

Appendices

Appendix A: Workshop Programme

Programme of the IPCC Asia-Pacific Workshop on Integrated Assessment Models [IAMs]

10-12 March 1997, United Nations University, Tokyo

- March 10 (Monday) -

9:00	Welcome and Introduction	Chairperson	Y. Kaya
	Welcome Address	UNU (Rector)	G. De Souza
		Government of Japan (Vice Minister)	T. Suzuki
		IPCC (Chairpersons)	B. Bolin/J. Bruce
	Introduction to the Workshop		H. Lee
	What does the IPCC expect of IAMs?		R. Moss
10:10	Coffee Break		
10:30	Session I		
	State of the Art in Computer Models Related to Climate Change		
		Chairperson	J. Bruce
	Socio-economic Models		J. Edmonds
	Climate Models		S. Schneider
	Impact Models		R. Leemans
	On some Integrated Assessment Model Debates		A. Amano
	Discussion		
12:45	Lunch		
14:15	Session II		
	Recent Trends of IAMs	Chairperson	R. Odingo
	Overview of Recent Research Results of IAMs		J. Weyant
	Several Gaps between IAMs and Developing Countries		T. Morita
	IAMs and Developing Countries		J. Sathaye
	Discussion		
15:40	Coffee Break		
16:00	Session III		
	How Adequately do IAMs reflect the Existing Socio-economic Structure in Developing Countries?		
		Chairperson	F. Lo
	Economic Structure in Developing Countries		P. R. Shukla
	(Nominated Discussion)		K. Ruffing
	Structural Changes and Energy System in China		F. Zhou
	(Nominated Discussion)		N. Nakicenovic
	Discussion		
18:00	Reception		

- March 11 (Tuesday)-

9:00	Session IV		
	Is it Possible to Apply the Same Policy Instruments to Developing and Developed Nations?		
		Chairperson	H. Hamanaka
	Policy Instruments for Developing Countries		M. Asaduzzaman
	(Nominated Discussion)		H. Pitcher
	Policy Integration in Developing Countries		T. Jung
	(Nominated Discussion)		S. Mori

- Discussion
- 10:55 Coffee Break
- 11:15 Session V
- Are Regional/Developmental characteristics well-represented within IAMs?
- Chairperson F. Langeweg
- Representation of Value Systems in Developing Countries M. Munasinghe
(Nominated Discussion) R. Tol
- Reflection of Indigenous Culture in Developing Countries W. Chantanakome
Discussion
- 13:00 Lunch
- 14:30 Session VI
- How Realistically do IAMs Estimate Climate Change Impacts on Developing Countries?
- Chairperson R. Moss
- Country-Specific Market Impacts of Climate Change M. Schlesinger
(Nominated Discussion) T. Downing
- Climatic Impacts on Developing Countries C. Hope
(Nominated Discussion) S. Liu
- (Nominated Discussion) K. Strzepek
- Climatic Impacts on the Asia and Pacific Regions Y. Matsuoka
(Nominated Discussion) J. Sun
- From Impact to Emission - Tolerable Windows Approach F. Toth
Discussion

- March 12 (Wednesday) -

- 9:00 Session VII
- How can IAMs Research Conclusions be applicable to both Developing and Developed Countries?
- Chairperson A. Amano
- Timing of Policy Response and Cost Distribution R. Richels
- Collective Decision-making and North-South Equity J. Parikh
- Safe Emissions Corridor J. Alcamo
- Role of Technology in Climate Change K. Yamaji
- Technical Changes in Developing Countries P. Wibulswas
- Decision Making under Uncertainty H. Dowlatabadi
Discussion
- 12:45 Lunch
- 14:15 Session VIII
- How to Increase Future Collaborative IAM Research in the Asian-Pacific Region
- Chairperson F. Lo
- Research Network in the Asia-Pacific S. Nishioka
- European Network for the Asia-Pacific F. Langeweg
(Nominated Discussion) D. Zhou
- (Nominated Discussion) A. Sugandhy
- (Nominated Discussion) H. Virji
- 15:45 Conclusions Chairperson Y. Kaya
- Summarizing Sessions and Chairpersons Additional Comments
- Closing Address B. Bolin
- Closing Address Y. Kaya
- 16:45 End of Workshop

