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

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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 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

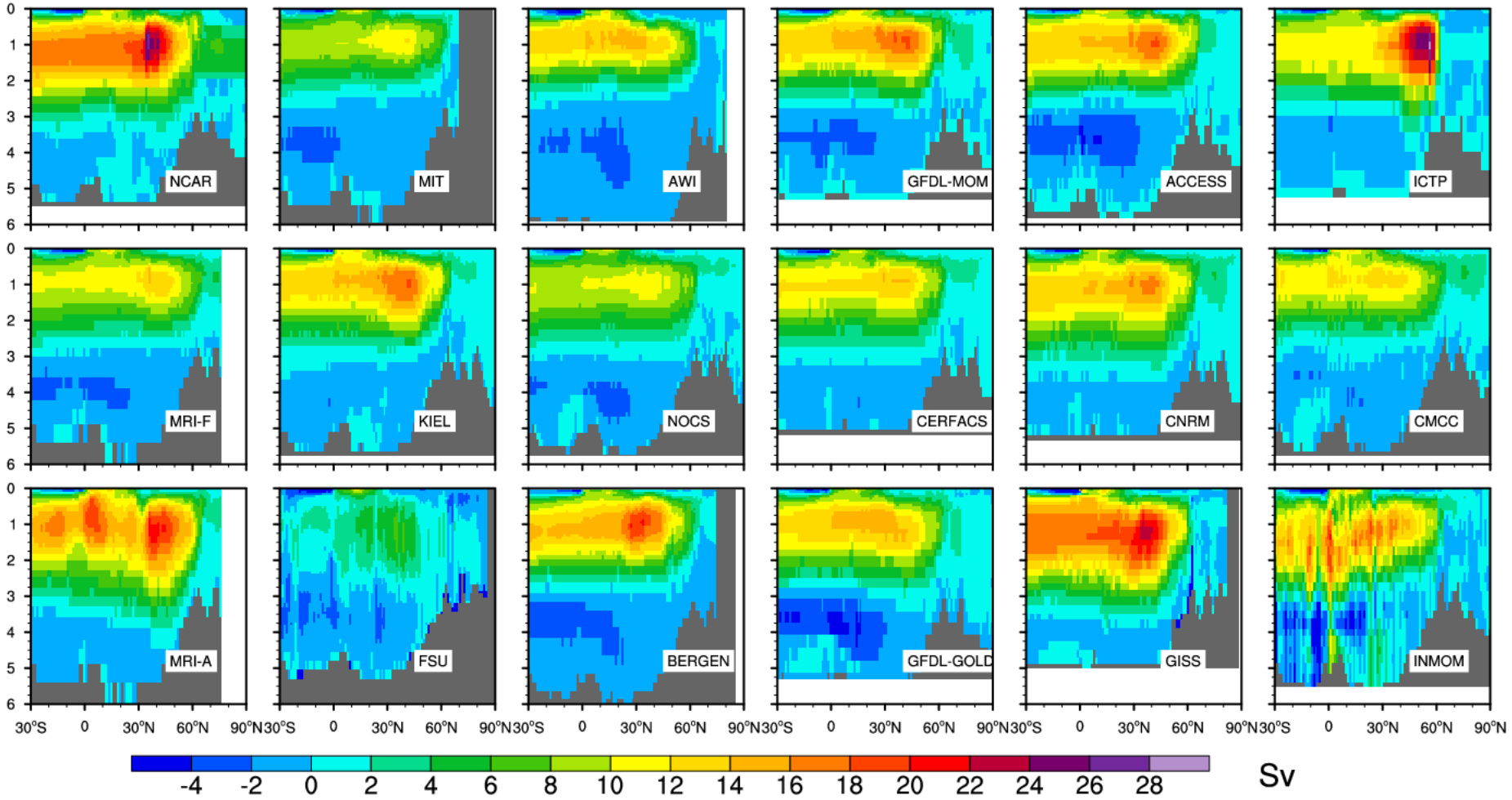
Level, isopycnal, hybrid, mass, and sigma coordinates; unstructured finite element ocean model; mostly nominal 1° horizontal resolutions

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.

