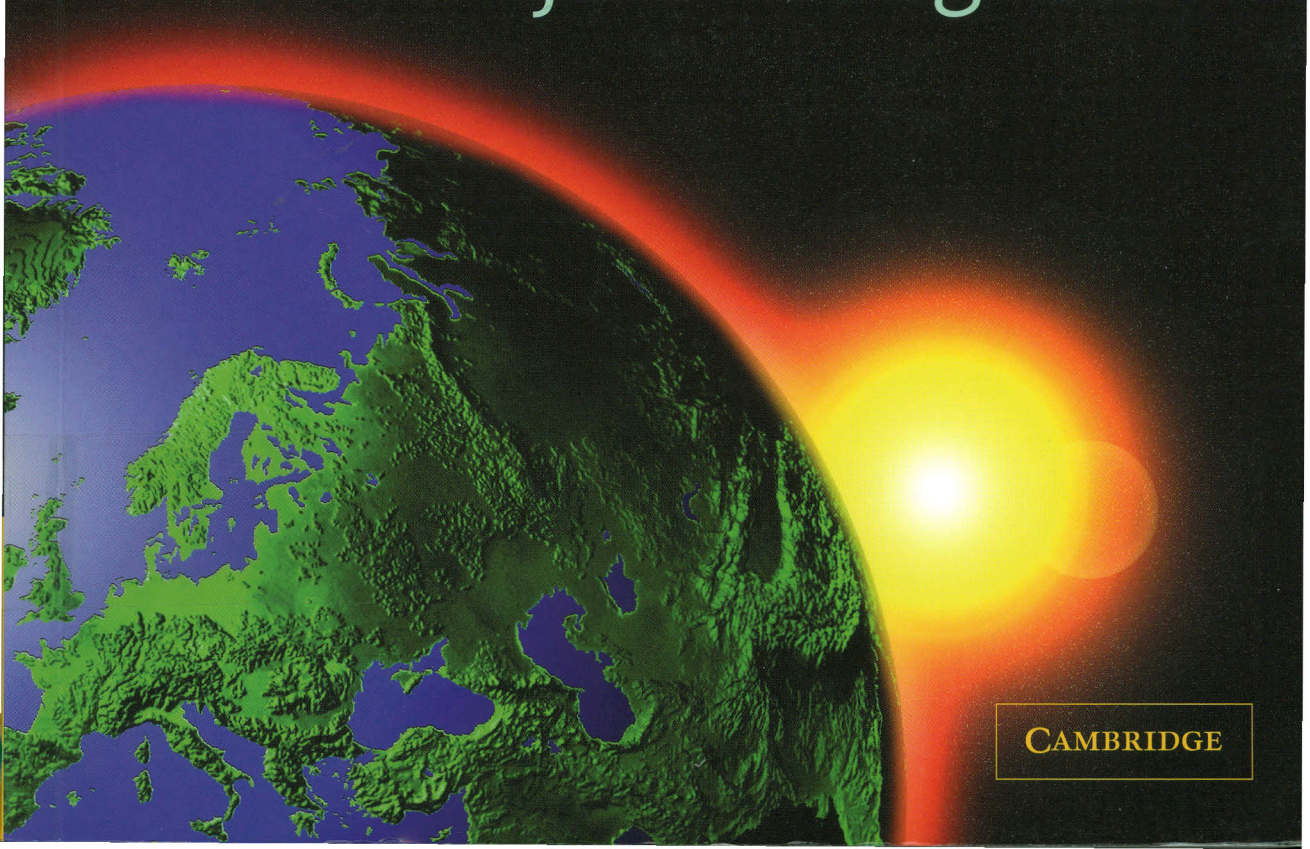


Global Warming

THE COMPLETE BRIEFING

THIRD EDITION

John Houghton



CAMBRIDGE

Global Warming

The Complete Briefing

THIRD EDITION

Sir John Houghton

J III 101

DLK: 551.583

551.590.3

551.588.7

354/4233

INSTITUT
FÜR METEOROLOGIE U. KLIMATOLOGIE
UNIVERSITÄT HANNOVER
HERRENHAUSER STR. 2 · 30419 HANNOVER



CAMBRIDGE
UNIVERSITY PRESS

Contents

List of figures	<i>page</i> xiv
List of SI unit prefixes	xxi
List of chemical symbols	xxii
Preface to the First Edition	xxiii
Preface to the Second Edition	xxvii
Preface to the Third Edition	xxix
1 Global warming and climate change	1
Is the climate changing?	1
The remarkable last decades of the twentieth century	2
El Niño events	5
The effect of volcanic eruptions on temperature extremes	7
Vulnerable to change	8
The problem of global warming	9
Adaptation and mitigation	10
Uncertainty and response	12
Questions	12
Notes	13
2 The greenhouse effect	14
How the Earth keeps warm	14
The greenhouse effect	16
Mars and Venus	21
The 'runaway' greenhouse effect	22
The enhanced greenhouse effect	23
Questions	25
Notes	26
3 The greenhouse gases	28
Which are the most important greenhouse gases?	28
Radiative forcing	29

Carbon dioxide and the carbon cycle	29
Future emissions of carbon dioxide	39
Other greenhouse gases	42
Gases with an indirect greenhouse effect	47
Particles in the atmosphere	48
Estimates of radiative forcing	51
Questions	53
Notes	54
4 Climates of the past	56
The last hundred years	56
The last thousand years	64
The past million years	66
How stable has past climate been?	71
Questions	75
Notes	75
5 Modelling the climate	77
Modelling the weather	77
Seasonal forecasting	85
The climate system	88
Feedbacks in the climate system	90
Models for climate prediction	95
Validation of the model	100
Comparison with observations	102
Is the climate chaotic?	106
Regional climate modelling	107
The future of climate modelling	109
Questions	110
Notes	111
6 Climate change in the twenty-first century and beyond	115
Emission scenarios	115
Model projections	118
Projections of global average temperature	120
Regional patterns of climate change	124
Changes in climate extremes	128
Regional climate models	133
Longer-term climate change	135

002	Changes in the ocean thermohaline circulation	136
002	Other factors that might influence climate change	137
