¿LOS CLIMAS DEL PASADO: CLAVE DEL FUTURO?

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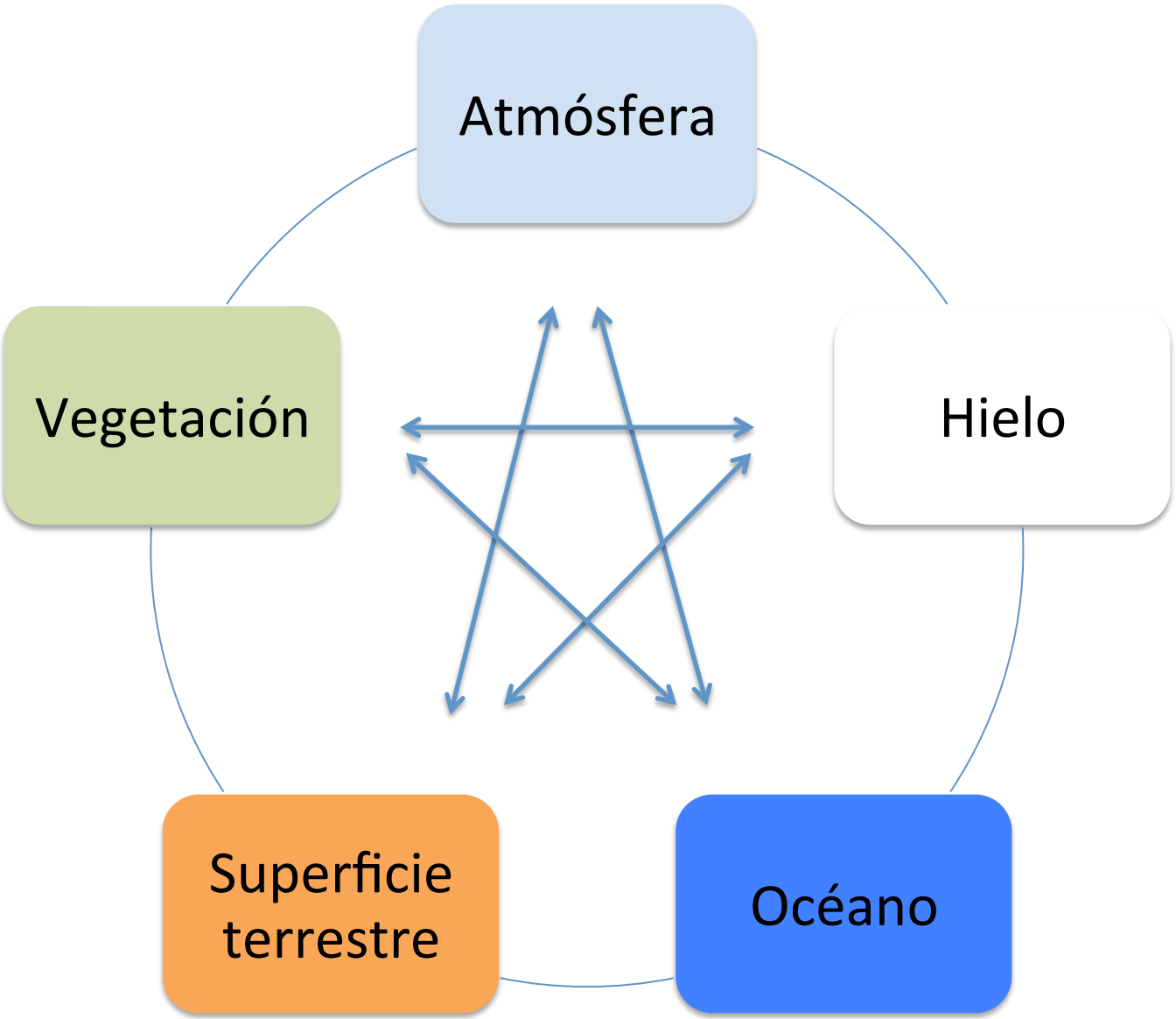
Universidad de Granada

Sistema climático

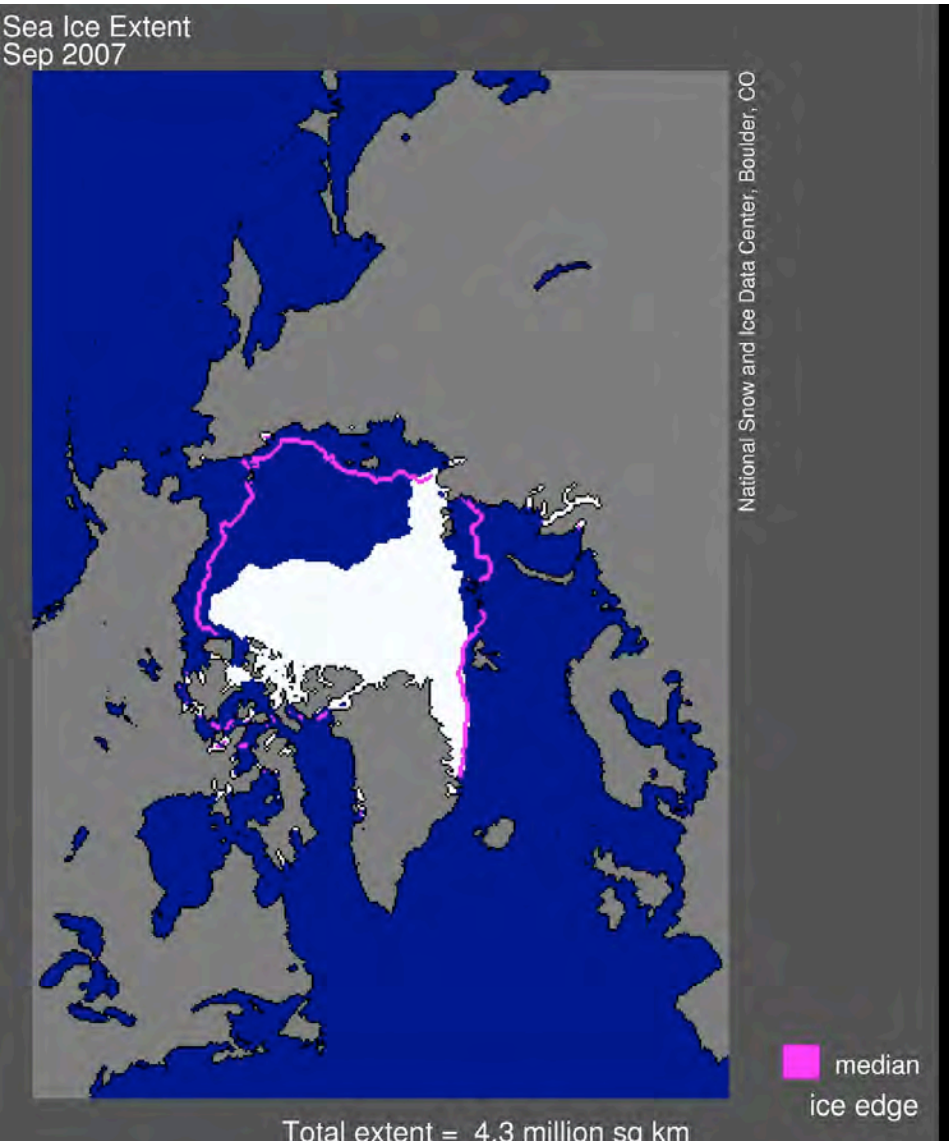


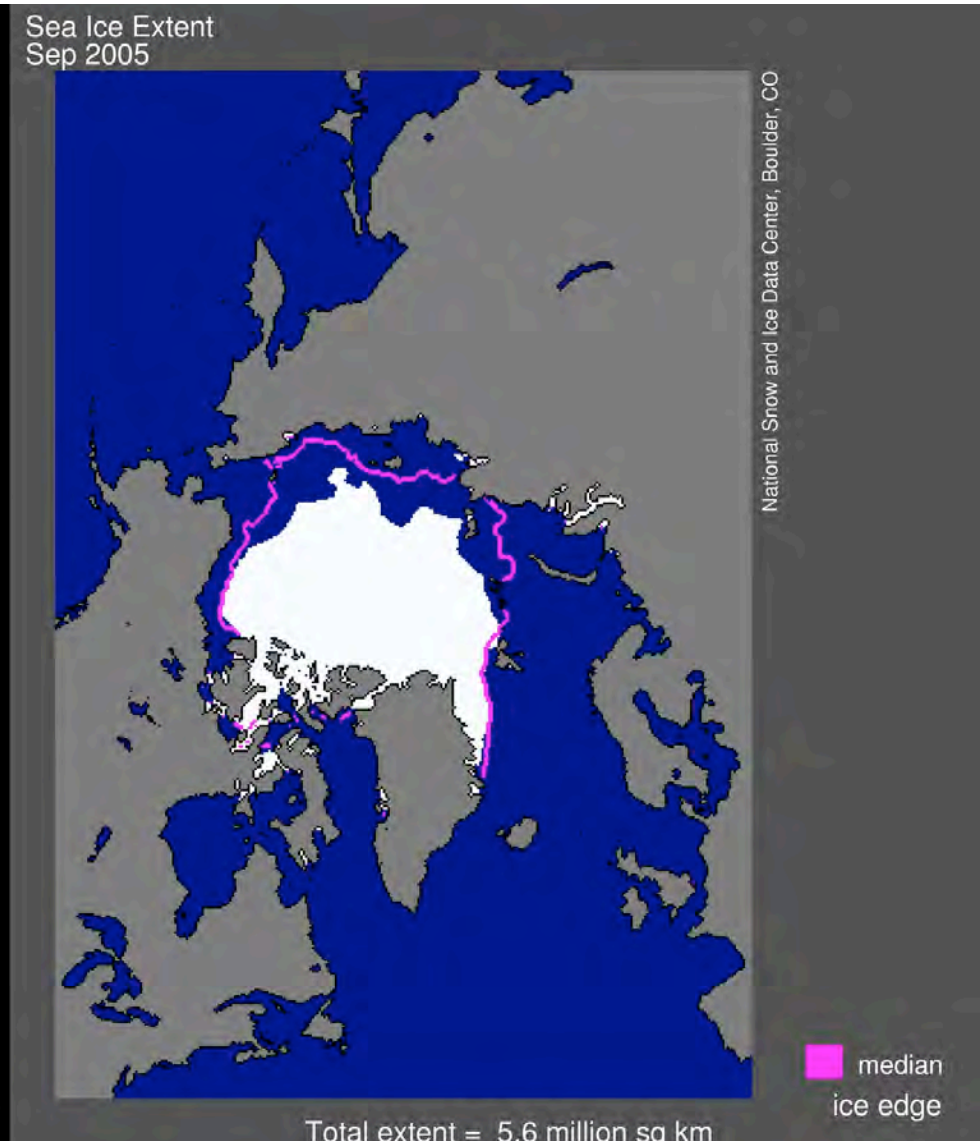
Cambio Climático: preocupación mundial

Cambio climático…… Con respecto a qué escenario

50 años?

100 años?





Hace unos 400 años

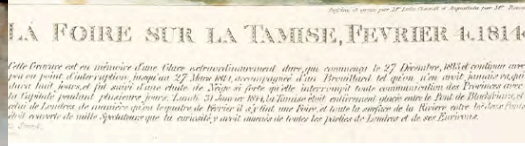
La Pequeña Edad de Hielo

(Little Ice Age: LIA)

S XVI-XIX

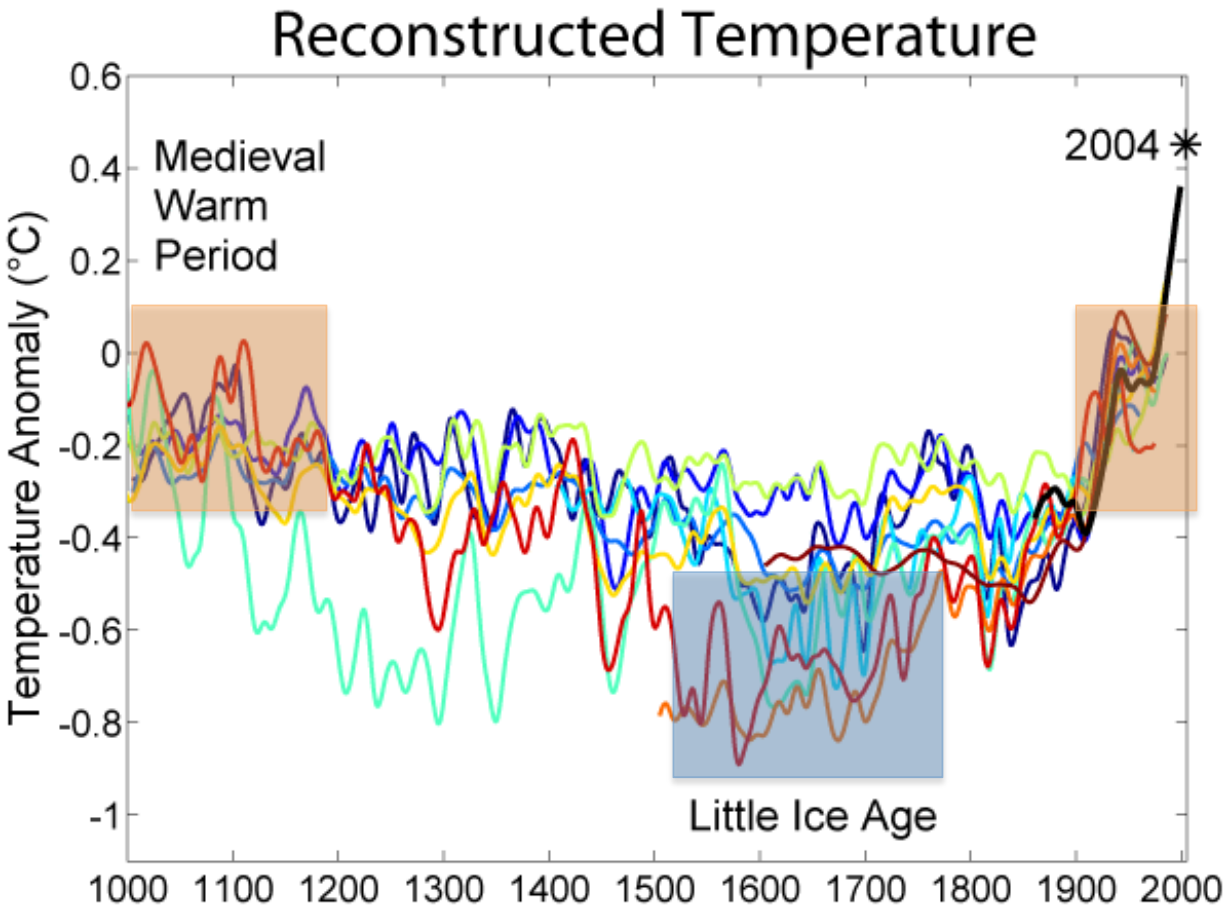
Thamesis helado

Puestos de ventas y feria



¿Preocupación?

Contraste pequeña Edad de Hielo y la Anomalía Climática Medieval

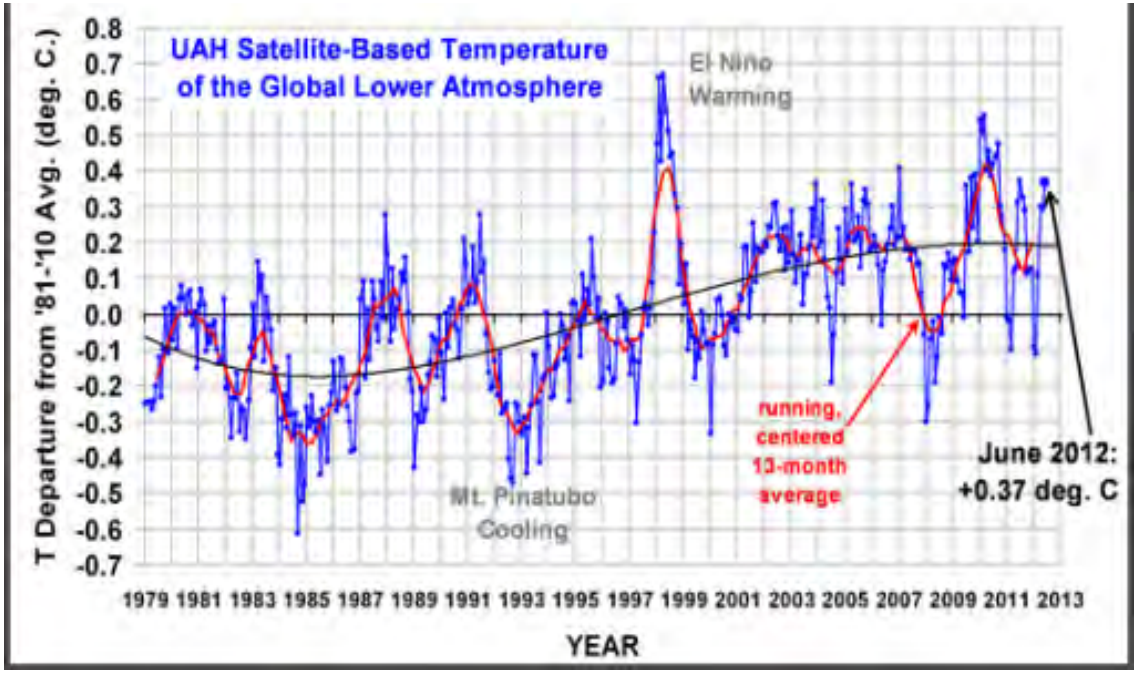


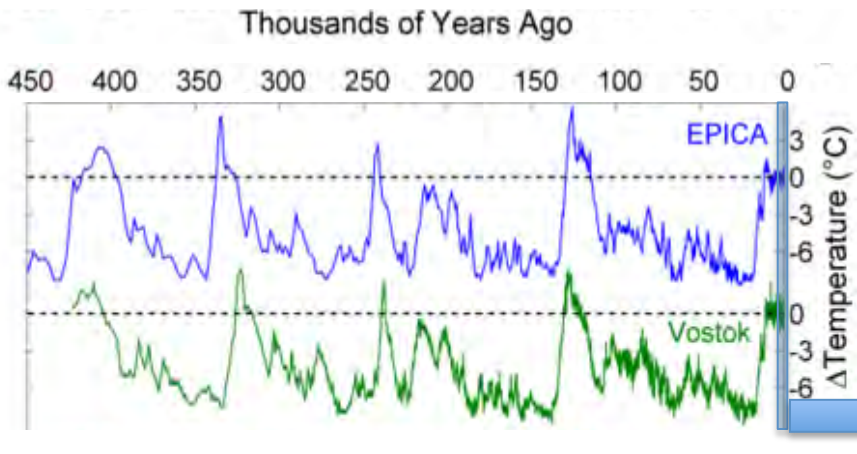
Anomalía Climática Medieval: Asentamientos humanos en el SE de Groenlandia

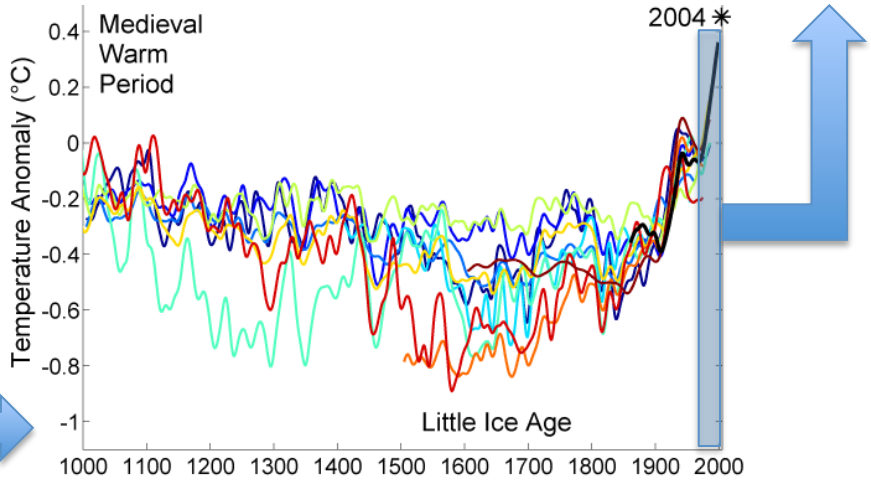
¿Qué pasa entonces hoy en día?

