Scientists have taken the first crack at solving a fundamental climate mystery: where and when greenhouse gases enter and leave the atmosphere.

By Douglas Fischer

BOULDER—Scientists have taken the first crack at solving a fundamental climate mystery: criss-crossing the globe in a souped-up corporate jet to determine where and when greenhouse gases enter and leave the atmosphere. An understanding of how these climate-warming gases move about the globe is a critical prerequisite for any policy aimed at curtling global warming, scientists said Thursday, and information gained over the next three years will play a crucial role in sharpening future predictions and improving their accuracy.

Using a high performance jet, scientists will take a series of "slices" of the atmosphere over the next few years from pole to pole and from the surface to the atmosphere's upper reaches. They are expected to return from their first mission this week—a series of 11 flights from Colorado to the Arctic Circle to Tahiti, Antarctica, Easter Island and Costa Rica. Scientists running the instruments say they have seen several "wonderful jewels" in the raw data that challenge current thinking and assumptions.

When all the measurements are assembled, scientists added, they will for the first time have a picture of the atmosphere—and a global snapshot showing where and when some of the estimated 30 billion tons of carbon emitted annually by cars, factories, deforestation and other human activities enters the atmosphere.

"We were essentially retracing Captain Cook's voyages—obviously much later and with much more sophisticated instruments, but with some very similar parallels," said Britton Stephens, a scientist with the National Center for Atmospheric Research and one of the project's principal investigators. "When he set sail, he knew the ocean was out there, but didn't really knew the details. Similarly, we've been standing on the edge of the atmosphere—the surface—but we don't really know the details."

Researchers expect the $4.5 million mission to provide several critical answers to atmospheric riddles, but the two most important are fundamental to any effort to curb climate change, team members said during a conference call with reporters near the end of the first of five missions:

First, the project will fill key gaps in our understanding of how carbon cycles through the atmosphere and among the earth, air and oceans. Roughly half the carbon emitted by humans stays in the atmosphere, with the remainder being absorbed by ocean and earth ecosystems. But scientists don't understand how the system works or how quickly various gases mix.

The result, Stephens said, is that models of this so-called carbon cycle grown wildly divergent as they are projected into the future, with nearly 100 percent uncertainty by 2050.

Second, and perhaps most important, the map will provide a baseline against which efforts worldwide to curb carbon emissions can be judged. Need for such a benchmark has gained urgency, scientists and policymakers say, as the world moves toward regional, national and international agreements to limit greenhouse gases.

"If we expect to make treaties," said Steven Wofsy, a Harvard University professor of atmospheric and environmental science and another principal investigator, "those treaties have to be based on sound science. This slice of the atmosphere is going to help us understand that.

The effort is distinctly different from other efforts—such as the launch last week of a Japanese research satellite—to map carbon dioxide. Most measurements to date look solely at points on the surface. Satellite pictures can see broad swathes of the Earth but with very fuzzy resolution. This work, scientists said, examines nearly 100 different greenhouse gases in very fine detail at almost every altitude.

They have seen some "stunning" things: ground-level ozone, or smog, through the entire depth of the Northern Hemisphere at nearly triple the concentration observed in the Southern Hemisphere; a cloud of industrial pollutants sitting above the Arctic; a large mass of oxygen above the Southern Ocean.

"It supports the view of people who say there's a very big effect of pollution, even in the wintertime," Wofsy said.

To map the atmosphere, scientists are flying a specially equipped Gulfstream V jet, owned by the National Science Foundation and operated by Colorado-based NCAR.

The plane has a range of 7,000 miles, allowing researchers to traverse vast swathes of the Pacific without refueling. Extraordinarily powerful engines allow the jet to cruise at altitudes from 1,000 feet to 47,000 feet, into the lower stratosphere nearly nine miles up.

In contrast, a typical Boeing 767 has a range of about 4,000 miles and cruises at about 35,000 feet.

And while the jet started as a luxury corporate item, it is now anything but: the cabin is stuffed with pipes, pumps, filters, analyzers, sensors computer and other laboratory equipment. They have drilled holes through the fuselage so lasers could point up and down, added pods and intake valves, ditched the leather.

"We have the equivalent of a very expensive laboratory where we can sit behind our instruments as we're going along," Stephens said.

Scientists from NCAR, Harvard, the National Oceanic and Atmospheric Administration, the Scripps Institution of Oceanography, the University of Miami and Princeton University will complete this week the first of five missions. They left Jan. 8, flying from Colorado to Alaska and the Arctic Circle, then south to New Zealand and Antarctica. Late this week they will return from Costa Rica to Colorado.

Four subsequent missions through mid-2011 will follow similar flight paths but at different times of the year, providing a range of seasonal snapshots of greenhouse gas emissions.

The research will help answer such questions as why atmospheric levels of methane, a potent greenhouse gas, have tripled since the Industrial Age and are on the rise again after leveling off in the 1990s. They will also answer how gases and particles in the atmosphere affect temperatures by influencing clouds or the amount of solar heat reaching the Earth's surface.

And by ramming their data, along with long-standing surface measurements, through computer models, they hope to expose the weaknesses of current projections.

"Some modeling approaches will simply fail," Wofsy said. "They won't be able to do this. That's what we're after here: We're confronting these global models with data.

And the experiment is also confronting scientists with a bit of perspective.

"It's quite an experience to fly in an airplane above the Arctic ice sheet, with moonlight illuminating it, and then a short time thereafter be above American Samoa and the lush tropical forest, and then a short time later be over New Zealand," Wofsy said. "It really gave a strong sense of the interconnection of the globe."

Douglas Fischer is editor of the Daily Climate. This article originally appeared at The Daily Climate, the climate change news source published by Environmental Health Sciences, a nonprofit media company.

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