On the vertical structure of eddies and Rossby waves and their effect on the meridional overturning circulation (MOC).

Louis Clement
l.clement@noc.soton.ac.uk
(University of Southampton, National Oceanography Centre, Southampton)
Eleanor Frajka-Williams, Zoltan Szuts and Stuart Cunningham.
Project funded by NERC/NSA/NOAA

16th July 2013

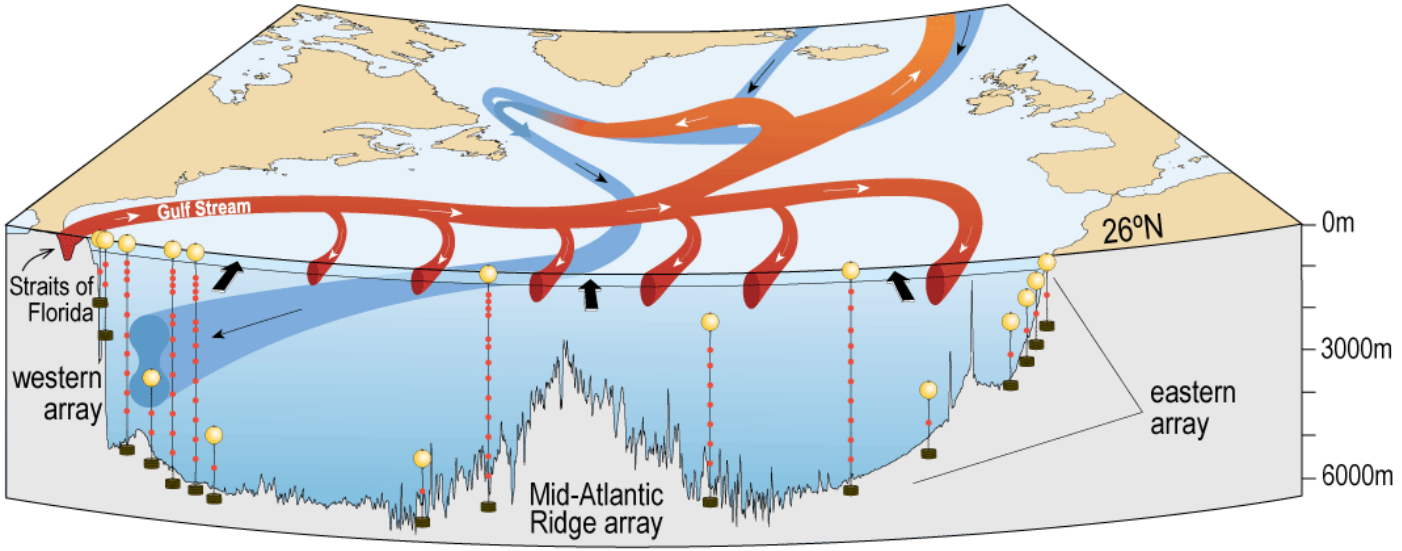
Contents

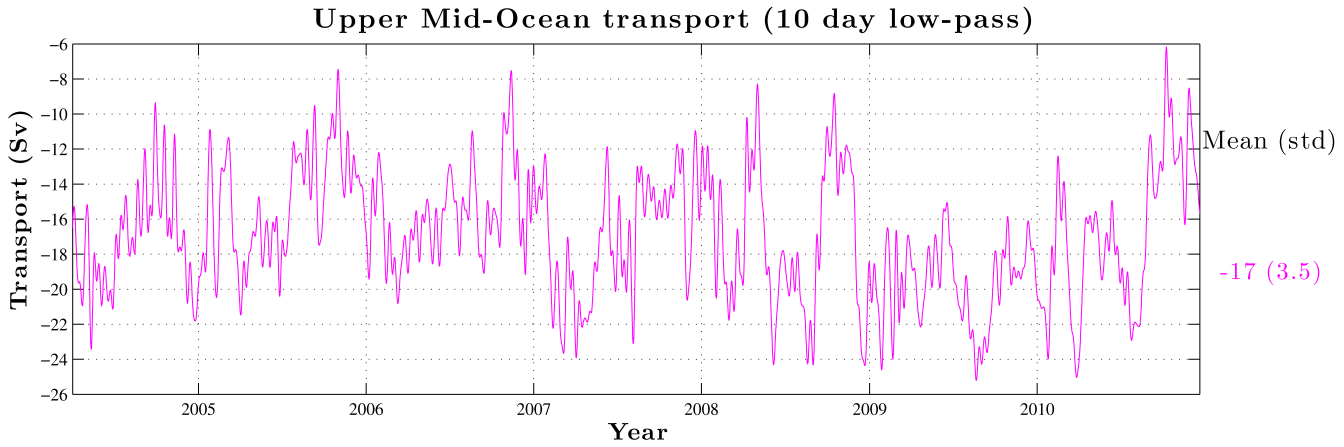
Introduction:

- RAPID array methodology and observations.
- Eddies and Rossby waves detection at the ocean surface and interior.

1) Horizontal structure of westward propagating signals (altimetry).
2) Vertical structure of westward propagating signals (moorings) and link to horizontal measurements.
3) Effect on the MOC.