Gran cantidad de datos globales sobre los últimos 100-150 años

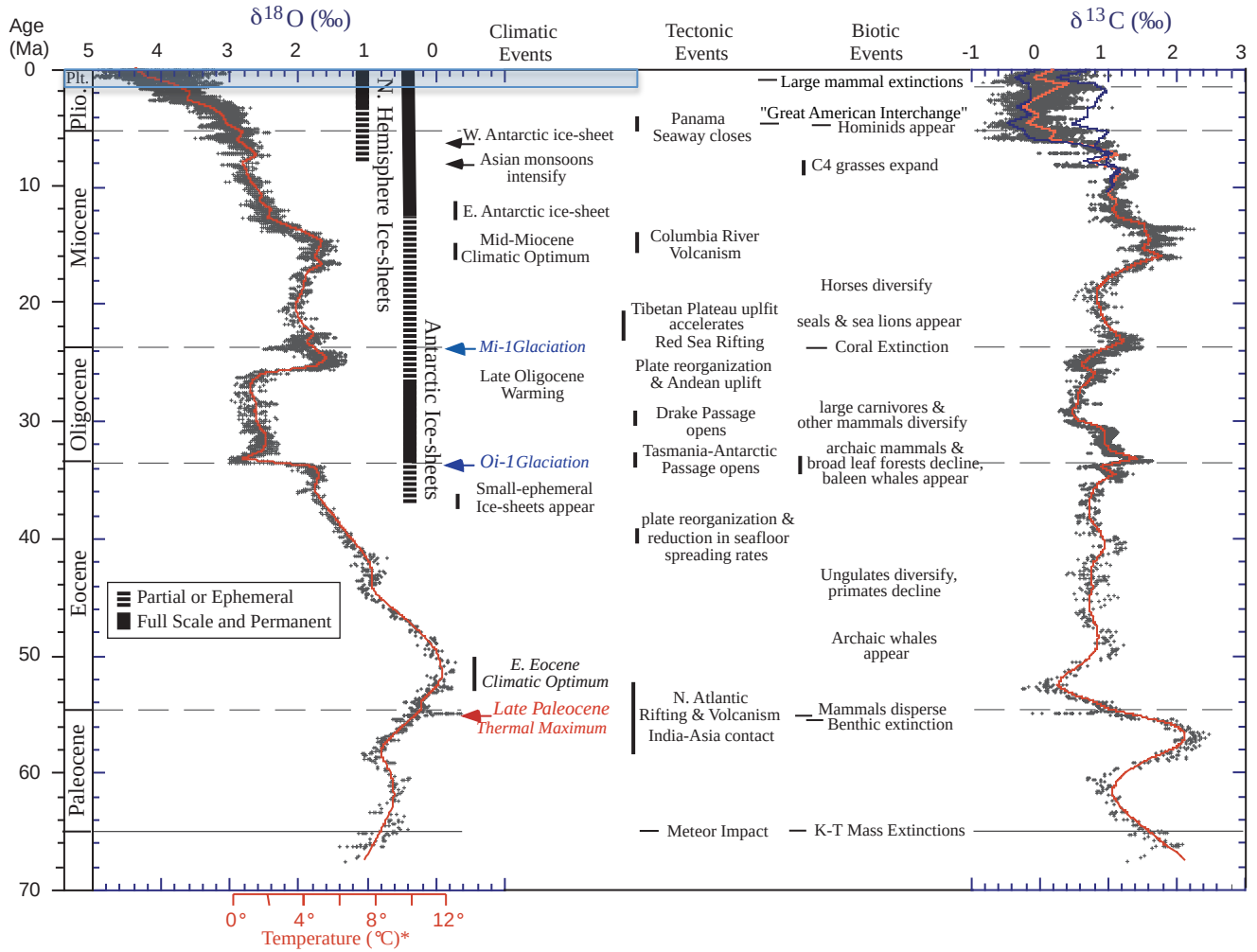
Perspectiva histórica del clima reciente que proponen modelos climáticos basados en los últimos cientos de años







Necesitamos una perspectiva geológica: Miles, decenas de miles, cientos de miles, millones de años



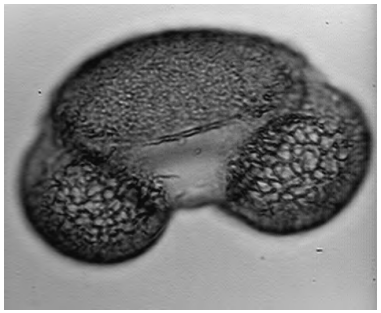
Zachos et al. (2001)

ESTUDIO DE LOS CLIMAS DEL PASADO

¿Cómo se estudian los climas pasados?

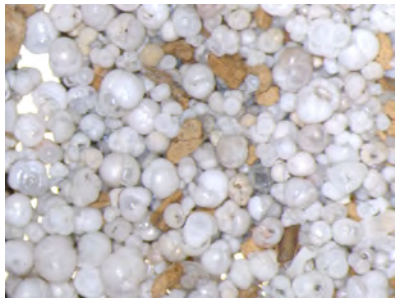
Indicadores paleoclimáticos

Anillos árboles

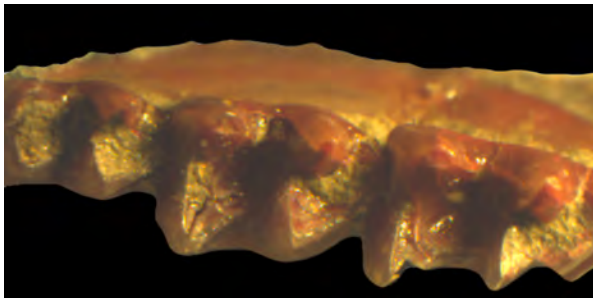


Polen

Restos fósiles

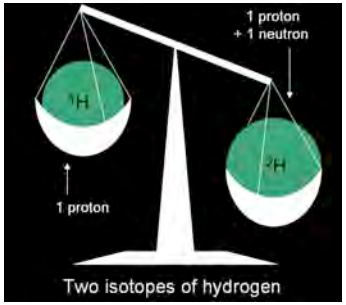


Foraminíferos

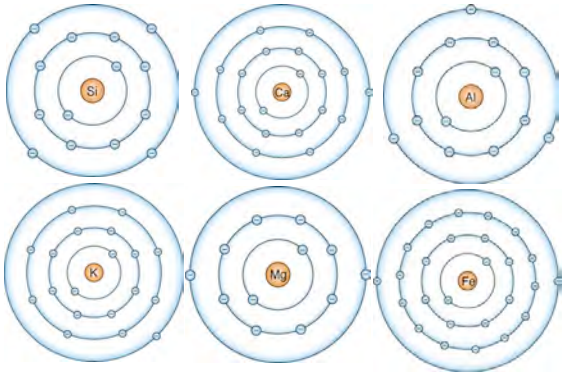


Mamíferos

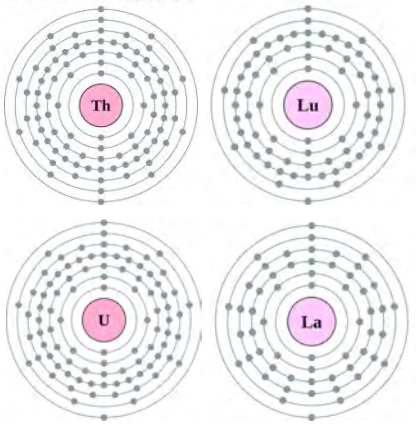
Análisis geoquímicos (fósiles/sedimento)



Isótopos estables



Elementos mayores >95%
Elementos menores 1-5%



Elementos trazas <1%

Estudio detallado de series paleoclimáticas

Cesare Emiliani

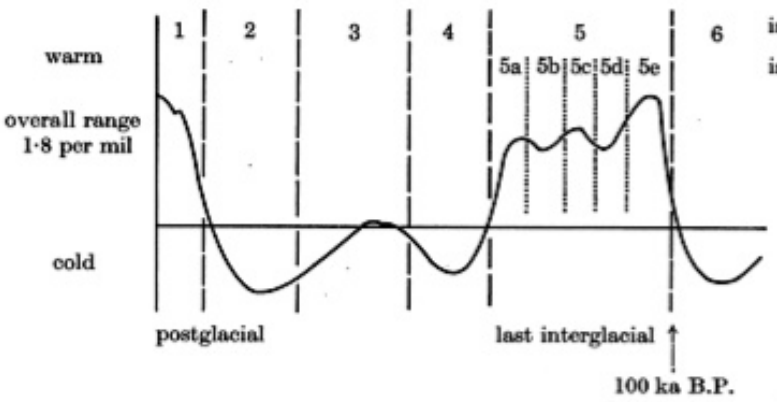
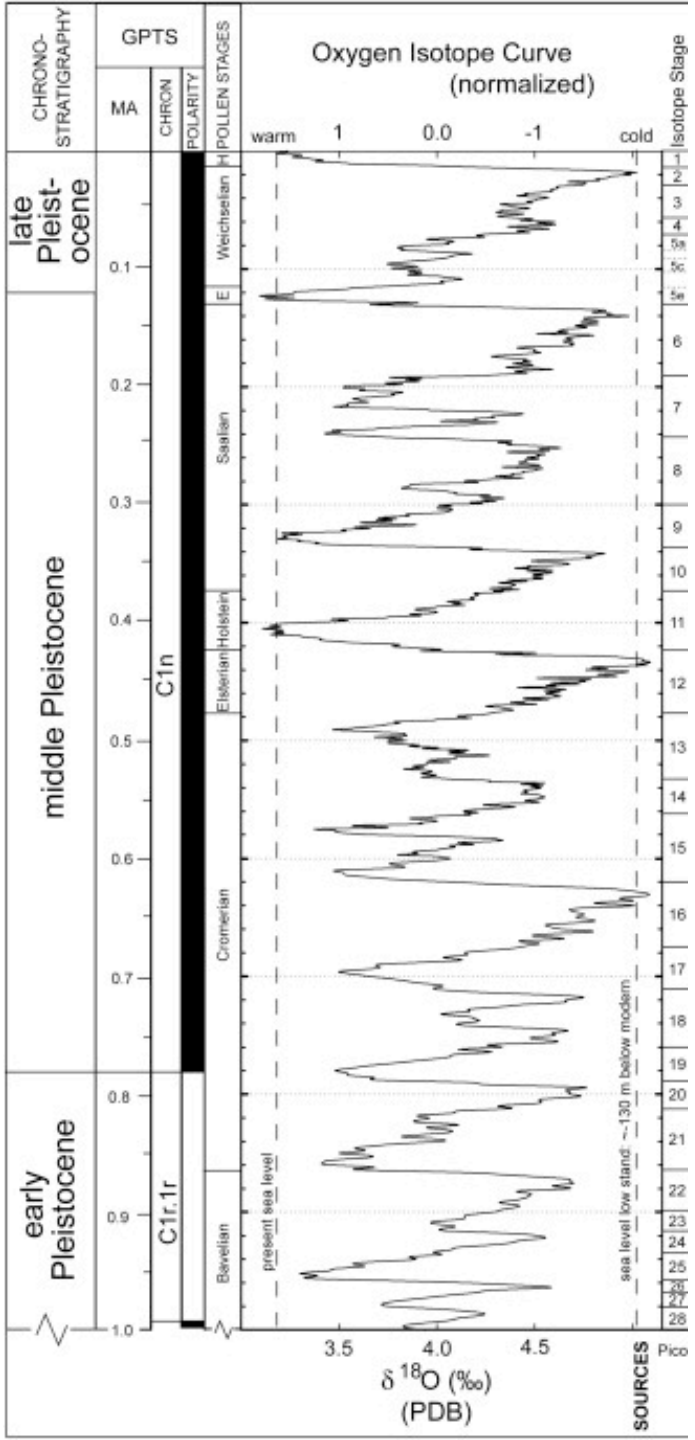


FIGURE 1. Generalized oxygen isotope palaeotemperature record through last six isotope stages, after Emiliani (1961).

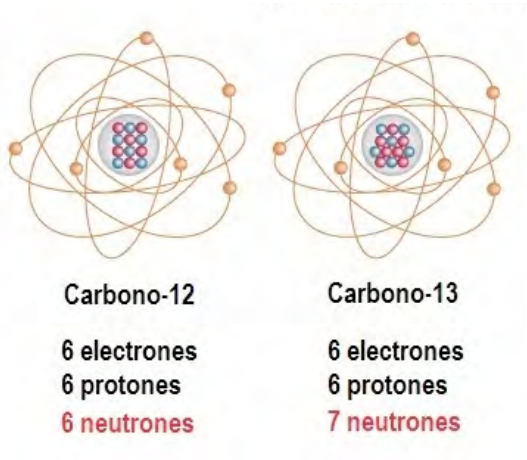


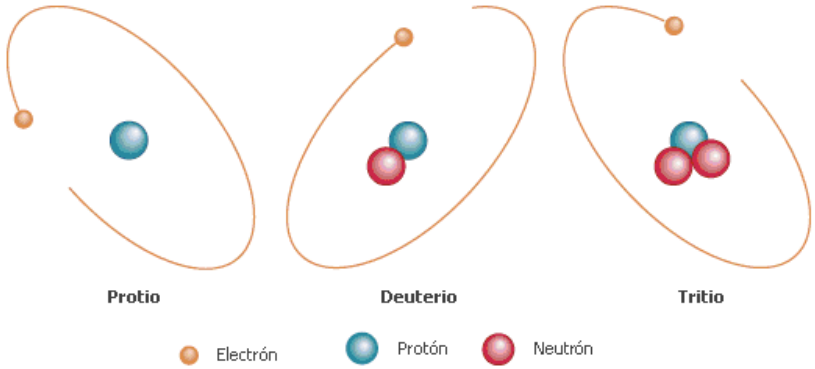
¿Qué son los isótopos?

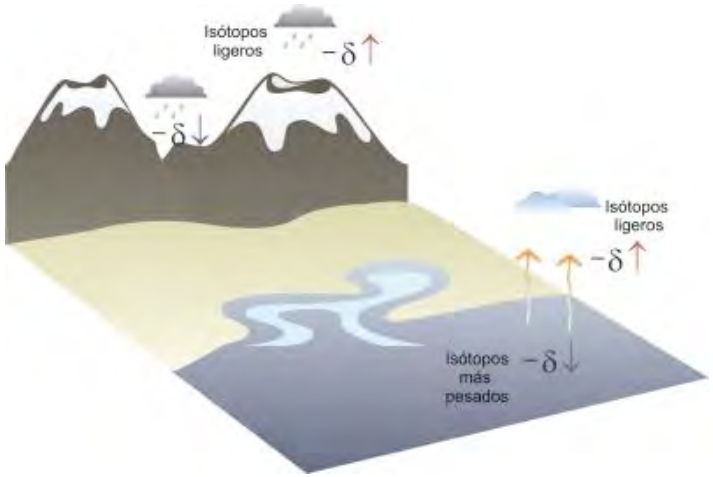
Isos "igual, mismo"; ***topos*** "lugar":

Átomos de un mismo elemento con distintos número de neutrones. Distinta masa atómica

