

## The Science and Politics of Global Climate Change

### A Guide to the Debate, Third Edition

This third edition has been comprehensively updated to reflect the large changes in scientific knowledge and policy debates on climate change since the previous edition in 2010. It provides a concise but thorough overview of the science, technology, economics, policy, and politics of climate change in a single volume. It explains how scientific and policy debates work, outlines the scientific evidence for the reality and seriousness of climate change and the basic atmospheric science that supports it, and discusses policy options and the current state of the policy debate. By pulling these elements together, the book explains why the issue can be so confusing and provides guidance on practical routes forward. Anyone interested in climate change, the global environment, or how science is used in policy debates should read this book. It is the ideal textbook for undergraduate or graduate courses in environmental policy and climate change.

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**Praise for the third edition:**

“This updated edition of a highly acclaimed book on the complex issues of climate change, societal implications, rational policy options, and political challenges is skillfully written for readers of all backgrounds. The presentation strikes the right balance by giving enough technical detail to explain the scientific evidence while candidly describing the remaining uncertainties and addressing the objections of the climate skeptics and deniers. I highly recommend it as a graduate and undergraduate textbook and as a book that should be high on everyone’s reading list, including policy-makers’ – the issues are that important.”

*Neal Lane, Baker Institute for Public Policy, Rice University; former  
Science Advisor to President Clinton; former Director of the  
US National Science Foundation*

“Our children are angry with us for the climate crisis we have created. They are looking for heroes – but mitigating and adapting to climate change is going to need a lot more than heroes. Whoever steps forward, whatever is done, will require negotiating a tangled web of politics, science, economics, entrepreneurship, and social justice that has been spun up by runaway global heating. No book comes even close to Dessler and Parson’s Zen-like mastery of what needs to be done if we are to address the climate crisis before it is too late. Fortunately, Dessler and Parson write with a crisp clarity that is intellectually sophisticated without showing off, or hiding behind jargon. If you care about climate change, there is no excuse for not reading this book.”

*Peter Kareiva, Director, Institute of the Environment and  
Sustainability, University of California, Los Angeles*

“The authors do a great service with a book that manages to be both readable and succinct, but also comprehensive in its analysis of the science, politics, and policy of climate change. I highly recommend it to beginners who want to grasp the overall problem, and experts who want depth on specific topics. I will keep this book at close reach on my bookshelf.”

*Ken Kimmell, President, Union of Concerned Scientists*

### Praise for previous editions:

“This timely, informative, and well-written book does an excellent job of explaining, in language accessible to everyone, the scientific basis for our current understanding of global warming and climate change, as well as societal implications and the political barriers to sound, rational policy. Its co-authors are well-recognized experts in science and in public policy. I recommend it to anyone who wishes to gain a better understanding of this complex issue – what the debate is all about – and as a core textbook for introductory courses on the environment, climate change, or public policy.”

*Neal Lane, Baker Institute for Public Policy, Rice University; former Science Advisor to President Clinton; former Director of the US National Science Foundation*

“As the scientific evidence on human-induced climate change becomes stronger and more widely accepted, voices that question it appear to get louder and seemingly more coordinated. In a complex area such as climate change, politics inevitably runs into conflict with the domain of science. This book is a timely analysis of the scientific evidence of climate change as well as the political forces that question its full acceptance. Dessler and Parson have produced a remarkable piece of work that is relevant for the scientific community in understanding the political implications of their work, and for politicians and the public at large in understanding not only the overwhelming scientific evidence that has emerged in recent years, but also the remaining uncertainties that need to be addressed in future scientific endeavor. This feature alone and the simple and readable manner in which the book is written make it essential reading for scientists as well as the concerned public at large.”

*Dr. R. K. Pachauri, Chairman, Intergovernmental Panel on Climate Change (IPCC), and Director General, The Energy and Resources Institute (TERI), India*

“... there is a real need for a comprehensive book on climate change... *The Science and Politics of Global Climate Change* is it. It does exactly what the title and subtitle promise, providing insights into the causes and effects of the contributing meteorological phenomena and into why it has been so hard to get consensus among governments... copies should be shipped to anyone who doubts the reality of climate change, starting with presidents in denial.”

*New Scientist*

“... requires no specialized knowledge, but is accessible to any educated general reader who wants to make more sense of the climate-change debate. It also sheds light on how science is used in policy debates.”

