WHY ENGINEERS (SPECIFICALLY) SHOULD BE VERY SKEPTICAL OF CLAIMS OF DANGEROUS MAN-MADE GLOBAL WARMING

I wholeheartedly advocate <u>general skepticism</u>. One of the best ways to be a pain-in-the-ass curmudgeon when just about <u>any</u> assertion is made is to ask: "On what evidence, exactly, do you make that statement?"   Perhaps you need not always make the statement verbally.   You can just think about it, and perhaps you will find that many or most statements that come your way are to be reasonably accepted, and you can forgo automatic inquisition.

Further, each individual has his/her own knowledge base and usual modes of thinking. Perhaps you know little about a topic and your request for evidence is a polite and serious inquiry about how that field works. On the other hand, you may know a good deal about a subject, and be trained in analytical and critical thinking well beyond average. While no person should unduly "flaunt" knowledge and talent, neither should specific abilities prevent you displaying them.   They may be welcomed.   If in a group being invited to sing, someone who can actually carry a tune takes the lead, I personally would appreciate that.

Here I am specifically thinking about engineers and about the subject of Catastrophic Anthropogenic Global Warming (CAGW). I am personally aware of many engineers who have studied the subject a fair amount and find it very unlikely <u>based on their specific knowledge of science and engineering</u>, as well as their suspicions about politics, and the fact that "money talks". Certainly however, there are other engineers, justifiably comfortable in their own specialty, who have not given CAGW much thought, who believe the CAGW advocates to be operating on a professional level with themselves. Indeed the CAGW public-relations effort (and financing!) is at a very high level. The CAGW proponents <u>are</u> the popular zeitgeist.   With only slightly intended prejudice, they can be termed CAGW activists, or CAGW alarmists.   In turn, they too often term the CAGW skeptics as "deniers" intending a considerable pejorative inference to be made.   But none of this is engineering-like thinking.

I will be attempting to make points about CAGW that is associated, if not in fact deeply rooted; in math, physics, and engineering. I am talking to engineers and their fellow-travelers. As such this is often engineering "gab" and I need not be entirely precise. Numbers mentioned will often be of orders of magnitude.   Precise mechanisms will usually not appear in great detail. But nothing below is included merely for effect.   When thermodynamics is mentioned, it is there for a purpose. When we say positive feedback, we expect the engineer to recognize the difference between mere amplification and run-away instability. When we discuss principal components, it is because they are used in climate study by proxy, and are in the toolbox of signal processing engineers.   There are no "buzz words" here used for their own sake. Anything contended here is openly contended, and defended. While the CAGW debate is rife with political implications and associated insult to intelligence, on both sides, <u>here we do engineering</u>.

Note that a few actual references are listed here.   For the most part the information, when not referenced specifically, is readily available with an internet search.

FACT: No Warming in 15 Years

It is probably fairly obvious that trying to attribute a single number as "THE temperature of the Earth" as a whole is quite absurd.   Ask any reasonably technologically literate person the question as to how, exactly, one would do this. While the notion itself might really be silly, possibly the best practical ballpark answer would be to suggest that the satellite measurements (which can examine the whole Earth frequently) are in a real sense the best; but these have been available only since about 1979.

   Pieced together, either the GW alarmists or the GW skeptics can find temperature data they are willing to promote, or to dispute. Unavoidably, no one should logically embrace a particular cache of numbers when they favor a view you favor, and then in turn dispute a similar cache later when an indicator changes.   That is - if you choose to be logical. So we found the skeptics during the 1990s saying that the time period was too short and data too unreliable to be evidence of warming. Now the alarmists say in the 2000s that the time period is too short and the data too unreliable to be evidence for a standstill in warming. [Note that there is considerable merit in questioning both the trustworthiness and accuracy of the measurements and the very limited time frames, in addition to the absurd notions of a single or ideal temperatures.]

   What is clear is that, to the extent that the available data might have meaning, if it previously showed warming, it now shows a standstill or possibly a slight cooling.   Here are some admissions from the alarmists camp (Google for full context and for comments by apologists):

Kevin Trenberth, NCDC, email of 12 October 2009 ("Climategate" email):

"The fact is that we can't account for the lack of warming at the moment and it is a travesty that we can't,"

Phil Jones, UEA, BBC Interview Feb. 13, 2010

BBC : Do you agree that from 1995 to the present there has been no statistically-significant global warming?   Jones: "Yes, but only just. …"

Note that few if any of the <u>skeptics</u> deny that there is likely some long term (couple of hundred years) of global temperature increase, associated with the recovery from the "Little Ice Age" (LIA) which was lowest in the 1700s or so. What they do deny is that there is any meaningful evidence of <u>Dangerous</u> Anthropogenic Global Warming, and that natural variability has always been with us, long term. However, if we were to (provisionally) accepted the notion that there is global warming <u>and that it is dangerous</u>, how are we to interpret statements such as the following:

Phil Jones, UEA, 2009 (another Climategate email): 'Bottom line: the "no upward trend" has to continue for a total of 15 years before we get worried.'

 In addition to remarking here that it is now 15 years, one is astounded by the "before we get worried" remark. If one is truly alarmed about the adverse consequences of warming, why would one be "worried" if evidence that warming was NOT happening was upon us?   What is their favorable outcome? Apparently not what they say.

