

# Climate Change Reconsidered II

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## Biological Impacts

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NIPCC

NONGOVERNMENTAL INTERNATIONAL PANEL  
ON CLIMATE CHANGE

## 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. 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**  
Reader Emeritus, Department of Geography, Hull University  
Editor, *Energy & Environment*

# Climate Change Reconsidered II

## Biological Impacts

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## Foreword

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For the past five years, The Heartland Institute has been proud to partner with the Center for the Study of Carbon Dioxide and Global Change and the Science and Environmental Policy Project (SEPP) to produce authoritative and independent assessments of the latest science concerning climate change. The present volume in the *Climate Change Reconsidered* series focuses on the biological impacts of rising temperatures and atmospheric carbon dioxide (CO<sub>2</sub>) levels.

The United Nations' Intergovernmental Panel on Climate Change (IPCC) insists that rising temperatures and CO<sub>2</sub> levels have harmful effects on Earth's plant and animal life. But as this report demonstrates, IPCC's claims are at odds with literally thousands of real-world observations, model-based projections, and laboratory and in-the-field experiments. The reality is that the world is getting greener over time as plants, animals, and humans benefit from higher temperatures and CO<sub>2</sub>-enriched air.

### **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 government agency.

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 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 IPCC's *Fourth Assessment Report* (AR4). NIPCC scientists concluded 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 IPCC's AR4, in 2008 SEPP partnered with The Heartland Institute to produce *Nature, Not Human Activity, Rules the Climate*. In 2009, the Center for the Study of Carbon Dioxide and Global Change joined the original two sponsors to 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 IPCC.

In 2010, a Web site ([www.nipccreport.org](http://www.nipccreport.org)) was created to highlight scientific studies NIPCC scientists believed likely would be downplayed or ignored by IPCC during preparation of its next assessment report. In 2011, the three sponsoring organizations produced *Climate Change Reconsidered: The 2011 Interim Report of the Nongovernmental International Panel on Climate Change (NIPCC)*.

In 2013, 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. Also in 2013, NIPCC released *Climate Change Reconsidered II: Physical Science*, the first of

three volumes bringing the original 2009 report up-to-date with research from the 2011 *Interim Report* plus research as current as the third quarter of 2013. A new Web site was created ([www.ClimateChangeReconsidered.org](http://www.ClimateChangeReconsidered.org)) to feature the new report and future volumes, including the current one, and news about their release.

The current volume is the second volume in the Climate Change Reconsidered II series, subtitled *Biological Impacts*. A third and final volume, subtitled *Human Welfare, Energy, and Policies*, is also being released in 2014.

## CCR II: Biological Impacts

In this new report, Lead Authors/Editors Craig D. Idso, Robert M. Carter, and S. Fred Singer have been joined by a fourth author, Sherwood B. Idso, one of the world's most distinguished soil scientists and authorities on the impact of CO<sub>2</sub> on plants. Together, they worked with a team of more than 30 scientists from 13 countries to produce a report that is comprehensive, objective, and faithful to the scientific method. The sheer size of this volume—more than 1,000 pages and containing references to thousands of peer-reviewed articles and books—suggests what an extraordinary research, writing, and editing endeavor this turned out to be.

As they did for previous volumes in the Climate Change Reconsidered series, NIPCC authors paid special attention to peer-reviewed articles that were either overlooked by IPCC or that contain data, discussion, or implications arguing against IPCC's claim that "human interference" in the global climate has "dangerous" consequences for the natural world and human populations. They found a large body of evidence produced by thousands of scientists over the

course of many years that directly challenges IPCC's narrative. Study after study reveals that warming produces more benefits than harms for a wide range of plants and animals and, not insignificantly, humans as well. So plentiful is the research and so clear are the conclusions that one can only wonder how IPCC's authors overlooked them.

The Lead Authors/Editors briefly discuss their perspective and findings in the Preface, followed by an Executive Summary beginning on page 1 summarizing the volume's principal findings. Most notably, its authors say IPCC has exaggerated the negative impacts of global warming and rising atmospheric CO<sub>2</sub> levels: "We find no net harm to the global environment or to human health, and often find the opposite: net benefits to plants, including important food crops, and to animals and human health."

## Acknowledgements

As we did in the forewords of previous volumes in the Climate Change Reconsidered series, we extend our sincere thanks and appreciation to the scientists and other experts who helped write this report and its precursors, to those who conducted the original research that is summarized and cited, and to those who participated in the peer-review process. Editors could not hope to work for a team of wiser, more distinguished, or more patient writers.

Funding for this effort once again 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.



**Diane Carol Bast**  
Executive Editor  
The Heartland Institute



**S.T. Karnick**  
Research Director  
The Heartland Institute

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## Preface

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*Climate Change Reconsidered II: Biological Impacts* (CCR-IIb) is produced by the Nongovernmental International Panel on Climate Change (NIPCC), a collaboration of three organizations—the Center for the Study of Carbon Dioxide and Global Change, Science and Environmental Policy Project (SEPP), and The Heartland Institute. The four Lead Authors/Editors—Craig D. Idso, Sherwood B. Idso, Robert M. Carter, and S. Fred Singer—sembled and worked closely with more than 30 contributors and reviewers from 13 countries. This report was subjected to the common standards of peer review. Reviewers who agreed to be identified are listed on the title page.

