6. The First International Polar Year (1882-83):

A big science experiment with small science equipment

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Introduction

At the end of the German-French war (1870-71), the German Empire consolidated all single big and small German states under its emperor Wilhelm I (1797-1888). Germany became one of the European great powers. Economy, trade and traffic were expanding. This time of stabilisation was very favourable for further institutionalisation of meteorology in Europe.[1] Economical interests demanded a well organised weather forecast, as meteorologists themselves had reached a new stage to develop their discipline towards a synoptic method.

Meteorology

On the occasion of a Meeting of the Association of German Naturalists and Physicians at Leipzig in 1872, an international meeting of meteorologists was held at the same place (14-16 August 1872) to prepare a Congress at Vienna in the following year. Meteorologists were searching for possibilities of international exchange of new ideas, instruments, methods of observations, and results. They were also looking for a network of observatories. "If there be any branch of science in which work on a uniform system can be especially useful and advantageous, that branch is the inquiry into laws of weather, which, from its very nature, can only be prosecuted with a hope of success by means of very extensive observations embracing large areas, in fact, we might almost say, extending over the whole surface of the globe".[2]

The results of the first International Meteorological Congress at Vienna (2-16 September 1873) was very promising. Delegates from different governments and important meteorologists had been invited. The most important discussions related to

standardising methods of observations and analysis, use of the same units of measure and of a single set of symbols, to publication and exchange of results, and to the completion and extension of the existing network.[3] Meteorologists had already understood that the weather in high latitudes held the key to the behaviour of the atmosphere on wide scales.[4] In this context a recommendation was made concerning "the institution of meteorological stations in the north polar regions*, the meteorological conditions of which are as yet either very slightly or not at all known, and in the first place at Spitsbergen".[5] After some discussions "and in high southern latitudes" was added as footnote to the protocol after the asterisk * by Georg Neumayer (1826-1909).[6] Obviously the need of meteorological observatories in polar regions was acknowledged by all participants.

When the Permanent Committee of the first International Meteorological Congress met under the presidency of Christopherus Buys-Ballot (1817-1890) at London on 21.4.1876, distant stations were one of the topics. The discussions were based upon a proposal coming from Carl Weyprecht (1838-1881) to establish observatories in the Arctic for securing simultaneous meteorological and magnetic measurements for at least one year.[7] The Committee was convinced "that such observations would be of the greatest value for the progress of both sciences". It recommended to all countries to take part in such an enterprise and directed attention to a regular distributed network of stations at the following locations: Spitsbergen, Point Barrow (Alaska), Alten in Finmark, Boothia Felix (Canada), The mouth of the Lena (Siberia), New Siberia (Russian Arctic Ocean), Upernavik (West Greenland), Pendulum Island (East Greenland).

Polar Research

Neumayer was pleading for south polar research since 1865. In the 1870s, he concentrated on astronomical and magnetic investigations in high southern latitudes.[8] Good opportunities were given by the transit of Venus in front of the sun to take place on 9.12.1874 and 6.12.1882. The observations were needed to calculate the astronomical unit. Neumayer favoured the Kerguelen Islands (1874) and South Georgia (1882) as locations for German expeditions which would be also very good starting-points for antarctic research. In a lecture on geographical problems in polar regions, held in 1874, Neumayer proposed co-ordinated similar and synchronous measurements in polar regions for a longer period.[9] Being hydrographer of the Imperial Admirality at Berlin he was involved in the preparations of the circumnavigation of the S.M. "Gazelle" (1874-76). One of its main tasks was the establishment of an astronomical observatory on the Kerguelen.[10] Here Neumayer was in charge of the first step to realise his idea of south polar research. Since 1876 he was in a more powerful position, when he became director of the German Naval Observatory at Hamburg.

In contrast to Neumayer, German Lieutenant of the Austro-Hungarian Navy Weyprecht had got polar experience leading the Austro-Hungarian Northpolar Expedition (1872-74), which discovered Franz-Josefs-Land, but lost its ship. Presenting the results of the expedition before the Geographical Society in London in 1875, Weyprecht stated: "Decisive scientific results can only be attained through a series of synchronous expeditions, whose task it would be to distribute themselves over the Arctic regions and to obtain one year's series of observations made according to the same method".[11] He elaborated his idea and on 18.9.1875, during the 48th Meeting of the Association of

German Naturalists and Physicians at Graz, Weyprecht presented six principles of arctic exploration[12]. He focussed on arctic exploration to be of the greatest importance for a knowledge of the laws of nature. It would not make sense to race for the North Pole, because detailed arctic topography was of secondary importance. The most important principle said that isolated series of observations had only a relative value. This idea was focussed in the German motto "Forschungswarten statt Forschungsfahrten".

