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UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

SUBSIDIARY BODY FOR SCIENTIFIC AND TECHNOLOGICAL ADVICE
Twenty-eighth session
Bonn, 4–13 June 2008

Item 7 (a) of the provisional agenda
Methodological issues under the Convention
Scientific and methodological aspects of the proposal by Brazil

Results of the work on scientific and methodological aspects of the proposal by Brazil

Submissions from Parties

1. The Subsidiary Body for Scientific and Technological Advice, at its twenty-fourth session, invited all Parties, research institutions and scientists engaged in work on the scientific and methodological aspects of the proposal by Brazil to forward to the secretariat, through interested Parties, by 30 October 2007, written reports about the results of their work (FCCC/SBSTA/2006/5, para. 82).

2. The secretariat has received one submission from the United Kingdom of Great Britain and Northern Ireland on behalf of the Ad-hoc Group for the Modelling and Assessment of Contributions to Climate Change (MATCH). In accordance with the procedure for miscellaneous documents, this submission is attached and reproduced[*] in the language in which it was received and without formal editing.

[*] This submission has been electronically imported in order to make it available on electronic systems, including the World Wide Web. The secretariat has made every effort to ensure the correct reproduction of the text as submitted.

SUBMISSION FROM THE UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND

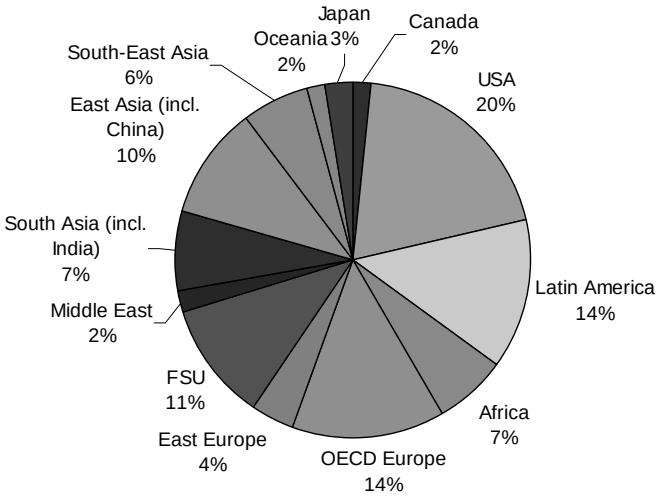
Summary report of the ad-hoc group for the modelling and assessment of contributions to climate change (MATCH)[1]

KEY POINTS

The ad-hoc group for modelling and assessment of historic contributions to climate change (MATCH) was formed at SBSTA's invitation to continue the scientific evaluation of the Brazil Proposal. MATCH has been an open research process, which has attracted more than 40 researchers from 14 countries. This final report summarises the results of MATCH.

Key findings

- **Scientific underpinnings, historical datasets and modelling tools are now available.** These allow us to evaluate contributions to climate change with some scientific confidence for the Kyoto gases by regional, national, or sectoral breakdown, except for emissions from land-use change and forestry.
- The sample **pie chart shows the relative regional / national contributions** to the global temperature increase in 2000 caused by emissions of CO_2, CH_4, and N_2O beginning in 1890.



- **Choices influence the relative contribution results**. The impact of the decisions depends on the countries' emissions time history. Some examples:
  - **Moving the beginning date for accountable emissions** from 1890 to 1990 decreases the contribution of OECD Europe from 14% to 11%.
  - **Including non-Kyoto greenhouse gases such as ozone precursors** increases the contribution of the Middle East from 2.0 to 2.4%.
  - **Land-use change and forestry emissions are highly uncertain.** The use of different published datasets shifts the contribution of Latin America from 14% to 8%.
- **Uncertainty in the contribution to *absolute* temperature is ±30% in the case of recent emissions**.[2] Uncertainty widens when also including earlier emissions. Uncertainty in the *relative* contribution will be much less, since some uncertain factors in the calculation apply to all sources equally. The magnitude of the decrease has not been rigorously evaluated.