CCR-IIb is the second of three volumes in the *Climate Change Reconsidered II* series. The first volume, *Climate Change Reconsidered II: Physical Science* (CCR-IIa) was published in September 2013. It examined the theory, models, and evidence regarding the science of climate change and concluded the human impact on global climate is small and any warming that may occur as a result of human carbon dioxide (CO<sub>2</sub>) and other greenhouse gas emissions is likely to have little effect on global temperatures, the cryosphere (ice-covered areas), hydrosphere (oceans, lakes, and rivers), or weather. (See Figure 1.) The current volume focuses on scientific research on the impacts of rising temperatures and atmospheric CO<sub>2</sub> levels on the biological world. It finds no net harm to the global environment or to human health and often finds the opposite: net benefits to plants, including important food crops, and to animals and human health.

CCR-IIb broadly tracks and critiques the work of IPCC's Working Group II, which is expected to release its report on the impacts of climate change around the same time as this report is presented. It

appears IPCC is continuing its pattern of selectively reporting data to present an alarmist view of the impacts of climate change. A draft of Working Group II's forthcoming *Summary for Policymakers* identifies eight "key risks":

- i. Risk of death, injury, and disrupted livelihoods in low-lying coastal zones and small island developing states, due to sea-level rise, coastal flooding, and storm surges.
- ii. Risk of food insecurity linked to warming, drought, and precipitation variability, particularly for poorer populations.
- iii. Risk of severe harm for large urban populations due to inland flooding.
- iv. Risk of loss of rural livelihoods and income due to insufficient access to drinking and irrigation water and reduced agricultural productivity, particularly for farmers and pastoralists with minimal capital in semi-arid regions.
- v. Systemic risks due to extreme events leading to breakdown of infrastructure networks and critical services.
- vi. Risk of loss of marine ecosystems and the services they provide for coastal livelihoods, especially for fishing communities in the tropics and the Arctic.
- vii. Risk of loss of terrestrial ecosystems and the services they provide for terrestrial livelihoods.
- viii. Risk of mortality, morbidity, and other harms during periods of extreme heat, particularly for vulnerable urban populations.

### Figure 1. Physical Science Summary

- Global climate models are unable to make accurate projections of climate even 10 years ahead, let alone the 100-year period that has been adopted by policy planners. The output of such models should therefore not be used to guide public policy formulation.
- Neither the rate nor the magnitude of the reported late twentieth century surface warming (1979–2000) lay outside the range of normal natural variability, nor were they in any way unusual compared to earlier episodes in Earth’s climatic history.
- Solar forcing of temperature change is likely more important than is currently recognized.
- No unambiguous evidence exists of dangerous interference in the global climate caused by human-related CO<sub>2</sub> emissions. In particular, the cryosphere is not melting at an enhanced rate; sea-level rise is not accelerating; and no systematic changes have been documented in evaporation or rainfall or in the magnitude or intensity of extreme meteorological events.
- Any human global climate signal is so small as to be nearly indiscernible against the background variability of the natural climate system. Climate change is always occurring.
- A phase of temperature stasis or cooling has succeeded the mild warming of the twentieth century. Similar periods of warming and cooling due to natural variability are certain to occur in the future irrespective of human emissions of greenhouse gases.
- *Source:* Idso, C.D., Carter, R.M., and Singer, S.F. (Eds.) 2013. *Climate Change Reconsidered II: Physical Science*. Chicago, IL: The Heartland Institute.

The research summarized in CCR-IIb effectively refutes five of these apocalyptic forecasts. The remaining three “key risks”—the harm coastal and inland flooding will do to people and to

infrastructure—are addressed in the first and third volumes of the Climate Change Reconsidered II series.

A careful reading of the chapters below reveals thousands of peer-reviewed scientific journal articles do not support and often contradict IPCC’s alarmist narrative. NIPCC scientists have worked hard to remain true to the facts in their representations of the studies cited in this work. The research is usually quoted directly and at some length, along with a description of the methodology used and qualifications that accompanied the stated conclusions. Editorial commentary is generally limited to introductions and sometimes brief conclusions at the end of sections.

Whether the subject is the likely effects of warming on crops, trees, weeds, birds, butterflies, or polar bears, it seems IPCC invariably picks the studies and models that paint global warming in the darkest possible hues. IPCC sees “death, injury, and disrupted livelihoods”—to borrow a phrase from Working Group II—everywhere it looks.

Oftentimes, IPCC’s pessimistic forecasts fly in the face of scientific observations. The global ecosystem is not suffering from the rising temperatures and atmospheric CO<sub>2</sub> levels IPCC has called “unprecedented,” despite all the models and hypotheses IPCC’s authors marshal to make that case. Real-world data show conclusively that most plants flourish when exposed to higher temperatures and higher levels of CO<sub>2</sub> and that the planet’s terrestrial biosphere is undergoing a great post-Industrial Revolution greening that is causing deserts to retreat and forests to expand, enlarging habitat for wildlife. Essentially the same story can be told of global warming’s impact on terrestrial animals, aquatic life, and human health.

Why are these research findings and this perspective missing from IPCC’s reports? NIPCC has been publishing volumes containing this research for five years—long enough, one would think, for the authors of IPCC’s reports to have taken notice, if only to disagree. But the draft of the Working Group II contribution to IPCC’s *Fifth Assessment Report* suggests otherwise. Either IPCC’s authors purposely ignore this research because it runs counter to their thesis that any human impact on climate must be bad and therefore stopped at any cost, or they are inept and have failed to conduct a proper and full scientific investigation of the pertinent literature. Either way,



## Preface

IPCC is misleading the scientific community, policymakers, and the general public. Because the stakes are high, this is a grave disservice.

