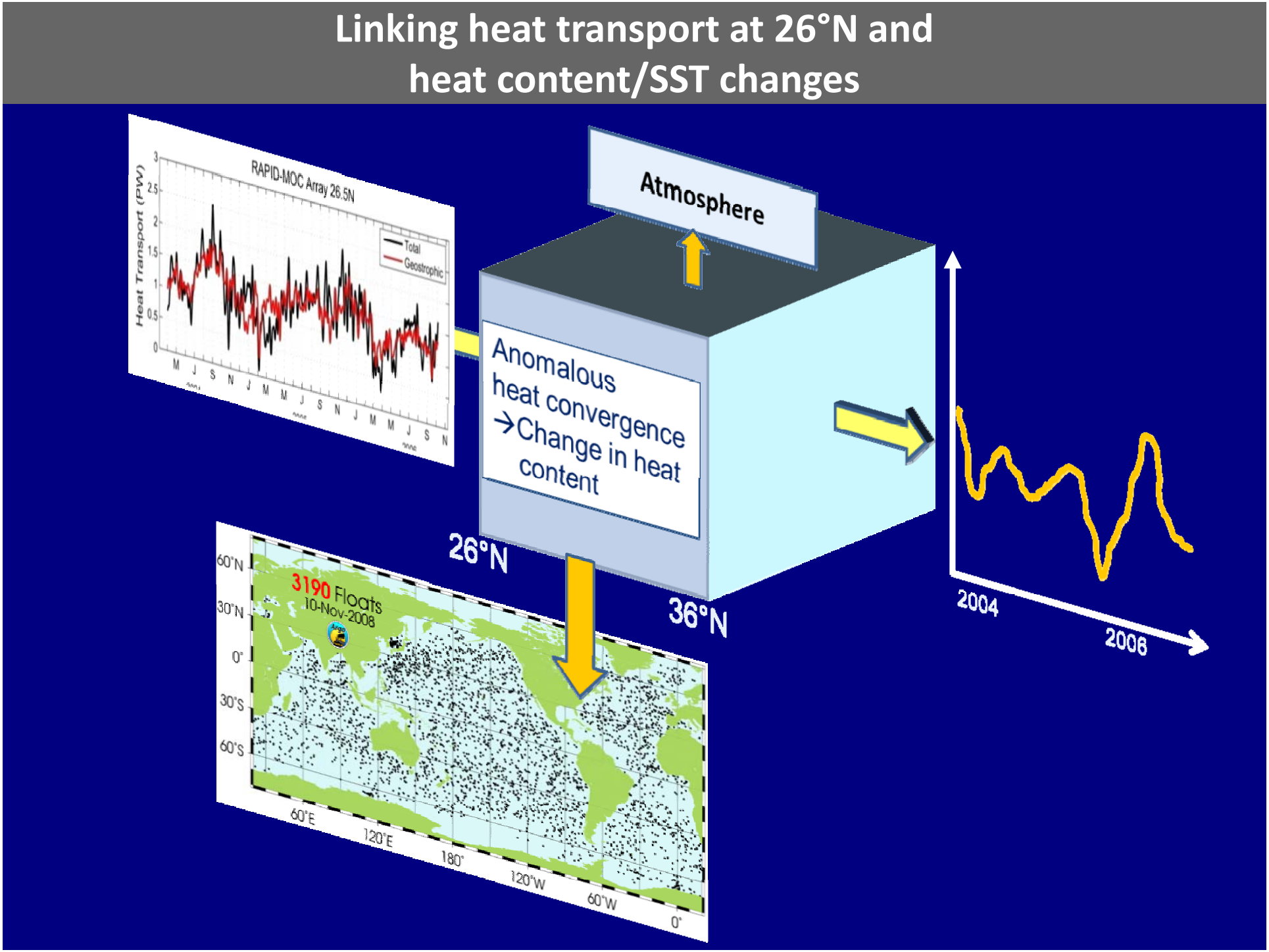
Meridional Overturning and North Atlantic heat COntent (MONACO)

N. Wells, J.Hirschi, V.Ivchenko, S.Josey, B. King
National Oceanography Centre
Southampton
U.K.

Linking heat transport at 26°N and heat content/SST changes



Overview

The main goal of MONACO is to understand the links between the MOC and the meridional heat transport (MHT) from the RAPID-WATCH observing system, and the subannual to interannual variability of oceanic heat content (HC) and sea surface temperatures (SSTs) in the North Atlantic inferred from Argo floats. The proposed work addresses question 1 (Qu.1) listed in the RAPID-WATCH announcement of opportunity.

