

Strategic Consortium

UK-HIGEM

A national programme in 'Grand Challenge' high resolution modelling of the global environment between NERC and the Hadley Centre

*NCAS/CGAM, NCAS/ACMSU, BADC, BAS,
CEH, ESSC, SOC, U. Cambridge, UEA
and the Hadley Centre*



UK-HIGEM AIMS

1. Science Aims:

- *To achieve a major advance in the fidelity of simulations of the Global Environment by developing an Earth System Model with unprecedented resolution, comprehensively evaluated.*
- *To perform a 'Grand Challenge' multi-century simulation with the new Earth System Model, HIGEM*
- *To study mechanisms of climate variability and change on timescales of days to centuries*
- *To improve our understanding of non-linear processes that to interactions between small spatial scales and larger scales, and between high and low frequencies, within the Earth system.*

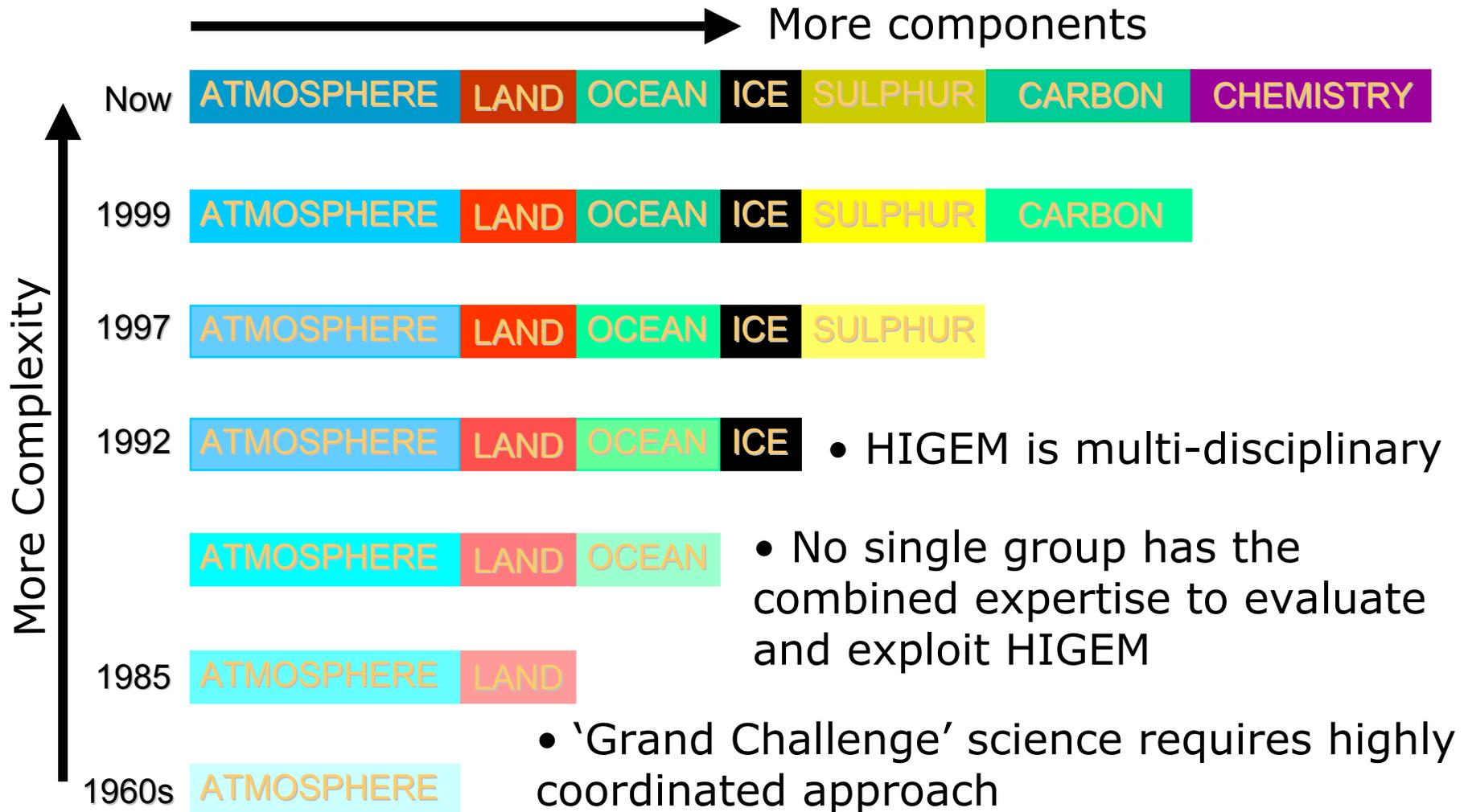
AND

2. Strategic Aims:

- *To integrate the global environment modelling activities across NERC*
- *To support the formation of a national partnership between NERC and the DEFRA/MOD funded Hadley Centre*
- *To contribute to the UK's pre-eminence in coupled climate modelling and climate change prediction.*
- *To exploit the major increases in computing power afforded by HPC(X) and the Earth Simulator*

Why a Consortium is needed:

Complexity of the Hadley Centre Global Environment Model



UK-HIGEM Partners

- **NCAS/CGAM:** Climate modelling, atmospheric processes, coordination activities (e.g. UGAMP), HPC expertise
- **NCAS/ACMSU:** Chemistry/climate interactions, chemistry modelling (UCHEM)
- **BADC:** Data management, e-science and the Data GRID
- **BAS:** Polar processes and observations, modelling the cryosphere
- **CEH:** Land surface processes and observations, land surface models (JULES)
- **ESSC:** Clouds and radiation processes, model evaluation against satellite data, land surface field studies, e-science.
- **SOC:** Ocean observations, ocean processes, ocean modelling (OCCAM, HYCOM), remote sensing
- **U. Cambridge (DAMTP):** Numerical methods, nested modelling techniques
- **UEA:** Ocean modelling, ocean processes in Hadley Centre models
- **Hadley Centre:** Provision of HadGEM, expert advice on climate modelling, evaluation.

