Chapter 7

Climate Change Science and Policy in the UK: An Over-Identified Scientific Problem in a Context of Political Intransigence

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A frequent paradox of global environmental issues is the stark contrast between the vast and often highly effective efforts and resources devoted to identification and study of an environmental problem, and the subsequent, repeated failures of policy and political measures to address the issue in substantive terms. Climate change might serve as the cause célèbre of this phenomenon.

The investment of resources into all sorts of research around climate change in the UK is considerable, and represents a quite major investment and commitment to the field. The study of global climate change is perceived as one of the key strengths of the UK's environmental research base, and heralded as a growth-point in the context of a competitive, globalized sphere of research activity. The instrumental benefits of research leadership are explicitly recognized among opinion-makers in the research and policy communities. These include positioning the UK as a leader in international negotiations (UN and EU) and in the provision of information which could be presented as assisting the productivity and competitiveness of "UK plc" (public limited company, the legal term for publicly-quoted companies in the UK) and a key requirement of research since the publication of the government's white paper on science "Realizing Our

Potential" in 1993 (HMG 1993). I will call this emphasis on world leadership in science the "elite strategy."

An element of national pride is also significant here. Never far from the surface in British political and public life of the post-war period has been the pervading sense of long-term national decline. This sense of decline infiltrates many different policy arenas with mixed results, but among elites it sometimes asserts itself as a form of patriotism and strained self-assurance. The scientific elite is no more immune to this than others. In the meteorological and climatological fields, that elite has centred principally around the UK Meteorological Office (UKMO) and the Royal Society. One voice of that scientific elite, a former Director of the UKMO, expressed this sentiment well at a meeting in March 1996 on a UK strategy for global environmental change research when he said that the UK had to be good at <u>something</u> at least, climate change research being one such area, and hence resources should continue to be directed towards this field.

The elite strategy implies relative marginalization of research not deemed to be "world-class," and a concentration of resources and personnel into a fairly tightly controlled scientific network. Understandably, there is resistance to an elite strategy from scientists who feel marginalized from the central research nexus. Less centrally coordinated and managed research is still possible, however, because there continue to be several channels of research funding, and some competition exists between the principal funders.

The elite strategy has also meant a privileging of the harder natural sciences over the softer varieties such as geography (seen as "woolly" and inexact) and social sciences (not really regarded as sciences at all). Of all the social sciences, economics has fared the best, but its

influence has been damaged by controversies within the social sciences concerning economic theory and precepts; skepticism among natural scientists; and the difficulties of implementing economic-based environmental policies with tools such as contingent valuation. One important case in point was the debacle at the IPCC's Working Group III during the preparation of Chapter 6 of the Second Assessment Report (SAR) over use of a "statistical valuation of life" measure for assessing the differential costs of climate change in different regions of the world (IPCC 1996a). This approach not only angered some development-oriented NGOs, but was also widely rejected by many in the economics and policy analysis peer community. David Pearce, a prominent British environmental economist, was a principal architect of the approach in Chapter 6. One senior British government official noted in response to the controversy that economists appeared to be taking decisions which ought to be political (personal communication, May 1996). This episode, and the effect of recent UK risk scares and controversies such as "mad cow disease" and the disposal of the Brent Spar oil platform in the North Sea, has raised the standing of the interpretative social sciences among decision makers, though still not very much in the climate change domain (Royal Society 1997).

Climate change research in the UK is certainly in a healthy state compared to many other research fields, some of which are adjusting to a "steady-state" or being down-sized as the limitations of the national research budget force greater prioritization upon funding agencies. Within the climate change field itself, recent priorities have allowed some specialties, such as climate modeling, oceanography, satellite-based observations, and some biological and ecological studies of impacts and adaptations, to do very well. Meanwhile, other specialties — notably including integrated environmental assessment (IEA) and regional studies of climate impacts — receive very little support.

In the mid- to late-1980s, the UK government perceived climate change as a scientifically defined issue which would lend itself to precise quantitatively-driven policy-making and which would be manageable by existing or emerging policy instruments. At that time a rational approach to environmental policy was in vogue, involving use of economic-based instruments (EBIs) to internalize the "true" environmental costs of economic activity and employing the best scientific information to inform planning decisions. The nuclear power option, promoted during this period by Prime Minister Thatcher and other ministers as an attractive solution to the climate change problem, was one early victim of these market-based approaches. Privatization of the energy sector revealed that nuclear power was not being judged at true costs and, because of public opposition and uncertain decommissioning costs, was regarded as very risky by the financial sector. As the 1990s wore on, the promise of EBIs failed to materialize, because of (inter alia) inadequate knowledge and political opposition. With the failure of the EU Commission's energy tax proposal in the early- to mid-1990s (Collier and Lofstedt 1997), and domestic political opposition to environmental taxation, the scope of climate change policy became more limited. A new set of sector-specific "solutions" had to be developed. These more modest policies were "bolted-on" to existing policy initiatives.

In the early- to mid-1990s, the UK government invested moderate resources into a wide-ranging consultation process focused on reducing greenhouse gas emissions. It also developed and operated voluntary information, advisory, and partnership schemes with the private and public sectors. The government has also supported an extensive, and expensive, advertising campaign to advise the public on energy efficiency. More ambitious policy measures have met with mixed fortunes. In general, these remained strongly shaped by the market-based individual choice paradigm which has become anchored within the government over the past two decades.

The hegemony of this paradigm has seriously limited the exploration and evaluation of bolder, more pro-active and ambitious policy measures. Hence, however effective the scientific research infrastructure has proven to be at providing new knowledge about climate change and contributing to the IPCC process, the experience of doing something about the problem by means of domestic policies has been far less encouraging.

