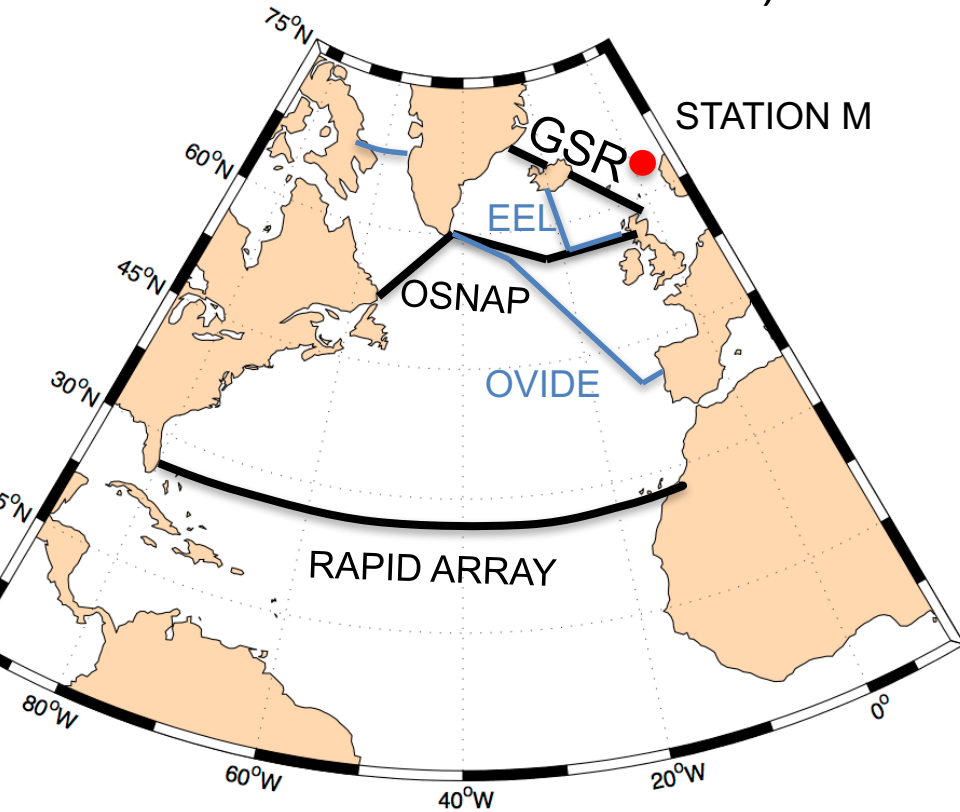


EVALUATING NORTH ATLANTIC OCEAN CIRCULATION AND PROPERTIES

B. Moat¹, B. Sinha¹, J. Hirschi¹, P. Holliday¹, G. McCarthy¹, and S. Olsen²

1) NOC UK, 2) DMI



- 1) What's happening in the Subpolar North Atlantic (from observations)
- 2) High resolution hindcast and coupled model evaluation (BLUE-ACTION)
Aim: look at the heat and freshwater transport anomalies into the Arctic.
- 3) Links to Ocean Metrics

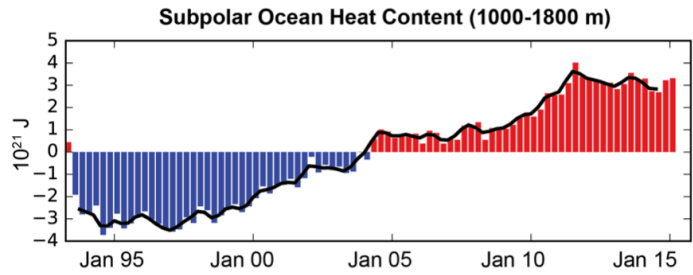
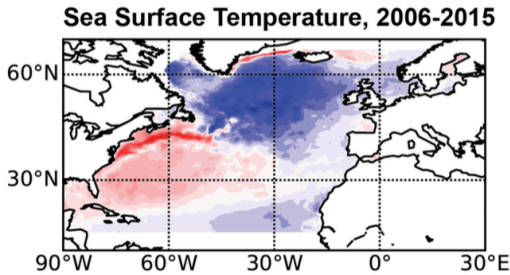
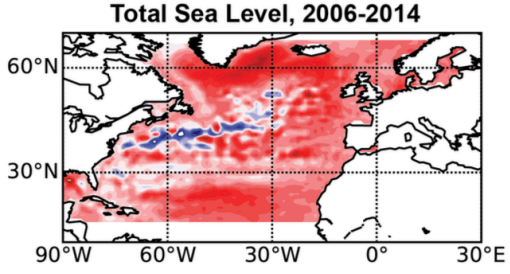
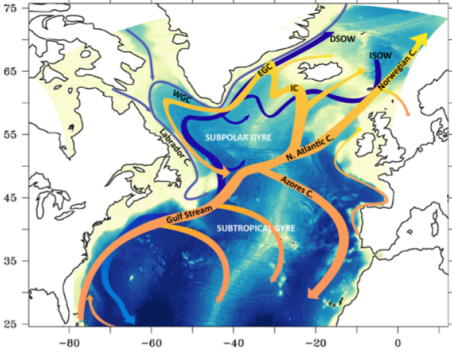
BLUE ACTION 

Modelling Workshop
Evaluating climate and Earth
System models at the process level.
23-24 May 2017, Brussels.

