Rapid Climate Change (RAPID)

Meric Srokosz
NOC

RAPID 2001-2008

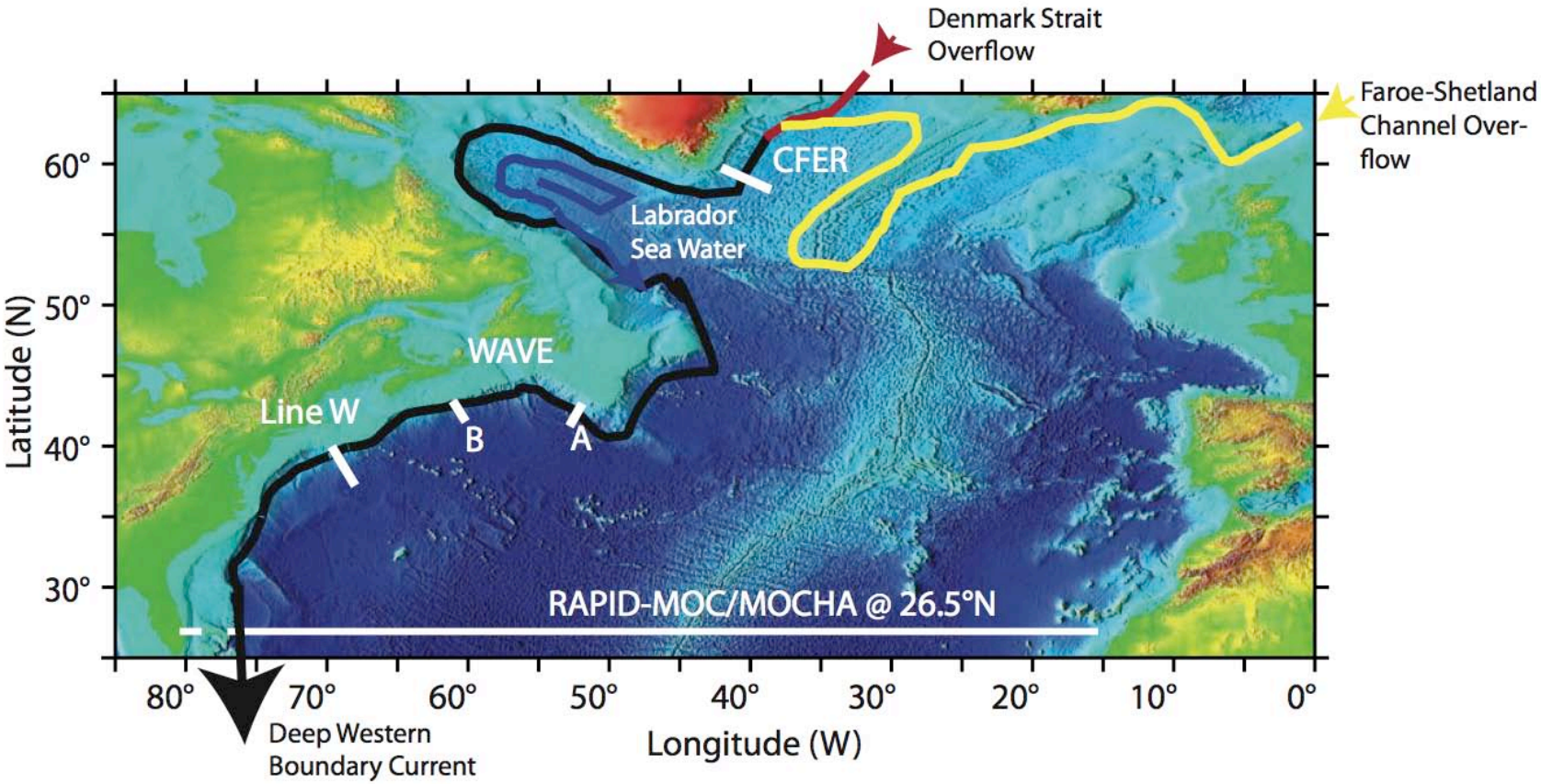
Involved:

- Observations (2004-2008)
- Paleo data
- Modelling

RAPID-WATCH 2008-2014

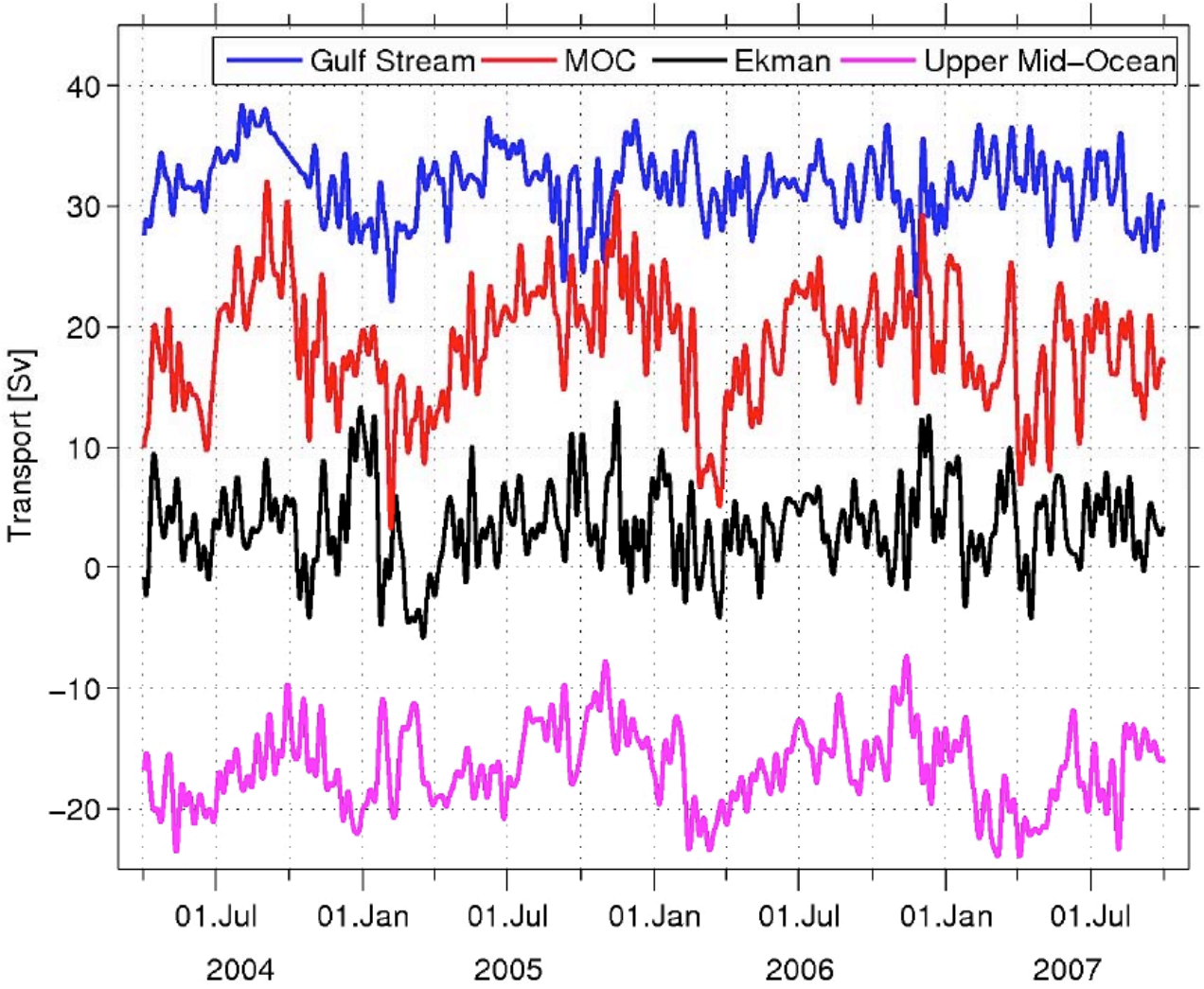
- Continues MOC observations - a decade
- Associated modelling - decadal prediction

