APPENDIX

MAJOR SCIENCE FLAWS OF THE AGW THEORY
(Abbreviated Summary)

by Bill Gray

Although rises in CO_2 gases act to block the normal long wave infrared (IR) radiation to space, this blockage is small – about 3.7 Wm^{-2} of IR energy interception for a doubling of CO_2. Since the mid-19th century, CO_2 IR blockage has increased by ~ 1.4 Wm^{-2} or 0.6 of 1 percent of the continuous average IR flux to space of 235 Wm^{-2}. The continuous balancing in-and-out net global average radiation flux is, by contrast, about 342 Wm_2, almost 100 times larger than will be the amount of radiation blockage due to a CO_2 doubling. A doubling of CO_2 gas requires a warming of the globe of ~1°C to enhance outward IR flux by 3.7 Wm^{-2} to just be enough to balance the blockage of IR flux to space for a doubling of CO_2.

But this pure IR energy blocking by CO_2 versus compensating temperature rise for radiation equilibrium is unrealistic for the long-period and slow CO_2 rises that are expected to occur. Only half of the blockage of 3.7 Wm^{-2} should be expected to go into temperature rise. The other half (~1.85 Wm^{-2}) of the blocked IR energy to space will be utilized for extra surface evaporation in a similar way as the earth's surface energy budget compensates to balance its total incoming solar energy absorption of 171 Wm^{-2} (Figure 1). Note that the globe's surface solar absorption of 171 Wm^{-2} is balanced about half by evaporation (85 Wm^{-2}) and the other half (86 Wm^{-2}) by net upward IR (59 Wm^{-2}) flux plus surface to air sensible heat transfer (27 Wm^{-2}). Assuming that the imposed extra CO_2 doubling of imposed IR energy of 3.7 Wm^{-2} is taken-up by the earth's surface as the solar absorption is taken-up and balanced by an equal surface to air opposite flux we should expect a warming of only ~ 0.5°C for a doubling of the CO_2. The 1°C assumes that surface evaporation is not part of the mix. But the global energy budgets show that about half the globe's surface absorption is accounted for by evaporation (Figures 1 and 2). These two figures show how equally the surface solar energy absorption (171 Wm^{-2}) is balanced by a near equal division between temperature rise (enhancing IR and sensible heat loss) and energy loss from surface evaporation. We should assume that the imposed downward IR energy gain due to a doubling of CO_2 will similarly be divided in this same approximate ratio. This will cause an enhancement of the strength of the hydrologic cycle by about 2 percent (or 1.85 Wm^{-2} of extra evaporation over the ~ 85 Wm^{-2} energy equivalent evaporation).

Failure of Global Models. AGW theory fails because the basic physics behind it is badly flawed. Its primary scientific justification has come from global climate model simulations which have serious embedded physical assumption errors. These model assumption errors cause their 75-100 year forecast simulations to give unrealistically too high warming results by a factor as much as 10. These GCM models indicate that when CO_2 doubles near the end of this century that the global average surface temperature should increase by about 3°C. All of the 19 global numerical models calculations that were discussed in the latest IPCC-AR4 (2007) report show about the same 3°C global warming for a doubling of CO_2 (Figures 3-4). If this magnitude of warming were realistic it would bring about a major disruption in our global climate system and severely impact all life on earth. If this was a realistic scenario I would be

for all the things Al Gore says we should do. But relax, it is not physically possible for this magnitude of 3°C global warming to occur as a consequence of the doubling of CO_2. All the global circulation models have the same major physical flaw which is known as the 'positive water-vapor feedback loop'. The argument goes like this:

1. Models assume that as CO_2 increases to doubling that this causes the atmosphere to warm 1°C in order to send more IR energy to space in order to come into a radiative equilibrium. [As discussed above, however, the real warming for a doubling of CO_2 should be only half this amount (~ 0.5°C)]. These GCM models then incorrectly assume that as the atmospheric temperatures increase and approach 1°C, that the relative humidity (RH) of the atmosphere remains constant. Any warming with constant RH causes the water vapor content of the atmosphere to rise. This extra assumed water vapor increase resulting from this warming then is assumed (incorrectly) to cause a large additional blockage of IR energy to space. This additional IR blockage due to moisture increase is twice as large as the original IR blockage from CO_2 doubling. This is known as the positive water-vapor feedback loop or the needed additional moisture-temperature rise that must occur to keep RH constant while achieving a new radiational equilibrium after CO_2 doubles. This extra water vapor gain needed to maintain constant RH while CO_2 doubles makes it necessary to increase the IR energy flux to space by twice (~ 7.4 Wm^{-2}) the amount of the original IR blockage from CO_2 doubling. To accomplish all these changes and maintain their system in radiation equilibrium they must increase the global temperatures by an additional 2°C beyond the original 1°C warming needed to balance 3.7 Wm^{-2}.

   This strong additional water vapor gain and resulting 2°C temperature increase are not realistic. In fact, our project's observational analysis (Gray and Schwartz, 2011) show that upper tropospheric RH does not go up as temperature rises and rainfall increases. By contrast, we find that upper level water vapor slightly decreases with additional rainfall and temperature rise. This is a result of the mass balancing upper-level subsidence drying from the return flow of deep penetrating cumulonimbus (Cb) convective updrafts.

   This strong positive water vapor feedback loop that the GCM models rely so heavily on for the largest part of their global warming simulations is not strongly positive as they have assumed, but slightly negative. There cannot be an extra global warming which is twice as great as the original amount of warming coming from the CO_2 increase itself (if 1°C) or four times as large a warming if the modelers had used the correct 0.5°C warming – as discussed above. This is the huge conceptual error of the GCM numerical simulations and the primary reason why they have so grossly exaggerated the global warming that would result from a doubling of CO_2. A number of us have for years been pointing out this massive conceptual error in the GCM simulations. But the modelers take no notice and proceed on with their erroneous GCM simulations and dire future warming predictions (Figure 5). They may feel that if they did not predict such a large amount of global warming that their research support would be threatened and they would not receive the media attention they have become accustomed to.

2. Our observational studies (Gray and Schwartz, 2011) of the variations of outward radiation (IR + albedo) energy flux to space (from **I**nternational **S**atellite **C**loud **C**limatology **P**roject or ISCCP data) vs. global average precipitation (from NCEP reanalysis data) indicates that there is not a reduction of global net radiation (IR + Albedo) to space which is associated with increased global or regional rainfall and

temperature. There is, in fact, a weak tendency to go the opposite way. We find that for an enhancement of global rainfall equivalent to 1 Wm^{-2} there is an associated small extra amount of net (IR + albedo) radiation to space of about 10-15 percent of the rainfall energy equivalent. Part of this outward radiation enhancement is due to albedo increase. We will here assume a value of about 12 percent (or, -0.12 Wm^{-2}) of enhanced extra radiation flux to space for every evaporation energy unit of 1 Wm^{-2}. This amounts to about an extra 0.2°C cooling enhancement for every 1.8 Wm^{-2} energy evaporation rate increase.

Near the end of this century we should expect global temperature increase due to a doubling of CO_2 of about 0.5°C (with 2 percent enhancement of the hydrologic cycle) and feedback rainfall enhanced cooling of about minus ~0.2°C. This would bring about an overall global warming of no more than about 0.3°C (Figure 5), only 10 percent as large as the GCM models indicate. This is a negligible amount of global warming that the world will be able to easily adapt to. We should certainly not institute costly crash programs to change from fossil-fuels to renewable energy if this is the degree of global warming that will occur when CO_2 doubles.

Last Century Warming. There is no way we can blame most of the last century's global warming of 0.7°C on rises in CO_2. Most of this long-period temperature rise has been caused by natural climate changes of which humans have played no significant role. This long-period warming of ~ 0.7°C is hypothesized to be a result of the long period slow down of the global ocean's **M**eridional **O**verturning **C**irculation (MOC) which is driven by natural multi-century variations of ocean salinity. The shorter period multi-decadal up-and-down global temperature changes we have experienced during the last 100-150 years are a result of stronger and shorter MOC changes (shown in Figures 6-8) associated with similar time-space changes in the Atlantic Ocean thermohaline circulation (THC). These changes are also driven primarily by Atlantic Ocean salinity changes.

