



# Perspectives of Earth and Space Scientists

## FEATURE ARTICLE

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### Key Points:

- Advice for young scientists: Be open to new experiences. Take advantage of chance meetings with smart people
- Regularly attend the AGU Fall Meeting. Meet new people and ask questions about potential opportunities; often the answer will be, "Yes."
- Become accomplished in what excites you, and then apply your skills and expertise to work on topics that will benefit humanity

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## Making Your Own Luck: A Meaningful Career From Being Open to Opportunities

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**Abstract** The most important work I have done in my career is to warn the world about the dangers of nuclear weapons. While the Soviet-American nuclear arms race has ended, and the 2017 United Nations Treaty on the Prohibition of Nuclear Weapons is on its way to ratification, there is still much more work to do. The smoke from fires ignited by nuclear weapons would block out the Sun, cooling Earth's surface. The United States and Russia can still produce a nuclear winter, killing most crops and producing a global famine. I have worked on this because I have been open to new opportunities, have used my scientific expertise to apply to important problems, and am sensitive to issues that present dangers to society. Having spent more than \$20 million of the public's money on my research, I feel an obligation to warn society of dangers I discover, and focus on that communication as an intimate part of my scientific efforts. And nuclear winter research has been very good to me. It led to meeting Sherri West (my wife), Carl Sagan, and Fidel Castro; to getting my current job at Rutgers; and to being a participant in the International Campaign to Abolish Nuclear Weapons, which won the 2017 Nobel Peace Prize. Taking advantage of chance encounters at the Fall American Geophysical Union Meetings has been an important factor in this tale.

**Plain Language Summary** Based on my career, I have some advice for young scientists. Be open to new experiences. Take advantage of chance meetings with smart people. Regularly attend the AGU Fall Meeting. Ask questions about potential opportunities, and often the answer will be, "Yes." Work on topics that will benefit humanity.

## 1. Introduction

Three years ago I taught a freshman seminar entitled, "Living the Good Life." In that class we discussed the story of an employer who, when interviewing prospective employees, asked them if they were lucky. She would only hire those who answered, "Yes." Since there is no such thing as luck, people who feel lucky are those who are open to new experiences and take advantage of the opportunities they provide. Those are the kind of employees she wanted. As we discussed this tale, I realized that I am one of those. I feel that I have been lucky my whole life. This essay is the story of some of those opportunities and how making the most of them led to a good life and great career. I hope it can serve as a model for my readers.

Some of my luck was not a choice. My parents were intellectuals. My father was a professor of International Business at Indiana University, and then at Columbia University, and my mother earned a master's degree. She subsumed her interests to my father's career, as was done in those days, but later worked on her own for housing rights for minorities. They took me to live in Brazil, at ages 4–6; for the summer in La Paz, Bolivia, at age 13; and on a trip to Europe in the summer when I was 16. So I was endowed with an intellect and a model of curiosity, with liberal values of taking care of others, and with a travel bug. I was born in the United States, which has given me freedom and a great education. I have white skin and did not have to endure racial discrimination. My ancestry is Jewish, but in my lifetime I have not had to deal with religious persecution. So I started with major advantages. Nevertheless, somehow I was also endowed with a personality that led me to take advantage of my opportunities.

## 2. Becoming a Meteorology Major

In ninth grade at Binford Junior High School in Bloomington, Indiana, I signed up for Earth Science. But the school counselor called me in and told me that course was for the poor students and that I should take Biology, which I did and did not enjoy. Fast forward to freshman year at the University of Wisconsin, where in the Integrated Liberal Studies program, I was able to take a course in Earth Science. It was taught by Lyle

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Horn, the Chair of the Meteorology Department, and about a third of the class was meteorology. I'll never forget sitting on the fifth floor of Science Hall, plotting my first weather map. I took the station data from the yellow teletype pages and plotted each one and then analyzed the isobars and fronts. I found a warm front just to the east of Madison, and when I glanced out the window I saw a wedge of clouds on the horizon that was actually that warm front. I quickly realized that meteorology was a science I could study that dealt with phenomena that are observable and relevant to people's lives, not something I would have to imagine in a test tube or in an accelerator. I had always been interested in science and good at math, but now I had found my calling. I was not a "weather wenie" as a child, like many of our undergrad meteorology majors, but because the University of Wisconsin had a Meteorology Department, I was lucky to be able to major in meteorology.

