

# Rapid Climate Change (RAPID)

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- NERC thematic programme
- RAPID personnel
  - Dr. Meric Srokosz, Science Coordinator
  - Dr. Christine Gommenginger, Assistant Sci. Coordinator
  - Dr. Catrin Yeomans, Programme Coordinator
  - Dr. Phil Newton, Superintending Officer
- Web page
  - <http://rapid.nerc.ac.uk/>
  - N.b. copies of RAPID logo will be made available



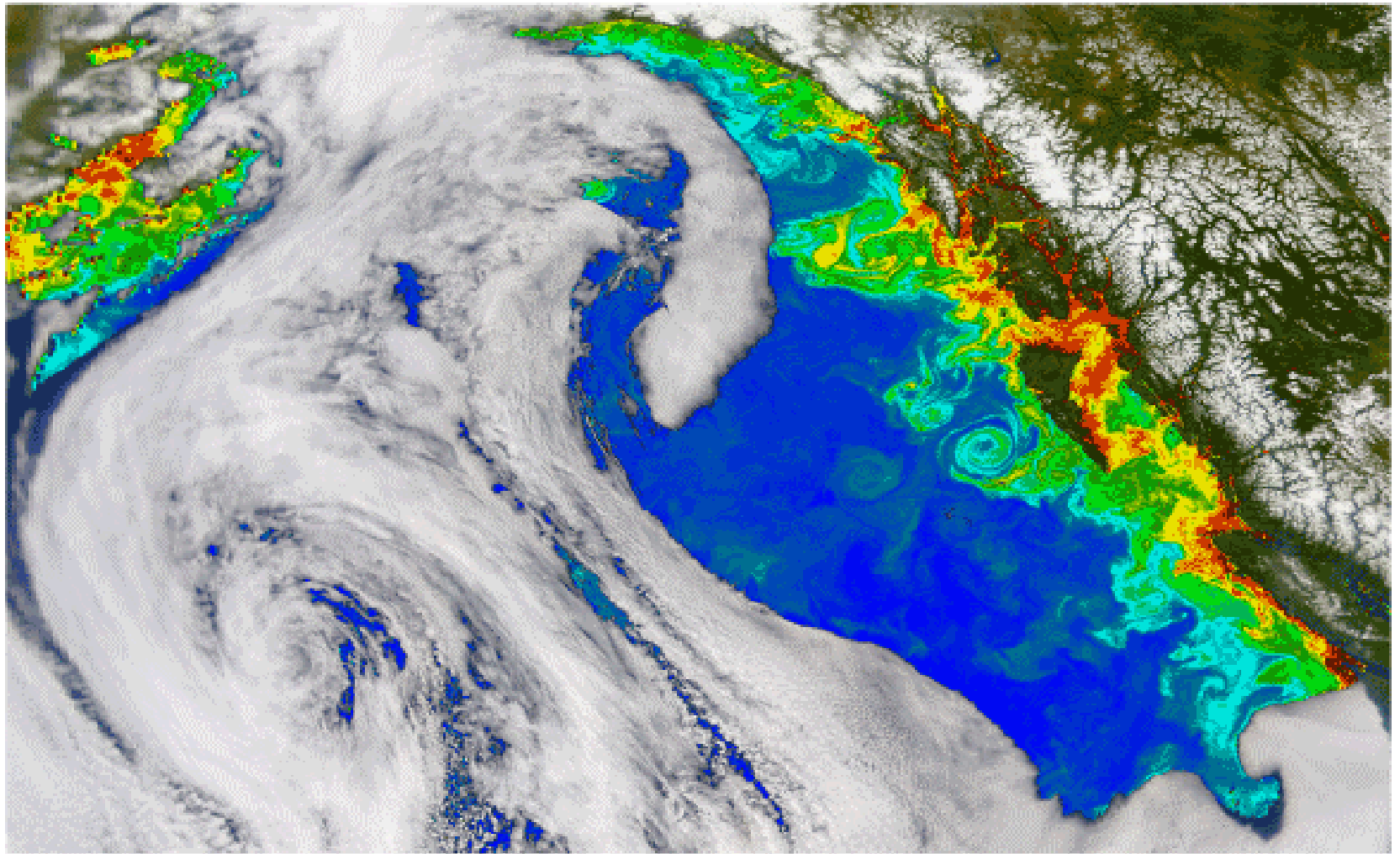
## RAPID - aims

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- RAPID aims to investigate and understand the causes of rapid climate change, with a main (but not exclusive) focus on the role of the Atlantic Ocean's thermohaline circulation (THC)
- NERC has awarded £20M over 6 years
- Basic elements of the programme are observations - present day and palaeo - and modelling
  - Focus in terms of ocean observations is the N. Atlantic
  - Linking the elements together is considered crucial