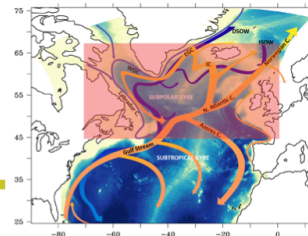
Overview: changes 2006-2015

- Increasing sea level across NA
- Cooling surface Subpolar NA
- Warming surface Subtropical NA
- Warming intermediate layer (both)

Basin-scale indicators: sea level, ocean heat content, surface temperature, and circulation indices
(linear trend maps + time series as anomalies from long-term mean)

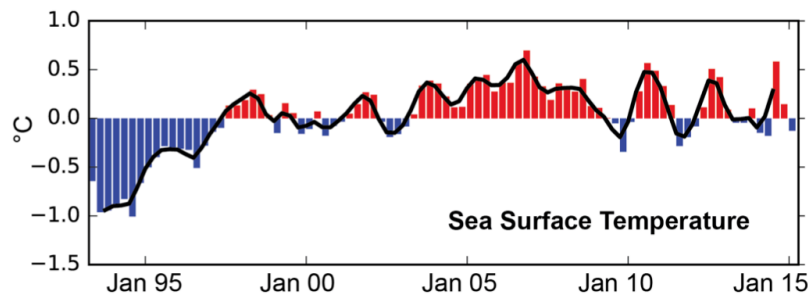
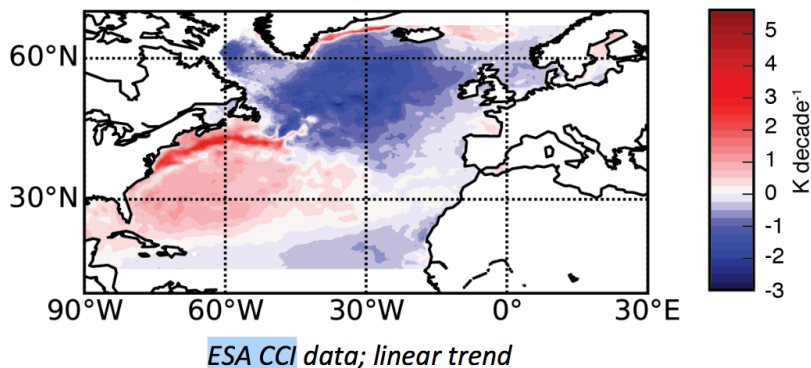


Subpolar Upper Ocean (0-1000m)

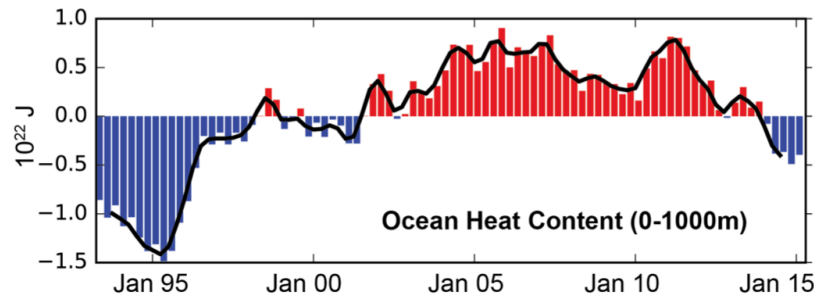


- Sea surface temperature decreased 2006-2015
(trends highly influenced by start/end years)

Sea Surface Temperature, 2006-2015



ESA CCI data;
anomaly from
1993-2015
mean



EN4;
anomaly from
1993-2014
mean

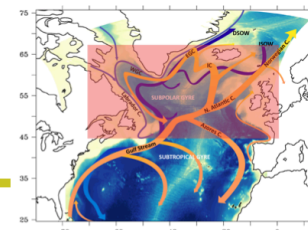
- Ocean Heat Content shows similar pattern to SST except in 2014-15 (unusual winter)

ESA CCI : <http://www.esa-sst-cci.org/>

EN4 : www.metoffice.gov.uk/hadobs/en4/



Subpolar Upper Ocean (0-1000m)



