Petrel Post

SANAE 58th Overwintering Team

Chapter 6

In this chapter you will meet our RADAR Engineer from SANSA (South African National Space Agency), Mr. Travis Duck. He will tell you more about himself and his responsibilities.

Further in this chapter you will learn about the HF radar, neutron monitors and cosmic radiation and more…

"Lorenzen Piggen" Viewed from the SANAE IV Base (Zoomed), Antarctic Petrel in flight over the top of the mountain.

From left to right: Marvin, Jacques, Bongisipho, Jufter, Mpati, Travis, Sanele, Ewald and Salomé.

SANAE 58

Editor: Salomé Odendaal

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In this issue:

Did you know?

Antarctica, the Arctic and some other remote islands are the only places in the world not colonized by ants and, Antarctica is the only continent without reptiles and snakes.

Neringa - https://www.boredpanda.com/interesting-antarctica-facts-south-pole/

MEET OUR RADAR ENGINEER: TRAVIS DUCK

Travis Duck (SANSA RADAR Engineer)

I studied Electronic Engineering and Computer Systems at Durban University of Technology. I got my diploma in 2015 and after taking a year off to go to Marion island (another South African National Antarctic Programme research base), I came back to finish my B-Tech in 2017.

The big driving factor for getting my B-Tech was the fact that I needed it to come to Antarctica for this expedition. I have had the great opportunity to work for SANSA (South African National Space Agency) on 2 different projects up to now and find the challenges and unique experiences remarkably interesting.

I grew up in a family of 3 brothers and learnt from a young age that my father was the 4th son in our family. He taught us the adventurous side of things that drives us to explore and try new things that many never get the chance to do, while our mother watched and stressed (but is slowly coming around to the fact that we will do silly things regularly). By now she has become rather amazing at keeping a lid on freaking out.

I work on the SuperDARN Radar for the South African National Space Agency (SANSA) and the thrilling part of the job is climbing the radar mast to replace any broken ropes or antennas. I have never experienced weather as badly as I have up there, cramping up my body and fingers makes it rather difficult to do the simplest of tasks, like screwing in a bolt or tying a knot. Lucky we have excellent working at heights training and equipment to look after us in case something happens.

Figure 1. Throwing boiling water up into the air and watching it turn into dust and icicles at -30°C.

This year I thought I came prepared for the year, but I was completely overwhelmed on how much the lack of sunlight messes with your mood and emotions. After experiencing Marion for a year, I thought projects and staying busy was the key but I underestimated how much just simply getting out for an hour or 2 makes a difference.

We are 9 months in and I already have a whole new outlook on motivation, life and what I thought I needed. It's weird how quickly priorities change when you are here and have little else to do but see what your mind throws at you in your free time.

Figure 2. The window in my room was not sealed 100% and snow piled up on the inside of my window during a snow storm. So I made a snow man !

The sun is coming back though, and that is one hell of an amazing thing to see, but it does signal the time to start looking at going home, a bitter sweet thing to contemplate.

For now, I look at the Aurora predictions every day, hoping to have a good display of the fire in the sky before our time is up. I had the great luck of making the announcement at 4am a few days ago, waking up the team to come look, so that was great fun. Hoping to get some better pics before we leave.

SUPER-DARN RADAR

Travis Duck (SANSA RADAR Engineer)

The South African National Space Agency (SANSA) operates the Super DARN (Super Dual Auroral Radar Network) Radar at the SANAE IV base in Antarctica for UKZN (University of KwaZulu-Natal). This radar detects plasma convections in Earth's upper atmosphere. It is a high frequency radar operating at 12.5MHz (that is adjustable) and is run by myself for the year of my expedition.

With this radar we look out for the effects of the sun sending plasma and other charged particles to the earth's magnetic field and track the movements of plasma pockets in the magnetosphere.


Figure 3. Sunset visible from SANAE IV.

SANAE IV is one of many radars pointing at the poles. Both North and South poles are tracked by the world wide collaboration of radars and we, of course, look at the South pole.

The radar operates 24 hours a day and is only shut down during excessive winds of 60 Knots (around 120km/h) and above or when maintenance is needed to be carried out on the system.


Figure 4. Travis and Mpati taking a bit of a break, during take-over, from all the climbing and working.