How can policy and political intransigence co-exist so readily with an authoritative, threat-producing scientific infrastructure of world standing? Since one might have expected to find a credibility gap for politicians and/or an alienated scientific community, this fact stands in need of explanation.

An important basis for this co-existence may be the presence of a distinct climate science/climate policy interface, described below, as the principal channel by which scientific knowledge of climate change reaches government. Its existence permits government to be seen to be taking serious note of climate change knowledge. But the divorce between climate policy, and policy making in transportation, finance, taxation, and energy, means that government can also end up in stalemate and intransigence. Furthermore, natural science knowledge of climate change is far from that knowledge which is “useable” (Lindblom & Cohen 1979) within the bureaucracy for making specific policy decisions aimed at reducing greenhouse gas emissions. Responsibility for this intransigence can also be rhetorically distributed beyond government to all the surrounding policy communities, and ultimately to individual citizens as consumers, energy users, automobile drivers, and so on. Scientific uncertainty can also be rhetorically deployed to reduce the credibility gap in a mutually convenient manner: taking the heat off politicians as they complain about how difficult it is to take decisions when everything is so

uncertain, and providing an ongoing rationale for scientists' work. It is even possible that scientific uncertainty might obstruct active participation from positions outside the science-policy discourse, because as long as there is the perception of basic scientific uncertainty other social actors — professional associations, industrialists, journalists, environmentalists, members of the public, etc. — may feel relatively disempowered and respond passively to the climate issue.

On May 1, 1997, the Conservative government of 18 years standing was demolished in the general election and a new Labor government was elected. The flavor of British political life has definitely changed since then, with a more pro-active approach to public policy initiatives on social and environmental issues emerging, especially around transportation. Gone is the frequently zealous free-market and anti-intervention ideology of the past two decades, which so often seemed to hold back any real policy reform or measures directed at changing patterns of energy consumption, industrial and agricultural practice, and transport. The new Deputy Prime Minister, John Prescott, played an important brokering role at Kyoto and has staked some of his political reputation on the environment, seen as intertwined with other social and political concerns. The Labor government has a long-standing manifesto commitment to an ambitious greenhouse gas emission reduction target of 20 percent by the year 2010, and has claimed that this target is independent of Kyoto or EU commitments. Since it is still too early to comment on the climate change policy of the new Labor government, this chapter concentrates on the period from the late 1980s to 1997.

Research Identifying the Problem and Analyzing Solutions

Much of the climate change research in the UK has concentrated on problem identification and characterization. The guiding questions have been: is there a problem of anthropogenic climate change? What sort of a problem? How much climate change might occur, and with what impacts? Much less has research concentrated on possible responses and analysis of policy options, though there have been "pockets" of activity here, for example around energy efficiency in buildings, macro-economic modeling, studies of "true-costing" of environmental externalities and assessments of the environmental consequences of energy privatization, and removal of subsidies. Compared to the natural science work on problem identification/characterization, such research tends to be far less visible and relatively "privatized" in the UK. Hence it is difficult to determine its actual extent and influence.

The focus on natural science is partly a consequence of existing national strengths, especially the investment made since the mid-1970s in climate modeling. Another factor is the government's massive withdrawal from energy R&D during the 1990s, justified by the privatization of the energy supply industry and particularly the running-down of nuclear energy, which previously absorbed a large proportion of publicly-funded energy R&D. One side-effect has been less resources available for impacts and policy research in the energy-environment and climate change fields. But it is also a result of an elite scientific and political culture in which "good science" has been regarded as the prime driver of good policy (e.g. Mason 1994). "Good science" in that culture meant the harder natural sciences, which might be "contaminate" by more applied R&D, let alone by contact with the social "sciences" (cf. Boehmer-Christiansen 1992, 1995). This kind of scientism has also dovetailed neatly with the policy paradigm of non-

interventionism, since it focuses government's efforts upon the upstream provision of information and problem assessment, rather than on interfering with the provision of solutions and new technologies, which are regarded as the prime responsibility of the market sector.

Scientism as it is generally understood flows smoothly from the belief that what effective policy formulation and implementation most needs is robust knowledge (with physics as the gold standard). Improvements in the form, scope, and certainty of knowledge, such that advances in system representation, comprehension, prediction and control occur, are regarded as improving the policy response and its likely effectiveness. Clearly such simplistic accounts do not carry much weight among most policy makers themselves — immersed as they are in the political complexity of organizational and institutional negotiations — nor among the many scientists who reject the de-politicization inherent in scientism. In short, many scientists and policy makers are only too aware of the limitations of "linear models" of science for policy.

Nevertheless, the belief in knowledge to inspire and guide policy is a persistent theme and all actors in the climate field do, at some stages, allude to it. Hence, it is more realistic to regard scientism as a resource — a ready-made set of arguments and beliefs which will be drawn upon in some contexts and in some debates, and which has a strong historical legacy. The authority of scientific consensus on the reality and seriousness of climate change is an important resource for those environment department officials and chief scientists who have to argue the climate cause against skeptical officials and ministers from finance, transport, trade and industry and their extended clienteles and networks in industry and finance. Natural science knowledge channeled into a few punchy consensus statements does not leave so many options open for the skeptical or reluctant. As Ezrahi notes (1990), the ability of science to anchor a wide range of

policy actors, and to provide them with authoritative systems of accountability, has been key to the continued persistence of technical instrumentalism in late modern society, even when all involved know the reality of decisionmaking to be more complex and messy. This is why the active promotion of the climate change issue by elite establishment scientists such as Sir John Houghton, former Chief Executive of the UKMO and co-chair of IPCC WGI, has been so important in the UK context.