*The Chemical Engineer*

“Each of the key aspects of global climate change is covered, with up-to-date and well-referenced information throughout. Its impressive breadth and the provision of succinct overviews of source material in the further reading sections of each chapter mean that teachers, lecturers, and researchers will all find this book a useful starting point for in-depth study. There are now numerous taught master’s courses on ‘global change issues,’ and this book constitutes a must-have addition to their reading lists . . . read the book in its entirety - it is well worth it . . . [This book] is an excellent attempt at deconstructing the confusion that surrounds the climate-change debate. This reviewer has been waiting some time for a book such as this to appear . . . The science and politics of climate change are brought together quite seamlessly, . . . Dessler and Parson’s book is a must for those who want to move beyond the rhetoric and understand the relationship between climate science and policy, and also for those seeking an interdisciplinary outlook on the management of global environmental issues . . . This book will be most useful to undergraduates and post-graduates in the fields of environmental science, sustainability, and international politics. Each of the key aspects of global climate change is covered, with up-to-date and well-referenced information throughout . . . as a primer that brings together global climate change science and politics, it succeeds very well indeed!”

*Times Higher Education Supplement*

“This is an excellent way into the subject for the beginner . . . one of the most lucid and readable introductory accounts of the topic that has been published in some while. As such, it should be seen as a ‘must-buy’ and an essential addition to the library.”

*TENews*

“This is a book which all scientists and the educated general public should read and reflect upon before it is too late to halt the apparently inevitable progress to Armageddon.”

*Chromatographia*

“ . . . a useful compendium of the current debates in the science and politics of climate change . . . succinct and consistent book . . . Ensure[s] fluent reading for non-expert, yet educated, citizens. The book is logically structured and it should become a key reading and teaching source in geography and environmental sciences. It can also be valuable to doctoral students and senior researchers interested in learning about climate change science and politics. Overall, it is a book worth having on one’s shelf.”

*Environmental Sciences*

“As more and more extreme weather events around the globe are being associated with climate change, it is sometimes difficult to be able to see the wood for the trees, but this book takes the reader very clearly through the ‘maze’ of claims and counter-claims . . . if only government leaders would read, digest, and follow up some of the suggestions in the last chapter, there would be optimism that the problem can be overcome. As always with Cambridge University Press, the book, which is illustrated with diagrams, charts, and boxes, is impeccably produced, and is an absolute ‘must’ for every reader of this journal.”

*International Journal of Meteorology*

“Written by an atmospheric scientist and a law professor with extensive public policy experience, the book effectively tackles the rough-and-tumble intersection of science and policy that has led to confusion and inaction . . . The scholarly value of [the book] is indisputable. Dessler and Parson independently possess significant authority on both the science and the politics of climate change. Their treatment of the subject illustrates the complexity of the problem with remarkable ease and clarity . . . the carefully thought-through recommendations make this book critical reading for policy-makers . . . considering action on the issue.”

*Maria Ivanova, The College of William and Mary*

“ . . . the book treats this contentious field clearly, dispassionately, and logically . . . Highly recommended.”

*CHOICE*

“ . . . one of the best summary backgrounds of this complex topic now available. [The authors] carefully describe what we know about the science of climate change, and why we can make some overall global forecasts with confidence.”

*Oceanography*

# The Science and Politics of Global Climate Change

A Guide to the Debate

THIRD EDITION

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## *Preface to the Third Edition*

Climate change is one of the gravest challenges facing human society in the twenty-first century, perhaps the gravest. In this book, we present a comprehensive view of the climate-change issue, including discussions of relevant science, technology, economics, policy, and politics, with particular focus on how all these aspects of the issue interact. We thereby aim to provide a well-founded description of where the issue stands now and how it developed, to illuminate why it is so difficult and contentious to manage and provide guidance on promising directions for doing so.

The book provides a teaching tool suitable for courses on climate change, environmental policy and politics, or science and public policy, at the upper-level undergraduate or introductory graduate/professional level. It also aims to serve audiences beyond students, in two ways. First, it provides an entry point for non-specialist readers wanting a one-stop place to learn about the various aspects of the climate issue and how they fit together. Second, recognizing the tensions between professional specialization and the vast scope of issues implicated in climate change, the book aims to help those already knowledgeable about one aspect or another of the climate-change issue – the science, policy, or politics – to see how their piece fits into the bigger puzzle: people engaged with policy or politics who want to learn more about the science than a recitation of facts, and people approaching climate change from the scientific side who want to learn more about policy and politics, including how scientific knowledge gets used in these processes.

