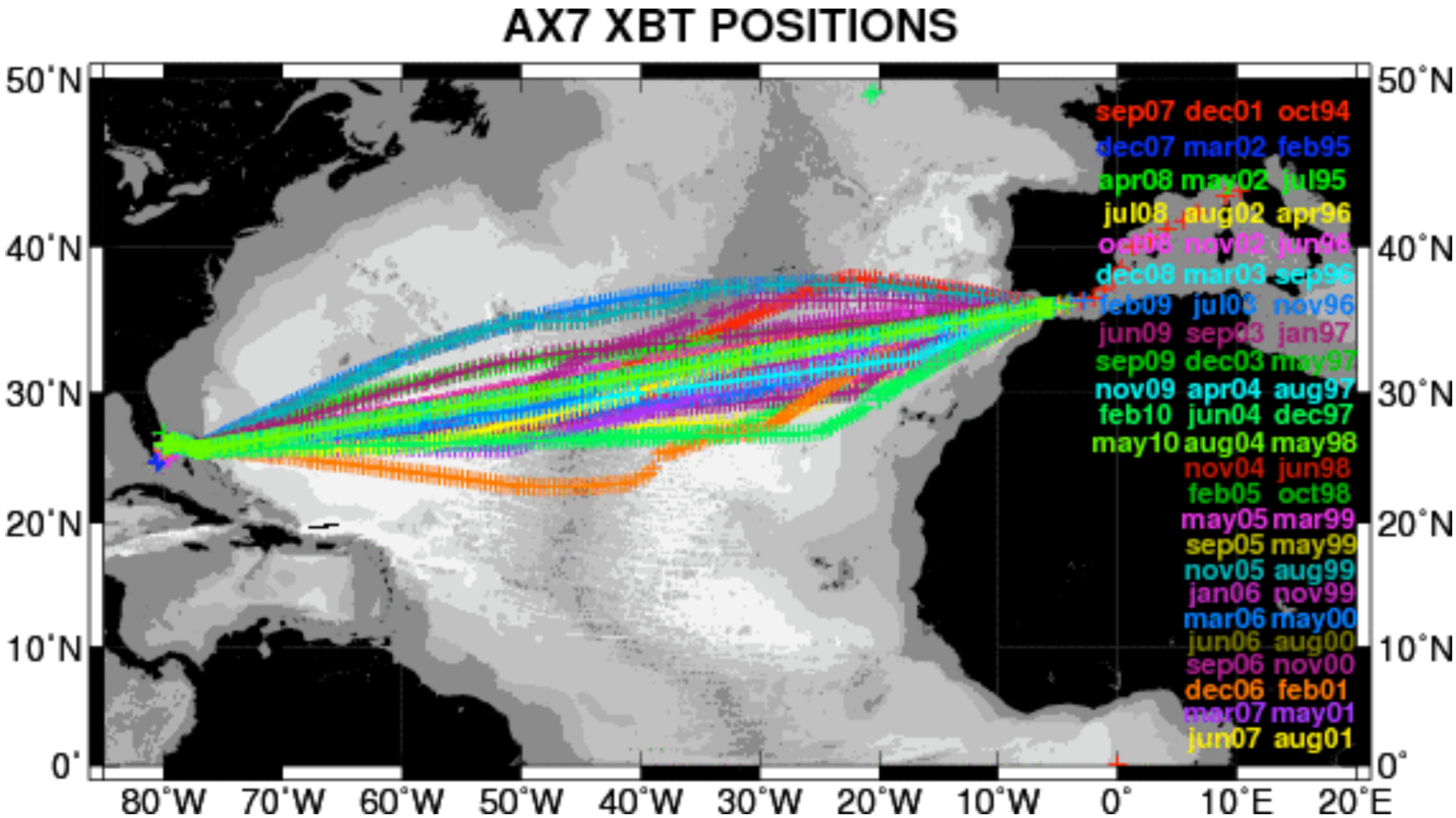
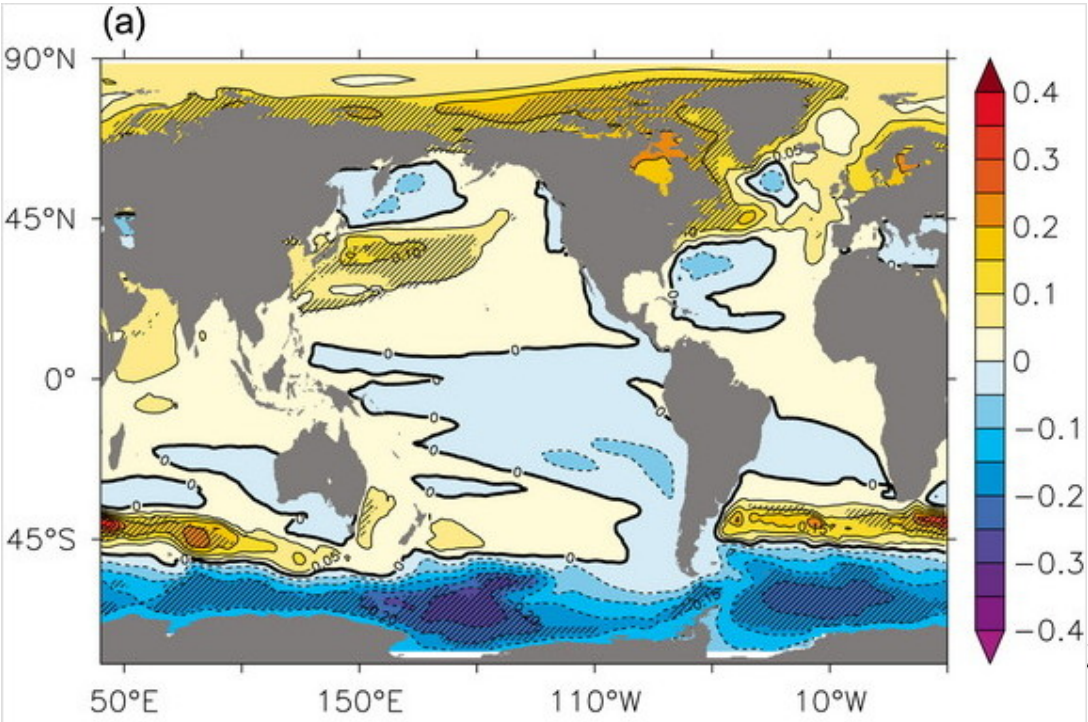


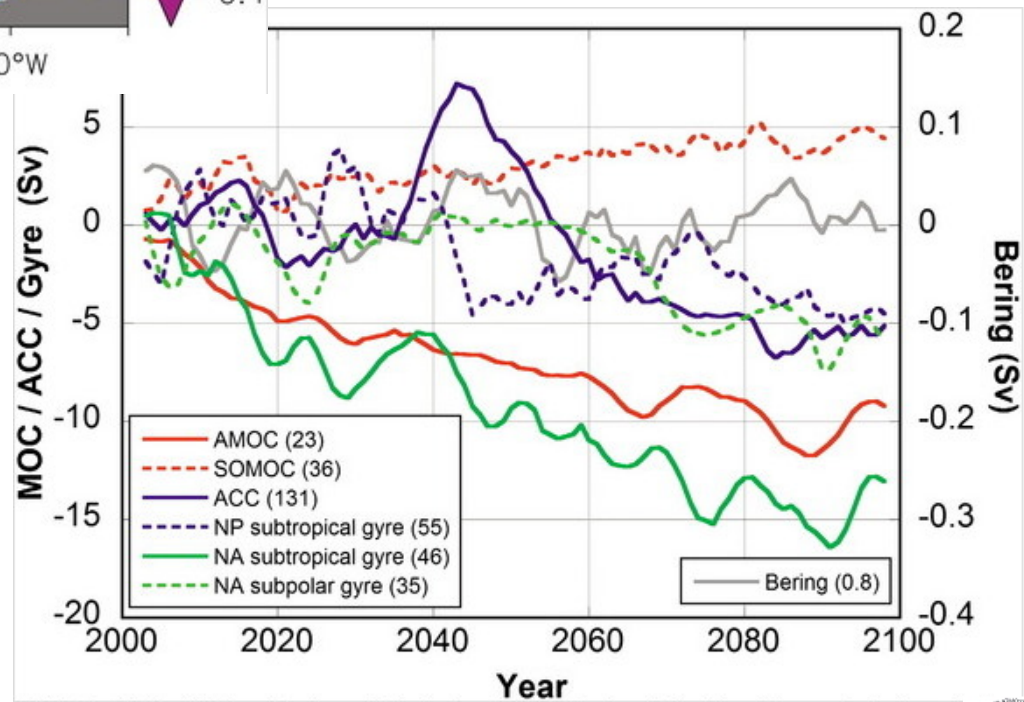
Meridional overturning and heat transport from expendable bathythermograph data

Molly Baringer



WHY?

