Testimony of Dr. Michael Oppenheimer
Princeton University
at the

Committee on Science, Space, and Technology
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On
Climate Change Science

Contents

Introduction

My name is Michael Oppenheimer. I am the Albert G. Milbank Professor of Geosciences and International Affairs at Princeton University and a member of the faculties of the Department of Geosciences, the School of Public and International Affairs, and the High Meadows Environmental Institute. I would like to thank Chairwoman Johnson and the members of this committee for inviting my testimony at this hearing. The views expressed in this testimony are my own. I am not speaking as an official representative of Princeton University. Let me first describe my professional background. A complete CV accompanies this testimony.

I received an S.B. from MIT and a PhD in chemical physics from the University of Chicago and served as a postdoctoral fellow and then Atomic and Molecular Astrophysicist at the Harvard Smithsonian Center for Astrophysics, researching interstellar gases and Earth's upper atmosphere. Subsequently, I served as Chief Scientist for the Environmental Defense Fund, a private, not-for-profit research and advocacy environmental organization (where I continue to serve as a paid advisor on scientific matters). In 2002, I became a professor at Princeton University where I direct the Center for Policy Research on Energy and the Environment. I have published over 200 articles in professional journals. Almost all of those published over the past 30 years cover aspects of climate change science and climate change policy. My current research focuses largely on projecting sea level rise and coastal flood levels in a warming world with special emphasis on the contribution of the Greenland and Antarctic ice sheets; the risk to coastal areas from sea level rise; and adaptation and other responses to climate change, sea level rise, and extreme climate events, such as human migration. I have served in various capacities as an author of assessments produced by the Intergovernmental Panel on Climate Change (IPCC) since its First Assessment Report in 1990, most recently as a Coordinating Lead Author of IPCC's Special Report on *Oceans and Cryosphere in a Climate Change* (SROCC), published 18 months ago. I shared responsibility for the chapter assessing sea level rise. I currently serve as a review editor on IPCC's Sixth Assessment Report for a chapter that synthesizes understanding of all risks associated with climate change. In 2018, along with six other experts in diverse fields, I published a book on scientific assessments, *Discerning Experts: The practices of scientific assessment for environmental policy*.

Purpose of This Testimony

The Committee invited me to discuss the state of our understanding of the effects of climate change on processes such as ice loss, sea level rise, coastal storms, and extreme heat; recent observations of accelerating rates of ice loss and sea level rise, and extreme heat events in the U.S., and how climate change is affecting the U.S. on regional and local scales. The Committee also asked for information on the relationship of climate change impacts to human migration, and the disproportionate impacts of climate change on vulnerable populations. In addition, I was asked to comment on the value of interdisciplinary research involving both the physical and social sciences in understanding climate risk, the importance of these fields of research to developing mitigation and adaptation solutions, and the importance of observations and modeling including research gaps or recommendations for additional investments in climate science that the Science Committee should address.

As background on the current state of the climate, some key findings of IPCC reports and research since their release are:

- In 2020, Earth was about 2°F (1.1°C) warmer than it was early in the industrial era.[1]
- IPCC's Fifth Assessment stated, "It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century",[2] i.e., the accumulation of greenhouse gases (such as carbon dioxide) in the atmosphere as a result of human activity (largely related to fossil fuel combustion to provide energy) is the primary cause of the observed global warming.

- Associated with this warming, pervasive changes have been detected in many features of Earth's climate system, including more frequent hot days and nights and fewer extremely cold ones, increases in the frequency, intensity, and amount of heavy precipitation events, greater intensity and duration of drought in some regions, increase in the intensity of North Atlantic hurricanes, and sea levels rising nearly worldwide.[3]
- Changes in heat, precipitation and sea level are attributed with medium or high confidence to the greenhouse gas buildup.[3]
- Characteristics of some extremely damaging events, like the intense precipitation from Hurricane Harvey, can now be attributed to the greenhouse gas buildup. In other words, it is no longer true that no single climate event can be connected quantitatively to the greenhouse gases – due to advances in computer modeling, many already have been.[4]
- All of these changes are projected with medium or high confidence to continue to build throughout this century. Those related to heat, precipitation, hurricanes, and sea level pertain to the US as well while the attribution of US drought changes is less clear.[5]
- Perhaps most important, global climate change cannot be halted unless emissions of the major greenhouse gases, particularly carbon dioxide, are eliminated. To keep warming from surpassing the Paris Agreement's long-term objective of maintaining the global average temperature well below 2^{o}C with the aspiration of not exceeding a 1.5^{o}C warming may require removing some carbon dioxide from the atmosphere by artificial means which are not yet economically viable.[6]

Sea Level Rise

According to IPCC's Special Report on *Oceans and Cryosphere in a Changing Climate (SROCC)*[7], global sea level is rising largely as a result of three processes that are adding water to the oceans and causing their volume to increase.

- Liquids generally expand when heated, and the same is true of ocean water as heat trapped by the greenhouse gases penetrates to great depths. As a result, the oceans are taking up greater and greater volume which translates into sea level rising. In addition, two other process are adding to the amount of water in the ocean and this also causes sea level rise:
- Mountain glaciers are in retreat nearly worldwide due to the warming and their meltwater generally winds up in the oceans.
- The major ice sheets have been losing ice faster and faster since about 1990. The Greenland ice sheet is melting at its lower elevations and the meltwater is running off into the ocean. In some locations, the ice is flowing faster down glacial fjords, breaking into icebergs at the coast, and in this way also adding more water to the ocean. Taken together, these two processes have caused a large increase in Greenland's contribution to global sea level rise. The Antarctic ice sheet is generally too cold to melt at its surface but, in several areas, warm waters beneath its floating shelves are causing melting from below, accelerating iceberg formation and causing a growing contribution to sea level rise (see Figure 2).
- As a result, the overall rate of sea level rise from 2006-2015 was about 2.5 times the rate during the 20th century (about 6 inches/century then; now about 14 inches/century). This may seem like a small amount but a rough rule of thumb applied to a typical East Coast beach estimates that each foot of vertical rise results in inland loss of about 100 feet due to erosion and permanent inundation, absent restoration. Taken together, losses from the ice sheets are now responsible for about 1/3 of the ongoing rise in sea level, and they are accelerating. *Sharpening our understanding of how fast the ice sheets will lose ice as the world warms further is a key to more precisely projecting sea level rise over this century.*

Sea level projection

The future behavior of the ice sheets presents the greatest uncertainty in projecting sea level rise. In a low emissions scenario that could meet the Paris target, global average sea level is expected to rise 7-13 inches by midcentury and 11-23 inches by 2100. In a high emissions scenario that could lead to global warming in excess of 9ºF (5ºC) above recent temperatures, sea level rise is expected to reach 9-16 inches by mid-century and 24-43 inches by year 2100 (Figure 1; all numbers compared to sea level around year 2000).[7]

However, sea level rise is not distributed uniformly around the world. Many local effects cause place-to-place variations of +/-30%. As it happens, the northeast US coast has already experienced sea level rise of 1.5-2.0 times the global average.

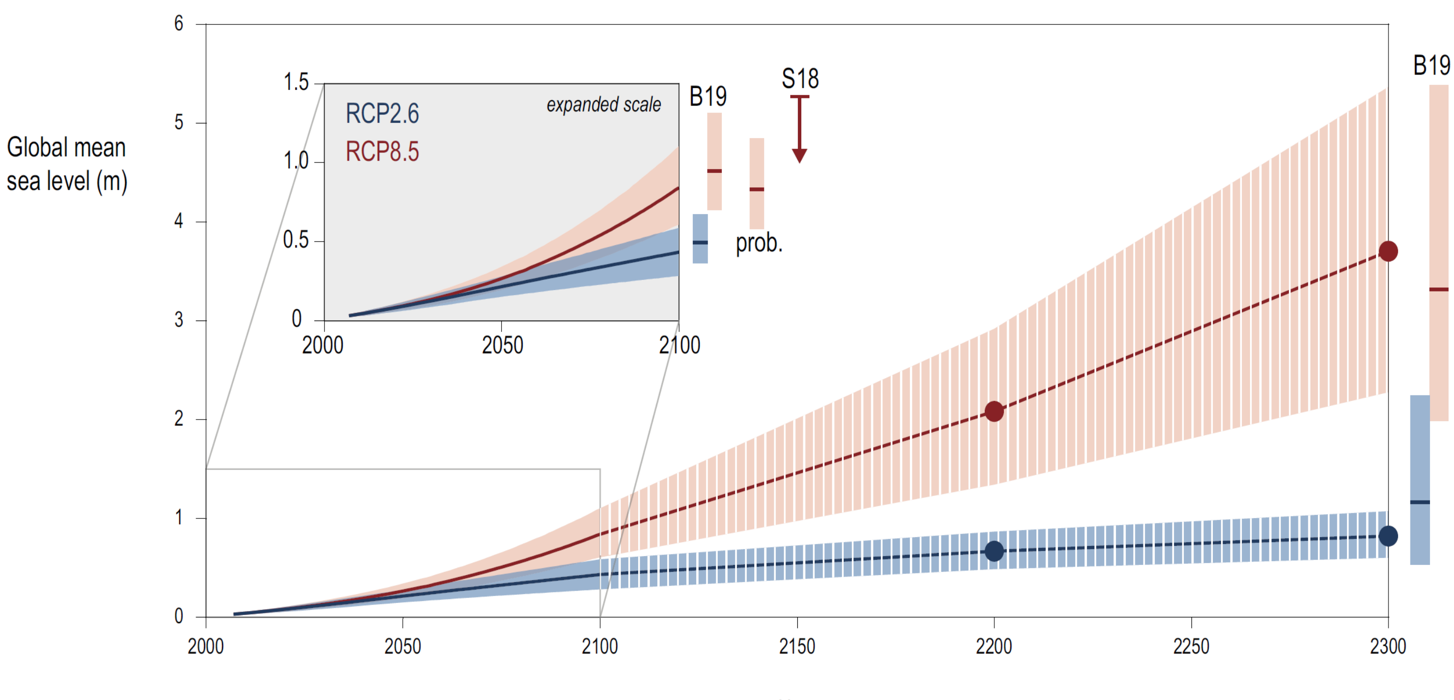

Figure 1. Projected global mean sea level rise for high (red) and low (blue) emissions scenarios. Large graph runs to year 2300, inset expands the period 2000-2100. Results are from mechanistic models that are based on equations describing the physics of ice. Solid lines are the median sea level rise for each case. The shaded blue or red areas above and below the median represent the 17—83% uncertainty range, combining both uncertainty in ice physics and uncertainty in climate and ocean sensitivity to

warming. Vertical bars show results from other estimation methods (sensitivity studies, partially probabilistic approaches, and expert elicitation) that may capture low-probability outcomes better than the mechanistic approach. From SROCC (2019), figure 4.2[7]

Due to the possibility of various ice sheet instabilities developing in response to ocean and atmospheric warming (Figure 2), retreat of Antarctic ice may occur faster than our best current models suggest, particularly beyond 2100. The potentially unstable sectors of Antarctica contain ice equivalent to roughly 15 meters (50 feet) of sea level rise. About 25% of that total may already be on the brink of unstable retreat. There is disagreement among experts as to how fast unstable retreat would occur once it begins, with estimates ranging from about 200-900 years to completion. Accordingly, SROCC recommended that stakeholders, including policy makers, take the possibility of higher sea level rise into account when making judgments related to building long-lived coastal infrastructure, such as coastal defenses.

