

GLOBAL WARMING 'HIATUS'

SCIENCE AS A HUMAN ENDEAVOUR INVESTIGATION

INTRODUCTION:

Between about 1998 and 2014, the rate of global warming seemed to have decreased or even stopped. The focus of this investigation is to look at the data behind this observation and to compare how society and the scientific community responded to this. These responses show how science informs public debate, and the global warming 'hiatus' is an example of how possible conclusions may be limited by complex, unanticipated variables or insufficient data.

EXPLANATION OF RELEVANT SCIENCE:

Earth's surface is kept at a steady temperature by an ongoing mechanism called the 'greenhouse effect'. Many kinds of electromagnetic radiation, such as visible and ultraviolet light, are produced by the Sun and absorbed by the Earth's surface. This warms the Earth, but only on the side facing the Sun; during the night the warm surface of the Earth emits its energy as infra-red radiation, which cools it down. A small percentage of the gases in the Earth's atmosphere are 'greenhouse gases' which are able to absorb the infra-red radiation, slowing the rate at which it is released to space. According to astrophysics professor Kenneth Lang, Earth without greenhouse gases would have an average surface temperature of -18 degrees Celsius, cold enough that water would freeze and life as we know it would be impossible (Lang, K 2010).

Human activity, particularly during the last hundred years, has disrupted this thermal balance by increasing the amount of warmth retained by the Earth. Anthropogenic processes (human activities) have led to increasing amounts of greenhouse gases in the atmosphere, and therefore decreased rates of infra-red radiation leaving Earth. Over a long period of time this produces climate change including increased annual global average temperatures.

There are many factors affecting global average temperature, so natural variations in these factors over time would be expected over relatively short time periods such as years or even decades. This report investigates one such period of approximately 15 years where the available data for Earth's annual average surface temperature appeared to show no immediate upward trend, despite continued increases in atmospheric greenhouse gas concentration over that time. Various explanations for the observed 'hiatus' have been proposed, including effects on data such as the peak caused by a strong El Niño in 1998 (Hanson, J et al. 2016) and possible environmental mechanisms such as warmth being carried into ocean depths (Crow, J 2014).

Commented [TB1]: A suggested layout for a max. 1500-word report (with approximate word counts) is:

- Introduction (75)
- Explanation of relevant science (350)
- Connections to SHE (650)
- Potential impact (275)
- Conclusion (150)

Commented [TB2]: The focus for the investigation does not have to be a question but it does need to be specific enough to enable you to analyse information in depth. It must be based on a recent discovery, innovation, issue, or advancement and be linked to one of the topics in the SACE Subject Outline.

Commented [TB3]: Your introduction must relate the focus of the investigation clearly to aspect(s) of Science as a Human Endeavour.

This SHE exemplar is examining **Application** of science (to public debate), and **Limitation** of conclusions. You may choose to emphasise (**bold**) words and phrases relating to the SHE key concepts, but it is not required.

Commented [TB4]: Relevant chemistry concepts or background. This must include the use of scientific terminology. This is the second-most important part of the report, and this should be reflected in the word count allocated to it.

Commented [TB5]: You don't need to include a reference for information that you are expected to know as part of the Chemistry course.

Commented [TB6]: Including information about the author or publishing information can add credibility to your references.

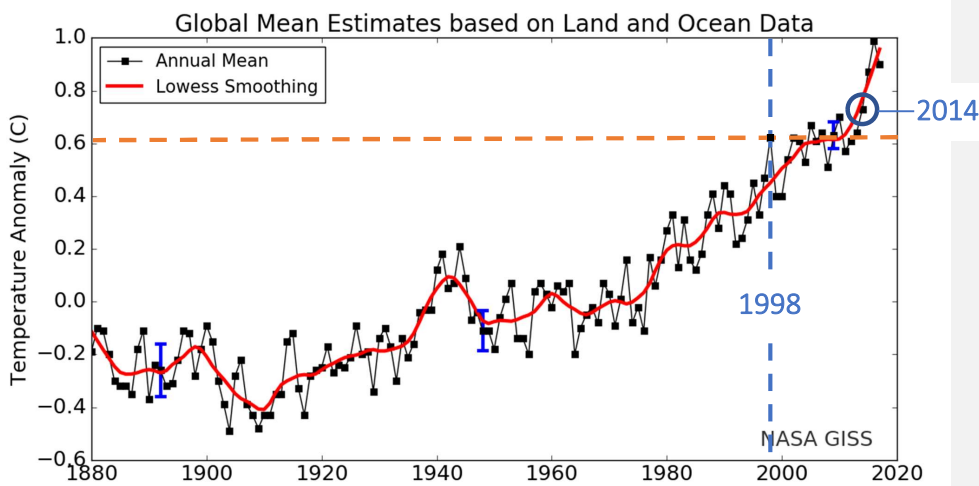
Commented [TB7]: Include a reference for facts, figures, or any other information that you would not know if you hadn't found them in your research. Even if you already knew it, a reference supports your point with evidence.

Regardless of any disagreement over the source of the observed hiatus pattern, the scientific consensus both at the time and in the years since then has been that it does not significantly change the already established long-range predictions (e.g. IPCC 2007: “consistent warming trends”, Shukman, D 2013: “global warming is still on”, Fischetti, M 2017: “Warming has continued.”).

CONNECTIONS TO SCIENCE AS A HUMAN ENDEAVOUR:

In the years leading up to 1998, measurements of global average surface temperature showed relatively steady increase (e.g. NASA GISS 2018, see figure below).

Commented [TB8]: An explanation of how the focus of the investigation illustrates the interaction between science and society, including a discussion of the potential impact of the focus. This is the most significant part of the report, so it should have the highest word count, even if it is spread throughout the report instead of as a separate section.