So, the fact is that, by the criterion which the alarmists declared warming, the warming has now stopped.   See Fig. 3 and more below.

Can CO2 be the Culprit?

The implication is widely that man is causing "disruption" through the burning of fossil fuels and the accumulation of excess CO_2 in the atmosphere. (We note with suspicion that carbon is something that can be easily taxed, while other possible factors, such as the Sun itself, are beyond the reach of the tax man.) As warming itself seemed to be less and less likely, the threat (or at least the

invocation of a perverted notion of a "Precautionary Principle"; a re-warmed "Pascal's Wager") morphed to "climate change", "climate disruption", and (currently) "increase in extreme weather events". Still, the alarmists want to blame CO2. This is simply not logical.

As other have pointed out, every path for blaming CO2 for a myriad of things claimed to be bad must go through the "greenhouse effect" and "global warming". For example, although there is no evidence of more severe hurricanes in recent years (to the contrary), those who choose to contend that there is an increase insist on a causal path stemming from warmer oceans. Apparently, with multiple levels of absurdity, although warming came to a standstill15 years ago, supposed consequences of this non-happening are cited as evidence.

The most direct indication that CO2 is not a significant cause of any warming of the Earth is that there is <u>no significant correlation between temperature and CO2 concentration</u>. It is widely recognized that "correlation is not causation", but correlation seems essential to causation.

In the temperature history discussed here to this point, we have seen from 1998 to 2013 about a 5% increase in CO2 concentration and as we emphasize, no warming. Going back further, we have numerous up-down zig-zags in temperature (typically a 60 year "cycle" – see Fig. 3 below) while at the same time, CO2 change is essential monotonic. In addition, although not universally agreed upon, there seems to be, in long term, an anti-causal lag of hundreds of years between temperature change and a <u>following</u> CO2 change.

In addition, and less obviously perhaps, the heat trapping effects of CO2 have a <u>logarithmic relationship to concentration</u>. That is, the "Greenhouse Effect" is largely acknowledged <u>by the skeptics</u>, but is understood to be largely saturated, <u>even by the alarmists</u>. It should be recognized that CO2 is a very rare (but biologically essential) gas. Currently, the concentration is just under 400 ppm (parts per million) or 0.04%. That's 4 one-hundredths of 1%. That's one molecule in 2500. That's one penny in $25 worth of pennies. The pre-industrial concentration is believed to have been about 280 ppm. Further it is believed that if the concentration were as low as 150 ppm, plant life (and all

other life in response) would begin to fail! Accordingly, the sometimes-held view that the current levels of atmospheric CO2 are not that far <u>above plant starvation</u> is reasonably held. Indeed, many commercial greenhouses (real glass greenhouses) add CO2 (like to1000-1500 ppm for something like 50% better growth, usually obtained by burning natural gas).

The reason CO2 is logarithmic is as follows.   Although called a "greenhouse effect" we do not have heat being held in by an enclosure.   What we do have are <u>discrete photons</u> many of which are headed from the surface for outer space, and the question is whether or not they will be intercepted by a CO2 molecule and radiated back down.   In order for them to be captured, they must run into such a molecule, <u>and</u> they must have an energy (wavelength) within a certain bandwidth.   This is a classic math calculation similar to the half-life calculation for radioactive decay. Let's however just use an analogy.

Say you are managing a baseball team, and you discover a loophole in the rules that allow you to have as many outfielders as you wish. So you start with the conventional three outfielders and find they catch the expected percentage of ordinary (in bandwidth – if you will) "fly balls" - let's suppose half of them. So you decide to double the number to six outfielders, supposing that they will get the remaining half.   That does not work – some balls still drop. So you double again to 12, and possibly now you are getting most of the flys. Doubling again to 24, you possibly won't see any improvement at all. You have saturated the defense against the supply.

Recall that the current concentration of CO2 is about 400 ppm. Suppose however that we start with an atmosphere with no CO2 at all, and add some. With CO2 and photons within their capture bandwidth, the first 20 ppm will capture half the photons. If we double the CO2 to 40 ppm, we now capture half those that remain, and so on. (It is perhaps useful here to think in terms of CO2 added in layers or shells.)   Ultimately we ask what happens when we double (as a convenient ratio) the CO2 concentration, which would be 560 ppm over pre-industrial values. Calculations and experiments, <u>not in dispute</u>, say that any doubling adds about 1.1°C to the greenhouse warming. This number, the temperature increase for a doubling of CO2 is called the "Climate Sensitivity".

Unfortunately for the alarmists, this is not enough to be alarming. They decide to invoke a notion that this 1.1°C/doubling is amplified to something more like 3°C/doubling by a "positive feedback". At this point, the CAGW activists intrude on the territory of the engineers.

Engineers, particularly electrical, mechanical, and control engineers understand feedback.   They certainly design using negative feedback, and associate essential long-term stability with proper negative feedback. They study the feedback mechanisms and parameters.   In turn, a natural scientist finding long term stability (perhaps the temperature of a biological organism) looks to find the naturally occurring negative feedback (thermostatting) mechanism, and the cause.