006	Questions	140
007	Notes	140
007	7 The impacts of climate change	143
	A complex network of changes	143
	How much will sea level rise?	145
	The impacts of sea level rise	150
	Increasing human use of fresh water resources	155
	The impact of climate change on fresh water resources	157
	Impact on agriculture and food supply	164
	The impact on ecosystems	167
	The impact on human health	176
	Adaptation to climate change	178
	Costing the impacts: extreme events	179
	Costing the total impacts	184
	The overall impact of global warming	188
	Questions	190
	Notes	191
008	8 Why should we be concerned?	197
	Earth in the balance	197
	Exploitation	198
	‘Back to nature’	199
	The technical fix	200
	Future generations	200
	The unity of the Earth	201
	Environmental values	205
	Stewards of the Earth	208
	The will to act	209
	Questions	211
	Notes	212
009	9 Weighing the uncertainty	216
	The scientific uncertainty	216
	The IPCC assessments	218
	Narrowing the uncertainty	222
	Sustainable development	225
	Why not wait and see?	227

The Precautionary Principle	228
Principles for international action	230
Some global economics	230
Questions	239
Notes	239
10 A strategy for action to slow and stabilise climate change	242
The climate convention	242
Stabilisation of emissions	244
The Montreal Protocol	245
The Kyoto Protocol	246
Forests	249
Reduction in the sources of methane	253
Stabilisation of carbon dioxide concentrations	254
The choice of stabilisation level	257
Realising the Climate Convention Objective	261
Summary of the action required	263
Questions	264
Notes	265
11 Energy and transport for the future	268
World energy demand and supply	268
Future energy projections	271
Energy conservation and efficiency in buildings	278
Energy savings in transport	283
Energy savings in industry	284
Capture and storage of carbon dioxide	289
Renewable energy	289
Hydro-power	291
Biomass as fuel	293
Wind energy	297
Energy from the Sun	299
Other renewable energies	305
The support and financing of renewable energy	306
Nuclear energy	308
Technology for the longer term	310
Summary	314
Questions	315
Notes	317

12	The global village	322
	The challenges of global warming	322
	Not the only global problem	326
	The conception and conduct of environmental research	327
	The goal of environmental stewardship	328
	Questions	330
	Notes	331
	Glossary	333
	Index	340