WDC-MARE Reports

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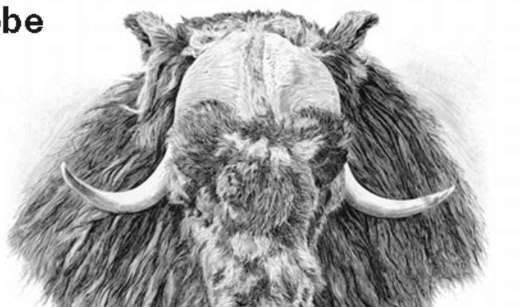
International Polar Year 1882-83

the digitized meteorological data legacy

Reinhard A. Krause, Hannes Grobe & Rainer Sieger



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International Polar Year 1882-1883

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Certainly Gentlemen, the idea of Weyprecht should be good and favourable.

It has survived the calamities of war, the discords of nations,

the obstacles of jealous people and the death of its author.

(Heinrich Wild on the opening of the third IPY Conference in St. Petersburg).

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The drawing of a musk ox head is from:

Adolphus Greely (1888)

Report on the proceedings of the United States expedition to Lady Franklin Bay, Grinnell Land,

International Polar Expedition, Washington, Government Printing Office, 545 S.

hdl:10013/epic.30055

Content

1 Introduction

The first International Polar Year (IPY) was an international effort to perform continous meteorological and geophysical observations over a time period of two years (1882-1883). Eleven nations established twelve research stations in the Arctic along with thirteen auxilary stations. Two stations were operated on the southern hemisphere (South Georgia and Tierra del Fuego). The data were published in 26 volumes on 8700+ pages of reports, descriptions, tables and graphs in total. The list of meteorological parameters includes temperature, wind, pressure, clouds, precipitation, evaporation, humidity and radiation.

In a first effort, data from the printed publications were presented in digital format at the NOAA Arctic Research Office by Kevin R. Wood and James E. Overland (National Oceanic and Atmospheric Administration). Also the images from the books were digitized and made available with additional contributions from Igor Smolyar (National Oceanographic Data Center). In 2010 daily and monthly mean data and images were available from the NOAA web site at *http://www.arctic.noaa.gov/aro/ipy-1*.

In the light of Global Change and the intensification of observations and continous measurements in both polar regions, long-time series increase in importance. The observations of the first IPY from the 19th century enable us to extend the data from the 20th century even more back into the past. In the occasion of the fourth IPY (2007-2009) WDC-MARE decided to digitize the complete set of meteorological data in full hourly resolution and publish it in its reports on DVD and make it available in Open Access via the data library PANGAEA. The report volumes were digitized using a Bookeye® Book scanner and were made full text searchable by optical character recognition (OCR). The books in pdf-format were stored in the publication repository ePIC of the Alfred Wegener Institute. ePIC provides handles as long-term stable identifiers of its content. Images were scanned in high resolution and uploaded to
Wikimedia Commons, category: *International Polar Year (1882-1883)*.

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The important contribution of France to the first IPY are observations and a station on Tierra del Fuego, published in seven volumes by L.-F. Martial et al., 1888. Data are not included in this report and will be made digitaly available in a second step.

The following chapter is an introduction to the initiation and goals of the IPY with a historical view. A more comprehensive historical perspective (in german) is published at the same time in:

Reinhard A. Krause (2010)
Daten statt Sensationen
Der Weg zur internationalen Polarforschung aus einer deutschen Perspektive
Reports on Polar and Marine Research, Bremerhaven, **609**, 163 pp
hdl:10013/epic.34343

2 Data versus headlines
- how the first International Polar Year 1882/83 was initiated

It goes without saying that the first phase of polar research is also to be seen as a part of the general history of world exploration. It is well-known that in the Middle Ages commodities were transported to Europe from India and the Far East. These transactions were often processed through Arabian middlemen. As early as the end of the 15th century, direct trading became the political and commercial objective of the European seafaring nations – this was also the motivation behind the voyages of explorers such as Christopher Columbus. Travelling to higher latitudes became a necessity because of the north to south extend of the continents. At the end of the 16th century, Dutch explorers attempted a circumnavigation of Eurasia. This marked the beginning of polar exploration.

There are two geographical visions which had a major influence on the history of world exploration. Both of these can be attributed to polar research. The first is the search for passages north of Asia and America including the localisation of a strait separating the two continents; and secondly, the quest for proof of the existence of a southern continent. This explains why polar expeditions, with a few exceptions, were always supported by ships. The peculiarities of shipping expeditions in higher latitudes demand the integration of nautical skills such as astronomy, oceanography, meteorology and geo-magnetics. Voyages of discovery to the polar regions can thus be seen as leading up to today's more abstract background for polar expeditions and research.

Great geographical discoveries, voyages leading to great geographical successes, are in themselves of a sensational nature. There is no doubt that Magellan's circumnavigation of the globe was a sensation in the eyes of his contemporaries. The same applies to the later voyages of Drake, Cook, Ross and Bougainville. As a rule, the publications resulting from successful voyages were invariably bestsellers. Educated readers of the 17th and 18th centuries were fascinated by reports from uncharted territory. Publications such as Sebastian Münster's Cosmographica (first edition 1544) were long-lasting successes in spite of their many shortcomings. However, geographical discoveries were not always given a lot of publicity in order to protect the anticipated commercial profits. Sensation for its own sake played a role in the pamphlets which were distributed by travelling peddlers. In order to increase sales, there were no limits to the use of imagination.

The newspaper as a medium accessible to all social strata does not begin to take shape until the 19th century. Thanks to the growth of major population centres as well as technological improvements such as telegraphy, printing methods and transportation, modern journalism was able to develop as from the 1850s. From then on, sensations became a marketable commodity which also required investment.

Polar research in the 18th century

Two of the most important developments in the political history of Europe in the 18th century were the emergence of Russia as a major power and the wars between Great Britain and France. Both of these factors had a major influence on polar exploration. The great Northern Expedition of 1734 to 1743 under Vitus Bering (1681-1741) is a story of legend. Even by modern standards, it was a formidable enterprise, and Breitfuß' appraisal of 1939 still holds true today. It demonstrated a feature which was not to be practised by the French and British until much later - the combination of exploration and scientific research.

The Northern Expedition, also known as the Kamchatka Expedition, had two major goals. The first, the surveying and charting of the Siberian coast, was a classical feature of polar exploration centred on verifying the existence of a Northeast Passage. In contrast with the Northwest Passage, this was never really doubted. The second aim was the geographical, natural-historical and ethnographic mapping of north-eastern Siberia. It should be noted that many aspects of these questions were dealt with by German explorers.

