

## Geoengineering researchers ponder ethical and regulatory issues

David Kramer

Citation: *Physics Today* **66**(11), 22 (2013); doi: 10.1063/PT.3.2174

View online: <http://dx.doi.org/10.1063/PT.3.2174>

View Table of Contents: <http://scitation.aip.org/content/aip/magazine/physicstoday/66/11?ver=pdfcov>

Published by the [AIP Publishing](#)

---

**JANIS** Does your research require low temperatures? Contact Janis today.  
Our engineers will assist you in choosing the best system for your application.



10 mK to 800 K  
Cryocoolers  
Dilution Refrigerator Systems  
Micro-manipulated Probe Stations

LHe/LN<sub>2</sub> Cryostats  
Magnet Systems

[sales@janis.com](mailto:sales@janis.com) [www.janis.com](http://www.janis.com)  
**Click to view our product web page.**

nuclear power. Restarting nuclear reactors is a higher priority than cleaning up the Fukushima site, critics say. Playing into the discussion about the future of nuclear power in Japan is debate over whether the meltdowns at Fukushima were caused by the earthquake or the tsunami. For nuclear power proponents, the tsunami is the more comfortable answer, since huge tsunamis are rarer than large earthquakes.

Last year saw the launch of Mayors for a Nuclear Power Free Japan. The group now has nearly 90 members, some from areas near the Fukushima

site, where economies have traditionally depended on the nuclear power plants. "If this body continues to grow," says Akira Kawasaki of the activist group Peace Boat, "it will have good political and even financial power to counter measures by the national government."

Pressure continues to mount: In early October, former prime minister Junichiro Koizumi announced that he now opposes nuclear power. And his son Shinjiro Koizumi, who has criticized the handling of the March 2011 disaster and is an advocate for its victims, was recently appointed one

of four parliamentary secretaries in charge of reconstruction.

According to Aldrich, it's unlikely that Japan will phase out nuclear power. But given public opposition, he predicts that "four to seven reactors will be as good as it gets." Before the Fukushima disaster Japan had around 50. Kawasaki notes that Tokyo survived the hot summer without nuclear power. "The case that Japan needs plants is not persuasive anymore," he says. The government is due to submit a broad energy policy by the end of this year.

Toni Feder

## Geoengineering researchers ponder ethical and regulatory issues

With interest in artificial climate intervention heating up, advocates and foes agree on the need for a governance regime to sanction experimental trials.

As part of a research project exploring stratospheric particle injection to possibly mitigate global warming, a team of UK scientists and engi-

neers in 2011 readied an experiment to spray water through a hose tethered to a balloon 1 km above Earth's surface. Although the experiment's environmental

impacts would have been nil, leaders of the research ultimately called it off.

In 2012 the indigenous Haida people of British Columbia contracted to dump 100 metric tons of iron sulfate into waters off the west coast of Canada in hopes of stimulating phytoplankton growth and restoring a salmon fishery. Such ocean fertilization also has been

## When an analog lock-in is your only option ... ... there's always

PAR124A (1960s design & unavailable)



- Low-noise, all analog design
- No digital noise — CPU stopping
- 0.2 Hz to 200 kHz range
- 2.8 nV/√Hz input noise
- Fiber-coupled GPIB, Ethernet and

Inspired by the 1960s PAR124A, but using today's low-noise analog components and design methodologies, the new SR124 is a tour de force in low-noise, high performance analog instrumentation. With its all-analog design, easy-to-use front panel, and wide frequency range, the SR124 will be right at home in your low-noise experiment.

proposed for removing and sequestering atmospheric carbon. But the practice is banned by the London Protocol on ocean dumping.

As discussion of geoengineering—the deliberate intervention in Earth’s climatic system to mitigate global warming—moves from the fringes of science to serious consideration as a possibly last-resort solution, such ethical quandaries are expected to proliferate for experimentalists. The Intergovernmental Panel on Climate Change, in its Fifth Assessment summary for policymakers released on 27 September, mentions geoengineering for the first time. It warns that solar radiation management—the injection of reflective particles into the atmosphere and arguably the most controversial geoengineering approach (see PHYSICS TODAY, February 2013, page 17)—could alter the global water cycle and would do nothing to slow ocean acidification.

