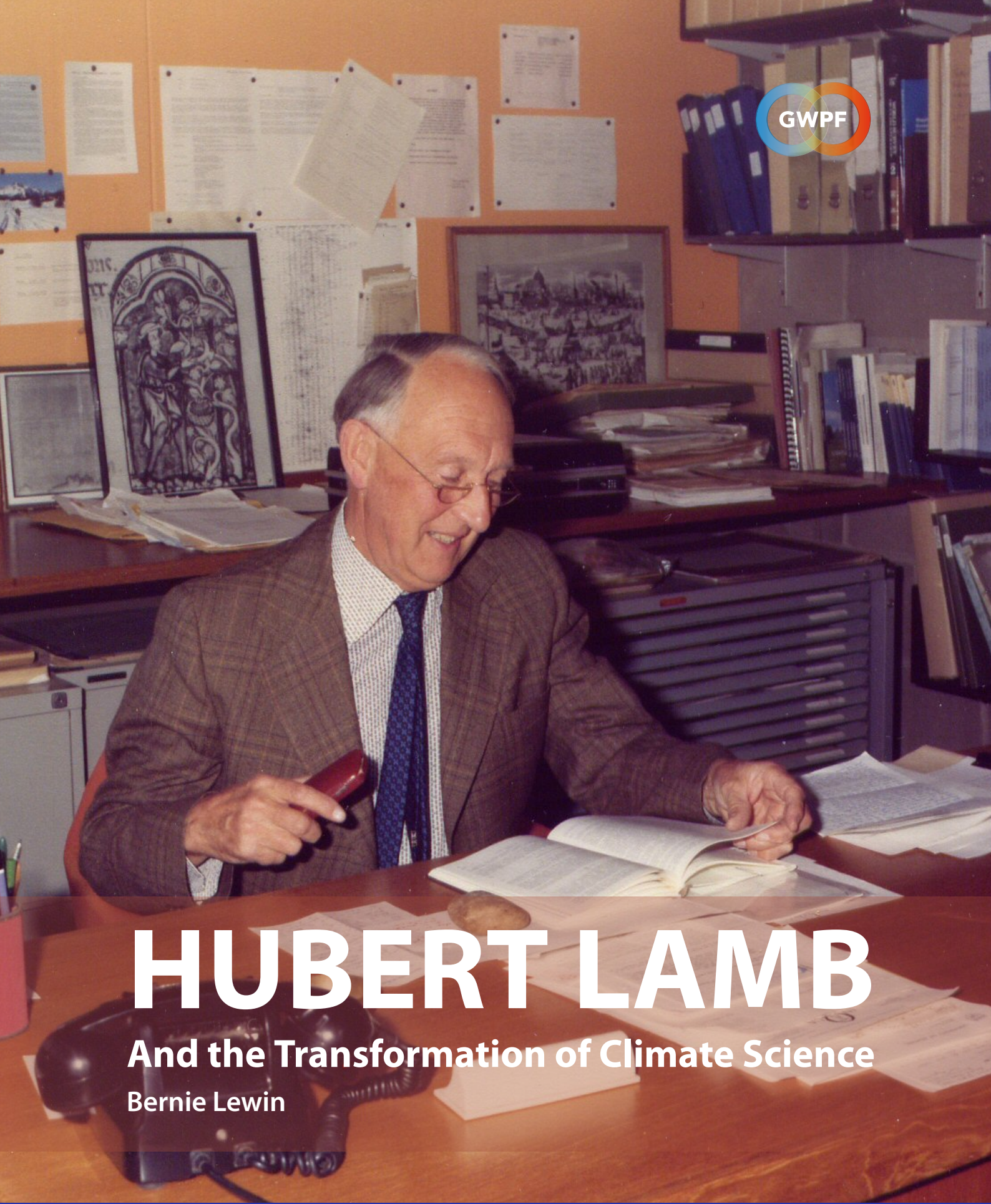

# HUBERT LAMB

## And the Transformation of Climate Science

Bernie Lewin

The Global Warming Policy Foundation

GWPF Report 17

# HUBERT LAMB

## And the Transformation of Climate Science

Bernie Lewin

ISBN 978-0-9573880-8-6

# Contents

# Foreword

**By Professor Richard Lindzen**

Bernie Lewin provides an interesting view of the evolution of the climate issue through the work and actions of one prominent individual, Hubert Lamb. Lamb was an important figure in the science of climatology. He devoted his career to the use of historic and/or proxy data to develop a picture of how climate has been changing on timescales from decades to centuries. The record provided rich evidence of profound changes. Lamb rationally maintained that one had to understand these changes before one could reasonably identify the role of man in climate change. As reasonable as Lamb's approach was, it encountered strong resistance. Initially the resistance came from a very influential movement within the earth science community of the sixties and early seventies. This was a movement to 'elevate' the earth sciences to a modern physical science rather than one that concentrated on descriptive and frequently qualitative methods. Thus, geophysics was emphasized over geology; in meteorology, theory and computer modelling as well as 'sophisticated' statistical studies were to be emphasized over traditional synoptic meteorology and such multidisciplinary approaches as those employed by Lamb. Lamb believed that he had sidestepped this movement by leaving the Met Office and going to the University of East Anglia, where he became the founding director of the Climatic Research Unit. However, in climatology, emphasis shifted to the issue of manmade climate change, which demanded a strong connection between industrial emissions and climate. Within this paradigm, the natural variability that Lamb emphasized was now relegated to 'noise'. Although the political interest in controlling manmade climate change provided stable funding for the CRU, it also constrained the possibilities for understanding climate more broadly, forcing Lamb to express his skepticism concerning the new emphasis more openly. Lamb's intellectual trajectory is typical of what many other senior climate scientists around the world experienced. Although each case has its individual character, Lamb's is certainly worthy of focus.

Richard Lindzen
November 2014

*Richard Lindzen was, until his retirement in 2013, the Alfred P. Sloan Professor of Meteorology at the Massachusetts Institute of Technology.*

# 1 Introduction

Hubert Horace Lamb, the founder of the Climatic Research Unit (CRU) at the University of East Anglia, was born in 1913 and died in 1997. When he died, the then director of CRU, Trevor Davies, described its founder as 'the greatest climatologist of his time'. In his obituary, Davies tells how Lamb experienced 'the satisfaction of convincing the remaining doubters of the reality of climate variation on time-scales of decades and centuries'.[1,2] All the various tributes to Lamb agree with Davies that this was his great achievement. Some even suggest that it was Lamb who first introduced the idea that climatic change has happened, and is still happening, on these very human timescales.[3] But this is just one of the many fictions propagated about Lamb.

Lamb certainly did some impressive work on natural climatic change. However, he was far from the first to introduce the idea of a constantly changing climate. Moreover, like others who tried before and since, he failed in his attempts to persuade the meteorological establishment to reorientate their climatic research accordingly.

One thing that Davies did get right concerns the idea of anthropogenic climate change. Lamb was a sceptic. But, curiously, Davies finds this ironic:

> An irony is that, now the world is acutely aware of global climate change, Lamb had maintained a guarded attitude to the importance of greenhouse warming.[4]

There is no irony in Lamb's position. Nor is there any surprise that the scientist who succeeded in promoting the idea of natural climate change is guarded about accepting a global human influence. With the old man's acute awareness of past variability, we should expect a guarded attitude towards the attribution of its continuance to a new and extraordinary cause.

The strangeness of Davies' view gives a first hint to the extraordinary transformation in climate science that occurred between Lamb's retirement as director of CRU in 1978 and his death less than two decades later. Davies seems blind to what he makes plain on the page: any irony in Lamb's position has only been introduced at Lamb's expense by a redefinition of the term 'climate change'. By restricting the meaning to only *manmade* change, and implicitly to only greenhouse warming, all previous and continuing scientific discussions of climatic/climate change could be re-framed to serve a political movement. Indeed, this new definition was confirmed by decree in the preamble of the 1992 Framework Convention on Climate Change (FCCC).[5]

But Hubert Lamb was more than just a climate change sceptic. As he witnessed the global warming scare take hold, he was also an outspoken critic of the way it was transforming the entire landscape of climate science. He aspersed this transformation for threatening the study of (natural) climatic change, and he despaired at how previous work towards the development of climatic forecasting was being swept aside in the rush to model the risk of a warming catastrophe.

Ever polite and softly spoken, our sceptic of the meteorologists' view (both new and old) was never formally trained as a meteorologist. Nor did Lamb train as a climatologist. His entry into that field was largely a trick of fate. Lamb was an unemployed geography major applying for all sorts of work when in 1936 the Meteorological Office took him on as a cadet weather forecaster. But his training there was forever postponed. Instead, he learned meteorology on the job while taking up posts in Scotland, Ireland, on a whaling ship in the Southern Ocean, in Germany and in Malta. The year 1954 found him back in England, a permanent employee without a position. At the age of 40, with nowhere else to go, he was

temporarily placed in the climatology department. The limited tenure with climatology was soon forgotten and he remained there until CRU was finally ready for launching at the end of 1971.[6]

In this essay, the revolution in climate science caused by the global warming scare is traced from its beginning through the eyes and the career of the founder of one pivotal institution. Lamb was no neutral observer; rather, he had a strong and particular interest. Against the old orthodoxy of unchanging climate – of random variability about a norm – Lamb had launched a major challenge, only then to find it replaced by a new doctrine that came to dominate the funded research programs across the globe. One of the main ways Lamb established non-random variability while still in the Met Office was by tracing past climatic trends through historical and archaeological evidence. This not only challenged the meteorologists' view of climate, but also the dominant view of how meteorology should be practised then and into the future. Lamb's work came into conflict with a push to transform meteorology into a wholly physical science, modernised through computerisation. It was not that he was against this transformation. Rather, he found that, in the rush to model the physics of climate change, the empirical grounding of these models, and especially the evidence of past climatic trends, was neglected. With the developing interest in climatic forecasting during the 1960s, Lamb's view was that this new science could only be established on a sure footing though the complex multidisciplinary work necessary to establish past climatic patterns. But, just when Lamb seemed to be making some headway with this view, the global warming scare came to dominance. In the transformation that ensued, exponential warming due to the impact of industrial greenhouse gas emissions came to be considered inevitable, with the additional inference that it would inevitably swamp any natural climatic variations in the foreseeable future. Lamb protested that the development of natural climatic forecasting was being eclipsed by a view based almost entirely on computer models, which assessed the impact of emissions against a background of natural climate stability. Once again, and against all the new evidence, natural climatic change had been reduced to random 'noise'.

Hubert Lamb may not have been the greatest climatologist of his time, but he is certainly a contender for another laurel. While defending the recent achievements of climatology, and promoting their advance, Lamb just may have been the most astute early critic of the emergent warming scare.

## 2 The origins of historical climatology

The controversy over climatic change that Hubert Lamb entered in the 1960s had its origins in the late 19th century, when both sides of a debate over human influences came under attack. On one side of the 19th century anthropogenic debate was a long-held view that the benign influence of European colonisation extended to climate.

In North America, the notion that civilisation civilises local climate served to counter the continent's reputation for harsh climatic extremes. Some anthropogenic effects were never much disputed, for example the microclimatic changes achieved with windbreaks. Direct heating and heat retention in towns and cities were generally acknowledged. But this apologetic for New World expansion went further, arguing that the removal of gloomy forests and the draining of dank marshes moderated the climate, especially when they were replaced with crops and open pasturelands. Promoted by scientists and in scientific publications on (dubious) evidence of causation, this theory was most resilient. Despite sustained attacks,

the theory persisted beyond the war of independence and into the 19th century, where we find Thomas Jefferson continuing to defend it; in fact, Jefferson's advocacy of accurate and consistent measurement of weather was so as to settle the matter in its favour.[7] Opposition to this view came with the emergence of the modern conservation movement. The retention of woodlands, it was argued, maintained rainfall over neighbouring farmlands. This case was supported by the scientific discovery of the enormous transpiration rates of trees. Instrumental weather records showing the expected trends in the local climate following land-use changes were produced in support of both anthropogenic theories.[8]

Criticism and ridicule of these popular anthropogenic theories came in the late 19th century from two very distinct scientific discourses. The first used what we might call 'statistical meteorology'. Relatively short time-series of meteorological readings were used to show that, while there are indeed marked variations, there is no overall trend. This argument against an anthropogenic influence was also an argument against there being any climatic change to investigate (or to forecast) other than the random variation about a norm.[9] Often persisting undefended as a convenient assumption upon which the statistics of random distribution could be practiced, this approach remained surprisingly resilient. Lamb would later attribute its persistence partly to its convenience and partly to the misfortune that the climate of the north in the late 19th century had returned to a condition much the same as it was when many instrumental records began in the late 18th century.[10] Whatever the reason, the presumption of unchanging variability dominated meteorological climatology down the course of the 20th century. It survived against repeated challenges from the other scientific discourse that punched its way into the popular controversy following some astonishing developments in northern European geology.

