May/June 1980

ZEPHYR

Automatic Weather Stations
instrumenting the future.

Cover: The Ennadai Lake MAPS[R] station shows an automatic weather station configuration of an instrument tower, a black instrument box at its base, a white, covered battery storage well just in front of the instrument box, and a precipitation detector behind it.

Zephyr is a periodical publication for employees of the Atmospheric Environment Service, Environment Canada. It is produced for the Atmospheric Environment Service by the Information Directorate of Environment Canada.

Please address all correspondence regarding this publication to: Zephyr, 4905 Dufferin St., Downsview, Ont., M3H 5T4.

Environment Canada | Environnement Canada

Atmospheric Environment Service | Service de l'environnement atmosphérique

MAPS[R] now on the map

December 11, 1979 marked the start of a new era in data collection, when the computer program required to translate data from the latest generation of automatic weather stations became operational, and the readings obtained automatically from five isolated locations were fed for the first time into the working forecast data base.

The five locations – Thelon River and Ennadai Lake, N.W.T., Border and Lake Eon, Que., and Caribou Island, Ont. – all have the new Canadian designed MAPS[R] automatic weather stations. MAPS[R] is the registered trademark of Bristol Aerospace Ltd. of Winnipeg, and stands for Modular Aquisition Processing System.

Unlike the older MARS I and II automatic stations which depend on the availability of power and communications land lines, MAPS[R] was developed for locations where land lines are not available. Transmission, therefore is by radio, and power must be generated on the spot.

Power sources for MAPS[R] are limited to solar and wind energy: the five stations mentioned use solar energy, while an early ice floe station used wind. Batteries are required to sustain the stations in the absence of sunlight or wind, and this means the stations must operate on low currents.

Low power availability has several consequences on the design of the station. Present instruments for measuring visibility and cloud cover require too much power and thus are missing from MAPS[R] stations. But the more important consequence of low power is that direct ground to ground radio transmission is not reliable.

Oddly enough, the way to overcome this problem is to relay the information via satellite. Fortunately, the United States makes available its Geostationary Operational Environmental Satellite (GOES) for this purpose at no cost. The United States Environmental Satellite Service has allocated a few minutes of each hour's GOES capacity to AES. But each MAPS[R] transmission must be limited in time and must conform to the satellite's code, which differs from that used for the normal transmission of data on the AES network. These differences necessitated the recently implemented computer translation. Until the computer program was implemented, data from MAPS[R] had not been useable in real time.

Another problem that had to be overcome was that of keeping the electronics warm enough to allow them to function in even the worst Arctic location. Again, because of power limitations, warming must be passive. Jim McTaggart-Cowan, while with the Instruments Branch, solved this problem by applying the old idea of the thermosyphon. Buried deep in the ground, a copper pipe will transfer heat from the warmer ground to the colder instrument box, keeping it a nice, toasty -20°C.

Needless to say, getting the thermosyphon deep into the ground in isolated locations isn't easy. Gunther Sachau of the Instruments Branch is the person charged with the installation of the MAPS[R] stations. He shares the work with regional technicians, who will eventually take over maintenance. Sometimes he gets lucky, and the installation occurs at a location which has a small bulldozer.

Floating weather stations

Accurate weather forecasts are so important to CANMAR, a company undertaking oil drilling operations in the Beaufort Sea, that is purchases its own automatic weather stations and has hired AES personnel to help install them and to prepare special forecasts. Since CANMAR may have to suspend drilling operations in the face of storms and ice, the company has found it worth its while to employ AES services every summer since 1976.

As the CANMAR helicopter lifted off from the ice floe, Bill Hart photographed the newly installed floating automatic weather station and the location device to its left.

The MAPS[R] instrument box sits on an insulated cylindrical column containing the thermosyphon, which passively draws heat from the ground to keep the electronics at an operational temperature.

Other locations with no pre-existing facilities mean flying in every last bit of equipment. Digging is then done by gas-powered bit, pick and shovel. Several days work means living in pup tents and plastic lean-tos improvised to allow a meal without the constant layer of insects. But discomfort is one thing, the danger quite another, and it's real. Mr. Sachau was once missing in action while installing a MAPS[R] (see opposite page).

Obviously, the trips to automated weather stations can be expensive. Jerry Musil, MAPS[R] project leader with the Instruments Branch points out, "a battery terminal, which corrodes and shuts down operation of the station, may take only five minutes to repair, but it may cost $5000 to get there to do it." His job is to examine the reliability of the methods or equipment the supplier is proposing. Mr. Musil is credited with several modifications to the MAPS[R] design. Such work continues in his group as Leif Hansen now analyses data received from MAPS[R] to permit further improvements.

