esa

# concordia

## → LIVING ON WHITE MARS

European Space Agency

# European Space Agency

From the beginnings of the 'space age', Europe has been actively involved in spaceflight. Today it launches satellites for Earth observation, navigation, telecommunications and astronomy, sends probes to the far reaches of the Solar System, and cooperates in the human exploration of space.

Space is a key asset for Europe, providing essential information needed by decision-makers to respond to global challenges. Space provides indispensable technologies and services, and increases our understanding of our planet and the Universe. Since 1975, the European Space Agency (ESA) has been shaping the development of this space capability.

By pooling the resources of 20 Member States, ESA undertakes programmes and activities far beyond the scope of any single European country, developing the launchers, spacecraft and ground facilities needed to keep Europe at the forefront of global space activities.

The Member States are: 18 states of the EU (Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Romania, Spain, Sweden and the United Kingdom) plus Norway and Switzerland.

Eight other EU states have Cooperation Agreements with ESA: Estonia, Slovenia, Hungary, Cyprus, Latvia, Lithuania, Malta and the Slovak Republic. Bulgaria is negotiating a Cooperation Agreement. Canada takes part in some programmes under a Cooperation Agreement.

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# → EXTREME SCIENCE

## ESA at the end of the world

ESA/IPEV/PNRA–A. Salam

**Concordia research station in Antarctica is one of the coldest, driest and most isolated human outposts on Earth. The extreme conditions found in the southernmost continent make this polar base a fascinating place for research. A small crew operates the scientific facility throughout the long and dark Antarctic winter.**

Studies in glaciology, atmospheric sciences, astronomy, Earth sciences, technology, human biology and medicine all benefit from the extreme environment high on the ice cap.

Concordia is the only permanent European station operated inland Antarctica. It was built and is operated by the French IPEV polar institute and the Italian PNRA Antarctic programme.

The European Space Agency (ESA) uses Concordia as a laboratory for fundamental research for human missions to the Moon or Mars, investigating things such as coping with stress, changes in the immune system, and alterations in circadian rhythms.

Each year since 2005 ESA carries out an ambitious human research protocol supplied by universities and research institutions from across Europe. ESA runs the research in cooperation with the builders and operators of Concordia, the French Polar Institute and the Italian Antarctic Programme.

Concordia's population is limited to 16 people, including scientists and technical staff. The base is located at around 3200 m altitude, meaning the crew lives with a third less oxygen than is available at sea level. During the Antarctic winter, they endure four months of complete darkness: the sun disappears from the beginning of May, and is not seen again until late August.

Science experiments are not an easy task to carry out in this frozen world. Access to the station is only possible during the 3-month Antarctic summer season. The nearest human beings are stationed some 600 km away at the Russian Vostok base, making Concordia more remote than the International Space Station.

European scientists are looking at how such an environment can affect the crew's thinking, mood and sleep quality, and whether exercise could be a good way to counteract unwanted effects.

The extreme confinement, self-reliance and limited resources make this international research facility a useful testbed for human interplanetary missions. Even the base's water-recycling technology is a test for life support systems in space.


IPEV/PNRA–A. Litterio


ESA/IPEV/PNRA–A. Kumar

## Why Concordia?

Why would anyone want to live in one of the coldest places on Earth with no hope of rescue during the harsher months? Because of its seclusion, Concordia offers scientists a unique location to conduct research far from civilisation in many disciplines.

The base is a unique platform to learn about planet Earth. An array of instruments around the station helps scientists harvest relevant data to study glaciology, seismography, Earth's magnetic field and the climate. Looking further afield, the stable, cloud-free skies make Concordia an excellent site for astronomy observation.

Living in extreme isolation is a great opportunity for ESA to study human adaptation from a psychological and physiological point of view. Space research has been conducted in the polar regions for years – offering conditions on Earth similar to long-term space travel.

# → THE REMOTEST PLACE ON EARTH

## An island on ice

**Considered the world's last true wilderness, Antarctica is the harshest, most forbidding land on Earth. At the white continent temperatures can plunge below –85°C during the dark winter months.**

Antarctica is covered by ice, in places three kilometres thick. This inhospitable land accounts for more than 60% of the world's fresh water. However, rain or snowfall is so sparse that it is classified as one of the driest deserts in the planet.

A place of extremes, the yearly average temperature inland is –50°C, ranging between –30°C during summer and –60°C in winter. No animals can survive in this region – even bacteria find it hard coping with the severe temperatures.

At the very southern tip of Earth, the Sun does not rise above the horizon in the winter and does not set in the summer. People must live without sunlight for four months of the year. In the great open landscape covered in darkness, colours, smells and sounds are almost non-existent. The altitude and location mean that the air in Concordia is very thin and holds less oxygen.

The Antarctic Treaty states that the continent is devoted to science and peace while the Protocol on Environment Protection designates the region as a natural reserve. Far removed from civilisation, this ice world offers researchers the opportunity to collect data and carry out experiments like no other place on Earth.

ESA/IPEV/PNRA– A. Salam


ESA/IPEV/PNRA- A. Kumar

## Voyage to the end of the world

Access to one of the most hostile places on Earth is only possible during the three-month summer season. The rest of the year, no aircraft can land and snow tractors are unable to reach it, leaving the crew to their own devices. For nine winter months they live in extreme isolation.

The voyage to Concordia station takes longer than the voyage to the International Space Station – travelling by plane, ship or caravans-on-skis can take up to 12 days in total.

People travelling to Concordia fly first to New Zealand or Tasmania on their first leg of the voyage. From there, they will get to the seventh continent either by plane or by boat, always depending on weather and logistical constraints.

From the coast it is another 1200 km to Concordia. Personnel, small equipment and fresh produce are transported in a twin-propeller plane organised by the Italian Antarctic programme.

