Rapid Climate Change
(RAPID)
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NOC
RAPID 2001-2008

Involved:
- Paleo data
- Modelling

RAPID-WATCH 2008-2014
- Continues MOC observations - a decade
- Associated modelling - decadal prediction
Observations
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
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*
DWBC transport east of Cape Farewell

(1) Mean ($\theta$<3°C): 7.1 Sv
(2) Mean ($\sigma_\theta$>27.8 kg/m³): 8.6 Sv
(3) Cf. Clarke, 13 Sv

Bacon and Saunders 2009, JPO, in revision

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

Total DWBC transport
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
Growth of optimal perturbations for the Atlantic Ocean in HadCM3

Shallow anomalies

Integrated Temperature  Integrated Salinity  Integrated Density

0 years

Hawkins & Sutton, 2009, in press

Ocean variables integrated to 1500m depth

36 years
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.
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
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.
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
RAPID Paleoclimate records

Peat bogs  Ocean cores  Ice cores  Lake cores  Speleothems  Volcanic ash

Greenland

Newfoundland

British Isles

Estonia
8.2 kyr event

~160 yrs

Outburst Lake Agassiz / Ojibway
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?