Intraseasonal to interannual variability of the AMOC in eddy-resolving HYCOM

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Question

- How well the eddy-resolving, or eddy-rich ocean circulation model can represent the AMOC structure and its variability, and what does the model tell us about the AMOC beyond the observations?

Eddy-resolving HYCOM

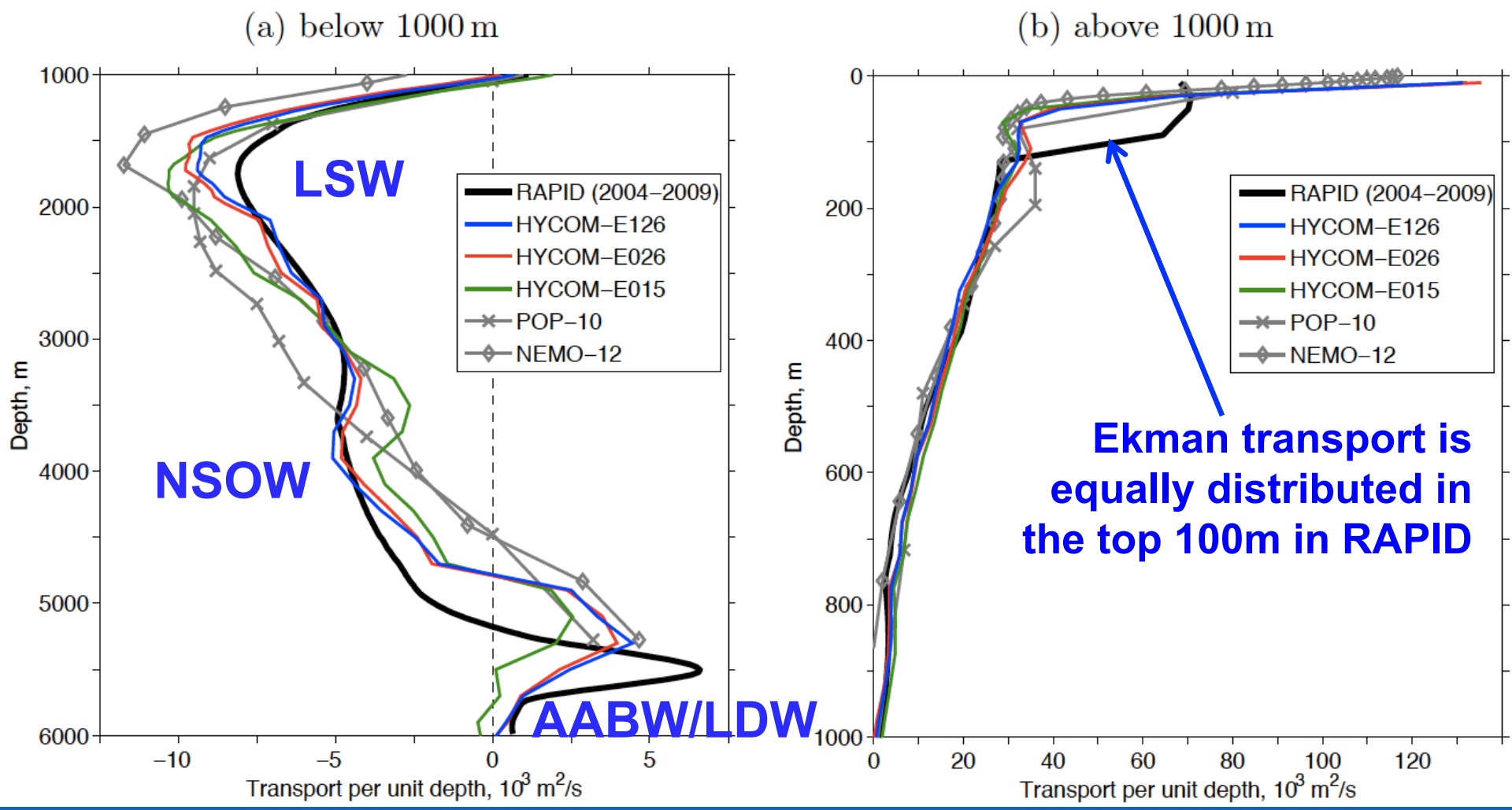
- HYbrid Coordinate Ocean Model (www.hycom.org): its vertical coordinate is isopycnic in stratified open ocean, and makes a dynamically smooth transition to terrain-following in shallow coastal regions and to fixed pressure levels in the surface mixed layer and/or un-stratified seas.

- Two experiments are discussed here: one global, the other north and equatorial Atlantic (28°S-80°N).
- Similar configurations: 1/12° resolution in horizontal; Initialization using GDEM4 T/S; surface forcing using the ECMWF reanalysis ERA40 for climatological simulations (spin-ups), and using the NOGAPS for interannual simulations.

- No data-assimilation is used.

Time mean structure (26.5°N)

