Global Warming

Facts and History

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Abstract

This paper attempts to explain the history of the theory of global warming and set it in the context of scientific and public opinion. From about 1960 onwards, calculations began to be carried out which led to predictions that global warming would take place over the coming century. The prediction was that rate of heat input would be greater than the rate of heat loss if the power consumption were in the region of 100TW, resulting in what is now termed global warming. The popular conception today is that global warming is caused by emissions of "greenhouse gasses". On the other hand, volconologists suggest that a major eruption could precipitate another ice age. One of the outcomes of energy calculations was the idea of using renewable energy sources. Many forms of renewable energy have been advocated over the years. Most of them only nibble at the edges of the problem. Many renewable energy sources have environmental side effects. The effect of the use of energy resources during the construction phase needs to be considered when calculating the effectiveness of any power generation capability. The Earth has been getting colder over a period of four thousand million years. Given the fractal nature of the climatic variations, any measurements of climate change must be treated with considerable caution.

1 Introduction

Global warming has become a topical issue in recent years. Much has been written and said, in many cases without any real knowledge of the issues involved. It has become a rallying call of various factions, many of whom have legitimate concerns, but some of whom are seemingly bent on simply asserting their own views over those of others. Sometimes these factions act with good intent, but often they are led by unreasonable emotion. The existence and consequences of global warming are now so widely accepted that people who have little knowledge of the facts or history of the subject routinely talk about it as though all the popular assumptions were well proven.

In order to aid the understanding of the issues and identify the facts, fiction and assumptions, both reasonable and unreasonable, this paper attempts to explain the history of the theory and set it in the context of scientific opinion. The development of the world and the future development of society also need to be considered, because these have a significant impact on the whole issue.

It does not set out to justify either the creation of emissions or energy misuse. Indeed, there are many reasons why emissions should be reduced and there are many useful means of reducing energy consumption or using alternative energy sources. It is often the case that measures adopted to counter global warming are prudent for other ecological reasons. In this sense, the drive to counter global warming may have some very good side effects. However, this paper sets out to eradicate some of the gloom and despondency that now seems to accompany almost all predictions about the future of wildlife and the environment in general.

2 Calculations

From about 1960 onwards, calculations began to be carried out which led to predictions that global warming would take place during the following century. These calculations were based on three main assumptions:

- That the so-called “developed” world would continue to increase its energy usage per person at a rate calculated to be an inverse exponential function, which would level off in the mid twenty first century at about twice the current level;

- That the population of the “developing” world would expand, again calculated as an inverse exponential function, which would also level off in the mid twenty first century;

- That the energy demand per person in the “developing” world would increase until it approached that predicted for the “developed” world.

Based on these three premises, the calculations predicted the energy generation and, consequently, heat output caused by human activity. The estimates generally indicate a stable global rate of energy consumption of between 50 and 100 TW by about 2070 (1 TW is one thousand million kilowatts). Circulation models of the Earth’s climate, which are very complex and not very accurate, add the rate of heat flow from the Earth’s core to the surface and the power absorbed from the Sun’s radiation (heat and light) and the heat losses from the surface of the Earth caused by radiation. The prediction was that rate of heat input would be greater than the rate of heat loss if the power consumption were in the region of 100TW, resulting in what is now termed global warming. At this stage there was no reference to carbon dioxide or other so-called greenhouse gasses. Before we move on, it would be useful to consider the validity of the three main assumptions.

Firstly, the increase in energy use in the “developed” world was based in part on trends during the previous decades. However, mass energy consumption was a recent phenomenon that began in the late nineteenth century with the expansion of heavy industry and continued into the second half of the twentieth century with an expansion in the demand for space heating. The calculations took no account of either the effects of energy efficient building designs or the introduction of low power electronics, among other possible factors. If these calculations were still considered an important contribution to the argument in favour of global warming, it would be useful to revisit this assumption on the basis of recent trends.

The second assumption is probably broadly valid, although it is probably still too early to make an accurate assessment of its validity.

The third assumption neglects the fact that most of the “developed” world is situated in colder climatic regions where the major contribution to energy consumption is space heating. Most of the “developing” world consists of land where there is much less cold weather. There is a counter argument, which maintains that hot countries consume energy because of the demand for air conditioning. However, this assumes that every culture desires the same form of dress, surroundings and working environment as the energy hungry “developed” nations. One could argue that the “developed” world has much to learn about values and standards from the cultures of the “developing” world. In addition, it takes no account of the fact the efficient heat exchangers in well-designed buildings are much less energy hungry than conventional space heating systems.