We are not alone in questioning the accuracy or reliability of IPCC reports. In 2010, the InterAcademy Council, an international organization representing the world's leading national academies of science, produced an audit of IPCC procedures. In its report, *Climate Change Assessments: Review of the Processes & Procedures of the IPCC*, the IAC decried the lack of independent review, reliance on unpublished and non-peer-reviewed sources, refusal by some of the lead authors to share their data with critics, and political interference in the selection of authors and contributors.

How CO<sub>2</sub> enrichment has affected global food production and biospheric productivity is a matter of fact, not opinion. The evidence is overwhelming that it has and will continue to help plants thrive, leading to greater biodiversity, shrinking deserts, expanded habitat for wildlife, and more food for a growing human population. In sharp contrast to IPCC's pessimistic forecast of declining food production, NIPCC's authors say a future warming of the climate coupled with rising atmospheric CO<sub>2</sub> levels will boost global agricultural production and help meet the food needs of the planet's growing population. They find

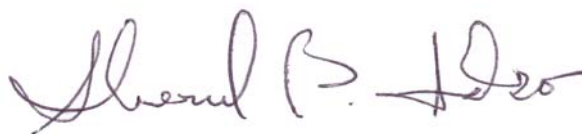
the positive direct effects of CO<sub>2</sub> on crop yields tend to overcome any negative effects associated with changed weather conditions. Journalists, policymakers, and the interested public should demand to know why IPCC either hides or is silent about these truths.

We acknowledge, as we did in the prefaces to previous volumes in this series, that not every scientist whose work we cite disagrees with IPCC positions even though their research points in different directions. We recognize there may be some among the thousands of scientists we quote who are dismayed to see their work cited in a book written by "skeptics." We ask them to read this book with an open mind and ask themselves how much of what they think they know to be true is based on trust, perhaps misplaced, in claims propagated by IPCC. Even scientists need to be reminded sometimes that skepticism, not conformity, is the higher value in the pursuit of knowledge.

We thank all those who participated in the writing, reviewing, editing, and proofreading of this volume. This was a huge undertaking that involved thousands of hours and scores of people over the course of several years. The result exceeded our hopes, and we trust it meets your expectations.



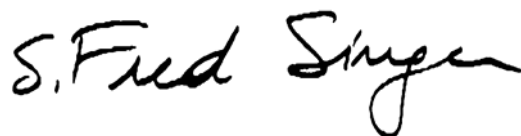
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## Executive Summary

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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 and Environmental Policy Project (SEPP), and The Heartland Institute. Four Lead Authors/Editors—Craig D. Idso, Sherwood B. Idso, Robert M. Carter, and S. Fred Singer—assembled and worked closely with more than 30 authors, contributors, and reviewers. This volume was subjected to the common standards of peer review.

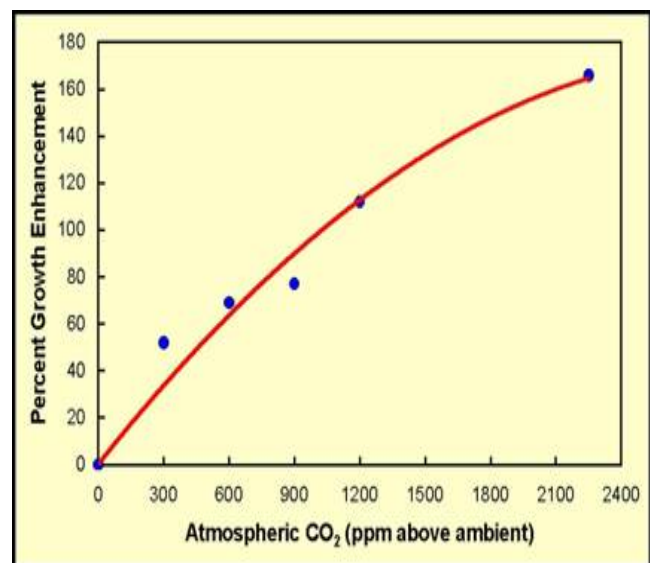
This work provides the scientific balance that is missing from the overly alarmist reports of the United Nations' Intergovernmental Panel on Climate Change (IPCC), which are highly selective in their review of climate science and controversial with regard to their projections of future climate change.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

### 1. Impact on Plants and Soil

Carbon dioxide (CO<sub>2</sub>) is the basis of nearly all life on Earth. It is the primary raw material utilized by most plants to produce the organic matter from which they construct their tissues. Not surprisingly, thousands of laboratory and field experiments conducted over the past 200 years demonstrate that plant productivity and growth both rise as the CO<sub>2</sub> concentration of the air increases.

As early as 1804, de Saussure showed that peas exposed to high CO<sub>2</sub> concentrations grew better than

control plants in ambient air, and work conducted in the early 1900s significantly increased the number of species in which a growth-enhancing effect of atmospheric CO<sub>2</sub> enrichment was observed to occur (Demoussy, 1902–1904; Cummings and Jones, 1918). By the time a group of scientists convened at Duke University in 1977 for a workshop on Anticipated Plant Responses to Global Carbon Dioxide Enrichment, an annotated bibliography of 590 scientific studies dealing with CO<sub>2</sub> effects on vegetation had been prepared (Strain, 1978). This body of research demonstrated increased levels of atmospheric CO<sub>2</sub> generally produce increases in plant photosynthesis, decreases in plant water loss by transpiration, increases in leaf area, and increases in plant branch and fruit numbers, to name but a few of the most commonly reported benefits. (See Figure 1.)