Inestables y **Estables**

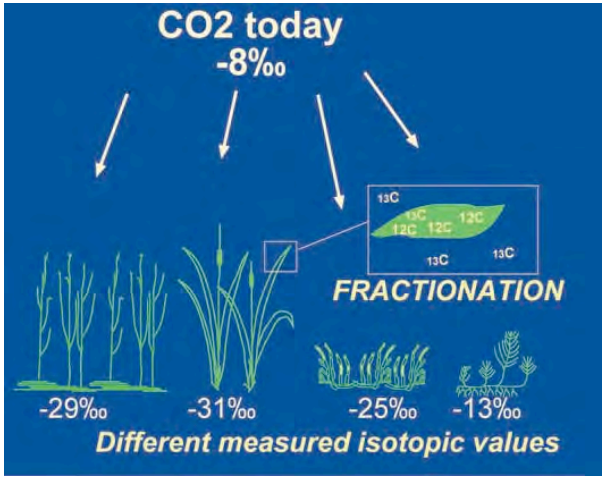




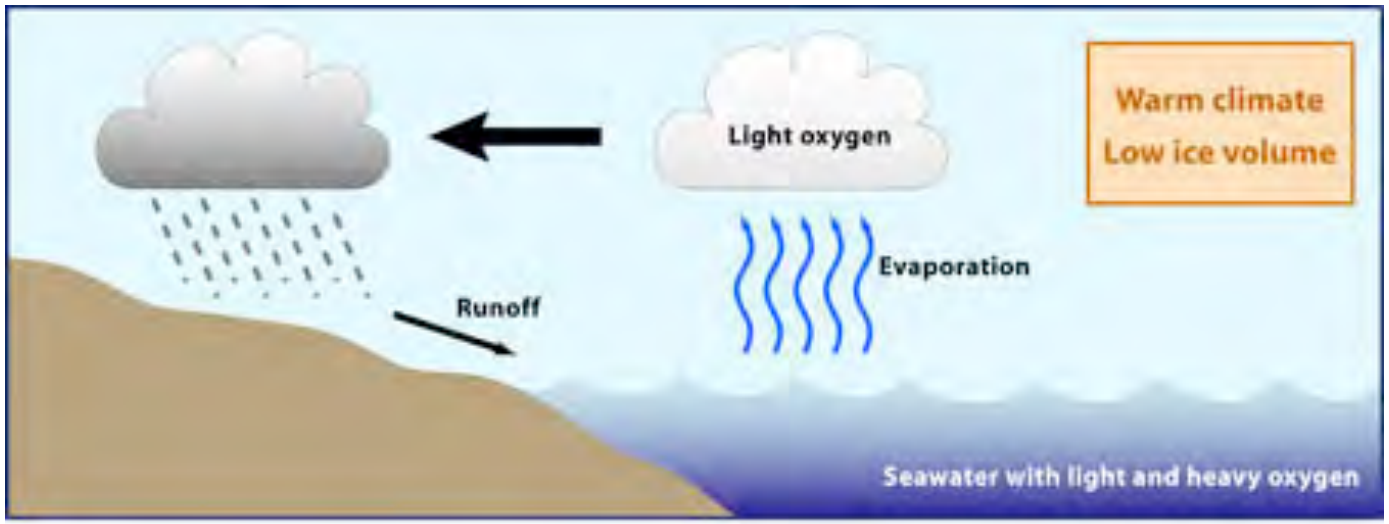


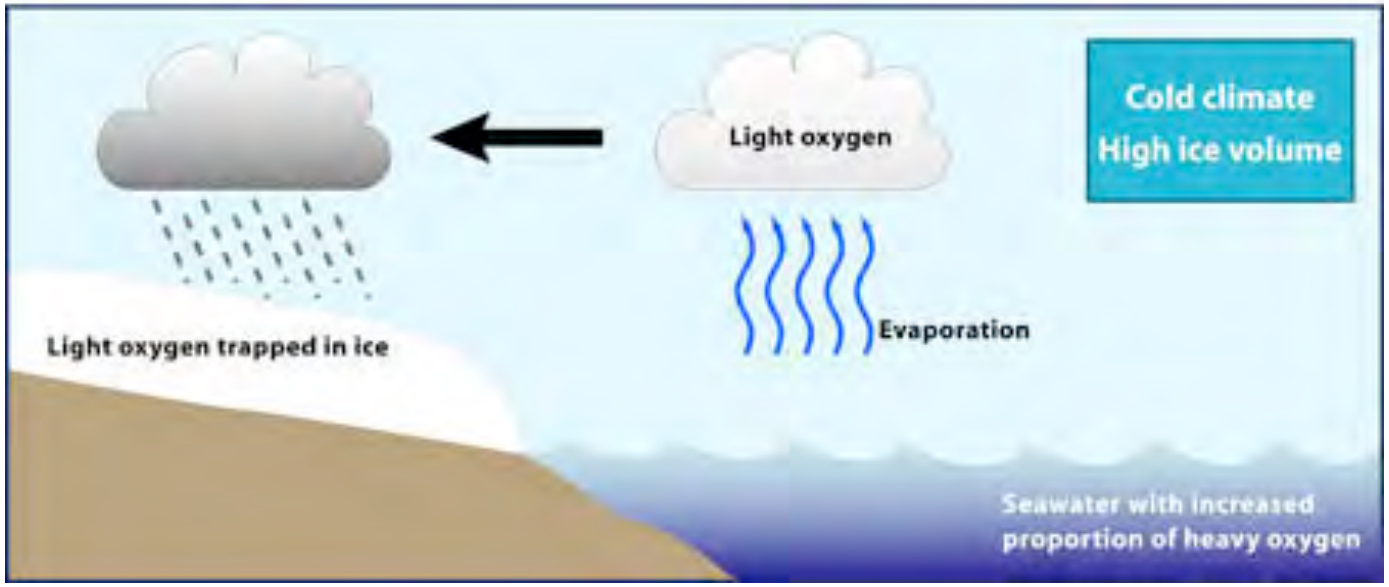
Fraccionan por:

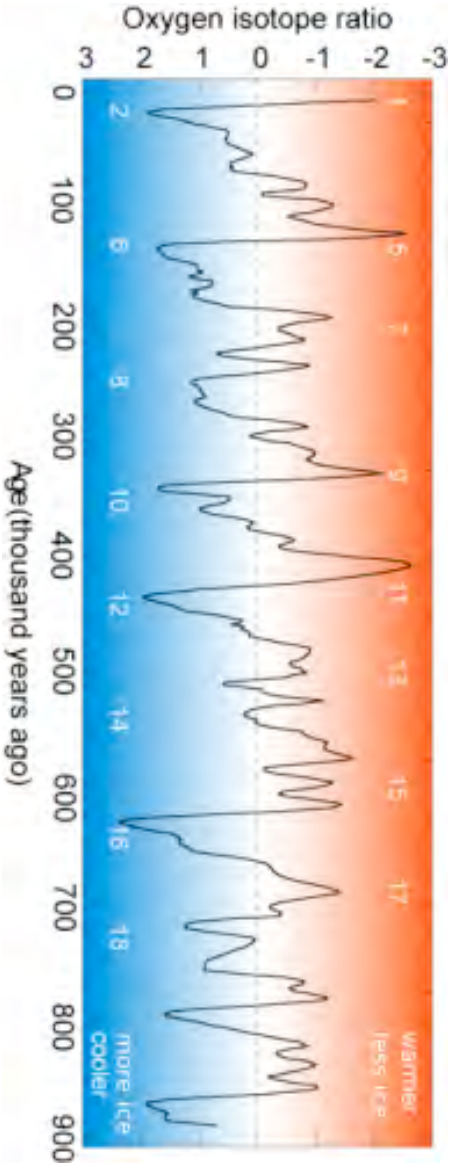
- Procesos físicos
- Procesos biológicos



¿Por qué cambia la composición isotópica del agua marina en periodos interglaciares y glaciares?







¿Cómo se estudia un registro paleoclimático continuo?

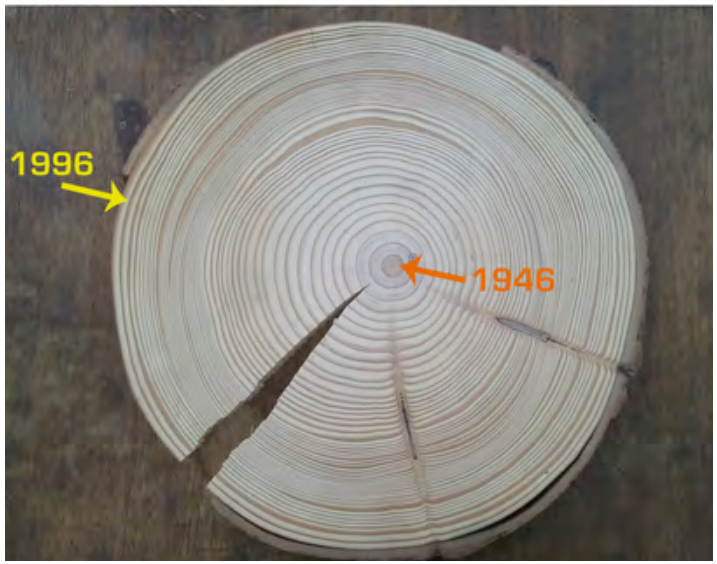
Sondeos en hielo

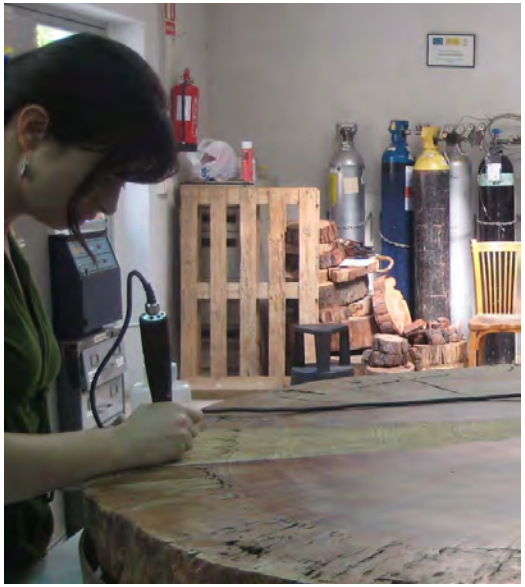
Sondeos marinos

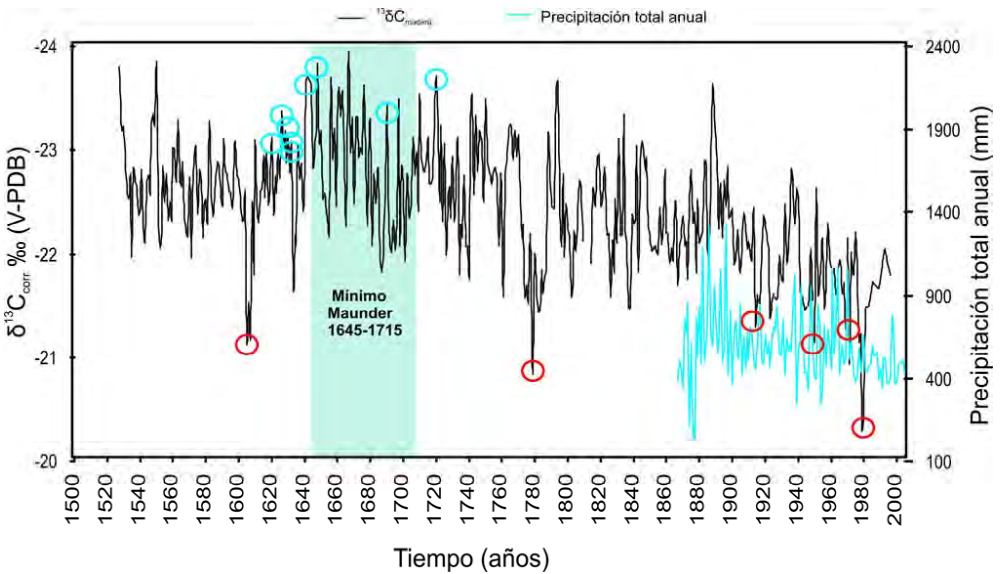
Sondeos continentales

Otros tipos de estudios continuos continentales:

Dendroclimatología

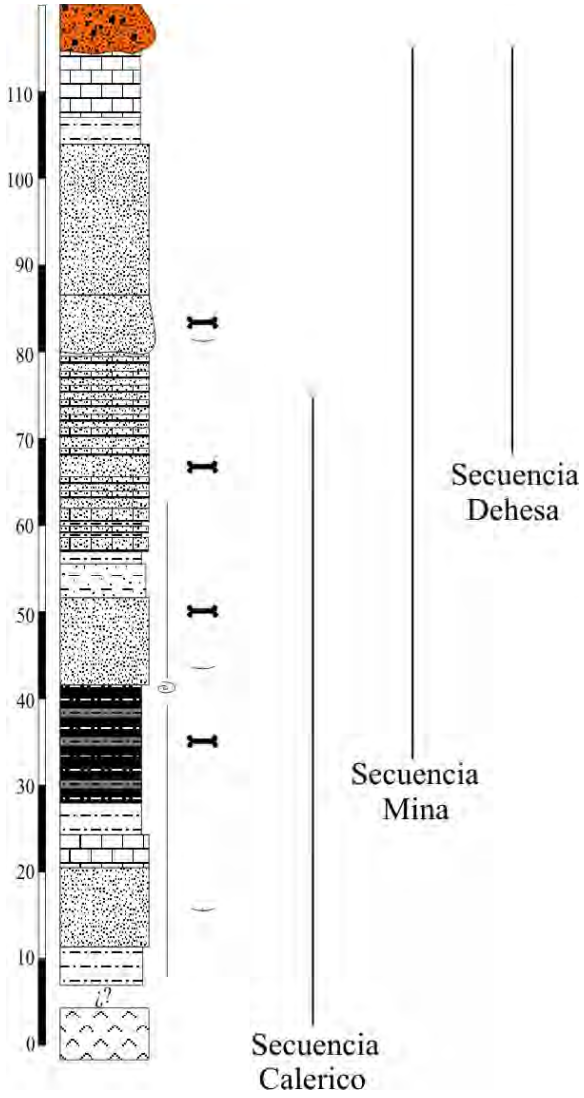


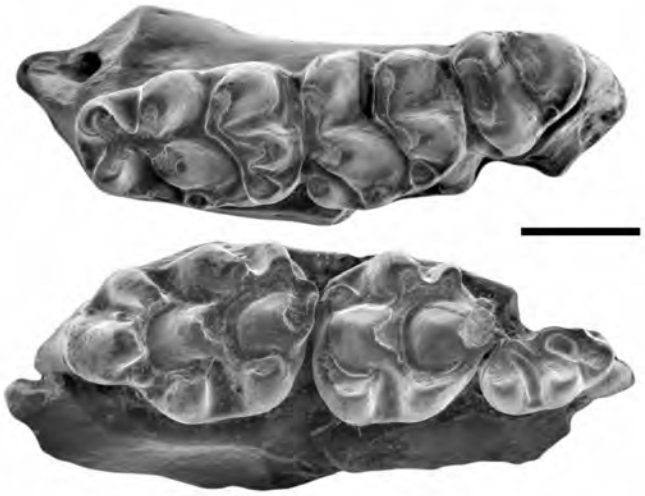




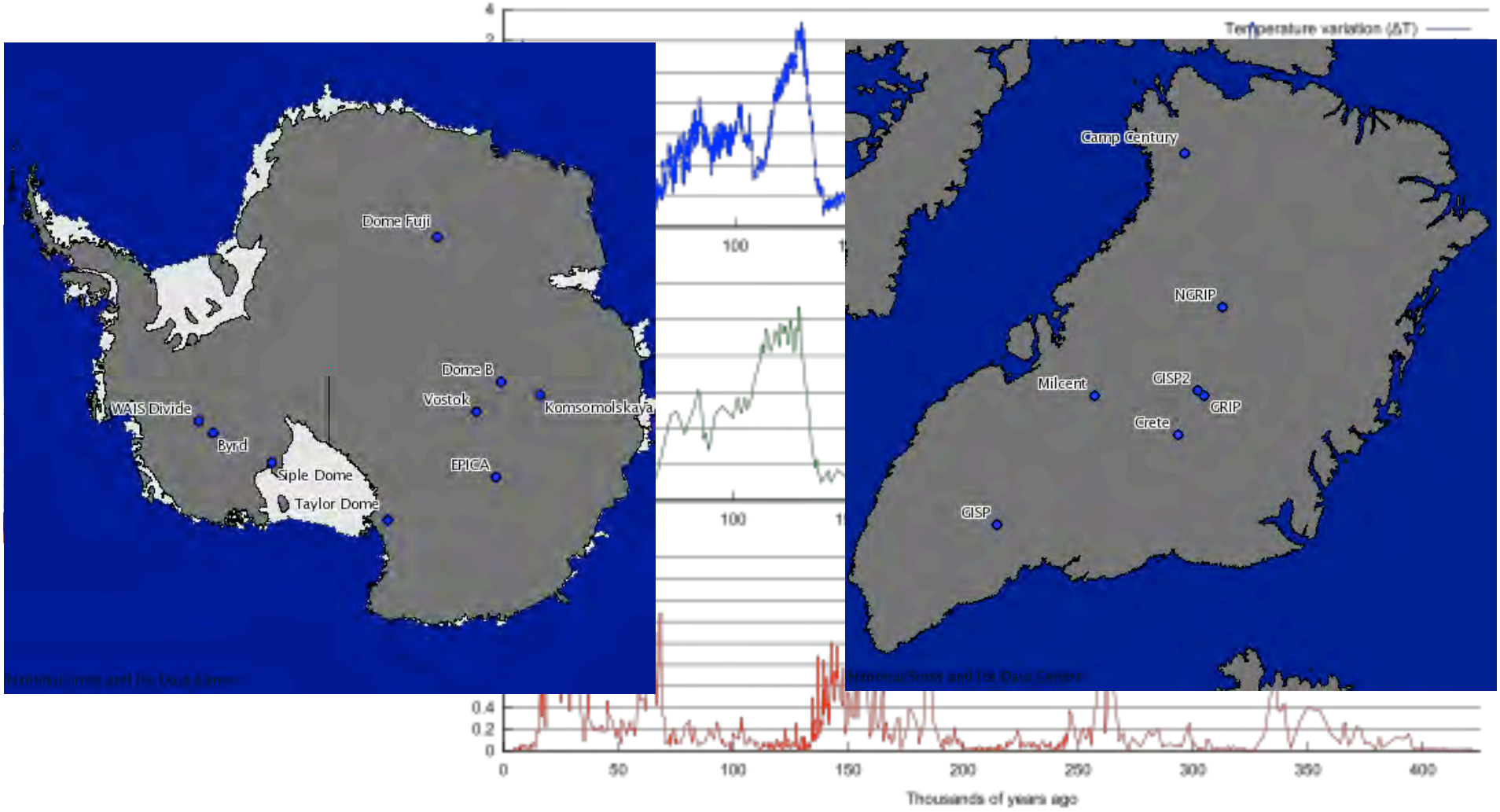
Otros tipos de estudios discontinuos:

Estudio de yacimientos fósiles

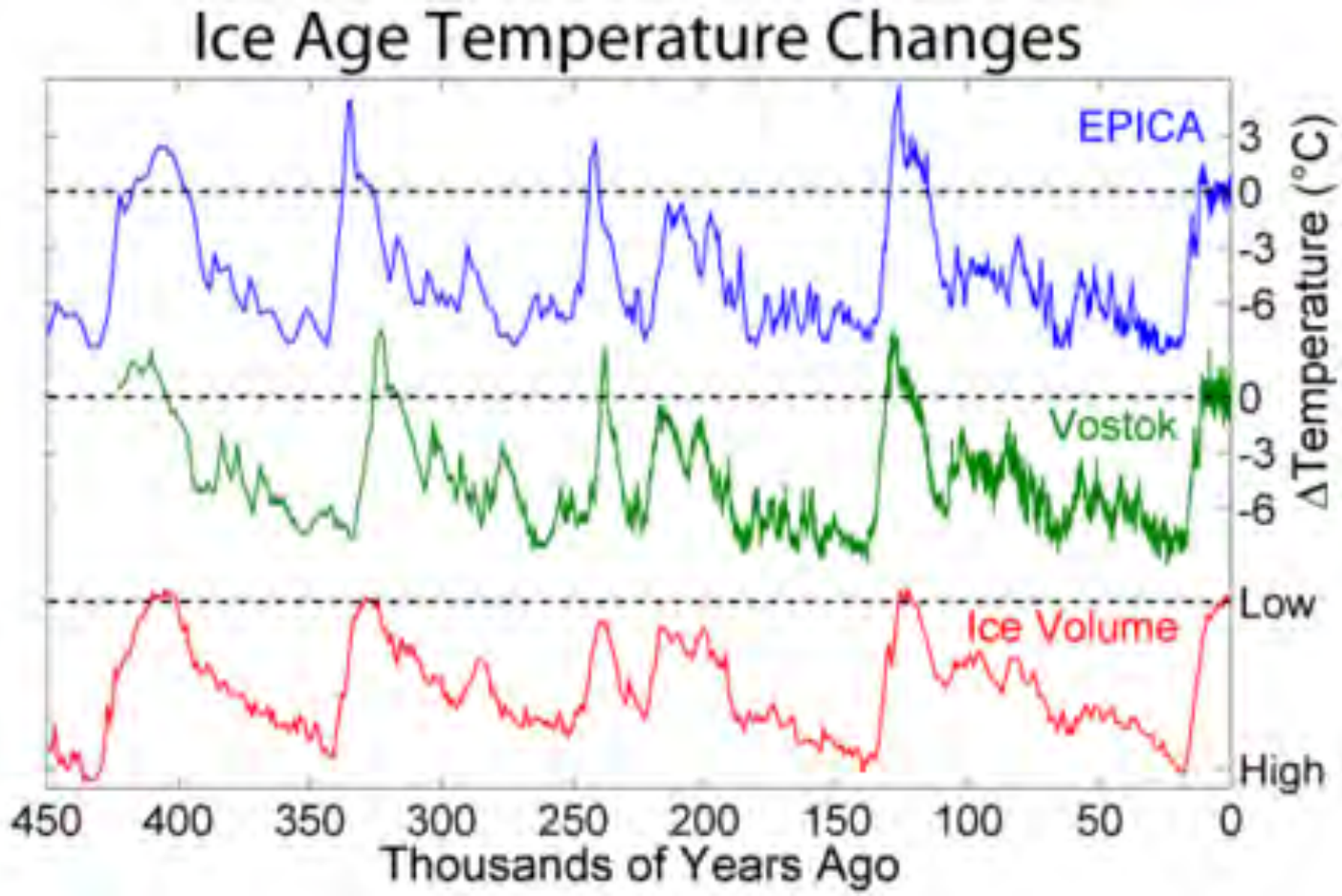




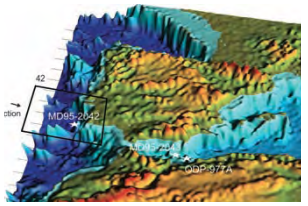
Ejemplos de reconstrucciones basadas en sondeos de hielo

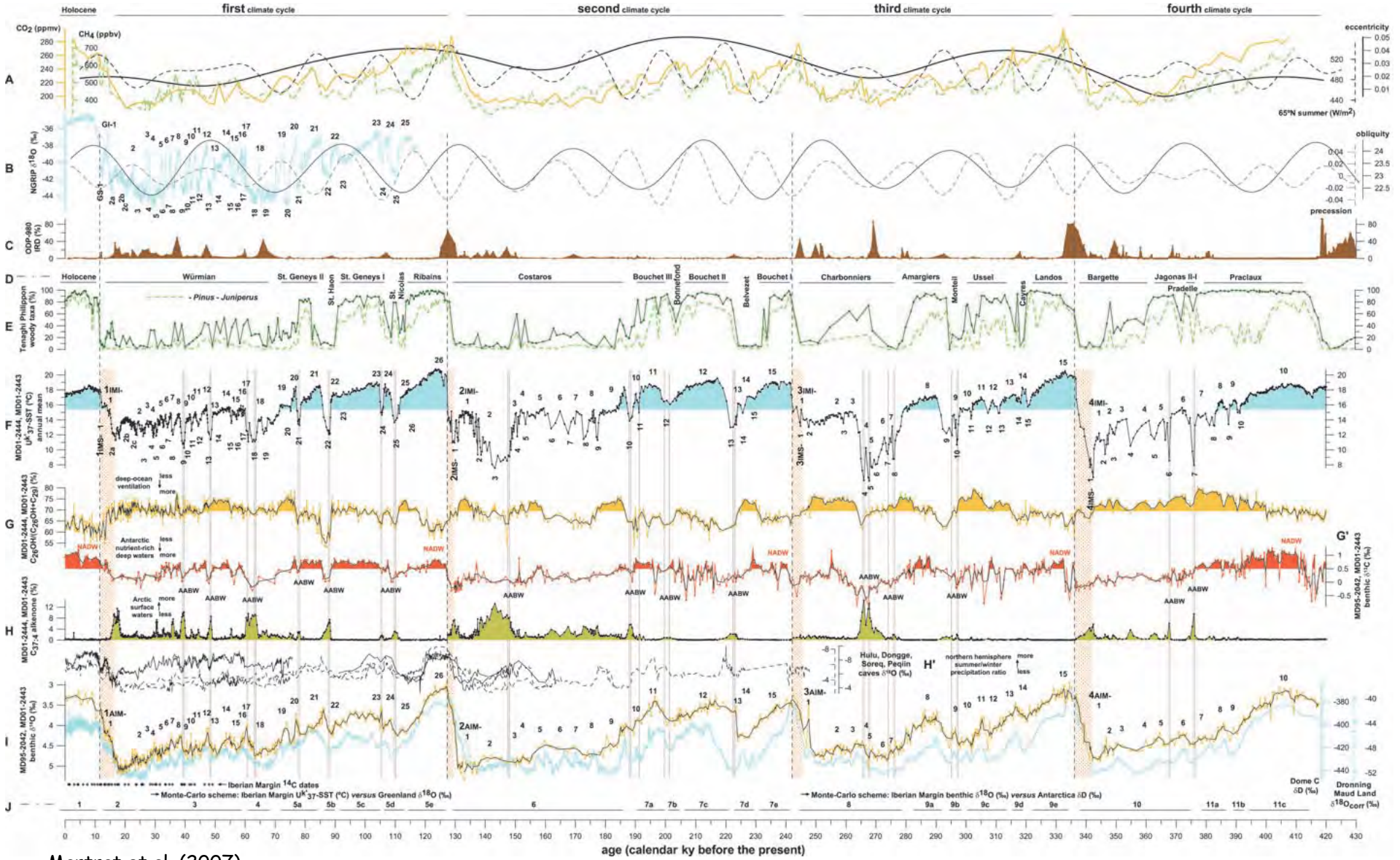


Ejemplos de correlación entre sondeos de hielo y sondeos marinos



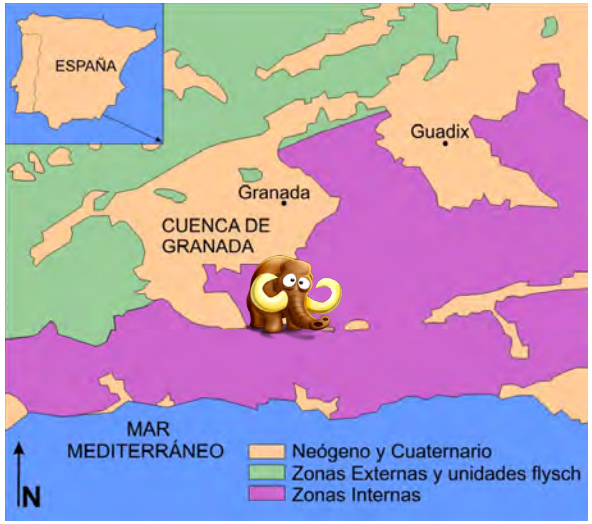
Ejemplos de reconstrucciones basadas en sondeos marinos

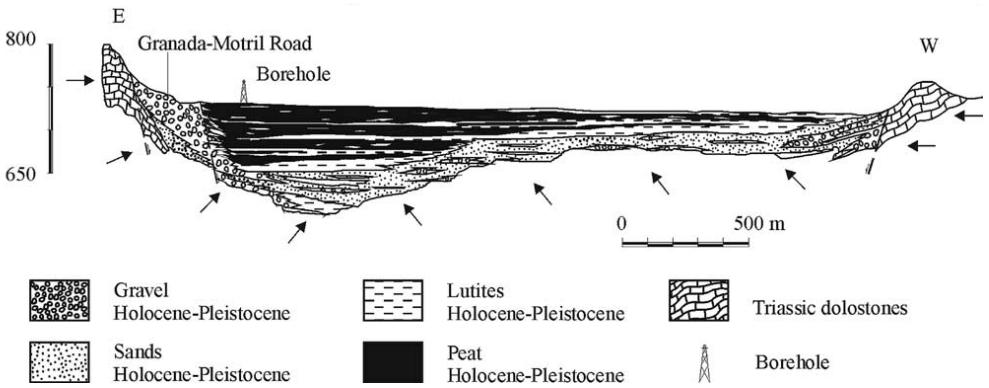




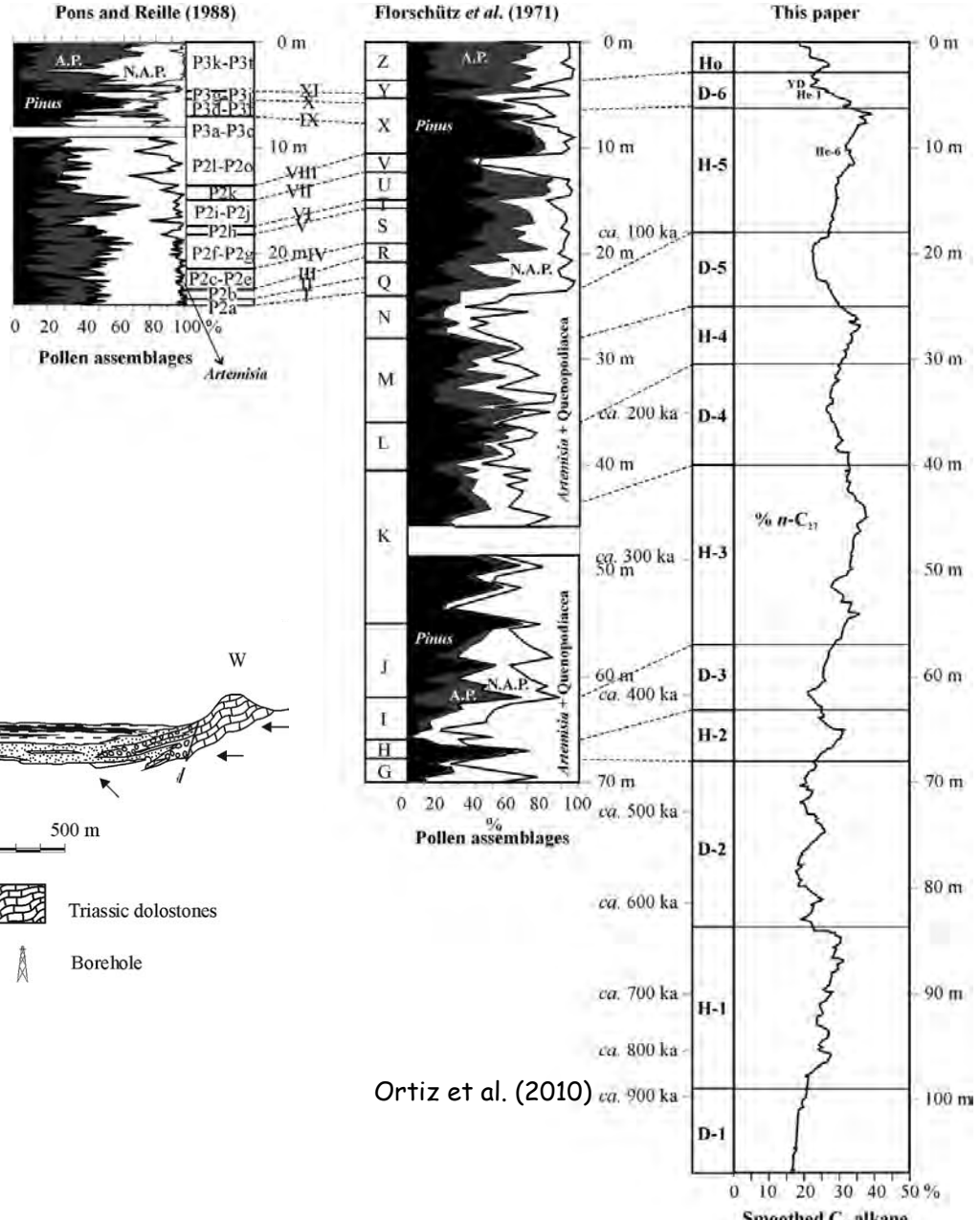
Martrat et al. (2007)

Ejemplos de reconstrucciones basadas en sondeos continentales



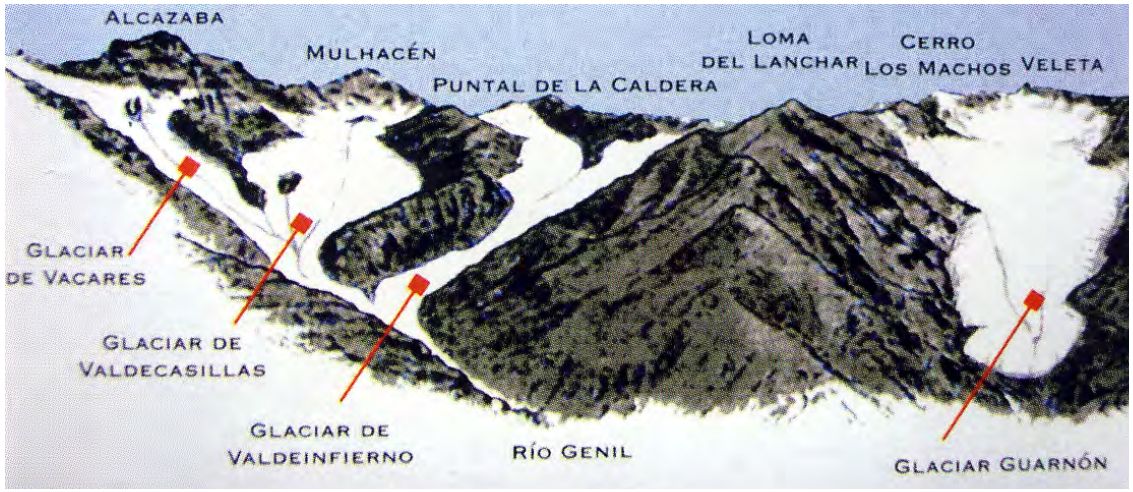


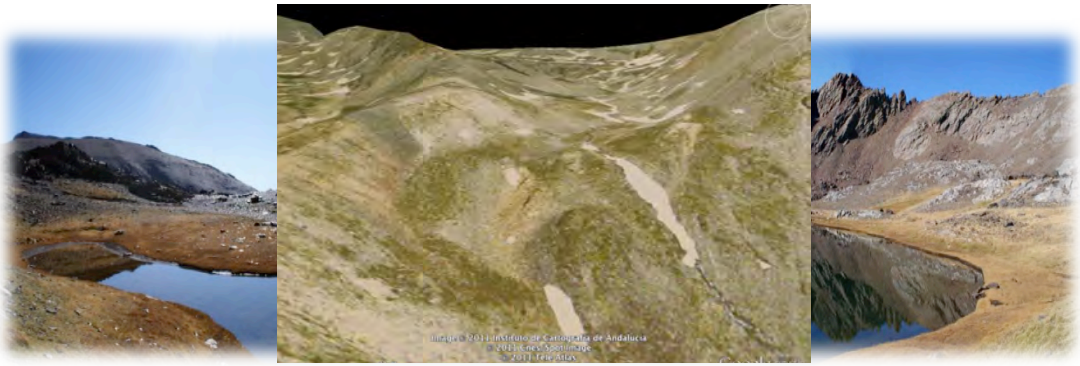
Ortiz et al. (2004)

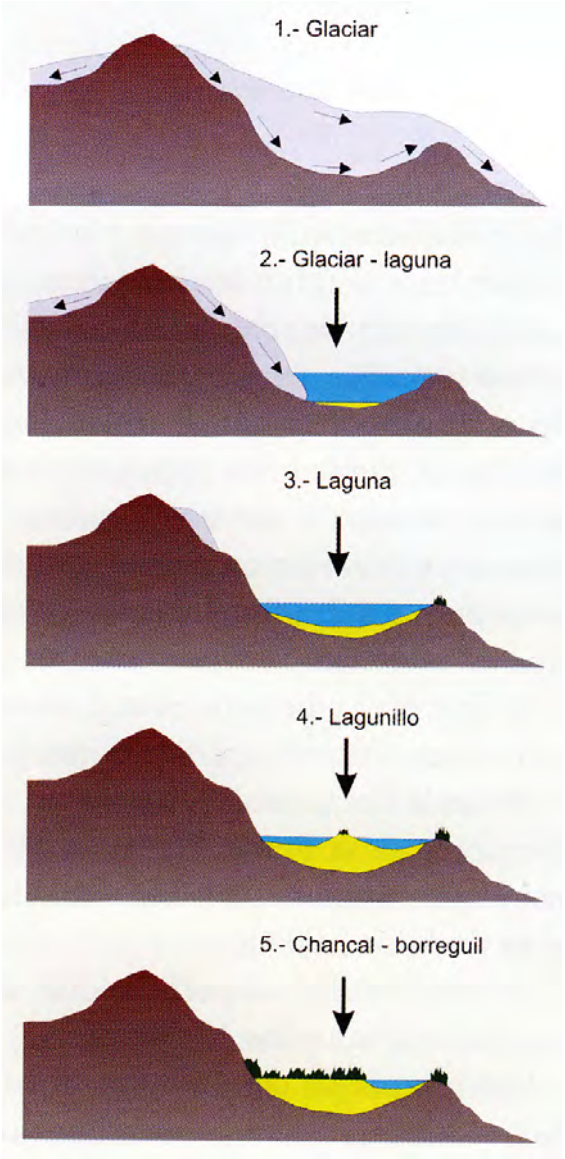


Ortiz et al. (2010)