Products and achievements

- **Publication of journal articles and the development of computer tools** were stimulated by MATCH. **Capacity building** also enabled scientific participation of scientists from many countries.
- **Historic country level emission datasets** of greenhouse gases stretching back to the 18th century were complied and evaluated by MATCH. Emissions and uptake of greenhouse gases due to land-use change and forestry were included, although these are much more uncertain.
- **Datasets showing a range of typical attribution results** and **on-line models** enabling user experiments with different options have been posted on the MATCH web site.

MATCH has led the scientific evaluation of assessing contributions to climate change on the basis of emissions originating from the territory of a country over time. We hope that this collective work and the network of scientists that developed it will prove useful to the governments in addressing climate change.

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[1] Prepared by Niklas Höhne, Joyce Penner, Michael Prather, Jan Fuglestvedt, Jason Lowe, Guoquan Hu.

[2] Emissions of Annex I countries that are also in the OECD from 1990 to 2002.

Contents

1 INTRODUCTION

In 1997, Brazil proposed a method to calculate contributions of emission sources to climate change (FCCC/AGBM/1997/MISC.1/Add.3). Although the original application to emissions reduction targets was not pursued, continued interest in the scientific and methodological aspects of the proposal by Brazil led to a series of expert meetings (reported in FCCC/SBSTA/2001/INF.2), followed by a model inter-comparison exercise on the "Attribution of Contributions to Climate Change" (ACCC, from which some results were reported in FCCC/SBSTA/2002/INF.14).

The SBSTA, at its seventeenth session, agreed that work on the scientific and methodological aspects of the proposal by Brazil should be continued by the scientific community, in particular to improve the robustness of the preliminary results and to explore the uncertainty and sensitivity of the results to different assumptions. (FCCC/SBSTA/2002/13, paragraphs 28-30).

Subsequent to this agreement the governments of UK, Brazil and Germany took the initiative to organize an expert meeting in September 2003 that formed the Ad Hoc Group on Modelling and Assessment of Contributions to Climate Change (MATCH).

MATCH reported progress to the SBSTA in June 2006, which renewed the mandate and requested a written report by 31 October 2007. This document responds to this mandate.

2 THE MATCH PROCESS

Encouraged by the SBSTA, the aim of MATCH has been to evaluate and improve the robustness of calculations of contributions to climate change due to specific emissions sources, building on the proposal by Brazil, and to explore the uncertainty and sensitivity of the results to different assumptions. The aim is to provide clear guidance on the implications of the use of the different scientific methods, models, and methodological choices. Where scientific arguments allow, the group would recommend one method/model/choice or several possible methods/models/choices for each step of the calculation of contributions to climate change, taking into account scientific robustness, practicality and data availability. Outputs of the group are primarily articles for the peer-reviewed scientific literature.

The SBSTA recognized the relevance of this work and the opportunity of this process to build capacity in climate change science. The governments of Germany, UK and Norway have generously provided funds for participation of experts from developing countries at the MATCH meetings.

Scientific experts of the MATCH group are listed in Annex A. MATCH was guided by a Scientific Coordination Committee, consisting of several experts engaged in the research on this issue including representatives from Brazil and the UK. Administrative support was provided by Ecofys under contract to UK DEFRA. All papers, meeting details and organizational matters are published on http://www.match-info.net.

Experts of the MATCH group regularly presented their work at side events at the SBSTA.

3 RESULTS OF MATCH

Several articles by individual members of the group on calculating contributions to climate change have been published in peer reviewed journals. These include details of the work of individual groups for MATCH as well as papers on issues that were felt to be outside of the self chosen mandate of MATCH. Details are included in the Annex B.

MATCH as a group has prepared four joint papers. Two papers analyse uncertainties, while two papers concentrate on providing concrete applications of the analysis. MATCH has also inspired research cooperation and contributions to computer tools. The results are described in detail below

3.1 UNCERTAINTIES ALONG THE CAUSE-EFFECT CHAIN

The joint MATCH paper "From human activities to climate change: uncertainties in the causal chain" examines the absolute contributions to climate change that can be attributed to a group of nations. While formal attribution of observed climate change to the overall increase in atmospheric greenhouse gases has been made, the relationship between specific human activities and their consequent levels of climate change has not been followed with the same level of scientific scrutiny. This paper tracks the causal chain from human activities to greenhouse gas emissions to changing atmospheric composition to climate change, propagating scientific assessment of the uncertainties in climate change caused by those activities. In the paper, large sources of uncertainty are removed in deriving climate change by combining forward and inverse models. In the chemistry and carbon-cycle models the application of inverse models to match the observed abundances constrains model parameters and emissions uncertainties. Likewise, the abundance-to-climate-change link is used with forward and inverse climate models to constrain key climate parameters, such as the climate sensitivity.