Appendix B:

Organisational Arrangements

International Organizing Committee

Prof. Akihiro Amano	(Kwansei Gakuin University)
Mr. James P. Bruce	(IPCC WG3 Co-chair, Co-chairman of Workshop)
Dr. Zhou Fengqi	(China Energy Research Institute)
Dr. L. Gylvan Meira Filho	(IPCC WG1 Co-chair)
Mr. Hironori Hamanaka	(Director-General, Environment Agency of Japan)
Sir John Houghton	(IPCC WG1 Co-chair)
Prof. Yoichi Kaya	(Keio University, Chairman of Local Organizing Committee)
Dr. Fred Langeweg	(National Institute of Public Health and the Environment [RIVM])
Dr. Hoesung Lee	(IPCC WG3 Co-chair, Co-chairman of Workshop, Chairman of International Organizing Committee)
Prof. Fu-chen Lo	(The United Nations University)
Mr. Lorents Lorentsen	(IPCC WG3 Co-vice-chair)
Dr. Shuzo Nishioka	(National Institute for Environmental Studies)
Prof. William D. Nordhaus	(Yale University)
Prof. Richard S. Odingo	(IPCC WG3 Co-vice-chair)
Prof. Jyoti Parikh	(Indira Gandhi Institute)
Prof. Hans-Joachim Schellnhuber	(Potsdam Institute for Climate Impact Research)
Dr. Narashimhan Sundararaman	(Secretary of the IPCC)
Prof. Hirofumi Uzawa	(UNU, Institute of Advanced Studies)
Dr. Robert T. Watson	(IPCC WG2 Co-chair, IPCC Chairman elect)
Prof. John P. Weyant	(Stanford University)
Dr. Marufu C. Zinyowera	(IPCC WG2 Co-chair)

Local Organizing Committee

Prof. Akihiro Amano	(Kwansei Gakuin University)
Prof. Yoichi Kaya	(Keio University, Chairman of Local Organizing Committee)
Prof. Fu-chen Lo	(The United Nations University)
Dr. Shuzo Nishioka	(National Institute for Environmental Studies)

Program & Editorial Committee

Prof. Yuzuru Matsuoka	(Nagoya University)
Prof. Shunsuke Mori	(Science University of Tokyo)
Dr. Tuneyuki Morita	(National Institute for Environmental Studies, Chair of Program & Editorial Committee)
Prof. John P. Weyant	(Stanford University)
Mr. Ryutaro Yatsu	(The United Nations University)

Special Coordinator

Mr. Masahiro Kawamata	(Environment Agency of Japan)
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Mr. Yoshihiro Natori (Director, Environment Agency of Japan)
Mr. Shinsuke Unisuga (Environment Agency of Japan)

Workshop Secretariat

Mr. Kiyoshi Fukuwatari (National Institute for Environmental Studies)
Mr. Yasunori Ito (Global Environmental Forum)
Ms. Mie Kobayashi (Environmental Research Center Co. Ltd.)
Ms. Hiromi Suzuki (The United Nations University)

Workshop Proceedings Coordinator

Dr. Owen K. Cameron (National Institute for Environmental Studies)

Rappoteurs/Transcription Coordinator

Mr. Randal Halten (Association of International Research Initiatives for Environmental Studies)

Supporting Staff

Ms. Yasuko Kawashima (National Institute for Environmental Studies)
Ms. Tomoko Morishita (The United Nations University)
Ms. Naoko Murakami (National Institute for Environmental Studies)
Mr. Nobuyuki Yoshinari (National Institute for Environmental Studies)

