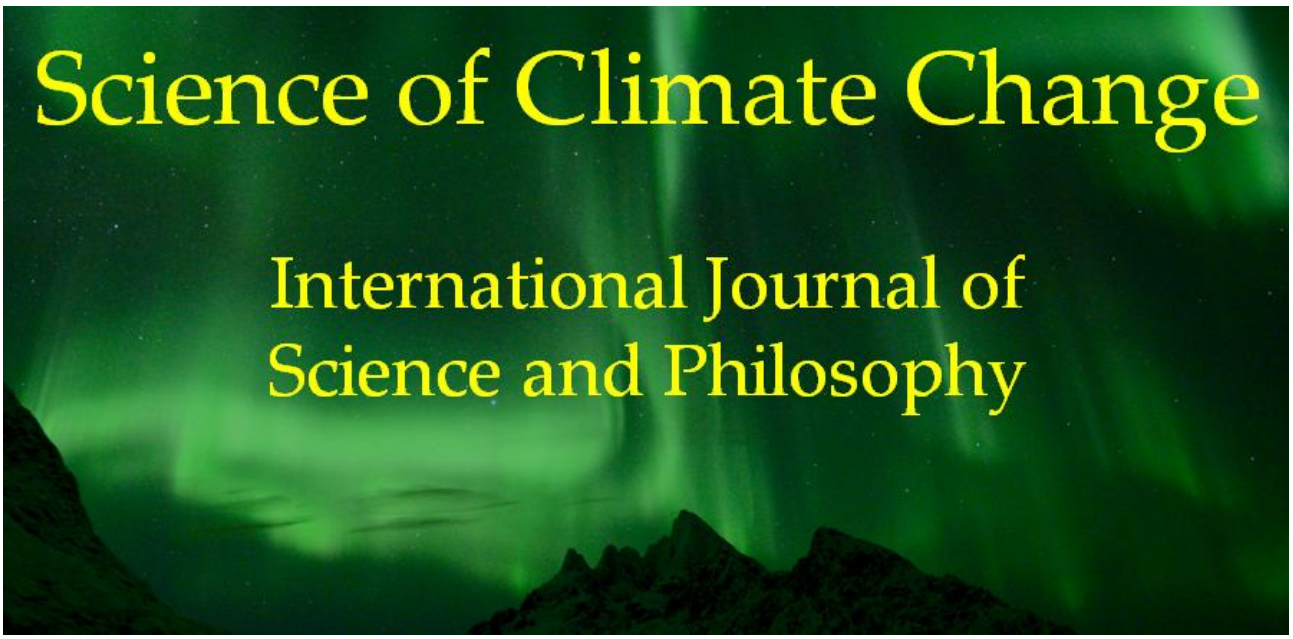
Science of Climate Change

International Journal of Science and Philosophy

VOL. I, NO. 1, AUGUST 2021

KLIMAREALISTENE



Call for Papers

to

the new peer reviewed journal

Science of Climate Change

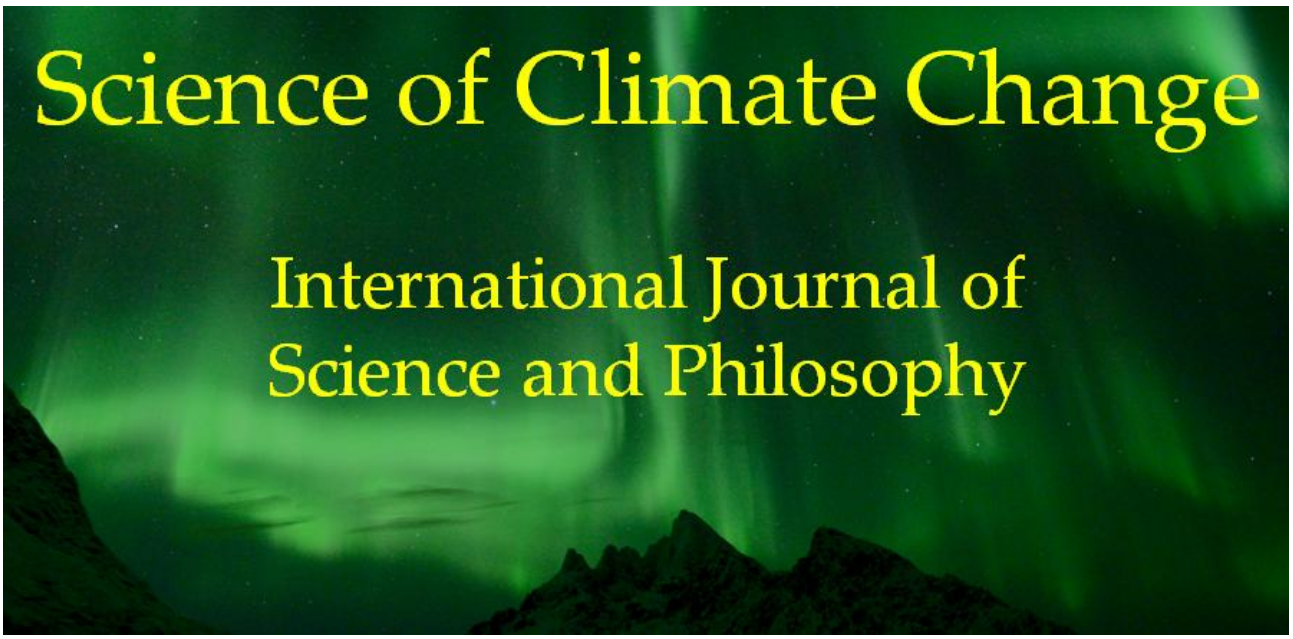
International Journal of Science and Philosophy

The journal is published by *Klimarealistene in Norway with an editorial board consisting of members of the Scientific Council of *Klimarealistene***

We hereby invite for submitted papers.

We are looking forward to Your contribution!

**Klimarealistene (in Norwegian) translates roughly into "The Climate Realists".*



VOLUME 1, NUMBER 1, AUGUST 2021

CONTENTS

PUBLISHED FOR *KLIMAREALISTENE*
BY CLASSICA FORLAG AS
KONGSBERG, NORWAY

Mission statement

Science of Climate Change. An International Journal of Science and Philosophy has as its objective to publish articles on science and the philosophy of science, especially in fields connected to climate and climate change.

It is an ideal journal, funded by the *Climate Realists of Norway* with an *Editorial Board* consisting of members of the *Scientific Council of the Climate Realists of Norway*.

We encourage submissions on all aspects of climate and climate change. The *Editorial Board* will consider every contribution with a view to finding qualified peer reviewers. We also welcome book reviews, reports, letters, and lighter articles which do not require peer review.

Although not always possible, we prefer known reviewers, in order to strengthen responsibility for the recommendations and the quality of any article. A wish for anonymity will be respected.

Accepted publications are free of charge. There is no charge for the use of color, as the journal is printed in full color. This means that independent scientists may be able to publish their results without having to limit themselves for economic reasons.

Accepted publications will be published on the website of the Climate Realists of Norway; *klimarealistene.com*, and a limited number of copies will be printed on paper for posterity.

Scientific consensus is an oxymoron.

Science of Climate Change. An International Journal of Science and Philosophy

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Editor: Geir Hasnes

Editorial board: Ole Henrik Ellestad, chairman; Stein Bergsmark, Martin Hovland, Ole Humlum, Morten Jødal, Jan-Erik Solheim.

All communication may be sent to scc@klimarealistene.com.

We will in the future publish special issues on special topics or conferences of interest.

Submission of manuscripts

When you submit your manuscript, keep text and illustrations from each other. Indicate with figure and table numbers where you want your illustrations and tables. Note that these may be shuffled around in order to fit the format.

Deliver your text in A4 format, with a margin of 2 cm on all sides. Use Times New Roman 12pt for all the text. Use 6pt after each heading and paragraph and 12pt after each section. Equations may be submitted in a font chosen by the author. The setup will be done by us and we will adjust when necessary. Illustrations should preferably be in .tiff or .png.

Advertising is accepted for books, conferences, and products related to the topics of the journal.

Membership in *Klimarealistene* (The Climate Realists of Norway) costs NOK 390 a year at https://www.klimarealistene.com/ which includes access to all articles published on the website, http://scc.klimarealistene.com.

A paper copy of the journal may be purchased for NOK 390 + postage.

Editorial: An Independent Scientific Journal

Geir Hasnes, editor[A]

Welcome to the first issue of *Science of Climate Change: An International Journal of Science and Philosophy*. Our scientific objectives are elaborated in our mission statement on the preceding page. We think it is important that science is not hindered by political directives about what can and cannot be communicated to the public; about what can and cannot be themes for scientific research.

This is why the term 'philosophy' is added to the title of the journal. The directives from above have nothing to do with science as such; therefore, such directives can only be treated on a philosophical basis. Freedom of expression is not science; it is one of the basic pillars of science, well grounded in philosophy throughout the ages. The scientific method is not science, it is a precondition for doing science. That we ought to use the scientific method when doing science, may seem glaringly obvious, but is not at all something that goes without saying within many scientific communities; it is a philosophy of action, and indeed, a prerequisite founded on logical principles and a strong and almost religious belief about what science is and what it is not.

The world today is dominated by those who see it as important that science surrounding climate change, is kept politically correct, and that scientific evidence to the contrary is kept under lock and key. Consequently, scientific journals all over the world have been directed not to publish articles that do not suit their political rulers and their elite. Climate change has become a key phrase for creating fear in the public; consequently, science showing that we do not have to fear climate change has no place in the scientific institutions supported by the State.

Scientists researching aspects of the climate and the fields it influences, have long complained that they have great difficulties in getting their contributions published in scientific journals, for whatever just or unjust reasons. One consequence is that those who believe there is catastrophic climate change going on, caused by anthropogenic emissons of carbon dioxide, state that those who claim otherwise have not been published in peer reviewed scientific journals.

"So why not create our own scientific journal?", I thought last summer, a journal that can be independent and will have no ties to anyone with a political agenda.

As a newly elected member of the board of the Norwegian "*Klimarealistene*", I brought out the idea of an uncensored journal in a board meeting last summer, and was met with acclamation. Many of the members had been thinking the same thought for years.

Members of our Scientific Council nominated their member, the renowned Nils-Axel Mörner, as Chief Editor with me as assistant editor, and brought it before him in August, and with his usual zest, he went wholeheartedly into it. The board of Klimarealistene and its Scientific Council members convened in September and elected 'Niklas' as Chief editor. He could not attend as he had got an appointment with his physician the same day. Little did we know that he had only three weeks left to live.

The shattering news that our beloved Niklas was dying reached us only one week before he passed away. We promised ourselves that we would carry on the work in that unwavering spirit of his. It has taken its time, but finally, here is the first issue of our journal, which we hope you will not only enjoy, but also contribute to if you have something to publish fit to the spirit of thoroughgoing science.

Klimarealistene, the "Climate Realists of Norway", fighting for the untainted science in all fields pertaining to climate and climate change, have established our own Scientific Council consisting of experienced scientists who are guiding us through the wilderness of un-scientific claims, assertions

[A] https://doi.org/10.53234/scc202111/23.

and allegations in the mass media. From this Council, an editorial board has been set up who are helping with the peer reviews of the incoming contributions.

Referring to our mission statement, there must be no doubt about our aim with regards to the quality of the published contributions. We don't publish in order to publish, such as scientists publish in order to keep their occupation. The world already suffers from too many scientific papers; the important ones may drown in the torrent from the scientific production. One may jokingly exaggerate that counting your articles may be counter-productive to what should count in science.

With this issue we include a Call for Papers. We didn't want to drown in contributions while we set up all the routines necessary to publish a scientific journal. From now on, contributions will be reviewed and when accepted, be published on our website. We aim to invite papers on certain topics which will be published in special issues; as such we have already begun working on several such possibilities.

Contributions that bring new issues to the discussion or may shed a critical light on weaknesses in previously published papers are prioritized. Justified criticism of any models not complying with the real world is welcomed. Science progresses through sound criticism.

This issue consists of four parts. The first part regards *Klimarealistene* and our Scientific Council. The second consists of several invited papers, most of them invited by Niklas Mörner himself. The third part contains several papers on the memory of Niklas Mörner, and the fourth part contains book reviews.

Contributions to the issue may be of any length. Lighter contributions including letters to the Editor are of course welcomed. We are not affiliated to any institution, which means that scientific discussions here will be unharmed by political dogma. We are running on as light as possible a budget, but publishing pdfs costs next to nothing. With a view to future sun flares, we will also publish a limited number on paper for posterity. The internet is flighty, and one day the powers that be may take over that too, in their supreme wish for censorship.

A Greeting to the New Journal

Ivar Giæver, Nobel Prize Laureate, member of Klimarealistene's Scientific Council[A]

We are extremely fortunate today because of the tremendous progress in science in the last century or so. People like Einstein, Onsager or Feynman have taught us how to study both the whole universe or a single atom in great detail and appreciate what we learn. In my lifetime innumerable inventions have been made and if you get bitten by the scientific bacillus there is no turning back. John Horgan has even written a book called "*The End of Science*" that was severely criticized by many people, but I found it close to the truth because there cannot be an infinity of scientific laws. But even if science is close to the end, new inventions are not, and the number is virtually limitless.

The power of the Catholic Church in the not too distance past is well known and it affected many great scientists. More recently the political thoughts tend to influence science, but not as successfully as the religion in the past. The Lysenko scandal in Stalin's Russia is a well known example from about 1930. Global warming may be a recent one because they claim that they are correct because 97% of scientist agree. But science cannot be verified by votes; either you are correct, or you are not. Science can only be verified by good experiments and if they do not agree, even the most beautiful theory must be disregarded.

[A] https://doi.org/10.53234/scc202111/24.

The Climate Realists of Norway

Morten Jødal, Chairman[A]

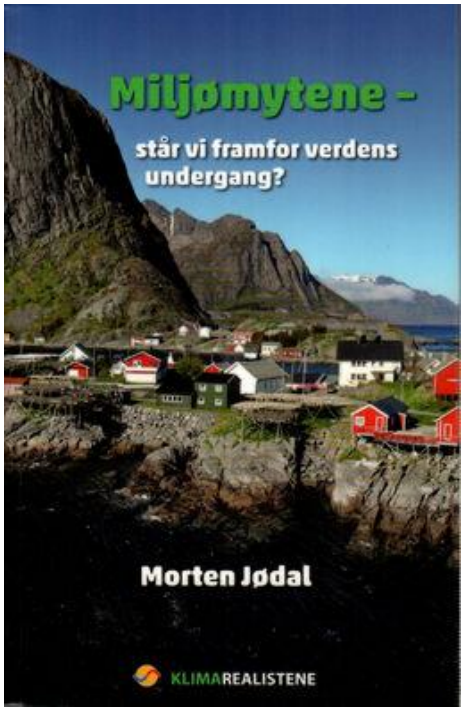
The member organization "*Klimarealistene*" was started in 2009, and in the summer of 2021 it has 1 150 paying members. The membership fee is the economic basis for all our activities. We have a main body of members in Oslo, as well as local units in many other Norwegian cities.

The main objective of *Klimarealistene*; the *Climate Realists of Norway*, is like that of our sister organizations all over the world: We participate in the public debate to declare that there is no climate emergency, and neither will it threaten us in future. This statement has deep consequences for the current climate politics, as it implies that there is no need for any drastic actions to influence the climate. We are convinced that such an influence is limited, since climate first of all is controlled by nature.

Our means to influence the public and the politicians are publication on our own website (www.klimarealistene.com), participation in the public debate in newspapers and other media, the regular newsletter 'Climate news', participation in social media, publication of books and booklets, as well as arranging public seminars, conferences and meetings.

The *Climate Realists of Norway* are advised by a scientific council, consisting of 30 members including several from other countries, most of whom have got a PhD in an area relevant to the scientific discussion. This group of scientists deliver the empirical facts and the scientific conclusions being the basis of our participation in the public debate.

The term 'Climate Realist' has, luckily, several connotations in Norway. In daily speech, it is understood as being realistic about climate, as opposed to the doom and gloom in the media. But it also alludes to the Norwegian term 'realist' being one who has studied subjects contained in the term 'real-fag' which in English means the sciences of mathematics, physics, chemistry, biology, astronomy, geology, and in the recent years computer science. This means that there is a connotation in the term that the *Climate Realists* have a scientific basis for their realistic view on climate.



Morten Jødal has written the book Miljømytene, 'the Environmental Myths', and Klimarealistene published it in 2017.

[A] Submitted 2021-05-24. Accepted 2021-07-21. Reviewed by G. Hasnes. https://doi.org/10.53234/scc202111/25.

Climate and Climate Research

Ole Henrik Ellestad, Chairman, Klimarealistene's Scientific Council[A]

The Norwegian organization Klimarealistene (Climate Realists) was founded in 2009 to provide the society with more balanced scientific information about climate change and the relevance of related technologies and political decisions. In 2015 Klimarealistene's Scientific Council was established to form a broader and more systematic basis for scientific discussion.

The members expertise covers the most important aspects of climate science including physics, astrophysics, geology, chemistry, biology, and mathematics as well as experiences within climatology, technology, economy and media. Together with international open data sources, this forms a sound basis for understanding the climate, its drivers, derived effects, and related political measures. The Council operates autonomously, and the members form their own scientific opinions and presentations for various purposes.

Now, Klimarealistene takes one more step by launching a new scientific journal which, hopefully, may contribute to the scientific debate and further clarification. The science is far from settled as explained in the following by some general considerations and examples including the Nordic and Arctic regions with the highest temperature anomalies. Science needs free speech not restricted by censorship of any kind.

Climate

Nature and most people prefer warmer to colder climate as shown by the distribution of people, plants and fauna at various latitudes and altitudes. Nearly ten times as many people live in the USA compared to the much larger, but colder area in Canada. Reliable forecasts of future climate variations in the various climate zones would be beneficial, particularly for everybody involved in activities related to nature and the derived businesses. Global predictions are of less importance.

Scientifically, the climate is formed and must be understood and modelled within the various climate zones, and then be aggregated on a global level if that would be of interest. Unfortunately, the large climate computer models focus on the global aspect. The important downscaling to regions is far from settled.

Reliable forecasts for the different climate zones would require detailed understanding of the influencing factors which generate a temperature span from –80°C to +60°C formed by the Sun, moon (tide), latitude and altitude positions, oceans, winds as well as derived effects, and even by cosmic influence from outside our solar system.

The variations of the Sun's internal sunspot cycle every 9-14 years are shown in Figure 1. They also have more long-range modulations with minima giving colder periods (dark red) like 1600-1750 (Maunder), around 1800 (Dalton), around 1900 and forecasted for 2030-50 in between the warmer periods (yellow). Our present warm period is part of the 'Grand Solar Maximum' between 1923 and 2004, the strongest in 8000 years according to the presence of isotopes generated by solar activity effects. They influence important characteristics like total solar insolation, spectral distribution, magnetic field strength, solar storms and Forbush effects.

In their selection of publications, IPCC favour results from modelling (PMOD) of the sun's activity instead of the best satellite measurements (ACRIM) and modern sunspot counting (Belgium). Thereby, the Sun's contribution to a major part of the present warming period is excluded. That is scientifically doubtful, and it is unacceptable to claim that science is settled. The normal practice of IPCC to settle crucial scientific questions by modelling instead of observations is continued.

[A] Submitted 2021-06-04. Accepted 2021-07-21. Reviewed by G. Hasnes. https://doi.org/10.53234/scc202111/26.

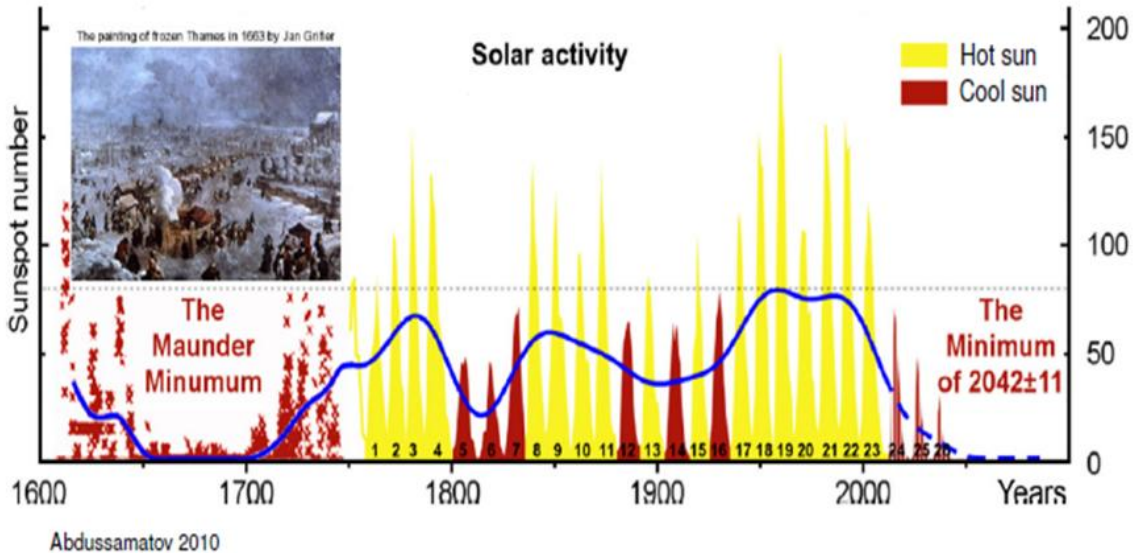


Figure 1. Counted sunspot numbers between the years 1600 and 2010 and forecasts. Warmer periods are painted yellow and colder dark red. The 'Grand Solar Maximum 1923-2004 appears outstanding. Occurrence of historic events correlates very well with the strength of the solar cycles. From Abdussamatov 2010.

Particularly, the Sun heats the equatorial zone generating pole-ward transport of surplus energy influenced by numerous factors including the formation of clouds. The systems are never fully balanced and may generally be considered as oscillating around quasi-equilibrium states. Everything varies over time and influences the weather and the climate to various degrees on different time scales. Colder and warmer periods of the Earth during the Holocene seem to correlate largely with variations of the planetary parameters of the solar system, the various internal cycles of the Sun and the derived effects. Chaotic processes also occur.

Greenhouse gases contribute with secondary effects making larger areas of the Earth warmer and habitable. The increase of the atmospheric infrared active gases contributes even less per molecule as they approach optical saturation as water vapour and CO_2.

The sun-ocean interaction may be a key element. About 90 % of the Sun's radiation is absorbed within a depth of ten metres, but the rest penetrates down to about 180 m, particularly in the blue part of the spectrum. Infrared radiation is almost totally absorbed within the surface skin activating hydrogen bonds in the surface layer. Heat transfer through the atmosphere is primarily by evaporation and convection the first kilometre, then radiation gradually increases and dominates at higher altitudes. The energy effect from the doubling of CO_2 (IPCC use sensitivity of ca 3.5 W/m²) is only a few percent of the heat transfer. The lower sea variation boundary is influenced by heat release through formation of sea-ice at -1.9 °C, the other one at about 30-32 °C through cooling by evaporation, which then starts to increase significantly according to the Clausius-Clapeyron equation.

It is almost unbelievable that these numerous variations, according to recent IPCC claims, have little or no influence on the climate and its variations in the affected zones. They are, according to IPCC-theory, anticipated to be balanced out, not influencing the global average figures, or are explained by volcano activity. Some effects may cancel out, and heavy volcano eruptions may influence the stratosphere for a few years. However, the natural processes are the more relevant, obviously for modelling the various climate zones. They may be difficult to track and quantify. Also, a given amount of energy makes much larger impact of the air temperatures than for ocean temperatures. There is an asymmetry in energy uptake and release from ocean and ice compared to the atmosphere, and major differences in transport speed by winds and ocean currents, which may be hard to settle, not least to calculate by the global computer models.

Over most of the world, systematic variations on various time scales are well known: The Sun's and the moon's cycles including ocean tidal effects and influence on the Earth's rotation, the Intertropical Convergence Zone (ITCZ), the Quasi Biannual Oscillation (QBO), the Pacific Decadal Oscillation (PDO), the Atlantic Multidecadal Oscillation (AMO, AMOC), the North-Atlantic Oscillation (NAO) as part of the Arctic Oscillation (AO), the Indian Ocean Dipole (IOD) and the Southern Annular Modulation (SAM), all influencing enormous regions, but changing at various time scales. Weather phenomena, like the El Niño Southern Oscillation (ENSO), may also show long term, systematic modulation.

One evident example is the systematic variations of wind patterns, JET-streams and others, and the Atlantic and Bering currents into the Arctic Ocean which generate well known changes in the ice cover with subsequent changes of the albedo and the heat exchange between the atmosphere and open sea. Today's changes are well within the many historical variations of the ice-edge over the last hundreds of years. The global effects from the Arctic are well recognised as observed by the warmer decades around the years 1870, 1940 and 2000 with intermediate colder periods. Meaningful correlation with atmospheric amounts of CO_2 is lacking.

Numerous scientific studies and even the media reported a large temperature increase in the atmosphere and in the Arctic Ocean in the 1920-40s with glaciers retreating several kilometres and plants and fauna thriving. "Almost ice free to the North Pole" Russian sources stated in the autumn 1945, which was referred in a major Norwegian newspaper by only seven lines in a small column. Later, the Arctic sea-ice recovered with a new maximum around 1980 followed by a new multidecadal reduction. In the 1930s, the warming was considered as climate improvement as part of the recovery after the Little Ice Age.

Variations in Antarctica are smaller due to circumpolar ocean currents and winds, the latter including the frequent, continental katabatic mode.

Such observed cycles cannot be refuted by adjusting temperatures, statistical methods and non-validated empirical computer models. Nature is too complicated. The large computer models have challenges of numerical kind, the physics and mathematics of turbulent fluid transport, they are global without proper zonal downscaling and have still too large a grid structure (100x100 km) to represent adequately many phenomena, particularly clouds, which also are poorly understood, even according to the IPCC reports. The parametrisations are numerous and essential in tuning the models, but it is not necessarily influencing the calculations in the way nature acts and will act in the future. The effect from the doubling of CO_2 is smaller than the uncertainty of the calculations.

Historical variations

Over the last 500 million years no systematic temperature variations have been found, giving evidence to any dominating, prevailing temperature influence from atmospheric CO_2 even with amounts 15 times the present level. On the contrary, several studies report low or no correlation. The average global temperature has been found to vary between 13-22 °C, the upper limit with living conditions supporting large animals for about 200 million years. Today, the average global temperature is 14.5 °C, about 7 °C lower, which is in the lower quartile.

For the last 2.5 million years, the Globe has experienced a geological ice age period, Pleistocene, with glacial periods of ca 100 000 years normally being interrupted by warmer, interglacial periods of up to 15 000 years. We are approaching the end of the Holocene period in about 1500-2500 years according to average periodicity, although there are studies reporting that the regularity occasionally has been disrupted.

A new Ice Age would cause an enormous climate crisis. Maybe even a new Little Ice Age with its natural decline of food production would be disastrous in some of the climate zones. A forecasted reduction of the Sun's activity in the coming decades may produce a cold Dalton or even, but less likely, a Maunder type of minimum in the coming decades according to recent solar research.

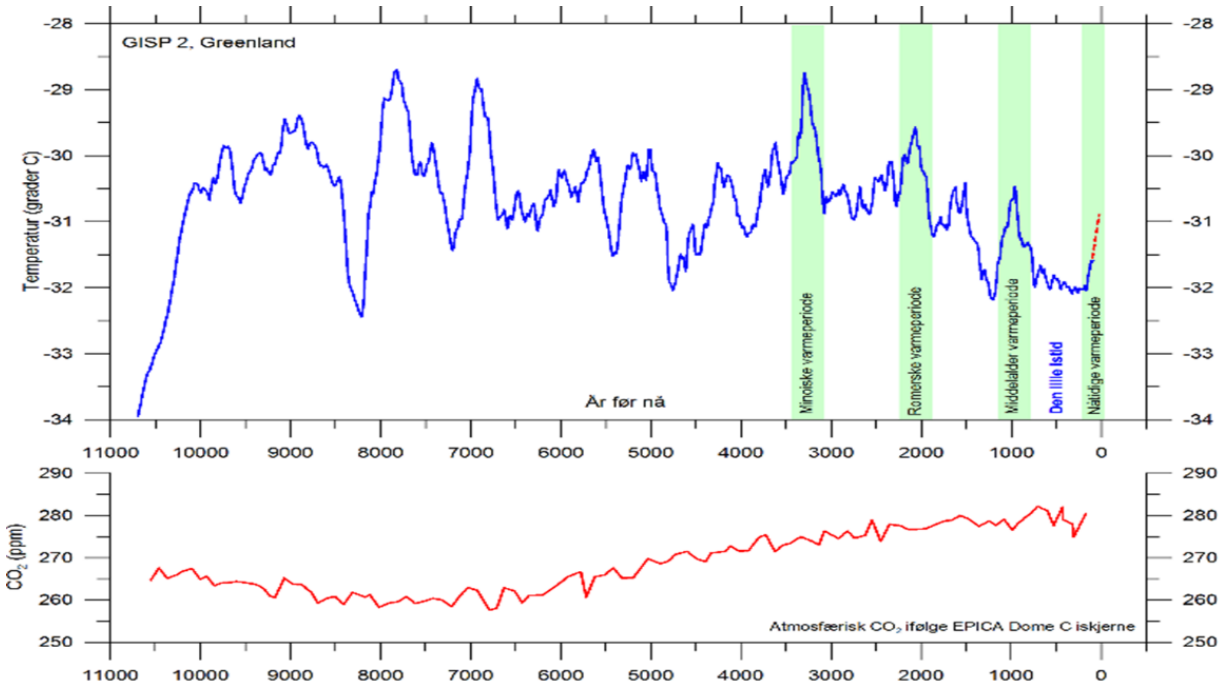


Figure 2. GISP 2 results from ice core drillings at Greenland summit. Green coloured regions are the known warming periods. Minoan, Roman, Middle Age and present, spaced with about 1000 years. CO_2 data are from Law Dome, Antarctica. From Ole Humlum, climate4you.

At the Holocene maximum 8000 years ago, the water in the Atlantic Current outside the Lofoten Islands in Norway reached a temperature of ca. 4 °C warmer than today with a summer insolation of ca. 35 W/m² above existing level. Norway was ice free with large pine forests up to present altitudes of 1400 m in the middle part. Other types of vegetation requiring considerably higher temperatures than today, have also been reported.

Ice cores from the Greenland summit show the Minoan, Roman and Medieval warming epochs spaced in time by a quasi-millennial cycle. The next cycle coincides with the present warming including the 'Grand Solar Maximum' from 1923 to 2004, the most active period of the Sun for the last 8000 years. Other planets and their moons, with different atmospheric compositions, have also warmed. There is ample evidence for largely correlating the Sun's activity and the Earth's major cold and warm periods of the last thousands of years. The warming periods were also beneficial for the societies.

From Greenland temperatures since 1840, the warm period of the 1930s is comparable with today's level and with rapid and substantial ice reduction as for other parts of the Arctic. Anthropogenic CO_2 started to increase noticeably after 1950 while the Greenland temperatures dropped further, and the glaciers started to grow. Not until 1990 were the processes reversed. Greenland's variations seem to differ by ca. 30 years from global averages.

The warming from about 1850 can easily be explained by recovery from the Little Ice Age. When CO_2 started to increase discernibly from 1950, the global temperature had already started to cool for the next 30 years. The World Meteorological Organization (WMO) forecasted in the 1960s even a possible coming ice age which was taken seriously by governments until the recent warming period started around 1975. The climate legend Hubert Lamb stated that it must be something else than CO_2 which dominates the climate variations as there is little correlation with CO_2, also in recent centuries. The 15 years temperature 'hiatus' reported by IPCC in 2013, may be part of these variations.

IPCC and its reports

United Nation's IPCC has tried to establish a reputation as the world's scientific climate change authority. The iconic conclusion from 2001 has been that more than 50 % of the climate change is anthropogenic. Even that contribution is heavily challenged scientifically with respect to the radiation effects as well as the anthropogenic CO_2 share of the atmosphere. The extreme statement that CO_2 is almost totally dominating climate is new in AR 6 without any scientific justification.

The IPCC climate reports give an impression of a split view. Partly, it presents many important results extracted from the scientific literature with proper handling of data and adequate discussions. This category is found deeper inside the reports and even put in appendixes, like John Christy's critical analysis of the computer models and temperatures (AR 5).

The other part is the one-sided selection, according to their mandate, of publications to support the anthropogenic global warming hypothesis and the rather exaggerated effects from that warming without adequate discussions, partly lacking the basic scientific criteria as presented by Carl Popper and promoted by Richard Feynman: Theories ought to be formulated so that they may stand the test of falsification, and theories not explained by observations and experiments should be rejected.

Turning from the major scientific part of the reports towards the summaries and the final 'Summary for Policymakers' (SPM), which is dominating the public debate, a distillation of information and views, under substantial politicised influence, have occurred in order to establish support for anthropogenic climate influence. More than one hundred computer models without observational backing are their main basis. The SPM deviates partly from the original scientific chapters. In some respects, it lacks scientific integrity as important holistic views are omitted. Consequently, the reader is left with false impressions. The selection of biased start and end points in time series are evident examples. The subsequent public debate is further apart from SPM and even past the limit of pseudoscience.

This is not a surprise. The evaluation in 2010 of the IPCC organization after the 'Climategate' event concluded with serious shortcomings in the IPCCs scientific processes, a lack of expressing scientific uncertainties in the reports and its dissemination, a mixing of roles and a mixing of science and politics. The various emails that appeared reflect viewpoints among key, scientific IPCC-reviewers, close to dialogs among strong IPCC critics, without any mentioning in the final IPCC-reports.

Politicised climate science

Climate science has become highly politicised. IPCC, researchers, politicians, non-governmental organizations and the mass media have for decades presented versions of a one-sided approach. Those conclusions are based on exaggerated CO_2 effects from computer models as compared to observations and experimental data, neglecting even the major influences from settled natural variations caused by the Sun, the moon, winds and oceans as well as from derived effects.

Many studies contain controversial elements like data, statistics and other methods, lack of representative start and end points in presentations of many time series, selection of non-representative temperatures and adjustments of surface temperatures, lack of recognising adequate satellite temperature measurements, wrong presentations and even manipulations of historical data and, finally, lack of focus on settled natural, regional, zonal and continental variations. In addition, many exaggerated extreme effects and forecasts have been presented, although many has later been disclaimed in the 2007, 2012 and 2013 IPCC-reports.

One example is the statement that the increase in atmospheric CO_2, beyond doubt, is anthropogenic. However, their Bern model show significantly slower response for disappearance of CO_2 from the atmosphere than measured for the radioactive ^{14}C-isotope. Other studies refer to the 50:1 ratio of CO_2 in the seas and in the atmosphere and the major CO_2-circulations giving a far less human

contribution, only about 5 %. Again, non-validated models are taken for granted within the IPCC-system and expressed as settled science.

The phrase "settled science" has been used even by the world's leading politicians. However, the last published article showed that only 0.64 % of nearly 12 000 scientific abstracts, supported the standard IPCC conclusion that more than 50 % of the warming is anthropogenic, a remarkably low figure.

Over the years, a fixed CO_2 sensitivity is frequently used as basis for calculations of various atmospheric CO_2 scenarios. Roger Pielke's literature search found more than 17 000 articles based on the IPCC's CMIP6 model version which is well known to be unrealistically exaggerated. An even more exaggerated high emission scenario, RCP8.5, on top of that makes modelling to a playground for creating alarms. In contrast, top rated scientists in their field, questioning the value of the CO_2-sensitivity, get their contributions refused since their results do not support the IPCC-hypothesis.

Small radiation effects from increased CO_2

The main scientific question in the climate debate is the quantification of the greenhouse gas effects of the various atmospheric gases including their mutual influence and possible feedback forcing. John Tyndall measured in 1859 the absorption effects of the main atmospheric molecules and found that water vapour is the dominating greenhouse gas making England habitable. The effects from CO_2, methane, ozone and nitrous oxide were not negligible, but were small. Since then, the physical laws, theories and relevant molecular spectra have been presented, not least, in the books (1935-50) by the Nobel Laureate (1970) Gerhard Hertzberg, frequently known as the spectroscopic bible.

From the 1960s and onwards, the US Air Force has been compiling the most recent high resolution infrared spectra of atmospheric gases (HITRAN, MODTRAN), which, together with thermo-dynamic data of the atmosphere, are well suited for calculations of atmospheric effects for various purposes surpassing the early calculations by Svante Arrhenius in 1896 and 1906.

There is no doubt that practically all gaseous molecules, liquids and solid materials absorb and emit infrared radiation. The temperature influence depends on the emission from the surface, how the absorbed energy is transformed and dissipated and the state of molecular emission from the atmosphere. While there is a focus on the absorption part, the emission is equally important as the net effect is the energy difference of the two mechanisms. It implies that a detailed understanding of the emission surface and atmosphere around the globe, particularly temperature and pressure profiles, is important. Neither of them is well expressed in detail by the large, global climate models.

Using HITRAN, the energies linked to absorption and emission of outgoing radiation throughout the atmosphere can be calculated quite accurately for known amounts of individual and mixed gases and the atmospheric conditions. A comparison with the frequency distribution of the Earth's surface emission according to Planck's law, corrected for variations of the emissivity coefficient, gives the net energy. This may give a quite correct picture of the radiation effects at clear sky for a particular location when atmospheric parameters are known.

Such calculations are more accurate for local effects than larger, global computer models. They give more precise answers to critical questions of impact from individual molecules, significance of overlapping bands, possible reinforcement by water vapour or not and effects from atmospheric variations like pressure shift and pressure broadening at various altitudes. Calculations may be performed for representative areas and be combined to give a global picture. Those results show far less CO_2 sensitivity and water vapour feedback than the large global models. Accordingly, the derived climate effects of various kinds must be correspondingly smaller.

John Tyndall and Knut Aangstrøm (1900) were right. The effect from increased CO_2 is small and is approaching optical saturation at the present amounts (Beer-Lamberts law). With the logarithmic

absorption pattern, the less abundant greenhouse molecules have stronger impact per molecule, but the minimal atmospheric amounts, now and in the future, give altogether a small impact. Water vapour is the dominant greenhouse gas, but the strengthened forcing by increased amounts is small due to saturation effects in most regions. The alarming 'tipping point' is far from reality.

Also, satellites and radiosondes measure reduced specific humidity in the altitudes where the large computer models calculate the highest impact. The missing 'hot spot' in the upper troposphere, considered as a lack of crucial evidence even by IPCC scientific advisors, is still not observed. A negative forcing from less water vapour in the critical emission zones is therefore most likely.

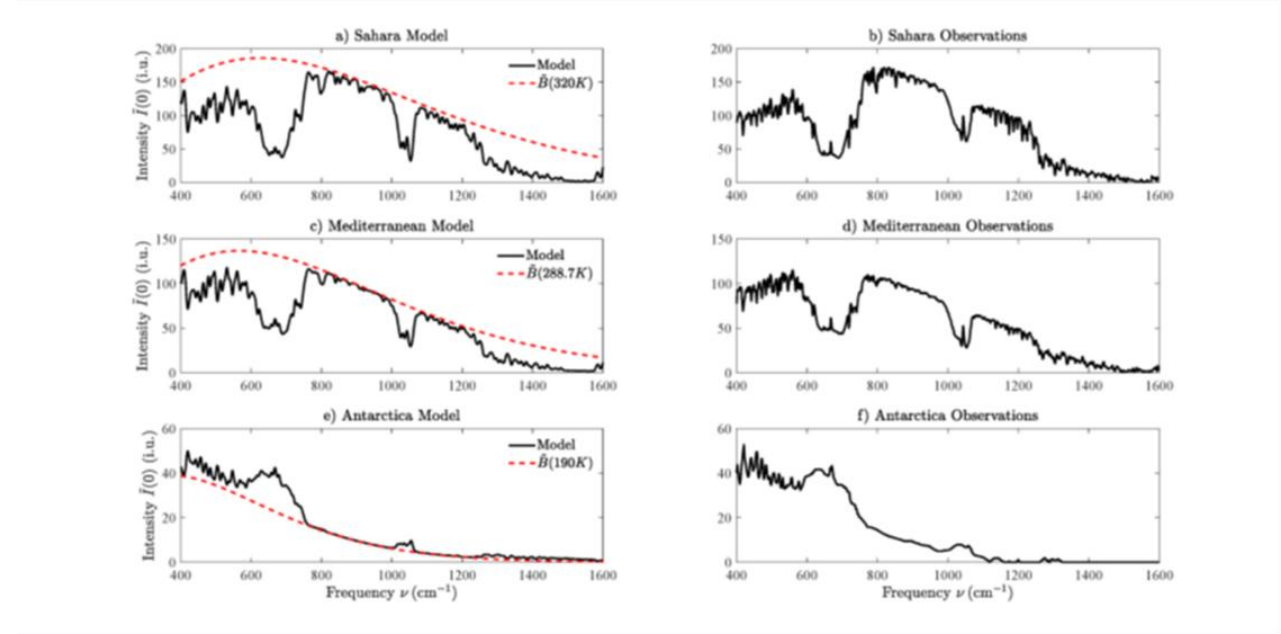


Figure 3. Modelled (left) and observed (right, from Nimbus satellite 1970) retention of radiative energy by CO_2 at typical regions like Sahara (upper), Mediterranean (middle) Antarctica (lower). The red, dotted lines are emissions from earth according to Planck distribution at the given temperatures. The area between the two lines represents the detained energy. From W. Weijngaarden and W. Happer 2020.

Calculating the radiation effects at various places on earth give some variations (Figure 3). For inverted atmospheric temperature profiles, CO_2 will give cooling, even more for increased amounts of CO_2. The stratosphere and polar areas during winter, particularly the very cold Antarctica, will reduce the global effect observed from the high temperature desert regions having the strongest ground emission and accordingly absorbed energy. An eventual melting of Antarctica glaciers will not be caused by increased CO_2 as calculated by the global computer models, which are far from as representative for important climate regions as claimed.

The calculations are based on clear sky conditions. Clouds interfere strongly as the radiation from the ground is absorbed. Their emission is controlled by the clouds' surfaces with normally lower temperatures than the ground. The impact from cloud cover change and altered albedo is larger than the calculated effect generated from increased CO_2. IPCC admits that clouds are poorly understood. The effect is calculated by parametrization and is strongly involved in the tuning of the models with no guarantee of being part of a future realistic approach.

There are ample observations that the average temperature increase is particularly influenced by warmer minimum values in colder periods like nights and winters. Greenhouse gases are among the possible explanations. That is far from causing a climate crisis, 'tipping point' and 'burning Globe'.

Beneficial effects from increased CO_2

Numerous alarms of increased frequencies and severity of natural disasters caused by higher temperatures have been reported by IPCC. However, this is not reflected in official statistics which show stable, reduced tendencies or similar patterns over the recent decades and centuries. In its 2012 and 2013 reports IPCC disclaimed previous alarming statements (concerning tropical cyclones, floods, droughts, major storms in the North-Atlantic, Gulf Stream will not stop etc.), not so in AR 6. No major hurricanes landing in the USA from 2005 to 2017 is another indication. The sea level rise follows the pattern from tide gauge measurements since 1810 as a natural recovery from the Litte Ice Age. It will take years to alter these conclusions as the number of extreme events is small.

Furthermore, the small temperature effect and significant CO_2 contribution to plant growth have made the Earth greener by approximately 15 % since satellite recordings started in 1979, also in critical areas like south of Sahara. This is consistent with up to 1200 ppm of CO_2 being added in greenhouses to stimulate photosynthesis and growth in particularly C3 plants, but also the less abundant C4 plants. Record crops are frequently reported over the later warmer years. A warmer world will make huge land areas towards the north and at higher altitudes better suited for farming and forestry, a favourable scenario when the world's population is on its way to ten billion people.

Even the corrected results from Richard Tol, working with environmental and climate strategies, justify his previous statement that the world would be a better place to live for richer and poorer within a temperature rise of 2 °C. Increased atmospheric level of greenhouse gases is no threat to that limit. They will contribute, regardless of the CO_2 increase, most likely significantly less than the low limit of the Paris agreement of 1.5 °C in year 2100, and the human part of that is even smaller. A CO_2 sensitivity of about 0.5 °C has been suggested in several studies. Today, about half of that level has been reached.

There is no climate crisis. Such a conclusion is not stated in the scientific related part of IPCC reports prior to AR 6. Natural variations are the more likely explanation for recent climate change. Increased warming from higher atmospheric CO_2 levels and less abundant greenhouse gases is small and will remain so in the future. Increased CO_2 will, most likely, contribute to a more favourable development in most climate zones.

The various political measures to reduce atmospheric CO_2 would be very costly and make fairly large impact on the society - but not much on climate. An eventual crisis linked to the forecasted cooling from a weaker Sun, the tide influencing moon, the earth's rotation and variations in wind and ocean patterns in the coming decades is probably more likely as the World's population increases.

Climate science is not settled. The new journal will, hopefully, contribute to clarify further aspects of our wonderful and interesting Globe, its climate and its variety.

What Is Science and What Is Not?

Christopher Monckton of Brenchley[A]

Abstract

In the classical scientific method, a proposed alternative hypothesis that an observable event is not attributable to chance is Popper-falsified by deductive testing of the corresponding null hypothesis that the occurrence is random. However, legalist post-modern scientism promotes a species of proposition that is not a true hypothesis at all: the manifestly irrational antihypothesis, which, though of its essence aprioristic and often imprecise, unquantified, untestable, untested or fallacious, may gain credence even where the null hypothesis has been demonstrated or falsification has not been attempted or is unattainable. The characteristics and dangers of antihypotheses are discussed.

Examples concern the supposedly divine or alien origin of the Great Pyramid, the alleged imperialism of the triangle in geometry, the notion that the Earth is flat, our purportedly dangerous influence on the Earth's climate and the alleged net welfare benefit of global-warming mitigation.

A mechanism is derived for the identification of antihypotheses and either for their outright elimination by means of the scientific method or for their emendation by sufficiently rigorous and precise formulation, quantitative where possible, to render them falsifiable and thereby to bring them safely within the orbit of the scientific method and hence within the compass of science itself.

Keywords: *Philosophy of science*; *Null hypothesis*; *Alternative hypothesis*; *Antihypothesis*; *Scientific method*; *Great Pyramid*; *Pi*; *Golden ratio*; *Euler's number*; *Flat-Earth theory*; *Climate change*; *Global warming*; *Logical fallacy*; *Mitigation economics*.

Introduction: The principle of the universality of truth

Truth alone, said Fr Vincent McNabb, a celebrated divine in the London of the early 20th century, is worthy of our entire devotion. The end and object of science, as of religion, is to answer the question posed by the judge in history's most celebrated show-trial: "What is the truth?" That question of questions underlies all true enquiry. Notoriously, the judge – the governor of an unconsidered province of the early Roman Empire – did not stay for an answer: but the Defendant in that trial, Who was uniquely qualified to provide the answer, had provoked Pilate's question by uttering the noble manifesto no less of the true scientist than of the man of true religion: "To this end was I born, and for this cause came I into the world, that I should bear witness unto the truth." (John XVIII, 37: King James Bible).

It was by that maxim that the late Professor Nils-Axel Mörner lived. For more than half a century he studied sea level. He found that it was not rising anything like as fast as had been predicted, and was vilified for telling the truth. But it is he, not his shoddy detractors, whom science will remember. This essay in the philosophy of science is dedicated to his memory.

Mathematics is the *lingua franca* of all the physical sciences. Logic is the heart and soul of mathematics. The fundamental principle of logic is the principle of the universality of truth. That great principle resonates thoughout the history of thought, in the Old Testament and the New, in Plato and Aristotle, in Euclid and Thales, in Kung Fu-Zhi and Lao-Tse, in Thabit ibn-Qurrah and Abu Ali ibn al-Haytham, in Cicero and Justinian, in Augustine and Aquinas, in Bacon and More, in Euler and Gauss and Einstein, in Huxley and Popper, in Feynman and Snow. It is this –

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> Each proposition that is true stands consistent with every proposition that ever was or is or ever will be true, throughout the universe of time and space, from the beginning of the beginning to the end of the end and from here to the outermost stars; but each proposition that is false, whether or not it stand consistent with any other propositions that are false, falls inconsistent with every proposition, in every time and place, that ever was or is or ever will be true.

Note *en passant* that the principle of the universality of truth does not conflict with Gödel's incompleteness theorem, which states that in every formal system there subsist statements whose truth-value is indeterminable. Just as the behavior of a chaotic system is deterministic but indeterminable, so there subsist propositions that are true, but whose truth we cannot determine. A Sufi story about Mullah Nasruddin illuminates the incompleteness theorem:

> The King decided that he could, and would, make people observe the truth. He could make them practise truthfulness.
>
> His city was entered by a bridge. On this he built a gallows. The following day, when the gates were opened at dawn, the Captain of the Guard was stationed with a squad of troops to examine all who entered.
>
> An announcement was made: "Everyone will be questioned. If he tells the truth, he will be allowed to enter. If he lies, he will be hanged."
>
> Nasruddin stepped forward.
>
> "Where are you going?", said the guard
>
> "I am on my way", said Nasrudin slowly, "to be hanged."
>
> "We don't believe you!"
>
> "Very well, if I have told a lie, hang me!"
>
> "But if we hang you for lying, we will have made what you said come true!"
>
> "That's right: now you know what truth is – YOUR truth!"

The sparse notation of formal logic states the principle of the universality of truth more prosaically (1):

$$\neg (\mathbf{P} \wedge \neg \mathbf{P}) \qquad \textbf{(1)}$$

Formal logic is a rare instance of common ground between the Two Cultures: the arts and the sciences (Snow 1959). Karl Popper (1934) formalized the scientific method in logical terms as an iterative algorithm starting with a general problem, to address which a falsifiable alternative hypothesis is advanced. During the subsequent error-elimination phase, the tentative theory is (very rarely) demonstrated, (less rarely) disproved, or (usually) neither. In the last case the hypothesis acquires some credibility not because any imagined consensus of experts endorses it but because it has endured falsification without disproof. By the iterative advancement of hypotheses and elimination of those that are erroneous via deductive testing of the null hypothesis, the original general problem is progressively refined. Science thus inches *pedetemptim* toward the truth. By contrast, falsification of the experimental or research hypothesis by inductive as opposed to deductive reasoning is vulnerable to Hume's "uniformity of nature" assumption (Wilkinson, 2013).

To falsify an alternative hypothesis, the corresponding null hypothesis that the occurrence of a given observable event is random is scrutinized. In Popper's words, "Insofar as a scientific statement speaks about reality, it must be falsifiable; and, insofar as it is not falsifiable, it does not speak about reality."

The summation of the scientific method attributed to Einstein is apt: "No amount of experimentation can ever prove me right. A single experiment can prove me wrong."

Huxley (1866) wrote:

> The improver of natural knowledge absolutely refuses to acknowledge authority, as such. For him, scepticism is the highest of duties: blind faith the one unpardonable sin. And it cannot be otherwise, for every great advance in natural knowledge has involved the absolute rejection of authority, the cherishing of the keenest scepticism, the annihilation of the spirit of blind faith, and the most ardent votary of science holds his firmest convictions not because the men he most venerates hold them; not because their verity is testified by portents and wonders; but because his experience teaches him that whenever he chooses to bring these convictions into contact with their primary source, Nature – whenever he thinks fit to test them by appealing to experiment and to observation – Nature will confirm them. The man of science has learned to believe in justification not by faith but by verification.

Except on the rare occasions when a theorem is demonstrated, science is a Sisyphean endeavour. Absent absolute proof, the best the scientist can do is to clamber crabwise towards the truth inch by inch, knowing that others behind him may at any time fault his footwork and bring him and his hypothesis down. As will be seen, even a universally-believed theorem may not be as universally true as is universally imagined. *A fortiori,* unprovable, unproven or disproven antihypotheses should not be paraded for our deference (Figure 1).

Figure 1. The Royal Society's motto: "Take no one's word for it."

Feynman and Robbins (1999) agreed: "Science is the belief in the ignorance of experts". For the deadliest form of appeal to authority is the pre-emptive adoption and enforcement of an aprioristic, ideological party line contrived to appear as a legitimate scientific hypothesis.

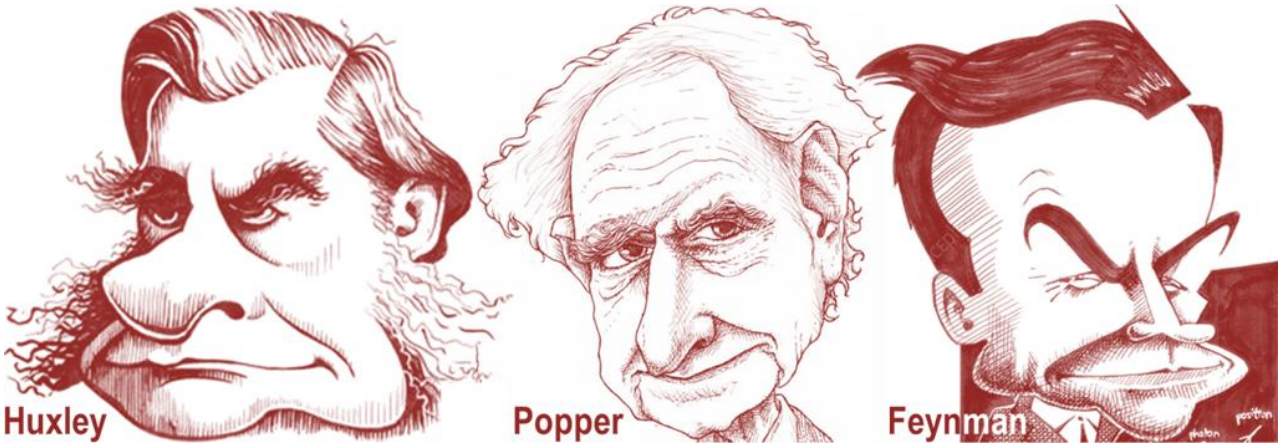


Figure 2. Three opponents of apriorism in science.

The true objective of science is the passionately dispassionate search for the objective truth. Science does not say, "I believe!" as does the man of religion, or "You must believe, or else!" as does the slavish adherent of some transient totalitarian tyranny. Science says, "I wonder!" and then, "I wonder?" For the true scientist stands at once in awe of Nature and in ceaseless curiosity as to her secrets. He hunts and hunts for the laws that underlie and govern the workings of the natural world. Diligently, he applies previously-established theory to the results of observation, mensuration and experimentation, either to disprove or to modify that theory, by little and little, until the objective truth is ever more clearly revealed, ever more deeply discerned and ever more merrily enjoyed.

1. The antihypothesis

Religion attains to the truth by accepting the Words handed down by Messiahs or Prophets and pondering these things in its heart (Luke II, 19: King James Bible). Religion, then, is at root aprioristic: it begins by accepting as axiomatic what it calls "revealed truth". The narrow-minded, intolerant, totalitarian, legalist scientism that holds sway in academe today is likewise aprioristic, but without any of the morality and merriment that are the saving graces of religion. Scientism has increasingly supplanted science in the universities. Questioners of the orthodoxy on a growing range of scientific topics are vilified, excluded, excoriated, condemned and even menaced with execution for "high crimes against humanity".

Figure 3. Al-Haytham on an Iraqi 10-dinar banknote

Yet Abu Ali Ibn al-Hassan Ibn Al-Hussain Ibn Al-Hussain Ibn Al-Haytham (Figure 3), founder in the East of the scientific method as Thales of Miletus had founded it in the West, wrote most beautifully during the golden age of Islamic scholarship in 11th-century Egypt:

> The seeker after truth is not one who studies the writings of the ancients and, following his natural disposition, puts his trust in them, but rather the one who suspects his faith in them and questions what he gathers from them, the one who submits to argument and demonstration and not the sayings of human beings whose nature is fraught with all kinds of imperfection and deficiency. Thus, the duty of the man who investigates the writings of scientists, if learning the truth is his goal, is to make himself an enemy of all that he reads, and, applying his mind to the core and margins of its content, to attack it from every side. He should also suspect himself as he performs his critical examination of it, so that he may avoid falling into either prejudice or leniency (Voss, 1985)

The "seeker after truth" – the scientist – places no faith in any mere totalitarian, ideological consensus, however venerable or widespread, but applies his hard-won scientific knowledge to check

and check again. "The road to the truth is long and hard," wrote al-Haytham, "but that is the road we must follow." In the classical understanding, then, the scientific method is a moral process whose end and object is the truth. If there were no such thing as objective truth, there would be no such thing as science. For without objectivity there is naught but apriorism, the adoption *a priori* (and often for purely ideological reasons) of propositions whose objective truth has not previously been demonstrated with sufficient rigor, if at all.

Apriorism – the adoption by faith alone of propositions that owe all to ideology and little or nothing to the scientific method – is a characteristic of all totalitarian systems of thought. Two of the commonest species of apriorism are superstition and legalism. A superstition is demonstrably false. A religion, by contrast, advances for its adherents' assent propositions that may or may not be true but, being unfalsifiable, fall outwith the scientific domain. The term "legalist" arose among the political philosophers of the early post-Confucian Chinese empire, who, meditating upon the fundamental divide in politics, concluded that an abyss was fixed between the "legalists" (with Fu 1996 we might call them "totalitarians", but will prefer the more neutral ancient term) and the "Confucians" (philosophical libertarians in the enlightened spirit of the *Analects*).

The eugenicist notion that the Jewish race is inferior to an imagined Aryan race, the Lysenkoist doctrine that soaking seed-corn in water over the winter rather than planting out the seeds in the autumn will produce better harvests, or the environmentalist demand that a billion people without electric power should be denied the life-saving benefits of affordable, reliable, low-tech, continuous, base-load, coal-fired or gas-fired electricity on the ground that the planet must be saved from global warming that is occurring at a third of the predicted rate are genocidal instances of a recent species of aprioristic, pseudo-scientific proposition that is not, properly speaking, a hypothesis at all. It is an intrusive, alien species whose legalist advocates demand that it be treated with obeisance, as though it were a demonstrated theorem, even where it is egregiously, patently false.

This alien species is the antihypothesis, a proposition that revels in its own falsity, monstrosity and even absurdity. Antihypotheses that spring from legalistic apriorism are likely to prove particularly pernicious, since the totalitarian governing power may decide not merely to adopt them even in the absence of legitimate scientific justification but also to enforce them for selfish, partisan reasons of political expediency, social convenience or financial profit. The dismal antihypotheses of Heydrich and Lysenko killed tens of millions. Those who escaped genocide were flung into "psychiatric" prisons, on the ground that disagreement with the Party Line was *a priori* evidence of lunacy.

The typical antihypothesis exhibits one or more of the following commonplace defects –

1. The antihypothesis is not expressed in quantitative terms and cannot be quantitatively Popper-falsified.
2. The antihypothesis is imprecisely defined (often by deliberate vagueness), or is otherwise of such a nature or in such a form that it is unfalsifiable.
3. The antihypothesis is Popper-falsifiable, but falsification has not been attempted.
4. The tyrant, the State or another agency of compulsory untruth has imposed legalistic or peer-pressure constraints inhibiting or even forbidding falsification.
5. The antihypothesis has been falsified but is perversely insisted upon.
6. Scientists sceptical of the antihypothesis are reviled, punished, subjected to "re-education", incarcerated, certified as lunatic, exiled or even executed for daring to question it.

Today, for instance, tens of millions die annually because they are denied electrical power. An unquantified but growing fraction of those millions die because they would by now have had access to electricity were it not for global-warming mitigation policies dictated by legalist institutions falsely praying science in aid to justify the taxation, regulation and rationing upon which they insist, but whose motive is chiefly political.

For instance, Christiana Figueres, for many years the chief executive of the secretariat of the United Nations' Framework Convention on Climate Change, said at a press conference shortly before the Paris climate conference of 2015:

> "This is the first time in the history of mankind that we are setting ourselves the task of intentionally, within a defined period of time, to change the economic development model that has been reigning for at least 150 years, since the Industrial Revolution. This is probably the most difficult task we have ever given ourselves, which is to intentionally transform the economic development model for the first time in human history."

Likewise, Dr Ottmar Edenhofer, lead author of the *Fourth Assessment Report* of the Intergovernmental Panel on Climate Change (IPCC, 2007), said in 2017:

> "One has to free oneself from the illusion that international climate policy is environmental policy. Instead, climate change policy is about how we redistribute *de facto* the world's wealth."

Such legalists are open about their distaste for the market economy that has served well those nations where it has been to some degree permitted. The legalists are also open about their intention to use climate policy to destroy capitalism from within.

Ms Figueres holds up Communist China as the model of how to deal with global warming. Legalists such as she now command the levers of international power.

How, then, will it be possible to establish a mechanism for the early identification and exposure of legalistic antihypotheses such as that upon which these new tyrants rely – that anthropogenic global warming will prove catastrophic without at least a radical interference with the market economy?

How can antihypotheses be rapidly identified and either eliminated outright from acceptable scientific and political discourse where they are not falsifiable or have already been falsified, or, at minimum, be modified to render them Popper-falsifiable and thus to remove them from the merely political sphere and bring them back within the ambit of the scientific method?

To assist in formulating a process for eliminating antihypotheses and reasserting the paramountcy of objective truth in science, some instances of antihypotheses will now be considered.

2. Superstitious antihypothesis: "Aliens made the Great Pyramid"

A series of antihypotheses concerning the mathematical principles that are thought by some to have underlain the design and construction of the Great Pyramid of Khufu (*Graece* Cheops) at Giza will illustrate the arbitrary, capricious and often fanciful approach that arises from superstitious apriorism.

The Pyramid was built during the reign of the Pharaoh Khufu some 4500 years ago. In that era, a royal cubit (0.524 m or 1.717 ft) was subdivided into seven palms each of almost 7.5 cm or 3 in. Each palm comprised four fingers of about 1.9 cm or 0.75 in. The standard cubit comprised six palms, but all references to a "cubit" hereinafter will be to a royal cubit of seven palms.

The Pyramid's altitude or *peremos* appears to have been 280 royal cubits (146.6 m, or 481 ft), and the base, the *ukha thebt*, 440 royal cubits (230.3 m, or 756 ft). The basal inradius is half the *ukha thebt.*

The *seqed* is the ratio of the basal inradius to the *peremos* in palms and fingers per cubit: i.e., the cotangent of the lateral inclination. With seven palms to a royal cubit, this cotangent expressed as a decimal is simply one-seventh of the *seqed*.

The *seqed* of the Great Pyramid is 5 palms 2 fingers (i.e. 5.5 palms) per cubit of the *peremos*: i.e., the cotangent of the lateral inclination is 5.5/7 or 0.786. The slant height of the triangular lateral faces is thus 356.090 cubits.

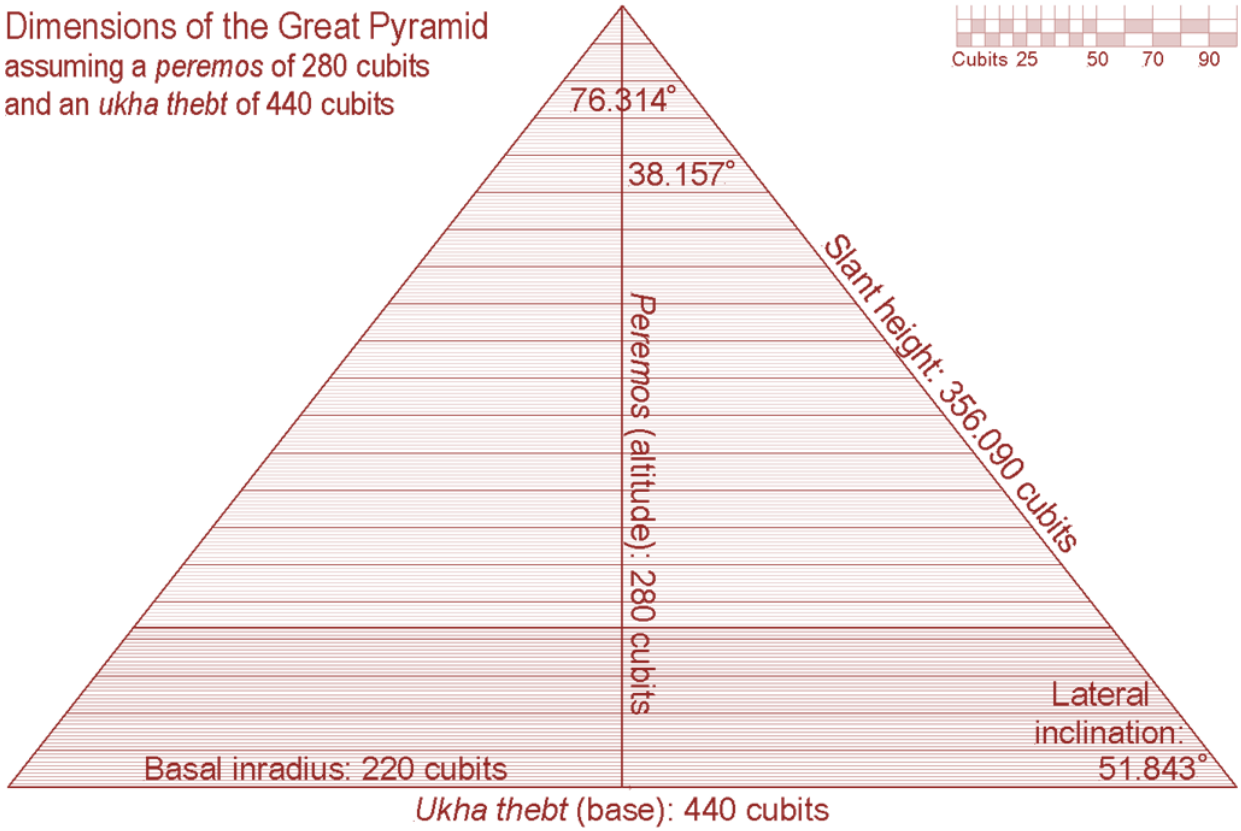


Figure 4. Sectional triangle of the Great Pyramid bisected through opposite slope heights. All 210 courses of masonry are shown approximately to scale. The lower 43 courses (darker) comprise approximately half the volume of the Pyramid.

The apical dihedral and semi-dihedral angles are 76.314° and 38.157° respectively. The basal dihedral or lateral inclination is 51.843° (Figure 4).