UK-HIGEM builds on core/strategic activities:

- 30 person years from UK-HIGEM **AND**
- **Minimum 15 person years committed by partners**

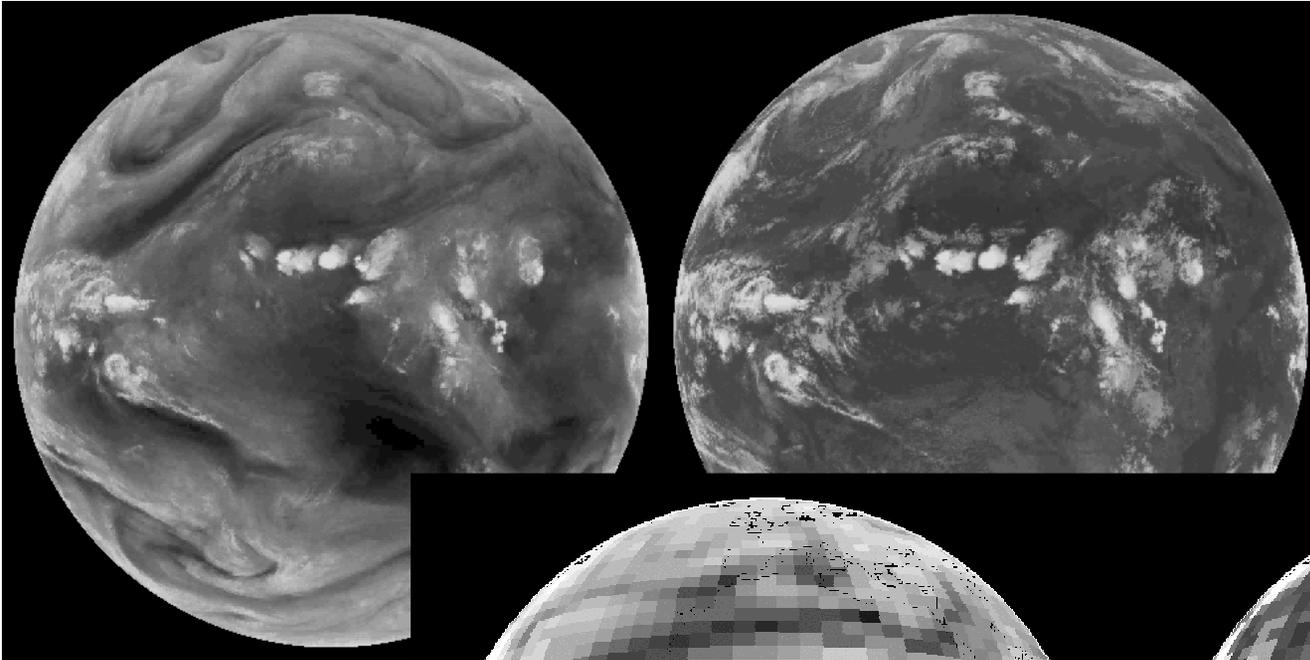
Partners are:

- Active users of the Hadley Centre model.
- Contributors to evaluation of specific components of HIGEM.
- Exploiting specific aspects of the 'Grand Challenge' Integration.

Several partners already have collaborative projects with the Hadley Centre.

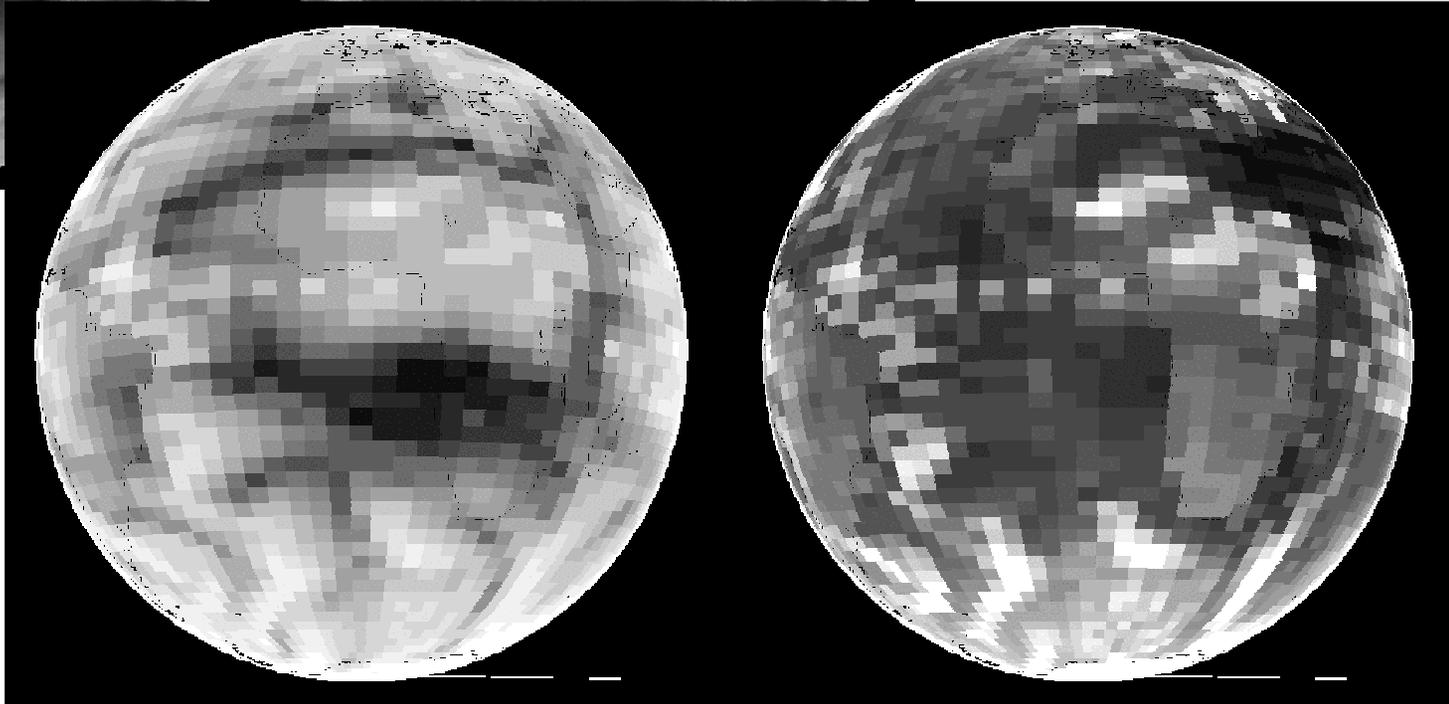
Why a move to higher resolution is necessary