AMOC vertical structure

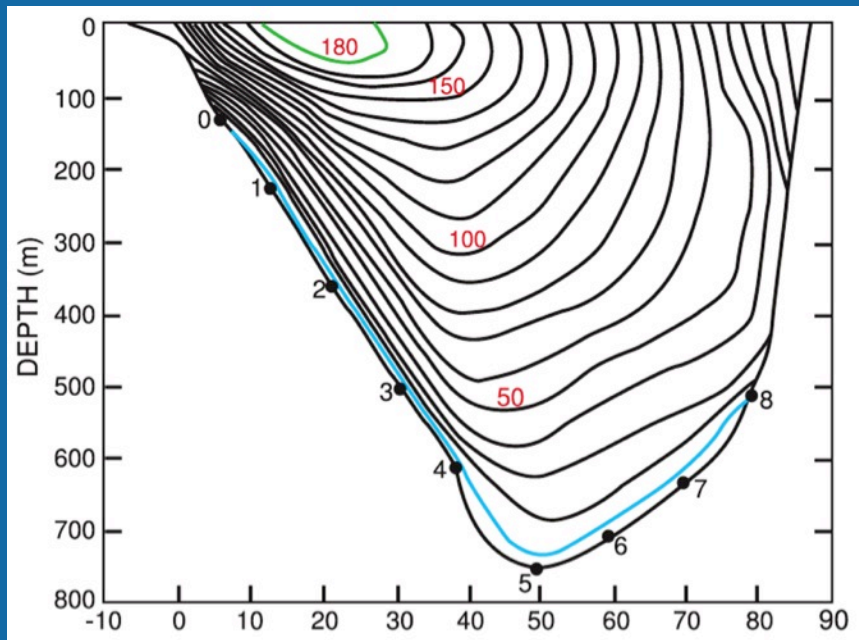


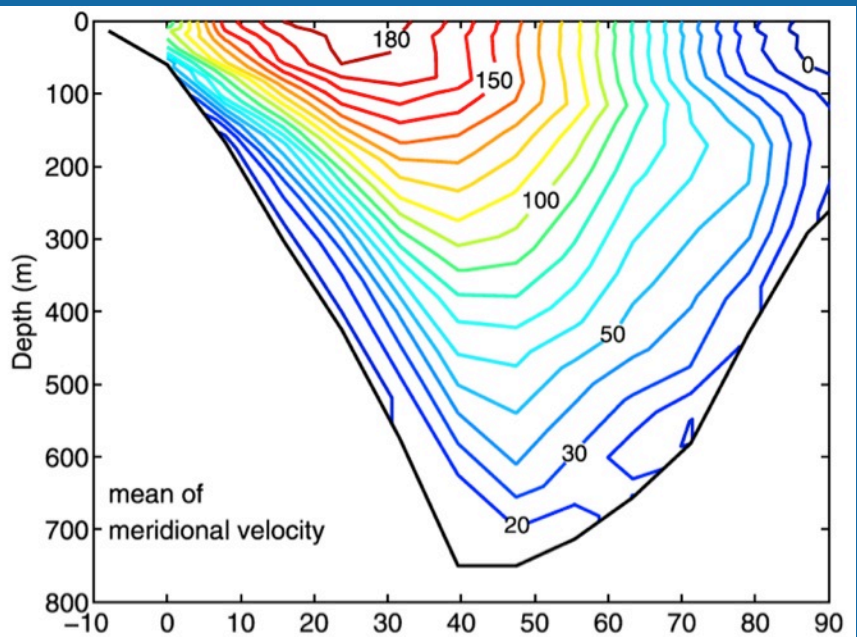
Improved vertical structure in HYCOM for southward transport of the NADW (below 1km); similar model structure in the upper 1km; *Xu et al. (2012)*

