Notes from call between GiveWell and Michael MacCracken, 05/18/12

GiveWell was represented by Alexander Berger (Research Analyst).

Michael MacCracken has been Chief Scientist for Climate Change Programs with the Climate Institute since 2002. He previously led the interagency Office of the U.S. Global Change Research Program. His research focuses on the potential benefits of limiting emissions of short-lived greenhouse gases and dark aerosols, the general impacts of human-induced climate change on the environment and society, and on geoengineering, particularly approaches that would reduce the Earth's absorption of solar radiation (Solar Radiation Management, or SRM).

The following transcript is edited for length, flow, and content based on an audio recording of the call by GiveWell; it is not meant to be a word-for-word transcript of the entire conversation. Questions by GiveWell are in **bold**; answers by Dr. MacCracken are in normal text.

GW: My impression is that a lot of the research on SRM right now consists of computational modeling, and things like studying records from volcanoes. Are there other major threads of research that are currently ongoing?

MM: I don't think there have been many experimental activities going on. A group in the UK held a workshop that came up with a preliminary experiment that would be an early step towards stratospheric injection. The preliminary experiment was to run a hose from the surface to a balloon at about a kilometer altitude and to pump out a couple bathtubs of water. The experiment was recently cancelled due primarily to issues of permissions and intellectual property.

Overall there have mainly been modeling studies. I tend to lean toward climate engineering approaches that are based in the troposphere or at the surface and that tend to have a regional focus, rather than approaches to take control of the global climate, which seems to me a huge jump.

I think there is still much to understand. For example, how are current SO_2 emissions and the resulting sulfate loading in the troposphere affecting the climate? How has moving the centroid of SO_2 emissions from countries bordering the North Atlantic (i.e., eastern North America and Europe) to China and India has affected the climate, if at all? I don't think that's been looked at very carefully, or perhaps at all yet.

I think we may be able to learn more from studies of the climatic effects of volcano eruptions. Alan Robock will have better ideas than me on that. There are lots of studies of volcano effects; the problem is that each situation is different. The volcanic eruptions come at different latitudes, seasons, and intensities, so it can be difficult to figure out what can be drawn from this.

Rather than field and observation based studies, I lean more toward carrying out a lot of modeling experiments. A few investigators have been running such experiments, but the effort is not very well funded, and there aren't very many people in the area doing it.

GW: It's not clear to us whether it's money or people who drive these processes. It seems like there are very few PI types who are championing this research. Ken Caldeira, David Keith, you mentioned Alan Robock, Phil Rasch, once you get beyond those it seems like there's not a deep shelf of academics who have big labs doing this research. Would just

spending more money get more of those? How does that process work from your perspective?

MM: If a government leader were to say that, within 5 years, we want to do some field testing of approaches in the Arctic (a region where we are on the verge of losing the natural environment), then there would be a purpose and an aggressive effort. There's no timetable or purpose right now. Researchers work on the interesting questions. Most of the experiments are quite idealized; only a few of the experiments are agenda-driven because there is no agenda right now. There is right now only very limited interest in the potential for climate engineering. Could climate engineering be a complementary policy to mitigation and adaptation? Might there be a way to limit warming in the high latitudes and preserve the ice caps? Such questions are not getting widely asked.

For much of the 1990s I was head of the interagency Office of the US Global Change Research Program (USGCRP). In the earliest years, funding was climbing so there was flexibility and it was possible to get scientists to look at interesting issues. Since that time, funding has been held nominally level (so now for ~ 20 years), so there's very little free energy in universities; both professors and students are all working on already approved projects, and so they don't have the free time and resources to explore and look at new topics. It's an unfortunate tightening of the budget that's gone on. There are all sorts of interesting questions about climate change to look at, but students, even in their master's programs, are already focused on some project.

With government funds pretty tied up in the first decade of this century, it took a privately funded effort to get focused research attention on a critical emerging subject [see "An Entrepreneur Does Climate Science," Richard A. Kerr, Science 24 February 2006: 1088-1090 DOI:10.1126/science.311.5764.1088]. The project focused on the issue of the potential for rapid changes in the climate. This effort involved a mega-funder providing resources that were allocated around the community by a small set of scientists, Wally Broecker being one. The effort funded roughly 30 postdocs at universities around the world based on a competition to undertake projects in this area. Each worked with a professor. And the professor would be delighted because here's a person coming in with funding to do something with them. To strengthen the overall effort and start to build an active research community, the project held annual conferences for its postdocs, former postdocs and professors. While it worked well, finding follow-on government money was still difficult.

My view is that, while geoengineering has interesting potential, there just isn't funding for a significant number of scientists to study the potential for climate engineering because there's no end-point/agenda driving the process. Part of the problem is the belief that mitigation can work and will keep us below 2 degrees, which nobody wants to give up on even though it is sounding less and less plausible.

GW: What are the highest value research activities that are not being done right now? What's holding them back?

MM: Some are modeling experiments; some are the starting of field tests.

One approach to climate engineering, at least on a local to regional scale, is to imitate a ship wake by injecting microbubbles to brighten the water, thus increasing the reflection of incoming solar radiation. How big should the bubbles be? What scale would you need? A first test could be done in

an aqueduct or reservoir to determine if one could decrease evaporation. If successful, the approach could gradually be scaled up to bigger bodies of water.

