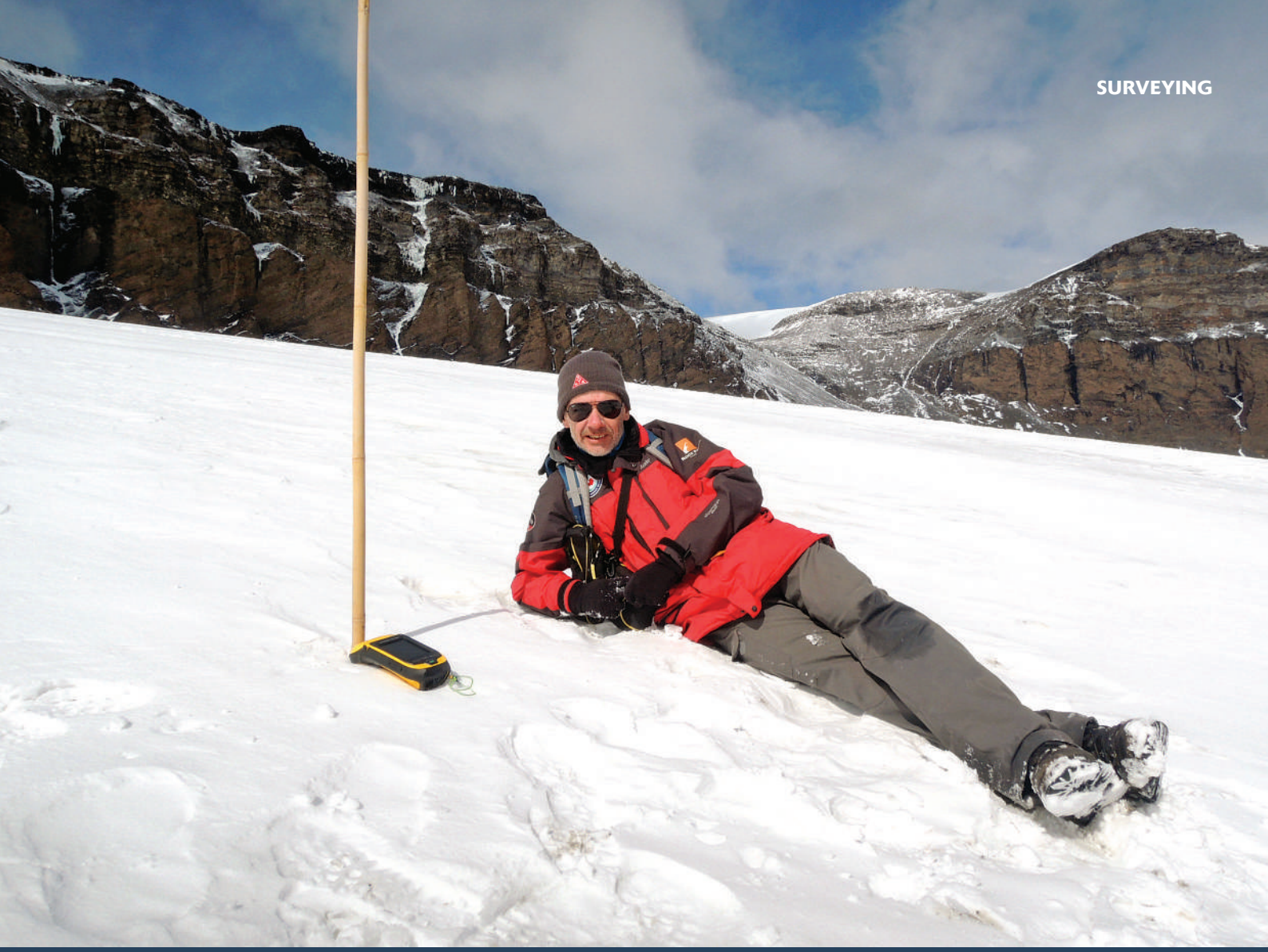


ANTARCTIC OASIS

BY ADAPTING GNSS METHODS TO THEIR SCIENTIFIC NEEDS, CZECH RESEARCHERS IMPROVED ACCURACY AND PRODUCTIVITY IN THEIR SOUTH POLE STUDIES. ERIK DAHLBERG REPORTS

