Climate Change Reconsidered II

Physical Science

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Reviews of *Climate Change Reconsidered II: Physical Science*

"I fully support the efforts of the Nongovernmental International Panel on Climate Change (NIPCC) and publication of its latest report, *Climate Change Reconsidered II: Physical Science,* to help the general public to understand the reality of global climate change."

Kumar Raina, Former Deputy Director General
Geological Survey of India

"*Climate Change Reconsidered II* fulfills an important role in countering the IPCC part by part, highlighting crucial things they ignore such as the Little Ice Age and the recovery (warming) which began in 1800–1850. Superimposed on that recovery, there is a prominent multi-decadal oscillation. These can explain much of climate change from 1800, including the fact that the warming has halted from 2000, phenomena the IPCC reports do not properly cover. In contrast to the IPCC, which often ignores evidence of past changes, the authors of the NIPCC report recognize that climatology requires studying past changes to infer future changes."

Syun-Ichi Akasofu
Founding Director & Professor of Physics Emeritus
International Arctic Research Center, University of Alaska Fairbanks

"The work of the NIPCC to present the evidence for natural climate warming and climate change is an essential counter-balance to the biased reporting of the IPCC. They have brought to focus a range of peer-reviewed publications showing that natural forces have in the past and continue today to dominate the climate signal."

Ian Clark, Department of Earth Sciences
University of Ottawa, Canada

"The CCR-II report correctly explains that most of the reports on global warming and its impacts on sea-level rise, ice melts, glacial retreats, impact on crop production, extreme weather events, rainfall changes, etc. have not properly considered factors such as physical impacts of human activities, natural variability in climate, lopsided models used in the prediction of production estimates, etc. There is a need to look into these phenomena at local and regional scales before sensationalization of global warming-related studies."

S. Jeevananda Reddy, Former Chief Technical Advisor
United Nations World Meteorological Organization

"Library shelves are cluttered with books on global warming. The problem is identifying which ones are worth reading. The NIPCC's CCR-II report is one of these. Its coverage of the topic is comprehensive without being superficial. It sorts through conflicting claims made by scientists and highlights mounting evidence that climate sensitivity to carbon dioxide increase is lower than climate models have until now assumed."

Chris de Freitas, School of Environment
The University of Auckland, New Zealand

"Rather than coming from a pre-determined politicized position that is typical of the IPCC, the NIPCC constrains itself to the scientific process so as to provide objective information. If we (scientists) are honest, we understand that the study of atmospheric processes/dynamics is in its infancy. Consequently, the work of the NIPCC and its most recent report is very important."

Bruce Borders, Professor of Forest Biometrics
Warnell School of Forestry and Natural Resources, University of Georgia

"I support [the work of the NIPCC] because I am convinced that the whole field of climate and climate change urgently needs an open debate between several 'schools of thought,' in science as well as other disciplines, many of which jumped on the IPCC bandwagon far too readily. Climate, and even more so impacts and responses, are far too complex and important to be left to an official body like the IPCC."

Sonja A. Boehmer-Christiansen
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Physical Science

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Foreword

The Heartland Institute is pleased to partner once again with the Center for the Study of Carbon Dioxide and Global Change and the Science and Environmental Policy Project to produce an authoritative and independent assessment of the latest science concerning the causes and consequences of climate change.

Many scientists, policymakers, and engaged citizens are concerned over the possibility that man-made greenhouse gas emissions, in particular carbon dioxide (CO2), may be causing dangerous climate change. A primary reason for this public alarm is a series of reports issued by the United Nations' Intergovernmental Panel on Climate Change (IPCC). The IPCC claims to know, with apparent rising certainty over time, that "most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations" (IPCC, 2007, p. 10). Is this conclusion based on sound science?

Climate change is a controversial topic because it is interdisciplinary: scientists and experts in widely divergent fields of study can rightfully weigh in on the debate with their insights and informed opinions. A historian of the global warming debate recently observed that "economists should be in a better position than others to make their own assessment of the science because much of it is about statistics and modeling" (Darwall, 2013, p. 239). He quotes Canadian economist Ross McKitrick as saying "the typical economist has way more training in data analysis than a typical climatologist," and "once they start reading climate papers they start spotting errors all over the place." Of course, economists also have their own blind spots.

