Temporal and Meridional Changes of MOC in the South Atlantic from Satellite Measurements

Shenfu Dong
CIMAS, University of Miami, and NOAA/AOML

Coauthors: Gustavo Goni, Francis Bringas (NOAA/AOML)

Research funded by NASA, NOAA CPO and AOML

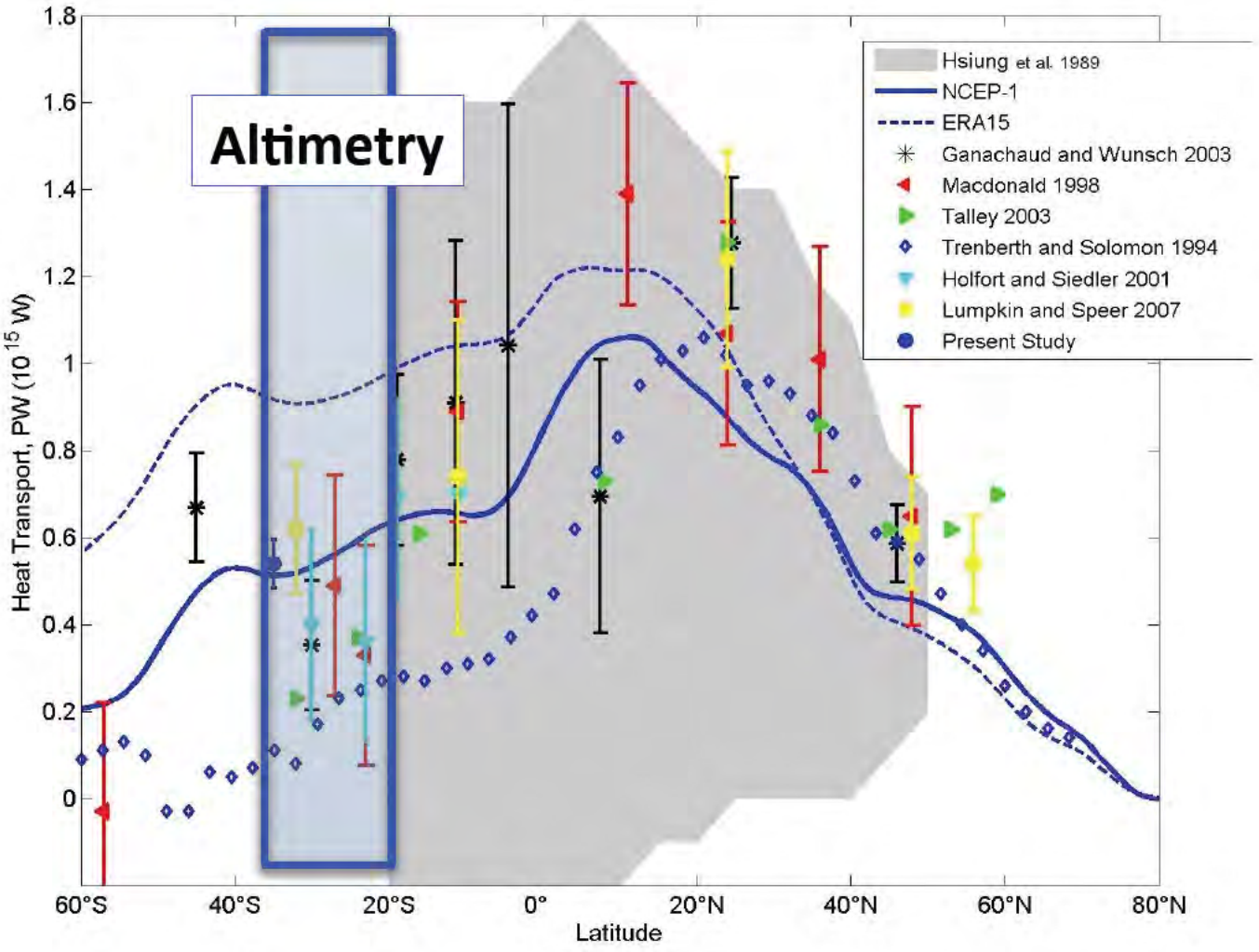
US AMOC Science Team Meeting
Seattle, WA, September 9-11, 2014

Goal

To test the ability of the altimeter SSH measurements (combined with *in situ* observations) in estimating the MOC/MHT in the South Atlantic.

To investigate spatial (latitudinal) and temporal changes of the MOC/MHT in the South Atlantic.

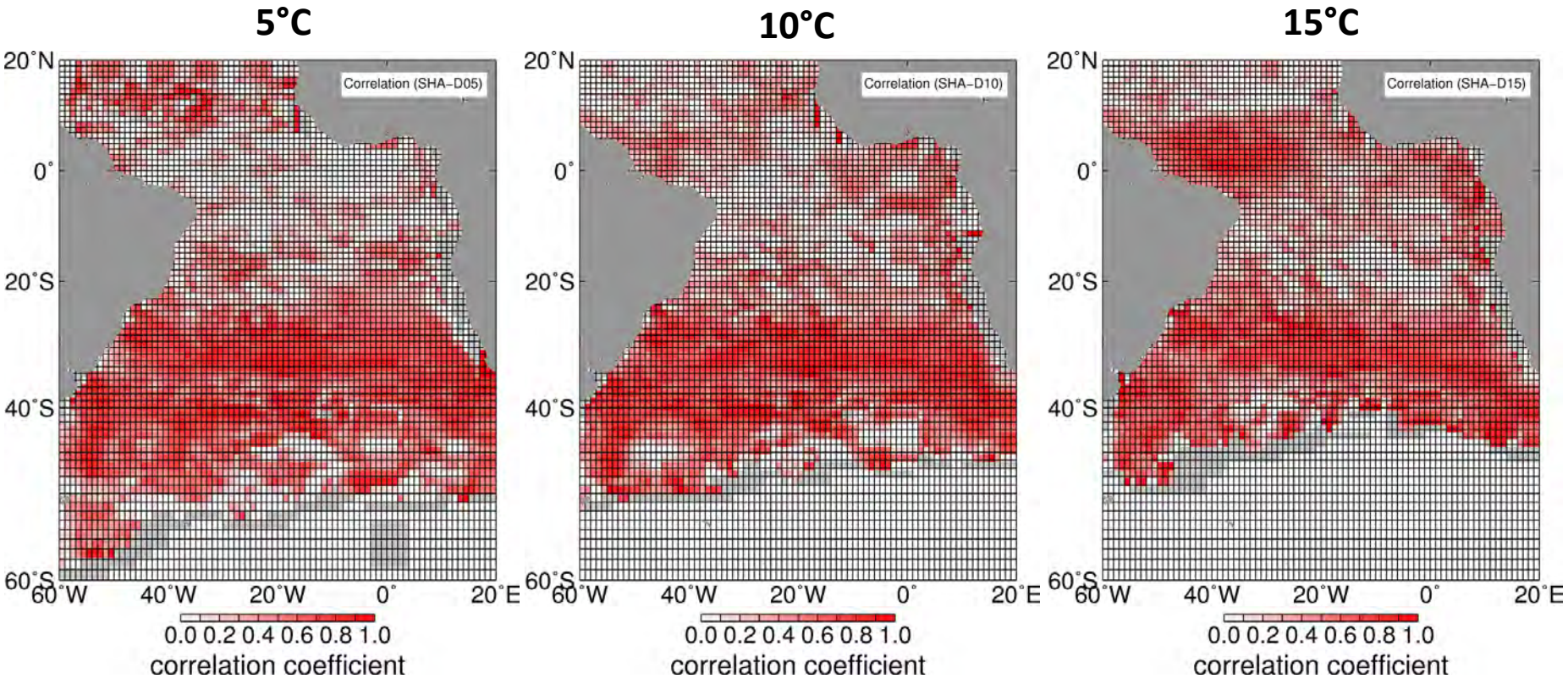
Meridional Heat Transport in the Atlantic Ocean