The idea that a climatic norm is revealed by averaging a few decades of weather records was anathema to the geologist, who came to approach the investigation of decadal-scale and annual-scale changes from the other direction. In the late 19th century drastic climatic pulsations across the much grander geological timescale had become well accepted, when some new findings – sometimes as simple as roughly dated raised beaches – introduced the idea of a time since the last ice age that had been generally warmer than the present. With the 'Holocene Climate Optimum,' paleoclimatology arrived obscurely at the dawn of civilisation. Then, the discovery of thin annual layers of lake sediment ('varves') suddenly delivered time-metered evidence down to a scale that had previously been the exclusive preserve of the meteorologists. Softer sources of indirect 'proxy' evidence were also sought. Soon new techniques were developing for tracing the subtler changes across the cycles of the seasons through historical time and right up to the present. When the proxy evidence was compared with archaeological evidence, for example abandoned settlements in today's great desert zones, and with ancient documentary evidence, such as of the Viking settlements in Greenland, a new interdisciplinary science – which we might call 'historical paleoclimatology' – began to tell a tale of climatic changes shaping the course of civilisation.

Thus, we have emergent in the climate debate at the end of the 19th century two very different approaches to the same problem: the geological and the meteorological. Across the next 100 years they were like oil and water: when shaken together they always tended to separation. Perhaps the first big shake came even before the 19th century was out, when the German geology-trained climatologist, Eduard Brückner, made a powerful intervention into the popular controversy over contemporary climatic change. Brückner directly challenged both of the old anthropogenic theories by first agreeing with advocates on both sides that they had indeed found evidence of change in the weather records. It was only that their

localised trends indicated general trends, which were themselves only segments of a larger, natural and somewhat erratic warm–dry/cold–wet oscillation. Findings of improving (or deteriorating) climate over short periods were only due to the particular segment of this oscillation they happened to have measured – and likewise for those meteorologists who claimed no trend at all.[11]

The first decades of the 20th century saw the old anthropogenic theories fade into folklore under the rising shadow of statistical meteorology, which was advanced by the various national and international meteorological institutions as they consolidated their activities. Quantitative analysis of controlled and standardised instrumental measurements lent the authority of a thoroughly modern science to the disparagement of every fancy that there might be some long-term patterns in the weather. Meanwhile, elsewhere, historical paleoclimatology flourished, if only in the shadow of the main game in geology, which was the great controversy over ice age causation. Numerous theories of geological-scale climatic change would contend down through the 20th century (and indeed it was not until late in Lamb's career that this great mystery came close to revelation).

Consideration of the causation of the more subtle changes across historical time also opened up in the 20th century, when this work expanded beyond northern Europe and beyond geology, including to the American founder of dendrochronology, Andrew E. Douglass. An astronomer by training, Douglass opened up the new field when he sought to show the influence of sunspot variations on the diameter of tree rings, but this would be via their influence on climate, specifically on variations in precipitation.[12] His work only added to all the other work on causal theories that had been proposed since the beginning. These were mostly spinoffs from the geological debate, the most popular of which concerned subtle changes in solar output and its variable veiling by volcanic emissions.

The first major impact of historical paleoclimatology on British meteorology came after the young meteorologist, Charles E.P. Brooks, took up the study of geology in his spare time. He was most impressed by the recent changes revealed by the rocks and other proxy sources. Completing his geology master's degree in 1916, Brooks proceeded to promote this hybrid science in publications across the following three decades. His *Climate Through The Ages* was first published in 1926 and updated in a new edition following his retirement as head of the Met Office Climatology Division in 1948.[13] Its Part III summarised 'The climate of the historical past' and served as the standard English-language text for what soon became known as 'historical climatology', at least until it was superseded by Lamb's own contribution. Yet, for all practical purposes, the old dogma prevailed under Brooks' successor when Lamb finally arrived at the Climatology Division in the mid-1950s. There, the work of climatology remained mostly descriptive. The 'bookkeeping branch of meteorology' extended little beyond collecting time-series of local meteorological readings to determine their mean and variance. Specific forecasting interventions in town and country planning, in engineering and insurance, were typically around the statistical determination of the once-in-100-year flood, frost or storm; that is, the calculation of what climatologists refer to as the 'return periods' of particular extreme events.[14,15]

When Lamb arrived, he was assigned to dealing with overseas inquiries, and it was there that the early experience of a forecasting disaster jolted him out of any tendency to complacency. For the construction of the Kariba Dam on the Zambezi River, the meteorologists supported the builders with calculations, based on 50 years of data, of the size of the once-in-50-year flood. The trouble was that during construction this flood size was exceeded in three consecutive years! Later, Lamb was ever ready to recall spates of severe winters, record

floods, extensive droughts and (supposedly) unprecedented extremes of all kinds – examples from the record books serving to mock the utility of these calculations. He saw 'return periods' as no more than convenient fictions that ignored what was already known generally about the history of climate – if only 'that the range of variation is itself subject to variation'.[16] Of particular concern was the continuing adherence to the International Meteorological Organization's recommendation in 1935 that the first three decades of the century should be taken as the 'climatic normal period'. This standard lasted into the early 1960s, when this period was widely recognised as abnormally stable and benign; not that Lamb could celebrate the shift to the new norm, 1931–60, for it contained what he had already identified as a period of exceptional variability.[17,18,19]

The limitations of the climatic-norm approach led Lamb to investigate the climate trends from the long instrumental records contained in a monumental archive of data from across Europe and the old British Empire, perchance stashed during the Second World War in the basement below his office. But soon inter-disciplinary collaborations helped him expand beyond their range with all sorts of proxies and historical documents.[20] In this way, like Brooks before him, Lamb brought the indirect methods of the geologists into the home of meteorology, where data and techniques from both traditions could be utilised to deliver surprisingly rapid results. This was not Lamb's earliest climatological research, but his intensive investigations of the non-random behaviour of climate in the Climatology Division during the late 1950s and early 1960s produced the bulk of his original contribution to the study of climatic change. The results of these investigations suggested various explanations of recent climatic changes, which, in turn, introduced the prospect of making predictions about the climate in the decades ahead.

## 3 Investigating the forces behind natural climatic change

For those interested in the influence of climatic change on the weather in the second half of the 20th century, the most immediate concern was to understand what had already come to pass earlier that century. By the 1950s it was becoming evident that northern Europe had come through four or five decades of exceptionally benign climate and a gradual, generalised warming. This became all the more evident in the early 1960s when this short climatic episode was situated in its longer historical context. On the near side, it was noticed that this pattern had already started to degenerate in the 1940s and that instability and a slight cooling had prevailed ever since. The forecasting question that began to attract popular attention was whether northern climes should expect the continuance of a recent spate of notoriously severe winters. The far side of the story provided by historical climatology suggested this as a real possibility.

More and more evidence was confirming that the High Middle Ages of agrarian western Europe had been supported by generally stable warm climate, especially around the Atlantic north. Since then there had been some sustained and widespread episodes of extraordinarily severe weather, from which the early 20th century had provided a brief respite.[21] The recent deterioration thus prompted the question of whether it heralded a return to the 'Little Ice Age' as the previous cool episodes came to be called, or, worse, that it was the beginning of the slow decline into the next full ice age. These anxieties were scotched by the meteorological authorities citing random fluctuations on the decadal scale. But scepticism was growing and this view was challenged with evidence of some physical drivers of change, both internal and external to the climatic system.[22,23] If positive causation of these recent

changes could be identified then the prize for the challengers to the meteorological orthodoxy would be that climatic forecasting could begin to develop on the basis of predictable patterns. This would be much as weather forecasting had previously been established, except that external perturbations might play a greater role. In this regard, Lamb found some success with evidence of causation both internal and external. Here we consider just two examples.

Prominent among Lamb's climatological work at the Met Office was his contribution to the developing understanding of the theory of North Atlantic Oscillation. This included his tracking the frequency of westerly winds across the British Isles back through the years. A more frequent westerly pattern is associated with milder winters and Lamb noticed a peak in this quasi-periodic oscillation during the famously benign 1920s (see Fig. 1).[24,25]

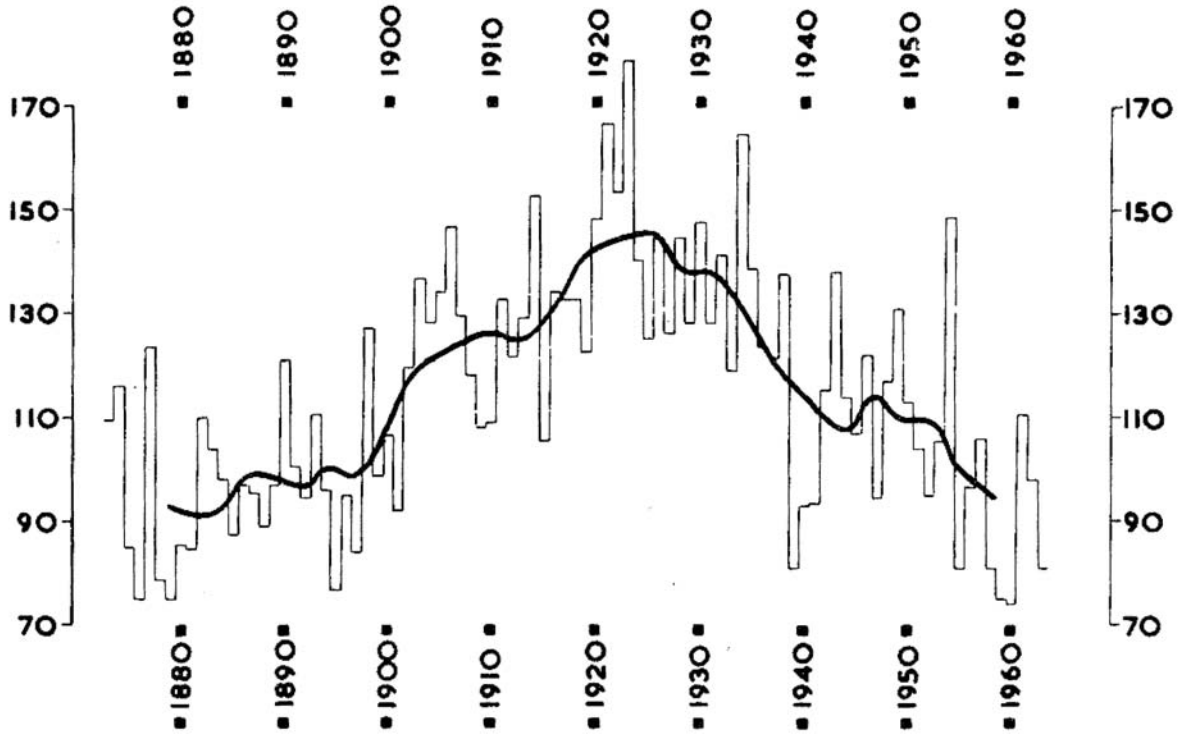


Figure 1: One of Lamb's early chartings of the North Atlantic Oscillation
The charts shows the number of days each year classified as 'westerly', with a peak in the westerly wind pattern during the warming period of the early 20th century. Dark line is a centred 10-year running mean. Source: Lamb, *The Changing Climate*, p. 177.

Also in the early 1960s, Lamb became keen to quantify the much-touted role of volcanic eruptions. After an intense investigation of the unfamiliar field of vulcanology, he prepared an extended paper. This began by dismissing one of the 19th century theories of glacial–interglacial cycles recently revived, namely that these were driven by variations in volcanic emissions of carbon dioxide. Disputing the strength of this forcing, Lamb downplayed its importance to both geological- and historical-scale changes. Instead, he placed all the emphasis on the type, volume and distribution of dust particles that volcanoes blasted above the clouds and into the stratosphere. He then proceeded to calculate these particles' varying

ability to shade the earth from the sun's rays and used the results to estimate, sometimes on scant historical evidence, the total strength of this 'veil' over the northern skies across the last four centuries (see Fig. 2). This is how Lamb came to the finding of an exceptional extended period where the sun's rays were all but free of any volcanic interference during the first half of the 20th century. He proposed that the prolonged lifting of the volcanic veil might partially explain the extraordinary warmth across those decades.

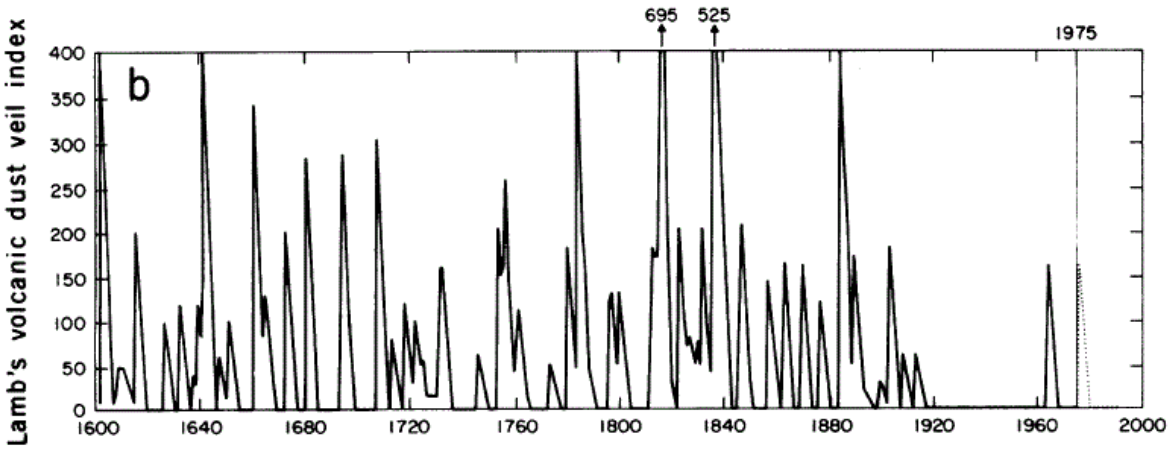


Figure 2: Northern Hemisphere dust veil

From Schneider and Mass[26] after Lamb.[27] Schneider and Mass do not acknowledge that the data is only for the Northern Hemisphere, but they present it as one factor, along with solar and carbon dioxide forcing, to account for the extraordinary Northern Hemisphere warming of the early 20th century.

