (CORE-II)

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NOAA — National Oceanic and Atmospheric Administration, U.S. Department of Commerce

NCAR — National Center for Atmospheric Research

CORE-II

An experimental protocol for ocean – ice coupled simulations forced with inter-annually varying atmospheric data sets for the 1948-2007 period (Large and Yeager 2009). This effort is coordinated by the CLIVAR Working Group on Ocean Model Development (WGOMD).

These hindcast simulations provide a framework for

- evaluation, understanding, and improvement of ocean models,
- investigation of mechanisms for seasonal, inter-annual, and decadal variability,
- evaluation of robustness of mechanisms across models,
- complementing data assimilation in bridging observations and modeling and in providing ocean initial conditions for climate (decadal) prediction simulations.

CORE-II PROTOCOL

- The models are integrated for a minimum of 300 years, corresponding to 5 cycles of the 60-year forcing period.
- After an assessment of degree of equilibrium achieved, the solutions from the last cycle are analyzed.
- Participants are free in their choices of ocean parameterizations, their parameter values, surface freshwater / salt flux treatments, and sea-ice models.

The CORE datasets are periodically updated (currently through 2009) and collaboratively supported by NCAR and GFDL. They can be accessed via

- WGOMD CORE web pages
- http://data1.gfdl.noaa.gov/nomads/forms/core.html

Participating groups (18 models):

- Australia: CSIRO (ACCESS)
- France: CERFACS, CNRM
- Germany: AWI, IfM-GEOMAR (KIEL)
- Italy: CMCC, ICTP
- Japan: MRI (free, DA)
- Norway: U. Bergen
- Russia: RAS (INMOM)
- UK: NOCS
- USA: FSU, GFDL-GOLD, GFDL-MOM, MIT, NASA GISS, NCAR

Level, isopycnal, hybrid, mass, and sigma coordinates; unstructured finite element ocean model; mostly nominal 1° horizontal resolutions

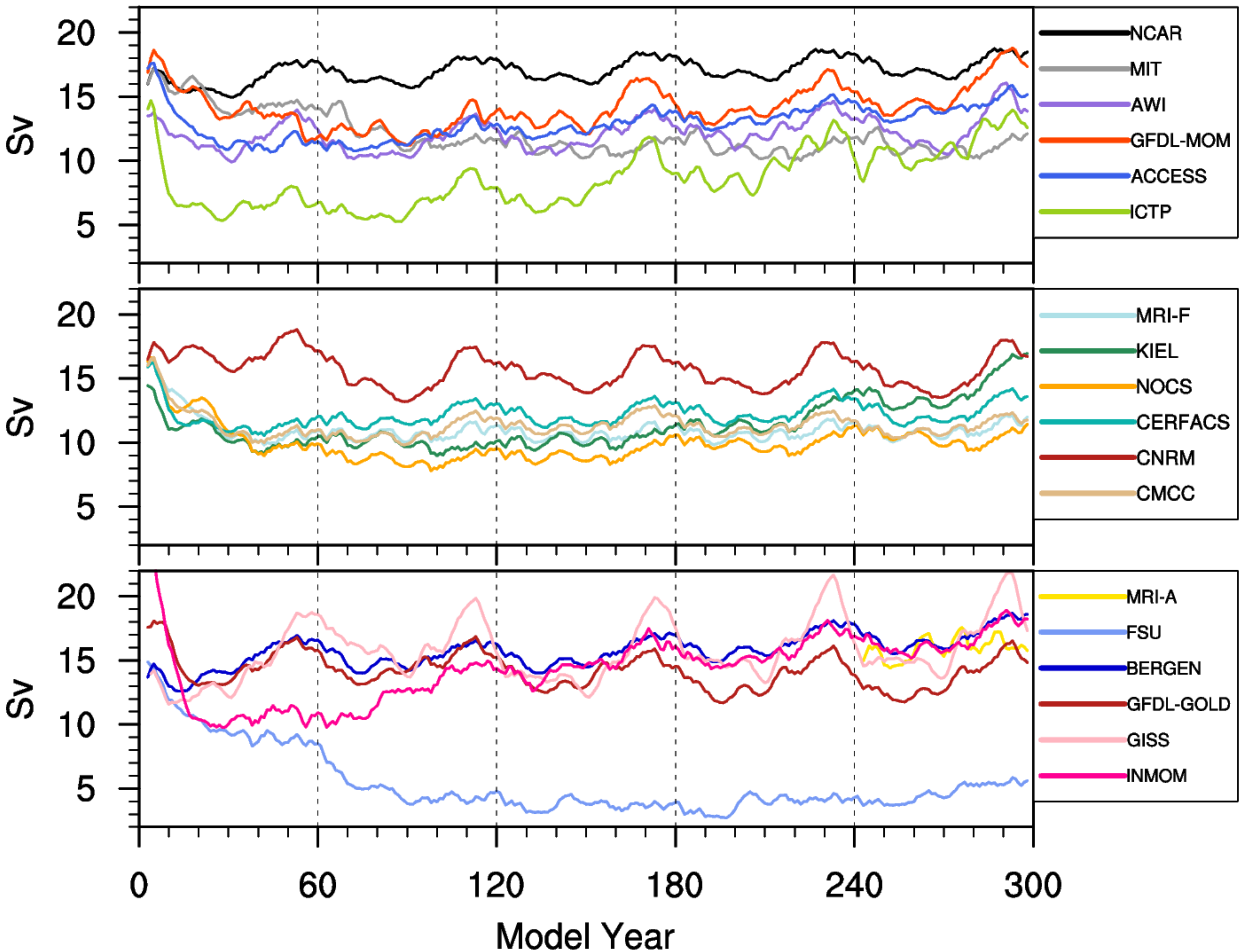
Hypothesis: Global ocean – sea-ice models integrated using the same inter-annually varying atmospheric forcing data sets produce qualitatively very similar mean and variability in their simulations.

We test this hypothesis, considering the mean states and inter-annual to decadal variability in the North Atlantic with a focus on the AMOC.

