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Edito

YEAR 2021/2022 a dynamic synonymous with hope

It is time for the French Polar Institute to present its annual activity report, at the end of a tumultuous but hopeful year. The year 2020 and the 2021/2022 southern season took place in the difficult context of a global pandemic that had a particularly strong impact on our human and material flows to the poles and the southern islands. Although the year 2021 saw temporary lulls in the circulation of the virus, our Institute still had to meet the double challenge of avoiding the introduction of SARS-CoV-2 into our territories, but also of ensuring the transfer of expeditionaries via Australia, a country that had closed itself off to other nations. In addition to this double challenge, there was the need to reduce the bottleneck created in 2020 by the postponement of 40 scientific projects out of the 78 initially validated by the CPST in 2019, which led to the management of an increased flow of scientific personnel, in particular to Dumont d'Urville.

The response to these challenges was again through strict quarantines at home ports and the chartering of four aircraft between Melbourne and Hobart, with the few commercial flights available between Europe and Melbourne to manage the intercontinental transfer phase. The pandemic also had a significant impact on our freight management costs given the extreme volatility of the global shipping market.

In this very particular context, the sea ice conditions fortunately proved to be very favourable throughout the 2021/2022 Antarctic campaign, allowing the supply ship L'Astrolabe to moor alongside l'île du Lion on each of the five logistical rotations, as in 2020. On the scientific front, in addition to our strong participation during the 2021/2022 campaign, the success of the first year of ice core drilling for the European Beyond EPICA project on the Little Dome C site near Concordia, the spearhead of the major projects supported by the Institute, should be highlighted.

In the sub-Antarctic islands, the results of the campaigns were also excellent, both in terms of the deployment of the selected projects and the maintenance of the many refuges under the Institute's management. Of particular note was a major operation carried out on the Entrecasteaux site in Amsterdam Island, in close collaboration with the TAAF, in order to secure the refuge following the fire that affected the overhanging slopes in early 2021. Finally, in the Arctic, improved pandemic conditions have allowed a return to near-normal support for numerous projects, both in Ny-Alesund and on the many other international sites.

In terms of infrastructure, the year 2021 was marked by two highly structuring elements: the submission to the MESRI and the Ministry of Overseas of a first scenario for the modernisation of the Dumont d'Urville station, co-designed by the French Polar Institute and the TAAF with the help of a group of architects/engineers and a design office, evaluated at 120 M€ over 30 years. Second element: a 10-year action plan to upgrade the Concordia station, for an amount of 30 M€ to be shared between the two co-managing nations, a project submitted in September 2021 to the MESRI and the Italian Ministry of Research. Following the same logic, the Institute continued its investment in the two stations, allowing the size of the working capital to be reduced as requested by the ministry in charge of research.

At the headquarters, 2021 will have seen the continuation of internal reforms initiated by the Direction in 2019 through the GPEC approach. Increased collegial functioning via a weekly management council, monthly meetings of the new internal council (QWL aspects), continued work on the Institute's procedures and information system with an operational implementation around personnel management, an engineer dedicated to safety and

the environment having formalised specific rules at headquarters, as well as in the polar stations.

Following the work carried out since 2020 by the technical group mandated by the Board of Directors, a general meeting of directors held in May 2021 confirmed the relevance of the GIP status for the Institute and listed a certain number of decisions and recommendations giving better visibility to the staff, many of whom had rightly expressed suffering at work. At the same time, the new ambassador for the poles and maritime issues, Olivier Poivre d'Arvor, accompanied by the Institute's direction, have worked hard throughout 2021 to bring out the very first national polar strategy, which was officially presented on 5 April 2022. In it, the Institute's scope of action has been greatly strengthened by the government.

Above all, significant progress has been made in terms of human resources, thanks to the increase in our employment ceiling in the 2021 Financial Act, but also thanks to the strong commitment of the CNRS-INSU Institute despite its own human resources constraints: new administrative and financial director, new operations director and head of Antarctic operations, appointment of a polar infrastructure manager, as well as the Concordia technical manager, head of fluid management in the stations, mechanical assistant, sub-Antarctic operations assistant, and human resources assistant. Thanks to financial control, we were also able to change some administrative rules that were previously penalizing the Institute: for example, VSCs no longer impact the Institute's employment ceiling, while VIs no longer forms part of the Institute's wage bill; moreover, field contract staff are now counted "under the ceiling" and no longer "outside the ceiling". Although they may seem very technical to the uninitiated, these regulatory advances are nevertheless essential to enable the Institute to properly fulfil its missions in the service of science.

The positive outcome of this latest exercise is also largely due to the tremendous momentum generated, with the support of parliamentarians, by the Direction within the framework of the Parliamentary Office for the Evaluation of Scientific and Technological Options (OPECST). The hearing held in May 2021, followed by the landmark sequence in June 2021 with the French presidency of the annual Antarctic Treaty meeting in Paris (which saw a remarkable commitment from our communication department), then the parliamentary

amendments tabled during the examinations of the 2021 rectifying finance law and the 2022 finance law, will have punctuated the year to culminate in the strong signals sent by the government at the end of October 2021: An increase in the Institute's employment ceiling by 7 units, €1M for project management assistance for the Dumont d'Urville station modernisation project, €7M over 3 years to start the work.

2021 was also the occasion for a symbolic gesture in memory of the politician who decided to create our Institute more than 30 years ago, a figure strongly committed to supporting French research at the poles: former Prime Minister Michel Rocard. His name was given to the bay located immediately east of the first French Antarctic station, Port Martin. A commemorative plaque was placed on the site in November 2021, 30 years after the signing of the Madrid Protocol, which was set up by Michel Rocard and which gave to the Antarctic continent the status of "natural reserve, dedicated to peace and science".

Finally, with this new activity report, we are marking the change in the Institute's management: Yan Ropert-Coudert, Deputy Director since July 2021, took over the reins in April 2022 from Jérôme Chappellaz. The French community conducting research at the poles can count on his total commitment so that the Polar Institute can be strongly supported by the government and fully fulfil its role as a solid agency of means and skills at the service of this science that is so important for our societies. He will thus continue the long-standing work begun by his predecessors, including the late Yves Frenot who sadly passed away prematurely on 7 February 2022 and in whose memory we dedicate this activity report.

Enjoy your reading.

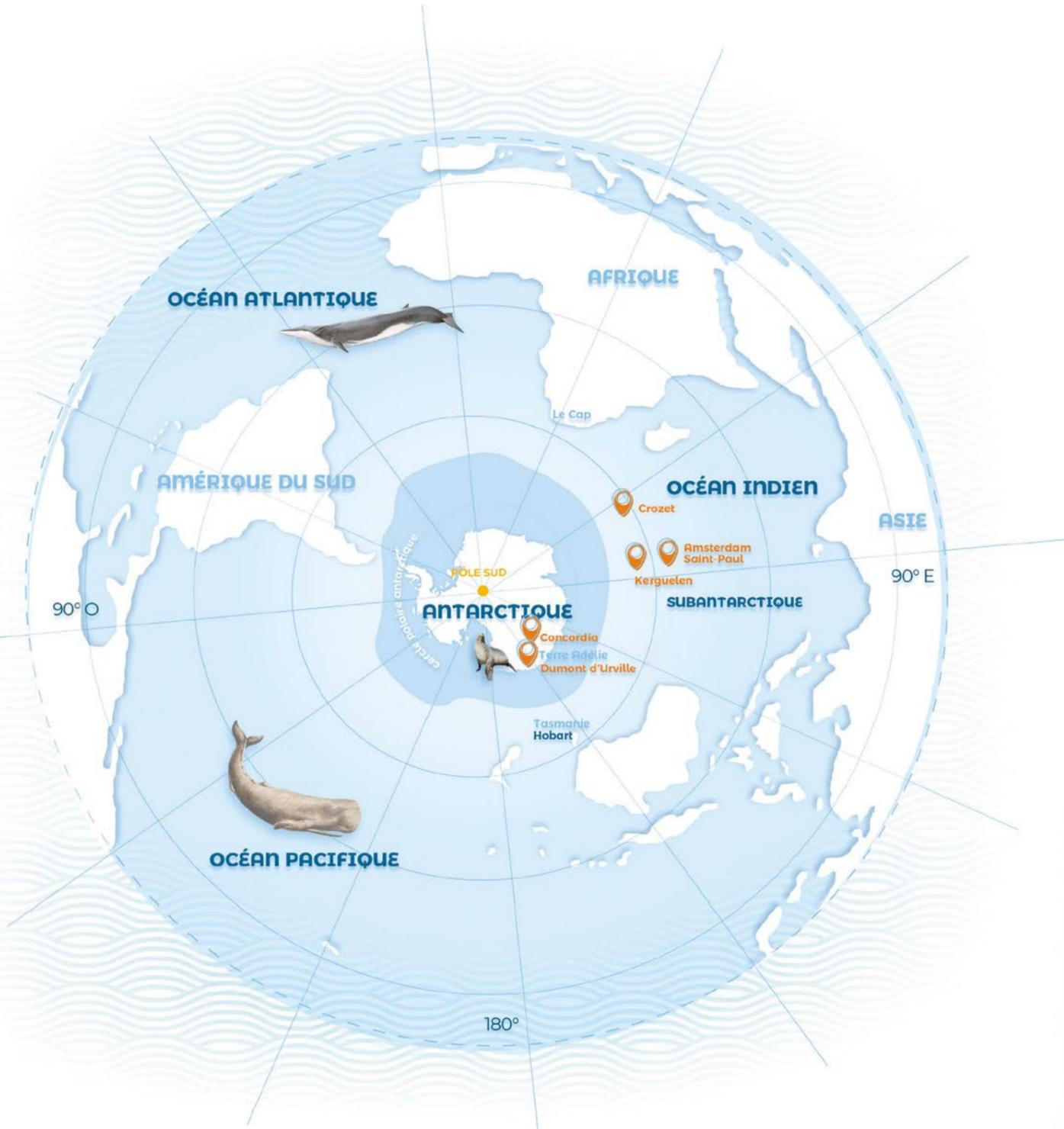
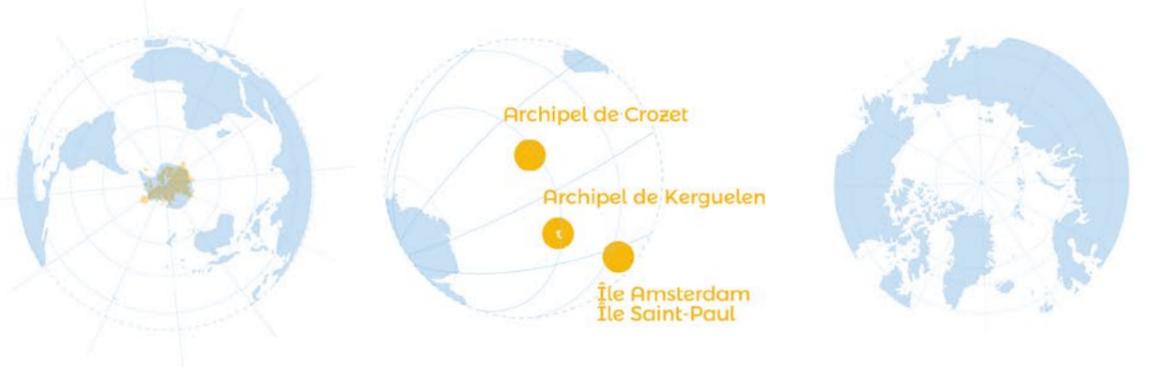
Jérôme Chappellaz
Director until 31 March 2022

Yan Ropert-Coudert
Director since 1 April 2022

Antarctica

Sub-Antarctic

Arctic



Antarctica Sub-Antarctic

Antarctica and sub-Antarctic maps are not at the same scale.



Arctic

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SCIENCE

supported by
the Institute

ETHNOGRAPHY OF A SCIENTIFIC BASE IN ANTARCTICA

The main objective of the programme 'Ethnography of a Scientific Base in Antarctica' (ESBA) – which is supported by the French Polar Institute – is to analyse the processes involved in the structuring of social life in an ephemeral community living in isolation.

Living in a closed environment is an issue which has already been the subject of numerous sociological studies adapted to other contexts and, for example, made it possible for the American psychologist Erving Goffman to develop the concept of Total Institution in his book *Asylums*.

In this work, he focuses on places of both residence and work in which individuals who are cut off from the outside world for a given period of time lead a life together that is constrained, regulated and completely controlled by the institution.

The data gathered can be used not only to increase our understanding of a scientific station in Antarctica, it can also provide ethnologists with a platform to address the processes involved in the setting up of a temporary and communal life. The ethnographic method based on participatory observation and the

This programme is led by **Isabelle Bianquis**, Professor of Anthropology at the University of Tours, member of the UMR 7324 Citeres and **Bernard Ancori**, Professor of Epistemology and History of Science at the University of Strasbourg, member of the UMR 7117

collection of biographical interviews is particularly effective for updating relational mechanisms, the transformation of professional practices, perceptions of the surrounding world, and the changes of these characteristics over time.



The ESBA programme was specifically designed to (1) introduce a comparative aspect by carrying out two studies on two different sites (Dumont d'Urville in Antarctica and Crozet in the Sub-Antarctic), and (2) include a temporal aspect by studying populations before they leave for the station, during the mission, and following their return.

ESBA is a multi-disciplinary project combining the following expertise: anthropology, history, cognitive psychology and information and communication sciences. The issues addressed relate to the organization of daily life, compliance with rules, relationship to time, the association between private and public spaces and between work and leisure, and between life on the base and contact with the outside world. Relationships between power, gender or age are examined, as is the creation of daily or festive rituals.

A scientific base is an ecosystem in which each activity is linked to others. Although differences in status and in hierarchies can sometimes give rise to tensions, people work together while adopting as many peaceable behaviours as possible to avoid disrupting the system.

It is through studying the life paths of the participants, and the role of imagination and inclusion in ordinary life, that the workings of this system can be deciphered. These indicators should give us a more nuanced understanding of how cultures are constructed and how common identities are defined in highly specific situations (above and beyond the apparent differences between each wintering and summer campaign).