The aircraft flies in extreme cold weather at altitudes where air pressure is very low. Depending on its cargo it generally stops for refuelling half-way to the station as a safety precaution. The airport is nothing more than a strip of cleared snow and a stockpile of fuel barrels.

In addition to the air transport, 'raid' traverses carry heavy items over land that takes ten days to complete. The expeditions, conducted by the French polar institute IPEV, climb over 3000 m from the coastline to reach the plateau where Concordia was built. Pulled by heavy-duty tractors, caravans-on-skis carry over 150 tonnes of fuel, food and equipment.

## Yukimarimo

→ Concordia's landscape changes little. Where snow is the only scenery and colours, sounds and smells are scarce, 'hivernauts' enjoy finding Yukimarimos as they walk through the snow. Yukimarimos are very light balls of fine frost formed by electrostatic attraction between ice crystals in very low temperatures and weak winds. These cotton-like features behave a bit like tumbleweed in deserts, and were named by a Japanese expedition in 1995.


IPEV/PNRA- A. Barbero

# How to get there?


## Concordia environment

- It has the driest desert climate on Earth. Overall mean temperature is –50°C.
- Access to the station is only possible from November to February.
- Exceptionally cold, clear and stable atmosphere.
- Low air-pressure and oxygen-poor atmosphere.
- The light is continuous during the Antarctic summer, but darkness prevails during winter.
- The landscape is an almost unending snow plain in the largest desert of the world.

ESA–I.Baroncini / K.Oldenburg

# → THE BASE

## A winter house

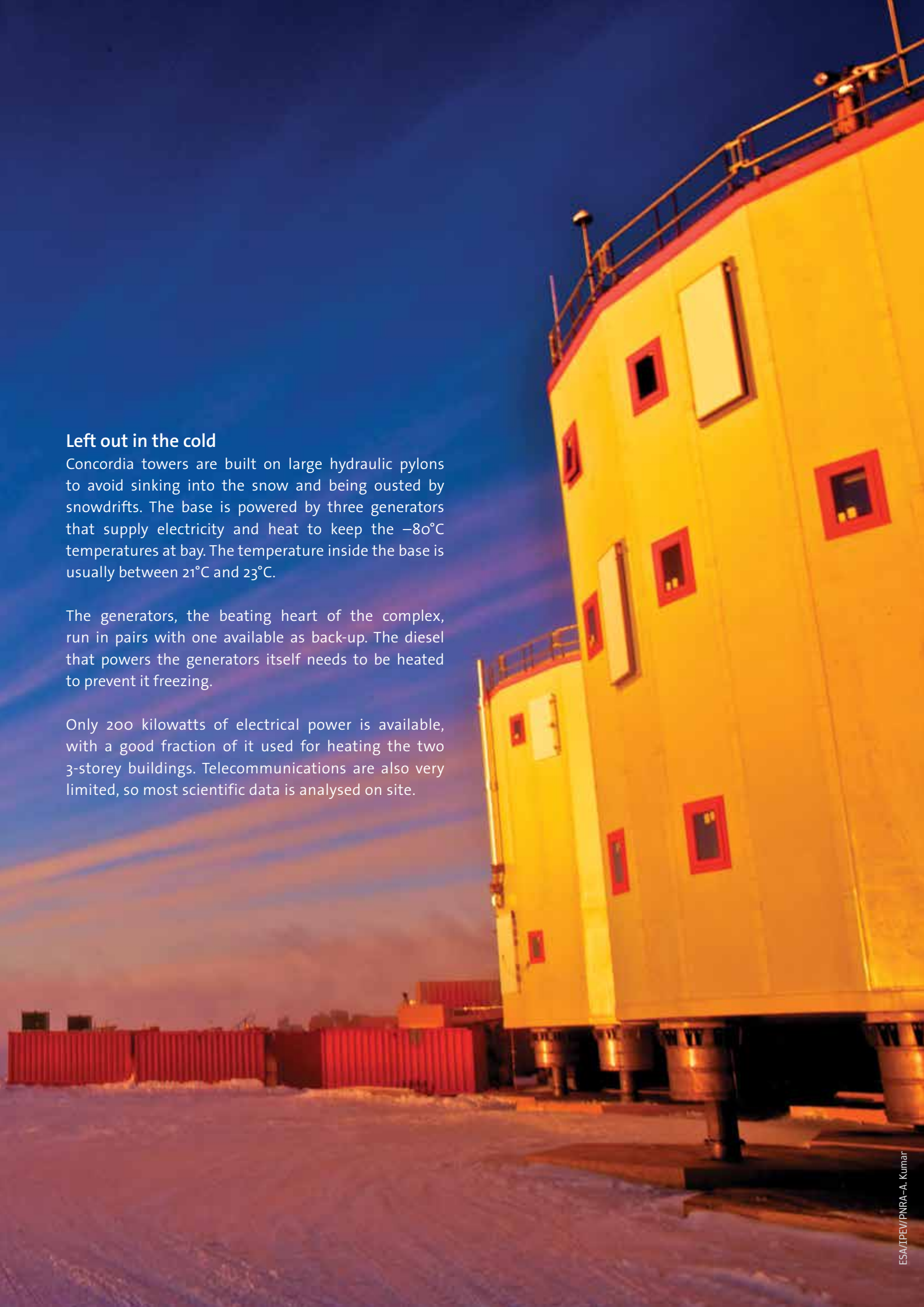
**Concordia station is a vulnerable speck of artificially supported life in an expanse of uninhabited and deadly ice. The base sits on a plateau called Dome C. Only two other research bases exist on the Antarctic inland, the American South Pole Station and the Russian Vostok, as most bases are built on the more temperate and safer coastline.**

Concordia is a joint French-Italian Antarctic research station run by the French polar institute IPEV and the Italian Antarctic programme PNRA. The site was originally selected for being one of the glacier domes where the ice hardly moves, a very favourable condition for drilling into ancient ice cores that are a treasure of climate recordings.