Observations



NATURAL
ENVIRONMENT
RESEARCH COUNCIL

26.5˚N MOC (3.5 years)



Mean±SD [Sv]

31.7±2.8

18.5±4.9

3.5±3.4

-16.6±3.2

NATURAL ENVIRONMENT RESEARCH COUNCIL

High Frequency Variability of the Atlantic MOC - RAPID THCMIP project

obs (5 day avg 4/2005-4/2006) 19.5±5.1

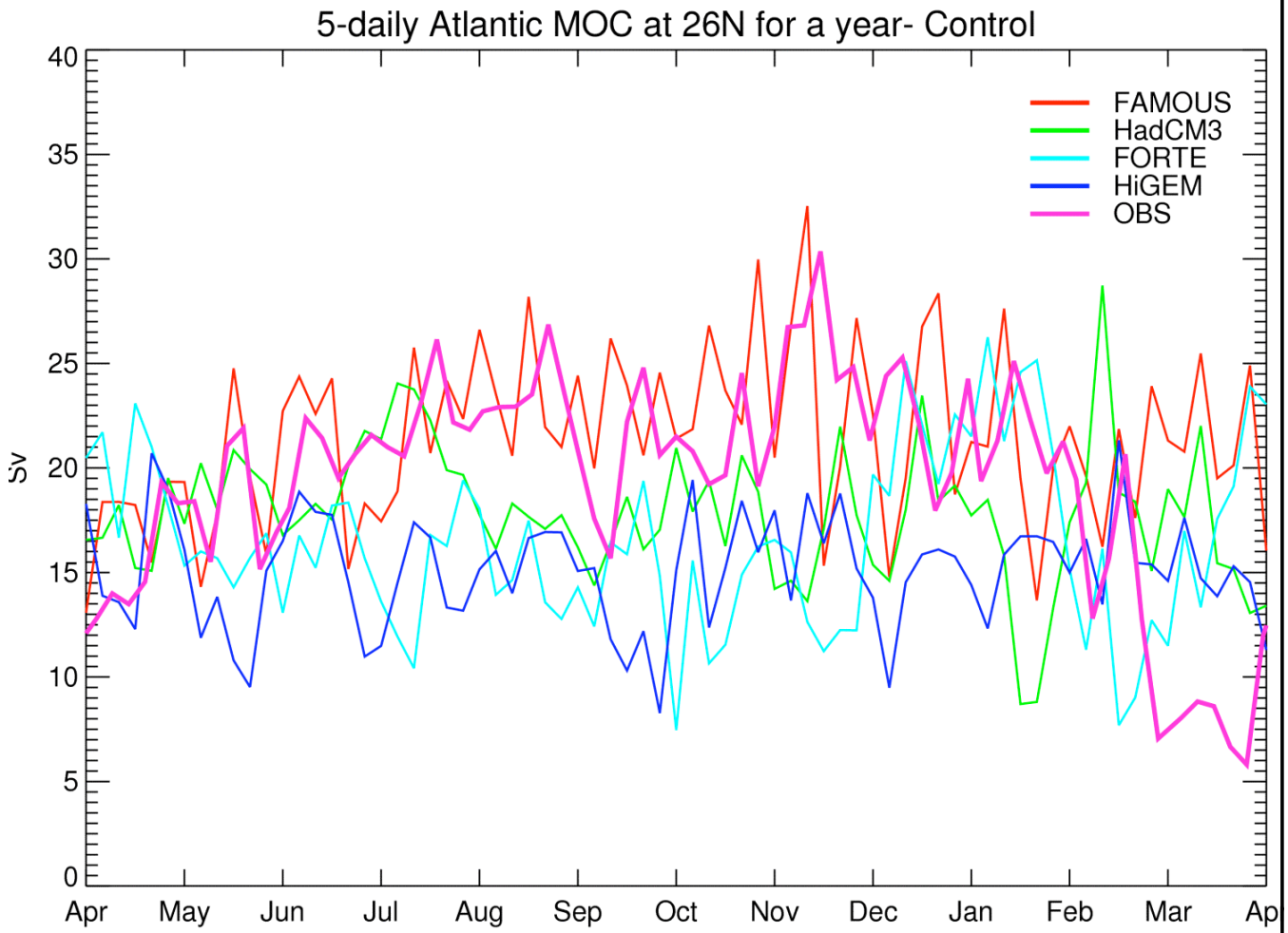
FAMOUS 21.4±4.1

HadCM3 16.3±3.1

FORTE 17.3±4.6

HiGEM 15.5±4.0

Sarojini, Gregory, Tailleux + many others

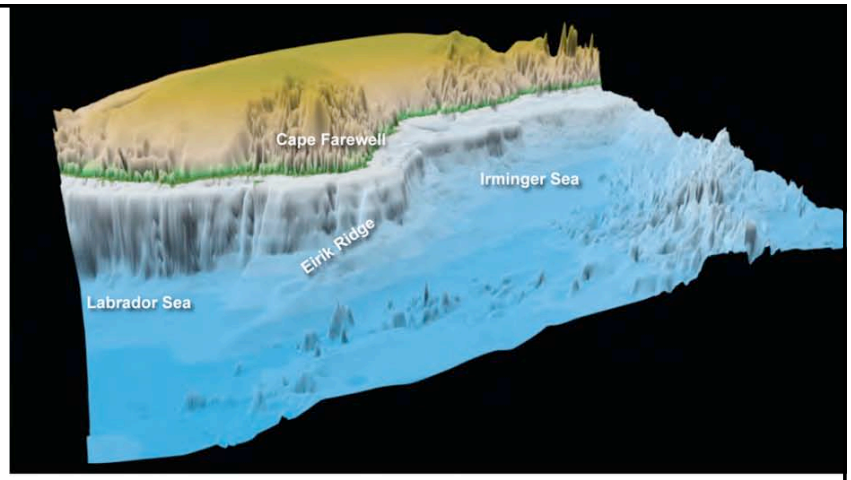


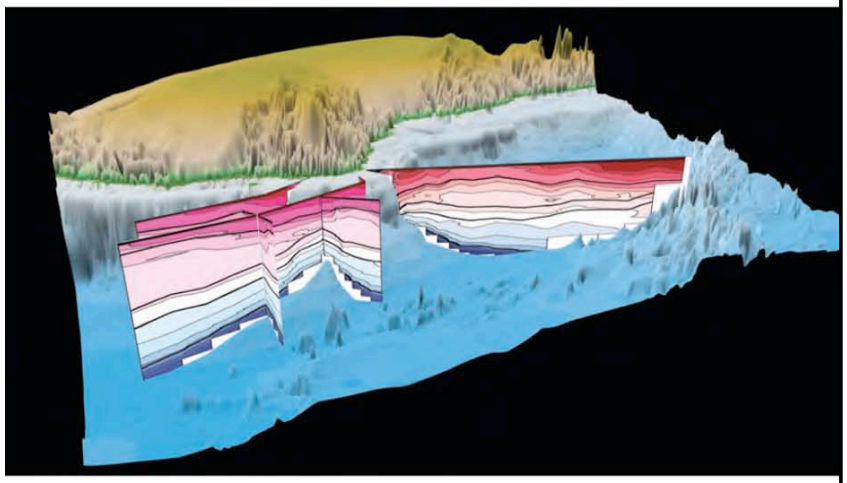
Circulation around Cape Farewell

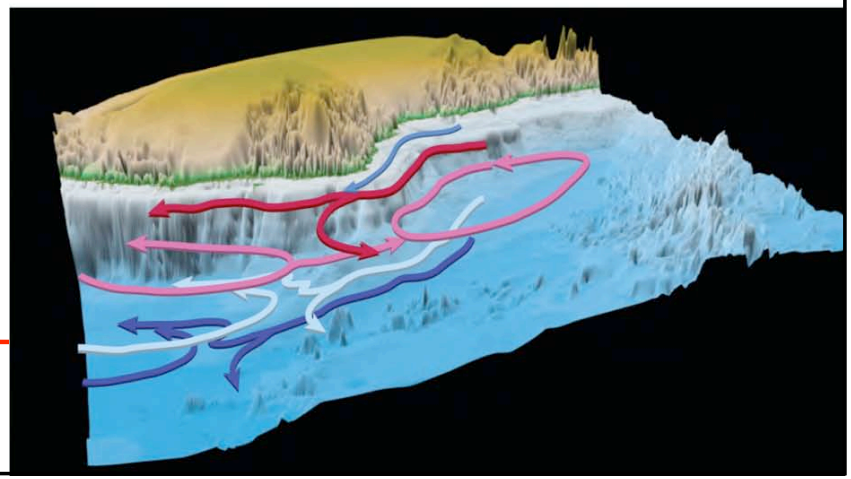