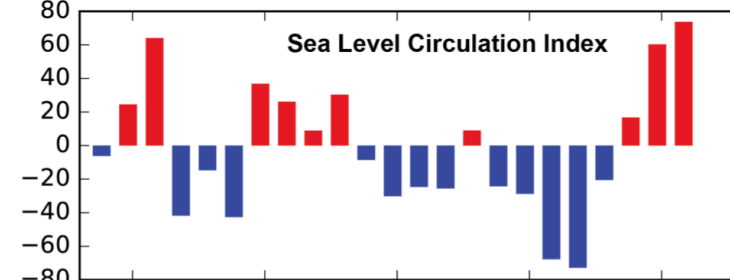
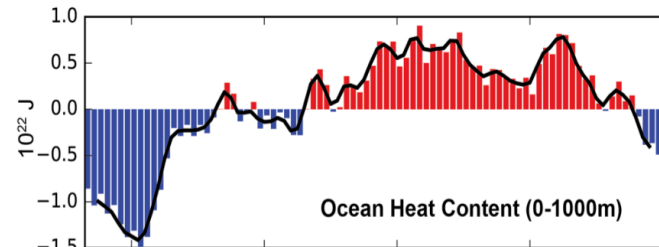
Multi-year timescales

- Ocean Heat Transport dominates heat content but no direct measurements

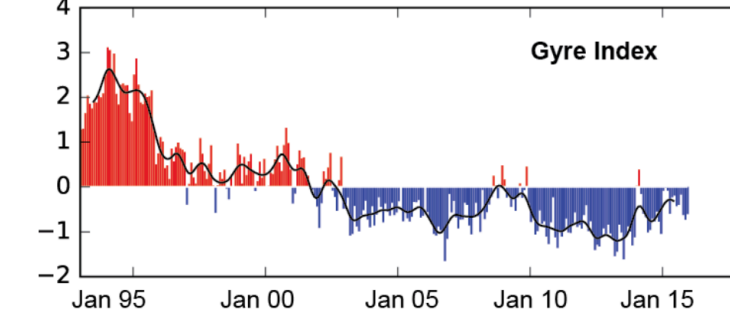
Williams et al 2014

- Meridional ocean heat transport represented by N-S sea level gradient (lower index => less heat content on decadal scales). Not so clear in 20yrs

- Gyre heat transport represented by SPNA sea surface height gradient (lower index = more heat content)



McCarthy et al, 2015



Berx et al, 2016

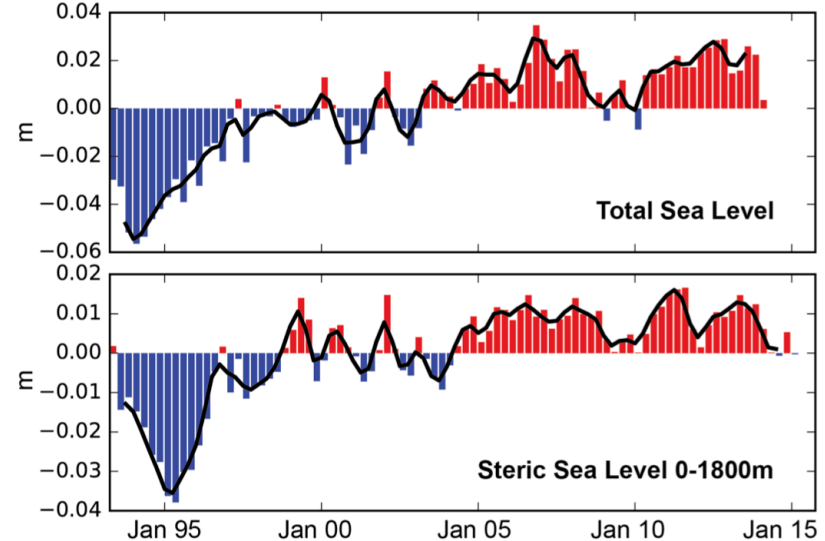
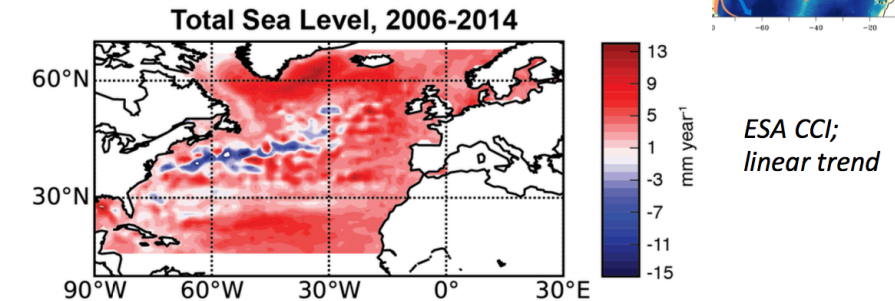
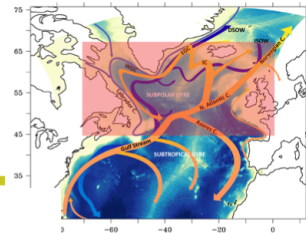


McCarthy: <https://www.nature.com/nature/journal/v521/n7553/full/nature14491.html>

