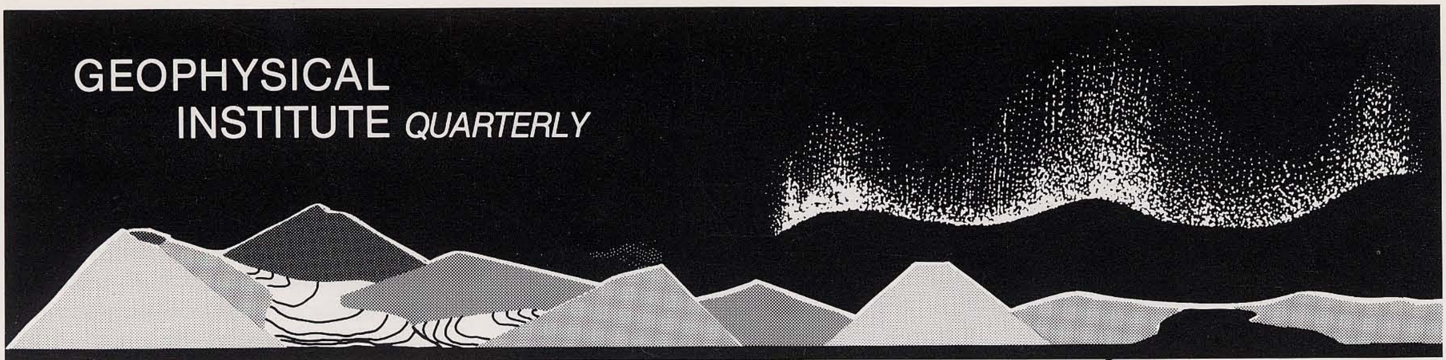



Vol. 11 No. 2 Winter 1993

# Cable Permits Deeper Probe into Sea Ice

Geophysical Institute researchers spent about two weeks aboard a 399-foot icebreaker this winter to study ultraviolet light transmission through sea ice. Their findings may help scientists learn how the shrinking ozone layer above Antarctica affects phytoplankton and other sea plants and creatures known to be critical first links in the food chain.

Professor of Geophysics Gerd Wendler and research assistants Carl Byers and Tim Quakenbush got on the U.S. Coast Guard icebreaker in Hobart, Tasmania, on December 14. The ship broke through ice up to 8 feet thick in Ross Sea and McMurdo Sound to carve an 18-mile path for tankers and cargo ships bringing supplies to McMurdo Station, a U.S. research base on Antarctica.

Many have gone to the Antarctic to study sea ice, but Quakenbush and Byers were the first to view the ice using a fiber optic cable. The cable enabled the researchers to see how UV light penetrates different layers of sea ice.

After being lowered by the ship's crane onto an ice floe, the researchers drilled a small hole in the ice, then eased down the fiber optic cable, with a probe on the end. The probe reflected light from inside the ice up through the cable and into a spectrometer, used to measure UV rays. Previously, researchers cut big holes and lowered their entire instruments under the ice sheet. Those instruments saw the whole ice mass above them, and could detect only the combined effect of UV coming through all the layers at once.

"The problem with that is not all sea ice is the same," Byers said. "There are many different kinds of crystals in sea ice, which interact with light in different ways."

Sea ice is formed at different times and by various means. Crystals are found in layers of snow ice, frazil ice, congelation ice, and platelet ice, but not always stacked up in that order.

Preliminary findings indicate that a covering of fresh snow or a top layer of snow ice or frazil ice can prevent the transmission of UV light through a mass of sea ice. However, if there is no snow cover and those layers are absent, UV light passes easily through the ice mass into the sea below. Snow ice that blocks UV transmission is common in the Antarctic, but it is relatively rare in the Arctic, a fact that could become important if an ozone hole develops over this end of the earth.

"Our crude results show that snow ice scatters UV strongly," Quakenbush said. "In about 20 centimeters of snow ice, the light was scattered so much I could no longer measure UV radiation. But in congelation ice with no snow cover, I could measure UV up to about 160 centimeters." There is probably more congelation ice by mass than any other kind of sea ice in arctic and antarctic seas.

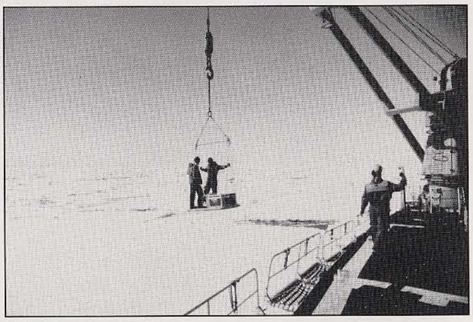
At least 12 meters of ice core samples collected during the trip are scheduled to arrive at the institute in March. The researchers plan to measure UV transmissions through the four-inch cores in the lab, then slice them to study ice crystal morphology.

