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Report

Consensus and Controversy

The Debate on Man-Made Global Warming

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ABSTRACT

This report outlines the main positions and debates surrounding the literally hot topic of man-made global warming. Inspired by social studies of science and technology, the goal of the report is to document, describe and take stock of this potent scientific and public "battlefield" that plays out arguably some of the more pressing issues of our time.

Presenting two broad "ideal type" of positions involved in the science of anthropogenic global warming (AGW), the "consensus" and the "contrarian" perspectives, the report analyses both their cultural premises and places them in relation to the philosophy of science. The report positively concludes that an alleged near unanimous scientific consensus on AGW, that "the science is settled", is overstated. The report finds a robust, critical scientific discourse in climate related research, yet it highlights that a "consensus-building" approach to science might represent a politicised and unscientific belief in science – a belief in tension with the ethos of "normal science".

The report calls for a continuing questioning, critical, and undogmatic public debate over man-made global warming, and for clearer separation between science and policy.

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1 Introduction

The debate about man-made global warming is literally a hot topic. In fact it's a discourse, and an empirical prospect, as some would argue, with quite a deadly intensity. This is a report about that debate. The title of the latest book by one of the central scientists in this field is telling: "The hockey stick and the climate wars" (Mann 2012). This alleged "climate war" is a scientific, political, economic, social and moral public field that is co-constructed and intersects in numerous ways, and which, to some extent at least, is characterized by the rhetoric of apocalypse, war and the communicative logic of the military trenches. Several other popular titles illustrate this: "The Suicidal Planet: How to prevent global climate catastrophe (Hillman 2007); "Storms of My Grandchildren: The Truth About the Coming Climate Catastrophe and Our Last Chance to Save Humanity" (Hansen 2009); "Climate Cover-Up: The Crusade to Deny Global Warming" (Hoggan and Littlemore 2009); "The Climate Crisis" (Archer and Rahmstorf 2010); "Tropic of Chaos: Climate Change and the New Geography of Violence" (Parenti 2011).

The language of fear and constructions of "catastrophe" regarding global warming has been firmly established during the last two decades, and professor of climate change Mike Hulme argues that this language has been embellished in the post 9/11 era (2009: 66). A report by the Institute of Public Policy Research in London commented on a comprehensive study of climate change discourses in the British media from 2006/2007 the following way: "The alarmist repertoire uses an inflated language, with terms such as "catastrophe", "chaos" and "havoc", and its tone is often urgent. It employs a quasi-religious register of doom, death, judgement, heaven and hell" (2007: 55). Likewise, the widely popular "tipping point" metaphor signifies the possible coming of sudden apocalypse.

The goal of this report is to enter this more or less inhospitable battlefield and take stock of the debate about anthropogenic (man-made) global warming. This will be done by both describing and counting the particular actors, activities and technologies (of both enchantment and production) performing on the scenes of this "theatre of war", and also by bringing to the table a more distanced and analytical perspective of the field as such, using as a guiding metaphor the (hopefully) neutral UN-observers' approach to zones of conflict and tension. The zone we are entering here and its particular mix of morality, science, politics, and polemics can certainly be explosive, confusing, and condescending.

There are several reasons for writing such a report. Needless to say, the debate on anthropogenic global warming is of high significance and consequence to people and society. More specifically, because of all that is publicly written and said about the dangers of global warming, one could easily get the impression that the major scientific issues on the subject is settled, and that the debate is, or is being, closed and “black boxed” (Latour 1987). On the other hand, there seems to be vocal and persistent scientists and advocates that on various grounds resist the alleged consensus. These voices sometimes claim that their legitimate dissent is silenced and marginalised in both scientific and public discourse. Thus, an explicit goal of this report has been to give the dissenting or “contrarian” perspectives a serious treatment. Has the science of anthropogenic global warming reached such a level of consensus saturation and cohesion that the debate is, legitimately or not, closed and “black boxed”? To be able to answer this question the contrarian perspectives receives relatively more space in this report. This choice is also justified by the wide attention and institutional support and promotion the consensus perspective(s) have received, not least through the IPCC.

In a 2007 speech before the UN Commission on Sustainable Development, Gro Harlem Brundtland, the UN Secretary General’s Special Envoy on Climate Change (and also former Prime Minister of Norway, and former Director-General of the World Health Organization) conveyed the mixture of politics, polemics, science and morality when she, in relation to global warming, famously stated that: “So what is it that is new today? What is new is that doubt has been eliminated. The report of the Intergovernmental Panel on Climate Change is clear. And so is the Stern report. It is irresponsible, reckless and deeply immoral to question the seriousness of the situation. The time for diagnosis is over. Now it is time to act.”¹

This statement has several significant and problematic aspects that will be discussed in this report. Has doubt been eliminated in the case of anthropogenic (man-made) global warming? Is it possible to eliminate doubt, and are efforts to do so pursuits pertinent to science and democracy in open societies? Is it immoral and reckless to question and doubt? The Brundtland statement displays both explicitly and implicitly key premises upon which the debate on global warming is being played out, and this report seeks to unfold some of the most important of these premises.

As noted above, in the American vernacular the particular geo-political arenas of war is often labelled a “theatre of war”. Even though the subject matter of this report is both deserving of, and demands to be taken highly seriously, the theatre metaphor is in itself also quite appropriate. The

debate on global warming has a theatrical ambience to it on several levels. It abounds with stories of tragedy, untermgang and apocalypse, of crisis, saviours and salvation, and in several of these also (unintended) genres of melodrama and comedy is not difficult to detect. It borrows several of its communicative scripts from classical narratives, often including plots of good and evil, of culprits and heroes, and of nature's ultimate revenge upon the unlimited folly of a humanity of myopic fools and malfeasants.

The theatrical tropes of the debate is also squarely pinpointed by the fact that the play's definitive number one villain and enfant terrible is the agent and actor (or rather "actant" in the vocabulary of actor-network-theory) that goes by the name of CO₂. Carbon dioxide. This gas is quite literally the "smoking gun" (Archer and Rahmstorf 2010: 11) of the play, metaphorically represented as something like the (Lord of The Rings') Sauron in the saga of global warming, and believed to play the major role in causing anthropogenic global warming – with all its possible detrimental consequences. Yet CO₂ is also a major actant in photosynthesis and the life-giving production of oxygen. With CO₂ at the centrepiece of the play, inhabiting this radically double-edged position of being both the gas of life and death, global warming as eschatological tales of humanity's end-times, and its embedded counter narrative of secular (or rather quasi-religious) earthly resurrection and salvation through heroic deeds and technological measures, the drama of global warming attains the level of meaning that myths are made of.

1.1 The four myths of climate change

To further explicate the cultural premises for understanding the debate about global warming, this section outlines the four core narratives, or myths, that arguably frame the discourse on climate change. Such a perspective is essential to be able to grasp the underlying and more subtle reasons for the intensity of the debate, and for understanding fundamental characteristics of the climate change field. Professor Mike Hulme, who has published over hundred peer-reviewed journal papers and more than thirty books or book chapters on climate change topics, and who has also been a contributor to the Intergovernmental Panel on Climate Change (IPCC), outlines the four dominating myths of climate change. He is using the term "myth" in the anthropological sense, not as something "untrue" but as something that reveals meanings and assumed truths among groups of people. He distinguishes between four main myths in which "our thoughts, discourses and feelings about climate change become loaded with deeper sets of assumptions about the world around us –

and the worlds behind us and ahead of us – and our relationship between them. This is one sense in which climate change (lower case – physical transformation) becomes Climate Change (upper case – carrier of ideology)” (2009: 341).

Hulme suggests that the four myths; 1) Lamenting Eden, 2) Presaging Apocalypse, 3) Constructing Babel, 4) Celebrating Jubilee, all are rooted in our human instincts for nostalgia, fear, pride and justice.

The first myth is the image of a lost Eden, and it captures the idea of a loss, and a yearning and lament for restoring the conditions preceding this loss. As such it is characteristic of the melancholy sometimes attached to the condition of modern man and his fall from the “natural state” (Larsen 2009). This notion of climate change as a dramatization of a lost Eden can be traced back to the very origins of Environmentalism. In Richard H. Grove’s ”Green Imperialism” (1995), a meticulous and ground-breaking historical outline of the emergence of environmentalism 1700-1860, he highlights the role of Utopian (as well as physiocratic and medical) thinking in the history of environmentalist ideas, and documents the importance of the tropical, oceanic island ”Eden” as a primary vehicle for the emergence of new conservationist notions of nature.

Through the myth of a lost Eden, the discourse on climate change is powerfully fuelled by a melancholic symbolic yearning for a paradise lost, for a pure and innocent nature, the last domain where (some parts of it) are still untouched and unsullied by human intervention. Through this narrative ”climate is viewed as a symbol of the natural or the wild, a manifestation of Nature that is pure and pristine and (should be) beyond the reach of humans” (Hulme 2011: 342-342). These mythic sentiments, argues Hulme, underpins the deep ecology movement and is distinctive in some forms of eco-theology, and moreover has “seeped more widely into mainstream environmentalism and perhaps lies hidden inside even broader climate change discourses across liberal Western societies” (ibid.: 344).

As noted above, the discourse on global warming has for a long time been deeply embedded in the language of apocalypse, and this forms the core of the second main myth of climate change: Presaging Apocalypse. Literary analysis have traced the discourse of doomsday back to Rachel Carson’s influential book “Silent Spring” from 1962, and through a trajectory involving publications such as “The Population Bomb” (1968) and “Limits to Growth” (1972), it led up to what Killingsworth and Palmer (1996) in 1996 labelled the “new Apocalypse of global warming” (Hulme 2011: 345). Hulme argues that the myth of apocalyptic climate change has become even

more dominant since that time, particularly in Western Europe and North America. The vocabulary of Apocalypse includes concepts such as “species wiped out”, “catastrophic climate change”, “approaching tipping points”, and illustrative is for example the following statement by scientist James Lovelock: “We [humans] are now so abusing the Earth that it may rise and move back to the hot state it was in 55 million years ago and if it does, most of us and our descendants will die” (ibid.). Fuelling the linguistic fires of Apocalypse are also an abundance of visual imagery, comprising for example dramatic pictures and films of the calving of ice from the Greenland Ice Sheet, devastations made by hurricanes, and maps of coastlines submerged under sea level. The complex relationships between the realities portrayed in the images and their causes are blurred and mythologized. The myth of Apocalypse serves arguably two opposite functions. On the one hand it instigates a sense of both fear and urgency to the discourse on climate change, and sparks political efforts and/or slogans to “reduce emissions” and “saving the climate”, yet as Hulme outlines, such language “frequently leads to disempowerment, apathy and scepticism among its audience” (ibid.: 348), and the myth is thus in a sense self-defeating and counterproductive in terms of enabling the behavioural change it is seeking to promote.

The third myth of climate change, “Constructing Babel”, relates to the ambitions and hubris embedded in the belief in climate control. As in the Genesis myth of the tower of Babel that was built to reach into the heavens, the myth of human abilities to control the climate relates meanings of our aspirations to god-like status, excessive self-confidence and a desire to dominate – in this case to dominate nature. The scientific genius John von Neumann envisioned this myth already in 1955: “intervention in atmospheric and climate matters will come in a few decades and will unfold on a scale difficult to imagine at present... what power over our environment, over all Nature, is implied!” (ibid.). This myth, according to Hulme, mobilises ideas about our abilities to engineer climate utopias, to craft the climate of our own desire. This human creation of a “global thermostat”, through various technological measures, to gain control of a climate that supposedly has “run amok”, partly due to the recklessness of humanity’s actions, is according to Hulme a “Procrustean option for delivering climate utopia to the masses. And which masses? Those who speak loudest, those who pay the most, or those who are condescendingly judged to be most in need of a dose of (our) utopian climate?” (ibid.: 351-2). He suggests that this confident belief in the human ability to control Nature is a modernist, techno-managerial ethos dominant among the international diplomacy that are engaged in the debate on climate change. The management of

climate change offers to them arguably the latest big project from which human magisterial control and mastery is demanded. It is not particularly difficult to agree with Hulme that “believing that we can ‘make a name for ourselves’ by mastering and stabilising global climate requires an inordinate degree of faith” (ibid.: 353).

The last of the four main myths of climate change is “Celebrating Jubilee”, and it relates to how the discourse on climate is framed in the language of morality and ethics. The Brundtland example above illustrates this myth succinctly. When people diagnose the responsibility for climate change (to human action) and propose responses it is often infused with moral connotations, and it “echoes the theological language of sin and repentance” (ibid.). Hulme suggests that the human proclivities for justice, freedom and celebration fuels this myth, and has thus labelled it “Jubilee” after the Jewish Torah’s notion that every fifty years, soil, slaves and debtors should be liberated from their oppression. This myth offers climate change a place for social and environmental justice to be mobilized. An entirely new category of justice has been invented as a vehicle for this mobilization, the concept of “climate justice”. Furthermore, this myth in its appeal to justice, serves as a mobilizing mechanism that hinges more on hope and salvation than for example the myth of Apocalypse and our obsession with end-times. Celebrating Jubilee gives meaning by offering humanity “the chance to do the right thing”. The myth calls for action in the sense of seeking to restore and preserve for example the (lost) paradisaical vision prominent in the myth of Eden. In this sense we can also see that the four myths overlap and interact in various ways.

1.2 Scope and definitions

This report is focused on the scientific and public discourse and dissent around the question of anthropogenic global warming. It outlines the main positions in this area and illuminates the key controversies. By way of organizing the report it covers the two main “camps” of the debate, on the one hand the “consensus camp” aligned broadly with the IPCC, and on the other hand the “contrarian camp”, that are in various ways in some form of disagreement with one or more elements of the perceived consensus position(s). Recognizing the overly schematic way of dividing the field in these two camps, an issue that will be discussed later, the consensus camp includes all positions that voice some sort of alarm (from conservative and sober to more radical and apocalyptic) and also those more focused on resolve, that is, finding solutions to the perceived threat from man-made global warming.

In the contrarian camp all types of positions that critiques or challenge the alarm and resolve perspectives are found, from critiques of quite minor elements of the IPCC reports, to the different types of perspectives that does not accept that a) human actions are (to some or a considerable degree) influencing the climate to produce global warming, or that b) this possible influence does not amount to a threat that needs any extra particular resolve or attention. A common position here is that climate change is the normal condition on earth, that climate most likely changes mainly due to natural variations (with possibly some human influence components), that the complex causations are not yet very well understood, and that the effects of climate change must be dealt with by humans appropriately.

It is important to note that perspectives and positions in both camps vary to a considerable extent, and that the choice of organizing the report in the “two camps” logic is a result of the heated public debate that has levelled the field in this dichotomist fashion. The report thus recognizes that at some level of public debate this polarized field certainly is apparent, yet it will challenge and qualify the very same polarization by way of analysing the field in more detail.

The main methods employed in the report are document studies and meta-analysis of scientific and public texts. The empirical material is to a large extent extracts and quotes from these texts. Substantial space is therefore given to present this empirical material.

1.3 Notes on the philosophy of science

Although seeking an open, (self)critical and impartial analysis, this report is, like any other human expression, based on some premises. This report is inspired by social studies of science and technology (STS) and it is necessary to briefly outline the epistemological premises that the analysis in this report is grounded in. That is, from the outset to highlight the report’s main underlying assumptions about the role and status of science in society. The report is based in the sociology of science in the form outlined especially by influential thinkers such as Robert K. Merton and Karl Polanyi. In general, Merton’s (1973) famous norms of science form the report’s epistemological gaze. Merton outlined what he termed the four sets of institutional imperatives that comprise the ethos of modern science. These four were communism, universalism, disinterestedness, and organized scepticism. Already forming the catching “CUDOS” acronym, later philosophers of science have added “originality” to Merton’s list, making the acronym even more fitting.

In later commonly accepted versions based on Merton (e.g. Ziman 2000) the ethos of science entails *Communalism* in the sense that scientific results are publicly shared by the entire scientific community; *Universalism*, in the sense that claims to truth are evaluated in terms of universal and impersonal criteria, independent of terms such as race, class, gender, religion and nationality; *Disinterestedness*, understood in the sense that scientists should act for the common good of science, rather than for personal gain; *Originality* in research contributions; and *Scepticism* (Organized Scepticism) through rigorous, systematic and critical scrutiny of all scientific claims by the scientific community. This last norm is achieved through peer-review and open publication. Merton and followers consider these principles to be both goals and methods of science and that they are binding to scientists.

In a complementary vein Michael Polanyi outlined his views on “the republic of science” (1962), a classic defence of the autonomy of the scientific endeavour. While not discarding the importance of science’s contribution to society, he argued that this could and should only be achieved under scientific self-governance: “... we reject today the interference of political or religious authorities with the pursuit of science [and] we must do this in the name of the established scientific authority which safeguards the pursuit of science”. Following Polanyi, imposing societal goals to the “Society of Explorers” would inhibit its spontaneity and freedom, and as a consequence the quality and results (also societal) of scientific inquiry. This argument highlight a continuing conflict regarding the role of science in society, on the one hand its free and unhampered pursuit of truth and the revealing of the world, and on the other hand society’s arguably legitimate interest in securing some instrumental goals and usefulness from scientific labors. Obviously, this tensional science-policy interface is at the core of some of the controversy related to climate science and the IPCC.

