The Geophysical Institute QUARTERLY

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Our Far-Flung Scientists

Since its establishment in 1946, the Geophysical Institute has earned an international reputation in the study of the earth and its physical environment at high latitudes. The work of the Institute focuses on Alaska as a geophysical laboratory of a kind almost unique on earth, but we cannot forget that the earth itself is a single integrated system. Our efforts here are relevant to understanding geophysical phenomena all over the world. It is likewise important that our scientists conduct field work in other places in order to understand fully what is happening in our own back yard. Take one example: for a scientist to assume that the aurora australis (of the southern hemisphere) has nothing to teach someone studying the aurora borealis (of the north) would be as unthinkable as a physiologist assuming that the circulation of blood on the right side of the body is immaterial to circulation on the left. Thus, some 20 years ago, Institute researchers participated in airborne photography experiments above the sea south of New Zealand. Comparisons of these photographs of the aurora australis with photos taken of the aurora borealis at the conjugate point (the other end of the field line, in effect) above Alaska not only showed the expected parallels in auroral form and intensity, but because of unexpected differences it also revealed much about the processes in the invisible realms of the magnetic field between the conjugate points. The experiments changed the way we think about our local northern lights and about the planet's whole electromagnetic environment.

Thus, it is part of a longstanding and proven pattern that the Institute has installed equipment to observe the magnetic pulsation spectrum at Cape Parry and Mould Bay in Canada (as well as at College and Barrow, Alaska); optical equipment to study the magnetospheric cusp and auroral phenomena in Svalbard; incoherent scatter radar equipment at Sondrestrom, Greenland, for studying the ionosphere; equipment at McMurdo station and on the Ross Ice Shelf in Antarctica for studying infrasonic waves; five automatic weather stations in Adelie Land, Antarctica, for observing katabatic winds; tracking equipment in Alaska that collects satellite imagery of Antarctica; equipment at Jakobshavns Glacier in Greenland; instrumentation on ice islands near Ellesmere and Axel Heiberg islands in Canada; and seismology equipment at Mt. Erebus, Antarctica.

Geophysical Institute scientists have enhanced their Alaska research by participating in such international projects as a rocket launching in Peru, a desertification study in Tunisia, arctic haze studies, sampling of carbon dioxide in the high latitudes toward both poles, north and south pole ice crystal studies, and the Greenland Ice Sheet Program. A few examples of our participation in international research projects will be presented in this issue of the *Quarterly*.

The Geophysical Institute has a scientific personnel exchange agreement with the National Institute of Polar Research in Tokyo, Japan, and formal cooperative research agreements with the Technical Research Center of Finland and with the Polar Geophysical Institute of the Soviet Academy of Sciences in Apatity and Murmansk. Several Geophysical Institute professors serve on committees for the Coupling, Energetics, and Dynamics of Atmospheric Regions (CEDAR), a multiphase international aeronomy research program proposed to the National Science Foundation. The Geophysical Institute's involvement in the Alaska SAR Facility (see *Quarterly* Vol. 5, No. 1) represents another international connection: European Space Agency, Japanese, and Canadian radar satellites will be launched in the early 1990s and will be sending signals to the receiving station at the Institute.

Our scientists conduct research in collaboration with colleagues from a dozen or so countries representing every continent. The participants may change as the needs for new information shift, but the pattern of reaching out continues. These international connections are important to the Institute and to the University, in order to apply knowledge gained in other locations to research in Alaska, to make contributions to the global science community, and to stay abreast of scientific research in the world.

Arctic to Antarctic

The Glacier That Sank the Titanic

Jakobshavns Glacier, Greenland, with the terminus and Jakobshavns Fjord in the background.

Ninety percent of Greenland is covered by an ice sheet. This ice sheet is not stationary – ice is continually being moved from the interior out toward the sea by "outlet" glaciers. Jakobshavns Glacier is one of the largest outlet glaciers in Greenland, draining about 7 percent of the area of the ice sheet. In fact, this is the fastest steadily moving glacier known to science. Jakobshavns supplies perhaps 11 percent of Greenland's icebergs; it is highly likely that the iceberg responsible for sinking the *Titanic* was from this glacier.

