NEW TOYS FOR ANTARCTICA'S AEROSOL MEN

Dr Alexander Mangold from the Royal Meteorological Institute (RMI) of Belgium is now on his sixth season in Antarctica. He and his colleague Dr Quentin Laffineur have been busy with some new projects this season.

Not only are they servicing the variety of instruments that the RMI and its collaborators - KU Leuven and the Belgian Institute for Space Aeronomy (BIRA-IASB) - use in the BELATMOS and Hydrant projects (including an automatic weather station as well as instruments to measure atmospheric particles and ozone). They're also launching weather balloons and working with a new instrument from Leipzig University that mesures cloud-forming aerosols.

What are your research objectives this season?

In brief, our objectives this season are setting up and re-starting all the instruments that measure atmospheric composition, cloud formation, precipitation and weather conditions.

Each time we come to Antarctica, we service the automatic weather station (AWS), as well as all the other 12 instruments. Before we leave at the end of this season, we need to make sure all the instruments are repaired. The work keeps us busy. We only have one more to reapir before we leave.

What are the new projects you're working on this season?

This year, we've been launching a weather balloon every day, and trying to determine the origins of aerosols in the atmosphere over the Queen Maud Land in Antarctica. If we can determine to what extent the aerosols influence cloud formation and precipitation, then this will help atmospheric scientists improve their models for predicting cloud formation and precipitation in Antarctica.

This year you've got a new radio-sounding system that you've been attaching to weather balloons you've been launching.

This is the second season we've been doing launching weather balloons in collaboration with the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) and the International Polar Foundation as part of the ACME project. Last season we used a radio-sounding system from WSL, but unfortunately, the radio sounding sensors compatible with their system are no longer produced. Therefore we switched to a new system and on 28 November we launched the first balloon with this system.

Every day at noon we fill a weather balloon with helium and launch it from the Princess Elisabeth station. We attach a radio-sounding sensor to each balloon, which transmits air temperature, atmospheric pressure, humidity, wind direction and wind speed by radio to a ground receiver every second as it rises into the atmosphere.

The balloon is tracked with a GPS receiver that measures the position of the balloon as it ascends, so we have a vertical profile of all these atmospheric conditions. The balloon rises up into the atmosphere and takes measurements as far up as the balloon will go before it pops in the stratosphere, some 30 km above the ground.

What use is the data you collect?

Aside from getting a vertical profile of atmospheric weather conditions above the Princess Elisabeth station, the information the radio sounder collects also gives us more information about air circulation and aerosol transport, as well as conditions for potential cloud formation in the region.

We freely share the data we're collecting with any other scientists who are interested in having it. There aren't so many vertical profile observations of atmospheric conditions in Antarctica, so the information we're collecting is very useful to many scientists.

For example, we send the data we collect to the German Neumayer III station at the coast, which is responsible for making weather forecasts for this part of Antarctica. They are more than happy to have the data we're collecting with the weather balloon.

So there aren't too many research stations in Antarctica from which researchers launch weather balloons?

I don't think so. Most of the stations that do launch them are at the coast. Towards the interior of the continent, there aren't so many. So having a vertical profile of atmospheric conditions further inland in Antarctica is data that atmospheric scientists and meteorologists are eager to have.

More of these kinds of observations are needed, and Princess Elisabeth is at a good location to provide them.

You're also working studying cloud formation in Antarctica with the Leibniz Institute for Tropospheric Research (TROPOS) at Leipzig University. They gave you a new instrument you've

been working with.

Indeed, we have a new instrument from TROPOS. It complements the measurements from other instruments we already have that measure aerosols. The instruments from the BELATMOS project measure all fine particles in the atmosphere; the instrument from TROPOS focuses on the fraction of particles that have the potential to form clouds and precipitation.

More specifically, the instrument from TROPOS determines the percentage of particles in the atmosphere onto which water vapour can condense and thus form cloud droplets and clouds, as well as at what ambient humidity precipitation could happen. Clouds only form if there are enough of these cloud-forming particles in the atmosphere, and if the humidity in the atmosphere is high enough.

For example, when a system of lower clouds moves into the area of the station, or if it starts to snow, we expect to see some kind of change in aerosol composition in the atmosphere.

What can one do with this information? One would imagine that it helps in weather forecasting.

This information is useful for helping those in the modelling community who run models on cloud formation and precipitation over Antarctica. So it can help meteorologists forecast precipitation in the region, for example.

It's also useful for us working on the BELATMOS project, because it tells us the kind of aerosols we have in the air in the vicinity of the Princess Elisabeth station, and if they are likely to form clouds or not. If a large share of particles does not form clouds, the particles are either too small or composed mostly of insoluble substances, such as fresh organic material.