The Real Cause of Global Temperature Change. During the last 1-2 thousands of years of the Holocene period when the solar influence of the earth's changing orbital parameters have been small, it is hypothesized that the back-and-forth variations of the globe's deep ocean circulation patterns operating on multi-century and multi-decadal time scales can explain most of our globe's prominent surface temperature variations. Solar variations, sunspots, and cosmic ray changes are energy-wise too small and mostly in the noise level to play a significant role in the important multi-decadal and multi-century temperature changes shown in Figures 9 and 10.

Variations of in-and-out radiation have been given far too much thought and credit and have carried far too much influence on the conceptual views of the causes of climate change. Volcano influences are present for only a year or two and cannot explain the long-period observed multi-decadal and multi-century temperature changes. And CO_2 changes have not played any significant role in these long multi-century temperature changes.

It is the earth's internal fluctuations which are the most important cause of climate and temperature change. These internal fluxuations are driven primarily by deep multi-decadal and multi-century ocean circulation changes of which naturally varying ocean salinity content is hypothesized to be the primary driving mechanism. Global salinity variations are hypothesized to be the cause of the globe's multi-century climate changes. Atlantic salinity changes seem to be the primary cause of multi-decadal climate variability. More detailed explanations will be given in forth coming papers.

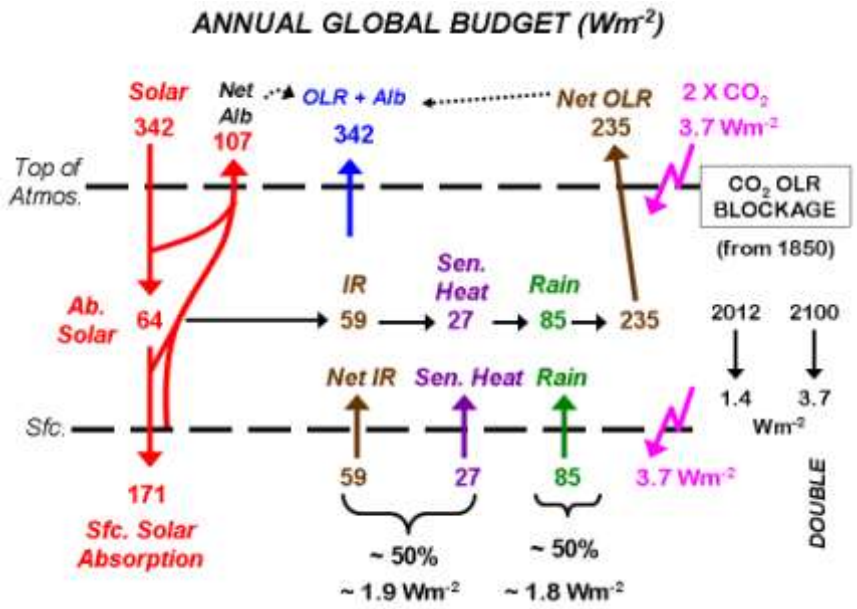

Figure 1. Vertical cross-section of the annual global energy budget as determined from a combination of ISCCP and NCEP reanalysis data over the period of 1984-2004. Note on the right, how small is the OLR (or IR) blockage that has occurred up to now due to CO_2 increases (~ 1.4 Wm^{-2}) and how relatively small is the blockage of 3.7 Wm^{-2} that is estimated to occur when a doubling of CO_2 occurs by the end of this century. Compare these small CO_2 induced IR changes in Wm^{-2} to the global average solar impingement of 342 Wm^{-2} of incoming energy, 235 Wm^{-2} of outgoing OLR, 107 Wm^{-2} of outgoing albedo flux, and 171 Wm^{-2} of surface solar absorption.

