In memory of Craig Walker,
whose brilliant vision for making science exciting
and funny inspired the Magic School Bus series—
and both of us.
He was much loved, and is much missed.
—J.C. and B.D.
The Magic School Bus
and the Climate Challenge
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and the Climate Challenge

By Joanna Cole
Illustrated by Bruce Degen

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Many have helped in the making of this book. In particular, our sincere thanks go to Dr. Bill Chameides, Dean and Nicholas Professor of the Environment, Duke University, for his enthusiastic and informed review.

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The text type was set in 15-point Bookman Light.
The illustrator used pen and ink, watercolor, color pencil, and gouache for the paintings in this book.
The text of this book prints on 100% recovered fiber of which 30% is post-consumer waste.
To all our friends in Korea.
We will never forget your warm and enthusiastic welcome to The Magic School Bus, and to us.
— J.C. and B.D.
Have you heard about our teacher, Ms. Frizzle? Almost every day, something weird happens in her class.
For example, take the day we started to study global warming. We were going to put on a play about Earth and all the changes that are happening. The Friz had brought a book from home, and we were using the pictures to help us paint the scenery.
“Ms. Frizzle’s book is kind of old,” said Tim.
“It came out before things really started heating up.”
“I’ll go online to get new pictures,” said Wanda.
She headed for a computer, but Ms. Frizzle was already out the door. “Come on, class,” she called.
“Bring my book, please.”

One degree doesn’t sound like much, but one small degree has caused big changes already—ice melting, seas rising, and more freak weather!

Global warming is a rise in the average temperature of the land and water on Earth. Today, the average temperature is more than 1 degree F warmer than it was 100 years ago.
Before you could say "North Pole," the Friz herded us onto the bus. She pushed a few buttons and pulled a few levers. Then we were on our way to the Arctic Sea—a place with a completely different climate.

CLASS, THE CLIMATE IN THE ARCTIC IS USUALLY VERY, VERY COLD.

AND I DIDN'T EVEN BRING A SWEATER!

A WORD FROM DOROTHY ANN

- The climate of an area is its usual weather.
- It's often cool and foggy here.
- The usual weather here is hot.

The global climate is the usual weather of the whole world.
When we got there, Dorothy Ann opened Ms. Frizzle's old book. The pictures showed ice everywhere. There was still plenty of ice in the Arctic, but a lot had melted, and more was melting all the time.
Ice is white. White reflects most of the sunlight that hits it. So the sun can’t heat up the ice.

Water is not white. It absorbs most of the sunlight that hits it. So the water gets warmer.

This starts a dangerous loop:
- The warm water melts more ice.
- That means there is more water.
- This water takes in more sunlight.
- So the water gets warmer and melts even more ice.
- And so on, and so on, until all the ice is gone.
Ms. Frizzle steered the bus-plane all over the earth.
We saw changes everywhere.

1. Global warming is melting permafrost. 
   **THERE GOES THE HOUSE!**
   **I'VE HAD IT UP TO HERE WITH ALL THIS MUD!**

2. It makes some places too dry.
   **THIS USED TO BE OUR FARM.**
   **NOW IT'S A DESERT.**

3. It raises the sea level.
   **WE WANT TO STAY ON OUR ISLAND, BUT THE WATER IS RISING...**

4. It changes the ocean chemistry and harms coral reefs and other sea life.
   **THIS IS TERRIBLE!**
5. Warming causes stronger hurricanes and tornadoes... and more forest fires... and bigger blizzards.

GLOBAL WARMING PUTS MORE WATER IN THE AIR IN SOME PLACES. THAT MEANS MORE RAIN, AND WHEN IT GETS COLD, MORE SNOW!

6. It causes animals and plants to die or to move.

IT'S TOO HOT HERE. LET'S GO NORTH.
YELLOW-BELLED MARMOTS

7. Strange weather hurts food crops.

ICE ON AVOCADOS

THAT WHOLE CROP MIGHT BE LOST!