Ms. Atsuko Imai (Global Environmental Forum)
Mr. Shosaku Kamei (Global Environmental Forum)
Ms. Fumi Kojima (Global Environmental Forum)
Mr. Izumi Kondo (Global Environmental Forum)
Mr. Ryoei Nakadera (Global Environmental Forum)
Mr. Yukio Okuma (Global Environmental Forum)
Mr. Toshikazu Shimazaki (Global Environmental Forum)
Ms. Noriko Yamagishi (Global Environmental Forum)
Mr. Naotaka Yamaguchi (Global Environmental Forum)

Ms. Megumi Ando
Ms. Makiko Fujita
Mr. Daisuke Hayashi
Mr. Yoshinori Kobayashi
Mr. Soichiro Minami
Mr. Yosuke Munesue
Ms. Keiko Saito
Ms. Kae Takase

Appendix C: Further descriptions of some IAMs – brief overview and contact details

THE CLIMATE FRAMEWORK FOR UNCERTAINTY, NEGOTIATION AND DISTRIBUTION (FUND)

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The *Climate Framework for Uncertainty, Negotiation and Distribution (FUND)* is an integrated assessment model of climate change of the policy optimization kind. Its main aim is to analyze the incentives of (groups of) countries to abate greenhouse gas emissions, under various settings of international (non-)cooperation, including capital transfers, and given the main uncertainties that prevail. To that end, the model pays particular attention to the distribution of the costs of greenhouse gas emissions reduction, the impact of climate change, and the obligations for emission abatement.

FUND describes the full circle of the climate problem. Population growth and economic activities lead to emissions of greenhouse gases lead to changes in the composition of the atmosphere lead to changes in climate lead to a range of impacts and adaptation policies lead to effects on economy, population and welfare lead to pressure to control emissions lead to lowered emissions, and so on. Figure 1 depicts the flow diagram of the model.

At the moment, version 1.5 of the model is fully tested and described. It is implemented in TurboPascal 7.0 for DOS. The source code is available on request. A basic understanding of Pascal and the problem at hand is required to usefully operate the model; *FUND* is a research machine, not a computer game. Further model versions are under development and will become available in due time.

FUND1.5 runs in time steps of one year from 1990 to 2200. Population and economic growth are largely driven by scenarios (e.g., IS92a) which are perturbed by climate change (e.g., migration, costs of coastal protection) and emission reduction (e.g., reduced economic growth). Other variables (e.g., emissions, temperature, distribution of disease vectors) are calculated by the model.

The model distinguishes nine regions: OECD-America, OECD-Europe, OECD-Pacific, Central and Eastern Europe and the former Soviet Union, Middle East, Latin America, South and Southeast Asia, Centrally Planned Asia, and Africa. Each region has its own growth rates, costs of emission reduction and impact of climate change, so that each region takes a unique position towards climate change.