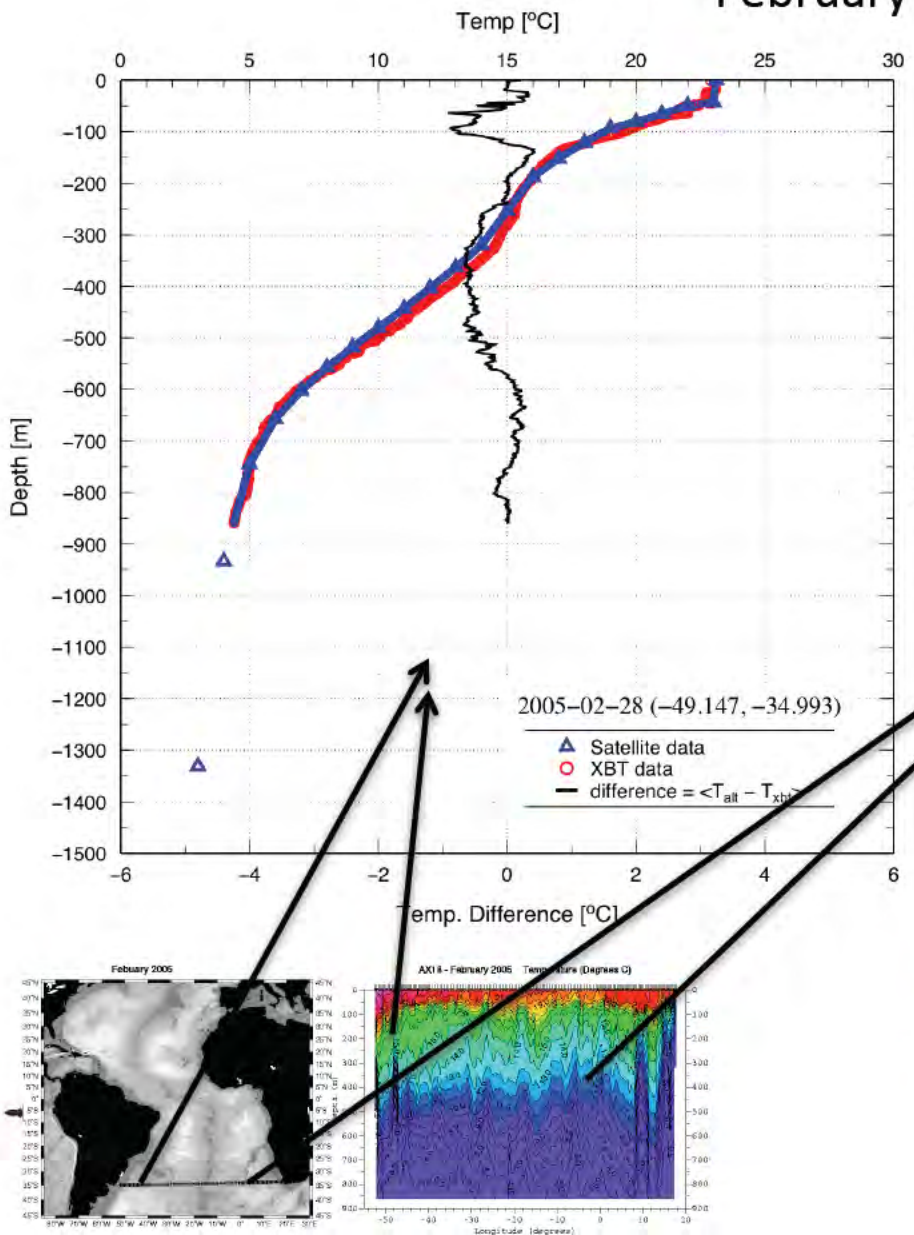
Methodology

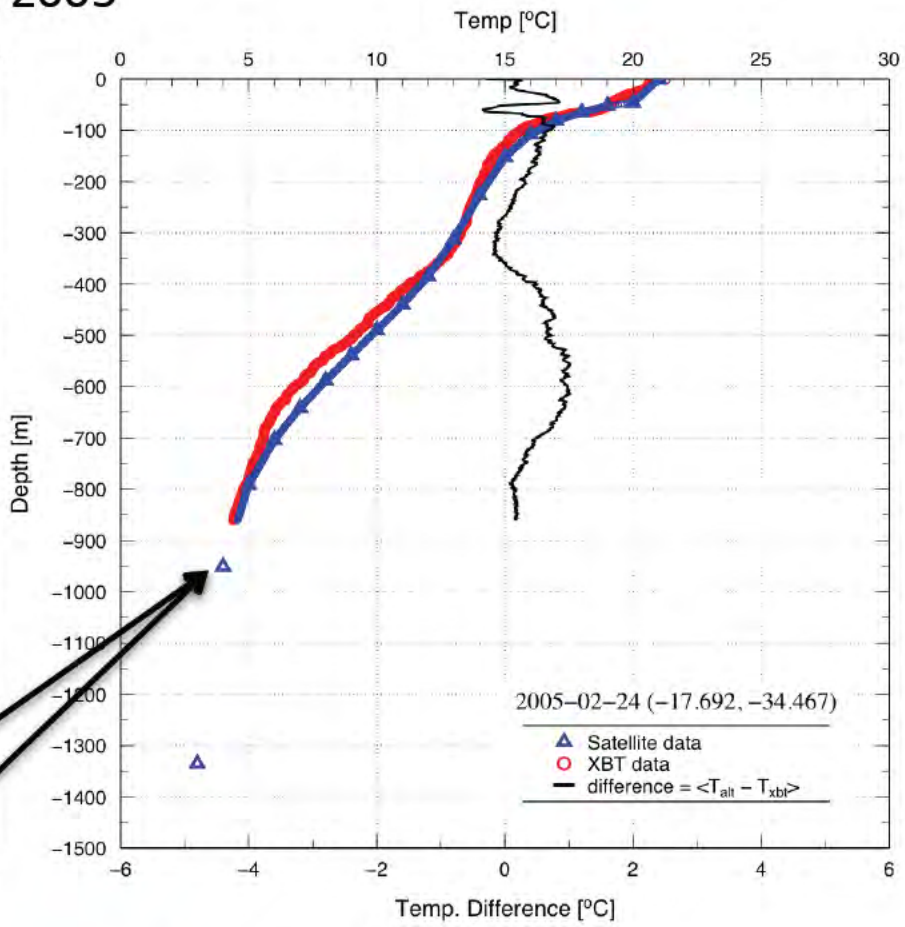
- ✧ Altimetry SSH observations as the main data set
  - T(z) derived from satellite altimetry, T(0) by satellite-derived SSTs
  - S(z) derived from T(z)-S(z) look up tables built using profiles from all available CTD and Argo observations
- ✧ XBT observations as the main complimentary data set (evaluation of the methodology).
- ✧ NCEP Winds are used to compute the Ekman transport.