Glaciologists chose the untouched area to drill a 3 km deep hole into the ice as part of the European Project for Ice Coring in Antarctica (EPICA). This large scientific project analysed samples for almost a decade to learn about Earth's climate history.

Concordia construction began in the 1990s with assembly starting in 1999 near the drilling site while EPICA was still taking place. Over 3000 tonnes of equipment and supplies were bought to the site over land in long convoys. Five Antartic summers after, on 15 February 2005, the station was opened permanently and the first team spent a complete winter living in the two towers that make up Concordia.

The base can hold 16 people but needs a technical manager, chef, doctor, communications technician, plumber, mechanic and an electrician to function safely. The remaining crewmembers are devoted to scientific projects.



## Left out in the cold

Concordia towers are built on large hydraulic pylons to avoid sinking into the snow and being ousted by snowdrifts. The base is powered by three generators that supply electricity and heat to keep the –80°C temperatures at bay. The temperature inside the base is usually between 21°C and 23°C.

The generators, the beating heart of the complex, run in pairs with one available as back-up. The diesel that powers the generators itself needs to be heated to prevent it freezing.

Only 200 kilowatts of electrical power is available, with a good fraction of it used for heating the two 3-storey buildings. Telecommunications are also very limited, so most scientific data is analysed on site.

ESA/IPEV/PNRA–A. Kumar


↑ Concordia rooftop. The crew have only themselves to rely on – there is no help from the outside during most of the year

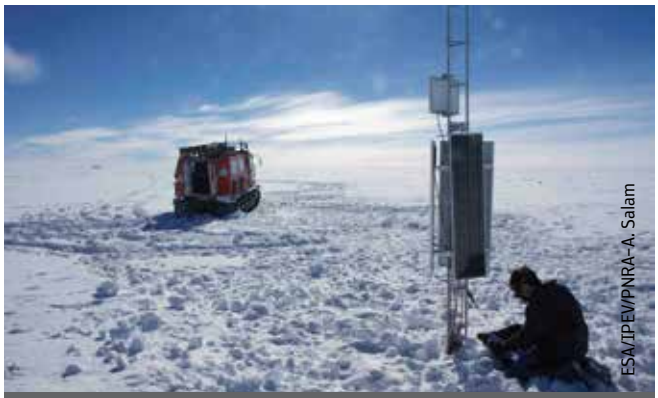
## Touring the base

The base consists of two towers connected by an enclosed walkway. The base is quite large: 1500 m² for 16 people, nearly 100 m² per person. Activities in the towers are separated into noisy and quiet. Spread over three levels, the restaurant, social rooms, gym and workshops are in the 'noisy' tower, whereas the laboratories, sleeping quarters, hospital and radio rooms are in the 'quiet' tower.

Refrigerators keep food inside the main building frozen to guarantee supplies during the long winter. Biological or ice samples are stored in special containers outside – the outside temperatures do the job cost-free.

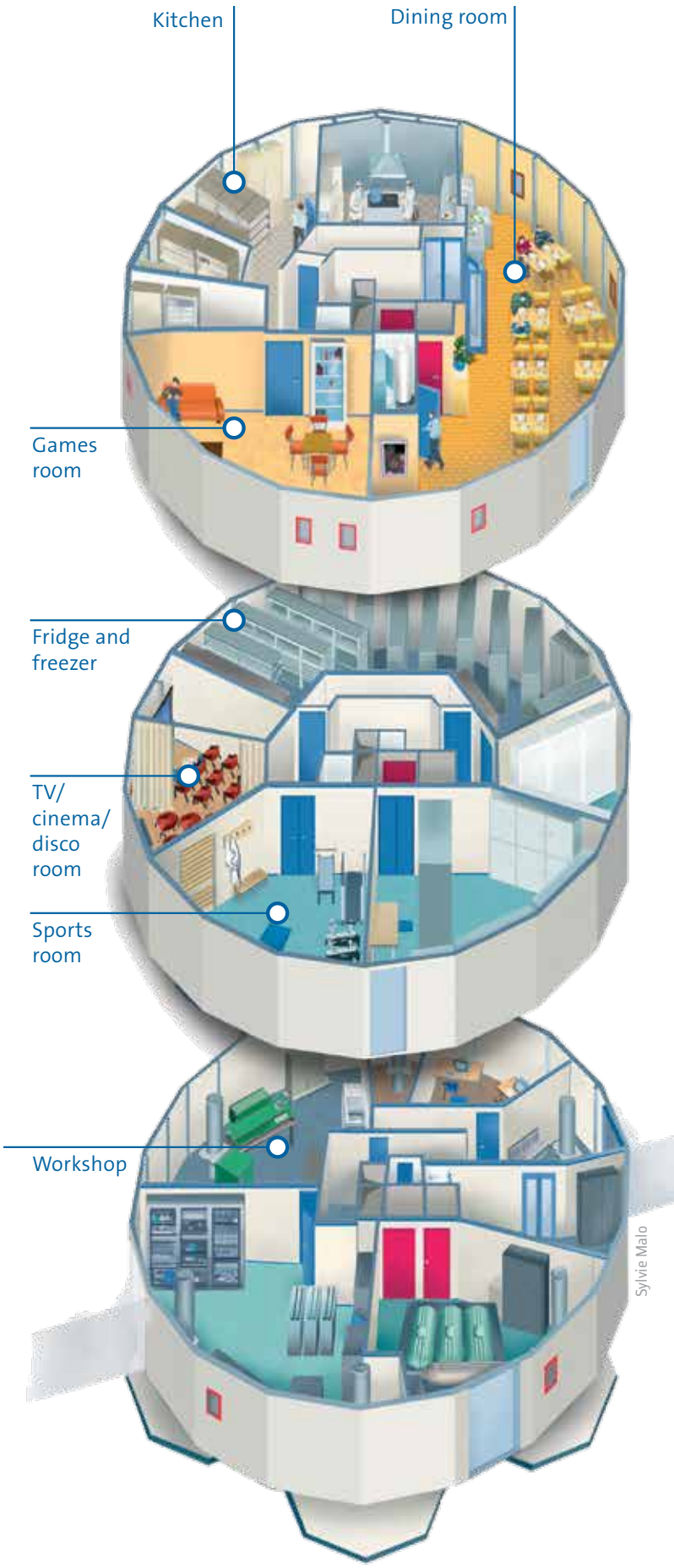
Scientific instruments are dotted outside the base. One of the tallest towers in Antarctica stands proud about a kilometre away from Concordia. The 40 m construction holds devices to measure atmospheric data such as wind speed and humidity. Many instruments observe the snow and ice to help calibrate Earth observation satellites.