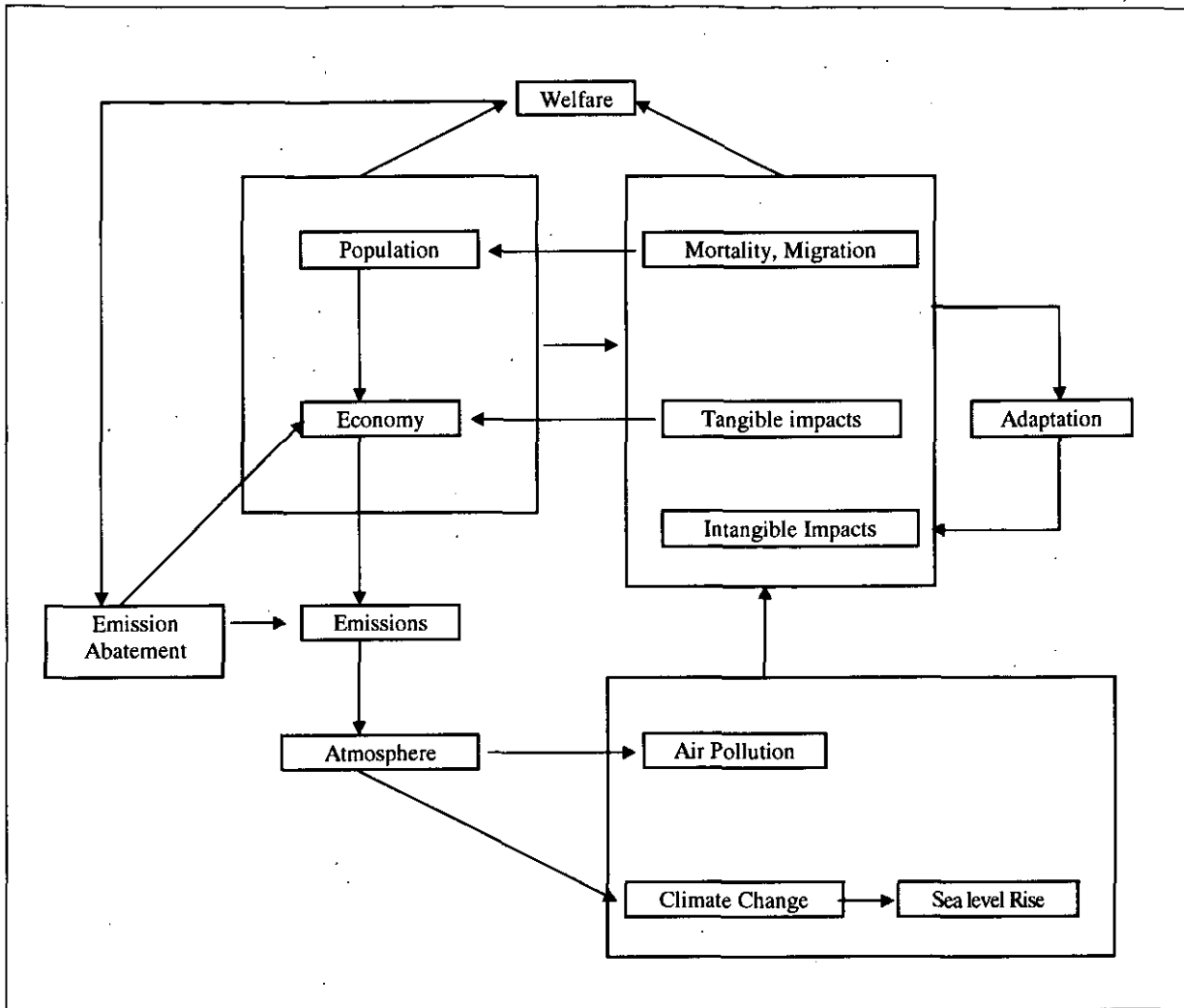


Figure 1 : Flow diagram of the *Climate Framework for Uncertainty, Negotiation and Distribution*, version 1.5.

Emission reduction can be achieved through energy saving, changes in the fuel mix, and forestry measures. Emission reduction policies are evaluated by their impact on the net present value of welfare. Welfare is governed by per capita income and the monetized impact of climate change. *FUND* is also equipped with an algorithm which seeks the optimal (i.e., welfare-maximizing) emission reduction policy.

Emission reduction policies can be optimized with full international cooperation or for each region on its own. Interregional capital transfers (joint implementation, or side payments to ensure cooperation) add to the instruments that regions have available for emission abatement. Restrictions (e.g., maximum allowable temperature change) may be added to the optimization.

Analyses with FUND show that optimization of the net present welfare does not call for substantive emission reductions. It is better to start reducing emissions now than to wait a couple of decades. Countries should reduce emissions irrespective of the other countries' actions, but should do more in case other countries also reduce emissions. International capital transfers play a limited role in the absence of internationally agreed and enforced limits of national emissions. In this case, the atmosphere is an open-access public good. This implies that those hurt most by climate change (the poor and warm countries) should convince those that emit most (the rich countries) to abate emissions. The victim pays, but lacks the money.