In observing the long-term stability of the Earth's climate, a climate scientist is well-advised to look for negative feedback.   Instead of even postulating the notion that a possible positive feedback (tipping point) is impending, the overall sign of all feedback mechanisms combined should be examined. Further, the mechanism of the feedbacks needs to be considered. Here we will find that there is a fundamental requirement, nothing less than the 2nd Law of Thermodynamics, that says that nature must invent (implement by whatever means) <u>this negative feedback</u>.

Heat Moves from Where There is More to Where There is Less

Examples of this are as follows: Suppose more CO2 causes more surface heat to be trapped below a CO2 "blanket". The heat causes more surface water to evaporate (become water vapor).   This is a "phase change" and energy is taken into the atmospheric molecules as "latent heat of evaporation". On many a hot summer day we see this result in an upwelling of most warm air - as thunderstorms. The air is carried miles up above much of the CO2 blanket, and as it cools, the water vapor condenses back to liquid water, giving up heat which is now above much of the greenhouse gas, and heads for space, having been sprung from its surface prison. And the water – the cooled water drops – they fall to the earth. This is of course just ordinary rain – just weather.

Another likely negative feedback mechanism is clouds. Warmer temperatures meaning more evaporation in turn results in more clouds (related to the first mechanism). This blocks incoming sunlight in the first instance, reducing temperatures. More on this relating to cosmic rays later.

Yet the alarmists want to claim a positive feedback. Positive feedback first results in an amplification, and potentially, a blow-up or tipping point. Here the CAGW alarmists postulate that the additional water vapor enhances the greenhouse effect.   Indeed, water vapor itself is a much more powerful greenhouse gas than CO2!   No one disputes that it is.   This is where they get their value of 3°C/doubling of CO2.   The water vapor amplification triples the "climate sensitivity".   Largely they did this to accommodate the observed warming of the 1970-2000 years (Fig 3).   The CO2 by itself was not enough, and not being able to think of anything else (ignoring natural variability), they postulated positive feedback, and put it in their models (all of which are currently over-estimating warming).   There are many problems with the positive feedback assumption.
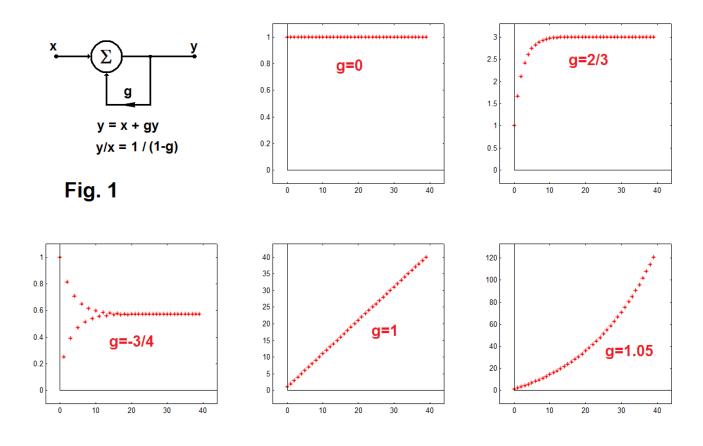
First, there is the issue of observed long-term stability.   While it may seem drastic that the Earth goes through ice ages, this is only a matter of a 10 °C, and thus of the same few °K, and thus the Earth stays constant to a few percent at most.   Earth has had millions of years and suffered some significant insults, and has not run away. If it were going to tip, it would have tipped.

Secondly, what is the mechanism? The alarmists say increased CO2 causes more warming and thus more water vapor, and more temperature increases.   One might ask, when a water molecule is vaporized, how does it "know" that it was vaporized by heat from CO2 trapping.   Wouldn't a runaway be just as likely (much more likely in fact) to be initiated by heat from water molecules in a chain reaction all on their own?   Isn't heat just heat?   This should have happened if it were going to.   As little CO2 as we have on the Earth, we have oceans of water. Well, the CAGW modelers, apparently, make an assumption of constant relative humidity (with time scales and regional scales unclear) such that the water does not amplify itself, although this is as unlikely as it is unclear. It seems much more likely that any total feedback, water vapor and CO2, is limited by some overriding negative feedback process.

The third point is that you can't just say that the positive feedback started in 1970 and was inoperative prior to then.   If the climate sensitivity really is 3°C/doubling, then the temperatures back pre-industrial should have been a degree or two colder to start with. No one claims that. It does not "back-cast" correctly [7].

So positive feedback was invented as a multiplier by three to accommodate the need to claim sufficient warming from weak CO2 warming, to accommodate the unusual rate of warming from 1970-2000, which was 1.64°C/century instead of the longer term 0.45°C/century (see Fig. 3). Illogical to begin with (as noted for the three reasons above), it failed spectacularly when the warming halted.

$$y = x + gy$$
$$y/x = 1/(1-g)$$

Fig. 1

It is probably a good idea to keep in mind the different types of feedback. In particular, notice that <u>positive feedback does not necessarily indicate an out-of-control result</u>.   Over a range, it is just an amplification. Fig. 1 shows the simplest possible feedback system: a feedback multiplier g sends the output back to the input summer.   Thus the output overall is the input multiplied by

1/(1-g) as shown. (Here we are using a discrete version of the feedback system for the plots.) The input is a uniform level (step-function) of ones, and the output starts at 1. When g=0 (no feedbacks at all) the output remains one. The second example g=2/3 (a positive feedback) results in an output value that changes from one to three. Note that it remains at three.   It does not run away. This is an important fact to keep in mind as many who have no knowledge associate <u>any positive feedback</u> with a mandatory blow-up or tipping point.

