FEATURE ARTICLE

Scientific UAS Missions in the Polar Regions

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Even though some still debate whether the observed climate change is man made or not, no one is debating the fact that the climate is warming. Further this change is much stronger in the Polar Regions, and these regions are keys to understanding the processes causing this change and the consequences for our planet. One of the major problems for polar researchers is the scarcity of data. For an area much larger than Europe there are only a handful of permanent research stations. The Polar Regions are mapped by a number of different satellite sensors, but these data also have their limitations both in spatial and temporal resolution and in the kind of measurements that can be done. Hence, use of airborne measurements yield a perfect bridge between the continuous point measurements of research stations and wide area satellite measurements. Operating manned airplanes in these environments are both extremely costly and in many instances very dangerous due to the nature of the data needed (low altitude, bad weather). This has severely limited the use of aircraft in polar research in the past.

Image taken from UAS on the Antarctic Plateau January 5th, 2009. The image shows the catapult launcher and one of the band wagons used to drive from the South Pole to the Norwegian Troll Station in East Antartica.

The first measurement campaigns using unmanned aircraft systems (UAS) in the Arctic were performed by Aerosonde in 1999 out of Barrow, Alaska, in connection with research on arctic cloud and climate interactions. On the European side of the Arctic the first climate and weather research UAS campaigns took place in connection with the International Polar Year from March 2007 to March 2009 (IPY). In Spitsbergen two different UA systems were used in 2008.

The SUMO (Small Unmanned Meteorological Observer) operated by the University of Bergen was used to obtain vertical profiles of winds, temperature and humidity from ground level to 4500 feet elevation. This campaign took place east of the Svalbard archipelago, operated from the Norwegian Coast Guard icebreaker KV Svalbard. The SUMO is a small electrical UAS weighing a bare 500g and with 25 minutes endurance, so basically this is a powered radio sonde system.

Norut performed four UAS campaigns in connection with the IPY in 2008, all using Norut's CryoWing UA system. Three campaigns were based on Svalbard and one on the Antarctic Plateau. During the Thorpex campaign, the missions were to gather meteorological data over the ocean west of Spitsbergen to study the conditions under which Polar Low Storms are created. Norut

As we are preparing for launch, a Basler pays us a visit with spare parts for the traced vehicles. Otherwise visiting aircraft are rare in this region.

based its operation out of Longyearbyen, which proved to be difficult. Longyearbyen airport turns out to be a very busy, and we could not fly when there were other aircraft within the Longyear TMA as part of the segregation of airspace requirements set by the Norwegian CAA for the operation.
During the next Svalbard campaign, which was part of the IPY project Glacidyn, the UAS was flown over glaciers to map the glacier terminus and measure surface elevation using a laser distance meter and differential GPS. By repeating these measurements annually for a large number of glaciers, we can determine whether the glaciers grow or shrink and assess how the climate impacts the behavior of glaciers in different regions. This campaign was based out of Ny-Ålesund at 79º degrees North. This turns out to be a very good place to operate UAS, as there are scheduled flights only two days per week and there is 24 hours of daylight from April 22th through August 20th. In August last year, we returned to Ny-Ålesund to measure sea-surface temperatures and meteorological parameters. This campaign was funded by the Japanese Agency for Marine-Earth Science and Technology. During a three-week period we performed 15 flights, where the longest was a 300 km flight across the Fram Strait.

Operating in the Arctic and Antarctic poses challenges, the equipment need to work at a chilly -40 ^{o}C,, and so must the pilot! Logistics are challenging, and getting supplies of tools or spare

SUMO aircraft used by University of Bergen

UAS image of the Research Station in Ny-Ålesund at 79ºN, 12ºE

Successful emergency landing on Kongsvegen Glacier 25 km from Ny-Ålesund after an engine failure. The emergency landing was fully autonomous.

parts is usually not trivial. Communications infra-structure is poor and geostationary communication satellites cannot be used, which leaves us with the Iridium system. Iridium has very good coverage close to the poles, but also has poor bandwidth, and is somewhat unstable, so users should expect the link to drop from time to time. Even in mid-summer severe icing conditions at low altitudes can be experienced. We experienced a case of severe ice build-up during the August campaign. Fortunately this did not affect the airplane much, but served as a reminder that clouds may be treacherous at freezing temperature. Evidently, icing pose a challenge when flying out of visual range with small UAS systems. The current Norut CryoWing UAS has a range of 500km, limited by the size of the fuel tank. An extended-range version is under development which will have a range of 2000 km with 10 kg payload.

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