NO AVOCADOS? HOLY GUACAMOLE!

WHY IS THERE STILL COLD WEATHER?
by Keesha
Global warming means that the average temperature of the whole earth is rising. Different places still have different weather, but, in most places, there are more hot days and fewer cold days than before.
“Aren’t you children wondering why the earth is getting warmer and warmer?” asked Ms. Frizzle. Actually, we were wondering why she was steering the bus-plane higher and higher.

Ms. Frizzle, aren’t there natural ups and downs in the climate?

Yes, but they do not really explain what is happening on the earth today.

Does anything explain what happens in this class?
“Most of today’s warming is caused by the increasing level of heat-trapping gases in the atmosphere,” said the Friz. “Heat-trapping gases are also called greenhouse gases.” She had that funny gleam in her eye. We could tell something “interesting” was about to happen.
The Friz was going to show us how the atmosphere could make the earth get warmer. She had flown up so we could look down on the earth. She gave us special microscope-goggles. We could see the gas molecules in the air.

**EXAMPLES OF MOLECULES:**

- **WATER (H₂O)**
  - two atoms of hydrogen
  - one atom of oxygen

- **CARBON DIOXIDE (CO₂)**
  - one atom of carbon
  - two atoms of oxygen

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**LOOK, I SEE AN OXYGEN MOLECULE.**

**OXYGEN'S NOT A HEAT-TRAPPING GAS.**

**THERE ARE CARBON DIOXIDE AND WATER VAPOR.**

**UH-OH, THOSE ARE HEAT-TRAPPING GASES.**
Now our teacher opened the bus door. “Catch a sunbeam, kids!” she said, cheerfully pushing us out.
We started sliding toward the earth on our own sunbeams.
WHAT IS THE
"GREENHOUSE EFFECT"?
by Keesha

A greenhouse uses glass to trap heat to keep the plants warm.

The greenhouse effect is when heat-trapping gases act like the glass in a greenhouse and make the earth warmer.

Our sunbeams landed gently and warmed the soil. As the heat started rising from the earth, we found ourselves going right along with it. "What an opportunity!" shouted the Friz. "We're going to learn about the greenhouse effect!"

The heat comes in, but it doesn't go out.

Then we changed into heat!

We were light!

Now we're going up into the atmosphere again!

Class, we're hot stuff!
The greenhouse gases trapped some of the heat. That heat headed back to Earth again. It raised the earth’s temperature even higher than before.

**WE'RE GOING DOWN TO EARTH AGAIN!**

**WE'RE BEING FRIZZLED AGAIN!**

**THE NATURAL GREENHOUSE EFFECT!**

**THANK GOODNESS FOR THE NATURAL GREENHOUSE EFFECT!**

**IS THE GREENHOUSE EFFECT BAD?**
by Carlos

The greenhouse effect isn’t all bad. If there weren’t any heat-trapping gases, the earth would freeze up.

The natural greenhouse effect keeps the earth at the right temperature for us.

But when there are too many greenhouse gases, the earth heats up too much. This causes trouble!

I AM ONE HOT DOG!
As we went back to Earth, we looked down. Carbon dioxide—CO₂—was rising into the air. “A lot of extra CO₂ is made when people burn fossil fuels,” said the Friz.

**GREENHOUSE GASES ALSO COME FROM:**
- Forest fires
- Decaying leaves
- Rotting garbage
- Garden manure
- Burning cattle

**LOOK AT ALL THE CO₂**

**IT’S COMING FROM**
- Buses, cars, and trucks...
- Houses and factories...
- And electric power plants...
Wow! We had finally found out what was causing climate change. It was mostly people—including us. We panicked!

MOST OF THAT CO₂ IS BEING MADE BY THINGS PEOPLE DO!

AND THE CO₂ IS MAKING THE EARTH WARMER AND WARMER!

Q: WHY DO PEOPLE BURN FOSSIL FUELS?

A: TO MAKE ENERGY

by Carlos

Energy is the power to do work.