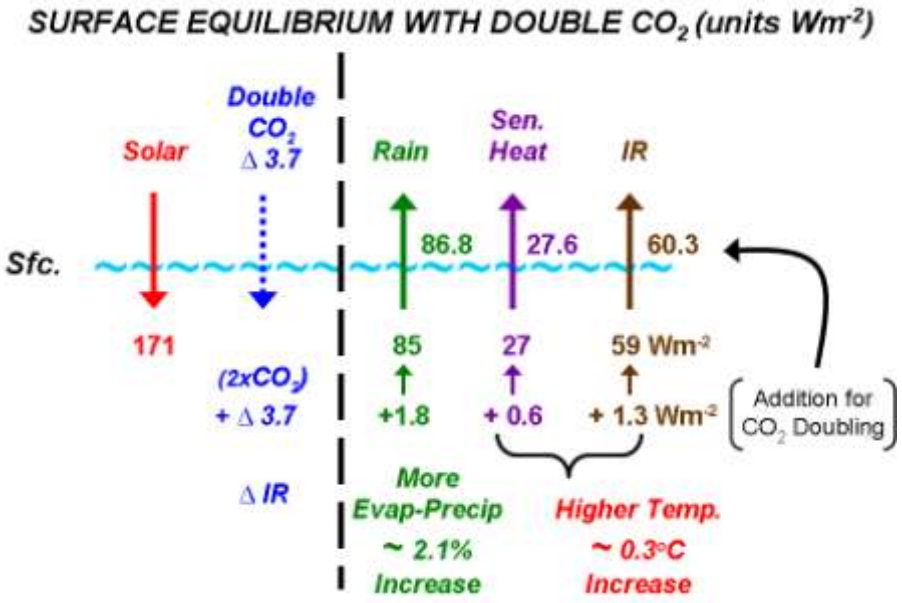

Figure 2. Estimated change at the surface of global mean rainfall (2.1% increase) and global mean temperature (~ 0.3°C) when, and if, equilibrium energy balance were even established for a doubling of CO_2 (and a blockage of IR energy to space of 3.7 Wm^{-2}).

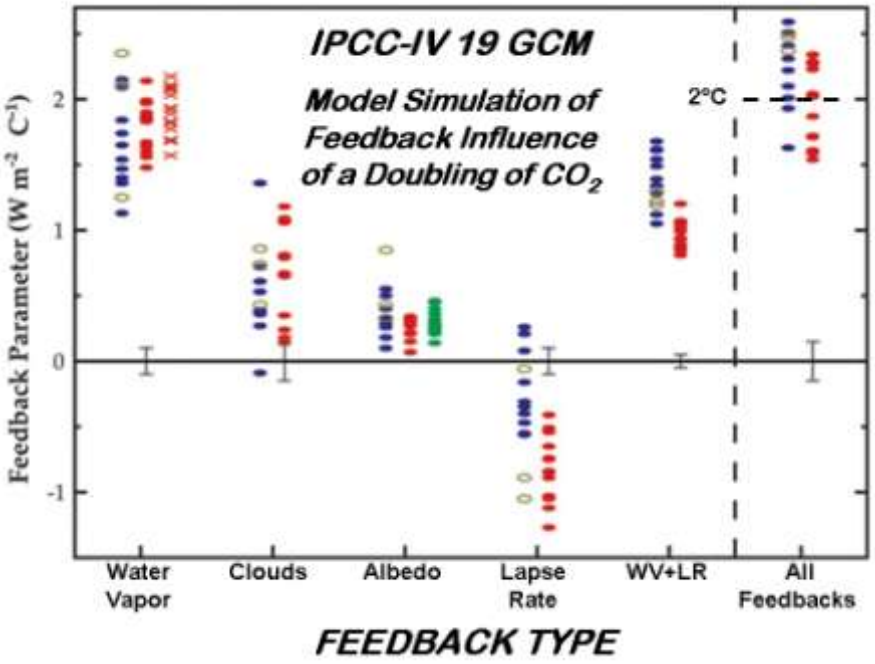

Figure 3. Scatter plot of the extra global feedback energy increases resulting from water vapor, albedo, cloud, and lapse-rate changes due to a doubling of CO_2 from 19 GCMs of the 2007 IPCC-AR4 report. All models give strong positive energy feedbacks equivalent to about 2^{o}C warming.