The following are among the many antihypotheses concerning the Pyramid's dimensions that have been promoted, some of them by respectable archaeological or mathematical sources:

1. The squaring of the circle is encoded in the Pyramid in that the *peremos* is the radius of a circle of circumference equal to the perimeter (four times the *ukha thebt*).
2. The ratio of the *peremos* to the basal inradius is $4/\pi$.
3. The ratio of the slant height to the basal inradius is the golden ratio φ.
4. The square of the ratio of the area of all four triangular faces to that of the base is φ.
5. The isosceles triangle whose base is the terrestrial diameter and whose altitude is the sum of the terrestrial and lunar radii (Figure 5) is similar to the sectional triangle of the Pyramid (Figure 4).
6. The sum of the lunar and terrestrial diameters in miles is equal to the sum of the vertex angles of the regular dodecahedon and the regular icosahedron in degrees.
7. On concentric *vesicae piscis* one being one-third the scale of the other as in Figure 6, a triangle similar to the sectional triangle in Figure 4 appears.
8. In Figure 4, the ratio of the basal to the apical dihedral is $e/4$, where e is Euler's number 2.718 ..., the base of the natural logarithms.
9. "Proceeding around the globe due north and due south of the Great Pyramid … there is more earth and less sea in that meridian than in any other meridian all the equator round." (Smyth, 1880, p. 89) (Figure 7).

10. “The height of the Pyramid is precisely one billionth of the distance from the Earth to the Sun.” (Smyth, *op. cit.*).
11. The small irregularities in the dimensions of the four lateral faces of the Pyramid were deliberate, so that both π and φ could be more precisely encoded in its dimensions.
12. The latitude of the center of the Grand Gallery within the Pyramid is 29º 58′ $\mathbf{45.28''\ N}$, or $\mathbf{29.9792458º\ N}$, encoding the velocity of light *in vacuo*, namely $\mathbf{299,792.458\ m\ s^{-1}}$.

Do these dozen superficially mathematical propositions indicate that the Egyptians of the Old Kingdom possessed knowledge that no mere humans of that age could possess, or that the pyramids were built by aliens or, a little less fancifully, by Egyptian architects ambitious to encode into its design such fundamental constants of mathematics as π, φ, and e, or units such as the meter, the mile and the velocity of light? Or are these propositions antihypotheses?

From the Middle Ages to the mid-20th century, the educated classes in Europe were trained in three foundational subjects, the *trivium*, as a *sine qua non* for any form of higher education. The elements of the *trivium* were grammar, logic, and rhetoric. Some acquaintance with logic was intended to liberate students from apriorism, and to enable them to recognize antihypotheses.

One simple logical test is Occam’s Razor: *essentia non sunt multiplicanda praeter necessitatem.* There is little to be gained from an excess of complication. Of several explanations for an observed event, the simplest is likeliest.

Occam’s Razor is inherent in the scientific method: it is the yardstick for the null hypothesis that an observable event arose not by design nor by necessity, still less by alien or divine agency, but by mere chance.

Applying Occam’s Razor to propositions 1-4 above, the null hypothesis is that the apparent encoding of π and φ in the Pyramid’s dimensions was either accidental or, even if intentional, unremarkable. Of the ~100 Egyptian pyramids of the period, many (see e.g. Table 1) had *seqeds* in the region of 5 palms 2 fingers per cubit of the *peremos.* Several earlier pyramids with large *seqeds* had suffered structural failures, but pyramids with small *seqeds* would consume disproportionately large volumes of stone in their lower courses and would accordingly lack the presence – what architects call the “massing” – of taller pyramids.

Pharaoh	*Ukha thebt* (base)	Basal inradius	*Peremos* (altitude)	*Seqed* (palms cubit^{-1})	Ratio *Seqed* / 7	Apical dihedral	Basal dihedral
Sahure	78.5 m	39.3 m	48.0 m	5.75 palms cubit^{-1}	0.821	79.0º	50.5º
Menkaure	103.4 m	51.7 m	66.5 m	5.50 palms cubit^{-1}	0.788	77.4º	51.3º
Khufu	**230.3 m**	**115.2 m**	**146.6 m**	**5.50 palms cubit^{-1}**	**0.788**	**76.3º**	**51.8º**
Userkaf	73.3 m	36.7 m	49.0 m	5.25 palms cubit^{-1}	0.750	74.0º	53.0º
Khafre	215.3 m	107.6 m	143.5 m	5.25 palms cubit^{-1}	0.750	73.8º	53.1º

Table 1. The similar seqeds or lateral-inclination cotangents of five pyramids at Giza.

Even with a steepish *seqed* of 5 palms 2 fingers, i. e., a lateral inclination of 51.843°, half the volume of stone in the Great Pyramid was taken up by the first 43 of the 210 courses (Figure 4), representing little more than 20%, or less than 100 ft, of the 481 ft *peremos*. It is likely, then, that the first four propositions listed above depend not upon “sacred geometry” but upon two far from esoteric circumstances: first, that the *seqed* was derived from experience, falling between a high value that risked structural failure and a low value that consumed much stone and labor for little massing; secondly, that the ratio of the *peremos* to the *ukha thebt* was 7: 11, so that ratios involving these two primes give tolerably close approximations both to π and to φ. For π is approximately $2 \times 11/7$ or 3.143, close to the true value 3.142 ... Likewise, φ is approximately $(2 \times 7/11)^2$ or 1.620, close to the true value 1.618 ... From the 7: 11 ratio of the *peremos* to the *ukha thebt*, taken

with these approximations expressed in that ratio or its reciprocal, the facts behind propositions 1-4 automatically follow, strongly suggesting nothing more than coincidence.

The fifth proposition likewise follows from the ratio of the *peremos* to the *ukha thebt*. All that is necessary is that the diameter of the Moon shall be approximately 3/11, or 0.2727, times the diameter of the Earth. Sure enough, NASA's lunar factsheet (NASA, 2015) gives the ratio of the lunar to the terrestrial diameter as 0.2725 (Figure 5).

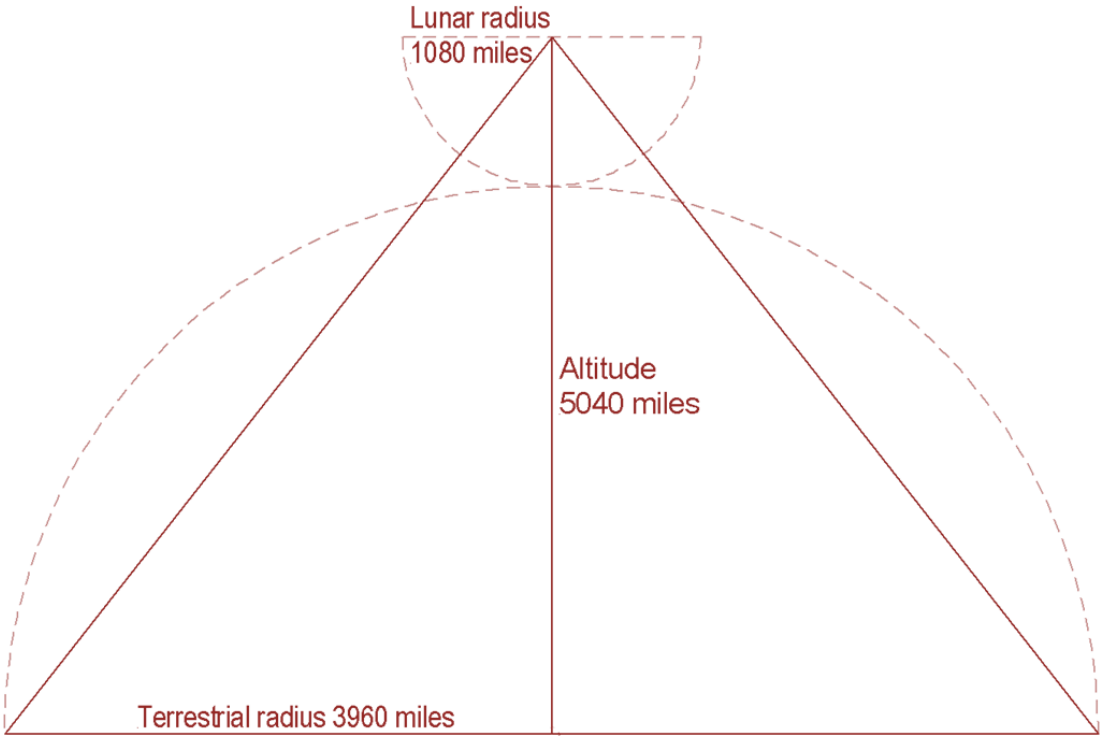


Figure 5. The lunar and terrestrial radii "encoded" in the peremos of the Great Pyramid.

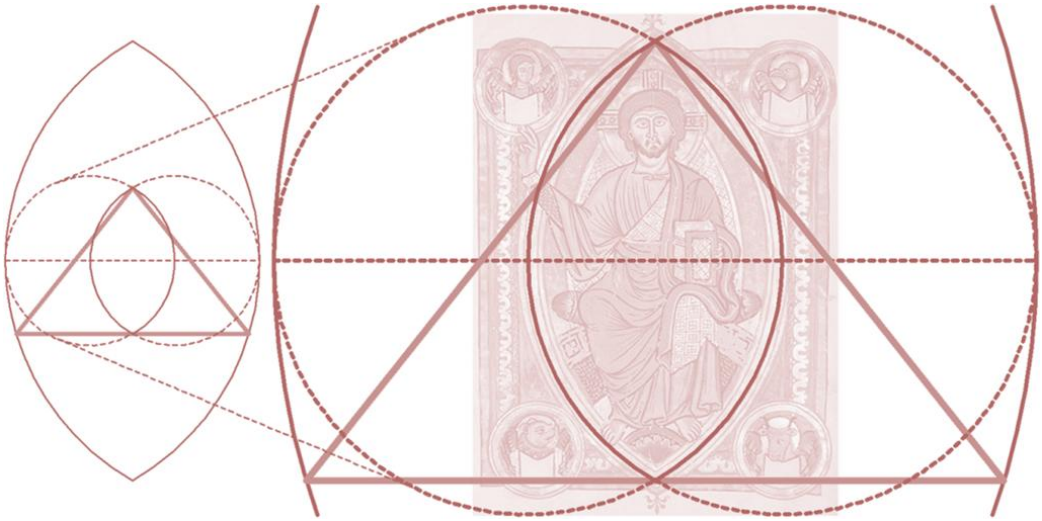


Figure 6. The vesica piscis ("fish bladder") or mandorla ("almond"), often used in Christian and Islamic art.is the symmetrical lens formed by the intersection of two unit circles whose centers are one radius apart (Pedoe, 1995, p. xii). Left panel: concentric vesicae, the outer having thrice the radius of the inner. Main panel: a triangle whose apex lies at the upper cusp of the inner vesica and whose base is the horizontal distance between the arcs of the outer vesica through the lower cusp of the inner vesica.

Proposition 6 has a similarly trivial explanation. The dodecahedron has 12 pentagonal faces each with an angle-sum 540°: total 6480°. The icosahedron has 20 triangular faces each with an angle-sum 180°: total 3600°. The combined angle-sum is 10,080°. The Earth's mean diameter is about 7920 miles; the Moon's diameter is about 2160 miles: the sum of the two diameters is 10,080 miles. Since degrees and miles are distinct units independent of one another, neither of them in use in ancient Egypt, this outcome is an unremarkable coincidence.

The seventh proposition is inexact. The ratio of the *peremos* to the base of the pyramid in Figure 5 is 0.631, while the same ratio in the Great Pyramid is 0.636. The two triangles are sufficiently dissimilar that their approximate similarity is more likely to be attributable to coincidence than to design (Figure 3).

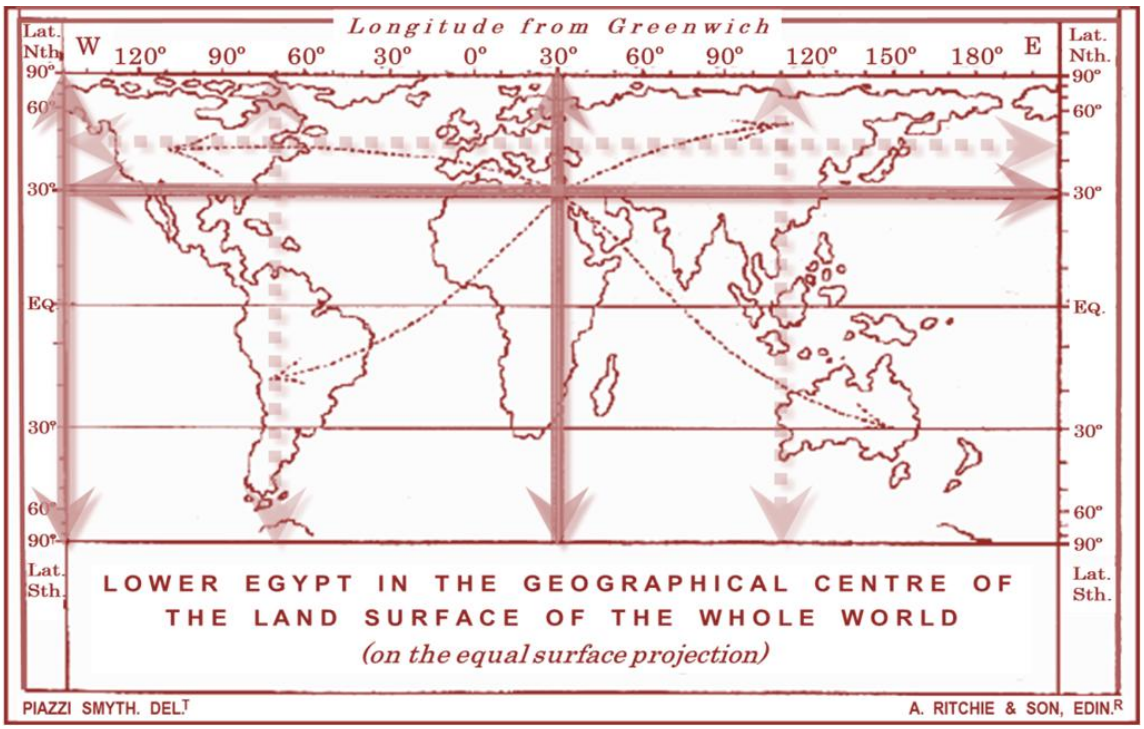


Figure 7. World map from Smyth (1880), enhanced to show lost detail and amended (dotted light gray arrows) to show the true latitudes and longitudes covering the greatest distances overland. Solid dark gray arrows show the latitudes and longitudes centered on lower Egypt, which Smyth had imagined to cover the greatest distances overland. The line of latitude at the edge of the map is a continuation of the line at the center but on the far side of the globe.

The eighth proposition likewise depends upon mere coincidence. There is no evidence that the Egyptians were familiar with the natural logarithms and, therefore, with Euler's number e, the base of the Naperian logarithmic system, which was not described until 1618. Therefore, the proposition that e was encoded in the Pyramid is no more likely than that the digits of the year 1618 are mystically connected to the first four digits of $\varphi = 1.618$ ...

The ninth proposition is false (Figure 7). The two points on Earth at which the lines of latitude and longitude pass over more land than anywhere else are at the mouth of the St. Lawrence River and in western China. Though Smyth (1880) has remained in print since its first edition, it contains many such readily-identifiable errors.

The tenth proposition, again attributable to Smyth, is likewise false. The International Astronomical Union declares the astronomical unit – the mean Sun-Earth distance – as $< 149.6 \times 10^9$ m. Since the Earth's orbital eccentricity varies on a 100,000-year cycle and thus did not greatly differ from today's during the Old Kingdom period a mere 4500 years ago, a billionth of the annual interval

from perihelion to aphelion falls on $[147, 152]$ m. However, the altitude of the Great Pyramid, at 146.6 m, does not quite fall on that interval. It is half a meter below one-billionth of even the perihelion. It is in any event implausible that the Egyptians were capable of obtaining a reliable estimate of the astronomical unit. And why would they capriciously adopt a billionth of it as their *peremos*?

As to the eleventh proposition, due to the dependency of common approximations of π and φ on the $7:11$ ratio any sufficiently small construction error in the alignment of the lateral faces will tend to pull the geometry of that face closer to one of the two fundamental constants and farther from the other. Since an error in one face will tend to cause a compensating error in another face, the approximation to π derivable on one face and to φ derivable on another is very likely to be an inadvertent consequence of these irregularities.

The twelfth proposition, like the sixth, is a contrived coincidence of units unknown to the Egyptians, who did not measure angles, latitudes, or longitudes in today's degrees of arc. The meter was not defined until after the French Revolution, and was then specified as one ten-millionth of the quadrant from the North Pole to the Equator along the Paris meridian, which in any event differs from the Greenwich meridian (the Earth being an irregular oblate spheroid), and was of no more significance to the Egyptians than to us, even if they had been no less capable than the French revolutionaries of conducting the necessary geodesy campaign. In any event, the French estimate of the Paris meridian was inaccurate.

Antihypotheses such as these were elegantly parodied by Umberto Eco (1995, ch. 48):

> He threw open the shutters dramatically and pointed. At the corner of the narrow street and the broad avenue stood a little wooden kiosk, where, presumably, lottery tickets were sold. "Gentlemen," he said, "I invite you to go and measure that kiosk. You will see that the length of the counter is 149 cm – in other words, one hundred-billionth of the distance between the Earth and the Sun. The height at the rear, 176 cm, divided by the width of the window, 56 cm, is 3.14. The height at the front is 19 dm [190 cm], equal, in other words, to the number of years of the Greek lunar cycle. The sum of the heights of the two front corners and the two rear corners is $2(190 + 176)$, which equals 732, the date of the victory at Poitiers. The thickness of the counter is 3.1 cm, and the width of the cornice of the window is 8.8 cm. Replacing the numbers before the decimals by the corresponding letters of the alphabet, we obtain C for 10 and *H* for 8, or $C_{10}H_8$, which is the formula for naphthalene."

These dozen antihypotheses at least have the merit that, to the extent that they are quantitatively expressed, they may be quantitatively falsified. However, the key antihypothesis underlying all of them, namely that what are shown to be scientifically unremarkable coincidences in the Pyramid's dimensions were encoded by aliens or Egyptian architects, is not Popper-falsifiable and falls out-with the purview of science. Nevertheless, if science does not stoop to correct those antihypotheses that are falsifiable, scientifically untenable notions may become entrenched and misguided policies may ensue.

3. Superstitious antihypothesis: "The Earth is flat"

Even today, a doggedly misguided faction of YouTube clickbait-miners contends that the Earth is not a near-spherical planet rotating about its own axis and orbiting the Sun but a flattish disk akin to a dinner-plate with the North Pole at its center and the ice-wall of Antarctica forming the rim (Figure 8).

This central antihypothesis is artfully bolstered by an elaborate compendium of suchlike ingenious but scientifically nonsensical antihypotheses. For instance:

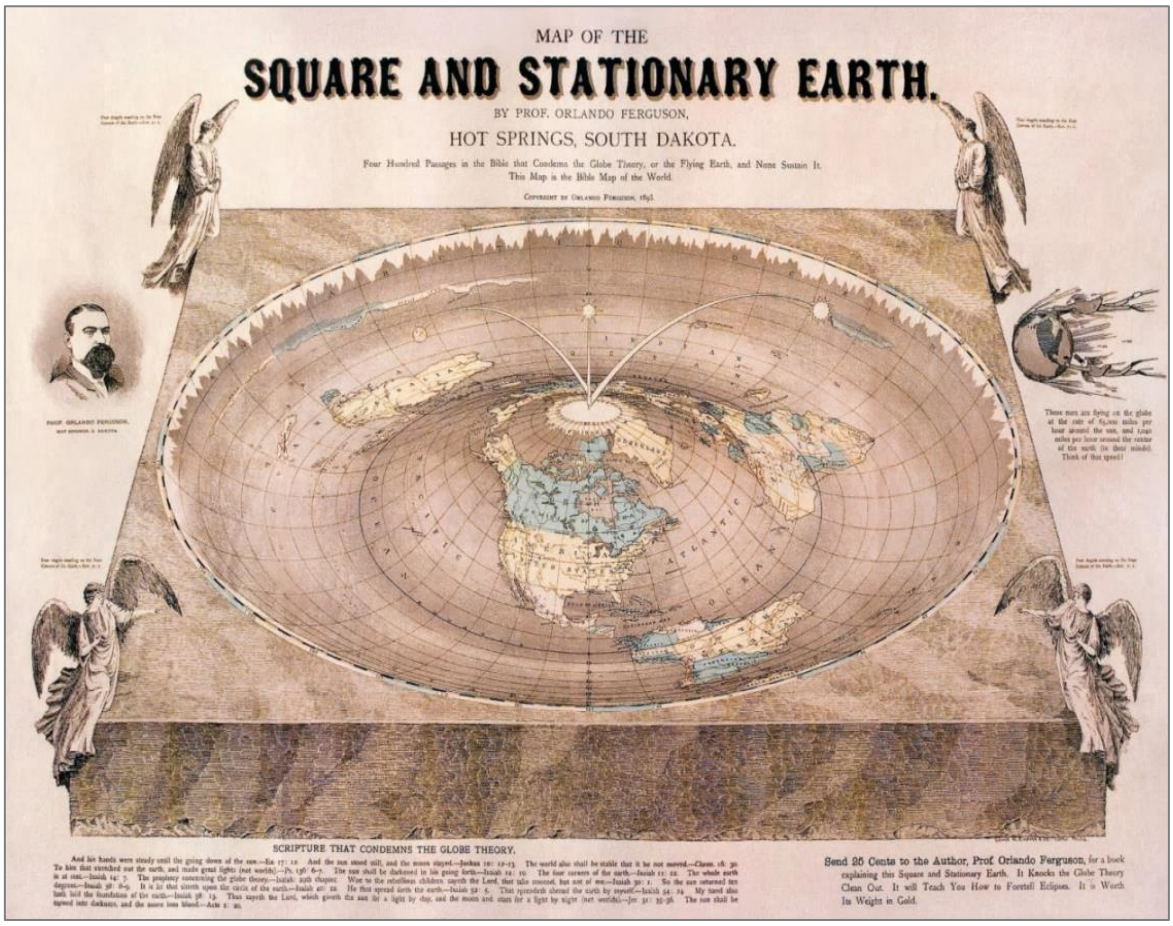


Figure 8. A dinner-plate-Earth image by Professor Orlando Ferguson (1893).

1. The Sun and Moon orbit only 3000 miles directly above the dinner-plate's "equator", the circle halfway between the center of the plate and the rim (3000 miles being the convenient altitude at which roughly the correct zenith angles would be observable);
2. No one can see beyond the icebound rim of the dinner-plate because various nations' armed forces deny access to Antarctica;
3. Space flight is impossible and all NASA films, including those of the Moon landing, of the space station and of the Earth from space, are costly and ingenious fabrications, as in the movie *Capricorn One*;
4. Cities that would be permanently below the horizon from certain vantage-points if the Earth were a spheroid are occasionally visible, proving that the surface of the ocean is not curved (atmospheric refraction due to transient temperature inversions having been meticulously overlooked).

The traditional response to flat-Earthers is to sneer at them. The rational approach, however, is to use Socratic elenchus: i.e., to test their antihypothesis against the null hypothesis using their own premises, deriving an observable conclusion that demonstrates the falsity of theirs in a manner that leaves them no escape route.

Assume *ad argumentum* the flat-Earthers' long-cherished assertion that the Earth is a flattish dinner-plate with the North Pole at its center. Then, wherever one stands on the dinner-plate, the Pole Star will always be visible and the northern constellations will appear to rotate widdershins about it.

On a spherical Earth, however, Polaris will be visible only from the Northern Hemisphere, while the Southern Cross will be visible only from the Southern Hemisphere. The southern constellations are visibly distinct from the northern, but would not be so as seen from the dinner-plate Earth. On the

sphere they will appear to rotate not widdershins but clockwise about the South Pole. It is necessary only to visit both Hemispheres and take time-lapse photographs of the stars on clear nights to demonstrate irrefutably the impossibility of the Flat-Earthers' long-standing dinner-plate model.

4. Superstitious antihypothesis: "The triangle is imperialist"

Ascher (1994) maintains that mathematics is one of the imperialistic mechanisms by which a Western *Weltanschauung* is inflicted willy-nilly upon a reluctant world:

> The relationship between the length of the hypotenuse and lengths of the sides of a right triangle is an eternal truth, but that does not mean that any other culture need share the categories triangle, right triangle, hypotenuse. … A critical issue is that, as it stands, much of mathematics education depends upon assumptions of Western culture and carries with it Western values.

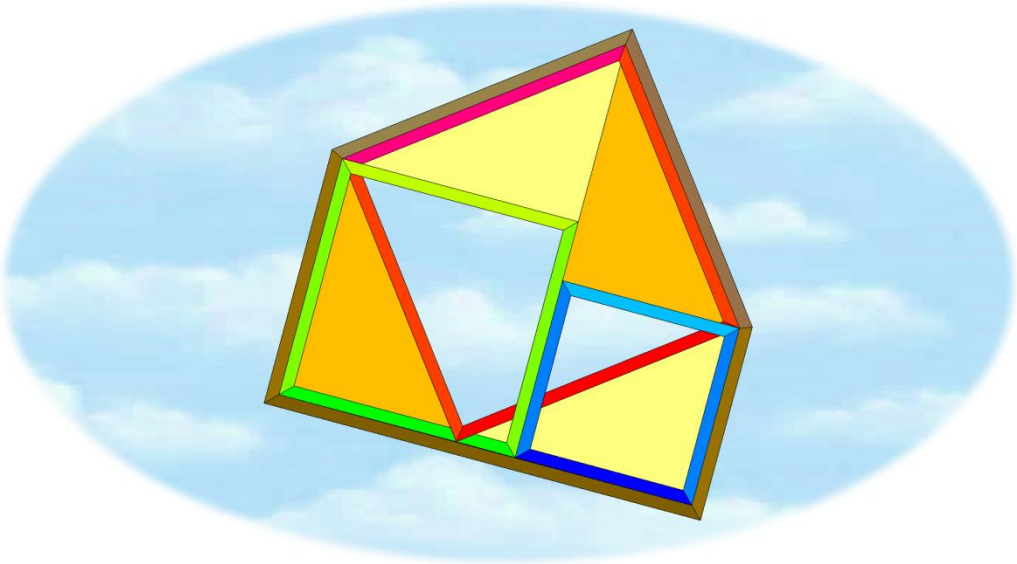


Figure 9. Beweisführung ohne Worte of Pythagoras' theorem. The irregular pentagon comprises either two congruent right-angled triangles and the square on the hypotenuse or the same two triangles translated and the squares on the two catheti. Subtract the two triangles from each disposition and the Pythagorean identity is established. The author's tessellation proof by inclusion is easier to grasp than Euclid's demonstration, justifiably described by Schopenhauer as "a triumph of perversity".

At least the cited passage concedes that there is such a thing as objective truth. The Pythagorean theorem is even described as an "eternal truth", which is not in fact the case. Though Pythagoras is demonstrably true in the Euclidean plane (Figure 9) and even in the hyperbolic domain, it is not true, for instance, on a spherical surface such as that on which we live and move and have our being. Ascher asserts that the triangles to which that "eternal truth" applies are not themselves eternal, in that by implication they are mere instruments of, or in some unspecified fashion contingent upon, "Western cultural imperialism".

Contrary to Ascher's belief, the archaeological and historical evidence is that the triangle and its properties are the common mathematical heritage of most sufficiently advanced cultures. The properties of the triangle were studied, and the Pythagorean identity understood and demonstrated, in the East no less than in the West. Therefore, the assertion that the triangle is an instance of Western imperialism is itself an instance of Western cultural imperialism.

The early Chinese – hardly Western – were well aware of the Pythagorean theorem. The *Zhou Bi Suan Jing* (Han Dynasty, 221-206 BCE) demonstrates it with concision as follows. Figure 10 (left) is a square of area $(a+b)^2$ comprising four congruent right triangles abc each of area $ab/2$, and

the square c^2 on their hypotenuses c. Thus, $(a+b)^2 = 4ab/2 + c^2 = 2ab + c^2$. Deducting $2ab$ from $(a+b)^2$ and from $2ab + c^2$ gives the identity $a^2 + b^2 = c^2$.

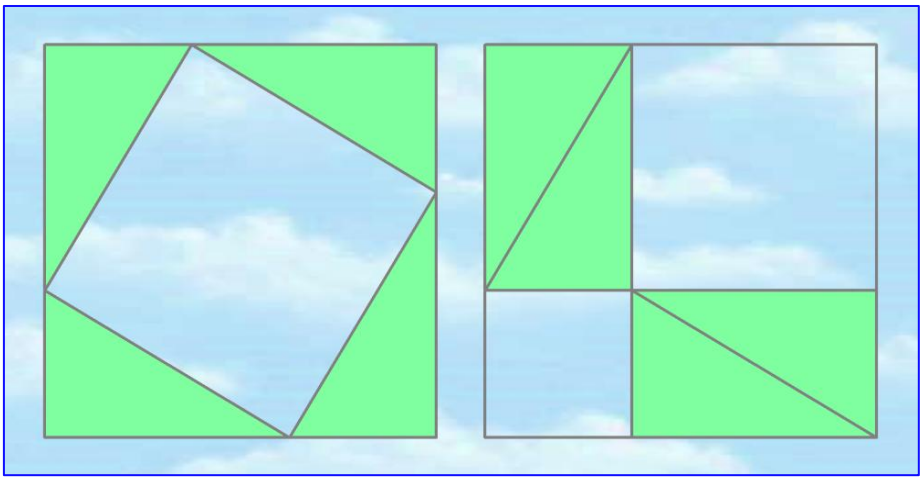


Figure 10. Bhaskara's demonstration of Pythagoras' Theorem

The *Beweisführung ohne Worte* attributed by Coxeter to the fifth-century Indian mathematician Aryabhata (Figure 10) is perhaps the most instantly comprehensible of the hundreds of demonstrations of Pythagoras found in all parts of the world.

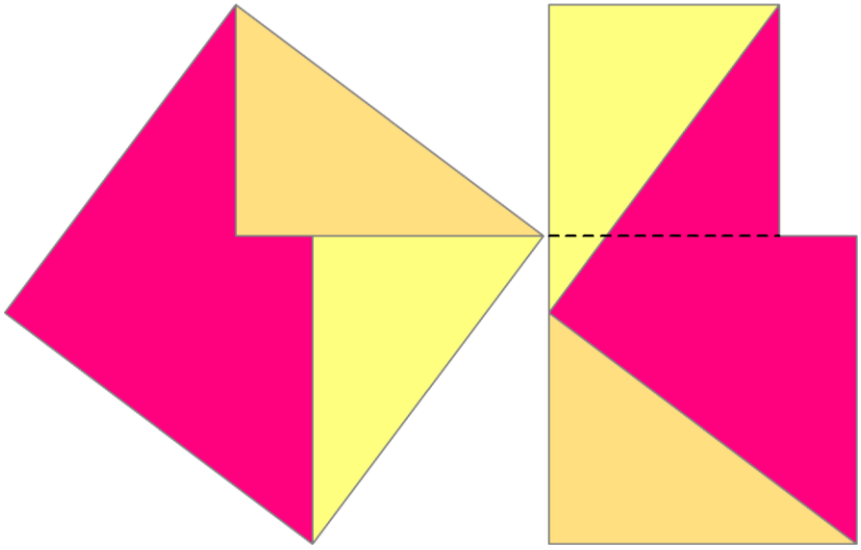


Figure 11. Thabit ibn-Qurra's demonstration of Pythagoras' Theorem.

Al-Sabi Thabit ibn-Qurrah al-Harrani (836-901 CE) of Baghdad devised an elegant tessellation proof (Figure 11), a variant of the earlier demonstration by the fifth-century Indian mathematician Bhaskara, which was itself a variant of the proof attributed to Aryabhata.

These dissection proofs are instantly comprehensible to the student, unlike that of Euclid in the West, which Schopenhauer justly described as "a triumph of perversity".

The Babylonians recorded Pythagorean triples on tablets in cuneiform, perhaps as an exercise for geometry students, such as Plimpton 322, dated 1800 BCE and thus long predating Pythagoras himself (Figure 12).

The tallest structure extant on Earth until the skyscrapers of the late 19th century was no glory of Western architecture but a Pharaoh's tomb all four sides of which remain, 4500 years after they were built, among the largest triangles ever erected by Man on Earth, East or West.

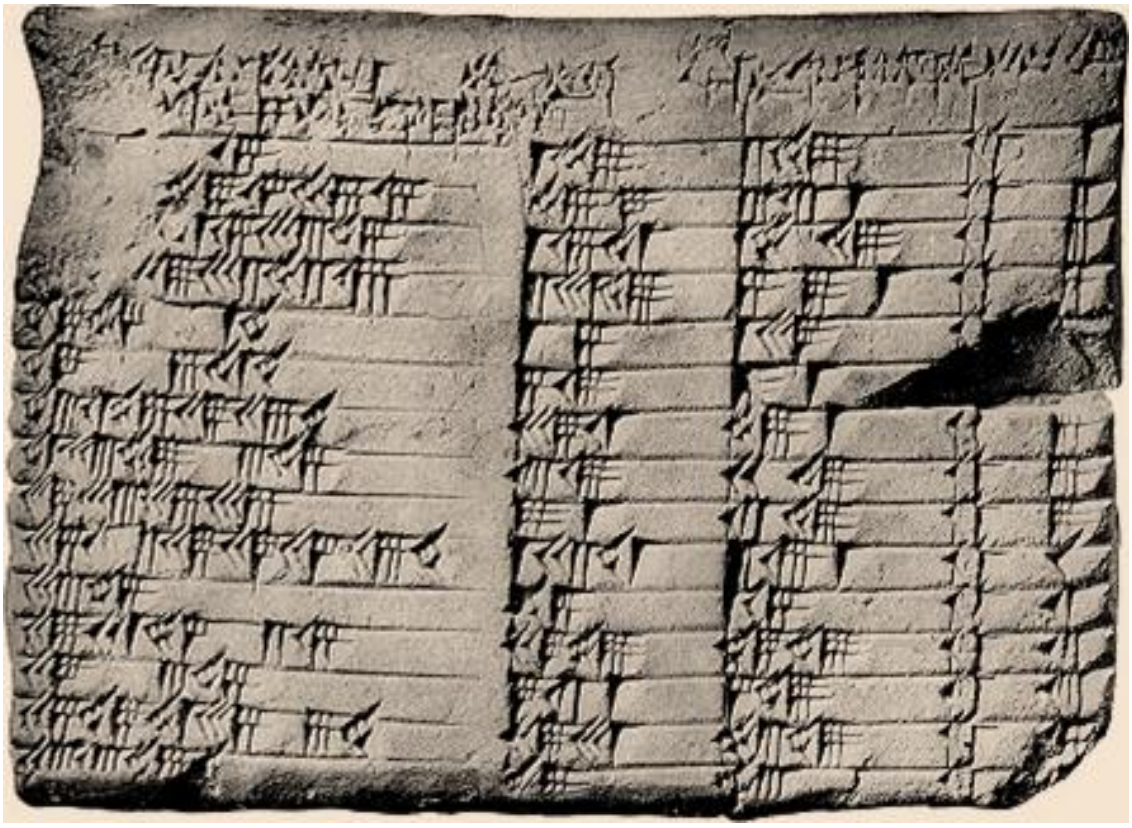


Figure 12. Cuneiform tablet Plimpton 322, listing several Pythagorean triples in sexagesimal notation.

In the face of such evidence for familiarity with the triangle and its properties from so many advanced Eastern civilizations, how did a paper fatuously alleging that the triangle was a manifestation of "Western cultural imperialism" ever pass peer review? One reason is that in recent decades academe has for various reasons, including direct subornation first by Russian and then by Chinese Communism, adopted a narrow-minded, intolerant, totalitarian, anti-Western prejudice.

5. Legalist antihypothesis: "Global warming is a global crisis"

Antihypotheses arising from superstition or prejudice, such as those described above, are these days less likely to prove harmful than those arising from legalism. Consider the notion that anthropogenic global warming is a global crisis demanding urgent and very costly intergovernmental action to mitigate it and thus to prevent "the end of the world" that might otherwise occur by 2100 (Dietz et al., 2007).

At minimum, the four logical sieves recommended in Popper (1934) should be applied to every such notion that is presented for peer review in a scientific journal or promoted by profiteering legalist lobby-groups to generally innumerate politicians and civil servants.

Popper's first sieve: the local-consistency test

The internal logical consistency of a theoretical system may be tested for the presence of any inherent contradictions. Socratic elenchus tests for logical consistency by contrasting the conclusions of two arguments. In logic, an argument is a formal system comprising at least one declarative premise and a conclusion. If the premises entail the conclusion, the argument is valid but the conclusion may or may not be true and the argument may or may not be sound. If the premises entail the conclusion and are all objectively true, the conclusion is necessarily true and the argument is described as not only valid but also sound.

To test an argument *A* for local consistency by Socratic elenchus, the premises of a second, related argument *B* are put to the proponent of *A* for assent. If *B* is well chosen, that assent will be

willingly granted. The conclusions of *A* and *B* are then compared and demonstrated to be mutually inconsistent. The local-consistency test having failed, the conclusions of either *A* or *B* or both must be rejected, in which event, if *B* is well chosen, the proponent of *A* is compelled to concede that *A* is untenable. *Exempli gratia,* the local-consistency test will now be applied to the climate debate.

The notion that unmitigated anthropogenic warming may prove cataclysmic is asserted to be a scientific proposition. It is fostered by legalist scientific societies worldwide – legalist because they are signally intolerant of dissent. Many such societies have issued tendentious, self-serving and more or less hysterical statements about global warming, as have numerous national, international and global entities, including the United Nations' Framework Convention on Climate Change and the Intergovernmental Panel on Climate Change.

IPCC presents itself as a scientific body producing authoritative scientific reports but is in reality a political entity founded at the instigation of a Communist resident in China, which has since profiteered greatly from the extensive transfer of energy-intensive manufacturing industries to it from Western nations where ill-informed global-warming mitigation policies have rendered bulk consumption of electrical power in manufacturing unaffordable.

If the notion of anthropogenic warming sufficient enough to be potentially catastrophic were scientific, it would be consistent with the scientific methodologies asserted by its advocates. That notion depends upon the proposition *A* that that temperature feedback response is the cause of two-thirds to three-quarters (at the extreme, up to nine-tenths) of all warming, and, therefore, of a similarly large fraction of the very broad and refractory interval of uncertainty in climate models' predictions. For instance –

> "Noncondensing greenhouse gases, which account for **25%** of the total terrestrial greenhouse effect, … provide the stable temperature structure that sustains the current levels of atmospheric water vapor and clouds via feedback processes that account for the remaining **75%** of the greenhouse effect" (Lacis et al. 2010).

Recall the universality of truth. Feedback formulism applies to all dynamical systems, from the electronic circuits for which and through which it was originally derived to climate. Therefore, we may offer to the adherents of the current orthodoxy the reference proposition *B* that the feedback formulism applied to the climate must be consistent with the long-established, definitively-demonstrated norms of control theory, the physics of feedback processes in dynamical systems, from which climatology explicitly borrowed and internalized feedback formulism in the 1980s. Our interlocutors must, if they wish to be regarded as scientifically credible, assent to that proposition.

Once they have done so, we are in a position to draw their attention to an inconvenient truth. For a substantial inconsistency, with grave consequences, subsists between official climatology and the wider scientific realm. Due to the barriers between overspecialized scientific disciplines, the resulting flagrant error of physics went unnoticed until recently.

For when climatologists borrowed feedback formulism from control theory they did not understand what they had borrowed. They erroneously defined temperature feedback as responding only to perturbations, such as the 8 K direct warming forced by preindustrial greenhouse gases, but not also to the 30-times-greater input signal, the 255 K emission temperature that would obtain near the surface even in the total absence of greenhouse gases.

For instance, IPCC (2013, p. 1450) defines a "climate feedback" as –

> "an interaction in which a *perturbation* in one climate quantity causes a change in a second, and the change in the second quantity ultimately leads to an additional change in the first. A negative feedback is one in which the initial *perturbation* is weakened by the changes it causes; a positive feedback is one in which the initial *perturbation* is enhanced. In this Assessment Report, a somewhat narrower definition is often used in which the climate quantity that is *perturbed* is the global mean surface temperature,

> which in turn causes changes in the global radiation budget. In either case, the initial *perturbation* can either be externally forced or arise as part of internal variability." [Author's emphases]

IPCC's definition repeatedly mentions *perturbation* as the driver of feedback but is silent on the emission-temperature feedback response. The definition should read:

> "**Temperature feedback,** in Watts per square meter per Kelvin of emission temperature or a perturbation thereof, induces a **feedback response** in Kelvin. Positive feedback amplifies output; negative feedback diminishes it."

The equilibrium temperature in 1850 was the 287 K observed global mean surface temperature (Morice et al. 2020). Climatology imagines that the emission temperature that would obtain near the surface in the absence of greenhouse gases is 255 K. The natural greenhouse effect is then the 32 K difference between these two. The directly-forced warming by the preindustrial noncondensing greenhouse gases present in 1850, before our influence became appreciable, was approximately 8 K. These are values derivable from mainstream climatology and planetary physics. Thus far, there is little argument between adherents to and dissenters from the orthodoxy on climate.

However, climatologists erroneously drew from the above agreed quantities the erroneous conclusion that the 32 K natural greenhouse effect comprised just two components: the 8 K reference sensitivity directly forced by the preindustrial greenhouse gases and 24 K feedback response thereto. The implications of this conclusion were that feedback response was about thrice the reference sensitivity to which it was a response; that, therefore, the eventual warming by (or equilibrium sensitivity ECS in response to to) the ∼1 K direct or reference warming RCS by doubled CO_2 would be approximately $32/8 = 4$ K; and that, therefore, unless the West were shut down there was a 10% probability that the Earth would come to an end by 2100 (e.g., Dietz et al., 2007). Sure enough, current models (Zelinka et al., 2020) predict that the 1 K reference doubled-CO_2 sensitivity will become close to 4 K equilibrium doubled-CO_2 sensitivity ECS. Climatology, therefore, implicitly assumes that unit feedback response is near-invariant with global temperature.

Climatologists had unfortunately, and expensively, neglected the observably fact that the Sun is shining. For in any feedback-moderated dynamical system the feedback processes must necessarily respond not only to perturbations in the input signal but also to the input signal itself. In the climate, the input signal – the overwhelmingly predominant temperature signal, representing almost nine-tenths of current global mean surface temperature – is the 255 K emission temperature that would obtain near the Earth's surface in the absence of any greenhouse gases, simply because the Sun is shining.

It follows that the 32 K natural greenhouse effect was the sum of not two but three components: the 8 K natural reference sensitivity forced by the preindustrial noncondensing greenhouse gases, the feedback response thereto, and the far larger feedback response to the 255 K emission temperature. Therefore, the equilibrium sensitivity to doubled CO_2 (ECS) is not $32/8 \approx 4$ K but more like $(255 + 32)/(255 + 8) \approx 1.1$ K. This result, like that of climatology, assumes near-invariance of unit feedback response with temperature. However, it is possible to verify that unit feedback response is indeed near-invariant with temperature across the narrow interval from emission temperature to current temperature.

For much the same ECS as was obtained above from preindustrial data may also be obtained by the distinct energy-balance method (first described in Gregory 2002) applied to the industrial era, using recent, midrange, mainstream data from 1850-2020. For 3.52 W m^{-2} doubled-CO_2 forcing (Zelinka et al. 2020), 3.2 W m^{-2} net period anthropogenic forcing from all causes (NOAA Annual Greenhouse-Gas Index: Butler et al., 2021), 1.04 K period observed global warming (HadCRUT5: Morice et al. 2020), 0.87 W m^{-2} Earth energy imbalance (von Schuckmann et al. 2020) and the 70%

anthropogenic fraction of period warming and hence of Earth energy imbalance (Wu et al. 2019), ECS is as follows:

$$\mathbf{ECS} = \mathbf{3.52}\,\frac{\mathbf{70\%\ of\ 1.04}}{\mathbf{3.2 - 70\%\ of\ 0.87}} \approx \mathbf{1.0\ C^{\circ}} \qquad \mathbf{(2)}$$

The two corrected results, obtained by different methods, cohere, confirming not only that unit feedback response is near-invariant with temperature but that it is negligible. With little error, feedback response may safely be ignored altogether in deriving equilibrium sensitivities.

Without the error arising from the inconsistency between the climate orthodoxy's erroneous definition of feedback and the definition universally applied in describing all other dynamical systems, the climate "emergency" vanishes as though it had never been.

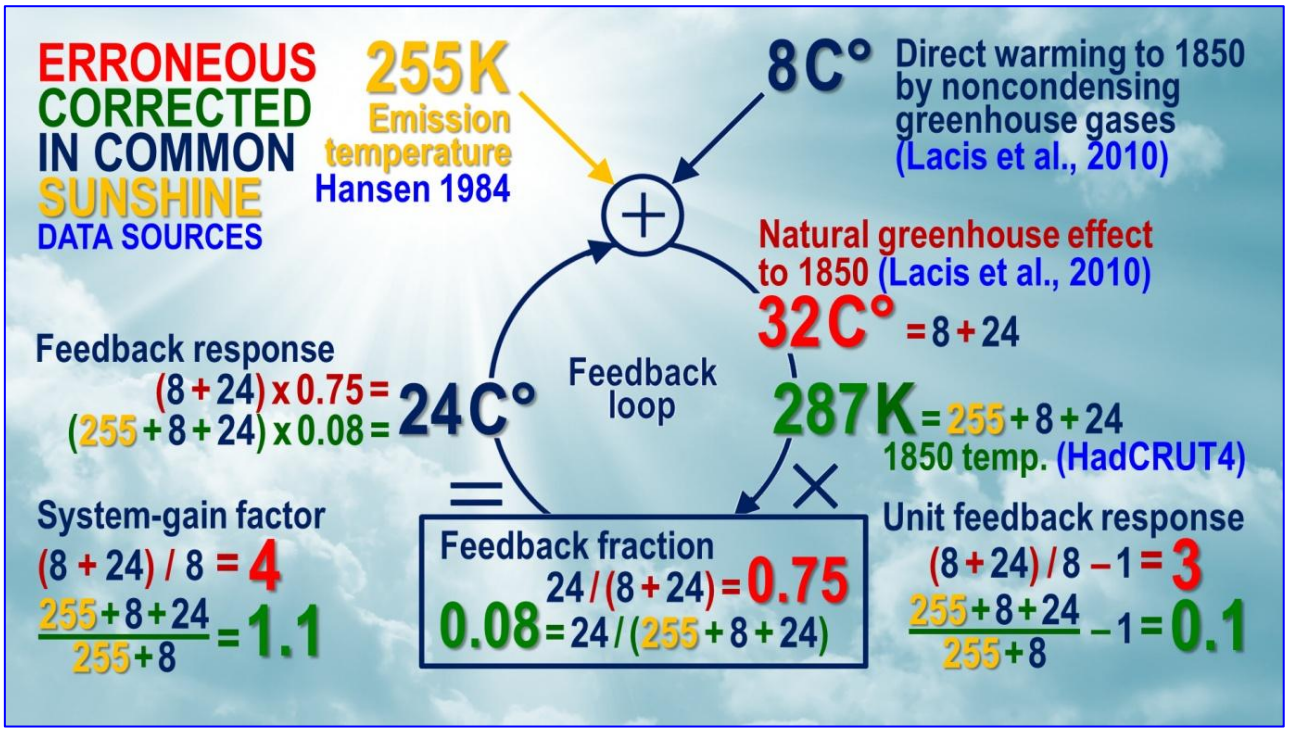


Figure 13. Climate feedback-amplifier block diagram. Erroneous values are in red; the emission temperature neglected by climatology is in yellow; corrected values are in green; values common to the erroneous and to the corrected approach are in dark blue; data sources are in bright blue. Values are rounded for clarity.

Figure 13, a simple control-theoretic block diagram for feedback amplification in the climate, demonstrates the differences between climatology's unfortunate neglect of the emission-temperature feedback response and the corrected position. It will be seen that climatology, misled by its misunderstanding of control theory, has overstated the unit feedback response by a factor 30, the fraction of equilibrium output represented by feedback response by a factor 10 and consequently the system-gain factor, and thus equilibrium sensitivity, by a factor 4. These order-of-magnitude errors misled climate modelers into expecting, and hence predicting, approximately four times as much global warming as is scientifically tenable.

How did so gross an error, with such grave and costly consequences, ever arise? Before sufficiently well-resolved satellite radiative flux densities and stratified bathythermographic ocean temperature profiles became available in about 2010, the energy-balance method was incapable of constraining equilibrium sensitivities reliably. Likewise, no response to any feedback process can be quantified by measurement, and even the aggregate feedback response could not be empirically derived.

Accordingly, when feedback formulism was imported into climatology in Hansen (1984) and Schlesinger (1988), a frame of reference to provide a basis for testing models' outputs was required.

Since satellites had measured the total solar irradiance as 1365 W m^{-2} and the mean terrestrial albedo as 0.3, climatologists were able to derive emission temperature R_0 via the Stefan-Boltzmann equation (2), in which the eponymous constant is 5.6704 x 10^{-8} W m^{-2} K^{-4} and the divisor 4 is the ratio of the Earth's surface area to that of its great circle:

$$\boldsymbol{R_0 = \left[\frac{1365(1-0.3)}{4 \times 5.6708 \times 10^{-8}}\right]^{¼} = 255\ \mathrm{K}} \qquad \textbf{(3)}$$

Even here, climatologists perpetrated an elementary error. They did not realize that at emission temperature the absence of greenhouse gases in the air would remove the clouds, reducing the albedo to 0.1.

Correcting this further error increases emission temperature from 255 to 271 K, and thus halves the natural greenhouse effect from 32 to 16 K, halving the system-gain factor (the ratio of equilibrium to reference sensitivity) from $32/8 = 4$ to $16/8 = 2$, correspondingly halving all global-warming predictions, even before taking account of the major error of neglecting the feedback response to emission temperature.

Once the correction of climatology's major error of neglecting the sunshine is made, the precise value of emission temperature is irrelevant: it is so much larger than the direct warming by preindustrial noncondensing greenhouse gases that any value from 255-271 K may be adopted without altering ECS.

Once climatology had made these errors, it tuned its models to predict equilibrium sensitivities of about 4 K, consistent with its erroneous system-gain factor 4. Then, when the satellite and bathythermograph data became available, allowing the energy-balance method to yield a far simpler, far more robust and far less alarming equilibrium sensitivity of 1-1.5 K, climatology had already set its heart on the high equilibrium sensitivity that had arisen from its errors.

Climatology was, therefore, unwilling to accept that the inclusion of the large feedback response to emission temperature as a component in the 16-32 K natural greenhouse effect, with a corresponding reduction in the feedback response to direct warming by preindustrial noncondensing greenhouse gases, provides a simple and robust benchmark against which models' predictions of global warming may be reliably subjected to falsification.

It is further demonstrable that the general-circulation models of climate, though they have many uses, are valueless for predicting the evolution of global temperature in response to a forcing.

First, the published estimates of the feedback fraction f derived from the models fall on the interval $[0, 1]$, implying system-gain factors $A = (1 - f)^{-1}$ on the interval $[1, \infty]$, rendering equilibrium sensitivity the least well-constrained quantity in the entire history of physics.

It is this broad interval of uncertainty that compelled climatologists to carry out the erroneous preindustrial calculation, neglecting the large emission-temperature feedback response, that led them to imagine that equilibrium warming would be four times direct warming.

Secondly, the models are required to solve the Navier-Stokes equations (Figure 14) for each of half a million atmospheric cells 100 km x 100 km x 1 km, and to do so repeatedly in a sequence of small, successive time-steps over periods of up to several centuries, the output of each time-step serving as the input to its successor. The chief processes being modeled, such as the resonance of the individual CO_2 molecules on interaction with photons in the principal absorption band of CO_2, or the Svensmark nucleation of water-vapor molecules to form cloud droplets, of course occur at sub-grid scale. The models do not capture them and must parameterize them. In modeling, "parameterize" is a long word for "guess".

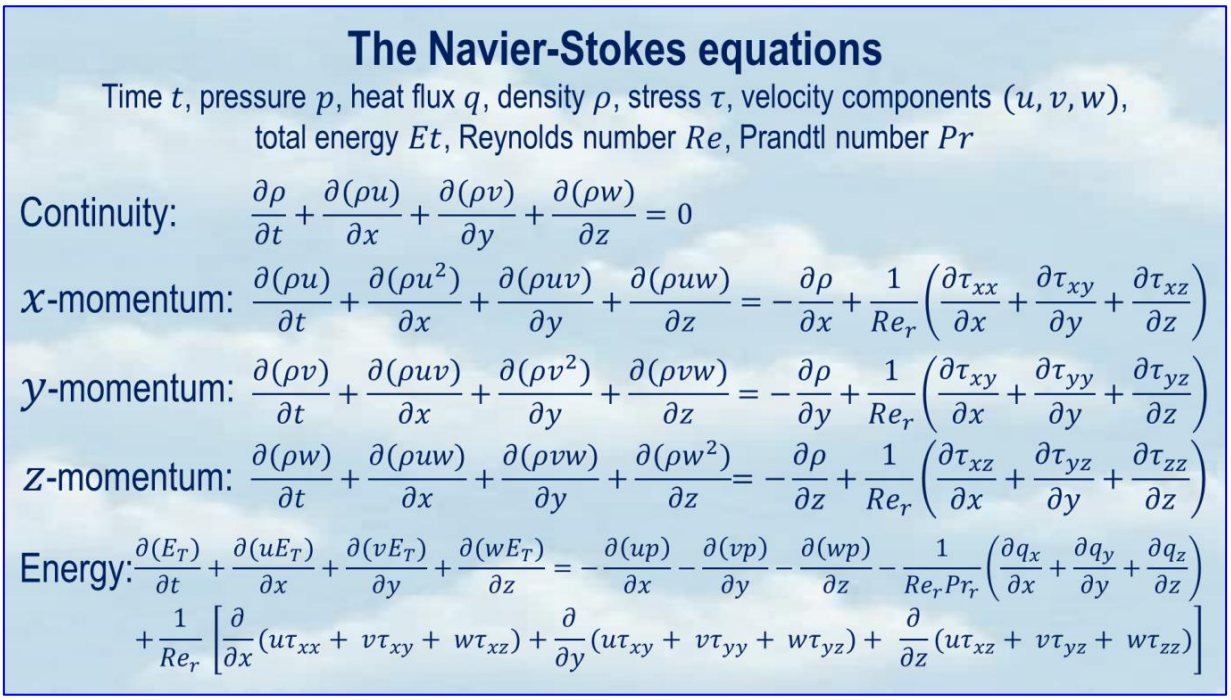


Figure 14. The Navier-Stokes equations

Thirdly, there are so many adjustable parameters that any desired output may be achieved, whether or not that output bears any relation to observed reality. In fact, because climatology has not yet realized its chief error – forgetting that the Sun is shining and would generate its own large feedback response even in the absence of any greenhouse gases at the outset – in 1990 the Intergovernmental Panel on Climate Change predicted two and a half to three times as much anthropogenic global surface and lower-troposphere warming from 1991-2020 as was subsequently observed, and similar overstatements have been observed in ocean-surface temperatures, in mid-troposphere temperatures and in bulk-troposphere temperatures.

These numerous and grave overstatements have been very widely unreported. So refractory are the complex partial differential equations of Navier-Stokes that no closed-form solutions to the equations have been found: indeed, the Clay Mathematical Institute offers $1 million to anyone who can find such solutions. In the absence of closed-form solutions, it is necessary to attempt to solve the equations numerically – a highly uncertain process.

Fourthly, any uncertainty in the initial conditions of any general-circulation model must propagate in quadrature through each successive time-step. Frank (2019) demonstrated the devastating effect of propagated uncertainty in just one of the thousands of initial conditions in the models – the 4 W m^{-2} annually-averaged uncertainty in the low-cloud fraction. This one uncertainty exceeds the 0.04 W m^{-2} total predicted annual anthropogenic signal by two orders of magnitude. Propagated over a century, this single uncertainty leads to an uncertainty interval of at least ±15 K, so that any prediction falling within that capacious uncertainty envelope is statistically meaningless (Figure 15). Whatever else the models can do, therefore, they are formally demonstrated to be incapable of predicting global temperature.

It is for reasons such as these that serious scientific observers do not consider climatology's use of general-circulation models in equilibrium-sensitivity studies to be worthwhile. Yet the entire case for concern about our influence on the climate is founded upon the outputs of these models, even though it is formally demonstrated not only that they are incapable of making any statistically-meaningful predictions but also that their outputs are as consistent with climatology's error of control theory as they are inconsistent with observed warming, of which there has been none at all for six or seven years.

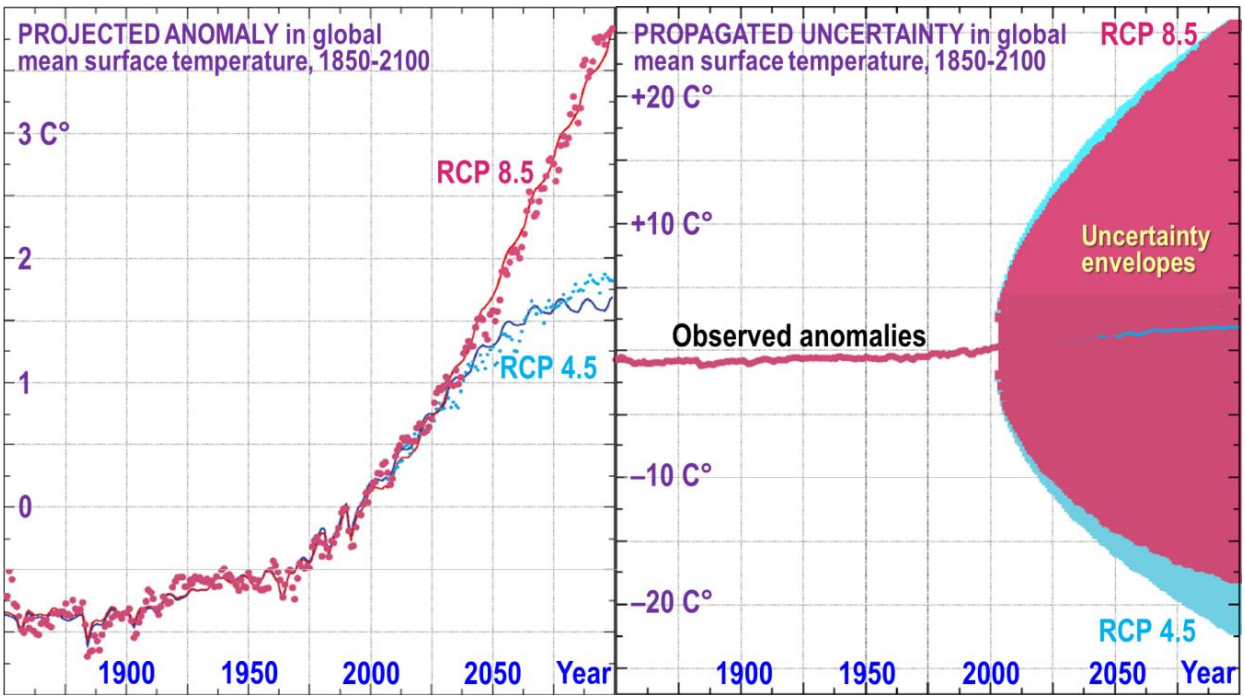


Figure 15. The [2, 5.7] *K interval of current models' global-warming predictions falls entirely within the broad propagated-uncertainty envelope, and is thus guesswork.*

Popper's second sieve: the external-consistency test

Popper's second sieve entails the separation of the hypothesis into its empirical and its logical elements, making the logical form explicit, whereupon it can be tested to determine its consistency with the wider principles of logic. A dozen commonly-asserted antihypotheses concerning the extent of Man's influence on the terrestrial climate will illustrate the operation of the second sieve:

1. "Ninety-seven percent of scientists agree: climate change is real, man-made and dangerous" (tweet from Mr Obama's Twitter account, 2013).
2. The consensus should be accepted because it is a consensus of experts (Anderegg et al. 2010).
3. The consensus should be accepted because it is a consilience of evidence (Cook et al. 2013).
4. Only a strong warming effect from CO_2 explains 60 years' warming (IPCC 2013, Figure SPM.6).
5. Global warming is accelerating, so we are to blame (IPCC 2007, FAQ Figure 3(1) caption).
6. Global warming endangers polar bears as a species (EPA 2009).
7. "Indications … confirm that the world is warming. For instance, … ocean heat content is increasing, …" (UK Committee on Climate Change).
8. CO_2 concentration has risen; warming has occurred; therefore the former caused the latter (mass-media reports, *passim*).
9. Global warming caused storm Sandy and typhoon Haiyan (mass-media reports, *passim*).
10. Melting Arctic sea ice indicates manmade global warming (IPCC 2013, SPM).
11. Those who spurn the consensus are paid by fossil-fuel interests (mass-media reports, *passim*).

12. Those who spurn the consensus should be executed (academics and pressure groups, *passim*).

It is telling that, though these dozen antihypotheses embody the pretexts most commonly advanced for drastic intervention to mitigate global warming, only the first is expressed quantitatively. It is a Tweet from the account of Mr Obama that appeared shortly after publication of Cook *et al.* (2013), in which it had been falsely alleged that 97.1% of 11,944 climate-related papers published in the reviewed journals over the 21 years 1991-2011 had explicitly stated that recent global warming was mostly anthropogenic.

The antihypothesis that a "consensus" had been identified was quantitatively refuted by Legates *et al.* (2013), who examined Cook's list of all 11,944 abstracts and found that Cook *et al*. had themselves marked only 64 abstracts, or 0.5% of the entire sample, as stating that that recent global warming was mostly anthropogenic. Examination of those 64 papers demonstrated that only 41 of the 64, or 0.3% of the entire sample, had thus written. It is for this reason, among many others, that argument from an alleged consensus, even of alleged experts, has no place in the scientific method. Indeed, its deployment indicates not sound science but interference with and politicization of scientific reasoning and argument by circumventing the formerly universal academic requirement that any proposition, however fashionable or venerable, only gains acceptance by little and little, and only after prolonged and searching scientific scrutiny.

At first blush, it may appear that the remaining 11 propositions will prove more difficult to falsify, since they are qualitative rather than quantitative. However, all 12 propositions share a common characteristic, not immediately obvious, by which each is shown to be an antihypothesis. Like the first, they are all instances of logical fallacies – categories of specious argument in which the premises do not validly entail the conclusion. Some 2350 years ago, Aristotle (c. 350 BCE, translated by Pickard-Cambridge) first categorized the dozen commonest fallacies in human discourse in his *Sophistical Refutations*. The medieval schoolmen would later give them their Latin names. The 12 commonly-asserted antihypotheses about climate change enumerated above are instances respectively of –

1. The headcount fallacy (*argumentum ad populum*), in that the fact of a consensus – supposing that it exists at all, which should not be assumed and is in the present instance proven false – demonstrates neither the truth nor the falsity of the proposition to which its supporters are said to adhere;
2. The fallacy of appeal to authority (*argumentum ad verecundiam*), in that even those with reputations as experts may be inexpert, prejudiced or simply wrong;
3. The red-herring fallacy (*argumentum ad ignorationem elenchi*), the fundamental fallacy of relevance, in that insentient evidence cannot hold opinions and, in any event, points both ways on the climate question, as the earlier internal-consistency test demonstrated;
4. Argument from ignorance (*argumentum ad ignorantiam*) in that unawareness of a natural cause of observed warming does not demonstrate that there is no such cause;
5. Argument from false cause (*non causa pro causa*) in that some or all of observed global warming may be of natural origin, so that, if some of the industrial-era warming were natural, the industrial-era feedback fraction might be still less than the 0.05 derived above;
6. Argument from misplaced pity (*argumentum ad misericordiam*), in that the polar-bear population is growing robustly, particularly where the Arctic has warmed fastest, as a report for the World Wide Fund for Nature inadvertently revealed in 2002, and polar bears survived the last interglacial, which was appreciably warmer than the present;

7. Circular argument (*argumentum ad petitionem principii*), in that the ocean heat content is calculated from measurements of ocean temperature. Increased ocean heat content is thus a consequence, not a cause, of directly-measured ocean warming.

8. The "after, therefore because" fallacy (the *post hoc ergo propter hoc* subspecies of the *non causa pro causa* fallacy), in that correlation, though it may be suggestive of correlation, does not necessarily entail it;

9. Inappropriate argument from the general to the particular (argument from accident or *argumentum a dicto simpliciter ad dictum secundum quid*), in that the slow rate of observed global warming rules out attribution of any recent extreme-weather event to warming (IPCC, 2012, *passim*; IPCC, 2013);

10. Inappropriate argument from the particular to the general (argument from converse accident or *argumentum a dicto secundum quid ad dictum simpliciter*), in that Antarctic sea ice has recently been near a satellite-era maximum and global sea-ice extent shows a rising trend since 1979 (Parkinson 2019);

11. Assault on the personal attributes or reputation of the scientist rather than on the soundness of his argument (*argumentum ad hominem,* a disfiguring subspecies of *ignoratio elenchi*), in that what matters scientifically is the quality of a scientist's research and the soundness of his scientific reasoning and argumentation, not his supposed character defects or the sources of his funding; and

12. The argument of force (*argumentum ad baculum*) in that, as Nazi and Soviet precedents have demonstrated, the brutal mistreatment of those who disagree on scientific grounds with the legalist position is an extreme, unwarrantable and sometimes fatal interference in academic freedom.

All of the above 12 propositions are antihypotheses because they are logical fallacies from which no conclusion can be drawn except that their proponents are insufficiently educated. The 12th and most dismal argument, the *argumentum ad baculum,* is of particular relevance to the debate about climate: for legalists demand that authors of research such as the present work should be tried, imprisoned, re-educated, sent to psychiatric institutions or even executed. A non-exhaustive list of such demands over the past dozen years is at Annex A.

Popper's third sieve: consistency with existing theory

The third sieve is the comparison of a new hypothesis with existing hypotheses that are either demonstrated or at least not yet disproven after expression in scientific and preferably quantitative terms in a learned journal, followed by a reasonable period for falsification. Climatology's method of deriving the temperature feedback fraction is inconsistent with control theory as enunciated, for instance, in Black (1934) or Bode (1945), and inconsistent with experiments commissioned by the author of the present work at a government laboratory, in that it errs by neglecting the emission-temperature feedback response and thus inadvertently adding it to, and miscounting it as though it were part of, the actually minuscule feedback response to direct warming forced by the preindustrial noncondensing greenhouse gases. Therefore, either the pre-existing and formally-demonstrated feedback theory is incorrect (though it is of course well-established and its essential characteristics may be demonstrated using a simple electronic feedback-amplifier circuit as an analog computer) or climatology's current basis for its prediction that equilibrium sensitivity to doubled CO_2 is high is inconsistent with existing feedback theory.

