The AMOC in CMIP5 Models: RCP and Historical Simulations

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CLIVAR Climate Model Evaluation Project (CMEP2011), funding from NOAA Climate Program Office
**Purpose:** to examine the AMOC across CMIP5 models, investigating common model behavior and inter-model spread

**Data Source:** basin overturning stream functions submitted to the PCMDI data sever, including ten models from seven modeling centers. 41 ensemble runs in “historical” time (1850-2005), RCP4.5 and RCP8.5 forcing runs for the future, and other variables

**Outline**
1. CMIP5 AMOCs in historical runs and changes in the future, compare with obs. and CMIP3 runs
2. multi-model ensemble mean AMOC in “historical” runs: multi-decadal variability and mechanisms
3. summary and remaining questions
Schneider, Latif, Schmittner 2007
CMIP3 A1B “best estimate”: 25-30%, Schmittner et al. 2005; Schneider et al. 2007
anomalies relative to “historical” mean state
anomalies relative to “historical” mean state
multi-model EOF modes

(a) PC1

(b) mode1, VE=44.2%

(c) PC2

(d) mode2, VE=27.2%

ensemble mean AMOC’
AMOC index
AMOC vs. subpolar E-P
AMOC vs. subpolar E-P
AMOC vs. NA Sfc SW Radiation
AMOC vs. NA Sfc SW Radiation
sfc SW radiation and AMOC anomalies in each model
AMOC ~ NA sfc SW radiation ~ NA SST
NA SST Anomalies

Red: NOAA ERASST
Regression Patterns

a) SST regression on SW

b) SSS regression on SW

c) SST regression on AMOC

d) SSS regression on AMOC
Regression Patterns

SST on SW flip

SST on AMOC

SSS on SW flip

SSS on AMOC
Roles of NAO?
NAO multi-model EOF modes

(a) PC1

(b) model1, VE=37.3%

(c) PC2

(d) model2, VE=21.1%

ensemble mean NAO'
Summary

1. The AMOC in CMIP5 “historical” runs matches better with observations than CMIP3 (?)
2. Weak but noticeable weakening in the 20thC by majority of models; weakening by 2100 is 21%–36% of the 20thC mean (depending on forcing strength), consistent with CMIP3 results
3. The AMOC recovers after forcing is stabilized; recovers faster in the stronger forcing case
4. Multi-model ensemble mean “historical” AMOC shows a multidecadal variation with ~60yr quasi-periodicity, consistent with ensemble mean subpolar E-P and NA surface net SW radiation flux anomalies
5. Multi-model ensemble NAO is correlated with the ensemble mean AMOC in the second half of the 20thC
More questions than answers...

- What drives the fluctuations in NA surface net SW radiation flux? Roles of external forcing agents, e.g., GHGs vs. aerosols?

- Inter-model variations? Model categorization?

- Lead time of SW radiation to AMOC fluctuations in the ensemble mean vs in individual models? Controlling dynamics?

- Local (e.g., NAO) vs remote forcing (e.g., tropical rainfall anomalies) on the NADW formation?
Acknowledgments

WCRP Coupled Modeling WG, responsible for CMIP.

Modeling groups for making available their model output

DoE PCMDI data server for housing the CMIP data

http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-12-00496.1

Thank you!