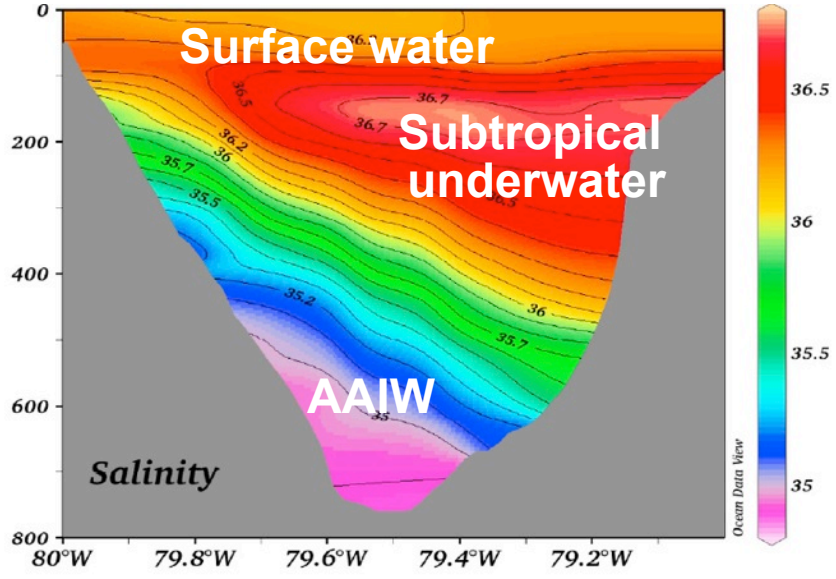
The Florida Current

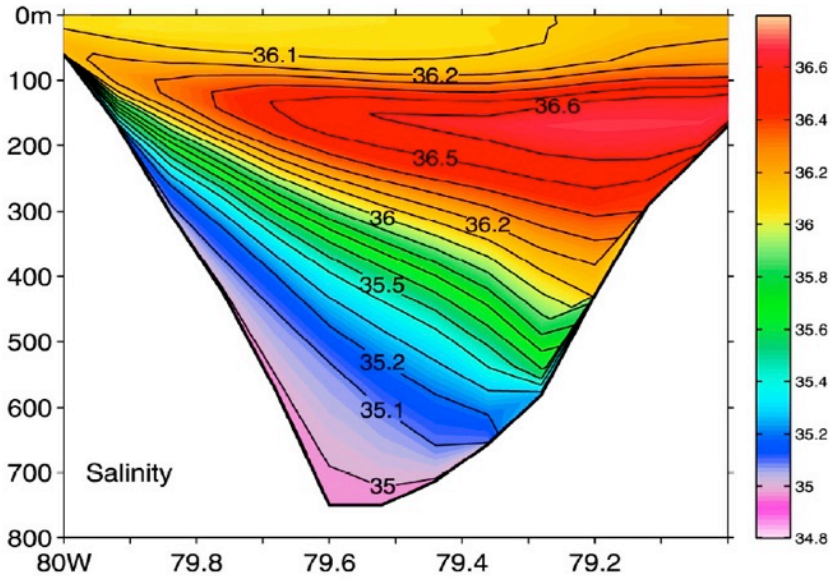
Observations

HYCOM

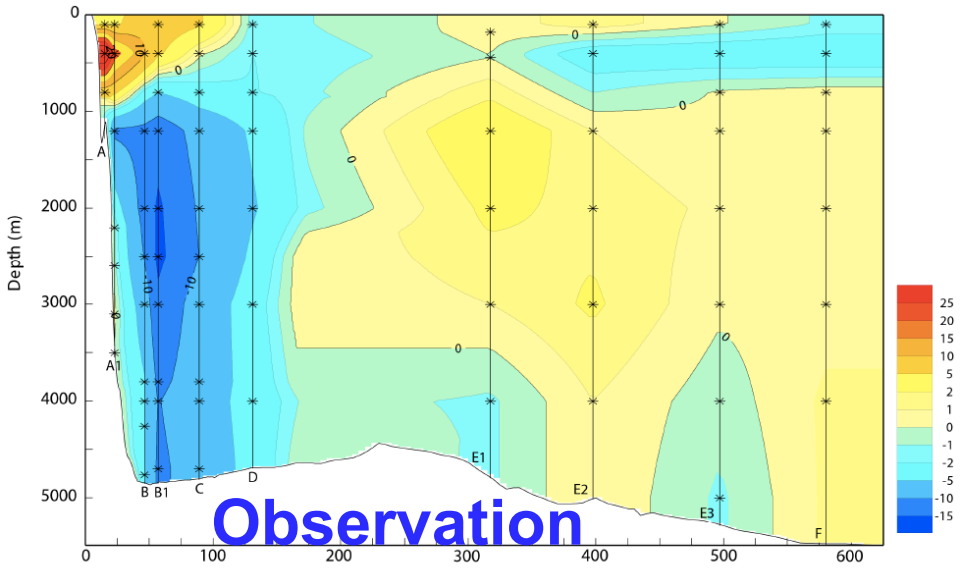


