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A Multi-Disciplinary Arctic Research Facility: From the Koldewey – Rabot – Corbel – Stations to the AWI-IPEV Research Base on Spitsbergen

by Roland Neuber[1]

Abstract: The German-French AWI-IPEV Arctic Research Base is located in the settlement Ny-Ålesund on the west coast of Spitsbergen (79 °N, 12 °E). This facility is operated jointly by the German and French polar research institutes, the Alfred Wegener Institute (AWI) and the Institut Polaire Français Paul Emile Victor (IPEV). It serves as a modern multi-disciplinary observatory and field base for atmospheric sciences, geosciences, and biological sciences. AWI-IPEV-Base is part of the Ny-Ålesund International Arctic Research and Monitoring Facility, which comprises installations from 15 research institutions from 10 nations. This short paper sketches the development of the German Koldewey Station, which was merged with the French Rabot Station and Corbel Station to form the AWIPEV-Base and describes the facilities of today, before the upcoming International Polar Year (IPY) 2007-2008.

Zusammenfassung: Die deutsch-französische AWI-IPEV Arktis-Forschungsbasis („AWIPEV-Basis") liegt in der Siedlung Ny-Ålesund an der Westküste von Spitzbergen (79 °N, 12 °O). Diese Einrichtung wird gemeinsam vom deutschen Alfred-Wegener-Institut (AWI) und dem französischen Institut Polaire Français Paul Emile Victor (IPEV, Brest) betrieben. Sie dient gleichzeitig als modernes multidisziplinäres Observatorium und als Basis für Feldarbeiten der Atmosphären-, Geo- und Bio-Wissenschaften. Die AWI-IPEV-Basis ist Teil der internationalen Forschungssiedlung Ny-Ålesund, in der Einrichtungen von 15 Forschungsinstitutionen aus zehn Nationen betrieben werden. Diese Mitteilung zeichnet kurz die Entwicklung der deutschen Koldewey-Station nach, die mit den französischen Stationen Rabot und Corbel in der "AWIPEV-Basis" zusammengeführt wurde, und beschreibt die heutigen Einrichtungen, wie sie für das kommende Internationale Polarjahr (IPY) 2007-2008 bereit stehen.

INTRODUCTION

The small Norwegian settlement Ny-Ålesund is located at 78°55'N, 11°56'E on the shore of the Kings Fjord (Kongsfjord) on the north-west coast of Spitsbergen, the main island of the Svalbard archipelago (Fig. 1). Due to the warm West Spitsbergen current the mouth of Kongsfjord and the adjacent Krossfjord is free of ice most of the year, which makes them easily navigable. The Kongsfjord is one of the most beautiful fjords of the archipelago, surrounded by mountains and limited by glaciers, soft shore lines as well as steep bird cliffs. The Broegger-Peninsula, which forms the southern shore, where Ny-Ålesund is located, is a geologically rich area and features various different habitats from tundra and grasslands to dry rocky areas and richly structured periglacial areas where glaciers have recently retreated dramatically.

As early as 1912 the first scientific over-wintering station was established here. Kurt Wegener, brother of Alfred Wegener and also a meteorologist established a small meteorological observatory at the mouth of Kross- and Kongsfjord, which was operative until the outbreak of the First World War in 1914. Ny-Ålesund was established as a coal mining town close by around the same time, but began regular operation in 1917. As the northernmost well equipped settlement of several hundred people, Ny-Ålesund soon became attractive for polar researchers, who tried to reach the North Pole. Most famous are Amundsen and Nobile, who used airships, which were stationed in Ny-Ålesund in 1926 ad 1928. Scientific activities after World War II began, when during the International Geophysical Year a French and a German station were set up east of Ny-Ålesund to observe the glaciers of the Kongsfjord, mainly the Kings Glacier (Kongsbreen) and Lovenbreen. Coal mining stopped in Ny-Ålesund in 1963, after deadly accidents in the mines. Slowly the settlement developed into the international research facility of today. A big satellite receiving station of ESRO (predecessor of today's ESA) was the first big installation in 1966, and Norwegian installations followed, namely the establishment of a station by the Norwegian Polar Institute in 1968. With the end of the Cold War in the late 1980s, many nations became interested in Arctic research again. Until today institutions from 10 nations have established themselves in Ny-Ålesund, but only three of them are operative all year round. One of them, the German Koldewey Station, named after Carl Koldewey, captain of the first

