

Statement to the House Committee on Science, Space, and Technology

Ranking member Johnson and members of the Committee: thank you for the opportunity to speak here today. I am Philip B. Duffy, President and Executive Director of the Woods Hole Research Center. Our mission is to develop and implement science-based solutions to climate change. We focus primarily on the role of natural systems in climate change, both as contributors to climate change—though for example greenhouse gas emissions from deforestation and thawing permafrost—and as part of the solution, through for example land management practices that remove carbon from the atmosphere and store it in forests, soils, and other natural systems. We work with countries, primarily in the developing world, to not only reduce their emissions of greenhouse gases (those that come from natural systems), but also to measure those emissions. Both of these actions help those countries to meet their commitments under the Paris climate agreement.

Before coming to WHRC I was a Senior Advisor and Senior Policy Analyst in the White House Office of Science and Technology Policy, where I advised policymakers on a number of issues including priorities for global change research spending. In the next few minutes I will explain what I view as the most critical unanswered questions in climate science.

Before discussing unanswered questions, however, I want to emphasize that we already understand enough to know, well beyond any reasonable doubt, that humanity needs to reduce—dramatically and quickly—its emissions of greenhouse gases to the atmosphere. This has been true for roughly 20 years. So any discussion of unanswered questions should not be used as justification to delay or scale back strong actions to mitigate climate change.

Climate policies should be based on the imperative to avoid the worst outcomes from climate change. In my view, the worst outcomes are those that are most difficult to adapt to, those that once set in motion become impossible to control, those that result in major loss of life and/or major financial losses, and those that impose major costs on future generations (who have no voice in decisions that might prevent them). These worst outcomes include:

- sea level rise resulting from uncontrolled disintegration of major land ice sheets (Greenland or Antarctica);
- large or uncontrollable emissions of greenhouse gases from thawing permafrost;
- disruptive increases in the frequency or intensity of extreme weather events;
- major release of greenhouse gases from forests, as a result of warming, fire, and/or drought;
- major societal disruption resulting from any of the above.

This is by no means an all-inclusive list of potential harms from climate change. Other major potential impacts include large-scale agricultural failures and direct human health impacts. Serious as those may be, I do not regard them as among the *most* serious consequences of climate change, because human ingenuity and resourcefulness can be effective in reducing the risks from those particular outcomes.

Some of the most serious outcomes mentioned above—in particular disintegration of major land ice sheets, and greenhouse gas emissions from thawing permafrost—may become unstoppable once a certain amount of warming (a threshold) is exceeded. Understanding what those warming thresholds are should be our most urgent research priority, since climate policies, if they accomplish nothing else, should keep us clear of those thresholds.

I think it is fair to say that the consequences of climate change appear more ominous as we have learned more about them. Projections of sea level rise, for example, have been revised upwards several times in recent years. Because of these trends in our understanding, the long-standing goal of limiting global warming to 2° has been increasingly supplanted by the stricter goal of limiting warming to 1.5°C.

Meeting either of the goals mentioned above (1.5 or 2°C) is extremely difficult, and that difficulty increases every day that we do not take decisive action. In rough terms, to limit warming to 2°C we would need to reduce overall greenhouse gas emissions by about half by mid-century, and cease emissions altogether by the end of this century. On top of that, we would need to remove somewhere between 100 and 200 billion metric tonnes of carbon from the atmosphere—an amount equivalent to 10 to 20 years of global emissions at the present rate. (How to do that, I should point out, remains an open question.) Of course limiting warming to 1.5°C would be even more difficult. The difficulty of meeting these climate policy goals underscores the importance of refining the goals through better understanding what it takes to avoid the worst outcomes of climate change.

Several of the most dire outcomes mentioned above—disintegration of land ice sheets and greenhouse gas emissions from thawing permafrost—result from warming in the polar regions. With this in mind, we should increase efforts to investigate regionally-focused policy options that would limit warming at the poles specifically, and thus reduce risk from consequences of polar warming. The options investigated should include so-called climate engineering, for example deliberately changing the reflectivity of the surface in order to reduce regional warming. I am not proposing that such measures should be implemented, only that we should understand better how they might work in order to possibly give policymakers a greater range of options.

In summary, our highest policy priority should be to avoid the worst outcomes from climate change. Our highest research priority, therefore, should be to understand as well as possible what would trigger those outcomes. Only with that understanding can we be confident that our policies and our goals are aligned. I emphasize again that we know much more than enough to be sure that our greatest efforts are needed, now, to control climate change. As we make those efforts, however, we also need to be continually refining our top-line goals through better understanding of the most harmful potential effects of climate change.

Thank you, and I look forward to answering any questions you might have.