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A Short History of the Sodankylä Geophysical Observatory

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Abstract

The first geophysical observatory at Sodankylä was the Polar Year observatory in years 1882-84. The Finnish Academy of Science and Letters, established in 1908, set up the Sodankylä Geophysical Observatory in 1913 as a geomagnetic observatory. Its activities increased before and during the Second Polar Year 1932-33, but then the observatory was destroyed because of war in autumn 1944. The rebuilt observatory started on January 1, 1946. During IGY (1957-58) the ionospheric station was started, as well as the seismological station. During the time 1961-71 there was an active period of construction. In 1973-92 an astronomical station (polar variation telescope) was run; this activity had been the original goal of the donation, which led to the establishing of the observatory. After 1970 the activities of the observatory have enhanced remarkably. In 1977 a receiving station of the EISCAT radar association was located at Sodankylä. A network of field stations is run, mainly in Northern Finland. In 1997 the observatory joined to the University of Oulu.

Sodankylä Geophysical Observatory (SGO) is situated near the southern edge of the Auroral Zone (Lat. 67°22'N, 26°38'E), 5 km south of the Sodankylä village on the left (eastern) bank of the Kitinen river.

Northern Scandinavia is sometimes called a 'natural geophysical laboratory' because of its unparalleled geographic, climatic and geophysical location. For more than one hundred years, there has been remarkable scientific expedition activity both on the mainland and in the Arctic Ocean.

Key words: Geophysical observatory, Polar Years

Early expeditions

The 19th century was a period of intensive explorations. Large parts of the world were as yet unknown to western countries, including the Arctic regions. Expeditions were sent to the Arctic Ocean, e.g. A.E. Nordenskiöld to the Spitsbergen Islands (1864, 1868, and 1872-73) and through the Northeast Passage (1978-79). An Austrian expedition, lead by Lieutn. K. Weyprecht, discovered Franz Josef Land (1873), but encounted severe troubles when returning. This voyage was the starting point of an initiative by Weyprecht: at least some of the troublesome and dangerous expeditions could be replaced by permanent or temporary fixed stations around the Arctic (and Antarctic) zone. After several years of negotiations, this initiative led to an international cooperative effort, later known as the First Polar Year. The purpose of this cooperation was to collect and analyze meteorological, geophysical - geomagnetic, auroral etc. - and other environmental data.

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Polar Year observatory (1882-84)

After thorough deliberations, and with remarkable support from the Main Physical Observatory in St. Petersburg, and its director H. Wild, it was possible, for the Finnish Society of Sciences and Letters (FSSL) to decide to participate in the Polar Year activities, establishing a magnetic and meteorological observatory in Finnish Lapland. The Sodankylä village was chosen as the site of the station. The leader of the expedition was Dr. Selim Lemström, professor in Physics at Helsinki University. The observer-in-charge was Mr. Ernst Biese (later the director of the Finnish Meteorological Institute, FMI). Lemström was personally interested in auroral physics, and he looked forward to testing his own hypothesis of auroras; according to this hypothesis the auroras are a near-earth electrical phenomenon. For this purpose he established special observing points on nearby hills. One of them was located in Kultala, some 100 km north of the observatory. Here, on nearby Pietarlauttasoaivi hills, auroras were to be produced artificially. He was sure that the light phenomena seen were real and supported his theory. Anyway, his observations were not quite convincing, and not in accordance with modern understanding.

Regular magnetic observations were started 21st August 1882, and continued to the end of the Polar Year, 31st August 1883. Later on, to the end of August 1884, only weekly magnetic observations were made, with some temporary additional measurements. In addition to magnetic measurements, electric earth currents were recorded at Sodankylä as well as at Kultala.

Meteorological observations at Sodankylä continued regularly through the two years of activities.

Thus, the temporary observatory was rather well equipped. Working at the station was demanding. No automatic recording devices for magnetic recording were available. Visual readings had to be made every hour, during special periods more often. Station crew's memoirs tell of great enthusiasm, diligence and high working moral.