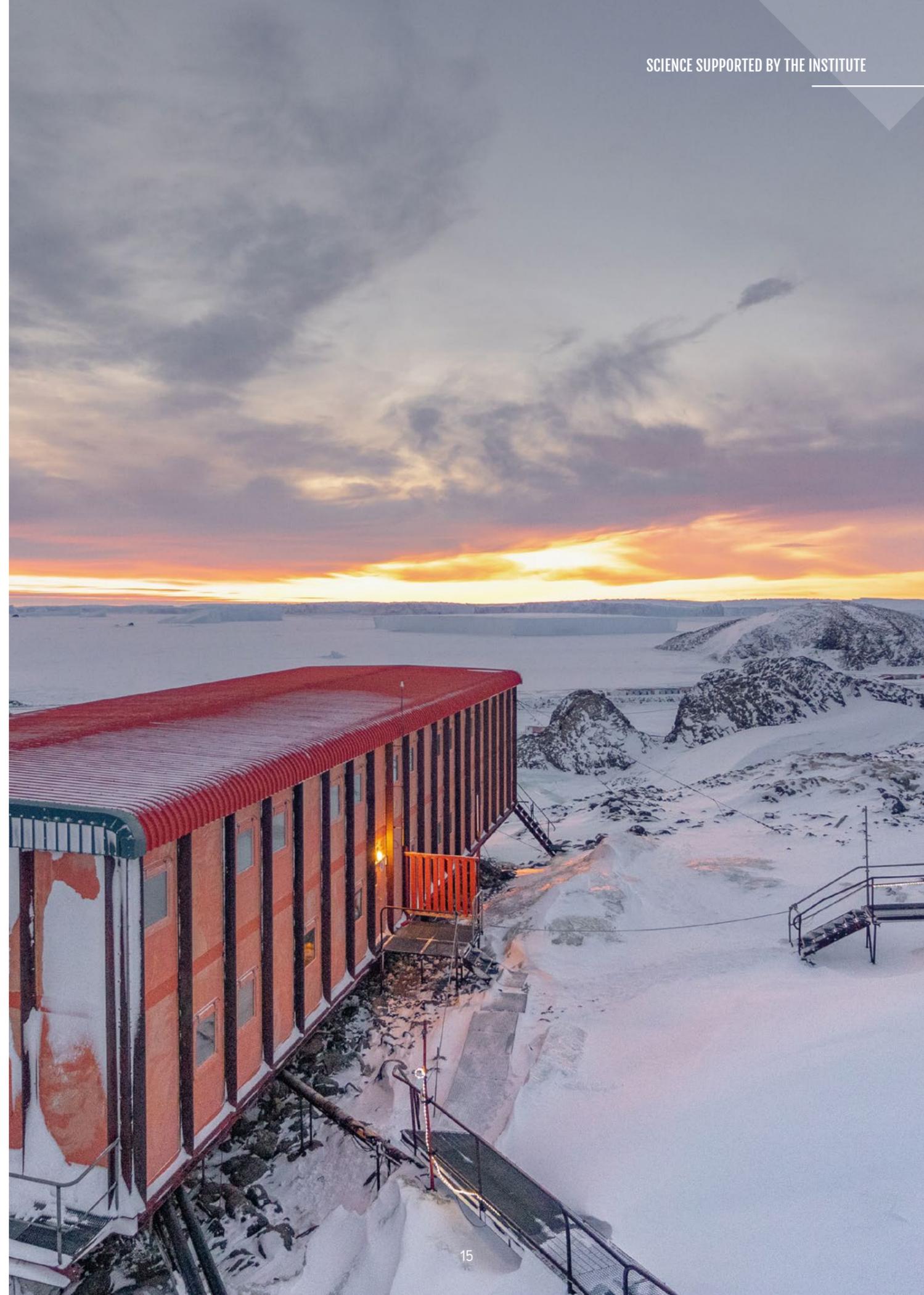
The purpose of ethnology is to identify the permanent features of a sound (advertent or inadvertent) reference framework. This framework cannot be dissociated from memory and as Halbwachs (1947) underlined: "when new groups form lasting or ephemeral groups (...) it is always a result of the separation of one or several larger and older groups. It is only natural that we find distinctive features of the parent communities in these new formations, and that many of the different notions developed in the former pass into the latter".

But what of this communal memory shaped by months of cohabitation?

The concrete applications expected from this study are increased knowledge about these non- autochthonous and heterogeneous groups both at the social and cultural level. More broadly, these studies could prove useful from a future anthropology perspective.

Western societies tend to put the individual first with bonds that are increasingly fluid, or "liquid", to use Zygmunt Bauman's concept (1998). Yet, in scientific stations, and also in other contexts such as spaceflights, and temporary cohabitations in constrained environments, we are dealing with forms of organization that are collectively created.

The individual only exists as part of a chain of professional relationships and requisite solidarity. The insight gained will therefore relate to the durability of the group, whether it has been soundly shaped, and the collective memory that will emerge.



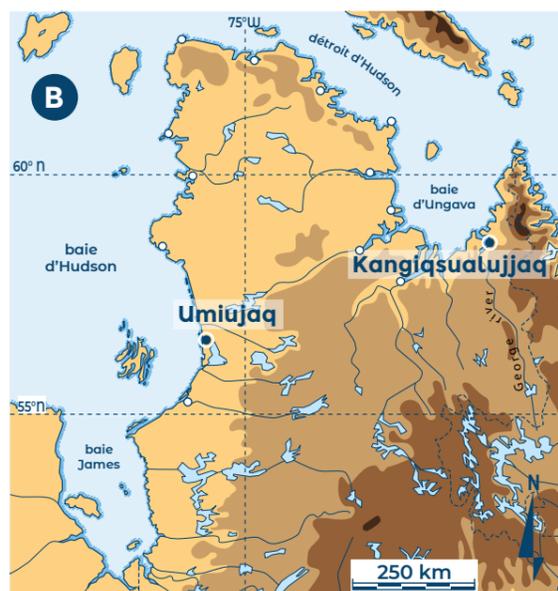
DeSiGN

DYNAMIC SLOPE GEOMORPHOLOGY AND VULNERABILITY IN NUNAVIK, CANADA

Geomorphological study of slope dynamics and situations of vulnerability in Nunavik, Canada



Fig. 1 Location of Nunavik, a region of northern Quebec located above 55°N (A), and the study sites (B).



Abstract. Few studies have provided knowledge about how slope dynamics function in northern Quebec, in the territory of Nunavik, where the Inuit population has been settled for only a few decades.

The villages of Umiujaq (founded in 1986) and Kangiqsualujjaq (founded in 1959) are located near slopes with different geomorphological characteristics: in Umiujaq, there is no written record of avalanche activity, whereas the geomorphological landforms highlight their occurrence. On the contrary, in Kangiqsualujjaq, it is a given that there will be avalanche activity that has impacts on the development of the village; however, this activity is not recorded by the geomorphological landforms.

Nunavik, a region of the province of Quebec located north of the 55th parallel (Figure 1), occupies a vast area of the Canadian Shield which is formed of undulating plateaus that have been flattened by multiple glacial flows from the Labrador-Quebec ice dome of the Laurentide Ice Sheet.

In general, Nunavik's reliefs are moderately high; however, some sites have steep slopes. These slopes are located both in and near coastal villages, or in national parks.

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Within a context of proven climate change in a territory where the population has only been sedentary for a short period of time, it is highly important that the inhabitants know how the slopes function because the stakes are quite high⁽³⁾.

Two sites have been selected for this study: Kangiqsualujjaq and Umiujaq. These villages are characterized by decreasing anthropization and latitudinal gradients, with contrasting slope dynamics (Figure 2).



Fig. 2 Views of Tasiapik Valley (A) and Kangiqsualujjaq (B)



Un appareil photographique à déclenchement automatique est installé sur le versant qui domine la route reliant le village de Kangiqsualujjaq à son aérodrome, documentant les éventuelles avalanches hivernales.

Opposite:
Morphometric data collection of rock debris
at the apex of a colluvial fan developing under
the rock face of the Tasiapik Valley,
near Umiujaq

TASIAPIK VALLEY, A LINK BETWEEN UMIUJAQ AND TURSUVUQ NATIONAL PARK

In the downstream one-third portion of Tasiapik Valley, the relief reaches significant heights with slopes up to 300 m high. Poorly developed slopes and colluvial cones* can be observed locally under the rock wall, indicating somewhat immature reliefs, whereas upstream in the valley, the rock ledge has almost disappeared and the colluvial cones are now practically connected to the plateau rim (Figure 3A). These slopes have been subject to somewhat intense geomorphological activity since the deglaciation of the valley around 8200 years BP.

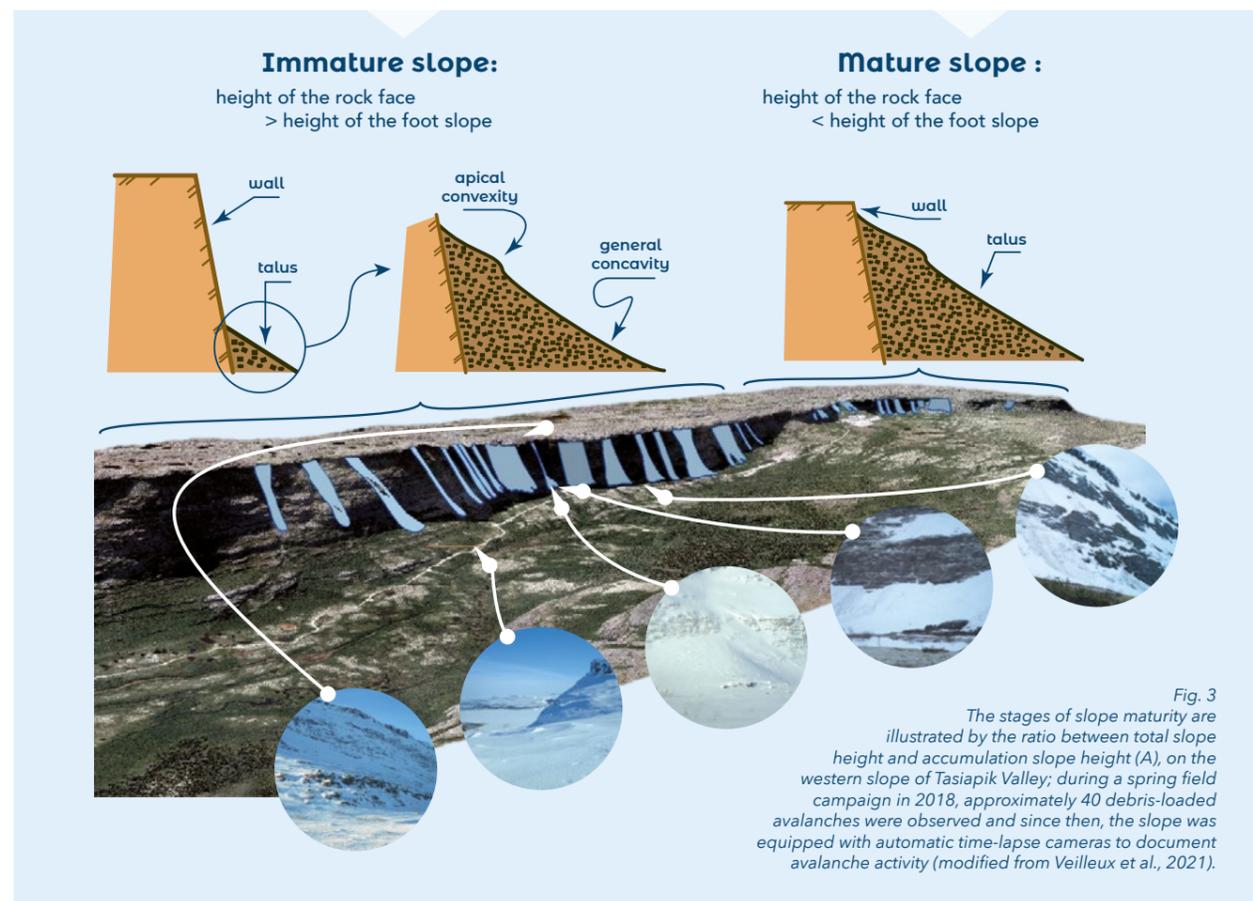
Longitudinal profiles produced on the distal accumulations highlight slightly concave slopes (Figure 3A), with convexities primarily located upstream⁽⁶⁾; this reflects the occurrence of rock debris remobilization processes and variable path lengths.

Conversely, vegetation surveys on boulders show that the newly detached ones are best observed in the distal part; this is proof that debris is being redistributed by avalanche

processes, confirmed by the direct observation of numerous debris-loaded avalanches in springtime (Figure 3B) during a field campaign⁽⁷⁾. Fieldwork has also revealed that major strike-slip faults are likely to occur and, like avalanches, they may extend as the road that stretches at the foot of the slope.

A network of self-activating cameras was installed so as to be able to report on slope activity in Tasiapik Valley. This makes it easier to recognize active avalanche paths, the length of the avalanche path as well as the meteorological conditions that may trigger these events (Figure 3B) in a territory where these data were non-existent up until now.

* A colluvial cone is a form of relief developing at the foot of rock faces and made up of debris transported by different slope dynamics along preferential corridors (avalanches, block falls, debris flows, etc.); its slope is generally greater than 10°.



KANGIQSUALUJJUAQ: DEVELOPMENT OF THE VILLAGE IS CONSTRAINED BY THE AVALANCH PROCESS

The village of Kangiqsuallujuaq is located on the shores of a cove that is subject to tides (average tidal range of 11 m) in the Georges River estuary, 25 km from its mouth in Ungava Bay, at the foot of a granite outcrop culminating at a height of 180 m to the northwest of the village. This village was founded in 1959 when a commercial co-operative was established; at that time, only two Inuit families had settled there⁽⁸⁾. Neighbouring camps were gradually abandoned for the village community.

The local geology, characterized by a very resistant rock, is not very sensitive to gelifraction. This prevents the accumulation of debris at the foot of the slope, which means that it is not possible to ascertain the slope dynamics at work, e.g., as can be observed in Tasiapik Valley near Umiujaq (where the relief is formed by a superposition of sedimentary rocks topped by a basaltic layer, all of which are more sensitive to frost weathering).



Reconnaissance of surface debris on a slope in Kangiqsuallujuaq



Figure 4 : The development of the village of Kangiqsuallujuaq since its foundation, illustrating the expansion of the village towards the avalanche slope and then its abandonment after 1999 to expand in the valley bottom and on the banks of the cove (modified from Decaulne et al., 2021).

However, as seen in Figure 4, we can trace the spatial expansion of the village by studying diachronic aerial photographs (images from 1967, 1972, 1984, 1991, 2002 and 2015⁽¹⁾).

We can see that the first buildings of the village were built between the slopes and the shoreline of Akilasakallak Cove (1967). The village then started to expand towards the slope (1972) where the habitat became denser (1984-1991), before abandoning the area close to the slope and investing more in the bottom of the valley and the north shore of the bay (2002-2019).

The area under the slope was abandoned due to a deadly avalanche which descended the steep 110 m slope and partially engulfed the gymnasium during the night from 31 December 1998 to 1 January

1999⁽⁵⁾, where a large part of the population had gathered for the end-of-year festivities. A significant amount of material damage occurred (several of the buildings built along the slope were destroyed or partially damaged), and there was a significant loss of human life, especially for a community of less than 700 inhabitants: 9 deaths and 25 injuries⁽²⁾.

However, research in the archives showed that several other events had occurred in the past and which had affected infrastructure and even caused minor injuries during the two decades prior to the deadly 1999 avalanche⁽⁴⁾. Orsane Rousset also provides an artistic view of this urban evolution (Figure 5).

The DeSiGN project is supported by OHMi Nunavik - LabEx DRIHM, "Investissements d'Avenir" programme - ANR-11-LABX-0010.

Figure 5: Artistic rendering of the diachronic spatial evolution of the Kangiqsuallujuaq village (©Orsane Rousset, 2021).



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Global seismological observatories in the southern lands and in Antarctica

GENERAL DESCRIPTION OF THESE OBSERVATORIES AND THE RENOVATION WORK UNDERTAKEN IN RECENT YEARS TO ENSURE THE SUSTAINABILITY OF THESE MEASUREMENT SITES.

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Our knowledge of the Earth's structure and of large earthquakes is based on the analysis of ground motion records from seismological stations.

By combining these records, it becomes possible to construct images of the Earth's interior and to characterize large earthquakes. To ensure that these images have a good resolution, the coverage of stations must be as dense and homogeneous as possible.

There is a lack of coverage in the Southern Hemisphere since a large part of the surface area is predominantly ocean and given the difficulties in accessing land. Within this context, the seismological observatories of Crozet, Kerguelen, Amsterdam & Saint-Paul, Dumont d'Urville and Concordia are of critical importance.