What is necessary, and too seldom takes place, is a respectful debate on the causes and consequences of climate change in which ideas and theories rise or fall on their merits rather than their pedigree or influence on public policy. A technique frequently used in industry, government, and law when dealing with complex or controversial matters is to deploy competing Green and Red Teams to pursue alternative approaches (e.g., Sandoz, 2001; Nemeth *et al.,* 2001). A Red Team provides a kind of "defense counsel" to verify and counter arguments mounted by the initial Green Team (the "prosecution") as well as discover and present alternatives the Green Team may have overlooked.

For many years, the Green Team of the IPCC has dominated the global debate over climate change. In 2003, however, at a meeting in Milan, a Red Team started to emerge composed of independent scientists drawn from universities and private institutions around the world. Since 2008 that team, the Nongovernmental International Panel on Climate Change (NIPCC), has been independently evaluating the impacts of rising atmospheric CO_2 concentrations on Earth's biosphere and evaluating forecasts of future climate effects.

NIPCC: A Brief History

The Nongovernmental International Panel on Climate Change, or NIPCC, is an international panel of scientists and scholars who came together to understand the causes and consequences of climate change. NIPCC has no formal attachment to or sponsorship from any government or governmental agency. It is wholly independent of political pressures and influences and therefore is not predisposed to produce politically motivated conclusions or policy recommendations.

NIPCC seeks to objectively analyze and interpret data and facts without conforming to any specific agenda. This organizational structure and purpose

stand in contrast to those of the United Nations' Intergovernmental Panel on Climate Change (IPCC), which *is* government-sponsored, politically motivated, and predisposed to believing that climate change is a problem in need of a U.N. solution.

NIPCC traces its beginnings to an informal meeting held in Milan, Italy in 2003 organized by Dr. S. Fred Singer and the Science and Environmental Policy Project (SEPP). The purpose was to produce an independent evaluation of the available scientific evidence on the subject of carbon dioxide-induced global warming in anticipation of the release of the IPCC's Fourth Assessment Report. NIPCC scientists concluded the IPCC was biased with respect to making future projections of climate change, discerning a significant human-induced influence on current and past climatic trends, and evaluating the impacts of potential carbon dioxide-induced environmental changes on Earth's biosphere.

To highlight such deficiencies in the IPCC's report, in 2008 SEPP partnered with The Heartland Institute to produce *Nature, Not Human Activity, Rules the Climate,* a summary of research for policymakers that has been widely distributed and translated into six languages. In 2009, Craig Idso and the Center for the Study of Carbon Dioxide and Global Change joined the original two sponsors to help produce *Climate Change Reconsidered: The 2009 Report of the Nongovernmental International Panel on Climate Change (NIPCC)*, the first comprehensive alternative to the alarmist reports of the IPCC.

In 2010, a Web site (www.nipccreport.org) was created to highlight scientific studies NIPCC scientists believed would likely be downplayed or ignored by the IPCC during preparation of its next assessment report. In 2011, the three sponsoring organizations along with a new co-author, Australian marine geologist Robert M. Carter, produced *Climate Change Reconsidered: The 2011 Interim Report of the Nongovernmental International Panel on Climate Change (NIPCC)*, a review and analysis of new research released since the 2009 report or overlooked by the authors of that report.

In 2013, the Information Center for Global Change Studies, a division of the Chinese Academy of Sciences, translated and published an abridged edition of the 2009 and 2011 NIPCC reports in a single volume. On June 15, the Chinese Academy of Sciences organized a NIPCC Workshop in Beijing to allow the NIPCC principal authors to present summaries of their conclusions.

For all its reports, NIPCC has worked with leading thinkers in the fields of statistics, physics, economics, geology, climatology, and biology. It has avoided the appeals to authority, assumptions, and circumstantial evidence that characterize the reports of the IPCC and other partisans in this debate. The result is a contribution to the debate that reveals some inconvenient truths based squarely on the best available research on climate.

CCR II: Physical Science

Climate Change Reconsidered II: Physical Science is NIPCC's latest report. Lead authors Craig D. Idso, Robert M. Carter, and S. Fred Singer have worked with a team of nearly 50 scientists to produce a report that is comprehensive, objective, and faithful to the scientific method. Despite its heft, it is only the first of two volumes that together mirror and rebut the IPCC's Working Group 1 and Working Group 2 reports. The second volume of *CCR II,* planned for release in 2014, will address impacts, adaptation, and vulnerabilities.