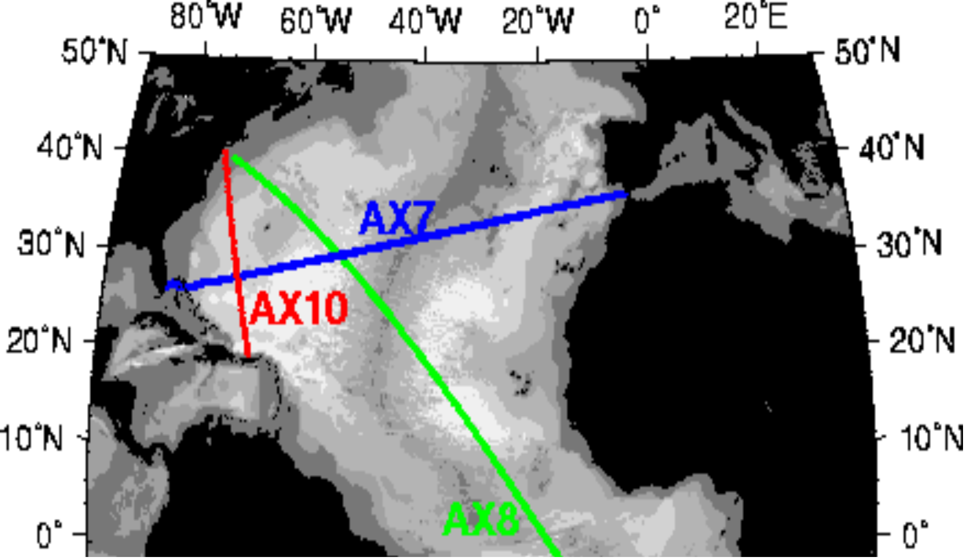
Top Yin et al 2010, JC show average dynamic sea level anomaly averaged over 12 IPCC models



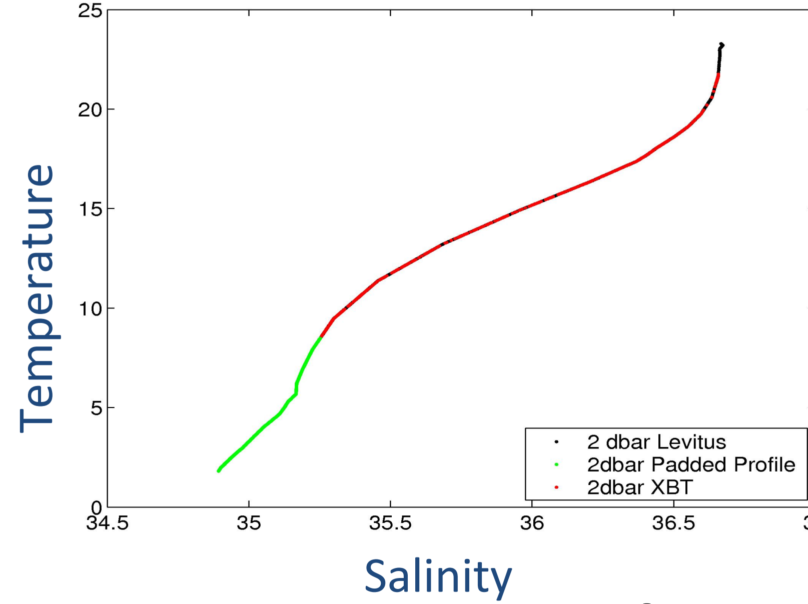
2010. Spatial Variability of Sea Level Rise in Twenty-First Century Projections [Figure . 8_8]. Journal Climate, 23, 4585â4607.
Publisher: American Meteorological Society

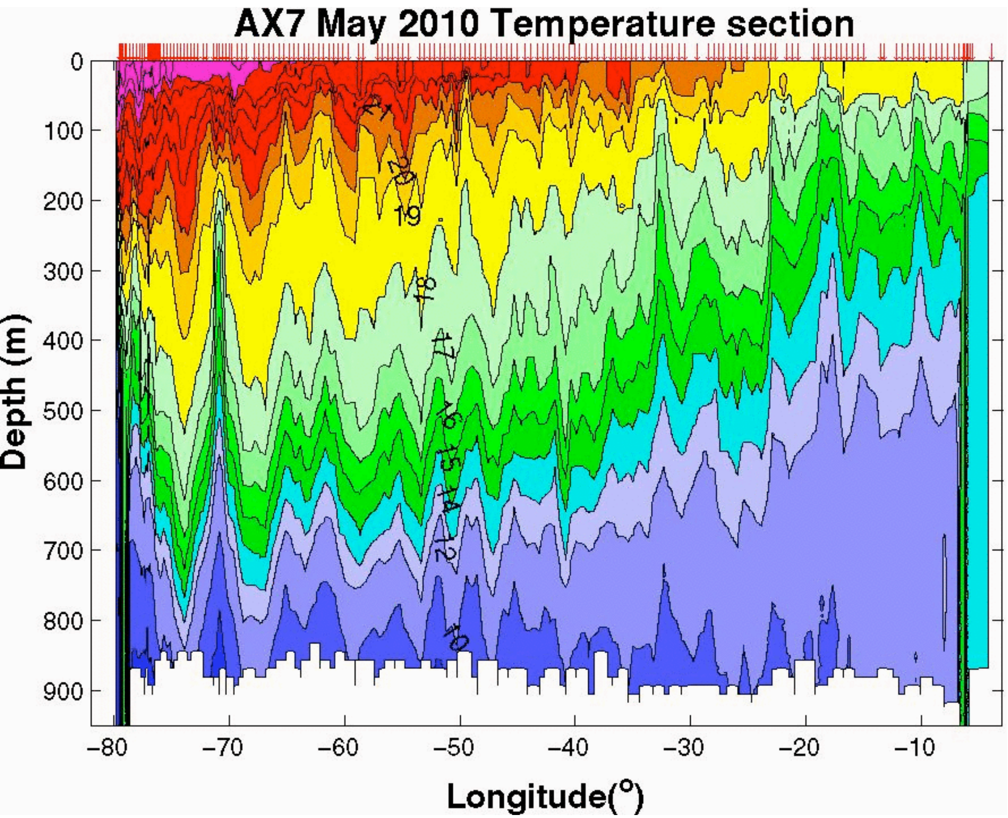
Right These Dynamic Sea level changes are associated with changes in the mean current structure

Yin et al JC, 2010



WHAT?



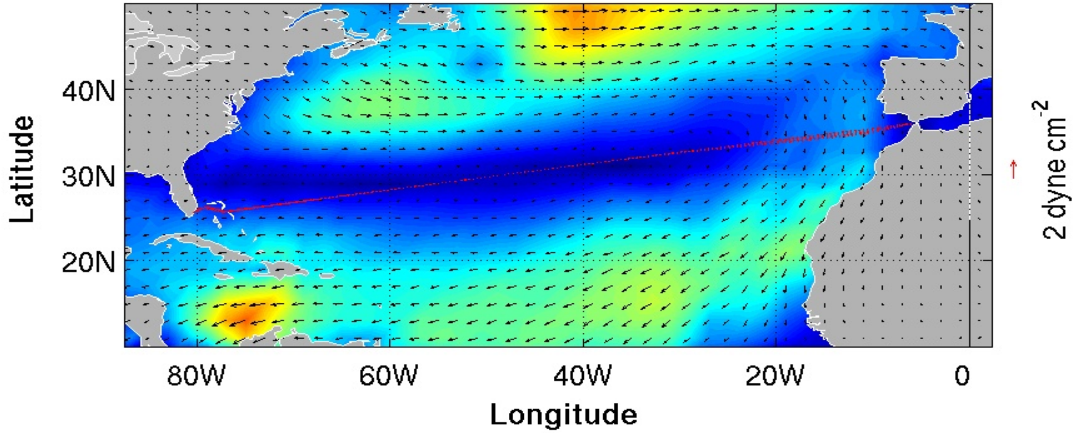


64 Repeat Sections along AX7 since 1995

Annual mean Levitus climatology provides a T/S look-up for missing salinity and any data below the depth of the XBT.

