

## Danish Ice Core Research 1952-1982

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**Biography:** This summer I will finish my master's in physics and history of science. I have a bachelor degree in physics, where I specialized in the field of climate physics. My bachelor project was a partly theoretical and partly experimental study of solar influence on climate. In the field of history of science I am mostly interested in the history of astronomy, physics and the geosciences. My master's project focuses on the geosciences in Denmark in the second half of the 20<sup>th</sup> century.

My master's project deals with the development of Danish ice core research from the early 1950's until 1982, when the second deep core – and the first with Danish participation – was retrieved. I study ice core research as an example of a research project in the field of climate science, through which I wish to identify some of the social, political and scientific factors that have influenced the development of ice core research in particular and climate research in general. The theoretical basis for ice core research was constructed in the early 1950's by the Danish physicist Willi Dansgaard, who is the central character of my study.

Dansgaard had a degree in physics and had been employed at the Meteorological Institute for a short period, but in 1950 he returned to the Biophysical Laboratory, where he had received his degree three years earlier. Dansgaard was employed to introduce the method of mass spectroscopy to the physiological and medical sciences, but for different reasons he ended up studying the isotopic composition of rainwater instead. The early 1950's, when Dansgaard conducted these studies, was generally a flourishing period for the geosciences. The support of and interest in the geosciences – and especially in quantitative studies of the geophysical system – at this time is probably part of the reason why Dansgaard was allowed to follow this line of study.



Figure 1. Willi Dansgaard (b. 1922). This photo is from the late 1990's when Dansgaard received the American Tyler Prize and the Swedish Craaford Prize for his achievements.

In 1954 Dansgaard published the results of his research[1]. He had studied water samples from most parts of the world, and analysed their isotopic composition. By measuring the relative content of  $^{18}\text{O}$  and  $^{16}\text{O}$ , he could show that there was a connection between the relative amount of the heavy isotope  $^{18}\text{O}$  in precipitation and the mean temperature in the area of collection. This meant that measures of the isotopic composition of precipitation could be used as an indicator of temperature and thereby of climate. Dansgaard also realised that if you could find and analyse ancient rainwater it would be possible to reconstruct the temperature variations of the past. He pointed out that ancient rainwater is exactly what is present in the Greenland ice cap, and therefore a study of the layers in the ice would reveal the changes in temperature several

hundred or several thousand years back in time. Although Dansgaard was in no position to realise such an expedition to the Greenland ice cap, he none the less wrote that “[a]n investigation will be undertaken as soon as an opportunity offers”. This sentence was to become almost prophetic in relation to his work during the following four decades: In the late 1960’s the opportunity offered itself, as the American military drilled through the ice sheet in northern Greenland and Dansgaard got the chance to do the isotopic analysis on the core. This analysis as well as the ones done on cores extracted in the following decades has revolutionised our understanding of climate changes and made one of the most significant contributions to our current knowledge of climate.

Part of my study on the development of ice core research focuses on the conditions for the geophysical sciences in Denmark in the 1950’s, when the techniques and ideas of ice core research were first developed. Internationally the scientific environment in the post-war years was very advantageous for the geosciences. In Denmark some specific political circumstances helped the development and institutionalisation of the geosciences even further. In this paper I will discuss the scientific and political development that led to the establishment of a professorship in theoretical meteorology at the University of Copenhagen.

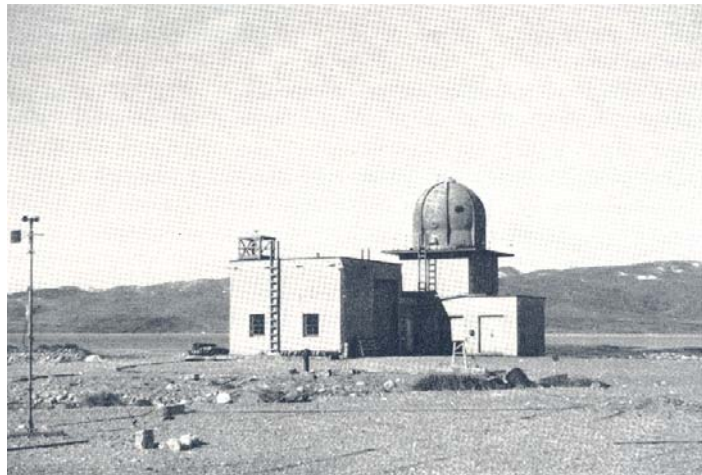
In most European countries meteorological institutions were established during the nineteenth century[2]. To a large extent the institutionalisation of meteorology was due to a military need for precise weather forecasts, and this was also reflected in the practical character of the meteorological work done at the institutions. In Denmark the Meteorological Institute was founded in 1872 under the Naval Ministry and with no relations to the University, which underlines the fact that the function of the Institute was concentrated on the practice of weather forecasting. It was not until the 1920’s that a scientific meteorology was founded by the Norwegian meteorologist Vilhelm Bjerknes. This scientific meteorology spread to other countries, but in Denmark the directors of the Meteorological Institute during the 1920’s and 1930’s were reluctant to incorporate the new methods in the forecasting process, so during this period Denmark fell behind its Nordic neighbours in the field of scientific meteorology[3]. The situation didn’t change until after the Second World War when political and military interests induced a new development within the field.

