CONTENTS

Part One: OBSERVATIONS

1. INTRODUCTION, p.3
2. A BREIF HISTORY OF PLANET EARTH, p.15
3. THE ICE AGES, p.27
4. CARBON DIOXIDE, p.39
5. ENERGY, p.51
6. CLIMATE SCIENCE, p.63

Part Two: PREDICTIONS

7. GLOBAL WARMING, p.77
8. WATER, p.89
9. LIFE ON EARTH, p.101
10. BEYOND 2100, p.111
11. UNCERTAINTY, p.121

Part Three: ACTIONS

12. THE TRAGEDY OF THE COMMONS, p.135
13. TECHNO—FIX, p.145
14. PUTTING A PRICE ON CARBON, p.159
15. BEYOND FOSSIL FUELS, p.171
16. THE CHALLENGE, p.183
Glossary, p.197
CHAPTER 2
A BRIEF HISTORY OF PLANET EARTH

Tell me everything that's happened so far.

Well, first the earth cooled...

...and then the dinosaurs came...
In the early days it was a great molten ball of liquid rock... which belched out hot gases and water vapor to form the early atmosphere and oceans.

Primitive life forms appeared in the oceans sometime within the first billion years.

What do you call a single-celled organism floating in a primordial sea? 

Bob.

What do you call a single-celled organism shaped like a tube? 

Rod.

You and your jokes are so primitive!
...some of these organisms figured out oxygenic photosynthesis...

...which is the chemical reaction that allows green things like plants and algae to grow.

It turns sunlight, water, and carbon dioxide...

...into things like broccoli and bean sprouts.

Green things are the base of the food chain.

Without them there could be no us.

Bill.

Art.

EUREKA!

Eek!

Harriet, put on some clothes!

Bill.

Will you two shut up!

I'm trying to concentrate!

Then, after hundreds of millions of years of evolution...
Mostly Water and Carbon

You are what you eat!

...which is crucial to all life on earth.

...and about that much returns to the atmosphere through fire, decomposition, and respiration by plants and animals.

Nowadays, green things play a key role in the carbon cycle...

And there's lots more, like mixing between the surface ocean and the deep ocean.

Meanwhile, about 120 billion tons gets sucked in by plants through photosynthesis.

And about that much returns to the atmosphere through decay of plants and animals.

Every year about 80 billion tons of atmospheric carbon gets stuck in the deep ocean...

In Chapter 4 we'll see the influence of human activity.
BETWEEN ABOUT 2.8 AND 2.3 BILLION YEARS AGO, HOWEVER, GREEN THINGS DID SOMETHING PERHAPS EVEN MORE IMPORTANT.

GREEN SLIME IS GROSSLY UNDERAPPRECIATED.

THEY PUMPED LOTS AND LOTS OF OXYGEN INTO THE ATMOSPHERE.

GETTING OXYGEN (O₂) INTO THE ATMOSPHERE WAS REALLY IMPORTANT BECAUSE...

DUH! BECAUSE ANIMALS NEED OXYGEN TO BREATHE.

WELL, THAT'S TRUE...

...BUT THIS WAS A BILLION YEARS BEFORE ANIMALS.

...BECAUSE IT LED TO THE CREATION OF A LAYER OF OZONE (O₃) ABOUT 15 MILES ABOVE THE SURFACE OF THE PLANET.

WHAT'S SO IMPORTANT ABOUT THAT?

WELL, DUH, TURN THE PAGE TO FIND OUT.
No wonder everybody got worried when scientists discovered a hole in the ozone layer in the 1980s.

Ozone is like sunscreen for the entire planet.

The Sun generates Visible Light...

...but it also generates deadly ultraviolet radiation.

That's why we live underwater or under rocks.

Before the ozone layer, life had to hide from the sun.

After the ozone layer, the sun's deadliest uv rays got blocked...

...and that allowed life to move into the sunshine.

No, Harriet, not again!

Eureka!
Despite what many people think, the ozone hole is not closely related to global warming...

...but it is valuable to compare and contrast the two issues.

The ozone hole is related to human emissions of ozone-destroying gases such as chlorofluorocarbons (CFCs).

Global warming is related to human emissions of greenhouse gases such as carbon dioxide (CO2).

And we can take heart from the progress we’ve made in repairing the ozone hole.

President Reagan signed the Montreal Protocol that helped phase out CFCs...

...and the ozone layer is recovering.

If only global warming were so easy!

...and you can’t solve them all by recycling.

But let’s get back to the history of planet Earth...
The past billion years have seen wild changes in the climate.