At first glance, the phrase 'Antarctic oasis' seems to be an oxymoron. But that's how polar researchers refer to the north end of James Ross Island. The largest island in the James Ross archipelago at the extreme northern tip of the Antarctic Peninsula, James Ross Island is shielded from storms by the Trinity Mountains. While glaciers cover 80% of its land area, the island has large regions that are free of year-round ice. The exposed rock and tundra provide important opportunities for research and scientific activities.

One of the newest scientific facilities is the Johan Gregor Mendel Research Station located on the Ulu Peninsula at the far north end of the island. Owned by Masaryk University (MU) in Brno and named after the Czech father of modern genetics, it is the Czech Republic's first permanent Antarctic research facility and the only research station located in James Ross Island's unique post-glacial environment.

In late 2015, a team of 11 MU scientists conducted the 10th expedition to the station. They would continue the work of observation and data collection and follow up on the activities of earlier visitors.

Like many scientific efforts, position information is an essential part of routine data collection. Researchers need to map the location of specimens and samples to correlate the data and to enable them to return to the exact same location for future work. And investigations to characterise the behaviour of the island's glacier surfaces require the ability to measure position accurately over time.

However, the time and resources available for accurate positioning are limited. Working under tight budgets, the researchers at Mendel must share duties that extend beyond their scientific roles. Necessary tasks such as cooking, cleaning and maintenance occupy a significant portion of the time. Therefore, the processes to capture positions must be simple, efficient and combine readily with the scientific activities.

A new way of working

David Jindra, a GNSS and positioning expert who accompanied the expedition, says the sparse geodetic control and lack of any real-time GNSS network near the station further hampered positioning efforts. As he spent time with the researchers and began to understand their workflows and requirements for accuracy, Jindra developed a strategy that would streamline the work.

The need for small, simple equipment led the Czech researchers to select Trimble's GeoExplorer series of GNSS handhelds for the project. In addition to their convenient size and low power consumption, the on-board Trimble Terrasync software was well-suited to attribute-

Researchers return to the Mendel Polar Station on James Ross Island. The station is in one of the island's 'oases' where permafrost is exposed during summer months

The Perito Moreno glacier in Patigonia. GNSS is a key tool in studies of glacial behaviour and change.

intensive data collection. The handhelds could provide the durability and easy workflows needed and Jindra's methodology would increase productivity and accuracy.

For data processing, the team would use Trimble Business Center (TBC) and Trimble GPS Pathfinder Office software. Developed to support surveying and engineering applications, TBC provides analysis and processing for geospatial data including GNSS, total stations and digital levels, as well as image management and processing for terrestrial and aerial photogrammetry. The software also produces a variety of deliverables for use in GIS, CAD and other downstream systems. Pathfinder Office is focused on GNSS post-processing primarily for mapping and GIS applications.

