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Policy Options for Stabilizing Global Climate
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Greenhouse Gas Emission Inventories
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The Energy Journal

WERNER GORDON

Revolutions that Made the Earth World Bank Publications
These results from the National Research Programme on Climate Change of the Netherlands offer a synthesis of present knowledge in the fields of: source and sinks of greenhouse gases and aerosols; land-atmosphere interactions; the global energy balance; and radiative forcing and climate variability.
Global Aspects of Atmospheric Chemistry United Nations
This comprehensive volume is the first to consider biomass burning as a globalphenomenon and to assess its impact on the atmosphere, on climate, and on the biosphereitself.
Effects of Changes in Stratospheric Ozone and Global Climate Routledge
Global Biomass Burning provides a convenient and current reference on such topics as the remote sensing of biomass burning from space, the geographical distribution of burning; the combustion products of burning in tropical, temperate, and boreal ecosystems; burning as a global source of atmospheric gases and particulates; the impact of biomass burning gases and particulates on global climate; and the role of biomass burning on biodiversity and past global extinctions."--Pub. desc.
The Greenhouse Gas Protocol MIT Press
Rice production is affected by changing climate conditions and has the dual role of contributing to global warming through emissions of the greenhouse gas methane. Climate change has been recognized as a major threat to the global environment. Because of insufficient field data, rice-growing countries face a problem when trying to comply with the United Nations Framework Convention on Climate Change stipulations to compile a national inventory of emissions and to explore mitigation options. Given the expected doubling in rice production in Asia, the need to evaluate the interaction between climate change and rice production is critical to forming a sound basis for future directions of technology developments by policy makers, agriculturists, environmentalists, rice producers, and rice consumers. The present book comprises two sections. The first part documents a comprehensive overview of the results achieved from an interregional research effort to quantify methane emission from

major rice ecosystems and to identify efficient mitigation options. This research report broadens understanding of the contribution of rice cultivation to methane emissions and clarifies that emissions are relatively low, except in specific rice ecosystems, and that these high emissions could be ameliorated without sacrificing yield. The second section shows results from other projects that investigated the role of rice cultivators in field and laboratory approaches. The findings represent inputs for future modeling approaches in the role of rice cultivators. The expanded database generated by other projects is reflected in modeling efforts.

Characterizing and Responding to Uncertainty in Climate Change MIT Press

The Intergovernmental Panel on Climate Change (IPCC) was set up jointly by UNEP and the World Meteorological Organisation in 1988 to provide periodic scientific analysis of the causes, impacts and possible policy response options to climate change issues. This synthesis report is the 4th and final part of the IPCC's third assessment report, and contains information on nine policy-relevant questions regarding the IPCC's 2001 assessment. It is intended to assist governments, individually and collectively, to formulate appropriate adaptation and mitigation responses to the threat of human-induced climate change.

Economic Issues In Global Climate Change World Resources Inst

Verifying Greenhouse Gas EmissionsNational Academies Press National Academies Press

The world's nations are moving toward agreements that will bind us together in an effort to limit future greenhouse gas emissions. With such agreements will come the need for all nations to make accurate estimates of greenhouse gas emissions and to monitor changes over time. In this context, the present book focuses on the greenhouse gases that result from human activities, have long lifetimes in the atmosphere and thus will change global climate for decades to millennia or more, and are currently included in international agreements. The book devotes considerably more space to CO2 than to the other gases because CO2 is the largest single contributor to global climate change and is thus the focus of many mitigation efforts. Only data in the public domain were considered because public access and transparency are necessary to build trust in a climate treaty. The book concludes that each country could estimate fossil-fuel CO2 emissions accurately enough to support monitoring of a climate treaty. However, current methods are not sufficiently accurate to check these self-reported estimates against independent data or to estimate other greenhouse gas emissions. Strategic investments would, within 5 years, improve reporting of emissions by countries and yield a useful capability for independent verification of greenhouse gas emissions reported by countries.

The Emissions Gap Report Cambridge University Press

Through different applications, electricity provides the energy required for light, heat, comfort, and mechanical work. In order to sustain society's expectation for comfort, convenience and productivity, it will remain necessary to continue to seek and find reasonable quantities of energy in forms which are accessible, affordable and have modest or zero environmental impacts. This in turn will call for an international imperative to make existing uses of electricity both efficient and practical. This book will guide the reader toward a clearer vision of that goal, with explanations of the concept of electrification, along with CO2 reductions through expanded end-use applications of electricity. Topics will include electric cars; airport, seaport, railroad and mining electrification; industrial uses of electricity in a variety of processes; residential building use of electricity; and enhancing energy efficiency and demand response.

