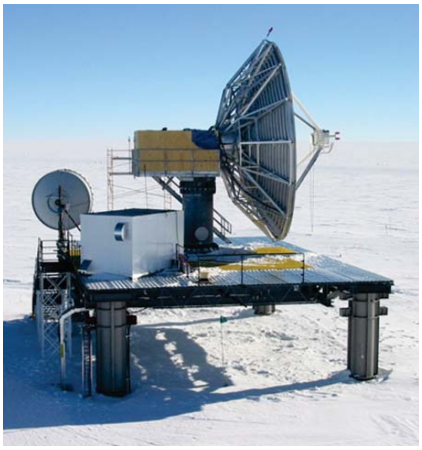
Keeping equipment cool can be a challenge at Antarctic ground station

Michael Ashley's Quick Study, "The care and feeding of an Antarctic telescope" (Physics Today, May 2013, page 60), was an enjoyable read. His comment on equipment overheating at ambient temperatures below −60 °C and the trickiness of thermal design brought back memories of a similar problem I experienced as the South Pole satellite communications engineer. The South Pole Marisat-GOES Terminal satellite communications ground station (see the photo at right) supported intercontinental communications to the Amundsen–Scott South Pole Station through two old but still viable highly inclined geosynchronous satellites, *Marisat-F2* and *GOES-3*. Not surprisingly, ground station operations and support for this large, complex system in the extreme temperature environment occupied much time on and off ice during my seven years with the program.



The South Pole Marisat-GOES Terminal, in 2002, with a 9-meter full-motion antenna pointed at *Marisat-F2* and a fixed 3-meter antenna pointed at *GOES-3*. Inlet and exhaust vents are opened and closed by temperature-controlled fans housed in the antenna shelter.

For several years after the terminal commenced operation in 2001, unexplained oscillations in the uplink solid-state power amplifier (SSPA) output were observed. They affected link performance and produced corresponding oscillations in the strength of signals received by satellites, particularly for *GOES-3*, which required an uplink power level more than five times that needed for *Marisat-F2*.

The SSPA electronics and power-supply equipment had forced-air cooling. While performing annual equipment maintenance in the terminal's shelter and monitoring the SSPA output one summer day, we serendipitously noticed the output changing at the same frequency as shelter temperature fluctuations in response to intervals of cooling-fan operation. Clearly, ambient air temperature and its ability to cool were factors in the SSPA output. The South Pole experiences a wide range of atmospheric pressure values, equivalent to altitudes between approximately 3050 m and 3600 m but typically staying around 3200 m in the summer. Midsummer temperatures usually range between −40 °C and −25 °C. A 1998 memo[1] by Jingquan Cheng at the National Radio Astronomy Observatory stated that cooling efficiency can decrease by about 15% at 3000 m. Apparently, that efficiency reduction affected the ability to cool electronics by the forced-air cooling system. Anecdotally, flat-panel plasma displays installed in the new station suffered premature failure, no doubt due to a similar problem with insufficient cooling at altitude.

The solution was relatively simple. We moved the SSPAs to the lowest rack location, disconnected the outside air inlet fan at the bottom of the shelter, and permanently opened the inlet fan vent slightly. The move placed the SSPAs in a cooler location—thermal stratification is quite noticeable—and reliance on only the exhaust fan at the top of the shelter evened out temperature and corresponding SSPA output variations. Hopefully, our experience can be used by others contemplating electronic equipment operation at high altitude.

Reference

1. J. Cheng, "Forced air cooling at high altitude," MMA Memo 203, National Radio Astronomy Observatory, Tucson, AZ (1998); http://legacy.nrao.edu/alma/memos/html-memos/alma203/memo203.html.

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Letters and commentary are encouraged and should be sent by email to ptletters@aip.org (using your surname as the Subject line), or by standard mail to Letters, Physics Today, American Center for Physics, One Physics Ellipse, College Park, MD 20740-3842. Please include your name, work affiliation, mailing address, email address, and daytime phone number on your letter and attachments. You can also contact us online at http://contact.physicstoday.org. We reserve the right to edit submissions.

Kenneth Wilson footnote: Stories of a great competitor

Theoretical physicist Kenneth Wilson, who received the 1982 Nobel Prize in Physics, died earlier this year. (See his obituary in Physics Today, November 2013, page 65.) I'd like to share with readers my first encounters with Ken, when we were both undergraduates.

On a particular Saturday in late fall of 1956, when I was a junior at Cornell University, two events were taking place in Ithaca, New York. One was the Heptagonal Indoor Track and Field meet, in which all Ivy League schools participate. The other was the annual William Lowell Putnam Mathematical Competition, a very challenging national undergraduate contest. Six problems were to be solved in three hours in the morning, and another six in three hours in the afternoon. By "challenging" I mean that the median score is often only about 1 out of 12.

As a dual major in math and physics, I had decided to try my hand at the Putnam. Those Cornellians who had signed up arrived at the exam room to find an additional competitor, Ken Wilson, a senior at Harvard University. Not only was Ken taking the Putnam exam in Ithaca by special permission, but he was also running the mile that evening in the Heptagonal Games. The star miler in the Ivy League at the time was