3 Other Theories

There has been much confusion between scientific theory and popular belief. In many cases the two have become convoluted in such a way that it is difficult to separate them. In the nineteen seventies and eighties some scientist became extremely interested in global warming. Their interest was based initially on the calculated predictions. An important concern was aerosols. Aerosols are small liquid droplets, mainly water, suspended in the atmosphere. The effect of aerosols is twofold: they absorb high frequency radiation from both the Sun and re-radiate it as lower frequency heat which is less easily reflected from the Earth’s surface. They also reflect the lower frequency radiation from the surface, reducing the heat loss. Thus, for circulation calculations, they have an important effect on the result.

During this time, scientists became aware of a hole in the ozone layer in the Antarctic (and later one in the Arctic). Confusion in the popular understanding was about to appear, because the main theory placed the blame on CFCs, the most common propellants for spray-cans, which are unfortunately known widely as aerosols. This was one strand in the move against emissions. Also popular at the time was the theory that life on Earth began with a high temperature atmosphere consisting largely of carbon dioxide and methane. These became known as the greenhouse gasses. There is evidence of some increase in the carbon dioxide content of the atmosphere over the last century. Thus, the popular conception today is that global warming is caused by such emissions, which are believed to cause the "greenhouse effect". The scientists who proclaim global warming see their names in the headlines, sell their publications and are rewarded with good jobs. This is not a new phenomenon in the world of science (see Section 3 below). Nor can it be used to discredit the theory of global warming. But it does help to explain the widespread nature of popular belief in gloomy predictions.

Another quite different theory is popular amongst volcanologists (who study volcanoes). The theory suggests that a major eruption could precipitate another ice age. Those who remember the eruption of Mount St Helens in 1980 will recall that the following two years were noted for reduced temperatures and poor summers, at least in Europe. This was attributed to many thousands of tonnes of ash particles emitted by the volcano and carried into the upper atmosphere. It is not known if the explosion of Krakatau in 1883 caused a change in climatic conditions, but it emitted about 20 times more ash than Mount St Helens. 75,000 years ago, Mt Toba emitted about 3,000 times more ash than Mount St Helens. This may have contributed to the effects of the last ice age. The existence of such a contrary theory with serious scientific support must be given due weight when considering the importance of global warming.

4 Environmentalists

People who proclaim the global warming theory usually regard themselves as environmentalists. There is a popular misconception that the term environmentalist equates to a branch of science. In reality, environmentalists can be physicists, chemists, earth or biological scientists or simply lay people interested in conservation in general. Environmentalism is a state of mind. Physicists concerned with the effects of energy equilibrium and ecologists concerned for the effect of human activity and development were probably the first real environmental force to influence public opinion. The concept spread to planners, politicians and people from all walks of life. Unfortunately, the success of the concept has contributed towards the disrepute of the term environmentalist. Anyone can take up the cause of environmentalism, without much, if indeed any, grasp of the issues involved or understanding of the implications of the actions they advocate. So while environmentalism is a worthwhile cause, when taken in perspective with human ideals and desires, it needs to be treated with some caution. When anyone declares her/himself to be an environmentalist, her/his credentials need to be checked.

There have always been fashions in science, some with substance and some without. In 1988, there was the cold fusion fashion, which lasted only a few months. Two decades before that, there was the Jupiter theory, which predicted a large impact on the Earth when several planets aligned with the Earth simultaneously. Thirty or so years earlier, there was a great movement for the rejection of Wegner's theory of continental drift, because it was counter to all established theory. Such fashions in science become particularly potent when combined with popular belief and when their champions include those whose knowledge base has little substance.

5 Renewable Energy

One of the outcomes of energy calculations was the idea of using renewable energy sources. Over hundreds of millions of years, plants such as trees and animals, such as crustaceans, converted carbon dioxide to minerals, using energy from the Sun to drive the chemical reactions. The result was that some of the surface energy was locked up in what has become regarded as capital energy. Burning fuels such as coal and oil unlock the energy stored over millions of years and release it at a far greater rate than it was stored. Nuclear fuels are also regarded as capital energy, because the reactions are irreversible in practical terms on our timescale. The obsession with greenhouse gasses has reached a point where a website that claims to be serious advocate of environmentalism, has stated that nuclear energy does not contribute to global warming because it does not produce carbon dioxide. Nothing could be further from the truth. Any energy production process that releases capital energy is a potential source of global warming.