Results of observations, made both at Sodankylä and at Kultala station, were published in three massive volumes.

Foundation of the new observatory

The First Polar Year showed that continuous observations in the arctic regions were needed for understanding the nature of geomagnetic and auroral phenomena. Professor J.J. Nervander had founded a magnetic observatory in Helsinki 1838, and regular observation were made from 1844. Its location in the heart of the growing city became problematic, especially when the electrical tramway was established in 1901. Measurements were continued until year 1912.

At the Imperial Academy of Science of St. Petersburg was proposed in the spring 1893, that a magnetic survey had to be carried out in the Empire. The FMI was asked to participate in the program. Biese, at that time the director of FMI, proposed that

absolute measurements should be made at ca. 300 sites in all parts of the country during four years, and that for comparison a temporary magnetic observatory had to operate at Sodankylä. Anyway, the FSSL, which at that time cared for FMI, was not able to make definitive decisions, and Biese's proposal failed.

In 1908 the Imperial Academy made a new proposal to the FMI to participate in the magnetic survey in Russia. In the same time the Carnegie-Institute in USA had started a global magnetic survey. In January 1909 the director of FMI, professor G. Melander, presented a proposal to the Physical Observatory at St. Petersburg, that a new meteorological observatory should preferentially be established in Lapland, because Pawlowsk and Helsinki were situated on same latitude. Hitherto only rare and rather sporadic observations were available in auroral regions. This proposal met very positive response abroad. It was planned that FMI be the manager of the new observatory.

After many deliberations, a somewhat unorthodox solution was found. In 1908 a new scientific society, the Finnish Academy of Sciences and Letters (FASL), was founded. Professor E. Bonsdorff, mathematician and astronomer, made a remarkable donation, in order to built an observatory in Lappland. His original goal was an astronomical (or geodetic) observatory, and his initiative was supported by some other individual donators. He was particularly interested in the Earth's polar variations. Anyway, he agreed to establish a magnetic observatory instead.

A special board prepared a detailed proposal, and two years later the Finnish Senate allocated a large area in Sodankylä for the proposed station. After thorough investigations, made by Dr. J. Keränen, a suitable place for the institute was found, and in December 1913 the observatory was ready to start in the New Year's Night, with Keränen as director and observer. He then headed the observatory until 1917; but later he was active in the Observatory Board almost to his death in 1979, at the age of 96 years. - As a curiosity it can be mentioned that he was born during the First Polar Year in 1883! Likewise, Lemström was born in 1838, the establishing year of the FSSL and FMI.

From the beginning, there was also a normal weather station. For the local people the best known part of the observatory was just the activity of weather station!

The first fifteen years

Sodankylä was the first permanent magnetic observatory inside the Arctic Circle. In the first year of operation the First World War broke out, which of course resulted in many troubles. Anyway, all necessary measurements and recordings could be performed. Only during the Finnish Independence war in 1918 there was an interruption of four months. Until the late 20ies, the Observatory remained a simple measuring and recording station. For a one-man scientist team, 1000 km from the country's capital, university and colleagues, there could not be much inspiration for

high-level science. Anyway, carefully edited year-books were published regularly, and as evaluated afterwards, results are reliable.

Second Polar Year (1932-33) and the Thirties

In the late 20'ies, the situation changed, Sodankylä moved close to the scientific world. A new geophysical challenge was coming, the Second Polar Year. Initiated by the Norwegian auroral scientist, professor Carl Störmer, auroral photography using Störmer's special camera was started here in 1927. In order to measure parallactically the auroral arch's altitude and geographical position, the photographing was mostly performed from two stations simultaneously. This cooperation was the beginning of direct international contacts. Participating in the Second Polar Year and its elaboration raised the scientific work to a higher level. Perhaps the most important early contacts were those with professor D. LaCour of the Danish Meteorological Institute (DMI). DMI was preparing new stations on Greenland for the coming Second Polar Year (1932-33) and LaCour had developed sets of new, light-weight, easy-operated and reliable observatory- and field instruments. Sodankylä was chosen as a testing station, because of its position as the northern-most observatory in Europe. At that time the transportations and travels to Greenland were difficult, scarce and tedious. The testing of instruments led to fruitful research cooperation using the new instruments. New "quick-run"-recorders, which were part of the new instrumentation, allowed studies of higher-frequency magnetic phenomena, pulsations.

