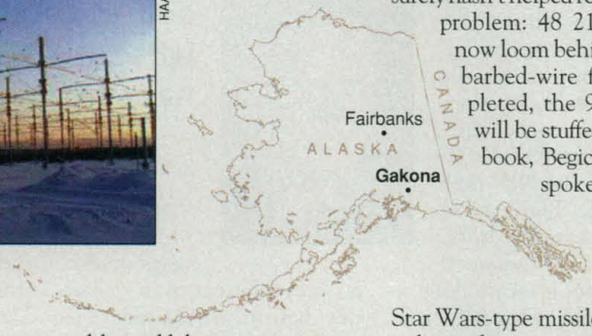
ATMOSPHERIC PHYSICS

Ionosphere Research Lab Sparks Fears in Alaska

SITKA, ALASKA—Public outreach doesn't always unfold according to plan. Just ask University of Alaska plasma physicist Joseph Kan. Last fall, Kan traveled to Gakona, a tiny town 300 kilometers southeast of Fairbanks, where the Department of Defense (DOD) is constructing the world's most powerful ionospheric research laboratory. His mission was to chat with townspeople about a $90 million program known as HAARP, or High-Frequency Active Auroral Research Program—an ambitious effort to study the roiling ionized gases of Earth's upper atmosphere. Kan was expecting technical questions, but instead he says he got an earful of "fears" about the facility. One person described seeing a mysterious "green glow" above the site; another claimed that it was making caribou walk backward and having a "mind-bending effect" on local residents.

Antenna farm. Gakona will sprout 180 transmitters.



Confusing caribou was not exactly what the military had in mind when in the late 1980s it decided to build the research facility at a DOD-owned site near Gakona. The project is designed to probe 50-kilometer patches of the ionosphere—the layer of charged gases that begins about 80 kilometers above Earth's surface and extends out beyond 400 kilometers—with a powerful beam of high-frequency radio waves. When completed, HAARP will allow scientists to study fundamental physical and chemical processes in the ionosphere, and the military to develop and enhance long-range radio communications, surveillance, and navigation systems.

But the project has come under fire from a diverse slew of critics, ranging from local residents worried about their health to activists who charge that the military is planning to use HAARP for a variety of top-secret, sinister purposes. Last year, for instance, anti-HAARP activist Nick Begich, son of a former Alaska congressman, published *Angels Don't Play This HAARP*, in which he argues that the military plans to use HAARP to manipulate weather patterns and jam the thoughts of millions of people worldwide, among other claims. All this is putting the project's backers on the defensive. While HAARP project director John Heckscher of the Phillips Laboratory in Boston vows that anti-HAARP activists won't stop the project, he allows that they may succeed in delaying its launch, which is scheduled for 2002.

The Gakona facility originally was established by the U.S. Air Force and the Office of Naval Research as an over-the-horizon radar station, part of the Distant Early Warning System for monitoring Soviet aircraft and missiles. When the Cold War ended, the military scrubbed the radar facility, and with the help of Alaska Senator Ted Stevens, chair of the defense appropriations subcommittee, won the federal funds to begin transforming it into an ionospheric lab.

For U.S. plasma physicists, HAARP is a dream come true. Re-creating ionospheric processes in earthbound laboratories is notoriously difficult. Space has no walls, so as soon as charged gases like those in the ionosphere hit a barrier of some kind, the experiment is effectively over, says Cornell University physicist Michael Kelley, chair of the U.S. Ionospheric Interactions Program steering committee. With its focused beam of high-frequency radio waves, HAARP will excite, or "heat," ions and electrons in the ionosphere, much as the sun does. This will allow scientists to observe in a controlled fashion the complex physical processes that occur naturally. Says Kelley, "Very little space science is manipulative. But the normal scientific method is done by cause and effect; this is our tiny tool to help us do that."

The DOD is equally enthusiastic about the project. The ionosphere reflects radio signals and so provides long-range capabilities for military and civilian communications, navigation, surveillance, and remote-sensing systems. But it also distorts and absorbs the signals. Researchers hope that a better understanding of how the sun interacts with the ionosphere will enable them to develop and enhance these crucial space-based systems.

