Climate Change

A Multidisciplinary Approach

2nd Edition

Climate Change: A Multidisciplinary Approach provides a concise, up-to-date presentation of current knowledge of climate change and its implications for society as a whole. This new edition has been thoroughly updated and extended to include the latest information.

The textbook describes the components of the global climate, and the physical principles of its behaviour on all timescales. It then considers how the many elements of climate combine to define its behaviour. The author reviews how climate change is measured. He stresses the importance of careful statistical analysis in seeking connections between observations and possible physical causes. The book discusses how the causes of climate change, including human activities, can be related to the evidence of change, and modelled to predict future changes. It then consider how these models inform the economic and political debate surrounding climate change, prevention and mitigation.

Climate Change: A Multidisciplinary Approach can be used on a wide range of introductory courses that consider the impact of a changing climate on the Earth and its inhabitants, within the departments of meteorology, oceanography, environmental science, earth science, geography, agriculture and social science. It will also appeal to a wider audience who wish to go beyond the standard 'coffee table' book and get to grips with the gritty issues of climate change.

William Burroughs is a professional science writer, and has published many books on weather and climate including *Climate Change in Prehistory, Does the Weather Really Matter?, Weather Cycles, The Climate Revealed*, *Watching the World's Weather*, and *Climate: Into the 21st Century* (all with Cambridge University Press). In 2005 he received the Michael Hunt Award from the Royal Meteorological Society for his work in popularising meteorology.

Reviews of the first edition

'. . . a recommended read for the informed layman and student seeking a wider background in this topical but complex field.'

Grant Bigg, *Weather*

'The book is well written, contains practically no mathematics and yet manages to explain, in a clear and attractive style, the subtleties of the subject . . . I recommend it to everybody interested in the climate of our Earth.'

Michael Hantel, *Meteorologische Zeitschrift*

'. . . the book enthusiastically achieves its aims of not oversimplifying but explaining the complexities of what is well established and unknown about the climate system for a wider audience . . .'

Claire Goodess, *International Journal of Climatology*

'Burroughs is to be congratulated for having written a serious and up-to-date book that competently surveys many highly technical aspects of modern climate science but manages to do so in a nonmathematical manner.'

American Meteorological Society

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Preface to the second edition

Since the first edition of this book was published in 2001, the subject of climate change has grown from just one of a number of pressing environmental issues to being seen as comparable with terrorism and nuclear proliferation as one of the greatest threats to humankind. Why has this dramatic change occurred? The principal reason is summed up in a quip by the British Prime Minister, in the late 1950s/early 1960s, Harold Macmillan. When asked by a young journalist after a long dinner what can most easily steer a government off course, he answered, "Events, dear boy. Events".

The climate has been anything but uneventful in recent years. The inundation of New Orleans, the European heat wave of 2003 and the accelerating melting of polar ice sheets are widely seen as examples of how climate change is a growing threat to the planet. It is not just the scale of these events but also the sense of inadequacy of our preparedness for managing adverse events and how this requires us to think in a multidisciplinary way in our preparedness. This wider thinking has inspired politicians to express far greater commitment to action on climate change. In part, this is the realisation that the first step had to be to sign up to and express commitment to the Kyoto Treaty of 1997. Then there was the remarkable impact of one of their number – Al Gore. Having come within a few hanging chads of becoming US President in 2000, he is now the international standard bearer for action on the climate.

Another feature of these changes is the increasing anthropomorphisation of the plight of creatures at threat from global warming. While this is a powerful method of publicising the potential consequences of melting sea ice for polar bears, penguins and walrus, it does need to be put in the context of past climate change. All these polar species survived the last interglacial warm spell around 125 000 years ago, when the peak global temperature was some 2 °C warmer than now and sea levels were about 6 metres higher. So, on the basis of this experience of these examples of polar species, they appear to have the capacity to survive for a while yet.

At the same time, the scientific community has reached a consensus on the nature of the scale of human contribution to recent climate change. These forecasts centred on the impact of the emission of greenhouse gases, which were seen as the dominant anthropogenic component in the recent

warming. This confidence has, however, been qualified by a widespread recognition that there are considerable uncertainties in the handling of such factors as cloudiness, the associated consequences of dust and aerosols. Furthermore, some of the high hopes expressed as to progress with seasonal and longer-term forecasts, based on the growing understanding of the El Niño, have had to recognise that such forecasts cannot restrict the analysis to the Pacific alone, but must include the rhythms of the Atlantic and Indian Oceans.

There is, however, no doubt we are part of the recent changes and that global models of the climate are the only way to calculate future trends. What is less clear is the true scale of the natural variability. Paradoxically, while the majority are inclined to downgrade the impact of natural fluctuations in recent centuries, there has been a growing recognition that abrupt and unpredictable changes in the climate have been a feature of climatic history. Furthermore, it is clear that we have had the good fortune to live in a period of relative climatic stability during the last 10 000 years. Our hope has to be that neither natural changes nor any changes that will be precipitated by anthropogenic activities will push us too far from the conditions of this relatively stable period, which encompasses all the recorded history of humankind and more.

Confronted with this array of forbidding prospects, the calls for action have abounded. The most practical seek to show that a virtuous circle of improved efficiency and progressive tax policies can produce major reductions in greenhouse emissions. In practice, some of these will be politically acceptable, others will not. So, while progress will be made, handling political objections to more demanding cuts will increasingly be difficult to overcome.

It is at this stage that the soundness of the scientific arguments will come in for more aggressive scrutiny. Balanced arguments that recognise the strengths and weaknesses of the scientific case are more likely to prevail. The alternative is to insist that the only answer is to concentrate on carbon dioxide emissions and, that these need to be cut by, say, 80% by 2050 stands little chance of electoral support. Of course, events of sufficient magnitude may steam-roller all objections, but let us hope it does not come to that.

In the meantime, the objective of this book remains to build on the groundwork of pioneers such as Hubert Lamb and Murray Mitchell, who devoted so much effort to climate change when it was not regarded as an important aspect of meteorology. The pace of events does not alter the need to present the current state of climatic knowledge in a balanced manner. In so doing, it must provide a gateway to the intricacies of the climate system,

that it properly integrates the analysis of how we have to face up to the challenge of changes that represent a serious threat to our current lifestyle. This can only be achieved by continued research into what are the most important features of climate change, how they will combine to produce imminent change, and what are the most realistic ways of averting these changes.