In 1965 Lamb submitted his volcanic dust veil paper for publication by the Met Office. Alas, as Lamb tells it, the paper was internally blocked from publication as 'unsound' due to its 'arguing in a circle'. It was only under pressure from volcanologists that it was released to the Royal Society for publication.[28] This is how the much-used 'Lamb Dust Veil Index' came to appear for the first time in 1970.[29]

The year that the volcanic paper was first rejected, 1965, was significant for Lamb. That year Graham Sutton retired as Director General of the Met Office. Sutton had recognised early the importance of Lamb's attempts to reconstruct climates past, enthusiastically supporting and rewarding this work. The strength of his enthusiasm is evident in the glowing foreword he later penned for the first volume of Lamb's great work, *Climate: Present, Past and Future*.

> …climatology is more than a branch of physics and it is in the wider aspects of its study that the unique nature of this book lies…This is the book that I always hoped Mr Lamb would write…I know of no other work in this field that approaches it in scope and reliability. I have no doubt that what I have been reading are the proofsheets of a classic of meteorology, and that here, if anywhere, climatology really enters into its own.[30]

However, Sutton's sentiments were not shared by many of Lamb's colleagues at the Met Office and certainly not by Sutton's replacement John Mason. Mason was vocal against all climatic forcing theories, explaining away the recent changes as random fluctuations on various timescales. On this view he found little value in historical investigation of climate, and he was known to raise concerns about Lamb's lack of qualifications.[31] But there was more to Mason's dim view of Lamb's efforts to glean climate data from historical archives.

By the late 1960s Lamb found himself the unwitting victim of the aspirations of meteorology to the status of an exact physical science. With these aspirations came great interest in computerisation but little toleration for historical methodology. The new proxy evidence was one thing, but Lamb remained convinced that historical documents would continue to provide vital detail unavailable elsewhere. Whether it be agricultural records, shipping records or casual descriptions of extreme events, Lamb believed that deep in the archives and libraries the answers lay hidden in unlikely places, thinly spread, only awaiting collation, interpretation and analysis. Yet he recalls at this time how he 'resigned from the Royal Meteorological Society's library committee in protest at a decision of the Council of the Society virtually to abolish its library'. Virtual abolition for Lamb was the reduction of the library to 'a limited selection of the latest theoretical and interpretive texts and journals' while the rest were removed off-site. This was perhaps an over-reaction, but the library had long associations with historical climatology, as Brooks had been its librarian until his retirement. For Lamb the decision to pack off the dusty old volumes must have been symbolic of the general attitude to historical research within the meteorological establishment.[32,33]

While Lamb's methods and views were making his life increasingly uncomfortable at the Met Office, elsewhere the possibility that advancing civilisation might be influencing climatic changes was commanding renewed interest. During the 1960s the main concerns were with various sorts of industrial pollution. It was only later that concern about greenhouse gas emissions came to dominate.

# 4 The anthropogenic revival

The revival of interest in anthropogenic climatic change in the 1960s emerged during a broader discussion of the climatic dimensions of various environmental disasters and emergencies around the globe. At lower latitudes, historical climatology had long told of climatic changes on the desert fringes and their monumental impacts on the course of civilisation.[34] Concern had been raised with the United Nations and its agencies that such changes might be behind the droughts that threatened food security among nomadic and agrarian nations in these areas. The timing was fortuitous for Lamb as it fed an interest in his work just as he had come up with some impressive, if preliminary, findings. In 1961 the World Meteorological Organization (WMO) teamed up with another UN agency, UNESCO, for an international conference on climatic change in arid regions, at which Lamb presented one of his classic papers on patterns of climatic change across historical times.[35] Interest in climatic change was also generated by extreme weather events in the wealthier northern mid-latitudes. These included a cluster of severe winters in the early 1960s that wrought havoc on transport and communications, causing agricultural losses and increased energy demand. Not only the cold, but dramatic seasonal swings suggested climatic instability.

Early interest in an anthropogenic influence was mostly associated with environmental degradation, especially desertification and atmospheric pollution. Most of these impacts were very visible and local. With atmospheric pollution, one of the oldest climatic concerns was the impacts of coal smoke on fog – the 'smog' notorious to London. In the 1960s interest in this topic shifted to the chemical processes involved in the generation of the 'photochemical' smog that could be seen hanging over many modern cities. Another highly visible effect was the contrails of jets slowly generating their own cirrus cloud formations. Another involved a famous anecdote of American climatologist, Reid Bryson, in which he recounted flying over the plains of India, which had been obscured by billowing dust clouds. The im-

pacts of agriculture and industrial aerosols on the lower atmosphere was for him comparable to that of volcanoes. A key problem with tropospheric aerosols, however, was that no one was ever sure whether the net effect of the various types and mixtures would be warming or cooling. Finally, there was one of the oldest and least controversial anthropogenic influences: the direct warming effect of industrial cities. During the 1960s the trend to urbanisation was gathering pace. The interest was not so much with the nightly retention of solar heat in the buildings and pavements, but more with the heat pollution from energy production and use. The exponential increase in energy demand (that could now be met by nuclear generation) might soon result in a more generalised effect.

All these concerns were raised with national governments and within UN agencies in the 1960s, alongside concerns about the enhanced greenhouse effect due to industrial emissions. In some ways the greenhouse effect did stand apart. It had some unique characteristics: its effect is invisible, delayed and, even then, hard to detect. Once it starts, it is difficult to stop. It was also the only truly global effect on the table. These peculiarities would become important later. However, right through to the early 1970s, while a cooling trend prevailed, the scientific discussion of anthropogenic effects remained divided over the likelihood of any significant greenhouse warming in the foreseeable future. What is also important to remember is that in the 1960s there remained an ambivalence as to whether such warming would be such a bad thing. Indeed, even this ambivalence was new, for it was not until the 1960s that there was much concern at all.

Certainly, no alarm had been raised when the idea of greenhouse warming first appeared in the late 19th century as an afterthought to the suggestion that volcanic carbon dioxide might be behind the cycle of the ice ages. That the burning of coal might one day add a little warmth to the outside temperature was sometimes considered far-fetched (we would never burn enough), and otherwise ill-conceived (the greenhouse effect is already at its limit with the effects of both water vapour and existing carbon dioxide). But a little greenhouse warming was no grave prospect for the northern Europeans who first discussed it, for it came with the promise of longer growing seasons and fewer killer winters.[36,37]

Nor did alarm arise with the first claim of detection. In 1938, after those four decades of extraordinarily consistent warming, a British steam engineer, Guy Callendar, credited some of this warmth to industrial carbon dioxide. Brooks and other members of the Royal Meteorological Society roundly rejected Callendar's argument as an over-simplistic interpretation of the atmospheric science, but not as a false alarm. Callendar's fancy of some good arising from all those chimneys ended sadly in the early 1960s when the final winters of his life were some of the harshest in living memory.[38,39]

Nor were there calls for warming mitigation when in the mid-1950s the first computer modelling confirmed earlier crude calculations of a few degrees of warming with a doubling of atmospheric carbon dioxide. Soon after that, the first careful time-series measurement of atmospheric carbon dioxide concentrations suggested a steady rise. It was at this time, during the international research program known as the Geophysical Year (1957–8), that the renowned American atmospheric scientist Roger Revelle first spoke of our injecting enormous amounts of carbon dioxide into the atmosphere 'as a large scale geophysical experiment'. Later, during the warming scare, this expression would be used to instil fear, but at the time this was not meant, nor interpreted, as scary.[40] In fact, Revelle remained ambivalent about the need to act on greenhouse warming for the rest of his life.[41]

Throughout the anthropogenic revival of the 1960s there was no significant change in this attitude. Some concerns were raised about greenhouse warming in the distant future

and possible mitigation action was even suggested, but there was more concern about the immediate cooling effect of aerosols. Indeed, the enhanced greenhouse hypothesis brought some comfort that industrialisation might also be neutralising its (supposed) exacerbation of dangerous cooling. Anyway, waves of interest in one or other proposal were never entirely distinct until greenhouse warming came to dominance well into the 1970s.

## 5 Early doubts about the greenhouse hypothesis

If Lamb wrote down his assessment of the science behind the enhanced greenhouse hypothesis in the 1960s, then we are yet to find it. His views are first found fully elaborated in the first volume of *Climate: Present, Past and Future*. This book had been under preparation for many years before its publication in 1972, which was just after he had left the Met Office to direct CRU.

In a systematic survey of the absorption of incoming solar radiation by the various gases in the atmosphere, Lamb's discussion turns to the increasing concentrations of carbon dioxide attributed to industrial emissions. Doubts about the proposed warming effect are raised on three main fronts. Firstly, there is the old argument[42] that current atmospheric levels of water vapour and carbon dioxide already block most of the radiation, and so any additional carbon dioxide would have little effect. Secondly, the suggestion of causation in the correlation across geological time between atmospheric carbon dioxide concentrations and temperature is disputed. There is another likely explanation: the solubility of the carbon dioxide in the oceans varies with temperature, and so the oceans could just be 'breathing out' carbon dioxide when they warm. Lamb's final objection was one that he would repeat over and over as a critical empirical fact. Even allowing that the effect is still weak, the case for its importance is not helped by the pause in warming during the post-War boom:

> The observed decline of global temperature since 1945 implies some other factor exercising about three times as strong an effect (in the opposite direction) as the carbon dioxide increase.[43]

This mid-century warming pause had indeed demolished the empirical grounds for Callendar's claim.[44] Until the warming commenced again, concerns about emission-driven warming could find no grounding in empirical science. Nonetheless, interest in the greenhouse hypothesis continued to develop during the anthropogenic revival, which was still at this stage mostly confined to the specialist scientific discussions. However, around the time that Lamb was sending his great work off to the printers, there was a major attempt to change this and launch the idea of 'Man's impact on climate' onto the world stage.

The year that Lamb's sceptical views were finally published was auspicious in the history of the environmental sciences. 1972 saw the carefully planned launch of the global environment movement at the UN 'Human Environment' conference in Stockholm. In the lead-up to Stockholm, there was a concerted attempt to push climate impacts up the agenda. It failed and so is largely forgotten. Nonetheless, the anthropogenic revival quietly entered a new phase in which the scientific discourse would be pressed up hard against the policy interface.

This new push had its beginnings in 1970 when a group of 70 invited US scientists participated in a month-long live-in workshop to produce a Study of Critical Environmental Problems (SCEP) under the leadership of an energy strategist at Massachusetts Institute of Technology, Carroll Wilson. A working group on 'climatic effects' chaired by the atmospheric

scientist, William Kellogg, chose to restrict itself as far as possible 'to atmospheric problems that are global in scale'. One of the conclusions of the overall report was that more intensive investigation of these climatic effects was required.

This led to another extended live-in workshop the following year called 'Study of Man's Impact on Climate' (SMIC). In the spring of 1971, Wilson and Kellogg joined another 30 invited scientists from 14 countries for a conference in Stockholm that ran for three weeks. Following many presentations and workshops, their report was developed and a summary agreed so that this group's consensus would 'provide an important input into planning' for the big environment summit to be held in that city the following year. Reports from both conferences, and a collection of climate-related papers from the first, were published and circulated without delay.[45,46,47] Yet there was hardly any need for the rush, as the consensus summaries on the climate question provided little to go by. In fact, they would be the first in a long series of consensus summaries up to and including the first assessment of the Intergovernmental Panel on Climate Change (IPCC) in 1990, which, despite the increasing fuss surrounding them, all provided little in the way of solid data or strong conclusions that could go any way to support climate alarm. The SMIC's consensus summary acknowledged the dearth of evidence:

> While it is conceivable that man may have had a small part in the most recent climate changes we have just described, it is clear that natural causes must be sought. In fact, as has been frequently pointed out, it will be difficult to identify any man-made effect because, first, with our present state of knowledge, we do not know how to relate cause and effect in such a complex system and, second, man-made effects will be obscured by the natural changes that we know must be occurring.[48]

If we consider only the weakness of its conclusions, then it is not surprising that the human impact on climate did not feature prominently in the ensuing UN global environment conference. Indeed, despite all efforts at promotion, SCEP and SMIC failed to draw much attention to the issue at all. (What is surprising is that the first IPCC report was only slightly less equivocal, yet it did become a vehicle for alarm.) Nonetheless, the SCEP and SMIC conferences are important because they represent the first in a series of expensive efforts to raise the profile of anthropogenic climate change and its possible dangers. At the time Lamb certainly thought them worthy of attention.