Arrayed against scientism has been the role of political and policy judgment. A cherished ideal of the British civil service, such judgment is believed to emerge from wide-ranging and lengthy service to the Crown. This is a very practical, process-oriented skill at assessing and mediating policy in its rich social and political complexity. Individuals with such qualities come to embody that mixture of knowledge, social intelligence, and authority which a pure scientism would wish to formalize in an intellectual construct such as integrated environmental assessment (IEA). Not surprisingly, such civil servants resist the notion that their authority and experience can be traded for an integrated assessment by expert scientists, preferring a well-demarcated role for experts as advisors on specific issue components.

Hence, we find scientism and a more tacit expert judgment co-existing, with policy actors deploying both accounts at different times and contexts. This epistemological table-tennis is also visible among the scientific advisors and science-policy gatekeepers (Shackley & Darier, forthcoming). The co-existence of the “pure” and more “hybrid” accounts (Latour 1993; Gilbert & Mulkay 1984) reflects the fact that intellectual consistency is not a requisite feature of real-life political practice; indeed, ambiguity and flexibility are important resources for policy actors and their knowledge-sponsors in the fluid and ever-changing policy nexus. In general, the scientistic

account is most commonly deployed when the context is outward-looking and involves social actors less familiar with the climate issue, who need to be persuaded, to be brought "on board." The judgmental account is reserved for more inward and informal deliberations with the insider community of policy actors and scientists.

For all these reasons, British climate change research in the last decade has focused on the identification of threats, not on the solution to policy problems, with the exceptions tending to be the consequence of opportunistic maneuvering by existing organizations, rather than of overall planning and explicit research policy. British climate science remains wedded to particular, rather sharply defined disciplinary knowledge, although interdisciplinarity is beginning to emerge in some areas (such as coupling of ocean and atmospheric circulation models). The climate scientist is expected to excel in a specialty and to feed advice into the policy process when called upon, rather than to second-guess policy requirements or to surrender quality in some over-ambitious integration exercise. Neither is the "activist-scientist," who finds a viable niche in the US system, welcome in the UK science-policy system; such people are commonly seen as trouble-makers who are motivated, and their science tainted, by extreme or marginal politics (or by alienation).

The Model as Cassandra: The Hadley Centre

I now turn to a discussion of the principal organization for provision of scientific advice on climate change to the UK government: the UKMO Hadley Centre (HC) for Climate Prediction and Research. How has the HC identified the climate problem and what is distinctive about its institutional and scientific roles?

The HC's approach is founded on a commitment to climate models as the source of the best possible analysis of climate change and its anthropogenic components. The HC also compiles and analyzes global observational data sets, but modeling activity is dominant. As Sir John Houghton explained at the opening of the HC in 1990: "The numerical model is an effective way — in fact the only way we know — of dealing in a meaningful way with all the non-linearities involved." The HC is also committed to representing the entire range of physical processes in the general circulation model (GCM) framework. As a result, they are driven to include more and more detail within the GCM so as to incorporate the complexity of the feedbacks and interactions, as the following quote from a HC publication illustrates.

> Representations of processes in the atmosphere, on land and in the ocean have steadily become more comprehensive with each successive version of the climate model. The need to include the full range of climate forcings and feedbacks has led to the development of models representing the sulfur cycle, the carbon cycle on land and in the ocean, and chemical processes. These have been used independently to start with, and are being incorporated progressively into the climate model (1996:1).

The implicit assumption is that greater realism will generate greater accuracy and hence trust in the projections. However, as I pointed out in Chapter 5 (this volume), in more policy-relevant research this purist orientation tends to give way to a pragmatist orientation geared towards producing future change scenarios.

The origins of the HC lie in the intersections between a range of influential policy actors in the mid- to late 1980s, especially the UK Department of the Environment (UKDoE), the

UKMO, and Prime Minister Thatcher, whose "conversion" and advocacy of global environmental issues from 1988 onwards has been well documented and analyzed. Boehmer-Christiansen (1995) has written informatively about the more explicitly political dimensions, including the role of energy policy, resistance to European Community-level policy initiatives, and inter- and intra-ministerial power battles. Our focus here will be more limited.

Entrepreneurial scientists at UKMO appear to have identified an opportunity for new sources of financial support from government, the potential being enhanced by the UKMO's favorable and trusted reputation within government among a range of departments, and effectively being treated by those departments as "one of us." Support of a new climate modeling center matched Thatcher's strategy towards research more generally, namely, to direct money toward those scientists who were "winners" in a global sense, bypassing established funding advisory mechanisms. She was impressed by scientists such as James Lovelock who excelled in the absence of institutional backing. But some of Thatcher's actions appear to have stemmed from the sense of patriotism we noted above: she wanted to support UK Research plc where it was most likely to excel internationally, and climate change was undoubtedly one of the strongest and internationally-relevant contenders. (After all, until the mid- to late-1980s there were no large GCM groups outside the USA except John Mitchell's small team at the UKMO.) In addition, Thatcher made much of the distinction between local and global environmental issues; she promoted international "green" issues while bypassing policy action (and criticism) on local and national-level environmental problems (Thatcher 1993).

The third key actor in the formation of the HC was the UKDoE, which had gone through some relevant experiences during the 1980s. Ozone studies had illustrated the potential

limitations of two-dimensional atmospheric models not coupled to atmospheric chemistry processes. Meanwhile, the UKDoE was seen to have backed the "wrong side" scientifically during the acid rain debate within Europe. The UK had relied especially on experimental laboratory-based studies in its scientific assessment, arguably less appropriate than the model-based strategy adopted by some other countries (Hajer 1995). Both episodes left the UKDoE appearing less than fully committed to a high standard of environmental protection; in the 1980s the epithet "dirty man of Europe" achieved currency in describing the UK's environmental record. For these reasons, a complex model-based approach proposed by the UKMO — which lent itself to coupling of all major physical processes, which could be used in threat-detection and assessment, and which would likely secure a strong place for UK research within the IPCC assessment — was appealing to UKDoE.