During the trip, which was funded by the National Science Foundation, Wendler and colleagues from the University of Wisconsin also deployed four automatic weather stations to measure katabatic winds on the perimeter of the Antarctic continent. Information from the stations will be sent back to the U.S. via satellite on a year-round basis.

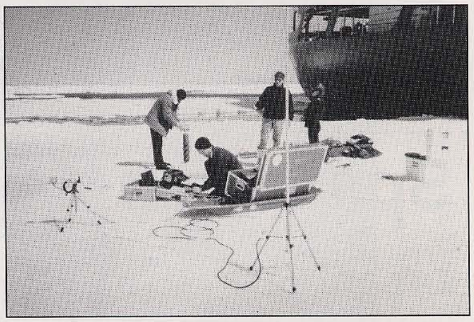
Katabatic winds are known as gravity winds because they move downslope like an avalanche of cold air. In the Antarctic, they contribute to the dispersion of sea ice and serve as a means of transporting moisture from the antarctic land mass to the sea.

UNIVERSITY OF ALASKA FAIRBANKS

CARL BYERS



GERD WENDLER

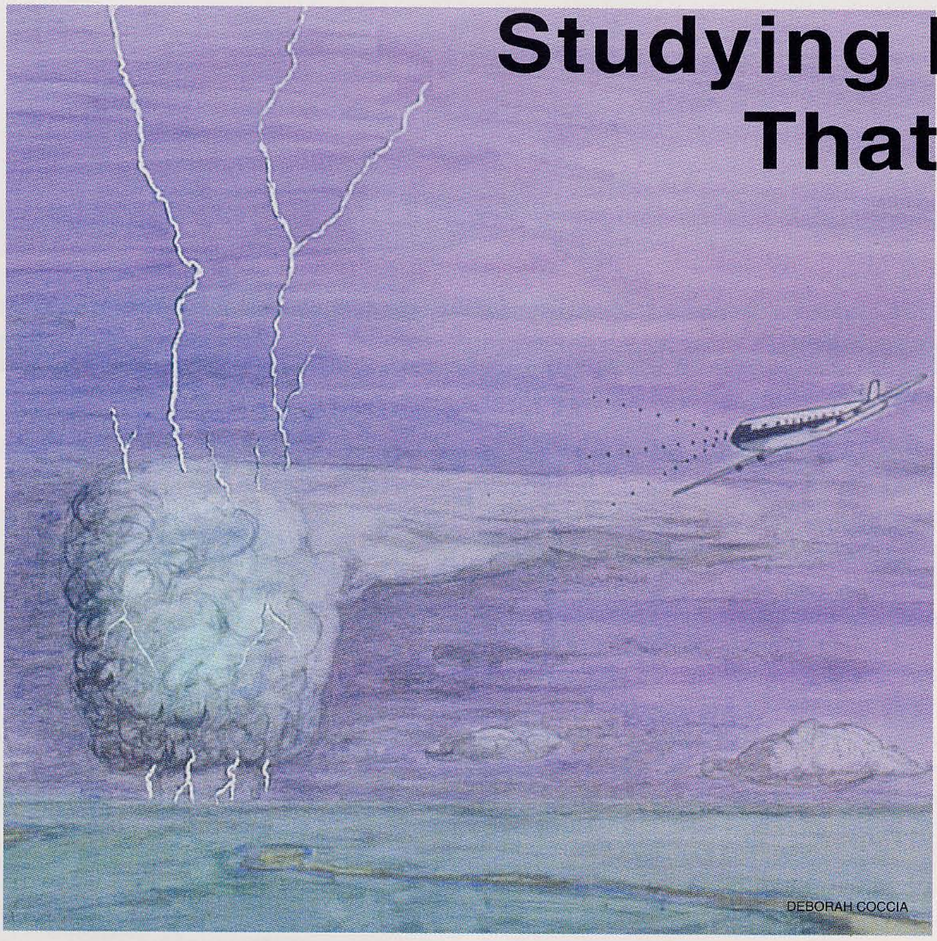


GERD WENDLER

CARL BYERS

*Carl Byers (middle) and Tim Quakenbush (bottom) measure UV light transmission through sea ice.*

# Studying Lightning That Strikes Up




What does lightning look like when it strikes up? Professors Dave Sentman, Gene Wescott, and Glenn Shaw intend to find out. Using a camera engineered by Dan Osborne, the professors will take photographs of "upward propagating lightning" over the Amazon Basin this June. The group received notification in January that they'll receive almost $126,000 from NASA to fund the five-week mission.

Lightning that strikes up from a layer of clouds to the ionosphere is a phenomenon scientists didn't know existed until about two years ago. That's when video footage taken from a camera mounted on the outside of one of the shuttle flights was analyzed, frame by frame, by Bill Boeck, a physics professor from Niagara University on sabbatical at Marshall Space Flight Center in Alabama.

"The scientific reason this kind of lightning is so interesting is that it constitutes a direct electrical short between the upper and lower atmosphere, something that has never before been studied," Sentman said.

