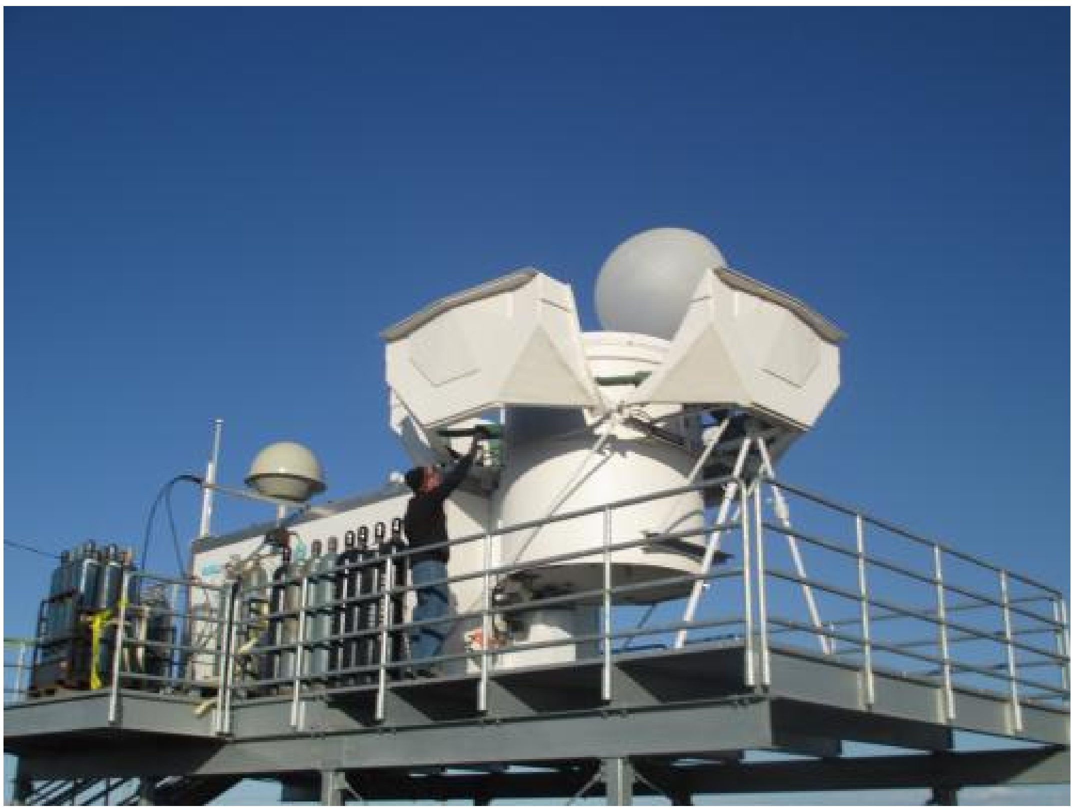
Alaskan North Slope climate: hard data from a hard place

August 14 2012, By Neal Singer



WE HAVE LIFT-OFF — Sandia National Laboratories station manager Mark Ivey indicates the path of a helium-filled weather balloon as it floats rapidly up from its cradle. The facility is part of DOE's Atmospheric Radiation Measurement (ARM) climate research program. Photo: Neal Singer

Sandia National Laboratories' researcher Mark Ivey and I (science writer Neal Singer) are standing on the tundra at an outpost of science at the northernmost point of the North American continent. We are five miles northeast of Barrow, an Alaskan village unreachable by roads, 320 miles north of the Arctic Circle and a mile south of the Arctic Ocean.

It is late spring, the ice breaking up and the snow melting around us, and Ivey — manager for Sandia of the Department of Energy's Atmospheric Radiation Measurement (ARM) climate research facility at Barrow — is waiting with me for the automated release of a weather balloon in two minutes, at 9:31 a.m.

The balloon, to be launched from the balcony of a metal-and-glass test facility about the size of a mobile home, is expected to measure the Arctic atmosphere's temperature, humidity and wind speeds at a rapid succession of altitudes as it rises. The tests are part of an ongoing effort to depict the structure of the atmosphere — an interesting concept to a layman — and the formation and elevation of its clouds. Imprecisions in both these areas cause disputes about the accuracies of global climate models, which need the kind of hard data provided by this facility for the most accurate results.

To this end, the launch facility inflates and releases two balloons every day, automatically, one at 9:31 a.m. and another at 9:31 p.m.

"We used to have our Barrow assistants come out here twice a day and fill a balloon with helium and let it go," Ivey tells me from the balcony as he checks the canisters used to fill each balloon. "This automated setup is much easier on everyone."