**Figure 1.** Positive Impact of CO<sub>2</sub> on Plants and Trees. Adapted from Idso, K.E. (1992).

Five years later, at the International Conference on Rising Atmospheric Carbon Dioxide and Plant Productivity, it was concluded a doubling of the air's CO<sub>2</sub> concentration likely would lead to a 50% increase in photosynthesis in C<sub>3</sub> plants, a doubling of water use efficiency in both C<sub>3</sub> and C<sub>4</sub> plants, significant increases in biological nitrogen fixation in almost all biological systems, and an increase in the ability of plants to adapt to a variety of environmental stresses (Lemon, 1983). In the years since, many other studies have been conducted on hundreds of different plant species, repeatedly confirming the growth-enhancing, water-saving, and stress-alleviating advantages that elevated atmospheric CO<sub>2</sub> concentrations bestow upon Earth's plants and soils (Idso and Singer, 2009; Idso and Idso, 2011).

Chapter 1 focuses on basic plant productivity responses to elevated CO<sub>2</sub> and includes in two appendices tabular presentations of more than 5,500 individual plant photosynthetic and biomass responses to CO<sub>2</sub>-enriched air, finding nearly all plants experience increases in these two parameters at higher levels of CO<sub>2</sub>. Chapter 1 also examines the effect of elevated CO<sub>2</sub> on ecosystems including forests, grasslands, peatlands, wetlands, and soils. This review of the literature reveals elevated CO<sub>2</sub> improves the productivity of ecosystems both in plant tissues aboveground and in the soils beneath them.

## 2. Impact on Plant Characteristics

There are two principal methods researchers utilize to ascertain how Earth's terrestrial plants will be affected by a continuation of the historical rise in the atmosphere's CO<sub>2</sub> concentration. One way is to grow plants in CO<sub>2</sub>-enriched air to levels expected to be experienced in the decades and centuries to come. In the case of long-lived trees, growth over prior decades and centuries as the CO<sub>2</sub> concentration has risen can be derived from studying the yearly growth rings produced over those time periods and that now comprise the living or dead trees' trunks.

The primary information sought in these studies are rates of photosynthesis and biomass production and the efficiency with which the various plants and trees utilize water. There are a host of other effects of significance, including substances produced in the growth process that impact how well it proceeds, substances deposited in the parts of agricultural crops that are harvested for human and animal consump-

tion, and substances that determine whether insect pests find the foliage or fruit of a certain crop or tree to be to their liking. Finally, there is the question of whether forest soils will have sufficient nitrogen to sustain the long-term CO<sub>2</sub>-enhanced growth rates of long-lived trees.

Chapter 2 examines these and other effects of atmospheric CO<sub>2</sub> enrichment on plant characteristics. Extensive research finds those effects are overwhelmingly positive. For example, rising CO<sub>2</sub> levels promote plant growth by increasing the concentrations of plant hormones that stimulate cell division, cell elongation, and protein synthesis; by enabling plants to produce more and larger flowers; by increasing the production of glomalin, an important protein created by fungi living in symbiotic association with the roots of most vascular plants; and by affecting leaf characteristics of agricultural plants that lead to higher rates and efficiencies of photosynthesis and growth as well as increased resistance to herbivory and pathogen attack.

## 3. Impact on Plants Under Stress

According to IPCC, a warmer future will introduce new sources of stress on the biological world, including increases in forest fires, droughts, and extreme heat events. IPCC fails to ask whether the higher levels of atmospheric CO<sub>2</sub> its models also predict will aid or hinder the ability of plants to cope with these challenges. Had it looked, IPCC would have discovered an extensive body of research showing how atmospheric CO<sub>2</sub> enrichment ameliorates the negative effects of a number of environmental plant stresses. The relative percentage growth enhancement produced by an increase in the air's CO<sub>2</sub> concentration is generally greater under stressful and resource-limited conditions than when growing conditions are ideal.

Chapter 3 reports research on the effects of rising CO<sub>2</sub> levels on the ability of plants to cope with pathogenic invaders, drought, rising temperatures, the deleterious effects of heavy metals in soil, herbivory by insects and animals, and shortages of essential nutrients in soil such as nitrogen. Rising CO<sub>2</sub> typically reduces and can completely override the negative effects of ozone pollution on the photosynthesis, growth, and yield of nearly all agricultural crops and trees that have been experimentally evaluated. Rising CO<sub>2</sub> also can help plants overcome



stresses imposed by the buildup of soil salinity from repeated irrigation.

#### 4. Likely Future Impacts on Plants

Chapter 4 analyzes how atmospheric CO<sub>2</sub> enrichment has boosted global food production and biospheric productivity since the beginning of the Industrial Revolution. It also reports how rising CO<sub>2</sub> helps plants avoid temperature-induced extinctions, which many models predict could occur if global temperatures rise significantly in the future. Whereas IPCC forecasts severe food shortages, the preponderance of evidence suggests the many yield-enhancing benefits of rising atmospheric CO<sub>2</sub> will help ensure more food is grown to meet the needs of the planet's growing population.

Chapter 4 also reports on the current health of the terrestrial biosphere, analyzing the productivity of the globe as a whole followed by regional analyses on continental and sub-continental scales. According to IPCC, the productivity of the terrestrial biosphere should be declining because of rising temperatures and other perceived negative climatic changes. In contrast, empirical data show it to be increasing, in large measure due to the aerial fertilization effect of rising atmospheric CO<sub>2</sub>.

Chapter 4 concludes with an examination of topics pertaining to biodiversity, plant extinctions, and plant evolution, which represent three important topics in assessing the future of Earth's terrestrial biosphere.