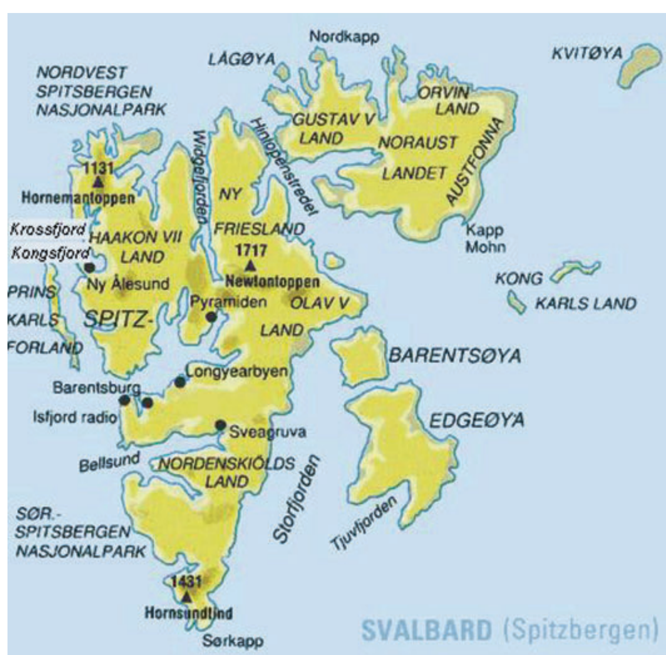

Fig. 1: Map of the Svalbard archipelago with Spitsbergen as the main island.

Abb. 1: Karte des Spitzbergen-Archipels mit Spitzbergen als größter Insel.

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Fig. 2: Science settlement Ny-Ålesund as seen from Zeppelin-Mountain, view towards the north. Photo: T. Wilhelm 2005.

Abb. 2: Das "Wissenschaftler-Dorf" Ny-Ålesund, gesehen vom Zeppelin-Berg Richtung Norden, Foto T: Wilhelm, 2005.

German Arctic research expedition in 1868, was officially opened in 1991. The French Rabot Station, which opened in 2001, is named after Charles Rabot, who conducted a series of French expeditions to the Arctic at the end of the 19th century.

Today Ny-Ålesund (Fig. 2) is a small modern village with a rich history. It is easily accessible from Europe with daily flights between Norway and Longyearbyen, the capital of Spitsbergen, and at least twice weekly commuter flights between Longyearbyen and Ny-Ålesund. The harbour is accessible for ships with moderate ice class from May to December and tourist ships visit the Kongsfjord regularly during the summer months. The settlement has access to high speed broadband internet and hosts a number of "high tech" installations, like satellite receiving antennas, a radio telescope, advanced meteorological and atmospheric instrumentations and one of the most modern marine biology research laboratories.

Ny-Ålesund is owned by the former coal mining company Kings Bay AS, which is completely owned by the Norwegian state. Kings Bay AS has transformed into a modern service provider with advanced facilities and an almost luxurious canteen and service centre. All services are for visiting scientists; tourism plays only a marginal role. Visitors from cruise ships are welcome; they can dwell in a small museum and a shop, but no facilities are provided for tourists to stay in Ny-Ålesund.

THE KOLDEWEY STATION

The west coast of Spitsbergen had been investigated and mapped by several research groups from various German universities (e.g. Blümel 1992, Piepjohn & Thiedig 1997) during the 1970s, 1980s, and 1990s. In 1988 the German Alfred Wegener Institute for Polar and Marine Research was invited by the Norwegian Polar Institute to perform atmospheric observations in Ny-Ålesund. The northernmost measurements of the Arctic ozone layer began, using a modern ozone lidar instrument and balloon borne sondes to monitor the vertical distribution of the ozone content. With rapidly increasing interest in Arctic research in general and in ozone research in particular, it was quickly decided to establish a permanent research station to serve as a platform for German scientists and to facilitate the regular observation of atmospheric parameters (Fig. 3). In fall of the year 1990 the Koldewey Station became operative; regular observations of meteorological parameters began in spring 1991 and the official inauguration of the station took place on 10 August 1991. The meteorological observations included the daily launch of balloon borne meteorological sondes and weekly ozone sondes. The observational programme was soon extended to cover meteorological and climatological parameters, as well as atmospheric trace constituents important for ozone chemistry. Particular focus was laid to utilize most modern instruments, which allowed measuring the vertical distribution of trace gases and aerosols. The high quality of the data together with the determination to perform long-term observations granted the station the status as a primary station of the Network for the Detection of Stratospheric Change (NDSC) already in 1992. In addition to the regular observational programme, the Koldewey Station was immediately used as a base for campaigns. With support from the German Ministry of Education and Research (BMBF) and the European Commission several ozone research campaigns took place.

