

The Greenhouse Papers by Jeff Hecht

“What puzzles me,” said Alice as she picked at her salad, “is where the extra carbon goes. The carbon dioxide budget must have been balanced before people messed it up. Clearing forests, burning fossil fuels, and other human activities add carbon dioxide to the atmosphere. But your model adds a lot more carbon dioxide than the measured increase.”

I nodded glumly as I chewed my alfalfa sprouts. My global carbon-cycle project was not going well. The computer model was supposed to be my stepping stone from a postdoc to a permanent job. Yet even the university's most powerful Cray couldn't make the numbers add up. “At least it isn't removing carbon dioxide from the atmosphere,” I reminded her.

“Your last run made carbon dioxide increase almost twice as fast as the real measurements,” Alice grumbled. “I know there are uncertainties, but they aren't that big. If your numbers were real, the greenhouse effect would be cooking us already.”

“Did I hear you talking about the greenhouse effect?” Professor Andrew Harrison Harding settled his 250 pounds of immaculately groomed and impeccably tailored bulk into an empty chair. His tray was laden with the faculty club's most fattening specials, rare roast beef, baked potato, and blueberry cheesecake.

“Yes we were, Andrew,” Alice sighed. “I suppose you're going to tell us that your economic voodoo rites can make it go away.”

“Now, now, Miss Morris,” he returned in his most condescending tone. Alice was a full professor with a named chair, at least ten years older than the economist, but he never used any of her proper titles. “I would certainly hesitate to put economic science in the same category with weather forecasting. After all, we do rely on fundamental principles and laws.”

Alice arched her eyebrows, holding her response until she finished chewing a slice of cucumber. “I suppose you do. Weather forecasters have to say which way the wind blows, but you only see it blowing to the right.”

“I suppose you claim to be objective?” he harrumphed. “The greenhouse effect is just the latest leftist cult in the physical sciences. You recall the energy crisis, perhaps? Or limits to growth? All futile efforts to find ways to stop the continual expansion possible with supply-side economics.”

“The buildup of atmospheric carbon dioxide is proven by carefully controlled measurements. The association of warmer global temperatures with increasing carbon dioxide is good enough to pass tests of statistical significance. Measurements of air preserved in the pores of glacial ice show that carbon dioxide levels rose at the end of the Ice Age. Would you like the references, Andrew? Or would they go beyond your ability to manipulate numbers to your advantage?”

He looked up from his plate. “My dear Miss Morris, I think you malign me. I distinctly overheard you say that you couldn't explain where all the carbon went.”

“So what does economics have to do with that?”

“Perhaps that excess carbon is going into consumer goods, produced by the workings of the new economics. Plastics, certainly,” he paused to look at his fork, but it was metal. “Housing, furniture, clothing, and even paper contain carbon.” He brought the fork the rest of the way to his mouth.

“Do you know how much excess carbon is involved, Andrew? Five billion metric tons a year. That's

more than the amount of hot air generated by all the world's economists and politicians.”

I had work to do and no patience for endless arguments. Alice's politics dated from grad school at Berkeley in the sixties; she secretly hoped the greenhouse effect would melt the ice caps, flood Wall Street, and drown the bloated capitalist swine. Andrew Harrison Harding was one of the new conservatives, getting rich with lucrative consulting contracts. I caught Alice's eye and excused myself.

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When I arrived at Alice's office later in the afternoon, I made the mistake of asking if Harding might have said something worthwhile.

“That fool makes me respect the academic credentials of the physical education department!”

“But shouldn't we consider human possessions in our carbon balance sheet? A wooden house must contain a few tons of carbon, and it stays there forever, or at least until it's replaced by a new house. Say four people per house, add the furniture, and...”

She shook her head. “It won't balance the books, Petra, even with Andrew's crooked numerology. People don't build houses every year, and they aren't all made of wood, anyway. There's probably some effect, if you multiply the rate of population increase by carbon per household. But most of it is in developing countries. They certainly aren't accumulating much wealth. You can add it to the model, but it's not going to solve anything.”

She was right, of course. I slumped discouraged in the chair, dwarfed by the stacks of journals on her work table. “What can we do to balance the equations?” I asked. “We must be missing SOME carbon sinks.”

Alice nodded. “It's all very hard to quantify, and it's even more complex because it might change with time, if the carbon sinks get saturated. Some new work claims the major sinks are on land in the northern hemisphere. and nobody knows how effectively sea water soaks up carbon dioxide or where it goes from the ocean surface.” She sighed in discouragement.

An undergraduate knocked at the door, a typically tall and skinny kid with rumpled kinky hair. “Professor Morris?” he asked, hesitatingly. “I had some questions about this assignment....”