The important and influential contributions of both Merton and Polanyi, not to forget Karl Popper’s well known work on scientific paradigms, and in Norwegian the work by Bjørkum (2009), shows how many of the most important scientific discoveries are made by people with the courage and imagination to think radically different and going against the established scientific truths. However, these works hark back to Immanuel Kant’s masterpiece the *Critique of Pure Reason*, arguably the main philosophical opus of the entire Enlightenment. In Kant’s magisterial book it is arguably not all the philosophical technicalities and intricate argumentation that springs out as its most significant contribution. Rather, as Espen Søybye interestingly points out,² it is arguably the

relatively anonymous footnote from the preface to the first edition in 1781 that comprises the high point of the work. The footnote is definitely worth quoting in its entirety:

”We very often hear complaints of the shallowness of the present age, and of the decay of profound science. But [...] Our age is the age of criticism, to which everything must be subjected. The sacredness of religion, and the authority of legislation, are by many regarded as grounds of exemption from the examination of this tribunal. But, if they on they are exempted, they become the subjects of just suspicion, and cannot lay claim to sincere respect, which reason accords only to that which has stood the test of a free and public examination.”³

The quote stands for itself. What it effectively does is to argue that religion, through its sacredness, and legislation through its power, seeks to escape the critique of pure reason. In trying to do so religion and legislation only raises legitimate suspicion and cannot expect respect in return. Reason respects only that which has stood the test of open and critical examination. Interestingly, Kant here defines reason more or less as the free public discourse, and not so much as an aspect of personality or a skill, rather a phenomena that can be established collectively. As Søybye notes, this little footnote (still) contains a permanent revolutionary power.⁴ And it fundamentally established this form of open, critical reasoning at the heart of the scientific endeavour.

Furthermore, with the Internet revolution Merton’s ideals for the ethos of science, and also the essence of Kant’s critique of pure reason reaches (at least potentially) a fuller maturity. The Internet has radically changed the context of science. With the Internet revolution the “republic of science” has been greatly expanded and become more open. Scientific results are more easily shared and not least are the underlying data behind the scientific results more accessible to others. In principle the scientific peer-review process, or rather the “peer-critique” process, that obviously has not been infallible, has now been opened up to include whoever that wants to engage in a subject of inquiry. Some of the critique of the consensus perspectives in climate science are illustrative examples, as will be discussed in this report in particular with the cases of the “hockey stick” and “climategate”.

Finally, a brief point should be mentioned about the theory of argumentation and the logic of justification. From a purely logical point of view it is much more difficult to rationally argue and “prove” positively the case for this or that, than to argue (negatively) against it. This insight is essential in the theory of argumentation (e.g. Vorobej 2006). Thus, in principle, to assemble the empirical facts and argue positively for AGW is in terms of rational argumentation much more

difficult and challenging than to provide empirical facts and justification that critiques and undermines the AGW theory. Large bodies of empirical and theoretical resources must be assembled and cohere logically to support a positive theory or position, but a simple fact might break it down. Building a position and keeping it, is in principle vastly more difficult than tearing it down. This is one of the reasons why science is built on critique and scientific truth is precarious.

With these premises in mind, and obviously there exists other valid arguments about the ethos and role of science in society, the debate and controversies related to the science and discourse on global warming can more easily be put in context. After presenting the empirical material in the following chapters, the report concludes by assessing climate science in terms of these vital issues in the philosophy of science.

2 Consensus perspectives in science (and the public)

There is a standard canon referred to when talking about the scientific consensus related to anthropogenic global warming (AGW). It comprises mainly the following elements: 1) The Intergovernmental Panel on Climate Change (IPCC), 2) Some core papers publishing surveys among climate change scientists (e.g. Oreskes 2004, 2005; Doran and Kendall Zimmermann 2009; Anderegg et al. 2010), and 3) The endorsement of the AGW position by many scientific institutional bodies, such as the National Academy of Sciences. This chapter outlines and quantifies the “consensus position”, and it ends by qualifying it by providing some of the critique against the studies that has documented the extent of the consensus. One of the most cited expressions of the consensus position is the following:

“The scientific consensus is clearly expressed in the reports of the Inter-governmental Panel on Climate Change (IPCC). Created in 1988 by the World Meteorological Organization and the United Nations Environmental Programme, IPCC’s purpose is to evaluate the state of climate science as a basis for informed policy action, primarily on the basis of peer-reviewed and published scientific literature [reference to www.ipcc.ch/about/about.htm.] In its most recent assessment, IPCC states unequivocally that the consensus of scientific opinion is that Earth’s climate is being affected by human activities: “Human activities ... are modifying the concentration of atmospheric constituents ... that absorb or scatter radiant energy. ... [M]ost of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations” [p. 21 in (4)]” (Oreskes 2004: 1686).

The quotation in Oreskes last sentence was to McCarthy et al. (2001). Oreskes own contribution in this paper was an analysis of 928 abstracts published in refereed scientific journals between 1993 and 2003. All where listed in the ISI database, and the key words used to sample the abstracts where “global climate change”. Their findings were the following: “The 928 papers were divided into six categories: explicit endorsement of the consensus position, evaluation of impacts, mitigation proposals, methods, paleoclimate analysis, and rejection of the consensus position. Of all the papers, 75% fell into the first three categories, either explicitly or implicitly accepting the consensus view; 25% dealt with methods or paleoclimate, taking no position on current anthropogenic climate change. Remarkably, none of the papers disagreed with the consensus position” (ibid.). The authors admitted that the papers evaluating impacts, developing methods, or studying paleoclimatic change

might believe that current climate change is natural, but they did not argue this point in the paper analysed. Oreskes conclusion based on this analysis is that it shows “that scientists publishing in the peer-reviewed literature agree with IPCC, the National Academy of Sciences, and the public statements of their professional societies. Politicians, economists, journalists, and others may have the impression of confusion, disagreement, or discord among climate scientists, but that impression is incorrect” (ibid.) She continues to acknowledge that the scientific consensus might be wrong, and that many details about climate interactions are not well understood, and give voice to the need for more research, but ends her short piece on this note: “Many details about climate interactions are not well understood, and there are ample grounds for continued research to provide a better basis for understanding climate dynamics. The question of what to do about climate change is also still open. But there is a scientific consensus on the reality of anthropogenic climate change. Climate scientists have repeatedly tried to make this clear. It is time for the rest of us to listen” (ibid.)

Other important papers surveying the scientific consensus are Kendall Zimmermann (2008), and Doran and Kendall Zimmermann (2009). These studies have sought to remedy the critique against the attempts at quantifying the scientific consensus on AGW, such as Oreskes study. For example Oreskes approach has been critiqued for overstating the level of consensus acceptance within the examined abstracts (Peiser 2005a, 2005b), and for not capturing the full diversity of scientific opinion (Pielke 2005). The Kendall Zimmermann study’s (2008) objective was to assess the scientific consensus on climate change through an unbiased survey of a large and broad group of Earth scientists. Here are the core excerpts from the study: “An invitation to participate in the survey was sent to 10,257 Earth scientists. The database was built from *Keane and Martinez (2007)*, which lists all geosciences faculty at reporting academic institutions, along with researchers at state geologic surveys associated with local universities, and researchers at U.S. federal research facilities (e.g., U.S. Geological Survey, NASA, and NOAA (U.S. National Oceanic and Atmospheric Administration) facilities; U.S. Department of Energy national laboratories; and so forth)” (Doran and Kendall Zimmerman 2009: 22).

The two primary questions of the study were:

“1. When compared with pre-1800s levels, do you think that mean global temperatures have generally risen, fallen, or remained relatively constant? 2. Do you think human activity is a significant contributing factor in changing mean global temperatures?” (ibid.) With a response rate of 30.7 % (3146 individuals), a typical response rate for web-based surveys, 90% of

respondents were from U.S. institutions, 6% were from Canadian institutions, and the remaining 4% were from institutions in 21 other nations. Furthermore, “more than 90% of participants had Ph.D.s, and 7% had master’s degrees. With survey participants asked to select a single category, the most common areas of expertise reported were geochemistry (15.5%), geophysics (12%), and oceanography (10.5%). General geology, hydrology/hydrogeology, and pale-ontology each accounted for 5–7% of the total respondents. Approximately 5% of the respondents were climate scientists, and 8.5% of the respondents indicated that more than 50% of their peer-reviewed publications in the past 5 years have been on the subject of climate change” (ibid.)

The results from the survey showed that 90% of participants answered “risen” to question 1 and 82% answered yes to question 2. In general, as the level of active research and specialization in climate science increases, so does agreement with the two primary questions. “In our survey, the most specialized and knowledge-able respondents (with regard to climate change) are those who listed climate science as their area of expertise and who also have published more than 50% of their recent peer-reviewed papers on the subject of climate change (79 individuals in total). Of these specialists, 96.2% (76 of 79) answered “risen” to question 1 and 97.4% (75 of 77) answered yes to question 2.” (ibid.). See the figure below, taken from the paper.

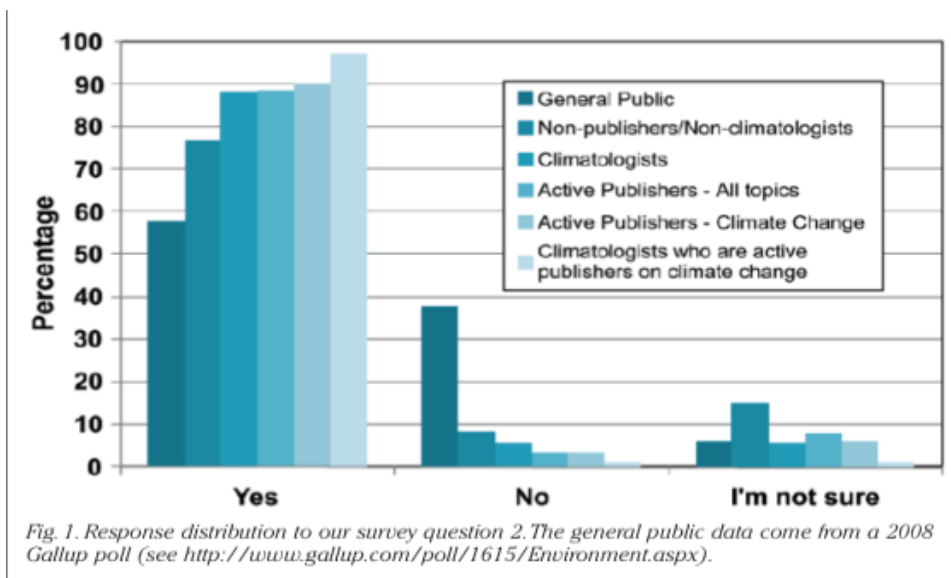


Figure 1. Measuring consensus on AGW among different groups of scientists and the general public (Doran and Kendall Zimmerman 2009).

The study concluded with the following: “It seems that the debate on the authenticity of global warming and the role played by human activity is largely nonexistent among those who understand the nuances and scientific basis of long-term climate processes. The challenge, rather, appears to be how to effectively communicate this fact to policy makers and to a public that continues to mistakenly perceive debate among scientists” (ibid.: 23). This is the study that most of all is responsible for the finding and popular saying that “97 % of active climate scientists” support the AGW position, implying that there is close to 100 percent consensus among the scientists that really understand the subject. The critique against the Doran/Kendall Zimmerman survey is presented below.

Another frequently cited study related to quantifying scientific AGW consensus is the Anderegg et al. study (2010), perhaps the other most important study to produce the “97 % consensus” impression. The abstract of the publication from the study reads the following: “Although preliminary estimates from published literature and expert surveys suggest striking agreement among climate scientists on the tenets of anthropogenic climate change (ACC), the American public expresses substantial doubt about both the anthropogenic cause and the level of scientific agreement underpinning ACC. A broad analysis of the climate scientist community itself, the distribution of credibility of dissenting researchers relative to agreeing researchers, and the level of agreement among top climate experts has not been conducted and would inform future ACC discussions. Here, we use an extensive dataset of 1,372 climate researchers and their publication and citation data to show that (i) 97–98% of the climate researchers most actively publishing in the field support the tenets of ACC outlined by the Intergovernmental Panel on Climate Change, and (ii) the relative climate expertise and scientific prominence of the researchers unconvinced of ACC are substantially below that of the convinced researchers” (Anderegg et al. 2010: 1). Similar to the Doran/Kendall Zimmerman study, the Anderegg study has also received critique, and some of that critique will be discussed below.

Lastly, in 2011 the results of a survey of 489 scientists working in academia, government, and industry was analysed in a published paper (Farnsworth and Lichter 2011). The scientists polled were members of the American Geophysical Union or the American Meteorological Society and listed in the 23rd edition of *American Men and Women of Science*, a biographical reference work on leading American scientists, and of those surveyed, 84% agreed that “human-induced

greenhouse warming” is now occurring. 5% disagreed with the idea that human activity is a significant cause of global warming.⁵

Concerning the scientific bodies if both national and international standing, the consensus on AGW also seems to be strong. Numerous scientific institutions have signed statements supporting AGW, see the “Union of Concerned Scientists” for one comprehensive overview.⁶

Another indicator of consensus on AGW are petitions signed by scientists. 2000 scientists sign petition for reducing emissions. In 2010 more than 2000 scientists and economists signed the letter: “U.S. Scientists and Economists' Call for Swift and Deep Cuts in Greenhouse Gas Emissions”. Organized by the Union of Concerned Scientists, the letter includes the following:

“We call on our nation's leaders to swiftly establish and implement policies to bring about deep reductions in heat-trapping emissions. The strength of the science on climate change compels us to warn the nation about the growing risk of irreversible consequences as global average temperatures continue to increase over pre-industrial levels (i.e., prior to 1860)... As temperatures rise further, the scope and severity of global warming impacts will continue to accelerate.

The 2007 report of the Intergovernmental Panel on Climate Change [2] unequivocally concluded that our climate is warming, stating with at least 90 percent certainty that the warming of the last several decades is primarily due to human activities. Global average temperatures have already risen $\sim 0.7^{\circ}\text{C}$ (1.3°F) over the last 100 years, and impacts are now being observed worldwide... Human-caused emissions to date have locked in further changes including sea-level rise that will intensify coastal flooding, and dramatic reductions in snowpack that will disrupt water supplies in the western United States... If emissions continue unabated, our nation and the world will face more sea level rise, heat waves, droughts, wildfires, snowmelt, flood risk, and public health threats, as well as increased rates of plant and animal species extinctions... A strong U.S. commitment to reduce emissions is essential to drive international climate progress. Voluntary initiatives to date have proven insufficient. **We urge U.S. policy makers to put our nation onto a path today to reduce emissions on the order of 80 percent below 2000 levels by 2050. The first step on this path should be reductions on the order of 15-20 percent below 2000 levels by 2020, which is achievable and consistent with sound economic policy...** There is no time to waste. The most risky thing we can do is nothing.”⁷ (bold in original text)

Signatories of the petition includes according to the Union of Concerned Scientists “eight Nobel Prize winners in science or economics, 32 members of the National Academy of Sciences, 10 members of the National Academy of Engineering, 11 recipients of the MacArthur Fellowship, three National Medal of Science recipients, and more than 100 members of the Intergovernmental Panel on Climate Change, which shared the 2007 Nobel Peace Prize.”⁸

2.1 Consensus repertoires

The consensus positions can be categorized by dividing them according to their various uses of “linguistic repertoires”. A summary of public discourse on climate change in UK society between March and July 2007 on the perceived consensus and outlying “linguistic repertoires” established a categorization of different types of consensus conceptual and linguistic “frames” (Segnit and Ereaut 2007, quoted in Hulme 2011: 231). They comprise two main categories, the first with three sub-categories, the second with four. They are the following:

1. Alarm

- a) Alarm
- b) Sober alarm
- c) Conservative alarm.

2. Resolve

- a) Reluctant belief
- b) Small actions
- c) Techno-optimism
- d) David & Goliath.

Environmental discourses of alarm have been heavily clothed in the rhetoric of doomsday and apocalypse (ibid.) A recent example of the language of apocalyptic catastrophe is the following:

“Interviewed Tuesday for Charlie Rose's PBS show, CNN founder Ted Turner argued that inaction on global warming “will be catastrophic” and those who don't die “will be cannibals.” He also applied moral equivalence in describing Iraqi insurgents as “patriots” who simply “don't like us because we've invaded their country” and so “if the Iraqis were in Washington, D.C., we'd be doing the same thing.” On not taking drastic action to correct global warming: Not doing it will be

catastrophic. We'll be eight degrees hotter in ten, not ten but 30 or 40 years and basically none of the crops will grow. Most of the people will have died and the rest of us will be cannibals.”⁹

A recurrent theme in the consensus repertoires is also a big media focus on previously sceptical scientists that have “converted” to the consensus position. This is one illustrative example. A study made by the Berkeley Earth Surface Temperature (BEST) project showed that land has warmed by 1.5C over the past 250 years, and that “humans are almost entirely the cause”. The study was led by Prof. Richard Muller, a physicist and (former) climate change sceptic. He said he was surprised by the findings:

“We were not expecting this, but as scientists, it is our duty to let the evidence change our minds.” He added that he now considers himself a “converted sceptic” and his views had undergone a “total turnaround” in a short space of time: “Our results show that the average temperature of the Earth's land has risen by 2.5F over the past 250 years, including an increase of 1.5 degrees over the most recent 50 years. Moreover, it appears likely that essentially all of this increase results from the human emission of greenhouse gases,” Muller wrote in an opinion piece for the New York Times. The headline in the printed version of the Guardian report on the study was “The Climate Study to End Them All. The online version used a somewhat more modest title: “Climate change study forces sceptical scientists to change minds.”¹⁰

At the time of the great media attention devoted to the study, the results were still not published in a peer-reviewed journal, but nevertheless widely circulated. Muller’s argument for this practice is on the other hand solid. In a June 2011 interview with Scientific American’s Michael Lemonick in “Science Talk”, Muller said: “I know that it is prior to acceptance, but in the tradition that I grew up in (under Nobel Laureate Luis Alvarez) we always widely distributed “preprints” of papers prior to their publication or even submission. That guaranteed a much wider peer review than we obtained from mere referees.”¹¹

In this particular case, the argumentation is somewhat hollow all the time both Muller and the media present the results as final. And not only final in the scientific sense (as final until rebutted or revised), but as the final end of the whole debate on AGW. There seems to be a large need in the public media for studies that say “now!” we can put a final end to this debate, and that need says something about the state of affair of consensus and dissent on the subject. Also, “conversions” the

other way, as for example in the (partial) case of climatologist Judith Curry, has seemingly not the same appeal in mainstream media.

