Quantifying and Understanding the Earth System (QUEST)
Scoping Study – Phase 2.

Martin Juckes, BADC
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Introduction

This report describes the outcome of the scoping study carried out by the BADC to support work of the NERC programme *Quantifying and Understanding the Earth System* (QUEST) projects DESIRE, QESM and the QUEST fellowship.

It supplements an initial scoping study covering theme 1 and theme 2 projects (excluding DESIRE).

The QUEST Data Management Scoping Study

The information on the DESIRE project was collected at a QUEST project meeting. Information on the QESM project and QUEST Fellowship has been obtained by email.

For the DESIRE project, estimates of data delivery dates have been obtained for the 14 subprojects.

Table 1 gives the key information about the 3 projects covered by this study. Table 2 summarises the expected datasets, their volume (where known) and the investigator responsible.

A number of investigators are unable to give information about data volumes at this stage. There is uncertainty about how much of the data has scientific value. The status of the data produced by collaborators at IPSL but not financed by NERC needs to be clarified.

The data volume expected is of the order of 5TBytes.

Next Steps

The investigators need to be contacted closer to the expected delivery date. Experience shows that scientists find it extremely hard to estimate the volume of data their research will generate.

As many of the project scientists are unclear about what data will be useful to other scientists, and as BADC is not well placed to make this judgement, some input from the QUEST Data Management Group would be useful.

Table 1. Details of projects included in this study

Component	Project acronym	Project title	Project duration	PI	PI's university
Theme 2	DESIRE	Dynamics of the Earth System and the Ice-Core Record	Apr 07 – Apr 10	Eric Wolff	BAS
Fellowship	Quest fellow	Precise atmospheric O2 measurements in the UK and their application to land and ocean carbon cycle studies	Nov 05 – Oct 10	Andrew Manning	UEA
Focussed stragtegic activities	QESM	Quest Earth System Modelling		Jonathan Gregory	Reading

Table 2. Summary of expected datasets

Project	Data set	Investigator	Delivery date	Data volume (Gb)
QESM	ESM output	Manoj Joshi	Sep. 2009	500
DESIRE 1.3	TOMCAT sensitivity study output: a). Control run (with Holocene emissions). b). CH_4 sources scaled down to reproduce LGM CH_4, interactive OH. c). CH_4 sources as in control, CH_4 sinks altered (for example via alteration of VOC emissions) to reproduce LGM CH_4. d). Possible additional scenarios.	BAS PDRA	September 2008	10
DESIRE 1.4	a). Compiled data on the last ig wetland extent. b). Assembled data on terrestrial environments during earlier igs.	Sandy Harrison	June 2009	0.1
	c). Reconstructed pollen-based vegetation changes through D-O 8 and D-O 19/20.	Maria Fernanda Sanchex Goni	June 2008	0.1
DESIRE 2.2	New state-of-the-art $\delta^{13}CO_2$ record. (*) Courtesy of Jérôme Chappellaz (ask Jérôme if he agrees to archive this dataset at BADC).	LGGE PDRA	December 2008	.1

DESIRE 2.2	a). New measurements or synthesised data on the 100 kyr cycle of the SO deepwater temperature, AABW production, Pacific ventilation, carbonate saturation and compensation.	Harry Elderfield	June 2009	1
	b).(?) (*)	Franck Bassinot		
	c). Maps of carbonates.	Harry Elderfield	June 2008	
DESIRE 2.3	Synthesised data on changes in Southern Ocean wind speed during glacial conditions.	Laurent Bopp K. Kohfeld (Queens University) Corinne Le Quéré	December 2008 - March 2009	1000
	NEMO model output from sensitivity studies.	David Marshall Corinne Le Quéré	December 2008 - March 2009	
	NEMO model output from sensitivity studies and simulations.	David Marshall Corinne Le Quéré	December 2009 - March 2010	
DESIRE 2.4	Gridded data set of atmospheric dust particle loading and dust particle properties (size, shape, mineralogy, density). This will be an extension of the dust particle loading synthesis dataset produced by QUEST Degliaciation.	Bristol PDRA Sandy Harrison	December 2008	0.5
DESIRE 2.5	Output from key sensitivity runs or excerpts of multi millenial simulations with the MGV model (archival based on scientific relevance and publication).	IPSL PDRA Gilles Ramstein	September 2008	
DESIRE 3.1	Output from the preindustrial (control), LGM, EH and MH snapshots performed with the QUEST ESM or its offline components.	Peter Cox	January-March 2010	
	Output from the preindustrial (control), LGM, EH and MH snapshots performed with the QUEST ESM or its offline components. (*)	Pierre Friedlingstein or Pascale Braconnot	January-March 2010	
DESIRE 3.2	Output from ig snapshots including MIS 5 & MIS 15 (FAMOUS model runs).	Bristol PDRA Paul Valdes	September 2008 &/or March 2010	1500
	Output from MIS5 & MIS 15 snapshopts (IPSL ESM runs). (*)	Pascale Braconnot	September 2008 &/or March 2010	
DESIRE 3.3	Output from one or several simulations of a generic D-O event performed with FAMOUS.	Paul Valdes	September 2009	1500
	Output from one or several simulations of a generic D-O event performed with MGV. (*)	Pascale Braconnot Gilles Ramstein	March 2009	
	Output from one or several simulations of a generic D-O event performed with the IPSL ESM. (*)	Pascale Braconnot Gilles Ramstein	September 2009	

