Belgium and Antarctica

Exploration, Science and Environment

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Preface

Princess Elisabeth Station: Belgian scientific policy at the heart of Antarctic research

The link between Belgium and the Antarctic has always been strong since the first overwintering of the scientific expedition led by Adrien de Gerlache from 1897 to 1899, passing through the construction of the King Baudouin Base in 1958 and Belgium's participation in the Antarctic Treaty negotiations in 1959. This link reflects the close cooperation that exists between the challenges of exploration and scientific research on this continent of extremes.

The construction of the new Belgian polar research station, Princess Elisabeth, the fruit of the indefatigable will and energy of Alain Hubert, a man who takes up any challenge, together with the enthusiastic engagement of the Federal science policy and the indispensable financial support of private partners willing to contribute to this scientific tool, is a modern example of how coordinated action can ensure the success of advanced research.

An external evaluation of the Federal science policy's "Antarctic" programme, carried out in 2002, praised the internationally recognised quality of Belgian research in this field. Beyond increasing the nation's involvement in the Antarctic Treaty system, the report also recommended ensuring the continuity of Belgian Antarctic research and securing the future financing of logistical means.

It is with the very real conviction of the relevance of Belgian scientific activity in the Antarctic region, that I have made it my expressed intention, for 2008 and 2009, to significantly increase the engagement of the Federal State in the financing of this research base. Belgium has always been, and should remain, an indispensable actor on this continent whose importance for the future of humanity cannot be overestimated.

To add further impetus to the engagement of our scientific institutions, universities and research centres in the scientific work at the Princess Elisabeth station, I have recently given my support to its reinforcement through the introduction of new climate research programmes.

As day breaks on the inauguration of this exceptional scientific tool, I take great pleasure in thanking the International Polar Foundation, Alain Hubert, all the sponsors and everyone who has believed in this project and worked towards the fruition of this extraordinary human and scientific adventure that is now rendered visible and real in the Princess Elisabeth Antarctic research station.

The Minister of Federal Science Policy/Scientific research

Antarctica: A region under strict protection

This splendid anthology of Antarctica is a response to two needs as it was necessary, firstly to refresh an "Antarctic memory" which was vanishing and, secondly, to highlight a series of successful Belgian initiatives.

With regard to environmental policy in this region, our department has implemented concrete actions since 2003, both under the Antarctic Treaty and the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). Belgium is now undertaking again a proactive environmental policy, such as advancing a future network of marine protected areas or working on a regulatory framework for bioprospecting.

Antarctica has become a research laboratory for sustainable development, representing an inexhaustible source of inspiration for present and, hopefully, future generations.

Our department will continue to co-operate with the Federal science policy, the Department of Foreign Affairs, the International Polar Foundation and the other non-governmental organisations, with a view to addressing Antarctic issues in an integrated and consistent way, to ensure the highest level of protection for Antarctica.

Roland MOREAU
Director-General
Directorate-General for Environment
Federal Public Service Health, Food Chain Safety and Environment

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Content

Chronology

1780

1800

1820

1773
James Cook (United Kingdom) crossed the Antarctic circle

1820
Fabian von Bellingshausen, captain of the Russian royal navy, glimpsed Antarctica for the first time. He discovered Alexander Island and called it Alexander I Land.

1928
The continent was flown over for the first time.

1900

1920

1940

1897
Adrien de Gerlache left Antwerp on board the Belgica, which was stuck in the ice for 375 days.

1911
The Norwegian Roald Amundsen reached the South Pole, followed by Robert Scott (United Kingdom), a month later.

1946–47
'Operation Highjump' from the United States under the command of Admiral E. Byrd: 13 boats, 23 planes and 4700 staff members. The biggest expedition ever, flying over and photographing a major part of Antarctica, confirming the presence of the United States in Antarctica.

1840 1860 1880

1840
While searching for the magnetic pole, James Clark Ross (United Kingdom), Sébastien Dumont d'Urville (France) and Charles Wilkes (United States) discovered the first contours of the Antarctic continent:

1963–1965
First Belgian-Dutch expedition and the construction of the new King Baudouin base

1964–1966
Second Belgian-Dutch expedition

1965–1967
Third Belgian-Dutch expedition

1967
Closure of the King Baudouin base

1967–68
First summer expedition in collaboration with South Africa

1968–1969
Second summer expedition in collaboration with South Africa

1969–1970
Third summer expedition in collaboration with South Africa

2008
Law creating the service d'Etat à gestion séparée (governmental body with autonomous management), named the Polar Secretariat

2009
Inauguration of the new research station Princess Elisabeth

1960 1980 2000

1957
International Geophysical Year and Gaston de Gerlache's first expedition with a view to constructing the King Baudouin base.

1958–1959
First Belgian Antarctic expedition

1959
Signature of the Antarctic Treaty in Washington (entered into force in 1961). Belgium was one of the twelve first signatories of the Treaty.

1959–1960
Second Belgian Antarctic expedition

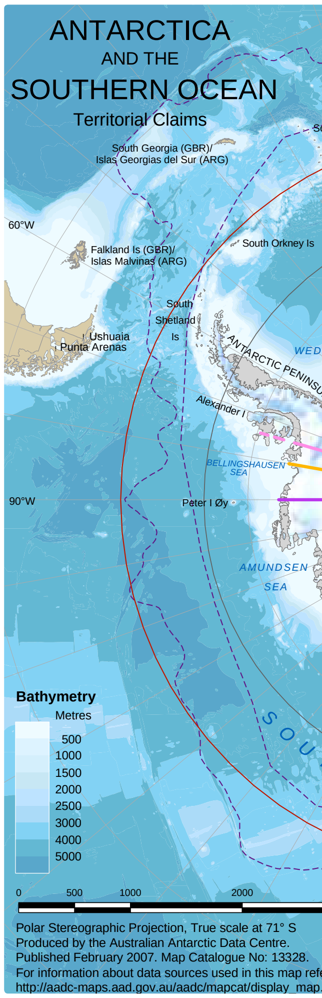
1960–1961
Third Belgian Antarctic expedition

1985
First Antarctic research programmes financed by the Federal science policy. These programmes are still ongoing.

1991
Signature of the Madrid Protocol relating to the protection of the environment in Antarctica (entered into force in 1998)

2004
The Belgian government decides to construct a new summer research station. The International Polar Foundation (IPF) coordinates the construction and organises the following expeditions:
- BELARE 2004-2005: selection of the construction site
- BELARE 2005-2006: inventory of possible unloading sites
- BELARE 2006-2007: preparation of the construction site; first unloading & traverses
- BELARE 2007-2008: first part of the construction of the polar research station
- BELARE 2008-2009: second part of the construction and first research projects

Science and peace: the legal destiny of Antarctica



Jean-François Mayence and Alexandre de Lichtervelde

History

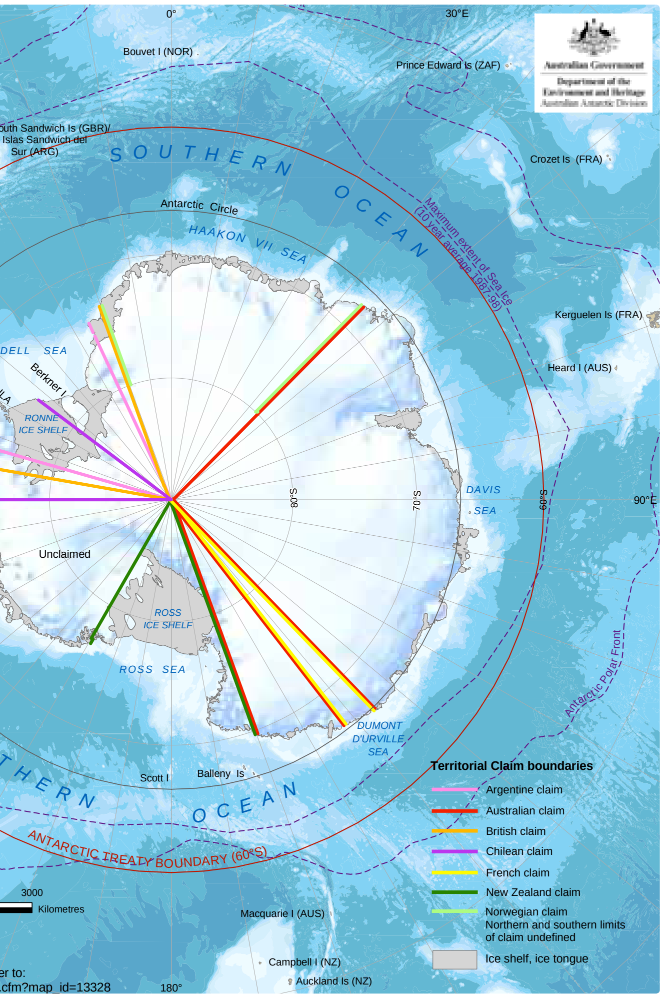
1957, the International Geophysical Year, was definitely the year for global awareness: land, sea, air and the cosmos were on everyone's mind and it was within this favourable context that the ice and rock of Antarctica became the object of particular attention, especially for lawyers.

Right in the middle of the Cold War, it didn't take much for a reserve of natural riches like Antarctica to become the object of genuine conflicts between nations. Numerous claims had already been made on the continent, some from the closest countries ('*Adjoining States*'), others from certain industrialised nations or exploring countries who intended to make the most of their scientific investment.

In reality, there were two sorts of national claims on all or part of the continent.

1° Some states claimed one or other part of the 'land' in Antarctica divided into concentric sections starting from the South Pole. Thus, Australia, France, the United Kingdom and Norway laid claim to their sovereignty and certain territorial rights on the grounds of their discovery and occupation (sporadic) of certain areas in Antarctica. As for the adjoining states (such as Chile and Argentina), the principle of proximity they referred to justified similar rights, in their opinion.

2° Other states, such as the United States or the Soviet Union, opposed these claims. This attitude, which may seem paradoxical at first sight given the background of the Cold War, can easily be explained if we bear in mind the continuous preoccupation of these two super-powers of not engaging in any bids that they were not sure winning. Some international legal systems, such as those concerning extra-atmospheric space or the high seas, thus benefited from the reciprocal fear of the East and West of seeing their rivalry extend to land or domains that escaped their control. In case of doubt, neutrality would be adopted. This was the case in Antarctica.



© *Australian Antarctic Division*

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Return to the 1957/1958 International Geophysical Year. This event offered scientists a unique opportunity to demonstrate the primary vocation of Antarctica. An almost immaculate continent at the time, which had been the planet's natural reserve and safe for hundreds of millions of years, the great white continent was to be dedicated first and foremost to research for the well-being of all humanity. The action launched in 1958 aimed at developing such research was entrusted to an international non-governmental organisation, the International Council for Science (ICSU). The special status of this body, acknowledged as being independent, allowed the inauguration in practice of what was to become the foundations for the Law of Antarctica and the Treaty of Washington.

The Washington Treaty

The Antarctic Treaty, signed in Washington D.C. on 1 December 1959, will go down in the history of international law as a special instrument, for several reasons relating to the system it established.

First of all, it was the first of the major treaties that subjected part of the planet to a specific international system, sanctioning scientific use with the exclusion of any military use.

Outside of the United Nations, it constituted a unique example of a hierarchical organisation of states and privileges granted to certain nations in relation to others. Although Antarctica's system was indeed an international system, it was not, however, universal. According to the 1959 Treaty, the states fell into three categories:

- first of all, there were the twelve founding states, the initial signatories of the treaty, including Belgium;
- then there were the advisory parties, i.e. the states who demonstrated their ability to participate in research in Antarctica. Initially 15, these advisory parties

could participate in the cooptation of new signatory states which could, in turn, participate in the research activities in Antarctica;
- finally, there were the non-signatory observers, who were interested in the activities although they didn't have the technical abilities to participate.

It was possible for any United Nations' member state to become a signatory of the Treaty.

Principles of the Washington Treaty

The delimitation of Antarctica. The area covered by the Treaty of 1959 is defined as that which extends below the 60th parallel of the southern hemisphere. Antarctica is therefore a continental zone and a marine zone.

The freezing of claims. This is also a special aspect of the Law of Antarctica: the territorial claims made by some states have not been neutralised owing to the participation of these states in the Treaty. It is specifically provided for that the rights acquired or claimed when the Treaty was concluded are preserved by the party states but they can only be exercised subject to the principles referred to in the Treaty. As often described, these rights remain 'frozen' as long as the Antarctic Treaty is in force.

Exclusive scientific use. While the technical and financial means required by a polar expedition in 1959 guaranteed scientists relative de facto exclusivity as regards access to and staying on the Antarctic continent, this is no longer the case today. In practice, and sometimes under cover of scientific purposes, some commercial activities (extreme tourism, cruises, etc.) are carried out beyond the 60th parallel.

The corollary of scientific exclusivity is to ban any military activity. While scientific research was in some way a pretext, at the time, for the 'pacification' of Antarctica, it currently represents a fundamental stake. The extreme and relatively virgin environment of the continent offers scientists a fabulous research laboratory. But this itself is a continuous subject for study. The problem of global warming shows to what extent the fate of our civilisations is linked to that of Antarctica. The complete melting of the austral icecap would correspond to sea levels rising 75 metres. The destiny of Antarctica is therefore not the exclusive right of a small community of states, even though they are the pioneers of its discovery and the guardians of its use...

Another corollary of exclusive scientific use – but which is not referred to in the Treaty of Washington – is the ban on, or at least the limitation of prospecting and exploitation activities relating to the natural mineral or fossil resources. These types of activities were the subject of future negotiations (see below, Black gold in a white paradise) which finally ended in their complete ban by the Madrid Protocol in 1991 (see *The Madrid Protocol*).

The freedom of scientific research and co-operation. While this freedom was to initially, and according to an American proposal, benefit all nations, the final version of the Treaty of Washington only gave the signatories the power to organise or authorise research activities in Antarctica. It is remarkable that the Treaty provides for the possibility of organisations or individuals under private law to carry out such research, as long as they come from one of the signatory countries.

This discrimination is somewhat softened by the co-operation principle which obliges the parties in the Treaty to implement measures aimed at facilitating the exchange of information, scientific results and staff, not only among themselves but also within the United Nations and its agencies or bodies interested in research in Antarctica.

Mutual control. In order to ensure each party state and its citizens respect their obligations, the Treaty organises a mutual control and visit system. This system is a pragmatic alternative to the establishment of an organisation or control body. One of the characteristics of the Treaty of Washington is indeed its low level of institutionalisation which can undoubtedly be

© *Australian Antarctic Division (Belgian delegation at the first Antarctic Treaty Consultative Meeting, Canberra, 10 July 1961)*

explained by the sensitive nature of the stakes and interests and the compromise this treaty represents. This mutual inspection system clearly has a dissuasive effect. No physical restraint is possible if a state fails to fulfil its obligations. However, the good level of co-operation and credibility a party state can hope to benefit from, is directly linked to its desire to comply with the rules of the game.

Criticism against the Washington Treaty

The relatively closed system of the Treaty of Washington restricting research in Antarctica to certain states has not escaped criticism.

First of all, it is based on a mechanism of extension of sovereignty – occupation – which has been significantly called into question, especially as regards the decolonisation policy within the United Nations. By freezing the issues of national sovereignty, the Treaty has nevertheless favoured the states that have put forward a claim, and it is not certain whether the result of these issues would be the same today as it would have been in 1959.

Discrimination between the signatory states, on the one hand, and the observer states or third-party states, on the other hand, is difficult to justify with regard to the issue of study and the protection of Antarctica on a global level. The mutual control system emphasises this discrimination by restricting the monopoly of monitoring Antarctica to the party states, at a moment when the diversification of activities in this part of the globe could risk harming its environment and the exclusive vocation of its use.

While it is correct that the party states have, up until now, shown an acute sense of responsibility, there is nothing to say that new economic or strategic claims on Antarctica and its natural resources won't damage the sense of solidarity and obligation which unites the states that are party to the Treaty of Washington.

Revision of the Washington Treaty

Contrary to what is sometimes claimed, the Antarctic Treaty has no specific validity date. Undoubtedly, it is because it 'suspends' these claims that it has this temporary appearance. It was also provided for that the Treaty could be reviewed upon the request of at least one advisory party upon the thirtieth anniversary of its coming into force, i.e. 23 June 1991. On this date, no request for a review was made. Since then, the Treaty may be revised or amended in accordance with its provisions and international law, just like any other treaty.

© *Damien Cardinal (encounter with a group of rorquals)*

OTHER TREATIES ON ANTARCTICA

The 1980 Canberra Convention. This convention concerns the protection of Antarctica's marine fauna and flora. Furthermore, it established an international body specific to Antarctica for the first time: the Commission for the conservation of Antarctic marine fauna and flora (see *Convention on the Conservation of Antarctic Living Marine Resources (CCAMLR)).*

The 1991 Madrid Protocol. This instrument reinforces the Treaty of Washington by establishing a system of protection for the environment, mainly based on control and international responsibility as regards the activities carried out in Antarctica (see *The Madrid Protocol*).

The 1972 Convention for the Conservation of Antarctic Seals.

BLACK GOLD IN A WHITE PARADISE

While some are attracted by Antarctica because of the magic of its landscapes, the discovery of its fauna and flora or the geological secrets hidden in the continent, others see it as an unexploited reserve of energy sources. Gas and oil are indeed riches but also a threat for Antarctica's continental subsoil and seabed.

The idea of industrially exploiting these resources certainly isn't new. In 1988, the Wellington Agreement attempted to make a compromise between those in favour of exploiting the mineral resources (defined as including all non-living resources): however, nobody was particularly happy with it. Its major fault was undoubtedly the overly complex mechanisms and a lack of transparency regarding the fundamental principles which each party expected to be confirmed. Technically-speaking, the Wellington Agreement provided for the creation of a court of arbitration responsible for settling differences regarding the implementation of its provisions. This system was mostly based on the one set up for the exploitation of the seabed by the 1982 Montego Bay Agreement on the law of the sea.

The issue of the exploitation of natural resources in places which are subject to an international system is acknowledged as being very difficult. By establishing these resources as the common heritage of humanity, the Montego Bay Agreement and the 1979 Moon Agreement taught the nations a lesson, disrupting the economic momentum of industrialised countries and attracting the distrust of developing countries. Today, no-one wants to hear about the common heritage of humanity anymore (a term that was never applied to Antarctica or its resources).

That said, avoiding the issue won't answer it: what will happen when the industrial consortiums demonstrate the opportunities and the profitability of exploiting these resources at a time when the other deposits are coming to an end?

Technically-speaking, the Wellington Agreement is still alive: its implementation was suspended by the 1991 Madrid Protocol, which exclusively sided with the protection of the environment by purely and simply banning any activity

© *Andrew Jackson (XXVI Antarctic Treaty Consultative Meeting (Madrid). Left: the Belgian delegation: Alexandre de Lichtervelde and Hugo Decleir)*

concerning prospecting or the exploitation of mineral resources in Antarctica. While there is very little chance that this agreement will come into force one day, it has the merit of offering certain avenues of thought on a global and international system to manage natural resources.

With the Madrid Protocol, international law seems to have blocked any possibility of seeing the mineral resources of the white continent being taken by storm one day by the major oil and gas producers. However, a legal loophole may allow the installation of extraction platforms a few cable lengths away from the Antarctic coast, even on the ice floe itself. This loophole concerns the definition of the Antarctic Treaty area in Article VI of the Washington Treaty. This text states that the Treaty cannot hinder the application of the regime of the high seas in the Antarctic zone. However, the high seas are defined by default as any area of sea that has not been placed under national sovereignty. With the freeze on the claims of sovereignty in 1959, we can conclude that beyond the 60th parallel, there are no areas of territorial sea. On the contrary, any marine zone in Antarctica, including the ice floe, can be considered as the high seas in the sense of international law. What is interesting for industrialists in this reasoning is that the seabeds corresponding to the high seas (except for the national continental shelf) have the status of common heritage for humanity. Their exploitation is placed under the surveillance and control of the International Seabed Authority, established in Jamaica. Even if this exploitation has remained extremely theoretical up until now, global needs in mineral resources may well justify having recourse to this system one day, or to envisage another more liberal one.

THE MADRID PROTOCOL

History and contents

This text, which was adopted in Madrid in 1991 and came into force in 1998, is a key stage in the evolution of the Antarctic Treaty. It has made Antarctica a nature reserve, devoted to peace and science and has established the environmental principles to which all activities are subjected. It forbids any mining activities and subjects all activities to a preliminary environmental impact study. Finally, it requires contingency plans to be developed in order to meet situations that are critical for the environment.