Joint Efforts

To be more effective with his programme, Weyprecht developed his proposal for presentation during the second International Meteorological Congress planned at Rome in September 1877.[13] It included a network of stations being identical with the recommendation of the Meteorological Committee except for Boothia Felix, which he replaced by Novaya Zemlya. Following Neumayer's ideas, he also added stations on the southern hemisphere at Cape Horn, the Kerguelen or Macdonald Islands, and Auckland Islands.

Due to the Balkan War, the congress had to be postponed until April 14-22, 1879. On 22 April Weyprecht gave a talk on co-ordinated meteorological research in the Arctic during the session of the Vth commission consisting of nine delegates and Weyprecht as secretary.[14] Since three years he was planning an expedition to Novaya Zemlya to continue his meteorological, magnetic, and hydrographical measurements as well as observations of the aurora borealis. For more effective research he demanded synchronous observations at different places in high northern and southern regions. In vain he had tried to initiate similar small expeditions. Nevertheless, he wanted to start his expedition in the following year and he asked the congress whether it would care for sending out additional expeditions at the same time or for sending one expedition in 1881 to continue his own measurements for another year. If there would be a sure promise of equipment and ships before the end of September 1879, then Weyprecht would postpone his expedition for another year until 1881.

In the following discussion, Neumayer advocated for a network around Antarctica. Besides he promoted observatories on the Kerguelen and Auckland Islands, to continue the measurements of the German transit of Venus expeditions in 1874/75. Besides other meteorologists, who were also in favour of investigations in both hemispheres, Heinrich von Wild (1883-1902, director of the Central Physical Observatory at St. Petersburg), wanted to focus the programme only to arctic research. Henrik Mohn (1835-1918, director of the Royal Norwegian Meteorological Institute at Christiania, today Oslo) was absolutely persuaded "que les régions arctiques sont le siége de cyclones, qui, avec leur partie méridionale, donnent lieu très-souvent à des tempêtes très-violentes dans les pays habités du nord, tandis que les détails de leur marche et de leur extension au delà de certaines limites nous restent tout à fait inconnus".[15]

The combination of magnetic and meteorological measurements on such observatories was in question. Here some delegates had to admit that they had no instructions to vote for or against magnetic investigations. This was the crucial point, because these instructions were absolutely important in decision making. At the end of the discussions, the congress recommended to all governments to support such undertakings and decided to entrust the International Meteorological Committee with the

establishment of a special commission which should only consist of members with instructions and full power of their governments, and coming from those countries which wanted to take part at that enterprise.[16] Due to lack of time, this commission should meet already at Hamburg on 1.10.1879 to discuss details and performance. This honoured Neumayer, member of the international Committee, as the meeting should take place at the German Naval Observatory.[17] This was the final initiation of the International Polar Year, which became the first co-ordinated international meteorological experiment.[18]

International Polar Commission

The International Polar Commission was established during the meeting under the chairmanship of Neumayer at Hamburg (1-5 October 1879).[19] Austria, Denmark, France, Germany, The Netherlands, Norway, Russia, and Sweden had sent representatives. Neumayer became president of the Commission to organise the realisation of the experiment. Objectives of the first meeting were number and places of observatories, starting time, duration, and minimum number of observations, uniformity of instruments and methods, and publication. Finally a programme was prepared following Weyprecht‘s proposal. Measurements should be taken from a minimum of eight circumpolar stations for the period of one year, starting in autumn of 1881. The locations were nearly the same as proposed by the Meteorological Committee in 1876. Instead New Siberia Weyprecht’s expedition to Novaya Zemlya came in, Boothia Felix was changed to any other point in the American arctic archipelago, and Pendulum Island could be changed to Jan Mayen. Besides, stations on the southern hemisphere were recommended at South-Georgia, on the Kerguelen, Auckland or Campbell Islands, and possibly on the Balleny-Island. The aim of International Polar Year (IPY), as it was called by then, laid in the extension of synchronous meteorological investigations in the Arctic for development of weather and storm prediction in Europe and the United States.