The French Dumont d'Urville station in Antarctica

PRESENTATION OF THE AUSTRAL SEISMOLOGICAL OBSERVATORIES

For more than 40 years, the French Polar Institute (IPEV) has been supporting, through programme #133 'SEISMOLOGY/OBS', the operation of 5 permanent seismological observatories set up on the Sub-Antarctic islands of the French Southern and Antarctic Lands (TAAF) Crozet, Kerguelen and Amsterdam as well as in Antarctica at the Dumont d'Urville and Concordia bases (Fig. 1). Programme #133 also provides support for a seismological station on Saint-Paul Island for regional seismicity studies.

All these seismological stations, some of which date back to the 1960s, were installed and managed by several generations of researchers and engineers from the Global Seismological Observatory Department at the Strasbourg School and Earth Sciences Observatory (EOST). Since 1982, EOST has been sharing its expertise in polar seismology with the French National Seismological Observation Service GEOSCOPE, which is today made up of a network of 33 stations in 18 countries.

The scientific objectives focus on understanding the Earth's dynamics based on the study of structures and seismological sources. In this context, the 5 stations of the SEISMOLOGY/OBS programme are crucial because of the quality of the sites and their unique location (Fig. 1).

Our observatory stations in the TAAF are the only ones located in a broad area covering the Southern Indian Ocean, which means that they are essential for the tsunami warning system. The Dumont d'Urville station was one of the first seismological observatories set up in Antarctica with broadband seismometers in 1986; this was an important step towards taking better samples at latitudes above the polar circle.

Lastly, since 2007 the Concordia seismological observatory that we manage with our Italian colleagues from the INGV, has filled an instrumental gap in the interior of the continent. The presence of permanent seismological stations in these remote and under-sampled areas is therefore a major scientific asset that enables various studies to be conducted such as tomographic* imaging of crustal and mantle

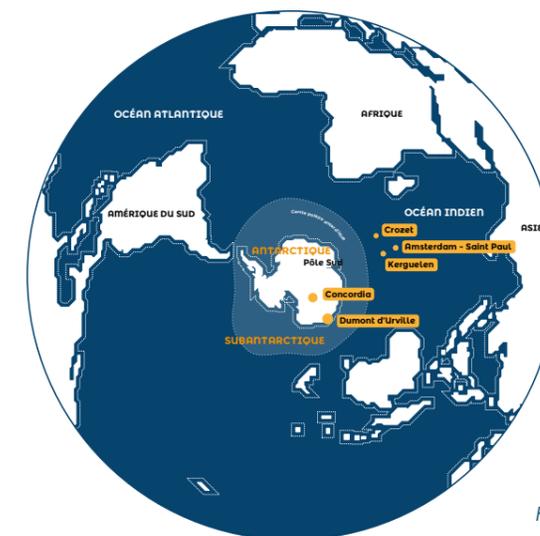


Fig. 1

The main missions of the observatory are to provide real-time broadband seismological data to French and international scientific communities as well as to earthquake detection and tsunami warning centres around the world.

structures, earthquake characterization on a global scale or analysis of ambient noise sources.

For example, related scientific questions involve understanding the effects of the ice cap on the topography; and the estimation of mantle viscosity and its impact on the response of the crust to changes in ice cover mass or the seismo-tectonic activity of high latitudes.



* Seismic tomography is a technique that uses the seismic waves generated by earthquakes to create three-dimensional images of the Earth's interior. Seismologists use the travel time of the seismic waves from the earthquake to the seismological stations to calculate the wave speeds and thus determine the slower or faster regions of the study area. As the speed of the seismic waves is controlled by the mechanical properties of the materials, it is possible to deduce the composition and mechanical state of the rocks in the Earth's crust and mantle.

The stations are equipped with two main structures: a seismological cave which houses the seismometers and a shelter which houses the acquisition electronics (Fig. 2).

The stations are equipped with two main structures: a seismological cave which houses the seismometers and a shelter which houses the acquisition electronics (Fig. 2). These infrastructures provided by the Polar Institute make it possible to isolate the sensors from external disturbances. However, despite the existence of these dedicated infrastructures, methodological and technical developments are required to ensure that the seismometers can operate outside their nominal parameters given the harsh environmental conditions (cold, humidity, wind, etc.).

In addition, the geographical remoteness of the sites means that we need to enlist observers, Civic Service Volunteers (VSC) employed by the Polar Institute, whom we train in Strasbourg and who oversee the installations on the southern bases year-round. Because they are on-site, this means that we can ensure an excellent level of responsiveness in the event of a breakdown. These observers also play a seismological monitoring role by systematically analysing all earthquakes visible on the data which is then sent to an international database.



Up : The Crozet seismological cave with STS-1 seismometers
Down : the Amsterdam station acquisition electronics

RENOVATION OF THE SEISMOLOGICAL STATIONS

Over the lifespan of an observatory, it is both important and compulsory to undertake renovations in order to be able to continue to make quality observations over the long term. In recent years, EOST, in close collaboration with the French Polar Institute, has begun major renovation work on several of the southern stations. Below, we provide the examples of the Concordia and Saint-Paul stations.

Since 2015, our main project has been to completely renovate the Concordia seismological station, one of only two stations found on the Antarctic plateau. There is a seismological cave buried 15 m in the snow at this site. Its purpose is to protect seismometers from the most extreme temperature conditions (down to -80°C) and sources of noise.

However, this cave is subjected to severe stress due to the hydrostatic pressure of the snow; this has led to a deformation that then causes the instruments to tilt* and creates parasitic noise in the observations.

Lastly, the surface shelter housing the acquisition electronics has been sinking with each passing year due to the accumulation of snowdrifts.

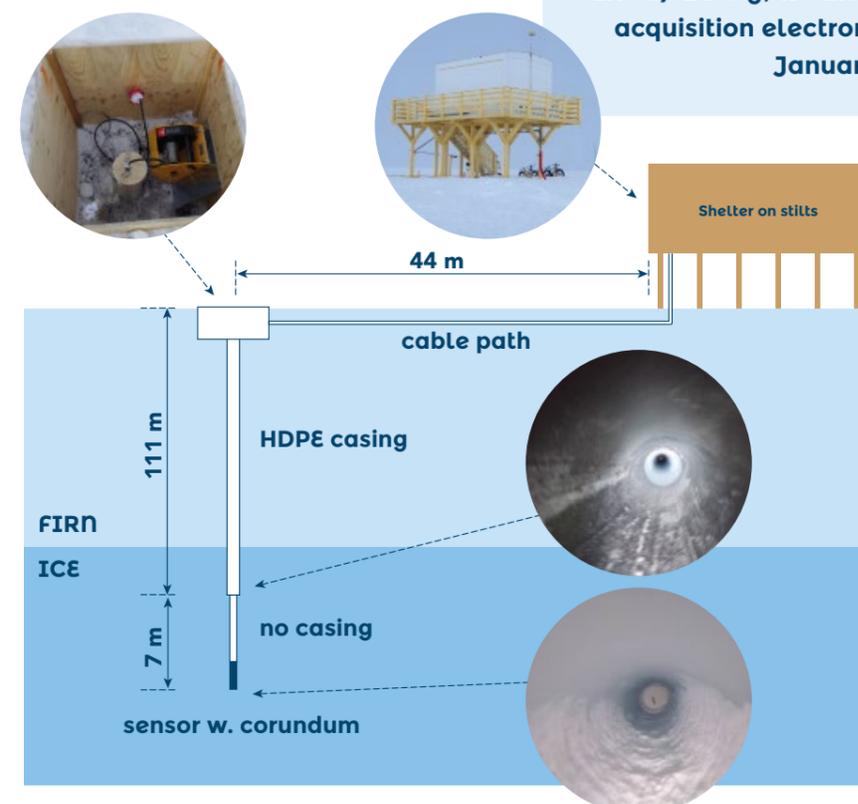
From a scientific and operational point of view, it has become necessary to reinstall the Concordia seismological station in order to ensure its sustainability. The project implemented since 2015 has revolved around a new shelter on stilts and the installation of a new seismological station at the bottom of a borehole, anchored in the ice at a depth of 120 m (Fig. 3). This configuration makes it possible to limit the accumulation of snow on the surface, to place the sensor under the firn field (thickness ~90 m) and to limit deformation caused by the hydrostatic pressure of the snow due to the cylindrical geometry of the borehole, while maintaining very good thermal stability.

The shelter was financed and set up in December 2018 by technical teams from the Polar Institute and drilling was carried out during the 2018/2019 summer campaign by a team from F2G (French Platform for Glacial Drilling from the CNRS-INSU). Lastly, we installed the seismometer and acquisition electronics in December 2019 and January 2020 (Fig. 4).



Fig. 4
Installation of the seismometer at the bottom of the 120 m deep borehole at the Concordia station in December 2019. In the background, the new shelter on stilts. Photo: D. Zigone.

Fig. 3
Diagram of the new facility at Concordia.
Credit: M. Bes de Berc



* The "tilt" is the inclination of a seismometer in the horizontal plane. To work optimally, seismometers must be perfectly oriented and levelled, which implies a zero 'tilt'. However, environmental (temperature, etc.) or mechanical changes in the seismological cellar that houses the instruments can cause the seismometers to incline over time, which requires us to check the levelling of the instruments regularly.

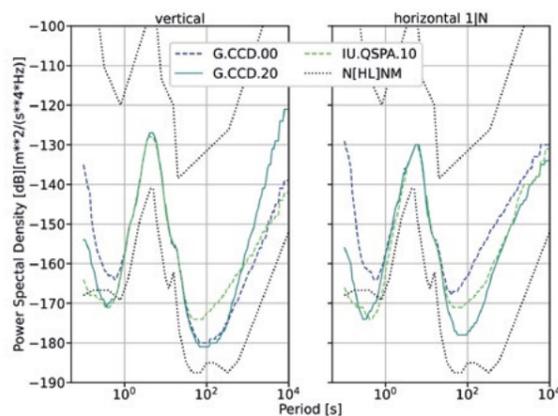


Fig. 5
10th percentile of the power spectral densities for the sensor in the historic cave (G.CCD.00) and for the sensor at the bottom of the new borehole (G.CCD.20) as well as for the sensor installed in a glacial borehole at the South Pole (IU.QSPA.10), for the vertical and horizontal components (either N or 1).

Data from the first two years of operation show a reduction in anthropogenic noise (-30 dB at 10 Hz) and better mechanical stability, therefore increasing the signal quality over long periods of time (-20 dB at 0.01Hz) (Fig. 5).

The noise level of all components is even lower than the New Low Noise Model* between 5 and 9 Hz, making this new facility one of the quietest seismological stations in the world for this frequency range (Fig. 5). There are still a few problems that need to be solved, such as disturbances linked to atmospheric pressure for periods of time longer than 600s on the vertical component (Fig. 5). Produced data are now sent to global data centres. This large-scale project is a major event for polar seismology due to the unique location of this station on Antarctica's Dome C, where it is essential for the scientific community to have a permanent station.

* The New Low Noise Model is a reference model for seismic background noise. It was constructed from a large number of vertical seismograms from many seismic stations around the world. It represents the minimum seismic noise level that is always expected in seismic records on Earth.

At the same time as the work at Concordia, EOST and the French Polar Institute reinstalled the seismological station on Saint-Paul Island. For over 30 years, EOST has been operating a short-term sensor on Saint-Paul Island to better understand the local and regional seismicity. Saint-Paul and Amsterdam are located above a hotspot as well as on a complex and segmented part of the Southeast Indian Ridge (SEIR). Both islands are found close to shear fracture zones that intersect the ridge. It is rare to find a hotspot, a mid-ocean ridge and transform faults* in the same area and therefore these islands are of interest in terms of being able to study the deformation mechanisms of these complex zones.

Because the acquisition system became obsolete and the on-site seismometer was starting to become faulty, it was decided in 2015 to dismantle the station before completely setting it up again elsewhere.

To limit the environmental impact, we decided to move the instrumented site (initially located in the middle of bird colonies) to the cabin installed on the shore. Prior to setting up the new station, the old installation was dismantled, and the site was completely cleaned in April 2016. Given that Saint-Paul Island does not have a scientific base, we decided, in collaboration with the Polar Institute and the NIVMER programme that manages the tide gauge station at the same site, to pool the power supply of various scientific equipment via a single solar power plant (Fig. 6). This power plant was installed by IPEV technical teams in December 2017.



Figure 6:
(left) The new seismological station on Saint-Paul Island with the seismometer in the foreground under a black thermal bell and the acquisition electronics in the background.
(right) Solar panels on the roof of the cabin.
Credit: A. Bernard.

* Transform faults are geologically active structures that cut perpendicularly, in several sections, the oceanic ridges, which are zones in extension where the oceanic crust is formed.

We then set up the new seismological station in April 2018 with a Trillium T120QA broadband seismometer (Fig. 6). The new sensor has a wider range of recording spectra, which means that it will also be possible to use the new station for tsunami warning systems, in addition to regional seismic applications, when real-time transmission becomes available in coming years. This project is part of a general service effort to add new measurement points in under-sampled regions of the Indian Ocean. The data from this new station, called STPA, will be distributed by GEOSCOPE following the observatory's usual procedures.

DISTRIBUTION OF DATA AND DATA PRODUCTS

During the past 15 years, developments in real-time seismology applications, such as tsunami warning systems, have forced seismological observatories to distribute their data in real time to ensure their use. For the stations that are part of the SEISMOLOGY/OBS programme, we use the VSAT satellite connections provided by the Polar Institute in order to transmit recordings from the southern bases in real time. After their collection in Strasbourg approximately 15s after they are recorded, the raw and validated data are freely distributed to the scientific community via the GEOSCOPE, RESIF (French seismological and geodetic network) and IRIS (Incorporated Research Institutions for Seismology) data centres. Figure 7 illustrates the volume of GEOSCOPE data distributed each year to users for scientific studies. More than 1600 articles based on GEOSCOPE observatory data have been published since 1982, and roughly 60 publications per year specifically cite the use of GEOSCOPE data.

In recent years, the GEOSCOPE observatory has also diversified its activities and now provides data-derived products to the community. The most-used product is the information provided in near real time for large earthquake parameters (focal mechanism, depth, moment magnitude, etc.) using the SCARDEC method⁽¹⁾. The web page created for each new earthquake (Fig. 8) also includes additional information on the seismicity of the area, the visualization of the GEOSCOPE waveforms corresponding to the earthquake and the 3D sketch of the earthquake mechanism. This near real time information is sent to mailing lists and 'tweeted' to the @geoscope_ipgp account.

Over the next few years, the renovation work will continue with the renovation of the seismological cave at the Dumont d'Urville station where we are encountering problems with sealing and disrepair (obsolescence).

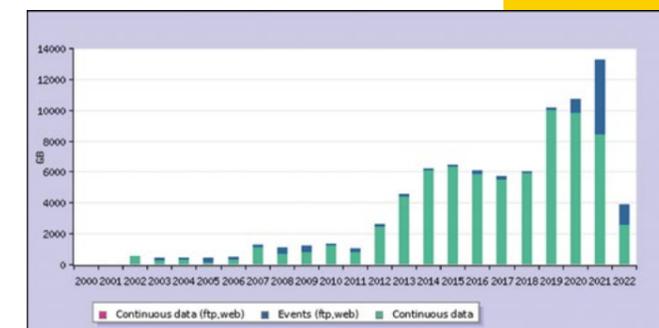


Figure 7: Annual amount of GEOSCOPE data distributed (updated in September 2022). It should be noted that the GEOSCOPE data retrieved at RESIF (1.6 TB in 2019, 2 TB in 2020, 1.9 TB in 2021) have not yet been included in this figure. (source: C. Pardo, IGP data centre).