It has six appendixes:

APPENDIX I Environmental Impact Assessment
APPENDIX II Conservation of Antarctic Fauna and Flora
APPENDIX III Waste Disposal and Waste Management
APPENDIX IV Prevention of Marine Pollution
APPENDIX V Area Protection and Management
APPENDIX VI Liability Arising from Environmental Emergencies (not yet in force)

A revision procedure is currently underway for some of the appendices.

The Committee for Environmental Protection (CEP) established in 1998, which currently includes 32 member countries, holds an annual meeting and advises the Treaty's Parties. Belgium is represented by the DG Environment of the FPS Health, Food chain safety and Environment, alongside representatives from the Federal science policy. It should be noted that the CEP's workload is continually increasing according to the growing number of subjects dealt with.

Belgium plays an active role in the following priority conservation themes: protected areas and, through an Antarctic Treaty Consultative Meeting (ATCM) working group, assessment of the possible environmental impact of bioprospecting and collaboration with another Antarctic Treaty System convention, the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR).

© Bruno Delille

Belgian law of 7 April 2005 (M.B. (law gazette) 19 May 2005)
It is our law of 7 April 2005 that implements the Protocol in Belgian law. The law includes the protection provisions provided for in the Protocol and designates the authority responsible for issuing the permits covering the activities envisaged in Antarctica, essentially by the Belgians or entities under Belgian law. Those concerned are the Princess Elisabeth research station and non-governmental tourist expeditions. The permits are issued by the federal minister whose remit is the environment. The latter may request an environmental impact report if the impact of the activity is minor or provisional, or if this impact is more than minor or provisional. The permit may be accompanied by conditions. Severe sanctions are provided for in case of a breach.

CONVENTION ON THE CONSERVATION OF ANTARCTIC LIVING MARINE RESOURCES (CCAMLR)

The Commission for the Conservation of Antarctic marine fauna and flora was established by the Canberra Convention and covers the vast waters of the Southern Ocean south of 60° South. Belgium has been a member of the Commission since its creation in 1982. It was the first regional fishing organisation to apply the ecosystem approach in combination with the principle of precaution. The Southern waters shelter much sought-after resources: mainly fish and krill. At the basis of the Antarctic food chain, krill has attracted increasing interest in industrial fishing. By participating in the organisation's work, Belgium is endeavouring, along with other non-fishing countries, to ensure that the environmental considerations are integrated into fishing activities. In 2005, the question of protected marine areas was put on the agenda and, since then, Belgium has been participating in a concrete way in the identification and creation process of a network representative of protected areas.

THE FUTURE OF THE ANTARCTIC TREATY

After 50 years in existence, and with its 47 member states, the Antarctic Treaty remains a reference in terms of multilateral governance. The practice of consensus in decision-making by the countries which are party to the Treaty, at least those with the status of Consultative Party, constitutes both a strength through the legitimacy it gives to the decisions and a weakness owing to the slowness of the process.

While the Treaty has succeeded in preserving the future of the White Continent up until now, it now has to face a variety of pressures: rapid growth in tourism, bioprospecting[1], illegal fishing, increase in the number of research stations and science projects with a variable environmental impact.

Tourism and bioprospecting affect the very principles of the Treaty: the Continent is indeed exclusively devoted to science & peace. This is why there is often mention of a new appendix to the Madrid Protocol, concerning tourism. As for fishing, whether it refers to fish or the now famous krill, the regulation of this activity is a prerequisite to ensure the future of Antarctica's fragile ecosystem.

The existence of areas under national sovereignty in the sub-Antarctic islands adds ambiguities linked to policies inspired by contradictory motivations.

Another recent development is the reinforced co-operation with the other elements of the Antarctic Treaty System. Several subjects are of common interest to the Committee for the Environmental Protection of the Treaty (CEP) and the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR): the monitoring of the environment, the protected areas and their management, species requiring special protection, marine pollution, exotic invasive species, climate change. If we consider that Antarctica constitutes one and the same ecosystem composed of a terrestrial part and a marine part, it is indeed desirable for these two organisations to increase their collaboration.

1 Bioprospecting is the research of biological components and processes that can lead to commercial applications.

© *Jean-Louis Tison (Krill)*

In April 2009, the fifty years of the Treaty will be celebrated in Baltimore (United States). It will also be an opportunity to think of a vision for the next 50 years. The host countries are determined on an alphabetic basis. In 2013, Belgium will host the Parties' annual meeting once again, after having hosted it in 1964 and 1985.

SPACE AND ANTARCTICA

Space at the service of Antarctica: nothing could be more justified when you consider that the white continent is a natural laboratory which is used to prepare long-term space missions: isolation, confinement, a hostile environment to humans, these are all conditions that are found in the cosmos.
But the similarities don't stop there. In the legal domain, space also took inspiration from the ideas and concepts developed in the Antarctic Treaty. The comparison is particularly relevant between the 1959 Antarctic Treaty and the 1979 Agreement on the Moon and other celestial bodies.

© Associated Press, Chilean Navy (sinking MV Explorer in Antarctica, 2007)

INTERNATIONAL SYSTEM / FREEDOM OF SCIENTIFIC RESEARCH

Both the Law of Outer Space and the Law of Antarctica systems guarantee the freedom of scientific research, apart from the fact that the Treaty of Washington limits this freedom to researchers from the party states.

MUTUAL CONTROL AND INSPECTION VISITS

This system is also applicable to (future) lunar bases and installations or those installed on other planets in our solar system. The mutual visits and inspections allow the provisions in the applicable treaties to be respected to a certain degree..

INTERNATIONAL RESPONSIBILITY

The Washington Treaty is complemented by the Madrid Protocol on the protection of the Antarctic environment. This protocol provides for the state's international responsibility owing to the activities it carries out or which are carried out by private individuals under its authorisation. This system is very similar to the one concerning activities in outer space.

PEACEFUL AIMS / BAN ON MILITARY ACTIVITIES

While the notion of peaceful aims has greatly evolved since their adoption right in the middle of the Cold War, both the Antarctic Treaty and the Moon Agreement ban military activities. However, they don't forbid the use of military personnel for peaceful purposes.

BAN ON NUCLEAR TESTS

Besides their military aim, the storage, test or activation of nuclear loads or waste are banned by both treaties.

Captivated by the Pole: the Belgians in Antarctica

Senne Starckx - Pictures: de Gerlache collection

When the Antarctic winter drew to an end in September 1898 the pack ice around the Belgica finally began to thaw and a chapter closed on a perilous Belgian adventure. The name Adrien de Gerlache would go down in history, and our nation would set out on an enduring commitment to the Antarctic continent.

When the sixth International geographical congress was held in London in 1895 there were only a few blind spots left on the world map. Explorers, often in the pay of the European powers, had pushed right into the deepest jungles of Black-Africa, and even the world's oceans contained only a few places which had not already been logged by a passing ship. But, at the bottom of the world atlas there lay a glaring exception: Antarctica, the seventh and last continent, of which only a few stretches of coastline had ever been seen by human eyes. The London congress had every reason for complaint. After the James Ross expedition of 1841 all exploration of this last piece of *terra incognita* had ground to a halt. All despite the fact that in the first half of the 19th century, after the fall of Napoleon, it was still looking as though the Southern Continent would soon be 'taken'. In spite of the many expeditions things had not progressed beyond feeling out the contours of the last continent and the many islands dotted around it. It was Russian naval officer Fabian Gottlieb von Bellingshausen who, from the deck of his ship, may well have been the first to see the Antarctic mainland (that was in 1820). Three years later British seafarer James Weddell reconnoitred the sea off the Antarctic Peninsula, a finger of land pointing out towards South America, and, exploring the sea named after Weddell, compatriot James Ross discovered the world's largest floating ice shelf (the Ross Ice Shelf). But none of these men, or their crews, had ever set foot on the mainland of the South Pole.

Scientists sought to use the Geographical congress of 1895 to prompt the governments of Europe and North America to lend their weight to the endeavour. A resolution containing the following keynote was passed: *The exploration of the Antarctic regions is the greatest piece of geographical exploration still to be undertaken... and this work should be undertaken before the close of the century.* Much of the southern continent would have to be

the Belgica

Emil Racovitsa in his laboratory

mapped out by 1900. Naturally, the London congress had in mind a British or American expedition, possibly with help from Scandinavia. The Norwegians, for example, were very much at home in the ice-cold polar waters, due for the most part to their whaling activities. In fact, in the same year, 1895, a Norwegian-born Australian, Carsten Borchgrevink, had already sailed to Antarctica and been the first to set foot on the mainland, near Cape Adare in Victoria Land. But before the turn of the century only one country was to heed the call of the London meeting. This South Pole expedition sailed not under the British or American flag, but under the tricolour of a country that actually had nothing to gain from the Antarctic.

This was a viewpoint shared by the Belgian government, not to mention Leopold II. The King already owned the Congo Free State, which, until he 'bestowed' it on the government in 1908, was the largest tract of land on earth belonging to one person. He was more than happy to send explorers to the Congo. After all, it paid dividends. But what was there to be had from a huge landmass under several kilometres of ice? However, a young Belgian navy lieutenant from Hasselt was dead set on the idea of sailing to Antarctica. His taste for adventure had probably been whetted by stories of expeditions to the Arctic Ocean, such as those of the Norwegian polar explorer, Fridtjof Nansen, who managed to get very close to the geographical North Pole in his ship, the *Fram*. But if this Adrien de Gerlache was to succeed he would have to set up his expedition without much help from the government. It was by forging a union with scientists that de Gerlache managed in the end to scrape together the resources he needed to provision his ship and crew. The expedition with the Belgica became the first polar expedition with a true scientific leaning.

Belgium may not have had a maritime history to speak of, but by the end of the XIX century it did have

Adrien de Gerlache on the bridge of the Belgica

LE OR LA BELGICA ?

La *Belgica* (female) is that famous Belgian polar exploration vessel, which was the first ship to winter in the Antarctic ice (1897-1899). Originally a Norwegian sealer called La Patria, built in 1884 and bought by Adrien de Gerlache in 1896 to be rebaptised Belgica in preparation for a polar expedition to the Antarctic. To this end certain modifications were carried out, such as hull, keel and tiller reinforcement in order to resist the punishing ice, as well as a new propeller screw and a new boiler. Finally a roof, intended to shelter the laboratories, was constructed on the bridge.

Le *Belgica* (male) is a public service oceanographic vessel; property of the Belgian State and dependent on the Federal science policy. Since 1984, the Belgica has assumed the surveillance of the North Sea, constantly gathering a rich diversity of data on the biological, chemical, physical, geological and hydrodynamic processes taking place there.

something of a tradition in the field of science, and particularly industry. There was Ernest Solvay, who, by discovering a simple process for making sodium carbonate, had built up a huge industrial empire in a short space of time. And then there was Edouard Empain, whose *Groupe Empain* was laying railway lines and tram and metro tracks all over the world. Therefore, in de Gerlache's plan the Belgian industrial world saw an opportunity to spread its reputation abroad - an early form of sponsoring, which it would be hard to imagine a modern-day expedition without. However, besides funding, de Gerlache was, of course, in need of competent crew, and, above all else, a well-found ship! To find one he went to the Svelvig shipyard in Oslo, where he purchased a three-masted vessel – although it did have steam engines – and had it refitted from top to bottom. He named it the Belgica. He also took on a few Norwegians as crew (among them Roald Amundsen, later the first man to reach the South Pole). In addition, he took two Polish, one Romanian, and even an American scientist aboard. More than just scientific, the Belgica expedition was highly international.

Adrien de Gerlache and his crew left Antwerp on 16 Augustus 1897 and set course for South America. Along the way, the consequence of having only scientists on board made itself keenly felt. Whereas a real explorer would have sailed south as quickly as possible, the American doctor, Frederick Cook, wanted to stop off and acquaint himself with the indigenous Indian peoples of Patagonia. And the Romanian biologist, Emil Racovitza, took great pleasure in studying the vegetation in the coastal region of Tierra del Fuego. In the end, the crew of the Belgica did not reach the Antarctic Peninsula until early February 1898, where they discovered straits which now appear on the map as the de Gerlache Strait and contain the islands of Anvers, Brabant, Gand and Liege.

In search of new land the Belgica then sailed south, but in early March it became trapped in the thickening pack ice, for the Antarctic winter was at the door. The Belgica was unable to move a yard forward or backwards and it became clear that de Gerlache and his crew would be the

first people ever to spend the winter below the Antarctic Circle. All indications seem to suggest that if the captain of the Belgica had not already been considering this plan he would not have sailed so far south with winter fast approaching. Moreover, the Belgica was well equipped for this: the U-shape of the hull, as opposed to a V-shape, meant that the ship was not crushed but raised in the pack ice. A trick de Gerlache had learned from Nansen. The polar winter came, and, by 18 May, brought with it the polar night: the sun would not show itself to the crew now until August. Not only was this very bad for moral, but it also robbed the men of their daily dose of vitamin C. Only in September 1898 was the Belgica able to free itself from its delicate situation, but it would take until February before the journey home could be undertaken. It goes without saying that de Gerlache and his crew were welcomed as heroes in Antwerp. But there was a damper on the party: two of the crew had not survived the expedition. The Norwegian seaman Auguste-Karl Wiencke had fallen overboard and drowned and the Belgian geophysicist Emile Danco had died of heart failure as a result of the extreme conditions. But the Belgica expedition results were acknowledged in scientific circles too. They had discovered that the temperature remained below zero in the Antarctic, even in the summer, which was not the case in the Arctic regions – a remarkable observation!

After the turn of the century the nature of South Pole expeditions changed dramatically. The race was on to be the first man to stand at the geographical South Pole. It was no longer a question of sailing as far south as possible in a ship, but of ploughing through thousands of kilometres through snow and ice by foot and by ski with a team of huskies. It was something like the race to the moon between the United States and the Soviet Union in the nineteen sixties, although in this case it was more of an individual contest. Roald Amundsen for Norway against Robert Falcon Scott for the United Kingdom – we are now in 1911. The story of Scott, who reached the South Pole only to find the Norwegian flag already planted there, is famous and tragic. Scott and his

fishing on the ice shelf

men would freeze to death on the leg home less than 18 kilometres from their supply post. And then there was the legendary fight for survival of Ernest Shackleton and his crew of the Endurance – we are now in 1914. With the coming of the First World War all plans to explore the southern pole were frozen.

But the Belgians would return to the Antarctic in the footsteps of Adrien de Gerlache. De Gerlache himself, for that matter, planned a second expedition, but was unable to raise the funds he needed. It was not until long after his death in 1934 that Belgium decided to send people to the South Pole. Once again this was spurred on by an international congress, this time the International Geophysical Year (IGY), sometimes referred to as the Third International Polar Year, which was held between 1 July 1957 and 31 December 1958. The purpose was again to gain a clearer picture of the earth's surface, only this time with the help of satellites. As part of the activities for IGY a number of observation stations were set up on the Antarctic coast, and the Americans set up a base right on the geographical South Pole. Here, scientists would measure the atmosphere, geomagnetism, etc. The part played by the Belgians in the history of Antarctic exploration gave Belgium a foothold in this observation programme. And on 1 December 1959 Belgium would be one of the twelve countries to sign the Antarctic Treaty. This treaty laid the foundations for the protected status enjoyed by the Antarctic continent to this day, as though it were one, huge nature reserve.

The first Belgian base at the South Pole was erected in Queen Maud Land, which is part of the Norwegian claim, and christened the King Baudouin Base. It was Adrien's son, Gaston de Gerlache, who led the first expedition, in which the entire base was transported on two ships. On Boxing Day 1957 the *Polarhav* and the *Polarsirkel* anchored off the coast of Antarctica. At their own base the Belgian scientists studied the southern lights (*aurora australis*), geomagnetism and the composition of the snow and ice, while others

reconnoitred the unexplored interior of the continent. They named the peaks of the Belgica and Queen Fabiola mountain ranges. The Belgian polar base was permanently manned for three expeditions, until late 1961, but the National Centre for Polar Research could not raise the funds needed to continue the Belgian Antarctic programme.

However, Belgium would work hard to find a new impulse for its southern pole research. New expeditions were organised from 1964 to 1967 in collaboration with the Netherlands (not one of our northern neighbours had ever set foot on the South Pole before). The destination was a new King Baudouin base less than one hundred metres from the old, which had been buried in snow and was completely unusable. From there the scientific observations continued. But this second base was to close fairly soon too, ending the Belgian logistic presence on the continent. In collaboration with South Africa, in the late sixties, and later, as of 1985, thanks to funding via the Antarctic Programme of the Federal science policy, Belgian scientists were again highly active in Antarctic research programmes, albeit as welcome guests at the bases and on the ships of other nations. To date this long-term federal research programme has ensured continuous funding for our Belgian Antarctic researchers.

But there have been other initiatives too: to mark the one hundredth anniversary of the de Gerlache expedition Belgian explorers Alain Hubert and Dixie Dansercoer crossed the continent of Antarctica with no help or provisioning from the outside. And climber Rudy Van Snick scaled the highest mountain at the South Pole, Mount Vinson, in 1995. With the installation of the brand new Princess Elisabeth Base our nation is again at the forefront of Antarctic research, 110 years after the first Belgians sailed to Antarctica aboard the Belgica.

ANTARCTIC HERITAGE

"At the end of the 19th Century, an initial scientific expedition to Antarctica opened the way for scientists to explore a continent which, up till then, had remained almost entirely unknown. Then, sixty years later, a new expedition was organized by Belgium. The memories of Antarctic exploration have always adorned the quiet walls of my family home; photographs familiar enough as to become almost nostalgically distant.

This is why I have decided to re-immerse myself in the history of these men, who each set off on their particular adventure, each at the heart of his era and each with his own motivation.

This history of exploration is the story of my grandfather, the aviator Gaston de Gerlache, who set off in 1957 with 17 men to construct a base in a previously virgin part of the continent. And, before him, of his father, Adrien, who was the first man to pass an entire year in the Antarctic with his team of scientists."

"Antarctic Heritage", a film by Henri de Gerlache (52 minutes) produced by Arctic productions and Alizé production, in collaboration with the *RTBF* and with the support of the Federal science policy.

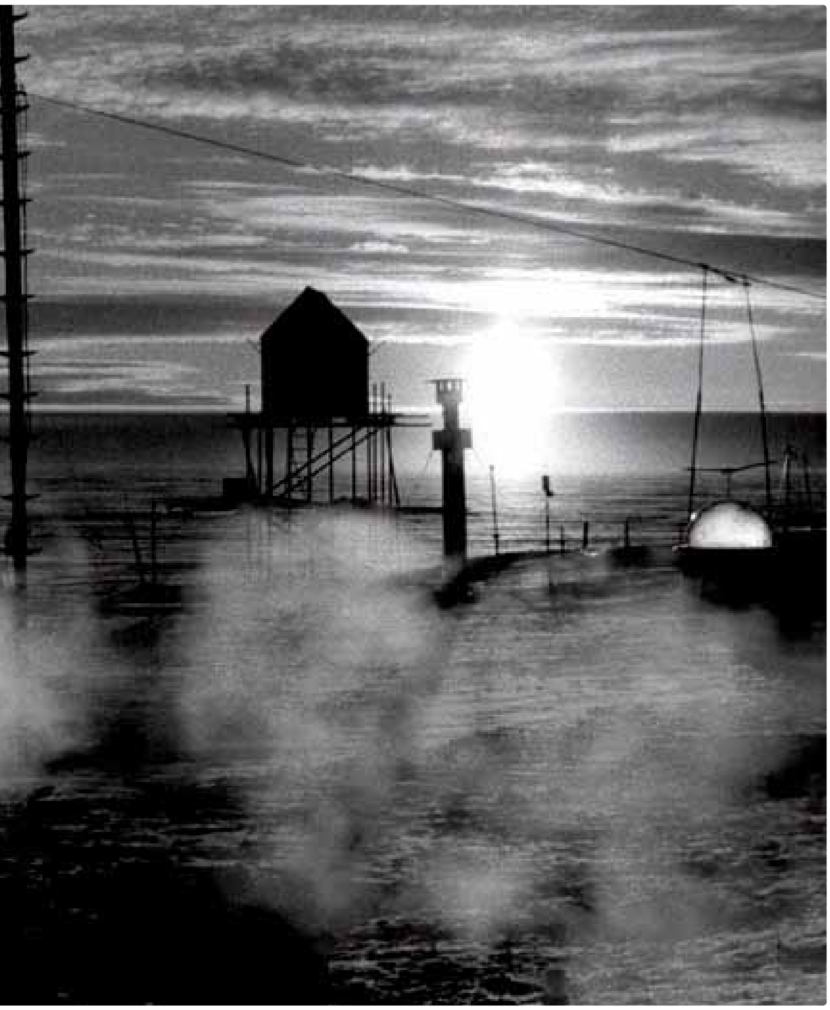
A century of research at the South Pole

Els Verweire

When Adrien de Gerlache allowed the pack ice to freeze around the Belgica, this marked the start of a more or less constant Belgian scientific presence in the Antarctic region. With the help of Prof. Dr. emeritus Hugo Decleir of the Vrije Universiteit Brussel and a few modern-day Antarctic researchers, we briefly run over a hundred years of Belgian research in Antarctica.

