



CONTENTS

PREFACE: WHY YOU NEED TO KNOW ABOUT CLIMATE CHANGE	XIII
ACKNOWLEDGMENTS	XXIII

1 Climate Science Basics	1
---------------------------------	----------

<i>What is the greenhouse effect and how does it warm the Earth?</i>	<i>1</i>
<i>Why are scientists so certain the climate system is warming?</i>	<i>2</i>
<i>How does global warming increase sea levels and what has been observed to date?</i>	<i>4</i>
<i>Where does most of human-caused warming go?</i>	<i>7</i>
<i>What fraction of recent global warming is due to human causes versus natural causes?</i>	<i>7</i>
<i>How certain are climate scientists that humans are the primary cause of recent warming?</i>	<i>9</i>
<i>How do scientists know that recent climate change is primarily caused by human activities?</i>	<i>10</i>
<i>Why has the climate changed in the past, before there were human-caused greenhouse gas emissions?</i>	<i>12</i>
<i>What are the climate system's amplifying feedbacks that turn a moderate initial warming into a big ultimate warming?</i>	<i>14</i>
<i>Is the current level of atmospheric CO₂ concentration unprecedented in human history?</i>	<i>15</i>
<i>Are recent climatic changes unprecedented?</i>	<i>17</i>



<i>Has recent human-caused climate change been occurring faster or not as fast as scientists predicted?</i>	18
<i>Is there a difference between global warming and climate change?</i>	19
<i>What are the sources of the most important human-caused pollutants that drive global warming?</i>	20
<i>How does deforestation contribute to warming?</i>	21
<i>What is global warming potential and why is it different for various greenhouse gases?</i>	22
<i>Why does the rate of warming appear to vary from decade to decade?</i>	23
<i>Has global warming slowed down or paused in recent years?</i>	24
<i>Can we reach a point where emitting more CO₂ into the air will not cause more climate change?</i>	28
<i>Have we already crossed tipping points (points of no return) in the climate system?</i>	29

2 Extreme Weather and Climate Change **31**

<i>What is the difference between weather and climate?</i>	31
<i>Which extreme weather events are being made worse by climate change and which are not?</i>	32
<i>What is the role of natural climatic variation, such as the El Niño–La Niña cycle, in extreme weather?</i>	34
<i>Did climate change cause Hurricanes Sandy and Harvey (and why is that the wrong question to ask)?</i>	37
<i>How does climate change affect heat waves?</i>	41
<i>How does climate change affect droughts?</i>	44
<i>How does climate change affect wildfires?</i>	47
<i>How does climate change affect the chances of deluges or severe precipitation?</i>	50
<i>Does climate change mean more snow or less, worse snowstorms or weaker ones?</i>	53
<i>How does climate change affect storm surge?</i>	57
<i>Is climate change making hurricanes more destructive?</i>	58
<i>What is Arctic amplification and how does it affect extreme weather?</i>	61



<i>Is climate change and/or Arctic amplification affecting extreme weather in the Northern Hemisphere?</i>	64
<i>Is climate change affecting tornado formation?</i>	70
<i>In a warming world, why do some winters still seem unusually severe?</i>	73

3 Projected Climate Impacts **77**

<i>What kind of impacts can we expect this century from business-as-usual climate change?</i>	77
<i>What are the biggest sources of uncertainty in projecting future global warming?</i>	79
<i>What do previous hot periods in Earth's climate tell us about what the future may hold in store?</i>	82
<i>How could the thawing permafrost speed up global warming beyond what climate models have projected?</i>	84
<i>How could an increase in wildfires speed up global warming beyond what climate models have projected?</i>	89
<i>What are some other key positive or amplifying feedbacks affecting the climate system?</i>	92
<i>What will the impacts of sea-level rise be?</i>	96
<i>How will climate change lead to more destructive superstorms this century?</i>	101
<i>What kind of droughts can we expect this century?</i>	103
<i>What are the expected health impacts of climate change?</i>	109
<i>How does global warming affect human productivity?</i>	113
<i>Does carbon dioxide at exposure levels expected this century have any direct impacts on human health or cognition?</i>	118
<i>What is ocean acidification and why does it matter to sea life?</i>	123
<i>What is biodiversity and how will climate change impact it?</i>	126
<i>How will climate change affect the agricultural sector and our ability to feed the world's growing population?</i>	129
<i>How is climate change a threat to national, regional, and global security?</i>	133
<i>What is the plausible best-case scenario for climate change this century?</i>	137