A seismic vault 15 m long excavated near the base is used for experiments inside the Antarctic ice. The vault's temperature is a very stable –59°C, making the environment not particularly suited to human beings and electrical equipment.

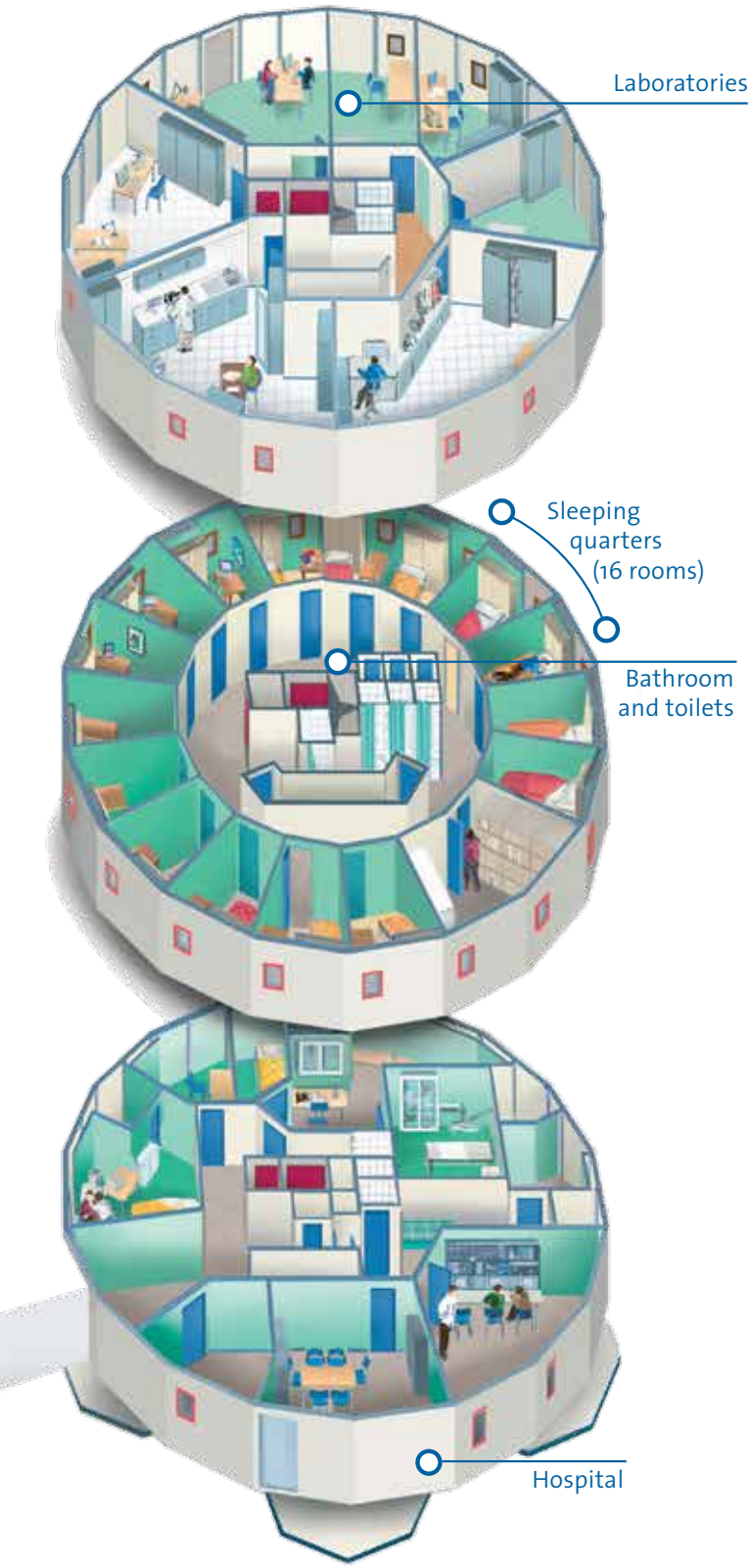



↑ A Concordia crew member inspecting scientific equipment near the Antarctic base

### Noisy Tower



## Quiet Tower




Above ground there are many telescopes as well as two wooden platforms to observe the heavens across a multitude of wavelengths. Wood is a very suitable material to build with in Dome C as no fungi that rot wood can survive.

