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Quantifying the consensus on global warming in the advocacy science: A cross examination

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Abstract
Global warming is the 'talk of the town' in this century, with its detrimental effects already being brought to limelight by the recurring events of massive floods, annihilating droughts and ravaging cyclones throughout the globe. The average global temperatures are higher than they have ever been during the past millennium, and the levels of CO2 in the atmosphere have crossed all previous records. We analyze the evolution of the scientific consensus on anthropogenic global warming (AGW) in the peer-reviewed scientific literature, examining 115 climate abstracts from 1991–2014 matching the topics 'global climate change' or 'global warming'. From 1991 to 2014 CO_2, CH_4 and NO_X has increased 27%, 145% and 13% respectively.

Keywords: advocacy science, global warming

1. Introduction

'Global warming is defined as an increase in the average temperature of the Earth's atmosphere, especially a sustained increase great enough to cause changes in the global climate. The term global warming is synonymous with Enhanced greenhouse effect, implying an increase in the amount of greenhouse gases in the earth's atmosphere, leading to entrapment of more and more solar radiations, and thus increasing the overall temperature of the earth. Global warming is the increase in the Earth's temperature caused by increased emission of greenhouse gases into the atmosphere. The greenhouse gases, including CO2, form a blanket in the Earth's atmosphere that traps heat and causes global temperatures to increase. This theory of global warming was first offered by a Swedish chemist named Svante Arrhenius in 1896. Arrhenius estimated that "doubling the level of carbon dioxide in the atmosphere would raise the mean global temperature by several degrees". Even then, his audience was skeptical as many other factors could also affect global temperature. Since Arrhenius' paper, the global warming discussion has grown convoluted as both scientists and the media have addressed the subject. Scientists track climate change and publish their evidence, but then the media hypes it up in its articles to the public. To add to the confusion, the public tends to avoid thinking much about the topic unless extreme weather occurs unexpectedly. However, despite overwhelming opinions, there are facts to support both sides of the debate. An accurate perception of the degree of scientific consensus is an essential element to public support for climate policy (Ding *et al* 2011). Communicating the scientific consensus also increases people's acceptance that climate change (CC) is happening (Lewandowsky *et al* 2012). Despite numerous indicators of a consensus, there is wide public perception that climate scientists disagree over the fundamental cause of global warming (GW; Leiserowitz *et al* 2012, Pew 2012). In the most comprehensive analysis performed to date, we have extended the analysis of peer-reviewed climate papers in Oreskes (2004).We examined a large sample of the scientific literature on global CC, published over a 21 year period, in order to determine the level of scientific consensus that human activity is very likely causing most of the current GW (anthropogenic global warming, or AGW). The peer-reviewed scientific literature provides a ground level assessment of the degree of consensus among publishing scientists. Senator John Kerry of Massachusetts stated that not a single peer-reviewed scientific paper contradicts the "consensus" view that increasing greenhouse gas emissions will lead to a "catastrophic" two degree Celsius increase in global mean temperatures. Senator Kerry is hardly alone in this belief. Virtually all environmental law scholars seem to believe that there is now a "scientific consensus" that anthropogenic greenhouse gas (ghg) emissions have caused late twentieth century global warming and that if dramatic steps are not immediately taken to reduce those emissions, then the warming trend will continue, with catastrophic consequences for the world. As the most authoritative and reliable evidence for the scientific "consensus" about human responsibility for and the likely future consequences of global warming, economists, legal scholars, legislators and regulators. The IPCC Assessment Reports are neutral, and objective assessments of what is known about "human-induced" climate change and its impacts -- has been reiterated recently by its longstanding Chairman, the energy economist R.K. Pachauri. He has said that the IPCC: "…mobilizes the best experts from all over the world… The Third Assessment Report (TAR) of the IPCC was released in 2001 through the collective efforts of around 2000 experts from a diverse range of countries and disciplines. All of the IPCC's reports go through a careful two stage review process by governments and experts and acceptance by the member governments composing the panel.

2. Methodology

We searched the web of Science for papers published from 1991–2014 using topic searches for 'global warming' or 'global climate change'. A large number of papers, abstract, article and other documents were discussed to proceed the paper. The search was updated in Feb 2014 with papers added to the Web of Science up to that date. To simplify the analysis, we have categorized all the abstract in sub categories.