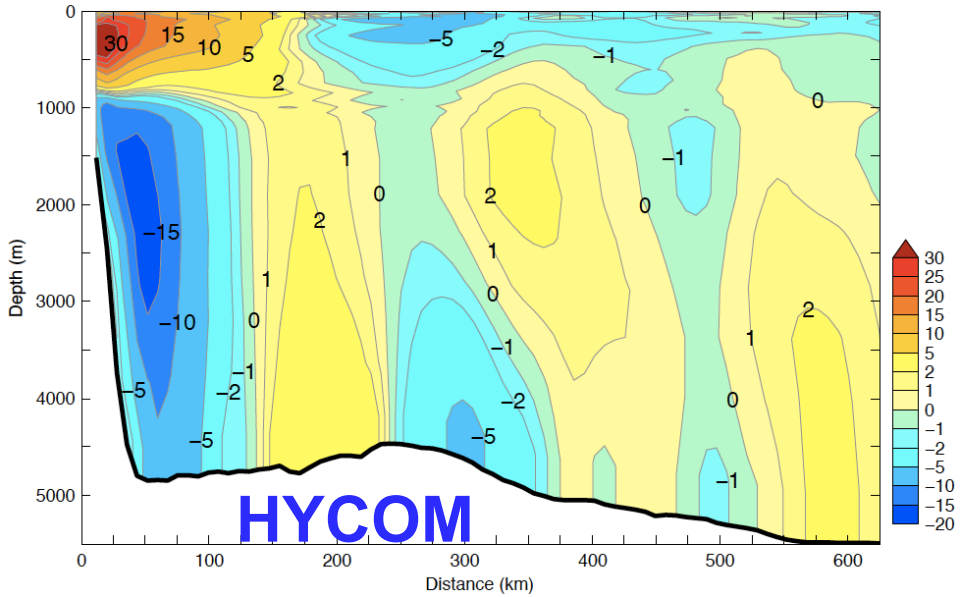


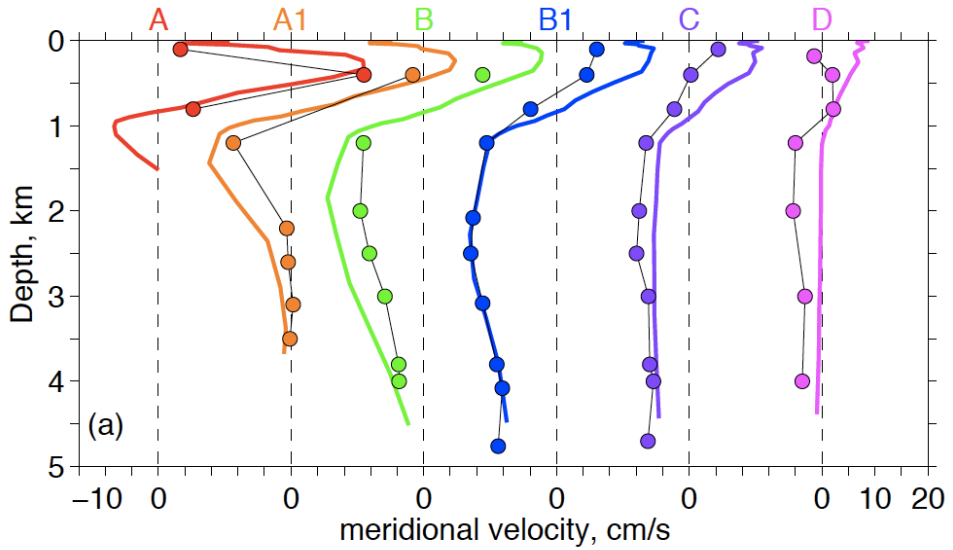


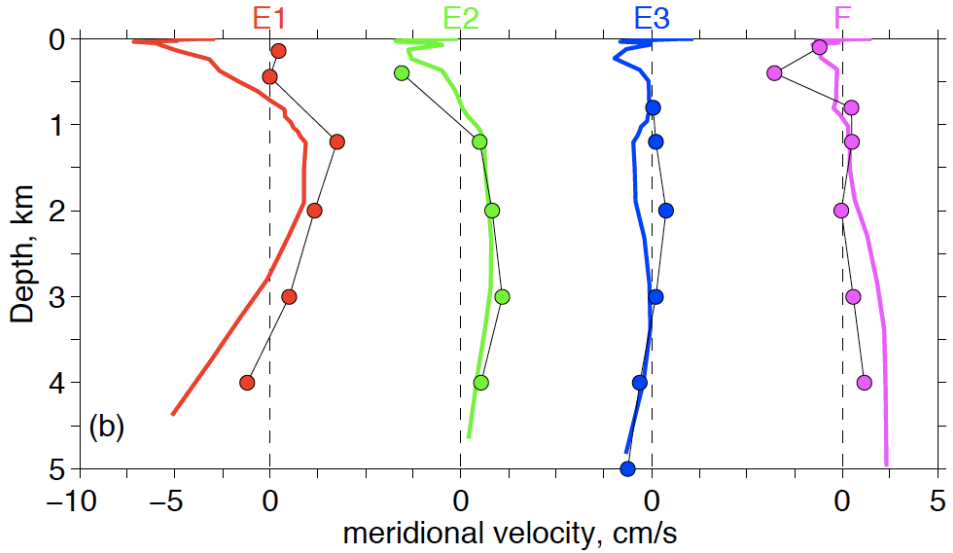


WBC east of Abaco

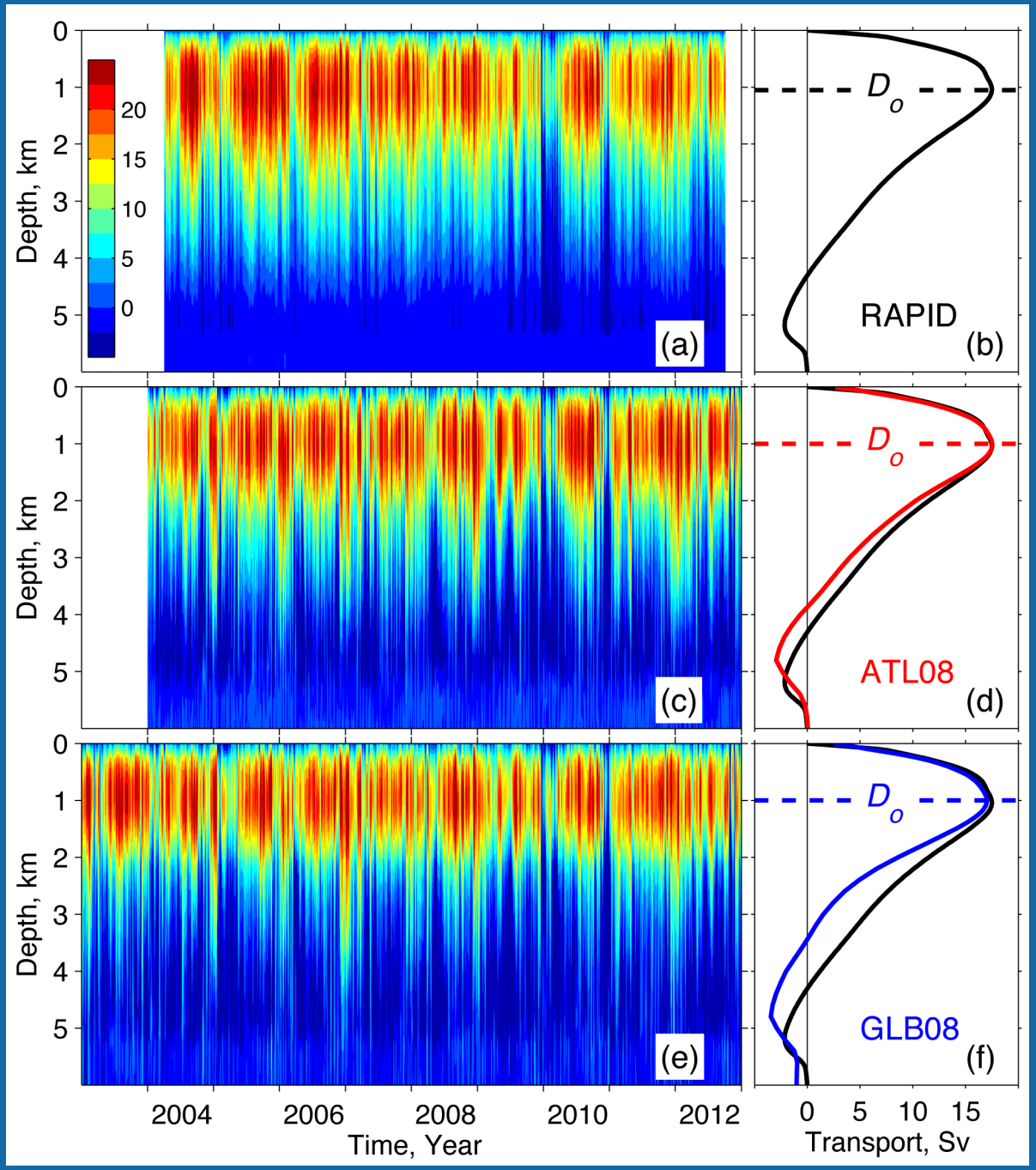