The time- and location-stamped data — collected every 10 seconds as the balloon soars upward — will be radioed to a receiving antenna at the test facility, and from there electronically to the ARM central Alaskan facility — an unpretentious one-story duplex a few miles away in Barrow. Along with other data collected at the wind-swept, often snowedin research site, which operates under the aegis of DOE's Office of Science, the information also helps calibrate satellite measurements of Earth's atmosphere, providing reality checks to the remote sensor inputs received from space orbit. These inputs are electronic zeroes and ones to which human beings assign meanings. Atmospheric measurements secured and analyzed, on the other hand, provide hard data against which satellite observations can be calibrated, improving their accuracy and reducing another possible source of error in climate computer models.

I am kneeling on one knee with my camera ready, my pants leg soaked in permafrost, about 12 feet below the deck where Ivey is standing. The balloon should bolt out of its chamber at 5 meters per second — "It pops up and goes pretty fast," Ivey had warned — and there would be no do-overs until 12 hours later if I miss its emergence..

Two metal petals of the machine's business end had opened a few minutes earlier like a huge mechanical rose, indicating its sensors had determined wind speeds were low enough for a balloon launch. At 9:31 a.m., the remaining two petals should open, releasing its 3-foot diameter, helium-filled balloon.

A mile or so distant, the white radar domes of the U.S. Air Force's Point Barrow Long Range Station are watching for planes or missiles on their way over the North Pole, some 1,300 miles to the north. A DOE radar dome and several slender, heavily instrumented towers stand nearby, also managed by Ivey, taking moment-by-moment data from a variety of ground- or tower-based sensors on humidity, methane, carbon dioxide, wind velocity, ground infrared (heat) emissions and microwave energy from the sky, all transmitted electronically to a computer. Nearby, sensors in facilities run by the National Oceanic and Atmospheric Administration and by the U.S. Geological Survey gather complementary geophysical data that includes precise measurements of the Earth's magnetic field and concentrations of greenhouse gases in the atmosphere.

“People had mentioned to me that they thought our operation would fade away,” Ivey had said in his reflective, soft-spoken way. “But because of the quality of the data and its ability to provide information about important topics in a trustworthy way, funding has actually increased. The program could be around for a long time to come.”

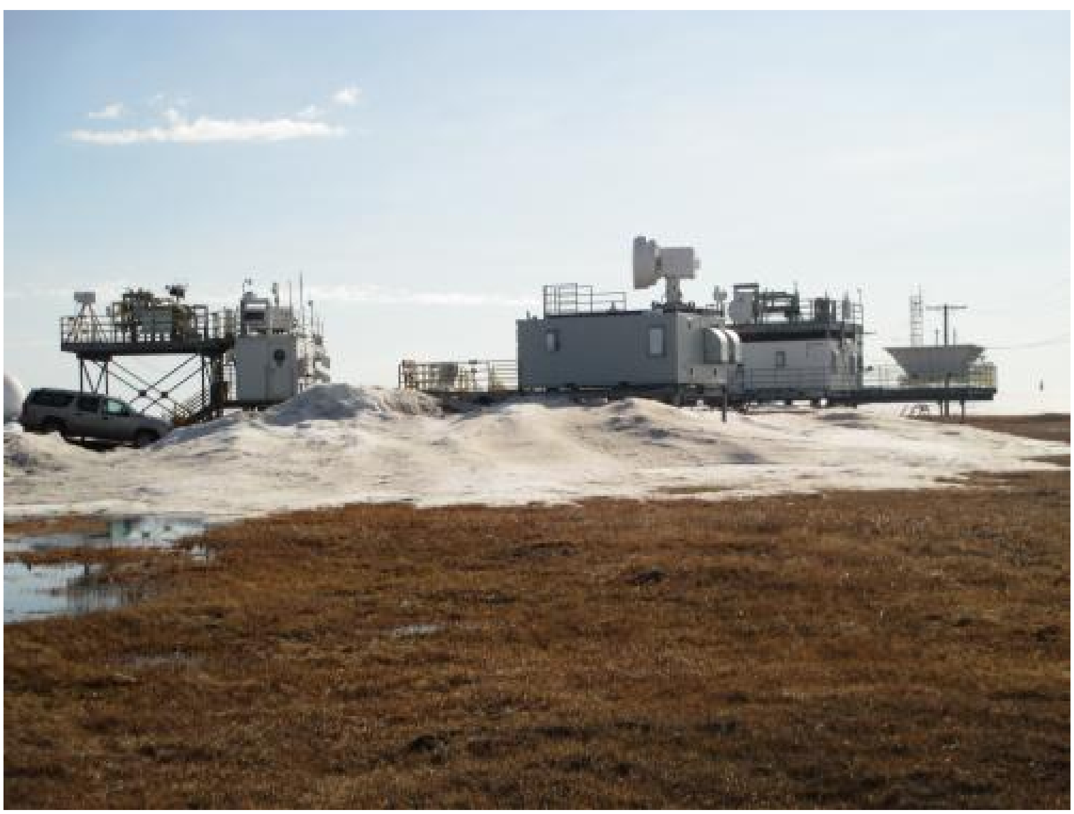
That is, of course, if Ivey and his colleagues can continue balancing the interests of federal and state agencies and the native corporation that manages land in and around Barrow. One of Ivey’s pressing tasks when I visited was to finalize agreements in the community for living quarters and meeting space for the scientists who come from elsewhere to do technical work. But lease prices could rise dramatically with an influx of workers if off-shore oil drilling commences north of Barrow. And uncertain economic times have sent mixed messages to the electrical co-op about where to install new utility lines needed for the scientific effort.