The second International Polar Conference was arranged at Bern (7-9 August 1880), where the International Meteorological Committee was to follow at the same place under the presidency of Wild (9-12 August 1880).[20] The work of the first Conference had been a failure, because only Austria, Denmark, Norway, and Russia had agreed upon establishing observatories, so the IPY was deferred for another year and definitely fixed for autumn 1882-83. A further outcome of the meeting was Neumayer’s resignation as president of the Commission.[21] Obviously he was disappointed on the behaviour of the German Empire not willing to support even a single expedition to the Arctic.

Neumayer’s successor Wild organised the third meeting of the Polar Commission at St. Petersburg (1-8 August 1881). Unfortunately, Weyprecht could watch the development of his initiative as he had died on tuberculosis on 29 March 1881. Finally eight stations to be established be seven nations were declared to be certain: Point Barrow and Lady Franklin Bay (United States), Godthaab/West-Greenland (Denmark), Jan Mayen (Austria), Mosselbay/Spitsbergen (Sweden), Bossekop near Alten/Finmark (Norway), The Mouth of the Lena (Russia), Dickson/Siberia (The Netherlands). The occupation of stations at Fort Simpson (Canada), and in the southern hemisphere on Cape Horn (France) and South Georgia (Germany) was probable. The conference adopted the final programme. From 1 August 1882 to 31 August 1883, besides the arctic stations, meteorological stations and magnetic observatories all over the world, as well as

merchant and navy ships were invited to join the experiment with more complete magnetic measurements of term days (1st and 15th each month). The investigation of earth magnetism seemed to be very promising as a considerable amount of sun spots was expected during the IPY. Besides the observation of the transit of Venus was one of the tasks of the planned German expedition to South Georgia. Finally eleven nations established twelve stations in the arctic and two on the southern hemisphere (Figure 1).