RRS *Discovery* cruise 298, 2005

(1) EGC (red) & EGCC (mid-blue): partial retroflection;
(2) Net LSW flow (pink) into Irminger Basin;
(3) Loss of ISOW (light blue) and DSOW (dark blue) into interior
(4) Holocene sediments in centre of “lee eddy” behind Eirik Ridge

Holliday, Bacon, Allen & McDonagh 2009, JPO, in press





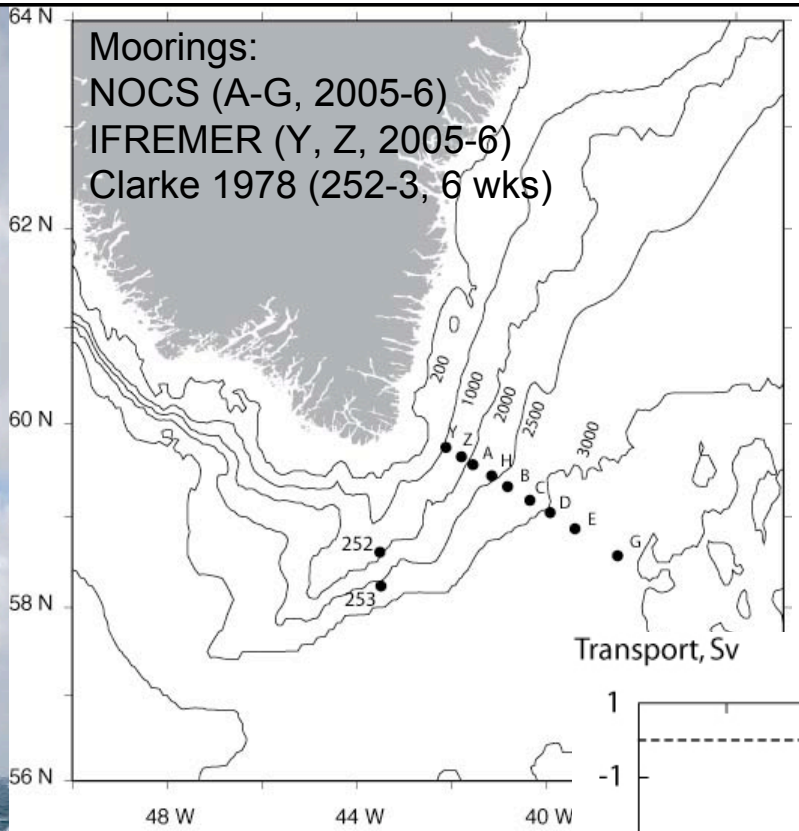


NATURAL ENVIRONMENT RESEARCH COUNCIL

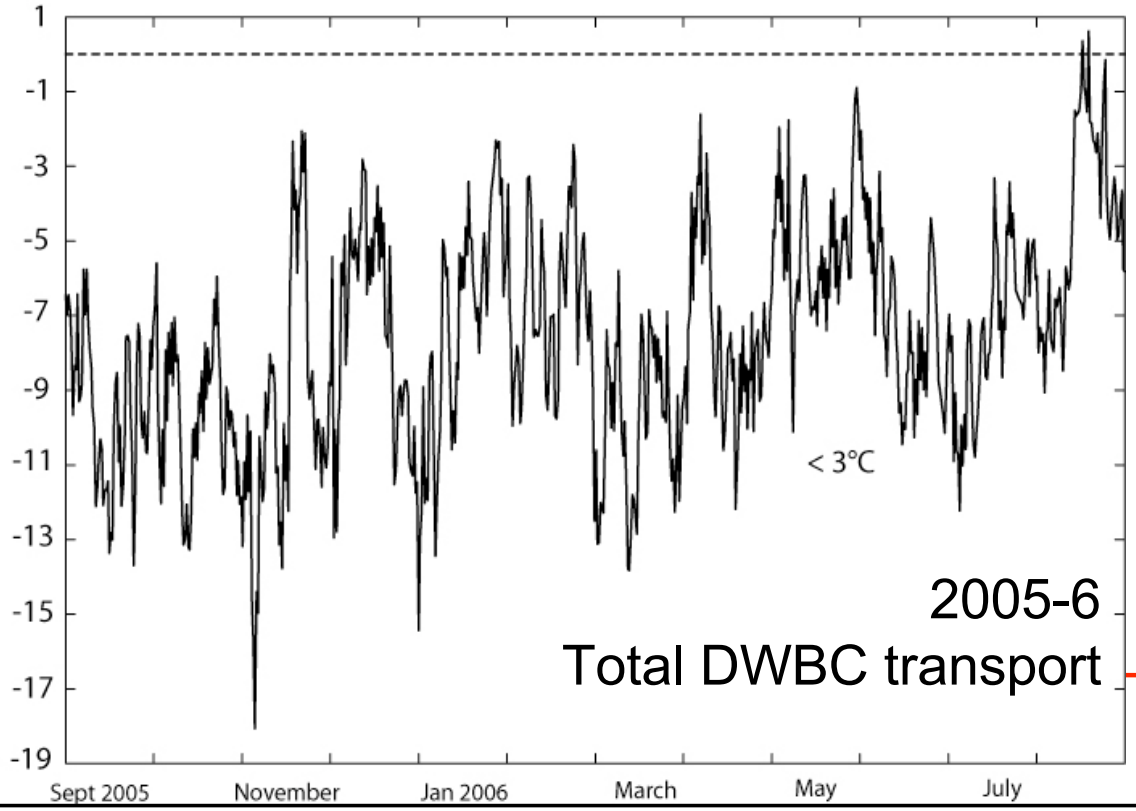
DWBC transport east of Cape Farewell

(1) Mean (θ<3˚C): 7.1 Sv
(2) Mean (σ_θ>27.8 kg/m^3): 8.6 Sv
(3) Cf. Clarke, 13 Sv

