Oral History of

Richard C. J. Somerville

Interview conducted by Laura Harkewicz

16 October 2006

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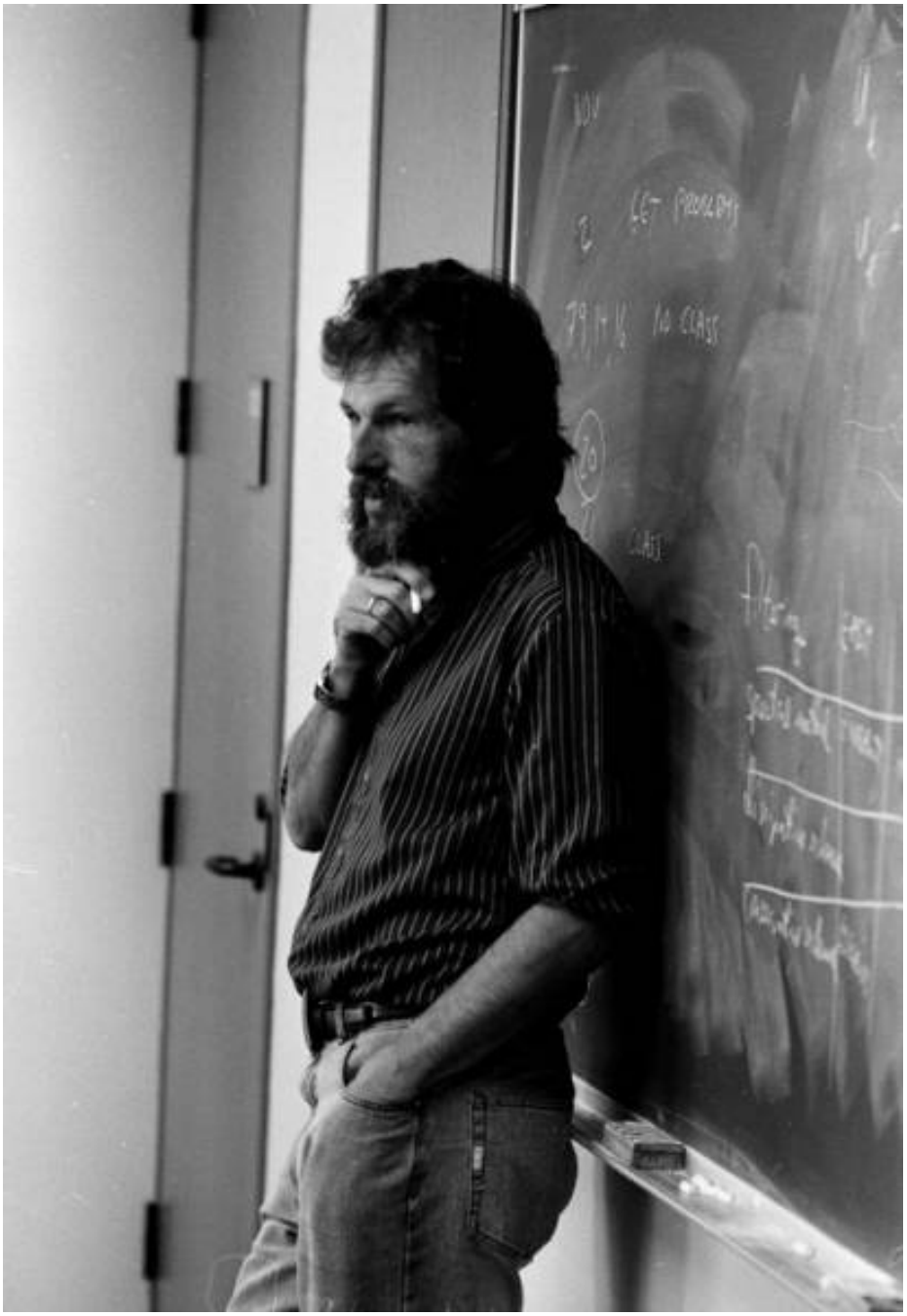
ABSTRACT:

Richard Chapin James Somerville was interviewed in his office in Nierenberg Hall, located on the campus of Scripps Institution of Oceanography in La Jolla, California on October 16, 2006. Somerville was born in Washington, D.C. on May 30, 1941. He received his B.S. in meteorology from the Pennsylvania State University in 1961 and his Ph.D. in meteorology from New York University (NYU) in 1966. He held postdoctoral appointments at the National Center for Atmospheric Research in Boulder, Colorado in 1966-1967 and at the NOAA Geophysical Fluid Dynamics Laboratory in Washington, D.C. and Princeton, New Jersey in 1967-1969. He served as a research scientist at the Courant Institute of Mathematical Sciences at NYU from 1969-1972. He worked in New York City for NASA at the Goddard Institute for Space Studies from 1971-1974 and as a scientist at the National Center for Atmospheric Research in Boulder, Colorado from 1974-1979. He has been a professor of meteorology in the Climate Research Division (formerly called the Climate Research Group) at Scripps Institution of Oceanography, UC San Diego since 1979. In addition to his work as a researcher, he is active in outreach and science education. He authored a critically-acclaimed and award-winning book on climate change directed at the general public: *The Forgiving Air: Understanding Environmental Change* and has been interviewed frequently on climate and environmental issues for the print and broadcast media. He is currently Coordinating Lead Author in Working Group I for the Fourth Report of the Intergovernmental Panel on Climate Change (see http://www.ipcc.ch for more information). His current research analyzes the role of clouds, cloud-radiation interaction, and cloud feedbacks in climate. The primary focus of this research is testing and improving the ways computer simulations of the global climate represent the effects of clouds through research involving measurements from field observational programs together with single-column models and other theoretical tools. The interview stressed Somerville's experiences at Scripps, especially those related to his interactions with other Scripps scientists working in climate research; in particular Jerome Namias and Charles David Keeling. We also discussed at length his outreach and education activities and their potential impact on public policy. In addition, we discussed his opinions and experiences with the highly politicized climate change debates.

INTERVIEW HISTORY: The interview took place on a clear fall afternoon in the office of Dr. Richard Somerville on October 16, 2006. Somerville's office is located in Nierenberg Hall at Scripps Institution of Oceanography in La Jolla, California. His office has a wonderful unobstructed view of the Pacific Ocean. The interview lasted for approximately two hours. We spoke without interruption. There was persistent construction noise in the background throughout our discussion.

Laura Harkewicz
Oral Historian, Scripps Institution of Oceanography, UC San Diego
May 14, 2007



Richard Somerville teaching class, 1989
Scripps Institution of Oceanography Archives, UC San Diego

INTERVIEW WITH RICHARD SOMERVILLE: 16 OCTOBER 2006

Harkewicz: This is Laura Harkewicz. I'm in the office of Dr. Richard Somerville, and it is October 16, 2006. Good afternoon, Dr. Somerville.

Somerville: Good afternoon, and this is a sound check just to see how the microphone picks me up.

Harkewicz: Correct. Again, thank you, Dr. Somerville for taking time to speak with me today.

Somerville: It's a pleasure. I'm looking forward to seeing the transcript and finding out what I've said.

Harkewicz: Okay. Well, the first thing I like to ask people is how they got involved in oceanography?

Somerville: Well, I'm a meteorologist. My degree's in meteorology, so I'm an atmospheric scientist. And I never expected to work at an oceanographic institution, but as you know the famous definition at Scripps is Revelle's: "Oceanography is what is done at Scripps." So in that sense I'm an oceanographer now. And I got involved because my interests became longer and longer in timescale, more away from weather and toward climate, at the same time that Scripps had made a decision to invest in climate as a new area of research. This was the late 1970s.

Harkewicz: So that sort of goes with my next two questions which I will ask you anyways—maybe you can tie the two together—about how you came to Scripps and how Scripps got involved in climate science?

Somerville: They are very closely related. Scripps got involved in climate science, at least in the modern era—there were abortive starts in the early history of Scripps—but in the modern era, Scripps got involved in what we would today call climate, certainly the atmospheric side of climate, because of one person whose name was Jerome Namias.[1] And, Namias was a legendary figure in twentieth century meteorology, and he became the head of the part of the Weather Service, formerly the Weather Bureau, that was in charge of long-range forecasts. And long-range, at that stage, meant seasonal forecasts. And Namias gradually moved to Scripps, you might say. He retired more than once. And he came to Scripps and in fact published more papers, after he had retired from his Weather Bureau career, while he was here, than he had before. And in the sixties and seventies he set up a small group at Scripps, in which he was very much the intellectual leader, that came to be known as the "Climate Research Group." And it included, among people who

[1] Jerome Namias (1910-1997), was trained as a meteorologist by Carl Gustaf Rossby at MIT and worked at the U.S. Weather Bureau for many years. He first came to Scripps in 1957 to participate in the Rancho Santa Fe Conference and eventually retired from the Weather Bureau and worked full time at Scripps.

are still here, Tim Barnett, John Roads, and Dan Cayan.[2] And Scripps actually advertised in the late 1970s for somebody to head up the development of a climate research program here. And someone put my name forward and there was a regular formal search, and that's how I got to be here. It was very much an outgrowth of Namias' program. Although what we all do now is very different from what Namias was focused on.

Harkewicz: But you had been at Woods Hole previously, hadn't you?

Somerville: No. I had only spent a few summers at Woods Hole. My field had been large-scale numerical modeling of the atmosphere, largely for weather forecasting and climate simulation purposes. And so my brief history is my Ph.D. was from NYU in '66, which at the time had a combined meteorology/oceanography graduate program. But I was very much on the meteorology side of it. My undergraduate degree's in meteorology from Penn State. And then, after that, in several postdocs and a couple of permanent positions, I moved from New York to the National Center for Atmospheric Research in Boulder, then to the NOAA[3] Geophysical Fluid Dynamics Laboratory, which was moved during the time I was there, from Washington, DC to Princeton. And then, at New York University in the Mathematics Department, which is called the Courant Institute of Mathematical Sciences. Then again, in New York City at the Goddard Institute for Space Studies, which was then, and still is today, a major modeling center. It's a NASA[4] center. And finally, back to NCAR, the National Center for Atmospheric Research in Boulder. So, that would all have been between 1966 when I finished my Ph.D. and 1974 when I moved from New York to Boulder. And I was there at NCAR when Scripps recruited me in '78 and '79, and I accepted the Scripps position in '79.

Harkewicz: So, what does that suggest, that you did all that moving around in that short time period, and you've been here since 1979?

Somerville: That's a very interesting question. All of those places that I mentioned, with the exception of the Courant Institute, the Math Department at NYU, are either government laboratories, NOAA or NASA laboratories, or they're federally funded research centers. NCAR, where I was twice, as a postdoc and as a staff member, in Boulder, is a federally funded research center. It gets most of its money from the National Science Foundation. And so this may seem unrealistic in today's world, but when I came to Scripps in 1979 as a full professor I had never written a proposal in my life. I didn't know what proposals were. I didn't know how funding worked. The places I'd been at were all block funded. Somebody paid my salary. Somebody installed the supercomputer in the

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[2] Tim Palmer Barnett (1938-), principal scientist and co-originator of the first U.S. Experimental Climate Forecaster Center at Scripps; Daniel Richard Cayan (1949-), researcher in the Climate Research Division at Scripps; John Owen Roads (1950-2008), research meteorologist at the Scripps Experimental Climate Forecast Center.
[3] National Oceanographic and Atmospheric Administration.
[4] National Aeronautics and Space Administration.

basement. Somebody provided a programmer, and so on. And I had done a lot of college teaching. I'd done university teaching as an adjunct professor at NYU and Columbia, while I was in New York at Goddard, but I didn't realize until I got here that I'm one of those people that are just happiest being an academic, being a professor at a university. It's different. It's not better or worse. It's chocolate and vanilla. And, in my case, I discovered, after I got here, that I liked chocolate. I liked the university life and Scripps is very much a university department, despite its size and complexity. And so I've been blissfully content from a professional point of view for twenty-seven years here.

