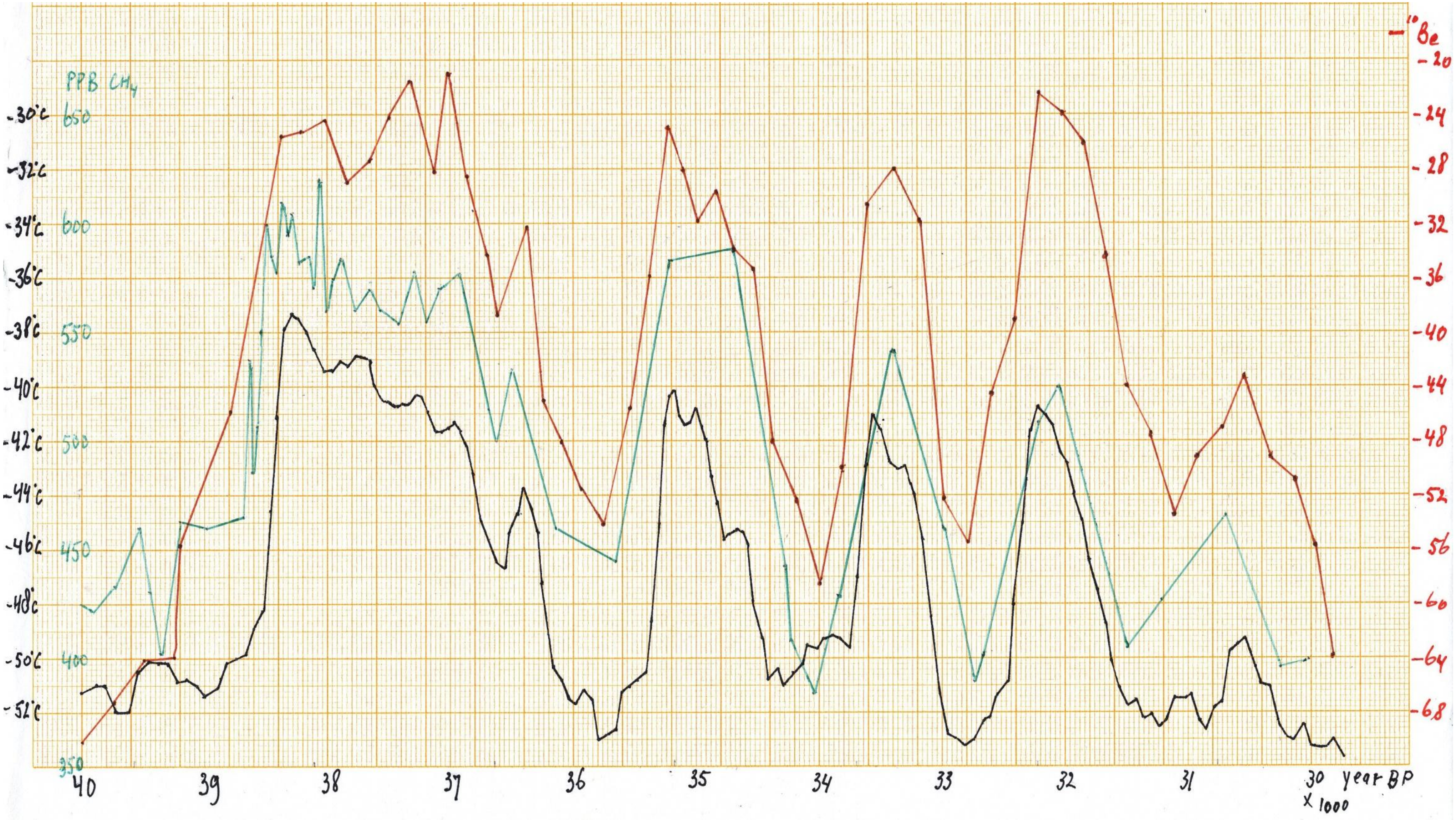
The sun, the greenhouse gas and the temperature

In **FIG 9** is tried to study the interaction between the solar proxy ^{10}Be, the temperature and the atmospheric concentration of the greenhouse gas methane, CH_4.

FIG 9



The red curve of the -^{10}Be concentration was derived from the tables of the GISP2 (Greenland) ice core data from RC Finkel ea **[Litt 1].** As Finkel and Alley pointed out, is the ice accumulation in this period of time very small and with few variation, so is the curve of the -10Be fluxus is resembling this of the concentration. Further found Finkel a very good correlation between the ^{10}Be data and the $\Delta^{14}C$ data of M. Stuiver over the period 8 to 5 ky BP. This good connection between these different solar proxies is also found in some studies here. The black curve of the temperature is from Alley ea **[Litt 2]**. It is a temperature reconstruction with use of the stable isotopes from the GISP2 ice core. The green curve of the CH_4 concentration in ppb is from the research of T Blunier and E.J. Brook **[Litt 4].** In this study the data of several ice cores were compared in an attempt to get a better dating and synchronization of the Greenland and Antarctica data by use of the global present CH_4 quantities. I however used the CH_4 data from their tables of both the neighboring GRIP and GISP2 ice cores together for comparison here with the ^{10}Be and temperature data from the GISP2 ice core following the tables of Finkel and Alley.

