18th International festival of Saint Dié (Vosges, France)
October 6th, 2007
Conference Debate moderated by Martine Tabeaud
12h00-15h30
"Climate Change: between reality and imposture, what place for science?"

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Thoughts of a geologist-geophysicist on climate change and energy forecast with lots of graphs for meditation.

"What is said everywhere, by every body and always is probably wrong."
Paul Valery (website of Robert Vivian, glaciologist).

Some argue that science has decided and the debate ended and that those who are skeptical are negationists.

In "Science et Vie HS" "*Climat: le dossier Vérité*" in September 2007, Y. Sciama writes "*Today, the defeat of these climate sceptical seems consumed*". But last year he refused to bet with me €1 000 that the temperature in 2015 would not be higher than today.

We must not confuse those who are sceptical before the results of the IPCC models (with the 2001 hockey stick curve) or the Al Gore documentary "*An inconvenient truth*", with those who reject global warming. It is important to define the terms we use!

The truths of field geologists are not the truths of economists or modellers or journalists in their offices.

Yes, temperature has increased since the end of the little ice age, yes human activity contributes, but it seems to me that we are not able to foresee what will happen in the century to come. The energy scenarios, written by economists, of the latest IPCC reports of 2001 and 2007 are unrealistic, are not forecasts but "stories" without any consideration of the resources of the planet and of the past.

IPCC ignores the peak oil and the realities of the industry.

The catastrophism on resources or growth is politically incorrect, unlike catastrophism in climate which is very well considered by the media and politicians.

But geologists are well paid to know what a climatic change represents and AAPG was the first organization to be skeptical about IPCC reports.

Any outcrop with, for example, an alternate series of clay and sandstone, derives from climate change that causes variations in sea level.

A geologist has no doubt about the climate change because it has existed since the creation of the earth. However, geologists are very few in the IPCC.

Saying that climate change is now a reality, for me geologist, is a joke. Because climate change has been around for 4.5 Gy!

But one fails to say that the definition of climate varies from the one by French Academy of Sciences which is only anthropogenic, while the one of IPCC is man-made as well as natural.

Lying by omission is very frequent and playing on words is not scientific.

Life is cycle: all varies, everything evolves.

Stabilizing climate would mean opposing the natural climate change or willing to oppose the movement of tectonic plates that cause earthquakes or volcanic eruptions.

Willing to consider the greenhouse effect as harmful ignores that without greenhouse effect, life on earth would not exist. Wanting to completely eliminate CO2 (or carbon with the era of hydrogen) is

also ridiculous, CO2 is the food for plants which are the food for mammals, and thus for the man!

It is predicted that the earth would be unbearable if the temperature would increase by 4°C when it was greater at upper Cretaceous and currently Marseilles has a higher average temperature of 4°C over that of Lille. Moving from Lille to Marseille does not mean going to hell!

The optimum ice age was 3°C higher than now and Sahara was verdant.
Some will win and others will loose!

The balance is difficult to do but it can be positive! The only certainty that I have is that I am going to die one day and that the earth will revert yet again into a new ice age, and then followed by a new period to finish in a few billion years burnt by the sun that will turn into a supernova

In 1975, we were afraid of global cooling (*La Marche du siècle,* Jean-Marie Cavada).

The geophysicist that I am knows well the inaccuracy of a measure and I often say that in terms of resources that an author giving more than 2 significant figures shows his incompetency. What about the means and statistics manipulated by persons who are not trained to these methods!

Most of the articles are from the work of the French theses who show ingenuity and novelty always with new models and new hypotheses to replace the uncertainty of data through the richness of imaginations. I am admiring miracles which some can make to obtain from indirect data, from various hypotheses, constructions (in fact castles of cards) which seem perfect, but built on sand and that the slightest wind can make collapse.

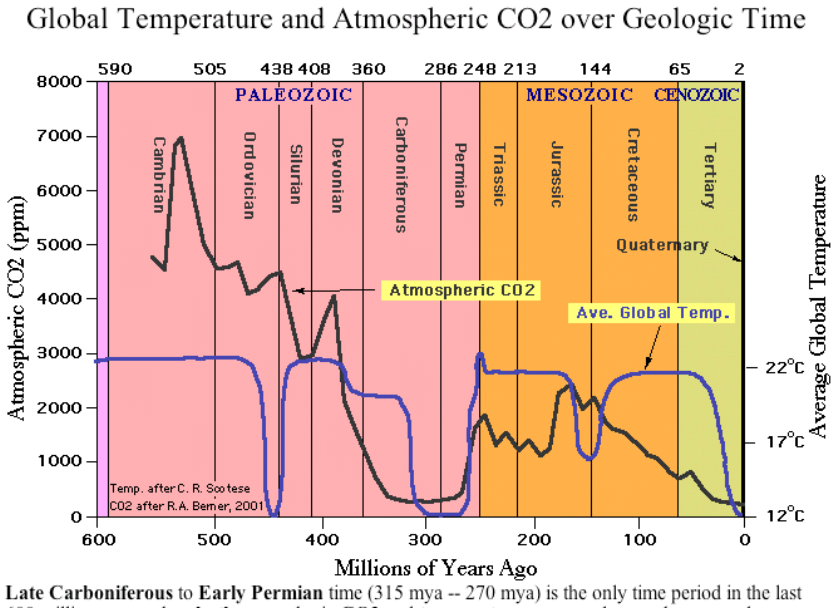
These authors gather to resist to the wind of legitimate criticism. Moreover, politics and the financing of academic work also distort the democratic game. Sceptics are treated as negationists (as for the Holocaust) or fans of petroleum companies. One passes from science to religion!

Let's show by the example what maintains my doubts on Climate Change.

-A- Geological Climatic Past

The past shows that the temperature and CO2 have varied in cyclical way, with no obvious trend at the scale of geological eras.

We find ourselves in the conditions prevailing 300 Ma ago. Clearly, everything is cyclical without being able to say what will be the next round.



Late Carboniferous to **Early Permian** time (315 mya -- 270 mya) is the only time period in the last 600 million years when **both** atmospheric **CO2** and **temperatures** were as low as they are today **(Quaternary Period).**

Figure 1: temperature and atmospheric CO2 from 600 Ma BP from Gerhard AAPG

It appears that there is no obvious correlation between CO2 and temperature over geological time! In Central Europe, the change in temperature during the passed 60 Ma shows a very sharp decrease with glaciations at the Pleistocene age. The fall is near 20°C. Those who say that an increase of 5°C would be the end of the world ignore what happened 50 Ma ago! There was no ice at the poles at Cretaceous time.

We are in an interglacial period in the middle of many glaciations over few million years, so in a very variable period of the geological time.

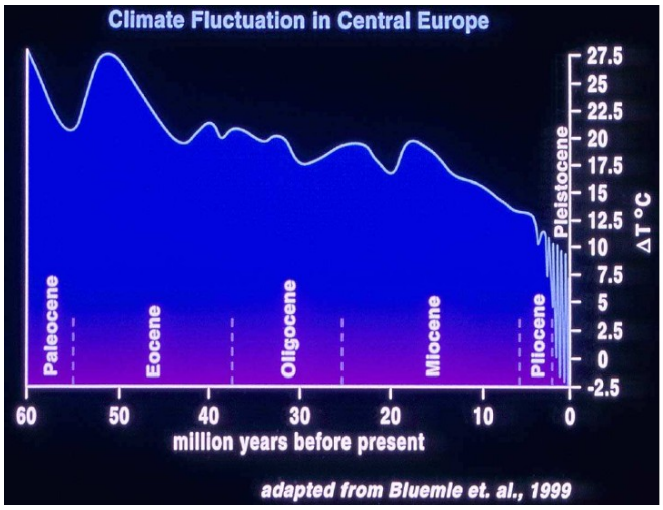


Figure 2 : Central Europe temperature fluctuation (last 60 Ma)

Let us look in more detail at the temperature of geological time to locate the current temperature compared to the past.