This takeover SANSA replaced the cables and cable trays leading to the 16 antennas. This required measuring and cutting each cable to the same exact length of 146 meters.
We needed to be accurate within 1mm and it was a rather intensive task to be performed. It was important to be that accurate because of the propagation delay between the antennas. In easy terms, the signals get sent at certain times, and have to reach the antennas at the exact time they are needed to. One signal can't arrive before another or there will be problems with where the plasma is detected within the radar's range. We need this to be accurate so that we can collaborate it with the other radars looking over the same area. This accuracy allows us to be certain that the radar will give the correct readings on where the detections are.

We pulled many all-nighters during this past takeover, but we are extremely proud of what we did. Hard work pays off and now we have a radar that is upgraded with better cables and receiving better data.

A bit of background on the system:

We have 16 antennas, all operating at around 550V currently, and these antennas do a sweep covering the area that we need to cover. Each antenna is around 25meters high and we need to inspect and climb if there is anything broken or needing to be replaced.


Figure 5. Climbing the antennas.

The radar operates inside a hut near the antennas. Inside the hut are the 16 transceiver boxes, timing box and 2 servers (one for backup).
The system sends its data to the servers at UKZN each night and from there it is uploaded to the international server, like all the rest of the data from all the other radars that are run all over the world. By using all the real time data from all the radars, a space weather plot can be produced to track space weather.

This is the second version of the radar. The first one was a TV style antenna array and was analogue. This current radar was designed and built in-house at SANSA in collaboration with the Australians. The first antenna design could not handle the high wind speeds and rough weather here. One poor Radar Engineer, years ago, had the terrible experience of going outside and finding that one antenna had fallen over and hit another one like a domino effect. This is my worst fear as I have no idea what I would do.

I have had to climb the antennas a few time during the year so far and found that it is a rather exhilarating experience. We never climb in wind speed anything above 10 knots and even at 10 knots it's unforgiving. I try for around 5 knots.