At the comparison of these curves it is important to take notice of the differences in the time resolution of the data. These is about 1 in 50 year for the temperature and about 1in 200 year for the -^{10}Be concentration. The time resolution of the CH_4 data is much more variable: before 37 ky BP it is in many observations higher than 1 in 100 year, but often lower than 1 in 1000 yr for the data from after 37 yr BP, despite of the use of two ice cores. So the time resolution of these CH_4 data is properly too low for this time scale. At a glance on the curves it seems the increases of the CH_4 concentrations are previous to the temperature rise, as is obvious between 39 and 38 ky BP. However here are different datings: The gas ages of the CH_4 are here compared with the ice ages of the stable water isotopes as temperature proxy. These differences in the dating between the ice layers and the small gas bubbles also increases with the depth and the age of the ice and they are difficult to estimate. So the correction of T. Blunier ea for this difference in the dating may be not totally accurate. Indeed, if is used the gas isotope ^{15}N, so from the same bubbles as the CH_4, the increases in the temperature are ever some decennia before the CH_4 increase, as described here below at **FIG 10**. Obvious is also the increases of the -^{10}Be (or the decreases of the +^{10}Be) concentrations are earlier than the temperature rises, but the temperature decline is often somewhat before the -^{10}Be decrease. This conforms to the premise of the solar driving of the warm interstadials. Although at the decreasing phases of the interstadials the temperature decline comes before the solar proxy. This however may be the consequence of negative feedback that comes, especially in areas on high latitude, to this sharp temperature increases. By that the Greenland temperature may collapse already before the solar activity declines. An indication for this is that the CH_4 declines often later than the temperature and has more correlation with the -^{10}Be concentration. This is poorly to be seen on **FIG 9**, but it is obvious at **FIG 10** with a much higher time resolution and on the data at the climate transit on **FIG 11a**.

The study of such curves may give some support for the a-priori hypothesis that climate change is accomplished by chains of linkage between the external primary factors, among which the Sun probably is dominant, and the internal factors on Earth that ‘regulate’ the climate. This theory is described more specified here further in Dutch at ‘Het klimaatsysteem’ of the climate and sun compilation. An instance of this linkage is the chain: increase of solar activity (ia magnetic) → temperature rise → [more heterotrofic organisms, ia CO_2 producing animals] → more greenhouse gases (ia CH_4) → temperature rise. In this linkage the stimulus of the Sun receives positive feedback from the climate system on Earth, because the greenhouse gasses increase by the temperature rise and this increase is caused direct physically by evaporation and indirect by the growth of organisms that produce CO_2 and CH_4. Also other positive feedback may exist as: More solar activity → temperature rise → snow melts → albedo loss → temperature rise. More solar activity → temperature rise → glacier melts → lower altitude → temperature rise, etc. These positive feedbacks induce reversals of the cause→ result chains and so arise effective cause → result circles which may bring substantial temperature rise and climate change. In the systems on Earth these chicken and egg circles, however generally are broken by the negative feedback and by depletion of the sources for the positive feedback. For instance the heterotrofic organisms cannot grow endless, at last their food and minerals are exhausted and if all the snow is melted, also this circle stops, etc. Also the negative feedback will stop the circles. Examples of negative feedback are : More solar activity → temperature rise → [more CO_2] → growth of autotrofic organisms, as plants and algae, that absorb CO_2 → decline of CO_2 → temperature decline. This negative feedback from the biosphere generally comes later than the positive feedback, because of several reasons. The heterotrofic metabolism works by oxidizing of organic stuff and this is more temperature dependent than the autotrofic metabolism that builds up organic compounds by the energy of sunlight. Moreover are much nutrients present at the beginning of the temperature rise by the increasing solar activity. In the cold period before many remnants of plants persisted that now are consumed and oxidized by bacteria, insects, etc. The plants grow slower, but their masses increases exponentially and their growth will also be stimulated by the increasing CO_2 concentrations later in the warming up phase.

Also outside of the biosphere are strong negative feedback mechanisms. In cold climate periods are large differences in temperature between areas on higher latitudes and the (sub)tropics and the moderate climate belt than also is smaller. This causes in cold periods strong streaming both in the atmosphere by the winds and the ocean by the currents mainly in the areas with moderate climate. The temperature gradients are important drivers for both atmospheric movements and ocean currents and by that for the transport of energy from the (sub)tropics to the higher latitudes. If solar em radiation increases the following climate warming is much larger colder areas on higher latitude, because of the radiation balance: That colder atmosphere and earth surface is more susceptible for the increasing solar radiation and by its temperature more capable to absorb the extra radiation. So in periods of climate warming by solar increase the temperature gradients become smaller as does the energy transport. This brings a negative feedback to the primary climate warming in the higher latitudes. In the case of the Atlantic ocean currents this negative feedback of the increasing water temperature furthermore is sharply enhanced by the decreasing salt level of the ocean water near to the surface. If the temperature rises by a primary factor, as is the sun, some ice of the huge glaciers on the continents melts. This brings more freshwater to the ocean. For the maintenance of the Atlantic currents, however, is necessary the water sinks down in the North, so that it can return on the ocean bottom to the tropics where it wells up in some areas. This sinking down becomes slowed or totally stopped by the increasing buoyancy of the surface water at periods with climate warming, because than the water temperature rises and its salinity decreases. Repeated starts and stops of the ocean currents by this thermo-haline[1] driving was the dominant factor for the for the sharp temperature fluctuations in Greenland, as shown in **FIG 9**, and in large areas elsewhere in the Pleistocene following the theory of some prominent climate scientists as S. Rahmstorf **[Litt 6]**. However, the dominance of this thermo-haline driving of the ocean currents and the climate is doubted by me here in the climate and sun compilation at 'Snelle klimaatveranderingen' and I will emphasize the ocean currents are mainly driven by the constant gravitation vectors by the Earth's rotation. In mine opinion the variable thermo-haline driving may have supporting influence on the currents and so this driving can give some acceleration and deceleration on the currents, but it cannot start or stop them totally. By that the thermo-haline driving gives anyway negative feedback to climate warming in the North Atlantic area. So as chains of linkages for physical (non biosphere) negative feedback on primary climate warming can be noted: More solar activity → temperature rise, more on higher latitudes → smaller temperature gradients in the atmosphere and ocean → decrease of the energy transport → temperature decline on higher latitudes. : More solar activity → temperature rise → melting glaciers → more freshwater in the ocean on higher latitudes → decrease of the ocean current and the energy transport → temperature decline on higher latitudes.