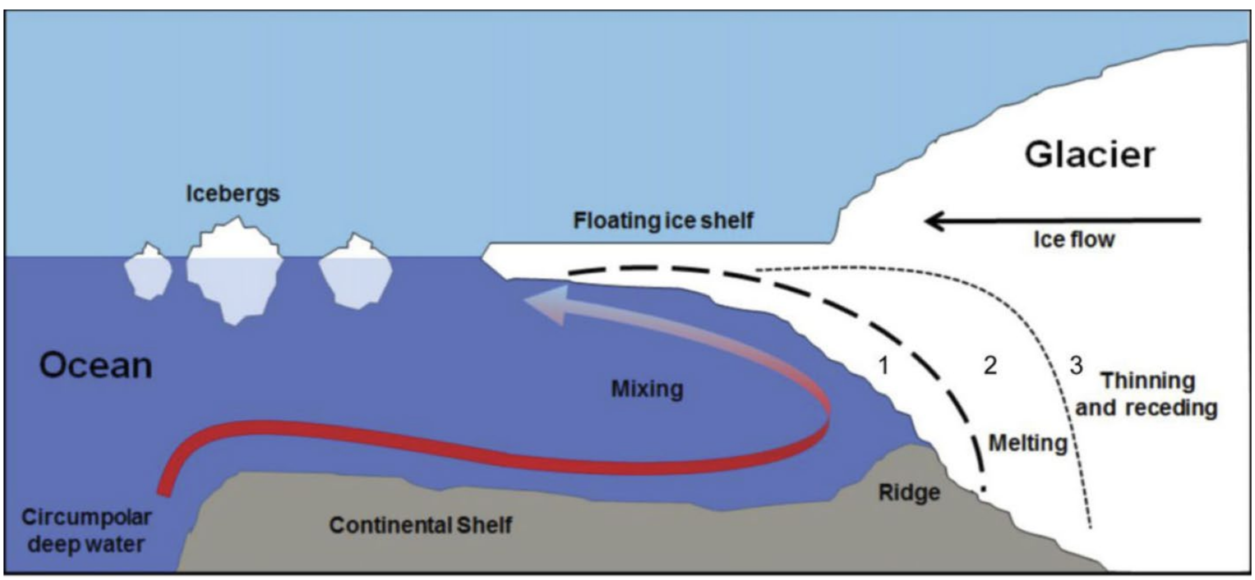

Figure 2: Warm water circulating under the floating ice shelf (red arrow) reaches the boundary, or grounding line, between ice resting on bedrock and the floating ice. Forward motion of the grounded ice there is obstructed by ridges in the bedrock but the warm water melts away some ice causing the ice just behind to lift off the ridge and accelerate into the ocean. This process can cause parts of the ice sheet to become unstable.[7] Figure from reference 8.

The flip side of this argument, indicated in figure 1, is that we have a pretty clear picture of sea level rise through 2050, when uncertainties are not large and provide a sound basis for coastal planning and implementation.

Consequences of sea level rise

Higher sea level sets a new baseline for the elevations along the coast and inland reached by water during high tides as well as the coastal storms like hurricanes and nor'easters that are accompanied by surge. That means that flood levels reached only rarely in recent times will become common as the sea rises. For example, at many US coastal locations, as well as worldwide, with about 2^0C global warming, the historical once-per-century water level is expected to occur ***every year*** or more often by 2050. The list of such locations includes Savannah, Jacksonville, Miami, Los Angeles, San Diego, and Honolulu. By 2100, New York and others will join this list.[7] Different cities will be affected to different extents – for some of these locations, particularly along the West Coast, the current hundred-year water level is a high tide rather than a storm so the corresponding flood level is lower than would be the case at, for instance, an East Coast city where the current hundred-year water level typically results from a hurricane. Nevertheless, substantial amounts of infrastructure have been built of the past century or two with the historical high-water level in mind, whether from a high tide or storm. Those sites will need to be reconsidered carefully, well before 2050, because building protection or implementing planned retreat to higher ground can take decades.

The effects of higher sea levels are already evident. The once-per-decade flood height in New York Harbor in 1940 now arrives once every five years. Sections of the old bulkhead that remains the only defense for some sections of lower Manhattan are only 5-6 feet tall,[9] about the same height as the current once-in-five-year event, leading to overtopping. Sunny-day or tidal flooding has become a regular event (several times per month) at many places along the coast where it was heretofore rare. Certain neighborhoods in Miami provide costly examples.

Adapting to the Risk

Recent experience with a growing list of deadly and costly climate disasters [Hurricane Katrina (2005), Hurricane Sandy (2012), Hurricane Harvey (2017), Hurricane Maria (2017), wildfires in California and elsewhere in several recent years, the Texas cold snap (2021) and several others] serves as a warning that we are not as effective at anticipating and adapting to *today's* level of risk as we should be. Yet, we are going to need to become much more effective, very quickly as climate change increases the likelihood of extreme heat, category 4 and 5 hurricanes, wildfire, and more frequent episodes of coastal high water.

We should learn from each case and start immediately to deal with the weak spots in our responses. Otherwise, the coming decades will bring ever more disastrous outcomes for more and more Americans. Before delving into causes, let me point out that there is some encouraging experience to learn from – *worldwide, deaths in coastal storm surge (e.g., accompanying hurricanes) have decreased since 1900*.[10] The same trend appears in US data but the uncertainty is larger due to the sparsity of events. While the reasons for this trend are unclear, improved forecasting has in all likelihood made an important contribution.

Now to the bad news: recent events show that we are still leaving much too much undone, or improperly done, before a big event strikes and it remains unclear how long the learning from any one event lasts. The levees that failed in Katrina in 2005 were the product of experience with Hurricane Betsy 40 years earlier. The current defenses are doubtless an improvement but are not designed to handle the higher surge that a category 5 storm may bring. Hurricane Sandy struck a metropolitan area (New York) that seemed to have grown complacent due to the lack of catastrophic coastal events in previous decades. Critical infrastructure (hospitals and an electric utility substation) were flooded, causing massive service disruptions and necessitating emergency evacuation of hospitalized patients and an enormous cost for repairs, on the order of a billion dollars in the case of one hospital. The subway system, the lifeblood of the City, was flooded and shut down for 3-4 days. Figure 3 shows that although Sandy was an unusual event with a return time of about 250 years, nine storms in the 60 previous years had *almost* flooded the system [11], yet little or nothing had been done to protect it.

Much of the damage could have been averted by measures taken only *after* Sandy struck: hardening low-lying subway entrances and ventilation systems, raising emergency generators and fuel to upper floors of hospitals where they had sat basements, forbidding construction of new hospitals in the flood zone. The same sort of hardening and rezoning is underway or has been completed for existing substations.

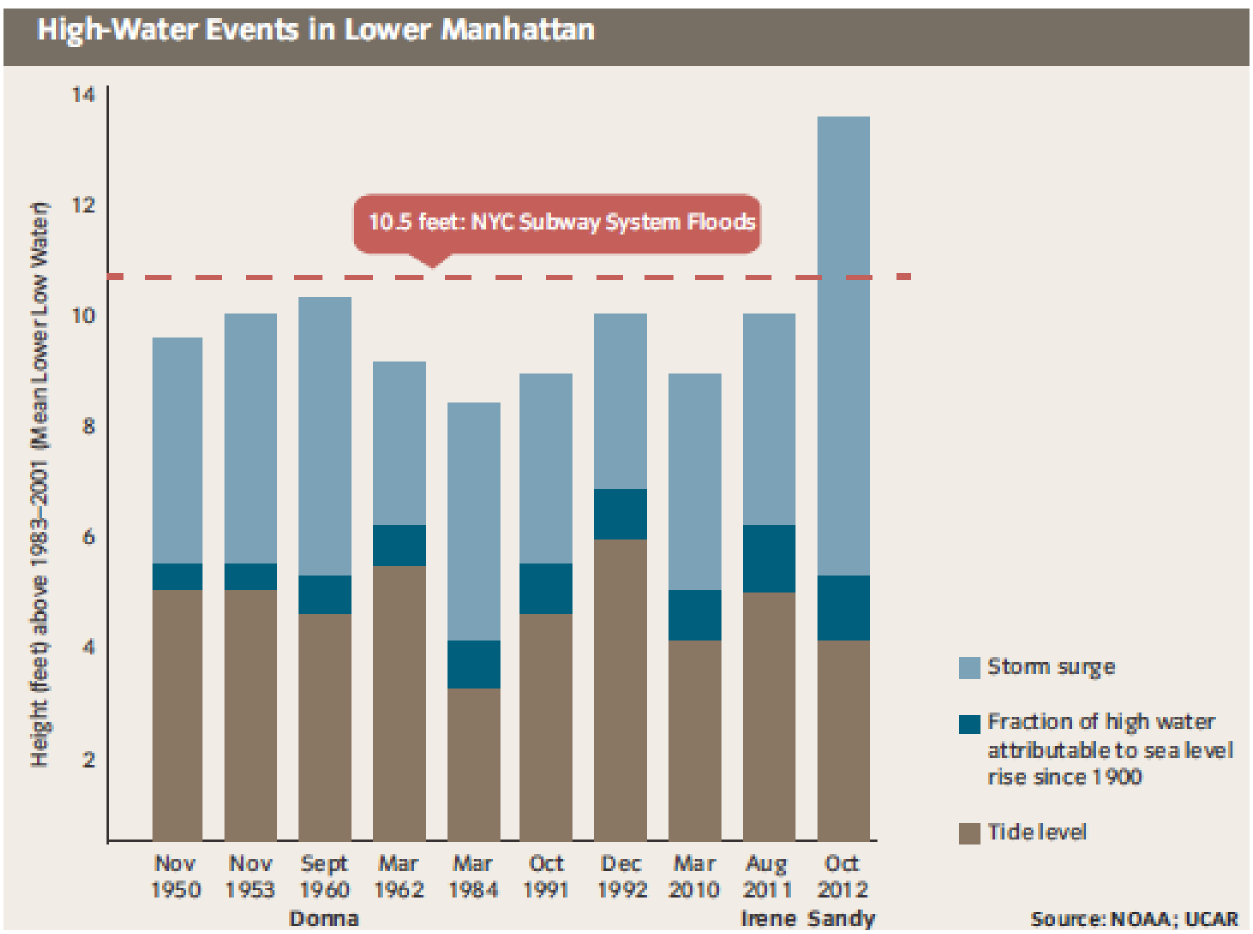

Figure 3: Nine highest flood levels at the southern tip of Manhattan (The Battery) preceding Hurricane

Sandy (tenth bar on right). Flood level where seawater enters the subway system indicated by red dashed horizontal line. Fraction of high-water due to sea level rise, tide, and storm surge indicated.[11]

Ignoring even recent experience, and failing to adequately anticipate and adapt to extreme events was by no means unique to Hurricane Sandy, as Hurricane Katrina and the Texas cold snap vividly illustrate. The situation will grow more perilous as the probability of some extreme events continues to increase.