HOW

Direct estimates of meridional volume, mass and heat (H) transport across a vertical section require T, S and velocity observations:



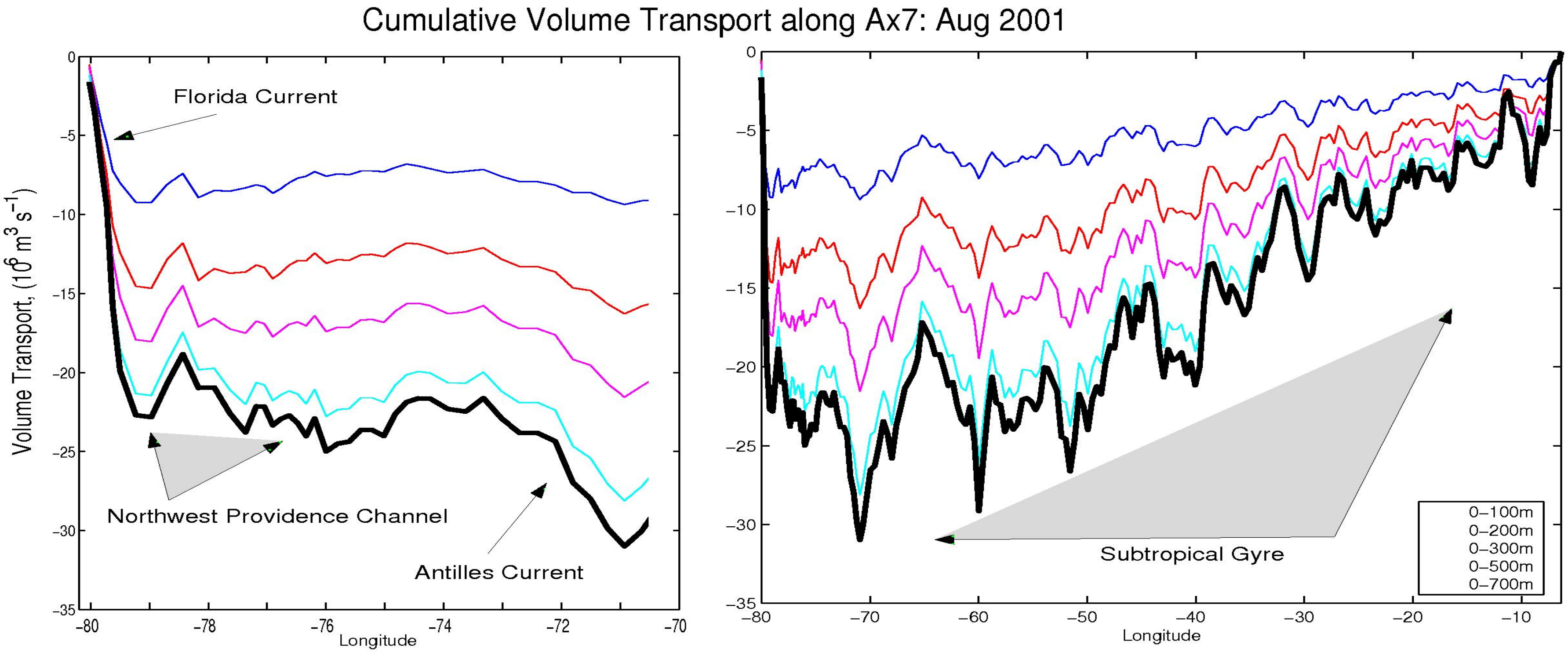
$$H = \int \int \rho c_p \theta v \, dx \, dz \qquad \left[PW = 10^{15} Watts \right]$$

$$v = v_g + v_{ag} + v_b$$

XBT observations

Wind products
+ ??

??
Florida
Current / Mass
Adjustments



•Florida Current Volume Transport: set to 32.11 Sv (long term mean from Cable)

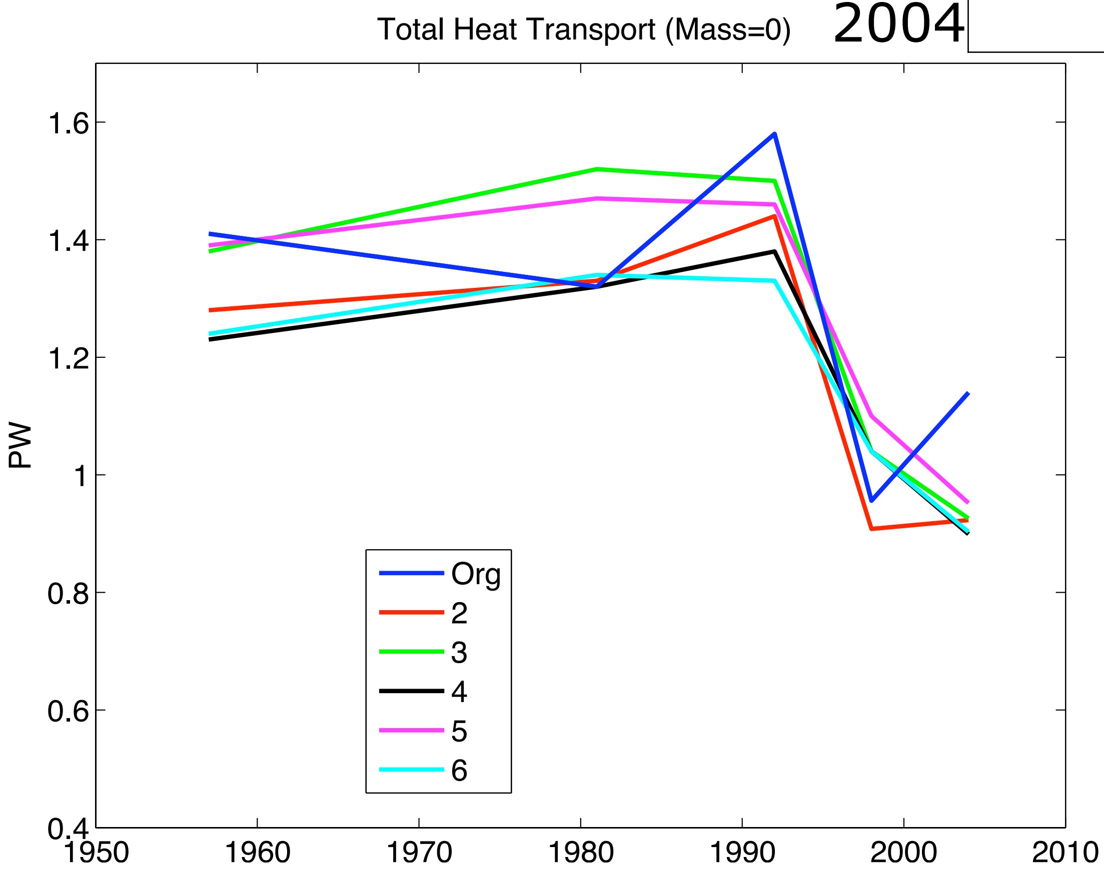
•Initial Reference Level sigma theta = 27.6

•Reference velocity applied at this reference level so that total massflux=0.

•Ekman transport determined from Hellerman annual winds

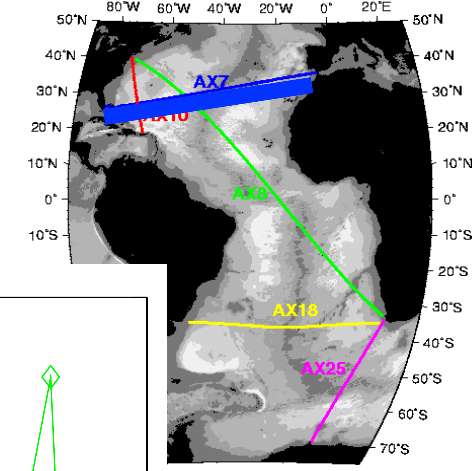
DOES THIS WORK?