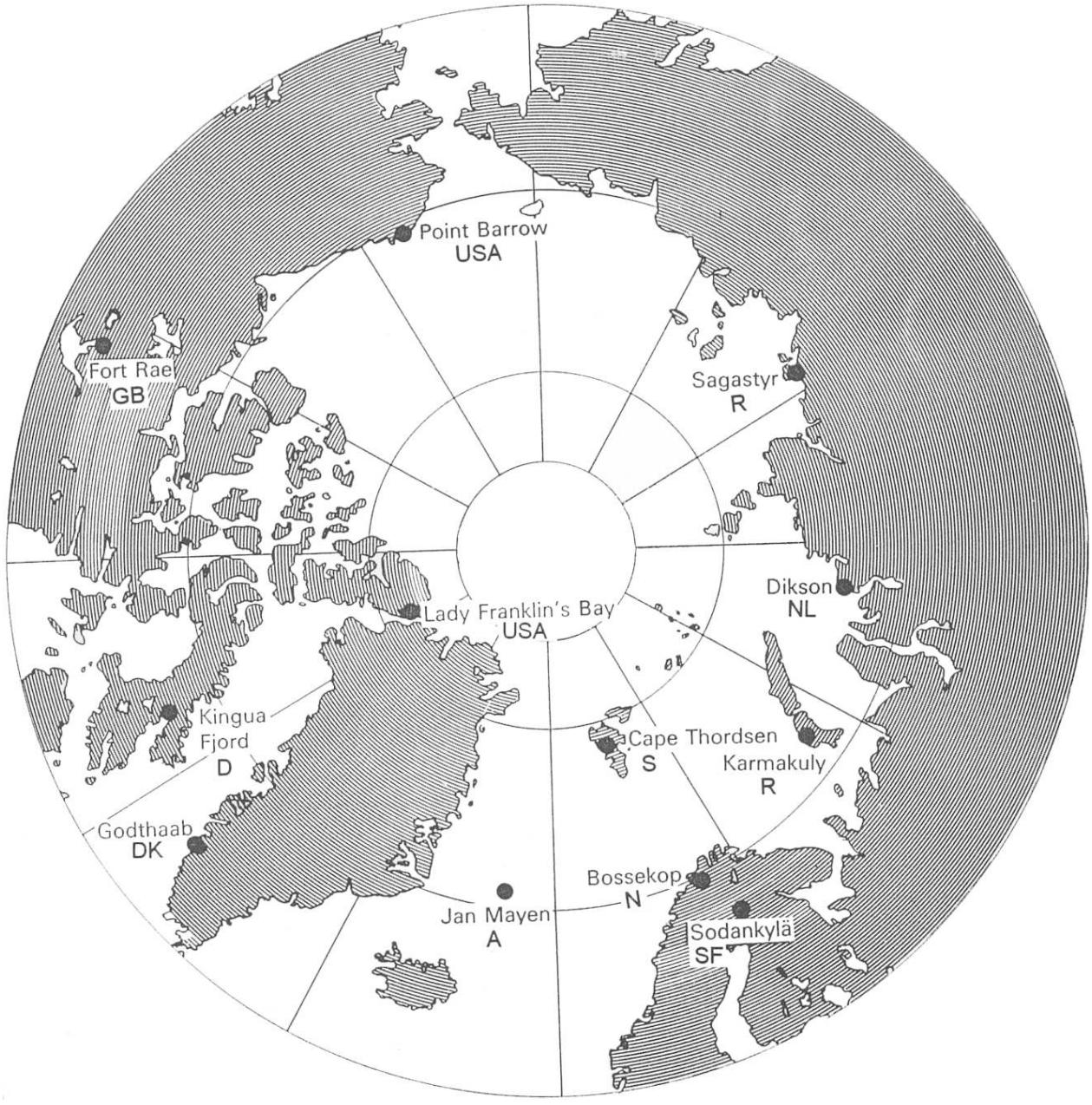

Fig. 1: Circumpolar stations in the Arctic during the first International Polar Year 1882-83.[22]

Big Science – Experiment – Internationality

Big science can be defined by a big scale of investments and operations, and the logistics of which are budget consuming and research is manpower intensive. Each participating state of the IPY was in charge of its own expedition being part of a big experiment to investigate the meteorology and earth magnetic field in high latitudes. Logistics varied from land expeditions, for example in Finland and Norway, to expensive expeditions by ship like the French one, which provided the three masted bark "Romanche" and a crew of 111 men for the duration of the whole IPY.[23] Few observatories could use already existing huts to establish their observatories like in Scandinavia. Even an existing network of missions of the German Herrenhuter Brüdergemeinde along the coastline of Labrador starting from Nain up to Rama in the north could be used for small meteorological stations.[24] Other expeditions had to carry prefabricated huts with them. The measurements were made by a civilian or military staff of small or big groups.

The co-ordination of the experiment was in hand of the International Polar Commission originating from the Meteorological Committee. The Commission divided the programme in two parts: Necessary observations consisted of hourly observations of surface elements, extreme values, weather, and sea temperatures.[25] Optional observations included the investigation of changing temperatures with height. Mostly mechanical instruments like barometer, thermometer, hygrometer, and few remote indicators of wind vane and anemometer were used. Telegraphy for time keeping was only available at Bossekop. Referring to this, the IPY used small science equipment over a large area to perform big science.

The experiment was designed to solve the problem of meteorology in the Arctic. As method for solution, fixed circumpolar stations were chosen to work for the duration of one year. This network was realised by international co-operation. Due to several postponements the period was defined by non scientific circumstances, but fortunately it fell together with a considerable sunspot activity. The measurements were synchronised by the Göttingen Standard Time, a relict from the International Geomagnetic Union initiated by Carl Friedrich Gauss (1777-1845) at Göttingen, which performed synchronous measurements during the period from 1836 to 1848. Finally, the data of the IPY were to be published on a national basis and distributed to the other participating countries.

Results

When the expeditionshad returned[26], the Polar Commission met again (17-24 April 1884).[27] Vienna was chosen as meeting place in honour of Weyprecht's earnings. The commission discussed analysis, form and deadline of publication, which was determined for December 1895.[28] In respect to the magnetic measurements they decided, which days should be classed as magnetically disturbed or undisturbed.