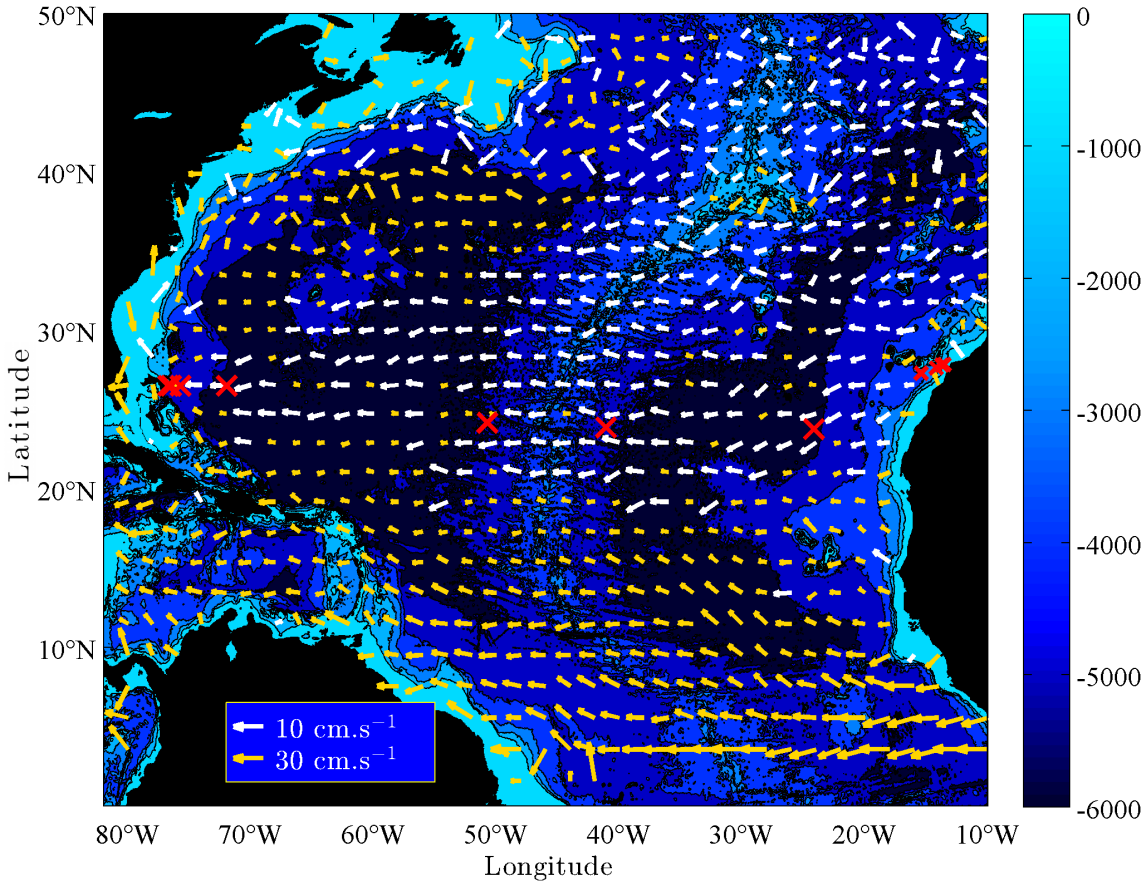
How we measure the MOC?





Introduction

Westward propagating signals from SSHA.

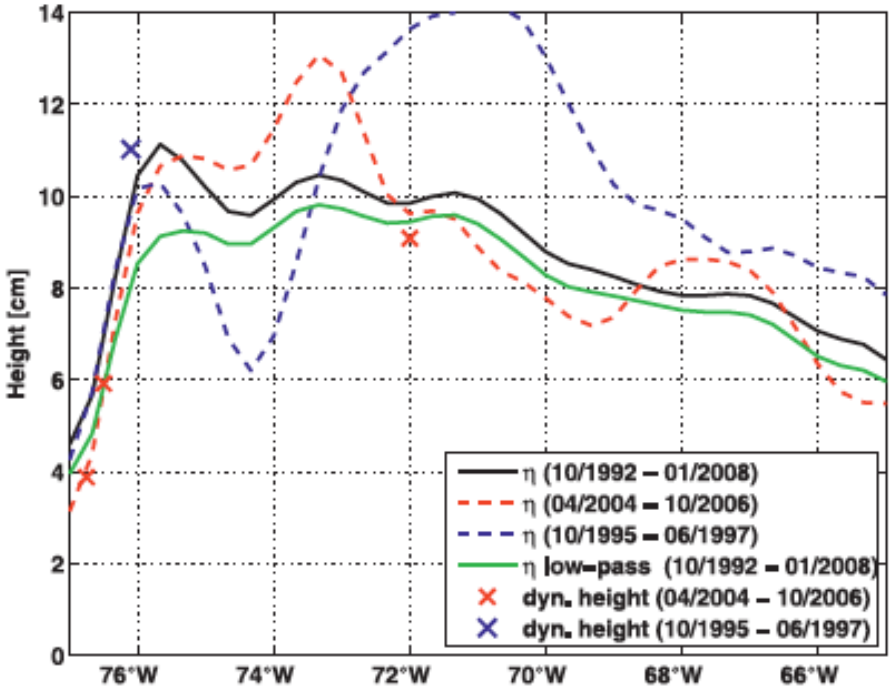


Introduction

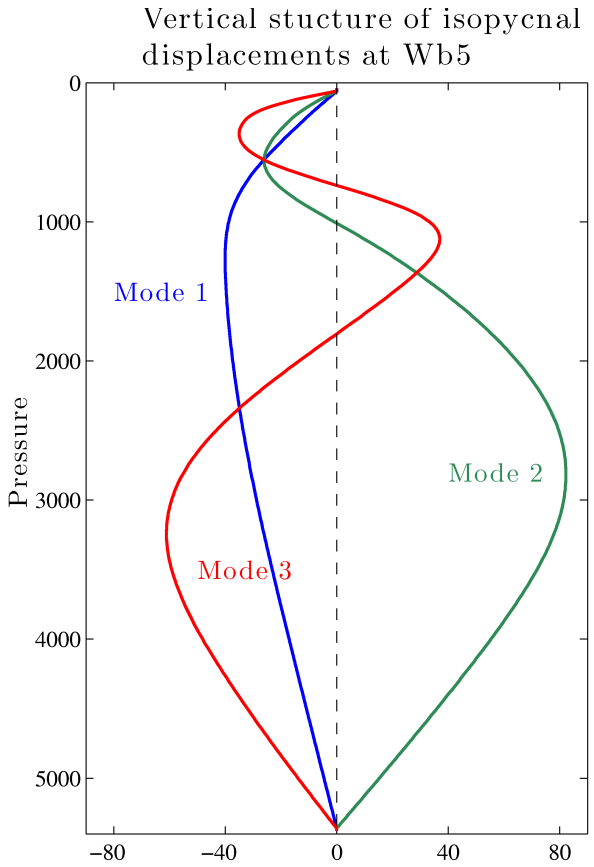
Standard deviation of geostrophic transport attributed to eddy / Rossby waves/

