Salt Advection Feedback and AMOC Stability Indicator in CESM and GFDL Models

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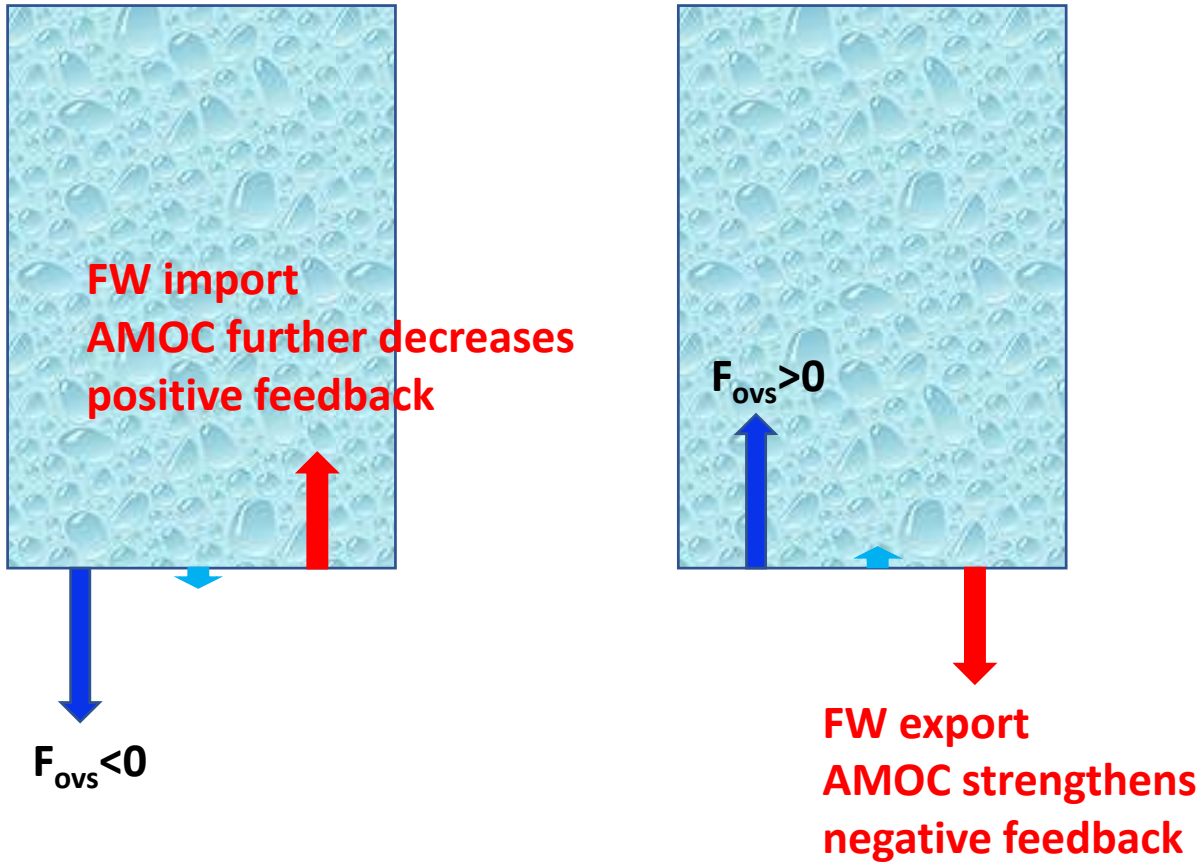


F_{ovs}: freshwater transport <u>by the AMOC</u> at the southern end of the Atlantic Ocean

$F_{ov}(y) = \frac{-1}{S_o} \int \overline{V^*} \langle S \rangle dz$ **Drijfhout et al. (2011)**