3. Causes and effect of global warming

It is well-known that humans have caused an increase in radiative forcing. In the past few centuries, atmospheric carbon dioxide has increased by more than 30 percent. The reality of this increase is undeniable, and virtually all climatologists agree that the cause is human activity, predominantly the burning of fossil fuels. To a lesser extent, deforestation and other land-use changes and industrial and agricultural activities like cement production and animal husbandry also contribute to greenhouse gas buildups. Most mainstream climate scientists agree that there has been an anomalous rise in global average surface temperatures since the time of the Industrial Revolution. Earth's temperature is highly variable, with year-to-year changes often masking the overall rise of approximately 0.7°C that has occurred since 1950.

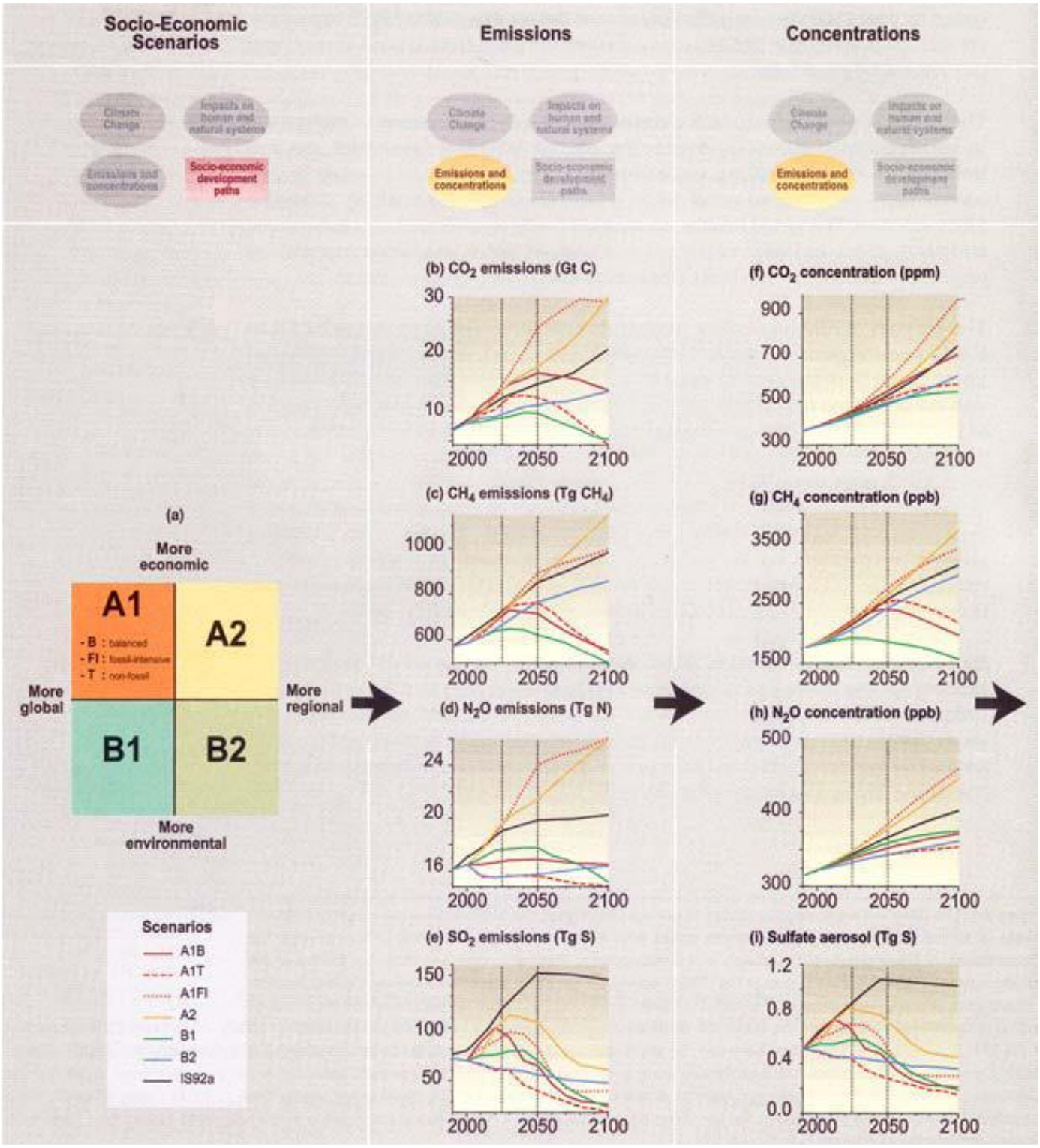
Gas	GWP
Carbon dioxide (CO2)	1
Methane (CH4)*	21
Nitrous oxide (N2O)	310
HFC-23	11,700
HFC-125	2,800
HFC-134a	1,300
HFC-143a	3,800
HFC-152a	140
HFC-227ea	2,900
HFC-236fa	6,300
HFC-4310mee	1,300
CF4	6,500
C2F6	9,200
C4F10	7,000
C6F14	7,400
SF6	23,900