Although debate has arisen over who decides whether geoengineering technologies will ever be deployed, the more urgent issue for researchers is the sanctioning of outdoor experiments that must occur long before deployment. Because of the inherent risks of

adverse impacts, agreement is widespread, even among geoengineering’s strongest proponents, that some sort of governance for such tests is needed.

### A slippery slope

No national or international governance for geoengineering experiments currently exists, and not surprisingly for such a controversial subject, no consensus has emerged on the form it should take. Some organizations, such as the ETC Group, an environmental organization based in Ottawa, Canada, argue for a ban on all outdoor experimentation. But geoengineering researcher David Keith of Harvard University and others advocate a voluntary code of conduct that would only have to be adopted by a handful of funding agencies in the US, Europe, and Asia.

“There are legitimate fears of a slippery slope, and there is a fundamental lack of regulation,” Keith said at a September meeting of a National Research Council (NRC) committee that is assessing geoengineering research. “If someone really wanted to put large amounts of sulfur into the stratosphere over the US, it’s not obvious what regulations would bind,” he warned. The Clean Air

Act doesn’t apply because, for one thing, it regulates only fixed emissions sources, and the Kyoto Protocol doesn’t apply because sulfur is not on its list of greenhouse gases. Federally funded experiments in the US could require an environmental assessment first, but no such restriction would apply to privately financed experiments. The lack of restrictions will create perceived—and possibly real—problems if large experiments do proceed.

In its 2009 report *Geoengineering the Climate: Science, Governance and Uncertainty*, the UK’s Royal Society called for international scientific organizations to join in developing a code of practice for research and a voluntary research governance framework. The UK House of Commons Science and Technology Committee and the US House Committee on Science, Space, and Technology cooperated on geoengineering investigations that produced reports in 2009 and 2010. Both endorsed the Oxford principles, a set of five conditions drafted by a team of scholars, under which geoengineering research should be allowed to proceed. Those principles state that research should be regulated in the public interest, public engagement

SR124 ... \$6950 (modern design & in stock)

the 124 !

architecture

RS-232



Call us for a free 30 day demo

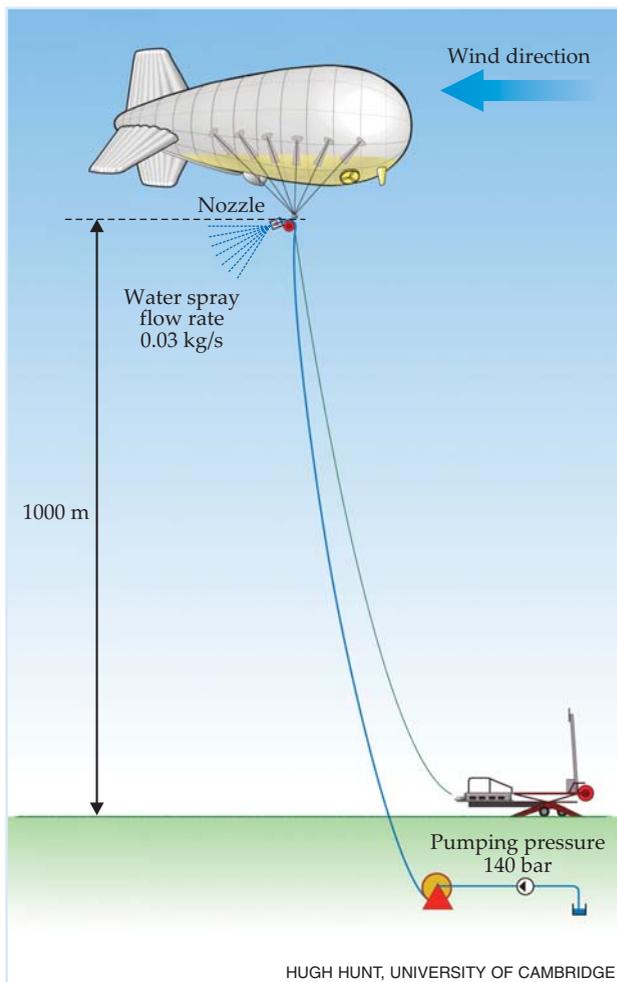
should be sought in the decision making, the research results should be publicly disclosed, the results should be independently assessed, and robust governance structures should be in place before any geoengineering technology is deployed.