Bacon and Saunders 2009, JPO, in revision



Subset of moorings re-deployed and recovered (2006-2008)



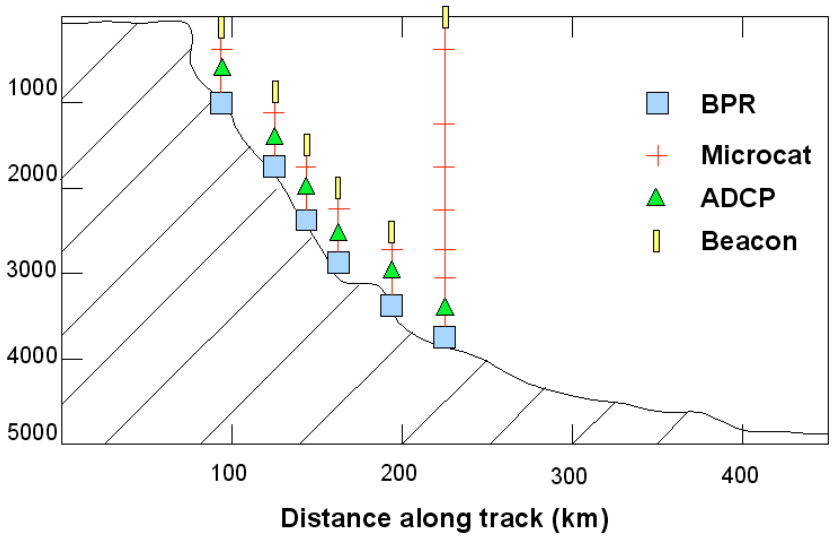
NATURAL ENVIRONMENT RESEARCH COUNCIL

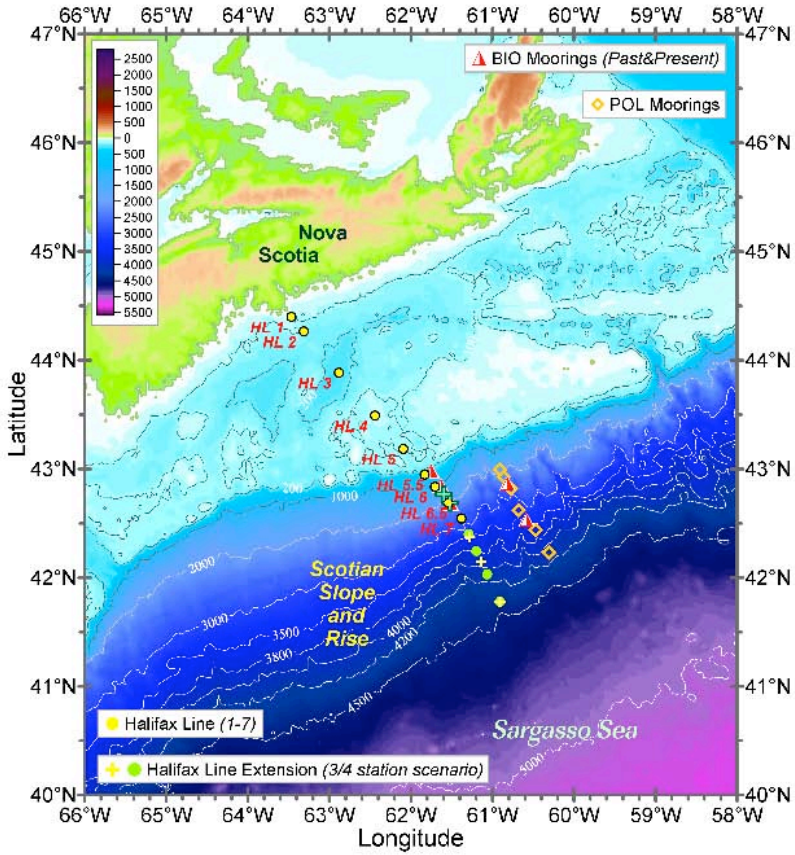
WAVE array

Variability of the meridional overturning circulation to be determined from western boundary bottom pressure (Bingham and Hughes, 2008)