Lessons for other Climate Change Risks

Some systematic problems with the US approach to climate adaptation, like those plaguing the National Flood Insurance Program, are unique to governmental arrangements for coastal and inland flood preparation. Other such failings inhibit attempts to design effective climate adaptation across the board. While our understanding continues to evolve, the social science and psychology literature provides some explanations for the shortcomings discussed above.

- The general public's memory of even disastrous events is short. Along with the long implementation times for infrastructure projects like hard coastal protection, this reduces pressure on local officials to develop long term plans and initiate their implementation.

- Political rewards favor *ex post* cleanup to *ex ante* preparation because the public tends to see the latter in terms of its immediate cost to them while benefits may become obvious only years or decades into the future. This situation is exemplified and exacerbated by the relatively sparse federal funding for adaptation measures not tied to a specific disaster(s) compared to the vast sums spent *ex post* on clean up (e.g., under the Stafford Act). The result is a perverse incentive to local officials to continually defer adaptation actions.[12]

- Households sometimes take a single action to prepare in advance, like raising their houses above the level of a recent damaging flood, rather than a broad set of actions, e.g., purchasing insurance as well, just in case a yet higher flood event occurs. This "single-action bias" is especially troublesome when households assume that a government action is sufficient, like dune restoration, and take no further action to reduce the risk to lives and property.[13]

- States and localities often lack sufficient revenue to execute large scale adaptation projects without substantial federal assistance. In the case of coastal and inland flooding, resources dedicated to the US Army Corps of Engineers partially meet these local needs but it is doubtful whether appropriations and priority setting are aligned with the increasing risk from climate change. Other areas of risk, like wildfire on private land, lack any established federal adaptation funding, planning, or insurance role.

- As illustrated by the case of the failure of the New Orleans evacuation plan when Hurricane Katrina made landfall (see next section), characteristics of vulnerable groups are often not accounted for when designing either adaptation or emergency response. Questions over looming gentrification[14] have been raised about Miami's response to increasing tidal flooding and about some of the voluntary buyout programs implemented in the wake of Hurricane Sandy. Some of this reflects the realities of the real estate market but program design is also a concern.

My bottom line is that the current US system for dealing with climate adaptation is highly fragmented across many dimensions, is performing far from adequately to meet today's level of risk, and must be reformed across the board to keep from falling far, far behind as risk increases. Furthermore, as mentioned above and as we now show in the context of extreme heat, under some circumstances, adaptation planning aggravates rather than ameliorates the problems of vulnerable populations.

Extreme Heat and Impacts on Vulnerable Populations

Some populations are more vulnerable than others to a range of climate impacts whether due to age, illness, persistent racial discrimination, or economic status. Any federal program to assure effective climate adaptation must address this inequality or it will fail a significant portion of the US population. I'll use the example of extreme heat to illustrate how this unequal distribution of vulnerabilities plays out in practice.

Extreme heat is the leading cause of climate-related death in the US. Heat is a contributory cause of about 700 deaths per year as indicated by death certificates. Heat also plays an indirect role as indicated by the much larger number of excess deaths attributed to high temperature, as many as 19,000 per year in one study.[15] Climate change will bring more frequent, more intense, and longer heat wave episodes. How we adapt will be critically important to avoiding a large increase in mortality, morbidity, and economic losses. Evidence between 1987-2005 suggests a decrease in heat-related deaths for the overall population but the constant death rate found for people 65 years and older is troubling.[16]

Adaptation to extreme heat is largely relegated to the household level and commonly includes air conditioning as well as behavior changes like shifts to less exertion and wearing lighter clothing. However, among the tens of millions living in the densest parts of urban areas where temperatures are generally several degrees above those of the surrounding countryside, are found many residents who cannot afford air conditioning. Many of them are among the aforementioned vulnerable groups as a consequence of race, income, health status, or age.

The frequent failure of governments to account for such differences in vulnerability was perhaps best illustrated during Hurricane Katrina – the New Orleans emergency evacuation plan was developed with the assumption that all residents had access to motor vehicles and could drive out of town. This assumption made no sense for a city whose residents were disproportionately of low income. Partially as a result, many people wound up in the Superdome or drowned. A similar lack of attention to vulnerable groups seems to characterize urban responses to heat emergencies.

Cities deal with this risk by establishing cooling centers. However, as shown by one recent study[17] of three US cities (Phoenix, New York, and Chicago), the locations of these centers bear no systematic relationship to the vulnerable populations that need them most and distances from their neighborhoods to cooling centers were often such as to make them effectively inaccessible to those aged, ill, or without access to a motor vehicle. Furthermore, days and hours of operation varied inexplicably from center to center.

Multidisciplinary Research to Address Climate Change

It should be apparent from the examples above that managing the climate change problem successfully requires a solid basis not just in the physical climate sciences (for which support certainly needs to be maintained and strengthened) but the social sciences, psychology, and climate economics, and for joint collaborations among these specialties. Such multidisciplinary research shouldn't mean experts burrowing ever deeper into their professional silos, then coming together periodically to share insights over lunch before returning to their silos. Rather, it means that specialists should assemble teams that are truly multidisciplinary and work together, sharing methods, and developing questions and answers in close collaboration. Universities were slow to realize what sort of arrangements for research and graduate education this requires but gradually, they are changing. None have solved the problem of how to do this optimally but many experiments are afoot, including on my own campus. The National Science Foundation has played a leadership role in supporting such efforts in the past but resources for the social sciences remain inadequate to fund multidisciplinary research. That would be my top priority for NSF and other agencies that consider it their mission to actually solve problems relevant to climate change that fall on real people.

Other priorities that are more specific to coastal defense, extreme heat, and other issues discussed in this testimony are too numerous to mention so here are my top 3 - my apologies for the many I have slighted. The first draws on traditional approaches but I place it there to underscore its importance.

- Continue and expand polar research programs including modeling of ice sheets and the ocean-ice sheet interaction, measurements and remote observations, because the fate of the ice sheets is a key unknown in projecting sea level rise.

- Expand research programs on voluntary migration, involuntary population displacement, and other forms of human mobility likely to be intensified by climate change. This requires a broadly multidisciplinary effort.

- Develop a comprehensive program to support research on adaptation to climate change including when, how, and why people make decisions about risk, what information these are based on, what actions result under which circumstances, and policies to encourage responses that are effective from both individual and collective perspectives.

Conclusion

Let us assume for the moment that the world, hopefully led by this country, attains the Paris Agreement's long-term objective. Even then, a large-scale, well-planned US adaptation effort, coordinated across the complex layers of government in our federal system, and adequately funded decade after decade, will be required to avoid calamity for many.

Absent such a program, the unavoidable warming that will occur, including what is already baked into the climate system, will cause more difficulties than much of the US population, not to mention the rest of humanity, can deal with.

On the other hand, if rapid, deep reductions in greenhouse gas emissions are not implemented, then we will eventually find ourselves in situations beyond our capacities to successfully adapt. Every few tenths of a degree of warming will bring more and more extreme heat, sea level rise, wildfire, decreases in access to water, and ecological destruction, accompanied by a panoply of social and political challenges.

Neither emissions reductions alone nor adaptation alone are sufficient. Only the combination of strong, persistent adaptation efforts coupled with transformation of our energy systems and modification of lifestyles sufficient to bring emissions sharply down to zero will solve the climate problem.

Only if both emissions reduction and adaptation are designed and implemented with our most vulnerable groups at the table rather than an afterthought, or as too often happens today, overlooked entirely, is the political consensus for this monumental task likely to gel. In this case, “vulnerable” includes not just those vulnerable groups I mentioned above in the context of adaptation, but also those who might come out at the losing end of the energy transformation needed to meet these challenges.

I’d like to thank the committee once again for affording me the opportunity to testify.

References

1. NASA,Goddard Institute for Space Studies, Surface Temperature Analysis, at https://data.giss.nasa.gov/gistemp/.

2. IPCC, 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., et al (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p.17.

3. *ibid* ref. 2, p.7

4. Emanuel, K, (2017), Assessing the present and future probability of Hurricane Harvey's rainfall. *PNAS,* **114**, 12681-12684; https://doi.org/10.1073/pnas.1716222114

5. *Climate Science Special Report*, Fourth National Climate Assessment, US Global Change Research Program, at https://science2017.globalchange.gov/chapter/executive-summary/.

6. Larson, E., et al (2021), *Net-Zero America: potential pathways*, infrastructure, and impacts, at https://environmenthalfcentury.princeton.edu/sites/g/files/toruqf331/files/2020-12/Princeton_NZA_Interim_Report_15_Dec_2020_FINAL.pdf

7. Oppenheimer, M., et al, 2019: *Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities*. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, et al (eds.)]. In press.

8. Gornitz, V, et al (2019) New York Panel on Climate Change 2019 Report: Sea level rise. Annals of the New York Academy of Sciences **1439,** 71-94.

9. Talke, S. A., P. Orton, and D. A. Jay (2014), Increasing storm tides in New York Harbor, 1844–2013, Geophys. Res. Lett., 41, 3149–3155, doi:10.1002/2014GL059574.

10. Bouwer, L.M. and Jonkman, S.N. Global mortality from storm surges is decreasing. *Environ. Res. Lett.* 13 (2018) 014008 https://doi.org/10.1088/1748-9326/aa98a3

11. NYC, (2013) Report from the Special Initiative for Rebuilding and Resiliency, at https://www1.nyc.gov/site/sirr/report/report.page

12. Rasmussen, DJ, et al (2021), The political complexity of coastal flood risk reduction: lessons for climate adaptation public works in the U.S. (Rasmussen et al). *Earth's Future*, https://doi.org/10.1029/2020EF001575

13. Buchanan, M., et al (2019), Values, Bias, and Stressors Affect Intentions to Adapt to Coastal Flood Risk: A Case Study from New York City. *Weather, Climate and Society* **11**, 809-821. https://doi.org/10.1175/WCAS-D-18-0082.1

14. Siders, A.R. (2019), Social justice implications of US managed retreat buyout programs. *Climatic Change* (2019) 152:239–257 https://doi.org/10.1007/s10584-018-2272-5

15. Watts, N., et al. (2020), The 2020 report of The *Lancet* Countdown on health and climate change: responding to converging crises. *The Lancet* 397, 129-170*, at https://doi.org/10.1016/S0140-6736(20)32290-X*

16. Bobb, J.F., et al, (2014), Heat-Related Mortality and Adaptation to Heat in the United States. Environ, Health Perspectives 122, 811-816.

17. Schneer, K.E., Urban Adaptation to Extreme Heat: Accessing cooling centers in Phoenix, Chicago, and NYC. Senior Thesis, Princeton University, submitted April 27, 2020

CURRICULUM VITAE
(March 2021)

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Coordinating Lead Author and Review Editor, Intergovernmental Panel on Climate Change

Fields of Specialization

Physics and chemistry of the atmosphere; climate change, ozone depletion, acid deposition and air pollution: their effects on natural systems and society, and public policy responses.

