Firm finances, weather derivatives and geography
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In practice the world is too complex for disciplines which wish to reduce its complexity. The grounds for post-disciplinary conversations are, clearly, less to do with making one discipline's obsessions and norms comparable with another. Rather, they derive from the realization that day-to-day practices undertaken by people going about their daily lives incorporate multiple influences that cannot be dismissed or downgraded merely because they do not fit within prevailing disciplinary norms of analysis or understanding. (Lee, 2002, p. 344).

1. Introduction

The UK Met Office has estimated that 70% of UK firms may be affected by the weather (Met Office, 2001); in the USA, estimates suggest that between 25% and 42% of the US gross domestic product (more than $2.7 trillion) is weather sensitive (National Research Council, 2003, p. 11). Examples of this weather sensitivity abound in the business pages of newspapers. Adverse weather, be it too warm, cool, wet or dry, affects the sale of goods and the day-to-day operations of transport, construction and utilities companies ([Anonymous, 2004a] and [Anonymous, 2004b]). Growing awareness and measurement of the economic costs of weather, fuelled by unease about climate change and weather variability, is one of the latest manifestations of scholarly and popular interest in the climate–society relationship.

This paper explores some intellectual and practical dimensions of collaboration between human and physical geographers who have explored how firms are using relatively new financial products – weather derivatives – to displace any costs of weather-related uncertainty and risk.[1] Our aim here is not to present an empirical examination of the weather derivatives industry or to focus on the limited nature of intra-disciplinary communication, but rather to draw attention to the possibilities and potentials of collaboration. There is little doubt that the human and physical strands of geography, conceived broadly, are characterized by markedly differing ontological positions, methodologies and work practices. Yet, the potential for synergistic interaction between the two sides of the discipline has, seemingly, long tormented the Anglo-American geography community and thus any current lack of integration should not be contrasted with a lost 'golden age' of harmonious interaction. Nevertheless, Western understandings of the relationship between society and nature do add to a general feeling that geographers could be contributing more assuredly to key contemporary debates.

The empirical focus of the paper is the nascent market in weather derivatives which has developed markedly during the last decade from its roots in North America. In what follows, we are not suggesting that geography as a disciplinary nexus is uniquely suited to a critical exploration of this market. We start from the premise that geography, however conceived, is not a naturally irreducible body of scientific thought and practice and we acknowledge the specificities of its social history buttressed by a whole range of vested interests as well as institutional and organizational structures. Nevertheless, we do argue that the confluence of knowledges existing within and across the geography academy – concerning meteorology, economy, the commodification of nature and risk – provide a potent intellectual milieu in which to explore weather derivatives. More to the point, as researchers, we share a commitment to collaborative efforts that explore the creative tensions between natural and social sciences. Further, we argue that when it comes to understanding the emergence of weather derivatives, working through our different, yet entangled, geographical knowledges is a very pragmatic (and also creative) strategy. The collaborative initiative outlined here is as much the consequence of the personal motivations and actions of the individuals involved, as it is the institutional and organizational context. Our collaboration was the product of a whole range of factors which conspired to produce a Ph.D. research project demanding input from areas of both human and physical geography. These included the particularities of Sam Randalls' (Ph.D. candidate) intellectual/academic development (characterized by links with both human geography and meteorological science), the willingness of the three supervisors (two 'human' geographers and one 'physical') to engage in debate 'across the divide' and, not least, the stimulus of an ESRC–NERC studentship.[2]

The paper is divided into three main sections. The first section briefly defines weather derivatives and indicates how they differ from standard weather insurance products. The second section outlines just some of the terrain covered through our collaboration by highlighting three elements in the creation of

