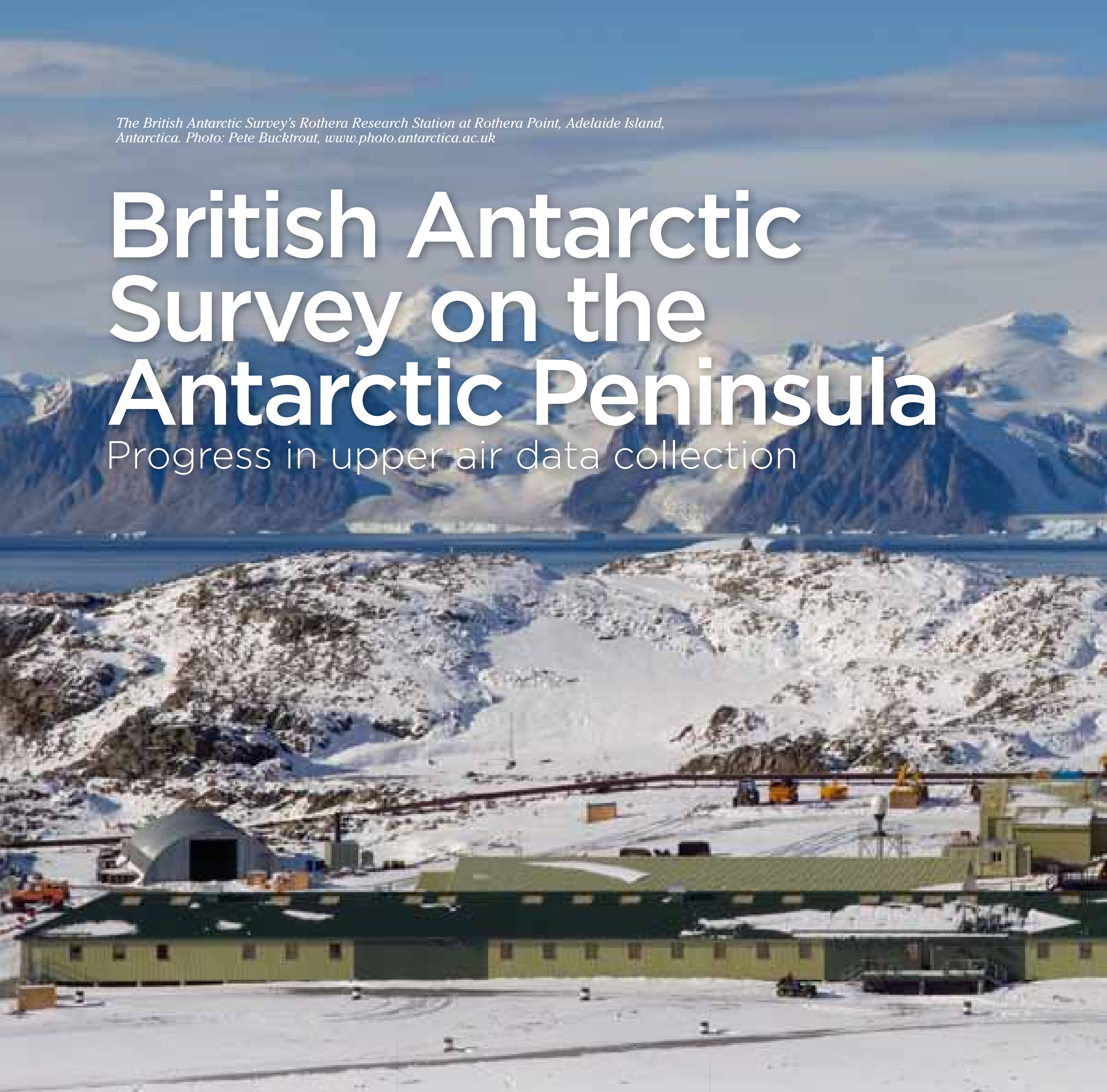
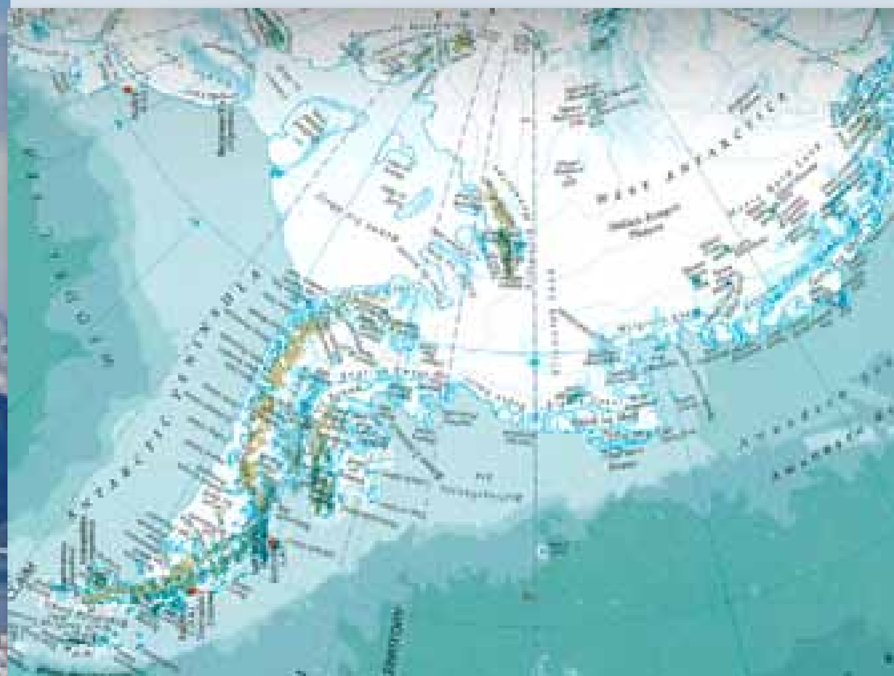


