I climi del passato

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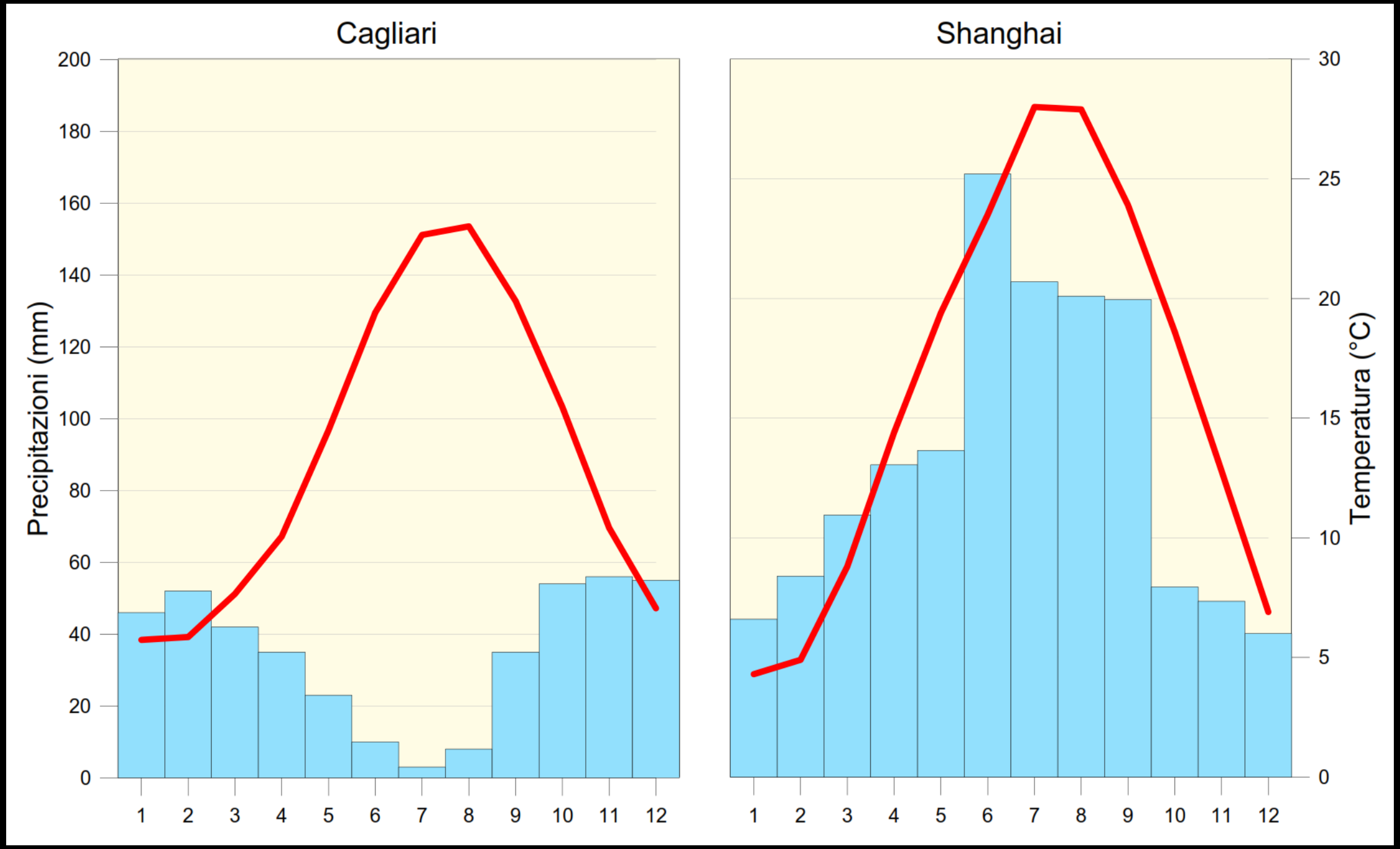
DEGLI STUDI
DI PADOVA

Cos'è il clima?

Clima: proiezione mediata delle condizioni meteorologiche previste per una certa area geografica in un determinato periodo dell'anno.

Osservazione ≥ 30 anni


Cagliari
Shanghai
Precipitazioni (mm)
Temperatura (°C)
0
20
40
60
80
100
120
140
160
180
200
0
5
10
15
20
25
30
1
2
3
4
5
6
7
8
9
10
11
12

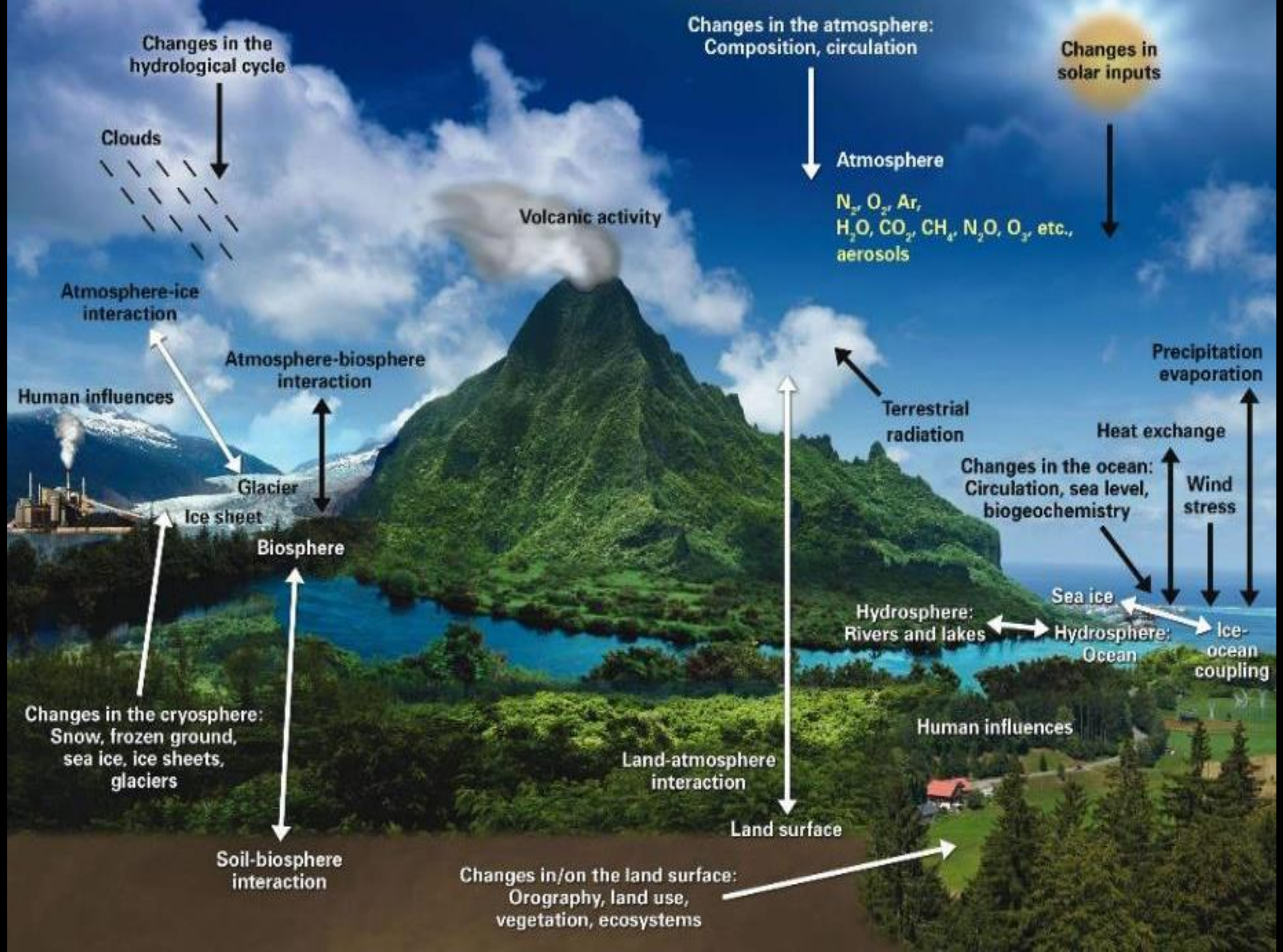
Climate is what you expect, weather is what you get.

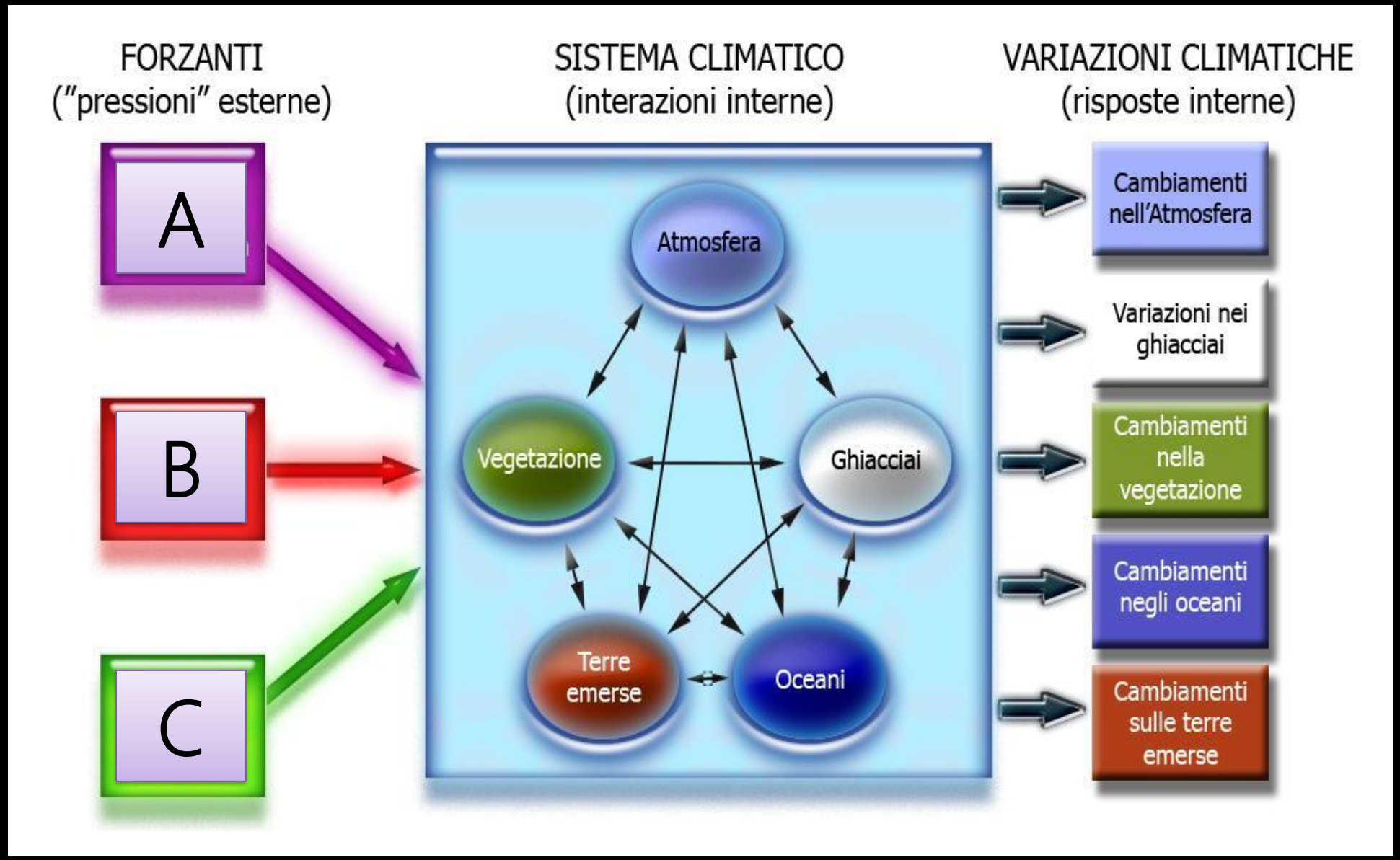
R.A. Heinlein, 1973

ALLORA TOCCA A NOI! CAMBIAMOCI, PRESTO! SCARPONI MONOLITICI... CASCO SUPERJET... TUTA TERMICA...

...OCCHIALI APOLLO E SCI SUPERPLASTICAX! SONO PRONTO! CHE C'E'?
EHM... UN PICCOLO PROBLEMA, ZIO!

MANCA LA NEVE!
UACK! VERDI PRATI E SASSOSI PENDII!


Changes in the hydrological cycle
Clouds
Changes in the atmosphere: Composition, circulation
Changes in solar inputs
Atmosphere
N_2, O_2, Ar, H_2O, CO_2, CH_4, N_2O, O_3, etc., aerosols
Volcanic activity
Atmosphere-ice interaction
Atmosphere-biosphere interaction
Human influences
Glacier
Ice sheet
Biosphere
Terrestrial radiation
Precipitation evaporation
Heat exchange
Changes in the ocean: Circulation, sea level, biogeochemistry
Wind stress
Sea ice
Hydrosphere: Rivers and lakes
Hydrosphere: Ocean
Ice-ocean coupling
Changes in the cryosphere: Snow, frozen ground, sea ice, ice sheets, glaciers
Human influences
Land-atmosphere interaction
Land surface
Soil-biosphere interaction
Changes in/on the land surface: Orography, land use, vegetation, ecosystems



Il sistema climatico è in condizioni di equilibrio instabile…

Quali sono le prospettive?

→ Modelli predittivi

Come validarli?

→ Paleoclimatologia

IL PAESAGGIO

Masso erratico
(Madison Boulder, NH, USA)

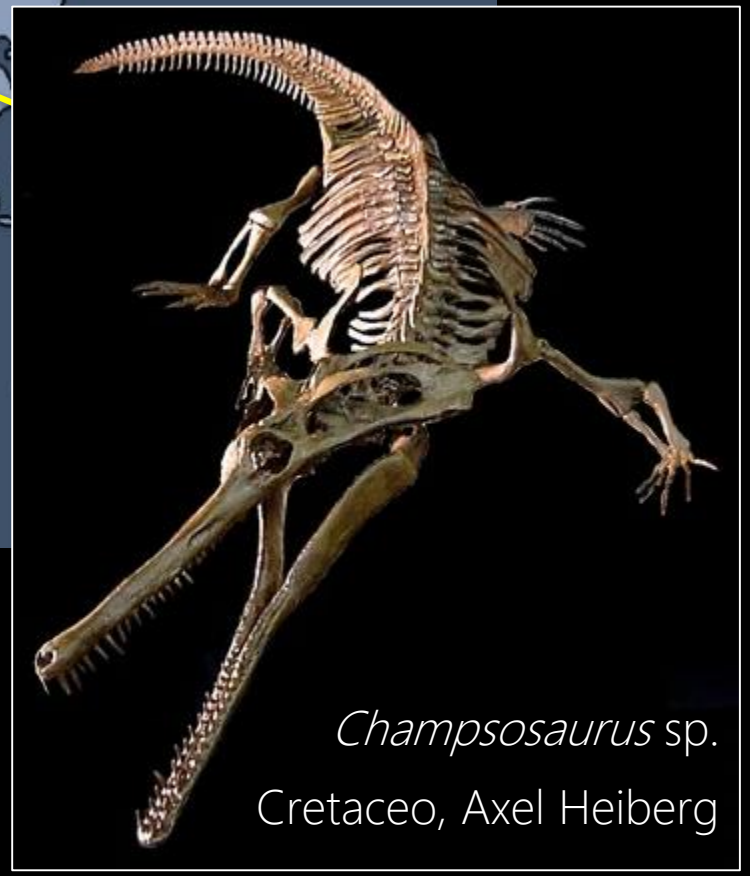
Morena "fossile" e rocce montonate

I FOSSILI

Arctica islandica
Pleistocene, Sicilia

Strombus bubonius
Pleistocene, Puglia

I FOSSILI



Champsosaurus sp.

Cretaceo, Axel Heiberg

ISOTOPI STABILI DELL'OSSIGENO

Le molecole d'acqua contengono due diversi "tipi" di ossigeno:

^{16}O *(99.8%)*: più "leggero" e reattivo, abbondante nei ghiacci

^{18}O *(0.2%)*: più "pesante", tende a risidere negli oceani

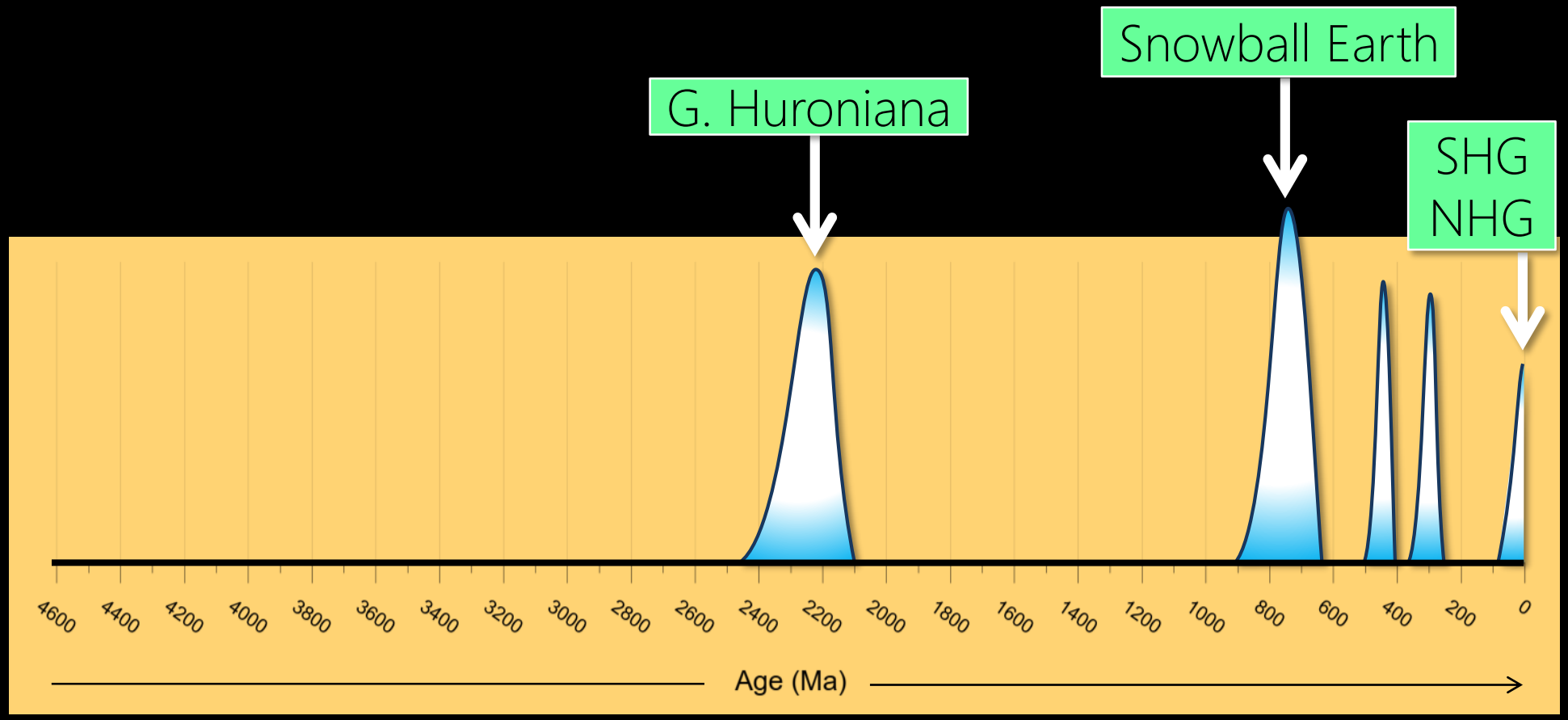
ISOTOPI STABILI DELL'OSSIGENO

Nei gusci (calcarei) possiamo misurare:

$>{}^{16}O$ → clima più caldo e/o meno ghiaccio

$>{}^{18}O$ → clima più freddo e/o più ghiaccio

COSA SAPPIAMO DEI CLIMI PASSATI?



La presenza di calotte glaciali è un'anomalia!

GLACIAZIONE HURONIANA (~2.5 Ga)

Scatenata dalla fotosintesi:

Produzione di ossigeno

↓

Ossidazione del metano atmosferico

↓

Crollo delle temperature

SNOWBALL EARTH (~600 Ma)

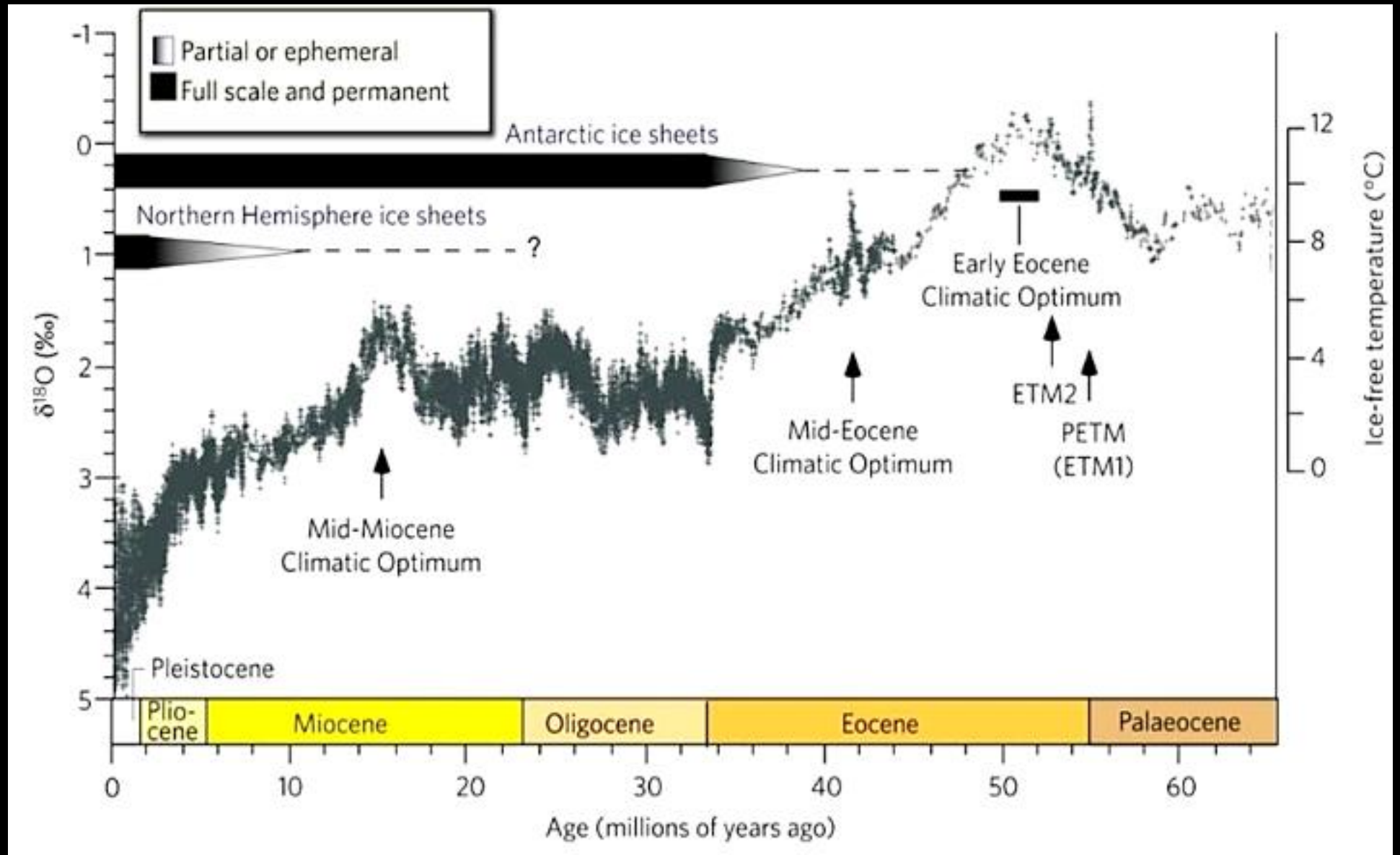
Cause non chiare:

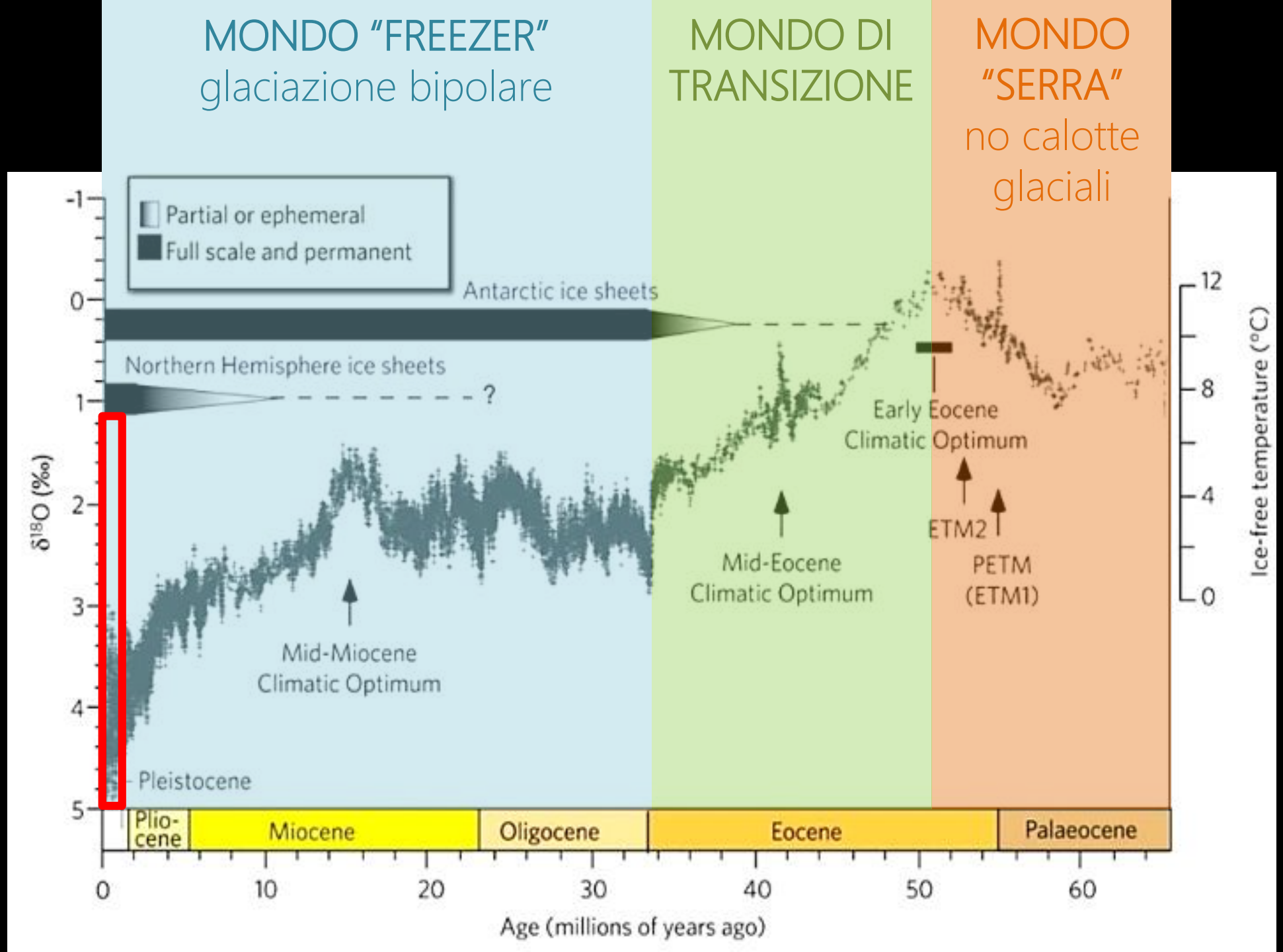
Terra ricoperta di ghiacci

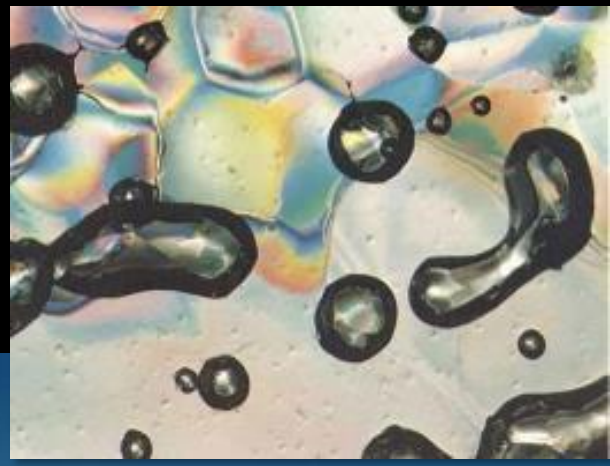
Attività vulcanica sui fondali oceanici

"Incubatrice" della Vita complessa

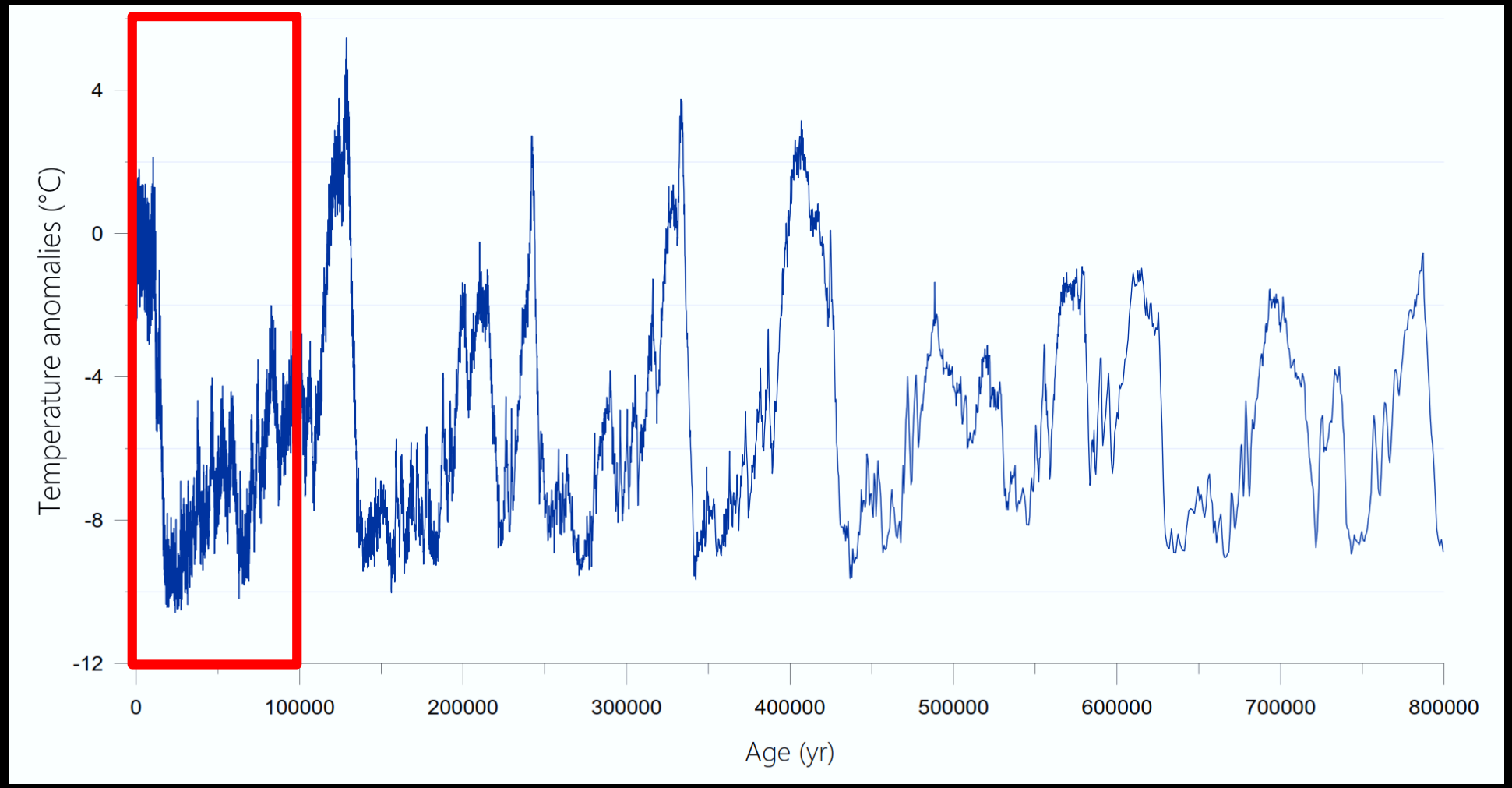
GLI ULTIMI 65 MILIONI DI ANNI




MONDO "FREEZER"
glaciazione bipolare
MONDO DI TRANSIZIONE
MONDO "SERRA"
no calotte glaciali
Partial or ephemeral
Full scale and permanent
Antarctic ice sheets
Northern Hemisphere ice sheets
?
Mid-Miocene Climatic Optimum
Mid-Eocene Climatic Optimum
Early Eocene Climatic Optimum
ETM2
PETM (ETM1)
Pleistocene
δ18O (‰)
Ice-free temperature (°C)
Plio-cene
Miocene
Oligocene
Eocene
Palaeocene
Age (millions of years ago)

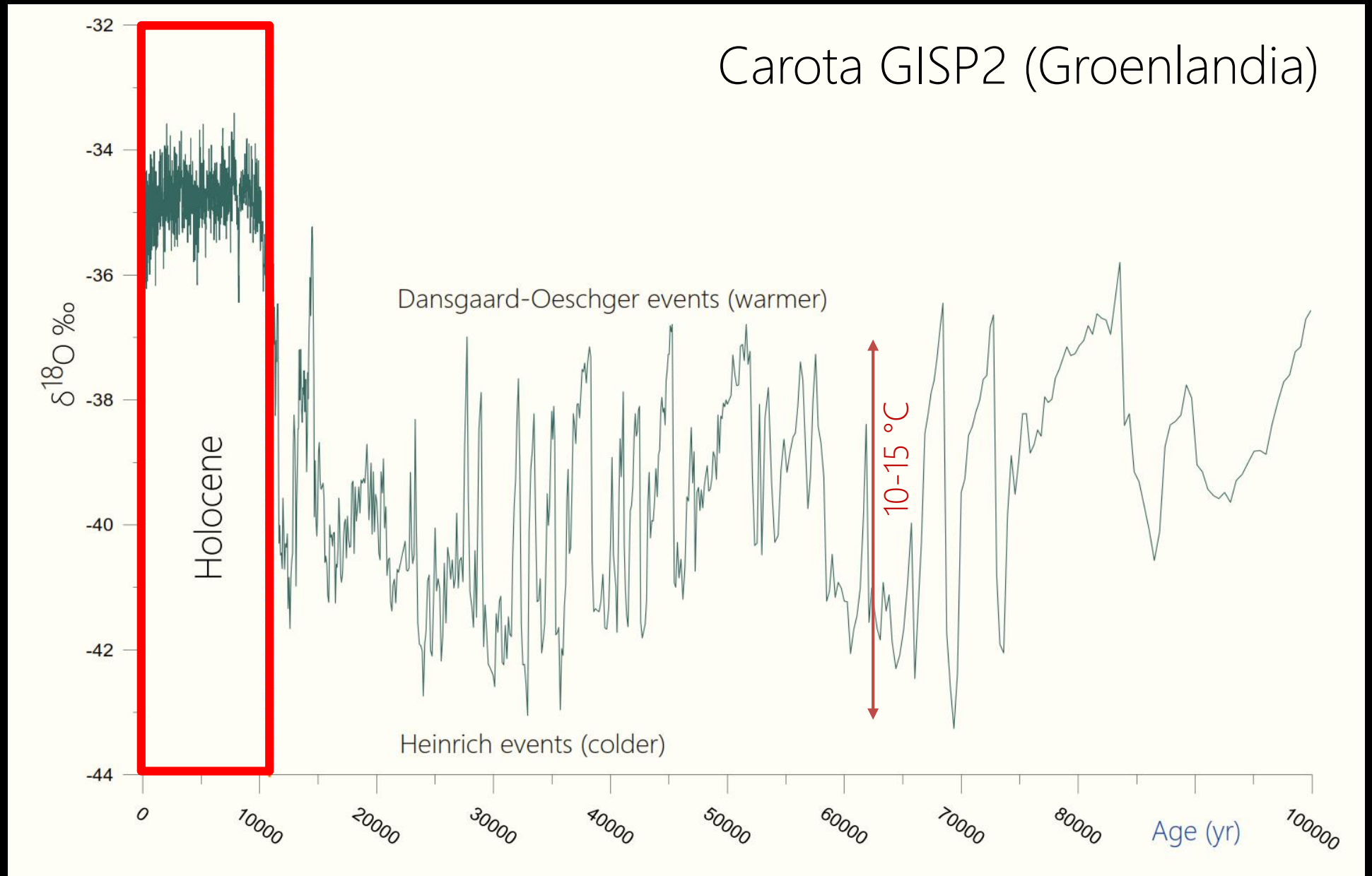


GLI ULTIMI 800.000 ANNI

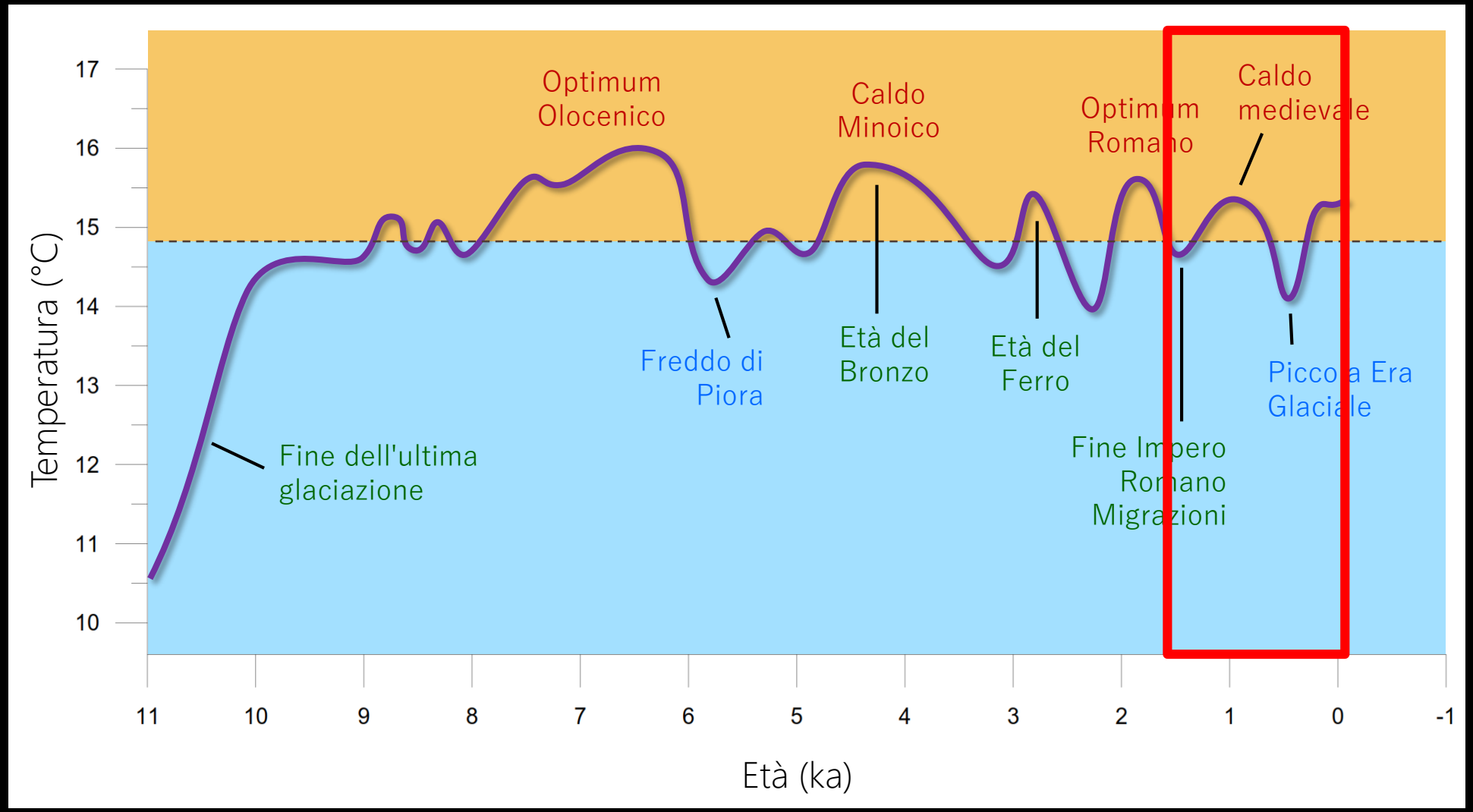


Record del Deuterio (^2H), Antartide

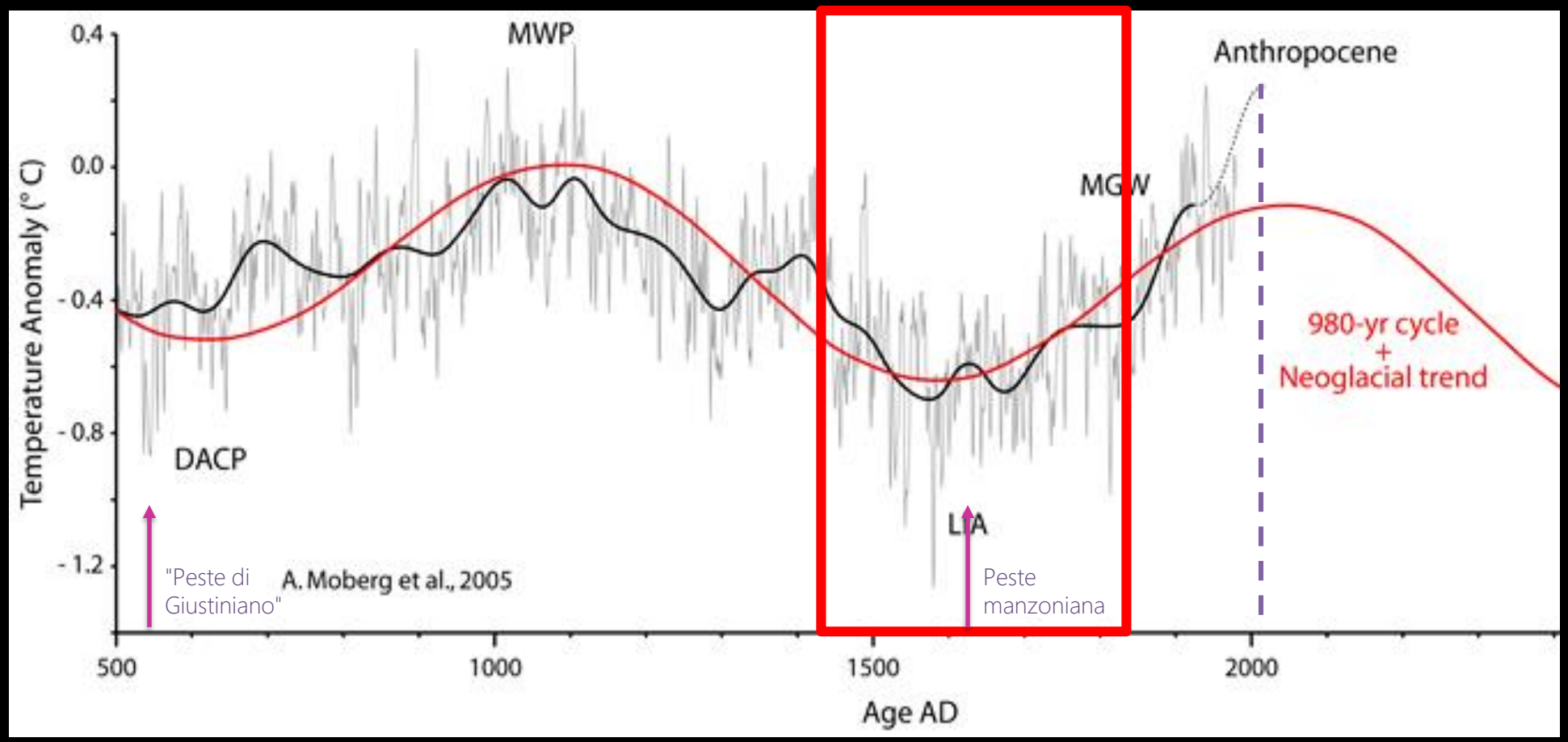
GLI ULTIMI 100.000 ANNI



GLI ULTIMI 10.000 ANNI



GLI ULTIMI 1.500 ANNI

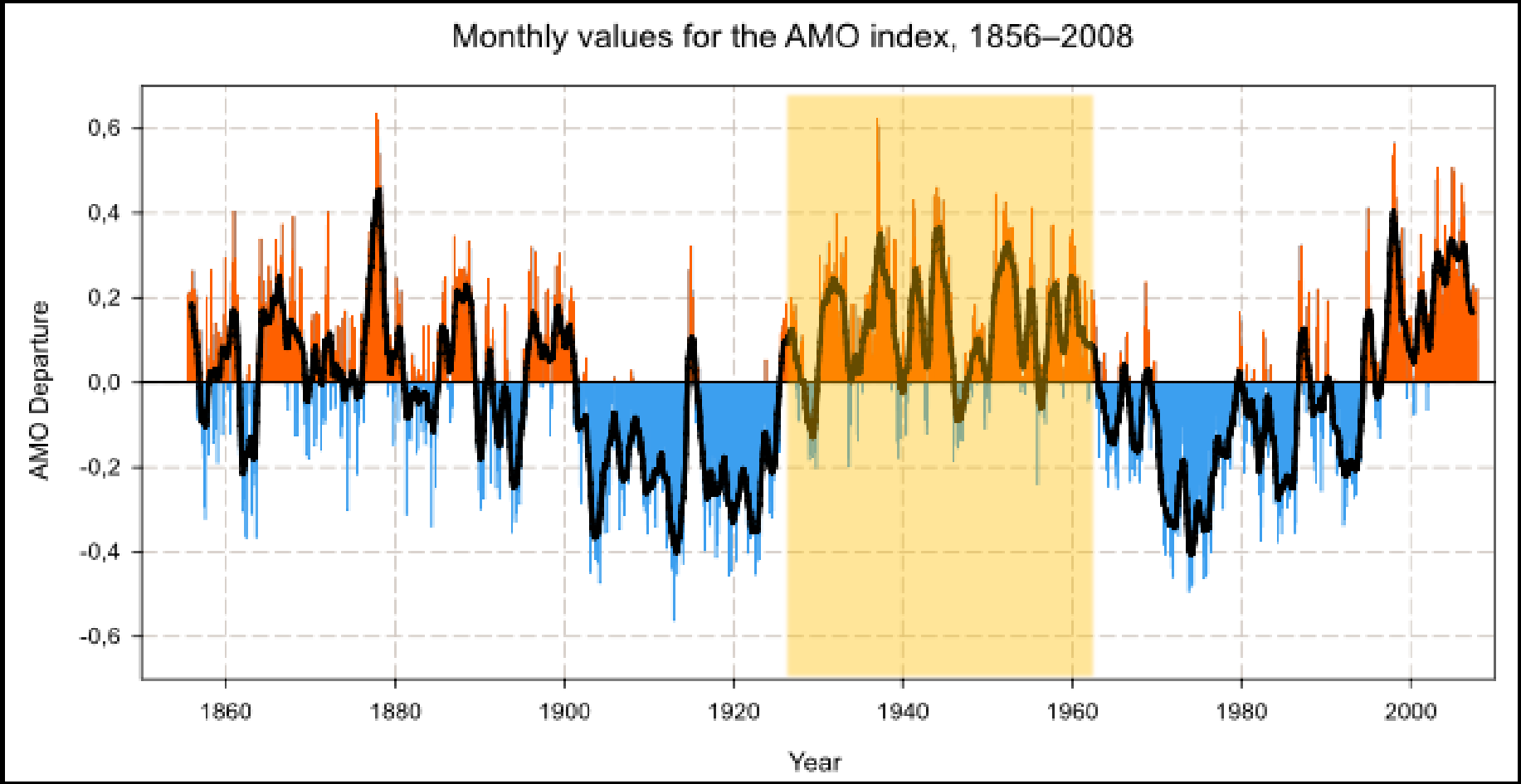


DACP: Dark Ages Cold Period
MWP: Medieval Warm Period
LIA: Little Ice Age
MGW: Modern Global Warming

LA "PICCOLA ERA GLACIALE"

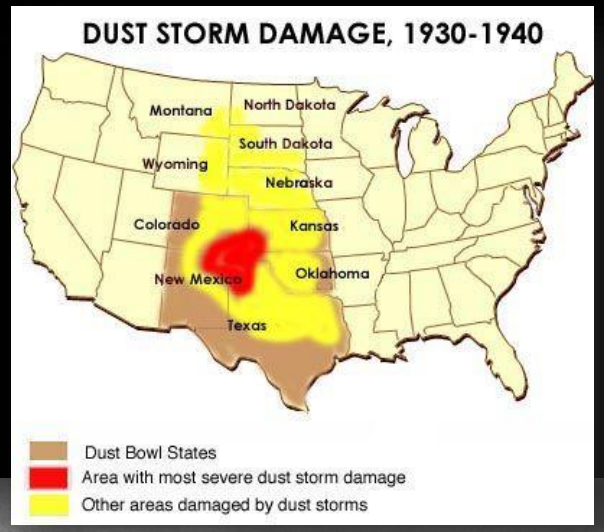
La laguna di Venezia gelata (1703), di G. Bella

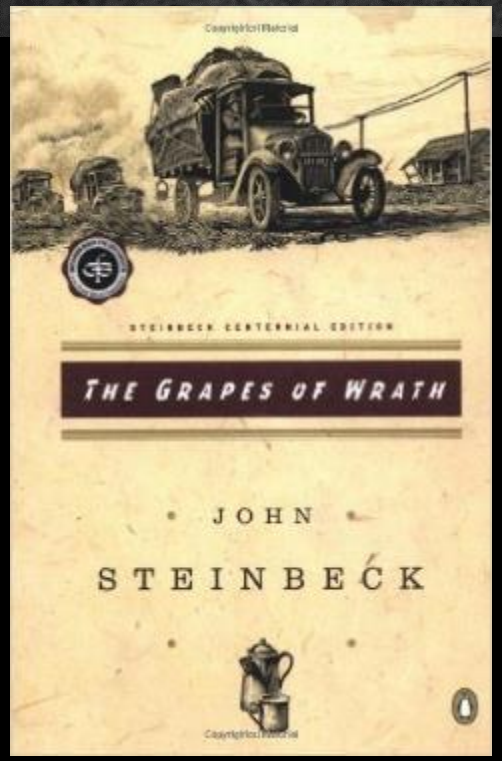
LA VARIABILITA' MODERNA:
OSCILLAZIONE MULTIDECADALE ATLANTICA (AMO)



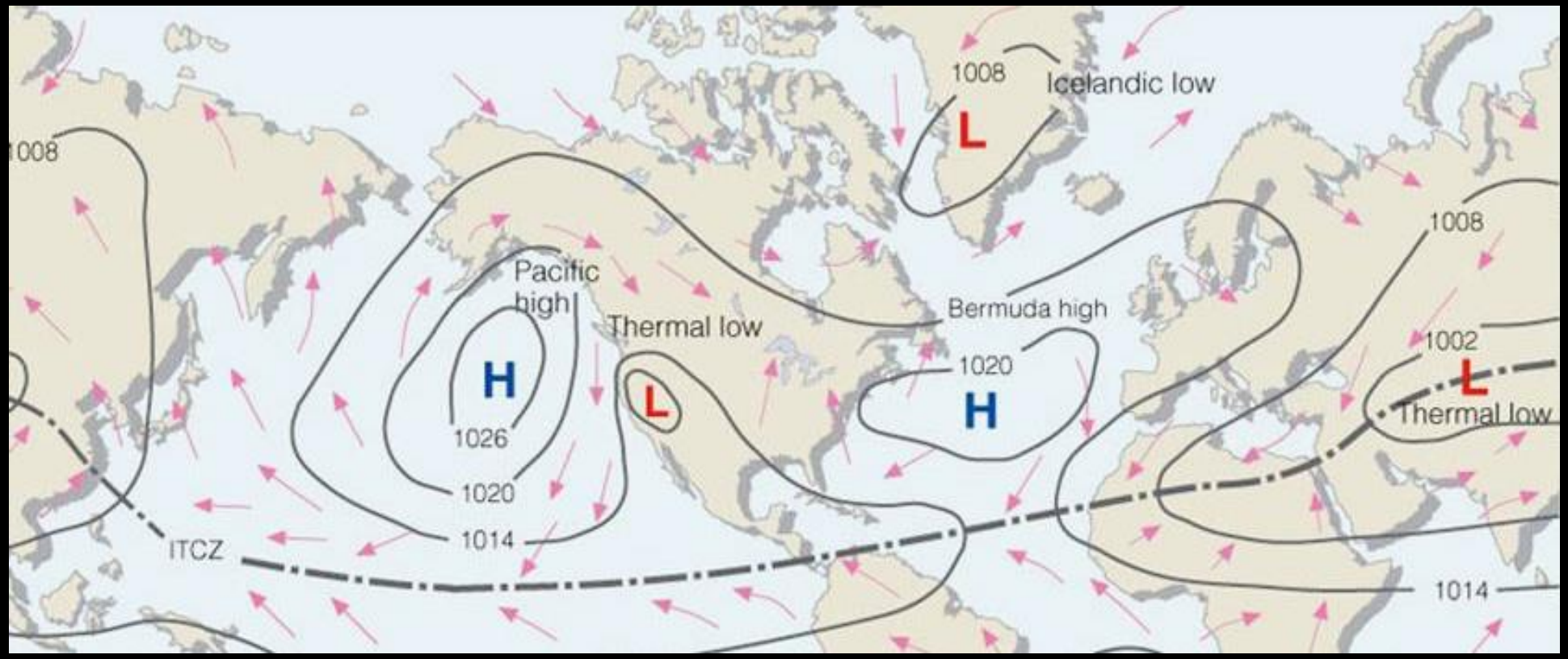
Variabilità delle SST nel N. Atlantico

Prossimo picco previsto per il 2020-2030


DUST STORM DAMAGE, 1930-1940
Montana
North Dakota
South Dakota
Wyoming
Nebraska
Colorado
Kansas
New Mexico
Oklahoma
Texas
Dust Bowl States
Area with most severe dust storm damage
Other areas damaged by dust storms

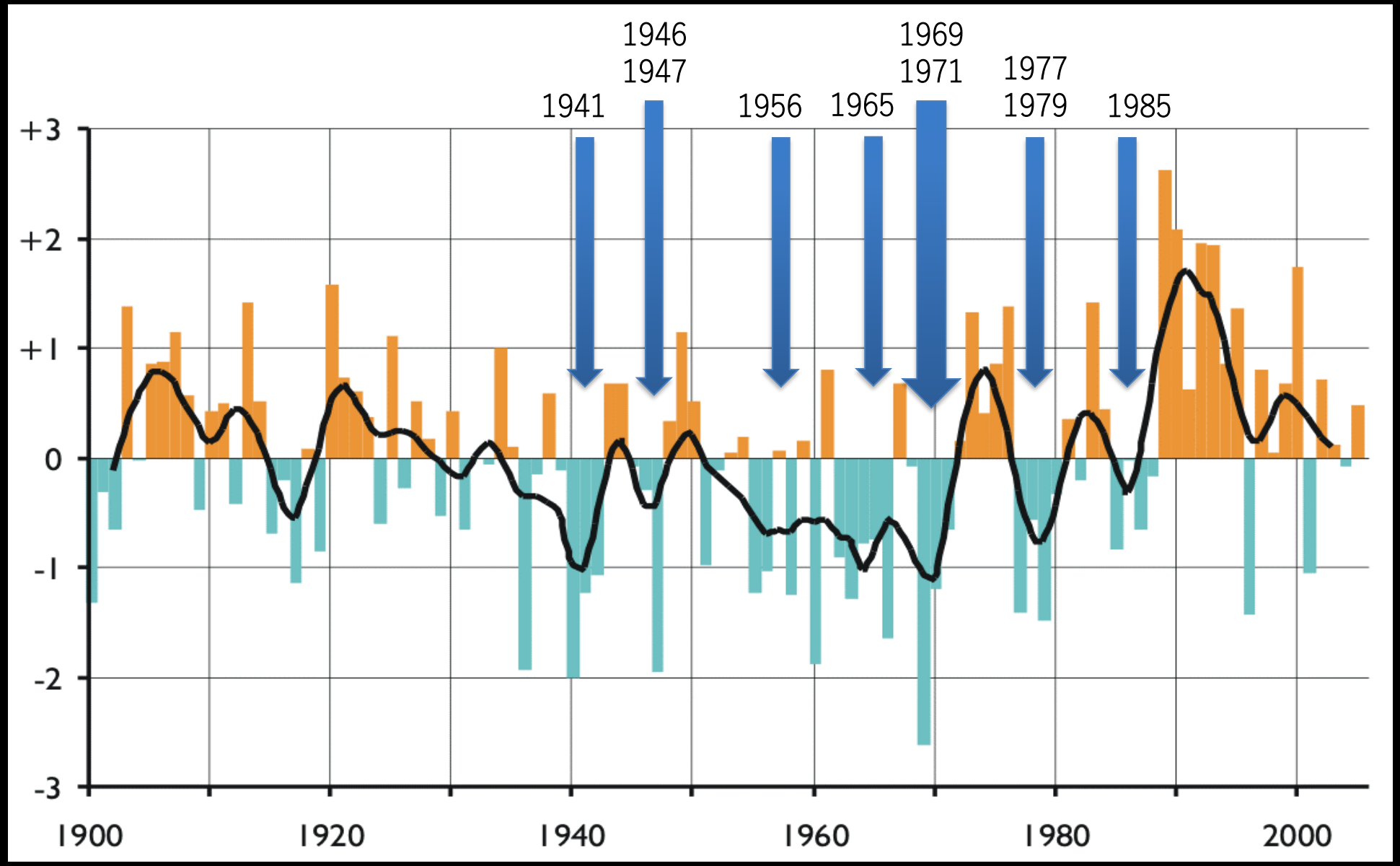

STEINBECK CENTENNIAL EDITION
THE GRAPES OF WRATH
JOHN
STEINBECK

NAO (OSCILLAZIONE NORD-ATLANTICA)

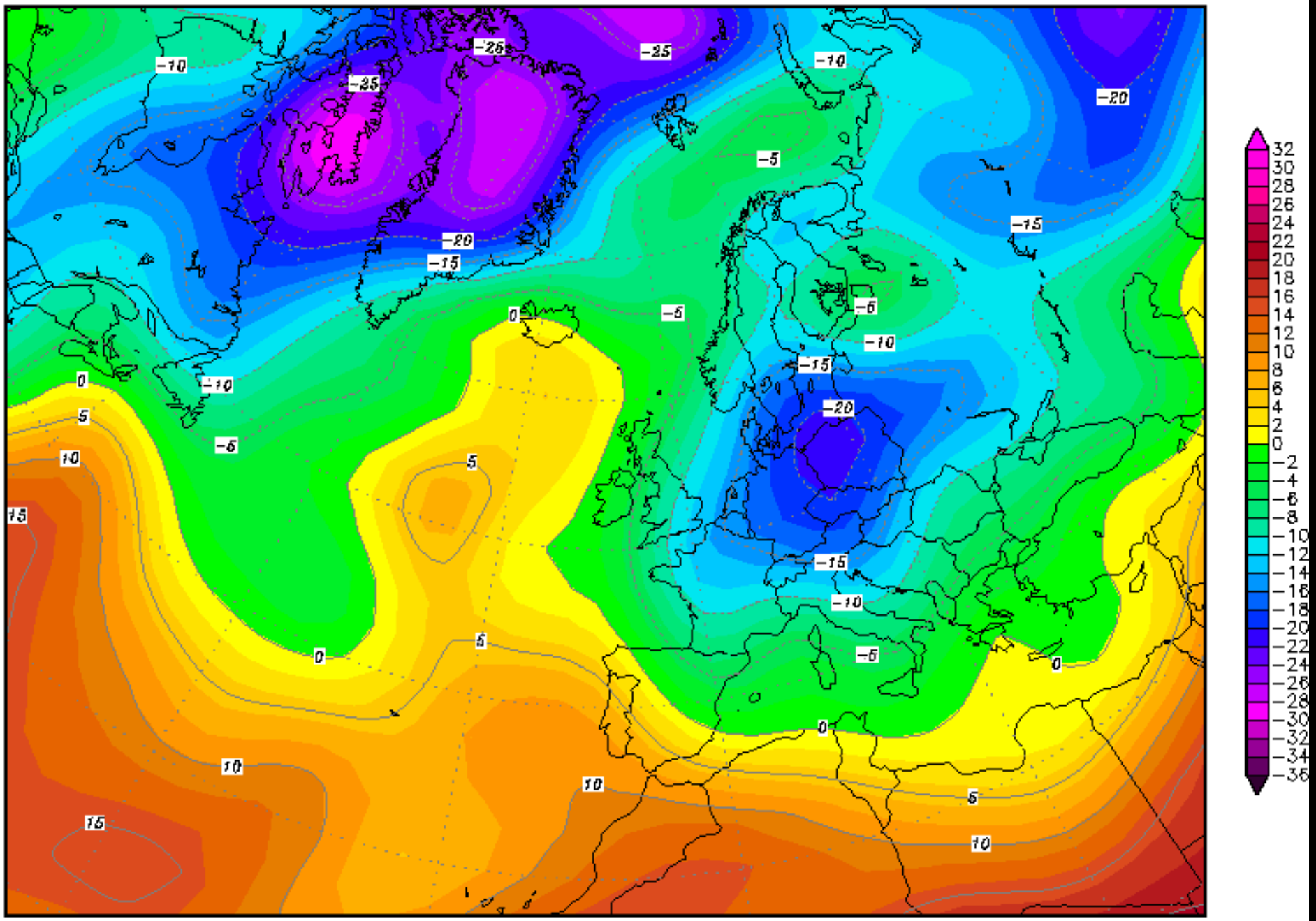


Variabilità nel rapporto di forza fra

L islandense e H delle Azzorre



NAO ed eventi nevosi estremi in N Italia



Daten: Reanalysis des NCEP
(C) Wetterzentrale
www.wetterzentrale.de

Temperature min al suolo, 5 marzo 1971