Strangely enough, the geographical findings of the great Northern Expedition were questioned and the resulting bickering led to the creation of the first major British polar expedition, which was conceived as an unarguably scientific voyage of discovery. This expedition set out in 1773 with the vessels Race horse and Carcasse under the command of Constantine J. Phipps (1744-1792).

It is well-known that the Phipps Expedition was not able to realise any of its demanding geographical goals. The vessels did not even get near the Central Arctic Basin. Instead they became trapped in the ice north of Spitzbergen. Phipps (aka Phips) had on board a Kendall (the famous K 2) and an Arnold chronometer (as well as an Arnold pocket watch). A navigation specialist from the Board of Longitude also took part in the expedition. It is also clear that a lot of effort was put into equipping the vessels appropriately for the special needs of the voyage.

There was a close research-based relationship between the Phipps expedition and the legendary voyages of the Resolution and the Adventure. These took place between 1772 and 1775 under the command of James Cook (1728-1779), with the German natural scientists Reinhold (1729-1798) and Georg Forster (1754-1794) on board. The plan was for the two expeditions to meet in the Pacific. It is well-known that Cook completed his circumnavigation of the Antarctic calotte without sighting land. The existence of the southern continent was thus definitively placed in the realm of fantasy. The question now was if there was any land at all in the vicinity of the Pole or if there was only an Antarctic ocean.

Towards the end of the 18th century, conflicts arose again between France and Great Britain over supremacy in Europe and around the globe. After decades of war and the reorganisation of Europe after the Congress of Vienna in 1815, Great Britain emerged as the dominant world power. However, the British were confronted with the problem of adapting their navy to the reduced demands of peacetime while at the same time maintaining an effective strike force. The man charged with solving this dilemma was Sir John Barrow (1764-1848). For 30 years, he was to become the promoter and driving force behind British voyages of scientific discovery. It is significant that he initially favoured the idea of a navigable Arctic Ocean and hoped for the discovery of a practical Northwest Passage. As a consequence, Barrow commissioned two expeditions with two ships each in 1818. John Ross (1777-1856) and Edward Parry (1790-1855) were to search for a Northwest Passage via Baffin Bay in the vessels Alexander and Isabell, while David Buchan (about 1782-1842) and John Franklin (1786-1847), in their ships Dorothea and Trent, were to go as far north as possible directly via Spitzbergen in the hope of traversing the North Pole and reaching the Bering Straits via the Arctic Basin. In actual fact, they became trapped in the ice at a latitude of 80°34'N and were forced to turn back. The Ross-Parry group were also unsuccessful.
As early as 1819, Parry was sent off once again in search of the Northwest Passage. This time he achieved legendary success in reaching beyond 112°W via Lancaster Sound and Viscount Melville Sound. After spending the winter there, he returned to England in 1820 with his two vessels, the Fury and the Hecla.

Parry also attempted to reach the North Pole: "*In April 1826, I proposed ... to attempt to reach the North Pole, by means of travelling with sledge-boats over the ice, or through any spaces of open water that might occour* (Parry 1828 S. -IX). Parry's expedition of 1827 is of key importance in the history of modern polar exploration even although he was forced to abort his drive north at a latitude of 82°45'N due to the relentless southwards drift of the ice. The deployment of sledge-boats was not only a bold departure from traditional expedition logistics; it was also a first indication of the depth of the Arctic waters. The expedition may not have found a navigable Arctic sea, but it did show that, generally speaking, the way to the Pole was not covered by a continuous blanket of ice.

A breakthrough in the South

The pioneering voyages of James Clarke Ross (1800-1862) and Francis Crozier (1796-1848) to the Antarctic between 1839-1843 also took place under the aegis of Sir John Barrow. A Russian expedition led by Fabian G. von Bellingshausen (1778-1852) and Michail Lazarev (1788-1851) had succeeded in completely circumnavigating the Antarctic in their vessels Vostock and Mirny between 1819-1821, paying close attention thereby to filling the gaps left by Cook, but there had been little to report apart from a few unconfirmed land sightings. Ross and Crozier on the other hand had pushed ahead into the interior of the Ross Sea as far as 78°S after overcoming a huge strip of drifting ice. Here they were confronted with a great barrier of ice, the Ross Ice Shelf, often rising 30 m high, and were able to report many impressive land sightings (Ross 1847). All in all, it was a major scientific sensation.

However, Ross and Crozier were not the only ones in the Antarctic at that time. French and American explorers were also active in the region. The French expedition in the Astrolabe and Zélée was under the command of J.-S.-C Dumont d'Urville (1790-1842), who had twice circumnavigated the globe, and his companion of many years C.H. Jacquinot (1796-1879). The American expedition was led more or less adequately by Charles Wilkes (1797-1877) in the Vincennes. In January of 1840, both expeditions reported land sightings several times between 100°-160° E; this represented an important enlargement of the geography of the Antarctic. The term Antarctic Continent is found for the first time on a map used by the Wilkes expedition (Headland 1989 p. 149). However, such nomenclatures remained controversial for quite some time, as will be explained below.

The question arises if this number of simultaneous expeditions was purely by chance. It can be considered a coincidence in as much as no agreements were made between the three participating nations. But at the same time there was a trend to carry out large-scale multidisciplinary research expeditions. Even although scurvy was still a problem, the quality of the ships, sailing technology, navigation techniques (the problem of determining longitude accurately had been solved by the introduction of the chronometer and lunar almanacs) and the knowledge of prevailing winds and currents, was so good that relatively safe and predictable voyages were possible, although there still remained a clear need for improved methods in the fields of meteorology and hydrography. However, this issue was being addressed more and more intensively. The entire world had been roughly mapped and scientists were becoming aware of the important gaps in their knowledge. In other words, they were now able to ask the right questions.

All three expeditions focused on biological and taxonomic subject matter. This also reflected the trend of the time. Since it was now extremely difficult to find new countries, what could be more glorious than discovering and describing a new species? The most prominent example of this type of work is the research of the botanist J. D. Hooker (1817-1911), who had enlisted at the age of 22 as assistant surgeon on the Erebus. Botanical and zoological examinations were a constant feature of both the French and the British expeditions. Wilkes had no biologists on board during his excursion into the Antarctic. He himself was competent in the physical sciences which were now becoming increasingly important.

