

THE CARTOON INTRODUCTION TO CLIMATE CHANGE

BY GRADY KLEIN AND
YORAM BAUMAN, Ph.D.
THE WORLD'S FIRST AND ONLY STAND-UP ECONOMIST

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BY **GRADY KLEIN** AND
YORAM BAUMAN, Ph.D.
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EFFICIENCY, ECONOMIC DEVELOPMENT, CARBON DIOXIDE, ICE-AGE, MILANKOVITCH
CYCLES, CAP-AND-TRADE, CARBON TAX

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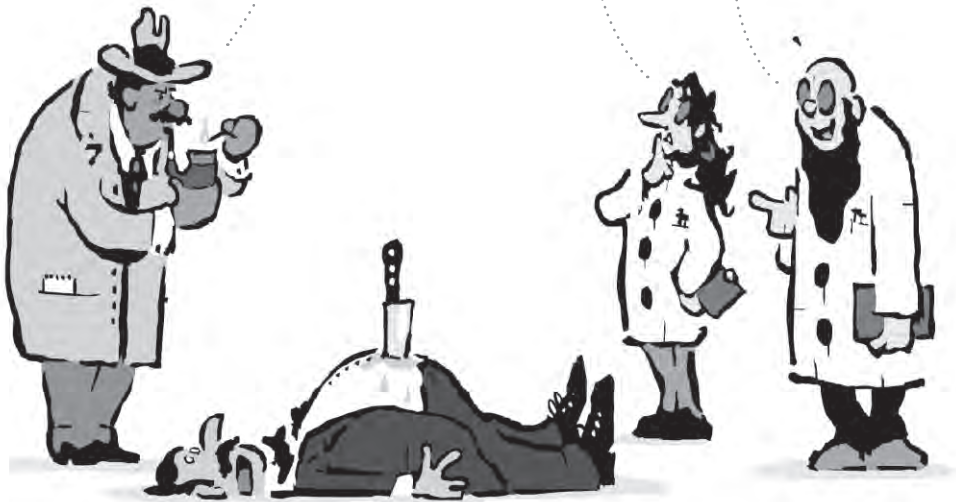
CHAPTER 2

A BRIEF HISTORY OF PLANET EARTH

TELL ME
EVERYTHING
THAT'S HAPPENED
SO FAR.

WELL, FIRST
THE **EARTH**
COOLED...

...AND
THEN THE
DINOSAURS
CAME...



THE EARTH FORMED ABOUT
4.6 BILLION YEARS AGO.

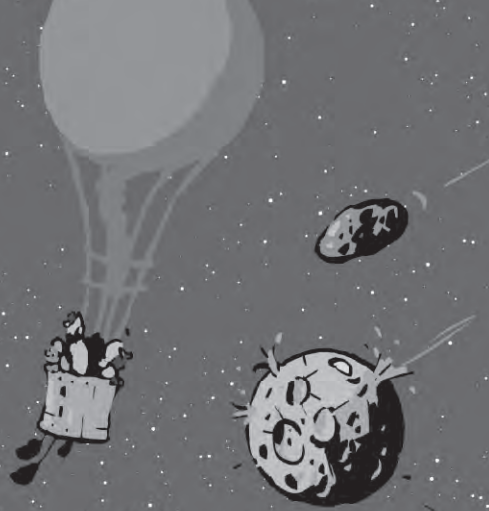
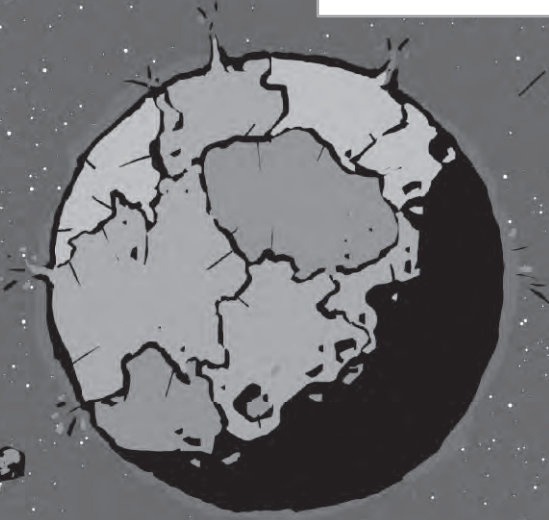
4.6 bya 4 bya 3 bya 2 bya 1 bya Now

THAT'S **50 MILLION**
TIMES OLDER THAN
GRANDPA.



