

**Report on the Expert meeting on the Brazilian Proposal:  
Scientific aspects and Data Availability**

Held in Cachoeira Paulista (Brazil), Centre Forecasts and Climate Studies (CPTEC) of the National Institute for Space Research (INPE), May 19-20, 1999,

Rapporteur: Dr. Michel den Elzen, National Institute of Public Health and the Environment (RIVM), the Netherlands

***Introduction***

At the invitation of the Government of Brazil's Minister of Science and Technology, an Expert meeting to evaluate the scientific aspects of the Brazilian Proposal (UNFCCC, 1997)<sup>11</sup> was held in Cachoeira Paulista (Brazil). The meeting was attended by 12 experts and interested participants from seven countries (see list of participants). The purpose of the Expert meeting was to discuss the scientific basis for the Brazilian Proposal currently under analysis by the Subsidiary Body for Scientific and Technological Advice (SBSTA) of the United Nations Framework Convention on Climate Change (UNFCCC) and to exchange information on related research activities by various experts within the international science community. The proposal contains a methodology for attributing changes in global mean temperature increases and possibly other indicators of climate change, such as sea level rise and rate of global mean surface temperature increase to specific anthropogenic greenhouse gas emissions (emissions)<sup>12</sup> of groups of countries, individual nations, or sub-national entities. The meeting was organised by the Brazilian Ministry of Science and Technology, and chaired by Dr. Luiz Gylvan Meira Filho, President of the Brazilian Space Agency.

***Background***

The Brazilian Proposal was first presented to Parties to the UNFCCC during the negotiations leading up to the Kyoto Protocol, as 'Proposed elements of a protocol to the UNFCCC: presented by Brazil in response to the Berlin Mandate'. The proposal was initially developed to help discussions on burden sharing between Annex I countries. However, it may also provide a framework for discussions between Annex I and non-Annex I countries on future participation of all countries in emission reductions. In essence, it applies the polluter pays principle to the issue of climate change by proposing a methodology for linking a (industrialised) country's contribution to emission control to its contribution to global warming. The proposal met support from many non-Annex I countries, because it accounts for industrialised countries' responsibility for historical emissions. While not adopted during the negotiations, it was referred to SBSTA for further study with respect to methodological and scientific aspects.

During initial discussion at SBSTA-8, some participants suggested that further development of the proposal consider the contribution of emissions to the rate of global mean surface temperature increase and global mean sea level rise as well as global mean temperature increase. At that meeting, Brazil also offered to organise a related Expert meeting.

At COP-4 in Buenos Aires (November 1998), the SBSTA-9 noted the information provided by Brazil on recent scientific activities (including a revision of the methodology) and invited Brazil to inform the SBSTA at the tenth session (Bonn, June 1999) on the results of its Expert meeting and provide it with other information.

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<sup>11</sup> Since the presentation of the proposal, Brazil has revised its methodology, as described in the report 'Note on time-dependent relationship between emissions of greenhouse gases and climate change'.

<sup>12</sup> In the Brazilian proposal, the word anthropogenic emissions is used to mean the net anthropogenic emissions of greenhouse gases or the difference between anthropogenic emissions by sources and direct anthropogenic removals by sinks of greenhouse gases. The proposal focuses on all greenhouse gases, which are not regulated in the Montreal Protocol.

Several groups in various countries, including China, Canada, France, the United States of America, Australia, and the Netherlands, have been assessing the Brazilian Proposal and its analysis. During COP-4 the RIVM in consultation with Brazil organised an informal Expert meeting to exchange information and explore relevant issues for the international Expert meeting. In particular, issues concerning problems related to non-linearities in the attribution of radiative forcing and temperature increase were considered.

### ***Discussions and results of the Expert meeting***

Dr. Luiz Gylvan Meira Filho gave a brief introduction of the Brazilian proposal, and an overview of the main findings of others who have studied it. These are: (i) temperature increase is not the only unique climate indicator. Others include global mean sea level rise and rate of global temperature increase; (ii) there are non-linearities involved in the translation from concentrations to radiative forcing, as well as in the attribution of radiative forcing. Meira Filho also emphasised that the idea is still to come up with a highly parameterised (spreadsheet type) model, which is transparent for policy makers. This model should be a time-dependent relationship between the emissions of greenhouse gases and the resulting climate change. Meira Filho also presented an alternative methodology of evaluating the climate effects of various greenhouse gases based on the temperature increase, the so-called GWBs, as a reaction of the problems related to the use of IPCC definitions and values for Global Warming Potentials (GWPs) of greenhouse gases. The GWP concept is problematic when applied to gases with very different lifetimes (perfluorocarbons with very long lifetimes, and methane with a short lifetime), or when comparing impacts of emissions released during different time periods (related to the time- and scenario-dependent). Next, GWPs are not comparing temperature effects of greenhouse gases, but only accumulated radiative effects, which implies that GWP values cannot return to zero, even when the emissions and the additional concentration do if all emissions are stopped (infinite memory of the climate system).