F_{ovs} – F_{ov} at 33°S, southern end of the Atlantic Ocean

$F_{ov}(y)$ – F_{ov} as a function of latitude

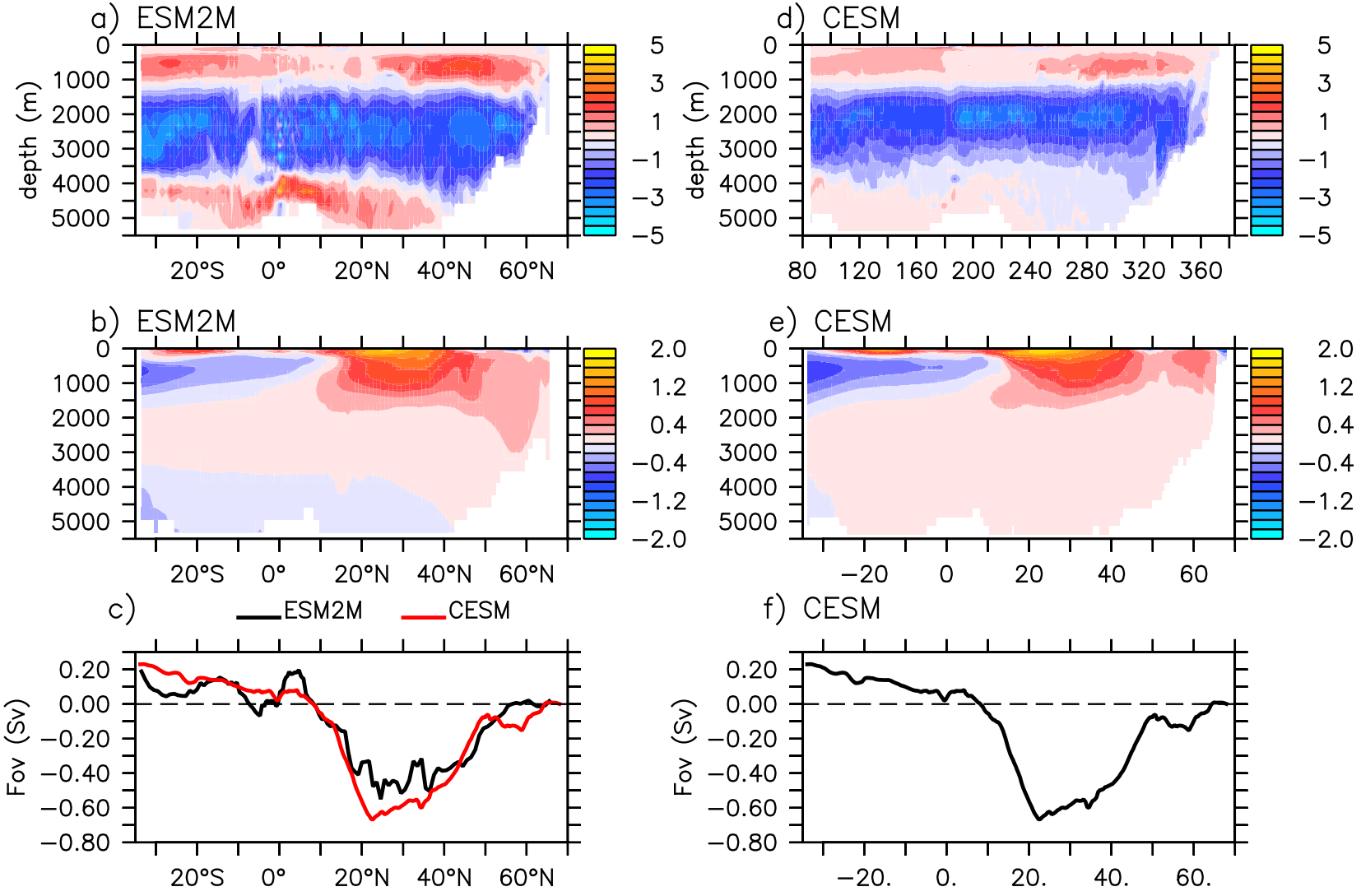
Input : GFDL and CESM, 1° ocean, pre-industrial control simulations, monthly mean fields