Sea Height Anomalies and Isotherm Depths



Altimetry-derived temperature profiles



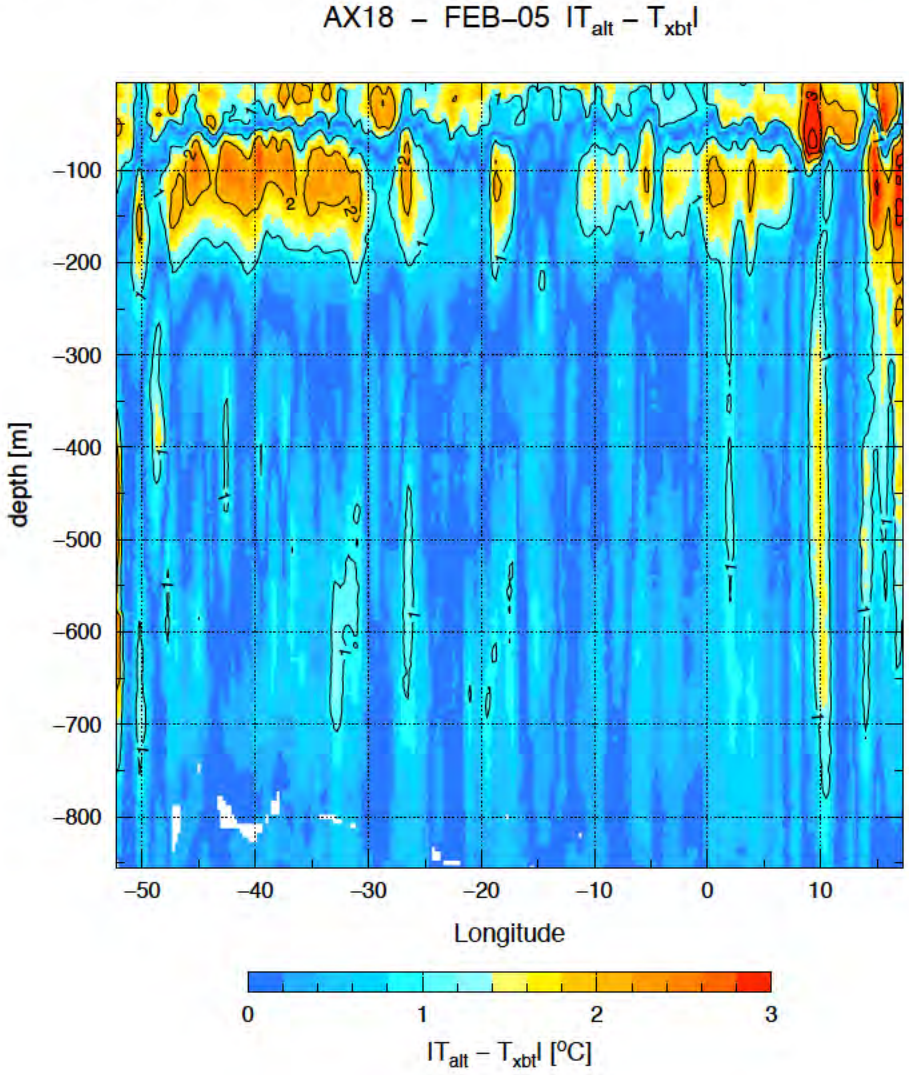


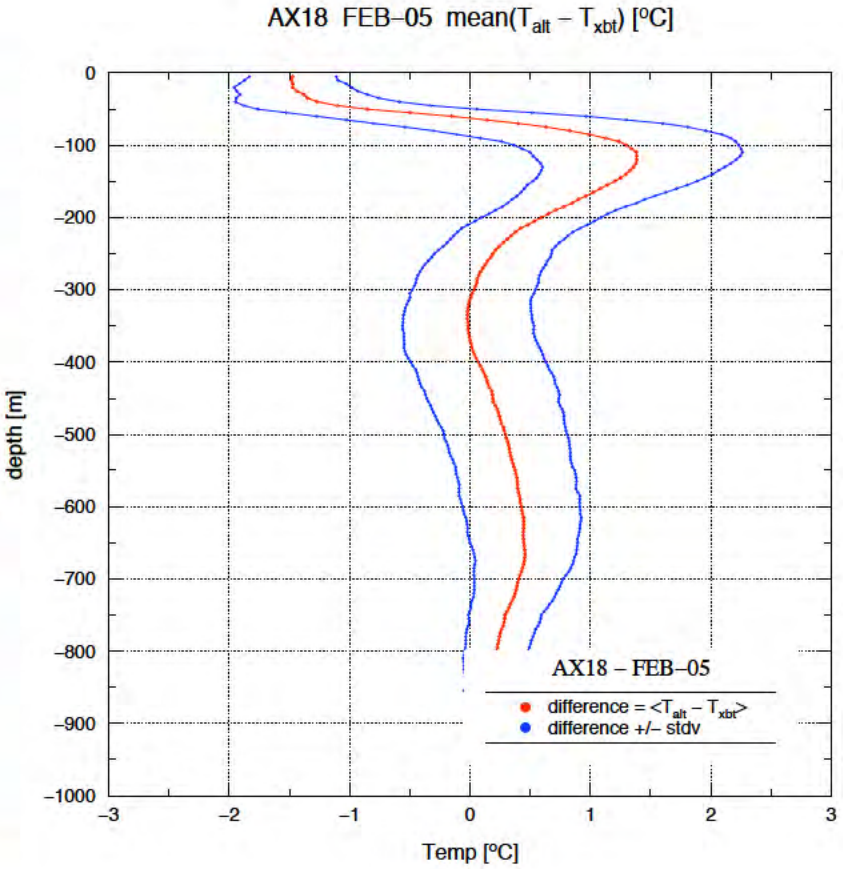
XBT T(z) profile