Like the IPCC's reports, NIPCC's reports cite thousands of articles appearing in peer-reviewed science journals relevant to the subject of human-induced climate change. NIPCC presents its findings in seven chapters:

Global Climate Models
Forcings and Feedbacks
Solar Forcing of Climate
Observations: Temperature Records
Observations: The Cryosphere
Observations: The Hydrosphere and Oceans
Observations: Extreme Weather

In keeping with its Red Team mission, NIPCC authors paid special attention to contributions that were either overlooked by the IPCC or that contain data, discussion, or implications arguing against the IPCC's claim that dangerous global warming is resulting, or will result, from human-related greenhouse gas emissions. The Executive Summary beginning on page 1 summarizes NIPCC's principal findings. Most notably, its authors say the IPCC has exaggerated the amount of warming they predict will occur in response to projected increases in atmospheric CO_2, Any such warming that may occur is likely to be modest and will not pose a dangerous

threat to the global environment or to human well-being.

Policy Implications

Few scientists deny that human activities can have an effect on local climate or that the sum of such local effects could hypothetically rise to the level of an observable global signal. The key questions to be answered, however, are whether the human global signal is large enough to be properly measured and if it is, does it represent, or is it likely to become, a dangerous change outside the range of natural variability?

NIPCC's conclusion, drawn from its extensive review of the scientific evidence, is that the greenhouse gas-induced global climate signal is so small as to be embedded within the background variability of the natural climate system and is not dangerous. At the same time, global temperature change is occurring, as it always naturally does. A phase of temperature stasis or cooling has succeeded the mild twentieth century warming. It is certain that similar natural climate changes will continue to occur.

In the face of such facts, the most prudent climate policy is to prepare for and adapt to natural climate events and the threats they pose to society regardless of their origin. Adaptive planning for future hazardous climate events and change should be tailored to provide reasonable responses to their known rates, magnitudes, and risks. Once in place, these plans will provide an adequate response to any human-caused change that may or may not emerge.

Policymakers should resist pressure from lobby groups to silence those who question the authority of the IPCC as the sole gatekeeper and voice speaking in behalf of "climate science." *Climate Change Reconsidered II: Physical Science* reveals a scientific community deeply uncertain about the reliability of the IPCC's computer models, its postulates, and its interpretation of circumstantial evidence. This criticism doesn't come from a "fringe" group of the climate science community: It is stated plainly and repeated in thousands of articles in the peer-reviewed literature.

The distinguished British biologist Conrad Waddington wrote in 1941,

> It is … important that scientists must be ready for their pet theories to turn out to be wrong. Science as a whole certainly cannot allow its judgment about facts to be distorted by ideas of what ought to be true, or what one may hope to be true (Waddington, 1941).

This prescient statement merits careful examination by those who continue to assert the fashionable belief, in the face of strong empirical evidence to the contrary, that human CO_2 emissions are going to cause dangerous global warming.

Acknowledgements

As we did in the forewords of previous volumes in the *Climate Change Reconsidered* series, we extend our thanks and appreciation to the many scientists and other experts who helped write this report and its precursors, and to those who conducted the original research that is summarized and cited.

Funding for this effort came from three family foundations, none of them having any commercial interest in the topic. We thank them for their generosity. No government or corporate funds were solicited or received to support this project.

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Preface

This report is the result of collaboration among three organizations: Center for the Study of Carbon Dioxide and Global Change, Science & Environmental Policy Project, and The Heartland Institute. Three lead authors -- Craig D. Idso, Robert M. Carter, and S. Fred Singer – assembled and worked closely with nearly 50 chapter lead authors, contributors, and reviewers from 15 countries. This volume was subjected to the common standards of peer-review. Reviewers who agreed to be identified are listed on the title page.

The material presented in this volume builds on three prior NIPCC reports, *Nature, Not Human Activity, Controls the Climate* (Singer, 2008), *Climate Change Reconsidered: The 2009 Report of the Nongovernmental International Panel on Climate Change (NIPCC)* (Idso and Singer, 2009), and *Climate Change Reconsidered: The 2011 Interim Report of the Nongovernmental International Panel on Climate Change* (Idso, Carter, and Singer, 2011).

Like its predecessor reports, this volume provides the scientific balance that is missing from the overly alarmist reports of the United Nations' Intergovernmental Panel on Climate Change (IPCC), which are highly selective in their review of climate science and controversial with regard to their projections of future climate change. Although the IPCC claims to be unbiased and to have based its assessment on the best available science, we have found this to not be the case. In many instances conclusions have been seriously exaggerated, relevant facts have been distorted, and key scientific studies have been ignored.