Only a few good shots of lightning strikes above the clouds were recorded on the shuttle video. "The lightning was really photographed by accident," Sentman said.

The camera was set up to monitor activity in the payload bay of the space shuttle, Sentman said, which means it was generally just rolling to take footage of anything the shuttle passed over. The result was hundreds of hours of footage of the top side of clouds during thunderstorms.

Osborne's camera should capture the lightning in much greater detail. It's scheduled to fly closer to the electrical phenomenon aboard NASA's DC-8 airborne laboratory.

Why analyze lightning above the clouds in Brazil? Because it's an area of intense and frequent lightning and that's where NASA's DC-8 airborne laboratory is scheduled to be in June, to collect data on the deforestation of the Amazon Basin with synthetic aperture radar. "Ours is a mission of opportunity," Sentman said. "We are piggy-backing our experiment on a flight that was going up anyway."

The official title of their experiment is "Optical Imaging of Cloud-to-Stratosphere/Mesosphere Lightning over the Amazon Basin."

# Space Lab May Drop on Poker

A Texas firm is considering Poker Flat Research Range as a place to parachute-land a satellite payload containing commercial scientific experiments. The plan involves dropping an 800-pound payload somewhere on the rocket range's 25 million acres of downrange impact area, which has an established chain of observing facilities from inland to the Arctic Ocean for monitoring and recovery.

Land recovery is important because the payload could contain live mice that need to be brought into a warm area within four hours after the drop out of orbit, according to Bill Nash, vice president of Space Industries, Inc. of Houston, the firm considering the commercial space venture.

Sites in Antarctica and Sweden also are being considered as possible locations for recovering the payload, which is scheduled to be launched into polar orbit on an Ariane rocket by the European Space Agency in 1994.

The experiment would be part of a joint venture between Space Industries and Westinghouse Electric Corporation called WESTAR—the Westinghouse Space Transportation and Recovery program. Interested firms will pay WESTAR to shoot experiments into space, then bring them back down to Earth. Possible payloads range from crystal growing experiments to medical tests using live mice. The weightlessness of space offers a unique environment that can't easily be duplicated on the ground, Nash said.

The first WESTAR payload is scheduled for launch this spring from NASA's Wallops Flight Facility in Virginia. That payload will be brought down in the salt desert of Utah, Nash said.

All negotiations for commercial business ventures will be handled by the Alaska Aerospace Development Corporation, formed to encourage and assist commercial launch firms in their exploration and development of space. AADC Executive Director Pat Ladner said the landing could be an important early step in developing a more vigorous space industry in Alaska.

Poker Flat is owned and operated by the Geophysical Institute under contract with NASA.

# Instrument to Watch for Arctic Ozone Hole

An instrument ready to measure ozone was hoisted by crane up onto the top of the Geophysical Institute in February.

The instrument—a Dobson spectrometer—and its 1500-pound dome shelter was previously located 30 miles out of town at Poker Flat Research Range, where it had been operating seasonally for about seven years. It was moved to the top of the Elvey building so scientists could more easily collect and analyze data this spring, when conditions could be right for the appearance of an ozone hole in the Arctic.

The Dobson is the world standard for measuring ozone. The instrument collects data on the number of ozone molecules found in a column between the ground and the sun.

In Alaska, there are two Dobson spectrometers: the one atop the Elvey building and one in Barrow operated by the National Oceanic and Atmospheric Administration (NOAA). There are over 50 Dobsons in operation in the world, but only 10 at latitudes above 60°N.

Concern an ozone hole might form in the northern hemisphere was generated last winter after NASA scientists completed a six-month, federally financed study that gathered data on ozone from satellites and airplanes. They reported that over the Arctic, they found the highest levels of ozone-destroying chemicals ever measured. Those chemicals (chlorine monoxide) need a combination of sunlight and very cold temperatures in the stratosphere to react. The return of the sun to the Interior could start the chemical reactions needed to deplete the ozone layer above the Arctic, according to Assistant Professor of Chemistry Dan Jaffe.

The ozone layer, 20 to 40 km above the earth, is responsible for screening out damaging ultraviolet light from the sun. Losses in ozone can cause an increase in risk of skin cancer, cataract-induced blindness and immune system damage. It also can cause crop damage and the death of phytoplankton in the ocean, a critical part of the food chain.

The Dobson takes some observations automatically, but the more accurate direct-sun measurements must be taken manually by a graduate student for about one hour daily between mid February and late October, when the sun is high in the sky. NOAA provides a small contract for the operational costs of the Dobson.

Professor of Physics Knut Stamnes and Research Assistant Jim Slusser will combine the data from the Dobson instrument with measurements from other ground-based spectrometers to find out more about nitrogen dioxide and other trace gases in the stratosphere affecting ozone. Through studies in Alaska and Antarctica, they hope to find a relationship among atmospheric ozone, cloud effects, and transmitted UV radiation. Their research provides crucial data on possible harm to the biosphere caused by the release of man-made chemicals depleting the ozone layer.