Concordia has its own airport in the form of a 'skiway' over 1.5 km long. Tractors, bulldozers, skidoos and other machinery are stored during the winter in a tunnel sheltered from the elements by a large pile of snow packed in front of the entrance. One excavator is kept outside during winter to clear the snow in the summer when temperatures and the Sun rise once again.

## Sustainable isolation

Rubbish is separated very carefully in Concordia, organic waste is treated in a special composter and drinkable water is obtained by melting snow from a protected area. Water from washing and cooking, known as 'grey water', is recycled as much as possible using a unit designed by ESA's life support team. The inhabitants of Concordia can only use certain soaps to avoid chemical damage to the membranes of the grey water recycling system.

Water processing is key when planning long-term expeditions on Earth and in space. In many aspects a realistic simulation of human spaceflight, Concordia is an ideal place to test water-recycling systems.

ESA's MELiSSA project has been working for over two decades to create self-sustaining eco-systems to support life indefinitely in a closed environment. A prototype for water recycling arrived at Concordia in 2005 to test its robustness under real-life situations. Since then, the unit has been working efficiently at the base.

The ESA system is helping the station cut down on costs and keep in line with the Antarctic treaty and the Madrid protocol that state no waste must be left behind.


↑ Water recycling unit at Concordia

# → PLANET CONCORDIA

## White Mars on Earth?


IPEV/PNRA–J. Zaccaria

**A stay at Concordia is the closest thing on Earth to living on the surface of another planet. The crew is more cut off than astronauts on the International Space Station. Studying the effects of isolation at the heart of Antarctica is preparing ESA for the real thing: a mission to Mars.**

The base is so unlike anything found elsewhere in the world that ESA uses it as a model for a habitat on extraterrestrial planets. It is not a coincidence that Concordia has been identified both by ESA and NASA as one the most important Earth-based analogues for long duration space missions and inter-planetary travel.

The base is an ideal place to study effects on small, multicultural teams isolated for long periods in an extreme, hostile environment. The inhospitable conditions around Concordia make living there similar to living on another planet.

Crews often feel emotionally isolated and detached from Earth. This is compounded by the limited contact with the outside world, including communication with friends and family. A Sun that never sets and then subsequently never rises adds to this surreal sense of detachment from Earth.

Concordia is even used to research suitable materials for space travel such as microbe-resistant materials. Similar to commercial aircraft, spacecraft can be lighter if the internal air pressure is lowered. It is easier for engineers to design spacecraft and habitats with lower atmospheric pressure.

## Stressors on Earth and in space

Hivernauts encounter many of the same challenges that early polar explorers and even astronauts have faced. The Antarctic and confined environment of Concordia places inhabitants under continuous stress.

ESA sponsors a medical research doctor in Concordia every winter to study the long-term effects of isolation. Understanding how our bodies and minds adapt to extreme environments will help to overcome the challenges of long flights aboard the International Space Station and beyond.

Concordia crewmembers are generally not adapted to living at high altitude with little oxygen. Observing how their bodies adapt gives a good indication to how astronauts will adapt to spaceflight far from Earth.

Data from Mars500, a simulated trip to Mars in which the crew spent 17 months in isolation, suggest that confinement similar to that experienced at Concordia can affect the brain.

Although as yet unproven, some of the personality changes and behavioural alterations observed at Concordia could be due to changes in brain structure from long-term isolation, sensory monotony and confinement. This is a critical area of research when planning for interplanetary travel.

What measures can be taken to keep the crew working together as a team and performing optimally? ESA is looking to answer this question in many areas, from regular exercise to ubiquitous computer aids and blue-enriched lights that could ultimately benefit people on Earth.

## Under pressure

Both air pressure and air density decrease as altitude increases. The atmospheric pressure at Concordia is equivalent to an altitude of 3700 m at the equator, and the air holds a third less oxygen than on the coast.

This hypobaric, hypoxic atmosphere means that the body is deprived of oxygen and can't function normally. The capacity to work and exercise is greatly reduced. The body adapts to this condition over time, but its onset and impact on performance are not well characterised yet.

Planetary bases might be built using hypobaric hypoxic atmosphere. Low pressure may reduce required resources, allow for lighter structures and shorten tasks in space. Concordia provides a well-suited set-up to study long-term effects of reduced pressure on people and materials.

## Mission to Mars and Concordia

- Limited rescue possibility
- Limited external communication
- Extreme environments
- Isolation and confinement
- Multicultural crew
- Close interpersonal contact


ESA/IPEV/PNRA–A. Kumar

## Lights to combat insomnia

A Sun that does not set in the summer and a night that lasts four months can break people's circadian rhythm at Concordia. Such an unusual daily cycle of light and dark heavily impacts the way the crew sleeps in the South Pole.

The human body produces many hormones but melatonin is very important to regulate the circadian rhythm. During daytime, especially when exposed to the blue spectrum of sunlight, melatonin production is suppressed. In the darkness melatonin levels rise, and your body tells you it is time to sleep. Light and lack of light are a good ally to fight insomnia. During the Antarctic winter melatonin production loses its circadian rhythm, leading to reduced alertness during day hours, and sleeping problems at night.

Special blue-enriched lights have been tested at Concordia and showed good results, stabilising circadian rhythms and improving sleep. Different lighting strategies can help astronauts sleep better during their nights in orbit, and ultimately benefit insomniacs on Earth.

ESA/IPEV/PNRA–A. Salam

# → SECLUDED SCIENCE

## Antarctic research

### Watching the watchers

Every day, a peculiar instrument transmits data from the extraordinary surroundings of Concordia to Europe. Attached to a tower, the Radomex radiometer observes the ice sheet at different angles and provides year-round measurements autonomously.

ESA supports this experiment campaign, called DOMEX-3, to collect brightness measurements over the years that can be compared with data from SMOS Earth Explorer and GOCE satellites. Radomex helps verify that the satellites are properly calibrated and stay that way over time.