First recovery of re-designed Halifax array in Oct 2009

Array schematic for new Halifax line

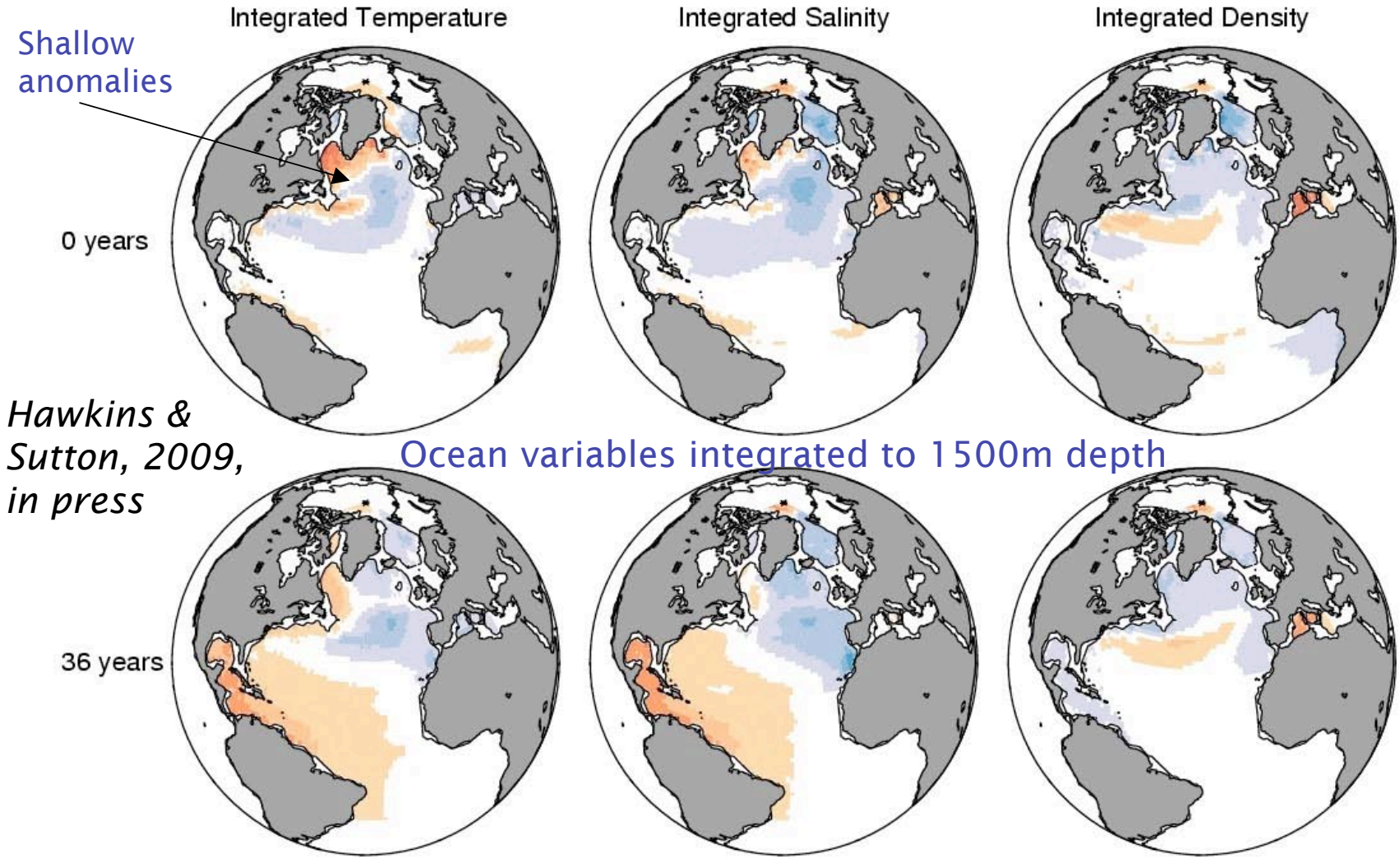




Bedford Institute of Oceanography

NATURAL ENVIRONMENT RESEARCH COUNCIL

Growth of optimal perturbations for the Atlantic Ocean in HadCM3



Hawkins & Sutton, 2009, in press

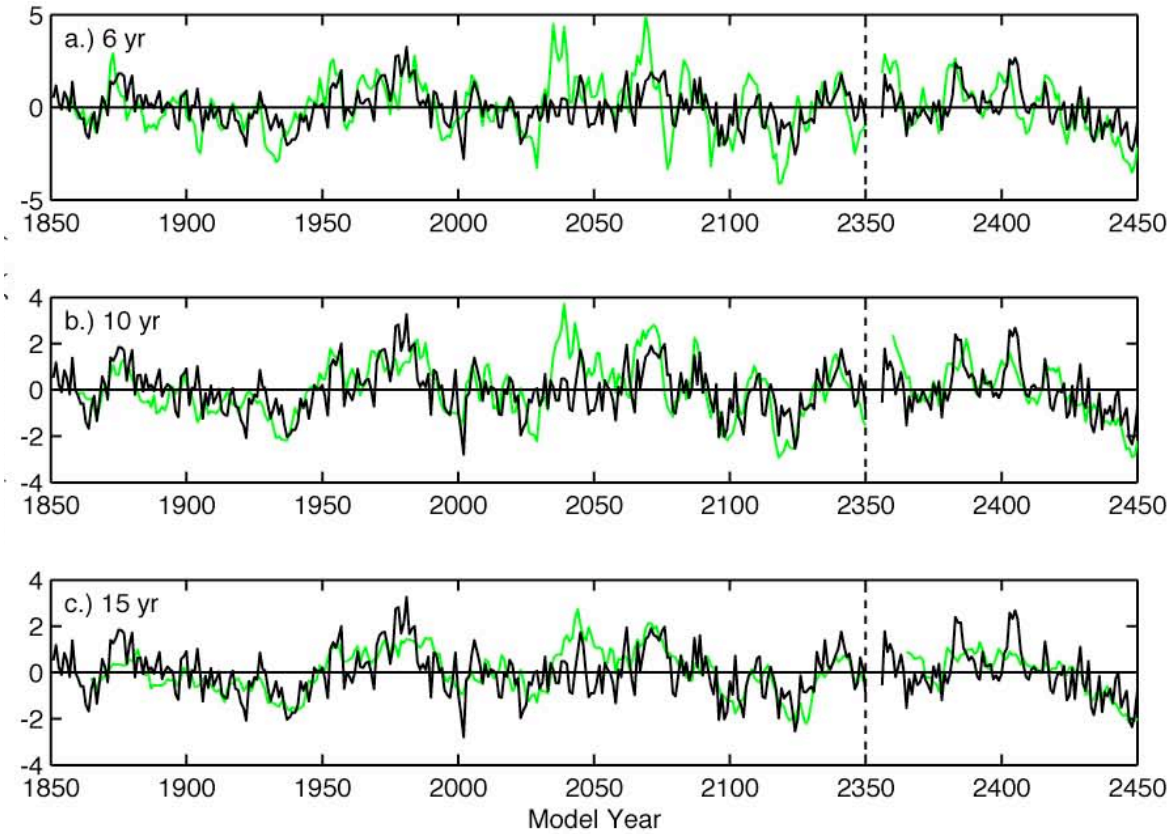
NATURAL ENVIRONMENT RESEARCH COUNCIL

Estimating the Atlantic MOC from the Surface Forced Overturning Circulation (SFOC)

Surface forced overturning circulation estimates of MOC at 48˚N in good agreement with actual MOC in HadCM3

Marsh 2000 Recent variability of the North Atlantic thermohaline circulation inferred from surface heat and freshwater fluxes J Clim ***13***

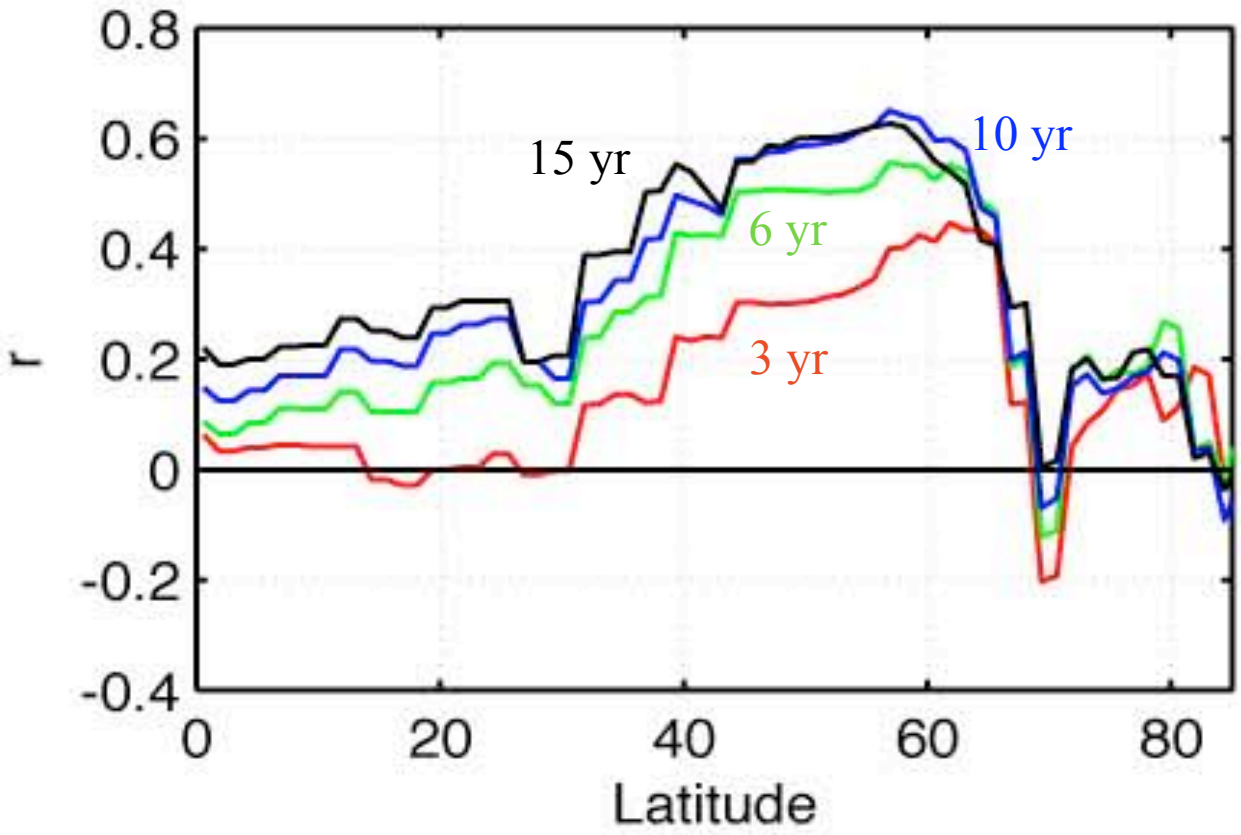
- **Variability too strong at 6 yr timescales.**
- **Best agreement found for 10 and 15 yr averaging intervals.**



