



GOOD NIGHT, GLACIERS

Ice Memory is our challenge against time to save the environmental history, understand change, and think about tomorrow

Lagazuoi EXPO Dolomiti
Cortina d'Ampezzo

icememory.it | memoriadeighiacci.it



The scientific mission conducted at Colle del Lys (Monte Rosa) from October 6 to 15, 2023, is featured. The photo shows the coring tent and the tents housing the research team, taken by Riccardo Selvatico.

Glaciers, far from being static bodies, are dynamic entities constantly in motion. Inside, they hide precious chemical information that tells the evolution of our Planet's climate and environmental conditions.

From 2020 to 2023, the Ice Memory project undertook scientific missions on five glaciers - witnesses of change (Corbassière, Colle Gnifetti, Calderone, Holtedahlfonna, Colle del Lys) to extract samples and create an archive in Antarctica for future researchers.

GOOD NIGHT, GLACIERS showcases the beauty, risks, and secrets of glaciers. It documents missions and core samplings and reveals how glaciers have changed over the past decades. The exhibition alternates between photos, videos, real sounds, and scientific data, depicting a journey from the dark calm of the unchanged night to the harsh light of increasingly warmer days, influenced by human actions.

Since the mid-1800s, Alpine glaciers have lost 80% of their mass. If we do not act now by drastically reducing the release of climate-altering gases into the atmosphere, we risk losing 95% of the Alpine glacier cover and all glaciers below 3,600 m altitude by the end of the century.

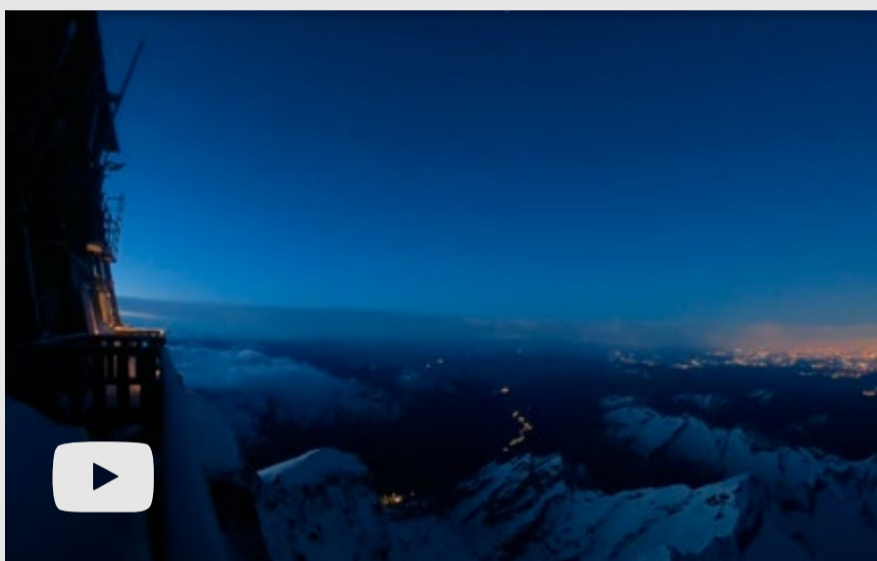
SCIENTISTS' OVERNIGHT PERSPECTIVES

**Images from the field: expeditions on
Monte Rosa and in Svalbard**

MONTE ROSA

Colle Gnifetti (June 2021)

video by Riccardo Selvatico



In these first two videos, we discover spectacular high-altitude sceneries from over 4,500 meters at Colle Gnifetti and Capanna Margherita, the highest refuge in Europe, built on a rocky peak 134 years ago to support scientific research. Researchers from CNR-ISP, the University of Venice, and the Paul Scherrer Institut set up the Ice Memory mission tent there in June 2021.

The Gorner Glacier, about 40 square kilometers in size, has lost approximately 40% of its area since the mid-1800s, retreating by around 3.3 kilometers. Ice cores from this glacier enable us to reconstruct the last 10,000 years of climate history. A sample will be kept in Antarctica for future generations of scientists.

Despite challenging weather conditions with strong wind and snow, the team continued their work, supported by the refuge's hospitality, and at sunset after the storm, they could see the lights of Milan in the distance.

SVALBARD

Holtedahlfonna (April 2023)

video by Riccardo Selvatico



We continue our journey to the Arctic environment, amid landscapes of great charm and extreme conditions for humans. The remote Ice Memory camp on the Holtedahlfonna glacier, at an altitude of 1,150 meters in Svalbard, operated for 23 endless days in April 2023. Ny-Ålesund, the nearest village, was 80 kilometers away, a 4-hour snowmobile journey through crevasses and critical passages on the fjord.

Despite obstacles like an unexpected aquifer in the glacier and extreme weather conditions, the international team successfully extracted three ice cores, 10 centimeters in diameter, from the ice surface to the rock layer at about 74 meters deep. The mission involved teams from CNR-ISP, CNRS, NPI, Ca' Foscari University of Venice, and the University of Perugia.



