





Mudanças Climáticas e Redução de Emissões PCA5019

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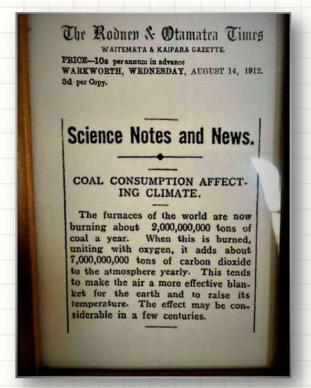




Em 1896, a primeira previsão climática: Svante Arrhenius



Arrhenius quantificou em 1896 as mudanças na temperatura da superfície (aprox. 5 C) que deveriam ocorrer se dobrássemos a concentração de CO₂, baseado nos conceito do efeito "glass bowl" introduzido em 1824 por Joseph Fourier.



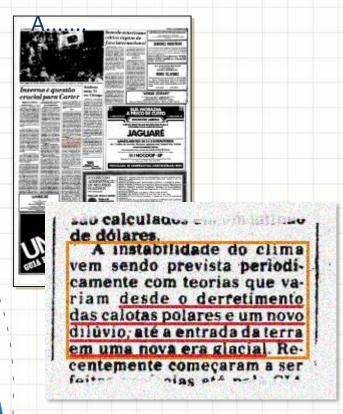
Matéria de jornal de 1912!

Programas em Energia (PPGE) e Ciência Ambiental (PROCAM)





Voltando no tempo ...



Jornal O Estado de S.Paulo - 06 2 1977



Ele faz esta afirmação baseado em conclusões de climatologistas e biólogos norte-americanos e europeus,
segundo os quais, "a terra
está entrando em nova fase
glacial, com redução das
areas de clima quente e intensificação do frio nas
áreas de clima temperado".

Jornal O Estado de S.Paulo - 24 5 1977



Pós-Graduação

Programas em Energia (PPGE) e Ciência Ambiental (PROCAM)





Mudanças Climáticas...produção desde o início do século passado



TITLE-ABS-KEY ("Climate change") AND DOCTYPE (ar OR re)







Considerações gerais sobre a natureza das mudanças climáticas

WEATHER AND GLACIATION¹

BY CHESTER A. REEDS

(Read before Section E of the American Association for the Advancement of Science, December 27, 1928)

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INTRODUCTION

Weather as it affects glaciation is a subject which has been under observation during the past century. Remnants of the last glaciation still exist in Greenland, Antarctica, and on some of the islands of the polar regions and in the high mountain fastenesses of the temperate and tropical zones. Weather conditions are modifying these ice-masses; in fact, the variability of the weather causes glaciers to grow at certain times and wane during other periods. The changes that are going on today are apparently similar to those that took place during past ages.

There is a distinction between weather and climate. Climate is the average of normal conditions of the atmosphere, while weather constitutes the variations from the normal. Weather changes are of a day-to-day occurrence. When averaged for the year and for longer periods, they yield differences which make the weather of one year vary from that of another, as well as for groups of years.

During the last decade a few meteorologists have correlated weather changes with variations in solar radiation. This correlation has been

¹ Manuscript received by the Secretary of the Seciety, December 21, 1929.

WEATHER AND GLACIATION BY CHESTER A. REEDS 1929

During the last decade a few meteorologists have correlated weather changes with variations in solar radiation. This correlation has been specially emphasized by H. H. Clayton in his volume, "World Weather," 1923. The correlation of changes in glaciation with solar radiation variations has been mentioned by various scientists, but it has not been discussed in the light of recent developments.

Durante a última década, alguns meteorologistas correlacionaram as mudanças climáticas com as variações na radiação solar. Essa correlação foi especialmente enfatizada por HH Clayton em seu volume 'World Weather', 1923. A correlação de mudanças na glaciação com variações da radiação solar foi mencionada por vários cientistas, mas não foi discutida à luz de desenvolvimentos recentes.







Considerações gerais sobre a natureza das mudanças climáticas

RECENT EVIDENCE ABOUT THE NATURE OF CLIMATE CHANGES AND ITS IMPLICATIONS*

I. I. Schell

Department of Geology, Tufts University, Medford, Mass.

Introduction

The solution of the problem of climate changes would be greatly aided by a better understanding of the nature of these changes, both during the earlier history of the earth as well as during the recent past which can be examined in greater detail. Although much remains to be accomplished before the true nature of these changes can be ascertained, the lengthening meteorological record, together with the other records from land and sea, makes it possible to probe deeper into the nature of these changes and into the validity of the different explanations that have been offered for them.

In seeking an explanation for a change in climate it was logical to consider that, since without the heat received from the sun the earth would be a cold body, this heat may have been "considerably diminished during glacial epochs" (Hitchcock, 1891). This very simple explanation of a change in climate poses a dilemma, as may be seen from the following quotation "... such a variation would be most effective in the low latitudes, but it is there that the climatic changes have been the smallest" (Brooks, 1950).

In explaining a climate change, such as, for example, an ice age, it becomes necessary, therefore, to reconcile the seeming paradox of a steeper equator-to-pole temperature gradient, increased circulation, evaporation, and precipitation with a decreased solar output that, because of the sphericity of the earth, seemingly calls for a greater decrease in temperature in the low than in the high latitudes and hence a less steep gradient, decreased circulation, evaporation, and precipitation.

In addition to a reconciliation between a greater decrease in temperature in the higher than in the lower latitudes and a decreased solar output, the explanation here offered must also account for (1) a change in climate that, although essentially global, is not simultaneous in all areas; (2) a more gradual onset of a cold period than of a mild period; (3) the long mild period preceding the Pleistocene and the transition to this epoch without, if possible, relying on extensive changes in the physical make-up of the globe; and (4) the smaller changes in climate or a climatic change.

As my first aim is to reconcile a decreased solar output with a greater lowering in temperature at the pole than at the equator, this point will be treated first.

A Reconciliation of a Greater Lowering of Temperature at the Pole than at the Equator with a Decrease in Solar Output

I shall try to show that while a slight increase in temperature gradient and in circulation will develop with a simple increase in solar output, a very much

* Tufts University Meteorological Studies No. 2.

The work described in this article was prepared with support from the National Science Foundation, Washington, D.C. Recent Evidence About the Nature of Climate Changes and its Implications

1961

Schell, I.I. 1961 - Annals of the New York Academy of Sciences 95(1), pp. 251-270

As discussões centravam-se especialmente nas condições para uma nova era glacial.



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Considerações gerais sobre a natureza das mudanças climáticas

551.583:551.521 (268)

(Department of Meteorology, McGill University, Montreal)

Climate Change over the Polar Ocean. I The Radiation Budget¹

Βv

E. Vowinckel and Svenn Orvig

With I Figure

(Received May 20, 1966)

Summary. Climatic change results from changes in the terms of the energy equation. The present study consists of an analysis of possible changes in the radiative terms of the Polar Ocean energy budget.

The absorbed global radiation at the surface depends mainly on clouds and surface albedo. These factors are discussed, and the absorbed global radiation is presented for various extreme surface and atmospheric conditions.

The short wave radiation absorbed in the atmosphere is next discussed. It is apparent that variations in the atmospheric short wave absorption are of rather small importance for climatic change.

There is greater possibility of variations in long wave radiation than of solar radiation. Theoretical polar atmospheres are discussed, with the consequent changes in the radiation balance. The conclusion appears that the atmosphere is at present adjusted in the best possible way for the conservation of energy.

Long wave fluxes have been calculated for the condition of an open Polar Ocean in winter and for a Polar Ocean completely frozen throughout the year.

It is concluded that, for cloudless conditions, there is little possibility for a change in the long wave balance in summer; the long wave balance would become much more negative in winter; the development of a winter balance less negative than the present seems unlikely. Changes in surface conditions are much more important than changes in the atmosphere, for the long wave radiation budget.