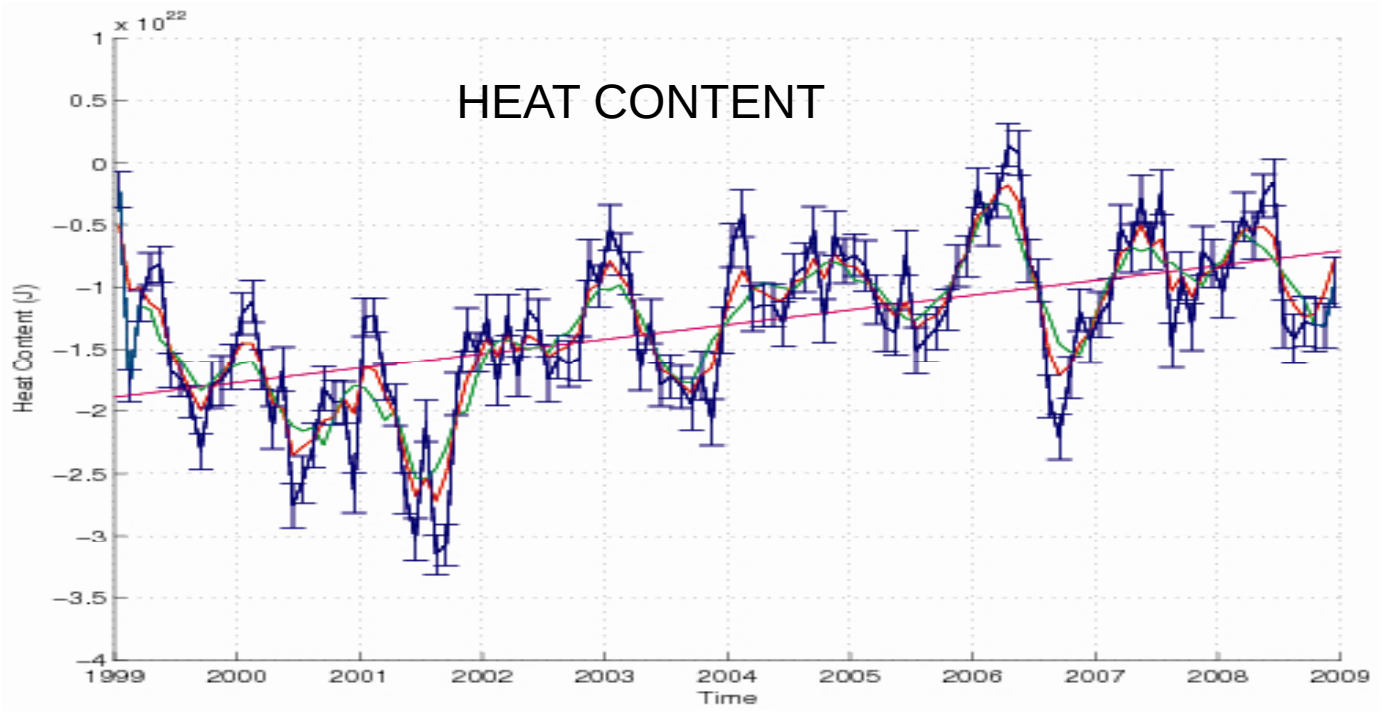
Why is MONACO important for RAPID WATCH ?

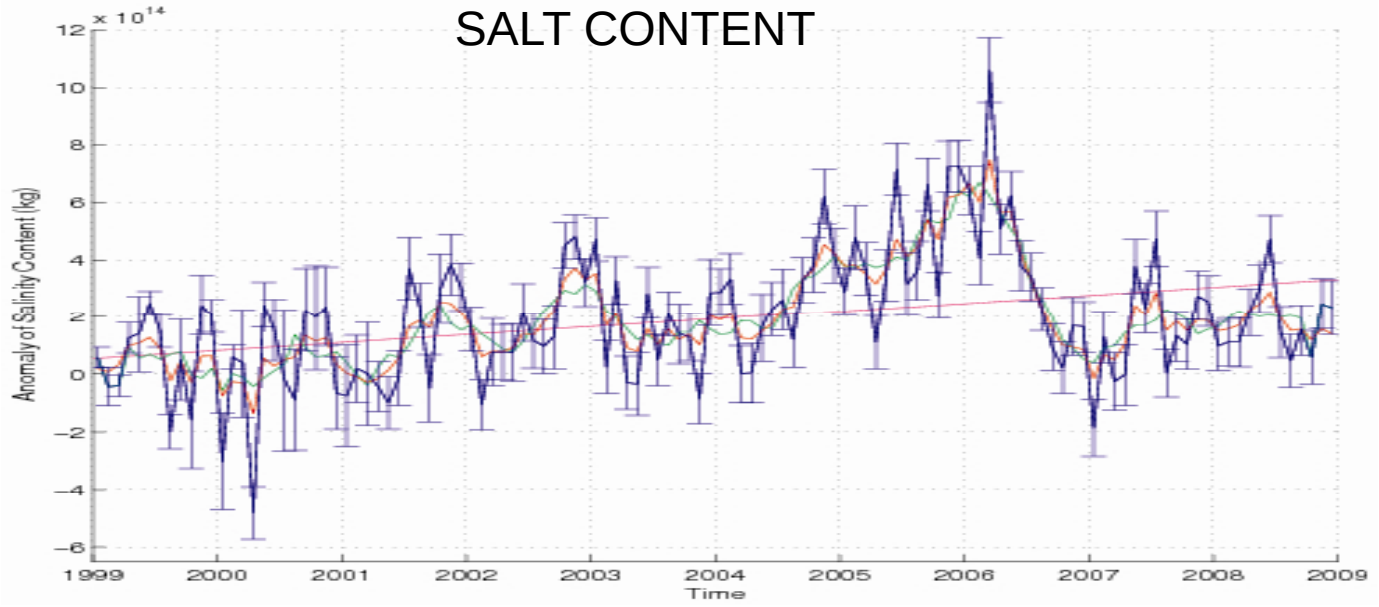
- **We will demonstrate the connections between the MOC array at 26.5°N and ocean heat storage changes from 10°N to 70°N**

- **We will look for connections between ocean heat content and sea surface temperature/air-sea fluxes**

- **We will provide observational evidence for the above, which will be key for validation of ocean models.**