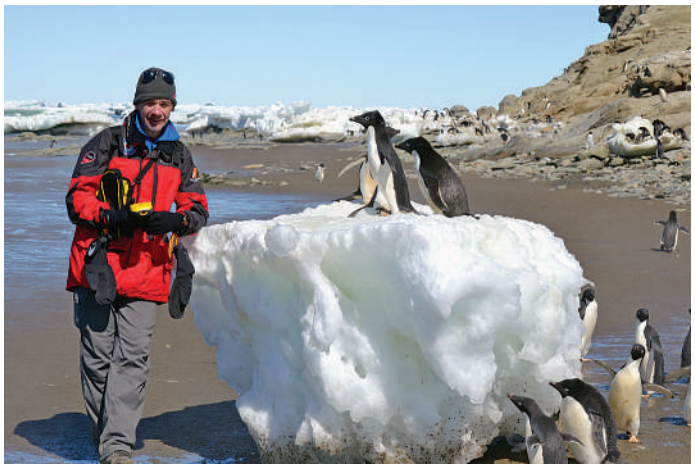
First tasks

One of the first tasks was to establish suitable control at Mendel. The nearest precise control point was at the Chilean General Bernardo O´Higgins station on the Antarctic Peninsula more than 50km away. Using a Trimble Geo7X GNSS handheld mounted on a tripod, Jindra created a new reference point named 4003. After collecting dual-frequency data over several days, he downloaded the data from the Geo7X and acquired corresponding data from the Chilean station. He then used TBC to compute the baseline from the Chilean station to point 4003. Jindra then compared the long-duration observations with measurements taken during past campaigns and confirmed that 4003 was indeed stable. The dual-frequency, carrier-phase results reinforced the plans to use 4003 as a reference station for the 2016 campaign. It will also provide a reference point for use by future expeditions.

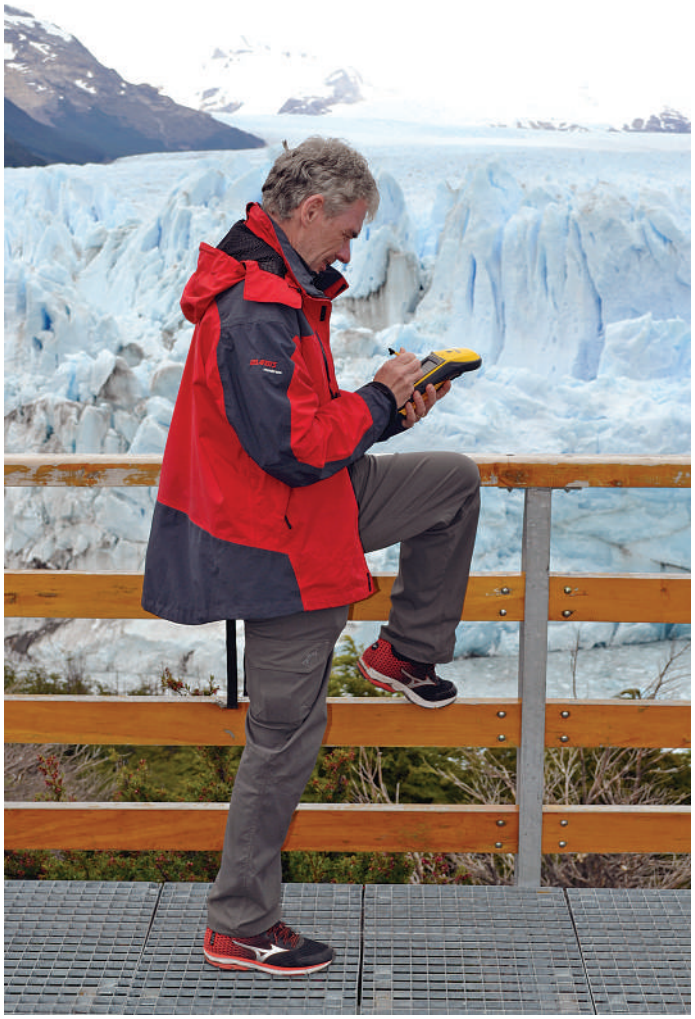
When the local control was in place, the researchers could incorporate GNSS positioning into their daily activities. With the Geo7X collecting data at the reference station, scientists carried Trimble GeoXH 6000 series GNSS handhelds to more remote locations, ranging up to 15km from the base. All their GNSS data could be processed against the data from 4003. Because the baselines were within 15km, they produced better accuracy than earlier expeditions that tied points to the distant O'Higgins station. In addition to the shorter lines, the ability to collect dual-frequency data reduced the time needed for GNSS observation at each location.