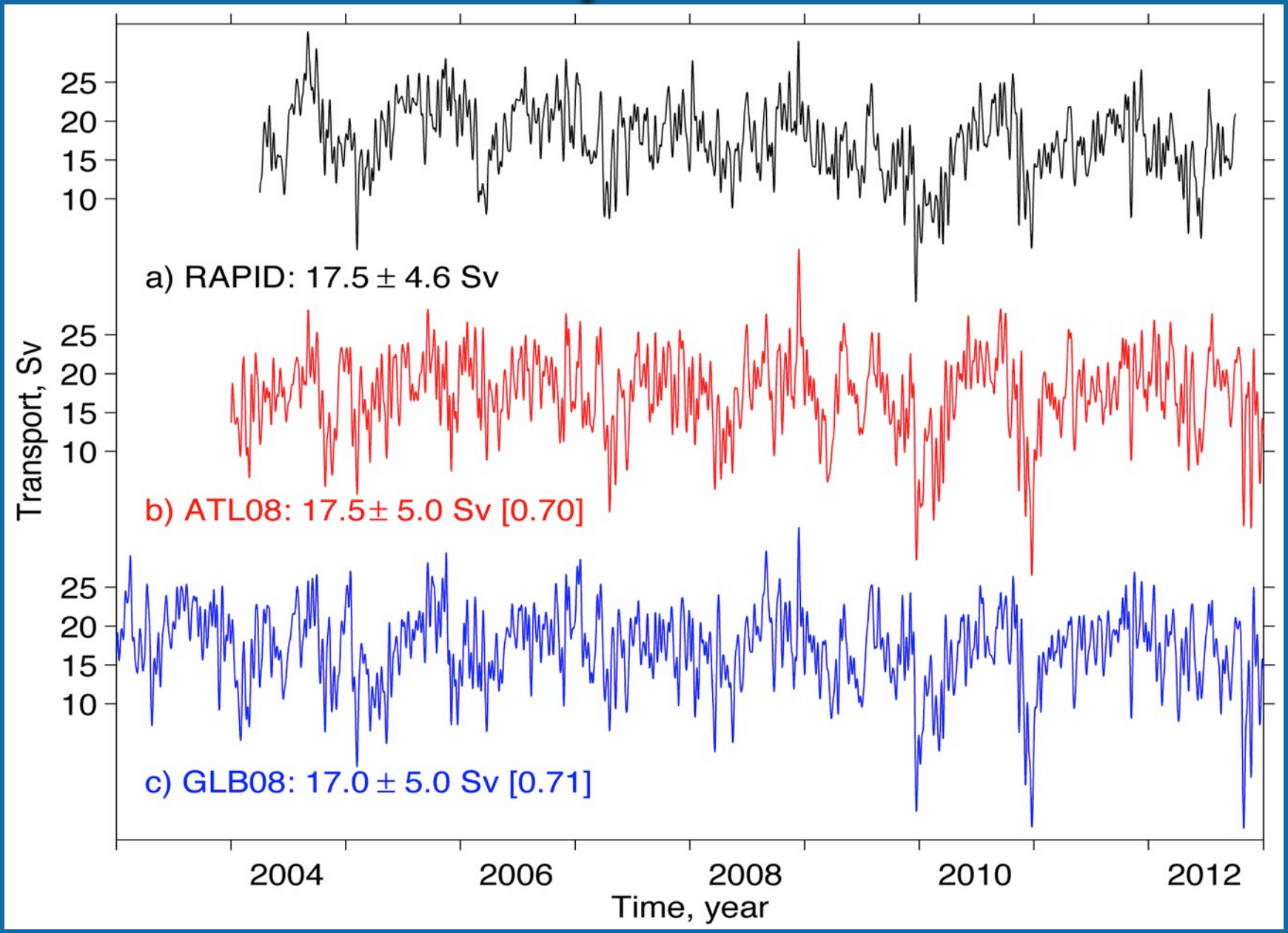
Temporal variability



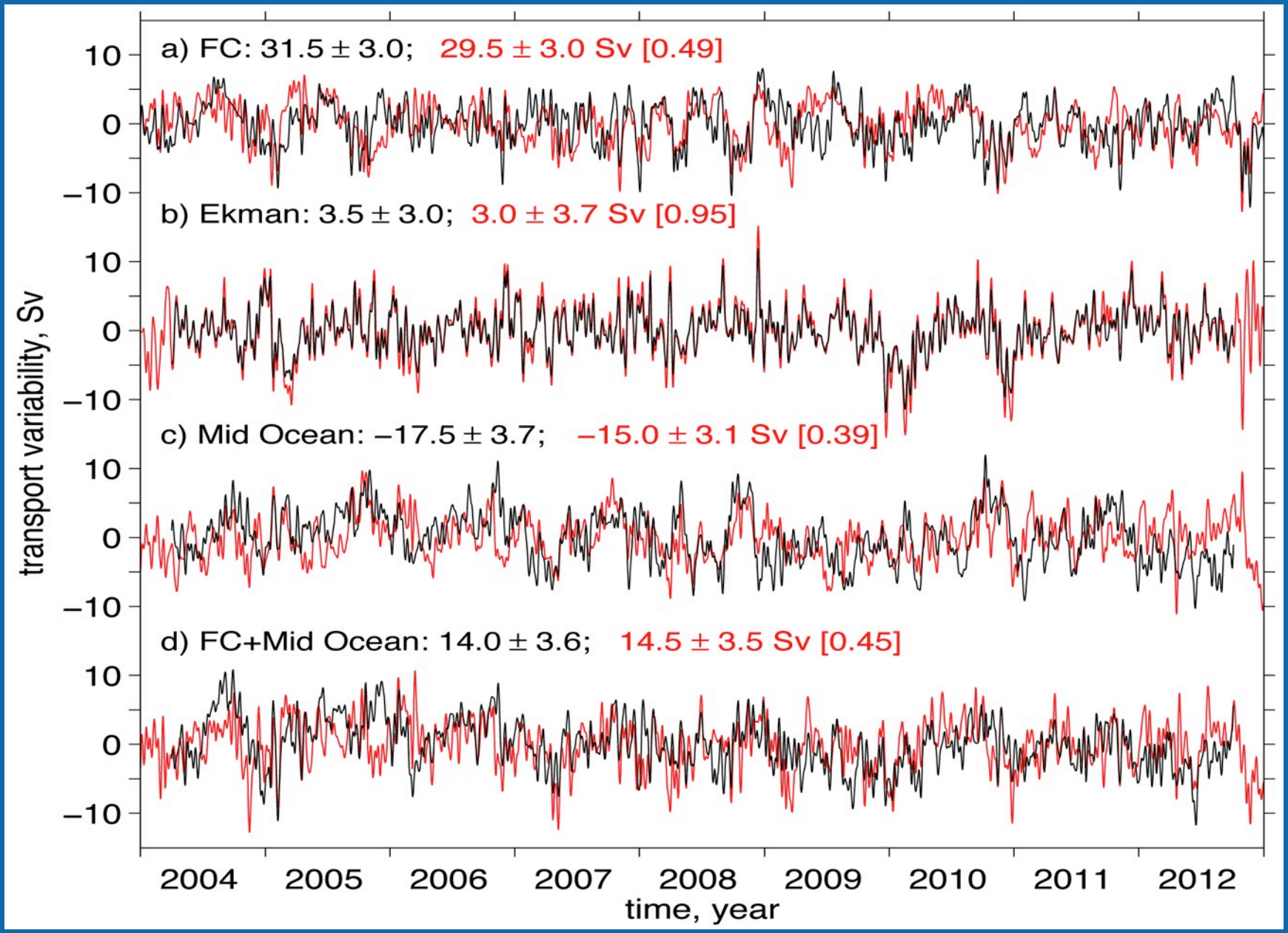
26.5°N

The AMOC stream function from the RAPID data