It is possible to have a negative feedback by using a negative sign for g, as is illustrated for g=-3/4. Now the output gets smaller than one, reaching 4/7. The cases where g reaches or exceeds 1 are in fact unstable cases. For g=1 as shown, the output ramps (an integrator driven by a step) and g=1.05 shows an exponential blow-up. These examples are just shown as a reminder, not to suggest any actual corresponding climatic results.

The Depth of Time, and of Temperature Variations

It is frequently said that no one has the slightest idea what the "ideal" temperature of the Earth is. So people kind of assume that whatever is currently (or at least recently) going on is what is "natural" for the Earth.   We are, or so it would seem, more uncomfortable with the unfamiliar than we are with what may well be truly inconvenient. Yet cold periods are clearly more dangerous than hot ones. Periods of a few degrees warmer, such as the Medieval Warm Period (MWP) of about 1000 years ago were more comfortable than the Little Ice Age (LIA) that followed, from which we are now still emerging. Yet, as they say, "geologically speaking" we are talking of time periods that are very short. We naturally think in terms of a human lifetime or a few generations.

From the view of a longer time perspective, the first thing to note is that, in the geological past, climate has been more extreme in both directions, relative

to today.   It is further a surprise to many that the Earth is <u>currently IN an ice age</u>. During an ice age (millions of years) actual glaciers come and go on a time scale of about 100,000 years. Mostly they come, and then they go back, staying away for something like 10,000 -15,000 years during what is called an "interglacial". We are currently in an interglacial, or are leaving one. The last glaciers departed about 12,000 years ago, and they will be back quite soon. Long term, we are cooling.   Short term, the temperature curve is very "noisy" because there are so many contributions at play.
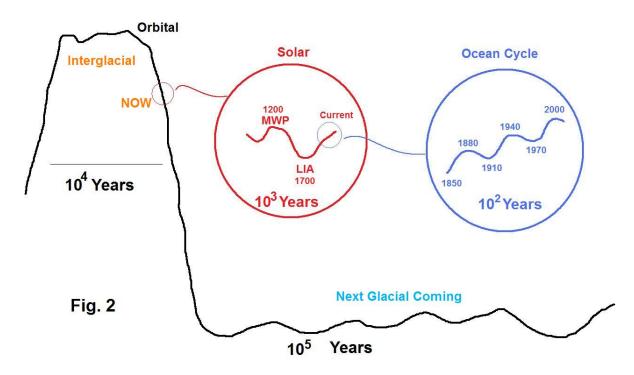

Fig. 2

Fig. 2 shows a cartoon version of the general time scales, and represents one glacial cycle of about 100,000 years that is itself within a much longer ice age (perhaps 3 million years). The cause of this longer ice age is not clear, but is probably galactic, something like dust in spiral arms.)   In Fig. 2, we show events on time scales of four orders of magnitude, using zoomed views.

On the largest scale (roughly 100,000 years) we have a glacial event and a much shorter interglacial (both as the black curve), and it is believed we are headed into a return of the glaciers.   The swing of the black curve is roughly 10°C (18°F).   One popular suspect as to the causes of these glacial/interglacial swings are periodic variations of the Earth's orbit about the Sun (Milankovitch cycles).   The transitions in and out of interglacials are far from monotonic so

that there may be medium and shorter terms trends of warmings and of coolings (1000 years as suggested by the red curve, perhaps a few degrees C). In the red curve, we specifically show the MWP and the LIA, and the current recovery from the LIA.   Possibly the variations on the scale of the red curve are caused by solar cycles (sunspots).   See more on this later.
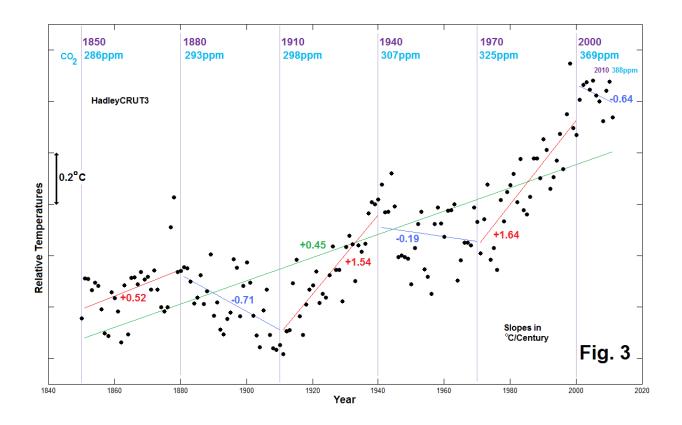
This brings us to the blue curve, on the scale of 100 years (about 160 years actually) where we have a slow warming with a superimposed sinusoidal-like variation.   Here the total rise (a roughly linear trend out of the LIA) is about 0.5°C (1°F) per century.   This time period (1850-today) corresponds to roughly the era of believable thermometers and reasonable area coverage. The three bumps suggested are actually found (see Fig. 3 below) and likely correspond to a thermal oscillation of the Pacific Ocean (or oceans in general).