The only thing permanent is change.

There were times when ice covered almost everything...

This snowball Earth is freezing!

Good thing there weren’t actually people back then.

...and times when the north pole was tropical.

Boy, I could really use some iced tea!

Sorry, there’s no ice.

Good thing there weren’t actually people back then.
OF CENTRAL IMPORTANCE TO OUR STORY IS THE CARBONIFEROUS PERIOD, SOME 360–300 MILLION YEARS AGO.

SOME OF THE ORGANISMS THAT DIED THEN GOT BURIED...

...AND COOKED UNDERGROUND FOR HUNDREDS OF MILLIONS OF YEARS...

WHAT DO YOU CALL A SINGLE-CELLED ORGANISM LYING IN A HOLE?

DOUG.

...AND EVENTUALLY TURNED INTO CARBON-BASED FOSSIL FUELS.

THAT'S WHERE A LOT OF OUR COAL COMES FROM... ...AND PLENTY OF OIL AND NATURAL GAS, TOO.
During the last 100 million years...

...the continents slowly drifted into the positions they have today...

Continents move at about the speed that your fingernails grow...
...about 100 miles every million years.

...and species either died off or slowly evolved into the forms they have today.

Thanks to an asteroid 65 million years ago...
...it was goodbye velociraptor...
...and hello chicken.

Even more recently, the Earth's climate has calmed down a bit...

...but calm is a relative term.

30 million years with no snowball earths...
...and no tropical north poles!

Look, we've calmed down!

Wow, what were you like before?
IN PARTICULAR, OVER THE PAST 2.6 MILLION YEARS THE PLANET HAS GONE THROUGH REPEATED CYCLES...

...OF WARM PERIODS...

...AND COOL PERIODS.

SCIENTISTS CALL THEM GLACIAL PERIODS.

EVERYONE ELSE CALLS THEM ICE AGES.
100 mya Now

**TA DA!**

Finally, about **200,000 YEARS AGO**...

...anatomically modern **human beings** appeared in Africa.

It wasn’t long before they started asking **tough questions**.

I wonder how I can avoid being eaten?

I wonder what caused the ice ages?

I wonder where I can find some hot sauce?

That’s only 2,000 times older than grandpa. A blink of an eye in the earth’s lifespan.
Advance Praise for *The Cartoon Introduction to Climate Change*

"I know we're trashing the planet, but do we have to add to our misery by reading gloom-and-doom books about it? *The Cartoon Introduction to Climate Change* offers another way: learn some serious science, evaluate strategies for change, and have a good laugh in the process."
—ANNE LEONARD, creator of *The Story of Stuff*

"Are you curious about the science and economics of global warming? You can find many dull books on the subject. A better bet is *The Cartoon Introduction to Climate Change*, which tickles and teaches at the same time. Who says that sophistication is only in equations?"
—WILLIAM NORDHAUS, Sterling Professor of Economics, Yale University, and author of *The Climate Casino: Risk, Uncertainty, and Economics for a Warming World*

"A clear, concise rendition of the story of human-induced climate change, candid and yet brimming with warm-hearted humor and well-founded optimism. Gently persuasive, beautifully illustrated . . . an innovative springboard for discussion of what we can do, as individuals and as a society, to turn down the heat in our planetary 'compost pile.'"
—JOHN MICHAEL WALLACE, Professor Emeritus, Department of Atmospheric Sciences, University of Washington, and coauthor of *Atmospheric Science: An Introductory Survey*

"Climate is no laughing matter—but it beats crying. Maybe this is the secret passage into people's hearts and minds."
—JAMES E. HANSEN, Former Director, NASA Goddard Institute For Space Studies, and author of *Storms of My Grandchildren*

[Yoram Bauman](https://www.islandpress.org/people/yoram-bauman), "the world's first and only stand-up economist," performs regularly at colleges and corporate events, sharing the stage with everyone from Robin Williams to Paul Krugman. He has appeared in *Time* magazine and on PBS and NPR, and his previous collaboration with Grady Klein resulted in the two-volume *Cartoon Introduction to Economics*. He is a carbon tax fellow at Sightline Institute and has taught economics and environmental studies classes at the University of Washington (where he received his PhD in economics) and at Lakeside High School.

[Grady Klein](https://www.islandpress.org/people/grady-klein) is a cartoonist, animator, and graphic designer. He is the coauthor, with Yoram Bauman, of the two-volume *Cartoon Introduction to Economics*; the coauthor, with Alan Dabney, of *The Cartoon Introduction to Statistics*; and the creator of the *Lost Colony* series of graphic novels.