Lamb first gave consideration to this initiative in a review of the collection of 44 climate-related papers from the earlier SCEP conference that had been published with the climate-related working group reports.[49] Appearing in the science journal *Nature*, Lamb's review is awkwardly disproportioned by too much emphasis on the hypothesis, recently advanced by Edward Lorenz, of the chaotic nature of weather systems. This is raised by Lorenz himself and by the famous American climatologist J Murray Mitchell in just two of the papers, both of which are deeply sceptical of any causal claims. Lamb first applauds Mitchell for making 'the often neglected point that we cannot hope to isolate man-made changes until we can trace the background of natural fluctuations of climate that are forever going on'. The implication of Lorenz's work, according to Lamb, is that it suggests the impossibility of confidently diagnosing 'cause and effect in the case of observed climatic variations, set up either by natural environment changes or the actions of human beings'. Lamb uses Lorenz's finding of non-linearity in the climate system to take the emphasis off the relatively simple and linear theoretical physics behind the cause-and-effect proposals for the human-driven change, and to shift it back towards the study of yet unexplained (perhaps chaotic) natural

fluctuations. He concludes that this and other considerations should 'alert [us] to climatic dangers which might otherwise be totally unsuspected'.

That too much attention was given to the human suspect – despite the broad agreement on the lack of evidence – now began to concern Lamb. Already at this time he was finding that this emerging preoccupation was distorting the investigation of climatic change. Lamb raised this concern while discussing SCEP and SMIC in another report he was drafting for the WMO at around this time. Lamb's involvement with the UN agency's early attempts to take command of the burgeoning public discussions of climatic change extended back across the decade before this report was completed in 1972. The WMO played a key role in the evolution of Lamb's scepticism, as it did in the eventual transformation of climate science. We therefore introduce it with some background.

## 6 Reporting on climatic change to the WMO

Prior to the formation of the United Nations, leaders of meteorological services around the world had come together as the International Meteorological Organization (IMO). At their conference in 1929, great interest in climatological issues led to the establishment of a Commission for Climatology. It was this commission that in 1935 recommended the first 30-year 'climatic normal period'. When the IMO was finally fully incorporated into the UN system in 1950, now as the 'WMO', the Commission for Climatology continued, and continued to set new reference periods of climatic normality. Through this commission, and generally, the WMO attempted to coordinate international climatic research at a time when interest was developing elsewhere in the UN about environmental changes impacting on human welfare. Thus in 1961 there was the joint WMO/UNESCO conference on climatic change in arid regions at which Lamb presented his classic paper on historical climatology (see p. 8). By then, Lamb had already gained some international notoriety for challenging the very idea of a climatic normality and the title of this paper made all too clear his target: 'On the nature of certain climatic epochs which differed from the modern (1900–39) normal'.[50] Two years later he was asked to climb on board and join the Climate Commission's working group on climatic fluctuations.

This group was chaired by J. Murray Mitchell, whom Lamb was starting to meet in various fora, and whom he came to hold in high esteem. Prominent among the other five members of the working group was Hermann Flohn. One of the most renowned climatologists of the day, Flohn had a special interest in historical climatology. This was a clear opportunity for Lamb's side of the argument; an opportunity neither wasted nor over-exploited. The report, 'Climatic Change', published in 1966, was pitched as preliminary and preparatory to the study of its topic, listing priority areas of research and including recommended definitions of terms. The bulk of the discussion covered the first two items of its brief, which concerned statistical techniques used to identify and investigate non-random changes. Nowhere did it venture into a substantive discussion of historical climatology, nor of possible mechanisms to explain or forecast change.[51]

The response to this foundational work was positive, and three years later a new climatic fluctuations group was formed. This time the group was specifically asked to explore methods for the development of climatic forecasting by giving consideration to various drivers of change – listing those that were natural and those due to the activities of mankind. Mitchell and Flohn were again selected, but this time with Lamb in the chair.[52] And so it was that right around the time of the big push to get manmade climate change on the agenda in

Stockholm, over in Geneva the WMO presented Lamb with an opportunity to promote his views on where the research effort should now be directed.

The new climatic fluctuations group did not get together until a week-long meeting during the autumn of 1971, when it surveyed proposed causes and related them to the various attempts at forecasting, including those at the Met Office in which Lamb had participated. Their report noted that most forecasting to date tended to be based on only one external driver, whereas it was clear that there were many influences on climate. It concluded by mapping out the areas of further research required to advance climatic forecasting, in effect presenting a manifesto for a new science of long-range forecasting.

'Climatic fluctuation and the problems of foresight' was, however, never published, never received the imprimatur of the WMO and seems not to have been fully finalised. As far as we can tell, the report only survives as the hand-corrected 'chairman's draft', copies of which were distributed from CRU during its early days.[53] What is important to our story is found in its extended discussion of manmade climatic change.[54]

The first thing to say about this discussion of human causation is that it found no great conflict with the recently released SMIC report. Indeed, it rather deferred to SMIC, including in recommending 'watchfulness regarding the unintended side-effects upon climate from Man's activities'.[55] It was not the weak conclusions of such studies that concerned Lamb's group, but that there was 'a tendency…to put too much emphasis on the likelihood' of an anthropogenic effect 'and to underrate the probability of natural climatic changes'. The report then raised the concern that this tendency had already started to distort climate forecasting. 'This has clearly happened in the last 25 years,' it said,

> …when warming was generally expected to increase and to accelerate because of Man's production of $CO_2$, whereas, in fact, there has been a net cooling, which is likely to be at least partly of natural origin.
>
> This situation demanded further improvement of knowledge of the past climatic record, and of the processes involved in natural climatic fluctuations, not only for the forecasting of future natural climatic changes, but as a background essential to assessing any novel effects introduced by Man's activities.[56]

While Lamb was raising these concerns about this new trend in research in the drafts of the working group report, his continuing battle with the old meteorological establishment had already reached breaking point. Now he was ready to make a move.

# 7 The Climatic Research Unit

The internal hostility to Lamb's historical climatology had been in stark contrast to its popularity elsewhere. Throughout the late 1960s interest was developing, not only among the international community of researchers but also among the media and the public. With inquiries increasing, requests for supporting staff repeatedly declined, and fast approaching the Met Office's strict retirement age of 60, Lamb started to look towards the university sector for a more favourable research environment. This interest was sparked by the professor of environmental sciences at Lancaster University, his old friend Gordon Manley.[57]

Much of Manley's career had been spent developing the world's longest instrument-based monthly mean temperature series, the now famous Central England Temperature Record. On documentary and proxy evidence, Lamb extended seasonal temperature anomalies for this region back more than 1000 years.[58] When Manley was about to retire, he suggested that Lamb should succeed him. Lamb eventually rejected this idea due to concerns

about again moving his family, this time into the bleak climate of the north-west (in his memoirs, weather and climate dominates the narrative of his personal life!), and he also knew that teaching and administrative duties would soon detract from his research. However, in the end, only a few years after abandoning him at the Met Office, Graham Sutton came riding back to the rescue.[59]

Sutton had since taken charge of the Natural Environment Research Council, and he now used his connections to obtain private funding for a unit dedicated to climatic research. Seed funding was secured from the petroleum company, Shell. More money was soon obtained from a private trust fund and later from other business sources including British Petroleum. By 1970, agreement had been reached that the 'Climatic Research Unit' would become part of the new school of environmental sciences at the University of East Anglia.[60]

Lamb might have failed to persuade the WMO and others to his view of how climatic research should progress, but at least with the move to Norwich in the new year of 1972 he thought that he could finally get together a team of researchers to complete the program of work most urgently required. This was not as easy as envisaged. He recalled in his memoirs:

> I was severely shocked to discover that our efforts still had not brought in enough funds to employ any staff besides myself for a contract lasting more than three years. This made us almost entirely dependent in those initial stages on whatever research on any topic might be commissioned by outside funding agencies.[61]

To those familiar with the university funding environment, Lamb's shock might seem naïve. Perhaps only now could he appreciate just how good he had had it under Sutton, all but directing research as he chose. He had spent an entire career in the Met Office before landing, in his 59th year, in the university sector at the time of economic stagflation, soon to be exacerbated by the OPEC oil crisis. Therefore, Lamb's discomfort with the grants process, and his incompetence in the art of winning them, might explain his failure to win British government support for his research at this time.[62] But Lamb tells another story of those tough first few years. His memoirs continue:

> It soon turned out to be very difficult to attract the money needed for a programme of systematically establishing the past record. We are living in a time when the glamour of the much more expensive work of the mathematical modelling laboratories, and the tempting prospect of their theoretical predictions, are stealing the limelight…It does not seem to have been widely recognised that the theoreticians' work was proceeding without adequate prior study (or any sure understanding) of the sometimes drastic swings of climate that have occurred over periods from a few years or decades to some centuries, often setting in abruptly and some of them still unexplained.[63]

We should remember that while the early 1970s might have been tough economically in Britain, it was at least a boom time for environmental science: this was when global environmentalism first came into its own. CRU's very first year was especially significant. It was not only the year of the Stockholm conference, but that year climate anxiety was launched to prominence in world news. In 1972 the horrors of the extended drought in the African Sahel region hit the TV news around the world, drought in Russia caused the failure of its grain crops, food and commodity prices rose sharply, and extreme weather events struck Britain and Western Europe. These all drew unprecedented policy and popular attention to climate. *Could it be changing?* Much to the chagrin of those meteorologists who responded with an adamant 'no,' the climatologists who answered 'yes' began attracting steady interest in the science press and also in the British dailies. Reading through the newspaper articles of the time there is no surprise that headlines sometimes simplified and amplifed – *An Ice*

*Age is coming!* (…in the next 10,000 years) – nor that conflict between experts was a little overplayed. Nonetheless, some of these pieces were surprisingly well informed.

Climatic change had become fashionable right at the time when Lamb cut loose from the Met Office, but this may have only exposed him as an easy target. One journalist certainly saw it that way. He described how in Britain 'attempts to turn climatology into a fashionable discipline have so far been baulked by the opposition of the meteorological establishment – in particular the Met Office'. This baulking is evident not only in how they denounced 'with more than necessary vehemence' the cooling alarm raised in a TV documentary (Nigel Calder's *The Weather Machine*)[64] but also where…

> …attempts to raise money to support the country's only climatic research unit ran into well-placed roadblocks.[65]

Whether or not Lamb was himself attempting to make climatology fashionable, he seems to have been comfortable with press attention. Journalists would visit or telephone CRU whenever a climate-related topic required comment, and Lamb enjoyed something of a public profile, with radio appearances and the occasional invitation to publish his own plain-language account. In 1974 this played in his favour when he leapt over the establishment barricades and went straight to the press with his story of a looming financial crisis.

Lamb let it be known that CRU was becoming 'seriously starved of funds' and that it might have to close the following year if substantial new funding could not soon be found. His plea hit the dailies and resulted in a strongly worded opinion piece in *Nature*. Under the headline 'Lamb's unit to the slaughter?' the article announced that 'one of the two climatic research establishments in the western world' is under threat right when 'the importance of climatic research is becoming increasingly clear'. Defending the value of CRU, it said that, while variations of climate cannot be prevented, 'they can be predicted with increasing reliability', and so careful planning based upon such forecasts 'may often save lives and money'.[66]

The story from here, as Lamb was told, is that a copy of the editorial was passed around government offices in Washington clipped to a hand-written note asking 'What can we do about this?' What was soon done about it was that the Rockefeller Foundation poured in a huge contribution. The Wolfson Foundation also stepped in at this time with a series of grants, including one for the construction of the building that now bears Lamb's name.[67,68] So where grant applications had failed, begging had worked. CRU was saved, surviving throughout Lamb's directorship mostly on private money, much of it associated, directly or indirectly, with the oil industry.[69]

The Rockefeller grant was the most exciting for Lamb because it was approved for the project that he considered fundamental to understanding the patterns and causes of climatic variability. This was to use documentary and proxy sources to reconstruct past seasonal weather patterns going back 1000 years and more, starting with Europe, for which the greatest wealth of descriptive accounts was available. Lamb had already completed and published some of this work, but for him that was little more than a pilot for the grand project now about to begin.

Alas, despite finally achieving generous funding, this project was never realised. According to Lamb's memoirs, it…

> …came to grief over an understandable difference of scientific judgement between me and the scientist, Dr Tom Wigley, whom we appointed to take charge of the research. In retrospect, this difficulty could have been avoided if Dr Wigley had been consulted at a much earlier stage on the design of the research.[70]

Indeed, given Wigley's subsequent stellar career using computer simulations of anthropogenic climate change to search for the human 'fingerprint' in the atmosphere, he hardly seems suitable for the job of poring over obscure medieval manuscripts. He never did so. Moreover, Wigley went on to become the director of CRU when Lamb retired in 1978, and under his leadership Lamb noticed historical climatology generally fall into neglect.

