Meridional Changes of MOC in the South Atlantic Ocean

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This presentation contains material provided by employees of NOAA (U. S. National Oceanic and Atmospheric Administration) who are now on furlough

Research funded by NASA, NOAA CPO and AOML

Ocean Surface Topography Science Team Meeting
Boulder, CO, October 2013

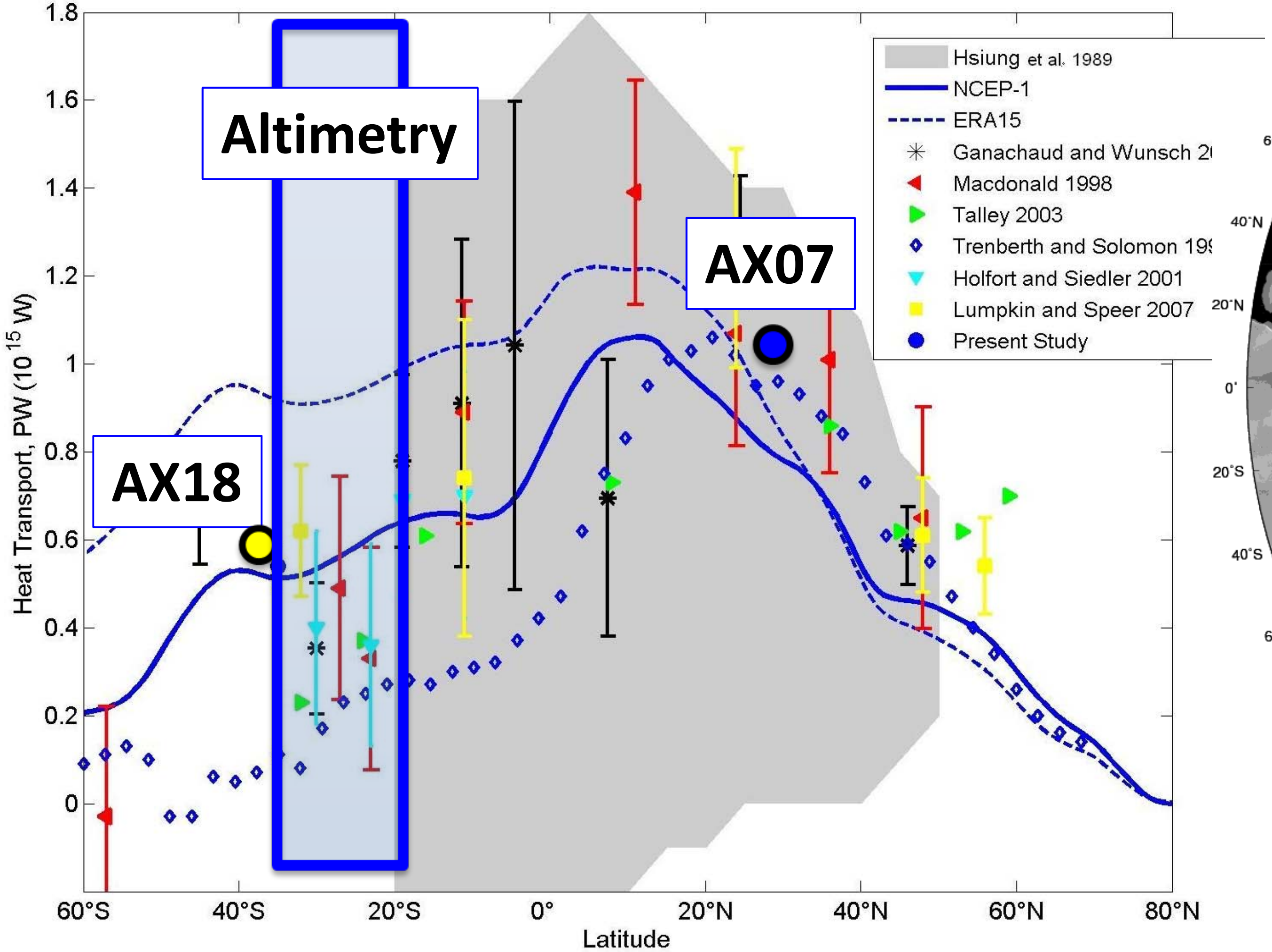
Goal

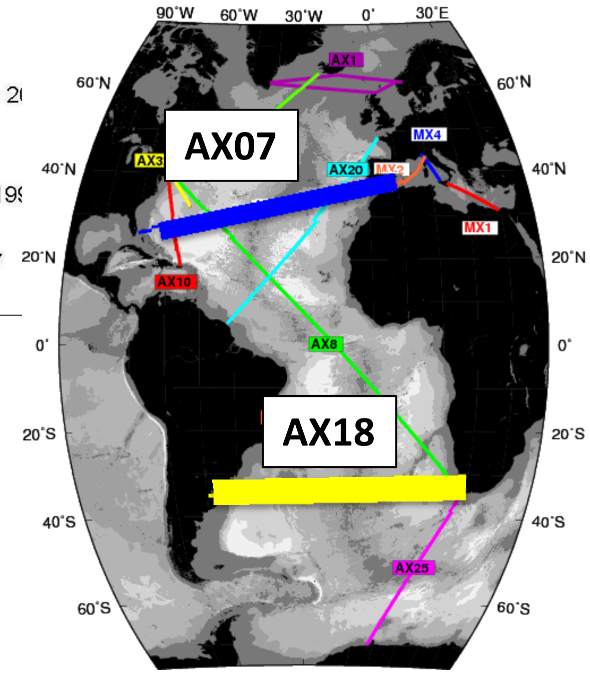
To investigate spatial (latitudinal) and temporal changes of the Meridional Overturning Circulation (MOC) and Meridional Heat Transport (MHT) in the South Atlantic Ocean using joint analysis of satellite and *in situ* observations.