Dr. Michel Den Elzen of the RIVM (Netherlands) and Dr. Ian Enting of CSIRO (Australia), both of whom have undertaken related studies<sup>13</sup> (Enting, 1998; den Elzen *et al.*, 1999), presented critiques and comments on the scientific merits of the original and revised methodology. Den Elzen concluded that the revised methodology is a major improvement compared to the original version, but it still contains a few shortcomings. The revised model still neglects the terrestrial part of the carbon cycle, and only focuses on the slow (oceanic) carbon dynamics. For the calculation of the methane concentration, the atmospheric lifetime is not constant, but depends on the concentration of methane itself and OH, and the absorption by soils. The revised model also ignores the non-linearities in the radiative forcing, and contains climate parameters, which seem to differ with those of other climate models, leading to a slow response of the climate system. These deficiencies can all be improved by corrections available in the literature (see references).

Enting raised the question of the non-linearity in the attribution of radiative forcing. He presented two methodologies for this attribution. The first is based on the principle that a 'late emitter' contributes less to the increase in radiative forcing per unit of concentration increase than does an 'early emitter', whereas the second assumes equal radiative effects of the 'early' and 'late' emitters. After discussions, the first method was preferred for the greenhouse gases with a non-linear radiative forcing response to increased concentrations, namely: CO<sub>2</sub>, methane and N<sub>2</sub>O<sup>14</sup>.

Den Elzen also provided an overview of the quality of various data sets (CDIAC-ORNL, EDGAR-HYDE, and IIASA) available for estimating greenhouse gas emissions during the past century. He argued that not only fossil CO<sub>2</sub> emissions, but also the land-use related CO<sub>2</sub> emissions and anthropogenic methane and N<sub>2</sub>O emissions should be included in the analysis, despite the

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<sup>13</sup> The original proposal has been discussed by Berk and den Elzen (1998) and Enting (1998). The revised proposal has been discussed by den Elzen *et al.* (1999).

<sup>14</sup> The choice is as much as a political choice rather than determined by the science.

uncertainties associated with these sources. Fossil CO<sub>2</sub> emissions can not be considered as a good proxy for these emissions.

Participants further discussed how, in addition to temperature change, *rates* of temperature change and global mean sea level rise (both possible criteria for potential climate impacts identified by IPCC) might also be attributed to individual nations or groups of nations. Sea level rise, an indicator of climate change of considerable interest to many coastal countries, is closely related to change in average global temperatures, and hence its attribution to specific emitters can be approximated by that for temperature increase. Attribution of changes in rates of temperature change to specific emitters will result in significantly different outcomes than that for average temperature change. Countries with fast growing emissions contribute most to rate of temperature increase, while countries with large historical emissions may have only a small contribution to rate of temperature increase.

Finally, the group also discussed the problems in the use of IPCC definitions and values for GWPs of greenhouse gases, and the alternative GWB-approach, as pointed out earlier by Meira Filho.

### **Conclusions**

The meeting came to the following conclusions:

- i) There is sufficient scientific and technical basis for operating the Brazilian proposal.
  - ii) The methodology proposed by Brazil of using a highly parameterised, simple climate model is conceptually sound given its purpose and when applied on short time horizons
  - iii) The proposal itself is seen as useful, and worthwhile to investigate, and has already led to a fruitful co-operation between Australia, Brazil, Canada, China, the Netherlands and the United States of America;
  - iv) The revised methodology is a major improvement compared to the original proposal, but still contains some important deficiencies:
    - the carbon cycle sub-model needs to be improved to better represent the non-linear response of CO<sub>2</sub> concentrations to a pulse emission. Such improvements must ensure adequate inclusion of terrestrial processes such as CO<sub>2</sub> fertilisation, although in a linear way. This linearisation of the CO<sub>2</sub> fertilisation is in contrast with the logarithm approach as assumed by the IPCC, but it is considered as of minor importance for the coming two commitment periods.
    - the calculation of the methane concentration needs to be improved by including the soil sink term, and the time-dependency of the atmospheric lifetime;
    - the radiative response to increasing concentration of greenhouse gases is non-linear for CO<sub>2</sub>, methane and N<sub>2</sub>O (due to saturation of the spectral windows). This non-linearity also affects the attribution of radiative forcing. Neglecting this non-linearity could underestimate the relative effects of early emissions relative to subsequent releases.
    - The model has a significantly slower climate response to increased radiative forcing than other models, hence underestimating the decay time of the effect of past emissions on climate change. These parameters, representing the climate adjustment period should be clarified.
    - The land-use related CO<sub>2</sub> emissions and anthropogenic methane and N<sub>2</sub>O emissions should be included in the analysis;
- However, it is agreed that these deficiencies can in general be readily addressed by improving the model by corrections or by importing techniques and processes already available in other models;
- v) Attribution of global mean sea level rise can be approximated by that for temperature increase;