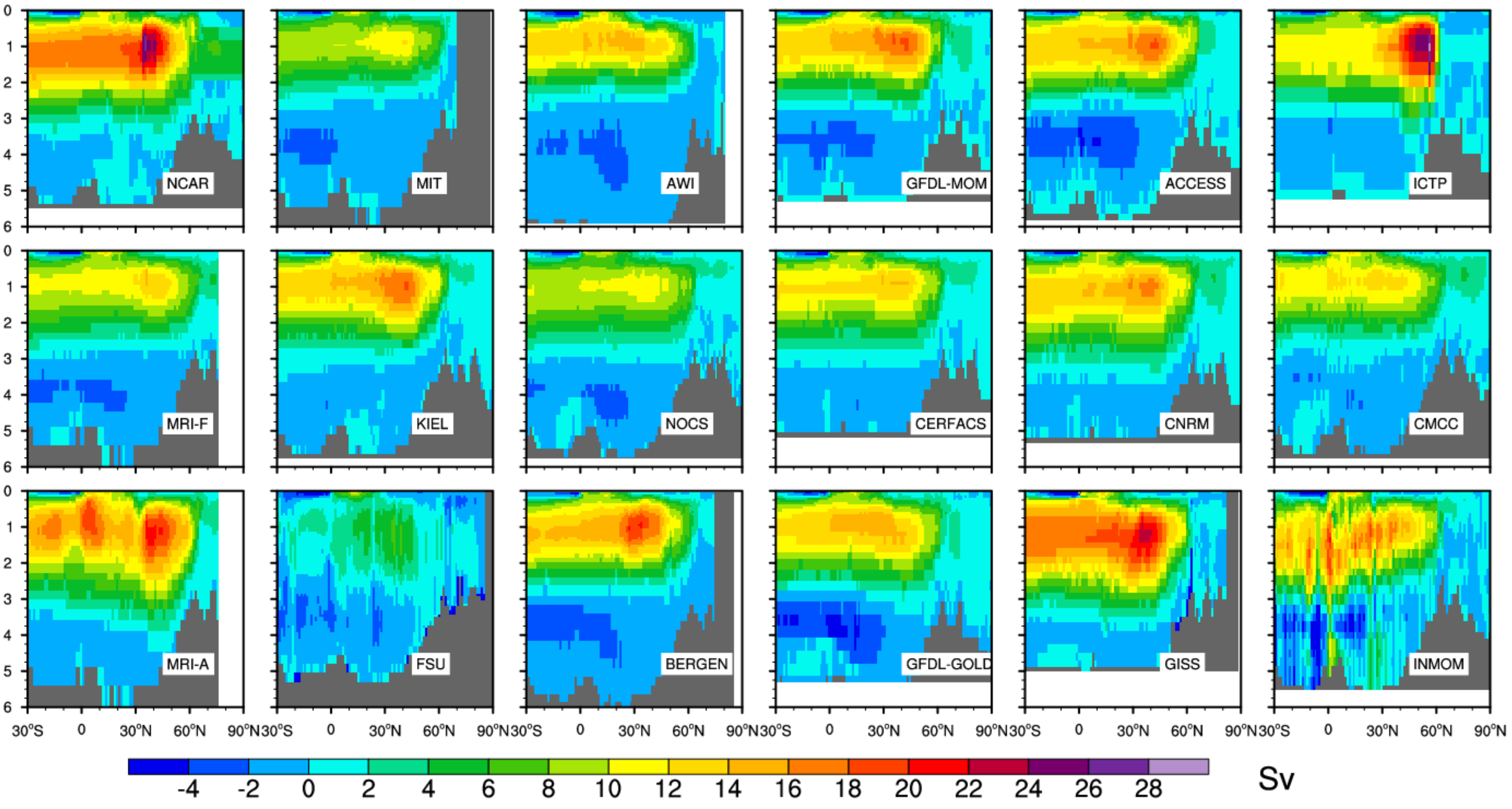
Danabasoglu, et al., 2014: North Atlantic Simulations in Coordinated Ocean-ice Reference Experiments phase II (CORE-II). Part I: Mean States. *Ocean Modelling,* v73, 76-107, doi:10.1016/j.ocemod.2013.10.005.

Two new HYCOM contributions: FSU2 and GISS2.

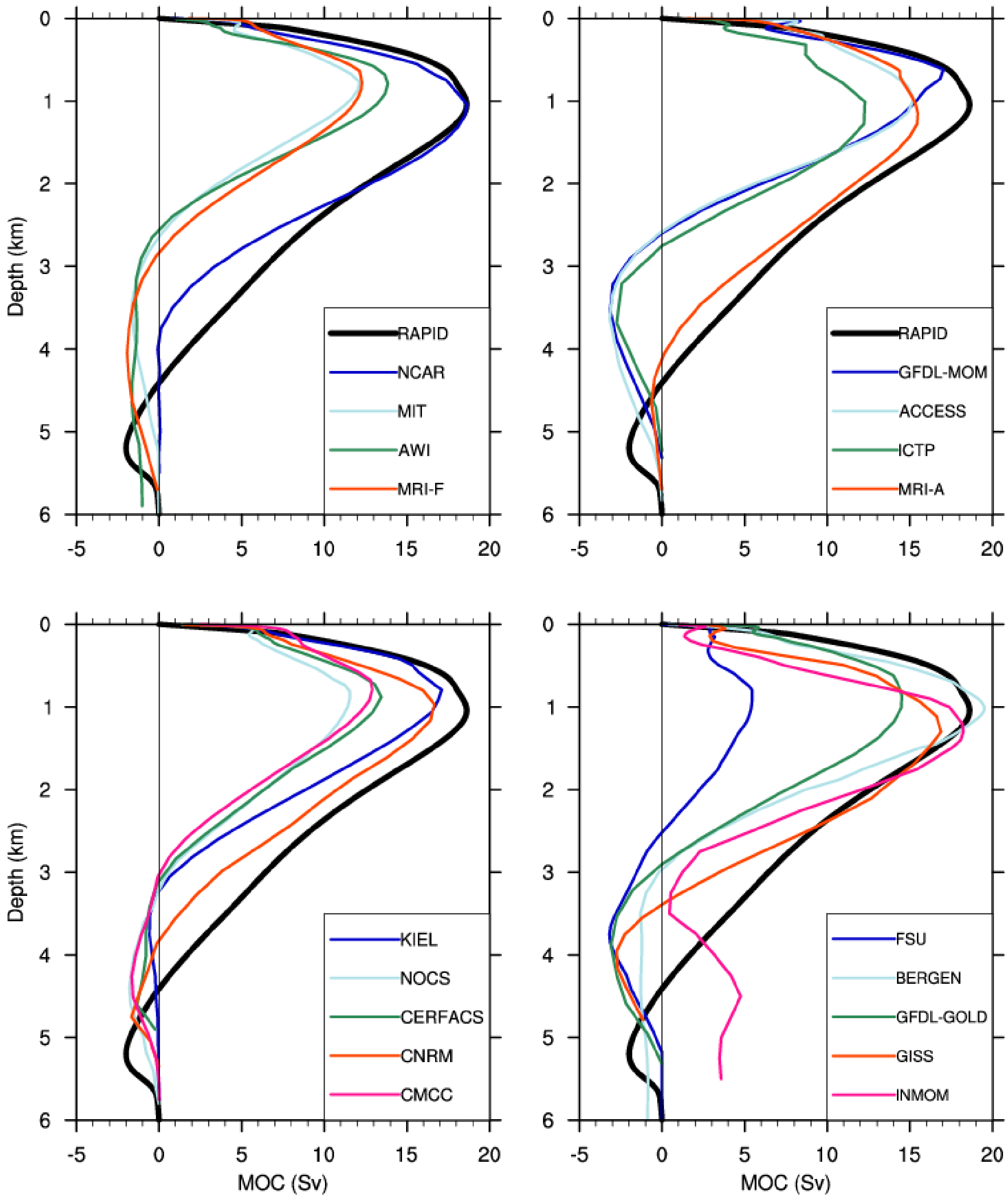
AMOC Annual-Mean Maximum Transport Time Series at 26.5°N