Since the beginning, the Koldewey Station was continuously expanded and modified to provide optimal facilities for the

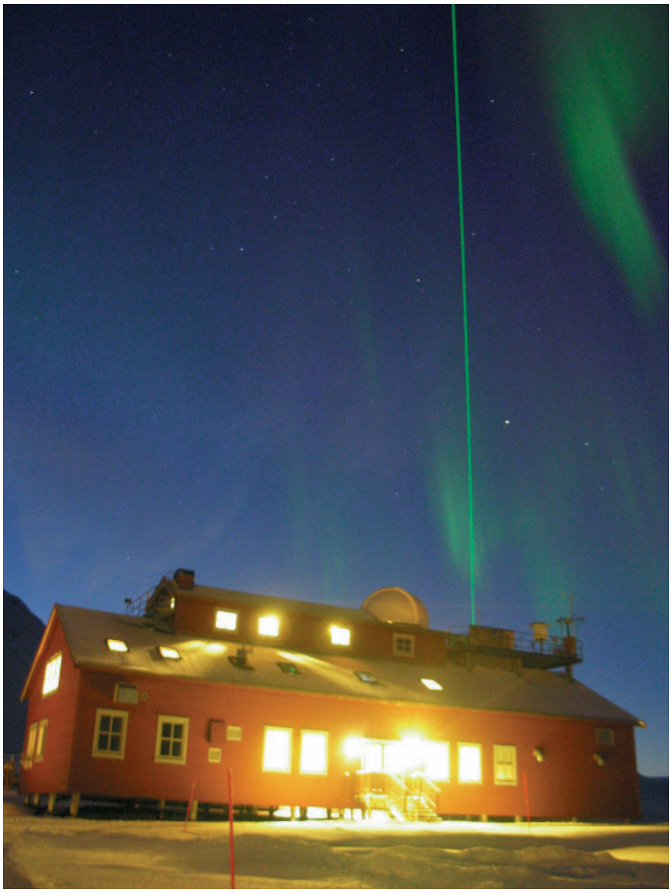

Fig. 3: The atmospheric observatory during the polar night. With the green laser beam the altitude distribution of aerosols and Polar Stratospheric Clouds (PSCs) are determined. Photo: R. Neuber, 2003.

Abb. 3: Das Atmosphären-Observatorium in der Polarnacht. Der grüne Laserstrahl dient zur Bestimmung der Höhenverteilung von Aerosolen und stratosphärischen Wolken (PSCs). Foto R. Neuber, 2003.

researchers. A small chemistry lab and a biological laboratory were installed, the later close to the harbour with access to running sea water and a facility with several holding tanks. This first marine biology laboratory in Ny-Ålesund (called Nansen Laboratory) was organised together with the Norwegian Polar Institute and installed in a former power plant. In 1995 a dedicated laboratory building for atmospheric research was put into service, which allowed the re-installation of the NDSC instruments from small containers into a modern laboratory. In 1999 this was extended by a balloon launching facility (Fig. 4), which considerably eased the daily launch of weather balloons as well as the launching of dedicated scientific balloons, which have been used since winter 1991 to probe *in situ* the ozone and aerosol content of the stratosphere. The latest addition to the research facilities is the participation of AWI in the International Arctic Marine Laboratory, which was opened in June 2005.

The long-term, regular observations and the dedicated campaign activity revealed the enormous interannual variability of the Arctic ozone content above Spitsbergen. Meteorology in the stratosphere and its dependence on tropospheric processes determines the conditions for chemical ozone loss anew in every winter/spring season. The measurements recorded that ozone loss occurred always, and only, when temperatures fall below a threshold value of about -80 °C in the midstratosphere (Rex et al. 2000). At those cold temperatures polar stratospheric clouds (PSCs) can exist, which occur in various formations (Massoli et al. 2006). On their surfaces heterogeneous reactions free ozone destroying radicals from their reservoir species, which destroy ozone when becoming sun lit (Notholt et al. 1995). With the regular PSC-observations from the observatory at the Koldewey-Station, performed with a light radar (lidar) and balloon borne sondes, their features in the core of the stratospheric polar vortex were revealed (Müller et al. 2001, Biele et al. 2001, Beyerle et al. 2001).