It was time for Alice's undergraduate office hours. I excused myself to look for some fresh ideas. They were very slow in coming.

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Over the next week, I added the carbon content of housing to the model, and it vanished into insignificance. I adjusted some assumptions about the atmosphere, with no visible result. Two days of searching every database vaguely related to carbon-dioxide absorption by the oceans gave me sore eyes, and left me amazed at how little solid information existed.

I was comparing two runs of the model when Alice arrived at my tiny basement office bearing her briefcase and a grim expression. “Did you keep track of how many runs you made last month, Petra?”

I shook my head, beginning to feel uneasy.

She pulled a green-and-white printout from the briefcase. “I just got our statement from the computer center. Your model has eaten my entire Cray budget, and there's four months left in the fiscal year.”

“So no more Cray?”

She nodded. “At least until you take on some of the fund-raising burden.” She dropped a fat manila envelope onto my desk. It was standard government issue, with a stylized black eagle printed in the upper right corner. Her expression told me to open it.

The form letter seemed to bear good news. “The Agency will entertain innovative conceptual proposals with objectives which bear relevance to alleviating the release of greenhouse gases into the atmospheric environment.” A quick scan of the photocopied polysyllables revealed no specific goals, but plenty of buzzwords: “innovative,” “fundamental concepts,” “high leverage,” “potential” and “breakthrough.”

I looked up at Alice. “It sounds like they want lots of blue sky with less carbon dioxide. You want me to write something?”

“You want any more computer time?”

I sighed and looked back at the cover letter. My eyes opened wide when they caught the name at the bottom. “Andrew Harrison Harding, special consultant to the Administrator!” I read in disbelief.

“Oh, it's *that* project,” groaned Alice. “I heard about it. Andy knows the administrator, and he pulled strings to sneak some money to needy economists. Don't bother with it,” she said. “I'll see if I can scare up something to get us some money. Meanwhile, stay off the Cray.”

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I stopped by Alice's office early the next morning, looking for something to do until I could get back to the computer model. She invited me in, apologizing as she removed a pile of journals that had slipped into the last empty chair. “I'm afraid I can't keep up with these journals. Sometimes I think they just grow here.”

Inspiration struck as I glanced around the cluttered office. Floor to ceiling bookcases packed with journals lined one wall. Another big bookcase stood beside the window, and two more along the same wall as her desk. All that paper was the product of years of research on the greenhouse effect. “Paper,” I said, as the light dawned, “the magic word is paper.”

She looked at me, completely baffled, not at all the usual self-possessed Alice.

“Paper,” I repeated, looking at the crammed bookcases and overflowing table. Alice had stocked her office with the better part of a forest. “How much paper do you have in this office?”

“I don't know,” she replied distantly. “A lot, but it contains a lot of-”

“You've saved tons of paper. As long as you keep it, the carbon in it will never become greenhouse carbon dioxide. That's what's helping the continents soak up carbon.”

“Oh, Petra!” she sighed, “don't be ridiculous. Why don't you settle down and think up a proposal to get some money for computer time? Do you want to be a postdoc forever?”

I trudged dejectedly back to my cubicle, in no mood to accomplish anything. Andrew Harrison Harding's request for proposals still sat on the desk. I picked it up, wondering how much paper had been wasted on it. Could accumulating paper really slow the greenhouse effect? With nothing better to do, I decided to quantify the matter.

The first task was to estimate the carbon content of a typical 8.5 by 11 inch page. Precision demanded

careful carbonization of several hundred representative sheets, weighing the ashes on analytical balances, averaging the results, and taking means and standard deviations. I took a ream of paper from the storeroom, weighed it on the department mail scale, divided, guessed at the carbon content, and got a rough estimate; one gram of carbon per sheet.

The next step was converting five billion tons of carbon into paper units. The result was on the back of an envelope in a second: 5×10^{15} sheets in proper scientific notation. or five quadrillion if I really wanted to impress someone. Divided by world population, it was a million sheets per person. That-I found by measuring a box of computer paper in the storeroom-is a pile about 100 meters high, or a volume of 6 cubic meters. Three solid closets a year! Even Alice did not collect that much.

What about junk mail and other solid waste? Trash in landfills doesn't decay very fast, so I could assume it stays there almost forever. One reference said each American generates about 750 kilograms of solid waste a year. If 100 kilograms was carbon sequestered in landfills, and if everyone in the world generated that much solid waste, that would only account for half a billion tons of carbon. However, most people live in developing countries where they don't generate as much trash.

I should have stopped there. I would have stopped, if I had had anything else to do. But I didn't, so I browsed through the library, getting more and more frustrated with the carbon-dioxide problem.