#### 5. Impact on Terrestrial Animals

IPCC's *Fourth Assessment Report* claimed "new evidence suggests that climate-driven extinctions and range retractions are already widespread" and the "projected impacts on biodiversity are significant and of key relevance, since global losses in biodiversity are irreversible (*very high confidence*)" (IPCC, 2007). However, as shown in the first volume of the Climate Change Reconsidered II series, *Physical Science*, there is a growing divide between IPCC's climate model simulations and real-world observations of global warmth. The species-modeling research IPCC almost exclusively relies on to make these predictions depends on climate models known to exaggerate future global warming and extreme weather events.

Even assuming IPCC climate models were unbiased and reasonably accurate at regional scales, the "climate envelope" models used by IPCC are deeply flawed due to assumptions about the immobility of species that are routinely contradicted by real-world observations. IPCC also improperly characterizes the adaptive responses (e.g., range shifts, phenotypic or genetic adaptations) of many species as supporting their model-based extinction claims, when in reality such adaptive responses provide documentary evidence of species resilience.

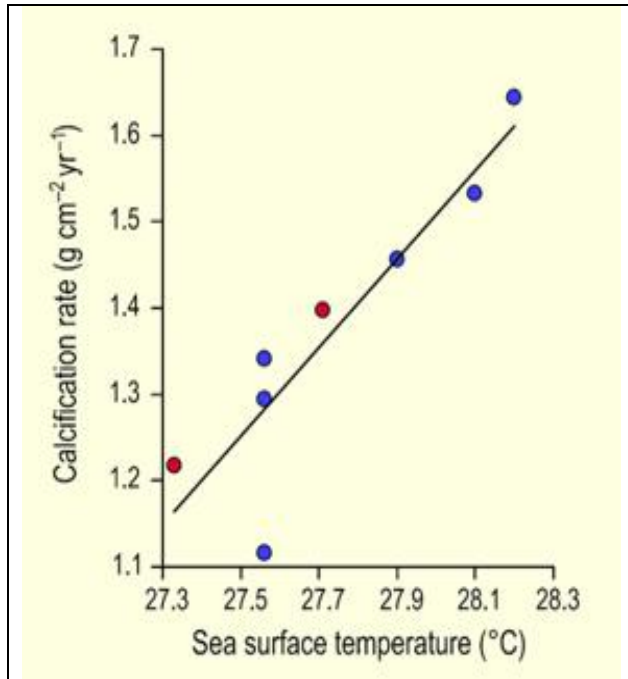
Chapter 5 begins with a review and analysis of IPCC-based species extinction claims, highlighting many of the problems inherent in the models on which such claims are based. The model projections are then evaluated against real-world observations of various animal species and their response to what IPCC has called the unprecedented rise in temperature and atmospheric CO<sub>2</sub> levels of the twentieth and twenty-first centuries. Results of that evaluation reveal that although there likely will be some changes in species population dynamics, few if any species likely will be driven even close to extinction. In a number of instances, real-world data indicate warmer temperatures and higher atmospheric CO<sub>2</sub> concentrations will be highly beneficial, favoring a proliferation of species. IPCC continues to ignore such positive externalities of rising temperature and atmospheric CO<sub>2</sub>.

#### 6. Impact on Aquatic Life

IPCC postulates that human interference in the climate will significantly harm aquatic life by causing temperatures of the world's water bodies to rise and through the absorption of CO<sub>2</sub> from the atmosphere into water, thereby lowering the pH of freshwater and ocean water (a process referred to as "acidification"). In both scenarios, IPCC projects marine and freshwater species will be negatively impacted and will experience future declines, which in some instances may be so severe as to cause species extinctions.

In contrast, the material presented in Chapter 6, representing the findings of hundreds of peer-reviewed research analyses, suggests a much better future is in store for Earth's aquatic life. Many laboratory and field studies demonstrate growth and developmental improvements in response to higher temperatures and reduced water pH levels. Other

research illustrates the capability of coral and other marine and freshwater species to tolerate and adapt to the rising temperature (see Figure 2) and pH decline of the planet's water bodies. When these observations are considered, the pessimistic projections of IPCC give way to considerable optimism with respect to the future of the planet's marine life.



**Figure 2.** Coral calcification rates rise with seawater temperature. Adapted from Carricart-Ganivet and Gonzalez-Diaz (2009).

## 7. Impact on Human Health

Carbon dioxide is invisible, odorless, nontoxic, and does not seriously affect human health until the CO<sub>2</sub> content of the air reaches approximately 15,000 ppm, more than 37 times greater than the current concentration of atmospheric CO<sub>2</sub> (Luft *et al.*, 1974). There is no reason to be concerned about any direct adverse human health consequences of the ongoing rise in the air's CO<sub>2</sub> content now or in the future, as even extreme model projections do not indicate anthropogenic activities will raise the air's CO<sub>2</sub> concentration above 1,000 to 2,000 ppm. Nevertheless, IPCC contends rising CO<sub>2</sub> concentrations are causing several indirect threats to human health, which they project will worsen as the air's CO<sub>2</sub> concentration rises in the future.

In a draft Technical Summary of its upcoming report, Working Group II claims, “The health of human populations is sensitive to shifts in weather patterns and other aspects of climate change [*very high confidence*] and “There is emerging evidence of non-linearities in response (such as greater-than-expected mortality due to heat waves) as climates become more extreme” (IPCC, 2013, p. 16; italics in original, bold removed).

Research reviewed in CCR-IIb, however, shows IPCC's view of the impacts of rising temperatures and atmospheric CO<sub>2</sub> on human health is simply wrong. Numerous peer-reviewed studies demonstrate a warmer planet is beneficial to humanity, as warmer temperatures in all parts of the world lead to decreases in temperature-related mortality. The medical literature shows warmer temperatures and a smaller difference between daily high and low temperatures, as occurred during the twentieth and early twenty-first centuries, reduce mortality rates due to cardiovascular and respiratory disease and stroke occurrence.