The fifth and final Polar Conference took place at Munich on 3 September 1891, following the 1st Conference of Directors of Meteorological Services at the same place (26 August – 2 September 1891).[29] Only a few publications on magnetic observations

from Godthaab, Sagastyr (Lena), and Sodankylä were still missing and all results from the Dutch expedition the ship of which got trapped in the ice of the Kara Sea.

Concerning the analysis of the total results of the IPY in meteorology and earth magnetism, two committees of three persons were established, with Neumayer being member of each. It was also decided that the publications of all expeditions should be archived together with the archive of the International Polar Commission at the Central Physical Observatory in St. Petersburg. Finally, when the last session had been closed, the International Polar Commission was dissolved.

As all scientists know data sets from only one year are rather limited. They only give insight in accidental conditions and can not be considered describing a mean status. Under consideration of this fact the results of the IPY gave the 1st data set describing the climate of the Arctic (Table 1).

Location (Nation)	**Longitude Latitude**	**Coldest Month**	**Warmest Month**	**Yearly Mean**	**Absolute Maximum**	**Absolute Minimum**
P. Barrow (America)	71° 17‘N 156°40‘W	-27,3 °C December	2,8 °C August	-12,9 °C	15,8 °C	-47,0 °C
Ft. Rae (America)	62° 39‘N 115°44‘W	-32,7 °C January	16,2 C° July	-6,1 °C	25,6 °C	-44,6 °C
Kinguafjord (Germany)	66° 36‘N 67° 19‘W	-35,8 °C February	7,4 °C August	-11,4 °C	19,7 °C	-48,1 °C
Ft. Conger (America)	81° 44‘N 64° 45‘W	-39,4 °C February	2,9 °C July	-19,3 °C	11,3 °C	-49,2 °C
Godthaab (Denmark)	64° 11‘N 51° 44‘W	-15,5 °C February	6,3 °C July	-3,0 °C	14,9 °C	-24,2 °C
Jan Mayen (Austria)	71° 0‘N 8° 28‘W	-10,3 °C March	3,5 °C July	-2,3 °C	9,0 °C	-30,6 °C
Bossekop (Norway)	69° 57‘N 23°15‘E	-10,7 °C December	11,6 °C July	1,5 °C	26,3 °C	-21,7 °C
Spitsbergen (Sweden)	78° 28‘N 15° 42‘E	-16,7 °C March	4,6 °C August	-6,2°C	13,6 °C	-35,5 °C
Sodankylä (Finland)	67° 27‘N 26° 34‘E	-16,7 °C December	14,9 °C June	-0,6 °C	25,2 °C	-37,7 °C
N. Zemlya (Russia)	72° 23‘N 52° 36‘E	-21,5 °C January	5,7 °C July	-6,6 °C	15,7 °C	-39,5 °C
Kara Sea (Netherland	71° 0‘N 63° 0‘E	-28,2 °C January	1,5 °C July	-11,2 °C	9,6 °C	-47,2 °C
Sagastyr/Lena (Russia)	73° 22‘N 124° 5‘E	-42,0 °C February	4,9 °C July	-17,5 °C	12,8 °C	-53,2 °C

Table 1: Temperature conditions circumpolar of the Arctic in the year 1882/83.[30]

The observations had been taken before aerological measurements were introduced, so they only give a two-dimensional view from the bottom of the atmosphere. Besides, the spacing of network had been much to wide to analyse the dynamics of polar depressions. As a result, these data were rather insufficient for weather or storm

prediction. Nevertheless, they provided a first climatology of the Arctic. Form the data synoptic charts of the North and South Atlantic were constructed in England and Germany.[31] In respect to earth magnetism, the period of the IPY was very interesting due to a rise in sunspot activity before the moderate maximum of 1883. The classification of the daily observations resulted in two very strongly disturbed days (17.11.1882 and 20.12.1882). Those data were acknowledged very much in expanding theories on earth magnetism later on.

Aftermath

The science community had always complained that no survey of the total results of the IPY had ever been provided. I only found a German PhD thesis on the distribution of temperature and pressure during the IPY presenting charts of monthly mean values for January and July.[32] Data from a total of 924 stations below 600 m were used. In the northern hemisphere it had been 799 temperature stations and 655 pressure stations, in the southern hemisphere 125 temperature stations and 74 pressure stations, and in addition 101 data points in the Atlantic Ocean for both parameters. 39 different reductions to daily mean values had to be reduced. Figure 2 shows the expansion of knowledge in the Arcitc especially concerning Davis Strait and influence of the Gulf Stream.