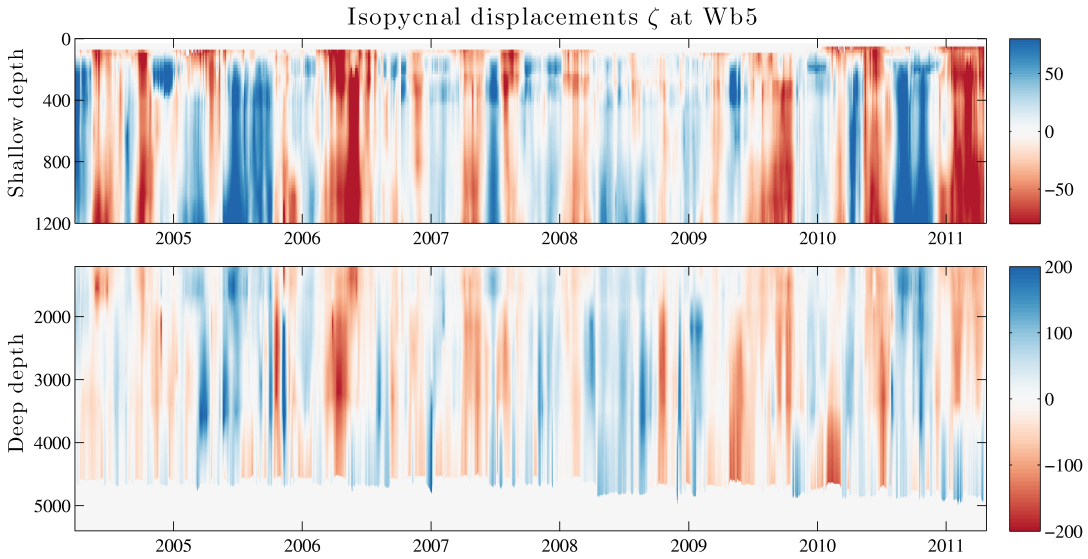
Wunsch (2008):
From SSH variability (16 cm) attributed a standard deviation of 16 Sv.

Kanzow (2009):
SSH variability is observed to decrease to 4 cm at the boundary.



Normal modes of isopycnal displacements.





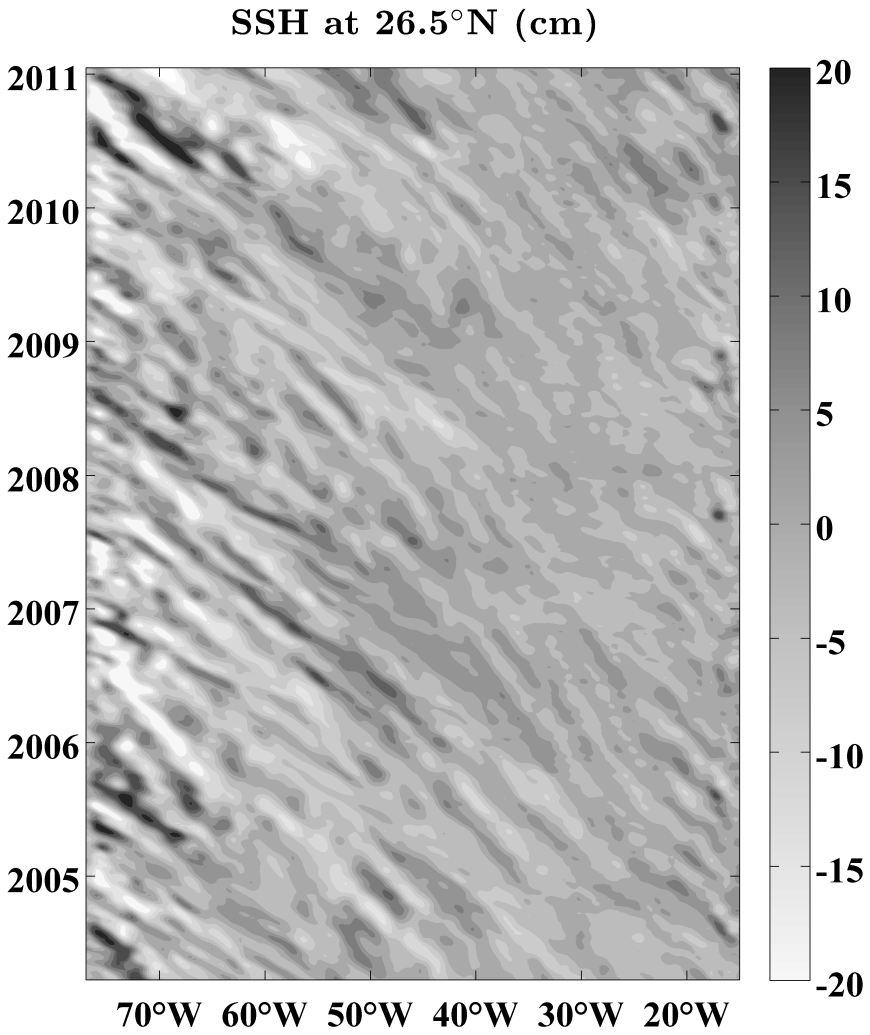
$$\zeta(z,t) = \sum_{m=1}^{M} \hat{\zeta}_m(t) F_m(z).$$

Isopycnal displacements

Modal amplitudes

Vertical structure

SSH variability is attributed to the first baroclinic mode from surface data (Stammer, 1997) and from interior data (Wunsch, 1997).