2.2 Critique of the consensus studies

Some of the critique levelled against the studies that seek to measure the level of consensus on AGW was briefly mentioned above, for example in the case of Oreskes frequently cited study (2004). Peiser (2005a, 2005b) argues that she overstates the level of consensus acceptance within the examined abstracts, and (Pielke 2005) critiques it for not capturing the full diversity of scientific opinion, and Mockton (2007) asks “Consensus? What consensus?”, and concludes that the debate is definitely not over among climate scientists. Commenting on Oreskes’ report that “none of the papers disagreed with the consensus position”, Roy Spencer, formerly a Senior Scientist for Climate Studies at NASA, noted that “[a]side from the fact that I have a stack of such papers in my office, I would wager that neither did any of those 928 articles demonstrate that our current global warming is not due to natural causes” (Spencer 2008: 44).

The Doran and Kendall Zimmerman study sought to overcome some of these problems, yet has received substantial criticism. Some of it is reported in the following. A critique of the paper was published in the Forbes magazine, by professor and commentator Larry Bell, author of the book “Climate of Corruption: Politics and Power Behind the Global Warming Hoax” (2011). Under the title “That Scientific Global Warming Consensus...Not!” among other things it said: “So where did that famous “consensus” claim that “98% of all scientists believe in global warming” come from? It originated from an endlessly reported 2009 American Geophysical Union (AGU) survey consisting of an intentionally brief two-minute, two question online survey sent to 10,257 earth scientists by two researchers at the University of Illinois. Of the about 3.000 who responded, 82% answered “yes” to the second question, which like the first, most people I know would also have agreed with. Then of those, only a small subset, just 77 who had been successful in getting more than half of their papers recently accepted by peer-reviewed climate science journals, were considered in their survey statistic. That “98% all scientists” referred to a laughably puny number of 75 of those 77 who answered “yes”. That anything-but-scientific survey asked two questions. The first: “When compared with pre-1800s levels, do you think that mean global temperatures have generally risen, fallen, or remained relatively constant?” Few would be expected to dispute this...the planet began thawing out of the “Little Ice Age” in the middle 19th century, predating the Industrial Revolution.

(That was the coldest period since the last real Ice Age ended roughly 10,000 years ago.) The second question asked: “Do you think human activity is a significant contributing factor in changing mean global temperatures?” So what constitutes “significant”? Does “changing” include both cooling and warming... and for both “better” and “worse”? And which contributions...does this include land use changes, such as agriculture and deforestation?”¹²

The What’sUpWithThat (WUWT) site posted a graphic to illustrate the data from where the 97-98 % consensus figure among active climate scientists was extracted.

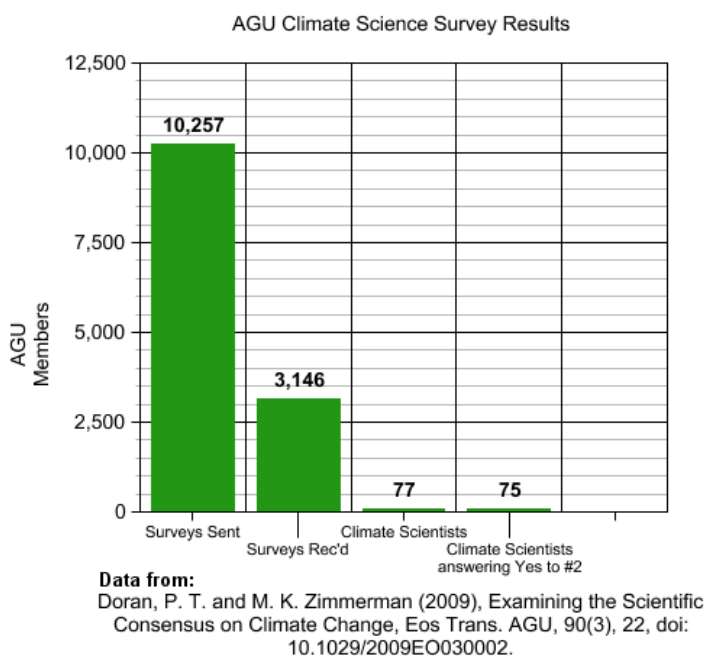


Figure 2. The consensus figure in perspective. Of all the 3,146 respondents, out of the total 10,257 survey sent out, only 77 scientists who responded were considered active climatologists and publishers on climate change, and out of those 75 answered yes to question 2.¹³

Discussing the Anderegg et al. paper for example Eli Kintisch noted that: “But the paper, published today in the Proceedings of the National Academy of Sciences, faces criticism on three fronts: how it divides scientists into one of two groups, whether the scientists have been chosen properly, and whether the peer review process stacks the deck in favor of the consensus view. "This is a completely unconvincing analysis," says climate expert Judith Curry of the Georgia Institute of Technology, who was included in neither group.”¹⁴

Extensive critical comments towards the Anderegg paper has been given by Roger Pielke Sr., among other things that: “This paper is yet another example of the attempt to marginalize and

“bin” scientists who differ from the IPCC perspective (except for those such as Jim Hansen who are more alarmist in their viewpoint)... The Anderegg et al. paper is another in a set of advocacy articles in the Proceedings of the National Academy of Sciences (see and see). This paper illustrates more generally how far we have gone from the appropriate scientific process.”¹⁵

Another critique towards the Anderegg et al. paper was levelled by Bodenstein (2010). A lengthy quote from Bodenstein follows:

“The study by Anderegg et al. (1) employed suspect methodology that treated publication metrics as a surrogate for expertise. Credentialed scientists, having devoted much of their careers to a certain area, with multiple relevant peer-reviewed publications, should be deemed core experts, notwithstanding that others are more or less prolific in print or that their views stand in the minority. In the climate change (CC) controversy, a priori, one expects that the much larger and more “politically correct” side would excel in certain publication metrics. They continue to cite each other's work in an upward spiral of self-affirmation. The authors' treatment of these deficiencies in Materials and Methods was unconvincing in the skewed and politically charged environment of the CC hubbub and where one group is in the vast majority (1). The data hoarding and publication blockade imbroglio was not addressed at all. The authors' framing of expertise was especially problematic. In a casting pregnant with self-fulfillment, the authors defined number of publications as expertise (*italics*). The *italics* were then dropped. Morphing the data of metrics into the conclusion of expertise (not *italicized*) was best supported by explicit argument in the Discussion section rather than by subtle wordplay. The same applied to prominence, although here the authors' construct was more aligned with common usage, and of course, prominence does not connote knowledge and correctness in the same way as expertise.

Scientific merit does not derive from the number, productivity, or prominence of those holding a certain view—truth by majority rule or oligarchical fiat. The history of science is replete with views (e.g., a geocentric universe or the immutability of species) that were widely held, held by the most prominent of men, and wrong. Here, we do not have homogeneous consensus absent a few crackpot dissenters. There is variation among the majority, and a minority, with core competency, who question some underlying premises. It would seem more profitable to critique the scientific evidence than count up scientists, publications, and the like. Policy needs may require action before scientific certainty, but one should not confuse taking a stand with obliteration of the factual and interpretive uncertainties underlying that stand. The

majority of climate scientists favor some form of anthropogenic CC (and that view is not disputed here). That they overshadow the small minority of dissenters in certain publication metrics is to be expected as almost tautological.

In the logical fallacy of an ad hominem argument, the characteristics, qualities, or failings of adversaries rather than the merits of their case are argued. Here, the authors addressed the worth of CC critics (and agnostics) as scientists rather than the validity of their science (1). Regarding purely scientific questions, it may be justified to discount nonexperts. However, here, dissenters included established climate researchers. The article undermined their expert standing and then, extrapolated expertise to the more personal credibility. Using these methods to portray certain researchers as not credible and, by implication, to be ignored is highly questionable. Tarring them as individuals by group metrics is unwarranted.

Publication of this article as an objective scientific study does a true disservice to scientific discourse. Prominent scientific journals must focus on scientific merit without sway from extracurricular forces. They must remain cautious about lending their imprimatur to works that seem more about agenda and less about science, more about promoting a certain dogma and less about using all of the evidence to better our understanding of the natural world” (ibid.).¹⁶

Comprehensive responses by Anderegg et al. to the critiques against their paper, including Bodenstein (2010) and Aarstad (2010), have been published (see bibliography).

In brief summary, the chapter has documented that there seems to be a strong agreement in large parts of the climate science communities on core tenets of AGW, and especially that consensus among scientific institutions is strong, yet that there are several grounds for critique of the basis upon which the idea of a “near unanimous consensus” on AGW has emerged. It is also documented that there is a lively, intense and partially antagonistic scientific and public debate about the status of consensus in the field.

3 Hot debates

This chapter looks more in detail into two of the most publicly controversial cases surrounding the debate on anthropogenic global warming. The two cases, “the hockey stick” and “climategate”, are in several ways related, in terms of both the sources of controversy (largely related to temperature reconstructions) and the central actors involved.

3.1 “The hockey stick”

The saga of the “hockey stick” is a long standing controversy in climate research that relates to the temperature reconstructions of the past 1000 years, prominently used in the IPCC reports. The story’s many twists and turns have by now been extensively documented and examined by numerous scientists and commentators. Only the Wikipedia entry about the topic is 25 000 words long (comprising about 66 printed pages), so the whole debate is too complicated and long to recount here. However, the crux of the matter relates to whether we have seen historically unprecedented high temperatures in the late twentieth century, and if so, if these should be attributed to natural variations or to the increase of greenhouse gases due to human activities.

During the 1990s a number of teams of climate scientists were using proxy indicators to estimate the temperature record of past centuries, and finding suggestions that recent warming was exceptional. At the core of the controversy was the temperature chart that originated from a couple of pioneering research papers published in *Nature* in 1998 and *Geophysical Research Letters* in 1999 by Michael Mann of the University of Virginia, Ray Bradley of the University of Massachusetts at Amherst and Malcolm Hughes of the University of Arizona. They used statistical analysis of a variety of proxies to produce the first quantitative hemispheric-scale reconstruction showing global patterns of annual surface temperature. The 1998 paper went back to 1400 and the 1999 paper back to year 1000, with the extended graph showing a downward trend in proxy temperatures from year 1000, followed by a 20th century rise and a steep increase in measured temperatures since the 1950s. The “hockey stick” term was seemingly coined by the climatologist Jerry Mahlman, to describe the pattern this figure showed, envisaging a graph that is relatively flat until about 1900 and which metaphorically forms the hockey stick's “shaft”, followed by a sharp increase that metaphorically corresponds to the hockey stick “blade”.

A version of the “hockey stick” graph was featured prominently in the 2001 United Nations Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report (TAR), which also

drew on four other reconstructions to support the conclusion that, in the Northern Hemisphere, the 1990s was likely to have been the warmest decade and 1998 the warmest year during the past 1,000 years. These representations and the public and political attention it received have been at the center of extensive controversy.

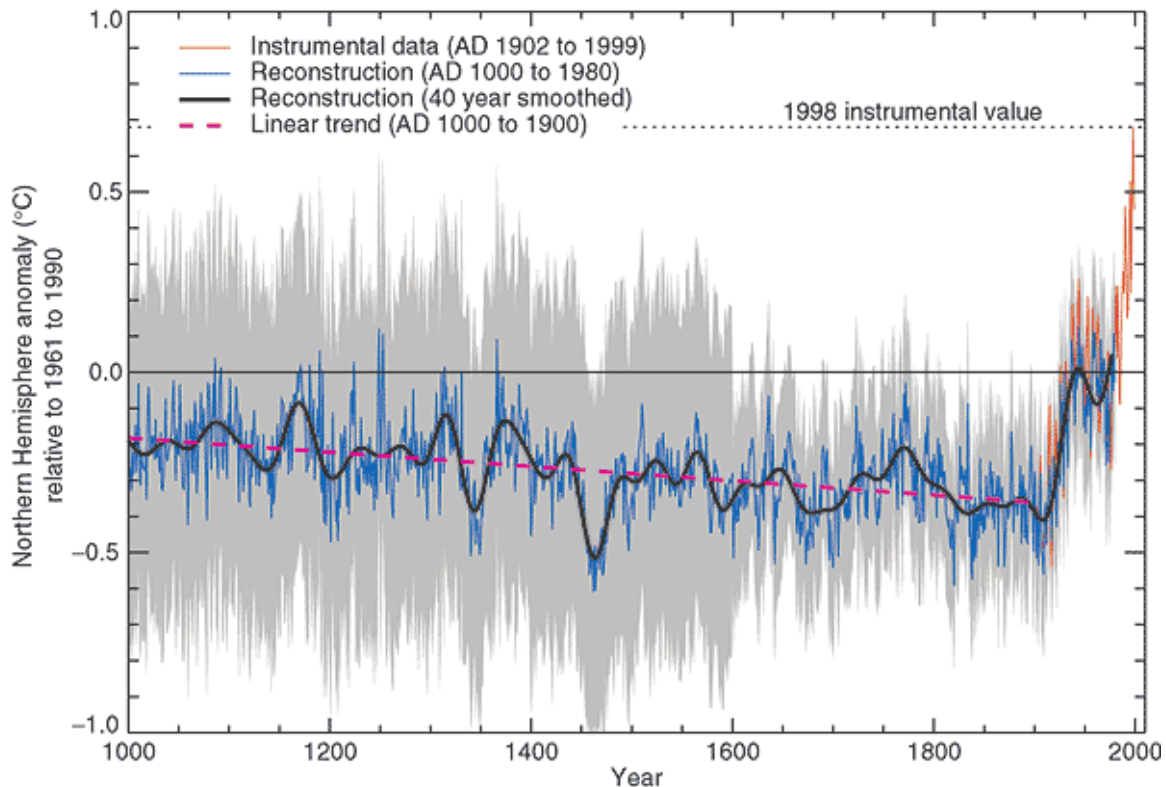


Figure 3. The controversial IPCC Third Assessment Report (2001) “hockey stick” temperature graph, adapted from Mann et al. (1999). The text accompanying the figure in the report (IPCC “Climate Change 2001: The Scientific Basis”, Figure 2.20, p. 134) is the following: “Millennial Northern Hemisphere (NH) temperature reconstruction (blue) and instrumental data (red) from AD 1000 to 1999, adapted from Mann et al. (1999). Smoother version of NH series (black), linear trend from AD 1000 to 1850 (purple-dashed) and two standard error limits (grey shaded) are shown.”¹⁷ The figure is also prominently presented both as Fig. 1 in the “Summary for Policymakers” (p. 3), and as Fig. 5 in the “Technical Summary of the Working Group I Report” (p. 29).¹⁸ Furthermore, modified versions are presented as Fig. 2-3 as well as Fig. 9-1b of the 2001 IPCC Synthesis Report.¹⁹

Notably, in 2003 Stephen McIntyre and Ross McKittrick published a paper (2003) questioning the data used in the Mann, Bradley and Hughes 1998 and 1999 papers, concluding they could not get

the statistical methods to produce the same results. In 2004 Hans von Storch published criticism of the statistical techniques as tending to underplay variations in earlier parts of the graph. In 2005 McIntyre and McKittrick published criticisms of the principal components analysis methodology as used in the 1998 and 1999 papers that have been at the center of controversy. The McIntyre and McKittrick papers have themselves been heavily discussed. For example Huybers (2005) and Wahl & Ammann (2007) pointed to errors in the McIntyre and McKittrick methodology. Because of the big controversy the “hockey stick” instigated at the request of the US Congress, a panel of scientists convened by the National Research Council was set up, which reported in 2006 and broadly supported Mann et al.’s findings, with some qualifications, for example that there were some statistical failings in the Mann et al. (1998) paper but these had little effect on the result.