A careful reading of the chapters below reveals *thousands* of peer-reviewed scientific journal articles that do not support, and indeed often contradict, the IPCC's alarmist perspective on climate change. This is not an exercise in "cherry picking": There are simply too many articles by too many prominent scientists, reporting too much real-world data and not merely opinions. Either the IPCC purposely ignores these articles because they run counter to their predetermined thesis that man is causing a climatic crisis, or the IPCC's authors are incompetent and failed to conduct a proper scientific investigation. Either way, the IPCC is misleading the scientific community, policymakers, and the general public by telling only half the story about the science of climate change.

If the IPCC truly considered and acknowledged *all* pertinent science in its assessment reports, there would be no need for a NIPCC. Until such time as the IPCC changes its ways (or is dissolved), NIPCC will continue to inject balance into the scientific debate by finding and reporting the scientific research that the IPCC overlooks. Much of it deals with natural climate processes or variability, weaknesses in climate models and data sets used to measure temperatures or forecast future climate conditions, or with data that raise serious scientific questions about the IPCC's attribution of climate change to human greenhouse gas emissions. Our sole goal in presenting this information is to enable fellow scientists, elected officials, educators, and the general public to make up their own minds about what the science says, to *understand* climate change rather than simply *believe* in it.

Each of the seven chapters in this volume begins with a list of key findings that contradict those of the IPCC. These findings are then discussed in detail using in-depth reviews and analyses of literally thousands of scientific papers. Full citations to the

work reviewed are presented at the end of each section. Some of the material is repeated from the 2011 Interim Report and from the earlier 2009 Report, though material from the oldest report is highly abridged and mostly consists of supporting references.

NIPCC scientists have worked hard to remain true to the facts in their representations of the cited studies. Quotations from the original authors are frequently used in discussing their findings and the significance of their work, while editorial commentary in each chapter section is generally limited to an initial introduction and/or conclusion.

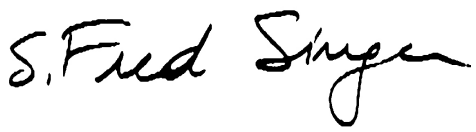
Not every scientist whose work we cite is skeptical of the IPCC positions. In fact, there may be many among the thousands we quote who fully embrace the IPCC's claims and projections who may be bothered to see their work quoted in a book written by "skeptics." In scientific research and writing, this is not unusual and is even to be expected. Climate change is a complex topic spanning many disciplines. Climatology as a field is young and new discoveries are being made seemingly every day that reveal how little we actually know about how the climate works. So an expert in one field may not understand or follow the latest developments in another field, and depends on an organization like the IPCC to report accurately and truthfully on the overall picture of the human impact on climate. One important finding from our work is that the IPCC has abused that trust and misled countless scientists and policymakers.

A related but different matter is that some of the authors whose papers we cite may not agree with our interpretation of their work. We are not infallible, so it may be the case that honest mistakes were made. More common, though, are instances noted in the text where we point out that an author's actual findings disagree with the opinions he or she express in introductions and conclusions. By providing ample quotations from the actual findings, we think readers can make up their own minds about who is right.

Finally, we acknowledge that none of NIPCC's scientists knows the truth of all matters related to the global change debate, nor can we say with certainty that this volume doesn't contain a mistake or two in our interpretations of the available evidence. Understanding climate change involves research in many branches of science across a multitude of spatial and temporal scales. We lay no claim to any special source of knowledge that is not available to anyone else on the planet, nor do we pretend to possess superlative powers of discernment. We just look at the data like everyone else does (or should) and then do our level best to decide what they mean. The fruits of that labor are contained in the NIPCC reports we produce, including the present volume.

We wish to thank all those who participated in the writing, reviewing, editing, and proofing of this volume. Our sincere hope is that this report will mark a return to a more balanced and factually-driven analysis of an issue that is in desperate need of much fuller and open discussion, and that it will help policymakers and politicians make rational decisions on climate and energy policy based on *all* the pertinent science, not just the one-sided narrative produced by the IPCC.