Ejemplos de reconstrucciones basadas en sondeos continentales

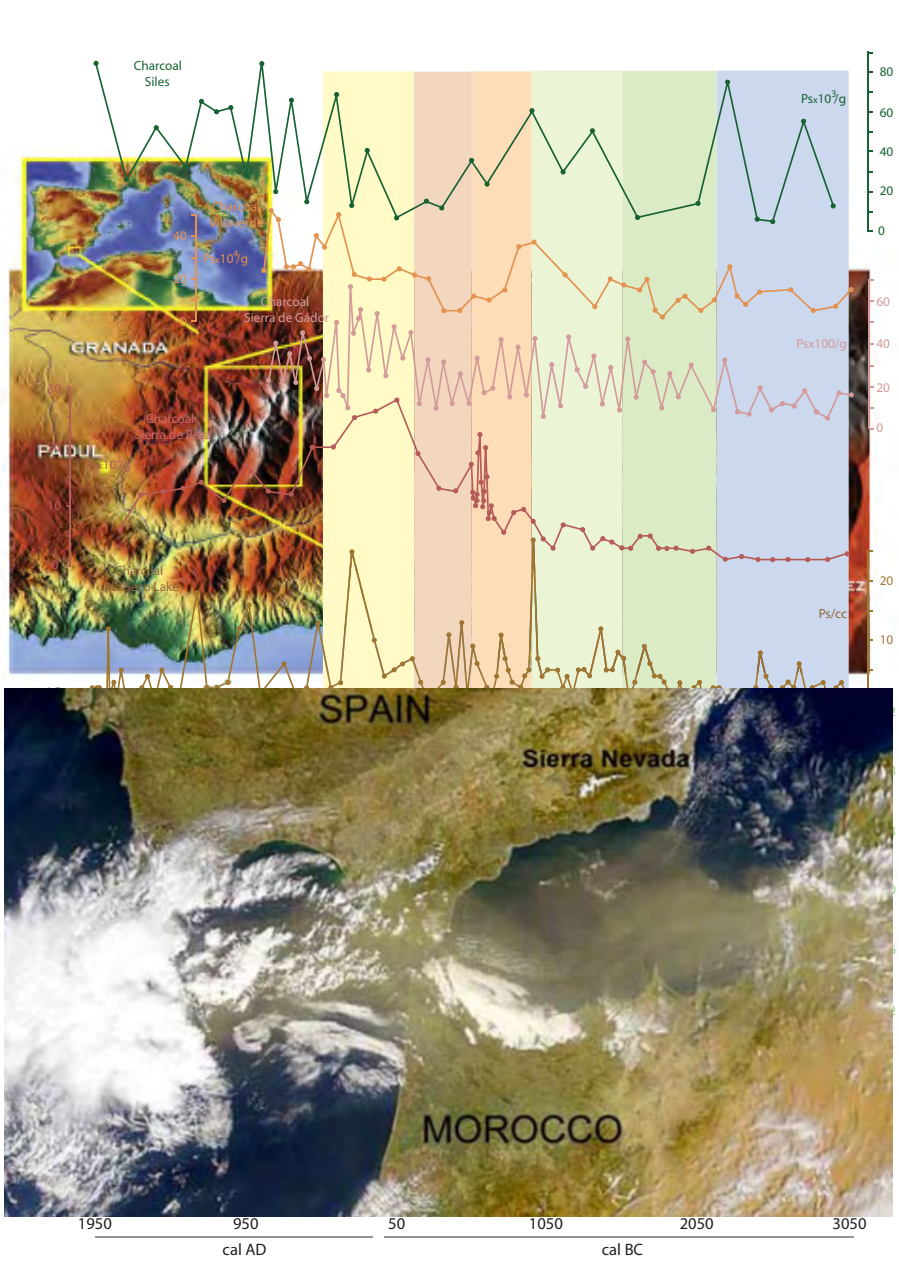


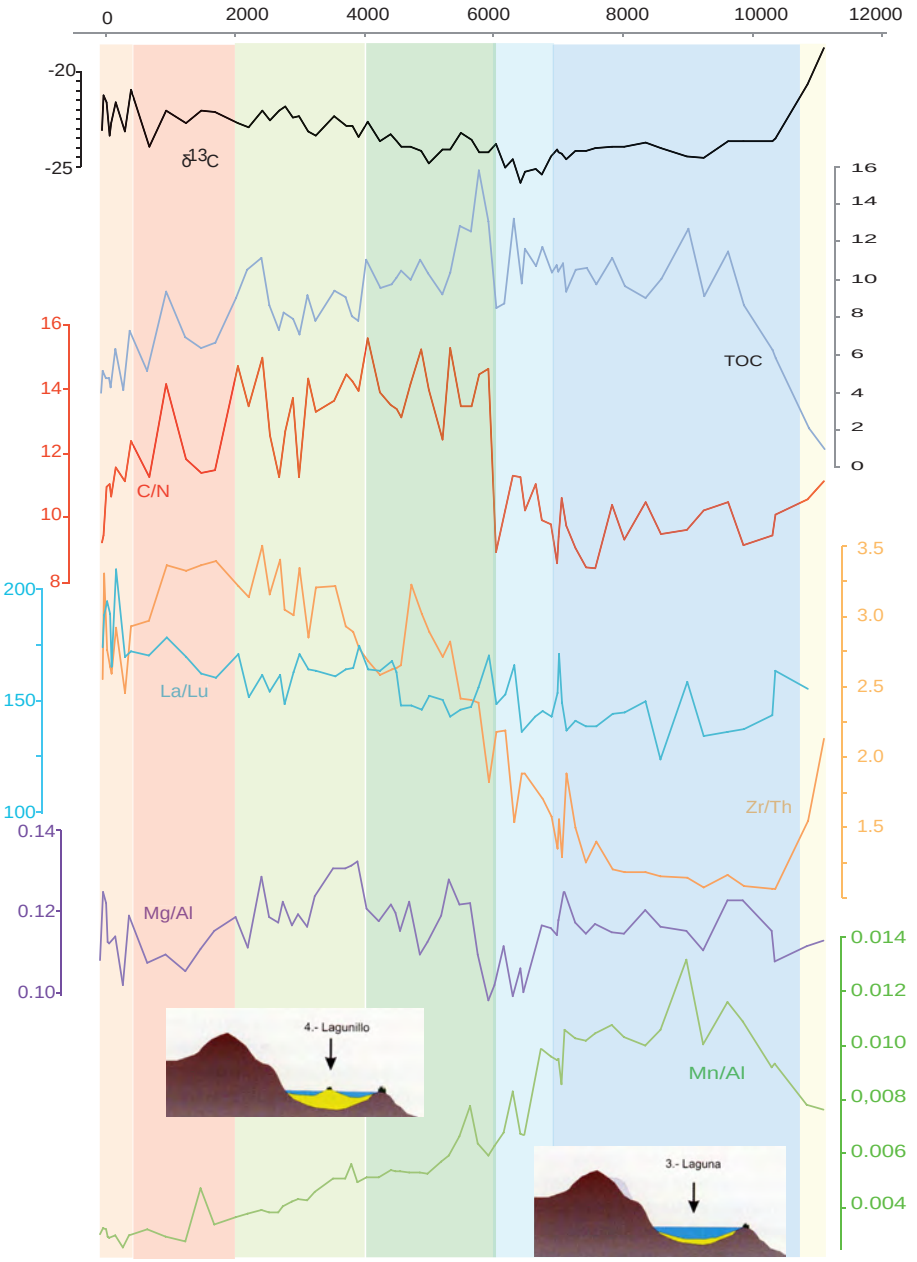




Castillo (2009)

Ejemplos de reconstrucciones basadas en sondeos continentales

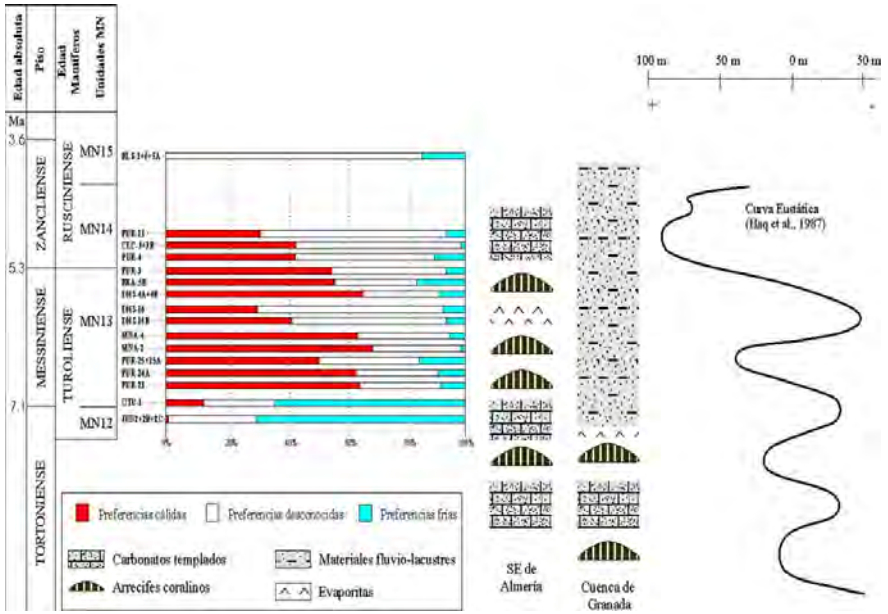




Ejemplos de reconstrucciones basadas en secciones discontinuas continentales

En el caso de mamíferos:

Cualitativas: Basadas en las preferencias ecológicas de los distintos taxones



Inconvenientes:

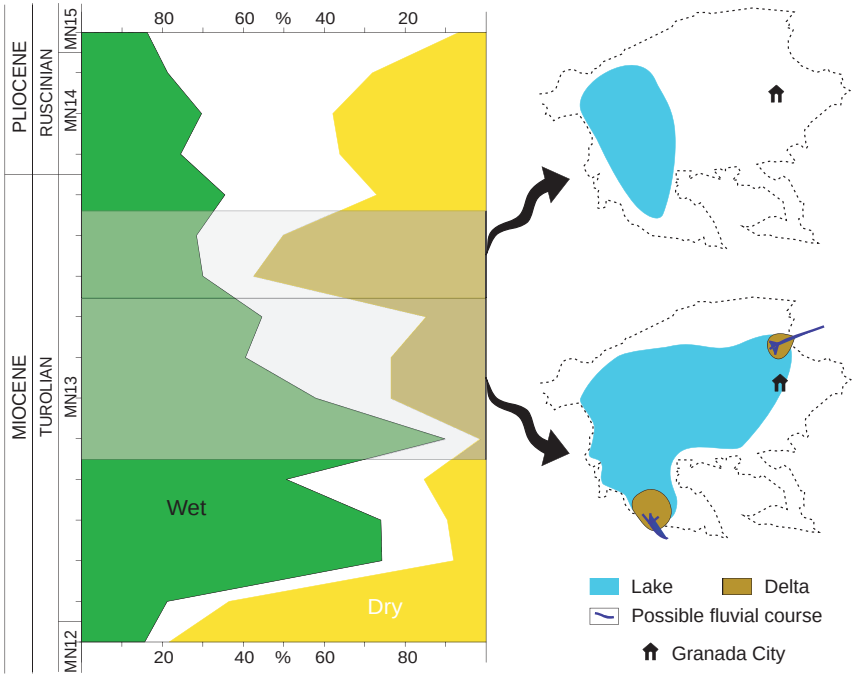
Afectados por ambiente local

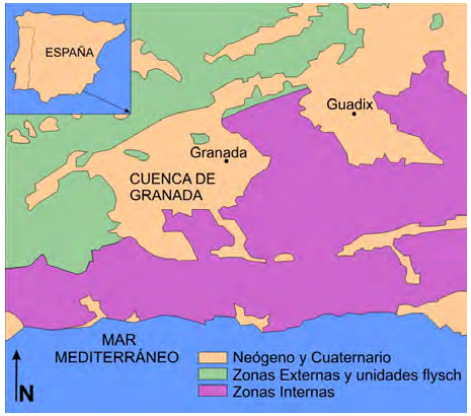
Resultados cualitativos

Cuantativos: Análisis isotópicos en dientes y huesos

Ingestión → Fraccionamiento isotópico → Incorporación a los tejidos animales

Discrepancias estimaciones cualitativas / cuantitativas

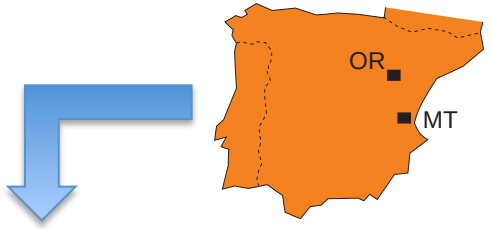


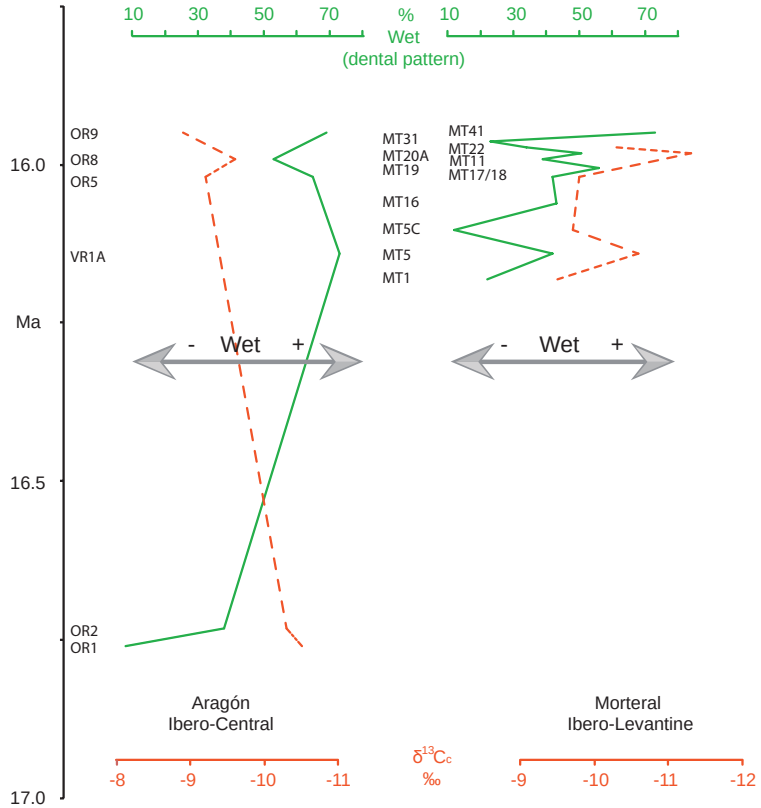


Isótopos en micromamíferos fósiles

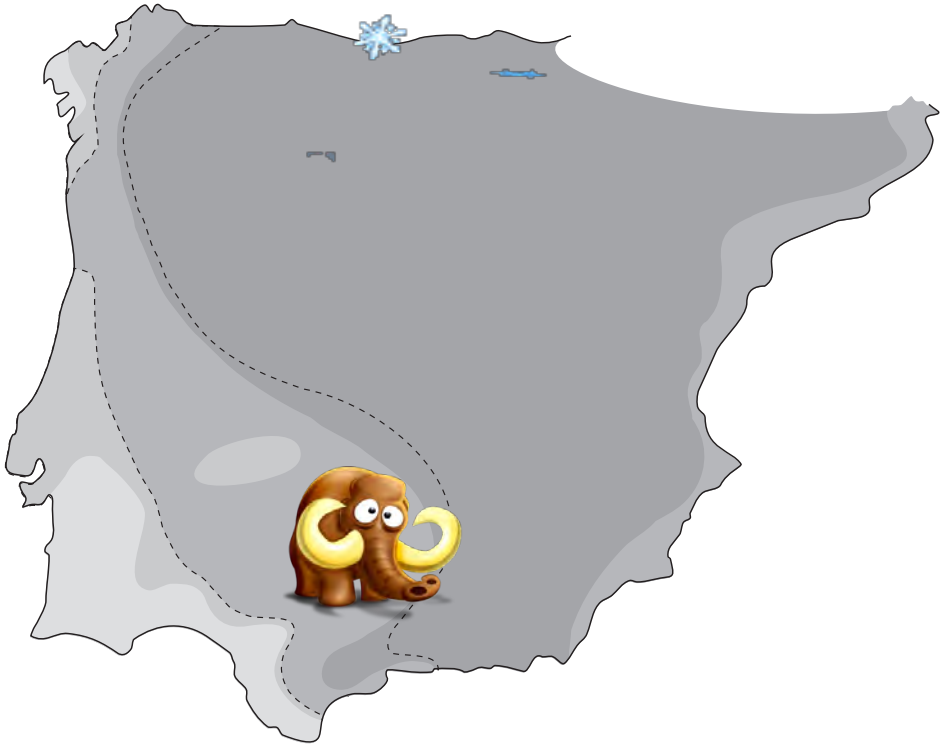
Humedad relativa verano 70%

Vegetación sin estrés hídrico





Posible habitat de los mamuts encontradas en la turbera de El Padul



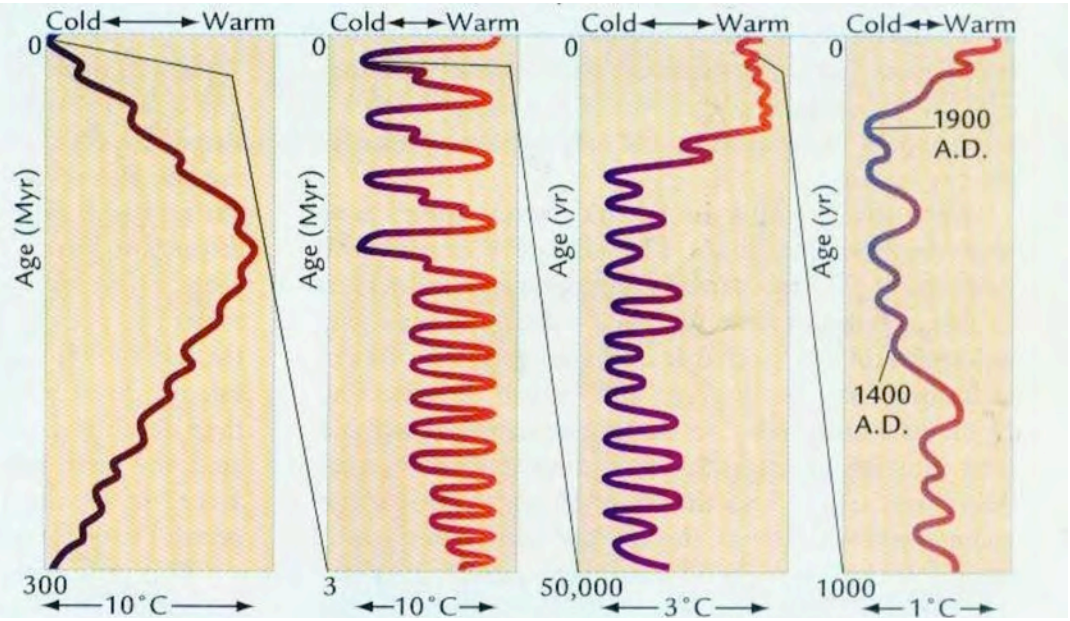
TMA≈ 9.9 a 11.1°C

Episodios fríos HS3 y HS4

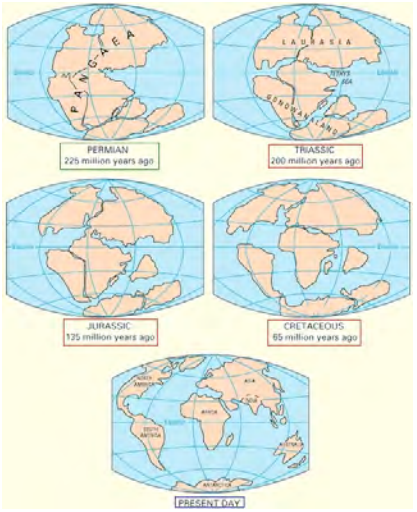
Causas de los cambios climáticos

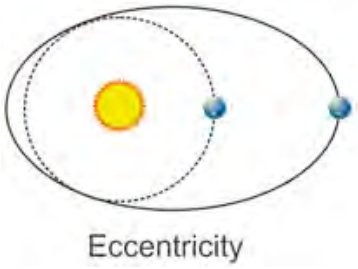
Causas de los cambios climáticos

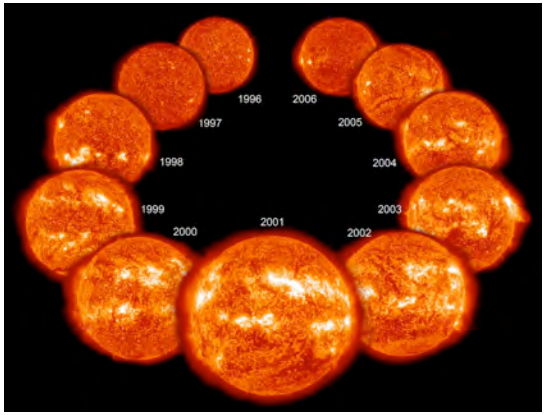
Depende de la escala temporal que tomemos