DESIRE 3.4	Comprehensive dataset of palaeoclimate parameters, including assessed uncertainties, generated by compiling existing datasets derived from ice cores, marine & terrestrial records. Variables will include Antarctic temperature, GHG concentrations, ice volume, sea level, benthic temperature, SST, sea ice, dust deposition to the SO, etc.	Nicola Lang BAS PDRA Eric Wolff	Jan 2010	<0.01
DESIRE 3.5	Output from selected g-ig-g transient simulation(s) with GENIE-1.	Phil Holden Eric Wolff Neil Edwards	December 2009	100-500Gb
	Output from selected multimillenial simulation(s) with the MGV. (*)	Gilles Ramstein	December 2009	

Appendix 1

Summary of Project Scoping Studies

Desire: Dynamics of the Earth System and the Ice-Core Record

Dr EW Wolff
British Antarctic Survey

Summary
Atmospheric composition and climate are closely linked because compounds such as carbon dioxide and methane are greenhouse gases: increases in their concentration are expected to warm the atmosphere. Such increases have occurred in the last two centuries, and are expected to accelerate in the next few decades. However, exactly how these concentrations and climate will evolve together depends on processes that link them within the so-called Earth System. Our understanding of these processes is expressed in models that represent and connect parts of the system such as the growth of vegetation, ocean circulation, atmospheric circulation and chemistry, etc. However, the best way we have of validating whether these models are correctly representing the Earth is by looking at the past. Various palaeoclimate records provide us with a view of how climate has behaved in the past. The ice core record is particularly valuable because it shows how both climate and atmospheric composition have evolved over the last 800,000 years. During this time, the Earth has passed into and out of glacial states many times, and it turns out that the principal greenhouse gases and climate have varied together during this period. Carbon dioxide and methane have high concentrations during warm interglacials and low concentrations in cold glacials. They thus offer numerous examples of how climate reacts to changes in atmospheric composition, and strong clues about how the sources and sinks of carbon dioxide and methane react to climate change. Our current understanding is that methane increases when climate warms because of a combination of expanded wetland sources and diminished atmospheric sinks. However, we lack many details about these sources and sinks, and have no clear evidence to differentiate their respective roles. For carbon dioxide, the changes are believed to stem mainly from processes in the Southern Ocean, but within this view there are a number of competing hypotheses. This proposal will combine the strongest elements of the relevant observational and modelling communities in the UK and France. Firstly, we will examine both the ice core and other datasets to provide as many constraints as possible on the causes of change in concentration of carbon dioxide and methane. This will involve particularly new measurements of isotopes of carbon that are diagnostic of sources, and new measurements of marine sediments in the Southern Ocean that can constrain mechanisms for changes in the carbon cycle. Particular aspects of the emission and processing of methane and carbon dioxide will be considered in order to make necessary improvements in models. We will then use a variety of models of different levels of complexity to explore the major changes seen in the ice record: between cold glacials and warm interglacials, between different interglacials, and at other particular times in the last 800,000 years that may allow us to differentiate the operation of certain mechanisms. Detailed models, including the new QUEST Earth System Model, will be used to assess the production and loss of methane at particular times in the record. Models of lower complexity will be run over longer time periods to determine the expected signal in different palaeoclimate archives of various mechanisms for changes in carbon dioxide, with a view to narrowing the uncertainties on the importance of each mechanism. Models will also be used to test whether we can understand the different climates seen in past interglacials knowing the energy input from the Sun and the concentrations of greenhouse gases seen in ice cores. The end result of this project will be an improved ability to simulate the past, a better understanding of the processes that control atmospheric composition, climate and the carbon cycle and, as an end result, an improved representation of all relevant processes in models used to predict the future evolution of the Earth System.