¹ The research reported in this paper was sponsored in part by the Natick Laboratories, U. S. Army Materiel Command, under contract No. DA 19-129 AMC-490 (N).

Arch. Met. Geoph. Biokl. B., Bd. 15, H. 1/2

Climate change over the Polar Ocean. I - The radiation budget

1967

Vowinckel, E., Orvig, S. 1967 - Archiv für Meteorologie, Geophysik und Bioklimatologie Serie B 15(1-2), pp. 1-23

As discussões também concentravamse em aspectos físicos naturais, sem a interferência antrópica.







Trabalhos primordiais...reconhecendo a existência do problema

Proceedings of the National Academy of Sciences Vol. 67, No. 2, pp. 898-899, October 1970

Carbon Dioxide and its Role in Climate Change

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Finally, the possibility of other factors in climatic change must be considered, other radiation may change slightly in intensity or wavelength distribution; other natural explanations have been suggested. Our measurements of radiaCarbon dioxide and its role in climate change.

1970

Benton, G.S. 1970 - Proceedings of the National Academy of Sciences of the United States of America 67(2), pp. 898-899

Até que, em 1970, o papel do CO₂ passa a ser discutido.

893







Trabalhos primordiais...reconhecendo a existência do problema

Proceedings of the National Academy of Sciences Vol. 67, No. 2, pp. 898–899, October 1970

Carbon Dioxide and its Role in Climate Change

George S. Benton

THE JOHNS HOPKINS UNIVERSITY, BALTIMORE, MARYLAND 21218

Contributed to the Symposium on Aids and Threats from Technology, April 29, 1970

Climate is variable. In historical times, many significant fluctuations in temperature and precipitation have been identified. In the period from 1880 to 1940, the mean temperature of the earth increased about 0.6°C; from 1940 to 1970, it decreased by 0.3°O.4°C. Locally, temperature changes as large as 3-4°C per decade have been recorded, especially in sub-polar regions.

The cause of these changes has been under extensive study. One factor is the steady increase in carbon dioxide which has been observed, presumably as a result of the combustion of fossil fuels. In the late 19th century, prior to the industrial revolution, the carbon dioxide content of the atmosphere was about 290 ppm. This had risen to 314 ppm in 1960, and to just over 320 ppm in 1970. Aircraft observations by the Atmospheric Physics and Chemistry Laboratory of the Environmental Science Services Administration have clearly shown the importance of metropolitan areas as a source of carbon dioxide.

The effect of carbon dioxide is to increase the earth's temperature by absorbing outgoing terrestrial radiation. Recent numerical studies have indicated that a 10% increase in earbon dioxide should result, on the average, in a temperature increase of about 0.3°C at the earth's surface. The present rate of increase of 0.7 ppm per year would therefore (if extrapolated to 2000 A.D.) result in a warming of about 0.6°C—a very substantial change.

A second cause of climatic change is particulate loading of the atmosphere. Some meteorologists have attributed the cooling of the earth since 1940 primarily to such pollution of the atmosphere by man. However, the net effect of particulate matter on climate is difficult to analyze. Such pollutants, depending upon their size distribution and the elevation at which they occur, both intercept incoming solar radiation and trap outgoing radiation from the earth. The first process tends to depress the temperature of the earth's surface; the latter tends to increase it. To further complicate matters, the effect of pollution by natural volcanic activity must be considered. Unlike most activities of man, violent volcanic entrylions inject particulates directly into the stratosphere, where they are most effective in cooling the earth. The drop in the earth's temperature ince 1940 has been paralleled by a substantial increase in natural volcanism. The effect of such volcanic activity is probably greater than the effect of manwach collustrate.

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A causa dessas mudanças está sendo estudada extensivamente. Um fator é o aumento constante do dióxido de carbono que foi observado, presumivelmente como resultado da combustão de combustíveis fósseis. No final do século 19, antes da revolução industrial, o conteúdo de dióxido de carbono na atmosfera era de cerca de 290 ppm. Isso aumentou para 314 ppm em 1960 e para pouco mais de 320 ppm em 1970.







Trabalhos primordiais...modelagem

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Carbon dioxide and its role in climate change.

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Benton, G.S.

1970 - Proceedings of the National Academy of Sciences of the United States of America 67(2), pp. 898-899

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O efeito do dióxido de carbono é aumentar a temperatura da Terra absorvendo a radiação terrestre que antes seria lançada ao espaço. Estudos numéricos recentes indicaram que um aumento de 10% no dióxido de carbono deve resultar, em média, em um aumento de temperatura de cerca de 0,3OC na superfície da Terra.

A presente taxa de aumento de 0,7 ppm por ano, portanto (se extrapolada para 2000 d.C.) resultaria em um aquecimento de cerca de $0,60\,^{\circ}\text{C}$ - uma mudança muito substancial.







In the past decade, scientists have become increasingly concerned with man's pollution of the atmosphere and his inadvertent ability to effect change in climate at macro scales. The nature of such change is not yet known, but in this article, the premise that continued atmospheric pollution will promote higher air temperatures and ultimately coastal flooding through melting of all solid water forms, is accepted as inevitable. The author speculates on the probability of such an event and cartographically analyzes the possible extent of change in continental shapes and sizes, as well as the impact of world inundation on population densities and distributions. Projecting to 2050 A.D. as the earliest possible date for the maximization of this occurrence, it is expected that the expanding oceans will have reduced continental surfaces by approximately 17%, and roughly 19% of the population of the mid-21st century will have been

1971

Na década passada, os cientistas se preocuparam cada vez mais com a poluição da atmosfera causada pelo homem e sua capacidade provocar mudanças no clima em macro escalas.

A natureza de tal mudança ainda não é conhecida, mas neste artigo a premissa tida como inevitável é de que a poluição atmosférica continuada provocará temperaturas mais altas do ar e levará à ocorrência de inundações costeiras pelo derretimento de todas as formas de água sólida é aceita como inevitável.

O autor especula sobre a probabilidade de tal evento e analisa cartograficamente a possível extensão da mudança de formas e tamanhos continentais, bem como o impacto Global climate change and da inundação, em escala mundial, nas densidades e distribuições populacionais.

the impact of a maximum sea level on coastal

settlement Kopec, R.J.

Projetando-se para o ano de 2050, espera-se que os oceanos em expansão reduzam as superfícies continentais em aproximadamente 17% e que aproximadamente 19% da população de meados do século XXI tenha sido realocada.







Trabalhos primordiais...reconhecendo a existência do problema

1973

This paper reviews some of the major findings, conclusions, and recommendations of the Study of Man's Impact on Climate (SMIC). This study was conducted in Stockholm during the summer of 1971 under the sponsorship of the Massachusetts Institute of Technology and was hosted by the Royal Swedish Academy of Sciences and the Royal Swedish Academy of Engineering Sciences. Thirty scientists from fourteen countries devoted 3 weeks of concentrated effort to develop a consensus concerning the present and future scale of man's activities that may affect the global temperature and heat balance and to determine whether such effects may become large enough to cause climate changes for the whole earth or for large regions. The principal conclusions of the study was that man may indeed be affecting local, regional, and global climate through a large number of varied activities. The gaps in present knowledge were identified and recommendations on how to fill these gaps were developed. © 1973, Taylor & Francis Group, LLC. All Rights Reserved.

International Journal of Environmental Studies Volume 4, Issue 1-4, 1 January 1973, Pages 283-289 Climatic effects of man's activities Matthewst, W.H.







Trabalhos primordiais...reconhecendo a existência do problema

Abstract

1973

Rates of consumption of fossil fuels have increased steadily since the beginning of the industrialization of the world. Amounts are tabulated, and based on estimated carbon content of each fuel type, the amount of carbon dioxide resulting from combustion processes is calculated. These inputs to the atmosphere are compared with the observed values which show annual increases. Observations at Mauna Loa, Hawaii, and other locations indicate that over 50 percent of the carbon dioxide resulting from fossil fuel burning has remained in the atmosphere. Atmospheric carbon dioxide is not yet present in quantities to cause great alarm, but continued heavy dependence on fossil fuels will raise carbon dioxide levels such that observable climate changes could result within the next several decades.

