

## CSPG BACKGROUNDER TO GLOBAL CLIMATE CHANGE

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### INTRODUCTION

It is noteworthy that most of the media coverage of climate change and related information from Environment Canada originates from atmospheric scientists. Geological information that is highly relevant to a balanced view of climate change science is rarely presented.. The following brief discourse examines the basic concepts of the CO<sub>2</sub> – global warming hypothesis, and offers some earth science-based alternate explanations of global climate change.

The possibility that CO<sub>2</sub> may affect climate was first put forward nearly 100 years ago. Arrhenius (1908) made a quantitative estimate of the CO<sub>2</sub> effect on climate. Callendar (1938) and Plass (1956) drew attention to CO<sub>2</sub> being an important factor in the earth's heat balance.

More recently (in 1988), James Hansen focused world attention on man-made CO<sub>2</sub> as a cause of global warming. In the same year, the Intergovernmental Panel on Climate Change (IPCC) was established under the auspices of the United Nations and the World Meteorological Organization. The Panel's first assessment report (FAR) was released in 1990, the second assessment report (SAR) in 1996, and the third assessment report (TAR) in 2001. With their assessment reports, the IPCC typically issues "The Summary for Policymakers" to the media. Unfortunately, these contain very little science, and do not convey the lack of consensus on science questions that often exist.

### FUNDAMENTAL ATMOSPHERIC FACTS

- Our atmosphere consists of 78% nitrogen, 21% oxygen, plus argon and trace gases (including so-called 'greenhouse' gases - water vapour, CO<sub>2</sub>, methane, nitrous oxides, and ozone). Among the trace gases, 98% of the 'greenhouse' effect is due to water vapor and clouds.
- CO<sub>2</sub> is not a pollutant. It is an essential ingredient for plant growth and hence life on earth.
- The Greenhouse Effect: Almost all solar radiation reaching the earth's surface would be reflected back into space were it not for the so-called greenhouse gases – particularly water vapour (including clouds), CO<sub>2</sub>, and methane – which trap some of the reflected radiation. There is general

scientific agreement that our planet would be about 33°C cooler without this atmospheric insulation.

## THE CO<sub>2</sub> – GLOBAL WARMING HYPOTHESIS

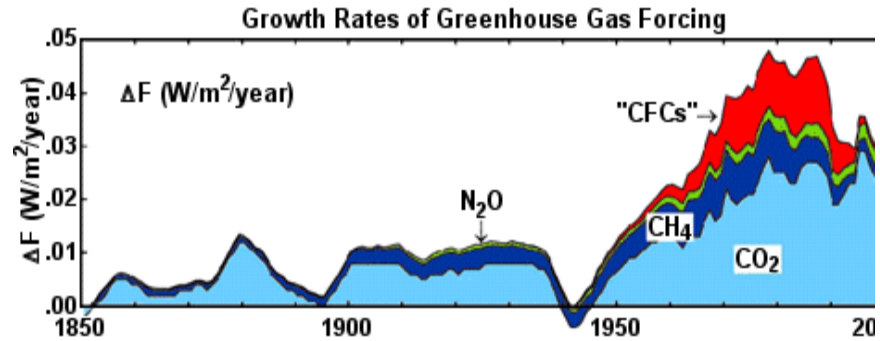
Hansen (1988) suggested that increasing levels of CO<sub>2</sub> produced from burning of fossil fuels would lead to catastrophic warming of the earth's atmosphere. To support that claim, some scientists point to the increase of atmospheric CO<sub>2</sub> from 280 ppm to 370 ppm over the last 100 years, and suggest this was the cause of a global temperature rise, purported to be on the order of 0.6°C.

Computer simulation models of the atmosphere, called General Circulation Models (GCM's), incorporate projections of ever-increasing CO<sub>2</sub> levels with many other parameters in efforts to forecast climate into the future. To date, many of these model runs suggest increasing temperature levels, which the IPCC and others attribute to CO<sub>2</sub>.

### Problems with the CO<sub>2</sub> – Global Warming Hypothesis

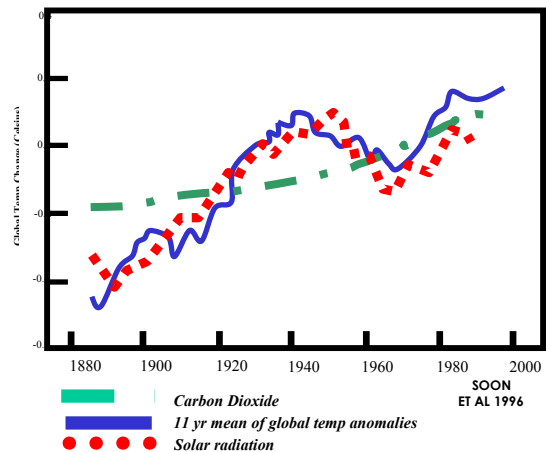
An examination of published scientific data show many inconsistencies between the climate record and the CO<sub>2</sub> – Global Warming hypothesis. Some of these are:

- As noted above, the major greenhouse gas is water vapour, and the nature of CO<sub>2</sub> / water vapour interactions is not clearly understood. Moreover, James Hansen (2000) downplayed the role of CO<sub>2</sub> as a greenhouse gas by stating "... warming in recent decades has been driven mainly by **non-CO2** greenhouse gases ... not by the products of fossil fuel burning".
- Antarctic ice cores in one study show carbon dioxide concentrations increased by 80 to 100 ppm about 600 years after the warming of the last three deglaciations, while other Antarctic ice core data show that CO<sub>2</sub> levels lag an increase in temperature by 900 to 1200 years. Clearly, increasing levels of CO<sub>2</sub> were not the cause of increased temperatures in these cases.
- World Climate Report (2002) shows that CO<sub>2</sub> levels have remained essentially flat from 1975 to the present – during a time of maximum production of CO<sub>2</sub> from fossil fuels. This obviously casts doubt on the claim that rapid and dramatic buildups of CO<sub>2</sub> will occur in the future.



The growth rate of major greenhouse gas warming potentials peaked around 1980, and has since fallen. Notice that CO<sub>2</sub>'s growth rate has been relatively flat since the mid-1970s—a fact that the IPCC's projections have yet to take into account (World Climate Report).

- We know that CO<sub>2</sub> from the burning of fossil fuels was not the cause of dramatic historical climate changes. For example, 1000 years ago, Earth experienced the pleasant Medieval Warm Period, with agriculture established in Greenland and Iceland, and settlements present in Newfoundland. A harsh cold period, the Little Ice Age, followed about 1350, and lasted until about 1860, during which time Greenland and Iceland settlements virtually perished. We are still emerging, in an oscillating fashion, on the warming trend that came after the Little Ice Age.
- In the 20th century, there was little correlation between temperature changes and CO<sub>2</sub> levels. Some surface temperature measurements show a 0.5°C rise over the past 100 years. However, that average hides some significant details. From 1905 to 1940, a rise of about 0.5°C was measured, during which time there was an imperceptible rise in CO<sub>2</sub>. From 1940 to 1975, the temperature decreased about 0.2°C, while CO<sub>2</sub> levels started to increase more rapidly. The out-of-sync relationship is obvious.



## POSSIBLE EXPLANATIONS FOR GLOBAL CLIMATE CHANGE

If the burning of fossil fuels was not the cause of earlier changes in climate, what might the possibilities be?

- *Total Solar Irradiance (TSI)*: Soon et al (1996) found an excellent correlation between global temperatures and the sun's variable radiant energy, while Baliunas and Soon (1996) found a near perfect fit between solar magnetic cycle length and earth temperature.

Historically, the correspondence of minima and maxima of radiation to the four glacial stages of the Alps (and the nine sub stages into which they are usually broken down) is remarkable. As recently as 1989, at a conference on Climate Change at the National Museum of Canada, the astronomical theory of variations in solar radiation was mentioned in most of the papers presented, and elicited no challenges.

- *Orbital Cycles*: Earth's distance and angle of exposure to the sun vary in several fashions:
  1. Orbital eccentricity, which changes from elliptical to more circular in a cycle of approximately 100,000 years
  2. Precession of the equinox, the so-called "wobble", in which the earth behaves like a spinning top, with a cycle of 19,000 to 23,000 years
  3. Variations in the tilt of the earth's spin axis with respect to the orbital plane, which occurs approximately on an 41,000 year cycle.

As all these influences have their own periodicity, there will be times when they coincide for maximum effect and times when they cancel each other out.

- *Ice Sheets*: The interactions of ice sheets and global temperature variations are not well understood. Increasing temperatures would increase oceanic evaporation, and thus may increase accumulation rates of snow and ice on the polar ice caps. As well, changes in ice-covered areas affect the amount of radiation absorbed or reflected by the globe. Thus, when an ice sheet shrinks, the additional soil and water surfaces exposed may absorb more solar heat and augment a warming trend. Conversely, expanding ice sheets would increase reflection of solar heat, and thus cause cooling.
- *Ocean Currents*: Currents are critical agents in the distribution of heat across the Earth's surface. Broecker and more recently, the Woods Hole Institute, have highlighted the possibility that a reorganization of the Gulf Stream in the North Atlantic might cause an abrupt cooling in North America and in Europe.

An excellent overview of climate change is contained in the introduction to the AAPG Studies in Geology #47. The authors classified climate change drivers into four orders, categorized by the potential range of temperature change forcing, and by the length of time over which the drivers operate. Their classification:

- *First Order Drivers* (longest duration, largest potential range): Solar system geometry, solar luminosity and greenhouse atmosphere. The

- authors suggest that the "greenhouse effect" has made the earth 20-40°C warmer than it would be otherwise.
- Second Order Drivers: Global distribution of the continents and the oceans. Redistribution of heat around the globe can be changed radically by reorganization of oceanic currents.
  - Third Order Drivers: Orbital and solar variability, large-scale oceanographic oscillations, and long ocean tide cycles. Solar variability has emerged as a major climate driver, and continuing research appears to be enhancing its importance. The authors suggest that large-scale ocean tidal currents may have driven the changes resulting in the "Medieval Warm" and the subsequent "Little Ice Age".
  - Fourth Order Drivers (controlling small (5°C) temperature changes over short (up to 100 years) periods of time): El Nino - La Nina oscillations, volcanic aerosols, regional tectonics, short ocean cycles, solar storms and flares, smaller orbital cycles, meteor impacts, and (possibly) human intervention.