weather derivatives during the mid-late 1990s; concern about climate change and variability, the deregulation of the US energy sector and the creeping commodification of atmosphere, weather and climate. In the third section we draw on our experience of this project to reflect more broadly on the challenges and benefits associated with the collaboration of human and physical geographers. We argue that conversations between physical and human geography remain, and are likely to become increasingly, pertinent. While academic geographers may still debate the precise nature of the relationship between human and physical geography, firms, forecasters and a host of financial and commercial intermediaries have already created or discovered compelling economic and strategic logics for combining and managing physical and social science knowledges. Moreover, their creation of this relatively new market in weather derivatives raises a host of urgent political and regulatory questions concerning the political and economic geographies of this form of financial 'fix' and the changing and deepening commodification of meteorological knowledges. Geographers are, at the very least, well positioned to take a lead in working across and beyond disciplinary boundaries to contribute to these questions and, as Clifford remarks (2002, p. 435) "No one owes us, as a discipline, a living". Through research, consulting and pedagogy, geographers have the potential to raise questions and to prompt academics, policy makers and others to think through knowledges around weather risk and uncertainty

1.1. Weather derivatives

As Rayner (2003, p. 280) has observed, humans "have attempted to domesticate weather, climate and their consequences for millennia", be it through technologies as diverse as clothing, building design, irrigation systems or, in the 1950s, through science-fiction imaginaries that predicted that late twentieth century cities would be domed to protect them from the elements (see Rayner, 2003). So, where do weather derivatives fit in this project of domesticating weather and how do they differ from more familiar weather insurance products?

Derivatives are assets, like futures or options, the value of which depends on the price of another 'underlying' asset. Given that weather *per se* cannot be traded, weather derivative contracts derive their value from selected meteorological indices (for example, temperature, wind-speed and rainfall indices computed from meteorological data) that correlate closely with 'real' weather. Weather derivatives are a relatively new financial innovation and they differ from traditional weather insurance instruments in three ways (Randalls, 2006). Standard insurance contracts are structured around two principal components, proof of loss and an insurable interest. Thus, firms taking out weather insurance must, first, have something at stake or something to lose and second, they must be able to prove that any loss sustained is the result of a particular weather event. A hotel proprietor in Florida, for example, may have hurricane insurance such that if, and only if, a hurricane causes damage to the hotel she/he may be compensated. Weather derivatives differ from these kinds of insurance contracts because they have neither of these two requirements. Firms do not need to specify any insurable interest or demonstrate that the weather has affected their business for them to be compensated. A third, and very important, difference is that weather insurance covers firms against high risk, low probability events normally caused by severe weather such as floods, hurricanes, windstorms and hailstorms. By contrast, weather derivatives are designed to compensate firms for low risk high-probability events, such as dry or wet periods or cold or warm seasons in a region that affect the turnover of businesses.

So, how does a firm use weather derivatives to manage the costs of the weather? Firms can use weather derivatives to protect themselves from the financial losses they might incur from, for example, a relatively warm winter (that would reduce profits for companies producing commodities like energy or soup) or, to give another example, a wetter than average summer (which might affect wine bars, restaurants or those selling ice creams). This ability to mitigate or 'hedge' is especially useful for firms in sectors that are highly weather sensitive. Using an example from the energy sector, a highly weather sensitive sector, a firm will purchase a weather derivative contract generally paying a small premium, so that in the event of, say, a warmer-than-average winter, they will be compensated (Thornes, 2003). Such 'winter hedges', in industry parlance, will often be purchased six to twelve months in advance and will cover a certain percentage of the risk the company faces. As the contract coverage period nears, the energy firm will use its meteorological expertise to make predictions about the future weather situation and either purchase increased cover or exercise options to reduce their cover. Weather derivatives thus allow a greater range of flexibility than insurance products. Moreover, in addition to providing firms with the ability to hedge against losses, weather derivatives also allow a

second possibility; if a firm has access to appropriate meteorological expertise, it can take advantage of any perceived mis-pricing to engage in speculative trading of weather derivative contracts.

2. Three elements in the creation of weather derivatives

2.1. Climate change and weather variability

Having established some of the characteristics of weather derivatives and how they are being used, it is important to consider the geo-political, cultural and economic context in which they have been created. While the experience, celebration and commiseration of weather has long provided a focal point in many societies (Strauss and Orlove, 2003), in the last 15 years the spectre of anthropogenic climate change has become a very powerful and increasingly visible discourse ([Shackley and Wynne, 1996], [Demeritt, 2001], [Ashford, 2002] and [Boehmer-Christiansen, 2003]). There is growing concern about rising levels of carbon dioxide and associated temperature increase and their climatological, economic, social, political and biological effects ([Houghton et al., 2001] and [Parker et al., 2004]). The Economist (Anonymous, 2000, p. 23) has argued that,

the time has come to accept that global warming is a credible enough threat to require a public-policy response.