North Atlantic heat and freshwather content inferred from Argo

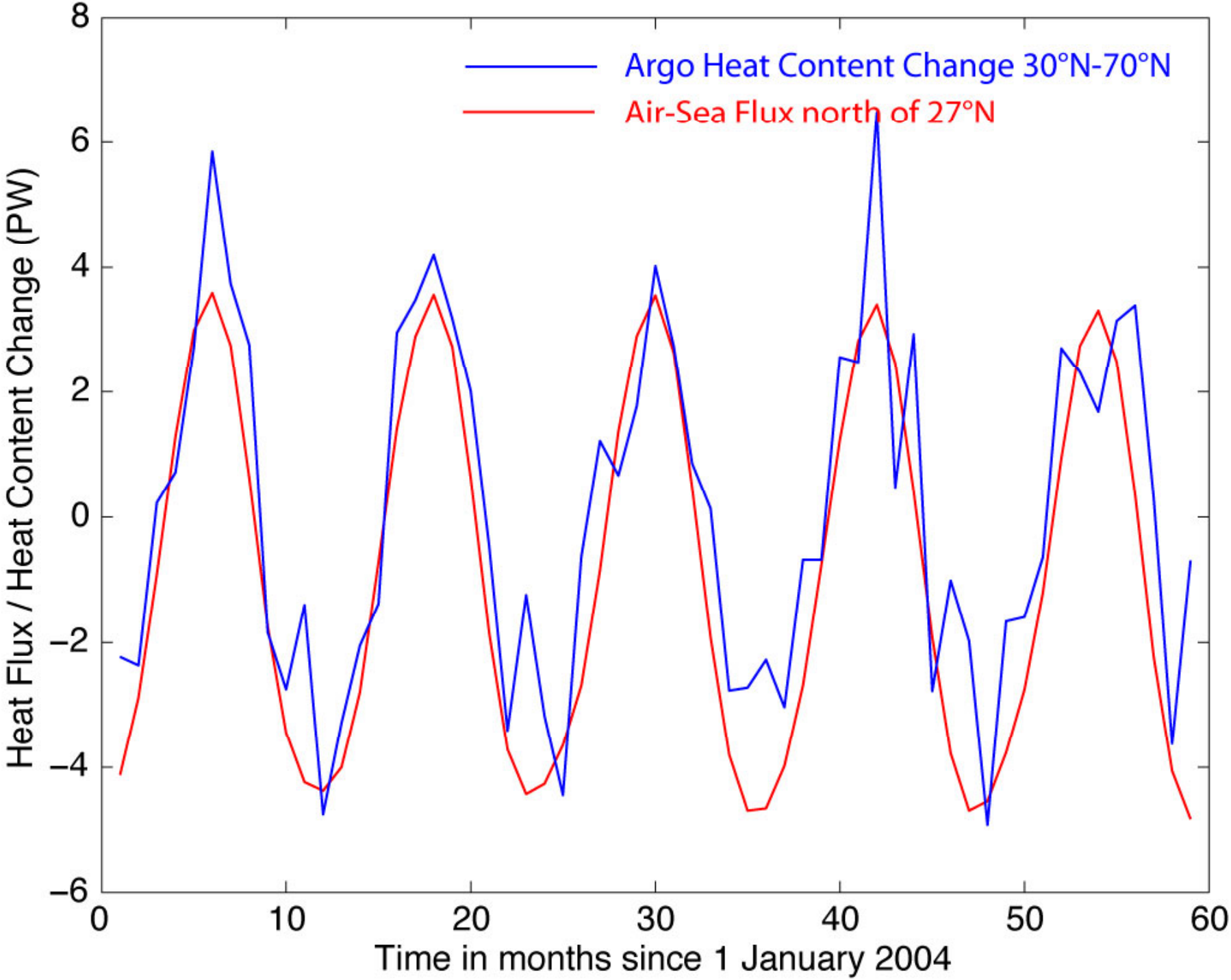


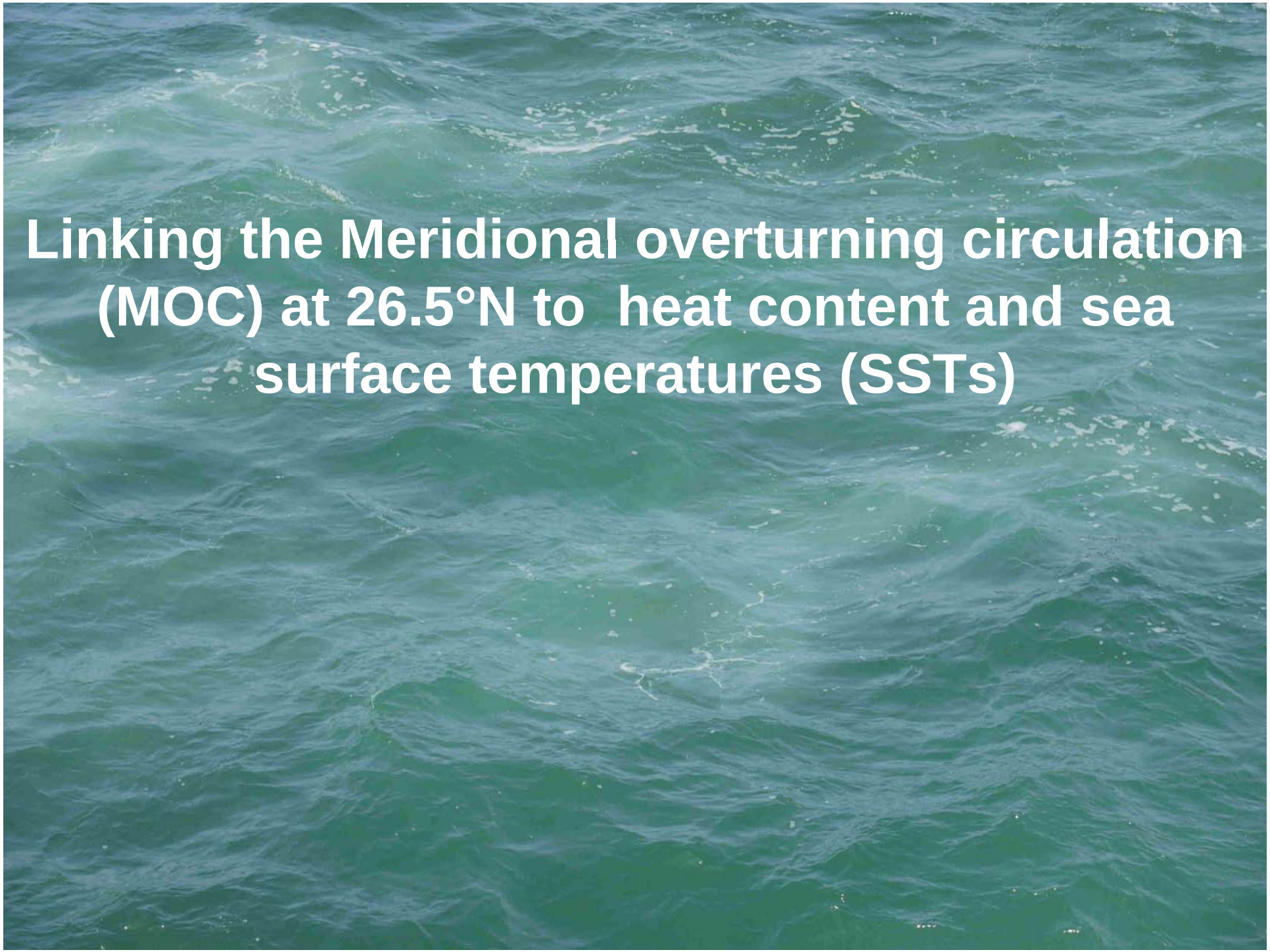


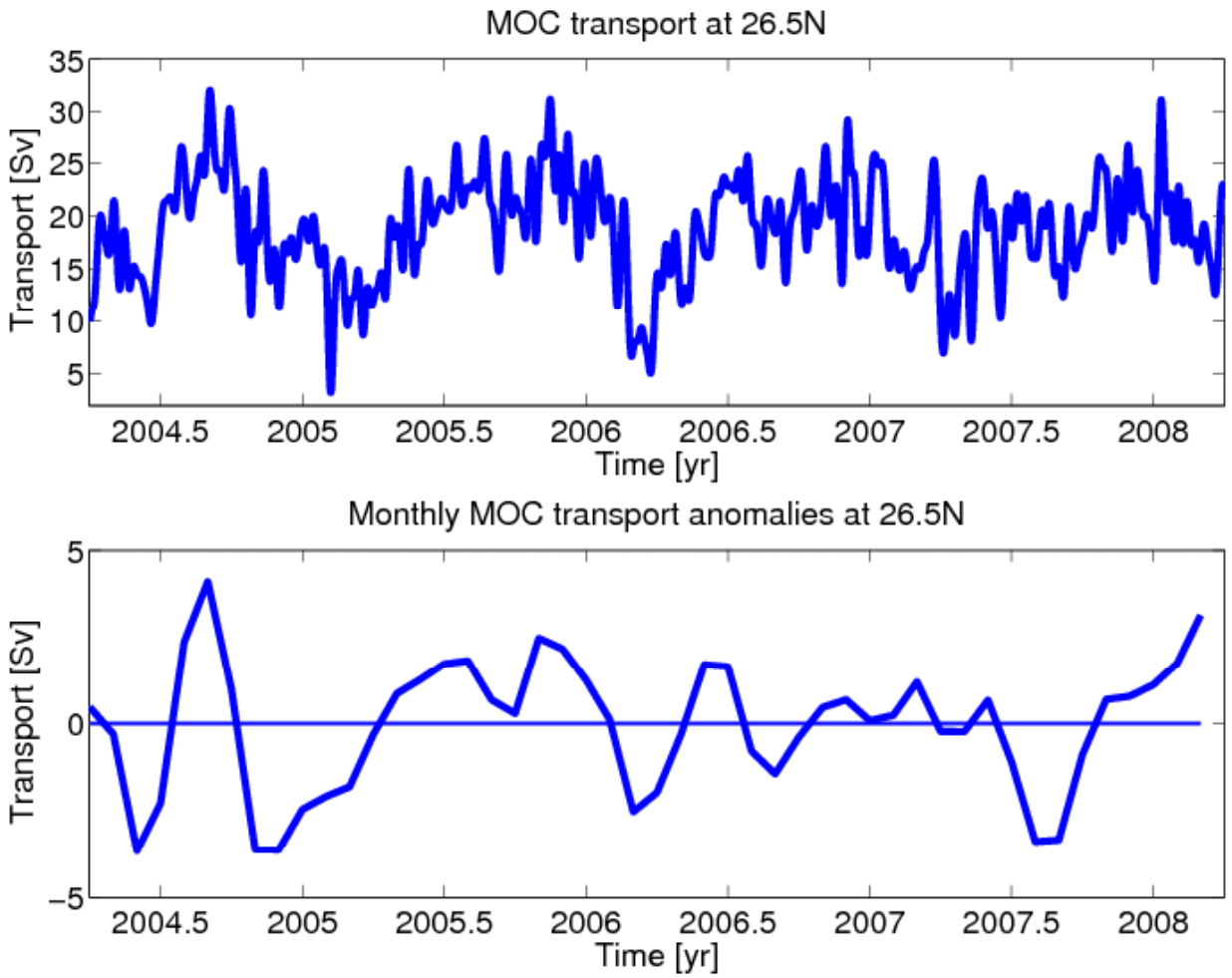
N.Atlantic
10 -70 N
0-2000m

Statistical Analysis

