Ocean resolution, heat uptake & transient sensitivity

Michael Winton
GFDL/NOAA
CLIVAR/Ocean Carbon and Heat Uptake
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CM2 ocean-resolution studies

Model	Atmos. Res.	Ocean Res.
CM2.6	50 km	1/10^o
CM2.5	50 km	1/4^o
FLOR (a6, b1, …)	50 km	1^o

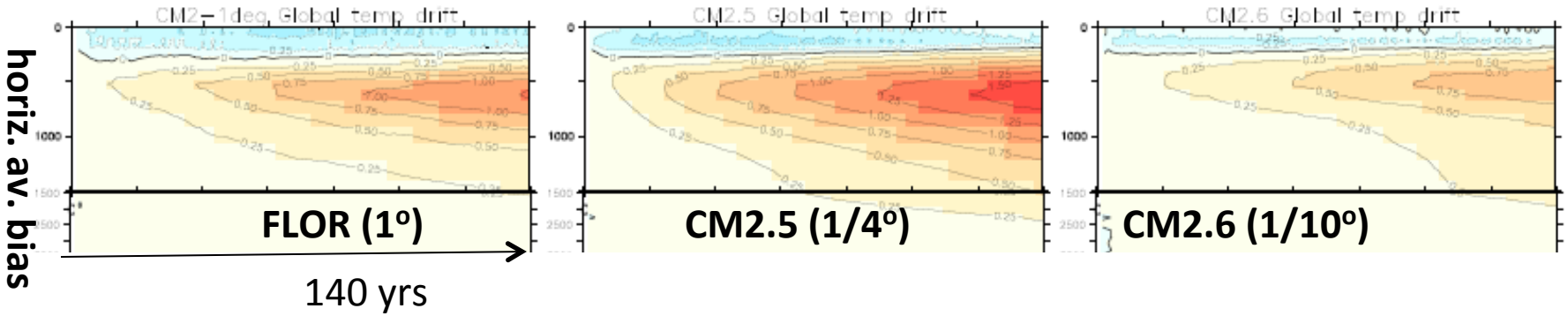
Experiments:

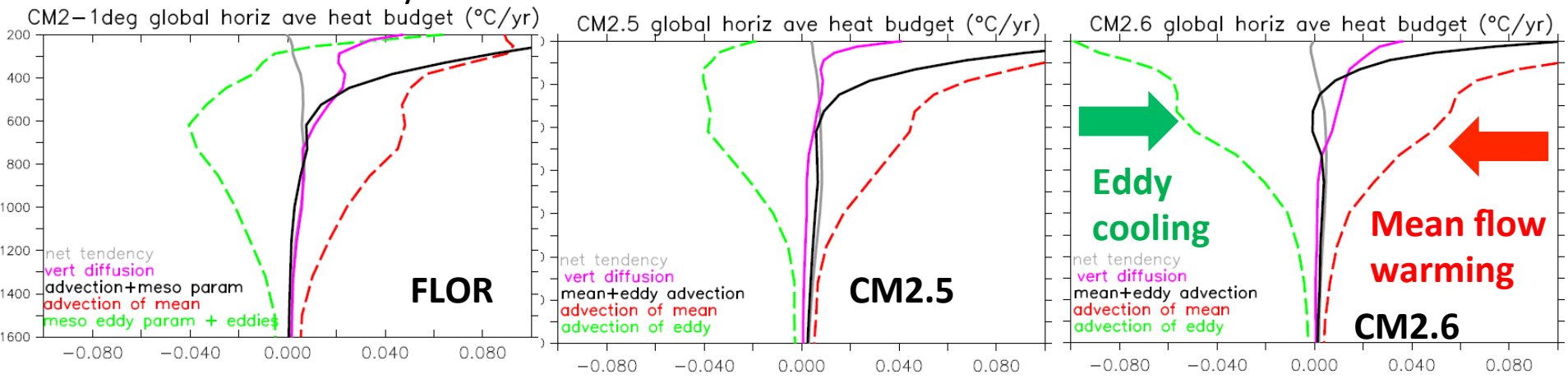
- 1990 control for climatology evaluation; Levitus initial cond.
- 1860 control: 100-year spin-up and branch …
- 1% CO_2 increase to doubling (year 61-80 average)

New papers:

- Griffies, S.M. et al: Impacts on ocean heat from transient mesoscale eddies in a hierarchy of climate models. J. Climate, in press
- Winton, M, et al: Has coarse ocean resolution biased simulations of transient climate sensitivity? GRL, in press.