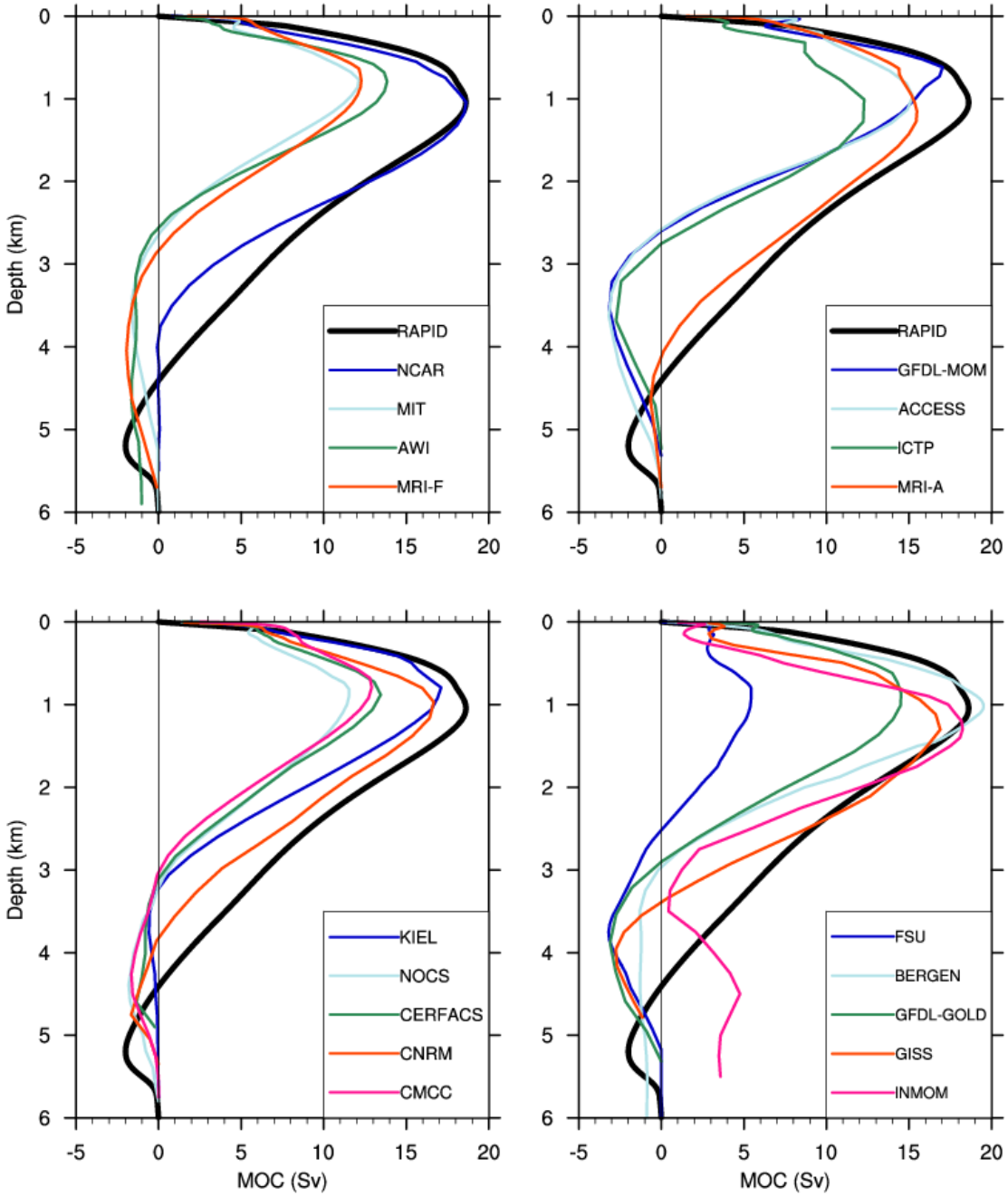
We test this hypothesis, considering the mean states in the North Atlantic with a focus on the AMOC.

