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Intergenerational Equity, Holism and Long-Termism in Green Economics
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Session #1: Intergenerational equity, long-termism and holism in economics

Paper title: <u>Rapid climate change and intergenerational inequity</u>

Dr Paul D. Williams
Department of Meteorology, Reading University

Biography. Paul Williams was born in Durham in 1977. He graduated with a first class honours degree in Physics from Lincoln College, Oxford in 1999. He then took a DPhil in Atmospheric, Oceanic and Planetary Physics at Balliol College, Oxford, for which he was awarded the Royal Astronomical Society's Blackwell Prize for the best UK doctoral thesis in atmospheric physics. Paul is committed to improving the public understanding of climate science. He won a prize for his entry in the 2002 New Scientist essay competition. In 2003, he was commissioned to research and write a report, published by the European Parliament, reviewing the likely impacts of climate change upon South East England. Aged 29, he currently holds a Research Fellowship in the Centre for Global Atmospheric Modelling at Reading University.

Abstract. Global climate change represents a classic example of intergenerational inequity. It brings enormous implications for economics, particularly because of the possibility of a rapid reduction in the strength of the ocean's thermohaline circulation (often mistakenly referred to as the Gulf Stream). This talk will attempt to describe the current state of scientific knowledge regarding the possibility of such a reduction, with a view to guiding economics goals. The thermohaline circulation transports the heat equivalent of one million power stations to northern Europe, but global warming-induced changes in rainfall patterns and Arctic ice could lead to a reduction in its strength. This would cool the northern hemisphere and reduce the net global primary productivity of vegetation. A survey of delegates at a recent climate change conference revealed a wide disagreement about the probability of a reduction in thermohaline circulation strength. It is hoped that such uncertainties will be reduced by a major UK research programme that is currently underway.

Text. Climate change represents a classic example of intergenerational inequity. The climate system responds to changes in atmospheric greenhouse gas forcing on timescales of decades or longer, due to the large heat capacity of the ocean, which is the driver of climate. Therefore, the generation of people that emits the greenhouse gases will always precede the generation that has to suffer the climatic changes caused.

Of particular concern is the possibility of relatively rapid climate changes caused by variations in the ocean's thermohaline circulation (THC), so-called because it is driven by variations in the temperature ('thermo') and salinity ('haline') of sea water. The term

‘Gulf Stream’ is often mistakenly used as a synonym for the THC, but in fact the two are distinct.

In the Atlantic Ocean, the THC brings equatorial surface water northwards. Because this water is warm, evaporation of water molecules to the atmosphere is high. Salty and therefore dense water is left behind, which eventually becomes so heavy that it sinks around Greenland and returns southwards near the ocean floor. This current transports over one petawatt of heat to northern Europe (the equivalent of one million power stations), propping up temperatures by as much as ten degrees.

The THC is maintained by a self-sustaining cycle of events: water sinks near Greenland because it is dense; it is dense because it is salty; it is salty because evaporation is high; evaporation is high because it is warm; it is warm because it comes northwards from the tropics; and it comes northwards from the tropics because it replaces water which sinks near Greenland. This is the classic chicken-and-egg situation, in which it is impossible to define a meaningful starting point to the chain.

The existence of the THC therefore depends upon a potentially delicate chain of feedbacks. One current concern of climate scientists is that global warming is likely to produce increases in rainfall in the North Atlantic region (e.g. Russell et al., 1995), plus an influx of fresh water due to the melting of Arctic ice (e.g. Stroeve et al., 2005). These effects are both likely to make the surface waters lighter and less able to sink, which could significantly reduce the strength of the THC, with profound implications for the climate of Europe. Unfortunately, the fate of the THC is notoriously difficult to estimate, with different computer models giving very different predictions (IPCC, 2001).

Vellinga & Wood (2002) have analyzed the impacts of a collapse of the THC using a state-of-the-art computer model. In first 50 years after the collapse, the surface air temperature in the northern hemisphere cools by 1-2 degrees on average (up to 8 degrees locally). The southern hemisphere warms by 0.2 degrees on average (up to 1 degree locally). Drier soil conditions occur over Europe and Asia due to a stronger reduction in precipitation than evaporation. Colder and drier conditions in much of the northern hemisphere reduce the net primary productivity of terrestrial vegetation. This is only partly compensated by an increase in productivity in the southern hemisphere. The total global net primary productivity of vegetation decreases by 5%, with important implications for food provision.

So concerning is the possibility of rapid climate change that the UK’s Natural Environment Research Council has set up a £20 million, six-year (2001-2007) programme to research it. The programme aims to improve our ability to quantify the probability and magnitude of future rapid change in climate, with a main (but not exclusive) focus on the role of the THC.

A picture of the views on THC collapse held by leading UK climate researchers was recently provided by Challenor (2005). He conducted a survey of delegates at a rapid climate change conference at the University of Swansea in 2005. Each delegate was asked two questions:

> "*What do you think is the probability of the THC weakening rapidly enough to have a discernable impact on the climate of the UK and NW Europe by 2100?*"; and
>
> "*Do you consider yourself to be an expert, have some expertise, have little expertise, or be complete amateur?*"

There were 67 respondents, and the distribution of probabilities was broad and ranged from 0.1% to 100%. The estimated probability decreased with increasing expertise, although the decrease appeared not to be statistically significant. These findings indicate the existence of a large uncertainty in the science, hindering an assessment of the economic implications, reinforcing the need for further research, and suggesting a precautionary principle-based response until such a time as the science is better understood.

References

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