Harkewicz: That's great. So we talked about how you came here and the climate science, and I was wondering—there's a lot of questions about what Scripps should and should not do, so to speak—do you think climate science is appropriate for an oceanographic institution?

Somerville: I think it all depends. Woods Hole[5] has made the opposite choice, and Scripps and Woods Hole like to compare themselves with one another. At Woods Hole there is essentially no atmospheric science. Whereas at Scripps, it's heresy to say it, but if you were to rename Scripps today with a clean sheet of paper and no sense of history or tradition, you'd call it "Scripps Institution of Earth Sciences." Because what goes on at Scripps pretty much spans the full spectrum of the earth sciences. And for some of the people who are here, like myself, I'm here because the longer the timescale of interest, the more the atmosphere and the ocean interact, and climate is very much a phenomenon that you can't disentangle, and the boundary between the atmosphere and the ocean is somewhat artificial. But there are parts of Scripps, and I'm thinking, for example, of solid-earth geophysics, the part that gave rise to a lot of brilliant theoretical developments, for example, that are only marginally or by a stretch of the imagination oceanographic in nature. This really is an earth science department. And I think that's been the history of Scripps.

You know, Scripps started out, as everyone knows, as a kind of summer marine biology place, and therefore every single discipline that was added was added one at a time afterwards. Nobody set out with a grand vision about what Scripps was going to be that in any way resembles what it has become today. And I think in many cases those things were added with a certain amount of controversy and with different opinions strongly held. And that was true when Scripps moved heavily into atmospheric science, too. There were people who said at the time, "Well, this is an oceanographic institution. We've got that in the name. Why are we hiring a bunch of atmospheric scientists?" for example. And yet, personally, I'm convinced it was the right decision to make for a place of the size and ambitions of Scripps, and that it's the very fact that we do have such a broad representation of earth sciences here that has facilitated the interdisciplinary work that everyone agrees is some of the most important work. Certainly that's true in climate.

[5] Woods Hole Oceanographic Institution (WHOI), located in Woods Hole, Massachusetts.

Harkewicz: Okay. Now earlier you mentioned Jerome Namias and I was wondering if you had had any experiences that you could share with us about him?

Somerville: I knew Namias very well. I knew him before I came to Scripps. He was a legendary figure in his own time. Namias was a synoptic meteorologist of the old school. He was not especially mathematical. His mathematical toolkit was very limited, but he had an uncanny feeling for weather data. And in the same way, I've often made the analogy, that a chess grandmaster can look at complicated position on the board and intuit that the important part of the position, the important theme is over here in this corner of the board. Namias could look at a weather map or another depiction of meteorological data with that same kind of physical insight. And also like a chess master he couldn't tell you how he did it, and he couldn't teach other people to do it. But nonetheless it was inspirational. And furthermore he was a very cultivated person. He had been in many of the places in the twentieth century where meteorology made important breakthroughs, if you like, or where important events occurred. He was at the Weather Bureau long before the Second World War when the so-called Bergen School, the Norwegian School of Meteorology, became established there.[6] He was at Princeton in the late forties when numerical weather prediction, the use of computers to make forecasts, was established, and so on. He knew everybody. And although he couldn't teach you how to do his particular brand of subjective long-range forecasting, which was largely based on physical intuition and some simple statistics and rules of thumb, he couldn't very well establish a school, so to speak, of students of his who could do that. Nonetheless he was a great pleasure to listen to about every other aspect of meteorology. He was extraordinarily articulate. He had a strong sense of history, but his passion was making these seasonal forecasts. He was competitive about it. He liked to prove that his forecasts were better than other people's forecasts. For many years there was a kind of press conference held here, around the first of December, when he would give his forecast for December, January, and February. And he was an extremely engaging guy, a very, very nice human being. I had hoped he would write a history of meteorology—a scientific history, not just anecdotes—but he didn't. He was felled by a stroke, which incapacitated him and he remained incapacitated until his death, and it's a great pity. But I have very fond memories of him.

Harkewicz: Did he have any influence on your career?

Somerville: Yes, I think so, in an indirect way. I always thought of his ability to, you might say, pull forecasts out of a collection of weather data as a sort of, what

[6] The seeds for many current ideas concerning extratropical cyclones were sown between 1912 and 1930 by a group of Scandinavian meteorologists working in Bergen, Norway. This so-called Bergen school, founded by Norwegian meteorologist and physicist Vilhelm Bjerknes (1862-1951), formulated a model for a cyclone that forms as a disturbance along a zone of strong temperature contrasts known as a front, which in turn constitutes a boundary between two contrasting air masses. For a history of the Bergen school, see Robert Marc Friedman, *Appropriating the Weather: Vilhelm Bjerknes and the Construction of a Modern Meteorology* (Ithaca: Cornell University Press, 1989).

mathematicians call "an existence proof." That is, he couldn't tell you how to do it, but, because he could do it, you knew it was doable. And again, I think there are chess metaphors there. One of the great challenges in the early days of artificial intelligence was to make computer programs that could play chess skillfully. And that's now succeeded. So for fifty bucks you can buy a program that does as well as a grand master and can beat the world champion when he's having a bad day. And so I thought that if Namias could make forecasts on subjective grounds, this so-called synoptic reasoning, basically intuiting the important features of a large disparate collection of weather data, then that means it's doable. The atmosphere is predictable on those space and time scales and therefore it ought to be possible to do that by something that is more mathematical, more theoretical, more objective if you like, or more scientific. So, he was kind of a trail blazer and proved that it's possible to do it.

On the other hand, our work was very different. And furthermore, to get ahead of the story a little bit, the development of what was then the Climate Research Group, which evolved into what today is the Climate Research Division, and many other related aspects of science at Scripps were a great departure from what Namias had done. He was very much focused and the efforts of the group at that time were very much focused—we're talking about the 1970s—on making these synoptic forecasts, these seasonal predictions. And so for example, Tim Barnett, who as I said was here at the time, made similar forecasts, but by statistical methods, rather than by the subjective, what I'm calling "synoptic," (which is a technical term in meteorology) methods. And so, there was a kind of rivalry there as to which was best. And, nobody here makes those kinds of forecasts anymore.

Harkewicz: The kinds that Namias made?

Somerville: Yes. The Weather Bureau—sorry—the Weather Service, the National Weather Service of NOAA, makes them operationally and many of the methods that they use were, in fact, evolved here by people like Barnett. And so he had an influence on the development, but if you go and survey what we are doing here today, what all the atmospheric scientists, and the oceanographers, and geologists, and others who work with us are doing, it is far away from what Namias did.

Harkewicz: Okay. What about Charles David Keeling?[7] How did he fit into this whole scenario?

Somerville: Well, I think the fact that Dave Keeling had spent his whole career at Scripps—I knew him very well for about the last twenty-five years of his life—was an inspiration to everyone. And you have to remember that there's been a gradual dawning on the whole scientific community, at Scripps, but also nationally and globally, of the importance of the anthropogenic or human-caused climate change issue. And it was Keeling's Mauna Loa data on atmospheric carbon dioxide concentrations that is the iconic figure, the most famous graph in earth science, I

[7] Charles David Keeling (1928 – 2005), Scripps geochemist.

suppose, that underlies all this. Every piece of work having to do with global warming tacitly or explicitly references that graph. And so I spent a lot of time talking to Dave Keeling. We worked together briefly. We wrote proposals together, and so on. But he also was a great pleasure to talk to. I'm not a chemist. He's very much a chemist. But I think the fact that you might say the whole subject began at Scripps, because it was Keeling's data, and Keeling spent his whole career at Scripps, although the data of course came from Mauna Loa, but that's for technical reasons, you might say. And so it certainly influenced me and was part of the long and gradual process of turning my own research focus towards climate change issues.

Harkewicz: So you said, I think, that when you came here they were sort of changing over to different kinds of thinking here at Scripps and that's how you got recruited?

Somerville: Well, that's right. If you go back and read what the pioneers, Revelle[8] in the days in the fifties when he was director of Scripps, for example, when he recruited Keeling to Scripps and helped Keeling set up his measurements, if you read what Revelle and others at that time said, there was no hint, no sense that there was something potentially very serious or even catastrophic about climate change. And there's a famous phrase in the paper by Revelle and Suess from that era along the lines of, "Mankind is doing an inadvertent and irreproducible geophysical experiment."[9] And so the tone there, the mental attitude that Revelle, who was deeply insightful in earth science, a titan of the field at that time, what he was thinking was, "Isn't it nice that Mother Nature is doing this experiment? Humans are putting CO_2 in the atmosphere and we scientists are going to see how the system responds to this extra burden of atmospheric CO_2." It's as though a volcano had gone off and you could study what volcanoes do to the climate. Or a tsunami had occurred and you could study how tsunamis propagate. And there wasn't at all the sense that you have today of great seriousness and even alarm that this process, if left unchecked, will have extremely serious consequences for the planet. That was a gradual dawning. By no means only at Scripps, but everywhere. And people very slowly began to realize the implications. It's a wonderful subject for a historian of science to go back and study the lecture notes, and so on, of how people spoke about that and how that attitude toward the global warming issue, what we now call the global warming issue, evolved over what is really half a century.[10] I think there are parallels, by the way. I think smoking and health offers interesting parallels to that. There were papers in the 1930s suggesting that cigarette smoking was bad for you and the scientific evidence was pretty solid in the sixties, but the high profile lawsuits, and so on, in the US didn't

[8] Roger Randall Dougan Revelle (1909-1991), Scripps director 1951-1964.

[9] Roger Revelle and Hans E. Suess [(1909-1993), professor of chemistry at UC San Diego and Scripps], "Carbon Dioxide Exchange Between Atmosphere and Ocean and the Question of an Increase of Atmospheric CO_2 during the Past Decades" *Tellus* 9: 18- 27 (1957). The quotation that Somerville cites states, "Thus human beings are now carrying out a large scale geophysical experiment of a kind that could not have happened in the past nor be reproduced in the future."

[10] For example see, Spencer R. Weart, *The Discovery of Global Warming*. (Cambridge, MA: Harvard University Press, 2003).

occur until the 1990s. And so it took a long time for this to permeate into the consciousness both of the medical community and the public.[11]

Harkewicz: Do you want to venture a guess as to why that might have been?

Somerville: Oh, I think it's a lot of things. In both cases there were active, and in climate there still are, active disinformation campaigns trying to sow the seeds of doubt and trying to create the impression of scientific controversy. A lot of climate science on this topic is today considered settled by the expert community. There are obviously research issues that are still there. There always are in any active field of science. But the big picture has been known for quite some time, and there's not a great deal of serious dispute amongst experts. Nevertheless, you find in the mass media perhaps a tendency to bend over backwards and to be fair and to hear both sides of the issue. This is a subject in which, for many parts of it, there isn't another side. There's settled science. You know, you don't start an AIDS story off with the fringe person who thinks that HIV is unrelated to AIDS, although there are such people. And that's true in general. I think that's changing now in the mass media in this country. But that was certainly a factor, the fact that there were powerful interests opposed to scientific clarity.

And then, quite frankly, this is a tricky, complicated, technical issue and we know from many polls that the public is concerned about climate change, but we also know that this concern is very broad and is not accompanied by any depth of understanding, that the great public is not well informed about what global warming is, what the "greenhouse effect" is, what the consequences are, how you do something about it. There's a lot of confusion between the ozone hole and the greenhouse effect. And I think, to be blunt about it, that part of this is a scientific issue, a scientific literacy issue, that people just are not used to thinking about technical subjects. They're not educated for it. They don't think in those terms. And that's by no means a criticism of the US. Polling data are exactly the same in Western Europe, for example.