> Since my retirement from the directorship of the Climatic Research Unit there have been changes there…My immediate successor, Professor Tom Wigley, was chiefly interested in the prospects of world climate being changed as a result of human activities…After only a few years almost all the work on historical reconstruction of past climate and weather situations, which had first made the Unit well known, was abandoned. There was an exception in the case of tree-ring studies…[71]

These strong claims of Lamb about the transformation at CRU warrant some analysis.

In the first place Lamb's claim that the Rockefeller project 'came to grief' is a little strong. It is true that the complete set of charts, as specified by Lamb, were not finalised. But much work under the grant proceeded under Wigley's direction. The historians made significant advances in the interdisciplinary field of historical methodology, just as Lamb had long desired. This included better usage of philological techniques in the critical treatment of primary and secondary documentary sources.[72,73] During the late 1970s many historical climate charts were constructed and datasets developed. CRU's reputation as a world centre for historical climatology at this time is evident in the number of experts in the field who started out there, or worked there for some time, or came on visits. This reputation was confirmed by the success of the first 'Climate and History' world conference hosted by CRU in 1979.[74,75,76,77,78]

While there is plenty of evidence in the annual reports and elsewhere that CRU was a world centre for historical climatology throughout the late 1970s and even into the early 1980s, a gradual shift is also evident. In 1979, the year after Lamb retired, came the first huge grant from the US Department of Energy under its '$CO_2$ program'.[79] This replaced US government funding that Lamb had previously arranged from the National Oceanic and Atmospheric Administration via J. Murray Mitchell, which was less explicitly associated with greenhouse anxieties. Some of this US money was allocated to historical climatology, but only for the purpose of better defining the low-frequency natural 'noise' against which any human carbon dioxide 'signal' would be detected.[80]

In contrast to the funding for the detection of the human signal, funding specifically for historical climatology had never been on a secure footing. In the early 1980s direct funding began to dry up. This hit hard in 1983 when two of the historians lost their jobs.[81] Granted, the young historians at CRU did not have much success with high-profile publications. Indeed, only one of their papers made it into their book of the Climate and History conference.[82] But otherwise, their lack of success outside highly specialised journals may only reflect the difficulties their obscure interdisciplinary science faced in competing with conventional disciplines, let alone with such emerging hot topics as global warming. The publication record of the historical climatologists in the early 1980s stands in stark contrast to Wigley's astonishing achievements at the time. These included three first-author publications on the carbon dioxide question within two months in the prestigious journal *Nature*.[83,84,85] The historians also faced the problem that by introducing more rigorous standards of analysis they had slowed the progress of research on documentary sources. This made their method more expensive by comparison with the tree-ring work that was taking off around this time.[86,87]

What is clear is that, following Lamb's departure, Wigley was quick to secure CRU's future by orientating it towards the new funding source. But it should also be noted that CRU's director until 1993 could hardly be accused of sustaining the flow of money by fanning the flames of alarm. This is in contrast to some other directors of similarly affected research institutions in the 1980s, including the head of the Goddard Institute for Space Studies at NASA, James Hansen. The difference with Wigley became embarrassingly obvious when Wigley finally entered the climate change mitigation debate after his departure from CRU and at a critical time in the controversy. By the end of 1995, the previously restrained Director General of the Met Office, John Houghton, who had taken over from Mason in 1983, had joined Hansen and other leading scientists in calling for immediate coordinated action to mitigate global warming by reducing emissions. The following year Wigley caused a stir by collaborating with two economists to argue exactly the opposite.[88,89]

After Wigley took over as director of CRU in 1978, Lamb was rarely in his campus office, but he did remain active throughout his emeritus years, writing his books and continuing to publish research articles. It was during these years that his scepticism became noticeably more strident. Freedom from leadership responsibilities might partly explain this change. Another reason would be that it was not until late in his life that the scare really took off. This change in the climate change landscape is usually placed in the hot dry summer of 1988, with Prime Minister Thatcher's decision to embrace global warming alarm, and when the IPCC was born.[90] However, Lamb himself considered that the warming scare had reached the critical stage of institutional corruption much earlier than this. This was two years before he retired. Therefore our consideration of his later, more strident scepticism best begins at that time, in the summer of 1976.

# 8 The rise of the warmers

Between 1972 and 1976 Lamb found himself preoccupied with the financial security of his new research unit. In those first five years while he was trying to realise his vision of climatic research, he wrote little about the greenhouse hypothesis. But meanwhile there had been four important developments in the anthropogenic movement that would then set the stage for his return to the subject during his last days at CRU.

The first of these developments was the coming to dominance of the ice-age scare. This was triggered by new sedimentary and ice core data giving more accurate timing of the various glaciations. When at last the cycles of the ice ages were known, it was realised that they fitted rather neatly the long-held hypothesis that they are set in motion by the subtle cyclic changes in the earth's rotation known as the Milanković cycles. The rhythmic pattern of these cycles reinforced the inevitability of a return to ice-age conditions, which, on a geological scale at least, now appeared imminent. On top of this, some scientists went further and suggested that anthropogenic effects, especially from aerosols, could trigger the cooling faster and earlier, even on a human timescale.[91,92] That we might already be slipping into the next ice age was proposed in a television documentary that opened up the entire subject of climatic change to a popular audience. When the BBC produced Nigel Calder's *The Weather Machine* in 1974, the many interviews with practicing scientists lent authority to this view.[93]

The second development while Lamb was establishing CRU concerned the computer modelling of the global climate. What is remarkable about the history of global climate modelling is that it is pretty much the history of global greenhouse modelling. From their

very crude beginnings in the 1950s, these models were mostly used to assess the impacts of increased (later increasing) greenhouse gases. This is all the more curious because this development occurred during the pause in the warming, when all the concern was about global cooling. *Why was greenhouse warming modelled and not the competing cooling impact of aerosols?* It may have something to do with the previously mentioned unique characteristics of the greenhouse hypothesis: the effect is global, delayed, hard to detect but difficult to stop. In the absence of empirical evidence – even of the *expectation* of obtaining empirical evidence before it was too late – global circulation models offered one way to investigate the hypothesis.

Grant money became available for this very expensive line of work, which was forever pushing the limits of computational power. Already by the 1970s the early crude systems of equations had evolved into complex models of three-dimensional atmospheric circulation. Yet each of them was only designed to show the greenhouse warming effect against a background of climatic stability. In this 'background' other possible climatic change mechanisms were completely ignored. The most obvious candidate for inclusion would have been volcanic forcing, for which Lamb's dust veil index could have provided a tool for quantification.[94] Internal forcing was also neglected, most notably where it involved the oceans.[95]

The third development during Lamb's CRU years was the increasing attention of scientific conferences and reports to the issue of anthropogenic climatic change. Sometimes governments or UN bodies made specific requests to address the issue, while other initiatives – much in the mould of SCEP and SMIC – were more independently motivated. The sense of urgency then starting to develop around the issue was often explicitly associated with the alarm raised by the likes of Paul Ehrlich and the Club of Rome about exponential population growth and the anticipated pressure on food, energy and (supposedly) non-renewable resource due to an expected explosive growth in demand.

In October 1975 Margaret Mead, the famous anthropologist and president of the American Association for the Advancement of Science, teamed up with William Kellogg to organise a conference of invited experts called 'The Atmosphere: Endangered and Endangering'. To match the 'Law of the Sea' that was currently under negotiation, Mead anticipated an international 'Law of the Air', towards which the gathered scientists would offer their advice. The report of the conference records her opening address:

> I have asked a group of atmospheric specialists to meet here to consider how the very real threat to humankind and life on this planet can be stated with credibility and persuasiveness before the present society of nations begins to enact laws of the air, or plan for 'international environmental impact statements'… [96]

After playing a key role in the SCEP and SMIC conferences a few years earlier, Kellogg hit the ground running.

> The important point to bear in mind is that mankind surely has already affected the climate of vast regions, and quite possibly of the entire earth, and that its ever escalating population and demand for energy and food will produce larger changes in the years ahead.[97]

Yet despite the stated urgency of the problem it still remained ill-defined, and resistance among the gathered scientists to any particular definition remained strong. Repeatedly in the records of these conferences we find protestations that the overwhelming ignorance of the workings of the climatic system makes causal claims impossible. But among those who were prepared to take up the idea that civilisation was (or might soon be) influencing

the global climate, a polarisation was emerging. Kellogg had noticed this back in 1971 at the SMIC conference, where those scientists proposing anthropogenic impacts were divided between aerosol 'coolers' and greenhouse 'warmers'. Kellogg later described how he tried to break the impasse that remained as the three-week conference was drawing to a close:

> …we decided to call an evening meeting to thrash out a consensus, and to decide (if we could) whether we would predict a net cooling or a warming in the decades ahead due to man's activities. It would clearly be useful if we could make such a prediction with some degree of conviction. However, the impasse prevailed, much to my disappointment. There were just too many honest differences of opinion and not enough facts at hand to resolve them…Additionally, there was a clear reluctance…to make any predictions at all about the future – to 'stick out one's neck'. Scientists are trained to be cautious about jumping to conclusions too fast, and furthermore we will always be awed by the complexity of the planetary climate system and aware of our inability to understand all of its interactions.[98]

According to Kellogg, this accounted for the weakness of the consensus statement (see p. 11).

Conflict against and between the anthropogenic claimants continued at Mead's Endangered and Endangering conference. The report of the proceedings records one dispute over what, if anything, could usefully be said to policymakers. One participant asked whether the conference was organized with preconceived notions that environmental change was automatically dangerous and bad. At one point Mead had to intervene and called a 'ceasefire' so as to avoid 'premature polarization'.[99] Not that Kellogg was in a conciliatory frame of mind. 'The conclusion that we must come to,' he said,

> ...is that mankind is almost surely heating up the surface of our planet by adding aerosols, carbon dioxide, and direct heat. We can argue about the details of this picture, but the main direction we are taking seems rather clear.[100]

The fourth and final important development during Lamb's time at CRU was the change in the weather. After a three-decade-long pause, the mid-northern latitudes again started to show a warming trend. Winters were milder and drier. But then came 1976. In the UK, the drought was so bad that it was much discussed in Parliament. Finally the Drought Act was passed and a Minister for Drought appointed (before the rains came…and came…and an extraordinarily wet autumn and winter followed).[101]

Just how important the summer of 1976 was in changing Lamb's attitude and hardening his scepticism can be better understood with some extended quotes. Firstly, consider the director's statement from the CRU Annual Report covering the year to September 1976:

> The extreme drought and high temperatures which affected Britain and neighbouring countries in the summer of 1976 has produced an extraordinary increase in the demand from many quarters for advice and any services which the Unit might be able to provide. The pressure on the staff's working time was further increased from May 1976 onwards by an unmanageable volume of inquiries stimulated by public and official reactions to an unprecedented series of warnings about possible future climatic tendencies, partly attributed to the impact of Man's activities and their increasing scale, as well as world population growth, which were issued successively by the CIA in the United States, by Professor M I Budyko of Moscow in an article in *Soviet Weekly*, and by the executive committee of the WMO.[102]

The 'official reaction' of the WMO Executive was particularly significant for Lamb. Their statement on climatic change, issued on midsummer's eve, is cited by Lamb in a number

of places. It first appears in a startling footnote inserted at the very end of the last chapter of *Climate: Present, Past and Future* Volume II. Most likely in the early stages of publication when the WMO statement was released, the final chapter, 'Approaches to the problem of forecasting', is an expanded discussion of the forgotten report that Lamb had drafted for the WMO climatic fluctuations working group back in 1972. The footnote reads:

> Since this chapter was written, however, an official statement, issued by the WMO in June 1976 places most emphasis on the prospects of Man's impact on the global climate, through the increasing production of $CO_2$ and waste heat, both producing a warming effect expected to become dominant over the natural climate fluctuations by about AD 2000. The statement warned of dire consequences to be expected within the next 50 to 100 years through the displacement of the natural vegetation and crop belts and melting of ice caps.[103]

The significance for Lamb is clear. The WMO's official view completely undermines his chapter's entire purpose: *Why would forecasters spend any effort determining the natural causes of climatic change when these influences would soon be dominated by mankind's disastrous impact?*

Lamb makes the same point in a book targeted at a popular audience that had been long in the planning, but which he set about finalising directly after retirement. Towards the end of *Climate History and the Modern World*, while discussing the possible global impact of human activity, Lamb raises the problem of detecting the supposed greenhouse warming signal.