### 3. Vietnam, Tear Gas

I learned some meteorology at Wisconsin, but I also learned not to trust my government. The Vietnam War raged during my entire undergraduate stint. When I graduated and my 2-S student draft deferment was to expire, they wanted me to go to Vietnam and kill people. This was an opportunity I was determined *not* to avail myself of. I was tear-gassed 3 out of my 4 years in Madison protesting the Vietnam War. In my eyes it was clearly immoral to participate in the killing of innocent people. As Voltaire (1771) wrote, "It is forbidden to kill; therefore all murderers are punished unless they kill in large numbers and to the sound of trumpets." Even in that case, my values told me, "I shall die, but that is all that I shall do for Death; I am not on his pay-roll" (Millay, 1934). I was number 8 in the first draft lottery, which meant that as soon as I graduated, I would be drafted into the Army. I could have joined the Navy and sat in Monterrey, California, forecasting the weather for them, but in my eyes, that was the same as pulling the trigger. Graduate school deferments no longer existed.

### 4. Peace Corps

A friend I met at Wisconsin, Bob Mory, had joined the Peace Corps, and the more I learned about it, the more it became my solution. I managed to flunk my draft physical and served for 2 years in the Philippines as a Peace Corps Volunteer, developing curricula and training teachers of meteorology in the fishery vocational colleges. My B.A. in Meteorology and my experience as a student in the U.S. educational system made me an "expert." I contributed much more to my country and my planet doing this than I would have across the South China Sea participating in war. But I was able to take advantage of my U.S. tax money by listening to excellent rock music at night on AM radio from 1,500 km away across the South China Sea, where I heard, "You're listening to Armed Forces Vietnam Radio Network, serving the American fighting man 24 hours a day, with transmitters in Pleiku, Danang, and Quang Tri, and studios in Saigon, South Vietnam."

### 5. Lorenz's Advice

After 2 years of grad school at MIT, my Master's advisor, Norman Phillips, left to go work at the National Oceanic and Atmospheric Administration, so I talked with other faculty members, looking for an advisor and Ph.D. dissertation topic. Edward Lorenz told me, "Climate would be a good field to get into these days." It was brilliant advice, and I was lucky enough to follow it and became his student. I found in my Ph.D. dissertation that increasing CO<sub>2</sub> would affect future climate and published the first transient climate model simulation of the effects of CO<sub>2</sub> on climate (Robock, 1978). What is surprising and exciting to me is how this topic has slowly, and now more rapidly, grown to become a dominant issue for the planet. It is the subject of international negotiations, political campaigns, criminal theft of private emails, and multimillion dollar lobbying and disinformation campaigns by multinational corporations.

### 6. AGU Nuclear Winter Talk

My resume when I earned my Ph.D. was more impressive than I realized at the time. It included phrases like, "Ph.D., MIT," and "advised by Norman Phillips and Edward Lorenz." I'm not as smart as they were, but it opened doors and I got a faculty position at the University of Maryland in 1977, not having done a postdoc. It helped that Helmut Landsberg had just retired, and they were looking for a climate scientist. I continued my climate research, focusing on the impacts of volcanic eruptions, which I had discovered were the most important natural cause of climate change on time scales up to millennia (Robock, 2000).