Education

S.B. (Chemistry) M.I.T., 1966
Ph.D. (Chemical Physics) University of Chicago, 1970

Positions

1966-67	Teaching Assistant, University of Chicago
1971-73	Research Fellow, Harvard College Observatory
1971-81	Astrophysicist, Harvard-Smithsonian Center for Astrophysics
1978-79	Visiting Astronomer, University of California, Santa Cruz
1981-96	Senior Scientist, Environmental Defense Fund (EDF)
1995 -2002	Manager, Global / Regional Air Program, EDF
1996 -2002	Chief Scientist, EDF
2002-	Professor of Geosciences and International Affairs, Princeton University

Honors, Awards

1969	Danforth Tutor, University of Chicago
1969-70	Union Carbide Fellow, University of Chicago
1978-79	John Simon Guggenheim Memorial Foundation Fellow
1978-79	Morrison Fellow, University of California, Santa Cruz
1989	The Henry Draper Award of the Hudson River Fishermen's Association
1989-2001	Streisand Chair in Environmental Studies, EDF
2000	League of Conservation Voters, Environmental Leadership Award
2001	Environmental Action Coalition Green Star Award
2005-2006	Russell Sage Foundation Visiting Scholar
2007	New Species Award, African Rainforest Conservancy
2007	Participant in the Intergovernmental Panel on Climate Change, which won the Nobel Peace Prize in 2007
2009-10	Russell Sage Foundation Associate Scholar
2010	Heinz Award Winner
2010	First Stephen Schneider Memorial Lecturer, AGU
2010-	Fellow, American Association for the Advancement of Science
2014	Linacre Lecturer, Oxford University
2014-15	Pace Academy Visiting Fellow, Pace University
2015	Agassiz Visiting Lecturer, Dept. Earth and Planetary Sciences, Harvard Univ.

Committees, Boards, and Panels

1982-90	Board of Directors, National Clean Air Coalition
1982	E.P.A. Lead Criteria Review Committee
1982-84	Acid Rain Advisory Committee, N.Y. State Department of Environmental Conservation
1982-86	Board of Directors, OSHA-Environmental Network
1983	Ad Hoc Committee to Review the National Acid Precipitation Assessment Program, White House Council on Environmental Quality
1985-90	Hudson River Panel, Hudson River Foundation
1986-88	Board of Directors, Environmental Planning Lobby
1987-88	E.P.A. Visibility Committee
1988-89	Panel on Greenhouse Warming, World Resources Institute

1988-95	Advisory Board, Pace University Center for Environmental Legal Studies
1989-95	NASA Advisory Committee on the Atmospheric Effects of Stratospheric Aircraft
1989-97	Chairman, Science Advisory Panel, Climate Change Exhibition, American Museum of Natural History
1990-96	Advisory Board, Environmental Media Association
1990	Contributing Author, Intergovernmental Panel on Climate Change, First Assessment Report, WGII Chapter 5
1991-02	Board of Analysts, "Greenwire"
1991-92	National Steering Committee, Florida Global Warming Education Project, American Horizons
1991-94	Environmental Advisory Committee to New York Governor Mario Cuomo
1992-94	Visiting Committee, Cornell Center for the Environment, Cornell University
1994	Interim Advisory Committee, Princeton Environmental Institute, Princeton University
1995-99	National Academy of Sciences/National Research Council, Panel on the Atmospheric Effects of Aviation
1996	Contributing author, Intergovernmental Panel on Climate Change, Second Assessment Report, WGI Technical Summary and Chapter 8
1997-98	Technical Advisory Panel, H. John Heinz III Center
1998	Global Change Steering Committee, H. John Heinz III Center
1998-99	Scientific Advisory Board, The Riverkeeper
1999-02	Advisory Board, Earth and Environmental Studies Program, Montclair State College
2000-02	Executive Campaign Cabinet, Earth System Science Research Center, University of California, Irvine
2000-02	Advisory Council, Center for Environmental Policy, Bard College
2001	Lead author, Intergovernmental Panel on Climate Change, Third Assessment Report, WGI Technical Summary; Drafting Team, WGI Summary for Policy Makers
2001-05	Environment Jury, Heinz Awards, Heinz Foundation
2003-09	Trustee, Tri-State Transportation Coalition
2003-06	Steering Committee, Aldo Leopold Leadership Program
2003-	Executive Committee, Cooperative Institute for Climate Science, Princeton University and NOAA Geophysical Fluid Dynamics Laboratory
2003-07	Science and Technology Council, Cummins, Inc.
2004-07	Lead Author, Intergovernmental Panel on Climate Change, Fourth Assessment Report, WGII Chapter 19
2005-06	Panel on Climate Variability and Change, National Research Council, National Academy of Sciences
2005-14	Executive Committee, Environmental Studies Program, Princeton University

2006-19	Executive Committee, Center for Information Technology Policy Policy, Princeton University
2006-8	Chair, steering committee for Arctic Expedition for Climate Action (Lindblad Expeditions, Aspen Institute, National Geographic Society)
2007-8	Advisory Board, African Rainforest Conservancy
2007-09	Panel on Alternative Liquid Transportation Fuels, National Academy of Sciences
2007-8	Co-curator, *Climate Change: The threat to life and our energy future*, American Museum of Natural History
2007-9	Editorial Board, Environmental Research Letters
2008-19	Executive Committee, Program in Sustainable Energy, Princeton University
2008-	Board of Directors, Climate Central
2008	Advisory Board to NJDEP commissioner on establishing an SAB
2009-12	Coordinating Lead Author, Intergovernmental Panel on Climate Change, Special Report on *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*, Chapter 1; Drafting Author Summary for Policy Makers
2009-16	National Academies Board on Energy & Environmental Systems
2010-12	American Geophysical Union (AGU) Outreach Committee
2010-14	Coordinating Lead Author, Intergovernmental Panel on Climate Change, Fifth Assessment Report, WGII Ch. 19; Drafting Author, Summary for Policy Makers; Member Core Writing Team, Synthesis Report
2011-14	Advisory Board, Yale Climate and Energy Institute
2012-	Sustainability Steering Committee, Princeton University
2012	AGU Climate Change Position Statement Panel
2012	AGU Journal Feasibility Study Task Force
2013-19	NYC Climate Change Panel, Mayor's Office
2015-19	AGU Climate Communication Prize Committee
2015-	Science Advisor, Climate Communication
2015-	Editorial Board, Journal of Extreme Events
2016	Co-coordinator, Climate Science Subgroup, Hillary Clinton Campaign
2016	AGU Panel on Statement on Scientists' Rights and Responsibilities
2016-2018	Andlinger Center Executive Committee, Princeton University
2017-20	AAAS Electorate Nominating Committee, Atm. & Hydro. Sci. Section
2017-	Board of Directors, Climate Scientists Legal Defense Fund
2017-19	Coordinating Lead Author, Intergovernmental Panel on Climate Change, Special Report of Oceans, Cryosphere and Climate Change, Chapter 4.
2018-21	Review Editor, Sixth Assessment Report, Intergovernmental Panel on Climate Change
2019-	Advisory Board, Metcalf Institute for Marine and Environmental Reporting, URI, Advisory Board

Membership in Professional Societies

American Association for the Advancement of Science
American Geophysical Union
American Meteorological Society
American Physical Society
International Glaciological Society

Current and Recent Sources of Research Support

Princeton School of Public and International Affairs
High Meadows Foundation (ongoing)
National Science Foundation Grants: *Risk Assessment and Risk Management: An Integrated Approach for Responding to Multiple Hazards from Tropical Cyclones in a Changing Climate* (2015-2020); Responses to complex disruptive events: Cognition in a socio-political context (2021-2023)

BIBLIOGRAPHY

Articles in Professional Journals

1971 Ultraviolet spectra of alkali halides in inert matrices (with R. S. Berry). *J. Chem. Phys*., **54**, 5058.

1972 Collision matrix elements near a pseudocrossing of potential energy curves. *J. Chem. Phys*., **57**, 3899.

1972 Non-resonant charge capture: $Na^+ + Li = Na + Li^+$ (with C. Bottcher). *J. Phys. B*., **5**, 492.

1972 Eigenvalues of the $2p3p^3P$ and $2p3d^{1,3}D$ bound states of the helium isoelectronic sequence (with H. Doyle and G. W. F. Drake). *Phys. Rev*., **A5**, 26.

1972 The charge transfer spectrum of $(LiNa)^+$ (with C. Bottcher and A. Dalgarno). *Chem. Phys. Lett*., **15**, 24.

1972 The calculation of photoabsorption processes in helium (with A. Dalgarno and H. T. Doyle). *Phys. Rev. Lett*., **29**, 1051.

1973 Chemiionization in interstellar clouds (with R. S. Berry and A. Dalgarno). *Ap. J.*

Lett., **183**, L21.

1973 The formation of formaldehyde in interstellar clouds (with A. Dalgarno and J. Black). *Nature*, **245**, 100.

1974 The chemistry of sulphur in interstellar clouds (with A. Dalgarno). *Ap. J.*, **187**, 231.

1974 The fractional ionization in dense interstellar clouds (with A. Dalgarno). *Ap. J.*, **192**, 29.

1974 Chemical heating in diffuse interstellar clouds (with A. Dalgarno). *Ap. J.,* **192**, 597.

1974 Configuration mixing effects on molecular dipole transition moments (with K. Docken). *Chem. Phys. Lett*., **29**, 349.

1974 Hydrogen chloride in dense interstellar clouds (with A. Dalgarno, T. de Jong, and J. H. Black). *Ap. J. Lett.*, **192**, L37.

1975 The formation of CO and thermal balance in interstellar clouds (with A.Dalgarno). *Ap. J.*, **200**, 419.

1975 Comets and interstellar masers. *Nature*, **254**, 677.

1975 Gas phase chemistry in comets. *Ap. J.,* **196**, 251.

1975 A bound state expansion method for calculating resonance and non-resonance contributions to continuum processes: Theoretical development and application to the photoionization of helium (with H. Doyle and A. Dalgarno). *Phys. Rev*., **A11**, 909.

1975 The formation of CH^+ in interstellar clouds (with A. Dalgarno and J. H. Black). *Ap. J.*, **199**, 633.

1975 Metastable ^2P oxygen ions in the daytime thermosphere (with several authors). *J. Geophys. Res*., **80**, 1026.

1975 A bound state method for phase shifts in elastic scattering of electrons from atoms and ions (with A. Dalgarno and H. Doyle). *Chem. Phys. Lett*., **32**, 6.

1976 An improved bound state method for calculating resonance eigenvectors and properties (with H. Doyle). *Phys. Rev*., **A13**, 665.

1976 Recombination of NO^+ in the ionosphere (with several authors). *Geophys. Res. Lett*., **3**, 209.

1976 Molecular oxygen abundances in the thermosphere from the chemistry of the O_2^+ ion based on Atmosphere Explorer-C composition measurements (with A.

Dalgarno and H. C. Brinton). *J. Geophys. Res*., **81**, 4678.

1976 Ion chemistry of N_2^+ and the solar ultraviolet flux in the thermosphere (with A. Dalgarno and H. C. Brinton). *J. Geophys. Res*., **81**, 3762.

1977 Isentropic instabilities in the interstellar gas. *Ap. J*., **211**, 400.

1977 Association ionization and interstellar TiO and TiO^+ (with A. Dalgarno). *Ap. J*., **212**, 683.

1977 Daytime chemistry of NO^+ from Atmosphere Explorer-C measurements (with A. Dalgarno, F. P. Trebino, L. H. Brace, H. C. Brinton and J. H. Hoffman). *J. Geophys. Res*., **82**, 191.

1977 Indirect determinations of molecular oxygen densities in the daytime thermosphere from Atmosphere Explorer-C composition measurements (with K. Kirby-Docken). *J. Geophys. Res*., **82**, 3503.