Popper's fourth sieve: empirical falsification

The fourth sieve is the testing of the normative or null hypothesis by the empirical application and consequent falsification of the conclusions derived from the alternative hypothesis. For empirical experience, in the Popperian analysis, cannot tell us which hypotheses are true, but it can tell us

which are false. It is already clear that the central predictive hypothesis advanced by IPCC with what it called "substantial confidence" in 1990 is failing. The least-squares trend on the anthropogenic fraction of the satellite monthly mean lower-troposphere temperature anomalies (UAH, 2021) is equivalent to 1.1 K century^{-1} (Figure 16) during the 30 years 1991-2020, about a third of the 3.4 K century^{-1} midrange estimate of originally predicted by IPCC (1990) but near-identical to the 1.1 K century^{-1} corrected midrange estimate derived earlier during the internal-consistency test.

IPCC (2013), though compelled to halve its medium-term predictions from 3.4 to 1.7 K century^{-1}, has not made corresponding reductions in its long-term predictions of equilibrium doubled-CO_2 sensitivity.

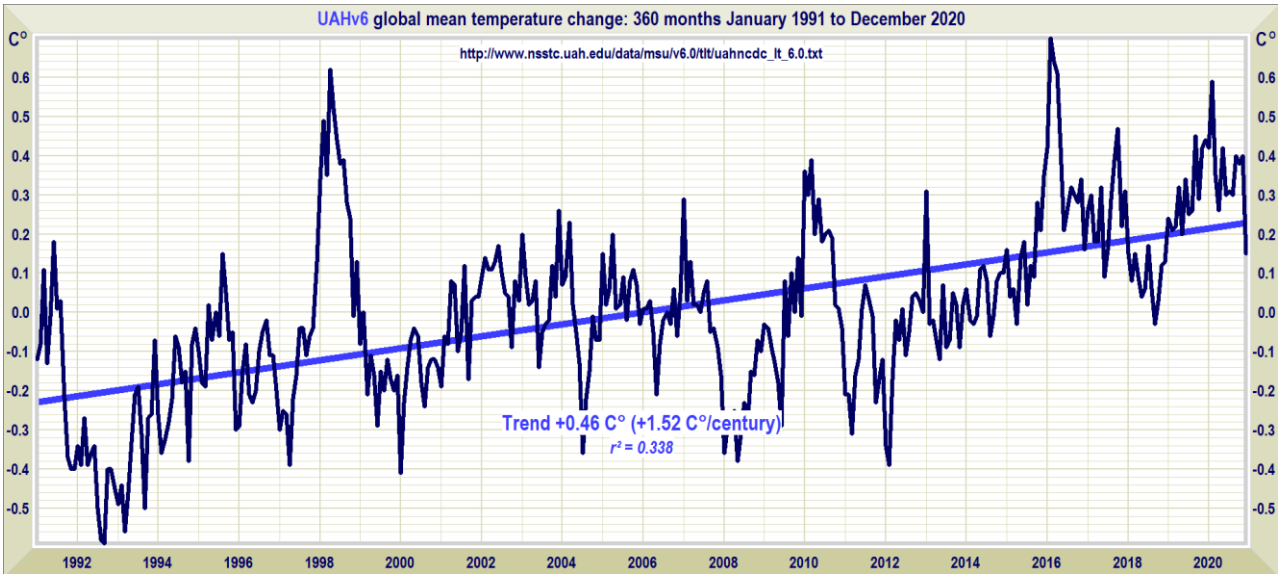


Figure 16. Of the 1.52 *K century*$^{-1}$*-equivalent global warming trend observed over the 30 years 1991-2020,* 70%*, or* 1.1 *K, was anthropogenic, one-third of what models had predicted.*

6. Legalistic antihypothesis: "Mitigation is cost-effective"

The economic case for mitigating global warming asserts that the welfare benefits of immediate mitigation of allegedly catastrophic global warming exceed the welfare losses anticipated from later adaptation to its consequences. Stern (2006) set out the premises:

1. Unmitigated global warming will be 3 K in the 21st century, costing 0-3% of GDP.
2. Since Stern estimated that 21st-century warming may reach 11 K by 2100, his estimated probability that global warming will end the world by then is 0.1 (Dietz et al. 2007).
3. To prevent the end of the world, a submarket intertemporal discount rate of 1.4% (rather than a mid-market rate such as the U.S. Treasury's 7%) should be adopted for appraisals of measures to abate global warming.

Stern concludes from these premises that global-warming mitigation is not only justifiable but mandatory on grounds of preventing extinction. Applying the falsification principles enunciated earlier, we may examine Stern's quantitative argument quantitatively.

In economic terms, intervention to abate greenhouse-gas emissions and thus to mitigate global warming is only justifiable if one assumes a significant probability that unmitigated anthropogenic warming will end the world by 2100. In the light of the findings discussed here, that probability is actually zero. Therefore, a standard intertemporal analysis, such as the following very simple but reliable analysis, is permissible.

The welfare losses and benefits of achieving global net-zero CO_2 emissions by 2020 will now be assessed. The first question is this: If the world were to cease to emit CO_2 by 2050, how much

global warming would be forestalled? What would be the direct welfare benefit in CO_2 emissions abated by that policy?

Business-as-usual CO_2 concentration by 2050 – if CO_2 concentration continues to grow unabated as it has throughout recent decades – would rise from 415 ppmv in 2020 to **497 ppmv** in 2050.

CO_2 concentration by 2050, with a straight-line reduction from 2021's emissions to zero emissions in 2050, would be $(415 + 497)/2$, or **456 ppmv.**

The CO_2 forcing coefficient, at midrange, is the ratio of the currently-estimated $3.52\ \mathrm{W\,m^{-2}}$ doubled-CO_2 forcing (Zelinka et al. 2020) to ln 2: i.e. **5.078**.

The CO_2 forcing abated over the 30-year term would then be $5.078 \ln(456/497)$, or $\mathbf{0.44\ W\,m^{-2}}$.

The industrial-era equilibrium-sensitivity parameter is the ratio of the equilibrium anthropogenic warming of 0.9 C° from 1850-2020 to the $3.2\ \mathrm{W\,m^{-2}}$ anthropogenic forcing: i.e., $0.28\ \mathrm{C°\ W^{-1}\ m^2}$.

Equilibrium warming abated by global net-zero emissions is the product of $0.28\ \mathrm{C°\ W^{-1}\ m^2}$ and the $0.44\ \mathrm{W\,m^{-2}}$ forcing abated by 2050 is **0.12 C°**, or less than one-eighth of a degree.

With the principal welfare benefit quantified and found to be negligible, the welfare losses arising from the policy may be assessed. Here, for simplicity, only the direct cost of the policy will be assessed. We shall not consider the far larger indirect costs caused by overpriced fuel and power, as well as by environmental damage from low-energy-density wind and solar power and by prevention of affordable and dispatchable electrification for the billion people who cannot so much as turn on a 60-Watt lightbulb for four hours a day (the International Energy Agency's less than generous definition of "access to electricity").

The cost of buying a barely measurable reduction of just 0.12 C° in global warming can be estimated from the (probably optimistic) estimate by HM Treasury that the cost of achieving net-zero in the UK, which accounts for 0.88% of global emissions, would rise from £15 billion per year in 2020 to **£70 billion per year** in 2050. The Grid authority estimates the realistic cost of net-zero as almost three times the Treasury estimate.

The discounted cost of net-zero for the UK alone, assuming a straight-line inflation-adjusted cash increase from £15 billion p.a. to £70 billion p.a., discounted at a commercial 7% p.a., would be **£440 billion** at present value, or at least **£1 trillion** if the Grid authority's estimates are correct.

The discounted cost of attaining global net-zero by 2050 would be £55 trillion **($76 trillion)**, or more like **$200 trillion** based on the Grid authority's estimate.

The cost of abating 1 C° of global warming would thus exceed £400 trillion **($560 trillion)**. The cost of abating 3.7 C° currently-projected ECS would exceed £1.5 quadrillion **($2.1 quadrillion)**, or up to **$5 quadrillion** if the Grid authority is right about the Treasury's cost understimate.

These very large welfare losses do not purchase any net welfare benefits, for there will be far too little warming to cause net harm. Therefore, there is no statable case at all for emissions abatement. The slow and modest warming that is foreseeable will be net-beneficial, and the very heavy welfare loss occasioned by the direct cost of abatement would exceed any legitimately foreseeable welfare benefit.

In the light of these results, the economic case for concerted international action against catastrophic global warming no longer exists.

7. Discussion and conclusion

Post-modern or totalitarian scientism has its origins in the modernist movement that emerged from the writings of Rousseau and the French Revolution and was condemned by Pope Pius X (1907) as the heresy of heresies, in that it repudiated the existence of objective truth. The modernist *Weltanschauung* is encapsulated in Feyerabend (1987): "There are no universal rules of science. Basically, anything goes. Truth and meaning are internal to theories." This approach is, in essence, indistinguishable from the "zetetic" pretext adopted by flat-Earthers, who assert that what they see and feel is more reliable than what is scientifically observed or objectively deduced.

Kuhn (1970) denies that science is a discipline in which understanding of the truth grows by little and little. "Science comes in cycles that we call paradigms. It is not a cumulative process. One [paradigm] supersedes another." And "facts" are interpreted in accordance with the aprioristic political outlook or world-view of the scientist. Post-modern aprioristic scientism, then, echoes political and religious modernism in maintaining that there is no such thing as objective truth, on the undisciplined ground that every observer is subjective and may please himself as to the answer to Pilate's question.

Post-modern scientism is an assault upon and a denial of science itself, motivated by a desire to replace scientific discipline and rigor with an aprioristic paradigm. Paul Johnson, in his *History of the Modern World*, argues that modernism's interference with science to create post-modern, aprioristic, totalitarian scientism arose in part from a semantic confusion between relativity and relativism: on the one hand, Einstein's rigorous theorems of relativity; on the other, the very antithesis of rigor that is the please-yourself moral nihilism inherent in Feyerabend's phrase "Anything goes".

If there were no objective truth, one important casualty would be the fundamental principle of logic: namely, that every proposition that is objectively true is consistent with all other truths and inconsistent with all propositions that are objectively false.

Hume's philosophy spotlights a contradiction inherent in traditional empiricism, which encompasses the zetetic notion that experience is the source of all knowledge (*experientia docet*) as well as the empirical notion that experience is the instrument by which universal scientific laws are falsified. The contradiction is rooted in the notion that, although experience is open-ended, it can definitively establish the truth of scientific laws.

Popper removes the contradiction by asserting that scientific hypotheses are not inferred from experience by induction, nor are experiments conducted to establish the truth of a hypothesis, but only to establish its falsity. If a hypothesis fails, it falls. If it be not shown false, until it is falsified or a better hypothesis survives falsification it may be retained as a working hypothesis. To the extent that it is demonstrably true, as the theorem of Pythagoras is true in the Euclidean and hyperbolic domains, it must be accepted.

Above all, the value of the Popperian scientific method lies in its exclusion of the irrational. By the mechanism illustrated here – outright rejection of merely superstitious or legalistic antihypotheses, dismissal *a priori* of predictions calculated to be unfalsifiable in a reasonable timeframe, exposure of internally inconsistent propositions, reformulation of unspecific, illogical or unquantified hypotheses in a rigorously logical and quantitative form that also identifies prospectively the criteria for predictive success or failure as in prospective clinical trials, comparison of the alternative hypothesis with the null hypothesis to establish whether anything new or better is offered, and finally deductive, experimental testing of the corresponding null hypothesis – science, including legalist climatology, may rid itself of antihypotheses and shake off the politicized interference that now menaces it.

If the four sieves that constitute the stages in Popper-falsification had been followed with no less rigor than has been attempted here, the error would not have survived.

How did the error persist? Here, the answer seems to be political rather than scientific. Global warming is one of a growing range of topics on which legalists, in academe as well as in politics, have adopted a Party Line, have then demanded no dissent from it, and have finally sought the punishment and even execution of all who question it (Appendix A).

The climate-change episode thus serves as a warning that, in academe, internal no less than external political interference with the freedom of scientific enquiry is to be firmly resisted.

A brief history of climatology's control-theoretic error is at Appendix B.

The legalist antihypotheses underpinning the global warming storyline are close cousins of the superstitious propositions about the origin and design of the Great Pyramid, in that climate predictions cast so far into the future that their makers will be retired or dead before they can be falsified are no more susceptible of Popper-falsification than speculations about the existence and terrestrial interventions of gods or aliens. Science should as readily reject the former as the latter.

Yet, to take one example, the Royal Society has said it will only reconsider its avowedly extreme propaganda stance on the climate question if there has been no warming at all for two-thirds of a century, when all current Fellows of the Royal Society will be safely dead. Their successors, if the Society survives, will surely look back in bafflement at the sullenly anti-scientific determination of a *soi-disant* scientific body, the world's oldest at that, to require universal deference to an antihypothesis that was not empirically falsifiable within a reasonable timeframe, and is now proven false.

The elimination or reformulation of antihypotheses will assist in the now-urgent task of removing internal as well as external legalist interference with academic freedom of thought, speech, research, publication and argumentation, and restoring the paramountcy of the exercise by scientists of the faculty of reason, regarded in traditional theology as the central property or charism of the soul. It is that faculty that distinguishes our species most markedly from the beasts and brings us closest in likeness to the Divine. Let us reclaim it, following the noble example of the long and splendid scientific lifetime of the late Professor Niklas Mörner. How much we shall miss his merriment. Never was such profound wisdom so lightly worn.

Appendix A

Legalists' demands to kill climate skeptics, end capitalism and cut population:

In 2005

- Margo Kingston, in Australia's *Daily Briefing*, said: "Perhaps there is a case for making climate change denial an offence. It is a crime against humanity, after all."

In 2006

- Bill McGuire, Professor of "Climate Change Impacts" at University College, London, said: "We have Holocaust deniers; we have climate change deniers. And, to be honest, I don't think there's a great deal of difference";
- The Grist.com website called for Nuremberg-style trials for climate skeptics (though the article was later retracted);
- Heidi Cullen featured Dave Roberts, who said online, "When we've finally gotten serious about global warming, when the impacts are really hitting us and we're in a full worldwide scramble to minimize the damage, we should have war crimes trials for these bastards – some sort of climate Nuremberg";
- Mark Lynas, a "green" columnist often published in *The Guardian*, a London legalist newspaper, wrote: "I wonder what sentences judges might hand down at future international criminal tribunals on those who will be partially but directly responsible for millions of deaths from starvation, famine and disease in decades ahead. I put [their climate change denial] in a similar moral category to Holocaust denial – except that this time the Holocaust is yet to come, and we still have time to avoid it. Those who try to ensure we don't will one day have to answer for their crimes";
- *Spiked Online* reported that when a correspondent for the American current affairs show *60 Minutes* was asked why his various feature programs on global warming did not include the views of global warming sceptics, he replied: "If I do an interview with Elie Wiesel, am I required as a journalist to find a Holocaust denier?";
- The UK's Foreign Secretary said climate skeptics should be denied access to the news media, following a much-publicized article in the *Sunday Telegraph* by the present author drawing attention to defects in official climate science.

In 2007

- The Weather Channel's climate expert called for skeptical meteorologists to have their certification withdrawn;
- Ellen Goodman, in the *Boston Globe*, said: "Let's just say that global warming deniers are now on a par with Holocaust deniers";
- In an interview with KGW TV, Governor Ted Kulongoski of Oregon confirmed that he wanted to take away the title of state climatologist from George Taylor on the ground that he had dared to cast doubt upon the extent of Man's contribution to global warming;
- Professor David Legates, the state climatologist in Delaware, received a letter from the Governor saying his views did not coincide with those of the legalist administration and warning him that if he spoke in public about climate change in future he must do so as an individual and not as the state climatologist;
- Robert F. Kennedy Jr. said of climate skeptics, "This is treason. And we need to start treating them as traitors" (the penalty for treason is death);
- Yvo de Boer, secretary general of the UN Framework Convention on Climate Change, said that ignoring the urgency of global warming would be "criminally irresponsible";
- Dr. Gro Harlem Brundtland, a UN special climate envoy, said: "It's completely immoral even to question" the UN's scientific opinion on climate;

- Dr Patrick Michaels lost his job as state climatologist in Virginia after the governor had told him he could no longer use his official title when mentioning his opinions on climate change;
- In June Dr James Hansen of NASA, in testimony before the U.S. Congress, demanded that skeptical chief executives of fossil-fuel companies be "put on trial for high crimes against humanity and nature" (the penalty for such crimes is death).

In 2008

- The *Herald-Sun* in Australia ran an article revealing that Vint Cerf, the manager of Google's "Internet for Everyone" project, had suggested that the internet should be nationalized as a public utility because, as a "tech policy blogger" had argued, "giving power over the internet to well-heeled interests and self-interested politicians is a bad idea";
- Dr David Bellamy revealed that the BBC had ceased to use him as a presenter when he decided that global warming was being exaggerated.

In 2009

- Robert F. Kennedy Jr said at a Capitol Climate Action rally that Don Blankenship, then chief executive officer of Massey Energy, a coal-producing corporation, "should be in jail … for all of eternity";
- David Suzuki, a Canadian environmentalist campaigner, said government leaders skeptical of global warming should be "thrown into jail";
- Alex Lockwood, a British journalism professor, said that writers questioning global warming should be banned; a writer at Talking Points Memo said global warming "deniers" should be executed or jailed (he later retracted this remark); the Washington DC *Examiner* reported that climate extremists have "a desire to kill heretics" and talked of "calls for capital punishment for 'global warming deniers'";
- The Talking Points Memo website carried, but later retracted, removed and apologized for an article asking "At what point do we jail or execute climate skeptics?";
- Joe Romm, a former official of the Clinton administration, wrote, under the heading *Strangle Skeptics in bed*, that "An entire generation will soon be ready to strangle you and your kind while you sleep in your beds"; At the University of the West of England in Bristol, a conference of "eco-psychologists", led by a professor, explored the notion that "climate change denial" should be classified as a form of "mental disorder".

In 2010

- James Lovelock, inventor of the "Gaia hypothesis", told *The Guardian*: "I have a feeling that climate change may be an issue as severe as a war, so it may be necessary to put democracy on hold for a while";
- Dr. Donald Brown, Professor of "Climate Ethics" at Penn State University, declared that skeptics, who had caused "a 25-year delay in acting to stop climate change", may be guilty of a "new crime against humanity" (death penalty again);
- A video from the "10:10 campaign" showed climate-skeptic children being blown up by their teacher in class, and their classmates being spattered with their blood and guts (the campaign was compelled to remove the video, but it was widely and uncritically reported in legalist news media).

In 2011

- An Australian journalist said climate skeptics should be "branded" with cattle-irons to mark them out from the rest of the population; another Australian journalist said skeptics should be "gassed";
- Ecosocialism Canada described "climate denial" as a "psychiatric disorder";
- Professor Richard Parncutt of the University of Graz, Austria, posted an article entitled "Death penalty for global warming deniers?" but later withdrew the article and apologized for it after having been reminded that in Austria hate-speech is a serious, imprisonable offence, then reposted it, then withdrew it again, but only under threat of prosecution.

In 2012

- Robyn Williams, on Australian Broadcasting's *Science Show*, compared climate skeptics to pedophiles, saying: "Now, what if I told you that pedophilia is good for children or that asbestos is an excellent inhalant for those with asthma, or that smoking crack is a normal part, and a healthy one, of teenage life, to be encouraged? You'd rightly find it outrageous. But there have been similar statements coming out of inexpert mouths again and again in recent times, distorting the science" about what *The Economist* called "the comforting myth that there is no such thing as climate change, or, if there is, that humans are not involved";
- Dr. Donald A. Brown, Professor of "Climate Ethics" at Widener University School of Law, again declared that skeptics may be guilty of a "new crime against humanity" (death penalty again).

In 2013

- Dr Kari Norgaard, professor of sociological and environmental studies at Oregon State University, wrote a paper calling for the treatment of climate denial as a psychiatric disorder;
- Dr Donald A. Brown, this time described as "Scholar in Residence in Sustainability Ethics and Law" at Widener University Law School, in an article entitled "The Climate Change Disinformation Campaign: What Kind Of Crime Against Humanity, Tort, Human Rights Violation, Malfeasance, Transgression, Villainy, Or Wrongdoing Is It?", wrote: "The climate change disinformation campaign is equal in destructive power to many human activities that are classified as crimes against humanity" (death penalty again).

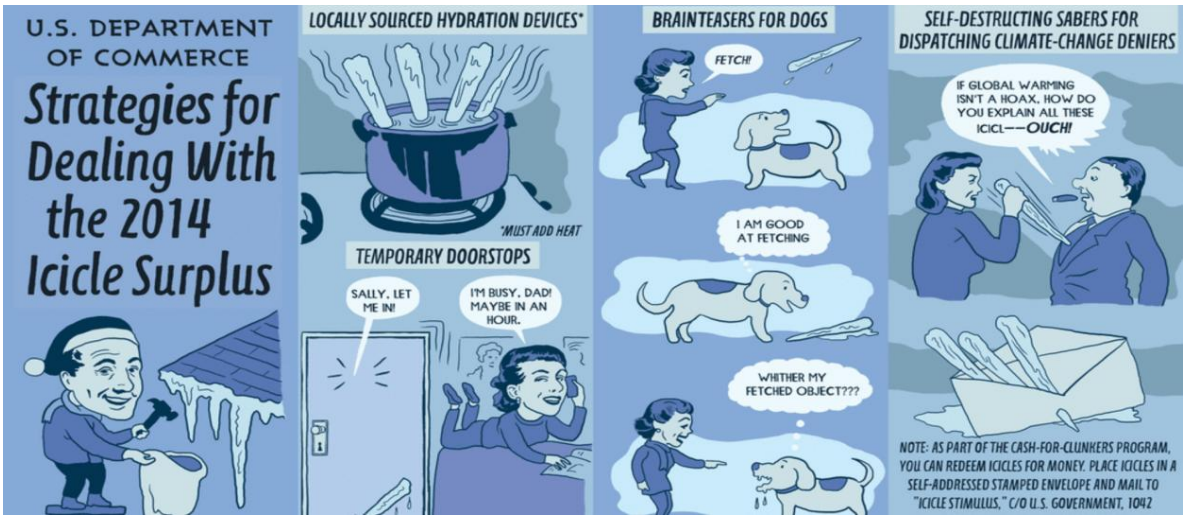


Figure A1. A February 2014 New York Times cartoon, Self-Destructing Sabers for Dispatching Climate-Change Deniers, showing a climate skeptic being stabbed with an icicle.

In 2014

- Dr Lawrence Torcello, assistant philosophy professor at Rochester Institute of Technology, wrote that people who disagreed with him on the climate question should be jailed; during a February cold snap,
- The *New York Times* ran a cartoon headed "Self-Destructing Sabers for Dispatching Climate-Change Deniers" and showing a climate skeptic being stabbed with an icicle (Figure A1);
- Adam Weinstein at the gawker.com website said: "Those denialists should face jail; they should face fines; they should face lawsuits from the classes of people whose lives and livelihoods are most threatened by denialist tactics";
- Bill Nye, a broadcaster in the United States who describes himself as "The Science Guy", discussed the idea of jailing those who disagreed with him on the climate question on the ground that they were "affecting his quality of life";

- The host of MSNBC's *The Ed Show* promoted Soviet-style re-education for climate skeptic politicians by conducting an on-air poll on the question "Should climate-denying Republicans be forced to take a basic earth science course?"

In 2015

- Katie Herzog at Grist.com wrote: "If this planet is to survive the scourge that is humanity, we *all* have to stop reproducing. Yes, all of us. In that spirit, I propose we … sterilize every human male on his 10th birthday";
- A comment on the webpage of the *Brisbane Times* about a category 5 cyclone along the Queensland coast on 19/20 February said: "These type of weather events could happen further south in future and be more intense with global warming … if anyone has to suffer out of this one I hope it is a climate change denier, if anyone";
- The Australian Capital Territory's Arts Fund gave $18,793 "to assist with costs of the creative development of a new theatre work, *Kill Climate Deniers*", which, however, did not appear owing to a public outcry;
- *The New York Times*, in an op-ed enitled *The Next Genocide*, said that "Climate 'deniers'" presented an "intellectual stance that is uncomfortably close to Hitler's";
- Scientists wrote an open letter to Mr Obama, who then occupied the office of President of the United States, calling for those who disagreed with their opinion on climate to be investigated, prosecuted and jailed as racketeers under the RICO statute;
- During a propaganda event held in Court 1 of the UK Supreme Court in London, Philippe Sands, a professor of international law at University College, London, said that a ruling by a body such as the International Court of Justice against climate skepticism would carry much more weight with public opinion and would pave the way for future legal cases on climate change;
- The "Ring of Fire Network" posted an article saying, "The people working at the [Crimes Against Humanity] Initiative need to include climate change denial as a crime against humanity".

In 2016

- Arnold Schwarzenegger, former governor of California, said in a YouTube video that if politicians wanted to take away the EPA's ability to regulate "carbon", "I would like to strap their mouth to an exhaust-pipe of a truck, turn on the engine and let's see how long it would take them to tap out," whereupon YouTube received several reports that this video contained hateful or abusive content, but did not take it down;
- Professor Joseph A. Palermo wrote in the *Huffington Post* that "people who dismiss science in one area shouldn't be able to benefit from science in others. If Trump and his cohort believe the science of global warming is bogus then they shouldn't be allowed to use the science of the Internet for their Twitter accounts, the science of global positioning for their drones, or the science of nuclear power for their weaponry."

In 2017

- Eric Idle, once a comedian with *Monty Python's Flying Circus,* circulated a tweet calling for global warming skeptics to be put on trial at the World Court because "denying climate change is a crime against humanity" (Idle said those whom he considered to be "deniers" of climate science should be "executed gently" or, like dogs, "put down humanely");
- Rob Quist, the legalist candidate to replace Ryan Zinke in the U.S. House of Representatives, said during a televised debate during the special-election campaign in Montana that climate change "is something that the entire world needs to address and you know what, if any of you that feel like this is not a problem, I challenge you to go into your car in your garage, start your car and see what happens there";
- John Gilkison, an astronomical technician at New Mexico State University, wrote a blog posting about a fictional trial for crimes against humanity held at the International Court at the Hague, in which various named climate skeptics, including the present author and President Trump, were tried,

convicted and executed for their role in questioning the climate change "consensus" (the posting was eventually taken down, but not until it had received extensive worldwide publicity);

- Brian Merchant in *The Outline* said "Climate change denial should be a crime … In the wake of [Hurricane] Harvey, it's time to treat science denial as gross negligence – and hold those who do the denying accountable … Call it what it is: negligence; criminal negligence, even … Harvey is a lightning rod that makes this clear: Climate change denial can and will leave people dead";
- Mark Hertsgaard argued in *The Nation*, under the title *Climate Denialism Is Literally Killing Us*, that "murder is murder" and "we should punish it as such," and the strapline read: "The victims of Hurricane Harvey have a murderer – and it's not the storm";
- Brad Johnson, executive director of Climate Hawks Vote, posted on Twitter a set of "climate disaster response rules," the third of which was to "put officials who reject science in jail";
- Jørgen Randers, professor of climate strategy at BI Norwegian Business School, wrote in the Swedish daily newspaper *Svenska Dagbladet* "If people don't want my preferred solution, then people are stupid, shouldn't be allowed to decide their fate, and we should install a climate dictatorship instead":
- Rob Quist, a "Democratic" congressional candidate, suggested during a televised Montana House of Representatives debate that sceptics of global warming should kill themselves.

In 2018

- A British environmentalist lobby group, "Forum for the Future", suggested the establishment of three penal concentration camps for those "criminals" who are "convicted of denying the existence of climate change": Kerguelen Island, South Georgia, and the South Island of New Zealand;
- The play *Kill Climate Sceptics* was shown in Australia.

In 2019

- "Generation Atomic", a Communist front group, published the following cartoon portraying "climate deniers" as on a par with flat-Earthers:

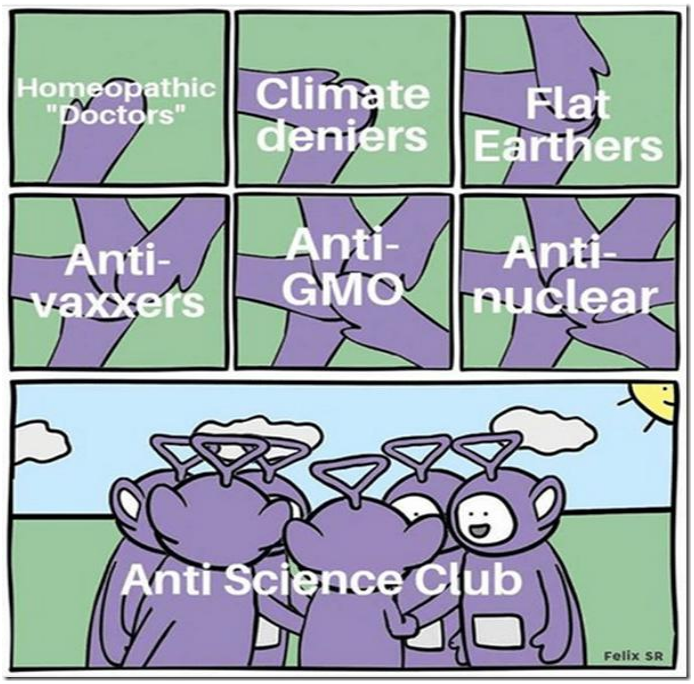


Figure A2: "Climate deniers" on a par with flat-Earthers

In 2021

- Roger Harrabin, the BBC's "environment analyst", said there would be "climate change police" by the 2040s.

Further instances of irrationality on the climate question include the following.

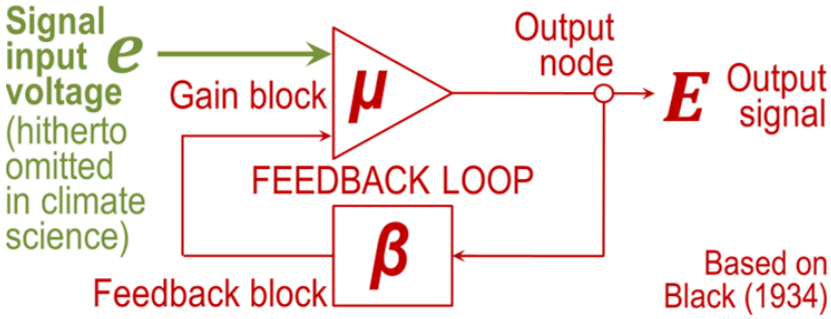
- Judy Bari, an "Earth First" activist, said: "If we don't overthrow capitalism, we don't have a chance of saving the world ecologically."
- David Brower, founder of "Friends of the Earth", said: "Loggers losing their jobs because of spotted-owl legislation is no different than people being out of work after the furnaces of Dachau shut down."
- David Graber, a scientist with the U.S. National Park Service, said: "People have become a cancer … a plague upon ourselves and upon the Earth. Until such time as *homo sapiens* should decide to rejoin nature, some of us can only hope for the right virus to come along."
- Prince Philip, consort to Queen Elizabeth II of England, said: "In the event that I am reincarnated, I should like to return as a deadly virus, to contribute something to solving overpopulation."
- Ingrid Newkirk, president of "People for the Ethical Treatment of Animals", said: "Even if animal research produced a cure for AIDS, we'd be against it." Ms Newkirk also said: "Six million people died in concentration camps, but six billion broiler chickens will die this year in slaughterhouses."
- Charles Wurster, a scientist with the "Environmental Defense Fund", said: "People are the cause of all the problems. We have too many of them. We need to get rid of some of them, and this [a malaria epidemic] is as good a way as any." Mr Wurster also said: "In the United States, DDT substitutes only kill farm workers, and most of them are Mexicans and Negroes."
- Paul Ehrlich said: "Giving society cheap, abundant energy would be the equivalent of giving an idiot child a machine gun."
- Brent Blackwelder, president of "Friends of the Earth", said people in developing countries "cannot expect to have the material lifestyle of the average American".

Appendix B

History of climatology's control-theoretic error

Fourier (1827) first posited the existence of a *châleur obscure* (invisible heat) in the atmosphere. **Tyndall (1868)** reported laboratory experiments from 1861 confirming the greenhouse effect. **Arrhenius (1906)** concluded that equilibrium sensitivity to doubled CO_2 would be about 4 degrees.

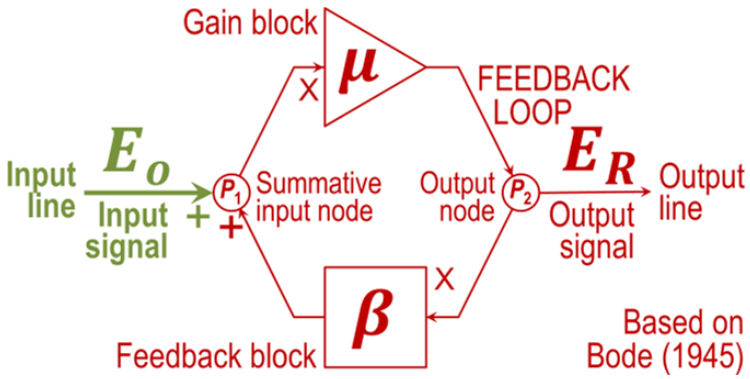
Temperature feedback operates analogously to voltage feedback in a feedback amplifier circuit, for feedback formulism applies *mutatis mutandis* to any feedback-moderated dynamical system. It was in electronics that the mathematical foundation of control theory – the physics governing feedback in dynamical systems – was first laid. In 1927 Harold S. Black, then at Bell Labs in New York, was going from Hoboken, NJ, to work in Manhattan on the Lackawanna Ferry when the feedback equations came to him. He jotted them down on that day's newspaper. His feedback amplifier block diagram (**Black, 1934**; here Figure 3) correctly shows the input signal $\boldsymbol{e}$ and labels it "signal input voltage". The equivalent input signal in the climate system is emission temperature. The diagram shows that the $\boldsymbol{\beta}$ feedback block, now usually labeled $\boldsymbol{H}$, modifies not only the signal from the $\boldsymbol{\mu}$ gain block (now usually labelled $\boldsymbol{G}$), but also the input signal $\boldsymbol{e}$ itself.



Feedback amplifier block diagram (based on **Black, 1934**). The input signal $\boldsymbol{e}$ (analogous to emission temperature $\boldsymbol{R_0}$) is amplified by the $\boldsymbol{\mu}$ gain block. The amplified signal $\boldsymbol{\mu e}$ passes round the loop, where the $\boldsymbol{\beta}$ feedback block further modifies it. It leaves the circuit via the output node.

Bode (1945), again at Bell Labs, wrote a textbook on feedback amplification in electronic circuits, which was published in annual editions for 30 years. His block diagram also correctly shows the input signal. At p. *vii*, he defines the input signal $\boldsymbol{E_0}$ as the "input voltage".

It is this input signal, the 255 K emission temperature that is missing in climatology's defective definition of feedback and its consequent overstatements of feedback response and so of ECS:



Feedback amplifier (based on **Bode 1945**). The input signal $\boldsymbol{E_0}$ (analogous to emission temperature $\boldsymbol{R_0}$ in climate) proceeds from the input line to the summative input node $\boldsymbol{P_1}$, and thence round the loop via the $\boldsymbol{\mu}$ gain and $\boldsymbol{\beta}$ feedback blocks to the output node $\boldsymbol{P_2}$ and the output line. Perturbations (in climate, reference sensitivities) are allowed for in the $\boldsymbol{\mu}$ gain block; feedbacks (e.g. more water vapor in warmer air) modify the signal in the $\boldsymbol{\beta}$ feedback block.

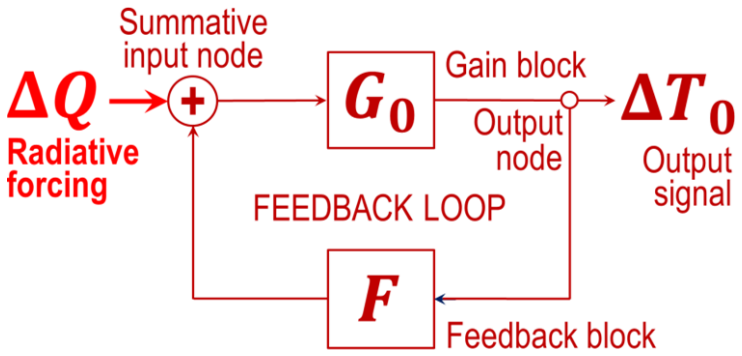
It was thus established at the earliest moment in the mathematical treatment of feedback in dynamical systems that not only any *perturbation* of the system but also the input signal is modified by the feedback block.

Hansen et al. (1984) cited Bode (1945) as the authority for feedback formulism. At this stage, sufficiently reliable measurements of the Earth's energy imbalance to derive ECS simply by the energy-balance method described in the learned paper were not available. Hansen, therefore, attempted to quantify the individual feedbacks by the use of a general-circulation model. He incorrectly used the term "system gain" for the feedback fraction, defining it as –

> "… the ratio of the net feedback portion of the temperature *change* to the total temperature *change*."

Hansen et al. did not encompass in that definition, or in any of their calculations, any reference to the fact that not only a *perturbation* but also the absolute input signal – the 255 K emission temperature – drives a large feedback response.

Schlesinger (1988) cemented Hansen's error. In his block diagram, the sole input is a *perturbation* $\boldsymbol{\Delta Q}$ (i.e., a radiative forcing). However, there is no originating input signal from the pre-existing state of the climate in the shape of the 255 K emission temperature.



Feedback amplifier block diagram based on Schlesinger (1988), omitting the input signal, emission temperature $\boldsymbol{R_0}$. The signal $\boldsymbol{\Delta Q}$ is a radiative forcing, driving a *perturbation* of $\boldsymbol{R_0}$. The input signal itself is omitted. There is also a confusion of units between the input (radiative forcing, in Watts per square meter) and the output (in degrees).

Since the natural greenhouse effect has a fixed magnitude of about 32 degrees, overlooking the large feedback response to emission temperature effectively adds that large response to, and miscounts it as part of, the small preindustrial feedback response. In round numbers, climatology follows Hansen and Schlesinger in assuming that there are only two components in the natural greenhouse effect: 8 degrees' direct warming by preindustrial noncondensing greenhouse gases, and 24 degrees' feedback response thereto, implying a system-gain factor $32/8 = 4$, where a more correct value would be $(255 + 32)/255 + 8) < 1.1$.

The American Meteorological Society (AMS, 2021) uses a definition of feedback that likewise overlooks feedback response to the initial state –

> "A sequence of interactions that determines the response of a system to an initial *perturbation*".

Soden & Held (2006) also talk of feedbacks responding solely to *perturbations,* but not also to emission temperature –

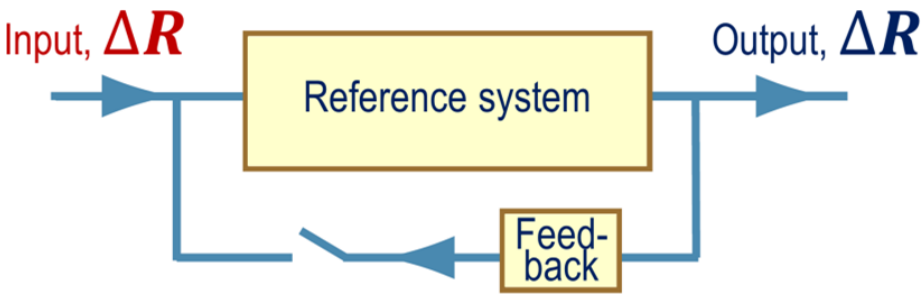
> "Climate models exhibit a large range of sensitivities in response to increased greenhouse gases due to differences in feedback processes that amplify or dampen the initial radiative *perturbation.*"

Sir John Houghton (*pers. comm.* 2006), then chairman of IPCC's climate-science working party, asked why IPCC expected a large anthropogenic warming, replied that, since feedback response in the preindustrial era accounted for three-quarters of the natural greenhouse effect, so that the preindustrial system-gain factor was 4, and one would thus expect a system-gain factor of 3 or 4 today.

IPCC (2007, ch. 6.1, p. 354) again overlooks the large feedback response to the 255 K emission temperature:

> "For different types of *perturbations,* the relative magnitudes of the feedbacks can vary substantially."

Roe (2009), like Schlesinger (1988), shows a feedback block diagram with a *perturbation* $\Delta \boldsymbol{R}$ as the only input –



Lacis et al. (2010) repeat the error and explicitly quantify its effect, defining temperature feedback as responding only to *changes* in the concentration of the preindustrial noncondensing greenhouse gases, but not also to emission temperature itself, consequently imagining that ECS will be ≥ 3 times the ~1 degree direct warming by those gases:

> "This allows an empirical determination of the climate feedback factor [the system-gain factor] as the ratio of the total global flux change to the flux *change* that is attributable to the radiative forcing due to the noncondensing greenhouse gases. This empirical determination … implies that Earth's climate system operates with strong positive feedback that arises from the forcing-induced *changes* of the condensable species. … noncondensing greenhouse gases constitute the key **25**% of the radiative forcing that supports and sustains the entire terrestrial greenhouse effect, the remaining **75**% coming as fast feedback contributions from the water vapor and clouds. … For the doubled CO_2 and the 2% solar irradiance forcings, for which the direct no-feedback responses of the global surface temperature are 1.2 and 1.3 degrees, respectively, the ~4 degrees' surface warming implies respective feedback factors [actually, system-gain factors] of 3.3 and 3.0."

Schmidt et al. (2010) find the equilibrium doubled-CO_2 radiative forcing to be five times the direct forcing:

> "At the doubled-CO_2 equilibrium, the global mean increase in … the total greenhouse effect is ~20 W m^{-2}, significantly larger than the 4 W m^{-2} initial forcing and demonstrating the overall effect of the long-wave feedbacks is positive (in this model)."

IPCC (2013, p. 1450) defines what Bates (2016) calls "sensitivity-altering feedback" as responding solely to *perturbations*, which are mentioned five times, but not also to the input signal, emission temperature:

> **"Climate feedback:** An interaction in which a *perturbation* in one climate quantity causes a change in a second, and the change in the second quantity ultimately leads to an additional change in the first. A negative feedback is one in which the initial *perturbation* is weakened by the changes it causes; a positive feedback is one in which the initial *perturbation* is enhanced … the climate quantity that is *perturbed* is the global mean surface temperature, which in turn causes changes in the global radiation budget. … the initial *perturbation* can … be externally forced or arise as part of internal variability."

Knutti & Rugenstein (2015) likewise make no mention of base feedback response:

> "The degree of imbalance at some time following a *perturbation* can be ascribed to the temperature response itself and changes induced by the temperature response, called feedbacks."

Dufresne & St.-Lu (2015) say:

> "The response of the various climatic processes to climate change can amplify (positive feedback) or damp (negative feedback) the initial temperature *perturbation.*"

Heinze et al. (2019) say:

> "The climate system reacts to *changes* in forcing through a response. This response can be amplified or damped through positive or negative feedbacks."

Sherwood et al. 2020 also neglect emission temperature as the primary driver of feedback response –

> "The responses of these [climate system] constituents to *warming* are termed feedback. The constituents, including atmospheric temperature, water vapor, clouds, and surface ice and snow, are controlled by processes such as radiation, turbulence, condensation, and others. The CO_2 radiative forcing and climate feedback may also depend on chemical and biological processes."

The interdisciplinary knowledge gap prevented anyone in climatology from noticing the error. It has not been possible to find a single climatological paper that specifically mentions the feedback response to emission temperature, still less that quantifies it and correspondingly reduces the feedback response to direct warming by greenhouse gases. The politicization of the climate-change question, and the adoption of an avowedly extreme, alarmist stance by the totalitarian faction in politics, coupled with the growing suppression of all dissent both in academe and its journals and in very nearly all news media, has ensured the perpetuation of the error and its severe economic and strategic consequences for the West.

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What Controls the Atmospheric CO_2 Level?

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Abstract:

The evolution of nuclear-perturbed $^{14}CO_2$ is used to determine the removal time of atmospheric CO_2. The exponential decline of anomalous $^{14}CO_2$ establishes that absorption of CO_2 is determined, not by extraneous reservoirs of carbon, but autonomously by the atmosphere. Specifically, the rate at which CO_2 is absorbed from the atmosphere is directly proportional to the instantaneous abundance of CO_2 in the atmosphere. It operates with a single time scale, which reflects the collective absorption by all sinks of CO_2 at the Earth's surface. The long-term decline of anomalous $^{14}CO_2$ reveals an effective absorption time of about 10 years. The accompanying removal of atmospheric CO_2 is much faster than has been presumed to interpret observed changes. Jointly with the Conservation Law governing atmospheric CO_2, that absorption time is shown to reproduce the observed evolution of CO_2, inclusive of its annual cycle. The latter treatment provides an upper bound on the absorption time, independent of but consistent with the value revealed by the decline of anomalous $^{14}CO_2$. Together, the two determinations of absorption provide an upper bound on the anthropogenic perturbation of atmospheric CO_2.

Keywords: *Carbon cycle*; *CO_2 residence time*; *anthropogenic emissions*; *radiocarbon measurements*; *seasonal CO_2 variations*

1. Introduction

A central question in the climate science of today is: How much does anthropogenic emission of CO_2 contribute to rising atmospheric CO_2 and, thereby, to global warming? The answer to this question requires a quantitative understanding of CO_2 exchange between the atmosphere and the Earth's surface, which removes CO_2 from the atmosphere.

A popular metric of such exchange is the residence time of CO_2, which characterizes how long CO_2 remains in the atmosphere before being absorbed at the Earth's surface. In its Fifth Assessment Report (AR5-Ch. 6) [1], the UN's Intergovernmental Panel on Climate Change (IPCC) defines multiple residence times, as well as adjustment times. They represent exchanges between extraneous carbon reservoirs at or beneath the Earth's surface. Unlike the atmosphere, those global reservoirs are virtually unobserved, leaving their exchanges largely a matter of speculation. Such time scales are relevant to the storage and sequestration capacity of those reservoirs. However, they are of no direct relevance to CO_2 in the atmosphere - because its abundance is dictated solely by transfers into and out of the atmosphere at the Earth's surface. What transpires to carbon outside of the atmosphere is immaterial.

Residence time is, in fact, incidental to the physics that controls atmospheric CO_2. Because CO_2 is conserved in the atmosphere, its abundance is determined entirely by emission and absorption of CO_2 at the Earth's surface. Residence time does not determine absorption of CO_2; it is determined by it.

Atmospheric CO_2 is governed by the 3D Continuity Equation. It embodies the Conservation Law for atmospheric carbon. Except for miniscule differences (much smaller than the observational uncertainty of global CO_2), absorption of atmospheric carbon dioxide does not discriminate between CO_2 of human origin and CO_2 of natural origin. As discussed previously (Harde, 2017 [2] and 2019 [3]), absorption channels at the Earth's surface (e.g., vegetation, soil, and ocean) operate in parallel.

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Their collective impact on atmospheric CO_2 is represented in the total absorptivity: $\alpha = \alpha_1+\alpha_2+\alpha_3\ldots$ Its inverse is the *direct absorption time* of atmospheric CO_2, τ, which characterizes its direct removal from the atmosphere. Because CO_2 is virtually conserved in the atmosphere, it is produced and destroyed only at the Earth's surface. The direct absorption time of CO_2 is therefore equal to its *residence time*:

$$\tau = \alpha^{-1} = \tau_R . \quad (1)$$

The direct absorption rate of atmospheric CO_2 is determined by τ and its instantaneous concentration, C_{CO2}:

$$\mathcal{A} = C_{CO2} / \tau \ . \quad (2)$$

Common in physical systems, the dependence of CO_2 removal on CO_2 abundance is an empirical feature of atmospheric carbon dioxide. It is documented in the monotonic decline of nuclear-perturbed carbon 14, an isotopic tracer of atmospheric CO_2 (Salby, 2015 [4]). Following the 1963 *Limited Test Ban Treaty* [5], $^{14}CO_2$ declined exponentially according to a single absorption time.

Another physical inconsistency in AR5 is its arbitrary division of the carbon budget into a native part, which is presumed to have remained constant before the industrial era, and an anthropogenic part, which is presumed to be solely responsible for increasing CO_2. The two arbitrarily-defined components are presumed to be independent and, somehow, distinguished by absorption processes. A consequence of the different treatment of these arbitrarily-defined components is that, when recombined, they no longer satisfy the Equivalence Principle of physics and the Conservation Law of atmospheric CO_2 - physical laws that *are* satisfied by CO_2 in the real atmosphere (Salby, 2018 [6]; Harde, 2019 [3], *Sec. 3.4*).

Moreover, models relied upon by the IPCC rest upon an unphysical premise: They assume that absorption of anthropogenic CO_2 is proportional, not to its instantaneous abundance (2), but to its instantaneous emission rate (e.g., Joos et al., 1988 [7]) – irrespective of how much CO_2 is actually in the atmosphere. A consequence of this premise is that CO_2 continuously accumulates in the atmosphere, regardless of its actual abundance. In the presence of real absorption, such behavior is impossible. For constant emission, CO_2 would eventually reach an equilibrium level, at which it is removed through absorption as fast as it is introduced through emission (Salby 2016 [8]; Harde 2017 [2], 2019 [3]; Berry 2019 [9]).

Numerous investigations have sought estimates of the absorption time. Most range between 5 and 15 years. However, some are as short as 1 year (see e.g. compilations by Sundquist 1985 [10] and Segalstad 1996 [11]: Murray τ = 5.4 yr (1992) [12]; Segalstad τ = 5.4 yr (1992) [13]; Broecker et al. $\tau \approx$ 8 yr (1979) [14]; Humlum et al. $\tau \approx$ 1 yr (2013) [15]; Salby $\tau \approx$ 1 yr (2013) [16]; Harde $\tau \leq$ 4 yr (2017, 2019) [2, 3]). The residence time has also been alleged to exceed a thousand years (Solomon et al, 2009) [17]. Many of the estimates rest upon the observed decline of the isotopic tracer $^{14}CO_2$, which (aside from miniscule differences) experiences the same absorption as overall CO_2 (e.g., Revelle & Suess τ = 7 yr (1957) [18]; Craig τ = 7 yr (1957) [19]; Bacastow & Keeling τ = 6.3 - 7 yr (1973) [20]; Keeling & Bacastow τ = 7.5 yr (1977) [21]; Siegenthaler τ = 4 - 9 yr (1989) [22]); Stuiver τ = 6.8 yr (1980) [23]). Some authors only specify the decay time $\tau_{\Delta 14C}$ for the fractional departure of anomalous ^{14}C from a reference abundance, $\Delta^{14}C$ (Levin et al. $\tau_{\Delta 14C}$ = 8.5 yr (1980, 1994) [24, 25]; Levin et al. $\tau_{\Delta 14C}$ = 15 yr (2013) [26]; Hua et al. $\tau_{\Delta 14C}$ = 16.5 yr (2013) [27]; Turnbull et al. $\tau_{\Delta 14C}$ = 16.5 yr (2017) [28]).

Absorption of atmospheric CO_2 determines if and how fast CO_2 accumulates in the atmosphere. Current views on this fundamental process rest, in large part, on observations of ^{14}C. Yet, interpretations of those data vary widely, as reflected in the range of estimated absorption times. The uncertainty in this key property is underpinned by the definition of ^{14}C itself, which also varies widely. Depending upon normalization, reference concentration, and units, carbon 14 has been quantified via "a jungle" of different definitions (Stenström et al. 2011 [29]). Relevant to the

absorption time of CO_2 is normalization in some definitions of carbon 14 by carbon 12, which is the principal constituent of CO_2 (Andrews 2020 [30]).

Here, we examine the impact of such normalization and use the observed decline of nuclear-perturbed $^{14}CO_2$ to determine the actual absorption time of atmospheric CO_2. Jointly with the Conservation Law governing atmospheric CO_2, that absorption time is then shown to reproduce the observed evolution of CO_2, inclusive of its annual cycle. The latter treatment provides an upper bound on the absorption time, independent of but consistent with the value revealed by the decline of anomalous $^{14}CO_2$. Thereby, it provides an upper bound on the anthropogenic perturbation of atmospheric CO_2.

2. Perturbation of $^{14}CO_2$

The carbon isotope ^{14}C has a radioactive half-life of 5730 yrs (an e-folding time for radioactive decay of 8267 yrs). On the time scale of the instrumental record of CO_2 (decades), ^{14}C is therefore conserved in the troposphere. Once introduced, it is neither produced nor destroyed. Like all CO_2, $^{14}CO_2$ is removed only through absorption at the Earth's surface. ^{14}C, however, is continuously formed in the upper atmosphere from ^{14}N via interaction with neutrons that are liberated by cosmic radiation, before ^{14}C rapidly oxidizes into $^{14}CO_2$.

Nuclear testing during the 1950s and early 1960s dramatically increased free neutrons in the stratosphere. It eventually led to a large perturbation of ^{14}C in the troposphere, where ^{14}C is measured – an increase in $\Delta^{14}C$ of order 100%. The cessation of atmospheric testing after 1963 [5] witnessed a systematic decline of the nuclear perturbation. The observed decline followed, not from radioactive decay, but from the absorption of $^{14}CO_2$ at the Earth's surface – the same process that absorbs all CO_2.

2.1 Quantification of Carbon 14

Definitions of ^{14}C follow from measurements of decay activity A, which is reported in counts. The quantity commonly relied upon in climate studies is *anomalous* ^{14}C, the fractional departure from a reference abundance:

$$\Delta^{14}C = \left(\frac{A_{SN}}{A_{ABS}} - 1 \right) \cdot 1000 \,, \tag{3}$$

where A_{SN} and A_{ABS} denote, respectively, the normalized activity of a measured sample and an absolute reference activity. Reported in ‰, $\Delta^{14}C$ measures the deviation of ^{14}C from the reference concentration. However, even the definition (3) is not universal (Stenström et al. 2011 [29]). In the original definition, the sample activity, A_{SN}, is normalized for the counting volume, change of mass, and dilution or impurity (see e.g., Stuiver & Polach [31]). But with the invention of accelerator mass spectrometry many groups are now measuring the fractional number density of ^{14}C to ^{12}C atoms; cf. Turnbull et al. (2017) [28]. The increasing concentration of $^{12}CO_2 \cong CO_2$ must then be accounted for to recover the true concentration of ^{14}C.

The decline of anomalous ^{14}C has been the basis for estimates of CO_2 absorption time (Sec. 1). In many investigations, however, it is unclear whether absorption time was deduced from measurements of ^{14}C based on the original definition or from values normalized by ^{12}C, which increased during the post-testing era with CO_2.

2.2 Observed Decline of Anomalous $^{14}CO_2$

Figure 1 presents the record of tropospheric $^{14}CO_2$ measured at Vermunt, Austria (Blue) (Levin et al. [24, 25], also archived at CDIAC [32]). Extending from 1959 until 1983, the Vermunt record of $\Delta^{14}C$ is recorded in ‰ deviation from the absolute international standard activity A_{ABS}. Following an abrupt increase in the early 1960s, $\Delta^{14}C$ underwent a systematic, albeit unsteady, decline. Initial

years are punctuated by half a dozen re-enrichments, which appear annually. Thereafter, $\Delta^{14}C$ declined more gradually.

The archived data in Fig 1 are normalized by ^{12}C, which distorts the actual concentration of ^{14}C according to the variation of CO_2. To quantify the effect of such normalization, particularly over the first 20 years after the test ban treaty, when $^{14}CO_2$ was observed at Vermunt, those data have been re-normalized to the initial (constant) atmospheric CO_2 concentration at time t_0 = 1959, $C_0 = C(t_0)$. In terms of the instantaneous CO_2 concentration at sample time t_s, $C_S = C(t_s)$, anomalous ^{14}C then has the actual or corrected concentration:

$$(\Delta^{14}C)_C = \left(\frac{A_{SN}}{A_{ABS}} \cdot \frac{C_S}{C_0} - 1 \right) \cdot 1000 \,. \qquad (4)$$

Expressing the normalized sample activity A_{SN} in terms of the original $\Delta^{14}C$ data, with $A_{SN} = (\Delta^{14}C/1000 + 1)\cdot A_{ABS}$, gives:

$$(\Delta^{14}C)_C = \left(\left(\frac{\Delta^{14}C}{1000} + 1 \right) \cdot \frac{C_S}{C_0} - 1 \right) \cdot 1000 \,. \qquad (5)$$

For the instantaneous CO_2 concentration C_S, we use the monthly Mauna Loa record, also archived at CDIAC [32], which was adapted to the slightly different sample times of the ^{14}C measurements. Superimposed in Figure 1 is the corrected concentration, $(\Delta^{14}C)_C$ (Green). It undergoes the same fast decline over the first half dozen years after the test ban treaty, followed by more gradual decline thereafter. Noteworthy is the almost-pure exponential form of the long-term decline. The rate of $^{14}CO_2$ removal is then directly proportional to its instantaneous abundance, in confirmation of (2). With e-folding time of about 10 yrs, the decline is nearly the same in both records. It differs only in a somewhat different equilibrium level to which the two metrics of $^{14}CO_2$ approach.

To understand the observed decline, we evaluate $^{14}CO_2$ through the Conservation Law governing it. Relative to its initial concentration in 1959, anomalous $^{14}CO_2$ is represented in (4) by the relative concentration $C'_{14} = (A_{SN}/A_{ABS})\cdot(C_S/C_0)$.

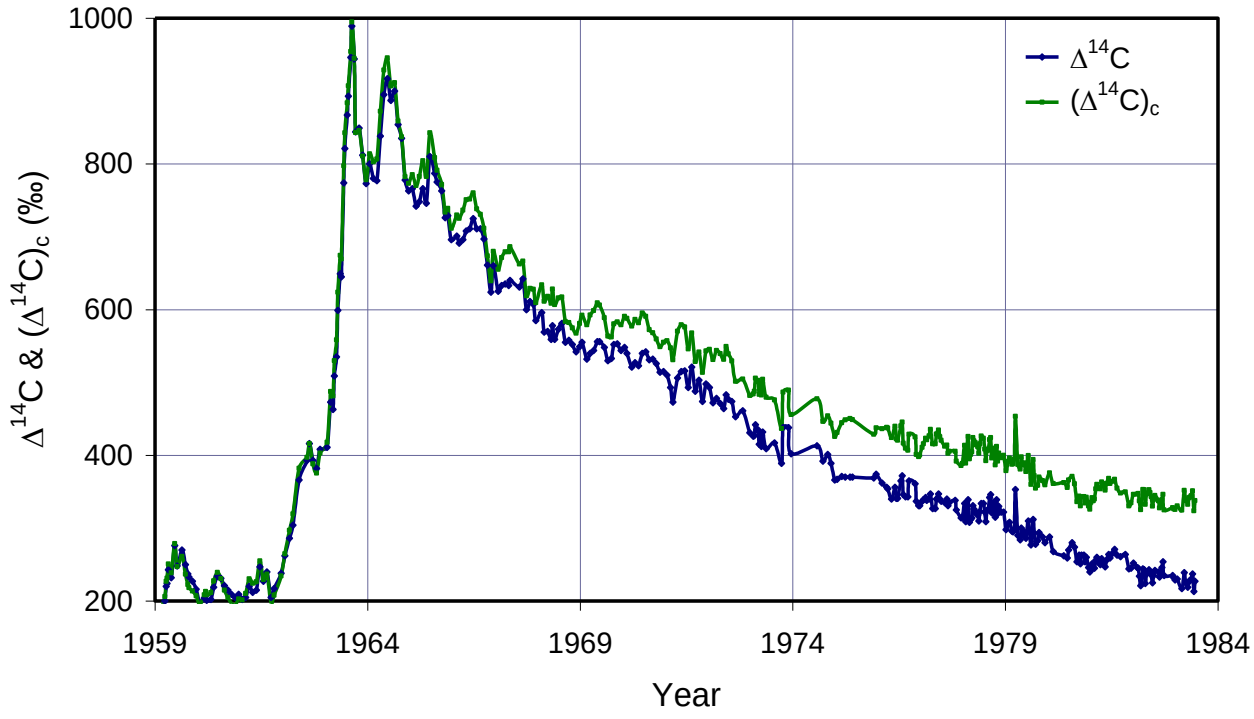

Figure 1: *Observed record of $\Delta^{14}C$ data (Blue) sampled at Vermunt and corrected concentration $(\Delta^{14}C)_C$ (Green).*

C'_{14} can change through changes of natural production in the stratosphere, described by the relative rate $e'_{N,14}$. More important is its absorption at the Earth's surface, which is proportional to its instantaneous abundance C'_{14} (2). Of $^{14}CO_2$ that is removed from the atmosphere with the direct absorption time τ, a fraction β is returned to the atmosphere through re-emission from the Earth's surface (e.g., via outgassing and decomposition of vegetation). Re-emission represents an additional source

$$e'_{R,14} = \beta \cdot C'_{14} / \tau \,, \tag{6}$$

which offsets direct absorption. Collecting these opposing influences gives the net absorption, which, with (2), operates with the *effective absorption time*

$$\tau_{eff} = \tau /(1-\beta) \,. \tag{7}$$

In terms of these influences, the Conservation Law governing the anomalous concentration C'_{14} becomes (cf. Harde 2019, Appendix B [3]):

$$\frac{dC'_{14}}{dt} = e'_{N,14} - \frac{C'_{14}}{\tau_{eff}} \,. \tag{8}$$

Integrating (8) reproduces the long-term decline of anomalous ^{14}C introduced by nuclear testing. However, it does not describe oscillations that are apparent during the initial half dozen years (Figure 1). Those oscillations reflect annual re-enrichments of tropospheric $^{14}CO_2$ from the stratosphere. Such transport occurs through the Brewer-Dobson circulation (BDC) of the stratosphere, an equator-to-pole overturning that intensifies each year during late winter and spring; see, e.g., Holton (2004) [33], Salby (2012) [34]. The intensified BDC transports ^{14}C-enriched stratospheric air downward into the Arctic troposphere.

To account for such enhancement, (8) is augmented by an oscillatory source with radial frequency ω that decays with the time scale τ_E, which reflects the gradual exhaustion of anomalous $^{14}CO_2$ in the stratosphere. The Conservation Law then becomes:

$$\frac{dC'_{14}}{dt} = e'_{N,14} + m' \cdot \cos(\omega \cdot t + \varphi) \cdot e^{-t/\tau_E} - \frac{C'_{14}}{\tau_{eff}} \,. \tag{9}$$

Equation (9) is integrated numerically, with an effective absorption time τ_{eff} =10 yrs, natural $^{14}CO_2$ production that accounts for a change from the pre-test era $e'_{N,14}$ = 123 ‰/yr, with m' = 0.65 yrs^{-1} and τ_E = 4 yrs. The calculated C'_{14} is then transformed back to anomalous carbon 14 that is referenced against the standard activity (5).

Plotted in Fig 2 is calculated $(\Delta^{14}C)_C$ (Magenta). It tracks the evolution of observed $(\Delta^{14}C)_C$, which is superimposed (Green). Reproduced by the perturbed Conservation Law (9) is the long-term decline of $(\Delta^{14}C)_C$, as well as its repeated enhancement during the initial half dozen years following the test ban treaty.

With a single effective absorption time of τ_{eff} = 10 yrs, calculated $(\Delta^{14}C)_C$ reproduces the salient features of the observed evolution. Direct absorption, however, is considerably faster. For a re-emission fraction β = 0.6, the time scale of direct absorption (7) is only τ = 4.0 yrs. That time scale is consistent with absorption evaluated from the global balance between total emission and absorption of CO_2 (Harde [2, 3]), as well as the observed decline of annual oscillations. Both reflect absorption that is an order of magnitude faster than the adjustment times used by the IPCC to interpret changes of CO_2.

The observed evolution is recovered by absorption that operates on a single time scale, τ_{eff} =10 years, and is proportional to the instantaneous abundance of $^{14}CO_2$. The calculated evolution of $^{14}CO_2$ demonstrates that multiple adjustment times, invented by the IPCC, are superfluous and, more importantly, are incongruous with the physics that actually controls atmospheric CO_2.

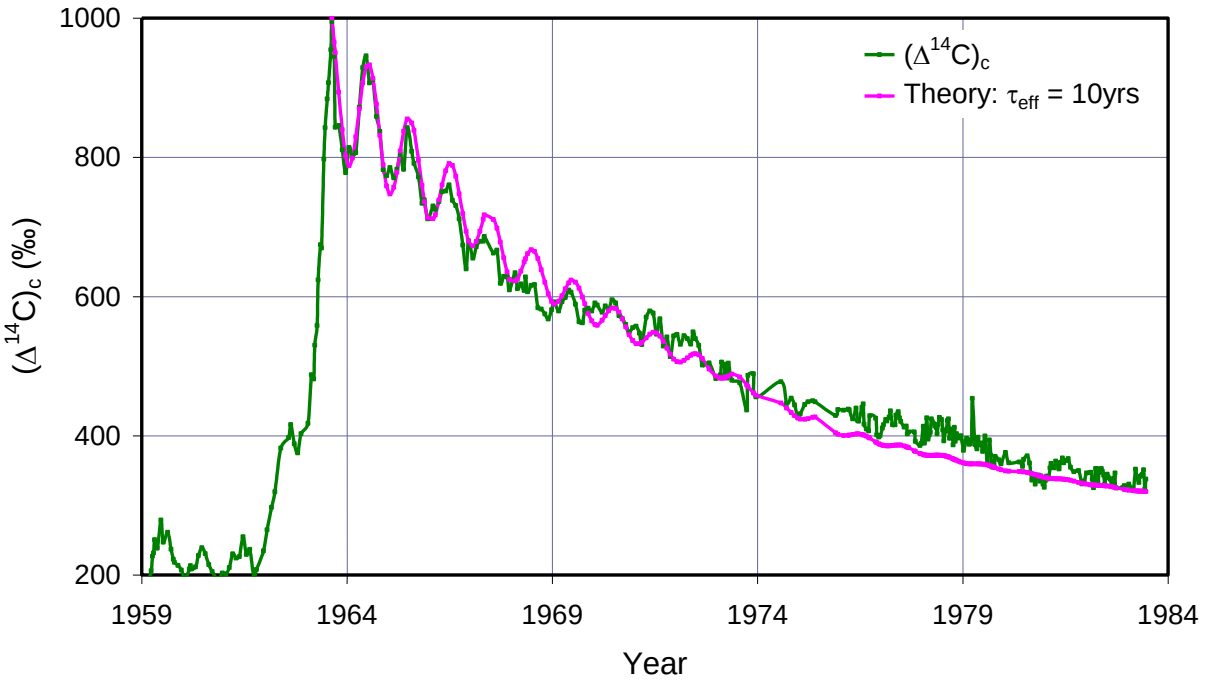

Figure 2: *Anomalous ^{14}C measured at Vermunt, $(\Delta^{14}C)_C$ (Green), compared against calculated $(\Delta^{14}C)_C$ with an effective absorption time of τ_{eff} = 10 yrs (Magenta).*

2.3 Extended Decline

Observations of $\Delta^{14}C$ at Vermunt end in 1983. Observations at Schauinsland Germany (Levin 2013 [26]) enable them to be extended almost continuously to 2012. Over durations longer than 20 years, normalization by increasing ^{12}C leads to greater distortion of $\Delta^{14}C$. The prolonged decline also brings carbon 14 closer to its unperturbed equilibrium level.