At the end of the nineteenth century the North and South poles were the last unexplored regions of the earth. Some adventurers headed there to stake a territorial claim; others had more commercial ends in mind and went after seals or whales. In 1897 a certain Adrien de Gerlache, undoubtedly the greatest mariner that Belgium has ever known, set sail for the South Pole in his ship the Belgica. His voyage would go down in history as the first truly scientific expedition to the Antarctic, and he himself as the first to overwinter there. "*Although not everyone is convinced that de Gerlache intended to get stuck in the pack ice, I for one am sure that it happened on purpose*," says Prof. Dr. emeritus Hugo Decleir, former glaciologist at the VUB. "*Reading through the Belgica's log it is obvious that he intended to spend the polar winter in the pack ice, as had his leading example, Norwegian explorer Fridtjof Nansen, in the Arctic Ocean. Nansen allowed the Arctic pack ice to freeze around the Fram, a ship built especially for that purpose.*"

Nansen's mission to reach the geographical North Pole may have failed, but, for its sheer audacity, his expedition was greeted as a remarkable achievement. Hugo Decleir: "*De Gerlache attempted the same kind of thing on the other side of the world, and with equal success. Having sought advice, before and after, from numerous Belgian universities and scientific institutes, and having taken accomplished scientists aboard from four different nations, his expedition brought in results, not least in terms of geographical discovery and scientific observation. Good examples of these include the first ever complete annual cycle of meteorological observations and a great many specimens of newly discovered biological species, which were still being studied midway into*



© L. Goossens (the King Baudouin base covered by snow)

© Tony Van Autenboer (Topographers)

the twentieth century." De Gerlache ushered in the Heroic Era of Antarctic exploration. Countless expeditions would follow, and, on 14 December 1911, the Norwegian, Roald Amundsen, second mate aboard the Belgica, would become the first man to set foot on the geographical South Pole. Little by little the contours of the Last Continent would be charted. But, for the time being, its geological, geophysical and biological significance to the earth system would remain unknown.

The King Baudouin base

The third International Polar Year of 1958-1959 heralded the second important phase of the Belgian presence in the Antarctic. "*This year was also known as the International Geophysical Year, in which not less than sixty-four nations signalled their commitment to study the physical characteristics of the earth,*" says Prof Decleir. "*In that period a massive scientific offensive was launched in all the unexplored areas of the planet. And, because hardly any real, systematic scientific observation had been done in the Antarctic, the South Pole became one of the central objectives. Twelve nations – of which Belgium – decided to establish more than fifty bases on the Pole with the principle aim of studying our planet's relationship with the sun. The Americans built the Amundsen-Scott base at its theoretically most important point – the geographical South Pole –, the Russians set up their Vostok base at its least accessible point – the middle of the East-Antarctic icecap – and, on the initiative of Adrien de Gerlache's son Gaston de Gerlache, the Belgians confirmed their scientific interest in the continent by establishing the*

King Baudouin base on a floating ice shelf off the coast of Dronning Maud Land."

On 1 December 1959 the same twelve nations signed the Antarctic Treaty. This brought an end to all territorial claims in the region, forbade all military activities within its boundaries, and declared Antarctica as a 'continent for science and peace'. At these fifty-five stations researchers from just about every field of study gathered all kinds of data, which they stored in a central databank. Hugo Decleir: "*In that period our knowledge of Antarctica progressed in a spectacular way. Two types of data were collected. Firstly, researchers took countless systematic readings, that is, at regular intervals and according to fixed procedures. These included the traditional meteorological observations of temperature, air pressure and wind speed, as well as observations of different layers of the atmosphere, such as the ionosphere and the ozone layer in the stratosphere. Secondly, the scientists mapped out the continent's geography, geology and glaciology. Belgian geologists, among whom Prof Tony Van Autenboer, played an important role in this. They performed studies in the Sør Rondane mountain range, at the foot of which the new Belgian Princess Elisabeth research station is built, and discovered, among other things, the Belgica and Queen Fabiola mountains.*"

Sadly, after barely ten years, the King Baudouin base was forced to close. In the years between 1958 and 1961, however, it served as a base camp for the Belgian Antarctic Expeditions, and later, after its rebuilding in 1964, for the Belgo-Dutch Antarctic Expeditions of 1964-1967. Hugo Decleir: "*Financial problems aside, the main reason for the base's closure was that it was in danger of vanishing beneath the snow. Heat was escaping from the building to the outside, so that the ice under the station was thawing. Also, the base had to contend with massive snowdrifts, caused by katabatic winds so typical for the Antarctic region, and the accumulating snow was gradually compressing the building.*" Nonetheless, the Belgian scientists managed to extend their presence in Antarctica for a few more years. "*We got another three years by cooperating with South Africa,*" continues Hugo Decleir. "*This was largely due to the fact that the South African researchers, unlike the Belgians, did not have airplanes. In return for having two small planes shipped to Antarctica, the Belgians flew logistic trips for the South African scientists. In that period the Belgian scientists, myself included, did mostly glaciological research, such as measuring the ice thickness of the glaciers, which, incidentally, we were the first to do using radio signals from an airplane, for until then this had only been possible by gravimetric and seismological measurement. Unfortunately, however, one of the planes crashed on an expedition, and thus, with nothing else to exchange, our nation was forced to abandon Antarctica for quite some time*".

It would be 1985 before Belgian researchers were again able to visit the Antarctic. "*In the meantime, concerns about the environment had heightened enormously*", explains Hugo Decleir. "*The term global change was being used for the first time: people had become conscious of the fact that they were polluting the earth on a massive scale and that global protective measures would have to be put in place. And research in the Antarctic fits in wonderfully well with this.*" In addition, pressure was mounting on Belgium as a signatory to the Antarctic Treaty. This is because when the Treaty was signed it had been agreed that a nation could only be accorded consultative status if it did important work in Antarctica. And, since Belgium had not been there in fifteen years, its signatory status was now is question. "*In 1985, due in part to this pressure, Belgian research resumed under the first phase of the Belgian Antarctic Scientific Research Programme run by the Federal science policy. But, with no research platform of their own (such as a ship or a polar base), the only way the Belgian researchers could get to work was in collaboration with other nations. On the positive side our Belgian researchers managed, like no other nation, to establish themselves in the international research networks, where they have remained active to this day. Recognition of their valued expertise comes every year in the form of invitations to join other nations' programmes. On the negative side, of course, they were always dependent on the nations they collaborated with and were not able to choose their own research area. Nor were they able to offer much in exchange for this free international cooperation. The idea gradually began to grow that a new Belgian base would solve these problems nicely.*"

A new station in exchange of rendered services

That base might never have actually materialised, had the Federal science policy not commissioned an international audit in that period to assess the quality of Belgian Antarctic research since 1985. Hugo Decleir: "*The results of that audit revealed that the research done by our scientists in ensuing phases after 1985 was of an extremely high quality. But it also revealed that there were calls for the Belgians to improve their visibility on the South Pole.*" It was then just waiting for Alain Hubert and his International Polar Foundation to take the initiative and start attracting private investors and winning politicians over to the need for a new station, after which there was nothing to stand in the way of the Princess Elisabeth base, which will be inaugurated early 2009.

© Frank Pattyn (ASPI and BELISSIMA projects)

According to Hugo Decleir the location of the new Belgian base – in Utsteinen in East Antarctic Dronning Maud Land – is ideal for just about any kind of research programme you might imagine. "*The location was carefully selected so that it would be easy to study every conceivable landscape from the base*", he tells us. "*We have the floating ice shelf off the coast, the Sør Rondane mountains, and the Antarctic plateau all within a radius of 200 kilometres, which opens up an enormous diversity of research opportunities.*" And this ties in perfectly with the new types of subject being studied today. "*Whereas the research undertaken during the International Geophysical Year focused on the geophysical study of the upper atmosphere and its relation to solar activity, the studies now tend to be directed towards environment and climate research, and subjects such as biology, and more specifically microbiology, have become much more important research topics*", he tells us. Another thing that has changed is the method of study. "*Whereas most of the research was systematic, this 'measurement for measurement's sake' is no longer valued. Of course the climate, the magnetic field and the ionosphere still have to be observed, but today the emphasis lies on problem solving science: a problem is raised and scientists are required to contribute to the solution.*"

Climate change and biodiversity

Modern-day Belgian research in the Antarctic falls under phase six of the Belgian Antarctic Research Programme, which runs from 2006 to 2010. The most important subjects under study are climate change and biodiversity. One of the researchers involved in the study of how our climate is changing is glaciologist Prof. Dr. Frank Pattyn of the Université Libre de Bruxelles. At the end of 2008 he and his ULB colleague Prof. Dr. Jean-Louis Tison will become the first people to use the Princess Elisabeth station for research purposes. "*The Antarctic is a passive and active research terrain for glaciologists*", he tells us. "*Passive because the ice records all kinds of information. This is because every year a layer of ice containing tiny air bubbles and other materials is laid down. Researchers drill down through centuries of accumulated ice and are able to use these air bubbles to reconstruct the climate over that period. The South Pole is an active research terrain because the Antarctic ice moves, and these movements affect our climate. The sea level changes when the icecap shrinks or expands. The changing ice mass also affects its albedo, or its ability to reflect back the incoming radiation from the sun.*"

The project that will be taking Pattyn to the Antarctic at the end of this year – BELISSIMA or *Belgian Ice Sheet & Shelf Ice Measurements in Antarctica*, a continuation of ASPI or *Antarctic Subglacial Processes and Interactions* – aims to uncover the mechanisms behind this dynamic aspect of the icecap. "*The Antarctic ice moves under the effect of its own weight. After time the ice ends up in the ocean, where it floats. This is a natural phenomenon. If icebergs are breaking off more frequently than normal this could mean that there is a greater quantity of ice being transported to the coast. Glaciologists want to monitor this, but, more than that, they want to understand the mechanisms behind it. This is because until we have understood these mechanisms we will*

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not be able to predict things like rising sea levels when coastal glaciers accelerate. These mechanisms come into play along the dividing line between the icecap – which is frozen solid to the ground – and the ice shelf – which floats on the sea – and this line is a day travel away from the new Belgian base. We will be collaborating with researchers from the University of Washington and using an ice radar to search for things like isocrones – these are ice layers of the same age. Our findings will be used to see if this dividing line is stable or shifting. Also, in collaboration with researchers from the University of Aberystwyth we will take a core sample at some point along this dividing line. We will see if it contains only meteoritic ice – ice deposited by precipitation – or if it also contains marine ice, which comes about through contact with the sea and changes the dynamics of the whole. The data we get from this will be fed into models to enable us to make predictions about how the icecap is evolving."

The BELCANTO oceanographic research network (*Belgian research on Carbon uptake in the Antarctic Ocean*), coordinated by Prof. Dr. Frank Dehairs of the Vrije Universiteit Brussel, was also set up to further the study of climate change. "*The main aim of our research in the Southern Ocean – the ocean around the Antarctic continent – is to gain a better understanding of how the marine biological carbon pump or biopump works, and assess how this process is affected by climate change*", he tells us. "*Sunlight causes photosynthesis taking place in the surface water of the ocean, just as it does on land. Only in this case the process involves microscopic organisms, single-celled algae. When organic carbon is created, CO_2 – carbon dioxide – is drawn from the atmosphere and transported to the deep sea where most of it is released again through bacterial degradation. This is not much of a phenomenon in just one litre of water, but across the whole of the Southern Ocean the exchange of carbon between the seawater and the atmosphere is actually a massive process. Ice core samples from Antarctica tell us that this process is one of the major driving forces behind CO_2 fluctuations between glacial and interglacial periods.*"

Frank Dehairs specifically wants to study how the carbon transported via the biopump is stored in the ocean's mesopelagic zone – at a depth of 100 to 1000 metres – and how long the CO_2 is kept out of the atmosphere. It is also important to find out how the biopump is affected by the current processes of global warming and ocean acidification. "*Both trends are the direct result of the exponential increase of CO_2 in the atmosphere*," he tells us. "*Warming increases the stability of the surface water (warm water floats on cold) and inhibits the supply of nutrients from the deep sea, thereby slowing productivity, while ocean acidification is caused by increasing CO_2 absorption, and impacts on the physiology of the biological carbon pump. At the present time it is difficult to predict exactly how the biopump will react to these changes in the future. Over the ocean as a whole, however, their effect on the biopump and how it functions will more than likely be negative.*"

Prof. Dr. Wim Vyverman and Prof. Dr. Marc De Batist (*Universiteit Gent*) and Dr Annick Wilmotte (*Université*

© *Martin Van Coppenolle (BELCANTO project and SIMBA campaign)*

de Liège) are doing their part for climate research via the HOLANT project, which stands for *Holocene Climate Variability and Ecosystem Change in Coastal East and Maritime Antarctica*. "*The main aim of the HOLANT project is to study the climate history and coastal evolution of the Antarctic*," Wim Vyverman tells us. This he does at his Protistology and Aquatic Ecology (PAE) laboratory, in collaboration with Marc De Batist of the Renard Centre of Marine Geology (RCMG), by studying archives of the sediments that accumulate in ice-free areas of the Antarctic coast and on the sub-Antarctic islands. "*Under the LAQUAN project and its successor, the HOLANT project, we are collaborating with international research partners to build up a network of accurately dated paleoclimate reconstructions covering the last 10,000 years, to be intercalibrated by means of ice core samples and deep sea marine sediments. This should give us a better understanding of spatial and temporal variations in the climate processes in and around the Antarctic and how they interact with the climate in the rest of the world. In fact, many of the lakes in the study have lain below sea level in the past. These transitions from salt to fresh water sediments enable us to reconstruct relative changes in sea level, which in turn gives us a picture of regional variations in the thickness of the icecap as the result of climate change. These data are then used by glaciologists to test and refine icecap models.*"

The AMBIO or *Antarctic Microbial Biodiversity* project is coordinated by Annick Wilmotte. "*Along with Wim Vyverman and his colleague Prof. Anne Willems of the Universiteit Gent I am studying present-day biodiversity in the Antarctic and the spread of bacteria, chlorophyceae and diatomaceans in the continent's permanent and temporary aquatic habitats*," she tells us. "*We look for historical and geographical factors to explain the spread of organisms, i.e. why a particular species is found in one place and not another. I will focus on cyanobacteria, Anne Willems on bacteria and Wim Vyverman on eukaryotes.*" "*Although microorganisms are the dominant life form in the aquatic and terrestrial ecosystems of the Antarctic, we know hardly anything about their species diversity, the extent of their endemism, or how adapted they have become to the extreme environmental conditions*", explains prof Vyverman. "*Given their short generation time microorganisms are also rapid indicators of environmental change as the result of pollution, introduction of exotic species, and climate change. In close cooperation with our international research partners we are carrying out a detailed study of microbial diversity using molecular techniques, biochemical markers and culture-based research. The results of this study will give us an understanding of the evolution of microorganisms in the Antarctic and serve as the basis for any future conservation plans. Furthermore the isolated strains will be deposited in the BCCM collections (Belgian Coordinated Collections of Micro-organisms.*"

One of AMBIO's sister projects, BELDIVA, will be looking at biodiversity in the environment around the Princess Elisabeth station. Dr. Damien Ertz and Dr. Bart Van De Vijver of the National Botanical Garden of Belgium, Meise, will be joining the research team to map out the biodiversity of prokaryote and eukaryote microorganisms and lichens. "A*t present we are analysing samples taken from Utsteinen during the reconnaissance expedition in January 2007, before the station was built" Elie Verleyen tells us. "The results will serve as a point of reference when it comes to analysing the station's impact on the local ecosystem. This is because Belgium has committed itself internationally to monitor the environmental effects of its activities and keep them to an absolute minimum.*"

In the coming season, i.e. January-February 2009, besides regular monitoring of the station site through sampling, the team will also start keeping records of the general biodiversity in the surrounding environment, to a distance of about 100 kilometres from the base. These records should then trigger specific biodiversity research projects in the Sør Rondane region, on which we have little or no biological data at the present time.

© Claude de Broyer (BIANZO project)

The third project on biodiversity – BIANZO, or *Biodiversity of the Antarctic Zoobenthos* – is coordinated by Prof. Dr. Ann Vanreusel of the Universiteit Gent. "*We concentrate on various aspects of benthos research in Antarctica, and, in particular, we specialise in nematodes, one of the most species-rich and numerous groups of multi-celled organisms found in the sea sediment. One project our research group was involved in was the international ANDEEP initiative, in which we went to the Weddell Sea to investigate whether zoobenthos migrate from the deep to the shallower areas and vice-versa, and whether an exchange takes place with other deepwater basins around the world, in this case the Atlantic Ocean. One of the things the BIANZO project sets out to ascertain is the effect of global warming on zoobenthos - how these organisms are affected, for example, by slight changes in the temperature or in the quality or quantity of food. We will focus our attention on nematodes, while the Royal Belgian Institute for Natural Sciences and the* Université de Liège *will investigate the effects on amphipods, and the* Université Libre de Bruxelles *will concentrate on echinoderms. The aim is to pursue comparable lines in inquiry for these different taxonomic groups to help us gain an understanding of biodiversity patterns and their possible adaptations.*"

Although the studies undertaken in each of these projects, and in countless more, relate to just a tiny part of the immense Antarctic continent, we certainly cannot underestimate their importance. "*The little bit of research we are doing may be quite limited, but it does fall within bigger international projects, which are in themselves part of an immense puzzle from which we are all guaranteed to benefit*," concludes Frank Pattyn. A puzzle in which our Belgian researchers have been passionately involved for over a hundred years.

© Wim Vyverman (HOLANT and LAQUAN projects)

scarmarbin.be: free and open access to Antarctic marine biodiversity information

Given the pace at which environmental changes occur in Polar Regions, it is of vital importance to establish comprehensive information on the Antarctic marine biodiversity as a sound benchmark against which future changes can be assessed.

The Census of Antarctic Marine Life (www.caml.aq) and the SCAR-Marine Biodiversity Information Network (www.scarmarbin.be) projects are devoted to these key objectives. SCAR-MarBIN is a developing network of over 93 interoperable databases distributed globally, providing instant access to comprehensive information on biodiversity, distribution and abundance of Antarctic marine species, from micro-organisms to whales.

SCAR-MarBIN is the information component of the International Polar Year Census of Antarctic Marine Life (CAML) and constitutes the Antarctic Node of the Ocean Biogeographic Information System (OBIS).

Hundreds of scientists from 50 institutions publish data and share expertise through SCAR-MarBIN, which gives access to about 1 million occurrence records pertaining to 8000 species. SCAR-MarBIN offers services and tools to help scientists, conservationists and environmental managers to visualize, explore and integrate complex data.

Since mid-2007 more than 22 millions records have been downloaded from the web portal for scientific, outreach, management and conservation purposes. The data and tools provided by SCAR-MarBIN are particularly instrumental for establishing a bioregionalisation of the Southern Ocean, for identifying future Marine Protected Areas and for detecting early shifts in Antarctic marine ecosystem regimes related to Global Change.

© Julian Gutt (AWI) (SCAR-MarBIN project)

SCAR-MarBIN was initiated by the Royal Belgian Institute of Natural Sciences and is supported by the Federal Science Policy. It is managed by the Belgian Biodiversity Platform under the aegis of the Scientific Committee on Antarctic Research (SCAR, ICSU).

MORE:

CAML : www.caml.aq
SCAR-MarBIN : www.scarmarbin.be

The Federal science policy: cornerstone of Belgian Antarctic policy

Maaike Vancauwenberghe and Xavier Lepoivre

The first Antarctic research programme in Belgium was set up in 1985 and is funded and run by the Federal science policy. Since that date it has continued in four-year cycles and is now in its sixth phase. Thanks to a four-year budget of about 5 million euro, the Federal science policy is providing about 20 Belgian research teams from 10 universities and research institutes with the financial backing needed to collaborate internationally with other researchers and place their research on an international footing. It is the only Antarctic research programme in Belgium to encourage a mix of scientific disciplines and national networking, and to pave the way for collaborations with foreign partners. The research results feed into our political decision-making processes and inspire the development of new poles of expertise.