Also important, however, is the growing mediation of our experiences of weather (see Rayner, 2003), buffered by infrastructure and mass media that now includes (at least in the USA) a 24-h Weather Channel, replete with commercial breaks offering videos of extreme weather events or, as Seabrook (2000) cited in Rayner (2003, p. 281) puts it, 'Weatherporn'.

This reporting of extreme weather events, like hurricanes and floods, is one of the most visible and now frequent manifestations of growing popular unease over climate change, ([Henderson-Sellers, 1998] and [Pearce, 2005]). Figures released at the International Climate Change Conference in Buenos Aires (December 2004) show that hurricanes, typhoons and other weather-related natural disasters in the first 10 months of 2004 cost the insurance industry just over $(US)35 billion, up from $16 billion in 2003. The uninsured economic losses from these events were estimated at about $90 billion (up from over $65 billion in 2003, Anonymous, 2004c). Losses were experienced most acutely in places like Grenada, Brazil and Haiti where hurricanes Ivan, Catarina and Jeanne wiped out homes, crops, sources of income and ways of life for thousands of inhabitants. Hurricane Katrina, that devasted New Orleans in August 2005, is estimated to be responsible for $75 billion in damages, making it the costliest hurricane in the United States' history. The extent of the uninsured economic losses remains unclear. In the short term, little can be done to prevent the physical damage caused by these extreme weather events, but their financial impacts have traditionally been mitigated, especially in more affluent economies, by weather insurance products. Insurance companies offering such products, in turn, mitigate their risk by taking out re-insurance. As insurance premiums rise, the affordability of such financial fixes diminishes, raising a whole series of questions about how such risks are 'managed' courtesy of the financial system and whether, indeed, there are other economic instruments that can be used to mitigate the impacts of weather and climate (see Leggett, 1996).

The growth of the market in weather derivatives, however, marks a rather different expression of concern about climate change. In addition to the practices of quantifying the costs of extreme weather events, there is now a growing trend to monitor, price and, courtesy of weather derivatives, displace the economic costs of more mundane, 'everyday' weather ([Geman, 1999] and [Banks, 2002]). The extent to which warmer/colder/wetter/windier-than-average weather affects profitability is now routinely calculated for a whole range of industries in North America and western Europe, from utility and energy companies through to construction firms, fashion retailers, restaurateurs and wine bars whose sales wax and wane with the weather.

The UK Met Office has estimated that weather costs UK businesses over £7.5 billion a year (Patel, 2003). Moreover in addition to *predicted* adverse weather, there is also the impact of forecasting errors. To give one example, just before the May bank holiday in 2003, the UK Met Office predicted a wet weekend, which had the effect of persuading people to head for indoor, and not outdoor, attractions. Given that the weekend in question was actually warm and sunny, owners of outdoor attractions were left counting the cost of the Met Office forecast. One outdoor venue owner in the Midlands argued,

The weathermen (sic) make me livid. I'm considering taking them to court for loss of earnings. The Met Office reports cost us a lot of money during the Easter Bank Holiday even though the weather turned out nice (Barkham, 2003, cited in Randalls, 2006).

While insurance policies will cover firms for losses experienced from extreme, rare events, weather derivative contracts offer firms the possibility to mitigate the effects of everyday weather trends.