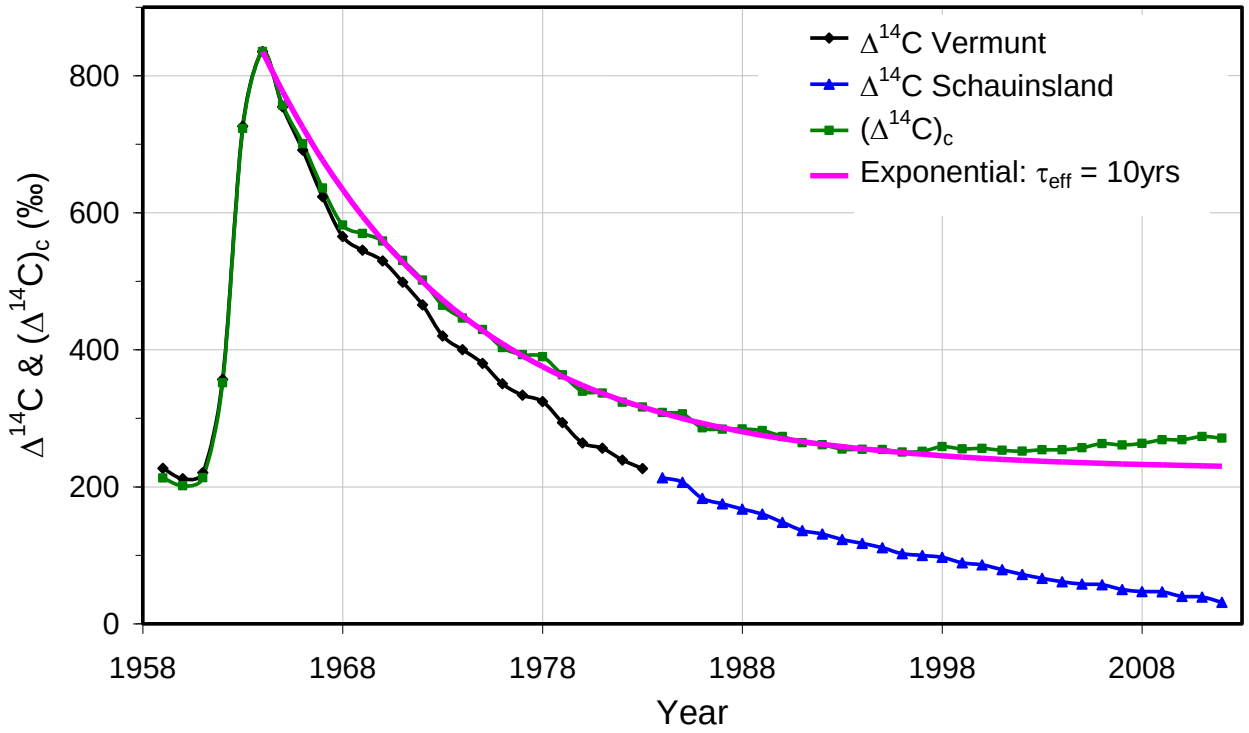

Figure 3: *Annual-mean $\Delta^{14}C$ observed at Vermunt (Black) and Schauinsland (Blue), along with the ^{12}C-corrected data, $(\Delta^{14}C)_C$ (Green). Superimposed is pure exponential decline with an effective absorption time τ_{eff} = 10 yrs (Magenta).*

Figure 3 displays the collective record of annual-mean $\Delta^{14}C$ measured at Vermunt (Black) and Schauinsland (Blue). Superimposed is corrected anomalous carbon 14, $(\Delta^{14}C)_C$, with normalization by ^{12}C (5) removed (Green). The long- term decline of perturbation ^{14}C apparent during the initial 20 years continues to the end of the concatenated record. The record of $(\Delta^{14}C)_C$, however, approaches an equilibrium level. It reflects carbon 14 in the early 1960s, somewhat higher than the equilibrium level inferred a decade earlier, when ^{14}C measurements began. Also superimposed in Figure 3 is pure exponential decline with an effective absorption time τ_{eff} = 10 yrs (Magenta). Having time scale equal to that of effective absorption in Figures 1 and 2, it tracks the observed record of $(\Delta^{14}C)_C$.

The equilibrium level of ^{14}C is determined by total production in (9). Most of this production is natural. Despite the *Limited Test Ban Treaty*, however, some nuclear testing continued after 1963. Involved were more than a thousand detonations (see Arms Control Association, 2020 [35]), the last ones in 2017 by North Korea. Albeit chiefly under ground and in the ocean, some of the ^{14}C produced in those tests emerged at the Earth's surface, where it was emitted into the atmosphere along with other ^{14}C. Contemporaneous is the release of ^{14}C from nuclear power generation, which increased sharply after 1963 (Runte, 2013 [36]). Both extraneous sources of ^{14}C act to elevate its equilibrium level.

More central to the equilibrium level, however, is natural production of ^{14}C in the stratosphere. Embodied in $e'_{N,14}$ (9), natural production occurs through absorption of free neutrons that are librated by cosmic radiation. The latter is modulated by solar wind. The departure from constant natural emission, $e'_{N,14}$, must evolve likewise (see also: Damon & Peristykh 2004 [37]; Connolly et al. 2021 [38]).

Neutron flux has been monitored for the last 56 years at the Cosmic Ray Station of the University of Oulu Finland [39]. Plotted in Fig 4, it reveals a systematic increase over the last 30 years - of 5-10%. The observed increase tracks decreasing sun spot number and weakening solar magnetic field.

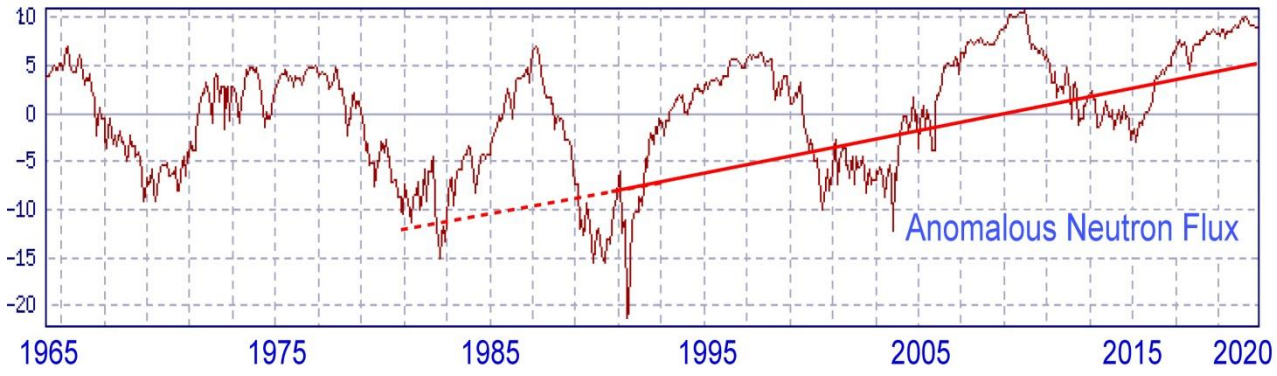

Figure 4: Anomalous neutron flux (%) observed at Oulu Finland.

Inclusive of time-varying natural production (but exclusive of oscillatory reinforcement), the Conservation Law becomes:

$$\frac{dC'_{14}}{dt} = e'_{NB,14}(t) - \frac{C'_{14}}{\tau_{eff}}, \qquad (10)$$

with $e'_{NB,14}$ accounting for time-varying natural emission as well as nuclear power generation and nuclear testing after the test ban treaty.

Equation (10) has been integrated for an effective absorption time of τ_{eff} = 10 yrs (with a re-emission fraction of β = 0.6, it corresponds to a direct absorption time of 4 yrs) and with total emission of $e'_{NB,14}$ = 123 ‰/yr that now increases since 1990 at 0.3 ‰/yr^2, characteristic of observed neutron flux in Figure 4. The resulting anomaly, C'_{14}, is then transformed back to anomalous carbon

14 that is referenced against the standard activity (5). Plotted in Figure 5 is calculated $(\Delta^{14}C)_C$ (Magenta). The calculated evolution tracks the observed evolution of $(\Delta^{14}C)_C$, which is superimposed (Green). Faithfully represented is its approach to a new equilibrium level. About 250‰ higher than the equilibrium level during the pre-test era, its elevation is well accounted for by the observed enhancement of neutron flux.

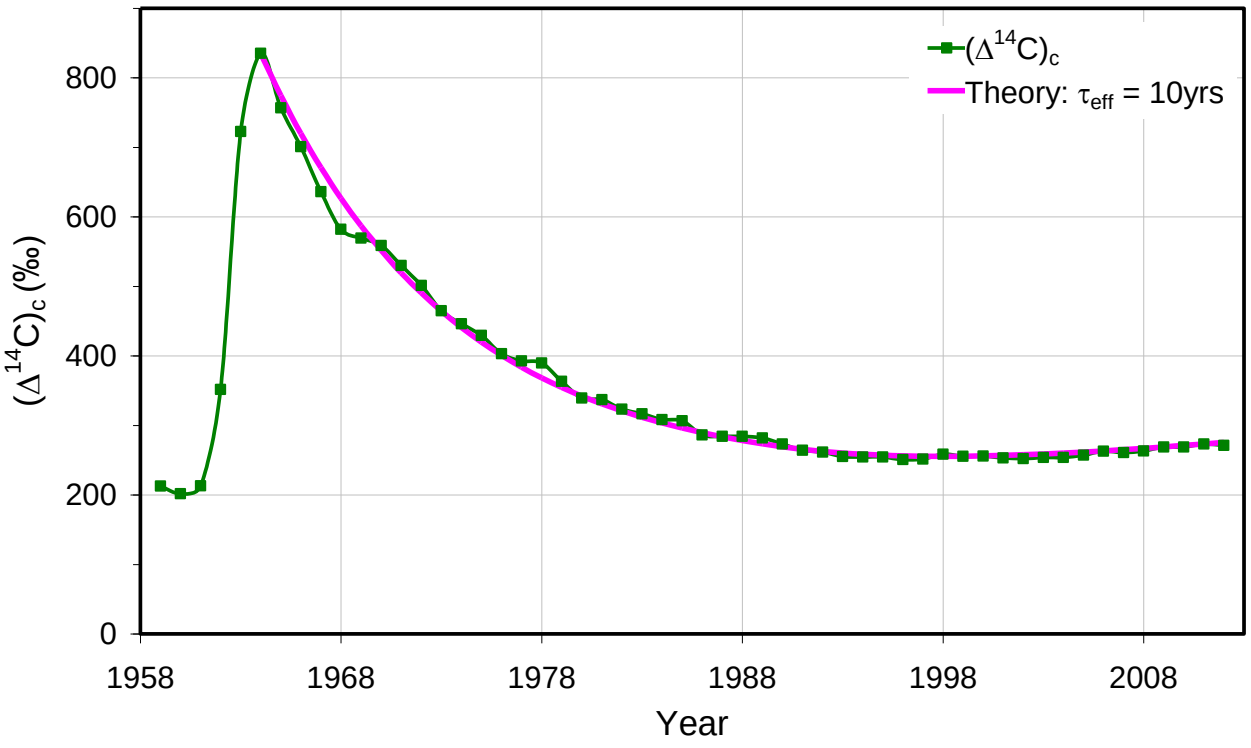

Figure 5: Evolution of calculated $(\Delta^{14}C)_C$ with effective absorption time of τ_{eff} = 10 years (Magenta), compared against observed $(\Delta^{14}C)_C$ (Green).

Integrations of the Conservation Law that governs atmospheric CO_2 (Figures 3 and 5) illustrate the operation of CO_2 absorption with a single absorption time of only 10 yrs. Thereby, they eviscerate unqualified claims that were advanced by Andrews 2020 [30]):

> *Unconventional models motivated by a misinterpretation of the isotope ratio variable "$\Delta^{14}C$" are excluded when the error is corrected… Harde and Berry erroneously concluded that after atmospheric nuclear testing ceased, the "pulse" of extra ^{14}C introduced by the tests exponentially disappeared from the atmosphere with a time constant of approximately 16 years.*

The foregoing integrations demonstrate that these claims are incorrect. It is noteworthy that, had the removal of perturbation ^{14}C and, hence, of CO_2 come to a halt after 1990, as implied by Andrews, continued emission (which is of order 100 ppmv/yr; see Sec 3.1) would have increased CO_2 since then by several hundred ppmv. The observed increase was nothing of the sort, proceeding at about the same rate as during earlier years.

3. Perturbation of CO_2

Independent of its isotopic tracer $^{14}CO_2$, CO_2 itself reveals its absorption - through its seasonal perturbation. In its monthly deviation from annual-mean conditions, CO_2 increases by ~6 ppmv, after which it declines by ~4 ppmv. Like perturbation $^{14}CO_2$, this seasonal perturbation depends on the absorption time of CO_2.

3.1 Simulation of CO_2

Inclusive of anthropogenic emission, e_A, the Conservation Law governing atmospheric CO_2 is

$$\frac{dC_{CO2}}{dt} = e_N(T,t) + e_A(t) - \frac{C_{CO2}}{\tau_{eff}}, \qquad (11)$$

where natural emission, e_N, is generally temperature and time dependent. Seasonality can enter CO_2 through emission, or absorption, or through a combination of the two. Its influence on CO_2, however, depends only on the seasonality of *net* emission: the residual between emission and absorption. Therefore, it is sufficient to introduce seasonality through emission; similar behavior can be obtained through equivalent seasonality in the other preliminary avenues.

Natural emission is allowed to vary with anomalous temperature, ΔT, and month:

$$e_N(T,t) = e_{N0} + e_T(\Delta T,t) + \frac{e_{S0}}{2}\cdot\left\{1+\cos\left(\omega(t-t_0)+\varphi_e + m\cdot\sin\omega(t-t_0)\right)\right\}, \qquad (12)$$

where e_{N0} is the undisturbed emission rate, e_{S0} is the amplitude of its seasonal modulation, φ_e is its constant background phase, and $m\cdot\sin\omega\cdot(t\text{-}t_0)$ is a modulation of its phase that recovers the asymmetric shape of the observed seasonality. Note: Because the seasonal modulation in (12) is nonnegative, it has non-vanishing annual mean.[A]

Background emission, unperturbed by temperature and anthropogenic emission, is prescribed as e_{N0} = 3 ppmv/yr, with remaining mean emission represented in the nonnegative seasonal emission. For anomalous temperature, $\Delta T(t)$, we rely on the record of annual-mean tropical temperature observed at Hawaii (NOAA [40]), which underwent systematic warming (trend) during the Mauna Loa era of 0.13°C/decade. Distinguished from other latitudes, the same warming was observed across the tropics by the Microwave Sounding Unit suite of satellite instruments (Spencer et al. 2017 [41]). It is also evident in the record of Tropical Sea Surface Temperature (Kennedy et al. 2019 [42]). The dependence of emission on temperature is defined to be slightly nonlinear (see, e.g., Harde 2019 [3]):

$$e_T(\Delta T,t) = \beta_e\cdot\Delta T(t)^{1.3}, \qquad (13)$$

where β_e = 10 ppmv/yr/°C$^{1.3}$ is the coefficient of temperature dependence. During the Mauna Loa era, this temperature dependence increases emission by 6.9 ppmv/yr, with an average of $\langle e_T\rangle$ = 3 ppmv/yr. τ_{eff} can also be temperature dependent. But, to deduce an upper limit on absorption time, it is sufficient to consider changes in e_N.

Seasonal modulation of emission is assigned an amplitude e_{S0} = 40 ppmv/yr, a background phase φ_e = π, and a modulation amplitude of m = 0.8. The asymmetric form of seasonal modulation intensifies emission during 8 months (September - April) but weakens it over only 4 months (May - August). Together with its non-vanishing mean, the asymmetry leads to annual-mean emission of $\langle e_S(t)\rangle$ = 27.4 ppmv/yr.

Anthropogenic emission, $e_A(t)$, is prescribed from the time-varying record Fossil Fuel Emissions, which are well documented (CDIAC [32]). Although poorly documented, we also include the record of Land Use Change (e.g., Le Quéré et al. [43]; CICERO [44]). Together, those contributions reach 5.5 ppmv/yr in 2018, about 5% of total emission.

The effective absorption time, τ_{eff}, is defined analogous to (7). Therefore, the absorption rate $\mathcal{A}$ = C_{CO2}/τ_{eff} in (11) includes re-emission, $e_R = \beta\cdot C_{CO2}/\tau$; see (6) – (7). It is noteworthy that τ_{eff}, here is determined independently of its determination in Sec. 2: by requiring the observed evolution, which is recovered from (11), to satisfy the Conservation Law.

[A] Retaining the annual mean of seasonal modulation in $e_S(t)$ is arbitrary. It could equivalently be isolated in the constant background emission, e_{N0}.

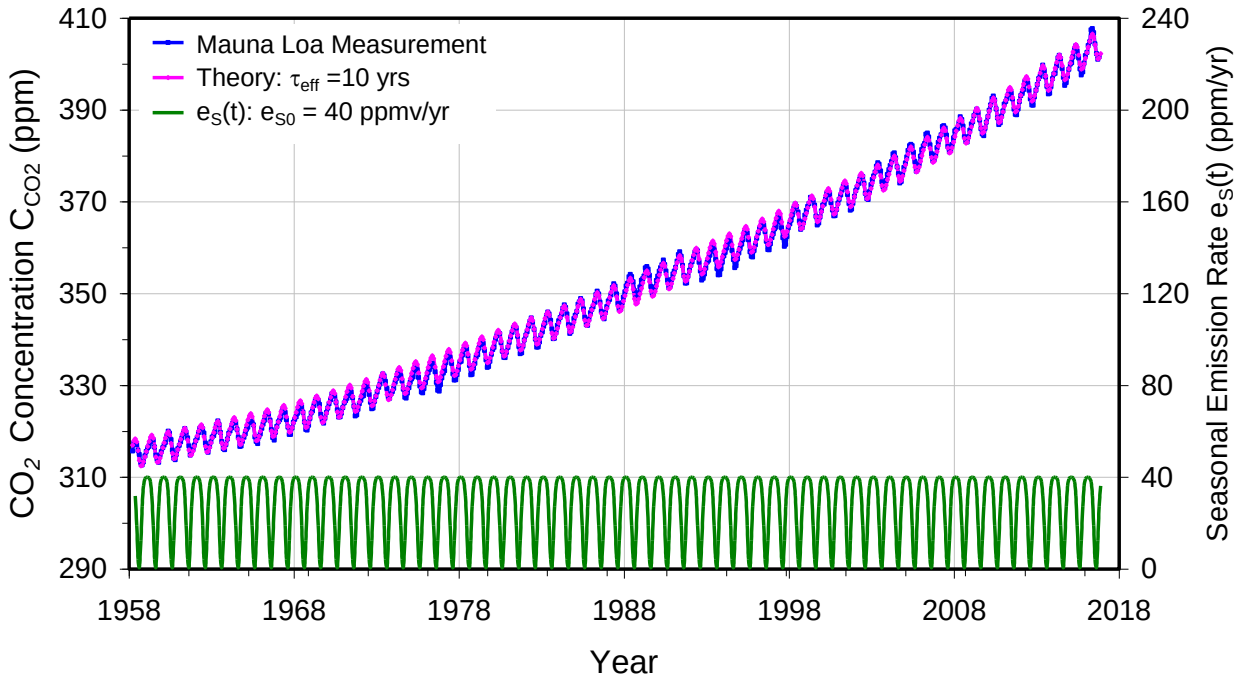

Figure 6: Calculated evolution of CO_2 (Magenta), inclusive of temperature-dependent natural emission, its seasonal modulation, and anthropogenic emission, all for an effective absorption time τ_{eff} =10 yrs (see text). Superimposed is the observed evolution of CO_2 (Blue). Also shown is the seasonal modulation of emission (Green).

With an effective absorption time of τ_{eff} = 10 yrs, numerical integration of (11) yields the evolution of CO_2 in Figure 6 (Magenta). It tracks the observed evolution of CO_2 which is superimposed (Blue). Also shown in Figure 6 is the seasonal modulation of emission $e_S(t)$ (Green).

Noteworthy is the fraction of total emission responsible for the observed evolution that follows from natural emission. Implicit in the absorption term in (11) is re-emission of CO_2:

$$-\frac{C_{CO2}}{\tau_{eff}} = -(1-\beta)\frac{C_{CO2}}{\tau}, \qquad (14)$$

where β is the fractional re-emission of CO_2 that was removed through direct absorption, which operates with the time scale τ. The term $+\beta \cdot C_{CO2}/\tau$ in (14) represents re-emission of absorbed CO_2 (6), most of which was emitted by natural sources. With β = 0.6 (τ = 4.0 yrs) and $\langle C_{CO2} \rangle \approx$ 395 ppm over the last decade, mean re-emission is then $\langle e_R \rangle = \beta \langle C_{CO2} \rangle / \tau$ = 59.3 ppmv/yr. Collective emission from natural sources is thus: $\langle e_{N0} \rangle + \langle e_S \rangle + \langle e_T \rangle + \langle e_R \rangle \cong 3+27.4+3+59.3 \cong 92.7$ ppmv/yr. It corresponds to natural emission of 93 ppmv/yr that was estimated by the IPCC who, in contrast to temperature dependence accounted for in (13), presumed that natural emission remained constant.

Figure 7 presents the same record as Figure 6, but on a magnified time scale. The asymmetric form of seasonality is well captured by the prescribed phase modulation (12). Accordingly, the calculated monthly variation (Magenta) tracks the observed variation of CO_2 (Blue). Seasonal modulation, (Green), intensifies emission during intervals of CO_2 growth, leaving it weaker during intervals of CO_2 decline.

The calculated seasonal variation of CO_2 is determined largely by the seasonality of emission. This dependence follows from absorption at τ_{eff} = 10 yrs being slow compared to seasonal transience in emission, which therefore alters anomalous CO_2 before it can be influenced substantially by absorption.

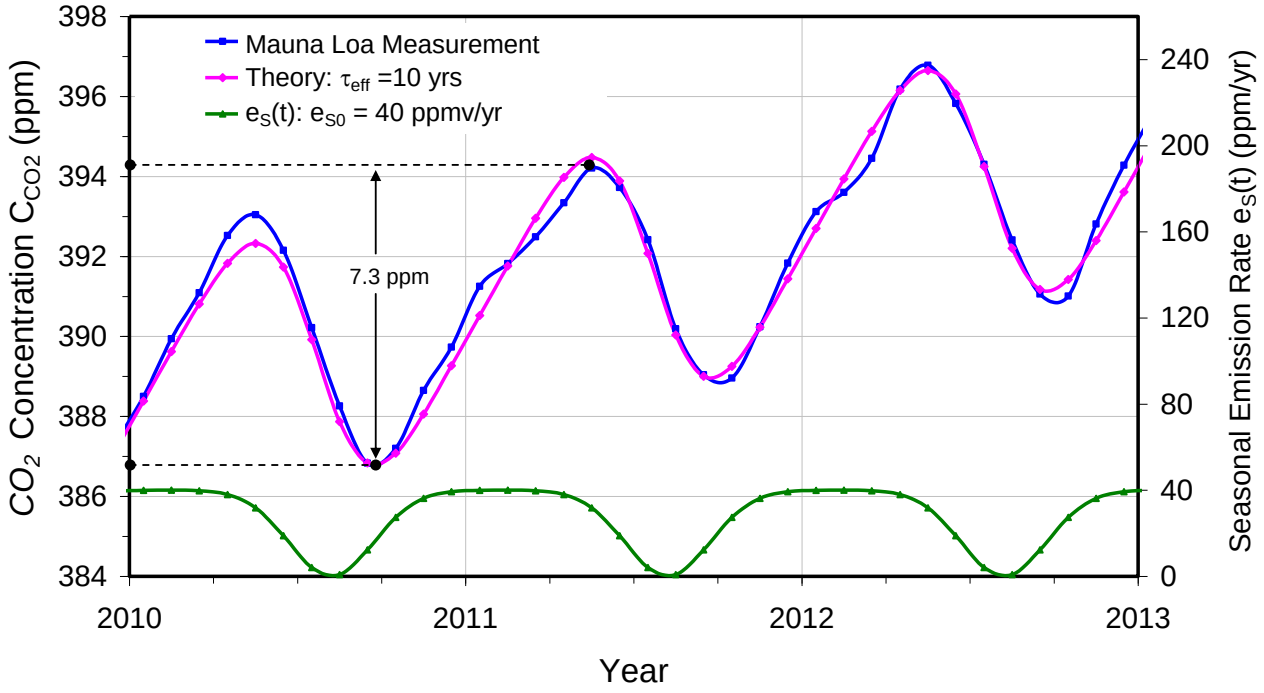

Figure 7: As in Figure 6, but on an expanded time scale.

The observed evolution (Figures 6 and 7) can, within bounds, be recovered for other values of emission. This is a consequence of the local mean of CO_2 being determined by the product of total emission and the absorption time (see Eq. (11)). A change in one can therefore be compensated by a change in the other. However, the observed evolution of CO_2 is recovered only for τ_{eff} *shorter than 11 yrs* - e.g., in previous simulations that reproduce observed features (Harde 2017 [2], 2019 [3]; Berry 2019 [9], 2021 [45]). Regardless of temperature dependence and seasonality in natural emission (12), slower absorption (τ_{eff} > 11 yrs) does not recover the long-term increase and the seasonality of observed CO_2.

This upper bound on τ_{eff} applies equally to pre-industrial conditions, for example, with CO_2 concentration of 280 ppmv and without anthropogenic or thermally-induced emission.[A] With seasonal perturbation as exists today, mean emission $\langle e_S(t)\rangle$ = 27.4 ppmv/yr, and under quasi-equilibrium conditions, (11) then gives an effective absorption time of

$$\tau_{eff} = \frac{C_{CO2}}{\langle e_S(t)\rangle} = 10.2\, yrs\,. \qquad (15)$$

Integrations with seasonality present in both emission and absorption (not shown) reveal much the same upper bound: τ_{eff} < 12 yrs. Following from the Conservation Law and the observed perturbation of CO_2, both upper bounds are consistent with the effective absorption time that was determined independently from the observed perturbation of $^{14}CO_2$ (Sec. 2).

All of the permissible absorption times represent removal of atmospheric CO_2 that is an order of magnitude faster than is assumed by the IPCC. Absorption times in (11) longer than 100 yrs, which are relied upon by the IPCC to interpret observed changes, lead to CO_2 evolution that diverges conspicuously from its observed evolution.

[A] The often-cited value of 280 ppmv, which is claimed to have been invariant before the industrial era, is merely a representative constant. That value follows, not by actual measurements of atmospheric CO_2, but from ice core analyses, which are shrouded in uncertainty (see, e.g., Jaworowski et. al, 1992) [46].

3.2 Anthropogenic Perturbation

The effective absorption time provides an upper bound on the anthropogenic perturbation of CO_2. In the presence of constant or increasing anthropogenic emission, the anthropogenic perturbation of CO_2 can never exceed its equilibrium level: that level at which CO_2 is removed by absorption, C^A_{CO2}/τ_{eff}, as fast as it is introduced by emission, e_A. The equilibrium level, thus, places a hard cap on accumulation of CO_2 in the atmosphere.

Contrasting fundamentally is the position adopted by the IPCC: that, even for constant emission, anthropogenic CO_2 would continue to accumulate in the atmosphere. The forgoing considerations, which rest on immutable physical constraints, show that actual CO_2 would do nothing of the sort.

Upon reaching its equilibrium level, the growth rate of anomalous CO_2 vanishes. The conservation law governing the anthropogenic perturbation (e.g., Eq. (11) with emission restricted to e_A) then reduces to

$$e_A = C^A_{CO2} / \tau_{eff} \,. \tag{16}$$

Rearrangement gives the equilibrium concentration of anthropogenic CO_2:

$$C^{A,Eq}_{CO2} = \tau_{eff} \cdot e_A \,. \tag{17}$$

With τ_{eff} = 10 yrs and anthropogenic emission equal to its mean over the Mauna Loa Era, $\langle e_A \rangle \cong 3.4$ ppmv/yr (e.g., CDIAC 2017) [32], (17) yields an upper bound on the net perturbation of CO_2:

$$\left\langle C^A_{CO2} \right\rangle \leq 34 \text{ppmv}. \tag{18}$$

The anthropogenic perturbation (which the IPCC claims was entirely responsible for increasing CO_2 during the Mauna Loa era) could actually have contributed no more than about a third of the observed increase (~100 ppmv). Much the same follows directly from the Conservation Law, without explicit reference to the equilibrium level (Appendix).[A]

Even if, throughout the last half century, anthropogenic emission had been as large as its recent maximum, 5.0 ppmv/yr, the anthropogenic perturbation of CO_2 could have contributed no more than half of the observed increase.

Whereas the perturbation introduced by anthropogenic emission cannot exceed this upper bound, it can be smaller. If anthropogenic CO_2 experiences absorption faster than the limiting absorption that was determined in Sec 2 and independently in Sec 3.1 (i.e., if τ_{eff} is shorter than ~10 yrs), the anthropogenic perturbation will be reduced accordingly. For example, at τ_{eff} = 4 yrs, anthropogenic emission, even as great as its recent maximum, could perturb CO_2 by no more than 20 ppmv. This perturbation of CO_2 represents less than 20% of its observed increase to date, mirroring the fractional increase of total emission (Appendix). Continued emission at this rate, even indefinitely, would not increase the anthropogenic fraction further. On the contrary, continued growth of observed CO_2, which has existed since at least the onset of uninterrupted monitoring, would render the anthropogenic fraction of increased CO_2 even smaller.

4. Conclusions

$^{14}CO_2$ is an isotopic tracer of all CO_2. The exponential decline of its nuclear perturbation establishes that absorption of CO_2 is determined, not by extraneous reservoirs of carbon, but autonomously by the atmosphere. Specifically, the rate at which CO_2 is removed from the atmosphere is directly proportional to the instantaneous abundance of CO_2 in the atmosphere. Removal of CO_2 operates

[A] If considered over the entire industrial era, the anthropogenic fraction of increased CO_2 must be even smaller. With emission equal to its mean since 1850, 1.8 ppmv/yr, (17) gives an upper bound on the anthropogenic perturbation of only 18 ppmv. The anthropogenic fraction of increased CO_2, allegedly from 280 ppmv in 1850, would then have been smaller than 14%.

with a single time scale, which reflects the collective absorption by all sinks of CO_2 at the Earth's surface.

The long-term decline of anomalous $^{14}CO_2$ reveals an effective absorption time of about 10 years. It represents removal of atmospheric CO_2 that is much faster than has been presumed to interpret observed changes. The absorption time establishes an upper bound on perturbations of CO_2. Included is anomalous CO_2 introduced by anthropogenic emission, a perturbation to natural emission that constitutes less than 5% of total emission.

The equilibrium level of anthropogenic CO_2 represents a hard cap on its accumulation in the atmosphere. Determined by anthropogenic emission and the effective absorption time, it is too small for anthropogenic emission to be responsible for the observed increase of atmospheric CO_2. At the existing level of anthropogenic emission, or even with foreseeable increases, the anthropogenic fraction of increased CO_2 will remain small.

The title of this paper poses the question: What controls atmospheric CO_2? - a question central to understanding its observed evolution. The preceding analysis of its removal follows independently from perturbations of CO_2 and of its isotopic tracer, $^{14}CO_2$. Through a diagnosis of exclusion, it provides a clear and unambiguous answer: The controlling influence is not anthropogenic emission.

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Appendix
Anthropogenic Contribution to Increased CO_2

During its long-term increase, atmospheric CO_2 remains in a state of quasi equilibrium, wherein emission of CO_2 is approximately balanced by its absorption. The Conservation Law for total CO_2 (11) then reduces to

$$e \cong C_{CO2} / \tau_{eff} . \tag{A1.1}$$

Differencing (A1.1) between initial and final states obtains the Conservation Law for the change of CO_2:

$$\Delta e \cong \Delta C_{CO2} / \tau_{eff} . \tag{A1.2}$$

As anthropogenic emission also changes gradually, anthropogenic CO_2 likewise remains in a state of quasi equilibrium. The Conservation Law governing the anthropogenic component of CO_2, which follows from (11) with e restricted to e_A, therefore assumes the same form as (A1.1):

$$e_A \cong C^A_{CO2} / \tau_{eff} . \tag{A2}$$

Dividing (A2) by (A1.2) obtains

$$\frac{C^A_{CO2}}{\Delta C_{CO2}} \cong \frac{e_A}{\Delta e} . \tag{A3}$$

Anthropogenic emission introduces a fractional increase of CO_2 that is equal to its fractional increase of emission.

Under quasi equilibrium, the change of emission must be approximately equal to the change of absorption. Incorporating the upper bound on absorption time, $\tau_{eff} \le \tau^{\max}_{eff}$, then gives

$$\frac{C^A_{CO2}}{\Delta C_{CO2}} \cong \frac{e_A \cdot \tau^{\max}_{eff}}{\Delta C_{CO2}} . \tag{A4}$$

For mean anthropogenic emission of 3.4 ppmv/yr, an upper bound on absorption time of $\tau_{eff}^{\max}$ =10 yrs, and a CO_2 increase over the Mauna Loa era of ~100 ppmv, (A4) yields the following upper bound on the anthropogenic contribution to increased CO_2:

$$\frac{C_{CO2}^{A}}{\Delta C_{CO2}} \leq 34\% . \qquad \text{(A5)}$$

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Climate Sensitivity and Carbon Footprint

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Abstract

A simple formula is suggested to policy makers to evaluate the impact on Earth's temperature of fossil fuel emissions or reductions. It is illustrated for main emitters, country by country. Two lists of estimates are compared.

One is based on the last report of the Intergovernmental Panel on Climate Change (IPCC AR5 2013) which retained a range of 1–2.5 °C for the Transient Climate Response (TCR) in case of atmospheric CO_2 doubling, a metric that is more relevant than the Equilibrium Climate Sensitivity (ECS) to estimate warming in the next few decades. At the rate of increase of 0.5 % per year since the beginning of this century, a CO_2 doubling in the atmosphere will hardly be reached before the end of the century.

The second estimate is based on infrared thermal emission spectra of atmospheric CO_2 near the tropopause that constrain the climate sensitivity below 1°C in the absence of feedbacks consistent with 109 studies concluding to low climate sensitivity. An increasing number of their publications is reported during both last decades. They are also confirmed by a plateau observed since 1994 for the temperature of the low stratosphere measured by the Earth System Science Center, University of Alabama in Huntsville (UAH), over a period corresponding to 42 % of the increase of CO_2 in the atmosphere since the beginning of the industrial era.

A tendency of "cooling" of climate sensitivity versus year of publication is confirmed for studies based on instrumental records of ocean and surface temperature, whereas CMIP6 climate models are running hotter. The correlation of (i) monthly temperature fluctuations measured by UAH at the Earth's surface and (ii) CO_2 increases in the atmosphere that lag temperature fluctuations instead of driving them, is updated and discussed.

Keywords: *TCR*, *ECS*, *infrared*, *fossil fuel emissions*, *carbon footprint*

Introduction

In 2020, the concentration of carbon dioxide in the atmosphere measured by NOAA at the observatory of Mauna Loa, detrended from seasonal oscillations, reached 414 parts per million (ppm). 1 ppm corresponds to 7.8 Gigatons of CO_2 ($GtCO_2$). The atmosphere, therefore, was composed in 2020 of 3.2 10^{12} tons of CO_2. The transient climate response (TCR) is defined as the increase of average Earth's temperature when the atmospheric CO_2 concentration would double. At the average rate of increase of 2.2 ppm per year observed since two decades as is detailed in Figure 6 of Section 4, viz. 2.2/414 = 0.5 %/year, doubling will hardly be achieved during this century.

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[B] The author acted as expert reviewer of IPCC AR5 and AR6.

[C] The work is dedicated to the memory of Professor Nils-Axel Mörner who encouraged the author to publish this study as proceedings of the Conference "Basic Science of a Changing Climate", University of Porto (2018) – www.portoconference2018.org – that Professor Mörner co-organized. The author was fascinated by the energy of Professor Mörner and his outstanding knowledge of oceans and sea level rise.

Section 1 complements the Summary for policymakers of IPCC AR5 (2013) by evaluating a key point that is missing, viz. the impact of the emission (or of reduction of emission) of one ton of CO_2 on the Earth's temperature, a metric that is more relevant than the carbon footprint in terms of climate. Results for largest emitter countries will illustrate their own climatic impact at their rate of emissions during 2019.

Section 2 is a review of published values of climate sensitivity lower than 1 °C that have not been considered in IPCC AR5 (2013) which retained for the TCR the interval from 1°C to 2.5 °C only.

In Section 3, the infrared thermal emission spectrum of atmospheric CO_2 near the tropopause – not shown in IPCC AR5 (2013) – is scrutinized. A TCR lower than 1 °C is deduced, confirming data of Section 2. Results of Section 1 are complemented with this value for comparison.

Section 4 updates the correlation of Earth's temperature measured by satellites and the yearly increase of CO_2, discuss them and focus on specific points.

1 Impact of one ton of CO_2 on Earth's temperature and contribution country by country

The Transient climate response (TCR) to CO_2 doubling is more relevant than Equilibrium climate sensitivity (ECS) to warming in the next few decades because to reach equilibrium would need several centuries while the present work focuses on next decades with the target of net zero emissions by 2050 announced by policy makers. Nijsse *et al.* 2020 report that the Coupled Model Intercomparison Project Phase 6 (CMIP6) models, the results of which are expected to be included in the IPCC Assessment Report AR6, constrain the likely range of TCR to 1.3–2.1°C, with a central estimate of 1.68 °C. This is near the medium value 1.75 °C of the TCR interval of 1 °C–2.5 °C of IPCC AR5 (2013).

In a first estimate, by considering

- an additional temperature of the Earth of 1.68 °C that would tentatively be reached if doubling, i.e. 3.2 10^{12} tCO_2 would be added to the 3.2 10^{12} tCO_2 already present in 2020 in the atmosphere,
- an airborne fraction of 44 % provided by IPCC AR5 (2013), the fraction of the CO_2 emissions that remains in the atmosphere at least several years (the number of years is still controversial and discussed in Section 4), a fraction found nearly constant for several decades, implying that to double atmospheric CO_2, the human activities should emit 3.2 10^{12} tCO_2/44 % = 7.3 10^{12} tCO_2,

then emitting one ton of CO_2 would warm the Earth by

$$(1/7.3\ 10^{12}\ tCO_2) \times 1.68\ °C = 2.3\ 10^{-13} °C/tCO_2 \qquad (1)$$

Thus, evaluated with the data of IPCC AR5 and CMIP6 models, the yearly emissions of 36 $GtCO_2$ warms the Earth by 0.008 °C. Although simple and useful, this fundamental evaluation is missing in IPCC AR5 (2013). Another fraction of emissions, ~ 1/3, enriches the vegetal biomass and nutritive plants by photosynthesis. The third smaller fraction is captured by the oceans (Section 4).

By replacing the molar weight of CO_2, 12 + 2 x 16 = 44, by that of carbon, 12, Eq. (1) provides

$$(1/7.3\ 10^{12}\ tCO_2) \times 1.68°C \times 44/12 = 8.4\ 10^{-13} °C/tC \qquad (2)$$

Equation (2) is the equivalent of Eq. (1) in terms of carbon footprint. It can be approximated as almost ~ 1 picodegree C/tC. To keep them as simple as possible, Equations (1) and (2) imply a linear interpolation. Section 3 considers the more relevant logarithmic law.

To illustrate the impact of Eq. (1), Table 1 lists the countries the largest emitters of CO_2 in 2019, as reported by *www.globalcarbonatlas.org.* The yearly impact of their emissions is evaluated with the central estimate of TCR of 1.68 °C of CMIP6 climate models.

Table 1. List of countries the most CO_2 emitters in 2019, as reported by *www.globalcarbonatlas.org*. The emissions per inhabitant per year listed in column 5 and compared with the world 5 tons average, changes the ranking of countries. Column 6 provides the contribution to the Earth warming per year calculated with Eq. (1) and a TCR of 1.68 °C (central estimate of CMIP6, Nijsse *et al* 2020). By considering that the accuracy generally admitted for the Earth's average temperature is 0.07°C, column 7 indicates how many years such warmings by each country will remain below the threshold of measurability. Values in excess of a century are omitted because they are beyond the limits of the method. Columns 8 and 9 indicate the results with a TCR of 0.78 °C deduced from the CO_2 infrared thermal emission spectrum as discussed in Section 3 and calculated by Eq. (7). Although a medium emitter with a tCO_2/inh/yr equal to the average for the world, France is added by reference to the COP21 Paris agreement.

Country	$MtCO_2$ /yr	% of emiss.	Popul. million	tCO_2/inh /yr	°C/yr (TCR CMIP6 1.68°C)	Years below +0.06°C (TCR 1.68°C)	°C/yr (TCR 0.78°C)	Warming until 2050 (TCR 0.78°C)
China	10175	28	1434	7	0.0023°C	30	0.0011°C	0.030°C
USA	5285	15	329	16	0.0012°C	58	0.0006°C	0.016°C
India	2616	7	1366	2	0.0006°C	> 100	0.0003°C	0.008°C
Russia	1678	5	146	11	0.0004°C	> 100	0.0002°C	0.005°C
Japan	1107	3	127	9	0.00025°C	> 100	0.0001°C	0.003°C
Iran	780	2	83	9	0.0002°C	> 100	0.0001°C	0.002°C
Germany	702	1.9	83	8	0.0002°C	> 100	0.0001°C	0.002°C
Indonesia	618	1.7	271	2	0.00014°C	> 100	0.00007°C	0.002°C
South Corea	611	1.7	51	12	0.00014°C	> 100	0.00007°C	0.002°C
France	324	0.9	65	5	0.00007°C	> 100	0.00003°C	0.001°C
World	36441		7594	5				

Lovejoy (2017) reports that the uncertainty on series of Earth's temperature is about 0.1°C. *berkeleyearth.org* rather considers an uncertainty of 0.045 °C. We therefore adopt an intermediate threshold of measurability of the Earth's average temperature of 0.07 °C. Column 7 of Table 1 indicates how many years the warmings with "business as usual" for each country according to the 2019 data of column 2 will remain below the threshold of measurability.

As seen in Table 1, the policy of any country, either "business as usual" or reduction of emissions, cannot significantly change the Earth's temperature since it remains below the threshold of measurability, at least on the term of several decades for two of them and above a century for the others. Column 9 focuses on the year target of "net zero" policies considering reaching zero fossil fuels emission by 2050. The values have to be multiplied by about 2 with a TCR of 1.78 °C. Again results are below the threshold of measurability of the Earth's temperature.

2 A brief review of studies concluding to low climate sensitivity

Table 2 lists 109 studies that conclude to climate sensitivity either low or negligible, below or equal to 1°C. They are listed per year of publication.

Table 2. 109 studies concluding to low climate sensitivity listed by year of publication. A number of them correspond to the list updated by P. Gosselin at *notrickszone.com/50-papers-low-sensitivity*. When a climate sensitivity per CO_2 doubling is indicated in the study, the value is reproduced in the Table. When indicated, radiative forcing is converted to climate sensitivity with Eq. (4). In their absence, key conclusion or keywords are briefly reproduced.

Rasool and Schneider 1971	0.8°C
Weare and Snell 1974	0.7°C
Willett 1974	~ 0°
Zdunkowski *et al* 1975	< 0.5°C
Oliver 1976	negligible
Bryson and Dittberner 1976	$\Delta T = 3.346 \ln(CO_2)$, corresponding to 0.7°C (Eqs. 4 and 5)
Dyson 1977	« great uncertainty"
Newell and Dopplick 1979	< 0.25°C
Robock 1979	"no significant effect"
Choudhury and Kukla 1979	"cooling rather than warming effect of CO_2"
Idso 1980	< 0.26°C
Ramanathan 1981	0.5°C
Gates *et al* 1981	0.3°C
Schuurmans 1983	0.2 to 0.4°C at present concentration
Idso 1984	inverse greenhouse effect
Balling 1994	< 1°C
Lindzen 1994	2 W/m^2, hence 0.66°C
Idso 1998	0.4°C
Hug 2000	"Resonance collisions reduce effect" (below 1°C)
Khilyuk and Chilingar 2003	< 0.01°C
Jelbring 2003	~ 0°
Cess and Udelhofen 2003	"effect temporally decreasing"
Khilyuk and Chilingar 2006	0.01°C
Barrett *et al* 2006	3.1 W/m^2, hence 0.9°C
Bellamy and Barrett 2007	< 1°C
Miskolczi 2007	0.24°C
Chillingar et al 2009	negligible
Florides and Christodoulides 2009	0.01–0.03°C
Gerlich and Tscheuschner 2009	"atmospheric greenhouse conjecture falsified"
Lindzen and Choi 2009	0.5°C
Miskolczi 2010	negligible
Soares 2010	negligible
Clark 2010	Cannot cause climate change
Wagoner *et al* 2010	"very small"
Gerlich and Tscheuschner 2010	"non-existing influence"
Lindzen and Choi 2011	0.7°C
Nahle 2011	negligible
Arrak 2011	Arctic warming: not greenhouse effect
Fang *et al* 2011	"large uncertainties"
Zhao 2011	"little evidence"
Kramm and Dugli 2011	« meritless conjectures »
Ollila 2013	0.51°C
Clark 2013	negligible
Singer 2013	~ 0°
Avakyan 2013	"insignificant"
Harde 2013	2.6 W/m^2, hence 0.78°C
Laubereau and Iglev 2013	~ 1°C

Choi *et al* 2014	0.5–1.2°C
Gervais 2014	2.2 W/m^2, hence 0.66°C
Ollila 2014	0.6°C
Chilingar *et al* 2014	"no essential effect"
Lightfoot and Mamer 2014	2.8 % of water vapor warming ~ 30° x 0.028 = 0.84°C
Miskolczi 2014	"effect impossible"
Harde 2014	0.6°C
Kauppinen et al 2014	"Less than 10 % of the temperature change"
Reynen 2014	0.03°C
Soon et al 2015	0.44°C
Kimoto 2015	0.14–0.17°C
Kissin 2015	0.6°C
Schmithüsen *et al* 2015	"cooling effect"
Monckton *et al* 2015	1°C
Ollila 2016	1°C
Smirnov 2016	0.4°C
Bates 2016	~ 1°C
Evans 2016	< 0.5°C
Gervais 2016	< 0.6°C
Haine 2016	negligible
Manheimer 2016	negligible
Vares *et al* 2016	negligible
Easterbrook 2016	negligible
Allmendinger 2016	negligible
Ellis and Palmer 2016	"play little or no part"
Specht *et al* 2016	0.4°C
Hertzberg and Schreuder 2016	"nothing supports"
Song *et al* 2016	"no significant change of OLR"
Harde 2017a	0.7°C
Ollila 2017	0.6°C
Abbot and Marohasy 2017	< 0.6°C
Scafetta *et al* 2017	< 1°C
Smirnov 2017	0.4°C
Kramm *et al* 2017	negligible
Lightfoot and Mamer 2017	negligible
Robertson and Chilingar 2017	negligible
Hertzberg *et al* 2017	"none of greenhouse description withstand scrutiny"
Davis 2017	no effect
Allmendinger 2017	negligible
Holmes 2017	negligible
Harde 2017b	0.7°C
Nikolov and Zeller 2017	Solar irradiance and atmospheric pressure only
Wong and Minnett 2018	negligible
Smirnov 2018	0.4°C
Lightfoot and Mamer 2018	negligible
Stallinga 2018	0.5°C
Davis *et al* 2018	weak at most
Allmendinger 2018	no effect
Fleming 2018	"no role"
Swift 2018	"increase of absorbed solar radiation by 3 W/m^2"
Kato *et al* 2018	"decrease of LW irradiance"
Sejas *et al* 2018	negative CO_2 effect
Ollila 2019	0.6°C
Holmes 2019	negligible
Krainov and Smirnov 2019	0.4°C
Kim and Lee 2019	1 W/m^2, hence 0.3°C
Varotsos and Efstathiou 2019	negligible
Kennedy and Hodzic 2019	negligible
Fleming 2020	negligible
Drotos *et al* 2020	negligible

Stallinga 2020	< 0.5°C
Schildknecht 2020	0.5°C

Figure 1 plots the climate sensitivity reported in the studies listed in Table 2 versus the year of publication. They are compared with the range of TCR, 1–2.5 °C, of IPCC AR5 (full lines) and with the range of equilibrium climate sensitivity, 1.5–4.5 °C (dotted lines).

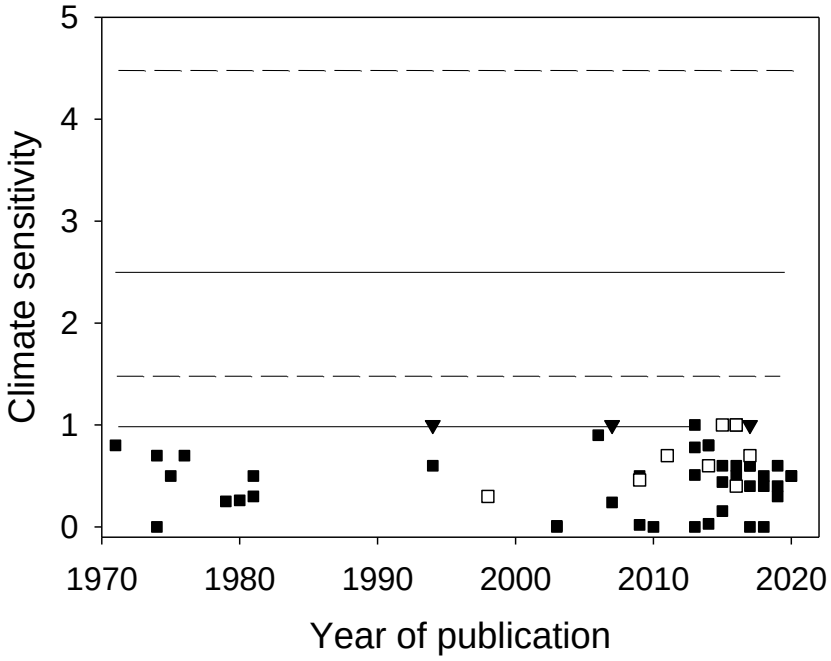

Figure 1. A plot of the data of Table 2 versus year of publication. White symbols correspond to the studies cited in the review of Knutti et al (2017) in which conversely studies corresponding to black symbols are ignored. Triangles correspond to the upper limit of the conclusions of the study. The full horizontal lines correspond to the limits of TCR in IPCC AR5 (2013) while the dotted lines correspond to the limits of ECS.

Figure 2 plots the number of studies of Table 2 published each year.

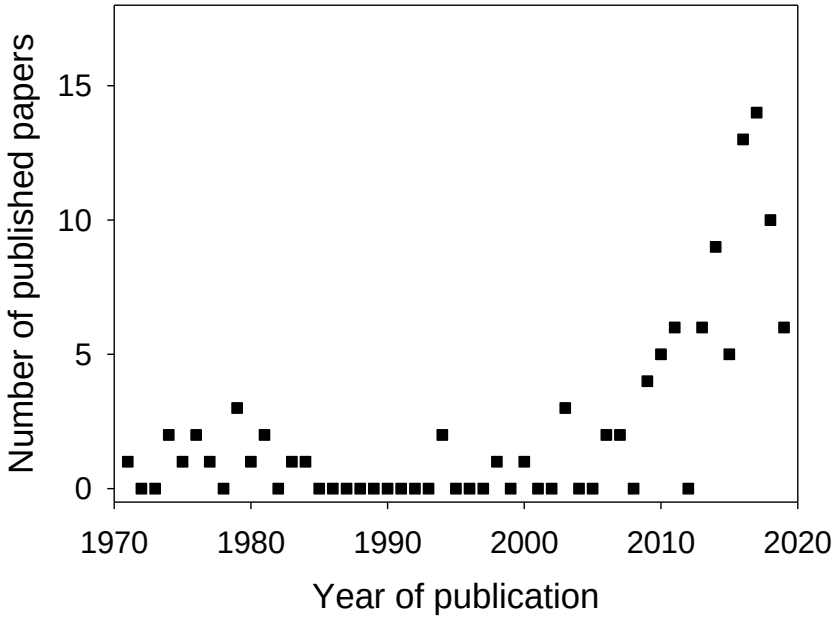

Figure 2. Acceleration since the beginning of this century, of the number of studies focusing on low climate sensitivity (equal or lower than 1 °C) as shown in Table 2 and Figure 1.

A tendency at acceleration emerges since the beginning of this century. The 108 studies of Table 2 may be compared to those reviewed by Knutti *et al* (2017) where 47 TCR or intervals of TCR are cited. Among them, only one study reports 1°C and only another one reports less than 1°C (Ollila 2014). 78 ECS or intervals of ECS are also reviewed. Among them, only 7 studies report 1°C or below (Idso 1998, Lindzen and Choi 2009, 2011, Monckton *et al* 2015, Bates 2016, Specht *et al* 2016, Harde 2017).

Figure 3 updates Figure 1 of Gervais (2016). It adds to the results plotted in Figure 1 the climate sensitivity estimated from instrumental records of surface temperature and ocean heat content as reported by Hausfather (2018), taken from the review of Knutti *et al* (2017), complemented by more recent results.

Figure 3 confirms that there is no consensus about the climate sensitivity. Each result appears disproved by a number of the others by as much as several degrees for some of them. A linear regression of results of Figure 3 indicates a "cooling" due to the tendency of decrease with year of publication of data deduced from instrumental records, a phenomenon which is amplified by the acceleration of results equal or below 1°C published recently as shown in Figures 1 and 2.

Conversely, no "cooling" is observed for ECS climate sensitivity of climate models, in particular CMIP5 and CMIP6, which remains essentially in the range from 1.5°C to 4.5°C without decrease of the uncertainty since the Charney report published in 1979. They are not shown in Figure 3 due to the deep uncertainty that persists to appear much too large.

Some CMIP6 models correspond to even larger climate sensitivity, with 5 of 34 models with TCR values above 2.5°C. Conversely, the lowest value of the range, 1.3°C, is the TCR reported by the INM-CM4-8 model (Volodin *et al* 2019). 12 of 34 models show an ECS value above 4.5°C (Nijsse *et al* 2020, McKitrick and Christy 2020). Figure TS.14(a) and Figure 1(a) of Box TS.3 of the IPCC AR5 (2013) show (i) that CMIP5 models do not agree between themselves while the IPCC AR5 (2013) does not make any choice between them, (ii) they run too "hot" to be validated by the observations from 1998 to 2014, a period that the AR5 designated as "hiatus".

Spencer (2021) has published an update with latest observations compared with CMIP6 models. Except INM-CM4-8, models persist to run hotter than observations.

The spread in estimated ECS has increased further in CMIP6 models. It reaches an uncertainty of 3.7 K as compared with 2.7 K in the previous CMIP5. McKitrick and Christy (2020) question pervasive warming bias in CMIP6 tropospheric layers. In addition, Zhu *et al* (2020, 2021) show that high climate sensitivity in CMIP6 models are not supported by paleoclimate. They find that the ECS is too large because of an incorrect treatment of clouds in the models. Wild (2020) shows that the inter-model spread amongst the magnitudes of the global energy balance components in the individual CMIP6 models is still unsatisfactorily large, typically of the order of 10–20 W/m^2. The inter-model spread in the simulated global mean surface latent heat flux reaches 18 W/m^2. These discrepancies have generally not decreased from the previous model generation CMIP5 to the latest model generation CMIP6, and the inter-model spreads and standard deviations remain similar.

Section 3 shows that in case of CO_2 doubling, the lack of flux at the TOA found from infrared thermal emission spectra could reaches 2.6 W/m^2. At the average rate of increase of CO_2 of 22 ppm/decade as shown in Figure 6, its contribution is of the order of (22/414) x 2.6 = 0.14 Wm^{-2}/ decade. The inter-model spread, therefore, appears more than 100 times larger, illustrating how much they are hardly convincing in the representation of the global energy imbalance.

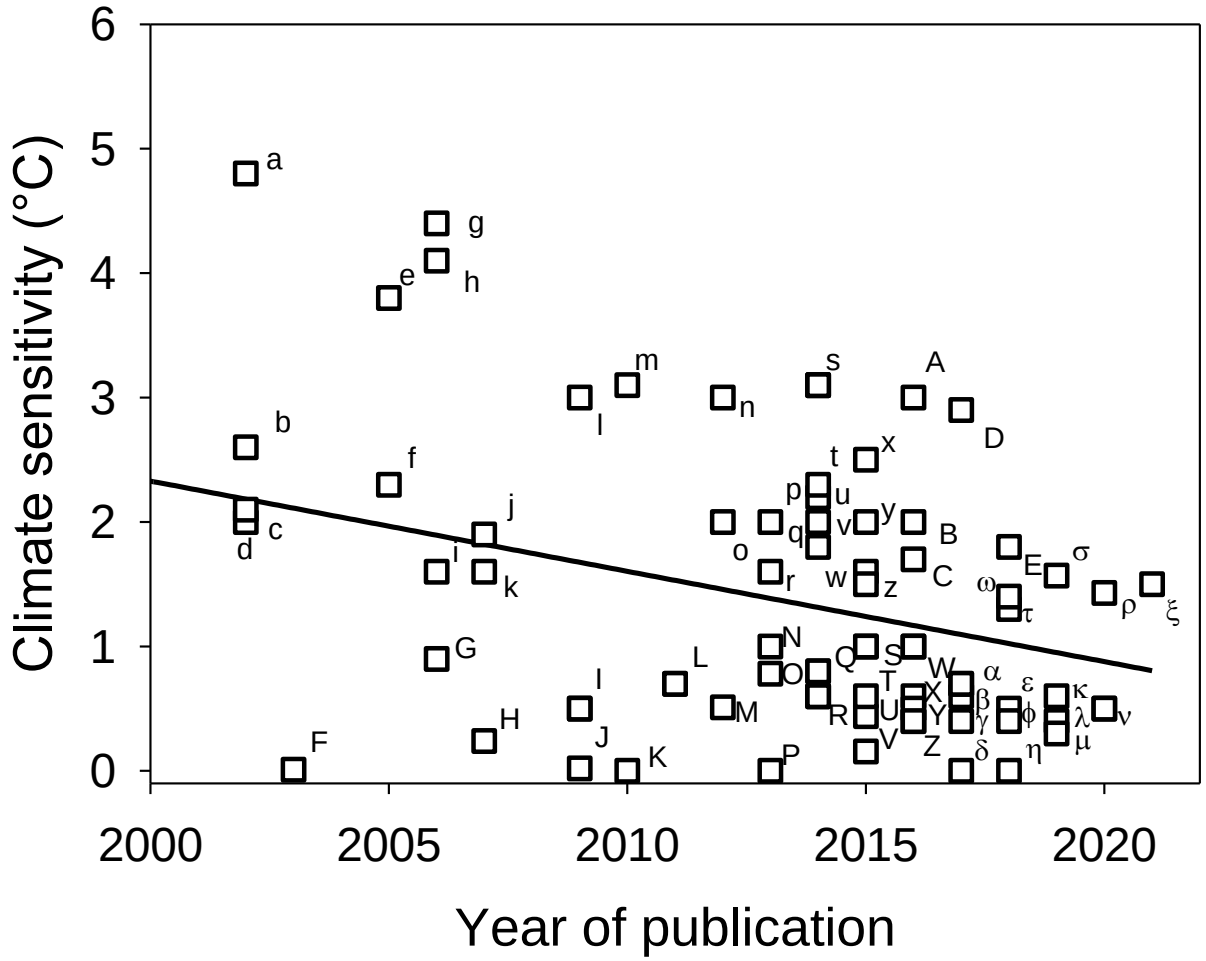

Figure 3. Climate sensitivity from instrumental records as listed by Hausfather (2018) taken from the review of Knutti et al (2017), complemented by more recent results, plotted together with data of Figure 1. ECS of CMIP5 and CMIP6 models that remains essentially in the range from 1.5 °C to 4.5 °C are not shown here due to the deep uncertainty that persists to appear much too large as discussed in the text. a: Knutti et al 2002; b: Kaufmann and Stern 2002; c: Gregory et al 2002; d: Harvey and Kaufmann 2002; e: Tsushima et al 2005; f: Frame et al 2005; g: Stern 2006; h: Forest et al 2006; i: Forster and Gregory 2006; j: Schwartz 2007; k: Chylek 2007; l: Murphy et al 2009; m: Lin et al 2010; n: Schwartz 2012; o: Aldrin et al 2012; p: Bengtsson and Schwartz 2013; q: Otto et al 2013; r: Lewis 2013; s: Urban et al 2014; Donohoe et al 2014; Lovejoy 2014; t: Kummer and Dessler 2014; u: Lewis 2014; v: Loehle 2014; w: Skeie et al 2014; x: Johansson et al 2015; y: Cawley et al 2015; z: Lewis and Curry 2015; Loehle 2015; A: Forster 2016; B: Loeb et al 2016; C: Lewis 2016; D: Armour 2017; E: Lewis and Curry 2018; F: Jelbring 2003; G: Barrett et al 2006; H: Miskolczi 2007; I: Lindzen and Choi 2009; J: Florides and Christodoulides 2009; K: Clark 2010; L: Lindzen and Choi 2011; M: Ollila 2013; N: Laubereau and Iglev 2013; O: Harde 2013; P: Singer 2013; Q: Lindzen 2014, Lightfoot and Mamer 2014; R: Gervais 2014; S: Monckton et al 2015; T: Kissin 2015; U: Soon et al 2015; V: Kimoto 2015; W: Bates 2016; X: Gervais 2016; Y: Evans 2016; Z: Smirnov 2016; α: Scafetta et al 2017; β: Abbot and Marohasy 2017, Ollila 2017; γ: Smirnov 2017; δ: Holmes 2017; ε: Stallinga 2018; ϕ: Smirnov 2018; η: Fleming 2018; κ: Ollila 2019; λ: Krainov and Smirnov 2019; μ: Kim and Lee 2019; ν: Stallinga 2020, Schildknecht 2020; ρ: Myrvoll-Nielsen et al 2020; σ: Haustein et al 2019; τ: Booth 2018; ω: Skeie et al 2018; ξ: Scafetta 2021a.

3 Infrared thermal flux towards space and climate sensitivity

Depending on the electromagnetic flux I_s received from the sun, the Boltzmann equation allows the evaluation of the temperature of the Earth via

$$(1 - a)I_s/4 = \varepsilon\sigma T^4 \qquad (3)$$

a is the Earth albedo, ε is the Earth emissivity and σ the Boltzmann constant. The derivation of this equation reads

$$\Delta F/F = 4\,\Delta T/T \qquad (4)$$

$F = 240\ W/m^2$ is the average thermal flux received from the sun and reemitted by the Earth towards space, averaged over day and night, latitude and seasons. To deduce the climate sensitivity ΔT to CO_2 doubling, a direct evaluation of ΔF can be deduced from the evolution of the infrared spectrum of the main CO_2 band that peaks near the maximum of the Planck thermal emission of the Earth, in case of doubling of its concentration, as shown in Figure 4.

The superposition of both curves – one for the CO_2 concentration observed at the observatory of Mauna Loa in 2005, the other in case of hypothetical doubling – in the immediate vicinity of the bending vibration mode of CO_2 of wavenumber 670 cm^{-1} (corresponding to a wavelength of 15 micrometers) illustrates the almost saturation of its emission towards space.

Rasool and Schneider (1971) already mentioned the almost saturation: « as more CO_2 is added to the atmosphere, the rate of temperature increase is proportionally less and less, and the increase eventually levels off. The runaway greenhouse effect does not occur because the 15 μm CO_2 band which is the main source of absorption *saturates*, and the addition of more CO_2 does not substantially increase the infrared opacity of the atmosphere.» The almost saturation is confirmed by Schildknecht (2020).