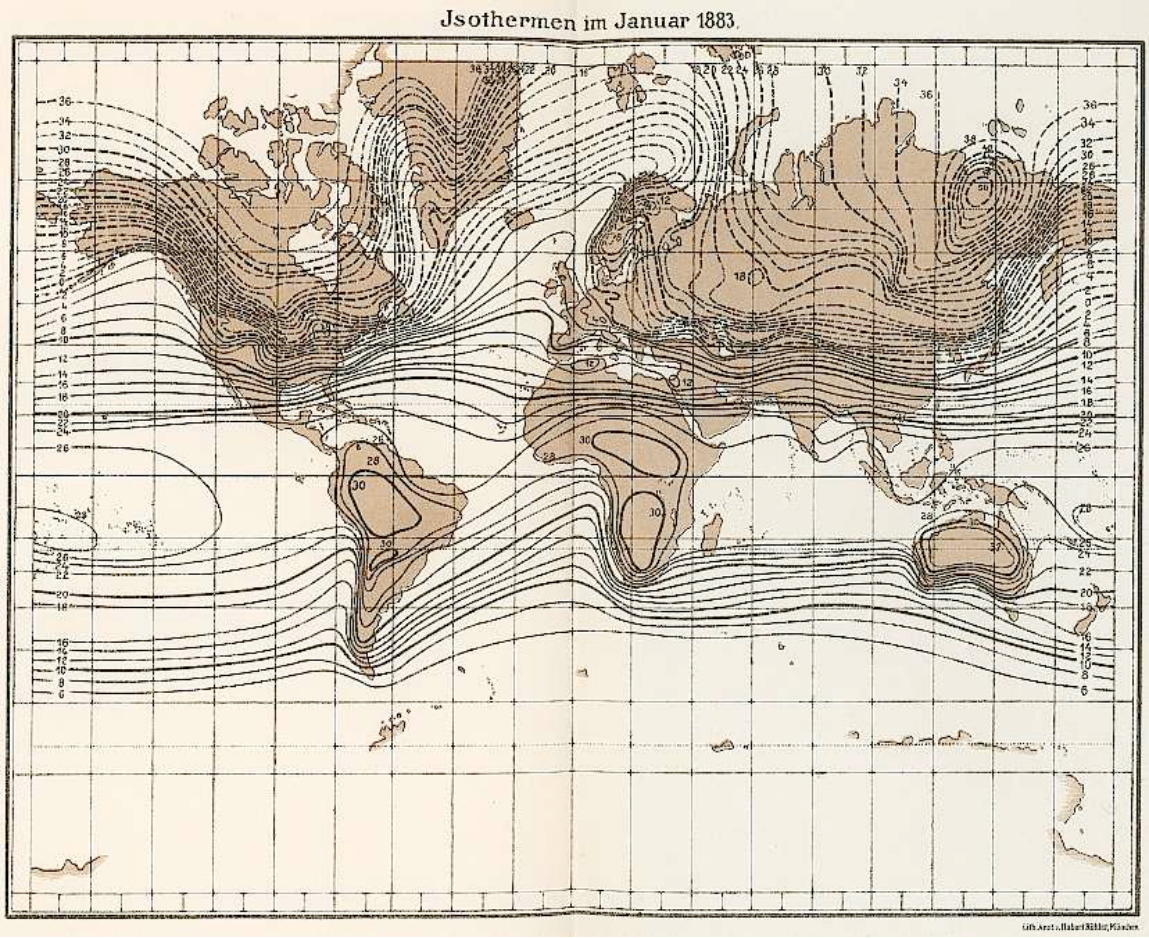

Figure 2: Isotherms for January 1883.[33]

Planning of the international airship expedition to the Russian Arctic, finally executed in 1931, the International Society for the Exploration of the Arctic Regions by Means of Aircraft (Aeroarctic), pressure data were used to construct circumpolar charts of 22 days from periods of March to June 1883 published in the memorial of 1924.[34] This shows that the measurements taken during the first big international meteorological experiment provided a valuable data set for half a century until the second International Polar Year took place in 1932-33.

Endnotes

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