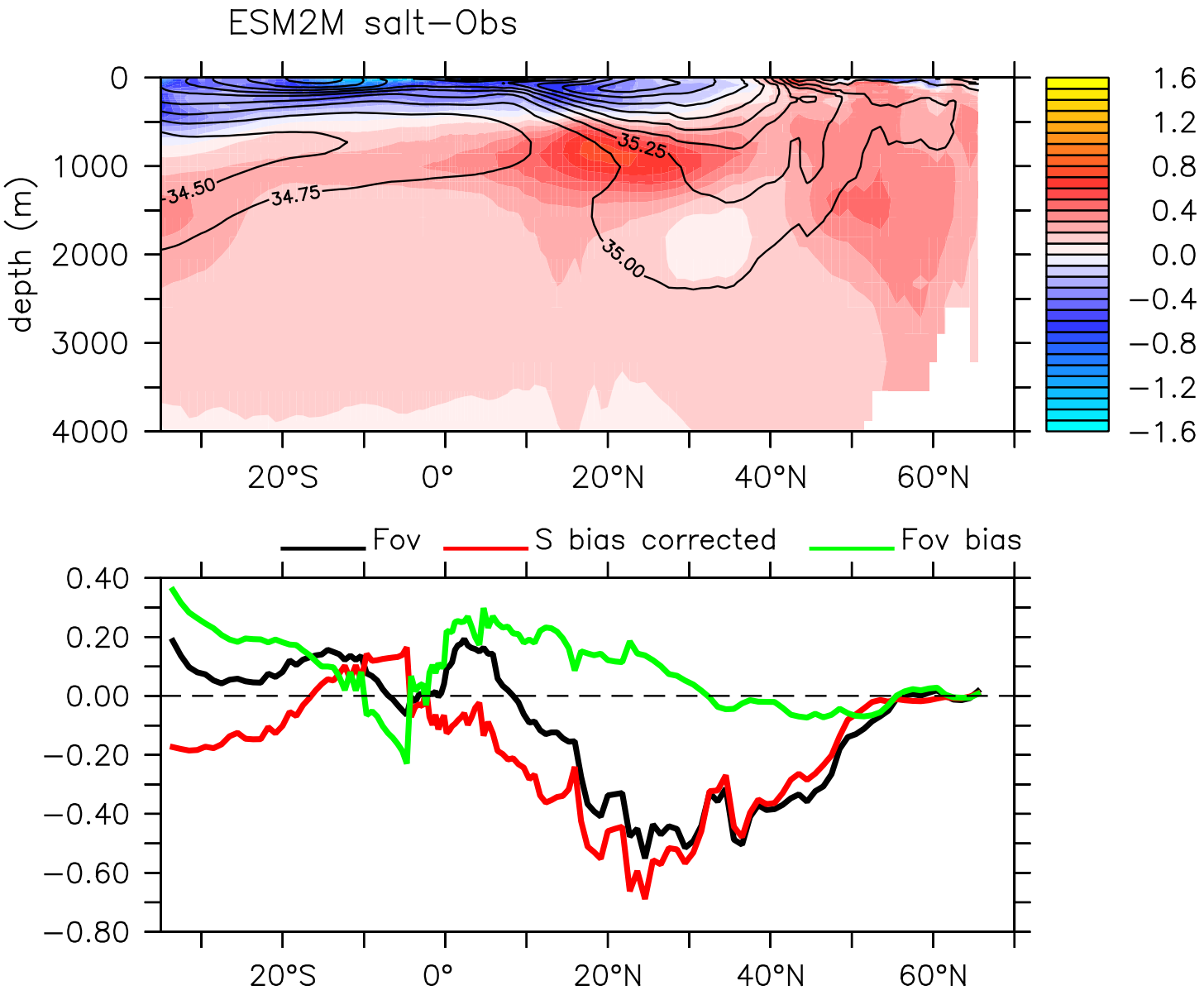
mean state structure

$\overline{V^*}$

$\langle S \rangle -$

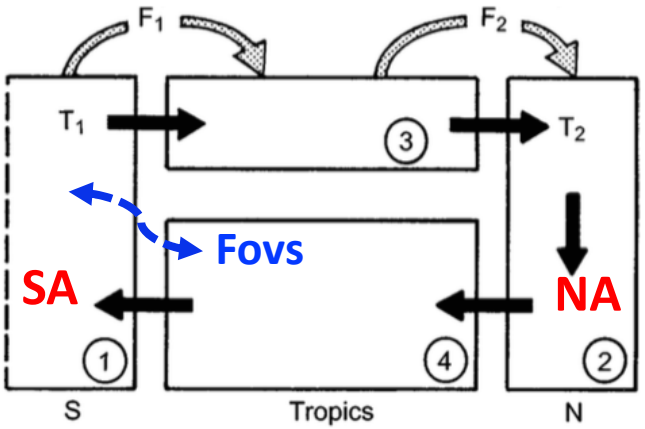
F_{ov}




ESM2M salt−Obs
depth (m)
0
1000
2000
3000
4000
34.50
34.75
35.00
35.25
1.6
1.2
0.8
0.4
0.0
−0.4
−0.8
−1.2
−1.6
20°S
0°
20°N
40°N
60°N
Fov
S bias corrected
Fov bias
0.40
0.20
0.00
−0.20
−0.40
−0.60
−0.80
20°S
0°
20°N
40°N
60°N

Sign of F_{ovs} as an AMOC stability indicator

Rahmstorf (1996)



$$m(S_2 - S_1) = -S_0 F_1$$

$$m = k(\rho_2 - \rho_1) = k[\beta(S_2 - S_1) - \alpha(T_2 - T_1)]$$

used by CGCM studies – e.g., Hawkins et al. (2011), Liu et al. (2017), etc.