Over-confidence in what GCMs could achieve, and by when, was common to all parties in this coalition of interests. Thatcher, for example, stated that:

> Of course, every detail of the forecast may not be quite right — it rarely is when you are trying to predict the future. ... particularly in trying to estimate the detailed distribution of the effect of global climate change ...We want to know what is happening in the regions; more than that, you want to know what is going to happen in each country. As the [IPCC] Panel's report itself makes clear, we should have a better understanding of many of these things in 10-15 years time, say by about the year 2005. By then, we shall have benefited from new measurements from satellites, from new and more powerful computers and the results now being done on ocean circulation. ...It will be on the basis of this

> [climate modeling] work that we shall be able to establish a realistic international programme of action and an equally realistic timetable (Prime Minister Thatcher, 1990).

The 10-15 year time frame for robust regional climate predictions, and the optimism about new technologies, indicate a misplaced confidence in GCMs relative to scientists' own understanding even at that time. The final sentence is a fairly typical expression of scientism which serves a rhetorical role in this context. A few years earlier, in 1988, a senior UKDoE official had assessed the resolution of key uncertainties in climate modeling and mapped out a trajectory of model development over the next 25 years or so, which looks in retrospect very over-confident (Shackley & Wynne 1996). The official title of the Hadley Centre includes the term "prediction," whereas climate scientists now agree — prompted by an influential paper from philosophers of science (Oreskes et al. 1994) — that "prediction" is a misleading term, since it suggests a probably impossible degree of precision and certainty. (This prompted the IPCC 1995 report to employ the term "projection" instead.)

Epistemic over-confidence on the part of policy actors was neither deliberately encouraged nor discouraged by key advisory scientists. After all, the scientists themselves were (and remain) confident in the GCM as the "best science" for climate change research, and the benefits flowing from policy patronage were obvious. Even if it were a matter of several decades, not just ten years, to achieve scientific closure, what realistic alternative was there? Also, policy actors' motivations probably did not rest entirely on their faith in future GCMs.

Epistemic over-confidence or not, the symbolic status and role of GCMs in international policy assessments provided a powerful rationale for promoting a leading role for them in the UK.[1]

In the first half of the 1990s, the policy community required the threat of climate change to be continually repeated and reinforced to keep the issue alive amidst the attempts by contrarians and some industrial interests to sideline it. The IPCC's 1990 consensus position was necessary but not sufficient; it had to be re-formulated and expressed with the aid of new experiments, new tools, better computers, new indicators, and so on. An important drive for the research community, meanwhile, is for novelty and priority in presenting new scientific findings, as well as a communal sense of "making progress." Hence, there was (and still is) a powerful pressure for GCMs to be continually developed and seemingly improved.

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[1] To bring the account up to date, we are now in a era of somewhat greater circumspection and caution in assessing tools for climate change research, and scientific knowledge for environmental policy more generally. The same senior UKDoE official mentioned above now explicitly rejects scientism and has argued for greater transparency in the underlying scientific basis for assessment as well as in the political assumptions presupposed by a response (Dr David Fisk, personal communication, July 1997). He also argues for an open approach to assessment, involving a range of disciplines and consultation with NGOs. Research scientists have also begun to express more caution about their methods and insights, listing all the caveats rather carefully. Boehmer-Christiansen (1994) is surely right to ask whether there is a social and "interests" dimension to such a shift.

Key developments in the HC GCM are indicated in Table 1.

— Table 1 about here —

The reproduction of the threat of climate change with ever more sophisticated models in the context of the IPCC and UNFCCC continues to provide a strong focus and rationale for research at the Hadley Centre. As the Director of the HC recently put it,

> .... the role of the [IPCC] has expanded rapidly to provide authoritative, up-to-date scientific advice to inform the [UNFCCC]. I am pleased that the Hadley Centre has played, and continues to play, a significant part in this progress. ...I am confident that we will continue to strengthen our research programme to meet short-term policy requirements and to conduct the longer-term research necessary to maintain a sound scientific understanding of climate issues (HC 1996: I).

The HC's scientific goals are closely tied to the IPCC's apparent "requirements." Of the HC's six stated aims[2], only one is primarily national in orientation, namely "to provide a focus

[2] They are: to understand climate processes and represent them in "increasingly realistic" models; to use models to simulate past climate change and to predict global and regional climate changes over the next 100 years; to use observations to monitor global and national climate trends; to explore attribution of recent climate change to human activities; and to advise government and the IPCC and to communicate results widely to the scientific community and the public.

for the interaction with other climate research institutes and activities, nationally and internationally."

About three-quarters of the HC's research is funded by UKDoE's Climate Prediction Programme (CPP), the remainder coming from the UKMO's own public meteorological service (in effect funded by the Ministry of Defence, as the ministerial-level overseer of the UKMO). The extent of UKDoE's support is indicated by the fact that the HC's CPP contract constitutes about two-thirds of the research budget of its Global Atmosphere Division and dwarfs any other UKDoE research grants in this area. In 1995-96 an evaluation of the CPP showed that the HC is seen by government, and by the research councils and leading scientists, as the hub of the UK's climate change research effort. The CPP evaluation was positive because it found that the HC had clearly established itself as a leading climate prediction center using state-of-the-art coupled GCMs; had developed close collaborative links with other research organizations nationally and internationally (especially relative to the UKMO's past, rather closed, culture); and had provided "timely advice to the UK government, which has allowed the UK to deliver authoritative scientific underpinning for negotiations at the Conference of Parties to the [UNFCCC] and contribute substantively to assessments of IPCC" (HC 1996:24).