The scope of the human, technical and regulatory problems facing Ivey as ARM representative reminded me of a statement Sandia’s president is fond of making: “Sandia doesn’t do easy,” Paul Hommert has said, “Sandia does hard.”

That certainly seems the case here.

The balloon site’s data streams are available electronically to labs and modelers around the world interested in honing their computer simulations with exact ongoing information on the Arctic climate, thought to be a precursor and influencer of the rest of the slower-responding world. Among the reasons for this sensitivity are the clear window to space for outgoing radiation provided by the very dry atmosphere and the expansion or contraction of the polar ice sheet. The latter causes large changes in surface sunlight reflectivity and regulates how much solar energy is absorbed by the darker ocean water. In addition, trends measured in the extent of Arctic ice indicate the Arctic likely will be ice-free in summer within the next few decades. At what rate is the extreme north's climate warming, and why? Up here in permafrost land is the data that may help decide these issues.

Among the site's findings to date has been that the Arctic's very cold clouds fill with supercooled liquids rather than ice particles. This difference has a big impact on the amount of heat entering or leaving Earth's surface, said Hans Verlinde, a meteorology professor at Penn State and site scientist for the Barrow ARM program. In the Arctic, where clouds help warm Earth's surface instead of cooling it, they do this more effectively with liquid in the clouds instead of solids, an important clarification for climate models.



Instrument shelters and a new radar are part of the ARM facility near Barrow, Alaska. Photo: Neal Singer

Information like this is so desirable that the Office of Science has allocated additional funding during the next two years through its Biological Environmental Research (BER) arm to build new facilities and buy equipment for another ARM site. Also to be managed by Sandia, it will be constructed 166 miles away at Oliktok Point, a spit of land that borders directly on the Arctic Ocean. The property is owned by the Air Force, which has been required by federal mandate to reduce its landholdings in Alaska. Part of its station may be transferred to other federal agencies, the State of Alaska or a native corporation. The idea from the scientists comprising the Barrow ARM group is to install a ground station of four prefabricated buildings and stock it with Doppler and high spectral resolution lidars, radar, and radiometers, along with meteorological equipment and other sensors. More important, an abandoned Air Force hangar a hundred yards away would shelter unmanned aerial vehicles (UAVs), probably to be owned by a university in collaboration with the Office of Science. These would be expected to fly through air space almost empty of civilian or military traffic from Oliktok Point to the North Pole, about 1,400 miles away, for additional atmospheric data collection.

“Routine measurements of the Arctic atmosphere would be very valuable in understanding it,” Ivey said, “and the ground station would be helpful in understanding cloud processes. But UAVs and balloons are ways to get at atmospheric structure that currently are poorly represented in our models.”

Oliktok Point has another advantage: It’s on a major north-south road (the “haul road” used by ice truckers on a popular reality TV show) that ends in the assorted collection of workaday buildings known as Deadhorse, an entrance point to Prudhoe Bay oil rigs. The flat, primitive peninsula that ends at Oliktok Point is eerily dotted with enormous facilities built every few miles by oil companies. The companies require personnel and heavy equipment brought in year-round to process oil to put into pipelines that send the precious liquid south.

Though Barrow is a real community, unlike the expanded truck-stop facilities that comprise Deadhorse, one of its limitations is that equipment, materials, fuel and food arrive by barge from Seattle only once a year, though smaller items can be flown in.

The existence of the Oliktok station depends on Ivey’s ability to get the Air Force, the Federal Aviation Administration, the Inupiats, federal and state land offices and the oil companies of the Prudhoe peninsula to agree. He needs power lines and building leases from the native corporation that oversees Barrow, site licenses from government organizations, Air Force permissions and oil company concurrence for access to the road system in Prudhoe Bay. Finally, the land may have been polluted by previous users; if ARM purchases it, or just takes it over with the Air Force’s blessings, who is responsible for cleanup?