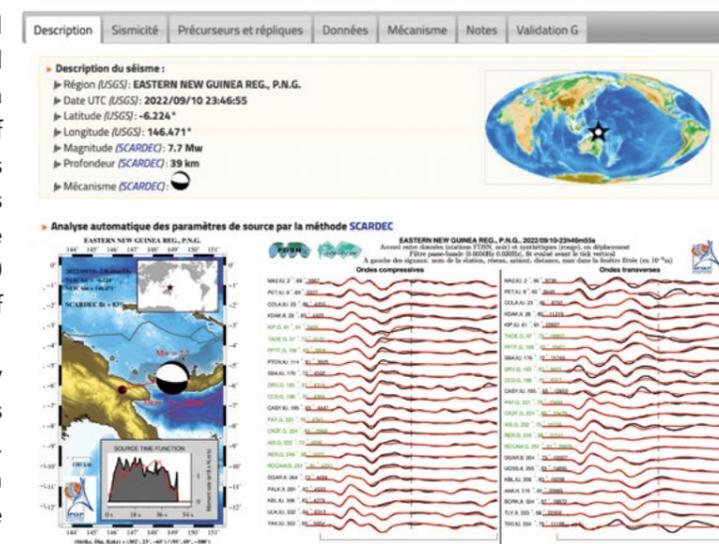


Figure 8: Screen shot of the GEOSCOPE earthquake web page providing information about the source parameters for the recent earthquake in New Guinea (Mw = 7.7, on 10 September 2022). Note the importance of the GEOSCOPE stations (in green on the figure), especially the southern stations (DRV, CCD, PAF, CRZF and AIS).

1 - Ref : Vallée, M., J. Charléty, A.M.G. Ferreira, B. Delouis, & J. Vergoz (2011). SCARDEC: a new technique for the rapid determination of seismic moment magnitude, focal mechanism and source time functions for large earthquakes using body wave deconvolution, Geophys. J. Int., 184, 338-358, 2011.



LOGISTICS

on polar region

Arctic – AWIPEV

In 2021, 11 French scientific projects took place at the AWIPEV station (2 of the 13 projects planned had to be postponed to 2022 due to the health crisis). In total, 45 French and German projects were deployed at the station.

The implementation of sanitary measures, Covid tests, quarantine in Oslo and a sanitary pass, allowed the scientific missions to proceed almost normally. The projects carried over from 2020 were also successfully completed.

The support of the AWIPEV station's overwinterers to the scientific projects was again very important: welcome, safety instructions, distribution of polar clothing, provision of the necessary means such as laboratories, vehicles, management of the transport of scientific material.... They were also involved in taking samples (snow, sea water, etc.) and releasing sounding balloons. The AWIPEV team has accompanied many

projects in the Fjord by piloting boats for marine biology and ornithology programmes, etc.

In the spring, the permanent logistics staff of the French Polar Institute comes every year to reinforce the new wintering team, but this mission has been postponed due to the health crisis. However, the autumn campaign concerning the logistical operations that are important for the proper functioning of the station was able to take place after a year and a half of absence of support from the Institute's staff in the field. Numerous maintenance actions and improvements to the procedures in force were carried out.



The helmsman Jean Floch

REPLACEMENT OF THE 'JEAN FLOCH' HELMSMAN'S ENGINES AND NAVIGATION SYSTEM

The helmsman Jean Floch is the largest boat in the AWIPEV base. It is used extensively by all projects in the Ny Alesund Fjord. The boat will gain slightly in power to make it easier to lift off when it is loaded.

NEW ELECTRIC VEHICLE ARRIVES

Only two vehicles were available at the AWIPEV station. The first one, "Emily", is thermal and is mainly used for logistics. The second one, "Ice Cream", is electric and has 2 seats with a rear tipper. The advantage of electric vehicles in the village is that they are quiet and non-polluting. In order to cope with the growing number of scientific projects, a second electric vehicle, the "Goupillette", has arrived. It has a large boot to keep the load safe from the weather and uses lead/gel batteries well suited to low temperature operation.

MAINTENANCE AND IMPROVEMENT OF THE POWER GENERATION SYSTEM AT CORBEL BASE

During the spring, when there are no staff at the station, there is a surplus of green energy production because no energy consumption and the solar panels are sufficient to fill the battery park to 100%. In this case, all the extra energy produced by the wind turbine has to be shed (converted into heat). Previously, the load shedding was done exclusively in the battery room in order to heat it up.

Batteries behave better when their temperature is positive. From now on, a temperature control in this room allows the wind turbine to be unloaded in another part of the building when the room temperature rises above 15°C. This new equipment protects the battery pack and the electronic charge control systems.



New electric vehicle

A grid controller has been installed to optimise the power consumption of the equipment during the critical winter period when energy is scarce. This winter, thanks to the grid controller, it was not necessary to use the generator to power the Polarlis polarimeter.

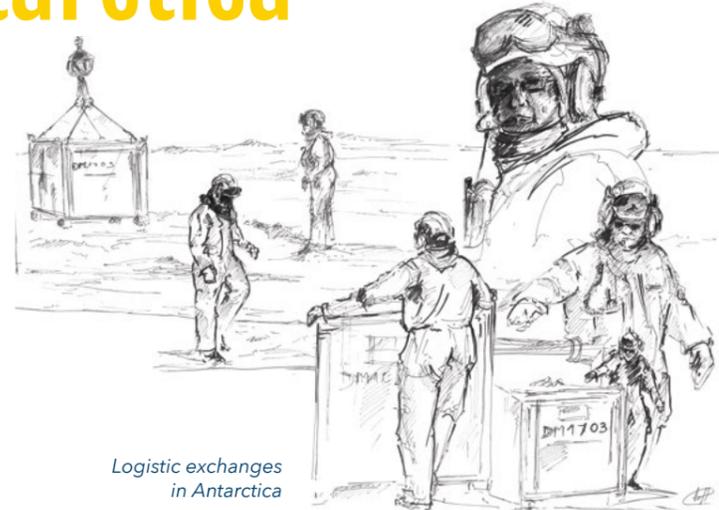


Modification of the electrical installation in Corbel

In 2022, a second wind turbine will be installed at the Corbel site to improve electricity production, especially during the polar winter.

Antarctica

Like the previous summer campaign, this one was marked by the Covid-19 pandemic. The common desire of all the operators, relayed by the Council of Managers of National Antarctic Programs (COMNAP), was to maintain strict procedures so as to absolutely avoid bringing infected people into the field.



Logistic exchanges in Antarctica

These procedures, for the French Polar Institute, had to remain compatible with the requirements of the transit countries, Australia and New Zealand, and with the Tasmanian state's own rules. Nevertheless, contrary to the previous season, although impacted by these strong and evolving constraints, the campaign progress was close to a return to normal.

GENERAL LOGISTICS

As the extra cost of chartering a flight the previous year was not renewable, the staff, with the support of the Tasmanian authorities, travelled on commercial routes to Melbourne. Charter flights were only operated between Melbourne and Hobart. Four flights took place for the opening of the season at the end of October, then with the Astrolabe R0, R1 and R2 rotations.

The staff then stayed in strict quatorzaine at the hotel before being transferred to Antarctica. The opening flight left Hobart for the Italian Mario Zucchelli station on 27 October. From there, two Basler flights took the Dumont d'Urville and Cap Prud'homme teams on 27 and 28 October and the Concordia team on 2 November.



Containers in Antarctica

As part of the mutual exchanges with the French Polar Institute, the Australian Antarctic Division (AAD) organised two transfers of 14 people, Hobart-Wilkins-Concordia in early December and Concordia-Wilkins-Hobart in early February.

MARITIME LOGISTICS

The extremely early break-up of the ice pack in the vicinity of Dumont d'Urville on 3 November enabled the Astrolabe to unload the cargo on the Lion runway on each rotation, thus facilitating all logistical operations. In total, 900 m³ of SAB were delivered on all the R0, R1, R2 and R3 rotations.

For the Australian Antarctic Division, L'Astrolabe passed through Macquarie Island on the outbound leg of the R0 to drop off 5 people and pick up 3 people on their way to Hobart.

In addition, important operations of tidying up, sorting and evacuation of old material were carried out throughout the campaign, in particular in the Biomar laboratory, Lab 3 and the engine shed.

All of this work was carried out in parallel with maintenance and logistics tasks: snow removal, transfers between the Lion and Robert Guillard, processing and packaging of waste from the station and Concordia.

CONCORDIA WORK

In addition to the routines of the summer campaign, i.e. the unloading of convoys and the management of aircraft, the setting up of the technicians for the wintering period and the preparation of the return cargo, the summer technical team worked on four main projects:

- ▶ The finalisation of the installation of the Beyond Epica camp on the Little Dome C site (located some 40 km from Concordia), in particular the electrification and the setting up of the

underground containers that make up the cellar for the conservation of the ice cores

- ▶ Replacement and maintenance of the generators
- ▶ Installation, cabling and connection to the grid of additional solar panels to increase from 7 to 30 kW and thus reach 30% of the average power required
- ▶ Partial fitting out of the general shop



Raid

RAIDS

Two convoys were organised to supply Concordia with equipment and consumables for the station, including 285 m³ of SAB diesel fuel.

The first raid delivered equipment to Little Dome C for the Beyond Epica drilling project and set up the cave that will store the ice cores extracted over the next few years.

The organisation of two convoys instead of three allowed time to be spent on equipment and maintenance tasks. Many small changes were made to the logistics caravan, including the installation of remote temperature control of the -20°C and frost-free containers.

WORKS AT DUMONT D'URVILLE

One of this season's major projects was the wood cladding of the lounge. Three façades were completed, involving major work on the walkways and modification of the water and fuel networks.

Due to its dilapidation, Lab 3 is now dedicated solely to the RAYCO project, for which it was originally built. The atmospheric chemistry activities have been temporarily transferred to 2 caravans of the CLIMCOR project. As these 2 caravans will be leaving for the ICORDA KATABATIC raid in the 22/23 campaign, the chemistry activities will be relocated in a new structure consisting of 2 modules delivered from Hobart and fitted out during the winter and at the beginning of the 22/23 campaign.

The platform on which they will be positioned was

significantly expanded and strengthened during the campaign.

The second unit of the power station was replaced and sent to Hobart for overhaul. A new osmosis plant was installed in place of the previous one.

In addition, major operations to tidy up, sort and remove old equipment were carried out throughout the campaign, particularly in the Biomar laboratory, Lab 3 and the machinery shed.

All of this work was carried out in parallel with maintenance and logistics tasks: snow removal, transfers between the Lion and Robert Guillard, processing and packaging of waste from the station and Concordia.

Sub-antarctic Islands

Once again this year, COVID 19 have affected the implementation of scientific campaigns in the Subantarctic Islands. However, major infrastructure projects were carried out and the vast majority of scientific campaigns were supported, although some adaptations were required.

SUPPLY OF REFUGES

In particular, the French Polar Institute provides supplies and maintenance for the refuges (50 potential sites) where scientists and civic service volunteers stay throughout the year. The drop-off of scientific materials, food and equipment is done exclusively by helicopter.

In 2021, helicopter supplies were carried out during the 4 annual rotations of the Marion Dufresne. The majority of the shelters required for the scientific missions were supplied during the November and December rotations.

ISOLATED SITES, FOCUS ON A MAJOR PROJECT: KERGUELEN, THE NEW CAMPBELL SHELTER

The Courbet Peninsula is located in the eastern part of Kerguelen. In order to carry out all the scientific missions and to cover the study sites as well as possible, a network of refuges covers the entire coastal part of this region. All of these refuges, located within a day's walk of each other, make it possible to complete the Courbet tour, which requires almost a week's walk to do the 200 km of this land transit.

Among the refuges that make up this network, the Cap Cotter refuge was established almost 20 years ago. The coastal location of this refuge has led to heavy wear and tear and it was no longer possible to maintain it in good condition.

A joint study for the establishment of a new site, further inland, was carried out with the TAAF Environment Department.



The new Campbell shelter

A site close to a water source and protected from the wind (as much as possible in this very exposed area) near Mount Campbell was thus validated. Initially, it was necessary to provide for the complete transport of the site and a temporary camp to accommodate the people who were building the new structure.

The Institute's departments managed the entire project: from the study to the drawing up of plans, the purchase of materials, the preparation of the site, including the cutting of the framework on the Brest site, the making of the loads and the transport of the heliportable loads from the metropolis for deployment on the Campbell site.

This project required 15 heliborne loading units for an equivalent of 12T of material deposited during OP3 2021 and the setting up of a temporary camp of 3 modules to accommodate the personnel.



ISOLATED SITES, OTHER SPECIFIC PROJECTS DURING THE YEAR

Kerguelen, rehabilitation of the Guetteur refuge

A scientific shelter has been set up for many years near the Ratmanoff penguin colony. The Polar Environment Committee in 2018 recommended minimising the human and technical presence in the vicinity of the penguin colony.

A dismantling phase was carried out in 2020 with the removal of almost all the living and storage structures. Two scientific modules remain to allow work to be carried out as close as possible to the penguin colony and to carry out long-term studies of this colony of 60,000 king penguin pairs.

A work camp was set up this year to improve the working areas, rehabilitate and perpetuate the structures in the colony area.

Amsterdam and St-Paul

In response to the prefectural decision to close the d'Entrecasteaux refuge area due to the risk of a potential landslide on the historic site, a specific logistical mission was coordinated with the TAAF administration to deploy a temporary scientific camp and maintain the monitoring activity of all the study colonies.



Penguin colonies near the Guetteur shelter

Four modules, including two 4-person sleeping modules, a laboratory module and a living space module, were set up to maintain scientific activities on this reference site that has been studied for decades.

WORK SITES ON THE BASES

Logistical, organisational and coordination support for scientific projects during the summer campaign remains the main activity of the Institute's teams. However, specific projects are also carried out to maintain the logistical and scientific structures of the base. For example, on Kerguelen, the CNES has left the base and the Geophy building in which they were based has to be reorganised and the teams have started to fit it out.

In Crozet, on the Alfred Faure base, the renovation plan for the Biomar laboratory rooms used by the scientists has been finalised.



THE POLAR INSTITUTE

general
information

Missions for the implementation of scientific projects

SELECTION

The French Polar Institute's mission is to implement scientific projects in environments whose specific characteristics (climate, isolation, etc.) require adapted skills and technologies.

- ▶ **Selects scientific projects:** researchers are invited to submit projects which are evaluated on the basis of scientific interest, timetable and costs by the CPST and feasibility by the Institute's teams. The Board of Directors then validates the list of selected projects according to the scores given by the CPST.
- ▶ **Finances these projects:** an envelope is allocated to project leaders to cover certain costs (purchase of scientific instruments, etc.)
- ▶ **Recruits staff to reinforce the project team** during all or part of a summer campaign and to ensure the work necessary to maintain scientific experiments during the winter. Recruited staff may be assigned to several supported projects.
- ▶ **Organises the transport of teams of**

scientists from their home laboratory to the project site and back, provides them with clothing, accommodation and food.

- ▶ **Provides freight** and sometimes buys the scientific equipment needed to carry out the projects in the field.
- ▶ **Adapts** scientific instruments to the environmental conditions of the project site and ensures their maintenance.
- ▶ **Plans** scientific operations and scientific logistics operations (moving an instrument, clearing snow from a shelter, etc.).
- ▶ **Organises** scientific expeditions outside the stations (25 km from Concordia, scientific raids, missions to Port-Martin and Commonwealth Bay, etc.)
- ▶ **Participates in making these research projects visible.**
- ▶ **Manages a research infrastructure***, the Concordia station.

INTERNATIONAL SCIENTIFIC COOPERATION

The Institute participates in representing France in international consultations on polar issues and promotes French polar research.

