Ejiri in Suruga Province (a sudden gust of wind), (19th century) by Katsushika Hokusai

Sudden Shower at Ohashi Bridge at Atake, (1857) by Ando Hiroshige

The UK-Japan Climate Collaboration

A unique Earth System study of the 21st century

In a ground-breaking international collaboration, the UK and Japan will combine some of the world's best climate-modelling expertise with cutting-edge supercomputing technology.

Modelling climate in more detail then ever before

Together we will develop a numerical model of the Earth System which will encompass not only the physical climate (atmosphere, ocean and land), but also the effects of plants and marine life, and atmospheric chemistry. By including these processes within an Earth System model, we can capture their interactions with climate; something that even many state-of-the-art global climate models ignore, due to the huge computing demands.

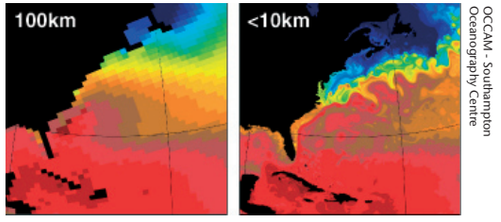
Climate models divide the atmosphere, ocean and other components into a grid of boxes. The smaller the box, the more spatial detail is represented, but the more computing power is required.

The power of the Earth Simulator means that we will be able to run climate simulations with much finer resolution than ever before.

Shedding light on key uncertainties in climate science

The benefits of increased resolution

Increased resolution will improve the way models represent phenomena such as the Gulf Stream, El Niño, the Asian monsoon and mid-latitude depressions. What will this tell us about the way these phenomena work in the real world? How will they respond to global warming? These are crucial questions that we can begin to address within the project.



OCCAM - Southampton Oceanography Centre

At 10 km resolution, an ocean model can simulate the sharp temperature change across the Gulf Stream in the N Atlantic and the small scale eddies that form there; this is not possible at 100km resolution

Interactions and feedbacks in the Earth System

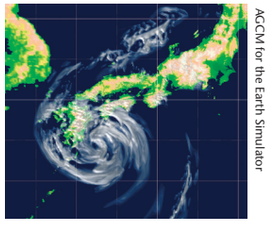
There is increasing concern that global warming and other environmental damage will affect the functioning of ecosystems (causing forests to die back, for example). This could reduce the amount of carbon dioxide they are able to absorb and enhance the pace of global warming, as well as having devastating regional and local impacts such as droughts or flooding.

It is only through the use of an Earth System approach that we can really start to tackle these vital questions.

The impacts of climate change

Climate is not just an abstract concept; it is something we experience every day as weather. Weather-related natural disasters such as flooding and typhoons/hurricanes have great human and financial consequences. Munich-Re estimates that natural disasters caused US$90 billion in damage during 2004. The European heatwave of 2003 caused as many as 35,000 additional deaths, and crop damage estimated at US$12.3 billion.

At the finer resolutions that the Earth Simulator will allow, we can begin to predict with more confidence whether the frequency of such extreme events will change in the future.

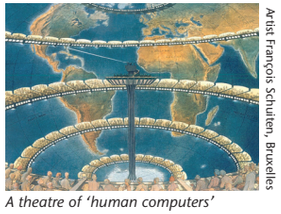


AGCM for the Earth Simulator

Typhoons like this one, simulated by a 10 km atmospheric model, have battered Japan during 2004.

Weather and climate - the vital role of computers

As far back as 1922, English mathematician Lewis F Richardson imagined that it would be possible to collect global information about the weather.
He imagined a theatre where 64,000 'human computers' could simultaneously share this information and calculate the evolution of weather systems.
A director at the theatre's centre would coordinate this activity by alternately shining a light on each computer. While this was impractical in his day, what Richardson envisioned is almost exactly analogous to the functioning of a modern multi-processor computer.



Artist François Schuiten, Bruxelles

A theatre of 'human computers'

Big machines to address big questions

In order to answer difficult questions about the functioning of the Earth System and the way human activity is altering it, we need to be able to formulate and test hypotheses, bridging large temporal and spatial scales. We are taking our planet into uncharted territory, and complex numerical models are the best tools we have for understanding the consequences.

The Earth Simulator

Completed in 2002, with 5,120 processors, it was designed with a holistic view of scientific problem-solving. It is used to simulate climate, earthquakes, volcanoes, tsunamis, nuclear physics and life and material sciences. Located in Yokohama, Japan, the Earth Simulator was ranked number 1 on the top-500 supercomputers list for more than two years. It is still the fastest vector supercomputer in the world.

The Earth Simulator Center

This project is a collaboration between the UK Met Office's Hadley Centre, NCAS Centre for Global Atmospheric Modelling, and The Earth Simulator Center.

Met Office Hadley Centre

NERC Centres for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

EARTH SIMULATOR

Further information: http://www.earthsimulator.org.uk; http://www.cgam.nerc.ac.uk; http://www.metoffice.gov.uk; http://www.es.jamstec.go.jp

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