International capital transfers do play a substantial role if there is a cap on accumulated emissions, particularly if emission entitlements progress towards an equal per capita distribution. In this case, high emitters carry most of the burden of emission reduction and will seek to abate at the lowest costs, for instance through joint implementation in southern countries.

For the crucial parameters of *FUND*, probability density functions are specified. This allows for an analysis of the propagation of uncertainty through the model. An outcome of such an exercise would be a confidence interval of the global mean temperature in 2100, given all the uncertainties about population growth, economic growth, technological development and climate change.

FUND can also optimize under uncertainty. Here, the expected value of the net present value is maximized. Alternatively, the chance to reach a certain target given a particular policy can be calculated.

Analyses show that uncertainty is a reason to abate more rather than less (as some argue). Analyses also show that the uncertainties are so great that an emission trajectory which avoids both the risks of excessive impacts of climate change and the risks of excessive impacts of emission reduction, does not exist.

References

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- Tol, R.S.J., T. van der Burg, H.M.A. Jansen and H. Verbruggen (1995), The Climate Fund - Some Notions on the Socio-Economic Impacts of Greenhouse Gas Emissions and Emission Reductions in an International Context, Institute for Environmental Studies R95/03, Vrije Universiteit, Amsterdam.

POTSDAM INSTITUTE FOR CLIMATE IMPACT RESEARCH (PIK)

ICLIPS

Integrated Assessment of Climate Protection Strategies

An International Integrated Assessment Project

supported by the

German Federal Ministry for Education, Science, Research and Technology
and the

German Federal Ministry for Environment, Nature Conservation and Nuclear Safety

Overview

The ICLIPS project is an international and interdisciplinary research activity which seeks to provide an Integrated Assessment of Climate Protection Strategies by using a new method: the Tolerable Windows Approach (TWA). To this end, the project brings together experts from leading research institutions in the field of global climate change under the leadership of the Potsdam Institute for Climate Impact Research (PIK), which has initiated the project and which will integrate the various model components within the framework of the Tolerable Windows Approach. The main objective of the ICLIPS project is to develop methods, collect data, and elaborate models needed to support the international decision-making community in the difficult choices faced in the realization of the Framework Convention on Climate Change (FCCC) and the Berlin Mandate. The project is a key component of the German Government's response to this important issue of global change and therefore gains its financial support from the German Federal Ministry for Education, Science, Research and Technology and from the German Federal Ministry for Environment, Nature Conservation and Nuclear Safety.

The Tolerable Windows Approach is based on the specification of tolerable sets of climate impacts, allowances and instruments for implementation. The related "tolerable windows" are derived successively in a "backwards mode": by first analysing the maximum stress levels caused by climate change that one can assume to be ecologically and socio-economically bearable, a tolerable window for future climate development is deduced. In a further step, the corresponding set of admissible emission profiles is calculated, i.e. those global greenhouse gas emission functions which keep the climate system within the demarcated window. From among the family of emission options so-defined, specific strategies are finally filtered out by feasibility criteria which constitute the aforementioned tolerable set of allowances and instruments.

The ICLIPS project involves the coupling of models for

- the impact of climate on natural and managed ecosystems as well as on human societies and those for
- natural geobiochemical cycles, climate, greenhouse gas and aerosol emissions and of
- instruments causing climate protection measures and influencing socio-economic development.

Together, these components will build an integrated set of models, each of them driven in the spirit of the "backwards mode".