Altimetry T(z) profile

Difference (z)

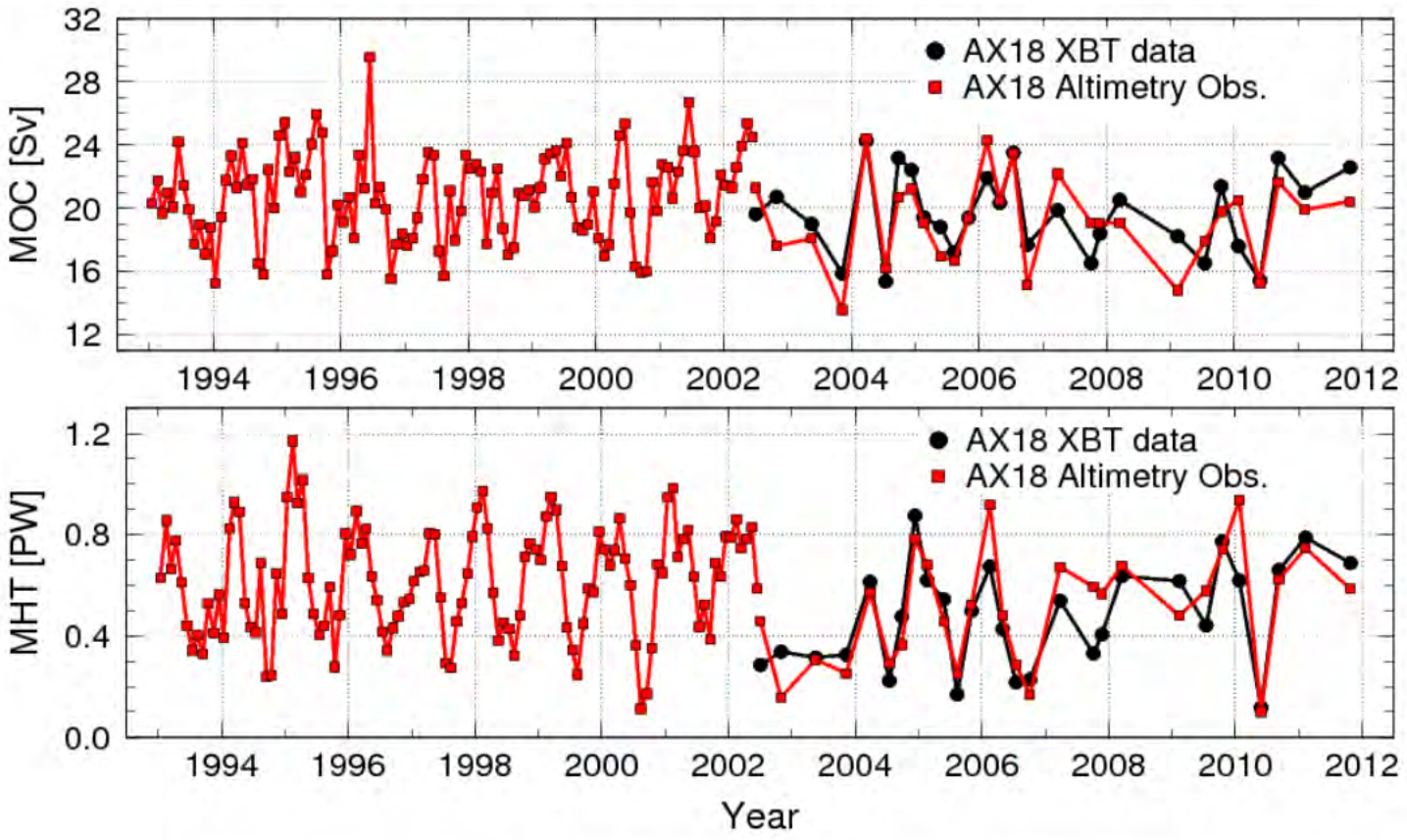
Difference between Altimetry-derived and XBT-derived temperature sections (34.5°S), February 2005