2.2. The deregulation of the US energy sector

Weather derivatives are products of a very particular North American and, more recently, western European financial and regulatory imagination. Contracts were first developed in the United States in 1996/1997 by three energy companies, Enron,[3] Aquila[4] and Koch Industries.[5] The context for the development of weather derivatives lay in the deregulation of the US energy sector through the mid to late 1990s, which shifted the strategies of energy firms from those of monopoly providers to players in a deregulated market (Randalls, 2006). A strong El Nino winter in 1997–1998 (which reduced gas demand across the North-East of the US) and the relative simplicity of correlating gas demand with temperature (see Randalls, 2005) were also prompts that encouraged Enron (a key innovator in this market) and others to design and transact weather contracts that would allow them to hedge against (or simply speculate on) changes in the weather. This basis in the US energy sector was extended to Europe during 1998 as Enron opened a London weather derivatives base and transacted the first UK weather derivative deal with Scottish Hydropower. Weather derivatives are now being employed in a growing range of sectors including construction, retail and leisure.

While the early growth of the market reflected, in part, Enron's ambitions to be an important financial player (de Goede, 2004), firms are also being exposed to pressures to use the financial system to commodify, and thus displace, uncertainty about the economic effects of weather. As one broker put it:

People manage their foreign exchange rates, and if they don't and they lose money then questions are asked as to why they didn't manage it. I think the same thing has got to happen to weather. You can't carry on using it as an excuse, you know, profits are down because we didn't sell our coats, because it was a milder start to the winter. Well you can now hedge that risk, so no excuse. I think it's a question of educating people. (Interview with broker at European Energy Company, cited in Randalls, 2006).

Firms now find themselves in a cultural and financial environment that is becoming less tolerant of weather-related losses. The Weather Risk Management Association (WRMA), established in 1999, actively campaigns to firms, shareholders and, crucially, credit rating agencies, that weather should no longer be an excuse for poor profitability. While we have found no examples, thus far, of a company having its credit rating downgraded for not managing weather uncertainty or risk, there are examples of credit rating agencies praising companies for their active weather risk management (Randalls, 2006). It is not inconceivable to imagine a future in which the management of weather risk is as routine as the management of currency risk.

2.3. The commodification and production of atmosphere, weather and climate

Another fundamental aspect of the development of the weather derivatives market is the role of meteorological science and its evolving capacity to measure, forecast and render, in commodity form, knowledges of different atmospheric components The commodification of the atmosphere is not a new phenomenon and probably began in a direct form when nitrogen and oxygen were first extracted for commercial use in the nineteenth century. The atmosphere was originally considered to be a common good (Ausubel, 1980), but the activities of many governments and industries have increasingly challenged the concept of the atmosphere as a 'public good' characterised by 'non-excludability and non-rivalrous consumption' (Ellig, 1989). For example, the civil and military aviation industry has enclosed airspace for both safety and security reasons. Wind power involves the direct extraction of power from the atmosphere, a form of exploitation used by windmills and sailing boats for over thousands of years. More recently wind power has become a favoured, if subsidised, form of alternative 'clean' energy (Rowlands, 2005).

Similarly, the exploitation and commodification of weather has been much more widespread than is appreciated. Agriculture has always relied upon adequate sunshine, moisture and warmth. Such 'resources' have historically been priced indirectly with farmers suffering (and consumers paying more) when the appropriate weather resources were in short supply. The production of weather observations, since the invention of meteorological instruments such as thermometers, barometers, anemometers, pluviometers, hygrometers and so forth, has provided a valuable market for reliable weather data and instrumentation. Nevertheless, consistent sets of weather observations from around the globe have only been available for about the last 50 years and weather satellites and weather radar/lidar have added to the vast amount of weather data that are collected around the globe every

day. Today there are international agreements concerning the free exchange of weather data between countries who are members of the World Meteorological Organisation (WMO), but national meteorological services can sell their data for profit. The European Union insists that weather data are made available to consumers and private industry through *Ecomet* which maintains a catalogue of weather data and weather forecasting products. Weather data cost between 0.5 and 10 Euros per data point or individual observation depending on the amount of processing required. In the USA, however, government policy has meant that weather data are freely available[6] to weather companies and consumers (National Research Council, 2003). This becomes critical when one considers that the weather derivatives market is dependent on data and is increasing the value of certain forms of data.