- vi) Attribution of changes in *rates* of temperature change to specific emitters will result in significantly different outcomes as that for temperature change. The nature of such changes and the implications and usefulness as a criterion for burden sharing needs much more careful study;
- vii) There are serious problems with the quantity and quality of data for global and particularly country level emissions of CO<sub>2</sub> from land-use change, and anthropogenic methane and nitrous oxide emissions during the past century. While the short lifetime of methane reduces potential error from inappropriate data, possible errors in attribution related to the other two types of emissions can be very significant. More attention is needed for the development of consistent global data sets. Emissions reported by countries were considered as an insufficient basis.
- viii) The IPCC GWP concept is inappropriate for very long-lived gases, since it inadequately addresses climate response decay over such time scales. Hence, these values significantly underestimate the ultimate contribution of such gases to global warming. There may also be problems with estimates of methane GWP values at different time scales, and in equating historical emissions. These need to be more thoroughly assessed and understood (the issue is already on the agenda of the IPCC);
- ix) It was suggested that the Brazilian approach to burden sharing might be appropriately complemented by the triptych approach, which attempts to make allowance for the effect of carbon emissions embedded in exported commodities and other differences in the economic structures of different nations on their emissions. This approach was successfully used in differentiating targets amongst the EU, and is now under study through a series of workshops sponsored by the Netherlands.

#### ***Future Steps***

- Dr Meira Filho will present a brief report on the Expert meeting at the next meeting of SBSTA in June.
- The Brazilian model will be updated to address the deficiencies identified. An Expert meeting involving a broader range of experts may be organised to evaluate the effects of changes in the model, to address some of the other unresolved issues related to its use in negotiating future burden sharing, and to further address concerns about IPCC GWPs relative to long-lived gases.
- Dr Meira Filho and colleagues were encouraged to publish their conceptual approach in peer-reviewed literature to generate broader exposure and comments from the science community.

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*List of people attending the meeting:*

Luiz Gylvan Meira Filho, Brazilian Space Agency, Brazil (chairman)  
Jose Domingos Gonzales Miquez, Ministry of Science and Technology (MCT), Brazil  
Michel den Elzen, RIVM, the Netherlands (reporter)  
Ian Enting, CSIRO, Australia  
Henry Hengeveld, Environment Canada, Canada  
Raymond Prince, US Department of Energy, USA  
Luiz Pinguelli Rosa, Federal University of Rio de Janeiro, Brazil  
Christophe de Gouvello, CIRED/CNRS, France  
Newton Paciornik, Ministry of Science and Technology (MCT), Brazil  
Andrej Kranjc, Meteorological Institute, Slovenia  
Michael Dutschke, Brazil  
Mark Lutes, Brazil

*List of people interested in the Expert meeting:*

Bert Metz , RIVM, Netherlands  
Sue Barrell, Bureau of Meteorology, Australia  
Chris Mitchel, CSIRO, Australia  
Jose Goldemberg, Univ. São Paulo, Brazil  
Art Jacques, Environment Canada, Canada  
Xuedu Lu, State Science & Technology Commission, China  
Shuguang Zhou, China Meteorological Administration, China  
Anil Agarwal, CSE, India  
Bill Hare, Greenpeace, the Netherlands  
Leo Meyer, VROM, the Netherlands  
Michiel Schaeffer, RIVM, the Netherlands  
Maressa Oosterman, KNMI, the Netherlands  
Jean-Jacques Becker, Mission interministérielle de ' effet de serre, France  
M. Heimann, MPI, Germany  
Geoff Jenkins, Hadley Centre, United Kingdom  
Richard Ball, US DOE, USA  
Clare Breidenich, EPA, USA  
William Breed, US DOE, USA  
Abraham Haspel, US DOE, USA  
Daniel Lashof, NRDC, USA

*Agenda:*

1. Introduction remarks on the Brazilian Proposal (Luiz Gylvan Meira Filho)
2. Presentation: An evaluation of the methodological aspects of the Brazilian Proposal (Michel den Elzen)
3. Presentation: Attribution of greenhouse gas emissions, concentrations and radiative forcing (Ian Enting)
4. Analysis of the scientific aspects of the Brazilian Proposal (discussions)

- Translation from emissions to concentrations
  - Translation from concentrations to radiative forcing
  - Translation from radiative forcing to temperature increase
  - Translation from temperature increase to sea level rise, or rate of temperature increase
5. Global Warming Potential – GWP
  6. Presentation: Data availability of historical emissions, comparison of data sets (Michel den Elzen)
  7. Final session: concluding remarks, main findings, future activities