Atmospheric Carbon Dioxide Control Mechanisms

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PART FOUR: THE IMPLICATIONS

Synopsis:- Part Four

Rising atmospheric CO_2 levels are at the heart of the theories behind Catastrophic Anthropogenic Global Warming. It is absolutely vital that the models used to predict future CO_2 levels and therefore future global temperatures are based upon sound and irrefutable science. It comes as a shock to discover that the theories offered in the IPCC Assessment Reports, based upon peer reviewed literature are wrong and consequently lead to major overestimates of predicted CO_2 levels and of course temperature. The Ocean Control Theory suggests that, even in the very worst-case scenario, where global CO_2 emissions are stabilised by the year 2100, at a level four times those of today's emission levels, global CO_2 will stabilise at a value of less than 950ppm in the year 2350. This is equivalent to a CO_2 doubling of less than 1.8 over the pre-industrial levels of 280ppm. Of more significance than even the actual levels is the prediction that the atmospheric CO_2 levels will actually stabilise and will not increase for centuries as predicted by the IPCC authors. This has major ramifications for the arguments that CO_2 emissions must be reduced without delay to avoid future catastrophe.

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4.0 THE IMPLICATIONS

4.1 IPCC Third assessment Report

It is worth repeating the claims of IPCC TAR**.** These claims form the core of the science of climate change

"Before the Industrial Era, circa 1750, atmospheric carbon dioxide (CO_2) concentration was 280 +/-10 ppm for several thousand years. It has risen continuously since then, reaching 367ppm in 1999.

The present atmospheric CO_2 concentration has not been exceeded during the past 420,000 years, and likely not during the past 20 million years. The rate of increase over the past century is unprecedented, at least during the past 20,000 years.

The present atmospheric CO_2 increase is caused by anthropogenic emissions of CO_2. About three quarters of these emissions are due to fossil fuel burning.

The concentration of CO_2 in the atmosphere has risen from close to 280ppm in 1800, at first slowly and then progressively faster to a value of 367ppm in 1999, echoing the increasing pace of global agricultural and industrial development. This is known from numerous, well-replicated measurements of the composition of air bubbles trapped in Antarctic ice. Atmospheric CO_2 concentrations have been measured directly with high precision since 1957; these measurements agree with ice-core measurements, and show a continuation of the increasing trend to the present.

Several additional lines of evidence confirm that the recent and continuing increase of atmospheric CO_2 content is caused by anthropogenic CO_2 emissions – most importantly fossil fuel burning. First, atmospheric O_2 is declining at a rate comparable with fossil fuel emissions of CO_2 (combustion consumes O_2). Second, the characteristic isotope signatures of fossil fuel (its lack of ^{14}C, and depleted content of ^{13}C) leave their mark in the atmosphere. Third, the increase in observed CO_2 concentration has been faster in the northern hemisphere, where most fossil fuel burning occurs.

Atmospheric CO_2 is, however, increasing only at about half the rate of fossil fuel emissions; the rest of the CO_2 emitted either dissolves in seawater and mixes into the deep ocean, or is taken up by terrestrial ecosystems.

The part of fossil fuel CO_2 that is taken up by the ocean and the part that is taken up by the land can be calculated from the changes in atmospheric CO_2 and O_2 content because terrestrial processes of CO_2 exchange involve exchange of oxygen whereas dissolution in the ocean does not."

From these excerpts from the IPCC Third Assessment Report it is clear that the contention is for future atmospheric CO_2 levels to inexorably rise while ever CO_2 emissions from anthropogenic activities continue. Since CO_2 is recognised as a powerful "greenhouse gas" it

follows that global temperatures will continuously increase as a result of these uncontrolled emissions. From the description of the process provided by the IPCC the only way in which this process can be arrested is for anthropogenic CO_2 emissions to be reduced to zero. The argument continues that since every single emission of CO_2 is adding to the atmospheric levels, it is imperative that the process of reducing CO_2 emissions is implemented without delay. Even though major arguments rage over the degree of warming caused by the increased levels of CO_2 it is argued that we cannot afford to risk the future of the planet. Action must not be delayed.

These are powerful arguments that surely no sane person can dispute. Am I therefore placing my sanity in question when I say that I can and do dispute them?

4.2 The Ocean Control Theory of Atmospheric CO_2 Levels

As discussed in the first three sections of this paper this IPCC TAR version of events does not withstand close scrutiny. It explains none of the varied observations related to atmospheric CO_2 levels, including the famous "anthropogenic fingerprints" of carbon isotope ratio measurements, declining atmospheric O_2 levels and northern hemisphere CO_2 bias, used as evidence by the IPCC. The killer however is that the concept of a biosphere in total equilibrium, or zero net biome production, which is the basis for all the theories behind Catastrophic Anthropogenic Global Warming, is totally discredited by the seasonal CO_2 variations attributed to photosynthetic activity, which cannot be explained by the TAR concept.

In stark contrast, the Ocean Control Theory based upon the simple acknowledgement that CO_2 and O_2 fluxes are governed by the differences in partial pressures between the atmosphere, sea surface and deep ocean, does offer a rational explanation for all the relevant observations, including O_2 seasonal variations and the startling differences and declining levels in carbon isotope ratios in the sea surface and atmosphere, none of which are even reported, let alone commented on in any IPCC assessment report so far.

The Ocean Control Theory results in simple expressions for the CO_2 levels in both the atmosphere and the sea surface.

Atmospheric CO_2 $$Ca = Cs - 1/g_2.Fa.(1 - e^{-t/\tau 2}) \quad (1)$$

and sea surface CO_2 $$Cs = C_0 - 1/g_1(Fa + Fs)(1 - e^{-t/\tau 1}) \quad (2)$$

where C_0 is the deep ocean CO_2 content, Fa and Fs are the net atmospheric and sea surface CO_2 fluxes, g_1 and g_2 are the transfer factors determining transport rate of CO_2 between the deep ocean and sea surface and between sea surface and atmosphere. τ_1 and τ_2 are the time constants for the two control equations and are related to the transfer factors g_1 and g_2.