Altimetry-derived MOC/MHT at 34.5°S

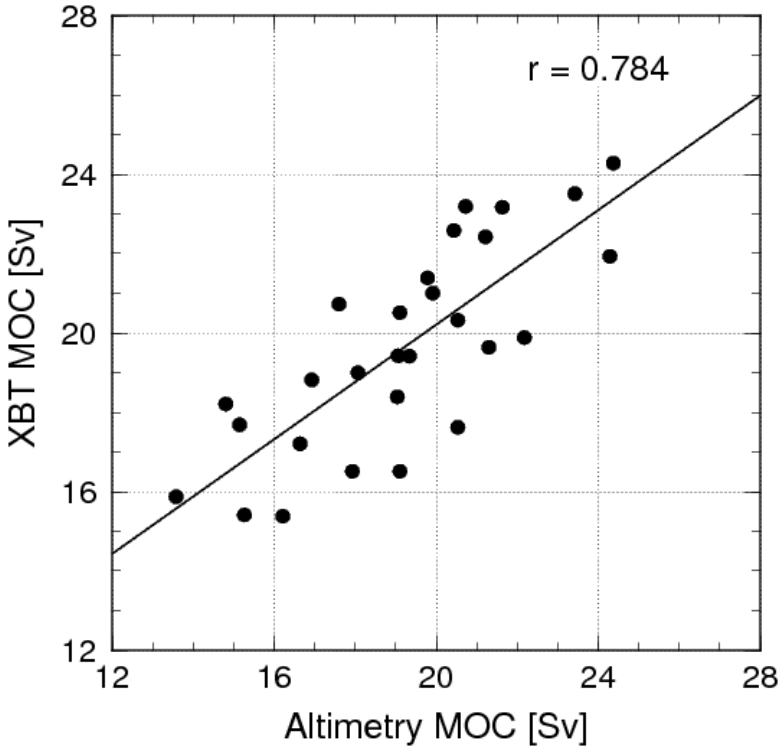
Altimetry-XBT comparison

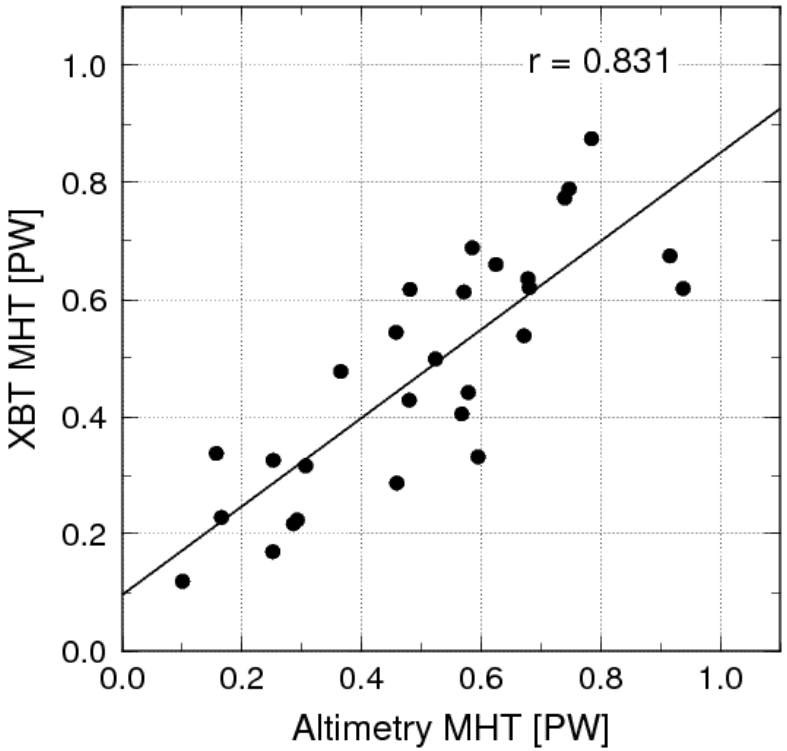


	MOC (Sv)	MHT (PW)
XBT AX18	19.6±2.6	0.48±0.20
Altimetry	19.2±2.8	0.51±0.22

Altimetry-derived MOC/MHT at 34.5°S

Altimetry-XBT comparison



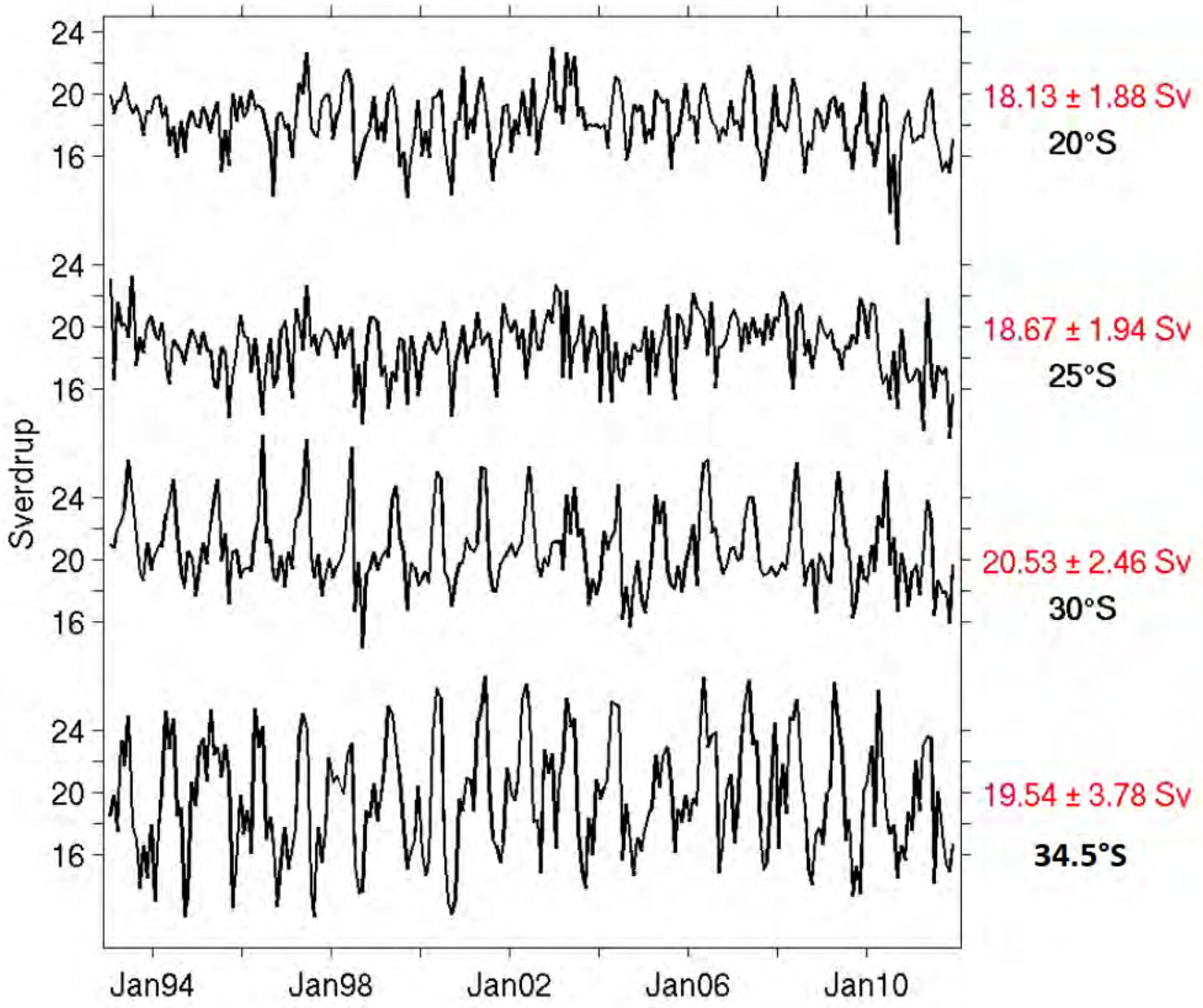