## PUBLIC REPORTING AND PERCEPTIONS OF CLIMATE CHANGE

### Global Circulation Models

Interpretive information and climatic forecasts are provided to governments and the public by the Intergovernmental Panel on Climate Change (IPCC) and Environment Canada. These predictions rely heavily on general circulation models (GCM's), which embody an immense number of assumptions in attempting to forecast events 50 to 100 years or more into the future. Assumptions impacting future CO<sub>2</sub> levels include: variations in population, per-capita income, amounts of fuel consumed, predictions of future industry, changes in technology and so on. The models themselves are simply immense sets of equations which attempt to characterize relationships among the many types of factors which climate scientists interpret to be climate drivers.

It has been observed that computer simulations must track over 5 million parameters, and such simulations require accurate information on two major natural greenhouse factors – water vapour and clouds – whose effects we still do not understand. It is not surprising that the IPCC forecasts for temperature have had to be revised downwards several times in the last 10 years.

### What About Recent Temperatures and Weather Extremes?

A certain percentage of the warming shown by surface stations is caused by the fact that most surface stations are either at airports or in urban areas. Heat absorbed during the day by concrete buildings and black tarmac is given off at night, thus skewing the readings. Temperature measurements of the troposphere by satellite over the last 21 years show no significant warming.

Some forecasters predict that warming from anthropogenic causes will be much more severe in the polar areas, and anecdotal evidence is continually being published to support this. One example is that robins are reported to have been seen recently for the first time on the shores of the Arctic Ocean. However, bird watching books published in the 1960's show the range of the robin to extend in a broad band down the Mackenzie River to the Arctic Ocean, and then east and west from the Tuktoyaktuk Peninsula to Point Barrow in Alaska. Apparently the person who saw robins for the "first" time had not looked too hard in previous years.

Much more to the point are temperature records from ground stations. In the Canadian Arctic, Inuvik and Resolute (stations at airports) show slight warming. Coral Harbor, Clyde, Frobisher Bay, and most other stations show either no change or slight cooling. Stations in Iceland show cooling. In Greenland, Thule (airport) shows slight warming, but Godthaab and Agmagssalik show very distinct cooling. Near the Antarctic, Punta Arenas (Chile) shows cooling. The stations on the Antarctic Peninsula show fairly distinct warming, generally ascribed to warm currents initiated by the El Nino - La Nina phenomena. However, inland on the continent, Vostock, Syona, and the South Pole station show distinct cooling, although CO<sub>2</sub> levels are increasing at the South Pole.

It appears that the threatened warming of polar areas is just not happening, and once again, the role of CO<sub>2</sub> as a significant greenhouse gas is suspect.

Worldwide, the news media commonly report that weather extremes such as droughts, floods, tornadoes, and hurricanes are becoming much more frequent, and the implication is made that global circulation models support this idea. However, the 1996 IPCC report states that "Overall, there is no evidence that extreme weather events, or climate variability, has increased, in a global sense, through the 20<sup>th</sup> century ...". What has happened is that weather-related damage to human infrastructure has increased as world population rises, and the distribution and value of housing and other buildings increases.

## CONCLUSIONS

Global climate change has been a constant throughout the history of the Earth, driven by a variety of global and astronomical natural factors. The variability of and interactions among these factors are the subjects of active research, but are still very poorly understood by climate scientists. Observations of past climatic variations show much better correlation with astronomical variables such as solar activity and orbital changes than they do with atmospheric CO<sub>2</sub> levels.

Since the beginning of the 20<sup>th</sup> century, atmospheric CO<sub>2</sub> has risen with accelerated production of CO<sub>2</sub> by human activities. However, using the best

attempts to remove biases from temperature data, there is not a good correlation between atmospheric CO<sub>2</sub> and global temperatures.

Global circulation models attempt to represent climatic influences with numerical equations, and are used to predict future climate variations. However, they are hampered by our poor understanding of the relationships and feedback loops among many of the key variables. GCM predictions of warming trends through the 21<sup>st</sup> century have decreased systematically as the models have become more sophisticated.

These observations suggest that global climate change is a natural and fundamental part of earth history, and that the effects of human activities on global climate are no more than a poorly-understood fourth-order factor.

**In terms of the recent public debates about global climate change, there is no body of evidence, and certainly no consensus in the scientific community, that man-made CO<sub>2</sub> emissions are a significant contributor to climate change.**

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