The table below shows a summary of the planned data output from this project. It has not been possible to obtain detailed information from all investigators at this stage. Data volumes are generally small, but there is considerable complexity in the variety of data expected.

WP		Investigators	Data deliverables	Data providers	Expected delivery date	Expected volume (GB) [or person who will provide the information in the near future]
Strand 1						
1.1	Methane source modelling	Sandy Harrison (Bristol) Pierre Friedlingstein (LSCE)	No data deliverable (model development).	/	/	0.0
1.2	Isotope modelling	Paul Valdes (Bristol) Jérôme Chappellaz (LGGE)	See WP 2.1.	/	/	0.0
1.3	Prospects for constraining source and sink contributions to methane change	Eric Wolff (BAS) Patricia Martinerie (LGGE) Joël Savarino (LGGE) Hélène Castelbrunet (LGGE) Anna Jones (BAS) Manuel Hutterli (BAS) Oliver Wild (Cambridge)	TOMCAT sensitivity study output: a). Control run (with Holocene emissions). b). CH_4 sources scaled down to reproduce LGM CH_4, interactive OH. c). CH_4 sources as in control, CH_4 sinks altered (for example via alteration of VOC emissions) to reproduce LGM CH_4. d). Possible additional scenarios.	BAS PDRA	September 2008	[Oliver Wild]
1.4	Characterisation of changes in terrestrial environments	Sandy Harrison (Bristol) Maria Fernanda Sanchez Goni (Bordeaux) Chronis Tzedakis (Leeds)	a). Compiled data on the last ig wetland extent. b). Assembled data on terrestrial environments during earlier igs.	Sandy Harrison	June 2009	0.1
			c). Reconstructed pollen-based vegetation changes through D-O 8 and D-O 19/20.	Maria Fernanda Sanchex Goni	June 2008	0.1
Strand 2						

2.1	$^{13}CO_2$ measurements and interpretation	Jérôme Chappellaz (LGGE) Eric Wolff (BAS)	New state-of-the-art $\delta^{13}CO_2$ record. (*) Courtesy of Jérôme Chappellaz (ask Jérôme if he agrees to archive this dataset at BADC).	LGGE PDRA	December 2008	[Jérôme Chappellaz]
2.2	Marine sediment constraints on the C cycle	Harry Elderfield (Cambridge) Franck Bassinot (LSCE) Michel (LSCE) I. McCave (Cambridge) Stephen Barker (Cardiff)	a). New measurements or synthesised data on the 100 kyr cycle of the SO deepwater temperature, AABW production, Pacific ventilation, carbonate saturation and compensation.	Harry Elderfield	June 2009	[Harry Elderfield]
			b).(?) (*)	Franck Bassinot		[Franck Bassinot]
			c). Maps of carbonates.	Harry Elderfield	June 2008	[Harry Elderfield]
2.3	Modelling Southern Ocean physics/biogeochemical coupling	David Marshall (Oxford) Corinne Le Quéré (UEA) Laurent Bopp (LSCE)	Synthesised data on changes in Southern Ocean wind speed during glacial conditions.	Laurent Bopp K. Kohfeld (Queens University) Corinne Le Quéré	December 2008 - March 2009	1000 [Rough estimate, following phone conversation with David Marshall, 11/1/08]
			NEMO model output from sensitivity studies.	David Marshall Corinne Le Quéré	December 2008 - March 2009	
			NEMO model output from sensitivity studies and simulations.	David Marshall Corinne Le Quéré	December 2009 - March 2010	
2.4	Improved specification of dust properties for dust-cycle simulations	Yves Balkanski (LSCE) Sandy Harrison (Bristol)	Gridded data set of atmospheric dust particle loading and dust particle properties (size, shape, mineralogy, density). This will be an extension of the dust particle loading synthesis dataset produced by QUEST Degliaciation.	Bristol PDRA Sandy Harrison	December 2008	0.5
2.5	MGV development	Gilles Ramstein (LSCE) Paul Valdes (Bristol)	(Possibly. Depends on Investigators and identification of results of prominent interest). Output from key sensitivity runs or excerpts of multi millenial simulations with the MGV model (archival based on scientific relevance and publication). (*)	IPSL PDRA Gilles Ramstein	September 2008	Needs discussion with investigator towards delivery date