# A question of scales and interactions



## Background to RAPID (political)

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- UK-Norway prime ministerial discussions
- Awareness that slowdown or shutdown of the N. Atlantic THC has potentially large impacts on European climate, and possibly greater impacts socio-economically
- Awareness that change in the N. Atlantic THC is possible due to global warming



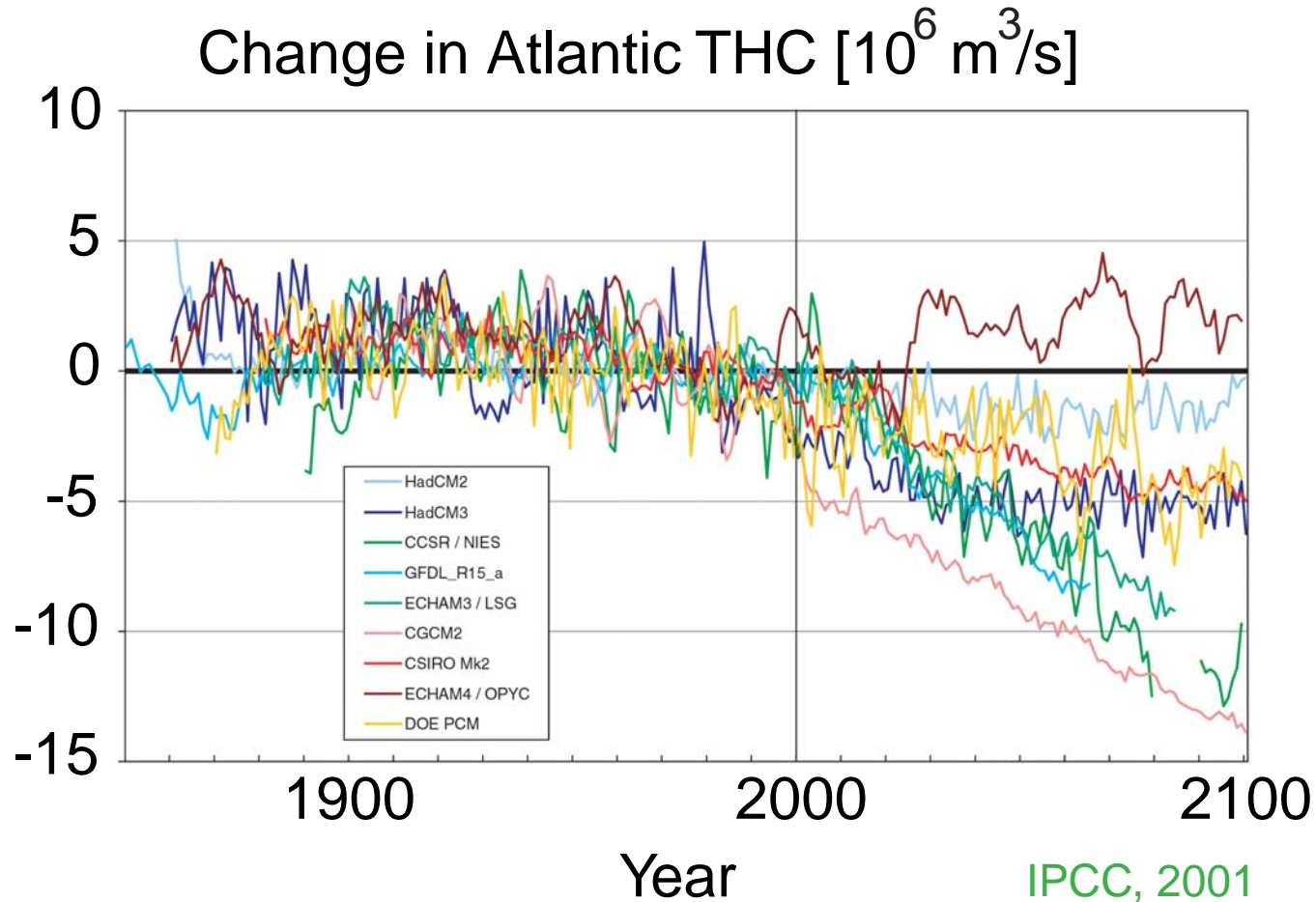
## Background to RAPID (scientific)