Steve Rayner, a political anthropologist at Oxford University and an author of the principles, says the degree and formality of governance should vary with the severity of the potential side effects. "If you were talking about sulfur aerosols in the atmosphere, it would seem that unless you were up for a great deal of international conflict, it's not something you would do without an international agreement," he says. On the other hand, the planting of trees to serve as a carbon sink could be reasonably governed with existing planning and environmental protection laws.

### Many approaches

Keith has proposed that NSF and a few other funding agencies, such as the European Research Council and the Chinese Academy of Sciences, develop a nonbinding memorandum of understanding (MOU) spelling out how they propose to evaluate experiments. Terms might include independent risk assessment, transparency, and degree of usefulness. Only a handful of agencies would need to sign the agreement, Keith said. "An MOU like that would tend to bind the research of even agencies that didn't sign it," he explained to the NRC committee, since other, nonsignatory funders would look to the MOU for guidance in reviewing research proposals they may receive.

Other parties argue for a more formal system of governance. Although his organization hasn't backed a particular approach yet, Mark Lawrence, scientific director of the Institute for Advanced Sustainability Studies in Potsdam, Germany, says that an international governance framework should be put in place before any field experimentation is done. "Our deep concern is with the potential for backlash and



**A UK experiment dubbed SPICE** (stratospheric particle injection for climate engineering) would have tested a method for injecting aerosols into the upper atmosphere through a 1-km-long pipe attached to a tethered balloon. It was canceled due to concerns over the lack of governance for geoengineering experiments.

how that may hinder future basic science," he says.

Scott Barrett, a Columbia University economist, advocates for an international agreement under the auspices of the United Nations (UN). But the regime can't be so heavy-handed that it loses participation from countries that are in a position to do geoengineering, he told the NRC panel. He added a note of realism: "The idea that people are going to spend a lot of effort and go right to high-level laws on things that aren't happening and may not ever happen is kind of naive."

Barrett disagreed with hardliners who argue that no geoengineering research should be done. "Do you really want to do nothing until we're in a very, very tight situation, and is it really plausible to think that you're going to get

193 countries to do nothing about this through an international agreement?" he asked.

To an extent, the ethical situation facing geoengineering is analogous to the advent of recombinant DNA technology in the mid 1970s. In that case, scientists agreed to an international moratorium on gene-splicing research until a code of conduct on biosafety, now known as the Asilomar principles, was developed. In the US, the National Institutes of Health created a committee of external advisers to review the safety and ethical issues involved with grant proposals involving rDNA. David Winickoff, an ethicist at the University of California, Berkeley, told the NRC panel that a geoengineering advisory committee could review experimental proposals, ensure public disclosure and access to results, perform annual reviews of the science, and reach out to other nations' governance bodies.

Lawrence thinks a likely scenario is for the scientific community to develop a code of conduct that will be administered by an international organization—perhaps the UN Framework Convention on Climate Change or the international Convention on Biological Diversity—or, alternatively, that will be adopted by the funding agencies of the research-funding nations.

Matt Watson, who heads the research project SPICE (stratospheric particle injection for climate engineering), which had planned to spray water from the tethered balloon, disputes news reports that blamed public opposition for cancellation of the experiment. A small element of the overall research project, the experiment was delayed to the point where it became less useful, he says. "From the standpoint of someone who was about to conduct an experiment that had absolutely no climate signature whatsoever, I would argue that a level of preexisting governance would have helped that experiment," he says. "We were going to make sure it was safe and very well communicated and legal. But we thought it might be used by other people to legitimize outdoor re-



# ORIGIN 9.1

## Data Analysis and Graphing Software

search that everybody would be uncomfortable with."