**Table 1**

Some of My AGU Fall Meeting Encounters That Led to Significant Career Opportunities

Year	Opportunity
1982	Nuclear winter talk, which was canceled
1996	Found out about job opportunity at Rutgers at Editors' dinner
2005	Chance meeting in hall with Brian Toon and Rich Turco
2005	Found out about Paul Crutzen's geoengineering paper
2006	Special nuclear winter session, where Steve Schneider supported our work
2016	Talk with Naomi Oreskes, which led to <i>New York Times</i> op-ed
2019	Nuclear winter poster session, which led to 2020 <i>Nature</i> article

I went to my first Fall AGU Meeting in 1977, where Steve Schneider introduced me to people whose papers I had read, but had never met, like Bob Cess and Jim Coakley. It made science real, that it was done by human beings and not just names on papers, and made me realize that collaborating with others was very important, not just working alone. This was the first of many opportunities that opened up to me at Fall AGU Meetings (Table 1).

In 1982, Crutzen and Birks (1982) pointed out that nuclear war could produce smoke from burning targets, which might cause climate change. Later that year at the AGU Fall Meeting, I noticed a talk that was being given on "Climatic Effects of Nuclear War." This intrigued me, so I went to hear it, but it was canceled. It turns out that some of the authors, Brian Toon, Tom

Ackerman, and Jim Pollack, worked for NASA, and they were told that they could not use the term "nuclear war," as it would cause problems with NASA Headquarters, so they went back, rethought this as they wrote their first paper, and called it "nuclear winter" (Turco et al., 1983). I went to the first conference on nuclear winter, "The World After Nuclear War," held at the Shoreham Hotel in Washington, DC, in November 1983, where the matching U.S. and Russian results were presented, by people including Carl Sagan and Vladimir Aleksandrov, who led the Russian effort, and this inspired me to use the energy-balance climate model I had been using to study the impacts of volcanic eruptions to look at the long-term effects of nuclear war (Robock, 1984).

I am proud to have been part of the team that warned the world of the danger of the use of nuclear weapons. Nuclear winter theory led to a vigorous discussion of the direct effects of the use of nuclear weapons and a realization that the nuclear arms race was crazy and dangerous and that the use of nuclear weapons would be suicide. This led directly to the end of the nuclear arms race, several years before the end of the Soviet Union. Mikhail Gorbachev, then leader of the Soviet Union, described in an interview in 1994 how he felt when he got control of the Soviet nuclear arsenal, "Perhaps there was an emotional side to it .... But it was rectified by my knowledge of the might that had been accumulated. One-thousandth of this might was enough to destroy all living things on earth. And I knew the report on 'nuclear winter'." And in 2000 he said, "Models made by Russian and American scientists showed that a nuclear war would result in a nuclear winter that would be extremely destructive to all life on Earth; the knowledge of that was a great stimulus to us, to people of honor and morality, to act in that situation" (Robock & Toon, 2010). U.S. President Ronald Reagan, who along with Gorbachev ended the nuclear arm race, said in a 1985 interview, "A great many reputable scientists are telling us that such a war could just end up in no victory for anyone because we would wipe out the earth as we know it. And if you think back to a couple of natural calamities—back in the last century, in the 1800's, ... volcanoes—we saw the weather so changed that there was snow in July in many temperate countries. And they called it the year in which there was no summer. Now if one volcano can do that, what are we talking about with the whole nuclear exchange, the nuclear winter that scientists have been talking about? It's possible ..." (Reagan, 1985).

## 7. Not Getting Promoted

It was difficult to get funding for nuclear winter research. For 2 years I had funding from the Defense Nuclear Agency, and I continued climate modeling and studied forest fires as a natural analog. However, when the Defense Department realized that the research their funding supported only strengthened nuclear winter theory, they pulled that support. But I could not not work on it. Talk about speaking truth to power! However, not all scientists felt that way. At the "Symposium on Nuclear Winter: Current Assessment and Implications" at the National Academy of Sciences in Washington in 1985, I had a discussion with Fred Luther, who worked at Lawrence Livermore National Laboratory. He told me that scientists should just do the science and leave it up to policymakers to deal with policy. But I told him that nuclear policymakers spend their careers planning how to use nuclear weapons, and so they would obviously reject our scientific findings, which presented an existential threat to them. If we discover threats to humanity, it is our duty to make sure there is a response. As Sherry Rowland (Nobel Prize in Chemistry awardee with Mario Molina and Paul Crutzen, for his work on ozone depletion) said in an interview in *The New Yorker*, 9 June 1986,