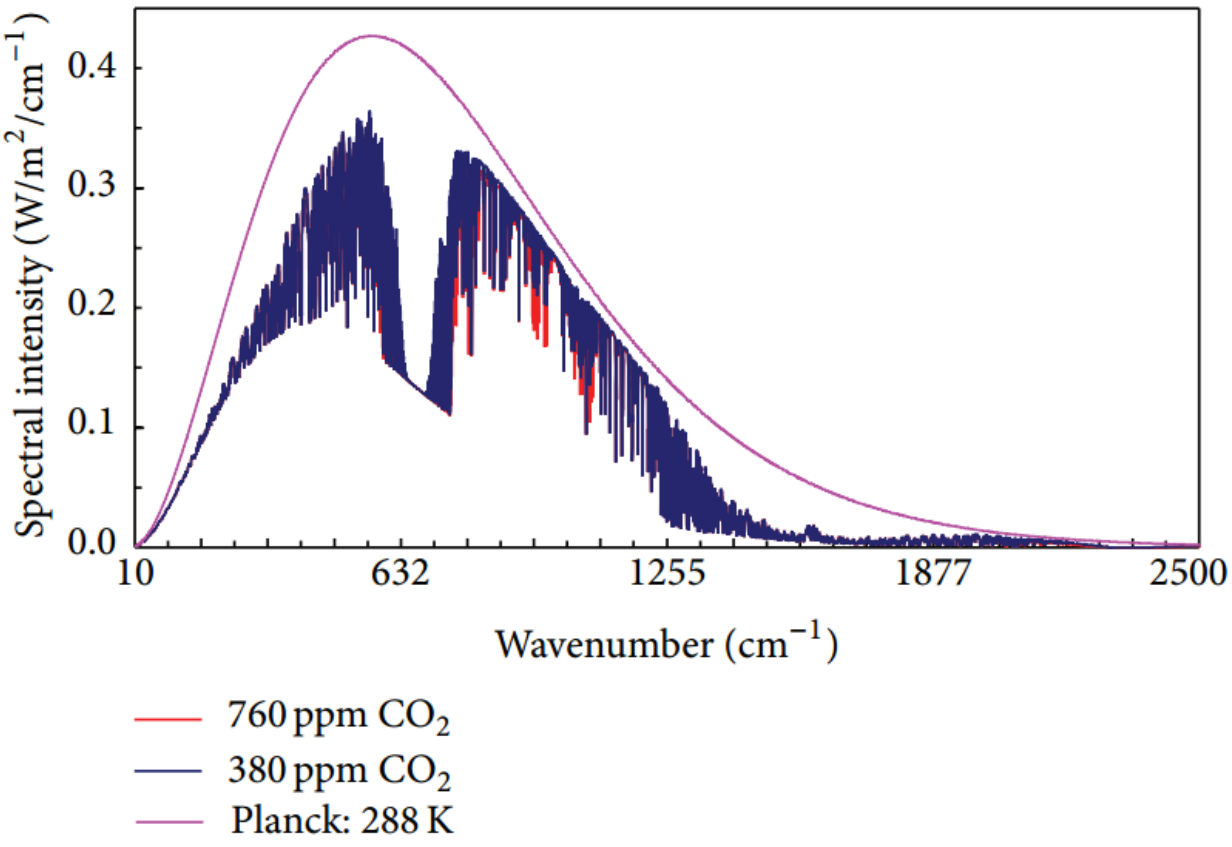

Figure 4. An illustration of the little change of atmospheric CO_2 emission towards space, here at an altitude of 12.5 km, in case of doubling of its concentration, reproduced from the open access paper of Harde (2013).

Figure 4 shows that at high CO_2 concentrations, adding more CO_2 does little due to the logarithmic law as shown by Myhre et al (1998). In addition, the CO_2 infrared linewidth is broadened by atmospheric pressure in the low troposphere. Conversely, the infrared absorption peaks become sharper with decreasing pressure, what happens with increasing altitude. As a result, there is no Earth radiation left for the wings of narrower lines at the top of the atmosphere where the pressure is lower, because the broader absorptions below mask it.

Harde (2014) evaluates a climate sensitivity of 0.6° ± 0.1°C. Such a tiny anthropogenic warming is consistent with the 108 other studies of Table 2. Besides, Figure 8.1b of Salby (2012) shows that the absorptivity of the infrared CO_2 band at 15 μm measured between the tropopause around 11 km and the top of the atmosphere is near 100 %. Above 11 km, the temperature does no longer decrease with altitude. As a result, the emission is no longer weakened – according to the key point of the definition of greenhouse effect in the glossary of the IPCC AR5 (2013) – with increasing concentration of CO_2. It could be weakened but only below the tropopause where the temperature decreases with altitude following to the atmospheric lapse rate.

Taking account of the shielding by cloudiness not shown in Figure 4, Harde (2013) evaluates that the difference of both spectra results in $\Delta F = 2.6\ W/m^2$. This is the flux that might be lacking in the energy balance at the top of the atmosphere (TOA) in case of CO_2 doubling, viz. a lack of 2.6/240 = 1.1 %. Other line by line radiative transfer model calculations confirm with a similar difference of $2.9\ W/m^2$ near the TOA in case of CO_2 doubling (Sherwood *et al* 2020). Ollila (2017a) reports $\Delta F = 2.2\ W/m^2$. With the intermediate value of $2.6\ W/m^2$ deduced from infrared spectra in Figure 4, the anthropogenic contribution to the Earth warming then would be

$$\Delta T_{CO2\,x\,2} = T/4 \text{ x } \Delta F/F = 288/4 \text{ x } 2.6/240 = 0.78\ °C \qquad (5)$$

consistent with values lower than 1°C in Table 2 and in Figures 1 to 3. Rewritten in terms of concentration C of CO_2 in the Earth atmosphere, Eq. (5) becomes

$$\Delta T = 288/4 \text{ x } 2{,}6\ ln(C/C_0)/240\ ln(2) = 1{,}1°C\ ln(C/C_0) \qquad (6)$$

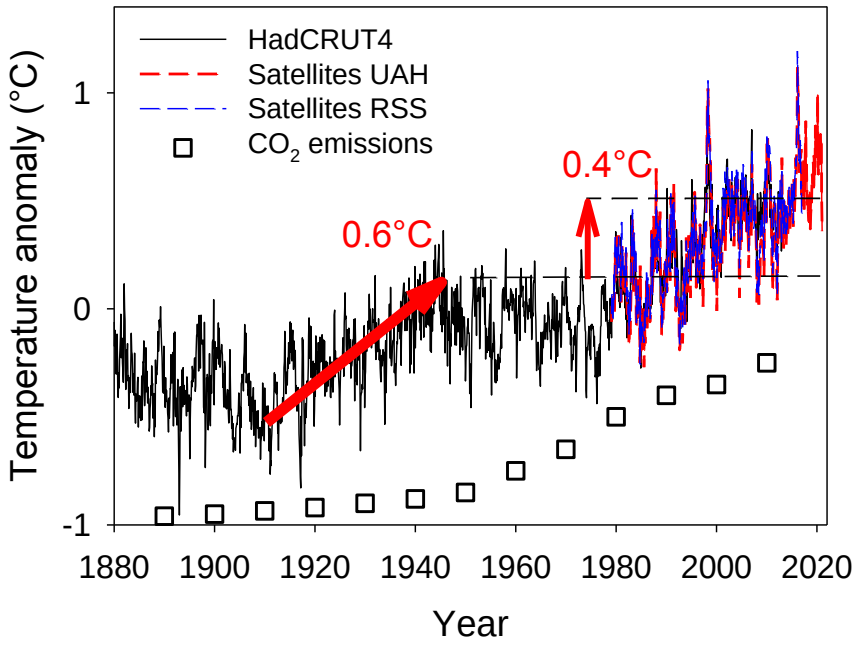

Figure 5. Temperature anomaly observed by the British Hadley Center HadCRUT4 (2021), satellites UAH TLT (2021) and RSS (2021), compared to the relative increase of CO_2 in the atmosphere.

Applied to the increase of CO_2 in the atmosphere since the beginning of acceleration of emissions in 1945, Eq. (6) provides *1,1°C ln(414 ppm/310 ppm) = 0.3°C*. Since 1945, HadCRUT4 data show a warming of about 0.4 °C if fluctuations like El Niño peaks that are natural phenomena related to the intensity of the dominant winds in the Pacific Ocean, are set aside to focus on the baseline as shown in Figure 5. The UAH satellite data indeed show that while a warming trend of 0.12 °C per decade is observed from 2000 to 2020, the trend is limited to only 0.01°C per decade from 2000 to 2015 before the onset of the strong El Niño peak of 2016 and replica afterwards.

Data are monthly. A warming of about 0.6 °C has been observed from 1910 to 1945 when CO_2 emissions were too low to explain it (Ring *et al* 2012), illustrating a contribution of the natural variability of climate. Since 1945, an anthropogenic contribution of 0.3°C evaluated above matches the observation of 0.4 °C, validating a climate sensitivity lower than 1°C, whereas higher values are not validated by observations in Figure 5.

With a climate sensitivity of 0.78 °C, Eq. 1 becomes

$$(1/7.3\ 10^{12}\ tCO_2) \times 0.78°C = 1.06\ 10^{-13}°C/tCO_2 \qquad (7)$$

This equation is applied in both right columns of Table 1. In terms of carbon footprint, the result reads $3.9\ 10^{-13}$°C/tC.

A climate sensitivity higher than 1°C assumes positive feedbacks that might increase the climate sensitivity $\Delta T_{CO2\ x\ 2}$ in the form

$$\Delta T_f = \Delta T_{CO2\ x\ 2}/(1 - f) \qquad (8)$$

if f is positive and lower than 1. The main supposed positive feedback is water vapor, considered to increase the CO_2 greenhouse effect in a warming world. A large fraction of emissions of infrared output longwave radiation (OLR) to space from the troposphere indeed is from water vapor. The radiation occurs at an average altitude of ~ 5 km that corresponds to the temperature of 255 K (– 18 °C) assuming an emissivity of 1, as given by Eq. (3). The difference of 33 K with the average surface Earth's temperature of 288 K is the warming attributed to greenhouse gases. This is essentially the greenhouse effect of the main one, water vapor (Ollila 2017a). Above the tropopause where the air is dryer, a fraction of OLR emissions is from CO_2 (Figure 4). Van Brunt (2020) has shown that changes in the concentration of water vapor and changes in water vapor heating are not a feedback response to changes in the concentration of CO_2.

Positive feedbacks due to water vapor were supposed to generate « hot spots », but none is found in the high troposphere in subtropical regions (Douglass *et al* 2004, 2008, Christy *et al* 2010, Fu *et al* 2011). Even more intricate in the context of such a hypothesis, at the altitude around 9 km where the hot spots are expected and where CO_2 emits heat towards colder space (Figure 4), the specific humidity that was supposed to increase actually has decreased. The decrease is from 0.28 g/kg in 1948 down to 0.25 g/kg these 15 last years as measured by NOAA (Humlum 2021). The supposed positive feedback of water vapor, therefore, is unsupported by observations and, therefore, not demonstrated.

Clouds may cool or warm the planet. If precipitating convective clouds cluster in larger clouds as temperature rise, negative feedbacks are expected (Mauritsen and Stevens 2015). Lindzen and Choi (2009, 2011) considered a negative feedback, the "iris" effect, which decreases the climate sensitivity down to 0.5–0.7 °C. Paltridge *et al* (2009), Spencer and Braswell (2010) also focus on negative feedbacks. Low-level clouds may be thick enough to reflect a part of the sun's radiation and increase the albedo (Loeb *et al* 2018, Delgado-Bonal *et al* 2020, Ollila 2020, Sfica *et al* 2021). More generally, cloud tuning (Golaz *et al* 2013) to achieve the desired radiation balance is a complementary cause of the scatter of climate sensitivity.

When Earth was cooling from 1945 to 1975 in spite of the acceleration of CO_2 emissions (Figure 5), Rasool and Schneider (1971) predicted even more cooling by introducing a strong concentration of aerosols known to have a cooling effect as confirmed by the momentary Earth's cooling of 0.5 °C

in 1992 after the eruption of the Mount Pinatubo volcano. The cooling offsets a warming related to a weak climate sensitivity of 0.8 °C (Rasool and Schneider 1971). Wang *et al* (2021) confirms this concept by reporting that highest ECS climate sensitivity in CMIP6 models are offset by highest cooling by aerosol-cloud interaction.

However, over the 20th century, changes in anthropogenic aerosols were mostly concentrated in the Northern Hemisphere. Consequently, models with strong or weak aerosol-cloud interactions produce different warming asymmetry over the historical period.

The observed warming asymmetry is more consistent with the models that have weak aerosol cloud interactions and, therefore, less positive cloud feedback. This asymmetry appears not considered in recent studies based on CMIP6 models (Gillett *et al* 2021).

Besides, Scafetta (2021b) reports that Urban Heat Island effects raise city temperatures above the temperatures in surrounding rural areas. These significant biases alter instrumental records. Sea surface temperatures and land temperatures showed matching variations and amplitudes from 1900 to 1980. After 1980, the land surface temperatures rose substantially more, suggesting nearly half of the land temperature increase is non-climatic. Both asymmetry of warming and urban heat island effects tend to disprove the highest climate sensitivity of CMIP6 models.

The low stratosphere (altitude of ~17 km) displays a long plateau of temperature since 1994 as shown in Figure 6.

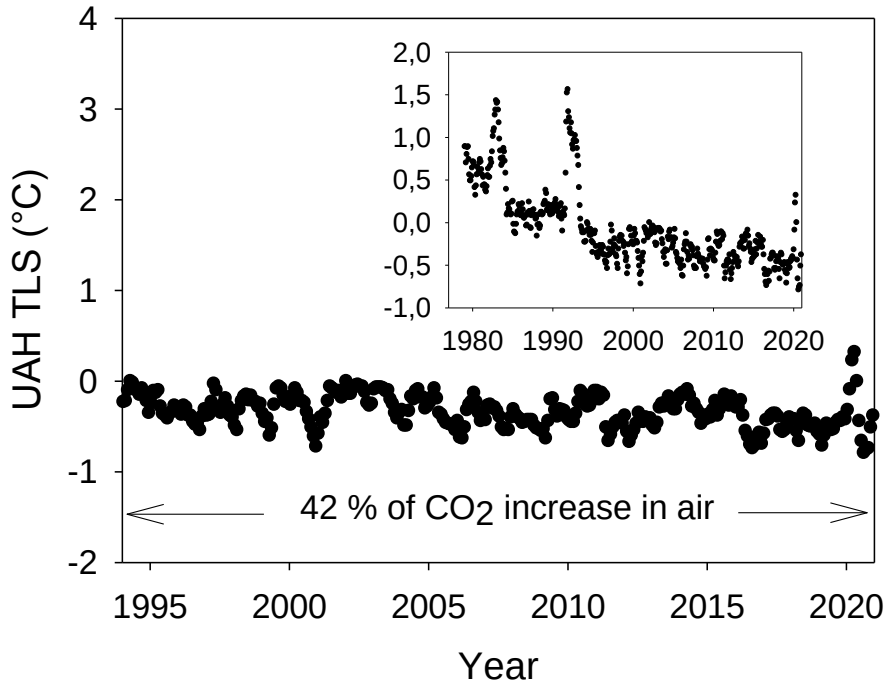

Figure 6. Plateau of anomaly of temperature in the low stratosphere (TLS) measured by satellite in the low stratosphere as reported by the Earth System Science Center, University of Alabama in Huntsville (UAH) (Spencer et al 2017, here updated), at the altitude of ~ 17 km from 1994 to 2020. A flatness emerges in a period corresponding to not less than ~ 42 % of all the increase of CO_2 in the atmosphere since the beginning of the industrial era. The inset shows all available data. Both peaks in the inset corresponds to aerosols emitted by volcanic eruptions. The smaller peak in 2020 could be due to the Tall volcano eruption.

4 Atmospheric CO_2 yearly increases mirror but lag surface temperature fluctuations

Figure 7 is an update of Figure 4 of Gervais (2014).

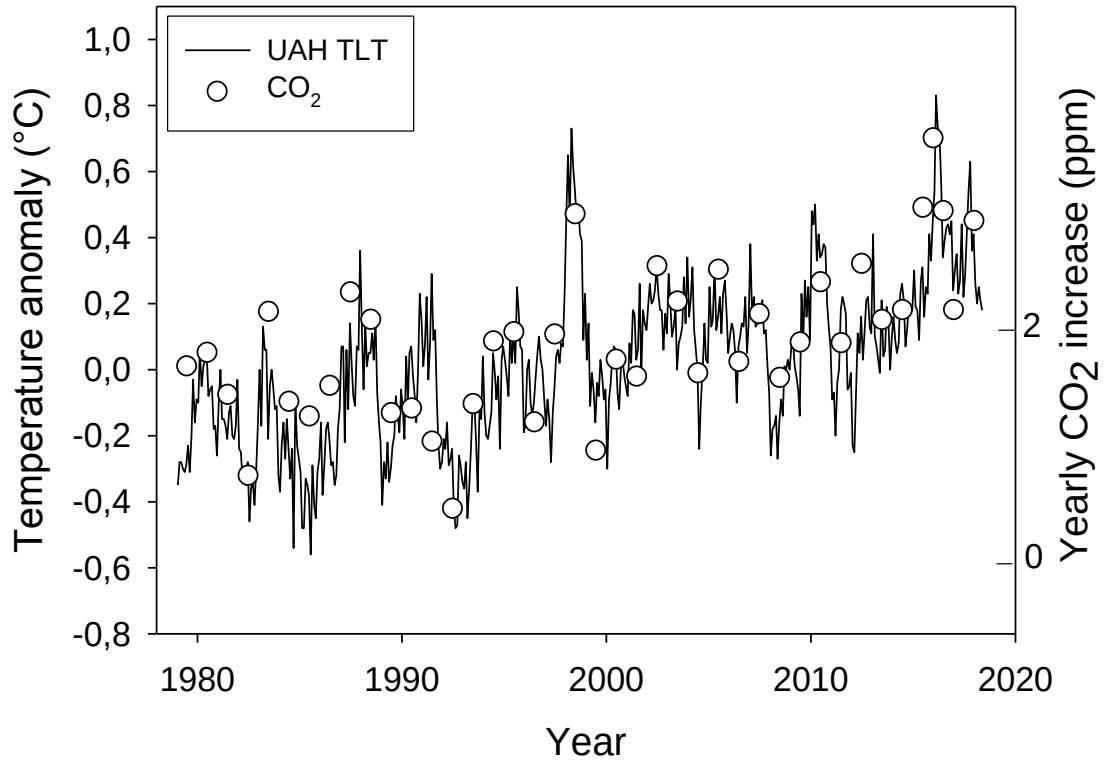

Figure 7. UAH temperature in the low troposphere (TLT), i.e. surface satellite measurements (Spencer et al 2017, updated) compared with yearly increases of CO_2 measured at Mauna Loa (NOAA 2020) shifted left by 6 months, showing the fit. The shift focus on a lag of CO_2 increases with respect to temperature fluctuations. The lowest CO_2 increase follows the cold year 1992 and the highest follow the hot El Niño years 1998 and 2016.

The yearly CO_2 increase in the atmosphere measured at the observatory of Mauna Loa is confirmed to be far from being a constant. The year 1992 was a cold year due to the aerosols emitted by the eruption of the Pinatubo volcano (see inset of Figure 6) in spite of the CO_2 emissions of the volcano itself and in spite of a warm El Niño which peaked at an excess of 2°C in the NINO3.4 Pacific region. The yearly increase of CO_2 in 1992 was 0.47 ppm only. The CO_2 increase since 12 months peaked at 4.6 ppm in the warm year 2016 related to a strong El Niño fluctuation as shown in Figure 8.

The increase of amplitude from 0.47 to 4.6 ppm is too large for mirroring changes in CO_2 anthropogenic emissions. These fluctuations show an amplitude larger than that related to the drop of CO_2 emissions related to the industrial slowdown and the lockdown due to the Covid-19 pandemic (NOAA 2020). The fluctuations of CO_2 correlated to temperature, therefore, appear mainly related to natural effects.

Kuo *et al* (1990) discussed the correlation temperature/CO_2. The changes in carbon dioxide content were reported to *lag* the temperature fluctuations by 5 months. The solubility of CO_2 in water increases with decreasing temperature. The correlation of Figure 7 may be interpreted, at least partly, by outgassing of CO_2 from the oceans that contains 60 times more CO_2 than the atmosphere (IPCC AR5 2013), during warmer years especially under the tropics (Park 2009, Quirk 2009, Beenstock *et al* 2012, Salby 2012, Humlum *et al* 2013, Gervais 2014, Harde 2017a, 2019, Berry 2019, Stallinga 2020).

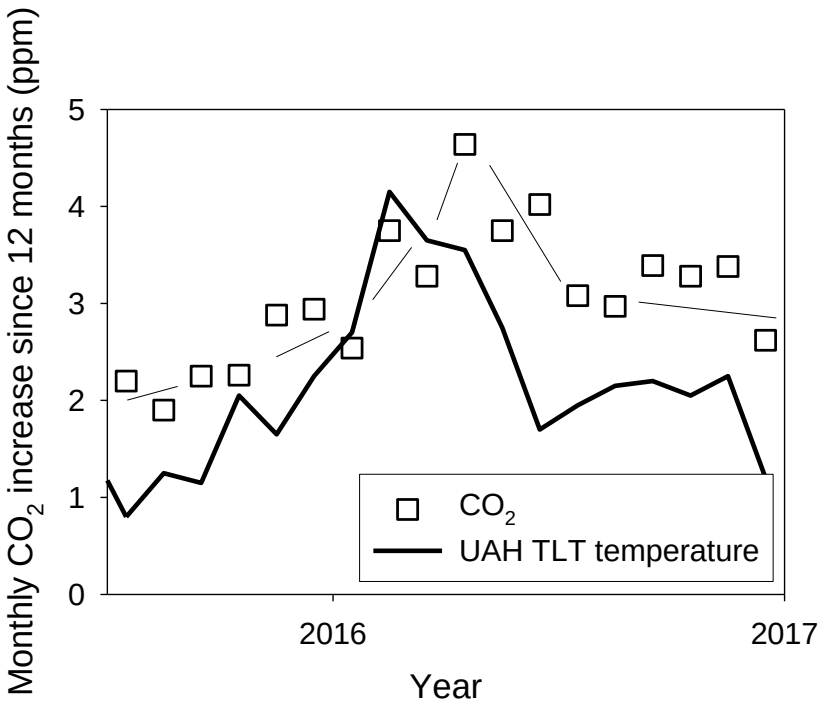

Figure 8. Lag of monthly CO_2 increase with respect to UAH TLT temperature.

Humlum *et al* (2013) concluded: « changes in ocean temperatures appear to explain a substantial part of the observed changes in atmospheric CO_2 since January 1980. CO_2 released from anthropogenic sources apparently have little influence on the observed changes in atmospheric CO_2. »

It is fair to concede that a convincing anthropogenic carbon budget does not seem to be settled. Many different models of carbon budget have been published (Friedlingstein *et al* 2006). Contemporary land uptakes show differences as large as 4 GtC per year, viz. nearly half the anthropogenic emissions, from a model to another. The difference is even larger in the projection to 2100 since it reaches 17 GtC per year, a level higher than contemporary emissions.

El Niño Southern Oscillation ENSO contributes to global temperature (Zeng *et al* 2005). However, (i) the lag of several months of CO_2 fluctuations that follows temperature fluctuations in general and (ii) the low increase of 1992 in spite of an El Niño fluctuation that year, contradict the hypothesis that ENSO would be the *driver* of the temperature-dependent fraction of the fluctuations of CO_2 addition in the atmosphere. The role of driver appears rather played by the temperature of oceans. It might appear counterintuitive that oceans that capture 23 % of anthropogenic CO_2 emissions might release it during warmest years. However (i) upwelling of 275 $GtC.yr^{-1}$ (corresponding to 130 $ppm.yr^{-1}$), larger than downwelling of 264 $GtC.yr^{-1}$ (corresponding to 125 $ppm.yr^{-1}$) reported by Levy *et al* (2013), permits within uncertainties a possibility of CO_2 release from oceans during warmest years. (ii) CO_2 may precipitate in the solid form of $CaCO_3$ because oceans contain calcium. (iii) Oceans appear as a biological carbon pump more efficient than previously considered (Buesseler *et al* 2020).

Lands and vegetation capture 1/3 of CO_2 emissions. To evaluate it, one method is linked to the amplitude of the seasonal drop of CO_2 concentration in the atmosphere in spring and summer due to enhanced uptake of carbon by photosynthesis also favored by longer days, in the northern hemisphere that shows a larger surface of vegetation than the southern hemisphere. The amplitude is nearly zero in Antarctica for lack of surrounding vegetation. Conversely, the amplitude of the drop has been found to increase 71 % more rapidly than the CO_2 concentration at La Jolla (California) between 1969 and 2013 (Gervais 2016). Does the amplitude of CO_2 fluctuations of

Figure 7 manifest themselves by fluctuations of seasonal amplitudes related to temperature? The cold year 1992 together with the warm year 1998 are compared in Figure 9.

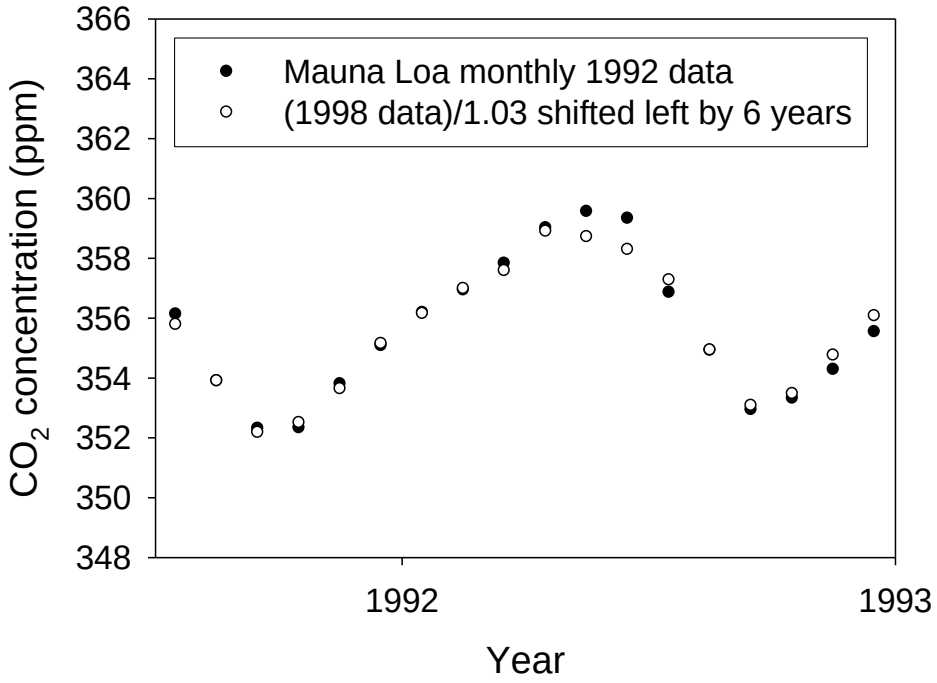

Figure 9. Seasonal oscillation of CO_2 concentration measured at the Observatory of Mauna Loa (NOAA 2020) from 1991 to 1993. It is compared with the oscillation from 1997 to 1999 shifted left by 6 years. Data of the latest have been divided by 1.03, the ratio of CO_2 concentration in autumn 1997 and autumn 1991 to start both curves with a same origin for accurate comparison.

Both seasonal oscillations of Figure 9 appear essentially superposed. This near superposition hardly supports Figure TS.4 of IPCC AR5 (2013) where it is seen that land sink would have been unable to absorb any anthropogenic emission in 1998, whereas land sink would have absorbed 4 GtC in 1992.

The yearly fraction of anthropogenic CO_2 added to the atmosphere may be estimated from the ratio $^{13}C/^{12}C$ (Segalstad 1998). The result is consistent with the low level of increase of CO_2 in 1992. This is confirmed by Harde (2017a, 2019) and Berry (2019).

Koutsoyiannis and Zbigniew (2020) raises the question of the correlation of Figure 7 in terms of hen-or-egg causality. They conclude: "the results of our study support the hypothesis that the dominant direction is $T \rightarrow CO_2$. Changes in CO_2 follow changes in T by about six months on a monthly scale."

The correlation of Figure 7 possibly might be transient. But if it persists at least on the short term and if, for natural reasons (combination of lower solar activity, aerosols emitted by volcanic eruption, strong La Niña fluctuation), the surface temperature would drop down to –0.6°C in the left vertical scale of Figure 7 corresponding to 0 ppm in the right scale, then the increase of CO_2 in the atmosphere would cease, independent of anthropogenic emissions. With a yearly CO_2 increase of only 0.47 ppm compared to the peak at 4.6 ppm in 2016 in Figure 8, this situation almost happened in 1992 for a single natural reason, viz. aerosols emitted by the Pinatubo volcano that partially and momentarily attenuated the solar flux.

5 Discussion

The airborne fraction is the ratio of the annual increase of atmospheric CO_2 to the emissions from fossil sources. IPCC AR5 (2013) reports a value of 0.44 ± 0.06 % for the airborne fraction. Surprisingly, the airborne fraction has not much changed during the past 50 years. At least, the change seems not exceeding the uncertainty. Since fossil fuels emissions have about tripled during half a century, this means that the carbon sinks, lands and oceans, became about triply more efficient. In particular, the yearly growth of atmospheric CO_2 half a century ago was about only 1/3 of what it is nowadays. Harde (2017a) confirms that the uptake of CO_2 by natural sinks scales proportional with its atmospheric concentration.

It is instructive to compare 1/3 of 9.9 GtC emitted in 2019 with 450 GtC, the total vegetal biomass (Bar-On *et al* 2018). 3.3/450 = 0.73 %. During the 33 years of the Earth's greening observed by satellites (Zhu *et al* 2016), the enrichment of the vegetal biomass has been, therefore, of the order of 33 years x 0,73 % = 24 %. The global warming shown in Figure 5 seems to have not prevented this estimated increase. It is beyond the scope of this study to discuss whether it has favored it. Nevertheless, the increase of biomass could reach 174 GtC until the end of the century (Haverd *et al* 2020), viz. 174/450 = 39 %.

There are some parallel arguments. Greening is observed in particular in arid areas (Metcalfe 2014), thanks to additional photosynthesis of increased CO_2 levels. Additional carbon dioxide causes plants to produce less water loss due to evaporation, less hydric stress, lower sensitivity to pollution, and more resistance to heat and cold. The rising carbon dioxide concentration in the atmosphere is a primary cause of observed recent greening of the Earth. Newly grown rainforests can absorb eleven times as much carbon from the atmosphere as old-growth forests (Poorter *et al* 2016), confirming by direct measurements enhanced carbon land uptake in tropical latitudes of Latin America. This is also true for the increased efficiency of the biological carbon pump of the oceans (Buesseler *et al* 2020). Note that the anthropogenic contribution to the pH of the oceans remains small, –0.0017 per year (Byrne *et al* 2010).

Summarizing, there are benefits of CO_2 emissions for the fertilization of oceans, lands, forests, grasslands and nutritive plants (Donohue *et al* 2013, Idso 2013, Kaptué *et al* 2015, Rivero-Calle *et al* 2015, Lu *et al* 2016, Cheng *et al*, 2017, Gao *et al* 2019, Winkler *et al* 2019, Bastin *et al* 2020, Sswat *et al* 2018, Clark *et al* 2020). By contrast, mitigation policies of CO_2 emissions will have little effect on Earth's temperature as shown country by country in Table 1 even in terms of policies of largest emitters, especially with a TCR climate sensitivity equal or lower than 1°C, constrained by atmospheric CO_2 infrared spectrum. Values lower than 1°C are consistent with the near saturation observed in Figure 4, the plateau of TLS temperature in Figure 6 and the studies listed in Table 2. The natural variability of climate should be better taken into account (Scafetta *et al* 2020).

Frederikse *et al* (2020) report an average trend of 1.52 ± 0.33 mm per year for the sea level rise from 1900 to 2018. Such a rise do not show anything catastrophic. By considering 2,133 tide gauges, Parker and Ollier (2015) report an even lower average rise of 1.04 mm per year. By scrutinizing advection and subduction phenomena, Mörner (2016) confirms low sea level rise. In addition, Donchyts *et al* (2016) and Luijendijk *et al* (2018) report an average increase of continental surface with respect to sea surface and an average increase of the area of beaches in spite of erosion of several shores.

The highest biomass and biodiversity is present in tropical rainforests, and the least in cold polar regions (Brown 2013, Kraft *et al* 2011). Thus, higher temperatures than currently existing on Earth seem to be more favorable. Schulze-Makuch *et al* (2020) suggest "a slightly higher temperature, perhaps by 5 °C, similar to that of the early Carboniferous time period, would provide more habitable conditions until some optimum is reached". This recommendation questions the COP21 Paris agreement that pretends to limit the warming to 2 °C or even to 1.5 °C with respect to the preindustrial period. This means an increase of only 1 °C or 0.5 °C with respect to the beginning of

this century since a warming of ~ 1 °C already occurred (Figure 2.5). Actually, it will be a benefit for the vegetal biomass as suggested by Schulze-Makuch *et al* (2020).

According to Kramm *et al* (2020), the average temperature of the Earth is 14.5 °C. Lindzen and Christy (2020) consider the average temperature as misleading because it is at any place on Earth almost as likely, at any given time, to be warmer or cooler than average. The temperature anomaly is much smaller than the temperature variations that all life on Earth regularly experiences, reason for which it appears questionable. As long as an additional average warning would not exceed 1.1 °C, it could remain beneficial to mankind in terms of global wealth (Tol 2009). In view of Table 1 and Eq. 6, an anthropogenic warning of 1.1 °C would hardly be reached until the end of this century at the present rate of CO_2 increase of 0.5 % per year even by retaining the CMIP6 TCR of 1.68 °C. The minor warming, therefore, remains beneficial to humanity in terms of global wealth (Tol 2009) and to vegetation (Schulze-Makuch *et al* 2020).

The origin of atmospheric CO_2, natural or anthropogenic, has no impact on the climate sensitivity. Conversely, the balance between natural and anthropogenic fractions as well as anthropogenic or natural origin of Earth's climate change, might have a decisive impact on policies of reduction of emissions if the anthropogenic fraction would appear minor. Since these policies have no impact on the natural fraction, massive expenditures might be useless or at least might have little efficiency.

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Planetary, Solar and Climatic Oscillations: An Overview

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Abstract

Solar activity and climate change are characterized by specific oscillations. The most relevant ones are known in the literature as the cycles of Bray–Hallstatt (2100–2500 year), Eddy (800–1200 year), Suess–de Vries (200–250 year), Jose (155–185 year), Gleissberg (80–100 year), the 55–65 year cluster, the 40–50 year cluster plus bidecadal and decadal oscillations, and others.

Herein I review some of my publications on this topic and show that these oscillations emerge from a specific set of planetary harmonics - the *orbital invariant inequalities* - produced by the Jovian planets (Jupiter, Saturn, Uranus, and Neptune) and other basic astronomical frequencies related to the soli-lunar tides and orbital period of the planets. The result suggests that both solar activity and climatic changes are modulated by harmonic planetary forcings. Since these same harmonics are also found in the climate system, they can be used, in first approximation, to model and forecast climate change.

As an example, I briefly comment and update a semi-empirical model for climate change proposed 8 years ago by the author (Scafetta, Earth-Science Reviews 126, 321, 2013), which uses some of the above astronomically determined oscillations in addition to volcanic and anthropogenic components. The proposed model's result continues to surpass the performance of the CMIP5 models used by the IPCC, in particular after 2000, in reconstructing the global surface temperature record.

Introduction

When the 11-year solar cycle was discovered, Wolf (1859) well understood the physical problem that this discovery posed and hypothesized that it could emerge from a planetary influence by Venus, Earth, Jupiter, and Saturn. The idea was that some type of periodic forcing linked to the orbital motion of the planets (for example, gravitational tides) could synchronize the internal dynamics of the Sun by causing it to vary harmoniously at specific frequencies. The 11-year solar cycle is today known in the scientific literature as the Schwabe sunspot cycle.

The theory has always been taken with a certain skepticism because the distance of the planets from our star is so great that the gravitational tides induced by them on the surface of the Sun are tiny. They are, in fact, so small - that is, of the order of a millimeter or smaller - to be considered entirely negligible: see, for example, the discussion in Scafetta (2012a). However, so far nobody has been able to explain in an alternative way why solar activity oscillates with a cycle of around 11 years.

In fact, the most modern theories on the solar dynamo assure us that the solar activity should oscillate, but they do not tell us that it must oscillate with the observed period and phase (Tobias, 2002). These models are appropriately calibrated to obtain something that vaguely resembles reality (Jiang et al., 2007). Their inability to predict the main cycle observed in solar activity is also recognized by the same critics of an astronomical influence on the Sun (cf.: de Jager and Versteegh, 2005). Therefore, what is causing the Sun to oscillate with a period, although variable, around 11 years remains a great mystery.

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In the last 50 years, many improvements have been made, and our knowledge about solar activity has significantly increased. It has been discovered, for example, that the 11-year solar cycle is only one of the most evident and macroscopic solar cycles.

In fact, it is a variable cycle, as mentioned. Longer and shorter solar activity oscillations have also been observed. For example, the 11-year solar cycle almost disappeared during the great solar minimum of Maunder from 1645 to 1715; period during which the climate on Earth cooled significantly by experiencing a Little Ice Age (Eddy, 1976). Other grand solar minima were observed during the Dalton minimum (1790-1830), around 1900-1920, and another one is expected between 2020-2040 (Scafetta, 2012b). This pattern makes an oscillation of about 115 years (cf: Scafetta, 2012b; Scafetta, 2014).

In fact, several studies have determined that, in addition to the Schwabe's 11-year sunspot cycle and its associated 22-year Hale magnetic cycle, solar activity is characterized by several longer oscillations. These are now known in the scientific literature as the cycles of Bray – Hallstatt (2100–2500 years), Eddy (800–1200 years), Suess – de Vries (200–250 years), Jose (155–185 years), from Gleissberg (80–100 years), the 55–65-year cycles and others: see the numerous citations in Scafetta (2020). Identical fluctuations are also observed in climate records, suggesting a close link between solar variability and climate.

These results, of course, have made this research not only fascinating from an astrophysical point of view, but also very useful because it can be used to develop models able to predict climate changes: see, for example, the analyzes proposed in Neff et al. (2001), Kerr (2001), Ogurtsov et al. (2002), Steinhilber et al. (2012) and other studies including those proposed by Scafetta and collegues.

Therefore, understanding solar dynamics has become increasingly important. Due to the inability of traditional solar models to explain the observed solar activity changes, in the last twenty years several works have appeared for re-proposing and modernizing Wolf's 1859 idea of a link between solar variability and planetary motions, which still today appears to be the only one capable of explaining solar oscillations.

Experimental evidence of a planetary influence on solar activity ranges from the discovery that various solar flares and other phenomena of a certain intensity occurred during specific planetary alignments (Hung, 2007; Bertolucci et al., 2017; Morner et al. 2015), to the observation that there is a certain spectral coherence between solar records and the functions deduced from the orbital motions of the planets of the solar systems. One of these commonly used functions is the motion of the sun relative to the center of mass of the solar system, which must, however, be understood as a proxy for conveniently determining the natural gravitational oscillations characterizing the solar system (Fairbridge and Shirley, 1987; Abreu et al., 2012; Scafetta and Willson, 2013; Scafetta et al., 2016; and others).

One of the author's latest work (Scafetta, 2020) identifies theoretically a set of planetary harmonics which appear to be responsible for the observations. These derive from the synodal cycles of the great jovian planets (Jupiter, Saturn, Uranus and Neptune) and their combinations or mutual beats. The main physical characteristic of these harmonics is that they are invariant with respect to any rotating reference system such as the sun and the heliosphere. This property is necessary to activate the synchronization processes between weak external harmonic forcings and an oscillating dynamic system, as initially discovered by Huygens in the 17th century who was impressed by the mutual synchronization of two pendulums attached to the same wall which after a while began to oscillate in the same way (Strogatz, 2009). For these properties, these planetary oscillations have been labeled "orbital invariant inequalities".

Section 1 summarizes the orbital invariant inequality model proposed Scafetta (2020). The result is purely theoretical and can be obtained only by using the well-known orbital periods of the four Jovian planets: Jupiter, T_1 = 11.86 year; Saturn, T_2 = 29.46 year; Uranus, T_3 = 84.01 year; and Neptune, T_4 = 164.79 yr. The model prediction is then compared versus the empirical results by

Neff et al. (2001), McCracken et al. (2013) and Scafetta et al. (2016). This model reconstructs the main long solar cycles.

Section 2 briefly discusses additional spectral coherence evidences linking planetary motions to climatic oscillations observed in the global surface temperature record at the decadal and multidecadal scales. Details regarding the material and methods yielding these results are found in Scafetta (2010, 2012a-d, 2013; 2014; 2016 2018; 2021a).

Section 3 updates the graphs published in Scafetta (2013) that compare the performance of the CMIP5 climate models adopted by the Intergovernmental Panel on Climate Change (IPCC) in 2013 versus a semi-empirical model that uses some of the identifies astronomical-coherent climate oscillations to reconstruct the natural variability of the climate system. The semi-empirical model also contains volcano and anthropogenic signatures evaluated as discussed in the above publication.

Finally, the conclusion section summarizes the results and briefly comments on them. Extended comments are found in the original papers.

1) The orbital invariant inequalities induced by the jovian planets

This section briefly recalls the definition of the orbital invariant inequalities. Details are found in Scafetta (2020).

In celestial mechanics, given two harmonics of period T_1 and T_2 and two integers n_1 and n_2, it is said that there is a resonance if $T_1/T_2 = n_1/n_2$. In general, this identity is not true and an inequality with frequency f and period T is defined as:

$$f = \frac{1}{T} = \left| \frac{n_1}{T_1} - \frac{n_2}{T_2} \right|. \tag{1}$$

The simplest cases deduced from equation (1) are the conjunction periods between two planets, also called synodal periods, see Table 1, which are defined as a beat, that is, as:

$$f_{12} = \frac{1}{T_{12}} = \left| \frac{1}{T_1} - \frac{1}{T_2} \right|. \tag{2}$$

Equation 2 can be generalized for a number n of harmonics such as:

$$f = \frac{1}{T} = \left| \sum_{i=1}^{n} \frac{a_i}{T_i} \right|, \tag{3}$$

where a_i are integers. Among all the possible orbital inequalities given by equation (3), there is a small subset which is defined by the condition:

$$\sum_{i=1}^{n} a_i = 0. \tag{4}$$

The synodal periods (Eq. 2) and all beats among them characterize the frequencies of this subset.

The condition imposed by equation (4) is very important because it defines a set of invariant harmonics with respect to a rotating system such as the Sun and the heliosphere. In fact, given a rotating reference system centered in the Sun with period P, the orbital periods or frequencies seen relative to it are given by:

$$f_i^{'} = \frac{1}{T_i^{'}} = \frac{1}{T_i} - \frac{1}{P}. \tag{5}$$

Hence, with respect to this rotating frame of reference, the orbital inequalities are given by:

$$f^{'} = \frac{1}{T^{'}} = \left| \sum_{i=1}^{n} \frac{a_i}{T_i^{'}} \right| = \left| \sum_{i=1}^{n} \frac{a_i}{T_i} - \frac{\sum_{i=1}^{n} a_i}{P} \right|. \tag{6}$$

	Orb. Inv. Ineq.	Period (yr)	Julian Date	Long.
Jup–Sat	(1, −1, 0, 0)	19.8593	2451718.4	52° 01′
Jup–Ura	(1, 0, −1, 0)	13.8125	2450535.8	305° 22′
Jup–Nep	(1, 0, 0, −1)	12.7823	2450442.1	297° 21′
Sat–Ura	(0, 1, −1, 0)	45.3636	2447322.1	269° 05′
Sat–Nep	(0, 1, 0, −1)	35.8697	2447725.6	281° 14′
Ura–Nep	(0, 0, 1, −1)	171.393	2449098.1	289° 22′

Table 1: Synodal periods of the Jovian planets.

If the condition of Eq. 4 is imposed, we have that f' = f and T' = T. Therefore, this specific set of orbital inequalities remains constant regardless of the rotating frame of reference from which they are observed. In other words, for example, the conjunction of two planets is an event that is observed in an equivalent way in all rotating systems centered in the Sun. For this physical property, the orbital inequalities fulfilling by the condition given by equation (4) can be defined as *invariant*.

Table 2 reports the orbital invariant inequalities generated by the large planets (Jupiter, Saturn, Uranus, and Neptune). They are listed using the formalism:

$$T = (a_1, a_2, a_3, a_4), \qquad (7)$$

where a_1, a_2, a_3 and a_4 are integers such that their sum gives zero, according to Eq. (4). Each index refers to a jovian planet according to the usual order from Jupiter to Neptune.

The harmonics are divided into clusters or groups that recall the solar oscillations known in the scientific literature and which have been listed above in the Introduction. The same harmonics are also shown in Figure 1 and reveal a harmonic structure with a base period of 179.2 years. This periodicity corresponds to a frequency of 0.00558 1/year and the resulting harmonic is known as the Jose's cycle (1965).

The harmonics were listed using two indices M and K. The most important here is K which is equal to half the sum of the absolute values of the coefficients a_i that form a harmonic. Since Eq. 4 must hold, K indicates the number of synodal frequencies between the Jovian planets that make up these orbital invariant inequalities.

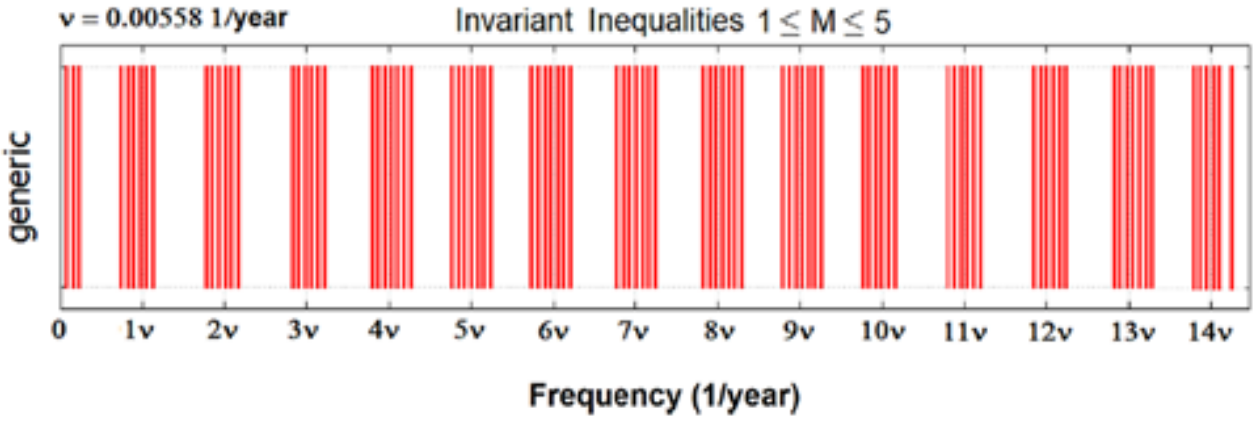

Figure 1: The orbital invariant inequalities of Jovian planets.
Note the clusters structured according to a harmonic series based on the Jose cycle.

(Jup, Sat, Ura, Nep)	(M, K)	T (year)	cluster
(1, −3, 5, −3)	(5, 6)	42.1	∼ 45 yr
(0, 0, 4, −4)	(4, 4)	**42.8**	
(2, −5, 1, 2)	(5, 5)	43.7	
(1, −3, −3, 5)	(5, 6)	43.7	
(1, −2, 0, 1)	(2, 2)	**44.5**	
(0, 1, −1, 0)	(1, 1)	**45.4**	
(1, −4, 2, 1)	(4, 4)	**46.3**	
(1, −1, −5, 5)	(5, 6)	47.2	
(1, −3, 4, −2)	(4, 5)	55.8	∼ 60 yr
(0, 0, 3, −3)	(3, 3)	**57.1**	
(2, −5, 0, 3)	(5, 5)	58.6	
(1, −3, −2, 4)	(4, 5)	58.6	
(1, −2, −1, 2)	(2, 3)	**60.1**	
(0, 1, −2, 1)	(2, 2)	**61.7**	
(1, −4, 3, 0)	(4, 4)	**63.4**	
(1, −3, 3, −1)	(3, 4)	**82.6**	Gleissberg
(0, 0, 2, −2)	(2, 2)	**85.7**	
(2, −5, −1, 4)	(5, 6)	89.0	
(1, −3, −1, 3)	(3, 4)	**89.0**	
(1, −2, −2, 3)	(3, 4)	**92.5**	
(0, 1, −3, 2)	(3, 3)	**96.4**	
(1, −4, 4, −1)	(4, 5)	100.6	
(1, −3, 2, 0)	(3, 3)	**159.6**	Jose
(0, 0, 1, −1)	(1, 1)	**171.4**	
(2, −5, −2, 5)	(5, 7)	185.1	
(1, −3, 0, 2)	(3, 3)	**185.1**	
(1, −2, −3, 4)	(4, 5)	**201.1**	Suess–de Vries
(0, 1, −4, 3)	(4, 4)	**220.2**	
(1, −4, 5, −2)	(5, 6)	243.4	
(0, 1, −5, 4)	(5, 5)	**772.7**	Eddy
(1, −2, −4, 5)	(5, 6)	**1159**	
(1, −3, 1, 1)	(3, 3)	**2318**	Bray–Hallstatt

*Table 2: The orbital invariant inequalities of the Jovian planets up to the orders **M** (= maximum value ai) and **K** (= half the sum of $|a_i|$).*

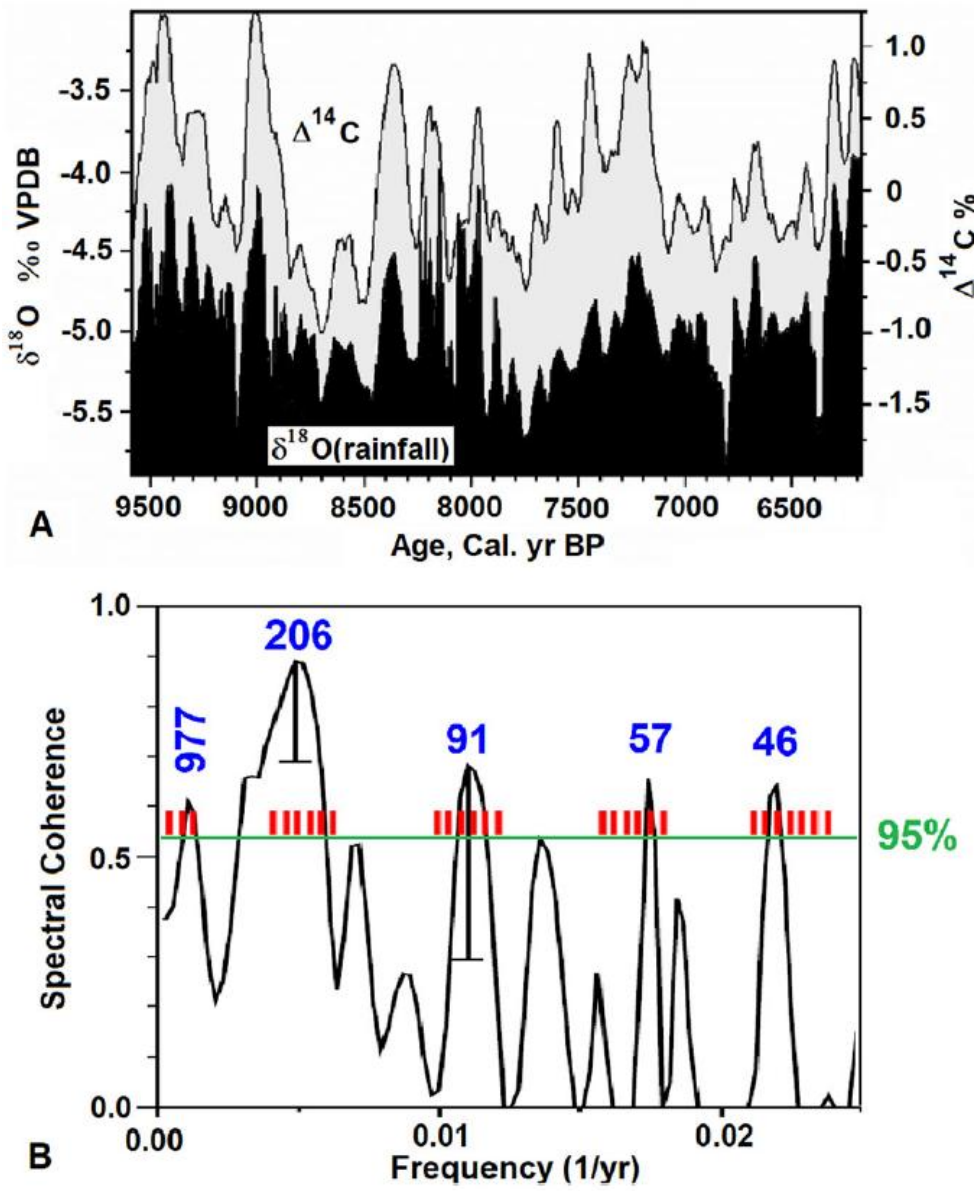

Figure 2: Solar and climatic frequencies compared with orbital invariant inequalities.

For example, the cycle (1, -3,1,1) has K = 3 and can be decomposed into three synodal cycles as it is equivalent to (1, -1, 0, 0) - (0,1, -1, 0) - (0,1,0, -1). Therefore, (1, -3,1,1) is a beat obtained from the combination of the synodal cycles of Jupiter-Saturn, Saturn-Uranus, and Saturn-Neptune. In the same way it is possible to decompose any orbital invariant inequality. Hence, these harmonics are the beats of the synodal cycles and can all be obtained using the periods and time phases listed in Table 1.

The physical importance of the harmonics listed in Table 2 is shown in Figure 2 which compares a reconstruction of the inferred solar variability from a ^{14}C record, and a climatic reconstruction deduced from a record of ^{18}O from 9500 to 6000 years ago (adapted from Neff et al., 2001). As the figure shows, the two records are strongly correlated and have numerous common frequencies corresponding to the cycles of Eddy (800–1200 years), Suess - de Vries (200–250 years), Jose (155–185 years), Gleissberg (80–100 years), the cluster 55–65, the cluster 40-50 and others.

In Figure 2B the common spectral peaks in the two records are compared against the clusters of the invariant orbital inequalities (red bars) shown in Figure 1 and listed in Table 2. Figure 2 shows that the orbital model well agrees with all the principal frequencies observed in the solar and climatic data for millennia.

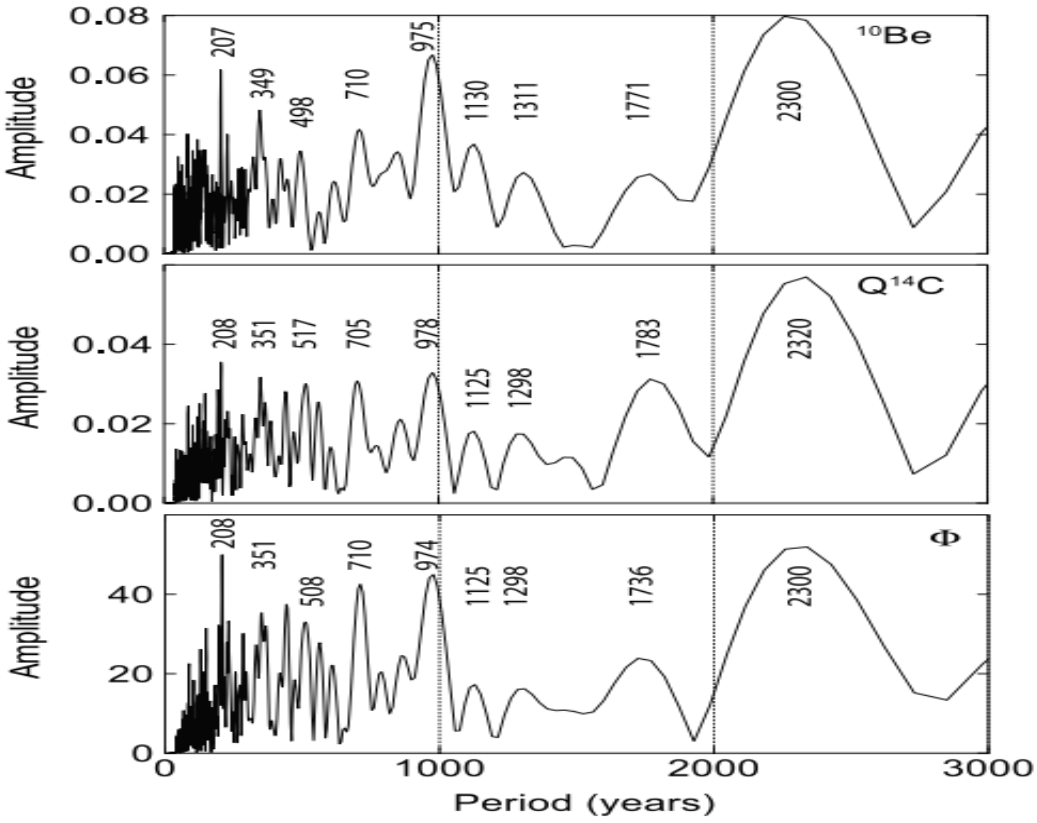

Figure 3: Cicli di Eddy (800-1200 anni) e di Bray–Hallstatt (2100–2500 anni) in tre alternativi record solari: da McCracken et al. (2013).

This can be shown more explicitly by directly reconstructing the great Bray – Hallstatt cycle (2100-2500 years). According to the proposed orbital model, this long oscillation is driven by the orbital invariant inequality (1, -3,1,1), which has a period of 2318 years. This cycle was studied in detail in McCracken et al. (2013) (Figure 3) and in Scafetta et al. (2016). Following the equations shown in Scafetta (2020), the complete reconstruction of the Bray – Hallstatt cycle (red curve in B) using the orbital invariant inequality (1, -3,1,1) (blue curve in A and B) is shown in Figure 4. To appreciate better the result, note that also the phase of the cycle is predicted by the same model.

2) Additional evidence linking planetary motions to climatic oscillations at the decadal and multidecadal scales

Additional analyses showed that climate oscillations and various gravitational oscillations of the solar system are spectrally coherent. In addition, also the soli-lunar tidal induced oscillations are expected to affects the Earth's climate by directly modulating the atmospheric and oceanic circulation. In general, we should expect the climate system to be mainly modulated by a series of complex cycles that mirror the astronomical ones. This hypothesis is currently supported by several empirical evidences using the available solar, astronomical, and climatic data proposed by a number of authors (e.g.: Scafetta, 2010, 2013; 2014; 2016; 2018; 2021a, and their references).

Figure 5 shows a time-frequency analysis comparison between the speed of the sun relative to the barycenter of the solar system (which can be considered a good proxy for empirically determining the main gravitational oscillations of the solar system) and that of the HadCRUT3 global surface temperature published in Scafetta (2014). The figure comparison clearly indicate that the global surface temperature is characterized by multiple astronomical oscillations at the decadal and multidecadal scales, as first noted in Scafetta (2010) and confirmed in Scafetta (2016, 2018) with the most advances spectral coherence techniques.

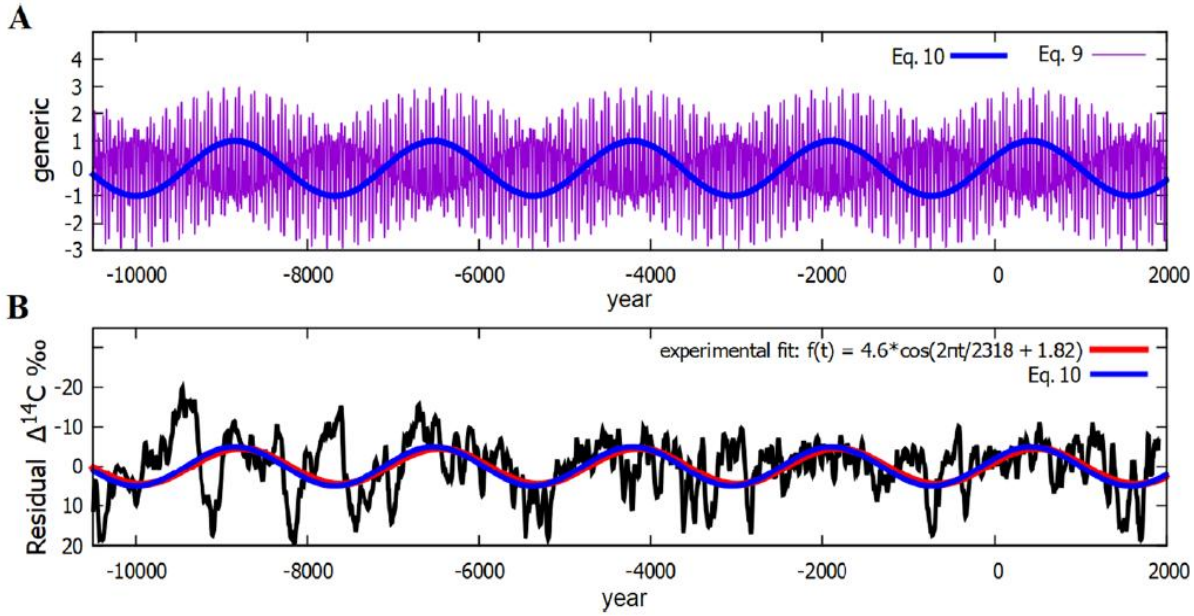

Figure 4: Reconstruction of the Bray – Hallstatt cycle (2100–2500 years) (red curve in B) using the orbital invariant inequality (1, -3,1,1) (blue curve in A and B). Details in Scafetta (2020).

The climate-astronomical common cycles include the following climatic and solar system oscillations at about: 5.93 years, 6.62 years, 7.42 years, 13.8 years, 20 years, 60 years. These oscillations are mostly related to Jupiter and Saturn, and the harmonics and subharmonics of their synodical cycle of 19.86 years. In particular, the quasi 60-year cycle is linked to three Jupiter and Saturn conjunction cycles that complete a great conjunction trigon.

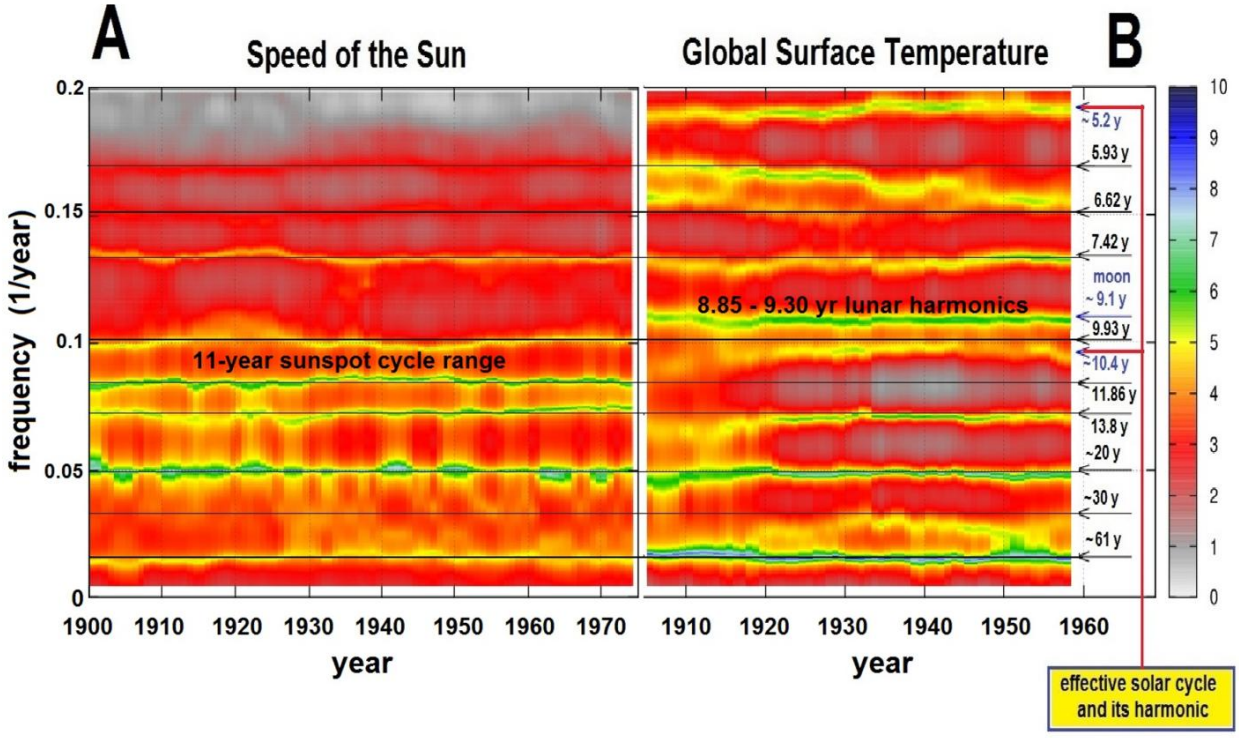

Figure 5. Frequency comparison: [A] Time-frequency analysis (L = 110 years) of the speed of the Sun relative to the center of mass of the solar system. [B] Time frequency analysis (L = 110 years) of the HadCRUT3 temperature record after a quadratic fit was removed to eliminate the non-stationary upward bias (from Scafetta, 2014).

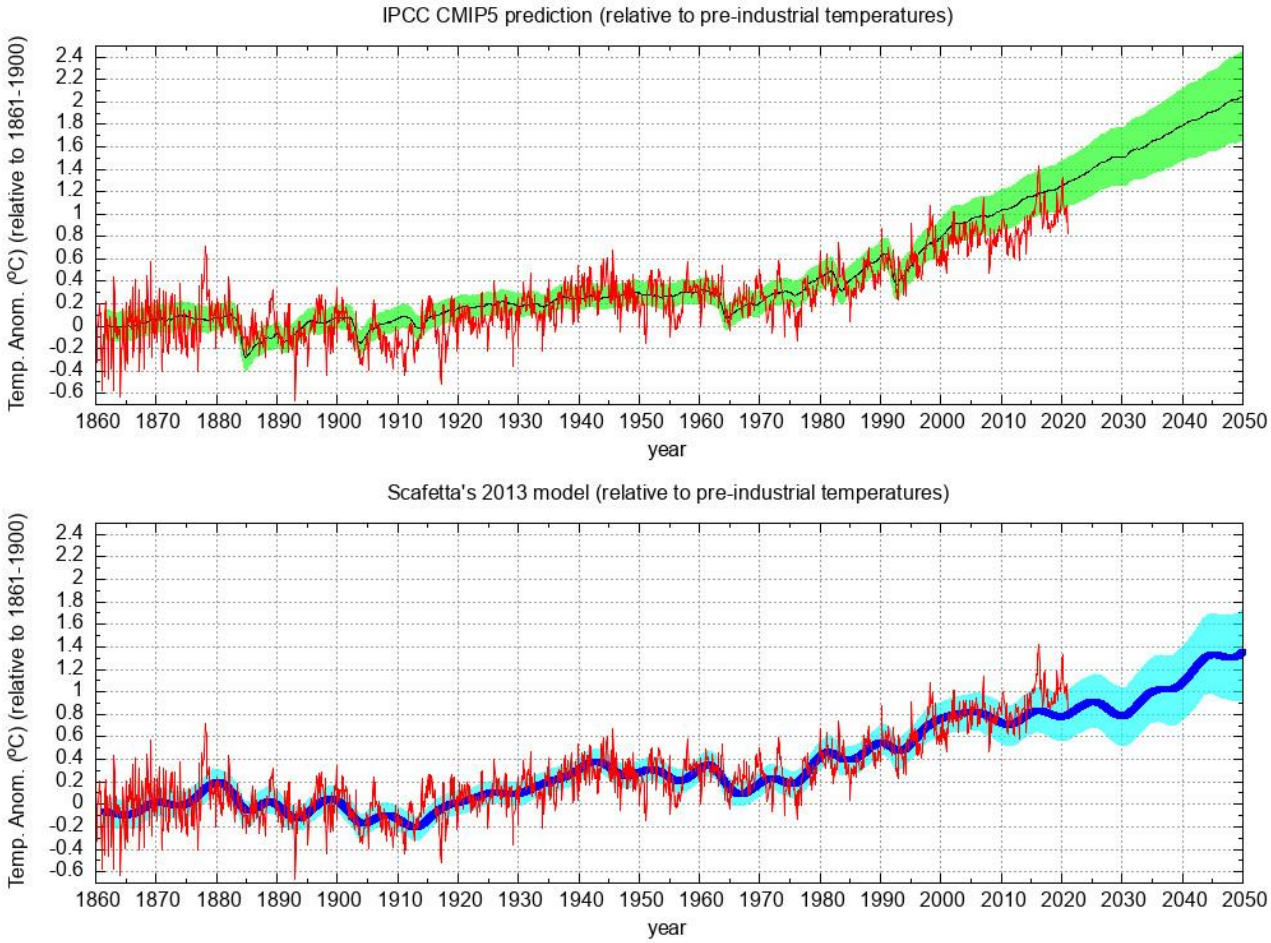

Figure 6. [Top] The average projection of the CMIP5 model ensemble against the GST HadCRUT4 record from January 1850 to January 2021 (black) (IPCCC, 2013). [Below] The solar-astronomical semi-empirical model with respect to the same climatic data proposed in Scafetta (2013). The colored area indicates 1-sigma dispersion from the average among the individual model simulations.

