issues &events

A physicist proselytizes about countering global warming

Moving to Mars is not the solution to global warming, says John Houghton. Rather, through lectures on such impacts as sea-level rise, droughts, and floods, he hopes to mobilize Christians to reduce human-induced climate change on Earth.

Creation care is John Houghton's mission. In what you might call a retirement career, Houghton, an atmospheric physicist, writes books, lectures extensively to Christians and others on the science and threats of global warming, and is a founder and president of the John Ray Initiative, a nonprofit organization that aims to educate Christians about the environment.

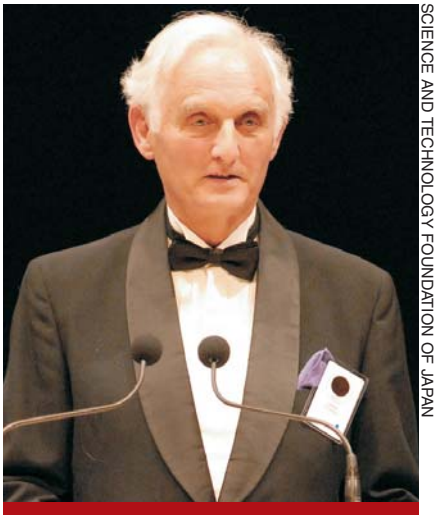
Not long after Houghton earned his PhD at Oxford University for measurements on radiation in the atmosphere, the Soviet Union launched the first Sputnik satellite in 1957. That and subsequent satellites opened the door to "not just observing a little bit of the atmosphere, but observing the whole atmosphere from above. It was really exciting to anyone involved in atmospheric science," says Houghton.

After a long career as an Oxford professor that included building instruments for NASA spacecraft to measure the temperature and composition of the stratosphere and mesosphere and later overseeing the merger of the UK's Appleton and Rutherford laboratories, in 1983 Houghton became director general of the Meteorological Office, the UK's weather bureau. There, he says, "We had the biggest computer complex in Europe at the time. We not only did global modeling of the atmosphere and the weather but also of the climate." And, he adds, "I got very interested in the climate and the role of human activities involved in changing the climate." In 1988, when the Intergovernmental Panel on Climate Change was formed, he became chair for scientific assessment, and over the next 14 years he worked on the first three IPCC reports; he was not involved in the fourth and most recent, which was released this past spring (see PHYSICS TODAY, May 2007, page 26).

Recently Houghton spoke with PHYSICS TODAY about his commitment to spreading the message about climate change.

PT: Was there any particular event that triggered you to evangelize about climate change?

JH: I realized from the start that it was the responsibility of the IPCC to present what we were doing to the public at large. When the first report came out in 1990, I was asked by [then Prime Minister] Margaret Thatcher to present to her cabinet in Downing Street. That was the first time an overhead projector had been used in the cabinet room. People said that she would interrupt me after two minutes, but she didn't. I got known as the person who kept her quiet for 20 minutes. That was a big piece of publicity and was the start of my giving lectures on human-induced climate change.



SCIENCE AND TECHNOLOGY FOUNDATION OF JAPAN

John Houghton

PT: In what venues do you lecture about climate change and creation care?

JH: I lecture a lot to Christian audiences—I am a Christian myself, so I have Christian connections—also at universities, colleges, and to people in business and government. These days I give 40 or 50 lectures a year, on average about one per week.

PT: What does creation care mean?

JH: Well, Christians believe that we have been put into the world to look after it and to care for the whole of creation. That's a message presented very early on in the Bible. Adam and Eve were put into a garden and they were told to look after that garden. That garden is Earth.

Because of the enormous population we now have and the rapid development of technology, we are putting pressure on resources, and our care of the Earth is very far from what it should be. We should pay much more care to looking after the Earth in a sustainable way. The simplest definition of sustainability that I know is not cheating on our children, not cheating on our neighbors, or the poor people in the world, who stand to be very disadvantaged by things like climate change. And also not cheating on the rest of creation. We are in danger of losing thousands, if not millions, of species because of climate change.

Of course, it's a very broad human responsibility, not just a Christian one. But on the whole, Christians have been lagging behind many other groups in their concern for the environment, care for the Earth, and care for poor people. And Christians, because of their beliefs, should really be out in front.

PT: Do you see a change in the attitude of US evangelicals? Do you see the Christian green movement gaining influence?

JH: In the United States, evangelicals have felt that green matters were a diversion from what they really should be doing. That is now beginning to change with a new realization that creation, incarnation, and resurrection are all linked together at the core of the Christian faith.

But there is still a battle going on. It began in 1992 after the first Earth summit in Rio de Janeiro, where all the nations of the world went, and they signed the Climate Convention, which said that action had to be taken to combat climate change, even though the science was not completely certain.