Global warming potential (GWP) = Infrared absorption + Life time

1) A decrease in the ozone layer which is causing a very slight average warming and more radiation from the sun. This affects the ecosystems and is forcing a migration toward the poles. It is also affecting crops, causing drought as well as more severe storms and related flooding - thus the economy of many nations. The Montreal Protocol is working, and ozone depletion due to human effects is expected to start decreasing in the next 10 years. Observations show that levels of ozone depleting gases are at a maximum now and are beginning to decline. Provided the Montreal Protocol is followed, the Antarctic ozone hole is expected to disappear by 2050.
2) The pesticide methyl bromide, another significant ozone-depleting substance, was scheduled to be phased out in 2004 in developing countries, but a U.S.-led delaying effort led to a one-year extension until the end of 2005. At least 183 counties are now signatories on the Montreal Protocol.
3) More frequent and bigger hurricanes/extreme heat/cold. Researchers report the number of Category 4 & 5 hurricanes, the strongest storms, which are often accompanied by huge storm surges, has increased by 80% in the last 30 years.
4) Melting of ice caps, particularly at the North Pole – create a rise in water levels of the oceans and the rivers. Usually sea levels rise between three and four millimeters a years, which would mean it would take at least 250 years for the seas to rise one meter. But this rate has doubled over the last century.
5) Similar to melting ice, melting Arctic permafrost is producing the colorless, odorless methane (which is 23 times more powerful than CO2) at five times faster than thought. Warming thaws the permafrost (mostly in Siberia), which is soil that has been continuously frozen for thousands of years
6) Tropical rain forests will shrivel. Traditionally, rainforests are regarded as carbon sponges as they absorb and store atmospheric carbon. However, as the earth warms, the thick, lush, and sky reaching tropical rain forests will dry up, creating more open land mass. Furthermore, as these tropical trees die, they actually release more CO2, both through decomposition and fires that are more prevalent in dry climates.
7) Higher temperatures accelerate the maturation of certain disease-causing agents and their vectors. Higher annual average temperatures can lengthen the season during which vectors are active. A warmer climate can expand the geographic range of tropical mosquito borne diseases, such as malaria, dengue fever, and yellow fever, to higher altitudes and latitudes.

4. Results and Observation

Two important greenhouse gasses for the past 440 years; CO2 and CH4 Scientists, technologists, and policy analysts have invested considerable effort in constructing "storylines" of plausible human demographic, economic, political, and technological futures from which a range of emissions scenarios can be described, the most well-known being the Intergovernmental Panel on Climate Change's (IPCC) Special Report on Emissions Scenarios (SRES), published in 2000.



- Many recent "fingerprint analyses" have reinforced these conclusions, though there is some on-going dispute about details in the medieval period many replicate studies confirm the basic picture of unusual warming in the past three decades compared to the past millennium. Carbon dioxide ($C0_2$) concentrations appear to be higher than any time in past ~23 million yrs. approximately ~70% of CO_2 emissions come from fossil fuel burning.
- The current concentration of methane (CH_4) has not been exceeded in at least 420,000 years. Slightly more than 50% of CH_4 emissions originate from human activities.
- The rate of warming in the 20th century is likely (66-90% chance) to have been the largest of any century in the last 1,000 years.
- There is a growing similarity between the pattern of warming predicted by global climate models and what has been observed (one line of evidence supporting the fact that human activities are a major source of the current warming)