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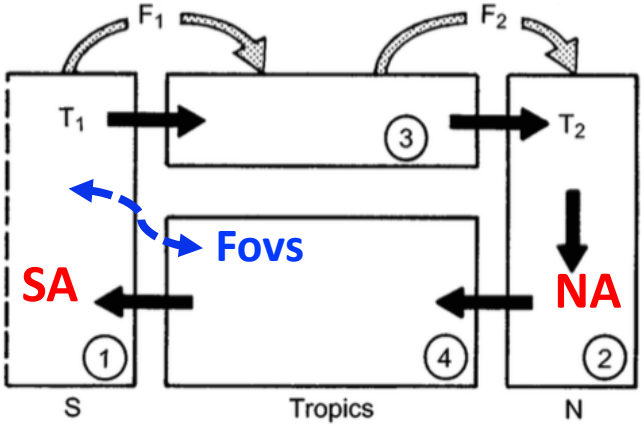
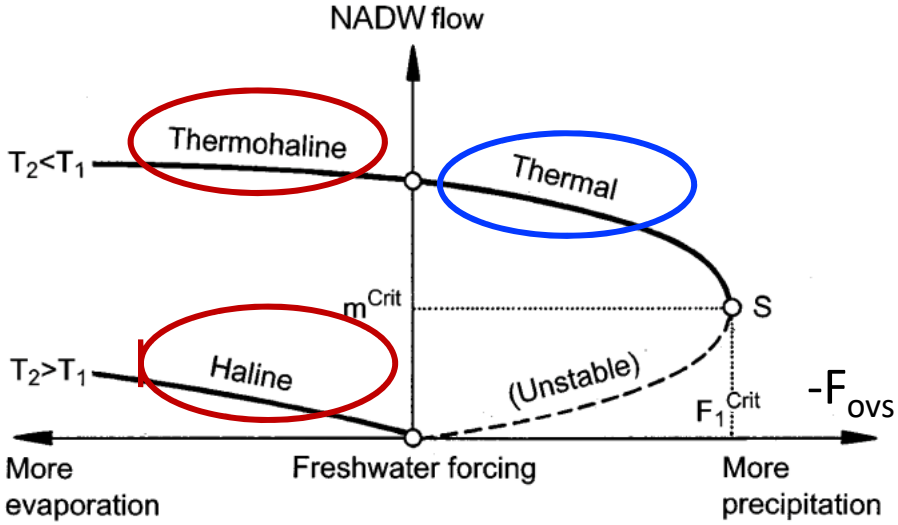
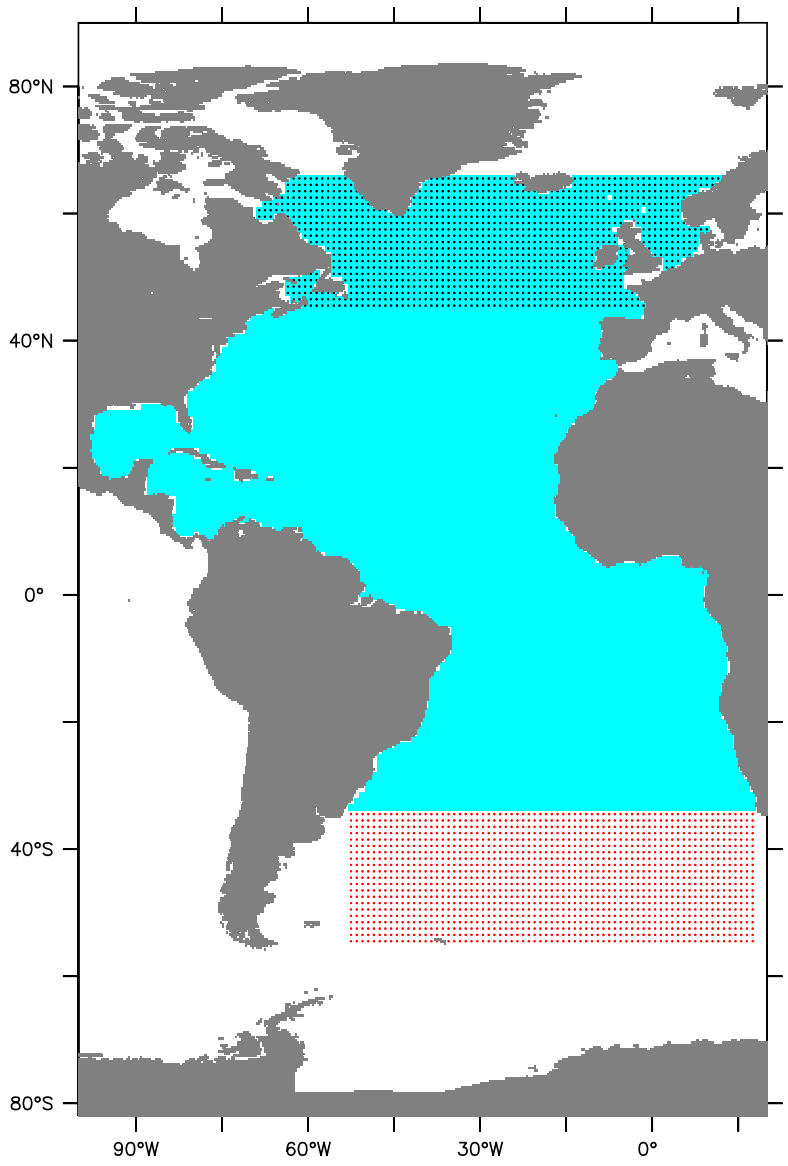