[If you haven't done so recently, pick up a globe, or use a virtual globe, and look at the Pacific Ocean. You can turn the globe so that the Pacific Ocean takes up a large chunk of a hemisphere.   And then as well, recall that the oceans contain about 1000 times more heat than the atmosphere. Then consider if perhaps oceans are a factor in climate!]

Let's address one common claim made here. The skeptics will claim that there has been no significant warming for 15 years, and the alarmists will counter by saying that a good number of the last 10 years are among the warmest "on record".   <u>There is a good reason why both claims CAN be true</u>, and this is so obvious it is a wonder so many people regard these as a pair of claims in contention.   The notions of "record setting" and "on record" are of course meaningless unless you state a corresponding time period. For one thing, if we say we have broken a 100 year old record, of necessity it must be true that it was nearly as hot (or cold) <u>100 years ago</u> - and now it is almost the same <u>again</u>.   So much for alarm! In the second place, if we have a time record that is short, with a corresponding linear trend, of necessity the points near the end (like the most recent) will have to be among the most extreme. For example, the blue curve around year 2000.   It is much like a climb over increasingly high mountains. As you cross over any current peak in your path, locally you may be near level (so no increase) but when you then look back a few steps, you certainly do see the highest overall elevations of your trek so far.

Actual Data and Trend Lines

Fig. 3

Above we have been discussing mostly general trends and rough estimates. In Fig. 3 I have taken some actual data that was discussed briefly in passing above.   This is the "HadCRUT3" data maintained by the UEA in UK that is very often used and widely accepted as having some possible meaning. I have plotted this myself and added trend lines by least squares (discussed in detail [1,2]).   An important thing about trend lines is that we really should just use them to guide our eyes, helping us see through the noise – we don't guarantee that they "mean" anything. But the trends as chosen are very often plotted and discussed.   In particular, they run from 1850, plotted for 30 year intervals (except most recent), and are meant to correspond exactly to the blue curve of Fig. 2.   Here we see three rises and three declines. The data is not monotonic although the contemporary CO2 increase is monotonic (CO2 does fluctuate slightly on a yearly cycle due to vegetative effects in the Northern Hemisphere).

The full trend line (green) has a slope of 0.45°C/century.   Not much!
Perhaps a degree or two F over nearly 200 years. You get more temperature
variation going out to pick up the mail, and at least 50 times that variation over a
year as the seasons change. That's worth keeping in mind.

Given that the overall trend is a certain value (0.45°C/century), and that we
have identified three warming and three cooling trends, it is axiomatic that we
have slopes for the shorter trends that exceed 0.45°C.   Note that two of the
warmings, 1910-1940, and 1970-2000 are quite similar and three times the
overall warming. The cooling slopes are less because of the overall linear rise.

The points to be made here are that these results can be easily plotted by
anyone (most computational computer languages do least squares, or you can
easily do it yourself).   Doing it and looking at the results will certainly give you
a better appreciation for a lack of significant meaning for the "alarming" warming
of 1970-2000 (very similar to 1910-1940) or a similar lack of meaning to post
2000 cooling, for that matter. <u>None the less</u>, the six segments of Fig. 3, taken
as a whole, with their 60 year periodicity, <u>are striking</u>. They are screaming at
you that they are quite likely a real part of the story. Well, they are a whole lot
better than so many other attempts to fit other climate data.

<u>Proxies – Before Thermometers</u>

Fig. 4 shows a photo or a cross-section of a spruce tree. The tree was cut
down in Ithaca NY in November of 2012. I know who cut it down and why – it
was shading a vegetable garden.   Anyone who cuts down such a tree is
strongly tempted to count the rings as everyone knows that this tells you how
old the tree is.   (This tree had about 50 rings so it was planted about 1962.)
Some folks believe you can determine other things than just the age of the tree
by examining the rings. Clearly they are not uniform – systematically, they get
generally thinner as you move to the outside, and possibly then you also see
other indications of regions of speeded-up and slowed-down growth. Clearly
this is not simple.   If you can't come up with at least a half-dozen possible
causes for these variations, you aren't trying.

You probably know that many "paleoclimatologists" use tree-ring analysis to try to reconstruct a temperature record, based on the ring widths or some phases of these growth rings.   It's very complicated and uncertain. But it is potentially a real science.

Fig. 4

It is clear that you resort to tree rings or other "proxies" because you don't have actual thermometer records for the time (prior to instrumental thermometers) and/or locations you want.   But how do you know if the tree is a good thermometer, and if so, how do you calibrate it. Well, you might have a theory. Likely there might be more growth during warmer years or wetter years, and so on.   And you have hopes perhaps that you can use statistics to "dig out" a "temperature signal".   As a corollary, if you do this, you or someone you work with ought to be highly competent in statistics, and that isn't easy for something this complicated. (Funny – looking for a synonym for "complicated" I found "knotty" but resisted the temptation!)