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Executive Summary

This report is produced by the Nongovernmental International Panel on Climate Change (NIPCC), a joint project of three organizations: Center for the Study of Carbon Dioxide and Global Change, Science & Environmental Policy Project, and The Heartland Institute. Three lead authors – Craig D. Idso, Robert M. Carter, and S. Fred Singer – assembled and worked closely with nearly 50 chapter lead authors, contributors, and reviewers from 15 countries. This volume was subjected to the common standards of peer-review.

This work provides the scientific balance that is missing from the overly alarmist reports of the United Nations' Intergovernmental Panel on Climate Change (IPCC), which are highly selective in their review of climate science and controversial with regard to their projections of future climate change. Although the IPCC claims to be unbiased and to have based its assessment on the best available science, we have found this to not be the case. In many instances conclusions have been seriously exaggerated, relevant facts have been distorted, and key scientific studies have been ignored.

In keeping with its "Red Team" mission, NIPCC authors paid special attention to contributions that were either overlooked by the IPCC or that contain data, discussion, or implications arguing against the IPCC's claim that dangerous global warming is resulting, or will result, from human-related greenhouse gas emissions. Most notably, its authors say the IPCC has exaggerated the amount of warming they predict to occur in response to future increases in atmospheric CO_2. Any warming that may occur is likely to be modest and cause no net harm to the global environment or to human well-being.

Key Findings by Chapter

Chapter 1. Global Climate Models and Their Limitations

- Properties inherent in models make dynamic predictability impossible. Without dynamic predictability, other techniques must be used to simulate climate. Such techniques introduce biases of varying magnitude into model projections.

- To have any validity in terms of future projections, GCMs must incorporate not only the many physical processes involved in determining climate, but also all important chemical and biological processes that influence climate over long time periods. Several of these important processes are either missing or inadequately represented in today's state-of-the-art climate models.

- Limitations in computing power frequently result in the inability of models to resolve important climate processes. Low-resolution models fail to capture many important phenomena of regional and lesser scales, such as clouds; downscaling to higher-resolution models introduces boundary interactions that can contaminate the modelling area and propagate error.

- The magnitude of the range of projected responses to a doubling of atmospheric CO_2 by itself establishes that large errors and limitations in the models remain to be corrected.

- Many GCMs fail to account properly for certain "multiplier effects" that may significantly amplify the initial impacts of various biospheric processes.

For example, although the absolute variations associated with some solar-related phenomena are rather small, Several multiplier effects may significantly amplify the initial perturbation.

- Major imperfections in the models prevent proper simulation of important elements of the climate system, including pressure, wind, clouds, temperature, precipitation, ocean currents, sea ice, permafrost, etc. Large differences between model predictions and observations frequently exist when comparing these elements or features. In some cases computer models fail to simulate even the correct sign of the observed parameters.

- Although some improvements have been noted in performance between the CMIP3 set of models used in AR4 and the newer CMIP5 models utilized in AR5, many researchers report finding little or no improvement in the CMIP5 model output for several important parameters and features of Earth's climate.

Chapter 2. Forcings and Feedbacks

- Research published in peer-reviewed science journals indicates the model-derived temperature sensitivity of Earth accepted by the IPCC is too large. Negative feedbacks in the climate system reduce that sensitivity to values an order of magnitude smaller.

- Establishing the historic phase relationship between atmospheric carbon dioxide and temperature is a necessary step toward understanding the physical relationship between CO_2 forcing and climate change. When such analyses are conducted, changes in CO_2 are frequently seen to *lag* changes in temperature by several hundred years.

- Many studies reveal a large *uncoupling* of temperature and CO_2 throughout portions of the historical record. Such findings contradict the IPCC's theory that changes in atmospheric CO_2 drive changes in temperature.

- Atmospheric methane observations over the past two decades reside far below the values projected by the IPCC in each of the four *Assessment Reports* it has released to date. The IPCC's temperature projections, which incorporate this inflated influence, should be revised downward to account for this discrepancy.

- Because agriculture accounts for almost half of nitrous oxide (N_2O) emissions in some countries, there is concern that enhanced plant growth due to CO_2 enrichment might increase the amount and warming effect of this greenhouse gas. But field research shows N_2O emissions will likely fall as CO_2 concentrations and temperatures rise, indicating this is actually another negative climate feedback.

- The IPCC has concluded "the net radiative feedback due to all cloud types is likely positive" (p. 9 of the Summary for Policy Makers, Second Order Draft of AR5, dated October 5, 2012). Contrary to that assessment, several studies indicate the net global effect of cloud feedbacks is a cooling, the magnitude of which may equal or exceed the warming projected from increasing greenhouse gases.