Similarly, the research is quite clear that climate has exerted only a minimal influence on recent trends in vector-borne diseases such as malaria, dengue fever, and tick-borne diseases. Other factors, many of them related to economic and technological setbacks or progress and not to weather, are far more important in determining the transmission and prevalence of such diseases.

Finally, and perhaps surprisingly, IPCC entirely overlooks the positive effects of rising levels of atmospheric CO<sub>2</sub> on human health. Carbon dioxide fertilization has been shown to enhance certain health-promoting substances in plants, such as antioxidants, vitamin C, and fatty acids, and promote the growth of plants such as St. John's wort used for the treatment of a variety of illnesses. In this way, global warming portends great health benefits for humans. IPCC makes no mention of these benefits.

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The remainder of this executive summary consists of key findings organized by chapter.

## Key Findings by Chapter

### Chapter 1. CO<sub>2</sub>, Plants, and Soils

- Results obtained under 3,586 separate sets of experimental conditions conducted on 549 plant species reveal nearly all plants experience increases in dry weight or biomass in response to atmospheric CO<sub>2</sub> enrichment (henceforth referred to as “rising CO<sub>2</sub>”). Additional results obtained under 2,094 separate experimental conditions conducted on 472 plant species reveal nearly all plants experience increases in their rates of photosynthesis in response to rising CO<sub>2</sub>.
- Long-term CO<sub>2</sub> enrichment studies confirm the findings of shorter-term experiments, demonstrating that the growth-enhancing, water-conserving, and stress-alleviating effects of rising CO<sub>2</sub> likely persist throughout plant lifetimes.
- Forest productivity and growth rates around the world have increased gradually since the Industrial Revolution in concert with, and in response to, the historical increase in the air’s CO<sub>2</sub> concentration. Therefore, as CO<sub>2</sub> continues to rise, forests likely will respond by exhibiting significant increases in biomass production and they likely will grow more robustly and significantly expand their ranges.
- Modest increases in air temperature tend to increase carbon storage in forests and their soils. Thus, old-growth forests can be significant carbon sinks and their capacity to sequester carbon in the future will be enhanced as CO<sub>2</sub> continues to rise.
- As CO<sub>2</sub> continues to rise, the productivity of grassland species will increase even under unfavorable growing conditions characterized by less-than-adequate soil moisture, inadequate soil nutrition, elevated air temperature, and physical stress imposed by herbivory.
- The thawing of permafrost caused by increases in air temperature likely will not transform peatlands from carbon sinks to carbon sources. Instead, rapid terrestrialization likely will act to intensify carbon-sink conditions.

- Rising CO<sub>2</sub> likely will enhance the productivity and carbon sequestering ability of Earth’s wetlands. In addition, rising CO<sub>2</sub> may help some coastal wetlands counterbalance the negative impacts of rising seas.
- Rising CO<sub>2</sub> likely will allow greater numbers of beneficial bacteria (that help sequester carbon and nitrogen) to exist within soils and anaerobic water environments, thereby benefitting both terrestrial and aquatic ecosystems.
- The aerial fertilization effect of rising CO<sub>2</sub> likely will result in greater soil carbon stores due to increased carbon input to soils, even in nutrient-poor soils and in spite of predicted increases in temperature. The carbon-sequestering capability of Earth’s vegetation likely will act as a significant brake on the rate-of-rise of the air’s CO<sub>2</sub> content and thereby help to mute the magnitude of any CO<sub>2</sub>-induced global warming.
- Rising CO<sub>2</sub> has significantly reduced the erosion of valuable topsoil over the past several decades; the continuing increase in atmospheric CO<sub>2</sub> can maintain this trend and perhaps even accelerate it for the foreseeable future.

### Chapter 2. Plant Characteristics

- Rising CO<sub>2</sub> enhances plant growth, development, and ultimate yield (in the case of agricultural crops) by increasing the concentrations of plant hormones that stimulate cell division, cell elongation, and protein synthesis.
- Rising CO<sub>2</sub> enables plants to produce more and larger flowers, as well as other flower-related changes having significant implications for plant productivity and survival, almost all of which are positive.
- Rising CO<sub>2</sub> increases the production of glomalin, a protein created by fungi living in symbiotic association with the roots of 80 percent of the planet’s vascular plants, where it is having a huge positive impact on the biosphere.
- Rising CO<sub>2</sub> likely will affect many leaf characteristics of agricultural plants, with the

majority of the changes leading to higher rates and efficiencies of photosynthesis and growth as well as increased resistance to herbivory and pathogen attack.

- Rising CO<sub>2</sub> stimulates photosynthesis in nearly all plants, enabling them to produce more nonstructural carbohydrates that can be used to create important carbon-based secondary compounds, one of which is lignin.
- Rising CO<sub>2</sub> leads to enhanced plant fitness, flower pollination, and nectar production, leading to increases in fruit, grain, and vegetable yields of agricultural crops as well as productivity increases in natural vegetation.
- As rising CO<sub>2</sub> causes many plants to increase biomass, the larger plants likely will develop more extensive root systems enabling them to extract greater amounts of mineral nutrients from the soil.
- Rising CO<sub>2</sub> causes plants to sequentially reduce the openness of their stomata, thus restricting unnecessary water loss via excessive transpiration, while some plants also reduce the density (number per area) of stomata on their leaves.
- Rising CO<sub>2</sub> significantly enhances the condensed tannin concentrations of the vast majority of trees and grasses, providing them with stronger defenses against various herbivores both above and below ground. This in turn reduces the amount of methane, a potent greenhouse gas, released to the atmosphere by ruminants browsing on tree leaves and grass.
- As the air's CO<sub>2</sub> content rises, many plant species may not experience photosynthetic acclimation even under conditions of low soil nitrogen. In the event that a plant cannot balance its carbohydrate sources and sinks, CO<sub>2</sub>-induced acclimation provides a way of achieving that balance by shifting resources away from the site of photosynthesis to enhance sink development or other important plant processes.