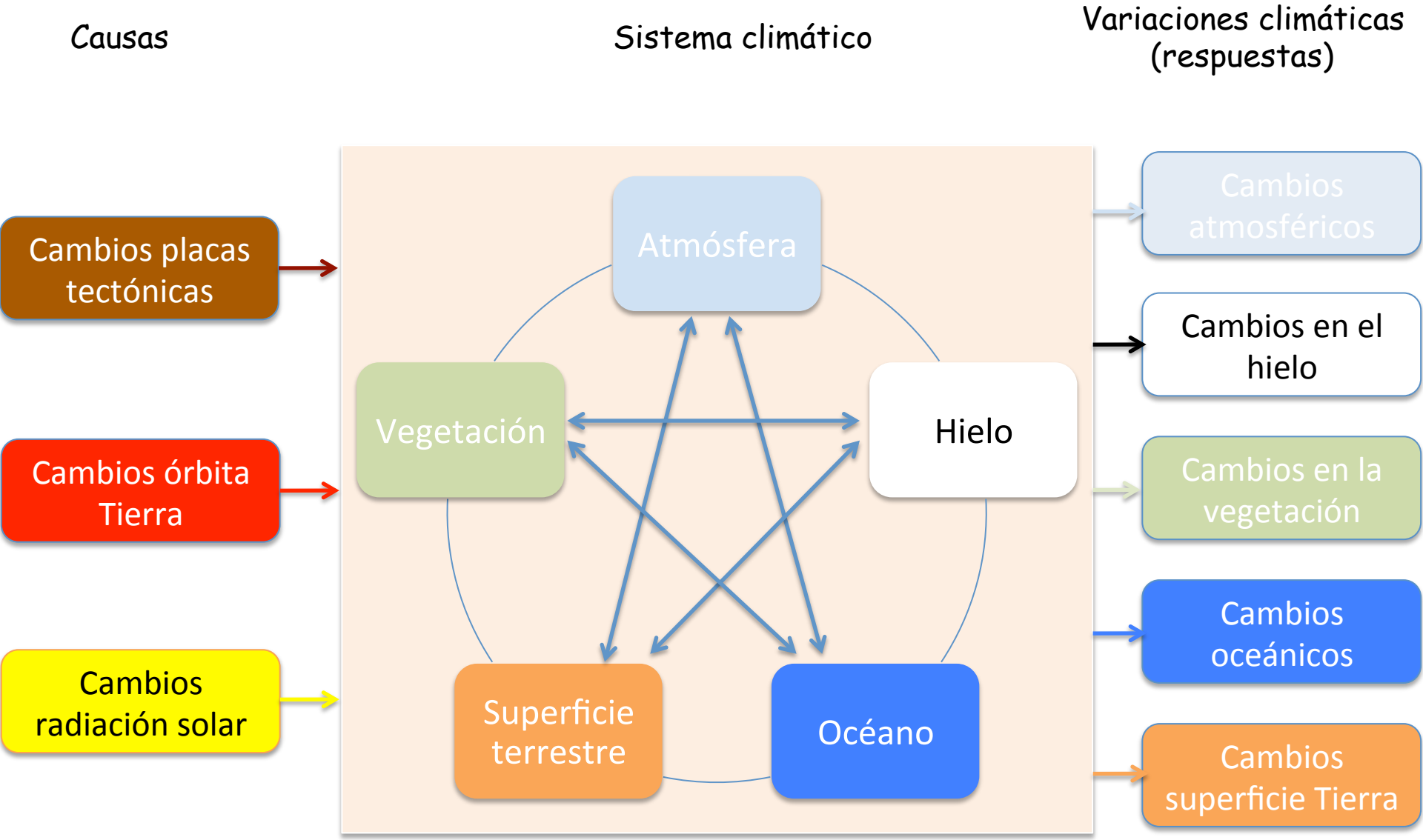
Tectónicas Orbitales Solares





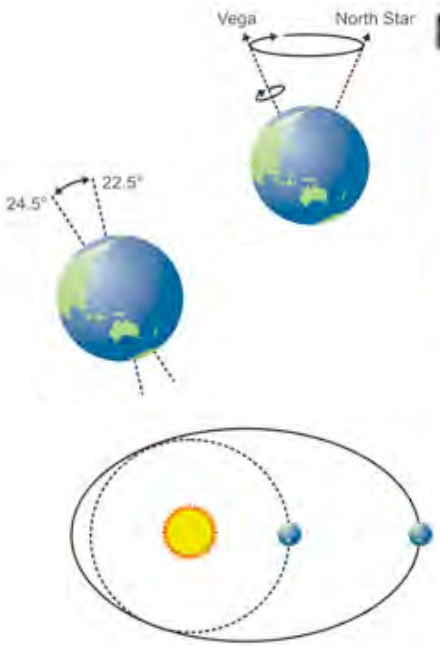


Causas de los cambios climáticos

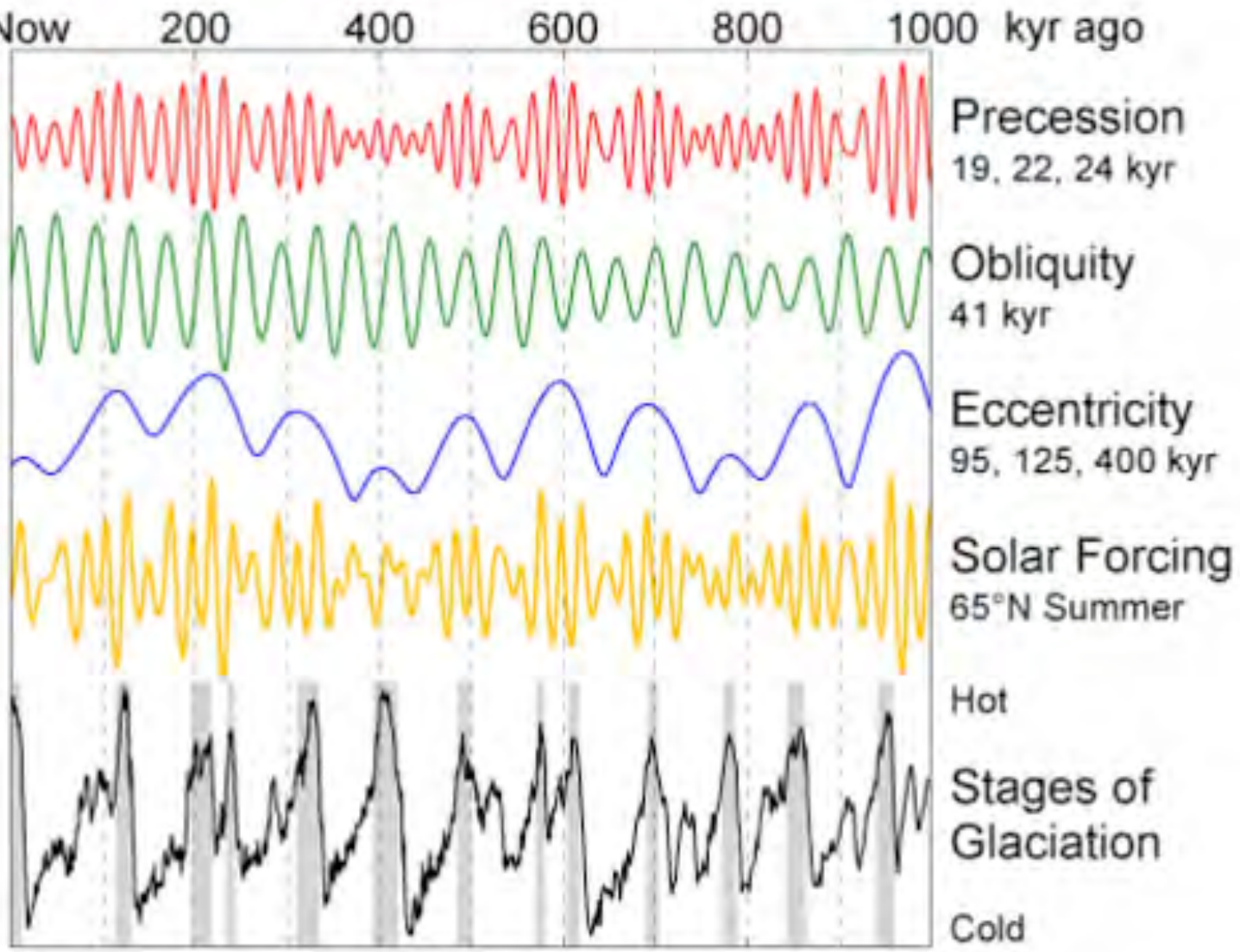


Causas de los cambios climáticos

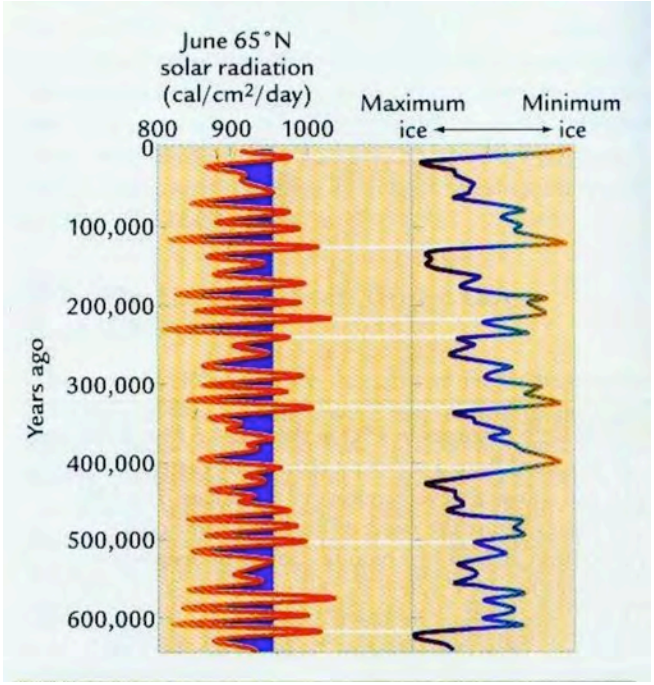
Ciclos de Milankovitch



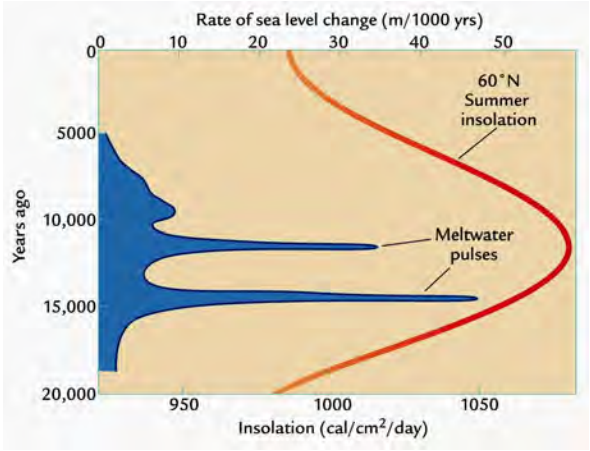
Varía la radiación solar recibida

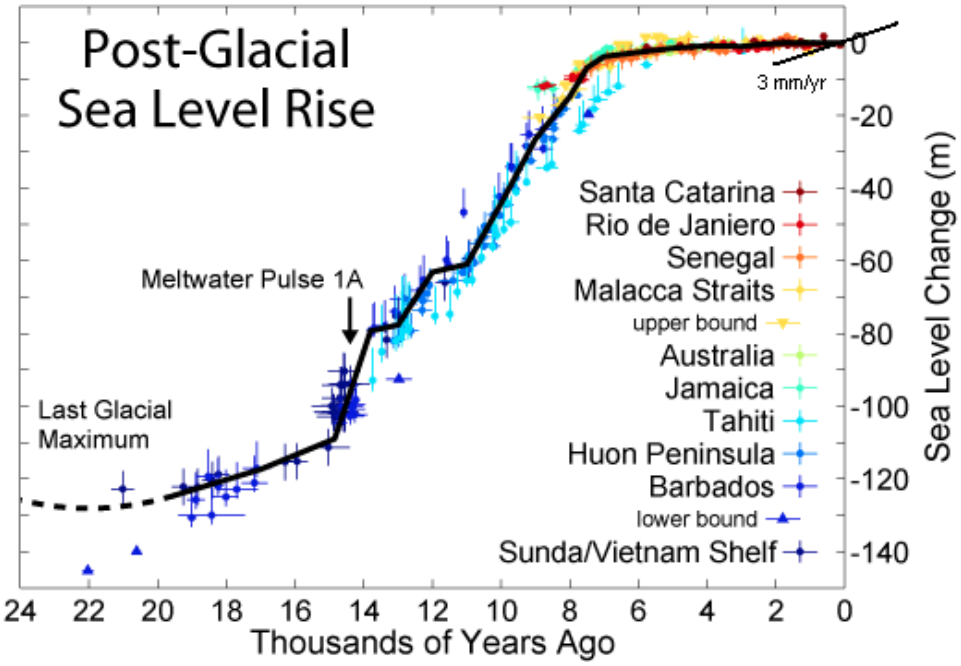


Causas de los cambios climáticos

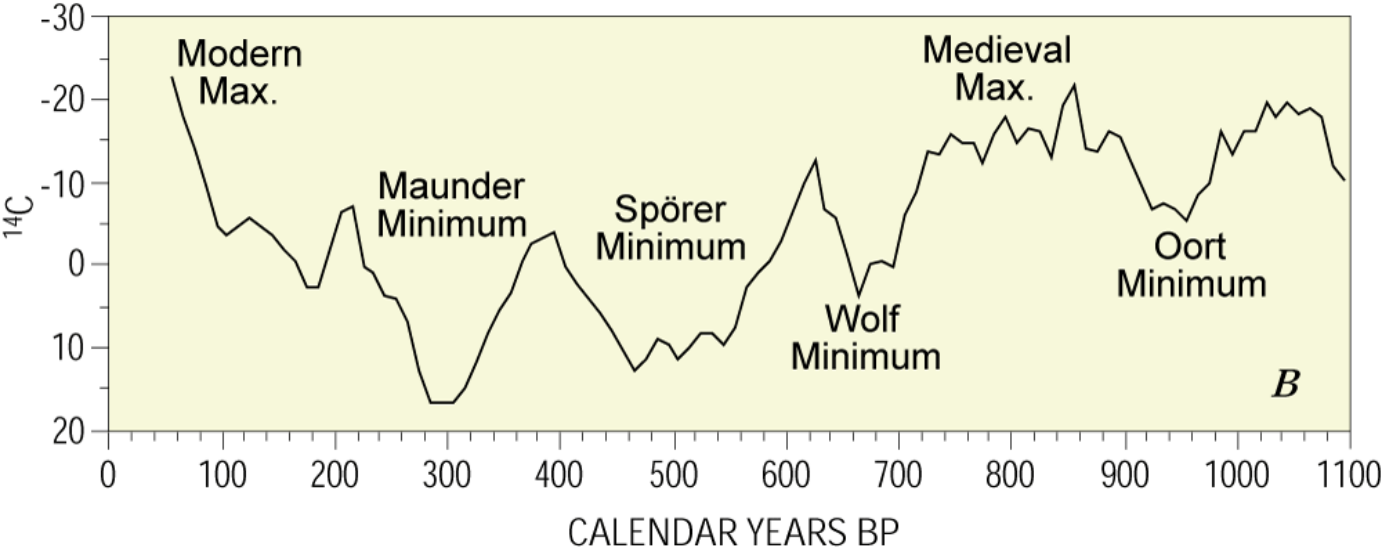


Máxima insolación, marcan rápidas deglaciaciones cada 100.000 años

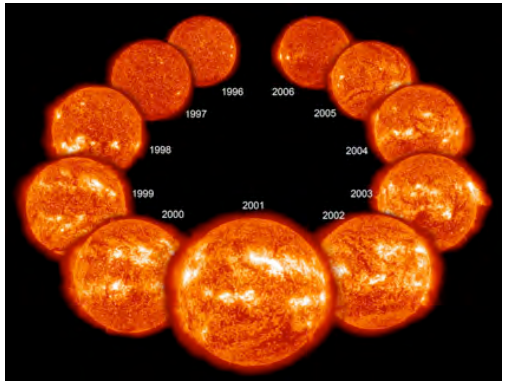


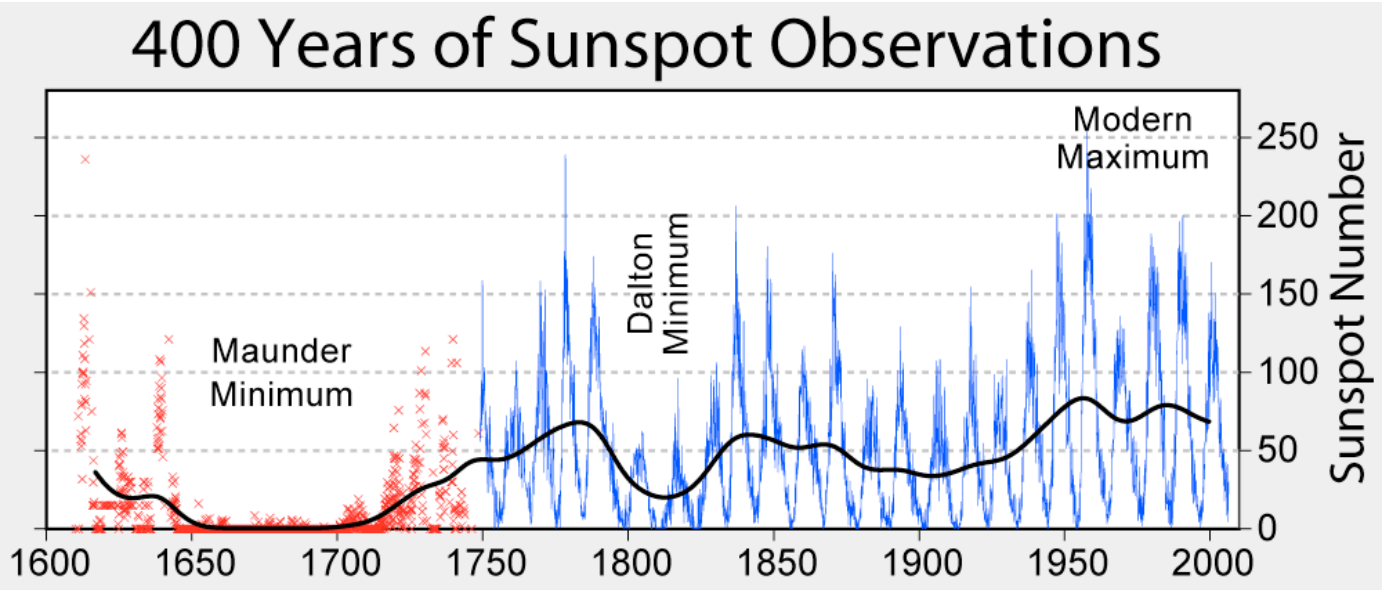


Causas de los cambios climáticos

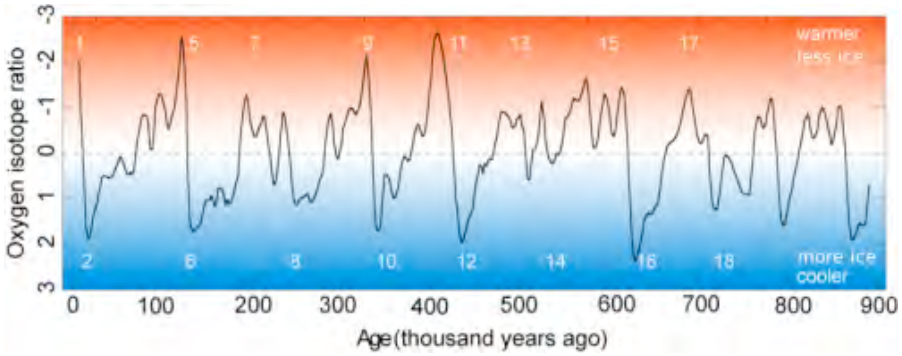


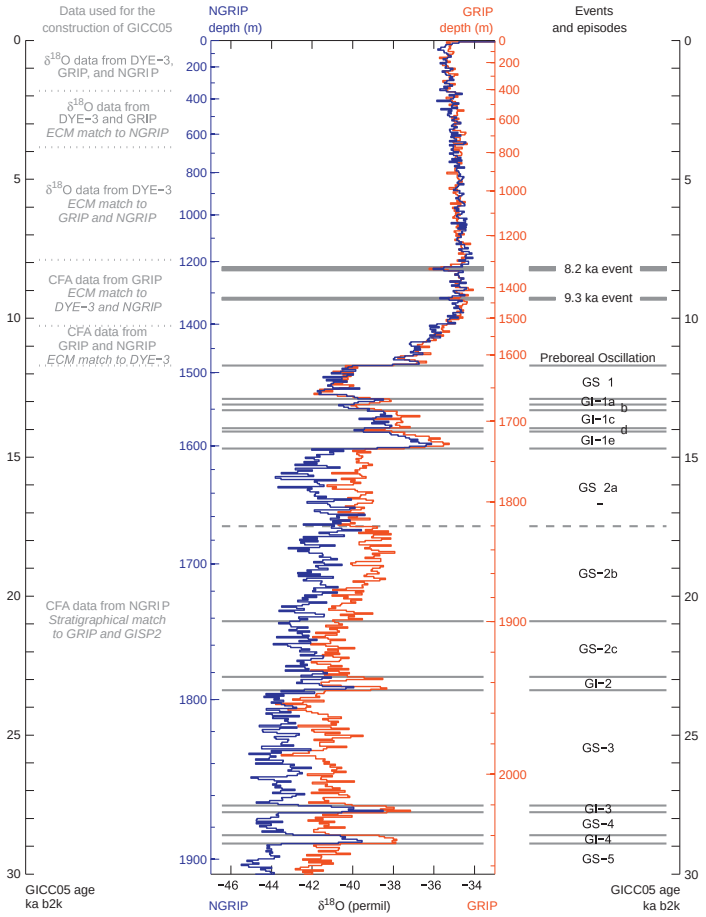
Ciclos solares: 1500, 208, 90, 22, 11 años





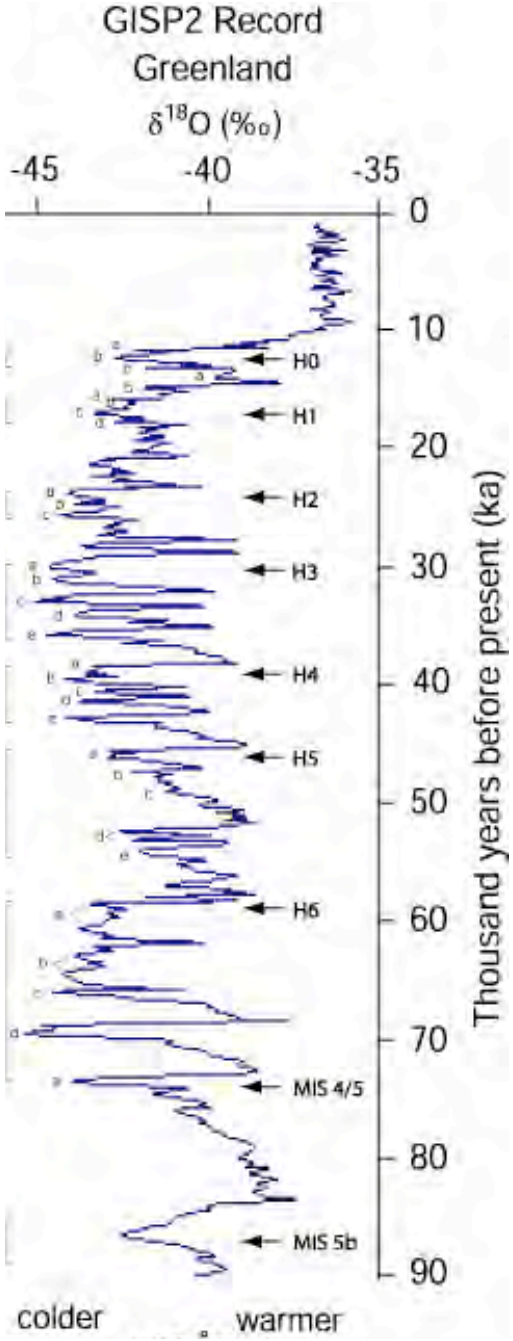
Variaciones climáticas de mayor frecuencia





Estadiales

Interestadiales



Causas de los cambios climáticos

Atmospheric CO_2 Concentrations over the Last Glacial Termination

Eric Monnin,[1]* Andreas Indermühle,[1] André Dällenbach,[1] Jacqueline Flückiger,[1] Bernhard Stauffer,[1] Thomas F. Stocker,[1] Dominique Raynaud,[2] Jean-Marc Barnola[2]

A record of atmospheric carbon dioxide (CO_2) concentration during the transition from the Last Glacial Maximum to the Holocene, obtained from the Dome Concordia, Antarctica, ice core, reveals that an increase of 76 parts per million by volume occurred over a period of 6000 years in four clearly distinguishable intervals. The close correlation between CO_2 concentration and Antarctic temperature indicates that the Southern Ocean played an important role in causing the CO_2 increase. However, the similarity of changes in CO_2 concentration and variations of atmospheric methane concentration suggests that processes in the tropics and in the Northern Hemisphere, where the main sources for methane are located, also had substantial effects on atmospheric CO_2 concentrations.

The concentration of atmospheric CO_2 has been increasing steadily since the beginning of industrialization, from ~280 parts per million by volume (ppmv) to its present value of ~368 ppmv (*1–4*). By investigating earlier, natural CO_2 variations, we expect to obtain information about feedbacks between the carbon cycle and climate and also the possible impact of the anthropogenic CO_2 on the climate system. The transition from the Last Glacial Maximum (LGM) to the Holocene, during which CO_2 increased by ~40%, is a key period for such investigations.