One obvious tool would be to measure tree rings in various ways as a time series, and compare that to any actual instrumentally measured parallel portion. That is, a "calibration period".   This might work, and even be convincing, but too often, it is too messy.   It is often stated that many of the trees just don't have the "signal".   This should tell you that you should not go further.
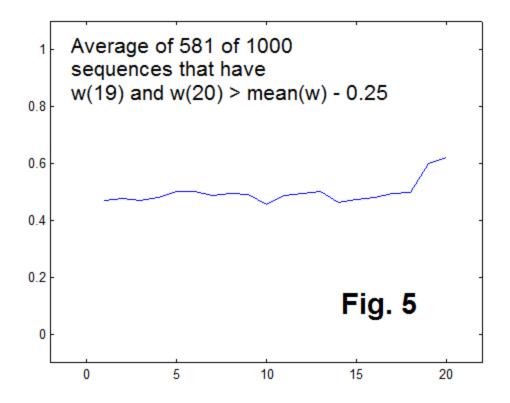
You have likely heard phrases such as the "hockey stick graph" and "hide the decline" and these are related to difficulties with this proxy problem.   IF you do make the decision to keep going, how do you decide which trees to keep, and how do you relate the uncertainties in your results?   Another tree-related word-play that comes in here is "cherry picking" and is not intended as a favorable description of a scientific method.

In general, we think of it as proper and honorable to discard bad data. Suppose for example that you had strong evidence that a particular instrument (a thermometer say) was actually faulty. Perhaps it went through the digestive system of a bear. You would be justified in discarding those results – likely the results wouldn't even look like what anyone would suppose <u>any</u> true signal could. Would you not be equally justified in discarding a <u>proxy</u> thermometer that seemed not to have a true signal?

Here is where problems, usually unintentionally inserted, can come up – called a "selection bias" or a "screening fallacy". This seems at first innocent enough. You recognize that not all your proxy thermometers are valid. Some tree growth data may well be confounded. (Again - that bear in the woods!) Let's further assume that you have a pretty good instrument record for recent temperature to work from. If you then correlate your tree ring data with this instrument, you can fool yourself into believing that you have detected a true temperature signal, and can extrapolate back to before the instrument record. <u>You may well be right</u>. It sounds a lot like the same thing an electrical engineer might do going through a box of old voltmeters and discarding those that seemed faulty as compared to a modern digital voltmeter. Indeed, why not?

Because you are not measuring voltage. You are testing an hypothesis: that the tree ring data correlates with temperature. You can't however first use a <u>correlation</u> procedure to <u>select</u> things as being the <u>same</u>, and then use the fact that they are the <u>same</u> to contend <u>correlation</u>. Yes, you can discard a faulty device. In the case of the voltmeters, you knew even the faulty ones were <u>supposed</u> to have needles that moved corresponding to a physical voltage – a valid belief – and you could do an independent test. The claim that "not all trees have the temperature signal" may be true, because in fact, perhaps none of them do, except by accident. But if you select (screen) those based on your expectations, you will surely get your expectations from those you do keep. This is rather elementary, and usually more subtly encountered, but it is not uncommon.

Fig. 5 shows an example [3], and perhaps illustrates how what seems to be a very weak screening can have a drastic, false result. Here we started out with

1000 length 20 random, white, sequences, uniformly distributed (on 0 to 1). If we were to average 1000 of them, for example, we would expect a very flat average over all 20 segments, averaging 0.5. There is no signal there, and it is not found. What happens if we discard some of these on some seemingly minor screening condition? Let's suppose we really believe the last two samples of the 20 should be special. Here the "minor screening" used is that the last two, samples w(19) and w(20) are both at least the mean, minus 0.25.

Fig. 5

Looking at Fig. 5 we find that fully 581 of the 1000 random signals passed this test. Roughly speaking, we were testing to see if the last two were both greater than 1/4. Each has a probability of 3/4 of being greater than 1/4, so the probability that both are greater than 1/4 is $(3/4)^2$ or 0.5625, and in our actual experiment, we got 0.581. This is not a surprise. The surprise might be that we get such a lovely "hockey stick", reaching about 0.6 (above 0.5). Keep in mind that all this was randomly generated, and non-randomly selected, but with what might seem a very week bias. If we, without intending to "cook the books", simply suppose there is something wrong with signals for which the last two don't exceed half the mean, this is the trap we fall into. Surprising.

As for the canonic "hockey stick graph", we will treat this below when discussing principal components.   The other phrase, "hide the decline" is conveniently mentioned right here as it relates well to tree rings. As we suggested, the fact that there may be an actual climate temperature signal in tree rings is at least to some degree speculation (and in some cases highly suspect).   We understand the notions of calibration with the recent instrument data – but what if the ring data disagree significantly with the instrument data?

More specifically, we would most likely suppose that greater growth should be associated with higher temperatures. If we find that the general shapes of the tree ring data and the instrument data match reasonably well, we could go ahead trying a calibration equation or procedure.   Then we could extrapolate back to the older pre-instrument ring data. But if the calibration curves don't match, we might suppose we have it wrong - perhaps greater growth is associated with colder temperatures for some reason. That would be interesting. But what do we do if mostly it matches, but sometimes it doesn't! Do we just turn it upside-down?   This was known to the insiders in the pro-CAGW camp as the "Divergence Problem".

Well, you might just discard the misbehaving data.   That would be another screening bias, actually.   But what if the older tail agrees with other (non-diverging) ring sequences that do seem to properly calibrate? You may not be concerned with the fact that the calibration portion (the most recent) turns colder, because your instruments tell you it wasn't actually colder. But if you actually publish those most recent data, someone might think that the whole series is bogus. Really! So why not truncate the inconvenient portion? (This was a portion from about 1960-1990). In its place, tack on the actual instrument record.   See if you can't make the transition in a "ball of yarn" where a lot of curves overlap. Hope no one notices.   Tell your associates that you are using "Mike's Nature trick" (the magazine **Nature**) and that you are using it to "Hide the Decline".   Hope the phrase never becomes known outside your group.