Global Preduction Of CO₂ From Fossil Fuels and Possible Changes in the World's Climate.

Rotty, R.M. 1973 - ASME Pap (73 -Pwr-11)







Trabalhos primordiais...reconhecendo a existência do problema

C. F. Baes, Jr., H. E. Goeller, J. S. Olson, and

Carbon Dioxide and Climate: The Uncontrolled Experiment

Possibly severe consequences of growing CO₂ releases from fossil fuels require a much better understanding of the carbon cycle, climate change, and the resulting impacts on the atmosphere

According to Revelle and Suess (1957), "Human beings are now carrying out a large-scale geophysical experiment of a kind that could not have happened in the past nor be repeated in the future. Within a few turies we are returning to the atmosphere and oceans the concenated organic carbon stored in the sedimentary rocks over hundreds of millions of years. This experiment, if adequately documented, may yield a far-reaching insight into the processes determining weather and climate." Thus well said is the need to observe vigilantly the consequences of man's consumption of fossil fuels—coal, oil, and natural gas—and the concomitant return of vast amounts of carbon to the atmosphere in the form of car-

C.F. Boes, H.E. Goeller, and J.S. Obson are, respectively, numbers of the Chemistry Division, the Program Planning and Assert Silvision, the Program Planning and Assert Silvision, the Charge Planning and Assert Silvision, and the Euternamental Sciences Division of the Institute for Energy Analysis, Oak Ridge Associated Universities. The paper as an adaption of a resistent. The Oalboid Carbon Distrible Profession The Oalboid Carbon Distrible Profession. The College Carbon Ca om discussions with a number of in-they wish especially to thank W. ecker, of the Lamont-Doherty Geologica ry; V. Ramanathen, of the National Atmospheric Research; L. Machta, f the Air Resources Laboratorie OAA; J. M. Mitchell, of the Environmental e, NOAA; S. Manabe, of the Geo-id Dynamics Laboratory, NOAA; and, Oak Ridge Associated Uni-dress: Oak Ridge National Labo

the greater need to anticipate the equences of this process well enough in advance to keep them within acceptable limits. The urgency stems from the uncontrolled manner in which the "experiment" is being conducted. The release of fossil car bon as COo has been increasing at an exponential rate since the beginning of the industrial revolution about 100 years ago (Fig. 1). As a result the concentration of CO₂ in the atmosphere, which thus far has grown only about 12%, may double in the next 60 years or so. The effects may well be-come visible suddenly and, because of the great momentum developed by the machinery that produces man's energy, could grow out of control be-fore remedial actions become effec-

Left unstated, however, is perhaps The principal effect of an increased The principal effect of an increased concentration of CO₂ in the atmosphere should be a warming (Schneider 1975). While CO₂ is transparent to the incoming solar radiation, it absorbs a portion of the infrared radiation returned to space by the Earth. This "greenhouse effect" has given the words themselves a rather specialized meaning. The amount of warming produced by a given increase is, as we shall see, still quite uncertain, involving as it does all the complexities of the world climate. Yet the impacts of increased atomspheric CO2 on man's environment could be large indeed, rendering this a problem in impact assessment of unprecedented scope and diffi-

> This matter has been considered extensively in the current literature by climatologists (e.g. Mitchell 1972, (e.g. Broecker 1975; Keeling, in press),

1973), but not often in all its impor tant aspects. In the present article we especially the important uncertainof impact assessment. Effective remedial actions, if and when they become necessary, quite obviously cannot be expected unless and until their need can be foretold with a reliability that will match the consid-

The growth of atmospheric CO2

Since the beginning of accurate and regular measurements in 1958, the concentration of CO₂ in the atmosphere has shown an accelerating inrease upon which is superimposed annual fluctuations from photosyn thesis and other seasonal effects (Fig 2). The current average value is about 330 ppm, compared to estimated preindustrial values between 290 and 300 ppm (Callendar 1958). The meaurements in Figure 2 were taken at Mauna Loa Observatory (3,400 m elevation) in Hawaii and were cor for any temporary disturbances from local sources. Measurements at Point Barrow, Alaska, from aircraft over Sweden, and at the South Pole all show quite clearly the same secular increase (Machta et al. 1976).

The excess of the annual average concentration over the preindustrial value has grown about 4% per year (lower curve in Fig. 3). Over the same period the cumulative amount of CO₂ produced by the burning of fossil carbon (upper curve in Fig. 3) has been about twice as great as the atmospheric increase and has shown a similar rate of growth. (Except for brief interruptions during the two

Carbon dioxide and climate: the uncontrolled experiment

Baes Jr., C.F., Goeller, H.E., Olson, J.S., Rotty, R.M. 1977 - American Scientist 65(3), pp. 310-320

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1977

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Trabalhos primordiais...modelagem

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the greater need to anticipate the equences of this process well enough in advance to keep them within acceptable limits. The urgency stems from the uncontrolled manner in which the "experiment" is being conducted. The release of fossil car bon as COo has been increasing at an exponential rate since the beginning of the industrial revolution about 100 years ago (Fig. 1). As a result the concentration of CO₂ in the atmosphere, which thus far has grown only about 12%, may double in the next 60 years or so. The effects may well be-come visible suddenly and, because of the great momentum developed by the machinery that produces man's energy, could grow out of control be-fore remedial actions become effec-

Left unstated, however, is perhaps The principal effect of an increased The principal effect of an increased concentration of CO₂ in the atmosphere should be a warming (Schneider 1975). While CO₂ is transparent to the incoming solar radiation, it absorbs a portion of the infrared radiation returned to space by the Earth. This "greenhouse effect" has given the words themselves a rather specialized meaning. The amount of warming produced by a given increase is, as we shall see, still quite uncertain, involving as it does all the complexities of the world climate. Yet the impacts of increased atomspheric CO2 on man's environment could be large indeed, rendering this a problem in impact assessment of unprecedented scope and diffi-

> This matter has been considered extensively in the current literature by climatologists (e.g. Mitchell 1972, (e.g. Broecker 1975; Keeling, in press), and biologists (e.g. Reiners et al.

1973), but not often in all its impor tant aspects. In the present article we especially the important uncertainof impact assessment. Effective remedial actions, if and when they become necessary, quite obviously cannot be expected unless and until their need can be foretold with a reliability that will match the considerable costs of their implementa

The growth of atmospheric CO2

Since the beginning of accurate and regular measurements in 1958, the concentration of CO₂ in the atmosphere has shown an accelerating inrease upon which is superimposed annual fluctuations from photosyn thesis and other seasonal effects (Fig 2). The current average value is about 330 ppm, compared to estimated preindustrial values between 290 and 300 ppm (Callendar 1958). The meaurements in Figure 2 were taken at Mauna Loa Observatory (3,400 m elevation) in Hawaii and were cor for any temporary disturbances from local sources. Measurements at Point Barrow, Alaska, from aircraft over Sweden, and at the South Pole all show quite clearly the same secular increase (Machta et al. 1976).