and two 1/12° HYCOM simulations

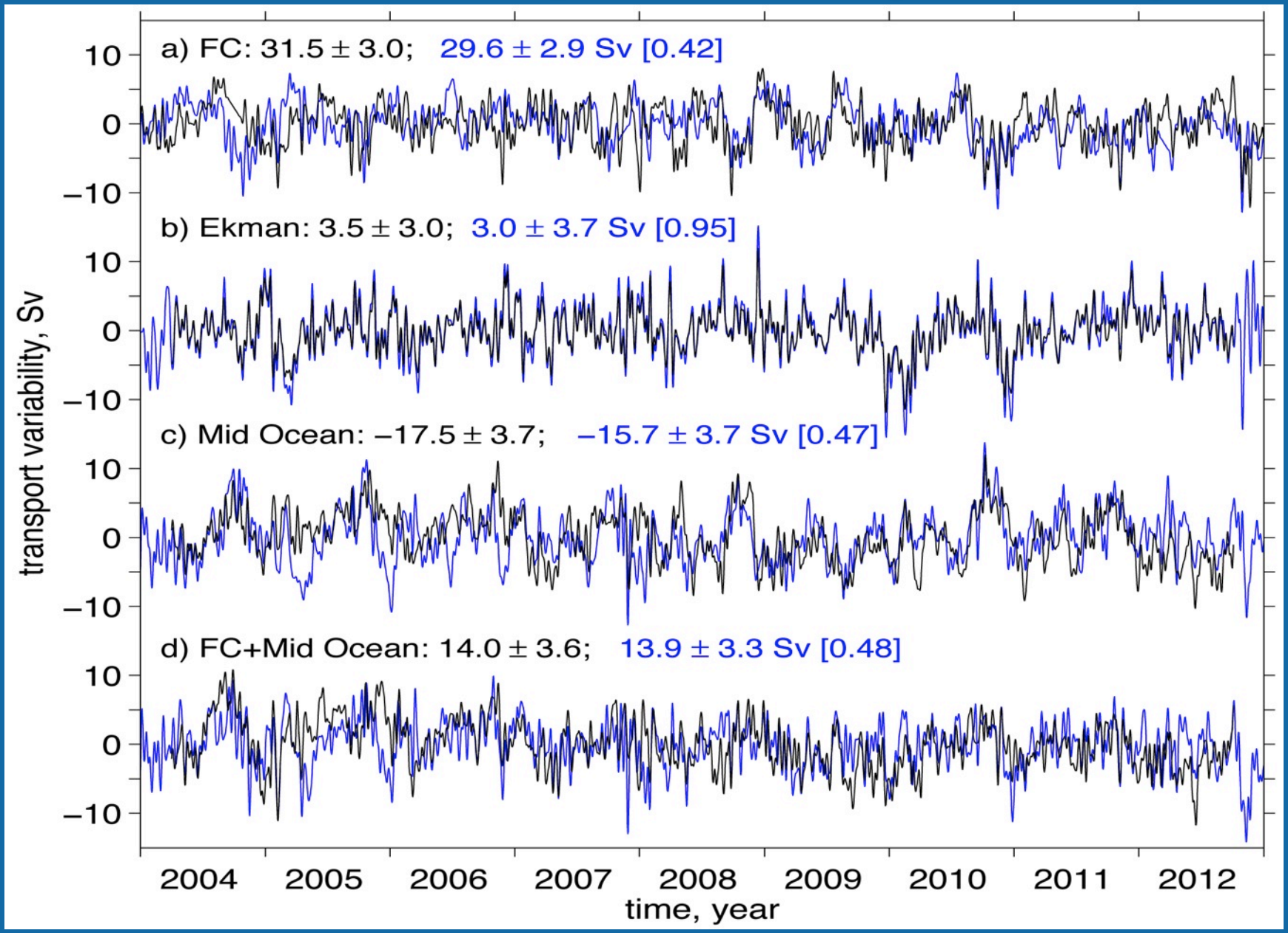
AMOC transport time series



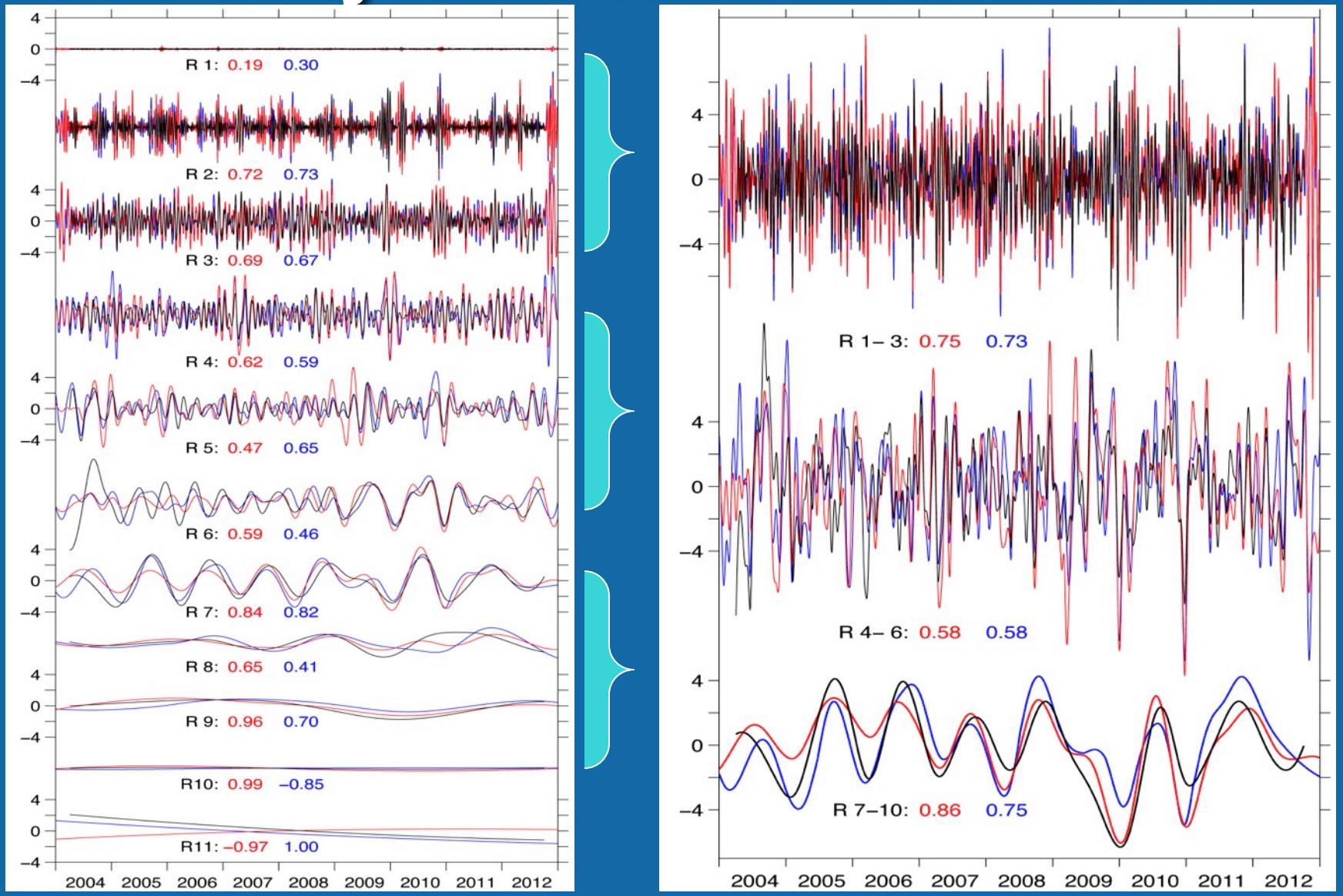
AMOC components (Atlantic)