As part of the Fourth International Polar Year (IPY) 2007-2009, fifty years after the International Geophysical Year (IGY – 1957-1958), the international scientific community has organised a new wave of observations at the Poles. On this occasion the environment took centre stage, particularly the issue of climate change and the role played in this by the icecap and its surrounding oceans. But studies on biodiversity loss and microbiological life in the most extreme environments were also of importance. Belgium is hoping that the newly built Princess Elisabeth research station will provide a sustainable and reliable platform which will be included in the monitoring network developed to study these environmental issues and to outline a sustainable development policy. In addition to the successful international research projects within the programme, more funding is planned to support research at the Princess Elisabeth station.

Since the start of the programme, Belgian researchers used research ships and bases of other nations for their necessary fieldwork. Those other nations will now be given the opportunity to make use of the Belgian Princess Elisabeth research station. All this in strict adherence to the Antarctic Treaty.

In 2008-2009 a Polar Secretariat will be set up as part of the Federal science policy, with the task of running the base and coordinating its activities. The governing body will be jointly composed of federal government representatives and private sector partners, including the International Polar Foundation (IPF), and will organise the maintenance of the base and its equipment along with the implementation of the scientific activities. The Federal science policy will have the specific task of managing and supervising the research projects, which will be selected on the basis of their scientific value and logistic feasibility.

The Federal science policy has always taken a keen interest in environmental and climate research and it is in this broader context that fits its long-standing commitment to Antarctica.

Since its creation exactly fifty years ago the Federal science policy has been actively involved in environmental research programmes. Following the troposphere programmes of the late 1980s, the 'Global Change' programme of the early 1990s, and the two most recent sustainable development support plans (SPSD I and II), we now have the 'Science for Sustainable Development' (SSD) programme.

For decades more people and budgetary resources have gone into these programmes than into any other Belgian initiative and they yield reliable information on which among others policy-makers can base their decisions. The Federal science policy is also setting up a climate expertise centre which will include representatives from the Royal Belgian Institute of Natural Science, the Royal Museum for Central Africa, the Royal Meteorological Institute, the Belgian Institute for Space Aeronomy, the Directorate-General 'Research Programmes and Aviation and Space Applications' and the Directorate-General 'Coordination and information'. This expertise centre has a variety of objectives, such as improving synergies between those Directorates-General of the Department which operate in this area, developing their strengths, furthering their incorporation in national and international scientific networks, and so on.

Also recent is the technical and scientific support to Professor Jean-Pascal van Ypersele, who was recently elected vice-president of the IPCC. The Federal science policy is covering the costs of two doctors whose expertise will be of great help to Mr van Ypersele. Both doctors will operate from the Catholic University of Louvain.

The Department also supports many international infrastructures and initiatives in the areas of climate and sustainable development (the Darwin Station on the Galapagos Islands, Eumetsat, the Diversitas programme, etc.). This is a clear indication that the commitment of the Federal science policy to Antarctica, manifested today in the Princess Elisabeth research station, is part of a lasting and uninterrupted policy which started with its foundation fifty years ago.

The Federal science policy is thus with its scientific institutes clearly in the centre of climate research.

Europe retraces the history of climate on Earth through EPICA

Christian Du Brulle

To go back in time, simply look upwards into deep space. A star situated several light years away from us appears exactly as it did a few years ago. A galaxy situated hundreds of light years away looks exactly as it did... hundreds of years ago.

To study the Earth's ancient climates and their evolution, climatologists and glaciologists prefer to look under their feet! In Antarctica, the ice that covers the continent is the result of an accumulation of successive layers of snow. Over the years, the snow has piled up, compacted and changed into ice, trapping tiny air bubbles in its crystals that bear witness to the state of the Earth's atmosphere when it was formed and deposited in Antarctica.

This, of course, is a great stroke of luck for climatologists. The deeper they dig in this icecap, the further they go back in the climatic history of our planet.

Hence this almost ludicrous idea that came to light following the International Geophysical Year half a century ago: why not take cores of ice from the polar icecaps (in Greenland and Antarctica) and then analyse their composition, layer by layer, to 'read' the history of the Earth's climate over thousands of years?

The Americans were the first to set out on this adventure, beginning in Greenland (Camp Century in 1964 – 1390 m), then going to Byrd in West Antarctica in 1968 (2164 m). Two years later, the Soviets began their own core boring at the Vostok station in East Antarctica, which revealed information that was more

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than 420,000 years old. They were able to achieve this thanks to various bore holes, the deepest of which reached 3623 m in 1999.

The analysis of minute gas bubbles has revealed information on the atmosphere's composition in the past, mainly regarding the content of greenhouse gases. But the dust contained in this 'mille-feuille' also has a story to tell. That of ancient atmospheres where specialists can discern periods of abundant precipitation, changes in atmospheric circulation and its intensity, fires in temperate latitudes, etc. The ice is giving up its secrets. Its isotopic composition retraces the temperature conditions that prevailed when it was formed.

Ice, and before that the snow that led to its formation, are composed of water molecules: H2O, two atoms of hydrogen to one of oxygen. The variability in this mixture depends on the nature of these atoms. Hydrogen may appear in different forms (isotopes): light, heavy (deuterium) or extremely heavy (tritium). At the same time, oxygen may appear as its light (oxygen 16) or heavier (oxygen 18) isotope. It is the relative proportion of these isotopes in ice that allow glaciologists to determine the temperature that reigned during its formation.

The recipe is therefore simple. All that remains to be done is to obtain ever older samples to go back in time. We 'simply' have to dig deeper to find out more. With a depth of three kilometres in certain places, the Antarctic icecap is indeed an area of choice for this type of exercise.

Europe understood it! The result? A sizeable ambition: to double our knowledge in terms of the climatic archives contained in the ice. In 1995, the EPICA project was born.

EPICA (*European Project for Ice Coring in Antarctica*), is a project led by twelve partners from ten European countries: Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland and the

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This scientific exploit, coupled with the technical and human exploit (the average annual temperature at Dome C is -54 degrees C°), earned the project's partners well-deserved recognition. The European Commission awarded it the Descartes Prize in March 2008, for its transnational research programme whose basic criteria has always been excellence.

United Kingdom. Two sites in Antarctica were chosen as the scene for deep coring: in the region of Queen Maud Land and Dome Concordia. Analyses from Dome C are currently the most advanced and this has enabled researchers to take up the challenge. More than 3,200 metres deep, it was possible to extricate climatic information from the core that was more than 800,000 years old, enabling ten glacial cycles on Earth to be retraced.

For the moment, it is the oldest climatic reconstitution based on glacial cores; almost twice as old as those obtained from the Vostok boring (420,000 years). The results of the two EPICA surveys are not only a temporal record! They also show an increase in temperature contrasts between the glacial (cold) and interglacial (hot) periods over the last 400,000 years, probably caused by the relative influences of the climate's various astronomic factors. In addition, they have made it possible to make a detailed comparison of the regular temperature fluctuations, within a thousand years, that pepper the last glacial period (-110,000 years to -20,000 years), both in Greenland and Antarctica, and phased opposition that reveals the importance of the role of global oceanic circulation in transferring climatic signals from the Northern to the Southern hemisphere, and vice-versa.

ATMOSPHERIC METHANE AND CO_2 MORE ABUNDANT THAN EVER..

Concentrations of CO_2 and methane, two powerful greenhouse gases present in our atmosphere, have never been as high as they are now! At least during the last 800,000 years, i.e., the period studied in the EPICA programme's glacial cores. Published in the review *Nature* of 15 May 2008, this is what one of the most recent studies by partners of the EPICA programme reveals.

"*Never have such high levels of greenhouse gases as those present today been measured in the last 800,000 years*," explain the French researchers from the Laboratory of Glaciology and Environmental Geophysics at the *Université de Grenoble* and the Laboratory of Climatic and Environmental Sciences at the *Université de Versailles St-Quentin*, along with their colleagues from the Institute of Physics and the Oeschger Centre on Climatic Research at the Université de Berne (Switzerland).

"*The current values exceed 380 ppmv (one part per million in volume) for CO_2 and 1,800 ppbv (one part per billion in volume) for CH_4). Moreover, the CO_2 curve reveals the lowest concentrations ever recorded, of 172 ppmv 667,000 years ago.*"

2007-2008, an austral summer with a focus on research

Christian Du Brulle

While waiting for the new Princess Elisabeth research station to be put into service, Belgian scientists involved in polar sciences certainly weren't sitting idly by!

During the 2007-2008 season, several scientific expeditions saw our researchers out in the field or collecting interesting data by proxy for their work. Here are three examples of the research carried out on the other side of the world.

We are, of course, referring to glaciology and marine biology. But, more unexpectedly, a study has also been carried out on human behaviour and, in particular, the impact of the long 'polar day' on the sleep pattern of Antarctica's 'summer visitors'. This project involves the Vrije Universiteit Brussel and the *Ecole Royale Militaire*.

Glaciology

SIMBA keeps the ice floe under close surveillance

Among the Belgian scientific expeditions to Antarctica last (austral) summer was a team of nine glaciologists, including six PhD students. It began work on the ice floe in September on the surrounding area of the Antarctic Peninsula, in the region where Adrien de Garlache's Belgica spent its famous and historic wintering more than a century ago!

At the end of August 2007, Prof. Dr. Jean-Louis Tison (*Université libre de Bruxelles*) and his colleagues, Jeroen de Jong and Frédéric Brabant from ULB's Glaciology Laboratory, as well as Isabelle Dumont and Florence

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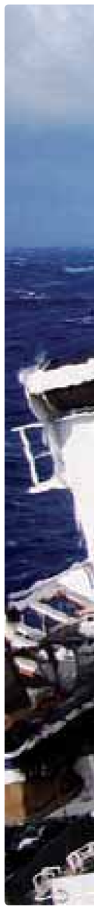
Masson from ULB's Ecology of Aquatic Systems Laboratory, Bruno Delille and Nicolas-Xavier Geilfus from the *Université de Liège*'s Chemical Oceanography Unit, Martin Vancoppenolle from the *Université catholique de Louvain*'s Institut Georges Lemaître, and Gauthier Carnat from the University of Manitoba's (Canada) 'Centre of Earth Observations', prepared to join the SIMBA expedition (*Sea Ice Mass Balance in Antarctica*) on board the American icebreaker Nathaniel B. Palmer.

Their expedition started out from Tierra del Fuego, at the far end of the South-American continent. But it was almost cut short in the first few days! The reason: a fire on board just as the ship had crossed the Drake Passage!

"*The fire broke out in one of the ship's laboratories as it was heading for Antarctica*," explains Professor Tison. "*We had to turn back and return to Punta Arenas. In the beginning, we were worried that our mission would quite simply be cancelled by the American authorities managing the ship. Finally, after several days in Punta Arenas and after the boat had been officially cleaned, we set off for Antarctica once again for a two-month campaign.*"

The work of the Belgian team (nine of the 32 scientists on board) focused on the ice floe's biogeochemistry. "*I.e. the study of the physics, biology and chemistry of the sea ice*," continues Jean-Louis Tison. "*It's a question of studying the behaviour of the ice floe in the South Pole, which is sometimes called sea ice. This ice*

© D.R. (Anne Goffart aboard the Astrolabe)



is caused by sea water freezing on the surface. Not to be confused with the icecap! This is the result of the snow falling on land (Antarctic continent or Greenland for instance) and piling up (plus compaction) over the years."

The ice cover of the Antarctic ice floe oscillates between 4 and 20 millions km² every year. It therefore doubles the surface covered by ice in Antarctica to the maximum of its extension. This surface area and the seasonal range mean that this Antarctic ice floe may potentially influence climate variations.

"*Its most well-known role is that of a gigantic reflective surface (high albedo) for incoming solar radiation, in comparison with the low level of reflection (high absorption) which characterises the open sea (low albedo),*" the researcher points out. "*But it does have several other roles such as the formation of deep-sea Antarctic waters: one of the main drivers behind global thermohaline circulation, an oceanic 'conveyor belt' which helps to transfer the equator's excess heat to the poles. The ice floe also has an impact on the stabilisation of the ocean's surface layer during the seasonal melt. Sea ice contains less salt – on average, six grams per kilo of ice – than sea water – approximately 34 to 35 grams of salt per litre of water. Therefore, its melt water 'floats' on the sea water, encouraging blooms of phytoplankton and, subsequently, gaseous exchanges between the ocean and the atmosphere.*"

It is these last two effects that constitute the main research objective of the Belgian projects carried out during the Simba mission. The projects are: SIBClim (*Sea Ice Biogeochemistry in a Climate Change Perspective*, a Concerted research action carried out by the French-speaking Community of Belgium - ULB), BELCANTO 3 (*Integrated Study of Southern Ocean Biogeochemistry and Climate Interactions in the Anthropocene*, a research network financed by the Federal science policy - ULg), and *BASICS in IPY* – (*Biogeochemistry of Antarctic Sea Ice and the Climate System under the International Polar Year,* project supported by the Collective Fundamental Research Fund of FRS-FNRS - ULB, ULg, UCL).

SIMBA is originally a project led by the American researcher Steve Ackley. This project leader is a professor at the University of San Antonio (Texas). The aim of SIMBA is to study the mass balance of Antarctic sea ice. In other words, it is a question of estimating the balance between the mass of melted ice and the ice mass created every year. This means measuring the surface covered by ice and its thickness,

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a thickness which may vary from several centimetres to a few dozen metres!

"*Technical progress over the last few years has led us to hope that we will be able to obtain this data with the help of the information collected by the observation satellites that revolve around the Earth*," the ULB scientist points out.

In reality, field work is always necessary, especially to measure the thickness of the ice. And in particular, to calibrate and validate the satellite data, as explained later on.

Subsequently, among the means implemented during the SIMBA campaign, fourteen drift stations were deposited on the ice floe by the researchers from the American icebreaker. One of these buoys was financed by the Belgian Federal science policy. It was set up on the ice on 6 October 2007 and drifted until mid-January 2008. Like all the mission's other buoys, these devices then fall into the water when the ice melts and stop emitting their data and their position.

Variations in the thickness of the ice were transmitted to the researchers over time by satellite relay. This data should allow researchers to verify the relevance of the mathematical models that predict the evolution of the sea ice in the coming centuries.

As for the biogeochemistry of the sea ice, which also interested the team during this science cruise, it was the subject of targeted studies.

"*As already indicated, the sea ice doesn't resemble glacier ice in any way*," continues Jean-Louis Tison. "*Neither does it resemble the ice cubes you make in your fridge, nor the ice which forms on the surface of ponds in winter, because this ice is formed from fresh water.*" When sea water freezes, it traps small inclusions of

© *Anne Goffart (the Astrolabe)*

brine (salt water), which form what scientists call brine pockets, tubes or channels depending on their geometry.

"*These can be interconnected when the ice is less cold (above 'minus five degrees' approximately),*" he continues. These brine inclusions are crucial because it is here that the microorganisms (from a micron to a millimetre) which live in the sea ice settle: microalgae, secondary consumers, bacteria, all in very high quantities.

Therefore, the concentrations of algae in the ice floe can reach several hundreds of microgram per litre, even though there are only a fraction of a microgram per litre in surface sea water.

Sea ice therefore plays an essential role in offering a place of refuge and culture (during the melt in spring and summer) in the surface polar sea waters.

And as these algae are plants, they photosynthesise. During this process, they take the carbon dioxide dissolved in the water, which serves as the basis for the creation of their cells. They therefore constitute a potential well of CO_2, whose extent is as yet unknown. It is the link between the ice floe's biogeochemistry and the climate…

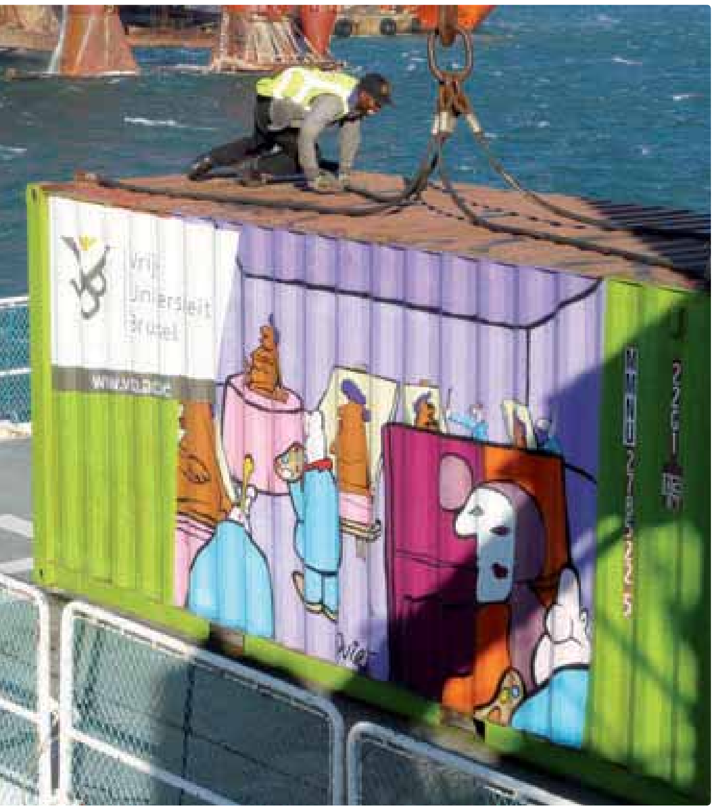
"*One of the main activities of our mission was to monitor the evolution of two sea ice stations for a month, with contrasting characteristics as regards their physical, chemical and biological properties. These measurements will allow us to better understand the dynamics of this complex ecosystem and to measure the potential impact on the regulation of the climate. The ultimate aim will be to develop a mathematical model that will attempt to reproduce the functioning of this environment, and to integrate its impact on the climate on a global scale.*"

This is why the team included Martin Vancoppenolle among its members, a young model-maker from the internationally renowned team of UCL's George Lemaître *Institut d'astronomie*.

Marine biogeochemistry

In February and March 2008, seven Belgian scientists took part in the BONUS-GOODHOPE campaign

The overall objective of BGH is to understand the exchanges, ventilation and route of the water mass as well as the biogeochemical cycles in the Atlantic sector of the Antarctic Ocean. This isolated region plays an essential role in the global circulation of the water



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in the exchange of heat, nutritive salts and carbon dioxide with the Atlantic and the Indian Ocean.

At the beginning of 2008, Prof. Dr. Frank Dehairs, Anne-Julie Cavagna from the *Vrije Universiteit Brussel*, Bruno Delille and Nicolas-Xavier Geilfus from the *Université de Liège* and Damien Cardinal, Frédéric Planchon and François Fripiat from the Royal Museum of Central Africa, went to the Cape (South Africa) to join the Paul-Emile Victor French Institute's research boat, the Marion Dufresne. Direction the Antarctic Ocean.

The Belgian team believes that Belgium's high level of participation in a major oceanography campaign would not have been possible ten years ago. But the researchers of the Belcanto Network (*Belgian research on carbon uptake in the Antarctic Ocean*) have acquired a certain credibility under the impetus of the Federal science policy. The latter has endeavoured to provide it with a critical size allowing it to learn about the carbon cycle in the Antarctic Ocean from the surface to the ocean deeps. The network's aim is to determine the effectiveness of the ocean's biological pump to prevent the increase in the concentration of carbon dioxide in the atmosphere. Furthermore, its researchers are endeavouring to digitally simulate the impact of the global climatic changes on this biological pump.

Marine biology

On board the Astrolabe, the Université de Liège tracks down the mysteries of marine diversity off Adélie Land

One month at sea off Antarctica in January 2008 to take samples of two cubic metres of water and all sorts of marine organisms: scientific cruises in the Antarctic Ocean are, for Dr. Anne Goffart, oceanographer at the *Université de Liège*, an almost 'routine' activity.

"*I have been working in Antarctica since 1985,»* she *tells us. "And these long sea trips are fascinating and essential. In my subject, all the data comes from the ocean; it must be acquired at sea.*"

For this marine biologist, there was definitely something special about the recently completed mission in the waters of East Antarctica. On board the French icebreaker, the Astrolabe, it was Anne Goffart who was heading the international science team's campaign. A team that was particularly interested in the life present in the surface waters.

"*Three ships took part in the CEAMARC campaign (*Collaborative East Antarctic Marine Census*) this year, which was actually part of the broader CAML programme (*Census of Antarctic Marine Life*),"* she explains. *«The Astrolabe as well as the Australian vessel Aurora Australis and the Japanese ship Umitaka Maru, explored the East Antarctic waters together off Adélie Land. Our joint objective was to improve our knowledge on pelagic and benthic biodiversity, as well as the factors that influence it."*

"The Umitaka Maru and the Aurora Australis worked especially in deep waters, on the continental slope. On board the Astrolabe, we focused on the coastal sector and the plateau, exploring waters up to 200 metres in depth, the surface waters".