- The IPCC likely underestimates the total cooling effect of aerosols. Studies have found their radiative effect is comparable to or larger than the temperature forcing caused by all the increase in greenhouse gas concentrations recorded since preindustrial times.

- Higher temperatures are known to increase emissions of dimethyl sulfide (DMS) from the world's oceans, which increases the albedo of marine stratus clouds, which has a cooling effect. The IPCC characterizes this chain of events as "a rather weak aerosol-climate feedback at the global scale" (p. 21 of the Technical Summary, Second Order Draft of AR5, dated October 5, 2012), but many studies suggest otherwise.

- Several other important negative forcings and feedbacks exist in nature, about which little is known or acknowledged by the IPCC. Such forcings and feedbacks have been shown by multiple scientific studies to significantly influence Earth's climate to a degree comparable to that of projected anthropogenic-induced global warming.

- The IPCC claims a positive feedback exists between climate and the carbon cycle on century to millennial time scales such that a warming climate will result in a loss of carbon storage. There is no empirical evidence to support such an assertion. Just the opposite appears to be the case, as global carbon uptake doubled over the past half-century.

Chapter 3. Solar Forcing of Climate

- Evidence is accruing that changes in Earth's surface temperature are largely driven by variations in solar activity. Examples of solar-controlled climate change epochs include the Medieval Warm Period, Little Ice Age and Early Twentieth Century (1910–1940) Warm Period.

- The Sun may have contributed as much as 66% of the observed twentieth century warming, and perhaps more.

- Strong empirical correlations have been reported from all around the world between solar variability and climate indices including temperature, precipitation, droughts, floods, streamflow, and monsoons.

- IPCC models do not incorporate important solar factors such as fluctuations in magnetic intensity and overestimate the role of human-related CO_2 forcing.

- The IPCC fails to consider the importance of the demonstrated empirical relationship between solar activity, the ingress of galactic cosmic rays, and the formation of low clouds.

- The respective importance of the Sun and CO_2 in forcing Earth climate remains unresolved; current climate models fail to account for a plethora of known Sun-climate connections.

- The recently quiet Sun and extrapolation of solar cycle patterns into the future suggest a planetary cooling may occur over the next few decades.

Chapter 4. Observations: Temperature Records

- The warming of the late-twentieth-century as well as the cessation of warming that occurred since 1998 fall well within the range of natural climate variability.

- Surface-based temperature histories of the globe contain a significant warming bias introduced by insufficient corrections for the non-greenhouse-gas-induced urban heat island effect. Filtering out urbanization and related land-use effects in the temperature record is a complicated task, and there is solid evidence the methods currently used are inadequate.

- Although all greenhouse models show an increasing warming trend with altitude, peaking around 10 km at roughly two times the surface value, the temperature data from balloons give the opposite result: no increasing warming, but rather a slight cooling with altitude in the tropical zone.

- The IPCC claim of robust evidence of amplified CO_2-induced warming in Earth's polar regions is false, having been invalidated time and again by real-world data.

- Earth's climate has both cooled and warmed independent of its atmospheric CO_2 concentration, revealing the true inability of carbon dioxide to drive climate change throughout the Holocene. Conditions as warm as, or warmer than, the present have persisted across the Holocene for decades and centuries even though the atmosphere's CO_2 concentration remained at values approximately 30% lower than those of today.

- An enormous body of literature clearly demonstrates the IPCC's assessment of the Medieval Climate Anomaly (MCA) is incorrect. The degree of warming and climatic influence during the MCA indeed varied from region to region, and hence its consequences were manifested in a variety of different ways. But that it occurred and was a global phenomenon is certain.

- Computer model simulations have given rise to three claims regarding the influence of global warming on ENSO events: (1) global warming will increase the frequency of ENSO events, (2) global warming will increase the intensity of ENSO events, and (3) weather-related disasters will be exacerbated under El Niño conditions. However, this is generally not what observational data reveal to be the case. In fact, in nearly all historical records it is seen that frequent and strong El Niño activity increases during periods of colder temperatures (e.g., the Little Ice Age) and decreases during warm ones (e.g., Medieval Warm Period, Current Warm Period).