F_{ovs}>0, saltier NA

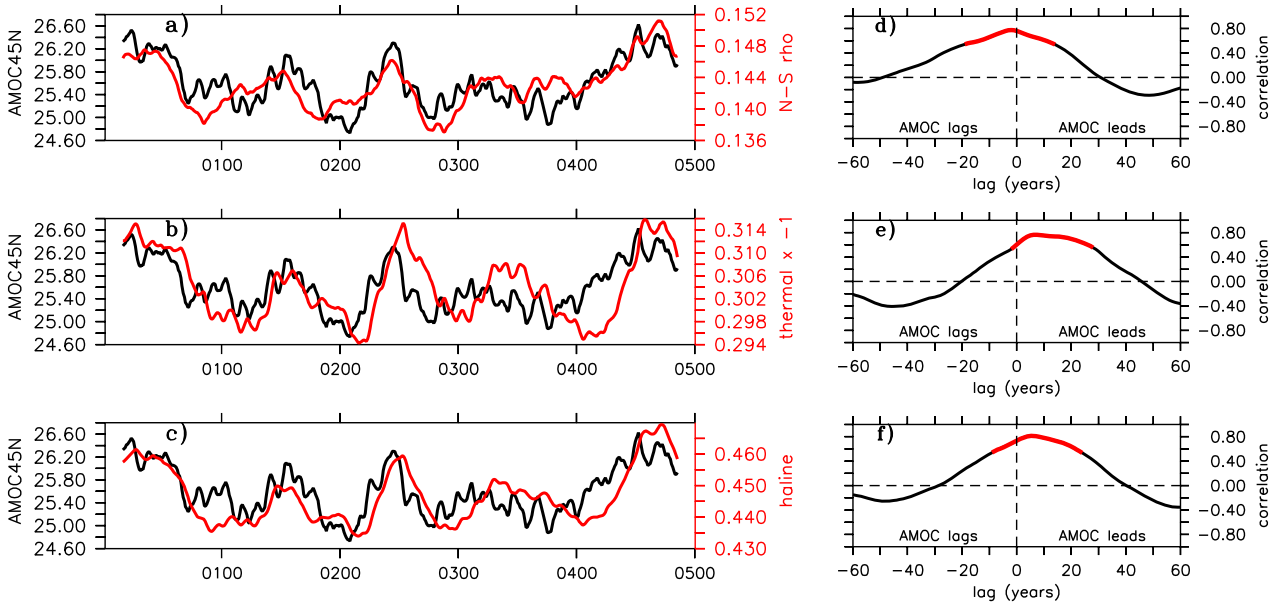
F_{ovs}<0, fresher colder NA

used by CGCM studies – e.g., Hawkins et al. (2011), Liu et al. (2017), etc.