One application the military is particularly interested in exploring with HAARP is the use of Extremely Low Frequency (ELF) signals for communicating with submerged submarines. Unlike conventional radio waves, ELF signals can penetrate several kilometers below the ocean surface, allowing subs to receive transmissions without risking detection by coming close to the surface. The military already operates an ELF system with two transmitting antennas, one in Michigan and one in Wisconsin. Unlike these facilities, HAARP would not transmit such signals from the ground. Instead, its many powerful antennas would be able to generate ELFs at an altitude of about 80 kilometers. By tapping into the supercharged portion of the ionosphere over the Arctic, called the electrojet, HAARP scientists are hoping to create a virtual transmitter in space that would allow the Navy to communicate with subs worldwide.

But anti-HAARP skeptics claim that the military has even bigger plans for the project. HAARP's somewhat menacing appearance surely hasn't helped resolve its public-relations problem: 48 21-meter radio antennas now loom behind the Gakona facility's barbed-wire fence, and, when completed, the 9-hectare antenna farm will be stuffed with 180 towers. In his book, Begich, who is the informal spokesperson for the loosely knit anti-HAARP coalition, writes that all this technology is part of a DOD plan to raise a Star Wars-type missile shield and devise technologies for jamming global communications worldwide. Physical chemist Richard Williams, a consultant for the David Sarnoff Institute in Princeton, New Jersey, further argues that HAARP could irreparably damage the ionosphere: "This is basically atmospheric physicists playing with the ionosphere, which is vital to the life of this planet." Also, he asserts that "this whole concept of electromagnetic warfare" needs to be "publicly debated."

The HAARP critics have asked for a public conference to discuss their concerns and hear more details about the science from the military. They have written hundreds of letters to Alaska's congressional delegation and have succeeded in getting the attention of several state legislators, who held legislative hearings on the subject last year.

Many scientists who work on HAARP are dumbfounded by the charges. "We are just improving on technology that already exists," says Heckscher. He points out that the Max Planck Institute has been running a big ionospheric "heater" in Tromsø, Norway, since the late 1970s with no lasting effects. U.S. scientists don't have good access because the United States did not join the Nor-

wegian consortium. Also, the United States already operates two other small ionospheric heaters, at the Arecibo Observatory in Puerto Rico and at HIPAS, operated by the University of California, Los Angeles, 325 kilometers down the road from HAARP in Chena Hot Springs, Alaska. The HAARP facility, with three times the power of current facilities and a vastly more flexible radio beam, will be the world's largest ionospheric heater.

Still, it will not be nearly powerful enough to change Earth's climate, say scientists. "They are talking science fiction," says Syun-Ichi Akasofu, who heads the University of Alaska's Geophysical Institute in Fairbanks, the lead institution in a university consortium that made recommendations to the military about how HAARP could be used for basic research. HAARP won't be doing anything to the ionosphere that doesn't happen naturally as a result of solar radiation, says Akasofu. Indeed, the beam's effect on the ionosphere is minuscule compared to normal day-night variations. "To do what [the critics] are talking about, we would have to flatten the entire state of Alaska and put up millions of antennas, and even then, I am not sure it would work."

Weather is generated, not in the ionosphere, but in the dense atmosphere close to Earth, points out University of Tulsa provost and plasma physicist Lewis Duncan, former chair of the U.S. Ionospheric Steering Committee. Because HAARP's radio beam only excites and heats ionized particles, it will slip right through the lower atmosphere, which is composed primarily of neutral gases. "If climate modifications were even conceivable using this technology, you can bet there would be a lot more funding available for it," he jokes.

Critics also charge that the HAARP project is suspect because—having been funded directly by Congress—it has never undergone a formal, scientific review process. Mitch Rose, Stevens's chief of staff, counters that the critics shouldn't look a gift horse in the mouth. "Let's face it, the DOD has a good budget, and they have the resources to support this type of program. ... We are hoping that HAARP will be a harbinger for a different Silicon Valley for Alaska."