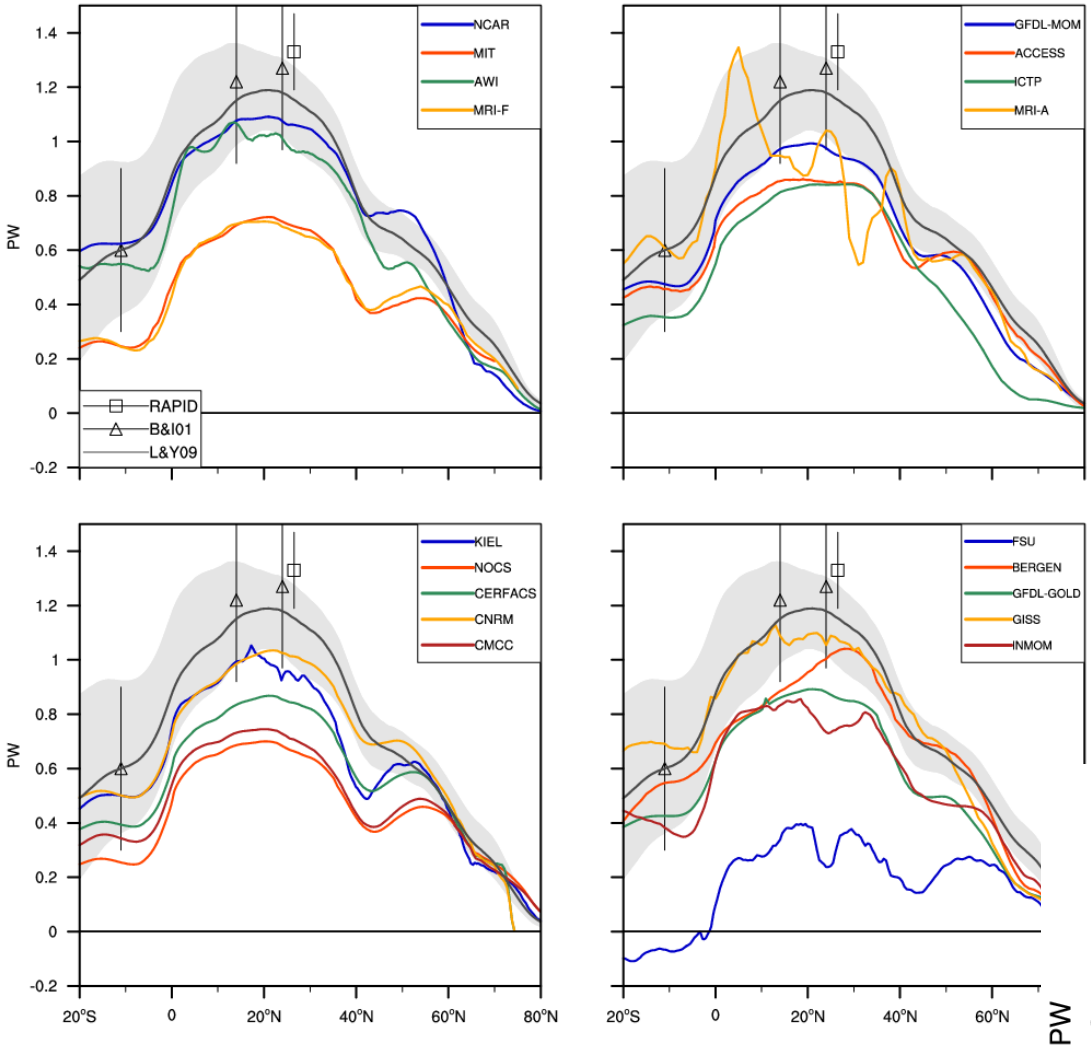
Danabasoglu, et al., 2013: North Atlantic Simulations in Coordinated Ocean-ice Reference Experiments phase II (CORE-II). Part I: Mean States. *Ocean Modelling* (in review).