What is new in this work

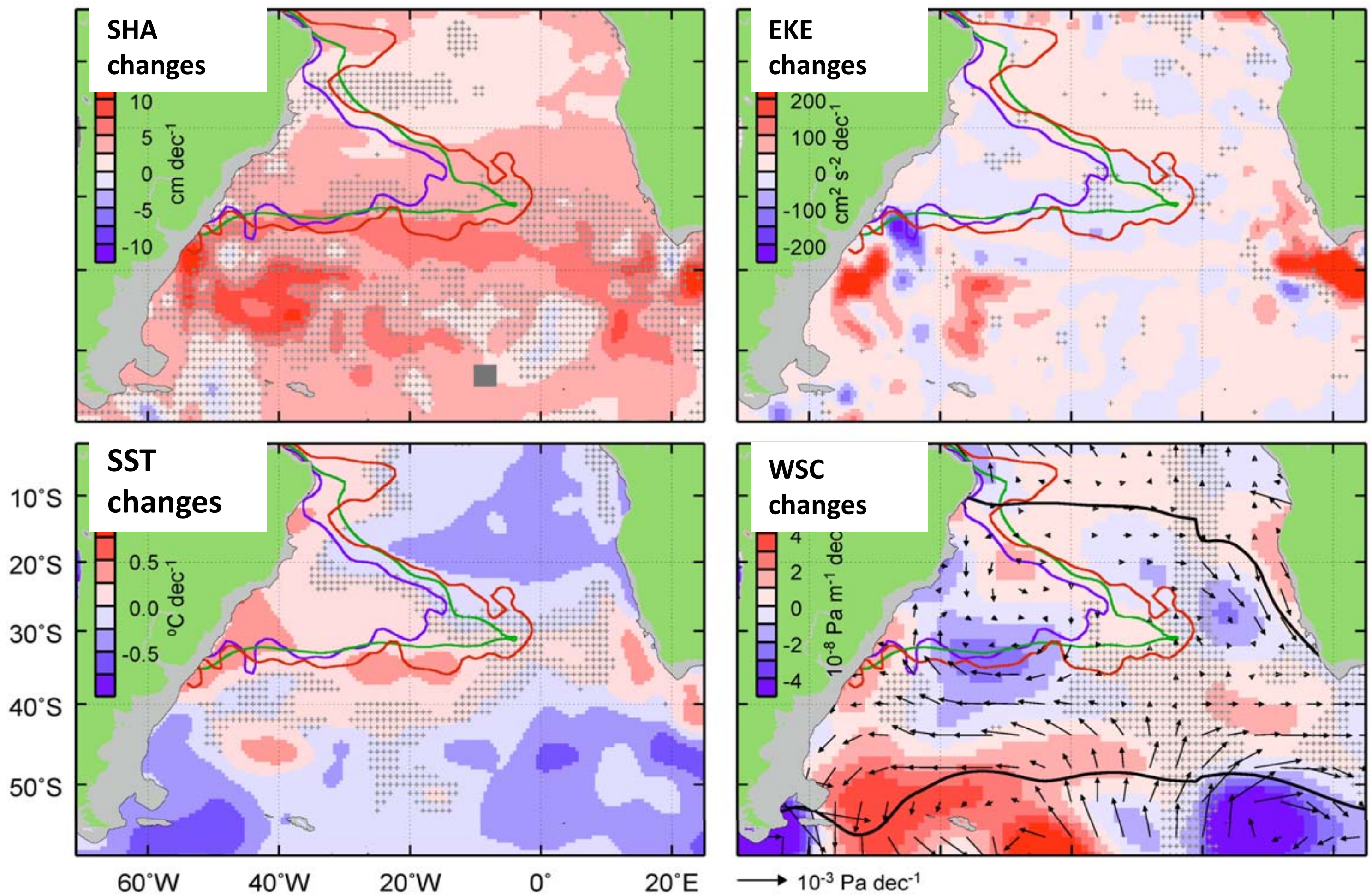
- **Extend time series of MHT/MOC at 34.5°S to 1993**
- **Extend coverage region (20°S-34.5°S)**

Meridional Heat Transport in the Atlantic Ocean





Non secular linear trends in the SA Ocean (1993-2010)



Multiplatform study

- **Altimetry observations as the main data set**
- **XBT observations as the main complimentary data set.**
- **T(z) derived from satellite altimetry, T(0) by satellite-derived SSTs**
- **S(z) derived from T(z)-S(z) look up tables built using profiles from all available CTD and Argo observations**
- **NCEP Winds**

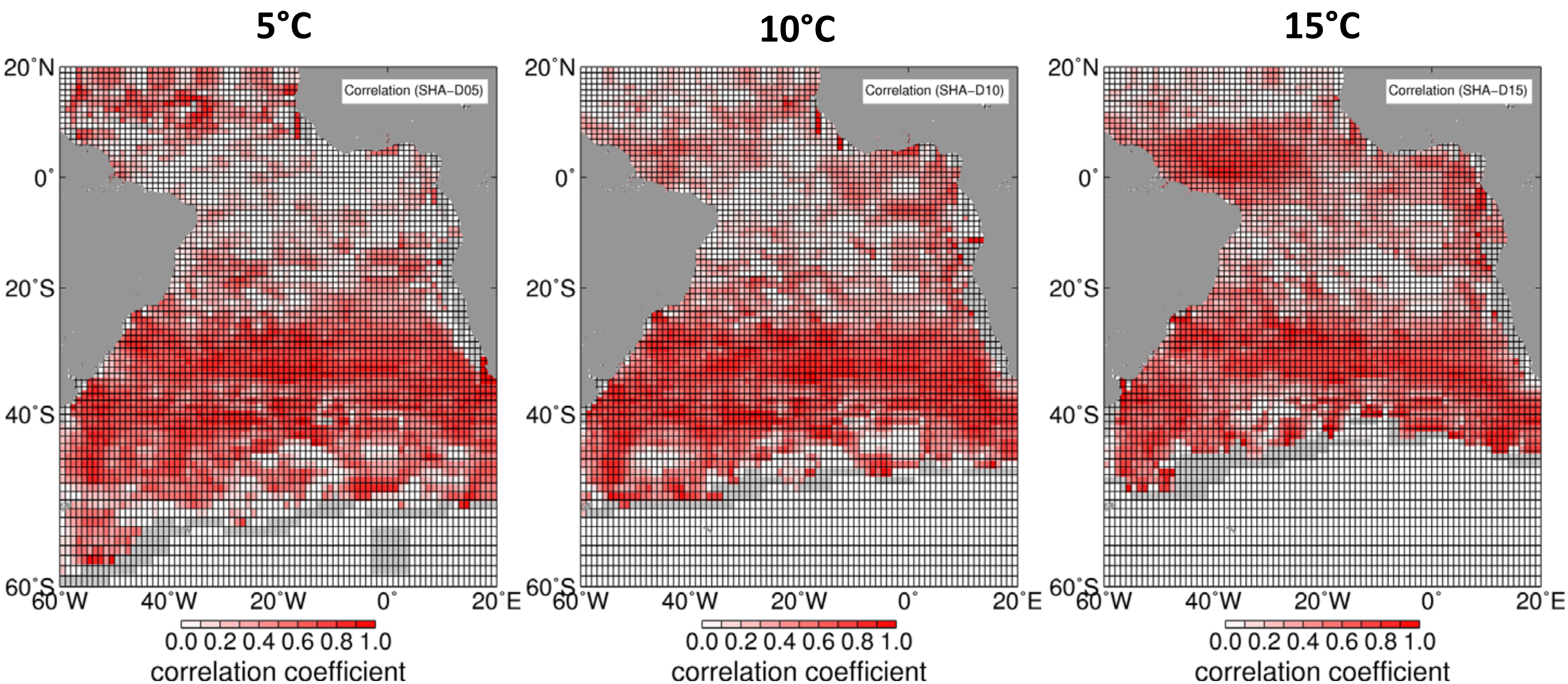
$$H = \int \int \rho c_p \theta v \, dx \, dz \qquad \left[PW = 10^{15} Watts \right]$$