Harkewicz: Now, I want to talk to you a little bit about that more, but before we get ahead to the public and science, and policy, and things like that, I wanted to ask you a little bit about your experiences at Scripps with administrators or colleagues and what kind of support you got from them, or if you ever had tension with them about

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[11] For scholarly work on the production of scientific disinformation and the health effects of tobacco use, see: Robert N. Proctor, *Cancer Wars: How Politics Shapes What We Know and Don't Know About Cancer* (New York: Basic Books, 1995); Robert N. Proctor, "Commentary: 'Everyone Knew But No One Had Proof': Tobacco Industry Use of Medical History Expertise in U. S. Courts, 1920-2002," *Tobacco Control* 15 (Supplement IV): iv117 – iv125 (2006); and Stanton A. Glantz, John Slade, Lisa A. Bero, Peter Hanauer, and Deborah E. Barnes, eds., *The Cigarette Papers* (Berkeley: University of California Press, 1996). For information about connections between the denial of climate change and the denial of scientific evidence that smoking tobacco causes cancer—including the fact that some of the same individuals have been responsible for both—see: Naomi Oreskes and Erik Conway, "Deny, Deny, Deny: How to Sow Confusion over Climate Change (or How Climate Science Became a Victim of the Cold War)" in Robert Proctor and Londa Schiebinger, eds., *Agnotology: The Making and Unmaking of Ignorance* (Stanford: Stanford University Press, 2008).

some of these issues that you felt on one side and they felt on the other, or something to that extent?

Somerville: Well, I'm not going to give you a catalog of all the Scripps, or UCSD, administrators and rate them on a scale of one to ten.

Harkewicz: That's fine.

Somerville: But, it's certainly true that Bill Nierenberg[12] felt strongly that Scripps ought to be doing climate, where climate included having atmospheric scientists like myself here. I was the first atmospheric science professor hired here. Namias and the other people I mentioned were members of the research staff. And so Nierenberg was, as everybody who met him knows, a very forceful person. It was his decision to commit the resources to a faculty position, for example. Nierenberg, on the other hand, was also very conservative in many ways and he was dubious himself, heavily skeptical, about the importance of the man-made increase in the greenhouse effect, and many other issues, too. But he definitely gets credit for having made the decision. Nierenberg, and I talked to him many times about this, basically thought there were only a certain number of reasons, besides intellectual curiosity, why it was important to study physical oceanography. It was important to anti-submarine warfare. It's important to fisheries. You can name a few other things. He thought one of those was climate, and he thought that if a place like Scripps was going to continue to have, as it clearly should and has, a very strong presence in physical oceanography, then one of the driving forces for that, and one, if you like, of the applications or motivations of it, ought to be climate or air-sea interactions broadly defined.

I think, in general, as I've said, this was a field that was added, as many other disciplines had been in the history of Scripps, to an existing institution. And, as I said, I've been blissfully happy here professionally over all, but I think that one way to characterize a place like Scripps is that, after all, there are many strong personalities here, and yet the place runs in a pretty much harmonious way, and there are reasons for that. One is that nearly all of us care deeply about the institution, and that's why the whole faculty turn out to vote on an assistant professor, no matter what the specialty is. We love the place, and we feel a collective responsibility toward it. That sounds, I suppose, corny when I put it in those terms but it's very real. So people take that seriously. But the other thing is that a lot of Scripps is not "zero sum" in the sense that if I write a proposal to Washington and get a $100,000, it doesn't diminish the chances of my colleague down the hall in another discipline getting his or her proposal funded, because Washington, in that sense, is a sort of infinite source of money, and my $100,000 doesn't much diminish the total pot that everyone else is proposing to. And that's true for a lot of things, but it's not true for some things that are "zero sum." There

[12] William Aaron Nierenberg (1919- 2000), SIO director 1965-1986.

are some things that are just limited here in quantity. And so if you get some of them, it does reduce your neighbor's or colleague's chance to get them.

And three of those that are important are space, graduate students, and faculty positions. The number of faculty positions at Scripps is fixed. It changes on rare occasions, but, for practical purposes, it's fixed, so you can't appoint a professor until one retires, if you're the director. And as soon as a vacant professorship turns up, you'll be lobbied heavily by people who say why their field is so important that you ought to assign that professorship to it. And one of the things that Scripps directors can do, and it has an important consequence, is to decide which fields to assign those FTEs, as we call them, to. Full-time Equivalent positions. Space is the same way. Once you've taken up an office or a lab, it's not available for anybody else. And graduate students are the same way, too. So if a graduate student comes here and enrolls in physical oceanography and then decides two years down the road that she'd like to do a thesis with me in meteorology, a physical oceanographer who might have fancied himself her better advisor is not going to be happy. So there's been a certain amount of that. And it's probably affected atmospheric science more than some of the more established fields, because we started from zero.

So, as I said, Nierenberg created a professorship for me. Basically, I negotiated it. I said, "I won't come as a research staff member." And he said, "I don't blame you," and he made a professorship. Namias, on the other hand, never wanted to be a professor. Namias was single-minded. He didn't like to teach, so he never taught. He didn't like to write proposals, so he got other people to do them for him. He didn't want to learn to drive, so he found people to drive him around. Whereas I did want to be a professor, for many reasons. And then it was about ten years before we appointed our second atmospheric science professor, and that was Ramanathan.[13] And then others have been added since, one at a time. And so that took time, essentially prying the resources loose from a system in which it's natural to compete. It's not because physical oceanographers, or anybody else, are evil. It's natural that we compete, we compete for those things. And so there is that underlying tension here. The default is just to replace the person who retired, but if you did that we would still be studying the things we were studying seventy years ago.

Harkewicz: I see. So, how do you suppose they make those kind of decisions? Is there some kind of justification by what you've done in the past, at what you can do in the future?

Somerville: I think that in recent years there's been a rather more formal advisory process, and so the director seeks advice. And, there's strong input from many sources. But essentially, collectively, we have to decide what direction we want Scripps to move into. And, you'll hear this from everybody who had a hand in building

[13] Veerabhadran Ramanthan (1944 -), Alderson professor of oceanographic sciences as well as director, Center for Atmospheric Sciences, and director of the Center for Clouds, Chemistry, and Climate at Scripps.

Scripps. Walter Munk[14] has told me how, when IGPP[15] started, Revelle assigned him a smallish number of FTEs. Walter filled them with people who have turned out to be wonderful. That's an oversimplification, of course, but something like that has been the case. On the other hand, there are areas where you're not constrained by "zero sum," so that some of the people we've hired have been very good at building up groups without the need for many, or any, faculty FTEs. So, if you bring in lots of grants, and you hire lots of research staff members, lots of postdocs, lots of visitors, that's also a possible route. And that has very much happened here—I'm thinking of things like C4, the Center for Clouds, Chemistry, and Climate that Ramanathan started as an NSF[16] Science and Technology Center, and many good things came from that. Also, when you hire prominent people, people come here because they're here. So Crutzen and Molina, both part-time faculty members at Scripps with joint appointments elsewhere, have been, because of their Nobel Prize halos, you might say, have also been magnets for people.[17]

In some cases, it's not fair to say that it was planned, because it was quite inadvertent. I've been told by people whom I respect that we might have the best atmospheric chemistry program in the world, with the people I've mentioned, plus younger atmospheric chemists, like Thiemens, and Prather, and Russell.[18] We never set out, I can promise you that, we never sat down around a table one day and said, "Let's build the best atmospheric chemistry program in the world." But, as positions became available, both at Scripps and in the Chemistry and Biochemistry Department on the main campus, sometimes the very best people who floated to the top of searches, although the searches were more general, turned out to be interested in atmospheric chemistry, and in the aspects of atmospheric chemistry that are important to climate. So, overall it's been a piecemeal uneven process. We'll see how long it lasts, by the way. This is a retrospective, but you have to look ahead. A lot of the people I've talked about are at or near retirement age and we'll see what happens.

Harkewicz: Well, you mentioned how someone who brings in a lot of grants is able to sort of run their own show, so to speak, but what kind of funding sources have you gotten in the past?

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[14] Walter Heinrich Munk (1917-), physical oceanographer and professor of geophysics at Scripps.
[15] Institute of Geophysics and Planetary Physics.
[16] National Science Foundation.
[17] Paul Jozef Crutzen (1933-), professor at the Scripps Center for Atmospheric Sciences; Mario Jose Molina (1943-), professor of chemistry and biochemistry at UC San Diego and at the Scripps Center for Atmospheric Sciences. In 1995, Crutzen and Molina won the Nobel Prize in Chemistry—along with Frank Sherwood Roland (1927-), professor of chemistry at the University of California, Irvine—for "their work in atmospheric chemistry, particularly concerning the formation and decomposition of ozone," (http://nobelprize.org/nobel_prizes/chemistry/laureates/1995/ , accessed 8/13/2008).
[18] Mark H. Thiemens (1950-), professor, Department of Chemistry, UC San Diego, chairman of the Department of Chemistry and Biochemistry at UC San Diego, and director of the Center for Environmental Training and Research at UC San Diego; Kimberly A. Prather, professor of chemistry and biochemistry at UC San Diego; Lynn M. Russell (1969-), professor of atmospheric chemistry at Scripps Center for Atmospheric Sciences.

Somerville: I'm a middle-sized grant person, because I'm a theorist. I'm a heavy user of observational data for computer models and for theory, but I don't actually build instruments or go into the field and make the measurements. I participate in programs where other people do that, and my graduate students have often gone into the field. But for someone like me, the only grant support I need, since my own salary is paid by the university, is to pay the people who work with me, programmers, postdoctoral fellows, graduate students, secretaries, technicians, and to pay ordinary research expenses, buy workstations and computer things, plane tickets. One of the good things about Scripps, I think, in the time I've been here, has been that we don't value people by the amount of money they bring in. After all, to pick an example of somebody that wasn't at Scripps, Einstein wouldn't have been a big money winner. Somebody would ask him, "Where's your laboratory?" and he'd pulled out his pen and say, "Here." And so you can do very fine science, and there are examples at Scripps of people like that, and they are essentially theorists, and their research costs are a few yellow pads and pens. And, at the other extreme there are people with large seagoing programs and mega-buck budgets. And I think it's been true when we hire people and we promote them, tenure them, we don't put stress on how much they bring in in terms of grant dollars. And I hope that lasts. Scripps is going through tough times financially now, but if you begin to think of scientists as cash cows and value them for their overhead dollars or things like that, that's a very slippery slope. I think that a healthy place, and Scripps is healthy in that sense, has a mixture of big dollar, small dollar, and medium-sized dollar people. I think that's the way it should be.

Harkewicz: You were talking about field work and seagoing people versus non-seagoing, I wondered if the fact that you're over here across the road from the ocean is significant in that there's less people that actually do go out to sea in this facility or this building here?

Somerville: There are lots of people who go to sea in this building and in the building next door. When we built this building in the early eighties, it was called "POSS," Physical Oceanography and Space Science, P-O-S-S, and the people who occupied it were physical oceanographers and the Climate Research Division, and later the Center for Atmospheric Science, which is also largely atmospheric people, and one now defunct organization, a multi-campus one called the California Space Institute. That was the space science part. And the building was built here, because that's where the vacant land was. It has nothing to do with being across the road, or distance from the sea; it's just a convenience. I mean, I have a lot of friends who go to sea. I have great respect for people who make measurements. I'm just inept at it. I mean, instruments break when I walk into the room. [*Laugh*] So, you know, I've learned.

Harkewicz: Okay.

Somerville: As I said, my students go into the field. I want them to know that those measurement data that they work with weren't handed down to Moses on tablets. They came from instruments that have their own problems, and issues, and characteristics.

Harkewicz: Okay. I just was wondering. I thought it was interesting.

Somerville: Actually, I did go to sea once. It took one afternoon. And in those days, it was right after I got here, and a friend said to me, "Well, now you're a professor at Scripps. You have to go to sea." [*Laugh*] So we set out from Point Loma and sailed up the coast past North County, never out of sight of land, for an afternoon. And in those days—you're not going to believe this—but the ships were not dry. So we drank the better part of a case of wine, and we put instruments into the sea, and we sailed back in a brilliant sunset, and that was my seagoing experience. [*Laugh*]

Harkewicz: Well, that doesn't sound too bad, though.

Somerville: No, I loved it.

Harkewicz: I wanted to ask you about computer modeling for global climate change. I wondered what the motivations are that drive the construction of computer modeling? I know you talked about Jerome Namias and his wanting to predict. What is driving modeling today?