Small ozone losses of between two and six percent have been observed in the northern hemisphere over the last 15 years.

EVELYN TRABANT/GEOPHYSICAL INSTITUTE

***On Top of It***—*Research Assistant Jim Slusser confers with crane operators, lower left, before the dome shelter for the Dobson instrument is hoisted to the top of the institute. Once on the roof, more than 40 graduate students carried the dome into place. Ray Ward removes the crane cables, upper right.*

**Geophysical Institute Quarterly**

This newsletter is published as a public service by the Geophysical Institute, University of Alaska Fairbanks. Free subscriptions are available on request from the Information Office, UAF Geophysical Institute, Fairbanks, AK 99775-0800. (907) 474-7863.

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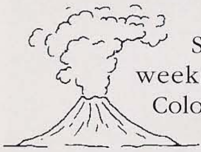
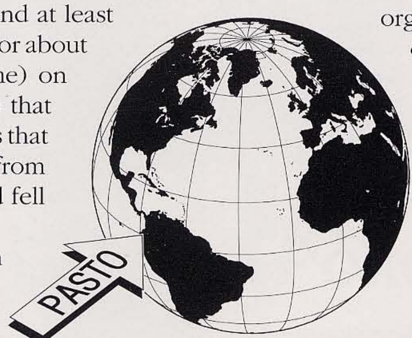
# McNutt Witnesses Volcano Tragedy



Steve McNutt was looking forward to the two weeks ahead when his plane landed in Pasto, Colombia, on January 10. He was there to study the Galeras Volcano with colleagues at an international convention. The 14,500-foot volcano lies just five miles outside Pasto, and is considered to be the country's most active inferno; it's erupted fifteen times in the past 400 years.

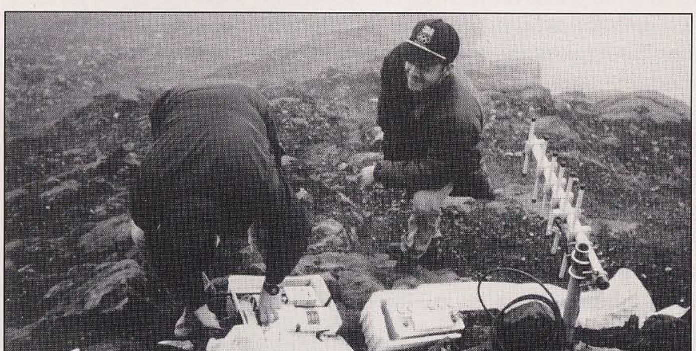
After attending workshops for a few days, he and 70 other volcano experts at the convention divided into groups so they could attend field trips related to their areas of expertise. Geophysical Institute Research Professor McNutt, who works as a seismologist for the Alaska Volcano Observatory, joined a group scheduled to look at seismic stations on the volcano's caldera. The caldera forms a circle about a mile wide around the active crater inside it.

Another group went down into the active crater to sample gases. From 700 meters away, McNutt watched the researchers descend. It was the last time he'd see six of them. About four hours later, the volcano erupted, killing six of the scientists and three others. Six people were injured and at least two others are still missing. Galeras erupted for about 15 minutes, starting at 1:41 p.m. (local time) on January 14. It spewed out hot rock bombs that landed up to a half mile away, and ash clouds that shot up to 2.5 miles high. The ash blew away from Pasto, a city of about 300,000 residents, and fell 10 to 20 miles to the north.




At the time of the eruption, McNutt was in a car headed down the mountain. Although he was only two miles away from the active crater, he felt no tremor and didn't expect to. The seismic stations he'd just monitored indicated no motion for a full six hours prior to the eruption. He didn't know the eruption had occurred until the car arrived at an observatory in Pasto. It was a cloudy day, but from there he could see gray ash clouds rising from the crater.

"At first it was exciting and we all starting taking pictures," McNutt said. "Then it started to dawn on us. I thought, 'Oh Jesus. Our colleagues are either supposed to be in the crater or nearby.'"



STEVE MCNUTT

***Measuring Up—*** *Two Colombian technicians work on a seismic station 900 meters from the vent of Galeras Volcano, which erupted on January 14 while scientists were inside it.*

***Time Out—*** *About an hour before the fatal eruption, seismologists on a field trip relax near the summit of the Galeras Volcano, about 700 meters from the active vent.*

He didn't know if anyone was hurt until he heard a radio report at the home of a local scientist about two hours later. It was then he first heard three people were dead and that conference organizer Stan Williams and others were injured. "The communication was bad and confusing," McNutt said. "At one point we heard a guy was injured, then dead, then fine. He ended up being injured."

A few hours later, McNutt returned to the hotel to learn others were even less informed than he. "As soon as I stepped in, people were all over, hugging me, saying they were glad to see me, that they didn't know what happened to me," McNutt said.