Known as ESA's water mission, SMOS makes global observations of soil moisture over land and sea-surface salinity of the oceans to improve our understanding of Earth's water cycle. Radomex Antarctic measurements are helping pioneer new applications of SMOS data on snow and ice surfaces.


IPEV/PNRA–A. Barbero

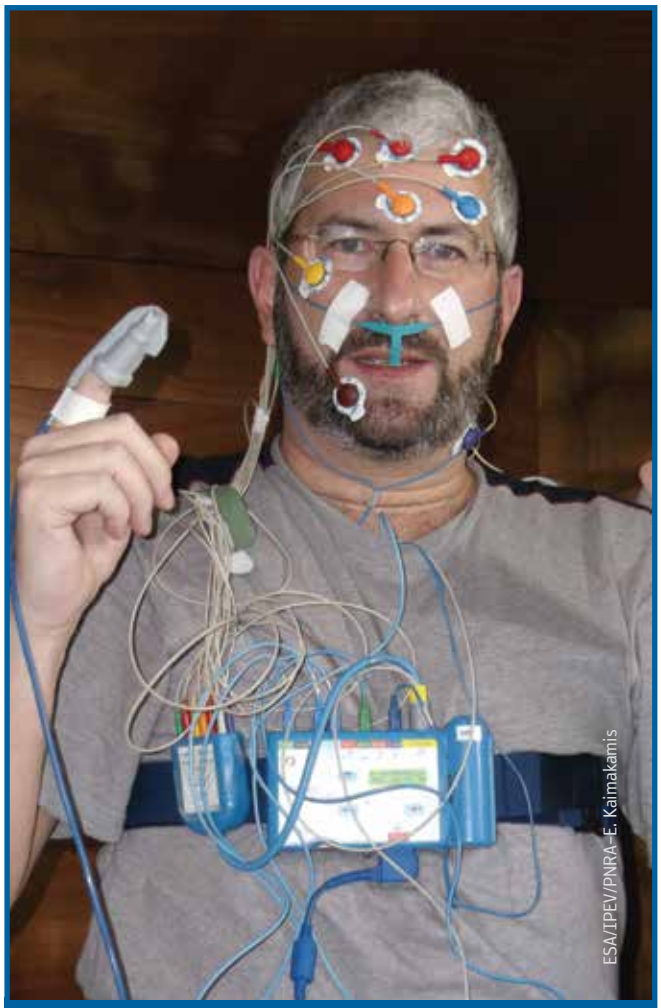
**Concordia is in many ways a science paradise. The small crew living at the station throughout the year not only carries out unique studies in glaciology, atmospheric sciences and even astronomy, but also uses the Antarctic shelter as a laboratory for medical monitoring, testing life-support technologies and psychological research for spaceflight.**

Glaciology research has a prime location in Concordia. Chemicals elements and other molecules trapped and frozen in the ice reveal clues to our past. Observing how the plateau shifts is helping understand the movement of ice in Antarctica.

Delving deeper, Concordia is looking at the inside movements of Earth to monitor how the core of our planet behaves. A seismograph at the base measures movement as part of a network of detectors around the world. The very southern location of Antarctica also makes it ideal for studying Earth's magnetic field as it passes the surface at near-vertical.

Studying Earth's climate is often influenced by the presence of people in the area. Concordia's remote location offers an ideal place to study an atmosphere free from pollution. The research is giving insights into how Earth's climate is changing.

The thin and dry air, clear skies and zero light-pollution around Concordia make it a very attractive place for observing the Universe. It was the possibility of non-stop, round-the-clock observations during the Antarctic winter that attracted astronomy pioneers to the ice continent. Nowadays, many telescopes have been installed around the research base.




## Sleep, sit and eat

One project requires sleep recordings, as sleep patterns are deeply affected by hypoxia, darkness and the isolation experienced at Concordia. Research on sleeping crewmembers will help understand sleep apnea – a pause in the breathing reflex – and benefit people suffering from intermittent breathing and snoring.

Living in Concordia changes the cardiovascular system – the distribution of blood – and researchers are interested to know if this affects how people stand and sit. One experiment looked at how crewmembers' posture shifts over time at Concordia.

How does mood influence food intake? Scientists hope to understand if feeling happy or sad changes how the body deals with energy needs through time. Special medical devices are used to calculate the resting metabolic rate of individuals as well as monitoring their daily activity and eating habits.

## Unwanted microbes

Aside from properties such as weight, strength and resistance, astronauts need a healthy environment free of harmful bacteria and mould. ESA is keen on knowingwhich materials are best suited to build spacecraft and is testing over 20 different antimicrobial samples in Concordia.

Plaques containing pieces of metals and plastics are hung up in various places in the research base. After the winter they are analysed for microbial growths, and their effectiveness for long-term space missions.

## What's on your mind?

ESA is specially interested in long-term medical, psychological and microbial monitoring. Institutes in Europe and the US support research protocols that look into the way the crew sleeps, feels and works together.

Some protocols require administering psychology surveys as the crew's mood and state of mind are likely to change during the winter. Social cohesion and cooperation between team members are also measured through computer-based applications that are run periodically.

Other computer programs are developing and testing an electronic partner to rely on in unexpected and complex situations. The computer will know how astronauts feel and deliver information tailored to their state of mind, even suggesting they conduct a procedure on another day if they are not in the right mood or if they need more training.

Another way of assessing moods is by interpreting video diaries. One of the projects aims to study speech patterns such as tone of voice, intonation, use of grammar and speed of speech. By looking at changes in the way crewmembers talk into the camera and comparing these with results from standard questionnaires, researchers hope to develop software that can analyse speech automatically.