The following observations are all explained by the ocean control theory

- Increasing CO_2 levels resulting primarily but not totally from fossil fuel combustion
- Seasonal variations in atmospheric CO_2 levels predominantly in the northern hemisphere
- Seasonal variation in atmospheric O_2 levels in both hemispheres.
- Interannual CO_2 variations due to sea surface temperature fluctuations.
- Reducing atmospheric O_2 levels resulting from declining oceanic photosynthesis
- Increasing atmospheric CO_2 isotope ratios
- Increasing sea surface CO_2 isotope ratios
- Differential between sea surface and atmospheric CO_2 isotope ratios
- Increasing sea surface acidity or, to be more precise, reducing sea surface alkalinity
- Northern hemisphere atmospheric CO_2 concentration bias

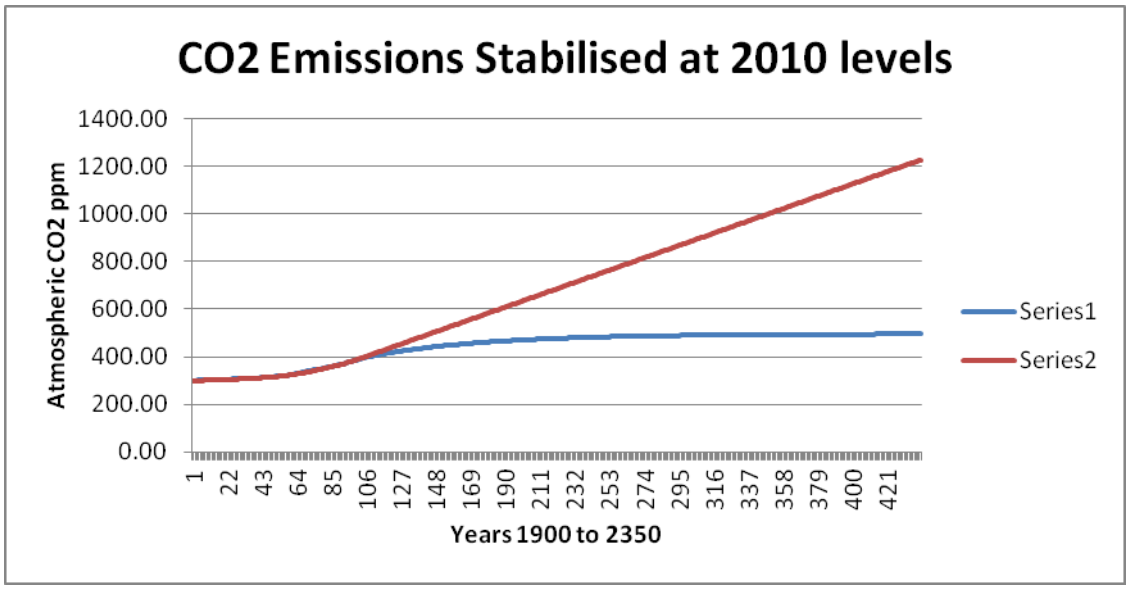
It is probably fair to say that none of the above phenomena are adequately explained by the theories propounded by the IPCC on which all current atmospheric models are based, models which are the basis for predictions of future global increases in temperature.

It is interesting to compare the future atmospheric CO_2 levels predicted by the TAR explanation and the ocean control theory for a number of anthropogenic emission scenarios.

4.3 Stabilisation of CO_2 Emissions at their Current Level.

Carbon emissions currently stand at 9.1 Gton/year, equivalent to an annual release to atmosphere of 4ppm of CO_2, increasing to 4.5ppm CO_2 when adding an estimated 12% to the value from the effects of deforestation. Let us imagine that these values can be immediately stabilised. Figure 4.1 shows the predicted atmospheric CO_2 levels for both the TAR theory and the Ocean Control Theory through to the year 2350.

Figure 4.1 Stabilised CO2 Emissions



Series 1 Predicted CO_2 levels from Ocean Control Theory
Series 2 Predicted CO_2 levels from TAR Theory

Because the TAR theory requires 50% (actually 53% to maintain agreement up to 2010) of the CO_2 emissions to be retained in the atmosphere, the predicted atmospheric CO_2 will increase linearly year on year, rising to over 1200ppm by the year 2350.

The Ocean Control Theory, by contrast, predicts that the atmospheric levels will themselves stabilise at a level determined by equations (1) and (2) above, with a value of 495ppm by the year 2350 representing significantly less than one doubling of CO_2 levels from pre-industrial levels of 280ppm. The time taken to achieve atmospheric stability is determined by the response times of the sea surface/deep ocean and atmosphere/sea surface interfaces τ_1 and τ_2.

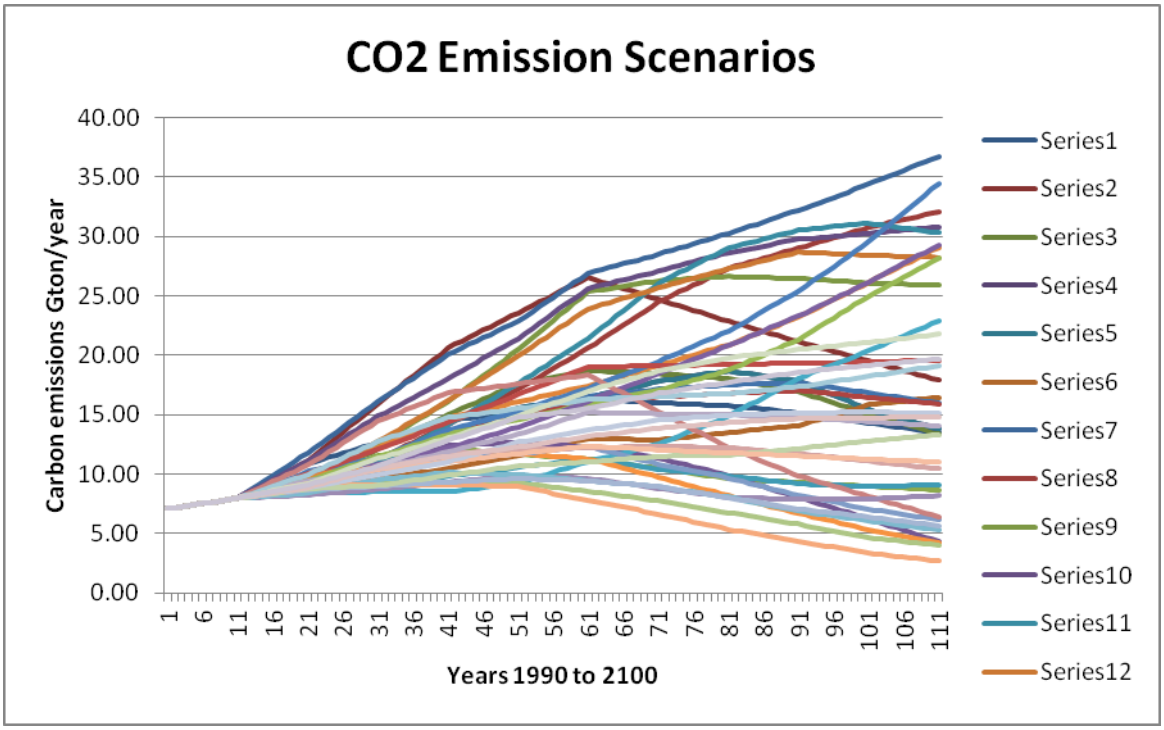
Atmospheric CO_2 levels are directly proportional to the rate of CO_2 emissions.