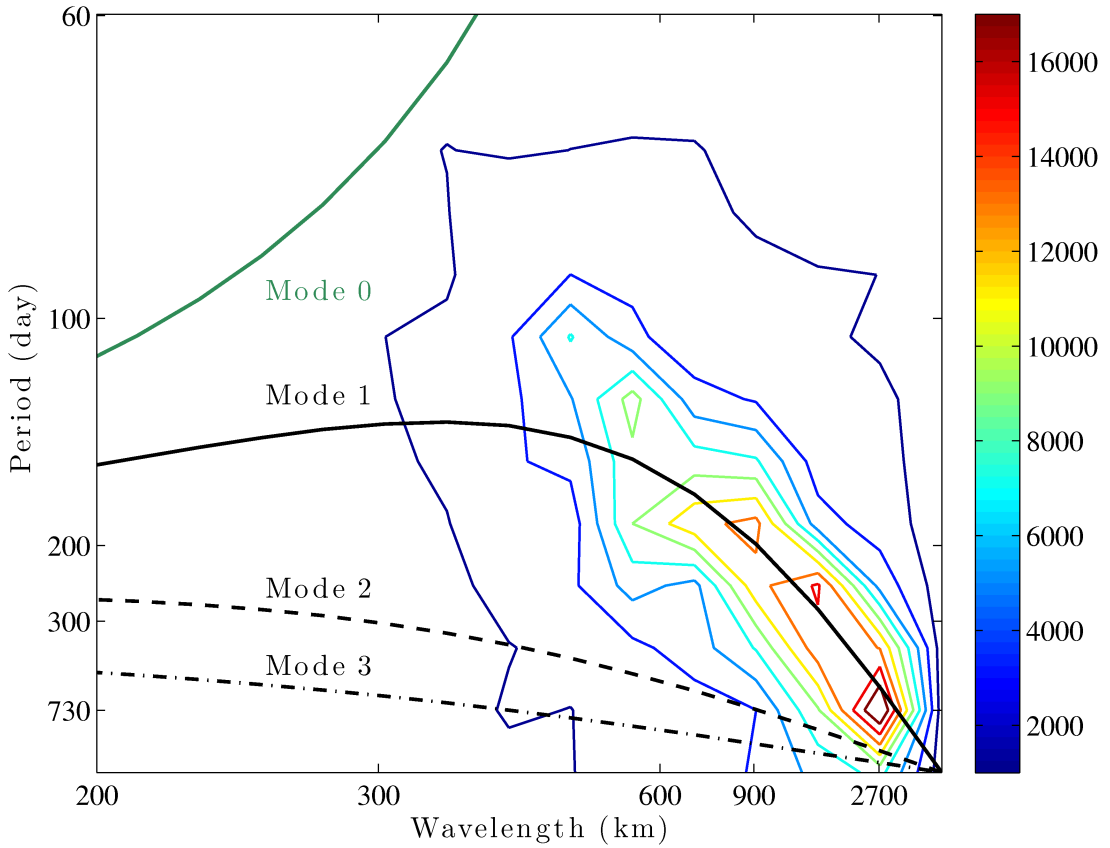


1) Observations from SSHA altimetry.

2D frequency/zonal wavelength spectra of SSHA.

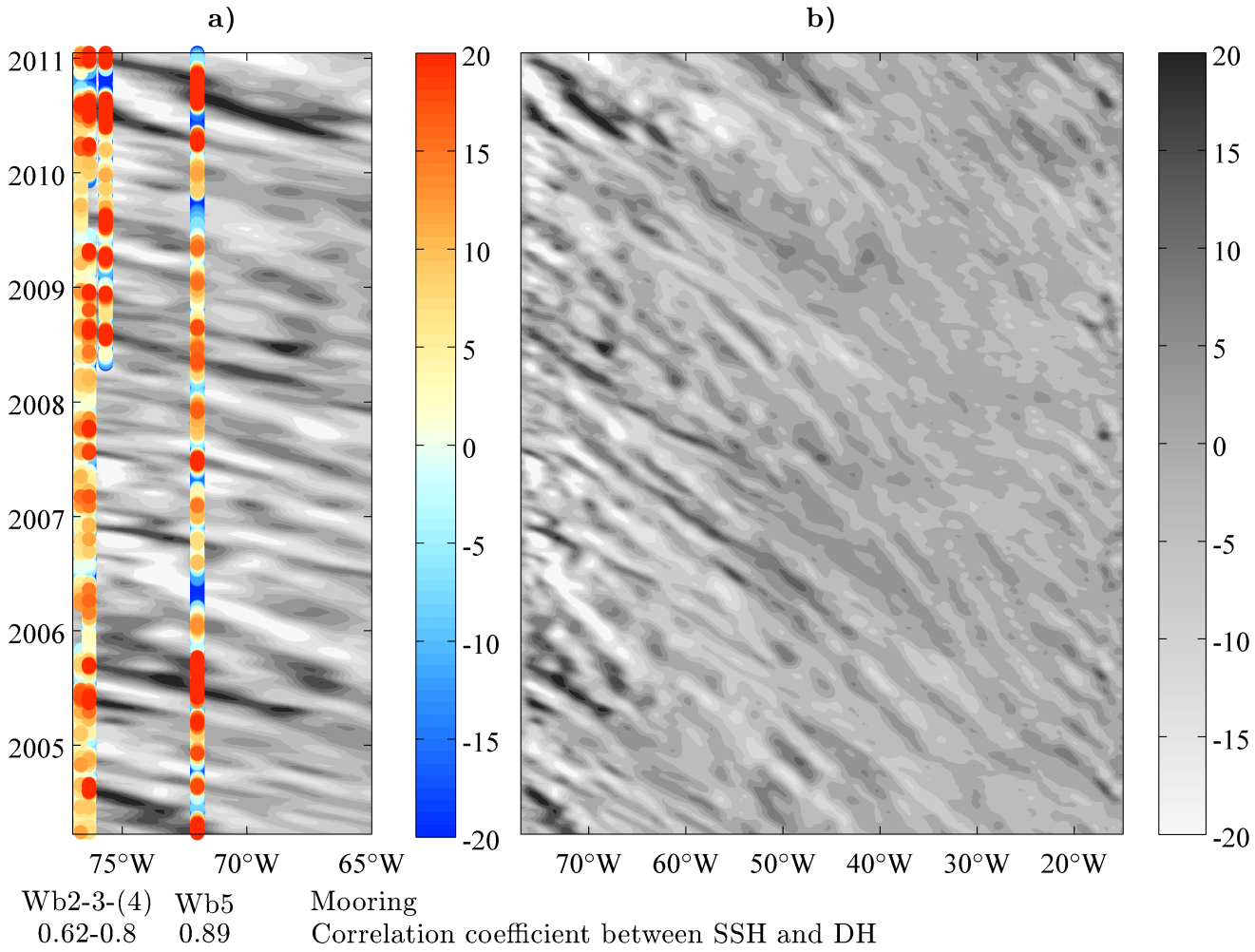
Rossby wave dispersion relation (n is the mode number):