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

XBT observations

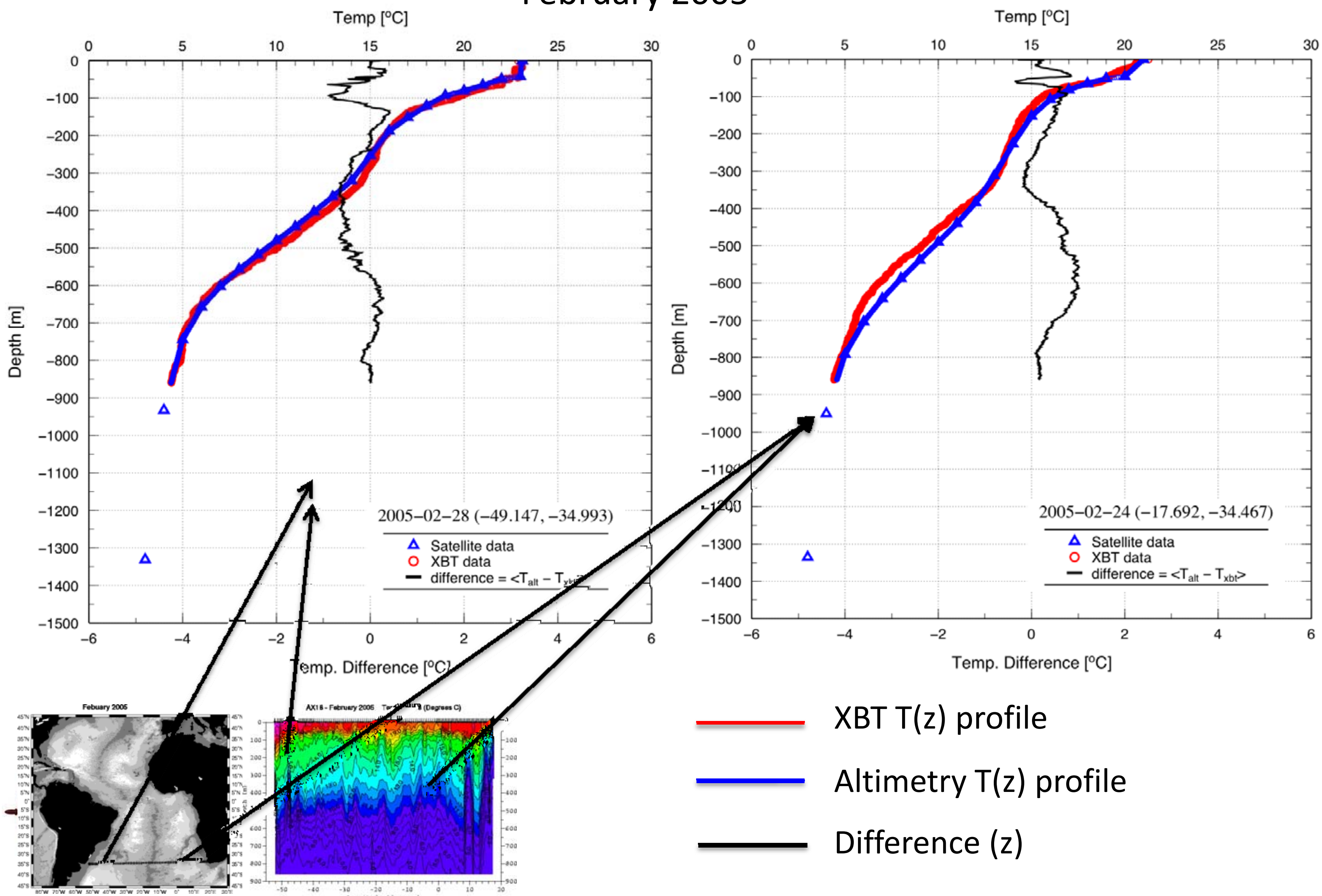
Wind products

Sea Height Anomalies and Isotherm Depths

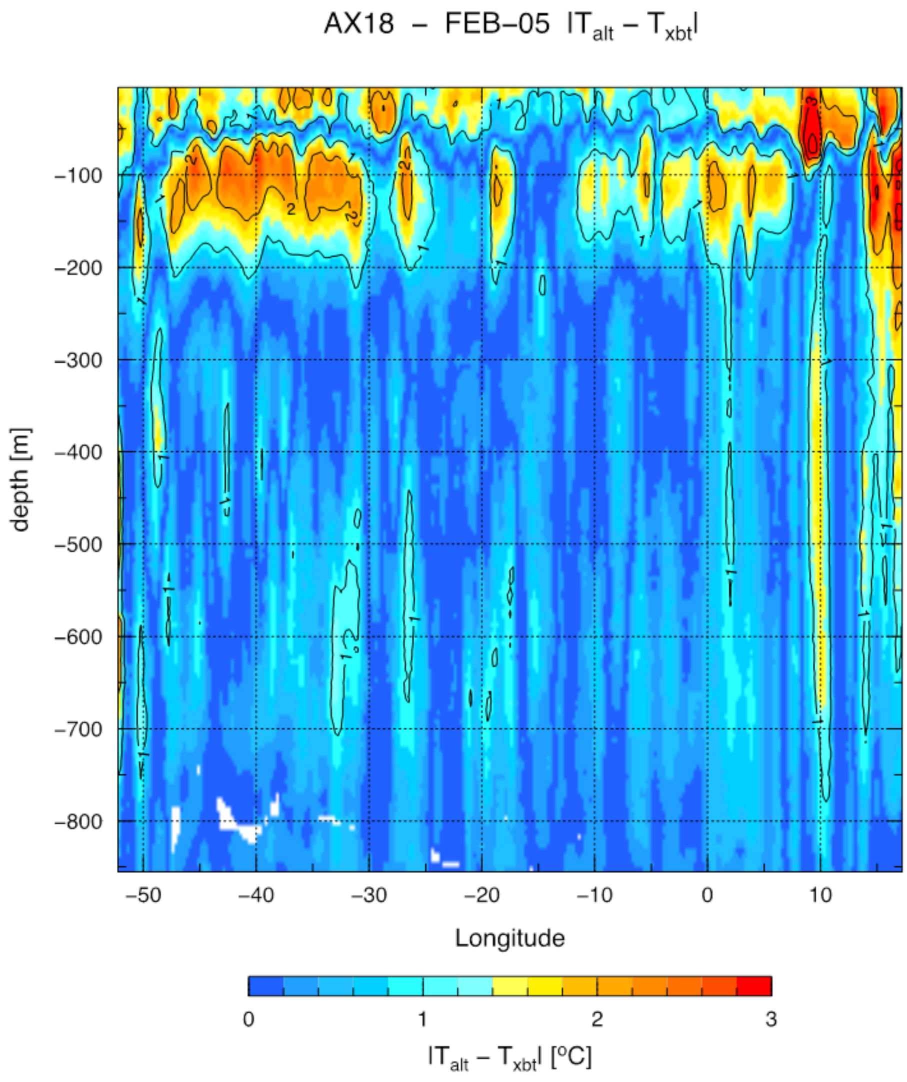


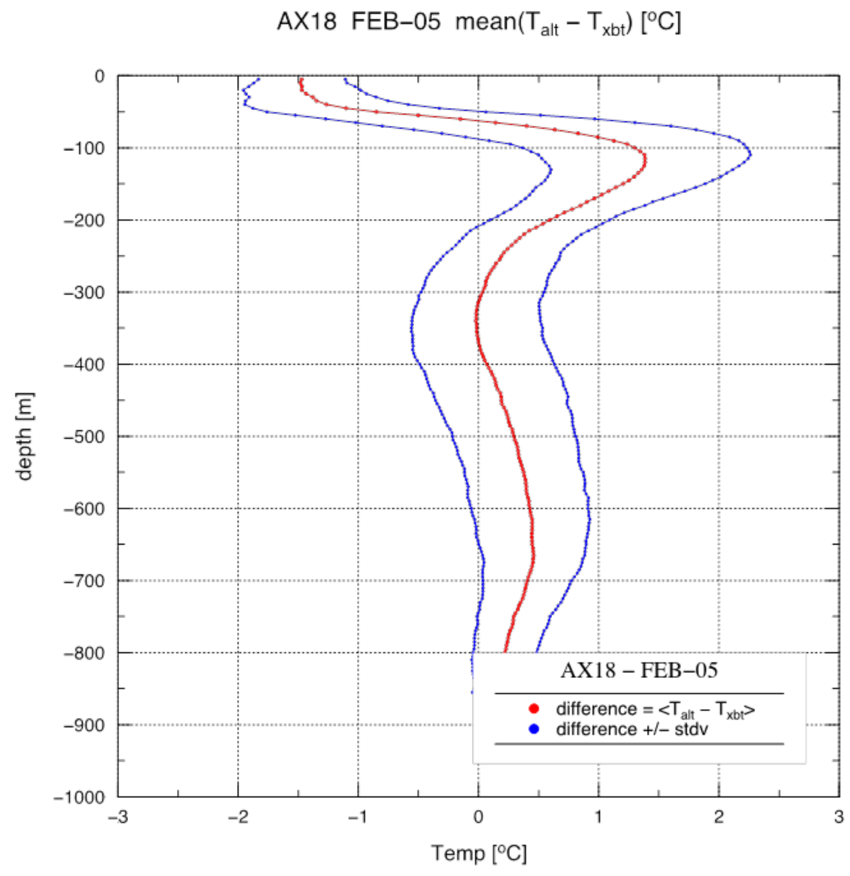
Altimetry-derived temperature profiles

February 2005



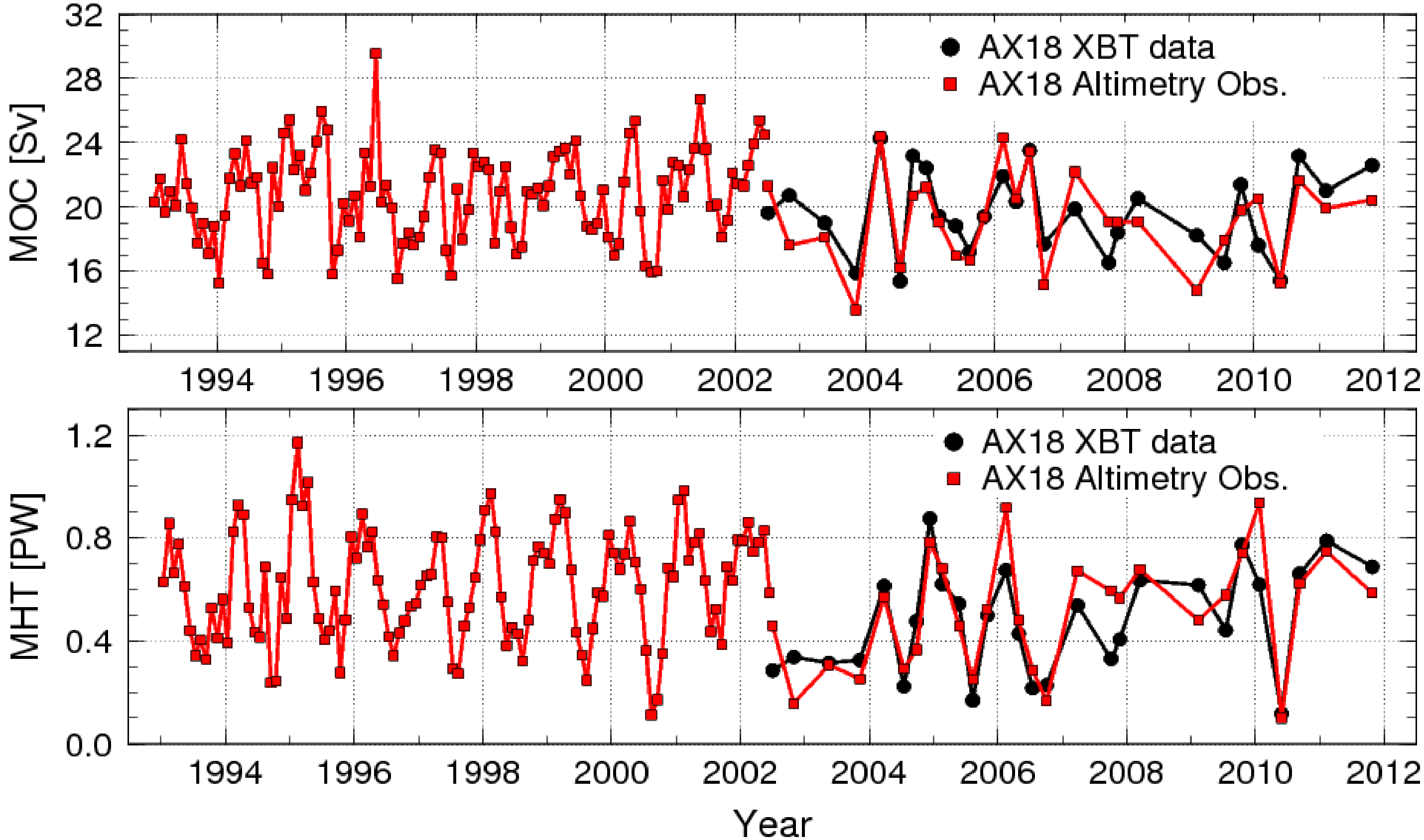