### Chapter 3. Plants Under Stress

- Rising CO<sub>2</sub> exerts a greater positive influence on diseased as opposed to healthy plants because it significantly ameliorates the negative effects of stresses imposed on plants by pathogenic invaders.
- Rising CO<sub>2</sub> helps many plants use water more efficiently, helping them overcome stressful conditions imposed by drought or other less-than-optimum soil moisture conditions.
- Enhanced rates of plant photosynthesis and biomass production from rising CO<sub>2</sub> will not be diminished by any global warming that might accompany it in the future. In fact, if ambient air temperatures rise concurrently, the growth-promoting effects of atmospheric CO<sub>2</sub> enrichment will likely rise even more.
- Although rising CO<sub>2</sub> increases the growth of many weeds, the fraction helped is not as large as that experienced by non-weeds. Thus, CO<sub>2</sub> enrichment of the air may provide non-weeds with greater protection against weed-induced decreases in productivity.
- Rising CO<sub>2</sub> improves plants' abilities to withstand the deleterious effects of heavy metals where they are present in soils at toxic levels.
- Rising CO<sub>2</sub> reduces the frequency and severity of herbivory against crops and trees by increasing production of natural substances that repel insects, leading to the production of more symmetrical leaves that are less susceptible to attacks by herbivores, and making trees more capable of surviving severe defoliation.
- Rising CO<sub>2</sub> increases net photosynthesis and biomass production by many agricultural crops, grasses, and grassland species even when soil nitrogen concentrations tend to limit their growth. Additional CO<sub>2</sub>-induced carbon input to the soil stimulates microbial decomposition and thus leads to more available soil nitrogen, thereby conclusively disproving the progressive nitrogen limitation hypothesis.
- Rising CO<sub>2</sub> typically reduces and can completely override the negative effects of ozone pollution on

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the photosynthesis, growth, and yield of nearly all agricultural crops and trees that have been experimentally evaluated.

- Rising CO<sub>2</sub> can help plants overcome stresses imposed by the buildup of soil salinity from repeated irrigation.
- Rising CO<sub>2</sub> is a powerful antidote for the deleterious biological impacts that might be caused by an increase in the flux of UV-B radiation at the surface of Earth due to depletion of the planet's stratospheric ozone layer.

### Chapter 4. Earth's Vegetative Future

- The vigor of Earth's terrestrial biosphere has been increasing with time, revealing a great post-Industrial Revolution greening of the Earth that extends across the entire globe. Over the past 50 years global carbon uptake has doubled from 2.4 ± 0.8 billion tons in 1960 to 5.0 ± 0.9 billion tons in 2010.
- The atmosphere's rising CO<sub>2</sub> content, which IPCC considers to be the chief culprit behind all of its "reasons for concern" about the future of the biosphere, is most likely the primary cause of the observed greening trend.
- The observed greening of the Earth has occurred in spite of all the many real and imagined assaults on Earth's vegetation, including fires, disease, pest outbreaks, air pollution, deforestation, and climatic change. Rising CO<sub>2</sub> is making the biosphere more resilient to stress even as it becomes more lush and productive.
- Agricultural productivity in the United States and across the globe dramatically increased over the last three decades of the twentieth century, a phenomenon partly due to new cultivation techniques but also due partly to warmer temperatures and higher CO<sub>2</sub> levels.
- A future warming of the climate coupled with rising CO<sub>2</sub> will further boost global agricultural production and help meet the food needs of the planet's growing population.

- The positive direct effects of higher levels of atmospheric CO<sub>2</sub> on future crop yields are likely to dominate any hypothetical negative effects associated with changing weather conditions, just as they have during the twentieth and early twenty-first centuries.
- Plants can adjust their physiology to accommodate a warming of both the magnitude and rate-of-rise typically predicted by climate models, should such a warming actually occur.
- Evidence continues to accumulate for substantial heritable variation of ecologically important plant traits, including root allocation, drought tolerance, and nutrient plasticity, which suggests rapid evolution is likely to occur based on epigenetic variation alone. Rising CO<sub>2</sub> will exert significant selection pressure on plants, which can be expected to improve their performance in the face of various environmental stressors via the process of micro-evolution.
- As good as things currently are for world agriculture, natural selection and bioengineering could bring about additional beneficial effects. For example, highly CO<sub>2</sub>-responsive genotypes of a wide variety of plants could be selected to take advantage of their genetic ability to optimize their growth in response to rising CO<sub>2</sub>.

### Chapter 5. Terrestrial Animals

- IPCC's forecast of future species extinction relies on a narrow view of the literature that is highly selective and based almost entirely on model projections as opposed to real-world observations; the latter often contradict the former.
- Numerous shortcomings are inherent in the models utilized in predicting the impact of climate on the health and distributions of animal species. Assumptions and limitations make them unreliable.
- Research suggests amphibian populations will suffer little, if any, harm from projected CO<sub>2</sub>-induced global warming, and they may even benefit from it.