He had an urgent message to call AVO Chief Scientist and Professor of Volcanology John Eichelberger. Getting through took a while. "There were two phones and about 50 people in the hotel trying to use them," McNutt said.

McNutt stayed in Colombia for a week after the eruption to write a report on the event in English for the local seismologists. Staying there gave him time to wrap up loose ends and to think. "Mostly, it felt strange to have dinner with somebody one night and the next night they are dead," McNutt said. "Even if you don't know them well, you don't expect it, especially when they are healthy people in the prime of their lives."

He remembers talking to a 26-year-old Colombian geophysicist who died in the eruption. "He was practicing English with me at dinner the night before. We were talking about science. He was young, just starting his career," McNutt said. "He'd done work in Russia. I liked him. I had a feeling we were going to be friends."

Geoff Brown, a respected English geophysist,also died in the eruption. "I saw him in December at the AGU meeting in San Fransico," McNutt recalled. "He came up after my talk and said he wanted one of my figures for a book he was writing. I'd brought the figure with me to Pasto but hadn't given it to him yet."

The eruption highlights the irratic nature of volcanoes and the difficulties involved with prediction. Some of the world's most renown researchers were in the volcano when it blew. "We had no warning," McNutt said. "We'd been looking at the seismic information and no one thought it was going to erupt."

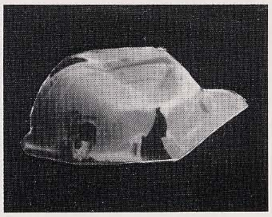
One weird type of earthquake was the only possible indication that trouble was brewing. That earthquake started showing up on seismographs about once a day in early January. The locals called the signal a tornillo because its shape resembled a wood screw. The tornillo didn't incite worry because it was infrequent in occurrence. Similar earthquakes had been seen on seismographs elsewhere, including those monitoring Redoubt. Tornillos are generally thought to be caused by vibrations shooting through fluid-filled cavities somewhere in the volcano.

"Volcanoes are notorious for unusual earthquakes," McNutt said. "If we hit the alarm every time a new earthquake showed up in Alaska, we'd be in alarm all the time."

Lots of tremor and seismic activity usually forecast an eruption—that and the presence of a lava dome. Domes are composed of thick, pasty lava that trap gases inside, allowing pressure to build up in the volcano. "Roughly speaking, they act like corks in a champagne bottle," McNutt said.

A dome sealed the active crater of Galeras before its previous eruption in July 1992. The summer eruption lasted only about 10 minutes. No one had been killed in a Galeras eruption for over 400 years, when European explorers began to keep track.

Interest in Galeras rose after the volcano was chosen for intensive study by an esteemed group of internal volcanologists in the early 1990s to celebrate the start of an International Decade of Natural Disaster Reduction. Of the dozen or more volcanoes selected for research, Galeras is the only one in South America.

***Fatal Descent**—Journalists and tourists watch as a group of international scientists descend into the Galeras Volcano four hours before it erupted. Six of these scientists and three onlookers were killed during the 15-minute explosion that sent ash clouds up to 2.5 miles high and shot hot rock bombs up to a half mile away.*

*The charred and damaged remains of items carried by scientists into the active crater are pictued above and at right (all photos by Steve McNutt).*

# Volcanic Clouds in Fairbanks Skies

Eruptions can affect more than the local people and environment surrounding a volcano. Large events can spew gas and ash high into the atmosphere, where they can damage the ozone layer and reduce the earth's temperature, according to GI Adjunct Assistant Professor Takashi Shibata.

Shibata discovered volcanic gas and ash in the upper atmosphere above Fairbanks using a $100,000 laser radar instrument (LIDAR) at Poker Flat Research Range. He brought the instrument with him from the Solar-Terrestrial Environment Laboratory in Japan's Nagoya University.

The gas and ash were spewed 20 km high into the earth's stratosphere by the gigantic eruption of Pinatubo on the Philippine Islands in June 1991. He detected the volcanic clouds above Fairbanks by shooting a laser beam high into the stratosphere. The beam hit particles in the air, then sent scattered light back to a large telescope at the range. Sensitive equipment identified the particles as droplets of sulfuric acid mixed with small bits of volcanic ash. Sulfuric acid forms after sulfur oxide gas ejected from a volcano undergoes chemical reactions in the stratosphere.

The stratosphere is high enough above Earth that it is unaffected by rain and other weather conditions. Consequently, sulfuric acid and ash injected into the stratosphere by volcanoes tend to remain there for longer periods than those spewed into the troposphere, where particles can be washed back to Earth after a rain. Shibata estimates that ash particles remain in the stratosphere for a year or more before falling back to Earth, while sulfuric acid particles can remain there for three years or more.

Similar volcanic clouds have been detected in the stratosphere all around the world by scientists conducting LIDAR experiments. The combined effect of these clouds is to prevent some of the sun's light from reaching Earth. Shibata estimates that the clouds cause about three percent of the sun's light headed for Earth to bounce back into space. "The presence of these clouds means that the average global temperature at ground level is going to be a few degrees cooler than normal," Shibata said.