Furthermore U.S. Rep. Joe Barton and U.S. Rep. Ed Whitfield requested noted statistician Prof. Edward Wegman of George Mason University to set up a team of statisticians to investigate the case comprehensively, and their 91 page report supported on the other hand broadly the critique McIntyre and McKittrick had levelled against the Mann et al. papers. The main critical findings of the Wegman report are the following:

“In general, we found MBH98 and MBH99 [Mann et al.] to be somewhat obscure and incomplete and the criticisms of MM03/05a/05b [McIntyre and McKittrick] to be valid and compelling. We also comment that they were attempting to draw attention to the discrepancies in MBH98 and MBH99, and not to do paleoclimatic temperature reconstruction. Normally, one would try to select a calibration dataset that is representative of the entire dataset. The 1902-1995 data is not fully appropriate for calibration and leads to a misuse in principal component analysis. However, the reasons for setting 1902-1995 as the calibration point presented in the narrative of MBH98 sounds reasonable, and the error may be easily overlooked by someone not trained in statistical methodology. We note that there is no evidence that Dr. Mann or any of the other authors in paleoclimatology studies have had significant interactions with mainstream statisticians. In our further exploration of the social network of authorships in temperature reconstruction, we found that at least 43 authors have direct ties to Dr. Mann by virtue of coauthored papers with him. Our findings from this analysis suggest that authors in the area of paleoclimate studies are closely connected and thus ‘independent studies’ may not be as independent as they might appear on the surface. This committee does not believe that web logs are an appropriate forum for the scientific debate on this issue. It is important to note the

isolation of the paleoclimate community; even though they rely heavily on statistical methods they do not seem to be interacting with the statistical community. Additionally, we judge that the sharing of research materials, data and results was haphazardly and grudgingly done. In this case we judge that there was too much reliance on peer review, which was not necessarily independent. Moreover, the work has been sufficiently politicized that this community can hardly reassess their public positions without losing credibility. Overall, our committee believes that Mann's assessments that the decade of the 1990s was the hottest decade of the millennium and that 1998 was the hottest year of the millennium cannot be supported by his analysis."²⁰

Likewise The George C. Marshall Institute alleged in June 1998 that MBH98 was deceptive in only going back to 1400: "Go back just a few hundred years more to the period 1000 - 1200 AD and you find that the climate was considerably warmer than now. This era is known as the Medieval Warm Period." It said that "by 1300 it began to cool, and by 1400 we were well into the Little Ice Age. It is no surprise that temperatures in 1997 were warmer than they were in the Little Ice Age", and so if "1997 had been compared with the years around 1000 AD, 1997 would have looked like a rather cool year" rather than being the warmest on record. It said that the Medieval Warm Period predated industrial greenhouse gas emissions, and had a natural origin.²¹

In the 2007 IPCC report a broader range of temperature reconstructions were presented. A comprehensive and updated overview of the challenges and progress made with respect to measuring and reconstructing global temperatures is presented by Ljungqvist (2010). With numerous references to past temperature research, the paper acknowledges that: "Despite significant improvement in our understanding of the temperature variability during the past one or two millennia, especially for the Northern Hemisphere, the controversial question whether Medieval Warm Period peak temperatures exceeded present temperatures remains unanswered. IPCC (2007) and NRC (2006) concluded that the data coverage still is too limited and unevenly distributed around the globe to say anything with reasonable certainty about temperatures on a global or hemispheric scale prior to c. AD 1600. The amplitude of the multi-decadal to centennial pre-industrial temperature variability constitutes a major uncertainty. The estimate of this variability ranges from c. 0.2 to 1°C in the different reconstructions" (2010: 339).

The paper's own contribution is the following:

“A new temperature reconstruction with decadal resolution, covering the last two millennia, is presented for the extratropical Northern Hemisphere (90–30°N), utilizing many palaeotemperature proxy records never previously included in any large scale temperature reconstruction. The amplitude of the reconstructed temperature variability on centennial timescales exceeds 0.6°C. This reconstruction is the first to show a distinct Roman Warm Period c. AD 1–300, reaching up to the 1961–1990 mean temperature level, followed by the Dark Age Cold Period c. AD 300–800. The Medieval Warm Period is seen c. AD 800–1300 and the Little Ice Age is clearly visible c. AD 1300–1900, followed by a rapid temperature increase in the twentieth century. The highest average temperatures in the reconstruction are encountered in the mid to late tenth century and the lowest in the late seventeenth century. Decadal mean temperatures seem to have reached or exceeded the 1961–1990 mean temperature level during substantial parts of the Roman Warm Period and the Medieval Warm Period. The temperature of the last two decades, however, is possibly higher than during any previous time in the past two millennia, although this is only seen in the instrumental temperature data and not in the multi-proxy reconstruction itself. Our temperature reconstruction agrees well with the reconstructions by Moberg et al. (2005) and Mann et al. (2008) with regard to the amplitude of the variability as well as the timing of warm and cold periods, except for the period c. AD 300–800, despite significant differences in both data coverage and methodology” (Ljungqvist 2010: 339).

The paper furthermore acknowledges that most recent temperature reconstructions, including Ljungqvist’s own, is quite different from the findings in the reconstructions presented by Mann et al (1999), the temperature curve that was adopted in the controversial 2001 IPCC report – the “hockey stick”. While discussing the different findings related to the magnitude of cooling during the little ice age Ljungqvist writes: “Our new reconstruction shows a temperature variability on centennial timescales exceeding 0.6°C, which is approximately similar to the amplitude of most more recent reconstructions. This amplitude is considerably larger than that in the pioneering reconstructions (e.g. Jones et al. 1998; Mann et al. 1999; Crowley and Lowery 2000) which were hampered by a very limited and unevenly distributed set of proxy data” (Ljungqvist 2010: 344). In other words, according to Ljungqvist, the “hockey stick” graph is in considerable disagreement with most more recent temperature reconstructions.

Related to the controversial question of whether or not we have seen record warm temperatures in the in the post 1990s, the paper provides both substantiation and a caution: “Substantial parts of the Roman Warm Period, from the first to the third centuries, and the Medieval Warm Period, from the ninth to the thirteenth centuries, seem to have equalled or exceeded the AD 1961–1990 mean temperature level in the extra-tropical Northern Hemisphere. Since AD 1990, though, average temperatures in the extra-tropical Northern Hemisphere exceed those of any other warm decades the last two millennia, even the peak of the Medieval Warm Period, if we look at the instrumental temperature data spliced to the proxy reconstruction. However, this sharp rise in temperature compared to the magnitude of warmth in previous warm periods should be cautiously interpreted since it is not visible in the proxy reconstruction itself” (2010: 347). See the figure below for a graph on the temperature reconstructions from the paper, a figure that can be directly compared with the Mann et al. 1999/IPCC 2001 “hockey stick” graph.

A NEW RECONSTRUCTION OF TEMPERATURE VARIABILITY IN THE EXTRA-TROPICAL NORTHERN HEMISPHERE

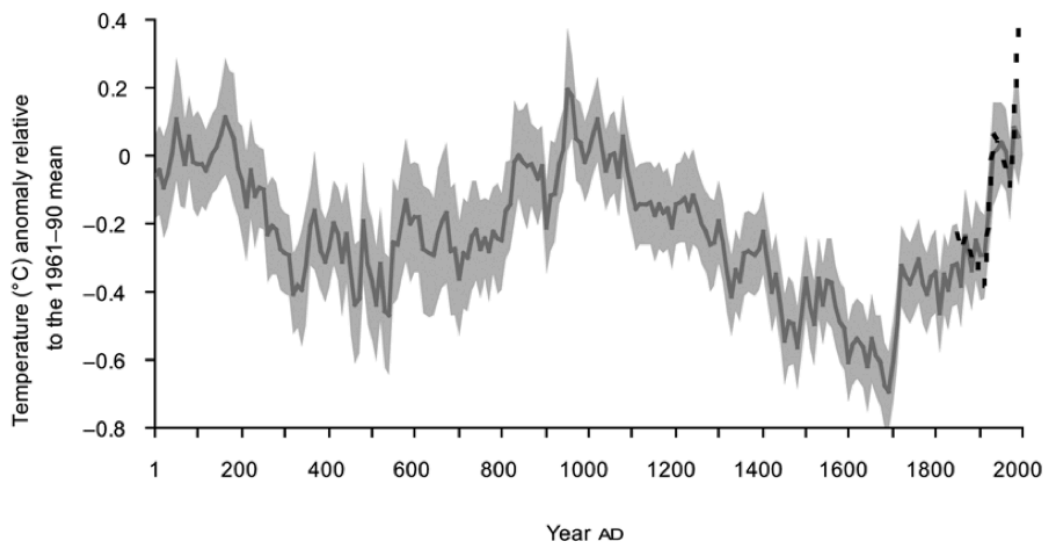


Fig. 3. Estimations of extra-tropical Northern Hemisphere (90–30°N) decadal mean temperature variations (dark grey line) AD 1–1999 relative to the 1961–1990 mean instrumental temperature from the variance adjusted CRUTEM3+HadSST2 90–30°N record (black dotted line showing decadal mean values AD 1850–1999) with 2 standard deviation error bars (light grey shading).

Figure 4. Temperature reconstruction of last 2000 years, by Ljungqvist (2010). It is directly comparable to the controversial “hockey stick” graph in figure 3 above.

If we compare the Ljungqvist graph with the controversial Mann/IPCC graph it is not difficult to detect the differences. While allegedly being in line with some or most of the notable most recent reconstructions, including Mann et al. (2008), it is easy to see how it substantially differs from the

Mann et al 1999/IPCC 2001 graph, and that there is no small wonder why the Mann/IPCC reconstruction have caused such a controversy. This includes allegations, not entirely unfounded (see section “Climategate” below), of for example seeking to “hide” the Mediaeval Warm Period (as well as the Little Ice Age) supposedly in an attempt to exaggerate and overstate the significance, unprecedentedness and man-made character of the current warming period. And when Mann in his book “The Hockey Stick and the Climate Wars” does not mention with a single word the comprehensive account and critique of the “hockey stick” made by Montford (2010) it just adds fuel to the fire.

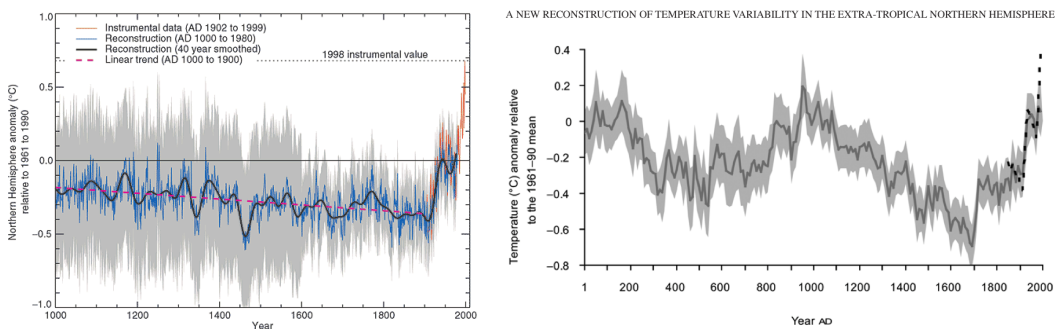
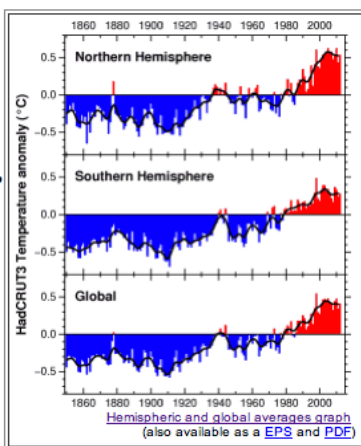


Figure 5. Comparing the “hockey stick” with the Ljungqvist (2010) temperature reconstruction.

Moreover, it is relatively uncontroversial that the temperature curves during the last decade or so have stopped increasing and seems rather to be flattening out and decreasing (see fig. below²²). If this is just a short change in the trend or more long-term trend remains to be seen. On any account, the difference between the peak of the Mediaeval warm period and the peak around year 2000, as



far as the “more or less official” record seem to stand today, is quite negligible however it turns out – whether the turn of the 1000 Millennium or the turn of the 2000 Millennium will collect a very small margin “victory” of being counted as the warmest time in the recorded history of hemispheric or global averages. Looking at the Ljungqvist graph it is, however, interesting to notice how warm and cold periods seem to fluctuate in long Millennial waves, but only within a very stable, relatively marginal and bounded about 1°C variability.

Figure 6. Latest recent HadCRU temperature data.²³

3.2 The measure of measuring: A note on temperature constructions

Moreover, there are considerable scientific controversy about the ontological status, the possibilities for and the meaningfulness of measuring global temperatures. A study by Watts et al. (2012)²⁴ showed that half of the recent warming measured in the US is artificial, caused by measuring problems:

“U.S. Temperature trends show a spurious doubling due to NOAA station siting problems and post measurement adjustments... A reanalysis of U.S. surface station temperatures has been performed using the recently WMO-approved Siting Classification System devised by METEO-France’s Michel Leroy. The new siting classification more accurately characterizes the quality of the location in terms of monitoring long-term spatially representative surface temperature trends. The new analysis demonstrates that reported 1979-2008 U.S. temperature trends are spuriously doubled, with 92% of that over-estimation resulting from erroneous NOAA adjustments of well-sited stations upward. The paper is the first to use the updated siting system which addresses USHCN siting issues and data adjustments.”

Reflecting on methodology, the paper concludes:

“It is inescapably demonstrated that stations with poor microsite (Class 3, 4, 5) have significantly higher warming trends than well sited stations (Class 1, 2): This is true for, in **all nine** geographical areas of **all five** data samples. The odds of this result having occurred randomly are vanishingly minuscule.” (Supplement to Watts et al, 2012).²⁵

An even more fundamental critique of the ontological status of measuring global temperatures is provided by Essex et al. (2007). They argue convincingly, from foundations in physics and mathematics that there is no such thing as a meaningful concept of a “global temperature”:

“There is no global temperature. The reasons lie in the properties of the equation of state governing local thermodynamic equilibrium, and the implications cannot be avoided by substituting statistics for physics... The problem can be (and has been) happily ignored in the name of the empirical study of climate. But nature is not obliged to respect our statistical conventions and conceptual shortcuts. Debates over the levels and trends in so-called global temperatures will continue interminably, as will disputes over the significance of these things for the human experience of climate, until some physical basis is established for the meaningful measurement of climate variables, if indeed that is even possible.”²⁶

These fundamental discussions are of course also part and parcel of the scholarly work in the social sciences and humanities about the history and social construction of measurements, facts and figures (e.g. Porter 1995, Crosby 1997, Poovey 1998).

As an example of the scientific discussion on temperature reconstructions on a larger geological scale, the scientific literature covering the Holocene (last 12 000 years or so) is interesting and puts current debates on global warming into some perspective. The work by Jensen and Vorren (2008) is illustrative. The paper infers summer temperatures throughout the Holocene from oscillations in forest-lines, as recorded by fossil pollen and plant macrofossiles in lake sediments, at four altitudinal levels at mount Skrubben in Dividalen in Northern Norway. One of the locations, at Gaup tjern, is included in fig. 4 below.

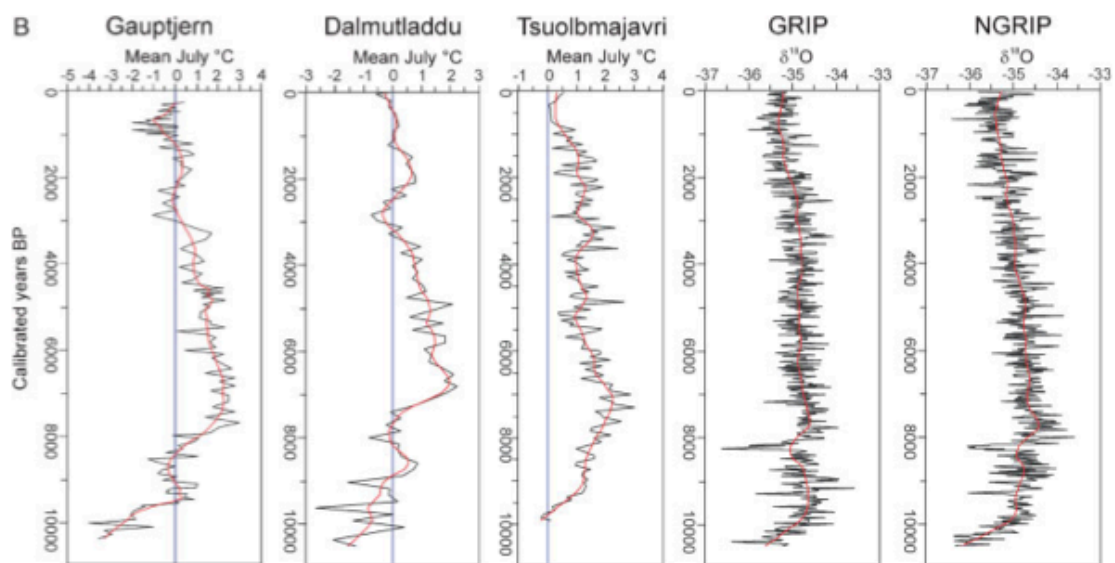


Figure 10 (A) Synthesis of the biostratigraphical zonation, vegetation development and mean July temperature (TAM July °C) reconstruction of Mt Skrubben, Dividalen. The temperature reconstruction is based on a three-component PLS (partial least squares) regression and leave-one-out cross-validation (jack-knifing). Loess smoothing, span 0.1: red line, $0.57 \text{ K } 100 \text{ m}^{-1}$; green line, $0.69 \text{ K } 100 \text{ m}^{-1}$. Reference lines are added for the present TAM July °C and for 12°C , which is representative of the *Pinus sylvestris* forest line. Calibrated ages of zone limits and events (%) referred to in the text are marked. (B) The reconstructed mean July temperature of lake Gaup tjern, Mt Skrubben, presented as difference from the present temperature and compared with results from lake Dalmutladdu (Bjune *et al.*, 2004), lake Tsuolbmajavri (Seppä and Birks, 2001), lapse rate $0.57 \text{ K } 100 \text{ m}^{-1}$, and the Greenland ice cores GRIP and NGRIP (Johnsen *et al.*, 2001, http://www.gfz.ku.dk/~www-glac/ngrip/index_eng.htm). Loess smoothing, span 0.1

Figure 7. Holocene mean summer temperatures in northwestern Fennoscandinavia (Gaup tjern, Dalmutladdu, Tsuolbmajavri), and Greenland ice cores (Jensen and Vorren 2008: 737).