© *International Polar Foundation (BELARE campaign, see page 48)*

Besides Anne Goffart, Pierre Lejeune, lecturer at ULg and director of Stareso, the *Université de Liège*'s submarine research station in the Mediterranean, was also on board the Astrolabe. As for Jean-Henri Hecq, oceanographer and research fellow at the FNRS (ULg), he was on board the Umitaka Maru. This triple Belgian participation in CEAMARC was mostly possible thanks to the support of the Federal science policy, the FNRS and the French Polar Institute, IPEV.

On the Astrolabe, every day was different. After it left for Tasmania, the ship first brought supplies to the French science base, Dumont d'Urville, on the Antarctic continent. Once it had delivered the supply containers, the ship loaded up the containers containing the oceanographers' equipment, which is stored year after year in Adélie Land.

"*We have been working with the French teams for six years*," Dr. Goffart continues. "*We have already carried out several campaigns with them in Antarctica within the framework of the ICOTA programme (coastal ichthyology on Adélie Land); the pelagic part is under the direction of Professor Philippe Koubbi, from the Laboratory of Oceanography in Villefranche-sur-Mer (France). We are interested in the dynamics of the plankton (phytoplankton and zooplankton). We want to know more about its ecology, its spatial and temporal distribution, why there is so much of it in certain places and much less in others. We are also trying to understand how the environmental and climatic factors influence the spatial distribution and the survival of fish larvae. Finally, it's a question of assessing the impact that global warming could have on this sensitive ecosystem.*"

For the scientists on board the icebreaker, there are busy moments, depending on the type of activities programmed. "*We work according to stations*," explains the mission leader. "*During approximately two hours, we take a series of samples from a site. Then, initial processing is carried out on board. We fix the samples according to their future use. We filter them, freeze them or sometimes preserve them in alcohol or formol.*"

Life on board is controlled by these stations. It is a unique and fascinating experience, despite the irregular tempo.

"*For safety reasons during the sampling operations, we're dependent on the weather which is sometimes very changeable in this area. When the sea is too rough, we can't take any samples. Sampling is done on a platform 50 centimetres away from the surface of the water. When the weather's really bad, it's too dangerous.*"

The first real scientific results of the 2008 campaign won't be known before next year. The researchers only collected their samples in May. "*And you need at least six months of work in the lab before you get the first set of concrete results*," the Belgian oceanographer tells us. This year, the researchers on the Astrolabe were confronted with an overall observation. "*There was very little wind in East Antarctica. The result? We had a lot of good weather to work in and were able to successfully complete our programme. But this lack of wind also had another impact on our research. All the biological processes in the ocean were running late. It's the wind that drives the swell. And it's the swell that breaks the ice floe and causes the ice break-up which, in turn, leads the ocean to make its exchanges with the atmosphere and the sun's direct rays. And without the sun there's very little planktonic activity!*"

In Liège like in Paris, Villefranche, Tokyo or Hobart in Tasmania, the scientists involved in CEAMARC must now measure and analyse the nutritive salts in the water samples, characterise the phytoplankton communities, identify the species present in the zooplankton preserved in formol or alcohol, study the isotopic compositions of the environment, dissect the fish larvae transferred to the various laboratories in order to learn more about their dietary habits. "*We often get surprises*," Anne Goffart explains further. "*The fish larvae, which are barely 3 mm long, don't necessarily have the diet we imagine. For instance, it's not because the phytoplankton was particularly abundant in their private domain that this was their main food source. These are fascinating areas of study.*"

Of course, these are themes that require long-term monitoring. "*The areas we've explored this year are among the less well known*," concludes the mission leader. "*Our project is to subsequently create a workshop area, a reference area whereby, through successive campaigns, it will be possible for us to carry out a study on the inter-annual variability of marine ecosystems.*"

You said climate changes? In the end, that's what it's all about.

© Martin Van Coppenolle (SIMBA campaign)

First study on sleep on the Princess Elisabeth research station
(Circadian rhythm, sleep and performance during an Antarctic summer expedition)

Interview with Nathalie Pattyn, doctor in medicine and psychology (VUB & RMA)

What is the impact of the long polar day on the sleep pattern of the builders of the new Belgian research station in Antarctica? Did the fact that there was a continuous period without any night have an effect on the quality and quantity of sleep among these people? And did their mood and cognitive behaviour also suffer? Nathalie Pattyn, doctor in medicine and psychology at the *Vrije Universiteit Brussel* (VUB), attached to this university's department of biological psychology, and junior lecturer and research fellow at the *École royale militaire* (ERM), is fascinated by these issues.

"*Since my PhD*," explains this military doctor, "*I have been interested in the problem of human performance in extreme environments. Of course, I've worked in the domains of aeronautics and space".*

"When the construction of the new Belgian station in Antarctica took shape, it gave us the chance to find out more about sleep and the physical and cognitive performances of these builders who were going to live in a very difficult environment during a long period with no night".

"In these types of studies, we are often confronted with the problem of the number of people to study. In the space sector, for instance, we work on one person or a small group of astronauts. Here, with the construction of the base, the potential human sample was significantly greater".

"In the experiment we wanted to carry out, there was another piece of data that also interested us. As it was an expedition to construct a new station, there was no pre-existing infrastructure available. Therefore, these workers had no possibility of getting away from the long polar day by sheltering in a building or of isolating themselves from the polar environment".

"Furthermore, we were presented with a variety of profiles: people who were going to be subject to heavy physical exercise (to build the base), which obviously would have an influence on sleep; and others whose physical effort would theoretically be lower (management, cooking, etc.)".

"We therefore got in contact with the International Polar Foundation to suggest carrying out a series of experiments on the staff who would be working in Antarctica during the Antarctic summer 2007-2008. The Foundation agreed, as well as a good part of the forty or so people who stayed at the construction site during the four months of the building season. We were therefore able to launch the programme".

"In total, twenty human guinea pigs volunteered. Throughout their stay, they were subjected to different tests. We wrote a user manual for the doctor or nurse who was going to carry out the tests. An information document was also given to those taking part in the study".

"We initially envisaged carrying out tests using a polysomnograph. This device has a series of electrodes that you place on the head, torso and legs of the subject, which allow you to monitor their sleep. But it quickly turned out that this device wasn't very easy to use, especially because of the number of electrodes that had to be placed on the volunteer's head before they went to sleep. Therefore, we had to give up".

"However, we were able to carry out other tests. Hormone levels were measured on the basis of melatonin levels in saliva before going to sleep and upon waking up. Melatonin is the hormone whose production is stimulated when it's dark and which helps us to fall asleep".

"Thanks to a number of questionnaires, an attention test and another measurement based on saliva (cortisol), we were able to gather information on the evolution of mood and state of stress among the participants. Finally, we also measured the physical activity of the participants through a bracelet (actigraph) fitted with accelerometers, which had to be worn during a continuous 72-hour period."

The first results of this study are not expected before this autumn. Part of the equipment used for these tests during the BELARE 2007-2008 expedition was supposed to return to Belgium by boat. However, the doctor is already clearly aware that the next building campaign, this time to finish the interior of the Princess Elisabeth research station, could be very useful to complete her data. Even if the number of people participating in the BELARE 2008-2009 expedition during the new Antarctic season were to be halved compared with the previous year.

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Belgium builds the most environment-friendly polar base ever

Els Verweire

Exactly forty years after being forced to leave the King Baudouin Base, the Belgians again have a research station at the South Pole. Relying on a unique combination of technologies the Princess Elisabeth research station is the first polar base ever to run entirely on renewable energy.

There were happy faces all around at the press conference in the buildings of the International Polar Foundation on 11 March this year. Alain Hubert had just returned from the Antarctic, where he and his specialist construction team had finished work on the external structure of the Princess Elisabeth station, the brand new Belgian research station at the South Pole. They made the base windproof, installed the garages, and set up the eight wind turbines which will power the base along with solar energy, and managed it all before the Antarctic winter starts and the continent is scourged by heavy winds and snowstorms. "*After four years of preparation we have successfully completed phase one of our project, a week ahead of schedule*", Hubert tells the journalists enthusiastically. With similar pride Johan Berte, leader of the Belgian station project, adds: "*We have obviously reached a historic milestone here. The base is up, and, it is the most environment-friendly ever. It will be the first to run solely on wind and solar power; it has the lowest energy requirement ever; and carbon emissions are extremely low.*"

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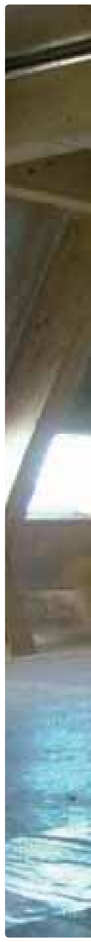
The initiative to build a new Belgian base came from Alain Hubert himself. In 2002 he and glaciologist Hugo Decleir of the *Vrije Universiteit Brussel*, and climatologist André Berger of the *Université Catholique de Louvain* set up the International Polar Foundation to raise awareness of climate change, of the vulnerability of the polar regions and of the need to preserve them. It quickly became apparent that a new Belgian base was needed in the Antarctic, one of the reasons being that since the closure of the King Baudouin base (the first Belgian research station in Antarctica), there had been a missing link in the scientific network for geophysical and climatological observation in the region. Alain Hubert went looking for the necessary funds. Johan Berte, a specialist in innovation projects who earned his credits as designer in space industry, took charge of designing the base and coordinating the project. The plan was to allow the construction of the base to coincide with the start of the fourth International Polar Year.



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Innovative puzzle

From the very start of the project it was clear to the team that it would be a base with close to zero impact on the environment. However mostly existing materials and technologies were used. "*For that purpose nothing new was developed for the base*," Johan Berte explains. "*Of course many of the techniques we applied were state of the art, but everything we used on the base was already in existence. The innovative thing about the design is the puzzle, not the pieces.*" His first assignment was to think of a design method for this unique project."*I didn't build on conventional wisdom, but called everything into question before getting together with our technical partners to select the systems most suited to our environment-friendly concept*", he tells us. "*For example, we chose timber for the window frames, not the more obvious hi-tech materials. We also took account of the special conditions in the Antarctic, something people strangely enough often overlook when building a polar base. It goes without saying that to develop and implement this concept we sought out a group of partners from industry and the research environment, all of whom contributed the know-how to make the project work in the end.*"

The objective was to build a base that would run solely on sustainable energy, so it had to be located at a place with enough sun and wind to keep it operating through the season. Berte: "*The idea was to build a summer station that would be operational from November to February. In the Antarctic, the sun does not set between the end of September and the end of March. This means that no matter how low the sun is over the horizon it will always provide a supply of energy in the summer months. This energy can be collected via photovoltaic panels, which supply some of the station's electrical energy, and via thermal solar panels, which take care of things like heating water for the bathroom and washing machines and thawing snow to make water." But the sun alone is not enough to supply the station's power, and what was needed was sufficient wind. "We calculated that an average wind speed of about 8 metres per second throughout the year would be ideal to keep the wind turbines turning*," Berte tells us. "*A lower speed would not provide the wind we needed, and excessive peaks might prove disastrous for the turbines. If we wanted the base to run on nothing but renewable energy we would have to find a location that met these requirements exactly.*"

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However, there were other elements involved in deciding the best location. Not wishing to be saddled with the limitations of the King Baudouin base they soon realised that it would have to be a land base. "*The first Belgian base was forced to close after barely ten years, and this had a lot to do with the fact that it was built on the ice. The building was heated, and, because some of that heat escaped to the outside, the ice below the station melted away, causing the building to distort and become unstable. Furthermore, it had to contend with snowdrifts, which piled up on the roof and gradually flattened the station.*" According to Berte these snowdrifts were caused by the Antarctic climate, which is dominated by so-called katabatic winds. "*These are enormously powerful winds caused by the gigantic Antarctic ice mass. When the air mass above the continent cools this creates winds which head down towards the sea at speeds of up to 300 kilometres per hour. The enormous masses of snow carried along with these winds can cause at the coast annual accumulations up to one and half metres. Some of the newer bases have hydraulic legs, with which they can be jacked up or moved. But this takes a huge amount of time and energy. We thought it would be better to find an area of rock oriented in such a way that it would stay free of snow naturally. Rock would also give us something firm to anchor on.*"

But the job did not stop there. "*We also wanted to steer clear of the usual disadvantages you get with a land base,*" Berte continues. "*Polar stations built on rock are generally more difficult to access than ice bases. Firstly, because they are often further inland, and away from the shore; and secondly because they are built on bare rock, where it is impossible to use snowmobiles. The big disadvantage with this is that you can only transport your supplies to the rock edge, after which you have a long way to carry them by hand. Also, storage areas have to be dug into the snow, and if the area of rock is big that snow can be a long way away from the base, which is a real problem.*" So they were looking for a needle in a haystack - a small area of rock that was naturally snow-free and big enough to anchor the base, yet small enough to offer good access. It would need to have enough snow around to make drinking water, and it would need to offer sufficient protection against the destructive katabatic winds.

The project team used satellite images, aerial photos and old topographical maps to select a number of potential locations. At one – in Utsteinen in East Antarctic Dronning Maud Land, a few kilometres from the Sør Rondane Mountains – they found a relative flat granite rock ridge, a pinnacle measuring 700 metres long, 16 metres wide, and rising twenty metres above the snow. It was just big enough for a stable base. "*To know the meterological conditions at this location we set up lots of measuring instruments on a first expedition, the Belgian Antarctic Research Expedition or BELARE 2004, and returned to check them on a second expedition the following year. To our amazement the figures showed an average wind speed of exactly 7 metres per second for the previous year,*

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and the wind never peaked over 36 metres per second - ideal conditions for our turbines. The station itself would be protected from the most severe katabatic winds by the Sør Rodanege mountain range."

It turned out that the ridge was also a prime location from a scientific point of view. Hugo Decleir: "*The position presents a broad range of research opportunities.*" He goes on to explain, "*Every conceivable type of landscape – from the coast to the Antarctic plateau, glaciers and mountain range – lies within a radius of less than 200 kilometres, which makes it possible for us to study different environments.*" And finally, a safe anchorage could be found for the Ivan Papanin, the ice breaker that will bring supplies and equipment to the selected site.

Energy efficient design

They had the ideal location – about half way between the Russian Novolazarevskaya base and the Japanese Syowa station – and now it was up to Johan Berte to get together with design bureau 3E to knock up an energy efficient design that would make the best use of the renewable energy. First of all, in order to limit the energy requirement, they deliberately kept the buildings – a living module on top of the rock, garages, and store rooms in the snow beside the rocks – to a fairly small, total usable area of 1,400 square metres (400m^2 in the living areas). Then, they gave the main building a concentric design. "*In the middle of the building there is a technical core containing the most temperature sensitive and vulnerable installations,*" explains Berte. "*The first buffer zone around this contains the active areas, such as the kitchen, bathroom and laundry room. The second layer contains the passive areas, such as the living room and bedrooms. Thanks to the concentric architecture, power, water and waste can be supplied or led off through the walls. This saves on materials (pipes and cables), but also on energy, because the water, for example, is pumped over a much shorter distance. Not only that, but fewer components mean a reduced risk of defect and the close proximity of the various systems allows for integration: the solar thermal system, for example, provides hot water, but it can also provide heat to the bioreactors for water purification.*" They also set up the solar panels on the main building in such a way that most power is actually generated when it is most in demand, and they kept energy losses to an absolute minimum by using the most energy efficient appliances, for example, and making sure the station was heavily insulated. As a result of all these measures the Princess Elisabeth base will need only a fifth of the energy used by an Antarctic station of comparable size.

A great deal of thought also went into the environmental impact of the base. "*Not only will we be doing everything we can to keep our production of waste to a minimum, but we will be using a new approach to how we process it - we won't incinerate it, because this creates toxic gasses, but we will collect it in containers and transport it away for further processing,*" explains Berte. "*Even the way we store fuel will be different. Most bases use so much fuel that they have to compress their empty drums to store them away. Our fuel consumption is so low that we can simply return the drums to Cape Town, where they can be refilled. Furthermore, the base will produce hardly any wastewater. We will only bring in fresh drinking water for drinking, cooking and showering, but that water will be collected, purified and used for other applications, such as the washing machines and toilets. If after a while the system does collect too much water and some has to be discharged, it will be purified to an extremely high degree first, to remove all biological traces. The water will drain* *into what we call a randkluft, a deep opening between the rock ridge and the permanent ice, where it will go deep underground, immediately freeze, and remain for centuries - more than ten thousand years the glaciologists tell us. As a result, damage to the environment can be more or less ruled out.*" Finally, the building is designed in such a way that it can be easily dismantled and removed, in 25 years time, say. Not only does this fit in with the base's concept, but it also complies with the Antarctic Treaty Regulations, which state that no trace of a base should remain once it has closed.

Finally, Johan Berte points out that a great deal of thought went into what he calls human factors. "*I have visited a great many polar institutes, and studied a few in the field, including the Norwegian Troll station. What I have learned is that there are many architectural design elements which allow people to live and work in and around polar bases comfortably and efficiently. We have tried to fit these into our design wherever we can. When placing the windows, for example, we looked at the energy requirements, but we also kept the psychological aspects in mind. We know that researchers are much happier if they have a good view of the environment while they are working, so we placed the windows in such a way that they are at eye-level for the scientists when seated, which they are 85% of the time. We also found the right balance between allowing in as much natural light as possible, avoiding blinding through the sun's low elevation, and finally, overheating. We have also avoided the dark-corridor effect that many bases are notorious for by making it possible to walk through the base in different ways and by creating viewpoints at the landscape. Of course, we have devoted a great deal of attention to safety. We have made it possible for the researchers to move safely between the main building and the utility areas, such as the garages, even in severe storm weather, simply by connecting all the areas together.*"

In the Antarctic summer of 2006-2007 the third expedition set off to prepare the site for construction of the base and to drop off vehicles, fuel and other heavy equipment. The external structure of the base was completed this winter. All that remains now is to bring in the base's internal functional systems, such as the power management and wastewater purification systems. These were thoroughly tested in Brussels during the 2008 summer before being installed in the base during the last phase of the project in November 2008. "*We are testing the separate subsystems as well as the proper functioning of the whole*," explains Berte. The importance of this became clear when the external structure of the base was erected in Brussels beforehand, on the Tour & Taxis ground. "*It was a huge effort, but it saved us a lot of time, because it is obviously much easier to solve problems or shortcomings here than it is in the Antarctic: here, you can easily send a component back to the factory to be adapted, but not at the South Pole. If everything runs to plan the technical core of the building can be fully installed in November this year and the Princess Elisabeth research station will be fully operational by March 2009.*" At the end of this year glaciologist Frank Pattyn of the Université Libre de Bruxelles will be the first researcher to be able to use the station as his base camp for an expedition.

Four new scientific research stations on the White continent

Christian Du Brulle

At the beginning of the International Polar Year 2007-2009, 65 scientific bases were active on the White continent. Since the beginning of this international year, four new bases, each with a strong personality, have been making their way to join them.

Besides the Belgian Princess Elisabeth research station, whose main characteristic will be a 100 % 'clean' scientific station, there is also a new British station, Halley VI, a new German base Neumayer Station III, but also a future Chinese station at the top of the polar icecap on Dome A (Argus), in East Antarctica. Let's go for a guided tour.

First construction season for Halley VI

Halley VI, the new British scientific station is currently being assembled in Antarctica. The works began in 2007-2008 on the Brunt Ice Shelf, a platform of floating ice some 200 metres thick, situated in the region of Queen Maud Land, or Dronning Maud Land. A region of Antarctica which the Germans are also directly involved with through their Neumayer station, as well as the Belgians with their Princess Elisabeth research station. However, there are several hundred kilometres between them!

The presence of the British on the Brunt Ice Shelf dates back to 1956. This is where the first Halley station was built within the framework of the 1957-1958 International Geophysical Year.

The Brunt Ice Shelf (an ice shelf refers to a place where the continental glacier is no longer resting on land but is floating on the ocean. These structures can be several hundred metres thick and several hundred

© *British Antarctic Survey (Halley VI)*

kilometres wide) flows in the direction of the Weddell Sea at a speed of approximately 500 metres a year. For the moment, it houses the Halley V station.

Large fragments of this platform sometimes break off, thus creating icebergs. The British studies of the British Antarctic Survey (BAS) – the British polar agency – revealed certain risks for the current scientific station. It could potentially become a victim of a major fragmentation of the ice in the next ten years. In order to ensure the continuity of the research begun in this region more than half a century ago, BAS therefore decided to replace Halley V with a new station, that is more modern and... more mobile!

Halley VI will actually be a station on skis! If the spur of ice on which it will be placed progresses too rapidly, it will be possible to tow Halley VI to a more appropriate and less dangerous place on the Ice Shelf.