NATURAL ENVIRONMENT RESEARCH COUNCIL

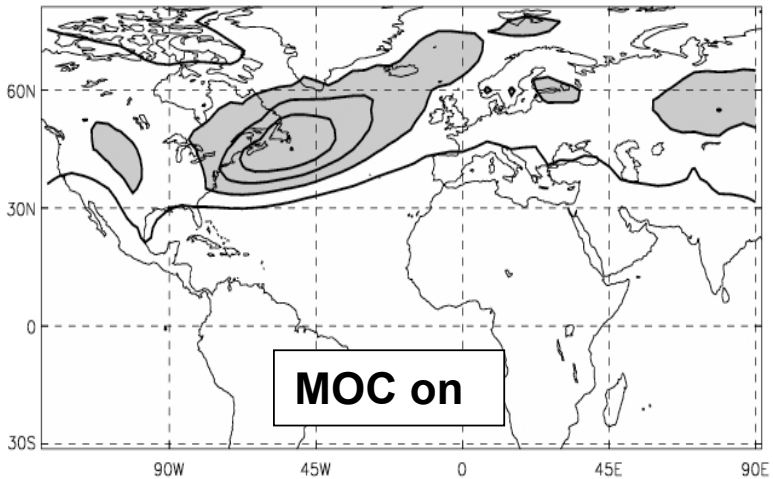
SFOC & MOC at other latitudes

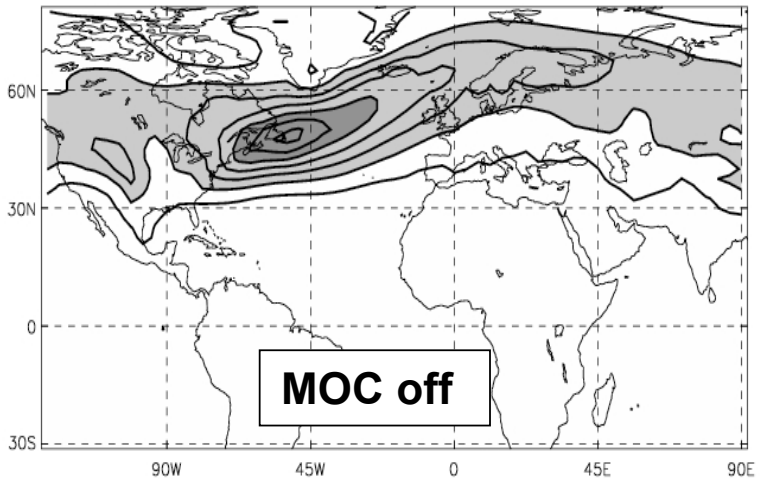
Correlation coefficient (r) between SFOC and MOC annual anomalies determined across range of latitudes for 400 year model output dataset



Grist et al 2009 J Clim (accepted), Josey et al 2009 JGR (submitted)

Storm tracks and the MOC





HadCM3, pre-industrial CO_2: Control run & "Continual hosing" to shut down MOC.

Note deeper penetration of storm track into Europe and intensified storms when MOC is off.