Science in the Antarctic

One of the most important uses of GNSS at the Mendel Polar Station is for monitoring

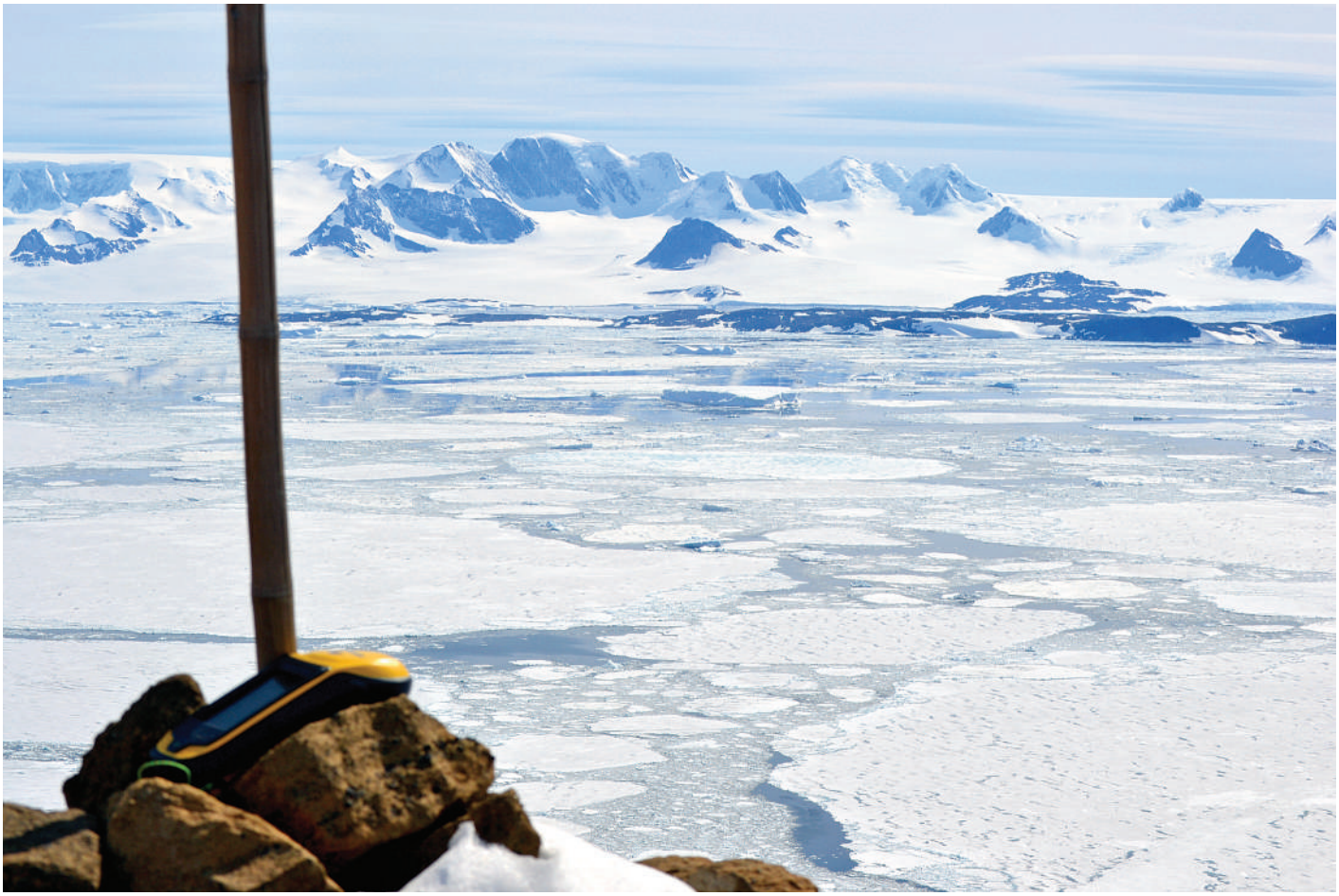


A group of penguins 'supervise' David Jindra as he collects GNSS observations



glaciers. Scientists are studying four glaciers on the island within 15km of the station. On three glaciers, networks of bamboo rods are installed into the ice at regular intervals. Researchers use GNSS to measure the 3D position at the base of each rod. They also measured the distance from the top of the bamboo to the ice surface.