4.4 IPCC SRES Scenarios

Of course a sudden stabilisation of CO_2 emissions is not a credible scenario. In order to provide a realistic input for climate modeling the IPCC published a Special Report on Emissions Scenarios, SRES, IPCC 2000 in which a wide range of scenarios of global economic activity and corresponding anthropogenic carbon emissions are considered. These range from an optimistic view of global prosperity assuming annual growth of GNP at 3% with carbon emissions of 36.75 GtC per year (4 times the 2010 emissions level) in 2100 to a

drastically lower growth world with emissions reduced to 2.68 GtC per year. The range of CO2 emission scenarios are shown in figure 4.2.

Figure 4.2 SRES Emission Scenarios



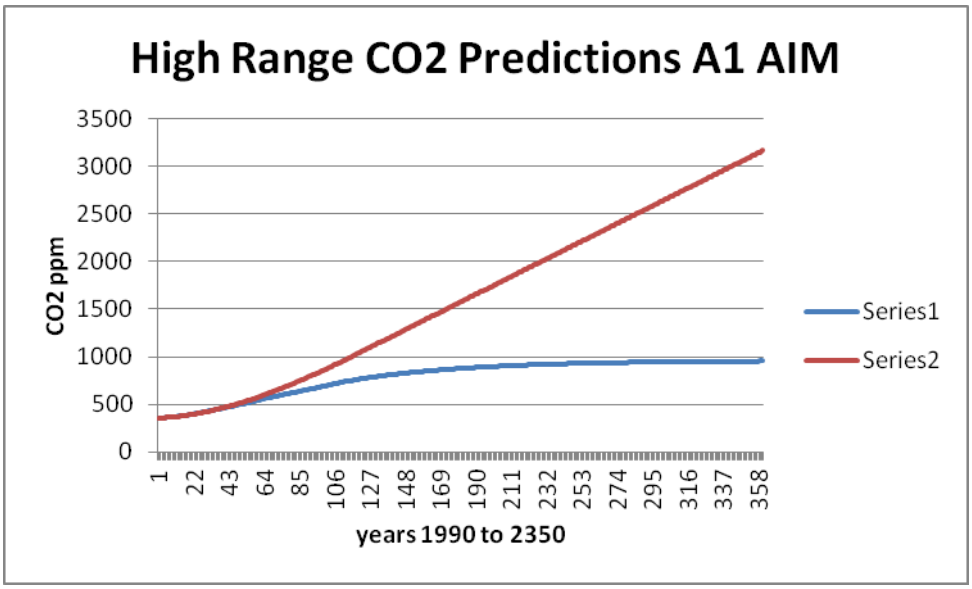
The carbon emissions from the complete range of 40 SRES scenarios.

4.4.1 SRES A1 AIM

SRES A1 AIM represents the high growth and the highest emission scenario. The scenario predictions cover the period from 1990 to the year 2100. Let us assume that by 2100 it has been possible to stabilise emissions at that level so avoiding any further increase of emissions to atmosphere. At an emission level of 36 GtC/year, or four times the 2010 rates of emission, it is unlikely that reserves of fossil energy could sustain an increase beyond that level. The question is what would be the predicted atmospheric CO_2 levels at future times. Figure 4.3 shows the calculated CO_2 levels through to the year 2350 for both the TAR and Ocean Control Theories.

The Ocean Control theory predicts a stable atmospheric level of 954 ppm in 2350, while the TAR theory is showing a conitinuously increasing CO_2 level of over 3000 ppm by the same year.

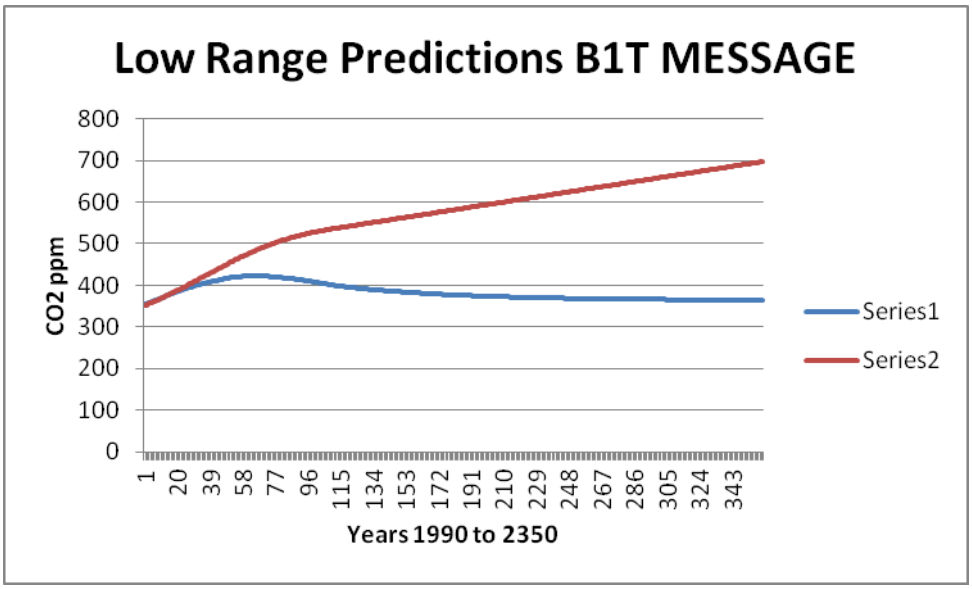
Figure 4.3 High Emission Scenario A1 AIM