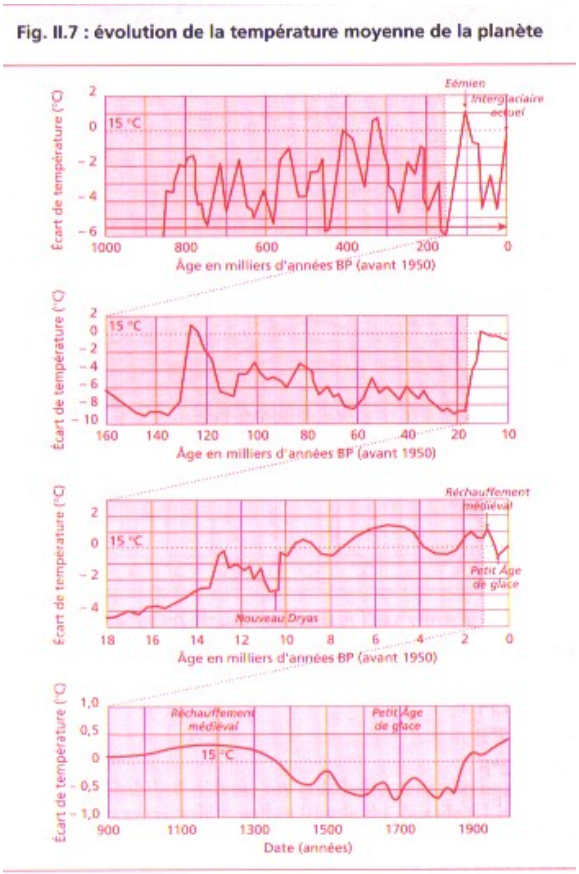


Figure 3: Evolution of the temperature of the planet on 1 Ma (one million years) according to Tabeaud "climatology" 2000

More detail show that current changes since the industrial age are insignificant compared to the past going back on 4 Gy (Deconinck 2006).

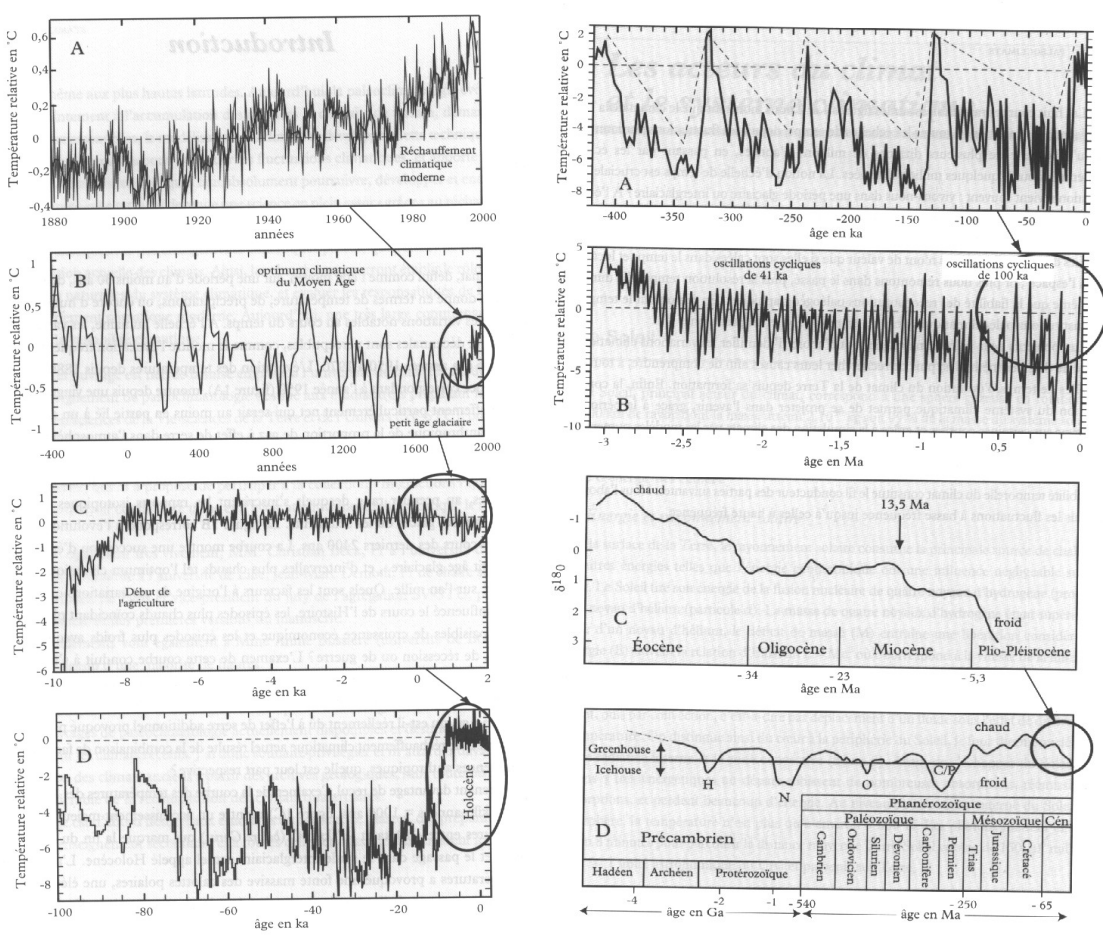


Figure 4: Evolution of the temperature over 100 ka according to Deconinck "Paleoclimats" 2006

The glaciations are given at -8°C rather than -5°C as says Mr. Petit in the letter 21 (Spring 2007) of the Academy of Sciences.

Cretaceous is the hottest period and there was no ice at the poles and yet the mammals were not deperishing, on the contrary!

The main factor of paleoclimates astronomical theory is highlighted by Milankovitch, which is now accepted by all. The variation of insolation of the sun is controlled by:
- Precession of the axis of rotation -periods of 23 and 19 ka- (common in alternations decimetric geological outcrops)
- The obliquity of the axis -period 41 ka-
- The eccentricity of the ellipse -period of 100 and 413 ka-

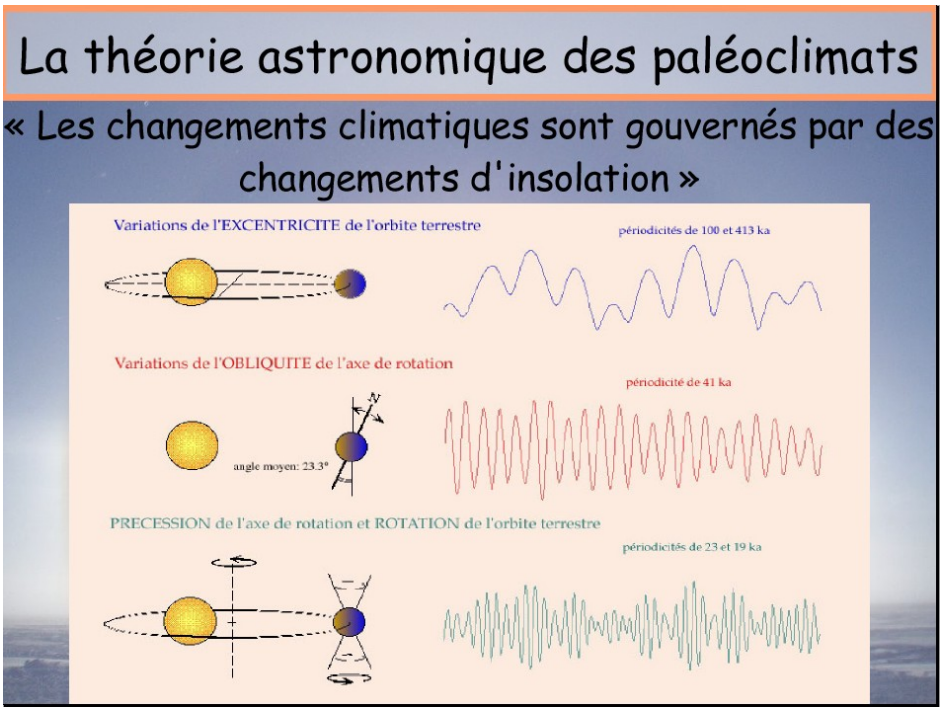


Figure 5: the astronomical theory of paleoclimates (Parrenin 2007)

The temperature measurements (proxy deuterium) at Vostok (1999): it is easy to model 420 000 years with 21 cycles at the same period (~ 23 ka).