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.**

4.6 bya

Now

WHAT DO YOU
CALL A SINGLE-CELLED
ORGANISM **FLOATING IN**
A PRIMORIDAL SEA?

BOB.



WHAT DO YOU
CALL A SINGLE-CELLED
ORGANISM **SHAPED**
LIKE A TUBE?

ROD.



YOU AND YOUR
JOKES ARE SO
PRIMITIVE!



THEN, AFTER **HUNDREDS OF MILLIONS OF YEARS OF EVOLUTION...**

4.6 bya

Now

WHAT DO YOU
CALL A SINGLE-CELLED
ORGANISM THAT **LIVES IN**
YOUR MAILBOX?

BILL.



WHAT DO YOU
CALL A SINGLE-CELLED
ORGANISM **SMEARED ON**
THE WALL?

ART.



WILL YOU TWO
SHUT UP!

I'M TRYING TO
CONCENTRATE!



... SOME OF THESE ORGANISMS FIGURED OUT
OXYGENIC **PHOTOSYNTHESIS...**

EUREKA!



E EK!
HARRIET,
PUT ON SOME
CLOTHES!



... 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.

OH **GREAT.**

WITHOUT **THEM**
THERE COULD BE
NO **US.**



NOWADAYS, GREEN THINGS PLAY A KEY ROLE IN THE CARBON CYCLE...



IN CHAPTER 4 WE'LL SEE THE INFLUENCE OF HUMAN ACTIVITY.

EVERY YEAR ABOUT **80 BILLION TONS** OF ATMOSPHERIC CARBON DISSOLVES IN SEAWATER...

...AND ABOUT THAT MUCH RETURNS TO THE ATMOSPHERE THROUGH **OUTGASSING**.

MEANWHILE, ABOUT **120 BILLION TONS** GETS SUCKED IN BY **PLANTS** THROUGH **PHOTOSYNTHESIS**...

...AND ABOUT THAT MUCH RETURNS TO THE ATMOSPHERE THROUGH **FIRE, DECOMPOSITION, AND RESPIRATION** BY PLANTS AND ANIMALS.

AND THERE'S LOTS MORE, LIKE MIXING BETWEEN THE **SURFACE OCEAN** AND THE **DEEP OCEAN**.

... WHICH IS CRUCIAL TO **ALL LIFE ON EARTH.**

YOU **ARE** WHAT YOU EAT!



Mostly Water
and Carbon

Mostly Water
and Carbon

Mostly Water
and Carbon

BETWEEN ABOUT 2.8 AND 2.3 BILLION YEARS AGO, HOWEVER, GREEN THINGS DID SOMETHING PERHAPS EVEN **MORE IMPORTANT**.

4,6 bya

Now

THEY PUMPED LOTS AND LOTS OF **OXYGEN** INTO THE ATMOSPHERE.

GREEN SLIME IS **GROSSLY** UNDERAPPRECIATED.

GETTING **OXYGEN** (O_2) 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** (O_3) ABOUT 15 MILES ABOVE THE SURFACE OF THE PLANET.

WHAT'S SO IMPORTANT ABOUT THAT?

WELL, **DUH**.

TURN THE PAGE TO FIND OUT.

OZONE LAYER

**BEFORE THE OZONE LAYER,
LIFE HAD TO HIDE FROM THE SUN.**

4.6 bya

Now



THE SUN GENERATES
VISIBLE LIGHT...