Series 1 Ocean Control theory prediction
Series 2 TAR theory prediction

4.4.2 SRES B1T MESSAGE

Figure 4.4 – Low Emission Range Scenario B1T MESSAGE



Series 1 Ocean Control theory predictions
Series 2 TAR theory predictions

The B1T Message scenario represents the lowest carbon emission of the 40 scenarios comprising SRES. In 2100 carbon emissions are forecast to be 2.68 Gt/year, a quarter of the 2010 levels. Stabilisation even at such low emission levels still results however in an increase in atmospheric CO_2 levels according to TAR. Figure 4.4 shows the predicted levels for both the TAR and Ocean Control theories through to 2350.

In this situation the Ocean Control prediction is for CO_2 levels to reduce and stabilise at 365 ppm in 2350 while the TAR prediction is 697 ppm and rising.

4.5 Climate Sensitivity

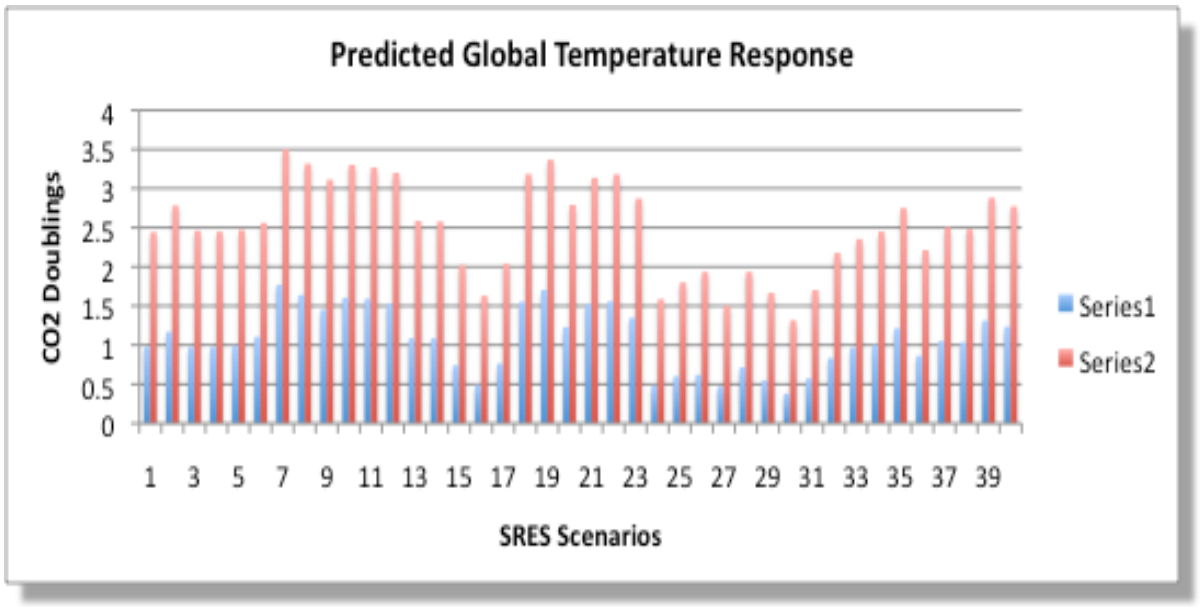
There are two major strands to the concept of Anthropogenic Global Warming. One is how much atmpospheric CO_2 levels will increase. The second is how much will global temperatures increase for a given increase in CO_2. This is a question of "climate sensitivity" about which there is much discussion.

It is generally accepted, although the origin of the concept is not at all clear, that a logarithmic relationship exists between global temperature and atmospheric CO_2 levels such that a doubling of atmospheric CO_2 concentration will produce a linear increase in temperature. This increase is termed "climate sensitivity. Figures quoted for this parameter vary from 1 to 8 Kelvin with current best estimates at around the 2 Kelvin mark. Calculations of atmospheric infra-red absorption suggests a figure of only 1 Kelvin for the direct impact of the "greenhouse effect" of CO_2,the higher figures result from presumed additional positive feedback effects, about which there is much dispute.

In order not to become embroilled in these particular arguments, it is possible to calculate how many doublings of atmospheric CO_2, over the pre-industrial levels of 280ppm will result from the various SRES scenarios, for both the TAR and Ocean Control theories. The estimated temperature increase can then be simply obtained by muliplying the CO_2 doubling by the agreed value for climate sensivity. Figure 4.5 shows the effective number of CO_2 doublings over the pre-industrial level of 280ppm for each SRESS scenario, for both Ocean Control and TAR theories which are predicted to occur by the year 2350.

Whereas the TAR theory is showing multipliers ranging from 1.3 for the lowest carbon emission scenario (B1T MESSAGE) to 3.5 for the highest emission scenario (A1 AIM), the Ocean Control theory suggests that even the absolute worst case A1 AIM scenario, where global carbon emissions stabilise at 4 times the 2010 levels, the CO_2 doubling, is less than 1.8. Note also that by 2350 the atmospheric CO_2 levels, according to the Ocean Control theory, would be stable even though CO_2 emissions stay at that high level. The TAR theory predicts no such stability, with ever increasing levels of CO_2 as can be seen from Figure 4.3.

