Our understanding of the Earth system is not much better than a nineteenth-century physician's understanding of a patient. But we are sufficiently aware of the physiology of the Earth to realize the severity of its illness.

We suspect the existence of a threshold, set by the temperature or the level of carbon dioxide in the air; once this is passed nothing the nations of the world do will alter the outcome and the Earth will move irreversibly to a new hot state.

We are now approaching one of these tipping points, and our future is like that of the passengers on a small pleasure boat sailing quietly above the Niagara Falls, not knowing that the engines are about to fail.

—physiologist James Lovelock, 2006

The widespread confusion about our climate crisis is no accident. For more than a decade, those who deny that climate change is an urgent problem have sought to delay action on global warming by running a brilliant rhetorical campaign and spreading multiple myths that misinform debate. As a result, many people still believe global warming is nothing more than a natural climate cycle that humans cannot influence, or that it might even have positive benefits for this nation. Neither is true. The science is crystal clear: We humans are the primary cause of global warming, and we face a bleak future if we fail to act quickly.

—oceanographer Joseph Romm, 2007

We never have 100 percent certainty. We never have it. If you wait until you have 100 percent certainty, something bad is going to happen on the battlefield.

—General Gordon R. Sullivan, 2007
(former Chief of Staff, U.S. Army)

4

"Pop!" Goes the Climate

I remained comfortable with the slow-but-sure metaphors for climate change until one day in 1984 when I learned that things could go "Pop!" That's when, quite by accident, I heard about the surprises from the past seen in the ice cores pulled up from the depths of Greenland's ice sheet.

The ancient climate records were full of sudden jumps in temperature and rainfall, lasting many centuries before flipping back. In the course of five minutes into a lecture by a visiting Swiss geochemist, Hans Oeschger, I had to abandon my limited notions of gradual change. Flips occur. They are commonplace events.

It was certainly unsettling—and even more so as I began to think about it. Anything that abrupt is probably not a simple analog tweaking at work—say, the sun getting hotter or cooler—but suggests there is a big positive feedback loop hidden somewhere.

Cause and effect get all mixed up when there's a feedback loop involved. You really have to think about it

differently, as reactions can be all out of proportion to the stimulus. We call a person "excitable" if a creeping pint-size stimulus suddenly elicits a gallon-sized response. We neurophysiologists study nerve and muscle cells with positive feedback mechanisms that help things to happen very quickly. With them, things often go "Pop!"

Often climate change is not, in the manner of a dimmer switch, proportional to the provocation. It is more like the traditional light switch which, with slightly more pressure, suddenly blinds you in the middle of the night.

Remember those cameras with an automatic pop-up flash, that flipped up right in front of your other eye when you were about to take a picture in insufficient light? Some people, startled, dropped their new camera. We have, it now appears, a pop-up climate to prepare for.

Climate abounds with situations where, even without a constant push from the outside, the internal dynamics propel change. Collapse. Runaways. Take offs. Some tipping points are especially serious because of the demolition derby that follows: Say, drought causing the Amazon rain forest to burn off (discussed in chapter 13).

To place all of this discontinuity in perspective, consider some less dramatic everyday examples. Processes often have "modes" of operation, such as gallop and walk. You pop from one to another without an intermediary mix.

Matter often comes in "states." Good old H_2O can be found in three states: as a solid called ice, as a liquid called water, or as a gas called water vapor (which we feel as

humidity). We can go back and forth between states, even jump over the liquid state via sublimation of the ice directly into water vapor. Thawing and evaporation are reversible by freezing and condensation.

Many climate processes are somewhat reversible. But it takes forever. Though we are still trying to digest the news about the slow track, some aspects of climate change may have already jumped to the fast track. Major glaciers in both Greenland and Antarctica are now dumping far more ice into the oceans than they were just five or ten years ago.

The biggest source of our climate problem is the soot and carbon dioxide from burning oil and coal. This has created an unwelcome blanket of pollution around the Earth. The global fever that results, especially in the high latitudes, is already causing sea level to rise and the flushing of the North Atlantic to diminish. Climate scientists are now predicting permanent flooding of countries such as the Netherlands, Bangladesh, Tuvalu, and the Maldives, not to mention such low-lying cities as London, Boston, New York, Miami and New Orleans.

In midcentury, about 70 percent of us will still be around, plus the kids and grandkids born between now and then. Historians will be busy writing books about the events in the hundred years since the first deadly serious greenhouse-is-happening warnings. Readers will be all too familiar with what did happen, but curious about why and how it all happened.

