Looking forward from the past

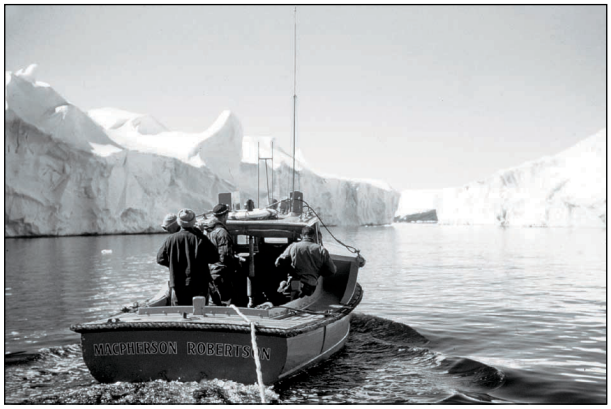
Technology and remote sensing have a long Antarctic pedigree built on years of accumulated experience. Scientists in the first wintering expeditions 100 years ago had only their own senses and a few instruments to observe what was happening around them. Their measurements of the earth's magnetic field sampled a phenomenon influenced by processes acting globally. These simple examples involve forms of remote sensing. But instruments able to collect or record data remotely were almost non-existent: data were collected only at the very few occupied sites and only sporadically. The spatial extent of the observations was as far as the expeditions could travel with their instruments across the sea or ice.

Around the middle of the century the scope and nature of activities started to change dramatically. Continuous occupation of stations and new equipment enabled longer-term, farther-reaching observations. Radiosondes on balloons and radar tracking yielded data on atmospheric winds, temperature, and humidity. Some instruments recorded observations of natural phenomena, either by pen chart-recorder, or on photosensitive paper. Most observations were made and analysed manually. Specially designed cameras recorded auroras. Such advances increased both the range of phenomena under study and frequency of observations.

The International Geophysical Year saw a concerted effort by many nations to study the Antarctic region, with emphasis on the earth sciences, notably geophysics, geology and meteorology. The many stations established on the continent, and the routes travelled greatly improved spatial sampling, but locations were still sparsely distributed. Support for systematic mapping of the coastal regions using aerial photography was a major effort, in addition to the huge task of extracting mapping information from the photographs.

Developments in electronics and communications including deployment of satellites have led to a continuing revolution in what is observed and how data are collected. The first new devices contained vacuum tubes; from the 1960s transistors and later integrated circuits brought much smaller, lower-powered devices. Digital technology, programmable devices, and solid-state recording of data have opened up an enormous range of applications.

The first automatic weather stations, placed on Chick and Lewis Islands in 1962, transmitted data via high-frequency radio. Radio echo sounding of ice thickness (recorded on photographic film) was introduced in 1967. A prototype battery-solar-wind-powered remote geophysical observatory using transistor circuits and a magnetic tape data recorder was deployed on Law Dome in 1971. Instruments included a riometer, micropulsations recorder, three-component fluxgate magnetometer, an all-sky camera, clock, and wind speed/direction, temperature, and pressure sensors. The remote observatory was designed to operate unattended for a year, duplicating an array of auroral physics instruments typical of occupied stations. From its development evolved later automatic weather stations, the longest running of which, about 600 km behind Casey, is still providing data 17 years after deployment.



Philip Law leads the 1958 party to establish the first automatic weather station in Antarctica Philip Law

From 1965, on-board recorders on weather satellites provided wide-area images of Antarctica using a television-like sensor operating at visible or thermal infrared wavelengths. Designed for observing cloud distribution and pattern, they also enabled observation of sea ice distribution, and drift of a huge section of Amery Ice Shelf that calved in 1963-64. Within a few years ship-board receivers acquired these images directly to assist passage to the stations. But the early satellite systems provided only a simple image. Position was determined crudely with reference to recognisable features. The first high-resolution images came from Landsat-1, launched in 1972.

Satellites soon provided new position determining capabilities. The US Navy's Navigation Satellite System, released for public use in the early 1970s, facilitated accurate positioning in the field independent of fixed features. The bulky geodetic survey equipment of early years became smaller, and computer power soon provided small units for weather-independent navigation. In the 1990s, the changeover to the US Defense Department's global positioning system (GPS) led to small hand-held positioning units. More recently these hand-held units have included a field data recording capability.

The same principles used in that first satellite navigation system were employed in a remote platform positioning and data collection system. Signals from the remote platform were recorded on the satellite for later relay to a user, along with information that allowed calculation of the platform's position. The ARGOS system, which evolved from this, is still used to collect data from such devices as automatic weather stations and sea ice buoys, although the platform's position tends now to be determined by an on-board GPS receiver. The combination of miniaturisation, GPS technology, very low power devices, solid-state recording and long-life lightweight batteries, together with the ARGOS data collection and relay services, provides the means for tracking and observing the behaviour of animals.

Innovation as well as adaptation of technology from other areas has made possible the impossible, the difficult tractable, and increased our ability to explore and learn about Antarctica many-fold. Animals can now be observed where people cannot go, large areas can be monitored regularly from satellite, and a new LIDAR system sounds the atmosphere from the surface out to its edge. Use of technology and automation is allowing effort to be re-directed away from the routine and applied to new areas of research. In less than a century the amount of data collected on Antarctica (and the ability to handle it) has increased by perhaps a billion-fold.

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