1977 Comparison of measured and calculated thermospheric molecular oxygen (with W. E. Potter, D. C. Kayser, H. C. Brinton and L. H. Brace). *J. Geophys. Res*., **82**, 5243.

1977 Ion photochemistry of the thermosphere from Atmosphere Explorer-C measurements (with E. R. Constantinides, K. Kirby-Docken, G. A. Victor, A. Dalgarno and J. H. Hoffman). *J. Geophys. Res*., **82**, 5485.

1978 An analysis of the coma of Comet Bennett 1970 II. *Ap. J*., **225**, 1083.

1978 The EUV flux inferred from AE-C He^+ abundances (with S. Babeu, J. H. Hoffman and E. Breig). *Geophys. Res. Lett*., **5**, 773.

1978 Evidence for shock chemistry in Orion (with C. Lada and T. W. Harquist). *Ap. J. Lett.*, **226**, L153.

1979 The effect of cosmic ray screening upon the stability of interstellar clouds (with B. Elmegreen and T. W. Hartquist). *Astron. Astrophys*, **75**, 137.

1979 Photoionization and photoabsorption cross sections of thermospheric species: He, O, N_2, and O_2 (with K. Kirby, S. Babeu, E. R. Constantinides and G. A. Victor). *Atomic Data and Nuclear Data Tables*, **23**, 63.

1980 Molecular diagnostics of interstellar shocks (with T. W. Hartquist and A. Dalgarno). *Ap. J*., **236**, 182.

1980 Sodium D-line emission in Comet West (1975n) and the sodium source in comets. *Ap. J*., **240**, 923.

1980 Chemical reactions and the nature of comets. *Accounts of Chemical Research*, **13**, 378.

1980 The effect of solar cycle ultraviolet flux variations on cometary gas (with C. J. Downey). *Ap. J. Lett.*, **241**, L123.

1981 EUV flux variations during solar cycle 21 from AE-E He+ abundances (with S. Babeu and H. C. Brinton). *J. Geophys. Res.*, **86**, 825.

1981 Ultraviolet absorption studies of H_2O and other species in Comet Halley with space telescope (with P. L. Smith and J. H. Black). *Icarus*, **47**, 441.

1982 Sulfur emissions. *Science* (Letters), **217**, 586.

1983 The relationship of sulfur emissions to sulfate in precipitation. *Atmos. Environment*, **17**, 451.

1983 The relationship of sulfur emissions to sulfate in precipitation II. Gas phase processes. *Atmos. Environment*, **17**, 1489.

1984 The relationship of sulfur emissions to sulfate in precipitation III. Subregional budget analysis. *Atmos. Environment*, **18**, 403.

1985 An analysis of the sulfur budget and interstate sulfur transport for Colorado. *Atmos. Environment*, **19**, 1439.

1985 Acid deposition (with J. N. Galloway, G. E. Likens and S. A. Norton). *Science* (Letters), **227**, 1154.

1985 Acid deposition, smelter emissions, and the linearity issue in the Western United States (with C. Epstein and R. Yuhnke). *Science*, **229**, 859.

1986 Acid deposition in the Western United States (with C. Epstein and R. Yuhnke). *Science* (Letters), **233**, 10.

1986 Empirical relation between sulfur dioxide emissions and acid deposition derived from monthly data (with C. Epstein). *Nature*, **323**, 245.

1987 Stratospheric sulphate production and the photochemistry of the Antarctic circumpolar vortex. *Nature*, **328**, 702.

1988 Restoration of the Chesapeake Bay: A Multi-State Institutional Challenge (with J. T. B. Tripp). *Maryland Law Review*, **47**, 425.

1989 Climate change and environmental pollution: physical and biological interactions. *Climatic Change*, **15**, 255.

1989 Developing policies for responding to climate change. *Climatic Change* **15**, 1-4.

1991 Atmospheric nitrate deposition and the Chesapeake Bay estuary (with D. C. Fisher). *Ambio*, **20**, 102.

1991 Carbon dioxide and temperature (with J. B. Marston, R. M. Fujita and S. R. Gaffin). *Nature* (Scientific Correspondence), **349**, 573.

1993 Pondering greenhouse policy. *Science* (Letters), **259**, 1382.

1994 Reservoir timescales for anthropogenic CO_2 in the atmosphere (with B. C. O'Neill, S. R. Gaffin, and F. N. Tubiello). *Tellus*, **46B,** 378.

1995 Impulse-response functions and anthropogenic CO_2 (with F. N. Tubiello). *J. Geophysical Res. Lett.*, **22**, 413.

1995 Comment on "The lifetime of excess atmospheric carbon dioxide" by Berrien Moore III and B. H. Braswell (with S. R. Gaffin and B. C. O'Neill). *Global Biogeochemical Cycles*, **9**, 167.

1997 Measuring time in the greenhouse: an editorial essay (with B. C. O'Neill and S. R. Gaffin). *Climatic Change*, **37**, 491.

1998 Global warming and the stability of the West Antarctic ice sheet. *Nature*, **393**, 325.

1998 Long-term scenarios for aviation: demand and emissions of CO_2 and NO_X (with A. Vedantham). *J. Energy Policy* **26**, 625.

2000 Counting the cost of deforestation (with R. Bonnie, S. Schwartzman, and J. Bloomfield). Perspectives: Environmental Policy, *Science* **288,** 1763-1764.

2002 Book Review: *The Carbon War: Global Warming and the End of the Oil Era. Climatic Change,* **54,** 497-505

2002 Dangerous climate impacts and the Kyoto Protocol (with B.C. O'Neill). *Science* **296,** 1971-2.

2003 On past temperatures and anomalous late-20th century warmth (with 12 co-authors). Eos **84,** 256-8.

2003 Response (to comments on, On past temperatures and anomalous late-20th century warmth, with 12 co-authors). *Eos* **84**, 473-4.

2003 Book Review: *Atmospheric Pollution: History, Science, and Regulation. Physics Today* **56**, 65-66.

2004 The West Antarctic Ice Sheet and Long Term Climate Policy (with R.B. Alley). *Climatic Change,* **64**, 1-10.

2004 Climate Change Impacts Sensitive to Path to Stabilization (with B.C. O'Neill). *Proc. Nat. Acad. Sci.* **101**, 16411–16416, doi_10.1073_pnas.0405522101.

2004 Book Review: *The Discovery of Global Warming. J. Environmental Hist*., **9**, 327-8.

2004 The influence of climate on in-stream removal of nitrogen (with S.D. Donner and C.J. Kucharik). *Geophys. Res. Letters*, **31**, L20509, doi:10.1029/2004GL020477.

2005 Ice Sheets, Global Warming, and Article 2 of the UNFCCC (with R.B. Alley). *Climatic Change* **68,** 257-267**.**

2005 Global Assessment of Coral Bleaching and Required Rates of Adaptation under Climate Change (with S.D. Donner, W.J.Skirving, C.M. Little, and O. Hoegh-Guldberg). *Global Change Biology,* **11**, 1–15, doi: 10.1111/j.1365-2486.2005.01073.x

2005 Article 2 of the UNFCCC: Historical Origins, Recent Interpretations (with A. Petsonk). *Climatic Change* **73**, 195-226.

2005 Attribution of Regional Radiative Forcing Due to Tropospheric Ozone: A Step Toward Climate Credit for Reductions in Emissions of Ozone Precursors (with V. Naik, D. Mauzerall, L. Horowitz, D. Schwarzkopf, V. Ramaswamy). *J. Geophys. Res*., **110**, D24306, doi:10.1029/2005JD005908

2005 Avoiding Dangerous Anthropogenic Interference with the Climate System (with K. Keller, M. Hall, S.-R. Kim, and D. F. Bradford). *Climatic Change* **73**, 227-238

2005 Defining Dangerous Anthropogenic Interference: The Role of Science, The Limits of Science. *Risk Analysis* **25,** 1-9

2006 Interim Targets and the Climate Treaty Regime (with Brian C. O'Neill, & Annie Petsonk). *Climate Policy* **5**, 639-645.

2006 Global Warming: The Psychology of Long Term Risk (with A. Todorov). *Climatic Change*, **77**, 1–6, DOI: 10.1007/s10584-006-9086-6.

2006 Science and Environmental Policy: The Role of Nongovernmental Organizations, *Social Research*, **73**, 881-90.

2006 Coral Reefs Reduce Tsunami Impact in Model Simulations (with C. Kunkel and R. Hallberg). Geophys. Res. Lett. **33**, L23612, doi:10.1029/2006GL027892.

2006 Learning and Climate Change (with many authors), *Climate Policy* **6,** 585–589.

2007 Model-based Assessment of the Role of Human-induced Climate Change in the 2005 Caribbean Coral Bleaching Event (with S.D. Donner and T.R. Knutson). *Proc Natl Acad Sci,* doi:10.1073/pnas.0610122104

2007 A "Manhattan Project" for Climate Change? (C-J Yang, M Oppenheimer), *Climatic Change* **80**, 199-204, 10.1007/s10584-006-9202-7.

2007 On the Sensitivity of Radiative Forcing from Biomass Burning Aerosols and Ozone to Location of Emissions (V.Naik, et al), *Geophys. Res. Letters,* **34**, L03818, doi:10.1029/2006GL028149.

2007 Carbon Trading over Taxes (B. Chameides, M Oppenheimer), *Science*, **315**, 1670.

2007 The regrets of procrastination in climate policy (K. Keller, et al), *Environmental Research Letters*, **2**, 024004 (4pp) doi:10.1088/1748-9326/2/2/024004.

2007 The Limits of Consensus (M Oppenheimer et al), *Science* **317**, 1505-6.

2007 The Economics of the Thermohaline Circulation – A Problem with Multiple Thresholds of Unknown Locations (with E. Nævdal). *Resource and Energy Economics* **29**, 262-283.

2007 Towards a New Generation of Ice Sheet Models (CM Little et al), *Eos* **88**, 578-9.

2008 Learning about ozone depletion (PJ Crutzen and M Oppenheimer), *Climatic Change* **89**, 143-154 DOI 10.1007/s10584-008-9400-6.

2008 The potential impacts of sea level rise on the coastal region of New Jersey, USA (MP Cooper, MD Beevers, M Oppenheimer), *Climatic Change* **90**, 475–492, DOI 10.1007/s10584-008-9422-0.

2008 Atmospheric stabilization and the timing of carbon mitigation (BK Mignone et al), *Climatic Change* **88**, 251-265. DOI 10.1007/s10584-007-9391-8.

2008 Book Review: An outspoken scientist, *Nature Reports Climate Change*, Published online: 16 January 2008|**doi:10.1038**/climate.2008.3

2008 A closer look at the IPCC report-Response (M Oppenheimer, BC O'Neill, M Webster, S Agrawala), *Science* **319**, 410 *(in Letters)*

2008 The boundaries of the thinkable: environmentalism in the early twenty-first century (P Tetlock and M Oppenheimer), *Dedaelus* **137**, 59–70.

2008 A physical science perspective on disaster: through the prism of global warming (M Oppenheimer), *Social Research* **75**, 659-668.

2008 Negative learning (M Oppenheimer, BC O'Neill, M Webster), *Climatic Change* **89***,* 155-172 DOI 10.1007/s10584-008-9405-1.