These mean global temperature measurements then dropped by approximately 0.2 degrees Celcius and did not show a significant consistent increasing pattern until 2014 (circled on the graph above). By the mid 2000s, people were already starting to claim a pattern was emerging. One example of this is an opinion piece posted by geologist Bob Carter in 2006, in which he claimed that global warming “stopped in 1998”, saying that “for the years 1998-2005 global average temperature did not increase” (Carter, B 2006). He criticised scientific consensus on global warming using his knowledge of paleoclimatology (study of distant past climates) and called for the British Government to make changes to the climate change data sources it relied on.

The scientific community was aware of the pattern showing in the average temperature data, but was much more focused on long term trends than such a short time period. For example the intergovernmental panel on climate change (IPCC), a scientific review body with 195 member countries, pointed out in their Fourth Assessment Report (2007) that “eleven of the last 12 years (1995-2006)...rank among the 12 warmest years

on record since 1850.” In fact one group of scientists from Germany, France, Australia, USA, and the UK said in a 2007 paper that the 16-year period since 1990 actually showed greater temperature increase than previous projections, and expressed concern that some changes may even have been underestimated (Rahmstorf et al, 2007).

When the ‘hiatus’ continued into the 2010s, so did public debate about climate change. David Rose (2010) wrote an article for Daily Mail in which he denied a significant long-term warming trend and claimed scientists ‘conceal a truth’ to push political agendas. He focused on short-term figures and used emotive language coupled with photographs of people in snow to argue that human activity is not causing global warming. A rebuttal was published not long afterward (Monbiot G, 2010) pointing out his arguments lacked credibility due to misinterpretation of data and misquotation of experts.

Commented [TB9]: Keep using the wording of the SACE SHE concepts. It should be clear that this part of the report is showing how your focus illustrates SHE.

The scientific community published reports about possible causes of the apparent hiatus. Kosaka and Xie (2013) for example proposed it was due to ocean cooling as part of regular natural climate cycles. Another suggestion described the heat as being absorbed by oceans due to strong winds (Crow, J 2014). Scientists did not propose altering long-term projections, since those are based on a lot more data than just average surface temperature.

Once the average global surface temperature once again showed a clearly increasing pattern in the years following 2013, suggestions that the ‘pause’ affected long-term projections became rarer. A small percentage of the public still believed global warming was a hoax (Caldwell, F 2017), but those people were unlikely to have been involved in the debate about the hiatus since they deny global warming entirely rather than suggesting changes to projections.

In the years following the end of the ‘hiatus’, scientists continued to study the data behind the observation. One result of this was the discovery that the observed ‘hiatus’ for average global temperature increase could be explained by insufficient available data. From this it was concluded that the rate of warming had not actually decreased during that period, but instead that our average was incorrect due to not including warming in the Arctic region (Masterson, A 2017). When the scientific community published these findings in 2015, there was a significant negative reaction from the public, especially from those who felt scientists were dishonestly selecting or rewriting data to support their conclusion (Corneliusson, S 2015). Others considered that scientists were genuinely correcting a mistake and that this response would improve confidence in future measurements (Mooney, C 2017).

The global scientific community has gained valuable experience about how their response to unexpected data can inform resulting public debate. As a community who work through the scientific method, their initial response was what would reasonably be expected; they studied the unusual observations to find out what causes might exist. Unfortunately, they did not often include clarifications in their communications to help the public see the context of the global average temperature data. Much of the debate became centred around this one aspect of climate data, and much of the other global warming data was essentially ignored. There might have been more clarity in the conversations if other data such as sea-level rise and glacier melt had been highlighted, since those indicators did not show a 'hiatus' during this period (Readfearn, G 2017). There is value, therefore, in scientists being more proactive in future, since public opinion and political decision-making should ideally be based on clear and confident understanding of scientific conclusions (Randerson, J 2016).

Commented [TB10]: Include a discussion of the potential impact of the focus of the investigation, e.g. further development, effect on quality of life, environmental implications, economic impact, intrinsic interest.

The response of society to the reports published by scientists during and after the 'hiatus' decade highlighted difficulties in the way people respond, in general, to statistical data. For example, society tended to focus on the most recent years' data, making the hiatus seem like a 'standstill' at the time (Shukman, D 2013). Groups with political influences may take results of research out of context or misread conclusions, since they are often motivated by a pre-existing goal (Smith, R 2011). This reinforces the responsibility of scientists to provide results to the public in a way that can lead to well-informed debate (Mooney, C 2013).

CONCLUSION:

The observation that global warming underwent a 'hiatus' in the years between 1998 and 2014 was based on global average surface temperature data over a relatively short time period. Society responded to the perceived pattern with debate over the effect this pattern might have on the long-term trend of global warming. The scientific community responded to the unexpected data by studying it, in the context of other available climate trend data, to identify possible causes for the 'hiatus'. Ultimately it was determined that the observations were based on incomplete data, with the conclusion that there was no hiatus at all. Scientists' communications with the public were misunderstood and misused, as they could have been clearer about the insignificance of short term temperature trends for long-term warming projections and how new data was used to refine conclusions.

Commented [TB11]: A conclusion that summarises the connection between your topic and the key concept(s) of science as a human endeavour. The conclusion should not introduce any new information.

1496 words

Commented [TB12]: The report, which can be in a format of your choice, should be a **maximum** of 1500 words if written, or a maximum of 10 minutes for an oral presentation, or the equivalent in multimodal form. The word count includes in-text referencing but does not include the reference list at the end of the document.

REFERENCE LIST:

Commented [TB13]: Remember to follow the reference formatting guidelines.

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