“What do you do when you clean up one year and next year something else leaks out?” said engineer Jerry Peace, a member of Sandia’s North Slope team. “Residual pollution requires ongoing inspections.”

“It was enlightening to see the complicated maze that must be negotiated to create the new Oliktok Point site and UAV capability,” said Sandia’s Marianne Walck during a visit that included Rick Stulen, Sandia’s vice president for its California lab, and Rob Leland, director of Sandia’s Computing Research Center and of its Climate Security program. Walck, who directs the Geoscience, Climate and Consequence Effects

Center, added, “We’re working on ideas on how to find funding so we can increase the scientific impact from our activities there.”

How did Ivey, an electrical engineer by training, develop these negotiating, managerial, and leadership skills? Ivey, who speaks slowly, shrugged and smiled. “I’m a lucky participant and partner in science,” he said quietly.

Thus far, Ivey’s continuous low-key negotiations have been successful in moving the work forward at Barrow and Oliktok Point.

“The work on the North Slope is producing uniquely important measurements that will enable vast improvements in today’s evolving climate models,” said Stulen. “There will be increased confidence in model accuracy in predicting the actions of nature.”

Stulen also was impressed by the petroleum industry. “I was really taken by the enormous oil industry infrastructure in Prudhoe Bay and the Alaska pipeline that provides for something like fifteen percent of U.S. petroleum – quite an engineering feat!”

Leland said, “What stood out for me most is the enormity of the scientific opportunity in the Arctic. Researchers believe that the effects of climate change are amplified substantially in the arctic, and yet comparatively little is known about the specifics. By combining the data coming from our ARM program with satellite data and the proposed UAV data with the new generation of high-resolution climate models we are developing, it should be possible to greatly advance our understanding of what is really happening there.

“There are a host of critical national security issues at stake in the Arctic — new shipping routes, new access to resources, new operational demands on the military to name a few — and you get a sense of the significance of the opportunity. We are just now developing our ability to work across that entire spectrum, and of course we need to do that in close partnership with many other agencies and institutions, but the prospect of Sandia being centrally engaged in addressing the Arctic challenge is just tremendously exciting to me."

One factor that could help forward Sandia's arctic research are the facilities and personnel at the University of Alaska, Fairbanks.

Sandia's Jerry Peace — whose master's in geophysics from U of A in 1979 included being treed by a grizzly when he went looking for mineral deposits on an industry-sponsored summer project — said, "The U of A's Geophysical Institute, established by Congress in 1946, studies a spectrum of geophysical processes ranging from the center of the earth to the center of the sun. It has an international reputation for studying the physical environment of the Arctic. Partnering with them could be useful in furthering our state and national needs."

The balloon-launch station is a robotic marvel. Twenty-four balloons at a time can be stacked on a conveyor belt. A half-hour before lift-off, the lead balloon is automatically chambered and inflated by the helium-filled canisters.

But by 9:36 a.m., no balloon has emerged. "Something's wrong," said Ivey, and we drive the few miles back to the one-story building housing the project's headquarters. There, Jimmy Ivanoff, hired as a technical aide from the Inupiat native corporation that runs Barrow, looks at the data in the duplex's office and erupts, "Darn, that thing has worked without a flaw for months. On the day we have a visitor, it fails!"

A balloon apparently was not loaded in the chamber casing. The chamber's sensors, detecting the absence, prevented the structure from opening and essentially shooting a blank.

"Fortunately, experts from the vendor are on their way here," Ivey said. "At least once or twice a year we bring someone here from there to check it out."

I remember what Ivey told me before we left: "It's Alaska. Expect delays and keep your sense of humor."

I have one more chance to photograph the rising balloon before leaving early the next morning. Because it's late spring in Alaska, the sun won't set tonight. I look at Jimmy poker-faced and say, "As long as you can fix the problem before nightfall, we can try again.

He looks at me, as does the Inupiat station manager WalterBrower, to see if I am kidding. "I guess I can," Jimmy said finally, "seeing as how it won't be dark for weeks." We all laugh.

That evening, promptly at 9:31 — my last photo opportunity before leaving Alaska — the balloon takes off like a sprinter. I have to estimate when to press the shutter button, because it takes almost two seconds for my camera to agree to snap a highly pixellated shot. I acheive the image, but with the balloon not quite fully airborne.

Nothing about any of this seems easy.

Provided by Sandia National Laboratories