I: Complexity in the atmosphere



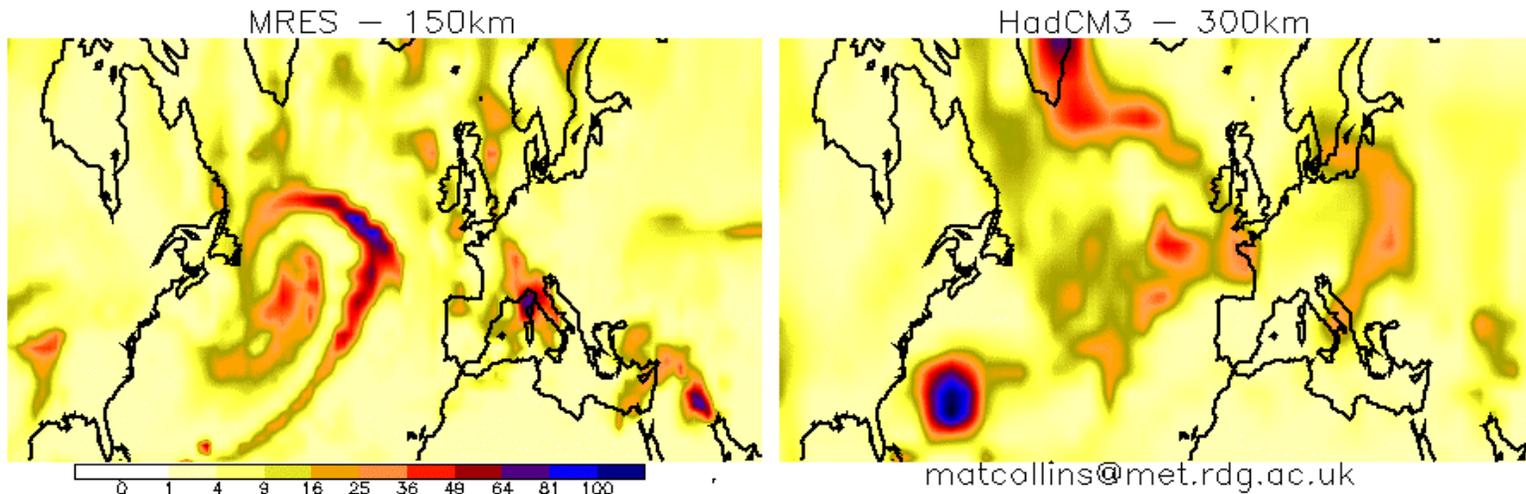
Water vapour
and window
channel
radiances from
Meteosat-7

Same fields
from HadAM3
at climate
resolution



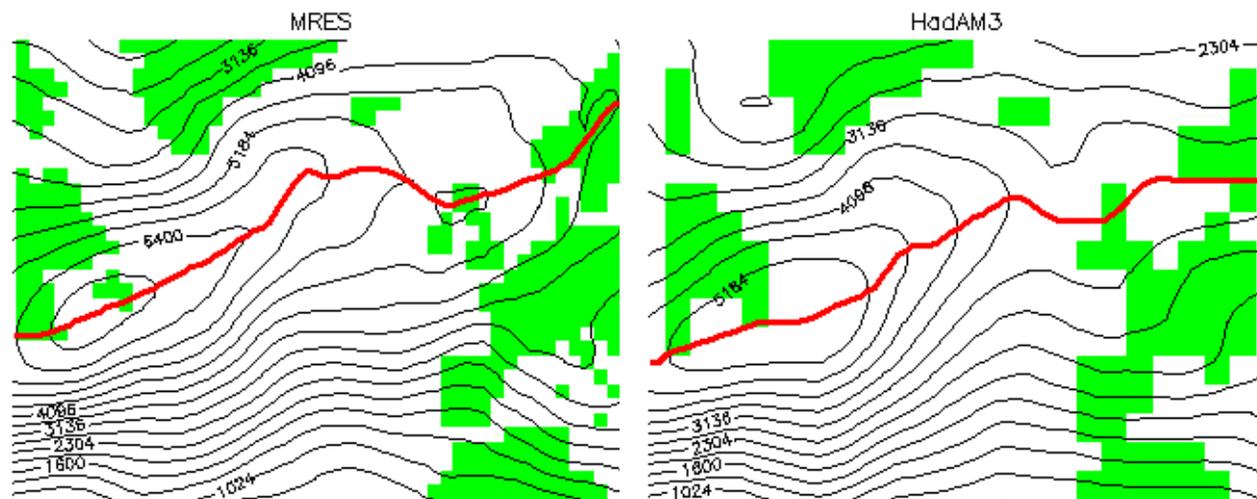
Better weather systems in a high resolution model

Precipitation in HadAM3 with 150km (left) and 300km (right) atmosphere



.....and stronger storm tracks

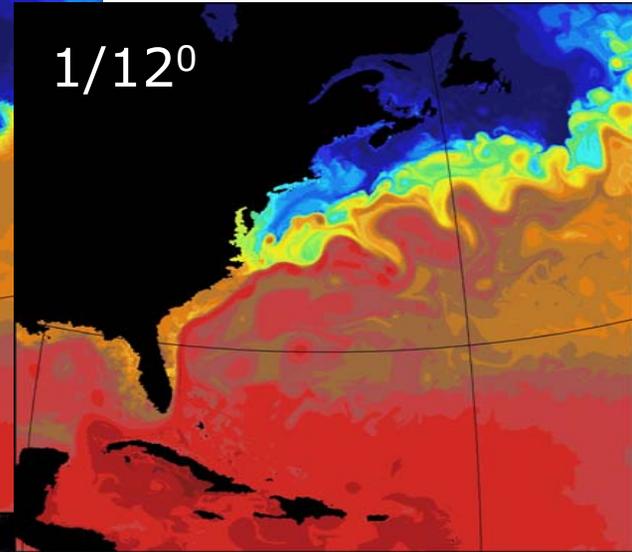
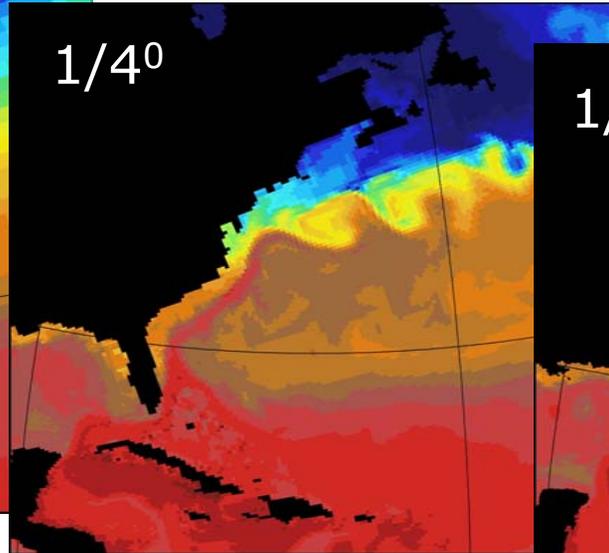
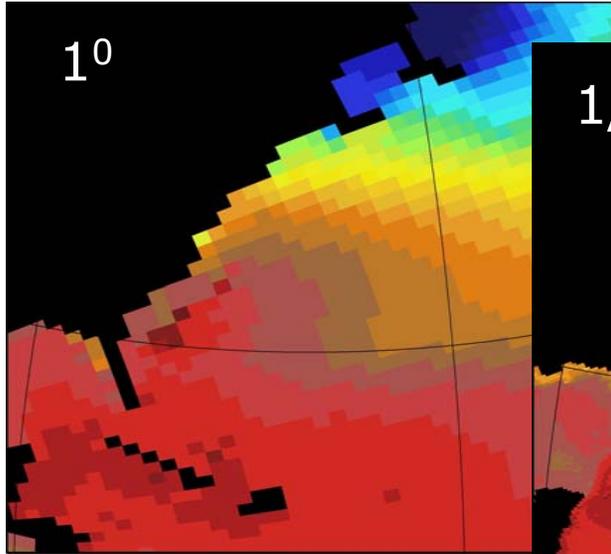
High pass (<10 days) 500hPa geopotential height variance