Whatever economic benefits HAARP bestows, they won't be felt for a few more years: While Congress has budgeted $15 million in the FY '97 budget for HAARP, Heckscher says that all the legislative hearings, requests for information, and piles of letters have slowed the project down. Still, the University of Alaska's Kan hopes the controversy will prove to be a boon for physics: "I see this as a tremendous opportunity to educate the public about physics and auroral studies."

–Lisa Busch

Lisa Busch is a science writer in Sitka, Alaska.

AAAS MEETING

Scientists Convene in Seattle To Discuss Science and Policy

SEATTLE—At the Annual Meeting and Science Innovation Exposition of the American Association for the Advancement of Science (which publishes *Science*), researchers, educators, and policy-makers shared their research results, and debated new developments in science policy and education. The conference ran from 13 to 18 February. Here are two reports from early sessions; more coverage will be published in next week's issue.

R&D Confronts Political, Fiscal Problems

To U.S. scientists, the $75.5 billion R&D budget released earlier this month by the Clinton Administration may seem like a blueprint for tough times ahead, with its projections of cuts in purchasing power over the next 4 years (*Science*, 14 February, p. 916). But to many top science policy-makers from around the world, who made up a panel on the opening day of the AAAS meeting, it must have seemed like an impossible dream.

Officials from both rich and poor countries spoke of inadequate budgets and a growing gap between the scientific resources and priorities of the industrialized countries and those of the developing world. "You scientists ... are part of a privileged world elite," said Peruvian R&D analyst Francisco Sagasti of researchers in the First World. He and other members of the AAAS panel urged R&D managers in developed countries to help heal the rifts between rich and poor nations by channeling resources into research in agriculture, telecommunications, and health.

In Russia, said Boris Saltykov, a former Russian science and technology minister who now runs a Moscow-based organization working to strengthen ties between Russian scientists and their counterparts in other nations, the challenge is simply to survive. Saltykov reported that R&D spending in Russia dropped by 70% over 5 years. Scientific employment in the former Soviet Union fell from a peak of 3,200,000 scientists and support personnel in the late 1980s to about 1,334,000 in 1995. Accompanying that decline were a host of reforms, many pushed by Saltykov, to unshackle science from the former Soviet Union's crippling bureaucracy. But the state research institutes created to protect Russian expertise in a host of scientific fields are now "inoperative" because only 60% of the money allocated by the Duma, or parliament, has been disbursed in 1996. One bright spot is increasing collaboration with Western researchers. "We are rapidly advancing toward ultimate integration into the world scientific community," he says.

For China, the challenge is to provide resources for a population expected to top 1.6 billion by the middle of the next century. That means focusing on agricultural research, says Zhou Guangzhao, who heads the China Association for Science and Technology. China needs to increase grain production by 50% by engineering new, pest- and drought-resistant strains of rice and wheat, among other endeavors. Zhou says that his country also must develop new energy-conservation technologies, and devise and build a massive transportation infrastructure that will be able to move millions with ease. "Achieving sustainability is a top priority," he says.

Latin America, meanwhile, is still trying to recover from the 1980s, a tumultuous decade in which R&D institutions were hard-hit by political and economic upheaval. "We really lost ground and have not been able to catch up," says Sagasti. He notes that in the late 1960s, Peru and South Korea both spent about the same amount—approximately $100 million—on R&D. Nearly 30 years later, Peru continues to spend at roughly the same level, while in South Korea, industry and government now spend $9.6 billion annually on R&D. Sagasti contends that Third World nations "cannot hold [on] to the illusion" that they will ever be able to spend and consume at First World levels, and, like Zhou, he calls for scientists to focus their efforts on devising and enhancing technologies that will allow people in all countries to live more sustainably.

Science managers from developed countries tend to be the most upbeat about the likelihood that science and technology will be able to knit together a fractured world. Jack Gibbons, U.S. President Bill Clinton's science adviser, cites CERN in Geneva as an example of a successful international endeavor that augurs stronger cooperation in the future in a variety of fields. He pointed to a proposal in the 1998 budget request for a U.S. plan to combat emerging infectious diseases as an example of research that will benefit people worldwide.

But U.K. science adviser Robert May of-