- **Statistical model fitted to time series (trend & annual cycle)**
- **Significant trend in heat content (55.4% variance explained).**
- **50% Argo data removed (53.9%) but trend still significant.**
- **Trend in salinity relatively weak (12.6%)**


Argo Heat Content Change 30°N-70°N
Air-Sea Flux north of 27°N
Heat Flux / Heat Content Change (PW)
Time in months since 1 January 2004
8
6
4
2
0
−2
−4
−6
0
10
20
30
40
50
60

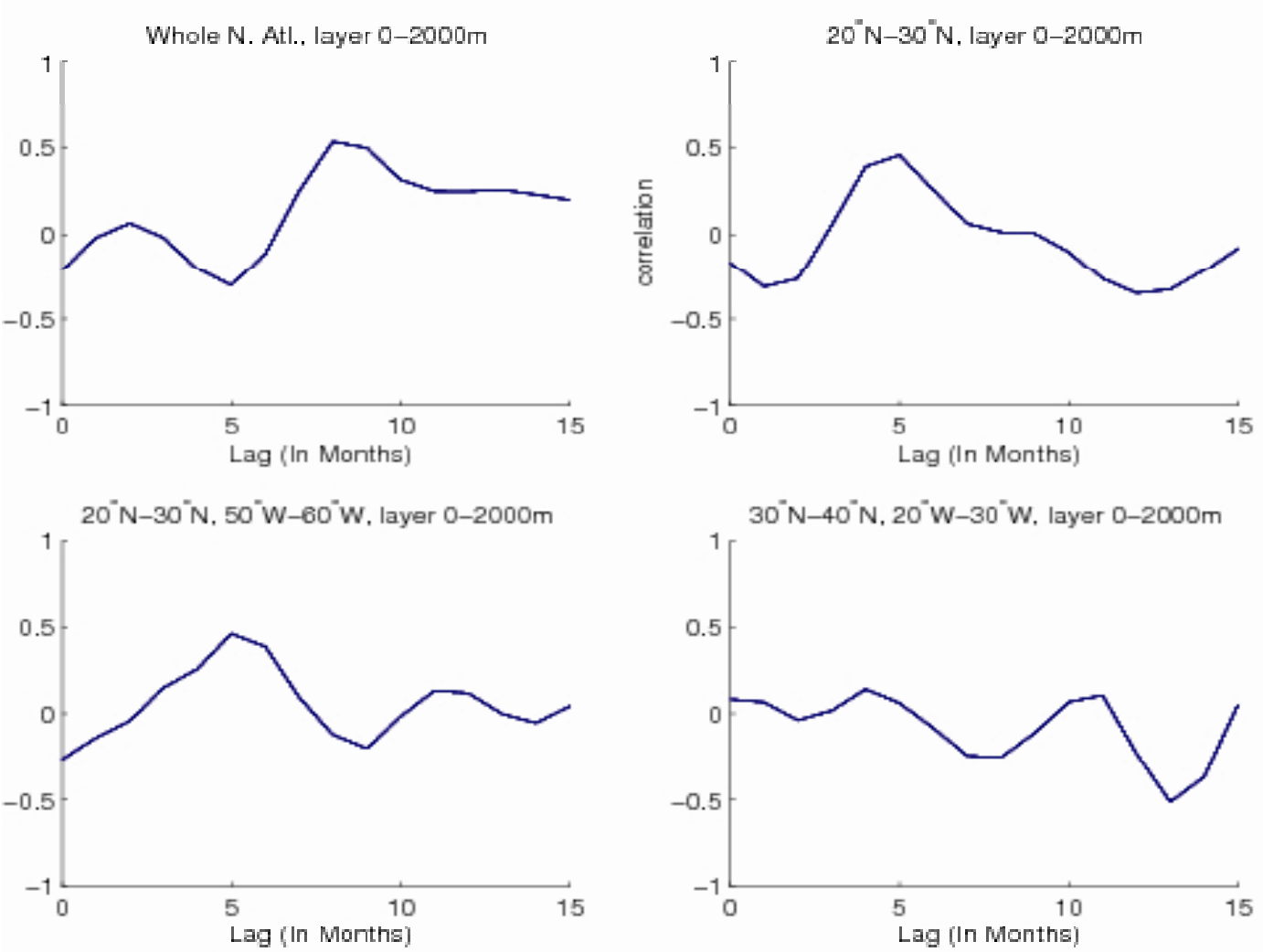

Linking the Meridional overturning circulation (MOC) at 26.5°N to heat content and sea surface temperatures (SSTs)