$$w_n = -\frac{\beta k}{k^2 + l^2 + (\frac{n\pi f_0}{NH})^2}$$



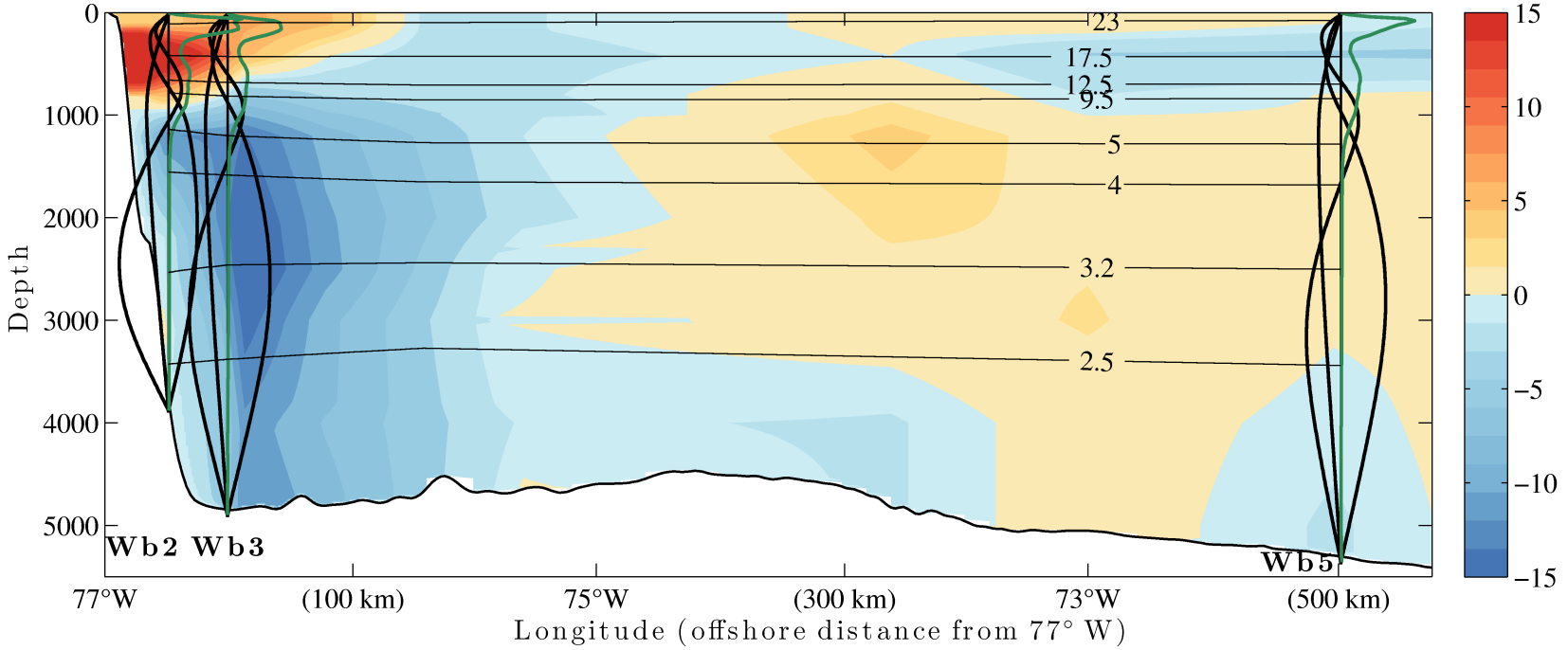
1) Observations from SSHA altimetry.

SSHA (grey) and DHA (colours).