Countdown to Kyoto, Parts I-III Cambridge University Press

In this dissertation, I present three essays that consider the environmental consequences of technological change, from an international perspective. The first two chapters use firm-level production data to estimate the response of CO2 emission intensity to changes in competition in foreign markets. The first chapter estimates this response with respect to foreign demand shocks, i.e., a positive shock to exports. The second chapter exploits a specific liberalization episode to estimate the impact with respect to foreign competition shocks, i.e., a negative shock to exports. Both papers are co-authored with Helene Ollivier. The final chapter analyzes the decision to adopt genetically engineered seeds in different countries around the world, and the attendant impacts on supply and land-use. This last chapter is co-authored with David Zilberman and Steven Sexton and was previously published in Environment and Development Economics. The first chapter investigates the impact of exporting on the CO2 emission intensity of manufacturing firms in India. Recent papers have argued that export market access encourages firms to upgrade technology, which lowers the emission intensity of production; however, data limitations confound previous attempts to separately identify productivity impacts from simultaneous changes in prices and product-mix. We present a model of how these alternative channels could also explain the results documented in the literature. Then, using a highly detailed production dataset of large Indian manufacturing firms that contains information on physical units of inputs and outputs by product, we are able to decompose the overall firm impact into three components -- prices, product-mix, and technology. Export impacts at the firm level are identified from import demand shocks of foreign trading partners. We find that prices systematically bias down estimates of emission intensity in value, that firms adjust emission intensity in quantity through changing output shares across products, but that firms do not lower emission intensity within products over time (technology). The results imply that the productivity benefits from market integration alone are not enough to induce clean technology adoption. The second chapter investigates the ``third-party'' impact of trade liberalization on the environmental performance of firms in countries that lose market share as a result of the liberalization. If competition matters for exporting (as previous research indicates), and exporting matters for emission intensity, then emission intensity reductions in liberalized markets may be offset by emission intensity increases in countries peripheral to the liberalization. To test for this indirect effect, we exploit quasi-natural variation arising from the elimination of quota constraints on textile and apparel exports to the US between 1994 and 2007. Using a detailed panel of production and emission data at the firm-product level, we find that Indian exporters in Prowess lost on average 14% export sales as a result of liberalized trade between the US and India's competitors. This loss of export sales was accompanied by an increase in CO2 intensity of 9%. The results do not appear to be due to fuel-switching, but there is suggestive evidence that capital investments and switching to higher emission intensity varieties may have played a role. Overall, the results support the importance of international competition for production and pollution decisions of firms around the world. The final chapter uses aggregate data to estimate supply, price, land-use, and greenhouse gas impacts of genetically engineered (GE) seed adoption due both

to increased yield per hectare (intensive margin) and increased planted area (extensive margin). An adoption model with profitability and risk considerations distinguishes between the two margins, where the intensive margin results from direct ``gene" impacts and higher complementary input use, and the extensive margin reflects the growing range of lands that become profitable with the GE technology. We identify yield increases from cross-country time series variation in GE adoption share within the main GE crops- cotton, corn, and soybeans. We find that GE increased yields 34% for cotton, 12% for corn and 3% for soybeans. We then estimate quantity of extensive margin lands from year-to-year changes in traditional and GE planted area. If all production on the extensive margin is attributed to GE technology, the supply effect of GE increases from 5% to 12% for corn, 15% to 20% for cotton, and 2% to 40% for soybeans, generating significant downward pressure on prices. Finally, we compute ``saved" lands and greenhouse gases as the difference between observed hectarage per crop and counterfactual hectarage needed to generate the same output without the yield boost from GE. We find that all together, GE saved 13 million hectares of land from conversion to agriculture in 2010, and averted emissions are equivalent to roughly 1/8 the annual emissions from automobiles in the US.

Essays on Technology and the Environment from an International Perspective Food & Agriculture Org.

Cepal Review is the leading journal for the study of economic and social development issues in Latin America and the Caribbean. Edited by the Economic Commission for Latin America, each issue focuses on economic trends, industrialization, income distribution, technological development and monetary systems, as well as the implementation of reforms and transfer of technology. Written in English and Spanish (Revista De La Cepal), each tri-annual issue brings you approximately 12 studies and essays undertaken by authoritative experts or gathered from conference proceedings.