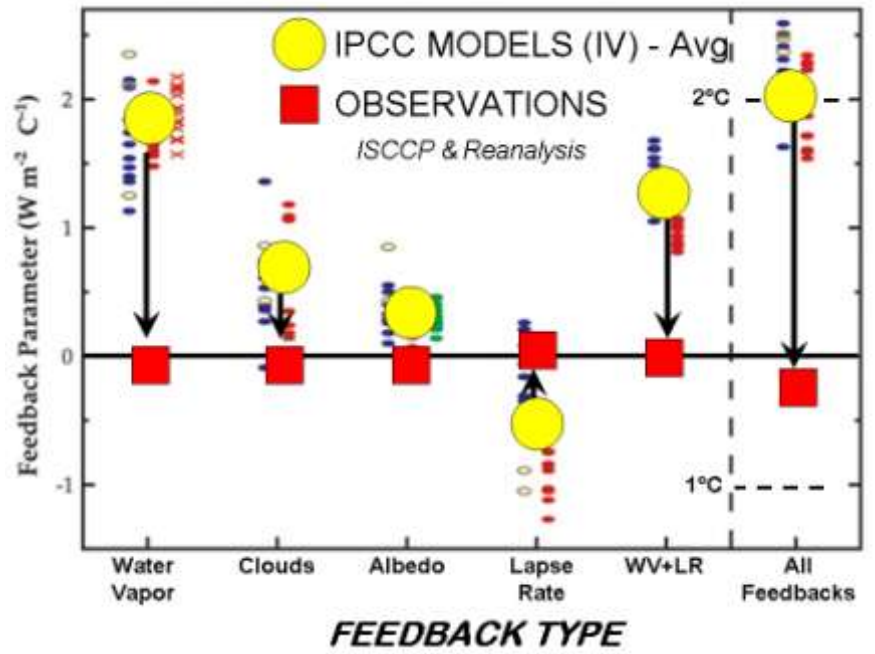

Figure 4. Comparison of the mean GCM feedback magnitudes (yellow circles) vs. what our observations imply as to the magnitude of the various feedback processes (red squares). We envisage the expected 0.5°C warming from a doubling of CO_2 to cause a small negative (not positive) feedback of about 0.2°C, certainly not positive feedback of 2.0°C as the GCMs indicate.

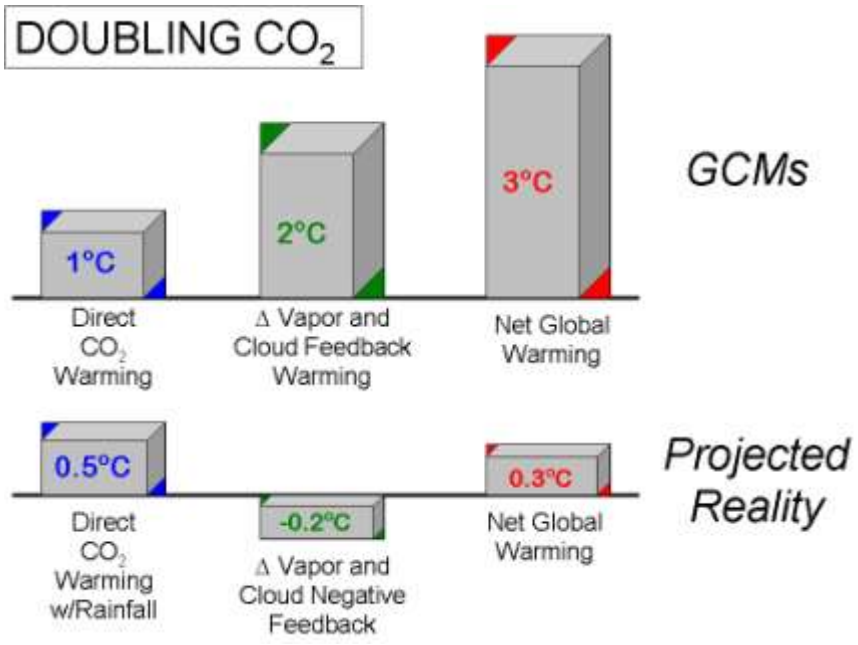

Figure 5. Comparison of the GCMs prediction of global warming vs. the author's estimate of global warming when CO_2 amounts double at the end of the 21st century.