In fact, consecutive Jupiter-Saturn conjunctions occur at about 120° from each other, and after three events, the conjunction occurs nearly at the same position of the sky: see the discussion in Scafetta (2012d).

Moreover, we find among the astronomical cycles, the 9.93-year cycle due to the spring tide on the Sun of Jupiter and Saturn, and the 11.86-year orbital cycle of Jupiter. These two cycles bound and contribute to generate the 11-year solar cycle as explained in Scafetta (2012a, 2012b). In the diagram referring to the climate system we find the signature of the 11-year solar cycle, which was slightly longer at the beginning of the 20th century and became shorter at the end of the 20th century; the average period of this cycle during the considered period is 10.4 years, and the 5.2-year cycle, which is also evident in the temperature dyagram, appears to be its first harmonic.

Finally, we find in the climate system a cycle with period equal to about 9.1-year. This oscillation is missing the main frequencies of the speed of the sun relative to the barycenter of the solar system. Scafetta (2010) and the supplement file in Scafetta (2012c) argued that this cycle is likely linked to a combination of the lunar apsidal line rotation period of 8.85 years, the first harmonic of Saros eclipse cycle of about 9 years and the first harmonic of the soli-lunar nodal cycle of 9.3 years. These three lunar cycles should induce equivalent tidal cycles with an average period of about 9.1 years that could affect the climate system.

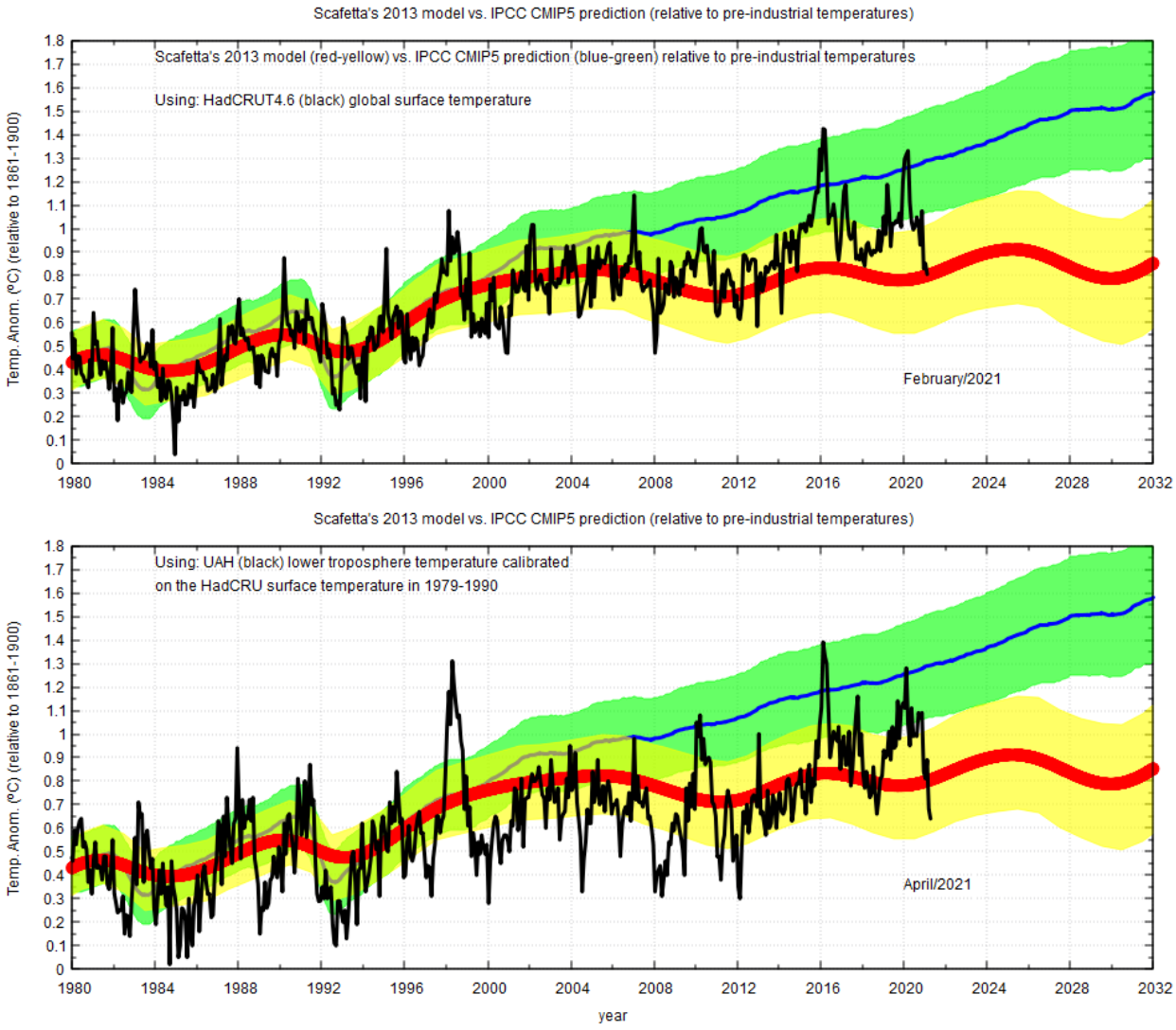

Figure 7. [Top] Zoom of Figure 6 bottom. [Below] The same model against the UAH lower troposphere global temperature record calibrated on the HadCRUT4.6 in the period 1979-1990. The green area indicates the prediction of the average CMIP5 models. The yellow one is the prediction of the model proposed in Scafetta (2013).

3) Update of the semi-empirical climate model proposed in Scafetta (2013)

Scafetta (2013) proposed a semiempirical model based on several of the astronomically identifies cycles discussed above. A model with additional high frequency cycles was proposed in Scafetta (2021a). Herein we update the model proposed in 2013 to check its forecasting ability.

The Scafetta (2013) model includes a 9.1-year cycle due to solar-lunar tidal influence, and several astronomical-solar cycles such as a 10.5-year solar cycle, 20-year, 60-year, 115-year cycles and an asymmetric quasi-millennial cycle with minimum in 1700 and maxima in 1080 and 2060, as theoretically deduced from the astronomical-solar model discussed in Scafetta (2012b). The model was then completed with a volcano and anthropogenic component deduced from the prediction of the CMIP5 global circulation models assuming, however, a halved climate sensitivity to CO_2 forcing because the identified natural oscillations can reconstruct by alone at least 50% of the warming observed since the pre-industrial period of 1850-1900: see the discussion in Scafetta (2010, 2012c, 2012d, 2013).

Figure 6 compares the proposed astronomical-based model and the CMIP5 global circulation models' average output versus the HadCRUT4.6 global surface temperature record from 1980 to

January 2021. The proposed astronomical-based model not only fits climate data better than the IPCC models since 1850 (as demonstrated in Scafetta, 2013), but also predicts only a moderate warming from 2000 to 2100. The result would imply that climate adaptation policies should suffice to address future climatic changes, which is a relevant conclusion since the mitigation policies are far more expensive.

Moreover, it is necessary to consider that recent studies (Scafetta and Ouyang, 2019; Scafetta, 2021b) determined that about 20% of the global warming observed from 1950 to 2020 could be due to non-climatic factors such the warming associated the urbanization development of most of the inhabited world regions since 1950. By considering that about 0.15 °C of the warming recorded in the dataset could be spurious, the observed disagreement between the data and the CMIP5 prediction further increases, while the agreement between the data and the proposed astronomical-based model based on astronomical cycles further improves.

In fact, Scafetta (2021b) showed that from 1980 to 2020, the real global warming trend should be more consistent with that observed in the UAH lower troposphere temperature record (Spencer et al., 2017). Figure 7 shows a zoom (from 1980 to 2032) of Figure 6 (bottom) using the HadCRUT4.6 record (top) and the equivalent diagram using the UAH6.0 record. The latter figure shows an even better agreement between the data and the prediction of Scafetta (2013)'s model, while the disagreement with the model predictions increases.

4) Discussion and Conclusion

Solar and climate data from the past 11,000 years show highly correlated variability characterized by several common harmonics such as the Bray – Hallstatt cycle (2100–2500 years), Eddy's (800–1200 years), Suess – de Vries (200–250 years), Jose (155–185 years), Gleissberg (80–100 years), 55–65 year cycles, bidecadal and decadal cycles, and others. Above we saw that all these harmonics are predicted by a set of orbital frequencies called the *orbital invariant inequalities* and other astronomical cycles usually related to the planetary orbital cycles, and their harmonics and subharmonics. Additional cycles are related to the Moon's orbit.

In particular, the orbital invariant inequalities derive from the synodal cycles of the great jovian planets (Jupiter, Saturn, Uranus, and Neptune). These harmonics have an important physical characteristic: they are invariant with respect to any rotating reference system and, therefore, they have the potential to synchronize the solar dynamo at specific frequencies.

Scafetta's study (2020) complements other studies, including some of his own where the proposed planetary models predict the 11-year solar cycle, this time using the orbital harmonics produced by the first harmonic the (2, -5, 2) invariant inequality between Venus, Earth and Jupiter (which gives a period of 11.07 years), and the combination of Jupiter and Saturn tidal harmonics at 9.93 years and 11.86 years. That Venus, Earth, Jupiter and Saturn could be involved in generating the variable 11-year solar cycle was already guessed by Wolf back in 1856: see detailed discussions in Scafetta (2012a, 2012b, 2014).

Common criticisms to a planetary-solar-climate hypothesis have mostly focused on the physical mechanism by which the planets could influence solar activity. Even if, at the moment, the physical problem is not fully resolved yet, the criticism appears weak because it does not demonstrate the non-existence of such a mechanism, but only the fact that the exact mechanism or a multitude of them are still debated. Indeed, no solar model that assumes our star as a body physically isolated from the rest of the solar system has been able to explain the observed solar cycles at any time scale. The author would like to point out that critics should propose an alternative theory capable to explain better the multitude of the observations, not just complain that planetary-solar-climate hypothesis is not a fully established theory yet.

For example, it is entirely possible that the effect of the small gravitational tides of the planets on the Sun are amplified by a million times, by internal nuclear fusion mechanisms (see the model

proposed in Scafetta, 2012a) and/or that planetary periodic configurations modulate flows of matter inside or outside the solar system which, by falling on the Sun or on the Earth, could modulate its activity: see also Bertolucci et al. (2017) and Scafetta et al. (2020b). Furthermore, the harmonic synchronization processes can also be activated by weak oscillating forcings.

The important result is that all these astronomical oscillations are found in the climate system as well, which make possible, at least in principle, to partially forecast climate change on the decadal to secular or even millennial scales. Indeed, harmonic climate models have been proposed and also the updates shown above indicate that they perform much better than the CMIP5 global circulation models used for example by the IPCC.

The latter models not only fail to properly reconstruct all oscillations found in the climate system, but the data-model divergence has been significantly widening since 2020, which indicates that the CMIP5 and similar global climate models overestimate significantly the climate sensitivity to radiative forcing by at least a factor of two. This failure would be even larger if one considers that about 20% of the post 1950 warming could be spurious because due to urbanization and other non-climatic factors as also a comparison against the UAH global lower tropospheric temperature suggests (cf: Scafetta and Ouyang, 2019; Scafetta, 2021b).

In conclusion, the collected evidence shows, in a sufficiently convincing way (at least this is the opinion of the author), that solar activity is very likely modulated by planetary harmonics which are then impressed in the climate system of the Earth because these same harmonics are also observed in climate changes.

To understand the interconnection among these phenomena, it is necessary to discover not only how the Sun behaves but also the physics of the solar system and how the matter moves within it. For example, the 60-year cycle is observed also in the meteorite fall records (Scafetta et al., 2020) that, together with a cosmic ray flux, implies the possibility of climatic particle forcings of the cloud system which has an astronomical origin and complement the radiative ones.

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Climate Change Consensus Only Achieved with Filtering and Selection Bias

A Review of Secondary Consensus Claim Papers

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Abstract

Based on the premises that there is a high rate of agreement among the scientific community concerning the key factors driving climate change, there have been growing calls from the public to 'unite behind science'. However, a careful assessment of the so-called climate research 'consensus', raises serious questions about the validity of this claim.

This work analyses key peer reviewed publications supposedly documenting a climate 'consensus', focusing on 'consensus' publications that are not based on the analysis of data, but rather of the subjective positioning and beliefs of scientists, obtained mainly from surveys.

We have used a 90 % agreement rate as a reasonable threshold for indicating consensus, and found that, in fact, an above 90 % consensus agreement rate is only achieved by filtering and selection bias. The same pattern was observed in the different studies analyzed, and we show that no 'consensus' has actually been documented.

The work further substantiates that the central anthropogenic global warming hypothesis of scientific consensus has not only not been documented, but in fact does not exist in the analyzed material.

Despite the obvious weaknesses observed in these climate consensus publications, the climate science community is yet to refute these claims which might lead to misinformation on the public scene. Hence, the objective of this study is to change this, as well as to shed light on potential data analysis issues in economic style surveys on climate change.

Keywords: *Climate Ch*ange, *Consensus, Systematic Review*, *Sample Selection Bias*

Introduction

Current climate science is at the forefront of a large portion of political discussions and debates. Hence, a phalanx of public voices from within as well as from outside the scientific community are demanding to 'unite behind the science'. One of the key implicit and often explicit assumptions for this political demand, is that 'science is settled' or 'science is united' on the questions of the main factors driving climate change, i. e. uniting behind an IPCC endorsed anthropogenic global warming (AGW)–view on climate science, specifically pinpointing to a dominant key factor, i. e. anthropogenic greenhouse gas (GHG) emissions, especially CO_2. This GHG-AGW-hypothesis is also at the fore and center of most political mitigation measures, as laid down in the Paris climate accord.

There is a seemingly credible scientific justification for the notion that 'science is united' on the GHG-AGW-hypothesis. This is the so-called *climate consensus*, which is postulated in a number of widely cited manuscripts (Cook et al. (2016), Cook et al. (2013), Doran & Zimmerman (2009),

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Oreskes (2004), Verheggen et al. (2014)), of which the most prominent one is the 97 % agreement notion created by Cook et al (2013). However, careful scientific scrutiny reveals that the so-called climate research consensus claim might actually be unfounded.

This work details a systematic review and debunking of peer-review published climate-consensus assertions, concentrating on those papers which claim to support a climate consensus based on a methodology which goes beyond the one employed by Cook et al. (2013). These papers are based on measuring the level of agreement in climate science, by analyzing the convictions of scientists with surveys. The pioneering work following this type of methodology is Doran and Zimmerman (2009), following in their footsteps, some of the key papers include works from Verheggen et al. (2014), Stenhouse et al. (2014), and Carlton et al. (2015). Lastly, in a similar fashion Anderegg et al. (2010) studied the publicly stated opinions of scientists in a database.

Material and Method

We scrutinized the peer-reviewed scientific literature for claims of having confirmed or documented a climate consensus, starting with the key paper of Cook et al. (2013) and working both backwards and forward. We are certain that we have captured the key works. We evaluated all papers for what they actually did and organized the results in categories as well as discussing key findings individually. We concentrated on the question of a documented agreement rate or 'consensus' for the key question of the GHG-AGW-hypothesis being the key climate factor to explain today's climate patterns. We used 90 % agreement as a threshold for indicating a consensus.

While we cannot fully exclude that there may be additional work claiming to support a climate consensus, we are certain that we have captured the key ones, and thus covered the key methods to arrive at a consensus claim notion in the peer-reviewed literature.

Results and Discussion

1 Background on Climate Change Consensus Studies

Investigations trying to gauge and quantify the level of agreement in climate science, typically conducted in the attempt to prove a 'climate consensus', can be categorized into two main categories as shown in Figure 1. In the first main category, the analyses are based on the positioning and beliefs of active scientists. This main category comprises subcategories. In the first subcategory, the analysis is centered around the positioning of scientists, in the abstracts of published works. The pioneering work here is from Oreskes (2004), while the key reference is the 97.1 % claim from Cook et al. (2013).

The second subcategory comprises works which employ a different methodology, i. e. gauging the beliefs and convictions of scientists with surveys. Here the pioneering work was published by Doran and Zimmermann (2009), while the key reference is Verheggen et al. (2014).

The third subcategory contains other scientist-centered methodologies, such as the work of Anderegg et al. (2010), which created and analyzed a database of scientists, which were categorized according to their publicly stated positions on climate change either supporting or criticizing the International Panel on Climate Change (IPCC).

In the other main category, the views and statements of the scientists are not being gauged, but the actual published data are input to the analysis. Thus, the analysis is based on what the published study presented in terms of results, investigations, modelling, scenarios, reviews, etc., which actually contributes to the underlying scientific question, and the GHG-AGW hypothesis.

In Figure 1, the current situation for climate research is summarized. There is a number of publications in the first main category, both as abstract analysis, survey investigations, or other scientist-centered analysis, while as of today no data-centered investigation has been conducted and reported in the scientific literature thus far.

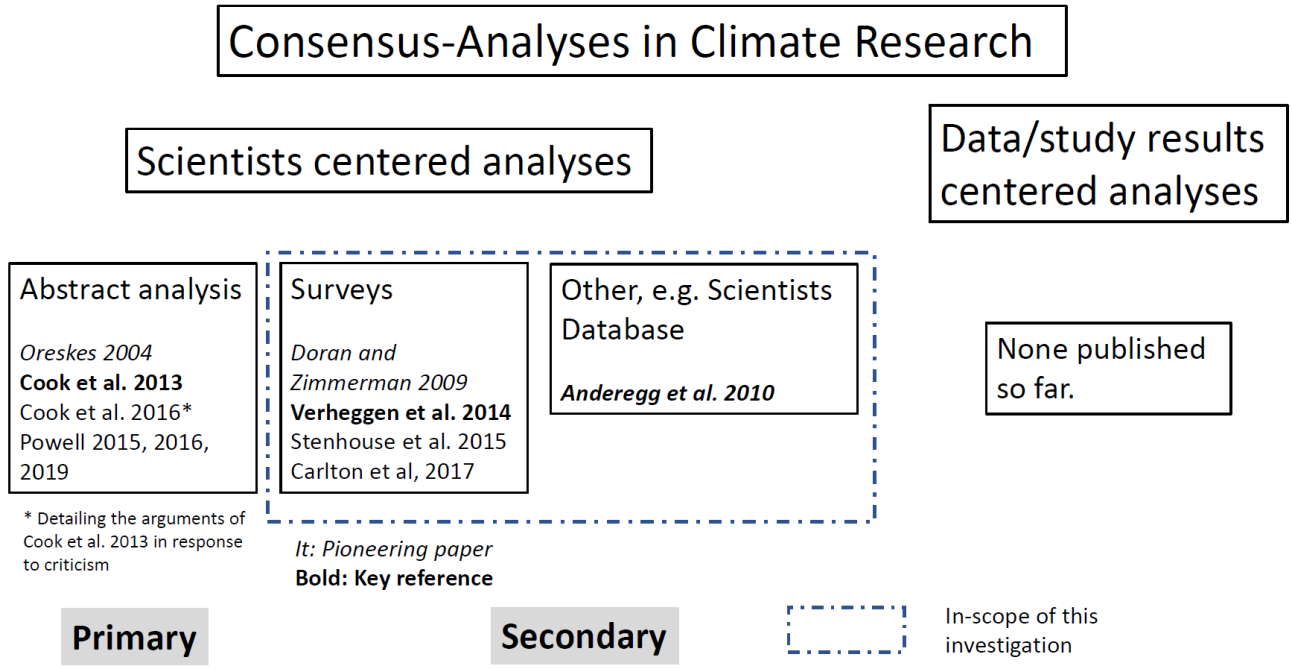

Figure 1. A visual representation of the main categories and sub-categories of the type of consensus analysis in climate research (categories of re:look climate).

We consider this to be the key finding of this systematic evaluation: The climate consensus claim is only based on investigations of the stated beliefs and positionings of scientists, be it via abstract analysis, survey, or other methodology. What the vast amount of data published actually tells the community, in an attempt to present a consensus-type agreement rate, has not yet been investigated.

However, this analysis will show that even within this narrowed scope of only focusing on the beliefs and convictions of scientists, no 'consensus' has actually been documented. We have previously documented by reanalyzing and refuting the lighthouse 97.1 % consensus claim published by Cook et al. (2013) that the abstract analysis type of consensus claims are in fact not showing anything resembling a 'scientific consensus'. This analysis is currently submitted elsewhere and waiting to be published (Lengsfeld et al., 2021).

The analysis presented here will concentrate on the consensus works centering around the analysis of beliefs and statements of scientists by surveys or scientist database analysis. On Figure 1, this is shown in the blocks 'Surveys' and 'Scientists Database'.

In conjunction with the authors themselves, we would consider survey or database categorization investigations to be supportive evidence for a consensus at best. However, the analysis is still worth pursuing as it will both show why all works in fact do not support the notion of a climate consensus, and moreover give a strong hint on how the climate consensus notion has in fact been constructed.

Firstly, three consensus-survey works were analyzed: Verheggen et al. (2014), Stenhouse et al. (2014) and Carlton et al. (2015), all of which followed in the footsteps of the 97.1 %-publication of Cook et al. (2013). Secondly, we were drawing on some of the key findings and connections to the pioneering work of Doran and Zimmerman (2009), and finally we conclude with the analysis of the key work on the scientist categorization by Anderegg et al. (2010).

2 Analysis of Verheggen et al.

Verheggen et al. (2014), a paper which has John Cook as a co-author, can be considered as a 'consensus' survey gold standard work (similar to Cook et al. (2013)) in the abstract analysis subcategory. The survey was conducted among climate scientists identified by a literature search. Verheggen et al. (2014) contacted 6,550 scientists, of which 1,868 (29 %) responded. The survey

contained two questions, which are directly relevant for the GHG-AGW-consensus hypothesis, i. e. on the qualitative and quantitative attribution of GHG (dominant influence) for global warming since industrialization began.

The answers to these questions clearly fell below a consensus threshold: an 82 % agreement on qualitative and a 66 % agreement of quantitative attribution. However, the authors drove these numbers by means of filtering, albeit at the cost of a significantly reduced base. Using filtering according to the number of publications which each respondent has in this field, the authors managed to considerably rise the agreement rates.

However, only in the subgroup with the strongest filtering, i. e. the IPCC AR (assessment report) 4 WG (working group) 1 authors group, the 90 % agreement threshold was passed, at least on the qualitative attribution, while notably even this select group did not pass a consensus threshold on the quantitative attribution question (agreement rate being still slightly below 80 %). This filtering considerably drove down the base number of scientists. The strongest filter, AR4 WG1, necessary to achieve the consensus threshold agreement rate of 90 percent, reduces the number of responses to Q3 from 1747 scientists to 165.

The effect of the filtering driving up the agreement rate while significantly lowering the base is envisaged in Figure 2, using the data for Q3 of Verheggen et al. (2014). It should be noted that the filtering not only significantly reduces the base, but also shifts the evaluation.

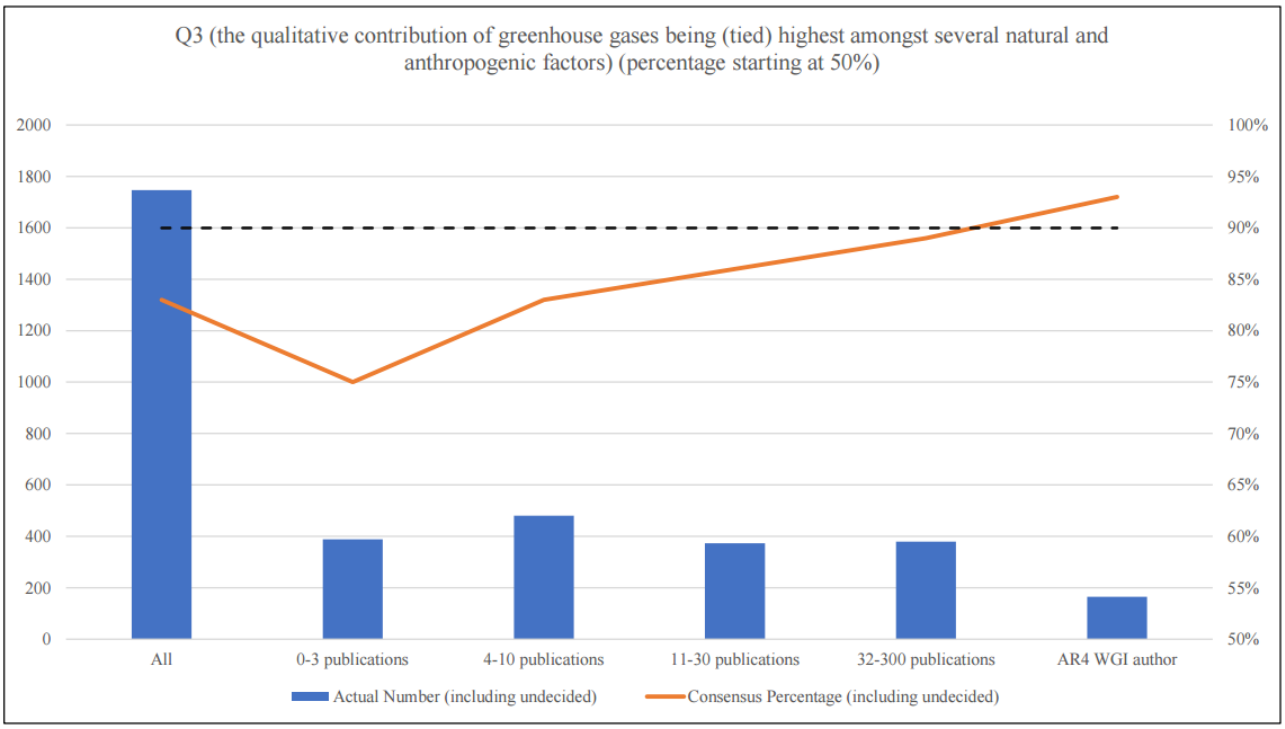

Figure 2. A graphical representation of the key results from Verheggen et al. (2014). (Question 3: The qualitative contribution of greenhouse gases being (tied) highest amongst several natural and anthropogenic factors. Data and exact phrasing taken from Verheggen et al. (2014), Figure 3 left side, and Table S3 from SI, Q3 (data including undecided)).

The figure shows both the actual numbers of scientists and the percentage agreement. The consensus threshold of 90 % (indicated in the figure with a dotted line) is only achieved for the group with the lowest number of scientists (AR 4 WG1 authors), i.e. after strongest filtering.

While originally any active climate scientists were surveyed, broadly identified by a literature search, the catchy consensus threshold level agreement rate is only achieved in the highly selected

group of the IPCC AR4 WG1 of 165 scientists representing less than 10 % of the respondents, and less than 3 % of the scientists originally contacted.

Just as a side note: It seems highly likely, although not analyzed by Verheggen et al. (2014), that the response rate of the IPCC AR4 WG1 authors was considerably higher than that of the overall group (which was 29 %), and it seems probable that IPCC AR4 WG1 authors supportive of the IPCC positions had a higher interest in responding, to further reinforce the already evident selection bias.

3 Analysis of Stenhouse et al.

Very similar patterns are seen in the investigations by Stenhouse et al. (2014). Stenhouse et al. (2014) surveyed 7062 members of the American Meteorological Society: In the group of the 'all respondents' (n=1821, response rate 26 %) the answers fall significantly short of the 90 % consensus threshold. The question "Is global warming happening? If so, what is the cause?" was answered with 52 % "yes: mostly human" and 10 % "yes: equally human and natural".

Filtering again changed the numbers: Setting a filter which only looks at those members of the American Meteorological Society (AMS) who are active in climate research, drove the numbers up in the direction of 90 %. To the above quoted question "Is Global Warming happening? If so, what is its cause?" the highest agreement rate, 78 % to the answer: "Yes: mostly human" was achieved in the group of AMS members with the area of expertise "climate science" and the publication focus "mostly climate". Again, the filtering significantly reduced the base, in this case from 1821 to 124 scientists. And, a clear selection was introduced, while from the original AMS members now only those with a self-declared "climate science" expertise and a publication focus "mostly climate" contributed to the judgment call. Evidently, this reduction in base from 1821 to 124 has increased the percentage to the question from 52 % to 78 %, however, even with this filtering Stenhouse et al. (2014) are still not close to the 90 % threshold for a consensus.

4 Analysis of Carlton et al.

We now move on to Carlton et al. (2015), who surveyed scientists beyond the core field of climate and meteorology. The survey went to scientists of the 10 biggest American universities active in life and technical science in the broader sense. The group survey comprised a sample of 1868 scientists and received 698 responses (37.4 % response rate). The core results in this survey are not easily digestible as the questioning was in a cascade form. The answer relevant to the GHG-AGW-hypothesis is the following combination: Q3 "When compared with pre-1800's levels, do you think that mean global temperatures have generally risen, fallen, or remained relatively constant?", if answered with "Risen" the following question was presented Q4 "Do you think human activity is a significant contributing factor in changing mean global temperatures?". Finally, if that answer was "yes" the following question was presented: Q12 "How sure are you that human activity is a significant contributing factor in changing mean global temperatures?".

When looking solely at Q12 and combining the percentages from "Extremely sure" and "Very sure", you get: 53.23 % + 35. 32 % = 88.55 %, which is still shy of a 90 % agreement rate. However, it is also important to note that progressing from Q3 to Q12 reduces the base size, as this 88.55% is not based on the original 698 responses. Given that Q3 was given to all 698 scientists and the percentage of those who replied "Risen" is 93.48 %, this would equate to 653 scientist which would also be the base value for Q4. Therefore, the number of replies to "Yes" on Q4 is: 96.66 % * 653 = 631. This 631 is the actual base value in Q12, this means that the 88.55 % is from 631 which yields a value of 559 scientists. If this is compared to the original 698, that would give only a percentage of 80 % of the original sample who say that either they are "Extremely sure" or "Very sure" that human activity is a significant contributing factor in changing global temperatures (Figure 3).

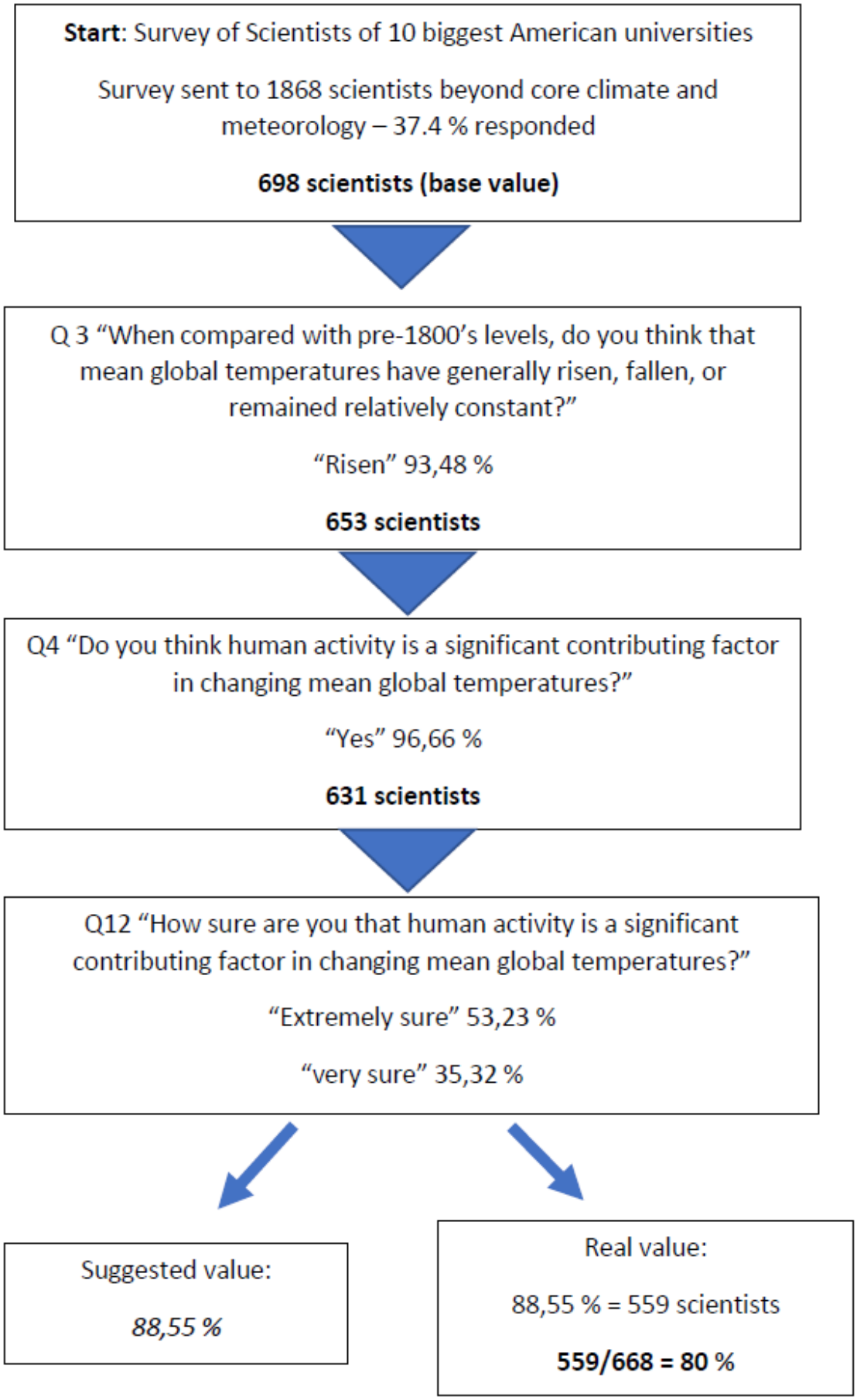

Figure 3: Illustration of the filtering/cascading performed in Carlton et al. (2015) analysis to achieve a higher agreement.

Carlton et al. (2015) did not necessarily employ filtering to increase this 86 % agreement rate, nonetheless it is important to note that the value is not based on the whole sample. Additionally, they did display in the text a conclusionary sentence; by only combining the answers of Q3 and Q4, omitting Q12: "Together, these two facts reveal that 91.9 % of scientists surveyed believed in anthropogenic climate change".

We would clearly state that omitting answers to Q12 ("How sure are you that human activity is a significant contributing factor in changing mean global temperatures?") such as "somewhat sure" and "not sure at all" and thus presenting the beyond 90 % result consensus-threshold passing level in the text, is not justified.

5 Analysis of Doran and Zimmerman.

It should be noted that there emerged criticism against the original pioneering work of Doran and Zimmerman (2009), from which Carlton et al. (2015) copied their question Q3 and Q4. The critics questioned the validity of the survey regarding how imprecisely the key questions were phrased (Granqvist, 2009; Helsdon, 2009). However, the imprecise questions may in fact not be the key weakness in the pioneering work of Doran and Zimmerman (2009).

The key weakness, again, is the use of filtering, which was already employed in this pioneer work, and also resulting in a clear selection bias. The survey was sent out to 10,257 earth scientists, of which 3146 scientists responded (response rate 31 %). In the overall response, 82 % answered the key question of "Do you think human activity is a significant contributing factor in changing mean global temperatures?", with "yes". This is the key result to look at, as it is the only question that is directly relating to the GHG-AGW hypothesis. This result clearly falls flat of a 90 % consensus threshold. The agreement rate goes up with filtering, albeit at the expense of a significantly reduced base.

The 90 % agreement rate threshold is touched in the subgroup 'Active publishers - Climate change', and passed with a 95 % agreement in the subgroup of "Climatologists, who are active publishers on climate change" (defined as more than 50 % of their publications). What is the key here, is the shift of base: Doran and Zimmerman (2009) only mentioned the number for the subgroup with the highest agreement rate: The 95 % agreement rate was reached only in an elite subset of 79 scientists: "Climatologists, who are active publishers on climate change", which is less than 3 % of the respondents and less than 1 % of the scientists who received the survey.

6 Analysis of Anderegg et al.

The final work to be considered is Anderegg et al. (2010), which is not a survey, but a database analysis of active scientists categorized according to their position on climate change. Anderegg et al. (2010) assembled a database of 1,372 active climate researchers and classified these scientists in two categories: 'convinced of the evidence' and 'unconvinced of the evidence' based on publicly signed statements relating to the IPCC. The results are striking, especially if one compares them with a 90 % consensus notion: 903 (66 %) were categorized as 'convinced of the evidence', while a sizable 472 scientists (34 %) were categorized as 'unconvinced of the evidence' (note that 3 scientists are found in both categories). Thus, this detailed analysis is in fact the first peer-reviewed documentation that, at least till 2010, there was nothing resembling a scientific consensus in the climate research community.

Only when using a filtering according to the number of publications did Anderegg et al. (2010) arrive at 90 % and above 'convinced' scientists. By creating top ranking groups, the authors report to have found a 97 % 'convinced' rate in the top 100 group – note again the shift of base. The top 100 of course only represents just about 7 % of the original 1,372 scientists. Note again, as the original group only comprises climate researchers, the publication filter results in the selection of those scientists who dominated the peer-reviewed literature on climate research.

Conclusion: Key Learnings

This is one of the key learnings from this analysis: The agreement rate to the GHG-AGW-hypothesis is clearly well below a consensus threshold rate of 90 % in any survey analysis. In every case the agreement numbers only increase via filtering, which significantly reduces the base, and narrows the field to those scientists who dominate the peer-reviewed climate research discussion. Please refer again to Figure 2, demonstrating the effect of the filtering, i. e. driving support up, while significantly reducing the base, taking data from Verheggen et al. (2014).

However, the filtering employed not only significantly reduces the base, but obviously introduces a selection bias, as suddenly not the overall groups' beliefs or convictions are in the center of attention, but only those of the scientists dominating the peer-reviewed scientific literature and the IPCC working groups on the topic in question.

So overall, we found a consistent pattern across the 'consensus' publications. The actual analysis does not support a consensus notion, sometimes quite the opposite, but by employing additional measures, i. e. filtering according to publication efforts a 'consensus claim' confirmation can be stated, and is actually being claimed. The cost of this 'consensus' claim is a significantly reduced base and a strong selection bias, completely devaluing the original notion of a 'consensus'. As it's widely known in the science community and explicitly stated by Winship and Mare (1992), "Sample selection bias occurs when observations are selected so that they are not independent of the outcome variables in the study; this sample selection leads to biased inferences about social processes". This is the phenomenon that we have observed and discussed in this paper, and which has led to the conclusion that the climate research consensus claim might actually be unfounded.

A further problem with the publication filtering is a possible mechanism of self-citation or clique citation. Anderegg et al. (2010) mentioned this issue at the end of their work; however, then explained that this is a tendency in climate change research and that this should be less of a problem with increased sample size. However, this may not be the case as shown above, even with a large sample; if the observations are not independent of the outcome, there will be bias in the results. Nonetheless, this issue may not be limited to this field of research alone, but also to the peer-review process in general. Work done by Siler et al. (2015), on publications in general showed that the peer-review process might be making "gate keeping mistakes", in that they are "Rejecting seminal contributions and accepting mediocre submissions", leading to statistics such as 12 of 14 most cited articles being desk rejected and overall suggesting that the peer-review process has issues with exceptional or unconventional submissions (Siler, Lee, & Bero, 2015).

We also want to point to a dangerous mechanism: while the original papers do contain the data discussed here, secondary quotations and especially media reports often shorten the respective findings to a 'consensus' confirmation. We would not only argue that this is a classical case of a confirmation bias mechanism, but also that the authors of all the works analyzed here in fact were hoping to achieve exactly that effect. In fact, Tony Leiserowitz, the last author of Stenhouse et al. (2014) in 2017 posted the following spin on YouTube-platform ("the five key beliefs (sic) in ten words: "It's real", "It's us", "Experts agree", "It's bad", "There's hope".") (Evidence Squared, 2017). Thus, the same authors of the 'consensus' claim publications actively engage in shortening the message into "experts agree".

This is questionable in several dimensions, and it clearly points to a mechanism of intended-result driven evidence-making (Rose, et al. 2020, Strassheim & Kettunen 2014). This is clearly very critical in conjunction with a political 'unite behind the science' notion, often encountered in the public space, as this notion actually derives its political force only from a perceived unity or consensus of the scientists.

This work further substantiates that the central GHG-AGW-hypothesis of a scientific consensus has not only not been documented, but in fact does not exist in the analyzed papers.

It should be noted that not refuting the 'consensus' notion puts the scientific community in a dilemma, as perceived discrepancies need to be bridged, albeit there is actually no basis for them.

It is evident that such a 'consensus' has a stronger political appeal, even if not rooted in science (Barrio, 2009). As stated by Michael Crichton, in the editorial from Barrio (2009),

> "Science, on the contrary, requires only one investigator who happens to be right, which means that he or she has results that are verifiable by reference to the real world. In science, consensus is irrelevant, what are relevant are reproducible results. The greatest scientists in history are great precisely because they broke with the consensus. There is no such thing as consensus science. If it's consensus, it isn't science. If it's science, it isn't consensus".

We quote the very first part of a line of argumentation, from the first paragraph of a key perspective by Palmer and Stevens (2019) recently published, titled: "*The scientific challenge of understanding and estimating climate change*". The authors start the perspective with the following words: "The idea that the science of climate change is largely 'settled', common among policy makers and environmentalists but not among the climate science community, (…)" Here Palmer and Stevens think that the notion that science is largely 'settled' is not common within the climate science community, but amongst "policy makers and environmentalists".

A dangerous line of argumentation for the scientific community: As long as the consensus claims are not refuted in peer-review literature, no policy maker or environmentalist can or indeed should be blamed for citing them.

So how strong is the level of agreement or disagreement in the scientific community regarding the GHG-AWG-hypothesis? If that question is really to be answered there can only be one real avenue, see Figure 1: The truth lies in the data. Thus, one needs to evaluate and categorize the actual study, investigations, modelling, and review data pertinent to the question at hand. This group is working on this task which, despite the numerous climate research publications published during the last years, has not been performed or at least not been reported so far.

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Author Contributions:

P. L and F. V. conceived the original idea, and M. G. refined the concepts. P. L. and M. G. produced and performed the analysis. The main authors for the writing and executing of the paper are P. L and M. G. Then in later stages M. G, A. A, and A. G examined and verified the analysis. Finally, all authors edited the completed work including adding, definitions, further calculations, and specific paragraphs for deeper development of the text. All authors discussed the results and contributed to the final manuscript.

Competing Interest Statement:

re:look climate is a gGmbH, i.e. a non-profit institute funded by tax-deductible donations to advance science and research – details, including scientific principles, list of donations on www.relook-climate.de. The authors from re:look climate gGmbH work under these codes. As with any other research institute re:look's core task and intrinsic motivation is scientific advancement and publishing. Given this background, there is no competing interests or conflict of interest from any of the authors directly related to this work.

Significance Statement

This work sheds light on and discusses the various mechanisms used in a selection of climate change consensus studies. This is a significant contribution not only for our interpretation of such works but also our general awareness of such issues in social sciences. As the issues of result filtering, sample selection bias, and triggering of inflated secondary communication can have implications beyond; the published work, the science community but also affect future results interpretation, and in later stages disperse into the political sphere.

A Comment on Sea Level in the IPCC Climate Reports

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former geodesists at The Norwegian Mapping Authority

Abstract

When meteorologists with today's great computing power can only predict the weather with some degree of certainty about 3 days into the future, how can we then expect climate scientists to predict the climate 100 years into the future?

We have considered a single tide gauge at the Norwegian coast, Tregde. It has been chosen because the change in sea level is zero in relation to a fixed point in the rock at the tide gauge. During the almost 100 years the tide gauge has been in operation, it does not at any time show a significant change in sea level.

Although the IPCC reports say that there may be local differences in the sea level change around the earth, we find that zero change at the random Norwegian station, cannot be covered under "local differences". A relevant question is whether climate scientists' models really manage to capture the complexity of Nature.

The theoretical models for sea level change

In September 2019, the Intergovernmental Panel on Climate Change (IPCC) released its latest report, which largely addresses the future theoretical changes in sea levels. A quick reading shows that the roughly 1100 pages span a large number of possible scenarios, from sea level rising by about 1 metre to only a few decimetres over the next 100 years. Indeed, one of the figures in the report claims to predict something about sea level rise as far ahead as 300 years into the future.

One is consequently tempted to ask some critical questions. Meteorologists - with their best models of the atmosphere, with their mathematical formulas developed over 100 years and with the largest and most modern computers available – seem unable to predict the weather with some certainty more than a week into the future. That being so, how can we then accept that climate researchers operate with models that enable them to say something about climate and sea level changes 20, 50 or even 300 years into the future? Are climate scientists' models really that good?

Testing the models

To test the quality of these models, we considered the first IPCC report that came out in 1990. There, we found a figure at p. xxx [*sic*.] that showed what climate scientists expected concerning global sea level rise from 1990 until the year 2100, reproduced here, Figure 1.

Of course, the report made it clear that there would be local variations in sea level rise. The curves in the figure show a cross-section of what the climate researchers then thought would happen to the average global sea level. The media in the 1990s immediately focused on the higher line describing the worst possible outcome of climate change. It was probably this worst-case scenario that slipped into the public consciousness. The upper curve in the figure forecasts that the sea level can rise globally by up to about 25 cm from 1990 to 2020. The lower curve shows that the sea level in the same period could rise globally by approximately 7 cm. So, what in fact actually happened? It has now been 25 years since the figure was presented, and this is a long enough time interval to make a careful check of the forecasts.

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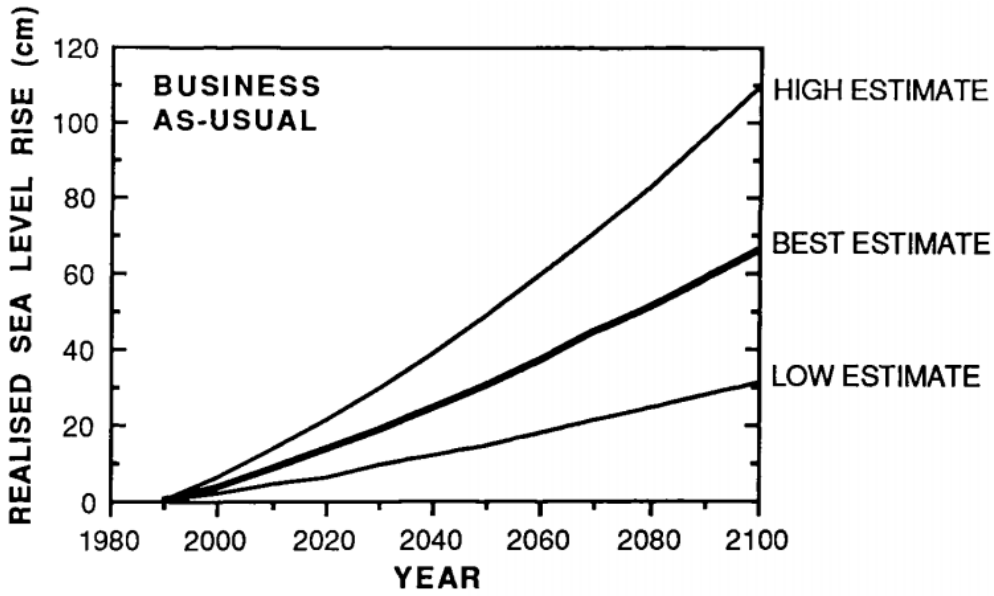

Figure 12: Sea level rise predicted to result from Business-as-Usual emissions, showing the best-estimate and range

Figure 1. Sea level change scenarios in the 1990 IPCC report.

The tide gauge at Tregde

In this connection, we have looked more closely at the data from one of the 25 tide gauges that the Norwegian Mapping Authority (NMA) has distributed around the Norwegian coast. The tide gauge at Tregde (southern Norway) near the southern tip of Norway was selected, not least because Tregde is located in an area that, according to geophysics researchers, has experienced no land uplift over a long period of time, compared to the mean sea level (See: *Geodetiske arbeider, hefte 6, Høyder for presisjonsnivellement i Sør-Norge*, published by Norges geografiske oppmåling, 1956).

At all of the NMA's tide gauges, sea level height as measured by the gauge is related to a fixpoint of known height that is emplaced in solid rock on land. This fixpoint is the reference mark for the tide gauge - the Tide Gauge Bench Mark (TGBM). The given height of the TGBM thus defines the position of the zero level in the tide gauge itself - somewhere in the water. What is measured by the tide gauge is therefore the water level at all times in relation to this defined zero level. At Tregde, the tide gauge has recorded the sea level continuously from 1927 until today. Data from the NMA provides the curves in Figure 2.

The vertical axis shows the height above or below the gauge's zero level in cm, while the horizontal axis shows the time from 1927 up to and including the year 2018.

The blue curve in the middle shows the average sea level for each year through the 91 years.

The upper curve shows the year's highest registered water level for each year during these 91 years.

The lower curve shows the corresponding year's lowest water level in the same time period.

What we can conclude from the curve for average sea level in Tregde (the middle curve), is that the sea level in relation to the TGBM in solid rock does not show any significant change during these 91 years. The curve appears to be fixed around a horizontal line from 1927 to 2018.

In other words, sea levels have remained stable relative to land throughout the observation period. We see no relative change in sea level in relation to land, neither before nor after 1990.

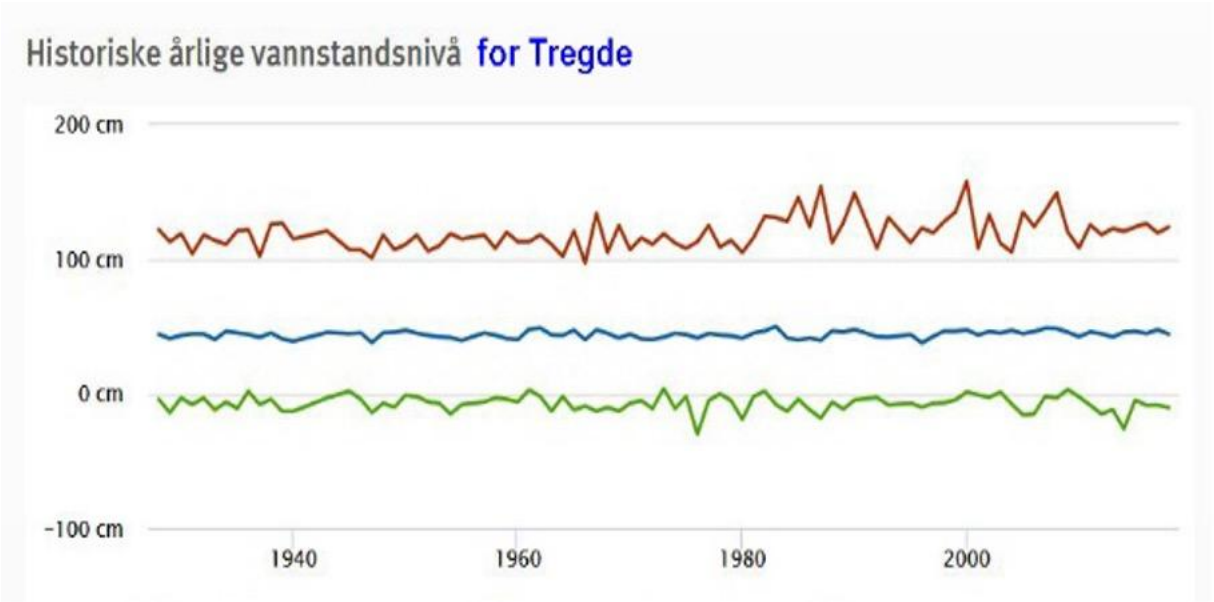

Figure 2. Historical annual sea level measures for Tregde.

If the sea has risen, then at Tregde it has risen steadily throughout the period of 91 years, and it must have risen at the same rate as land uplift, since the tide gauge shows no change in mean sea level at Tregde. At no point along the curve do we see a change in the speed at which the sea may rise.

Conclusion

Among professionals, it is estimated that land uplift has been very close to constant for at least 1000 years. Therefore, there is good reason to believe that the land uplift speed has been unchanged in Tregde throughout the time the water level gauge has been in operation.

Although the IPCC report from 1990 makes reservations about local differences in sea level rise, it must be possible to characterise Tregde as an unexplained exception, where mean sea level has remained unchanged in relation to land for 91 years since 1927.

We can only conclude that the climate scientists here have a difficulty of explanation. Zero change at Tregde cannot be covered by an explanation about local deviations from a global sea level change. Is it conceivable that climate scientists have models that do not fully reflect natural phenomena that are more complex than we are willing to admit? Do we have reason to believe that the models on which the 2019 report is based are more reliable?

We believe that all nations should do their part to reduce emissions that can be detrimental to the climate, and we must work for the sustainable development of our inhabitation of the planet. The way the climate debate has taken off in recent years, however, seems to suggest that climate is becoming the religion of our time. Raising critical questions about the climate panel's claims is by many non-specialists considered almost blasphemous. The data from the tide gauge at Tregde alone gives reason to question the quality of some of the climate models that may govern large investments in the future.

Figure 3. The house of the tide gauge at Tregde.

Minoan rock art at Vigdel beach, near Ræge, at Sola.
Note the Shaman with an axe (right) and the boat (left) (Photo: M. Hovland).

The Holocene climate change story: Witnessed from Sola, Norway.

Part 1

Martin Hovland, MSc PhD, FGS[A]

Abstract

The Holocene time-period on the geological time scale is defined as the period following the last glaciation, about 14,000 to 15,000 years ago, until the present ('Holocene', after the Greek words: 'halos', entire, and 'ceno', new). Although this is a short period in the geological sense, it is an important and defining period for the immigration and settlement by modern humans (*Homo sapiens*) to northern Europe/Scandinavia.

The county of Sola, just south of Stavanger, SW-Norway, has a rather unique geographical locality and physiography of low-lying country on the North Sea coast, it became accessible for long-range hunter gatherers due to early deglaciation in the Mesolithic (middle stone age), abt 14,600 years BP, and thereafter, for nomads and settlers in the Neolithic (new stone age) and Minoan (bronze age).

The early presence of humans at Sola has provided archaeologists with thousands of traces and artefacts that tell a story of the waxing and waning of settlers, followed by abandonment and resettling, - up through the ages, mainly due to shifting climate throughout the Holocene.

This story is patched together in six installments and renders a crude narrative based on the archaeological evidence and what we know about the shifting physical environment surrounding Sola. We start with a description of the pre-settlement period, and follow as best possible where and how the settlers arrived, with small glimpses of culture from the Mesolithic, through the Neolithic, to the Minoan, ending with the age of the Vikings.

The parts will cover the following aspects:

Part 1: General introduction to the series.

Part 2: Transition from interglacial (Eem) to glaciation (Weichsel), to the current interglacial period, Holocene, including changing sea-levels: transgressions and regressions.

Part 3: The very first Mesolithic settlers at Sola, - first ever settlement of *Homo sapiens* in SW Norway.

Part 4: The mysterious Bronze Age (Minoan): Long-distant, wealthy visitors (or climate refugees).

Part 5: Denser populations in the Iron Age: Agriculture and the first village.

Part 6: The Viking age at Sola: Mighty Erling Skjalgsson and his wife Astrid.

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Introduction

The county of Sola (58° 55’ N, 5° 40’ E; Figure 1) located in coastal Norway has a long and rich history of archaeological finds that date back to when Norway was first populated, immediately after the Weichselian glaciation. This glaciation culminated during the Last Glacial Maximum (LGM), about 19,000 years BP. The warming started then, and continued for about 6,000 years before a short, new glaciation pulse arrived, during the Younger Dryas (YD), 12,800 years BP. This 1200 year long, brutally cold period, caused the fast-retreating glaciers to suddenly stop, and re-advance, leaving tell-tale morainic ridges along the advancing ice margin throughout Scandinavia and Siberia (Mangerud, 2021). The nearest YD-morainic ridge, to Sola, occurs in the Lysefjord, about 30 km inland.

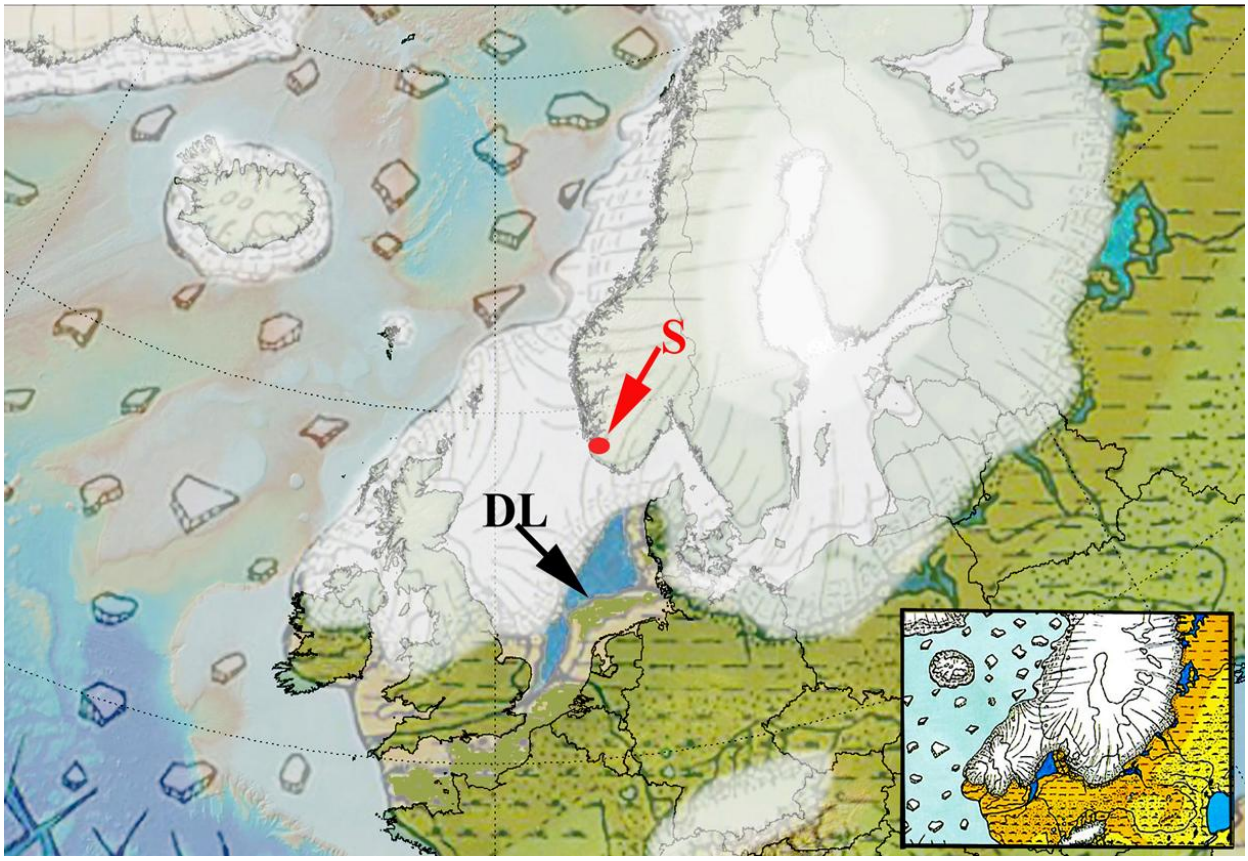

Figure 1. The situation in Europe during the Last Glacial Maximum (LGM), about 19,000 BP.

In Figure 1, the red dot shows Sola (S), then located beneath some hundreds of metres of ice and snow. It is known that ‘The north European ice sheet’ reached as far south as Berlin and Warsaw, and still further south during earlier ice ages (Vorren & Mangerud, 2006). Tundra and steppe/park-land covered most of Europe including parts of the North Sea, such as ‘Dogger Land’ (DL) and ‘Agderia’, see (Figure 2) (Gaffney et al., 2007; Hammer et al., 2016). An exotic ice age fauna with mammoth, woolly rhinoceros and reindeer lived on the tundra and steppes all the way south to the Mediterranean, where early humans also lived and hunted (Modified from Andersen & Borns, 1994; parts of the original drawing shown in the inset).

Present-day Europe received much of its most recent sediment cover during the Weichselian ice age. The glaciers left a blanket of glacial deposits, and large quantities of sand and gravel supplied by glacial rivers. Also, strong winds, partly generated over the glaciers, spread sand and fine-grained silt/loess over much of the tundra and steppe beyond the glaciers. The climate was extremely cold, particularly during winters and in areas adjacent to the ice sheet and over the pack ice that covered part of the North Atlantic. Figure 1 shows winter-ice conditions in the north Atlantic Ocean. Note that parts of the North Sea were dry land because of the much lower sea level

(about 120 metres) during the LGM, when some of the ocean water was tied up in the ice masses over Europe and America and other smaller glaciers the world over.

Because Sola became ice-free just before the new cold spell, the YD, and because it is located on a low-lying coast with inlets, bays, small islands and calm beaches, the first human artefacts and traces are dated from around 11,000 BP. However, there are no suggestions of proper settlements in Sola before a couple of thousand years later.

Along the SW-Norwegian coastline, including Sola, there is a deeper trough, the Norwegian Trough, see (Figure 2), that hindered people walking onto our coast earlier. They needed vessels to bring them over, or they had to cross over on the ice, during the winters.

Recent archaeological excavations have unraveled an interesting and complex history of the settlement at Sola. It provides a chronology of events that, combined with scarce global temperature proxy information, can be used to reconstruct the conditions facing the settlers through the Stone Age (Neolithic) and the Bronze Age (Minoan) up until the Iron Age, around 3,000 BP.

The main objective of this set of six short essays is to provide a fact-based narrative of the climatic and environmental changes at one of the very first Scandinavian locations settled by human beings and how they developed through parts of the Holocene.

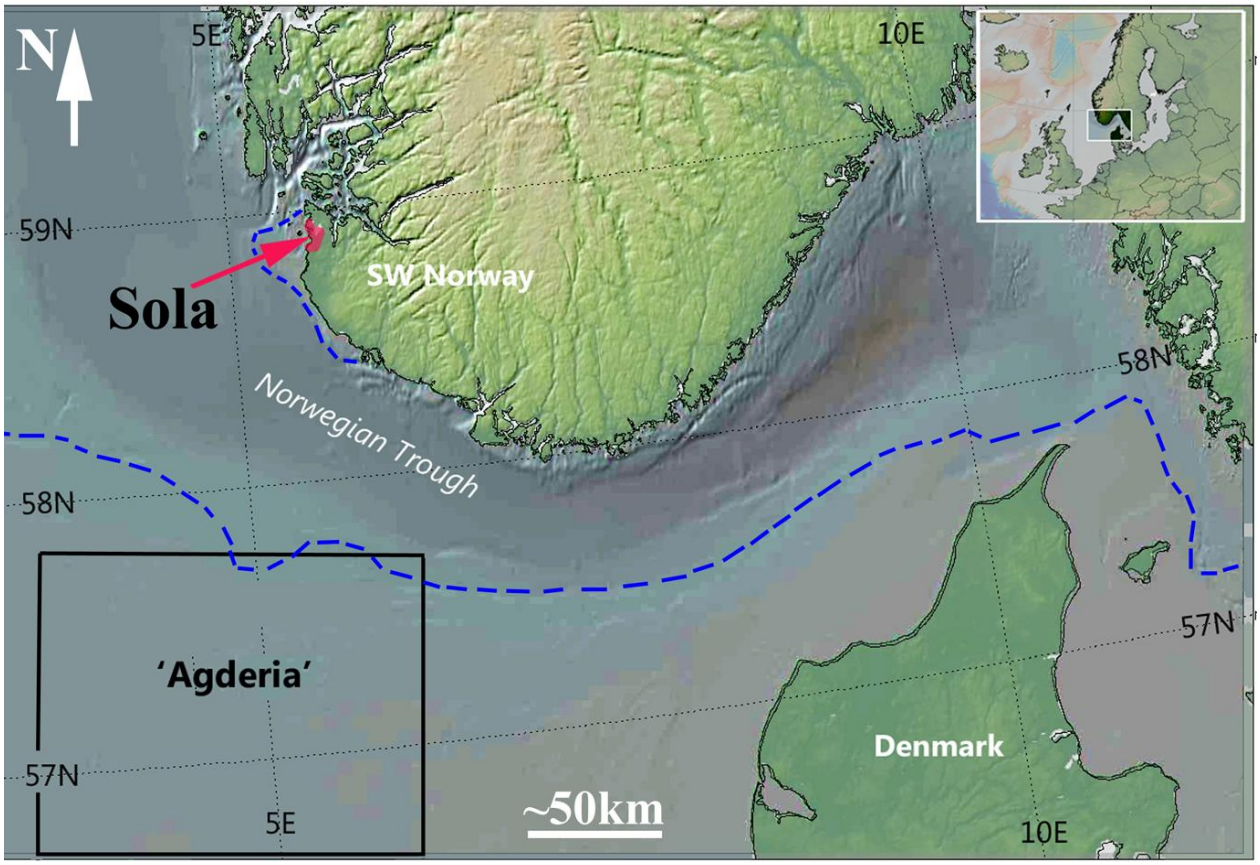

Figure 2. Map of southern Norway showing the location of the Sola county.