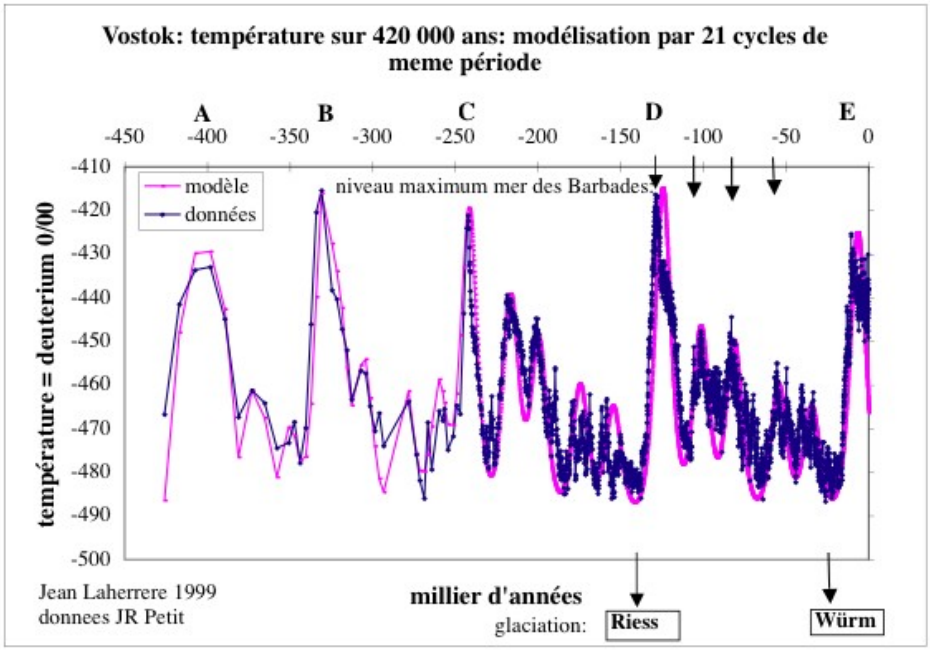


Figure 6: temperature (deuterium) at Vostok; data Petit 1999 modeled with 21 cycles

We shall see in the chapter B1 on ice that the dating of ice (unlike bubble dating) is uncertain with a precision of a thousand year. Therefore, we should not make a comparison with current annual or even decade measures.

The famous hockey stick curve from the tree rings of the IPCC 2001 report, which denies the Little Ice Age visible on the paintings of Bruegels and the medieval warm period experienced by the green Greenland and the harvest in London, has disappeared from the last IPCC 2007 report. The annual variations in tree rings cannot keep centenarians variations!

The hockey stick curve is replaced by a bunch of curves all as imprecise as others are.

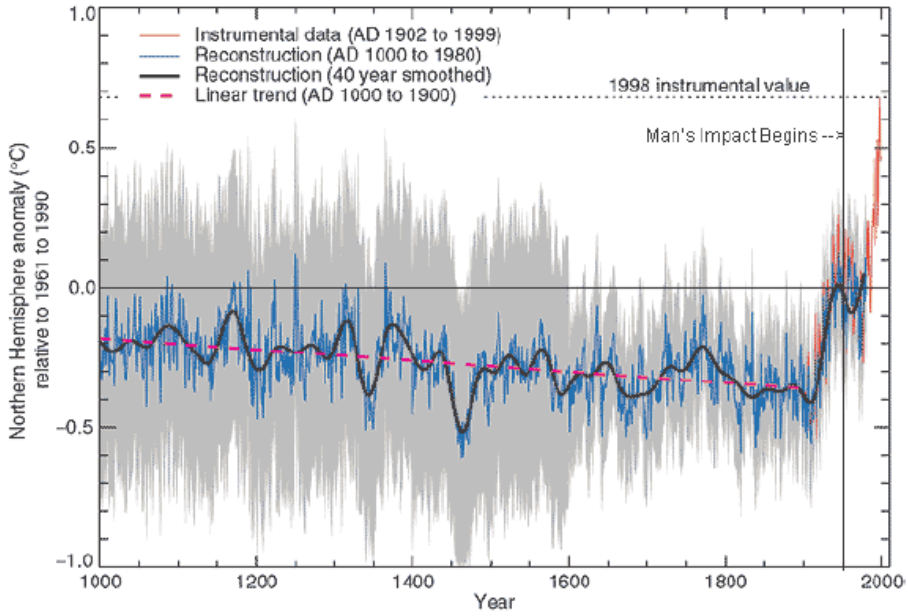


Figure 7: hockey stick curve: temperature y1000-y2000 from tree rings.

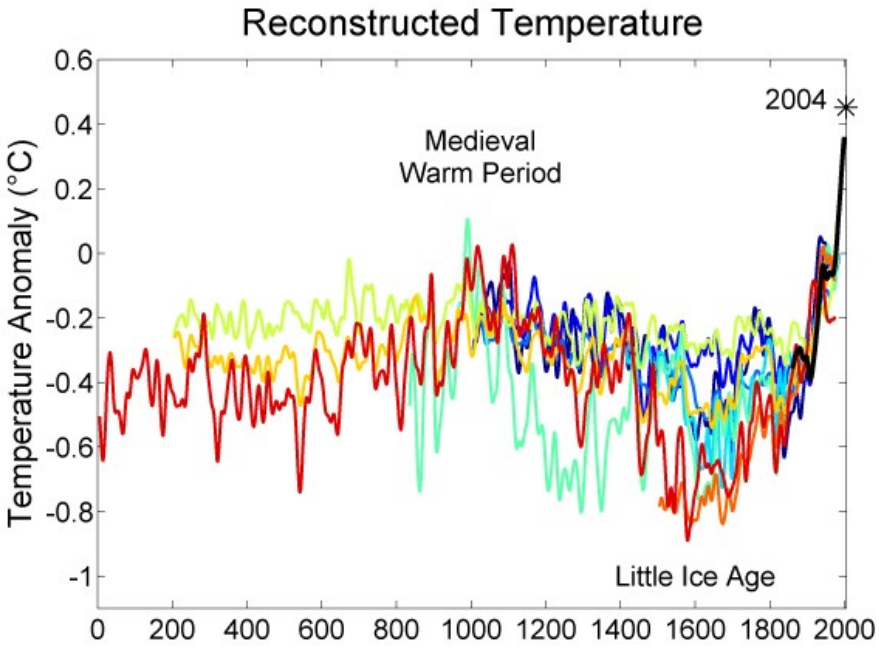


Figure 8: temperature y0-y2004 from IPCC 2007 from several sources

But the Milankovitch astronomical variations are only part of the causes, there are others such as the distribution of continents and hence their drift, the greenhouse effect, the brightness of the sun, the ocean currents, El Nino oscillations, La Niña, volcanoes and finally human activity to the 4th order, as shown Gerhard AAPG in this graph.

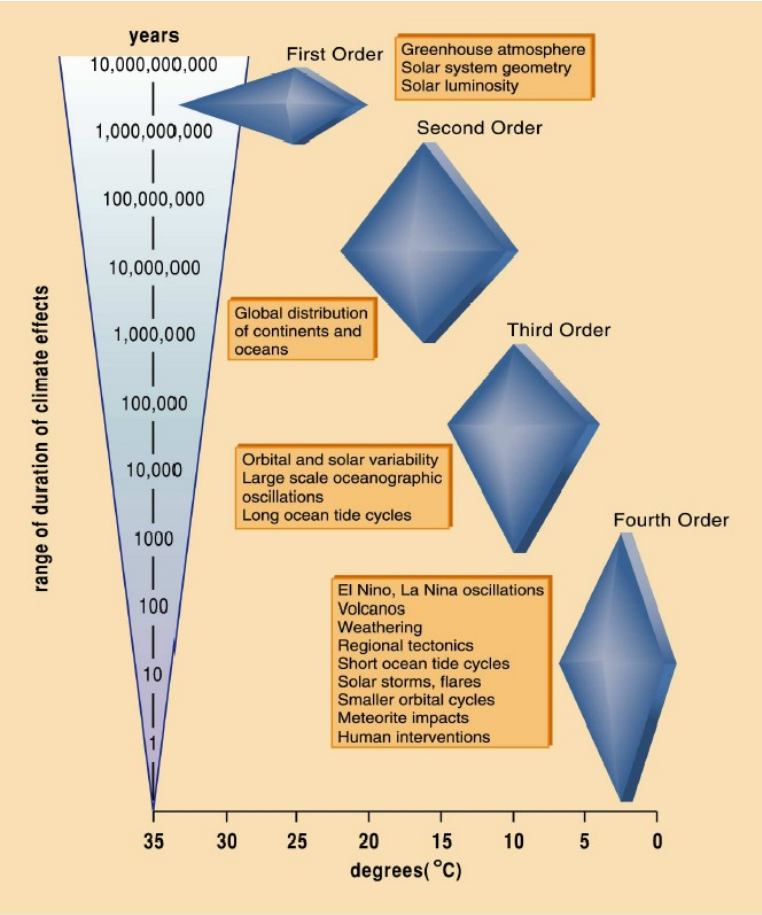


Figure 9: range effects of climate according Gerhard AAPG

-B- Measurements of the recent past

The paleoclimatological conditions are found in the sediment, and in particular in ice.