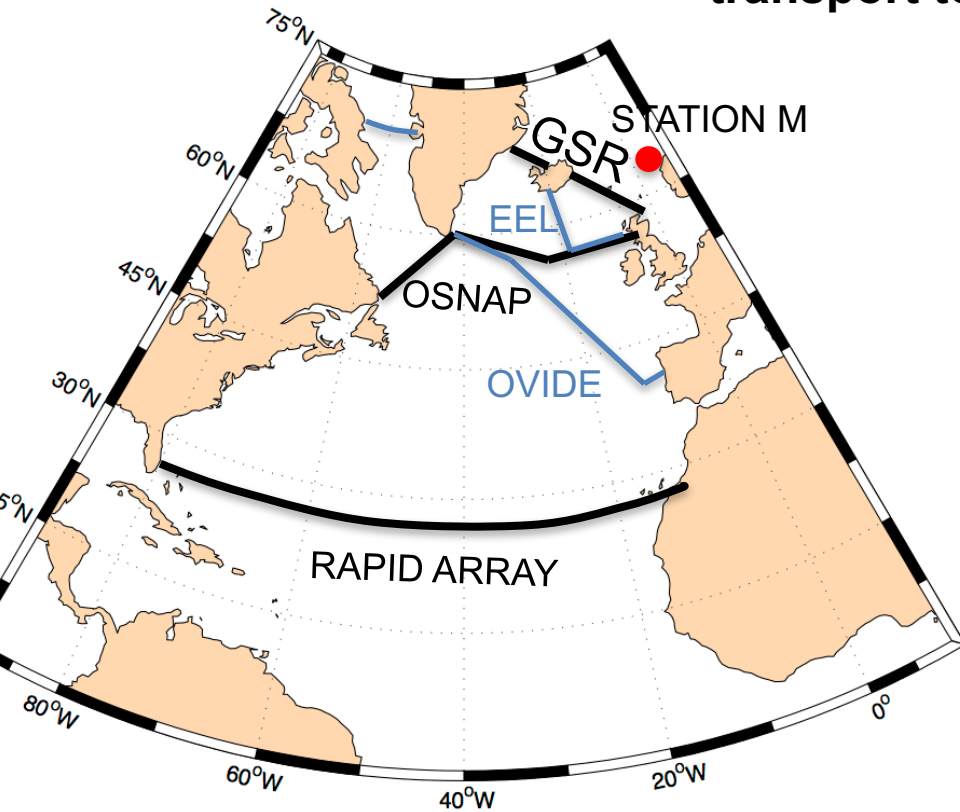
Berx: <http://data.marine.gov.scot/dataset/sub-polar-gyre-index>

Subpolar Upper Ocean (0-1000m)

- Total sea level trend is to higher, rate is similar to global sea level rise (~3 mm/yr)
- Spatial variations associated with movement of the Gulf Stream/ North Atlantic Current
- Steric sea level highly correlated with total SL, but there is additional structure in total SL



WP2.1 Model-observation and re-analyses comparison at key locations for heat transport to the Arctic



1) NEMO Ocean only hindcast
1/12° 1958 to 2015
1/12° 1958 to present day (ACSIS)