"Knowing what they did, how could they have done this to us" may be a familiar refrain. "They kept saying that the chances of climate change were low—but even if they had been right about that, to ignore the huge potential consequences was really stupid." Risk is the chance an event will happen, multiplied by the consequences if it does happen. But this doesn't register with many people. It took fifty years to largely overcome the reluctance to wear one's seat belt.

Historians will have a more nuanced view and one of their themes will be how fear of nuclear power led to the vast expansion of the dirtiest power source of all, coal. "The Green emphasis on small individual efficiencies worked about as well as dieting worked to keep weight off," some historian might say.

Others will focus on the disinformation campaigns created by Big Coal and Big Oil to maintain business-as-usual profits. And why they succeeded better in some countries than in others.

They will all analyze how big decisions were made (or avoided) by politicians and regulatory agencies. And how normal scientific uncertainty (the stance we routinely adopt regarding a problem that is incompletely solved) was exploited by them all in order to postpone inconvenient decisions.

Still, anyone who spots a burning house has a civic and moral duty to spread the alarm and awaken the occupants. But before acting, how certain must you be? Can you tell the difference between smoke and the exhalations of the

clothes dryer? Better safe than sorry. Many climate scientists, historians will note, faced this dilemma squarely and issued warnings.

The universal lament in 2050, however, may be that the problem proved too big and complicated for nonscientists to comprehend.

That's not my experience so far. Even lawyers and policy types—and others who might have earlier skimped on science courses—are perfectly capable of appreciating how the climate story hangs together.

While I'm a medical school professor and not a climate scientist, I've been following the climate story for a quarter century by now, and trying to explain it to general readers for a decade. (I wrote the first major magazine article on the climate flips back in 1998, a cover story for the *Atlantic Monthly* called "The great climate flip-flop.")

My experience is that good analogies from everyday experience suffice to get across the main ideas of how one thing leads to another—and where we might intervene to break up feedback loops.

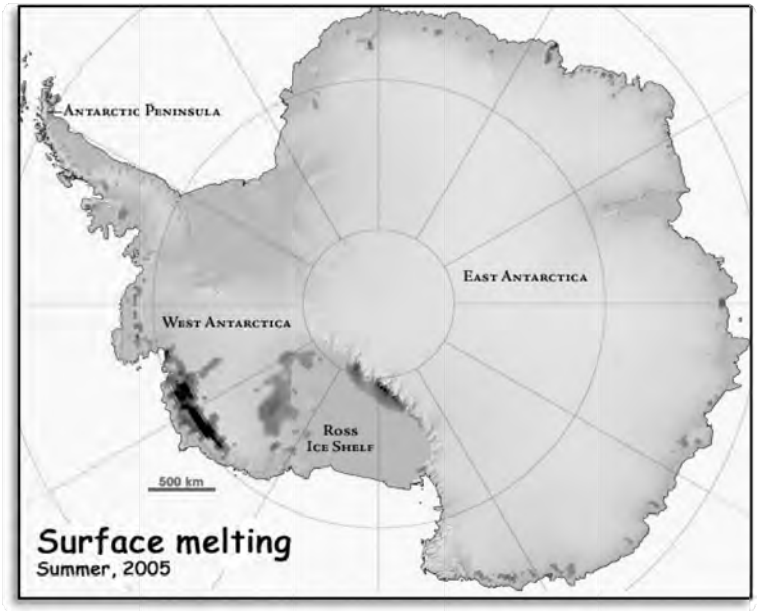
This book is not the place to get the latest survey of the latest climate data. Much of who, what, when, and where is always a little out of date. My book is more about the principles of acceleration—which probably won't change—that underlie tip, slip, and flip. But why and how are what you need for a deeper understanding of why we're in this mess and how we might intervene.

William H. Calvin, GLOBAL FEVER (University of Chicago Press, 2008)

Opposite: The Antarctic Peninsula is the most rapidly warming place on earth. Over several weeks of 2002, an ice shelf there, bigger than Rhode Island, was observed to shatter. This made room for more ice to flow downhill and raise sea level.

An ice stream well uphill of Larsen B has been observed to stop advancing during low tide but, as the tide rises and lifts the terminus, it accelerates to 1 m per hour.

The worry expressed then was that the large West Antarctic Ice Sheet could do the same thing if summer temperatures there were to rise above freezing. That occurred in the summer of 2005 when a surface area as large as California melted and then refroze.



William H. Calvin, GLOBAL FEVER (University of Chicago Press, 2008)

GLOBAL FEVER

How to Treat Climate Change

WILLIAM H. CALVIN

THE UNIVERSITY OF CHICAGO PRESS
CHICAGO AND LONDON

Visit http://Global-Fever.org for additional chapters

Contents

Visit http://Global-Fever.org for additional chapters