-B-1- Ice

The Antarctic and Arctic ices were drilled in recent decades, as evidenced by these charts Parrenin 2007 "*What will become our climate*?".

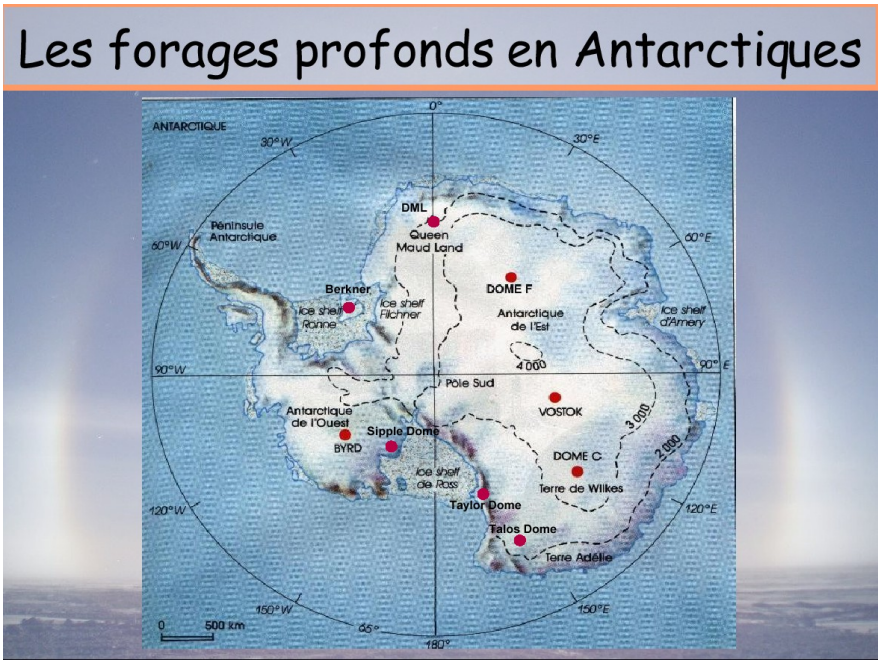


Figure 10: ice drilling locations in Antarctic

Figure 11: ice drilling locations in Greenland

The snow turns to ice after some time and it should not melt to be an archive; sites are in locations where the temperature is always below 0°C!

-B1-a- Firn turning into ice

Snow has a density of 0.3 at the surface and settles gradually to acquire a density of 0.83 where air bubbles are closed (close off) to a depth that varies in Antarctica from 20 to 150 m. Claude Lorius had the idea to exploit the analysis of gas bubbles in ice cores from Vostok. This study has resulted in the historic greenhouse gases very often used in the study of climate change.

However, the problems of bubble dating are often "forgotten" in most publications that present the results as certain. Indeed, if the dating of ice is easy when one see variations, when those are gone you must make assumptions on packing, accumulation and fit with identifiable points (known volcanic

eruptions) or cosmogenic measures (Be10). Ice dating is marred by inaccuracies and thus are temperature measurements, which are deducted from isotopic variations of hydrogen or oxygen within the water.

By contrast, gas bubbles move in the firn above the closeoff zone; and gas are more or less in communication with the atmosphere. Therefore, throughout the period of bubbles openness (which may be more than 5 000 years) there is aggregation by convection and gravity diffusion of gases in the atmosphere of the whole era. And therefore, it causes a smoothing (average) over several thousand years which explain the very flat CO2 measurements from ice cores if compared with other measures of indirect temperature (proxy) such as stomata or otherwise. Saying that the ice data are very stable shows that the author does not know where reality has been archived.

In addition, the ideal method of extraction of gas is yet to find.

The following graph (thesis B. Bellier 2004 "*study of the variation in the carbon cycle during the Holocene from the coupled analysis of CO2-CH4 trapped in the polar ice*") shows the density of a firn.

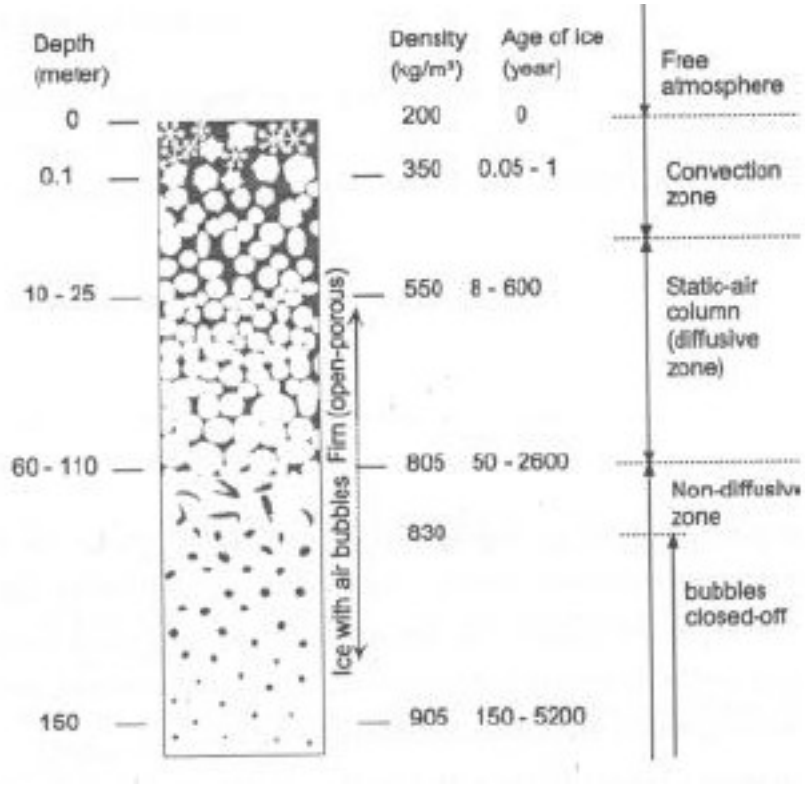


Figure 12: evolution of the gas bubbles during burial.

The following graph (Bellier 2004) shows that the values of CO2 in the bubbles not closed (in blue) move between a value at surface and a value closed (in red) and that there is a gap, because after closing, where there is no longer (?) influence of the atmosphere of past times.

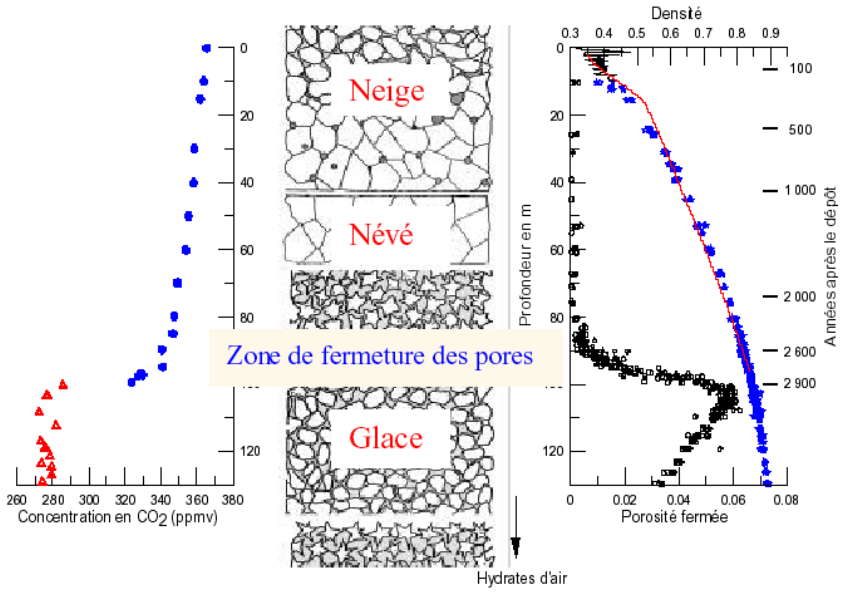


Figure II.1 : Représentation de la transformation de la neige en glace en fonction de la profondeur (Barnola, com. pers.) La figure de gauche représente l'évolution de la concentration en CO_2 à l'intérieur du névé polaire ; la figure à droite, les profils de densité et de porosité ouverte sur les 120 premiers mètres de la calotte polaire.