The PIK Research Team

- Prof. Dr. Ferenc Toth (Project Leader, Economic Science)
- Dipl.-Phys. Thomas Bruckner (Theoretical Physics)
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- Dipl.-Pol. MA Carsten Helm (Economic Science)
- Dr. Marian Leimbach (Economic Science)
- Dr. Gerhard Petschel-Held (Theoretical Physics)
- Prof. Dr. Hans-Joachim Schellnhuber (Director of PIK, Theoretical Physics)

The Project Partners

In addition to the Potsdam Institute for Climate Impact Research as the coordinating centre of the ICLIPS project, the following collaborators and institutions are participating:

- Prof. Dr. Joe Alcamo, Environmental Systems Research Center, University of Kassel, Kassel
- Dr. Jae Edmonds, Battelle Pacific Northwest National Laboratories, Washington, D.C.
- Prof. Dr. Klaus Hasselmann, Max Planck Institute for Meteorology, Hamburg
- Dr. Gernot Klepper, Kiel Institute of World Economics, Kiel
- Dr. Nebojsa Nakicenovic, International Institute for Applied Systems Analysis (IIASA), Laxenburg
- Prof. Martin Parry, Jackson Environment Institute, University College, London

Preliminary List of Associated Partners

- Prof. Dr. Peter Henricke, Wuppertal Institute for Climate, Environment and Energy, Wuppertal
- Dr. Richard Richels, Electric Power Research Institute, Palo Alto, CA
- Mr. David Victor, MIT, Cambridge, MA
- Dr. Hans-Joachim Ziesing, German Institute for Economic Research, Berlin

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OPEN FRAMEWORK FOR CLIMATE CHANGE IMPACT ASSESSMENT (OF)

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Availability:

The OF will be available by the end of 1997 on CD-Rom for a modest fee to cover the cost of duplication and documentation.

Overview:

The Open Framework for Climate Change Impact Assessment (OF) estimates the cost of climate change for two reference scenarios (IS92a, IS92d) by linking projections of global temperature change (using MAGICC), a spatial GCM scenario of monthly change in temperature and precipitation (GISS, although others could be run), first-order spatial impact indices for space cooling and heating, agriculture, water resources, and country-level damage estimates (including sea level rise in addition to the above). Global damages are added for disasters, biodiversity and 'other sectors' to provide a comprehensive estimate of the cost of climate change. Throughout the OF, a range of uncertainty is evaluated (low, medium and high, following MAGICC's temperature and sea level rise predictions), although this is not a formal estimate of the probable distribution of costs. The marginal costs of specific fuel cycles (for example, a coal-fired plant without GHG abatement) and pulses of emissions of specific GHGs (to calculate generic costs per GHG) are also estimated. Tables and maps can be viewed within the OF.

The climate negotiations: climate goals and their emission corridors

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Method for Finding Safe Emission Corridors

The following steps are followed in computing a safe emission corridor:

1. The IMAGE 2 model is run separately for a large number of different emission scenarios.
2. Using data from step 1, a statistical relationship is determined between cumulative CO₂-equivalent emissions and each of the three climate indicators noted in the text. The indicators "cumulative temperature change" and "cumulative sea-level rise" in 2100 relative to 1990 are correlated with the cumulative equivalent CO₂ emissions over the period 1990-2100. The indicator "decadal rate of temperature change", is correlated with the cumulative emissions from the 20 years preceding each decade (for example, the rate of temperature change in the decade 2020-2030 is correlated with the cumulative CO₂-equivalent emissions over the period 2010-2030). The cumulative CO₂-equivalent emissions in the analysis consist of anthropogenic sources of CO₂, CH₄ and N₂O because these sources are of most relevance to policy. Other emission sources are either uncontrollable (as in N₂O emissions from soils underlying natural vegetation soils) or already covered by international agreements (e.g. CFCs and other halocarbons). However, we note that *all* emissions are used by the IMAGE 2 model to compute climate change and its impacts. Emissions of CFCs and natural sources of N₂O and CH₄ are taken from the IMAGE2 scenario Baseline-A (Alcamo *et al.*, 1996b).
3. Using the correlations from Step 2, we can now select a climate goal corresponding to a maximum temperature change or sea-level rise and compute the maximum allowable cumulative emissions. However, this does not tell us the allowable pathway of emissions because in theory there are an infinite number of pathways that can achieve the same level of cumulative emissions. Hence, in this step we identify a sub-set of *acceptable* pathways. By "acceptable" we mean that the pathways do not exhibit unlikely trends, for example oscillating behaviour, or sharp reversals of direction. We compute and compile a database of acceptable pathways by specifying the following constraints on the pathways:
 - The absolute rate of change of emissions is bounded by +3% per year (the highest rate of increase of emissions in all the IPCC scenarios (Leggett *et al.* 1992)) and -4% per year (the highest rate of emission reduction evaluated for the calculation of the safe emission corridor).
 - The rate of change of emissions in one decade is within a user-specified percentage of the rate of change of these emissions in the previous decade; this percentage can be set at any value between 0 and 4% (for example, if the rate of change of emissions is set at 2% and if the rate of change in one decade is +1% per year, the rate of change in the next decade is allowed to be between -1% and +3% per year).