rms dif = 1.8Sv

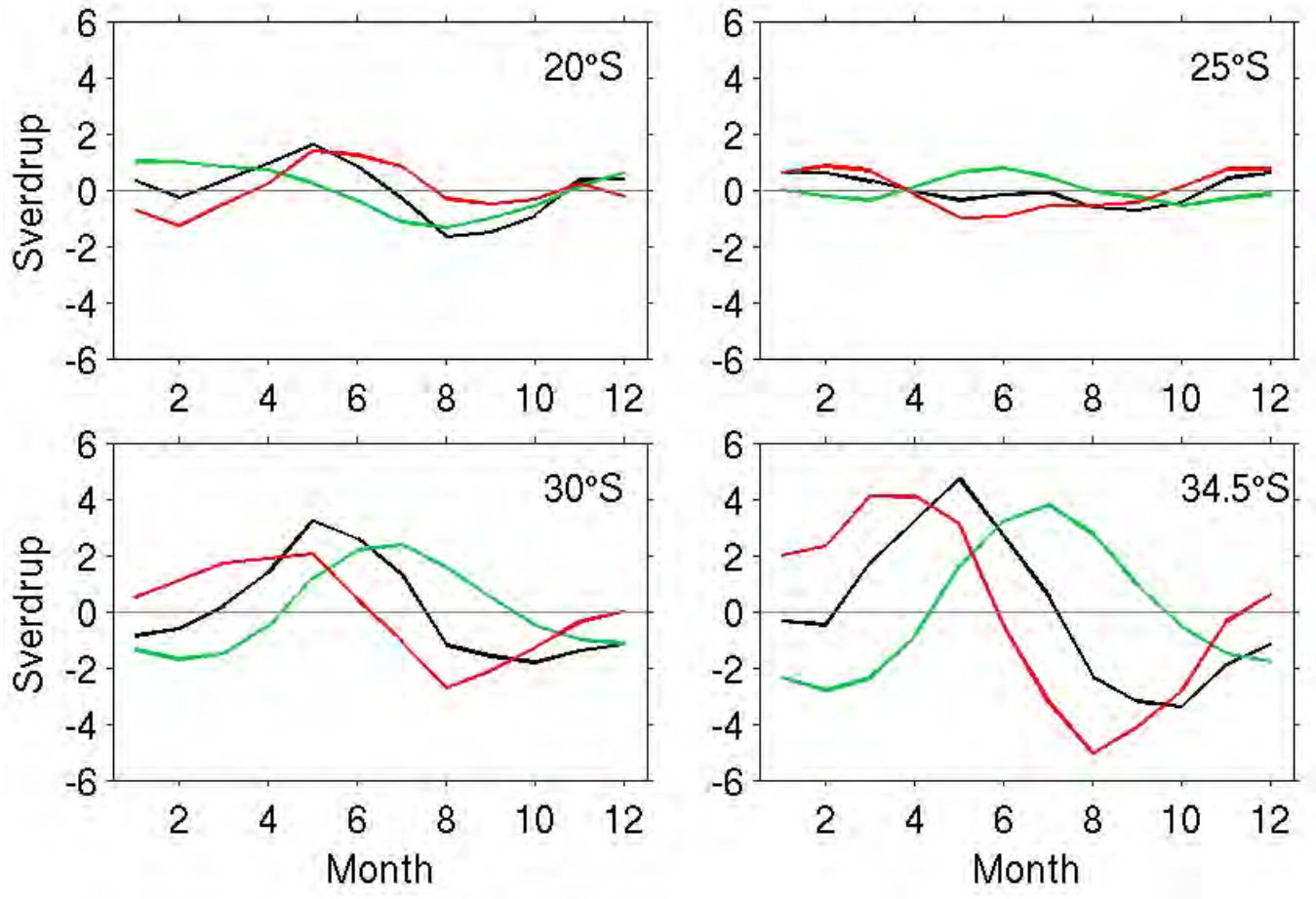
rms dif = 0.13PW

Altimetry-derived MOC

- Mean MOC increases slightly southward from 20°S to 30°S, but not significant.
- Maximum variability at 34.5°S, twice as large as that at 20°S.
- Strong seasonal variations at 34.5°S and 30°S.