Figure 13: transformation of firn into ice and datation of bubble close off

However, the value in red does not correspond to the value at the time of closing (here 2 900 years), but at the time of the aggregation of all existing values during 2 900 years. The weighting of this aggregation is not easy and one must speak of average age and age corresponding to the maximum at the closeoff of bubbles. The jump from 280 to 320 ppm in the graph shows that there is discontinuity and complexity.

In the following graph in Greenland for methane Grisp has a very young age compared LGGE Sophie Bertrand "*temporal evolution of methane and nitrous oxide in the atmosphere: constrained by analysis of their stable isotopes in the firn and in polar ice*" 10 December 2004.

All molecules of a given gas are not even on the same route in the firn and do not migrate at the same vertical speed which leads to a probability distribution of an age at a given depth. A depth no longer reflects an age but a distribution of age (the age of the gas molecule is defined as the time elapsed since the molecule crossed for the last time the limit atmosphere-snow).

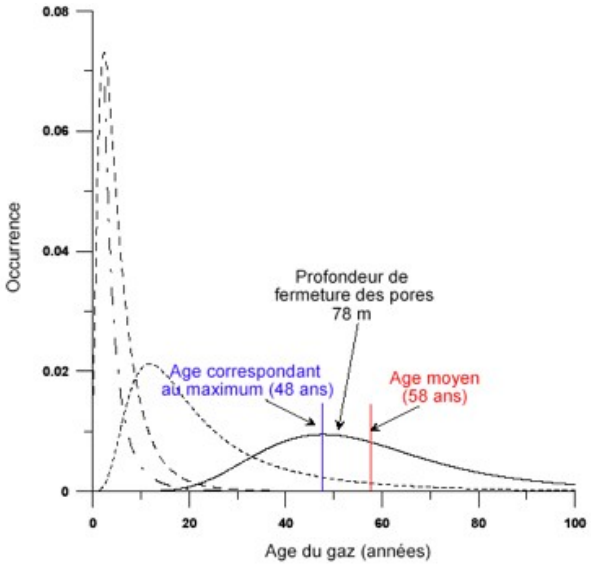


Figure II-8 : Age moyen et âge correspondant au maximum de la fonction de distribution du méthane dans le névé de North GRIP.

Figure 14 : average age and age corresponding to the distribution maximum

We should not speak of gas at a certain age, but of average (smoothing on hundreds to thousands

years period during firn time) at a certain age that is uncertain by several millennia.

In addition, when the depth of the core is important, compaction of the ice means that the 50 cm ice sample, which is necessary for measuring gas concentrations, corresponds to a period millennium.

There is thus smoothing in the firn and smoothing in the sampling of the bubbles.

The closeoff depth varies in Antarctica between 20 and 150 m.

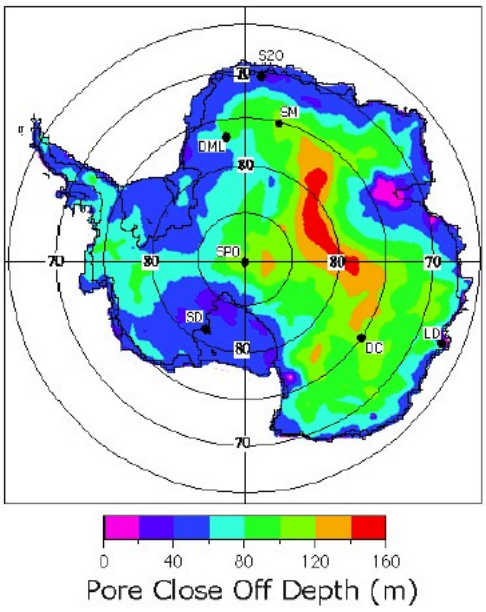


Fig. 6. Depth of the PCOD in m, calculated with the density-depth model of Herron and Langway (1980). The location with the deepest PCOD, being 150±15 m (2σ), is found for 72° E and 82° S.

Figure 15: Pore close off depth according to Kaspers 2004

This depth varies depending on the rate of accumulation of snow and the temperature. The annual accumulation rate ranges from 2 cm/y (Vostok) to 50 cm/y on the edges of the continent.