Arguing that the sensitivity of forest-line forming trees to climate makes it a very good proxy temperature measure, the paper found for example that mean July temperatures at 400 meters above

sea level was 1.5-3 degrees Celsius warmer than the present temperature, in the period of maximum forest expansion (that is, the period ca. 7900-4500 before our present time, see fig. 4).

Recently a team of researchers (Marcott et al. 2013) published in the journal *Science* *global* temperature reconstructions for the past 11.300 years (the Holocene period). Their findings suggest that:

“Early Holocene (10,000 to 5000 years ago) warmth is followed by $\sim 0.7^{\circ}\text{C}$ cooling through the middle to late Holocene (< 5000 years ago), culminating in the coolest temperatures of the Holocene during the Little Ice Age, about 200 years ago. This cooling is largely associated with $\sim 2^{\circ}\text{C}$ change in the North Atlantic. Current global temperatures of the past decade have not yet exceeded peak interglacial values but are warmer than during $\sim 75\%$ of the Holocene temperature history. Intergovernmental Panel on Climate Change model projections for 2100 exceed the full distribution of Holocene temperature under all plausible greenhouse gas emission scenarios” (ibid.: 1198).

The paper caused headlines in major papers all over the world. Clearly overstating the findings “The Independent” for example claimed in its headline that “The world is hottest it has been since the end of the ice age - and the temperature's still rising”.²⁷ More sober, The New York Times wrote that the paper showed that “global temperatures are warmer than at any time in at least 4,000 years”, and “over the coming decades are likely to surpass levels not seen in the planet since before the last ice age”. It also noted that the paper showed that global temperatures during the long climatic plateau of the early Holocene were roughly the same as those of today.²⁸ Comparing the Holocene global temperature findings of the Marcott et al. paper with the Holocene local temperatures of the Jensen and Vorren paper some of the larger temperature trends are comparable, but the amplitudes vary considerably, and thus also large parts of the overall picture. For example, and comparing also with the global temperature reconstructions of the Ljungqvist paper referred above, the roman warming period about 2000 years ago is clearly present in the Jensen and Vorren paper, while being not so significant in the Marcott et al paper. Also, the paper relies primarily on other established sources with regards to the temperature the last 100 years, and does not contribute with new knowledge in that respect. The debate has surely not ended with the Marcott et al. paper.

3.3 “Climategate”

In November 2009 more than 1000 e-mails from a server at the University of East Anglia’s Climate Research Unit (CRU) was hacked and published on the web.²⁹ The controversy that followed has been labeled “Climategate”, a somewhat stigmatizing and contested term, and it has been the subject of heated debate in the public and subject to analysis in many fields of science, including STS. Much of the frenzy and controversy revolves around the “hockey stick” (see above), but also about the ethical practices of the scientists involved in the controversy more generally. A google search finds 2 520 000 hits with the search term “climategate”. The term is referred 450 times in Norwegian papers (printed and online).³⁰ This report will not embark on a detailed analysis of all aspects of this controversy, but rather document some of the key e-mails at the core of the debate and recount some of the conclusions drawn from of what we find to be the most comprehensive and seasoned social science analysis of the controversy. A main reason for the intensity of the debate is that the CRU researchers and colleagues are central in the IPCC consensus building science related to AGW. First we present some of the e-mails.

3.3.1 Noteworthy CRU e-mails

A list of 250+ noteworthy “Climategate” e-mails can be found at the WhatsUpWithThat (WUWT) website.³¹ Here are a few examples, first related to the alleged manipulation of evidence: “I’ve just completed Mike’s Nature trick of adding in the real temps to each series for the last 20 years (ie, from 1981 onwards) and from 1961 for Keith’s to hide the decline.” Related to their own private doubts about whether the world is really warming: “The fact is that we can’t account for the lack of warming at the moment and it is a travesty that we can’t. The CERES data published in the August BAMS 09 supplement on 2008 shows there should be even more warming: but the data are surely wrong. Our observing system is inadequate.”

Related to the alleged suppression and destruction of evidence: “Can you delete any emails you may have had with Keith re AR4? Keith will do likewise. He’s not in at the moment – minor family crisis. Can you also email Gene and get him to do the same? I don’t have his new email address. We will be getting Caspar to do likewise.” Similarly, yet not part of the hacked climategate e-mails, the following was stated by Prof. P. D. Jones, central scientist related to the temperature reconstructions used by IPCC, in a letter to Australian climatologist Warrick Hughes the following: “We have 25 years or so invested in the work. Why should I make the data available to you, when your aim is to try and find something wrong with it?”³²

Related to aggression towards climate sceptics: “Next time I see Pat Michaels at a scientific meeting, I’ll be tempted to beat the crap out of him. Very tempted.” Related to attempts to disguise the “inconvenient truth” of the Medieval Warm Period (MWP): “...Phil and I have recently submitted a paper using about a dozen NH records that fit this category, and many of which are available nearly 2K back—I think that trying to adopt a timeframe of 2K, rather than the usual 1K, addresses a good earlier point that Peck made w/ regard to the memo, that it would be nice to try to “contain” the putative “MWP”, even if we don’t yet have a hemispheric mean reconstruction available that far back...”

Related to the Medieval Warm Period: “So, at this stage I would argue that the Medieval Warm Period was probably a global extra-tropical event, at the very least, with warmth that was persistent and probably comparable to much of what we have experienced in the 20th century. However, I would not claim (and nor would Jan) that it exceeded the warmth of the late 20th century. We simply do not have the precision or the proxy replication to say that yet. This being said, I do find the dismissal of the Medieval Warm Period as a meaningful global event to be grossly premature and probably wrong. Kind of like Mark Twain's comment that accounts of his death were greatly exaggerated. If, as some people believe, a degree of symmetry in climate exists between the hemispheres, which would appear to arise from the tropics, then the existence of a Medieval Warm Period in the extra-tropics of the NH and SH argues for its existence in the tropics as well. Only time and an enlarged suite of proxies that extend into the tropics will tell if this is true.”

And here are a few examples of emails related to allegations about how to best squeeze dissenting scientists out of the publishing game:

“This was the danger of always criticising the skeptics for not publishing in the “peer-reviewed literature”. Obviously, they found a solution to that—take over a journal! So what do we do about this? I think we have to stop considering “Climate Research” as a legitimate peer-reviewed journal. Perhaps we should encourage our colleagues in the climate research community to no longer submit to, or cite papers in, this journal. We would also need to consider what we tell or request of our more reasonable colleagues who currently sit on the editorial board...What do others think?”

“I will be emailing the journal to tell them I’m having nothing more to do with it until they rid themselves of this troublesome editor.”

“It results from this journal having a number of editors. The responsible one for this is a well-known skeptic in NZ. He has let a few papers through by Michaels and Gray in the past. I’ve had words with Hans von Storch about this, but got nowhere. Another thing to discuss in Nice !”³³

3.3.2 STS analysis of “climategate”

There has by now been published several social science analysis of the “climategate” case. Arguably the best overview and review of this literature to date is provided by Grundmann’s (2012a, 2012b) meta-analysis of these social science studies of climategate. Grundmann discusses all the major problems in the climategate case, and assess the various social science analysis of it. He argues generally first that “climategate revealed problematic practices of climate scientists which are only partly recognized” in these [social science] analyses, and furthermore that they have a tendency to condone such practices (2012b). Secondly Grundmann argues that in the social science studies of climategate there is “overall agreement that climate science needs more openness and transparency, and that trust and credibility are of highest concern when it comes to climate policy” (ibid.)

To some particular points he notes for example that “the trick of omitting inconvenient data from the time series in the hockey stick is highly problematic. It is curious that Pearce [2010] in his otherwise illuminating account misses this point.” (ibid.). He also concludes that: “In fact, what the emails reveal are problematic practices of leading climate researchers acting as zealous gatekeepers in a scientific and political project”. Related to the politicization of science he notes that “Beck [2010] sees major flaws in the design of the IPCC, flaws linked to the linear model of policy making. This has led to a politicization of climate science and a depoliticization of politics, giving rise to ‘proxy debates’ about scientific evidence.” (ibid.). His conclusions puts the “climategate” affair, and the social science’s analysis of it in timely perspective, and this report is in fundamental agreement on all points:

“In conclusion, we see a variety of approaches and evaluations of the climategate affair, emphasizing different aspects and taking care how to take a stance in this highly politicized debate. What I find most interesting is how authors have dealt with the problem of reflexivity (or not!), given that their intellectual heritage is rooted in STS and varieties of constructivism. While this approach broadly informs Wynne and Jasanoff’s papers, they have not really examined the affair as ‘science in the making’ in any detailed way. Ryghaug and Skjølsvold provide such detail but shrink back from an evaluation in the light of what has been seen as a loss of

credibility and a scandal. Van der Sluijs and Beck's call for institutional reform of the IPCC and more openness in climate science goes further. And Ravetz steps up to the challenge of reflexivity giving a very personal account, looking into the mirror and describing the powerful social mechanisms of being co-opted by the dominant discourse, which led him to suspend critical reflection for a while. If social scientists want to avoid the dilemma sketched by Wynne of either denying the authority of IPCC science or faithfully following its conventional wisdom down the corresponding technocratic policy, they had better examine climategate more deeply and ponder the lessons. We need much more reflection on this case which should not be closed off because of political expediency. The debate has only just begun." (ibid.)

The chapter has revealed that there are core debates in the climate sciences that are rife with scientific and social controversies related to the construction and measurement (and the construction of measurement) of scientific facts and figures in the field. It has illuminated that mainstream positions, practices and actors in the field have been thoroughly scrutinised and criticised for both scientific methods and for social practices related to their scientific work.

In the next chapter a more detailed account of the wider ecology of dissenting, sceptical or contrarian perspectives on AGW is presented. It substantiates the general claim that there is indeed an ongoing scientific debate in this field.

4 Contrarian perspectives in science (and the public)

In this chapter we look in more detail into critical, contrarian and sceptical perspectives and positions in the debate on Anthropogenic Global Warming. To be able to answer the main question of the report, if the science of AGW is more or less settled, substantial space is given to present the empirical material that comprises various forms of critique of the consensus. As the main methods employed in the report are document studies and meta-analysis of scientific and public texts the empirical material is to a large extent extracts and quotes from such texts. From our review in chapter 3, the claim of consensus on AGW in science is strong. However, as documented, the quantitative surveys of scientific consensus on AGW have nonetheless received substantial critique, and have instigated heated debate about both the level and robustness of consensus, as well as about the fruitfulness of the whole “consensus approach” to climate science in particular, and to science more in general. In this chapter the critical and contrarian perspectives in science (and the public) will be given voice, as somewhat provocatively illustrated by the quote below:

“The fact that the developed world went into hysterics over changes in global mean temperature anomaly of a few tenths of a degree will astound future generations. Such hysteria simply represents the scientific illiteracy of much of the public, the susceptibility of the public to the substitution of repetition for truth, and the exploitation of these weaknesses by politicians, environmental promoters, and, after 20 years of media drum beating, many others as well. Climate is always changing.” (Richard S. Lindzen, Alfred P. Sloan Professor of Atmospheric Sciences at MIT).³⁴

In a 2012 opinion piece in the Wall Street Journal, 16 prominent scientists signed a letter titled “No need to Panic About Global Warming”. Among other things it said that the “oft-repeated claim that nearly all scientists demand that something dramatic be done to stop global warming is not true. In fact, a large and growing number of distinguished scientists and engineers do not agree that drastic actions on global warming are needed.”³⁵ See Ridley (2011) for a short overview of literature that argues that some warming in sum will have more positive than negative effects.

The Wall Street Journal letter was signed by scientists such as Claude Allegre, former director of the Institute for the Study of the Earth, University of Paris; J. Scott Armstrong, cofounder of the Journal of Forecasting and the International Journal of Forecasting; William Happer, professor of physics, Princeton University; Michael Kelly, professor of technology, University of Cambridge, U.K.; William Kininmonth, former head of climate research at the Australian Bureau of Meteorology; Richard Lindzen, professor of atmospheric sciences, MIT; Rodney Nichols, former

president and CEO of the New York Academy of Sciences; Henk Tennekes, former director, Royal Dutch Meteorological Service; and Antonio Zichichi, president of the World Federation of Scientists, Geneva.

The letter also referred to another well-known scientist, Norwegian Nobel laureate in physics Ivar Giaever, who publicly resigned from the American Physical Society (APS) on September 13, 2011 with an accompanying statement that read the following:

“Thank you for your letter inquiring about my membership. I did not renew it because I cannot live with the (APS) statement below (on global warming): APS: **'The evidence is incontrovertible:** Global warming is occurring. If no mitigating actions are taken, significant disruptions in the Earth's physical and ecological systems, social systems, security and human health are likely to occur. We must reduce emissions of greenhouse gases beginning now.'

Giaever explained that his resignation from APS was due to the institution's statement on man-made global warming fears. Giaever explained in the email to APS that: “In the APS it is ok to discuss whether the mass of the proton changes over time and how a multi-universe behaves, but the evidence of global warming is incontrovertible? The claim (how can you measure the average temperature of the whole earth for a whole year?) is that the temperature has changed from ~288.0 to ~288.8 degree Kelvin in about 150 years, which (if true) means to me is that the temperature has been amazingly stable, and both human health and happiness have definitely improved in this 'warming' period.”³⁶

However, notwithstanding the APS policy statement about the “incontrovertible evidence”, adopted in November 2007,³⁷ the same issue is stated much less dogmatic in a 2008 editorial of the APS Forum on Physics & Society: “There is a considerable presence within the scientific community of people who do not agree with the IPCC conclusion that anthropogenic CO₂ emissions are very probably likely to be primarily responsible for the global warming that has occurred since the Industrial Revolution. Since the correctness or fallacy of that conclusion has immense implications for public policy and for the future of the biosphere, we thought it appropriate to present a debate within the pages of P&S concerning that conclusion.”³⁸

An excellent place to start to take stock of the scientific diversity of positions on AGW is the site Popular Technology, that has assembled more than 1100 peer-reviewed scientific papers that voices

various arguments that are in different types of disagreement and tension towards the alleged consensus. According to the site: “The following papers support skeptic arguments against Anthropogenic Climate Change (ACC), Anthropogenic Global Warming (AGW) or ACC/AGW Alarm.³⁹ The site has, to the best of our knowledge, answered, rebutted and reacted appropriately to all critique it has received concerning the collection. What follows are some illustrative examples, showing that various types of dissenting arguments are highly prevalent in science, including published in the highest ranked climate related journals. This is just to give a hint about the extent and serious ongoing questioning and discussion on AGW and climate change. All the 1100 papers are easily accessible for individual review through the Popular Technology site.

Does a Global Temperature Exist?

(Journal of Non-Equilibrium Thermodynamics, Volume 32, Issue 1, pp. 1–27, February 2007)

- Christopher Essex, Ross McKittrick, Bjarne Andresen

This paper argues that there is no such thing as a meaningful concept of a “global temperature”. “There is no global temperature. The reasons lie in the properties of the equation of state governing local thermodynamic equilibrium, and the implications cannot be avoided by substituting statistics for physics... Since temperature is an intensive variable, the total temperature is meaningless in terms of the system being measured, and hence any one simple average has no necessary meaning. Neither does temperature have a constant proportional relationship with energy or other extensive thermodynamic properties... The purpose of this paper was to explain the fundamental meaninglessness of so-called global temperature data. The problem can be (and has been) happily ignored in the name of the empirical study of climate. But nature is not obliged to respect our statistical conventions and conceptual shortcuts. Debates over the levels and trends in so-called global temperatures will continue interminably, as will disputes over the significance of these things for the human experience of climate, until some physical basis is established for the meaningful measurement of climate variables, if indeed that is even possible.”⁴⁰

Falsification Of The Atmospheric CO₂ Greenhouse Effects Within The Frame Of Physics

(International Journal of Modern Physics B, Volume 23, Issue 3, pp. 275-364, January 2009)

- Gerhard Gerlich, Ralf D. Tscheuschner

The paper argues that: “The atmospheric greenhouse effect, an idea that many authors trace back to the traditional works of Fourier (1824), Tyndall (1861), and Arrhenius (1896), and which is still

supported in global climatology, essentially describes a fictitious mechanism, in which a planetary atmosphere acts as a heat pump driven by an environment that is radiatively interacting with but radiatively equilibrated to the atmospheric system. According to the second law of thermodynamics, such a planetary machine can never exist. Nevertheless, in almost all texts of global climatology and in a widespread secondary literature, it is taken for granted that such a mechanism is real and stands on a firm scientific foundation. In this paper, the popular conjecture is analyzed and the underlying physical principles are clarified. By showing that (a) there are no common physical laws between the warming phenomenon in glass houses and the fictitious atmospheric greenhouse effects, (b) there are no calculations to determine an average surface temperature of a planet, (c) the frequently mentioned difference of 33 degrees is a meaningless number calculated wrongly, (d) the formulas of cavity radiation are used inappropriately, (e) the assumption of a radiative balance is unphysical, (f) thermal conductivity and friction must not be set to zero, the atmospheric greenhouse conjecture is falsified.”