The British Antarctic Survey's Rothera Research Station at Rothera Point, Adelaide Island, Antarctica. Photo: Pete Bucktrout, www.photo.antarctica.ac.uk

British Antarctic Survey on the Antarctic Peninsula

Progress in upper air data collection

Although the main principles remain unchanged, radiosonde sounding has developed significantly over the years. Comparing the routines involved at the end of the 1970s and the situation now provides some insights into the changes that have taken place in almost three decades. In the following, two meteorologists describe their experiences with the British Antarctic Survey operating on the Antarctic Peninsula.



Faraday, now called Vernadsky, and Rothera.

Radiosonde sounding at Faraday in 1980

Mike Brettle, Faraday, 1978–1980: My first job out of university in 1977 was as a meteorologist/physicist with the British Antarctic Survey (BAS). This included two winters at one of their Antarctic stations. I was sent to Faraday on the Antarctic Peninsula where a major part of my duties involved the daily radiosonde ascent.

Preparations for flying the radiosonde started the night before. One of the jobs of the meteorologist on night duty was to prepare the radiosonde for the following morning's ascent.

The radiosondes at that time were polystyrene devices about the size of shoeboxes and not especially reliable. They had to be assembled and tested with their humidity sensor, which in those days was a carbon hygristor about half the size of a credit card. The night met was wise to get this task completed early in the night because of the high failure rate. The next duty, before waking his colleagues, was filling the balloon. We had a sizeable balloon shed and a hydrogen generator. The balloons were large by modern standards, about 1500g, because they had to carry a radar target as well as the heavy sonde.

Launching the sonde was a labour-intensive affair needing the whole met team. In the sonde room, one person would be needed on the sonde receiver and another, the wind man, on the radar controls. Outdoors, someone would be responsible for guiding the radar with a kind of gun sight arrangement and someone, usually the night met, would launch the balloon.

In any kind of wind it would take two people to launch the balloon – one to actually let the thing go before it disintegrated, and another person energetic enough to stand downwind at the full extent of the suspension string and start running, or more often, wading through snow, downwind to give the sonde a chance of getting airborne without hitting the ground.

The knack was to give the sonde a sideways push before it was snatched out of your hand. With any luck this would give the sonde a conical pendulum motion keeping it above the ground. Meanwhile, the radar aimer would follow the radar target as long as he could, the radar itself following his move-

Purple skies behind the Piggot platform, Halley Research Station. To help predictions of climate change, BAS meteorologists look at the formation and properties of Antarctic clouds as part of a wider study of interactons between the atmosphere, sea-ice and the oceans. Photo: Miriam Lorwerth, www.photo.antarctica.ac.uk

ments. Indoors, the wind man had to lock onto the target manually. This involved staring at a CRT display, a bit like an oscilloscope trace, and moving a box, representing the radar range gate, back and forth to trap a spike in the trace representing the target. As soon as this was achieved, he pressed a button and then hopefully the radar would follow automatically. If the balloon was lost from sight before lock, the wind man would have to control the azimuth and elevation of the radar in an attempt to find it.

Assuming all went well at launch and the radar could track the balloon, the real work began. The radar had no memory or electronic output. Instead, once a minute, it would beep and momentarily freeze three digital displays showing slant range, azimuth and elevation. The wind man then wrote these down and converted the range and elevation to distance, using tables, and plotted them on a huge sheet of paper. A large, snooker-sized table dominated the sonde room, with a kind of protractor-ruler arrangement. This allowed the wind man to plot the balloon location minute by minute. Wind speed and direction was then simply read off as the vector between the two successive minutes. The knack here was to keep ahead of the radar and its nagging beeps. This was not an easy task, especially at long ranges when the radar was liable to lose its lock and need to be manually brought back on target. Plotting all the winds ten degrees out or accidentally missing minute data were also common problems on the wind computation.