The ±30% uncertainty in predicting absolute climate change in 2003 from Annex-I emissions from 1990 through 2002 reflects the accumulation of possible errors through the steps from reporting to climate change. This uncertainty will become larger when evaluating historical emissions prior to 1990 and when evaluating climate change over multi-decadal scales where additional climate feedbacks increase uncertainty. It will become smaller when evaluating the relative climate change among nations. A careful analysis of the scientific uncertainty, including correlated and uncorrelated errors, is needed.

The paper has been submitted to *Geophysical Research Letters* in November, 2007.

3.2 HISTORICAL EMISSIONS FROM FORESTRY

The joint MATCH paper "Can we reconcile differences in estimates of carbon fluxes from land-use change and forestry for the 1990s?" examines the large uncertainties in estimates for land-use change and forestry (LUCF), including those reported to the UNFCCC. The paper examines the contribution of LUCF to carbon emissions in a variety of models of different types with different land cover change maps in the 1990s. Annual carbon pools and their changes are separated into different components for separate geographical regions, while annual land cover change areas and carbon fluxes are disaggregated into different LUCF activities and the biospheric response due to CO_2 fertilization and climate change. Model estimates for LUCF emissions without the effects of environmental change range from –0.5 to 1.4 PgC yr^{-1}. The environmental changes in two biogeochemical models lead to a carbon sink ranging from 0.9 to 1.4 PgC yr^{-1}.

In order to compare these bottom-up estimates with top-down model calculations constrained by measurements of atmospheric concentrations, we developed a consolidated estimate of the terrestrial carbon fluxes for the USA, Latin America, and 8 other countries or regions. Combining book-keeping model results with the process-based biogeochemical modelling and inventory estimates yields a consolidated estimate of the global terrestrial carbon flux (–0.4 PgC yr^{-1}) that is within the uncertainty range developed in the IPCC 4th Assessment Report, but the portion associated with LUCF emissions (0.96 PgC yr^{-1}) is opposite in sign and larger than the estimate from the UNFCCC reporting total (–0.24 PgC yr^{-1}).

We performed a detailed analysis for two countries: the USA and Brazil. Because there are different sources of errors at the country level, there is no easy reconciliation of different estimates of carbon fluxes at the global level. Clearly, further work is required to develop data sets for historical land cover change areas and models of biogeochemical changes for an accurate representation of carbon dynamics.

The paper has been submitted to *Atmospheric Chemistry and Physics Discussions* in November, 2007.

3.3 FIRST ANALYSIS OF REGIONS' CONTRIBUTION TO CLIMATE CHANGE

The joint MATCH paper "Analysing countries' contribution to climate change: scientific and policy-related choices" (published in *Environmental Science & Policy*, Volume 8, Issue 6, December 2005) evaluates the influence of different policy-related and scientific choices on the calculated regional contributions to global climate change (the ''Brazilian Proposal''). Policy-related choices include the time period of emissions, the mix of greenhouse gases and different indicators of climate change impacts. The scientific choices include different estimates of historical emissions and model representations of the climate system. Results from several simple climate models were compared. The paper was the first joint effort by the MATCH group and formed the basis for further work.

This paper finds that the relative contributions of different nations to global climate change—attributing only emissions of long-lived greenhouse gases—are robust, despite the varying model complexity and differences in calculated absolute changes. For the default calculations, the average calculated contributions to the global mean surface temperature increase in 2000 are about 40% from OECD90, 14% from Eastern Europe and Former Soviet Union, 24% from Asia and 22% from Africa, Latin America and the Middle East.