AMOC Mean (1988-2007) in Depth Space

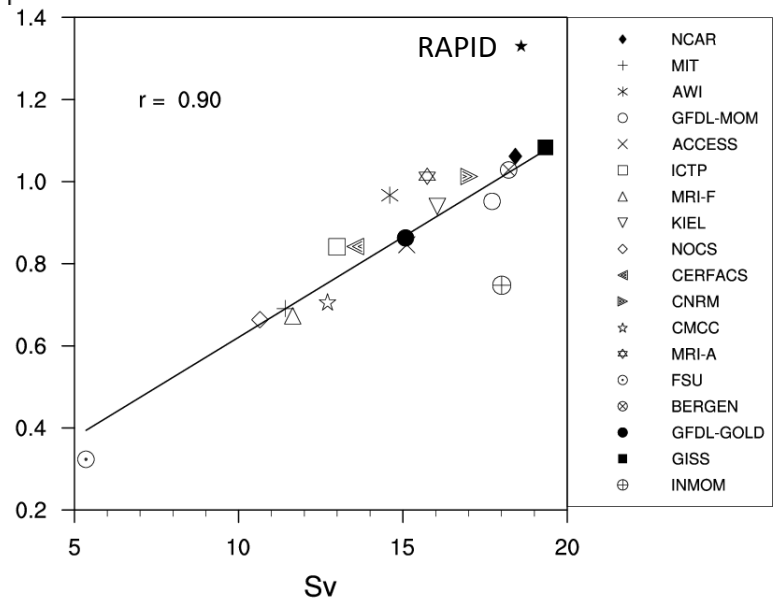


AMOC at 26.5ºN (2004-2007)