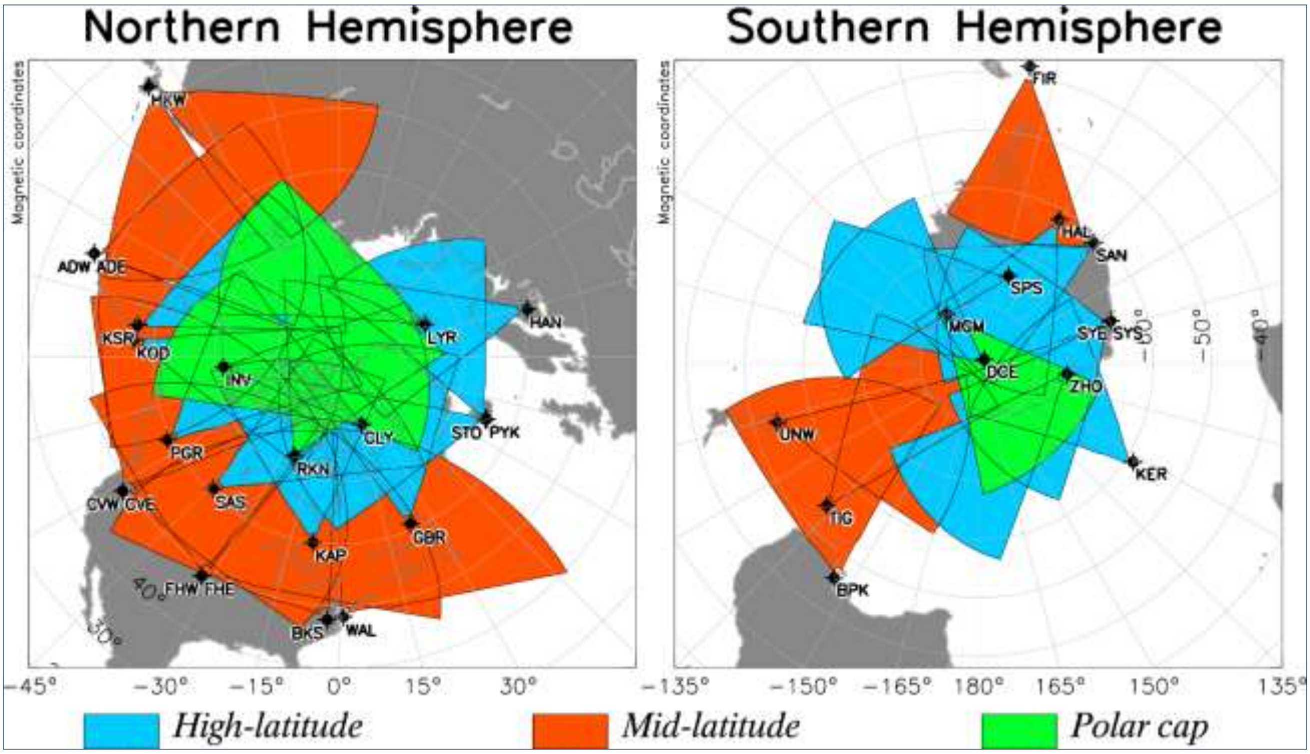

Figure 6. Radar coverage for the Northern and Southern hemispheres. Obtained from http://vt.superdarn.org/tiki-index.php?page=Radar+Overview. More information also available from www.sansa.org.za or https://www.sansa.org.za/wp-content/uploads/2018/06/SANSA-SuperDARN-Digital-Radar.pdf

The Radar is working brilliantly and has only given me a few curve balls to figure out during this year. So far, it has been a fun and interesting experience.

NEUTRON MONITORS & DETECTING COSMIC RADIATION

Travis Duck (SANSA RADAR Engineer)

The NWU (North-West University) is one of two South African Universities with long term scientific research programs in Antarctica.

NWU has been involved with SANAE since 1964, taking the first observations of cosmic radiation at the base. A second set of neutron monitors were installed in 1971 and both sets are still running.

The first thing to understand is that we are constantly bombarded by cosmic radiation that originates from outer space. These galactic events, like supernova, occur outside the heliosphere of our solar system, sending these high energy particles (mostly protons) travelling through space. Cosmic rays are affected by magnetic fields. Earth's magnetic field is one of the reasons we are able to exist on this planet.

The energy associated with cosmic rays determines its magnetic cut-off rigidity. Therefore, stronger magnetic fields will require higher energy levels to penetrate. The magnetic field is strongest at the equator and weakest at the poles. We can therefore expect to see more cosmic radiation events at the poles than at lines of latitude closer to the equator. Hence we have equipment installed at SANAE IV.

The second important thing to understand is the effect atmospheric depth has on cosmic radiation. Cosmic rays hitting the atmosphere are called primary cosmic rays. The primary rays collide with particles in the atmosphere. These collisions cause secondary particles as by-products. The by-product can be broken up into nucleonic components (neutrons and protons), hard components (muons) and soft components (electrons). The secondary particles then cause similar reactions when colliding with the next particle. Thus creating what is called an "air shower". Since we have these "showers", which cause the particles to lose energy with each collision, the intensity of the cosmic ray at the earth's surface is a function of atmospheric pressure.

The research done at CSR (Centre for Space Research) focuses on monitoring the nucleonic by-products caused by cosmic radiation. Since these neutrons carry no charge, they will not react with matter by means of Columbic forces (Coulombs law: the force of attraction or repulsion is directly proportional to the charge on the particles and inversely proportional to the distance between the two charges). Another method must therefore be implemented to detect the presence of neutral charge particles.

The solution is to measure the reaction a collision has on other atoms and molecules. A tube filled with an easily ionisable gas is kept at a high potential (2800V). The high-energy neutron passes through the tube and collides with the gas molecules. The molecule is hit with enough energy to release electrons from its valence structure, leaving a positively charged ion and an electron. The electric field created by the large potential prevents the ion and electron to recombine and pulls each one to its opposite polarity. The electrons reaching the anode will generate a pulse proportional to the energy level of the particle it collided with. These pulses are then recorded as events.

<u>What am I to do with this system at SANAE IV?</u>

The current system was upgraded last year by the Neutron Monitor Engineer, Mr. Cobus van der Merwe (SANAE 57 member). This upgrade allowed the system to function mostly autonomously, as well as the ability to login and adjust settings from the NWU.

Figure 7. Graph indicating the counts per minute, pressure and temperature of the neutron monitor tubes.

This made it possible for the system to be passed onto me to look after it, while still maintaining all of my other systems and workload. What I do daily, is to check on the tube counts and scatter plots per tube as well as the voltage levels per tube. This information tells me if the system is functioning properly or not. If I see a problem or anything that looks out of the ordinary, I let the project manager know and start troubleshooting the problematic system.