“What’s the use of having developed a science well enough to make predictions if, in the end, all we are willing to do is stand around and wait for them to come true?” In 1997, at the White House he said, “Is it enough for a scientist simply to publish a paper? Isn’t it a responsibility of scientists, if you believe that you have found something that can affect the environment, is not it your responsibility to actually do something about it, enough so that action actually takes place? If not us, who? If not now, when?” (Blake & Simpson, 2012). This philosophy governed me, too, and I continued to write papers not just on the science but on the policy implications of nuclear war.

I was promoted to Associate Professor at the University of Maryland in 1982, and by the mid-1990s, I decided it was time to apply for Full Professor. But my first application, in 1994, was turned down. In my subsequent discussion with the Dean, I asked for some feedback. He said that the letters (which I could not see) said that I had not distinguished myself in a specific area and that I had worked on too many things. Some even said that I had too many papers in *Science* (6) and *Nature* (3), which were too short to lay out substantive work, which I found hilarious and unbelievable. I suspect the real reason was that several of the letter writers agreed with Fred Luther, that my work on nuclear winter was too political, and gave me less than stellar letters. Nevertheless, I could not stop work on nuclear winter, despite lack of funding, and in 2 years was promoted anyway. Later, I found out that Paul Crutzen had written a letter for me, and the next time I saw him I thanked him. He told me that he had actually done it twice, and later I came to the realization that the first time he wrote me a letter, in 1994, he did not have a Nobel Prize, and the second time, in 1996, he did. I’m sure that helped.

## 8. Digression on Soil Moisture

In 1979, I got a call from Larry Gates (Oregon State University) asking if I would like to join a U.S. delegation to attend a Soviet-American Symposium on Climate Modeling, Climate Change and Statistics, in Tbilisi, USSR, in October. I thought about it for a microsecond and said, “Yes.” There I met Konstantin (Kostya) Vinnikov, who impressed me as being one of the best Russian scientists there and a very nice person. He hosted me for a short visit to his home town of Leningrad following the meeting, and as Humphrey Bogart said at the end of Casablanca, this was “the beginning of a beautiful friendship.” In 1989, on a visit to Leningrad, Kostya told me that there was an extensive Soviet data set on soil moisture and that if I could get some money for research, perhaps we could buy him his first personal computer. I said, “OK. But I have one question. What’s soil moisture?” After he explained, I wrote a very quick proposal to the National Oceanic and Atmospheric Administration, which got glowing reviews and was funded, leading to his first PC, my first PC, a collaboration that resulted in 45 journal articles, a lifelong friendship, and his coming to work with me at the University of Maryland in 1993, where he still is. This is another example of the benefits of being open to new opportunities.

## 9. Job at Rutgers

On 10 April 1986, in an elevator on the way to give a talk on nuclear winter at a conference on nuclear war education at the Key Bridge Marriott in Arlington, Virginia, I met a woman, Sherri West, who was teaching a course on “U.S. in the Nuclear Age” at Brookdale Community College in Monmouth County, New Jersey. We fell in love and got married 4 years later, but I was still working at the University of Maryland. I was able to spend a year on sabbatical at the Geophysical Fluid Dynamics Laboratory in New Jersey with Suki Manabe, but it did not result in a job there, and she did a sabbatical in Maryland, but we were stuck with traveling between the two places.