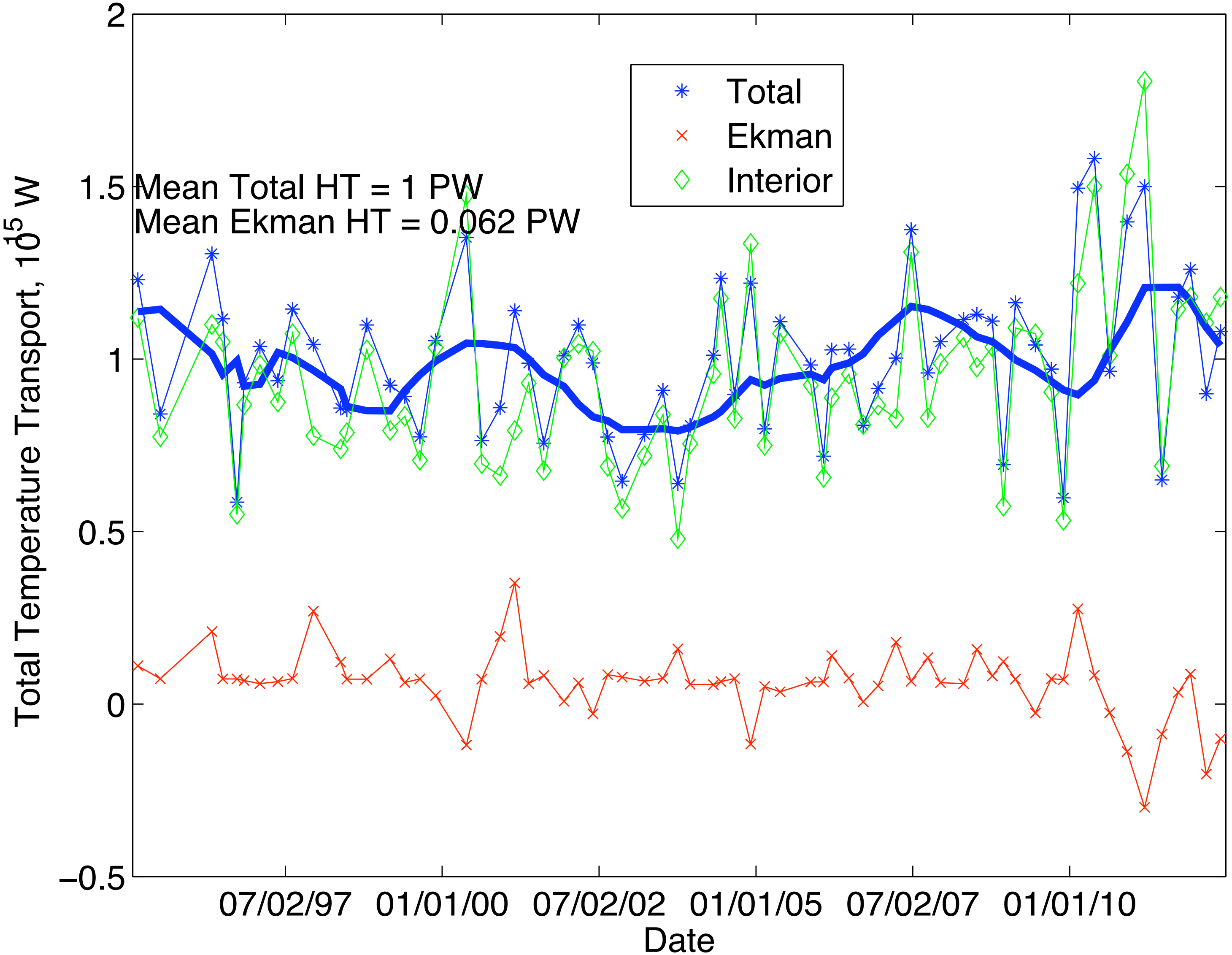
	Full Section	Mean Diff	Stnd Dev
1957	1.41	0.12	0.07
1981	1.32	-0.06	0.09
1992	1.58	0.16	0.06
1998	0.96	-0.07	0.06
2004	1.1	0.22	0.02
		0.07	0.14



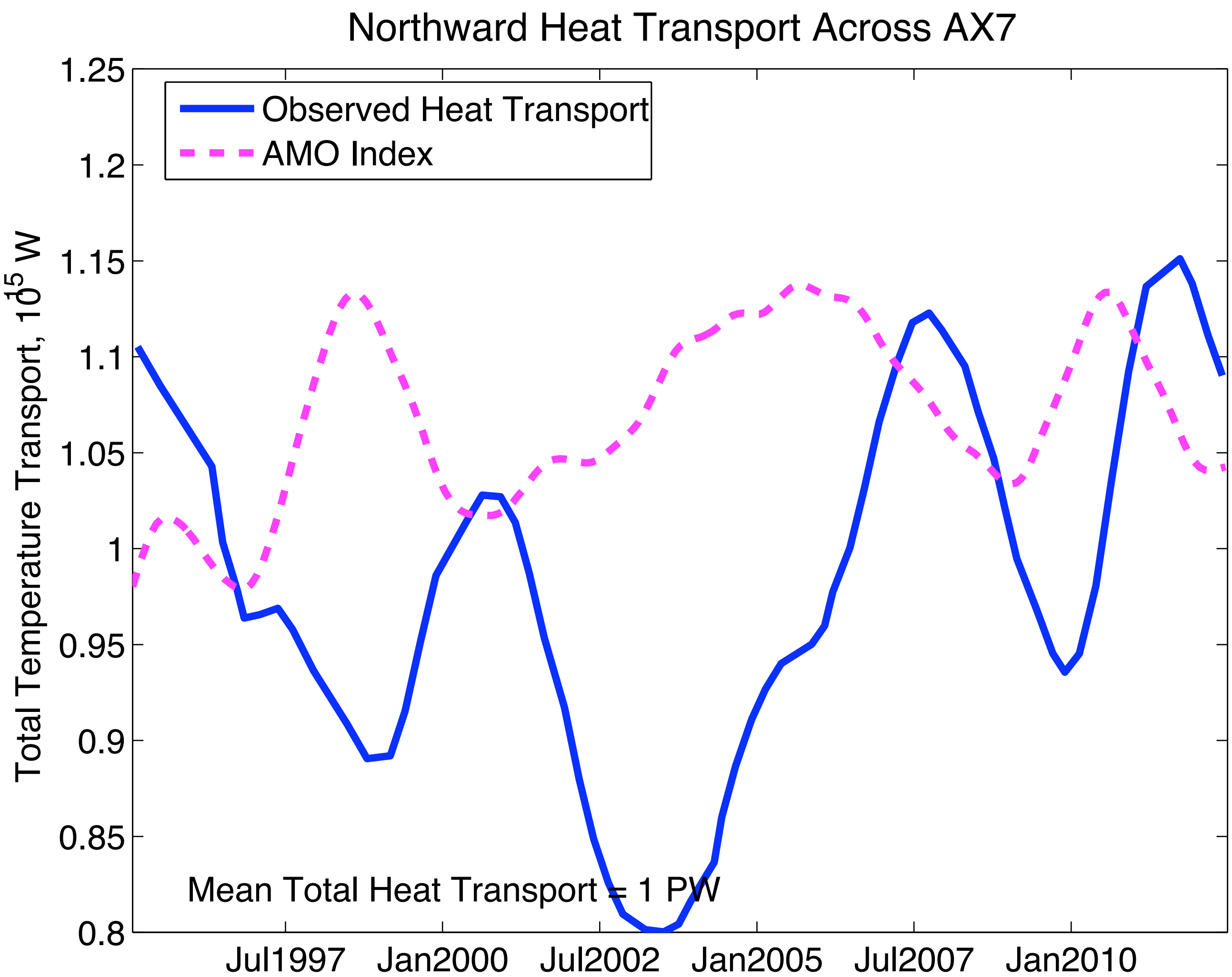
Using full hydrographic sections along 24N using various choices to estimate transport as if there was only XBT data to 800 m gives a mean error of 0.07 +/- 0.14 PW