Difference between Altimetry-derived and XBT-derived temperature sections (34.5°S), February 2005





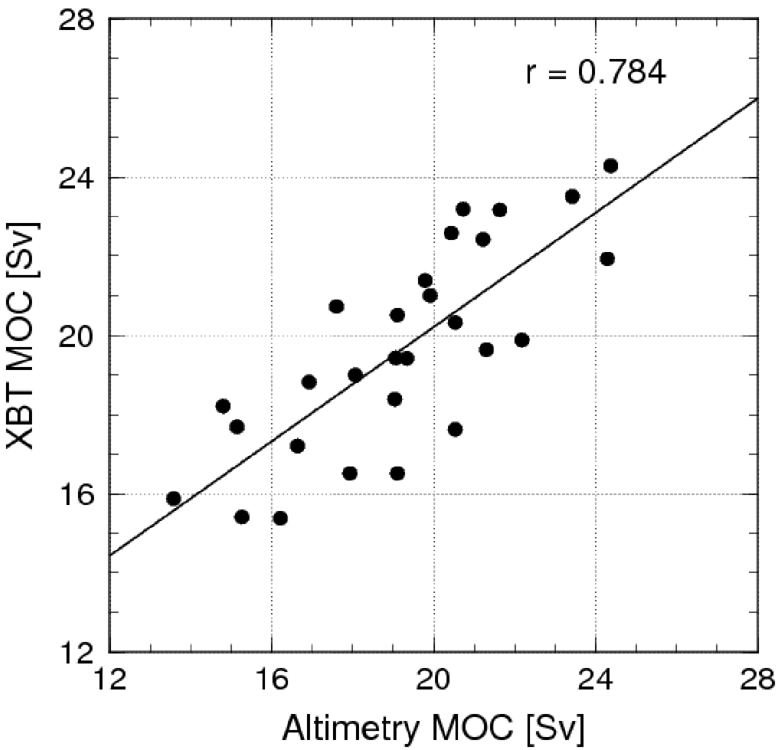
Altimetry-derived MOC/MHT at 34.5°S

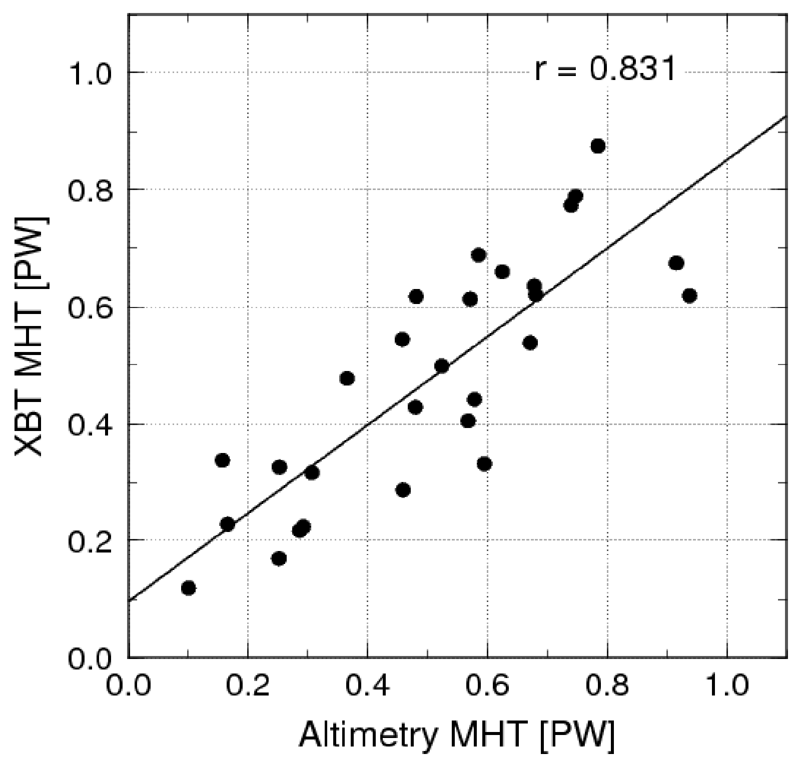
Altimetry-XBT comparison



	MOC (Sv)	MHT (PW)
XBT AX18	**19.6±2.6**	**0.48±0.20**
Altimetry	**19.2±2.8**	**0.51±0.22**