AMOC components (Global)

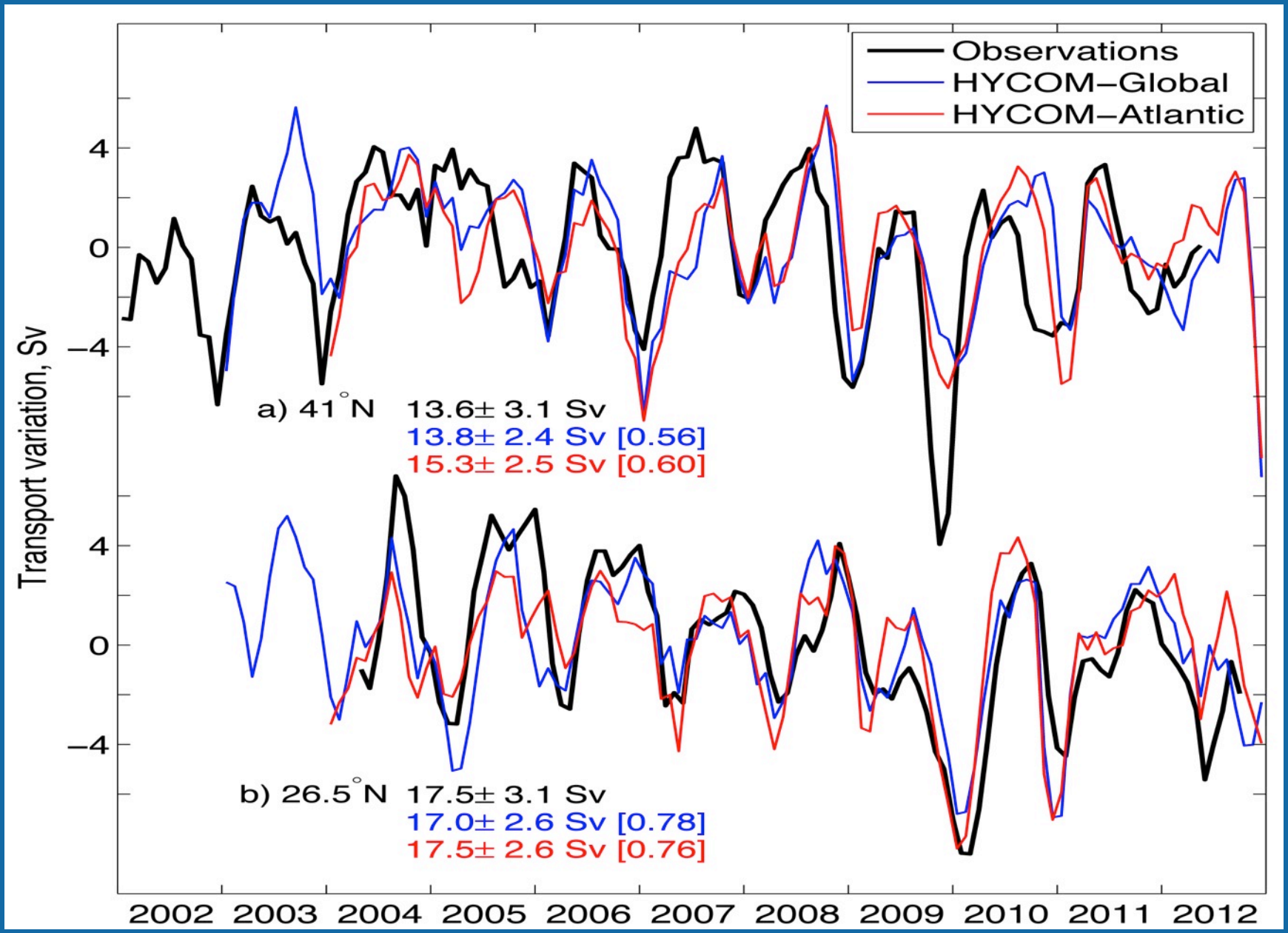


Variability on different time scales

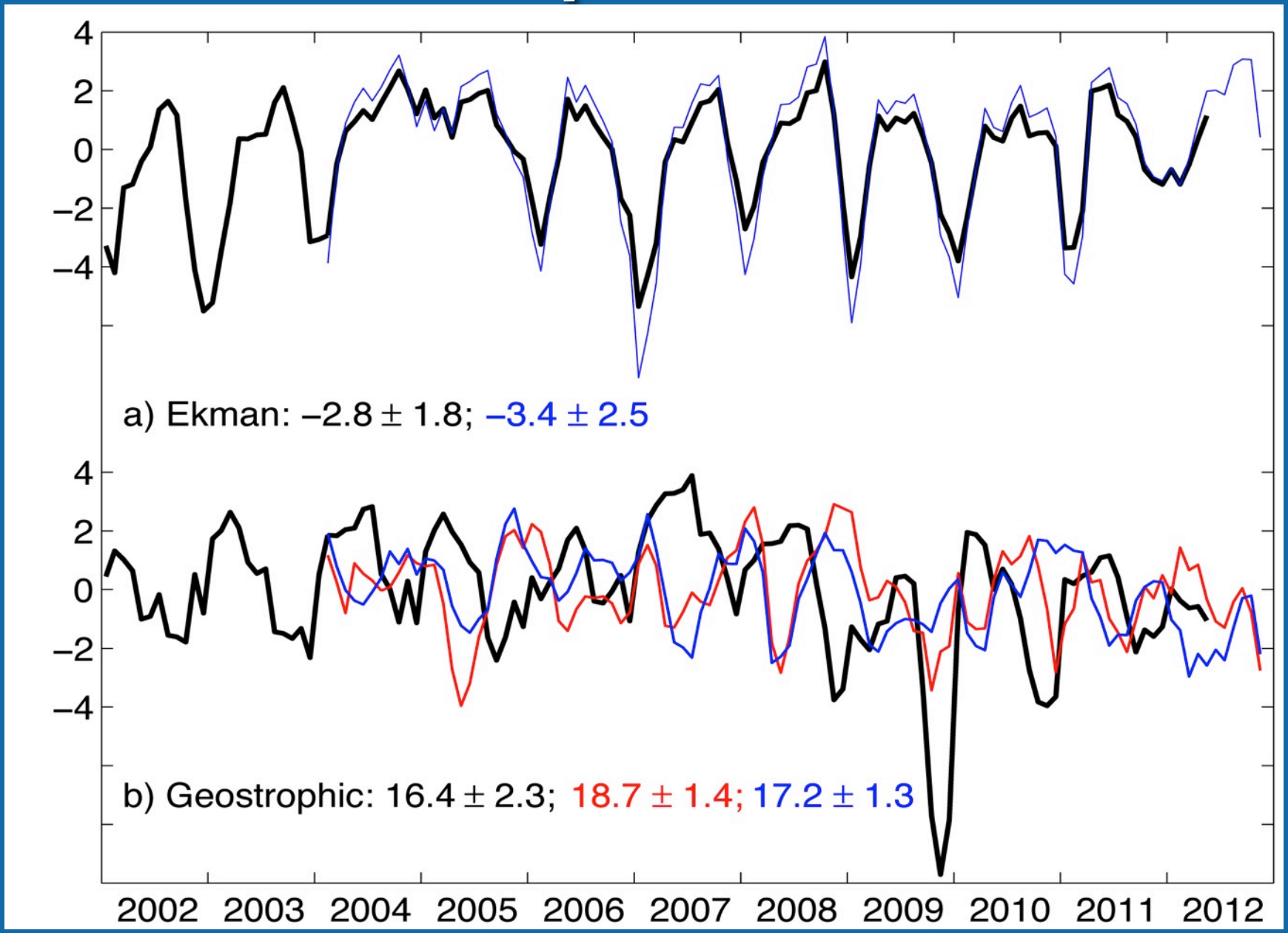


AMOC time series decomposed using the Ensemble Empirical Mode Decomposition (EEMD, *Huang and Wu, 2008; Wu and Huang, 2009*)

AMOC at 41°N

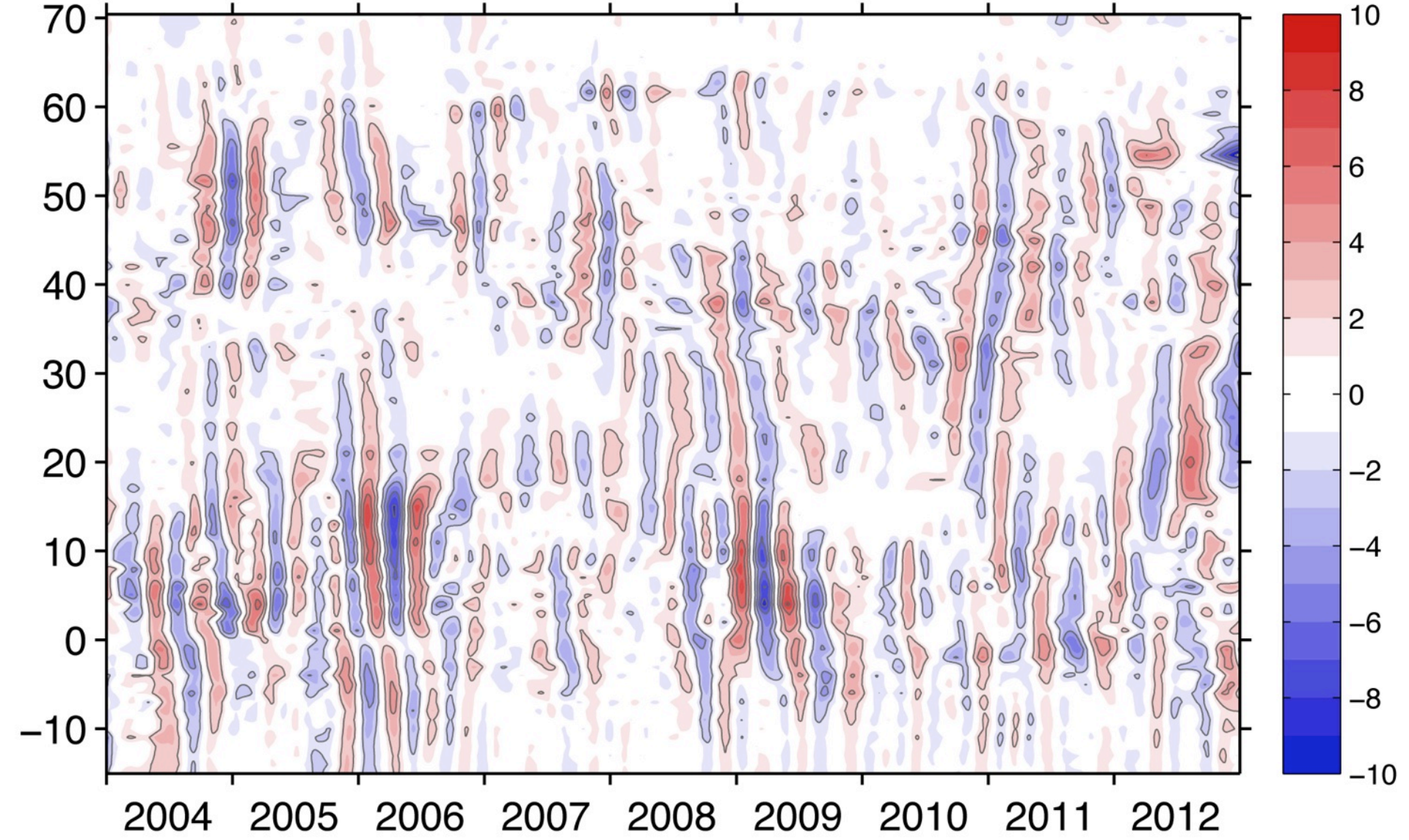

Observations
HYCOM–Global
HYCOM–Atlantic
Transport variation, Sv
4
0
−4
a) 41°N 13.6± 3.1 Sv
13.8± 2.4 Sv [0.56]
15.3± 2.5 Sv [0.60]
4
0
−4
b) 26.5°N 17.5± 3.1 Sv
17.0± 2.6 Sv [0.78]
17.5± 2.6 Sv [0.76]
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012