Meanwhile two met men worked at the sonde receiver. The sonde output appeared on a chart recorder. As the sonde ascended, an aneroid capsule connected via an arrangement of levers switched the sonde transmitter output between temperature and relative humidity. By counting the number of switches that had occurred, it was possible to derive the pressure at any point. Selecting points for a TEMP (the code for a pressure, temperature, humidity and wind report) message was a matter of drawing connecting straight pencil lines along the chart, so that temperature and RH (relative humidity) did not deviate too far from these lines. The potential for miscounting the pressure switches or other errors was huge.

After a radiosonde balloon burst, there would be a rush to complete the TEMP message combining the sonde data with the radar wind data. The wind man had selected his own significant points and now had to give wind data for the tropopause and other levels needed from the sonde data. Geopotential heights had to be calculated by iteration from the surface using a tephigram (thermodynamic diagram) to approximate the hydrostatic equation (one of the most important equations in meteorology) over small intervals.

The TEMP message finally came together. It was sent out via a communications station in Port Stanley, Falkland Islands, by Morse code in the first instance. For this we needed our wireless operator. As the sending of the 1200GMT meteorological codes was his first job of the day, he would normally blunder from the bunkroom in his pyjamas straight into the radio shack.

This whole process took two hours or more and involved 4 or 5 people. The potential for human error was enormous. We were very careful to check for these before we passed the message to the radio shack.

There was also a lot of potential for mechanical error. A foot getting tangled with the balloon string was the most common, but the equipment often seemed designed to invite stupid mistakes, such as sending the sonde away fixed on transmitting humidity only or with the radar target upside down.

Getting the sonde away in a strong wind and getting the radar to track it to an extreme range was a matter of pride, as was a complete CLIMAT TEMP statistics message at the end of the month.

Soundings at Halley and Rothera in 2006

Cathy Moore, Halley and Rothera, 2000-present: My first job out of university in 2000 was also as a meteorologist/physicist with the British Antarctic Survey. I first spent two winters at the Halley Station on the Brunt Ice Shelf and now spend the summer months at the Rothera station on the Antarctic Peninsula. At both stations, launching radiosondes is a main part of the met observer's job.

At the Rothera station, the work begins after the morning forecaster's brief for the pilots. The whole radiosonde ascent process requires only one person, so the on-duty met person takes a baked balloon from our oven and takes a walk over to the aircraft hanger on the far side of the station (across the runway). We use 350g balloons and we bake them at 60oC for 24 hours before launch, as this makes the balloon material more pliable and increases the height they eventually reach.

In the hanger we have a small heated container where we prepare the sonde and check it for accurate temperature, pressure and humidity. The sondes are Vaisala Radiosonde RS80s, which use GPS wind finding and transmit the signal back to a receiver on the hanger roof. This makes the calculation of wind speed and direction all a matter of computer processing of the GPS positions as the balloon rises.

We fill the balloons with helium while inside the hanger and, when full, open the hanger doors, then walk out and let go of the balloon with the sonde attached to the bottom. The string then unwinds on the top of the sonde until it is a clear distance from the balloon.

We then let the computer system do the processing of the data in the hanger. We can see the data coming in by remotely connecting to the computer from the met room back in the main building. The program calculates the winds and plots the temperature and humidity. It plots the significant points, but needs checking, and we often add more points if necessary. The TEMP message is calculated automatically and we then email it directly to the Met Office in Exeter, UK. The profile is also directly used by the forecaster at Rothera in the summer.

The whole balloon launching process seems much simpler than it used to be, although we still have to contend with the Antarctic weather conditions, which can't be improved by the latest technology! Many hours are still spent chipping out doors from the ice or shovelling snow away to be able to launch the balloons. And lots of fun is had struggling with unwieldy balloons in 40 or 50kt winds!

At Halley, the balloon launching process is very similar to Rothera, but there is a specially designed balloon launching facility. This is a fancy name for a shipping container raised up on steel legs, but it does the job well. Halley has about 1m of snow accumulation a year, so all buildings would be buried if they were not annually raised on their legs above the surface. The container has doors opening at either end to allow shelter from the wind when launching the balloon. However, as it can be about 4–5 m above the surface, in strong winds of around 50kts, the balloon often goes down before going up again! It also gives the met person a feeling of slight sea-sickness as the building sways in the wind. Halley has just started using the newer Vaisala Radiosonde RS92. These give more accurate humidity measurements as they use two sensors, heating one to remove condensation while the other takes measurements, and then swapping between the two during the ascent.

There are a few other difficulties met people at each station have to overcome. At Halley, sometimes we had to battle against the blowing snow in high winds. Some days you would not even be able to see beyond the end of your arm. At Rothera, during the winter months, seals can sometimes be found near the base. They can be very grumpy if stumbled over by an unsuspecting met person early in the morning in the darkness!

At both stations, in the cold months, a tried and tested technique is to dip the balloons, up to the neck, in a mix of aviation fuel and oil for about 15 minutes and then hang them to dry. This makes the balloons reach much higher altitudes during the very cold winter months.

Further information:
www.vaisala.com/weather/products/soundingequipment