Altimetry-derived MOC/MHT at 34.5°S
Altimetry-XBT comparison

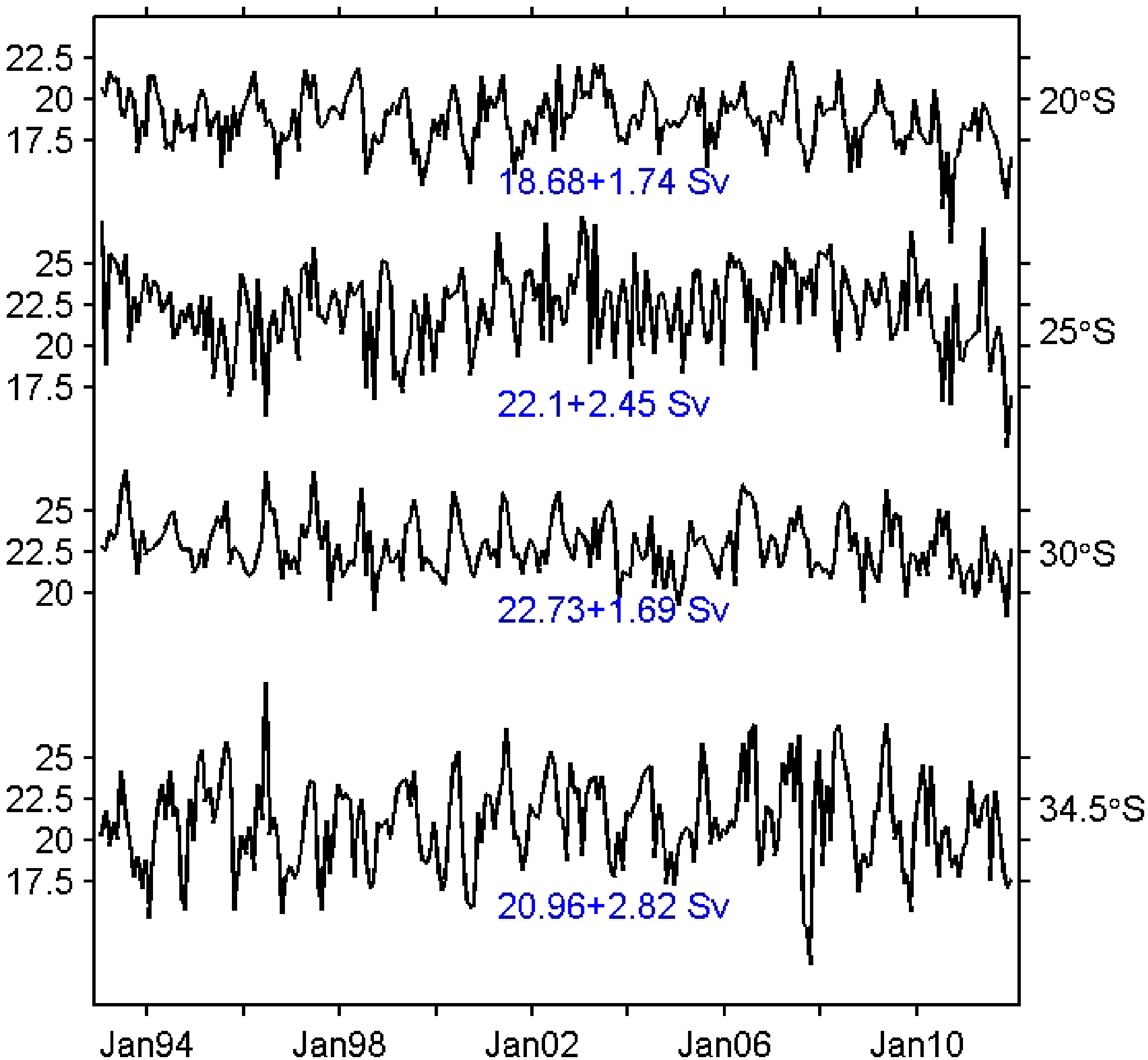




rms dif = 1.8Sv

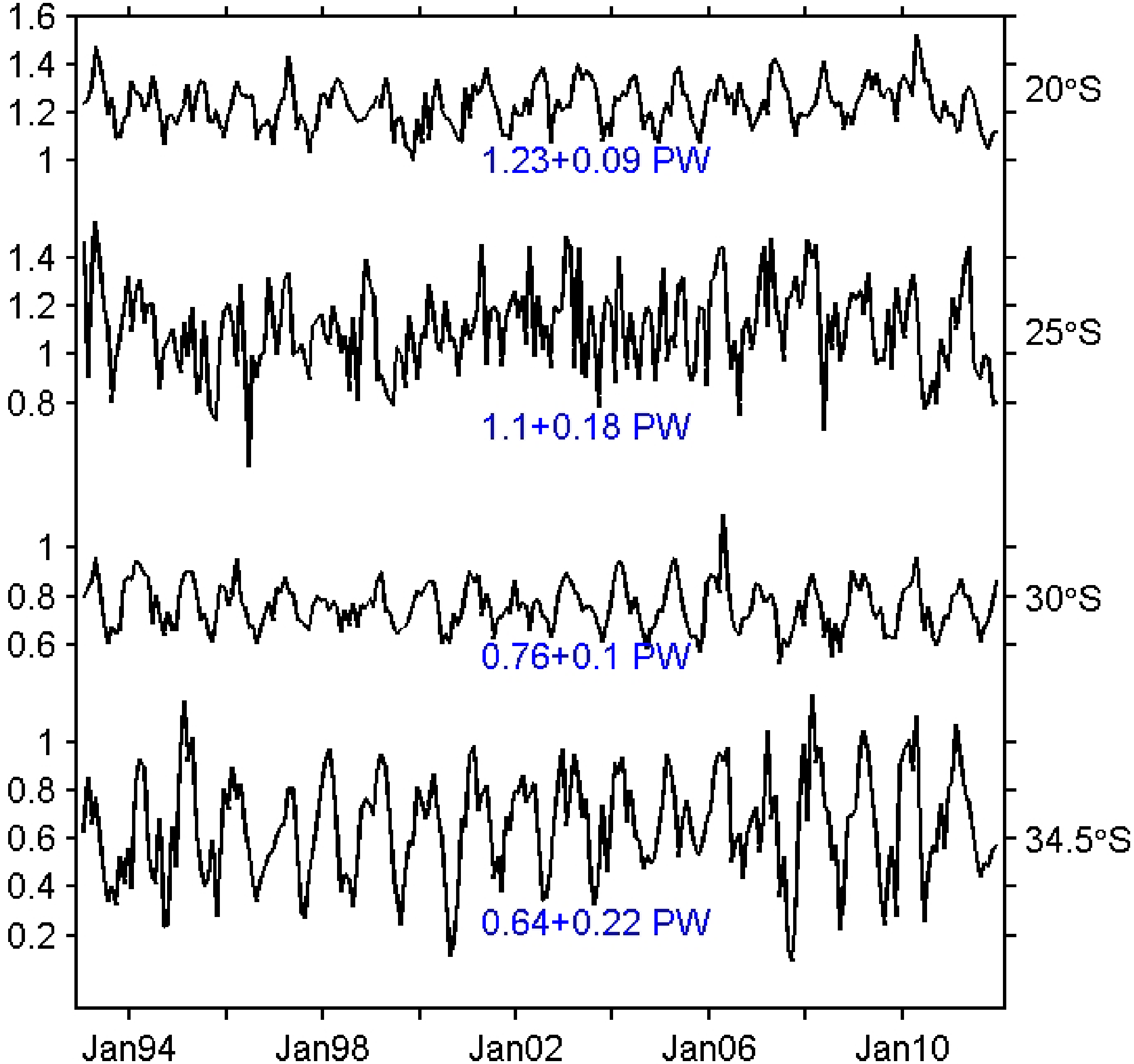
rms dif = 0.13PW

Altimetry-derived MOC



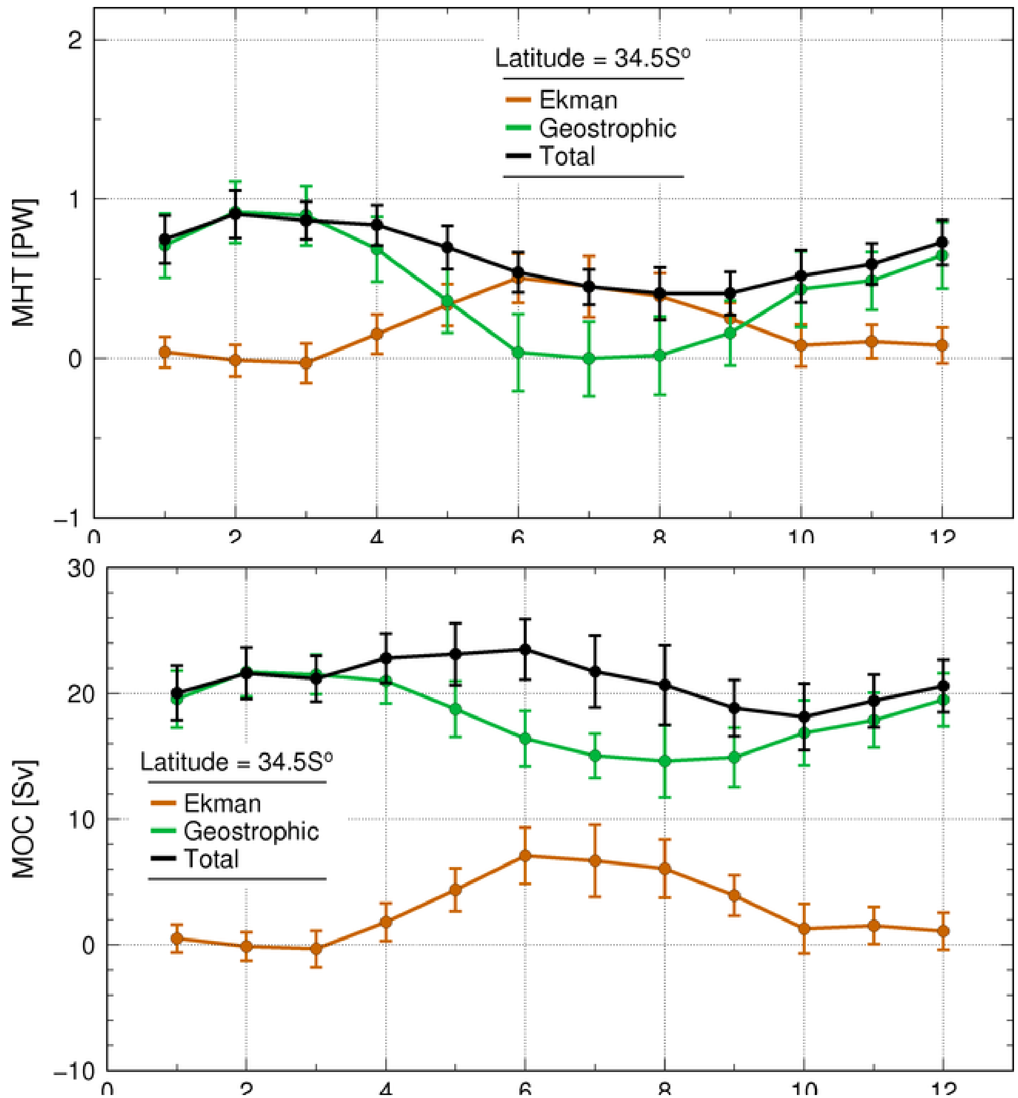
- Mean MOC increases towards the center of the subtropical gyre (25-30°S)
- Variability is minimum at 30°S
- Maximum variability at 34.5°S