Ocean res. and temp. drift

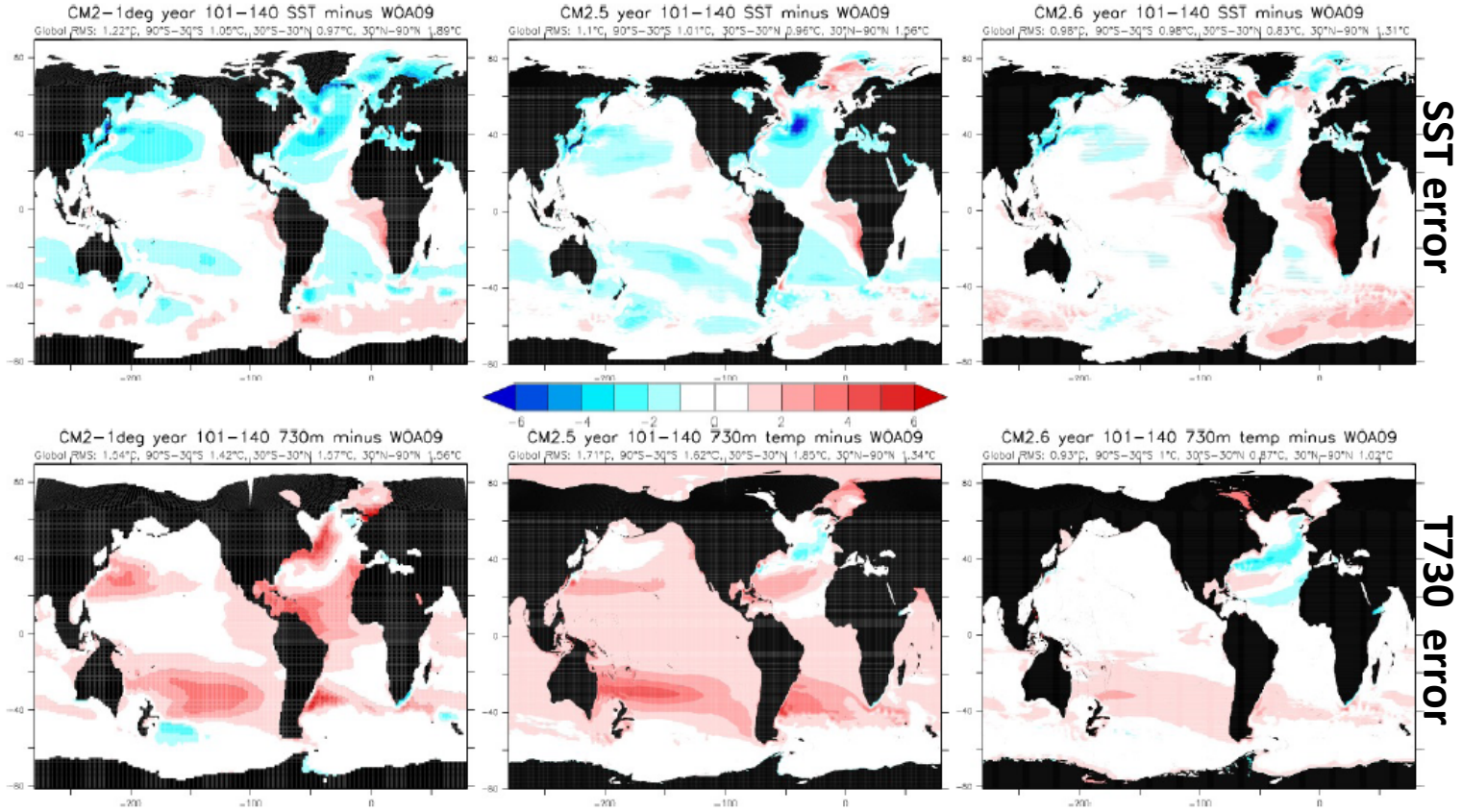




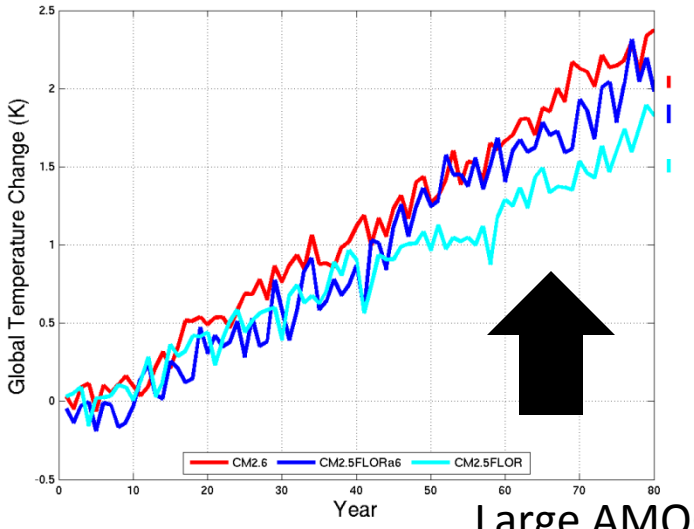