Rich Turco had invited me to be an Associate Editor of *Reviews of Geophysics*, which entitled me to attend the fabulous Editors’ Dinners at the AGU Fall Meetings. At the dinner in 1996, I ran into Roni Avissar, who was a professor at Rutgers University and Editor of *Journal of Geophysical Research–Atmospheres*. I asked him if they had any jobs, and he told me that they actually had permission to hire a full professor, as someone had just recently turned them down. I applied and was hired, something that would never have happened without this chance opportunity, another example of “good luck,” Fall Meeting opportunities, and beneficial side effects of nuclear winter research. I’ve been living happily with Sherri in New Jersey ever since.

## 10. AGU Talk With Turco and Toon

At the 2005 AGU Fall Meeting, I ran into Brian Toon and Rich Turco in the hall. They told me that they had been asked about the consequences of a nuclear war between two new nuclear states, India and Pakistan, and after first thinking it would not amount to significant global impacts, had now estimated that it could produce several million tons of smoke. I asked who was going to calculate the climate impacts. They said they thought I might do it and thus began a 15-year-long, and continuing, collaboration to study the climatic impacts of nuclear war with modern climate models.

Even though we had no funding, we started work on our own and discovered that a nuclear war between India and Pakistan could produce climate change unprecedented in recorded human history, with devastating global impacts on agriculture. We organized a session at the 2006 Fall AGU Meeting and invited Steve Schneider to give a talk. We were nervous, as Steve in the past had claimed erroneously that nuclear fall would be a better description of nuclear winter, but he gave a great talk. He said that after nuclear winter was discovered, the rest of the world realized that a nuclear war between the United States and Russia could devastate them, even if no bombs were dropped there. Now we know that a war on the other side of the Earth, between two new nuclear states, could devastate us.

## 11. Finding Out at AGU About Crutzen's Geoengineering Paper

Also at the 2005 AGU Fall Meeting, people were saying, "Did you hear about the paper that Paul is writing?" It turned out to be a suggestion that we consider stratospheric sulfur geoengineering to reduce global warming (Crutzen, 2006). This opened up another entire field of science to me, which I have also been pursuing since, establishing the Geoengineering Model Intercomparison Project with my former student, Ben Kravitz, and publishing 60 papers so far on the science, ethics, and governance of deliberate climate intervention. And it led to my talk with Claire Zabel, described below, which produced two giant grants to study nuclear winter.

## 12. Meeting Fidel Castro (Twice)

On 23 August 2010, I received an email from my former student Juan Carlos Antuña that the head of the Cuban Weather Service wanted to invite me to Cuba for a meeting. He knew nothing more than that. On 26 August 2010, I received an invitation from Dr. Tomás Gutiérrez, Director General of the Instituto de Meteorología in Cuba, to attend an internal workshop to discuss "environmental consequences of climate change." It turned out that Fidel Castro had become interested in my work on nuclear winter and wanted me to come give a talk he could attend to get out the message of the dangers of nuclear weapons. I did not find out that I would meet the Comandante until an hour before my talk. But the fact that the Cubans would pay all the expenses of my trip gave me a hint that it was important. I also did not know where I would stay until I arrived. I flew to Havana from Toronto. At the José Martí International Airport, I was taken through the VIP lounge and to a van on the tarmac to leave the airport. When I found out on the ride into the city that I would stay at the Hotel Nacional, the nicest hotel in Havana; when five people were lined up to meet me upon arrival, including the hotel manager; and when I was given a two-bedroom, two-bathroom, and one-living room suite on the executive floor and then taken to lunch in their fanciest restaurant, I began to have my suspicions.