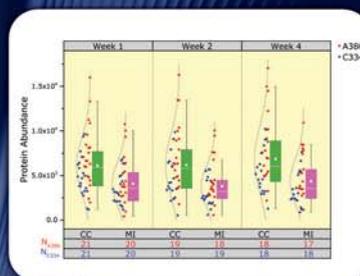
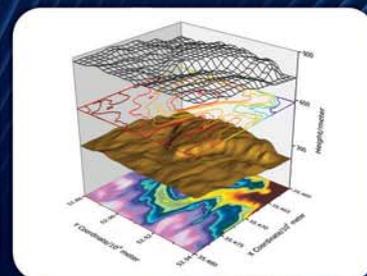
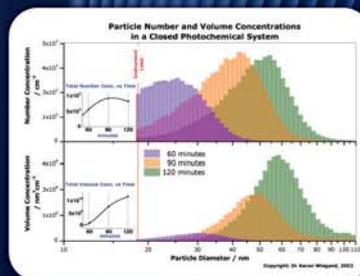
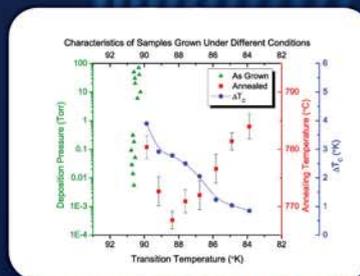
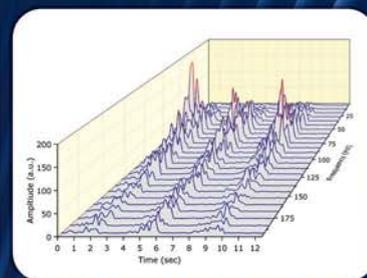
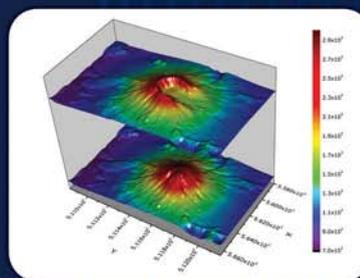
Watson favors strong international governance and says that it must include representation from outside the US and Europe. The governing body he foresees would register experiments, ensure the transparency and communication of the results, and review proposals for scale and possible adverse effects.

### Negligible impacts?

A key point of division in the governance debate is over whether outdoor experiments below a certain size should be allowed to proceed without approval. Keith, a proponent of such a threshold, has proposed an experiment that would deliver 1 kg of sulfur and 100 kg of water by balloon into the stratosphere and observe the effects. He says the experiment could help inform models that predict whether stratospheric sulfate injection could keep Earth's temperature within safe levels. Keith suggests that his experiment is sufficiently small, as measured by its estimated annual impact on radiative forcing, to be allowed to proceed without a specific ethical review.

But others interviewed say there should be no threshold level for experiments. Watson, for instance, agrees that Keith's experiment would be inconsequential climatologically and its effects so small that he would have trouble even detecting them. But, he says, "the social impacts and the reverberations around undertaking that experiment are significant. I don't know if they can or should be predicted or managed." Intentions are very important, he says; if the experiment was labeled as something other than geoengineering, no one would care. He points to a 2011 experiment on cloud microphysics that was performed off the coast of Monterey, California. Although much larger in scale than SPICE and having what Watson says was "a profound effect on the local climate," the experiment created no public stir because few people realized at the time that it was related to geoengineering. "People release atmospheric tracers for experiments all the time, but because it's about atmospheric chemistry and looking at weather systems, nobody would ever object to them."

Lawrence argues that potential backlash from even very small-scale experiments involving solar radiation management could threaten research in noncontroversial areas of atmospheric



- Point-and-Click GUI plus Programming Capability
- 2D, 3D, Contour, Statistical, Specialized Graphs
- Import Data from 3rd Party Files or Database
- Curve Fitting, Peak Analysis, Signal Processing, Statistics
- Batch Plotting and Analysis
- Publication-Quality Reports

Over 500,000 registered users worldwide in:

- 6,000+ Companies including 120+ Fortune Global 500
- 6,500+ Colleges & Universities
- 3,000+ Government Agencies & Research Labs

**OriginLab**

20+ years serving the scientific & engineering community

(800) 969-7720  
sales@originlab.com



**OVER 200 NEW FEATURES & IMPROVEMENTS IN ORIGIN 9.1!**

[www.OriginLab.com/91](http://www.OriginLab.com/91)

research as well. He notes how the 2012 ocean fertilization incident off Canada may influence the changes being made to the London Protocol that will make it difficult for non-climate-related research on surface water nutrient cycling to proceed. The 87 countries that are

parties to the protocol agreed in 2010 to ban ocean fertilization for other than scientific research purposes; they also established a framework for assessing such experiments that does not include a threshold.