Halley, Humboldt, Gauß and Sabine

The earth's magnetic field is a phenomenon of which we are seldom aware. Nevertheless, it was dealt with by scientists from a relatively early period (cf: Balmer 1956, an indispensable work on the subject). The reason for this was that the magnetic needle of the compass had made it possible for mariners to navigate independently of celestial objects and events. This made it the traveller's most important navigation instrument. The first volume devoted to geomagnetics was published as early as 1600 (Gilbert 1600/1893).

The works of Edmond Halley (1656-1742) were also exceptionally important at the time. In his General Chart of the Variation of the Compass, he also created the first maps to determine declination using isogonic lines (1701). Geomagnetism was also the subject of intense scientific research in the 19th century. First of all, it should be noted that, due to the multitude of different theories developed, one aspect can be easily overlooked. Until James Clerk Maxwell (1831-1879) had published his famous equations on electrodynamics around 1864, Newton's law of gravity was the only universally valid law governing interaction known at the time. More than a few scientists believed that geomagnetism could be presented in a similarly fundamental form, that is to say, they were hoping for a Newton of geomagnetism.

Since 1819 at the latest, when, in a questionable experiment, H. Oerstedt (1777-1851) had connected magnetism (magnetic field) with electricity (current), geomagnetism had been an academic challenge of the highest order. And so it was hardly surprising when a mathematician of the calibre of Carl Friedrich Gauß (1777-1855) decided to examine the subject (Gauß 1838). He stated that he had been prompted by the latest findings of the British geophysicist Edward Sabine (1788-1883), who had taken part in several polar expeditions, to test the mathematical model which he had developed (Gauß 1838, p 149). The most significant conclusion for further research was probably the emphasis on the importance of previously unrecorded observations in such great geographical areas, especially in as much as they diverge from the current data available. (Gauß 1838 S. 167) this was Gauß' challenge to polar research! Alexander v. Humboldt (1769-1859) can also be regarded as one of the main promoters of research on geomagnetism. He wrote a historical introduction to the subject as well as a treatise on the latest developments of the time (Humboldt 1845/62 Bd. II, pp. 372-376 and Bd. VI, pp. 48-209).

What was being practised here on a large international scale at the beginning of the 19th century was, irrespective of the many applications for shipping, first and foremost "science for science's sake". It is sometimes quite remarkable to read who was employed in this work and how much polar expeditions (and circumnavigations) contributed to the acquisition of data (cf Humboldt 1845/62 Bd. IV, p. 65). Even a short glance at the list of people involved reads like a Who's Who of the great names in science of the 19th century. From Germany there came Humboldt, Gauß, Weber, Lamont later Neumayer, Schmidt etc., then their counterparts from Great Britain and France, Airy, Faraday, Lord Kelvin, Sabine, Scoresby, Biot, Coulomb, Poisson, Sarvart, etc. and from Scandinavia Oerstedt, Hansteen, Angstroem etc. The great expenditure was worthwhile and it produced a considerable spin-off. It goes without saying that Maxwell's theory on electrodynamics would not have been possible without the work of the scientists mentioned above.

This all had a great long-term impact. The establishment of observatories to record magnetism became obligatory - geomagnetic monitoring was a must and it was no longer possible to evade the institutionalisation of research. Refinements in measuring techniques led to further significant consequences. Short-term deviations in magnetism could now be recorded. The desire to trace the causes of the phenomenon of magnetic storms was another reason why scientists covered great geographical distances while at the same time demanding and promoting simultaneous geomagnetic measurements. All this meant that international cooperation in geomagnetics became standard procedure. In this process, natural scientists in particular developed an elitist but idealistic approach to the pursuit of truth. This evolution went hand-in-hand with the professionalisation and institutionalisation of the sciences and was also of great significance for the establishment of the International Polar Commission in 1879.

Franklin, Osborn and Petermann, the North Pole makes a comeback as target for expeditions

In 1845 an Arctic expedition with three ships under the command of John Franklin set off from Great Britain. The primary aim of this state-of-the-art expedition sponsored by the Royal Navy was to find the Northwest Passage. However the hopes of finding a navigable channel were slim and it was certainly not expected to find anything of military or geostrategic significance. The instructions issued to the expedition focused much more on scientific work, especially in the field of geomagnetism.

In spite of its excellent technical standards, the expedition failed to return and 129 men were lost. Hitherto unheard of measures were taken to find out what had happened to the expedition. In the course of more than 40 Franklin search expeditions, the Northwest Passage was finally found and great expanses of the Canadian Arctic Archipelago were mapped. Nevertheless, the whole affair was a disaster for the Royal Navy and the English people. And so it was not until 1865 that the polar veteran Sherard Osborn (1822-1875) approached the British public with plans for a polar expedition. The proclaimed target was to push through the Kennedy Channel into the central polar region. A deviation from Barrow's philosophy could now be observed. The focus henceforth was on moving on from the failures of the past and achieving the sensational goal of the Royal Navy reaching the North Pole.

The German geographer August Petermann (1822-1878), publisher of the leading geographic journal of the time, "Petermanns Geographische Mittheilungen" (PGM), and a member of the Royal Geographic Society, had worked in England for seven years and was keen to take up this cause. His initial purpose was to support Osborn's plans. Before long, however, his ideas diverged from those of the expedition. This concerned the approach route to the central polar region. Osborn preferred access via Baffin Bay and Kennedy Channel. Petermann on the other hand favoured using the Gulfstream and approaching the North Pole through the waters around Spitzbergen. He saw Parry's failure of 1827 not as a falsification but rather a support for his theory that a central, navigable polar sea was separated from the Barents Sea by a barrier of ice. After all, Parry had observed a reduction in the density of the floating ice as he had travelled further north (Parry 1828, pp. 73, 148). Petermann was also undying in his praise for the heroic deeds of James Clark Ross, who had not been deterred by the massive ice barrier protecting the Ross Sea. Based on Antarctic conditions, his theory was that there was an open and navigable Arctic sea surrounded by an ice barrier. He believed that Greenland stretched through the central Arctic region and ended at about 72°N, to the west of the Bering Straits and that the South Pole was situated in the middle of an "Antarctic Ocean". Land sightings reported here were to be interpreted as island chains formed from glacial residue.

Some explanation is necessary to help understand this situation. There was some criticism of his ideas - the famous Danish Greenland explorer Hinrich Rink (1819-1893), for example, named Petermann's theory a geographically poetic transgression - but these and other criticisms were obviously of a polemic nature. In other words, until 1871, a scientifically sound evaluation of "Petermann's System" had not been carried out. On the other hand, there was great support, also among reputable scientists, for the theory of the open Arctic sea (cf. Krause 1992, pp. 6-15). The most prominent member of this faction was probably the American oceanographer Fontaine Maury (1806-1873). In his famous book – The Physical Geography of the Sea - a complete chapter is devoted to the subject (Maury 1855 p. 146).