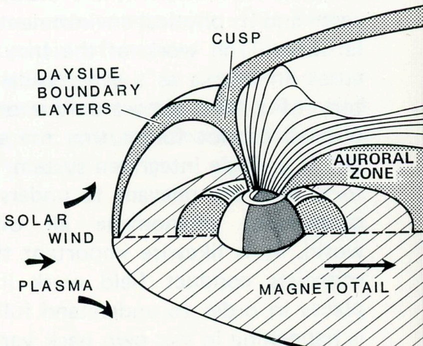
In 1984 Geophysical Institute researchers Keith Echelmeyer and Will Harrison began a study of the dynamics of this glacier system. They see Jakobshavns Glacier as being divided into at least four areas that flow at different rates: the floating terminus in Jakobshavns Fjord, a grounded portion confined to the upper part of the fjord, a rapidly moving ice stream up to 100 km back into the Greenland ice sheet, and the ice sheet itself. Echelmeyer's research group, including students, identified these areas by installing markers for measuring the velocity from the terminus back to 120 km into the ice sheet, and checking many of the markers every hour during the spring and summer. They also noted the ice temperature and the elevation of the glacier surface, and they installed five automatic cameras to measure velocity and surface elevation changes. Although Echelmeyer had expected to find that the glacier moves more slowly in the winter, as most glaciers do, he found that this one keeps the same rate of movement summer and winter.

The information gained from this research will be useful in studying ice sheet stability, the dynamics of ice streaming and "surging" in Alaska's glaciers and other glaciers in the world, and in studying the responses of these glaciers to climatic change.

A Look at Deep Space Th

Students of architecture learn that a "cusp" is a "pointed projection or peak created by the intersection of two arcs." The image may help students of auroral physics envision the polar cusp, where th "arcs" are the lines of the earth's magneti field. At the cusp, a narrow region on the poleward side of the auroral zone on the day side of the earth, the field lines divide (see diagram below). Some field lines loop around to the opposite polar zone and the others stream out into the magnetotail. At the cusp, electrons and protons ejected from the sun can go directly into the earth's upper atmosphere, so a cusp aurora is caused by the raw stuff of the solar wind, not – as we usually see – by particles accelerated in the magnetosphere.

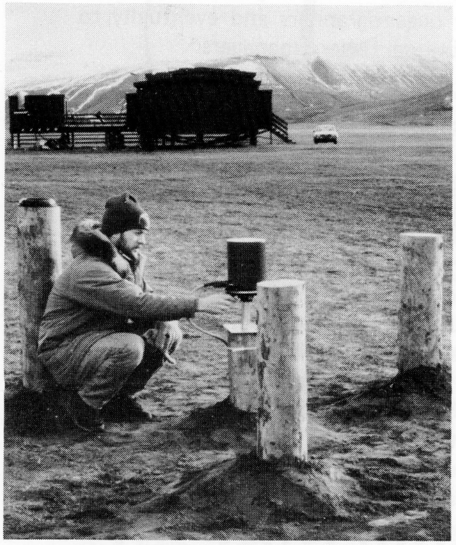
Spitsbergen, a large island east of Greenland in an archipelago called



This diagram shows some of the details of th earth's magnetic field.

Svalbard, is one of two locations in the northern hemisphere where cusp auroras can be observed around the time of winter solstice (Heiss Island, USSR, is th second location). Dr. Chuck Deehr and other Geophysical Institute scientists have been interested in observing cusp auroras over the past few years to get a look through the "window to outer space Many geophysical effects displayed at th window demonstrate what is happening in the solar wind and interplanetary space

...ough a Small Window



Dan Osborne, project engineer with the Geophysical Institute, is shown adjusting a fluxgate magnetometer to start the dayside aurora observing season. This instrument measures small variations in the earth's magnetic field due to current associated with the aurora.

Deehr and his co-workers have joined with scientists from the Universities of Tromsø and Oslo, Norway, and the Polar Geophysical Institute of the Soviet Academy of Sciences, to conduct optical and geomagnetic studies of the aurora and airglow at high latitudes. They have been particularly interested in comparing the morphology of the daytime cusp aurora in Svalbard to the aurora observed simultaneously at night in Alaska. Another facet is the study of the region of the high-latitude atmosphere with the greatest proton energy, the mesosphere. This is the transition region between the earth's weather system and that controlled by the sun.

The field season for optical observations of the cusp auroras extends from late November to late January. An observatory has been established near Longyearbyen, Svalbard, and it includes optical instruments for recording the changing color and position of the aurora. This observatory has opened opportunities for optical observations of very high latitude phenomena in a truly international cooperative effort in space research.