After that, vested interests, led very much by the ExxonMobil oil company and some [US] coal companies, set up a misinformation campaign aimed at persuading people that the science was flawed and that no action was required. In particular, they tried very hard to discredit the IPCC. That campaign was influential at all levels of American society.

PT: Do you think that is turning around now?

JH: It is actually still going on, although their message has become different. They used to say there was no such thing as global warming. Now the message is that global warming is happening—because nobody who knows any-

thing disputes it anymore—but it's not a matter of urgency, and it's something we can fix when it gets really bad. Of course, they don't provide evidence for that because the scientific evidence cannot support that kind of message.

PT: Are such misinformation campaigns going on in other parts of the world?

JH: Not on the same scale, but it's spread around to much of the developed world. And largely, but not entirely, it comes from your country [the US].

PT: Do you see the green Christian movement having any influence?

JH: In February 2006, 90 evangelical leaders in the United States published a statement in the *New York Times*, the *Washington Post*, and other media outlets stating clearly that global warming is an important issue for Christians and that urgent action is required.

Coming from a quarter that people were not expecting, it had, I think, a lot of influence in your country. In particular, members of Congress realized that there is a significant body of evangelical Christians—right-wing people, largely Republicans, including perhaps 30 or 40 million Americans—who are beginning to take this issue very seriously.

PT: The US is far behind a lot of other countries in doing anything about climate change and reducing emissions.

JH: Yes it is. US carbon dioxide emissions are well over 20% greater than they were in 1990 and still rising. Your administration is extremely backward in doing anything about it. However, there are signs of change. For instance, I gave testimony to the US Senate in July 2005 along with three other scientists. There was a big audience, and we had a robust exchange. Since that time the Senate has been expressing more concern about the issue.

There are good signs too in other parts of the US—California and some of the eastern states are beginning to set targets for greenhouse gas emissions. Many cities are setting targets for reducing emissions, and much of the population is beginning to take the problem seriously. But you have an awful long way to go.

PT: What kinds of responses do you get from your audiences?

JH: On the whole, the response is very positive. One problem in climate change is that people at large are very ignorant about it. They know it will get a bit warmer, but they don't know the influence climate change will have on sea level, or extreme events like droughts, floods, and heat waves, and what the impacts will be. But they are keen to learn and to discover there's a lot they can do about it.

PT: What suggestions do you give people about what they can do about climate change?

JH: I tell them they can look at their own carbon dioxide emissions. In this country [the UK], anyway, I encourage people to buy green electricity, guaranteed to come from non-fossil-fuel sources. Then they can make sure their home is well insulated and not overheated in winter or overcooled in summer. They can buy appliances that are very efficient and don't use more energy than they need. They can buy an efficient car which offers good miles per gallon and travel less than they might otherwise. They can recycle their waste. And they can get well informed so as to be able to influence government and industry to do the right things.

PT: In lectures aimed largely at nonscientists, how much science do you include?

JH: I try to explain clearly the science behind climate change. The greenhouse effect has been known for over 200 years. If carbon dioxide is added to the atmosphere, its blanketing effect increases as it absorbs more of the infrared radiation emitted by the surface, making the Earth warmer than it would otherwise be. That effect is multiplied by positive feedbacks—for instance, water vapor, another powerful greenhouse gas, increases in the atmosphere as the Earth warms, thus enhancing the blanketing effect. There are other feedbacks too, some positive, some negative. Some we know about quite well, some we are rather uncertain about, like the effects of clouds. I try to explain the uncertainties and what we are not sure about, but there is enough there that we are sure about to give great cause for concern.

I then talk about the impacts. I say the most important impact of climate change will be the rise of sea level, because as the oceans warm, the water expands and also glaciers are melting. The rate of rise will be around half a meter per century. It could be more because of a contribution from melting of the polar ice caps. Just how fast the ice caps will melt is uncertain at the moment, but there are increasing signs it could be substantial.

If you happen to live near the ocean, sea-level rise is likely to become a big problem. In Bangladesh, 10 million people live below the 1-meter contour; 25 million people in southern China and millions too in the Nile Delta; Florida and some parts of the Gulf Coast will notice it seriously too. Lots of cities are built close to the ocean and will have to take expensive actions to cope with sea-level rise.

The oceans will take centuries to

warm to the bottom. Sea-level rise is not going to stop, even if we turn the carbon dioxide tap off tomorrow.

Another impact is more heat waves. A heat wave in Europe in 2003 killed over 20 000 people. It was completely unprecedented, way outside the bounds of normal natural variability. Scientists who have studied it concluded that most of the risk of that event arose from the increase in greenhouse gases. As the Earth warms further, such a summer is likely to be normal by the middle of the century and [be considered] a cool summer by 2100. That's something to make one sit up and think.