In 1868, Petermann finally managed to commission a first German expedition in the Grönland under the command of Carl Koldewey (1837-1908). In the meantime, Petermann had altered his opinion concerning pushing through the central Arctic to the North Pole and beyond. He now favoured the coastal water theory, by which an ice free strip of water was said to be navigable along the eastern coast of Greenland. This assumption could be supported by physical facts and historical observations. However, in order to reach the Greenland coast, one had to traverse the East Greenland Current, an ice stream which could easily reach the width of 100 miles and, depending on the winds and temperature, could quickly turn into a blanket of pack ice from which there was no escape for the ships of that time. Koldewey was not able to cross the East Greenland Current in his "nutshell" of a vessel, the Grönland.

As early as 1869, a second German expedition to the Arctic was launched using the vessels Hansa and Germania. It set off from Bremerhaven and was once again led by Koldewey (for more details on this expedition cf. Verein dt. Nordpolarf. 1874, Bd. 1). In summary, the Germania was able to push forwards as far as the coast of East Greenland. On sledges they reached the record latitude 77°N and in the summer of 1870 the ships discovered a magnificent system of fjords and mountains. There were five scientists on board the Germania and two on the Hansa. In October 1869, the Hansa was crushed by ice in the East Greenland Current, while the Germania returned to Bremerhaven in September of 1870.

Weyprecht and Payer, two Arctic explorers as Petermann imagined they should be

The second German Arctic expedition was organised and funded for the most part by the Bremer Verein für die deutsche Nordpolfahrt. Unfortunately, differences of opinion arose between Petermann and the Bremen polar enthusiasts and he was not involved in the evaluation and publication of the findings.

New expedition plans were being made in Bremen as early as 1871. These plans did not take Petermann's imaginative ideas into account, but concentrated rather on expanding on what had already been achieved as well as focusing on East Greenland. If Petermann were to fulfil his dream of discovering the North Pole from the drawing board, he would now have to take action. The English were not interested in following his plans. The Americans may have been "fans" of Petermann and also determined to reach the North Pole, but they operated exclusively to the north of the Davis Strait, which Petermann was known to consider pointless, although the Americans had allegedly discovered an "open polar sea" (Hayes 1868) there. However this did not mean that they could sail to the Pole.

After the Germania returned in 1870, Petermann dropped the idea of the coastal route and changed his opinion once more. His preferred access to the central Arctic was now through the Barents Sea, which he was accustomed to call the sea between Spitzbergen and Nowaja Semlja.

In early 1871 he succeeded in recruiting Carl Weyprecht (1838-1881) as well as the mountaineer and geodesist Julius Payer (1841-1915) for a journey whose aim it was to reach the so-called Gillis Land. Payer had already taken part in the second German expedition. At a longitude of 42°E, they did in fact come close to a latitude of 79°N (an account of this journey can be found in Payer 1876, pp. 659-696). Petermann rejoiced - the open polar sea appeared to have been discovered. As a result of this success, it was now possible to launch the Austro-Hungarian polar expedition. This left Bremerhaven in the ice-proof vessel Tegetthoff in June of 1872 under the command of Weyprecht. During the course of the expedition, the Franz Josef Archipelago was discovered. However, they did not achieve their aim of finding a North East passage. After two winters in the Arctic, the ship had to be abandoned. The crew managed to reach safety after a heroic escape journey which lasted 95 days.

The most remarkable aspect of this expedition, sometimes known as the Tegetthoff Expedition, was the finding of the Franz Josef Archipelago. This was without doubt the most important discovery of land in the Arctic since the rediscovery of Spitzbergen in 1596 by Wilhelm Barents (1550-1597). Under extreme conditions Payer pushed northwards a further two degrees on sledges. Weyprecht, on the other hand, could at most be proud of the fact that he had managed to bring his crew back to Europe. Apart from that, the voyage was of no other nautical value, as Payer noted in a letter to Petermann (Krause 1992 p. 246). Against this background, we can understand Weyprecht's rejection of sensational voyages of discovery and his preference for the establishment of permanent observation stations.

Based on an appraisal of the Bremen plans to continue exploration of East Greenland

The German Greenland expedition of 1869/70 was an international success. The Bremer Polarverein, as it was popularly known, benefited from donations and guaranteed credits. But it was understandable that this movement attempted, by securing state funding, to become more independent when it came to planning expeditions. They also realised that a continuation of their work in the scientific field would not be possible without a solid foundation in academic institutions and societies. In this respect, all roads led to Berlin. But neither the prominent scientific groups in Berlin nor the navy were prepared to act quickly. Delaying tactics were employed and the seemingly concrete plans for the establishment of a German polar society slowly disappeared.

At the end of 1874, the Polarverein applied to the German government for immediate funding of a polar expedition. The plan for a new expedition to East Greenland was submitted with the application (Weyprecht's Austro-Hungarian North Pole expedition had returned from the Arctic just two months earlier). This plan mentioned specifically a close co-operation with the British Arctic expedition, which was to be launched in 1875 under the leadership of G. S. Nares (1831-1915). This was based on the understanding that only through simultaneous measurements taken by standardised instruments could reliable observations be made, especially in the fields of meteorology and geomagnetism. In October 1875, a meeting of a commission took place in Berlin. This was attended by 13 scientists. The commission's report on the appraisal of questions concerning polar research reads like a first German national policy on polar research and, with a few small alterations, the Bremen plan would have corresponded with the logistical principles which that policy had arrived at.

Nevertheless, the application was turned down by the German government (16.3.1876). It can only be speculated as to the real reasons for the refusal. But there can be no doubt that in Germany there was competition between polar research and so-called "African Exploration" (cf. Krause 1992, pp. 271, 273, 278). The approval commission had stressed that, in polar research, co-operation between nations was desirable. And so, on April 22, 1876, the German foreign office was requested to make enquiries to the governments of Russia, Sweden, Norway, Great Britain and the United States concerning their willingness to take part in an international polar exploration campaign.

Weyprecht, Wilczek, Neumayer and Wild establish the International Polar Year- IPY

The part played by Weyprecht in the creation of the IPY has become more apparent in recent years. Frank Berger of the Frankfurt historical museum has transcribed most of the correspondence between Weyprecht and Count Hans Wilczek (1837-1922). Wilczek gave his comprehensive support to the idea of setting up a ring of circumpolar stations as well as guaranteeing the complete funding of an Austrian station (Berger, Besser, Krause 2008).