The enigma of the many fast and intense climate fluctuations during the ice ages, the so called interstadials or D-O events, which existed in very large areas and practically global is an amazing question which must be answered well. Our society asks and will require from science more and more knowledge about climate change. An example of this phenomenon is shown here on **FIG 9** for this period in Greenland. Should these substantial changes be explained as internal fluctuations within the systems on Earth and so by changes in the transport and allocation of the energy on Earth, which then are possibly triggered by minor variations in the solar radiation. Or on the other hand should be the variation in the em radiation and magnetic activity of the sun in the Pleistocene much larger than we know from observations in our days and be the direct and dominant cause of the arise of interstadials at which the influence of the systems on Earth is less important and only secondary as feedback to the consequences of solar variation. Although the first premise is very preferred by scientists and the second is not even considered by them, as far as I know, I do emphasize the importance of the solar driving, as pointed out in some other chapters here, because there is no evidence and few probability for the good old premise of the (nearly) constant sun. In fact is a sun that is variable in its radiation for some percents at the longer term, a-priori is more likely because everything is variable and one observes now a sun which varies some 0,1% in a very short period of 30 year in its em radiation and much more in its magnetic activity. Furthermore study of the radionuclides as proxies of the solar magnetic activity brings evidence for important climate driving by a much more variable sun in the Pleistocene.

[1] Thermo-haline is Greek for (by) warmth-salinity

An accurate temperature proxy and the CH_4
FIG10

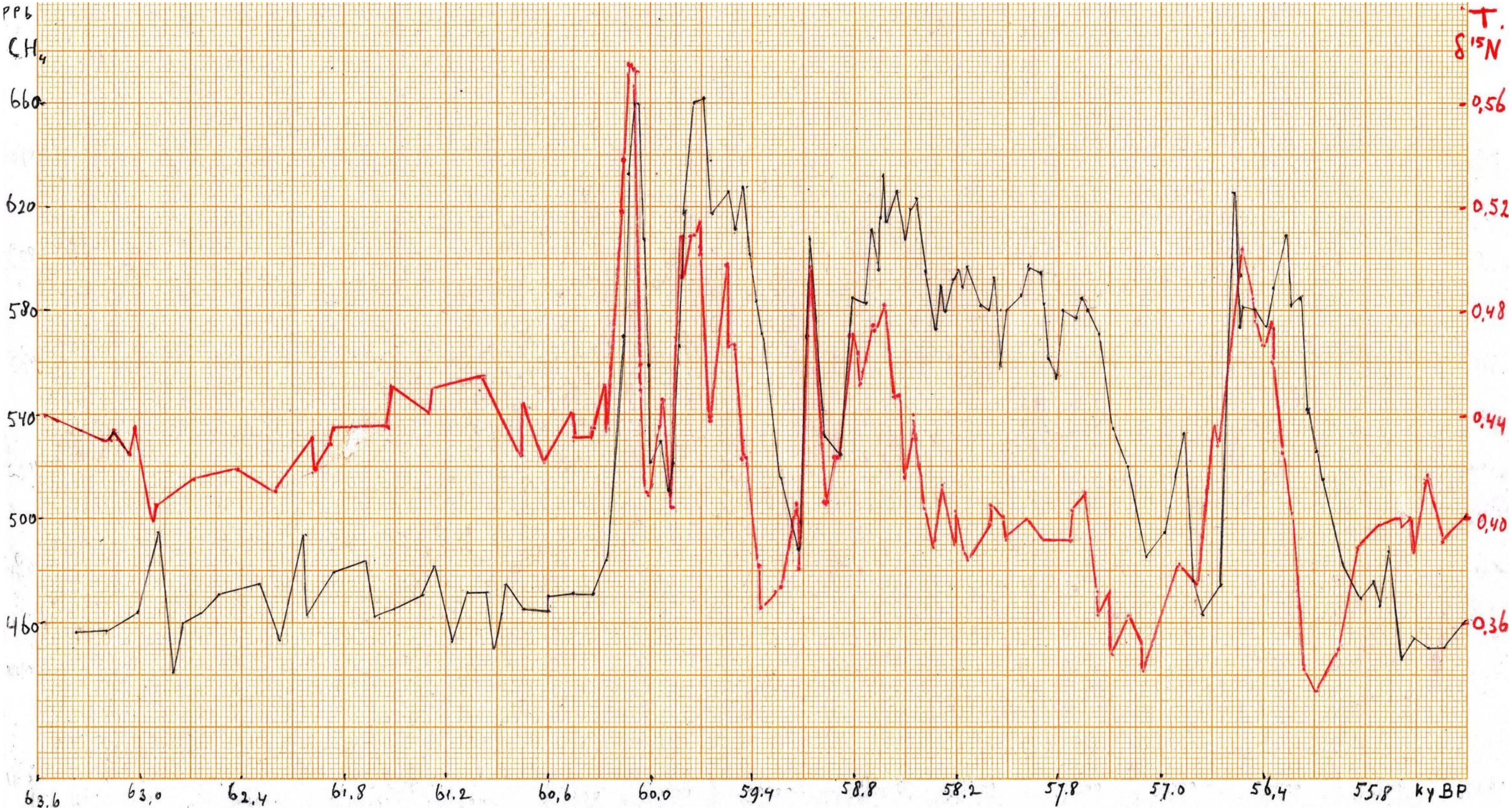


FIG 10 is based on a more accurate data for a study to the interaction of the temperature and the CH_4 concentration in a period some 25 ky before **FIG 9**. Unfortunately here are no data of the solar proxies.