Carbon Cycling in the Glacial Ocean: Constraints on the Ocean's Role in Global Change CRC Press

The Earth that sustains us today was born out of a few remarkable, near-catastrophic revolutions, started by biological innovations and marked by global environmental consequences. The revolutions have certain features in common, such as an increase in complexity, energy utilization, and information processing by life. This book describes these revolutions, showing the fundamental interdependence of the evolution of life and its non-living environment. We would not exist unless these upheavals had led eventually to 'successful' outcomes - meaning that after each one, at length, a new stable world emerged. The current planet-reshaping activities of our species may be the start of another great Earth system revolution, but there is no guarantee that this one will be successful. The book explains what a successful transition through it might look like, if we are wise enough to steer such a course. This book places humanity in context as part of the Earth system, using a new scientific synthesis to illustrate our debt to the deep past and our potential for the future.

Global Biomass Burning MIT Press

The Department for Energy and Climate Change's (DECC) official CO2 figures - that count territorial emissions from power stations and transport, etc, within UK borders - show nearly 20% reduction between 1990-2009. But research commissioned for the Department for the Environment Food and Rural Affairs reveals that CO2 emissions were 20% higher in 2009 if consumption based emissions - from imported goods - are included. The fall in territorial emissions was not mainly the consequence of the Government's climate policy. Rather it was the result of the shift in manufacturing industries away from the UK and the switch from coal to gas-fired electricity generation that began in the early 1990s. Since 1990 carbon dioxide emissions from imports have almost doubled (from 166 million tonnes (Mt) CO2 to 331 Mt CO2 in 2009). If the UK wishes to encourage emissions reductions in countries that manufacture and export goods to the UK, the MPs say the Government should recognise the growth in the UK's consumption-based emissions. Acknowledging that UK consumption is driving up territorial emissions in other countries could increase the UK's leverage over those emissions and help to secure a binding global agreement on carbon cuts. There is sufficiently robust data available to develop new policy options and identify carbon-intensive behaviours that are overlooked by concentrating on territorial emissions alone. Ministers should explore the options for incorporating consumption-based emissions data in to the policy making process and setting emissions targets on a consumption-basis at the national level.

Green Energy and Technology United Nations

IPCC Report on sources, capture, transport, and storage of CO2, for researchers, policy-makers and engineers.

Emissions of Atmospheric Trace Compounds Springer Science & Business Media

This book provides a snapshot on economic thinking about global change and provides a starting point for researchers for evaluating the economics of global change in the context of agriculture, forestry, and resource issues. It attempts to rectify the scarcity of economic analysis in global change.

Climate Stabilization Targets CRC Press

Atmospheric Chemistry has been a rapidly growing field with a recent focus on the major aspects of global environmental change, including stratospheric ozone depletion, UV-B change, and global warming. This book describes recent developments in our understanding of the global aspects of the chemistry in the main parts of the atmosphere, troposphere, and stratosphere, as obtained from field observations, laboratory investigations, and modeling studies. Although this chemistry is largely driven by reactions between gas phase species, recent progress made in the understanding of chemical reactions occuring in clouds and on the surface of aerosols is also reported.

The Climate System Springer Science & Business Media

This book is the result of a research project entitled "Reference function for Global Air Pollution/C0 " initiated by RIVM. It deals with the description 2 of a computer simulation model of the greenhouse effect. This model, IMAGE, tries to capture the fundamentals of the complex problem of climate change in a simplified way. The model is a multidisciplinary product and is based on knowledge from disciplines as economics, atmospheric chemistry, marine and terrestrial biogeochemistry, ecology, climatology, and glaciology. This book might be of interest for anyone working in the broad field of climate change. Furthermore, it can be useful for model builders, simulation experts, mathematicians etc. A PC version of the model will become avail able free of charge. Requests can be sent to the author. Although being the only author of this book, I could never have written it without the help of many other people. First of all I would like to thank Koos Vrieze, originally a colleague at RIVM, later my professor. Without his inspiring attitude I would have never finished this thesis. I am also very grateful to RIVM for giving me the opportunity to write this

thesis. lowe many thanks to Hans de Boois and Rob Swart for their support and assis tance during the research. Furthermore, I would like to thank my trainees who have substantially contributed to the contents of this book.