Griffies et al 2014 (also Delworth et al 2012)

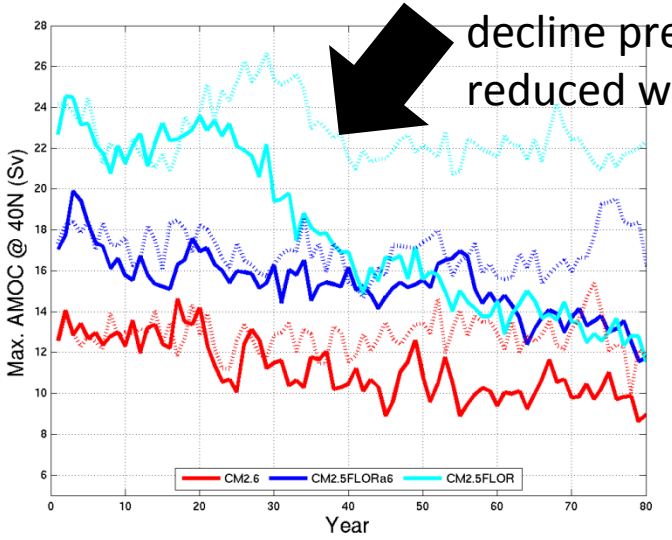
Eddy temperature pattern: subtropical warm over cold