The production of weather forecasts, since the advent of computerised Numerical Weather Prediction in the 1960s, has facilitated growth in the commodification of weather forecasting. Climate trading (also known as emissions trading) has given rise to a new, fast-growing profession of emissions brokers (Stowell, 2005) and an expansion of energy brokers into this new area. Global and regional models now forecast the weather up to 10 days ahead and both national weather services, outside the USA, and private weather companies sell these forecasts to government departments, industry, media and commerce. Generally the 24-h weather forecast is correct about six days out of seven (85%) but at site specific locations, for example, a reservoir or a farm or a holiday resort, the quality and value is much less ([Katz and Murphy, 1997] and [Thornes and Stephenson, 2001]). Since weather derivatives are settled on a particular station, forecasts may often be ill-suited for the requirements that derivatives traders require.

Commercial enterprises that rely on the weather and need advanced warning of changes in the weather to manage their businesses would still be vulnerable to weather risk even if 24-h weather forecasts were 100% accurate. In many business situations, the economic loss will still occur with a particular weather event regardless of how well it is forecast. Thus although weather forecasts form a key component of the weather derivatives market they also become somewhat redundant in economic risk mitigation strategies using the financial markets (Randalls, 2006). A firm's annual turnover may also be dependent on 'reliable' weather over a full year; weather forecasts can never fulfil this demand and thus weather derivatives have become an attractive option for some firms to hedge against unfavourable weather variations on a monthly/seasonal time-scale.

The relationship between weather prediction and business performance thus may not be just about a quantitative relationship, but also a stimulation of types of information with particular intended or unintended outcomes. As Shurmer-Smith argues (2002 p. 30), paraphrasing Marx, commodification is not just a matter of paying for things which were once free; it changes value in all senses. Commodification creates a desire for things and experiences which goes beyond need and want. There are signs that desire for weather and climate information is being stimulated. To take but one example, the UK Met Office announced in September 2005 that it was going to be a cold winter (Met Office, 2005). Following a sell-out workshop at the Royal Institution in London (at £495 per delegate or £250 for a CD-Rom of the proceedings) and widespread media coverage of the forecast, British Petroleum's share price rose to a record high for 2005 as a direct consequence of the likelihood of increased sales. The impact of this forecast on the earnings of the Met Office, a key provider of services for winter-sensitive agencies, is not yet clear.

Weather derivatives, similarly, are clearly not a direct form of commodification of nature, but rather highlight a growing practice to commodify information about nature as for example in gene databases (Castree, 2003). Weather indices, in this case, are an informational nature that becomes a commodity within the weather derivatives market that places increasing value on those datasets as well as investing time and expertise into creating knowledges about weather indices. Commodification is clearly articulated in different ways in different places at different times; although weather derivatives do not represent a direct form of commodification, this does not mean they are absolved from discursive and material effects. Rather weather derivatives may re-shape forms of economic and environmental governance and do so in ways not conducive to the future production of sustainable ecologies and economies (see Randalls, 2006).

3. Weather derivatives and geography: opening conversations

The quote from Roger Lee with which we began this paper hints at the impulses of academic endeavour that lead us to seek to reduce complexity and to work within habits, norms and traditions that reproduce the political economy of contemporary academe. As Fitzsimmons (2004) reminds us, however, this argument about the need for conversation across boundaries because real world problems come along in packages that defy our disciplinary boundaries, is not new. In this section, we

restrict ourselves to commenting on our experiences of working together across the boundaries of physical and human geography within the framework of research on weather derivatives. Our comments relate initially to our sub-disciplines and then more broadly to our intellectual project.

Although geography has played, and continues to play, an important role with respect to the science of climate change through both historical and contemporary research programmes (Thornes and McGregor, 2003), these weather-related stories have occupied relatively little space in economic geographical consciousness. Thinking about how particular firms cope with weather-related losses pushes economic geographers into two areas beyond the immediate confines of traditionally conceived analyses of production systems. First, it points to a need to interrogate not just the expansion of modern financial markets and the financialisation of economies, but also to open up the largely taken-for-granted black box of *firm* finances (Pollard, 2003) that is traditionally the province of the disciplines of economics and business studies. Second, and of central concern in this paper, these stories push economic geographers to take seriously the bio-physical world and to emulate other branches of human geography that have long interrogated the relationships between people and nature. As Harvey (1996) has argued, human geographies *always* engage socio-ecological projects and the social relations that they pre-suppose; more recent literatures on how capitalist social relations have mediated and shaped humans' relations with nature ([Steinberg, 2001], [Castree, 2003], [Fitzsimmons, 2004] and [Hudson, 2005]), however, bring this reality into sharper focus. Weather derivatives are interesting in that they take us beyond the usual economy-nature intersections of mineral extraction, agriculture, biotechnologies and GM foods, to consider the long history of the identification, measurement and, increasingly, the commodification of atmosphere and weather.