...BUT IT ALSO GENERATES
DEADLY ULTRAVIOLET
RADIATION.

THAT'S WHY WE LIVE
UNDERWATER OR
UNDER ROCKS.



**AFTER THE OZONE LAYER, THE
SUN'S DEADLIEST UV RAYS GOT BLOCKED...**

4.6 bya

Now

OZONE IS LIKE
SUNSCREEN
FOR THE ENTIRE
PLANET.



...AND THAT ALLOWED LIFE TO MOVE **INTO THE SUNSHINE.**

EUREKA!



NO, HARRIET,
NOT AGAIN!

NO WONDER EVERYBODY GOT WORRIED WHEN SCIENTISTS DISCOVERED
A HOLE IN THE OZONE LAYER IN THE 1980s,

DESPITE WHAT MANY PEOPLE THINK,
THE OZONE HOLE IS **NOT** CLOSELY
RELATED TO GLOBAL WARMING...

ENVIRONMENTAL
PROBLEMS ARE **NOT**
ALL THE SAME...

...AND YOU CAN'T
SOLVE THEM ALL BY
RECYCLING.

...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!**

BUT LET'S GET BACK TO THE
HISTORY OF PLANET EARTH...

**THE PAST BILLION YEARS HAVE SEEN
WILD CHANGES IN THE CLIMATE.**

4.6 bya

Now

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.

4.6 bya

Now

**GIANT
BUGS!**

**GIANT
REPTILES!**

**GIANT
FERNS!**

**BUT STILL
NO PEOPLE.**

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

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

DOUG.

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

KNOCK KNOCK

WHO'S THERE?

OIL.

OIL WHO?

OIL BE BACK.

... 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...

4,6 bya

4 bya

3 bya

2 bya

1 bya

100 mya

80 mya

60 mya

40 mya

20 mya

Now

... 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**.