- Although some changes in bird populations and their habitat areas have been documented in the literature, linking such changes to CO<sub>2</sub>-induced global warming remains elusive. Also, when there have been changes, they often are positive, as many species have adapted and are thriving in response to rising temperatures of the modern era.
- Polar bears have survived historic changes in climate that have exceeded those of the twentieth century or are forecast by computer models to occur in the future. In addition, some populations of polar bears appear to be stable despite rising temperatures and summer sea ice declines. The biggest threat they face is not from global warming but hunting by humans, which historically has taken a huge toll on polar bear populations.
- The net effect of climate change on the spread of parasitic and vector-borne diseases is complex and at this time appears difficult to predict. Rising temperatures increase the mortality rates as well as the development rates of many parasites of veterinary importance, and temperature is only one of many variables that influence the range of viruses and other sources of diseases.
- Existing published research indicates rising temperatures likely will not increase, and may decrease, plant damage from leaf-eating herbivores, as rising atmospheric CO<sub>2</sub> boosts the production of certain defensive compounds in plants that are detrimental to animal pests.
- Empirical data on many animal species, including butterflies, other insects, reptiles, and mammals, indicate global warming and its myriad ecological effects tend to foster the expansion and proliferation of animal habitats, ranges, and populations, or otherwise have no observable impacts one way or the other.
- Multiple lines of evidence indicate animal species are adapting, and in some cases evolving, to cope with climate change of the modern era, as expected by Darwinian evolution and well-established ecological concepts.

## Chapter 6. Aquatic Life

- Multiple studies from multiple ocean regions confirm ocean productivity tends to increase with temperature. Subjects of this research include phytoplankton and macroalgae, corals, crustaceans, and fish.
- Aquatic life has survived decadal, centennial, and millennial-scale climate oscillations that have persisted for millions of years. Evidence indicates they are well-equipped to adapt to forecasted increases in temperature, if necessary.
- Many aquatic species demonstrate the capability to adjust their individual critical thermal maximum (the upper temperature at which the onset of behavioral incapacitation occurs) upwards in response to temperature increases forecast by IPCC.
- The decline in ocean pH levels in the year 2100 (as compared to preindustrial times) may only be half the 0.4 value IPCC has calculated.
- The natural variability in ocean pH levels often is much greater than the change in pH levels forecast by IPCC.
- Natural fluctuations in pH may have a large impact on the development of resilience in marine populations, as heterogeneity in the environment with regard to pH and *p*CO<sub>2</sub> exposure may result in populations that are acclimatized to variable pH or extremes in pH.
- Caution should be applied when interpreting results from laboratory-based studies of lower seawater pH levels. Such studies often are incapable, or fall far short, of mimicking conditions in the real world, and thus they frequently yield results quite different than what is observed in nature.
- Rising temperatures and atmospheric CO<sub>2</sub> levels do not pose a significant threat to aquatic life. Many aquatic species have shown considerable tolerance to temperatures and CO<sub>2</sub> values predicted for the next few centuries, and many have demonstrated a likelihood of positive responses in empirical studies.

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- Rising seawater temperature is conducive to enhanced coral calcification, leading some experts to forecast coral calcification will increase by about 35% beyond pre-industrial levels by 2100, and no extinction of coral reefs will occur in the future.
- For those species showing negative responses, there are adequate reasons to conclude such responses will be largely mitigated through phenotypic adaptation or evolution during the many decades to centuries the pH concentration is projected to fall. A similar assessment can be made with respect to the impact of rising temperatures or a combination of rising temperature and marine/freshwater “acidification.”

## Chapter 7. Human Health

- Warmer temperatures lead to a decrease in temperature-related mortality, including deaths associated with cardiovascular disease, respiratory disease, and strokes. The evidence of this benefit comes from research conducted in every major country of the world.
  - In the United States the average person who died because of cold temperature exposure lost in excess of 10 years of potential life, whereas the average person who died because of hot temperature exposure likely lost no more than a few days or weeks of life.
  - In the United States, some 4,600 deaths are delayed each year as people move from cold northeastern states to warm southwestern states. Between 3 and 7% of the gain in longevity experienced over the past three decades was due simply to people moving to warmer states.
  - Cold-related deaths are far more numerous than heat-related deaths in the United States, Europe, and almost all countries outside the tropics. Coronary and cerebral thrombosis account for about half of all cold-related mortality.
  - Global warming is reducing the incidence of cardiovascular diseases related to low temperatures and wintry weather by a much greater degree than it increases the incidence of cardiovascular diseases associated with high temperatures and summer heat waves.
- Extensive scientific examination and research contradict the claim that malaria will expand across the globe and intensify as a result of CO<sub>2</sub>-induced warming.
  - Concerns over large increases in vector-borne diseases such as dengue as a result of rising temperatures are unfounded and unsupported by the scientific literature, as climatic indices are poor predictors for dengue disease.
  - Although temperature and climate largely determine the geographical distribution of ticks, they are not among the significant factors determining the incidence of tick-borne diseases.
  - Rising CO<sub>2</sub> is not only raising the productivity of Earth’s common food plants but also significantly increasing the quantity and potency of the many health-promoting substances found in their tissues, which are the ultimate sources of sustenance for essentially all animals and humans.
  - Rising CO<sub>2</sub> positively impacts the production of numerous health-promoting substances found in medicinal or “health food” plants, and this phenomenon may have contributed to the increase in human life span that has occurred over the past century or so.
  - There is little reason to expect any significant CO<sub>2</sub>-induced increases in human-health-harming substances produced by plants as atmospheric CO<sub>2</sub> levels continue to rise.

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