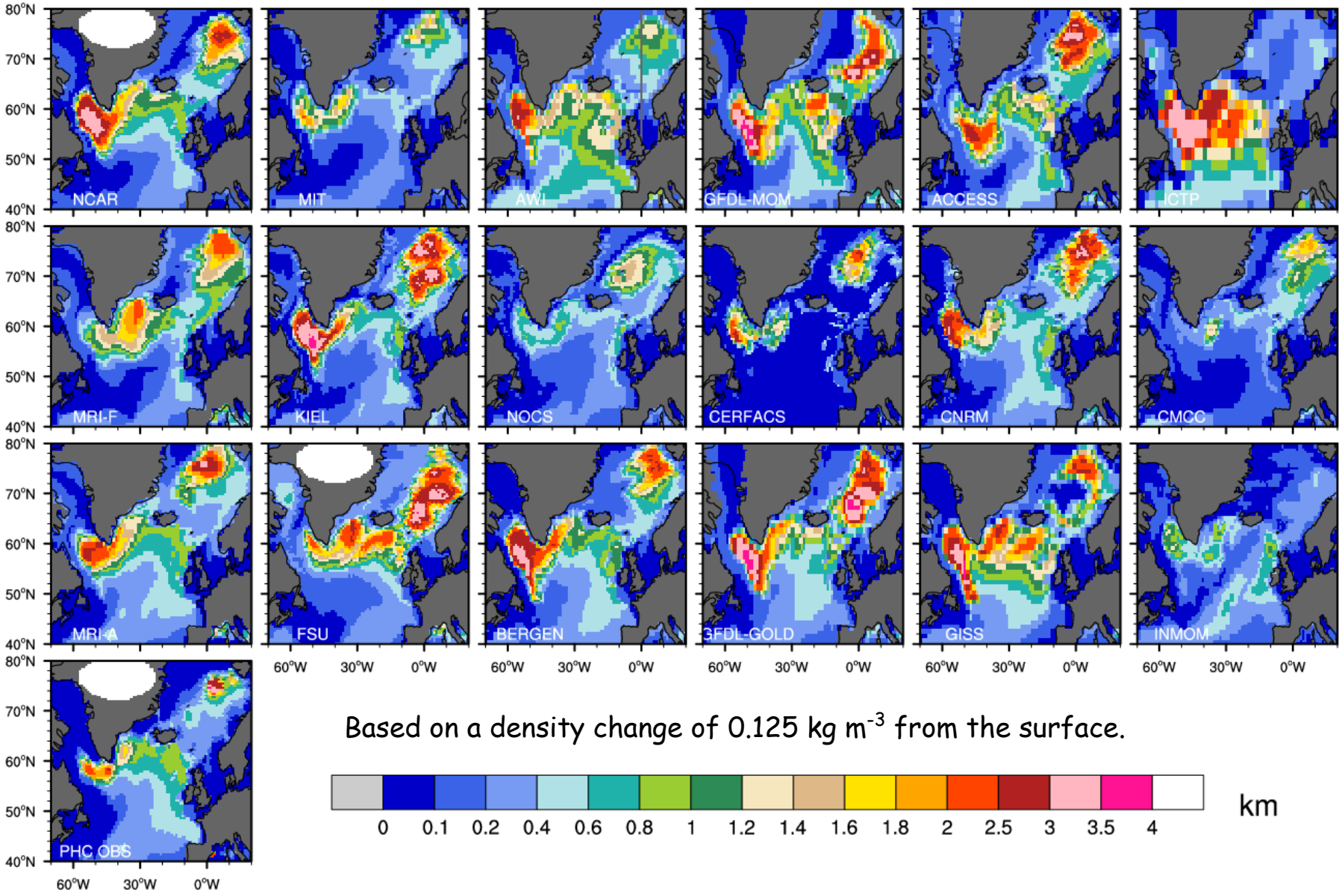


Atlantic Meridional Heat Transport (1988-2007)



