



The author and his granddaughter Sophie

Preface

Sophie's Planet is the world today's young people and their children will live in. There's no good reason that it can't be a spectacular place. Nature is remarkable; it can adapt and heal from human-caused wounds, especially if we limit further stress on the planet.

Yes, I realize that climate change is a rising threat. Extreme climate events – floods, storms, heat waves, fires – are becoming more extreme. Sea level is rising and threatens coastal cities. The subtropics in summer and tropics most of the year are becoming uncomfortably hot. If we let these effects continue to grow, pressures to emigrate from low latitudes and coastal cities could make the planet ungovernable. Moreover, a warming world incubates pathogens and infectious diseases. Disease vectors – living organisms that can transmit disease to humans – can survive winter and spread to higher latitudes and altitudes. If we don't reverse the warming, the great outdoors won't be quite as welcoming to people as in the past.

Sophie's Planet – this book – aims to help young people realize that climate change is no reason to panic or be depressed. We can preserve and restore our planet, but not with past or present energy and climate policies. Fortunately, present government turmoil provides an opportunity to reset policies. I hope that the picture exposed by my experience in recent decades helps young people understand that they have the power to make all the difference.

I was lucky to be born in Iowa and at an opportune time. I grew up in western Iowa, a place that is colored red on political maps, as most people there are conservative. I went to college in Iowa City, a blue (liberal) place in politics. My good fortune was to become a student in the Physics and Astronomy Department, chaired by Prof. James Van Allen, at the University of Iowa. I had been a junior in high school in 1958 when Van Allen – with an instrument on the first United States artificial Earth satellite – discovered the radiation belts encircling Earth.¹

Prof. Van Allen taught science by example, relishing in the puzzle of understanding new observations. Success in science requires you to be most skeptical of your own analysis of an issue, to reassess when new data become available, and to not let preference or ideology affect your assessment. Minimizing bias is easier for a political independent, so, for that reason, as well as to respect both conservatives and liberals, I chose to be an independent.

Government supported education in the 1960s. It was feasible to work one's way through college without ending up in debt. I was too shy and diffident to approach Prof. Van Allen. I sat quietly in the back of classes (not an approach to emulate) but was lucky that Van Allen noticed when I was one of the first two undergraduate students to pass the Ph.D. qualifying examination. Thus, I received a NASA traineeship for graduate school education, benefitting from federal government support for space exploration.

Prof. Van Allen told me about observations of Venus, which led to my Ph.D. dissertation and instilled in me a fascination with the “veil of Venus,” pale-yellow clouds shrouding the planet. I obtained a post-doctoral fellowship at a NASA lab located near Columbia University in New York City, the Goddard Institute for Space Studies (NASA GISS). Using measurements of the polarization of sunlight reflected by Venus as it circled the Sun, I inferred precise microphysical properties of the Venusian clouds – cloud particle shape, size distribution, and refractive index – which led to identification of the clouds of Venus as sulfuric acid.

So, Venus was not the romantic planet Carl Sagan had imagined, with water bodies on the surface and Earth-like water clouds. Hope of life on Venus was dashed by the Soviet Union's Venera 7 space probe, which measured a surface temperature of 450 degrees Celsius (850 degrees Fahrenheit) – hot enough to melt lead. Still, Venus was interesting – why was it so hot, what was its history? With help of colleagues at NASA GISS, I proposed an instrument for the U.S. Pioneer Venus mission – a small telescope that would take images of Venus and measure cloud properties as far into the atmosphere as could be seen from an orbiting spacecraft.

It took five years to build the Pioneer Venus spacecraft. Meanwhile, we realized that humans were rapidly changing our own planet's atmosphere. Thus, while the spacecraft was being built, we began to study how humanmade gases and aerosols (fine airborne particles) altered Earth's climate. We soon realized that we had to build a climate model – a computer simulation of Earth's climate – which is a huge task. So, I resigned as the lead investigator for our Venus instrument to focus fulltime on climate research. Sometimes it felt like we were viewed as outsiders by the Earth science community. But we thrived in having our own perspective, as we looked at Earth as a planet, and tried to help chart its future course.

Climate science is not rocket science. The public can understand the climate story, despite its many facets, if the science is made clear. Climate's delayed response is a key feature. Climate responds slowly when humans alter Earth's atmosphere – over decades, a century, and longer. Slow response is due to the ocean, which has huge heat capacity, as it covers 70% of the planet, is four kilometers (two and a half miles) deep on average, and wind-mixed, so it takes a long time for its temperature to change. This delayed response is both bad and good. The bad thing: the danger of leaving young people a climate running out of control. The good thing: the delay provides time to take actions to restore favorable climate before control is lost – if we understand the needed actions. For that purpose, we need good understanding of the climate system.