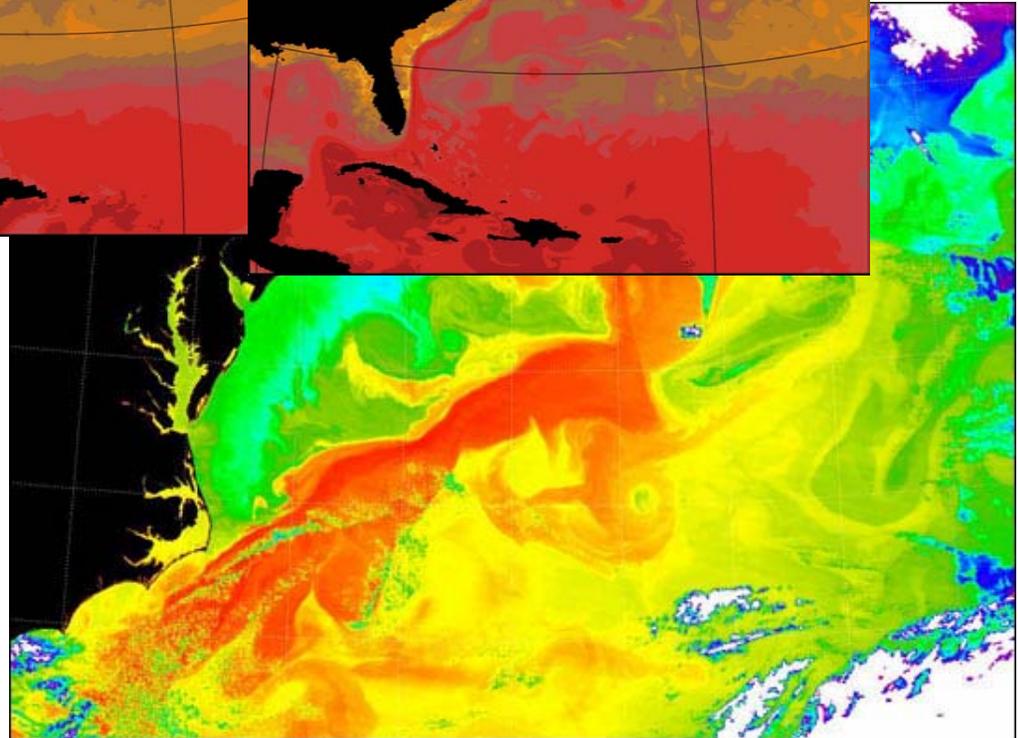
Why a move to higher resolution is necessary

II: Complexity in the ocean

.... and as simulated by OCCAM

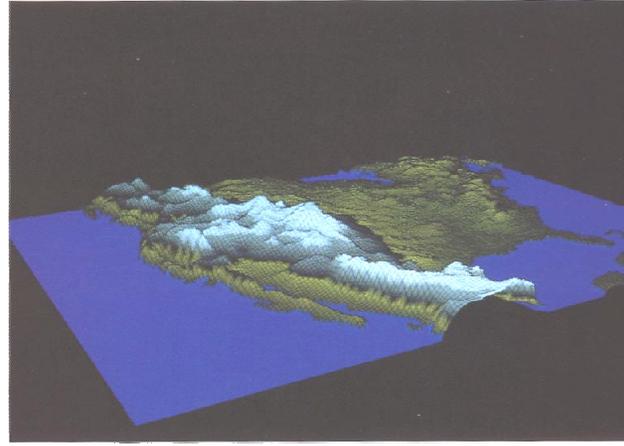
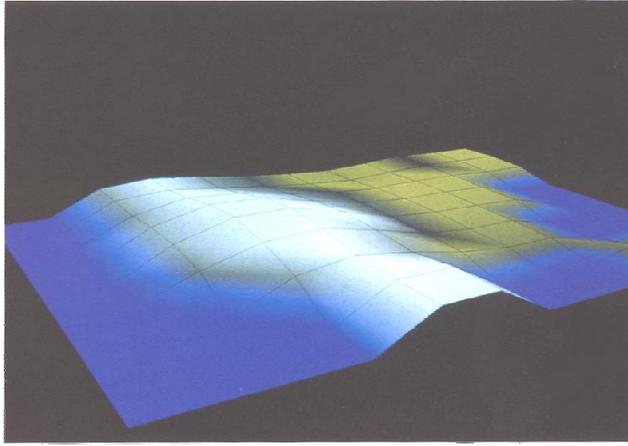