It collaborates with its foreign counterparts, establishes international partnerships, participates in international meetings on polar research strategy (International Arctic Science Committee, Forum of Arctic Research Operators, EU-Polarnet, NySMAC, CEP, COMNAP, SCAR, EPB) as well as in the consultation on the Antarctic Treaty and the Madrid Protocol.

MISSIONS FOR THE MANAGEMENT OF THE LOGISTICAL MEANS NECESSARY FOR THE IMPLEMENTATION OF PROJECTS

To ensure the implementation of scientific projects, the Institute relies on the following means, infrastructures and human resources:

- ▶ **manages its budget** and seeks sources of funding.
- ▶ **recruits staff** for its headquarters and scientific stations.
- ▶ **ensures the safety** of its staff, both at headquarters and in the field, and that of its scientists by establishing rules and organising training.
- ▶ **It also ensures the protection** of the places where it carries out its activities by establishing rules.
- ▶ **manages scientific research stations:** it builds and maintains them, purchases and transports equipment and supplies.
- ▶ **develops logistical and technological tools.**
- ▶ **establishes partnerships** with local, national and international industrial, scientific, technological and cultural players.

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**REPRESENTATION
IN INTERNATIONAL BODIES
April 2021 to March 2022**

Jérôme CHAPPELLAZ

- ♦ Member of the French delegation to the Antarctic Treaty (RCTA) and Environmental Protection Committee (CPE) meetings
- ♦ French delegate to the Council of Managers of National Antarctic Programs (COMNAP)
- ♦ Full member of the European Polar Board (EPB)
- ♦ French representative to the Ny-Alesund Scientific Operators Committee (NySMAC)
- ♦ French representative in the Arctic Research Operators Forum (FARO), and member of the executive committee
- ♦ French representative in the International Arctic Science Committee (IASC), on behalf of CNRS
- ♦ Member of the IR* Concordia Steering Committee

- ♦ Co-coordinator of the “logistics working group” of the European project Beyond EPICA
- ♦ Representative of the Institute in the International Ice Memory Foundation

Yan ROPERT-COUDERT

- ♦ Member of the French delegation to the meetings of the Antarctic Treaty (RCTA) and the Environmental Protection Committee (CPE)
- ♦ Alternate member of the European Polar Board (EPB)
- ♦ French representative to the Ny-Alesund Scientific Operators Committee (NySMAC)
- ♦ French representative to the Arctic Research Operators Forum (FARO)

Laurent De BOISSIEU

French deputy delegate to the National Antarctic Programme Managers' Council (COMNAP)

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- Gilles Pinay** INEE
- Stéphanie Vermeersch** INSHS
- Paul Laforêt** médecine TAAF



European and international meetings

PARTICIPATION OF J. CHAPPELLAZ, MEETINGS WITH FOREIGN COUNTERPARTS AND ACTIONS OF THE POLAR INSTITUTE

- ♦ Executive committees of the Forum of Arctic Research Operators (FARO) (April, May, June, October, November 2021 & January, February 2022)
- ♦ Public consultation of the Council of National Antarctic Programme Managers - COMNAP, by videoconference (April 2021)
- ♦ Ice Memory Foundation meeting, in Grenoble (April 2021)
- ♦ European Polar Board plenary meeting by videoconference (April 2021)
- ♦ Concordia Steering Committees, by videoconference (April, May and September 2021)
- ♦ International Arctic Scientific Committee “Carbon Footprint Group” by videoconference (April 2021)
- ♦ 3rd Arctic Ministerial Summit, by videoconference (May 2021)
- ♦ Antarctic Treaty (RCTA) and Environmental Protection Committee (CPE) meetings in Paris (June 2021)
- ♦ General Assembly and regional meetings of the Council of National Antarctic Programme Managers - COMNAP, by videoconference (July 2021)
- ♦ Strategic Councils of the Ice Memory Foundation, in Grenoble (July, November 2021, & March 2022)
- ♦ European Polar Board “Environmental Impact Group”, by videoconference (July, September 2021 & February 2022)
- ♦ Official trip with the Ambassador of the Poles to Ny-Alesund and Norway (August 2021)
- ♦ Inaugural sailing of Commander Charcot in Norway (August / September 2021)
- ♦ COMNAP “Gateways” meetings, by videoconference (September and November 2021)
- ♦ Swiss Polar Day in Lausanne (September/October 2021)
- ♦ Ice Memory Foundation” Executive Committee (October 2021 in Geneva & Jan, Feb & Mar 2022 in videoconference)
- ♦ Development of Franco-Danish collaborations on the polar regions in Copenhagen, with the Ambassador for Poles and Maritime Issues (October 2021)
- ♦ Executive committee of the European project “Beyond EPICA”, by videoconference (October 2021)
- ♦ Steering committee of the “Ice Memory” project, by videoconference (December 2021)
- ♦ One Ocean Summit in Brest (February 2022)
- ♦ Polar Symposium in Monaco (February 2022)
- ♦ Annual meeting of the Arctic Research Operators Forum, by videoconference (March 2022)

PARTICIPATION OF Y. ROBERT-COUDERT, MEETINGS WITH FOREIGN COUNTERPARTS AND ACTIONS OF THE POLAR INSTITUTE

- ♦ Meetings of the Antarctic Treaty (RCTA) and the Environmental Protection Committee (CPE) in Paris (June 2021)
- ♦ One Ocean Summit in Brest (February 2022)
- ♦ Polar Symposium in Monaco (February 2022)
- ♦ Round table on Swiss-French collaboration in the polar regions at the Swiss Embassy in Paris (March 2022)



The Communication at the Polar Institute

In 2021, France hosted and chaired the 43rd Antarctic Treaty Consultative Meeting (ATCM).

The purpose of this diplomatic meeting is to negotiate new regulatory measures and to exchange information and discuss issues of common interest concerning Antarctica. It is also an annual opportunity to consider, formulate and recommend to governments measures to ensure compliance with the principles and objectives of the Treaty.

Some of the communication activities were linked to this event.

Actions around the RCTA: Polar months

▶ At the end of March, launch of the polar months with a press release "The Polar Institute presents its carbon footprint".

▶ ANIMATION OF THE CONNECTED POLAR FESTIVAL IN PARTNERSHIP WITH OCEANOPOLIS (DURING THE MONTHS PRECEDING THE RCTA)

Junior Polar Seminar - 29 March 2021

Like the scientific colloquiums, the 115 students taking part in this junior polar seminar were invited to prepare a topic dedicated to the poles in class beforehand, which they presented to a jury and the other classes.

Conference - round table "The Poles: science, geopolitics and risk management" - 2 April 2021

Broadcast live on Facebook and replay on YouTube

The two poles of the planet concentrate important societal issues relating to research, the environment, the economy, geostrategy and defence. Interventions by the director of the Polar Institute, the Maritime Prefect, the former commander of the Astrolabe and the former commander of the Rhone, as well as a lawyer specialising in poles.



* Cumulative statistics of the live video on the pages of Océanopolis and the French Polar Institute (total number of minutes during which the video has been played, including the time spent replaying the video)

SHORT NEWS



The website was redesigned to update, clarify and enrich the main content related to the Institute's activities and to modernise the interface and ergonomics.



The new exhibition dedicated to the operation of the Institute was sent and installed in all the districts as well as at headquarters. The existing photo exhibitions were also updated.



With our Italian partners, the Institute is working on the creation of a new identity for Concordia Station. The first step at the beginning of 2022 will be the choice of the logo and the graphic charter that follows.

Live broadcasts around the exhibition "Polar animals, a life of a scientist" 3 and 4 April 2021

Live broadcast and animation on Facebook and replay on YouTube

<https://www.facebook.com/oceanopolisbrest/videos/439419037351414/>

How can animals tell us more about climate change in the polar regions?

In total, 6 researchers took turns on these two afternoons dedicated to the knowledge of polar animals.



Cumulative live statistics on the Océanopolis and French Polar Institute pages

¹ likes, comments, shares cumulated with the live video

² total number of minutes the video has been played, including the time spent playing the video

³ number of people for whom information about the event was displayed on their screen



▶ ROUND-TABLE DISCUSSION ON THE QUESTION: "POLAR REGIONS, A NEED FOR RISK MANAGEMENT?"
Co-organised by Brest Business School, UMR Amure, Université de Bretagne Occidentale, Institut Universitaire Européen de la Mer.

▶ POLAR WEEK: A POPULAR SCIENCE EVENT ON THE THEME OF THE POLES
It is organised by APECS-France, the French national committee of the Association of Polar Early Career Scientists (APECS) and takes place twice a year in spring and autumn. During the Polar Week, young researchers present different aspects of science around the poles in the form of free video lectures for primary school children.

▶ MONDAYS WITH A PASTILLE
Creation of 9 short discovery or interview videos for a different look at the poles, broadcast on the web and social networks every Monday before the RCTA

▶ FRIDAYS OF POLAR HISTORY
An archive from the Archipoles website unveiled to tell the story of the French poles

▶ CNFRAA DAYS AT THE OCEANOGRAPHY INSTITUTE WITH A CONFERENCE FOR THE GENERAL PUBLIC
Screening of the film "L'Odysée Antarctique" by Djamel Tahy and debate on today's polar missions and their challenges in the context of global change

▶ PUBLIC EVENT NATIONAL MUSEUM OF NATURAL HISTORY
Participation in Round Table 2: Humans in Antarctica

▶ "ANTARCTICA, A NATURE RESERVE DEDICATED TO PEACE, SCIENCE AND COOPERATION"
Polar photo exhibitions on the walls of ministries in Paris

▶ POLAR SUMMER
Setting up of a photo exhibition in several French cities, action of the ambassador of the poles in partnership with the Institute.

▶ CREATION OF A ROCARD- HAWK MEDAL as well as a Michel Rocard plaque at Dumont d'Urville in Antarctica to commemorate the 30th anniversary of the Madrid Protocol.

► **PRESS RELEASE**

- **21 January 2021:** Project Survostral, Antarctica, the ocean is cooling at the surface, but warming at depth
- **25 March 2021:** Bilan Carbone® 2020 of the French Polar Institute. An institutional operator in the polar environment leads the way
- **8 April 2021:** More than 5,000 tonnes of extraterrestrial dust fall to Earth each year
- **30 September 2021:** CNRS honours Antarctica at the France Pavilion of the Dubai World Expo
- **30 November 2021:** Antarctica: Beyond Epica explores the climate of the past



Filming of the programme "C'est toujours pas sorcier" at the Polar Institute
Opposite:
Broadcast of the show on Okoo

► **C'EST TOUJOURS PAS SORCIER**

Devoted to the poles: filming at the Institute, interviews and assignment of illustrations.

Polar archives

Partnership signed with IFREMER for the provision of their archivist to process and deposit the Marion Dufresne ship's holdings at the Institute in the French National Archives.

Creation of a historical corpus on the history of the French Polar Institute based on an inventory and study of the documents present at the Institute and elsewhere. The aim of this corpus is to present the history of the EPF and the Institute based on institutional archives and the analysis of an archivist.

Signing of the agreement for the transfer of the photo and video collections of the French Polar Expeditions association.

Participation in the TAAF heritage commission: ten-year archive management policy.

Video creation

9 video clips

The Polar Minute broadcast every Monday on social networks

Podcast of 4 episodes

Land of ice

7 videos to present all the implications required of winterers during their participation in biomedical projects deployed during wintering in the polar field.

Creation of exhibitions

Creation of a **photo exhibition for the RCTA** commissioned by the Ministry of Foreign Affairs and presented on the walls of the Ministry of Europe and Foreign Affairs and the Ministry of Research.

Creation of a **webdoc, an online game, on Concordia**

Participation in the preparation of the **Monaco Museum exhibition**, setting up a loan partnership

Dubai World Expo: provision of still and moving images

"Longueur d'onde" Festival: participation of the Institute's director in a round table discussion and provision of sounds

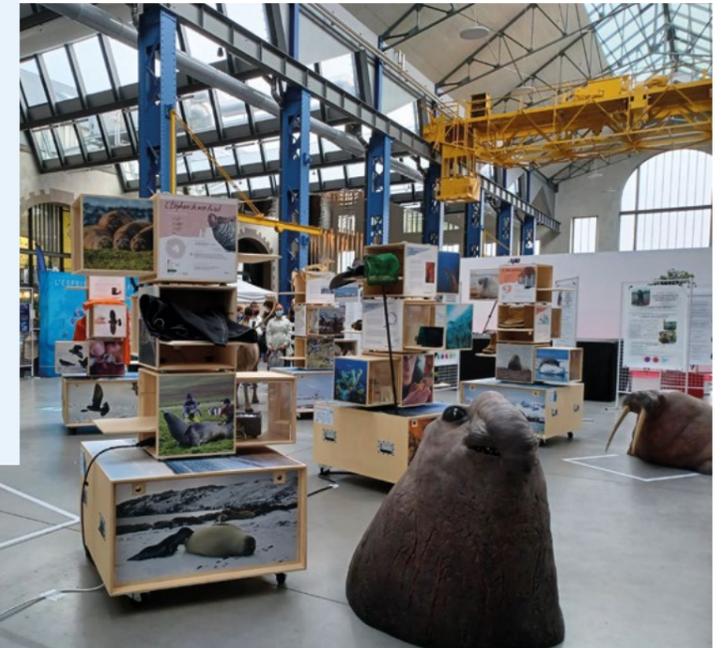
Creation of **new models of animals** of Antarctic seabed animals as well as an albatross chick and various decorative objects for the polar animals exhibition

Events

Fête de la Science

The Polar Institute presented part of the exhibition Polar Animals, a Life of a Scientist at the Brest Science Village from Thursday 7 to Sunday 10 October 2021. The village welcomed 2000 schoolchildren on Thursday and Friday and 5144 people on Saturday and Sunday.

A conference on Antarctica was also presented by Claire Le Calvez, an engineer from the Institute.



The Fête de la Science at the Ateliers des Capucins in Brest

Loan of exhibition material

At the French Institute Bremen, from 15 March to 30 April, then in November and December: loan of exhibition material to accompany the exhibition Boréal - 15 months in the Arctic by Simon Escalle, former AWIPEV winterer

15 April: Conference by Christine David-Beausire and Roland Neuber (AWI) to present the AWIPEV station and Franco-German cooperation in the Arctic

At the Institut pluridisciplinaire Hubert Curien in Strasbourg: on the occasion of the 60th anniversary of the CNRS campus in Cronenbourg, celebrated during the Fête de la science The IPHC opened its doors and was able to present to the public part of the exhibition Polar animals, a life of a scientist. The exhibition was presented in September in the CROUS restaurant so that students could also enjoy it outside the open doors.

After the great success of the exhibition in 2020, the **Jean-Moulin high school** once again wanted to present an exhibition from the Polar Institute's collections. This was the case from 15 November 2021 to 15 January 2022, with the exhibitions presenting the Polar Institute and the science developed in the French polar stations, accompanied by a few elements of the decor.

Creation of a new space at Zoodyssée, an animal park managed by the Deux-Sèvres departmental council dedicated to research into polar and sub-polar fauna: donation of a polar outfit, two touques and authorisation to reproduce panels from the exhibition presenting the Polar Institute.