Griffies et al 2014
Also Delworth et al 2012

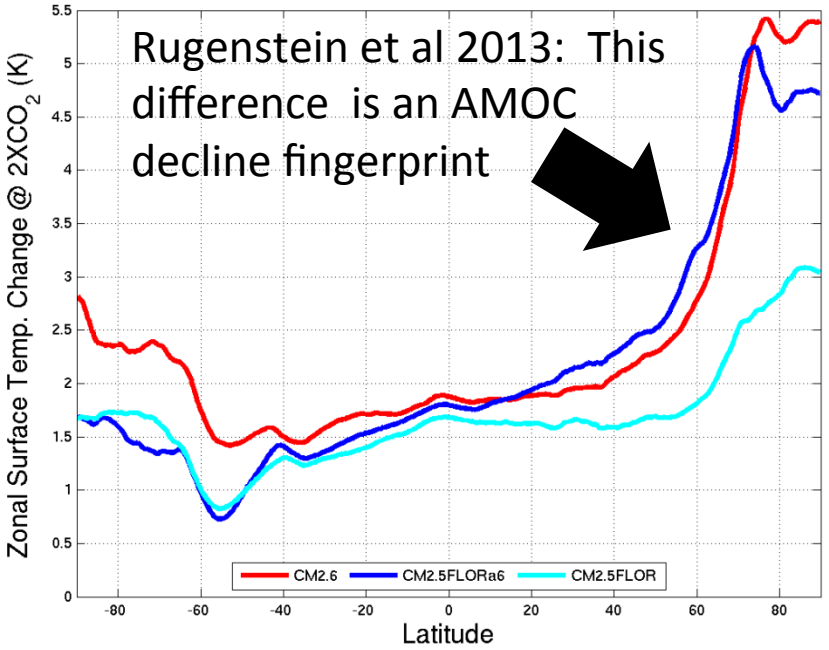


1/10°-ocean warms more than 1°-ocean

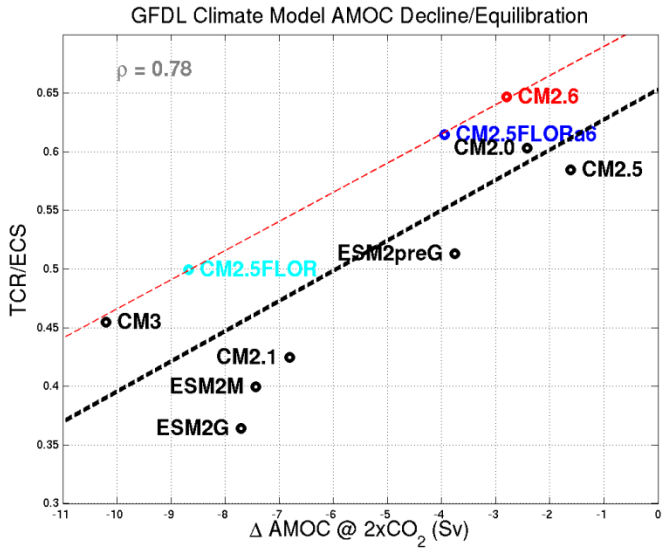


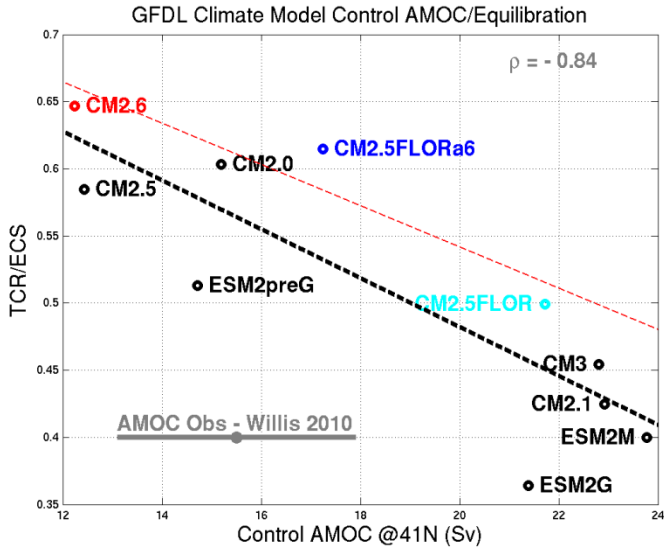


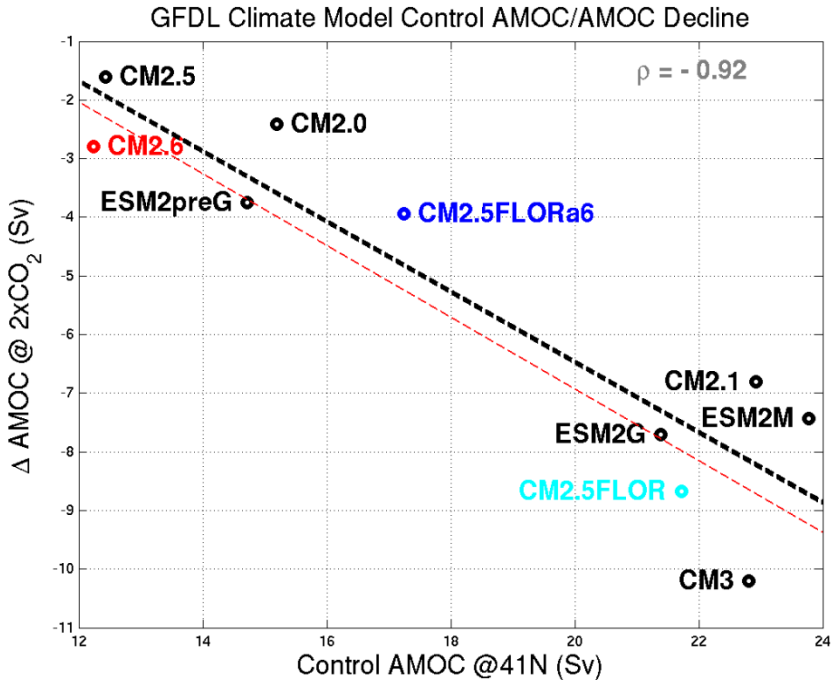
Large AMOC decline precedes reduced warming



