CASE STUDY

eBee saves the day: mapping Greenland's Zackenberg Research Station

When global mapping specialist COWI was employed to map 125 square kilometres of remotest Greenland, its staff took two drones into the field: a long-range UAV system and a backup eBee. When the larger system developed technical issues, the senseFly more than proved its mettle

In August 2014, the Danish consulting group, COWI, was employed to map a large 125 km parcel of northeast Greenland, home to the Zackenberg Research Station. Owned by The Government of Greenland and run by Aarhus University's Department of Bioscience, this centre monitors thousands of parameters of the high arctic ecosystem as part of a long-term research and monitoring programme that is the most extensive of its kind in the Arctic.

The site that COWI mapped is the definition of remote, connected to the outside world only via satellite phone, occasional snail mail, and one scheduled flight — weather permitting — every one to two weeks.

Image: Google Earth

The project

The goal of the project was to produce accurate, high-resolution data products that Zackenberg's researchers could use to better optimise their work. These products included:

- A precise digital terrain model (DTM) covering an area of 75 km^2
- A near-infrared (NIR), 10 cm GSD orthophoto of the same 75 km^2 area (with which to produce a high-resolution vegetation map)
- A colour (RGB), 10 cm GSD orthophoto spanning 75 km^2

These products were then to be made available to scientists and other stakeholders with an interest in the station's work, via the Greenland Ecosystem Monitoring program.

"The DTM was needed to feed into a large number of research and monitoring efforts at Zackenberg," explains Jesper Falk, market director and head of section for surveying and inspection at COWI. "This would, for instance, allow for the development of high-resolution hydrological models, and the NIR and RGB orthomosaics — together with the DTM — will be used to develop high-resolution, predictive vegetation models of the area."

senseFly
a Parrot company

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Unmanned aerial vehicles (UAVs or drones) were chosen for the job, in place of manned aircraft, due to their lower mobilisation cost, Falk explains: "The mobilisation cost for UAV mapping is less than aerial mapping by airplane, meaning a much larger area would need to be involved before using traditional airplanes became the favoured approach".

Zackenberg Research Station is located far from civilisation in north eastern Greenland. (Photo: H Spanggaard, Aarhus University – Department of Bioscience.)

Experienced operators

COWI's surveying and inspection staff are no strangers to mapping with drones. The team has used its fleet of UAVs for two previous projects in Greenland alone (one of which involved mapping one of the country's largest glaciers). These systems include two senseFly eBee drones — which between them have already completed over 1,200 flights — plus larger, longer-range fixed-wing UAVs and rotary solutions.

With such extensive drone mapping experience, Jesper and his colleagues knew that planning and spares were key, particularly when working in such a remote spot. "Zackenberg is so isolated that we needed to carefully plan the equipment and backup materials we required," he says. "Each potential breakdown of sensors, hardware, software etc. had to be considered and a plan B prepared. Even if we had previously acquired data in Greenland, new locations always bring unexpected challenges that must be solved on location."

COWI decided to take two drones on-site: a large-area, fixed-wing system, and a backup senseFly eBee. "We chose the longer-range UAV as our primary data collection device because of its hour and a half flight time. This meant the drone would need relatively few flights," Falk says.

In addition to its UAVs, the team also packed: a rifle for protection against animals and flares for scaring them away; a VHF radio; and a single GNSS/GPS system for recording GCPs and check points using differential GNSS (alongside Zackenberg's stationary GNSS/GPS which has known, fixed coordinates).

However after arriving on-site it soon become clear that there was a problem. "Our larger drone had a technical failure," explains Erik Lysdal, a COWI surveyor who worked on the project. "The connection between the computer we use for flight management and the UAV kept dropping out, which meant the drone returned to base after each error. So when we couldn't find a solution to this issue, we turned to the eBee, which we know from experience is reliable and robust. But still, with its size, this was easily the largest eBee job we've conducted to date."

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Flight planning

Using the eBee's eMotion flight planning software, COWI's team set a required ground resolution of 10 cm per pixel. This equated to a flight altitude of approximately 300 metres above the take-off point, with the system's image overlap set to 70/70%.

Since the terrain was a mixture of flat and mountainous areas, this flight plan was then enhanced with digital elevation data, again done inside eMotion. "We used a model from a previous airborne mapping project that we conducted many years ago with 50 meter contour line spacing," Falk explain.