2) Three (HadGEM3) - Coupled simulations

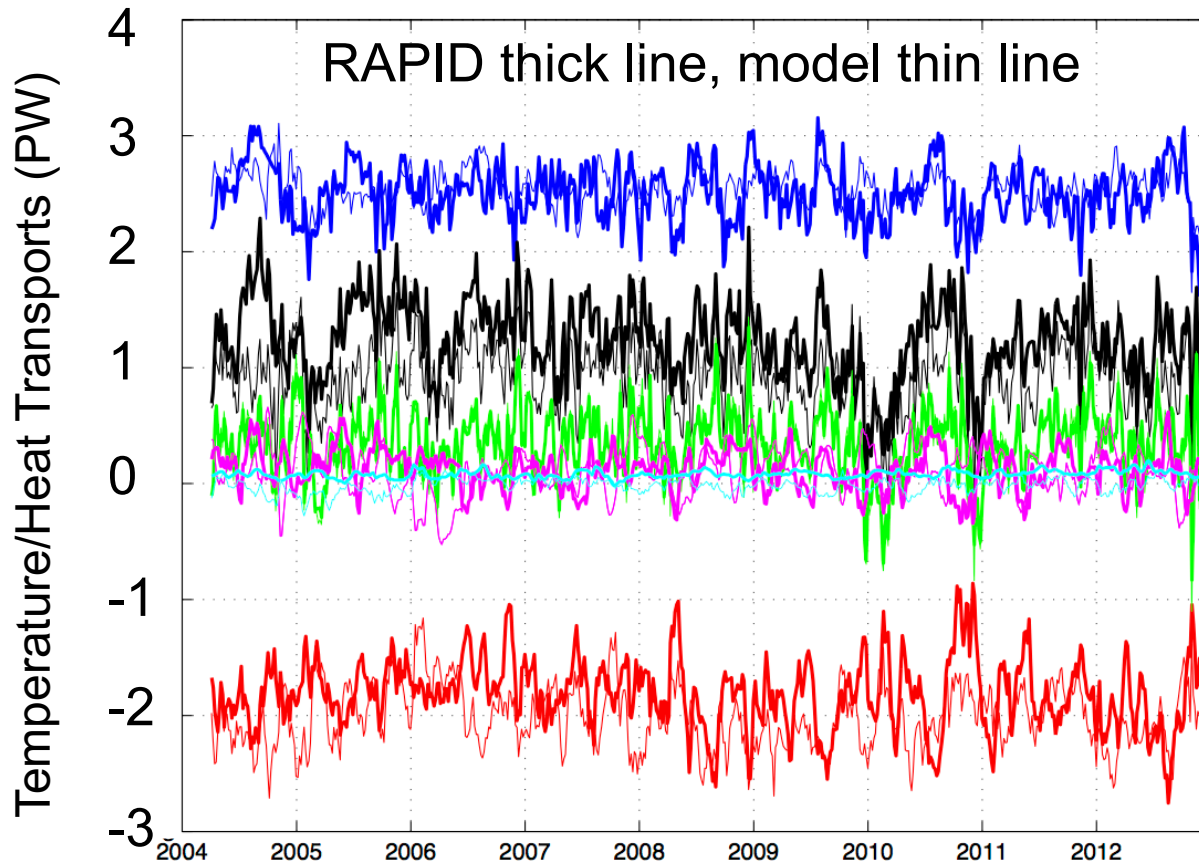
All are 1/12° Ocean N512 Atmosphere

- a) 20 year control run
- b) 100 year control run (RUNNING NOC)
fixed present day CO₂
- c) 100 year “all-forced” run to present day
and then a RCP scenario