The 1-day meeting of about 30 meteorologists to which I was invited was scheduled in the old casino of the Hotel Nacional, but to have enough room and to make it easier for the Comandante, we were taken to the Palacio de Convenciones several miles away. The others went in a bus, but I went in a black Mercedes with Tomás. When I got there, we were taken to a room in which 170 top scientists from Havana were gathered, with many TV cameras set to record the event. Fidel Castro Ruz (the Comandante) came in, and I was introduced to him. Tomás gave an introduction and then I talked for an hour about nuclear winter. Fidel sat at the front and took notes as he watched the presentation. Then Fidel presented me with his signed memoirs. I told Fidel that I had a Cuban student and brought Juan Carlos up to meet him and shake his hand. He was nervous but thrilled. Because the talk was being translated, I had to skip over a number of slides I normally show, but it all went much better than I could have imagined. Then, as the other meteorologists went back to the Hotel Nacional, I went to a private meeting with Fidel and his family, including his wife, his son Fidel Castro Diaz-Balart, and his other son Antonio, who was the medical doctor for the Cuban baseball



**Figure 1.** Signed photo of Fidel Castro Ruz and Alan Robock, 14 September 2010, taken in Havana after my nuclear winter lecture.

team. Then we had a photo taken together (Figure 1). After I left, Fidel wrote extensively about the need to rid the world of nuclear weapons on his regular blog. Needless to say, this was all very surreal. For the complete story of my trip, please visit <http://climate.envsci.rutgers.edu/Cuba/>.

The next year, in December 2011, as part of an American Association for the Advancement of Science delegation on scientific cooperation, I returned to Cuba. I was surprised to get to meet Fidel again. He spent 3.5 hr telling his entire life story, again very surreal, and you can read about it at <http://climate.envsci.rutgers.edu/Cuba2/>. During the meeting I asked him if, on the fiftieth anniversary of the Cuban Missile Crisis the next year, he could convene a meeting in Havana with the foreign ministers of the nine nuclear states, to warn them of the dangers of nuclear war. He said it was a good idea, but unfortunately, the meeting never materialized.

### **13. Publicizing Nuclear Winter**

It has been a struggle to make the world aware of our nuclear winter results. Brian Toon and I submitted an op-ed to the *New York Times* several times, with no response. But then at the 2015 Fall Meeting we ran into Naomi Oreskes and asked her how she got published there. She said, "I know a guy," and gave us the email of the op-ed page Editor. We sent him our article, and it was published in early 2016 (Robock & Toon, 2016). Richard A. Clarke, former National Security Advisor in the White House, read the article and invited me to meet him in New York City to talk about it. A year later, I was Chapter 13 in his book about people warning about catastrophes and not being listened to (Clarke & Eddy, 2017), and in January 2018, I was presented with the first Cassandra Award in a fancy ceremony in New York by R. P. Eddy.

### **14. Talk With Claire Zabel**

Three years ago, Claire Zabel, a program manager for the Open Philanthropy Project, called me up for some advice on a project they were considering funding related to geoengineering. I was only in this position because of my previous work on the topic. After we talked, I asked her if they would consider funding our work on nuclear winter. I told her that no U.S. government agencies would consider a proposal. My colleague, Brian Toon, and I had asked the Defense Department (who have our nuclear arsenal and could use it), the Department of Energy (who makes the nuclear weapons), the Department of Homeland Security (who should be concerned about the effects in the U.S. from the use of nuclear weapons elsewhere), the National Science Foundation, and the intelligence community, and no program managers were willing to consider our proposal. Claire was not familiar with this topic, so she asked for a five-page proposal, which we provided, with what we thought was an audacious \$1.2 million budget for a 3-year project. After a quick review, she asked for a longer proposal she would send out for external review and said that if we needed more money to be sure we got results in 3 years, to ask for more money. We assembled a team to study the topic comprehensively, including establishing scenarios of how nuclear war might be fought between different nuclear states; assessing the fuel loads in cities and industrial areas that would be ignited by nuclear weapons; and modeling how those areas would burn and inject smoke into the upper troposphere, how the smoke would loft into the stratosphere, how the smoke would be lofted by solar heating and be transported around the world, the properties of the smoke, the climate response, the impact on ozone, the agricultural response to the changed climate, and how the world economic system would produce changed prices and availability of food. We asked for \$2.98 million and within a couple months had the grant. I never in my career had had such an experience. We got more money than we originally asked for, and in a record time. This only happened because on the spur of the moment, I asked a program manager for support. And as we just now complete our 3 years, we have produced several papers in high-impact journals, including *Science* and the *Proceedings of the National Academy of Sciences*. Also, there was just a very nice article in *Nature* describing our project, based on reporting by Alex Witze (2020) after she spent time at our poster session on our work at the 2019 Fall AGU Meeting. And we have just been renewed for another 3 years for another \$3 million. For more on this work, please visit <http://climate.envsci.rutgers.edu/nuclear/>.