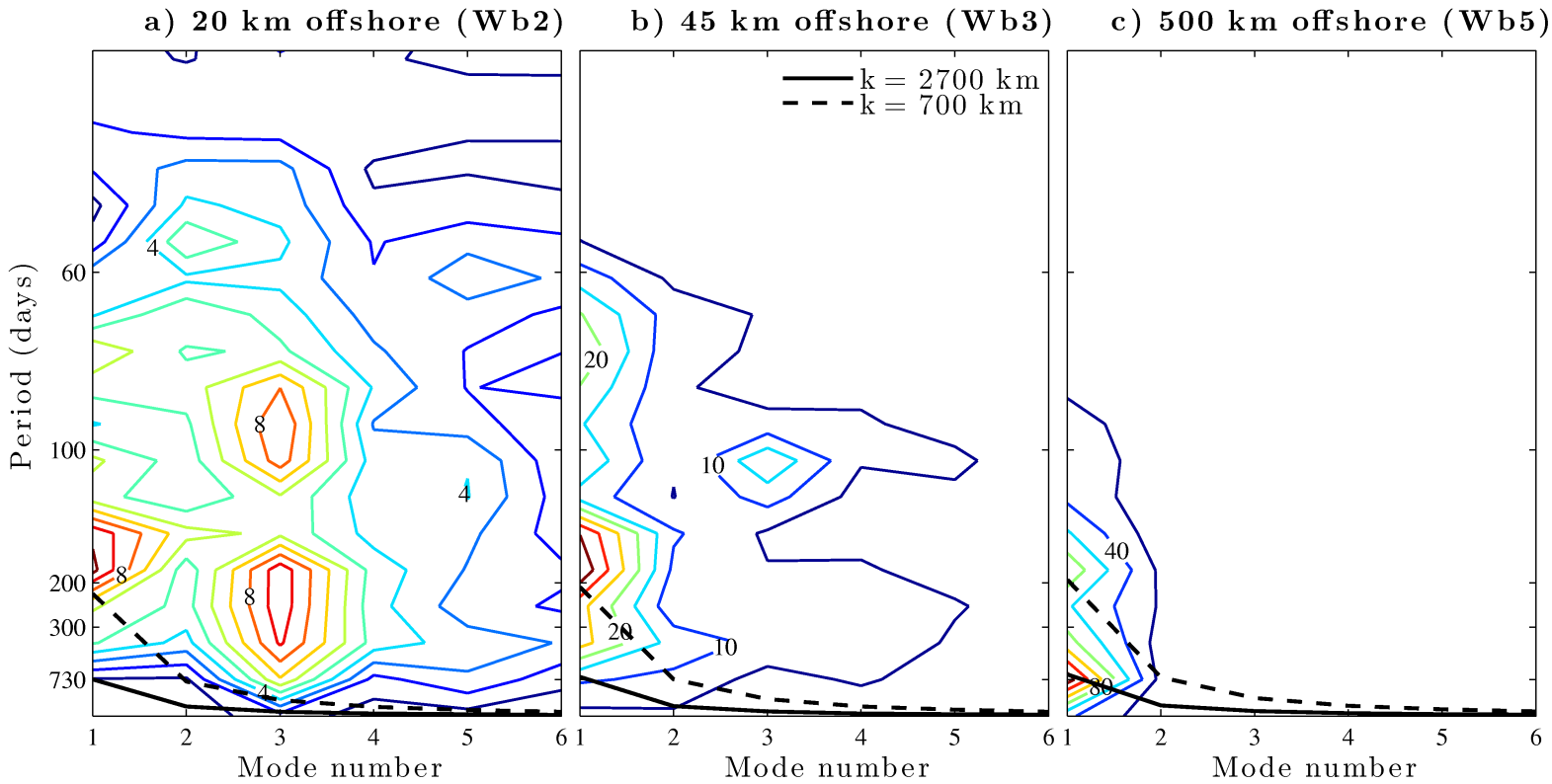
1) Observations from SSH altimetry and DHA at the western boundary.

Mean current (colours), isotherms (horizontal black lines), stratification (green) and first 3 baroclinic modes (black) of the western boundary.



1) The western boundary

Link between SSHA and subsurface modes: Spectra of normal modal amplitudes.