During the Climategate (2009) email leaks, emails to this effect were made public. CAGW apologists explained that by "trick" is means a "clever method" of dealing with a problem (true, scientists sometimes use "trick" in that sense), and that nothing was hidden as it was all in plain sight (NO, scientists should not hide anything!) [4].

I mention this because it helps illustrate the unreliability of the tree rings and other proxies, and the biases and other unreliable aspects of the CAGW proponents' presentations. Also, at about the same time that "hide the decline" became a mantra, it was also being more and more publicized that the temperatures were not rising for 10 years.   Many assumed erroneously that the "hide the decline" comment related to denying the 21st Century cooling. The timing was off for that, and the emails were explicit. It was of course the divergence problem (and possibly faulty proxy data) that was being hidden.

Faulty Principal Components

The so-called hockey stick graph is famous. There are lots of ways these could appear. For example, they could be real – perhaps the temperature really was flat for 1000 years and then zoomed up starting about 1970 so that by 2000 it looked like a sharp uptick.   It is also clear that selection bias, intentional or inadvertent, could produce one (as in Fig. 5) from purely white random noise. Other procedures could enhance or "mine" them from a big pile of data. While few skeptics would contest the uptick, the <u>flatness of the shaft</u>, with its implied denial of the reality of the MWP and of the LIA, is extremely unlikely, and even the alarmists gave ground on that issue, increasingly since about 2000.
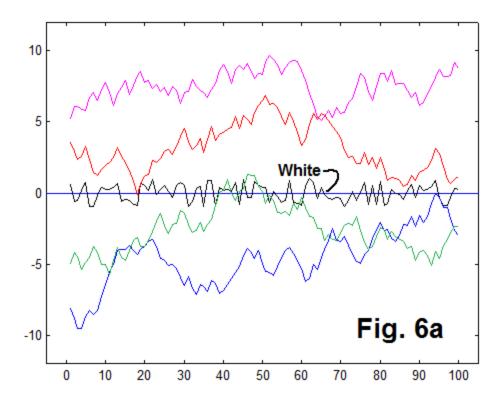
Famously the fact that a hockey stick can be produced from random noise by faulty statistical methods is readily apparent [4]. As we have said, digging a signal out of noise with a competent statistical methodology (verified by mainstream statisticians, not just peripherally by the climate scientists themselves) is tricky. Statistics is tricky, very tricky at times, and this particular case pushes the limits.

The original hockey stick production by the alarmists used the method of "Principal Component Analysis" (PCA) to identify a signal from a large set of proxies, mostly tree rings. Subsequently the skeptics showed that the exact implementation of the PCA that was used by the hockey stick authors was non-standard (perhaps just not understood) and it not only enhanced (mined) <u>for</u>
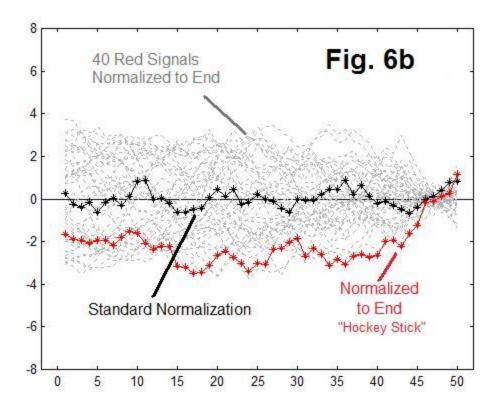
any actual hockey sticks actually present in the data, but could actually produce hockey sticks from random noise – "red noise" in this case.   This is a surprise. But it surely must means that for this methodology, applied to any other data, a claim of a significant result is necessarily totally unjustified.

First – why red noise rather than white? Red noise is nothing more that integrated white noise, the classic "random walk" or more colorfully the "drunkard's walk".   If we were really thinking about tree growth, trees living for 100 years (if no bad boy cuts them down!), anything that happens for a year or two or three that affects growth, is smeared. A year of unfavorable weather is likely mitigated by nutrients stored in the roots. That sort of memory effect. Hence a correlation of successive samples. Fig. 6a shows four typical red noise signals as compared to one white noise signal [5]. Note well that the white noise signal tends to hover around zero and has many zero crossings. The red noise signals have long term trends, and generally are found hovering well away from zero.

Fig. 6a

Fig. 6b

Red noise has little directly to do with tree rings except as we usefully compare the tree ring data to it, and the fact that red signals are the obvious choice to use to test statistical methods. If it is the case that the mathematical methodology produces a hockey stick with nothing more than random test signals, then any similar results using tree ring sequences are of no value at all.