Mr. Musil and Jan Skalski of Instruments Branch have developed a portable set of instruments to test automatic stations. The testing devices have such features as "power up timers," a type of push-button switch which turns itself off to prevent batteries from running down, a major inconvenience in the Arctic.

But Mr. Musil has gone one step further. After Mr. Sachau went missing, Mr. Musil developed the "red box" at Mr. Sachau's urging. The box can generate nine numbers, each standing for an emergency message. When the box is plugged into the barometric MAPS[R] coupler, the emergency message is sent during that few seconds each hour when the station turns on to signal the satellite. Thus, AES staff will be just that much safer.

Floating weather stations (continued)

The CANMAR automatic stations are installed on Beaufort Sea ice floes to give some indication of weather coming from the sea. Since the stations float, generally into Soviet territory, location devices must be placed on the ice with the stations. As the stations float off, the data's value becomes limited, so batteries are used to power the observations and transmission since a longer term source of power is not necessary.

The stations are simpler than those used elsewhere by AES and only measure pressure, wind speed and direction. Nonetheless, the data is fed into the overall national data base by AES staff manning the Beaufort weather office at Tuktoyaktuk.

Last summer's station was installed by Bill Hart of the Arctic Weather Center in Edmonton and a representative of a private company. They helicoptered to pack ice 400 km north of Tuktoyaktuk. The first step was to drill a hole 2.5 m into the dark blue-purple ice which fortunately was over 2.5 m thick.

Bill Hart reports, "Both of us worked with one eye looking for polar bears, not trusting their hospitality or helping hand." But the potential of meeting a polar bear may have been a help after all. They had the station unloaded, assembled, and frozen into place in the record time of less than two hours.

There are other concerns about automatic weather stations. Ken Asmus was OIC at Ennadai Lake when it closed. He is now working out of Edmonton as an inspector. He has mixed feelings about automatic weather stations. "I feel that more automated stations will mean fewer jobs for met technicians placing limitations on careers," he said. On the other hand, he realizes that it is also difficult to staff isolated stations.

He notes, "remote manned stations like Ennadai Lake also serve other functions, such as providing shelter to those passing through the region." He notes that local users protested the closing. Among them were local pilots, mining and oil company employees, and other federal government agencies.

Nonetheless, he thinks the idea of automated stations is great if used to fill in the gaps in the observational network. Great, that is, if some of the technical limitations can be overcome.

What are the limitations? As mentioned, not all variables are observed. Also, according to Mr. Musil, although the electronics have proved themselves to be reliable, sensors do fail and it may be months before they can be repaired or replaced. Sometimes the sensors themselves have limitations. The relative humidity sensor now employed uses a human hair which fails in dry weather, and a mechanical linkage which can freeze. The atmospheric pressure sensor used in MAPS^R is temperature dependent, non-linear, and thereby not interchangeable with those from other stations without complicated recalibrations.

The MAPS^R automatic weather station tower holds two unconventional pieces of equipment; a cylindrical antenna for broadcasting data to a geostationary satellite and, above it, a square plate holding the several circular solar energy cells which power the station.

Missing in action

Gunther Sachau is a cautious man. As the man responsible for installing MAPS^R automatic weather stations in usually remote locations for the Instruments Branch, he has learned to come prepared for most any contingency.

But when, in 1978, the commercial airline which had taken him to Churchill lost the collar which insulates the system's thermosyphon and he had to make a return trip to the Thelon River MAPS^R site for its installation, he saw no cause for concern.

After all, it was a straight-forward enough matter: four hours to fly in, four hours to install the collar and instruments box, and four hours to fly back. Hardly reason to take sleeping bags and extra food.

Coming back, however, the aircraft encountered unexpected headwinds. Suddenly warning lights flashed that only ten minutes of fuel remained. The pilot reckoned they were only 30 miles from Churchill, but decided to descend to search out an emergency landing spot rather than try to make it back. He found a suitable body of water, radioed his position, landed on what could best be described as a puddle, and decided to wait till another company plane came to get them.

The two pilots, plus Gunther Sachau and Ed Higham, a Central Region inspector, spent the chill late October night in the cold aluminum body of the aircraft. The next morning when they tried to send another radio call for help, they found the radio battery had gone dead. They passed the day exploring the area, looking for something other than their unpalatable dried food, but ceased when they spotted two adult black bears.