Luckily up until now there have been no major issues. Cobus has done a great job at the upgrade and besides a few teething problems in the beginning, the system is functioning perfectly. The system only fails to record when there are high wind speeds as the base shakes and this throws the delicate controllers off. Once things calm down again, I restart the systems and everything returns to normal, allowing me to get back to my other systems.

This system is one of a kind at SANAE and it provides the scientists back home with a very interesting and unique view of the external cosmic radiation from outside of our solar system, which our sun and the earth's magnetic fields normally stops from getting to us.

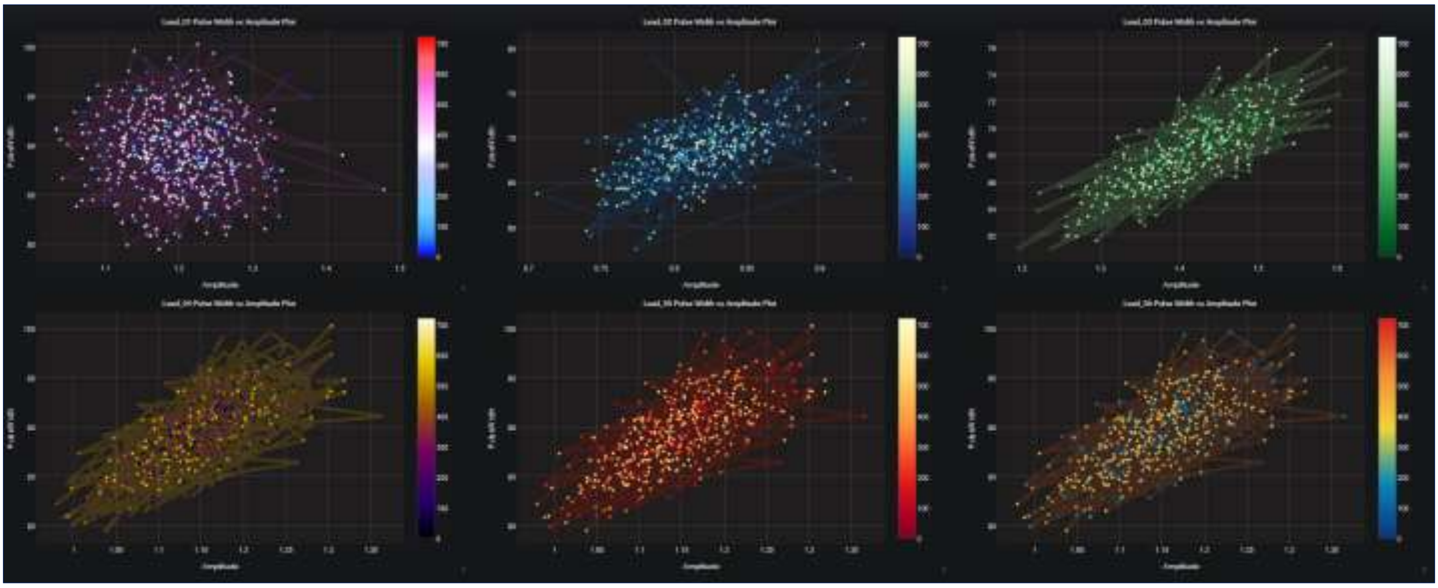

Figure 8. Scatter plots of the captured data from the neutron monitors.

INTERNET CHALLENGES…

Travis Duck (SANSA RADAR Engineer)

Fixing the internet when it turns out you are tech support….

On the 17th of April, we lost our second modem, our only link to the outside world for the year. Only then did we figure out that the first modem failing was not a normal end of life situation (it had been here for nearly 10 years) but a problem with construction changes that happened shortly before takeover ended.

Figure 9. The modem, after being opened and being inspected.

When you are in the middle of nowhere, with no parts or shops anywhere nearby, you learn how to make a plan or deal with not having things.

We are not the type of people to just sit for a year without internet, so we surely made a plan. Even though the thought of no reports for a year was tempting…

As Bongishipo constantly said:
"Guys don't worry the internet is coming back. I am going to be submitting on Monday". Sure thing, he submitted his university work on a working internet connection on the Monday afternoon.

Here at SANAE 4, static build-up is a major problem. When you get shocked first thing in the morning as you wake up and get out of bed, that is just Antarctica saying: "Remember to be ready, I'm coming for you if I get the chance". This was the fate of both our friendly modems, and with them went Marvin's sanity.