SSTs in the Gulf stream
from infrared
measurements aboard
MODIS



Why a move to higher resolution is necessary

III: Complexity in the land surface

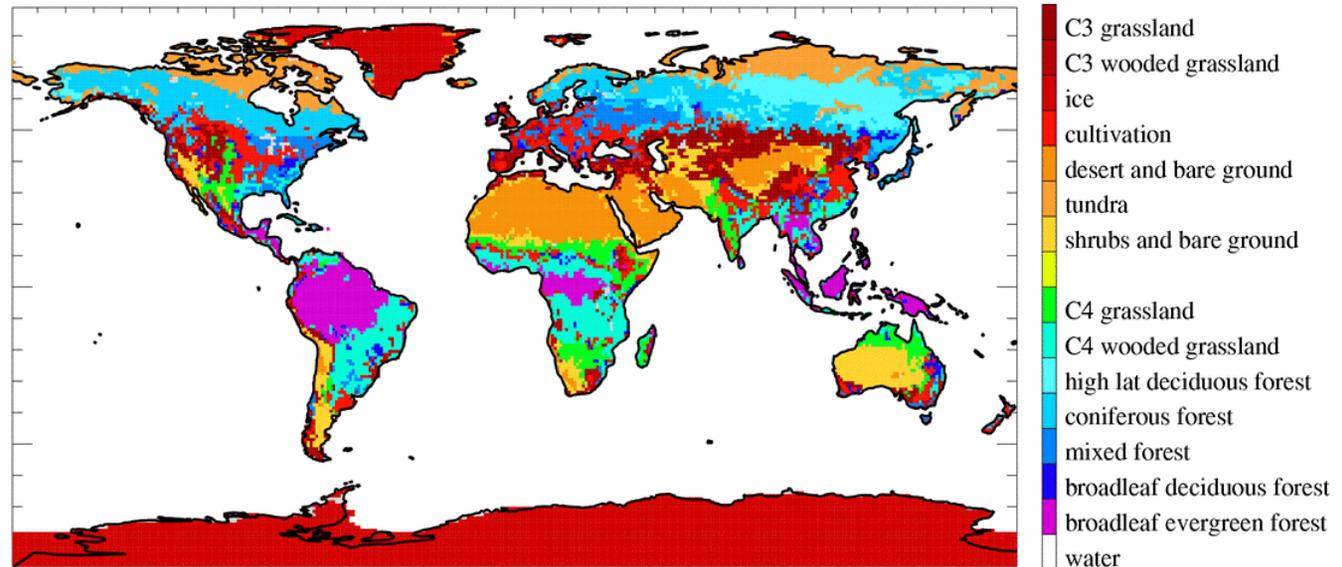


How the Rockies appear in a standard resolution ($\sim 400\text{km}$) model

..... and in a high resolution ($\sim 60\text{km}$) model.

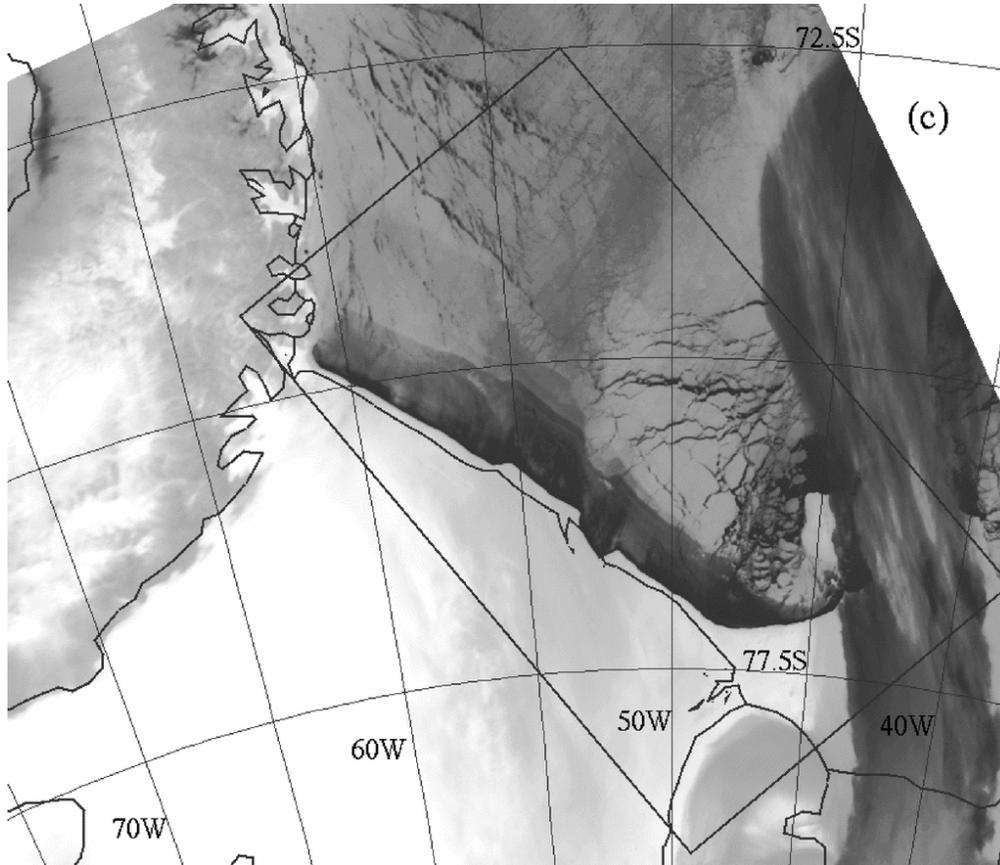
Large variations in vegetation are not resolved but have impacts on local climate

Vegetation Class
ISLSCP I



Why a move to higher resolution is necessary

IV: Complexity in the cryosphere



AVHRR image of the southern Weddell Sea showing coastal polynyas (typically 100km x 20km).

Polynyas are sites of intense air-sea interaction and play a major role in production of Antarctic bottom water



**British
Antarctic Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

UK-HIGEM Work Packages

WP0: Pre-Project Planning and Implementation (Lead: CGAM)

WP1: Development and testing of HIGEM (Lead: CGAM)

WP2: 'Grand Challenge' multi-century control integration using HIGEM (Lead: CGAM, **Hadley Centre**)

WP3: Dissemination, post-processing and visualisation of output from HIGEM integrations (Lead: BADC)

WP4: Evaluation of HIGEM performance (Coordination: CGAM, **Hadley Centre**)

- WP4.1: Atmosphere (Lead: CGAM, ESSC)
- *WP4.2: Atmospheric Chemistry (Lead: ACMSU, DAMTP)*
- WP4.3: Ocean (Lead: SOC, UEA)
- WP4.4: Land (Lead: CEH)
- WP4.5: Polar Regions (Lead: BAS)