Somerville: Historically, these models all trace their lineage back to weather prediction, and there's a century-long scientific history behind that. In the early days of the twentieth century, some visionary people in Europe realized that it ought to be possible to predict the weather objectively, the way we predict tides or eclipses, instead of by hunches and rules of thumb and intuition. And that dream came to fruition after the Second World War. Because what was missing, until that time, were: first of all, the degree of theory you need to write down the correct equations. After all, you're looking for an equation that has the property that, if you put in today's weather and solve it, you get out tomorrow's weather. And how to write that equation is not obvious, and even today we're learning. It's a very, very complicated equation, a big set of equations. Secondly, it required a lot of data that wasn't present in the early twentieth century, and that data, so you can measure the present state of the atmosphere, really came about during the Second World War, due to the needs of military aviation. So, for example, balloons that carried instruments into the high atmosphere put the third dimension into the data.

And the other thing you needed was computers, and the digital electronic computer was also invented in the 1940s. And as soon as that happened, it revolutionized weather forecasting, and in the 1950s, the US and other countries that could afford it switched to making weather forecasting by computer models. And for the half century since then, that's gotten better and better. So the forecast

you see today on TV is made by people, based on the results of a computer model. So there's an immense amount of experience with that, and an immense amount of model development and data improvement and computer speed increases and all the rest that's gone into it. It's hugely expensive, but the economic value of weather forecasts is so high to the weather sensitive parts of the economy like agriculture that it justifies all the satellites and supercomputers and the people. And then, starting in the fifties, and especially starting in the sixties and seventies, these same kinds of models were applied to the climate problem. That is, to longer timescales and to the extension beyond the atmosphere alone to include the ocean, the ice, the land surface, all the other parts of the climate system. And it's certainly true that the main driver for that today is the global warming problem. You can't put the Earth in a test tube and see what it would be like with more CO_2, but you can do that in a computer model. And so that is very much a major driver of that subject today.

And the other thing that's happened is that because computer power has become cheap, and the models have become commodities, that means they're publicly available. And so it used to be, in the early sixties when the field started, and when I started, that there were only a few computer models. They were closely-held private intellectual property. And to have one you had to be in one of those labs that had a big supercomputer. Nowadays, your laptop is as powerful as a pretty good supercomputer of yesteryear, and the model codes are public, and we use them as educational toys. So you can download a climate model, which is hundreds of thousands of lines of professionally coded programming. You can play with it. You can change it around. And that's because of the, as I said, the huge increase in cheap computer speed and the fact that the models have become essentially community property. So we run those models here, for example. In fact, this building is a tribute to the inability of us to forecast our own field. If you notice, if you walk around this building, which we designed, the scientists who were going to occupy it designed it with the architects, you'll find on the second floor a big computer lab, and it looked like the kind of thing that mainframe computers used to be in, in 1980 and before. It has a false floor for the wiring. It has a big air conditioning plant, and it has big bay windows to the hallway, which are now covered up, so that the tourists could look in and see the lights flashing on the big computer. Because we said to the architect, "We can't predict science, but we know for sure we're going to need a big mainframe computer in here. So, you know, build for it." Now we put people in there, and there's no such thing as a mainframe computer in there.

Harkewicz: That's kind of funny. When I interviewed Miriam Kastner[19] she talked about a leg of the Deep Sea Drilling Project that she had gone on where they had gotten data from seawater sulfur deposited in the ocean floor, and how some people had

[19] Miriam Kastner (1935-), professor of earth sciences in the Geosciences Research Division at Scripps. Her oral history interview is at http://repositories.cdlib.org/sio/arch/oh/kastner/ .

used that to construct models on climate change. And I wondered if you had ever used any of that kind of data?

Somerville: No, I haven't. The kind of climate topics that I've been working on lately have to do with clouds. So one of the big unknowns on climate, and one of the reasons we don't know exactly how warm it will be when carbon dioxide has doubled its pre-industrial amount, is we don't know how clouds will respond. We don't know if the world will have more clouds, fewer clouds, higher, lower, brighter, darker, how that goes with geography and other things. And so the models give different results, because the model algorithms that incorporate our knowledge of clouds differ, and well-meaning, clever people come to different conclusions about it. And so one of the ways to reduce that kind of uncertainty is to study real clouds. The kinds of programs I participate in are the ones that take measurements in real clouds and simultaneously measure the little microphysical parts of the cloud, "How much water is in the cloud? Is it liquid or ice? What size are the particles?" and so on. And the big picture things, "How much sunlight does the cloud reflect? How much does it add to the greenhouse?" And we've been making improvements in climate models by comparing the model treatments, the rules the models use to create clouds and characterize them, with how real clouds behave. So it's very much on the atmospheric side of things.

Harkewicz: So when you say, "taking samples from real clouds," is that like with balloons or something?

Somerville: Yes. That's right. You can stake out, and it's been done in several field programs, you can stake out a chunk of atmosphere and just measure the heck out of it. You fly instrumented aircraft through it. You fly unpiloted drone aircraft. You send up balloons. You look down from satellites. You look upwards with radars and lidars, and you use conventional meteorological instruments, thermometers, and barometers, and wind-vanes, and so on. And so you can simultaneously measure the meteorology, the large-scale picture, and what's going on in the clouds, too. And we've been doing that for quite some time and improving our treatment of how models respond to clouds by making those kinds of comparisons.

Harkewicz: You have written that "climate models should be taken seriously but not literally."[20] I wondered if you could explain that comment?

Somerville: That's perhaps an overly clever way to put it. We often get the question when newspaper writers and journalists in general, or when politicians ask about climate change, often the question that they're really trying to ask, the one that they have in the backs of their minds, is whether they can believe these model

[20] Richard C.J. Somerville, *The Forgiving Air: Understanding Environmental Change* (Boston: American Meteorological Society, 2008), pp. 92, 156. See web sites http://theforgivingair.com/ and http://richardsomerville.com/ .

predictions. The model predictions for what happens to the world if humanity continues on its present course, which is having babies and getting the bulk of its energy from fossil fuels, and thereby putting carbon dioxide, which is the most serious man-made greenhouse gas, the most concerning one, into the atmosphere. Then what you really often hear from the general public, as I said from journalists and politicians, is "Well, are you just guessing what's going to happen, or is this a serious forecast that people have to pay attention to?" And the answer, more and more, is that it's very serious, and the longer you neglect the problem, the more you run the risk that the world gets transformed into what is really another planet, with much higher sea levels, very altered patterns of storms, stronger hurricanes, perhaps, more heat waves, droughts and floods, melted polar ice, and so on. And it's almost inevitable that you get to some tipping points or thresholds where essentially irreversible processes happen. And it's in that sense that the climate models deserve to be taken seriously.

When I said you can't take them literally, that means that a given model might say that as greenhouse gases increase there comes a time in maybe 2102 when big chunks of ice in Greenland slip off and cause rapid rises in sea level. Because we've learned in recent years that one of the tipping points has to do with the fact that melt water on Greenland seeps through crevasses to the base and lubricates the interface between the ice and the rock. There are lots of conceivable things like that, and they're inherently unpredictable. So I don't know if it's going to happen tomorrow afternoon or in fifty or a hundred years, and there are a lot of things like that. I think that it's a bit unfair to ask the climate scientists to predict those things. We warn of the possibility, but we can't give you an exact date. And I have medical analogies to many of these things, as you know, and my analogy for that one is, you don't ask your doctor to predict the date when your heart attack will come or to tell you what the surgical options will be on that date. You take her seriously when she says, "Hey, you're overweight, and you're smoking, and you need to shape up, because you're headed for a heart attack." And I think that in the same way climate science, like medical science, is imperfect, it's incomplete, all active science is, but it's good enough to be taken seriously and to base action on. So climate science can provide useful input to wise public policy. It's already good enough for that.

Harkewicz: But if you said that to someone who asked you, like your question before, "Can you tell us when, or are they truthful?" or whatever, what do you think their response would be to what you have just said?

Somerville: I think how people respond to that depends on a lot of things that aren't very scientific. It depends on people's value systems, their political and economic convictions, and where they stand, you might say. And, you see that in the political debate that surrounds climate. As I said, anthropogenic climate change, the reality and seriousness of human-caused climate change, is largely agreed upon by the science community. There are research issues and things we don't know, like those tipping points. But, the degree to which a politician or a

corporate head, or a religious leader, or Joe Six-Pack takes that seriously depends on their own viewpoints. But I think that's reasonable. I think that's perfectly reasonable.

Harkewicz: I wondered about people that don't agree with the consensus, especially graduate students? What happens to people that disagree with the majority in controversial areas?

Somerville: Well, you know, although reporters and historians ask all the time about these kinds of questions, it's not what scientists do every day. So, once the reporter leaves the room, I don't sit here fretting about the reality of climate change. I go back and crunch some more numbers on my cloud physics model. And so I accept that I'm a citizen of the world and have brought children into this, into this world. I'm not especially concerned with that. We don't indoctrinate our graduate students, and they'll come to their own conclusions about these issues. But, as I said, the nonscientific public has, I think, a rather distorted perspective, to the degree that they think about it at all, as to where the science community stands on this. Because, there has been both an active disinformation campaign, a kind of propaganda campaign, designed to confuse the issue and cast doubt on the science. Plus, there has been less than optimal media coverage of it. Plus, this is controversial in the political world. I'm not surprised or even disappointed that it would be. You can take the same science input and come to different political conclusions.

Harkewicz: Do you feel a responsibility to be politically active?

Somerville: I do. I do. And, I spend a lot of my time nowadays in what you might call outreach. I give lots of media interviews. I write popular books and articles. I visit UN climate change negotiations. I participate in making films about climate change. But a lot of scientists don't, and that's fine, too. Different people should do different things. I do think that it's hard for a working scientist to do that while they're still junior and still making their name in research and becoming secure, becoming tenured, acquiring steady funding, and that kind of thing. So I think it's natural that more senior scientists would be the ones who speak out a lot.

Harkewicz: So you don't necessarily feel that every scientist should be involved in educating the public or being politically active?

Somerville: No, certainly not. Some scientists would rather not. There is one strong—I don't know what you'd call it. You might call it a character streak, or something like that, in scientists, which says, "My job is to stick to the lab, do research, publish technical papers in the journals. End of story. And now and then, teach a course for graduate students or advise them." And I respect those people. Furthermore, some people are terribly inept at it. There are scientists who don't understand anything about the media, who can't speak without using jargon, and so on, and

these are acquirable skills, but different people have different degrees of aptitude and enthusiasm. So, that's fine.

Harkewicz: Have you gotten any flak from anybody for being outspoken in that area?

Somerville: I get my share of hate mail, if that's what you mean, or hate email, but not at Scripps, no.

Harkewicz: I meant more from your colleagues.

Somerville: No, certainly not. I think scientists respect—first of all, we're tolerant of one another. There's a very strong streak of academic freedom, if you want to call it that. If I did only talking to the *New York Times* and never published any scientific papers, people would say I'm in the wrong line of work, and ought to make room here for somebody who does science. But I think, once you've established your bona fides—you are a productive research scientist, you teach courses well, you advise graduate students well, you publish well-regarded research—then I don't think there's any stigma attached to speaking out.

Harkewicz: We talked about the fact that there is a consensus among scientists about climate change and you talked about the disinformation campaign. And you've been pretty clear about where you think that comes from, from different corporations or politicians, but how do you deal with that on a daily basis? It must be frustrating to you?

Somerville: Well, I think we're winning. I think we're winning. And again, I think there are analogies from the past. I've mentioned the tobacco wars, and for a long time some tobacco companies funded what might be called disinformation. And there are some fossil fuel companies, some big major oil companies that have funded disinformation on this issue, too. Recently the Royal Society, which is the equivalent in the UK of the National Academy of Sciences here, sent a public letter to Exxon Mobil reproaching them for doing exactly that, for funding disreputable people, essentially, who were saying things that were scientifically false. But I think things change, and one of my positive stories is the story of ozone and chlorofluorocarbons; the companies that made the offending chemicals, DuPont and other major chemical companies, initially denied the connection between CFCs and ozone loss. And, as you know, two of the people who won the Nobel Prize are now here at Scripps.[21] But that Nobel Prize came in 1995 and the theory came out in the seventies, late seventies and early eighties, prior to the announcement of the discovery of the ozone hole in Antarctica, and then there was a strong disinformation effort. But later, those same companies changed.