The third impact is on the hydrological, or water, cycle. With more water vapor in the atmosphere because of more evaporation from the warmer oceans, there will be more average rainfall. That is already occurring in some parts of the world. But that extra water vapor provides more energy for the hydrological cycle through the release of latent heat as water vapor condenses to form clouds. The result is that rainfall will tend to come down in more intense storms—hence more floods. It also means there will tend to be more frequent and intense droughts.

Climate models, which include all the physical processes and all the dynamics and so on, don't tell you exactly where all this is going to occur, because we are not clever enough yet. But the tendency to more frequent and intense floods and droughts is a robust result. Recent scientific papers estimating the likely increase in such events suggest possible increases of factors of 5 and even 10 by later this century. An increase by a factor of 5 in the number of floods in many parts of the world would be very devastating. And droughts lasting years rather than months—an expectation from the models—is a very frightening prospect, particularly in parts of the world which are prone to drought and where they don't have the ability to cope with it.

So there are going to be lots of environmental refugees. We are talking perhaps hundreds of millions of environmental refugees in the world by 2050.

That's the story I tell. I don't hype it up. I believe in giving the most conservative picture I can while being faithful to the evidence. It has been generated through much lively discussion and debate within the IPCC by hundreds, even thousands, of the world's best climate scientists.

PT: Before the G8 meeting in Germany last June, you told me about a statement that the presidents of the science academies of the G8+5 nations—the G8 plus observer countries Brazil, China, India, Mexico, and South Africa—had signed, appealing to the G8 to take action on climate change.

JH: Yes, those academies don't get together over many issues. They don't write statements of this kind very often. There could not be a stronger statement from the world's top scientific community.

PT: In the end, though, the G8 nations did not make climate change a major topic at their recent summit.

JH: Their actions did not meet the gravity of the problem. Some progress was made, in that the nations are still engaged. But the lack of urgency was very disappointing, especially on the part of the US. President Bush said there could be no definite agreements or targets until 2009, when he will have left office. That was a great shame because we really need to get on with it. Certainly [German chancellor Angela] Merkel was very much behind our statement. She is a scientist by background, she understands climate-change science, and she is very keen to see the G8 really move on the subject. She even spoke about limiting the temperature increase to 2 °C above preindustrial temperatures. That's the sort of target we should be discussing. It will be a tough target to reach, but then we have a tough problem.

The task nations are faced with is, How do you treat all the nations of the world—or at least the nations who are significant emitters—fairly? How can they agree to targets for their emissions to be reduced when the disparity between per capita emissions is so enormous? The United States, Canada, and Australia emit about six tonnes of carbon per capita per year. It's about two and a half tonnes for the European states, about one tonne for China, and about a quarter of a tonne for India.

PT: Some people would say that having ruined or used up resources on Earth, we should set our sights on colonizing Mars or other planets. What's your view?

JH: Well, it could be interesting to go to Mars and see what's there. But the practicalities of moving even small numbers of people to other planets, the energy and resources required to get them there, are just enormous. So it's really not a sensible idea. The Earth will not become wholly uninhabitable, although because of lack of water, droughts and floods, and sea-level rise, substantial areas will become less habitable. But you cannot put hundreds of millions of people on Mars or the Moon or anywhere else in space. You'd be lucky if you put two or three there. The scale of the operation is completely out of kilter with what is required to do something about global warming. We'd be much better off in putting efforts in doing something here.

PT: Is there any area that the US is doing well in regarding combating climate change?

JH: The US is pushing the technology quite hard, and that is good. But we don't only need technology. Governments need to set a framework in which the technology can thrive and can really get into the marketplace. The opportunities for industry to help reduce carbon dioxide emissions are large. We have, for instance, to sequester the carbon dioxide emitted by big fossil-fuel-powered stations. We need very large growth in renewable energy sources—solar, biomass, use of waste of all kinds, et cetera. We have to get on with these things, fast. The challenges to the world are very strong. What will the cost of action be? Actually not that much—less than the loss of one year's economic growth over 50 years is often quoted—and certainly very much less than the cost to the world of doing nothing.

Toni Feder

Multiple problems push LHC start to next spring

CERN engineers are relieved to have more time to finish constructing the LHC.

In June CERN director general Robert Aymar announced that the $7 billion Large Hadron Collider would start up in May 2008, eight months later than planned. The delay was no surprise to accelerator and particle physicists, and it was generally blamed on a highly publicized failure related to magnets made at the US's Fermilab. Actually, the magnets only added to other complications at the LHC.

"We've had to adjust the schedule to take into account the problems we've had," says LHC project leader Lyn Evans. The current plan is to begin engineering trials at 900 GeV next May and then ramp up to 14 TeV by mid-July. Even with the delays, Aymar says that for physics experiments, "the startup date remains exactly the same—July 2008."

The LHC was first proposed in 1984,