ESA/IPEV/PNRA–A. Salam

# → TO THE LIMIT

## Acclimatisation challenges

**Antarctica is the world's largest stretch of inhospitable land on Earth. Despite all the hardships, up to 16 European 'hivernauts' volunteer to live around a year at a time in Concordia in the name of science. And it is not only about enduring the freezing cold weather.**

Concordia welcomes the visitor with a fascinating, but hostile natural environment. On arrival a period of acclimatisation is required, similar to that of astronauts in space. As soon as the crew steps off the plane they notice the low pressure of the air and feel breathless in the oxygen-poor atmosphere. The high altitude, extreme cold and dry air can overwhelm the human brain as it adjusts to the new environment.

Venturing outside the base requires wearing layers of clothes and limits the time spent outdoors. Only a few seconds of exposure to the cold can cause frostbite. There is limited mobility outside the buildings – the crew never goes further than three kilometres from the base in the winter months.

Although temperatures go down to around –80°C (the lowest temperature ever recorded was –86°C in 2011), hypothermia is not likely to occur at Concordia. Good quality suits and boots, heated shelters and strict safety rules for outdoor work protect the crew. There is always someone listening on the radio in case people outside encounter any difficulties.

An injured person outside would get hypothermic extremely quickly – just ten minutes of lying in the snow could be very dangerous. During the harsh winter no outside help can be flown in or reach the base over land. The crew has to solve any problems on their own, even in emergencies. Hivernauts learn to be highly autonomous with limited resources.

Living at Concordia is in many ways like living on a desolate planet. There is essentially no weather system as there are almost no clouds, nor precipitation. The landscape has no topography, and there is no sign of life in the ocean of ice that surrounds the station.

## What happens to the body?

A winter stay at Concordia can be very difficult and challenging, both physically and emotionally. The long separation from close relatives and friends can place a significant emotional strain on the crewmembers. Physical changes such as hypoxia – lack of oxygen – chapped lips and sore throats never go away and are some of the many challenges of living through the world's longest, darkest and coldest winter.

### Out of breath

The altitude at Concordia (3233 m) is high enough to cause the same problems suffered by mountaineers. There is not enough oxygen in the air for normal levels of activity. The crew get easily tired and breathless, especially climbing the stairs or carrying heavy objects. They live in a permanent state of hypoxia.

### Insomnia

Misalignment between the internal clock and the external environment, with a never-setting sun or constant darkness, can disrupt crewmembers' biological clock. The isolation and sensory deprivation also make it hard to get a good night's sleep.

### Frostbite

The air is extremely dry, so the crew suffers from continuously chapped lips and irritated eyes. Frostbite and snow blindness are more dangerous and can cause serious damage.

### Feeling blue

During the winter, the absence of sunlight can also be associated with low mood, low energy and poor concentration, otherwise known as seasonal affective disorder (SAD). The sense of loneliness can come with anxiety, irritability or withdrawal.

### Boredom

Life at Concordia is not a polar expedition. Monotony is a factor to contend with and comes in several forms including sensory, intellectual, recreational and social. Sensory monotony is profound. There are very few colours, sounds or smells in the environment or on the station, and those that do exist hardly change.

## Trained for the cold

How does crew performance and social interaction suffer as morale sinks, sleep is disturbed and stress becomes a factor of daily life? ESA offers a Human Behaviour and Performance training to help the crew prepare for a successful, productive and pleasant winter.

The course includes best practices learnt by others who have lived in extreme environments such as in space, submarines or caves, covering communication skills, cultural influences and teamwork. The cohesiveness of a group can make or break the Concordia winter experience. Participants learn how important group dynamics are including diplomacy, tolerance and respect for the crewmembers.

Questionnaires to assess mood, instruments to monitor sleep patterns as well as blood sampling to chart bodily reactions are common practice for volunteers at Concordia. ESA also provides debriefings and organises calls with the International Space Station.

**"Some people just find life easier than others. It is a journey of personal discovery down here. You never know what you will find."**

*Alexander Kumar*
*2012 ESA-sponsored medical doctor*

ESA/IPEV/PNRA–A. Kumar

# → WINTER IS COMING

## Darkness versus the kingdom of light

**Life in Concordia can be divided into four seasons even though the weather in Concordia hardly changes all year. The seasons in Concordia are linked to sunlight and routines. As the Sun disappears completely during the winter, social events become important to help keep track of time.**