In special publications entitled *Principien der arktischen Forschung* (dating from summer 1875 onwards), Weyprecht drew the attention of prominent scientists at home and abroad to his approach to Arctic exploration, which he summarised in six principles:

1. Polar research is of the greatest importance for our understanding of the laws of nature.

2. Geographical exploration in these regions is only of high value if it leads to scientific research in a purer sense.

3. Topographical details in the Arctic regions are not of major importance.

4. The geographical pole is not of any more importance for science than any other point at high latitudes.

5. Regardless of the latitude at which they are located, the value of the observation stations is proportional to the degree to which the targeted phenomena can be observed.

6. Isolated observation records are only of relative value.

In Weyprecht's opinion, the continued implementation of his principles could be guaranteed by the establishment of circumpolar stations from where the tasks could be executed: making observations as far as possible at the same time throughout the year using the same instruments and according to the same instructions. The summary of his essay reads as follows: If we do not break with the principles as practised up till now, if polar research is not carried out systematically and on a truly scientific basis, and if simple geographical discovery remains the objective of all our endeavours, then expeditions will continue to see their success in nothing more than uncovering at great cost and expenditure a piece of land under a sheet of ice or a few miles of uncharted territory, all of which is almost negligible when compared with the great scientific problems which mankind has always sought to solve.

A list of names has recently been found of those people who were familiar with this text (Berger, Besser, Krause 2008, p. 446). Among them were the geophysicist Georg v. Neumayer (1826-1909) and the meteorologist Wilhelm Dove (1803-1879), both of whom were members of the commission charged with assessing the Bremen application. And so Weyprecht's idea was known to the commission. It remains a mystery why Weyprecht's name appears in neither the minutes nor the report of the commission. It is all the more interesting that, as described earlier, the German government had decided to take steps to establish co-operation in polar research at international level. In other words, the rejection of the Bremen application on the grounds that international co-operation was initially desirable, was in certain respects helpful for the acceptance of the Weyprecht/Wilczekschen-IPY idea.

In order to implement the IPY plan, it was first of all necessary to convince enough nations to become involved. The effective propagation of the IPY idea was helped by the fact that Weyprecht was simultaneously founder, promoter and director of a virtual Austrian polar station. Since the middle of the 1870s, the geophysicist Neumayer had been an important figure in marine research in Germany. At first he had reacted negatively to Weyprecht's ideas. Weyprecht assumed that people in Berlin could not bear to accept even the possibility that a major project could be initiated anywhere else. Weyprecht may have been right as to his psychological analysis of Neumayer's motives, but it is not recorded that he had to overcome resistance from Berlin as he had feared. Neumayer had previously expressed similar opinions to Weyprecht's, and he soon became his most important supporter.

Independently of Weyprecht, Neumayer had developed the idea of the IPY and repeatedly stressed the importance of simultaneous bipolar observations (Neumayer 1874, pp. 51-53, 63-68, 75-82; Neumayer 1901, pp. 139-168). In connection with this, there is a popular misconception which has to be corrected. The matter in discussion here is not, as proposed by Weyprecht in a letter to Wilzcek, the establishment of observation stations in the southern hemisphere. Neumayer's main idea was that the solution to scientific problems could only be found by comparing results from both polar regions. Observations taken at both poles were a prerequisite for scientific advance, especially in the fields of meteorology and geomagnetism. In other words, polar research does not become especially significant until observations are carried out at both poles, with special emphasis placed on simultaneous readings taken from an adequate network of observation stations. This was especially important in the field of geomagnetism. In 1872, the prominent Dutch meteorologist, Christoph Buys-Ballot (1817-1890), had submitted similar proposals (Barr 1985, p. 123).

In the first half of 1876, Weyprecht was extremely active in promoting the IPY Organisation. This work included correspondence with scientists and institutions in the USA, Brazil, England, France, Norway, Sweden, Russia, Holland, Belgium, Denmark and Italy. Finally, he focused his hopes on the second International Meteorological Congress scheduled to take place in Rome in 1877. Item 31 of the agenda read as follows: how can the Congress contribute to the success of the project proposed by Wilczek and Weyprecht (Weyprecht-Wilczek 13.6.77). But it was not until April 1879 that the congress in Rome actually took place. The same point on the agenda now read: establishment of a number of observation stations in the Arctic and Antarctic regions for the purpose of taking simultaneous meteorological and magnetic readings at hourly intervals around the poles. This meaningful and pragmatic title bears Neumayer's handwriting. Just like Buys Ballot, he had submitted a paper on the subject (Neumayer 1901, p. 171-188). In the meantime Neumayer had become Director of the German Reichsinstitut and established German marine observation stations, and so he was well-suited to act as host to prominent polar researchers. The International Polar Commission was founded in Hamburg as early as October 05, 1879 and Neumayer was elected as its first chairman. A maximum number of sunspots was predicted for 1881, and so it made sense to choose that year as the first IPY. In Bericht HH IPY (sometimes known as the Hamburg Resolutions) Item I/10 names eight Arctic locations where stations were to be built.

During the second meeting of the International Commission on August 07, 1880 in Berne, it soon became clear that the 1881 deadline could not be kept and so the starting year had to be postponed until 1882. This meant that stations at high latitudes in the southern hemisphere would be able to observe the second Transit of Venus of the 19th century on December 06, 1882. And in actual fact, these observations were later made at the French and German stations at Cape Horn and South Georgia. Neumayer was not able to present a guarantee from the German government in Berne and was therefore forced to give up his presidency of the International Polar Commission. His successor was the geophysicist Heinrich Wild (1833-1903), who was working at that time for the Russian government, and it was only natural that he should act as host for the last session of the commission before the campaign started. This session was planned in St Petersburg from August 1-6, 1881. Carl Weyprecht had already died in March of that year.

The final breakthrough leading to the realisation of the IPY was hastened not only by the fact that the Russian government was considering setting up an additional station to close the gaps in the observation network, but also by the decision of the USA to man "one or more stations" (Circular 12, 13 v. 6.2., 6.4.1881). Finally, on May 15 (Circular 16), statements of intent were also received from France and Holland. In Germany, however, the situation was still very unsettled. Neumayer had not been given accreditation in time to leave on August 1 for the conference in Saint Petersburg, and it seemed that this would end in a fiasco. It was not until December 13, 1881 that Neumayer could write to Wild to confirm the participation of the German government. (For an idea of how these difficulties emerged and how they were overcome cf. Krause 2008) And so, in the end, the Germans could be proud of having played a considerable role in setting up the IPY as well as having made a substantial scientific contribution. Circular 30 of February 15, 1883 includes another of Wild's initiatives. In it he raises the question of doubling the period of observation. However, he was not able to secure a majority for this idea.