Several new measurements were added to the program of the Sodankylä observatory, e.g. recording of earth currents, and attempts to observe rapid magnetic field variations using large induction coils. An active spirit was dominating. Not only was purely observational activity high; also several scientific papers on magnetic activity, rapid magnetic variations etc., were published. Remarkable are E. Sucksdorff's papers on magnetic micropulsations (1936), simultaneously with L. Harang from Norway, on practising the new instruments with D. LaCour from Denmark, and on geomagnetic activity measured using a new activity index AZ developed by himself (a doctoral thesis, 1942).

In addition to magnetic and auroral observations, the observatory was responsible for a standard meteorological station. Already since 1922 daily upper atmosphere wind (pilot)-observations were made. During the Polar Year their number was doubled. For measuring of atmospheric electricity a new device was built.

During the Second Polar Year there was a temporary magnetic station at Petsamo, at that time Finnish territory. Results from Petsamo station were published in the Sodankylä Year book series.

Wartime, destruction and rebuilding

The winter war in 1939-40 did not interrupt activities, and neither did the breaking of new hostilities in 1941. The importance of the weather station increased appreciably. Until the break of the Finnish-German conflict in September 1944 the observatory stayed practically unaffected by military operations. Now it was necessary to evacuate the observatory, together with the evacuation of people. Practically all instruments, library etc. were left; only the most important archives could be moved to South Finland. This took place on the 15th of September 1944. During their retreat to the North, the German troops destroyed the observatory, all buildings with movables. The observatory was burnt probably on the 19th of October.

Immediately after returning to Sodankylä, the FASL and the Observatory Board initiated the planning of rebuilding. The task was not easy. Practically all Lappland had been destroyed and had to be rebuilt. The Academy had very limited financial means. Anyway, in May 1945 the first building was ready - sauna, of course - and then instrument buildings and, finally, a small house for the staff. The operations of the weather station could start in June, and on January 1, 1946 the magnetic recordings were running again.

The first post-war years were not easy. Expansion of activities was not possible. Most important was to maintain the existing facilities and try to keep the measurements uninterrupted and their reliability at a reasonable level.

In due time, the circumstances were normalized, and in 1949 the first phase of a new development started. A new residence- and office house was ready in May 1950. As a sign of the new phase in the history of the observatory an international meeting was organized on the 1st of September for the purpose of making intercomparisons between magnetic instruments from several Scandinavian observatories.

In the preceding year the FMI had established a new aerological observatory in the vicinity of the magnetic station, and it took over all the meteorological work. The planning of a meteorological and aerological station had been under consideration since the 30'ies. Because of the war it had not been possible to realize the plans earlier. Now it was possible to start a proper aerological, radiosounding station. For the magnetic observatory the meteorological observations had been an additional task, most important one of course.

The development of the magnetic observatory continued in 1953, when the old recording instruments were substituted by three new sets, in order to quarantee the continuity of recordings also during intensive disturbances, and to facilitate studies of short-period magnetic disturbances.

International Geophysical Year IGY (1957-58)

The third Polar Year, now renamed International Geophysical Year (IGY), was planned to years 1957-58, 75 years after the First Polar Year, and 25 years after the

Second one. This hitherto largest international scientific effort imposed a great challenge to all participating countries and institutions, also to the Sodankylä geophysical observatory. The scope of electromagnetic geophysics had grown remarkably since the Second Polar Year. The active role of the uppermost atmosphere, the ionosphere, in geophysical phenomena had been discovered. Solar-terrestrial relationships proved to be interesting and important. No wonder the auroral zone came into focus. Auroral photography using automatized all-sky cameras became a necessary research method in polar and subpolar regions. Sodankylä joined the Scandinavian network in early spring 1957.