To streamline the GNSS portion of the work, Jindra trained the scientists to use the stop-and-go kinematic method (SGK). This is used to obtain precision similar to RTK but without the need to have a base station or other source or real-time corrections. The GNSS receiver collects satellite continuously while in motion between points of interest. It is held stationary at a point for a few minutes. The in-motion and stationary data is downloaded to post-processing software, which can then produce centimetre results.



A typical view from a GNSS measurement station. The science team achieved centimetre precision on most measurements

The Johan Gregor Mendel Research Station as seen from a nearby hilltop. The facility is accessible by helicopter from an Argentinian station 75km away. The Antarctic Peninsula is visible in the distance

Jindra selected the SGK technique because the continuous tracking of satellites could produce precise positions with short occupation times. With the handhelds collecting data continuously, they could produce accurate positions at the bamboo rods with just three minutes of occupation time. Each day's data was processed in Pathfinder Office to produce 3D coordinates.

"As you would expect, working on the glaciers was a good environment for GNSS," Jindra says. "There are no obstructions and the satellite availability was always quite good." As the glacial motion could be of the order of 2-3m per year, position accuracy of a few centimetres is sufficient.

Following a process that is repeated every year, the team measured several hundred points on the glaciers to quantify changes in position at the bamboo rods. Data from the recurring measurement of coordinates is combined with remote sensing and climatology data to develop information about the glaciers' evolution, motion, trends and shrinking volume. While more complex data analyses are conducted after the expeditions return home, they rely heavily on accurate GNSS data. Jindra says that because the teams could work quickly and confirm each day's data, the researchers came away with a high level of confidence in their results. They could also use TBC and Pathfinder Office to produce output and reports formatted for use by other software and analysis tools.

Another goal of the research was to better understand the behaviour and evolution of the ground at the station. For their studies on permafrost, the team used GNSS approaches similar to the glacier measurements. They identified several experimental areas for soil sample collection on nearby mesas. The locations of the collection points were marked and accurately measured using SGK. They also recovered several points previously established by British teams on volcanic hummocks and established precise coordinates on the station's climate and meteorological sensors. In nearly all cases, the GNSS system produced coordinates with accuracy well within the team's needs. The points were catalogued and monitored; the GNSS data will enable future expeditions to

MY TOUCH ANSWERING CHINA'S NEED FOR GEO-INFORMATION EXPERTISE

YUAN ZHUANG,
MASTER'S STUDENT GEO-INFORMATION SCIENCE AND EARTH OBSERVATION AT ITC

'I enrolled in the Master's programme for Natural Resources Management after earning my Bachelor's degree in Forestry Engineering back in China. The programme fits my interests perfectly. There is huge demand in China right now for geo-information expertise. I'm looking into different possibilities: a job position, maybe a PhD, or a lectureship.'

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HIGH TECH HUMAN TOUCH

A tripod is set up over point 4003 at the Mendel Polar Station. The on-site control point enabled scientists to quickly achieve accurate positions

A bird shares a marker with a GNSS handheld. The team collected position data for samples and locations of meteorological sensors

continue precise observation of the points in coming years.