The first International Polar Year - execution, events, results

There are no contemporary accounts of the implementation and events surrounding the first International Polar Year. However, the publication of volumes of data include descriptions of the execution of the expeditions. These are summarised in Barr 1985/2008, while Heathcote, Armitage 1959 provides an overview of the scientific work carried out although it does not include specific monographs or articles from scientific journals; that is to say, there is no mention of any biological or geological observations. A comprehensive assessment of the scientific endeavours of the first IPY has not yet been published. Eleven nations took part in the initiative: USA, Denmark, Germany, Great Britain, Finland, France, Holland, Norway, Austria, Russia and Sweden. The Americans, Russians and Germans each fitted out two expeditions or stations, but it was only the Germans who maintained a station in the southern hemisphere (South Georgia).

Special mention has to be made of the French expedition to Tierra del Fuego (the only other campaign in the southern hemisphere besides the German project). More than all the others, the French expedition resembled a traditional voyage of exploration, that is to say, it was furthest removed from the principles of a "pure" station. After a permanently manned station had been established, the research vessel Romanche patrolled the Tierra del Fuego Archipelago for months. Besides making comprehensive geodesic observations, they also collected meteorological and oceanographic data as well as carrying out geological, biological and ethnographical investigations. The expedition could record a further success on its journey home. Bathymetric and oceanographic tests revealed the existence of the famous Romanche Trench. Named after the research vessel, it plunges to a depth of about 7700 m.

German activities included three auxiliary expeditions. The one led by K. R. Koch deserves a special mention since it made a considerable contribution to the expansion of the database by setting up six ancillary stations on Labrador. For the most part, these stations were depots of the Herrnhuter Brüdergemeinde, which continued to collect sustained meteorological data in later years.

The voyage of Franz Boas (1858-1942), the internationally renowned cultural anthropologist, is also related to the IPY. He arrived on Baffin Island in 1883 in the Germania. The expedition was intended to bring back the researchers who had spent the winter in the Kingua Fjord. As well as the collections of data published in 1886 (Neumayer/Börgen 1886), there appeared an interesting two-volume work on the German expeditions (Neumayer 1890/91), which includes historical and scientific reports as well as numerous illustrations. There are no photographs from the Baffin Island expedition but we do have such records from South Georgia (Kretzer 2007). Like most of the other expeditions, the German enterprise was carried out, with two exceptions, without major incident. The ship of the Dutch expedition, the Varna, was lost in the ice of the Kara See, but fortunately the crew members could be rescued. Much more dramatic was the tragic end of the American expedition to Lady Franklin Bay on the north west coast of the Hall Basin (81°45'N °64°30'W). Of the 25 members on board, only seven survived to be rescued on June 22, 1884.

After the return of the German expeditions, the first step was to catalogue the entire records, and it soon transpired that the data had been collected according to the instructions. In order to guarantee a systematic processing of data, the setting up of a bureau or work group with this purpose was considered necessary. The meteorological data were to be kept at the Marine Observatory in Hamburg, while the magnetic data were to be processed at the Geomagnetic Observatory of the Imperial Navy in Wilhelmshaven. The evaluation of more specific data was left to the expedition members. Most of the objects collected on the expeditions were handed over to the Museum of Natural History in Hamburg (Neumayer 1891, 189-199).

After meetings in Hamburg, Berne and Petersburg, a fourth IPY conference took place in Vienna from April 17-24. This congress was attended by 20 participants. Besides Graf Wilczek and some institute directors, there were also eight researchers who had spent the winter in the polar regions. One major topic of the meeting was the publication of their findings.

The reports and summaries of the expeditions were published in German, English and French. The Russian publications were printed in Russian and German.

The Germans had set themselves a special target. Their idea was to create a day-by-day weather chart for the South Atlantic; in other words, a presentation of the South Atlantic meteorology over the course of one year. For this, data was collected from all available land stations and especially from the ships' logbooks. The charts were to cover the period from August 1882 to June 1883 and were to be drawn by hand (Neumayer 1891 S. 196). However, due to an alleged lack of funding, the charts were never printed. The British had carried out the same task for the North Atlantic (Barr 1985 p. 5). It could not be determined if these charts have been published.

According to the accounts published on March 31, 1885, a total of 328,823.55 German Marks was spent on the German IPY expeditions of 1882/83, the equivalent of €8.22 million in today's money. From February 1884 until the end of March 1887, the sum of 68,693.64 German Marks) was spent on the evaluation and publication of the data including any additional costs. Of this, 24,700 German Marks was accounted for by personnel costs; this is the equivalent of about 10 man years. This means that from 1884 until 1886 an average of five or six scientists were on the payroll of the IPY. This number is reflected in the accounts.

By spring of 1886, the assessment of the meteorological and geophysical data had been more or less completed. This had taken about two years. In view of the volume of the material to be evaluated, this seems like a reasonable time. About three years after the return of the expeditions, the data were published in two volumes (Neumayer/Börgen September 1886). But it was not until 1890/91 that a commentary on the scientific findings and a historical assessment appeared (Neumayer 1891). The reason for these delays have not been identified.

The first IPY brought to light a whole series of interesting scientific findings, ranging from the Transit of Venus observed by the French and the Germans to the comprehensive geographical discoveries of the ill-fated American expedition. Of particular significance are the Aurora observations carried out by the Scandinavians and the Austrians including their attempts to photograph this phenomenon and to determine its elevation. As far as its main target was concerned, the IPY could only record a limited success. The core objectives of the meteorological and geophysical elements, for example, were never reflected in a publication or in a synopsis of the circumpolar data.

The two Neumayer/Börgen volumes published in 1886 both include summarising presentations. However, these articles deal mostly with the technicalities of recording observations. In 1891, Neumayer published an Atlas of Geomagnetism. In the preface to this book, he included a detailed critique of the data. However, we find here only a few brief comments on the IPY data (Neumayer 1891.2, pp. 4, 5, 16), although the volume itself met the standard of a synoptical presentation.

According to Neumayer 1891.2, for example, it would have been one of the main objectives to develop from the polar data a theoretical presentation of secular drift; that is to say, it was his goal to create a globally valid analytical presentation of secular drift. It goes without saying that this would have been of great practical value, for example for shipping. By 1891, however, he realised that this goal would not be achieved (Neumayer 1891.2, p.6).