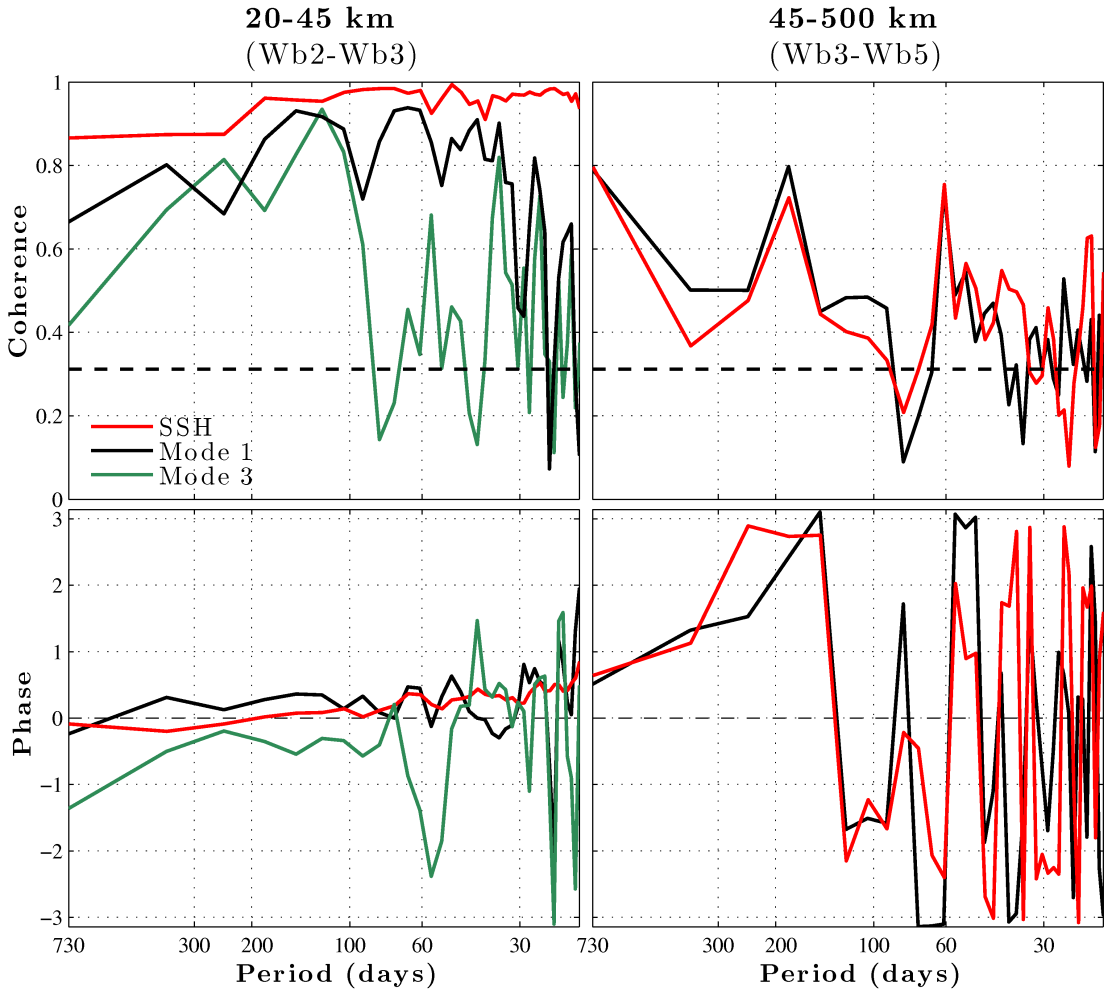


2) Observations from isopycnal displacements.

Coherence between SSHA and modal amplitudes at the western boundary.

Westward

Eastward



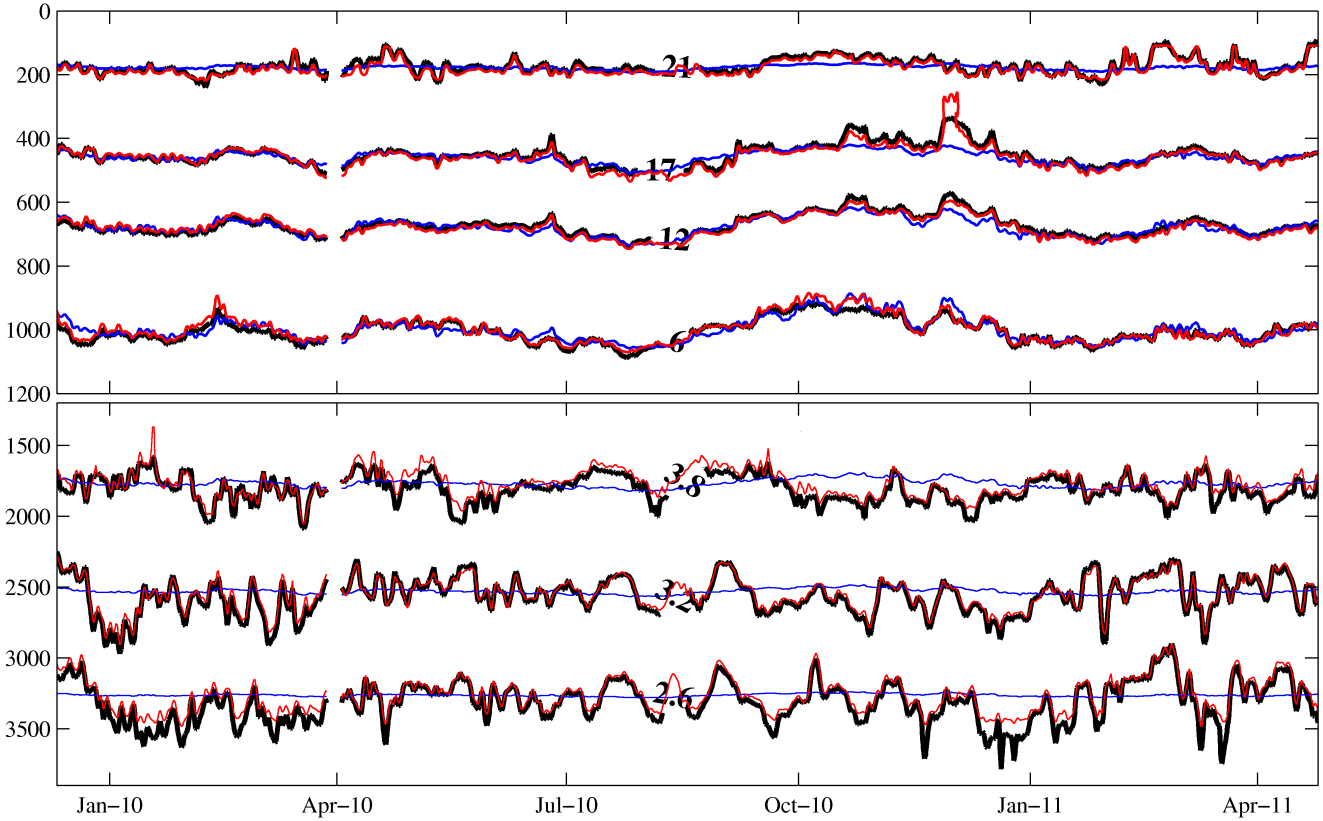
2) Observations from isopycnal displacements.

Comparisons between observed isotherms and reconstructed isotherms.

Observed isotherms (black) and reconstructed from the first 20th baroclinic modes (red) and the 1st baroclinic mode (blue).