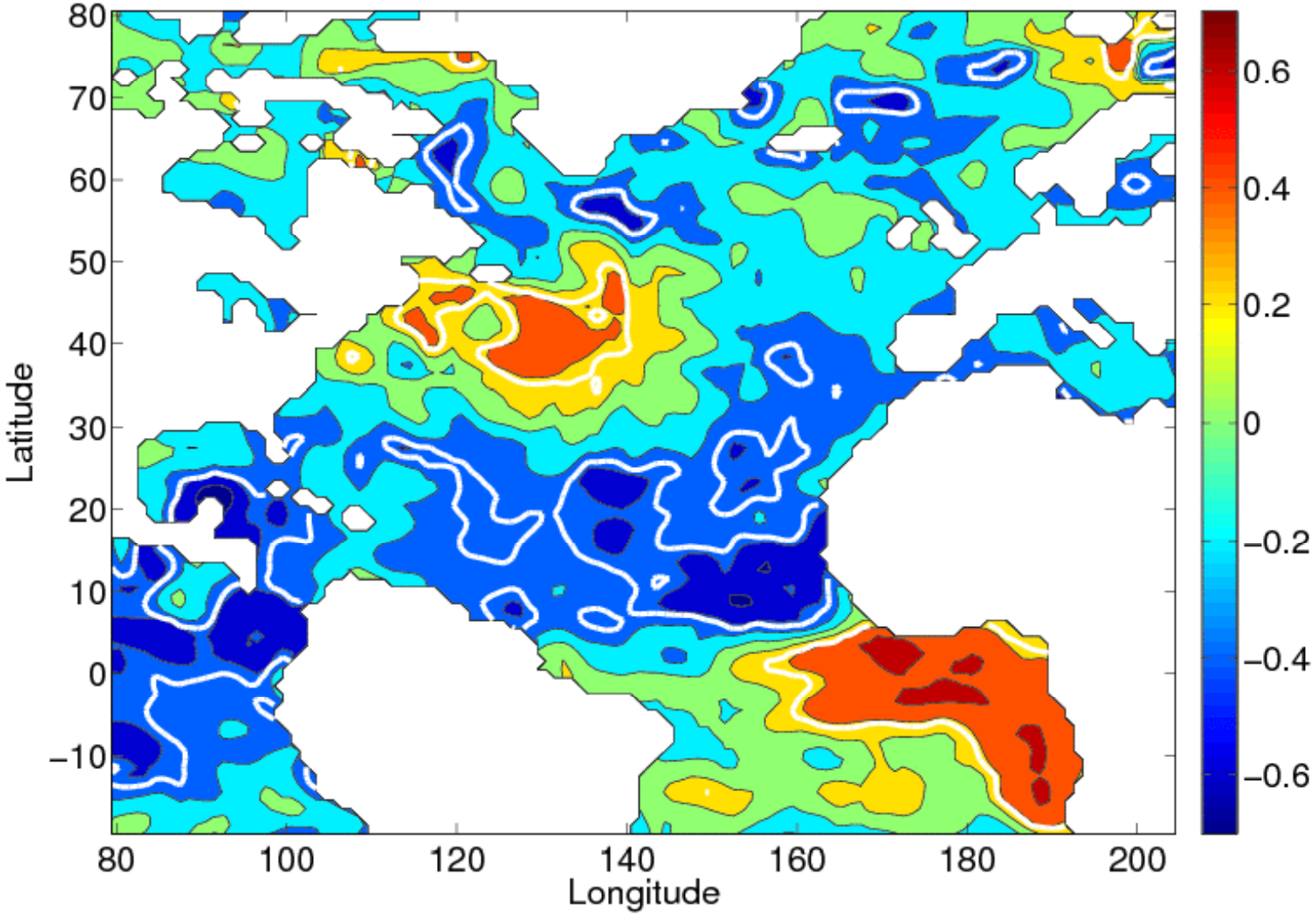
Top: RAPID MOC timeseries from April 2004 to April 2008 (transport in the top 1000m filtered with a 10-day low pass filter.

Bottom: Monthly, de-seasoned MOC anomalies smoothed by applying a 2-month running mean.

Lag correlations between MOC transport anomalies and heat content anomalies (0-2000m). MOC leads



Correlation between MOC and SSTs (MOC leads by 6 months)



- **SST from NOAA OI (Reynolds et. al.2004)**

Summary and next steps

North Atlantic heat and salt content timeseries have been calculated from 1999 to 2009

First indications that MOC leads both the development of heat content and SST anomalies

North Atlantic heat content fluctuations inferred from Argo and air-sea heat fluxes have similar amplitudes and phase - differences may allow us to infer the oceanic contribution to heat content changes

RAPID MOC timeseries still short (April 2004 – April 2008) - more work needed to assess the robustness of the observed lag correlations (using longer timeseries in models)

Acknowledgements

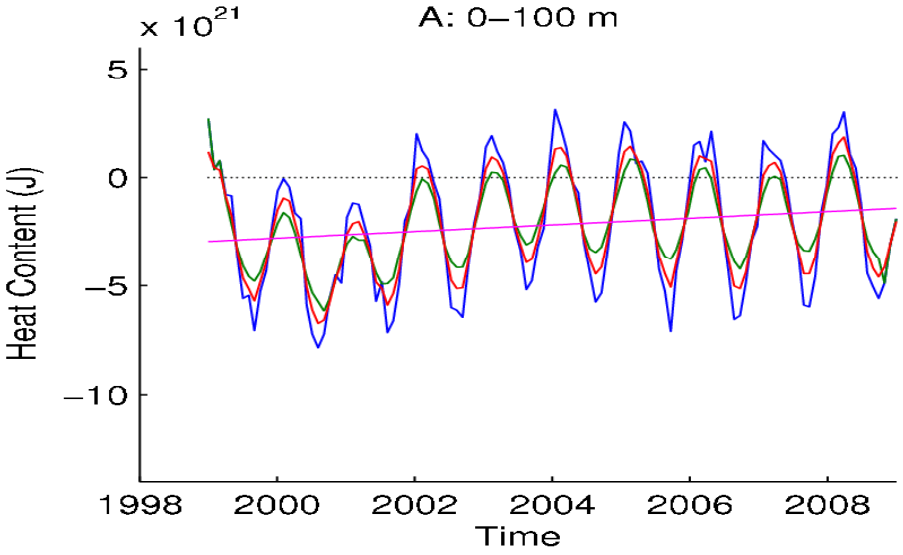
The ARGO data were collected and made freely available by the International ARGO project and the national programmes that contribute to it. ARGO is a pilot programme of the Global Ocean Observing System.