In 1882, the physicist Carl Börgen (1843-1909), Director of the Naval Observatory in Wilhelmshaven and member of the German East Greenland expedition of 1869/70, had stated *that great, even decisive progress could be expected in our knowledge of the causes of geomagnetism and its variations; things which until now have remained a dark mystery* (Börgen 1882, p. 287). It has to be stated that the above quotation represents a maximum as far as concrete details are concerned. It is not even hinted at how one should progress from data to "knowledge". Closer study of Börgen's essay suggests that neither he nor anybody else was able to offer anything more specific.

The Polish Arctic researcher Henryk Arctowski (1871-1958) hit a nerve in 1931 when he stated that - *it is surprising that no monograph on the international Polar expeditions has been written, that no discovery or general scientific fact has become known universally as a fruit of the work carried out by these expeditions...* (Baker 1982, p. 282). Other articles on this subject agree that the findings recorded are presented as scientifically significant.

Consequences – Arctic research after the IPY

Independent of the publications of IPY data, several atlases were released in Germany about this time (Hann 1887, Neumayer 1891.2, Berghaus 1891, Berghaus/Zittel 1892). These volumes can be considered as global synopses. Some of them include references which we can assume are based on IPY data (accompanying texts in Hann 1887 and Neumayer 1891.2, and maps in Berghaus 1891), although this is not acknowledged as such. This is not the case in the dissertation of Erhart 1902, which was discovered recently in Munich by C. Lüdecke, and which mentions for the first time the term polar year. But Erhart's work was not the last to deal with IPY data. Sydney Chapman (1888-1970) carried out a systematic evaluation of the magnetic data of the first IPY (until 1925 according to his own statement) as well as publishing several papers as from 1919 (Chapman 1960, p. 314). The famous Norwegian physicist Kristian Birkeland (1867-1917) also made use of data from the first Polar Year (Vestine, Nagata 1959 p. 344). And so, the idea expressed by C. Börgen in 1882 was actually realised.

A German polar commission had been set up in December 1881 to organise the IPY campaign, but it was not able to make a significant contribution to the establishment of sustained polar research. After the conference of April 1884 in Vienna, a fifth meeting took place in Munich on September 03, 1891. This was part of the Conference of Directors of Meteorological Institutes, which had meanwhile been established, and it ended with the formal dissolution of the International Polar Commission (Lüdecke 2004, p. 60).

Polar research was given a new platform after 1881 in the annual Conference of German Geographers. On several occasions, Neumayer used this forum to make passionate pleas on behalf of Antarctic research. The first geographers' conference had taken place in Frankfurt am Main in 1865. This event had also focused on Arctic research and Neumayer also took the opportunity to promote research at the southern pole. Since the death of Petermann, Germany lacked a prominent advocate of Arctic research. However, the Bremer Polarverein did continue its activities and sent expeditions to Spitzbergen, Siberia und Alaska. Also deserving a mention are the two voyages of Erich v. Drygalski (1865-1948) to West Greenland in 1891 and 1892-93. These were funded by the Gesellschaft für Erdkunde zu Berlin (Lüdecke 1995, S. 125). These expeditions concentrated on glaciological research which had been prompted by new studies in the field of historical global icing.

Purely as a result of the scientific arguments and untiring agitation of Georg v. Neumayer, the southern hemisphere was included in the programme of the first Polar Year. By the time Weyprecht's lobbying had led to the execution of the large-scale acquisition of simultaneous data in the polar regions in 1882, the idea was already well-established at less extreme latitudes. In this case, the setting up of meteorological observatories was primarily linked to the practical objective of meeting the increasing demand for short-term weather forecasts. Polar meteorology, on the other hand, pursued more academic goals, as did studies in geomagnetism. The hope was that gathering data in the polar regions would make a contribution to the forming of theories. This idea of polar data had been under discussion among specialised scientists since 1870.

Weyprecht and Wilczek's commitment to this idea led to two further important general aspects being created and becoming understandable to a wider public - the academic and scientific consolidation of polar research as well as the closely linked growth of international activities. The term "polar research" thus stood for the acquisition of data from the inaccessible polar regions as part of a holistic understanding of our planet. As such, it was a useful contribution to the human cultural heritage.

3 Data archiving and quality

With the integration of this data collection in the data library PANGAEA, the data centre WDC-MARE has archived meteorological parameter to give them an added value through consistency, electronic availability and integration into an archive for observations from earth system research. The IPY data collection comprises 58 different parameters, which are added as a list on this DVD in the file parameter-ipy-1.txt. A total of 90 data sets are included with the DVD of this report.

The data tables as stored on the DVD were generated by the relational database management system of PANGAEA which ensures a consistent organisation of the metadata documentation, heading each files data table. The search capability added as front end software enables the user to find and download data of interest through individual queries.

The data underwent technical and consistency checks after typing and prior to the import. Whenever users find errors, WDC-MARE should be contacted so that corrections can be made. PANGAEA will always present online the most recent version of the IPY data compilation: http://www.pangaea.de/search?q=ipy-1

4 Policy and citation

As data publishing system and library, WDC-MARE makes use of PANGAEA® – Publishing Network for Geoscientific & Environmental Data http://www.pangaea.de for georeferenced data from earth system research. It is operated in the sense of the Budapest Open Access Initiative 2002 (http://www.soros.org/openaccess/) and guarantees long-term availability of scientific primary data of projects and as supplements to publications. The policy follows the Recommendations of the Commission on Professional Self Regulation in Science for Safeguarding Good Scientific Practice, 1998 and the Principles and Responsibilities of ICSU World Data Centers, 1987 (http://www.ngdc.noaa.gov/wdc/guide/gdsystema.html). The availability of scientific primary data in public repositories consequently follows the recommmendations of the OECD Principles and Guidelines for Access to Research Data from Public Funding 2007, see http://www.oecd.org/dataoecd/9/61/38500813.pdf) and the ERC Scientific Council Guidelines for Open Access of the European Research Council (2007), see http://erc.europa.eu/pdf/ScC_Guidelines_Open_Access_revised_Dec07_FINAL.pdf.

*It may seem unnecessary to publish data as a static collection on DVD, if the data are available on the Internet. This print-publication with DVD has a global distribution through the major libraries and marine research institutes and will help to bridge the '**digital divide**' between developed and developing countries with limited Internet access as demanded by IOC/IODE (Intergovernmental Oceanographic Commission of UNESCO, International Oceanographic Data and Information Exchange).*

Under the terms of the WDC data policy, the compiled and harmonized data on this DVD will have entered the public domain by the time the DVD is published. The data is intended mainly for scholarly use by the academic and scientific community, with the express understanding that any such use will properly **acknowledge the originating references** as provided in the data description.