The ice layers arise by freezing together of the snow. By that process small air canals are included in the ice. In the upper ice layers, the firn, these fine pores remain in contact with the open air decennia to some centuries before they are closed and become isolated air bubbles . These closed bubbles contain ancient air, so are specimens of the paleo-atmosphere, but the date of that air is ever since the closure of the bubbles and that is later than the moment of snowfall, the date of the ice. This makes a difference between the air age and the ice age, which also increases when the ice layers become older and deeper and thinner. That difference in the dating of air and ice specimens from the same level depends on various factors and so it is difficult to estimate. In their study on this problem and in order to escape the difference in the dating at the research to the changes in the greenhouses gasses and the temperature, C. Huber ea [Litt 3] used another proxy for the temperature, ^{15}N. That stable nitrogen isotope occurs normally in some quantity in the open air. Because ^{15}N is heavier than the other nitrogen isotopes a little bit more of it sinks down into the small pores in the ice and becomes included. This process however depends on the speed of the gas diffusion through the fine pores and that speed of diffusion is determined by the temperature. So the difference in ^{15}N between the bubbles and the plain air, the $\delta^{15}N$, is a temperature proxy, not related the circulation of water. The $\delta^{15}N$ has the same age as the other gasses in the bubbles at an equal level in the ice and so can be well compared with the amounts of CH_4 in the same air bubbles.

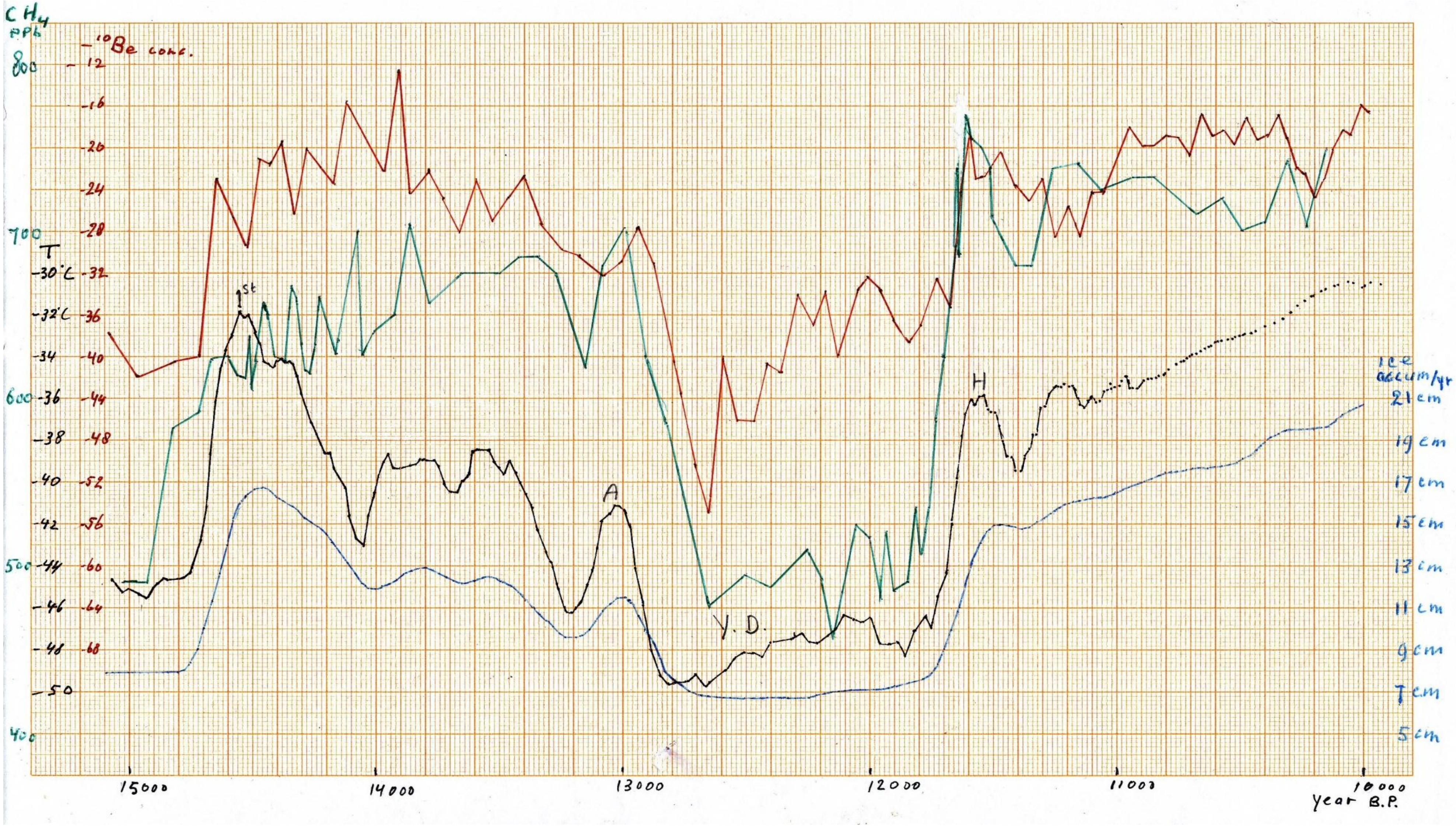
In the curves of **FIG 10** the course of the temperature and the CH_4 concentrations is shown in air ages. Notice the colors of **FIG 10** are different from the other figures here: The temperature curve is red and the CH_4 curve is black. Indeed these curves show a primary increase of the temperature and often after a short decline the temperature rises sharply together with the CH_4. Huber ea describe that the temperature increase at the beginning of the interstadials ever was 25 to 70 year before the rise in the CH_4. A simple glance at their tables however gives the impression that this lag time even may be smaller. At the decreasing phases of these interstadials the temperature also goes before the CH_4, but the lag than is much larger and is often substantial.