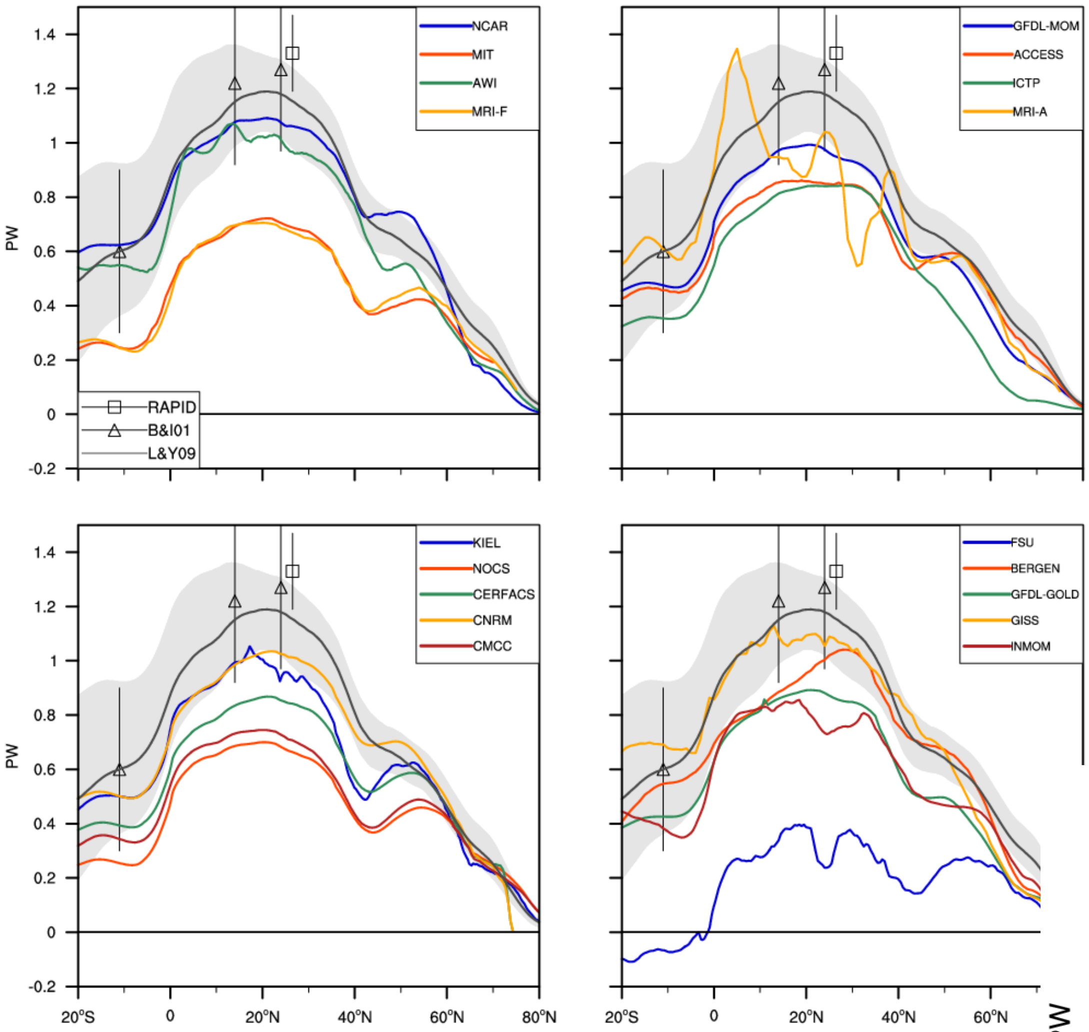


AMOC Mean (1988-2007) in Depth Space

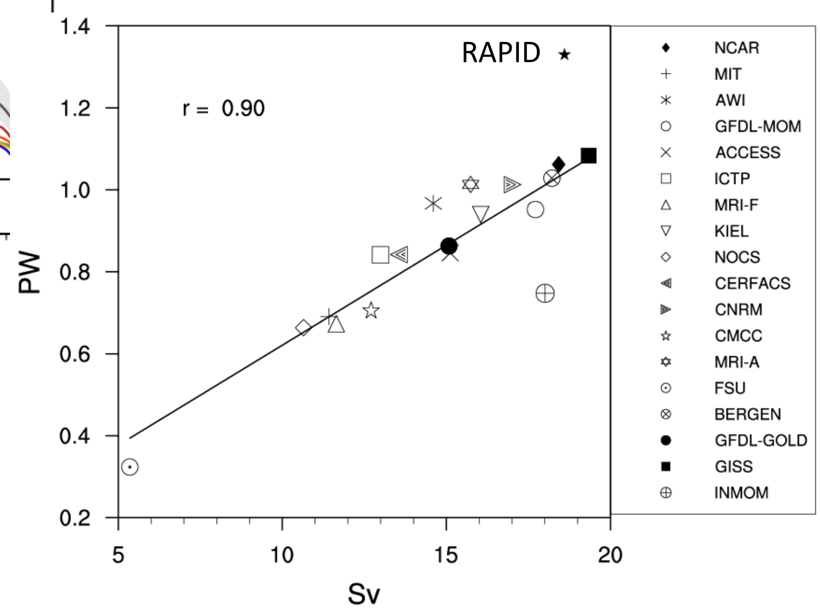


AMOC at 26.5ºN (2004-2007)