By far the most important investment in Sodankylä was the building of a new ionospheric sounding station. In order to make oblique ionospheric soundings between middle and auroral latitudes the Max-Planck-Institut (MPI) für Aeronomie, Katlenburg-Lindau, Germany chose Sodankylä as a temporary auxiliary station in the auroral zone. In August 1957 regular measurements could be started between Germany and the temporary facilities at the Sodankylä observatory.

At the beginning the station was run by German scientists and technicians from MPI, but the Finnish staff was very soon able to take over the task. In addition to the oblique soundings between Sodankylä and Lindau, normal vertical soundings were performed. Thus it was possible to study the interesting region between the auroral zone and the middle latitudes. At times, oblique incidence soundings between Sodankylä and another MPI station at Tsumed (Namibia) were performed. Very soon it turned out that it was possible and even desirable to continue the station's activity after IGY because of its favourable geographical location in the auroral zone, where the ionospheric and magnetospheric processes meet. The FASL and the Finnish officials were able to take over also the economical responsibility for the ionospheric station. The MPI delivered the instrumentation to the observatory and helped technically also after the change of ownership. In 1962 a new station was built, and two years later an office- and living quarters were added. This establishing of the ionospheric station was a most important step in the development of the observatory.

Another extension of the activity was the start of a small seismological station. For several reasons there was interest in seismological observations as well. It was known that in Northern Finland there sometimes occur small earthquakes, and a seismological recording station was needed to determine their location and type, as well as to detect distant seismic events. The first vertical seismograph was installed 1956. Later on, a complete set of seismographs was run at the Pittiövaara auxiliary station. The seismological station has worked as a part of the national seismological network of the University of Helsinki. A special task of the Sodankylä seismological station has been to collect and summarize macro-observations of local earthquakes.

After IGY

An important extension of activities was the installation of a few riometers from Lindau in 1963 to complete the ionospheric studies. In later years it has been possible to built an extended network of riometer stations in Finland. The study of the lower ionosphere, using riometers, proved to be a very fruitful addition to the ionospheric research program. Using riometers it is possible to study especially the lowest (D- and also C-regions), which are not easily reached with other methods. A network of several riometers has been built in Northern Finland, with some observing sites also in Norway. These investigations have also led to theoretical work, concerning especially the atmospheric chemistry. In connection with the EISCAT radar these studies have turned to be fruitful.

The original German ionosond could operate until year 1976. Then it was replaced with a new Finnish construction, which was principally designed in the observatory. Since, the rapid development of electronic and radar technique has made necessary to modernize all equipments of the observatory. This concerns the ionospheric instrumentation (ionosonds, riometers etc.), as well as magnetic measurements. Earlier photographic analogical recording have been replaced by digital electronic devices. Part of the new instruments have been constructed in the own workshop, especially when suitable commercial instruments have not been available at reasonable prices.

The years 1961-71 were a period of active construction. In 1962 and 1964 new buildings for the ionospheric station were constructed, and in 1968 a new building with living facilities, library, archives, etc. was completed. Finally, in 1971 housing for six families, a laboratory building, and an auxiliary station at Pittiövaara, 9 km NW of the observatory, were built. Thus the observatory had obtained satisfactory working conditions.

The Pittiövaara station has proved to be an important part of the observatory facilities, because many measurements need quiet environment, free both of mechanical and electrical disturbances. Seismometers, riometers, all-sky-cameras, and some other special measurements are run at this auxiliary station. Also visiting scientists can use the Pittiövaara station as their hold.