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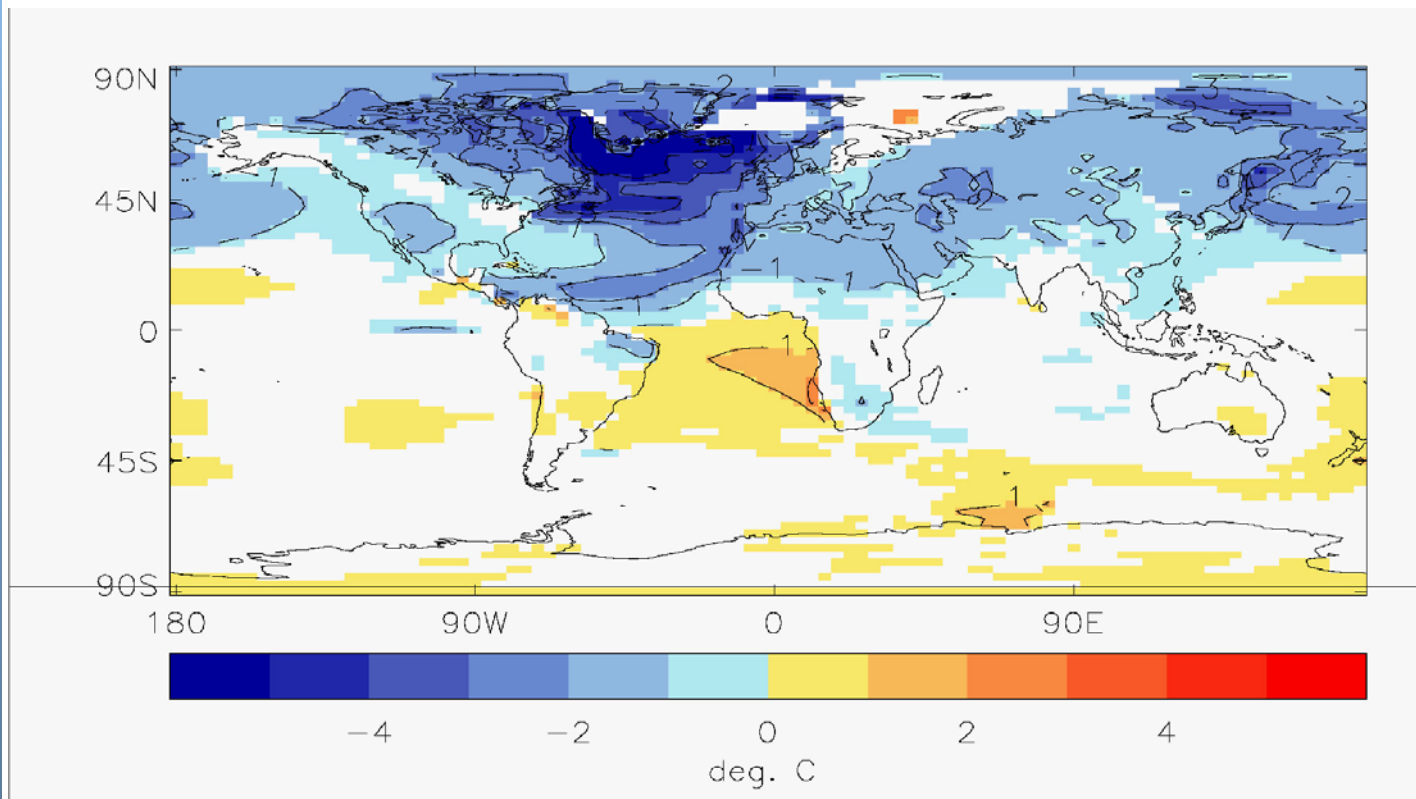
- There is palaeo evidence of past rapid changes in the N. Atlantic THC
- Observations suggests that the N. Atlantic THC may be changing (e.g. deep overflows)
  - but too few observations to be sure
- Model studies of global warming scenarios show range of results from no change to complete shutdown of the N. Atlantic THC



# Model THC changes due to global warming



# Air temperature change with no-THC (HadCM3)



**Surface air temperature change 20-30 years after THC shutdown by large freshwater input. THC recovers after 120 years (Vellinga & Wood, 2002).**