And DuPont, which made a lot of money manufacturing CFCs, as did other companies, and which put a lot of effort into saying that it was essentially unproven conjecture that they had any harmful effects, changed its mind, and part

[21] Paul J. Crutzen and Mario Molina. See footnote #15 for more information.

of the success story there is that science, politics, and big business got on the same page, and to their credit. And DuPont subsequently has made a lot of money making ozone-safe CFC substitutes. So I think something like that is happening in the climate story now, in that there are powerful corporate interests that have very much moved over to the side of saying that, "Climate change is real. It's serious. We have to do something about it, and we, this big company, intend to be part of the solution." BP[22] has very clearly made that choice. Now, you could be cynical and say part of that is green publicity, but part of that is sincere. I can tell you that the reinsurance industry is very much alert to the idea that phenomena like hurricanes might alter for the worse in a warmer climate, and that affects their business in a big way. And so you find many companies also finding that it's profitable, that environmentalism, if you want to call it that, is not necessarily in conflict with economic well being. Toyota is selling all the Priuses it can, and there are still waiting lists.

Harkewicz: Does that kind of corporate environmental activism, or however you want to refer to it, does that directly affect your research at all or is it more just public acceptance of what you've been trying to say?

Somerville: I don't think it affects my research at all. I think I'd still be interested in cloud feedbacks in the climate system, regardless of what any corporation did. It's a scientifically important and interesting and fascinating area. And I don't think that it has freed up any of the kind of federal research money that scientists like me propose to. My money comes from agencies like NOAA, and NASA, and the Department of Energy, and NSF. Not all at the same time, but over time. And I don't think they're affected by things like that. And in fact, this funding picture has been pretty much level for quite some time, which is a pity, but that's a fact. But I do think that there has been a change in both the public attitude and the corporate attitude, and also the media attitude. As I said earlier, there's less tendency on the part of the media to do the knee-jerk reaction, to hear "the other side of the story." "We've heard Somerville saying 'Climate change is serious.' Let's find somebody else who says that it's way overblown." That's probably something you learn in Journalism 101, I've decided, but there are areas of settled science. Naomi Oreskes, a historian of science at UCSD, has written very eloquently about these things, and she's also published extensively on the story of how plate tectonics came to be accepted. It wasn't smooth and easy. One of her books is called, *The Rejection of Continental Drift.*[23] Many leading geologists and geophysicists of that time never came to terms with the fact that the science had undergone a kind of revolution, and some of them went to their graves unconvinced of the reality of plate tectonics. That's happening in this field, too.

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[22] BP, originally "British Petroleum" is a multinational oil company headquartered in London.

[23] Naomi Oreskes (1958-), professor of history at UC San Diego. Naomi Oreskes, *The Rejection of Continental Drift: Theory and Method in American Earth Science* (New York: Oxford University Press, 1999). See also: Naomi Oreskes, editor, with Homer Le Grand, *Plate Tectonics: An Insider's History of the Modern Theory of the Earth* (Boulder: Westview Press, 2001).

Harkewicz: Well, as long as you brought Naomi up, I was going to ask you what you thought about her essay about climate change in *Science*, and if you thought historians involvement in climate change is a good thing?[24]

Somerville: I think it's extremely good. I think that essay has been attacked, often for what it did not say, people would build a straw man and say, "Oreskes said this," where in point of fact she did not. But I think I'm very glad she has done that and I'm very glad about some of the other things she's written about climate change, and I welcome the fact that first-class historians of science are becoming involved in this. I am, in fact, becoming involved in the history of science. I've started going to their conferences. In part, because I was never able to persuade Namias to interrupt his research long enough to write a history of the twentieth century meteorological evolution that he'd seen and participated in. I also like the idea because mathematical scientists, of whom I am one, often burn out young. You know, thirty is pretty old for some mathematicians, whereas historians keep ripening at seventy-five, eighty. [*Laugh*] So, I may have a second career as a historian of climate science.

Harkewicz: That would be great.

Somerville: I'm serious.

Harkewicz: I wanted to ask you, too, though, in terms of people that accept—I know you have written somewhere, I think it was in your book, *The Forgiving Air*, something like, "People that accept climate change don't see the necessity for more research at the same time as people that don't accept climate change don't see the necessity for more research."[25] So, I wondered about the state of the necessity for climate change research at this point in time. Is more research necessary, and how so?

Somerville: That's a little bit like asking a barber if you need a haircut. [*Laugh*] I don't think you're going to find very many scientists that say, "Oh, no. The field's over-funded."

Harkewicz: "We know everything we need to know."

Somerville: "We know everything we need to know and I've got all the grants I want." You know, we turn down good prospective graduate students every year because we don't have grants enough to put them on assistantships. And as an example, there's an active area of research right now, motivated largely by Hurricane Katrina and the hurricane season, the Atlantic hurricane season of last year, 2005, which is basically concerned with the idea, "What will happen to hurricanes in a warming climate?" They're heat engines. They get their energy from the warm

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[24] Naomi Oreskes, "The Scientific Consensus on Climate Change," *Science* 306: 1686 (3 December 2004).
[25] Somerville actually made this comment in a PBS interview available online at: http://www.pbs.org./wgbh/warming/debate/somerville.html (accessed 3/27/2006). This statement was made on page 21 of the twenty-three page transcript in response to a question about climate scientists and public policy.

ocean. If you warm the ocean, which we are doing, what does that do to hurricanes. And there's a little bit of research on that, with many open questions. So there is some evidence that hurricanes have become more intense, or that there have been more intense hurricanes, and fewer less intense hurricanes, in the warmer world. There's a certain degree of controversy. But in point of fact, there are very few people working on this. There are good people involved in the operational aspects of hurricane forecasting. And the Hurricane Center, which is part of NOAA, did a great job forecasting the track of Katrina. So the operational side has got some very skillful people. They are nobody's fools. They're first-rate operational meteorologists. But if you look in the academic research community, and you might hope or expect to find lots of scientists with lots of grad students and lots of funded projects, researching these issues, "How much should a warming world change hurricanes? Does it just change the intensity? Does it also change the frequency? Does it change the hurricane season? Does it change the area, the geographic area that's vulnerable to hurricanes?" All kinds of questions. It's easy to pose them. There aren't very many scientists, and there aren't very many research dollars, and it seems to me that's something you really ought to know, and it ought to be non-political. You know, who's going to vote for ignorance when the question is posed, "Do we need to know more about this"? So, I think the fact that some people are convinced about the reality of climate change ought not to mean turning off research. And once again, I think it's easy to jump for medical metaphors there. You've reformed. You exercise well. You eat sensibly. You watch your cholesterol. Does that mean that having figured all of this out, you'd like to shut down medical research? I mean, I think when you pose it in those terms, the answer is kind of obvious. And furthermore, the costs are trivial compared to the costs of climate change. Absolutely trivial.

Harkewicz: Is that the kind of analogies you like to make when you talk to the media or the public when you . . .

Somerville: I'm an amateur communicator, and a professional scientist, but I'm learning a lot about communicating from professional communicators. And one of the things you learn is that people don't want to hear a lot of jargon and long sentences and caveats, and that metaphors, and images, and analogies are wonderful ways of presenting things. You can go on and on and talk about greenhouse gases, and how triatomic molecules contribute and diatomic molecules don't, and that's because of quantum mechanics, but until you say that the "Greenhouse effect is like a blanket," a lot of ordinary folk don't get it.

Harkewicz: I wonder if you could elaborate on that a little bit more because one of the things that I'm interested in in my own research is the whole separation between science and the general public how scientists sometimes can put up boundaries between themselves and the public by saying—I mean some of the people that I've interviewed, when I ask, "Well, what do you say to people that don't believe in climate change?" They'll say, "Well, they're just ignorant," or something like that. And that really isn't a very useful way to get your point across or to get

people to hear what you have to say. So how do you confront issues of uncertainty in science? With these analogies that you're talking about or are there other methods that you've been learning to use that seem to be effective?

Somerville: I think there are lots of ways that are effective. I think that a lot of people who saw Al Gore's movie, *An Inconvenient Truth*,[26] or read the book based on it, learned a lot from that movie. You can quibble about details, but the big picture of the science presented there is quite good. It's well done. And I tell people who don't like Al Gore to pretend that it was narrated by somebody else, Trevor Hoffman, who, for readers a hundred years from now of this transcript, was a pitcher for the Padres.[27] And that kind of thing. There was a wonderful HBO film put out earlier this year called *Too Hot Not to Handle*.[28] It's still showing on HBO outlets. And the Museum of Natural History in San Diego will show both of those films this fall. I think that's one way people learn. Not everybody is going to read books of any kind or get familiar with the science. We just have to face the fact that there's a huge degree of science illiteracy in our culture, that most people are not well informed about science. The numbers are scary. Most people don't realize the Earth goes around the sun once every year. And so you have to overcome a big barrier to communicate across that kind of chasm. There's no silver bullet for this. I think that who you're talking to and in what circumstances largely determines what the best way to get the point across is.

And furthermore, as I said, you're fighting a campaign that's directed to obscure this. One US senator, Senator Inhofe,[29] who is no friend of climate science and who has called global warming "the biggest hoax ever perpetrated on the American people," invited Michael Crichton,[30] who is a science fiction author, to testify before Congress. That simply boggles the mind of any reasonable person, I think, to have a celebrity with no credentials whatever in climate science, who's written some very silly things about it, advising the Congress. So I think you just swallow that and move on. I do think that the caliber of journalism is increasing, but there is very little of it out there. Sagan, Carl Sagan,[31] remarked once that "Every newspaper, pretty much every one, has a daily astrology column, but only the New York Times has even a weekly Science Section." And so you have to face that, and you have to talk about the science in ways that are relevant. And once again, I think the health sciences have done this better, better than we have. I think their professional societies, the American Medical Association and so on, have done a better job than their counterparts, my professional societies. The

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[26] Al Gore (1948-), politician, teacher, businessman, environmentalist, and vice-president of the United States from 1993-2001. Al Gore, *An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It* (New York: Rodale Books, 2006). The film *An Inconvenient Truth* (Paramount, 2006) won two Academy Awards in 2007: Best Documentary, Features, and Best Achievement in Music Written for Motion Pictures.

[27] Trevor Hoffman (1967-), relief pitcher who has played for the San Diego Padres since 1993.

[28] *Too Hot Not To Handle* (HBO Documentary Films, 2006). For more information see: http://www.hbo.com/docs/programs/toohot/index.html .

[29] James Mountain Inhofe (1934-), Republican senator from Oklahoma.

[30] John Michael Crichton (1942-), American author, film and television producer, who trained as an M.D.

[31] Carl Edward Sagan (1934-1996), American astronomer, astrobiologist, and author.

societies I belong to operate for scientists. They publish technical journals and put on technical meetings, but they have limited public outreach campaigns, they have limited, you know, political efforts, lobbying if you want to call it that. And I hope, I hope that improves. I think local efforts like the aquarium, the Birch Aquarium at Scripps, and a lot of the climate materials put out by the communications side of Scripps are helpful, but it's a long, long slog. There's no silver bullet.

Harkewicz: Do you really think that's due to outreach by those groups like the American Medical Association, or do you think it's more because people are more interested in their bodies because that's something they have to carry around every day, whereas we take the environment for granted many times?

Somerville: I do think that's right. I think that people are interested in their health, they're interested in economic issues that affect them directly, and climate change is insidious. It does sneak up on you. It's interesting to speculate what would have happened to the ozone issue had there not been the spectacular event of the ozone hole, which wasn't predicted. What had been predicted was a gradual decline in ozone. The fact that half the ozone over Antarctica was observed to disappear every year and then reappear was completely unpredicted, and that got the world's attention. So I very much hope that it doesn't take a climate catastrophe, some sudden unanticipated event. And part of the problem is that climate is inherently a statistical and a probabilistic thing. We can't say that global warming caused Katrina. We can't say that global warming caused the 2003 heat wave in Western Europe that killed some 35,000 people. But, what you can say is that certain weather phenomena, like those things, are made more probable in a warmer world. And so you have to get people used to the idea of thinking in probabilistic terms, which presumably they do when they go on vacation in Las Vegas. [*Laugh*]

Harkewicz: You have to work on your gambling metaphors, I guess, then?