Carbon Dioxide Capture and Storage

Springer Science & Business Media

The development and analysis of climate policy proposals intertwine with the structure of knowledge and the possibility for changing it. Key questions concern the long-term interaction between policy, technology, infrastructure, and the earth system, but each of these components is deeply uncertain. This dissertation advances the description of knowledge about the climate system, the assessment of economic responses to climatic possibilities, and the development of policy that positions society to achieve long-term climate goals. It offers new paths to describing understanding of complex systems and to modeling optimal management under structural uncertainty. The first chapter formalizes uncertainty about equilibrium climate change. Its hierarchical Bayes framework allows climate models to be incomplete and to share biases, and it shows how prior beliefs about models' completeness and independence interact with models' estimates of feedback strength to determine distributions for temperature change. When models might share biases, the results of additional models might tell us more about models' common structure than about the real-world processes they aim to represent. The most valuable information would then come not from related models but from alternate estimates that should carry a different set of unobservable biases. The possibility that models are wrong in common ways limits the degree to which models' estimates can narrow the probability distribution for feedback strength, which also limits our ability to rule out extreme climatic outcomes. The second chapter empirically estimates a feedback that is especially difficult to model. Climate-carbon feedbacks (or carbon cycle feedbacks) describe the effect of temperature on carbon dioxide (CO2). If they are positive, then not only does anthropogenic CO2 cause warming via the greenhouse effect and earth system feedbacks, but this warming itself increases CO2 and so causes further warming. Previous empirical work estimated a stronger feedback than did coupled climate-carbon cycle models. However, those empirical estimates were probably biased upwards while coupled models' estimates were primarily driven by a few ill-constrained parameters. This chapter attempts to obtain an unbiased estimate of climate-carbon feedback strength by using variations in summer radiation in the Arctic (i.e., variations in orbital forcing) to identify the effect of temperature on CO2 in 800 ky ice core records. It finds a range for climate-carbon feedbacks that is closer to coupled models' estimates than to previous empirical work. Since climate-carbon feedbacks are probably positive, temperature change projections tend to underestimate an emission path's consequences if they do not allow the carbon cycle to respond to changing temperatures. The next three chapters assess economic responses to climate change in a policy-optimizing integrated assessment model, in games with long-lived investments into abatement capital, and in a cost-effectiveness model with multiple policy options stretching over long time horizons. The first of these chapters extends a well-known integrated assessment model to include the possibility of abrupt shifts in the climate system. It also changes the model's structure to make the decision-maker aware of uncertainty and of the possibility for learning over time, and it generalizes the welfare evaluation to reflect that uncertainty about temperature change is qualitatively unlike uncertainty about climate thresholds. It finds that tipping points can increase the near-term social cost of carbon by more than 50% when they raise climate sensitivity or make damages more convex. They have less of an effect when they increase the atmospheric lifetime of CO2 or the quantity of non-CO2 greenhouse gases. Allowing the policymaker to be differentially averse to consumption fluctuations over time and over risk increases the near-term social cost of carbon by 150%, with tipping point possibilities then increasing it by another 50%. The possibility of tipping points is more important for the social cost of carbon than is the ambiguity attitude the decision-maker uses in evaluating them. The second of these climate economics chapters models the optimal emission tax when firms can adopt low-pollution technology that reduces abatement cost. The regulator anticipates this adoption but must set the tax before firms invest. In many cases, a linear emission tax cannot obtain both socially optimal investment and socially optimal emissions because the regulator either will set it inefficiently high to stimulate investment or will set it at an ex post optimal level that obtains inefficiently low investment. The difficulty is that an emission tax fixes both the incentive to invest and the incentive to abate, but these two goals rarely align perfectly when investment is lumpy. In contrast, tradable permits policies do not suffer this tension because the permit price responds automatically to realized investment. A numerical model then considers the ability of the regulator to select not only the level but also the duration of the tax. It shows that outcomes are still often socially inefficient. Further, the regulator will occasionally use a longer tax to obtain investment when firms expect their investments to lower the tax in the next period, but the cost of not being able to adjust the next period's tax limits the parameter space in which the longer tax is employed. The fifth chapter constructs cost-effective dynamic policy portfolios of abatement, research and development (R & D), and negative emission technology deployment in order to achieve 21st century climate targets. It includes two types of stochastic technological change in a stylized numerical model and allows each type of technology to respond both to public R & D and to abatement policies. It compares worlds where negative emission technologies are and are not available, and it compares a world where the century's cumulative net emissions are constrained with a world in which threshold possibilities lead policy to constrain cumulative net emissions in each year during the century. It finds that R & D options are valuable and exercised but do not substitute for near-term abatement. The type of R & D undertaken depends on long-term emission goals because those determine the magnitude of future abatement. When the cumulative emission constraint is stringent, negative emission technologies substitute for near-term abatement and affect the type of R & D undertaken, but if threshold considerations eliminate the freedom to temporarily overshoot emission targets, negative emission technologies become less valuable. The availability of negative emission technologies provides a valuable option to partially undo previous emissions, but abatement also gains option value from increasing future flexibility to forgo reliance on negative emission technologies if the technology or climate prove problematic in the interim. The concluding chapter directly connects uncertainty about climate change to uncertainty about the cost of achieving CO2 targets. It shows how beliefs about technology, temperature, and damages interact to affect the cost-effectiveness of climate targets. It finds that the speed