It is also too bad that it is taking so long to move ahead with field experiments of the potential for the cloud brightening. There's a UK group working on this, seeking to imitate the production of "contrails" in the marine stratus clouds when freighters are passing underneath. In clean ocean air, there are a relatively few particles for the water vapor to condense around, so relatively large drops form. With more ice nuclei, the drops end up being smaller, which makes the clouds brighter.

Phil Rasch has been doing modeling experiments on this. One proposal for distributing the injection of ice nuclei is to put the injection devices on freighters, thus brightening shipping routes. That's not necessarily the best place to do it, but the logistics are easy. Anther idea is to build a fleet of clipper-size trimarans that can be computer-driven and self-propelling, lofting ice nuclei in relatively clean areas around the world.

GW: I've seen numbers like a $5 or 10 million annual research budget for geoengineering, scaling up over time as deployment becomes more likely. What would $5 or $10 million of research buy you?

MM: In Europe, where countries have said that they're going to cut emissions, they have funded some research, and the EU is funding multiyear projects of roughly that magnitude. In my view, they can move forward on such research because their planned emissions cutbacks have been useful in setting the upper limit of conditions that might occur. Here in the U.S., until we bound the problem, it's hard to figure out how much climate engineering might be needed. It's going to be this way until Congress (for the US) and the world make a commitment to doing something.

Reducing black carbon and methane emissions, which has important health co-benefits, can cut the projected warming from 2010 to 2050 in half. In February, Secretary of State Hillary Clinton said in a speech that the U.S. will work with other nations to limit such emissions, but then the US only provided $12 million over three years to take these very fundamental steps. We just don't seem to have the commitment we need on the basics, much less on geoengineering.

My particular interest is in trying to save the Arctic. I was just at a conference where there wasn't, however, a huge sense of outrage at what is happening there—mainly acceptance as there is no sense that anything can be done. I think for the Arctic, the next 5-10 years will be critical, especially now that the Greenland and Antarctic ice sheets are starting to lose mass at an accelerating rate. If there is further amplification, this will be very worrisome. The warming Arctic is starting to change the weather over the US, and this is going to start getting to people. Looking at projections for the southern U.S, the landscape is going to change. Australians have been saying that they are having a 30-40 year drought; this might well be a result of climate change, and so will be continuing on and on. There are going to be some changes in the climate that people may want to work on changing in the near term.

It seems to me for the Arctic, an interesting experiment could be done over one summer to see if the amount of solar absorption could be reduced. If the ice could be made thicker, maybe it would last a few years, so we would only have to intervene with climate engineering every couple of years.

GW: Do you know why NSF, NASA and DOE aren't already funding more climate

engineering research? It seems like we've read a lot of reports recently advocating more research.

MM: Let's go back in time a little bit. There have been suggestions for them to do that. President G. W. Bush's 2001 energy program included a provision for geoengineering. For each of the nine or so elements of his plan, Bush got an agency to run a study workshop. DOE held the workshop in October 2001, a document was drafted, and then the report got put in the drawer and not released. It's since been leaked. There was a lot of speculation about why nothing ever happened with it. One problem was likely climate deniers–why would one do geoengineering research if there were not a problem? But even if you accept climate change, if the U.S. said it was going to do climate engineering before it committed to reduce emissions, it wouldn't be accepted well internationally.

The problem has continued with the present administration, likely in large part because the Administration and Congress are not in agreement climate change. The country needs to first indicate how it is going to address emissions, because otherwise there will be significant criticism for focusing on climate engineering before reducing emissions. If the U.S. Congress isn't going to try to transition the world to low emissions to get us over the hump in GHG concentrations, how much sense does it make to pursue climate engineering?

As to establishing research priorities, the National Research Council held a workshop in 2008 and put together a list of things that merited funding. There were 10 or 12 topical areas in the physical sciences, and geoengineering was on there, but it didn't make the cut for real funding when things played out. With no new funding around, any funding for climate engineering would to be cannibalized from something else. The NRC panel had a good list of high priority things to be done; unfortunately, geoengineering is just not near the top of the list.

It's not clear that the modeling has to be that expensive, but for the effort to really be driven, there really needs to be a purpose, goal or commitment.

GW: What's your theory for how that commitment comes about?

MM: We need the President to lead. Back during the 2008 campaign, there was a meeting about where climate change should be ranked in the priority list. A university group got high-level staff of from both the Obama and McCain campaigns to come to a climate change briefing. The first panel was about science and the second was about impacts. It was pretty much what you read in the media. The third panel was made up of three Vice Admirals, who together said that climate change should be one of the top three issues for the incoming president. That got the attention of both campaigns. This discussion, however, was before the recession. When the economic collapse came along, it was joined in the top three the war in Afghanistan and health care legislation. Since then there hasn't been near enough support and attention from the top to get the country moving, even on the easy things to be done [see "Cool the Earth, Save the Economy: Solving the Climate Crisis is EASY"].

GW: Whom else should I talk to about climate engineering?

MM: You should talk to Ken Caldeira, David Keith and Jane Long. There's also a group at CalTech at JPL. The Keck Institute has a history of doing studies for NASA of things that need to be measured. They've recently been looking at things related to climate engineering.