This is what explains the very particular architecture of this station. It is composed of eight independent modules mounted on hydraulic columns, which are fixed to an impressive set of skates. The hydraulic columns allow the station to be lifted, module by module, especially in the summer, in order to allow motorised snow ploughs to pass. Snow accumulates at the feet of the station all year round. Lifting it from time to time to clear the snow using heavy machinery will allow the operation to be carried out in just a few days.

© British Antarctic Survey (Halley VI)

The chain-shaped architecture of Halley VI, with each module interconnected to the next one, makes this station look like an enormous convoy, a sort of gigantic ‘ice train’, where each wagon can be repositioned according to the arrangement required for the laboratories and research programmes.

However, a certain logic will be respected. The station will be divided into two major parts. One side will contain the living quarters, while the other side will be composed of the laboratory and scientific modules. Between these two extremes is a refuge platform, designed to receive the station’s occupants in case of an accident. Furthermore, the complete station will also include a series of independent modules that aren’t connected to the ‘train’. They will serve as garages, technical premises and places to store waste or temporary accommodation for the summer teams.

Its initial position on the ice shelf will be situated some twenty kilometres from the edge of the ice, off the coast (Caird coast) (75°36’56”S; 26°07’52”W). An ‘address’ that will have to change on a regular basis, undoubtedly as from the first year the new structure is in operation, predicted to be during the 2009-2010 season. It will actually take three Antarctic summers to build the new station. At the same time, the current station, Halley V, will serve as a base camp for the construction teams. It will then be dismantled and evacuated to South Africa and Europe.

During the initial construction campaign (2007-2008), the first module was completely assembled right next to the Halley V station. Others that were finalised on site were protected by tents to see them through the Antarctic winter. As soon as the new season began, the works started up again. During the second half of the 2008-2009 season, the complete modules will be towed to their operating site.

The BAS’ polar supply ship, the Ernest Shackleton, is responsible for transporting part of the new station to the construction site. But the workload is such that a second, much bigger icebreaker was chartered by BAS to accelerate the manoeuvre: the MV Amderma. The pre-assembled modules are taken care of in South Africa and directly transported to Antarctica.

The various British Halley stations that have followed on from each other in this corner of Antarctica over the past fifty years have done a lot for science, especially in terms of atmospheric research and as regards the chemistry of snow and ice. One of the most well-known examples: it was from this site that the BAS teams identified the famous hole in the stratospheric ozone layer in 1985.

With Halley VI, the United Kingdom firmly intends to remain on site for another twenty years: the expected lifetime of the new station.

The six Halley stations constructed on the Brunt Ice Shelf

Station	Years in operation	Construction
Halley I	1957-1968	Wooden huts built on the snow
Halley II	1967-1973	Seven wooden huts, lined up two by two, on the snow.
Halley III	1973-1984	Series of prefabricated wooden modules integrated into a sort of oval-shaped gigantic metal tube.
Halley IV	1983-1992	Two-storey cabins protected by half-tunnels in wood.
Halley V	Since 1991	Four buildings perched on metal feet and two buildings on skis that are repositioned every year.
Halley VI	Under construction since summer 2007-2008	Interconnected modules on feet and skis. The new station is built to house a team of 52 people in summer and 16 winter visitors.

© *Alfred-Wegener-Institut Germany (Neumayer Station III)*

The German Neumayer Station III is currently being built on the Ekström Ice Shelf

For more than 25 years, the Ekström Ice Shelf has been home to German Neumayer research stations in Antarctica. They are named after the German explorer Georg von Neumayer (1826-1909).

The first of these stations was built during the summer of 1980-1981 and began its scientific activities in March 1981. It was a structure buried in the ice. It was composed of modules assembled in a sort of protective steel tube.

This type of station has certain advantages in an environment as difficult as the one of the White Continent. But it also poses a problem... longevity. Over the seasons, the snow continuously accumulates on the structure, which is finally crushed by this icy mass. This first German Station was in operation for eleven years before being destroyed.

In 1992, it was replaced by the current Neumayer Station II. The architecture of this second scientific base is similar to that of the first research station. Neumayer Station II was established seven kilometres south of its older sister. It is also threatened by the successive layers of snow that have accumulated on the surface. Neumayer Station II is currently lying under seven metres of ice.

For the Alfred Wegener Institute for Polar and Marine Research (AWI), the German polar institute that manages these structures, this situation has become too dangerous. It is therefore necessary to construct a third Neumayer Station in Antarctica.

Neumayer Station III has been under construction since summer 2007-2008. This time, however, it is no longer question of a station under the ice but of an aerial structure that should house its first scientists in 2009-2010.

The new station is a building perched six metres above the ground and will be a total of 28 metres high. It rests on sixteen motorised pillars allowing it to adapt to the level of the ice. Every year, the snow that has accumulated under the station will be evened out. These embankments will serve as new points of support for the hydraulic feet of the structure, which will be raised each time. However, everything has been studied to limit the accumulation of snow at the foot of the station, as proven by the aerodynamic form of its external wall, tested at length in a wind tunnel. According to the measurements previously taken on site, 80 centimetres to 1 metre of snow will accumulate in this region every year.

The body of the building is in the form of a long, two-storey rectangle, 68 m by 25 m.

In winter, it will be able to house around ten people. In summer, some 40 extra researchers will be able to benefit from this thoroughly modern infrastructure endowed with 210 m^2 of laboratories, i.e. the double of the previous station. In total, the useable surface of Neumayer Station III (station and buried garages) will be 4,473 m^2. Just like the first two stations installed on the Ekström Ice Shelf, it will be in continuous movement. The station will be carried away by the ice that flows towards the sea. Every year, it will advance 157 metres towards the north. Much less than Neumayer Station I, which drifted 187.6 m and Neumayer Station II, which advanced 200 metres a year.

According to the AWI, the new station should be in operation for a minimum of 25 to 30 years.

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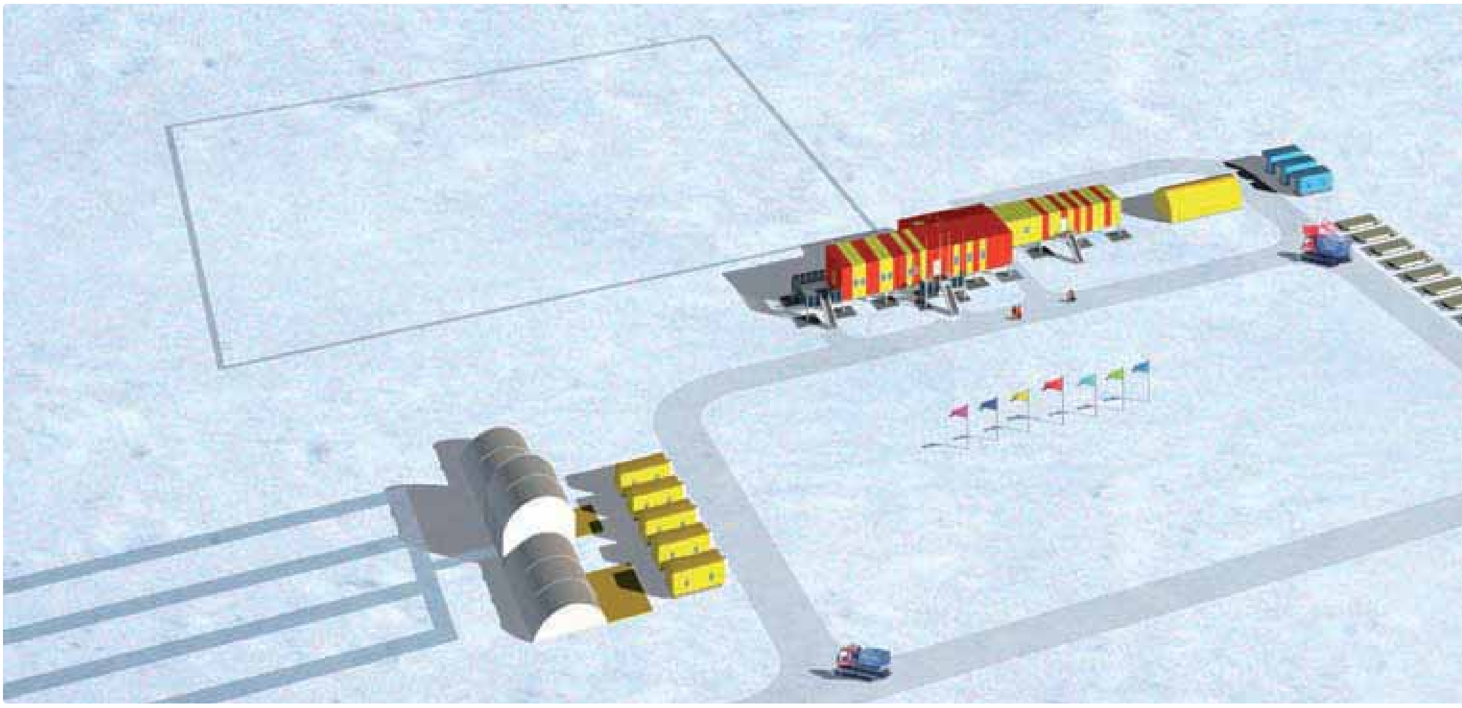
SCIENCES AT NEUMAYER STATION III: CHEMISTRY, PHYSICS, WHALE SONG AND... NUCLEAR EXPLOSIONS!

The research carried out on the Ekström Ice Shelf for more than a quarter of a century by German scientists and their partners is mostly related to atmospheric chemistry, geophysics and meteorology. Since 2002, researchers have also been listening to the infrasounds in the region. The detection system for this type of sound belongs to a global network of some sixty similar stations. In fact, this is Germany's contribution to the monitoring network set up to check that the international treaty banning nuclear testing is properly respected.

Undoubtedly less strategic is the other 'ear' deployed off Neumayer Station, which takes the form of a hydroacoustic observatory, 'Palaoa' (*Perennial Acoustic Observatory in the Antarctic Ocean*), set up in 2005. It records the natural sounds that circulate in the ocean via a system of immersed microphones, allowing researchers to study the behaviour and 'conversations' of marine mammals!

NEUMAYER STATION III AS A LOGISTIC BASE

Neumayer Station III is not only designed for science but it is also the logistic base for all field activities and aircraft missions in Dronning Maud Land. The German summer only base Kohnen Station at the inland ice is logistically supported by aircraft and surface traverses form Neumayer Station III. The station also provides the weather service for the Dronning Maud Land region supporting the aircraft operations and field activities of all national operators within the Dronning Maud Land Air Network (DROMLAN – Belgium, Finland, Germany, India, Japan, the Netherlands, Norway, Russia, South Africa, Sweden and the United Kingdom).



© *Chinese Arctic and Antarctic Administration (Dome A)*

China focuses on Dome A

An icebreaker called Xuelong, a research station on Svalbard (the Yellow River station), a scientific base established since 1984 on the Antarctic Peninsula baptised the Great Wall and another one established on the eastern part of the continent (Zhongshan)... Without a shadow of a doubt, the People's Republic of China is now a major player in terms of polar research.

And it intends to firmly reconfirm this (at an altitude of more than 4,000 metres!) in the coming months. Within the framework of the International Polar Year, this great Asiatic power aims to erect a third scientific station on the White Continent.

Preliminary explorations were carried out during the last few summer seasons in the southern hemisphere. From the Zhongshan station, based in the east of the continent, caravans have been mounting on the plateau, heading for Dome Argus (Dome A). In January 2008, the seventeen members of the 24th Chinare expedition (*Chinese Antarctic Expedition*) successfully completed a series of measurements and searches with a view to defining the ideal place to establish the new scientific station. This site, which interests China is situated at an altitude of 4,100, at the summit of the icecap that covers East Antarctica, which is in the form of a plateau 60 km long and some fifteen km wide.

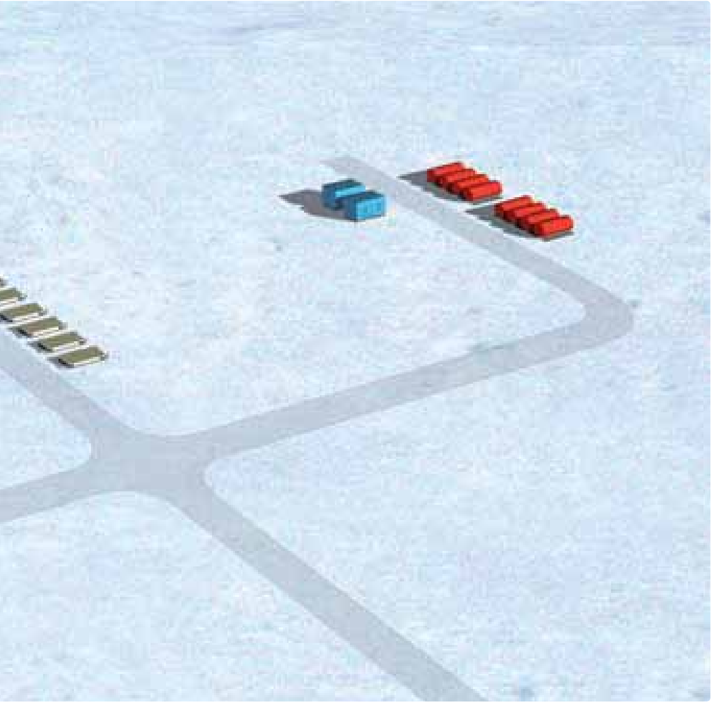
Initially, it is a matter of establishing a summer station only on Dome A, based on an assembly of specially-developed containers. This infrastructure should be able to house approximately fifteen people every summer. The infrastructure could then be developed with a view to transforming it into a permanent station.

The site, which is very difficult to access, should be linked to the Zhongshan station by land (1,280 km). China is also examining the possibility of acquiring a specially-designed plane to ensure this link. It first intends to form partnerships with the other countries present in this region of Antarctica, especially the Australians whose Mawson station is close to Zhongshan.

The research that will be carried out at Dome A by the Chinese researchers and their foreign partners has already begun! After having deployed an automatic meteorological station in 2006-2007, China installed a series of four telescopes in 2007-2008, 14.5 cm in diameter.

The site benefits from exceptional climatic conditions for certain types of observations. Considering its altitude and the cold that reigns there (annual average of -58 degrees!), the atmosphere there is particularly fine and stable. Furthermore, it has an uninterrupted polar night for three months of the year.

The data collected by the first telescopes deployed during the last Chinare expedition will be analysed by



the Chinese astronomers but also by their American (Texas A&M University) and Australian (University of New South Wales) partners from the Plato programme in order to accurately characterise the qualities of the site from a photometric point of view. This will help them to decide which type of telescope to install there for scientific observations. It could be a telescope that observes the universe in the far infrared, whose main mirror would be four metres in diameter.

Besides astronomy, this site also has the advantage of theoretically preserving the Earth's most ancient climatic archives. Considering the thickness of the ice here (at least 3,000 metres) and the exceptional location of the site (very little movement / flow in the icecap), glacial boring carried out on Dome A similar to the EPICA European project carried out on Dome C (located 1,200 kilometres from here), should potentially provide climate archives that are a million years old. And even 1.2 million years old according to the most optimistic estimations.

The construction of the new Chinese station should begin during the austral summer of 2008-2009 and extend over two years. It will have a lifetime of at least 25 years. It will be used exclusively as a summer scientific station during the first ten years, before possibly being completed with a view to permanent occupation.

Main Chinese polar infrastructures

Station / 'tool'	Location	Main types of research	Remarks
Great Wall station	King George Island (Antarctic peninsula)	Sub-Antarctic ecology, marine biology, geodesy, meteorology and study of the ionosphere	In service since 1984
Zhongshan station	Pritz Bay region (East Antarctica)	Atmospheric physics (magnetosphere), glaciology, oceanography	Main Chinese station (4000 m^2), in service since 1989
Xuelong icebreaker (snow dragon)	Arctic and Antarctic oceanographic campaigns	Oceanography / supplies / logistics	Ship of Ukrainian origin acquired in 1993 and refitted
Dome A	East Antarctica, at the summit of the icecap	Mainly paleoclimatology (glaciology) and astronomy	The definitive name of this 600 m^2 station is yet to be decided
Yellow River station	Ny Alesund (Svalbard)	Ocean-atmosphere interactions, oceanic geology, biology, glaciology, auroras	500 m^2 station, inaugurated on 28 July 2004 (and active since October 2003)

'New' American Amundsen-Scott base in the South Pole

The United States have been present in the South Pole since 1957, with their permanent Amundsen-Scott base. However, this (international polar) year, they have inaugurated a new structure. On 12 January 2008, the 'new' station was officially inaugurated by a whole series of official representatives. This third station is definitely 'new'...since 2003 already! Built between 1999 and 2003, it is actually the third American base in the geographic South Pole.

The first station goes back to 1957 and the International Geophysical Year. That year, it housed eighteen researchers and soldiers. In 1975, when the first building was buried under the snow that had been accumulating for years, a second station was built. Partly buried in order to protect it against the extreme climatic conditions that reign in the Pole, only the geodesic dome protective structure, 50 m in diameter, protruded from the ice. It is this building that was replaced in 2003 by the new aerial building inaugurated this year. A two-storey building that offers its staff approximately 7,400 m^2 living space!

IN HONOUR OF THE PIONEERS

The American station is named after the first two polar explorers to reach the South Pole: the Norwegian Roald Amundsen, on 14 December 1911, and the Englishman Robert Scott one month later, on 17 January 1912.

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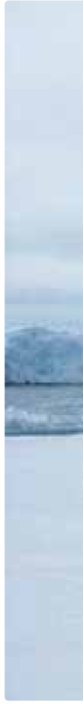
Observers at the end of the Earth

Christian Du Brulle



No light pollution, polar nights lasting several months, extremely low temperatures… All very useful for certain observations. Astronomers are also interested in Antarctica.

And while some plan to add telescopes to their polar infrastructures – like the Chinese who intend to endow their new research station on Dome A with an observatory – others have already done so.

Starting with the Americans, on Amundsen-Scott base, established at the South Pole. Since February 2007, they have a telescope there that has been fitted with a mirror ten metres in diameter, called SPT (*South Pole Telescope*). The result of a collaboration between several American and Canadian universities, and mostly financed by the NSF (*National Science Foundation*), this telescope observes the sky in its millimetric component. This machine is slightly different from the usual optical telescopes since it functions in the area between radio and infrared waves. These wavelengths are suited to the study of molecular clouds and galaxies of star clusters. During its first three years in operation, its main mission will be to scan the sky in order to detect galaxies of star clusters through the minuscule temperature variations which are discernable in the background radiation. By attempting to identify these star clusters, the researchers hope to learn more about the mysterious dark matter that shrouds the universe and its density.

The Belgians at the South Pole

Another gigantic telescope is also currently being assembled in the South Pole. This falls under the scope of the international IceCube project, led by the University of Wisconsin in Madison, and includes four Belgian universities: Brussels (ULB and VUB), Mons (UMH) and Ghent (UG).

IceCube is a giant detector of neutrinos, the elementary particles produced by the sun and when violent events occur in the universe (such as the explosion of supernovae, the giant black holes at

© *Bruno Delille*

the heart of galaxies, or cataclysmic events between black holes and neutron stars). IceCube will be focusing on this second category of neutrinos, cosmic neutrinos.

The telescope in question is currently under construction in the South Pole. It comes in the form of a collection of photomultipliers sunk into the depths of the polar ice. These photomultipliers are assembled on strings of 60 modules each along a cable immersed in the polar ice. Every austral summer up until 2010-2011 – the year the neutrino telescope will be brought into operation – the project's partner physicists will drill wells 2,500 metres deep in the polar ice. Each of these wells (there will be 80 in total), will receive a string of 60 detectors sunk between 1,450 and 2,450 metres deep. Once the 4,800 photomultipliers have been assembled in a one cubic kilometre ice mass (hence its name), researchers hope to detect minuscule lights known as Cherenkov radiation. These weak, fleeting flashes of light indicate a passing neutrino interacting with the ice atoms. During these interactions, a muon is emitted. It is this muon which is at the origin of the light signal.

Our atmosphere also produces a high level of muons. To prevent these atmospheric muons from interfering with the signals studied in the ice, IceCube will focus on the study of the neutrinos that come from 'down under', i.e. those that have crossed the entire earth before appearing in the polar ice. These neutrinos travel smoothly cross the entire thickness of our planet, contrary to the muons which are stopped.

Since March 2008, half the telescope has been assembled and is in a test phase: it is already recording events of cosmic origin. But why this interest in neutrinos? Because by getting to know these almost elusive particles better, researchers hope to shed some light on the history of our universe. The cosmic neutrinos are the messengers of information that may go back to the universe's very first moments in existence. IceCube is also adapted to research into dark matter, the invisible matter that represents 90 % of the universe's mass...