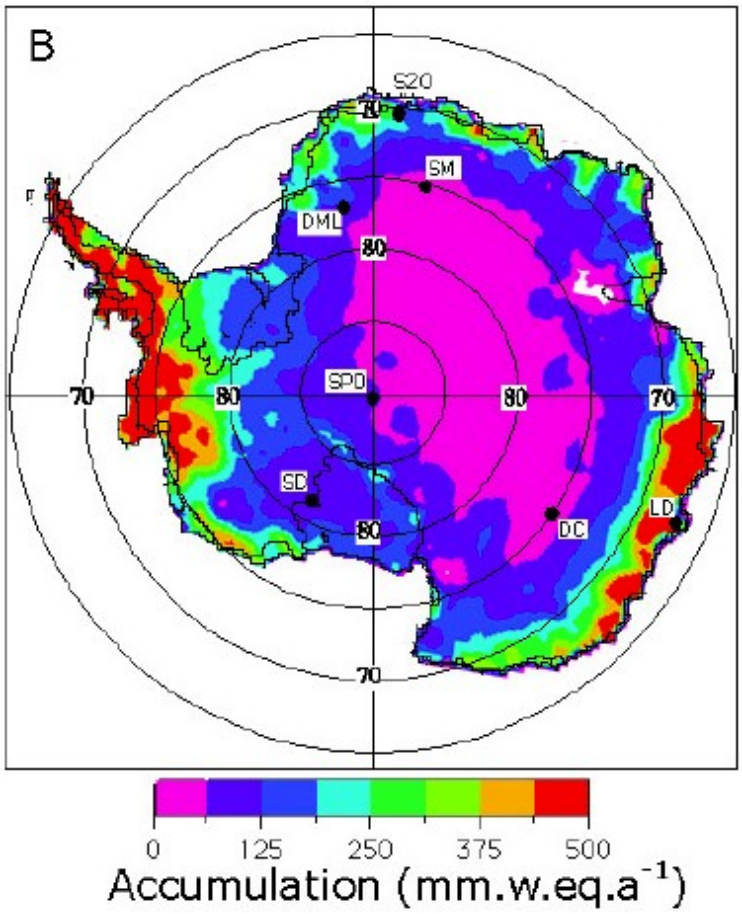


Figure 16: yearly accumulation of snow after Kaspers 2004

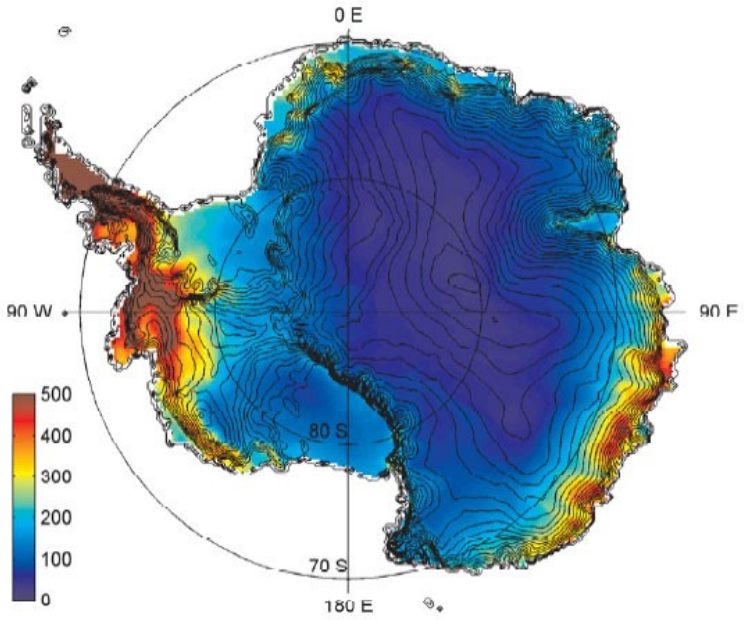


Figure 17: yearly accumulation of snow after Arthern et al 2006

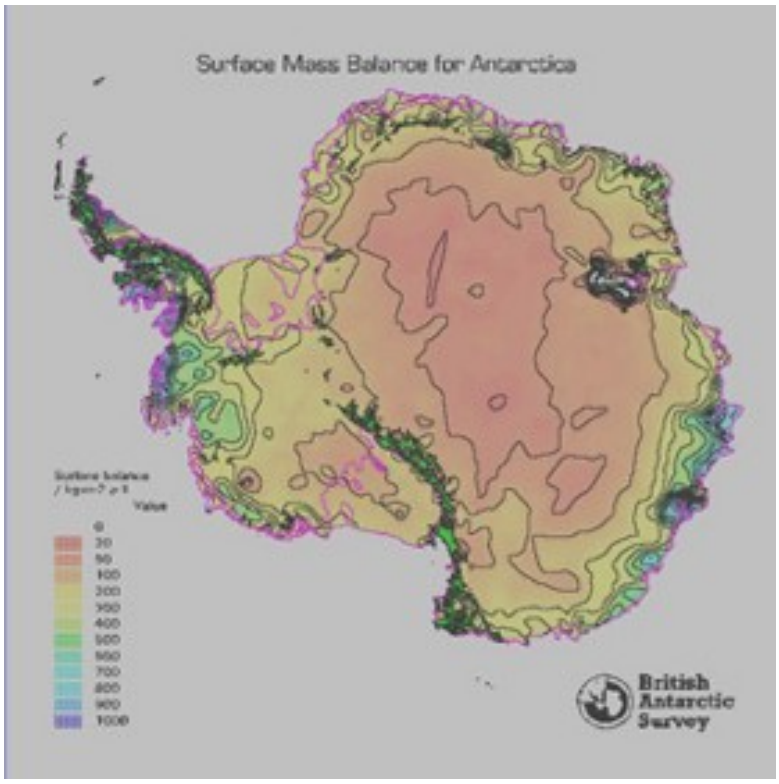


Figure 18: yearly accumulation of snow after British Antarctic Survey

There is agreement on the various published data on snow accumulation and depth of the bubbles close off, but disagreement on the age of the close off bubles.

Kaspers 2004 (*Model calculations of the age of firn air across the Antarctic continent*) gives a maximum age of 150 years for this PCOD (Pore Close Off Depth), but the majority speaks of a range of 30 years (Sipple Dome) to over 5 000 years (100 meter depth firn at 2 cm/y accumulation per year). I do not understand such a contradiction, and the lack of debate! The dating of ice and bubbles are estimated using models and we enter the world of a very "black box" approach with little explicit assumptions, very mathematical models of inverse problem with Monte Carlo simulation and calibration on items selected for desired purpose.

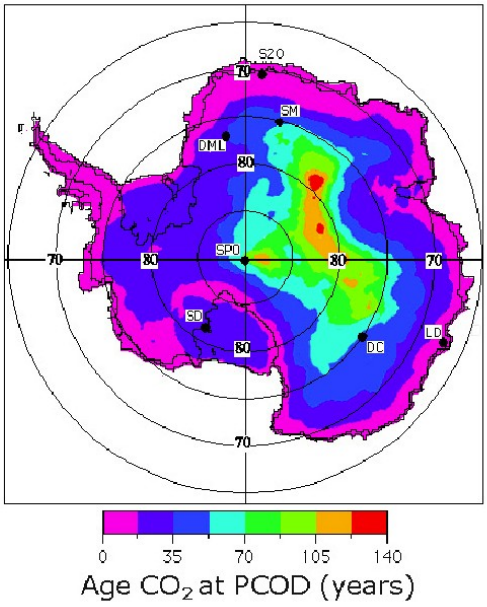


Fig. 9. The mean CO_2 age at PCOD in years for the entire Antarctic continent. The oldest CO_2 at PCOD, being 148±23 years (1σ), is predicted as located at 43° E and 78° S.

1850

Figure 19: age of the bubbles closeoff according Kaspers 2004

In addition, Kaspers gives an inaccuracy on the close off age with a maximum of 40 years. The oldest close off would be 150 years ± 40 years, it is far from the 7 000 years!

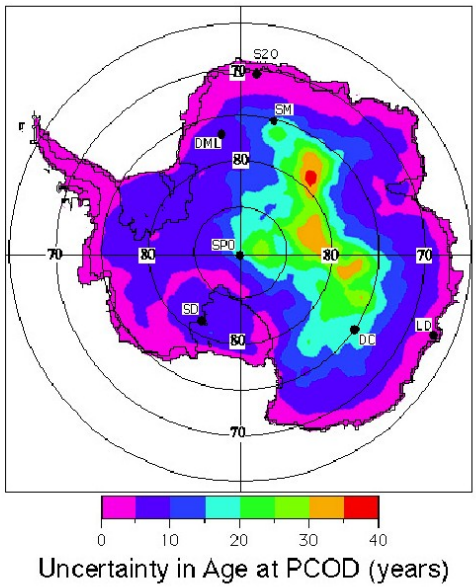


Fig. 12. The model uncertainty in derived CO_2 age at PCOD (2σ, in years). Here, twice the uncertainty (2σ) for the tortuosity (γ_b) and the pore close-off density (ρ_{CO}) and a deviation of 5% in the modelled density profile were taken into account.

1853

Figure 20: imprecision on the age of the bubbles closeoff after Kaspers 2004

While others emphasize several thousands of years for the age of the bubble close off at Vostok where annual accumulation is low? They seem to talk about different things!

Who is wrong? I am uncomfortable with all these estimates on assumptions that are very debatable, but little discussed.

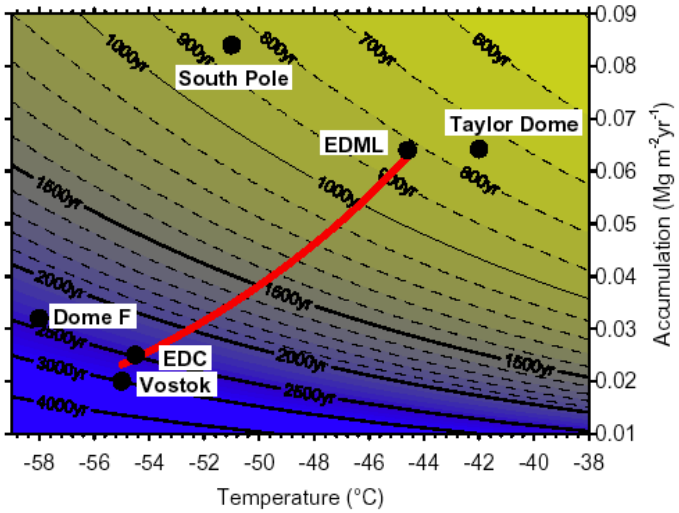


Fig. 2. Δage over the range of temperature and accumulation rate of the EDML record back to 60 kyr BP. Δage was calculated with a steady state version of our model. The red line shows the temperature and accumulation range used for the Δage calculation. The black dots show present conditions for several Antarctic ice cores.

Figure 21: temperature, accumulation and Δage of sites in Antarctica

I have found no discussion on these glaring discrepancies. I am lost because the age of the closeoff should be in the order of magnitude of the depth divided by the annual accumulation, i.e. for Dome C (DC on the depth map) 100 m accumulation 3 cm/y. Therefore, age should be 100 /0.03 = 3 000 years and not 50 years as on the map Kaspers with an accuracy of 15 years!

Only Sipple Dome and Law Dome sites are also shown with an age of 30-60 year close off as a way to obtain concentrations of CO2 that can connect to the direct physical measurements and give a continuous curve to the present day (a hockey stick).

The estimated rate of accumulation over time shows a degree of correction for high for Vostok, therefore of imprecision.