This research exposes relations between events in the past that are much broader than only the CH_4 and the temperature. For some practical reasons was chosen here for CH_4 as an example of the greenhouse gasses. There is good evidence the variations in the different greenhouse gasses are closely correlated. So the CH_4 curve here stands also for the CO_2 changes, but still for more. CH_4 and the other greenhouse gasses also generally are connected with factors that participate in the systems on Earth that may cause climate change. For instance: the speed of ocean currents in the North – South direction may change the climate in areas on higher latitude. However, increase of the ocean current will cause not only climate warming, but also immediate increase of greenhouse gasses like CH_4. That is because the faster ocean current brings melting of the sea ice, more contact between ocean and atmosphere, more evaporation of CO_2 and CH_4, more organisms the produce those gasses, etc. So the picture of **FIG 10** with primary increases of the temperature before the CH_4 at the interstadials indicates a primary cause outside of the systems on Earth for these phases with substantial climate warming. The sun provides nearly all the energy that exists on the surface and in the atmosphere and the sun is variable, so solar variation is a-priori the most probable cause for these large primary climate warming phases of the interstadials. This probability of the most simple explanation is confirmed by research to the radionuclides, which is pointed out on **FIG 9:** increase of the temperature is a short time after the increase of solar activity. Furthermore the fast temperature rise at the interstadials is often more than 10^o C in a century in central Greenland. This is probably too much to be achieved by the dynamics of systems like ocean currents, atmospheric variation and greenhouse gasses, mainly on this location. Of course in central Greenland ever is a severe polar climate with an eternal high pressure, because of the high density of the relative cold air in this area. So this area is less sensible for atmospheric disturbances and if they should occur, they must be accompanied here by enormous snowstorms. Well in the research at the ice cores the ice accumulation of course also is measured and that brings good evidence: there is only a tiny increase in the precipitation during the interstadials in Central Greenland. So there is good reason to exclude fluctuations in the atmosphere and ocean currents as a cause of the sharp temperature incline in Central Greenland at the interstadials. On the phases of climate cooling, however, the picture is different: The decline of the temperature in Greenland at the end of the interdstadials generally is a lot of time before the decrease of the CH_4. Now, however, research on the radionuclides ^{10}Be and ^{14}C indicates this temperature decline is not simultaneous with or preceded by decrease in solar activity. As further shown here at **FIG 11a** and **11b** the ^{10}Be curves show at the end of the interstadials much more connection with the CH_4 curves than with the Greenland temperature curve. The reason is probably this area is prone to lose its energy by the ever existing streams from the high in this area. So especially this area is sensible for the negative feedback the interstadial climate warming brings. The CH_4 curve indicates here probably the course of the temperature in a larger area that remained longer high and declined later together with solar decrease.

Sun, greenhouse gas and temperature at the large climate transit

FIG 11a and **11b** describe the interesting period of the last deglaciation, 15000 – 10000 years BP.

FIG 11a



In **FIG 11a** is the red curve the -^{10}Be concentration from RC Finkel **[Litt1].** The black curve are the temperature data is from Alley**[Litt2]**. Recorded at the black curve are the temperature maxima of the first interstadial (1st); the Allerød interstadial (A); the start for the Holocene (H) and the cold period of the Younger Dryass (YD). The -^{10}Be and temperature curves in **FIG 11a** and **FIG 9** are data from the same research of which the total survey is described here on **FIG 7** of 'The dominant sun in the Pleistocene', page ... Here also is added the data of the ice accumulation from Alley at the blue curve below. The green curve on **FIG 11a** is the CH_4 concentration following the tables of E.J. Brook ea [2]. All the four curves here are made from data of the GISP2 ice core.