### **15. Humanitarian Conferences, Treaty on the Prohibition of Nuclear Weapons, Nobel Prize**

Because of my work on the climate and agricultural impacts of nuclear war, I was invited to the International Campaign to Abolish Nuclear Weapons (ICAN) Civil Society Forum and the Conference on the Humanitarian Impact of Nuclear Weapons in Oslo, Norway, in March 2013 and the Second Conference on the Humanitarian Impact of Nuclear Weapons in Nayarit, Mexico in February 2014. Mike Mills presented our work at the Third Conference on the Humanitarian Impact of Nuclear Weapons in Vienna, Austria, in December 2014. More than 100 nations attended these meetings, which led to the United Nations passing the Treaty on the Prohibition of Nuclear Weapons in July 2017. ICAN received the Nobel Peace Prize in December 2017, "for its work to draw attention to the catastrophic humanitarian consequences of any use of nuclear weapons and for its ground-breaking efforts to achieve a treaty-based prohibition on such weapons." I like to think that I had a hand in this Nobel Peace Prize, as I did in the 2007 Intergovernmental Panel on Climate Change Nobel Peace Prize, even though in both cases the award was to the organizations and not to the individuals who did the work.

## 16. Advice to Young Scientists

In my value system, scientists should work hard on topics about which they are curious and publish their work so that all can be able to access the new knowledge. But if you find that your work can be used for what you consider to be evil purposes, then it is your obligation not to do the work. If you find dangers to society as a result of your work, it is your obligation to warn society of them. If you find positive contributions you can make from your work, it is good to work on those aspects. For our individual careers we have to publish in peer-reviewed literature. But for the good of the planet, we also have to inform the general public.

Subjectivity cannot be removed from science. To start with, we make subjective judgments about what research to undertake. We make subjective decisions about stopping certain lines of research. And we make subjective choices about how much time to spend on our work and on how to divide our work time on research, teaching, administration, and public outreach. Both scientific culture and different national cultures affect how we behave and how scientific research programs are organized and funded. My feeling is that large organized projects such as those that develop satellite and other observing programs or general circulation modeling centers, with models, computers, and technical support, are crucial to science, but they also need to be combined with curiosity-based work by individual investigators and small groups. Instinct is important to recognize new concepts when analyzing data and model outputs. I am always inspired when I think of Ed Lorenz recognizing chaos when he got diverging results after repeating a calculation started with slightly different initial conditions.

Pay attention to the ideas of really smart people you encounter. I have been lucky to have spent time with Edward Lorenz, Steve Schneider, Paul Crutzen, Carl Sagan, and Dan Ellsberg. Lorenz pointed me to a life as a climate scientist. He was a hands-off advisor but gave excellent advice when I asked for it. Unlike many others at MIT, he was a gentleman and a model of treating others with respect. Lorenz introduced me to Steve Schneider when I was a graduate student, and Steve invited me out to the National Center for Atmospheric Research during my first summer as an Assistant Professor at Maryland, where I met Vladimir Aleksandrov, who was spending 6 months there. Later, I collaborated with him on nuclear winter. Paul Crutzen established two areas of research, nuclear winter and geoengineering, which have been the focus of most of my research for the past two decades. His Nobel Prize was in Chemistry, for helping to understand ozone depletion, but I think he should have also gotten a Nobel Peace Prize for his nuclear winter work. I met Carl Sagan through my nuclear winter work. He and Steve Schneider were charismatic science communicators, and they really inspired me. Anyone who has not heard them talk should immediately listen to some of their presentations on YouTube. Daniel Ellsberg found out about my nuclear winter work and included it in his recent book, *The Doomsday Machine* (Ellsberg, 2017). He came to the kickoff meeting of our current nuclear winter project and was very helpful in discussing nuclear war scenarios, which is his expertise, and sets a moral example of telling truth to power.