Brayshaw

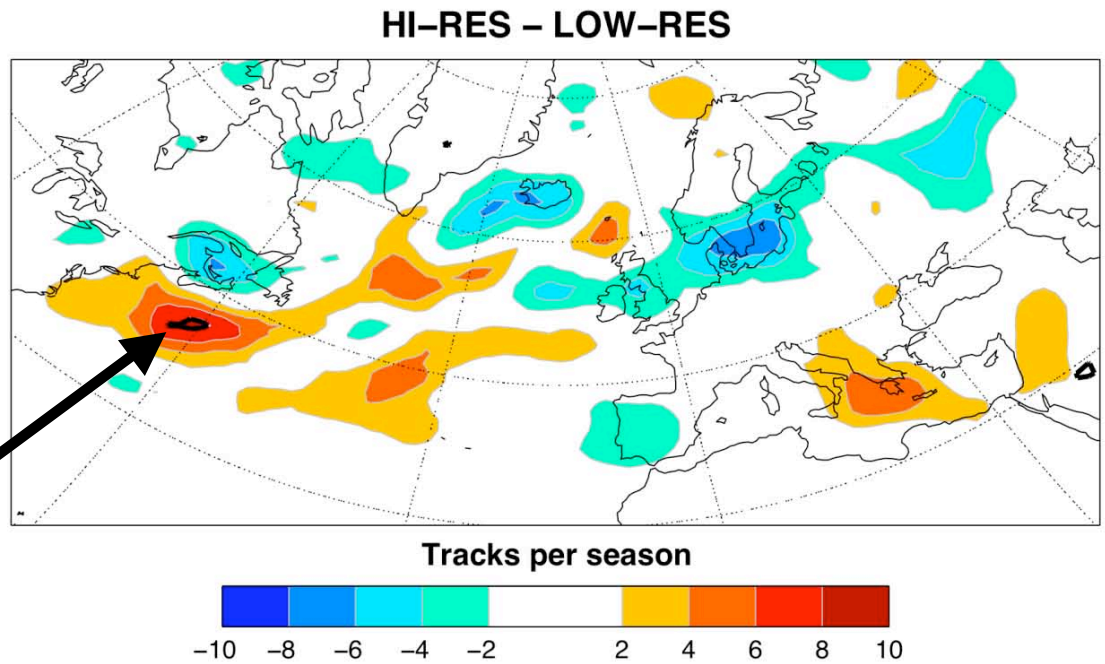
NATURAL ENVIRONMENT RESEARCH COUNCIL

Storm tracks

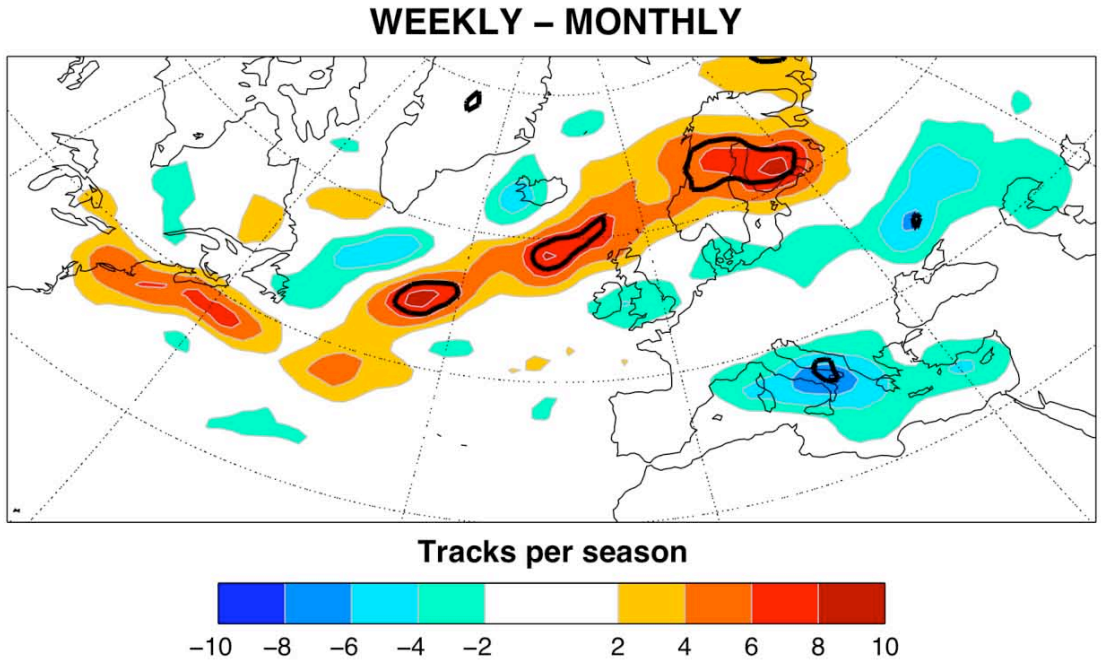
Climate models do not resolve strong SST gradients such as the Gulf Stream. This was investigated using a high-resolution Regional Atmosphere Model.

Increasing the SST resolution shifts the storm track off the coast of North America.

The storm track is also sensitive to the temporal resolution of SST data – here the difference between using monthly and weekly SSTs.

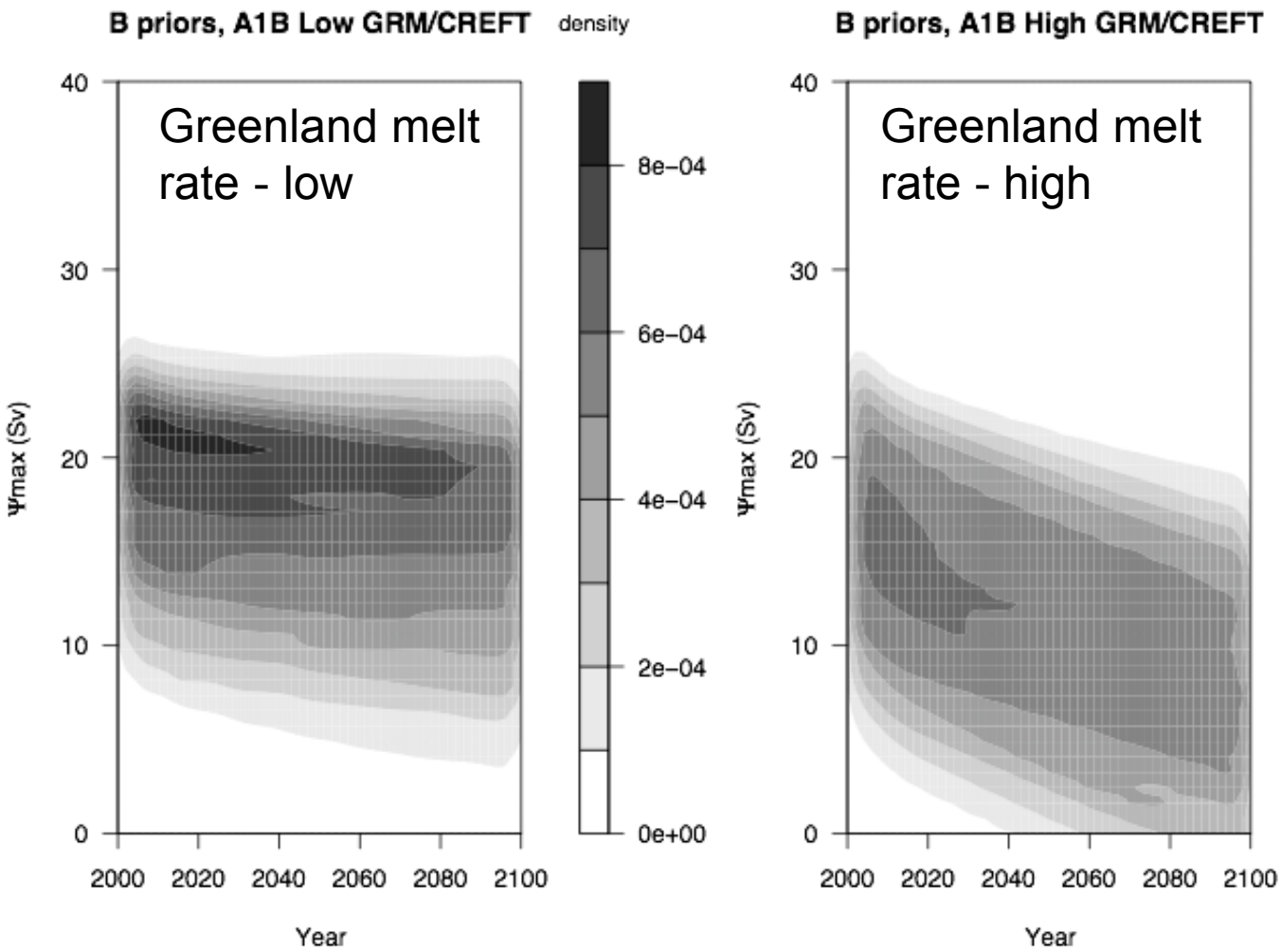


Woollings et al 2009 Climate Dynamics, in press



NATURAL ENVIRONMENT RESEARCH COUNCIL

Estimating collapse - emulating GENIE



10 Sv seems to be tipping point in GENIE, below 10Sv collapse appears inevitable. Probability of crossing this threshold is 10% for low melting rate and 30% for the high…