People need energy to:
• heat houses
• cook food
• run vehicles
• run machines
• make light
"How can we stop global warming?" we wailed.
"One way is to use less energy," the Friz said.
"Another way is to use alternative energy!
That's energy made with less—or no—fossil fuels."
Our teacher shoed us back on the bus-plane. Like it or not, we were on our way to see some alternative energy.

IF THE FRIZ IS GOING, WE HAVE TO GO, TOO.

WE DON'T HAVE AN ALTERNATIVE.

TONS OF CO₂

Q: How much CO₂ goes into the atmosphere for each person in the U.S.?
A: Too much!
About 44,000 pounds a year.
That's the same as eight hefty hippos per person every year!

REDUCING CO₂ — WHAT'S OUR GOAL?
By the year 2050, Americans should have reduced their hippos a lot. Instead of eight hippos, an American should emit less than one hippo per year.
We set out to see generators—machines that make electricity. Most generators burn fossil fuel to spin their turbines and make electricity. Alternative generators make it without fossil fuels.

**HYDROELECTRIC PLANT**
Movement of water over a dam spins turbines in a generator.

**GEOTHERMAL PLANT**
Heat from inside the earth makes steam to move turbines.

**NUCLEAR-ELECTRIC PLANT**
Heat made in nuclear reactors does the same thing.
In the countryside, we saw another alternative: windmills. The wind turned the blades.
“Anything that moves has energy,” the Friz said. “And energy can be made into electricity.”
As we flew over a desert, we heard a loud crunch.
Out the window, we saw the bus-plane's wings fall off!
"Ms. Frizzle!" we yelled, but she didn't seem to notice.
She was too busy telling us about more alternative energy.
This time she pointed to a huge solar generator below.

1. Sun hits mirrors.
2. Mirrors concentrate heat energy.
3. Heat boils water to make steam.
4. Steam turns turbines to make electricity.
5. Wires carry power to users.
The bus made a crash landing.
Oops, we mean a splash landing.
We were floating in a solar-heated swimming pool.
Ms. Frizzle kept talking, telling us about solar cells.
They make energy directly from the sun—with no moving parts.

**SOLAR CELLS:**
- **YOU ARE MY SUNSHINE** by Ralphie
- Solar cells are made of special materials that make electric current when light shines on them.
- The cells are microscopic... They can be put on panels or on a thin film.

**CHILDREN,**
**DO YOU NOTICE THE MANY DEVICES POWERED BY SOLAR CELLS?**

**UM... MS. FRIZZLE, DO YOU NOTICE THAT THE BUS IS A GIANT POOL TOY?**

**ROOF COVERED WITH SOLAR FILM MAKES ALL THE ELECTRICITY A FAMILY NEEDS.**

**SOLAR BAGS CHARGE LAPTOPS.**

**WALKERVILLE TOWN POOL.**

**HEY! NO SPLASHING!**

**A solar “briefcase” makes energy wherever you need it.**
The bus stopped being a pool toy, so we rode into town. Everywhere, people were saving energy. Instead of driving private cars, many were using trains, buses, taxis, and bikes, as well as more fuel-efficient vehicles.
Ms. Frizzle pulled a bright green lever. At once the bus morphed into a hybrid vehicle that ran on gasoline and a rechargeable battery.

"Can we please go back to school, Ms. Frizzle?" we begged. "We've been on this bus too long!" For once our teacher listened.
"We’re back!" the Friz exclaimed, pulling into the school parking lot. We put our goggles back on, and we saw greenhouse gases all over the place.

Richer countries can help poorer countries get alternative energy. That way, less CO₂ will go into the whole Earth’s atmosphere, and we’ll all be better off.
We had to start saving energy right away.
“Conserve, conserve, conserve!” shouted the Friz.
“Recycle, recycle, recycle!”

I CONSERVE PAPER BY WRITING ON THE BACK.

I CONSERVE PAPER, TOO—BY NOT DOING MY HOMEWORK!

