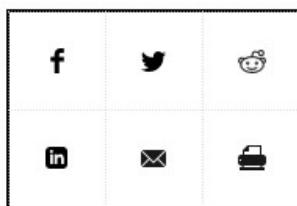


Organisms from the Ice? As Earth Warms, the Diseases That May Lie within Permafrost Become a Bigger Worry

Scientists are witnessing the theoretical turning into reality: infectious microbes emerging from a deep freeze

November 1, 2016 [Véalo en español](#)



This past summer anthrax killed a 12-year-old boy in a remote part of

ANTHROPOLOGY

Mammoths Roamed when Humans Started Using Tobacco at Least 12,300 Years Ago

Rachel Nuwer

ASTRONOMY

'Auroral' Exoplanets Could Help Boost Searches for Alien Life

Nola Taylor Tillman

MEDICINE

A Strategy for Rescheduling Psilocybin

Mason Marks | Opinion

ANIMALS

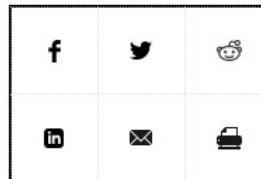
Save the Right Whales by Cutting through the Wrong Noise

CLIMATE CHANGE | OPINION

Deep Frozen Arctic Microbes Are Waking Up

Thawing permafrost is releasing microorganisms, with consequences that are still largely unknown

By Kimberley R. Miner, Arwyn Edwards, Charles Miller on November 20, 2020



Thermokarst, Russia. Credit: Alamy

In August 2019, Iceland held a funeral for the Okjökull Glacier, the first Icelandic glacier lost to climate change. The community commemorated the

PLANETARY SCIENCE

Meteorite Crashes into Woman's Bed in Canada

Mindy Weisberger and LiveScience

RENEWABLE ENERGY

How to Build an Offshore Wind Farm

Benjamin Storrow and E&E News

ARTS

Beethoven's Unfinished 10th Symphony Brought to Life by Artificial Intelligence

Teresa Carey

COGNITION

People Who Jump to Conclusions Show Other Kinds of Thinking Errors

Carmen Sanchez and David Dunning

μ organismi dal ghiaccio? NATURE | NEWS

Giant virus resurrected from 30,000-year-old ice

Largest virus yet discovered hints at viral diversity trapped in permafrost.

Ed Yong

03 March 2014



Julia Bartoli & Chantal Abergel; Information Génomique et Structurale, CNRS-AMU

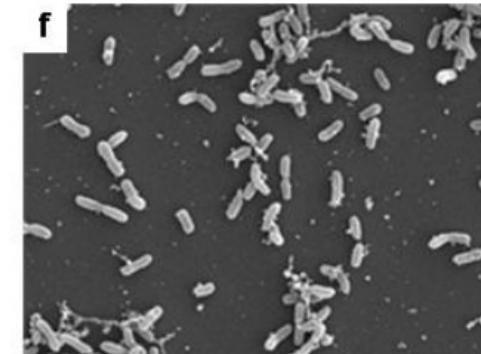
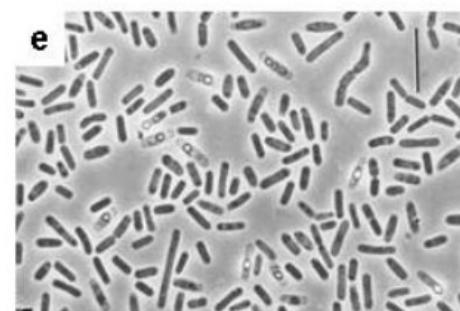
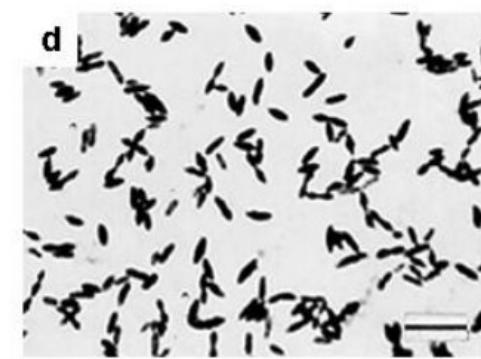
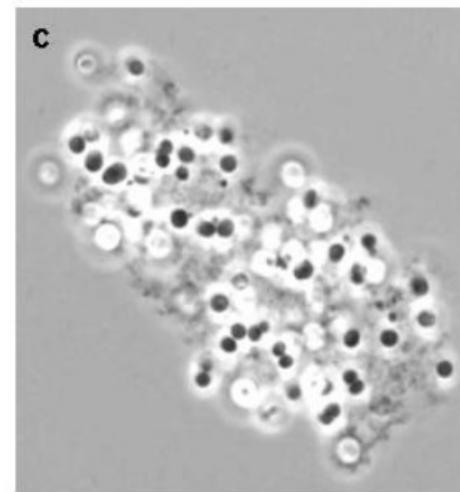
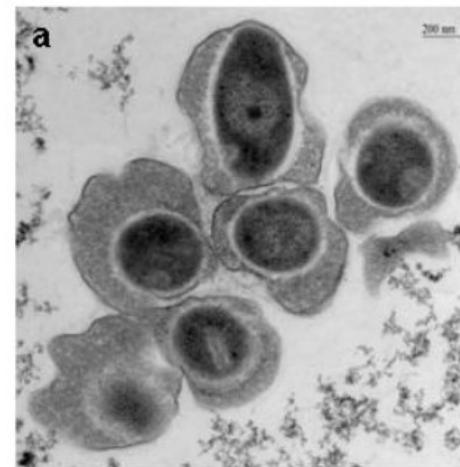
Larger than some bacteria, this virus — seen in a cross-section under a transmission electron microscope — was still able to infect amoebae despite having spent 30 millennia in a frozen state.

Microorganismi dal ghiaccio?

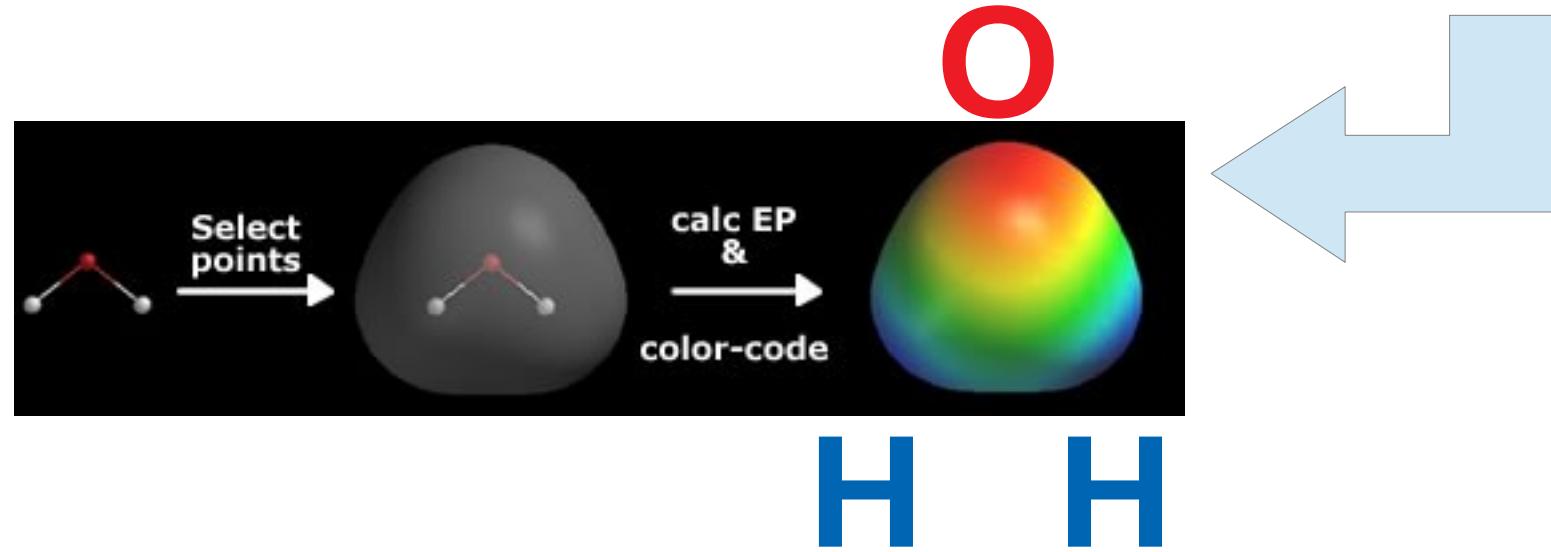
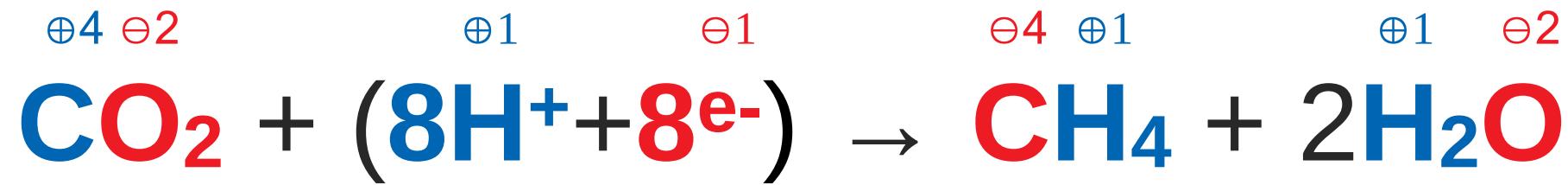
Più che i potenziali patogeni, sono gli Archaea metanigeni a destare le maggiori preoccupazioni...

Selected microorganisms (Archaea) isolated from different permafrost environments:

- a. *Candidatus Nitrotoga arctica*;
- b. *Methylobacter tundripaludum*;
- c. *Methanosarcina* sp.;
- d. *Acetobacterium tundrae*;
- e. *Clostridium algoriphilum*.



Metanogenesi batterica

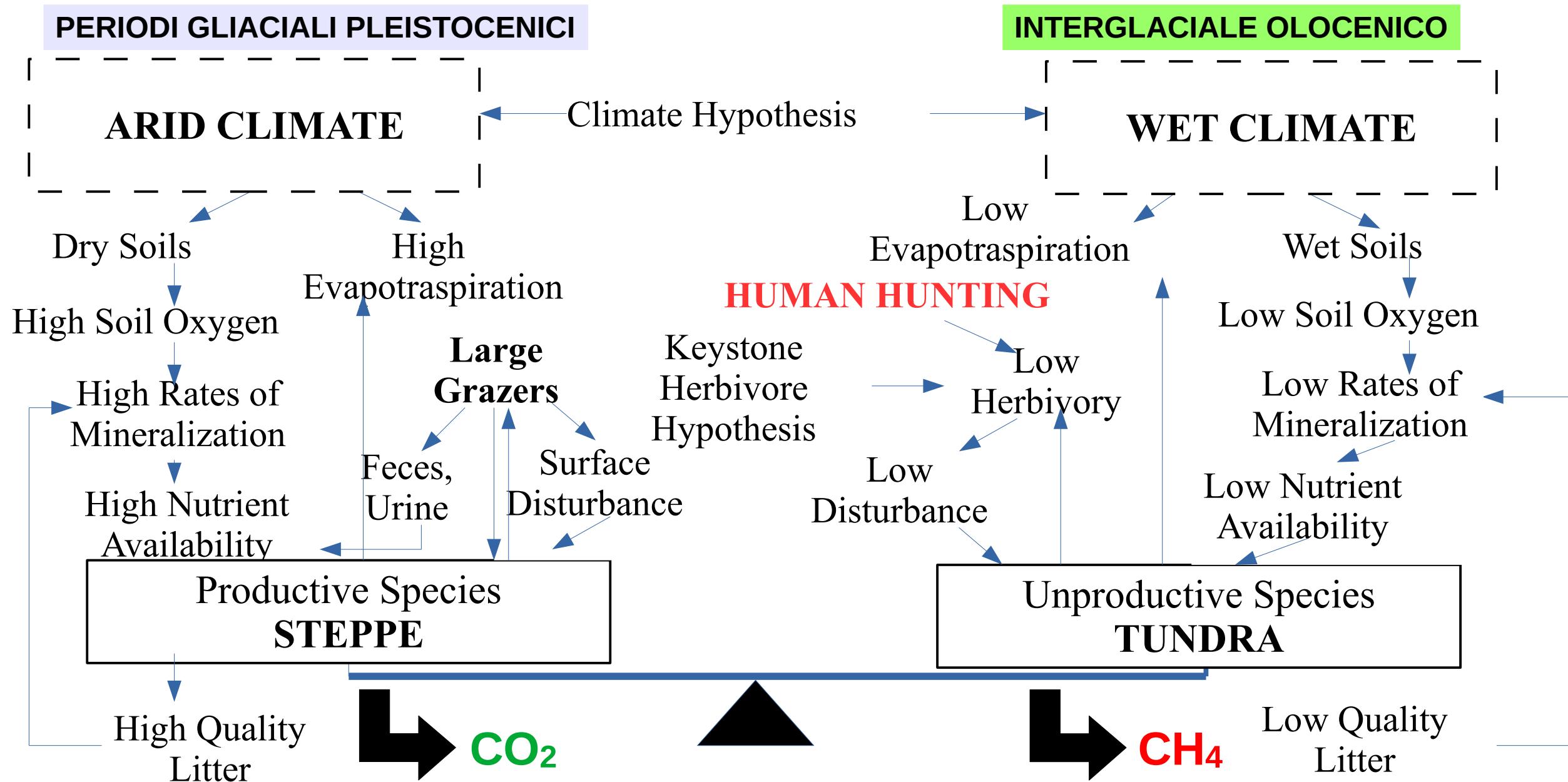


Mappa del potenziale elettrico [quantità di energia necessaria per spostare una unità di carica (1 Coulomb) da un punto ad un altro] di una molecola d'acqua, in cui l'**atomo di ossigeno** ha una carica più negativa rispetto agli **atomi di idrogeno** (positivi).

Metanogenesi batterica



Steppa o tundra?

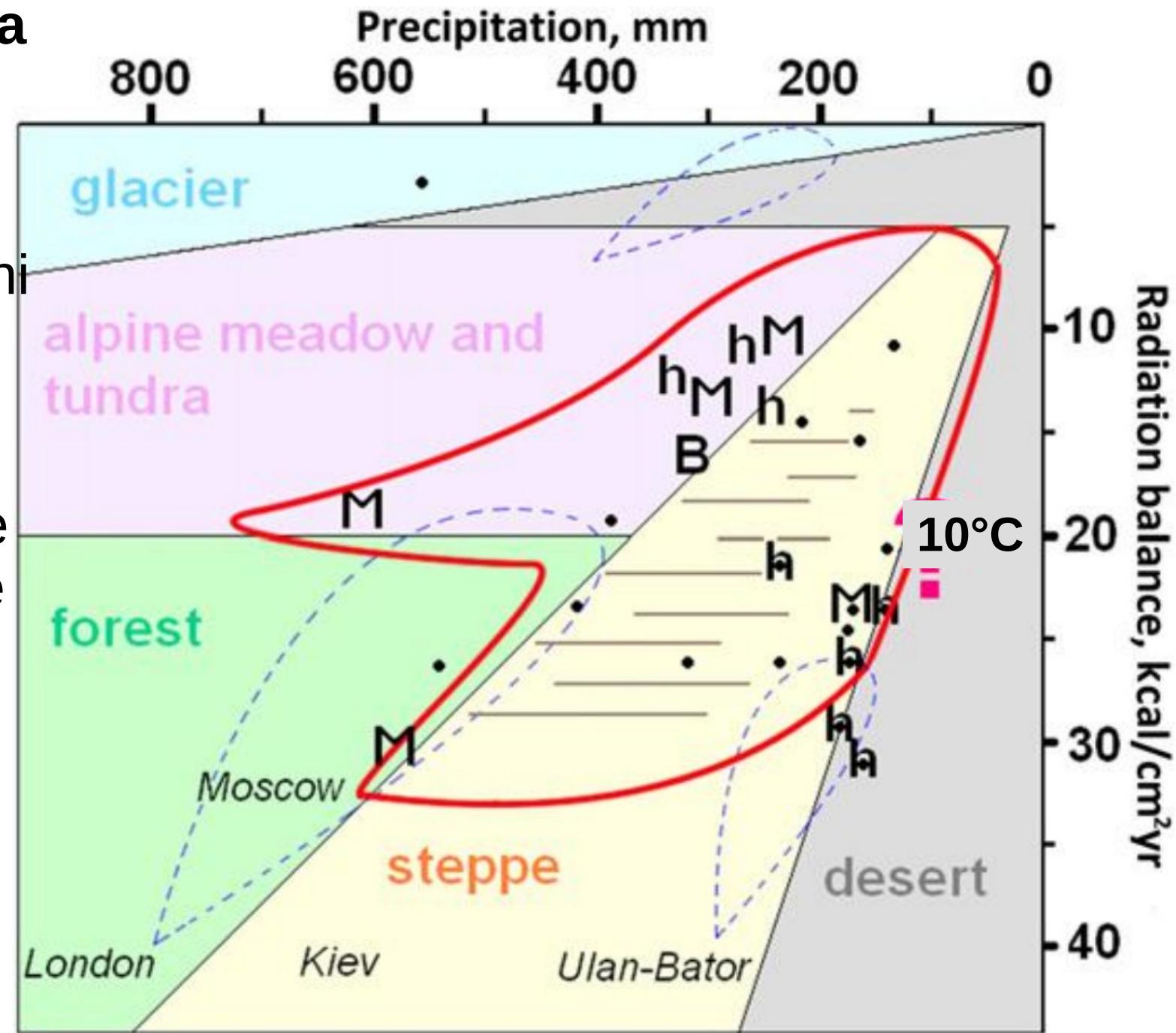


La necromassa



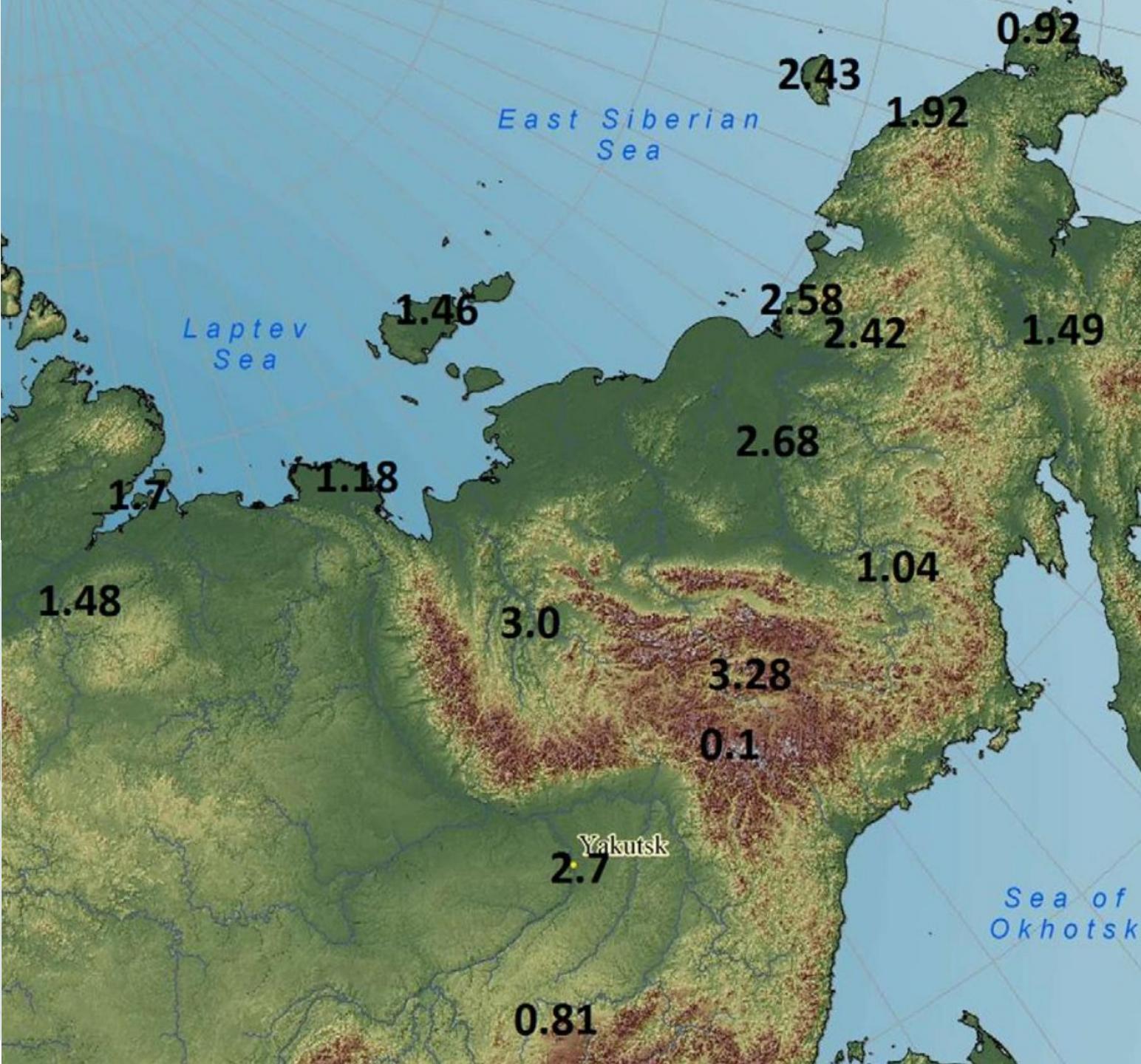
Il clima attuale della Siberia orientale è umido o arido?

- Aumento delle precipitazioni compensato dall'aumento delle temperature estive
- La forte evapotraspirazione mantiene il suolo asciutto e ben aerato



Budyko's Radiation Aridity Index (RAI)

- RAI < 1:** the climate is humid
- RAI > 1:** the climate is arid
- 1 ≤ RAI ≤ 2:** steppe
- 2 ≤ RAI ≤ 3:** semi-desert
- RAI > 3:** desert environments



Il Parco del Pleistocene

Progetto di **biomanipolazione** mirato a:

- spostare il funzionamento dell'ecosistema artico dalla produzione di CH₄ (metanogenesi) alla produzione di CO₂
- ridurre la fusione del permafrost (?) attraverso l'aumento della quantità di energia solare assorbita dall'erba mediante la fotosintesi e dal suolo mediante l'evaporazione

Ecosystem Hypothesis

The mammoth ecosystem was relatively insensitive to climatic variation: numerous animals maintained highly productive grasslands over a wide range of climates. Under such a strong disturbance regime, mosses and shrubs were trampled, and highly productive actively transpiring graminoids and herbs dominated.

During the **Pleistocene-Holocene Transition (PHT)** the rise in precipitation was accompanied by increased temperature, so climatic aridity did not change substantially.

Ecosystem Hypothesis

These, in turn, would have altered the competitive balance among species, promoting the growth of mosses and shrubs and reducing the abundance of grasses. The net effect would be a decline in forage quantity and quality, leading to continued decline in animal numbers.

An important implication of the Ecosystem Hypothesis is that **the grassland ecosystem could be regenerated in the north if one could increase the density and diversity of animals.**

La tundra



Ecosystem Hypothesis

During the deglaciation, warming created more favorable conditions for human survival in the north. As a consequence of strong hunting pressures, **the density of animals became insufficient for grassland maintenance.** The resulting decline in abundance of animals would have reduced forage consumption, causing an accumulation of surface leaf litter, insulating the soil, and reducing summer soil temperatures. This would have initiated a cascade of other ecosystem changes, including a **decline in productivity and transpiration**, **wetter soils**, and lower nutrient availability.

Ecosystem Hypothesis

Mammoth Steppe (MS) soils have been preserved in the permafrost of Siberia and Alaska (locally called “yedoma”).

MS soils are the largest reservoir of organic carbon in the past and at present. **If this permafrost thaws in the future, this reservoir will be a strong source of greenhouse gases**, and modern ecosystems covering the yedoma will be disrupted by erosion.

Therefore, the possibility exists for reintroducing herbivores and for a revival of ecosystems similar to MS that could slow permafrost degradation and mitigate global warming.

La steppa-tundra alpina



Il DNA delle specie estinte (DNA antico)

In May 2007, Nenets reindeer herders traveling northward on their annual migratory cycle discovered the frozen body of a female woolly mammoth (*Mammuthus primigenius*) calf exposed on a point bar along the Yuribei River, on the Yamal Peninsula, northwest Siberia. This specimen was reposed in the Shemanovskiy Museum and Exhibition Center in Salekhard, administrative center of the Yamalo-Nenets Autonomous Okrug. Recognizing the importance of the specimen, museum officials conferred on it the name Lyuba, honoring the wife of the Nenets reindeer herder, Yuri Khudi, who reported her.

Lyuba is essentially complete and in better overall condition than any previously recovered mammoth remains.



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Article | [Open access](#) | Published: 14 November 2024

Mummy of a juvenile sabre-toothed cat *Homotherium latidens* from the Upper Pleistocene of Siberia

[A. V. Lopatin](#) , [M. V. Sotnikova](#), [A. I. Klimovsky](#), [A. V. Lavrov](#), [A. V. Protopopov](#), [D. O. Gimranov](#) & [E. V. Parkhomchuk](#)

[Scientific Reports](#) **14**, Article number: 28016 (2024) | [Cite this article](#)

343k Accesses | **1** Citations | **4234** Altmetric | [Metrics](#)

Abstract

Il DNA delle specie estinte (DNA antico)

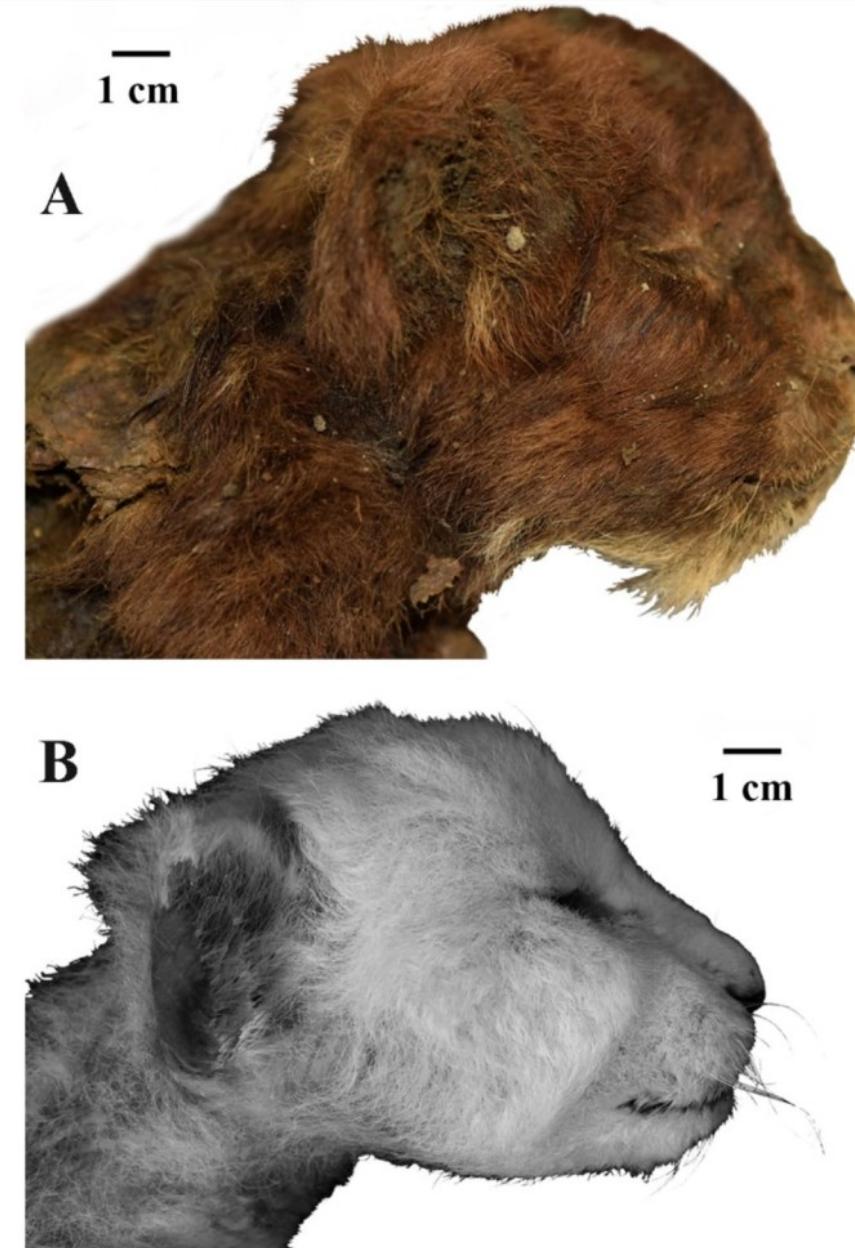


Fig. 2. External appearance of three-week-old heads of large felid cubs, right lateral view: (A) *Homotherium latidens* (Owen, 1846), specimen DMF AS RS, no. Met-20-1, frozen mummy, Russia, Republic of Sakha (Yakutia), Indigirka River basin, Badyarikha River; Upper Pleistocene; (B) *Panthera leo* (Linnaeus, 1758), specimen ZMMU, no. S-210286; Recent.

Nobel Prize Awarded to Scientist Who Sequenced Neanderthal Genome

Svante Pääbo, a Swedish geneticist, was honored for work that created a new field of ancient DNA studies and identified populations at higher risk of disease.

 Share full article



 74

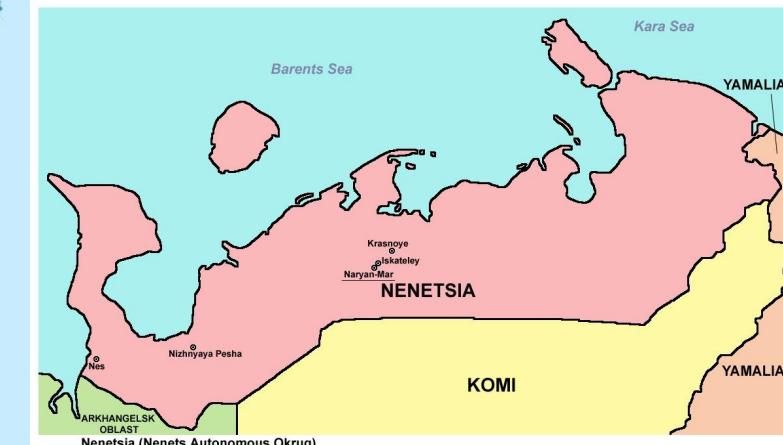


I Nenets



I Nenets

Nenets Autonomous Okrug is a federal subject of Russia (an autonomous okrug of Arkhangelsk Oblast). It has an area of 176,700 square kilometers and a population of 42,090 as of the 2010 Census (the smallest of all federal subjects by population).



Come clonare un mammut

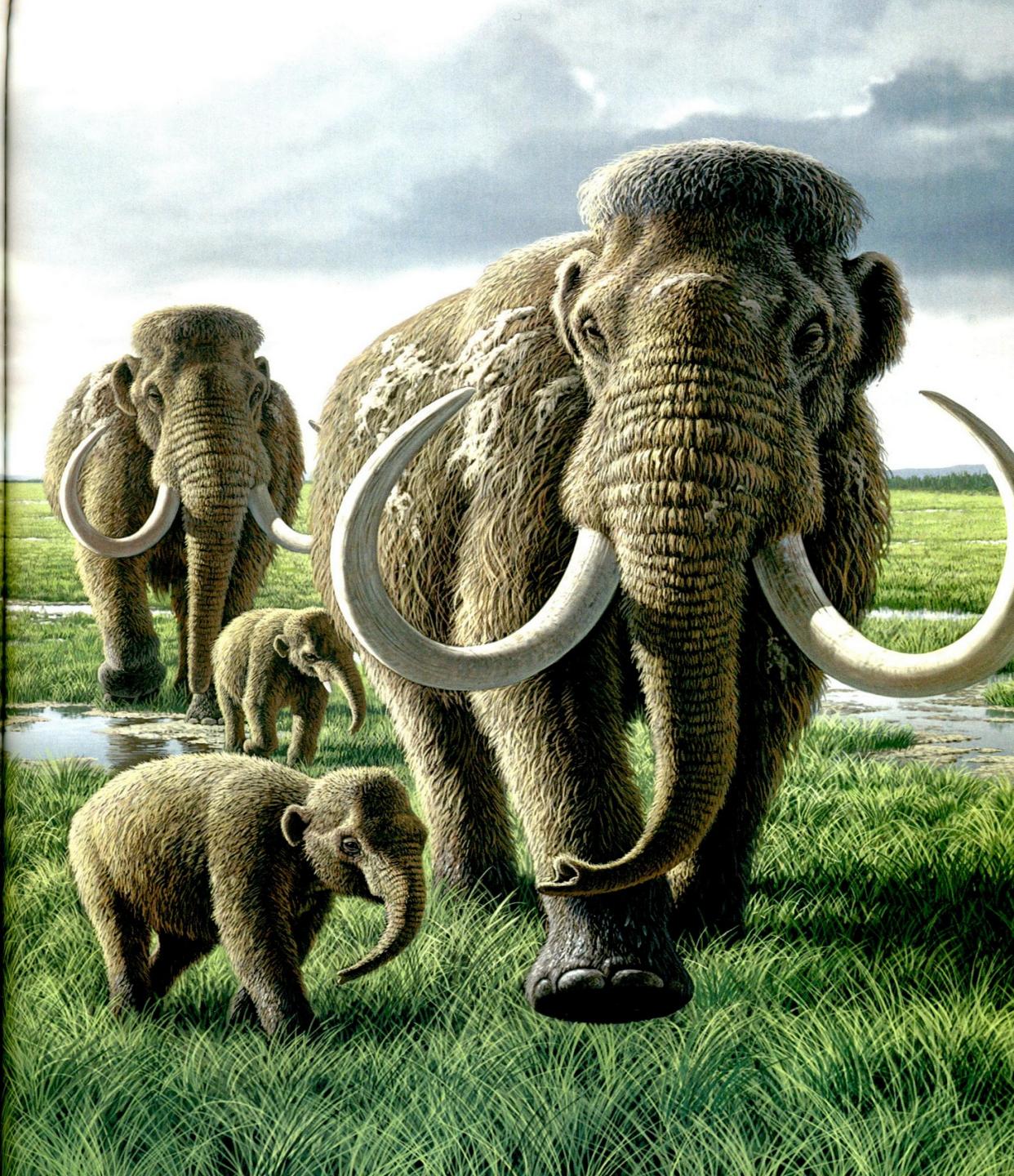
How to clone a mammoth



RINASCITA RUSSA

Cosa faremmo dei mammut se riuscissimo a clonarli? Ecco l'idea di Sergej Zimov: lasciamoli in libertà nel parco del Pleistocene, la riserva naturale che ha creato nella Siberia orientale nel 1996. Zimov sostiene che i mammut e gli altri grandi erbivori dell'Era Glaciale erano cruciali per le steppe siberiane dove vivevano: mangiavano l'erba, ma fertilizzavano il suolo e lo aravano con le zampe. Cavalli, bisoni e altri erbivori introdotti nel parco stanno già trasformando la tundra dominata dai muschi nella distesa erbosa in cui vivevano i mammut.

Il Parco del Pleistocene



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Il Parco del Pleistocene



Il Parco del Pleistocene



Il Parco del Pleistocene



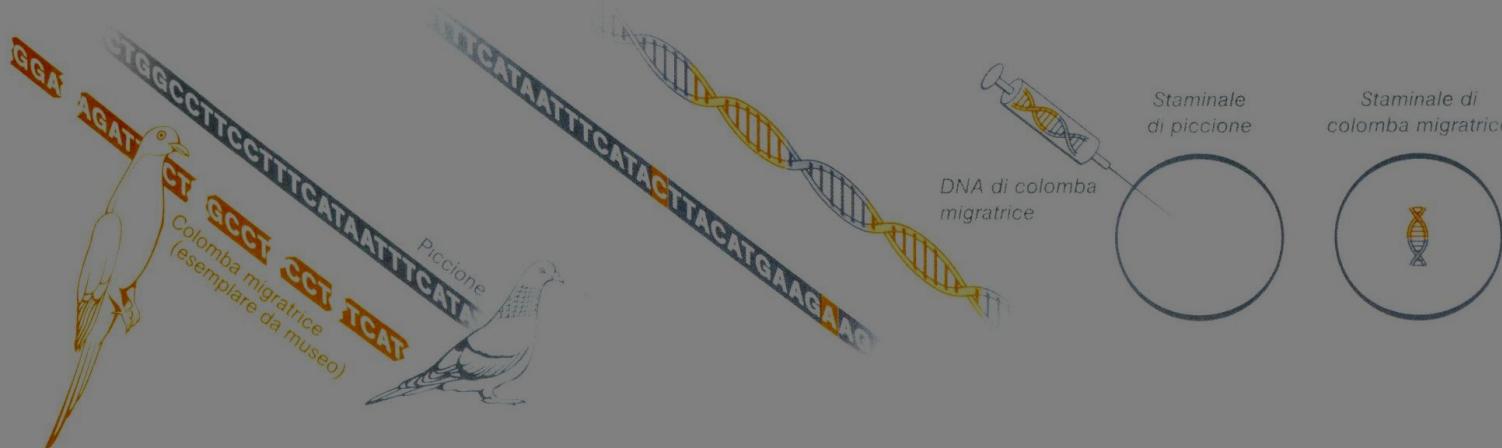
Il Parco del Pleistocene



Come resuscitare una specie estinta

LA RICETTA PER LA RISURREZIONE

È possibile riportare in vita la colomba migratrice, estinta a causa della caccia, servendosi di esemplari da museo? Secondo il genetista George Church della Harvard University sì. Basta trasferire i geni fondamentali della specie in un parente vivente.



1 Ricavare il genoma di una colomba migratrice dai frammenti di DNA degli esemplari da museo. Confrontarlo con quello del piccione, il cugino vivente.

2 Identificare e sintetizzare le mutazioni distintive della colomba, quelle che le danno petto rosso, coda più lunga e altri tratti fondamentali.

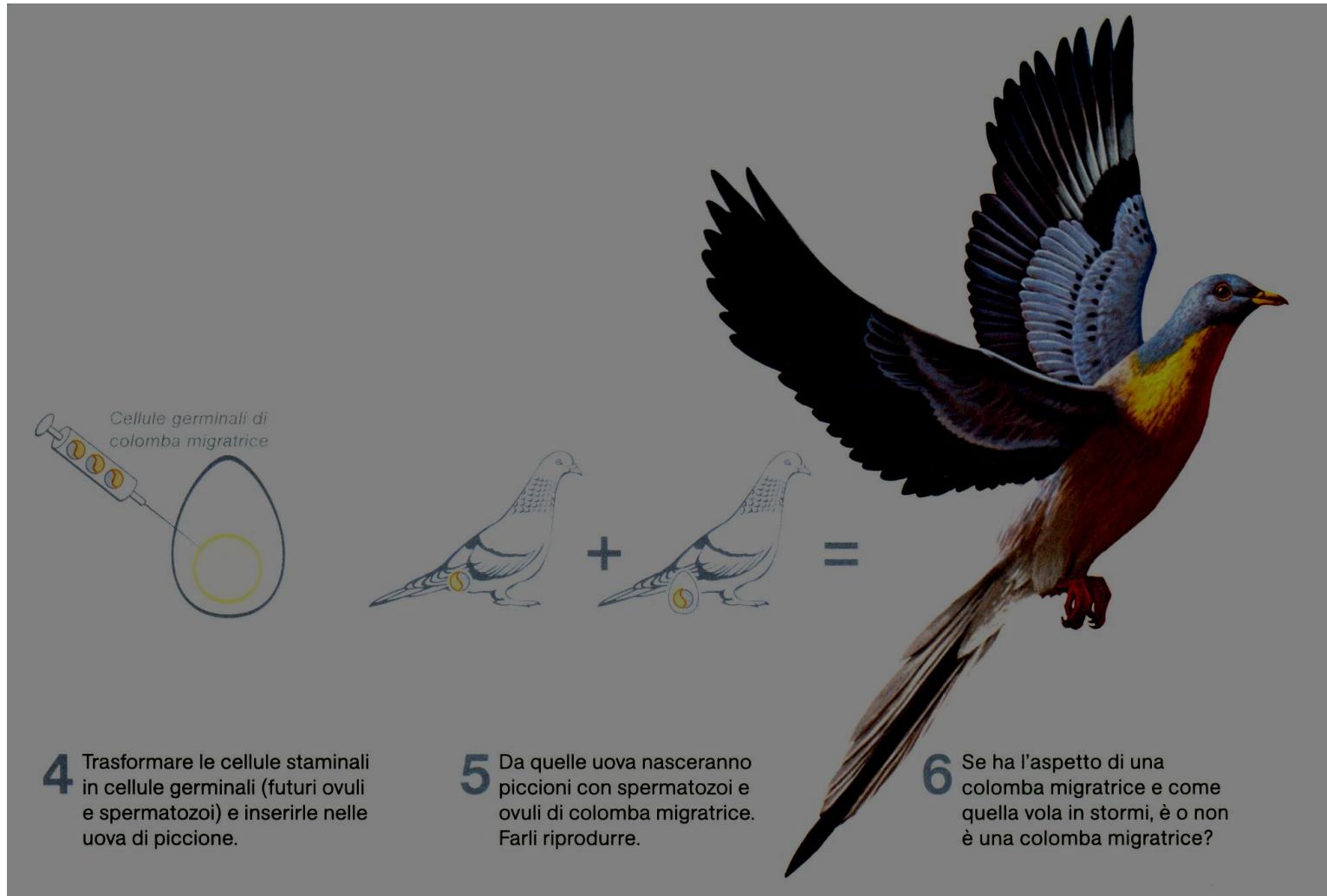
3 Scambiare quei pezzi di DNA con quelli corrispondenti nelle cellule staminali del piccione, creando cellule staminali di colomba migratrice.



COLOMBA MIGRATRICE
Ectopistes migratorius

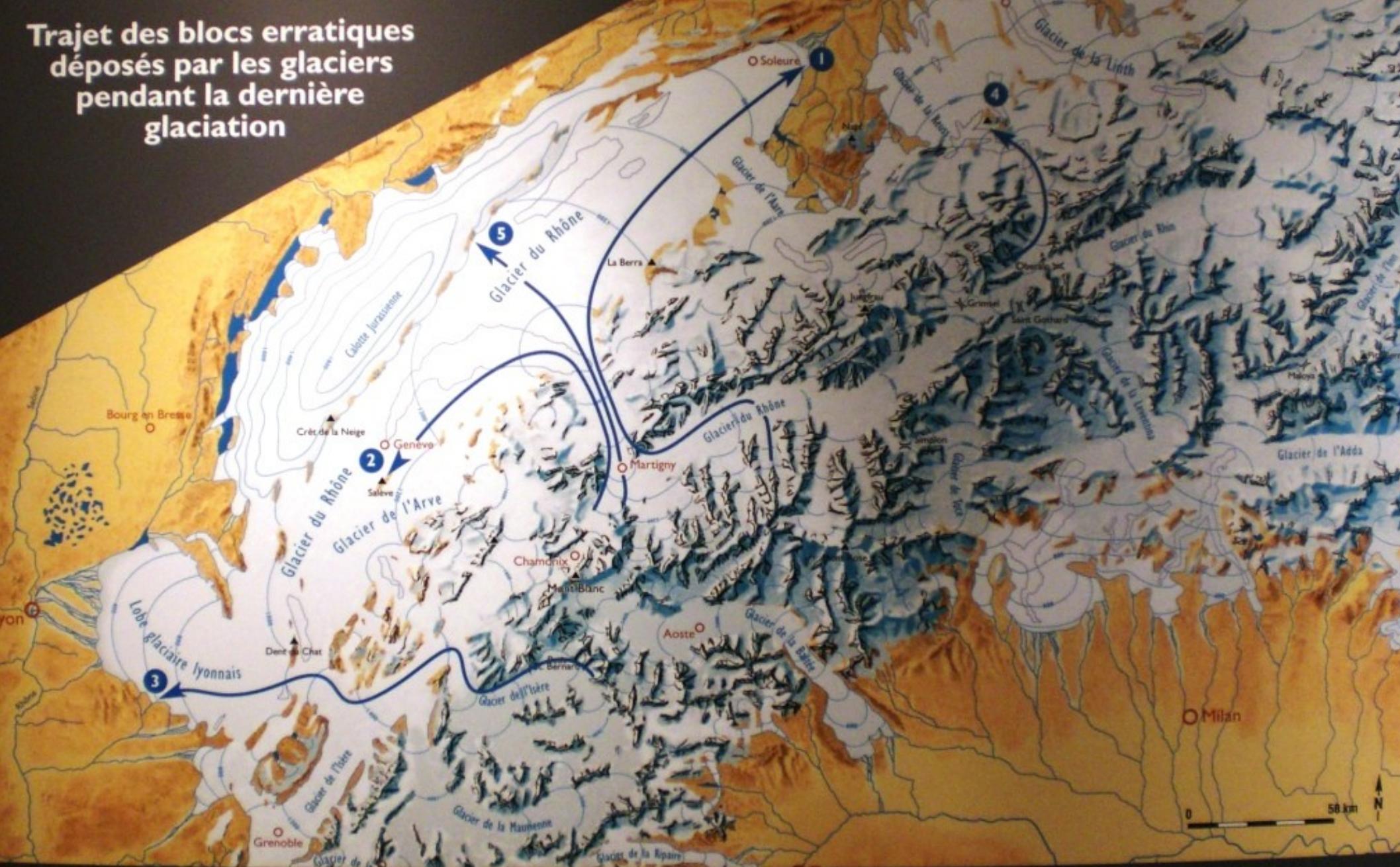
Un tempo questo uccello affollava i cieli dell'America nordorientale. Martha, l'ultimo esemplare (nella foto), morì nello zoo di Cincinnati nel 1914. I genetisti ora pensano di poter resuscitare la specie.

Come resuscitare una specie estinta



Le Alpi 20 Kya...

Trajet des blocs erratiques déposés par les glaciers pendant la dernière glaciation



Véritable empreinte digitale du passage des glaciers, les blocs erratiques découverts jusqu'à la périphérie des Alpes permettent de reconstituer les flux glaciaires. En effet leur composition nous informe avec précision de la provenance des glaces. Ainsi les blocs de greiss du Steinhof 1 proviennent du Valais, les blocs de granite du Mont Blanc et du Gothard abandonnés respectivement sur les flancs du Jura 5 et du Rigi 4 démontrent l'origine des flux glaciaires depuis ces deux massifs granitiques.

E oggi

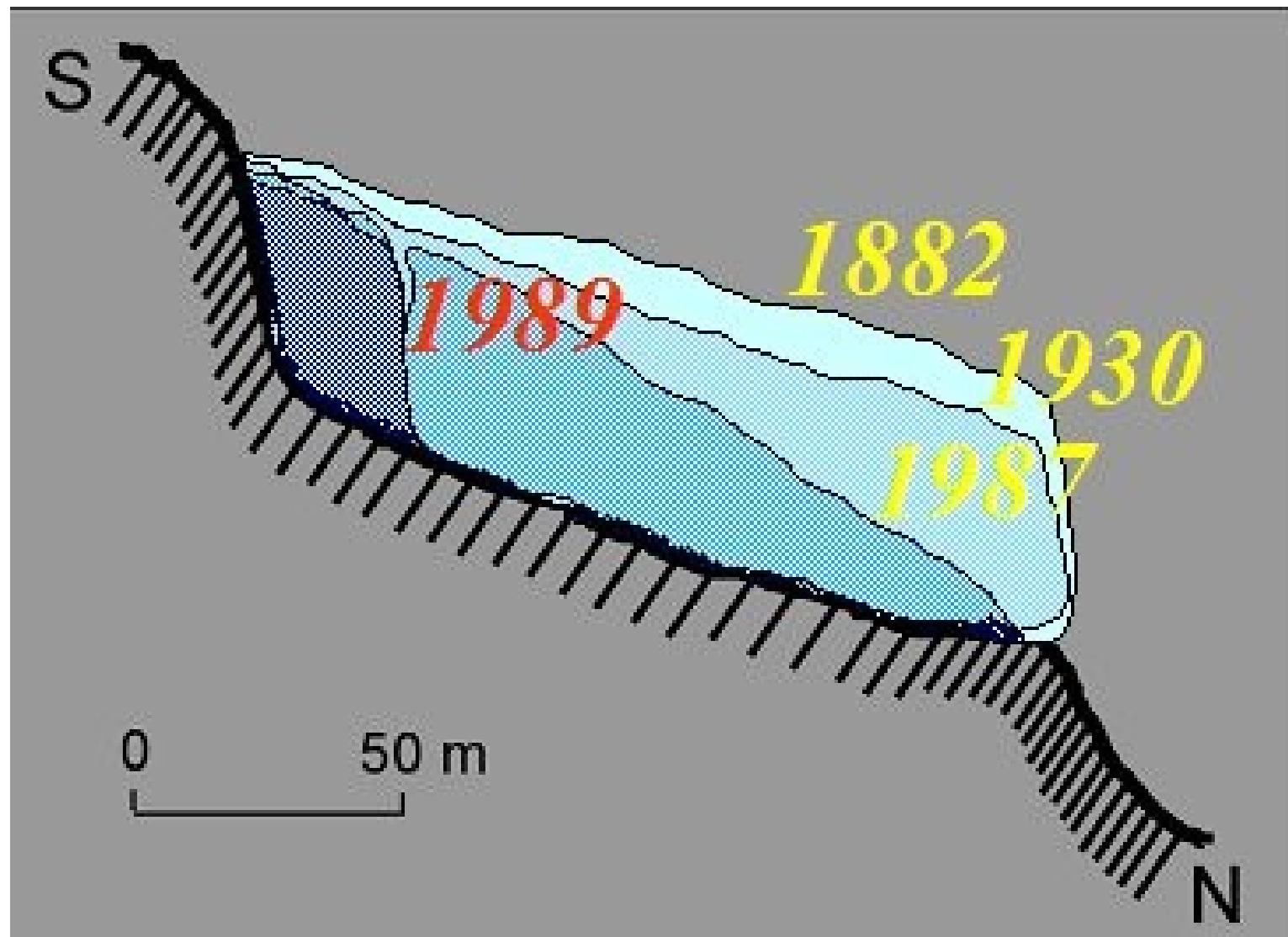


Il Ghiacciaio Superiore di Coolidge

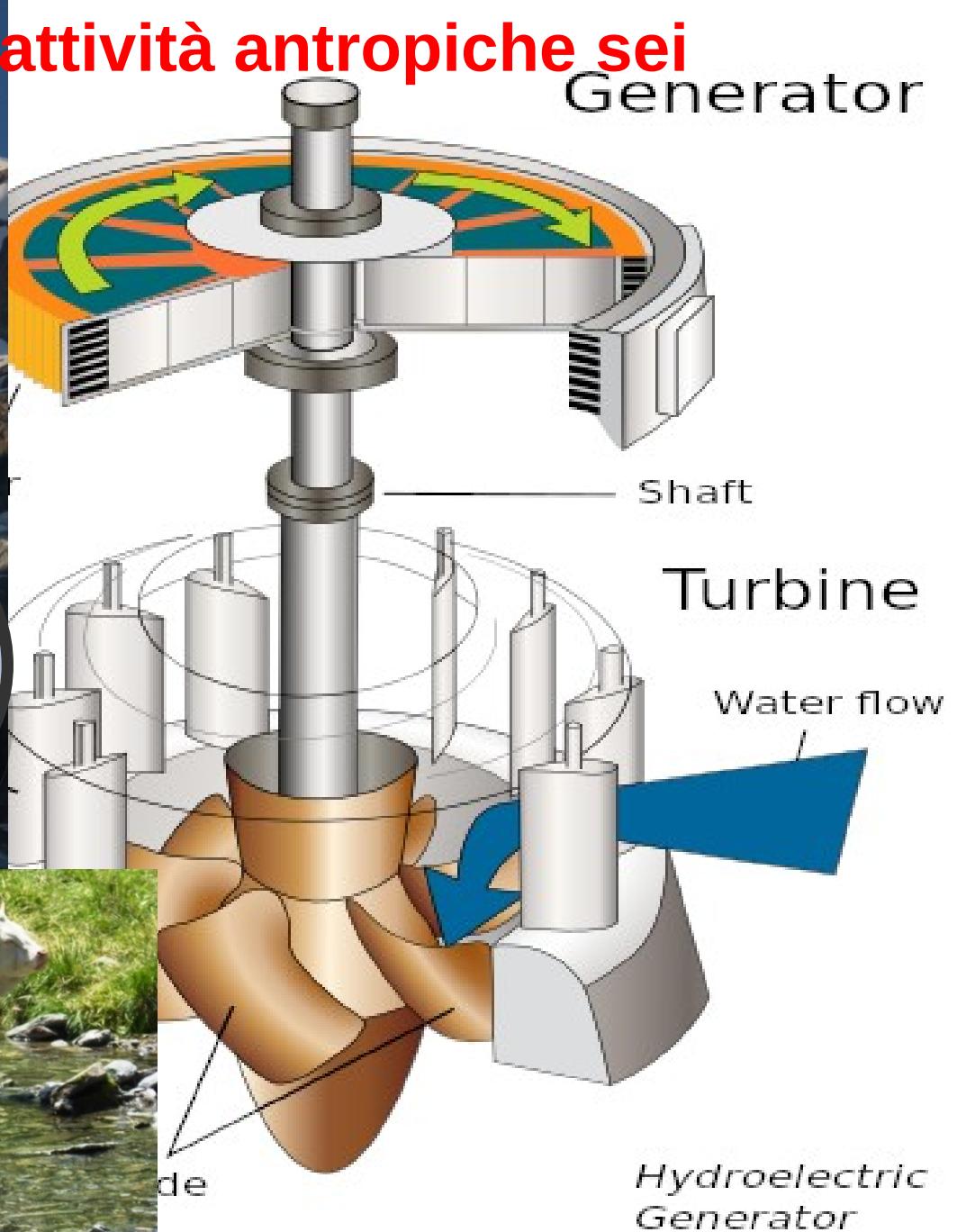
"Assieme al Ghiacciaio Coolidge Inferiore, il Ghiacciaio Coolidge Superiore è l'ultimo sopravvissuto di un gruppo di apparati glaciali originariamente ospitati sul versante nordorientale del Monviso. Prende il nome da William Augustus Brevoort Coolidge (New York, 1850 - Grindelwald, 1926), reverendo, esploratore e storico dell'alpinismo che il 28 luglio 1881, insieme alle guide svizzere Christian e Ulrich Almer, aprì una nuova bella via per il Viso salendo lungo il gran canalone che solca la parte bassa della parete Nord e che, successivamente, avrebbe preso il suo stesso nome. Nel 1989 gran parte del ghiacciaio si scollò dal substrato precipitando nel sottostante Canalone Coolidge. La valanga di ghiaccio, il cui volume è stato stimato ammontare a **200.000 m³**, impattò sul sottostante ed omonimo Ghiacciaio Inferiore provocando un'onda sismica che fu registrata a 20 Km di distanza. Fino agli anni Trenta, il ghiacciaio presentava un fronte subverticale spesso alcune decine di metri. Con il tempo, il netto gradino che si era formato in seguito al crollo ha perso evidenza". Da Christian Casarotto & Andrea Parodi, MERIDIANI Montagne 81 - GHIACCIAI D'ITALIA, LUGLIO 2016



Il Ghiacciaio Superiore di Coolidge



Quante e quali relazioni fra ghiaccio ed attività antropiche sei
in grado di individuare?





18.03.2025 - - - ambiente

SCI, L'ITALIA È UN CIMITERO DI IMPIANTI DISMESSI. RECORD NEGATIVO IN PIEMONTE

di Gian Luca Gasca

In Italia il numero di impianti sciistici dismessi è raddoppiato in cinque anni, con il Piemonte in testa. La crisi climatica impone un ripensamento del turismo invernale, mentre aumentano i costi dell'innevamento artificiale e il divario tra lusso e abbandono in montagna. Il report "Nevediversa 2025".



Impianto dismesso in Valle di Viù (Piemonte)

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ARTICOLI RECENTI



26.03.2025
cronaca

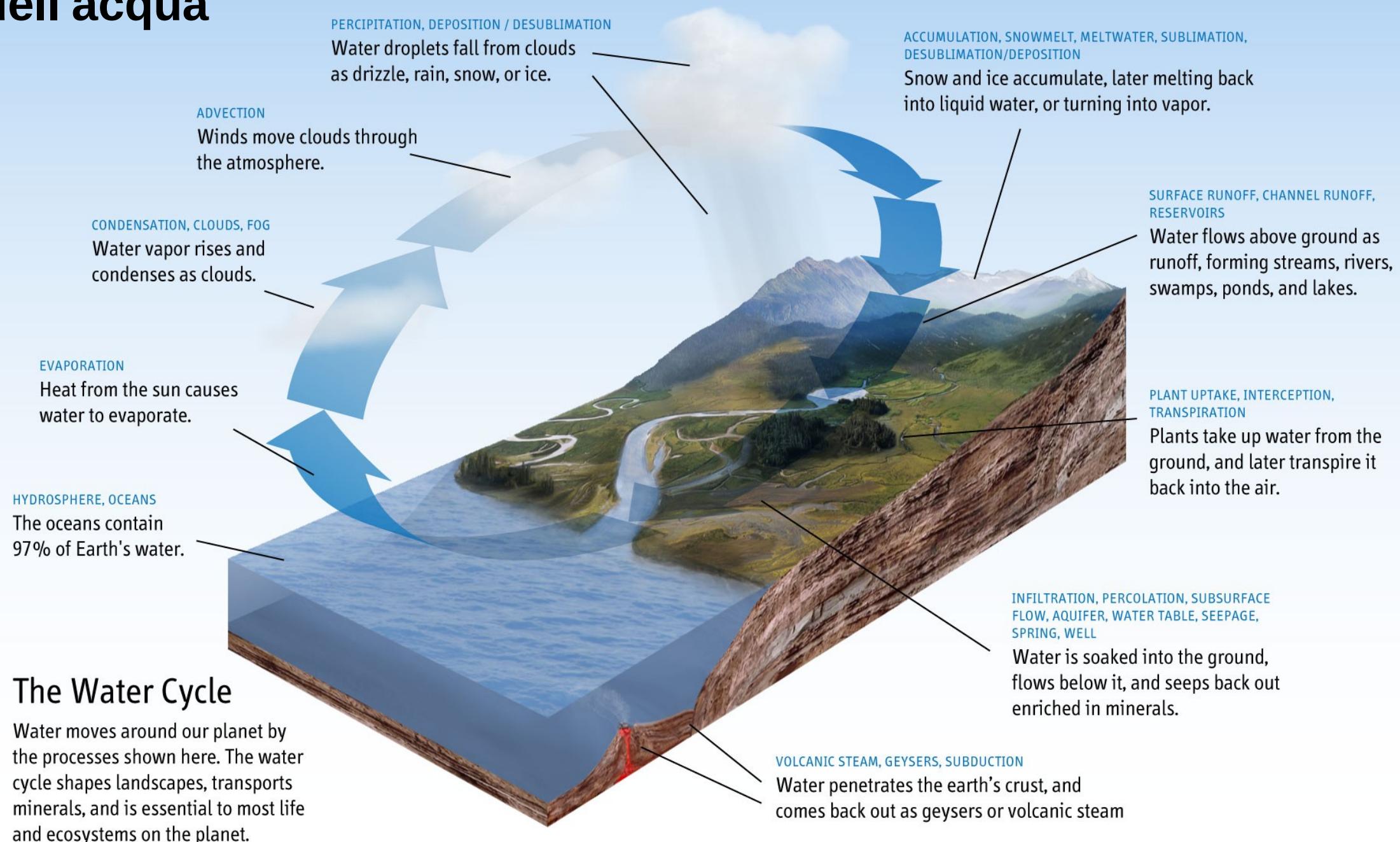
AD AMATRICE SI CRESCE INSIEME:
2 GIORNI DI FORMAZIONE PER
L'ALPINISMO ...

di Redazione CAI

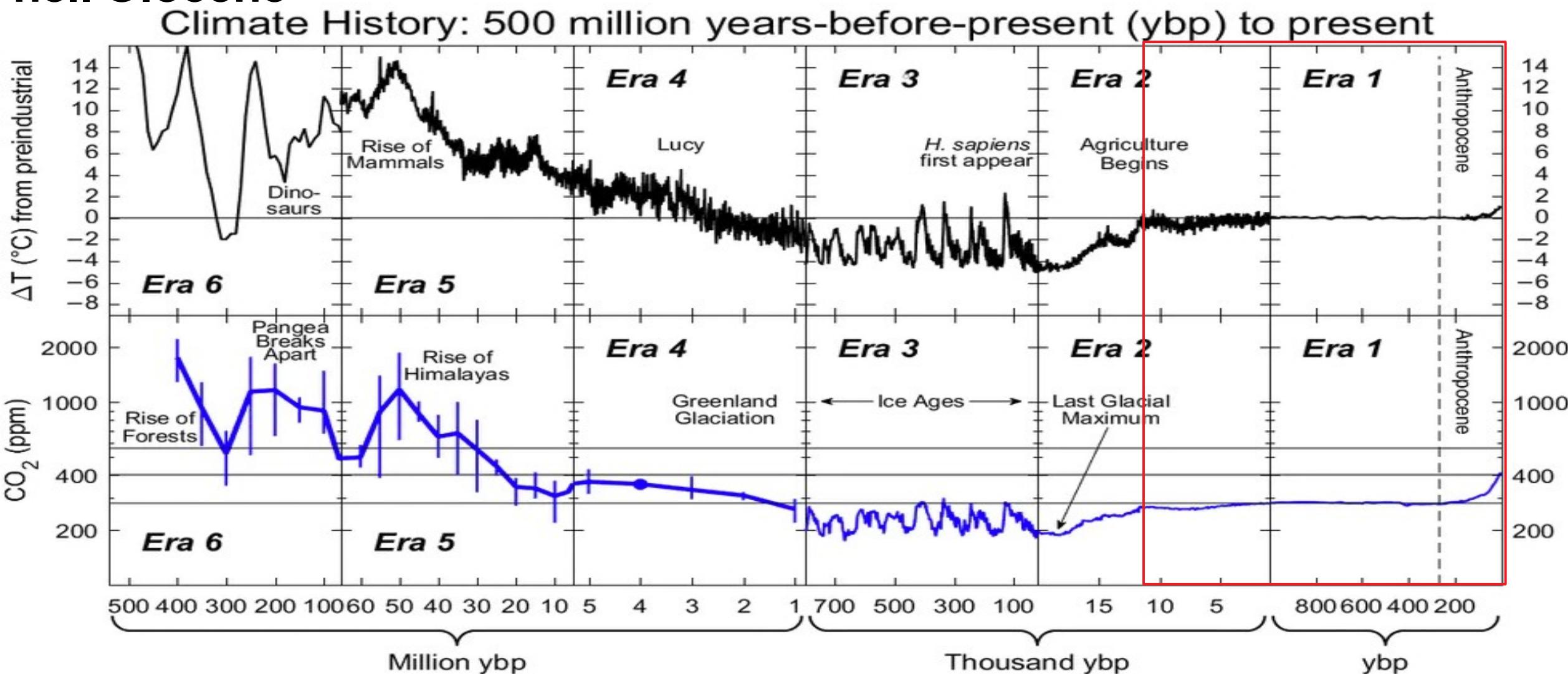


26.03.2025
cronaca + alpinismo

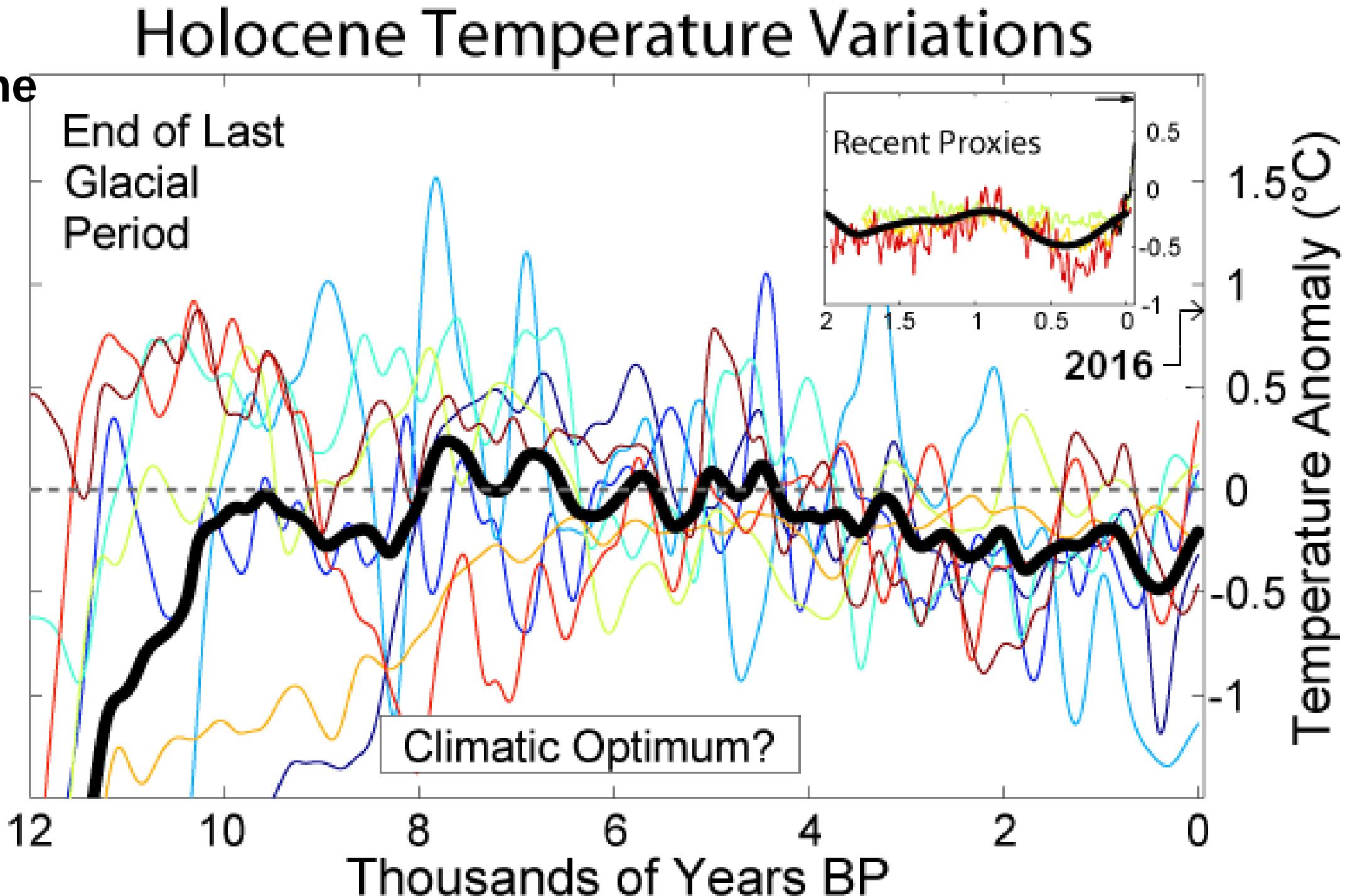
Il ciclo dell'acqua



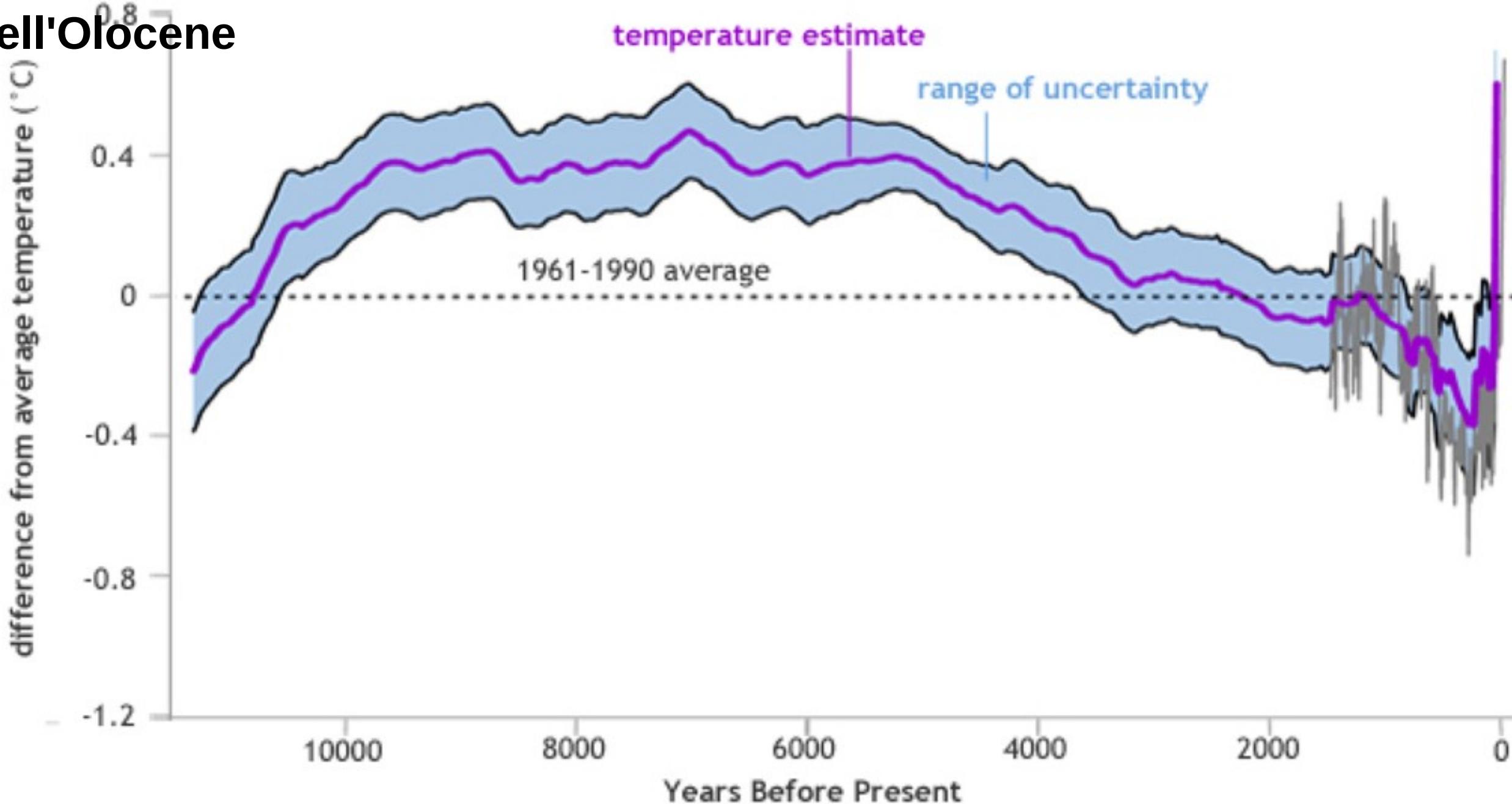
Il clima nell'Olocene



Il clima nell'Olocene



Il clima nell'Olocene



nature > scientific data > analyses > article

Analysis | Open access | Published: 30 June 2020

Holocene global mean surface temperature, a multi-method reconstruction approach

Darrell Kaufman , Nicholas McKay, Cody Routson, Michael Erb, Christoph Dätwyler, Philipp S. Sommer, Oliver Heiri & Basil Davis

Scientific Data 7, Article number: 201 (2020) | [Cite this article](#)

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Abstract

An extensive new multi-proxy database of paleo-temperature time series (Temperature 12k) enables a more robust analysis of global mean surface temperature (GMST) and associated uncertainties than was previously available. We applied five different statistical methods to reconstruct the GMST of the past 12,000 years (Holocene). Each method used different approaches to averaging the globally distributed time series and to characterizing various sources of uncertainty, including proxy temperature, chronology and methodological choices. The results were aggregated to generate a multi-method ensemble of plausible GMST and latitudinal-zone temperature reconstructions with a realistic range of uncertainties. The warmest 200-year-long interval took place around 6500 years ago when GMST was 0.7 °C (0.3, 1.8) warmer than the 19th Century (median, 5th, 95th percentiles). Following the

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Associated content

Collection

Paleoclimate data

A global database of Holocene paleotemperature records

Darrell Kaufman, Nicholas McKay ... Snezhana Zhilich
Scientific Data | Data Descriptor | Open Access | 14 Apr 2020

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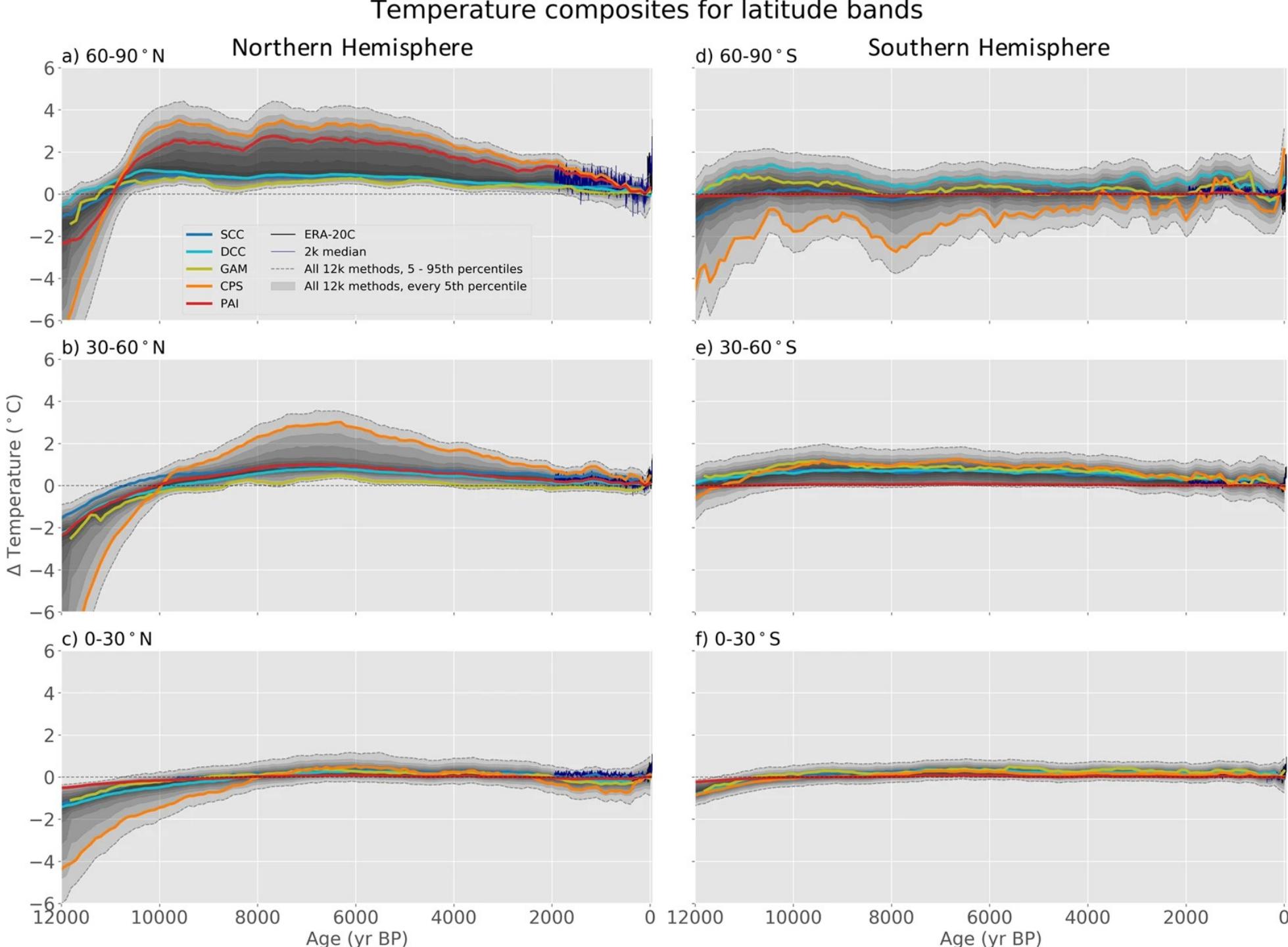
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Il clima nell'Olocene

Temperature composites for latitude bands



Andamento della [CO₂]atm nell'Olocene

(<https://github.com/pierorivoira/CO2/blob/main/CO2.xlsx>)

The screenshot shows a GitHub repository page for the 'CO2' repository, which is public. The main content area displays a list of files in the 'main' branch:

- pierorivoira Update README.md · 35e64ec · 2 years ago · 6 Commits
- CO2.csv · Add files via upload · 2 years ago
- CO2.txt · Add files via upload · 2 years ago
- CO2.xlsx · Add files via upload · 2 years ago (highlighted with a red arrow)
- RAW_DATA.txt · Add files via upload · 2 years ago
- RAW_DATA_CO2.txt · Add files via upload · 2 years ago
- README.md · Update README.md · 2 years ago

On the right side of the page, there is an 'About' section with the following text:
Costruire un grafico della serie temporale
della CO₂ atm con colab e python

Below the 'About' section are links to 'Readme', 'Activity', '1 star', '1 watching', and '0 forks'. There are also sections for 'Releases' (No releases published) and 'Packages'.

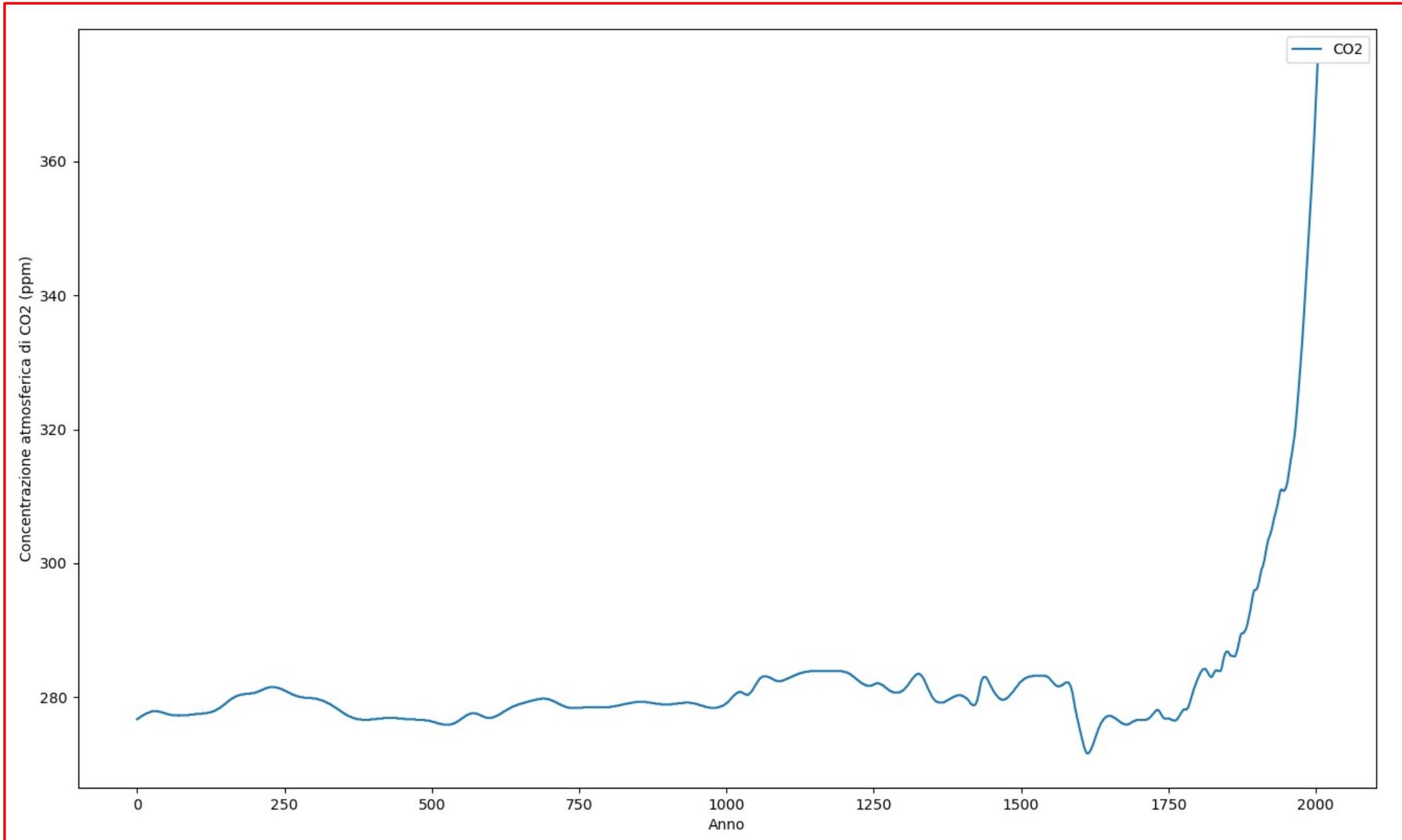
Andamento della [CO₂]atm nell'Olocene

Fonte dei dati:

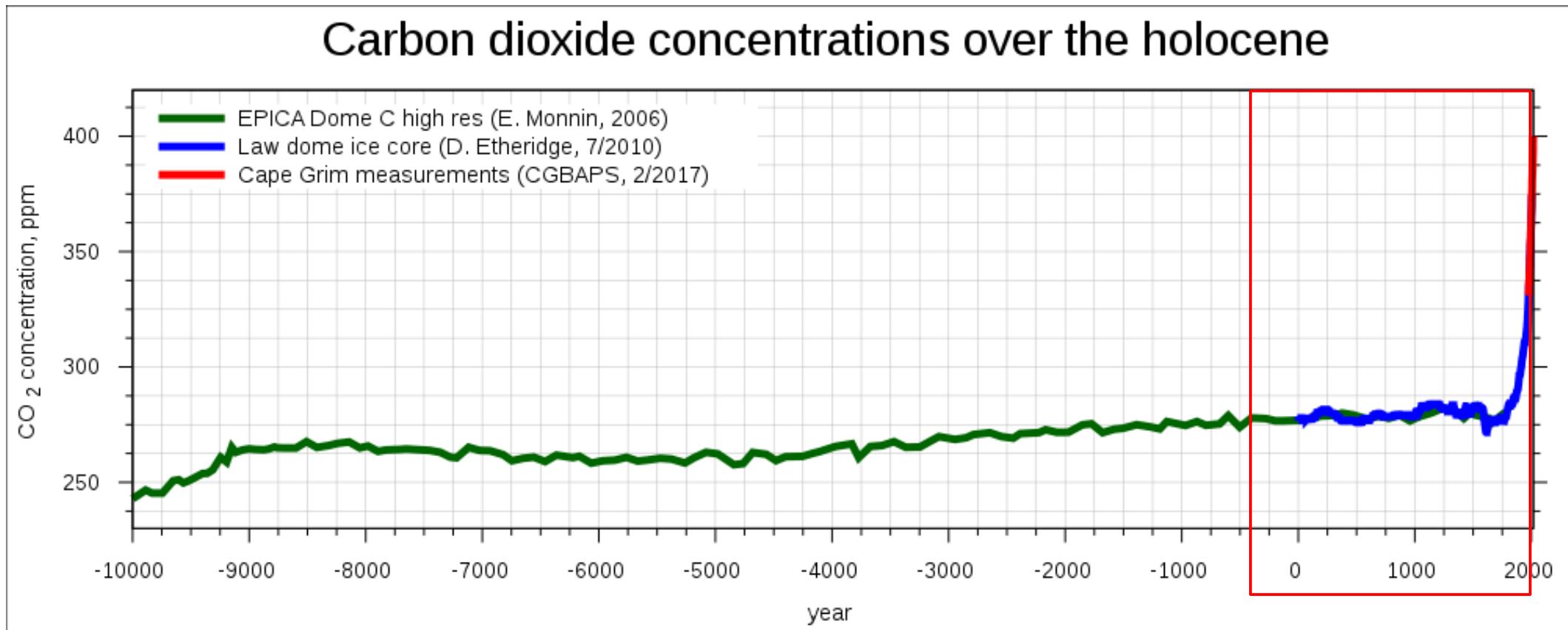
<https://www1.ncdc.noaa.gov/pub/data/paleo/icecore/antarctica/law/law2006.txt>

```
> install.packages('readxl')
> library(readxl)
> CO2 = read_excel('CO2.xlsx')
# legge il file e lo salva come oggetto di R
> str(CO2)
tibble [2,004 × 1] (S3:tbl_df/tbl/data.frame)
  $ CO2: chr [1:2004] "276.7" "276.8" "276.8" "276.9" ...
> variazione_CO2 = CO2$CO2
# estrae i dati dalla tabella e li salva come vettore
> str(variazione_CO2)
  chr [1:2004] "276.7" "276.8" "276.8" "276.9" "276.9" "277.0" "277.1"
"277.1" "277.2" "277.2" "277.3" "277.3" "277.4" "277.4" "277.5" ...
> plot(variazione_CO2, type = 'l', col = 'red', lwd = 3, xlab = 'Anno',
ylab = 'Concentrazione atmosferica di CO2', main = 'VARIAZIONE DELLA
[CO2]atm NEGLI ULTIMI 2000 ANNI')
```

Andamento della $[CO_2]_{atm}$ negli ultimi 2000 anni



Andamento della $[CO_2]_{atm}$ negli ultimi 12000 anni



[nature](#) > [articles](#) > [article](#)

Article | Published: 11 March 1999

Holocene carbon-cycle dynamics based on CO₂ trapped in ice at Taylor Dome, Antarctica

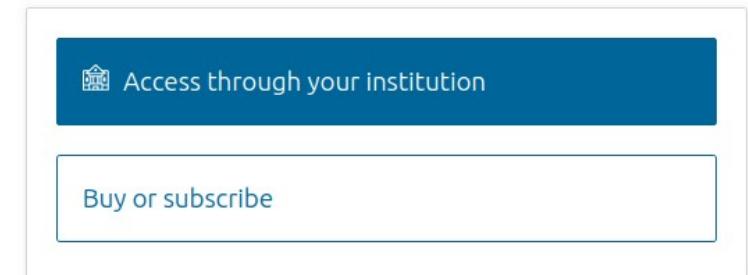
A. Indermühle, T. F. Stocker , F. Joos, H. Fischer, H. J. Smith, M. Wahlen, B. Deck, D. Mastroianni, J. Tschumi, T. Blunier, R. Meyer & B. Stauffer

[Nature](#) 398, 121–126 (1999) | [Cite this article](#)

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Abstract

A high-resolution ice-core record of atmospheric CO₂ concentration over the Holocene epoch shows that the global carbon cycle has not been in steady state during the past 11,000 years. Analysis of the CO₂ concentration and carbon stable-isotope records, using a one-dimensional carbon-cycle model, suggests that changes in terrestrial biomass and sea surface temperature were largely responsible for the observed millennial-scale changes of atmospheric CO₂ concentrations.



Associated content

The mysterious missing sink

David W. Schindler

[Nature](#) | [News & Views](#) | 11 Mar 1999

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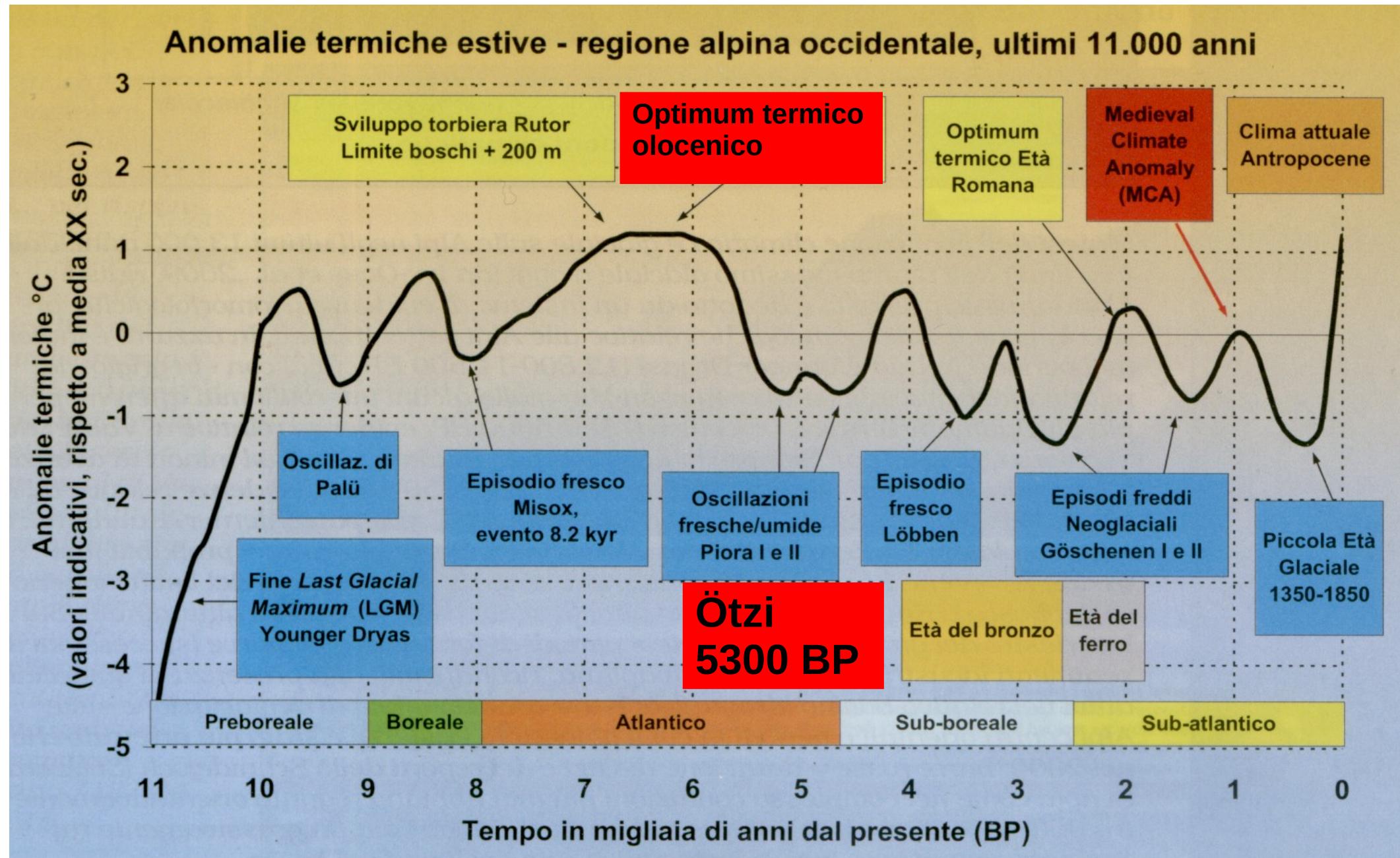
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Il clima nell'Olocene



La torbiera del Rutor



La torbiera del Rutor (coming soon)

*Geogr. Fis. Dinam. Quat.,
8 (1985), 144-149, 3 ff., 2 tabb.*

ERNESTO ARMANDO (*) & GIOVANNI CHARRIER (**)

LA TORBIERA DEL RUTOR (Valle d'Aosta). RELAZIONE SUI RISULTATI CONSEGUITI DALLO STUDIO PALINOSTRATIGRAFICO DI NUOVI AFFIORAMENTI TORBOSI SEGNALATI ALLA FRONTE ATTUALE DEL GHIACCIAIO (***)

ABSTRACT: ARMANDO E. & CHARRIER G., *The peat formation of the Rutor Glacier (Aosta Valley). Results obtained by palynostratigraphic study of new peat outcrops near the glacier snout (IT ISSN 0084-8948, 1985).*

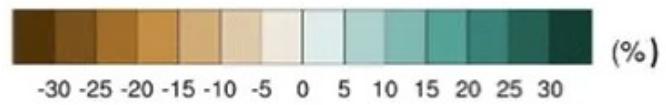
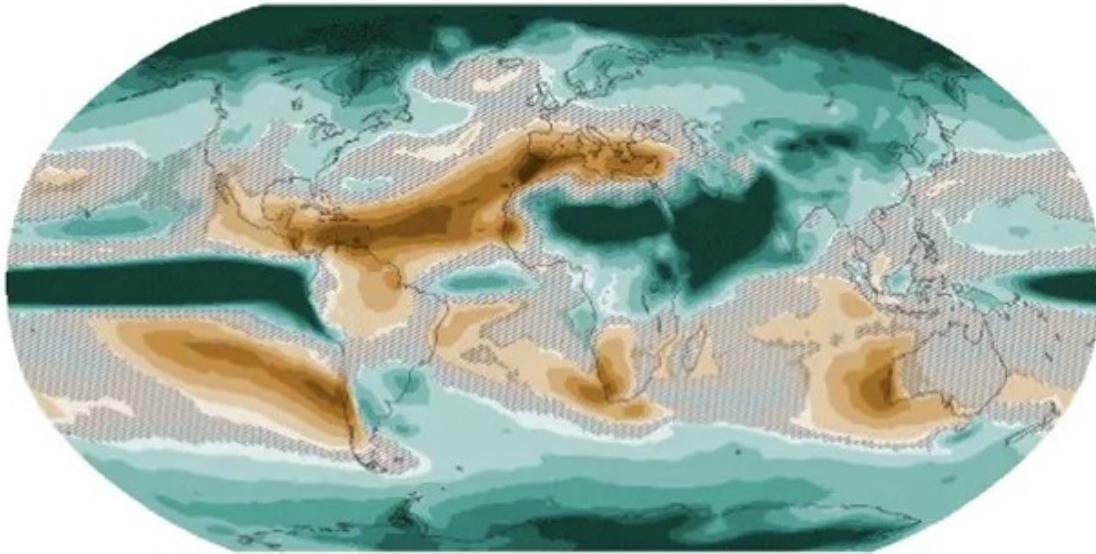
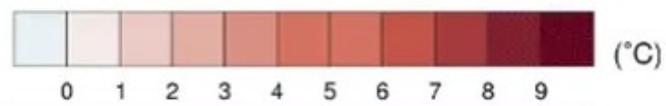
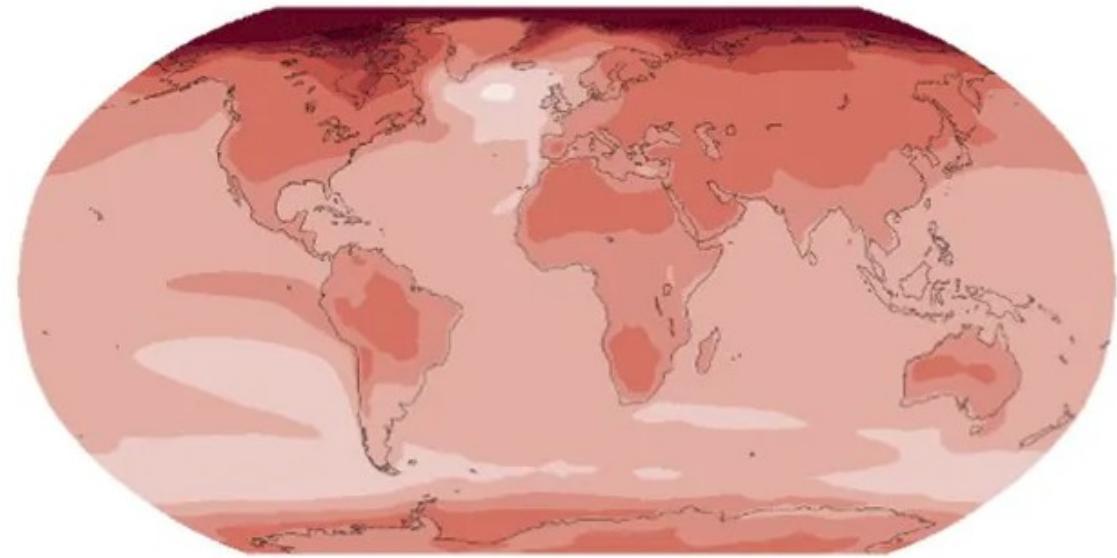
The paper reports the results of palynological analyses carried out on peat and clay samples collected near the snout of the Rutor Glacier (Aosta Valley).

These analyses confirm the hypothesis formerly expressed regarding the age of the peat formation (8000-5000 years) and its dislocations caused by fluctuations of the snout which, however, probably did not affect the clay bed underlying the peat deposit.

RETTI quale operatore del Comitato Glaciologico Italiano, nel corso di un sopralluogo alla fronte del ghiacciaio, rinvenne un affioramento di torba localizzato presso la sommità della scarpata, sulla sponda destra del torrente che fuoriesce dal ramo occidentale del Ghiacciaio del Rutor, a una decina di metri dall'estremità della lingua glaciale. Il nuovo ritrovamento, situato 100 m a monte del luogo dove PERETTI aveva raccolto nel 1957 le prime zolle di torba rimaneggiata, si configurava come un pacco di letti torbosì pianeggianti alternati a strati

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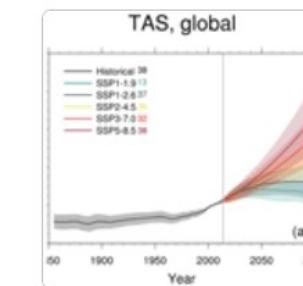
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Climate model projections from the Scenario Model Intercomparison Project (ScenarioMIP) of CMIP6

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Range-Wide Snow Leopard Phylogeography Supports Three Subspecies

Jan E Janecka , Yuguang Zhang, Diqiang Li, Bariushaa Munkhtsog, Munkhtsog Bayaraa, Naranbaatar Galsandorj, Tshewang R Wangchuk, Dibesh Karmacharya, Juan Li, Zhi Lu ... Show more

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- Abstract
- Materials and Methods
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- Funding
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Abstract

The snow leopard, *Panthera uncia*, is an elusive high-altitude specialist that inhabits vast, inaccessible habitat across Asia. We conducted the first range-wide genetic assessment of snow leopards based on noninvasive scat surveys. Thirty-three microsatellites were genotyped and a total of 683 bp of mitochondrial DNA sequenced in 70 individuals. Snow leopards exhibited low genetic diversity at microsatellites ($A_N = 5.8$, $H_0 = 0.433$, $H_E = 0.568$), virtually no mtDNA variation, and underwent a bottleneck in the Holocene (~8000 years ago) coinciding with increased temperatures, precipitation, and upward treeline shift in the Tibetan Plateau. Multiple analyses supported 3 primary genetic clusters: (1) Northern (the Altai region), (2) Central (core Himalaya and Tibetan Plateau), and (3) Western (Tian Shan, Pamir, trans-Himalaya regions). Accordingly, we recognize 3 subspecies, *Panthera uncia irbis* (Northern group), *Panthera uncia uncia* (Western group), and *Panthera uncia unciooides* (Central group) based upon genetic distinctness, low levels of admixture, unambiguous population assignment, and geographic separation. The patterns of variation



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Il declino del leopardo delle nevi durante l'Optimum termico olocenico



Il declino del leopardo delle nevi durante l'Optimum termico olocenico

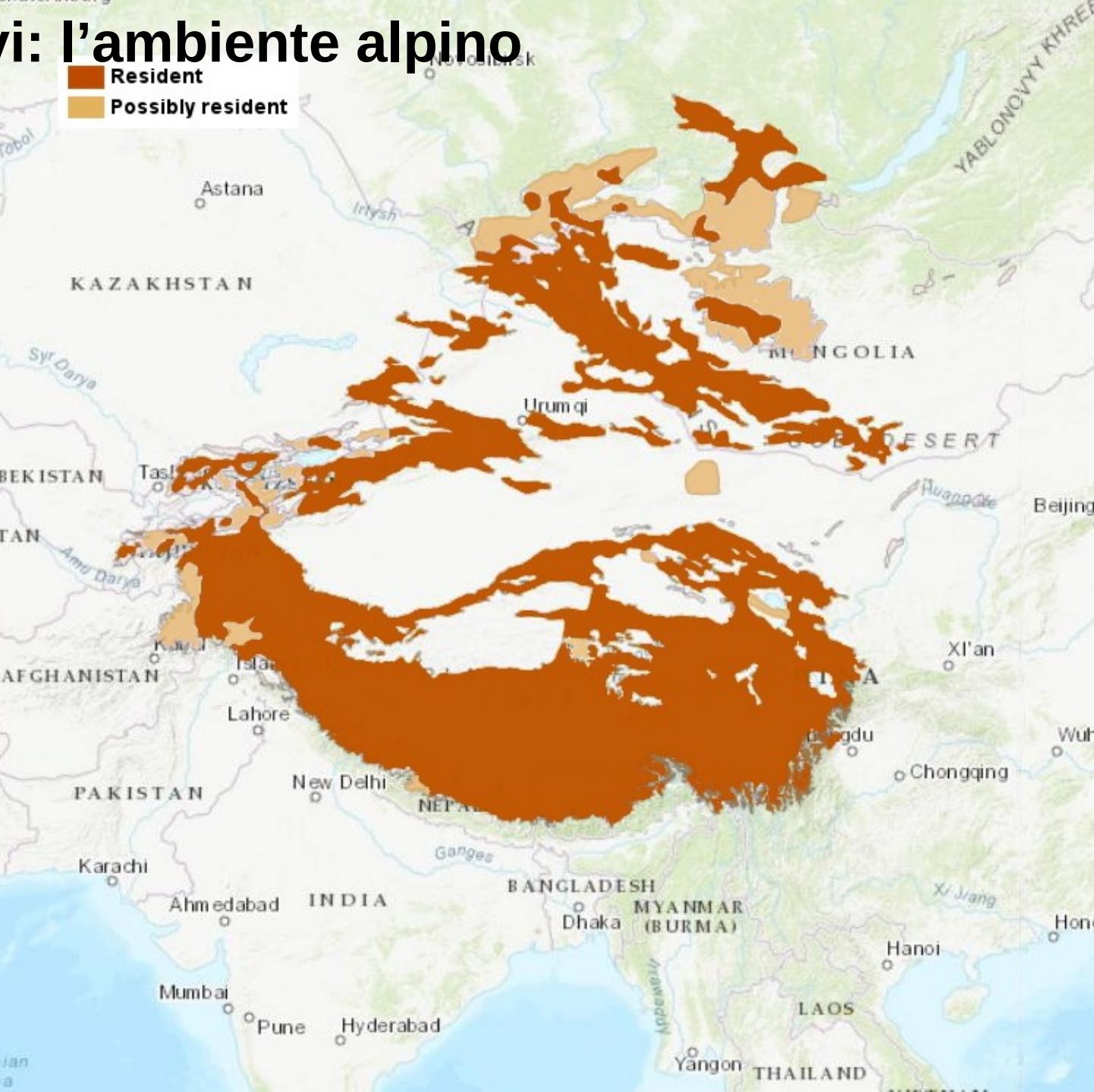
The **snow leopard** (*Panthera uncia*), considered the world's most elusive large felid, inhabits a vast area (~1.6 million km²) across 12 countries in Asia.

It is a high-altitude specialist that primarily occupies mountains above 3000 m in elevation.

This region is characterized by low oxygen levels, temperature extremes, aridity, low productivity, and harsh climatic condition, yet harbors many distinctive taxa, including the Tibetan fox (*Vulpes ferrilata*), Chinese desert cat (*Felis bieti*), argali (*Ovis ammon*), markhor (*Capra falconeri*), urial (*Ovis orientalis*), and Tibetan antelope (*Pantholops hodgsonii*).

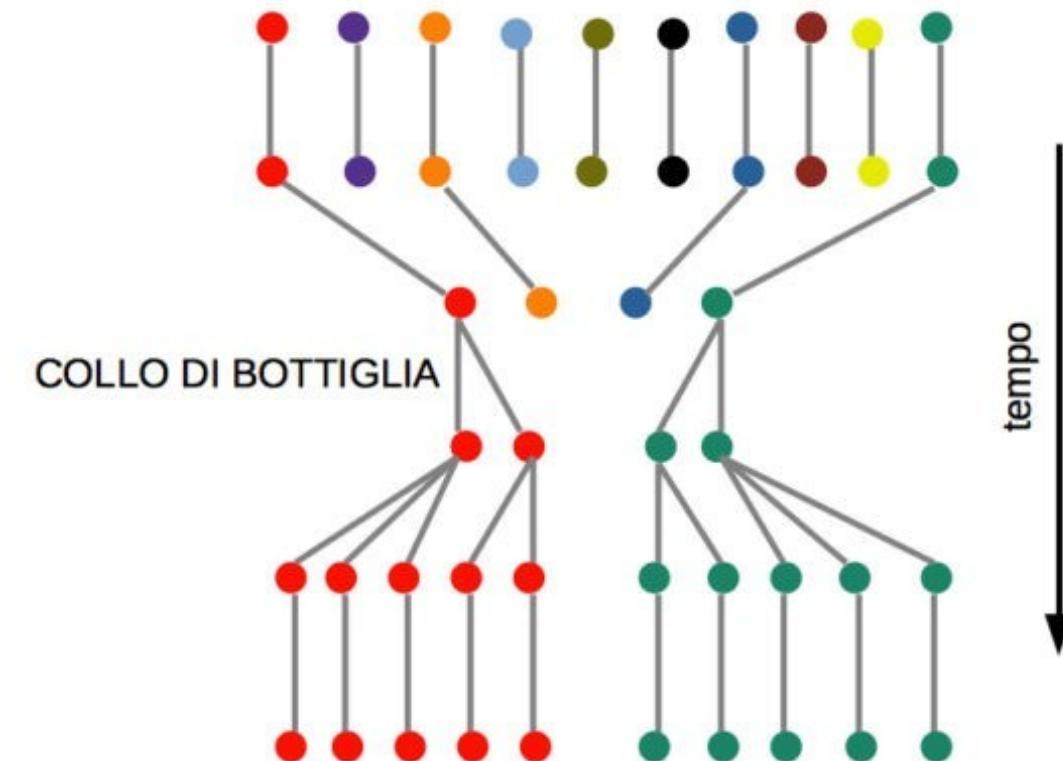
L'habitat del leopardo delle nevi: l'ambiente alpino

(oltre il limite altitudinale della vegetazione arborea)



Il declino del leopardo delle nevi durante l'Optimum termico olocenico

Snow leopards exhibit low genetic diversity and underwent a **bottleneck** in the Holocene (~8000 years ago) coinciding with increased temperatures, precipitation, and upward treeline shift in the Tibetan Plateau.



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$0,32 * 10^{-6}$ mutazioni $\text{bp}^{-1} \text{yr}^{-1}$
(mtDNA nella specie umana)

Am. J. Hum. Genet. 66:1599–1609, 2000

The Mutation Rate in the Human mtDNA Control Region

Sigrún Sigurðardóttir,¹ Agnar Helgason,² Jeffrey R. Gulcher,¹ Kári Stefansson,¹ and Peter Donnelly³

¹deCODE Genetics, Inc., Reykjavik; and ²Institute of Biological Anthropology and ³Department of Statistics, University of Oxford, Oxford

▼ The Mutation Rate in the Human mtDNA Control Region
Introduction
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Pedigrees
Sequencing
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Accuracy of the Genealogy Database
Point Mutations
Insertion/Deletion Mutations
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Discussion
Conclusion
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The mutation rate of the mitochondrial control region has been widely used to calibrate human population history. However, estimates of the mutation rate in this region have spanned two orders of magnitude. To readdress this rate, we sequenced the mtDNA control region in 272 individuals, who were related by a total of 705 mtDNA transmission events, from 26 large Icelandic pedigrees. Three base substitutions were observed, and the mutation rate across the two hypervariable regions was estimated to be $3/705 = .0043$ per generation (95% confidence interval [CI] .00088–.013), or $.32/\text{site}/1 \text{ million years}$ (95% CI .065–.97). This study is substantially larger than others published, which have directly assessed mtDNA mutation rates on the basis of pedigrees, and the estimated mutation rate is intermediate among those derived from pedigree-based studies. Our estimated rate remains higher than those based on phylogenetic comparisons. We discuss possible reasons for—and consequences of—this discrepancy. The present study also provides information on rates of insertion/deletion mutations, rates of heteroplasmy, and the reliability of maternal links in the Icelandic genealogy database.

Il declino del leopardo delle nevi durante l'Optimum termico olocenico

$0,32 \times 10^{-6}$ mutazioni $\text{bp}^{-1} \text{yr}^{-1}$ * 4000 yr = 0,00128 mutazioni / sito nucleot. in 4000 anni =

= 0,00128 mut. / sito * **16.773** siti/ind. in 4000 anni =
≈ 21 mutazioni/ind. in 4000 anni

Ma...

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Snow leopard mitochondrial reference genome

Panthera uncia (snow leopard)

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