LISTEN TO THE MELTING GLACIER

The soundscape accompanying the images from Monte Rosa and Svalbard was created by artist and researcher Ludwig Berger, a contributor to the Melting Landscapes project (2016). This audiovisual research project reveals the sounds and internal structures of the Morteratsch Glacier in Switzerland.

Underwater microphones captured sounds of crevasses, internal pools, and the glacier's tongue. Inaudible sounds became perceptible: melodic creaks, ticking, rumbling, gurgles, hisses, deep hums. Microscopic melting processes, interrupted by breaking ice blocks, were recorded.

These recordings were published as a disc and photo book, spatial sound installations, and concert series. The project provides a new perspective on glaciers amid global warming, offering an intimate, bodily experience of the melting process and highlighting the microscopic scale of climate catastrophe.



| Ludwig Berger while making the recordings. Credits: Johannes Rebsamen

THE STARS ARE WATCHING US

MONTE ROSA, Colle del Lys (October 2023)

video by Riccardo Selvatico



A hypnotic timelapse invites us to take a break from our activities, to contemplate the wonders of our planet and space, and to remember that we are part of them. As we look at the stars, the stars look at us, and since the birth of mankind, they listen to us, amaze us and guide us, over seas and mountains.

THE VOICES OF ICE MEMORY

SVALBARD

Holtedahlfonna (April 2023)

video by Riccardo Selvatico



Just 1000 km from the North Pole, at 1500 meters on the Holtedahlfonna glacier, the Ice Memory expedition takes place, aiming to preserve the region's climate and environmental memory. In this testimony from Svalbard, CNR-ISP researchers Fabrizio De Blasi and Jacopo Gabrieli explain why they initiated an international mission lasting over 20 days under extreme conditions. *'Ice cores are an invaluable heritage, both scientifically and culturally. Losing these ice archives means losing our past. The only way to save these white giants is to reduce our impact on the Earth system,'* explains Fabrizio De Blasi.

MONTE ROSA

Colle Gnifetti (June 2021)

video by Riccardo Selvatico



The Ice Memory mission on Colle Gnifetti was a success. Two ice cores were extracted, revealing climate and environmental history over the last 10,000 years. Carlo Barbante, director of CNR-ISP and professor at Ca' Foscari University of Venice, and researchers Jacopo Gabrieli and Fabrizio De Blasi discuss choosing the site, the steps taken to safely set up the camp at 4,550 meters and start operations. They also discuss the expected insights from the ice analysis and the final destination of Antarctica, preserving the archives for future generations.

Fabio Trincardi, director of the CNR's Earth and Environment Department, adds, *'Ice is an exceptional recorder. Losing it is like a person losing their memory. Ice is our greatest ally in combating climate change. The solution? Avoid releasing climate-altering gases into the atmosphere.'*

THE IMAGES OF GLACIER RETREAT

Photographic Comparisons

LUPO

1938 A. Corti - 2023 R. Scotti



Maximum altitude: 2684 m above sea level | Area: 0.1 km² (2016)

If we do not act now, by 2100 there will be left:

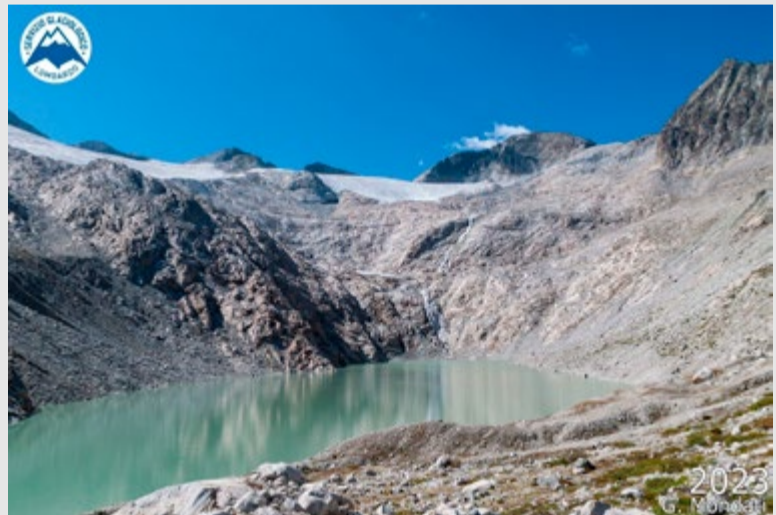
0%

If we reduce emissions, by 2100 there will be left

5%

PISGANA OVEST

1990 G. Stella - 2023 G. Mondati



Maximum altitude: 3265 m above sea level | Area: 2.4 km² (2016)

If we do not act now, by 2100 there will be left:

0%

If we reduce emissions, by 2100 there will be left

2%

CEVEDALE / ZUFALL

1930 M. Bossolasco – 2021 S. Perona



Maximum altitude: 3610 m above sea level | Area: 3 km² (2016)

If we do not act now, by 2100 there will be left:

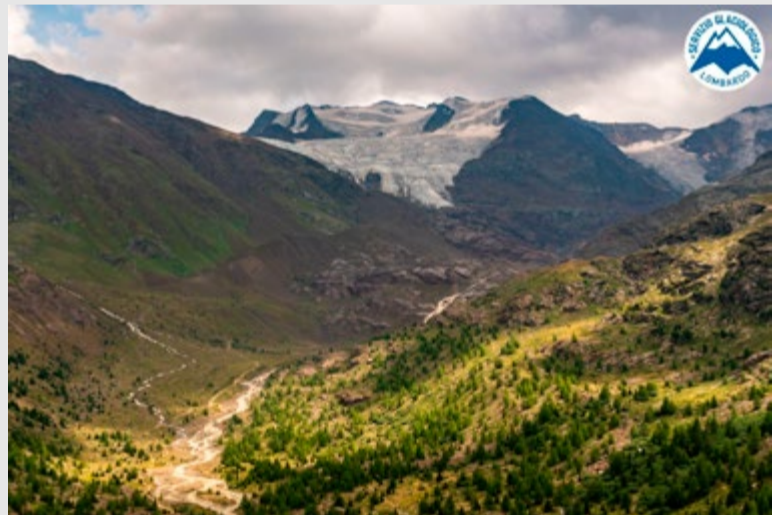
0%

If we reduce emissions, by 2100 there will be left

6%

FORNI

1860/1870 A. Vismara - 2022 R. Scotti



Maximum altitude: 3663 m above sea level | Area: 10.5 km² (2016)

If we do not act now, by 2100 there will be left:

0%

If we reduce emissions, by 2100 there will be left

21%

FELLARIA EST

1898 L. Marson - 2023 R. Scotti



Maximum altitude: 3860 m above sea level | Area: 4.3 km² (2016)

If we do not act now, by 2100 there will be left:

0%

If we reduce emissions, by 2100 there will be left:

52%

VENTINA

1910 A. Corti - 2021 R. Scotti



Maximum altitude: 3532 m above sea level | Area: 1.7 km² (2016)

If we do not act now, by 2100 there will be left:

8%

Se abbattiamo le emissioni, nel 2100 ne rimarrà:

65%

CARESER

1933 A. Desio - 2012 L. Carturan



Maximum altitude: 3278 m above sea level | Area: 1 km² (2016)

**If we do not act now, by 2100 there
will be left:**

0%*

**If we reduce emissions, by 2100
there will be left**

0% (2%)*

*The figure is derived from global models that do not take local conditions into account.

MARMOLADA

1985 - 2022



Maximum altitude: 3241 m above sea level | Area: 1,2 km² (2016)

**If we do not act now, by 2100 there
will be left:**

0%*

**If we reduce emissions, by 2100
there will be left**

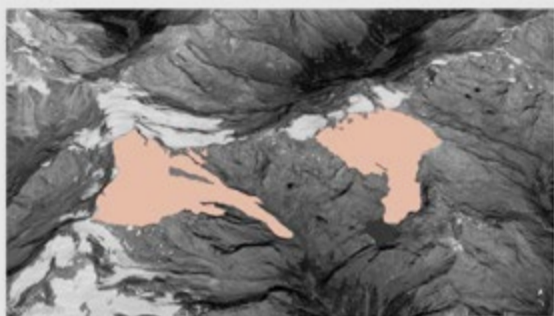
0% (14%)*

*The figure is derived from global models that do not take local conditions into account.

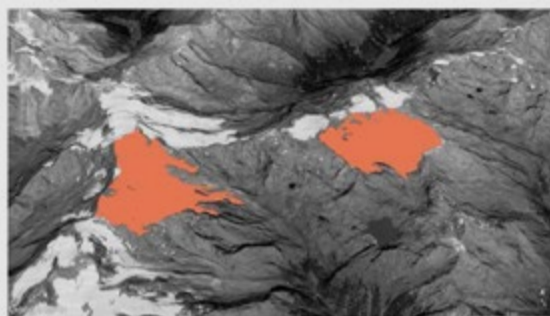
for more glaciers visit: www.memoriadeighiacci.it