The ice core record from Vostok, Antarctica, covering the past 420,000 years, shows increases of the CO_2 concentration between 80 and 100 ppmv for each of the past four glacial terminations (*5*). The increase during the last termination is well established on the basis of various polar ice cores from both hemispheres (*6–10*). However, not all ice cores are well suited to investigate the details of such an increase. Some CO_2 records, especially those from Greenland ice cores, are compromised by the production of CO_2 by chemical reactions between impurities in the ice (*11–13*). Ice cores from Antarctica are less affected, but a small amount of in situ CO_2 production by chemical reactions cannot be excluded for all Antarctic ice cores and all climatic periods (*14, 15*). CO_2 records from Vostok and Taylor Dome are thought to be the most accurate (*5, 10, 16*). However, the time resolution of these two records is too low to provide a history of CO_2 changes that shows the detailed evolution of atmospheric CO_2 over the last glacial termination.

Here, we present a record from the Dome Concordia (Dome C), Antarctica (75°06′S, 123°24′E), ice core drilled in the frame of the European Project for Ice Coring in Antarctica (EPICA) during the field season 1998–99. We measured CO_2 in a total of 432 samples from 72 different depth intervals, between depths of 350 and 580 m, covering the period from 22 to 9 ky B.P. (ky B.P. is thousand years before present, where present is chosen as A.D. 1950). For each depth level, six samples were measured on a 60- to 100-mm length interval. On the same core, 74 methane measurements were performed. The analytical methods are described in (*17*).

The age scale for the ice, as well as for the enclosed air (which is younger than the surrounding ice because it is enclosed at the bottom of the firn layer), is based on the time scale by Schwander *et al.* (*18*). The uncertainty of the absolute time scale for the ice is estimated to ±200 years back to 10 ky B.P. and up to ±2000 years back to 41 ky B.P. The gas-ice age difference (Δage) is calculated with a firn densification model. The value of Δage is ~2000 years in the Holocene, increasing to ~5500 years during the LGM, and has an estimated uncertainty of ~10%.

The main feature of the CO_2 record (Fig. 1) is an increase from a mean value of 189 ppmv between 18.1 and 17.0 ky B.P. (*19*) to a mean value of 265 ppmv between 11.1 and 10.5 ky B.P. (beginning of the Holocene). The increase of 76 ± 1 ppmv occurs in four distinct intervals. From 17.0 to 15.4 ky B.P. (interval I), CO_2 increases from 189 to 219 ppmv at a mean rate of 20 ppmv/ky. From 15.4 to 13.8 ky B.P. (interval II), CO_2 rises from 219 to 231 ppmv at a rather constant rate of 8 ppmv/ky before a rapid increase of ~8 ppmv within three centuries at 13.8 ky B.P. Between 13.8 and 12.3 ky B.P. (interval III), a small decrease from 239 to 237 ppmv occurs at a rate of

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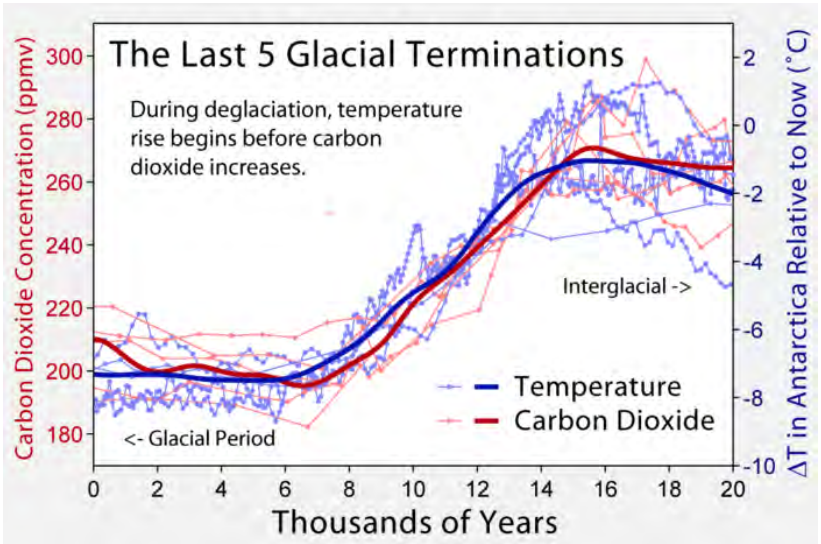
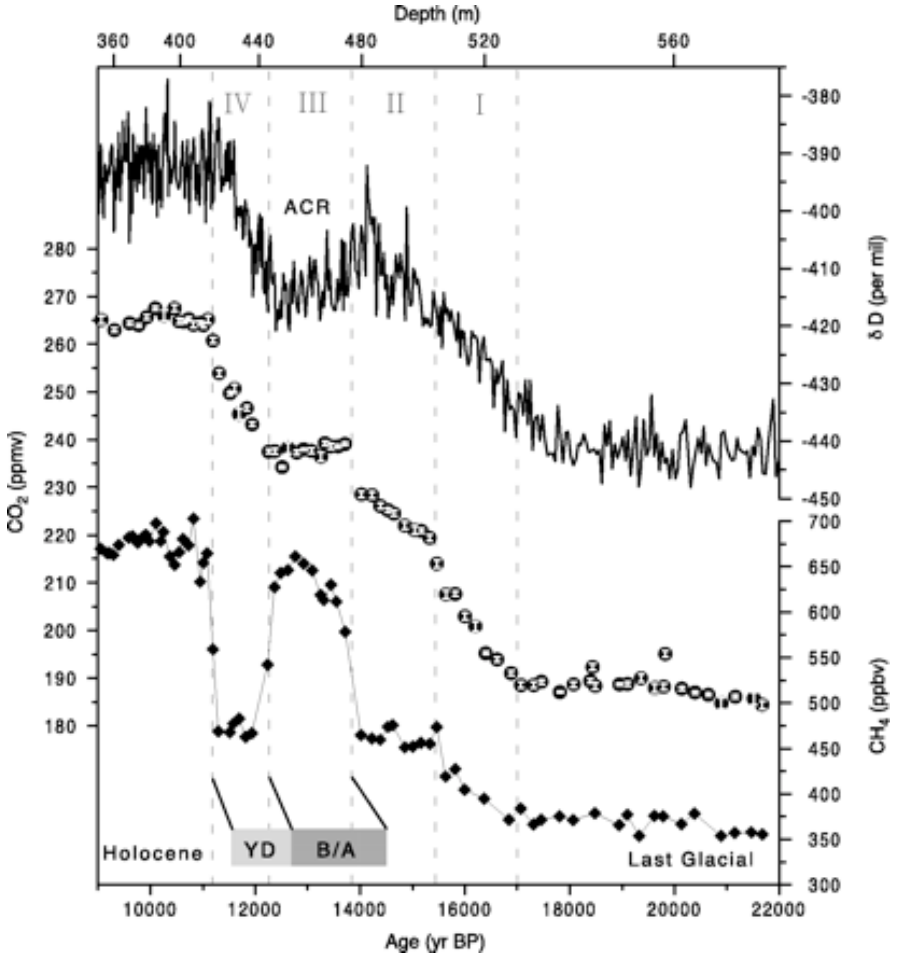
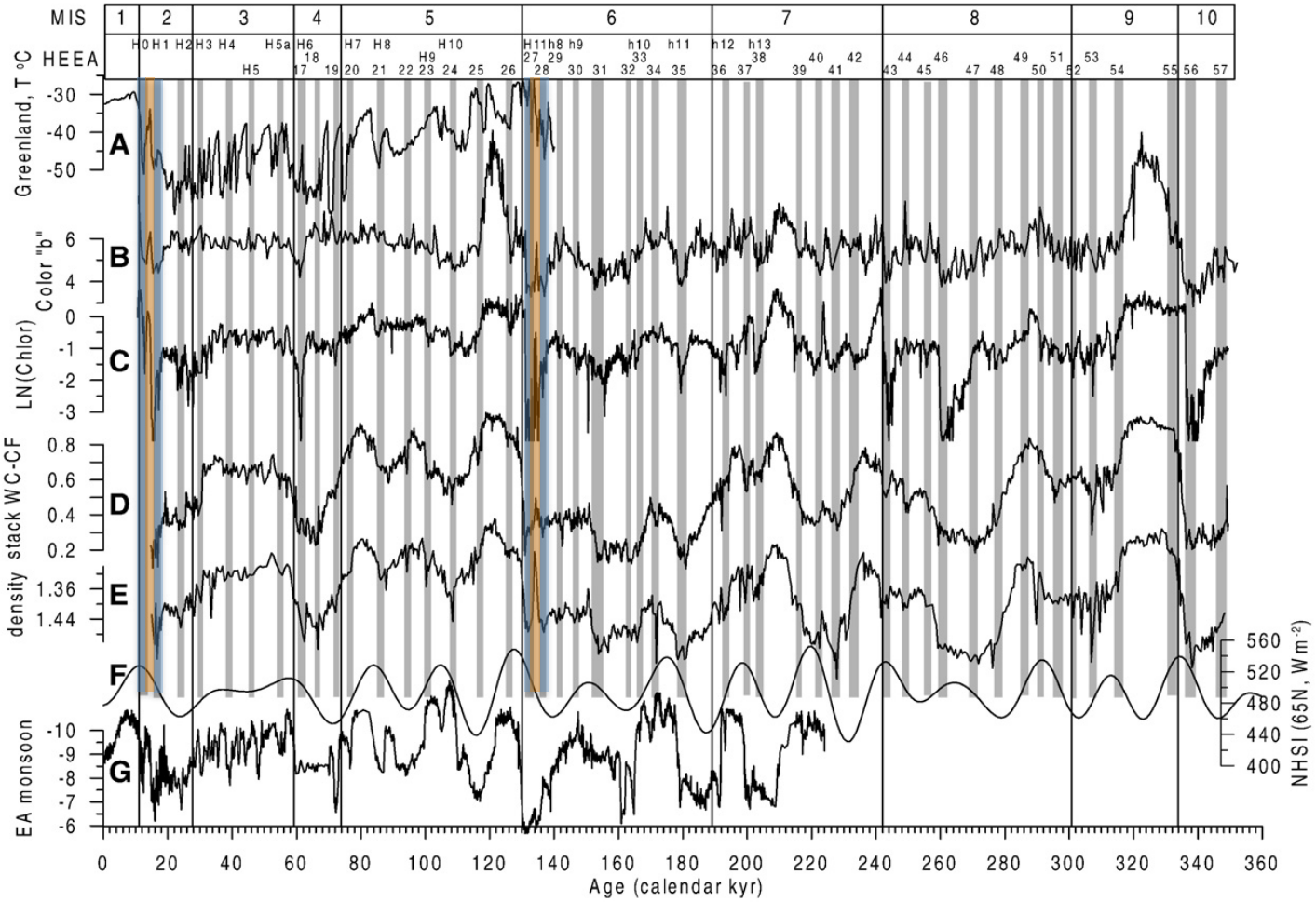
*To whom correspondence should be addressed. E-mail: monnin@climate.unibe.ch





¿QUÉ NOS DEPARA EL FUTURO?