Figure 4.5 – Predicted Global CO_2 Response



Series 1 :- Predictions from Ocean Control theory
Series 2 :- Predictions from TAR theory

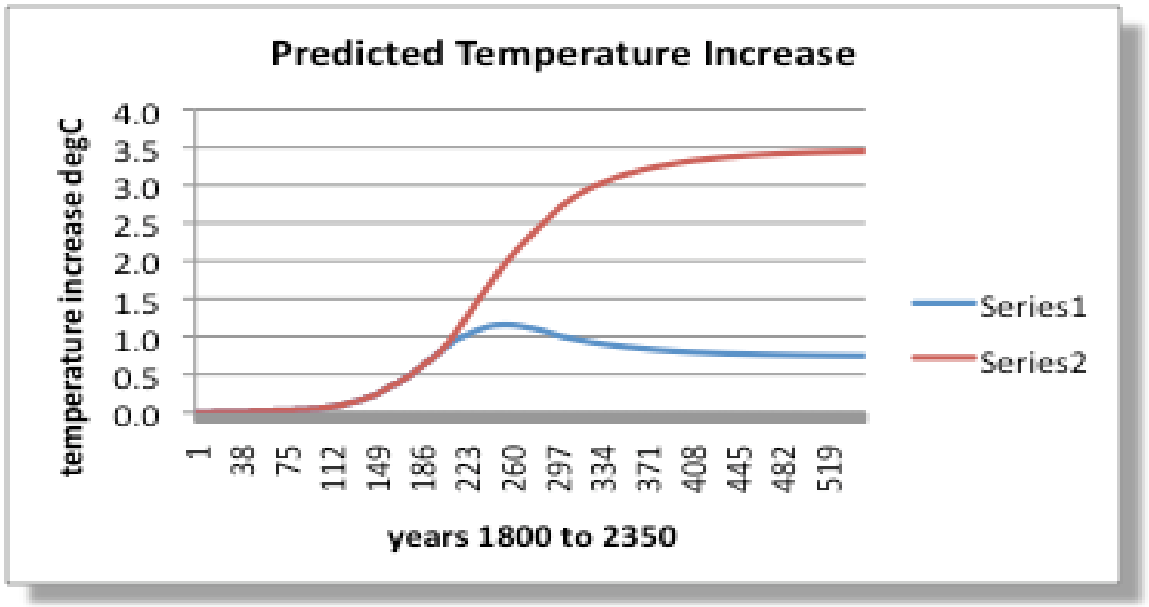
4.5.1 Predicted Temperature

Use of current data as a measure of climate sensitivity allows us to estimate future global temperatures from the predicted CO_2 levels. Between the years 1800 and 2000 atmospheric CO_2 levels have increased from 280ppm to 370ppm, representing a 0.4 doubling, During that period it is estimated that the globe has warmed by 0.78degC. Assuming, as a worst case, that this temperature increase can be attributed solely to the increase in CO_2, this represents a climate sensitivty of 1.95 degC/doubling.

Taking the very worst case scenario from the IPCC SRES series A1 AIM where CO_2 emissions stabilise in 2100 at a level of 36GtC/year, some four times the current rate of emission, the calculated global temperature increase, using the OCR model, is shown in Fig 4.6, along with the predictions for B1T MESSAGE, the most optimistic scenario, with emissions of only 2.7GtC per year.

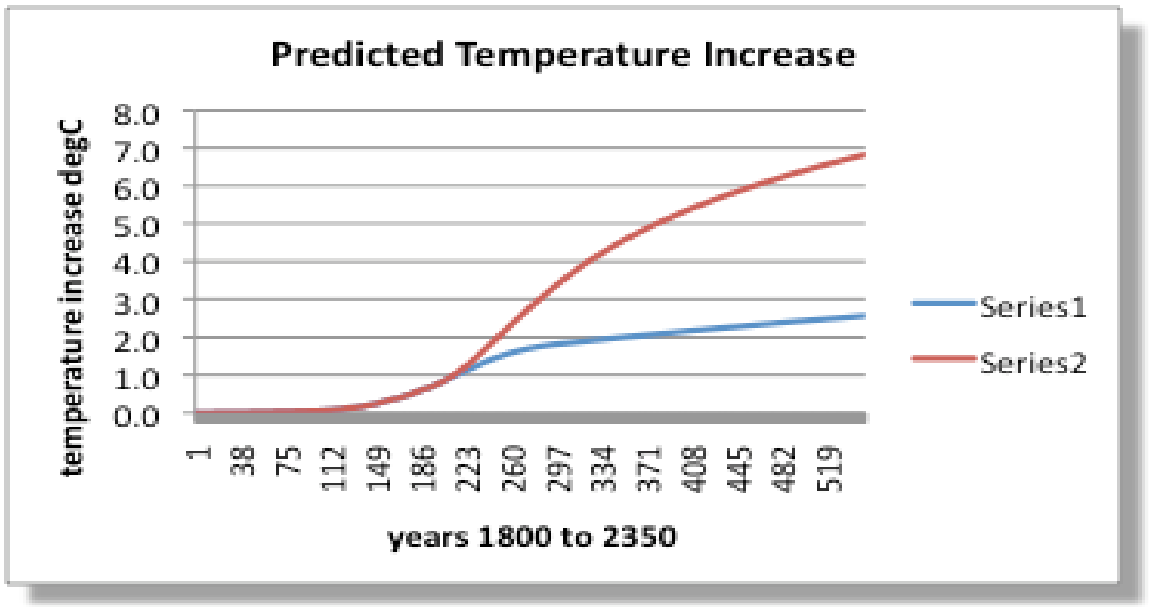
Similar predictions may be made using the future CO_2 levels for the A1 AIM and B1T MESSAGE scenarios using the TAR theory for atmospheric CO_2 increases. The results are shown in Figure 4.7.