2009 Climate change and plant invasions: restoration opportunities ahead? (BA Bradley, M Oppenheimer, DS Wilcove), *Global Change Biology,* **15**, 1511–1521, doi: 10.1111/j.1365-2486.2008.01824.x.

2009 Assessing dangerous climate change through an update of the Intergovernmental Panel on Climate Change (IPCC) ''reasons for concern'' (J Smith et al), *Proc Natl Acad Sci* **106***,* 4133-4137 (http://www.pnas.org/content/106/11/4133.full).

2009 Climate change increases risk of plant invasion in the Eastern United States (B Bradley, D Wilcove, M Oppenheimer), *Biological Invasions*, DOI 10.1007/s10530-009-9597-y.

2009 Ice shelf morphology and the efficiency of basal melting (CM Little, A Gnanadesikan, M Oppenheimer), J. Geophysical Res. **114**, C12007, doi:10.1029/2008JC005197.

2009 Probabilistic assessment of sea level during the Last Interglacial stage (RE Kopp et al), *Nature* **462**, 963-868, doi:10.1038/nature08686.

2009 Toward ethical norms and institutions for geo-engineering research (D Morrow, R Kopp, M Oppenheimer), *Environ. Res. Lett.* **4,** p.1-8, doi:10.1088/1748-9326/4/4/045106.

2009 A force to fight global warming (WR Turner, M Oppenheimer, DS Wilcove), *Nature* **462**, 278-9.

2009 Fixing a critical climate accounting error (T Searchinger et al), *Science* **326**, 527–528, DOI: 10.1126/science.1178797.

2009 *Climatic Change Letters* inaugural editorial (SH Schneider, M Oppenheimer), Climatic Change **97**, 1–2, DOI 10.1007/s10584-009-9751-7.

2010 Climate change: Helping Nature survive the human response (WR Turner et al), *Conservation Letters* **3,** 304-312 doi: 10.1111/j.1755-263X.2010.00128.x.

2010 Nitrogen cycling and feedbacks in a global dynamic land model, (S Gerber et al), *Global Biogeochem. Cycles*, **24**, GB1001, doi:10.1029/2008GB003336.

2010 Urbanization, climate change and flood policy in the United States (AA Ntelekos et al), *Climatic Change* **103**, 597-616 [DOI 10.1007/s10584-009-9789-6].

2010 Climatic change letters: a modest effort to address a gigantic problem, *Climatic Change* **100**, 7-10, DOI 10.1007/s10584-010-9837-2 (editorial).

2010 Carbon Calculations to Consider-Response (Searchinger et al), *Science* **327**, 781 [DOI: 10.1126/science.327.5967.781-a] (in Letters).

2010 Bioenergy: Counting on Incentives-Response (Searchinger et al), *Science* **327,** 1200-1201 [DOI: 10.1126/science.327.5970.1200-a] (in Letters).

2010 Linkages among climate change, crop yields and Mexico–US cross-border migration (S Feng, A Krueger, M Oppenheimer), *Proc Natl Acad Sci,* **107***,* 14257–14262 www.pnas.org/cgi/doi/10.1073/pnas.1002632107.
See also www.pnas.org/cgi/doi/10.1073/pnas.1212226109 for Correction.

2011 Characterizing uncertainty in expert panel assessments (J O'Reilly, et al), *WIREs Clim Change* **2,** 728–743 DOI: 10.1002/wcc.135

2011 Exploring high-end scenarios for local sea level rise to develop flood protection strategies for a low-lying delta - the Netherlands as an example (CA Katsman, et al), *Climatic Change* **109**, 617-645 DOI: 10.1007/s10584-011-0037-5

2011 The Politics and Policy of Carbon Capture and Storage: Framing an Emergent Technology (K Backstrand, J Meadowcroft, M Oppenheimer), *Global Environmental Change*, **21**, 275–281 doi:10.1016/j.gloenvcha.2011.03.008

2011 Evaluation, Characterization, and Communication of Uncertainty by the Intergovernmental Panel on Climate Change (G Yohe, M Oppenheimer), *Climatic Change* **108**:629–639 DOI 10.1007/s10584-011-0176-8

2012 Predicting how adaptation to climate change could affect ecological conservation: secondary impacts of shifting agricultural suitability (B Bradley et al), *Diversity and Distributions*, **18,** 425-437
http://onlinelibrary.wiley.com/doi/10.1111/j.1472-4642.2011.00875.x/pdf

2012 The Rapid Disintegration of Predictions: Climate Science, Bureaucratic Institutions, and the West Antarctic ice sheet (J O'Reilly, N Oreskes, M Oppenheimer), *Social Studies of Science* **42**, 709-731 DOI: 10.1177/0306312712448130, at http://sss.sagepub.com/content/early/2012/06/26/0306312712448130

2012 On the coupled response to ice shelf basal melting (CM Little, D Goldberg, A Gnanadesikan, M Oppenheimer), *Journal of Glaciology* **58**, 203-215 doi: 10.3189/2012JoG11J037

2012 Climate Change Impacts: Accounting for the Human Response (M Oppenheimer), *Climatic Change* **117**, 439-449 (2013); DOI 10.1007/s10584-012-0571-9

2012 Physically-based Assessment of Hurricane Surge Threat under Climate Change (N Lin, K Emanuel, M Oppenheimer, E Vanmarcke), *Nature Climate Change* **2**, 462-467 DOI: 10.1038/NCLIMATE1389

2012 Simulation of ocean-land ice interactions through a strongly thermally-forced ice shelf, Part 1: Model description and behavior (Goldberg et al), *J. Geophys. Res. E,* DOI: 10.1029/2011JF002246

2012 Simulation of ocean-land ice interactions through a strongly thermally-forced ice shelf, Part 2: Sensitivity to external forcings (Goldberg et al), *J. Geophys. Res. E,* DOI: 10.1029/2011JF002247

2012 Applying statistical models of the climate-migration relationship (S Feng, M Oppenheimer), *PNAS* **109**, E2915 www.pnas.org/cgi/doi/10.1073/pnas.1212226109

2013 Climate change prediction: erring on the side of least drama? (Brysse et al), *Global Environmental Change*, 23, 327-337 http://dx.doi.org/10.1016/j.gloenvcha.2012.10.008

2013 A probabilistic assessment of sea level variations within the Last Interglacial stage (R Kopp et al), *Geophysical Journal International*. *Geophysical Journal International* 193, 711– 716 doi: 10.1093/gji/ggt029

2013 Projected climate impacts to South African maize and wheat production in 2055: A comparison of empirical and mechanistic modeling approaches (L Estes et al), *Global Change Biology* doi: 10.1111/gcb.12325

2013 Building a More Effective Global Climate Regime through a Bottom-Up Approach (with RB Stewart and B Rydek), *Stanford Environmental Law Journal* **32**, 341-392.

2013 Quantum Cascade Laser-based Sensing for Carbon Sequestration Leakage Monitoring (M Escarra et al), *IEEE Sensors Journal*, DOI 10.1109/JSEN.2013.2253731

2013 Comparing mechanistic and empirical model projections of crop suitability and productivity: Implications for ecological forecasting (Estes et al), *Global Ecology and Biogeography*, http://onlinelibrary.wiley.com/doi/10.1111/geb.12034/pdf.

2013 Probabilistic framework for assessing the ice sheet contribution to sea level change (CM Little, NM Urban, M Oppenheimer), *PNAS* **110**, 3264-69 http://www.pnas.org/content/110/9/3264.full.pdf+html

2013 Upper bounds on twenty-first-century Antarctic ice loss assessed using a probabilistic framework (CM Little, M Oppenheimer, NM Urban), *Nature Climate Change* **3**, 654-659 doi:10.1038/nclimate1845 http://www.nature.com/nclimate/journal/vaop/ncurrent/full/nclimate1845.html

2013 Norms and Abnormal Problems: Behaviors, Values, and Global Problems (A Kinzig et al), *BioScience* **63**,164-175 http://www.jstor.org/stable/info/10.1525/bio.2013.63.3.5

2013 A New Strategy for Global Climate Protection (RB Stewart, M Oppenheimer, B Rudyk), *Climatic Change* **120**, 1-12 DOI 10.1007/s10584-013-0790-8 http://link.springer.com/article/10.1007/s10584-013-0790-8/fulltext.html

2014 On the Design of an International Governance Framework for Geoengineering (ID Lloyd, M Oppenheimer), *Global Environmental Politics* **14**:2, May 2014, doi:10.1162/GLEP_a_00228

2014 Using Changes in Agricultural Value to Quantify Future Climate-Induced Risk to Conservation (Estes et al), *Conservation Biology*, DOI: 10.1111/cobi.12205

2014 The Effectiveness of Cool and Green Roofs as Urban Heat Island Mitigation Strategies (D Li, E Bou-Zeid, M Oppenheimer), *Environ. Res. Lett.* **9** (2014) 055002 doi:10.1088/1748-9326/9/5/055002

2014 Estimating the Spatially Varying Responses of Corn Yields to Weather Variations Using Geographically Weighted Panel Regression (Cai, Yu, and Oppenheimer), *Journal of Agricultural and Resource Economics*, **39**, 230–252.

2014 Nonlinear permanent migration response to climatic variations but minimal response to disasters (P Bohra- Mishra, M Oppenheimer, and S Hsiang), *PNAS* **27**, 9780-85 www.pnas.org/cgi/doi/10.1073/pnas.1317166111

2014 The Ethics of Scientific Communication under Uncertainty (R Keohane, M Lane, M Oppenheimer) *Politics, Philosophy, and Economics*, 1-26 DOI: 10.1177/1470594X14538570 https://journals.sagepub.com/doi/full/10.1177/1470594x14538570

2014 Probabilistic 21st and 22nd century sea-level projections at a global network of tide gauge sites (RE Kopp et al), *Earth's Future* **2**, 383-406 http://onlinelibrary.wiley.com/doi/10.1002/2014EF000239/abstract

2014 Improve economic models of climate change (Revesz et al), *Nature*, **508**, 173-175

2014 International Migration Desires Related to Subjective Well-Being (R Cai et al), *IZA Journal of Migration*, 2014, 3:8 doi:10.1186/2193-9039-3-8, http://www.izajom.com/content/3/1/8

2014 Warming goal: still the best indicator (M Oppenheimer), *Nature (Correspondence)* **514,** 434.

2015 Uncertainty in 21st century CMIP5 sea level projections (Little et al), *JClim* **28**, 838-852 DOI: 10.1175/JCLI-D-14-00453.1.

2015 Developing country finance in a post-2020 global climate agreement (P Hannam, Z Liao, SJ Davis, M Oppenheimer), *Nature Climate Change* **5**, 983–987 doi:10.1038/nclimate2731.

2015 Joint projections of US east coast sea level and storm surge (Little et al), *Nature Climate Change* **5**, 1114-1121 DOI: 10.1038/NCLIMATE2801.

2015 New York City Panel on Climate Change 2015 Report Chapter 2: Sea Level Rise and Coastal Storms (Horton et al) *Proc NY Acad Sci*, **36,** 1336–44 doi: 10.1111/nyas.12593

2015 Adapting to Climate Change: Rising Seas, Limiting Risks (M Oppenheimer) *Social Research* **82**, 673-680.

2015 Push renewables to spur carbon pricing (Wagner et al), *Nature* **525**, 27-29.

2016 Expert Judgment and Uncertainty Quantification for Climate Change (M Oppenheimer, CM Little, RM Cooke), *Nature Climate Change,* **6***,* 445-451.