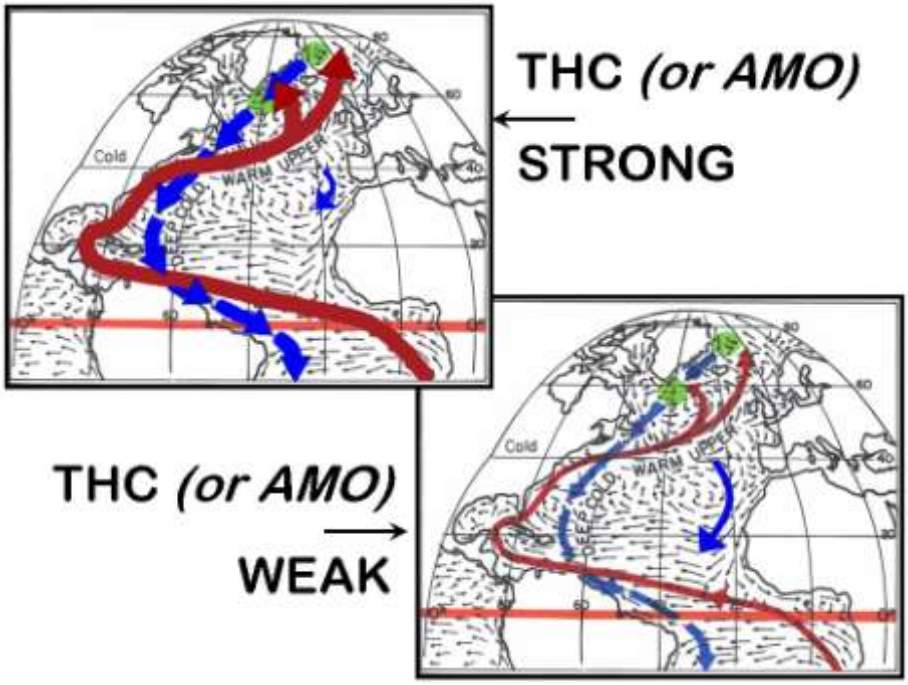

Figure 6. Idealized portrayal of the primary Atlantic Ocean currents during strong vs. weak phases of the thermohaline circulation (THC).