4. The cumulative CO₂-equivalent emissions between 1990 and 2100 are calculated for the pathways found in Step 3.
5. The width and magnitude of the emission corridor depends very much on the specified limits of the three climate indicators used in the analysis. Therefore to compute a corridor, the limits on these climate indicators over the period 1990 to 2100 have to be set. Once these limits are specified, the correlations from Step 2 are used to compute the maximum level of cumulative CO₂-equivalent emissions that comply with these limits.
6. Once the maximum allowable cumulative CO₂-equivalent emissions have been calculated in Step 4, and a limit is set on the maximum rate of emission reductions for the CO₂-equivalent emissions, the results from step 3 are used to select the set of allowable emission scenarios.
7. The allowable emission scenarios from Step 6 are then plotted from 1990 to 2100 to indicate the safe emission corridor. This corridor depicts the allowable range of emissions from 1990 to 2100 complying with the specified short and long-term limits of both climate indicators and emission reduction rates. Any point within the corridor will be on a path to meeting short and long-term climate goals. It should be noted that complying with these goals also depends on the path of emissions after 2100, as discussed in the text.

Overview of the IMAGE 2 Model

The IMAGE 2 model is a multi-disciplinary, integrated model designed to simulate the dynamics of the global society-biosphere-climate system. The objectives of the model are to investigate linkages and feedbacks in the system, and to evaluate consequences of climate policies. Dynamic calculations are performed from year 1970 to 2100, with a spatial scale ranging from grid (0.5° x 0.5° latitude-longitude) to world regional level, depending on the sub-model.

The model consists of three fully linked subsystems: Energy-Industry, Terrestrial Environment, and Atmosphere-Ocean. The *Energy-Industry* models compute the emissions of greenhouse gases in thirteen world regions as a function of energy consumption and industrial production. End use energy consumption is computed from various economic/demographic driving forces. The *Terrestrial Environment* models simulate the changes in global land cover on a grid-scale based on climatic and economic factors, and the flux of carbon dioxide and other greenhouse gases from the biosphere to the atmosphere. The *Atmosphere-Ocean* models compute the buildup of greenhouse gases in the atmosphere and the resulting zonal-average temperature and precipitation patterns.

The fully linked model has been tested against data from 1970 to 1990, and after calibration can reproduce the following observed trends: regional energy consumption and energy-related emissions, terrestrial flux of carbon dioxide and emissions of greenhouse gases, concentrations of greenhouse gases in the atmosphere, and transformation of land cover. The model can also simulate current zonal average surface and vertical temperatures.

For further information : Alcamo, J. (ed.), 1994. IMAGE 2.0: Integrated Modeling of Global Climate Change. Kluwer Academic Publishers, Dordrecht, 318 pp. Also published as Special Issue of *Water, Air and Soil Pollution*, 1994. Volume 76, Nos 1-2.