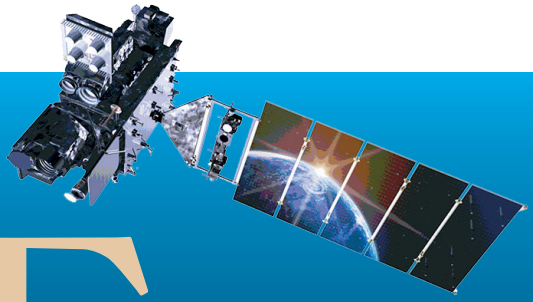

Eyes in the Skies

OU scientists and NASA have teamed up on a mission to put an observatory in space that will monitor Earth's carbon cycle in unprecedented detail.

By Chip Minty
Photos by Travis Caperton

Sometimes, to get a better look at something, you need to step back a little.

And sometimes, you need to step back a lot, like when you're investigating carbon migration in the Western Hemisphere. In that case, you need a rocket and a $166 million budget funded by NASA.

Getting there was a journey in itself, but University of Oklahoma researcher and Chesapeake Energy Corporation Chair in Climate Studies Berrien Moore III finally got a rocket and his NASA funding. Within a few years, he and his team will be managing an enormous stream of data beaming down from a communications satellite stationed 22,000 miles over the Earth's equator. — *continued*

The instrument will peer over North America, South America and the Gulf of Mexico, sending continuous streams of data home. The feed will allow scientists to do real-time analysis of patterns and cycles that might further explain the nature of carbon and ecology.

Moore, who is also dean of OU's College of Atmospheric and Geographic Sciences and director of the National Weather Center in Norman, is the primary investigator of GeoCarb, a geostationary carbon cycle observatory. Engineers from Lockheed Martin are designing and building the instrument and, within four to five years, it will be attached to a communications satellite and launched into space by SES Government Solutions.

The telecommunications satellite will find its perch just west of South America and GeoCarb will begin scanning both continents for information that will help sharpen scientific perspectives on carbon and climate.

Berrien Moore III, dean of OU's College of Atmospheric and Geographic Sciences and director of the National Weather Center, is the principal investigator of GeoCarb, a project that will allow researchers to gain invaluable data about how carbon moves around the planet.

"We're super excited about all of the great science that will come out of this project," says Sean Crowell, who holds a Ph.D. in mathematics from OU and has been a member of Moore's team for six years. "The sheer amount of information is going to revolutionize carbon cycle science in the Western Hemisphere."

These days, the words "carbon" and "climate" have been married in a political melting pot of national and international debate. Moore and Crowell hold themselves above the fray and focus on an objective pursuit of science, gathering data that might lead to more informed public policy decisions.

"It's not a policy mission, and it's not a climate mission," Crowell says. "It's a mission to provide data for researchers to use."

Crowell says the GeoCarb mission will help answer questions about the carbon cycle, the processes by which carbon travels among its major reservoirs — the atmosphere, oceans, soil, rocks and living organisms. Through GeoCarb, scientists will monitor soil and plants along with carbon in the atmosphere as they construct a better understanding of how carbon moves around the earth and what influences its migration.

Carbon is a fundamental element and a building block of life. Bacteria in the soil use carbon to help build their tiny bodies. Plants grow by drawing carbon dioxide from the atmosphere through photosynthesis, and carbon dissolved in the oceans is a building block for phytoplankton, a food source for a wide range of sea life.

GeoCarb is being designed to monitor these activities and much more, Crowell says. Aerospace manufacturer Lockheed Martin will pack an assortment of capabilities into a 300-pound cube about the size of a living room recliner. Its lenses will allow GeoCarb to monitor the health of vegetation by scanning the florescent light plants emit.