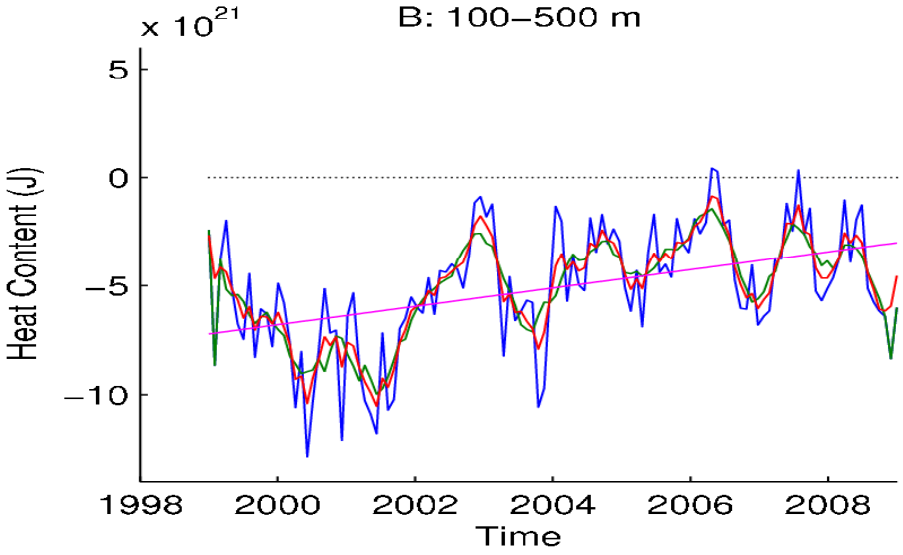
The work is funded by a NERC RAPID WATCH grant, grant no. NE/G00787/1

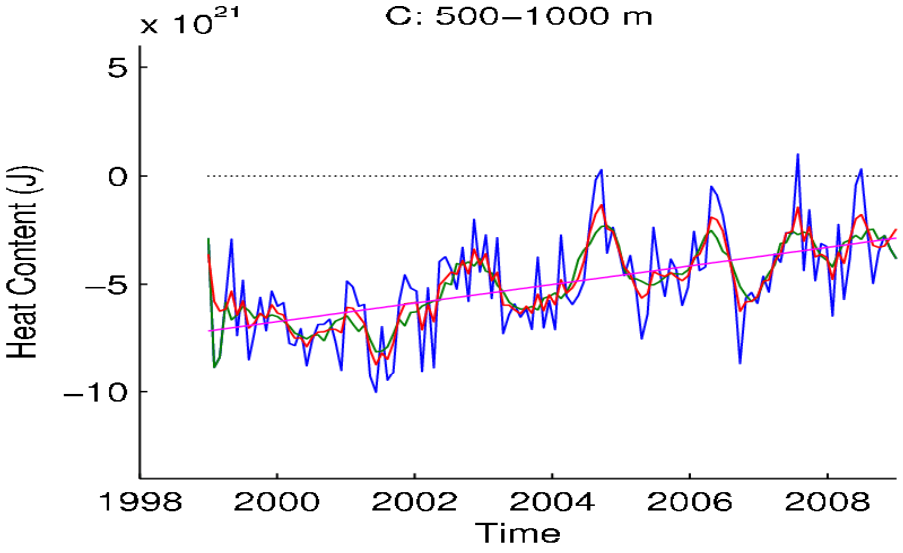
Any Questions ?

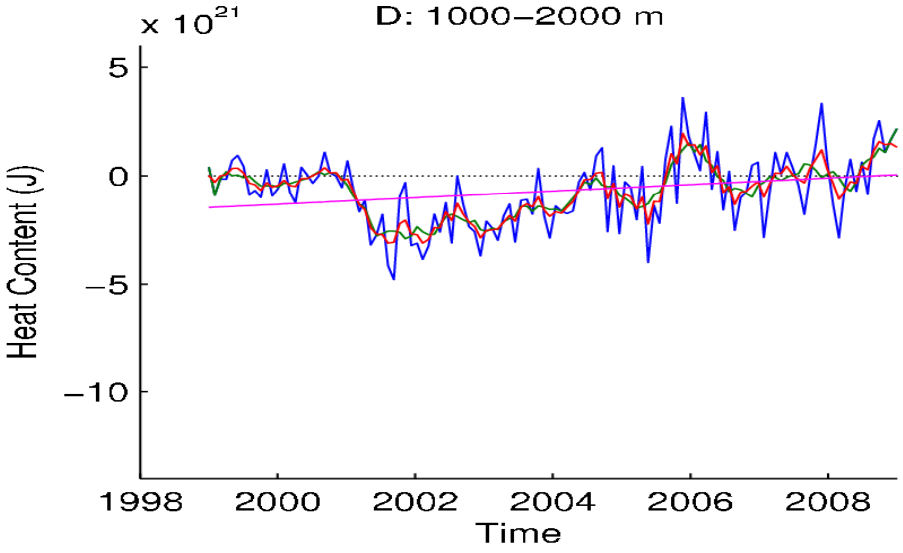
Thank you !