The concept of renewable energy is to use some of the existing energy on the surface of the Earth to satisfy our needs. The use of renewable energy sources reduces the human input factor in the energy calculations. It also reduces the emission of "greenhouse" gases, which satisfies the popular belief that these are the main drivers of global warming. Unfortunately, it has also become synonymous with a desire to turn away from progress and return to a more basic form of life.

Many forms of renewable energy have been advocated over the years. Most of them are capable of addressing only a small fraction of our need for energy. Wood burning is a practical option, but it would require a large renewable forest to supply a single power station. Contrary to popular belief, wood burning is a truly renewable system. The trees use the Sun's energy to convert carbon dioxide to cellulose and the power station reconverts the cellulose back to carbon dioxide, releasing the energy for our use. Another concept, popular in the 1980s, was the Ocean Thermal Energy Converter, where it was proposed to use the difference in temperature between the surface and deep water in tropical seas. The product, either hydrogen or ammonia, was to have been transported ashore by tankers.

Many renewable energy sources have environmental side effects. For example, river barrages cause rivers to silt up and change the habitat in the region of the barrage. Large wind farms are often regarded as unsightly, a blot on the landscape. The construction of a large wind farm, like the construction of a large, rural power station, either powered by nuclear or conventional fuel, consumes enormous energy resources during the construction phase, as compared with the energy output. The require many years operation to recover the initial energy usage. The effect of the use of such resources needs to be considered when calculating the effectiveness of any power generation capability.

Taking the energy out of waves may convert a rocky coastline into a sandy beach. Thus, if global warming really were a problem, a reduction in the use of energy (*i.e.* LESS energy) would be preferable to *renewable* energy.

6 Weather and Climate

The Earth is getting colder. It has been doing so over a period of four thousand million years. However, this is not a constant process. On a scale of hundreds of thousands of years, there is a cyclic pattern, where the low temperature excursions are known as ice ages and the high temperature excursions are known as inter-glacial periods. Currently, the climate is getting warmer. There can be no doubt about it. 50,000 years ago the Earth was in the grip of an ice age. 20,000 years ago, the ice age had finished but temperate zones were considerably colder than they are today. Convincing geological evidence supports the existence of such long-term cycles.

It is not clear whether or not there are any patterns associated with a timescale of thousands of years. Such periods are too short to be supported by geological evidence, yet stretch too far into the past to be supported by either anecdotal or observational evidence.

In the shorter term, on a scale of a few centuries, the climate also varies. The evidence for this is mainly anecdotal. Detailed records do not exist for much more than a century and, even then, their usefulness decreases as one goes back in time. There is both observational and anecdotal evidence that the climate varies on a scale of a few decades. There is also good observational evidence that there are short-term variations on a scale of a few years.

When even shorter-term variations are considered, these are usually regarded as variations in weather (as opposed to climate). Thy occur on a seasonal basis, on the scale of a few months, on a weather system basis, on a scale of a few days and on day to day basis within individual weather systems.

Such patterns display all the characteristics of a fractal system[1][1], where, without a scale notation, it is impossible to determine the scale length of the observed data. It is widely accepted that the average surface temperature of the Earth has increased by between 0.25ºC and 0.5ºC over the last 100 years. However, measurements at higher altitudes do not reflect this. Given the fractal nature of the problem, such measurements must be treated with considerable caution. Differentiating between climate change and various weather patterns is difficult, if not impossible. Also, if any changes are observed, it is all but impossible to tell whether they are caused by long-term trends or by cyclic effects. To be fair to the advocates of global warming, it is better to err on the side of caution. But that does not mean we have to adopt the gloomy outlook that currently prevails.

7 Conclusions

The foundation for the global warming theory is at best tenuous. It depends on empirical calculations made more than four decades ago. The nature of climatic change has the characteristics of a fractal system. The evidence for global warming would be more conclusive if it were set against a background of a steady climatic state. Although global warming cannot be refuted, it is likely that the evidence has been presented in a manner likely to enhance the reputations of those who may benefit from its promulgation.

8 References

[1] B B Mandelbrot *Fractals, Form and Chance* **Freeman** (1977)