<i>What is the plausible worst-case scenario for climate change this century?</i>	140
<i>What do scientists mean by “irreversible impacts” and why are they such a concern with climate change?</i>	146

4 Avoiding the Worst Impacts 151

<i>What is the biggest source of confusion about what humanity needs to do to avoid the worst climate impacts?</i>	151
<i>What is the December 2015 Paris climate accord and why is it so important?</i>	153
<i>Why did scientists and governments decide 2°C (3.6°F) was the limit beyond which climate change becomes “dangerous” to humanity?</i>	156
<i>What kind of greenhouse gas emissions reductions are needed to keep warming well below 2°C?</i>	159
<i>What would the economic cost of meeting the 2°C target be?</i>	160
<i>What happens if we miss the 2°C target?</i>	164
<i>Can we adapt to human-caused climate change?</i>	165
<i>What is geoengineering and can it play a major role in reducing the impact of climate change?</i>	169

5 Climate Politics and Policies 175

<i>What climate policies are governments around the world using to fight climate change?</i>	175
<i>What is a carbon tax?</i>	176
<i>What are cap-and-trade and carbon trading?</i>	178
<i>What are China and India doing to restrict carbon dioxide emissions?</i>	182
<i>What is the United States doing to restrict carbon dioxide emissions?</i>	185
<i>How do different political parties view climate science and policies in the United States and around the world?</i>	187
<i>Is there a large-scale effort to spread misinformation on climate science and, if so, who funds it?</i>	190
<i>What are climate science deniers?</i>	195



6 The Role of Clean Energy **199**

<i>What kind of changes in our energy system would a 2°C target require?</i>	199
<i>What is energy efficiency and what role will it play?</i>	201
<i>Will nuclear power be a major factor in the effort to minimize climate change?</i>	206
<i>What role does natural gas have in the transition to a 2°C world?</i>	209
<i>How much can solar power contribute to averting dangerous climate change?</i>	212
<i>How big a role will wind power play in averting dangerous climate change?</i>	216
<i>What is carbon capture and storage (a.k.a. carbon sequestration) and what role can it play?</i>	218
<i>What is bioenergy and what is its role in cutting carbon pollution?</i>	224
<i>What other carbon-free forms of energy can contribute to cutting greenhouse gas emissions?</i>	228
<i>How can we reduce carbon dioxide emissions in the transportation sector?</i>	231
<i>What challenges have limited the marketplace success of alternative fuels and alternative fuel vehicles to date?</i>	234
<i>What role can electric vehicles play?</i>	239
<i>What are hydrogen fuel cells and hydrogen fuel-cell vehicles?</i>	244
<i>What are the challenges facing hydrogen fuel-cell vehicles as a climate solution?</i>	247
<i>What role can energy storage play in the transition off of fossil fuels?</i>	254
<i>What can the agricultural and livestock sector do to minimize climate change?</i>	257
<i>What role can energy conservation play?</i>	261

7 Climate Change and You **263**

<i>How will climate change impact you and your family in the coming decades?</i>	263
<i>How might climate change affect the future price of coastal property?</i>	264



<i>How might climate change affect decisions about where to live and retire in the coming decades?</i>	268
<i>What should students study today if they want to prepare themselves for working in a globally warmed world?</i>	269
<i>Should climate change affect how you invest for the future?</i>	271
<i>How can you reduce your carbon footprint?</i>	272
<i>What role can dietary changes play in reducing your carbon footprint?</i>	275
<i>What is the best way to talk to someone who does not accept the growing body of evidence on climate science?</i>	276
<i>Do we still have time to preserve a livable climate with a U.S. President who rejects climate science?</i>	280

PRIMARY SOURCES	283
NOTES	286
INDEX	299