When the German occupation of Denmark began on April 9<sup>th</sup> 1940 the connections to Denmark’s northern colony, Greenland, was cut off. Because Greenland had great strategic significance in a war situation as an air bridge between North America and Europe, the US government began negotiations with the Danish ambassador in Washington, Henrik Kauffmann, on the establishment of American military bases on Greenland. In April 1941 Kauffmann entered an agreement with the US that allowed American bases in Greenland, without the Danish government’s knowledge. When these bases were established they included meteorological stations. In the agreement between Kauffmann and the American government it was said that “[t]his agreement shall remain in force until it is agreed that the present dangers to the peace and security of the American Continent have passed”[4]. When the Danish government, which cooperated with the German occupiers, learnt of the Greenland Agreement, Kauffmann was proclaimed a traitor, since the agreement was in direct opposition to German interests. However, when the war ended Kauffmann was greeted as a hero in Denmark and the Danish government ratified the Greenland Agreement at their first meeting after the war. Yet, now that the war had ended, Denmark wished to redemonstrate its sovereignty over Greenland, and the government wanted to start negotiations on the American retreat from Greenland.

However, as the Cold War succeeded the hot, the strategic importance of Greenland seemed to increase rather than decrease. It was believed that a potential nuclear war between

the two superpowers, the US and the Soviet Union, would become a polar war, as the route crossing the polar sea marked the shortest distance between the capitals of the two countries. Therefore it was of utmost importance to the Americans to preserve the military bases in Greenland. The agreement from 1941 had been so vaguely formulated, that Denmark could not demand the retreat of the American military personnel in Greenland. Instead a diplomatic game began in which the meteorological stations in Greenland would play a significant role.

Figure 2. The meteorological station at the base in Narssarssuaq in South Greenland.



Almost immediately after the war, Danish personnel was placed on the meteorological stations in Greenland, and from a Danish point of view this was seen as the first step towards a complete take over of the American bases[5]. By the end of 1946 all meteorological service in Greenland

had been taken over by Denmark, but it was not long before the Danish service was heavily criticised by the Americans. In a letter to the Danish foreign minister Henrik Kauffmann, who had been reinstated as Denmark's ambassador in Washington, wrote that the Americans had expressed dissatisfaction with the Danish personnel, which they found to be of "poor quality". To a certain extent this critique was probably justified, as Denmark had no formal education for meteorologists, which meant that the people at the stations were not well prepared for the job. However the vague formulation of the critique indicates that the US had other reasons for criticising the Danish meteorological service in Greenland. After the Second World War civil aviation had expanded drastically, and the meteorological observations from Greenland were crucial for the transatlantic flights. By indicating that Denmark was not able to conduct a satisfying meteorological service, the US could argue for continued American presence in Greenland.

In line with this critique the Americans also pointed out that Denmark had not shown much interest in scientific meteorology before, a fact which was reflected in the lack of proper education for Danish meteorologists. Therefore American presence in Greenland would guarantee professional competence in the conduction of the meteorological service. In reaction to this critique it was decided to establish a professorship in meteorology at the University of Copenhagen to ensure the professional standard of the Danish meteorological service.

The professorship was announced in early 1949 and one of the applicants was the highly esteemed Norwegian meteorologist Sverre Petterssen, who had directed the meteorological services for the allies during the war. Contrary to some of the other applicants Petterssen was decidedly practical, and he had very little experience with the mathematical meteorology of Vilhelm Bjerknes. Since the 1930's some of the younger employees at the Meteorological Institute had pleaded for an introduction of the Norwegian theoretical meteorology. With the establishment of the professorship they saw an opportunity for fulfilling their wish. However, the political role of the professorship overshadowed the professional wish for a professor with theoretical skills, and Petterssen was chosen because of his international reputation.

If Petterssen had actually obtained the position it would probably have meant that the introduction of scientific meteorology to Danish meteorologists would have been delayed

even more. But as events would have it, Petterssen never took on the professorship. Just after he was assigned to the position the Korean War broke out and he received a better offer to work for the American military.

By the end of 1950 the professorship was advertised again, but before a professor was elected, a new agreement on the American bases in Greenland was made. As a consequence of the new political situation after the war and the establishment of NATO, the US was given wide authority to conduct military activities in Greenland. This meant that the political situation that was the original motivation for the establishment of a professorship had changed, which meant that the professorship no longer had a political function. This may be the reason why a candidate who in most respects was the direct opposite of Petterssen was elected. The choice fell on the young Norwegian meteorologist Ragnar Fjørtoft who was a great mathematical talent and well trained in the Norwegian school of scientific meteorology. Moreover he had been one of the pioneers working with John von Neumann in Princeton on the construction of the first numerical weather models[6].

Although working meteorologists had expressed a desire to introduce scientific meteorology in Denmark since the 1930's, it was – as we have seen – not until the 1950's when the political situation in Greenland required a modernisation of the meteorology education that it was finally introduced. The fact that Ragnar Fjørtoft and not Sverre Petterssen became the first professor had great influence on future research in meteorology in Denmark. Because Fjørtoft was a talented theoretician and because of his pioneering position in the field of meteorology a school of theoretical meteorology was established in Copenhagen. Though Fjørtoft didn't stay long in Copenhagen – he became director of the Norwegian Meteorological Institute in 1955 – the relations with him remained close, and the research and education in theoretical meteorology continued.

The history of the institutionalisation of scientific meteorology in Denmark illustrates how important the political situation can be for the development of science. In Denmark many meteorologists had wanted an introduction of scientific meteorology for several years, but it was not until there was a political need for a professional education in meteorology that the professorship was established. This development also took place in a period of general support for the geosciences and during the 1950's professorships in oceanography and geophysics was established at Copenhagen University. It was in this environment that Willi Dansgaard conducted his studies of rain water and founded a research programme that would give revolutionising new insight to the mechanisms of climate change.

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