First, we need paleoclimate data – information from Earth’s history on how the planet responds to applied forces. Fortunately, Earth’s history contains many natural events in which known forces drove climate change. These natural “experiments” include volcanic eruptions that inject aerosols into Earth’s stratosphere where they reflect sunlight, reducing solar heating of Earth. Also, Earth’s orbit around the Sun changes on long time scales due to gravitational attraction of Jupiter and other astronomical bodies. These astronomical perturbations of Earth’s orbit change the seasonal and geographical distribution of sunlight on Earth. Geologists have reconstructed climate changes that occurred in response to these natural forces. So, Earth’s history is a laboratory that helps us investigate and understand climate change.

Second, we need a numerical climate model to simulate climate on a computer. Basic equations for conservation of energy, mass and momentum, for example, must be solved together to produce properties and motions of the atmosphere and ocean. Weather forecasters use these equations to predict how air masses move and change. So, we started with a weather prediction model and added processes that become important on long time scales, such as changes of atmospheric composition and changes of Earth’s orbit.

Third, we must study ongoing climate change and climate processes, comparing real-world data with our climate simulations. One of the first things I did was to use data from weather stations around the world to develop a record of Earth’s temperature during the period of instrumental temperature measurements, for comparison with climate simulations of our climate model.

Our hallmark is a similar level of effort in each of the three areas: paleoclimate studies, global climate modeling, and modern observations. This broad approach to climate science allows us to reach conclusions sooner and with greater confidence than would otherwise be possible.

Humanity now drives climate change. We began to affect the composition of the air several millennia ago with the advent of land-clearing and agriculture. The human effect grew with the industrial revolution, mainly from burning of fossil fuels – coal, oil and gas – which were a boon to humanity. One gallon (3.8 liters) of gasoline (petrol) contains energy equal to that in 400 hours of labor by an adult. Fossil fuels raised living standards in much of the world by replacing back-breaking human labor. The challenge now is to find adequate energy for the entire world without driving unacceptable climate change. That will not be easy. Fossil fuels provide about 80 percent of the world’s energy and some of their industrial uses are difficult to replace.

The global climate threat caused by fossil fuels is sneaking up on the public like a big jungle cat. People hear a rustling in the leaves: regional climate extremes such as droughts, heat waves, fires, storms, and floods are increasing. Yet the number of deaths from climate disasters has declined as global observing systems provide warnings. Air conditioning helps us adapt to a warming climate. Yes, there is danger of pushing climate beyond a point such that irreversible effects – a dramatic change of ocean circulation and large sea level rise – are locked in, but such effects seem remote and uncertain. The public is concerned about their immediate economic well-being, and they want their energy sources to be reliable and inexpensive. The public expects the government to look out for distant, hard-to-understand, dangers. However, for that purpose, the government should be objective and not under the influence of special interests.

The greatest driver of climate change is the carbon dioxide gas produced by burning fossil fuels, with its climate effect proportional to cumulative historic emissions because of the long lifetime

of carbon in the climate system. Thus, the U.S. is most responsible for present climate change, while China is now the largest source of emissions. Even though U.S. emissions are a declining fraction of global emissions, energy policies in the United States will have a major effect on future climate. Emissions within U.S. borders, emissions in other nations from production of merchandise for the U.S. market, international travel and transport associated with the U.S., the role of the U.S. in the fossil fuel industry, and the effect of U.S. policies on emissions worldwide all make it essential for the U.S. to have effective climate policies, if the world is to be successful in stabilizing climate. Thus, we need to understand why it is so difficult to achieve a science-based climate policy in today's American democracy.

American democracy is a product of the Age of Science and Reason. The Enlightenment – the intellectual movement of the 17th and 18th centuries that prized rationalism and individualism over tradition – was born in Europe under the influence of philosophers such as Rene Descartes, John Locke and Isaac Newton. However, the principal political product of the Enlightenment blossomed in America, expressed eloquently in the Declaration of Independence and the Constitution by founders of the U. S. democracy, especially Thomas Jefferson in the Declaration and James Madison in the Constitution.

From this fervent milieu was born the fundamental American dream, the concept that all people are created equal and all people should have equal opportunity to better themselves and their lives. Reality was far from that ideal, but the founders designed the Constitution to allow continual progress toward “a more perfect union.” They realized that forces of greed and corruption always exist, and they speculated that an occasional “revolution” would be needed, no doubt thinking of revolutionary political change, not a war with guns blazing.