2016 Climate Variability and International Migration: The Importance of the Agricultural Linkage (R Cai et al), *J Environ Econ Management* **79**, 135-151 *http://dx.doi.org/10.1016/j.jeem.2016.06.005.*

2016 The Science of Climate Change (M Oppenheimer, JK Anttila-Hughes), *Future of Children* **26**, 13-30.

2016 Climate Change and Migration in the Philippines (Bohra-Mishra et al), *Population and Environment*, **38,** 286–308 http://rdcu.be/mFnl.

2016 Mapping the climate change challenge (Hallegatte et al), *Nature Climate Change*, **6**, 663-668.

2016 The Influence of Climate Variability on Internal Migration Flows in South Africa (Mastrorillo et al), *Global Environmental Change* **39**, 155-169.

2016 Beyond the Climate Dead End Through Pledge and Review? (RO Keohane and M Oppenheimer). *Politics and Governance* **4,** 142-151 doi: 10.17645/pag.v4i3.634.

2016 Make climate-change assessments more relevant (Hallegatte, Mach, et al). *Nature*, http://www.nature.com/news/make-climate-change-assessments-more-relevant- 1.20155

2016 Allowances for evolving coastal flood risk under uncertain local sea-level rise (Buchanan et al). *Climatic Change* **137**, 347–36.

2016 How high will the seas rise? (M Oppenheimer, RB Alley), *Science* **354,** 1375-77.

2017 Key Risks of Climate Change: The IPCC Reasons for Concern, (O'Neill et al), *Nature Climate Change* **7**, 28-37 http://rdcu.be/ohnY

2017 Climate response to the meltwater runoff from Greenland Ice Sheet: evolving sensitivity to discharging locations (Liu et al), *Climate Dynamics*, https://link.springer.com/article/10.1007/s00382-017-3980-7

2017 Leakage risks of geologic CO2 storage and the impacts on the global energy system and climate mitigation" (Deng et al), *Climatic Change*, **144,** 151–163 DOI 10.1007/s10584-017-2035-8

2017 Unmask temporal tradeoffs in climate policy debates (I Ocko et al), *Science* **356**, 492-93.

2017 Social Cost of Carbon: Global Imperative (Revesz et al, Letter to the Editor). *Review of Environmental Economics and Policy* **11**, 172–173 doi:10.1093/reep/rew022

2017 The Intergovernmental Panel on Climate Change: Challenges and Opportunities (Vardy et al), Ann. Rev. Environment and Resources **42**, 55-75. http://www.annualreviews.org/doi/full/10.1146/annurev-environ-102016- 061053

2017 Amplification of flood frequencies with local sea level rise and emerging flood regimes (M Buchanan, M Oppenheimer, R Kopp), *Environ. Res. Lett.* **12** https://doi.org/10.1088/1748-9326/aa6cb3

2017 Evolving understanding of Antarctic ice-sheet physics and ambiguity in probabilistic sea-level projections (R Kopp et al), *Earth's Future*, **5**, 1217–1233. doi:10.1002/2017EF000663 http://rdcu.be/EW7I.

2017 Building Blocks: A Strategy for Near-term Action within the New Global Climate Framework (RB Stewart, M Oppenheimer, B Rudyk), *Climatic Change* **144**, 1–13 DOI 10.1007/s10584-017-1932-1.

2017 Estimating Economic Damage from Climate Change in the United States (Hsiang et al), *Science* **356***,* 1362-1369 at http://science.sciencemag.org/content/356/6345/1362.full

2017 Evaluating Tropical Cyclone Size in Reanalysis Datasets using QuikSCAT Data (Schenkel et al), *Journal of Climate* **30**, 8745-62

2017 Influence of Risk Factors and Past Events on Flood Resilience in Coastal Megacities: Comparative Analysis of NYC and Shanghai (Xian et al). *Science of the Total Environment,* **610–611**, 1251–1261, https://doi.org/10.1016/j.scitotenv.2017.07.229

2018 Interactions between Urban Heat Islands and Heat Waves (Zhao et al). *Environ. Res. Letters*, https://doi.org/10.1088/1748-9326/aa9f73

2018 Lifetime Evolution of Outer Tropical Cyclone Size and Structure as Diagnosed from Reanalysis and Climate Model Data (Schenkel et al). *JClim*., https://doi.org/10.1175/JCLI-D-17-0630.1

2018 Extreme sea level implications of 1.5 °C, 2.0 °C, and 2.5 °C temperature stabilization targets in the 21st and 22nd century (Rasmussen et al). *Environ. Res. Letters*. **13**, https://doi.org/10.1088/1748-9326/aaac87

2018 Emissions are still rising: ramp up the cuts (Figueres et al). *Nature* **564**, 27-30

2019 Values, Bias, and Stressors Affect Intentions to Adapt to Coastal Flood Risk: A Case Study from New York City (M Buchanan, M Oppenheimer, Parris). *Weather, Climate and Society* **11**, 809-821. https://doi.org/10.1175/WCAS-D-18-0082.1

2019 Temporally Compound Heat Wave Events and Global Warming: An Emerging Hazard (J Baldwin et al), *Earth's Future*, **7**. https://doi.org/10.1029/2018EF000989

2019 Ice sheet contributions to future sea level rise from structured expert judgement (Bamber et al), *PNAS*, https://www.pnas.org/cgi/doi/10.1073/pnas.1817205116

2019 Migration, Intensification, and Diversification as Adaptive Strategies (Bell, A, Calvo-Hernandez, C, & Oppenheimer, M). *Socio-Environmental Systems Modeling*, **1**, 1–18. https://doi.org/10.18174/sesmo.2019a16102

2019 Meeting the looming policy challenge of sea-level change and human migration (Wrathall et al). *Nature Climate Change* **9,** 898–901 doi:10.1038/s41558-019-0640-4

2019 New York Panel on Climate Change 2019 Report: Sea level rise (Gornitz et al). Annals of the New York Academy of Sciences **1439,** 71-94

2019 New York Panel on Climate Change 2019 Report: Coastal flooding (Orton et al). Annals of the New York Academy of Sciences **1439,** 95-114

2020 Antarctic Ice Sheet and emission scenario controls on 21st-century extreme sea-level changes (Frederikse et al). *Nature Communications,* **11**, 1-11, https://rdcu.be/b0wGX.

2020 A flood damage allowance framework for coastal protection with deep uncertainty in sea-level rise (Rasmussen et al). *Earth's Future,* http://dx.doi.org/10.1029/2019EF001340

2020 Understanding and managing connected extreme events (Raymond et al). *Nature Climate Change,* https://doi.org/10.1038/s41558-020-0790-4.

2020 Enhancing New York City's Resilience to Sea Level Rise and Increased Coastal Flooding (Gornitz et al). *Urban Climate,* **33** *https://doi.org/10.1016/j.uclim.2020.100654*

2020 Effect of Border Policy on Exposure and Vulnerability to Climate Change (H Benveniste, M Oppenheimer, M Fleurbaey. *PNAS*, https://doi.org/10.1073/pnas.2007597117

2020 As the world burns. *Foreign Affairs*, Nov/Dec https://www.foreignaffairs.com/articles/world/2020-10-13/world-burns

2021 Global multi-model projections of local urban climates (Zhao et al). *Nature Climate Change,* https://doi.org/10.1038/s41558-020-00958-8

2021 Evaluating the economic cost of coastal flooding (Desmet et al), *AEJ – Macroeconomics*, to be published April 2021. http://faculty.smu.edu/kdesmet/papers/sealevel.pdf

2021 Migration towards Bangladesh coastlines projected to increase with sea-level rise through 2100 (Bell et al). *Environ. Res. Letters,* https://doi.org/10.1088/1748-9326/abdc5b

2021 The political complexity of coastal flood risk reduction: lessons for climate adaptation public works in the U.S. (Rasmussen et al). *Earth's Future*, https://doi.org/10.1029/2020EF001575

2021 Environmental integrity of emissions reductions depends on scale and systemic changes, not sector of origin (Schwartzman et al). Submitted to *Environmental Res. Letters*

2021 Climate Scientists may misrepresent future flood risks using popular extreme sea level metrics (Rasmussen et al). Submitted to *Climatic Change* https://www.essoar.org/doi/10.1002/essoar.10503428.1

2021 Sea-level rise risks and adaptation benefits in low-lying coastal areas (Magnan et al). Submitted to *Science*.

2021 Risk Transfer Policies Facilitate Smallholder Farmer Climate Adaptation (Chocquette-Levy et al), submitted to *Nature Climate Change*.

2021 Cooperative food bank: a collective insurance regime to govern food insecurity and nitrogen pollution under climate change (Liao, et al). Submitted to *Environ. Res. Letters*.

2021 Climate change increases resource-constrained immobility (Beneveniste, Oppenheimer, Fleurbaey). Submitted to *Nature Climate Change*.

(Michael Oppenheimer)

2021 Acting rapidly to deploy readily available methane mitigation measures by sector can immediately slow global warming (Ocko et al). Submitted to *Environ Res Lett*.

Working Papers

2021 A Framework for Classifying and Assessing Sea Level Rise Risk (Hauer et al).

2021 Impacts of Climate Variability and Migrant Networks on South African Internal Migration Using a Network Model (Xiao et al).

Authorship of IPCC and NAS/NRC Reports

1990 *Climate Change: **the IPCC Scientific Assessment*** [First Assessment Report, Contributing Author, WGII Chapter 5] (Cambridge University Press, Cambridge, UK)

1996 *Climate Change 1995: The Science of Climate Change.* Contribution of Working Group I to the *Second Assessment Report of the **Intergovernmental Panel on Climate Change***, Chapter 8, "Detection of Climate Change and Attribution of Causes," and Technical Summary (Cambridge University /Press, Cambridge, UK). [Contributing Author].

1997 *The Atmospheric Effects of Stratospheric Aircraft Project: An Interim Review of Science and Progress*, **National Research Council Panel Report** (National Academy Press, Washington, DC).

1998 *A Review of NASA's Atmospheric Effects of Stratospheric Aircraft Project*, **National Research Council Panel Report** (National Academy Press, Washington, DC).

2001 *Climate Change 2001: The Science of Climate Change*. Contribution of Working Group I to the *Third Assessment Report of the **Intergovernmental Panel on Climate Change***, Chapter 11, "Changes in Sea Level," (Cambridge University Press, Cambridge, UK) [Contributing Author]

2001 *Climate Change 2001: The Science of Climate Change*. Contribution of Working Group I to the Third Assessment Report of the ***Intergovernmental Panel on Climate Change***, Technical Summary [Lead Author] and Summary for Policymakers [Drafting Team] (Cambridge University Press, Cambridge, UK).

2007 Assessing Key Vulnerabilities and the Risks from Climate Change (SH Schneider et al), *in Climate Change 2007: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the *Fourth Assessment Report of the **Intergovernmental Panel on Climate Change***, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 779-810. [Lead Author]

2007 Technical Summary. *Climate Change 2007: Impacts, Adaptation and*

Vulnerability (M Parry et al). Contribution of Working Group II to the *Fourth Assessment Report of the* ***Intergovernmental Panel on Climate Change,*** M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 23-78. [Lead Author]

2007 IPCC, 2007: Summary for Policymakers. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the *Fourth Assessment Report of the* ***Intergovernmental Panel on Climate Change,*** M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 7-22. [Drafting Team]

2007 Climate Variability and Change (**National Research Council** Panel Report), in E*arth Science and Applications from Space: National Imperatives for the Next Decade and Beyond* (National Academy Press, Washington, DC), Ch.9.