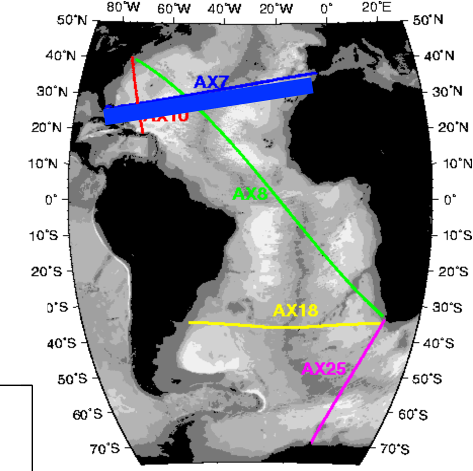
MHT TIME SERIES

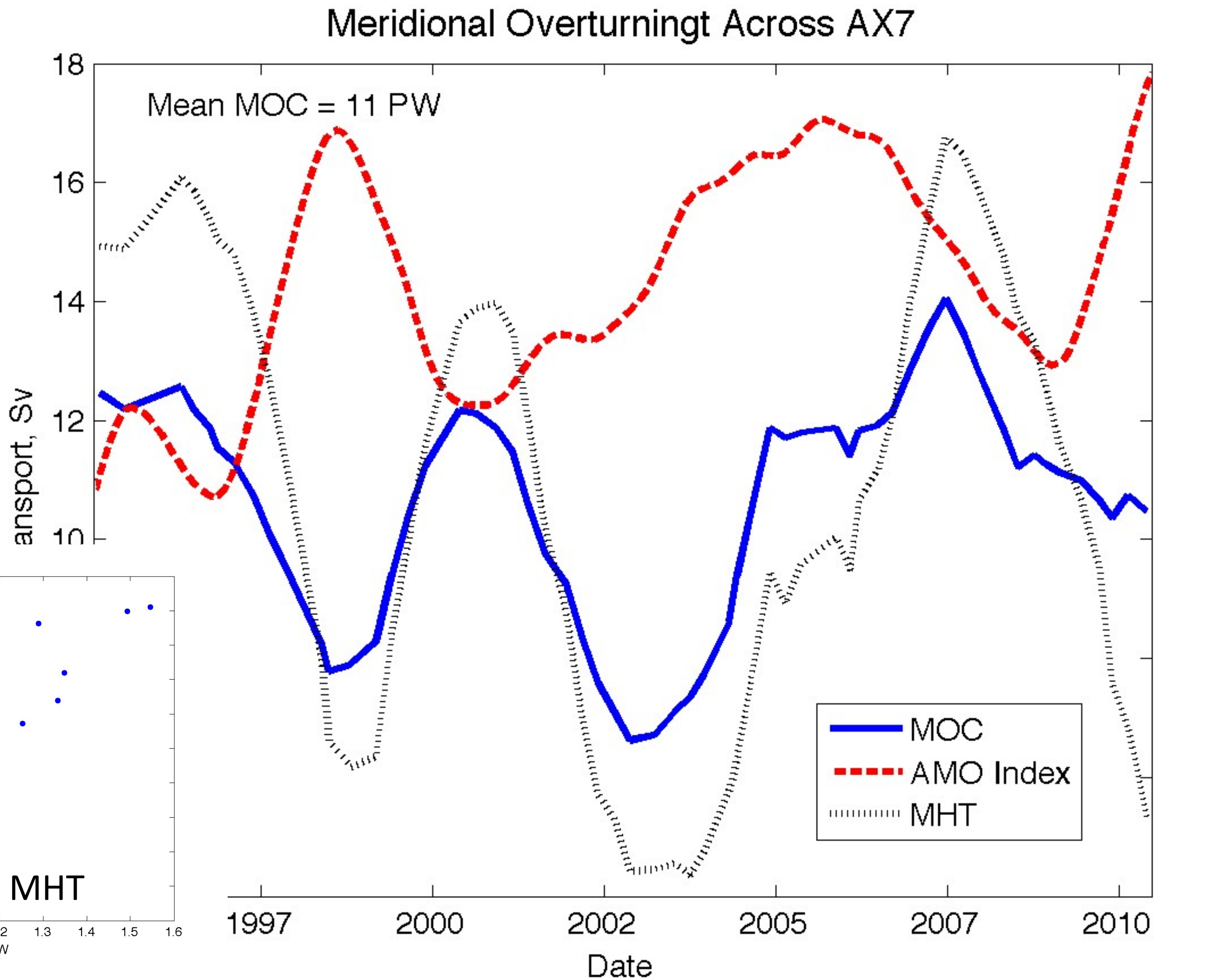


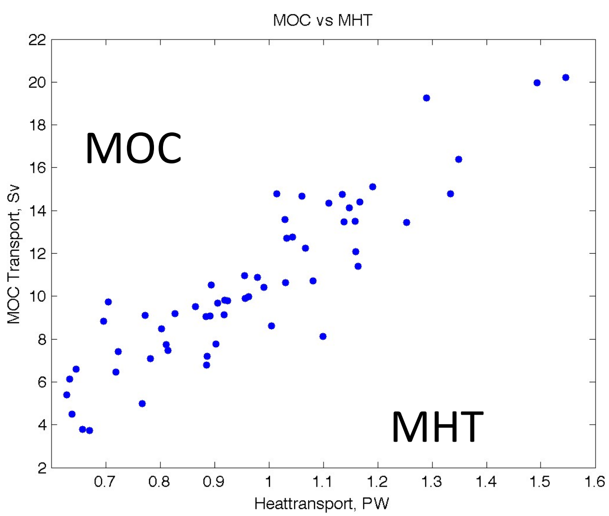


HEAT TRANSPORT AND THE AMO



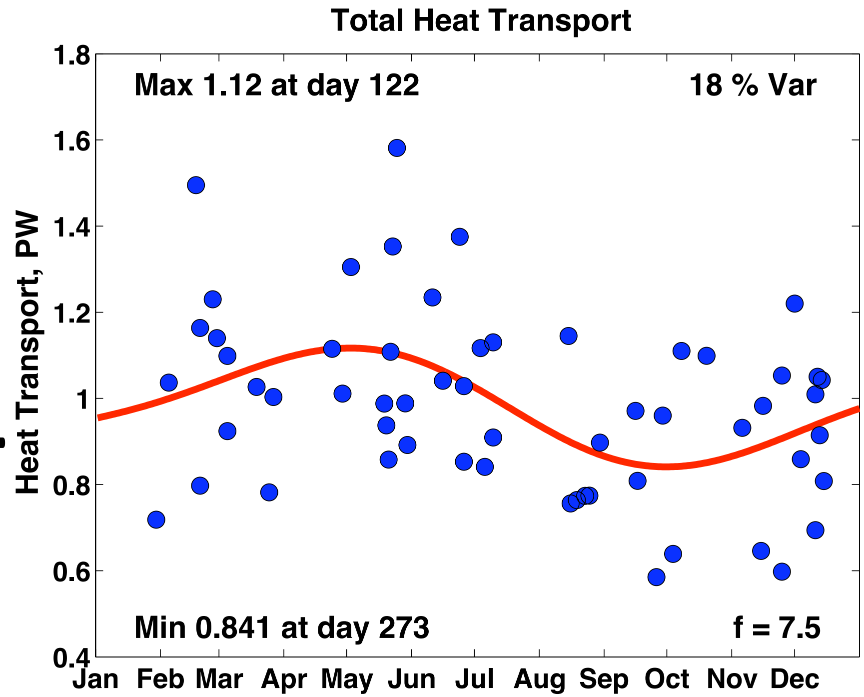


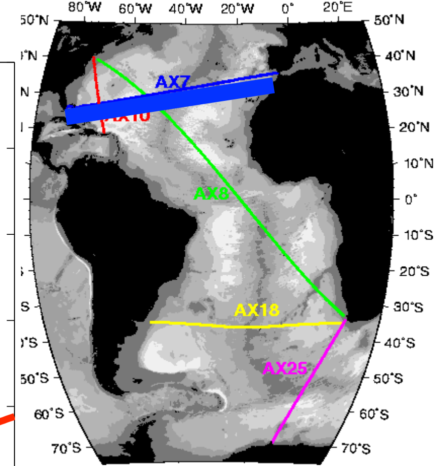

Meridional Overturningt Across AX7
Mean MOC = 11 PW
ansport, Sv
18
16
14
12
10
1997
2000
2002
2005
2007
2010
Date
MOC
AMO Index
MHT