The American democratic experiment survived a brutal Civil War and made progress, albeit slowly, towards equal rights. Global democracies survived authoritarian governments in World War II, after which the United States participated in formation of the United Nations, the World Bank, and other institutions that helped raise living standards in much of the world. Cooperation was not a zero-sum game – it lifted all boats. A high point of American democracy was reached under the leadership of John F. Kennedy, who established the Peace Corps and the goal of reaching the moon, saying: “We set sail on this new sea because there is new knowledge to be gained, and new rights to be won, and they must be won and used for the progress of all people.”

In parallel with progress toward those ideals, a problem was growing – a problem so ingrained that its solution requires the sort of revolution that the founders anticipated. Such a revolution is not only possible, it is so appropriate that the only wonder will be: why did we wait so long?

President Eisenhower was reticent to describe the full problem. In his farewell address in January 1961, Eisenhower warned of the danger of the “military-industrial complex,” but he defined only a symptom of the problem. In a draft of his speech, Eisenhower used the phrase military-industrial-congressional complex, but he deleted “congressional” in his delivered speech. When Dr. Milton Eisenhower, the President's brother, asked about the omission, “Ike” explained “It was more than enough to take on the military and private industry. I couldn't take on the Congress as well.”² The public wishes he had. The public knows that Washington is a swamp of special interests. One product of the military-industrial-congressional complex is

continual war-making that many of the public do not support. Indeed, most people today are unaware of the [number of wars](#)³ that the United States is now involved in.

Once elected to Congress, politicians join the elite class and reelection is unwritten priority. Money from special interests is needed for reelection and lifestyle support. As a result, the best interests of the public are secondary to special interests. This is a harsh criticism that I reached reluctantly. My first impression of legislators -- when I went to Washington and capitals of other nations to talk about climate change -- was positive: most elected officials are intelligent, concerned, and articulate. However, when politicians propose policies to address climate change, they commonly choose complex, expensive, ineffective policies that favor special interests.

The power of special interests has made Congress unable to address many issues on which the public has clear consensus. Resulting public frustration has led to the rise of political extremes, with people voting against the extreme that they fear the most. This crisis for democracy creates an opportunity, because it demands a revolution. The task now is to speed that revolution and assure that it includes a focus on reversing climate change.

President John F. Kennedy had the potential to address core problems. In a brief [City on a Hill](#)⁴ speech in Boston just before he took office as President, Kennedy referred to a sermon John Winthrop gave to pilgrims in 1630 as they were about to embark on the ship *Arabella* to form the Massachusetts Bay Colony. Winthrop warned his congregation that they would be judged: “We must always consider that we shall be as a city upon a hill—the eyes of all people are upon us.” Kennedy stayed close to Winthrop’s meaning for the parable, concluding “when at some future date the high court of history sits in judgment” we will be judged by qualities that he described and then summarized in four words – courage, judgment, integrity and dedication – which, he hoped, “will characterize our government’s conduct in the four stormy years that lie ahead.”

Kennedy’s surpassing [Peace Speech](#),⁵ in June 1963, stressed the need for mutual respect and communication among nations, especially between adversaries. His speech was welcomed by the Soviet Union’s Nikita Khrushchev, leading to the Partial Nuclear Test Ban Treaty and plans for a more substantive Khrushchev-Kennedy summit that were dashed by Kennedy’s assassination in November 1963. Prior to his assassination, President Kennedy decided on a plan for withdrawal from Vietnam to begin in December 1963 regardless of the military situation; he was resolute.⁶

History may have unfolded differently if Kennedy’s presidency had not been cut short at 2 years and 10 months. Kennedy understood the big picture. In his Peace speech, he drew attention to the common interests of humanity, “...we all inhabit this small planet. We all breathe the same air. We all cherish our children’s future.” Early in his administration, he established the Peace Corps, which sent thousands of young volunteers to work in other countries in fields such as health, teaching, agriculture, forestry, sanitation and technology – in the process improving mutual understanding of the people of America and the other nations. Had Kennedy’s tenure reached two full terms, would the military-intelligence-national-security complex have grown as it did? We cannot afford to be haunted by apparitions of the path not taken, but we can learn from the past, and we can learn from our mistakes, to help shape a better future.