The observations in Ny-Ålesund constitute the northernmost sources in a thin network of Arctic observatories. Their analysis provided an empirical quantification of the relation between winter-spring loss of Arctic ozone and changes in stratospheric climate (Rex et al. 2004). The observations show that about 15 Dobson Units (DU, a measure of the total column of ozone, 300 DU is a typical column density) additional loss of column ozone can be expected per degree Celsius cooling of the Arctic lower stratosphere. Severe Arctic ozone loss during the past decade occurred as a result of the combined effect of this long-term climate change and the anthropogenic increase in stratospheric halogens (Rex et al. 2002).

Observations of the trace constituents which take part in the ozone chemistry have been performed with spectrometers working in the Infrared (Notholt & Schrems 1995) and in the UV / visible spectral range (Wittrock et al. 2004). Several instrumental developments were achieved, for example the utilization of moon light for spectral absorption measurements, which are necessary for observations during the polar night (Becker & Notholt 2000, Notholt & Lehmann 2003). These developments allowed for the determination of annual cycles, as well as inter-annual variabilities (Notholt et al. 1997, Rinsland et al. 2003). As the atmospheric observations are part of the NDSC, they have been quality checked by different on-site intercomparison campaigns (Walsh et al. 1997, Steinbrecht et al. 1999, Wohltmann et al. 2000).

Motivated by the concern about increased UV radiation due to possibly reduced ozone content of the atmosphere, marine biologists worked every year in the Kongsfjord since 1991.

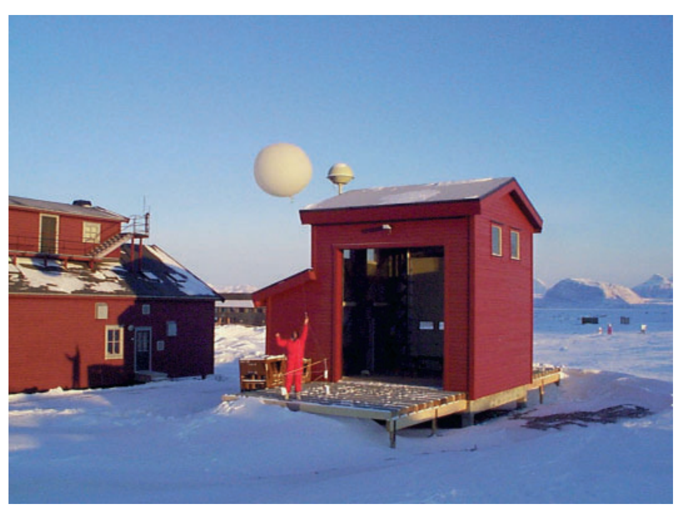

Fig. 4: Launch of an ozone sonde from the balloon house. Photo: R. Neuber.

Abb. 4: Start einer Ozonsonde vom Ballonhaus aus. Foto: R. Neuber.

The investigations focused immediately on the effects of UV radiation on the biota and their possible shielding mechanisms. The investigations centred on macro-algae in the Kongsfjord (Fig. 5), which appear there in large underwater "forests" (BISCHOF et al. 2002). Their physiology and its dependence on the physical conditions of the environment was and still is a main topic. Their susceptibility to UV-radiation and related ozone depletion stems from the fact that they reproduce during late winter and spring, the time when ozone depletion can peak (HANELT et al. 2001). The research about macro-algae was soon extended to include also other plants and animals, which are associated to these kelp forests (see WIENCKE 2004).