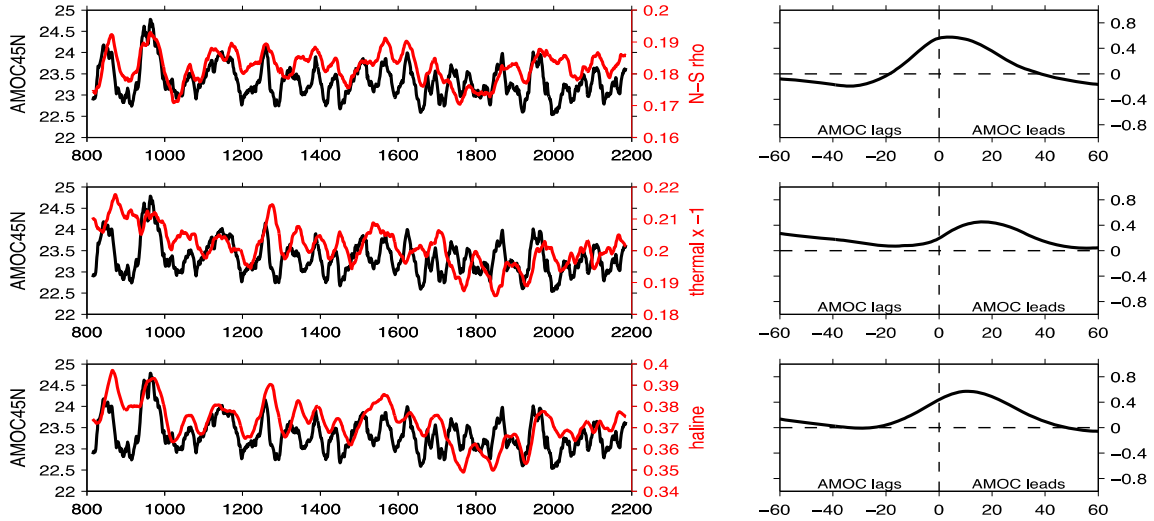


0-4000 m

AMOC highly correlated with N-S density difference – as in the box model

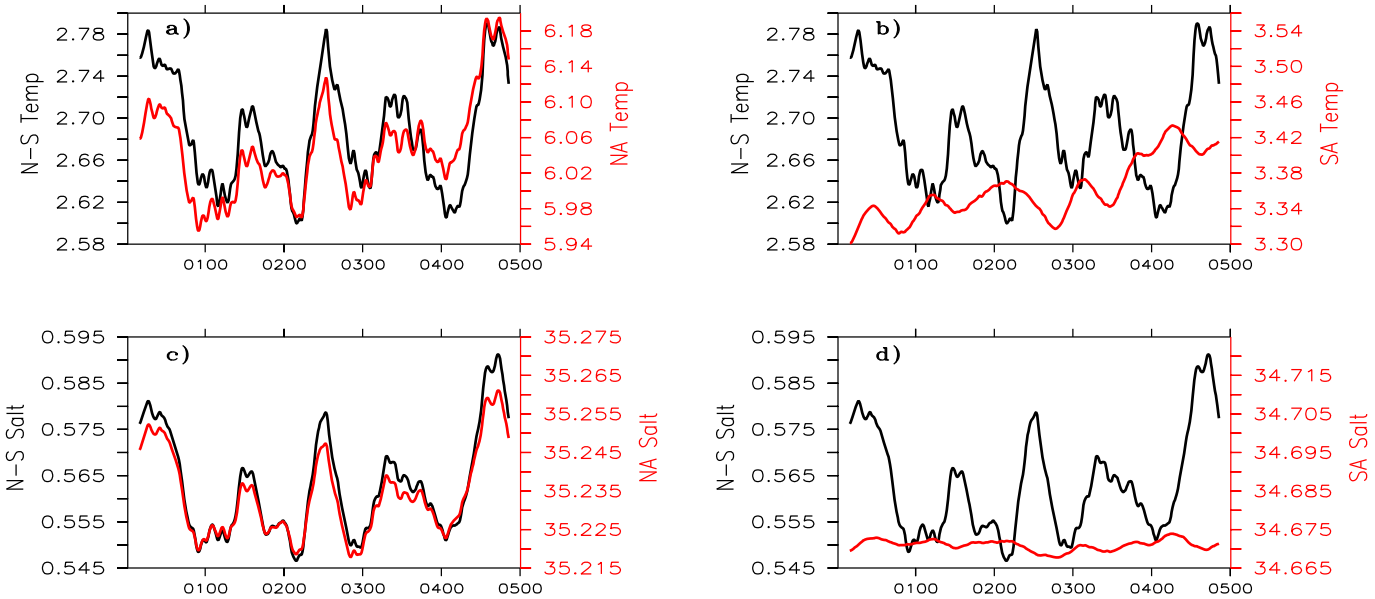


ESM2M



CESM

But, what contributes to the N-S density difference, is it NA or SA or both?



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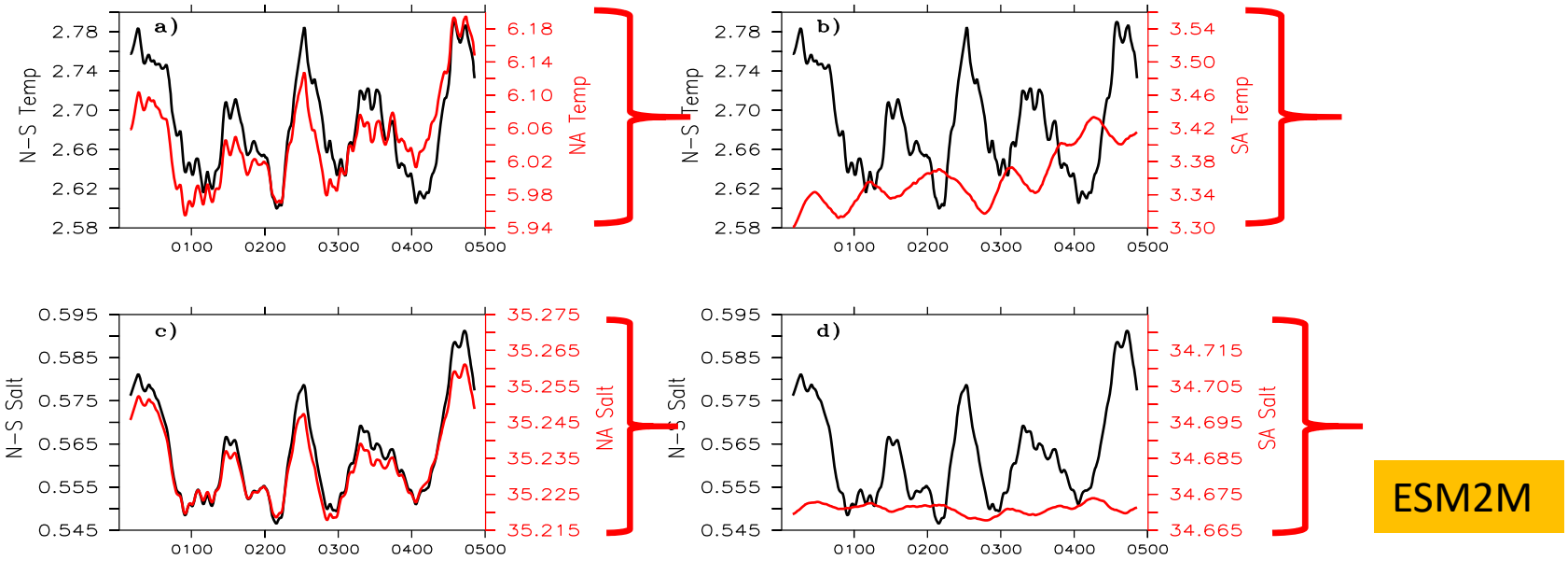