So, in order to avoid full scale team insanity for the year and to stop my mom from worrying about whether I am safe or not for the year, myself and Ewald decided to make a plan.

The modem was opened and looked at for hours, we found nothing. We had lunch and looked again, we found nothing. We then started testing and poking around. We even tried the fix-it-all-solution: turned it off and on again. Nothing.

Figure 10. The broken modem card.

Comparing the 2 modems was only sort of helpful, as both failed in different ways. I tested voltage levels, swapped components and use the satellite phone to call in part number to see what the different chips did. The whole time looking at a 64 pin, tiny chip that I was praying not to be the cause of our problems, as it would be a mission to remove and I doubted we had any spares. There was nothing left at the end of our second day to do besides trying that chip. We succumbed to the possibility and decided to swap the chips between the broken boards and see what happens.

It took the better part of 2 hours to swap the one chip out with the other and check, double and triple check that I had not shorted any pins together (possibly breaking something else when we powered her on).

Figure 11. The chip in question on the broken modem card.

The happiness felt the moment the problems swapped modems, was amazing. We had found the broken part and still had two broken modems…. but we knew what was wrong.

We found that there was an unused port that we could shamelessly steal a working chip from and make that port useless (but in theory we would have a modem again, so well worth it).

It was late, so we had dinner with smiles on our faces (not telling the team anything in case we still could not fix it).

The next day we set to work on scavenging of the other chip. This was in no way to be screwed up, so we took nearly 4 hours to remove the working chip and replace the broken one with it.

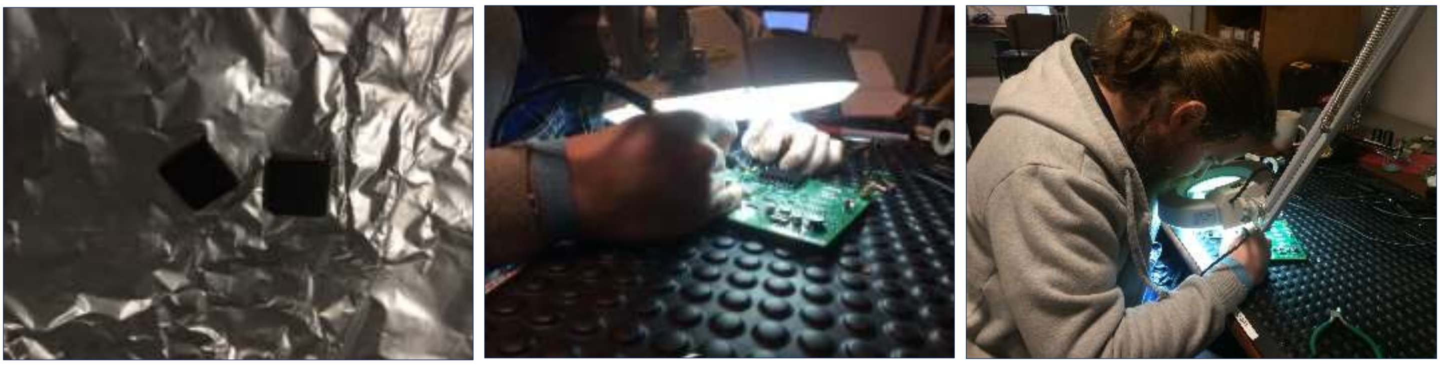

Figure 12, 13 & 14. The chips in question. Travis concentrating and working carefully, replacing the chip on the broken modem card.

Again, we didn't tell anyone that we had something and first went to the Satellite Dome to test it. We did not even get back before Bongisipho had WhatsApp's coming through. Good times!

The second modem was fixed in much the same way and **a lot of** static protectors were placed in the Satellite Dome. The problem now is that we have 2 working modems that Ewald and myself have dubbed "the Frankenstein modems" as we made this plan to get them working and changed so many things during testing, they will never be the same again.

BUUUUT, they are working! So hey, we are good.

OUR WEATHER

Marvin Rankudu (Senior Meteorological Technician)

Table 1. SANAE IV weather statistics, as recorded for the month of Aug. 2019.