David Kramer

## Breaking from tradition, some scientists self-publish

Online platforms offer more control over the publishing process, but no editorial peer review.

Earlier this year, University of Michigan condensed-matter physicist Leonard Sander sent out a mass email promoting his new textbook. “I published this book using [the online self-publishing platform] CreateSpace (a subsidiary of Amazon),” he wrote. “One reason for this choice is the out-of-control inflation of textbook prices. The downside of this publishing method is that the marketing offered by a publishing house is not available, hence this email.”

Sander’s choice is not common. The self-publishing route is more typically taken by aspiring novelists looking for a breakthrough or by amateur scientists peddling rejected theories. But for every *Fifty Shades of Grey*—the best-selling, originally self-published romance novel—there are thousands more self-published books that barely make a dime. And for every profes-

sional scientist who experiments with self-publishing, there are several more pseudoscientists who are publishing for validation.

Although most scientists with established or budding reputations continue to opt for traditional publishing, a few are giving self-publishing a shot. For Sander, the ability to manage the overhead costs and make his book more affordable for students was reason enough. At \$42, the list price for *Equilibrium Statistical Physics with Computer Simulations in Python* is about half what he estimates a traditional publisher would have charged.

The self-publishing industry claims other benefits. For example, says Amazon .com spokeswoman Brittany Turner, CreateSpace lets authors “keep control, publish quickly, publish for free, publish globally, and earn more money.” On many self-publishing platforms, authors can take home up to 50% in royalties from print sales and up to 70% from ebook sales; the typical royalty rate for academic publishers is 10–20%.

### \$1 per error

Despite having a poor, lingering reputation as a modern form of the vanity press, self-published books sell. “Over a third of the top 100 best sellers on Kindle [Amazon’s ebook platform] in September were [self-published] titles,” says Turner. (None of the best sellers were serious books on science.) And from 2006 to 2011, the period when a number of online self-publishing platforms launched, the annual production of self-published titles tripled, according to a 2011 report from Bowker, the official US agency that grants ISBNs.

Depending on the platform, authors pay little or nothing and do the entire layout, editing, and marketing, or they hire freelancers to do that work for them. Even when submitting to tradi-

tional publishers, “you write the book, you typeset it, you make the figures, and you send them the PDF,” says physicist Mark Newman, Sander’s colleague at the University of Michigan, who self-published his own 2012 textbook, *Computational Physics* after traditionally publishing his previous seven books. “[They mainly] copyedit it and handle the sales and marketing.”

But what traditional publishers also offer is “the gatekeeping—useful, independent feedback,” says Simon Capelin, editorial director for physical sciences at Cambridge University Press, which published Sander’s previous textbook. “The production of the book is the cheap and easy part.” For prepublishing feedback, both Sander and Newman sent their manuscripts to colleagues; Sander also offered the students taking his statistical physics course a dollar for each misprint they found. Both professors say their self-publishing was “an experiment”; Newman says that his book has been adopted by several physics departments, so “I feel like [the experiment] has been a reasonable success.”

Textbook prices have skyrocketed in the freshman physics category, because they demand a lot of marketing and because the used-books industry has undercut profits from their sales, says Capelin. Cambridge University Press does not compete in that category, he adds, but publishers that do, like Cengage Learning, have explicitly stated that their long-term business strategy is to transition from print to digital educational and research materials. “When Amazon first started up, I couldn’t imagine that they would have essentially replaced traditional bookstores,” says Capelin. “I don’t know that [online self-publishing] will have a similar impact on academic publishing, but I may be proved wrong.”

### Blazing a trail?

Capelin says he encourages authors of some rejected manuscripts to try self-publishing, which transfers the publishing risks and the marketing costs to the author and offers feedback in the form of sales. That’s what theoretical physicist Teman Cooke did after being turned down by Cengage. His book, *The First Semester Physics Survival Guide: A Lifeline for the Reluctant Physics Student*, details a pedagogical approach he says he developed in seven years of teaching introductory physics courses at Georgia Perimeter College in Atlanta. Cooke says he used \$6000 that he raised on the crowdfunding site Kickstarter.com to



**Blazing the Trail** coeditor and Yale University PhD physics student Emma Ideal signs copies of the self-published book at the 2013 SACNAS conference—SACNAS is a society for the advancement of Hispanics and Native Americans in science.