Somerville: You have to work on gambling metaphors. And once again, I think you have to get communications professionals involved. The anti-smoking campaign has worked. The number of smokers has gone down. Smoking deaths have decreased. You could say the same thing about seat belts and a lot of other things. People are motivatable, and human behavior has changed. I live in France for four months of every year, and in France I've watched the drunk driving laws and the speeding laws suddenly enforced rigorously, and it changed the behavior of French motorists in a very short time. So I'm optimistic about that, just as I'm optimistic technologically. We've had a kind of gloomy discussion about how tough this is, but I think the tough parts are the political will, and I'm a technological optimist, so that once you have in this country and other countries averting climate change as a national priority, once governments have acknowledged the seriousness of it, started to reward good behavior and tax bad behavior, for example, carbon taxes on gasoline is a good example, then you free

up a huge amount of technological creativity and you can hope for better changes. You can hope for more competitive renewable energy sources. You can hope for drastically improved energy conservation and energy efficiency. There are many, many things that are doable, and what we lack is not so much the knowledge of what to do as the political will to do it. So I talk to people who ask, "What can I do? Does it help to recycle a can?" and my reply is "That's a consciousness-raising activity, and that's good and helpful, but what you really also want to do is tell the politician who wants your vote that this is important to you." And, I think, once you get past that, then all kinds of things are doable. We already see in the US, again to pick this one example because we happen to live here, that there are a lot of initiatives at the state and local level, and at the corporate level, and rather little at the federal level so far. The US rejected Kyoto. That's its privilege, and you can't blame that on the Bush Administration. Kyoto was rejected soundly by the Congress as well, but the US hasn't put something serious forward in place of it. That's what we're waiting for.

Harkewicz: Well, you mentioned living in France. How do the French look at climate change and global warming?

Somerville: First of all, gasoline costs six bucks a gallon, so people drive little cars and commute short distances. Secondly, the French made a conscious decision, not based on climate, to switch to nuclear power for their electricity. So over thirty years, they went from zero to eighty percent nuclear. So those are two big examples. And France, like the rest of Western Europe, signed on to Kyoto, which doesn't solve the problem but keeps it on the political table, you might say. So I think that in Western Europe, in general, at this stage, in 2006, it's probably fair to say that climate change is less politicized there than in the US, in terms of how the political classes, you might say, think about it. And, in the US, it has become part of the partisan divide. In Europe, mainstream, or centrist, or center-right governments still consider climate change important, and it's higher on people's agenda. So there's more—now mind you, Europe's not just like the US, and the same solutions don't work everywhere, but everyone knows there's better mass transport, for example, in Europe.

Harkewicz: Well, when I talked to John McGowan[32] about this, and the climate change's effects on marine environments, he was pretty depressing. He said that Third World countries want the same things that we have, so he didn't see anything really happening unless there was some major disaster. And he talked about China and how they have this huge stored amount of fossil fuel that they could mine. But from what you've said you don't sound quite so depressing in thinking that it's such a bleak thing, that's it's not something that can't be dealt with.

Somerville: China is industrializing on coal and is building coal-fired power plants. It wishes it didn't have to do so, not only for the climate issue but because coal-fired power

[32] John Arthur McGowan (1924-), professor of biological oceanography at Scripps.

plants are environmental disasters in lots of ways. And some of the most polluted air in the world is in big Chinese cities, and they have respiratory diseases, and all of the other serious consequences. What China has not seen its way clear to is a viable alternative to that. And I think that one of the things that can happen when the First World countries begin to take this seriously is that you start to produce those alternatives. Again, the ozone issue is easier, but CFCs were invented in the US and manufactured in the US, and their substitutes were also invented in the US, but now they're made all over the world. And so you can export the technology. I think in many developing countries there's the chance to leapfrog over intermediate technology to the most advanced technologies in the same way that countries just installing phone systems go wireless instead of stringing lines on poles, or building railroads don't go through wood-fired steam engines. And so, for example, nuclear power, which raises strong emotions, and which has strong advantages and disadvantages, is something that I think is worth looking at, and if the effort to avoid fossil fuels gave rise to a serious effort to look at the well-known problems of nuclear power, which are cost, and reactor safety, and proliferation, and waste disposal, all four big problems, then there's no reason to think that that couldn't be a part of the solution. I think, also, if your goal is the fusion economy, or the hydrogen economy, or whatever futuristic not-yet-available combination of technologies, then you can either mosey down that road, baby steps at a time, as we're currently doing, or you can accelerate that progress. So, I think it's as I said, environmentalism can be profitable, and the country that leads in developing those technologies is going to make money as well as do good.

Harkewicz: Well, during the Eisenhower Administration he had this whole Atoms for Peace Program and things like that, but they ran into a lot of problems with environmentalists, and issues such as Three Mile Island, and now Chernobyl. So, what do you think stalled future, you know, technical, technological advancements in nuclear power? And do you see that that could be . . .

Somerville: I think you've put your finger on it, that those disasters, I think, frightened a lot of people away. But nuclear power is a significant fraction of the power capacity both in the US and globally today. We're talking about a twenty percent level for electricity, which is not negligible, and much more in some countries, of which I named France. And so why not, instead of saying, "Oh, there are these scary possibilities," why not do what it takes to reduce those risks, design passively safe reactors, work harder on the waste disposal and proliferation issues, and beat down the cost issue by working on this problem of externalizing costs. That is to say, you don't pay at the gas pump for the health consequences of using fossil fuels. So, I think it's good to take an open-minded attitude toward those things. I'm neither condemning nor advocating nuclear power. I'm just saying that there are things to be learned and there's progress to be made, and it shouldn't be declared off limits for emotional reasons.

Harkewicz: But would you go out in support of research into nuclear power?

Somerville: One thing that has surprised me about our discussion is that I thought we were going to talk about my history at Scripps and instead you're asking a poor meteorologist for policy prescriptions for the globe. [*Laugh*]

Harkewicz: Well, I know that you're involved in that so I'm curious about your involvement.

Somerville: Well, I'm giving advice on the science. I have no special expertise to offer in policy, but I talk a lot to the people who are experts and who do write thoughtfully about these subjects. And so I don't think it's up to me to advocate for or against nuclear power. If I want to do that as a private citizen, that's fine, but you know the fact that I'm a climate scientist hasn't given me any special insights into that, except to say that you cannot continue on the present path, and so that even to a climate denialist who thinks that doubling the carbon dioxide amount, the pre-industrial concentration of CO_2, which we're headed for in the near term, who doesn't think that's serious, ask about tripling. Ask about quadrupling. Because, if you keep having babies and if you keep using fossil fuels as the world's primary energy source, it's about eighty percent today globally, then, and you watch the Third World, the developing world, strive for prosperity in the same way that the First World acquired it, mainly by cheap fossil fuel-based energy, then you very quickly get to a planet which you don't want to see. Believe me, you don't want to see it. The fact that I can't tell you whether it's going to happen in twenty years, or a hundred, or two hundred years doesn't mean that one can be blasé about it. There's a timescale built into this. You have to do things soon. Many people who've looked at this issue thoughtfully will say that we have a rather short window in which to start taking serious action, to stop just yapping about the problem and start looking at energy alternatives. You just can't postpone it. The problem gets worse the longer you postpone it.

And you know, population is part of this issue. That's something no politician can talk about because it's too much of a hot-button issue. It touches people's most personal values and decisions, and convictions. But the US, this month, October 2006, hit three hundred million people. In 1967, when I was a postdoc, there were two hundred million people. That's a fifty percent increase in my career. Globally, the population is about six and a half billion today. It was two billion in 1930, in round numbers. So, it's more than tripled in the one human lifetime, from 1930 to the present, and that's a multiplier for all these problems. And, I think that deserves serious attention. And we know that it's possible to slow and to stop population growth, and it has happened in many countries already, and we know how to do it. And, the fact that it's not talked about, and not talked about in connection with the environment more than it is, is a great shame, in my view.

Harkewicz: But again, in relation to what you had said about nuclear power and population growth, as a scientist, a climate scientist you wouldn't feel like you could go out

and make any kind of recommendation, or say, "This is what I think is important about population growth?" or . . .

Somerville: Personally, I think that it's up to people's personal choices, but mathematically it's sort of obvious that if you have half as many people, you can live twice as cavalierly, in terms of emissions per capita. And sometimes when I'm in a grumpy mood and a reporter asks me, "Well, what have you done personally, Professor Somerville? Do you bike to work or do you telecommute?" I say, "Well, my wife and I stopped at two children." [*Laugh*]

Harkewicz: Well, that stops them right there, I guess.

Somerville: Yes.

Harkewicz: Well, I didn't want to get us off on this track too much but I just was curious about how you felt about larger issues—maybe issues that are beyond your expertise—whether or not scientists should speak on them?

Somerville: I think that we can inform them. I think that in areas like this, where there's a strong scientific and technical component to a policy decision, then sound science can be an input to wise policy. I don't think you want scientists as policy makers. We've got a better mechanism for that. Someone said, and I agree, that they'd "rather be governed by the first five hundred names in the Boston phone book than by the Harvard faculty," [*laugh*] and I think that's probably a very good policy.

Harkewicz: Okay. But, I did want to ask you about your science education and outreach, and you mentioned a few times about scientific illiteracy. I know that you chaired the GeoScience Education Working Group of the National Science Foundation. In 1996, the group put together a report titled, "GeoScience Education: A Recommended Strategy." And I was wondering what kind of recommendations you suggested in the report.

Somerville: Oh, we talked about a lot of things, and there's been much more work by many, many people since then, but we thought it was important that scientists participate in education. Not because everybody should aspire to be a scientist, but because there's just a minimum level of scientific knowledge and understanding that someone who's well equipped to participate in a modern democracy ought to have. And NSF for a long time has danced around the issue of how much it should be concerned with that. So I think that was probably a helpful report saying that it should be part of the scientific enterprise, and so on. And I think you see that here when you see scientists participating in the outreach activities at the aquarium at Scripps, for example. I mean, people do different things. Judging a high school science fair is a help, and so on. The book you've mentioned, *The Forgiving Air*, came out of an effort to train K-12 teachers. So I and some friends from Extension actually got a grant from the Department of Education, a federal

agency I had never had anything to do with, and we brought teachers to the campus. I've done a lot of, subsequently, a lot of other work with school teachers. I love school teachers. They're marvelous people. They come up after your lecture and hug you, you know, which never happens at a seminar at Scripps. [*Laugh*] And they're dedicated, and they're bright, and they're motivated, and they're highly professional, but in many countries, not just the US, it's been true for a long time but many school teachers lack the content knowledge. They're expert pedagogues, but when it comes to teaching something about physics, or biology, or chemistry, they themselves are often uncomfortable about it. And I wrote that book, *The Forgiving Air*, without any equations in it because I had talked to those teachers and I had seen the white knuckles gripping the armrests when you would write even the simplest equation on the board. They're not stupid. There's nothing wrong with them. It's just that the educational process that they went through to become grade school and middle school and high school teachers didn't have enough of science content. And that may be a factor in a lot of things. For example, the average school teacher in the US, the median one, you might say, is a forty-year-old white mother of two who is a role model, especially to little girls. And if that teacher, because she's uncomfortable with science, transmits unwittingly to the little girls in her class that science is difficult, or boring, or only for boys, that's a powerful negative impact. We lose students to science when they're very young. We don't lose them in the last part of high school or in college. We're not trying for a society in which everyone's a scientist, but we are, I think, we will be better off when there's a greater average level of understanding of what scientists do, what science is. When we say, "Scientists say," blah, blah, blah, what do we mean by that?