Figure 4.6 - Predicted Temperatures fom Ocean Control Theory



Series 1 Sres B1T MESSAGE low emission scenario
Series 2 Sres A1 AIM high emission scenario

Figure 4.7 - Predicted Temperatures from TAR theory



Series 1 Sres B1T MESSAGE low emission scenario
Series 2 Sres A1 AIM high emission scenario

It is clear that the atmospheric model (TAR theory) expounded by the IPCC contributors to WG 1 is grossly exagerating the impact of anthropogenic emissions, to the extent that the worse case prediction, from scenario A1 AIM, by the Ocean Control Theory is for a temperature increase only 0.6 degC more than the TAR predictions for the most optimistic scenario, B1T MESSAGE. This optimistic scenario can only be achieved by drastic changes in energy consumption practices, a significant reduction in living standards for most of the world's population and the expenditure of trillions of dollars.

How can the IPCC contributors get it so wrong? And what will be the overall cost to society of the trillions of dollars being spent to resolve a problem that only exits in the minds of the scientists who have promulgated this error? The contention that 50% of CO_2 emissions are retained in the atmosphere for centuries, on the basis that that is what appears to happen, is almost childlike in its naivity. It ranks alongside the claim that the sun and heavens orbit the earth; and yet billions of dollars have been invested into researching the impact of such a theory. The madness, however does not stop there. Let us examine one of the key approaches being recommended to reduce these "dangerous" emissions. Of the 11 of the 40 SRES scenarios that result in a lower CO_2 emission than currently experienced, an average of 20% of global energy use will be delivered from biofuels, representing an energy use of some 200EJ per annum.

4.6 The Use of Biofuels

The theory behind the use of biofuels is that they are carbon neutral. CO_2 is extracted from the atmosphere by photosynthesis to produce the plants that are ultimately burned to produce energy thereby releasing again the CO_2 to the atmosphere. Energy has been produced with zero CO_2 impact.

The problem here is that we are using the wrong model. The model for this scenario is based upon the TAR theory that the biosphere is in perfect balance, with a zero Net Biome Production. In this model the plants, if not burned, would eventually decompose and return to the atmosphere as CO_2 anyway. So the energy released by their combustion is effectively for free.

It is true that growing biofuels extracts CO_2 from the atmosphere. However, these plants are not grown in the desert. They are grown in substitution of other plants, mostly food crops or tropical forest. Growing biofuels has no impact upon atmospheric CO_2 extraction by photosynthesis. CO_2 will be removed from the atmosphere whatever plants are grown, even weeds.

The question is what happens to the carbon that gets removed from the atmosphere by photosynthesis. TAR assumes that it degrades quickly back into the atmosphere as CO_2 to provide the balanced biosphere. The ocean control theory however makes no such assumption. It is highly probable that once converted to organic carbon the CO_2 remains

locked in that form for centuries or even millennia before being incorporated into the land biospheric sink as future fossil fuel or recycled back into the oceans to be reconverted to CO_2 and become part of the CO_2 "infinite" sink. Burning the biofuel simply short circuits this process resulting in a rapid release of the carbon to atmosphere. Burning biofuel produces exactly the same result as burning fossil fuel. It releases carbon from the global sink. It is not carbon neutral and brings absolutely no benefit to the issue of atmospheric CO_2 levels. It does, arguably however, produce much distortion of the world agricultural economy, which inevitably impacts hardest on the poorest of the world. The potential economic and social damage represented by producing 200EJ of energy from biofuels is unimaginable. Current total world energy usage is 370EJ!

4.7 Optimal Atmospheric CO_2 Levels

What is an optimal level for atmospheric CO_2? It is believed, not unreasonably, that higher CO_2 levels will promote more active photosynthesis and thus more efficient plant growth. CO_2 is after all "plant food". Indeed the TAR theory that approximately 25% of the anthropogenic CO_2 emissions are taken up by the biosphere intrinsically assumes this, since photosynthetic activity would need to grow linearly with increasing CO_2 emissions to achieve such a take up. At levels below 150ppm it is thought that plant activity will suffer and photosynthesis could effectively cease. What will be the impact of such a scenario? From the equation for atmospheric CO_2 equilibrium

$$Ca = Cs - \tau Fa$$

we can see that the CO_2 flux Fa, which is primarily due to photosynthesis, is holding down the atmospheric CO_2 levels. Any reduction in this flux will cause CO_2 levels to rise again, whereupon plant activity will be reactivated

Similarly increased photosynthetic activity that might result from higher CO_2 levels will tend to reduce atmospheric CO_2 levels. We therefore have a classic negative feedback whereby the interaction of CO_2 and photosynthetic activity applies a constraint upon the variations of atmospheric CO_2. Unlike the TAR theory, this factor has not been built into the ocean control theory predictions. Such an effect would mitigate against the anthropogenic emissions thereby reducing the predicted atmospheric CO_2 levels and consequently the associated temperature increase. We simply do not know however what the magnitude of the biological response will be in order to forecast the impact on future CO_2 levels. All we can say is that the effect will be to reduce atmospheric CO_2 levels.

4.8 IPCC Working Group 1 - The Physical Science Basis

IPCC Working Group 1 represents the core of the IPCC process. It identifies the scientific basis for the whole of the work underpinning the hypothesis of climate change as a result of anthropogenic activities. Section 7.3.1 Overview of the Global Carbon Cycle of IPPC 4th Assessment Report answers in respect of the question FAQ 7.1 "Are the Increases in

Atmospheric Carbon Dioxide and Other Greenhouse Gases During the Industrial Era Caused by Human Activities?"

"Yes, the increases in atmospheric carbon dioxide (CO_2) and other greenhouse gases during the industrial era are caused by human activities. In fact, the observed increase in atmospheric CO_2 concentrations does not reveal the full extent of human emissions in that it accounts for only 55% of the CO_2 released by human activity since 1959. The rest has been taken up by plants on land and by the oceans. In all cases, atmospheric concentrations of greenhouse gases, and their increases, are determined by the balance between sources (emissions of the gas from human activities and natural systems) and sinks (the removal of the gas from the atmosphere by conversion to a different chemical compound)."

This view of the science permeates every aspect and every published paper related to CAGW for over 50 years. It forms the basis for every climate and ocean model. That view, however, is not supported by the objective evidence illustrated in section 1 of this paper and yet appears never to have been questioned. Countless researchers have written countless papers at a cost of hundreds of millions, if not billions, of dollars into how much of the anthropogenic CO_2 emissions to atmosphere have been taken up by the oceans, when in fact the simple explanation is that the CO_2 emissions are simply offsetting the much larger photosynthetic biospheric absorption fluxes, thus causing atmospheric CO_2 to rise. There is simply no question of CO_2 emissions being taken up by the oceans.