And that's not all. Sulfuric acid particles in the clouds also react to deplete ozone in the stratosphere. Then, when the volcanic particles finally drop back to Earth they can act as seeds that cause wispy cirrus clouds to form about 10 km high.

Shibata plans to operate the LIDAR for a few hours after sunset every clear night in February and March. Volcanic clouds above Fairbanks also were discovered last winter, when preliminary LIDAR experiments started at Poker Flat. The LIDAR is operated with a microwave radar that detects airplanes in the vicinity. When a plane is detected, the LIDAR shuts down. Although the laser beam would not interfere with the instruments aboard the plane, the backscatter of light bouncing off it could ruin the scientific instruments on the ground.

# GI NOTES

**The Geophysical Institute Associates Endowment Fund** was created in December with assistance from Daniel Crevensten, executive officer for past director Keith Mather. This permanent endowment will support future institute activities by supplementing its base non-restricted income. A sizable endowment could help preserve the institute's continued innovation during these times when there are increasing demands on a declining state budget. These funds will be used for initiating new research, for supporting graduate students, for purchasing equipment otherwise difficult to acquire, and for other appropriate endeavors. Contributions to the fund from 29 Associates already have been made for a total of $16,427 in cash and pledges. The fund is managed by the University of Alaska Foundation.

**Architects Visited the Elvey Building** this winter to interview institute faculty, staff, and external agency personnel to assess future needs of potential users of the institute's new addition. The architects, Kumin Associates, Inc., of Anchorage, are scheduled to return with a draft plan for review that will include schematic design drawings, a color rendering of the building, a scale model, and a brochure. The final design is scheduled to be completed in April. The University Board of Regents approved an $800,000 request to the legislature to continue design work. Efforts also are being focused on raising money from the federal government, from other external agencies who wish to collocate with us and through a bond issue.

**The NASA Scientific and Technical Information Database** is now available in the Geophysical Institute's Keith B. Mather Library. The database consists of more than 3 million records and increases at a rate of 90,000 records annually. The records represent hundreds of millions of hours of research in the form of projects, journal articles, patents, reports, dissertations, and technical books on a variety of topics, with an emphasis on aerospace technology. The literature comes from many sources including NASA and its contractors, other federal agencies, private firms, and foreign institutions and universities. It has background information on almost everything that's ever been invented. "If you want to learn how someone solved a problem or made a widget, you can find out all about it in this database," said Associate Director of Institute Relations Merritt Helfferich.

**Welcome to Ruth Duerr**, who is now the Science Data Manager for the Alaska Synthetic Aperture Radar Facility and the manager of the institute's GeoData Center. Prior to coming here, Duerr worked for nine years at the Laboratory for Atmospheric and Space Physics at the University of Colorado in Boulder. There she worked with data systems for the Solar Mesospheric Explorer Satellite, the Upper Atmosphere Research Satellite and the National Snow and Ice Data Center. She received bachelor degrees in math and physics from the University of North Dakota in Grand Forks and a masters degree in astronomy from the University of Arizona in Tucson.

## Upgrade Planned for Poker Flat

Poker Flat is being upgraded for scientific purposes, mainly to make the site more efficient to operate and more effective for upper atmospheric research.

Kumin Associates, Inc., of Anchorage, was selected to do the architectural work for the federally funded upgrade. "The firm is known for cost-effective, straightforward designs that work," according to Range Director Jim Strandberg, who said the preliminary engineering reports for the upgrade will be finished this winter.

"The upgrade is a combination of improving ground-based science instrumentation that will expand the research capability of the range and of improving sounding rocket facilities so we can more effectively launch sounding rockets containing scientific payloads," Strandberg said.

Federal funding for the upgrade is routed through NASA/Wallops Flight Facility in Virginia. About $12.5 million was appropriated for range improvements and renovations this winter.

The funds will be used to construct new buildings at the range and to renovate others. The new buildings include a Science Operations Center (SOC), a rocket assembly building, a range control center, and a telemetry building. Renovations are planned for the range's payload assembly building, block house, rocket storage, and warehouse.

Groundbreaking for the new Science Operations Center is scheduled for fall 1993. Other major construction activity is scheduled to occur in 1994.

The upgrade is driven by the new Science Operations Center, which will become the primary display and decision-making center for sounding rocket launches and also will function as a classroom for graduate students. "The SOC will operate as a science hub, where researchers can access data all in one place from satellites (which look at the aurora and other phenomena from above), from sounding rockets (which fly into the middle of these phenomena), and from instruments that take measurements from the ground," Strandberg said.

## Congratulations!

**Alice Danielson** won third place for best student poster in the physical sciences category of the national AAAS meeting in Boston. Tying with her for the award was a student from Harvard University. A graduate student in physical oceanography, Danielson's poster was entitled "The Role of Snow in Antarctic Sea Ice Growth." Her poster and presentation also won the best student paper award at the 1992 meeting of AAAS in Valdez. **Carl Byers**, a graduate student in applied geoscience, shared the Valdez award for his presentation entitled "Ground-truthing SMMR Brightness Temperatures of Arctic Multiyear Ice."