This project has forced us to consider one element of precisely how UK firms are negotiating their socio-bio-physical relations. Part of that agenda has involved working with intermediaries and firms that have sometimes had contrasting knowledges of and views pertaining to the importance of weather risk and uncertainty and whether they are worth trying to 'manage'. The project has also made us interrogate how firms' relations with the weather (and a host of related intermediaries) is changing and how it is that weather-related losses once viewed as 'natural' uncertainty in the business cycle are now viewed (in some sectors and places) as a 'manageable risk', as 'hedgeable' and hence, inexcusable. As de Goede (2004, p. 199) puts it:

The successful marketing of risk management products requires cultural parameters that see it as morally and economically compulsory to be insured against the risk in question.

This project testifies to the diverse knowledges that need to be mobilised to construct a particular financial product and a market in that product; these financial products are possible only through advances in meteorological measurement and data and the verification of their (relative) reliability. In turn, the growth of these markets gives considerable value to previously unvalued daily average meteorological data in many locations (Randalls, 2005). Finally, in terms of debates on nature and society within geography, weather derivatives highlight the entangled hybridity of contemporary issues and problems and also demonstrate how vital it is for nature-society theorists to broaden their approaches beyond the highly theoretical terrain to examine the physical implications of their research (see also Spencer and Whatmore, 2001). Weather derivatives simply displace, rather than mitigate, uncertainty by transforming the weather variability into credit risk. As such, weather derivatives not only respond to, but also *create* uncertainty ([Tickell, 2000] and [de Goede, 2004]) and, in so doing, create new geographies of unevenness.

In terms of significance for those working in branches of physical geography, this project illustrates not only the growing topicality and significance of the study of climate (see Carleton, 1999), but also,

... the dangers of uncritical acceptance of knowledge about nature as proposed by natural sciences, as ontologically prior to knowledge of and political choices about ourselves and our intentions (Fitzsimmons, 2004, p. 31).

Meteorological data are now being collected and priced as a commodity for sale because of existing cultural parameters that make it acceptable and, in some cases compulsory, to treat weather uncertainty and risk as something that can be displaced through the financial system. Through this project we talked about how physical scientists, like their social science counterparts, have to build social structures to develop funding sources, journals, flows of new recruits and to construct and re-construct what it is that constitutes 'the state of the art' in terms of research. Given the long history of commercial, industrial and military rationales that have shaped not only the funding of atmospheric sciences but also the development of technologies for measuring and forecasting weather, questions concerning the value or ownership of the atmosphere, the management of the atmosphere and the

dialectic between atmosphere/weather/climate/society should be key sources of concern for the meteorological community. Yet, such questions have been largely ignored. Further, for all the immense bio-physical, social, economic and political implications of managing the atmosphere (as both a precious resource and as a hazard), meteorologists have been unable to communicate effectively with politicians, economists and environmentalists, such that recent achievements, like the Kyoto Protocol, are probably too little too late ([Henderson-Sellers, 1998] and [Thornes and McGregor, 2003]).

For Thornes and McGregor (2003, p. 174), the agenda is one of making a case for 'a more society or culture orientated climatology'. This is not to propose a wholesale shift away from synoptic, dynamic and physical climatology, but rather a prompt to work at and beyond the traditional boundaries of climatology, and to engage with questions such as, is the atmosphere a common good or can parts of it be owned? How is the atmosphere used as a resource? How can we ensure a sustainable atmosphere? What are the environmental and political implications of the different forms of commodification of the atmosphere that we described in the previous section? Furthermore, what new geographies of power, domination and exclusion are being, or have the potential to be, created around the commodification of the atmosphere?