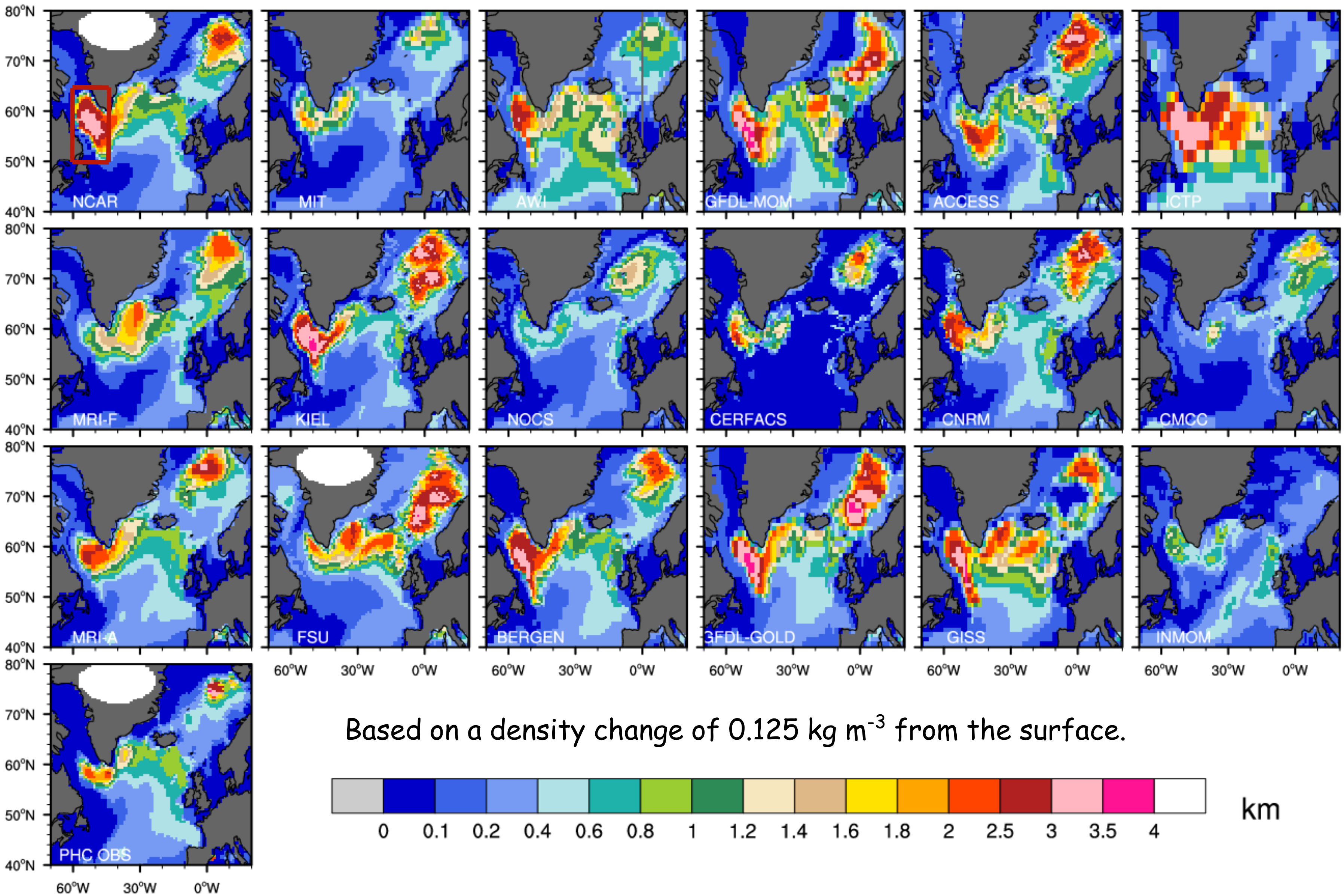


Atlantic Meridional Heat Transport (1988-2007)



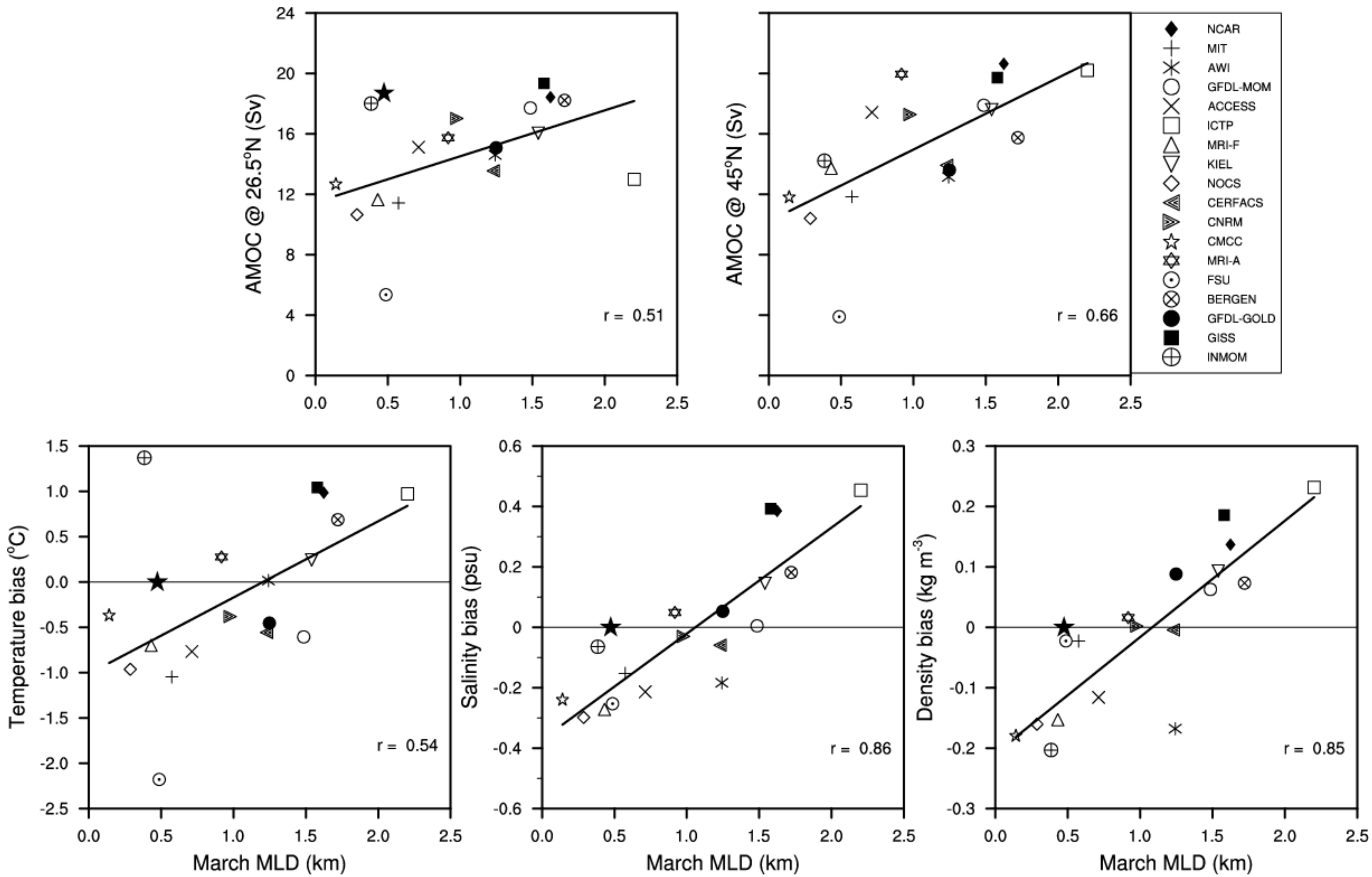
MHT vs. AMOC maximum at 26.5°N

March-Mean Mixed Layer Depth (MLD) (1988-2007)



Based on a density change of 0.125 kg m^{-3} from the surface.