THE CHANGE SEEN FROM ABOVE

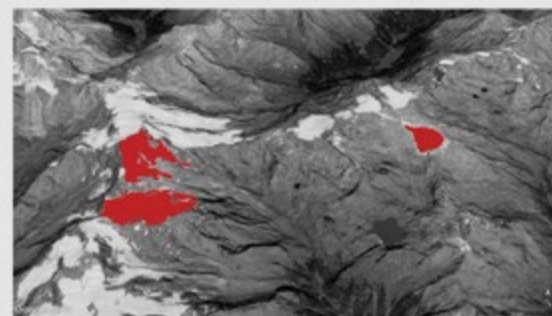
LE MARE | CARESER



1850

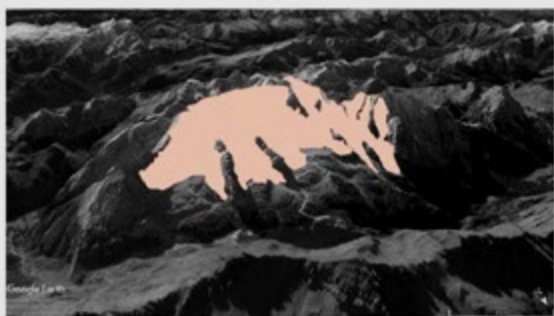


1959

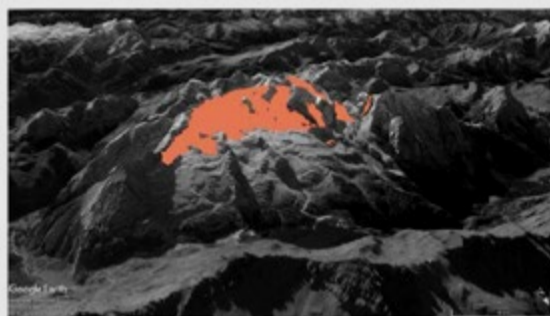


2023

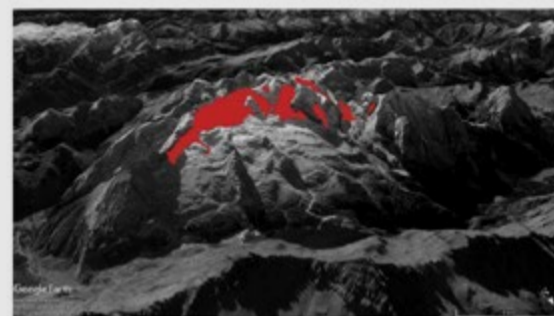
MARMOLADA



1850



2003



2022

Background satellite images: Google Earth, Image Landast/Copernicus Data SIO, NOAA, U.S. Navy, NGA, GEBCO. Glacier extent for the year 1959: Carturan, L., Baroni, C., Carton, A., Cazorzi, F., Dalla Fontana, G., Delpero C., Salvatore M.C., Seppi, R., Zanoner, T., (2014). Reconstructing fluctuations of la mare glacier (eastern italian alps) in the late holocene: new evidence for a little ice age maximum around 1600 AD. Glacier extents for the years 1850 and 2003: <https://siat.provincia.tn.it/geonetwork/srv/ita/catalog.search#/home>.

Monitoring, historical photos, and satellite data enable us to reconstruct the changes in the extents of Alpine glaciers.

Two significant examples are presented: the retreat of the La Mare and Careser glaciers, drastically reduced in the last century and a half due to temperature increases, and the Marmolada glacier, with accelerated retreat in the last 20 years visible from satellite data.

Future prospects are bleak, but emission reduction can make a difference. Without drastic emission policies, La Mare will disappear, but significant cuts could save 14% of its volume by century's end. However, experts believe little hope remains for preserving significant parts of Careser and Marmolada glaciers beyond the next decade.

ON A MISSION WITH ICE MEMORY

GRAND COMBIN

Corbassière (September 2020)

photo by Riccardo Selvatico



We delve into the core activities of the Ice Memory drilling missions. Researchers work at night on the glacier to avoid daytime temperatures above 0°C at over 4,100 meters altitude, preventing surface water formation. Sampling was suspended after 10 days due to 'ancient' snow layers soaked with liquid water at about 25 meters depth.

Analysis by the Paul Scherrer Institute (Switzerland) and the CNR's Institute of Polar Sciences (Italy) revealed the climatic signal in the studied glacier part is now compromised due to high temperatures. Over the last 170 years, the Corbassière glacier has lost about a third of its area, with the glacier tongue retreating about 3.5 kilometers.

GRAN SASSO D'ITALIA

Calderone (March-April 2022)

photo by Riccardo Selvatico



Only 26 meters of ice remain under a layer of debris at the Calderone Glacier, the last example of Apennine glaciation. The mission to extract a deep sample from the glacier-snow was carried out in the spring of 2022, when the snow cover concealed the debris surface. In the photo, a panorama of the massif with the station for ice core extraction operations at the center of the basin.

The mission was organized by the Institute of Polar Sciences of the National Research Council (Cnr-Isp) and Ca' Foscari University of Venice, in collaboration with the National Institute of Geophysics and Volcanology (INGV), the University of Padua, and the companies Georicerche Srl and Engeoneering Srls.

Despite initial weather challenges, the 12-day drilling expedition was supported by the National Fire Brigade (VVF), providing transportation and personnel to reach the glacier's basin at the foot of Corno Grande at 2,673 meters altitude. Scientists noted plant and insect residues in the ice cores, aiding in dating and understanding the age of the corresponding ice layers.”

SVALBARD

Holtedahlfonna (April 2023)

photo by Riccardo Selvatico



GOOD NIGHT, GLACIERS

22

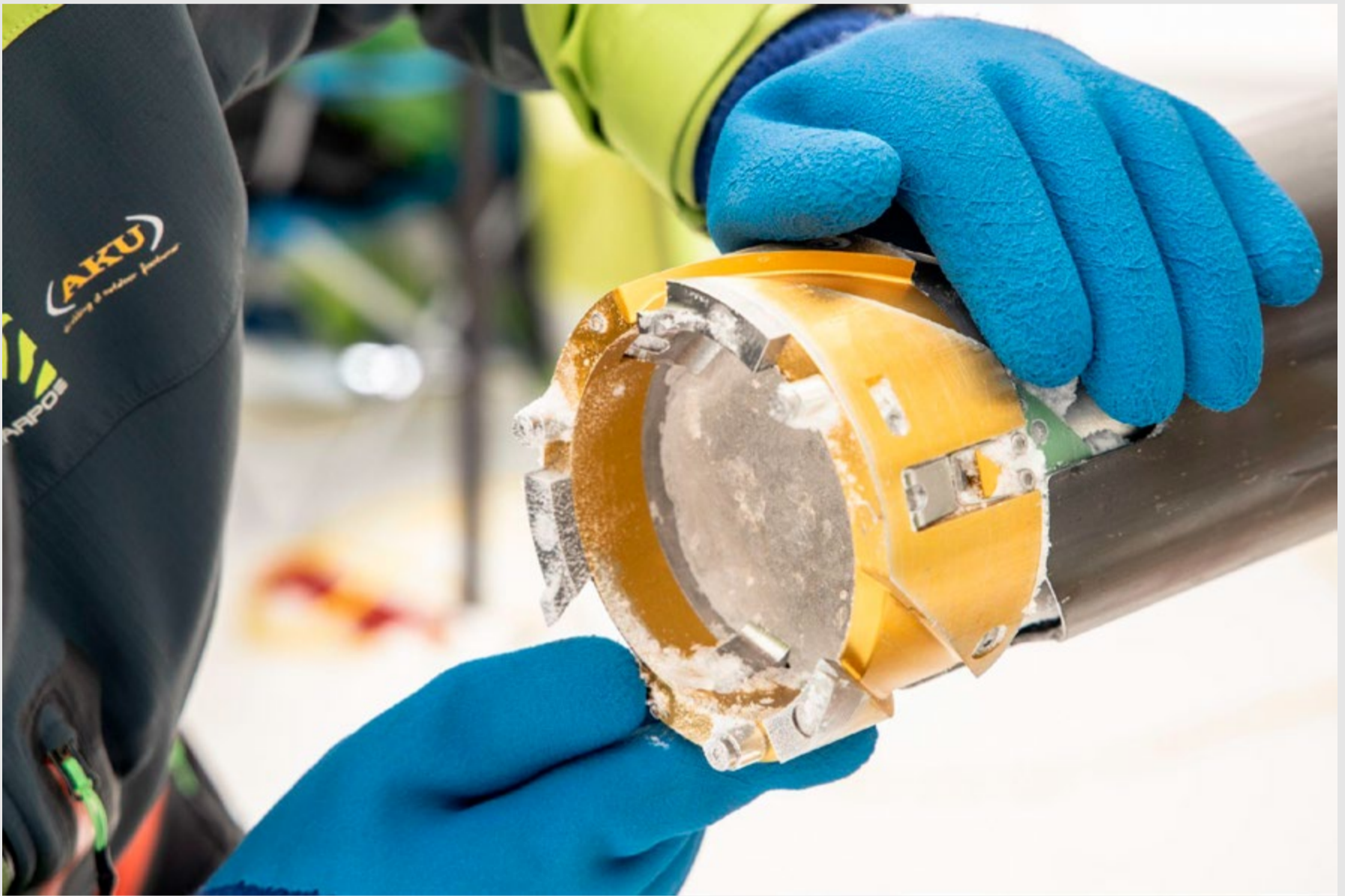
Despite challenges from an unexpected aquifer in the glacier and extreme weather, an international team of scientists successfully extracted three ice cores (10 cm in diameter) from the Holtedahlfonna glacier in Svalbard in April 2023. This success enables the analysis and preservation of a valuable Arctic climate archive.

The team worked for 23 days at a remote camp 1,150 meters high and 80 km from the Ny-Ålesund research station. The mission was led by the Institute of Polar Sciences of the National Research Council, with scientists from the French National Centre for Scientific Research (CNRS), the Norwegian Polar Institute (NPI), Ca' Foscari University of Venice, and the University of Perugia.

MONTE ROSA

Colle del Lys (October 2023)

photo by Riccardo Selvatico



In October 2023, an Italian scientific team worked at 4,155 meters on the Colle del Lys glacier in the Monte Rosa massif, successfully extracting two deep ice cores over 100 meters deep.

This mission, coordinated by the Institute of Polar Sciences of the National Research Council (CNR-ISP), involved collaboration with Ca' Foscari University of Venice, the CNR's Institute of Clinical Physiology, the National Institute of Geophysics and Volcanology, the Autonomous Region of Valle d'Aosta, Fondazione Montagna Sicura, the Municipality of Gressoney-La-Trinité, Forte di Bard, and the Alpine Rescue Stations of the Guardia di Finanza of Cervinia and Alagna.

This significant effort will allow future scientists to study the climatic and environmental history of Monte Rosa, even after the glacier's disappearance due to climate change.

MONTE ROSA

Colle Gnifetti (June 2021)

photo by Riccardo Selvatico



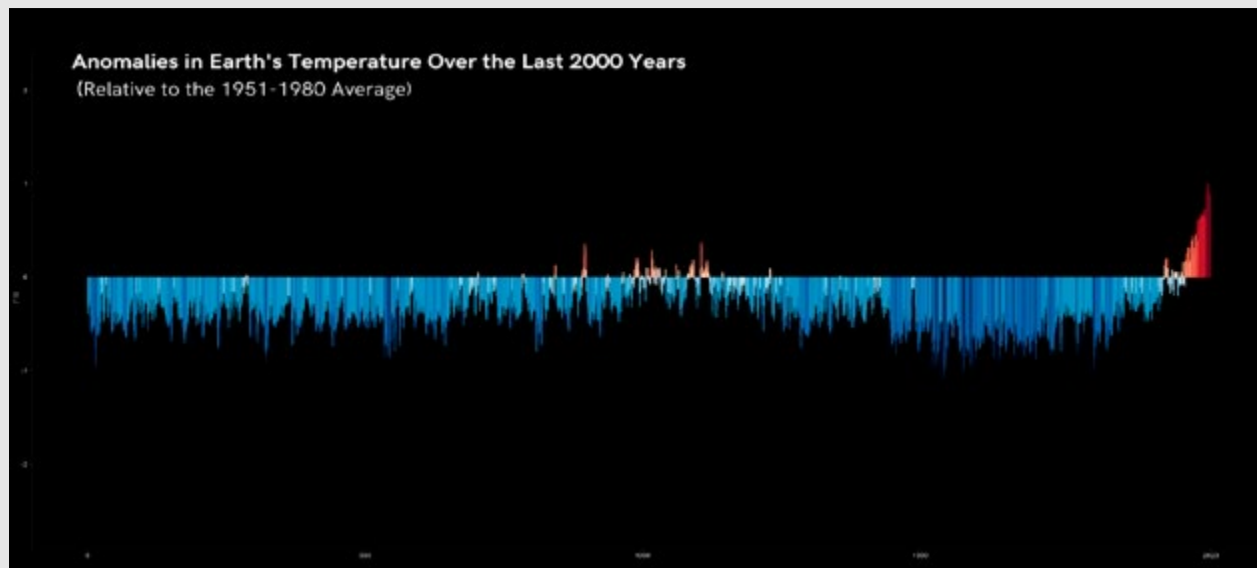
GOOD NIGHT, GLACIERS

24

The Ice Memory project's mission on Monte Rosa was successful, with scientists working on the Gorner Glacier at 4,468 meters altitude for five days. They extracted two surface ice cores and two deeper cores over 82 meters deep. The deepest sample, close to the rock layer, might contain climate and environmental information dating back 10,000 years. If confirmed, this would mean the oldest ice from the Alpine arch is preserved in Antarctica.

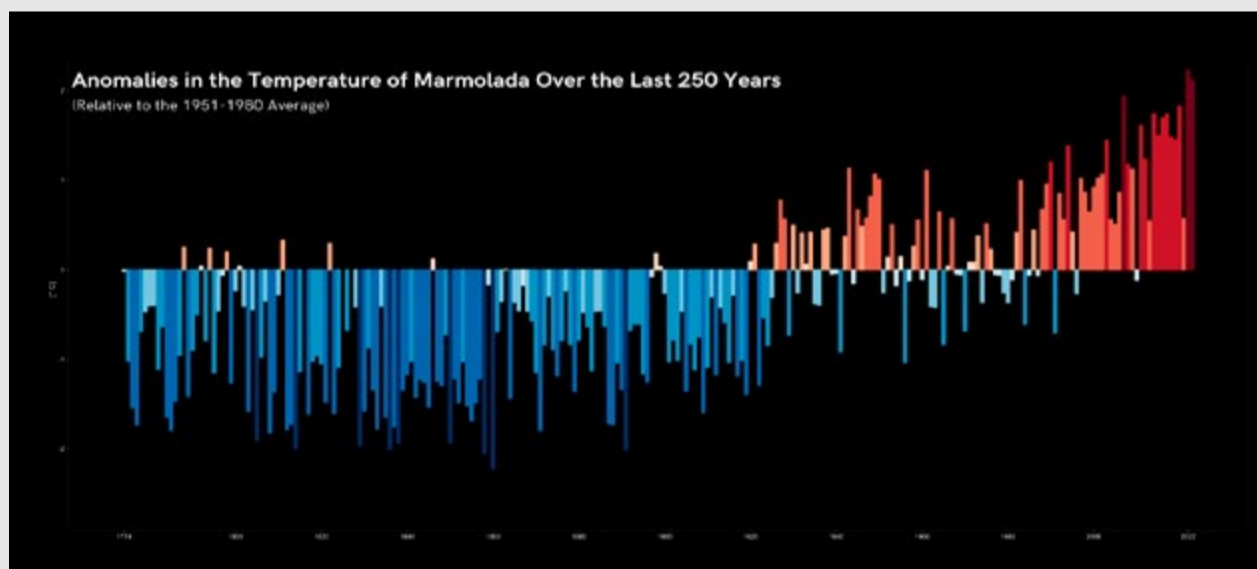
The mission was organized by the Institute of Polar Sciences of the National Research Council and Ca' Foscari University of Venice, in collaboration with the Swiss research center Paul Scherrer Institut. Throughout the mission, scientists stayed at Capanna Margherita, Europe's highest refuge, built 134 years ago to support scientific research in physiology, climatology, and environmental sciences. The photo shows the refuge on the left and the drilling site on the right.

HOT SPOT



The chart was created by researcher Matteo Zucchetta (CNR-ISP) using data extracted from NASA datasets and the publication Moberg, A., Sonechkin, D., Holmgren, K., et al. (*Nature* 433, 2005).

Understanding climate evolution in the past is crucial, as effectively demonstrated by this reconstruction of temperatures over the last 2000 years. The colored bars indicate how much the average global temperature of each year deviates from a reference period (1951-1980). Cool colors represent pre-Industrial Revolution conditions with significantly lower temperatures. Then, a shift occurs due to human-caused emissions, leading to a spike in temperatures and anomalies towards warmth, indicated by shades of red.

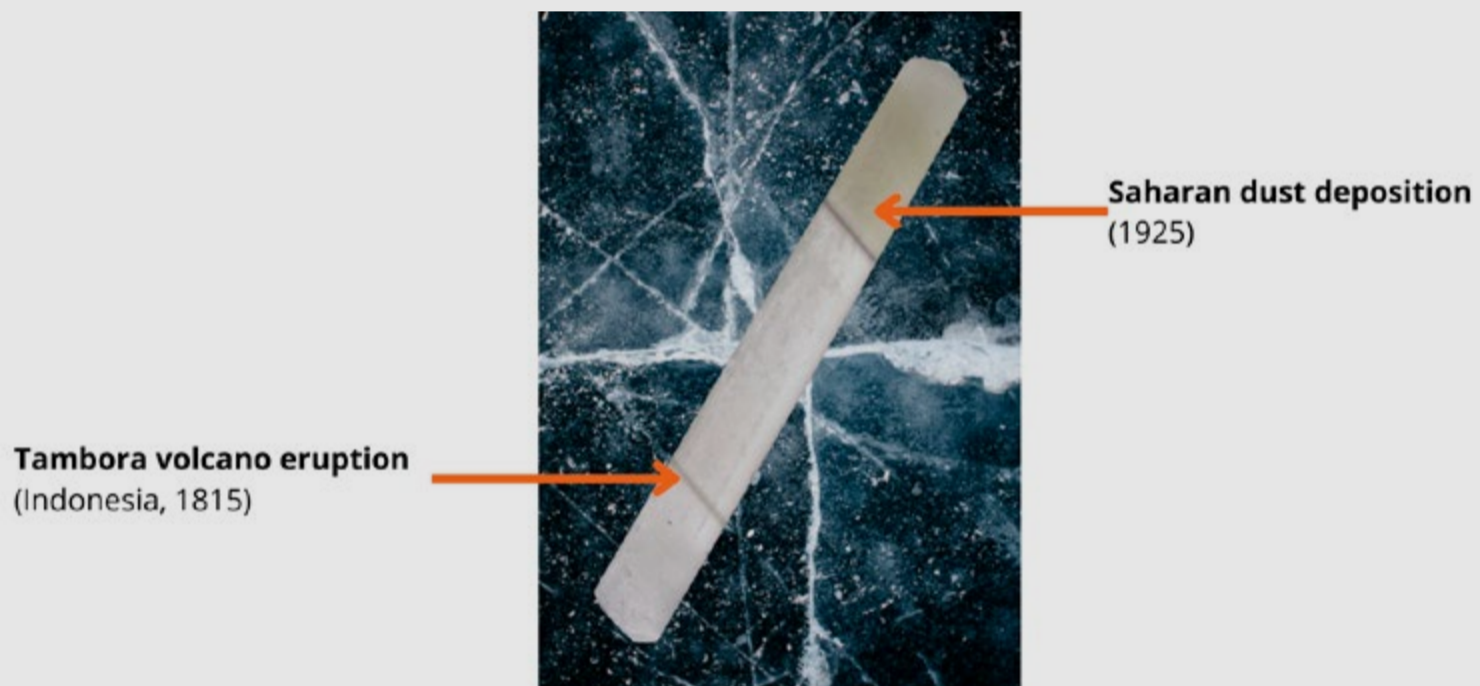


Temperature anomaly data for Marmolada was processed by CNR-ISP researchers using temperature datasets at Punta Penia elevation, calculated by Michele Brunetti from CNR-ISAC (https://www.isac.cnr.it/climstor/climate_news.html, https://www.isac.cnr.it/clim-stor/DPC/climate_news.html).

This graph, in the same manner as the previous one, shows temperature anomalies at Punta Penia (3,343 m above sea level) on Marmolada over the last 250 years. The findings are startling: the Dolomites are experiencing a temperature increase twice the local average. The Alps are considered a climate 'hot spot,' where climate change impacts are significantly more pronounced than global averages. This leads to inevitable consequences for the accelerating and seemingly irreversible change affecting Marmolada.

LIKE PAGES OF AN ANCIENT BOOK

Glaciers preserve our memory like pages of an ancient book, with layers of compressed snow holding valuable information. To understand our past, we analyze ancient ice samples from the glacier's deepest layers. Ice Memory project researchers extract vertical ice cores for future analysis with more advanced technologies.



In ice cores, we read the history of humanity, its relationship with the mountains, mining activities, and industry. Within each core, we find ourselves and our ancestors. The core displayed in the exhibition was extracted from the Gorner Glacier on the Colle Gnifetti of the Monte Rosa massif at 4,468 meters in June 2021. The sample was taken from a depth of 37 meters, and it is estimated that the ice contains information about the climate and environment dating back to around 1936.

To learn more about Ice Memory missions in the Alps and Svalbard from 2020 to the present, visit icememory.it (ITA).

The future is in our hands. Today **#SaveMarmoladaMemory**

Our environmental impact is closely linked to the health of glaciers. Every ton of greenhouse gas emissions increases global warming, threatening entire ecosystems and causing glaciers to melt. But there is hope in daily action. For example, we can reduce plastic use, prioritize sustainable transportation, save energy, choose local products, and practice the three Rs (reduce, reuse, recycle). These simple actions can have a tremendous impact, but they must go hand in hand with drastic reduction and mitigation policies to be implemented TODAY.

In this regard, the outcome of COP28, which finally recognizes the need to address fossil fuels, is unexpected and positive, but still too weak. Policymakers have agreed to promote a 'transition' from fossil fuels when what was needed was their abandonment. There is still a long way to go, but we have the power (and now the duty) to act. Our future depends on how we collectively face this challenge. Endangered glaciers require immediate action. Let's take responsibility and act today to preserve these natural monuments and protect our planet for future generations.

Share a picture of you in the exhibition on social media and add
#SaveMarmoladaMemory

THE STARS WATCH OVER

text by Erica Villa

Down deep below, beneath my feet,
the ancient ice whispers memories sweet,
concealing secrets, suspended tales...

It starts from here, in darkest night,
stars watch over, aware of our plight,
that metallic finger strides through time,
extracts mysteries, fragments of prime.

Traces remain silent in the ice's grip,
telling the chemistry of ages' far trip,
scribed by frost on silent pages,
with tales of a climate, time engages.

The sounds I hear from the winds do flow,
ice crackles, incessant snow,
our thoughts, the cold, that distant echo of events,
the sand, the desert, or perhaps a volcano's vents!

One day in the future, knowledge unsealed,
shall reveal the secrets, long concealed,
our ice cores will speak and convey
ancient and recent tales, choices we shall make.

REFERENCES

Geographic and topographic information on glacier bodies is taken from the international RGI and GLIMS catalogues:

a) RGI Consortium, (2017). Randolph Glacier Inventory - A Dataset of Global Glacier Outlines, Version 6 [Data Set]. Boulder, Colorado USA. National Snow and Ice Data Center. <https://doi.org/10.7265/4m1f-gd79>. b) GLIMS Consortium, 2005. GLIMS Glacier Database, Version 1. Boulder, Colorado, USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. DOI: <http://dx.doi.org/10.7265/N5V98602>.

Percentage volume reductions to 2100:

Zekollari, H., Huss, M., & Farinotti, D. (2019). Modelling the future evolution of glaciers in the European Alps under the EURO-CORDEX RCM ensemble. *Cryosphere*, 13(4), 1125-1146. <https://doi.org/10.5194/tc-13-1125-2019>.

Glacial extent relative to the year 1959:

Carturan, L., Baroni, C., Carton, A., Cazorzi, F., Dalla Fontana, G., Delpero C., Salvatore M.C., Seppi, R., Zanoner, T., (2014). Reconstructing fluctuations of la mare glacier (eastern Italian Alps) in the late Holocene: new evidence for a little ice age maximum around 1600 AD.

Glacial extensions for the years 1850 and 2003:

<https://siat.provincia.tn.it/geonetwork/srv/ita/catalog.search#/home>

Background satellite images:

Google Earth, Image Landsat/Copernicus Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Annual mean temperature anomalies (December - November) calculated on the Marmolada glacier at Punta Penia (3,343 m a.s.l.):

https://www.isac.cnr.it/climstor/climate_news.html, https://www.isac.cnr.it/climstor/DPC/climate_news.html.

Global annual mean temperature anomalies (January - December) from year 0 to 1979:

Moberg, A., Sonechkin, D., Holmgren, K. et al. (2005). Highly variable Northern Hemisphere temperatures reconstructed from low- and high-resolution proxy data. *Nature* 433, 613-617. <https://doi.org/10.1038/nature03265>.

Global annual mean temperature anomalies (January - December) from 1880 to 2022:

https://data.giss.nasa.gov/gistemp/tabledata_v4/GLB.Ts+dSST.txt

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Erica Villa - curatrice arte e scienza

fotografia e video / photography and video / Fotografie und Video

Riccardo Selvatico - Areaphoto Image&Communication

suono del ghiacciaio (Morteratsch) che fonde / sound of a melting glacier (Morteratsch) / Geräusch des schmelzenden Gletschers (Morteratsch)

Ludwig Berger - landscape sound artist

relazioni istituzionali / institutional relations / institutionelle Beziehungen

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UQIDO

Do you have questions
about core missions or
glaciers or want to share your
impressions of the exhibition?

Write to icememory@unive.it