- Long period signals observed at all latitudes

Altimetry-derived MHT



- Mean MHT increases towards the north
- Variability is minimum at 30°S
- Maximum variability at 34.5°S
- Long period signals observed at all latitudes

Altimetry-derived MOC/MHT at 34.5°S Seasonal Variability

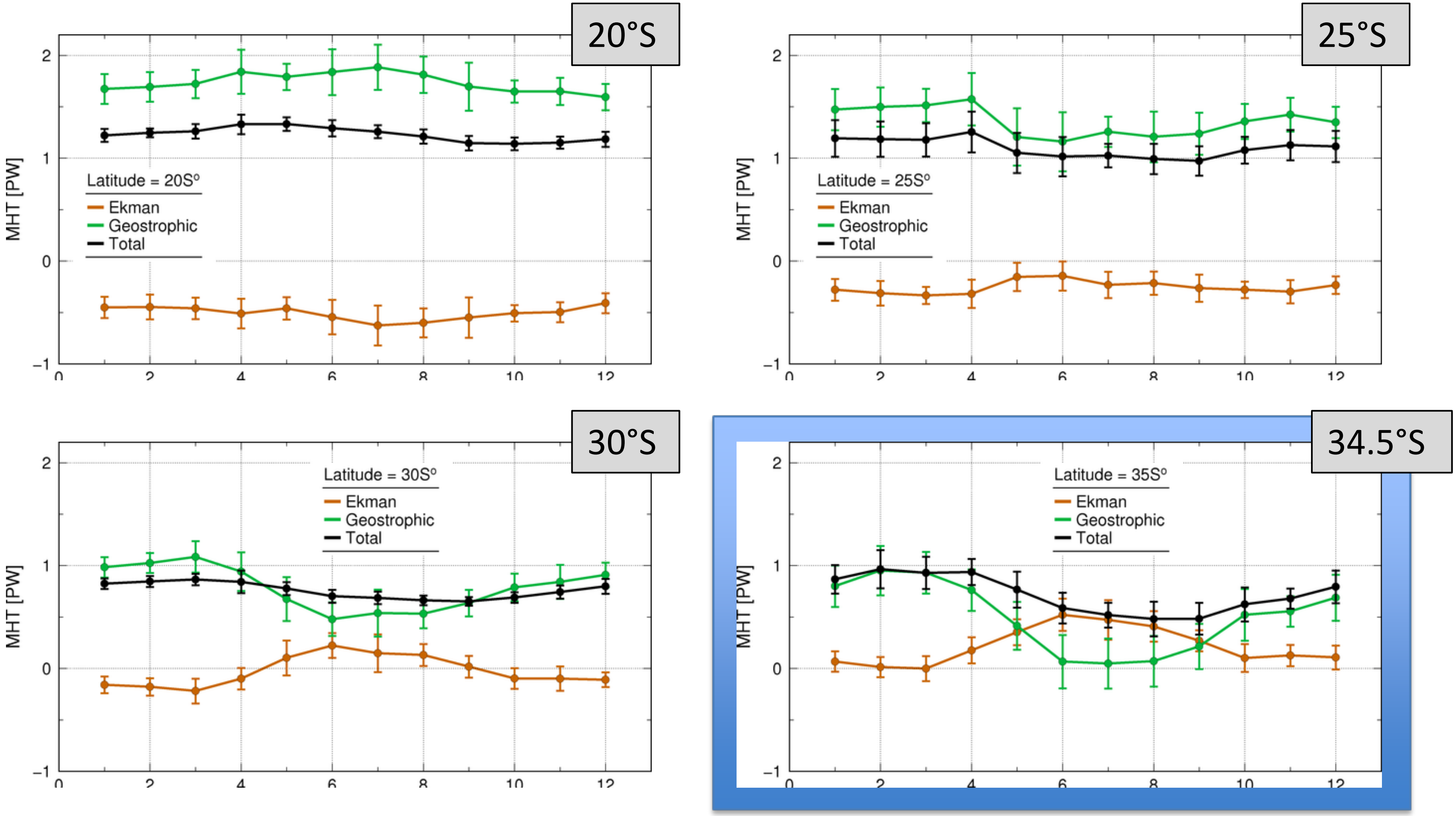


Marked seasonality of Ekman and Geostrophic components.