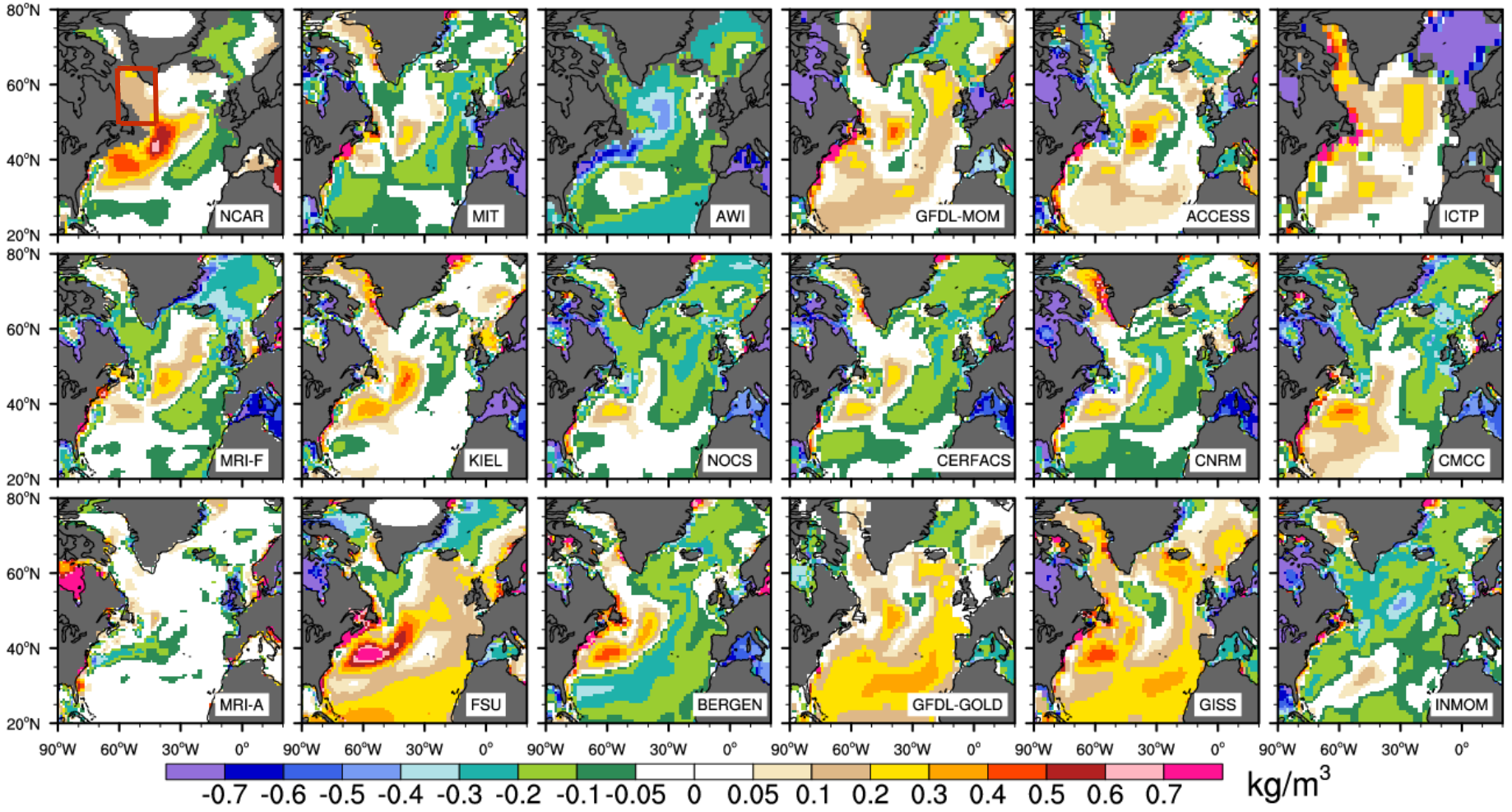
MHT vs. AMOC maximum at 26.5°N

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