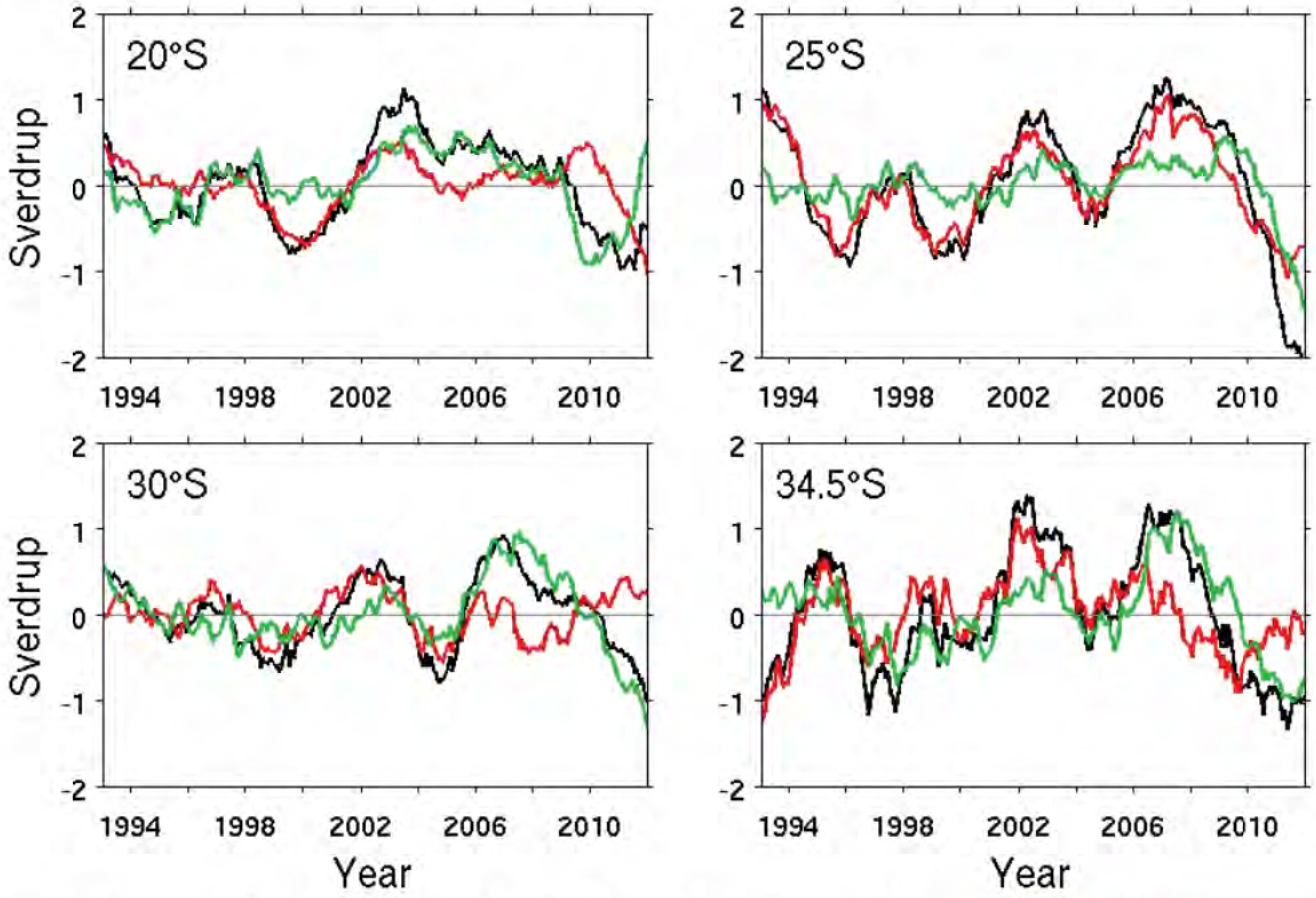


Altimetry-derived MOC: Seasonal Variability



- The amplitude of seasonal cycle in the AMOC decreases toward the north.
- Both the Geostrophic and Ekman components contribute equally to the AMOC seasonal variation.

Altimetry-derived MOC: Interannual Variability



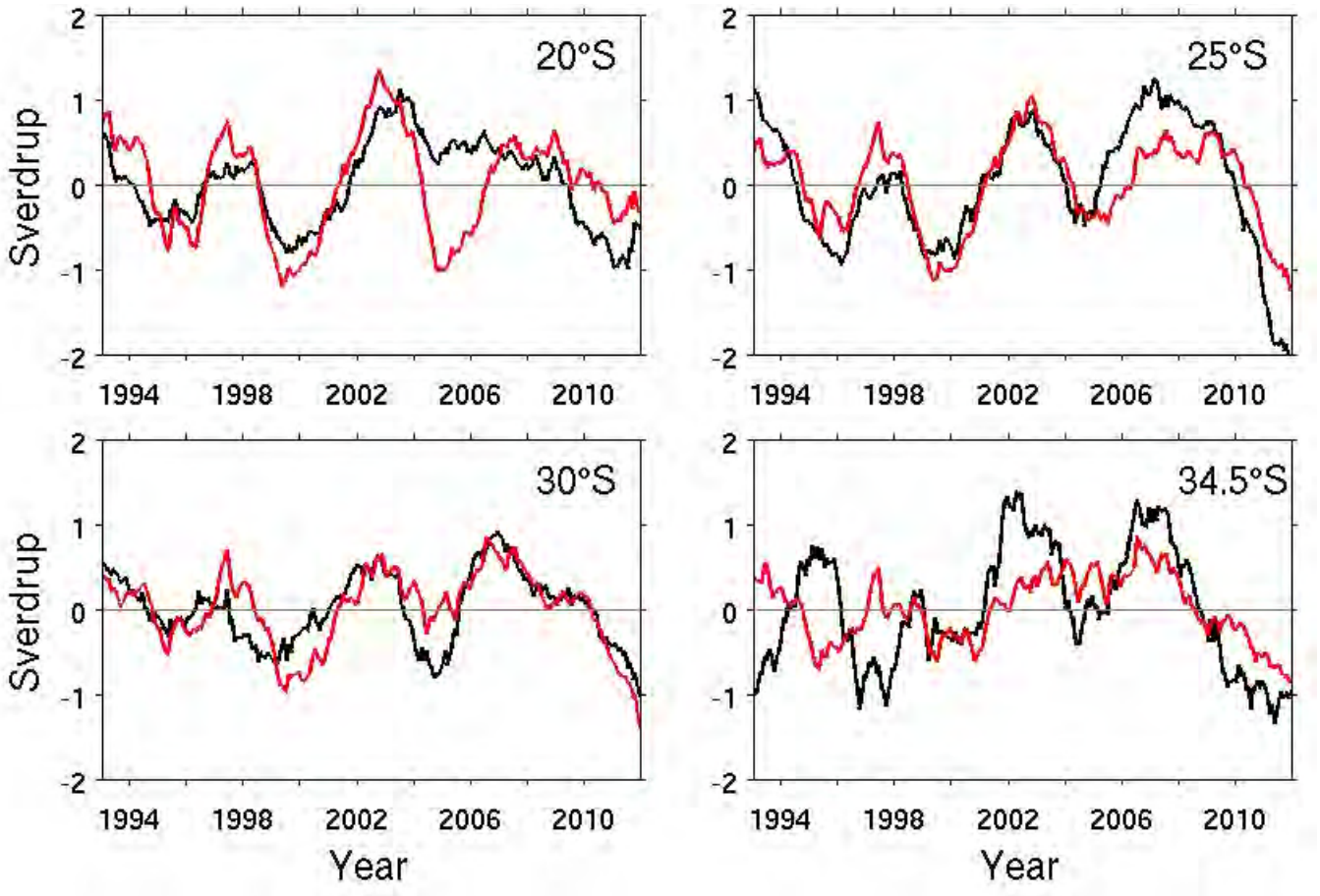
✧ Interannual variations in the AMOC are dominated by geostrophic component before 2006. Ekman component plays a larger role since 2006 (except 25°S).