> This range of natural climatic fluctuation is sometimes described as the 'noise level', which must of course make it difficult to identify any new trend – whether or not the trend were produced by Man's impact – before it had already reached a substantial amplitude. Efforts have therefore been made to decide how soon the (assumed) further increase of carbon dioxide will produce a warming too strong to be offset or obscured by the natural variability of climate. In such writing the natural variability is dismissed as unforecastable and therefore to be treated as random. Those putting forward this view of the matter have taken $\pm 1^{\circ}$C as the approximate range of variation of the long-term temperature average produced by natural causes in the post-glacial world. In consequence of this, they expect the warming by carbon dioxide, combined with the other substances contributing to an intensification of the greenhouse effect, to gain the upper hand and 'swamp' all other elements of climatic variation from the end of this century onwards and possibly from the 1980s on. This view was strongly put in a statement approved by the executive committee of the WMO in 1976 (reported in *The Times*, London 22 June 1976).[104]

In a footnote, Lamb refers to the climatic coincidence behind the WMO statement:

> Coincidentally, Europe was experiencing an exceptional heat wave at the time, in the second of the two great warm summers of the 1970s, and both Europe and much of North America had enjoyed an unbroken run of three to six mild winters.[105]

These three passages suggest that Lamb felt all the climate anxiety that had been whipped up in the early 1970s had caused the WMO executive to weaken its resolve, abandon judicious science and embrace manmade warming alarm. Yet the WMO statement is hardly recognisable in these accounts.

The WMO statement was explicitly reactionary, responding, as its preamble says, to 'several controversial statements on climatic changes'. It reads as an attempt by the WMO to

moderate, rather than exacerbate, popular anxiety. Its main thrust is to hose down the excitement that had been building in the press about an imminent ice age. Instead, it says that shorter-term fluctuations, including those potentially influenced by human activity, are of greater concern – but only so as to recommend that these should be *studied* in greater depth. Any warnings of consequences are not expressed in 'dire' language and are highly contextualised.[106] *How did Lamb get it so wrong?*

Part of the answer comes with the report in *The Times* to which Lamb also refers. Reporting from Geneva on the release by the WMO Executive Committee the previous day, the headline reads:

> World's temperature likely to rise

And the article begins:

> A warning that significant rises in global temperatures are probable over the next century has been issued here by the World Meteorological Organization.

It goes on to say that the WMO consensus position is that recent forecasts of cooling in the coming years 'suggested by knowledge of past natural climatic changes' are 'completely invalidated by' the influence of carbon dioxide emissions and other human activities. Assisted though it is by inflammatory quotations from a WMO official, the story is a stark contrast to the moderation of the WMO report.[107]

Perhaps it was while reading his morning paper that Lamb first heard of the statement and so formed his impressions of it. But even so, he seems to have over-reacted. One of the great fears associated with global warming in scary press stories at the time was rising seas due to the 'melting of the ice caps', just as Lamb mentions in the first accounts as quoted above. Yet while the WMO statement and the *Times* article do mention the melting of *sea ice* (which will cause no sea level rise), neither mention the melting of land ice. Also, Lamb interpolates (from other sources no doubt) the date at which this warming is expected to dominate natural fluctuations, which he puts at about 2000, and then, 'possibly from the 1980s'. The *Times* gives no such dates and the WMO statement itself says instead that 'it is not possible to give an accurate assessment of the magnitude of [anthropogenic] changes'.

In this extraordinary and repeated lapse of his usual high standard of accurate and methodical analysis, Lamb is guilty of plainly misrepresenting the extent to which the WMO was drumming up the scare at this time. This lapse is of interest because of the insight it provides into Lamb's increasing concern about what was happening to climatology generally and for the first signs of his marginalisation on this matter.

That popular interest and pressure were drawing attention to climatic research was not, for Lamb, such a bad thing. What did concern him was the response of the scientific institutions to this pressure. He feared that short-term thinking, poor science and feigned ignorance might prevail, and overwhelm the development of the new field of (natural) climatic forecasting that he was striving to establish on a sound footing. The WMO had turned its attention away from sober science in an attempt to take command of a popular discussion that was spiralling out of its control. In doing so, it had tipped the balance towards the 'warmers'. With attention shifting to the possibility of an exponential greenhouse warming, the development of natural climatic forecasting would surely be neglected in the expectation that this warming would completely 'swamp' all other elements of climatic variation. Lamb was not alone in promoting the need to establish the patterns of natural climatic change through historical climatology, but he was fast becoming the most vocal sceptic of green-

house alarm, and this might have already placed him on the outside when the WMO pushed out its climatic change statement in that fateful summer of 1976.

Consider that the WMO Commission of Climatology had abandoned to obscurity the climatic fluctuations report of 1972, in which Lamb had declared that an excess of attention to anthropogenic causation was already distorting the science. In 1973 another climatic fluctuations group was established with a briefing orientated even more strongly to 'the increasing evidence that man inadvertently modifies climate'.[108] While the intention was clear, however, this group seems to have failed to produce any report at all, perhaps because the WMO Executive Committee soon took control. Directed by a decision of the 7th World Meteorological Congress (1975) to 'take the lead' in research and to issue 'authoritative statements', the WMO Executive established a Panel of Experts on Climatic Change. It was this group's report that formed the basis of their 'authoritative statement' of 1976. The panel included Mitchell and Flohn but not Lamb.[109]

Lamb's anxieties over the threat to climate forecasting might also have been exacerbated by the cessation of seasonal forecasting at CRU. During its early years, CRU published regular seasonal forecasts for the UK and Europe. However, under pressure from his old boss, John Mason, this practice was stopped while the Met Office monthly forecasts continued. This was so as to avoid 'possible embarrassment' – an understandable concern given CRU's increasing public profile and its boast of 'a 70% success rate' with these forecasts.[110,111]

That Lamb felt trapped during his CRU years between the old Met Office dogma and the new greenhouse scare is evident in his final director's statement at the end of 1978. Lamb's parting words tried to find a middle road for CRU:

> Unfortunately the present state of knowledge has allowed various well-informed scientific authorities to make pronouncements which in recent years have ranged from alarmist forecasts of an impending ice age to equally threatening forecasts of drastic warming, melting of ice caps and rise of world sea level as a side effect of Man's activities. Other authorities in this field of science give voice to a perhaps equally unrealistic complacency that no significant change of climate need be expected. There is therefore a very clear need for a centre of calm academic research, which will…[be based on the climate record]…rather than either over-elaborate theoretical modelling or on ignorance of the record of observable behaviour of the natural climate.[112]

# 9 Witness to a science transforming

After six years as director of CRU, Lamb's idyll of 'calm academic research' had finally slipped away. In retirement he began to wonder aloud about what had caused the science to go astray. One factor was the distorting influence of public controversy:

> Money to fund research may be more or less readily forthcoming according to what the results appear (or are expected) to indicate. This irrelevant influence – to which all countries seem liable in only varying degrees – may be backed by powerful interests and threatens to cloud the possibilities of scientific understanding.[113]

Then there was the problem of powerful individuals 'creating barriers to scientific advance' in order to protect their own interests. But Lamb considered that 'neither political ulterior motives nor the abuse of power by individuals is the whole story'.

> There are also fashions in scientific work, whereby some theory catches on and gains a wide following, and while that situation reigns, most workers aim their efforts to follow-

> ing the logic of the theory and its applications, and tend to be oblivious to things that do not quite fit.
>
> The swings of fashion among meteorological and climatic research leaders over the carbon dioxide effect provide an extreme example.[114]

In his reflections elsewhere on scientific fashion, Lamb also recalls how solar forcing suddenly went out of fashion in the 1930s after bold forecasts based on the sunspot cycle by senior British meteorologists turned out to be wildly wrong.[115] Years later, and despite new evidence, for a young scientist 'to entertain any statement of sun–weather relationships,' recalls Lamb, 'was to brand oneself as a crank'.[116] But in his 'extreme example' of fashion swings, Lamb observes how the fashion for the carbon dioxide effect waxed and waned as the climate in mid-northern latitudes warmed and cooled – yet with some years' lag. It waxed mid-century, following early 20th century warming, only to wane in the 1960s…

> …when it was obvious that the climate in the Northern Hemisphere was getting colder (despite greater output of synthetic carbon dioxide than ever before) from the late 1950s till about 1974.

Then the theory 'rose to renewed dominance around 1980':

> It only revived after a run of up to 8 mild winters in a row affected much of Europe and parts of North America in the 1970s and 1980s. There then came a tremendous preponderance of publications on global warming, dominating the research literature, although over-all temperature averages in some regions, particularly in the Arctic, were still moving downward.[117]

Lamb had spent half a lifetime studying climatic change and its impacts on civilisation only to find another pattern of impacts transforming the very study itself. Whatever the causes of this transformation – changes in the weather, politically-driven funding, scientific fashion, or theoreticians who 'prefer the tidy, beautiful patterns of theory to the complexities of the real world'[118] – Lamb remained concerned in the last years of his life that…

> …the prospects of global warming are now spoken of on every side and are treated by many, including people whose decisions affect millions, as if the more alarming forecasts were already established as fact.[119]

In the great transformation that climate science underwent during the late 20th century, one thing is made evident by Lamb's story; this is that the old dogma of an unchanging climate against which he had struggled decades earlier resurfaced as part of the new doctrine of anthropogenic climate change. Lamb referred to this re-emergence several times, yet in posthumous tributes he is generally credited with a key role in its demolition, and this is given as his claim to fame. We saw an example of this at the beginning of our essay, where Trevor Davies has Lamb 'convincing the remaining doubter' of the reality of the ever-changing climate. This is also in the obituary in *Nature* by one of his former colleagues: Mick Kelly explains how Lamb did more than any other modern-day climatologist to overturn the old orthodoxy of climate stability prevailing in the meteorological establishment. He then goes on to introduce Lamb's scepticism by explaining how 'during his later years he had found a new orthodoxy to challenge'.[120]

But this is wrong on both counts. Lamb was not the first to challenge the old orthodoxy of climate stability; not even the first in the British Met Office. Nor was it overturned. Just as the dogma of variability around a fixed norm returned after Brooks, it kept returning to torment Lamb throughout his career. It revived under the new leadership at the Met Office after 1965. It was also carried as an assumption in the projections of greenhouse warming.

Right through to the end of the 20th century the claim was that both models and data were showing the enhanced greenhouse effect emerging out of the background 'noise' of natural variations. Thus the popular idea that global warming is now emerging from a background of climate stability cannot be blamed on simplifications introduced (mischievously or otherwise) by translation into a popular account. Rather, this idea is in perfect fidelity with the new science, where the old meteorologist's dogma of natural climate stability has been reintroduced as the baseline assumption, despite all the new evidence to the contrary. In this way, the new orthodoxy of anthropogenic climate change is only the undefeated old orthodoxy re-appearing, but cloaked anew.

Another way to view this is that, indeed, Lamb did help establish the idea of a changing climate. But this quickly became the ground upon which the anthropogenic scare was built. Once built, the foundations were artfully concealed by the new definition of 'climate change' as all manmade. Lamb's fame was then appropriated to support this new view. This enhanced his reputation, while at the same time traducing it.

In 2006 Lamb appeared in a listing of the 'top 100 world-changing discoveries, innovations and research projects to come out of the UK universities' for the innovation of establishing 'climate change as a serious research subject'.[121,122] Thus, and in the same year that the CRU building was renamed in his honour, Lamb came to be honoured for an innovation that he had aspersed from the beginning right until the end of his life.

Reflecting recently on Lamb's persona at CRU, former CRU staff note the generation gap between Lamb and the young researchers he employed. This gap became evident in many ways, one of which was when their emeritus founder turned out to be the only sceptic. As Wigley says 'the field moved on, but Hubert did not'.[123,124] Yet Lamb was not alone among leaders of climatological research during the 1970s who did not move on with the transformation of the science during the 1980s and 1990s. Resistance is evident across the old guard, among all specialisations and irrespective of any prior sympathies for 'warmers' or 'coolers'.

Consider firstly Robert White, an influential US member of the WMO executive committee during the 1970s. He chaired the first World Climate Conference in 1979, which declared that 'it is now urgently necessary for the nations of the world…to foresee and to prevent potential man made changes in climate that might be adverse to the well-being of humanity'.[125] But by the late 1980s he became concerned that the politics was getting ahead of the science. In 1989, while the IPCC was completing its first assessment, White warned of an 'inverted pyramid of knowledge' where 'a huge and growing mass of proposals for policy action is balanced upon a handful of real facts'.[126] In that same year other leaders of the old guard raised their concerns with the US government. These included two former leaders at the privately funded Scripps Institution of Oceanography: William Nierenberg, the director from 1965 to 1986, and Jerome Namias, a renowned climate forecaster who had led the Climate Research Group at Scripps throughout the 1970s.[127,128] In the university sector, there was Reid Bryson, the founding director of CRU's sister organization in the USA, the Center for Climatic Research at the University of Wisconsin. King of the 'coolers' in the 1970s, Bryson was never adverse to the possibility of an anthropogenic influence, but he refused to come in from the cold and he aired his concerns about the rise of the 'warmers' during the 1990s and until his death in 2008.