Weather Statistics: August 2019								
SANAE IV - VESLESKARVET								
	Minimum		Q1	Median	Average	Q3	Maximum	
Temperature (°C)	-40.8	(16th)	-33	-30	-30	-27	-15.4	(26th)
Humidity (%)	15	(6th)	44	51	51	57	79	(18th)
Wind Gust (m/s)	0	(14th)	9	11	11	14	46.2	(19th)
Pressure (hPa)	859	(19th)	876	881	880	884	894	(31st)

°C, degrees Celsius; Q1, first quartile or 25th percentile; Q3, third quartile or 75th percentile; %, percentage; m/s, meter per second; hPa, hectopascal

ANTARCTICA MATTERS

Salomé Odendaal (Team Medical Doctor)

Since you now know that there are no ants, reptiles or snakes in Antarctica, I am going to tell you a little bit about two non-penguin birds found in Antarctica, the South Polar Skua and the Snow Petrel.

Before I do that, please note that there are no polar bears in Antarctica. Polar bears live in the Arctic, near the North Pole and penguins live near the South Pole. They only meet in Zoo's, cartoons and children books.

The Snow Petrel is an all-white bird with dark eyes, black bill and bluish grey feet. It is native to Antarctica. Its weight ranges from 260 to 460 grams with a length of 30 to 40 centimetres and a wingspan of 75 to 95 centimetres. The snow petrel's diet consists of fish, squid, molluscs, krill, euphausiids, carrion of seals, whales and penguins and refuse.

Figure 15. Snow Petrel (Pagodroma nivea) by Samuel Blanc as obtained from Wikipedia. Available at: https://en.wikipedia.org/wiki/Snow_petrel

Figure 16. Snow Petrel (Pagodroma nivea) as obtained from Wikimedia Commons. Available at: https://commons.wikimedia.org/wiki/File:Pagodroma_nivea in ross sea1.jpg

Snow petrel populations are mostly in the Antarctic continent and peri-Antarctic islands, as well as South Georgia, Bouvetoya, South Sandwich, and South Orkney Islands. They nest on cliffs as colonies. To avoid predators, like the south polar skua, a snow petrel flies low over the water or very high over the land. They are sociable and fly erratically in bat like motion. A snow petrel can squirt foul smelling oils with its mouth at intruders. It can also fight with its bills and wings. The snow petrel's average age of sexual maturity is seven years and it can reportedly live for up to 20 years.

Figure17. South Polar Skua by Greg Schechter from flickr.com.

The South Polar Skua will attack humans who finds themselves too close to their nests.

The south polar skua's appearance are gull-like, dirty brown or grey with darker wings. They have barrel chests, blue hooked bills and broad, round wings. South Polar Skuas are the greyest members of the Skua species but they also tend to be slighter in the body, thinner in the bill, smaller in the head, and narrower in the wings compared to other Skuas.

The south polar skua's weight ranges from 900 to 1 600 grams with a length of approximately 50 centimetres, with the females being larger than the males.

They are usually located in the Antarctic and during winters in the Atlantic, Indian, and Pacific Oceans but have a huge migratory range, with some wintering as far north as Alaska and Greenland. They can reach flight speeds of up to 50 km per hour.

When they are not breeding, the South Polar Skuas are mainly pelagic (live entirely at sea). Their diet consists of fish, birds, rabbits and carrion, with a large portion of their dietary fish being obtained by bullying other smaller birds for their catches. It can also dive or pluck fish from just under the surface of the sea.

These skua's reach sexual maturity around 6 years of age and live for about 10 years in the wild. They tend to be monogamous and the pair returns to the same nesting site every year. Nests are and area in the ground that is clear of any ice or snow and little more than scratches or scrapes.

The female lays an average of 2 eggs in either November or December. Both adults take turns incubating the eggs for a month with the eggs tending to hatch a few days apart. The first hatchling being larger than the second, with the older chick often either driving the younger hatchling from the nest, leaving it to die or it will just kill it outright.

Figure 18. Two south polar brown skuas fight over the remains of an Antarctic finfish. Photographer: Ray Buchheit. Credit: NOAA NMFS SWFSC Antarctic Marine Living Resources (AMLR) Program. Obtained from flickr.com

South Polar Skuas don't really face any natural predators, but they have low success rates at breeding which makes maintaining their population naturally difficult.

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Ultimate Heli
http://www.ultimateheli.com
A dartboard and charcoal for the year as ours was “forgotten” back home.
Thanks guys, you made every braai day this year happen for us.

We would like to thank each of our sponsors for making our year that much more durable and comfortable.