5 Data format and access

The data on this DVD is a copy of the PANGAEA content at the time of publication. The inventory might be extended by further data. At http://www.pangaea.de always the most recent status of IPY-1 data will be available. This DVD enables the user to access the data through a computer system locally. Data sets are stored in the folder \docs\datasets\ as tab-delimited text (ASCII) files organized in one ZIP-archive.

Each name of a file in the ZIP-archive consist of a six digit number followed by the extension **.tab*. This number is also part of the DOI (Digital Object Identifier); e.g. if a filename is *711818.tab* the related DOI is *10.1594/pangaea.711818*. Each DOI is the persistent link to find the data set on the Internet (not on the DVD).
A DOI in the metadescription is spelled as doi:10.1594/pangaea.711818 and can be resolved by copleting the link to http://dx.doi.org/10.1594/pangaea.711818. See http://www.doi.org for further information about the DOI system.

All data sets have a similar format, which consists of the **Data Description** (metadata) followed by the factual **Data** in a table.

Data Description

(consists of the following fields, not necessarily all are used):
Citation: is the formal correct citation to use if you refer to a specific data set (e.g., in a publication). Part of the citation is a DOI (Digital Object Identifier) as a persistent identifier for reliable long-term access;

(1) Reference(s): is the related expedition report, where the data were published;
(2) Coverage: gives the four geographic boundaries (W-E-S-N) of a rectangle around the area where the data was measured or sampling occured (if the data is related to one sampling point only, W and E as well as N and S have identical values);
(3) Event(s): gives the label of the deployment followed by its latitude, longitude, and elevation, as well as device type, campaign label (IPY-1);
(4) Comment: may contain individual remarks (only shown if filled);
(5) Parameter(s): shows the list of parameters with units for each column in the data set. Each parameter is related to at least one column showing a 'Short Name' as used in the header of the data matrix, the 'Principle Investigator' (PI), the method and (optional) comments;
(6) Size: displays the number of data points of a data set.

Data

A table consists of a header followed by the data columns:
Event label i.e. the label of the deployment as explained in (5) (only shown in tables containing data from several locations);

- one to several geo-codes, i.e. latitude; longitude; depth, water m; depth, sediment m; altitude m; date/time;
- one to many parameter with unit.

Data Access

The data collection is supplied with a simple search engine, allowing access to and navigate in the inventory by the submission of querries. The search engine is running on a local auto installing web server supplied with the DVD. Both, the web server and the database engine, are built on JavaTM Technology. Usually, no manual installation is needed since the DVD starts automatically while inserted.
In the WDC-MARE efforts to archive data in a reliable format, which is readable on a long-term scale, data are ASCII (text) formatted. Access through a long-term stable URI (Uniform Resource Identifier) is ensured by the use of persistent identifiers (DOI). The search engine on this DVD is provided for current convenient access but may not run stable on a long-term due to the continuously changing constraints through further development of the Java technology. This is out of control of WDC-MARE.

The following software is recommended (minimum requirement):
- *Linux*: SUSE, Debian, Ubuntu, Gentoo, Redhat
- *Macintosh*: Mac OS X
- *Solaris*: Version 8
- *Windows*: Windows 2000/XP/Vista/7 using Java Runtime Engine JRE 1.4 or higher

In order to run the database properly, your computer must have a Java Runtime Engine 1.4 or higher (JRE) installed. On *Linux*, *Macintosh*, and *Solaris* computers JRE is already part of the operating system. Computers using the *Windows* operating system need separate installation of JRE. The start-up routine supplied on the DVD will automatically detect the respective computer system, the version of its operating system check the JRE version. If JRE is not installed or the version number is not appropriate, the start-up routine will offer to install the bundled JRE version from DVD-ROM.

The DVD will start automatically once you have inserted it in your DVD device. If the DVD does not start automatically, you can launch it manually:

- *Windows*: double-click the file **winstart.exe**;
- *MacOS X*: double-click the **macstart** application;
- *Unix (Linus, Solaris, BSD, ...)*: execute **sh ./unixstart.sh** from terminal and follow the instructions; Solaris users have to mount the DVD/DVD explicitely as Rockridge/ISO9660 volume

Important: The local search engine requires a Java VM installed on your system. If for some reason the Java environment is not found, the starting procedure offers the option to install the latest JRE from Sun (see folder support). In addition JavaScript must be enabled in your browser.
If your browser does not display the homepage after starting the local webserver, you should disable proxies in your browser configuration. If you cannot do this because of firewall or access restrictions (ask your system administrator), add 127.0.0.1 to the proxy exemptions or send an email to tech@pangaea.de.

Data search and processing

Assuming that the search engine properly displays the search query mask the user can create queries. To enter a search query, just type in one to several descriptive words and hit the <Enter> key or click on the <Search> button. Since the search engine only returns data sets that contain all the words in your query, refining or narrowing your search is as simple as adding more words to the search terms. A 'Help' text with search examples is provided below the 'Search' button. With Show map a simple map with minimum functionality will open, showing the location of sites.

The user may search for any words included in a data set, e.g. a name of a principle investigator or a parameter. A link to the *parameter list* is provided on the search mask. A search query typically results in a list of data sets that subsequently can be accessed by striking a hot link. The outcome displays the *Data description* and at its end the options to:

Download data set as tab-delimited text or
- *View data set as HTML.*

Additionally, the entire result set (i.e. all data sets found and listed) can be loaded as a *ZIP*-archive, see:
Download complete results as ZIP-file

The ZIP-file can be processed with a variety of analysis and visualization software packages, including

- Ocean Data View, (http://odv.awi.de/),
- PanPlot doi: 10.1594/PANGAEA.330147,
- PanMap doi:10.1594/PANGAEA.104840 or
- GIS systems by conversion using the software tool
- **Pan2Applic** (doi:10.1594/PANGAEA.288115).

Pan2Applic is provided with the DVD and can be used to transfer single files, folders of files, or a ZIP-archive from the PANGAEA output to formats of the applications listed above. Also a georeferenced flat text file may be produced for individual processing.

Please contact the WDC-MARE office with any comments or questions pertaining to this publication at info@pangaea.de.

6 Acknowledgements

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In addition, the references are listed in *file references-ipy-1.pdf* with hot links behind the handles.
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