The excess of the annual average concentration over the preindustrial value has grown about 4% per year (lower curve in Fig. 3). Over the same period the cumulative amount of CO₂ produced by the burning of fossil carbon (upper curve in Fig. 3) has been about twice as great as the atmospheric increase and has shown a similar rate of growth. (Except for brief interruptions during the two

Carbon dioxide and climate: the uncontrolled experiment

Baes Jr., C.F., Goeller, H.E., Olson, J.S., Rotty, R.M. 1977 - American Scientist 65(3), pp. 310-320

The impact on climate to be expected from a particular stimulus has been deduced from models developed over the last several decades, from simple one-dimensional radiation-balance models of the Earth's atmosphere to quite complicated so-called general circulation models that include the circulation of the atmosphere in three dimensions. Such models indicate an increase in temperature with increased CO₂ and suggest that the temperature response is approximately logarithmic, i.e. each doubling in the concentration of CO₂ produces about the same increase in the average temperature of the troposphere. The more sophisticated models predict, moreover, that the temperature change is much greater at high latitudes. The amount of the average increase in temperature per doubling



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Trabalhos primordiais...modelagem

HOW LONG IS COAL'S FUTURE?*

1977

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Abstract. Nearly all scenarios for future U.S. energy supply systems show heavy dependence on coal. The magnitude depends on assumptions as to reliance on nuclear fission, degree of electrification, and rate of GNP growth, and ranges from 700 million tons to 2300 million tons per year, However, potential climate change resulting from increasing atmospheric carbon dioxide concentrations may prevent coal from playing a major role. The carbon in the carbon dioxide produced from fossil fuels each year is about 1/10 the net primary production by terrestrial plants, but the fossil fuel production has been growing exponentially at 4.3% per year. Observed atmospheric CO, concentrations have increased from 315 ppm in 1958 to 330 ppm in 1974 - in 1900, before much fossil fuel was burned, it was about 290-295 ppm. Slightly over one-half the CO₂ released from fossil fuels is accounted for by the increase observed in the atmosphere; at present growth rates the quantities are doubling every 15-18 years. Atmospheric models suggest a global warming of about 2 K if the concentration were to rise to two times its pre-1900 value - enough to change the global climate in major (but largely unknown) ways. With the current rate of increase in fossil fuel use, the atmospheric concentration should reach these levels by about 2030. A shift to coal as a replacement for oil and gas gives more carbon dioxide per unit of energy; thus if energy growth continues with a concurrent shift toward coal, high concentrations can be reached somewhat earlier. Even projections with very heavy reliance on non-fossil energy (Neihaus) after 2000 show atmospheric carbon dioxide concentrations reaching 475 ppm.

How long is coal's future? Rotty, R.M., Weinberg, A.M. 1977 - Climatic Change 1(1), pp. 45-57



Pós-Graduação

Programas em Energia (PPGE) e Ciência Ambiental (PROCAM)





Editorial da "Climate Change"...políticas públicas

EDITORIAL FOR THE FIRST ISSUE OF CLIMATIC CHANGE

1977

Climatic Change is a new journal designed to provide a means of exchange among researchers from a variety of disciplines who are working on problems related to climatic variations. Climatic Change will give authors an opportunity to communicate the essence of their studies both to researchers in other climate-related disciplines and to interested non-disciplinarians, who might be unable to follow the details of new results published in highly technical journals. The intention of this exchange will be to stimulate interdisciplinary interest that will lead to new research possibilities and will help to define and sharpen issues that have a climatic component—issues that could also relate ultimately to public policy questions.

Researchers from any discipline — meteorology, anthropology, medicine, agricultural science, economics, ecology, etc. — are invited to submit articles about work related to any aspect of climatic change that would be of interest to specialists in at least two disciplines. Articles should be written at a level that is professional though not specialized.

The other important objectives of *Climatic Change* are perhaps less directly related to issues of climatic variations, but are, nonetheless, of considerable importance to the general progress of interdisciplinary research. One such objective is to define and maintain

<u>Editorial</u> for the first issue of climatic change Schneider, S.H.

1977 - Climatic Change

1(1), pp. 3-4







Trabalhos primordiais...geoengenharia

ON GEOENGINEERING AND THE CO. PROBLEM

CÉSARÉ MARCHETTI

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Abstract. The problem of CO_2 control in the atmosphere is tackled by proposing a kind of 'fuel cycle' for fossil fuels where CO_2 is partially or totally collected at certain transformation points and properly disposed of,

CO₂ is disposed of by injection into suitable sinking thermohaline currents that carry and spread it into the deep ocean that has a very large equilibrium capacity.

The Mediterranean undercurrent entering the Atlantic at Gibraltar has been identified as one such current; it would have sufficient capacity to deal with all CO₂ produced in Europe even in the year 2100.

. Introduction

The problem of climatological effects of CO_2 has recently attracted much attention, but the related question of how much fossil fuel we can still burn without burning our fingers is yet open. It may turn out that burning fossils 'à gogo' will have no really important consequences at least for our generation; yet reports on the subject, following the spirit of the time perhaps, tend to be more and more pessimistic [1,2].

The first order effects are thought to be caused by the intense absorption bands of this gas in the infrared window of the atmosphere, i.e. in the region between approximately 8μ and 12μ . Calculations show that the isotropic scattering and absorption-re-emission of infrared radiation by CO₂ molecules in the atmosphere reduce the diffusiveness of infrared radiation, consequently producing a so-called greenhouse effect (greenhouses do in fact operate on different principles).

As water is competing with CO_2 in the same window, the effect will be larger where water concentration is lowest; this is so in the anticyclonic areas over the deserts, for example, and especially over the poles where due to the very low temperatures the water content is at a minimum. This can produce a second order effect, namely a decreased horizontal lapse rate between the poles and the equator, which would directly influence the circulation cells and the precipitation regime.

A third order effect may come from the increased photosynthetic rate of plants for which atmospheric CO_2 tends to be a limiting factor [3, 4]. This increase may induce a higher level of plant coverage, thus tendentially decreasing the earth's albedo and consequently working in much the same way as the greenhouse effect but with a concentrated influence upon temperate zones and tropical savannas.

An increase in temperature in the polar regions would bring about a similar positive feedback as it would induce a reduction in the snow cover and floating ice coverage, thus reducing the albedo and increasing the energy input.

These effects have been analyzed mainly at the level of total energy balance [1] with

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On **geoengineering** and the CO2 problem

Marchetti, C. 1977 - Climatic Change 1(1), pp. 59-68 1977

3. CO₂ Transportation

Geoengenharia

 ${
m CO_2}$ can be easily compressed to a liquid of 60-70 atm at room temperature. This liquid has a low viscosity and pumps like water. It can be transported in pipelines that are essentially the same as those for methane.

The high pressures needed to carry CO_2 in a liquid form, even if it is moderately chilled, make the use of normal oil tankers improbable. But the problem has not been examined in detail and simple tricks may be discovered to do that. Solid CO_2 , for example, can be piled on barges.

For the sake of the discussion I will assume that only liquid CO₂ is carried overland in pipelines. I am also confident that the cost of transporting it anywhere will finally be lower than the cost of 'forward' fuel transportation which could be taken as a reference.

CO₂ Disposal

This could be done in the form of a permanent underground storage, e.g. by using exhausted gas fields. This possible storage of liquid CO_2 at pressure lower than 100 atm guarantees a large storage capacity than for the original methane, although the solubility of CO_2 in water and the solubilization of carbonate rocks do not guarantee a similar



Pós-Graduação

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Trabalhos primordiais...reconhecendo a existência do problema 1978

ATMOSPHERIC CARBON DIOXIDE

Possible Consequences of Future Fossil Fuel Use*

Ralph M. ROTTY

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Accurate and regular measurements of the concentration of CO2 in the atmosphere during the past 20 years show an accelerating increase. Although clearing of tropical forests has released large amounts of carbon to the atmosphere, evidence is strong that a major contributor is the

combustion of fossil fuels. Future energy demands exploitation of fossil fuels, and projections show the fuel alternatives, the atmospheric concentration will of require serious attention:

The developing countries will require vastly incre develop suitable (inexpensive) non-fossil energy s demand are required.

The distribution of carbon released from fossil fu among the reservoirs of the carbon cycle must be be -Uncertainties regarding the effect of the increased

-Possible political and social responses to a substant to more fully understand all of the implication of

The release of carbon as CO2 as a increasing at an exponential rate for more

continues, the concentration of CO₂ in the atmosphere may be doubled in the next 60 years or so. The effects on global climate may well become apparent suddenly, and because of the great momentum developed by the machinery that produces man's energy, could grow out of control before remedial actions become effective.