The last point above refers to the presentation of a coupled AOGCM run with a representation of sulfate aerosols to the First Conference of the Parties to the FCCC in Berlin in March/April 1995 (COP-1). That work was regarded as important because it showed for the first time that a GCM which represented the cooling effects of sulfate aerosols could reproduce accurately the past instrumental record of temperature change (though major uncertainties persist in the available methodologies). One of the most powerful arguments of the skeptics had been

that most GCMs predicted a temperature change of 1°C over the last 100 years, but that only about a half of this had been observed; hence GCMs must be significantly in error. Hadley's demonstration of an ability to reproduce the known climate of the past century was widely regarded as a critical step in validating GCMs and putting confidence in their predictions of future change. In an interview, the Secretary of State for the Environment in the last government, Mr. John Gummer, mentioned the importance of this experiment; this was the only specific scientific insight he volunteered (November 1997).

The evaluation of the CPP articulated a specific role for the Hadley Centre as follows:

> The close interaction between the CPP, the wider scientific community, and the DoE's policy context makes the Hadley Centre unique among the principal climate research centers. The CPP cannot exist in isolation, and the correct balance between policy-led experiments and innovative research must be struck in order that all parties benefit and that DoE is provided with credible advice on climate issues. In particular, the programme draws heavily on many other components of the research base elsewhere in the Hadley Centre, the rest of the Met. Office and in other institutes in the UK and internationally (HC 1996:24).

Reading between the lines, this paragraph perhaps aims to legitimate more basic, purist-style research at the HC, and makes a point of relating the HC's work to other basic research programs. The context of the evaluation was DoE's need for policy deliverables from the HC in accounting for such research spending in a time of budgetary cutbacks, but there is a disparity between the required provision of new and policy-useful knowledge and the time scale of developing and operating a large complex model.

Social relations between the HC and UKDoE (and other government departments) are close, informal and rather private. The same UKDoE officials who manage the CPP contract also advise government ministers on scientific questions. They are scientists, usually trained to the doctoral level, and sometimes seconded from, or ex-employees of, the UKMO. The current head of the science unit within the UKDoE's Global Atmosphere Division, for example, worked previously at the UKMO, at one time in climate research. He also has an important role in the UK's delegation to the IPCC and UNFCCC. Such officials visit the HC frequently, and engage in continual verbal and written contact with the Director, Deputy Directors and other key scientists, though the Research Coordinator of the HC has the most important role here as the "gatekeeper" between the HC's 100-odd staff and the UKDoE (as well as having a similar role in relations with other outside organizations).

These relatively informal and personal contacts are integral to the UKDoE's assessment of the scientific research of the HC, and of climate change research internationally. Important ways in which trust has been built up include the UKDoE's requests from the HC for advice and comment on scientific issues; the HC's pro-active alerting of the UKDoE to controversial or important scientific advances; the HC's active participation in the IPCC; and, to a lesser extent, the HC's role at UNFCCC meetings, such as COP-1 and COP-3 (as witnessed by the presence of a UKDoE delegation at these meetings).

The organic emergence of the UKDoE-HC nexus is undoubtedly one CPP success, and has permitted the intriguing blend of "pure" and policy-applied research that was noted in the review of the CPP. In a sense, integration of research and policy is achieved by a relatively informal and closed social nexus involving a few key scientists who manage the HC research,

DoE officials, the GCM, the supercomputer and some in-house observational databases. Science and policy become intermingled and "mutually constructed" (Shackley and Wynne 1995) when the coterie of leading scientists, managers, and DoE officials collectively decide on what model runs need to be performed, and on how and when GCM output and observational records are analyzed and interpreted. That this is a viable form of science-policy integration reflects the significance of the symbolic warning role of climate science, for which GCMs are eminently suitable given their high status within the climate science community as the "best tools for the job" of climate change prediction. Priorities flowing out of mutual construction are, however, not the same as those from the specialties which contribute to GCMs. For example, one HC expert in the parameterization of the radiative effects of gases commented in 1993 that the problems with parameterizing sulfate aerosol effects were enormous. It was just not "do-able" science. Yet a year or so later, the Hadley model included a simple representation of sulfate aerosols in response to policy requests for a better test of the model's ability to simulate the past temperature record.

The UKDoE-HC nexus is also important in communicating the authority of the HC to other departments and ministries within government. DoE's close relationship with the HC increases the trustworthiness of the HC for other departments (though the UKMO also has separate links to the Ministry of Defence, Civil Aviation Authority, Ministry of Agriculture, and so on). Officials from the UK Department of Trade and Industry (UKDTI) treat the HC as the "natural" organizational source of scientific advice on climate issues. Seminars have been organized at the HC for the benefit of UKDTI officials (interviews, DTI, September 1996). But the UKDoE also benefits in its internal governmental relations from its close association with the

HC. Not only does any international-level recognition, influence and status of the HC reflect back favorably upon the DoE, but its leading role within government is reinforced.