The correlation between the solar proxy -^{10}Be, the CH_4 and the temperature obviously is good. However in this period, so ever since the first interstadial, the variation in ice accumulation and so in precipitation is much more than in the other interstadials of the Pleistocene, as it was in the period of **FIG 9**. So the curve of the -^{10}Be fluxus, as described by Finkel, is different and much more flat over this period than the **FIG 9** curve of the –^{10}Be concentration. As described also here in 'Two solar proxies and the climate' I do still here prefer also the concentration to the fluxus as a likely better approach of the ^{10}Be production in the atmosphere and solar activity, shortly: Despite the large relative variation, the precipitation remains small in absolute figures and much smaller than in neighboring areas at some 1000's of km distance. Within the atmosphere the ^{10}Be concentration in snowflakes and in the air is in equilibrium. If the ^{10}Be deposition is only wet, so within snowflakes, increase of the precipitation brings no extra dilution of the ^{10}Be in the ice. However, if the precipitation exceeds some threshold value the ^{10}Be scavenging from the air will cause a decrease in the ^{10}Be concentration, but it is probable that the influence of this remains small in this arid polar area, because of that threshold but mainly because of the much larger precipitation in the surrounding areas. Because the precipitation in the surrounding areas is much larger few ^{10}Be will reach Central Greenland from elsewhere and much more ^{10}Be that was produced in the arid polar area will disappear to wet areas and will be deposited there. The fluxus is the total local deposition over a period, but this is only a smaller part from the total local output of ^{10}Be from the local troposphere. A larger part out the local output is ^{10}Be that streams away and is deposited in much more wet areas. In fact we are not interested in the ^{10}Be output from the atmosphere but in the input. The input cannot be measured, but here in Central Greenland it is a favorable point that the local input is probably nearly equal to the local production. The local input is more in direct relation to the ^{10}Be production dynamics and consists mainly of : ^{10}Be production in the troposphere and the ^{10}Be that comes from the stratosphere into the troposphere. At that comes the small quantity of tropospheric ^{10}Be from elsewhere, not related to the production. So nearly all the ^{10}Be found at the site is produced within the arid area and a large part of ^{10}Be produced in the area is deposited elsewhere. The ^{10}Be troposphere concentration is determined by the input into the troposphere and only by scavenging, so to a fewer extent also by the output. Variations in output by local precipitation and local deposition are less important confounders for the signal than change in the transport from this site to wet areas and variations in the ^{10}Be exchange between troposphere and stratosphere. That is why the local fluxus does not give the best information about the production. So exist indeed still much uncertainties, which can be challenged by comparing the different radionuclides, as done here in 'Two solar proxies and the climate'. The fluxus anyway gives a bad indication in this situation, because the total local deposition (=fluxus) is small in comparison to the local production. This becomes odd in areas with a still smaller precipitation, as is probably the case at some sites in East Antarctica, than arises dry deposition of ^{10}Be and precipitation increase then will cause dilution. The fluxus can be a better approach at these sites with dry deposition. Also in areas with more precipitation scavenging and input of ^{10}Be by transport in the troposphere from other areas become important confounders for the signal. The situation in Central Greenland probably is optimal for the concentration in the ice as an approach for the ^{10}Be production. Also in the observation here are indications for the premise the variation in the ^{10}Be concentration is independent of the precipitation: The decrease in the ^{10}Be concentration, so the rising phases in the -^{10}Be curve here start before theincrease in the ice accumulation and from about 14500 to 13400 BP the -^{10}Be rises or is constant, at a declining ice accumulation.

On the other hand at ±13000 BP the temperature and ice accumulation decrease occurs before the decline of the -^{10}Be and this may indicate still influence of the precipitation or other atmospheric factors on the ^{10}Be concentration by dilution or scavenging. It is however probable by some evidence that the

[2] See for the tables the NOAA site: ftp://ftp.ncdc.noaa.gov/pub/data/paleo/icecore/greenland/summit/gisp2/gases/gisp2_ch4_highres.txt

temperature decrease often is secondary and may be in some locations perhaps totally determined by negative feedback to the high temperature from factors within the systems on Earth like ocean currents and the NAO. This is what these curves here indicate for the period 14500 – 14100 BP, the cooling after the 1st interstadial and 13000 – 12900 bp, after the Allerød interstadial. At this in the period after the 1st interstadial the solar proxy even indicates increase of solar activity, while the temperature then sharply declines, but after the Allerød interstadial the proxy for solar activity also decreases, however later than the temperature. Interesting is at this is that the CH_4 has much connection with the solar proxy than the Greenland temperature, especially after the 1st interstadial. This may indicate the global average temperature, which always is in close relation to the greenhouse gasses, did not make that sharp decline at 14500 – 14100 BP and followed the solar variability much more than the Greenland temperature. However, after the Allerød interstadial the course of the temperature, the CH_4 and the solar proxy are well connected. Indeed this period of the Younger Dryas was a cold period globally. Also after the initiating of the Holocene, at 11600 BP, is less connection between the smaller fluctuations in the temperature and the solar proxy: There is steady increase in the temperature, whereas the -^{10}Be is more variable with only very small increase on the longer term. Also after 10000 year BP is continued this connection between the Greenland temperature and the solar proxy much smaller than in the glacial period (FIG 8a of the climate and sun compilation). The premise is: The Sun appears to be the determinant for all primary phases of warming-up during the glacial period, as is indicated by the figures 10 and 11. At the cooling-down phases the sun seems to be of less or none importance during the glacial. As described here further on this collapse of the high temperature climates in the glacial may be more determined by the reactions of the internal factors of the terrestrial climate system or web than in the glacial periods. Examples of the many determining factors for this internal climate web are living organisms: After the primary warming-up the heterotrophic organisms, as (small) animals and bacteria, dominate, because they are very sensible for temperature, so do have much advantage by the initial climate warming the more while large resources of dead plant residues become now accessible for them. The heterotrophic organisms produce greenhouse gasses and give so positive feedback to the climate warming by solar increase. Afterwards the resources for the heterotrophic organisms are getting exhausted. Moreover the autotrophic organism, as plants and algae then begin to dominate. The plants are growing slower, are less sensible for cold, so have less advantage by climate warming, but the tolal mass of the plants increases exponentially and they do not have less limited resources. So at some time after the climate warming the autotrophic organisms begin to dominate, giving negative feedback to the climate warming by the autotrophic CO_2 absorption. Moreover especially the coniferous woods of the taiga are hostile for heterotrophic organisms, so that all the carbon they absorb also is reserved. However, for the period after the Holocene initiation, this secondary declining course of the temperature does less or not exist, which is contrary to the glacial situation: The warming up now is continued and perhaps more than it should be in connection with the solar proxy, whereas the warm climate often collapsed in the glacial period already before the decrease of the solar proxy. Also in many other factors probably arose negative feedback to the climate warming by external driving, mainly by the sun, as for instance variation in ocean currents and the (North) Atlantic Oscillation in the atmosphere. It is simply intelligible how substantial solar variation together with the many feedback factors within the systems on Earth can cause the huge climate fluctuations during the glacial period of the Pleistocene that are observed by research of these data from the ice of Greenland and also at data from matter at many sites all over the world. It seems, however, much more difficult to guess what factors then may have determined this new different behavior of the climate web by which arose the present interglacial, the Holocene. I can only give some consideration:

1st The terrestrial climate web may react different in the Holocene without external forcing. This seems improbable, because the question 'why should the climate system be different now in the Holocene from the glacial period?' here is not or very difficult to be answered. The climate system does not have natural rhythms and could before not maintain the warmth, that was started so many times during the glacial by primary probable external factors, as the Sun.