How and when did this erroneous consensus view first take hold? To answer that we must look back over 50 years to a seminal paper by Roger Revelle and Hans Suess of the Scripps Institution of Oceanography in 1957. At the time of this paper it was understood that the residence time of CO_2 in the atmosphere before it re-entered the oceans was of the order of 5 to 10 years, and, as a consequence, the oceans would very quickly absorb anthropogenic emissions to atmosphere. Indeed the abstract of the paper by Revelle and Suess "Carbon Dioxide Exchange Between atmosphere and Ocean and the Question of an Increase of atmospheric CO_2 During the Past Decades" includes the following sentences.

"From a comparison of C^{14}/C^{12} and C^{13}/C^{12} ratios in wood and in marine material and from a slight decrease of the C^{14} concentration in terrestrial plants over the past 50 years it can be concluded that the average lifetime of a CO_2 molecule in the atmosphere before it is dissolved into the sea is of the order of 10 years. This means that most of the CO_2 released by artificial fuel combustion since the beginning of the industrial revolution must have been absorbed by the oceans."

In 1957 the historical atmospheric measurements of CO_2 were sufficiently uncertain for anyone to dispute this statement.
However hidden in a section towards the end of the paper is the claim

"Because of the peculiar buffer mechanism of seawater, however, the increase in partial CO_2 pressure is about 10 times higher than the increase in the total CO_2 concentration of seawater when CO_2 is added."

They assigned the symbol γ to a value defined by the relationship

$$r/A_0 = \gamma s/S_0$$

where r is the amount of CO_2 derived from industrial fuel combustion retained in the atmosphere at time t, A_0 is the atmospheric CO_2 at time zero, s is the amount of CO_2 from industrial combustion in the sea at time t and S_0 is the total carbon of the marine carbon reservoir at equilibrium condition at time zero, with the comment that γ is a numerical factor of the order of 10. There was no physical explanation offered for this relationship.

Interestingly examination of the original manuscript of this paper shows that this section of the paper was added later as an extension to the main paper. This, almost throw-away, comment was to spawn a whole research industry. The factor γ became known as the "Revelle Factor" which now forms an indispensible part of the "science of climate change".

4.8.1 The Revelle Factor

It was not until two years later that a mathematical treatment of this factor was presented in a paper by Bolin and Eriksson. This paper identified the different components of CO_2 present in seawater as CO_2, H_2CO_3, HCO_3^-, and CO_3^{--}. The following average values for the concentrations of these components were taken as

C_{CO2} = 0.0133 mmol/l (sum of CO_2 and H_2CO_3)
C_{HCO3} = 1.90 mmol/l
C_{CO3} = 0.235 mmol/l

and the sum of all these species, designated ΣC_{CO2}, is 2.148 mmol/l, demonstrating that the vast majority of CO_2 in the ocean exists as bicarbonates HCO_3^-. Bolin and Eriksson pointed out that the relationship between sea water CO_2 concentration C_{CO2} and atmospheric partial pressure P_{CO2} was

$$P_{CO2} = 1/\alpha.C_{CO2}$$

This is essentially Henry's law and α the Henry constant. Thus

$$\delta P_{CO2}/P_{CO2} = \delta C_{CO2}/C_{CO2}$$

They make the comment that

"First we see that if P_{CO2} varies and the hydrogen ion concentration were kept constant, the relative changes would be the same in the sea as in the atmosphere. As the total amount of CO_2 is about 50 times that in the air, practically all excess CO_2 delivered to the atmosphere would be taken up by the sea, when equilibrium has been established."

At that time, however, it was becoming apparent that atmospheric CO_2 concentrations were increasing. How could this be explained in view of the uncomfortable recognition of Henry's law and the above comment?

To remove this discomfort, Bolin and Eriksson postulated that when the total carbonate content of the sea ΣC_{CO2} is taken into account the relationships change and they proposed that

$$\delta P_{CO2}/P_{CO2} = \delta C_{CO2}/C_{CO2} = 12.5\ \delta\Sigma C_{CO2}/\Sigma C_{CO2}$$

Total Dissolved Inorganic Carbon is the sum of the components

$$DIC = [CO_2] + [HCO_3^-] + [CO_3^{--}]$$

This is the parameter referred to by Bolin and Eriksson as Σ_{CO2} and the Revelle factor R is now defined after Bolin and Eriksson as

$$R = \frac{\Delta P_{CO2}/P_{CO2}}{\Delta\Sigma_{CO2}/\Sigma_{CO2}}$$

They go on to explain that *"This tells us that 1 percent change in the total CO_2 concentration in the sea would require 12.5 percent change in the atmospheric CO_2 to maintain equilibrium. If we consider only the "mixed layer" of the oceans, i.e. the surface layer which contains about as much CO_2 as the atmosphere, less than 10 percent of the excess fossil CO_2 in the atmosphere should have been taken up by the mixed layer. It is therefore obvious that the mixed layer acts as a bottleneck in the transport of fossil CO_2 into the deep sea".*

The effect of this postulate is that for CO_2 in sea-water Henry's Constant is multiplied by a factor of 12.5. What Bolin and Eriksson failed to explain however was how the pre-industrial equilibrium between ocean and atmosphere was maintained, since it followed Henry's Law. It seems that it is only anthropogenic CO_2 emissions that are subject to the "Revelle Effect".

Subsequent contributors to the subject of take up of fossil CO_2 by the oceans have used and still are using this Revelle factor to explain the incomplete take up of fossil fuel by the seas. The explanation put forward by Bolin and Eriksson appears never to have been questioned. It after all provides a welcome explanation for the uncomfortable observation that anthropogenic CO_2 emissions to atmosphere appear not to be wholly taken up by the ocean when according to Revelle and Suess *"the average lifetime of a CO_2 molecule in the atmosphere before it is dissolved into the sea is of the order of 10 years".*

Use of the Revelle factor is conveniently summarised by Sabine et al in the paper "The Oceanic Sink for Anthropogenic CO_2" published in Science Vol 305 July 2004, some 56 years after Bolin and Eriksson.