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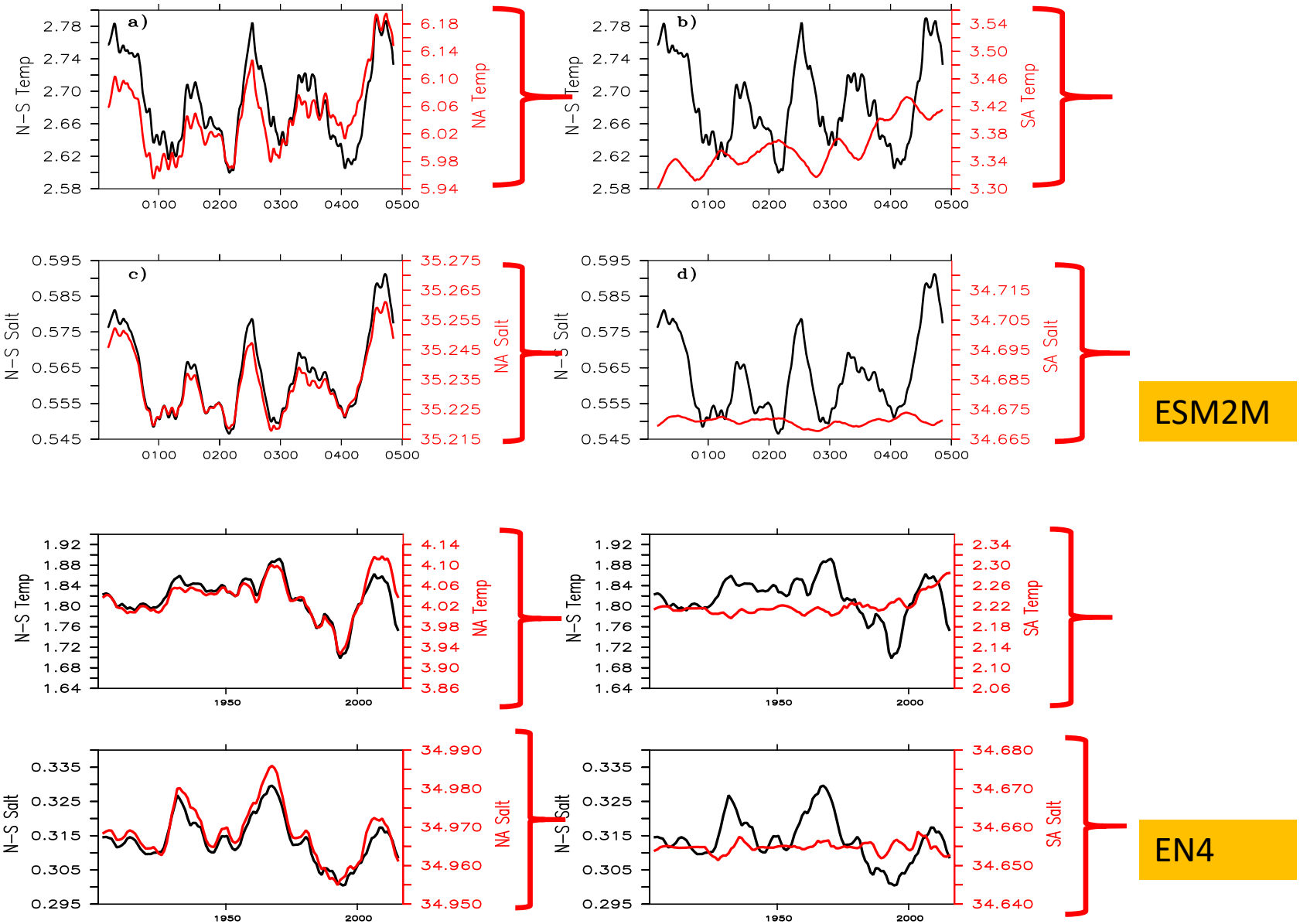