"The cost of the IceCube project is USD 275 million", explains Daniel Bertrand (Department of Physics of Elementary Particles / ULB). "*Belgium's participation through the Federal science policy, the FNRS and the FWO is EUR 1.5 million. The IceCube telescope (a name which amuses real astronomers who have observation devices capable of distinguishing objects that are several fractions of an arc-second away) will be approximately two degrees... But this should be sufficient to identify the source of the cosmic neutrinos that will be detected and, for those furthest away, that will be the result of events situated within a radius of several million light years from Earth.*"

As from 2011, the minimum lifetime of the telescope will be six years. At least two people will ensure it runs smoothly throughout the year at the Amundsen-Scott base. This extraordinary detector could continue to function beyond this period. But researchers don't have all the data concerning its ageing. Since it is sunk in a glacier, which by definition is advancing towards the sea, cutting movements in the deep ice could cause some of the cables linking the photomultipliers with the data reception centre on the surface to deteriorate beyond the first six years in service.

France and Italy have chosen Dome C

In the east of the continent, at Dome Concordia (Dome C), the French and the Italians are also setting up astronomical projects. In 2007, Italy installed its first 25-centimetre test telescope within the framework of the *International Robotic Antarctic Infrared Telescope* (IRAIT) project. The intention is to have a device 80 centimetres in diameter to study the sky's infrared component and microwaves in order to study stars such as the brown dwarfs in the Milky Way.

IRAIT (*International Robotic Antarctic Infrared Telescope*) is a project supported by the Italian Antarctic programme (*PNRA, Programma Nazionale di Ricerche in Antartide*) and the University of Perugia.

France has launched the ASTEP project at the same site. This project involves a 40-centimetre telescope that will be dedicated to exoplanetary research. The aim is to record a planet as it passes in front of its star at the same time as its radial speed. This will allow researchers to calculate the radius and the mass; this in turn will give an indication of its composition. This project will be complementary – on the ground – to the French CoRot satellite, which is also dedicated to exoplanetary research and stellar seismology, but from outer space! CoRot was put into orbit in December 2006.

ARENA: Europe is also interested in Concordia station.

Since 2006, the European ARENA project has had its eye on Dome Concordia. This project, which is part of the European Commission's R&D framework project, will now go on for four years (3+1) and includes 21 academic and industrial partners from seven Union members (Belgium, France, Germany, Italy,,Portugal, Spain and the United Kingdom) plus Australia.

Among these numerous partners are the University of Liège, Amos and Spacebel from Belgium. This network is co-ordinated by Nicolas Epchtein, from the University of Nice's Astrophysics Laboratory (LUAN).

The main aim of this network is to rigorously define the real attraction of Dome Concordia for astronomy. Clear, cold, dry, pollution-free, low levels of precipitation, reduced wind speed, limited turbulence, almost inexistent seismic activity, climatic stability, etc. At first glance, there are numerous assets to this high altitude place (3,300 m). Preliminary data reveals that during the austral winter, the night sky is light 95 % of the time. Only one reservation: the quality of the site will not be optimum at 0 to 30 metres above ground (above the icecap). The reason is the temperature inversion which is responsible for disturbances.

However, according to specialists, if these turbulences are stable throughout the year at high altitude and in depth, this won't be a major handicap. Owing to their structure, the big observation instruments are almost above this turbulence. As for the smaller telescopes, the construction of towers 20 to 30 metres high doesn't seem to pose too much of a problem either.

So, will very big European observatories like the *Very Large Telescope* (VLT) set up in the Chilean Andes, be installed in Antarctica one day?

A decisive evaluation of the ARENA project is expected at the end of 2009. If it turns out to be positive, a new European astronomic strategy could result from it. And Australia, one of the project's partners, already seems convinced. It is envisaging the construction of a telescope 2.4 metres in diameter at the site.

AIRBORNE OBSERVATORIES

When we refer to astronomy in Antarctica, we mustn't forget the other types of observations. At the American McMurdo station, astronomers study the sky – in particular cosmic rays – using instruments on board sounding balloons, sent up to an altitude of more than 40 kilometres.

EXPRESS INTERVIEW: JEAN-PIERRE SWINGS

Jean-Pierre Swings is an astrophysicist at the University of Liège. For more than 15 years, he was Belgium's representative at the European Southern Observatory (ESO). He has also sat on many committees to define and design satellites with an astronomical vocation. He is currently representing the University of Liège in the European consortium led by the Nice Observatory relating to the Arena project.

'Astronomical' projects are increasing in Antarctica. Why do astronomers find the White Continent so attractive?

Jean-Pierre Swings – The very low temperatures that reign in Antarctica, the altitude of the chosen sites, 3,300 metres at Concordia (Dome C) for instance, and the stability of the atmosphere are the main assets astronomers hope to take advantage of in Antarctica. In addition, there's the long polar night that allows observations to be made over long periods of time, which isn't possible in average latitudes on Earth where the day-night pattern interrupts the observations.

What sorts of observations are the most popular in these skies?

J-P. S. – Some windows of the electromagnetic spectrum that are practically inaccessible anywhere else on Earth, even at sites such as that of the European VLT in Paranal (Chile) or Mauna Kea (Hawaii), open slightly in Antarctica. For instance, in the infrared domain, around three microns of a wavelength or between 20 and 30 microns. The long periods of continuous observation are also interesting in terms of asteroseismology, detection or exoplanetary observation.

Is the inaccessibility of polar observatories a disadvantage?

J-P. S. – It's true that they aren't easy to access. For instance, within the framework of the Dome C projects, you have to pass by the French Dumont d'Urville base on the coast. Then there's a long journey across land on tracked vehicles. This makes it difficult and really tough to construct observatories, and it requires complex logistics. They're also complicated to operate. It isn't an easy decision to take when considering spending winter on Dome C. You're practically cut off from the rest of the world for a year when you're there. One solution uses remote-controlled automatic observation devices. But this also poses certain challenges. For instance, the mirrors icing up. A heated de-icing system is out of the question. We have to find other technical solutions. The challenges we have to face are fascinating.

Is the new Belgian Princess Elisabeth research station of interest to astronomers?

J-P. S. – Not at all. It's too badly located to be able to carry out quality observations.

What is the alternative to these 'white' observatories?

J-P. S. – We have to envisage space telescopes. But in this case, the budgets required are significantly larger.

CryoSat-2, the space spy who loved the cold

Christian Du Brulle

The European cryosphere surveillance satellite will be launched in 2009

An ice floe that increases in winter in the North Pole but is increasingly shrinking in summer. An icecap some 3,000 metres thick in Greenland. Another icecap more than 14 million kilometres square on the Antarctic continent. And land-based glaciers, in the Alps, the Andes, etc.

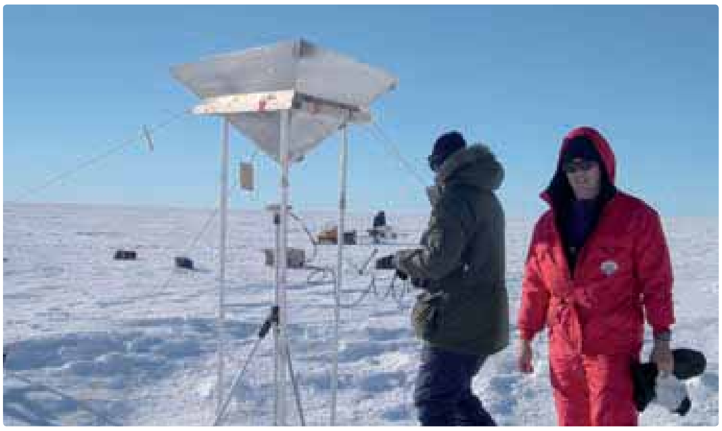
Planet Earth is above all a 'blue' planet, three-quarters of which is covered by seas and oceans. But it is also a 'white' planet. White like the ice which covers it at the poles and at altitude.

Polar ice is an important climatic factor on Earth. It plays a major role in the stability of the global climate, in terms of the seas and oceans, and the circulation of the major ocean currents. Knowing it well, and knowing it better, is a scientific asset that will help predict the evolution of the climate, and understand the impact on global warming.

In order to effectively complete the data collected on the ground by the teams at the science stations in the Arctic, Antarctica, Greenland and Spitzberg, it is necessary to have a global vision that is as detailed as possible. A vision that only a scientific satellite specifically elaborated for this type of mission can provide.

This is exactly the *raison d'être* of CryoSat-2. This European Space Agency (ESA) mission enters into the framework of its 'Living Planet' programme and its satellites called 'Earth Explorers'.

There are two types of Earth Explorers. Either it is a question of meeting basic scientific needs that require the elaboration of sizeable satellites, or it is question of missions called 'opportunities' to quickly answer a specific scientific question. CryoSat-2 enters into the second category. And the questions to which the



© ESA

© ESA (Cryosat)

researchers would like to obtain a quick answer is very simple: is the ice melting at the poles? And, of course, to what extent and according to which cycles?

The initial launch of CryoSat was planned in 2005. Unfortunately, a fault in the Russian launcher responsible for taking it into orbit led to the mission being aborted. Considering its interest, the ESA and its partners very quickly decided (in 2006) to relaunch it. CryoSat-2 was put back on the rails. An identical model was reconstructed by the same project manager (Astrium); the new observation device should therefore be put into orbit in 2009. Among its assets is its work orbit. For the first time, in terms of studying the ice, it will be possible to take measurements up to a latitude of 88 degrees, with a spatial resolution of 250 metres, while previous radar satellites (like ESA's ERS-1) only had a resolution limited to five kilometres.

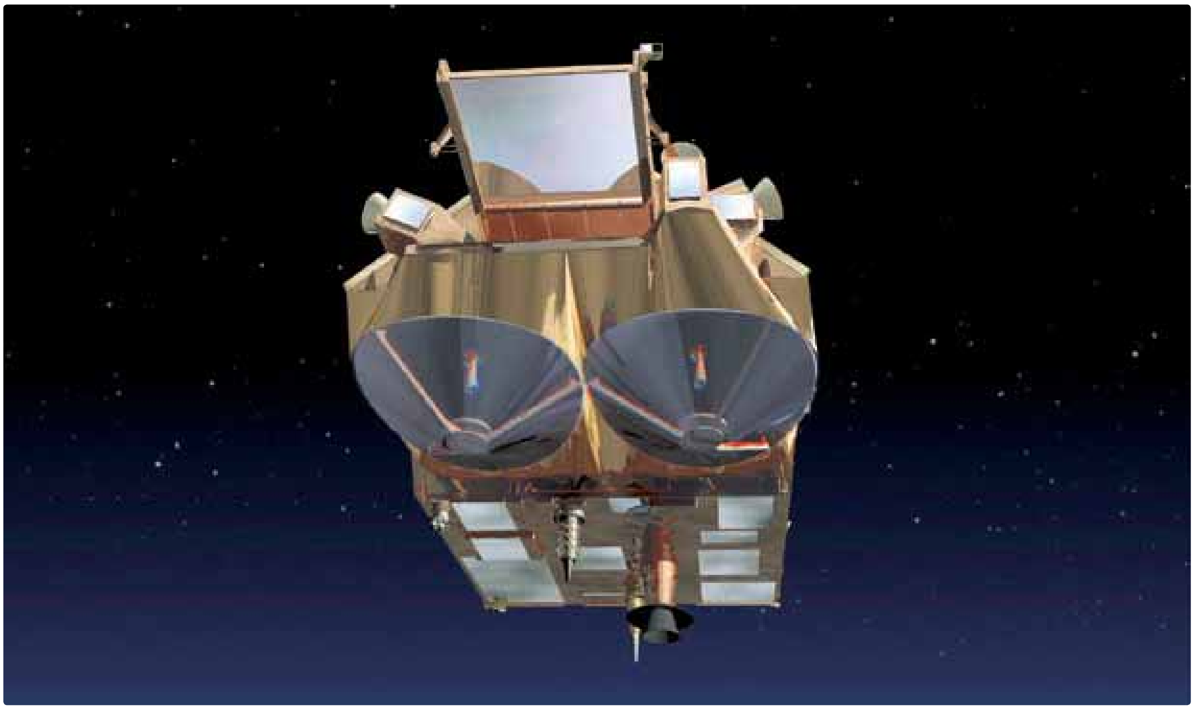
SIRAL: an interferometer radar altimeter

To answer the question about the ice melting, CryoSat-2 is equipped with an exceptional instrument: an ultra-sophisticated altimeter. Baptised SIRAL (*Synthetic Aperture Interferometer Radar Altimeter*), it combines various leading technologies that will allow it, according to the areas flown over, to work at different degrees of precision. To evaluate the melting of the ice floe and the evolution of the icecaps, researchers are going to measure their relief and their expansion with a level of precision never before achieved.

SIRAL is derived from the Poseidon altimeter, which equips the Jason oceanic altimetry satellites. It is capable of providing topographic data on the most rugged areas of the cryosphere. For instance, the coastal regions of Antarctica where the continental ice changes into an ice shelf before forming icebergs. And in the same way that we can see the relief thanks to our binocular vision, SIRAL will be able to see the relief of the areas flown over thanks to its two antennas. The analysis of this data will also make it possible to define the nature of the terrain observed and to measure the floating ice mass.

The interferometer radar altimeter will function according to three types of distinct measurements, depending on its position above the globe:

- ➔ In low resolution mode, SIRAL will carry out conventional altimetric measurements limited to interior continental ice and the sea.
- ➔ In synthetic aperture radar mode, the satellite will carry out high resolution measurements for the seas of ice.
- ➔ Finally, in interferometric radar mode, the instrument will study the transition zones between the ice floe and the continent in particular.



© ESA (SIRAL)

Exemplary positioning

To carry out the ultra-precise altimetric measurements at an altitude of more than 700 kilometres, the position of the satellite itself must also be defined with the greatest precision.

Three systems of instruments will be combined to ensure this locating: Doris, laser retroreflectors and a stellar plotting system.

Besides the stellar plotters that allow the correct orientation of the satellite, the Doris system (*Doppler Orbitography and Radiopositioning Integrated by Satellite*) developed by France (*especially the CNES, the French Space Agency*) twenty years ago will allow it to be precisely located.

This system has already equipped oceanic altimetric systems such as Topex, followed by the Jason series, but also the ESA's Envisat satellite. An antenna and an on-board computer pick up and process the signals emitted by a dense network of markers on the ground which emit signals for the satellite. Through Doppler measurements, these signals provide information on the orbit (the trajectory) and the altitude of the satellite to the nearest centimetre, and to correct them if necessary. A third system, the laser reflectors, complete the CryoSat-2 control.

CryoSat-2 in figures

Launch	2009
Duration of the mission	3.5 years
Orbit	at an altitude of 717 kilometres, tilted at 92 degrees
Mass	669 kilos, including 36 kg of fuel for orbital manoeuvres
Dimensions	4.6 x 2.34 x 2.2 m

Validations on Earth and at sea…

The ground segment of the CryoSat-2 system is located in Scandinavia. It is the ESA station in Kiruna, in the north of Sweden, which will be responsible for monitoring the correct functioning of the satellite eleven times a day, and for ten minutes every time. When this occurs, the operators will send orders to the satellite and they will take this opportunity to receive the data stored on board. The mission will be managed from the ESA control centre in Darmstadt in Germany.

Finally, to calibrate the CryoSat instruments and then validate its data, it is also necessary to compare its observations with precise field measurements. Several missions to evaluate the quality of the ice, its actual thickness and any inaccuracies that can be caused when it is covered by certain snow conditions, for instance, were carried out in the Arctic, Greenland and in the Gulf of Bothnia, in the Baltic sea.

The last one lasted three weeks and took place in spring 2008. Baptised CryoVEx 2008 (*CryoSat Validation Experiment*), it took place in the north of Canada and in Greenland, and mobilised Danish, British, German and Canadian researchers.

This campaign was one of the biggest. Three sites were examined on the ground (on the ice to be exact) but also from the air. An almost exact replica of the CryoSat radar altimeter was used in a plane to simulate the data collection that would soon be performed by the satellite. Of course, this was also an opportunity for researchers to compare the data collected from the air concerning the sea ice, its thickness and quality, with that collected on the ground.

Even some polar explorers have helped in this assessment in the not-so-distant past. In particular, this involved the Belgian Dixie Dansercoer and Alain Hubert.

During their 'Arctic Arc' expedition on the ice floe in 2007, from Siberia to Greenland via the North Pole, they took regular snow and ice samples during their sporting exploit in order to refine the satellite data and validate the accompanying mathematical data. All this will allow CryoSat-2, once in orbit, to keep an even more precise eye on our cryosphere!

With 'Spirit', Spot 5 offers its services to glaciologists

Among the many international partners who have decided to pool their resources to help advance polar research within the framework of the International Polar Year (IPY), there is the French Space Agency (CNES) and Spot-images, the company which markets the data acquired by the satellites from the Spot network, in which Belgium co-operates.

These two partners launched the 'Spirit' project (*Spot 5 Stereoscopic Survey of Polar Ice, Reference Images and Topographies*) in February 2008. Thanks to the Spot 5 satellite and its ability to take high-resolution stereoscopic images (via its 'HRS' instrument, as it is known), the aim is to compile the most complete and detailed database possible of the polar regions.

The HRS instrument allows couples of stereoscopic images to be obtained with a spatial resolution of 5 metres, covering a large surface area (120 km x 600 km).

Spot 5's archives will of course contribute to this project (the satellite was launched in May 2002), so that the ice's evolution can be monitored.

The three main goals of the Spirit project aim to carry out massive HRS coverage of more than 2.5 million km² of the Arctic and Antarctic regions: glaciers, small polar icecaps and coastal regions in Antarctica and Greenland; to allow the international scientific community, whose projects are in line with the theme of the Polar Year, to visualise this HRS archive thanks to a specially constituted web interface and finally, to freely distribute topographical data among the authorised laboratories, which is currently missing for the study of polar ice, and to thus map the evolutions in these regions.

The first campaign in the northern hemisphere allowed us to cover nearly 30,000 km² of the Arctic regions. The current Antarctic campaign aims to cover 2 million km² of the icecap.

Antarctica in our dreams

Jean-François Mayence

The ultimate adventure

"*In space, no one can hear you scream.*" Neither in Antarctica. The famous slogan from *Alien* in 1979[1] could well have applied to the huge 14 million km² mass of rock and ice that covers our planet's South Pole. Moreover, it is where the Aliens would probably meet the *Predators*[2] in an unlikely sequel…

The saga of monsters in Antarctica isn't new: in 1982, John Carpenter made fantastic use of the assets offered by this frozen desert to locate the action of his fantasy film *The Thing*. A team of American scientists look on in fear as a sled dog is pursued by a helicopter flown by their Norwegian colleagues. It later turns out that the poor animal is possessed by a particularly ferocious extra-terrestrial.

The relationship between Antarctica and extra-terrestrial forms of life is also a theme dear to science fiction and Hollywood. In the full-length feature film *The X-Files*[3], Mulder and Scully discover a base used by beings from outer space. The place, supposed to be close to Wilkes Land, a district formerly claimed by Australia, is in the eastern part of Antarctica. Since the exploits of the two FBI agents take place right in the middle of July, it is rather surprising to see them in everyday clothes in a region that is, in reality, almost inaccessible during the Antarctic winter and plunged in darkness. But so what! The contingencies of cinema allow a few liberties with the geographical truth…

© Hergé/Moulinsart 2008 (greeting card drawn by Hergé for the 1957 Belgian Antarctic Expedition)

Antarctica has a collection of fabulous ingredients for authors: although part of our world, it is isolated from other lands, subject to extreme natural conditions, a desert, hostile to man. However, it contains the secrets of our past. The apparent desolation of this country – the only one that has no human inhabitants – has inspired plenty of action-packed stories. We already mentioned some of them in issue 17 of *Science Connection*[4]. *La Nuit des Temps*[5] is one of those. René Barjavel imagines a 900,000-year-old civilisation whose last survivors were cryogenised and buried deep in the ice. When scientists wake them up, they also awaken a passion between two beings, a drama whose seeds have been inexorably sown.

1 *Alien by Ridley Scott and Dan O'Bannon*
2 *Alien vs. Predator (2004)*
3 *X-Files, The Movie by Rob Bowman and Chris Carter (1998)*
4 www.scienceconnection.be
5 René Barjavel, *La Nuit des Temps* (1968)

Well before Barjavel, Edgar Allan Poe took the hero of his only finished novel, Arthur Gordon Pym[6], to the far reaches of the world to discover this unknown continent. We are in 1838, two years before the French navigators led by Dumont d'Urville and the Americans led by Charles Wilkes planted their flag on the seventh continent.[7] Undoubtedly, Poe's mistake was to pretend that his novel was an authentic travelogue.