with which damages increase at higher temperatures is the most important of these factors. Both 450 parts per million (ppm) and 550 ppm CO2 targets provide net benefits for quadratic damage functions that reduce annual output by less than the 1-2% estimated for 2.5°C of warming. Cubic damage functions support both CO2 targets even if 2.5°C of warming only reduces output by 0.2% or less. More convex damage functions also reduce the importance of abatement cost uncertainty. significantly increase the range of damage functions that support these targets and decrease the importance of abatement cost uncertainty. In addition, because extreme feedback outcomes have little effect over the next decades, a thinner-tailed temperature distribution (resulting from optimistic prior beliefs about climate models' independence and biases) supports CO2 targets under slightly less severe damages than does the thicker-tailed distribution (resulting from skepticism about climate models' independence and biases). Emission reductions hedge against greater societal sensitivity to temperature increases while exposing society to the upside of positive technology surprises. The epistemology of complex systems in an out-of-sample world is a key motif. This dissertation advances knowledge of climate change and understanding of policy design in settings with limited ability to predict future changes or responses. Further work should seek a more unified framework for describing and acting on knowledge of evolving complex systems.

The Emissions Gap Report 2016 United Nations

This book grows out of a 2001 workshop on "Emission of Chemical Species and Aerosols into the Atmosphere." The contents deal with inventories of emissions related to anthropogenic emissions or biomass burning; emissions from vegetation and soils; emissions of mineral and sea-salt aerosols; and emissions of sulphur compounds from the oceans. Concluding chapters show how atmospheric observations have been used to improve our knowledge of emissions.

CEPAL Review No.116, August 2015 CRC Press

Emissions of carbon dioxide from the burning of fossil fuels have ushered in a new epoch where human activities will largely determine the evolution of Earth's climate. Because carbon dioxide in the atmosphere is long lived, it can effectively lock the Earth and future generations into a range of impacts, some of which could become very severe. Emissions reductions decisions made today matter in determining impacts experienced not just over the next few decades, but in the coming centuries and millennia. According to Climate Stabilization Targets: Emissions, Concentrations, and Impacts Over Decades to Millennia, important policy decisions can be informed by recent advances in climate science that quantify the relationships between increases in carbon dioxide and global warming, related climate changes, and resulting impacts, such as changes in streamflow, wildfires, crop productivity, extreme hot summers, and sea level rise. One way to inform these choices is to consider the projected climate changes and impacts that would occur if greenhouse gases in the atmosphere were stabilized at a particular concentration level. The book quantifies the outcomes of different stabilization targets for greenhouse gas concentrations using analyses and information drawn from the scientific literature. Although it does not recommend or justify any particular stabilization target, it does provide important scientific insights about the relationships among emissions, greenhouse gas concentrations, temperatures, and impacts. Climate Stabilization Targets emphasizes the importance of 21st century choices regarding long-term climate stabilization. It is a useful resource for scientists, educators and policy makers, among others.

Verifying Greenhouse Gas Emissions National Academies Press

A comprehensive progress report on the multi-disciplinary field of ocean and climate change research is given. It compiles introductory background papers and leading scientific results on the ocean-atmosphere carbon cycle with emphasis on the ocean's carbon inventory and the various components involved. The relationship between plankton productivity, carbon fixation, oceanic PCO2 and climate change is investigated from the viewpoint of long-term climatic change during the late Quaternary cycles of ice ages and warm ages. The various approaches range from micropaleontology over organic and trace element geochemistry to molecular isotope geochemistry.

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