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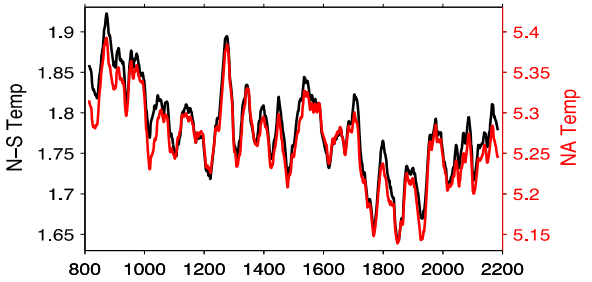
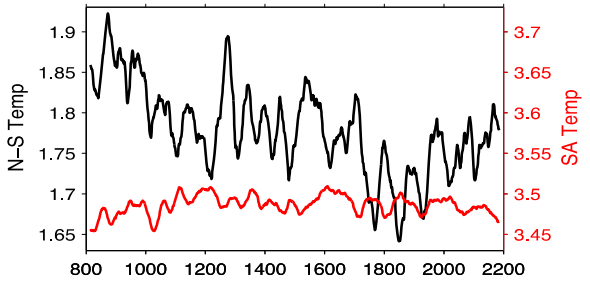
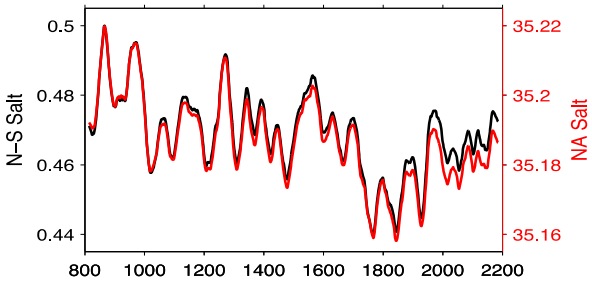
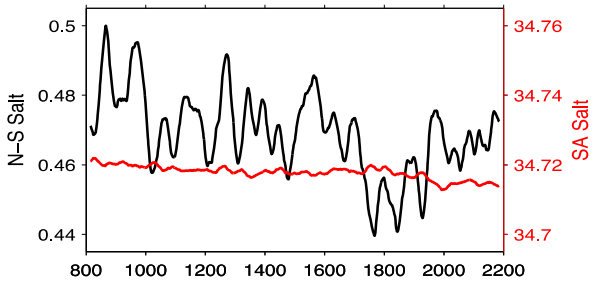
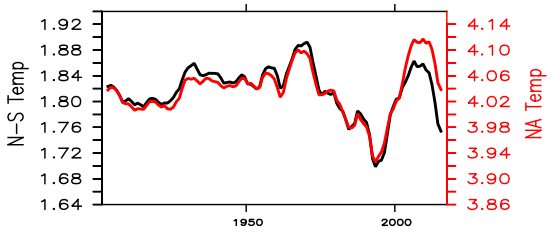


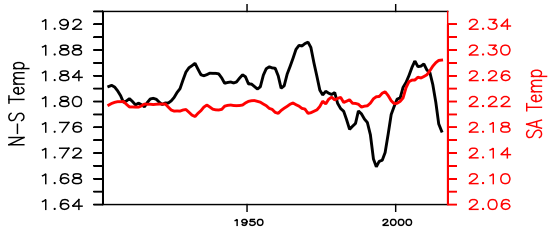


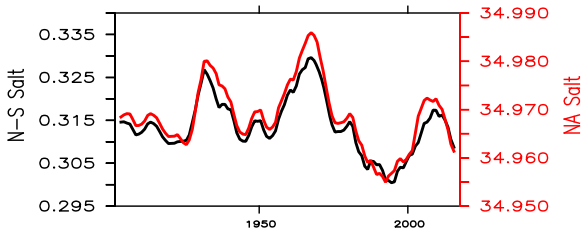


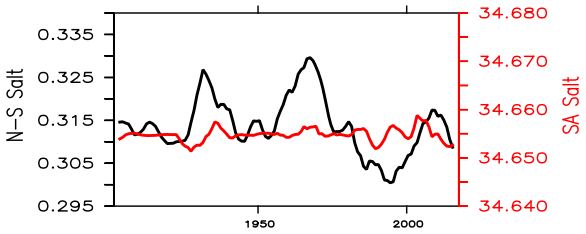


CESM









EN4

Summary

- A large part of the F_{ov} mean state (including its sign) and variability is controlled by salinity distribution.

- Observed and modeled North Atlantic is warmer and saltier than the South Atlantic. Observed F_{ovs} is likely negative, and modeled F_{ovs} would be negative if we correct salinity bias. But, the Rahmstorf box model does not permit a solution with saltier NA and negative F_{ovs}.