100 mya

Now

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!**

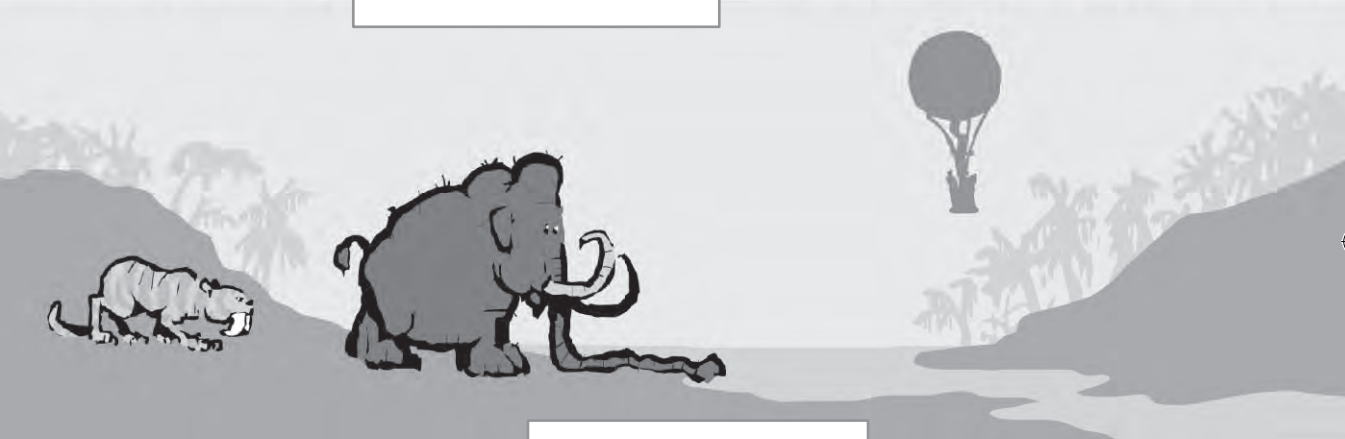
LOOK, WE'VE **CALMED DOWN!**

WOW, WHAT WERE YOU LIKE **BEFORE?**

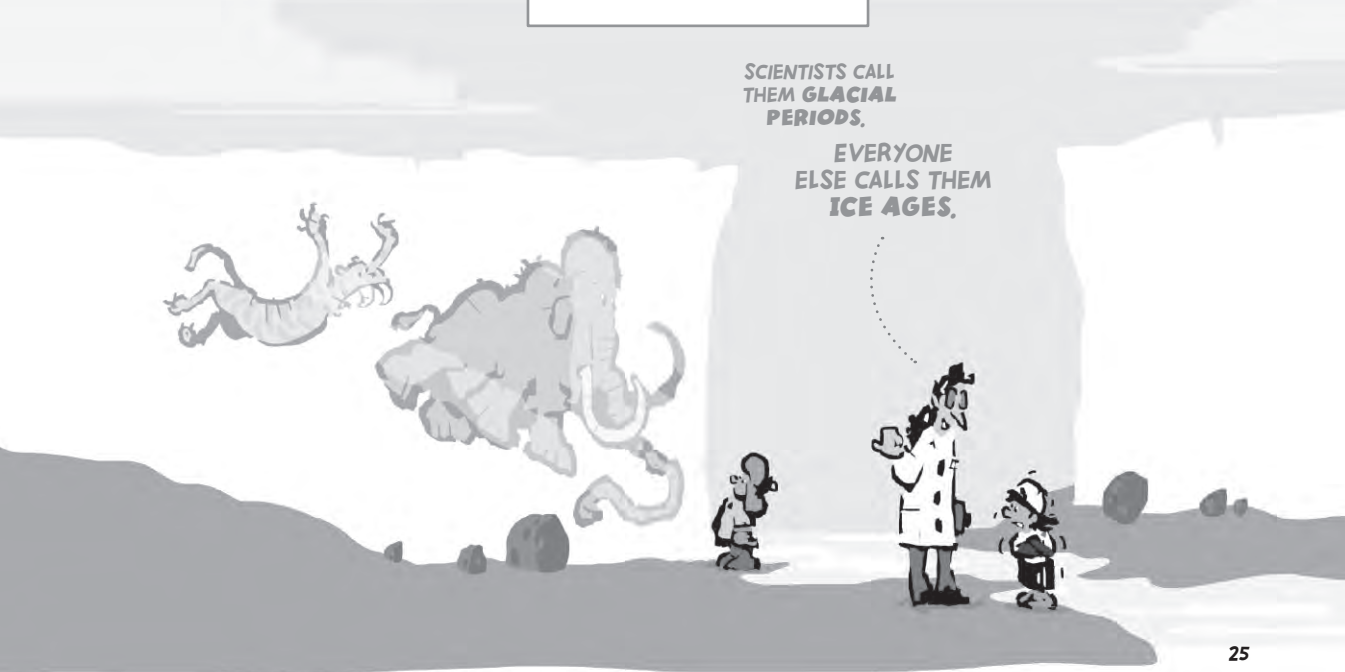
IN PARTICULAR, OVER THE PAST
2.6 MILLION YEARS THE PLANET HAS GONE
THROUGH **REPEATED CYCLES...**



...OF **WARM PERIODS...**



...AND **COOL PERIODS.**



SCIENTISTS CALL
THEM **GLACIAL
PERIODS.**

EVERYONE
ELSE CALLS THEM
ICE AGES.

100 mya

Now

FINALLY, ABOUT 200,000 YEARS AGO...

THAT'S ONLY 2,000
TIMES OLDER THAN
GRANDPA.

A BLINK
OF AN EYE
IN THE EARTH'S
LIFESPAN.

...ANATOMICALLY MODERN **HUMAN BEINGS** APPEARED IN AFRICA.

TA DA!

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?

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."

—ANNIE 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*



Photo by: Andrea Lee

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 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.

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