Heat Content 10-70 N

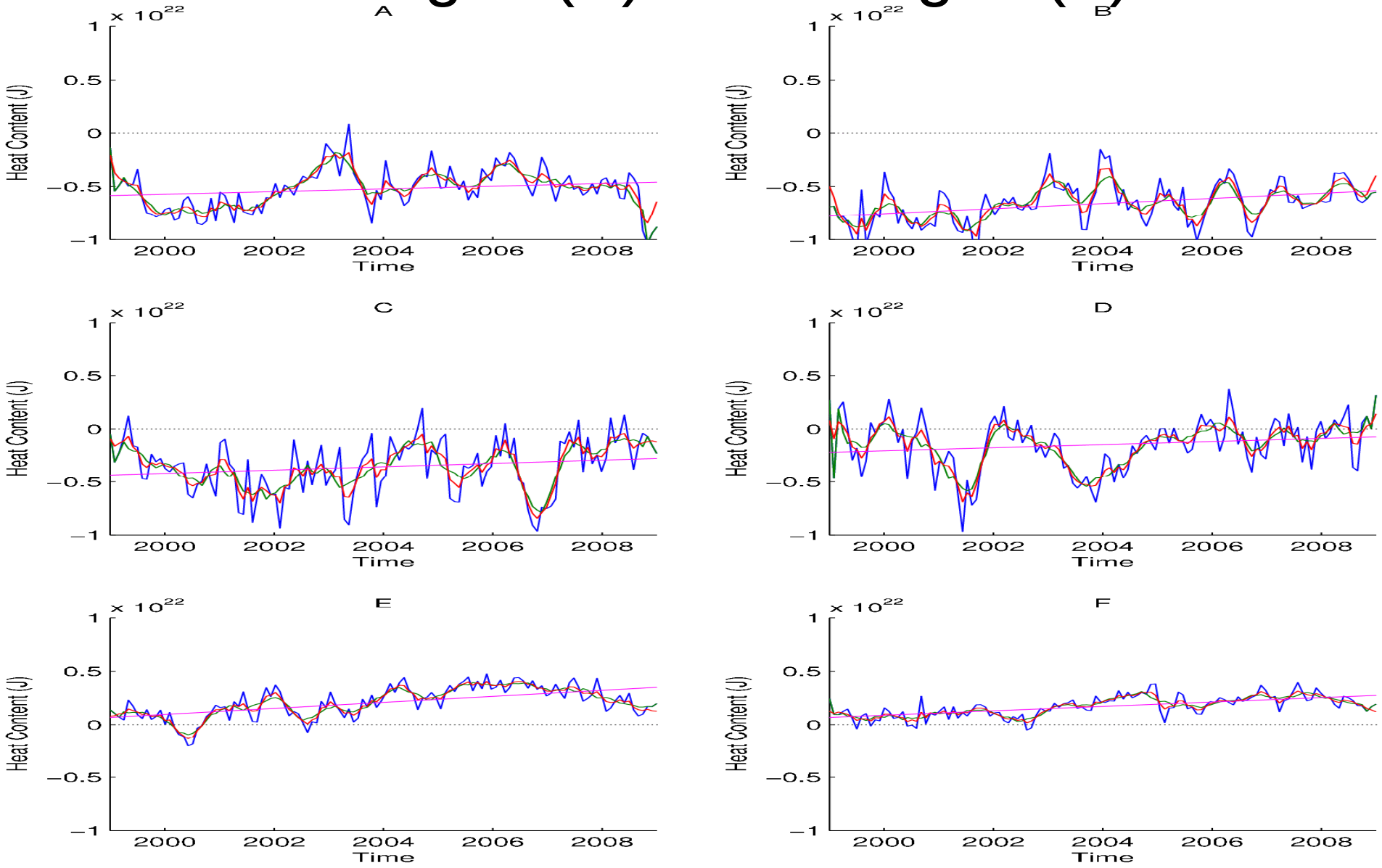








Heat Content 10 deg zonal belts from 10 deg N (A) to 70 deg N (F)



Research Plan Year 1

- Monthly Ocean Heat and Salt Storage anomalies 1999-2009 from 10N to 70N; 0-2000m; 10 deg. latitudinal bands. W and E Atlantic. **Done**
- Lead/lag relationships between MOC time series and heat and salt storage anomalies. **In progress**
- Progress report to PEB by month 10 ?

June 2010 to May 2012

- Lead/lag relationships between Anomalies and MOC time series completed.
  - heat transport and heat storage
  - freshwater transport and salt storage
- Rapid Watch evaluation in 2011
- Neutral surfaces and diagnostics completed- internal ocean changes.
- Links of Anomalies to air-sea exchange and sea surface temperature

Next 6 months

- Is another report to PAG required in March 2010 ?
- Further analysis of links of MOC to heat content and SST.
- Analysis of links of heat storage to heat transport; links of salinity storage to fresh water transport.

Risks

- Inverse calculations for heat/freshwater budgets have been published and are well established.
- Ocean heat transports at other latitudes have only been tested in models.
- We are dependent on ocean state estimates from VALOR and THOR.