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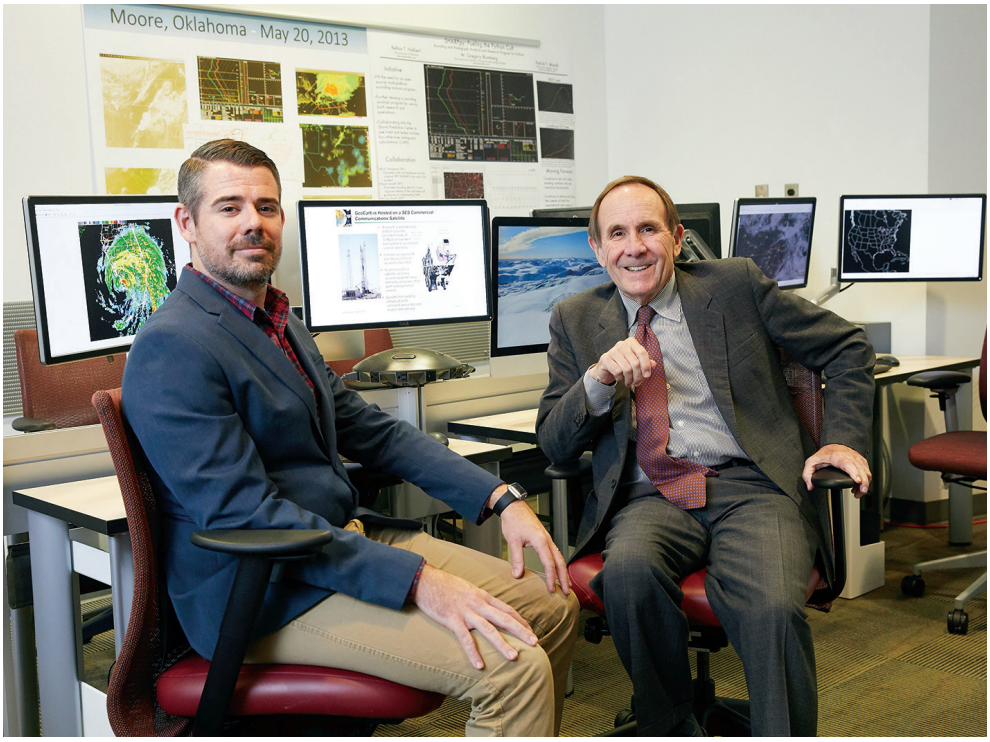


Berrien Moore (right) and GeoCarb colleague Sean Crowell are part of an international team of researchers that earned a $166 million NASA grant after two years of writing and submission. Landing the grant puts OU on the path to compete for larger prestigious awards.

form photosynthesis, so they re-emit, or fluoresce, the surplus light at a wave length that people can't see. Reduced florescence is an indicator of a slowing in photosynthetic processes. That is important because sick plants — those that are under stress because of drought or disease — don't absorb as much carbon, and that influences the carbon cycle, Crowell says.

The instrument also will monitor basic atmospheric gases associated with the carbon cycle, including methane, carbon monoxide, carbon dioxide and oxygen.

In addition to the carbon dioxide emissions from natural sources, the team will identify carbon monoxide emissions that occur through the burning of fossil fuels, such as coal, oil and natural gas. Distinguishing between the two types of emissions will allow researchers to isolate what humans are accountable for, which could result in more informed public policy decisions, Crowell says.

The GeoCarb project represents a new method NASA is using to support smaller-scale scientific discovery missions in space. Through its Earth Venture Mission program, the space agency captures efficiencies by awarding grants to external entities, such as OU, that utilize established engineering and technical expertise.

"It's not that $100 million dollars is not a lot of money, but any project that requires going into space costs at least $100 million dollars," says Crowell.

While the $166 million grant amounts to a small drop in NASA's multi-billion-dollar bucket, it represents an enormous accomplishment for OU and Moore's international team of researchers. This will be a unique mission on the frontier of science, says Moore, who is trained in theoretical mathematics and has spent most of his 48-year career studying the earth's carbon cycle.