1950 to 2050 (RUNNING UK MET
OFFICE ?)

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Temperature/Heat transports at 26.5°N

(Moat et al. 2016, JGR-Oceans)

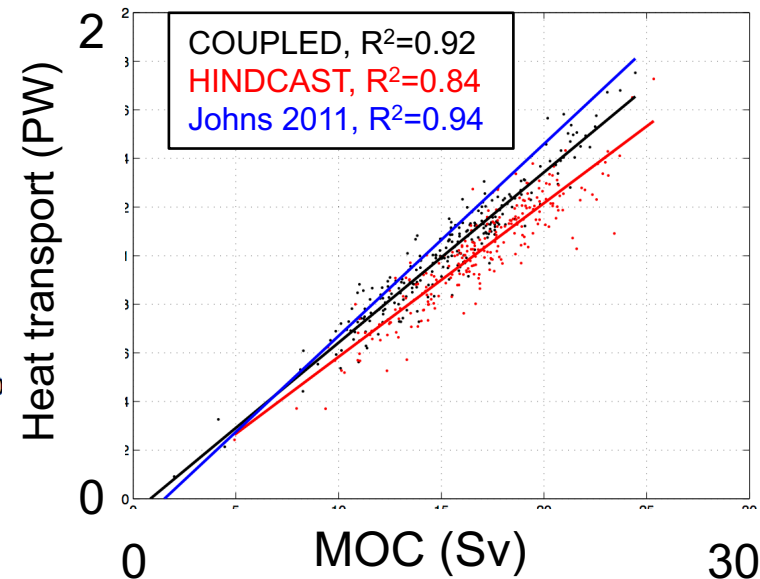
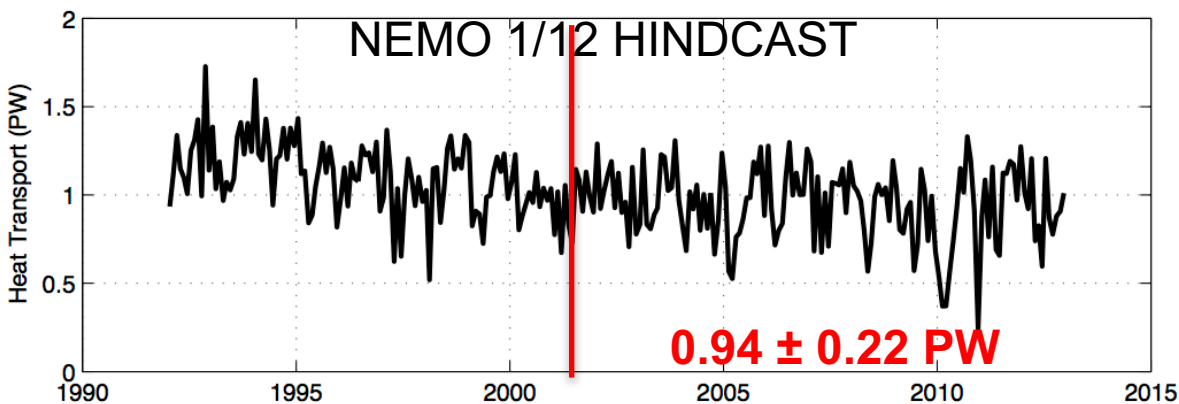
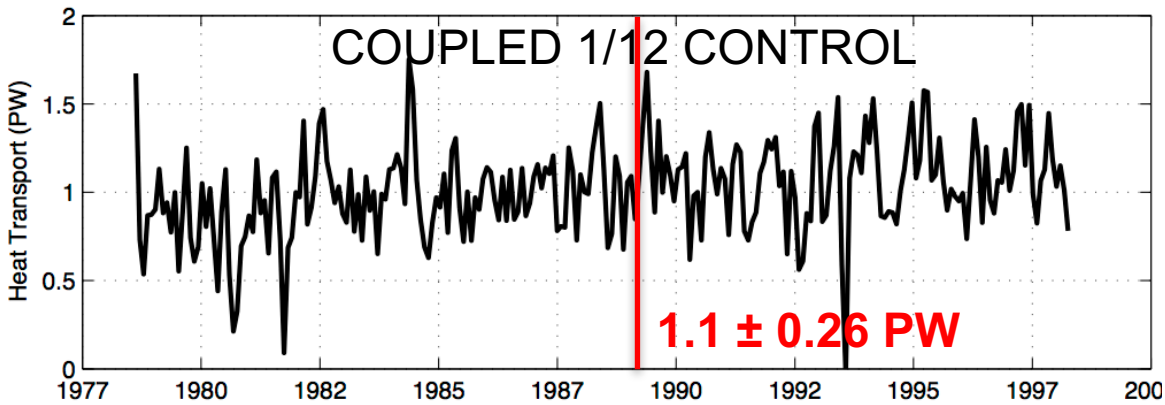