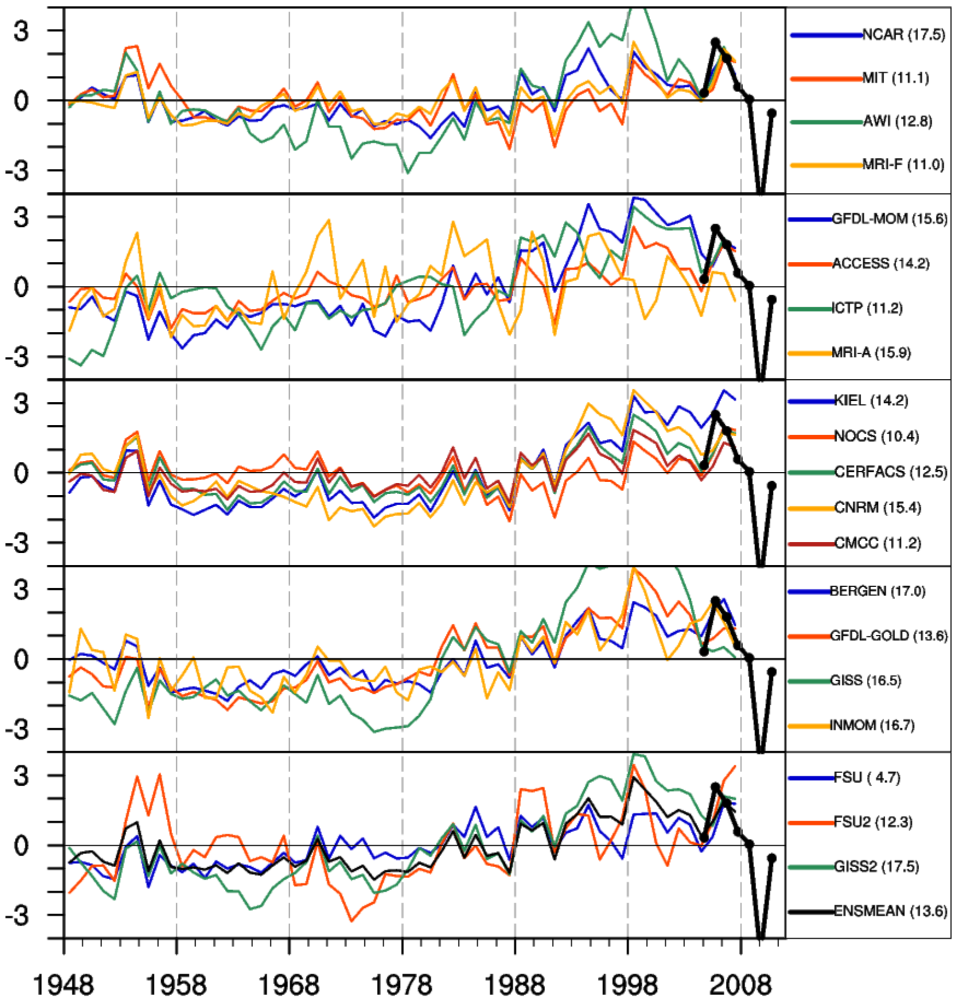
AMOC Maximum Transports, Labrador Sea Potential Temperature, Salinity, and Density Biases vs. Labrador Sea March-Mean Mixed Layer Depth



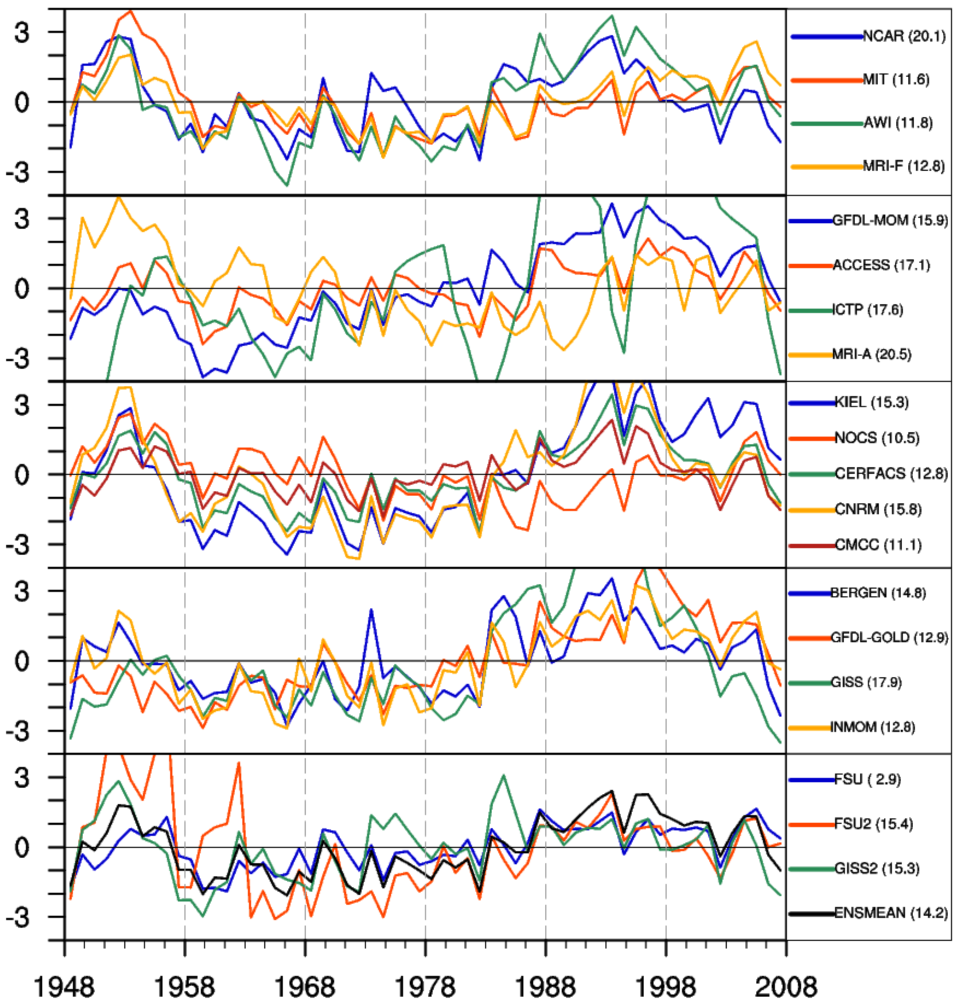
Stars denote observations.