Strand 3						
3.1	Comprehensive simulations of the Last Glacial Maximum, Early Holocene and Mid-Holocene	Pascale Braconnot (LSCE) Peter Cox (Exeter) Pierre Friedlingstein (LSCE)	Output from the preindustrial (control), LGM, EH and MH snapshots performed with the QUEST ESM or its offline components.	Peter Cox	January-March 2010	[Peter Braconnot]
			Output from the preindustrial (control), LGM, EH and MH snapshots performed with the QUEST ESM or its offline components. (*)	Pierre Friedlingstein or Pascale Braconnot	January-March 2010	[Pascale Braconnot]
3.2	Simulations of previous interglacials	Paul Valdes (Bristol) Pascale Braconnot (LSCE)	Output from ig snapshots including MIS 5 & MIS 15 (FAMOUS model runs).	Bristol PDRA Paul Valdes	March 2010	1500
			Output from MIS5 & MIS 15 snapshopts (IPSL ESM runs). (*)	Pascale Braconnot	September 2008 &/or March 2010	[Pascale Braconnot]
3.3	Dansgaard-Oeschger Simulations	Paul Valdes (Bristol) Gilles Ramstein (LSCE) Pascale Braconnot (LSCE)	Output from one or several simulations of a generic D-O event performed with FAMOUS.	Paul Valdes	March 2010	1500
			Output from one or several simulations of a generic D-O event performed with MGV. (*)	Pascale Braconnot Gilles Ramstein	March 2009	[Pascale Braconnot]
			Output from one or several simulations of a generic D-O event performed with the IPSL ESM. (*)	Pascale Braconnot Gilles Ramstein	September 2009	[Pascale Braconnot]
3.4	Compilation and assessment of datasets covering the "zoo" of interglacials, transitions and glacials from 800 kyr to present	Eric Wolff (BAS) Sandy Harrison (Bristol) Harry Elderfield (Cambridge) Jérôme Chappellaz (LGGE)	Comprehensive dataset of palaeoclimate parameters, including assessed uncertainties, generated by compiling existing datasets derived from ice cores, marine & terrestrial records. Variables will include Antarctic temperature, GHG concentrations, ice volume, sea level, benthic temperature, SST, sea ice, dust deposition to the SO, etc.	Nicola Lang BAS PDRA Eric Wolff	Jan 2010	<0.01
3.5	Interglacial transient simulations	Neil Edwards (OU) Gilles Ramstein (LSCE)	Output from selected g-ig-g transient simulation(s) with GENIE-1.	Phil Holden Eric Wolff Neil Edwards	December 2009	100-500Gb
			Output from selected multimillenial simulation(s) with the MGV. (*)	Gilles Ramstein	December 2009	[Gilles Ramstein]

(*) The provision of data exclusively generated with French funding is left to the French investigator's courtesy and is in no way mandatory. However, it is encouraged on the grounds that a central DESIRE data base is DESIREable. The provision to BADC of IPSL model data (in NetCDF) has been agreed (providers: Pierre Friedlkingstein, Pascale Braconnot).

Fellowship: Precise atmospheric O2 measurements in the UK and their application to land and ocean carbon cycle studies

Andrew Manning
University of East Anglia

The QUEST Fellow has informed us that he will not be generating any data which is not covered by other projects, so we have no action items specific to this project.

QESM: QUEST Earth System Modelling
Jonathan Gregory
Reading University

The QESM project components are covered by other projects, except for the core team at Reading.

Manoj Joshi m.m.joshi@reading.ac.uk is likely to be responsible for the main runs with the model. The project ends (including a no-cost extension) in Sep 2009. Data might start to be generated, if things go well, in the second half of 2008. However, this is a model development project and its main aim is not (on paper) to do experiments, so there may be no data delivered.