There was apparently a peak in atmospheric particles two weeks ago. Can you explain what happened?

Normally the air is very clean in Antarctica – only about 200-300 particles per cm^3. That's very clean compared to say, anywhere in Europe.

However last week we saw a sudden increase in the concentration of particles in the atmosphere, from 200 to 6,000 particles per cm^3, as the wind was increasing and low clouds were coming in. From another instrument we were able to see that ice particles were forming in the upper atmosphere, but they weren't reaching the ground as snow.

The TROPOS instrument saw no increase in the number of cloud-forming particles, however. This means that the increase in the overall number of particles was due to an increase in tiny particles that had just formed.

So very small particles don’t lead to cloud formation?

Usually older and larger particles tend to be cloud-forming particles. But the fact that the particles we observed were smaller means that they were newly-formed particles, probably formed within a 100 km radius of the station. Such small particles (below 100 nanometres) grow rapidly enough that we can be sure that they were produced not too far away.

This means that Antarctica has its own source of particles. This is very interesting. We can't say more at the moment, but it's something we atmospheric scientists should investigate further. Where do these articles come from? How are they formed? We would like to be able to answer these questions.

Part of the whole particle budget of Antarctica is formed locally, and another part is transported to Antarctica from the lower latitudes of the Southern Hemisphere. One of the objectives of the BELATMOS project is to determine what percentage of atmospheric particles is formed locally, and what percentage is transported from elsewhere.

What kind of very small particles are formed locally in Antarctica?

It's difficult to say exactly. My colleagues in the atmospheric sciences community and I are still investigating exactly where these particles come from and how they're formed. But we have some hypotheses.

These very small particles can't be dust. Dust would be too large. These particles are more likely organic material and sulphates that come from the coast and are transported to the upper atmosphere. Then, through the interaction of atmospheric circulation, the influence of sunlight, and turbulence, new particles are also formed and come down closer to the ground near the station, where we can measure them with our instruments.

Would it be possible to collect some of these particles and do an analysis of them to determine exactly what they are?

Yes, it would be possible to do this with some kind of air pump and filtration system. Air would need to be pumped through a filter long enough – say, several days – before we could collect enough particulate matter mass to analyze in a laboratory (they'd have to be transported elsewhere as we don't have the facilities at Princess Elisabeth station to do the chemical analysis of the particles). So if an analysis could be done, we would be able to determine the chemical composition of the particles.

We're planning setting up a pump-filtration system in one of the coming seasons. Alain is going to take care of the necessary zero-emission power supply for the pumps, and we'll take care of the filtration system. Suitable pumps are already at the station. These experiments have to be done at least 1 km away from the station to avoid potential contamination. We'd only be able to do these filtration experiments while the station is occupied during the austral summer, though. You need to have someone there to change the filters. So hopefully this will happen in the coming years.

Back in November, your ozone spectrometer measured dangerously low ozone levels above East Antarctica. Have they improved?

Ozone levels were low and the strength of UV radiation was high back in November. But now things have improved. Ozone levels have gone from dangerously low 180 Dobson Units (DU) up to 320 DU, a level which is normal. The UV index is still moderate to high (5 to 6). But it's less dangerous than the before (9 to 10). It's not especially dangerous to go outside without sunscreen anymore, although it's still important to wear it if you're going to be outside for long periods of time.

You and your colleague Quentin will be leaving Antarctica just in time to get home for Christmas. Will someone look after the instruments after you've left?

Most of them can run during the winter and take data year-round. But others you need to have someone there, because they're too sensitive. For example, you need to have someone present to look after the ozone spectrometer, and the TROPOS instrument. But all the other instruments can run unattended when no one is at the station. This means that the TROPOS and the ozone instrument will be de-installed by station staff mid-February. During January and February, the station's engineer or electrician will regularly check our instruments. And via email and remote sattelite control we can handle all potential issues.

Do you have anything special planned for future seasons?

Not really. If we can get the filtration system operational that would be nice. We have 12 instruments already, and this is already a lot to take care of. It's always nice to have more instruments, but then we would need more people to take care of them, and that's not in our budget. We have to first see if there will be financing for upcoming seasons that will allow us to continue our research as it currently is.

Over your six seasons at the station, have you had any interesting experiences?

The first two seasons I came here there were really bad storms. I'm not sure I want to live through that again. Other than that, my time here has been spent working on my research projects.

But the thing about Antarctica is that is has this special flair to it. It's a unique experience, every single season I come here.