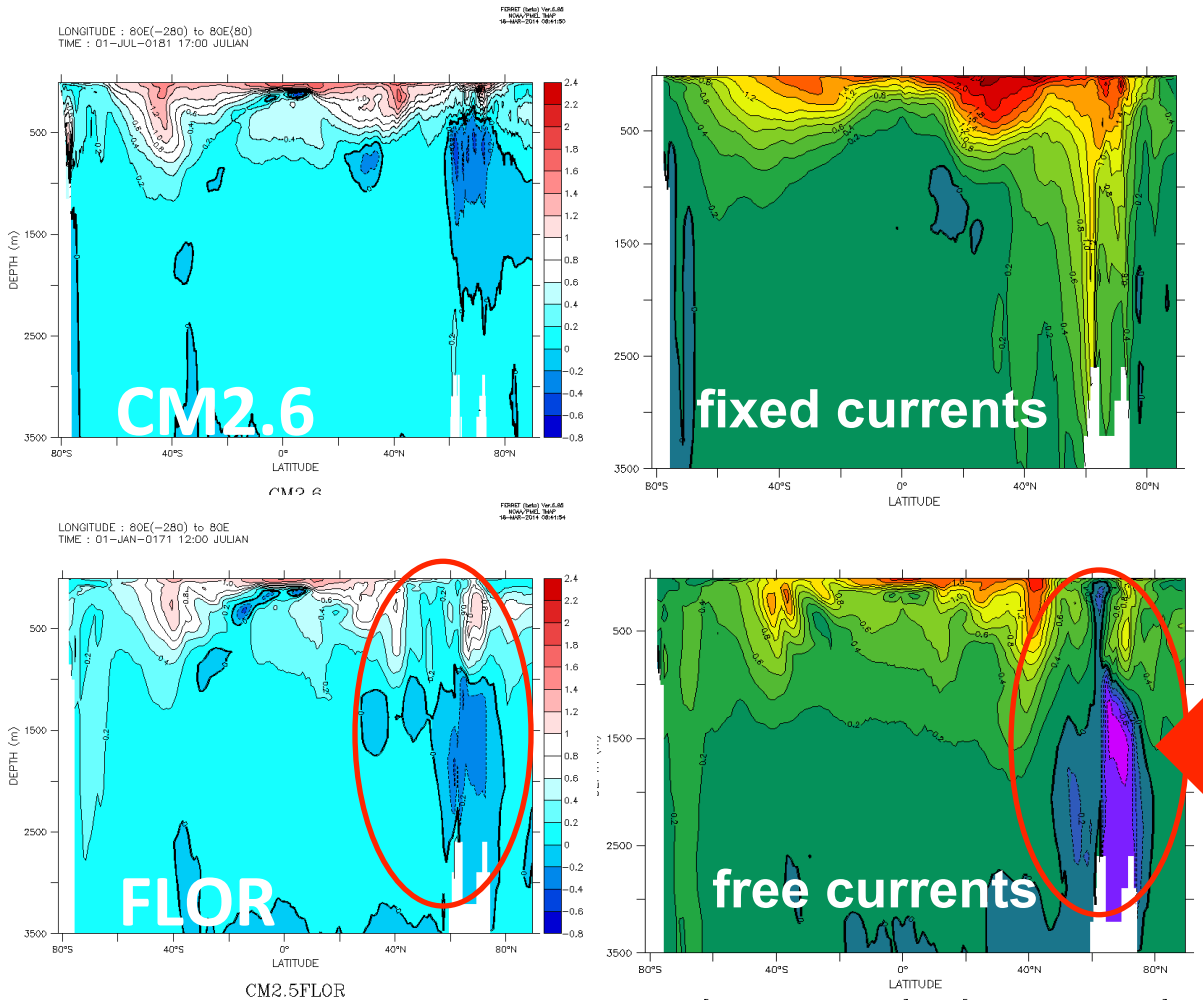
TCR, ΔAMOC and AMOC are related







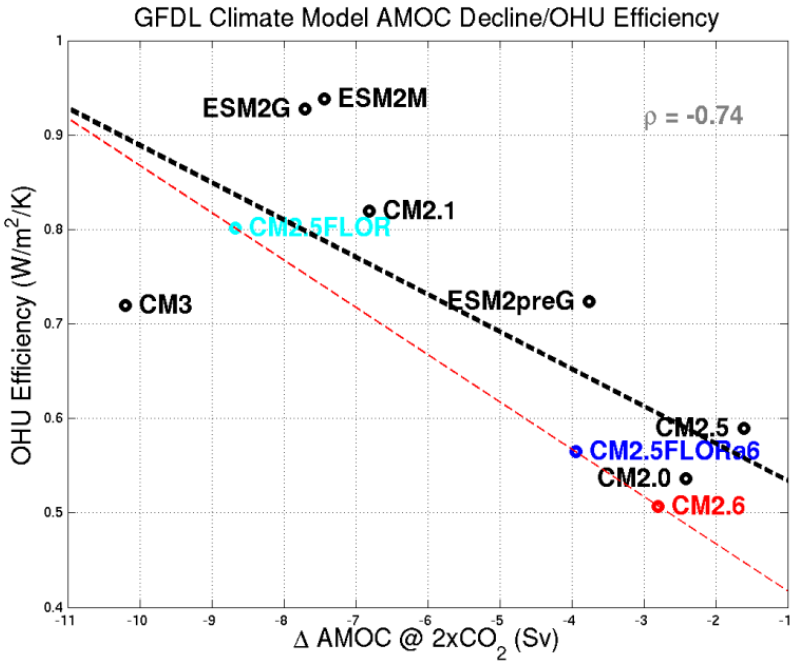
Warming pattern favors ΔAMOC mechanism

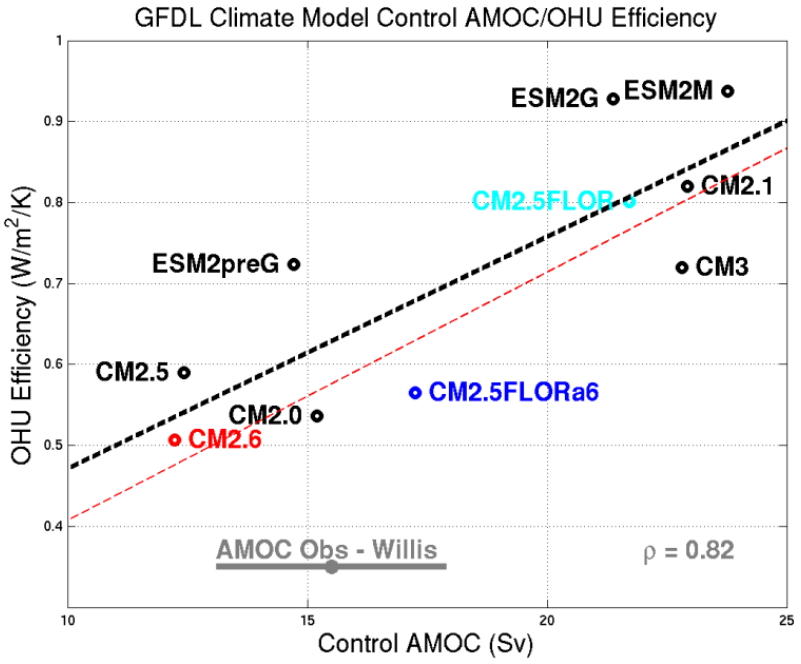


Northern ocean "warming hole" is fingerprint of AMOC weakening

Winton et al 2013

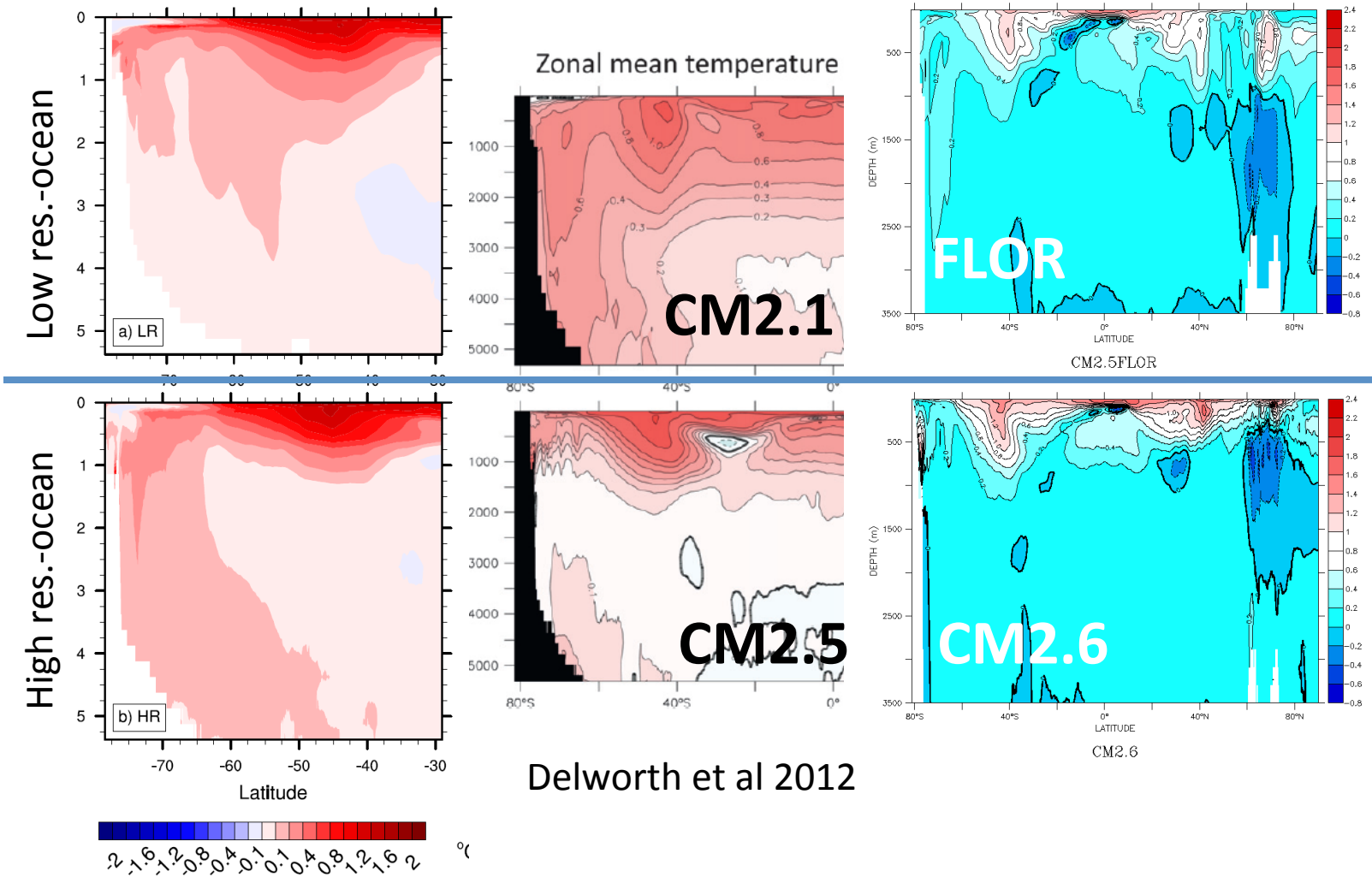
Heat uptake efficiency related to ΔAMOC & AMOC





- Relationship to AMOC is incidental? AMOC not useful for constraining heat uptake/TCR.
- AMOC is fundamental? Need to simulate control AMOC accurately.
- ΔAMOC is fundamental? Need to worry about Atlantic heat transport simulation too.

NCAR/GFDL high/low res comparisons disagree in Southern Ocean



Delworth et al 2012

NCAR - Bryan et al, 2014

Summary

- Better ocean eddy representation improves ocean temperature simulation.
- GFDL model heat uptake efficiency and TCR variations are related to ΔAMOC/AMOC. What is the general mechanism? Can we apply a climatological constraint?
- Southern Ocean response is not resolution specific but vertical heat transport processes seem important.