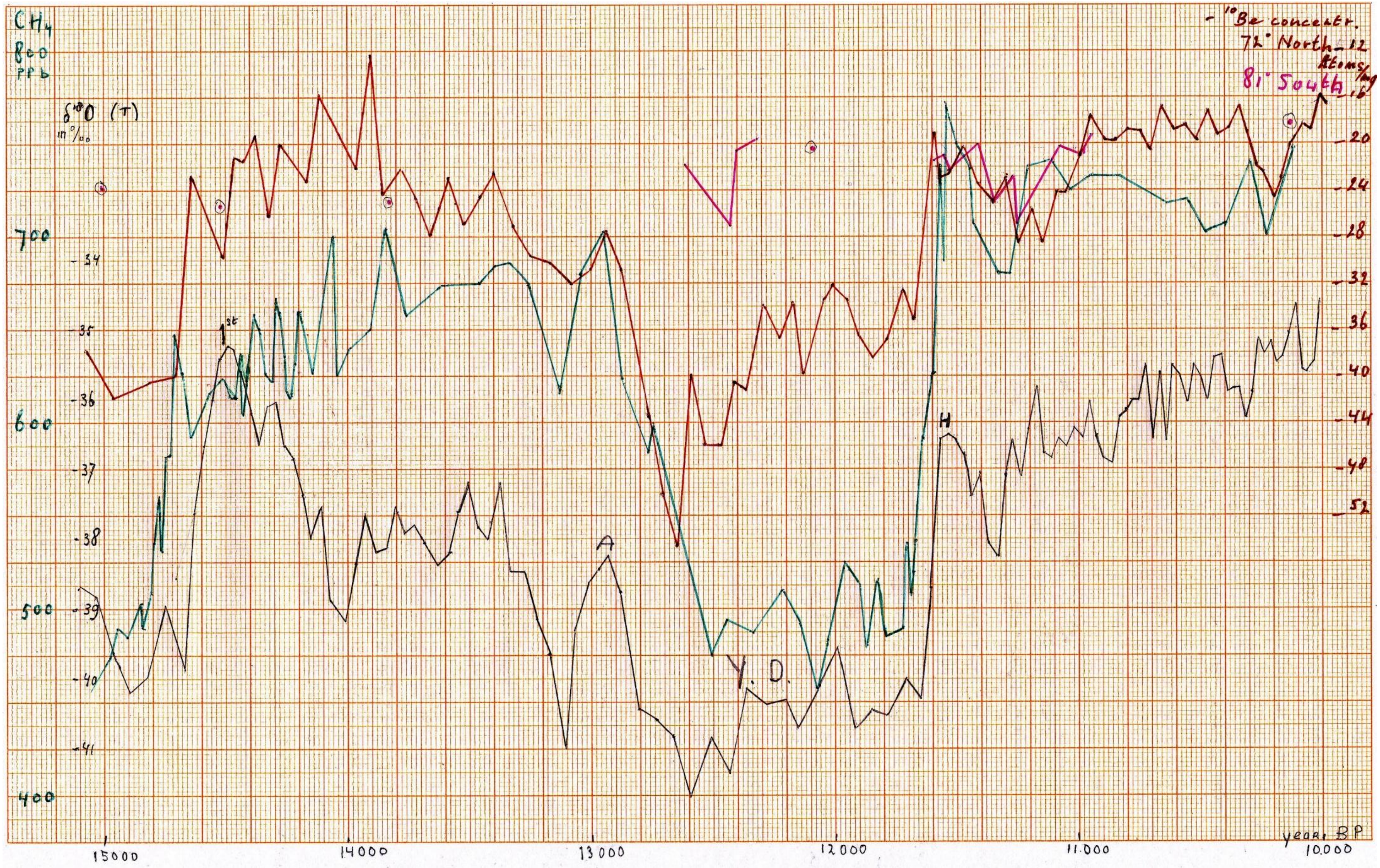
2nd The slowly increasing external forcing by orbit now starts up the climate web for a long lasting warming-up. The warming stimulus by orbit did exist already some time, but now at 11600 BP the irradiation by orbit came near to its maximum and passed the critical point on which the climate system will react (see FIG 3k of 'Klimaat invloed van de aardbaan'). Moreover the climate web may have become then more sensible for the orbit stimulus by the simultaneous existing solar stimulus.

3rd The magnetic solar activity and its electro-magnetic radiation became different in the Holocene. The Sun does have natural rhythms and they may also vary the solar radiation on a very long term. The proxies -^{10}Be and -^{14}C are indirect indications (proxies) for only the magnetic activity of the Sun. There is no information about radiated energy of the Sun in the past. Variations of some percents in the solar EM radiation in the past are in principle possible, but the realism of this opportunity is, I think, denied by most of the specialists, because no proof exists for this long term variation in the solar radiation. However, as pointed out here in 'Is the solar radiation steady?' logically no cast-iron proof needs here because a-priori is a Sun with variable radiation more likely than a total steady Sun. If these variations in radiation exist, they are physically connected with the variations in magnetic activity. Anyway no evidence at all exists for a Sun that has been radiating in the Pleistocene and the Holocene with nearly constant intensity, behave of the observation in the last 3 decennia, at which variations of more than 0,1% in annual averages is established. So this already is an indication for much more solar variability at the term of tens of thousands of years, but also the research provides some specified evidence for this: The curves of the ^{10}Be concentration and the ^{14}C quantities give good indications for large variations in solar magnetic activity during the Pleistocene glacial period and for a much higher and relative constant solar activity in the Holocene (FIG 9, FIG 11 and of 'The dominant sun in the Pleistocene climate' FIG 7; of 'two solar proxies and the climate' FIG 1 and 2) This evidence, however, may be debated because it is less in the course of the ^{10}Be fluxus, but as pointed out here the ^{10}Be concentration of Central Greenland is probably a better approach for the solar activity than the fluxus is, also brings the ^{14}C curve of 'Two solar proxies..'. independent affirmation. This evidence for different forms of solar activity in the Pleistocene and Holocene is at least strong and important enough for taking more research at this topic, I think. Thus more research should bring more evidence for or against the premise of the higher and more constant solar radiation in the Holocene and other interglacials in comparison with the glacial periods.

