



The flight tracks of each of the GFDex flights. Map image: Google.

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Flying into the storm

– Greenland Flow Distortion experiment

Flying 30 m above the raging sea is a special feeling. Watching the white capped waves so close and seeing the white streak where the wind rips the waves. Feeling the turbulence shake the aircraft and the stomach starting to complain.

The reason for being there was to make atmospheric measurements in the extreme situations that often occur by the coast of Greenland. During three weeks in February and March 2007 I participated in a field campaign, a part of the Greenland Flow Distortion experiment (GFDex), a UK-led international project which took place at the start of the International Polar Year.

Greenland, the largest island on Earth, is also a massive mountain.

The ice sheet stands over 2 km and extends for thousands of kilometres. This means that Greenland is a massive obstacle to the atmospheric flow and the low level air prefers to flow along and around Greenland if possible, rather than attempting to flow over the ice sheet. This results in flow distortion by Greenland with, for example, intense low level jets by the steep coast, lee cyclones forming on the leeward side of the mountain and cyclones moving northeastward

over the North Atlantic lingering a bit longer in the Iceland region than elsewhere. Greenland can also impact the airflow higher up in the atmosphere, affecting the weather downstream as far as Europe and Africa a few days later.

Strong winds under scrutiny

The strong winds around Greenland are thought to be important for the

climate system. The area that we were looking at during the GFDex, the Irminger Sea between Greenland and Iceland and the Greenland Sea north of Iceland, is thought to be a key part of the thermohaline circulation; the large scale overturning ocean circulation that is partly responsible for the temperate climate of Europe. This circulation is driven by temperature and salinity making it almost entirely horizontal. The vertical overturning happens only in a few places, restricted by a cyclonic gyre and cold, strong winds sucking heat and moisture out of the ocean. When these conditions are fulfilled, open-ocean convection can happen and dense water sinks down to the ocean bed. Such open-ocean convection has been found in the Labrador Sea, between Greenland and Canada, and in the Greenland Sea. Recently, the Irminger Sea has also been recognised as a region where these conditions may be met, with the strong low level wind jets formed due to the impact of Greenland on the atmospheric flow playing an important role.

Among the aims of the GFDex field campaign was to measure the atmosphere in these strong winds as well as sample the air-sea fluxes that are important for the climate system.

Intensive field campaign preparations

Going on a field campaign like this one is not done without preparations. For example I was a part of a group going to Iceland, where we had our field base during the flying campaign, 6 months prior to the campaign. Among the tasks was to find a suitable hotel with a conference room we could take over during the field campaign. We spoke to the civic aviation administration, introducing our plans to them and discussing possible problems and solutions. At the airport we met up with the ground handling service companies and inspected aircraft hangars we might possibly use during the field campaign.

During the following months the planning intensified. The UK Met Office, the European Centre for Medium-Range Weather Forecasts and the Icelandic Met Office tailored weather charts for us, we planned the day-to-day schedule and tried to prepare ourselves as well as possible. We also discussed which instruments we needed onboard the aircraft. As we were flying in an area with few airports - and a lot of open water - we needed the aircraft to be as light as possible so we had as long flight range as possible.

Long days on and off the ground

The group met in Iceland on 19 February 2007. It consisted of the aircraft crew and atmospheric scientists from the UK, Iceland, Norway, Canada and the US. Each day the weather forecasts for the next few days were studied and discussed. New forecasts arrived every 6 hours but those most important for the planning were available early in the morning. If it was decided to fly the day after the flight mission was planned in details with the help of one of the pilots, the objectives, the flight track and what kind of observations were needed. The days on the ground were long and filled with weather discussions and flight planning, but the days when we were flying were even longer.

We usually took off at 10:30LT with one flight taking off as early as 08:00LT. This may sound like a late start but the preparations for each flight took about 3.5 hours. This meant that at 7 o'clock the engineers started preparing the aircraft. At a similar time the scientists flying that day had a final look at the latest forecasts and satellite pictures and prepared for a pre-flight brief. The flights lasted for 4-6 hours and every flight mission ended with a debrief in the conference room around five in the afternoon. There would then be an update from the ground crew about the decisions made regarding the next

day and the eventual preparations. The discussions and planning could then last into the evening.

Good atmospheric data gained

During the three weeks in Iceland we flew twelve times sampling a mixture of high impact weather events, an easterly tip jet at the southern tip of Greenland, barrier flow parallel to the coast of Greenland, lee cyclones and a polar low north of Iceland. When mapping out the low level jet we usually flew at 18-20 thousand feet height (5-6 km). The atmosphere at the flight level was measured by the instrumented aircraft, e.g. wind speed and direction, temperature, humidity and ozone concentration. At regular intervals dropsondes were launched. A dropsonde is the falling equivalent of a radiosonde making a vertical profile of the atmosphere. However, instead of being attached to a balloon it has a parachute and is dropped from an aircraft. The measurements are transmitted back to the aircraft for onward satellite transmission into the Global Telecommunication System (GTS). Measuring the impact of these strong winds on the ocean below meant flying at about 100 feet (~30 m) above the ocean to make measurements of fluxes of momentum, heat and moisture from the ocean to the atmosphere. At such low levels in strong winds you were in for a bumpy ride!

The field campaign was successful and we left Iceland with loads of atmospheric data. Since then we have been working hard analysing the data and looking at the cases in details. The field campaign was hard work, early mornings, late evening and long days but it was also a fantastic experience working in a group with the main goal of every day making the best possible measurements of the extreme weather.

Further information:

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