Among the European leadership of the 1970s there were also many who would resist the transformation of climate science. These include Hendrik Tennekes, the director of research at the Royal Netherlands Meteorological Institute from 1977 to 1990, who claimed that the

publication of his doubts contributed to his ousting.[129] Two leading Scandinavian meteorologists, Aksel Wiin-Nielson and Lennart Bengtsson, also came out sceptical after extraordinary careers spanning the post-War period, which included leadership in the establishment of the European Centre for Medium-Range Weather Forecasts.[130]

By the 1990s, some of these old leaders had arrived in the freedom of their retirement. Not that this entirely protected them from various forms of hostility and alienation. When Wiin-Nielson began raising his concerns in the late 1990s he was met with a public rebuke from the founding chairman of the IPCC, Bert Bolin, marking a rift in their long personal relationship.[131] Much later, in 2014, when Bengtsson took the step of offering support to the Global Warming Policy Foundation as a gesture towards redeeming the science to which he had dedicated his life, he was overwhelmed by a wave of hostility that led to his withdrawal.[132]

At least retirees are not faced with the decision on whether to risk jeopardising their team's funding by speaking out. Of those still holding leadership positions during the scare, tales of private scepticism abound. Some chose to come out only when they were fully released from such responsibilities. Perhaps the earliest and most surprising of these was Brian Tucker in Australia. The head of CSIRO Division of Atmospheric Physics, Tucker oversaw the research into greenhouse warming from the late 1970s. However, by the late 1980s he was becoming uncomfortable with the greenhouse activism of some of his scientists. When he retired in 1992, Tucker immediately enlisted as a spokesman for the sceptical opposition.

Others who came out in retirement would avoid activism while nevertheless making a special point of announcing their scepticism. These included John Theon, who had oversight of all weather and climate research at NASA during the 1980s, and Joanne Simpson, the head of a 'severe storms' research group at NASA from 1979. The first woman to attain a PhD in Meteorology, Simpson rose in her maturity to become the first female president of the American Meteorological Society. Years later, in 2008, aged 85, she made a solemn declaration of scepticism under the title 'Joanne Simpson, private citizen'. It began:

> Since I am no longer affiliated with any organization nor receive any funding, I can speak quite frankly…[133]

Undoubtedly there is more to the story within the labyrinths of NASA than is currently in the public domain. Where the transformation of the science became most apparent was at the Goddard Institute of Space Studies. In 1981 there was a change of leadership exemplifying the transformation as starkly as with the Lamb-to-Wigley transition at CRU a few years earlier.

The Institute of Space Studies was a New York satellite of the Goddard Space Flight Center in Maryland and it was created in 1961 for Robert Jastrow, its founding director. Jastrow was one leader at NASA who, like Lamb, was openly sceptical of greenhouse alarm from the beginning. When Jastrow resigned in 1981, NASA attempted to bring the satellite back to Maryland, but a few staff held out. NASA cut the funding (it would later resume) but the EPA stepped in so that atmospheric research could continue in New York under the leadership of James Hansen. That very summer Hansen won the first front page headline for global warming in the *New York Times.* The *Times* reported how Hansen's research predicted a global warming of 'almost unprecedented magnitude', with the potential collapse of the West Antarctic ice sheet, sea level rise, coastal flooding, and widespread disruption of agriculture.[134]

And so it was that during the 1980s the science transformed. But by the end of that decade some of its concerned former leaders began to join a rising fogy chorus of atmo-

spheric scientists, geologists, engineers and others all railing against the new guard. And as they grew old and many died, they left the new leadership – and the marketing teams under them – with the unenviable task of dealing with their protests against a science corrupted. Some were slandered or ignored; the legacy of others would be felted, smoothed and woven back into an heroic narrative of the great transformation. This, at least, is what happened with Lamb.

Hubert Lamb had promoted historical climatology with some considerable success, and it delivered him some renown among climatologists. But Lamb would not be so famous if it were not for what followed his departure from CRU. The science he found corrupted is the same science that made his research unit truly famous. In fact, it was only when Wigley led the early strategic shift into all the key fields of global warming research that CRU was at last able to stabilise its funding. This then positioned it well for the late 1980s, when Thatcher came a-calling, and when the unit's fame, and the funding, really took off. Without the change of direction following the departure of its charismatic founder, one can hardly imagine how CRU could have survived. But more than survive, it thrived; from the handful of researchers at CRU when Wigley arrived in 1975, it came to support around 50 staff at its peak. With this explosive expansion repeating across the science, what young climatologist would dare argue with the theory that was laying the golden eggs? The new generation might not even recognise the transformation into which their careers had been born, and might well be incredulous on reading this warning issued by the old master in 1994:

> A precarious and threatening situation has developed for climatology: a tremendous effort was made to land research funds in all countries, mostly the USA, on the basis of frightening people about the possible drastic effect of Man's activities, and so much has been said about climate warming that there will be an awkward situation if the warming doesn't happen or not to the extent predicted.[135]

## Acknowledgements

For assistance with research: Tom Wigley for his reflections on Lamb and the early days at CRU and also for providing key documents; Astrid Ogilvie and Phil Jones for their reflections on the early days at CRU; among the current staff at UEA thanks go to Alan Overden (CRU), Tim Osborn (CRU), Richard Cornes (UEA) and Bridget Gillies (UEA). Others who assisted include John Zillman, Ray Bates, John Maunder, James Fleming, Mark Beswick (UK Met Office Archive), Rosa Serratore and the staff at the Australian National Meteorological Library.

For reviewing drafts: Bob Carter, David Henderson, Richard Lindzen, Benny Peiser, Simon Scott and John Zillman. Proofreading: Kelsey Hegarty, Simon Scott. The photograph of Hubert Lamb is reproduced with permission from the Climatic Research Unit, University of East Anglia.

While these people and more assisted generously with the production of this essay, the final judgement on what to say and how to say it remains with the author, as does responsibility for any errors.

## Notes

1. T. Davies, 'Obituary: Hubert Horace Lamb (1913–97)', *The Independent*, 9 July 1997, p. 12.
2. T. Davies, 'Hubert Horace Lamb (1913–1997)', *Oxford Dictionary of National Biography*, 2004.
3. A. Tucker, 'A change in the weather (Obituary: H H Lamb)', *The Guardian*, Jun. 1997.
4. Davies, Obituary in the *Independent*.
5. United Nations, Framework Convention on Climate Change, 1992.
6. H.H. Lamb, *Through All The Changing Scenes Of Life: A meteorologist's tale*. East Harling: Taverner, 1997.
7. J. Fleming, *Historical Perspectives on Climate Change*. New York: Oxford University Press, 1998: Chapter 2.
8. R. Grove, *Green Imperialism: Colonial expansion, tropical island Edens and the origins of environmentalism, 1600–1860*. Cambridge: Cambridge University Press, 1995.
9. Fleming, *Historical Perspectives*, pp. 52–3.
10. H.H. Lamb, *Weather, Climate and Human Affairs: A book of essays and other papers*. London: Routledge, 1988: p. 2.
11. E. Brückner, Klima-Schwankungen seit 1700, nebst Bemerkungen über die Klimaschwankungen der Diluvialzeit. Wien; Olmütz: E. Hölzel, 1890. Translation: E. Brückner, *The Sources and Consequences of Climate change and Climate Variability in Historical Times*. Boston, London: Kluwer Academic Publishers, 2000. See Chapter 4.
12. A.E. Douglass, 'Weather cycles in the growth of big trees', *Mon. Weather Rev.* 1909; vol. 37: pp. 225–237.
13. C.E.P. Brooks, *Climate Through The Ages*. London: E. Benn, 1926.
14. H.H. Lamb, *Climate, History and the Modern World*. London: Methuen, 1982: pp. 10–12.
15. Lamb, *Changing Scenes of Life*, p. 178.
16. Lamb, *Climate, History and the Modern World*, p. 330.
17. Lamb, *Climate, History and the Modern World*, pp. 10–12, 330.
18. Lamb, *Weather, Climate and Human Affairs*, pp. 2–3.
19. Lamb, *Changing Scenes of Life*, p. 178.
20. Lamb, *Changing Scenes of Life*, pp. 178–93.
21. H. H. Lamb, 'On the nature of certain climatic epochs which differed from the modern (1900–39) normal', in *Changes of Climate: Proceedings of the Rome symposium organized by UNESCO and WMO*. Paris, UNESCO, 1963.
22. W. Sullivan, 'Scientists agree the world is colder', *New York Times*, 30 January 1961.
23. H. Lansford, 'Weather watchers', *Nature* 1975; vol. 265: pp. 688–90.
24. H.H. Lamb, *The Changing Climate: Selected papers*. London: Methuen, 1966: pp. 170–195.
25. By the mid-1970s, the study of this oscillation was sufficiently advanced for Lamb and others to announce the recent passing of a deep cyclic minimum, which led to the expectation of more mild winters.[136]
26. S.H. Schneider and C. Mass, 'Volcanic dust, sunspots, and temperature trends', *Science* 1975, vol. 190, pp. 741–746.
27. H.H. Lamb, 'Volcanic dust in the atmosphere; with a chronology and assessment of its meteorological significance', *Philos. Trans. R. Soc. Math. Phys. Eng. Sci.* 1970, vol. 266, pp. 425–533.
28. Lamb, Changing Scenes, p. 189
29. Lamb, Volcanic dust in the atmosphere.

30. H.H. Lamb, *Climate: Present, Past and Future*, vol. 1. London: Methuen, 1972: p. xxiii.
31. Lamb, *Changing Scenes of Life*, p. 198.
32. Lamb, *Changing Scenes of Life*, p. 200.
33. J.M. Kenworthy, 'Meteorologist's profile – Charles Ernest Pelham Brooks ISO, DSc (1888–1957)', *Weather* 2012, vol. 67, pp. 235–237.
34. See for example E. Huntington, *The Pulse of Asia: A journey in Central Asia illustrating the geographic basis of history*. Boston: Houghton Mifflin Company, 1907.
35. Lamb, 'On the nature of certain climatic epochs'.
36. Fleming, *Historical Perspectives*, pp. 74–82
37. J. Fleming, *The Callendar Effect: The life and times of Guy Stewart Callendar (1898–1964)*. Boston, Mass: American Meteorological Society, 2007.
38. Fleming, *The Callendar Effect*, pp. 71–83.
39. G.S. Callendar, 'The artificial production of carbon dioxide and its influence on temperature', *Q. J. R. Meteorol. Soc.* 1938; vol. 64, pp. 223–240.
40. S.R. Weart, *The Discovery of Global Warming*. Harvard University Press, 2003: pp. 28–30.
41. C. Booker, *The Real Global Warming Disaster*. London: Continuum, 2009: p. 59
42. See for example Knut Ångström, 'Über die Bedeutung des Wasserdampfes und der Kohlensaüres bei der Absorption der Erdatmosphäre'. *Annalen der Physik* 1900; 4: 720–32.
43. Lamb, *Climate: Present, Past and Future*, pp. 46. See also p. 439.
44. According to Lamb, late in his life Callendar himself was worried by the discrepancy between more rapidly increasing carbon dioxide and falling temperatures and he contacted both Lamb and Gordon Manley to discuss it.[137]
45. *Study of Critical Environmental Problems (SCEP), Man's impact on the global environment: assessment and recommendations for action*. Cambridge, Mass: MIT Press, 1970.
46. W.H. Matthews, W.W. Kellogg, and G.D. Robinson, *Man's Impact on the Climate*. Cambridge, Mass.: MIT Press, 1971.
47. *Study of Man's Impact on Climate (SMIC), Inadvertent climate modification*. Cambridge, Mass, London: MIT Press, 1971.
48. SMIC Report, p. 10.
49. H. H. Lamb, 'A critical problem', *Nature* 1972, vol. 237, pp. 53–4.
50. Lamb, 'On the nature of certain climatic epochs'.
51. J.M. Mitchell, Climatic change: report of a working group of the Commission for Climatology. Geneva: Secretariat of the World Meteorological Organization, 1966.
52. World Meteorological Organization Commission for Climatology. Abridged final report of the fifth session Geneva, 20–31 October 1969. Geneva. WMO, 1970: Res 10.
53. After its 1969 session, where the second Climatic Fluctuations Working Group was conceived, the Commission for Climatology was abolished. A restructure of the commissions by the WMO Congress replaced it with a new commission with a new brief: the Commission for Special Applications of Meteorology and Climatology. It was agreed by the presidents of the two commissions that the Climatic Fluctuations working group would not report to this new commission but to the Commission for Atmospheric Science. In fact, 1973 sessions of both commissions briefly considered versions of the report.[138,139,140] According to CRU's second annual report, as late as December 1972 J. Murray Mitchell visited CRU to discuss the draft report.[141] 'Numerous requests for copies' are noted in the Second Annual Report[142] and requests continued through to the following year.[143] Yet today there is no trace of any version of the report in the CRU library. The 'chairman's draft' used here is held by the Australian

Bureau of Meteorology Library. Another 'chairman's draft' of the same length (unsighted) is archived at the Met Office Library.

54. H.H. Lamb, Climatic fluctuation and the problems of foresight. Final report of a working group of the Commission for Atmospheric Sciences, 1972.

55. Lamb, Climatic fluctuation, p. 4a.

56. Lamb, Climatic fluctuation, pp. 20–20a.

57. Lamb, *Changing Scenes of Life*, pp. 197–198.

58. Lamb's millennium charts for central England are also famous, if only for their humps of warming in the High Middle Ages. For an early (1964) integrated treatment of both charts in a history of British climate, see Chapter 7 of Lamb's *The Changing Climate*.

