IPF, WSL AND CU BOULDER INNOVATE TO BETTER UNDERSTAND CLIMATE CHANGE

Since 2012, with the help of its partners from the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) in Zürich, Switzerland and the University of Colorado Boulder (CU Boulder), the International Polar Foundation (IPF) has maintained and expanded a network of automatic weather stations (AWS) under the Princess Elisabeth Antarctica Climate Experiments (PEACE) project.

The network of automatic weather stations is set up along a 280 km transect from the Princess Ragnhild Coast to the Antarctic Plateau and passes by the Princess Elisabeth Antarctica (the world's first zero-emission polar research station, operated by IPF on behalf of the Belgian State) in Queen Maud Land, East Antarctica. The weather stations measure many parameters including temperature, humidity, pressure, wind speed and direction, incoming solar radiation, reflected solar radiation, and snow accumulation or ice loss.

In 2012, the late Professor Dr. Konrad Steffen, the acting director of WSL at the time, came to personally install the first two automatic weather stations in the PEACE project transect. The following year, his son, Simon, installed a third AWS at Perseus Intercontinental Airfield with the help of IPF.

In 2021, CU Boulder officially donated all three of its stations to IPF for the PEACE project. The same year, two additional stations assembled from parts of automatic weather stations recovered from Swiss Camp on

the Greenland Ice Sheet also joined the transect, bringing the total number of weather stations in the project to five.

Expanding the network

During the 2023-24 austral summer research season, IPF intends to add more stations, allowing for higher resolution observations across a three-dimensional area of Queen Maud Land in East Antarctica, a part of the continent that to date has not been well understood due in part to the lack of ground truthing stations in the region.

A team of researchers from the EPFL in Lausanne, Switzerland has installed additional automatic weather stations in the area close to the Princess Elisabeth Antarctica for a different research project. The data from these stations will also eventually be added to the network.

Having additional weather stations will create a unique high-resolution data set to feed regional climate models, and will contribute to ice mass balance estimates for East Antarctica, which are currently only based on satellite data.

Robust construction

The automatic weather stations run on solar energy. They were set up in an extremely robust and resilient manner to survive the harsh Antarctic climate. These stations have the same design as the Greenland Climate Network, some of which have been operational for over thirty years. They are therefore remarkably robust and efficient in collecting data, and are able to survive brutal conditions of -40°C with sustained 70 km per hour winds in complete darkness for months.

Each weather station is equipped with two of each instrument or sensor plus a barometer in order to have a backup or control reading and to monitor faults that might develop in one of the sensors. The height of the two primary instrument arms of the tower are typically 1 and 2 metres above the ground. In certain areas with lots of snow accumulation, the stations must be raised from year to year to avoid any instruments being buried in the snow.

As there is no sun for nearly six months during the long, dark Antarctic winter, the station’s power usage has to be reduced to a minimum to ride out the periods where it can only rely on battery power. Therefore IPF engineers working to implement a switch control into the program of the weather stations in the coming years that will shut off the newly installed radio communication antenna on each if power becomes too low. This will preserve the battery for the instruments and allow the data logger to operate until the sun returns and it can recharge the batteries sufficiently.

IPF engineers are also working on a system of small yet durable wind turbines capable of withstanding the harsh Antarctic winter to give the stations more energy autonomy during the six months of the year when there is little or no sunlight.

Repatriating open data

From its inception in 2012, the PEACE project has been transmitting its data via Argos to polar-orbiting satellites that pick up its transmitted data packages every hour and reroute them to servers before being forwarded on to their correct target destinations.

However, during the 2022-23 austral summer research season, IPF engineers conceived and experimented with a different system for repatriating data from the automatic weather stations in the PEACE project. The new system uses a terrestrial hub model, where the Princess Elisabeth Antarctica acts as the hub for collecting data directly from the weather stations using terrestrial data repatriation infrastructure. To make this possible, IPF engineers installed a point-to-point link on the network, enabling each weather station to communicate with the relay station and repatriate all the data back to the Princess Elisabeth Antarctica. From PEA the data is sent to a geostationary communications satellite, after which the data are eventually rerouted to IPF servers back in Brussels.

Given the long distances between the weather stations and the Princess Elisabeth Antarctica, and taking into account Earth's curvature, signal loss and attenuation can be an issue. IPF engineers solved this problem by installing a relay station to establish a line of sight linking all automatic weather stations. This station was installed at a height of 2700 metres on Van Autenboer Peak in the Sør Rondane Mountains (the tallest peak in the surrounding mountain range), creating a direct line of sight between the Antarctic Plateau and the Princess Ragnhild Coast.

The relay station on Van Autenboer Peak is equipped with multiple 12-volt batteries and a small wind turbine to ensure the batteries will remain charged and in turn keep the point-to-point link operational. This allows for radio frequency contact from the Princess Elisabeth Antarctica to the weather stations on the Antarctic Plateau (which would otherwise be hidden behind Vikinghogda Mountain Ridge south of the station). The weather stations located north of the Princess Elisabeth Antarctica towards the coast would also be too far away to communicate directly with PEA without the relay station installed on top of Van Autenboer Peak in the neighbuoring Sør Rondane Mountains.

Tests performed this season have been promising. The majority of the automatic weather stations are currently delivering data to an online data repository using the Argos System. If all goes according to plan this coming austral winter, it will be possible to link up all the weather stations using the point-to-point system IPF engineers installed this season. This will provide open access to data once or twice daily as well as to long-term data sets that can contribute to regional and global climate models.