In this third edition, the aims of the book and its intended audience are unchanged. But a great deal has changed in our subject matter – in the five years between the first and second editions, and even more in the ten years between the second and third – requiring extensive revisions and additions.

In this new edition, we address substantial developments in policy and politics. The 2015 Paris Agreement stated ambitious new targets to limit global-average

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temperature and established a new, decentralized international approach to pursue them. The United States experienced a significant strengthening of mitigation efforts under the Obama administration, albeit still constrained by the existing statutory framework and the inability to enact any new, more aptly targeted climate legislation. The Trump administration has since attempted a sharp retreat from these initiatives. Although many pieces of this retreat are likely to be restrained by pending legal challenges, it has still intensified the trend of US climate leadership shifting to the states. Other major emitters remain on a track of gradually strengthening efforts, although these are encountering significant setbacks – even in places like Germany, long regarded as climate-change leaders. Overall, current targets and actions are falling far short of what would be required to achieve reasonably prudent climate limits such as the Paris temperature targets, and it is not clear how, or whether, the increasingly obvious obstacles to the strength of action needed will be surmounted.

Scientific knowledge related to climate change has continued to progress since our last edition, although the most significant advances largely represent increased validation and specification of what was already known. To the extent there is significant new scientific knowledge available, it mostly tends to show that the problem is even more dire than was previously thought. The most salient improvements in climate science deal with impacts – better understanding of the disintegration of the major ice sheets, better understanding of the factors that control regional climate, and better attribution of the role of climate change in severe weather events, such as hurricanes, precipitation events, and heat waves.

Perhaps the best way to describe recent changes in knowledge of climate change is that conditions that were present all along are becoming more visible and prominent. This characterization applies, for example, to the basic tension we state at the beginning of the book – that climate change is both the most serious present environmental problem and the hardest to manage. This tension has been present from the start, but its starkness and intensity have become increasingly clear over time.

This is a hard thing to accept. Many people observing climate change want to believe that one part or the other of this is not true: either that the risks of climate change are not so bad, or that the costs and difficulties of managing it are not so bad. If either of these was the case, identifying and choosing the preferred course of action would be easy: little action beyond continued research and monitoring in the first case, and aggressive (but easy and cheap) emissions cuts in the second. The reality is more difficult, and more conducive to political conflict. Strong action on climate change is imperative. But the strength of action required is likely to be difficult and costly, at least in disruption of current policies and practices and possibly also in aggregate cost. Just how difficult and

costly remains uncertain, of course, but this uncertainty cannot be resolved until the serious work begins.

This stark situation is more visible today than when we last wrote. The situation is also objectively worse, since long-standing delay, inaction, and obstruction have meant that many opportunities for relatively cheap and easy adjustment to limit climate-change risks have been lost.

Yet at the same time, climate change retains its slow-motion, easy-to-miss character. Climate change is a train wreck happening in slow-motion. This pattern of slow, inexorable trends superimposed on faster variations makes the gravity of the changes underway easy to overlook, and gives continuing aid to those who wish to deny the problem. Human decision processes and institutions are not skilled at dealing with problems that are both imperative and slow-motion: Indeed, we lack even effective language to think about them.

This combination of severity and slow dynamics fundamentally shapes what responses are necessary and possible. It thwarts simple, seemingly attractive answers. It increases the intensity of linkages between climate and other issues, globally and domestically – and thereby makes the associated choices and trade-offs both more visible and more difficult.

Above all, it makes even more imperative a coherent, integrated, long-run response strategy. Such a strategy must consider all promising approaches to rapid emissions reduction, not attempt to pre-limit the approach to options favored for other, non-climate reasons – for example, to relying exclusively on solar and wind power.

In addition to cutting emissions, an effective response strategy must also pursue other elements of climate response: both serious investment in adaptation, and research, development, and governance investigations of climate engineering – both large-scale atmospheric carbon removal and solar geoengineering.

The increased priority we give to both adaptation and climate engineering is one of the biggest changes in the book from the last edition. Adaptation has long been more strongly praised in theory than effectively pursued in practice. This must change, because of impacts already evident and more serious ones coming that even greatly strengthened mitigation efforts are unlikely to avoid. But serious adaptation measures will be more contentious and difficult than has previously been recognized. Climate engineering has also received inadequate attention and study, but these are now needed because of the growing likelihood that even much stronger mitigation and adaptation may not sufficiently reduce risks. All these responses will severely challenge decision-making institutions, domestically and especially internationally.