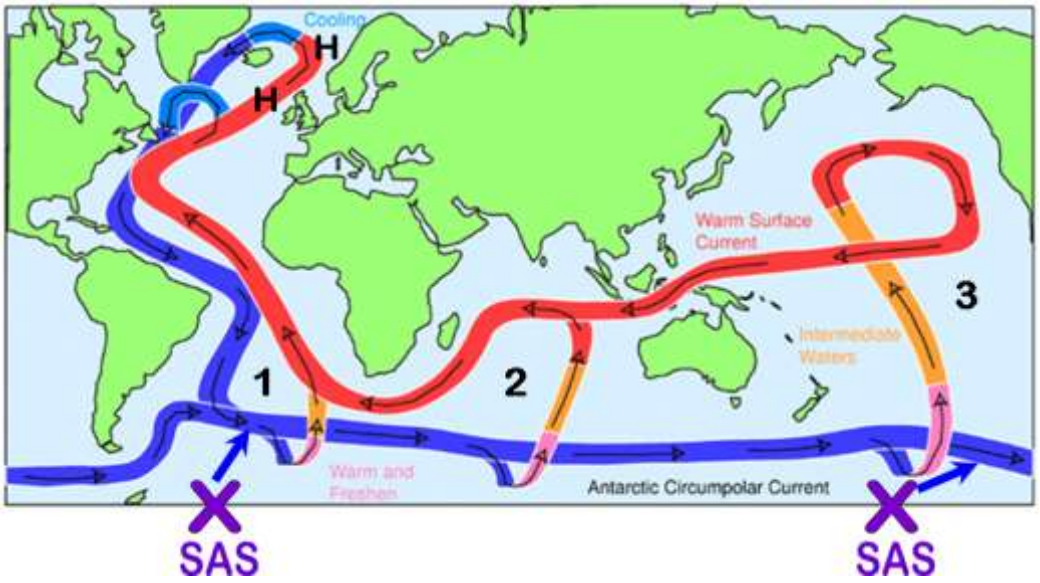

*Figure 7. Idealized representation of the globe's salinity driven ocean **M**eridional **O**verturning **C**irculation (MOC) which is composed of deep ocean sinking by the North Atlantic Thermohaline Circulation (areas H) and in the **S**urrounding **A**ntarctic **S**ubsidence (SAS – areas X). Figure adapted from John Marshall.*

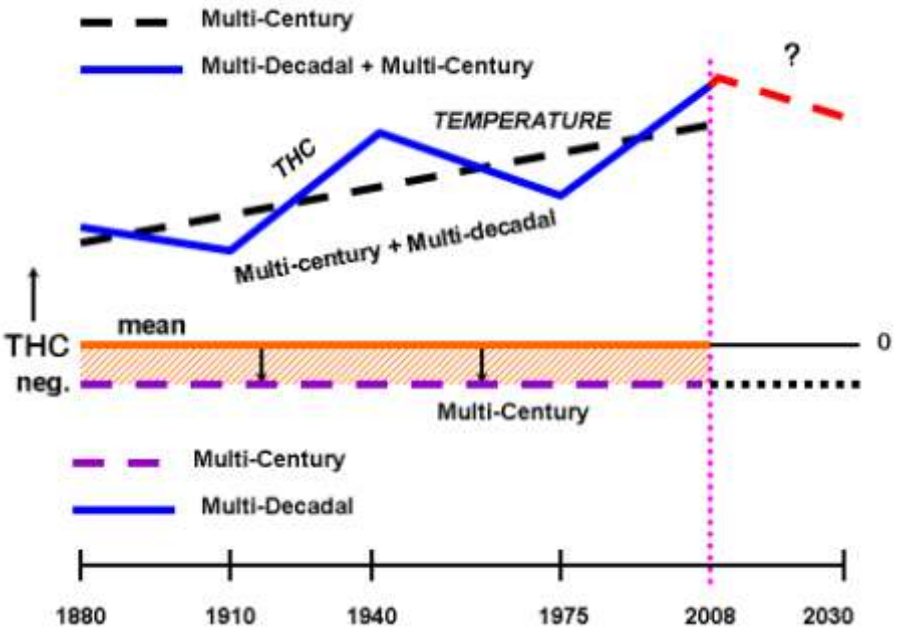

Figure 8. Idealized portrayal of the negative long-term multi-century Meridional Overturning Circulation (MOC) that we have had since the mid-19th century (orange). This has caused the last century-and-a-half mean warming of 0.7°C. Superimposed on this long-term warming are the multi-decadal warming and cooling periods shown by the up-and-down blue line that is influenced by the multi-decadal variation in the salinity induced strength of the Atlantic Ocean thermohaline circulation (THC).