	ORCA083 (PW)	RAPID (PW)
FC	2.54±0.16	2.50±0.25
EKMAN	0.34±0.31	0.35±0.30
Mid-Ocean	-2.02±0.27	-1.81±0.31
WBW	0.12±0.21	0.12±0.18
EDDY	-0.02±0.06	0.08±0.03
Total heat transport	0.93±0.32	1.24±0.36

1/12° NEMO hindcast model overestimates the Southwards Mid-Ocean temperature transport.

Model HT 0.3 PW lower than RAPID, but good agreement in the variability.

Heat transports at 26.5°N



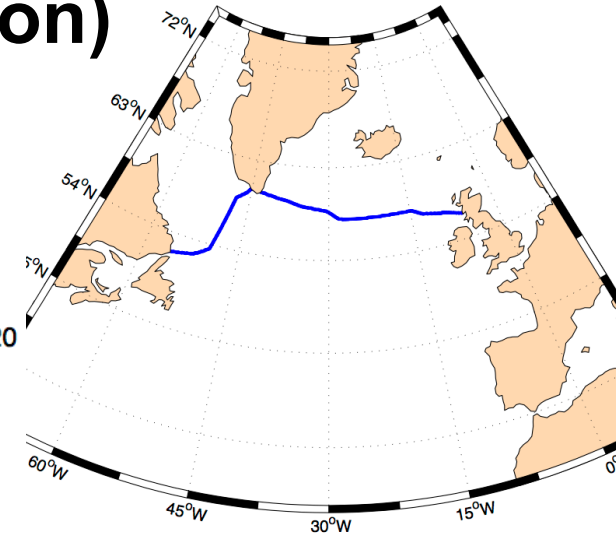
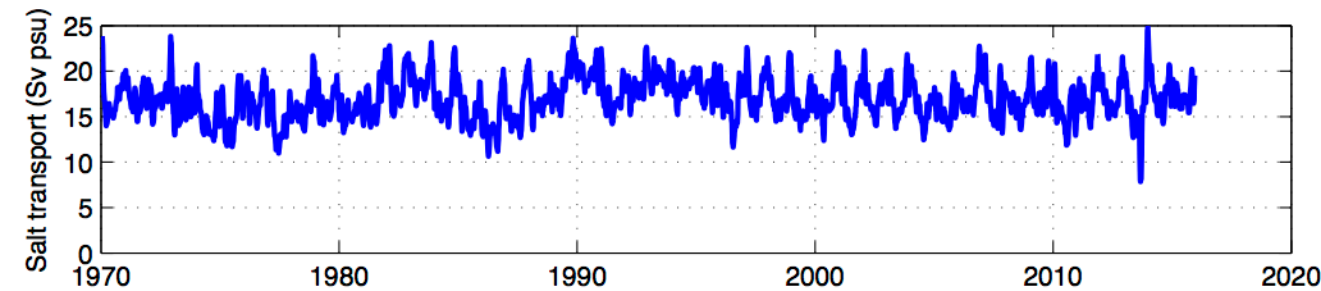
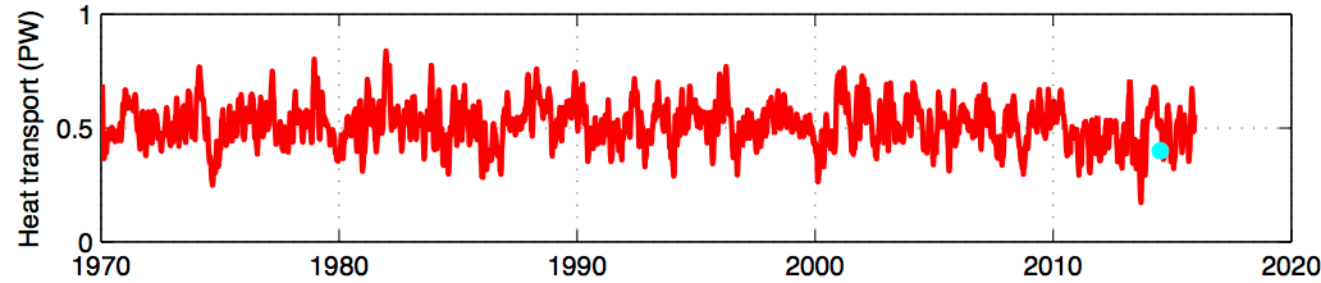
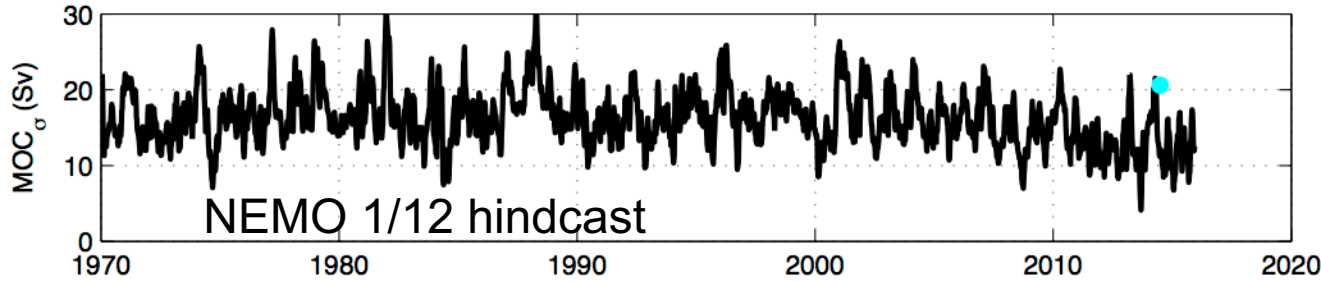
Larger variability in 20year coupled model 1/12 degree