### Bright and busy summer

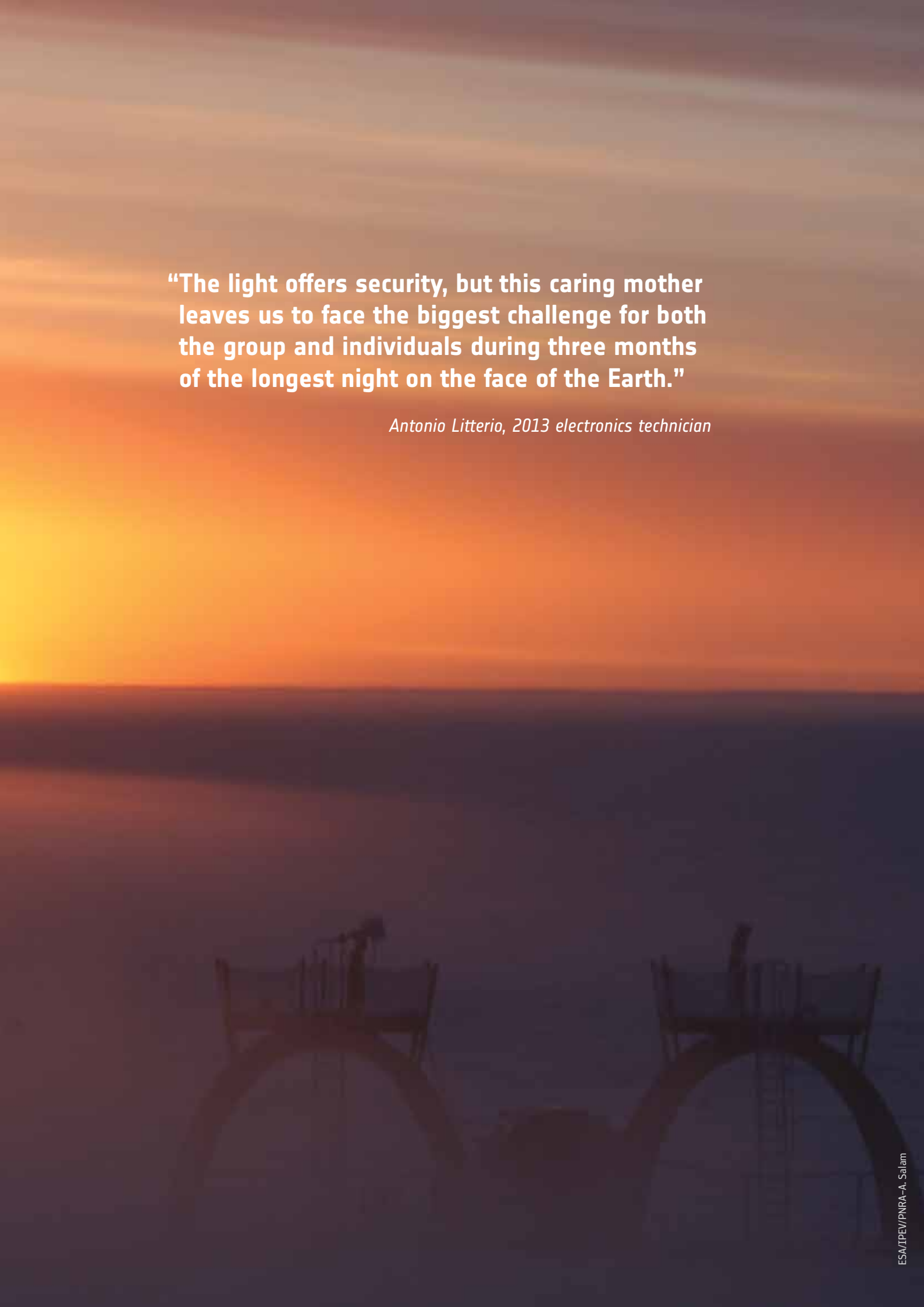
NOVEMBER TO FEBRUARY

November is the start of the summer campaign, and the base is awash with over 60 scientists and technicians performing science and maintenance in preparation for the winter.

During this time the Sun never sets below the horizon and aircraft arrive on an almost daily basis. The Concordia crew have to unload stock, organise supplies and place them in appropriate containers and refrigerators for the next ten months.

The first few weeks are crucial in defining the group and understanding people's preferences and roles.

As February progresses the shadows of Concordia's two towers become longer. Most of the logistics personnel start leaving the base and human presence is reduced to a third of its number in just a few days. The day the last plane leaves is the first time the crew comes together as a team.



**“The light offers security, but this caring mother leaves us to face the biggest challenge for both the group and individuals during three months of the longest night on the face of the Earth.”**

*Antonio Litterio, 2013 electronics technician*

ESA/IPEV/PNRA–A. Salam

## Failing Sun

MARCH TO MAY

The Sun begins to touch the horizon. After many weeks of living under an intense blue the sky starts to be painted with a yellowish reflection, with shades ranging from blue to red.

All but a handful of people have departed from Concordia, leaving a skeleton crew on the base to fend for themselves. This is a period of adjustment for the crew, getting to know each other and preparing for the onset of winter.

## The long darkness

MAY TO AUGUST

Winter proper arrives shortly after Easter with over four months of darkness, cold temperatures and no chance of rescue in an emergency. Life becomes very structured, centred on social moments such as evening meals or birthday celebrations.

It is around this time that the third-quarter phenomenon is described in isolated missions. Crewmembers have passed the halfway point, but they also realise that the second half of the mission is yet to come before they can return home.

For many this is the most difficult phase from a psychological point of view – emotional and interpersonal problems can increase significantly.

## The Sun reborn

SEPTEMBER TO NOVEMBER

The first sunrise following three months of darkness is a very defining time. Once past the longest night in the world, things start to get brighter as the Sun rises near the horizon.

From then on the winter crew start preparing for the arrival of the scientists that work around Concordia during the summer. The base is cleaned thoroughly, machinery is serviced, tents are erected and heated, and the runway is cleared of snow. Extensive work is required to welcome the new arrivals back to the base at the end of the world.

## Calendar

| | |
|---|---|
| Winter-crew arrival | December |
| Christmas & New Year | December |
| Arrival of traverse raids | January |
| Departure of last plane | February |
| First sunset | February |
| Easter | March–April |
| Midwinter | June |
| First sunrise | August |
| Last sunset | October |
| First plane | November |
| Return of summer crew | November |

**"Nature seemed to hibernate and together with it we entered a state of subconscious that lowered activity and morale, like small and insignificant polar organisms waiting for the new light."**

*Vangelis Kaimakamis*
*2013 ESA-sponsored medical doctor*

**"My heart leaps and I murmur 'Welcome back'. I could never have imagined how powerful you [the Sun] are in the mind and heart of someone who has been deprived of you for so long. Ninety days after our last goodbye, here you are once again in all your splendour."**

*Antonio Litterio, 2013 electronics technician*

ESA/IPEV/PNRA–A. Kumar

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