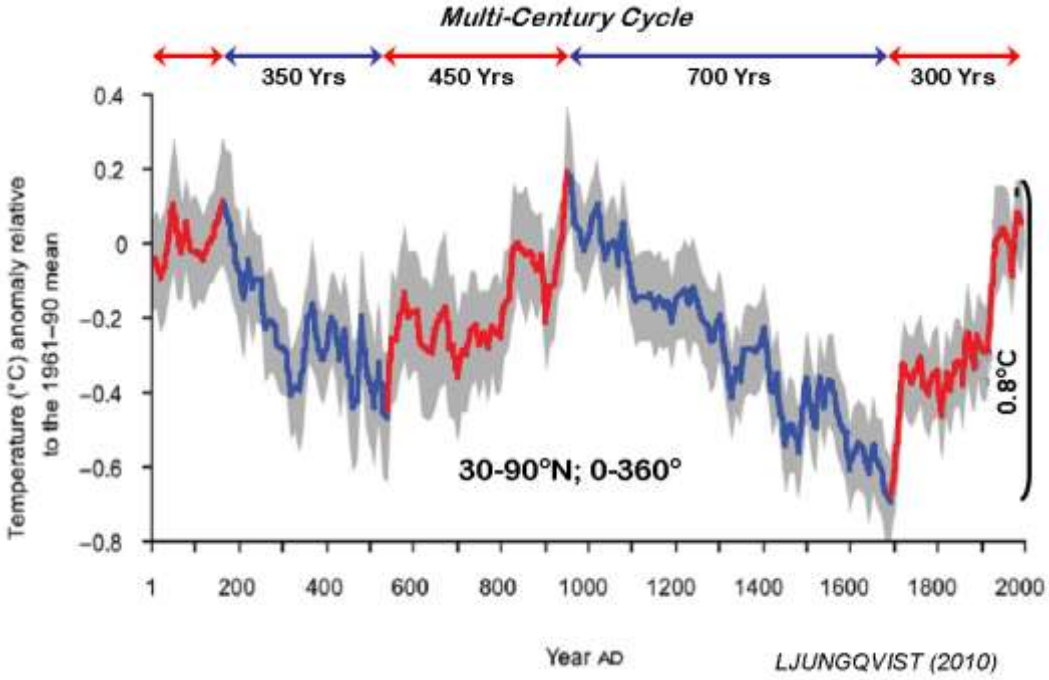

Figure 9. Last two thousand year surface temperatures between 30-90°N constructed from a synthesis of a large variety of observational data sources. Red lines are warming, blue lines are cooling. This figure illustrates the 300 to 700 year long multi-century temperature changes hypothesized to be caused by the multi-century variation in the full globe ocean's salinity changes on this time scale.

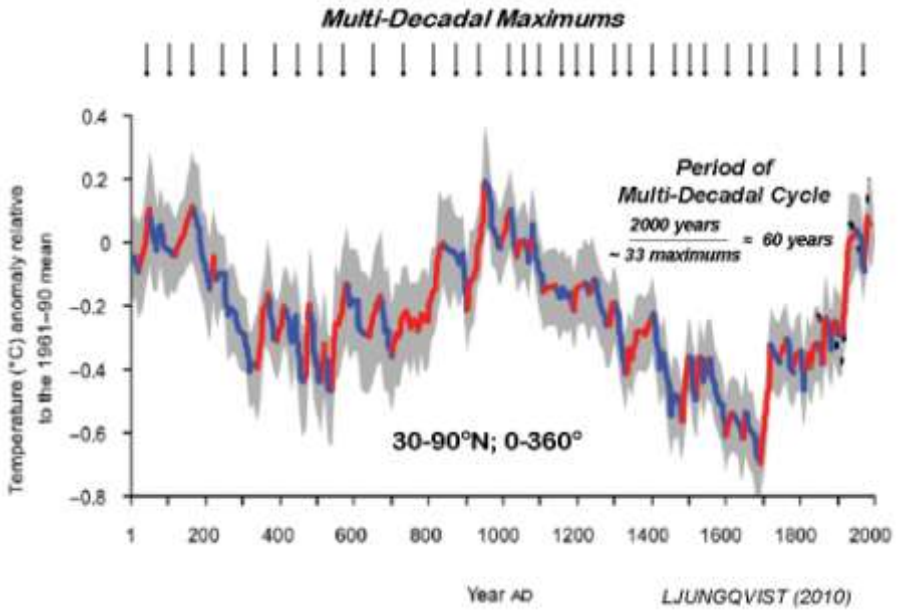

Figure 10. Same as in Figure 9, but emphasizing the multi-decadal variation of surface temperature what have an average period of about 60 years. These changes are hypothesized to be a result of the variations of the Atlantic Thermohaline Circulation (THC) on this time scale. Natural multi-decadal variations of Atlantic salinity are believed to be their cause.

General Background Bibliography

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Ljungqvist, F.C. 2010: A new reconstruction of temperature variability in the extra-tropical Northern Hemisphere during the last two millennia. *Geografiska Annaler: Series A,* **92**: 339-351.

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