Reply to "Comment on 'Falsification Of The Atmospheric CO2 Greenhouse Effects Within The Frame Of Physics' by Joshua B. Halpern, Christopher M. Colose, Chris H0-Stuart, Joel D. Shore, Arthur P. Smith, Jorg Zimmermann"

*(International Journal of Modern Physics B, Volume 24, Issue 10, pp. 1333-1359, April 2010)
- Gerhard Gerlich, Ralf D. Tscheuschner*

The paper rebuts a critique of their former paper (from 2009, cited above). In the same journal, Halpern et al. (2010), Vol. 24(10), critiqued the 2009 paper in the following way: “In this journal, Gerhard Gerlich and Ralf D. Tscheuschner claim to have falsified the existence of an atmospheric greenhouse effect. Here, we show that their methods, logic, and conclusions are in error.” In their reply Gerlich and Tscheuschner states: “It is shown that the notorious claim by Halpern et al. recently repeated in their comment that the method, logic, and conclusions of our "Falsification Of The CO2 Greenhouse Effects Within The Frame Of Physics" would be in error has no foundation. Since Halpern et al. communicate our arguments incorrectly, their comment is scientifically vacuous. In particular, it is not true that we are "trying to apply the Clausius statement of the Second Law of Thermodynamics to only one side of a heat transfer process rather than the entire process" and that we are "systematically ignoring most non-radiative heat flows applicable to Earth's surface and atmosphere". Rather, our falsification paper discusses the violation of fundamental physical and mathematical principles in 14 examples of common pseudo-derivations

of fictitious greenhouse effects that are all based on simplistic pictures of radiative transfer and their obscure relation to thermodynamics, including but not limited to those descriptions (a) that define a "Perpetuum Mobile Of The 2nd Kind", (b) that rely on incorrectly calculated averages of global temperatures, (c) that refer to incorrectly normalized spectra of electromagnetic radiation. Halpern et al. completely missed an exceptional chance to formulate a scientifically well-founded antithesis. They do not even define a greenhouse effect that they wish to defend. We take the opportunity to clarify some misunderstandings, which are communicated in the current discussion on the non-measurable, i.e., physically non-existing influence of the trace gas CO₂ on the climates of the Earth.”

Implications of the Secondary Role of Carbon Dioxide and Methane Forcing in Climate Change: Past, Present, and Future

(Physical Geography, Volume 28, Number 2, pp. 97-125, March 2007)

- Willie H. Soon

The paper argues that: “A review of the recent refereed literature fails to confirm quantitatively that carbon dioxide (CO₂) radiative forcing was the prime mover in the changes in temperature, ice-sheet volume, and related climatic variables in the glacial and interglacial episodes of the past 650,000 years, even under the "fast-response" framework where the convenient if artificial distinction between forcing and feedback is assumed. Atmospheric CO₂ variations generally follow changes in temperature and other climatic variables rather than preceding them.”⁴¹

Ancient atmospheric CO₂ pressures inferred from natural goethites

(Nature, Volume 355, Number 6385, pp. 342-344, January 1992)

- J. Crayton Yapp, Harald Poeths

This paper, published in *Nature*, suggests that: “440 Myr ago atmospheric P Co₂ was ~ 16 times higher than today. However, this enhanced level of atmospheric CO₂ does not seem to have been accompanied by unusually warm temperatures in the tropics, and in fact may have been contemporaneous with high-latitude continental glaciation on Gondwanaland.”⁴²

Knock, Knock: Where Is the Evidence for Dangerous Human-caused Global Warming?

(Economic Analysis and Policy, Volume 38, Issue 2, pp. 177-202, September 2008)

- Robert M. Carter

The paper concludes that: “To focus on the chimera of human-caused greenhouse warming while ignoring the real threats posed by the natural variability of the climate system itself is self-delusion on a grand scale... That human-caused climate change will prove dangerous is under strong dispute amongst equally well qualified scientific groups. The null hypothesis, which is yet to be contradicted, is that observed changes in climate or climate-related phenomena are natural unless and until it can be shown otherwise. The science of climate change is far from settled. Meanwhile, there is no compelling evidence that human-caused climate change poses a strong future danger... No measurable environmental benefits have resulted from actions taken under the Kyoto Protocol, nor can they be predicted to result from carbon dioxide emission restrictions more generally. On the other hand, the social and economic disbenefits of governments deploying such instruments are now reported daily in the media. The available scientific data, and proved relationships, do not justify the belief that carbon dioxide emission controls can be used as a means of ‘managing’ or ‘stopping’ future climate change. The projections (which are not predictions) of computer modellers that are now almost the sole basis for IPCC climate alarmism must be assessed against the best available empirical evidence... Lastly, because we are far from understanding all the climatic feedback loops concerned, cutting carbon dioxide emissions is as likely to ‘harm’ as to ‘help’ future climate as judged against a human viewpoint. Therefore, application of the principles of ‘do no harm’ and ‘precaution’ implies that the correct climate policy is one of monitoring climate change as it happens, adapting to any deleterious trends that emerge, and compensating those who are disadvantaged through no fault of their own.”

Atmospheric Oscillations do not Explain the Temperature-Industrialization Correlation
(*Statistics, Politics, and Policy, Volume 1, Issue 1, pp. 1–18, July 2010*)
- Ross McKittrick

The paper argues that “the correlations between warming patterns and patterns of socioeconomic development remain large and significant in the presence of controls for atmospheric oscillations, contradicting the IPCC claim.”⁴³

Insignificant change in Antarctic snowmelt volume since 1979
(*Geophysical Research Letters, Volume 39, L01501, January 2012*)
- P. Kuipers Munneke et al.

The paper, published in *Geophysical Research Letters* 2012, argues that snowmelt has not changed significantly the past 31 years in Antarctica. It finds that there is no significant statistical change in Antarctic meltwater volume since 1979. “Surface snowmelt is widespread in coastal Antarctica. Satellite-based microwave sensors have been observing melt area and duration for over three decades. However, these observations do not reveal the total volume of meltwater produced on the ice sheet. Here we present an Antarctic melt volume climatology for the period 1979–2010, obtained using a regional climate model equipped with realistic snow physics. We find that mean continent-wide meltwater volume (1979–2010) amounts to 89 Gt y⁻¹ with large interannual variability ($\sigma = 41$ Gt y⁻¹). Of this amount, 57 Gt y⁻¹ (64%) is produced on the floating ice shelves extending from the grounded ice sheet, and 71 Gt y⁻¹ in West-Antarctica, including the Antarctic Peninsula. *We find no statistically significant trend in either continent-wide or regional meltwater volume for the 31-year period 1979–2010.*” [our emphasis]⁴⁴ Furthermore the paper states that this finding in fact is aligned with air temperature trends in the region: “A reconstruction of near-surface temperature without the questionable Byrd station (A. Monaghan, unpublished data, 2011) leaves DJF temperature trends for 1979–2010 insignificant over nearly the entire continent, and mostly suggests statistically insignificant cooling along the coastal margins. This finding also seems consistent with RACMO2 DJF near-surface temperatures, which show no statistically significant trends for 1979–2010 in any of the areas that experience melt” (ibid.: 4).

Global Warming: A Critique of the Anthropogenic Model and its Consequences
(*Geoscience Canada, Volume 38, Number 1, pp. 41-48, March 2011*)
- Norman R. Paterson

The paper states that: “According to popular belief, recent global warming has been caused largely by greenhouse gases, primarily CO₂, accruing in the atmosphere, and man is responsible for most of the ~120 ppm increase in CO₂ over the last 100 years. This article cites a number of recent peer-reviewed scientific papers, and finds that contrary arguments by a growing body of scientists are generally supported by better empirical data than those that favour the ‘anthropogenic warming’ hypothesis. These arguments invoke the effects of solar irradiance and ocean–atmosphere interactions, both of which have been shown to have warming effects at least as great as those claimed for CO₂, and to be based on sound, well-understood scientific theory. Furthermore, the global warming models used by the Intergovernmental Panel on Climate Change (IPCC) and others have in some cases been shown to be incorrect and contrary to current temperature statistics. For

these and other reasons, the CO₂-driven, anthropogenic warming hypothesis is regarded by many as suspect and lacking in empirical evidence. The difficulty of refuting this popular hypothesis is exacerbated by the IPCC's United Nations mandate to advise governments on the severity of man-made global warming, a mandate that they have followed faithfully, encouraging the emergence of a large body of funded research that supports their view. This presents a problem for global society, as the human-caused warming scenario diverts attention from other, at least equally serious environmental impacts of our industrial society. Recently, however, there appears to be a tilting of public opinion away from global warming alarmism, which may fundamentally affect the direction of the climate change debate.”⁴⁵

On the recovery from the Little Ice Age

(Natural Science, Volume 2, Number 7, pp. 1211-1224, November 2010)

- *Syun-Ichi Akasofu*

The paper states that: “We learn that the recovery from the LIA [Little Ice Age] has proceeded continuously, roughly in a linear manner, from 1800-1850 to the present. The rate of the recovery in terms of temperature is about 0.5°C/100 years and thus it has important implications for understanding the present global warming. It is suggested on the basis of a much longer period covering that the Earth is still in the process of recovery from the LIA; there is no sign to indicate the end of the recovery before 1900. Cosmic-ray intensity data show that solar activity was related to both the LIA and its recovery. The multi-decadal oscillation of a period of 50 to 60 years was superposed on the linear change; it peaked in 1940 and 2000, causing the halting of warming temporarily after 2000.”

A statistical analysis of multiple temperature proxies: Are reconstructions of surface temperatures over the last 1000 years reliable?

(Annals of Applied Statistics, Volume 5, Number 1, pp. 5-44, March 2011)

- *Blakeley B. McShane, Abraham J. Wyner*

In this paper, the authors “assess the reliability of such reconstructions and their statistical significance against various null models. We find that the proxies do not predict temperature significantly better than random series generated independently of temperature. Furthermore, various model specifications that perform similarly at predicting temperature produce extremely different historical backcasts. Finally, the proxies seem unable to forecast the high levels of and sharp run-up in temperature in the 1990s either in-sample or from contiguous holdout blocks, thus

casting doubt on their ability to predict such phenomena if in fact they occurred several hundred years ago.”

Why Hasn't Earth Warmed as Much as Expected?

(Journal of Climate, Volume 23, Issue 10, pp. 2453–2464, May 2010)

- Stephen E. Schwartz et al.

The paper argues that “the observed increase in global mean surface temperature (GMST) over the industrial era is less than 40% of that expected from observed increases in long-lived greenhouse gases together with the best-estimate equilibrium climate sensitivity given by the 2007 Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). Possible reasons for this warming discrepancy are systematically examined here. The warming discrepancy is found to be due mainly to some combination of two factors: the IPCC best estimate of climate sensitivity being too high and/or the greenhouse gas forcing being partially offset by forcing by increased concentrations of atmospheric aerosols; the increase in global heat content due to thermal disequilibrium accounts for less than 25% of the discrepancy, and cooling by natural temperature variation can account for only about 15%. Current uncertainty in climate sensitivity is shown to preclude determining the amount of future fossil fuel CO₂ emissions that would be compatible with any chosen maximum allowable increase in GMST.”

This last example of a paper is in line with recent self-critique by such prominent AGW alarmist figures as James Lovelock, the creator of the Gaia hypothesis. Lovelock’s newfound doubt is chronicled in a 2012 Forbes commentary titled “Global Warming Chorus Discord Rising To Feverish Pitch”, by Larry Bell: “In 2006 he [Lovelock] claimed: “Before this century is over billions of us will die and the few breeding pairs of people that survive will be in the Arctic where climate remains tolerable.” Recently, however, he has obviously cooled on global warming as a crisis, admitting to MSNBC that he overstated the case and now acknowledges that: “...we don’t know what the climate is doing. We thought we knew 20 years ago. That led to some alarmist books...mine included...because it looked clear cut...but it hasn’t happened.” Lovelock pointed to Al Gore’s “An Inconvenient Truth” and Tim Flannery’s “The Weather Makers” as other alarmist publications. The 92-year-old Lovelock went on to note, “...the climate is doing its usual tricks...there’s nothing much happening yet even though we were supposed to be halfway toward a

frying world now.” He added, “The world has not warmed up very much since the millennium. Twelve years is a reasonable time.” Yet the temperature “has stayed almost constant, whereas it should have been rising...carbon dioxide has been rising, no question about that.”⁴⁶

While not claiming to be representative for the dissenting voices on AGW and climate change, this section closes with a quote from Nigel Lawson, former UK Chancellor of the Exchequer and Secretary of State for Energy: “The new religion of global warming is a great story, and a phenomenal best seller. It contains a grain of truth and a mountain of nonsense. And that nonsense could be very damaging indeed. We appear to have entered a new age of unreason, which threatens to be as economically harmful as it is profoundly disquieting. It is from this, above all, that we really do need to save the planet” (2009: 106). The quote is also quite illustrative of the intensity of the debate.

4.1 Surveys and petitions of dissenting and contrarian positions

There exist also numerous petitions and surveys among scientists that show extensive dissent on the question of AGW and its possible detrimental effects. We present some of the more significant below. First some surveys indicating diverse expert opinion on the topics of climate change (the surveys indicating strongest AGW consensus and critique of them was documented in the former chapter).

In a survey of state climatologists the majority said that recent global warming is largely a natural phenomenon (National Center for Public Policy Research):

“By a 44 to 17 per cent margin, climatologists say that "recent global warming is a largely natural phenomenon," while nine out of 10 of the climatologists surveyed agreed that "scientific evidence indicates variations in global temperature are likely to be naturally-occurring and cyclical over very long periods of time. Eighty-nine percent of the climatologists said that "current science is unable to isolate and measure variations in global temperatures caused only by man-made factors." Sixty-one percent of the state climate experts said historical data does not indicate "that fluctuations in global temperatures are attributable to human influences such as burning fossil fuels," and nearly all said the earth "experienced large global temperature fluctuations with both warming and cooling periods prior to the beginning of the industrial age" and the advent of burning fossil fuels.”⁴⁷

Another survey, conducted by Dennis Bray and Hans von Storch in August 2008 of 2058 climate scientists from 34 different countries showed some disagreement on their question number 21. It stated that: "How convinced are you that most of recent or near future climate change is, or will be, a result of anthropogenic causes?" and received 34.6% very much agree, 48.9% agreeing to a large extent (5–6), 15.1% to a small extent (2–4), and 1.35% not agreeing at all.

An attempt to update Oreskes' consensus study from 2004 (see the former chapter of this report) has been done by Schulte (2010). He sampled and reviewed 539 papers on 'global climate change', from the ISI Web of Science database between January 2004 to mid-February 2007, and found that 45% (cf. 75% reported by Oreskes) either explicitly (7%) or implicitly (38%) endorsed AGW, while 6% (0% in Oreskes review) either explicitly (1%) or implicitly (5%) rejected it. He concluded that: "There appears to be little basis in the peer-reviewed literature for the degree of alarm on the issue of man-made climate change which is being expressed in the media and by politicians' (Schulte 2008: 285). The study has been critiqued, for example by Hausfather (2007) who published his critique before the paper was published, and noted among other things that Oreskes and Schulte framed the issue in very different ways - Oreskes searched for papers at odds with the consensus, while Schulte looked for papers that backed it, something that might account for the substantial difference in results.

The work of Anderegg at al. who uncovered 472 scientists who had "signed statements strongly dissenting from the views of the IPCC", compared with 903 who had supported it, and the survey research of Bray and Storch, who in 2003 found 29% disagreeing that 'climate change is mostly the result of anthropogenic causes' (see also the survey reported by Lichter 2008), suggests that while there certainly are strong arguments for a scientific consensus in favour of the view that AGW is responsible for most of the global warming, with about two-thirds of those who publish in the area supporting it, it is a consensus that falls much short of any kind of unanimity; there are well-credentialed scientists who reject it (see for example Spencer 2008, Paltridge 2009, Carter 2010). Next, we look at some major "petition projects" that have assembled and compiled scientists with dissenting opinions.

A) "Global warming petition project: "31,487 Scientists Reject 'Global Warming' Agenda, including 9,029 with PhD's."⁴⁸ The petition text in its entirety is as follows:

“We urge the United States government to reject the global warming agreement that was written in Kyoto, Japan in December, 1997, and any other similar proposals. The proposed limits on greenhouse gases would harm the environment, hinder the advance of science and technology, and damage the health and welfare of mankind. There is no convincing scientific evidence that human release of carbon dioxide, methane, or other greenhouse gasses is causing or will, in the foreseeable future, cause catastrophic heating of the Earth's atmosphere and disruption of the Earth's climate. Moreover, there is substantial scientific evidence that increases in atmospheric carbon dioxide produce many beneficial effects upon the natural plant and animal environments of the Earth.”

According to the Petition project's website the current list of petition signers includes 9,029 PhD; 7,157 MS; 2,586 MD and DVM; and 12,715 BS or equivalent academic degrees. Most of the MD and DVM signers also have underlying degrees in basic science. The project has subdivided the signatories by educational specialities, and have categorized them as follows: 3,805 from atmospheric, environmental, and Earth sciences; 935 from computer and mathematical sciences; 5,812 from physics and aerospace sciences; 4,822 from chemistry; 2,965 from biology and agriculture; 3,046 from medicine; 10,102 from engineering and general sciences.