**John Davies** was elected as Democratic Representative for District #29. His last day working as state seismologist at the Geophysical Institute was January 4. If you didn't get to say goodbye, you can call him at 465-4457 in his new office in Juneau.

# Let it Snow! Let it Snow! Let it Snow!

Whether it's caused by global warming or an act of God, Fairbanks got hit with record amounts of snow this year. Birds-eye views from windows on the upper floors of the Geophysical Institute reveal all; the whole town is smothered with a blanket of white.

It's rumored that on one particularly snowy day, the business office and others on the sixth floor took bets on how long it would take cars to get unstuck from drifts on the road below. "The snow has caused definite problems this year," said GI Operations Manager Bob Grove. "We've even had trouble with the basics, like keeping access clear in and out of the building."

Before it was shoveled, the snow load came close to the limit for the institute's annex roof above the Alaska Synthetic Aperture Radar Facility, Computer Resource Center, and the Globe Room. The cold storage building and remote trailer also were in danger, Grove said.

Even the pattern of accumulation has been unusual this year. Heavy snow usually comes to the Interior dramatically, in the form of great storms, according to Assistant Professor of Geophysics Sue Ann Bowling, who has studied precipitation and weather records at the institute for about 20 years. "This year, it's just been steadily plugging on. It's never really let up."

Snow accumulation has been above normal every month this winter starting in September, when a record 24.4 inches fell in Fairbanks, compared with a 30-year average of less than one inch. More than 40 inches of snow fell in January, compared to an average of 8.85 inches.

"We have never had so much snow accumulate in a winter before February 10," Bowling said, and about 10 inches more will steal the record for heaviest annual snowfall. That record was set during the winter of 1990-91 which amassed 147.3 inches of snow. An average year for snow accumulation between September and April is 70.2 inches. Record-keeping for Fairbanks began in 1904.

When it's snowing, at least it's not 50 below. The mercury dropped to 58 below zero on February 2 to set a daily record of its own—a record low. It's a pattern Bowling anticipated; years of heavy snowfall are typically years of extremely cold temperatures. "The usual pattern is to flip-flop between days of lots of snow, and days of extremely cold temperatures," Bowling said.

The record for the second greatest snow accumulation was set during the winter of 1970-71, when 145.7 inches fell. That also was a record year for the greatest number of average temperatures in the 50 below zero range.

"I remember that winter. It was a rough one," Bowling said. "We had four months of snow, then the bottom dropped out on temperatures."

She recalls picking up her father at the airport on December 23, 1970. "It was about 36 above and raining, and the rain was falling on top of more than 100 inches of snow," Bowling said. "I've never driven on anything so slippery in my life. I literally couldn't go any faster than 5 Mph without fishtailing. Then, by the time my father left Fairbanks a week later, it was 38 below."

Sound familiar?

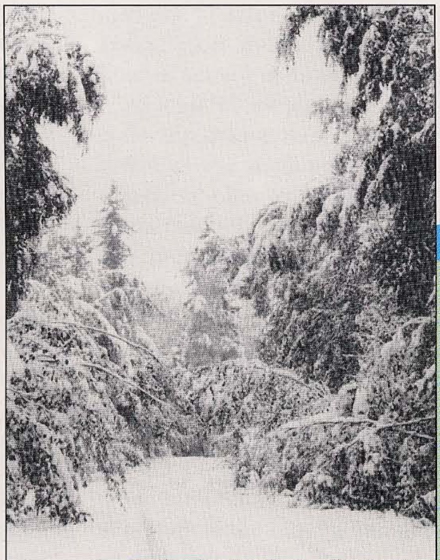
## Global Climate Change or Just Another Day in Paradise?

This year's extreme weather can be traced to large variations in the jet stream, a river of high speed air that girdles the earth in a scalloped pattern about 30,000 to 40,000 feet high. That scalloped pattern is somewhat larger than normal this year, bringing extremes of weather all over the country, according to Professor of Physics Glenn Shaw.