Here we will not review PCA (see [6]). It is a method of digging a signal out of combined data sets. Here as an example a data set of 40 red noise signals (Fig. 6b) of the type shown in Fig. 6a were the input data. In a proper PCA, a mean is subtracted from each individual signal as a first step. In the improper (unconventional!) procedure used by the CAGW activists, they subtracted a mean calculated from the most recent samples only, which has the effect of clamping all the signals into a region near the end, as seen in Fig. 6b. When taking the principle components of these "normalized" data, non-untypically a pronounced hockey stick shape is the result. Note that both downward and upward hockey stick "blades" contribute equally to the blade of the result (red). With correct normalization, the principle component is much more nearly flat (black). See the full discussion for more examples [6]. The reasons for doing the statistics improperly, whether innocent error or through some degree of confirmation bias, are not clear.

Cosmic Rays ?

It comes as a surprise to some that the Sun is involved with the temperature of the Earth!   It is astounding to hear from some that it is too far away to make a difference – it's should be only the CO2!   Even some who understand that the Sun is ultimately the only significant source of energy have been heard to ridiculed the notion that sunspots indicate anything – relegating them to somewhat the same status as "tea-leaves"! In truth, even those who fully understand and suspect the important involvement of the Sun were taken aback by the suggestion that cosmic rays were involved.   It is thus important to understand the full proposed mechanism. It <u>may</u> well be correct.

No one can doubt that, through a basic "black body" discussion, if the Sun gets warmer (or cooler) so should the Earth.   So the argument that the Sun, although variable, has not shown <u>enough</u> variation recently to explain the amount of warming observed, seems to have merit.   Further, if we postulate that there is a path to warming involving cosmic rays, this seems even less likely.   If cosmic rays were in fact <u>delivering energy</u> sufficient to warm the atmosphere and surface, it would seem that all life would have been destroyed. Very true.   Clearly that's not the argument.

The key to understanding the argument here is to remind ourselves of cloud-chamber pictures which were first used to discuss cosmic rays. We have seen a whole menagerie of particle paths resulting from a single ray. Here we need to be mindful of the fact that the cosmic rays and all its daughter particles formed nucleation sites – the "cloud" part of the cloud-chamber. Likely most people have seen artist depictions of a cosmic ray (like a near light-speed proton) striking an atom in the upper atmosphere and then showing an immense array (probably 100s) of daughter particles cascading down like fireworks.   So the idea is first that cosmic rays, although perhaps individually sparse, may result in significant nucleation sites, resulting water droplets, and thus cloud formation. So what?

We know that the "activity" of the Sun varies, and that this is usually monitored by "sunspot numbers" and we have all heard of an 11-year cycle of

sunspots, and probably of times in the recent past (1000 years) when few if any spots appeared for times like 100 years (called solar minima).   These are generally associated with cooling.

What happens when the Sun is more active? Well, for one thing, it might be a bit warmer, and be a factor in warming the Earth. According to the theory involving cosmic rays, the more active Sun <u>also</u> has much stronger magnetic field, and this field extends well beyond the Sun itself, beyond the Earth. During a more active Sun, combined with the solar wind, the magnetic field deflects away many of the cosmic rays (which come from deep space in all directions). Fewer cosmic rays mean fewer nucleation sites and fewer clouds, particularly at lower altitudes.   Fewer low clouds means less shading of the surface (deflection of sunlight back to space), and thus – more warming.   That's the mechanism, which is plausible, and to some degree, a testable hypothesis.

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<u>The great Freeman Dyson Warns us:</u>

In the modern world, science and society often interact in a perverse way. We live in a technological society, and technology causes political problems. The politicians and the public expect science to provide answers to the problems. Scientific experts are paid and encouraged to provide answers. The public does not have much use for a scientist who says, "Sorry, but we don't know." The public prefers to listen to scientists who give confident answers to questions and make confident predictions of what will happen as a result of human activities. So it happens that the experts who talk publicly about politically contentious questions tend to speak more clearly than they think. They make confident predictions about the future, and end up believing their own predictions. Their predictions become dogmas which they do not question. The public is led to believe that the fashionable scientific dogmas are true, and it may sometimes happen that they are wrong. That is why heretics who question the dogmas are needed.

*–Freeman Dyson, **<u>A Many-Colored Glass</u>**, Univ. of Virginia Press (2007)*

Indeed – Engineers Should Share their Understandings

[1] Hutchins, B., "False Ideas About Random Sequences," Electronotes Application Note AN-377 Feb. 2012

http://electronotes.netfirms.com/AN377.pdf

[2] Hutchins, B., "Fun Plotting your Own Global Warming Curves," Electronotes Application Note AN-379 July 2012

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[3] Hutchins, B., "Models – Good, and Bad: and the (Mis-)Use of Engineering Ideas in

Them," *Electronotes* Volume 22, Number 211 July 2012

http://electronotes.netfirms.com/EN211.pdf

[4]   Montford, Andrew W., *The Hockey Stick Illusion, Climategate and the Corruption of*

Science, Stacey International (2010). See also Monford's more recent book *Hiding the*

Decline (2012).

[5]   Hutchins, B., "Fun with Red Noise", Electronotes Application Note AN-384 Sept 1,

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http://electronotes.netfirms.com/AN384.pdf

[6]   Hutchins, B., "Looking at Principal Component Analysis," Electronotes Application Note AN-385 Sept 5, 2012

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[7] Here is Warren Meyer's presentation that is outstanding – another engineer:

http://www.climate-skeptic.com/2010/01/catastrophe-denied-the-science-of-theskeptics-position.html?gclid=COScy_W9mqUCFdV95QodjR3PHQ