Harkewicz: So, when you talked earlier about communicators and educating, do you feel that teachers are in that group of communicators?

Somerville: I think they can be and I think the best ones are. Science is tremendously exciting. It's one of the great adventures of the human mind, and in some ways we all get to participate in an activity that has produced magnificent things, including the iconic heroes that we all admire, the people whose accomplishments are beyond the grasp of most people, the Newtons and the Einsteins. To be growing up in the twenty-first century and to be largely ignorant of all that—I think it's a great shame.

Harkewicz: Do you have any suggestions as to how that might have happened? Is it just that science doesn't seem glamorous enough?

Somerville: You tell me.

Harkewicz: I don't know.

Somerville: You tell me. Why aren't you an oceanographer? [*Laughter*]

Harkewicz: I get white knuckled with the math. [*Laugh*]

Somerville: As I said, we don't need everybody to be a scientist, but it would be good for people to understand the basics of how science works, and how science progresses, and what scientists actually do.

Harkewicz: That's true. I don't think most people understand how science works.

Somerville: When one of my sons was small, he participated in a project run by a psychologist for gifted children, and one of the questions was, "What does your daddy do?" And he said, at age seven or something like that, "He talks on the phone." [*Laughter*]

Harkewicz: But how do you think that science education today can affect public policy in the future?

Somerville: I think if you have an electorate that is less gullible and more knowledgeable about science, and that can more easily spot a quack and tell the difference between real science and fake science, then you certainly get a better set of decisions, certainly a better informed voter, on science issues like this. You know, there's a quantitative aspect to all science, and to this science in particular. Some things matter and some things are just trivially small. For example, in the global warming issue the problem is inherently international. You can't change the California climate by changing California emissions and greenhouse gases. Because once you put that CO_2 in the atmosphere, it stays there for decades or more, and that's plenty of time for the winds to mix it all around.

That, by the way, was one of Dave Keeling's insights. He realized that one pristine location with continuous measurements, Mauna Loa, could be representative of the world, and indeed the Mauna Loa record is a little different than the South Pole record, but not very much quantitatively. For climate purposes the amount of CO_2 in the atmosphere is the same everywhere, simply because of the long residence time of the molecules. Well, that's important. That affects how you solve the problem. Once you realize that the US is, with five percent of the population, emitting twenty-five percent of the CO_2, but that that fraction is decreasing, because the US is not growing anywhere near as fast as China, and India, and other large-population developing countries, then you begin to realize that, even if the US were somehow magically to solve its own problems tomorrow morning, and never produce another molecule of CO_2, we'd still have a climate change issue. And it helps you appreciate the geopolitics of this and how the developing world is angry at the developed world, saying, "You've become prosperous, and now you want us to deny our people the benefits of cheap, readily-available energy." I think that informs a lot of things.

I think one of the things that disturbs me about what even well-intentioned American laypeople think about the climate change issue is that they see the

world through American eyes: "Well, let's see. If I reduce my commute or buy an SUV next year that's not quite as big as the SUV that I have this year, maybe a hybrid SUV, that will solve the problem, right?" Wrong. We're still increasing the amount of CO_2 in the atmosphere. There's more in there now than there was when you and I started talking, and there's much more than last year. And so we're in the position of an obese person who ought to be ingesting fewer calories but is actually ingesting more calories every year. And until you see that quantitatively, and realize that the reductions in CO_2 emissions have to be not a percent or two, or five, but maybe seventy or eighty percent, so you have to really wean the world from fossil fuels, the whole world, until then, you don't grasp the nature of the problem. And that means, I think, that for even well-intentioned politicians, you have to think globally on this issue. You really, really do, for quantitative reasons. China soon passes the US on most estimates. That's a forecast of human behavior, as well as the climate system, but China will pass the US as the country with the single largest emissions of CO_2 in a very short time, maybe a few years. So it has to be an international effort.

Harkewicz: What did you think about the Kyoto Protocol?[33] I mean, do you think that it should have been signed by the US?

Somerville: It probably would have been helpful had it been signed by the US, because it has come into force anyway. And cynics will say, "But we're not going to meet the Kyoto targets." Some countries will. Some countries will have made a good-faith effort. In some ways I think the benefit of Kyoto having come into force is that it removes Kyoto as an obstacle to further progress, that Kyoto was never intended to solve the problem. And, as is often the case, I have learned in these international issues, is that it's a first step. It brings things to the table. It gets countries taking them seriously, and it paves the way for the next step. The fabled Montreal Protocol[34] would not have solved the ozone issue, but it made it possible to have subsequent agreements that sped up the timetable, put more of the ozone depleting gases under consideration, and so on. So Kyoto, if everybody obeyed and nobody cheated, would only slightly slow the rate of global warming. So it has distressed me to see so much effort devoted only to making the Kyoto targets, or evading the Kyoto targets. Because, as I said, even perfectly implemented, it doesn't solve the problem. It's a step. So if your attitude is going to be, as a company, "I'm going to do the bare minimum possible to satisfy the Kyoto restrictions," then that's not helpful. But one can be hopeful.

Now the nations that are meeting—there's annual meetings, of conferences of the parties to the UN framework convention on climate change, to which the US is a

[33] The Kyoto Protocol to the United Nations Framework Convention on Climate Change is an amendment to the international treaty on climate change. The amendment assigns mandatory emission limits for the reduction of greenhouse gases to signatory nations.

[34] The Montreal Protocol on Substances That Deplete the Ozone Layer is an international treaty designed to protect the ozone layer through phasing out the production of substances believed to deplete it.

signatory, signed by the first President Bush at the Rio Earth Summit.[35] Those meetings are now being devoted to what comes after Kyoto. "What comes next?" "What can we do?" And so I think by making it a partisan issue, it diverted attention to the seriousness of the problem. But that's water under the dam now. It doesn't matter what the US does or doesn't do about Kyoto. And by the way, a lot of multinational corporations headquartered in the US, or with a big foot in the US, have to obey Kyoto where they are. There are carbon exchanges and so on. If you're a unit manager for some of those corporations you have to make your production numbers and your profit numbers in country X but you also have to make your greenhouse gas emission reduction numbers. And so I think it's, in some sense, a dead issue now. It's something we had to get past. And what's important now is how to craft a meaningful agreement that comes next. That comes next. You basically have to get off the emissions path. If you can find a very clever way to do it, like sequestering carbon, pulling it out of the smokestack before it goes into the atmosphere, the way we scrub it for sulfur, fine. But, that's not been demonstrated on a practical, large-scale basis yet. It's one route, one of the many non-silver bullets. But otherwise, you have to think about weaning the world from fossil fuels. I'm very much in sync with, I believe it was a Saudi prince, who was fond of saying that "We didn't end the Stone Age because we ran out of stones, but because people found out better ways of doing things." And you'd like to think that the Oil Age is going to end before we run out of oil. Because, there's plenty of oil and even more coal in the ground, and so the worry is that we'll burn it all.

Harkewicz: Well, sort of, to bring us back sort of to where we started . . .

Somerville: To Scripps.

Harkewicz: To Scripps. Yes. I was wondering, you know, you've been here for almost thirty years or so, what do you think has been the biggest change that you've seen at Scripps? And was it can related to science or the administration, or something else?

Somerville: Well, I mean if I were to answer that parochially, I could talk for a long time about how happy I am to have seen the growth of the area that I'm in, from this little group of Jerry Namias and three or four scientists around him concerned with seasonal forecasting, to now a truly powerful and impressive contingent of atmospheric scientists and other scientists who are concerned with climate. After all, there are geologists here working on paleoclimate, and there are physical oceanographers here working on many climate-related issues. So Scripps has moved to become more climate oriented. There's no single person that gets credit for that, but I think I've helped. I was the head of the Climate Research Group. I

[35] The Rio Earth Summit was the United Nations Conference on Environment and Development held in Rio de Janeiro, Brazil from June 3 to June 14, 1992. Governments from 172 countries as well as 2400 non-governmental organizations participated. A key achievement of the Summit was an agreement of the Climate Change Convention that led to the Kyoto Protocol.

was the first director of the Climate Research Division when it was upgraded to a division. I was the first coordinator of the Climate Sciences Curricular Group, which is a branch of the graduate department. So there's been a big effort to build climate, and I think I've had a hand in bringing some of the key people here and helping to retain other people. So I'm very pleased by that, and to the extent that I've played some small role in bringing it about, I'm proud of that.

But in terms of Scripps itself, it hasn't changed much. It's gotten bigger, but I think you might say the Scripps culture, the attitude of Scripps people, hasn't changed very much. It was when I got here, had been for a long time, still is, an absolutely first-class earth sciences department, world class by any measure. But for me, the biggest change has been in the students, and it's been an amazing change. I think we still get cream-of-the-crop students who are very high-aptitude, or extremely skilled, or extremely well-prepared and highly motivated. They come here because they have a calling to do science. They're fascinated by science, and they work like crazy. They're brilliant. They're well prepared. But, what's changed about them—that has always been true—what's changed about them is that I think fewer and fewer of them have their heart set on a career exactly like their advisor's. That is, they're willing to think of things other than research, or other than the kind of research, you know, to be a professor in a top-class research university, as all of their advisors here are. And that's good. In the first place, they can't all do that because this field is now a steady state. And in meteorology, I can tell you the numbers. There were, when I was a graduate student, fourteen universities that had Ph.D. programs in the US in atmospheric science, and now there are seventy-plus. So there's been a five-fold increase in the forty years that I've had a Ph.D. And in some statistical sense, that increase has created positions for people like me. After all, the position that I filled at Scripps, that Bill Nierenberg established in the seventies, wasn't there in the sixties. That's not going to happen again. There's not going to be another five-fold increase, and there may be flat, no growth, or a slight decrease in the next forty years.

And yet, we're producing these students. Wonderful people with Ph.D.s. And I think what's going to happen, it's already happening, is that a lot of these students are going to find nontraditional careers. I already know, and all of us know, Scripps graduate students who have gone into education, who have gone into the corporate world, who have gone into government, who are doing things other than research. I think that's terrific. So—this, by the way, has to do also with the great increase in women among students. When I was in graduate school there weren't any women in atmospheric science. There actually was one famous atmospheric science researcher.[36] And I didn't have females as my colleagues, my classmates. Now Scripps is fifty-fifty for all practical purposes. And so the Scripps faculty, which is still overwhelmingly male, is changing towards fifty-fifty as that pipeline opens up. I think it's preferentially the women scientists, women students, anecdotally, just a hunch from many conversations, who are

[36] Joanne M. Simpson (1923-), meteorologist who recently retired from Goddard Space Center.

more open to nontraditional careers. Some of them will be professors in research universities. Some of them will have traditional research-oriented careers. But I think it's not just at Scripps, but nationwide, globally probably, that we are producing more highly-trained people with scientific credentials who will bring that knowledge and that intellectual fire-power to careers where we haven't traditionally seen people with scientific Ph.D.s from first-rate places.

Harkewicz: Are there any other changes that you see that may have occurred, because of women being in atmospheric science?

Somerville: There's certainly a greater sensitivity, you know, to issues like sexual harassment, and all kinds of affirmative action. I think there's been a maturing, you might say, which by the way has also happened in undergraduates. But in some sense, I think it's been a refreshing development, all told. Otherwise, Scripps has grown in size. It has become a smaller and smaller part of UCSD. I think our relationship to the University has gotten better. It's less isolated. Scripps professors teach lots of undergraduate courses now, for example. I've had undergrads working with me for many, many years. I think that's very healthy.

Harkewicz: You said you really wanted to be a professor when you came here. Is teaching still an important part of your work?

Somerville: Yes. Teaching is important. I had taught some before as an adjunct professor at universities near the various research labs that I was in, but I think when I moved here from the National Center for Atmospheric Research, NCAR, which is a place comparable in size to Scripps, a big first-rate research center but one without teaching responsibilities and so on, at that time NCAR was largely block funded. A big grant came from NSF. The administrative hierarchy parceled that out. And so it was a big surprise for me to show up here and say, "Well . . ." In those days we had typewriters. You may have heard of them. [*Laugh*] And I said, "Who types my letter?" And they said, "Well, if you want a secretary, you write a proposal, you get a grant, you put the secretary on the grant and you hire one." So I suddenly realized that what I had traded was resources for autonomy. That at NCAR and other places where I had worked, at that time, they've evolved, too, but at that time there was very much central funding. You didn't have to worry about where your next dollar was coming from. But with that came a certain degree of hierarchy, and control, and organization.