4th Solar radiation is larger in the Holocene than in the Pleistocene. The climate forcing by this was strengthened by the maximal irradiation by orbit during the begin of the Holocene, this concerning the summer irradiation on the Northern hemisphere and winter to early spring irradiation on the Southern hemisphere. See the graphics about the connections between orbit variations and climate change over 800000 year in 'Klimaat invloed van de aardbaan'. At the start of the Holocene, as well as of the other interglacials the Milankovitch parameters for climate driving were maximal, but decreased of course afterwards, coming often to a minimum while the interglacial was persisting in the same or sometimes even higher temperatures. This indicates that something else then the orbit must have sustained the continuation or increase of the high temperature. As described here under 3rd it is probable that this other factor is the sun. So in this premise is the coincidence of higher solar activity and orbit driving the cause for the origin of the interglacials. In the case of the precession and obliquity factors of the Milankovitch driving this coincidence is very likely accidental, because these factors probably are varying independent from the sun. The variation in the ellipse form of the orbit, however, may be physically connected to solar variation: This periodic high solar energy releases may be physically allied with a change in the ellipse form of the orbit of the Earth and the other planets, because when some more energy leaks from the solar body into space, this means energy loss from the energy stock mainly of the solar radiative zone and this will cause less pressure within the plasma of some parts of the solar body. The volume of the Sun is preserved against collapsing by gravity by the energy of the plasma particles. So less energy means some shrinkage of the solar body. If the solar core has no decrease in its energy production and stock, the energy loss of the solar body can also cause some extension of relative small, but very massive solar core. By these both volume changes the gravitation field of the Sun is changed and the position of the common baricenters of the sun with the planets are shifted. This can change the ellipse orbits of the planets. However, also if the solar variation is not physically connected with some aspects of the orbit variation the periodic variation of both brings anyway some cyclicity in the simultaneous climate driving of both the sun and the orbit.

In this the 4th possibility is the most likely, I think. The terrestrial climate web gives evidence in the glacial period not to be capable in maintaining alone a high temperature climate.

FIG 11b



For **FIG 11b** are taken different observational data of mainly the same parameters for more study of this important period. The red brown curve of the 72^{o} North -^{10}Be concentration is the same as in

FIG 11a. Added is now the purple curve with the data of the -^{10}Be concentration of 81^{o} South from the Siple Dome table of K Nishiizumi **[Litt 7]** ea. These Antarctic 10Be data are only available for the period 11600 – 10950 BP and the comparison at this period shows a good correlation between the Northern and Southern ^{10}Be concentrations, but the 5 observations of the ^{10}Be concentrations for the period of the Younger Dryas give substantial smaller ^{10}Be values for the Siple Dome tables than for the GISP2 tables. The green curve of the CH_4 concentration now is taken from the GISP2 CH_4 concentrations of T. Blunier ea at the tables for synchronization of the Byrd and Greenland (GISP2/GRIP) ***3***, so they are mainly from the same ice core site as the CH4 data of FIG 11a, but with different dating. The black curve of the temperature proxy now is the $\delta^{18}O$ in ‰. The $\delta^{18}O$ data also are taken from these tables for synchronization ***4***, so also data from the same site as the temperature reconstruction of Alley, but by Brook ea the temperature is approached by only the $\delta^{18}O$ and the dating is different. Between the data of **FIG 11a** and **FIG 11b** are mainly differences in dating. The excursions in the CH_4 and temperature curves of **FIG 11b** come about 50 years later than in **FIG 11a** and by that these movements in **FIG 11b** fall more after the changes in the solar proxy ^{10}Be. That is why the data of **FIG 11b** more compatible with the premise of the solar forcing of these substantive climate changes. The timing between the temperature proxies and the CH_4, however in the both curves of **FIG 11a** and **b** indicate that the CH_4 changes should ever go before the temperature variations. This should be conflicting with the premise of the solar forcing, but much other research as explained at **FIG 10** does give evidence for the fact temperature increase goes generally before the greenhouse gas increase. So problems in the dating and estimation of the differences between gas ages and ice (water) ages probable caused the picture of the time rank of the CH_4 and the temperature at **FIG 11a** and **b**. The black curve of the temperature proxy here at **FIG 11b** is more dynamic than at **FIG 11a**. So more small excursions in the temperature here are shown and those do have in some periods less connection with the solar proxies than in others.

[3] See for the table ftp://ftp.ncdc.noaa.gov/pub/data/paleo/icecore/greenland/summit/grip/synchronization/ch4_blunier01.txt and the literature ia “Timing of millennial scale climate change in Antarctica and Greenland during the last glacial period”, Science 5 January 2001, 291, pp 109-112; http://www.sciencemag.org/cgi/content/full/291/5501/109

[4] See for the table ftp://ftp.ncdc.noaa.gov/pub/data/paleo/icecore/greenland/summit/grip/synchronization/iso_blunier01.txt

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