A very important part of the observatory work has been the maintaining of an expensive network of observing and recording station in Northern Finland, in many cases in cooperation with other institutions. The most important of them are the FMI, especially its geophysical research, and the University of Oulu. Part of stations have been temporary, being in operation only a few years; part of them are more permanent. The riometer network is an own permanent effort. The all-sky camera sites of FMI are technically maintained by the observatory staff, as well as the magnetic recording chains (IMAGE etc.). Temporary, expedition-like campaigns have been performed both independently and in cooperation with other institutions.

Astronomical work

Originally, the goal of Bonsdorff's donation was to establish an astronomical observatory. Even though the observatory finally became a geophysical one, the original purpose was never forgotten. Several proposals to built an astronomical station were made, e.g. 1919. In 1944 already a grant was given for that purpose, together with rebuilding. At that time it could not be realized, however. In 1964, a new proposal was made; and now a zenith telescope was built, as was originally proposed by Bonsdorff. The measurements of polar variations could begin in 1972 using a zenith telescope constructed by Academician Y. Väisälä. It was functioning about 20 years; thereafter satellite-born method have deplaced the classical ones.

Why to measure polar variations, i.e. the tiny changes in position of the rotation axis pole? It is an interesting theoretical problem; and at the high latitude of Sodankylä makes it possible to compare measurements from lower latitudes and to study possible latitude effects.

During IGY a temporary small radioastronomical receiver was run, in order to observe the scintillation of a radio star (cas A). Later on, some preliminary observations of quasars have been made using the EISCAT receiving equipment.

EISCAT

A very important decision was made, when Finland joined the European Incoherent Scatter Radar Association (EISCAT) in 1975, together with France, Germany, and Great Britain, and the Scandinavian countries Norway and Sweden. The importance of this step is at least comparable with the establishing of the ionospheric station some twenty years earlier. This international community runs a radar complex, with a transmitter (in Tromsø, Norway) and three receiving stations (Tromsø, Kiruna in Sweden, and Sodankylä). The original plan was to start the measurements already in 1977. In reality the system was ready to operate only in 1981.

1992 an important extension of the EISCAT system was realized, when an additional station was constructed at Longyearbyen, Spitsbergen Island, and Japan joined the organization.

Formally the Sodankylä EISCAT station operated independently of the observatory, as a tenant. In practice, the new tenant worked in close cooperation with other part of the observatory. The formal independence made the administration simpler, since EISCAT Headquarters was responsible for both economy and operations.

The operations of EISCAT radars were fully computerized from beginning. Also the observatory could utilize the EISCAT-computer. In 1977 and -78 the first own small desk computers were taken into use. The first proper general purpose computer could be purchased in 1983. At the time it was inevitable to thoroughly justify to the financing officials the necessity of such an expensive device. Only a few years later it was self-evident that computers, with e-mail and internet connections, are principal and necessary tools of all laboratories.

Fig. 1. Main building of Sodankylä Geophysical Observatory 1913-1944.

Fig. 2. Sodankylä EISCAT site.

Towards the Nineties: Affiliation to the University of Oulu

It became ever more evident that the economic basis of the observatory was insufficient to guarantee a sound development. The FASL had only very poor financial resources. The state could not afford proper financing for a formally private enterprise. The only way to secure the future development and the scientific quality of the observatory seemed to be an affiliation to a more powerful scientific, publicly financed unit. Practically only two choices existed; the Finnish Meteorological Institute, which has a prominent division of geophysics, and an aeronomical observatory in the vicinity of the geophysical observatory; with and the University of Oulu and its existing versatile and high-class physical and geophysical research. The observatory owns long and fruitful cooperation relations with both institutions. The final solution was to join the observatory to the University of Oulu, and the new organisation has been effective from the 1st of August 1997.

The new organisation was fulfilled, when the existing geophysical observatory of the University of Oulu, consisting of cosmic radiation receiving station in Oulu, seismological station and Oulujärvi magnetic station was joined to the organisation of the Sodankylä Geophysical Observatory as of the 1st of January, 1998.

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