I would recommend that students not go into an interdisciplinary degree program. To work in an interdisciplinary or multidisciplinary or transdisciplinary field, first you need to have a discipline. Certainly, progress in science depends on various members of a team contributing their own expertise, but each person needs to be an expert in a field. If a person becomes spread too thin at the beginning, they will not learn as well how to be a scientist. Only after becoming a scientist in a discipline can they contribute to an interdisciplinary team. I would tell students to go deep into a narrow area; learn how to be a scientist; learn various techniques, such as data analysis, instrumental design, making observations, and modeling; learn how to write papers and proposals; and most importantly learn how to ask scientific questions. Once you are a scientist, you will then have the tools to take advantage of opportunities that present themselves and chart a new path to discoveries and service to humanity.

## References

- Blake, D. R., & Simpson, I. J. (2012). F. Sherwood "Sherry" Rowland (1927–2012). *Eos*, 93(41), 403. <https://doi.org/10.1029/2012EO410005>
- Clarke, R. A., & Eddy, R. P. (2017). *Warnings: Finding Cassandras to stop catastrophes* (p. 405). New York: HarperCollins.
- Crutzen, P. (2006). Albedo enhancement by stratospheric sulfur injections: A contribution to solve a policy dilemma? *Climatic Change*, 77, 211–219.
- Crutzen, P. J., & Birks, J. W. (1982). The atmosphere after a nuclear war: Twilight at noon. *Ambio*, 11, 114–125.
- Ellsberg, D. (2017). *The Doomsday Machine: Confessions of a Nuclear War Planner* (p. 421). New York: Bloomsbury.
- Millay, E. S. V. (1934). Conscientious objector. In *Wine From These Grapes* (p. 47–48). New York: Harper & Brothers.

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- Reagan, R. (1985, February 12). Transcript of interview with President on a range of issues. *The New York Times*. Retrieved from <https://www.nytimes.com/1985/02/12/world/transcript-of-interview-with-president-on-a-range-of-issues.html>
- Robock, A. (1978). Internally and externally caused climate change. *Journal of the Atmospheric Sciences*, 35, 1,111–1,122.
- Robock, A. (1984). Snow and ice feedbacks prolong effects of nuclear winter. *Nature*, 310, 667–670.
- Robock, A. (2000). Volcanic eruptions and climate. *Reviews of Geophysics*, 38(2), 191–219. <https://doi.org/10.1029/1998RG000054>
- Robock, A., & Toon, O. B. (2010). Local nuclear war, global suffering. *Scientific American*, 302(1), 74–81. <https://doi.org/10.1038/scientificamerican0110-74>
- Robock, A., & Toon, O. B. (2016, February 11). Let's end the peril of a nuclear winter, Op-ed, *The New York Times*. Retrieved from <https://www.nytimes.com/2016/02/11/opinion/lets-end-the-peril-of-a-nuclear-winter.html>
- Turco, R. P., Toon, O. B., Ackerman, T. P., Pollack, J. B., & Sagan, C. (1983). Nuclear Winter: Global consequences of multiple nuclear explosions. *Science*, 222(4630), 1,283–1,292. <https://doi.org/10.1126/science.222.4630.1283>
- Voltaire (1771). Rights, in *A philosophical dictionary in ten volumes*, Vol. IX.
- Witze, A. (2020). How a small nuclear war would transform the entire planet. *Nature*, 579, 485–487. <https://doi.org/10.1038/d41586-020-00794-y>