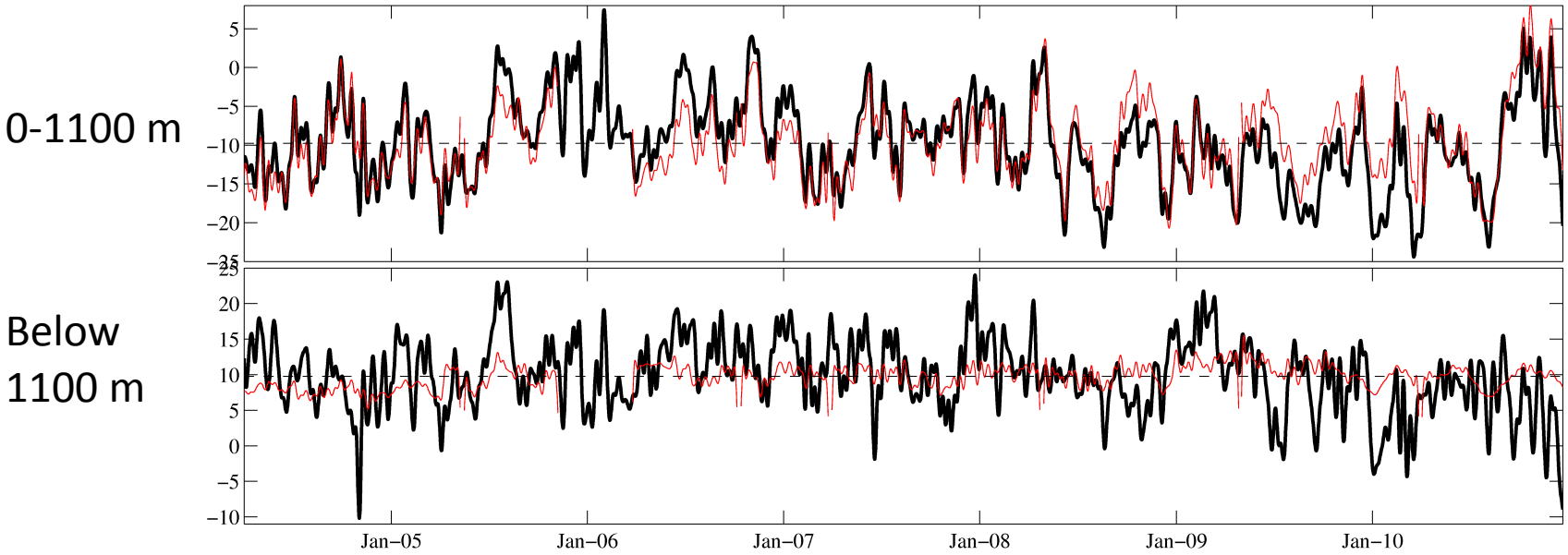
0-1200 m

1200-3900 m



3) Effect on the MOC.

Observed (black) and mode 1 reconstructed (red) geostrophic transport.



3) Effect on the MOC.

Conclusions

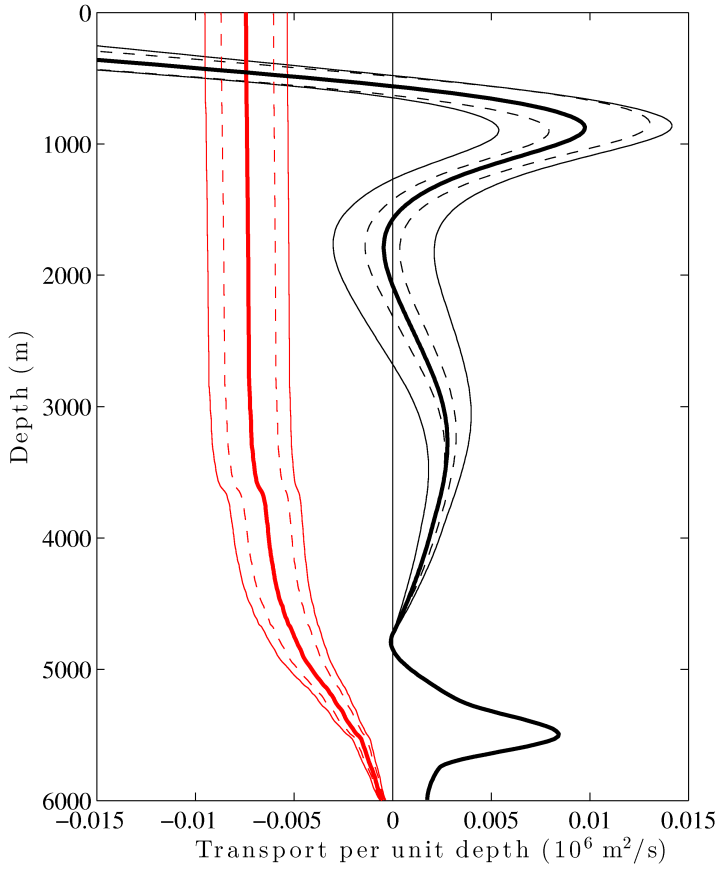
- Westward propagating signals are observed in SSHA with a period of 180 days in the North Atlantic western basin at 26.5°N.

- These propagations are also observed in the first baroclinic mode of isopycnal displacements at the same period (180 days).

- 47% of the variance of the upper mid-ocean transport can be attributed to the variability of the first baroclinic mode associated with eddies and Rossby waves at periods of 50-200 days.

- At the boundary the third baroclinic mode is also excited and the mode 1 and 3 coherence suggests that a conversion process may be involved.

Temporal mean of the geostrophic transport (thick black line) and the barotropic component (thick red line), standard deviations about these means are shown for the measurements (thin solid lines) and 1st mode reconstruction (thin dashed lines).



3) Effect on the MOC.