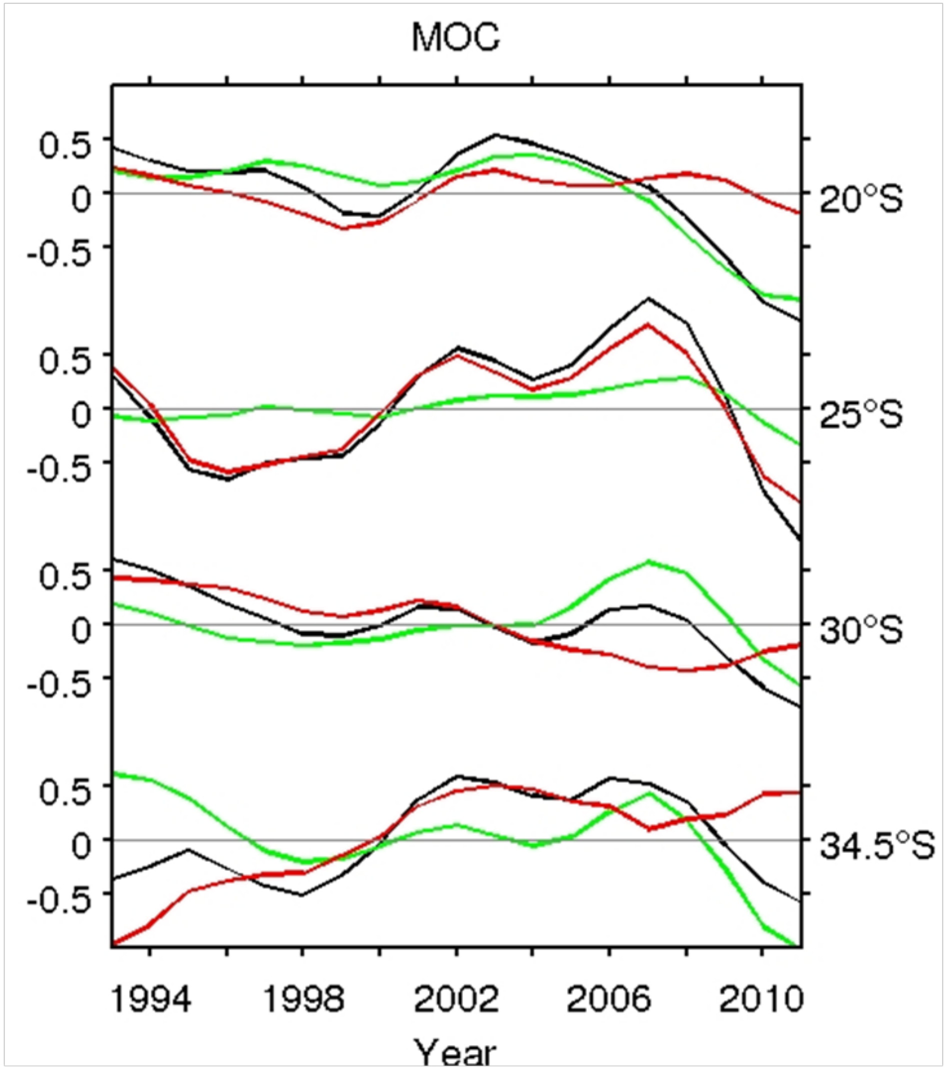
Ekman and Geostrophic components of MOC and MHT are out of phase.

Total MHT and MOC have weak seasonality.

Altimetry-derived MHT (20-34.5°S)
Seasonal Variability



Altimetry-derived MOC
Temporal Variability

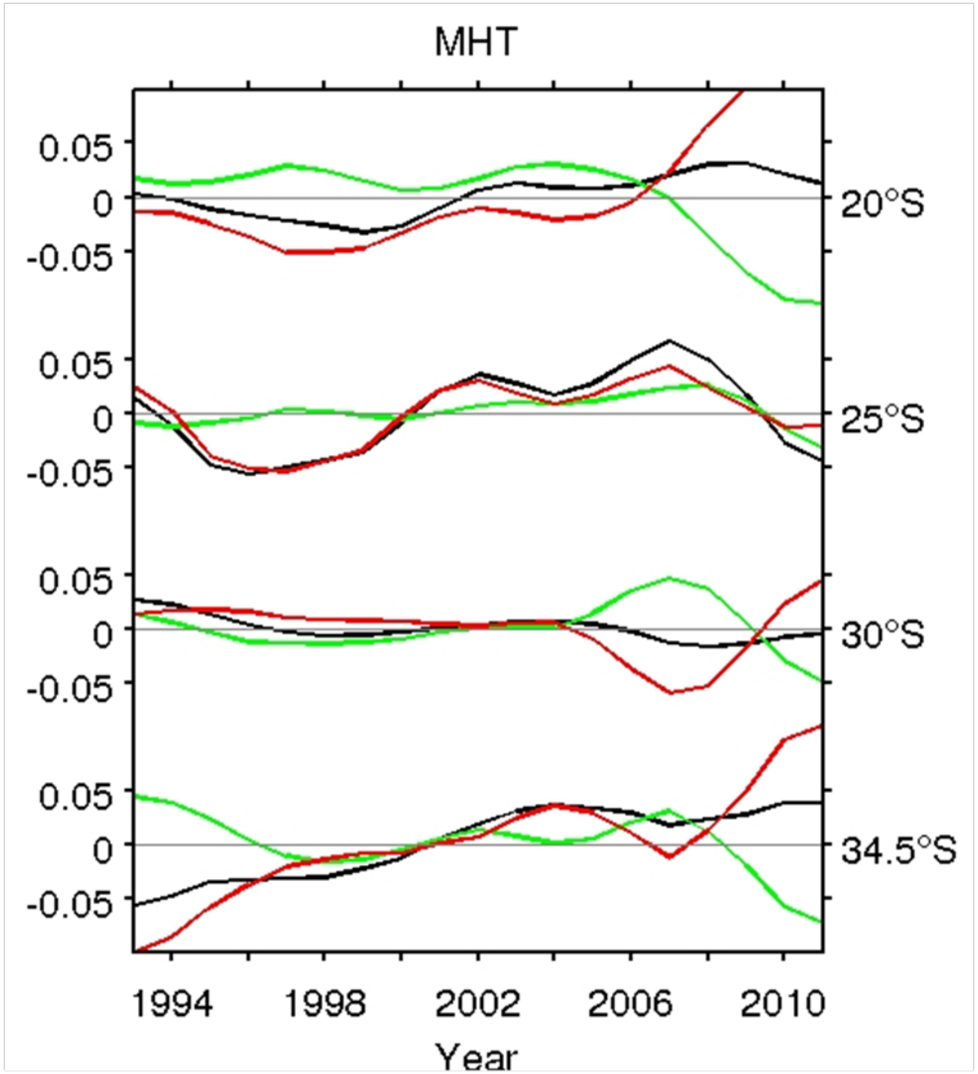


Largely dominated by geostrophic component before 2006.

