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Global Warming

The Complete Briefing • Fourth Edition

John Houghton's market-leading textbook is now in full colour and includes the latest IPCC findings and future energy scenarios from the International Energy Agency, making it the definitive guide to climate change. Written for students across a wide range of disciplines, its simple, logical flow of ideas gives an invaluable grounding in the science and impacts of climate change and highlights the need for action on global warming.

'The addition of colour serves the diagrams so they deliver the necessary message and information they intend ... to instructors and students in interdisciplinary programmes who need an accessible, broad-view text on the subject of climate change.'

YOCHANAN KUSHNIR, *Lamont-Doherty Earth Observatory of Columbia University*

'The new edition provides the most up-to-date and comprehensive coverage of climate change for teaching in an undergraduate class. It covers the latest on climate science, climate change impacts and adaptation, and approaches to slowing climate change through reducing emissions from energy use, transport, and deforestation. These complex issues are presented clearly and thoroughly, based on the recent Fourth Assessment Report of the Intergovernmental Panel on Climate Change and many other sources. The new edition has significantly expanded and updated sections on slowing and stabilising climate change and on energy and transport for the future, which complement the sections on climate science. The addition of colour adds clarity and emphasis to the many valuable figures. I will definitely be using this book in all my courses on climate change.'

PROF DAVID KAROLY, *University of Melbourne (formerly of the University of Oklahoma)*

'It is difficult to imagine how Houghton's exposition of this complex body of information might be substantially improved upon ... Seldom has such a complex topic been presented with such remarkable simplicity, directness and crystalline clarity ... Houghton's complete briefing is without doubt the best briefing the concerned citizen could hope to find within the pages of a pocketable book.'

JOHN PERRY, *Bulletin of the American Meteorological Society*

'I can recommend (this book) to anyone who wants to get a better perspective on the topic of global warming ... a very readable and comprehensive guide to the changes that are occurring now, and could occur in the future, as a result of human action ... brings the global warming debate right up to date ...'

WILLIAM HARSTON, *The Independent*

'... a widely praised book on global warming and its consequences.'

The Economist

'I would thoroughly recommend this book to anyone concerned about global warming. It provides an excellent, essentially non-technical guide on scientific and political aspects of the subject. It is an essential briefing for students and science teachers.'

TONY WATERS, *The Observatory*

'For the non-technical reader, the best program guide to the political and scientific debate is John Houghton's book *Global Warming: The Complete Briefing*. With this book in hand you are ready to make sense of the debate and reach your own conclusions.'

ALAN HECHT, *Climate Change*

'This is a remarkable book ... It is a model of clear exposition and comprehensible writing ... Quite apart from its value as a background reader for science teachers and students, it would make a splendid basis for a college general course.'

ANDREW BISHOP, *Association for Science Education*

'... a useful book for students and laymen to understand some of the complexities of the global warming issue. Questions and essay topics at the end of each chapter provide useful follow-up work and the range of material provided under one cover is impressive. At a student-friendly price, this is a book to buy for yourself and not rely on the library copy.'

ALLEN PERRY, *Holocene*

'This book is one of the best I have encountered, that deal with climate change and some of its anthropogenic causes. Well written, well organised, richly illustrated and referenced, it should be required reading for anybody concerned with the fate of our planet.'

ELMAR R. REITER, *Meteorology and Atmospheric Physics*

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‘Sir John Houghton is one of the few people who can legitimately use the phrase “the complete briefing” as a subtitle for a book on global warming ... Sir John has done us all a great favour in presenting such a wealth of material so clearly and accessibly and in drawing attention to the ethical underpinnings of our interpretation of this area of environmental science.’

Progress in Physical Geography

‘Throughout the book this argument is well developed and explained in a way that the average reader could understand – especially because there are many diagrams, tables, graphs and maps which are easy to interpret.’

SATYA

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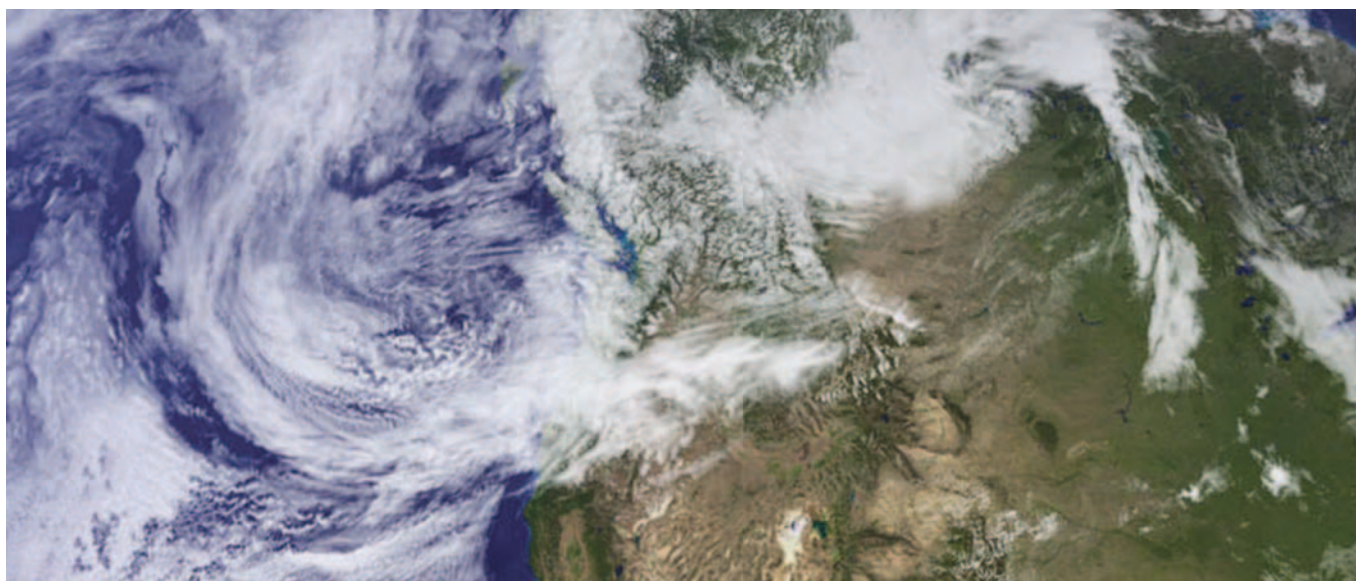
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To my grandchildren,
Daniel, Hannah, Esther, Max,
Jonathan, Jemima and Sam
and their generation