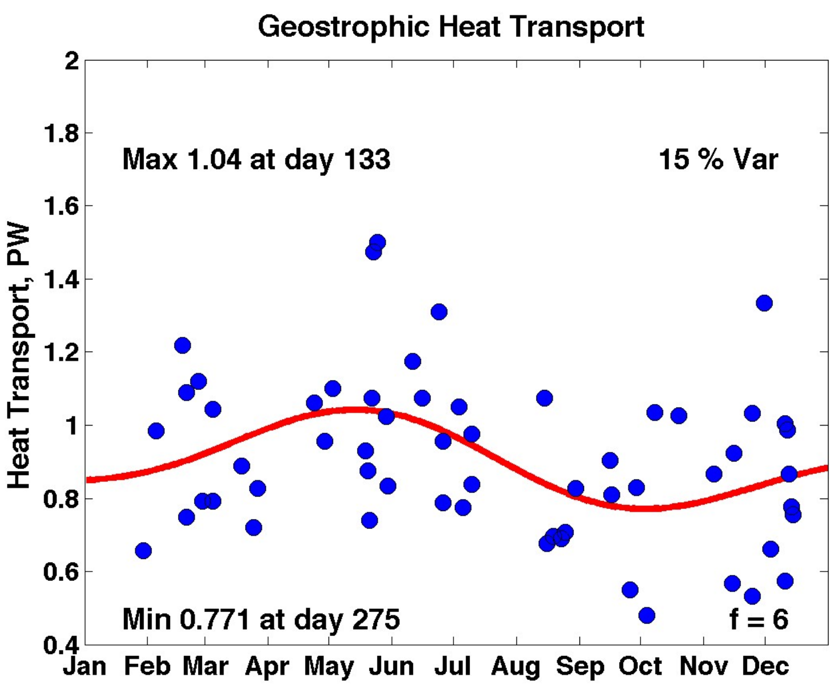

MOC vs MHT
MOC
MHT
MOC Transport, Sv
Heattransport, PW
22
20
18
16
14
12
10
8
6
4
2
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6