Challenor

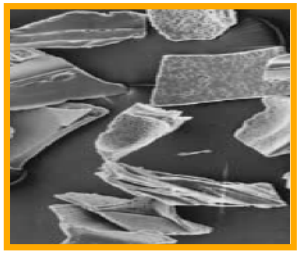
NATURAL ENVIRONMENT RESEARCH COUNCIL

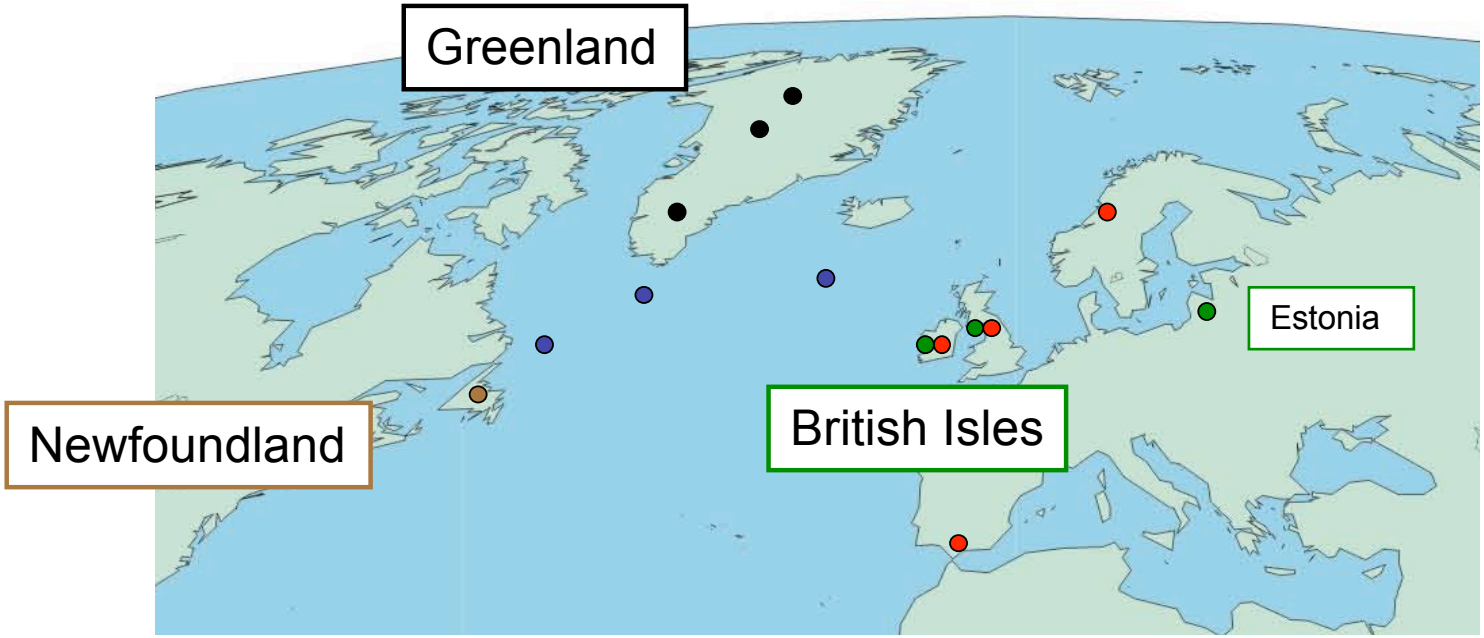
RAPID Paleoclimate records

Peat bogs | Ocean cores | Ice cores | Lake cores | Speleothems | Volcanic ash



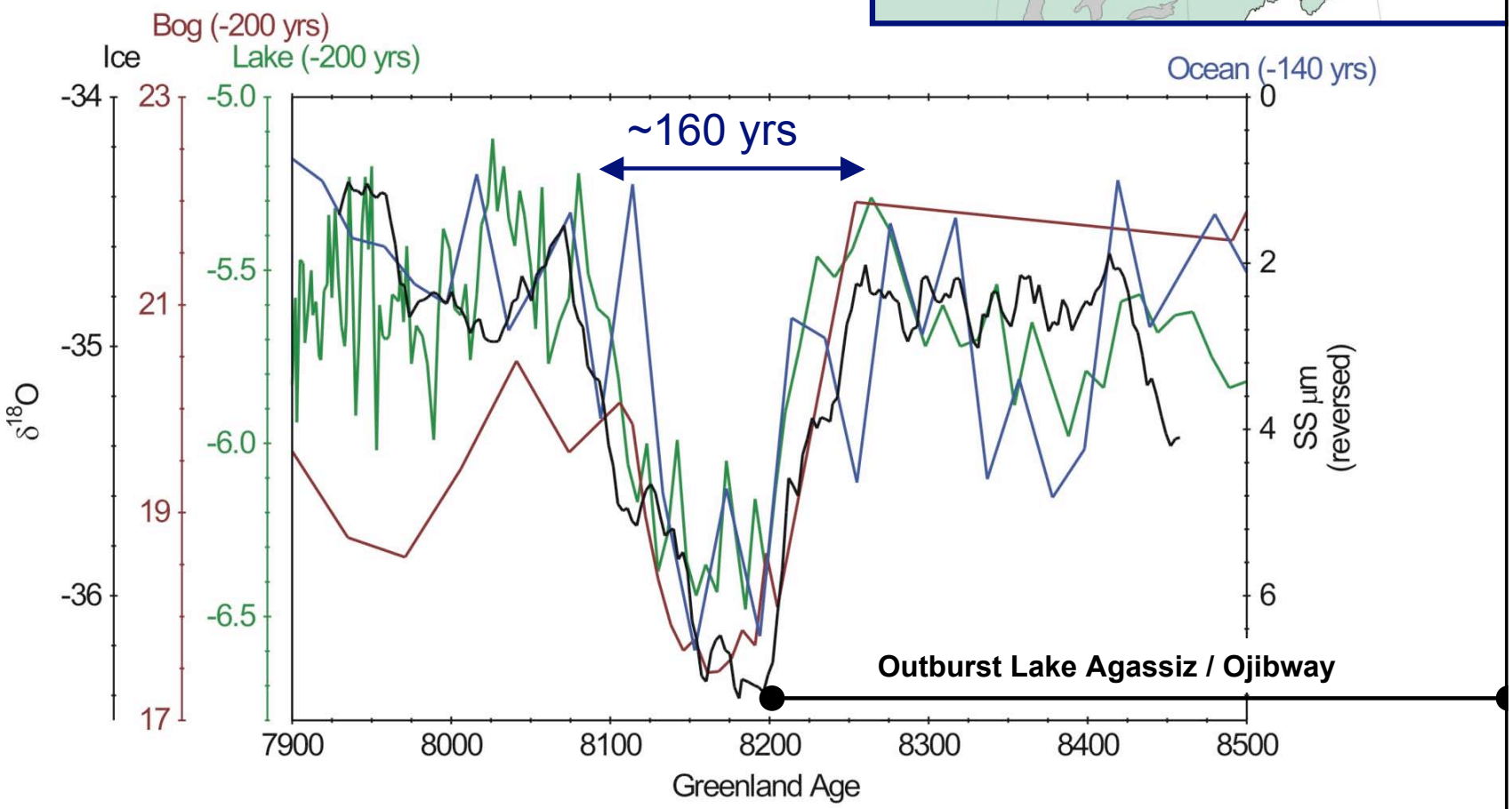






NATURAL ENVIRONMENT RESEARCH COUNCIL

8.2kyr event



NATURAL ENVIRONMENT RESEARCH COUNCIL

RAPID-WATCH aims

- Obtain a decade of MOC observations 2004-2014
- To exploit these data (with other data) to determine and interpret recent changes in the Atlantic MOC, assess the risk of rapid climate change, and investigate the potential for (decadal) predictions of the MOC and its impacts on climate
  - Working closely with Hadley Centre
  - 4 projects funded (currently)
- Determine whether observational system should become operational beyond 2014
  - International review in fall 2011

Questions?