Space precludes a deeper study of the UKDoE-HC nexus. Suffice it to say here that the HC is a rather hierarchical, cohesive and structured organization. The CPP, the GCM, and the supercomputer are important foci of work program planning, organization and control. Competition is perhaps rather strongly externalized, which may hinder development of research networks between the HC and other climate centers. The work occurs in distinct groups, with group leaders having a large say in what is done, by whom, and when. Individuals have less leeway and freedom than in a university research context; this may sometimes inhibit individual creativity and produce inertia or conservatism. The more hierarchical approach does, however, hold many compensating advantages in research which involves many different individuals acting in unison and sharing a central resource pool. The deputy directors and group leaders can deploy intellectual and material resources where they are most needed to promote the specific objectives of the CPP. The fact that the "higher-level" behavior of the GCM is only fully understood by a few senior modelers also gives them unique knowledge of the model and authority over its interpretation, hence over the work program. At the HC, climate modeling is a form of knowledge which invests the hierarchical approach with legitimacy.[3]

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[3] Developing a more horizontal intellectual and social organization might be seen as a luxury which the HC cannot afford given its CPP contract obligations. The hierarchical organization of the work undoubtedly influences other scientific practices, for example

If the focus of climate science for policy were to shift to the analysis of possible policy solutions, the UKDoE-HC nexus might cease to be so important for the integration and mutual construction of climate science and policy. There is some evidence that the scientific case for taking climate change seriously has now been accepted in the UK as a consequence of the greenhouse-gas-plus-sulfate-aerosols model run and the IPCC SAR's assessment that "the balance of evidence suggests a discernible human influence on global climate" (IPCC 1996:4). Also significant for governmental actors has been the political commitment to reduce greenhouse gas emissions, made at Berlin, Geneva and Kyoto (COP-1, -2 and -3), which effectively black-boxes the scientific arguments. Any remaining arguments that it is all too uncertain to act can be dealt with by reference to the so-called "precautionary principle" (interviews, DTI, Sept. 1996). In this emerging context, the key knowledge requirements derive less from climate modeling and more from "problem-solving" research on energy, transport, fiscal policy, and agriculture.

Other Research Programs

I have concentrated on the HC because it has by far the most influence on UKDoE climate policy making and is the most internationally visible UK scientific contribution. However, a large UK research community has also emerged over the past decade devoted to hydrological, ecological, physiological, and agricultural impacts of climate change, including feedbacks to climate processes. Oceanography, polar science, atmospheric chemistry, and

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uncertainty analysis and specific methodological choices such as the decision to use flux adjustment in coupled AO GCMs (see Shackley, Risbey, Stone and Wynne, forthcoming).

paleoclimatology communities, both modeling-oriented and empirically-based, are also highly active. These communities are typically less “dedicated” to climate change than the HC. They are much more fragmented, dispersed within university departments, and typically address disciplinary research questions. Climate change offered an opportunity for many of these researchers to continue their activities, changing their focus somewhat to align with new funding sources such as the TIGER (Terrestrial Impacts and Global Environmental Research program). Here I have space to discuss only a few of the prominent research communities and programs in the climate domain.

Research programs such as TIGER and BAGEC (Biological Adaptations to Global Environmental Change) have been funded by the Natural Environment Research Council (NERC) and Biotechnology and Biological Science Research Council (BBSRC). Their research policy, which MacKeron (1994) has described for TIGER as “occupying the territory: a science-led approach in which the direction of work, the choices of disciplines, and the subjects for study all depend on opportunistic captains” (MacKeron 1994) has not lent itself to policy-oriented comprehensive scientific analysis of the climate issue. Although such programs produced climate threat-type knowledge, the latter was more parochial and localized than the HC’s simulations (focused on a particular species, ecosystem, etc.), with little attempt at aggregation.

Nearest to a policy-driven impacts program has been the climate impacts study funded by the Scottish Office Agriculture and Fisheries Department (SOAFD). This aimed at assessing the impacts of climate change on Scottish agriculture, a research ambition which led to it tackling “all unavoidable obstacles on a narrow front between the present position and a defined objective” (MacKeron 1994). Hence, farm and rural economics featured as an important part of

the research program, and one of the key conceptual issues was how to relate the time and spatial scales typical of physical models to economic models. Of all the research programs discussed so far, this is the only one to have considered integration with non-natural science disciplines, the reasoning being that economic change is highly significant in influencing the effects of climate change upon agriculture, and the research has been policy-driven by that question.

Other research groups in the UK have integrated climate, crop physiological and agricultural economic models, notably the Climatic Research Unit (CRU) (University of East Anglia) and Environmental Change Unit (University of Oxford). Their funding has come mainly from other sources than the UKDoE or the research councils however: e.g. from the UKMAFF, DGXII (science directorate of the European Commission) and USEPA. Generally, however, the epistemic dominance of the natural sciences in the UK accounts for the absence of more genuinely integrated modeling efforts, even though they are certainly one logical conclusion of policy-relevant climate research. The philosophy has been that the respective scientific fields are too immature to warrant integration, and attempts to do so are of very uncertain quality (because, for example, they employ overly simple models or require large adjustment factors or other speculative approximations).

For the above reasons, integrated assessment modeling has not advanced in the UK. Some early studies in the field were conducted at CRU and University of Cambridge (the ESCAPE model, built in collaboration with the Netherlands' RIVM), but these were largely funded by DGXI (environment directorate of the EU Commission). The social sciences have had more success in disciplinary-based economic studies of climate change, especially the work of CSERGE (Centre for Social and Economic Research on the Global Environment) and the RIIA

(Royal Institute for International Affairs) in the areas of valuation of the economic costs, assessment of economic policy options, and how a climate convention might progress.

