ClimateWire
THE POLITICS AND BUSINESS OF CLIMATE CHANGE

2. MODELING: Cloud program takes one man to corners of the Earth for a clearer view ahead *(06/22/2009)*

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Probing clouds for the U.S. Department of Energy can be a tough business. Take the storm that hit in Niger in 2006. It lasted only 45 minutes but sent 150-mile-per-hour winds and a wall of dust crashing into Mike Alsop's array of instruments, overturning many of them in the field. That was the only time that his entire site was shut down in the four years it has traveled around the globe.

But it was only one of the encounters Alsop, an Australian who works for the Australian Bureau of Meteorology, has had with nature as the field engineer for a DOE-funded program that is trying to answer one of the most baffling question facing climate change scientists: What will climate change do to clouds, and how will clouds in turn affect climate change?

In China, Alsop braved sub-freezing temperatures. In the Azores, a trip down to the bubbling sulfur of a volcano left him huffing and puffing up the steep sides. Alsop spends most of his days, though, routinely monitoring the equipment and computer screens that tell him what is happening in the sky above Graciosa, a Portuguese island in the middle of the North Atlantic on which he is the only Energy Department staff member.

An array of instruments probing the clouds in the Azores. The tower on the left measures temperature, humidity, barometric pressure and how much radiation the ground is emitting. Two upright boxes in the middle measure how much solar radiation is coming down from the sky. The white box on the right measures how much water vapor is in the sky. Photo courtesy of Mike and Sharon Alsop.

From his red-roofed house, he can see how many clouds there are miles into the sky, even if they are blocked from the human eye by other clouds, and at what height they begin and end. He can measure how much water there would be if all of it fell from the sky into a bucket. He can see exactly how much light is reaching the Earth, how many tiny particles are floating in the air near the ground, and in what direction the wind is blowing high up in the sky.

By Internet, the information travels to scientists around the world who will interpret it to try to better understand how the climate will change as the temperature warms from greenhouse gases. Alsop and the scientists are part of one of DOE's major scientific undertakings, the Atmospheric Radiation Measurement (ARM) program, which investigates clouds, the largest uncertainty in climate models today.

The mysteries of puffy structures

Those puffy, wispy or smooth structures that can change people's moods also have dramatic effects on how much sunlight reaches the Earth, how much rain falls and all the climate patterns that result. In scientists' terms, they are a feedback onto the climate system.

But just how they will feed back on temperature, rain and other factors is poorly known. That's why they constitute more than half the uncertainty in predictions of how much temperatures will warm in the future, according to Tony Del Genio, a climate scientist at NASA's Goddard Institute for Space Studies. How much warming will occur is the starting point for understanding where there will be more rain, drought and storms and how much the oceans will rise and affect coastal regions.

What has taken Alsop around the world is also a key aspect of the climate system: It is global. Scientists say that only by learning about it in all its heterogeneous locations and many parts will scientists be able to put together a comprehensive picture of climate.

Only seven fixed locations around the world make measurements as thorough and long-term as the ARM program. While satellites can capture images of cloud cover worldwide, they do not measure to much detail. Field experiments take detailed measurements, but they only cover one point and last for a few weeks. ARM does it all.

ARM owns three of the ground facilities, and four more are in Europe. A few years ago, the program added a site that can move. To fill the information gaps, it is going to places where climate scientists have not trekked before, to obtain reliable monthlong or yearlong views of them.

"The mobile facilities are the first that can go anywhere," said Mark Miller, site scientist for the mobile project.

So far, five locations have been tackled, and at each place, a new question has arisen.

Making charts in uncharted territory

Six light-colored shipping containers sit in a flat, grassy field, five minutes' drive from Alsop's house. Inside, on top, and around are the

various antennas, boxes and data systems that form the ARM Mobile Facility.

In March, they were taken off a ship after sailing halfway around the world from China, where they were last stationed.

"We literally arrive on a piece of flat dirt," Alsop said. A team from the United States and Australia spent two weeks setting up the facilities and then left, leaving Mike, accompanied by his wife Sharon, as the only remaining person from the project on the island.

China had been an extremely difficult place for Alsop, because of the day-to-day bureaucracy, the cold, the months away from Sharon and the time difference. By comparison, the Azores have been "a breeze." Alsop is, as always, still on call 24/7 -- but it's warm.

The ocean -- which can temper climate or generate hurricanes -- also poses some of the greatest mysteries in cloud science. From this island, Rob Wood, the lead scientist, based at the University of Washington, is studying marine stratus clouds. It's the first project that has made the long-term, detailed measurements that ARM does over the ocean.

"If you look at the clouds that cover most of the world's oceans, it's kind of this type of clouds that dominates," Wood says, estimating that about a third of the world's oceans have them. Given that oceans cover 70 percent of the Earth's surface, they have a huge effect on climate.

Scientists hope ARM's second mobile facility, which is under development, will take it farther onto the ocean. Brad Orr, the site manager for the second facility, envisions that it will be mounted on ships, for example.

Taking the search to sea

The first mobile studies were on land but explored equally baffling questions. In Niger, scientists investigated the climate's behavior in a region sandwiched between the Sahara desert and the sub-Saharan tropics. In China, scientists are examining the interactions of aerosols -- tiny particles in the air, from soot to airborne salt -- with clouds.

"From the beginning of the program, it was clear that clouds and aerosols were going to be big issues," said Wanda Ferrell, program director of ARM at the Department of Energy.

Cloud-aerosol interactions are another large source of uncertainty. It's a different question from how clouds will change from warming temperatures alone, because it involves the contribution that pollution -- like the kind that leads to smog and acid rain -- plays in climate.

"We really don't have a good picture of what these particles are and how they affect clouds," said Surabi Menon, a scientist at Lawrence Berkeley National Laboratory who focuses on this question.

Aerosols, when they interact with clouds, can have a large tempering effect on the warming from greenhouse gas-driven climate change. But how much they temper warming is unknown -- ranging from close to none to potentially offsetting all the warming. Del Genio, from NASA, does not think a complete offset is likely, due to the warming already seen.

An 'encyclopedia' coded in math

Mark Chandler, a scientist at NASA's Goddard institute for Space Studies, called climate models "a giant encyclopedia of the Earth's climate system put into equation form."

Clouds ultimately affect how much sunlight reaches the Earth, which is the engine behind all of climate -- driving the atmospheric and ocean currents, and consequently the patterns of rainfall, storms and everything else under the sun.

So far, scientists do not even know if clouds will be a positive or negative feedback on warming. Will more clouds heat the Earth more, or cool it?

The Intergovernmental Panel on Climate Change predicts that the Earth will warm an average of 1.7 to 4.4 degrees Celsius, under what it calls a realistic scenario (or what Del Genio called an "optimistic" realistic scenario) in which clean energy is adopted into the fuel mix, while fossil fuels continue to be a part of it. That uncertainty in the range is due to unknowns in the science, and from it arises the uncertainty in the rest of climate.

So could understanding the science of clouds better lead to better predictions of exactly what will happen, leading political leaders and the public to a clearer idea of how to mitigate and adapt to climate change?

Del Genio says, in theory, yes.

In practice, he points to political will.

"I would argue right now society is barely taking any steps at all to deal with climate change," Del Genio said. "The question right now is whether we'll decide quickly enough to start doing things." In terms of whether honing the science makes a difference to the actors, he said, "Right now I think people just have a vague notion of how much climate is going to change."