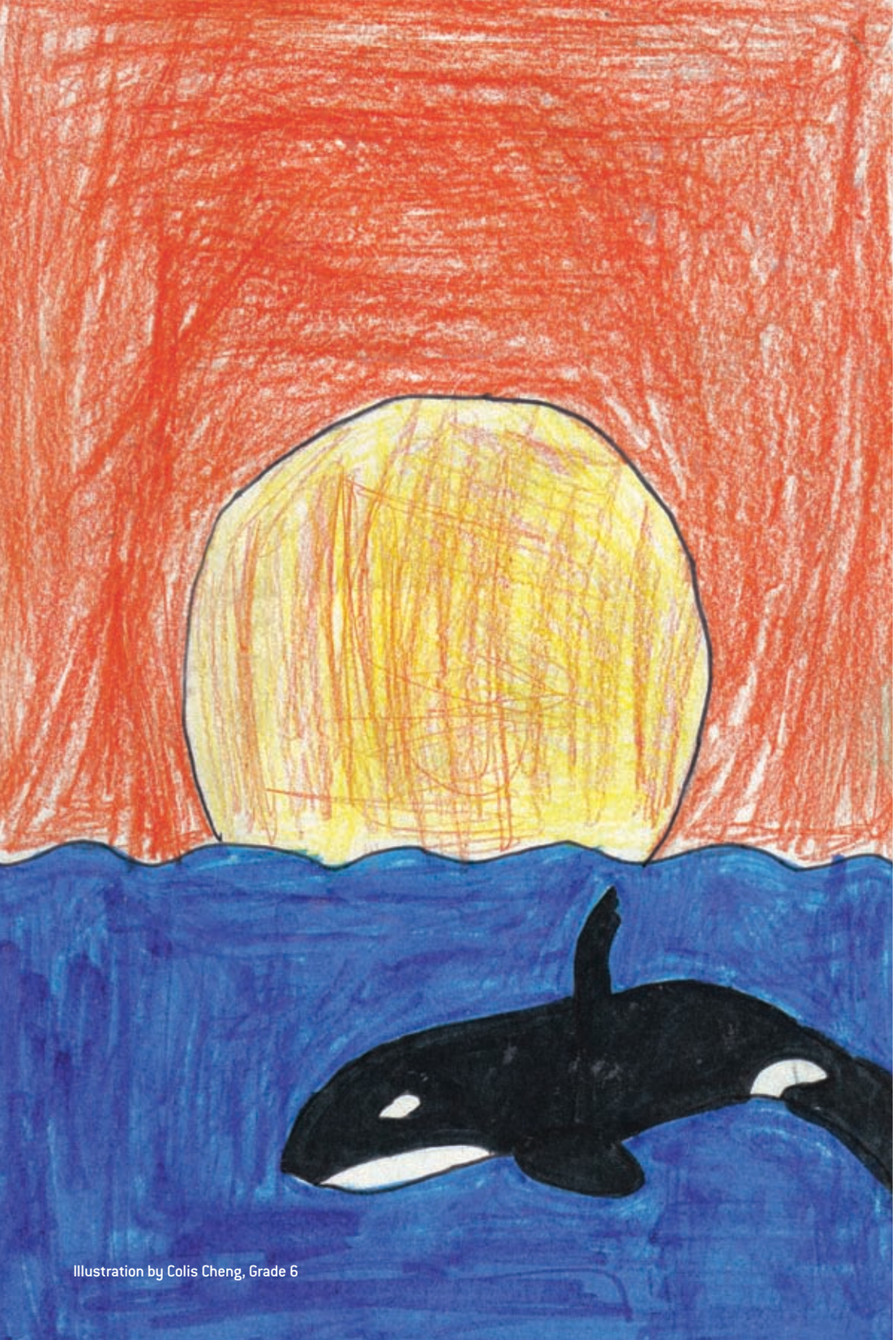


Illustration by Colis Cheng, Grade 6

PART 1

What You Need to Know: A Climate Change Primer

Climate change confusion has kept many people – and even entire nations – from taking decisive action. But the issue is actually straightforward. Climate scientist DR. JOHN FYFE explains what's going on and why everyone, including schools, urgently needs to go carbon neutral.