The literature contained perfectly serious proposals to plant an area the size of Australia in fast-growing trees, cut them down every few years, and bury the wood so it would not decay. Nobody was doing anything about the greenhouse effect but generating hot air and paper.

The least I could do, I decided on the way back to my basement office, was to show how ludicrous the whole thing was. Sitting at my desk, I devised a purely paper solution. To generate the needed paper, I would put scientists to work generating reports. The greenhouse is an important global problem, so everyone in the world should get the reports, and preserve them indefinitely. It would take 10,000 scientists, each writing a 100-page report each year, to generate the required million sheets of paper per person.

I would be lucky to wind up as one of them, I thought sourly, then saw Andrew Harrison Harding's request for proposals sitting in my basket. "Why not?" I asked myself, and switched on my word processor, convinced I could do better than any economist.

The words flowed freely all afternoon. At least, I told myself, I was practicing the proposal-writing skills that Alice thought were important. Gloss over difficulties, she had advised in a cynical mood. Waving my hands, I dismissed the energy costs of producing paper as "an issue to be studied in more detail in a separate study, but obviously of an order of magnitude no more than comparable to the energy costs of burying biomass to sequester carbon." I passed off the request for a preliminary environmental impact statement by saying that paper producers would be required to abide by existing laws.

I broke for a light dinner at the university cafeteria, and returned with the best idea of the day. In the section on "Long-term impact" I explained how paper reserves could provide a feedback mechanism to prevent a return of the ice ages. "Ice core measurements show that past declines in atmospheric carbon dioxide were associated with cooler temperatures and glacial episodes." I wrote. "In the event that too much carbon is removed from the atmosphere, the paper reserves could be burned, depositing extra carbon dioxide in the atmosphere to restore the proper greenhouse balance, and providing short-term heat to people in the bargain."

By midnight, the whole crazy thing was finished. I printed it out, bundled it with the request for proposals, and left it sitting on Alice's desk for her perusal in the morning.

What I had not counted on was Alice coming down with the flu. She didn't show up Friday, and it was my turn the following Monday. Tuesday and Wednesday she was out of town at a seminar, and by Thursday I had gotten involved with another postdoc's simulations of atmospheric methane flux. It was not until the following week that I asked Alice what she had thought of my mock proposal.

“What?” She had never seen it, and a careful exploration of the desktop debris revealed no sign of it.

“I'm sure I put it right here,” I said, pointing at a basket on her desk.

“Are you sure it was that basket?” A troubled expression came over Alice's face.

I nodded. “It was the only one I could see.”

“That's the OUT basket. I think it lost its label. IN is over here,” she pointed to a second basket hidden by a foot of papers. “Things left in the OUT basket are mailed.”

As my stomach sank, I asked what might happen.

“Knowing how the wheels of bureaucracy grind, with any luck we'll never hear of it again.”

Somehow I was not reassured.

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It was several weeks before Andrew Harrison Harding again settled his pin-striped bulk at our table with a tray over-flowing with lunch. He was all smiles.

“My dear Petra,” he began. “I was so pleased to see your proposal. The reviewers gave it the highest rating of any that we saw.”

I stuttered an expression of gratitude as Alice's jaw dropped in astonishment. I kept cool. Crazy idea or not, this could be my ticket to a permanent job.

“We're going to give you the full half million. of course,” he continued. “But we did have one long-term suggestion. It's our deep belief that the best solutions to any problem-indeed the only possible solutions-come from the private sector. That's why we have no faith in planting trees or trying to be more energy efficient. There's no profit in it. But your proposal nicely complements one of my own ideas, which is to draw on the expertise of the magazine and advertising industries. We can minimize public-sector expense and demonstrate once again that the private sector can provide the proper economic solutions.”

I didn't dare look at Alice. It was all I could do to keep my own composure.

“The optimum solution,” he continued, “is publication by the private sector. It should be easy to demonstrate potential profits. Look at the success of trade magazines, and free weekly papers mailed to residents of suburban communities. These publications will go to everyone on the planet, for a guaranteed circulation of five billion. They have a long-term captive audience, moreover, because everyone will have to keep them. We can have different demographic editions, and companies can use their advertising to show their concern with bettering the planet. In fact, I am proposing an economic assessment to show the idea is impossible for advertisers to resist.”

Steam was rising from Alice's ears. “Andrew,” she sputtered, “this is the most....”

Knowing what was coming, I kicked her firmly under the table. Speechless, she looked at me in

bewilderment and dismay. This might be the most insane geophysical project in recorded history. But if they wanted to give me all that money, the least I could do was take it with a straight face.

About the Author

Jeff Hecht is a free-lance science and technology writer and Boston correspondent for the British weekly *New Scientist*. His book, *City of Light: The Story of Fiber Optics*, appeared in 1999 from Oxford University Press