"We will be making exciting discoveries, and those discoveries will always come back to OU and GeoCarb," he says.

The grant puts OU on NASA's radar as an institution with a team experienced in space research, and it puts the university on a path to compete for other large, prestigious grants.

"There is nothing like experience to help you take that next step," Moore says, especially when the first step was a long, arduous process.

First inspired by Bob Frost, NASA administrator under the Carter administration, Moore approaches his study of the Earth as though it is any other planet, stepping away and looking at it in its entirety as though he were on a platform in space. Prior to joining OU, Moore served at the University of New Hampshire as professor and director of the Institute for the Study of Earth, Oceans and Space.

He was at a National Meteorological Society meeting in 2010 when he first began thinking about a project that ultimately became GeoCarb. When he accepted the deanship at OU later that year, he continued his vision of launching a carbon cycle observatory into space.

Moore intended to submit his first NASA proposal in late 2010, but abandoned the application after learning about a stipulation he could not meet. He wrote another proposal in 2012, but it was not selected, and he tried again in 2014, but was rejected a second time.

Finally, in summer 2015, he took another shot. This time, he followed a cue from his wife, Gail, who suggested closer consideration of NASA's overall objectives. He discarded plans to include China and India and realigned his project to focus only on the Americas. The mission would address fundamental scientific questions, and his team devised management plans for potential risks, such as unexpected costs and unforeseen circumstances.

The 2015 proposal writing process was different and difficult, he says.

"It was a little bit like learning how to hit a curve ball," Moore says. "I finally learned."

They submitted what he thought was a solid proposal in December 2015, and then they waited.

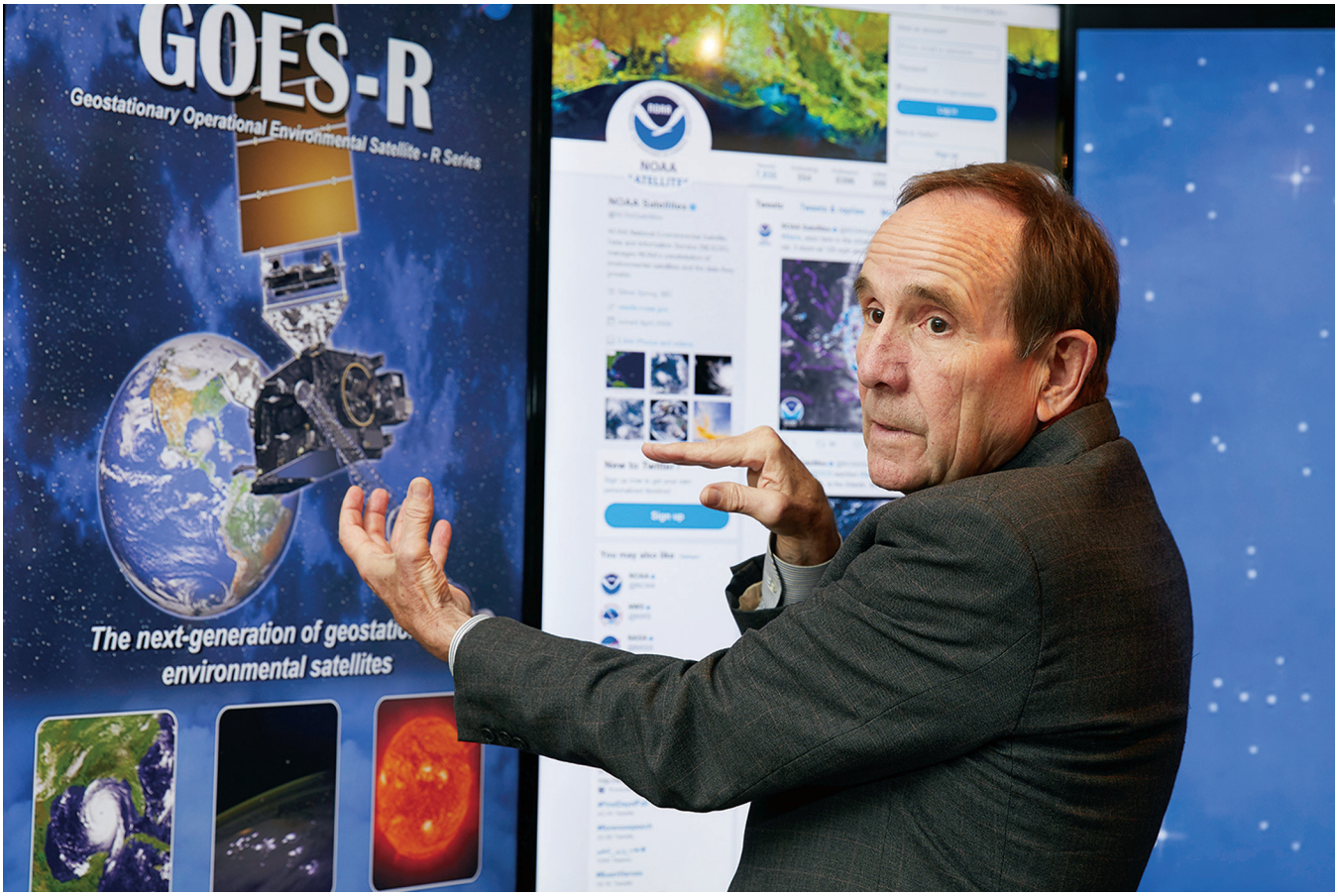
On Dec. 6, 2016, while sitting through a difficult budget meeting, Moore's cell phone went off. The call was from NASA. The dean was not in the mood for more bad news, so he decided not to answer. The space agency called back on another line and surprised Moore's executive assistant, Lee Anne Sallee, on her birthday with the good news. Moore's project had won approval. The vote was unanimous.