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Preface

Global Warming is a topic that increasingly occupies the attention of the world. Is it really happening? If so, how much of it is due to human activities? How far will it be possible to adapt to changes of climate? What action to combat it can or should we take? How much will it cost? Or is it already too late for useful action? This book sets out to provide answers to all these questions by providing the best and latest information available.

I was privileged to chair or co-chair the Scientific Assessments for the Intergovernmental Panel on Climate Change (IPCC) from its inception in 1988 until 2002. During this period the IPCC published three major comprehensive reports – in 1990, 1995 and 2001 – that have influenced and informed those involved in climate change research and those concerned with the impacts of climate change. In 2007, a fourth assessment report was published. It is the extensive new material in this latest report that has provided the basis for the substantial revision necessary to update this fourth edition.

The IPCC reports have been widely recognised as the most authoritative and comprehensive assessments on a complex scientific subject ever produced by the world's scientific community. On the completion of the first assessment in 1990, I was asked to present it to Prime Minister Margaret Thatcher's cabinet – the first time an overhead projector had been used in the Cabinet Room in Number 10 Downing Street. In 2005, the work of the IPCC was cited in a joint statement urging action on climate change presented to the G8 meeting in that year by the Academies of Science of all G8 countries plus China, India and Brazil. The world's top scientists could not have provided stronger approval of the IPCC's work. An even wider endorsement came in 2007 when the IPCC was awarded a Nobel Peace Prize.

Many books have been published on global warming. My choice of material has been much influenced by the many lectures I have given in recent years to professional, student and general audiences.

The strengths of this book are that it is:

- **up-to-date with the latest reliable, accurate and understandable information** about all aspects of the global warming problem for students, professionals and interested or concerned citizens.
- **accessible** to both scientists and non-scientists. Although there are many numbers in the book – I believe quantification to be essential – there are no

mathematical equations. Some important technical material is included in boxes.

- **comprehensive**, as it moves through the basic science of global warming, impacts on human communities and ecosystems, economic, technological and ethical considerations and policy options for action both national and international.
- appropriate as a **general text for students**, from high-school level up to university graduate. Questions and problems for students to consider and to test their understanding of the material are included in each chapter.
- Its **simple and effective visual presentation of the vast quantities of data** available on climate change ensures that readers can see how conclusions are made, without being overwhelmed. Illustrations are available online.

Over the 20 years since the inception of the IPCC, our understanding of climate change has much increased and significant changes in climate due to human activities have been experienced. Further, studies of the feedbacks that determine the climate response have shown an increasing likelihood of enhanced response, so leading over these years to greater concern about the future impact of climate change on both human populations and ecosystems. Can much be done to alleviate the impact or mitigate future climate change? Later chapters of the book address this question and demonstrate that the technology is largely available to support urgent and affordable action. They also point to the many other benefits that will accrue to all sectors of society as the necessary action is taken. However, what seems lacking as yet is the will to take that action.

As I complete this revised edition I want to express my gratitude, first to those who inspired me and helped with the preparation of the earlier editions, with many of whom I was also involved in the work of the IPCC or of the Hadley Centre. I also acknowledge those who have assisted with the material for this edition or who have read and helpfully commented on my drafts, in particular, Fiona Carroll, Jim Coakley, Peter Cox, Simon Desjardin, Michael Hambery, Marc Humphreys, Chris Jones, Linda Livingstone, Jason Lowe, Tim Palmer, Martin Parry, Ralph Sims, Susan Solomon, Peter Smith, Chris West, Sue Whitehouse and Richard Wood. My thanks are also due to Catherine Flack, Matt Lloyd, Anna-Marie Lovett and Jo Endell-Cooper of Cambridge University Press for their competence and courtesy as they steered the book through its gestation and production.

Finally, I owe an especial debt to my wife, Sheila, who gave me strong encouragement to write the book in the first place, and who has continued her encouragement and support through the long hours of its production.