By the 1980s, the “city on a hill” metaphor took on a new meaning. President Ronald Reagan, in his farewell address, described a “shining city on a hill” as “...teeming with people of all kinds living in harmony and peace – a city with free ports that hummed with commerce and creativity,

and if there had to be city walls, the walls had doors, and the doors were open to anyone with the will and the heart to get here.” This “city on a hill” concept is sometimes described as belief in “American exceptionalism” and [criticized, even by a United States President](#).⁷ Today the shining city metaphor may seem to be a parody. Public dissatisfaction with Congress is high, for good reason. The contempt with which elite Congresspeople of both parties view the public is openly displayed in their trading of stocks affected by their legislative committee work.⁸

The coincidence of this valley of confidence in the American government and the global climate crisis is an opportunity to make overdue fundamental changes. The American Constitution allows change as needed to maintain a government of the people, by the people, for the people. To address these major issues, I believe that it is necessary to restore the American Dream.

How realistic is the American Dream of equal rights and equal opportunity? It is good to maintain a balance between pride in our government and self-criticism. Equal rights and equal opportunity do not exist now and never have. There is much to criticize in American history including genocide of Native Americans, slavery, militarism, and money-grubbing by politicians in both major parties. Progress toward a “more perfect union” has been made, for example, in women’s rights and civil rights of minorities, but there has also been backsliding, and today the American Dream has faded for many people. Higher education is within reach of the common person only via acceptance of life-throttling personal debt. Immigration, our lifeblood for renewal, has broken down, as Congress is increasingly polarized and dysfunctional.

Yet there also has been much progress toward “a more perfect union,” and young people have the potential to add their contribution and shape their world. In 2008, I saw the wave of enthusiasm for Barack Obama on campuses; student support spurred Obama’s overcoming of Hillary Clinton, the favorite of the Democratic Party establishment. In 2016, young people nearly carried Bernie Sanders to an upset of Clinton in the Democratic primaries. Today’s political polarization presents an opportunity for young people to use their clout to address the basic problems preventing good governance, and to do so with an approach that restores our climate and preserves our remarkable planet as a home for people and all life.

Young people can shape their future. Our nation’s founders pledged to each other their lives, fortunes and sacred honor to secure the unalienable right to life, liberty and pursuit of happiness. They declared that governments derive their just powers from consent of the governed, and when a government becomes destructive of those ends, it is the right and duty of the people to alter or abolish it. Prospects for today’s young people suffer from a long train of abuses, such as failure to address climate change, spiraling national debt, and retreat of the American dream.

When I testified to Congress in 1988, Robert Pool described me with a religious metaphor as a “witness” – someone with information so important that he cannot keep silent.⁹ Today, after decades of experience with governments, I am a witness with understanding of the suffocating impact of special interests on democracies. I am convinced that young people can play a leading role in forging the revolution needed to restore not only a propitious climate, but civility in our democracy and effectiveness in our government. I hope that my experience might help inform an effective pathway; I will work tirelessly to assist young people in any way that I can.

Jim Hansen

¹ Prof. Van Allen had a Geiger counter on Explorer 1, the first U.S. satellite, launched 31 January 1958, to measure cosmic rays (energetic electrically charged particles). Such particles are emitted continuously by the Sun, carried outward in a “solar wind.” Van Allen found a large amount of these charged particles temporarily trapped by Earth’s magnetic field in large donut-shaped “belts” encircling Earth.

² Goodman MA. *National Insecurity: The Cost of American Militarism*, City Lights Publishers, 464 pp, 2013

³ Wertheim S. [How Many Wars Is America Fighting?](#) The Gravel Institute, last access 5 January 2023

⁴ Kennedy JF. [The City Upon a Hill](#), speech to Massachusetts General Assembly, Boston, 9 January 1961

⁵ Kennedy JF. [Peace Speech](#), American University Commencement Address, Washington, 10 June 1963

⁶ Galbraith JK. [Exit Strategy: In 1963, JFK ordered a complete withdrawal from Vietnam](#), *Boston Review*, 1 September 2003

⁷ In a 2014 interview, President Donald Trump explained that he did not like the phrase *American exceptionalism*, because it offended Vladimir Putin: “Well, I think it’s a very dangerous term in one way, because I heard Putin saying, ‘Who do they think they are, saying they’re exceptional?’ ” Kaczynski A, Meyersohn N. [Trump in 2014: American exceptionalism is a very dangerous term to use](#), *BuzzFeed News*, 26 September 2016

⁸ Kelly K, Playford A, Parlapiano A. [Stock trades reported by nearly a fifth of Congress show possible conflicts](#), *New York Times*, 13 September 2022

⁹ Pool R. Struggling to do science for society, *Science* 248, 672-3, 1990