Figure 10

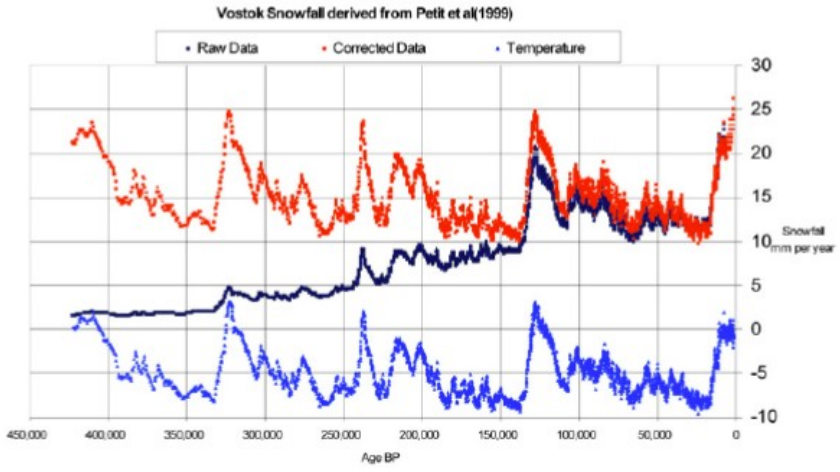


Figure 22: change in the accumulation of snow at Vostok and correction

-B1-b- Δdelta age: ice age minus gas age

The difference between the ages of the ice age (actually highly smoothed over thousands of years) and the age of the gas is called delta age (Δage). Both ages are estimated thanks to complex models of inverse problems solved by Monte Carlo method; and models are numerous (Herron & Langway 1980, Barnola 1991, Arnaud 2000) and often changing with the publication of a new thesis. For many PhD student of LGGE (Laboratory of Glaciology and Geophysics of the Environment) have written

well-made theses: Aballain, Bellier, Bernard, Dumas, Durand, Loulergue, Parrenin, Pepin, Rabatel.

The inaccuracies about the age are considerable and vary according to the authors and the models for the same data.

On a depth curve, the Δage in ka of two models seems to be very close but the difference is significant in hundred years.

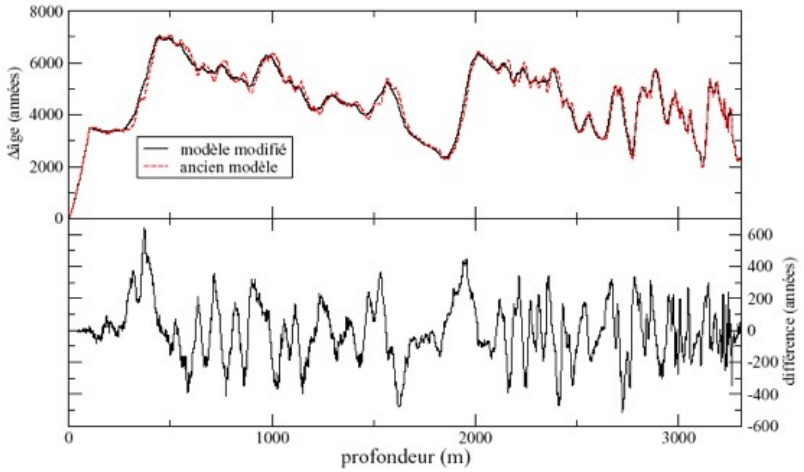


Illustration VIII.1 Modification numérique du modèle d'*Arnaud et al.* [2000]. En haut, évaluation du $\Delta_{âge}$ avec l'ancien et le nouveau modèle. En bas, différence entre les deux simulations.

Figure 23: Δage variation and inaccuracy: Parrenin

In two simulations, the Δage varies between 2 000 and 7 000 years with differences between -400 years and +600 years.

Between the various stations in Antarctic and Arctic, Delta ice age minus gas age varies between 20 and 6 000 years. For the same site, it may remain constant with depth for some sites (GISP2 about 1600 m) or vary considerably as for Vostok or Dome C due to the variation in the rate of accumulation.

On the Siple site where there is an estimation allowing the calibration of CO2 on the past centuries with a delta age of 30 years for the first few meters, another study (Brook 2005) gives values beyond 500 m to over 200 years. Studies ignore each other without fighting, leaving the reader to notice the incompatibilities.

I am sceptical before such variations between sites and between models

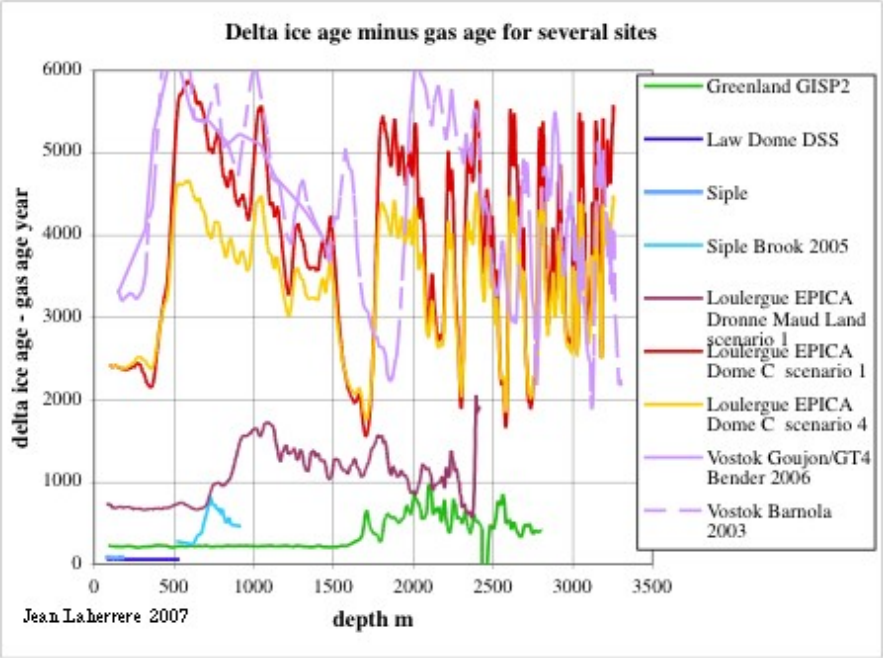


Figure 24: Variation of Δage with depth for several sites

Most interesting is the article by Loulergue et al 2007 about EPICA drilling where Dome C drilling is the subject of 4 different scenarios; and the difference between scenario 1 and scenario 4 is greater than 1 000 years which makes it possible to say that with such a scenario the delay on all sites of Antarctica between CO2 (bubbles) and temperature (ice) varies between 600 and 1 000 years, delay which bothers the supporters of global warming mainly due to CO2, as ice reveals that the engine is temperature triggered by changes astronomical or else.

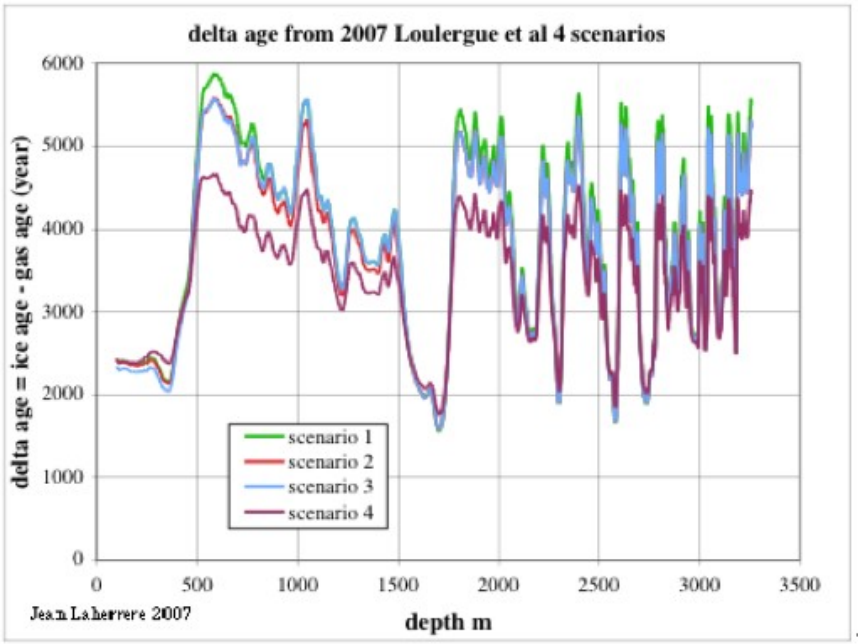


Figure 25: Variation of Δage on Dome C as a function of depth: Loulergue 2007

Previously, measures at the site of Vostok depth led to other models and to small differences on the age but significant on the delta age.