Model info : Hewitt et al. (2016)
Roberts et al. (2016)

Mean over RAPID period = **1.24±0.36 PW**



OSNAP Challenge 2017 (NOC won)



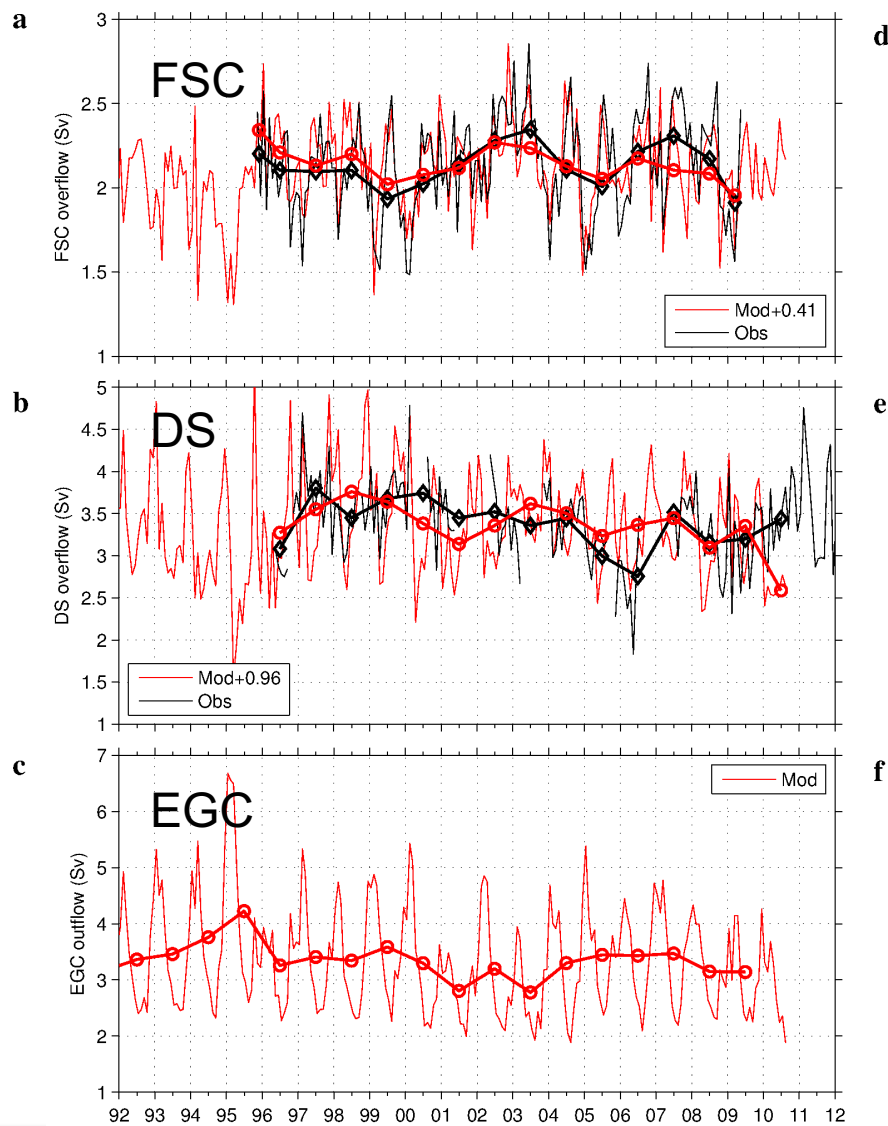
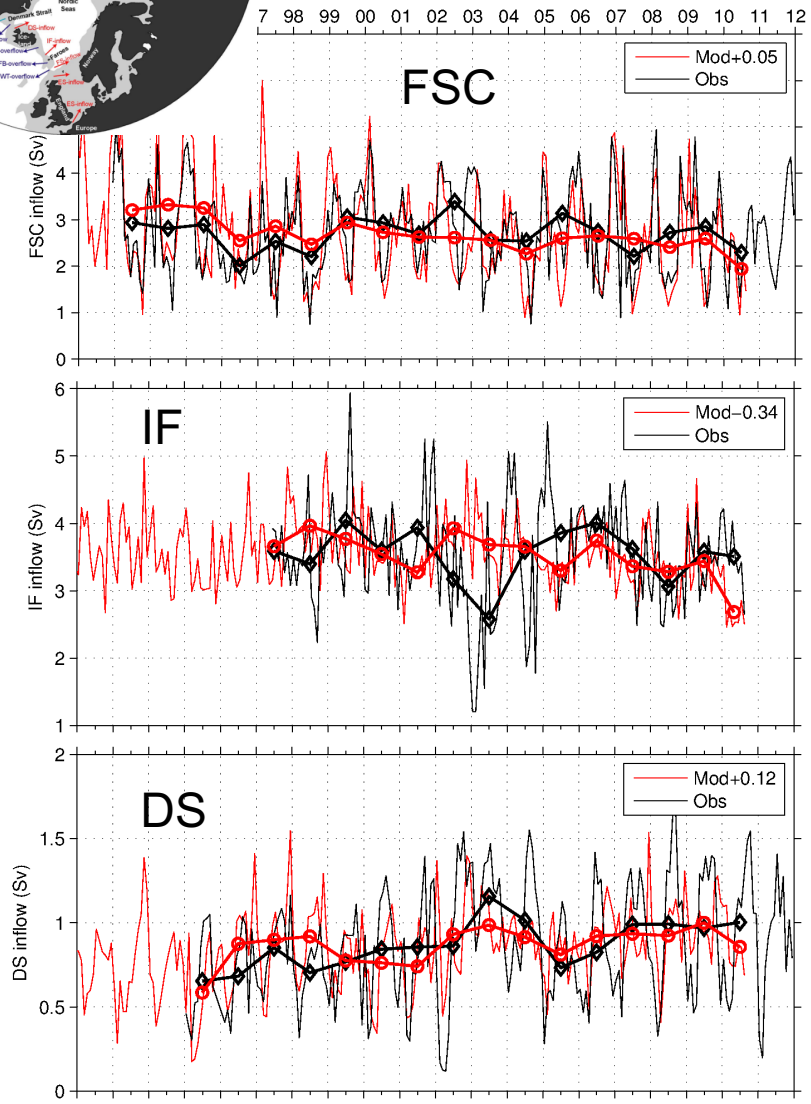
OSNAP time series from the array will be released October 2017.

BLUE ACTION 



Inflow

Overflow/Outflow



26N AMOC time series: April 2004 to Oct 2015 (update to Feb 2017 in October)

http://www.rapid.ac.uk/rapidmoc/rapid_data/datadl.php

Contact: gerard.mccarthy@noc.ac.uk or ben.moat@noc.ac.uk

26N HT time series : April 2004 to March 2014 update to Feb 2017 in October)

http://www.rsmas.miami.edu/users/mocha/mocha_results.htm

Contact: Bill Johns bjohns@rsmas.miami.edu

OSNAP time series : Summer 2014 to Summer 2016 (will be released in the Autumn 2017) <http://www.o-snap.org/>

Contact: Stuart.Cunningham@sams.ac.uk

OVIDE : every two years since 2002. (2018 and 2020 cruises in planning stage)

<https://cchdo.ucsd.edu/>

Contact: Marie-Noelle Houssais mnh@locean-ipsl.upmc.fr

Faroe Shetland Channel Transport Mooring Array (1993 to present)

Barbara Berx B.Berx@MARLAB.AC.UK; Karin Margretha H. Larsen

Bering Strait : 1990 to present. <http://psc.apl.washington.edu/HLD/Bstrait/Data/woodgate@apl.washington.edu>



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