Whereas at Scripps, the model then was and still is, you write a proposal, you get that funded, and then you do whatever you want. So essentially, you've given up the sure safety valve, if you like, of having resources provided—the supercomputer in the basement, the draftsperson down the hall. But in return for that you've acquired the freedom to do whatever you want to get funded. And so I think that scientists here take that for granted. That's how we work. You're good enough to get here, and then to prosper here, you have to be competitive in what amounts to laissez faire intellectual capitalism. You're writing proposals,

and they're competing in what in the end is a meritocracy, never a perfect one, but in the end the people who write good proposals get them funded, and the people who write bad proposals don't, and they gradually leave this business. But the return for that is you do what you want. No Scripps director, for example, past, or present, or future, would dream of telling a Scripps professor, "I want you to do this research. This is what you ought to be working on." Instead, we decide that. We write the proposals. Nobody censors then. Nobody vets them. Nobody torques them around. Nobody internally reviews them unless you ask your friends to review them.

And, as I said, it's chocolate and vanilla. And excellent science has been done in both kinds of environments. But I just discovered when I got here and suddenly didn't have the resources, but also didn't have the administrative hierarchy to cope with, where each year you had to fit what you wanted to do into what the mission of your unit that year was decreed to be, that I was much happier in this kind of environment. So I was never unhappy before, but I'm blissfully happy here in that professional sense, because of the freedom, the intellectual liberty to do what I want and change my mind about what I do. I'm not doing the kind of research I did in 1990 or 1980. I think that's priceless for me, really, a tremendous, tremendous advantage. And I just happen to be wired to prefer this kind of environment. As I said, it's not better or worse. It just suits some people better or worse.

Harkewicz: That's very interesting because a lot of the people that I have interviewed, who are from a older generation, you know, they had ONR[37] funding, and they don't like the fact that they feel more and more that they have to write these proposals, and they spend so much time writing proposals that they don't feel like they get enough work done. So it's interesting to see like the other side.

Somerville: Yes, I think that's right. The world has changed so that in some respects the ONR funding that grew out of the wartime experience at Scripps was very much an old boy's club, and the leading scientists, at Scripps and elsewhere, at that time had very chummy relationships with the people who funded them. In fact, some people, like Revelle, passed back and forth between those two worlds. That's a very nice situation, to, basically, have your own private funding stream. That was easier back when science was much smaller, but harder today. It is inefficient in the sense that, at places like Scripps, which are largely soft money, and the great bulk of our budget, as you know, comes from proposals that we generate, it is terribly inefficient and people do spend a lot of time writing proposals. It can be frustrating. In fact, I think one of the reasons why students are willing to consider alternate professional lifestyles is that they look at the junior faculty and the junior research staff here, and they see the stress. The long hours, the low pay, and the anxiety over tenure, and the angst over proposals, and they think, "Maybe there's a better way." I'm not convinced that corporations, for example, are any less stressful, but nonetheless students here see that on a daily basis in terms of

[37] Office of Naval Research.

the younger faculty and research staff here who are pretty much the same age as the students, not much difference. But for me, I have thrived in that atmosphere. And right now, I wouldn't, I couldn't, imagine trading that. That is, getting more, if you like, economic security, more foreknowledge of what next year's research budget is going to be in return for having given up this degree of freedom. I'm willing to compete.

There's something else, and it's unique to climate science and a few other subjects, which is that we know for a fact that government scientists, that is climate scientists who are civil servants and who have worked for NASA, or NOAA, or EPA,[38] for example, have in some cases been subject to heavy political pressure amounting to censorship not to say things that would embarrass their agency. So there are clear examples where political appointees in the agencies have forbidden scientists from talking to the media unless a minder from the agency was present, or in altering the speeches that a scientist was going to give, or in requiring scientists to clear their papers and their public presentations with the agency beforehand. That would be unthinkable in a place like Scripps. I mean, no Scripps scientist is ever going to have to run his manuscript past some censor before he can publish a paper and give a talk. So, that's one pernicious example of what I mean by a heavy administrative burden.

Harkewicz: You mentioned Roger Revelle and I just wondered if you had much interaction with him?

Somerville: I knew Roger very well in the last years of his life, after he came back from Harvard, from that time up until his death. And I admired him very much. We talked a lot. We traveled somewhat together. Revelle was always enthusiastic about whatever he was doing. So sometimes we would go off to some hearing in Sacramento that struck me as deadly dull, but for Roger it was the most important thing in the world to do that. Here you had a guy who had received every possible accolade—he could have played golf and done nothing else, but he was still engaged and he still thought it was important. Everyone uses words like "charismatic" with respect to Revelle, and there was something to that. He caught you up in his own enthusiasm. It was so sincere. And he was a lot of fun to be around, you know, a big, larger-than-life character in a lot of ways. I enjoyed him very much. I miss him still.

Harkewicz: Hmm. Well, there's a few questions that I ask everybody at the end here, so I wanted to ask you them so I can get out of your hair. First of all—you may have been talking about this for the whole time that we've been talking here, but what would you say Scripps has meant to you?

Somerville: Well, it's been a chance to associate with wonderful people. I think it's facilitated and hasn't impeded anything I've wanted to do. As I've said, I cherish the freedom here, and it's been a lot of pleasure watching the side of Scripps that I've

[38] Environmental Protection Agency.

participated most in prosper and do well and come to be very well regarded. The students who have worked with me and the colleagues that I've worked with, and some colleagues that I just haven't been that close to but I've had a chance to go hear their seminars or listen to them talk, that's been a source of unending pleasure. The sheer intellectual caliber of the people who are here at all levels, not just the scientific superstars, is extremely impressive. So that's just been a blessing. I like that most. I've made very fast friends here, including some, with some people who are no longer here. If you've been here as long as I have there's been a certain amount of flow through. But there are people who came here, spent some time here, some of whom were my students or my postdocs, but some were just colleagues. But I've stayed close to them. So that's been the biggest treat by far. And I think in science, example is very important, and that's one reason why it's good for people to collect together in a place like this rather than, say, do it by correspondence school. You know, I can't imagine a virtual Scripps in which everybody participates over the Web, but we're actually all scattered around. I think it's a treat not only for the students who come and get a chance to see science being done, when they're shopping for an advisor, for example, but I think it's good for all of us. Some of the best Scripps Ph.D. theses—I've worked a lot with students over my time here, and I still am, so that's important to me—a lot of those things have been jointly advised, essentially. And so I tell prospective students, when we're trying to persuade them to come here rather than to a rival place, that one advantage of Scripps is that "You can find not only a great advisor working in an area that excites you and with whom you're compatible, but you can find other people who will be on your Ph.D. dissertation committee who have this expertise, or that expertise, or the other expertise." And watching some of these groups coming together for that purpose has been very, very inspirational, you know.

Harkewicz: Have you found at Scripps, either in general or the Climate Group specifically to be a good place to socialize with people?

Somerville: Not especially. Not especially. I've met some of my personal friends, if you want to put it that way, rather than professional friends or scientists, here but many are not. But I will say that the Climate Research Division, formerly the Climate Research Group, has been very close-knit in the sense that we have, over the history of the group, which is now thirty-plus years, we've done a lot of joint things together, so that I've heard some Scripps research units described as, "Just a collection of people who share a business office and a bathroom." But the Climate Group has not been like that. And so that, in addition to everybody having their own research projects that they've proposed and gotten funded and run, we've done a lot of collaborative projects. And, we're still doing that. And over the life of the group there have been some really big ones. And, that's been very helpful, because this is a very disparate group, very heterogeneous group with people coming from all kinds of backgrounds. Physical oceanography for several of them. Atmospheric science for others. Chemistry for others. Hydrology for some. And so it's really been good to see the degree of collegiality

here. And, I must say that applies outside this little area too, but that group has been certainly much more cooperative and collaborative than many others, yeah.

Harkewicz: But more on a professional basis then, right?

Somerville: Yes. In the sense that, "Do we marry each other's siblings?" and "Do we hang out every Friday night at the same house, opening a keg?" No. I don't think so. But that might be because we're spread all around. Frankly, you've already asked me what I like about Scripps. The part that I don't like about it is that we're geographically spread all around. I think, and Roger Revelle thought, that it would have been better, in retrospect, if there had been an affordable residential community around UCSD where everybody could live. And I've lived in both and worked in both kinds of places, and I think something is lost when at the end of the day everyone gets in a car and scatters to the four corners of the county. I think that's part of it. So that's just a fact of life. It's true at many places, and it's true here.

Harkewicz: Okay. Final two questions. What do you think has made Scripps successful? And, what has threatened its success?

Somerville: I don't know what has made Scripps successful. I think that there has been some visionary leadership, and some people really did see the big picture. And, as I said, I'm not going to stand in front of a tape recorder and give you a rank ordering of the people I admire or don't who have been important in the history of the place. But I think overall the fact that we, as I've said, we all care deeply about the place, and that we've been able to attract absolutely first-rate people consistently, decade, after decade after decade, that counts. We have ranked quality above all. We've ranked quality above warm fuzzy human qualities. We've ranked it above grantsmanship, or political savvy, or anything like that. In every search I've ever been involved in, we were just looking for the best and the brightest and the finest scientists and we've been successful overall. I mean, it really is a first-rate place. So, that's first and foremost.

Harkewicz: What about threats to its success?

Somerville: I worry, in the future, not only about the state of science in the United States in general, in which I think there's plenty to worry about, but I worry about the plight of the University of California, which does not pay competitive salaries and which is located in some of the most outrageously expensive housing markets of the world. We've already lost many people in searches whom we would have liked to have had here, because they didn't want to spend their life parked on I-5, or they wanted to bike to work, or they wanted to able to live without depending on a spouse's income, or something like that. Or to send their children to good schools. The University of California has fallen on hard times in that respect. And so you combine San Diego real estate prices with uncompetitive UC salaries and a UC budget that's not happy, not healthy. That concerns me. So I think

those are going to be the things that I would worry about if I were director. Just simply, the decline in state support for the university, and all the things that that implies, and the increasing pressure to bring in grants, and increasing need for private funding. Those are big, big issues. And in my field, you know, we, Scripps has this longstanding problem of having a faculty and a research staff, and there are many, many issues both social, and financial, and otherwise, that accrue from that. We, in fields like atmospheric science, which are Johnny-come-latelies to Scripps, we have a higher ratio of research staff to faculty, because to make a new professor, you have to have a faculty FTE. Somebody has to have retired. To make a new researcher, you just need resources. But we pay our researchers in a less attractive way, because they're more dependent on grants. And we're competing with those other seventy schools that give Ph.D.s that tend to have all their scientists on the faculty with nine months of hard money. So there are uncompetitive aspects like that. Despite that, we have attracted and retained some wonderful people, but the long-term trends in that direction are troubling.

Harkewicz: Do you think that could ever change?

Somerville: Absolutely. Of course it could change. There was a time when there wasn't the University of California. I can imagine a world in which the public is less excited about funding prisons and more excited about funding great universities.

Harkewicz: Well, I guess specifically I meant about the whole split between faculty and research at Scripps. I mean, historically that's what they've been like. Do you see that that could ever change?

Somerville: Yes. Yes. And, it could change rather rapidly once people decided it was to their advantage. Now mind you, many people have spent their entire careers as members of the research staff here and flourished, thrived. I'm just saying that institutionally it's a split that has many downsides. It concerns me very much.

Harkewicz: Okay. Well, I think I've taken up more than enough of your time. Is there anything you wanted to add?

Somerville: I didn't bring a little speech.

Harkewicz: Okay.

Somerville: So this will be fine. We can always have another session.

Harkewicz: Right. Well, thank you very much for talking to me today.

Somerville: It's been a pleasure.