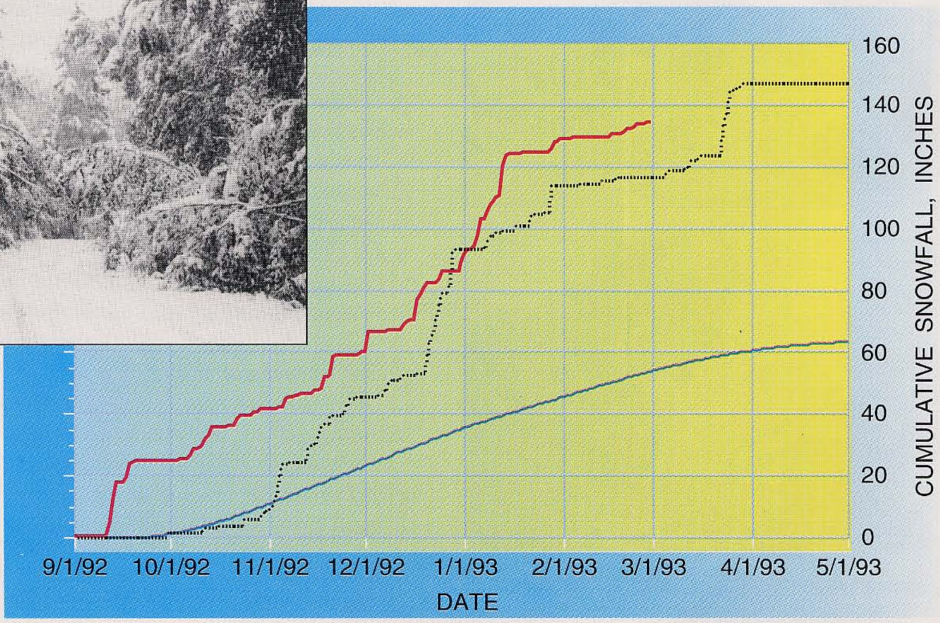
Some scientists say the increase in these planetary-scale waves is a result of global climate warming or the greenhouse effect. They suggest that increased carbon dioxide in the atmosphere leads to increased undulations in the jet stream. The January 16 issue of *New Scientist* magazine states "there is evidence we seem to be entering an era of strong storms, which might be associated with global warming."

It's a popular but controversial theory. "Another theory is that God is mad at us, and in my mind, it may be just as plausible," Shaw said.

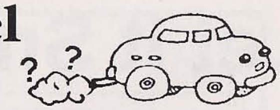
Earlier in the year, Shaw theorized that dust from large volcanic eruptions, like Mt. Pinatubo, caused the waves to amplify. He now thinks that theory is passé. Another theory suggests that fluctuations in the sun's light might trigger the amplification, but Shaw's favorite theory is that the large waves are the simple result of an internal phenomenon of the atmospheric system, which is inherently chaotic. "In other words, I think it's natural, not something forced upon it by an outside entity," Shaw said.



***Record High***—*The red line on the graph shows that about 10 inches more snow this winter will break the record for heaviest annual accumulation since 1904. The current record for Fairbanks was set during the winter of 1990-91, shown by the dotted black line. The solid line indicates an average year of snow between September and April (graph by S. A Bowling, photo by Evelyn Trabant/Geophysical Institute).*



# Oxyfuel Sparks Air Quality Study



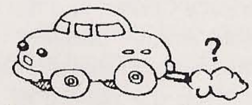
Oxyfuel drew more spark from local residents than it did from their engines this winter. In November, the Environmental Protection Agency required gas stations in Fairbanks and 39 other metropolitan areas nationwide to sell gasoline with added oxygen. The idea was to reduce emissions of CO (carbon monoxide), the suffocating gas that reaches peak levels during cold weather.

The Fairbanks oxygenated fuel program lasted less than two months. Opponents argued the fuel (which added 14 cents to a gallon of gas) made them physically ill, caused mechanical problems, and drastically reduced gas mileage. Assistant Professor of Chemistry Richard Benner was drawn into the controversy as an expert, having studied oxyfuel previously at the University of Denver in Colorado. "There was no research available to show how oxyfuel performs at temperatures below 20°F," Benner said, "and every study known about the effects of oxyfuel in the Arctic was outdated by at least 15 years, during which time car technology changed tremendously."

Benner and graduate student Dave Veasey began their own testing of CO emissions from cold starts, idling, and moving vehicles and compared those with cars using oxyfuel to those that didn't. The Fairbanks North Star Borough Assembly gave the pair $10,000 to continue their research in late February, shortly after learning that EPA plans to require oxyfuel in the borough again next winter.

Benner is conducting several statistical studies never before completed in the Arctic. He's tallying total weights of CO contributed by idling cars around Fairbanks at different temperatures, testing cold start emissions from various automobiles at low temperatures, and outfitting three cars with a complete battery of instruments to monitor CO emissions while moving down the road. He hopes his research will provide the missing pieces needed to make winter air easier to breathe in Fairbanks. "Our main goal is to find out what are the major sources of CO and then to figure out what is the best, most cost-effective way to clear up the air problem here," Benner said.

One problem with requiring the use of oxyfuel is the gas only cleans up grossly polluting vehicles. Researchers have shown that only about 10 percent of the cars in a given area put out more than 50 percent of the pollution. Benner studied under Donald Stedman, a nationally acclained expert who has devised an instrument aimed at reducing emissions from these gross polluters. The "Stedman device" uses an infrared beam that can determine the amount of CO put out by a moving vehicle. If the major polluters are forced to clean up, blanket requirements that affect all drivers may not be necessary.



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