The decade since we worked on the second edition has deepened our sense of the urgency and peril of addressing climate change. With this in mind, we once

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again dedicate our efforts in this new edition to our children: Matthew, Joshua, Alexander, and Michael. We suspect that they and their contemporaries will face many challenges distinct and more severe than we have. Climate change will be the first of these, and the context for all of them. It will remain a priority concern, and a source of sharp trade-offs with other valued aims, over their entire lives and those of their children. It will always be slow, always easy to set aside or neglect relative to faster-moving, more immediate concerns. Yet it will remain imperative to keep in focus and sustain efforts. We hope this book will provide a useful guide for navigating this treacherous future.

## *Preface to the First Edition*

The Kyoto Protocol, the first international treaty to limit human contributions to global climate change, entered into force in February 2005. With this milestone, binding obligations to reduce the greenhouse-gas emissions that are contributing to global climate change came into effect for many of the world's industrial countries.

This event has also deepened pre-existing divisions among the world's nations that have been growing for nearly a decade. The most prominent division is between the majority of rich industrialized countries, led by the European Union and Japan, which have joined the Protocol, and the United States (joined only by Australia among the rich industrialized nations), which has rejected the Protocol as well as other proposals for near-term measures to limit greenhouse-gas emissions. Even among the nations that have joined Kyoto, there is great variation in the seriousness and timeliness of the emission-limiting measures they have adopted, and consequently in their likelihood of achieving the required reductions.

There is also a large division between the industrialized and the developing countries. The Kyoto Protocol only requires emission cuts by industrialized countries. Neither the Protocol nor the Framework Convention on Climate Change, an earlier treaty, provides any specific obligations for developing countries to limit their emissions. This has emerged as one of the sharpest points of controversy over the Protocol – a controversy that is particularly acute since the Protocol only controls industrialized-country emissions for the five-year period 2008–2012. In its present form, it includes no specific policies or obligations beyond 2012 for either industrialized or developing countries. While the Kyoto Protocol represents a modest first step toward a concrete response to climate change, there has been essentially no progress in negotiating the larger, longer-term changes that will be required to slow, stop, or reverse any human-induced climate changes that are occurring.

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As these political divisions have grown sharper, public arguments concerning what we know about climate change have also grown more heated. Climate change may well be the most contentious environmental issue that we have yet seen. Follow the issue in the news or in policy debates and you will see arguments over whether or not the climate is changing, whether or not human activities are causing it to change, how much and how fast it is going to change in the future, how big and how serious the impacts will be, and what can be done – at what cost – to slow or stop it. These arguments are intense because the stakes are high. But what is puzzling, indeed troubling, about these arguments is that they include bitter public disagreements, between political figures and commentators and also between scientists, over points that would appear to be straightforward questions of scientific knowledge.

In this book, we try to clarify both the scientific and the policy arguments now being waged over climate change. We first consider the atmospheric- science issues that form the core of the climate-change science debate. We review present scientific knowledge and uncertainty about climate change and the way this knowledge is used in public and policy debate, and examine the interactions between political and scientific debate – in effect, to ask how can the climate-change debate be so contentious and so confusing, when so many of the participants say that they are basing their arguments on scientific knowledge.

We then broaden our focus, to consider the potential impacts of climate change, and the available responses – both in terms of technological options that might be developed or deployed, and in terms of policies that might be adopted. For these areas as for climate science, we review present knowledge and discuss its implications for action and how it is being used in public and policy debate. Finally, we pull these strands of scientific, technical, economic, and political argument together to present an outline of a path forward out of the present deadlock.

The book is aimed at an educated but non-specialist audience. A course or two in physics, chemistry, or Earth science might make you a little more comfortable with the exposition, but is not necessary. We assume no specific prior knowledge except the ability to read a graph. The book is suitable to support a detailed case-study of climate change in college courses on environmental policy or science and public policy. It should also be useful for scientists seeking to understand how science is used – and misused – in policy debates.

Many people have helped this project come to fruition. Helpful comments on the manuscript have been provided by David Ballon, Steve Porter, Mark Shahinian, and Scott Siff, as well as seminar participants at the University of British Columbia, the University of Michigan School of Public Health, and the University of Michigan Law School. A. E. D. received support for this project from a NASA

New Investigator Program grant to the University of Maryland, as well as from the University of Maryland's Department of Meteorology and College of Computer, Mathematical, and Physical Sciences. All these contributions are gratefully acknowledged. A. E. D. especially notes the contributions of Professor David Dessler, for discussions in which many of the early ideas for the book were developed or refined.