Antarctica—Some Serious Winds

If you have seen car exhaust or chimney smoke moving downslope on a cold morning, you have seen the effects of gravity winds. In a sense, gravity winds are like an avalanche of cold air. They are caused by the cooling of the air near a sloped surface, producing a layer of air with relatively high density. (The lower the temperature, the more closely the air molecules are packed together.) *Katabatic winds* are the result of a combination of gravity winds and the Coriolis effect. In Antarctica the katabatic winds flow downslope and against the spin of the earth, or to the left. Katabatic winds serve as a major means of transporting moisture from the antarctic land mass to the sea, and they contribute to breaking and dispersing sea ice. Such fluctuations in the ice cover can modify the climate of the southern hemisphere.

Drs. Joan Gosink and Gerd Wendler, and other Geophysical Institute researchers, have been working with French colleagues on studies of these sometimes gale-force winds in Adélie Land. Their recent discoveries include the effects of blowing snow or ice crystals on the katabatic winds. Since the average density of the snow-air mixture is greater than clear air, katabatic wind velocity increases as more and more snow is carried along from the surface. The sublimation, or direct evaporation, of ice crystals also increases the density and velocity of these winds by lowering the temperature of the moving air mass.

Dr. Gosink's studies include collecting data from an airplane flying in katabatic wind conditions over Adélie Land. On one of the flights, she and the rest of the crew had the "privilege" of flying through a hydraulic jump—the turbulent area where the land slope meets the sea and the katabatic wind velocity abruptly slows. The data she collected during that flight are the only aerial records now known to be collected in one of these hydraulic jump areas.

In honor of this joint French-Geophysical Institute science venture, a postage stamp has recently been issued. The French have created an attractive stamp that shows many facets of the katabatic wind research project in Antarctica.

At McMurdo Station, Antarctica, this Hercules LC-130 plane was loaded for a katabatic wind trajectory flight. The conditions during the flight went from excellent visibility at its maximum elevation, through a rapid increase in wind intensity and blowing snow, to white-out conditions. At the coast, the plane was buffeted and suddenly lifted 120 m; this flight may have been the first through a hydraulic jump, much to the excitement of the crew on board.

Recent Grants and Contracts

ICE ISLANDS

Drs. Martin Jeffries and William Sackinger of the Geophysical Institute have been granted funds from Exxon and Shell, to deploy two radio-equipped "buoys" on ice islands west of McClure Strait in the international waters north of Canada. They have been following the movement of as many as six other ice islands in the Queen Elizabeth Islands area by satellite over the last two years. (There are over 25 ice islands clustered in the region north of Axel Heiburg Island at present.) Every 90 minutes a NOAA satellite passes over the ice islands and receives a signal from the buoys on them; the data are later transmitted to the Geophysical Institute and the ice island movement can thus be detected.

Although Jeffries and Sackinger expect the ice islands to move eventually toward the northern coast of Alaska on the Beaufort Sea, this won't happen until some unusual weather moves the ice islands out of the coastal locations where they are now confined by prevailing winds.

ISHTAR

Ken Dean is the Geophysical Institute's participant in an international program with headquarters at our neighboring Institute of Marine Science. The program is known as ISHTAR—short for Inner Shelf Transfer and Recycling, but also the Babylonian name for the goddess better known as Venus; in this case, the sea foam from which she rises would be cold indeed, for ISHTAR's field of study is the Bering Sea.

As well as several American universities, participants represent Denmark and Belgium. The Europeans are able to bring to bear (and hope to enhance) their understanding of the North Sea in the work on the similarly shallow and productive Bering and Chukchi waters.

Dean's contribution permits him to stay dry and warm as he analyzes computer-enhanced satellite imagery that reveals near-surface sea temperatures and turbidities (relative cloudiness caused by particles suspended in the water). Since the distinct water masses in the Bering Sea of interest to ISHTAR can be differentiated by these factors, the satellite data accurately depict the distribution, boundaries, and flow characteristics of the water masses—information of great interest now to the oceanographers and eventually to international fishery managers.

MAGNETIC CHAIN OF STATIONS

Early in the International Magnetospheric Study, in 1976, the Geophysical Institute began operating a chain of "digital magnetometer stations," designed to study the magnetosphere. Dr. John Olson has recently been awarded a grant to continue the operation of the Alaska-Canada chain of stations, which currently consists of nine sites that lie near a line of constant geomagnetic longitude, from Talkeetna, Alaska, to Narssarssuaq, Greenland. Data are collected at these sites at one-minute intervals and transmitted via a satellite to the World Data Center in Boulder, Colorado, where they are available to the world research community. This Alaska-Canada chain of stations is only one of many such "chains" in the world, which gather data that scientists can use to help put together a larger picture of the earth's magnetic field.

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