Another line of evidence of the human contribution to current warming: natural agents of climate change, namely volcanic eruptions and solar fluctuations, would have produced cooling

over the past 50 years Satellite documentation of the area covered by sea ice in the Arctic Ocean extends back three decades. This area, measured each September, decreased at a rate of about 8.6% per decade from 1979 to 2007. In 2007 alone, 24% of the ice disappeared. In 2006 the Northwest Passage was ice free for the first time in recorded history. As noted earlier, polar ice sheets are slower to respond to temperature rise than the smaller mountain glaciers, but they, too, are melting. The Greenland ice sheet has also experienced dramatic ice melt in recent years. There has been an increase in both the number and the size of lakes in the southern part of the ice sheet, and crevices can serve as conduits (called moulins) that transport melt water rapidly into the glacier. The ice in Antarctica is also melting. The late John Mercer, a glacial geologist at The Ohio State University, long ago concluded that the first evidence of global warming due to increasing carbon dioxide (CO2) would be the breakup of the Antarctic ice shelves (Mercer, 1978). Greenhouse gases are captured in ice, so ice cores allow us to see the levels of greenhouse gases in ages past. The longest ice core ever recovered (from the European Project for Ice Coring in Antarctica takes us 800,000 years back in time, and includes a history of CO2 and methane levels preserved in bubbles in the ice (Loulergue *et al*., 2008; Lu¨ thi *et al*., 2008). Globally, CO2concentrations have varied between 180 and 190 parts per million per volume (ppm) during glacial (cold) periods and between 270 and 290 ppm during interglacial (warm) periods. However, since the onset of the Industrial Revolution, when fossil fuel use (chiefly coal and oil) began to burgeon, CO2 concentration has increased about 38% over the natural interglacial levels (Forster *et al*., 2007). Between 1975 and 2005, CO2 emissions increased 70%, and between 1999 and 2005 global emissions increased 3% per year (Mar land, Boden, & Andres, 2006). As of this writing, the CO2concentration in the atmosphere is 391 ppm (Mauna Loa CO2annual mean data from the National Oceanic and Atmospheric Administration, 2010), a level not seen at any time in 800,000 years. Climatologists have identified no natural forces that could account for this rapid and previously unseen rise in CO2.Methane raises temperature even more than CO2, and the amount of methane in the atmosphere, like that of CO2, is also at a level not seen in 800 millennia. The evidence is overwhelming that human activity is responsible for the rise in CO2, methane, and other greenhouse gas levels, and that the increase in these gases is fueling the rise in mean global temperature. There has been an increase in both the number and the size of lakes in the southern part of the ice sheet, and crevices can serve as conduits (called moulins) that transport melt water rapidly into the glacier. The ice in Antarctica is also melting.

5. Conclusion

This research study revealed that the climatic variation as occurrence of drought have significant impact on the production of Rainfed crops. The small and medium Rainfed farmers were highly vulnerable to climate change and to a larger extent the small and medium Rainfed farmers adopted coping mechanisms for climate change compared to large farmers. The farmers already act to the changes in the climatic changes both by adopting the technological coping mechanisms on the positive side and negatively through shifting to other professions. The study suggests that as the impact of climate change is intensifying day by day it should be addressed through policy perspective at the earliest to avoid short term effect such as yield and income loss and long-term effects such as quitting agricultural profession by the Rainfed farmers.

When trying to determine if global warming is fact or fiction, we must take into account evidence from all sides. Plenty of evidence exists within the science community, including skeptical opinions against global warming. While the evidence points to the existence of global warming, the cause is still widely disputed. Additionally, the media reports on other sources of evidence for global warming from different political groups. Ultimately, the world still lacks a consensus on the topic of global warming: its causes, its presence, and its effects. However, armed with the proper knowledge, we can each decide for ourselves where we stand in the global warming debate.

6. Recommendation

Our recommendation would be to take the time required to improve our knowledge of the critical factors driving temperature prediction uncertainty before attempting to make critical high-economic impact public policy decisions of doubtful effectiveness based on projections of unvalidated computer simulations. We find no convincing evidence indicating our planet is in a climate crisis.

We encourage more government sponsored climate change research to remove critical areas of prediction uncertainty. However, we recommend a broader study of all important climate variables and less concentration on CO2 effects in studies using only predictions of unvalidated models. Until models can be improved beyond their present state of effectiveness, and validated with empirical data covering the vast array of variables in physical, chemical and biological processes that they attempt to simulate over time, numerous studies with unvalidated computer simulations have questionable scientific benefits. Eco-engineering solutions for cooling and warming the planet should be studied as well as methods and cost estimates to adapt to a changing climate that we currently do not understand with sufficient precision to try to control.

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