WP5: Application of HIGEM results to key scientific issues

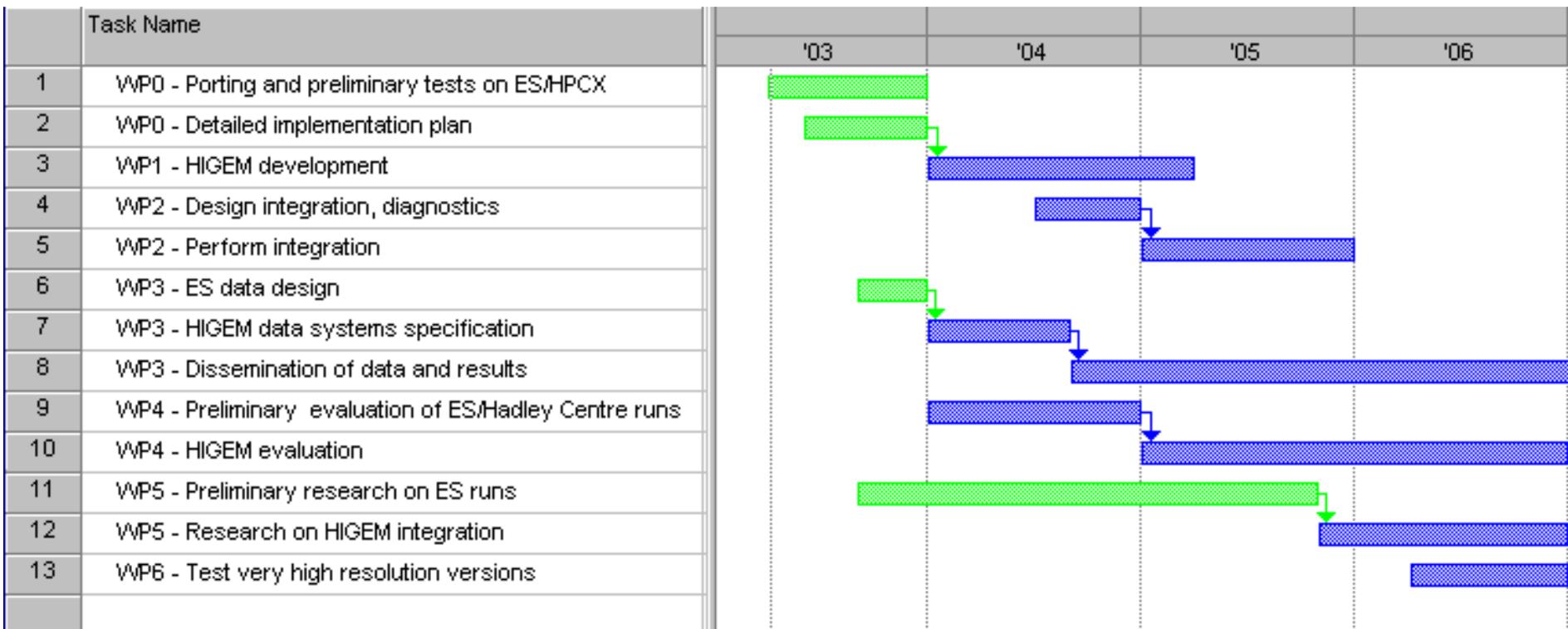
WP6: Pushing at the limits of resolution - looking forward to the next generation supercomputers

UK-HIGEM Science

UK-HIGEM will enable us to address key science issues with more confidence, such as:

- Extreme events and modes of climate variability
- Climate variability on seasonal to centennial timescales
 - Variability in thermohaline circulation
 - El Nino and Indian Ocean variability
 - Warming of the Antarctic Peninsula
- Land-atmosphere interactions

UK-HIGEM GANTT Chart showing progression of activities



- Pre-project and complementary activities
- UK-HIGEM activities

Proposed new start date is Jan. 2004, based on time required for:

- Recruitment of new staff, particularly UK-HIGEM Project Manager
- Development of Implementation Plan
- Proposed date for prototype HadGEM1 (September 2003)

UK-HIGEM Management Structure

UK-HIGEM Coordinator (Slingo)
UK-HIGEM Model/HPC Coordinator (Steenman-Clark)
UK-HIGEM Data Coordinator (Lawrence)