Largely dominated by Ekman component after 2006 (except 25S).

At 34.5°S, long period variability with high in mid 2000's and low in mid 1990s.

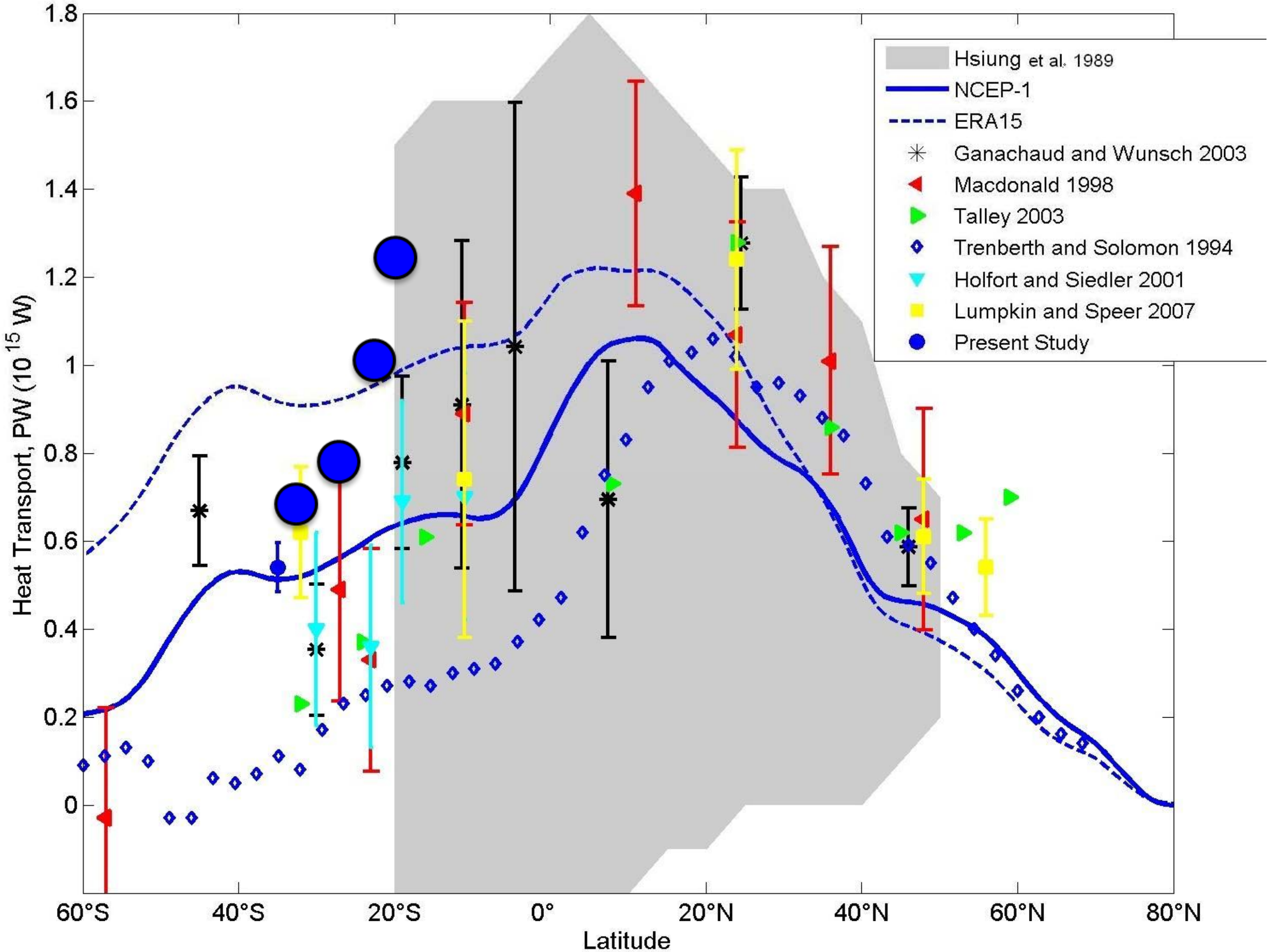
Altimetry-derived MHT
Temporal Variability



Ekman and geostrophic components out of phase at longer than seasonal time scales.

Although the variability of Ekman and geostrophic components exhibit large values, the total component does not

Altimetry-derived Meridional Heat transport



Main Conclusions

- **Satellite altimetry allows to obtain an extended time series of MHT and MOC to 1993.**

- **RMS difference between XBT and altimetry estimates are smaller than year-to-year changes in MHT and MOC.**

- **Ekman (geostrophic) component dominant after (before) 2006.**

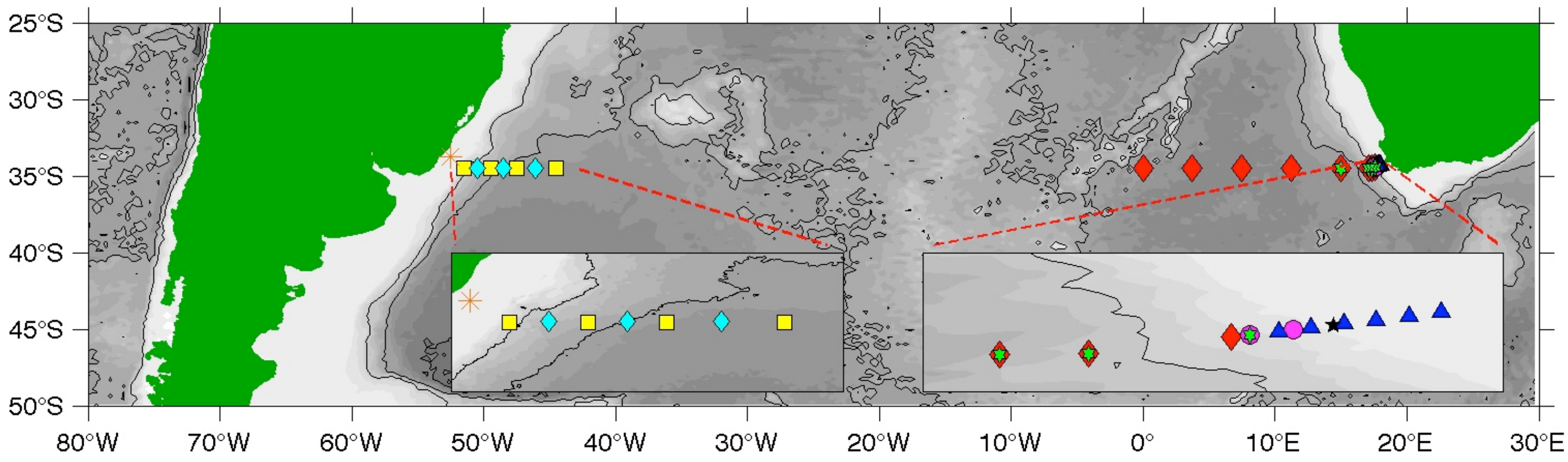
- **Results show that:**
  - **mean values of MHT at 20-34°S are actually larger than previous estimates**
  - **mean values of MHT decrease by approximately half between 20°S and 34°S**

Immediate Plans

- **Continue joint analysis of data (altimetry, XBT, and other in situ observations) for MHT and MOC studies.**

- **Investigate year-to-year variability** (annual cycle removed) **and possible MHT/MOC trends** (linked to EKE, SH, SST, Wind variability?)

- **Indexes for model comparisons,** in collaboration with NOAA/GDFL



Methodology

- Assume that sea height deviations are proportional to temperature deviations.

- For mass transport, MHT, and AMOC follow same methodology currently used with XBT observations.

- Construct a (long, starting in 1993) time series of MHT in the South Atlantic.

Meridional Heat Transport in the South Atlantic Ocean from XBT transect AX18 (~34.5°S)