AMOC Maximum Transport Anomaly Time Series for the Last Cycle (base period 1948-2007)

26.5°N

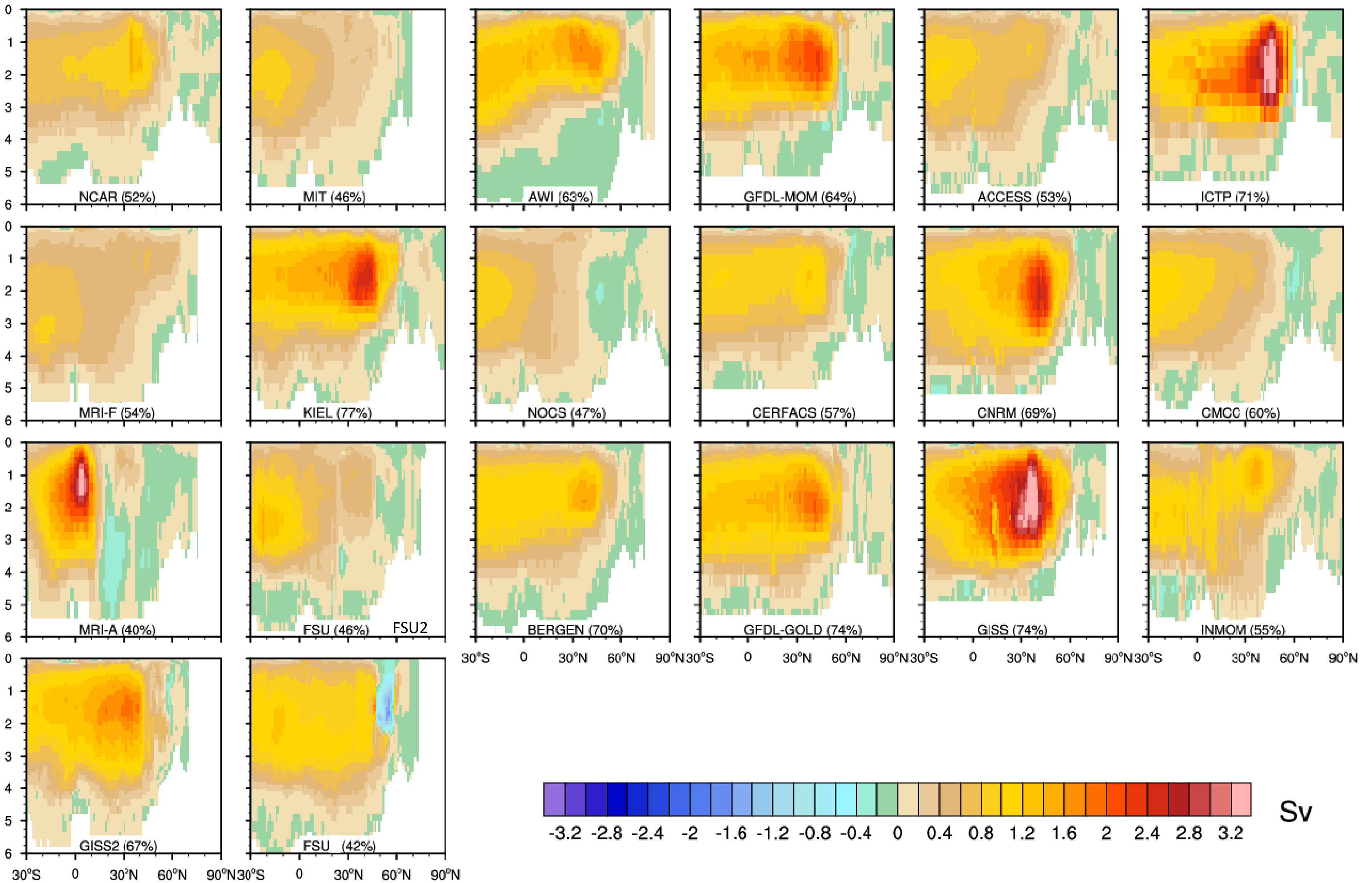


45°N

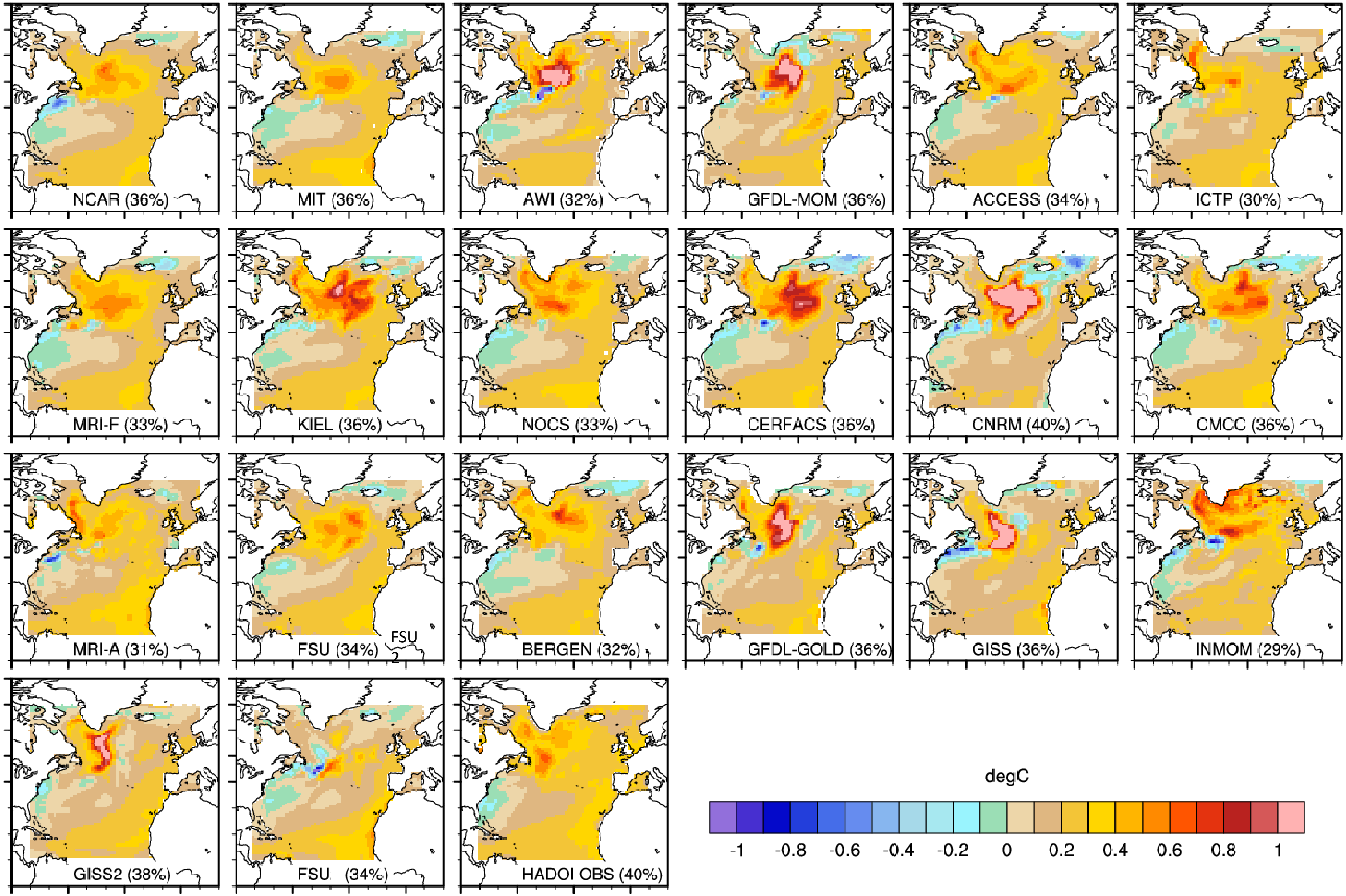


in Sv

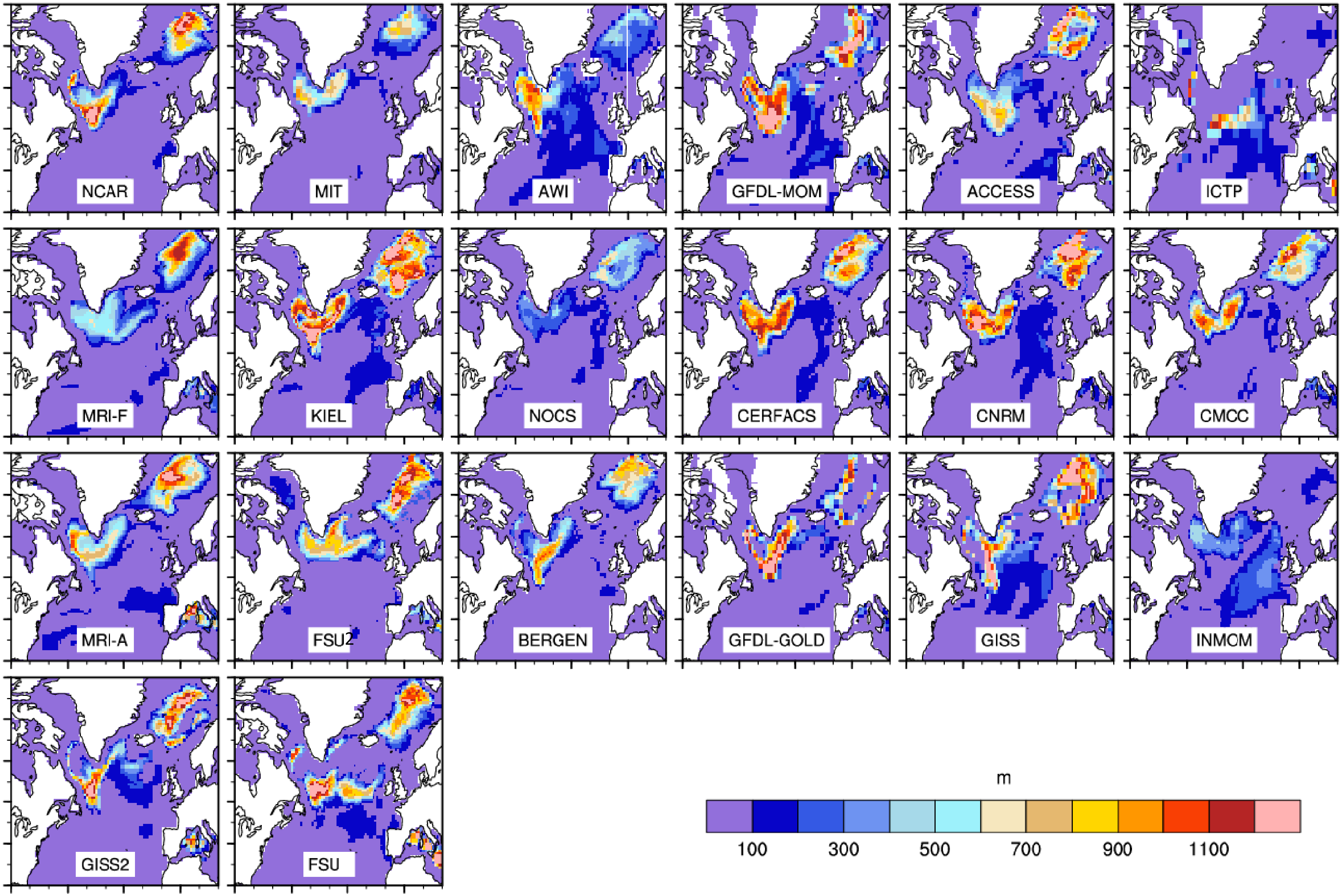
AMOC EOF1 (1958-2007)



Sea Surface Temperature EOF1 (1958-2007)



March-Mean MLD Standard Deviation (1958-2007)



SUMMARY AND CONCLUSIONS

•Ocean – sea-ice simulations forced with the same CORE-II atmospheric data sets produce significantly different mean states and variability.

•No grouping of model solutions based on model family or vertical coordinate representation is obvious.