UK-HIGEM
Advisory Group:
NERC, external experts
Meets annually

UK-HIGEM
Executive Group:
PIs, Hadley staff
Meets quarterly

**UK-HIGEM
Project Manager**

UK-HIGEM
funded

**CGAM/BADC Core
Computational
Scientists**

**WP & Project
Teams**



CGAM's Track Record in NERC Climate Modelling

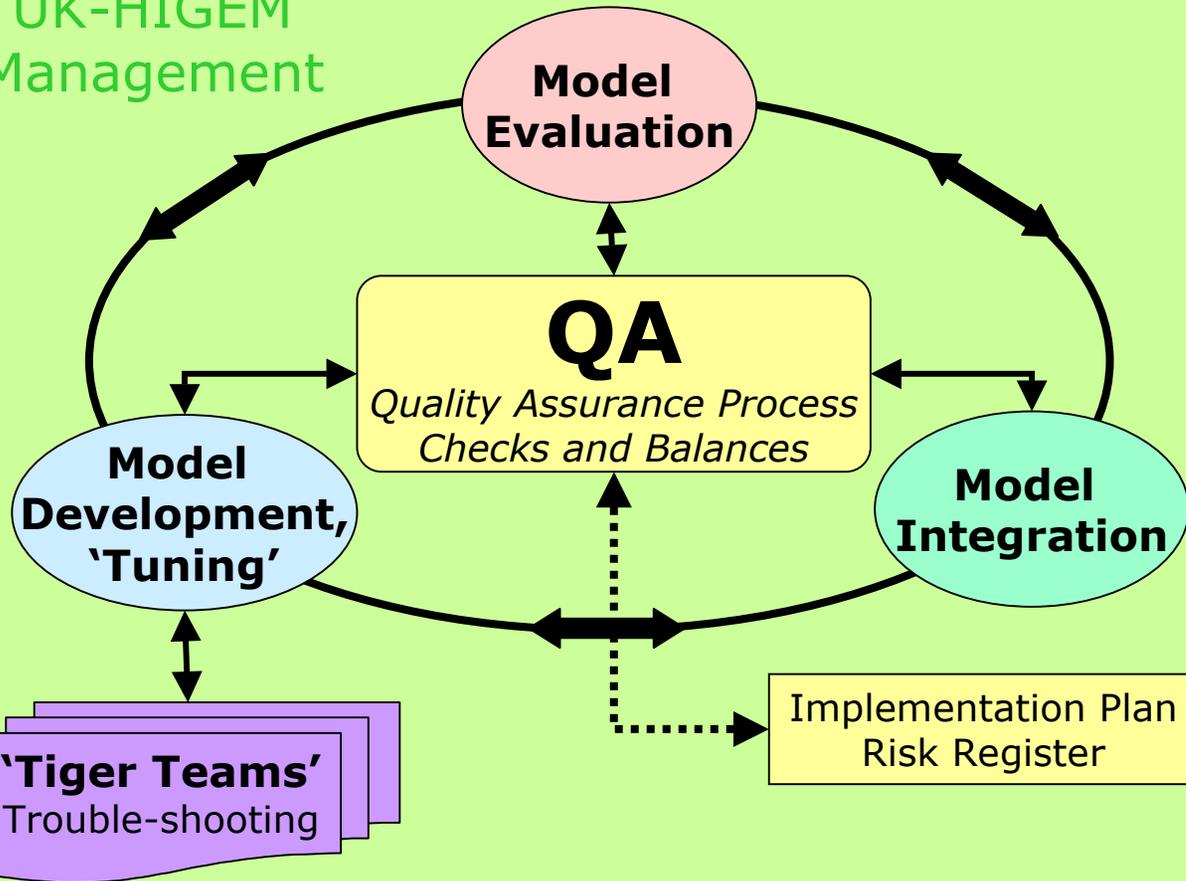
- Coordinates and supports U.K. Universities' Global Atmospheric Modelling Programme (UGAMP)
 - 19 Affiliated Groups within 14 University/Research Labs.
 - Engages over 100 research staff and students
 - Wide range of applications built principally around Met Office Unified Model
- Enabled **355** UGAMP Publications in last 5 years
- Provides centralised support for models and data analysis
 - Unified Model Information Service (UMIS)
 - Ported, optimised and tested UM versions on many different computer systems, from PCs to the Earth Simulator
 - Participated in the development of new versions of the UM (e.g. HADOPA, aquaplanet)
- Provides many opportunities for sharing and learning within the UGAMP climate modelling community



UK-HIGEM will require tight coordination:

Constant flow of information around the project and the consortium

UK-HIGEM
Management



QA Process:

- Defining validation procedure e.g. identifying key variables for each component of earth system
- Setting acceptable levels of model performance, optimisation
- Setting criteria for success of simulation e.g. acceptable levels of drift, systematic error



Coordination activities and flow of information/data:

- Rapid sharing of information – Collaboratories, 'Blackboards'
- Dynamic re-allocation of resources – 'Tiger' Teams
- Discussion groups – Access Grid, Virtual Network Computing (VNC)

Earth Simulator Working Collaboration

Home | Partner's Home | Documents | Software/Resources | Help | Blackboard | Logout Add Item

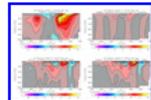
- Models
- Projects**
- People

Projects

1. Select a Project:

- Earth Simulator CGAM
- Earth Simulator CCSR
- Earth Simulator Hadley

Select A Project

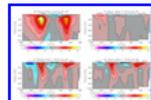


[Test CGAM Med Res JJA](#)

2. Select Category:

- CGAM High Resolution Atmosphere
- CGAM Medium Resolution
- CGAM Model Development

Select A Category



[Test CGAM Model Development DJF](#)

3. Select Experiment:

- CGAM Model Dev Experiment 1
- CGAM Model Dev Experiment 2

View

Blackboard: Courses - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://www.bb.rdg.ac.uk:8800/bin/common/course.pl?course_id=_15320_1&frame=top

The University of Reading
My Institution Courses
COURSES > MT001-02-3

Announcements
Information
Staff Information
Documents
Communication
Discussion Board
Groups
Web Sites
User Tools
Course Map
Control Panel

Announcements
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Staff Information
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Control Panel

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Blackboard: Courses - Microsoft Internet Explorer
File Edit View Favorites Tools Help
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Control Panel

Day 1 : 12th February 2003

We arrived at the ES mid-morning. The security arrangements were very simple as Emori-san had made all the necessary administrative arrangements before we arrived. A simple show of passports was required before we were given the badges that would allow us access to the ES building and the Frontiers research building. We were then introduced to the groups who would help or we would work with: the ES user management team, the NASDAC administration team, colleagues who are based in the ES user room.

The setting up of the laptops was again relatively trivial as Emori-san had all the settings needed prepared. It is not clear that we can have the ES laptops next to the external laptops as external connections seem to be from the Frontiers building rather than the ES user room. There also seem to be some restrictions as to what can be accessed from the web on the ES network. These are all minor problems which can be sorted out during our stay here. Logging onto the ES front-end was again simple and the userid and password also gives us access to ES web documentation in English.