With various disciplines hosted at the Koldewey Station and within the very open international community in Ny-Ålesund, interdisciplinary projects are more often the rule than the exception. A particularly outstanding example is the investigation into the Kongsfjord ecosystem, which is ongoing since several years in Ny-Ålesund (HOP et al. 2002, SVENDSEN et al. 2002, WIENCKE 2004). At its core is the investigation of the effects of climate change on marine biota, with one particular focus on the increase of UV radiation and possible mitigation strategies of marine fauna and flora (AGUILERA et al. 2002). The combination of the comprehensive atmospheric investigations at Koldewey Station and the very detailed biochemical research performed in the Nansen Laboratory and the new Arctic Marine Laboratory constitute a cornerstone of the research activities at Koldewey-Station.

Fig. 5: Scientific divers ((M. Schwanitz, U. Kunz, and S. Spahic) on the ice of Kongsfjord, May 2005. They are preparing for in situ observations and a dive to collect algae samples for laboratory investigations of their UV resistance. Photo: A. Hormes.

Abb. 5: Wissenschaftliche Taucher (M. Schwanitz, U. Kunz und S. Spahic) auf dem Meereis des Königsfjords, Mai 2005, bei der Vorbereitung eines Tauchgangs zur in situ Beobachtung von Algen und Beprobung für Laborversuche zur UV-Verträglichkeit. Foto: A. Hormes.

Long-term geoscintific investigations deal with the permafrost soil at the Broegger-Peninsula. A high temporal resolution soil and climate monitoring station was set up in 1998 close to Ny-Ålesund. The seasonal thermal and hydraulic dynamics of the active layer at a catchment of the Bayelva river was documented for several consecutive years and the energy balance of the seasonal snow cover was modelled (BOIKE et al. 2003a). The balance yields two distinct types of snow ablation, winter and spring ablation. Energy transferred by sensible heat and rain input reduces the snow cover during the winter, creating internal ice lenses and basal ice. These ice layers can block winter grazing, thus have fatal consequences for the Svalbard caribou herd. The comparison of snow ablation at three circumpolar sites on Svalbard, in Siberia, and in Alaska showed significant differences due to local and regional climate effects (BOIKE et al. 2003b).

One climatically important factor of the Arctic atmosphere is the aerosol content. Unexpectedly, the Arctic troposphere is influenced by anthropogenic emissions from more southerly latitudes, particularly in spring, when tropospheric transport occurs towards high latitudes. The absorption and scattering of sun-light and of the earth's infrared emission can increase the temperature in the lower troposphere (RINKE et al. 2004). Long-term monitoring of the aerosol content is performed with photometers which record the total aerosol optical density (HERBER et al. 2002), and with a light radar (aerosol lidar), which determines the vertical distribution (SCHUMACHER et al. 2001). In order to cover the horizontally inhomogeneous distribution of the aerosol content, dedicated aircraft campaigns have been performed in recent years (ASTAR 2000 and 2004, SvalEx 2005, see YAMANOUCHI et al. 2005, TREFFEISEN et al. 2005). The ground based observations from Ny-Ålesund are an integral part of these campaigns.

THE FRENCH – GERMAN ARCTIC RESEARCH BASE – AWIPEV-BASE

In the first years of the new century, the research activities at the French and German stations in Ny-Ålesund had been highly complementary. At Koldewey Station atmospheric physics and marine biology were the main topics, utilizing the observatory and laboratories, while at Rabot Station field work for terrestrial biology and atmospheric chemistry had the highest attention. While the AWI station was operated all year round, Rabot Station had only summer activities. In spring 2003 AWI and IPEV agreed on merging the stations with the goal to boost joint French – German research activities. Commemorating the 40th Anniversary of the French-German friendship-contract, an agreement was signed in Brest onboard of RV *Polarstern* by the directors of both – AWI and IPEV institutions – and the joint French-German Arctic Research Base was formed, almost immediately nicknamed AWIPEV-Base.

Practical matters on site were soon organized and a joint management of projects and guests was installed, as well as a new, common web appearance (www.ipev.fr/awipev). In March 2005 the first French-German scientific workshop for research in Svalbard was conducted in Strasbourg at the headquarters of the European Science Foundation (ESF). During the workshop ten joint French-German research proposals were sketched and out of these already four projects are running during 2006, namely in marine biology and the geosciences. The biological projects will investigate the biological responses to climate change, in particular effects of changing energetic supplies in form of lipid contents to higher trophic levels in the food chain of the Kongsfjord ecosystem. One focus will be laid on the over-wintering of zoo plankton species and their particular ability to store energy in large amounts of unusual lipids, which help to overwinter with long periods of scarce food supply (GRAEVE et al. 2002). Beautiful winged snails will be one of the investigated life forms. One important target of the geosciences projects will be the Loven Glacier (Lovenbreen) close to Corbel Station. The water and sediment flows from the glacier to the Kongsfjord will be measured as well as their further distribution in the fjord system.