PART 1

What You Need to Know

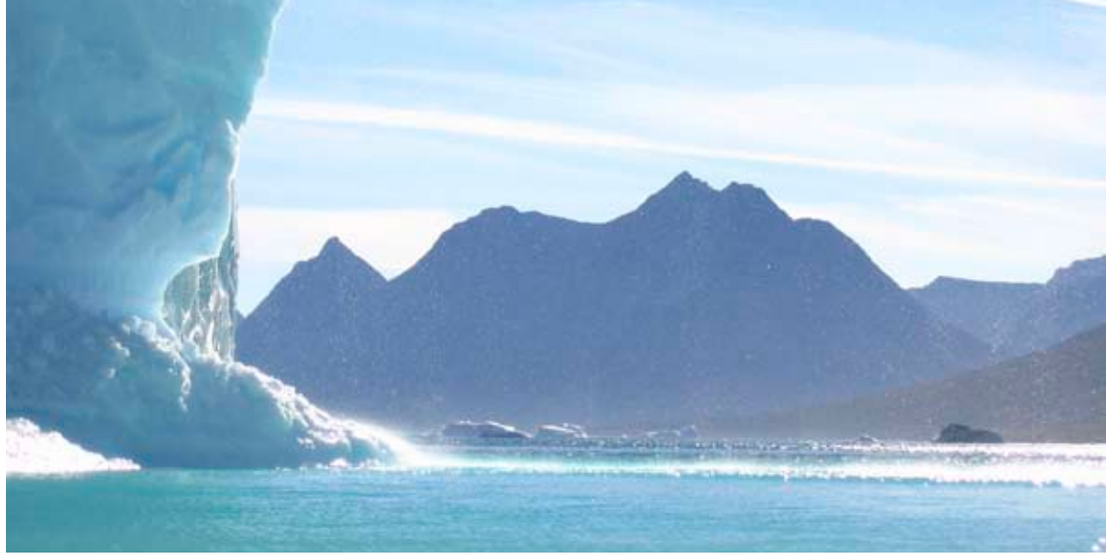
A Climate Change Primer

DR. JOHN FYFE is a research scientist in the Canadian Centre for Climate Modelling and Analysis of Environment Canada and an adjunct professor at the University of Victoria. He is also a lead author of the Nobel Peace Prize-winning IPCC Working Group 1 Fourth Assessment Report entitled "Climate Change: The Physical Science Basis" 2007.

Much of this book is geared towards helping those involved in the education system start to move towards carbon neutrality in their schools and their districts. My job is to convince you that this is crucial. I'll do this in three parts.

First, I describe the dominant changes in the climate system, including the atmosphere, ocean, snow and ice. Next, I explain why we believe these changes are occurring. Finally, I describe what we think is in store for us if we don't curb our appetite for carbon.

Most of what I discuss here comes from the Working Group I Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). The report was written by about 150 lead authors, of which I am one. It involved contributions from over 1,000 other leading scientists in the field, from 130 countries. It took five years of work and involved a rigorous review process, involving about 1,000 reviewers. It's being described as the largest environmental assessment of all time, and it is part of the reason why the IPCC, along with Al Gore, was awarded the Nobel Peace Prize in 2007.



HISTORICAL CONTEXT: In the last 150 years, the temperature has risen faster than anything we've seen in the last 1,300 years. This is global warming, which the vast majority of scientists believe is due to human interference.

> PAST VERSUS PRESENT GLOBAL WARMING

It's useful to look back in time and examine the changes that have happened in the distant past, so we can compare them to the changes we've seen more recently: are they similar or dissimilar, and what are their causes?

From analyzing ice cores, we've got a record of the atmosphere's temperature and chemical composition going back 650,000 years, and we know early climate change was primarily due to changes in how close the earth was from the sun, and had nothing to do with human activity.

Within the past 1,300 years or so, we see climate changes like the Medieval Warm Period, or the Little Ice Age of 100 years ago, where Europe skipped a summer. These changes are thought to reflect natural internal variations as well as the influence of solar output and volcanic activity.

But in the last 150 years, the temperature has risen faster than anything we've seen in the last 1,300 years. This is global warming, which the vast majority of scientists believe is due to human interference. Since 1850 we have seen the global average temperature increase by about one degree. The temperature has not only been rising, but the rate of change has been increasing. We're not only warming, we're warming faster and faster, and again this is very likely due to human activity.

Where is this all happening? Warming is happening everywhere on the surface of the earth as well as in the atmosphere 10 kilometres above the surface, and it's happening nearly everywhere on the planet. There's now strong scientific evidence that along with rising temperatures in the atmosphere, the oceans are warming, glaciers, ice sheets, and sea ice are melting, and as a result sea level is rising.

> WARMING OCEANS

Ninety per cent of the new heat that has been going into the atmosphere has been sucked up by the ocean. Otherwise, we probably would have fried a long time ago. The ocean is our great saviour, yet there is emerging scientific evidence that the global ocean is beginning to take up less and less heat because of global warming, which is certainly not a good thing.

> MELTING GLACIERS, ICE SHEETS, AND SEA ICE

We have before-and-after photographs from all over the world, showing that most of the world's mountain glaciers are retreating. The Greenland and Antarctica ice sheets are melting. There is convincing evidence that this melting is accelerating quite dramatically. Artic sea ice is melting too. In 1980, there was seven million square kilometres of Artic summer sea ice. In 2006, there was less than five million square kilometres.