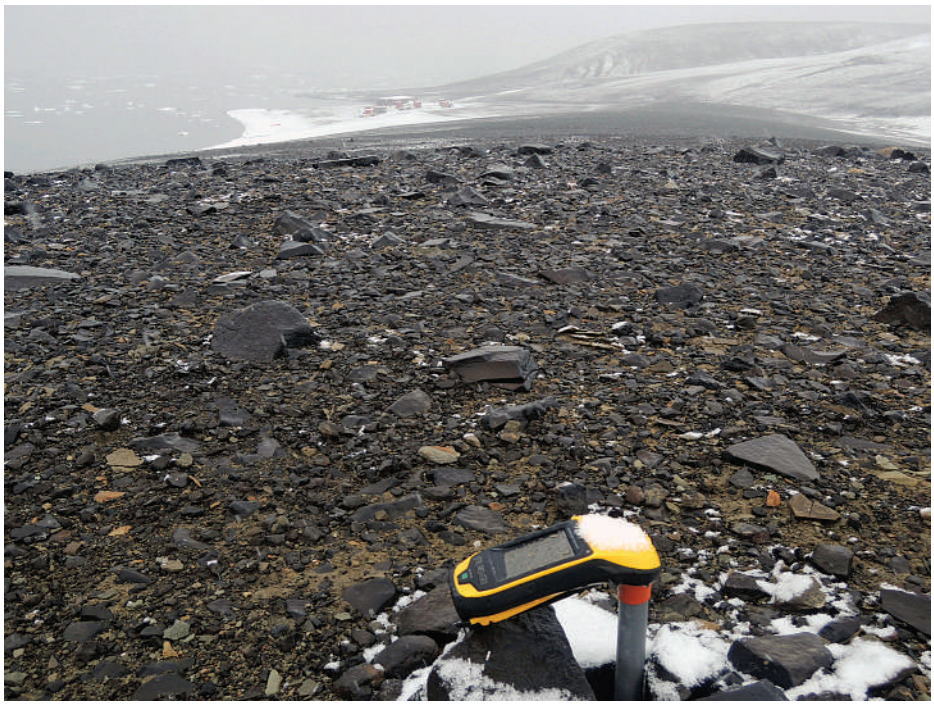
The busy season

Mendel operates only during the Antarctic summer. The small facility consists of a station building and several shipping containers repurposed for use as storage and other purposes. Solar panels and small wind turbines supply electricity. As part of the scientific efforts, the teams conducted measurements on the buildings and containers to detect any motion related to shifts in the permafrost. By establishing the local control point 4003, Jindra provided a fixed reference for monitoring the structures using very short GNSS baselines.

He also conducted some research of his own. He wanted to examine the performance of real-time GNSS positioning using satellite-delivered GNSS correction services in the Antarctic. Trimble's RTX technology uses an established global reference station network along with satellite orbit and clock data to supply corrections for high accuracy positions in real time. The corrections can be supplied at different levels of accuracy and via cellular Internet connection or satellite broadcast. It includes different levels of accuracy to suit specific needs. One example is the ViewPoint RTX service, which can provide accuracy that is equal to or better than DGPS. As the corrections can be delivered by satellite, the service can operate in remote areas where DGPS reference stations are unavailable.

To conduct the tests, Jindra used a Trimble Juno 3B handheld connected via Bluetooth to a Trimble R1 GNSS receiver. Using ViewPoint RTX, he tested the system at Mendel and at an Argentinian station on Seymour Island roughly 75km southwest of the base. In both locations he obtained sub-metre real-time positions with less than one minute of convergence time.

"Our tests have documented that Trimble RTX corrections are functional at the area of northern Antarctic Peninsula," Jindra says. "In



A GNSS handheld collects data during a summer snowstorm. The short visit required the team to work long hours and in all weather

the future, they could be used for a spectrum of precise collection of geographical data. It's important not only for the scientific community. Other applications can benefit by knowing that real-time sub-metre to metre accuracy can be achieved in Antarctic locations and conditions." He says that the question of broader usage of RTX for scientific activities in Antarctica remains open.

After two short, intensely busy weeks, part of the expedition departed Mendel Polar Station. The data they collected will support months and years of processing and analysis. Plans are already underway for future visits by Czech teams to James Ross Island.

"The new methodology will bring more accurate and valuable results to all applications in future campaigns," Jindra

explains. "This combination of different geospatial technologies and methods is the right way to reach a maximum quality and complexity of scientific activities results in this unique area."

OTHER APPLICATIONS CAN BENEFIT BY KNOWING THAT REAL-TIME SUB-METRE TO METRE ACCURACY CAN BE ACHIEVED IN ANTARCTIC LOCATIONS AND CONDITIONS

Erik Dahlberg is a writer specialising in the geomatics, civil engineering and construction industries