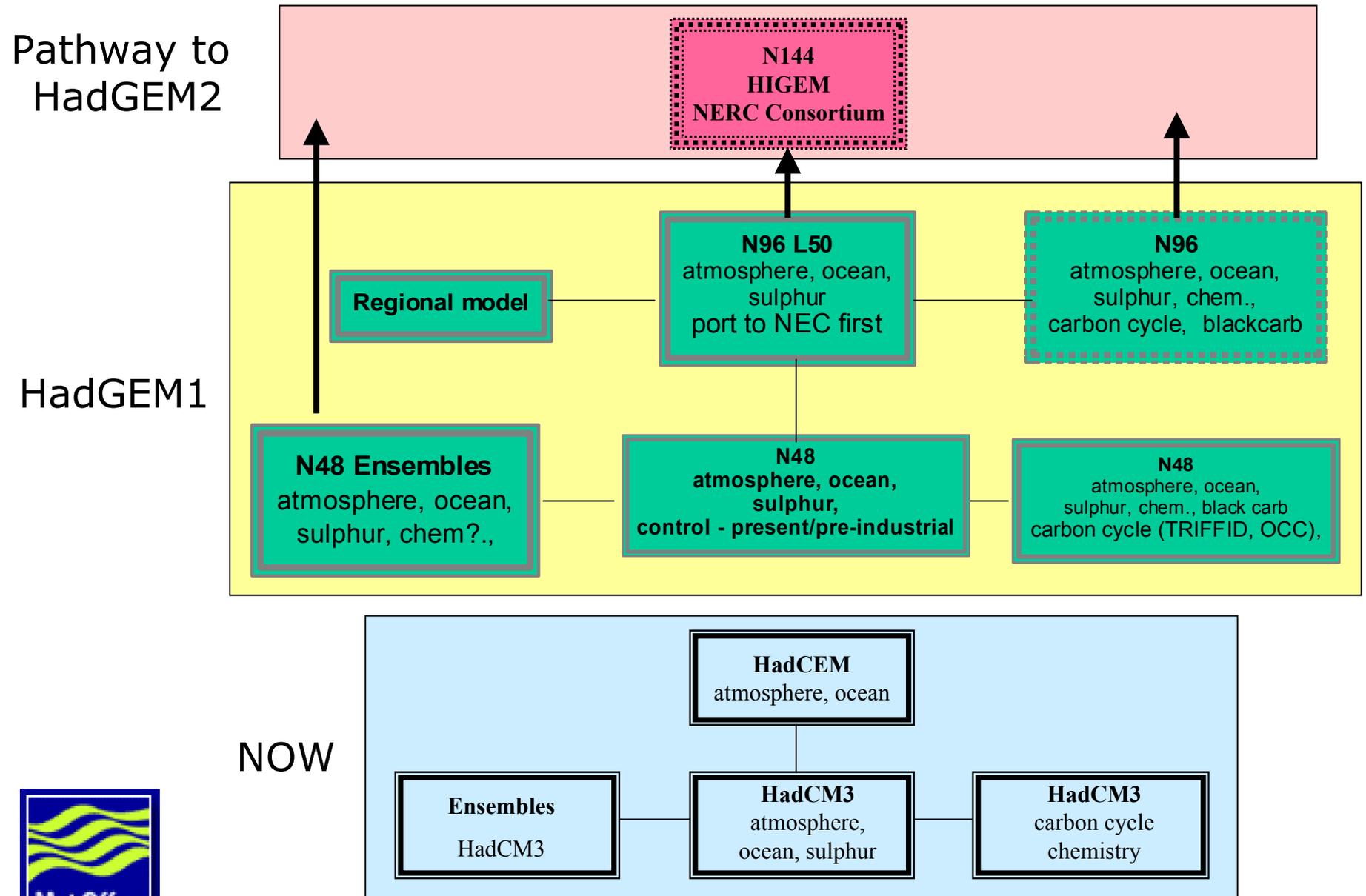
After transferring all our files from CD-ROMs or the laptops to the frontend, we started to build the model. The model is being built in Jeff's space as we don't want to have multiple copies of the base library. This will be the reference version for the ES experiments.

Jeff's experience of building the UM on the SX6 in Paris is invaluable. We decided to start with the options used by Jeff on the SX5. The ES cross-compiler seems to have the same options as the SX5 cross compiler and so there were only a few minor changes to be made to the install script, which were

- 1) The Paris SX5 has an SGI front-end so Jeff had used a fix to solve the SGI problem with set -s. A quick test showed that the HP ES front-end doesn't need this fix.
- 2) We started by using the default sed, awk, grep
- 3) We included 2 fixes timerfix and nec_smallx.mod.

The install should have build a file call OBJ_XREF but because of a 100 instruction limit for sed, the file, obj_xref, failed to be made. Normally we would, at this point, build GNU sed, and use this instead of the system sed which is the cause of the problem. However building the GNU sed would take time and the file, obj_xref, is only made once. So we took the obj_xref file from the build on the Paris SX5 as we thought that there would be other similar problems.

Hadley Centre Model development strategy



UK-HIGEM: Budget Summary

Running Costs:

Staff (30 person years):	835,894
Travel and Subsistence:	30,152
Consumables:	21,220
Equipment:	62,112
Exceptional Items:	69,104
<ul style="list-style-type: none">• Collaboration activities<ul style="list-style-type: none">• Exchange programme to support HIGEM staff working at other locations, including Hadley Centre• Project Team and Executive Group meetings• Advisory Group Meetings• Annual meeting of consortium to publicise progress and results to the wider community• Training in Global Environment Modelling• Publicity	

TOTAL Running Costs:

1,402,995

Computing Costs:

~800,000

Note this is an estimate based on T3E usage. Timings, costings for HPC(X) still to be determined

UK-HIGEM Deliverables

- Integration of the NERC and Hadley Centre programmes in global environment modelling
- Development of high resolution global environment model
- Advanced methods for the comprehensive evaluation of global environment models
- Multi-century simulation, made available to the wider NERC community
- Advances in key areas related to Earth System Science and climate change
- Enable NERC to make major contribution to 4th IPCC Assessment Report

UK-HIGEM: Technical feasibility – current status and plans

<u>Time Line</u>	<u>Model</u>	<u>Model Description</u>	<u>Capability Computing</u>	<u>Technical Issues</u>
Feb./Mar. 2003	HadAM3 PUM v4.5	N48 (SRES); L19 N96 (MRES); L19	HPCX - IBM NEC - Earth Simulator	Comparison with T3E : speed and scaling
	HadCM3 PUM v4.5	Atmos : N48 L19 Ocean : Global 1deg. L20	HPCX - IBM NEC - Earth Simulator	Ocean code reproducibility
	HadCEM	Atmos : N48 L19 Ocean : Global 1/3deg. L40	NEC - Earth Simulator	Ocean scaling : interconnect issues : vectorisation : portability
Apr./May/June 2003	HIGAM	HadAM3 (HRES) Atmos : N144 L30+	HPCX - IBM NEC - Earth Simulator	Atmosphere scaling : IO issues and interconnect
	HadCEM	Atmos : N48 L19 Ocean : Global 1/3deg. L40	NEC - UKMO	As for Earth Simulator
	HadGEM1	v4.5.3 climate version Atmos : N48 and N96 Ocean : Tropics 1/3deg. L40	NEC - UKMO	Still to be assessed
Summer 2003	HIGAM	HadAM3 (HRES)	NEC - Earth Simulator	Multi-decadal simulations
	HadAM3	SRES, MRES, HRES Ensemble framework	HPCX - IBM	Capability to submit ensembles as single jobs
Autumn 2003	HadGEM1	Prototype frozen version Atmos : N96 Ocean : Tropics 1/3deg. L40	NEC - UKMO HPCX - IBM CSAR - SGI	Century control run by Hadley Port Port
Late 2003/Early 2004	HIGEM	HadGEM1 prototype Atmos : N144 Ocean : Global 1/3deg. L40	HPCX - IBM NEC - Earth Simulator CSAR - SGI	Technical and scientific issues : tiling, scaling, tuning etc