That's very dramatic and unprecedented. We've heard a lot from the media about Arctic sea ice melting for two main reasons. First, the melting has opened up the possibility of a navigable Northwest Passage. Second, it opens up the prospect of easier oil and gas exploration in the North. That's why most northern countries are queuing up to claim sovereignty in the North.

> RISING SEA LEVELS

The warming of the oceans causes seawater to expand, while the melting of mountain glaciers and ice sheets sends more water into the ocean. Sea water expansion, melting mountain glaciers, and melting ice sheets are each responsible for about a third of the total sea level rise. Since 1880 there has been a sea level rise of about 20 centimetres – about the length of a person's forearm. This is not huge, but it's larger in some places than others and we expect that it will rise much more in the future.

> WHY IT'S HAPPENING

We've looked at why these changes are happening by using climate models. These are very sophisticated programs, built on sound physical principles, exhaustively validated, and run on supercomputers. A few years ago, each of the world's top climate modelling groups compared the results.

When the models include increasing greenhouse gases in the atmosphere, the programs show increased global average temperature. When the models don't include increasing greenhouse gas concentrations, they do not show warming — they actually predict global cooling.

That's partly why the IPCC has concluded humans are most likely responsible for most of the warming observed over the last century.

RECEDING GLACIERS: We have before-and-after photographs from all over the world, showing that most of the world's mountain glaciers are retreating.

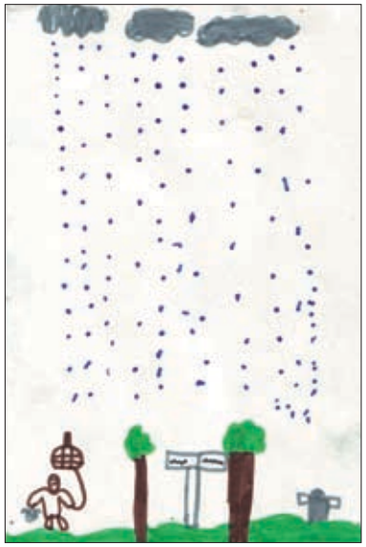
> LOOKING AHEAD

These models predict that regardless of how much we emit, by the year 2025 we will end up at about the same place. We've put so much carbon dioxide into the atmosphere that we must live with the consequences for at least the next 20 years, and that amounts to about another half-degree rise in temperature. But what we emit now will make a big difference in the amount of warming expected by 2100. We could have a one-degree rise, if we have low greenhouse gas emissions, or a four- to five-degree rise if we have high emissions.

So the choices we make today will make a big difference in the lifetimes of our childrens' children. We have to start making changes now. We will need to have made significant emission reductions by no later than 2020 – otherwise we may end up with dangerous climate change.

> CONSEQUENCES FOR OUR FUTURE

What will happen if our greenhouse gas emissions go unchecked? Sea level, of course, will continue to rise, likely by more than a half meter by the end of the century. It will rise more in some places than in others. That is another message from climate scientists: this is a global phenomenon with regional impacts. Different regions will be affected in different ways. Temperature change will be uneven as well. Most warming will occur over land and especially over high northern latitudes. In other words, the dramatic changes seen in the Arctic today will likely carry on and worsen in the future. For this reason Canadians especially need to pay attention to this climate change problem.



RAINFALL CHANGE: Precipitation will change regionally. In general, we expect the atmosphere to become moister, because warmer air holds more moisture. But where the extra water falls out will vary around the globe. ILLUSTRATION BY RONIC PARMAR, GRADE 5

Precipitation will also change regionally. In general, we expect the atmosphere to become moister, because warmer air holds more moisture. But where the extra water falls out will vary around the globe. We expect that in our region and in the rest of the mid- to high-latitude regions, we will have increased precipitation over time. On the other hand, places like southern Europe, northern Africa, and the southern United States will probably see decreased precipitation.

> CLIMATE EXTREMES

The data tells us that when it rains, it will rain more heavily. This would be consistent with what we saw in the winter of 2006/2007 in British Columbia, when we had a sequence of historic storms that brought an unprecedented amount of moisture to our region over a very short period. In the future we should expect this kind of thing to happen more and more often.

On the other hand, in some regions we expect there to be more drought. For example, in summer in B.C., we should expect to have more frequent and longer droughts. Already in Australia we have seen unprecedented drought conditions and wildfires; there was the Atlanta drought in the summer of 2007 and the California wildfires. We should expect more and more of these extreme events in the future if our greenhouse gas emissions go unchecked.

Finally, on the subject of climate extremes we should expect more heat waves like the European heat wave of 2003. We should expect there to be more and more of these kinds of events affecting the environment in far-reaching ways.

> THREE KEY MESSAGES

I have three key messages. The first is that the planet is warming, humans are very likely the cause, and the warming will most certainly continue into the future. Next, mitigation will not substantially affect the warming over the next few decades. And finally, choices that we make now will have a big impact on the climate seen at the end of this century. So it does matter. We have to start going carbon neutral today.