¿Los climas del pasado: clave del futuro?



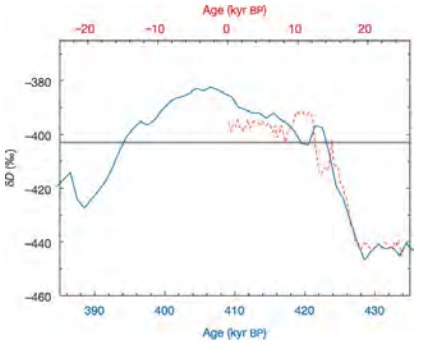
Gorbarenko et al. (2010)

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

Facing future climate change: is the past relevant?

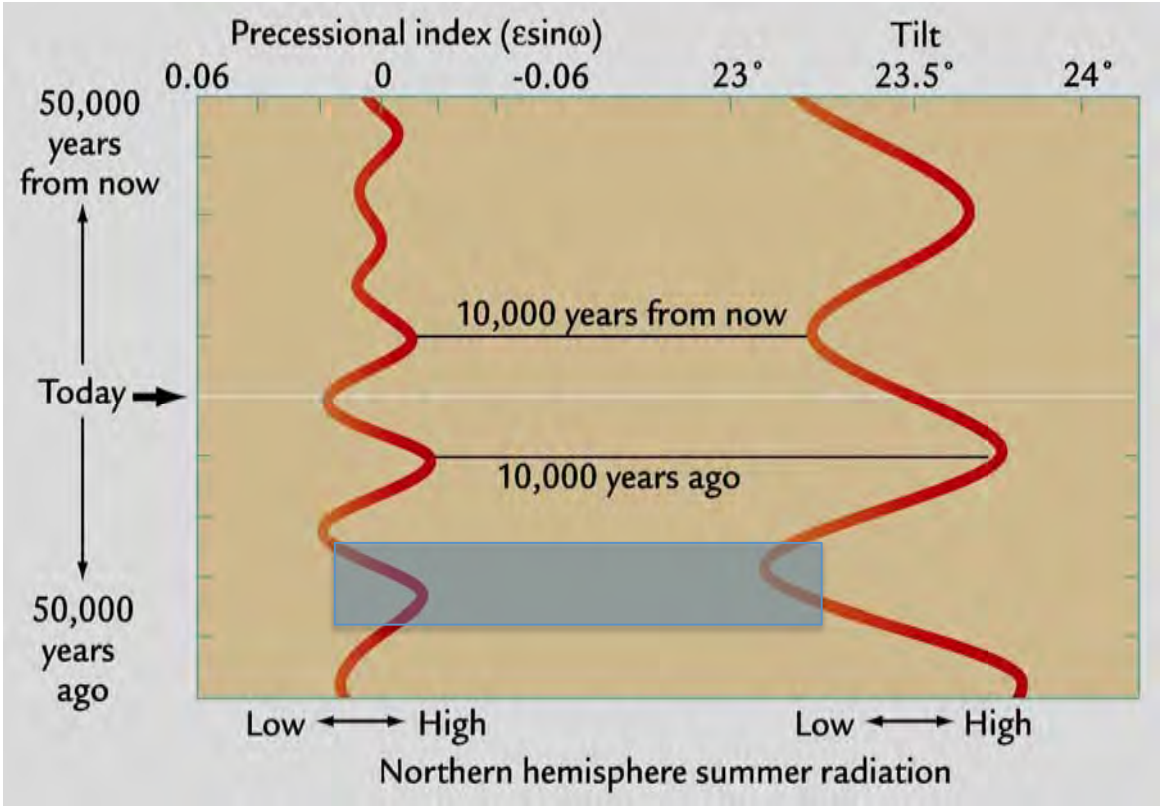
Luke Skinner

Phil. Trans. R. Soc. A 2008 **366**, doi: 10.1098/rsta.2008.0228, published 28 December 2008



¿Los climas del pasado: clave del futuro?

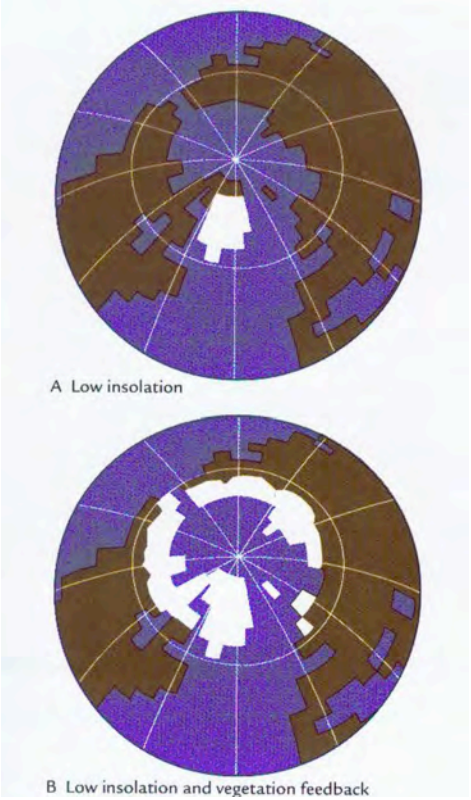
Modelos astronómicos: previsión



Controla la insolación
a bajas latitudes

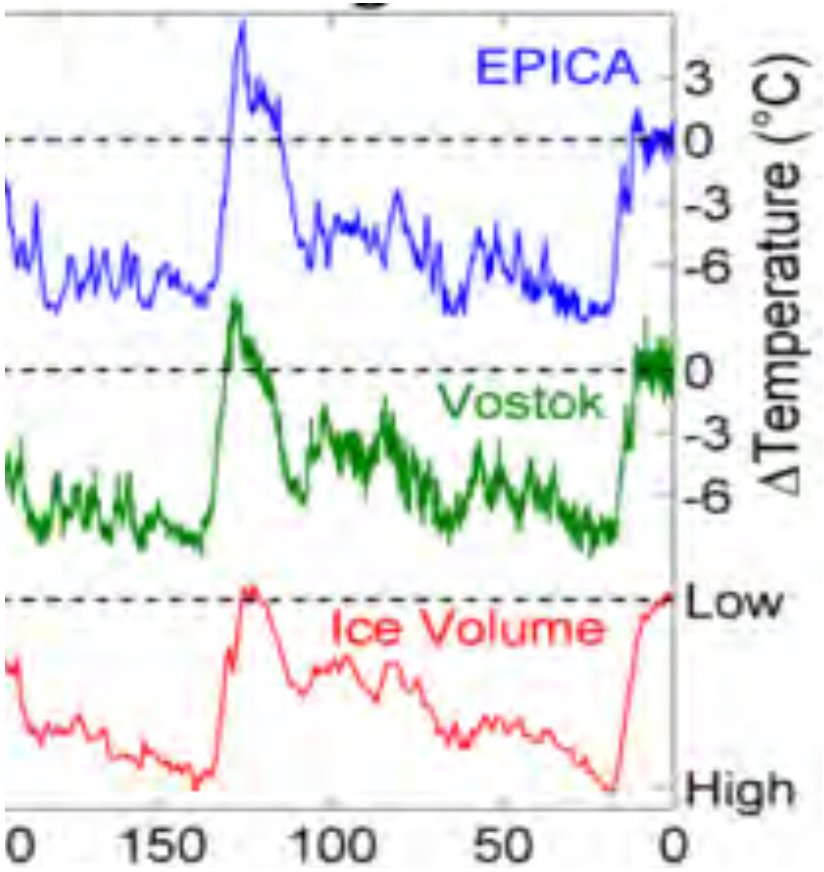
Controla la insolación
a altas latitudes

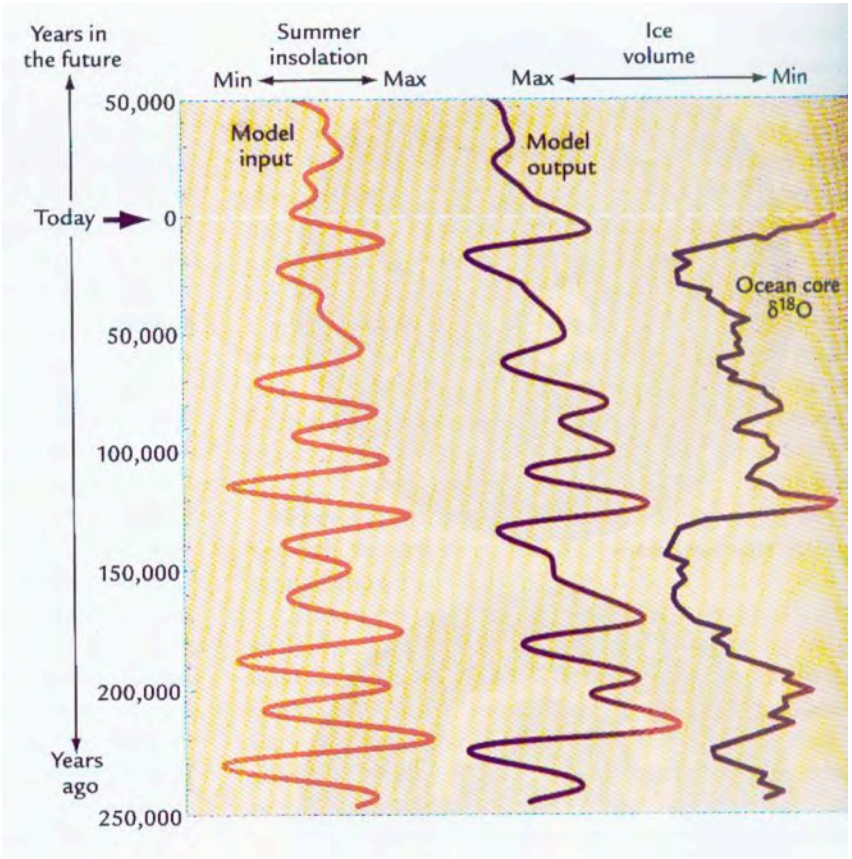
Modelizaciones
Baja insolación
a altas latitudes



La baja insolación en las altas latitudes provoca aumento de glaciares: ¿Nueva glaciación?

¿Los climas del pasado: clave del futuro?



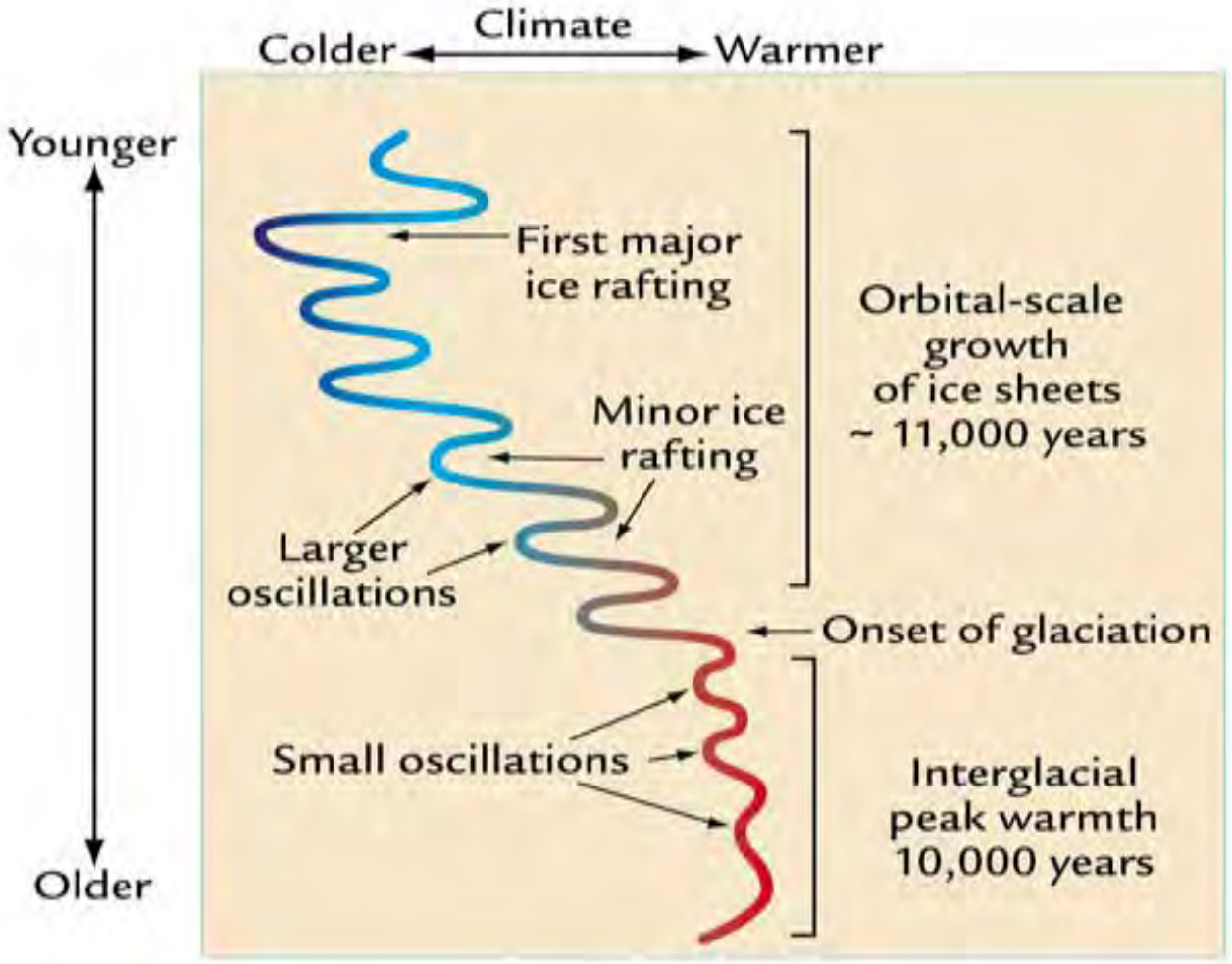


Modelos basados en el desarrollo de hielos del último millón de años.

Similitudes con el último interglacial (15.000 años). Los últimos 5.000 degradación climática

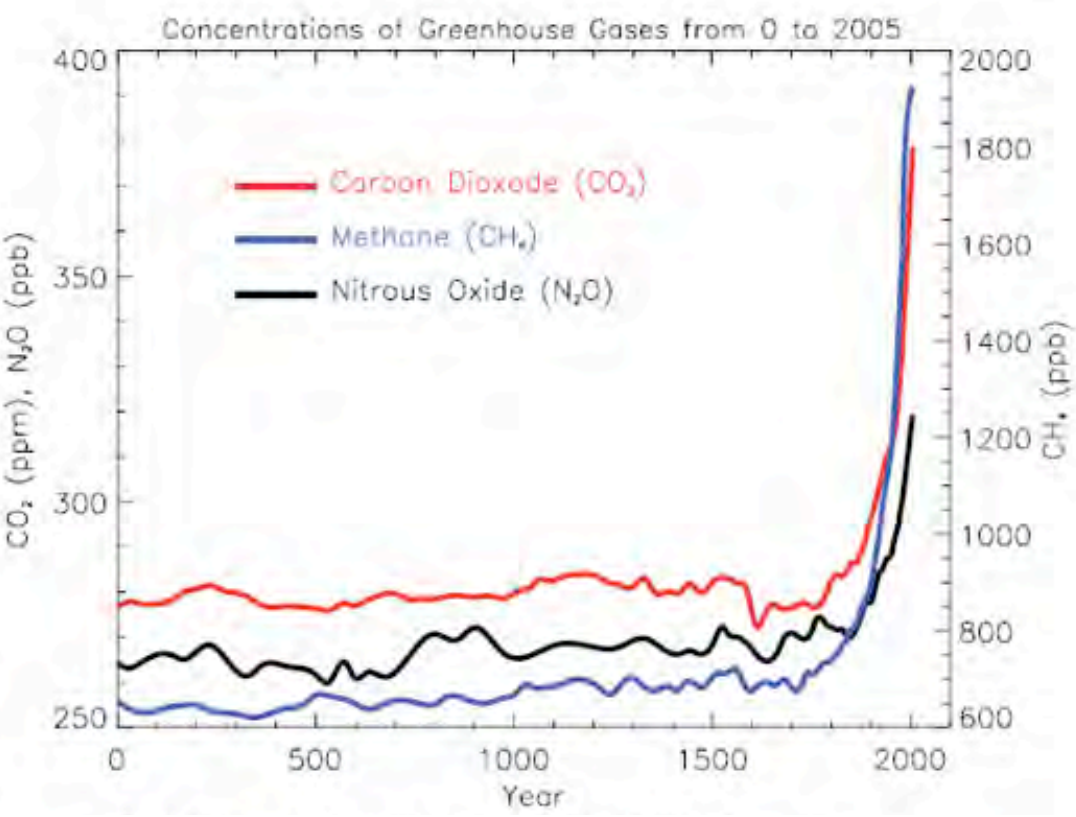
Proximidad de una glaciación

¿Los climas del pasado: clave del futuro?



Nueva variable: El efecto del HOMBRE:

Gases Invernadero
Aerosoles
Deforestación




Gracias por
su atención