Because the amount of carbon contained in easily accessible fossil fuels is so vast, there is great temptation to use these resources as a source of energy

*This paper was originally prepared for and at the request of the Committee on Health and Ecological Effects of Increased Coal Utilization, a national advisory committee mandated by the United States National Energy Plan submitted to Congress by President Carter in 1977.

**Operated by the U.S. Department of Energy under contract number EY-65-C-05-0033. The work on which this paper is based was supported by DOE Assistant Secretary for Environment.

As these reserves are used, an increase in concentration of CO₂ in the atmosphere will surely result; and because CO₂ absorbs a portion of the infrared radiation emitted by the Earth, it is generally believed that a warmer global climate will result. Although the amount of warming produced by a given increase is uncertain, the impact of increased atmospheric CO, on man's environment could be quite large. The potential CO, problem may present a challenge of unprecedented scope and difficulty.

Atmospheric carbon dioxide. Possible consequences of future fossil fuel use Rotty, R.M. 1978 - Resources and Energy 1(3), pp. 231-249







Trabalhos primordiais...abordagem interdisciplinar

SOCIETAL RESPONSE TO CO2-INDUCED

CLIMATE CHANGE: OPPORTUNITIES FOR RESEARCH

1981

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Abstract. How might a climate change, induced by increased CO₂ in the atmosphere, affect societies? What is the range of existing and potential mechanisms for societal response? And how might research contribute to a reduction of the adverse impact (or enhancement of the unique opportunities) of a climate change by providing greater understanding of the processes involved in climate and society interaction? This paper reflects an initial effort to shed light on these questions. It offers first a framework for identifying key issues in climate-society interaction; eight major questions are suggested by the framework. A discussion of each major question is then presented with the purpose of reviewing the current state of knowledge, identifying the gaps in understanding, and offering opportunities for research to fill those gaps. In all, twenty-two research needs are outlined and are summarized at the conclusion of the paper. The perspective is interdisciplinary, but the review draws heavily from the geographic literature, reflecting

0. Climate and Society Relationships

Initially, we would like to comment on recent As the need for, and interest in, climate impar last several years, a flurry of research activities oftentimes rely upon a rather simple concept would like to term 'neo-environmental dete conceptual model which depicts a one-way environment, if you will) and human activit

Second, because of the complexity and holistic character of the CO₂ issue, disciplinary research foci have only limited application. Interdisciplinary communication and research are central to progress in understanding climate-society interaction in general and CO₂-induced climate change in particular. The research opportunities suggested herein reflect this view.

of society can be traced to the classical Greeks, a resurgence of intellectual environmental determinism was strongly evident in the first decades of the 20th century. Ellsworth Huntington, a geographer, was noteworthy as the spokeperson for this view, as reflected in his Civilization and Climate (1915). This view assumes that climate is the independent variable whose explanatory power is pervasive in understanding social structure, settlement patterns, and human behavior. The arguments led easily into racial or cultural stereotyping (the tropical climate fosters lazy, unmotivated peoples, and the midlatitude regimes promote vigorous, industrious humans), and finally to explanations of the differences in the global patterns of economic development we see today. These views fell out of intellectual favor as being too simplistic and mechanistic, and largely disappeared (at least in their overt form) for many decades. With the recent concern over CO₂ and other

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Societal response to CO2 -induced climate change:

Opportunities for research Warrick, R.A., Riebsame, W.E. 1981-Climatic Change 3(4), pp. 387-428







Trabalhos primordiais...impactos econômicos

1982

ECONOMIC IMPACT ANALYSIS AND CLIMATE CHANGE: A CONCEPTUAL INTRODUCTION

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Chama a atenção para a necessidade de cientistas que possam analisar os impactos econômicos e sobre a importância de pesquisas sobre o tema.

1. Introduction

The purpose of this pape a capacity to conduct ec changes. In order to und we must first consider th analysis in estimating the there is a variety of speci to, or indeed complete the 'social science machin at the present time. That with these questions: (1) matic system to appreciat and (2) an accumulated se tions of climate for econ sidering the prospects fo analyses of changes or va with economic methodolo ment of a social science is on the methodological

To begin this process, analysis. A brief outline of analysis will then serve to methodologies. Following attributes of climate as a difficulties which can ari consequences of changes we consider the elements for economic impact analy

2. Conventional Econo

The programs of analysis impact analysis as part of

analysis in estimating the economic consequences of climate change. It will be argued that there is a variety of special features of climate change that require substantial amendments to, or indeed complete replacement of, these traditional methodologies. Unfortunately, the 'social science machinery' necessary to address these problems is simply not available at the present time. That is, we do not have two important ingredients to making progress with these questions: (1) a sufficient community of social scientists with knowledge of climatic system to appreciate the problems of economic impact analyses for climate change; and (2) an accumulated set of research information directed toward evaluating the implications of climate for economic activities and social structures. As a consequence, in considering the prospects for the development of a capacity to perform economic impact analyses of changes or variations in climate we must address both issues purely associated with economic methodology and those of an institutional nature pertaining to the development of a social science research community in this area. The primary focus of this paper is on the methodological issues.

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Economic impact analysis and climate change: A conceptual introduction Smith, V.K.

1982-Climatic Change
4(1), pp. 5-22







Trabalhos primordiais...captura de carbono

GLOBAL FOREST SYSTEMS: AN UNCERTAIN RESPONSE TO ATMOSPHERIC POLLUTANTS AND GLOBAL CLIMATE CHANGE?

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¹U.S. Support for Country Studies to Address Climate Change, PO-63, 1000 Independence Avenue, SW, Washington, DC 20585 USA, ⁵Wisniewski and Associates, Inc., 6862 McLean Province Circle, Falls Church, VA 22043 USA

Abstract. Forest systems cover more than 4.1 x 10° ha of the Earth's land area. The future response and feedbacks of forest systems to atmospheric pollutants and projected climate change may be significant. Boreal, temperate and tropical forest systems play a prominent role in carbon (C), nitrogen (N) and sulfur (S) biogeochemical cycles at regional and global scales. The timing and magnitude of future changes in forest systems will depend on environmental factors such as a changing global climate, an accumulation of CO₂ in the atmosphere, and increase global mineralization of nutrients such as N and S. The interactive effects of all these factors on the world's forest regions are complex and not intuitively obvious and are likely to differ among geographic regions. Although the potential effects of some atmospheric pollutants on forest systems have been observed or simulated, large uncertainty exists in our ability to project future forest distribution, composition and productivity under transient or nontransient global climate change scenarios. The potential to manage and adapt forests to future global curious entangement to sequester CO₂ are now being applied in aslected rations worldwide.

Key words: carbon, nitrogen, sulfur, biogeochemistry, mitigation, global change

1. Introduction

Globally, forests cover 4.1 x 10° ha of the Earth's land surface with approximately 13% of the forests protected by governments and less than 10% actively managed (Sharma, 1992). The largest area of forests (42%) is in low latitudes, where more than half are in tropical America. Mid-latitude forest make up approximately 25% of the global total. Russia has the largest area of forests, approximately 21% of the global forest area. Brazil is next with approximately 10% of the total. Forest systems play a prominent role in global carbon (C), nitrogen (N) and sulfur (S) cycles, as well as response and feedbacks to atmospheric pollutants and global climate change. Given our current understanding of atmospheric pollutants, global change, and global biogeochemical cycles, the prospect for managing forest systems to mitigate or ameliorate adverse impacts are promising.