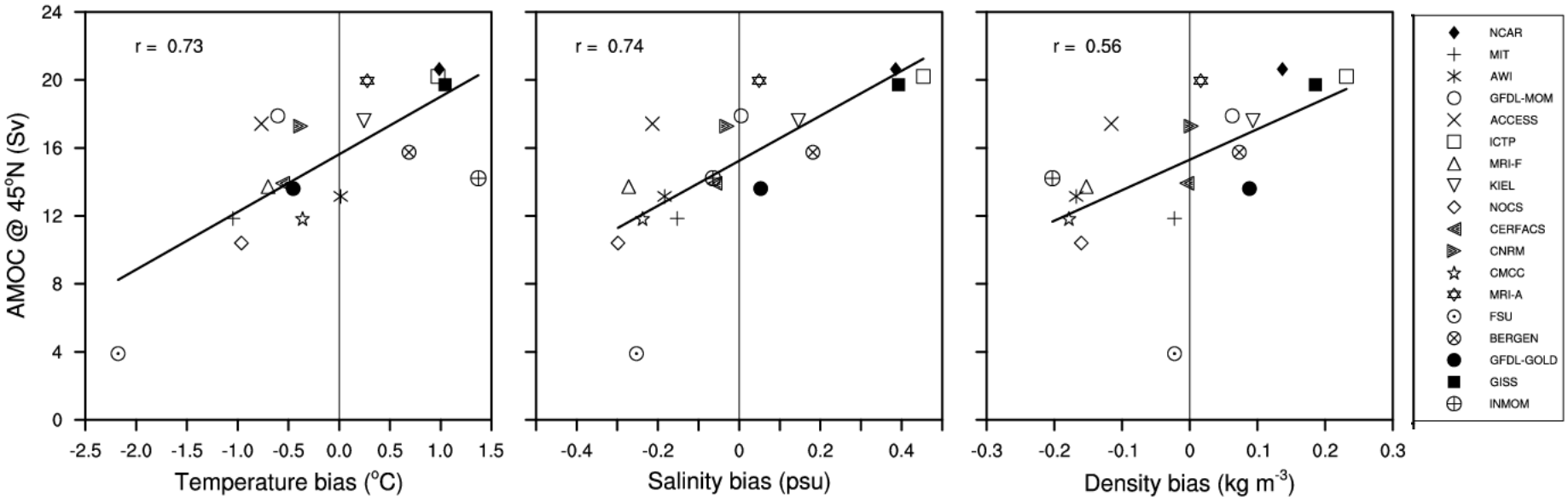


Density Bias from WOA09

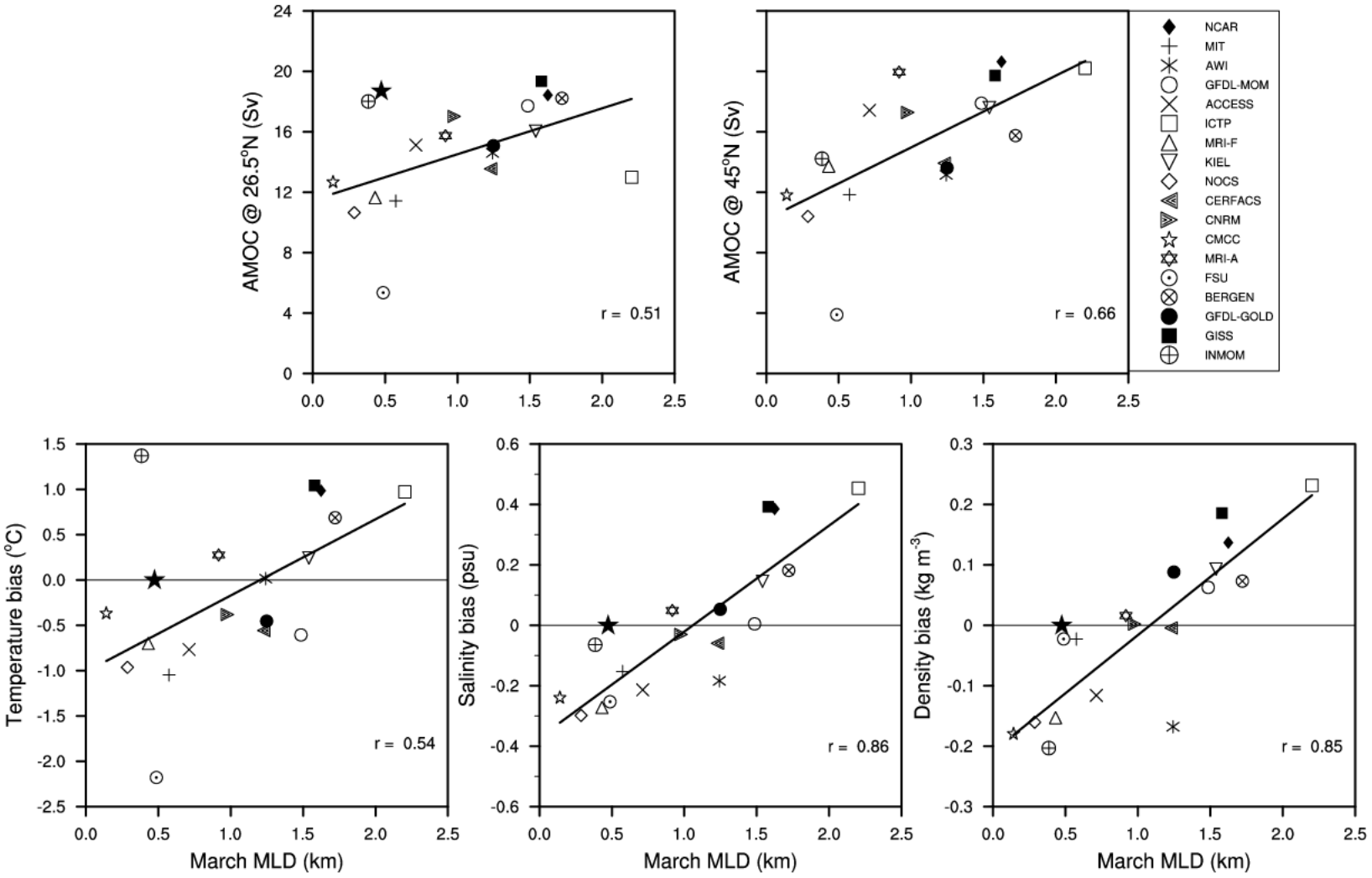
(0-700 m, 1988-2007)