2009 *Liquid Transportation Fuels from Coal and Biomass*, Report of the Panel on Alternative Liquid Transportation Fuels, **National Research Council (**National Academies Press, Washington, DC).

2011 *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, Special Report of the* ***Intergovernmental Panel On Climate Change***. Summary for Policy Makers [Drafting Team member]

2012 **Lavell**, A., M. Oppenheimer, C. Diop, J. Hess, R. Lempert, J. Li, R. Muir-Wood, and S. Myeong, 2012: Climate change: new dimensions in disaster risk, exposure, vulnerability, and resilience. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. ,Mastrandrea, K.J.Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. *A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC).* Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 25-64. [Coordinating Lead Author]

2014 **Oppenheimer**, M., M. Campos, R. Warren, J. Birkmann, G. Luber, B. O'Neill, and K. Takahashi, 2014: Emergent risks and key vulnerabilities. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects.* Contribution of Working Group II to the *Fifth Assessment Report of the* ***Intergovernmental Panel on Climate Change*** *[Field, C.B., et al (eds.)].* Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp.1039-1099. [Coordinating Lead Author]

2014 **IPCC**, 2014: Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, And Vulnerability Part A: Global and Sectoral Aspects. Contribution of Working Group II to the *Fifth Assessment Report of the* ***Intergovernmental Panel on Climate Change*** [Field, et al (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32 [Drafting Author]

2014 IPCC, 2014 *Synthesis Report of the Fifth Assessment,* ***Intergovernmental Panel on Climate Change*** [Core Writing Team]

2019 Oppenheimer, M., B.C. Glavovic , J. Hinkel, R. van de Wal, A.K. Magnan, A. Abd-Elgawad, R. Cai, M. Cifuentes-Jara, R.M. DeConto, T. Ghosh, J. Hay, F. Isla, B. Marzeion, B. Meyssignac, and Z. Sebesvari, 2019: Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. In press. [Coordinating Lead Author]

2019 IPCC, 2019: Summary for Policymakers. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, M. Nicolai, A. Okem, J. Petzold, B. Rama, N. Weyer (eds.)]. In press. [Drafting Author]

Book Chapters (also see IPCC and NAS/NRC Reports, above)

1986 The Implications of Health and Environmental Effects for Policy (with D. J. Dudek), in *Effects of Changes in Stratospheric Ozone and Global Climate*, Vol. 1, U.S. E.P.A.

1989 Vulnerable Ecosystems, in *Ozone Depletion: Health and Environmental Consequences* (John Wiley & Sons, Chichester, UK) Ch. 9.

1990 The Atmosphere and the Future of the Biosphere: Points of Interactive Disturbance, in *The Earth in Transition: Patterns and Processes of Biotic Impoverishment* (Cambridge University Press, New York) p.111.

2003 Global Warming: The Intersection of Long-Term Goals and Near-Term Policy (with A. Petsonk), in *Michel, D. (ed.), Climate Policy for the 21st Century: Meeting the Long-Term Challenge of Global Warming,* Center for Transatlantic Relations, Johns Hopkins University, Washington, pp.79-112.

2005 Emissions Pathways to Avoid Dangerous Climate Change: A Transatlantic View (with C. Jaeger) in *Options for Future Climate Policy: Transatlantic Perspectives*, German Institute for International and Security Affairs, Berlin.

2007 How Warm is Too Warm: Avoiding Dangerous Climate Change, in International Science School lecture series, University of Sydney, Australia.

2007 What is the economic value of information about climate thresholds? (with several authors), in: *Human-induced Climate Change: An Interdisciplinary Assessment*, ed. Michael Schlesinger, H. Kheshgi, J. Smith, F. de la Chesnaye, J. M. Reilly, T. Wilson and C. Kolstad. Published by Cambridge University Press. Cambridge University Press 2007.

2009 Understanding the causes and implications of climate change, in *Climate Finance: Regulatory and Funding Strategies for Climate Change and Global Development* R Stewart, B Kingsbury, B Rudyk, eds, NYU press, at www.climatefinance.org.

2011 Political legitimacy in decisions about experiments in solar radiation management (DR Morrow, RA Kopp, M Oppenheimer), in *Climate Change Geoengineering: Philosophical Perspectives, Legal Issues, and Governance Frameworks* (William C.G. Burns & Andrew Strauss, editors, 2011, Cambridge University Press)

2011 Climate Change and World Cities, in *Rising Currents: Projects for New York's Waterfront*, MOMA (New York).

2015 Opening Commentary, *America's Climate Future* in Houser et al, Economic Risks of Climate Change, Columbia University Press, New York.

2015 A building blocks strategy for global climate change, in *Towards a Workable and Effective Climate Regime* (S Barrett, C Carraro, and J de Melo, eds), Shamdasani Publishing Services Ltd., UK, chapter 15. At voxeu.org/content/towards-workable-and- effective-climate-regime

Books, Journal Volumes

1989 Guest Editor, *Climatic Change* **vol. 15** Special Issue. *Greenhouse Gas Emissions: Environmental Consequences and Policy Responses.*

1990 *Dead Heat: The Race Against The Greenhouse Effect* (with R. H. Boyle). (Basic Books, New York).

2006 Guest Editor, *Climatic Change* **vol. 77,** Nos.1-2 Special Issue: Global Warming: The Psychology of Long Term Risk.

2011 Guest Editor, Special Issue on Carbon Capture and Storage, *Global Environmental Change.*

2019 *Discerning Experts: The Practices of Scientific Assessment for Environmental Policy* (Oppenheimer et al), University of Chicago Press, March 2019

Other Publications

1978 What are comets made of? *Natural History*, **87**, 42.

1980 The comet syndrome (with L. Haimson). *Natural History*, **89**, 54.

1984 Reducing Acid Rain: The Scientific Basis for an Acid Rain Control Policy. Environmental Defense Fund, New York (also appeared as "Reducing Acid Rain in Eastern North America: The Scientific Basis for an Acid Rain Control Policy" in *Journal of Law Reform, University of Michigan*, **19**, 989 (1986).

1984 Safeguarding Acid-Sensitive Waters in the Intermountain West (with R. Yuhnke). Environmental Defense Fund, New York.

1985 Is There Scientific Consensus on Acid Rain? Report of Ad Hoc Committee on Acid Rain: Science and Policy.

1986 Thresholds for Acidification: A Framework for Policy and Research. Environmental Defense Fund, New York.

1986 New York City's Water Supply: Acid Deposition, Inorganic Pollution, and the Catskill Reservoirs (with J. Ceraso, C. B. Epstein, and S. L. Clark). Environmental Defense Fund, New York.

1988 Global Lessons From The Ozone Hole. Environmental Defense Fund, New York.

1988 Polluted Coastal Waters: The Role of Acid Rain (with D. Fisher, J. Ceraso, and Matthew). Environmental Defense Fund, New York.

1988 Contributor to Developing Policies For Responding To Climatic Change, World Meteorological Organization.

1994 Aircraft Emissions and the Global Atmosphere: Long-term Scenarios (with A. Vedantham.) Environmental Defense Fund, New York.

1995 The Way Things *Really* Are: Debunking Rush Limbaugh on the Environment (with L. Haimson and D. Wilcove). Environmental Defense Fund, New York.

1995 Context, Connection, and Opportunity in Environmental Problem Solving. *Environment Magazine*, **10**.

1996 A Moment of Truth: Correcting the Scientific Errors in Gregg Easterbrook's A Moment on the Earth, Part One (with D. S. Wilcove and M. J. Bean). Environmental Defense Fund, New York.

1996 A Moment of Truth: Correcting More Errors in Gregg Easterbrook's A Moment on the Earth, Part Two (with L. Blum, et al.). Environmental Defense Fund, New York.

1999 Contributing author, Common Questions About Climate Change. United Nations Environment Programme and World Meteorological Organization.

1999 Sustainability And Renewal of Civil Infrastructure: An Environmental Perspective (with Michael Replogle). Presented at a conference organized by the Institute for Civil Infrastructure Systems; New York University.

2003 Climate Change: The Case for Long Term Targets, prepared for *High-Level Transatlantic Dialogue on Climate Change*, German Institute for International and Security Affairs and the Brookings Institution, October 17.

2003 Global Climate Change, prepared for *Old Rules and New Threats*, Council on Foreign Relations, September 19.

2004 Reinvigorating the Kyoto System and Beyond: Maintaining the Fundamental Architecture, Meeting Long-Term Goals, prepared for *Leaders' Summit on Post-Kyoto Architecture: Toward an L20?* (with A. Petsonk), Council on Foreign Relations, September 20-21.

2005 The Latest Myths and Facts on Global Warming (with James D. Wang), Environmental Defense.

2005 Future of Sea Level Rise and the New Jersey Coast: Assessing Potential Impacts and Opportunities (With M.J.P. Cooper and M. Beevers) November 16, 2005

2006 Linked Regimes to Solve the Timing Problem for Global Warming (with A. Petsonk), Prepared for the conference on Nesting and Overlapping Institutions, School of Public and International Affairs, Princeton University, 24 February 2006.

2007 Report of the Ice Sheet Modeling Workshop (with many authors), 8 January 2007

2008 Exploring high-end climate change scenarios for flood protection of the Netherlands (Vellinga et al), a report to the Delta Committee of the Netherlands, September.

2011 What Roles Can Scientists Play in Public Discourse?, *Eos* **92**, 133-134

2011 Obituary: Stephen Henry Schneider, *Physics Today*, January, pp.66-7

2012 Climate Change, Crop Yields, and Internal Migration in the United States (S Feng, M Oppenheimer, W Schlenker), submitted to *J Environ Econ Management* NBER working paper 17734 at http://www.nber.org/papers/w17734.

2013 Climate Risk Information 2013, NYC Panel on Climate Change, NYC Mayor's Office June

2014 Plug methane leaks in the booming natural gas industry, *Scientific American*, April 4.

2015 What Role for Scientists? (N Oreskes, D Jamieson, M Oppenheimer, in *Sustainable Humanity, Sustainable Nature, Our Responsibility*, P.S. Dasgupta,V Ramanathan, and M

Sanchez Sorondo, eds., Pontifical Academy of Sciences and Pontifical Academy of Social Sciences, Proceedings of a Joint Workshop, p.617-649

2015 Science and Policy: Crossing the Boundary (D Jamieson, N Oreskes, M Oppenheimer), *Bulletin of the Atomic Scientists*, **71**, 53-58 DOI: 10.1177/0096340214563675 http://thebulletin.sagepub.com

2017 Rethinking Approaches to Climate Change Policy (S Barrett et al), Social Science Research Center. https://s3.amazonaws.com/ssrc-cdn1/crmuploads/new_publication_3/%7B393FD942-01CE-E711-80C9-005056AB0BD9%7D.pdf

2019 Scientists Have Been Underestimating the Pace of Climate Change (Oreskes, Oppenheimer, Jamieson). *Scientific American*, August 19.