Forest systems are concomitantly influenced by changes in atmospheric chemistry, land use and global climate (Melillo, 1995; Dixon et al., 1994; Skelly and Innes, 1994). Recent analyses suggest that current atmospheric CO₂ increases could lead to global warming of between 0.2° and 0.3° per decade in the next century (IPCC, 1995). Shifts in the area distribution and productivity of forest systems are predicted in response to global climate change (Smith et al., 1993). Changes in atmospheric chemistry, such as observed increases in CO₂ (Keeling and Wharf, 1994) and N compounds (Melillo, 1995)

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Global forest systems: An uncertain response to atmospheric pollutants and global climate change?
Dixon, R.K., Wisniewski, J.
1995 - Water, Air, & Soil Pollution
85(1), pp. 101-110

1995







Trabalhos primordiais...modelagem

2000

letters to nature

strong evidence for a dissociative mechanism by measuring the rate nine exchange between assemblies 15: (BuCYA)6 and 2₃(BuCYA)₆ by ¹H NMR spectroscopy. Upon mixing these assemblies in a 1:1 ratio in benzene-d₆ at 70 °C, well-separated signals for the new heteromeric assemblies 1221 (BuCYA)6 and 1122 (BuCYA)6 appear over time as a result of the exchange of calix[4] arene melamines 1 and 2. The rate-determining step in the exchange ocess involves the dissociation of calix[4] arene dimelamines fro in intact assembly, a process that requires the disruption of a total of 12 hydrogen bonds. If racemization occurred via a dissociative mechanism, the rates of dimelamine exchange and racemization should be of similar magnitude. We studied the concentration lependence of the rate of dimelamine exchange, both with and without (S)-BAR present, and found that this rate can be expressed by the same equation as the rate of racemization, with slightly different values of k_{at} and k_{uncat} (14.7 × 10⁻³ l mol⁻¹ s⁻¹ and 7.0 × 10⁻⁵ s⁻¹, respectively, at 70 °C). These values relate well to those tained from the racemization studies. (The slightly higher values for dimelamine exchange are due to the slightly higher temperature at which these ¹H NMR experiments were conducted, 70 versus 50 °C). From these results we conclude that racemization occurs predominantly via a dissociative mechanism, both uncatalysed and catalysed (Fig. 5b and c). The rate-limiting step involves the dissociation of calix [4] arene dimelamines from the intact assembly, followed by rapid racemization and formation of the opposite

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tary Information is available on Nature's World-Wide Web sit

408(6809), pp. 184-187

We thank G Marjo and A Biolejowska for their work on the model complexes 4 and R. Fokkens and NAMA Nibbering for the MALDI-TOFMS measurement work was supported by the Causal for Chemical Sciences of the Nethorlands Organization for Scient Ele Research (CW-NWO).

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Acceleration of global warming due to carbon-cycle feedbacks in a coupled climate model

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The continued increase in the atmospheric concentration of carbon dioxide due to anthropogenic emissions is predicted to lead to significant changes in climate. About half of the current emissions are being absorbed by the ocean and by land ecosystems2, but this absorption is sensitive to climate34 as well as to atmospheric carbon dioxide concentrations, creating feedback loop. General circulation models have generally excluded the feedback between climate and the biosphere, using static vegetation distributions and CO2 concentrations from simple carbon-cycle models that do not include climate change. Here we present results from a fully coupled, three-dimension carbon-climate model, indicating that carbon-cycle feedbacks could significantly accelerate climate change over the twenty-first century. We find that under a 'business as usual' scenario, the terrestrial biosphere acts as an overall carbon sink until about 2050, but turns into a source thereafter. By 2100, the ocean uptake rate of 5 GtC yr⁻¹ is balanced by the terrestrial carbon source, and atmospheric CO2 concentrations are 250 p.p.m.v. higher in our fully coupled simulation than in uncoupled carbon models², resulting in a global-mean warming of 5.5 K, as compared to 4 K without the carbon-cycle feed back.

The general circulation model (GCM) that we used is based of the third Hadley Centre coupled ocean-atmosphere model, HadCM37, which we have coupled to an ocean carbon-cycle model (HadOCC) and a dynamic global vegetation model (TRIFidentical to those used in HadCM3, but the additional computa tional expense of including an interactive carbon cycle made it necessary to reduce the ocean resolution to 2.5° × 3.75°, necessitating the use of flux adjustments in the ocean component to counter act climate drift. HadOCC accounts for the atmosphere exchange of CO2, and the transfer of CO2 to depth through both the solubility pump and the biological pump⁸. TRIFFID models the state of the biosphere in terms of the soil carbon, and the structure and coverage of five functional types of plant within each model gridbox (broadleaf tree, needleleaf tree, C₅ grass, C₄ grass and shrub). Further details on HadOCC and TRIFFID are given in Methods.

librium with a 'pre-industrial' atmospheric CO₂ concentration of 290 p.p.m.v., starting from an observed landcover data set. The resulting state was stable, with negligible net land-atmosphere and Here we present results from a fully coupled, three-dimensional carbon-climate model, indicating that carbon-cycle feedbacks could significantly accelerate climate change over the twenty-first century. We find that under a 'business as usual' scenario, the terrestrial biosphere acts as an overall carbon sink until about 2050, but turns into a source thereafter. By 2100, the ocean uptake rate of 5 Gt Cyr⁻¹ is balanced by the terrestrial carbon source, and atmospheric CO₂ concentrations are 250 p.p.m.v. higher in our fully coupled simulation than in uncoupled carbon models², resulting in a global-mean warming of 5.5 K, as compared to 4 K without the carbon-cycle feedback.

Descobrimos que, em um cenário "business as usual", a biosfera terrestre atua como um sumidouro global de carbono até cerca de 2050, mas se transforma em uma fonte a partir de então.

Acceleration of global warming due to carbon-cycle feedbacks in a coupled climate model Cox, P.M., Betts, R.A., Jones, C.D., Spall, S.A., Totterdell, I.J. 2000 - Nature







Trabalhos primordiais...busca por soluções/alternativas

2006

REVIEW

The Path Forward for Biofuels and Biomaterials

Arthur J. Ragauskas, ^{1a} Charlotte K. Williams, ⁴ Brian H. Davison, ⁶ George Britovsek, ⁴ John Caimey, ² Charles A. Eckert, ³ William J. Frederick Jr., ³ Jason P. Hallett, ³ David J. Leak, ⁵ Charles L. Liotta, 1 Jonathan R. Mielenz, 6 Richard Murphy, 5 Richard Templer, Tim othy Tschanlinski

Biomass represents an abundant carbon-neutral renewable resource for the production of bioenergy and biomaterials, and its enhanced use would address several societal needs. Advances in genetics, biotechnology, process chemistry, and engineering are leading to a new manufacturing concept for converting renewable biomass to valuable fuels and products, generally referred to as the biorefinery. The integration of agroenergy crops and biorefinery manufacturing technologies offers the potential for the development of sustainable biopower and biomaterials that will lead to a new manufacturing paradigm.

e are apt to forget the gasoline short-ages of the 1970s or the fuel price panic after Hurricane Katrina, but these are but harbingers of the inevitable excess of growing demand over dwindling supplies of geological reserves. Before we freeze in the dark, we must prepare to make the transition from nonrenewable carbon resources to renewable bioresources. This paper is a road nap for such an endeavor. Among the earliest drivers of chemical and

cal research were the benefits to be gained from converting biomass into fuels and chemical products. At the beginning of the 20th entury, many industrial materials such as dyes, solvents, and synthetic fibers were made from trees and agricultural crops. By the late 1960s, many of these bio-based chemical products had been displaced by petroleum derivatives (1). The energy crisis of the 1970s sparked renewed interest in the synthesis of fuels and materials from bioresources. This interest waned in the decades that followed as the oil price abated. However, this meant that global consumption of liquid petroleum tripled in the ensuing years (2) Indeed, energy demand is projected to grow by more than 50% by 2025, with much of this increase in demand emerging from several rapidly developing nations. Clearly, increasing emand for finite petroleum resources cannot be a satisfactory policy for the long term.