Fig. 6: The Blue House, main station building of AWIPEVV-Base, where the office of the AWIPEV-Base leader, as well as several offices and four sleeping rooms for guests are located. Photo: AWI.

Abb. 6: Das Blaue Haus, Hauptgebäu der AWIPEV-Basis. Es beherbergt das Büro des Leiters der AWIPEV-Basis, mehrere Büros und vier Schlafräume für Gastwissenschaftler. Foto: AWI.

FACILITIES AT THE AWIPEV-BASE

The AWIPEV Research Base in Ny-Ålesund is run by three over-wintering personnel, namely the scientific station leader and two engineers. They maintain the facilities at the base, perform the continuous measurements and support the visiting scientists and their projects on site. At the AWIPEV-Base up to 17 guests can be accommodated in the Blue House (Fig. 6) and the Rabot Station (Fig. 7). They find living quarters, offices, workshops and laboratories, broadband internet access and a range of vehicles for transportation needs. At Corbel Station (Fig. 8), which is located 6 km to the east of Ny-Ålesund, additional seven to nine persons can stay and work, although under field conditions. The laboratories of the base in Ny-Ålesund include various dry labs, wet labs, a small chemical laboratory and an atmospheric observatory with a balloon launching facility. The laboratories are suited to host research projects in the fields of marine and terrestrial biology, geosciences, glaciology, atmospheric physics and chemistry, and related fields. A major recent addition is the participation in the International Marine Laboratory in Ny-Ålesund, which is a state-of-the-art, large laboratory for the marine sciences, with running seawater supplies at different temperatures, cold labs, wet labs, and an array of different holding tanks for marine samples. The Marine Laboratory is owned and operated by Kings Bay AS (Fig. 9).

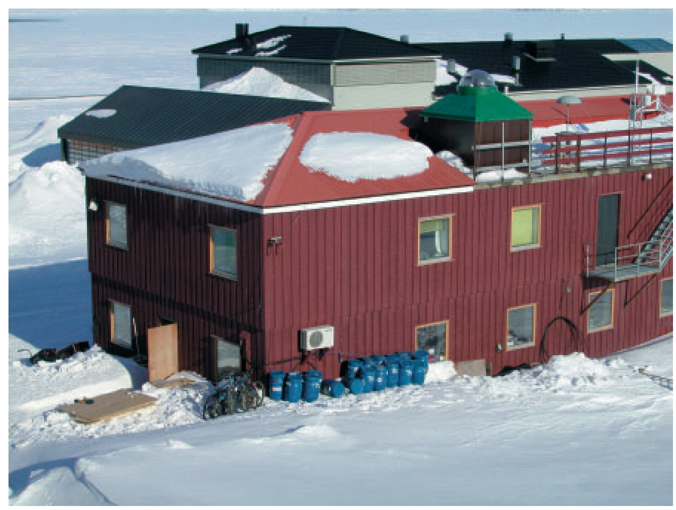

Fig. 7: Rabot Station of AWIPEV. It contains sleeping rooms, wet and dry labs, and a workshop for the preparation of field work and for repairs. Photo IPEV.

Abb. 7: Rabot-Station als Teil von AWIPEV; hier sind zusätzlich zum Blauen Haus weitere Schlafräume, sowie verschiedene Nass- und Trockenlabors untergebracht. Hier steht auch eine Werkstatt für Reparaturen und zur Vorbereitung von Feldarbeiten zur Verfügung. Foto IPEV.