In Figure 2, note the 'Norwegian Trough', that is currently a 200 to 700 m deep trough in the seafloor. Whereas other parts of the North Sea were dry land during the LGM, this trough was water-filled, and must have been crossed by the first settlers of Sola. 'Agderia' (Hammer et al., 2016) and 'Dogger Land' further south (not shown) were locations where the early settlers may have trekked, hunted and lived before arriving at Sola after crossing the Norwegian Trough, probably in skin-covered framework boats (such as known from Greenland, e.g., umiaks).

Figure 3. The current county of Sola.

Figure 3 is a panorama view from the north-east is overlooking the central Sola county. The view is towards the west and south, where the Weichselian ice cap melted away early in the Holocene, around 14,000 years ago, well before the Younger Dryas glaciation pulse. The water body to the right is the fjord Hafrsfjord, which was dry land, also after the ice had melted, for a thousand years or so. The sea-level was much lower during the LGM (by about 120 m), and did not reach the current level before 8–9,000 BP. The two arrows point at important archaeological locations in Sola, R=Ræge, and T=Tjora (Photo by M. Hovland).

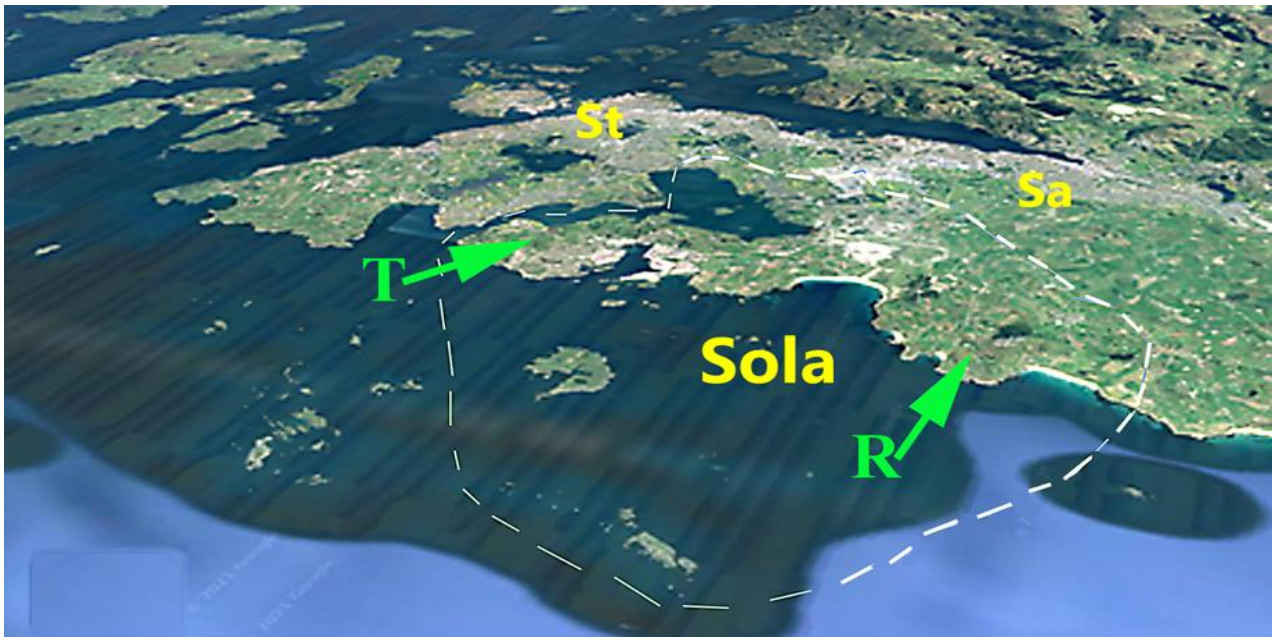

Figure 4. The current county of Sola.

Figure 4 is a Google Earth oblique view of Sola County from the west. The county borders are shown, with the cities Stavanger (St) and Sandnes (Sa) also indicated. Notice the Hafrsfjord and two large sandy beaches (Sola Beach and Hellestø Beach). The green arrows, 'T' and 'R' point at the locations Tjora and Ræge, respectively.

A short preview: 'Once upon a time….'

Once upon a time, there was a fine beach facing south-west, overlooking the great North Sea. In this part of the ocean, there is a warm-water current flowing northwards, called the Gulf Stream. It provides this Sola beach with a mild and pleasant climate, also during most of the winter months.

Not many years after the great ice sheet thawed away from Sola, hunter gatherers arrived at its shores and survived by hunting reindeer and other game along the glaciers in the mountains nearby. They arrived in their skin-covered boats from the other side of the Norwegian Trough, from the sandy stretches of land called 'Agderia' adjacent to 'Dogger Land' (e.g., places that are now at the bottom of the North Sea, Figure 1). At Sola they found plenty of fish, shells and birds around the small islands and numerous inlets (Figure 2). In the nearby fjords there were larger prey, like seals and small whales, where the nutrient-rich meltwater from glaciers mixed with seawater. Polar bears are also known to have wandered around in the vicinity of the glaciers and iceberg-loaded fjords to the east and north of Sola.

Hunter gatherers only lived at one place over short periods of time, before moving on. They lived in whatever shelter they could find, as there were no trees on the tundra. Therefore, the only signs of their existence, now, are the accumulation of shells and bones left in and around the caves and rock-shelters ('hellers') which they occupied.

Then, after some hundred years, bushes and small trees including birch started growing in the region. This is when putative settlements probably appear at Sola. Based on the early finds, one reckons that people settled and stayed at Sola from around 8,500 BP. At this time, the temperature had risen considerably (Figure 5), and the ice had retreated far back into the inland valleys and fjords and the high mountains. In the same period, from the Younger Dryas glaciation pulse, the seawater level had risen, little by little.

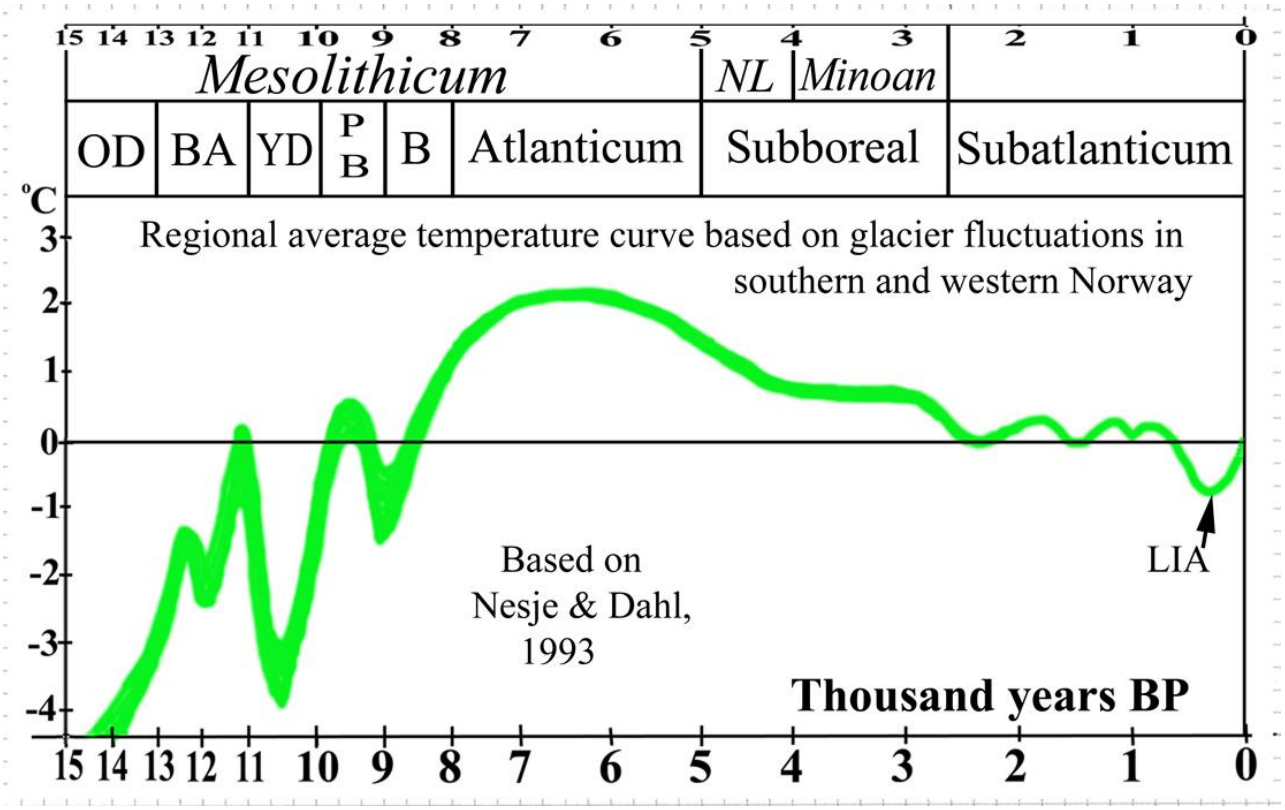

Figure 5. The green curve shows the approximate regional average temperature deviation from the current average temperature (0 °C, horizontal line) during the Holocene.

The curve in Figure 5 is based on evidence from terminal moraines, palynological data, and tree limits at glaciers in south-western and western Norway. "…*most of the west Norwegian glaciers*

disappeared during the early Holocene Hypsithermal interval (ca. 8,000 to 6,000 BP) and were reformed about 5,000 BP." (Nesje & Dahl, 1993). NL=Neolithicum; OD=Older Dryas; BA=Bölling, Allerød; YD=Younger Dryas; PB=Preboreal; B=Boreal; LIA=Little Ice Age. The figure is modified from Figure 2 in Nesje & Dahl (1993).

Suddenly, however, just as people had settled here for 3 to 4 generations, a terrible natural disaster occurred. This 'Great Catastrophe' happened as the ocean suddenly rose up from the west and north. It must have killed many, if not most of the settlers and frightened them from living along the coast. They would probably have been scared away from the coastal areas for some time (perhaps for one generation or so). The Great Catastrophe has been dated to 8,150 BP and was a consequence of a tsunami-like wave that struck the Norwegian coastline from off mid-Norway in the north and as far south as Denmark.

This very brief outline of the first settlers arriving at Sola provides a simple narrative, which we shall now add more details to. One may also ask: Why is it that Sola had some of the earliest settlements in northern Scandinavia? It is likely because this location could have been one of the very first open gateways into northern Scandinavia, which was free of ice immediately after the YD.

What is a tsunami wave?

There is no doubt that a huge tsunami-like wave hit the coastline from Norway and southwards as far as Lindesnes, southern Norway, 200 km south of Sola. It occurred sometime close to 8,150 years ago. The wave was triggered by one of the greatest submarine avalanches ever known, the 'Storegga Slide', at 400 – 800 metres water depth, west of Trøndelag, Norway (Bugge et al., 1988; Bondevik, 2003). This sudden disruption of the seafloor lead to a sudden pulse on the sea surface that induced the wave, which started migrating in all directions from the epicentre of the slide. Although these waves may only have a 2 – 3 m amplitude out on the open ocean, they rise rapidly up to 10 – 15 m as they travel towards shallower water near the coast. However, their most destructive aspect is their speed. Having very long wavelengths, their speed across the sea surface can reach over 150 km/h. We will return to this incident later.

Now, let us take a more thorough look at the climate, the physiology and the interaction with humans and their development. What was it like to be early settlers at Sola, and how did society develop here, during the early- and mid-Holocene? Archeological studies and finds have some of the answers.

The Last Ice Age (Weichsel), at Sola: ice landscape devoid of people

The Quaternary period comprises the time interval from around 2.7 – 3 million years ago until the present day. This period is characterized by a multiple of large-scale glaciations and relatively short warm intervals, called interglacial periods, between each glaciation.

The latest interglacial (warm) period, which is still ongoing, is called the Holocene. The onset of the Holocene is marked by a global drastic temperature increase of an estimated 7 °C at the end of the YD, about 11,600 BP. This sudden warming occurred over a short period of only a few decades. Since then, the Holocene climate has been stable by comparison with the preceding glacial period.

During the LGM, the glaciers and ice sheets covered the whole of Scandinavia, parts of the northern European continent, parts of the North Sea, most of the UK, Iceland, the Barents Sea, Svalbard, and parts of northern Siberia (Figure 1).

In addition to 'The north-western European ice sheet', there were, globally, numerous small and large ice sheets that had formed. The largest one ('The Laurentian ice sheet') covered northern America, including the whole of Canada and Greenland (Andersen and Borns, 1994).

The development of *Homo sapiens* (modern humans) occurred during this Weichselian, last glacial period, mainly in Africa, around 130,000 BP. Some of the humans migrated east and northwards into Europe around 45,000 BP, e.g., about 20 thousand years before the transition into the Holocene interglacial period. This means that the people who eventually migrated and settled in Norway and Scandinavia around 10,000 BP, were the very first humans to occupy this northern part of the world (Gibbons, 2021).

During the glaciation period, some of these humans lived in caves on the continent, further south, - as graphically, and briefly described by Ann Gibbons (2021):

> "*The four-story labyrinth of galleries in Bulgaria's Bacho Kiro cave has long been a magnet for all sorts of humans. Neanderthals came first, more than 50,000 years ago, and left their characteristic Mousterian stone tools among the stalagmites. Next came modern humans in at least two waves; the first littered the cave floor with beads and stone blades stained with ochre, about 45,000 years ago. Another group settled only 36,000 years ago with even more sophisticated artefacts*".

Leading up to the Weichselian Last Glacial Maximum

Why and how did the Weichselian glaciation originate, - and why did the humans arrive only around 10,000 years BP to northern Scandinavia? To address these questions, we step even further back in time, and look at the general climatic development from around 2.5 million years BP.

Paleoclimatologists, e.g., geologists and geochemists, have managed to reconstruct climatic change and development by so-called proxies in sediment- and ice-cores.

The climatic alterations on Earth had up till then been rather unpredictable, with abrupt changes of unknown causes. However, in the early Quaternary, the climate started to flip in and out of abrupt cold periods, so-called ice ages (glaciations) to warmer periods, interglacials.

During glacials, enormous snow and ice masses engulfed northern Europe (Figure 1) and the northern parts of the USA, Alaska and Canada. Each of these cold periods lasted for about 40,000 years whereas the warm interglacials lasted for 15 – 30,000 years. These cyclic climate variations occurred with, more-or-less, clockwork precision, until a slight change happened around 1 million years ago. Then the rhythm altered, so that the glacials lasted longer, up to 100,000 years, whereas the interglacials lasted the same as before.

The reason why the climate flipped in and out of glaciations was found by Milutin Milankovitch to be cyclic alterations of the Earth's geometry relative to the sun, e.g., the 'Milankovitch Cycles'. Because each of the glaciations disrupted the soil and sediments, and even the topography of the mountains, we do not know very much about the plant and animal life before about 200,000 years ago.

The previous glacial period was named Saale, which started about 235,000 years BP and lasted until 130,000 years BP (Figure 6). Its lowest average temperature was estimated to be about 9 °C lower than at present. Saale ended with a sudden warming, which lead up to the previous interglacial, Eem, starting about 125,000 years BP (Figure 6).

Figure 6 shows a proxy-reconstruction of the annual mean global temperatures from 450,000 years BP, until present. Here, we get an impression of how the Holocene interglacial period (at the very right), seems to stand out as an anomaly in contrast to the blue, glacial periods, which makes up around 90 percent of the whole period.

The tiny red portions of the temperature curve represent the five interglacials (warm periods). Thus, most of this long period has seen Europe up to 9 degrees C colder, on average, than at present. The last glacial, Weichselian, ended about 12,000 BP (in north America, this glacial is called the 'Laurentian glacial').

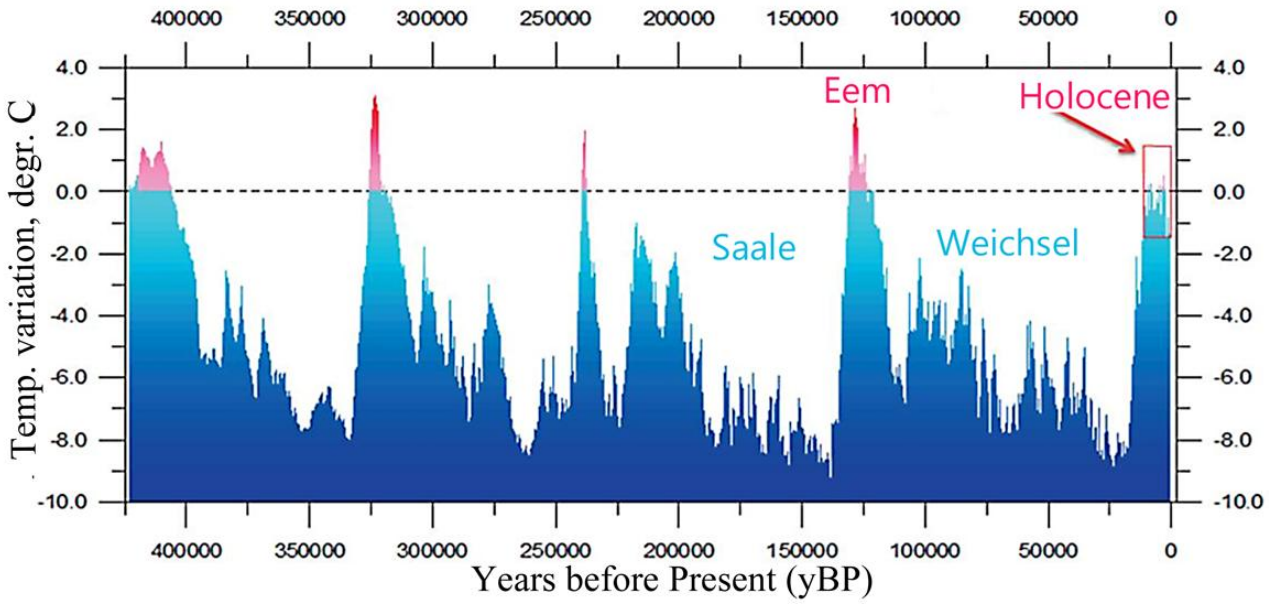

Figure 6. A reconstruction of Earth's mean surface temperature variations for the last 450,000 years BP. It is based on two Antarctic ice-cores: Vostok and EPICA Domes. (See www.climatedata.info/proxies/ice-cores).

The previous interglacial (Eem) lasted only about 15,000 years, but was up to 2 degrees warmer than the Holocene. Before that we had the Saale glaciation, which lasted about 90,000 years. From the blue curves, during glacials, it is evident that the ice-ages were also sprinkled with warmer periods, which were only a couple of degrees colder, on average, than at present.

To be continued in the next issue.

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Nils-Axel Mörner in Memoriam

A collection of memorial articles by friends and colleagues[A]

Nils-Axel Mörner (Niklas among friends) was born on March 17, 1938 in Stockholm, Sweden. He took his Ph.D. in 1969, becoming associate professor in Quaternary Geology at Stockholm University that year. He conducted his postdoctoral research in Canada and was then employed by the Swedish Research Council.

He was awarded a personal associate professorship at the Institute for Palaeogeophysics & Geodynamics, which from 1991 became a special research institute at Stockholm University. As head of the unit, he addressed a variety of geological and geophysical problems.

He organized two major international conferences: *Earth Rheology, Isostasy and Eustasy* in 1977, and *Climatic Changes on a Yearly to Millennial Basis* in 1983.

Professor Mörner led several international field excursions throughout Sweden. Overseas, he was President of the *INQUA Commission on Neotectonics* (1981-1989) and President of the *INQUA Commission on Sea Level Changes and Coastal Evolution* (1999-2003). He also headed the INTAS Project on Geomagnetism and Climate from 1997-2003.

In 2000, he launched an international research project on sea level in the Maldives, probably his most famous project, proving that there is no sea-level rise going on there.

After his 'retirement' in 2005, he continued working on several projects and producing books, booklets, reports and articles, many of which are told about on the succeeding pages.

Among his more than seven hundred publications are studies on the following –

- the interaction between isostasy and eustasy;
- the oscillating regional eustatic curve of NW Europe;
- the changing concept of the geoid;
- the redefinition of the concept of eustasy;
- the dynamic-rotational redistribution of oceanic water masses;
- the interchange of angular momentum between the Earth's hydrosphere and lithosphere;
- a new sea-level curve in the Maldives (showing no sea-level rise);
- a new sea-level study in the Sundarban delta of Bangladesh.

In 2008, at an international meeting on sea level in Portugal, Professor Mörner was awarded the Golden Chondrite of Merit from the University of the Algarve "for his irreverence and his contribution to our understanding of sea-level change".

He became a member of the Scientific Council of the Norwegian association *Klimarealistene* (the Climate Realists) in 2015, and was chosen as Chief Editor of our journal *Science of Climate Change* Sep. 26, 2020, a name he coined himself, but sadly died after a short illness on Oct. 16, less than a month later.

Niklas insisted that we should use the Northern Lights on the cover of the journal, as a symbol of the Scandinavian cooperation behind it.

Peace be with his memory.

The editor.

[A] Submitted 2021-08-14. Accepted 2021-08-15. Reviewed by M. Jødal. https://doi.org/10.53234/scc202111/214.

Professor Nils-Axel Mörner, 1938-2020

Christopher Monckton of Brenchley[A]

Professor Nils-Axel Mörner, who died on Friday October 16 aged 82 after a short illness, knew more about sea level than did Poseidon himself. He wrote more than 650 papers on the subject in his long and distinguished career. He became even more well-known after his retirement than before it, because he decided to take the risk of publicly opposing the false notion, profitably peddled by the Intergovernmental Panel on Climate Change *et hoc genus omne,* that global warming would cause many meters of sea-level rise.

Silent upon a peak in Darien

I first came across Niklas Mörner when he and I met at St. Andrews University in Scotland, where we had been invited to debate the climate question with true-believers at the University Union, one of the oldest debating societies in the world.

At the beginning of the evening, the President asked us whether we minded taking part in a debate in which 97% of the students were against our viewpoint. Niklas replied cheerfully that he had faced worse odds than that.

During the debate, Professor Mörner's speech won us the day. Within seconds, he had the undergraduates eating out of his hand. His manner was calculatedly eccentric, and yet all through his speech one could see how passionate he was about seeking scientific truth objectively by measurement, observation and the application of previous theory to the results so as to confirm and develop or to overthrow that theory. Either way, said Niklas, science advances by little and little towards the truth, and nothing but the truth matters.

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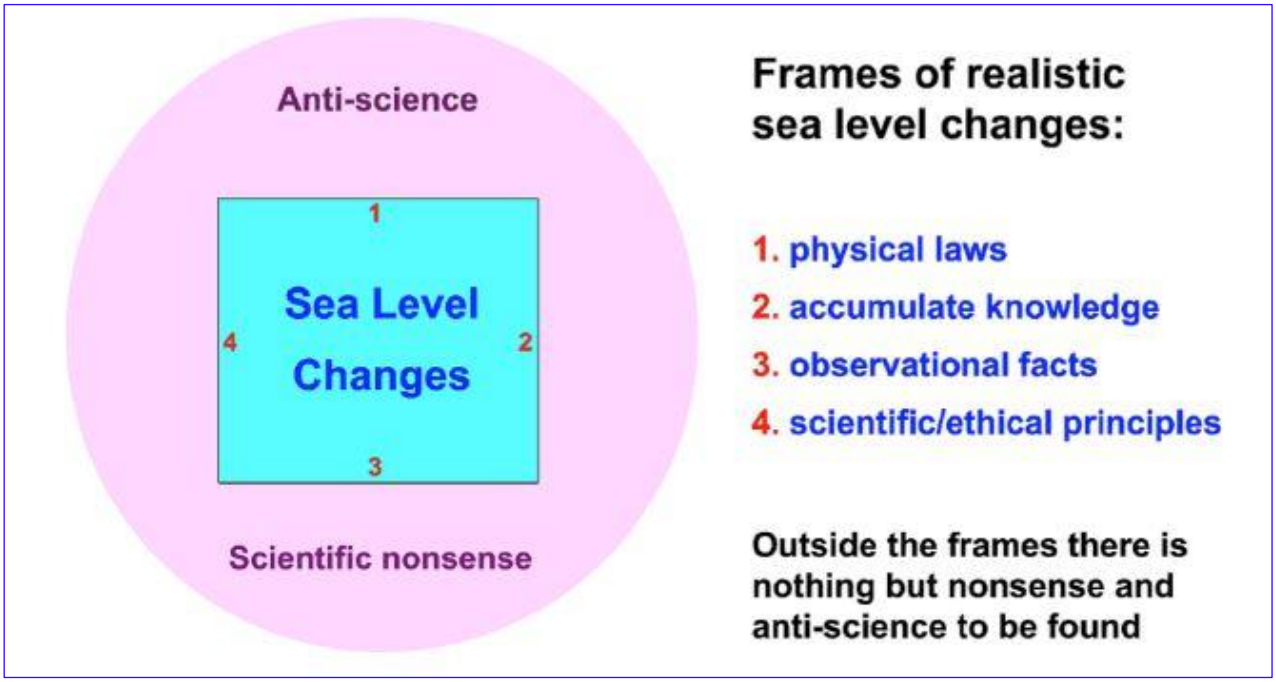


The scientific method applied to sea-level change: a slide by Niklas Mörner

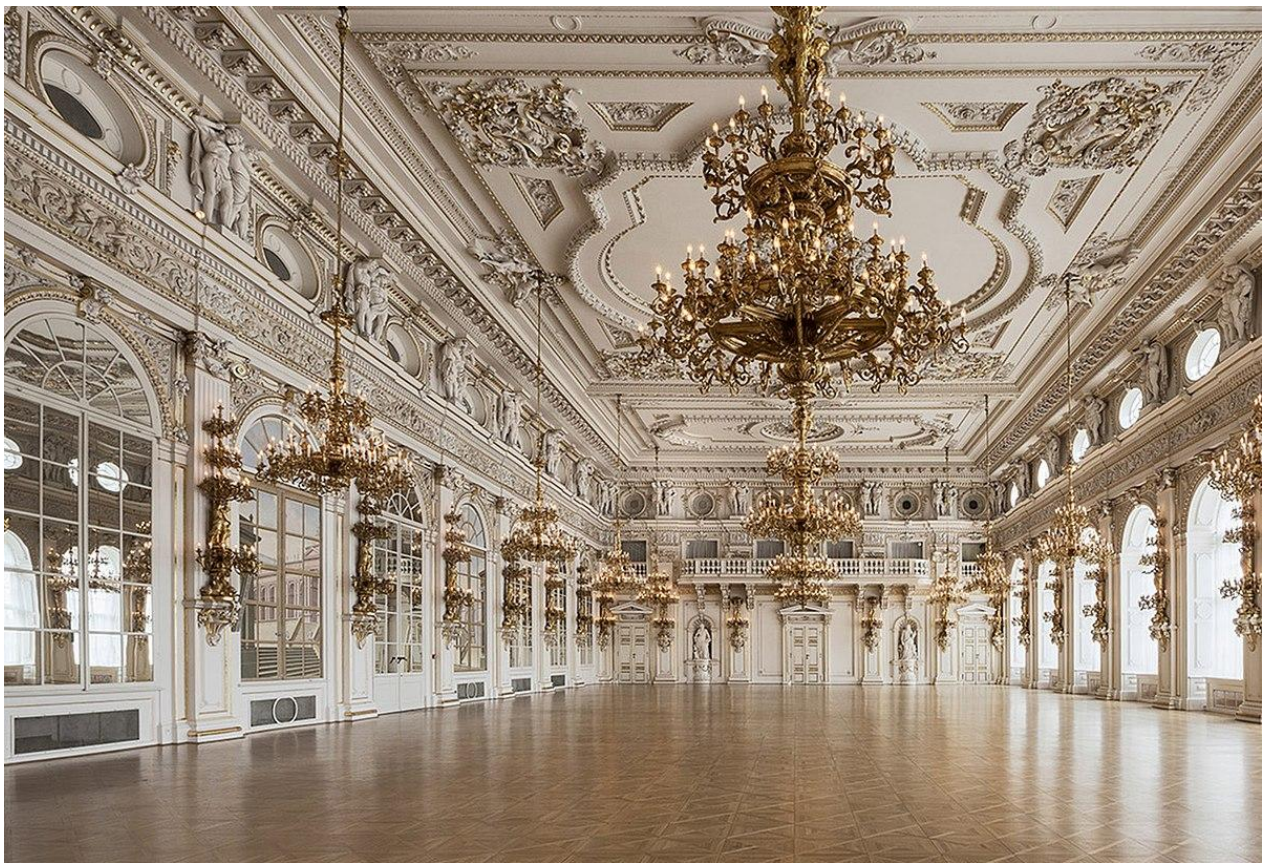
Mörner's fork

The undergraduates were visibly fascinated. After 40 years of lecturing, he knew that keeping them entertained was the best way to hold their attention, and that making visible his personal dedication to the hunt for objective truth in scientific enquiry would lead the students to emulate him. He was rapturously received throughout his speech, and was accorded a thunderous round of applause at the end.

When the vote was taken, the skeptics had won by a margin of 3 votes. It was the first time that any student audience in Britain had voted to oppose the climate-Communist Party line.

Thereafter, Niklas and I kept in regular touch until just a couple of months ago, when he wrote asking me to contribute two papers to a new scientific journal that he was setting up. He wanted one paper on *What is science and what is not?* and another on our team's demonstration that concern about global warming sprang from an elementary but significant error of physics. At the Copenhagen climate conference in 2009, Niklas gave a speech on sea-level rise to a press briefing organized by the Committee for a Constructive Tomorrow. The meeting was well attended, and Niklas – who needed a pointer for his slides but could not find one – seized a passing wooden salad fork and used that instead, to the delight of the journalists.

He also established the influential International Committee on Geoethics, with the aim of removing partisan politics and reintroducing open debate on scientific questions at universities. The Committee held its inaugural conference in Prague, where the presentations were given in the Spanish Ballroom of the Hradcany Palace at the invitation of then-President Vaclav Klaus, who also spoke.



Geoethics in style: the Spanish Ballroom at the Hradcany Palace, Prague

Professor Mörner was a hands-on scientist. He did not enjoy squatting in his ivory tower. He liked to travel the world investigating sea level by the novel method of actually going to the coastline and having a look.

On one occasion, when the climate Communists were reporting that Bangladesh was subsiding beneath the rising waves, he went on a fact-finding trip to Bangladesh with a group of fellow sea-level specialists. All the others were true-believers, so they just drifted along with the Party Line and took few measurements.

Only the Professor not only used his altimeter but walked 100 meters uphill, in his late 70s, and back down again so that the instrument would be correctly calibrated. Only the Professor subsequently reported that, as a result of those measurements, sea level off Bangladesh was actually falling. Only the Professor reported that in the few beaches where the sea had encroached, it had done so not because of global warming and consequent sea-level rise but because local prawn farmers had grubbed up the mangroves whose roots had previously kept the coastline stable.

On another occasion Professor Mörner was visiting the Maldives when he noticed a small tree, 40 years old, right on the beach, in leaf but lying on its side. The fact that the tree was still there, feet from the ocean and inches above sea level, after 40 years told him that there had been no sea-level rise since the tree had first begun to grow, or it would have been drowned.

He enquired locally about whether there had been an exceptional spring tide caused by global warming and sea-level rise that had overthrown the tree. He discovered, however, that a group of Australian environmental extremists had visited the beach shortly before him. They had realized that the presence of the tree showed that the official sea-level record showing a sharp rise over the past half-century must be incorrect, and had uprooted the tree. Professor Mörner stood it back up again and photographed it.

The Tree of the Knowledge of Good and Evil

He was plainly very distressed by incidents such as this, for he was a highly moral man with a strong regard for the truth. He took each of the numerous lies and frauds perpetrated by climate Communism as a personal affront, and was saddened at the widespread decline in scientific standards, particularly in the universities.

He was hated and feared by the climate extremists. The online fake-news outfall Wokipedia, one of whose founders has now publicly admitted that it is wholly in the hands of Communists, has the usual hatchet-job biography for the Professor, devoting more sniffily disapproving prominence to his interest in dowsing for water with hazel twigs than to his formidable record of investigation and publication in the field of sea-level rise.

Wokipedia's hate-filled scribblers did not – could not – comprehend that Niklas Mörner's interest in dowsing was motivated chiefly by scientific curiosity. I once told him that my late father had been commissioned some years back by the Maltese Government to find three Punic tombs at the foot of the limestone escarpment on which stands the lofty *village perché* that is the ancient walled city of Mdina. Local archaeologists had records showing that the tombs existed, but they had never been found.

My father, armed with two angled steel rods, marched up and down the stony fields below the ramparts for half a day, putting sticks in the ground at various points. The sticks formed three separate crosses. Where each of the crosses intersected, my father told the workmen to dig. In each place, a fine Punic tomb was found – though there had been absolutely no sign of any such thing on the surface. From one of the tombs a fine half-size marble bust of a Roman was removed. I sketched it (there were no cellphones, let alone cellphone cameras, in those days) and sent the sketch to the Museum of Classical Archaeology at Cambridge, where it was identified as a good example of a first-century head of Seneca.

Mörner 'sacrificing' a fellow-scientist on a South American tectonics field trip in 2012

Niklas was greatly excited by this story, and asked me how I thought dowsing might work. I said I had no idea. All three of my brothers had the gift, but I – for some reason – did not. But I had seen my father dowsing for – and finding – a major Roman iron-working and Samian-ware pottery-firing settlement on his farm in Kent.

I also told Niklas that when I had invited my father to Cambridge to have his dowsing ability tested under laboratory conditions he had firmly declined, though he told me that he had won a lot of money while at Cambridge when in the pub by leaving the room and inviting his fellow-undergraduates to hide a signet ring under one of them.

He said the only time he had lost the bet was when someone turned on a tap at the wrong moment and water passed through a pipe under the floorboards where the three caps lay.

I had the honor to co-author a paper with Niklas for a climate-change conference at Downing College, Cambridge. The paper was uncompromisingly titled *Sea Level Is Not Rising.* The organizer, who had made his fortune selling pills and potions and had hoped for a quiet conference, refused to allow the paper to be distributed, though he had previously consented. The papers were gathered up and taken away.

However, I mounted a raid on the store where they were hidden and made sure that a copy was on every seat. The climate Communists present were furious, but the students who attended were intrigued, particularly when they began to read arguments, facts and data that had been denied to them by their professors throughout their time at Cambridge. Niklas was delighted at what he called my SAS raid.

It is honorable men like Niklas Mörner whose legacy to the world is as much of merriment as of the relentless pursuit of truth. Like St. Thomas More, I can confidently write that my old friend is now as "merry in Heaven" as he was merry, and gave merriment to all whom he touched, here below.

A couple of weeks before Niklas died, I wrote to cheer him up. I ended the letter with a poem that described Niklas perfectly. It is St. Thomas Campion's free but beautiful translation of the Horatian ode *Integer vitae scelerisque purus:*

The man of life upright,
Whose cheerful mind is free
From weight of impious deedes
And yoke of vanity,

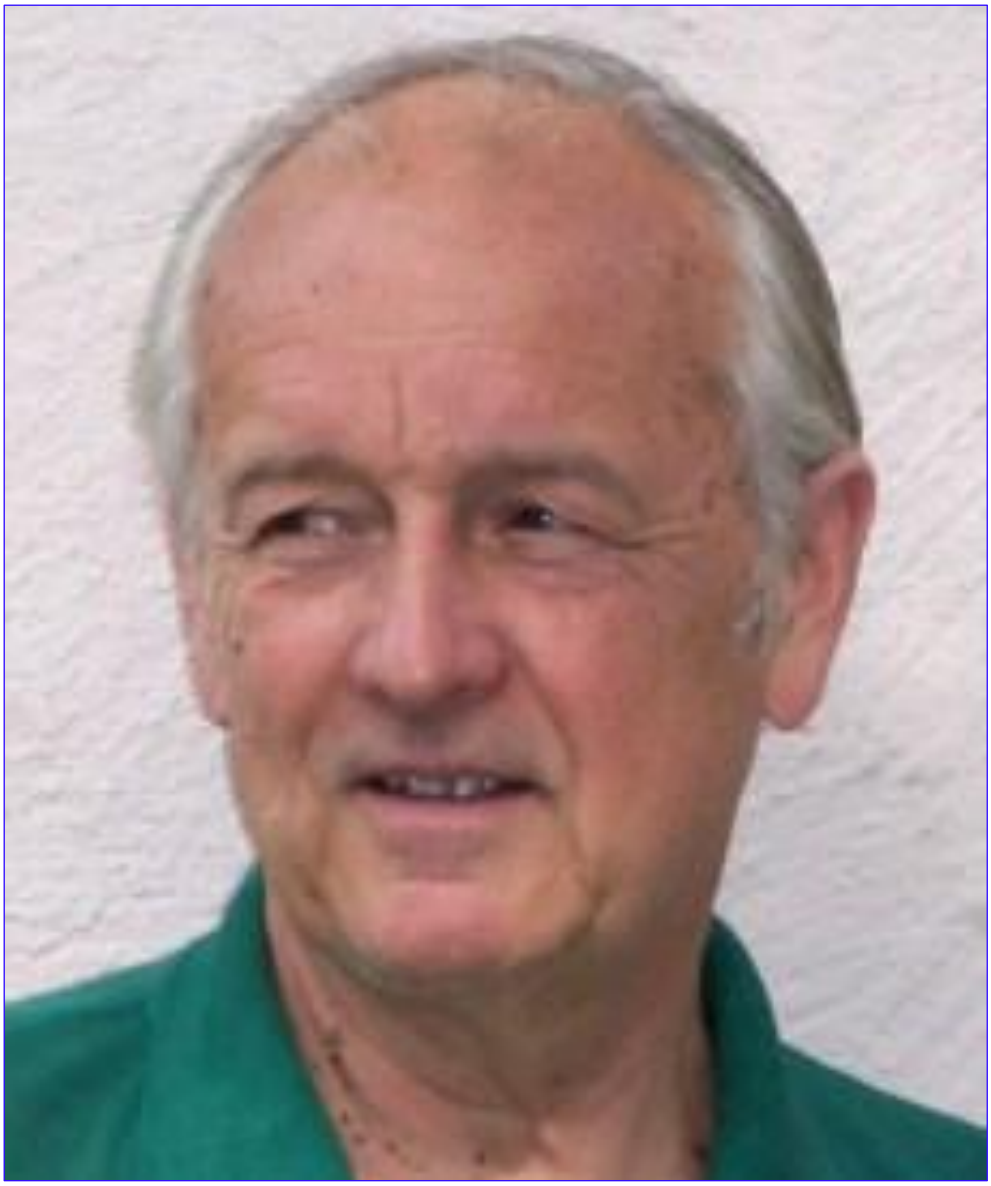
The man whose silent days
In harmless joys are spent:
Whom hopes cannot delude,
Nor sorrows discontent,

That man needs neyther towers,
Nor armour for defence:
Nor vaults his guilt to shroud
From thunder's violence;

He only can behold
With unaffrighted eyes
The horrors of the deep,
And terrors of the skies.

Thus, scorning all the cares
That fate or fortune brings,
His Book the Heavens he makes,
His wisdom heavenly things.

Good thoughts his surest friends,
His wealth a well-spent age,
The Earth his sober inn,
And quiet pilgrimage.



Nils-Axel Mörner, 1938-2020. May he rest in peace.

Nils–Axel Mörner in Memoriam

Don J. Easterbrook1[A]

Niklas Morner and I were close friends for 55 years. We met in 1965 at an INQUA Congress field trip that I led in North-West Washington, and in 1969 he invited me to join him in the field in southern Sweden to look at Pleistocene glacial and shoreline features that he was working on for his PhD thesis. My wife, Ellen, and I spent several weeks with Niklas and Ulla in 1969 at Torekov in southern Sweden.

Niklas, his wife Ulla and family at Torekov in 1969.

Over a period of 55 years, we traveled many times together in Sweden, America, and various parts of the world, cored peat bogs together in Sweden and Washington, and frequently exchanged visits in Stockholm, Torekov, Bellingham, and various parts of the US.

One of my favorite photos, on the next page, is Niklas pointing to a notch cut in rock along the shores of the Baltic Sea in southern Sweden. A written document states that this notch was cut one meter above sea level in 1704.

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Niklas finding the sea level in 1704.

Present sea level may be seen in the background of the photo, several meters lower. Niklas used this and other field evidence to accurately document the rate of isostatic uplift in Sweden.

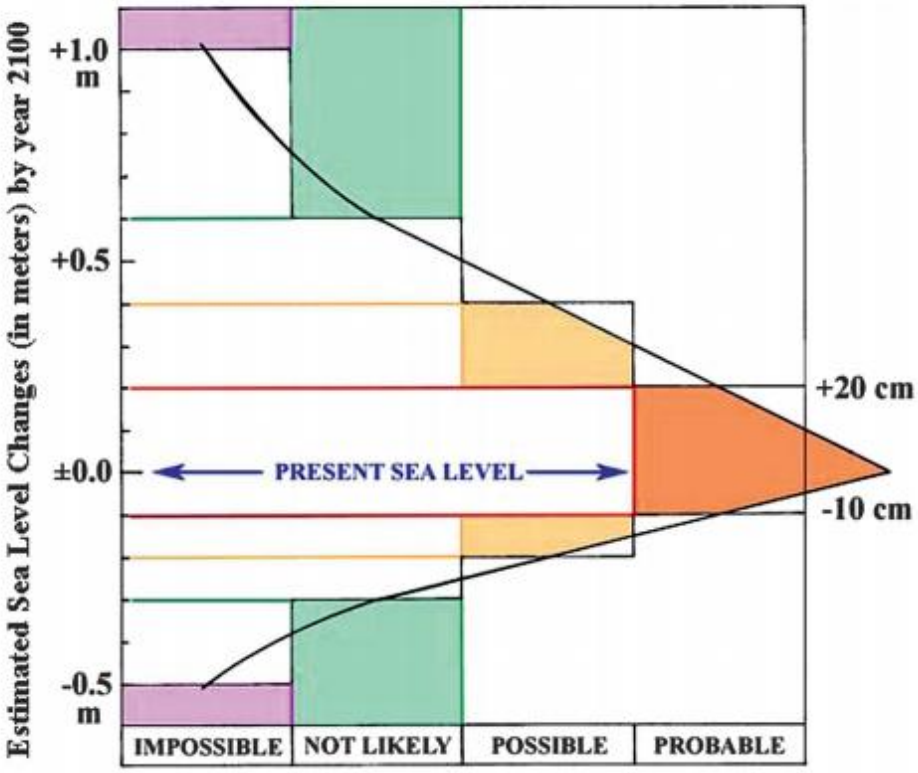
Niklas was a brilliant scientist, undoubtedly the number one sea level expert in the world. He was a strong advocate of the scientific method and use of direct field evidence to confirm conclusions. He rejected IPCC claims of enormous sea level rise, purportedly due to catastrophic global warming from CO_2, based on model studies and unsupported by field and laboratory data. This, of course, placed him in direct conflict with climate alarmists who claimed that various low–lying coral / volcanic islands in the Pacific and Indian Oceans were about to be drowned by rising sea levels.

One of the main examples used was the Maldive Islands in the Indian Ocean, where the president demanded millions of dollars to move the entire population off the islands before they disappeared beneath the sea. In his inimitable fashion, Niklas decided to go to the Maldives and see for himself what has going on there. What he found was clear evidence of a significant, rapid *drop* in sea level since the 1970s and no recent submergence as shown by the survival of a ~50–year–old live tree growing at sea level (below). As Niklas pointed out, 'a tree cannot lie!' It would surely have drowned if sea level had risen.

Niklas went on to examine other 'poster sites' of claimed sea level drowning in Tuvalu, Kiribati and Fiji in the Pacific Ocean and Bangladesh and Goa in the Indian Ocean. In each case, his rigorous field work proved that none of these shorelines were drowning.

Among the most important of the 700 papers published by Niklas was his paper describing possible limits for sea level rise. He showed in the diagram on the next page that some predicted sea levels by 2100 were outside reasonable limits and not likely to impossible, whereas -10 to 20 cm was the most probable. Thus, wild claims of 20m and more were simply not possible.

The famous 'trees don't lie' tree living at sea level in the Maldives before it was cut down by global warming activists.



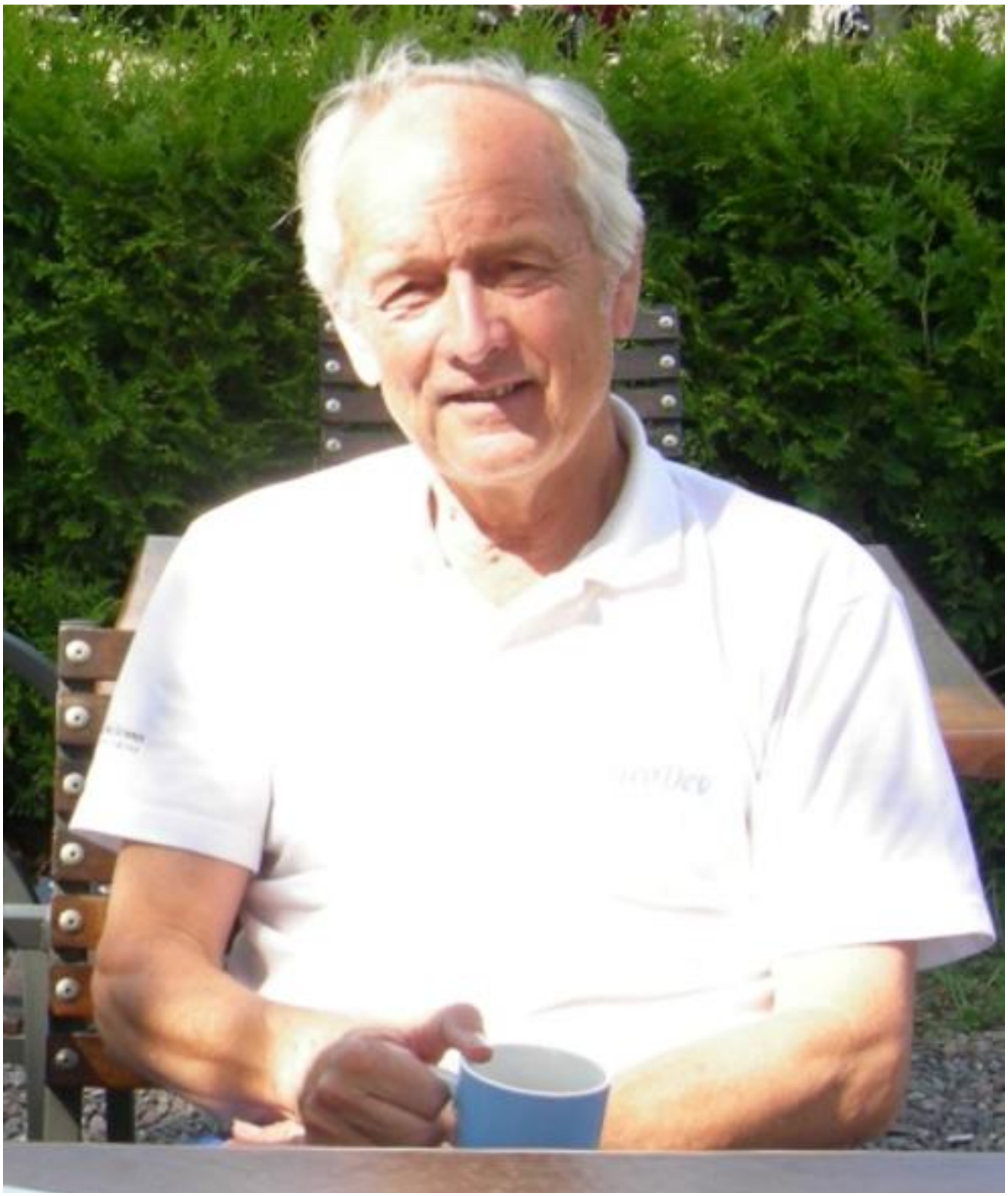
Frames and likelihoods of sea level changes by 2100 showing the most probable values ranging from –10 cm to + 20 cm.

Niklas, Ulla, my wife Ellen and I spent many days together in Sweden and America. Here are some photographs:

Niklas, Ulla, Ellen and Don in Stockholm.

Niklas, Don, Ellen, and Ulla in Stockholm.

Don and Niklas at a Viking site in Denmark.



Niklas at home in Stockholm.

I will greatly miss Niklas as a respected colleague and dear friend, but I shall always retain many wonderful memories of the times we spent together.

Don J. Easterbrook, Dept. of Geology, Western Washington University, Bellingham, WA, USA.

Nils-Axel Mörner in Memoriam

Göran Henriksson[A]

The Earth's rotation and the global sea level

My first contact with Nils-Axel Mörner's scientific research was during my studies of the land uplift and sea level changes in the Baltic Sea during the 1980s. Among his friends he wanted to be called Niklas, and I will use this name in this paper.

Niklas early became one of the leading experts on the evolution of the global sea level and published a great number of important papers in this field. When the global warming became an important topic, one of the predicted consequences was going to be a threatening rise of the global sea level. Niklas had made measurements of the sea levels all over the world and he collected long time series to study their evolution. However, his results disagreed in many respects with the conclusions and predictions reported by the United Nation's IPCC committee.

It was important for IPCC to show that the sea level today was rising significantly faster than according to earlier predictions because that should be the consequence of their model for the global warming. However, Niklas's measurements showed a much smaller rise of the sea level. In fact, he pointed out that the predicted rise of the global sea level today, by IPCC, was impossible because it corresponded to 1/2 of the sea level rise/year during the end of the Ice Age when several km thick ice sheets were rapidly melting, Figures 1 and 2. His conclusion was that the amount of water available today, needed to cause the predicted rise of the global sea level, does not exist.

The sea level is today, according to IPCC, rising at the rate 3 mm/yr (Gornits 2007, quoted in a presentation by Mörner 2010). The average since the Last Glacial Minimum is however, 6 mm/yr.

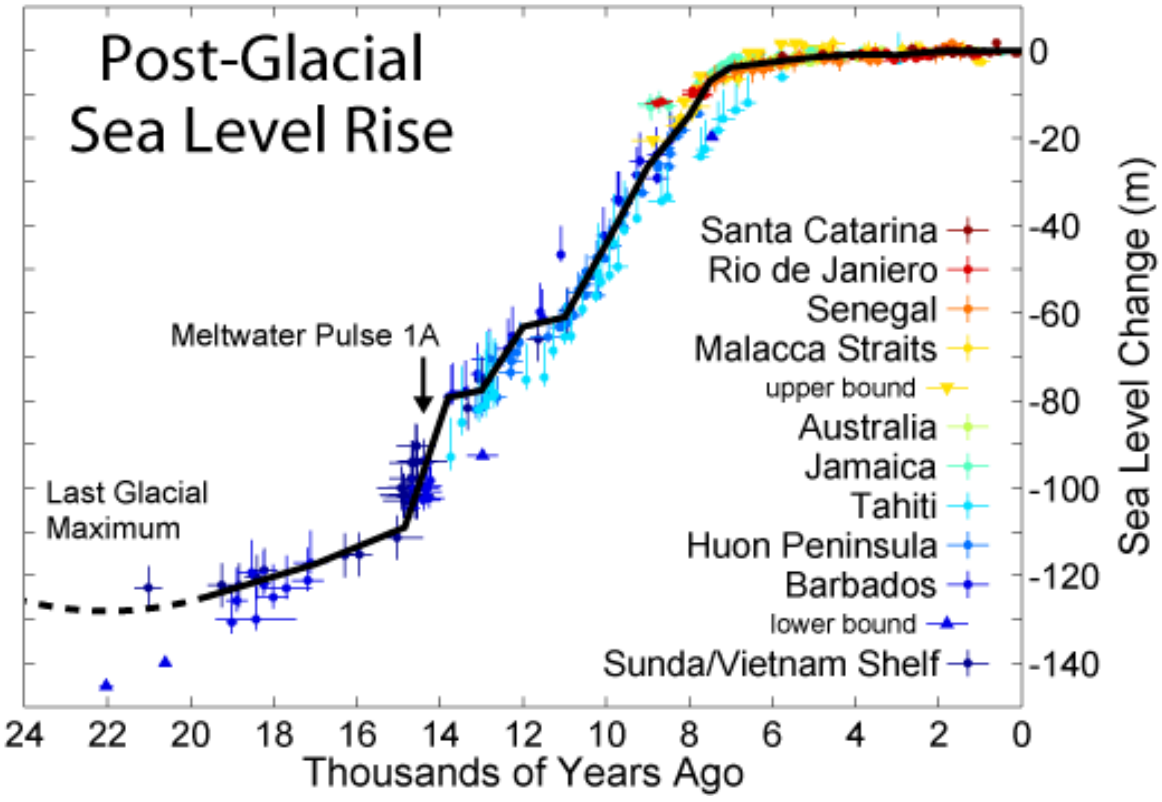


Figure 1. Since the Last Glacial Maximum, about 20,000 years ago, sea level has risen by more than 125 m, averaging 6 mm/yr, as a result of melting of major ice sheets.

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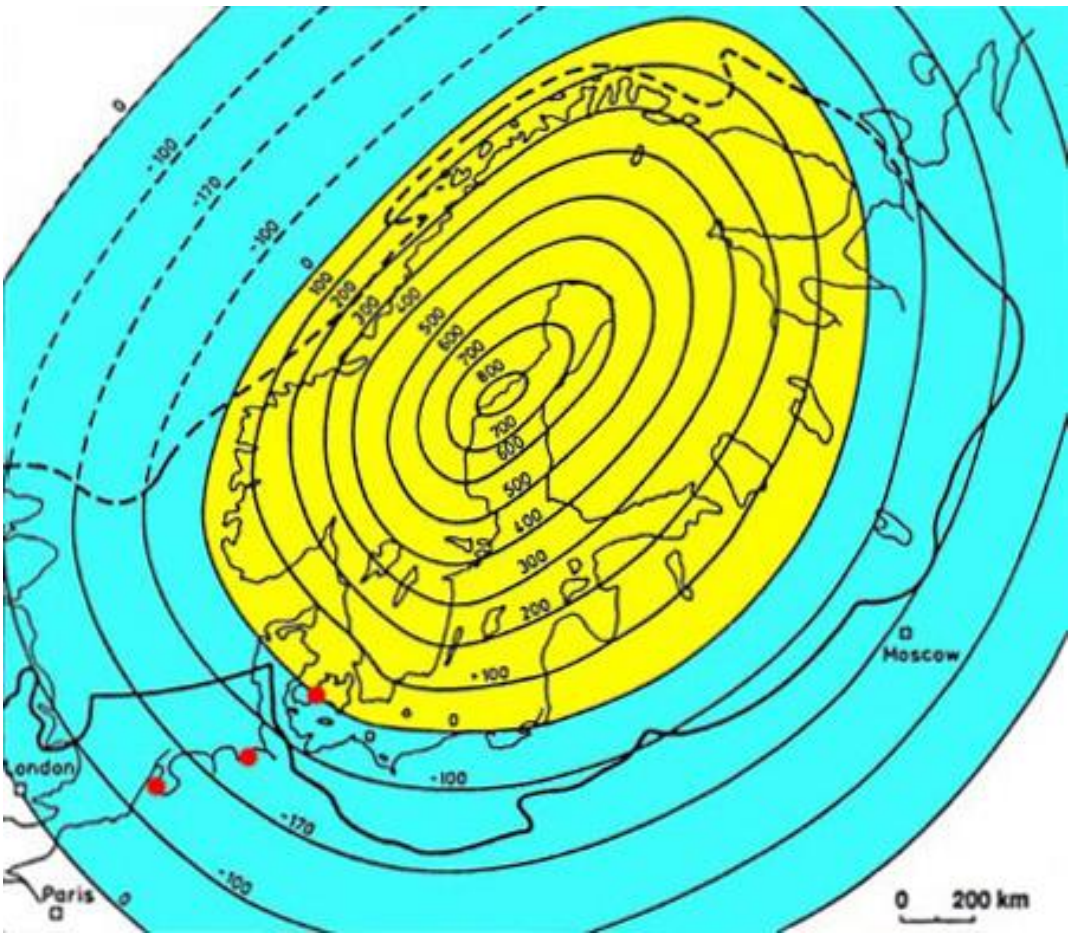

Figure 2. Within the yellow area in the figure we have land up-lift and outside this area the land is sinking. On the border line between these areas the water level is stationary.

A sea level rise of zero is almost the case in the Danish harbour at Korsør where the water level is rising linearly by 0.68 mm/yr, 1895-2005. There exists no effect of the global warming. Korsør is situated at the red right dot on the map (From a presentation by Mörner 2010.)

Niklas realized that a change of the global sea level, caused by climate change, should also change the rotation rate of the Earth. He has written many papers on this topic, for example Mörner (2013).

One consequence of a rising sea level should be a faster slowing down of the Earth's rotation rate than without global warming.

A study of the slowing down of the Earth rotation rate was necessary when I developed my computer program for calculations of ancient solar eclipses. The rotation rate of the Earth determines where a solar eclipse will take place. The angular momentum in the Earth-Moon system must be conserved and the deceleration of the Earth's rotation effects directly the secular acceleration of the longitude of the Moon that determines the time for the eclipse. My conclusion is that the rise in the global sea level, predicted by IPCC, is much greater than my calibrated slowing down of the Earth's rotation rate during the last 6000 years, calculated from 33 ancient total solar eclipses back to 3653 BC, Henriksson (2017).

After reading several of my papers, concerning the slowing down of the Earth's rotation rate, Niklas considered my theory as the best existing today.

During the last ten years, Niklas and I have had many useful discussions about the correlation between the global sea level and the slowing down of the rotation rate of the Earth. I asked Niklas about his opinion concerning my main opponent in this research field, Richard Stephenson and his conclusion that the length of the day had changed dramatically around 1000 AD, caused by a hypo-

thetical significant geological event. Niklas told me that Stephenson at the end of the 1980s visited him at his summerhouse in Scania to discuss this problem. He asked Niklas if he could confirm his hypothesis about a geological significant event around 1000 AD. Stephenson was very disappointed when Niklas told him that there exist no traces at all of such a catastrophic event, Figure 3.

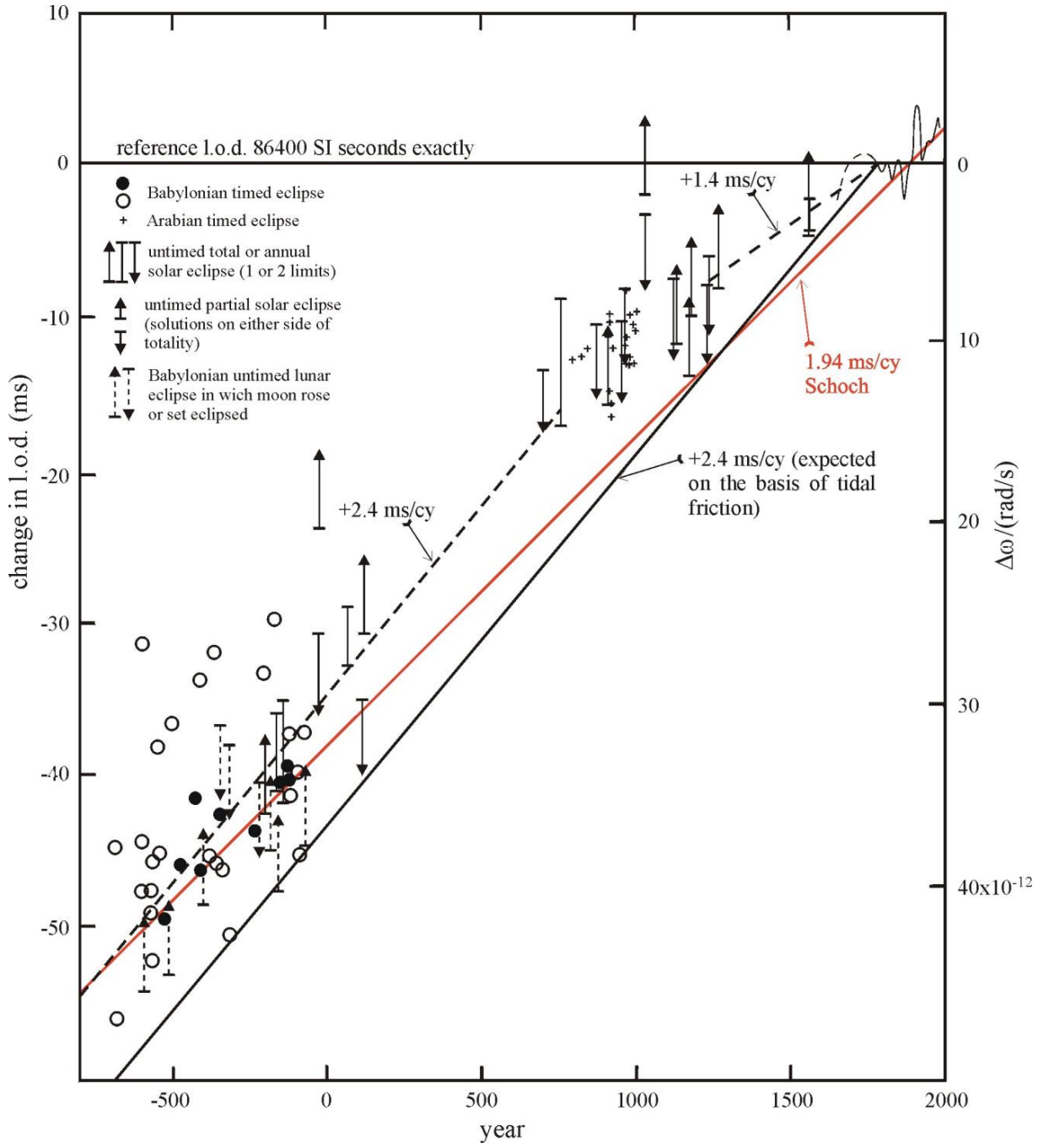

Figure 3. Changes in l.o.d. for the period 700 B.C. to A.D. 1980. The expected rate of change due to tidal braking is shown as a continuous line. The mean observed rates of change are represented by dashed lines (Stephenson and Morrison 1984). The red line and text has been added by the author.

Unfortunately, Stephenson did not abandon his strange model for the evolution of the length of day even if it had no scientific support. His theory is still used in all computer programs for calculation of ancient solar eclipses even though the predictions are very uncertain before 700 BC. Furthermore, I have proved that Stephenson's theory contradicts Einstein's Theory of General Relativity by three-sigma significance, Henriksson (2009, 2010).

Ale's Stones

Another field of common interest has been the 67 m long stone ship, Ale's Stones, at Kåseberga in southern Scania. The main expert on this magnificent monument is Bob G. Lind who has studied the risings and settings of the sun in relation to the stones in the ship setting during the year and has published his results in many papers and books in Swedish listed in the references. Ale's Stones may have played an important role for keeping of a correct solar calendar in ancient times, Figures 4 and 5.

Figur 4. Ale's Stones from the north. It is a 67 m long stone ship, at Kåseberga in the province of Scania, in southern Sweden (Photo by G. Henriksson, 1977).

Figur 5. Ale's Stones from southeast. The ship's axis of symmetry is perfectly oriented towards the rising sun at the winter solstice and the setting sun at the summer solstice. The stem stones are 5 m high and have a weight of about 7 tons and consist of a hard quartsite sand stone. The low stone in the foregroud and a similar stone close to the northwestern stem stone consist of the same material (Photo by G. Henriksson, 1994).

Niklas was mostly interested in the stones themselves and especially the high stem stones at both ends of the ship, situated on its main axis. There exist four stones placed along the main axis and they consist of a certain kind of hard quartzite sandstone. The two stem stones have a weight of about 7 ton. These four stones have been transported from a quarry at Brantevik 20 km north of Ale's Stones, mainly by sea.

Niklas has been able to identify the quarry and exactly determined the place where these stones have been taken, Figure 6. Niklas also found traces after an earthquake that he dated to about 750 BC. The cracks caused by this earthquake made it easier to remove and use the stones in the quarry. Niklas also found the easiest way to transport these heavy stones from the sea level up to their positions on top of the 35 m high Kåseberga ridge. He also identified traces of a wooden construction where the stones were landed. A fireplace at this site has been excavated and was C^{14}-dated to 783 ± 20 BC.

Figure 6. Niklas at the quarry at Brantevik. To the left we can see the place were the quartsite sand stones at Ale's Stones have been taken (Photo by the local news paper Ystad Allehanda).

My main contribution to this investigation was a very exact calculation of the rising of the sun at the winter solstice in 700 BC in relation to the great south-eastern stone as observed from the observation point in the middle of the ship, Figures 5 and 7. Lind and Mörner have published several papers in international scientific journals about Ale's Stones; see the list of their publications in the succeeding article by Bob Lind.

The golden calendar from the Bronze Age

Mörner, Lind and I have written a paper together about "A golden calendar from the Bronze Age", Figure 8. During a visit to the Historical Museum in Stockholm, Niklas realized that there might be an astronomical meaning behind the many concentric circles on a beautiful golden bowl displayed at the Gold Room. When Bob G. Lind studied pictures of the golden bowl he discovered that it could function as a luni-solar calendar (Mörner, Lind and Henriksson 2018). I supported this interpretation and made comparisons with the Swedish rock carvings from the Bronze Age, Henriksson (2005).