Moving beyond our sub-disciplinary concerns, what have we learned from our conversations with each other on this project? One outcome has been an extended period of thinking for us about geography as a discipline, but also as a creative node or hub from which to address key contemporary debates (see, for example, [Clifford, 2002], [Gregory et al., 2002], [Johnston, 2002], [Thrift, 2002], [Turner, 2002], [Johnston, 2003], [Harrison et al., 2004] and [Smith, 2005]). One of the difficulties for us in talking about this potential and in contemplating what we have in common as 'geographers' concerns our respective socializations in highly specialized sub-disciplines that equip us with different vocabularies, audiences, and taken-for-granted framings of intellectual puzzles; we all have a sense of how little time we spend thinking about 'geography' as an integrated subject, with the exception of some of our experiences in undergraduate teaching. Our respective specialisms and their different 'ways of doing' have generated tensions in the current research project. The spirit and energy to sustain a genuinely interdisciplinary approach to weather derivatives have also, at times, sat uneasily with a host of very practical concerns related to the choice of an external examiner, publishing strategies, future employment prospects and all the other forms of professional capital that need to be acquired by Sam to ensure his advancement in an academy that is still financially and politically wedded to the reproduction of disciplinary boundaries (see Evans and Randalls, 2007).

It is impossible to ignore this institutional political economy and the interests vested in maintaining boundaries between human and physical geographers (and, of course, between geography and other social and physical science disciplines). Nevertheless, in addition to the Research Assessment Exercise (RAE) and the financial and political necessities of building our respective power bases in the academy, we do think it is also important to acknowledge the agency and modes of operation of us as individuals (see also Flynn and Oldfield, forthcoming). Thrift (2002, p. 295) has referred to the absence of 'mutual respect' between human and physical geographers, blamed largely on the oft-cited differences in the 'ways of doing' things, differences in what is valued and indeed, the demographics of the personnel involved. While we would agree that this lack of respect is a problem, intellectual arrogance is by no means universal in geography and there are people genuinely interested in breaking down barriers and working across conventional divides. To give but one recent example, Bracken and Mawdsley (2004) have drawn on feminist and postcolonial debates to not only comment on fieldwork as one of the 'shared spaces' for human and physical geographers, but also to 'reclaim' it as a space in which women 'can and do make spaces in what is undoubtedly a male dominated and often gender discriminating environment' (pp. 280–281).

Our *acts* of working together generated greater knowledge and mutual respect even as we diverged over methodology and philosophy. What became clear to all of us (and most especially the three supervisors who have long been socialised in our respective specialisms), was that our only hope of achieving any satisfying degree of collaboration was for this to be a genuinely collective endeavour. Thus, we all met regularly and talked about the whole project, in all its natural and social dimensions, rather than farming out different parts of the Ph.D. supervision to each of us as individual 'specialists'. For Sam, the challenge of the project was experienced differently in that his ERSC–NERC studentship established, from the outset, that his mission was to work at and across the borders of social–natural sciences. The interdisciplinary nature of the work grew from his secondary school and university training in both physical (particularly meteorology) and human geography. Indeed being at a secondary school with its own meteorological station and that taught meteorology in its A-level

geography curriculum is an increasing rarity. One of the things the project has forced us to contemplate is whether there are generational differences in how we produce geographers and how our undergraduate and postgraduate curricula perform when it comes to teaching not only respect for different parts of the discipline, but also a sense of a geographical identity and project?

Our act of working together also encouraged us to talk about our language barriers and emphasised the importance of conceptual clarity. A key aspect of our collaboration was its role in helping us to gain confidence (both individually and collectively) and reduce any discomfort in terms of talking about and presenting findings from the project to audiences outside our usual specialist comfort zones. One of the things we most enjoyed during the course of our collaboration, and especially towards the end of the project when we had all been immersed in the material for over three years, was the growing space we found to talk about some of the questions mentioned earlier (e.g. how the atmosphere is used as a resource, the environmental and political implications of different forms of commodification of the atmosphere and so forth).