# RAPID Steering Committee

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Dr Lloyd Keigwin (Chair)	Woods Hole Oceanographic Institution (USA)
Professor Keith Briffa	University of East Anglia
Mr Peter Challenor	Southampton Oceanography Centre
Professor Bob Dickson	CEFAS (plus <b>ASOF</b> )
Professor Peter Haugan	University of Bergen (Norway - <b>NOClim</b> )
Dr Mike Hulme	Tyndall Centre
Professor Peter Lemke	Alfred Wegener Institute (Germany)
Professor John Lowe	Royal Holloway University of London
Professor Jochem Marotzke	Southampton Oceanography Centre
Professor Nick McCave	University of Cambridge
Dr Maria Noguera	DEFRA
Professor Julia Slingo	University of Reading
Dr Simon Tett	Hadley Centre
Dr AW (Sandy) Tudhope	University of Edinburgh
Dr Bill Turrell	Marine Lab., SERAD
Professor Paul Valdes	University of Reading
Professor Andy Watson	University of East Anglia
Dr Eric Wolff	British Antarctic Survey
Dr Richard Wood	Hadley Centre



# RAPID Objectives (1-4)

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- To establish a pre-operational prototype system to continuously observe the strength and structure of the Atlantic meridional overturning circulation (MOC).
- To support long-term direct observations of water, heat, salt, and ice transports at critical locations in the northern North Atlantic, to quantify the atmospheric and other (e.g. river run-off, ice sheet discharge) forcing of these transports, and to perform process studies of ocean mixing at northern high latitudes.
- To construct well-calibrated and time-resolved palaeo data records of past climate change, including error estimates, with a particular emphasis on the quantification of the timing and magnitude of rapid change at annual to centennial time-scales.
- To develop and use high-resolution physical models to synthesise observational data.



## RAPID Objectives (5-8)

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- To apply a hierarchy of modelling approaches to understand the processes that connect changes in ocean convection and its atmospheric forcing to the large-scale transports relevant to the modulation of climate.
- To understand, using model experimentation and data (palaeo and present day), the atmosphere's response to large changes in Atlantic northward heat transport, in particular changes in storm tracks, storm frequency, storm strengths, and energy and moisture transports.
- To use both instrumental and palaeo data for the quantitative testing of models' abilities to reproduce climate variability and rapid changes on annual to centennial time-scales. To explore the extent to which these data can provide direct information about the THC and other possible rapid changes in the climate system and their impact.
- To quantify the probability and magnitude of potential future rapid climate change, and the uncertainties in these estimates.



# RAPID timetable

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- 2 AOs Jan. 2002 (MOC & “science”)
- Outline bids assessed April 2002
  - 99 science => 43 to full bid, 5 MOC
- Full bids July 2002 => referees
  - for MOC joint refereeing of proposals with NSF (USA)
- End of Nov. 2002 - Steering Committee decisions
  - ~ £6-7M for science, ~£5m for MOC monitoring
  - 39 science => 17 funded + 1 pending
  - 5 MOC => 3 funded + 1 pending ( + 3 NSF funded)
- Small Business Research Initiative (SBRI)
  - £0.5M to spend, 5 full proposals



# MOC - NERC and NSF funded

<i>Monitoring the MOC (science objective 1)</i>	
Hughes C (POL)	<i>A monitoring array along the western margin of the Atlantic</i>
Marotzke J (SOC)	<i>Monitoring the Atlantic Meridional Overturning Circulation at 26.5°N</i>
Watson A (UEA)	<i>Time series of transient tracers in North Atlantic deep waters</i>
<i>Complementary NSF funded studies</i>	
Johns (U. of Miami)	<i>An Observing System for Meridional Heat Transport Variability in the Subtropical North Atlantic</i>
Rosby (U. of Rhode Island)	<i>The Oleander Project: Sustained Observation of Ocean Currents and Transports in the Gulf Stream and Adjacent Waters from New York to Bermuda</i>
Toole (WHOI)	<i>Investigating the Characteristics and Consequences of Interannual Variations in the Northwest Atlantic's Deep Western Boundary Current</i>
<i>Pending</i>	
Cromwell D. (SOC)	<i>Measuring the meridional overturning circulation from space: a feasibility study</i>



## Studies addressing RAPID objectives 2 to 8

Bacon S (SOC)	<i>Cape Farewell and Eirik Ridge: Interannual to Millennial Thermohaline Circulation Variability</i>
Bamber J (Bristol)	<i>The role of the cryosphere on modulating the thermohaline circulation of the North Atlantic</i>
Briffa K (UEA)	<i>Quantitative applications of high-resolution late Holocene proxy data sets: estimating climate sensitivity and thermohaline circulation influences</i>
Bryden H (SOC)	<i>Extending the time series of Atlantic Meridional Overturning backwards in time using historical measurements</i>
Challenor P (SOC)	<i>The Probability of Rapid Climate Change</i>
Fairchild I (Keele)	<i>Atlantic Seaboard Climate Responses including Bounding Errors (ASCRIBE)</i>
Guilyardi E (Reading)	<i>The role of salinity in ocean circulation and climate response to greenhouse gas forcing</i>
Holmes J (UCL)	<i>ISOMAP UK: a combined data-modelling investigation of water isotopes and their interpretation during rapid climate change events</i>
Hoskins B (Reading)	<i>The atmospheric water vapour budget and its relevance to the THC</i>