Hoffert et al. (3) and others (4) have provided a global perspective on these energy challenges and their relationship to global climate stability. As these authors point out,

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311(5760), pp. 484-489

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future reductions in the ecological footnrint of energy generation will reside in a multifaceted approach that includes nuclear, solar, hydrogen, wind, and fossil fuels (from which carbon is sequestered) and biofuels. These concerns have also been advanced by the recent Joint Science Academies' statement to the Gleneagles G8 Summit in July 2005, to biotic and abiotic challenge, and biomass Global Response to Climate Change, which asserts that the warming of the planet can be attributed to human activities and identifies need for action now to pinpoint cost effective steps to contribute to substantial and long-term reductions in net greenhouse gas

Shifting society's dependence away from petroleum to renewable biomass resources is generally viewed as an important contributor to the development of a sustainable industrial society and effective management of greenhouse gas emissions. In the United States, bioethanol derived primarily from com contributes ~2% to the total transportation fuels mix: another ~0.01% is based on biodiesel. The U.S. Department of Energy has set goals to replace 30% of the liquid petroleum transportation fuel with biofuels and to replace 25% of industrial organic chemicals with biomass-derived chemicals by 2025 (2, 6). The European Union Directive 2003/30/EC ("the Biofuels Directive") adopted in 2003 targeted 2% of all petrol and December 2005 and 5.75% by December 2010. This directive was motivated by concerns to ensure the security of the European energy supply, environmental sustainability, and achievement of Kyoto Protocol targets (2). These biomaterials and biofuels production targets are certainly achievable; Parikka (7) has reported the current sustainable global biomass energy potential at ~1020 joules per year, of which ~40%

Given these accomplishments, a key ques-

make a major contribution?" One answer, com ing from a forum at the 27th Symposium or Biotechnology for Fuels and Chemicals, was that some applications are ready now, but their impact will be limited with current technologies and feedstocks (8). We need commercialization and policy support for current and near-term oportunities to grow the industry from its presen base. Equally important, we need research and development to increase the impact, efficiency, and sustainability of biorefinery facilities. The biodiesel processes are a starting point. It is our belief that the next generational change in the use of bioresources will come from a total integration of innovative plant resources, synthesis of biomaterials, and generation of biofuels and biopower (Fig. 1).

Innovative Plant Design via Accelerated Domestication

"More, Bigger, and Better," the mantra of modern consumerism, also summarizes— ironically—the goals of research aimed a biomass production. Interrelated plant traits such as higher yield, altered stature, resilience composition will increase industrial crop value in terms of biofuels and biomaterials. The challenge is to weave these different strands of re-

Currently, the global yield for all biomass crops, including woody and herbaceous crops growing in temperate and subtropical regi varies from ~8 dry Mg ha-1 year-1 (for willow in Sweden) to 10 to 22 dry Mg ha-1 year-1 (for short-rotation woody crops in the United States). Some commercial plantations in Brazil have reported up to 20 dry Mg ha-1 year-1. A conservative global biomass average would be -10 dry Mg ha-1 year-1, although some small-scale field trials have reported four times this level of biomass production (9, 10). The grand challenge for biomass production is to develop crops with a suite of desirable physical and chemical traits while increasing biomass yields by a factor of 2 or more. Although many annual crops benefit from centuries of domestication efforts, perennial species that could play a central role in providing a renewable source of feedstock for conversion to fuels and materials have not had such attention to date. Doubling the global productivity of energy crops will depend on identifying the fundamental constraints on productivity and addresstools (Fig. 2).

An obvious target is manipulation of photosynthesis to increase the initial capture of light energy, which at present is less than 2%. Reusing engineered genes from plants and phototion is "When will biorefineries be ready to synthetic bacteria. For example, ribulose-15-

CORRECTED 23 JUNE 2006; SEE LAST PAGE

evaluate and set energy policy in this impor-

To better understand the energy and environ-

mental implications of ethanol, we surveyed the

published and gray literature and present a comparison of six studies illustrating the range

of assumptions and data found for the case

(11-16). To permit a direct and meaningful

comparison of the data and assumptions across

the studies, we developed the Energy and

Model (EBAMM) (10), For each study, we

compared data sources and methods and param-eterized EBAMM to replicate the published

net energy results to within half a percent. In

addition to net energy, we also calculated

metrics for greenhouse gas (GHG) emissions

and primary energy inputs (table S1 and Fig. 1).

because they report negative net energy values

and imply relatively high GHG emissions and petroleum inputs (11, 12). The close evaluation

required to replicate the net energy results showed that these two studies also stand apart from the

others by incorrectly assuming that ethanol

coproducts (materials inevitably generated when

ethanol is made, such as dried distiller grains with

solubles, corn gluten feed, and corn oil) should

not be credited with any of the input energy and

by including some input data that are old and

unrepresentative of current processes, or so

poorly documented that their quality cannot be

Sensitivity analyses with FRAMM and else

where show that net energy calculations are

most sensitive to assumptions about coproduct allocation (17). Coproducts of ethanol have

positive economic value and displace compet-

ing products that require energy to make. There

fore, increases in corn ethanol production to

meet the requirements of EPACT 2005 will

lead to more coproducts that displace whole

energy thereby saved will partly offset the en-

ergy required for ethanol production (5, 18).

The studies that correctly accounted for this

nent effect reported that ethanol and

evaluated (tables S2 and S3).

Two of the studies stand out from the other

urces Group (ERG) Biofuel Analysis Meta

com-based (Zea mays, or maize) ethano

Ethanol Can Contribute to Energy and Environmental Goals

Alexander E. Farrell, ²⁸ Richard J. Plevin, ² Brian T. Turner, ^{2, 2} Andrew D. Jones, ² Michael O'Hare, ² Daniel M. Kammen ^{2, 2, 3}

To study the potential effects of increased biofuel use, we evaluated six representative analyses of fuel ethanol. Studies that reported negative net energy incorrectly ignored coproducts and used some obsolete data. All studies indicated that current corn ethanol technologies are much less petroleum-intensive than gas oline but have greenhouse gas emissions similar to those of gasoline However, many important environmental effects of biofuel production are poorly understood New metrics that measure specific resource inputs are developed, but further research into nmental metrics is needed. Nonetheless, it is already clear that large-scale use of ethanol

tant arena.

ergy security and climate change imperatives require large-scale substitu-tion of petroleum-based fuels as well as mproved vehicle efficiency (1, 2). Although biofuels offer a diverse range of promising alternatives, ethanol constitutes 99% of all biofuels in the United States. The 3.4 billion gallons of ethanol blended into gasoline in 2004 amounted to about 2% of all gasoline sold by volume and 1.3% (2.5 \times 10¹⁷ J) of its energy content (3). Greater quantities of ethmol are expected to be used as a motor fuel in the future because of two federal policies; a \$0.51 tax credit per gallon of ethanol used as notor fuel and a new mandate for up to 7.5 billion gallons of "renewable fuel" to be used in gasoline by 2012, which was included in the ntly passed Energy Policy Act (EPACT

Thus, the energy and environmental impli-cations of ethanol production are more important than ever. Much of the analysis and public lebate about ethanol has focused on the sign of the net energy of ethanol: whether manu-facturing ethanol takes more nonrenewable energy than the resulting fuel provides (6, 7). has long been recognized that calculations of net energy are highly sensitive to assump-tions about both system boundaries and key parameter values (8). In addition, net energy calculations ignore vast differences between different types of fossil energy (9). Moreover, net energy ratios are extremely sensitive to specification and assumptions and can produce unintermetable values in some important case (10). However, comparing across published studies to evaluate how these assumptions af-fect outcomes is difficult owing to the use of different units and system boundaries across studies. Finding intuitive and meaningful replacements for net energy as a performance metric would be an advance in our ability to

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coproducts manufactured from corn yielded a

positive net energy of about 4 MJ/l to 9 MJ/l. The study that ignored coproducts but used recent data found a slightly positive net energy for corn ethanol (13). However, comparison

because of many incommensurate assumptions

We used EBAMM to (i) add coproduct credit where needed, (ii) apply a consistent system boundary by adding missing parameters (e.g., effluent processing energy) and dropping extraneous ones (e.g., laborer food energy), (iii) account for different energy types, and (iv) calculate policy-relevant metrics (19).