In all of this, what kept us working together, from Sam's days as an M.Sc. student, through to his choice of Ph.D. project, was a strong sense that weather derivatives open up all manner of important political and environmental questions that *have to be* interrogated through approaches which recognize the immense complexity of their physical–social construction. What we agreed upon, in essence, was the case that *can* be made for the contemporary relevance of geography, overlapping with recent debates about geography's practical and political relevance in terms of providing insights that satisfy diverse audiences both within and outside the academy ([Massey, 1999], [Peck, 1999], [Elwood and Martin, 2000], [Pollard et al., 2000], [Martin, 2001] and [Clifford, 2002]). Although the apparent inability of geography to marshal effectively its resources and realise its potential in a range of thematic areas is a continual source of intellectual and political frustration (Dicken, 2004), collaborative work is taking place and there is scope for more determined effort within geography to advance a coherent approach to a considerable range of contemporary issues such as sustainable development.

4. Conclusion

The advent and use of weather derivatives spans debates in both the social and natural sciences and raises a host of questions that defy disciplinary norms of understanding. Our experience on this project suggests that rather than retreating to our sub-disciplinary comfort zones, we can instead draw strength from a renewed engagement with each other's work. Managing a range of personal intellectual histories has been challenging, but not only has the research project significantly benefited from this, but it has also extended our own understandings of both what we and others produce and provided a basis for developing mutual respect for each others work. Through the understandings that we have created during this research we see inter-disciplinarity as very positive, but as something that needs to be continually strived for and maintained given our disciplinary and institutional political economies.

Nevertheless, these are testing times for geographers keen to foster more communication across human and physical geography. We maintain that there are grounds for intellectual and pedagogical persistence in this respect, if not necessarily optimism. Our insistence on this stance stems from our focus on a specific issue, a determination to work through what weather derivatives might mean for different constituencies in the context of growing concerns about climate change. If a financial fix is going to become the preferred technique for managing weather uncertainty and risk, who and where are the likely winners and losers from that fix? Issues of climatic and economic stability are critical societal issues and the emergence of weather derivatives requires the generation of inter-disciplinary and post-disciplinary understandings.

Research frontiers and a host of political engagements around issues of climate change and the commodification of nature are crying out for geographical research that is relevant, informed, ethical and engaged. While we can argue about the diversity of audiences to which our research appeals, or to what is meant by 'relevance' (see Pollard et al., 2000), geography is unusual in the breadth of expertise it houses; the critical issue is what kinds of virtue can be created from such breadth (see Clifford, 2002)? In this research project we have explored the resources of several sub-disciplines both within and beyond the borders of academic geography. Weather derivatives challenge us to think in many different disciplinary directions and we do not necessarily feel the compulsion for one unified way of thinking to emerge at the end of the project.

Politically, pedagogically and ethically (see Richards in Harrison et al., 2004), we argue that geographers should persist in trying to talk to a wide range of audiences (including each other) about

what Richards terms 'trans-boundary' problems. In the example of weather derivatives, it is clear that constellations of meteorological and economic knowledges are changing the way in which some firms can relate to climate uncertainty and, in so doing, generating new geographies of unevenness. As geographers we can unite around seeking to understand the complex ways in which different factors at different spatial (e.g. from the personal to the institutional) and temporal scales interact to produce outcomes. In this sense, we are advancing a rather pragmatic view of geographical practice, one which in its breadth remains very relevant for contemporary society.

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[1] For the purposes of this paper, we follow Knight (1921) and argue that risk is present when future events occur with measurable probability and that uncertainty is present when the likelihood of future events is indefinite or incalculable.
[2] The UKs Economic and Social Research Council (ESRC) and the Natural Environment Research Council (NERC) established this scheme in 1998 as an experiment to develop interdisciplinary researchers (see Evans and Randalls, 2007).
[3] Enron collapsed and ceased trading in December 2001.
[4] Aquila pulled out of weather trading in 2002.
[5] Koch Industries became part of Entergy-Koch Trading and, from November 2004, part of Merrill Lynch.
[6] Although there are other costs, because in Europe data is cleaned and packaged.