"Variations in surface concentrations are related to the length of time that the waters have been exposed to the atmosphere and to the buffer capacity, or Revelle factor, for seawater. This factor describes how the partial pressure of CO_2 in seawater (P_{CO2}) changes for a given

change in DIC. Its value is proportional to the ratio between DIC and alkalinity, where the latter term describes the oceanic charge balance. Low Revelle factors are generally found in the warm tropical and subtropical waters and high Revelle factors are found in the cold high latitude waters. The capacity for ocean waters to take up anthropogenic CO_2 from the atmosphere is inversely proportional to the value of the Revelle factor; hence, the lower the Revelle factor, the higher the oceanic equilibrium concentration of anthropogenic CO_2 for a given atmospheric perturbation. The highest anthropogenic CO_2 concentrations are found in the subtropical Atlantic surface waters because of the low Revelle factors in that region. By contrast the near surface waters of the North Pacific have a higher Revelle factor at comparable latitudes and consequently lower anthropogenic CO_2 concentrations primarily because North Pacific alkalinity values are as much as 100µmol kg^{-1} lower than those in the North Atlantic."

Henry's Law established from the fundamentals of thermodynamics, equates the partial pressure of CO_2 in the atmosphere P_{CO2} to the partial pressure developed by the molar concentration of CO_2 dissolved in water, in this case the sea surface. As was shown above, because of the low value of the dissociation constant $K_r = 1.7\ 10^{-3}$. over 99% of the dissolved CO_2 remains in the solvated form. Carol and Mather in 1992, based upon the collation of data from dozens of independent experimental scientists, showed how the dissolution of CO_2 in water could be described by the Krichevsky – Kasarnovsky equation, itself being closely related to Henry's Law for temperatures up to 100 degC and pressures to 100MPa (1000 atmospheres). Unsurprisingly, there is not a single mention of the "buffering effect" due to the Revelle factor. In short the dissolution of CO_2 in water behaves exactly as Henry predicted. It is **only** in climate related literature that this Revelle factor is ever cited. It is however cited in almost every paper that has ever been published on the climate effects of CO_2 as a justification for the low estimation of ocean uptake of anthropogenic CO_2.

This "Revelle Effect" is used to support the utterly preposterous concept that the atmosphere and oceans have been in thermodynamic equilibrium from the distant past, with the partial pressure of solvated CO_2 in the oceans being in equilibrium with the partial pressure of CO_2 in the atmosphere, while anthropogenic emissions are miraculously buffered from entering those oceans, when, in reality, there is no such concept as take up of CO_2 by the oceans. The oceans and the atmosphere are in a dynamic equilibrium where sea surface and atmospheric absorptive fluxes are balanced by equal fluxes from ocean to atmosphere. The appearance of an anthropogenic emissive flux has simply perturbed that equilibrium, resulting in an increase in atmospheric and sea surface CO_2 concentrations.

4.9 Climate Science

What began as an almost casual reference to an idea by Revelle and Suess in 1957 was seized upon by climate science as an artifact to explain the uncomfortable paradox that a sea surface atmosphere response time of a few years did not produce greater "take up" of anthropogenic CO_2 emissions. The Revelle Factor was introduced to explain that limited take up of atmospheric CO_2.

Fifty years later this same Revelle factor is used to justify the idea that the oceans "take up" anthropogenic CO_2 and the determination of the variations in Revelle factors throughout the oceans of the world is used to "compute" the amounts of CO_2 "taken up" by those oceans. A more complete example of circular argument would be difficult to find. The evidence offered in this paper strongly suggests that the question of how much CO_2 is taken up by the oceans is a meaningless question. The oceans are a net provider of CO_2 to the atmosphere, necessary in order to balance the absorptive flux of biospheric photosynthesis.

This paper began in section 1 with the questions how and why, related to the stability of the atmosphere composition. These simple questions are the essence of science, of mankind's curiosity to understand the world around him. Sadly there is little evidence that these questions are asked within the bubble that is climate science. For over half a century, during which time man has walked on the moon, air travel has become commonplace, personal computers have been bestowed with more computing power than all the world's computers combined in 1960, and the internet has revolutionised communications, an off the cuff artifact has been enshrined into the very sinews of climate science, and no-one has asked the questions how and why. This "science" has been enthusiastically endorsed by the authors of IPCC Working Group 1, the very pinnacle, indeed the very essence, of the science used to steer the governments and politicians of the world into a utopia of sustainability and environment protection. That this science is built upon an unstable foundation of guesswork and ideology can be strongly argued. Would the adjective "disgraceful" be inappropriate to describe the way in which climate science has been conducted? Would "tragedy" be an inappropriate noun for the misguided follies of gullible politicians, believing that adoption of "green" credentials would endear them to their electorate?

There is, here, undoubtedly a tragedy, a tragedy for science. The tragedy however is not that the science is not settled, as was earlier proclaimed by certain UK government ministers. The tragedy is not even that the science is wrong. The tragedy is that the science of climate science is not actually science!

Academia, with its new generation of Climate Science departments and ten a penny professors, has discarded all values in its grubby pursuit of ever lucrative, green agenda driven, government research funding. President Eisenhower in his farewell address to the US nation in 1961 was prescient when he said

The free university, historically the fountainhead of free ideas and scientific discovery, has experienced a revolution in the conduct of research. Partly because of the huge costs involved, a government contract becomes virtually a substitute for intellectual curiosity. For every old blackboard there are now hundreds of new electronic computers.

The prospect of domination of the nation's scholars by Federal employment, project allocations, and the power of money is ever present – and is gravely to be regarded.

Yet, in holding scientific research and discovery in respect, as we should, we must also be alert to the equal and opposite danger that public policy could itself become the captive of a scientific-technological elite.

I am not sure that elite is the word that I would use, but it is clear that the world is destined to pay a high price for the vanity of these self proclaimed “climate scientists” and their “green” disciples.

4.10 References

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