Exhibition at the Institut pluridisciplinaire Hubert Curien in Strasbourg

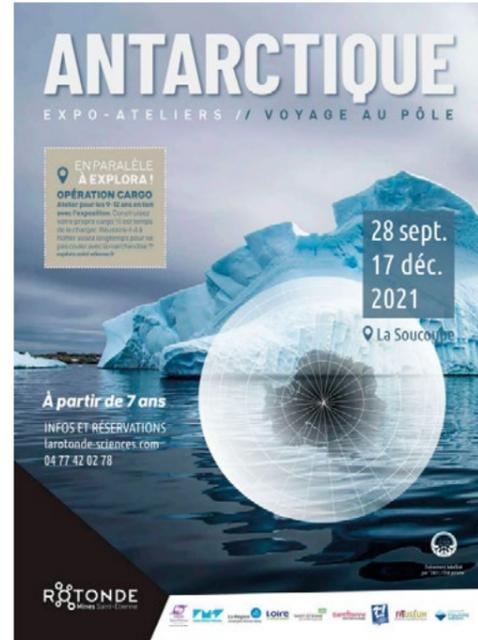
At the CCSTI, La Rotonde de Saint-Étienne

From 28 September 2021 to 5 January 2022, La Rotonde hosted the exhibition "Antarctica, an explosion of life" created in 2012 by the Pavillon des sciences CCSTI de Bourgogne Franche-Comté, the Muséum du Havre and the Polar Institute. In order to enrich the exhibition's décor and design activities for young people, La Rotonde borrowed many exhibition elements from the Polar Institute. The exhibition was visited by 1229 schoolchildren, 301 visitors from social centres and 1059 families.



Above
Poster of the exhibition

Opposite
Animation for the young
public



Partnership

► Partnership with APECS

In 2021, the French Polar Institute and the French branch of the Association of Polar Early Career Scientists (APECS-France) signed an agreement formalising their collaboration to promote polar research among their audiences.

The Polar Institute was therefore a partner in the APECS-France polar weeks, a series of online conferences for school classes.

- The spring edition, from 17 to 21 May, reached 24 classes from 10 different academies, for a total of 532 students.
- The autumn edition, from 15 to 19 November, 41 classes from 15 academies, for a total of 943 pupils.

On the occasion of France's hosting of the RCTA, APECS and the Polar Institute also offered a webinar for the general public, hosted by Anne Choquet, on the theme "Conducting activities in Antarctica, who decides?"

APECS-France and the Polar Institute also co-organised a webinar for the general public on 19 August with the winterers and researchers present at the AWIPEV station.

- **Webinar on the Arctic**, organised by the association Children for the Ocean, on the occasion of World Oceans Day on 8 June 2021.

- As a partner of Océanopolis, the Institute participated in providing researcher contacts for the **Young Reporter of Arts and Sciences project**.

Correspondence projects between the Institute's overwinterers/campaigners and classes

- **weather technician in Dumont d'Urville**: two classes
- **technical manager at Dumont d'Urville**: with 4 classes from the Hubert Reeves school in Champagnole in the Jura.
- **computer technician in Dumont d'Urville**: one class
- **district manager in Dumont d'Urville**: one class
- **baker in Dumont d'Urville**: with the Saint Laurent school in Concoret and the public school in Mohon, and the St Cyr school in Moreac
- **boilermaker in Dumont d'Urville**: a class from the Notre Dame de Liesse school in St Renan, a class from the Vicq primary school
- **cook-intendant in Dumont d'Urville**: a class from the école des pignons, in Léon and the pupils of the collège Lucie Aubrac in Linxe.
- **in charge of the weather station in Dumont d'Urville**: a class from the Anne Sylvestre school in Vindry sur Turdine
- **second at the Dumont d'Urville power station**: a class from the Louis Guilloux secondary school in Montfort-sur-Meu
- **chemist at Concordia**: children from the Sappey-en-Chartreuse activity centre, a class of first graders from the Stendhal high school in Milan
- **electronics scientist in Kerguelen**: with pupils from the second, first and final year of the Gaston Bachelard high school in Bar-sur-Aube and a class from Les Templiers elementary school in Verrières.
- **biologist for the Subanteco project in Kerguelen**: a class from the Léonce Bourliaguet school in Toulouse, two classes from the Omeba Tobo secondary school in French Guiana
- **carpenter in Kerguelen**: a class
- **computer scientist in Crozet**: a class from the Pasteur school in Lambersat
- **weather technician in Dumont d'Urville**: a class from Lot et Garonne, a class from the school of Périgueux, a class from the school in Coursac



Carpentry
at Dumont d'Urville

Accompanying scientists for scientific culture projects

- **ARLItA project**: correspondence with students of the Rouret middle school
- **ICORDA KATABATIC project**: videoconferences with the Pierre and Marie Curie primary schools in Toulouse and the Tilleuls middle school in Claye Souilly.
- **Enviker project**: publication on the Institute's website of the educational sheets designed during the campaign for classes following the work of the Enviker team



PARTNERS



Partners of the Polar Institute

In June 2021, for the third time after the 1968 and 1989 meetings, France organised and chaired the Antarctic Treaty Consultative Meeting (ATCM). This 43rd annual meeting of the States Parties to the Antarctic Treaty of 1st December 1959, which dedicates Antarctica to peace and science, was held for the first time in virtual form, in Paris, from 14 to 24 June 2021. It marked the 60th anniversary of the entry into force (23 June 1961) of the Treaty and the 30th anniversary of the signing of the Protocol on Environmental Protection of 4th October 1991 (the “Madrid Protocol”), which complements it.

Since 1961, the ATCM has brought together annually the 55 States Parties to the Treaty (29 “Consultative Parties” and 26 “Non-Consultative Parties”). It enables those with the status of “Consultative Parties”, such as France, one of the 12 original signatories, to adopt measures to ensure compliance with the principles and objectives of the Treaty and the Protocol. The elaboration of French positions within this international consultation body therefore requires close collaboration between the various French actors concerned and real expertise on the polar and Antarctic environments.

This is why the Director of the French Polar Institute, an institute with a public service mission to implement scientific research in the polar regions, is a member of the French delegation led by the Ministry of Europe and Foreign Affairs, alongside the Ministry of Ecological Transition and the TAAF, and contributes his expertise on polar issues. It also sits on the Environmental Protection Committee (CPE), which provides the ATCM with scientific and technical expertise.

During the 43rd ATCM, the French Polar Institute made an essential contribution, through its expertise, to the promotion of French positions on the various subjects discussed during the meeting, such as:

- ▶ **the assessment of draft applications for Consultative Party status, which must “demonstrate interest in Antarctica by carrying out substantial scientific research activities there, such as the establishment of a station or the dispatch of an expedition” (Article IX 2. of the Treaty);**
- ▶ **the development of a set of recommendations to ensure that climate change is taken into account in its work and to enhance the value of scientific research in this area;**
- ▶ **the analysis of the comprehensive environmental impact assessments prior to the construction of two new stations;**
- ▶ **advice on the revision of 23 management plans for specially protected areas in the Antarctic;**
- ▶ **the development of a list of “CPE measures and tools related to the protection of the marine environment”.**

In addition, the French Polar Institute supported the Franco-Italian project Ice Memory, the objective of which is to create a sanctuary at the Franco-Italian research station Concordia to protect the memory of ice collected from the world’s endangered glaciers for the benefit of new generations.

The French Polar Institute was also heavily involved in the implementation of communication for the general public in the framework of the organisation of the 43rd RCTA, led by the Ministry of Europe and Foreign Affairs. It thus contributed to the development of a dedicated website, provided photographs for the photographic exhibition “Antarctica, a nature reserve dedicated to peace”, showing all aspects of the issues at stake in Antarctica, on the railings of two sites of the Ministry of Europe and Foreign Affairs, including the Quai d’Orsay, as well as on the façade of the Ministry of Ecological Transition and also at the Maison des Océans in Paris.

Also during the 43rd RCTA, at the Maison de la Mutualité, French Polar Institute took part in workshops and exchanges with the public organised by the MNHN, as well as in the opening ceremony of the Meeting in the presence of numerous guests.

Finally, on the initiative of the French Polar Institute, for the first time, France awarded a special prize on the occasion of the 30th anniversary of the adoption of the Madrid Protocol, the Madrid Protocol 30th Anniversary Medal.

Indeed, France and Australia had played a decisive role under the impetus of their respective Prime Ministers (Michel Rocard and Bob Hawke) for the adoption of this Protocol. This medal, which was intended to recognise the work of a scientist who has contributed through his work to the spirit of the Madrid Protocol, was awarded by the Minister for Europe and Foreign Affairs, in the presence of the Director of the French Polar Institute, to Professor Steven Chown of Melbourne’s Monash University, during a video conference on 22 June 2021.

A world-renowned physiologist, one of whose main research interests is understanding thermal limits and the impacts of environmental change on Antarctic terrestrial invertebrates, Professor Chown is best known for his studies on invasive species and their impacts on the Antarctic environment.

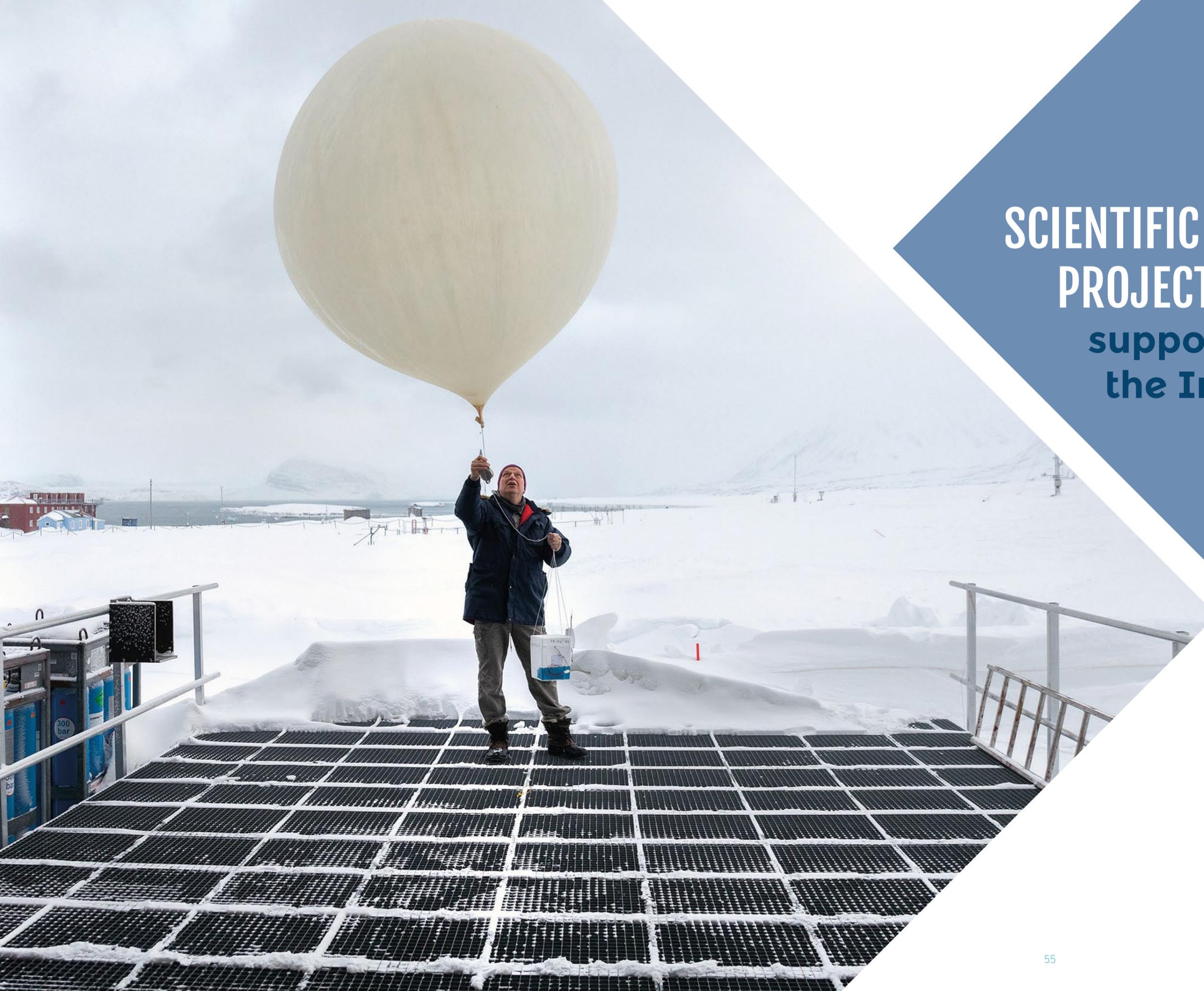
Caroline Krajka
Jeanne Bayle
*Ministère de l’Europe
et des affaires étrangères*



*The photographic exhibition
« Antarctica, a nature reserve
dedicated to peace »*



43rd ATCM



SCIENTIFIC PROJECTS

supported by
the Institute

New projects supported by the Institute in 2021/2022



Sharing a meal is an important moment for the teams in the field.

At its November 2020 session, the CPST validated 19 new or renewed projects to be deployed in 2021-2022 and monitored the progress of 26 ongoing multi-annual projects.

- New supported projects -

HUMAN BIOLOGY

persens

1170

Study on the Evolution of individuals' Relation with their Close Spaciality during a mission extreme & unusual and/or isolated & confined environment from the perspective of a take into account of adaptive stress

The sensory perception assessment protocol ERISI, Year 2 - known as « Per-Sens » part, aims to study the possible sensory perception changes that might experiment individuals during long stay/missions in extreme & unusual environments (EUE - eg. [sub]antarctic stations - up to 14 months in the field) or isolated & confined environments (ICE - eg. Submarines SSBN - board from 70 to 90 days).

If, literature indicates that sense, considered independently of each other, might be modified by such experiences, no holistic research has yet measured what is the very impact of a long stay/mission in EUE/ICE on the sensory perception of individuals and, consequently, the impact of possible changes of perception on their mood, stress level and/or performance.

This study will focus on the evaluation of (1) visual, (2) olfactory, (3) gustatory, (4) tactile, (5) auditory individuals' perceptions and (6) proprioception and body scheme, on an triple investigative pattern "at the beginning", "during" "at the end" of the stay/mission in ICE/EUE.

► **Marion TROUSSELARD**
Antarctica

ICE-TELEOP

1234

Intra Crew Evaluation for Tele Operations

The main objective of the ICE-TELEOP experiment is to study the impact of confinement and isolation on the performance of astronauts during long-term missions during human-robot interaction (HRI) activities, such as rendezvous and docking operations or teleoperation of exploration rovers on the surface of a celestial body.

Three points of view are taken into account: the psychological aspects, the physiological aspects, and the technical performances. These are evaluated by measurements during HRI tasks, but also during sleep and normal activities of the day, as well as by questionnaires. The performance is indeed affected by many parameters, including physical activity and sleep, themselves affected by isolation and confinement.

In order to facilitate extra-vehicular activities (EVA) on the Moon and Mars in particular, space agencies plan to create future interplanetary habitats to operate with a hypobaric hypoxic atmosphere, similar to that found at high altitude. However, the latter could also have consequences on the many parameters influencing the performance of astronauts. Before being able to draw conclusions, it is, therefore, necessary to decouple the effects of each of the components of the environment that future astronauts will encounter: 1) microgravity; 2) hypobaric hypoxic atmosphere; 3) confinement/isolation/ extreme environment.

In addition, it is necessary to develop a model of astronaut's activity which includes, in addition to the context of the mission and the current operation, behavioral and subjective data as well as measurements of its psycho-physiological state performed in real time. This will better characterize his cognitive and emotional state, but also:

1. To provide effective flight training adapted to the condition of the astronaut at all times (i.e. adaptive training);
2. To be able to adapt the operation to the state of the astronaut (ex: adaptive interface).

In this context, ISAE - SUPAERO has already studied HRI performance during similar simulation campaigns (MDRS - 189 and LunAres - III in 2018, MDRS - 206 and SIRIUS - 19 in 2019). As part of the extension of this project, long-term missions in ecological and operational contexts will be studied through the following missions:

- SIRIUS campaign of 8 months in 2020;
- 12-month SIRIUS campaign in 2021-2022;
- TELEOP + experience in flight zero-g to prepare the experiment aboard the ISS in 2020;
- ELEOP + experience aboard the ISS (as part of the PILOT-T experiment) in 2021-2024.