It is probably fair to say that the UK government has been most comfortable with natural-social science integration at the sectoral level in an instrumental and realist framework, for example via studies of greenhouse gas emissions from specific types of land-use. The recently initiated UK Climate Impacts Programme under DoE indicates a move towards integration at the regional level. A limited shift in the research community is also witnessed by the 1996 report of the Interagency Committee on Global Environmental Change (IACGEC 1996), a loose coordination mechanism between the research councils and the other major funders, which embraced a more holistic and integrated vision of global environmental research, as a supplement to discipline-based studies. It is telling that in its six identified growth points, however, IACGEC does not prioritize integrated environmental assessment or modeling, but focuses on discipline-based opportunities.

Political Intransigence: Breaching the Gulf Between Climate Policy and Greenhouse Gas Emission Reductions

In many ways the UK has enjoyed a highly effective interface between climate science and the UKDoE, the lead agency within government in formulating climate policy. The climate change issue has been rather effectively communicated to, and heard by, the core of government, and has attained a fairly strong presence in the media and in public discourse. This has been assisted by a long run of unusually warm weather, especially the drought of 1995 (extending into 1996 in many regions); press reports have frequently discussed its relation to global climate

change. Yet a major gulf remains between such threat recognition and effective policy and political actions. If nothing else, this illustrates convincingly that the "climate problem" is not one of a lack of knowledge or scientific understanding on the part of key policy actors (though different conceptual frameworks, such as what time scales are deemed to be of most significance, might contribute to intransigence).

As I have noted, thinking in the mid- to late-1980s promised much better connections between problem and solution identification through the increasing internalization of environmental costs, the initial steps being privatization of energy supply and removal of subsidies for coal mining. The uptake of the climate change problem at that time coincided with the emergence of a new commitment and belief within the UKDoE that environmental economics would provide a rational, cost-efficient basis for environmental policy, one which would be difficult for economic and industry ministries to dispute. Chris Patten, then Secretary of State for the Environment, appointed prominent environmental economist David Pearce to articulate this viewpoint, resulting in an influential book, Blueprint for a Green Economy (1989). Pearce and his colleagues devoted much effort to the climate change issue from that time onwards. The main thrust of their work has been that not only is it possible to conduct cost-benefit analysis of climate change, but that such analysis will be ready in the near future. (For a critique, see Adams 1995.) So, in the late 1980s, it seemed that climate change policy could be dealt with almost as a branch of economic policy, informed by the best scientific analysis of the Hadley Centre and climate impacts community.

The lack of practical success in economic-based environmental policy in the 1990s can be attributed to problems in acquiring sufficiently robust knowledge, and opposition (from many

quarters) which often bypassed the “rational” policy decision process. The financial market’s reluctance to risk the nuclear power option also suggested that markets were less controllable policy vehicles than traditional planning. Without an overall policy framework such as an energy tax, climate change policy has become not only more modest, but also more concentrated within sectors. O’Riordan and colleagues (1996) note that climate change policy has always to be translated further, into sector-specific policies. An aggregate emission-reduction target requires translation into “transport policy,” “energy policy,” “agricultural policy,” and so forth. The “problem” is that policy makers in those domains do not currently perceive climate change as a dominant concern. Hence they are likely to translate a climate-driven policy initiative to agree broadly with their own key objectives and criteria. This introduces a further level of complexity and contingency into the climate policy process. Similarly, at the level of the individual citizen or firm, climate change is not a readily identified or identifiable concern or criterion for assessing actions. Thus some translation of policy into a more readily accessible form is necessary if it is to be effective at such levels, and the policy framework or paradigm will have much influence on the dominant mode of translation.

O’Riordan and colleagues (1996) note that in the distributed policy communities which collectively make climate change policy, any one government department is unlikely to exert its exclusive will. Rather, coalition- and consensus-building must be undertaken with industry, NGOs, other departments and levels of government, etc., all of whom will shape the policy discourse, so that it ends up looking different from the activists’ or promoters’ initial conception. That socio-political process occurs through certain frameworks or paradigms of understanding, which also shape the discourse coalition, though not in a deterministic way. And herein lies the

obvious, but important, fact that policymaking is a negotiated process, contingent and unpredictable.

The last Conservative government had fairly powerful and consistent policy frameworks. Some of these still remain, including a concept of government's role as partnership with other social actors, i.e. a preference for voluntary and economic-based instruments rather than regulation or other intervention. Economic efficiency and cost-effectiveness were important banners throughout the 1980s and 1990s, and government implicitly took for granted that policy actions would have to have a very powerful rationale if there was any perceived threat to the competitiveness of "UK plc" — a sentiment which lives on in the Department of Trade and Industry. It is clear from presentations by senior civil servants and by John Gummer that the climate change problem was regarded by government as a shared responsibility: government could only do so much, because of the role of the individual consumer, and it was not about to force unilateral change upon individuals or the private sector. This laissez faire approach perceived individuals and companies as best placed to make optimal decisions; government intervention would only frustrate social actors while reducing efficiency. Government defined its key role as provision of the best available information to social actors, and much of its research and policy initiatives were premised on confidence in this strategy. For example, many millions of pounds were spent on an advertisement campaign, "Helping the Earth Begins At Home," which appealed to individuals' personal avarice (and secondarily to their moral sense of personal responsibility), to reduce energy consumption by closing curtains, using energy efficient light bulbs, driving more slowly, and so on. Unfortunately, according to qualitative research, the assumption of trust in the Energy Efficiency Office's exhortations, and of government's

intentions and motivations more generally, was mistaken, suggesting only limited success for the campaign (Hinchliffe 1996).