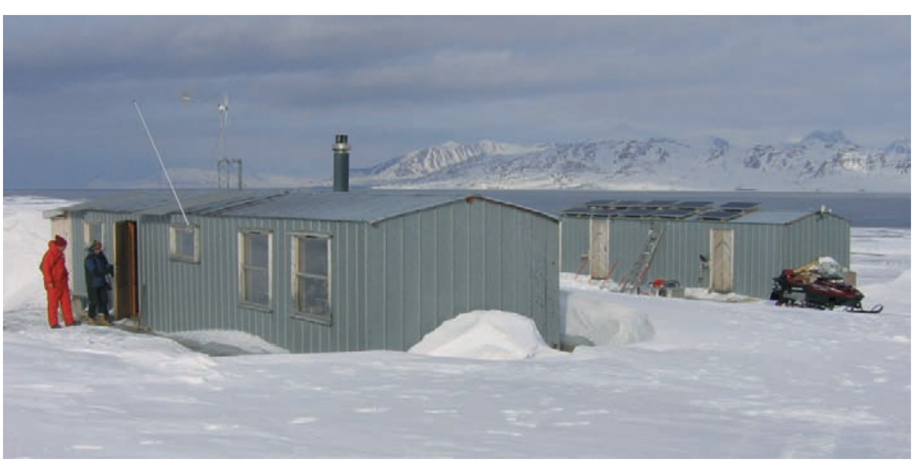

Fig. 8: Corbel Station of AWIPEV, ca. 6 km east of Ny-Ålesund. It will be further developed to a clean-air laboratory with an environmental friendly power supply. Photo: B. Saier 2005.

Abb. 8: Corbel-Station als Teil von AWIPEV, ca. 6 km östlich von Ny-Ålesund. Sie wird wieder zu einer Reinluft-Station mit umweltfreundlicher Energieversorgung ausgebaut. Foto: B. Saier 2005.

Fig. 9: The new Arctic Marine Laboratory of Kings Bay AS on the shore in Ny-Ålesund. Photo: M. Schwanitz.

Abb. 9: Das neue arktische marin-biologische Labor der Kings Bay AS am Strand in Ny-Ålesund. Foto: M. Schwanitz.

ACCESS TO THE AWIPEV-BASE

Information about the joint French-German Arctic Research Base AWIPEV and its various facilities (Fig. 10) is provided via a dedicated web portal at www.ipev.fr/awipev. Scientists, who want to use the base need to submit a proposal either to IPEV (Institut Polaire Français Paul Emile Victor) or to AWI (Alfred Wegener Institute). An advisory board assesses the proposals and distributes the available resources. In Ny-Ålesund all infrastructures and services are provided by Kings Bay AS, which is organized in a way like a big hotel complex. All meals are provided in a central mess. Transportation services via the harbour and the air field are organized by Kings Bay AS, including the sale of tickets for the commuter plane between Ny-Ålesund and the main airport in Longyearbyen. Funding possibilities for scientific projects are mainly provided by national sources (e.g. through IPEV), but additional funding is possible from the European Union.

Fig. 10: The scientific settlement of Ny-Ålesund and overview of AWIPEV-Base facilities. "Vaskeriet" houses the chemical laboratory, "Rabot" and "Blue House" are the station buildings containing offices and dry laboratories. The "Observatory" contains the atmospheric measurement systems, and "Nansen Lab" and "Marine Lab" house the biological experiments. "Champ" denotes a satellite receiving antenna at the Ny-Ålesund airfield. Photo: J. Kube.

Abb. 10: Übersicht des „Wissenschaftler-Dorfs" und Forschungs-Einrichtungen der AWIPEV-Basis. Das Gebäude "Vaskeriet" enthält das chemische Labor, „Rabot" und „Blue House" sind die Stationsgebäude mit Büros und Trockenlabors. Im „Observatory" sind die Atmosphären-Messsysteme untergebracht und im „Nansen-Lab." und „Marine Lab." die biologischen Experimente. "Champ" bezeichnet eine Satellitenantenne am Flugfeld von Ny-Ålesund. Foto: J. Kube.

The AWIPEV-Base is open to researchers from France and Germany and to teams co-operating with French or German research institutions. Applications are welcome from all disciplines for projects which rely on the specific high latitude location.

For further information and how your research interests can be supported by the AWIPEV-Base please refer to the web site at http://www.ipev.fr/awipev and address your inquiries to awipev@awi-potsdam.de or to the author.

ACKNOWLEDGMENTS

The great success of the Koldewey Station and the AWIPEV-Base would not be possible without the dedicated work of the over-wintering personnel, which keeps the station alive and living conditions favourable. Kings Bay AS is an excellent host for an international community and maintains Ny-Ålesund at high standards, irrespective of the location so far up in the North. The German and the French Ministries of Education and Research, as well as the European Commission have provided the funds to establish the stations and to conduct particular research campaigns.

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