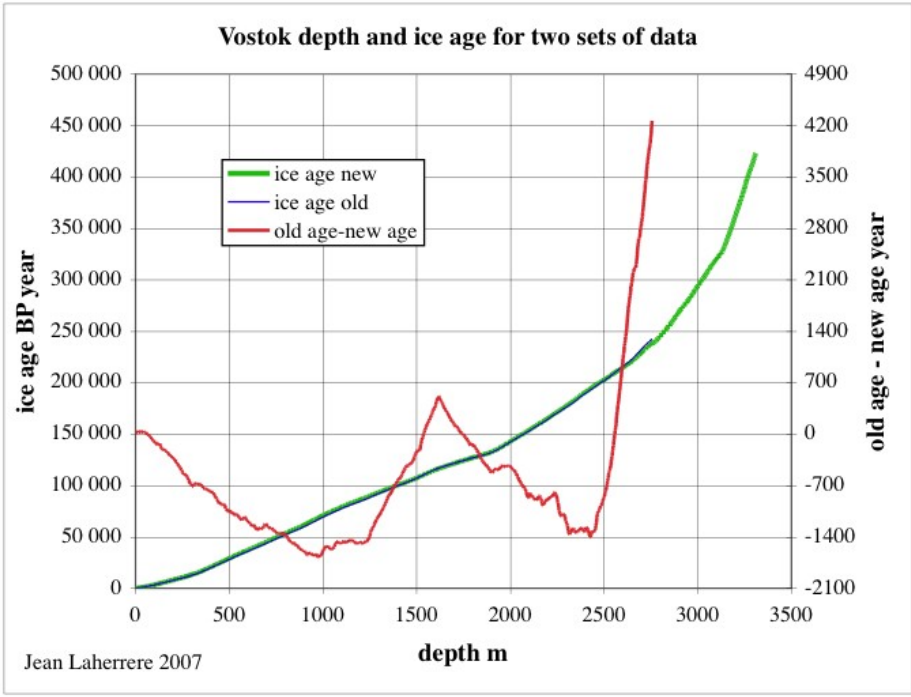


Figure 26 : Variation in the age of the ice for 2 measures on Vostok

In conclusion hockey stick graphics for gases: CO2, methane and nitrogen oxides are biased by the millennium smoothing due to firn because these millennia mean values should be compared to current millennia values, and not annual values.

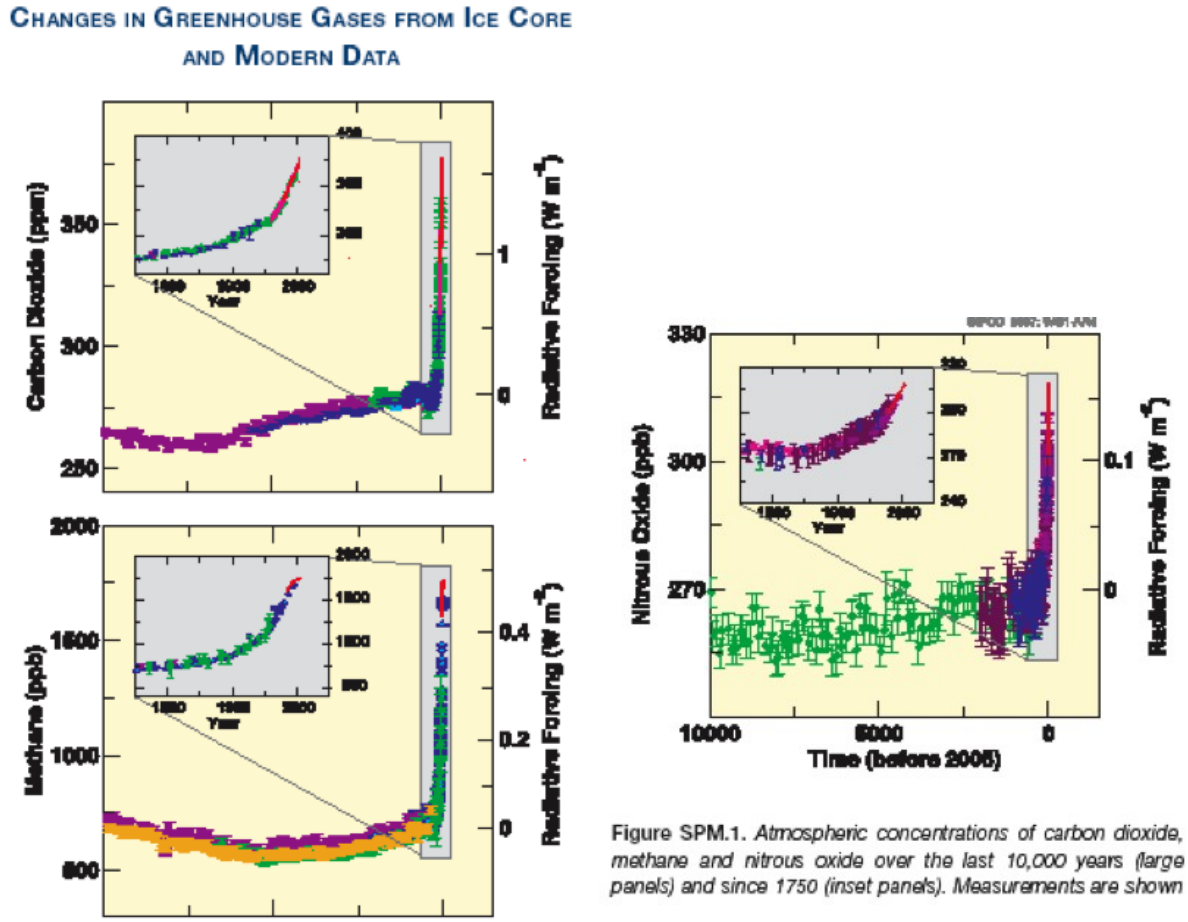


Figure 26a: changes in hockey stick after IPCC 2007 CO2, CH4 & NO2

- B2-Temperature

- B2-a- Indirect Measures

First, we need to remember that, if Galileo invented the thermometer in the 16th century, consistent and continuous measures have existed only since 1850-1880. For earlier times, it requires the use of substitutes (proxy), and they are diverse.

The temperature since 600 Ma shows mostly warmer periods with shorter cold periods such as Quaternary. The CO2 rate at Cambrian was 7 000 ppm (20 times the current rate) and it plummeted during Carboniferous to the present concentration to go up later in Jurassic then decline until today.

It is therefore evident that there is no correlation between CO2 and temperature over geological time!

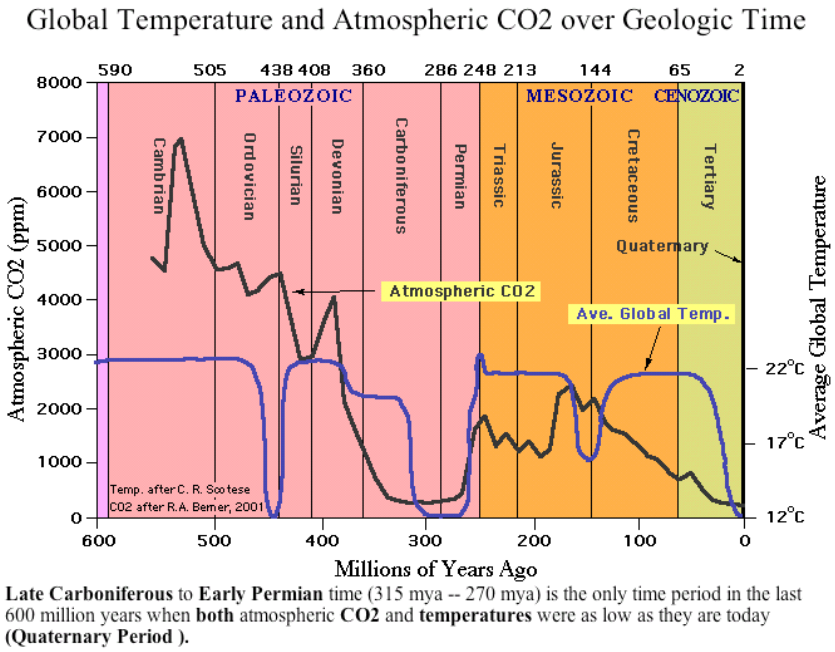


Figure 27 : temperature and atmospheric CO2 from 600 Ma after Gerhard AAPG

End of Part 1