✧ High correlations of the AMOC between 20°S-30°S.

20°S	⟷	25°S	⟷	30°S ⟷ 34.5°S
r =		0.66		0.71 0.26

Comparison with An Ocean Model Results

R = 0.59



R = 0.79

R = 0.80

R = 0.19

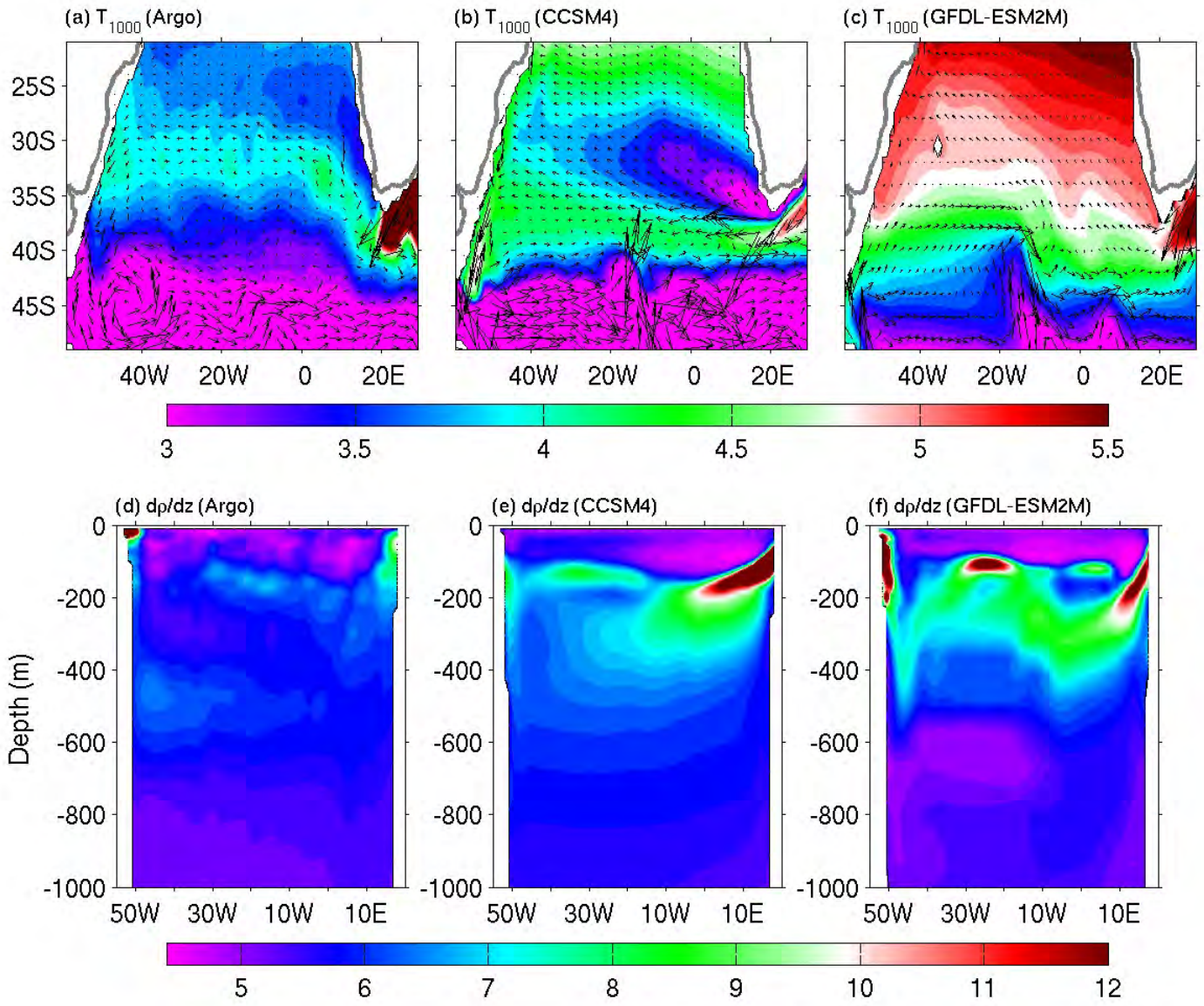
Good comparison between estimates from Altimeter and Model results at 20°S, 25°S, and 30°S, but not at 34.5°S.

Model: Global ocean-sea ice coupled model of the NCAR CESM1 forced with the 20th century Reanalysis surface forcing (S. Lee).

Conclusions

- ✧ RMS difference between XBT and altimetry estimates are smaller than year-to-year changes in MOC.
- ✧ Satellite altimetry allows to obtain an extended time series of MOC to 1993.
- ✧ MOC variability decreases toward north from 34.5°S to 20°S.
- ✧ Geostrophic component dominant the AMOC interannual vaiations before 2006. Ekman component plays a larger role after 2006.
- ✧ Altimetry-based MOC estimates show well comparison with results from an ocean-sea ice coupled model between 20°S and 30°S.

Model-data Comparison: Temperature at 1000 m depth And vertical density gradient



Model-data Comparison: Zonally-averaged meridional velocity at 34°S