Moore compared it to a professional golfer winning his first major tournament.

While teams of engineers and scientists work to design and assemble GeoCarb, SES will zero in on a launch date. As they move closer to the launch, Moore's team will grow with more OU graduate students and post-doctorates coming on board to help manage the torrent of information GeoCarb will produce.

GeoCarb is funded to operate for only three years, Moore says, but the life of a satellite is much longer, and it is likely their observatory will be available for a long time, too. It could be there to monitor El Niño and La Niña cycles, wet

Sean Crowell believes that the GeoCarb team's work will revolutionize the science of carbon cycles. They aim to rise above the climate science political debate that has been raging for years while still informing public policy.



Using an animated display about satellites carrying scientific instruments into space, Berrien Moore illustrates how Geocarb — a cube roughly the size of a recliner — will someday perch 22,000 miles above earth to monitor carbon in the atmosphere, soil and plants.

years and dry years, watching stories unfold and answering questions that have been beyond human reach.

Ironically, Moore was offered an opportunity to serve as chief scientist at NASA in 2010, but he gave it up to work at OU. One visit to Norman was all it took to recognize the intellectual vibrancy on campus and to see the vision President David Boren had for the university.

OU is a leader in many different fields, and Moore is proud of the fact that GeoCarb will open doors for the university to lead in one more. He draws again from the golf analogy.

"We won a major, and now we can go on to win the next one," Moore says. "This mission gives us a chance to surprise and enchant others.

"We can say we play a pretty good game of football, we have a pretty good school of dance and ballet, we have a pretty good French art collection, we have a pretty good Galileo collection, and we're the principal investigator for GeoCarb."

Moore is already envisioning GeoCarb's launch, when the side of the rocket will carry insignias from NASA, SES Government Solutions and OU.

There is one more thing that Moore says will be painted on the side of the rocket as it carries its payload into space.

"Boomer Sooner! Beat Texas!"

Chip Minty is a Norman-based writer and the principal of Minty Communications, LLC.