Much of the problem with government's attempt to extend responsibility was that many social actors and citizens still believed that government should first take steps to demonstrate that it took its responsibility seriously. For example, while many social actors were pleased to be involved in the policy consultation of 1994 which led to the UK's climate action plan, all groups — including industry — were evidently suspicious that the government was shedding its responsibility, under the guise of greater participation. Thus government promoted its vision of shared responsibility to many social actors who did not entirely agree. This more normative interpretation of "participation" rhetoric is supported by a statement in the UK's national climate plan: "Participation is also a central part of the marketing strategy for the 'Helping the Earth Begins At Home' publicity campaign" (HMG 1994:59). Unfortunately, this hardly leaves open the possibility of "bottom-up" problem definitions and ideas about solutions. Indeed, consultation is rather strictly limited to elite stakeholders, and their assistance is especially sought by government in selling the finished product as a "package" to the public.

O'Riordan and colleagues note that successful climate-related policies are ones which fit within the prevailing issue-framing(s) or paradigm(s), while also being agreeable to, and hence promoted by, the relevant policy coalitions. So, for example, climate-related transportation policy has been very limited because of the influence of the car lobby, which has restricted the incorporation of environmental considerations. The Energy Savings Trust (EST) was a proposed levy on energy suppliers to fund energy efficiency programs, and fit well with the approach of the last government, as O'Riordan and Rowbotham note: "It combines a private money raising

initiative with a public purpose, and couples a consumer levy to a consumer gain without the need for intervention" (1996:252). However, the EST ran into problems when the new head of the regulatory office for the gas industry objected to the scheme in the absence of a legislative basis for what was effectively a tax. The fate of the EST came to be influenced by the contingent facts that the regulatory office was an institutional innovation, with uncertain levels of discretion, as well as by the reluctance of the Tory backbench to support a new legal basis for the EST.

Formal taxation proposals have included a value-added tax (VAT) on domestic fuel prices. Again, however, political contingency intervened and prevented the imposition of the full 17.5 percent rate, settling at 8 percent instead because of bipartisan opposition to the perceived high costs to the poor and elderly. Meanwhile, a constant 5 percent per annum levy on petrol has so far been more successful: "Here is an example where the market force interest of the government coincides with the determination to raise revenue by indirect taxation" (O'Riordan & Rowbotham 1996:249). The above authors summarize the last UK government's climate policy as follows:

> This is a modest package. The cost is low, the impact will contain cost-effective zones, and the structural change will be all but zero. Most of the promises are based on the rules of information provision, voluntary compliance and general exhortation to civic duty. Non-intervention, a core institutional parameter, remains a primary policy factor in limiting action (1996:261).

There are also, however, important differences in how government departments frame climate change issues. For example, UKDoE wishes to see "realistic" pricing of environmental goods and externalities. This applies to energy sources, so that subsidies on nuclear and coal

energy sources will be removed (now partially achieved), and to inclusion of the environmental costs of transport (a longer-term ambition). Policy Planning Guidance 13 (PPG 13) has been issued by UKDoE to encourage out of town planning which does not necessitate use of cars. UKDoE also appears to be committed to the eventual achievement of sustainable CO_2 emission trajectories, implying medium to long-term changes in lifestyle and a greater role for environmental criteria in planning decisions.

The limitations of policy initiatives aside, it could be argued that the UK's recent record is rather good, with the year 2000 target of stabilization (and even reduction) firmly in hand. However, the "dash to gas" — more connected to privatization of the energy supply industry than to any deliberate climate policy — largely explains the achievement of stabilization. And it is revealing that the former government only suggested the reduction target (of between 5 and 10 percent by the year 2010) after the Department of Trade and Industry had determined that reductions of this order could be achieved at zero economic cost, due to the continued move to natural gas and more efficient energy conversion technologies (interviews, DTI, September 1996).

As part of the EU's negotiating position for Kyoto — namely, a 15 percent reduction in emissions of carbon dioxide, methane and nitrous oxide by the year 2010 — the UK agreed in March 1997 to reduce its emissions of those gases by 10 percent by 2010. Consistent with the government's own economic analysis, one report indicated that 6-7 percent of that reduction would have taken place even without a greenhouse gas abatement policy (ENDS 1997). Nevertheless, the fact that any reduction target was agreed at all is noteworthy, considering that the last Conservative government was generally hostile to EU policy initiatives and there was

skepticism from leading politicians to differentiated targets within the EU (interview John Gummer, Nov. 1997). The Dutch Presidency's negotiation of the minus 15 percent target occurred at a time (February and March 1997) when a general election campaign was in full swing in the UK. It appears that the UK's agreement to the minus 10 percent target, supported by the minister John Gummer, was not widely challenged by Tory colleagues who had on their minds the more immediate concern of fighting to save their government (ibid.).

Concluding Comments

We have observed how climate change arose as a major issue for policy and research in the UK in the late 1980s. A window of opportunity emerged between the successful fields of climate modeling and data analysis; high-level political ambitions and entrepreneurship; and an emerging policy consensus within the Department of the Environment around internalizing external environmental costs. In retrospect, the potential of climate change modeling for robust regional scenarios of climate change was over-estimated, as was the potential (in both knowledge and political terms) for economic-based climate change policy. The two sets of knowledge-claims and beliefs reinforced one another in a wider elite context which favored scientism and promoted "world class" science for its own reasons, serving to advance climate change as public policy concern.

This elevation of climate change to the policy stage proved problematic when the anticipated progress in modeling and in the development and wider political acceptance of EBIs failed to emerge. Climate policy then fragmented and attached itself to sectoral policy initiatives. Because of this, climate change has become more closely related to a mixed bag of policy

programs, initiatives, beliefs, coalitions and framings in a diverse range of sectors, than to any single policy "solution." This multiple and diverse black-boxing of the climate change problem is, however, likely always to be necessary for effective actions to reduce greenhouse gas emissions.

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