There wasn't much point to exploration anyway since, although the plane carried shotgun shells, the shotgun itself was missing. They limited their activity to boiling the bug laden water of their puddle and came to the realization that there was no way to walk out.

No plane arrived for them that day. They had to wait until someone found their red plane sitting on a small body of water – one of thousands surrounding them and effectively blocking any surface escape route.

To overcome such problems AES is working on the development of new sensors such as a solid state atmospheric pressure gauge and laser cloud detectors. Even so, there are still things that a human observer can do better than an instrument.

Whatever their present imperfections, automatic weather stations are here to stay. Right now, MARS stations total 39 – half at manned locations. Those at manned stations are used to supplement human observers after hours and on weekends. Manned observations get priority since they are more complete.

MAPS^R stations have been used for some stations that were isolated or closed down for reasons of economy. MAPS^R stations on the Pacific rim are to be tested as part of the replacement for Ocean Station PAPA. If they and the system of floating buoys prove adequate, then PAPA can be retired saving AES about $3 million in the first year alone.

Another seven MAPS^R stations remain to be purchased under a current agreement. Their deployment is now under review by Ron Miller and Griffith Toole of Field Services.

But AES intends to move on to the next generation of automatic weather stations as quickly as possible. Roy Bourke of Central Services chairs a committee which has already drafted the specifications for the station which is to follow MAPS^R and has moved on to begin development.

Dave Colwell of Field Services, who has been considering the policy and manpower implications of the next generation station, says, "The upcoming automated station is being designed so that AES staff can work with it as an observer/machine partnership. The procedure AES now uses relies on observers working with tools, and we regard the automated stations as just a more sophisticated tool."

"One example of the long range value of this tool is at flight service stations or joint presentation offices where the priority of staff duties means that the taking of observations must sometimes be ignored. A properly designed observer-machine operation would reduce the staff time required for observations or provide a basic set of automatic observations when staff is unavailable for monitoring. The reserve capabilities will assure the quality of observations."

"In the end, the changes should make the observer's job much more interesting."

The upcoming system, which is as yet unnamed, should incorporate several advances. The drawing board version will have much more advanced electronics, including micro-processors to undertake on-site processing and to allow observer-machine interaction, the ability to transmit either to geostationary or polar orbiting satellites or by land line, and additional sensors to measure parameters related to ceilings, visibility, and types of precipitation. On top of all this, the system will be much more versatile in its deployment configuration and will cost less. What it still lacks is a delivery date. Hopefully it will be sometime during 1983. □

Missing in action (continued)

That night it was back to that refrigerator of an airplane. The first day, the pilot had been confident that they would be found and thus had not set up the Emergency Location Transmitter (ELT). The second day Sachau decided it was time. He found, however, that the ELT had corroded batteries.

Ed Higham managed to clean it up and rig it with flashlight batteries. Within the hour an Air Canada plane passing over a hundred miles away had noted their location and shortly after a wheeled plane had spotted them but could not land. The pilot dropped a radio transmitter, and it was then that they learned they were 90 miles from Churchill, not the 30 the pilot had reckoned. They also found out that their last radio message had been garbled because they were so low.

That ELT had probably kept them from becoming the casualties their families already thought they were.

They were told that a rescue plane would pick them up in an hour. The same wheeled spotter plane circled, but then had to inform them that the pontoon plane had engine troubles and would only be able to get to them the next day.

In the excitement of having been found, they forgot to ask for sleeping bags.

Gunther Sachau says, "I now check every piece of equipment in any plane which we charter even if the pilot things I'm crazy. I also take enough supplies for a week even if I'm only going for a few hours."

It can take a week to install an automated weather station. Sleeping quarters at Thelon River consisted of pup tents but. . .

. . .the need for a messhall was not anticipated. The constant swarm of blackflies necessitated the hasty construction of one.

Modular Acquisition Processing System seminar

A MAPS[R] maintenance seminar was presented to representatives of each of the six AES Regions and AES Downsview by Jerry Musil (AIDR), of the Research and Project Support Section, Instruments Branch, and a team of specialists from March 17th through 21st, 1980. The seminar provided information ranging from over-all concepts, to electronic circuits, to a practical exercise for this automatic weather station.

Fine spring weather facilitated the practical portion of the seminar. Using information provided in a lecture, Gordon Pool (AIMM) of Installation and Maintenance, Instrument Branch, provided antenna coordinates to a GOES satellite from AES Headquarters and successfully transmitted meteorological data from a trailer-mounted MAPS[R] system - a fitting end to the formal portion of the program.