Military Scientists Study Ionoshpere

By Bob Freeman
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WASHINGTON, Feb. 26, 2010 – At a facility in a remote part of south-central Alaska, the largest radio transmitter on Earth sends high-frequency signals into the ionosphere to better understand the influence of charged particles on radio communications and satellite surveillance systems. Surprisingly, it also is able to create a mini-ionosphere.

“The High Frequency Active Auroral Research Program, a program known as HAARP, is basically a joint Air Force-Navy program to investigate ionospheric physics and radio science,” explained James Battis, HAARP program manager at the Air Force Research Laboratory, in a Feb. 24 interview on Pentagon Web Radio’s audio webcast “Armed with Science: Research and Applications for the Modern Military.”

Battis was joined in the interview by Craig Selcher, HAARP program manager at the Naval Research Laboratory, and Todd Pedersen, a senior research physicist at AFRL.

“The ionosphere is a region of the upper atmosphere where there are a significant number of charged particles,” Pedersen said. He explained that energy from the sun, particularly in the ultraviolet wavelengths, strikes atmospheric gas molecules and atoms with enough force to dislodge electrons. This results in a field of negatively charged electrons and positively charged atoms and molecules [ions], maintained in a plasma state, which conducts electrical currents and responds to electric and magnetic fields.

Battis mentioned that radio waves passing through the ionosphere are affected by the charged particles. “This can affect things like the quality of the signal from a satellite to the ground, or short-wave communications from ground to ground,” he said.

He added that the signals from satellite-based surveillance and positioning systems also can be affected by the ionosphere.

“When the signals from GPS come down [from the satellite], their paths are actually deflected by the structure of the ionosphere,” he said, “and some GPS errors are due to distortions created by the ionosphere.” He explained that while these errors may not be significant to the average user, they can be significant for precise military positioning. “That’s one of the reasons [the Defense Department] is interested,” he noted.

But the scientists all agreed that communications are the major reason for Defense Department interest.

“These are the transmissions which are used to communicate with aircraft and satellites, so the Air Force is interested largely in effects of the ionosphere on communications,” Battis said.

The Navy’s Selcher agreed. “We have ships all over the globe that we want to be in contact with at all times, so any effect the ionosphere has on communications is something that we want to study,” he said.

Battis noted that the research conducted by HAARP will benefit civilian communication systems as well, including those supporting civil aviation and ground communications.

"Satellite radio and satellite television can also be impacted by naturally occurring ionospheric conditions," Selcher added. "And trying to understand those is to begin to learn to predict, and maybe to ameliorate, the problem."

Battis described much of the previous ionospheric research as passive, with the evaluation of ionospheric effects based on the quality of reception of a normally transmitted radio signal. "The radio waves we transmit from the array at our facility actively create processes and interactions with the particles in the ionosphere,” he said. “Hopefully, we can learn what the responses are and how to use them to improve transmissions through the ionosphere," he said.

"We have radio-wave sensors which send waves up to the ionosphere and listen for a reflection or an echo off something up there," Pedersen remarked. "And we have passive sensors that will listen to waves produced in the ionosphere, and also optical sensors."

Pedersen explained that when energy is directed at the ionosphere, some of it eventually comes back in the form of radio waves and some in the form of optical emissions.

"When these electrons get moved around by the electric field, they ultimately run into molecules up there, and when they have enough energy they'll become excited and give off light, just like the inside of a fluorescent light bulb," he said.

Battis and Selcher observed that the radio waves emitted from the HAARP array create reactions that mimic natural processes in the ionosphere, but they are more controlled and their time and frequency input is measured, allowing the researchers to differentiate them from natural occurrences and better understand the processes at play.

"You can actually repeat the experiment again and again to verify that you're getting the right data, and that the data means what you think it means," Selcher explained.

Battis described the unique nature of the HAARP array, consisting of 180 transmitters distributed over 35 to 40 acres of land, with a frequency range of 2.65 to 10 megahertz.

"We can actually direct the signal within about 15 degrees of the zenith and move the signal in time," he said. "So we can paint the sky. Similar facilities are typically restricted to three or four frequencies in that band, whereas we're able to do more continuous frequencies."

"That allows you to really expand the kind of experiments that you can do," Selcher added. "You can start sweeping the beam around in space, and you can change frequencies to determine if there's a frequency that has a stronger interaction with the ionosphere."

Pedersen described a surprising advance in the use of HAARP transmitters. He explained that at full power, HAARP is energetic enough that its signals not only light up the gas molecules, they're also able to knock additional electrons off, creating small areas of artificial plasma.

"Sunlight does that, and that's how we get the ionosphere in the first place," Pedersen said. "The aurora also does it. Electrons come shooting in from the aurora, from far out in space, hit the gas molecules, knock electrons off, and create a temporary ionosphere for the duration of time the aurora is there," he explained.

In short, HAARP is able to create a small addition to the ionosphere. "We can add to the ionosphere enough that we can actually start doing experiments in that little spot of plasma that we created from the transmitter," Pedersen said.

Pedersen remarked that the next step was to figure out exactly what's happening in this artificial plasma and how to control it.

"This field has been data-starved for many, many years," Selcher noted, "because there weren't enough facilities that had the kind of power that HAARP has." He explained that theorists proposed many ideas to explain ionospheric interactions, but the data wasn't available to support them. HAARP is changing that.

"It's a nice position to be in as an experimentalist," he said.
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