59. Lamb, *Changing Scenes of Life*, p. 198.

60. Lamb, *Changing Scenes of Life*, p. 200.

61. Lamb, *Changing Scenes of Life*, p. 203.

62. T.M.L. Wigley, 'Responses to questions sent by email to the author', 19 June 2014.

63. Lamb, *Changing Scenes of Life*, p. 203.

64. See below for more about *The Weather Machine* documentary and book. Calder also addressed the conflict between theorist–modellers and the empiricists: 'The numerical modellers…doubt the rather vague meteorological arguments of the investigators of past climates. Those investigators in turn doubt the ability of computers to capture the slow and subtle changes in the weather machine, for which they have concrete evidence from the past. Meanwhile the divisions are debilitating. They have become scandalous in Britain where Lamb's own climatic research unit, esteemed throughout the world, has been denied government funding owing to opposition from the meteorological establishment'.[144]

65. N. Hawkes, 'When summer snow doth make sage weathermen dispute', *The Observer*, 8 June 1975, p. 11.

66. A. Piper, 'Lamb's unit to the slaughter?', *Nature* 1974, vol. 248, pp. 466–7.

67. CRU Third Annual Report, pp. 1, 22.

68. Lamb, *Changing Scenes of Life*, p. 203.

69. The interests of petroleum companies included energy consumption planning where, for example, CRU investigated the possibility of severe winters occurring at the same time in Europe, eastern North America and the Far East.[145] Studies of severe storms of the North Sea also had implications for the development of offshore oil fields.[146]

70. Lamb, *Changing Scenes of Life*, p. 204.

71. Lamb, *Changing Scenes of Life*, p. 249.

72. W. Bell and A. Ogilvie, 'Weather compilations as a source of data for the reconstruction of European climate during the medieval period', *Clim. Change* 1978, vol. 1, pp. 331–348.

73. Wigley, 'Responses to questions'.

74. Fourth Annual Report, Climatic Research Unit in the School of Environmental Sciences, University of East Anglia, covering the academic year October 1974 to September 1975. UEA, 1975.

75. Fifth Annual Report, Climatic Research Unit in the School of Environmental Sciences, University of East Anglia, covering the academic year October 1975 to September 1976. UEA, 1976.

76. Sixth Annual Report, Climatic Research Unit in the School of Environmental Sciences, University of East Anglia, covering the academic year October 1976 to September 1977. UEA, 1977.

77. Seventh Annual Report, Climatic Research Unit in the School of Environmental Sciences, University of East Anglia, covering the academic year October 1977 to September 1978. UEA, 1978.
78. Eighth Annual Report, Climatic Research Unit in the School of Environmental Sciences, University of East Anglia, covering the academic year October 1978 to September 1979. UEA, 1979.
79. CRU Eighth Annual Report, p. 232. This is a line of funding that expanded and continues to this day, per T.M.L. Wigley, 'Responses to questions'.
80. Wigley, 'Responses to questions'.
81. Biennial Report, Climatic Research Unit in the School of Environmental Sciences, University of East Anglia, 1982–84. UEA, 1984, p. 3.
82. T.M.L. Wigley, M.J. Ingram, and G. Farmer, (eds), *Climate and History: Studies in past climates and their impact on man*. Cambridge: Cambridge University Press, 1981.
83. T. M. L. Wigley and P. Brimblecombe, 'Carbon dioxide, ammonia and the origin of life', *Nature* 1981, vol. 291, pp. 213–215.
84. T.M.L. Wigley, P.D. Jones, and P.M. Kelly, 'Global warming?', *Nature* 1981, vol. 291, p. 285.
85. T.M.L. Wigley and P.D. Jones, 'Detecting $CO_2$-induced climatic change', *Nature* 1981, vol. 292, p. 205.
86. CRU Biennial Report 1982–84, p. 3.
87. A.E.J. Ogilvie, 'Responses to questions sent by email to the author', 7 July 2014.
88. T.M.L. Wigley, R. Richels, and J.A. Edmonds, 'Economic and environmental choices in the stabilization of atmospheric $CO_2$ concentrations', *Nature* 1996, vol. 379, pp. 240–243.
89. F. Pearce, 'Sit tight for 30 years, argues climate guru', *New Sci.*, Jan. 1996.
90. R. Darwall, *The Age of Global Warming: A history*. Quartet Books, 2013: pp. 100–7.
91. S. Rasool and S.H. Schneider, 'Atmospheric carbon dioxide and aerosols: effects of large increases on global climate', *Science* 1971, vol. 173, pp. 138–141.
92. R.A. Bryson, 'A perspective on climatic change', *Science* 1974, vol. 184, pp. 753–760.
93. Calder, *The Weather Machine*.
94. There were exceptions. In 1975 a crude model was reported to have approximated the global temperature trend over the last four centuries by incorporating recent greenhouse warming into a modelling of primarily solar and volcanic influences. In this case Lamb's dust veil index was used.[147]
95. In 20th century climatology, the primary role of the oceans in the climatic system had always been well accepted. This included their role in climatic oscillations that had been found to be grounded in movement of heat through these massive solar heat banks. In the 1970s, the El Niño/La Niña oscillation and the North Atlantic Oscillation were already well-studied.[148] Yet there was insufficient computer power to 'couple' ocean models into atmospheric circulation models until around 1990.[149] It was even later that crude simulations of anthropogenic aerosol cooling were incorporated, but this was only after governments had already committed to a framework convention for warming mitigation.[150,151]
96. M. Mead and W.W. Kellogg, The atmosphere: endangered and endangering. Bethesda, Washington: U.S. Dept. of Health, Education, and Welfare, Public Health Service, National Institutes of Health, 1977: p. xxiii.
97. Mead and Kellogg, The atmosphere, p. 97.
98. W.W. Kellogg, 'Mankind's impact on climate: The evolution of an awareness', *Clim. Change* 1987, vol. 10, pp. 113–136.
99. Mead and Kellogg, The atmosphere, pp. 67–70.

100. Mead and Kellogg, The atmosphere, p. 100.
101. M. Walker, *History of the Meteorological Office*. Cambridge: Cambridge University Press, 2012: p. 404.
102. CRU Fifth Annual Report, p. 2.
103. H.H. Lamb, *Climate: Present, Past and Future*, vol. 2. London: Methuen, 1977: p. 698.
104. Lamb, *Climate, history and the modern world*, p. 330.
105. Lamb, *Climate, history and the modern world*, p. 330.
106. World Meteorological Organization, 'WMO Statement on Climatic Change', *WMO Bull.* 1976, vol. 25, pp. 211–2.
107. World's temperature likely to rise, *The Times* 22 June 1976, p. 9.
108. WMO Sixth Session report, Res 15.
109. WMO Statement 1976.
110. CRU Second Annual Report, p. 4.
111. CRU Third Annual Report, p. 10.
112. CRU Seventh Annual Report, p. 2–3.
113. Lamb, *Weather, Climate and Human Affairs*, p. 9.
114. Lamb, *Weather, Climate and Human Affairs*, p. 9.
115. One of these embarrassed meteorologists was Charles Brooks[152]
116. Lamb, *Weather, Climate and Human Affairs*, pp. 192–3.
117. Lamb, *Weather, Climate and Human Affairs*, p. 9.
118. Lamb, *Weather, climate and Human Affairs*, p. 225.
119. H.H. Lamb, *Climate, History, and the Modern World*, 2nd edn. London; New York: Routledge, 1995: p. 384.
120. M. Kelly, 'Obituary: Hubert Horace Lamb (1913–97)', *Nature* 1997, vol. 388, p. 836.
121. Climatic Research Unit, University of East Anglia, 'Hubert Lamb', September 2014. Available: http://www.cru.uea.ac.uk/about-cru/hubert-lamb.
122. L.E. Major, 100 discoveries and developments in UK universities that have changed the world. London: Universities UK, 2006.
123. Wigley, 'Responses to questions'.
124. Ogilvie, 'Responses to questions'.
125. World Meteorological Organization, Declaration of the World Climate Conference, February 1979.
126. R.M. White, 'Greenhouse policy and climate uncertainty. Speech given at the Annual Meeting of the National Academy of Science, April 1989, Washington, DC', *Bull. Am. Meteorol. Soc.* 1989, vol. 70, pp. 1123–1127.
127. L. Roberts, 'Global warming: blaming the sun', *Science* 1989, vol. 246, pp. 992–993.
128. R. Jastrow, W. Nierenberg, and F. Seitz, *Scientific Perspectives on the Greenhouse Problem*. Washington, DC: George C Marshall Institute, 1989.
129. E. Timmer, 'Het Gelijk van Henk Tennekes', *De Telegraaf*, Netherlands, 13 February 2010.
130. A. Wiin-Nielsen, 'The greenhouse effect, yes or no? A scientific evaluation', *Water Resour. Manag.* 1999, vol. 13, pp. 59–72.
131. B. Bolin, *A History of the Science and Politics of Climate Change: The role of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press, 2008: p. 136.
132. D. Henderson, 'The Bengtsson affair and the Global Warming Policy Foundation', De Staat van het Klimaat. Available: http://www.staatvanhetklimaat.nl/2014/05/30/the-bengtsson-affair-and-the-global-warming-policy-foundation/. Accessed 20 October 2014.

133. J. Simpson, 'TRMM (Tropical Rainfall Measuring Mission) data set potential in climate controversy, by Joanne Simpson, private citizen', *Climate Science: Roger Pielke Sr.* weblog. Available: http://pielkeclimatesci.wordpress.com/2008/02/27/trmm-tropical-rainfall-measuring-mission-data-set-potential-in-climate-controversy-by-joanne-simpson-private-citizen/. Accessed: 3 November 2014.
134. W. Sullivan, 'Study finds warming trend that could raise sea levels', *New York Times*, 22 August 1981, p. 1.
135. 'Professor Hubert H Lamb', *WMO Bull.* 1994, vol. 43, p. 277–8.

## About the Global Warming Policy Foundation

The Global Warming Policy Foundation is an all-party and non-party think tank and a registered educational charity which, while openminded on the contested science of global warming, is deeply concerned about the costs and other implications of many of the policies currently being advocated.

Our main focus is to analyse global warming policies and their economic and other implications. Our aim is to provide the most robust and reliable economic analysis and advice. Above all we seek to inform the media, politicians and the public, in a newsworthy way, on the subject in general and on the misinformation to which they are all too frequently being subjected at the present time.

The key to the success of the GWPF is the trust and credibility that we have earned in the eyes of a growing number of policy makers, journalists and the interested public. The GWPF is funded overwhelmingly by voluntary donations from a number of private individuals and charitable trusts. In order to make clear its complete independence, it does not accept gifts from either energy companies or anyone with a significant interest in an energy company.

**GWPF REPORTS**

| | | |
|---|---|---|
| 1 | Montford | The Climategate Inquiries |
| 2 | Ridley | The Shale Gas Shock |
| 3 | Hughes | The Myth of Green Jobs |
| 4 | McKitrick | What Is Wrong With the IPCC? |
| 5 | Booker | The BBC and Climate Change |
| 6 | Montford | Nullius in Verba: The Royal Society and Climate Change |
| 7 | Goklany | Global Warming Policies Might Be Bad for Your Health |
| 8 | Hughes | Why Is Wind Power So Expensive? |
| 9 | Lilley | What Is Wrong With Stern? |
| 10 | Whitehouse | The Global Warming Standstill |
| 11 | Khandekar | The Global Warming-Extreme Weather Link |
| 12 | Lewis and Crok | Oversensitive |
| 13 | Lewis and Crok | A Sensitive Matter |
| 14 | Montford and Shade | Climate Control: Brainwashing in Schools |
| 15 | De Lange and Carter | Sea-level Change: Living with Uncertainty |
| 16 | Montford | Unintended Consequences of Climate Change Policy |
| 17 | Lewin | Hubert Lamb and the Transformation of Climate Science |
| 18 | Goklany | Carbon Dioxide: The Good News |
| 19 | Adams | The Truth About China |
| 20 | Laframboise | Peer Review: Why Scepticism is Essential |
| 21 | Constable | Energy Intensive Users: Climate Policy Casualties |
| 22 | Lilley | £300 Billion: The Cost of the Climate Change Act |
| 23 | Humlum | The State of the Climate in 2016 |
| 24 | Curry et al. | Assumptions, Policy Implications and the Scientific Method |
| 25 | Hughes | The Bottomless Pit: The Economics of CCS |
| 26 | Tsonis | The Little Boy: El Niño and Natural Climate Change |
| 27 | Darwall | The Anti-development Bank |
| 28 | Booker | Global Warming: A Case Study in Groupthink |
| 29 | Crockford | The State of the Polar Bear Report 2017 |
| 30 | Humlum | State of the Climate 2017 |
| 31 | Darwall | The Climate Change Act at Ten |
| 32 | Crockford | The State of the Polar Bear Report 2018 |
| 33 | Svensmark | Force Majeure: The Sun's Role in Climate Change |
| 34 | Humlum | State of the Climate 2018 |

For further information about the Global Warming Policy Foundation, please visit our website at www.thegwpf.org.

The GWPF is a registered charity, number 1131448.