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

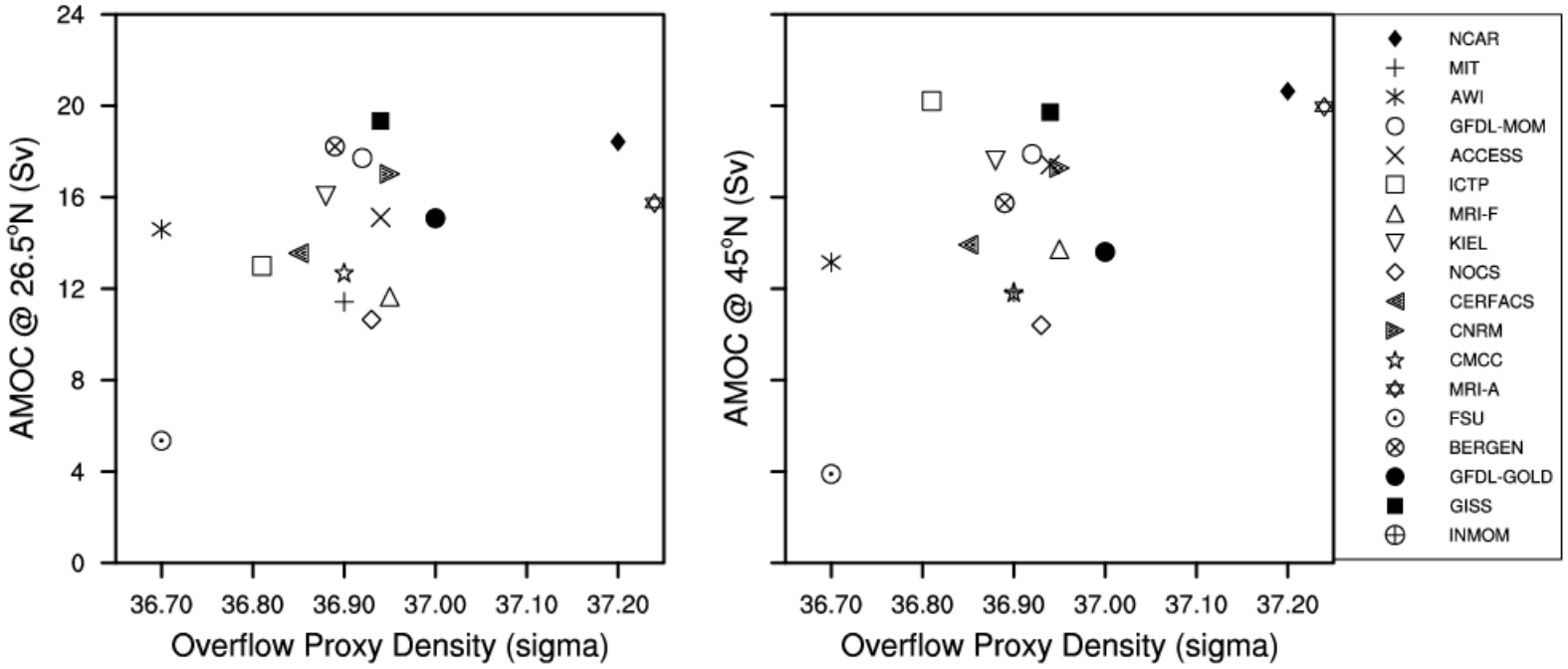


AMOC Maximum Transports, Labrador Sea Potential Temperature, Salinity, and Density Biases vs. Labrador Sea March-Mean Mixed Layer Depth



Stars denote observations.

AMOC Maximum Transports vs. Nordic Seas Overflow Density



SUMMARY AND CONCLUSIONS

- Ocean – sea-ice simulations forced with the same CORE-II atmospheric data sets produce significantly different mean states, with implications for initialization of climate (decadal) prediction experiments.
- 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:
  - 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.