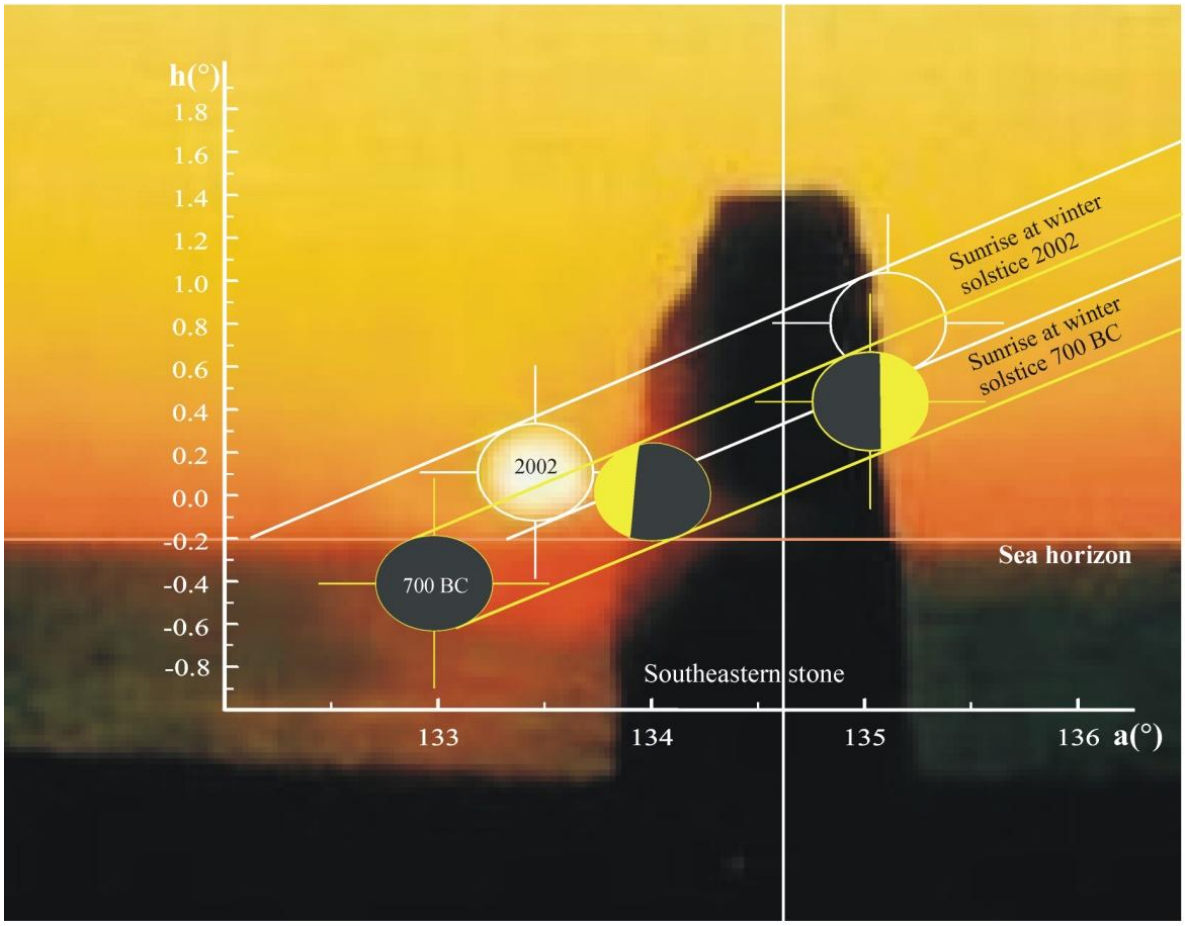

Figure 7. Sunrise at the winter solstice observed from the centre of Ales Stones calculated for 700 BC and 2002 AD (Calculation by G. Henriksson 2019).

Figure 8. Lind's interpretation of the luni-solar calendar on the semi-spherical golden bowl from Mjövik in the province of Blekinge in southeastern Sweden. Here, Swedish words are used for winter and summer solstice and the equinoxes (Photo Statens Historiska Museum in Stockholm).

Public lectures together with Niklas

I have had the privilege to appear together with Niklas at public lectures. He always started the lecture and I finished it. Afterwards, people could ask questions to both of us. Our lectures were very popular and our enthusiasm was transferred to the audience.

I am very thankful to have got the privilege to become a personal friend and colleague to the great scientist: Nils-Axel Mörner (1938-2020).

The death of Nils-Axel Mörner is a great loss to the scientific community (Photo private).

Göran Henriksson, FD in Astronomy at the Department of Astronomy, Uppsala University, Sweden

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Jan-Erik Solheim, Marc Morano and Nils-Axel Mörner at COP22 in Marrakech, 2016.

This is how I remember Nils-Axel Mörner

Bob Lind[A]

Ale's stones

My first contact with Nils-Axel Mörner came like a thunderbolt from the blue sky on 25 July 1998. I was just finishing a show up at Ale's stones regarding the orientation of the stones in relation to the sun, when Niklas suddenly appeared on the left wing of the audience, and immediately began to talk about the way the archaeologists looked at the matter. Then he went straight to me, standing in the middle of the stone formation, and put his right arm over my shoulder and said:

> "This man is absolutely right in what he says! I understand that many of you have come here to listen to Bob, and I myself have stood here in the background and listened and now I support without any doubt his research. My name is Nils-Axel Mörner, and I am an associate professor of geology at Stockholm University, i.e. neither an archaeologist, historian nor an astronomer. I decided last night to go down from Torekov to Kåseberga after I read about his research via the book "*The Sun's Ship and Ale's Stones*". I was already here this morning and made my own calculations of the sun's orientation to the stones and thus I can certify that Bob's research work is completely correct, i. e. just as he has now told us about Ale's stones age and function."

With that exposition, Niklas immediately received standing ovations and a great cheer broke out in the large crowd, which, after Niklas appeared and made his entrance, had become even larger. After my report one year earlier, I had been strongly opposed by the Swedish archaeologists, led by the National Heritage Board, but now Niklas entered my arena and immediately supported my research regarding Ale's stones.

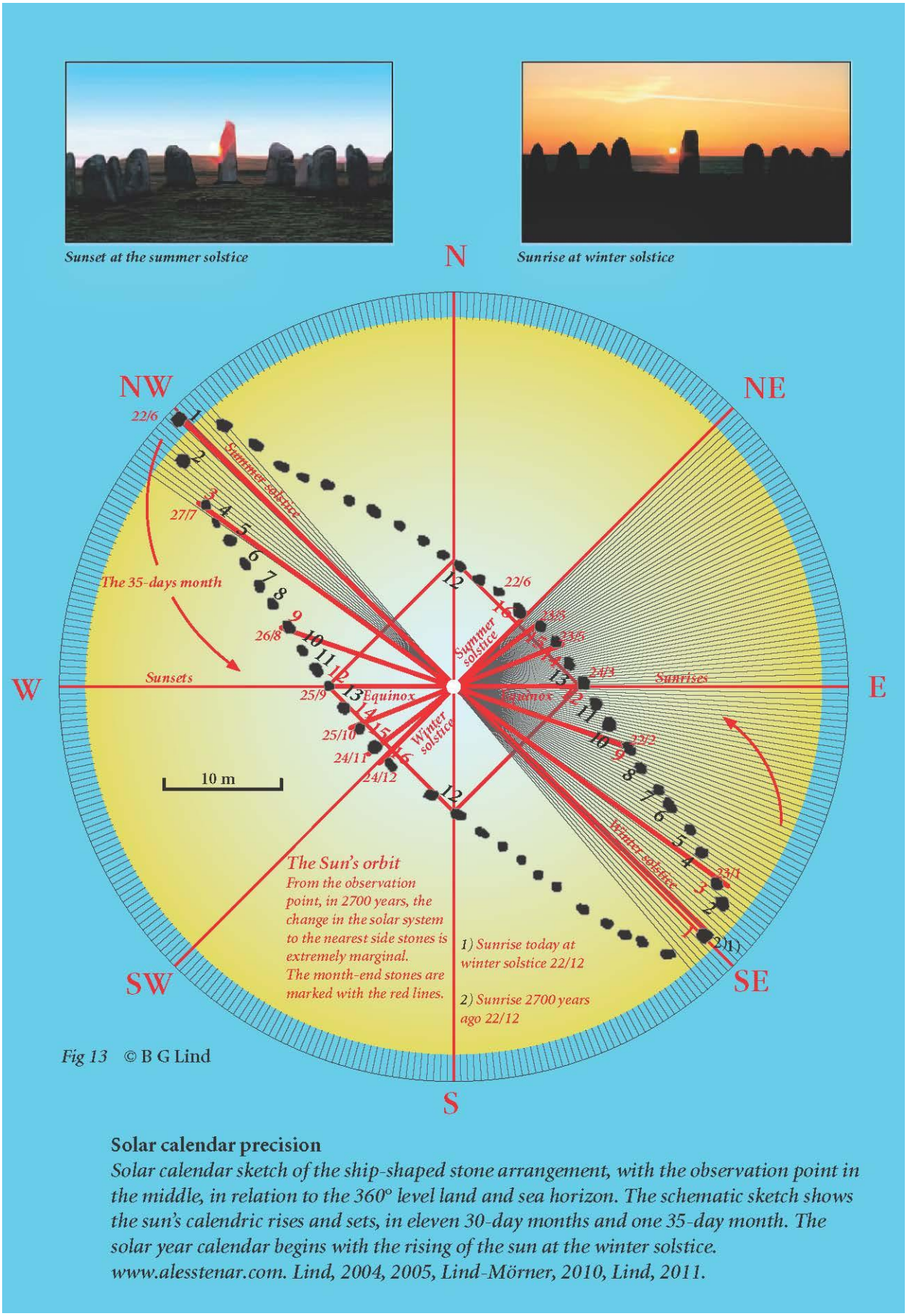
After the lecture, we went together down to the smokehouse in Kåseberga and ate some smoked herring and talked, among other things, about the two mighty quartzite blocks in the stem and stern of which I could inform him that these two blocks had most likely been quarried in Brantevik about 30 km from Kåseberga. After that, it actually took a few years before we actively began our field cooperation, more specifically in the autumn of 2007.

Heimdall's stones

Heimdall's stones, a fantastic stone monument, was embedded in sand when I discovered it in August 2007, a few kilometres north of Kivik. Heimdall's stones is a gigantic stone construction, more than 3 hectares, and with almost 120 boulders under a thick layer of flying sand, which is oriented according to the sun's rising and setting during a calendar year just like Ale's stones. After the discovery of this construction, I called Niklas and we started the investigations together at full speed. We cleared the area and kept secret what we were doing.

At the same time, Niklas took some carbon^{14} samples, which showed that the boulders had probably been erected in 700 - 800 years BC. What we did not know was that a small group of 11 stones already had been registered in the 1930s, as a burial site from the Iron Age. However, our investigation showed that this classification was completely wrong, so we did not care about this forgery by the authorities. We continued working and found, among other things, a stone formation in the form of a phallus symbol and lots of cup marks on several boulders, which clearly showed that it was a Bronze Age monument! Furthermore, we encountered a large engraved omega sign just like the other two in the Kivik's tomb which is situated two kilometres from Heimdal's stones.

[A] Submitted 2021-06-09. Accepted 2021-07-20. Anonymously reviewed. https://doi.org/10.53234/scc202111/218.



Solar calendar precision

Solar calendar sketch of the ship-shaped stone arrangement, with the observation point in the middle, in relation to the 360° level land and sea horizon. The schematic sketch shows the sun's calendric rises and sets, in eleven 30-day months and one 35-day month. The solar year calendar begins with the rising of the sun at the winter solstice. www.alesstenar.com. Lind, 2004, 2005, Lind-Mörner, 2010, Lind, 2011.

Figure 1. Ale's Stones as a Solar Calendar.

Figure 2. Niklas and I clearing at Heimdall's stones 27 March 2008 (Photo Ystads Allehanda).

The area is as at Ale's stones located high above the sea on a plateau near the shore of the Baltic Sea. The beaches below Heimdal's stones have always been called the amber coast because for thousands of years shining amber in different colours and shades has flowed ashore. In this context, it can be mentioned that there are also amber streaks in the ground at the sea-walls above the sea level, i. e. the Baltic Sea, please see Niklas and my book "*Mycenaean and Phoenician traces on Österlen*" which was published in 2010. On the beach below Heimdal's stones, a Phoenician trading pearl was found during the 1930s that the Swedish Crown Prince, later King Gustav VI Adolf, came down from Stockholm to document.

Geophysical surveys

After our discoveries in the spring of 2008, SGU, i. e. the Swedish Geological Survey, scanned the entire area and were then able to establish that there were no graves in the area. This meant that the Swedish National Heritage Board had been completely wrong since the 1930s, regarding the importance of this area, and they are actually even wrong concerning Ale's stones. The entire inner circle of Heimdal's stones is oriented according to the sun's risings and settings at the winter and summer solstices as well as the spring and autumn equinoxes.

In the spring of 2009, Niklas went to Greece and was able to establish that the amber from the Mycenaean royal tombs is identical to the kind of amber that is washed ashore on the beach below Heimdal's stones. This is very important information to take note of for future researchers because

the Swedish National Heritage Board has completely ignored what Niklas and I have reported, not least when it comes to our scientific articles.

The old beach below Ale's stones

In the summer of 2009, Niklas and I found at the old Bronze Age beach, just west of the current harbour basin in Kåseberga, a huge fireplace, about 30 meters, which Professor Göran Possnert at the Ångström Laboratory in Uppsala was able to date to 785 ± 20 BC. This is exactly the same date that I and now also astronomer Göran Henriksson have determined regarding the age of Ale's stones.

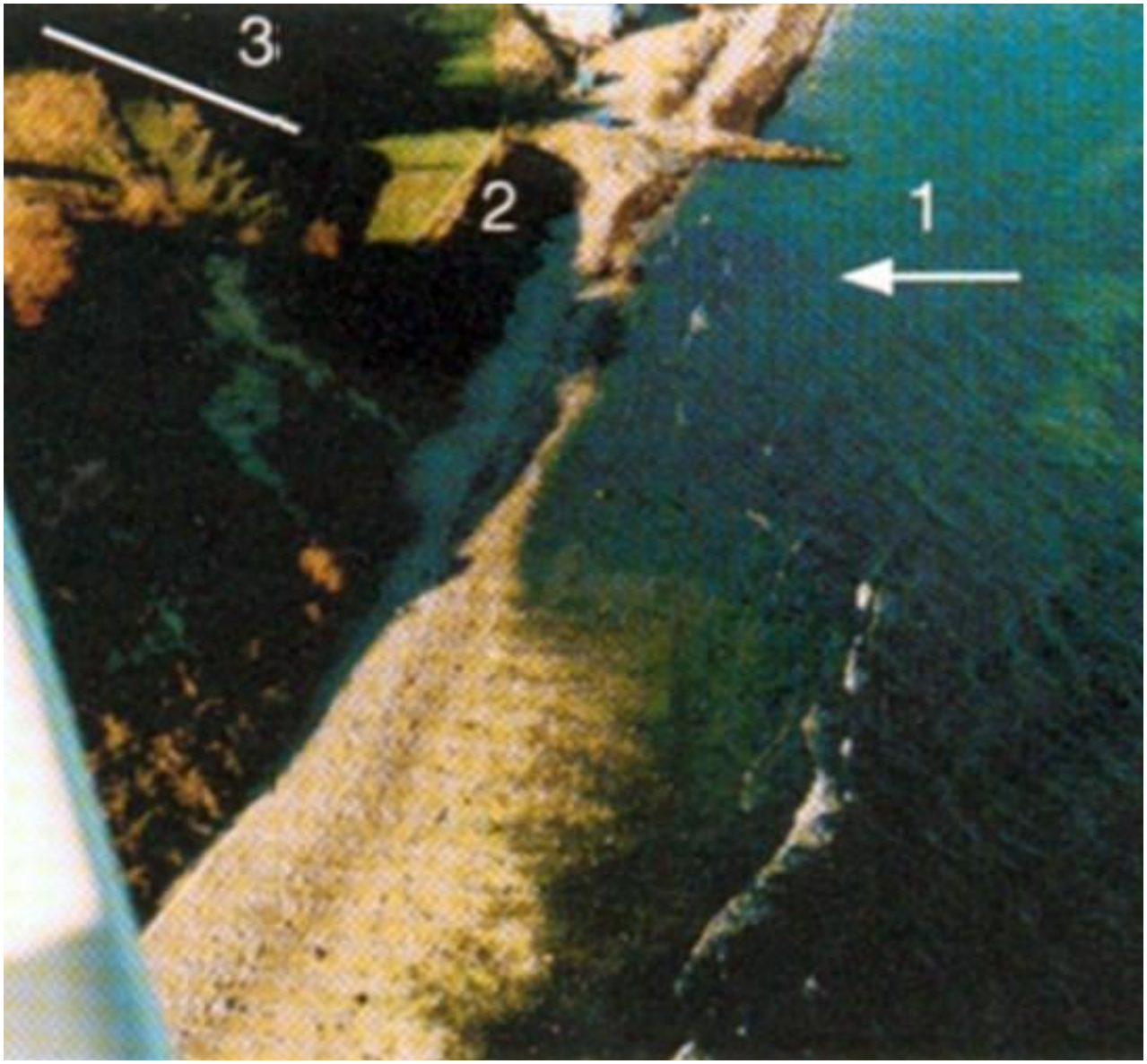


Figure 3. Bronze Age Site at Kåseberga. 1) Harbour, 2) Fireplace 3) Transport way through a ravine (Photo Erik Tenland).

Figure 4. Fireplace at Kåseberga dated to 785 ± 20 BC (Photo Nils-Axel Mörner).

The quarry in Brantevik

Two years later, with my guidance, Nils-Axel Mörner and I found, in a jungle-like forest area in Brantevik about 30 km from Ale's stones, the quarry where the large quartzite blocks to the two fore and aft stones in the ship setting most likely have been quarried, 2700 years ago. Since I was born in Brantevik, I personally knew the place very well.

In my first book about Ale's stones, i.e. "*The Sun's Ship and Ale's Stones*", which was published in 1996, I presented the theory that the large blocks have been transported from Brantevik to Kåseberga. This information later reached Thor Heyerdahl via my book, and the following year I received a postcard from him, which was sent from Tenerife on April 15, 1999, where he wrote:

> "Thank you for the nice book, *The Sun's Ship and Ale's Stones* that I received from Norway a few months ago. Particularly interesting is the orientation of the stones to the sun and the transport route along the coast for the two huge quartzite blocks in the bow and stern, which by all accounts do not seem difficult to reconstruct with the floating route you have shown in the book etc. This project should without major complications to implement with a well-built raft!"

Right! In the spirit of Thor Heyerdahl, this project will now be carried out next summer at midsummer time with a raft of 8x5 meters and with a copy of the approximately 7 ton heavy stem stone. We can only hope that Niklas then will be following this historic rafting from his heaven.

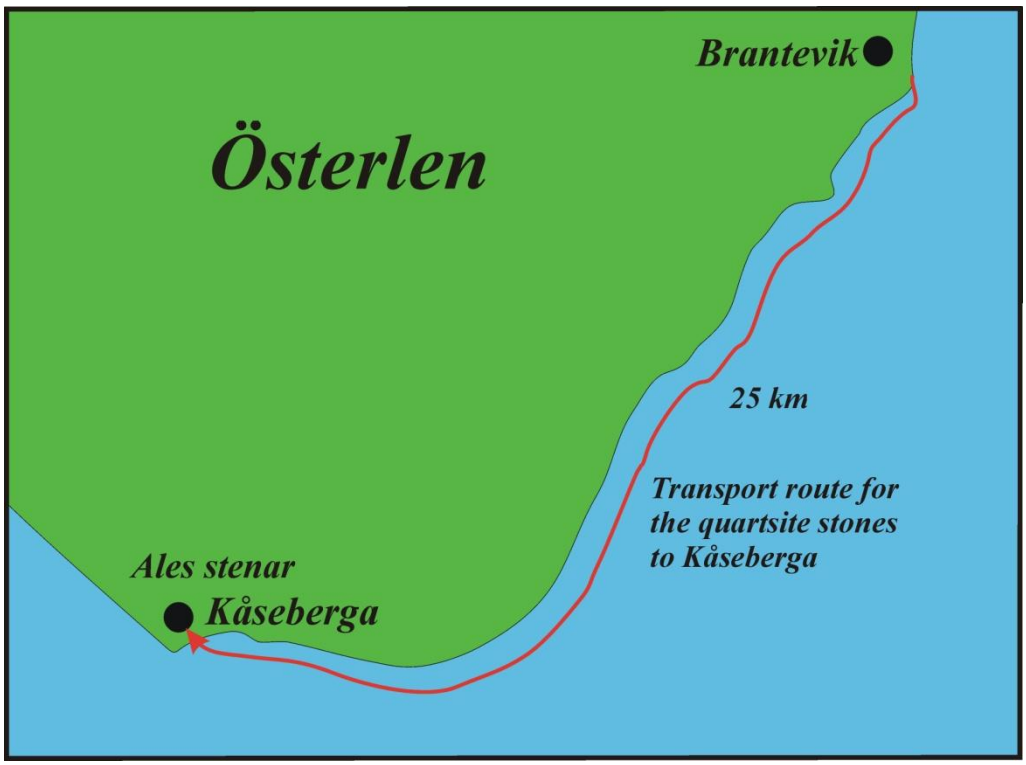


Figure 5. The transport route from the quarry in Brantevik to Kåseberga.

Our scientific articles

Together, Niklas and I have been published in no less than 11 well-known peer reviewed scientific journals, including "Stonehenge Has Got A Younger Sister" and "A Golden Calendar" in which Göran Henriksson is also included. These two latter works are some of the most downloaded articles on the Internet. This is just part of our joint research work, as we have done much more together. Of course, if Niklas had been alive, we would all want to see him on the raft next year. I miss him!

Bob G. Lind, Archaeo-astronomer and author.

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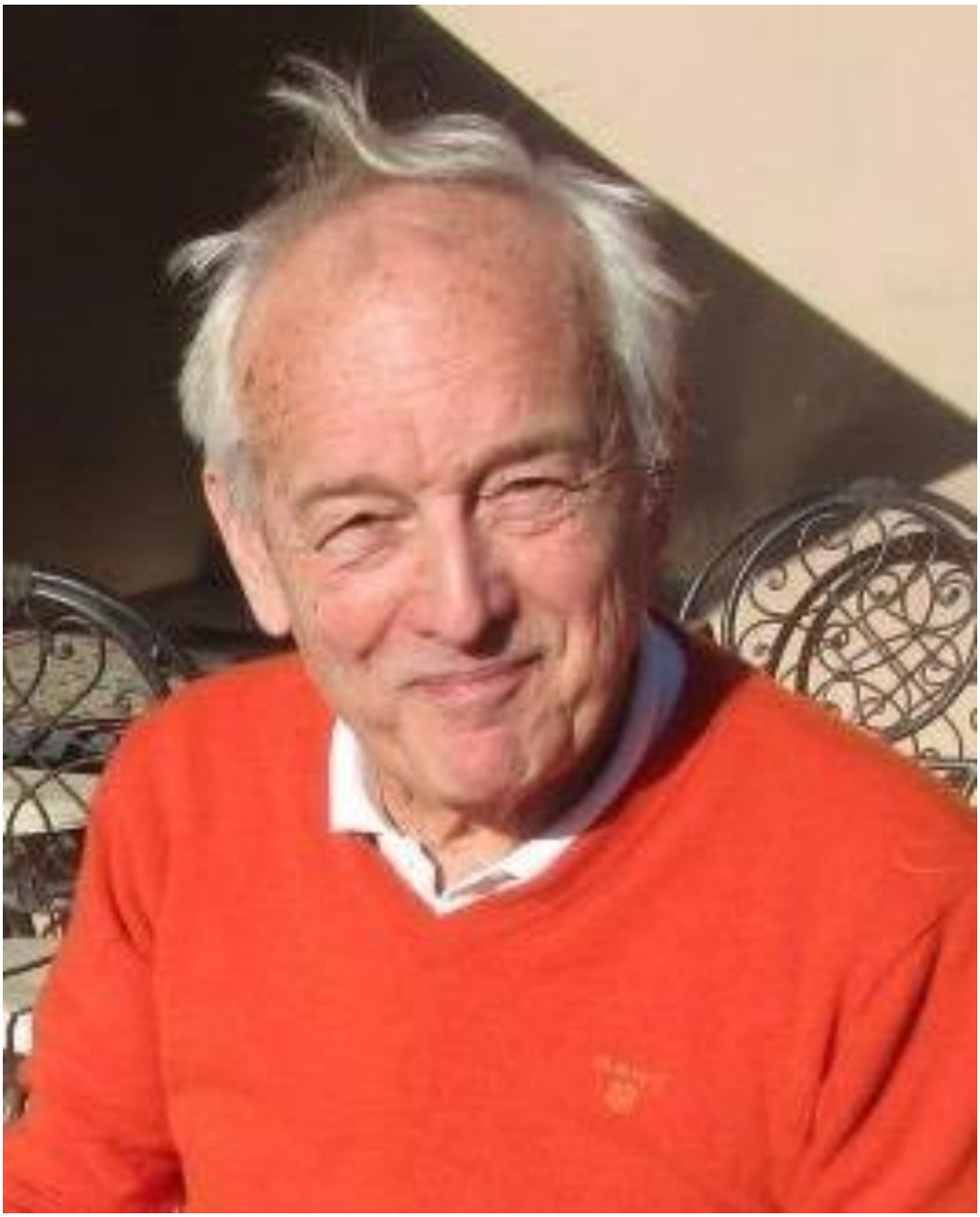
Nils-Axel Mörner in Memoriam

An unexpected loss of an exceptional scientist, climate realist, and good friend

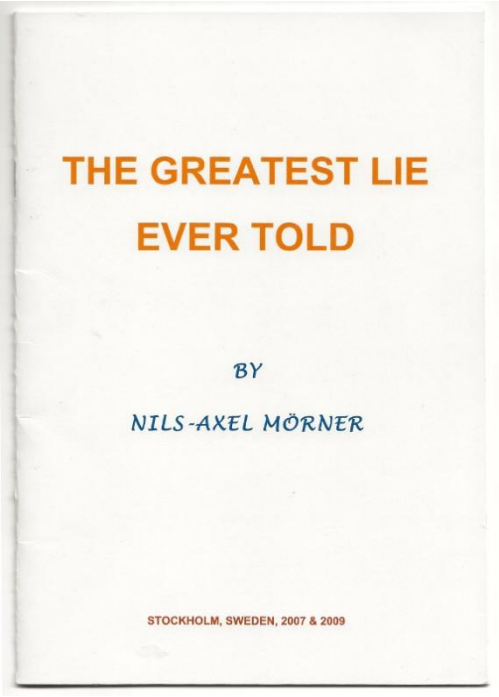
Jan-Erik Solheim, Independent scientist[A] *Apr. 15, 2021*



Nils-Axel Mörner (Niklas) on an excursion in the Atlas Mountains in Maroc in November 2016.

My first meeting with Niklas was when he came to Oslo to give a talk at the University of Oslo organized by the Climate Realists of Norway in 2010. He gave, as usual, a lively talk on sea level changes, and recommended his little booklet "*The Greatest Lie Ever Told".* This booklet explains shore morphology, and that the conception of the main threat of sea level rising now is wrong. I bought several to give to family and friends.

[A] Submitted 2021-03-29. Accepted 2021-05-02. Anonymously reviewed. https://doi.org/10.53234/scc202111/219.



Niklas Mörner's booklet "The Greatest Lie Ever Told".

Niklas advocated the tested methods of science: *observation – interpretation – conclusion*, instead of the new IPCC-type of science: *idea – modelling to prove the scenario – and finally: lobbying to endorse the scenario*. It includes the choice of loyal persons instead of relevant experts.

As an example of model deception, he described the very first celestial model of Aristotle, sustained by Ptolemy and the Christian Church, with the Earth in the center, which fooled the world for 1800 years.

Niklas -- the scientist

Niklas received a Ph. D. in geology in 1969. He then became Associate Professor at Stockholm University, where he then led the Institute for Paleogeophysics and Geodynamics from 1991 until his retirement in 2005. The institute became an international center for topics such as global sea level changes (eustasy), climate and earthquakes in earlier periods (paleo-climate and paleo-seismic). A specialty was the study of how movements in the Earth's outer layer have changed the landscape (neo-technics). He also worked with isostasy, that is how the outer parts of the Earth float on the deeper, heavier layers. He organized two major international conferences; one on "Earth Rheology, Isostasy and Eustacy" in 1977, and one on "Climate Changes on a Yearly to Millennial Basis" in 1983.

In the period 1981-89 he was president for the commission of neo-technics under INQUA (the International Union for Quaternary Research). Later he became the president of the INQUA commission for sea-level and coastal research. He has performed field work in 60 different countries to investigate how the sea level has changed during the past. His conclusion is that the global sea level from now until 2100 will change 5±15 cm. But this research based on observations, was totally ignored by IPCC, and the "*The greatest lie*" was a fact.

He was incredibly effective producing scientific papers. He counted them, and they numbered more than 700 at the time of this death. In the following I will comment on the few years when I was lucky to work with him. It was always a pleasure. He was quick to answer questions and provide new ideas on how to proceed. We had our last scientific discussion only one week before he died. The second and final paper on our analysis of the position of the ice edge in the Barents Sea during 402 years was published in June 2021 [1].

Solar activity and Earth's changing climate

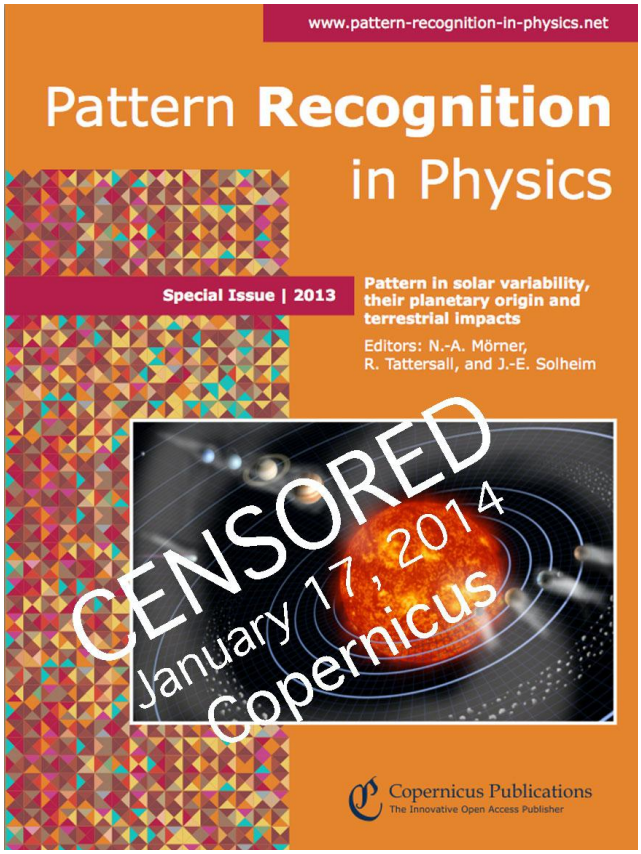
Niklas has contributed several ideas on what governs the Earth's climate. In 1984 he presented a theory for a relation between the Earth's rotation and the relative strength of the two branches of the Gulf Stream [2]. The idea was that a slower rotation leads to a stronger northern branch and a more rapid rotation to a stronger southern branch of the Gulf Stream. In 1996 he presented the hypothesis that the solar wind forces change in the Earth's rotation, ocean currents and heat distribution on the Earth [3]. This was followed up with a prediction that a deep solar minimum this century will lead to a new Little ice age [4]. This was certainly not a popular idea in the IPCC-camp.

A short history as a scientific journal Chief-Editor

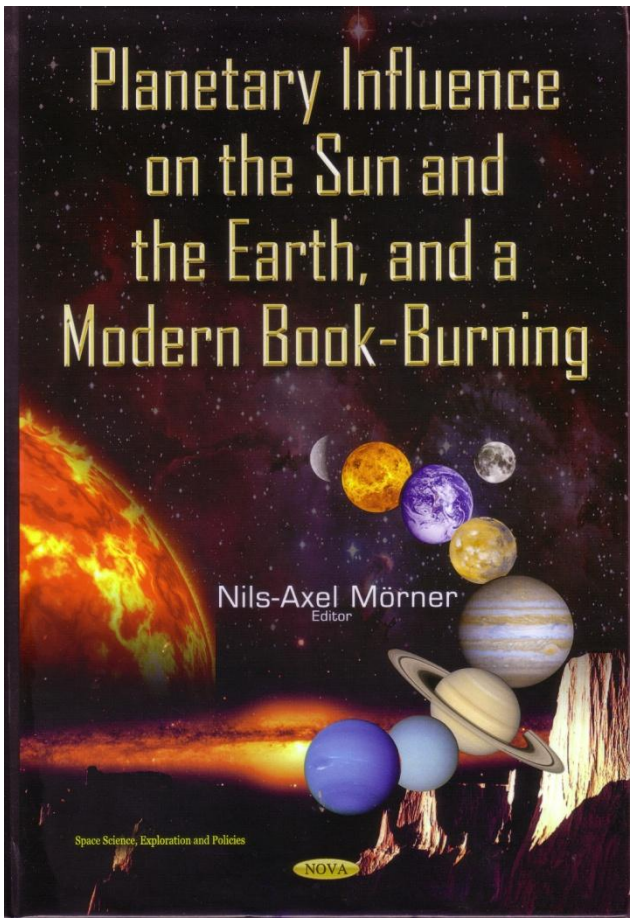
In March 2013 a new scientific journal *Pattern Recognition in Physics (PRP)* was established by the Copernicus Publications. Niklas became one of the two Chief editors. In the summer of 2013, we participated in the 5th Space Climate conference in Oulu, Finland. Possible relations between the solar system planets, the Sun and the Earth's climate were presented at a session during the conference, and Niklas tried to get the participants to publish in PRP. He received some responses, but he then decided that more people could join, and he said: "Let us make a special edition of PRP – before the end of the year."

And so, we did. Roger Tattersall joined us, and we worked like hell the following months and succeeded in having ten papers peer reviewed and printed in the journal by the end of the year [5]. Two more papers were accepted in January 2014. The last paper had just been published when the general manager of Copernicus Publications, Mr. Martin Rasmussen, decided, without warning or discussion, to terminate the journal on January 17, 2014. The special edition with twelve papers was reprinted in 2020 with an epilogue by Niklas:

> *"By this unbelievable decision we were suddenly thrown back in the evolution of humanism and culture to the stage of inquisition and books burning."*



The terminated scientific journal "Pattern Recognition in Physics".



Niklas edited the book Planetary Influence on the Sun and the Earth, and a Modern Book-Burning.

That was the end of Niklas' career as Chief Editor. But he was not one to be silenced. The idea of planetary influence could not be stopped. Another book was produced with Niklas as editor: *Planetary Influence on the Sun and the Earth, and a Modern Book-Burning* [6], with more papers and an excellent conclusion by him:

> *"There is a lot of dirty laundry around the IPCC to take care of. Not until this is done, will a deep nightmare be over. Nonsense is nonsense, albeit packed in golden boxes and promoted by the UN."*

More science and meetings

It was always a pleasure to participate in meetings organized by Niklas or with him as speaker. His large network of scientific friends brought many excellent scientists to the meetings. In his last years I participated in meetings with him in Stockholm, Göteborg, London, Pribam, Prague, Rome, Porto, Oslo and on the ferry between Oslo and Kiel. The meetings in Pribam and Prague concerned the topic of Geoethics, which resulted in founding an *Independent Committee on Geoethics* [7], with a definition of *Aims and Methods*, formulated in words typical of Niklas:

> *"We will speak up and "use the sword of truth" when scientific facts, observational evidence and physical laws are being set aside, and when geoethical principles are violated."*

The geoethical principles:

> *Keep to science – always being ready for new findings and concepts*
> *Always anchor your ideas in observational facts – from nature and firm experiments*
> *Beware of advocacy and lobbying – by or on behalf of special interest groups*
> *Never let your opinion be influenced – by money, promotion, or easy publication*

An advertisement of the Climate Change conference in London in 2016.

The *Independent Committee on Geoethics* took the initiative to organize the London (2016) and Porto (2018) conferences. The meeting in London was to take place at the University College of London, by invitation of a staff member in physics. However, a few days before the meeting were to start, the invitation was withdrawn because of resistance to free speech in climate issues at the University. Niklas however found another venue outside the University and the meeting took place as planned.

In Porto there was also resistance against the meeting at the University, but the Dean of the Faculty stood up and defended the academic freedom, and the meeting was held at the University as planned.

Some relevant quotations for the ethical scientist selected by Niklas:

Virtue is knowledge. What I don't know, I don't pretend I know – Socrates (470-399 BC)

Do to others whatever you would like them to do to you – Jesus Christ (~0–34 AD)

You must read the book written by Mother Nature – Leonardo da Vinci (1452-1519)

False facts are highly injurious to the progress of science – Charles Darwin (1809-1882)

Challenging the UN

One particularly interesting event was our visit to the UN COP22 climate conference in Marrakech in November 2016. We gave talks on *"No dangerous sea level rise"* and "*No effect on climate from* CO_2" at the side-event venue. Our participation was organized by Dr. Albrect Glatzle, Sustainable Agrarian Technologies, Paraguay, standing to the right in the photograph on the following page. It is sad to have to write that among the 20 000 who participated in the COP event, only a handful listened to our talks. We must confess that the forces misleading us are gigantic. But we shall fight them "*With the Sword of Truth*", Niklas declared.

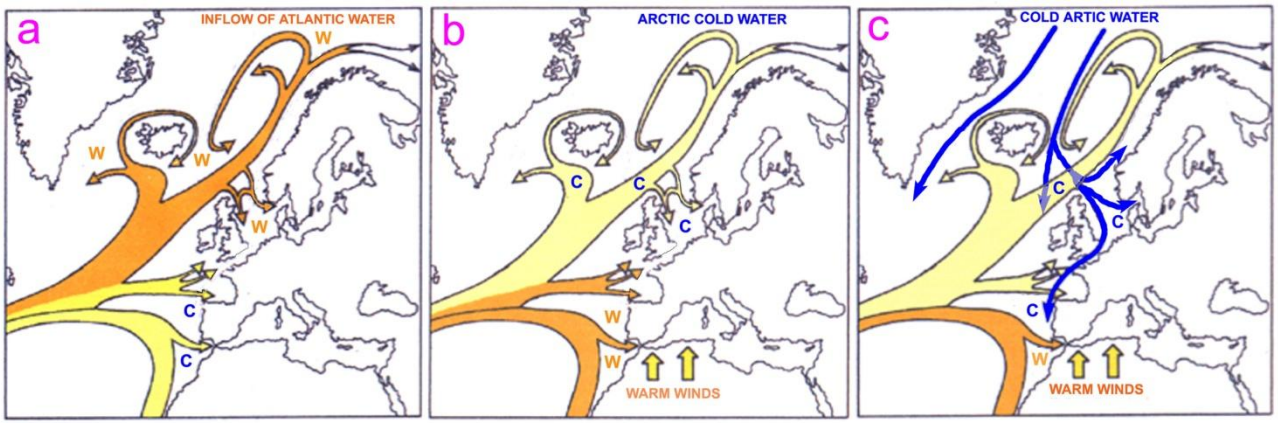
Mörner, Solheim and Glatzle after talks at the
COP22 UN climate conference, Marrakesh, Nov. 2016.

The last - even shorter, Chief Editor period

When the Climate Realists in Norway established a Scientific Council in 2015, Niklas was one of the first to be invited as a member. He contributed with two chapters on sea level rise in our book "*Nature forces the climate*" (in Norwegian). When the idea of a Climate Change Journal was launched, Niklas was the first to be asked to be its Chief Editor in June 2020. We told him that the formal decision on starting a journal would be taken by the Council of the Climate Realists in September. He answered enthusiastically that he would accept the position and lay aside all other scientific work to spend his time on the journal. Nor did he or we know that the time was even more limited than in his first Chief Editor period.

However, the meeting in September was held without Niklas present, due to Covid19 travel restrictions between Sweden and Norway. It was decided to start a journal, and we received a happy response from Niklas, who already had started to plan the three first editions and had contacted many possible contributors. When Niklas was taken away from us already in October 2020, manuscripts for the first editions were in production and we can proudly continue on the foundation made by him. Fortunately, we have an assistant editor, who was able to take over the work.

The course is set. We will continue in the spirit of Niklas!



The beat of the Gulf Stream as a function of the Earth's rate of Rotation [3], [4], [5], [8]. Panel a) corresponds to Earth's deceleration during solar maxima. Panels b) and c) to Earth's acceleration during solar minima, with c) in deep solar minima like the Maunder 1687-1703 and Dalton 1808-1821 and maybe the next deep minimum.

The science continues

In order to verify or falsify Niklas' hyphothesis on a relation between the solar wind, Earth rotation and ocean currents, we realized that a long series of data was needed. In 2016 we started a joint project on analyzing a long series of positions of the August ice edge in the Barents Sea. Data are available back to 1579 and cover both the Maunder and Dalton solar minima. We found many relations that may affect the arctic ice cover. The first paper was published in 2020 [8] and the final in June 2021 [1]. Niklas was actively participating till one week before he died.

What a remarkable person. We will never forget him.

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Niklas and the author in Marrakesh.

BOOK REVIEW

We must discuss the most important issues

By Morten Jødal, Cand Real in biology[A]

Western societies are taking a u-turn. We are abandoning the basis of modern civilization, and what created the industrial revolution: cheap fossil fuels. We are running to become zero emitters of carbon dioxide, in just a few years. And what appears to be most astonishing: It´s said to cost us little.

In his book *False Alarm* (2020), the Danish statistician Bjørn Lomborg tells a new story. He describes the Paris agreement of 2015 as climate change panic that costs us trillions, hurts the poor, and fails to fix the planet. And he is in good company. His think tank Copenhagen Consensus Center works with the best climate economists.

We therefore should be willing to listen when the best scientists tell us that the Paris agreement is the costliest international agreement ever and will do more harm than good. They state that the whole effort is based on false assumptions. Lomborg is a lukewarmer. He agrees that humans effect the climate, and we should tackle it. But he denies that there is a climate crisis. He points out that the exaggerations are endless and describes them. So, we should calm down the rhetoric, and base the politics on best knowledge. We should be willing to discuss the approach to an ever changing and variable nature: how much will it cost, does it help, and does the medicine hurt? This is what *False Alarm* is about.

The western societies are facing the largest economic costs in human history. The yearly expenses of the Paris agreement are heading up to 1 trillion dollars per year in 2030. But that's only a start. Climate panic is likely to end up costing humanity hundreds of trillions of dollars, every single year. And still, that will hardly change the temperature. According to the climate models of IPCC, a fully implemented Paris agreement will reduce the temperature rise by the end of the century by an almost imperceptible 0,028^{o}C. Therefore, the agreement is purely symbolic.

Lomborg therefore argues that we have to prioritize We have to discuss which route to take. We have to discuss a reasonable level of taxation, as well as other precautions. We should avoid climate politics that is based on increasing bids from political parties heading to capture young voters in the next election. We need to take a deep collective breath and understand what climate change is and isn´t.

What should we do?

Economic growth is important. And the magnitude makes a difference. Today the world leaders are poised to pick a lower-growth pathway, "because climate". It condemns our children and grand-children to a worse existence than our own, and ensures that the world´s poorest are trapped in a future with fewer opportunities, less prospects, and less welfare, to the tune of 500 trillion dollars. Per year. That's the difference of a global growth rate of 1,27 and 1,89 percent.

Lomborg argues that we should take several actions to meet global challenges, like climate change. A richer world is important, because it increases both private and public premises to withstand the effects of hurricanes or rising sea level. Rich countries like the Netherlands, where more than half of the country is below sea level, have no problems in tackling the Northern Sea, while poor Haiti suffers immensely after earthquakes. That´s one of the reasons why we have to become richer.

Climate politics has a blank page. Or a nearly hated focus, denied or overlooked by most activists and politicians: *adaption.* They tend to want a pure focus on CO_2 taxation. When reading climate scare stories in newspapers and magazines, we are presented figures on immense climate conse-

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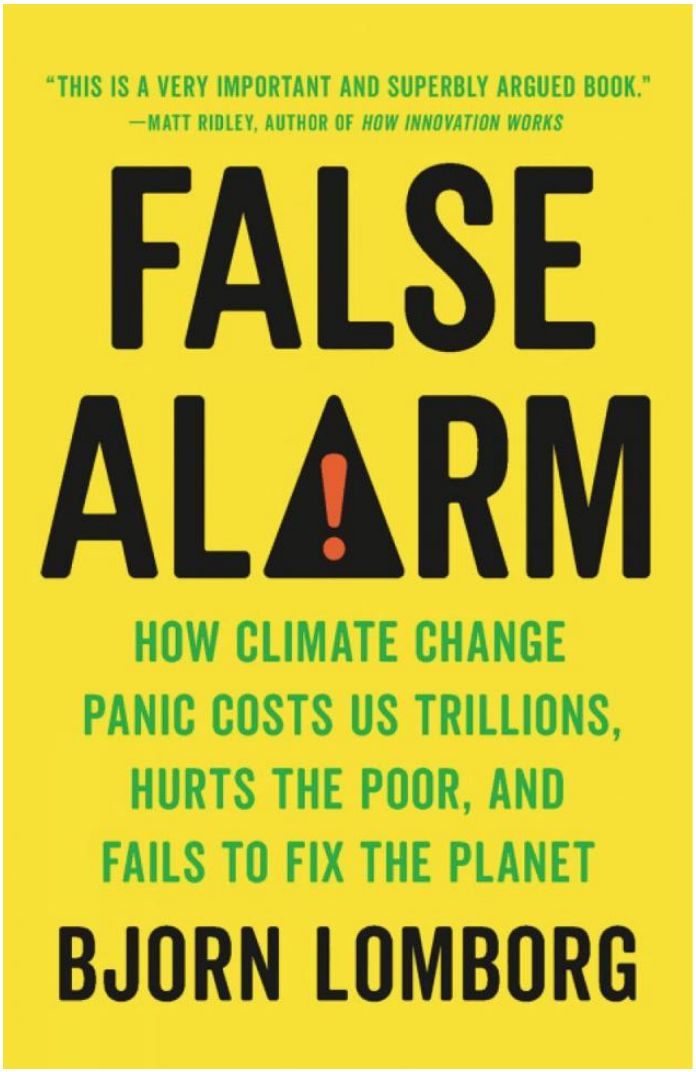
quences and costs. Lomborg gives us an example from Vietnam. In 2019 the *New York Times* presented a story which swept the world, based on a peer reviewed article in *Nature*, on how much of Southern Vietnam would be under high tide by 2050. The maps showed nearly hundred percent. 20 million people, a quarter of the population, would be flooded by then. "Climate change is shrinking the planet – in the scariest possible way" – tweeted Bill McKibbon – the founder of 350.org.



The scare story comes with a deficiency. It avoids to tell the situation of today, which is nearly similar to 2050. This southern part of Vietnam is already beneath high sea level, but is protected by dikes. In other means: the country has adapted. As humans always do, when meeting a changing world. Without doubt, this is the most important way to tackle an ever-changing nature.

The actual research on which the *New York Times* article is based mentions in its introduction that "coastal defenses are not considered". That's unproblematic for an academic paper, but it´s ludicrous for the media to use its findings to produce claims of "20 million people underwater", or for campaigners to suggest that this gives us reason to become "alarmist".

False Alarm argues that we should implement a CO_2-taxation at a reasonable level. The best climate economist suggests 20 dollars/ton – increasing throughout the century. The Norwegian goal of 238 dollar/ton from 2030 is far beyond sound economics and implies that rich countries will spend much more money on a hardly existing problem, than what we could expect to get in return from reduced climate problems.

Lomborg is a technological optimist and believes innovation can participate in solving what he argues to be the coming problems connected to climate change. Among them, he is positive to geoingeneering. I strongly disagree when he argues that "more recently, deniers are not given space (in press), and this is for the better". This is strange, because it hits back at himself.

I do not follow his openmindedness to geoingeneering, and I am strongly critical to the unbalanced public debate, but I am extremely happy for his book. In my opinion it should be read by every policy maker in the western world. It is a good cure against climate alarmism, and a sound basis against the waste of large amounts of green money.

BOOK REVIEW

Hot Talk, Cold Science
Global Warming's Unfinished Debate

Jan-Erik Solheim, Independent Scientist[A]

The book Hot Talk, Cold Science is a «must» for everybody who wants to know the background for today's climate hysteria. In addition, it gives an updated summary of how little we understand about the Earth's climate. It shows how wrong it can get if we use complicated and un-validated climate models to predict climate hundred years from now, while the same models go wrong for a few days weather forecasts.

Twenty-two years have now passed since the first edition of the book *Hot Talk, Cold Science* by S. Fred Singer. The second edition arrived a couple of years later. Singer passed away in April 2020. He had then just finished this third and updated edition with assistance of David R. Legates and Anthony R. Lupo. This edition is published by the Independent Institute in the US in 2021.

Fred Singer was a pioneer in the development of satellite and rocket technology. He constructed the first instruments for measuring ozone from satellites and was the main responsible for the development of weather satellites in the US. He was founder and first director of the science and Environmental Policy Project (SEPP) and founder of the Nongovernmental International Panel on Climate Change (NIPCC) and the main author of most of the NIPCC-reports.

Most people find the climate debate difficult. Alarming predictions of a climate crisis and the doom of the world we know if we don't sacrifice the way of living we are accustomed to, scare people to accept expensive and unnecessary actions to save the planet. What we observe is a small warming trend – almost not measurable, accompanied with an increase in atmospheric CO_2 which is greening the Earth and provides more food for all living.

In the book we are told with supreme clarity what lies behind the creation of a supranational organization: The International Panel of Climate Change (IPCC) and the United Nations Frame-work Convention on Climate Change (UNFCCC) which is an international agreement based on CO_2 as the main driver of climate. When enough countries had signed the convention (now signed by 197 parties), a series of yearly climate Conferences of the Parties (COP) started. The COPs have agreed on protocols and rules for more-or-less-binding agreements on how to reduce CO_2 emissions. As a result, we got the Kyoto-Protocol Disaster, the Copenhagen-Failure, the Paris-Agreement and may expect Something Stronger in Glasgow in November this year.

Singer tells how the scientists in the IPCC second main report (AR2) were sabotaged. They concluded that "None of the studies cited above has shown clear evidence that we can attribute the observed [climate] changes to the specific cause of increases in greenhouse gases" and "No study to date has positively attributed all or part [of the climate change observed to date] to anthropogenic [man-made] causes." This was changed to "the pattern of evidence suggests a discernible human influence on global climate" in the editorial process.

The change came after a letter of instruction from the US Department of State to the head of the IPCC Working Group I, Sir John Houghton, which asked for changes designed to the political agenda of setting up international control of energy. This corruption was reinforced by climate models which predicted a climate sensitivity [by doubling the CO_2 content] of 1.5 to 4.5 °C. In the last report (SR15), "discernible evidence" had grown to anthropogenic emissions as *the only reason for all temperature increase since 1950. This will, for political reasons, be reinforced in the next report (Gilett et al. 2021).*

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In the section *Hot Talk* we can read about A Fake Consensus of Scientists, Corruption of the Peer Review Process, the Missing Hotspot, the Hockey Stick Deception, and the Climategate Scandal. The latter revealed how key IPCC scientists were hiding their raw temperature data and the methodology of their selection of adjustments, conspiring to delete incriminating emails, and undermining the peer review system, making it difficult for skeptical scientists to publish their work in scientific journals.

In part two: *Cold Science,* we learn *What Science Really Says*. This part is updated with the help of Legates and Lupo and is a concise and well written summary of what we know and don't know about climate. Here we learn how the extreme claims by IPCC are modified by IPCC itself – the missing Hot Spot, temperature hiatus, hurricane drought and modest sea level rise.

To challenge the findings of IPCC, Fred Singer convened a group of scientists in 2003 and this became the Nongovernmental International Panel of Climate Change (NIPCC). Hundreds of scientists around the world have participated in production of a series of reports titled *Climate Change Reconsidered.*

Short summaries of the findings of NIPCC are written under the heading *What We Think We Know*: orbital, natural internal and solar variability, water vapor responsible for most of the greenhouse effect and a greener world because or more CO_2, and *What We Know We Don't Know* which is far more than we know. Some examples: No scientific value of a single global temperature estimate, inaccurate and corrupted surface temperature records, un-validated climate models, and many claims of extreme weather events and sea level acceleration which do not happen. A very interesting graph is Figure 18, which shows how the number of stations in the Global Historical Climatology Network (GHCN) declined from 3500 in 1970 to less than 500 in 2000, while the relative number of stations at airports increased from ≈35% to ≈80% during the same period.

Fred Singer is not afraid of challenging the conventional wisdom in chapter 10: *Does CO_2 Lead to Cooling?* He claims that a possible warming by greenhouse gases is negated by water vapor and our planet's temperature remains stable. He explains that "greenhouse gas" means only that CO_2 absorbs some IR-radiation: it does not guarantee climate warming. He shows (Box 6) how the warming/cooling depends on the atmospheric lapse rate: A greenhouse gas produces cooling of the climate if the molecular transitions are in a region of positive lapse rate. This happens in the stratosphere and at the winter poles.

Finally, they explain how little, if any, money is spent of the $2billon yearly environmental research budget to study the benefits of more CO_2 in the atmosphere. The greatest impact of climate change, historically, is that warm periods produce larger harvest and cold periods cause famine. The small warming and more CO_2 have produced a boon for agriculture and a positive effect on human health.

The book also discusses the topics of the ongoing climate debate: Mitigation (Reduce Emissions), Sequestration (Storing CO_2) or Adaption (turning Tragedy into Opportunity). Many good arguments are presented here, as under- or over-conservation, costs and environmental risks, and the normal adaption to climate and weather, which is always better with a strong economy. Singer also presents ideas for what to do if we need to warm the Earth to overcome a Little Ice Age, which may start this century because of diminishing solar activity. He proposes to inject water as mist just above the tropopause, creating ice particles which will temporarily stop IR-radiation in the window 8 to 10 µ and warm the Earth.

Singer, Legates and Lubo conclude that climate change is a complex and difficult subject requiring the insights of many disciplines. It is easy to get lost in technical debates for instance on the radiative properties of carbon dioxide (CO_2), while other more important topics as the water cycle, are overlooked. They recommend focusing the discussion on the following four essential truths:

1. "The warming from 1910 to 1945 was real: it is confirmed by thermometer records as well as proxy data, but it occurred *before* human greenhouse gases could have caused it. The warming from 1978 is

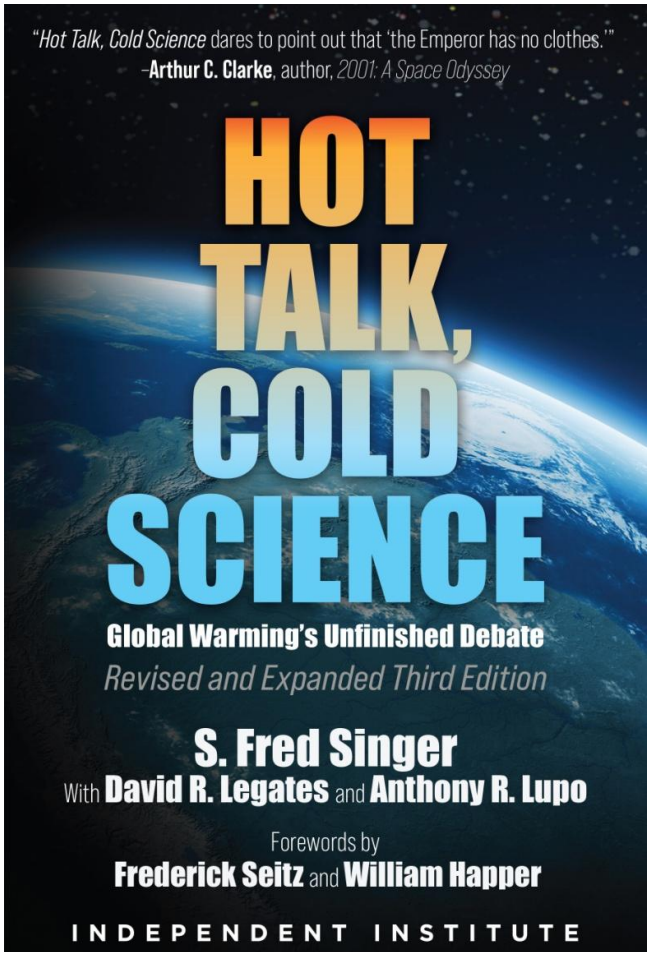
almost entirely fake, an instrumental artifact found only in one heavily manipulated and unreliable database of surface observations.

2. ”Since 2000, there has been little if any warming attributable to GHGs, a pause that is now approaching twenty years (omitting El Niño events). This means none of the extreme weather, floods, hurricanes, etc. that are so often attributed to “global warming” by the popular press and some prominent scientists could have been triggered by our GHG emissions. It is all fake news.
3. ”Climate models fail to accurately replicate global temperatures since 1979 (when accurate satellite data became available); they “run hot”, meaning they forecast more warming than has occurred in the past or will happen in the future. They are therefore unvalidated by observations, making them unsuited for use in policy making.
4. ”The most reliable data on sea level rise show a steady linear rise of 18 cm per century and no acceleration in the past century. The historical record shows the rate of sea level rise did not increase during the warming 1910-45, demonstrating that sea level rise does not depend on air or sea-surface temperatures. Therefore, predictions of increased coastal flooding or “disappearing islands” are not based on science, but instead are intended to to frighten the people into supporting someone’s political agenda.”

If these four findings are true, there is no climate crisis. However, in a final note the authors point to the parallel between Lysenkoism and the current state of politics. It may take a whole generation of scientists to pass away before we can return to a state where climate change can be studied and evaluated in the light of true scientific inquiry and not from a politically correct perspective. We sincerely hope that we are wrong.

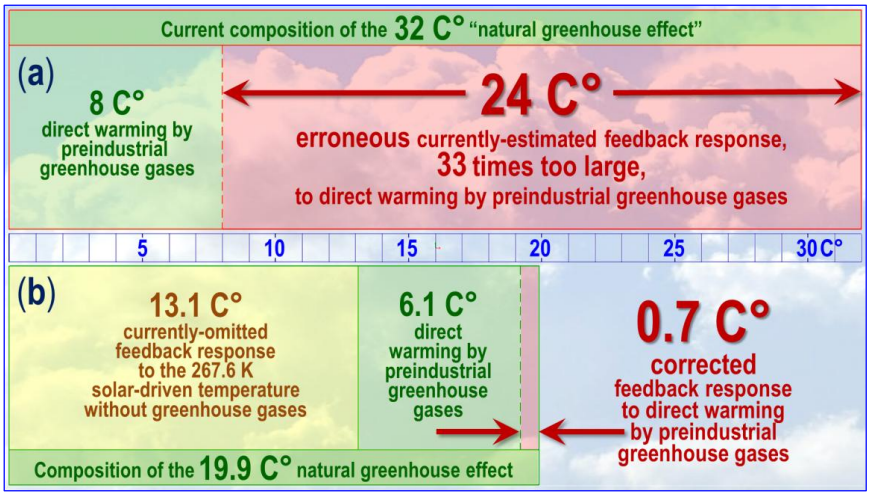
Reference:

Gillett, N. P. + 14 (2021) **Constraining human contributions to observed warming since the pre-industrial period**, Nature Climate Change. https://doi.org/10.1038/s4558-020-00965-9



The grave error of physics that created a climate 'emergency'

Christopher Monckton of Brenchley[A]

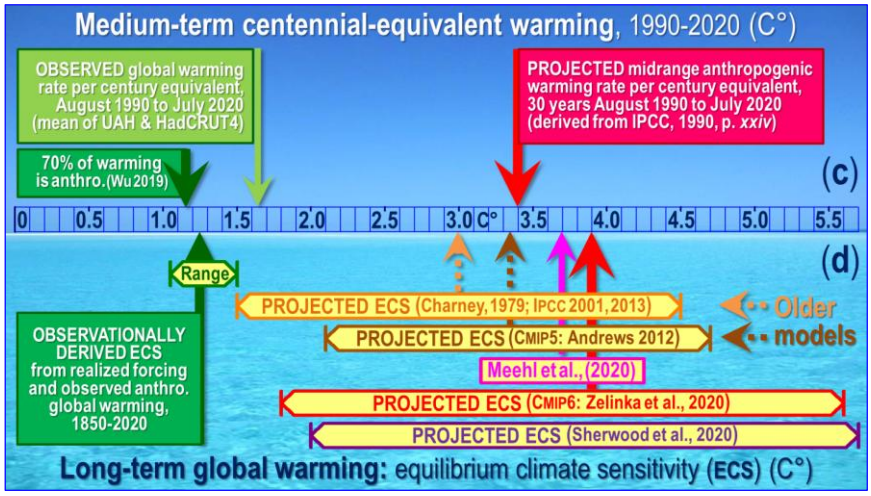


Climate scientists overstated natural feedback response ***33-fold****, turning a gentle warming into a "crisis"*

Climate scientists cried "Emergency!" because they had made an error when borrowing feedback math from engineering physics. They imagined the difference between surface temperatures with and without greenhouse gases in 1850, the natural greenhouse effect, was 32 C°: 8 C° direct warming by preindustrial greenhouse gases and 24 C° natural feedback response (***a*** *above*), mostly from more water vapor in warmer air. Thus, they thought the unit feedback response – the extra warming for every 1 C° of direct warming by greenhouse gases – was 24 ÷ 8, i.e., 3. That is why, given 1 C° direct warming by doubled CO_2 today, they predict as much as **4 C° final warming** or equilibrium climate sensitivity (ECS) (***d*** *below*).

They had also forgotten that without greenhouse gases no clouds reflect the Sun's heat back to space: so surface temperature without greenhouse gases is about 12 C° warmer than they had thought. Thus, the true natural greenhouse effect in 1850 was not 32 C° but just 19.9 C°. Of this, 6.1 C° was direct warming by greenhouse gases, driving a feedback response of only 0.7 C°. Their 24 C° was **33 times too large.** The remaining 13.1 C° was feedback response to the Sun's heat (***b*** *above*). **Climate scientists had forgotten the Sun was shining.** They mistakenly added the large feedback response to the Sun's heat to, and miscounted it as part of, the actually small natural feedback response to direct preindustrial greenhouse-gas warming. That is how they came to predict large, fast, dangerous warming today rather than **small, slow, harmless, net-beneficial warming.**

The true preindustrial unit feedback response was 0.7 ÷ 6.1, or just 0.12. So their imagined unit feedback response of 3 was **25 times too large**, or **15 times** today's unit feedback response of about 0.19. So, given 1.06 C° direct warming by doubled CO_2, there will be 1.06 (1 + 0.19) or **1.25 C° final warming.** That is only a third of their 4 C° final warming, ending their "emergency". Sure enough, real-world, observed manmade warming since 1990 (***c*** *below*) has turned out to be just a third of what they had predicted that year. After correcting their error, **there will be far too little global warming to do net harm.**



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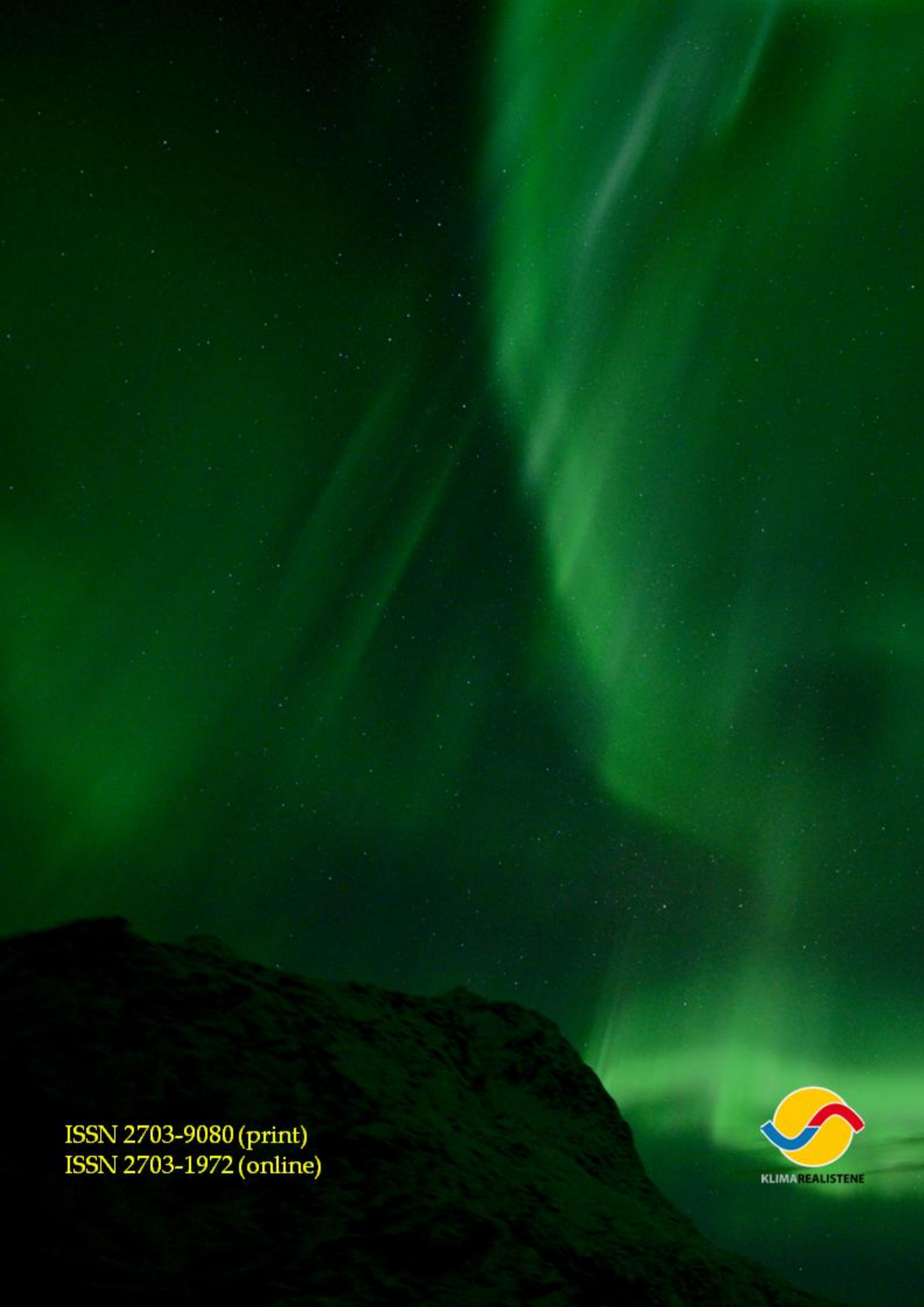

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