Policy related choices, such as time period of emissions, climate change indicator and gas mix generally have larger influence on the results than scientific choices. More specifically, choosing a later attribution start date (1990 instead of 1890) for historical emissions, decreases the contributions of regions that started emitting early, such as the OECD countries by 6 percentage points, whereas it increases the contribution of late emitters such as Asia by 8 percentage points. However, including only the fossil CO2 emissions instead of the emissions of all Kyoto gases (fossil and land use change), increases the OECD contributions by 21 percentage points and decreases the contribution of Asia by 14 percentage points.

3.4 DETAILED ANALYSIS OF COUNTRIES CONTRIBUTION TO CLIMATE CHANGE

The joint MATCH paper "Contributions of individual countries' emissions to climate change and their uncertainty" provides an update of the first joint MATCH paper and includes new elements not covered by previous papers:

- Calculations country by country
- Split by sectors (energy & industry, agriculture & waste, land-use change & forestry)
- Evaluation of effect of the uncertainty of emission estimates

Our approach was to provide more numerical detail (i.e. per country and sector) for the most important choices. We leave out the choices that do not make a large difference based on previous analysis. The approach is pragmatic and result-oriented as opposed to comprehensive and all encompassing. All input emissions and results will be available electronically on www.match-info.net as soon as the paper is accepted for publication.

We find that uncertainty in historical emission estimates differs between countries due to different shares of greenhouse gases and time history. Although historical emissions are much more uncertain, their influence on total contributions is relatively small, since these results are dominated by current emissions. Emissions from LUCF were only roughly estimated and need further work. For relative contributions, the uncertainty introduced by unknown historical emissions is larger than the uncertainty introduced by the use of different climate models. The choice of different parameters in the calculation of relative contributions is most relevant for countries that are different from the world average in their greenhouse gas mix and timing of emissions. The choice of the indicator is relevant (up to factor of 2) for only a few countries, while the choice of the start date is relevant for many countries. Including or excluding LUCF or non-CO_2 gases changes relative contributions substantially for a third of the countries. Although industrialised countries started much earlier with CO_2 emissions from energy use, developing countries' emissions from land use change and forestry as well as their emissions of CH_4 and

N_2O are substantial relatively early. Although further work on estimates from LUCF and on a finer sectoral resolution is recommended, we hope that the data and results provided in this paper proves useful for designing effective climate change policies.

The paper has been submitted to *Climatic Change* in November, 2007.

3.5 RESEARCH COOPERATION

Capacity was developed as inspiration of the MATCH process: For example, the first joint paper identified that for relative contributions a key scientific uncertainty derived from land-use-change emissions, particularly when considering contributions integrated over a long time horizon. Recognising this, a team from IVIG (Brazil) developed a detailed and flexible model of land-use emissions which has recently been coupled with the JCM carbon/climate model developed in UCL-ASTR (Belgium). This combination can now calculate contributions to climate change, including uncertainty distributions, for any country over any time-horizon. The complex results still require further analysis, documentation, and publication in a peer-reviewed journal. In addition, a researcher from CMA (China) visited NIWA (New Zealand) for an extended period to gain experience in modelling. Likewise a researcher from IVIG (Brazil) visited Ecofys (Germany). These examples show the role of the MATCH process in inspiring such cooperation and capacity development.

3.6 CALCULATION TOOLS

The MATCH group was available to assess and evaluate existing calculation tools to assess contributions to climate change, but did not develop a new tool. Members of the group developed or contributed to several tools:

- Java Climate Model, Ben Matthews (www.climate.be/jcm)
- FAIR model, Michel den Elzen (www.mnp.nl/fair)
- CAIT tool, Jonathan Pershing (cait.wri.org)

4 CONCLUSION

This concludes the MATCH process. MATCH has led the scientific evaluation of assessing contributions to climate change on the basis of emissions originating from the territory of a country over time.

Some open issues remain, such as analysis of further sectoral split or reconciliation of emissions from land-use change and forestry.

We hope that this collective work and the network of scientists that developed it will prove useful to the governments in addressing climate change.

ANNEX A: EXPERTS CONTRIBUTING TO MATCH

Akinori Ito	Agency for Marine-Earth Science & Technology, Japan
Ana Claudia Nioac de Salles	University of Rio de Janeiro, