LIX SAIt, Catania

Effetti astronomici a lungo periodo ed evoluzione umana

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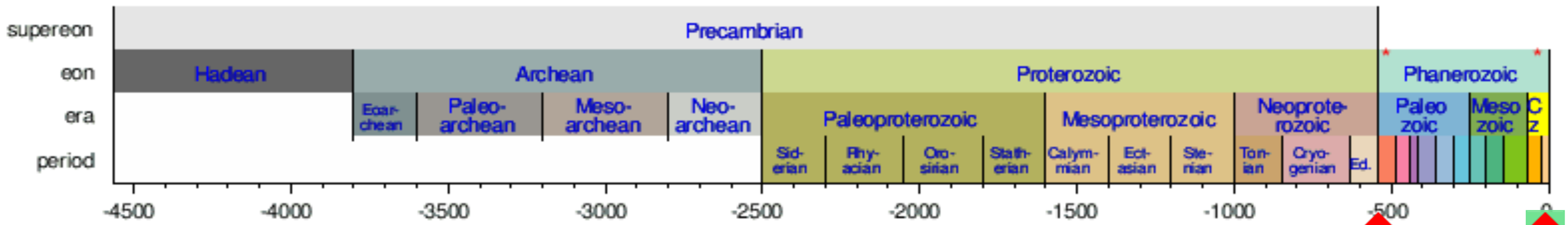
Effetto del clima sull’**evoluzione darwiniana** degli *Hominini* negli ultimi tre milioni di anni, e della specie umana :

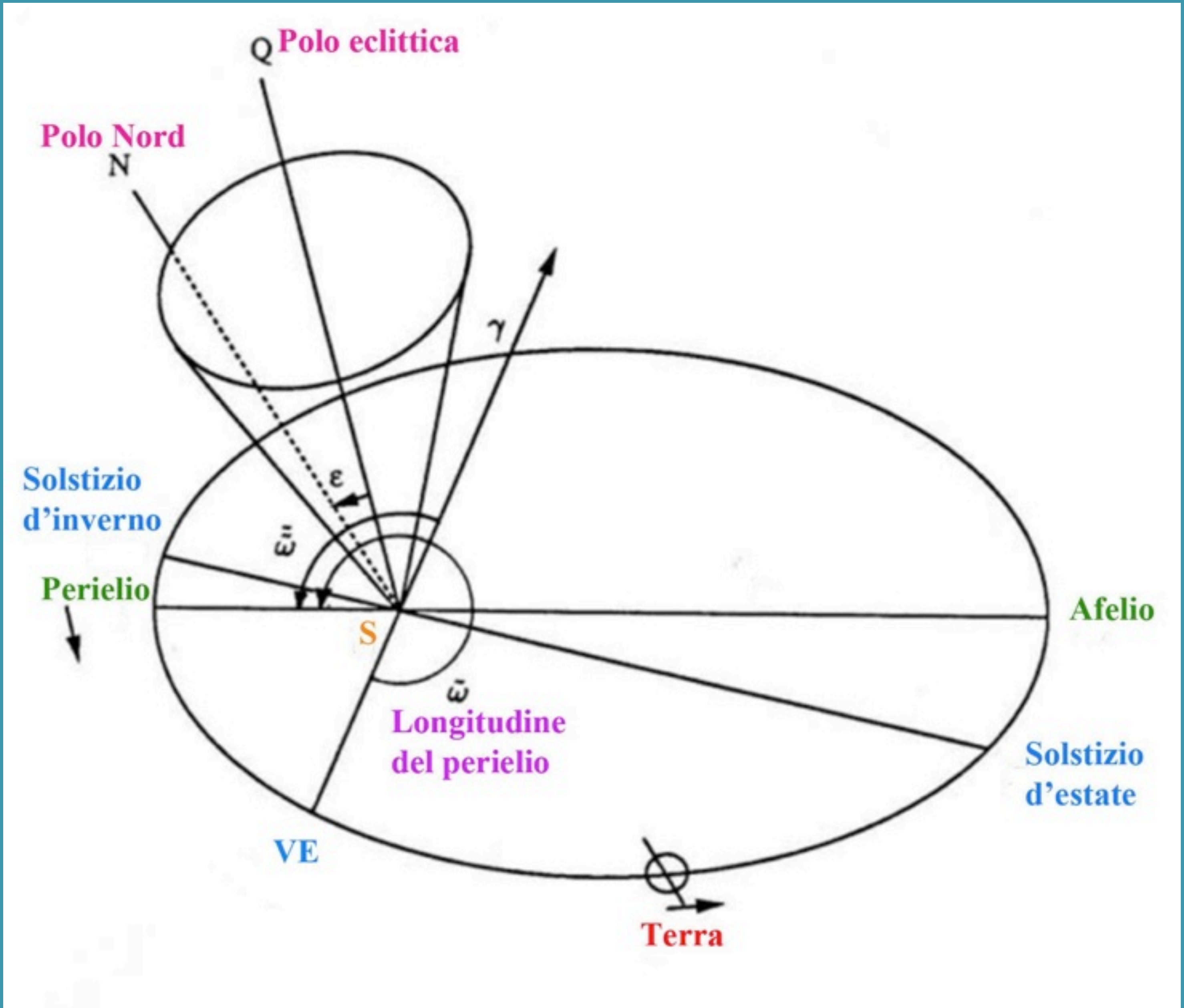
P. deMenocal, 2014, *Climate shocks*, Scientific American, 9/2014;   *Shock climatici*, Le Scienze, 11/2014

“L'importanza del contributo delle variazioni climatiche all'evoluzione dell'uomo nel corso di milioni di anni si fa sempre più evidente”.

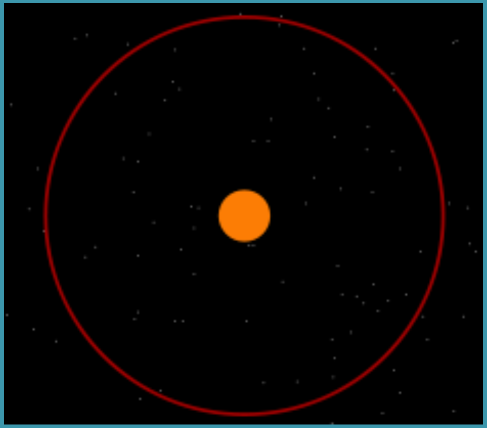
Le variazioni climatiche dipendono da parametri astronomici.

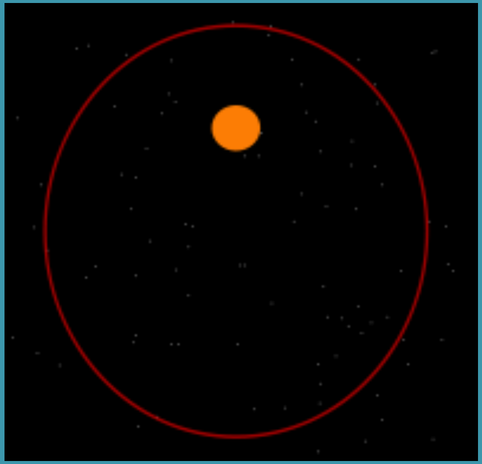

supereon
eon
era
period
Precambrian
Hadean
Archean
Proterozoic
Phanerozoic
Eoar-chean
Paleo-archean
Meso-archean
Neo-archean
Paleoproterozoic
Mesoproterozoic
Neoprote-rozoic
Paleo zoic
Meso zoic
C z
Sid-erian
Rhy-acian
Oro-sirian
Stath-erian
Calym-mian
Ect-asian
Ste-nian
Ton-ian
Cryo-genian
Ed.
-4500
-4000
-3500
-3000
-2500
-2000
-1500
-1000
-500
0

Elements of the Earth's orbit (Berger & Loutre, 1994)

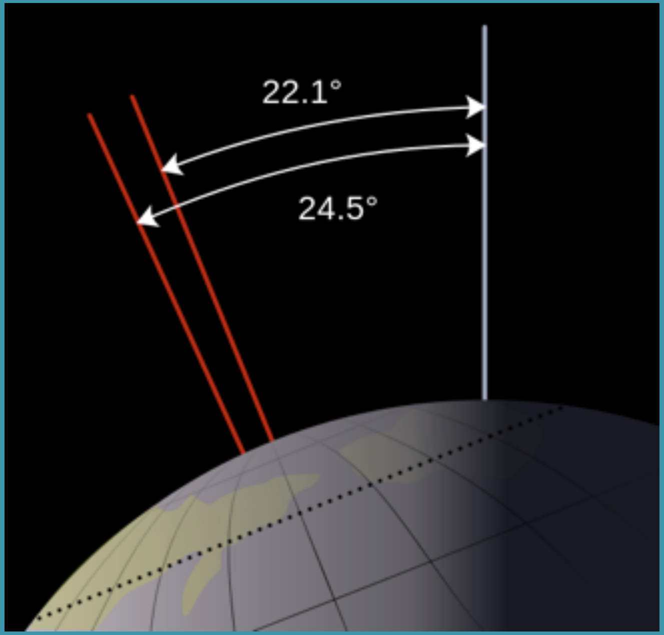


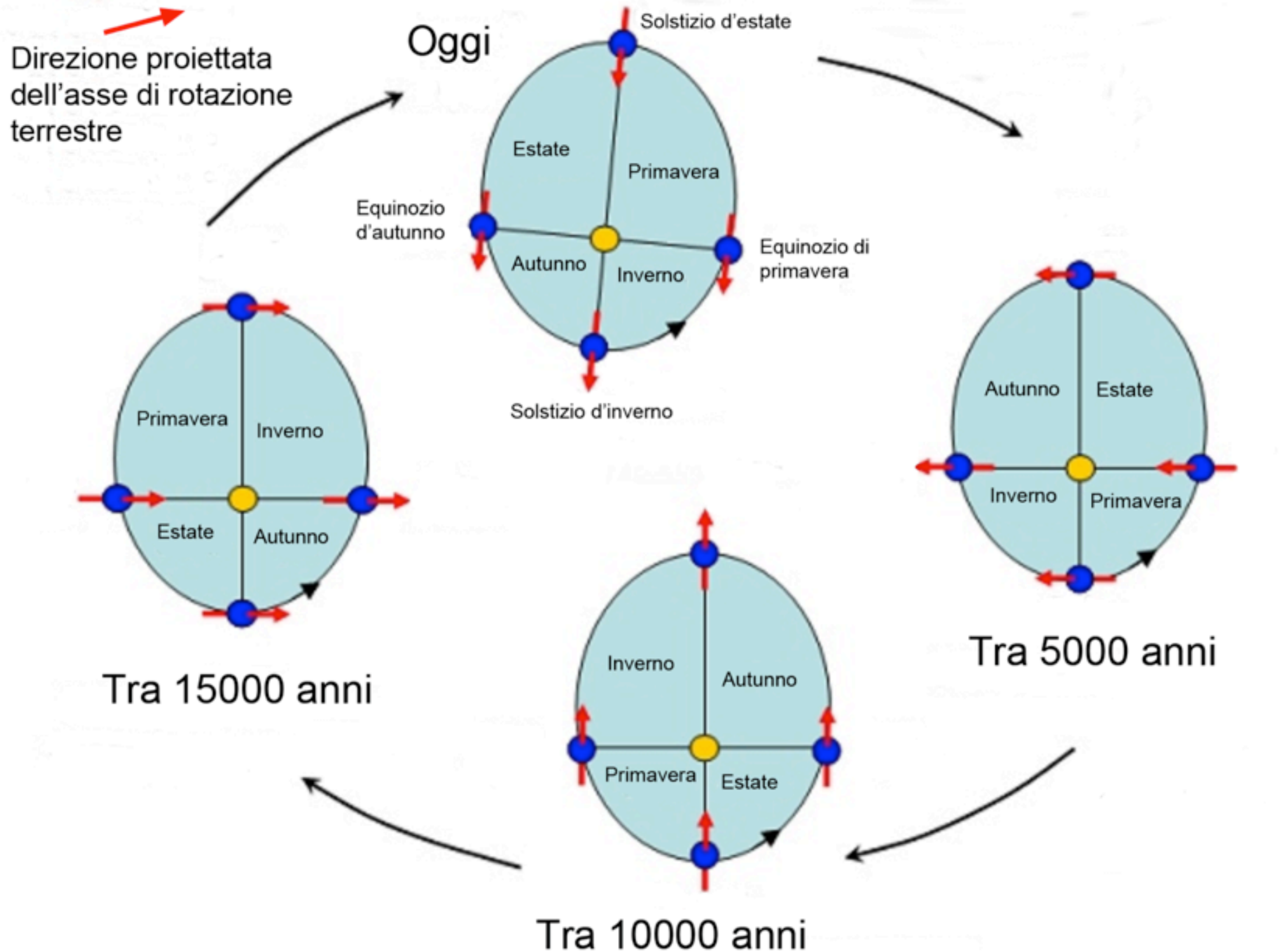
e eccentricità (scala 100000 anni)





Obliquità dell'eclittica (circa 41000 anni)

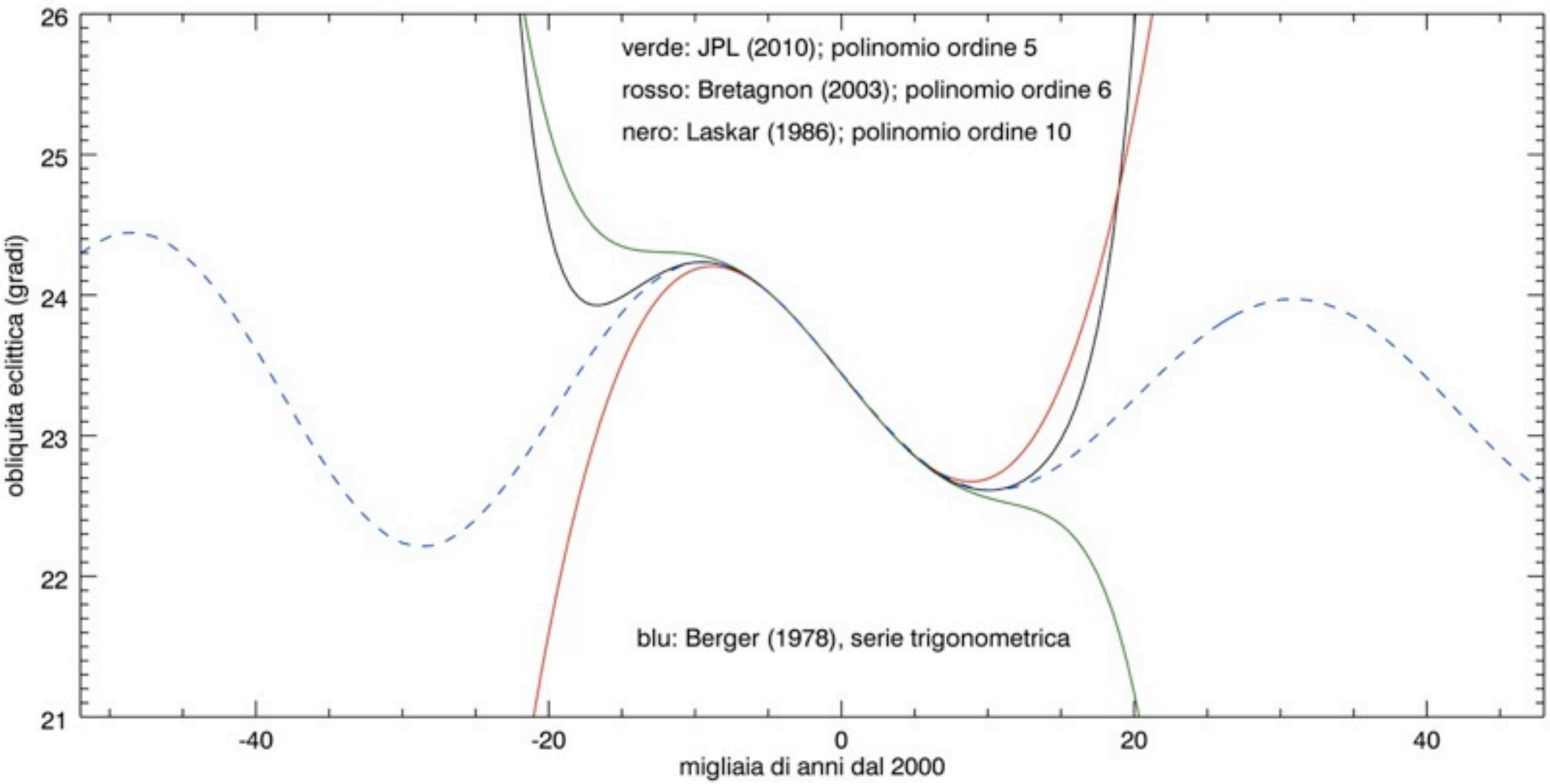




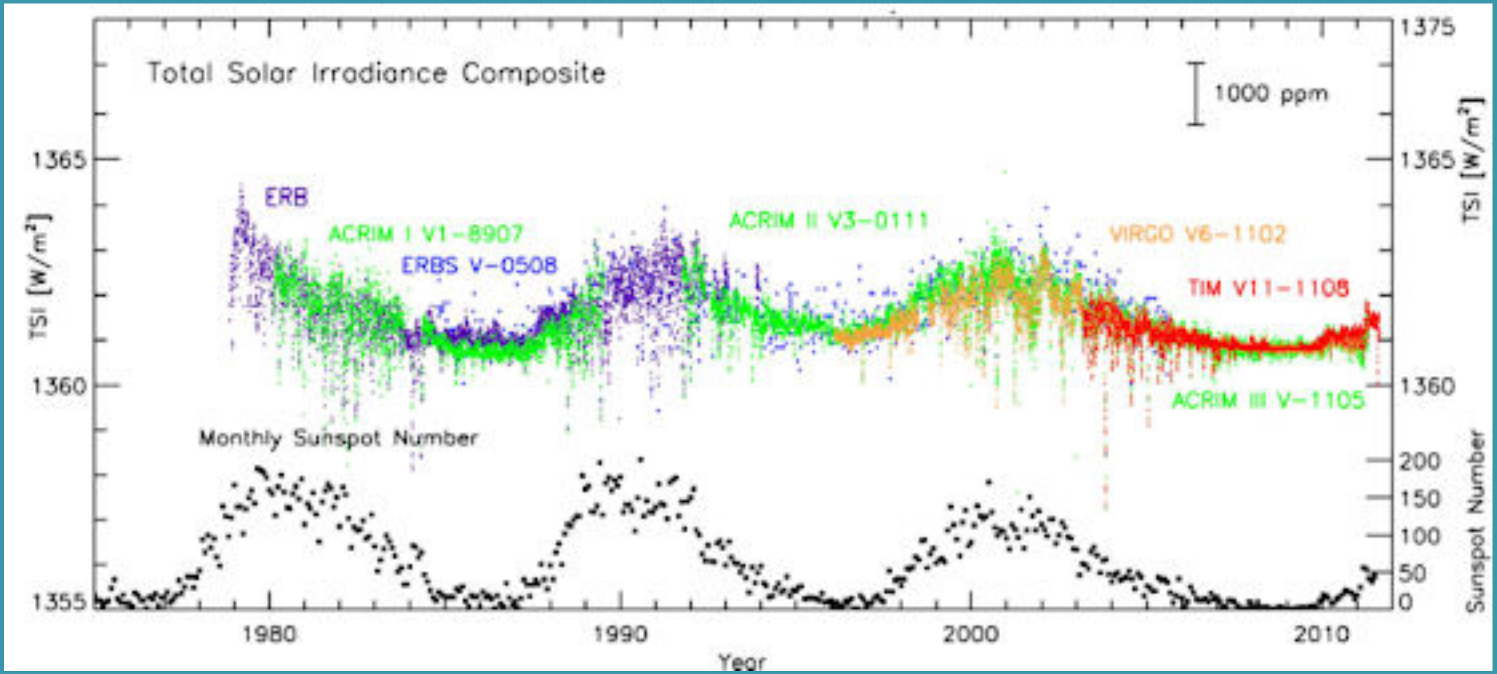
Precessione equinozi + apsidi = precessione climatica (circa 19000 - 23000 anni)

Obliquità dell’eclittica ε (periodo circa 41000 anni)

Soluzione equazioni meccanica celeste. Perturbazioni secolari.
Confronto tra espansioni polinomiali in tempo e serie trigonometriche.



“Costante” solare: energia per unità di tempo e di superficie (ortogonale ai raggi solari), senza atmosfera.



Space-borne measurements of the total solar irradiance (TSI) show ~0.1 percent variations with solar activity on 11-year and shorter timescales. These data have been corrected for calibration offsets between the various instruments used to measure TSI. SOURCE: Courtesy of Greg Kopp, University of Colorado. (NASA – Science News 2013)

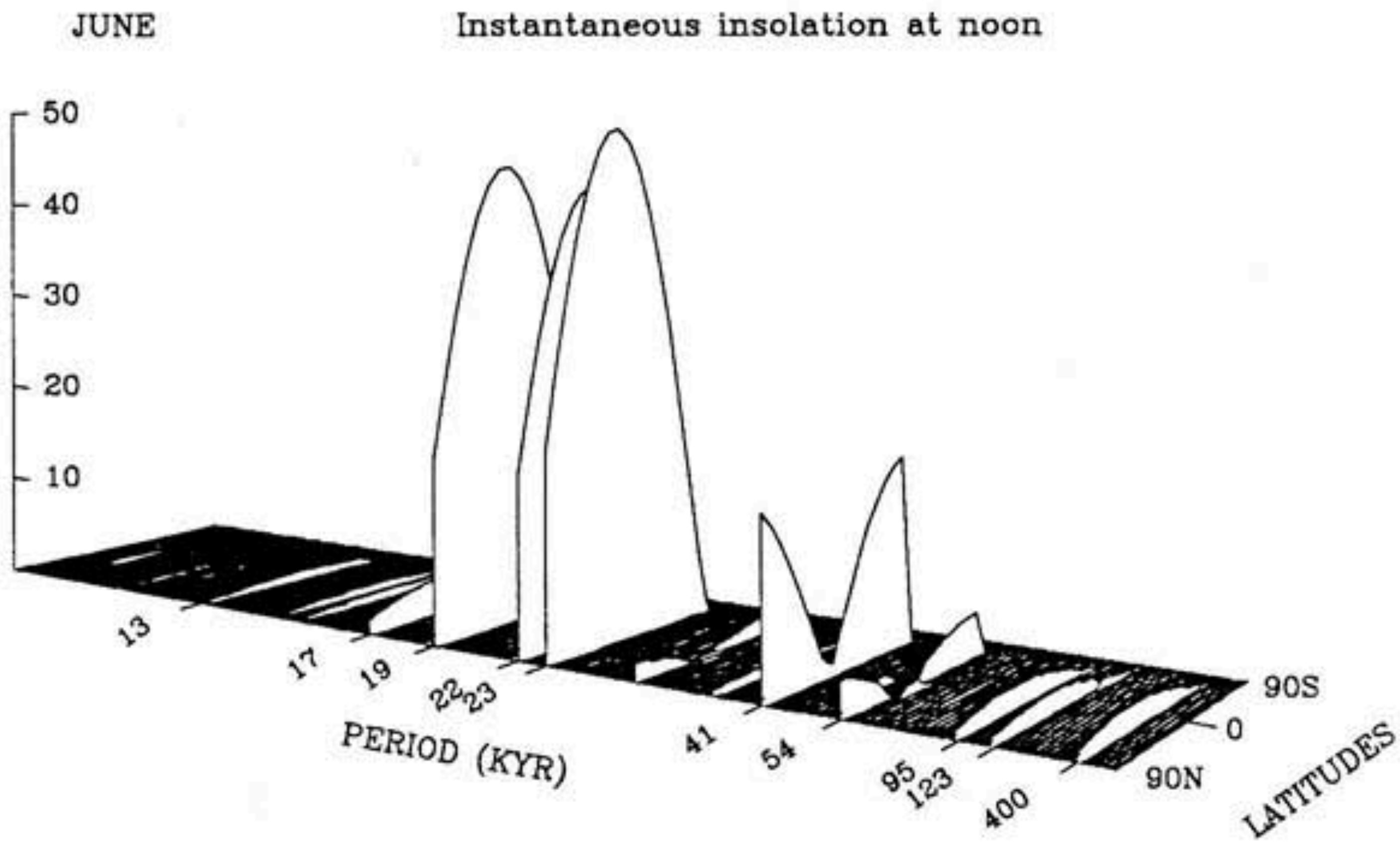
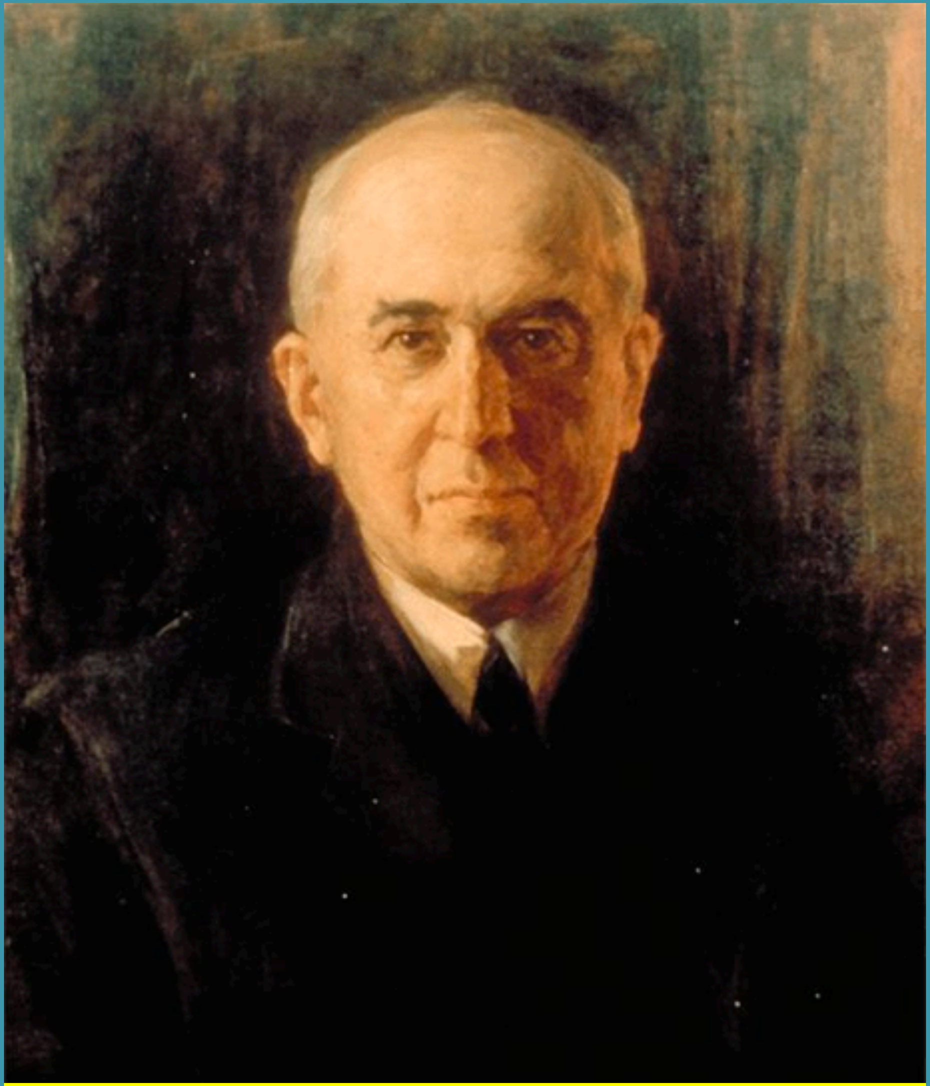


Figure 9: Spectral amplitude in the Thomson multi-taper harmonic analysis of the instantaneous insolation at noon for summer solstice (June) and for each latitude between the north pole and the south pole.

Berger A. and Loutre M.F., 1994. *Precession, eccentricity, obliquity, insolation and paleoclimates.* In: Long Term Climatic Variations, Data and Modelling. J.C. Duplessy and M.-T. Spyridakis (eds). Nato ASI series, Serie I: Global Environmental Change, Springer-Verlag, Berlin, vol. 22. p107-151. http://ebookbrowsee.net/berger-loutre-1994-pdf-d362816449



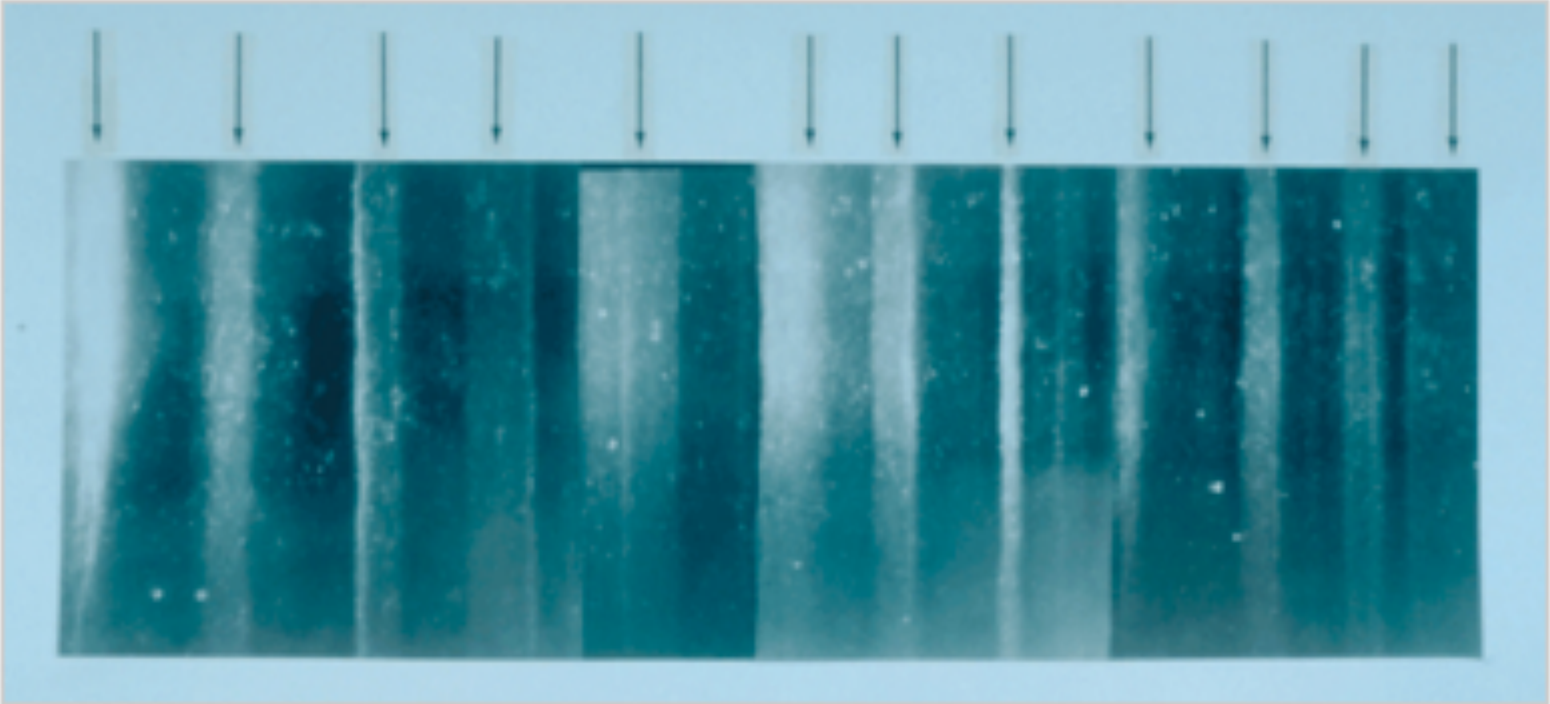
Milutin Milankovitch (1879-1958)

Milankovitch (1941) ha riassunto in un libro i risultati dei suoi calcoli dell'insolazione, basati su lavori precedenti di Leverrier, Stockwell e Pilgrim.

Ha proposto che l'insolazione estiva è quella dominante.

Fino agli anni '70 del secolo scorso non è stato possibile effettuare tests convincenti, data la scarsità di dati geologici specifici.

CLIMATE PROXIES: ICE CORES



19 cm long section of GISP 2 ice core from 1855 m showing annual layer structure illuminated from below by a fiber optic source. Section contains 11 annual layers with summer layers (arrowed) sandwiched between darker winter layers.

CLIMATE PROXIES: Corals, Benthic Foraminifera

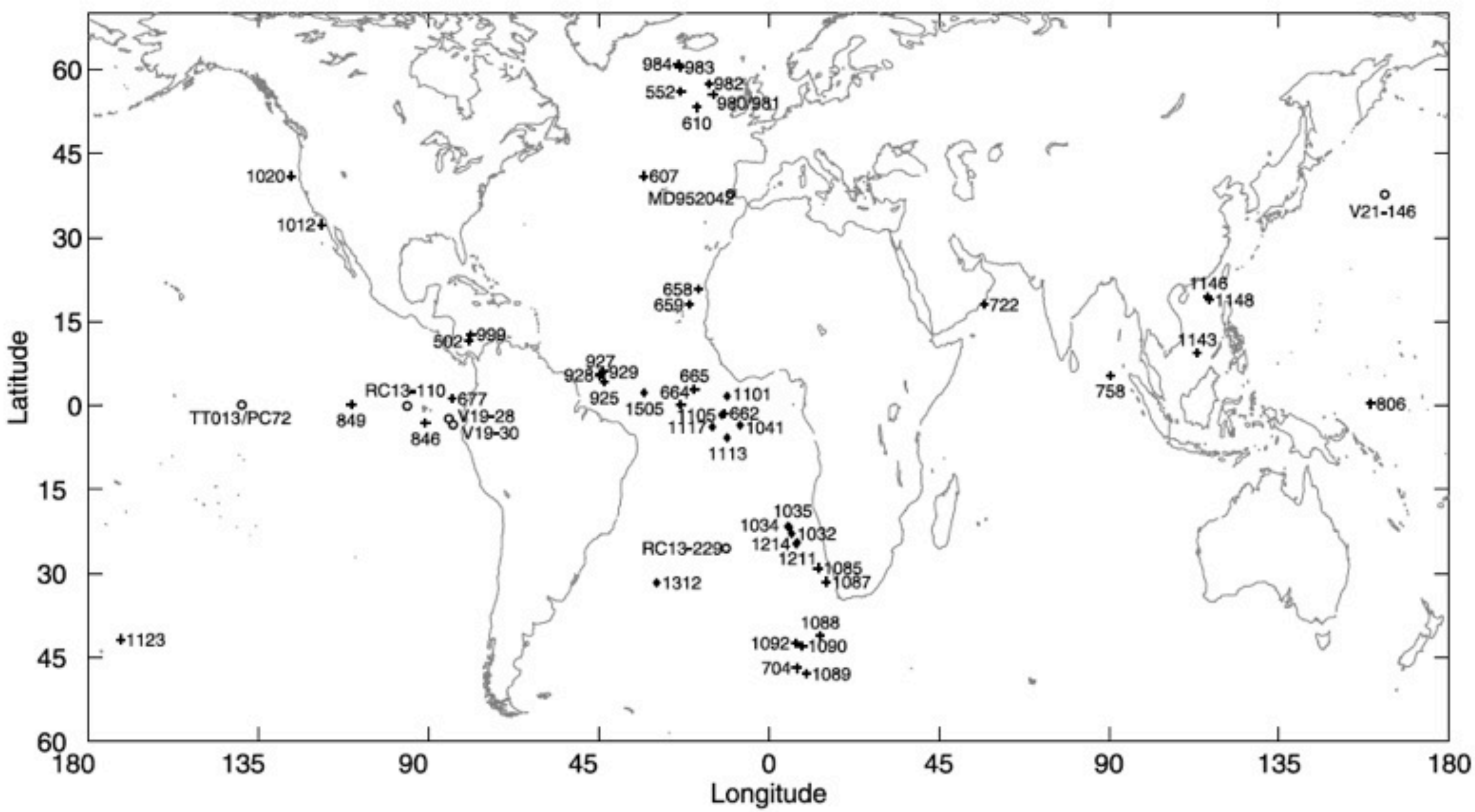


Figure 1. Location of the cores used in this study. Benthic $\delta^{18}O$ data are taken from Deep-Sea Drilling Project (DSDP) and Ocean Drilling Program (ODP) sites (crosses), GeoB sites (diamonds), and others (circles).

Lisiecki, L. E.; Raymo, M. E. (January 2005). *A Pliocene-Pleistocene stack of 57 globally distributed benthic δ18O records*. Paleoceanography 20: PA1003.

$\delta^{18}O$

From Wikipedia, the free encyclopedia

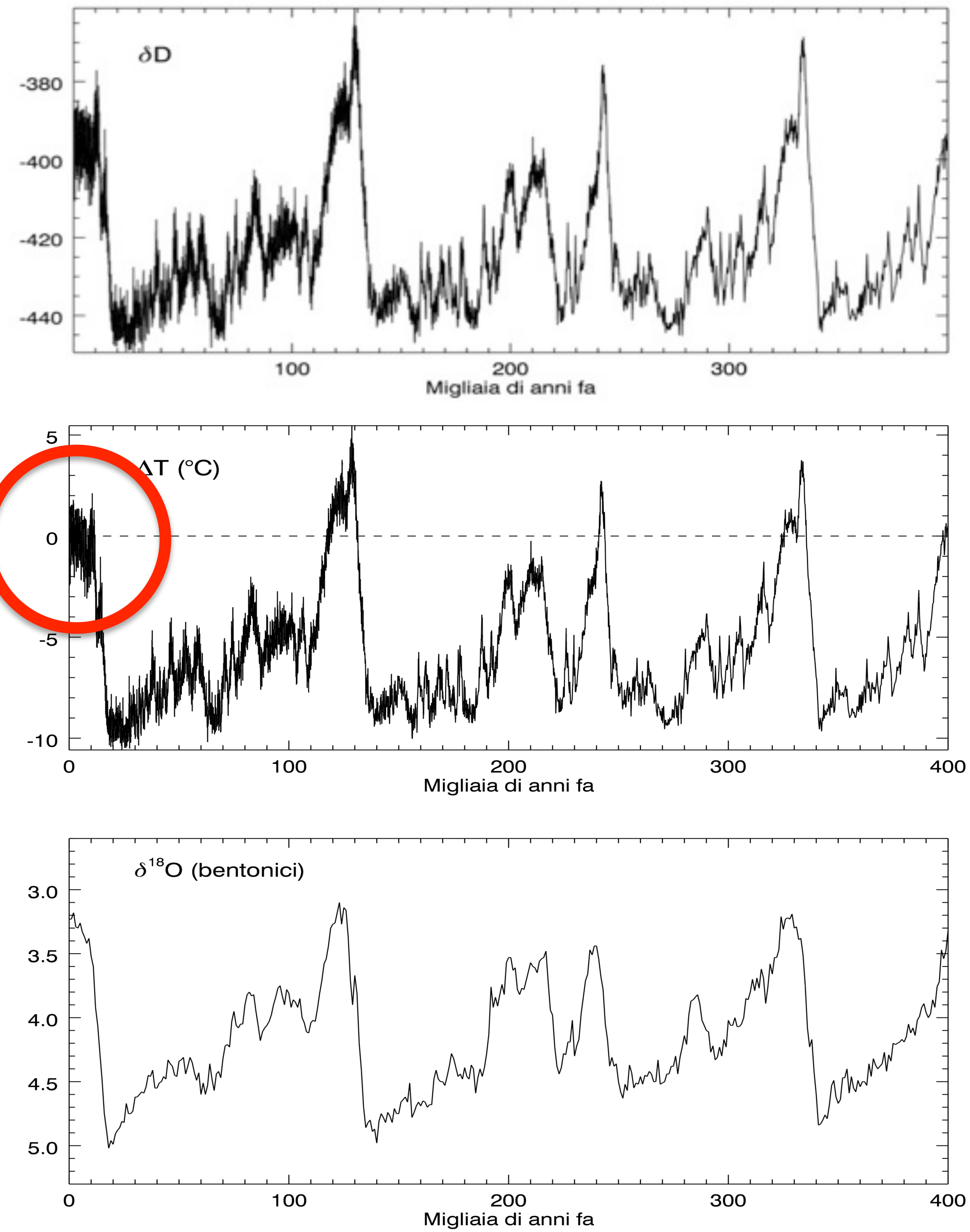
In geochemistry, paleoclimatology and paleoceanography **$\delta^{18}O$** or **delta-O-18** is a measure of the ratio of stable isotopes **^{18}O:^{16}O** (oxygen-18:oxygen-16). It is commonly used as a measure of the temperature of precipitation, as a measure of groundwater/mineral interactions, as an indicator of processes that show isotopic fractionation, like methanogenesis. In paleosciences, ^{18}O:^{16}O data from corals, foraminifera and ice cores are used as a proxy for temperature. The definition is, in "per mil" (‰, parts per thousand):

$$\delta^{18}O = \left(\frac{\left(\frac{^{18}O}{^{16}O}\right)_{sample}}{\left(\frac{^{18}O}{^{16}O}\right)_{standard}} - 1 \right) * 1000\ {}^{o}\!/_{oo}$$

where the standard has a known isotopic composition, such as Vienna Standard Mean Ocean Water (VSMOW).[2] The fractionation can arise from kinetic, equilibrium, or mass-independent fractionation.

^{16}O	99.76%	^{16}O is stable with 8 neutrons
^{17}O	0.039%	^{17}O is stable with 9 neutrons
^{18}O	0.201%	^{18}O is stable with 10 neutrons

Antartide EPICA/DomeC
(Jouzel et al. 2007):
eccesso di deuterio
(per mille)



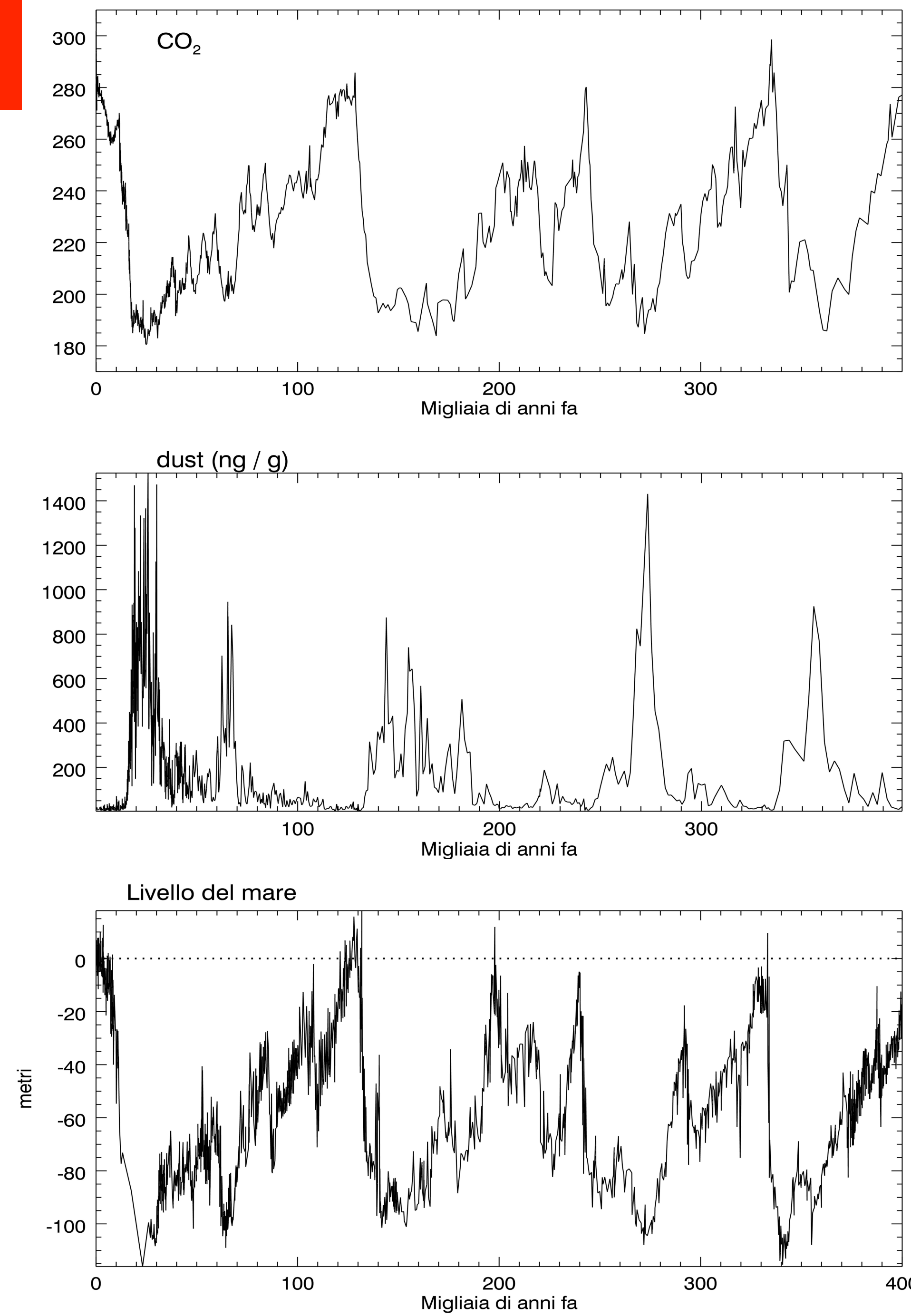
Ocean drillings
(Lisiecki, Raymo, 2005)
eccesso di ossigeno

2015:
400 p.p.m.!

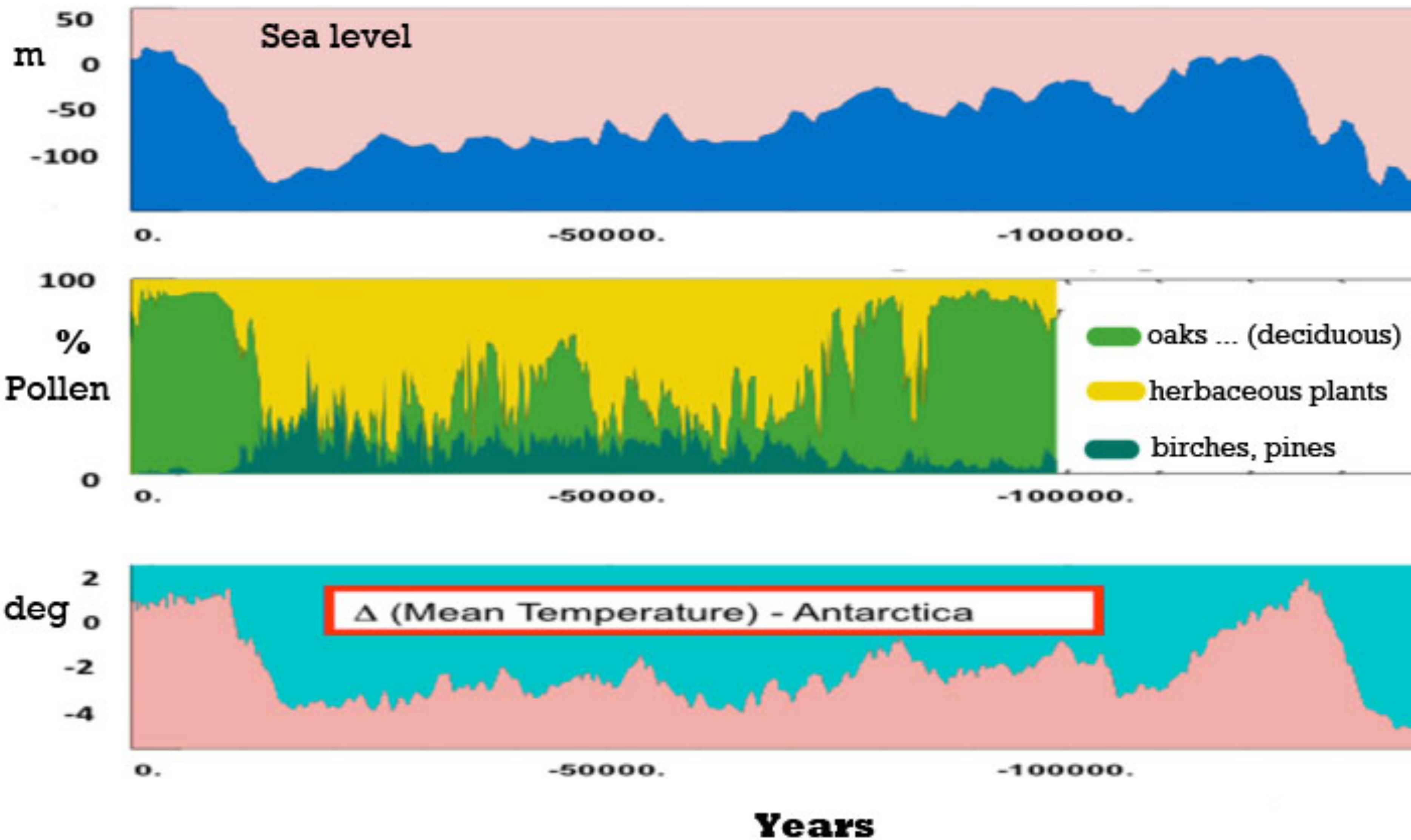
Antartide: CO2 (p.p.m.)

Antartide (Lambert et al., 2008)

Mar Rosso (Grant et al. 2014)

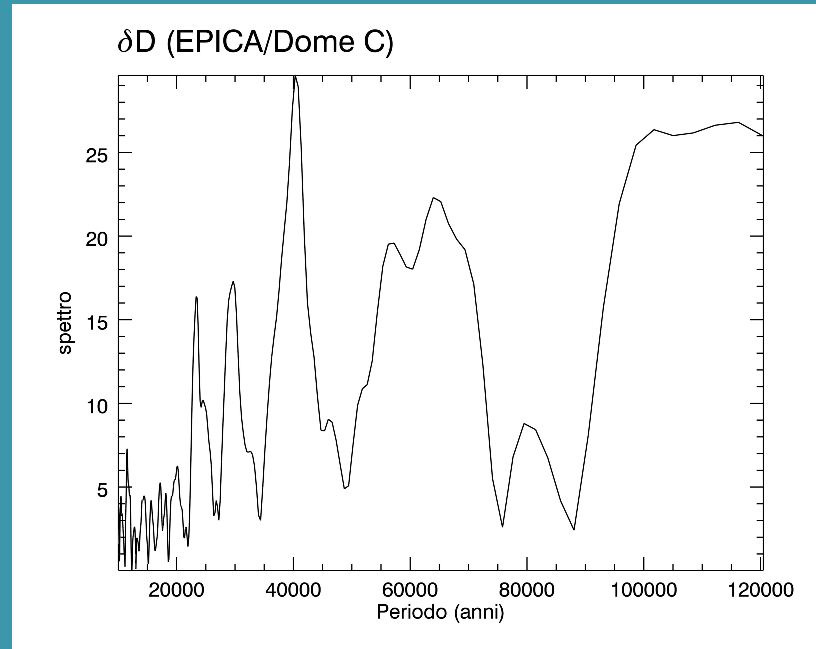


CLIMATE PROXIES: Pollen

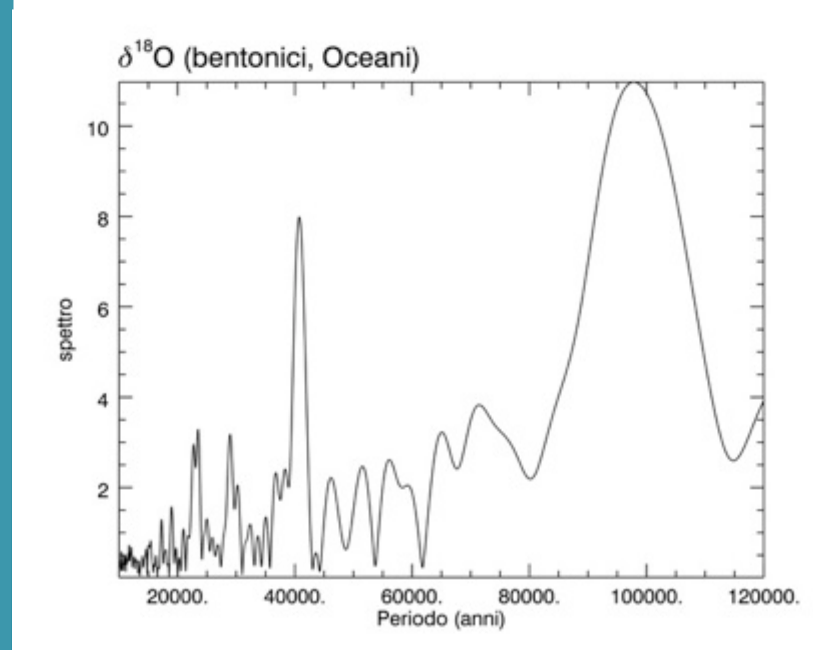


Allen, J. R.M., Watts, W. A., McGee, E. & Huntley, B. (2002). Holocene environmental variability - the record from Lago Grande di Monticchio, Italy. *Quaternary International* **88**: 69-80.

Spettri di ampiezza
(Lomb-Scargle)



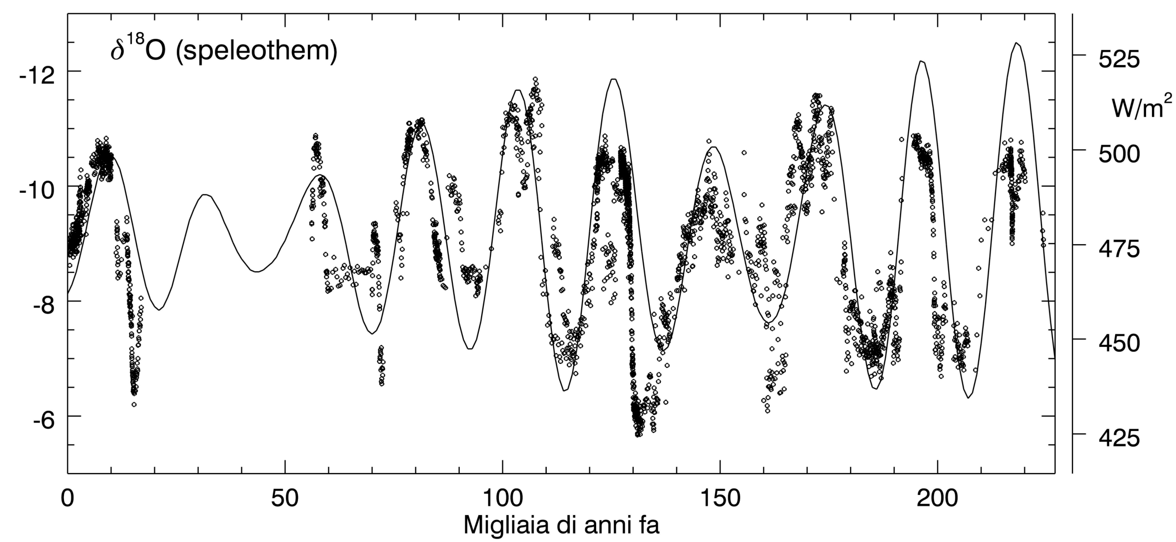
Antartide EPICA/DomeC
(Jouzel et al. 2007)
circa 800 Kyr



Ocean drillings
(Lisiecki, Raymo, 2005)
circa 5 Myr

PROXY: Speleothem

Andamento dell'eccesso di ^{18}O (in per mille) misurato in stalagmiti della Sanbao Cave in Cina (dati di **Wang et al. 2008**) confrontato con quello dell'insolazione estiva (mese di luglio) a latitudine 30° N (curva continua; dati di A. Berger).



Il dibattito in corso è volto a capire quanto è legato all'*orbital forcing* il sistema climatico del *South Asian Summer Monsoon*, *"da cui dipende la sopravvivenza di un quarto della popolazione mondiale"* (Shi et al., 2014).

PROXY: Speleothem

Andamento dell'eccesso di ^{18}O (in per mille) misurato in

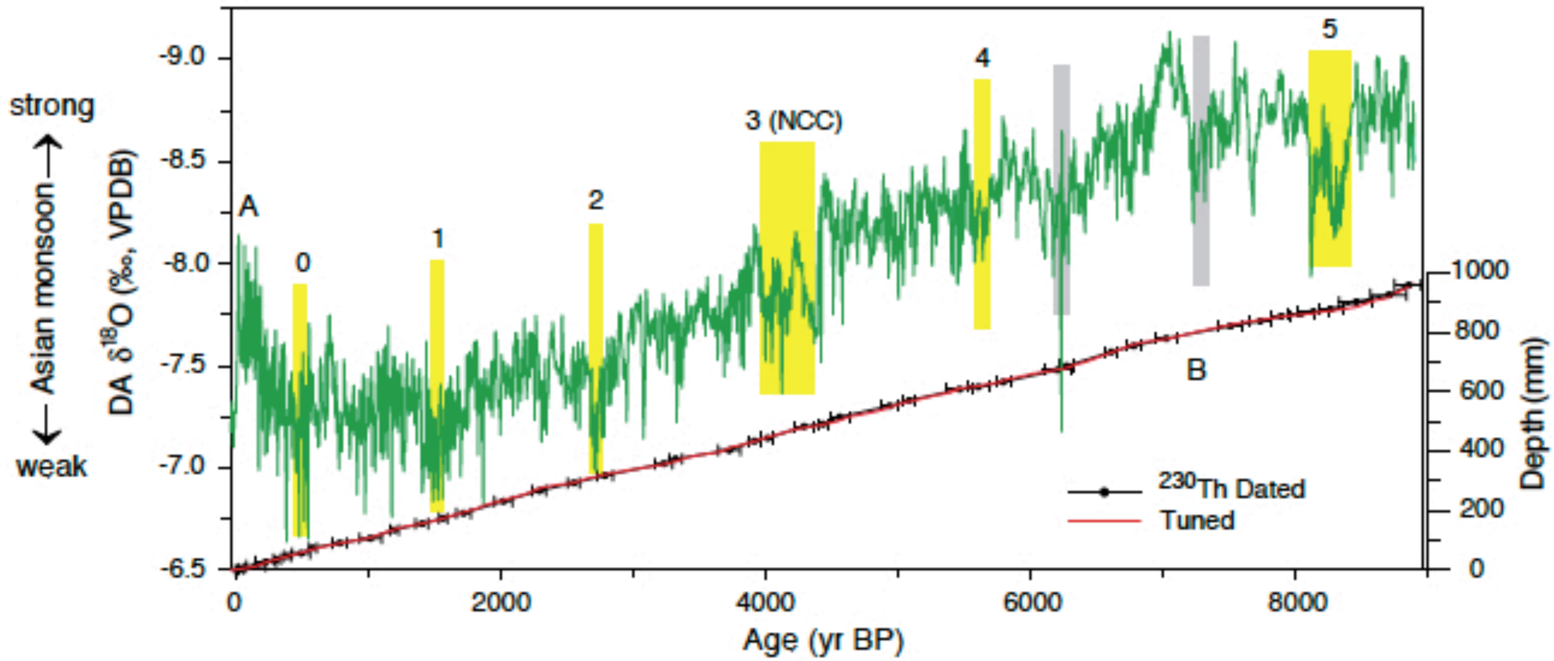
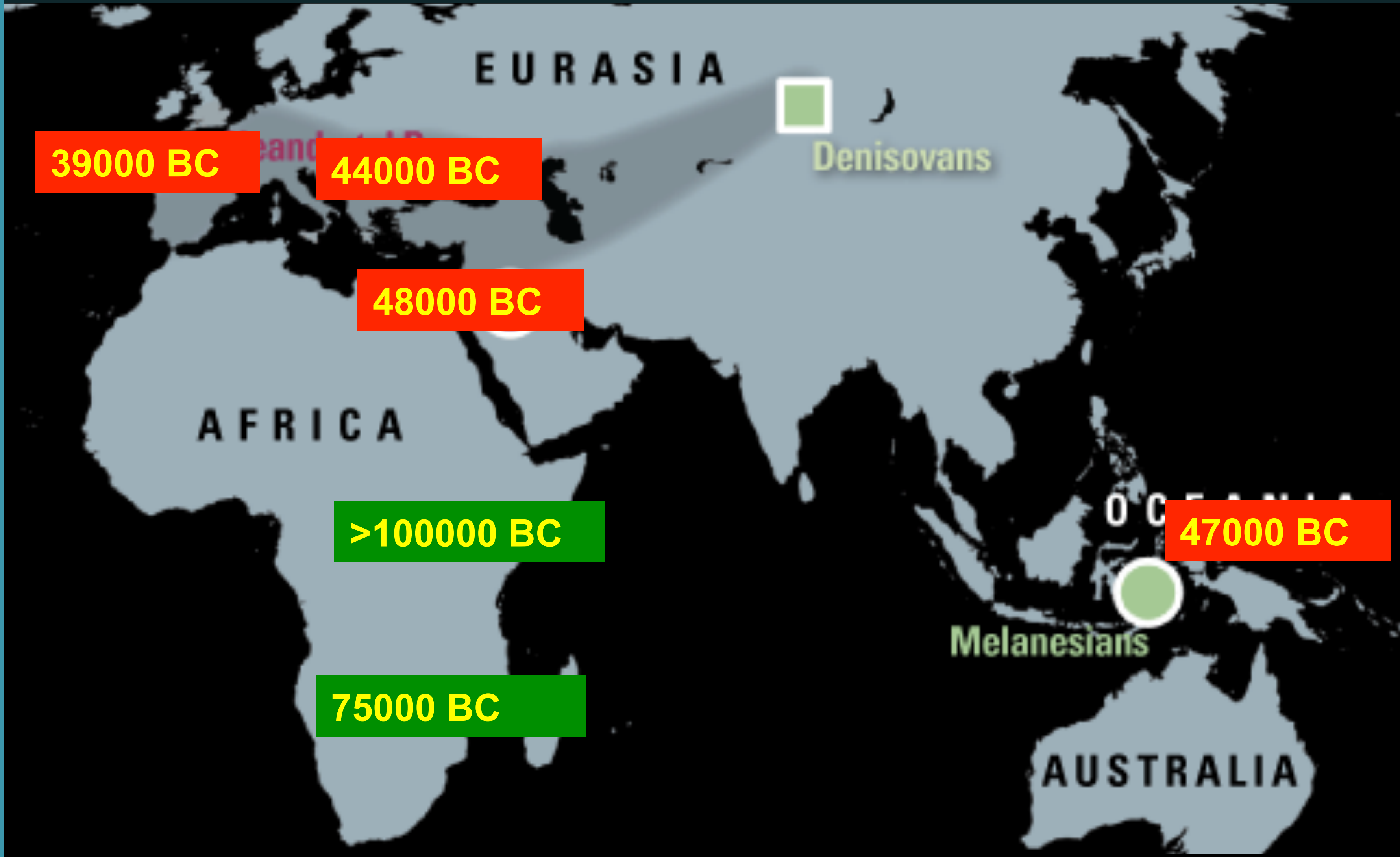


Fig. 1. (**A**) $\delta^{18}O$ time series of the Dongge Cave stalagmite DA (green line). Six vertical yellow bars denote the timing of Bond events 0 to 5 in the North Atlantic (*2*). The Chinese events that correlate with Bond events 3 and 5 coincide within error with the collapse of the Neolithic Culture of China (NCC) (*23*) and the timing of an abrupt outflow event from a Laurentide ice-margin lake (*22*), respectively. Two vertical gray bars indicate two other notable weak AM events that can be correlated to ice-rafted debris events (*2*). (**B**) DA age-depth (mm, relative to the top) relations. Black error bars show ^{230}Th dates with 2σ errors (table S1). We use two different age-depth curves, one employing linear interpolation between dated depths and the second slightly modified by tuning to INTCAL98 (*15*) within the ^{230}Th dating error (*26*).

Il dibattito in corso è volto a capire quanto è legato all'*orbital forcing* il sistema climatico del *South Asian Summer Monsoon*, *"da cui dipende la sopravvivenza di un quarto della popolazione mondiale"* (Shi et al., 2014).

EVOLUZIONE UMANA



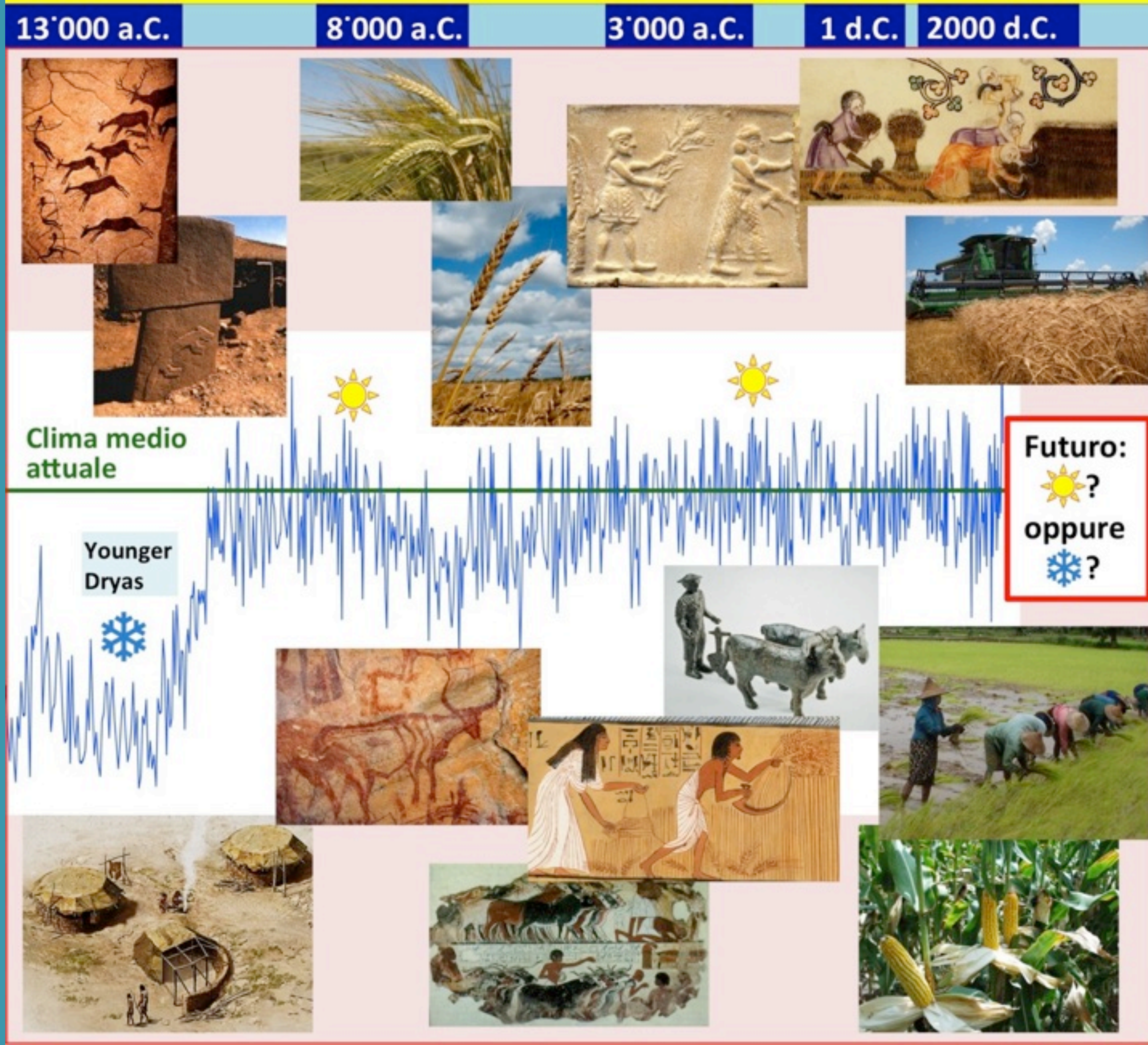
A. Gibbons, 2011, *A new view of the birth of Homo sapiens*, Science, 331, 392

Diffusione dell' *Homo sapiens* dall' Africa

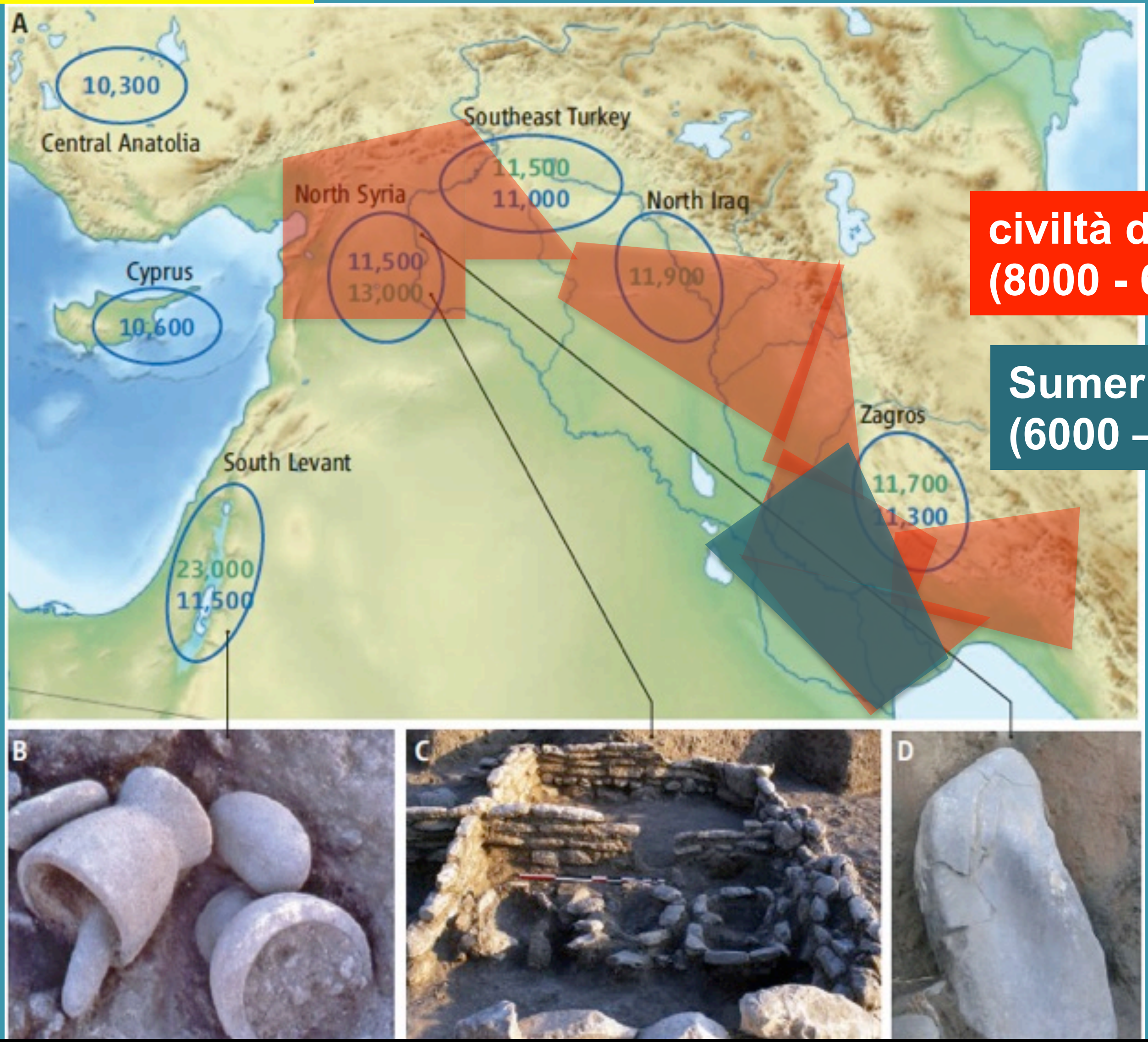
Paleolitico

Tempo →

L'ANDAMENTO DEL CLIMA E LA NOSTRA EVOLUZIONE
(ultimi 15˙000 anni)



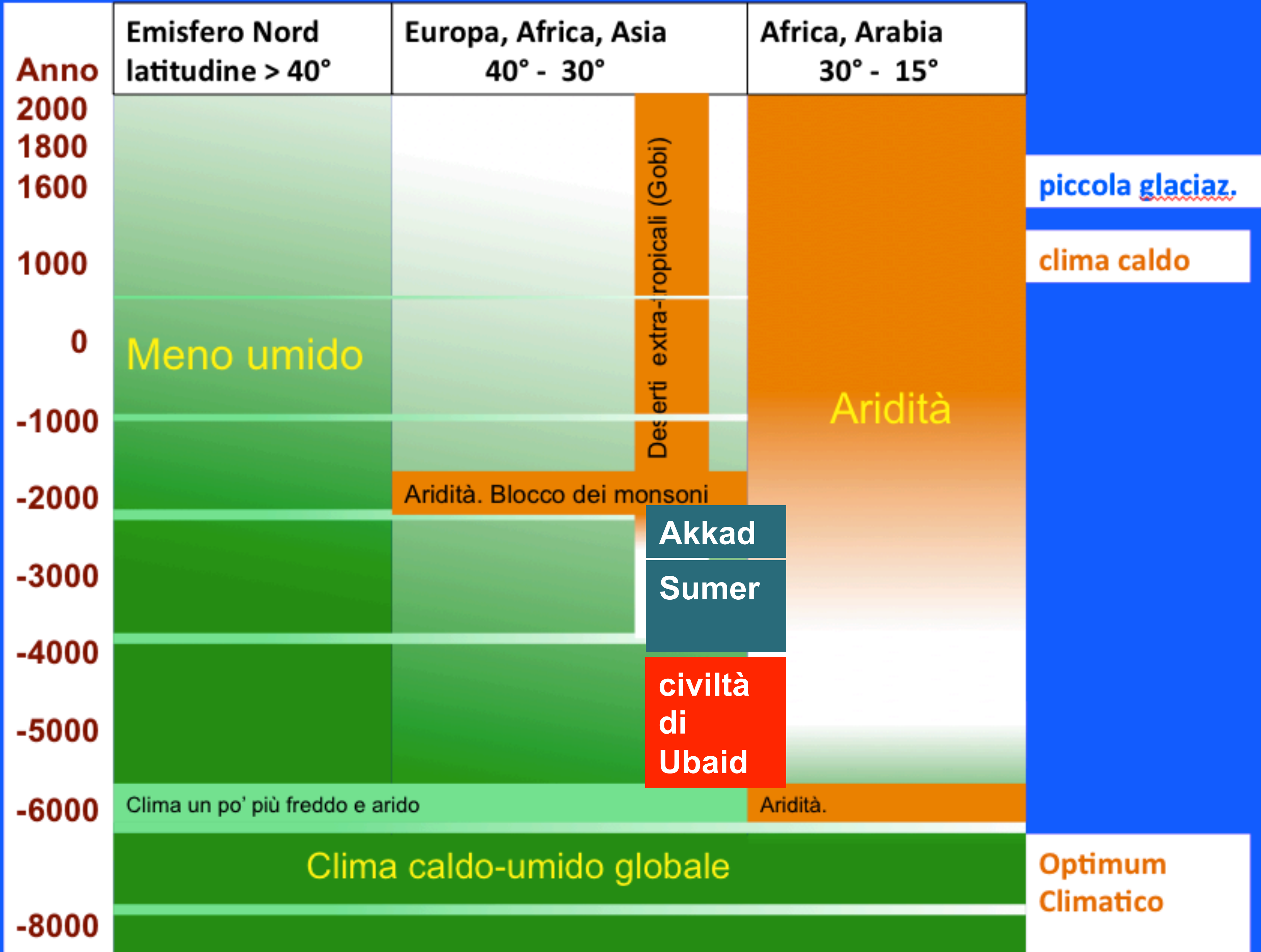
Neolitico



civiltà di Ubaid
(8000 - 6000 anni fa)

Sumer
(6000 – 4400 anni fa)

Willcox, 2013, *The roots of cultivation in Southwestern Asia*, Science 341, 39
Lawler, 2012, *Uncovering civilization's roots*, Science 335, 790.



Anno
Emisfero Nord
latitudine > 40°
Europa, Africa, Asia
40° - 30°
Africa, Arabia
30° - 15°
2000
1800
1600
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-8000
Meno umido
Deserti extra-tropicali (Gobi)
Aridità
Aridità. Blocco dei monsoni
Akkad
Sumer
civiltà di Ubaid
Clima un po' più freddo e arido
Aridità.
Clima caldo-umido globale
piccola glaciaz.
clima caldo
Optimum Climatico

Terribile inaridimento tra il 2200 e il 2100 a.C. circa. Crollano nello stesso periodo: l'impero di **Akkad in Mesopotamia**, **l'Antico Regno in Egitto** e la **civiltà neolitica in Cina.** Difficoltà nella **Valle dell'Indo (Harappa).**


Per comprendere la storia
dell’umanità non si può fare a
meno dell’astronomia.