The Université Libre de Bruxelles has already been involved in several experiments onboard the ISS and during "head-down tilt bed rest" campaigns. In addition, it was selected by ESA, IPEV and PNRA to perform sleep monitoring and cardiorespiratory response measurements at Concordia Antarctic Base (AO-2017-Concordia_022_Rabineau). Finally, it also submitted a similar protocol to ESA to conduct this same type of experiment onboard the ISS.

Implementing this experience during wintering campaigns at the Dumont d'Urville station would go a step further towards the development of teleoperation training tools that can be adapted to the state of the operator. Subsequently, the estimation models of the state of the operator can then be used to adapt the interface of the real operation.

Finally, volunteers recruited at the Dumont d'Urville station will be able to evaluate more precisely the influence of a hypobaric hypoxic atmosphere on sleep and crew performance. Indeed, they will be exposed to conditions similar to those of wintering scientists on the Concordia station (isolation, confinement, extreme environment, tasks), except for the hypobaric hypoxic atmosphere.

► **Stéphanie LIZY-DESTREZ**
Antarctica

- New supported projects -

EARTH AND UNIVERSE SCIENCES



Storage of foodstuffs involving all the people at the Dumont d'Urville station

COG-IPEV-DDU

1261

A study of cognitive coping mechanisms while wintering in winterers in the French Austral and Antarctic Territories

The objective of this study is to investigate the coping mechanisms of cognitive functions in winterers during wintering in Antarctic (DDU) and, if possible, compare it to the results of the study 1232 CPOG-IPEV-TAAF conducted in the three Austral districts: Crozet, Kerguelen and Amsterdam of the French Austral and Antarctic Territories.

During wintering period from March to November, winterers are subject to extreme environment conditions which may entail coping difficulties that have been investigated from a psychological perspective, i.e. essentially affective: anxiety, mood disorders and/or behavior disturbances.

Conversely, possible difficulties in cognitive coping (i.e. essentially intellectual capabilities of information management, communication, planification and implementation) have not been investigated by the using up to date evaluation tools.

This study will be conducted in a population of Civil Service Servants (VSC) and Wildlife Sanctuary Agents. Baseline parameters (test, baseline) will be measured after R1 (November 2021). Retest (observed values during wintering) will be conducted in July 2022, in order to collect data at the peak of risk of cognitive/affective disturbances. Return to baseline will be assessed at the end of wintering period in October 2022, before R0-2022. A total sample of 20 subjects is expected.

Each subject will be his own reference for retest values. Study results will be communicated to the volunteers who will ask for them.

This study, of which results can be extrapolated to many isolation situations in professional settings, shall allow to implement early detection tools of warning and tools to help winterers at high risk of developing a "Wintering mental syndrome". It should also permit to update the selection criteria of winterers in order to minimize this risk.

Philippe AZOUVI
Marc SINDRES
Antarctica

LISISKER

1239

Study of lithosphere structures and seismicity of Kerguelen

The main goal of the LISISKER (study of lithosphere structures and seismicity of Kerguelen) project is to characterize the structure and the deformation of the Kerguelen lithosphere through the use of seismological and geological data.

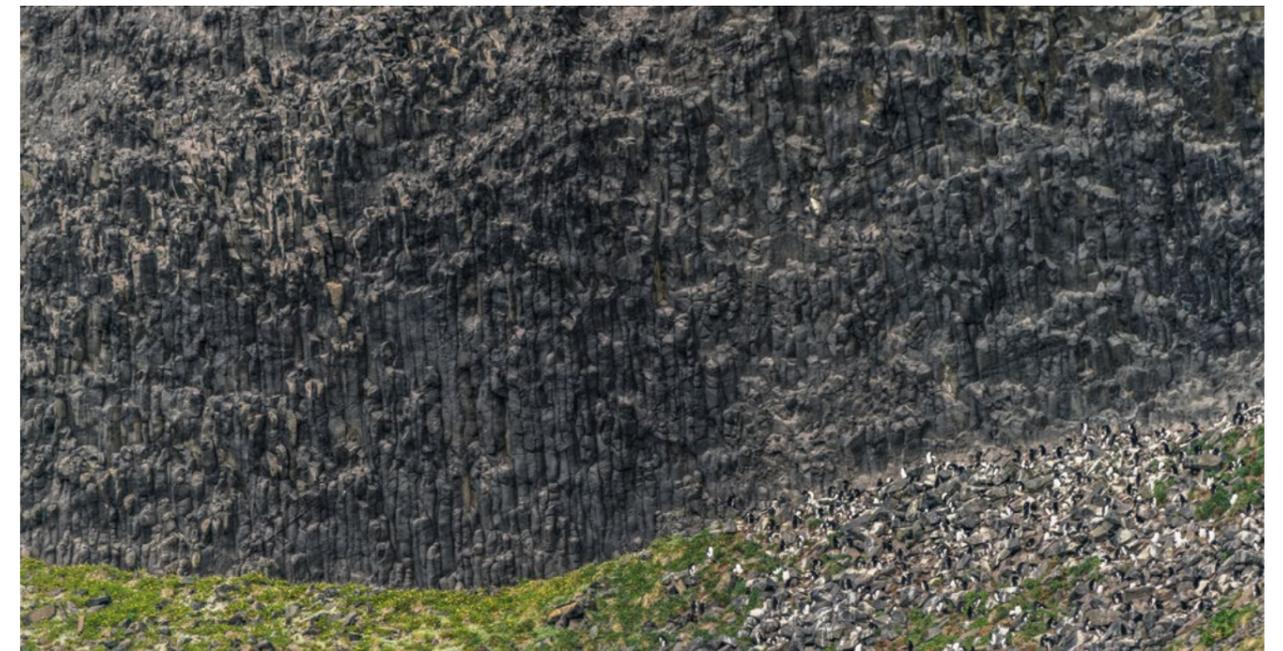
The LISISKER project corresponds to a multidisciplinary approach and combines a set of various analysis and interpretation methods, in order to relate geophysical records (in particular from seismology), multiscale geological characterizations and geodynamic models. Large-scale structures of the lithosphere such as the Moho and the privileged areas of fluids and matter transfer over the Kerguelen plume are characterized using the seismic waves from distant earthquakes (study of SKS waves, receiver functions,...).

The seismic recordings are interpreted by taking into account petrophysical characterizations carried out on xenoliths brought to the surface by the basaltic flows. These xenoliths, centimetric in size, represent pieces of the deep crust and the lithospheric mantle. Seismic properties of these samples are calculated taking into account petrological, geochemical and crystallographic fabrics characterizations.

The project also aims to characterize the deep dynamics of the lithosphere by locating the seismicity sources near the archipelago. With regard to the current seismic station coverage, the Kerguelen archipelago only currently benefits from the permanent station of the GEOSCOPE seismic network. Then, the deployment of several seismic stations operating on the Kerguelen area will locally improve the instrumental coverage and will complete the seismological network of the Indian Ocean.

Jérôme BASCOU
Sub-antarctic

Cliff in Kerguelen



SLW-CLOUD

1247

Supercooled Liquid Water Clouds

During the international YOPP campaign (2018-2019), remote-sensed observations of Supercooled Liquid Water (SLW, the water staying in liquid phase below 0°C) clouds at Dome C have shown that ~50% of the days in summer time exhibited SLW clouds for at least one hour.

The lack of simulated SLW in meteorological forecasts or reanalyses impacted the net surface radiation that was, in some cases, 50 W m⁻² higher in the observations than in the calculations. Therefore, accurately modelling the presence of SLW clouds appears crucial to correctly simulate the surface energy budget over the Antarctic Plateau.

The main objective of the Supercooled Liquid Water Cloud (SLW-CLOUD) programme 1247 is to measure in-situ SLW clouds over Dome C, to get the vertical and horizontal distributions of these clouds, and a time distribution of their appearance over the summertime period in order to check their impacts

on the net surface radiation. These observations will be performed during two different campaigns.

The first campaign will be held in summer 2021-2022 using in-situ SLW sondes mounted on meteorological balloons and coupled to conventional radiosondes. During the second campaign in summer 2022-2023, similar observations will be conducted on balloons, and completed with SLW sondes aboard a light remotely-piloted aircraft system (RPAS).

These unique in-situ SLW observations will be compared and analysed with 1) remote-sensed SLW measurements performed at the station (microwave radiometer HAMSTRAD and depolarization backscattering LIDAR) together with surface radiation from the Baseline Surface Radiation Network (BSRN) and 2) modelled results: meteorological reanalyses (ERA5 and ARPEGE) and PolarWRF.

► **Philippe RICAUD**
Antarctica



Concordia station at the heart of Antarctica

ICORDA-KATABATIC

1250

Firn air pumping campaigns for improving deep ice core dating constraints (ICORDA project) and identifying signature of past katabatic wind activity in noble gases trapped in ice cores (KATABATIC project)

The study envisaged is the field mission associated with three funded projects (ANR JCJC KATABATIC, PI A. Orsi ; ERC CoG ICORDA, PI A. Landais ; ITN DEEPICE, PI A. Landais). It has strong links with the European project Beyond EPICA Oldest Ice Core.

The interpretation of deep ice cores relies on the establishment of a robust chronology. For long time scales, ice core chronologies are based on the measurement and interpretation of orbital dating tracers such as the elemental ratio O₂/N₂ or the air content in air bubbles trapped in the ice. Empirical measurements in the ice show that these two tracers are influenced by the insolation received by the snow on the surface of the ice cap. However, the exact associated process linking the metamorphism of snow grains at the surface and the trapping of air bubbles at a depth of about 100 m is not understood. In particular, a significant role of temperature and accumulation rate is expected.

In order to understand this mechanism, it is essential to measure the evolution of the physical properties of snow and the O₂/N₂ and air content parameters at two very different sites in terms of temperature and accumulation rate. This is the main objective of WP1 of the ICORDA project. In parallel, the KATABATIC project aims to study the influence of katabatic winds on surface temperatures in East Antarctica. For this purpose, measurements of noble gases in the air trapped in the ice should make it possible to quantify the strength of katabatic winds in the past. In order to calibrate this effect, it is essential to study it at one of the sites with extremely strong katabatic winds, D47. We also wish to better understand the isotopic signature in water vapour of katabatic winds (link with the ADELISE project).

In this project, to address these two issues, we therefore propose to carry out two boreholes and firn air pumping for analysis of the elemental and isotopic composition in the open and closed



Ice-core for BE-OI project

porosity at the sites of D47 (strong katabatic wind, high accumulation, high temperature) and Little Dome C (low accumulation, low temperature). The Little Dome C site has another advantage in connection with the Beyond EPICA project. Indeed, this European project does not include firn analysis, which is essential for the interpretation of the deep ice core that will be drilled there. This analysis has therefore been planned within the framework of the DEEPICE associated project with 2 PhD students who will work on the results of this field mission.

Our project will therefore also greatly improve not only the dating but also the interpretation of the greenhouse gases records on the 1.5 million year old Beyond EPICA ice core. Finally, we also wish to deploy during the 3 weeks at D47 and Little Dome C the measurement of water isotopes in water vapor in parallel with the long-term monitoring carried out at Dumont d'Urville and Concordia.

► **Amaelle LANDAIS**
Antarctica

SeMPER 018

1255

Long term (Semper) continuous water vapor and precipitation isotopic measurements (O18) in Eastern Greenland

The objectives of the SeMPER O18 project are the reconstruction of changes in the origin of precipitation and the identification of isotopic signature of mesoscale phenomena affecting the polar region in Eastern Greenland. Those goals will be achieved by continuously measuring the isotopic composition (d18O and dD) of water vapor for a period of 4 years at Ittoqqortoormiit. Isotopic composition of precipitation will be also measured.

This project builds on the ongoing work of the transdisciplinary project SeMPER Arctic that aimed at understanding the sources of resilience in the Arctic by focusing on local narratives of changes in 3 Arctic communities, including Ittoqqortoormiit.

The involvement of community actors in a co-production process will be a major asset of the project. The installation on site of a laser analyzer and its follow up will allow for the continuous measurement of isotopes of water vapor throughout the duration of the project.

Jeanne GHÉRARDI
Arctic



Arctic

- New supported projects -

LIFE SCIENCE

MUSSELKER

1245

MUSSEL-KER: A multi-omics platform for studying the health status of Kerguelen marine coastal ecosystems

It is now well established that climate change combined with pollution is causing profound changes in coastal marine ecosystems. These repercussions are particularly accentuated in polar environments where it has profound impact on the biodiversity, abundance and geographic distribution of populations of intertidal marine species.

This is particularly true in the case of sentinel species such as the blue mussel (*Mytilus* spp.). Mussels are considered true "engineers" of marine ecosystem, helping to shape the biodiversity of the intertidal zones.

Assessing the health status of mussels is thus of primary importance for monitoring programs. Yet, our knowledge of the impact of these environmental stresses on the biodiversity of marine coastal ecosystems remains fragmentary.

In polar regions, this problem is amplified by the difficult conditions and high costs associated with sampling logistics. Building on the results of

our previous campaigns at Kerguelen, we propose here to combine recent advances in the biomedical field and standard taxonomy approaches in order to establish a new sampling platform which exploits the concept of liquid biopsies collected from mussels in order to facilitate monitoring of Kerguelen's coastal ecosystems.

More specifically, we will use a new high-throughput sequencing technology for analysis of hemolymphatic circulating cell free DNA to characterize bacterial and viral microbiomes and the biodiversity of coastal marine ecosystems. A particular attention will be paid to pathogenic bacteria and viruses frequently in marine ecosystems found in densely populated.

We will further carry out on-site studies to determine how physico-chemical characteristics of the ecosystems impact these microbiomes and the diversity of the ecosystem. The high-throughput sequencing approach will also allow us to confirm the presence of rare organisms and to identify new species of bacteria, viruses and marine organisms not previously identified in Kerguelen.

In the long term, this project will develop new tools for monitoring the health of Kerguelen's marine ecosystems in the face of climate change.