Chapter 5. Observations: The Cryosphere

- Satellite and airborne geophysical datasets used to quantify the global ice budget are short and the methods involved in their infancy, but results to date suggest both the Greenland and Antarctic Ice Caps are close to balance.

- Deep ice cores from Antarctica and Greenland show climate change occurs as both major glacial-interglacial cycles and as shorter decadal and centennial events with high rates of warming and cooling, including abrupt temperature steps.

- Observed changes in temperature, snowfall, ice flow speed, glacial extent, and iceberg calving in both Greenland and Antarctica appear to lie within the limits of natural climate variation.

- Global sea-ice cover remains similar in area to that at the start of satellite observations in 1979, with ice shrinkage in the Arctic Ocean since then being offset by growth around Antarctica.

- During the past 25,000 years (late Pleistocene and Holocene) glaciers around the world have fluctuated broadly in concert with changing climate, at times shrinking to positions and volumes smaller than today.

- This fact notwithstanding, mountain glaciers around the world show a wide variety of responses to local climate variation, and do not respond to global temperature change in a simple, uniform way.

- Tropical mountain glaciers in both South America and Africa have retreated in the past 100 years because of reduced precipitation and increased solar radiation; some glaciers elsewhere also have retreated since the end of the Little Ice Age.

- The data on global glacial history and ice mass balance do not support the claims made by the IPCC that CO_2 emissions are causing most glaciers today to retreat and melt.

- No evidence exists that current changes in Arctic permafrost are other than natural or that methane released by thawing would significantly affect Earth's climate.

- Most of Earth's gas hydrates occur at low saturations and in sediments at such great depths below the seafloor or onshore permafrost that they will barely be affected by warming over even one thousand years.

Chapter 6. Observations: The Hydrosphere and Oceans

The Hydrosphere

- Little evidence exists for an overall increase in global precipitation during the twentieth century independent of natural multidecadal climate rhythmicity.

- Monsoon precipitation did not become more variable or intense during late twentieth century warming; instead, precipitation responded mostly to variations in solar activity.

- South American and Asian monsoons were more active during the cold Little Ice Age and less active during the Medieval Warm Period. Neither global nor local changes in streamflow have been linked to CO_2 emissions.

- The relationship between drought and global warming is weak, since severe droughts occurred during both the Medieval Warm Period and the Little Ice Age.

Oceans

- Knowledge of local sea-level change is vital for coastal management; such change occurs at widely variable rates around the world, typically between about +5 and -5 mm/year.
- Global (eustatic) sea level, knowledge of which has only limited use for coastal management, rose at an average rate of between 1 and 2 mm/year over the past century.
- Satellite altimeter studies of sea-level change indicate rates of global rise since 1993 of over 3 mm/year, but complexities of processing and the infancy of the method precludes viewing this result as secure.
- Rates of global sea-level change vary in decadal and multidecadal ways and show neither recent acceleration nor any simple relationship with increasing CO_2 emissions.
- Pacific coral atolls are not being drowned by extra sea-level rise; rather, atoll shorelines are affected by direct weather and infrequent high tide events, ENSO sea level variations, and impacts of increasing human populations.
- Extra sea-level rise due to heat expansion (thermosteric rise) is also unlikely given that the Argo buoy network shows no significant ocean warming over the past nine years.
- Though the range of natural variation has yet to be fully described, evidence is lacking for any recent changes in global ocean circulation that lie outside natural variation or were forced by human CO_2 emissions.

Chapter 7. Observations: Extreme Weather

- Air temperature variability decreases as mean air temperature rises, on all time scales.
- Therefore the claim that global warming will lead to more extremes of climate and weather, including of temperature itself, seems theoretically unsound; the claim is also unsupported by empirical evidence.
- Although specific regions have experienced significant changes in the intensity or number of extreme events over the twentieth century, for the globe as a whole no relationship exists between such events and global warming over the past 100 years.
- Observations from across the planet demonstrate droughts have not become more extreme or erratic in response to global warming. In most cases, the worst droughts in recorded meteorological history were much milder than droughts that occurred periodically during much colder times.
- There is little or no evidence that precipitation will become more variable and intense in a warming world; indeed, some observations show just the opposite.
- There has been no significant increase in either the frequency or intensity of stormy weather in the modern era.
- Despite the supposedly “unprecedented” warming of the twentieth century, there has been no increase in the intensity or frequency of tropical cyclones globally or in any of the specific ocean basins.