This report has not done a detailed study of the accuracy in all aspects of the Petition project, and it has received different types of critique. For example, *Scientific American* investigated the petition and concluded in 2001 that: “... Crudely extrapolating, the petition supporters include a core of about 200 climate researchers – a respectable number, though rather a small fraction of the climatological community.”⁴⁹

B) “The Manhattan Declaration on Climate Change” attracted in 2008, from March to June, 1,100 signatories from 40 countries, including more than 600 experts and scientists from diverse fields, and 206 “endorsers who are climate science specialists or scientists in closely related fields”, to quote from the site.⁵⁰ The declaration text was as follows:

“We, the scientists and researchers in climate and related fields, economists, policymakers, and business leaders, assembled at Times Square, New York City, participating in the 2008 International Conference on Climate Change,

Resolving that scientific questions should be evaluated solely by the scientific method;

Affirming that global climate has always changed and always will, independent of the actions of humans, and that carbon dioxide (CO₂) is not a pollutant but rather a necessity for all life;

Recognising that the causes and extent of recently-observed climatic change are the subject of intense debates in the climate science community and that oft-repeated assertions of a supposed ‘consensus’ among climate experts are false;

Affirming that attempts by governments to legislate costly regulations on industry and individual citizens to encourage CO₂ emission reduction will slow development while having no appreciable impact on the future trajectory of global climate change. Such policies will markedly diminish future prosperity and so reduce the ability of societies to adapt to inevitable climate change, thereby increasing, not decreasing human suffering;

Noting that warmer weather is generally less harmful to life on Earth than colder:

Hereby declare: That current plans to restrict anthropogenic CO₂ emissions are a dangerous misallocation of intellectual capital and resources that should be dedicated to solving humanity’s real and serious problems. That there is no convincing evidence that CO₂ emissions from modern industrial activity has in the past, is now, or will in the future cause catastrophic climate change. That attempts by governments to inflict taxes and costly regulations on industry and individual citizens with the aim of reducing emissions of CO₂ will pointlessly curtail the prosperity of the West and progress of developing nations without affecting climate. That adaptation as needed is massively more cost-effective than any attempted mitigation, and that a focus on such mitigation will divert the attention and resources of governments away from addressing the real problems of their peoples. That human-caused climate change is not a global crisis.

Now, therefore, we recommend – That world leaders reject the views expressed by the United Nations Intergovernmental Panel on Climate Change as well as popular, but misguided works such as “An Inconvenient Truth”.

That all taxes, regulations, and other interventions intended to reduce emissions of CO₂ be abandoned forthwith.”⁵¹

In 2012 an open letter to the UN Secretary-General Ban Ki-Moon was submitted by the International Climate Science Coalition (ICSC), published for example in the Financial Post,⁵² and extracts from the letter is the following:

“The U.K. Met Office recently released data showing that there has been no statistically significant global warming for almost 16 years. During this period, according to the U.S. National Oceanic and Atmospheric Administration (NOAA), carbon dioxide (CO₂) concentrations rose by nearly 9% to now constitute 0.039% of the atmosphere. Global warming that has not occurred cannot have caused the extreme weather of the past few years. Whether, when and how atmospheric warming will resume is unknown. The science is unclear. Some scientists point out that near-term natural cooling, linked to variations in solar output, is also a distinct possibility. The “even larger climate shocks” you have mentioned would be worse if the world cooled than if it warmed. Climate changes naturally all the time, sometimes dramatically. The hypothesis that our emissions of CO₂ have caused, or will cause, dangerous warming is not supported by the evidence. The incidence and severity of extreme weather has not increased. There is little evidence that dangerous weather-related events will occur more often in the future. The U.N.’s own Intergovernmental Panel on Climate Change says in its Special Report on Extreme Weather (2012) that there is “an absence of an attributable climate change signal” in trends in extreme weather losses to date... Rigorous analysis of unbiased observational data does not support the projections of future global warming predicted by computer models now proven to exaggerate warming and its effects.

The NOAA “State of the Climate in 2008” report asserted that 15 years or more without any statistically-significant warming would indicate a discrepancy between observation and prediction. Sixteen years without warming have therefore now proven that the models are wrong by their creators’ own criterion.”

The letter was signed by 134 experts, well qualified in climate-related matters. Signatories included prominent scientists in many fields for example:

“Richard A. Keen, PhD (climatology, University of Colorado), Emeritus Instructor of Atmospheric Science, University of Colorado; former President, Boulder-Denver branch of the American Meteorological Society; Expert Reviewer, IPCC AR5; author of reports and books on the regional weather and climate of Alaska, the Arctic, and North America; NWS co-op observer, Coal Creek Canyon, Golden, Colorado, U.S.A.

Ivar Giaever PhD, Nobel Laureate in Physics 1973, professor emeritus at the Rensselaer Polytechnic Institute, a professor-at-large at the University of Oslo, Applied BioPhysics, Troy, New York, U.S.A.

Don J. Easterbrook, PhD, Emeritus Professor of Geology, Western Washington, University, Bellingham, Washington, U.S.A.

Habibullo I. Abdussamatov, Dr. Sci., mathematician and astrophysicist, Head of the Selenometria project on the Russian segment of the ISS, Head of Space Research of the Sun Sector at the Pulkovo Observatory of the Russian Academy of Sciences, St. Petersburg, Russia.

Syun-Ichi Akasofu, PhD, Professor of Physics, Emeritus and Founding Director, International Arctic Research Center of the University of Alaska, Fairbanks, Alaska, U.S.A.

Bjarne Andresen, Dr. Scient., physicist, published and presents on the impossibility of a “global temperature”, Professor, Niels Bohr Institute (physics (thermodynamics) and chemistry), University of Copenhagen, Copenhagen, Denmark

J. Scott Armstrong, PhD, Professor of Marketing, The Wharton School, University of Pennsylvania, Founder of the International Journal of Forecasting, focus on analyzing climate forecasts, Philadelphia, Pennsylvania, U.S.A.”

Among the signatories were also a number of Norwegian scientists:

“Ole Henrik Ellestad, PhD, former Research Director, applied chemistry SINTEF, Professor in physical chemistry, University of Oslo, Managing director Norsk Regnesentral and Director for Science and Technology, Norwegian Research Council, widely published in infrared spectroscopy, Oslo, Norway.

Rune Berg-Edland Larsen, PhD (Geology, Geochemistry), Professor, Dep. Geology and Geoengineering, Norwegian University of Science and Technology (NTNU), Trondheim, Norway.

Tom V. Segalstad, PhD (Geology/Geochemistry), Associate Professor of Resource and Environmental Geology, University of Oslo, former IPCC expert reviewer, former Head of the Geological Museum, and former head of the Natural History Museum and Botanical Garden (UO), Oslo, Norway

Per Engene, MSc, Biologist, Co-author - The Climate, Science and Politics (2009), Bø i Telemark, Norway.

Jan-Erik Solheim, MSc (Astrophysics), Professor, Institute of Physics, University of Tromsø, Norway (1971-2002), Professor (emeritus), Institute of Theoretical Astrophysics, University of Oslo, Norway (1965-1970, 2002- present), climate specialties: sun and periodic climate variations, scientific paper by Professor Solheim “Solen varsler et kaldere tiår“, Baerum, Norway.

Martin Hovland, M.Sc. (Meteorology, University of Bergen), PhD (Dr Philos, University of Tromsø), FGS, Emeritus Professor, Geophysics, Centre for Geobiology, University of Bergen, member of the expert panel: Environmental Protection and Safety Panel (EPSP) for the Ocean Drilling Program (ODP) and the Integrated ODP, Stavanger, Norway.

Ole Humlum, PhD, Professor of Physical Geography, Department of Physical Geography, Institute of Geosciences, University of Oslo, Oslo, Norway.”

C) The 2010 updated “US Senate Minority report” (updated last in 2010) features according to the report more than 1000 international scientists that dissent on the question of AGW. The following is a sample abstract from the report. It is easily accessible on the web, an updated version can be found here.⁵³ The report presents itself the following way:

“More than 1,000 dissenting scientists (updates previous 700 scientist report) from around the globe have now challenged man-made global warming claims made by the United Nations Intergovernmental Panel on Climate Change (IPCC) and former Vice President Al Gore. This new 2010 321-page Climate Depot Special Report -- updated from the 2007 ground-breaking U.S. Senate Report of over 400 scientists who voiced skepticism about the so-called global warming —consensus -- features the skeptical voices of over 1,000 international scientists, including many current and former UN IPCC scientists, who have now turned against the UN IPCC. This updated 2010 report includes a dramatic increase of over 300 additional (and growing) scientists and climate researchers since the last update in March 2009. This report's release coincides with the 2010 UN global warming summit in being held in Cancun. The more than 300 additional scientists added to this report since March 2009 (21 months ago), represents an average of nearly four skeptical scientists a week speaking out publicly. The well over 1,000

dissenting scientists are almost 20 times the number of UN scientists (52) who authored the media-hyped IPCC 2007 Summary for Policymakers. The chorus of skeptical scientific voices grew louder in 2010 as the Climategate scandal - - which involved the upper echelon of UN IPCC scientists -- detonated upon on the international climate movement. "I view Climategate as science fraud, pure and simple," said noted Princeton Physicist Dr. Robert Austin shortly after the scandal broke. Climategate prompted UN IPCC scientists to turn on each other. UN IPCC scientist Eduardo Zorita publicly declared that his Climategate colleagues Michael Mann and Phil Jones "should be barred from the IPCC process...They are not credible anymore." Zorita also noted how insular the IPCC science had become. "By writing these lines I will just probably achieve that a few of my future studies will, again, not see the light of publication," Zorita wrote. A UN lead author Richard Tol grew disillusioned with the IPCC and lamented that it had been "captured" and demanded that "the Chair of IPCC and the Chairs of the IPCC Working Groups should be removed." Tol also publicly called for the "suspension" of IPCC Process in 2010 after being invited by the UN to participate as lead author again in the next IPCC Report. [Note: Zorita and Tol are not included in the count of dissenting scientists in this report.] Other UN scientists were more blunt. A South African UN scientist declared the UN IPCC a "worthless carcass" and noted IPCC chair Pachauri is in "disgrace". He also explained that the "fraudulent science continues to be exposed." Alexander, a former member of the UN Scientific and Technical Committee on Natural Disasters harshly critiqued the UN. "I was subjected to vilification tactics at the time. I persisted. Now, at long last, my persistence has been rewarded...There is no believable evidence to support [the IPCC] claims. I rest my case!"... Geologist Dr. Don Easterbrook, a professor of geology at Western Washington University, summed up the scandal on December 3, 2010: "The corruption within the IPCC revealed by the Climategate scandal, the doctoring of data and the refusal to admit mistakes have so severely tainted the IPCC that it is no longer a credible agency."

The updated 2010 Senate report, in its own words "featuring over 1,000 international scientists dissenting from man-made climate fears", selected some highlights from their own report to present. They are presented below.

"We're not scientifically there yet. Despite what you may have heard in the media, there is nothing like a consensus of scientific opinion that this is a problem. Because there is natural

variability in the weather, you cannot statistically know for another 150 years.” -- UN IPCC’s Tom Tripp, a member of the UN IPCC since 2004 and listed as one of the lead authors and serves as the Director of Technical Services & Development for U.S. Magnesium.

“Any reasonable scientific analysis must conclude the basic theory wrong!!” -- NASA Scientist Dr. Leonard Weinstein who worked 35 years at the NASA Langley Research Center and finished his career there as a Senior Research Scientist. Weinstein is presently a Senior Research Fellow at the National Institute of Aerospace.

“Please remain calm: The Earth will heal itself -- Climate is beyond our power to control...Earth doesn't care about governments or their legislation. You can't find much actual global warming in present-day weather observations. Climate change is a matter of geologic time, something that the earth routinely does on its own without asking anyone's permission or explaining itself.‖ -- Nobel Prize-Winning Stanford University Physicist Dr. Robert B. Laughlin, who won the Nobel Prize for physics in 1998, and was formerly a research scientist at Lawrence Livermore National Laboratory.

“In essence, the jig is up. The whole thing is a fraud. And even the fraudsters that fudged data are admitting to temperature history that they used to say didn't happen...Perhaps what has doomed the Climategate fraudsters the most was their brazenness in fudging the data” -- Dr. Christopher J. Kobus, Associate Professor of Mechanical Engineering at Oakland University, specializes in alternative energy, thermal transport phenomena, two-phase flow and fluid and thermal energy systems and has published peer-reviewed papers.

“The energy mankind generates is so small compared to that overall energy budget that it simply cannot affect the climate...The planet’s climate is doing its own thing, but we cannot pinpoint significant trends in changes to it because it dates back millions of years while the study of it began only recently. We are children of the Sun; we simply lack data to draw the proper conclusions.” -- Russian Scientist Dr. Anatoly Levitin, the head of geomagnetic variations laboratory at the Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation of the Russian Academy of Sciences who has published numerous peer-reviewed studies about the interaction of solar radiation with the Earth’s magnetic field.

“Hundreds of billion dollars have been wasted with the attempt of imposing a Anthropogenic Global Warming (AGW) theory that is not supported by physical world evidences...AGW has been forcefully imposed by means of a barrage of scare stories and

indoctrination that begins in the elementary school textbooks.” -- Brazilian Geologist Geraldo Luís Lino, who authored the 2009 book —The Global Warming Fraud: How a Natural Phenomenon Was Converted into a False World Emergency.

"I am an environmentalist," but "I must disagree with Mr. Gore -- Chemistry Professor Dr. Mary Mumper, the chair of the Chemistry Department at Frostburg State University in Maryland, has published several peer-reviewed studies in biochemistry. Mumper's presentation was titled —Anthropogenic Carbon Dioxide and Global Warming, the Skeptic's View.

"I am ashamed of what climate science has become today." The science "community is relying on an inadequate model to blame CO2 and innocent citizens for global warming in order to generate funding and to gain attention. If this is what „science“ has become today, I, as a scientist, am ashamed." -- Research Chemist William C. Gilbert published a study in August 2010 in the journal Energy & Environment titled —The thermodynamic relationship between surface temperature and water vapor concentration in the troposphere and he published a paper in August 2009 titled —Atmospheric Temperature Distribution in a Gravitational Field. [Updated December 9, 2010]

“The dysfunctional nature of the climate sciences is nothing short of a scandal. Science is too important for our society to be misused in the way it has been done within the Climate Science Community.” The global warming establishment “has actively suppressed research results presented by researchers that do not comply with the dogma of the IPCC.” -- Swedish Climatologist Dr. Hans Jelbring of the Paleogeophysics & Geodynamics Unit at Stockholm University. [Updated December 9, 2010. Corrects Jelbring's quote.]

“Those who call themselves „Green planet advocates“ should be arguing for a CO2-fertilized atmosphere, not a CO2-starved atmosphere...Diversity increases when the planet was warm AND had high CO2 atmospheric content...Al Gore's personal behavior supports a green planet - his enormous energy use with his 4 homes and his bizjet, does indeed help make the planet greener. Kudos, Al for doing your part to save the planet.” -- Renowned engineer and aviation/space pioneer Burt Rutan, who was named "100 most influential people in the world, 2004" by Time Magazine and Newsweek called him "the man responsible for more innovations in modern aviation than any living engineer."

“Global warming is the central tenet of this new belief system in much the same way that the Resurrection is the central tenet of Christianity. Al Gore has taken a role corresponding to that of

St Paul in proselytizing the new faith...My skepticism about AGW arises from the fact that as a physicist who has worked in closely related areas, I know how poor the underlying science is. In effect the scientific method has been abandoned in this field.” -- Atmospheric Physicist Dr. John Reid, who worked with Australia’s CSIRO’s (Commonwealth Scientific and Industrial Research Organization) Division of Oceanography and worked in surface gravity waves (ocean waves) research.

Numerous other examples could have been extracted from the report. It is a massive compilation of scientist’s dissenting views and statements. However, it has also received criticism. Critique of the Senate minority report have been published, most notably by the Center for Inquiry’s Credibility project. The results of their critical assessment are summarized as follows:

“...while there are indeed some well respected scientists on the list, the vast majority are neither climate scientists, nor have they published in fields that bear directly on climate science. After assessing 687 individuals named as “dissenting scientists” in the January 2009 version of the United States Senate Minority Report, the Center for Inquiry’s Credibility Project found that: Slightly fewer than 10 percent could be identified as climate scientists; Approximately 15 percent published in the recognizable refereed literature on subjects related to climate science; Approximately 80 percent clearly had no refereed publication record on climate science at all; Approximately 4 percent appeared to favor the current IPCC-2007 consensus and should not have been on the list.”⁵⁴

Notwithstanding this critique, the updated US Senate minority report provides extensive documentation on the very diverse and dissenting voices in the debate about AGW.

D) International Conference on Climate Change (ICCC). This international conference, hosted by The Heartland Institute, “the world’s most prominent think tank promoting skepticism about man-made climate change (The Economist, May 26, 2012), that include many dissenting voices on the question of AGW was for example in 2009 attended by people such as former Czech President Václav Klaus, and atmospheric physicist and Alfred P. Sloan Professor of Meteorology at the Massachusetts Institute of Technology (MIT), Richard S. Lindzen. Václav Klaus stated that “The politicians sometimes look at the very condensed version of the IPCC’s Summaries for

Policymakers but these documents do not represent science, but rather politics and environmental activism. They (politicians) did not fully subscribe to the idea that the IPCC publications represent ‘the’ climate science. We know that is not true, and that there is no scientific discipline of climate science”. Klaus added, “I am looking forward to new ideas, arguments and data coming out of this conference.”

Dr Richard Lindzen of MIT said, “Global warming alarm has always been a political movement, and opposing it has always been an up-hill battle”. Lindzen adds, “What can be done? The most obvious point here is to preserve and better understand the science and to emphasize logic- which ultimately trumps ‘authority’.”⁵⁵

The seventh IPCC conference took place in 2012, and Václav Klaus and more than 50 speakers addressed an audience of about 300. According to their site, “invitations were extended to more than 50 scientists who support the United Nations Intergovernmental Panel on Climate Change’s perspective, but none agreed to attend. It was a stunning admission that the scientific debate has turned decisively away from the IPCC’s alarmism and toward a more realistic perspective.”⁵⁶ Still, the conference will be discontinued.