## *Preface to the Second Edition*

In the three years since the first edition of this book appeared, events related to climate change have moved rapidly. The fourth IPCC assessment report has documented the continued strengthening of scientific evidence for climate change, its predominant human causes, and the likely rate and risks of continuing changes. The Stern Review and subsequent debate have provoked a more serious discussion of the long-run character of climate-change risks and the appropriate way to evaluate them. The Kyoto Protocol first commitment period has arrived with many nations failing to meet their commitments, even as discussions starting in Bali in 2007 and continuing through Copenhagen in 2009 have sought to reenergize international actions. The United States has re-engaged with international efforts to build an effective response to climate change. And significant policy initiatives have been advanced by many nations, including comprehensive climate and energy legislation being considered in the US Congress. The accumulation of these events required this rewriting, even if continued rapid movement of climate-change policy and politics may mean that the summary of recent events in this edition will also have a short shelf-life. But not everything about climate change moves fast. On the contrary, many key elements of the issue have changed little since we wrote the first edition. Although climate has many layers of variation on multiple timescales, the basic dynamics of greenhouse-gas driven climate change operate on timescales of decades and longer. Similarly in the energy system, the largest source of human-driven climate disruptions, the basic dynamics of capital turnover and technological change operate over decades. This is why – as we illustrate with the analogy of steering a supertanker that closes the book – most potential interventions to limit or respond to climate change only exert their full effect over decades of effort. Interventions to change course must be made well in advance of their effects, and in the face of considerable uncertainty. Scientific knowledge

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of climate change also advances slowly, for the most part. Many fields of research relevant to climate change are now fairly mature, so the major uncertainties about climate change, associated risks, and potential responses are increasingly well characterized. Sudden breakthroughs that would substantially change current understanding could happen, but appear rather unlikely. It is relative to this fast–slow tension that recent events must be understood.

The core structure of the climate problem can remain essentially unchanged, even while changes in public concern, prevailing framings, and political declarations and actions have transformed its surface. So the central conclusion of the first edition remains essentially unchanged: serious action on climate change must start immediately to avoid grave risks, and the urgency for action increases and the opportunities to avoid risks at low cost decrease with each year of delay. The flood of activity now occurring in multiple nations and internationally *might* add up to that first serious step needed to begin re-orienting investment toward the required transformations – but this is not yet clear. As we discuss within, while we share the widespread hope that the climate challenge is at last truly engaged, we have little confidence in the success of the current international process. And in case current efforts continue failing to deliver the required rapid, concrete progress, we propose an alternative approach that emphasizes strong unilateral leadership, coupled with action by a small group of major nations.

In addition to updating the discussion to reflect recent developments in the science, technology, economics, policy, and politics of climate change, we have also used the opportunity to strengthen a few parts of the first edition that we found weak. The most important change is to provide a more thorough primer on the basic science of atmospheric radiation that underlies climate change. In addition, we have integrated the discussion of contrarian claims with the discussion of current scientific knowledge in Chapter 3; extended the discussion of cost and benefit estimates, including a new section elaborating on the basis of current controversies in inter-temporal valuation and discounting; and provided an improved glossary.

Beyond these changes, the aims of the book and its intended audience are unchanged. Its key contribution remains bringing together a basic presentation of issues in science, technology, economics, policy, and politics as they pertain to climate change and highlighting the interactions among these domains, to provide a well founded understanding of where we are, how we got here, and where we need to go. With this breadth, it is targeted at the educated non-specialist reader seeking an introduction to the climate-change issue. In addition, for readers who are involved in climate issues from one side or another – the science, the policy, or the politics – the book aims to help them see how their piece fits into the bigger puzzle. In teaching, the book remains suitable for

college courses at the upper-level undergraduate or introductory graduate/professional level, on climate change, environmental policy and politics, or science and public policy, with a prior course in physics, chemistry, or Earth science helpful but not necessary.

The few years since we worked on the first edition have deepened our own sense of the urgency and peril of addressing climate change. With this in mind, we dedicate our efforts in this new edition to our children: Matthew, Joshua, Alexander, and Michael. We do this in the hope that a prudent and competent global response to climate change – surely not too much to ask! – can preserve for them the opportunities for a secure, prosperous, and fulfilling life, and for connection with an undegraded natural world, that we have enjoyed.

College Station, Texas  
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