Figure 1 shows both published and commensu-rate values as well as equivalent values for the

reference, conventional gasoline The published results, adjusted for com-

surate system boundaries, indicate that with current production methods corn ethanol displaces petroleum use substantially; only 5 to 26% of the energy content is renewable. The rest is primarily natural gas and coal (Fig. 2), ethanol has an ambiguous effect on GHG emissions, with the reported values ranging from a 20% increase to a decrease of 32%. These values have their bases in the same system boundaries, but some of them rely on data of dubious quality. Our best point estimate for average performance today is that corn ethanol reduces petroleum use by about 95% on an energetic basis and reduces GHG Uncertainty analysis suggests these results are robust (10). It is important to realize that actual performance will vary from place to place and that these values reflect an absence of incenquate policy incentives the performance of corn ethanol in terms of GHG emissions can likely be improved (20). However, current data suggest that only cellulosic ethanol offers large reductions in GHG emissions.

The remaining differences among the six studies are due to different input parameters which are relatively easy to evaluate within the simple, transparent EBAMM framework. For instance, most of the difference between the highest and lowest values for GHG emissions in our data are due to differences in limestone (CaCO.,) application rate and energy embodied in farm machinery (table S1). The former is truly uncertain; data for lime application and for the resulting GHG emissions are noor (15) In contrast, the higher farm machinery energy values are unverifiable and more than an order of magnitude greater than values reported elsewhere and calculated here, suggesting that the lower

This analysis illustrates the major con tribution of agricultural practices to life-cycle GHG emissions (34% to 44%) and petroleum

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311(5760), pp. 506-508







Trabalhos atuais...captura de carbono

A Large and Persistent Carbon Sink in the World's Forests

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The terrestrial carbon sink has been large in recent decades, but its size and location remain uncertain. Using forest inventory data and long-term ecosystem carbon studies, we estimate a total forest sink of 2.4 \pm 0.4 petagrams of carbon per year (Pg C year $^{-1}$) globally for 1990 to 2007. We also estimate a source of 1.3 \pm 0.7 Pg C year $^{-1}$ from tropical land-use change, consisting of a gross tropical deforestation emission of 2.9 \pm 0.5 Pg C year $^{-1}$ partially compensated by a carbon sink in tropical forest regrowth of 1.6 \pm 0.5 Pg C year $^{-1}$. Together, the fluxes comprise a net global forest sink of 1.1 \pm 0.8 Pg C year $^{-1}$, with tropical estimates having the largest uncertainties. Our total forest sink estimate is equivalent in magnitude to the terrestrial sink deduced from fossil fuel emissions and land-use change sources minus ocean and atmospheric sinks.

Porests have an important role in the global carbon cycle and are valued globally for the services they provide to society. International negotiations to limit greenhouse gases require an understanding of the current and potential future role of forest C emissions and sequestra-

tion in both managed and unmanaged forests. Estimates by the Intergovernmental Panel on Climate Change (IPCC) show that the net uptake by terrestrial ecosystems ranges from less than 1.0 to as much as 2.6 Pg C year⁻¹ for the 1990s (1). More recent global C analyses have estimated a

terrestrial C sink in the range of 2.0 to 3.4 Pg C year⁻¹ on the basis of atmospheric CO₂ observations and inverse modeling, as well as land observations (2–4). Because of this uncertainty and the possible change in magnitude over time, constraining these estimates is critically important to support future climate mitigation actions.

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2011







Trabalhos atuais...impactos

REVIEW SUMMARY

Declining oxygen in the global ocean and coastal waters

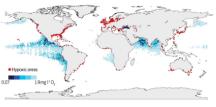
Francisco P. Chavez, Daniel J. Conley, Véronique Garçon, Denis Gilbert, Dimitri Gutiérrez, Kirsten Isensee, Gil S. Jacinto, Karin E. Limburg, Ivonne Montes S. W. A. Naqvi, Grant C. Pitcher, Nancy N. Rabalais, Michael R. Roman, Kenneth A. Rose, Brad A. Seibel, Maciej Telszewski, Moriaki Yasuhara, Jing Zhang

both the open ocean and coastal waters have been declining since at least the middle of the 20th century. This oxygen loss, or deoxygenation, is one of the most important changes occurring in an ocean increasingly modified by human activities that have raised temperatures, CO. levels, and nutrient inputs and have altered the abundances and distributions of marine species. Oxygen is fundamental to biological and biogeochemical processes in the ocean. Its decline can cause major changes in ocean productivity, biodiversity, and biogeochemical cycles. Analyses of direct measurements at sites around the world indicate that oxygen-minimum zones in the open ocean have expanded by several million square kilometers and that hundreds of coastal sites now have oxygen concentrations low enough to limit the distribution and abundance of animal populations and alter the cycling of important nutrients.

ADVANCES: In the open ocean, global warm-

BACKGROUND: Oxygen concentrations in | greenhouse gas emissions, is considered the merical models project further oxygen declines during the 21st century, even with ambitious emission reductions. Rising global temperatures decrease oxygen solubility in water, increase the rate of oxygen consumption via respiration, and are predicted to reduce the introduction of oxygen from the atmosphere and surface waters into the ocean interior by increasing stratification and weakening ocean overturn-

In estuaries and other coastal systems strongly influenced by their watershed, oxygen declines have been caused by increased loadings of nutrients (nitrogen and phosphorus) and organic matter, primarily from agriculture; sewage; and the combustion of fossil fuels. In many regions, further increases in nitrogen discharges to coastal waters are projected as human populations and agricultural production rise. Climate change exacerbates oxygen decline in coastal systems through similar mechanisms as those in the open ocean, as well as by increasing nutrient



ranging from biogeochemistry to food security. The global map indicates coastal sites where anthropogenic nutrients have exacerbated or caused O2 declines to <2 mg liter-1 (<63 μmol liter⁻¹) (red dots), as well as ocean oxygen-minimum zones at 300 m of depth (blue shaded regions). [Map created from data provided by R. Diaz, updated by members of the GO₂NE network, and downloaded from the World Ocean Atlas 2009]

increased precipitation.

Expansion of low-oxygen zones can increase production of N₂O, a potent greenhouse gas: reduce cukaryote biodiversity; alter the structure of food webs; and negatively affect food security and livelihoods. Both acidification and increasing temperature are mechanistically linked with the process of deoxygenation and combine with low-oxygen conditions to affect biogeo

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chemical, physiological, and ON OUR WEBSITE ecological processes. How ever, an important paradox to consider in predicting large-scale effects of future levels of productivity in

nutrient-enriched coastal systems and upwelling areas associated with oxygen-minimum zones also support some of the world's most prolific

OUTLOOK: Major advances have been made toward understanding patterns, drivers, and consequences of ocean deoxygenation, but there is a need to improve predictions at large spatial and temporal scales important to ecosystem services provided by the ocean. Improved numerical models of oceanographic processes that control oxygen depletion and the large-scale influence of altered biogeochemical cycles are needed to better predict the magnitude and spatial patterns of deoxygenation in the open ocean, as well as feedbacks to climate. Developing and verifying the next generation of these models improved mechanistic understanding on a variety of scales. Models useful for managing nutrient loads can simulate oxygen loss in coast al waters with some skill, but their ability to project future oxygen loss is often hampered by insufficient data and climate model projections on drivers at appropriate temporal and spatial scales. Predicting deoxygenation-induced changes in ecosystem services and human welwebs, and fisheries stocks; considering combined effects of deoxygenation and other ocean emphasis on developing nations. Reducing the impacts of other stressors may provide some protection to species negatively affected by low oxygen conditions. Ultimately, though limiting deoxygenation and its negative effects will necessitate a substantial global decrease in greenhouse gas emissions, as well as reductions in nutrient discharges to coastal waters.

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