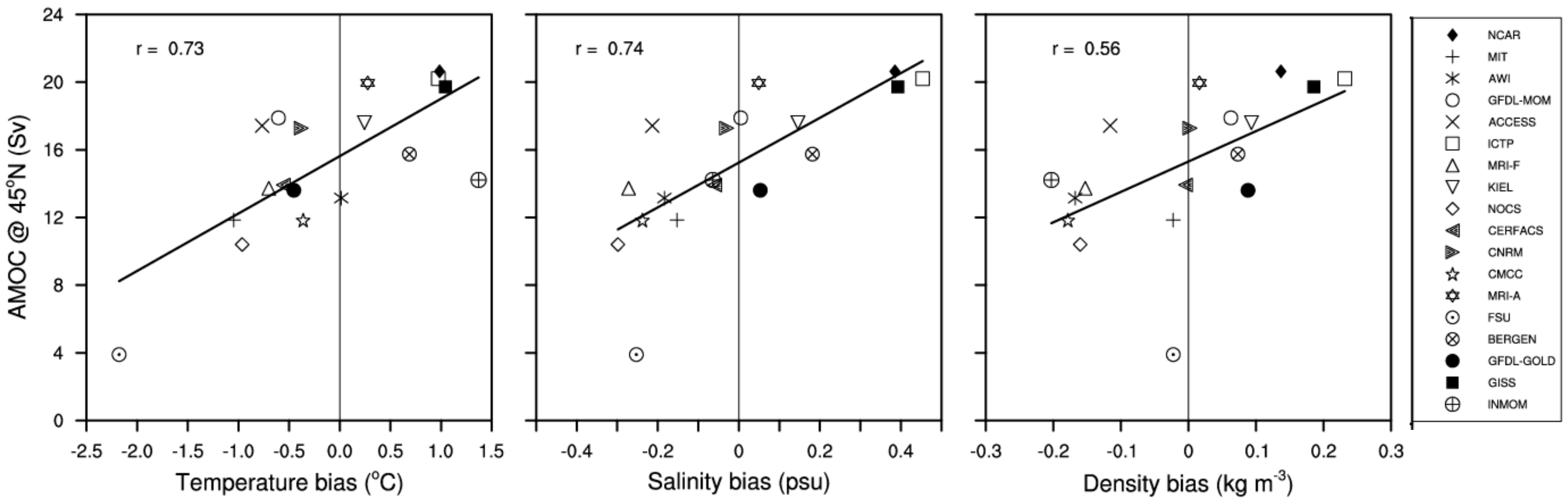
•Solution differences are primarily due to differences in ocean model parameterizations and their parameter choices. Use of a wide variety of sea-ice models with diverse snow and sea-ice albedo treatments also contributes to the solution differences.

•In general for the mean states:

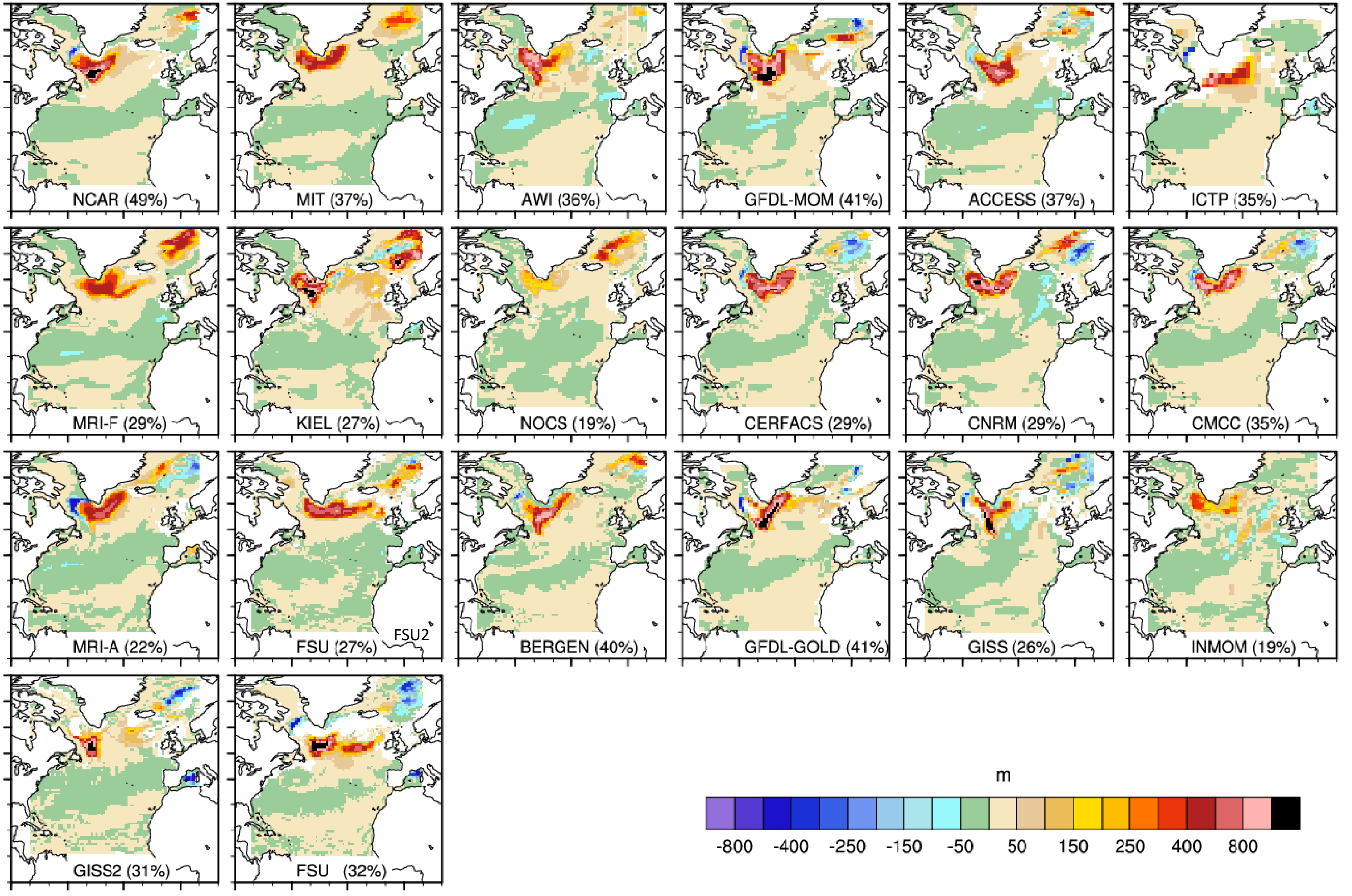
- the models with deeper MLDs in the LS region tend to have larger AMOC transports,

- in such models, the LS region exhibits positive temperature and salinity biases, with the latter dominating changes in density.

AMOC Maximum Transport at 45°N vs. Labrador Sea Upper-Ocean Potential Temperature, Salinity, and Density Biases



March-Mean Mixed Layer Depth EOF1 (1958-2007)



AMOC Standard Deviation (1958-2007)