We also note the similarity between this story and the famous poem of Samuel Taylor Coleridge[8] , « Rime of the Ancient Mariner », in which an old sailor tells his supernatural adventures which brought him to Antarctica. This poem was adapted in a song by the hard rock group Iron Maiden[9].

The work was discredited and forgotten, until the precursors of science fiction used it as a model. The first to do so was Jules Verne who, in 1895, followed up Poe's novel with *Le Sphinx des Glaces*. The action takes place in Antarctica, starting from the Kerguelen Islands. In the lines of this great storyteller, we can already discern concerns for the environment, the fauna and the flora of this region.

Another precursor of science fiction was inspired by the work of Poe: the controversial H.P. Lovecraft whose *At the Mountains of Madness*, published in 1931 employs the theme of Antarctic exploration and the discovery of a lost city. Another reference: *La Compagnie des Glaces*[10], famous '*série fleuve*' (98 episodes!) describing a post-apocalyptic epic on a frozen land dominated by rail companies.

SOS Antarctica[11], the novel by Kim Stanley Robinson, is set in the future and refers to the struggle of eco-terrorists against the industrialisation of Antarctica. This opus follows his Mars trilogy in which the author broaches the problem of the human colonisation of new territories.

From Buck Danny to Bob Morane, with the new environmental heroes

There are also comic strips set in Antarctica: in the *Les Sarcophages du 6ᵉ Continent*[12] , a story in two volumes about the adventures of Blake and Mortimer set against the background of Expo 58 and the struggle for the domination of Antarctica's resources; as usual in this series, the plot mixes crime and the supernatural.

Another brand new release : *Climax* by Brahy, Corbeyran and Braquelaire brings adventure in Antarctica back as a hot plot, with the climatic

6 Edgar Allan Poe, The Narrative of Arthur Gordon Pym of Nantucket (1838), translated into French by Charles Baudelaire in 1858
7 According to the geographical reference model, Antarctica may be considered as the 5th or the 7th continent. Some models even identify 4 or 6 continents. Actually, it depends on how Europe is considered with regard to Asia, how Africa is considered with regard to Eurasia and how South America is considered with regard to North America. From a geological standpoint, the earth's crust is made of seven tectonic plates.
8 Poem written between 1797 and 1798
9 Iron Maiden, *Powerslave*, EMI 1984
10 G.-J. Arnaud, *La Compagnie des Glaces*, éditions Fleuve Noir
11 Kim Stanley Robinson, *SOS Antarctica*, Presses de la Cité (1997)
12 Yves Sente, André Juillard, Blake & Mortimer (2003)

changes as background. The first part of this new serie published by Dargaud is titled *Le Désert blanc* and makes us follow a young female scientist just arrived at a South pole base and whose life seems to be threatened.

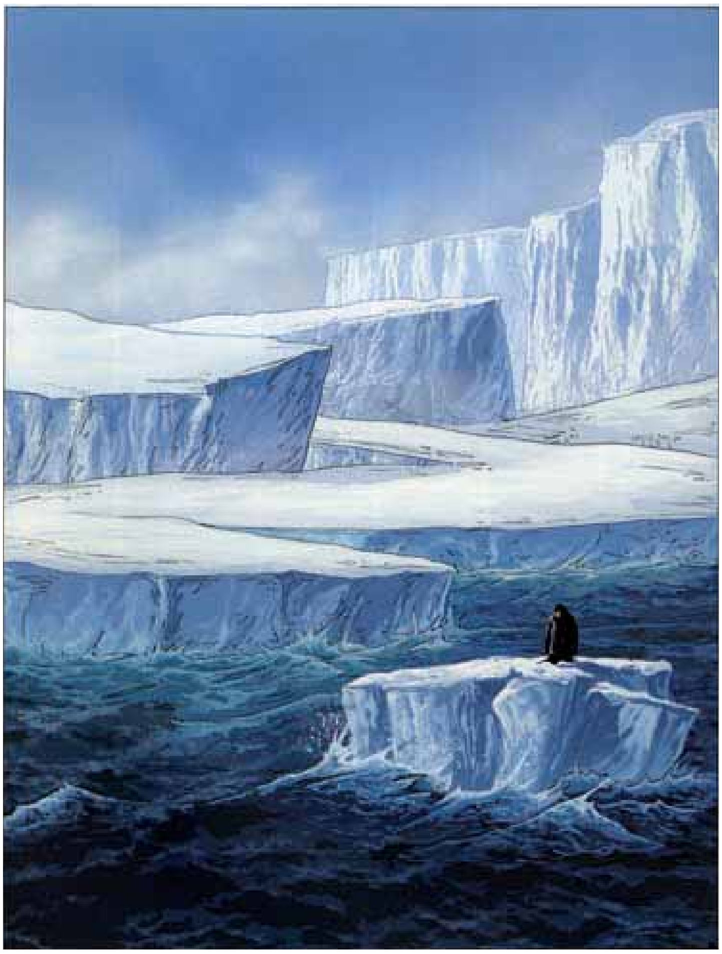
Climax offers one of the best fictional and documented story on Antarctica.

Let's mention also the new serie *Arctica*, by Pecqueur and Kovacevic, published by Delcourt.

Another hero transposed into the ice floes of the south: Buck Danny[13], flanked by his incredible companion Sonny Tuckson, goes to investigate suspicious military activities off the Antarctic coast.

There is also the beautiful film *Antarctica* by the Japanese director Koreyoshi Kurahara, which came out in 1983. It tells the true story of sled dogs that were abandoned during a scientific expedition and their fight for survival. A watered-down version of this story was brought out by the Disney studios in 2006.

While discovering all these works, we may forget that the reality in Antarctica goes far beyond fiction: there are the underground lakes whose water has been trapped for millions of years and the icy storms that polish the ice floe; human exploration is far from having discovered all the secrets of the continent. It hides many mysteries that haunt our dreams and our imagination.

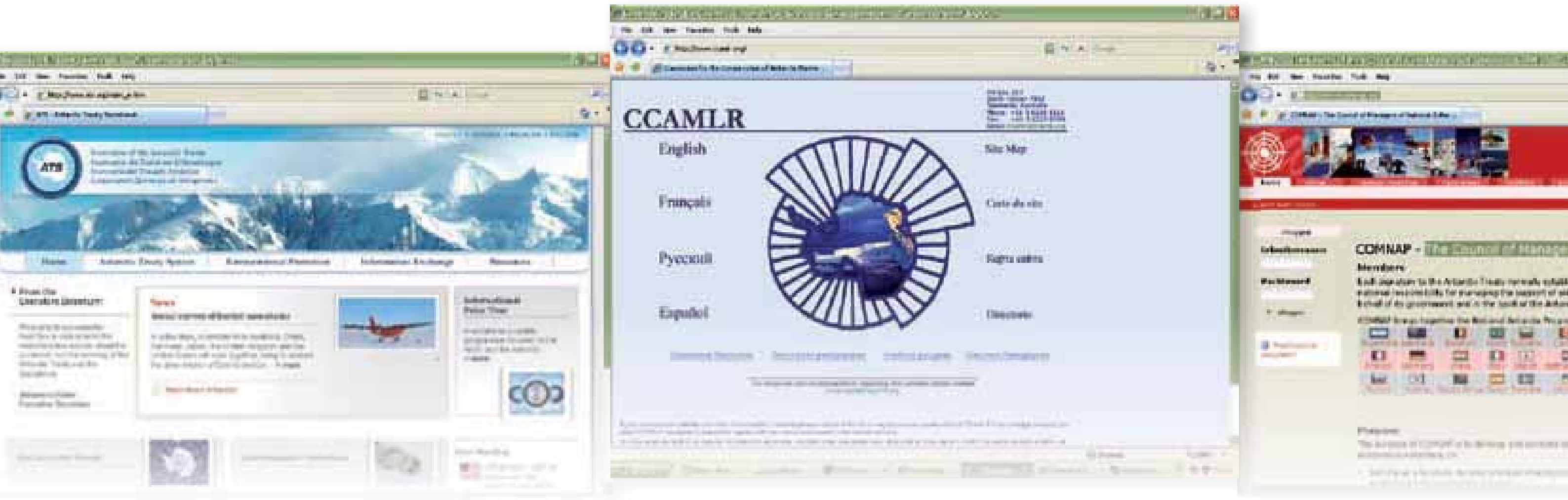


© Vostok (Climax, n° 2), Braquelaire, Corbeyran, Brahy, Dargaud Bénélux (Dargaud – Lombard s.a.), 2008

How can we describe the feeling of wonder, but also certainly terror, that the first European navigators must have felt in the 17th century when they were rerouted by the storms of Cape Horn to the snowy coast of Antarctica? What beliefs must have arisen from the huge blocks of ice drifting along the coastline of Easter Island, which the natives considered to be sacred boats ?[14]

While literature or film plays on our fears, it is science – real science – that must generate our respect for this sanctuary of humanity.

13 Francis Bergèse, *Mystery in Antarctica*, Dupuis (2005)
14 as the film *Rapa Nui* suggests, by Kevin Reynold (1994)



Antarctica on the web

Denis Renard

Denis Renard

OFFICIAL INTERNATIONAL SITES

Antarctic Treaty Secretariat (ATS)

Prior to the 1st September 2004, the Antarctic Treaty had no permanent secretariat. The Antarctic Treaty Secretariat is based in Buenos Aires, Argentina. The ATS primarily ensures the support of the organisation's annual meetings and facilitates data exchange among them in accordance with their engagements under the Treaty itself and the Environmental Protocol. Part of the site is reserved to the CEP - Committee for Environmental Protection, http://www.ats.aq/e/cep.htm, which is responsible for monitoring the correct application of the Environmental Protocol and which meets annually within the margin of meetings of the Consultative Parties.

www: http://www.ats.aq

⚐: English, Spanish, French, Russian

Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)

The Convention for the Conservation of Antarctic Marine Living Resources came into force in 1982 within the framework of the Treaty of Antarctica. It was principally drawn up in response to a marked increase in krill fishing in the Southern Ocean, which would have a severe impact on the krill population and other marine life. Krill is a particularly important food source for birds, seals, whales and fish. This Commission is charged with the conservation of the fauna and flora of the Southern Ocean; rational exploitation is permitted.

www: http://www.ccamlr.org/

⚐: English, Spanish, French, Russian

The Council of Managers of National Antarctic Programs (COMNAP)

Le COMNAP favours the development and exchange of best practice procedures in support of Antarctic research. The aim is to make Antarctic research more effective, while nonetheless ensuring that it is carried out in a responsible and environmentally respectful manner. Its members are representatives of the signatory nations to the Antarctic Treaty. The website includes a list of currently operational Antarctic research stations as well as a series of publications.

www: https://www.comnap.aq/

⚐*: English*

Scientific Committee on Antarctic Research (SCAR)

The SCAR is an interdisciplinary committee of the International Council for Science (ICSU). The SCAR exerts a driving force on Antarctic scientific research into the influence of this continent on world climate. In addition it provides scientific input to the consultative meetings of signatory nations to the Antarctic Treaty as well as to other organisations concerned with the Antarctic zone.

www: http://www.scar.org

⚐*: English*

International Polar Year (IPY)

The *International Polar Year* is an important scientific programme whose axes are the Arctic and Antarctic and which lasts from March 2007 until March 2009. It is jointly organised by the *International Council for Science* (ICSU) and the World Meteorological Organization. The website offers an abundance of information on the projects and activities connected with the programme in a wide variety of forms: project descriptions, events calendar, new publications, blogs, videos, podcasts, RSS feeds, etc. Several blogs are even supported by the International Polar Foundation and carry updates on the life of the Belgian *Princess Elisabeth* station, whose construction perfectly fits, both temporally and thematically, within the International Polar Year.

www : http://www.ipy.org

⚐*: English*

OFFICIAL BELGIAN WEBSITES AND CONTACT POINTS

SPF Affaires étrangères, Commerce extérieur et Coopération au Développement (FPS External Affairs, Foreign Trade and Development Cooperation)

Belgian Contact Point for
- AT - Antarctic Treaty
- ATCM – Antarctic Treaty Consultative Meeting

Chris vanden Bilcke
SPF Affaires étrangères, Commerce extérieur et Coopération au Développement
rue des Carmélites 15
B-1000 Brussels
Tel.: +32 2 501 37 12
Fax: +32 2 501 37 03
E-mail: chris.vandenbilcke@diplobel.fed.be

SPF Santé publique, Sécurité de la chaîne alimentaire et Environnement (FPS Public Health, Food Chain Safety and Environment)

Belgian Contact Point for:
- Committee for Environmental Protection of the Antarctic Treaty - CEP
- The Commission for the Conservation of Antarctic Marine Living Resources - CCAMLR

Alexandre de Lichtervelde
Affaires multilatérales et stratégiques
Eurostation II
Place Victor Horta 40, box 10
B-1060 Brussels

Tel.: +32 2 524 96 17
Fax: +32 2 524 96 00
Email: Alexandre.DeLichtervelde@health.fgov.be
www: http://www.health.fgov.be
(via Home |Environment | Biodiversity and GMO | Biodiversity | Antarctica)
⚐*: English, French, Dutch*

Politique scientifique fédérale (Belgian Science Policy)

Belgian Contact Point for:

- The Council of Managers of National Antarctic Programs (COMNAP)
- The Joint Committee Antarctic Data Management (JCADM)
- The Dronning Maud Land Air Network (DROMLAN)

Maaike Vancauwenberghe
Belgian Science Policy
Antarctic Programme Manager
rue de la Science 8
B-1000 Brussels
Belgium
Tel.: +32 2 238 36 78
Fax: +32 2 230 59 12
Email: vcau@belspo.be
www: http://www.belspo.be
⚐*: English, French, Dutch*

BePoles

The website of the polar platform of Belgian Science Policy informs scientists and political decision-makers of the history and current status of Belgian polar scientific activities, as well as the publications, events and educational projects associated with them. In a general manner it throws light on Belgian involvement in international polar endeavours.
http://www.belspo.be/belspo/BePoles/index_en.stm
(or Home| Research Programmes | ANTARCTIC)
⚐*: English, French, Dutch*

The Royal Academies for Science and the Arts of Belgium (RASAB)

Belgian Contact Point for:
Scientific Committee on Antarctic Research (SCAR)
Hugo Decleir
President of the National Committee on Antarctic Research
Vrije Universiteit Brussel (VUB)
Vakgroep Geografie
Pleinlaan 2
B-1050 Brussels
Tel: +32 2 629 33 84
Fax: +32 2 629 33 78
Email: hdecleir@vub.ac.be
www: http://www.interacademies.net
⚐*: English*

GENERAL AND EDUCATIONAL WEBSITES

International Polar Foundation

The International Polar Foundation was created by Royal Decree in 2002 for the purpose of raising public awareness of polar research, and of how it can help our understanding of climate changes and the introduction of sustainable environmental and developmental policies in the region. It was given the task by the Belgian government of designing and constructing the polar research station *Princess Elisabeth.*
www: http://www.polarfoundation.org
⚐*: English*

Princess Elisabeth Station

Antarcticstation.org is the website of the *Princess Elisabeth* research station.

The site not only features a description of the station but also a wealth of photos documenting the various stages of construction work on this extraordinary new infrastructure. The tri-lingual site (English, French, Dutch) also issues the latest updates on the lifecycle and work of the station. Also worth mentioning are the site's navigability and user friendliness.

www: http://www.antarcticstation.org

⚐: *English, French, Dutch*

The International Polar Foundation also manages three other websites specifically dedicated to polar themes in the light of scientific, educational and exploration activities.

Educapoles

The aim of Educapoles is to raise awareness among young people and their teachers of the importance of the Polar Regions to the issues of global climate change. To this end, the website offers a variety of educational resources: study files, stories for children, activities, quizzes and videos, everything imaginable to stimulate a young public to take seriously the importance of our polar regions for our climate and environment. There is also an RSS feed bringing regular updates of polar news.

www: http://www.educapoles.org

⚐*: English, French and Dutch*

Explorapoles

ExploraPoles takes a plunge into the dynamic adventure of polar exploration: stories of great explorations and the famous explorers who undertook them. Here too, the accent is on the importance of such exploits in enriching our understanding of the Polar Regions and their influence on the world's climate. And here, too, you will find news from the field as well as a photo archive.

www: http://www.explorapoles.org

⚐*: English, French*

Sciencepoles

SciencePoles.org brings the latest discoveries and developments in the field of Polar science to a wider public. Articles, interviews with researchers, the latest news, a calendar of scientific events and, of course, multimedia resources, principally photos.

www: http://www.sciencepoles.org

⚐*: English*

Antarctic and Southern Ocean Coalition (ASOC)

The ASOC is a coalition of more than 100 environmental organisations from all over the world, currently working to preserve the Antarctic continent, the surrounding islands and the Southern Ocean. This site carries an abundance of documents describing their actions and campaigns.

www: http://www.asoc.org

⚐*: English*

Het laatste continent (the last continent)

"Het Laatste continent" is THE essential Dutch language internet resource on the Antarctic. The site contains sections on current developments, the history of Antarctic exploration, zoological and geographical information etc. This is an excellent educational tool, comprehensive and user-friendly. It also contains some sequences of video footage and very beautiful photos.

www: http://www.hetlaatstecontinent.be

⚐*: Dutch*

Of tooth and gum...

Pierre Demoitié

Unlike the French Austral and sub-Antarctic Territories (a French overseas dominion), Belgium has not actually issued a postage stamp directly from the Antarctic.

Nonetheless, the Belgian Post Office has consistently rendered homage to the polar adventure since its inception.

In 1947, the Post celebrated the fiftieth anniversary of the winter layover of the Belgica with a carmine stamp bearing the likeness of Adrien de Gerlache (1.35 Francs) and a second showing the sailing vessel trapped in the ice (2.25 Francs). It did the same in 1997 for the 100th anniversary of the event, giving François Schuiten the task of immortalizing the blocked ship (17 francs).

Another stamp, more Bordeaux in colour, carried the same portrait with the famous ship in the background.

For the 150th anniversary of Belgium, a four-colour portrait of Adrien de Gerlache was reproduced on a 6 Franc stamp.

The 1957 expedition led by Gaston de Gerlache was the theme of three stamps: a scene with sled-dogs (5 and 2.5 Francs), in green and brown tones; the release of a meteorological balloon (6 and 3 Francs), slightly more sepia, and a core sampling (1 and 0.5 franc), entirely green.

The 10th anniversary of the Antarctica Treaty in 1971 was also commemorated on a 10 Franc stamp.

Finally, the Princess Elisabeth polar research base has, of course, its own stamp, once again designed by Schuiten. Issued last year in an edition of 500,000, this was voted the second most beautiful stamp of 2007...

A new stamp, calling for the preservation of the Polar Regions, will be issued by the Belgian Post Office in March 2009.

ALSO:

Polar Philatelism: www.philatelie-polaire.com
The Philatelism of TAAF (French Austral and sub-Antarctic Territories): www.taaf.fr > philatelie

ANTARCTIQUE BELGE
1958
30F
OOLEXPEDITIE
F+50c
BELGICA
1897
BELGIË
EXPÉDITIONS ANTARCTIQUES
ZUIDPOOLEXPEDITIES
10F +5F
BELGIQUE
1961·1971
ANTARCTISCH PACT
TRAITÉ SUR L'ANTARCTIQUE
1831 BELGIQUE BELGIË 1981
de GERLACHE
BELGIQUE-BELGIË
BELGIË-BELGIQUE
Preserve the Polar Regions and Glaciers
BELGIË·BELGIQUE

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Coordination:
Maaike Vancauwenberghe (Federal science policy), in collaboration with Pierre Demoité (Federal science policy)

Editing:
Alexandre de Lichtervelde (Health, Food chain safety and Environment), Pierre Demoitié (Federal science policy), Christian Du Brulle, Xavier Lepoivre (Federal science policy), Jean-François Mayence (Federal science policy), Denis Renard (Federal science policy), Maaike Vancauwenberghe (Federal science policy), Raf Scheers, Senne Starckx and Els Verweire

Proofreading:
Mireille Lecoutre (Federal science policy), Patrick Ribouville (Federal science policy) and Maaike Vancauwenberghe

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BELGIAN SCIENCE POLICY

Rue de la Science 8
1000 Bruxelles

T : 32 2 238 34 11
F : 32 2 230 59 12
W : www.belspo.be
E : www@belspo.be

federal public service
HEALTH, FOOD CHAIN SAFETY
AND ENVIRONMENT

Eurostation Building

Place Victor Horta, 40, bte 10
1060 Bruxelles

T : 32 2 524 95 26
F : 32 2 524 95 27
W : www.health.fgov.be
E : info_environment@health.fgov.be