Stéphane BÉTOULLE
Yves SAINT-PIERRE
Subantarctic

In Kerguelen, team in survival gear ready to board

Arctos

1248

Effects of multiple environmental drivers on Arctic benthic organisms and communities

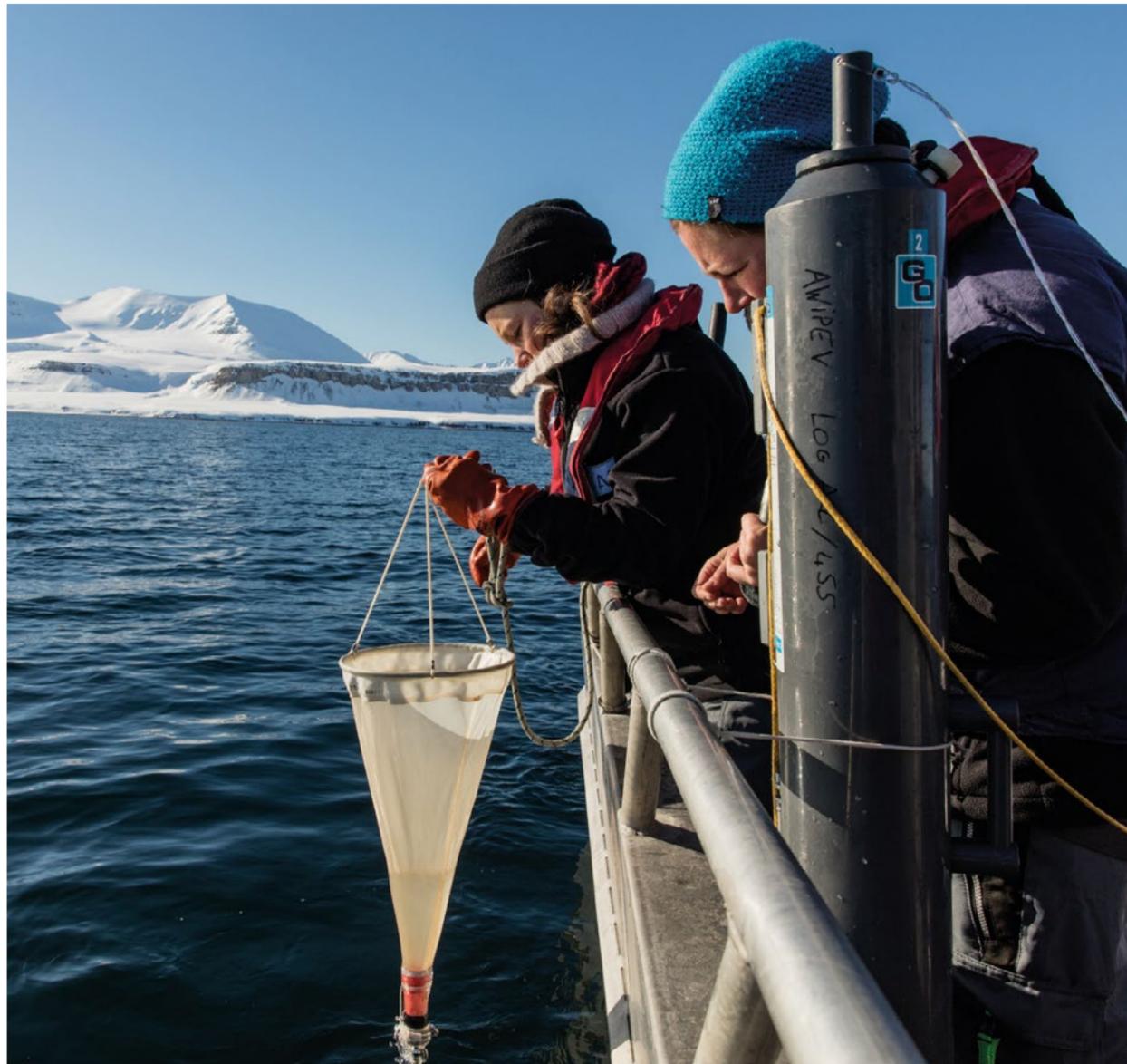
Climate change will have sweeping impacts on the cryosphere and marine biodiversity in the Arctic. We have a collaborative project with German colleagues from the AWI and the University of Bremen to identify the transitions taking place in fjords, adjacent coastal regions, and the impacts on local populations.

More specifically for Kongsfjorden, our goal in 2021 is (1) to run large-scale perturbation mesocosm experiments on benthic organisms, (2) assess the benthic biodiversity in Kongsfjorden, (3) determine

the effects of run-off on primary production, and (4) quantify the blue carbon potential of macroalgal detritus.

In 2022, the focus will be on in situ determinations of the metabolism of benthic communities in Kongsfjorden and their role in the cycles of carbon and carbonate. Most of these research will occur within the framework of the H2020 project FACE-IT (2020-2024).

▶ **Steeve COMEAU**
Frédéric GAZEAU
Arctic



Samples in Arctic

- New supported projects -

EARTH AND UNIVERSE SCIENCE & LIFE SCIENCE

WiSeNet

1258

Implementation of Wireless environmental Sensor Networks in the French Southern and Antarctic Lands using the Long Range (LoRa) technology and Wide Area Network (LoRaWAN) protocol

The Zone Atelier Antarctique et Terres Australes (ZATA) is a French CNRS Long Term Socio-Ecological Research Infrastructure (LTSER) and one of the two French components of eLTER (Integrated European Long-Term Ecosystem & Socio-Ecological Research Infrastructure).

It aims at monitoring the dynamics of biodiversity in the sub-Antarctic and Antarctic marine and terrestrial ecosystems, analyzing biodiversity patterns, mechanisms and interactions, as well as the effect of direct anthropogenic activities (fishing, tourism, management) and global changes (climate, toxics) on the resilience of biodiversity and ecosystems.

Understanding the dynamics of biodiversity requires a correct assessment of environmental variations in either marine, terrestrial or freshwater ecosystems. Up to now, such an assessment is mainly achieved in the French Southern Lands by each IPEV scientific project individually and at the geographic scale of the respective study areas.

Additionally, most of the sensors deployed in the field must be accessed on a regular schedule so as to download data but also to check for sensor integrity and state.

Finally, not all datasets are fully known by the whole scientific community, since it requires an effort for each project to provide access to these data.

In this context, the present WiSeNet project # 1258 (Implementation of Wireless environmental Sensor Networks in the French Southern and Antarctic Territories using the Long Range (LoRa) technology and Wide Area Network (LoRaWAN) protocol) proposes a joint effort to design a common strategy between scientific projects of ZATA (but not only) and the French Polar Institute, to conceive, experiment and deploy intelligent networks of sensors in the various districts (Crozet, Kerguelen, and Dumont d'Urville).

The main objectives are to create a technical, economical and methodological synergy between projects, to produce a replicable design for intelligent networks, wherein the Polar Institute resources are optimally allocated, and thereby to help science projects to take the next step of environmental variation sensing.

▶ **Guillaume BOUGER**
Thomas SAUCÈDE
Subantarctic



Penguins, terre Adélie



All the projects
supported
over the year 2021
summer campaign 2021/2022

72 supported projects
included 8 ESA
and 1 european
project

- All supported projects -

Antarctica



EARTH AND UNIVERSE SCIENCE

- 411 GLACIOCLIM-SAMBA** The glaciers, an observatory of climate, Antarctic component
 - 694 SURVOSTRAL** Monitoring the Southern Ocean
 - 910 HAMSTRAD** H2O Antarctica Microwave Stratospheric and Tropospheric Radiometers
 - 1003 ArLiTA_3** Architecture of the lithosphere of Terre Adélie
 - 1013 CALVA** In situ data for the calibration and validation of meteorological and climate models and satellite remote sensing, from the coast of Adélie Land to Dome C
 - 1053 DACOTA** Dynamics of coastal outlet glaciers and implications on the overall mass balance of the East Antarctic ice sheet
 - 1066 ASTEP+** ASTEP+ : Antarctic SouThErn Photometry telescope
 - 1110 NIVO** Snow properties evolution in a changing climate in Antarctica
 - 1112 CHINSTRAP** Continuous High-altitude Investigation of Neutron Spectra for Terrestrial Radiation Antarctic Project
 - 1177 CAPOXI 35-75** Oxidizing capacity of the atmosphere 35-75 °S
 - 1203 Archive EPICA** Management of the EPICA-DC ice core stored at Concordia
 - 1214 SEIS-ADELICE** Seismic Monitoring of Ice Dynamics in Terre Adélie, East-Antarctica
 - 1247 SLW-CLOUD** Supercooled Liquid Water Clouds
 - 1250 ICORDA-KATABATIC** Firn air pumping campaigns for improving deep ice core dating constraints (ICORDA project) and identifying signature of past katabatic wind activity in noble gases trapped in ice cores (KATABATIC project)
- 990020 / EEU 730258 Beyond EPICA** Recovering the climate history of the Mid-Pleistocene transition and beyond

LIFE SCIENCE

- 600 SOHN AREA** Southern Ocean Hydrophone Network at AREA V
- 1901 L'AMMER** Adelie penguins, environmental bioplatform

EARTH AND UNIVERSE SCIENCE & LIFE SCIENCE

- 1182 ASSET** Antarctic Seals and the Sea-ice Environment (ASSET)

HUMAN AND SOCIETY SCIENCE

- 1237 HABIT-ANT ?** Habiter l'Antarctique ? Preliminary study: anthropological analysis and Participative Action Research
- 1238 ESBA** Ethnography of a Scientific Base in Antarctica

HUMAN BIOLOGY

- 1170 persens** Study on the Evolution of individuals' Relation with their Close Spaciality during a mission extreme & unusual and/or isolated & confined environment from the perspective of a take into account of adaptive stress
- 1220 SLEEPcount** Sleep and neurocognitive disturbances: Countermeasures and innovative investigation tools under polar extreme conditions in Antarctica
- 1234 ICETELEOP** Intra-Crew Evaluation for Tele-Operations
- 1261 COG-IPEV-DDU** A study of cognitive coping mechanisms while wintering in winterers in the French Austral and Antarctic Territories

BIOMEDICAL (ESA projects)

- 990001 MICERA**
- 991708 CHOICE III** Consequences of longterm-Confinement and Hypobaric HypOxia on Immunity in the Antarctic Concordia Environment (CHO2ICE III - Study)
- 991725 ICELAND-TWO** A counter measure for the effects of Immune and Microbiome Changes in Environments with Limited ANTigen Diversity (ICELAND-TWO)
- 991726 ARES** ARES - Astronauts Resistance Enhancement to Stress
- 991727 PARADIGM** PhysiologicAl Adaptation effects upon DecIsion makinG and skills Maintenance in ICE (PARADIGM)
- 991729 WINTERBRAIN** Investigation on brain physiology, operational task performance and sleep polysomnography using ambulatory diffuse optical tomography and a multimodality physiological monitoring system during an Antarctic winter-over
- 991730 CARDICORTEX** Evaluation of circadian rhythm alterations by functional biomarkers during winter over at Concordia (CardiCorTEX)
- 991731 KINOSOMNO** Long-term exposure to hypobaric hypoxia: Kino-cardiograph based sleep monitoring of cardiac mechanics changes caused by periodic breathing (KINOSOMNO)

- All supported projects -

Arctic



EARTH AND UNIVERSE SCIENCE

- 337 GRAVITÉ** Gravity variations in polar and sub-Antarctic regions - Constraints on post-glacial rebound and present-day ice melting
- 1026 POLARLIS3** POLARisation of the thermospheric Red Line In Svalbard
- 1042 ESCAPE-Arctic 3** Ecosystems - Snow - ClimAte - PERmafrost feedbacks - 3
- 1108 ALSI** Austre Lovénbreen - Snow and Ice
- 1126 ARCSNOW-2** Long-term interactions between snow and the atmosphere in the Arctic - 2
- 1215 ALPACA** ALaskan Pollution Arctic Chemistry-climate Analysis
- 1216 EXTREMEVENT** Study of the impact of extreme events on morphosedimentary changes in Icelandic coasts
- 1255 SeMPER O18** Long term (Semper) continuous water vapor and precipitation isotopic measurements (O18) in Eastern Greenland

LIFE SCIENCE

- 330 ORNITHO-ENDOCRINO** Contaminants exposure and maternal effects in arctic seabirds
- 388 ADACLIM** Responses of Arctic marine birds to environmental constraints in the context of climate change
- 1036 INTERACTIONS** Direct and indirect impacts of different parasite-predator-prey interactions on the cyclic dynamics of an Arctic terrestrial vertebrate community subject to climate change
- 1192 MicroLife 2** Microorganisms living in the Arctic
- 1248 Arctos** Effects of multiple environmental drivers on Arctic benthic organisms and communities

EARTH AND UNIVERSE SCIENCE & LIFE SCIENCE

- 1206 INTAROS-SVALBARD** Contributing to an INTegrated ARtic Observation System around SVALBARD
- 1223 KONBHAS** Kongsforden New Benthic Habitats



SOCIETY AND HUMAN SCIENCE

- 1127 BRISK's OBS ENV** OBServatories for BRIdging Indigenous and Scientific Knowledge about ENVIRONMENTAL Changes in the Arctic: Adaptation and Vulnerabilities of the Environment and Related Societies

SOCIETY AND HUMAN SCIENCE & LIFE SCIENCE

- 1208 BOAZU** A Sameby-driven research project investigating the cumulative impacts of environmental and social change on reindeer herding and the future for Saami youth

- All supported projects -

Antarctica Subantarctic



Îles subantarctiques

EARTH AND UNIVERSE SCIENCE

133	SISMOLOGIE/OBS	Antarctica Subantarctic	GEOSCOPE - EOST : Global Seismological Observatory
139	GEOMAGNETISM/OBS	Antarctica Subantarctic	BCMT-EOST: the Five French magnetic observatories in Austral territories and Antarctica (AMS, CZT, DMC, DRV & PAF)
209	NDACC Antarctica	Antarctica Subantarctic	NDACC Antarctica
227	RAYCO	Antarctica Subantarctic	Monitoring galactic and solar cosmic rays for astrophysical research and space weather applications
416	SNO-AMS / ICOS-France	Subantarctic	Greenhouse gases monitoring at Amsterdam Island
688	NIVMER	Antarctica Subantarctic	NIVMER
1028	GMOSTRAL 3	Antarctica Subantarctic	Global Mercury Observations: atmospheric monitoring and process studies in Sub-AnTartic Regions and Antarctic Lands 3
1165	AERONET	Subantarctic	Aerosol Monitoring using sun photometer at Amsterdam Island (AERONET/PHOTONS station)
1200	EnvKiKer	Subantarctic	Characterization and monitoring of environments and paleoenvironments from Kerguelen using testate amoebae
1205	ADELISE	Antarctica Subantarctic	To better constrain the origin of surface accumulation and recent climate change in Terre Adélie via the contribution of water isotopes (ADELISE)
1239	LISISKER	Subantarctic	Study of lithosphere structures and seismicity of Kerguelen

EARTH AND UNIVERSE SCIENCE & LIFE SCIENCE

1258	WiSeNet	Subantarctic	Implementation of Wireless environmental Sensor Networks in the French Southern and Antarctic Lands using the Long Range (LoRa) technology and Wide Area Network (LoRaWAN) protocol
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HUMAN BIOLOGY

1232	COG-IPEV-TAAF	Subantarctic	A study of cognitive coping mechanisms while wintering in winterers in the French Australs and Antarctic Territories
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LIFE SCIENCE

109	ORNITHOECO	Antarctica Subantarctic	Seabirds and marine mammals as sentinels of global changes in the Southern Ocean
119	ECONERGY	Subantarctic	Coping with environmental change in colonial seabirds: physiological adaptations and limitations
131	Physionergy	Subantarctic	Energetic challenges in penguins: Physiological, Bioenergetics and molecular Adjustments
136	SUBANTECO	Subantarctic	Subantarctic biodiversity, effects of climate change and biological invasions on terrestrial biota
137	ECOPHY - ANTAVIA	Antarctica Subantarctic	Adaptive strategies and population dynamics of polar seabirds under environmental constraints
354	ETHOTAAF	Subantarctic	Behavioural ecology of subantarctic birds
394	OISEAUX PLONGEURS OIPLO	Subantarctic	Foraging Ecology and Energetics of Southern Diving Predators in Relation to Climatic Variability
1044	PROTEKER	Subantarctic	Effects of global change on coastal marine habitats of the Kerguelen Islands. Establishment of a base line for ecological and genetic monitoring, protection and conservation
1151	ECOPATH	Subantarctic	Circulation of directly transmitted and tick-borne infectious agents in sub-Antarctic and Antarctic colonial vertebrate populations: surveillance, understanding and management implications
1201	CYCLELEPH	Subantarctic	Life cycle of Southern Elephant seals: energetic, physiological and behavioural adaptations to environmental constraints
1245	MUSSELKER	Subantarctic	MUSSEL-KER: A multi-omics platform for studying the health status of Kerguelen marine coastal ecosystems

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