Finding a take-off and landing location was a challenge, for several reasons. "The terrain on-site is covered with large, sometimes huge, rocks. Plus, the grass mainly grows in the areas where melting heaps of snow drain away, so there was a risk that the drone would land in water rather than on dry land. And lastly, there is also a conflict with musk oxes, which like to graze in the kind of locations we wanted to land in. One musk ox already had to be killed in self-defence this year, so we needed to treat these animals with a lot of respect," Lysdal adds.

The site's harsh, rocky terrain made identifying a suitable take-off and landing point a challenge.

The project's KML file in Google Earth, showing the total area surveyed.

In addition to flight planning, the entire project also needed to be geo-referenced with ground control points (GCPs). The team set 72 GCPs in total — typically natural points such as easily identifiable, different coloured rocks — plus 40 additional check points, measured using differential GNSS. The data was processed using Agisoft PhotoScan.

COWI's team then flew 87 eBee flights in total, averaging 30 minutes each, in winds of up to 13 metres per second. At roughly 200 photos per flight, this meant capturing 17,500 images in all.

Flights were typically flown when the sun was best positioned to maximise image quality, for example photographing east-facing slopes in the morning rather than in the afternoon (when such slopes would be in shadow). However this approach meant accepting a compromise: less hours spent mapping each day, for less coverage (an average of 7km2 per day), in exchange for higher quality, more useable images.

"We took approximately 10,000 NIR images, with 90% of these high enough quality for processing. For our RGB images we had 7,500, with 7,000 of these used for generating the DTM and colour orthophoto," Lysdal explains.

The difference in the number of NIR and RGB images acquired was due to snow; before COWI's RGB flights had been completed a storm passed by, which deposited snow on the site's higher areas, meaning some regions could not be accurately photographed. As a result the final RGB orthophoto covered an area of 50 km^2, rather than the predicted 75 km^2.

The processing time for all these images was eight days, says Falk. This included the creation of the project's two orthophotos and its digital terrain model, with all of this work completed back at COWI's headquarters in Denmark.

"The 7,000 RGB images were processed in one batch and the 10,000 NIR photos were processed in two. But next time we will split these images into smaller batches, as the processing time was enormous," Lysdal adds.

Project workflow

01 Quotation

02 Contract negotiation & agreement

03 Planning & mobilisation (Denmark HQ)

04 Transport to Greenland via Iceland

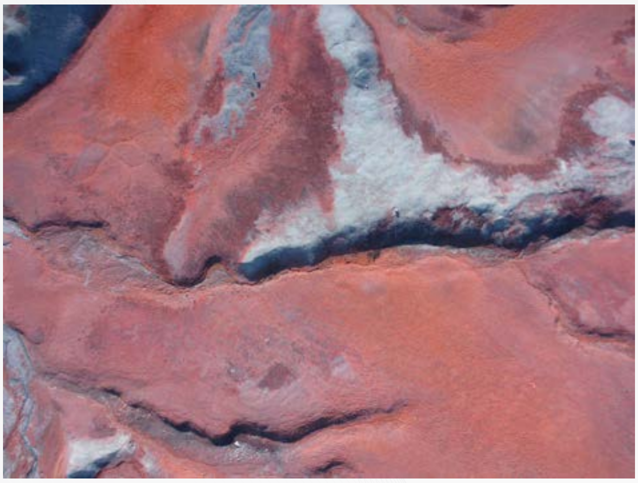
05 4 weeks on-site: planning, GCPs, flying

06 Return to Denmark

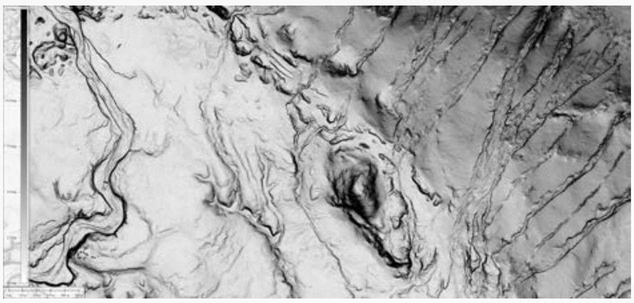
07 2 weeks in office: image processing, product creation

08 Data submitted to client

Results



A section of the project's 10 cm/pixel near-infrared orthophoto, on which three musk oxen are easily visible (top/centre left).