Serious dissenting scientists broadly argue against the alleged IPCC “consensus” on four different grounds: 1) scientists arguing against the accuracy of the IPCC reports and their projections, 2) scientists arguing that global warming is caused largely by natural processes, and 3) that the cause(s) of global warming are to a large extent unknown, and 4) that global warming will have few negative effects, or that all things considered it will likely have more positive effects than negative ones.

Unrelated to the IPCC conference, in a 2012 interview with noted climatologist Judith Curry, Chair of the School of Earth and Atmospheric Sciences at the Georgia Institute of Technology, and recently a partially “converted” dissenter in the debate about AGW, she outlines neatly several of the dimensions of both “consensus and dissent”. Under the heading “The IPCC May Have Outlived its Usefulness” Curry states:

“The climate is always changing. Climate is currently changing because of a combination of natural and human induced effects. The natural effects include variations of the sun, volcanic eruptions, and oscillations of the ocean. The human induced effects include the greenhouse gases such as carbon dioxide, pollution aerosols, and land use changes. The key scientific issue is

determining how much of the climate change is associated with humans. This is not a simple thing to determine. The most recent IPCC assessment report states: “Most [50%] of the warming in the latter half of the 20th century is very likely [>90%] due to the observed increase in greenhouse gas concentrations.” There is certainly some contribution from the greenhouse gases, but whether it is currently a dominant factor or will be a dominant factor in the next century, is a topic under active debate, and I don’t think the high confidence level [>90%] is warranted given the uncertainties. As I stated in my testimony last year: “Based upon the background knowledge that we have, the threat does not seem to be an existential one on the time scale of the 21st century, even in its most alarming incarnation.”⁵⁷

On her climate research blog “Climate Etc.”⁵⁸ she gives voice to the full spectrum of science, knowledge, discussion, questioning and dissent on AGW. For example she has posted on her site, and later published an interesting paper entitled: “Climate change: no consensus on consensus” (Curry and Webster 2012). Exploring the history and consequences of the activities of scientific consensus building by the IPCC on the issues of dangerous anthropogenic climate change, the conclusion of the paper is the following:

“The climate community has worked for more than 20 years to establish a scientific consensus on anthropogenic climate change. The IPCC consensus building process arguably played a useful role in the early synthesis of the scientific knowledge and in building political will to act. We have presented perspectives from multiple disciplines that support the inference that the scientific consensus seeking process used by the IPCC has had the unintended consequence of introducing biases into the both the science and related decision making processes. The IPCC scientific consensus has become convoluted with consensus decision making through a ‘speaking consensus to power’ approach. The growing implications of the messy wickedness of the climate change problem are becoming increasingly apparent, highlighting the inadequacies of the ‘consensus to power’ approach for decision making on the complex issues associated with climate change. Further, research from the field of science and technology studies are finding that manufacturing a consensus in the context of the IPCC has acted to hyper-politicize the scientific and policy debates, to the detriment of both. Arguments are increasingly being made to abandon the scientific consensus seeking approach in favour of open debate of the arguments themselves and discussion of a broad range of policy options that stimulate local and regional

solutions to the multifaceted and interrelated issues of climate change, land use, resource management, cost effective clean energy solutions, and developing technologies to expand energy access efficiently” (ibid.: 10-11).⁵⁹

As a preliminary conclusion of this chapter we simply note that there are strong scientific currents of dissent and continuing questioning on most aspects of climate change and anthropogenic global warming, and it happens also to a large extent in the peer-reviewed mainstream journals of “normal science.” Thus the claim of a near 100 % consensus and lack of dissent on key aspects of AGW is simply not true, and likewise, the claim that “mainstream science” is closed off to dissenting voices is also not true.

5 Conclusions

To illustrate the way that scientific, political and ethical concerns are mixed in the debate on Anthropogenic Global Warming this report used the by now famous quote from Gro Harlem Brundtland, that "doubt has been eliminated", and that it is "irresponsible, reckless and deeply immoral to question the seriousness of the situation" as a point of departure. The goal of the report was to enter this debate and "battlefield" of arguments and take stock of the debate about anthropogenic (man-made) global warming. Based on the present review of this debate there are several conclusions to be drawn. The first and simplest one is that considered as an empirical statement, the assertion that "doubt has been eliminated" on AGW is plainly false. Although as documented the level of agreement in the scientific literature that AGW is occurring is quite extensive, the magnitude of dissent, questioning and contrarian perspectives and positions in both scientific discourse and public opinion on the question of AGW evidently contradicts such a proclamation.

The second conclusion is that the *scientific* debate may be considered healthy. The levels and types of disagreement crosscuts most camps and categorizations, so that a presentation of two-sided war with a 97-98 % majority consensus and 2-3 % group of sceptics and "deniers" is flawed. At the level of scientific exchange, there is in the climate sciences an ongoing discussion and organized critique that seems to a large extent (with arguably some major exceptions as highlighted in the "climategate" affair) to be working as "normal science" should. The allegation that the science of AGW is settled to such a degree and cohesion that the debate can be closed, contradicts the findings in this report. There are multiple on-going debates and questioning, also in mainstream scientific outlets, even on such fundamental issues as whether the greenhouse warming effect is a reality or a fiction; if it is scientifically meaningful at all to talk about a global temperature; if the significant warming that seems to have happened since the Little Ice Age in the perspective of longer timescales can be considered extraordinary; the significance of other sources, such as the sun, on climate change; if warming means better or worse conditions on earth; and the extent to which man contributes to the changing climate of earth.

The scientific debate has not yet been "black boxed" in the case of AGW, and the case illustrates a general argument made that the more "upstream" into the specific details of the diverse topics scientists dive, the more technical and controversial the issues become (cf. Latour 1987). It is not uncommon to seek to close scientific debates prematurely (ibid.), but although seemingly

substantial efforts are being made to do so in the case of AGW, they have not fully succeeded. We might add, in light of the findings in this report the scientific debate should (and most likely will) continue on its own terms, unhampered to the extent possible by ideological constraints.

Thirdly, we see that the normativity in the Brundtland statement has several problems when interpreted as a general statement about the practices, authority and truth claims of science in the context of science. In this context the form of dogmatism expressed by Brundtland, even explicitly asserting that raising further critical questions is immoral, is itself unscientific and contrary to the norms of the scientific institution from which she lends her authority in this case. Such a position then rather seems to represent a form of quasi-religious *faith* in science (cf. Strand 2012).

The general questions about the justification and legitimacy of the authority of types of perspectives and positions have received massive attention in philosophical and epistemological discourse, and they have no easy answers, yet Brundtland's and other similar statements, carries with it an inherent contradiction that undermines its legitimacy. If, as we have shown earlier, science is defined epistemologically as fallible and as a practice "that embodies norms of doubt and self-criticism, the belief in Science cannot be too dogmatic and too hostile towards criticism raised against it without becoming unscientific" (Strand 2012: 58). This problem is undoubtedly (sic!) something we can observe in the quote from Brundtland, and as shown in the case of "climategate" and other examples used in this report, it also arguably applies to some extent to parts of climate science more in general.

Indeed, the Norwegian Research Ethics Committee for Science and Technology (NENT) processed a complaint about Brundtland's speech in 2009, and gave an answer including these comments: "Traditional academic norms allow and encourage doubt and critical questions. Doubt may in such contexts be well or ill founded, but not irresponsible and immoral by itself" (NENT 2009). NENT concluded that Brundtland's speech differed from "accepted language use in scientific contexts" (ibid.), implying that they violated the ethos of science.

As a response to this critique one might argue that Brundtland not at all was representing the voice of science, participated in the context of science, or was trying to be a philosopher of science, but rather communicated as a concerned citizen and public official that sought to spur the public to action based on the precautionary principle and broader beliefs (not only based in scientific beliefs) about the looming dangers of global warming. Based on all the diverse experience of Brundtland, this caveat is not entirely unlikely. Nevertheless, her statement, and the similar voices of the

“consensus camp”, to the extent that they solely rely upon, represent or construct more or less dogmatic or relatively “undoubtful” truth claims adopted or adapted from IPCC and other science-based institutions, they are simultaneously undermining the authority and legitimacy of their broader concerns by expressing this unscientific faith in Science (with capital S as the one and only Truth).

By insisting on scientific consensus and the “elimination of doubt”, seeking to declare the science of AGW settled once and for all, and imbuing this putative settlement with highly normative and pejorative allegations (to question is “irresponsible, reckless and immoral”), the consensus approach clings to being (solely) “science-based”, but its position is at the same time implicitly in direct opposition to the ethos of “normal science”. It is not supported, justified or endorsed by science in its canonical expression, where science, based on thinkers such as Kant, Popper, Merton and Polanyi is seen to be constituted on continued discussion, open criticism, anti-dogmatism, (self)critical mindset, methodological doubt, and the organization of scepticism.

In the more prosaic words of novelist Michael Crichton, from a 2003 talk he held at the California Institute of Technology, the critique against this anti-scientific science can be expressed in the following way:

“I want to pause here and talk about this notion of consensus, and the rise of what has been called consensus science. I regard consensus science as an extremely pernicious development that ought to be stopped cold in its tracks. Historically, the claim of consensus has been the first refuge of scoundrels; it is a way to avoid debate by claiming that the matter is already settled. Whenever you hear the consensus of scientists agrees on something or other, reach for your wallet, because you're being had. Let's be clear: the work of science has nothing whatever to do with consensus. Consensus is the business of politics. 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 is relevant is 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. Period.”⁶¹

It is not difficult the consent to the comments by Mike Hulme, professor of climate change in the School of Environmental Sciences at the University of East Anglia and a contributor to the

Intergovernmental Panel on Climate Change (IPCC), when he states that: “The three questions ... What is causing climate change? By how much is warming likely to accelerate? What level of warming is dangerous? — represent just three of a number of contested or uncertain areas of knowledge about climate change” (2009: 74). Related to IPCC Hulme also noted that “It was to be governed by a Bureau consisting of selected governmental representatives, thus ensuring that the Panel’s work was clearly seen to be serving the needs of government and policy. The Panel was not to be a self-governing body of independent scientists.” (2009: 95). If this is correct it arguably stands in some tension to Polanyi’s defence of the autonomy of science.

In open societies where both scientists and the general public are equipped with critical skills and the tools of inquiry, not least enabled by the information revolution provided through the Internet, the ethos of science as open, questioning, critical and anti-dogmatic should and can be defended also by the public at large. Efforts to make people bow uncritically to the authority of a dogmatic representation of Science, seems largely to produce ridicule, opposition and inaction, and ultimately undermines the legitimacy and role of both science and politics in open democracies.

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² Espen Søybye, *Morgenbladet* 31. Aug-6. Sep. 2012, p. 38.

³ The footnote can be found in Critique online at the Gutenberg project:
<http://www.gutenberg.org/files/4280/4280-h/4280-h.htm> (accessed 12 September 2012).

⁴ Espen Søybye, *Morgenbladet* 31. Aug-6. Sep 2012, p. 38.

⁵ See <http://journalistsresource.org/studies/environment/climate-change/structure-scientific-opinion-climate-change/> (accessed 10 December 2012).

⁶ See <http://www.ucsusa.org/ssi/climate-change/scientific-consensus-on.html> (accessed 14 October 2012).

⁷ See http://www.ucsusa.org/global_warming/solutions/big_picture_solutions/us-scientists-economists.html (accessed 14 October 2012).

⁸ See the note above.

⁹ See <http://newsbusters.org/blogs/brent-baker/2008/04/02/turner-iraqi-insurgents-patriots-inaction-warming-cannibalism#ixzz27gGyD87y> (accessed 27 September 2012).

¹⁰ See <http://www.guardian.co.uk/science/2012/jul/29/climate-change-sceptics-change-mind?INTCMP=SRCH> (accessed 10 December 2012).

¹¹ See <http://wattsupwiththat.com/2012/07/29/press-release-2/> (aksessert 4. september 2012).

¹² See <http://www.forbes.com/sites/larrybell/2012/07/17/that-scientific-global-warming-consensus-not/> (accessed 14 October 2012).

¹³ See <http://wattsupwiththat.com/2012/07/18/about-that-overwhelming-98-number-of-scientists-consensus/> (accessed 14 October 2012).

¹⁴ See <http://news.sciencemag.org/scienceinsider/2010/06/scientists-convinced-of-climate.html> (accessed 10 November 2012).

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¹⁷ See IPCC Third Assessment Report 2001, http://www.grida.no/publications/other/ipcc%5Ftar/?src=/climate/ipcc_tar/wg1/005.htm (accessed 10 September 2012).

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¹⁹ See "Figures and Tables" of the Third IPCC Assessment Report – Climate Change 2001 – Synthesis Report, http://www.grida.no/publications/other/ipcc_tar/ (accessed 10 September 2012).

²⁰ The Wegman report can be downloaded here: <http://www.uoguelph.ca/~rmckitri/research/WegmanReport.pdf> (accessed 10 November 2012).

²¹ See <http://www.marshall.org/article.php?id=49> (accessed 10 October 2012).

²² See <http://www.cru.uea.ac.uk/cru/data/temperature/> (accessed 12 September 2012).

²³ See <http://www.cru.uea.ac.uk/cru/data/temperature/> (accessed 10 October 2012).

²⁴ See <http://wattsupwiththat.com/2012/07/29/press-release-2/> (accessed 15 November 2012).

²⁵ See "Supplement to Watts et al. 2012", <http://wattsupwiththat.files.wordpress.com/2012/07/watts-et-al-station-siting-7-29-12.ppt> (accessed 4 September 2012).

²⁶ See <http://www.uoguelph.ca/~rmckitri/research/globaltemp/GlobTemp.JNET.pdf> (accessed 15 December 2012).

²⁷ See <http://www.independent.co.uk/environment/climate-change/the-world-is-hottest-it-has-been-since-the-end-of-the-ice-age--and-the-temperatures-still-rising-8525089.html> (accessed 10 March 2013).

²⁸ See <http://www.nytimes.com/2013/03/08/science/earth/global-temperatures-highest-in-4000-years-study-says.html> (accessed 10 March 2013).

²⁹ The site <http://eastangliaemails.com/> that have posted the emails is "temporarily unavailable" (accessed 20 December 2012).

³⁰ Source: atext.

³¹ <http://wattsupwiththat.com/2012/01/06/250-plus-noteworthy-climategate-2-0-emails/> (accessed 23 June 2012).

³² On 21 February, 2005, see <http://www.publications.parliament.uk/pa/cm200910/cmselect/cmsctech/memo/climatedata/uc3502.htm> (accessed 12 December 2012).

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³⁵ See <http://online.wsj.com/article/SB10001424052970204301404577171531838421366.html> (accessed 26 October, 2012)

³⁶ See <http://www.climatedepot.com/a/12797/Exclusive-Nobel-PrizeWinning-Physicist-Who-Endorsed-Obama-Dissents-Resigns-from-American-Physical-Society-Over-Groups-Promotion-of-ManMade-Global-Warming> (accessed 15 November 2012).

³⁷ See http://www.aps.org/policy/statements/07_1.cfm (accessed 15 November 2012).

³⁸ See APS Forum on Physics & Society "Editor's Comments", July 2008, <http://www.aps.org/units/fps/newsletters/200807/editor.cfm> (accessed 15 November 2012).

³⁹ See <http://www.populartechnology.net/2009/10/peer-reviewed-papers-supporting.html> (accessed 25 August 2012).

⁴⁰ See <http://www.uoguelph.ca/~rmckitri/research/globaltemp/GlobTemp.JNET.pdf> (accessed 15 December 2012).

⁴¹ See <http://bellwether.metapress.com/content/6024h28209141257/> (accessed 15 September 2012).

⁴² See <http://www.nature.com/nature/journal/v355/n6358/abs/355342a0.html> (accessed 10 December 2012).

⁴³ See <http://www.degruyter.com/view/j/spp.2010.1.1/spp.2010.1.1.1004/spp.2010.1.1.1004.xml> (accessed 10 December 2012).

⁴⁴ See <http://www.agu.org/pubs/crossref/2012/2011GL050207.shtml> (accessed 15 December 2012).

⁴⁵ See <http://journals.hil.unb.ca/index.php/GC/article/view/18590> (accessed 15 December 2012).

⁴⁶ See <http://www.forbes.com/sites/larrybell/2012/05/08/global-warming-chorus-discord-rising-to-feverish-pitch/> (accessed 12 December 2012).

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⁴⁸ See <http://www.petitionproject.org/> (accessed 15 December 2012).

⁴⁹ See http://en.wikipedia.org/wiki/Oregon_Petition (accessed 15 December 2012).

⁵⁰ See

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⁵¹ See

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⁵⁴ See

http://www.centerforinquiry.net/opp/news/senate_minority_report_on_global_warming_not_credible/ (accessed 10 December 2012).

⁵⁵ See <http://lib.store.yahoo.net/lib/realityzone/UFNeupresblastsgwskeptics.html> (accessed 10 December 2012).

⁵⁶ See <http://climateconference.heartland.org/> (accessed 10 December 2012).

⁵⁷ See <http://oilprice.com/Interviews/The-IPCC-May-Have-Outlived-its-Usefulness-An-Interview-with-Judith-Curry.html> (accessed 10 December 2012).

⁵⁸ See <http://judithcurry.com/> (accessed 15 October 2012).

⁵⁹ At the time of writing the paper is still in press, but the final version is accessible online, the page numbers refer to this version. <http://curryja.files.wordpress.com/2012/10/consensus-paper-revised-final.doc> (accessed 15 December 2012).

⁶¹ Crichton, Michael, 'Aliens cause Global Warming', 17 January 2003 speech at the California Institute of Technology (<http://s8int.com/crichton.html>) (accessed 10 December 2012).