MORE WORDS FROM D.A.
Conserve means to avoid waste.
Recycle means to treat waste materials so they can be used again.

RECYCLING SAVES ENERGY
by Tim
Making new cans from recycled cans uses 30% less energy than making them from new aluminum.

KIDS CAN...
Recycle cans and bottles!

A LITTLE CAN DO A LOT
If your town recycled 2,000 pounds of aluminum cans, it would save enough energy to heat the typical home for 10 years.
We started making changes at our school. There was plenty of room for improvement. Then we called the mayor of our town. Then we wrote to the president.
We told everyone, “Let’s cut down on greenhouse gases now!”

- Don’t leave the fridge open too long.
- Buy Energy Star appliances.

It’s not cool to leave the fridge open!

...Saves on packaging and transportation.

- Buy things with less packaging.
- Buying more local produce...

Air-dry your laundry.

- Use cloth shopping bags.
- Buy less bottled water.

A little can do a lot

If every household in the U.S. switched three lights to compact fluorescent lamps (CFLs), it would reduce as much CO₂ as taking 3.5 million cars off the road.

That’s because old incandescent bulbs waste a lot of energy making heat. CFLs use most of their energy making light.

The less energy you use, the less CO₂ goes into the air.
Finally, we had time to put on our play. It was about everything we had seen on our trip. We showed what global warming was doing to our planet. And we told about how people can help.

Warming isn’t so good for our forests, either.

It causes droughts and wildfires...

...and it brings more insect pests.

Yum! We love global warming!

Hey, bugs! Stop eating our forests!

Applause!
Can you believe it?
A TV station found out about us, and we got to be on television!

A LITTLE CAN DO A LOT
If every computer and monitor in the U.S. were turned off at night, we would prevent 7 million tons of CO₂ from going into the atmosphere.

KIDS CAN...
- put computers into sleep or hibernate instead of screen-saver mode
- switch off and unplug after using for the day

KIDS CAN...
- IN THE SUMMER: Ask an adult to turn the air conditioner one degree warmer
- IN THE WINTER: Ask an adult to turn the thermostat one degree cooler
As we left school, we asked our teacher, "Will the earth really be okay, Ms. Frizzle?"
"I hope so," said the Friz.
“Our only chance is to work together—every person, every city, every country."
To learn more about climate change, visit your local library or book store, and look for kids' sites online.

Your teacher's dress is unusual!

Yes, her taste in clothes is evolving.

NOW - NOT LATER!

by Phoebe

On our trip, we saw many kinds of alternative energy. The good news is: All of them are available now. The bad news is: Not enough of them are being used yet.

We want more energy choices!

We want less greenhouse gases!

PAPERS IN RECYCLING BIN
QUESTIONS FOR MS. FRIZZLE’S CLASS
... an online chat

Q. Can a class really go up in the sky and ride sunbeams into the earth?
from IvannaNO@once.now

A. According to our research, only Ms. Frizzle’s class can do that.
from Dorothy.Ann@a.loss.to.explain.net

Q. Why are you so worried about global warming? There were warm times in Earth’s past, weren’t there?
from Onceupon@time.now

A. In past times, Earth’s climate has been cool, cold, warm, and hot. But these changes have happened over millions of years. Animals and plants had time to adjust. The warming we see now has happened in only a few hundred years. We can’t adapt that fast.
from Ralphie@a.gallop.net
Q. Can a single person really change things?
from Juan@atime4change.net

A. One individual can’t make a big difference. But millions of individuals can!
from Phoebe@longlast/together.net

Q. Don’t we need bigger help?
from a.giant@least?.net

A. You’re right. We need all the governments of the world to cooperate in solving the climate crisis.
from Ms.Frizzle@the.crossroads

Q. Why does Ms. Frizzle always go on such weird class trips?
from kids@risk?safety.net

A. That’s what I would like to know.
from Arnold@home.sweet.home
I'M GOING GREEN!

I've always been GREEN!