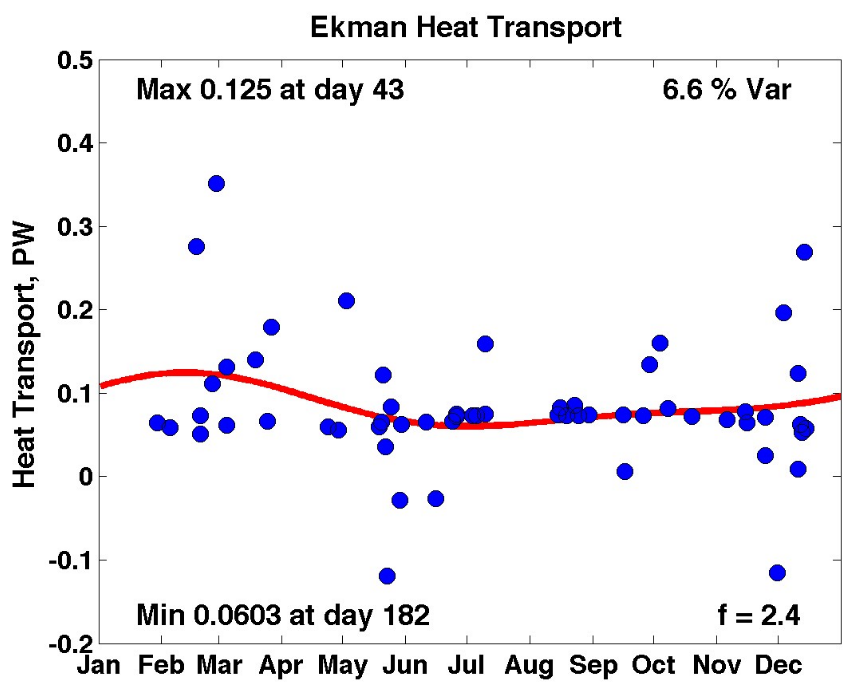
MHT VS MOC

MHT SEASONAL CYCLE

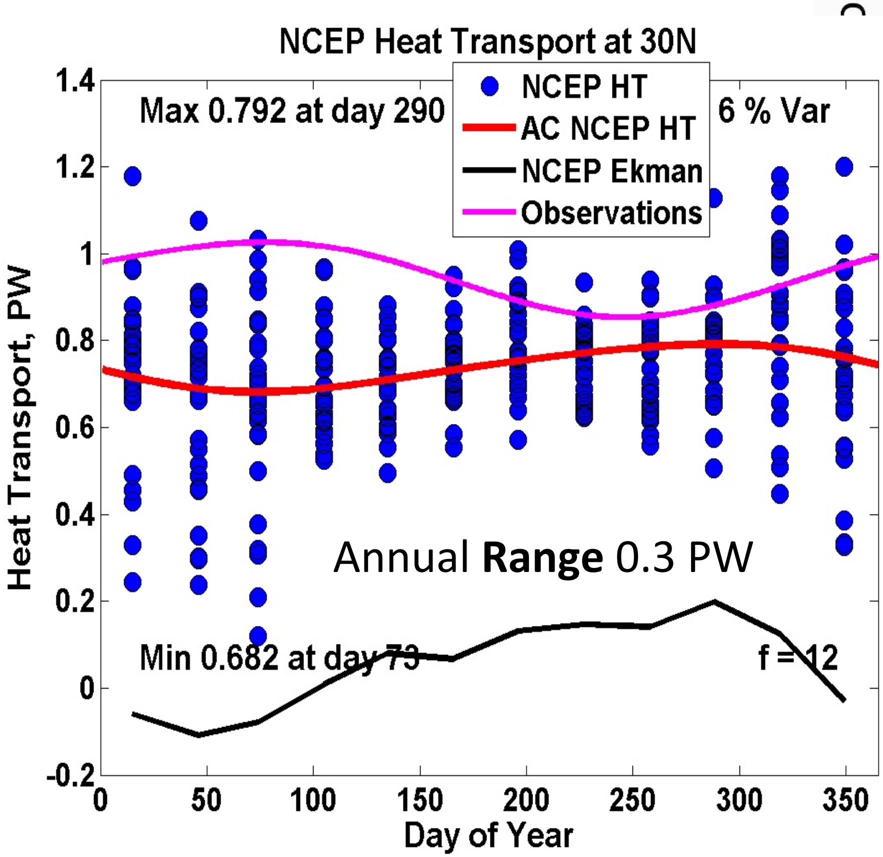


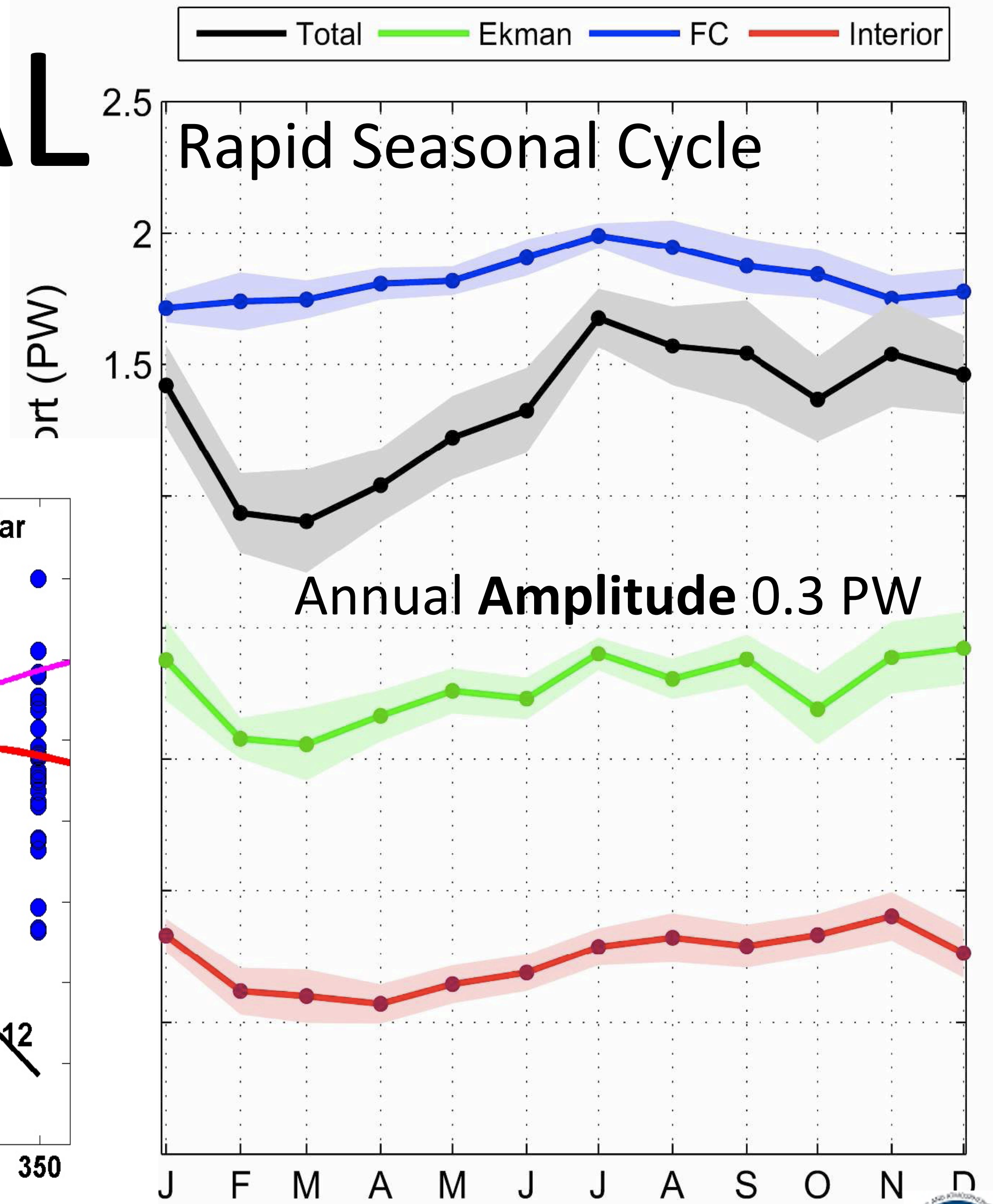






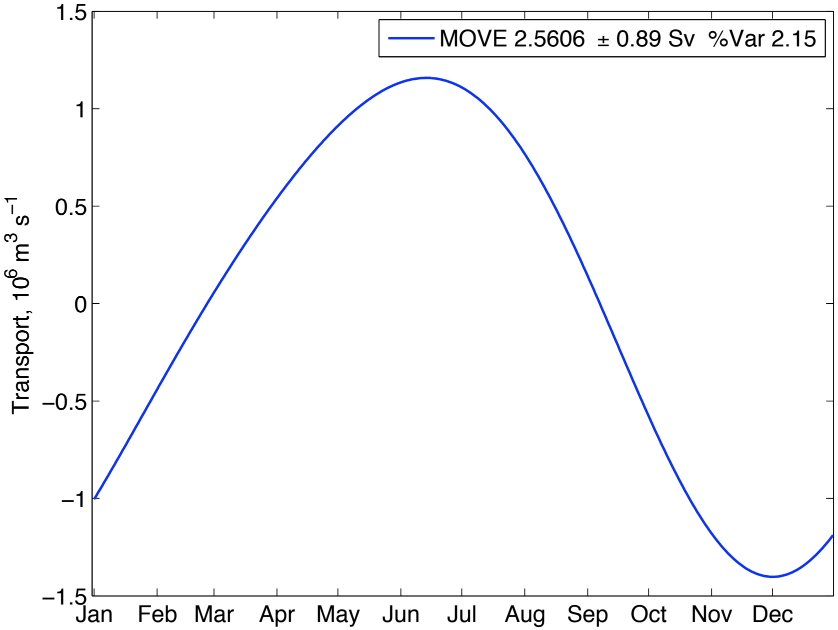
SEASONAL CYCLE

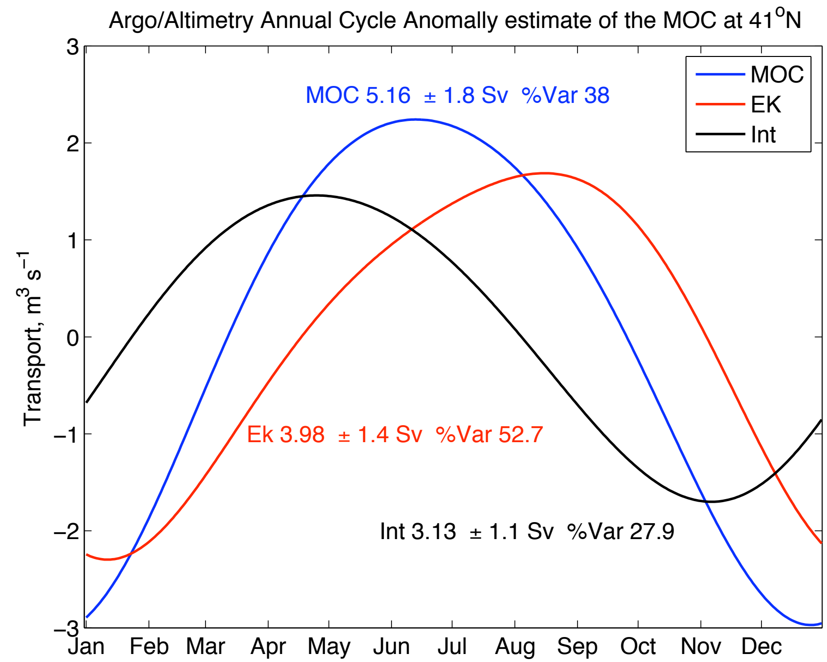


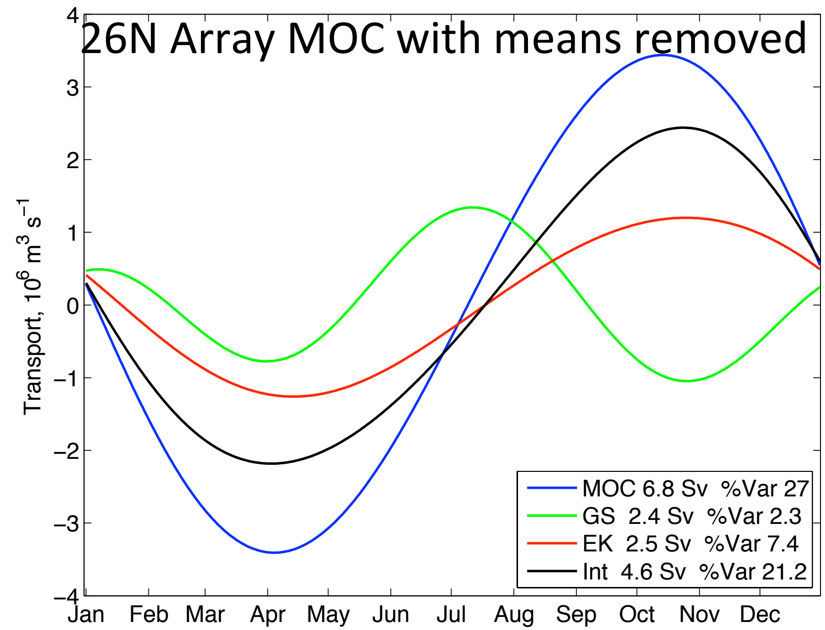


Johns et al, 2011, JC

COMPARED TO MOC AC AT OTHER LATITUDES







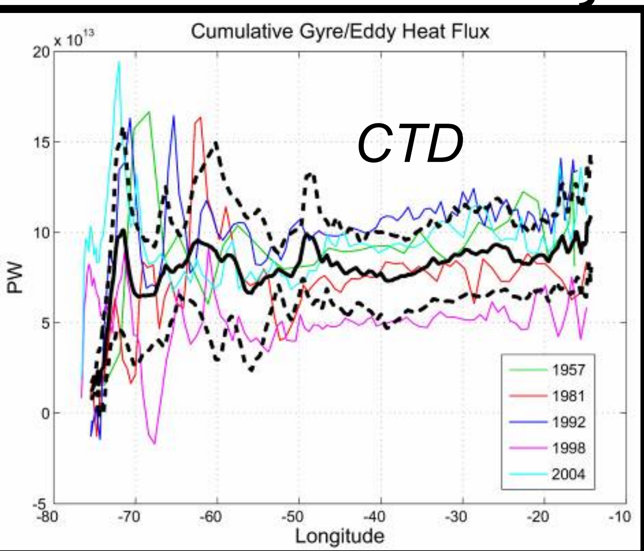
MOC AC Range:

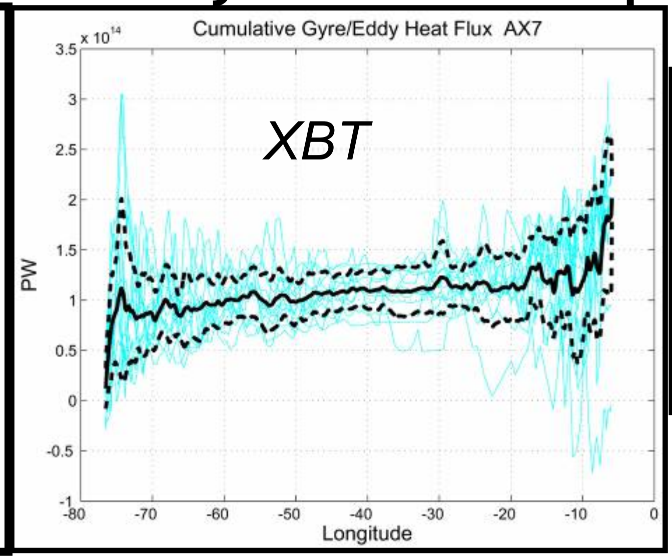
41N = 5.2 Sv (38% Var)

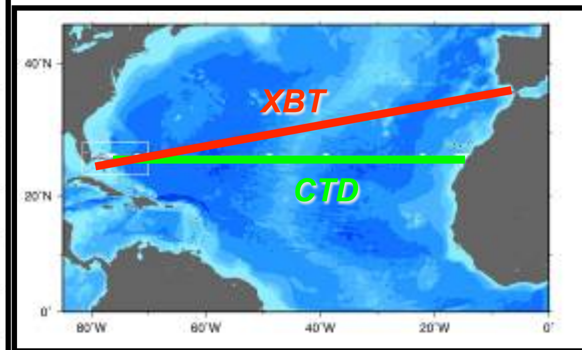
26N = 6.7 Sv (26% Var)

Move = 2.5 Sv (2.2% Var)

Gyre/eddy Heat Transport



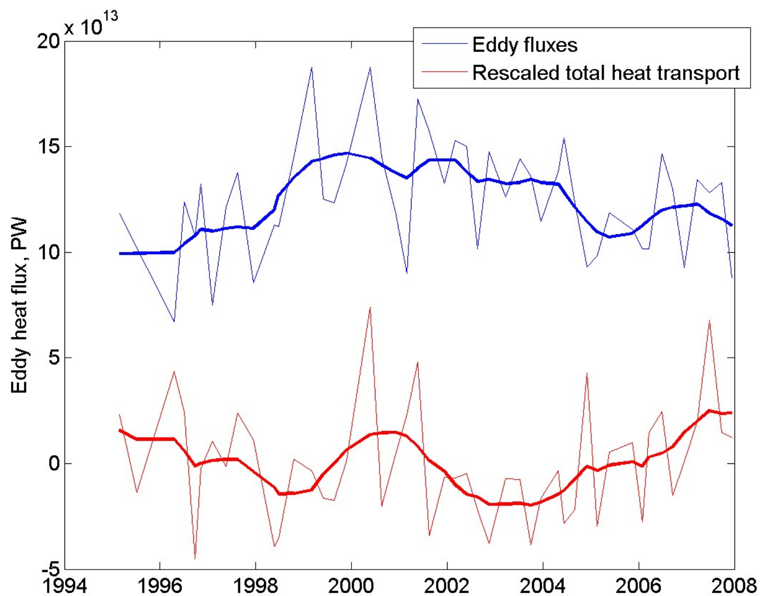




$Q_{gyre/eddy}$ =

$\iint \rho c_p\, v'\theta'\, dx\, dz$

~ 0.10 ± 0.03 PW

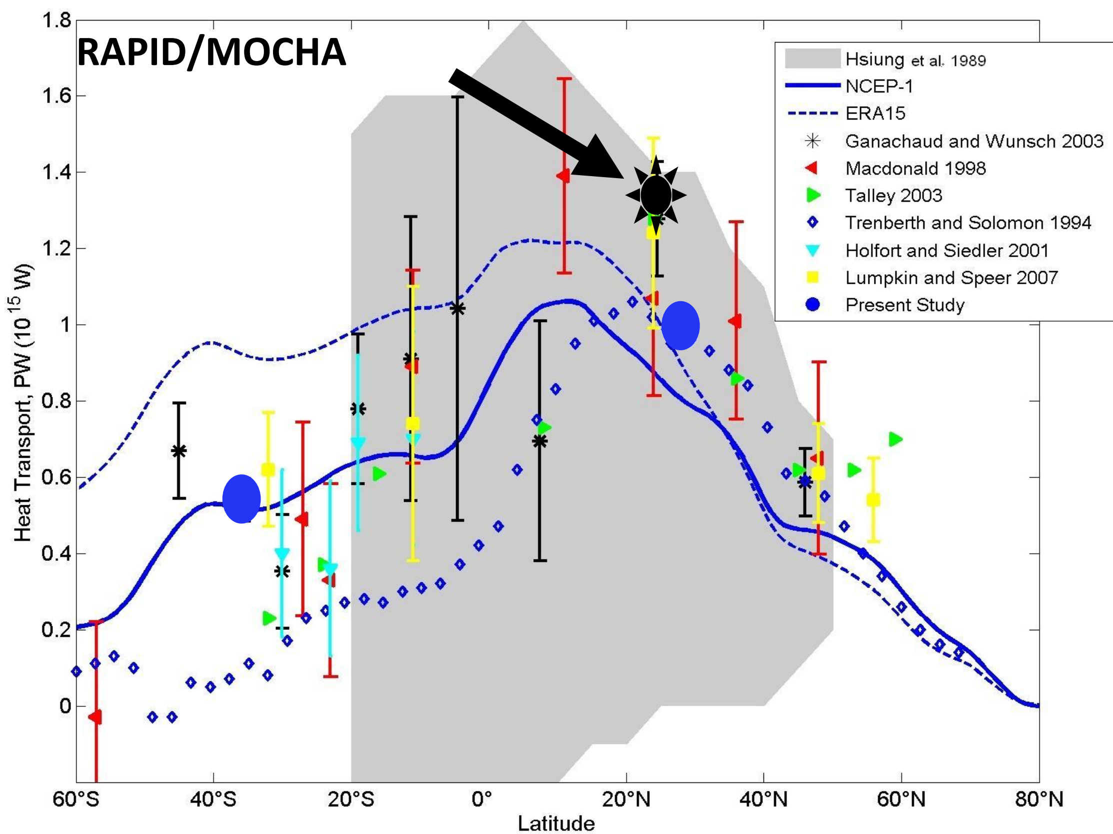


Subannual variability as large as 0.05 PW

Interannual variability as large as 0.025 PW

CONCLUSION

- Annual mean (1995-2010) heat transport AX7 (approximately 30N) = 0.97 PW with a standard deviation of +/- 0.21 PW.
- Annual mean MOC transport = 10.6 Sv with a standard deviation = +/- 3.8 Sv, which is much lower than other estimates at 24-26N.



CONCLUSION

- The heat transport mean and variability is dominated by the geostrophic heat transport (0.91 PW   +/- 0.22 PW).
- Ekman transport is expected to be low given the choices made here: 0.08 PW   +/- 0.08. Use of actual winds should increase the variability substantially.
- Short term variability is large: ranging from 0.58 to 1.58 PW HT and from 3.7 to 20.2 Sv.
- With a longer time series, the annual cycle appears to be small, but significant (about 15-20% of the variance).
- Annual cycle of MHT/MOC very different at 30N vs 26N, 41N and 16N (Resolved? Meaningful?)