A slope/shade version of the project's DTM. The Zackenberg camp is just visible in the far southwest corner, with mountains rising in the northeast.

"The client was very impressed by the quality of the terrain model we produced," Falk says. "For the orthophotos, the client ran an acceptance test when they received these, which the products passed, but to our knowledge their team hasn't started extracting the vegetation map yet. However we remain regularly in touch with them in order to get this response and to help us continually improve our services."

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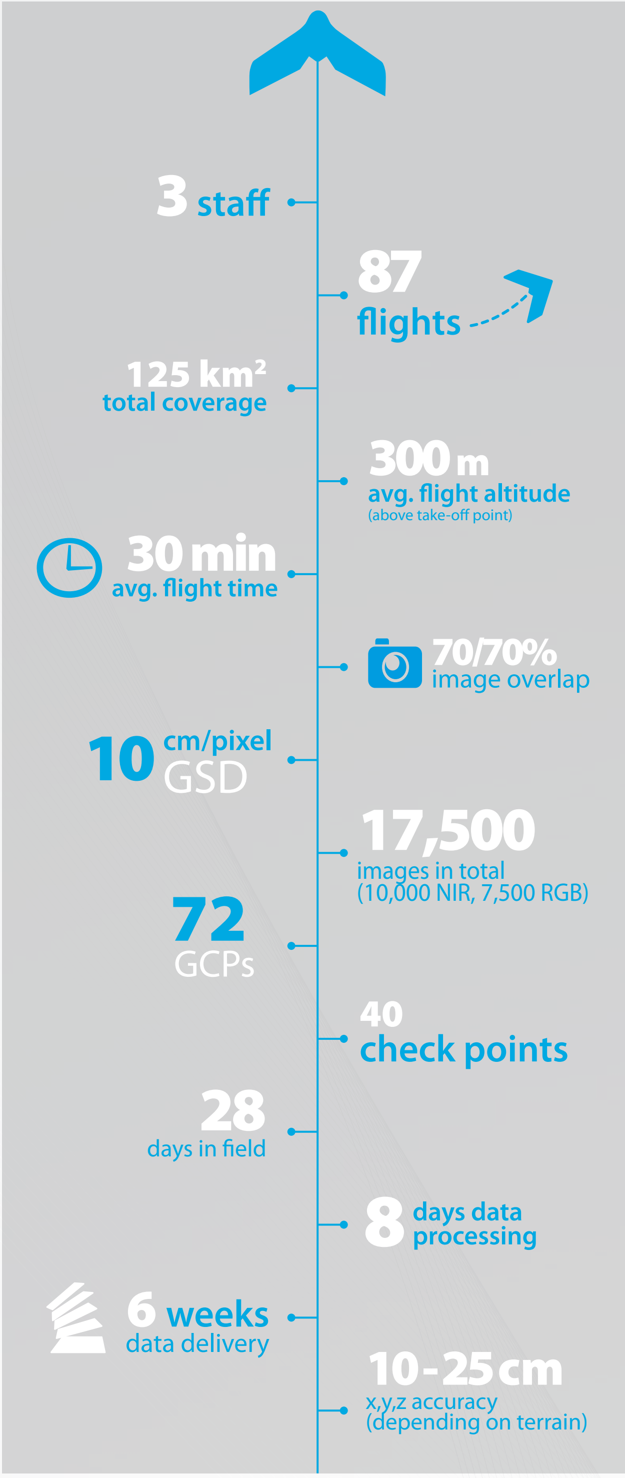
In August 2015, COWI will head back to Greenland to perform a similar orthophoto and DTM project in the Kobbefjord research area, 20 km east of Nuuk in the west of the country. "We will build on our Zackenberg mapping experience, but of course in such remote areas there are sure to be new challenges that will occur," Falk predicts.

Erik Lysdal of COWI giving an on-site demonstrating of the eBee to a group that included Kim Kielsen (green jacket), who is now the Prime Minister of Greenland. (Photo: Niels Martin Schmidt, Aarhus University.)

About COWI

COWI (www.cowi.com) is a leading consulting group that creates value for customers, people and society through its unique 360° approach. With offices all over the world, it combines global presence with local knowledge to take on projects anywhere in the world. COWI is one of the largest private mapping and surveying companies in Europe with more than 40 years of experience, covering a wide range of activities in the fields of photogrammetry, laser scanning, traditional and new technology surveying.

PROJECT STATISTICS



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