AMOC components at 41°N

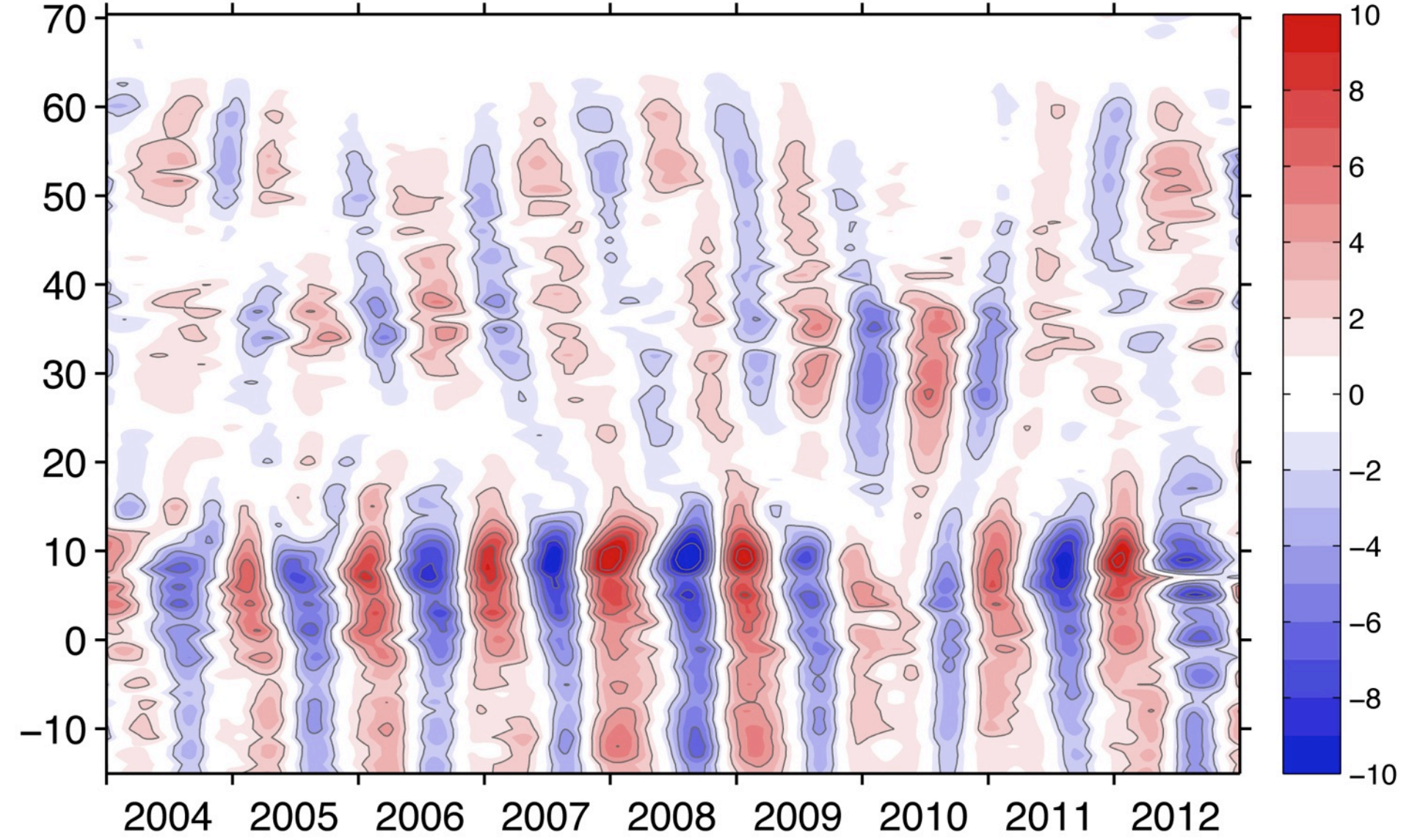


Variability coherence

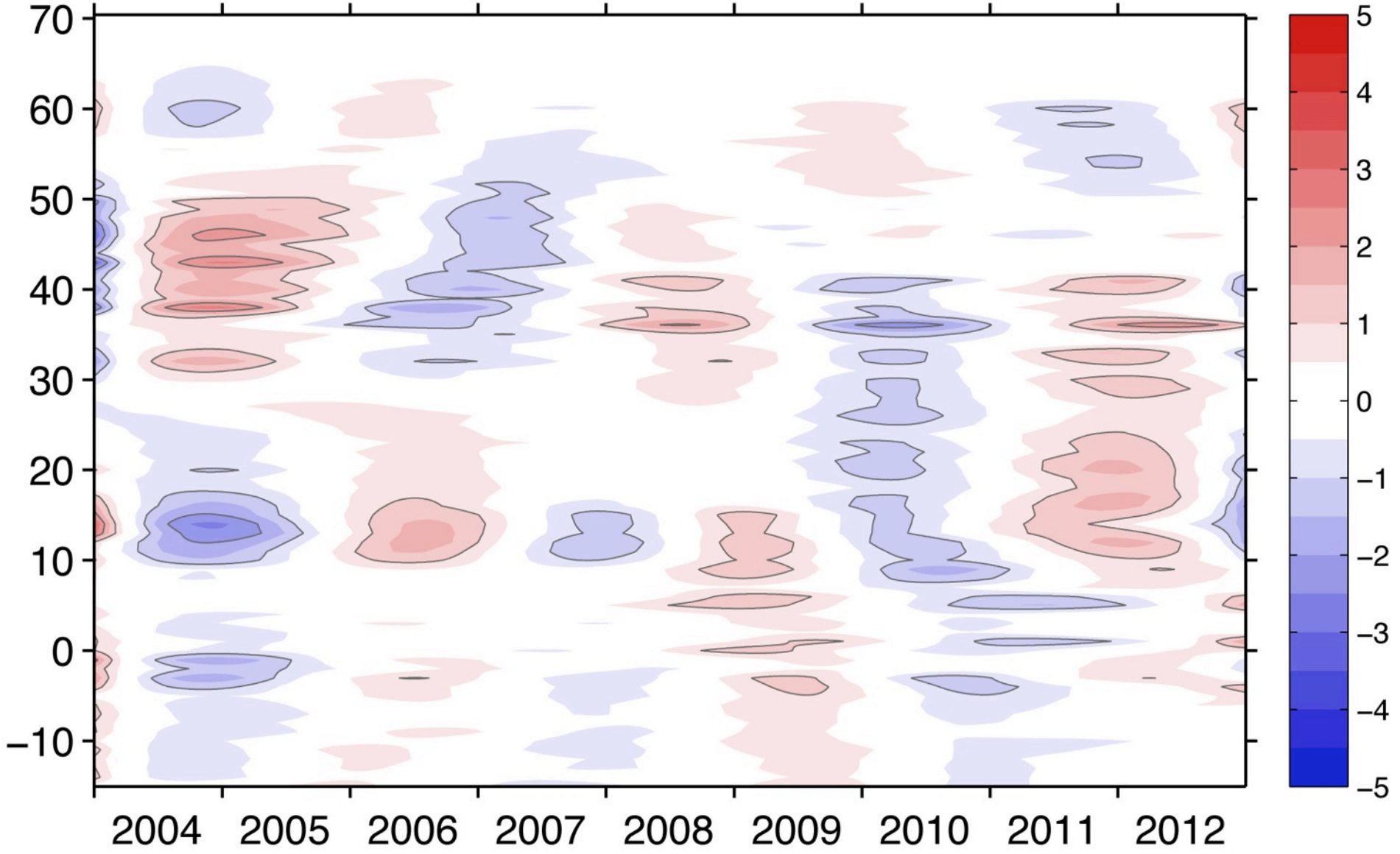
intraseasonal



seasonal


70
60
50
40
30
20
10
0
−10
2004
2005
2006
2007
2008
2009
2010
2011
2012
10
8
6
4
2
0
−2
−4
−6
−8
−10

interannual



Summary

- The 1/12° HYCOM simulations represent the time mean structure and the temporal variability of the observed AMOC at 26.5°N. However, the modeled geostrophic transport variability at 41°N differs from the observations.

- Very similar AMOC variability in the global and Atlantic simulations, implying that they are 'locally' forced. Remote forcing mostly operate on long-term scale (decadal and longer).
- The AMOC exhibits a higher variability on seasonal and shorter time scales than on interannual and longer time scales.
- The AMOC variability on intraseasonal and interannual time scales can be coherent over wide latitudinal ranges, but lacks an overall consistent coherent pattern. The seasonal AMOC variability exhibits two distinct coherent regimes north and south of 20°N, the boundary of subtropical/ tropical gyres.