## Studies addressing RAPID objectives 2 to 8 (cont'd)

Josey S (SOC)	<i>The Role of Air-Sea Forcing in Causing Rapid Changes in the North Atlantic Thermohaline Circulation</i>
McCave IN (Cambridge)	<i>Hydrographic and flow changes at sharp climate transitions in the North Atlantic MOC, 0-16ka BP</i>
Tudhope A (Edinburgh)	<i>Improving our ability to predict rapid changes in the El Nino Southern Oscillation climatic phenomenon</i>
Watson A (UEA)	<i>Circulation, overflow, and deep convection studies in the Nordic Seas using tracers and models</i>
Wells N (SOC)	<i>The determination of heat transfer and storage, and their changes in the North Atlantic Ocean</i>
Williams R (Liverpool)	<i>The role of sloping topography in the overturning circulation of the North Atlantic</i>
Willmott A (Keele)	<i>Processes controlling dense water formation and transport on Arctic continental shelves</i>
Wolff E (BAS)	<i>High resolution anatomy of rapid climate transitions in the last glacial period from a Greenland ice core</i>
<b><i>Pending</i></b>	
Pain C (Imperial)	<i>Better Understanding of Open Ocean Deep Convection (OODC) with Reference to THC</i>



# RAPID objectives v. funded projects

	1	2	3	4	5	6	7	8
Bacon S		x	x					
Bamber J					x		x	
Briffa K			x				x	
Bryden H		x						
Challenor P								x
Fairchild I			x				x	
Guilyardi E					x			x
Holmes J			x				x	
Hoskins B						x		
Hughes C	x							
Josey S		x			x		x	
McCave IN			x					
Marotzke	x							
Tudhope A			x				x	x
Watson A		x		x	x			
Watson A	x							
Wells N		x						
Williams R				x	x		x	
Willmott A					x			
Wolff E			x				x	



# National collaborations

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- Hadley Centre
  - climate modelling
- Tyndall Centre
  - prevention, mitigation, and adaptation strategies
- Various government laboratories
  - e.g. Marine Lab. (SERAD), CEFAS
- Users
  - such as government departments (e.g. DEFRA) and government agencies (e.g. Environment Agency)



# International links

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- Norwegian NOClim programme, ASOF
- NSF (USA) complementary projects for MOC monitoring
  - Leinen (NSF) & Patermann (EU) have also signed an agreement covering cooperative research in this area
- EU FP6 Integrated Project O(10-20M€)?
  - Will the Atlantic Thermohaline Circulation Halt: is Europe at Risk? (WATCHER)
  - Eol submitted 7<sup>th</sup> June 2002, IP in 2<sup>nd</sup> call - later in 2003?
- Other non-EU interest - Iceland
- CLIVAR (GOALS, DecCen, ACC)
- IGBP (PAGES, IMAGES)



# **RAPID Steering Committee Subgroups**

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- International = Dickson, Haugan, Lowe, Valdes
- Data = Briffa, Challenor, Tett
  - with involvement of BODC and BADC
- Modelling = Marotzke, Slingo, Valdes, Wood
- Technology = Turrell, others TBD (link to SBRI)
- Science Coordinator and/or Assistant Science Coordinator also involved in all subgroups



## RAPID data policy

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- data should be lodged with the appropriate data centre **on acquisition**, together with such metadata as are defined under the RAPID data management plan
- data would be embargoed for **1 year** from acquisition, allowing the PI and co-workers to exploit it in the first instance. The metadata would not be embargoed, to allow the wider community to be aware of work being carried out under RAPID and facilitate community building



## RAPID data policy (cont'd)

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- data would be made available to the RAPID community after **1 year**, and to everyone after **2 years**
- anyone making use of RAPID data within 3 years of it being lodged at the data centre would be required to include the PI and/or co-workers (as appropriate) as co-author/s on any resulting papers
- PIs and/or co-workers failing to comply with the RAPID data policy would be subject to appropriate sanctions

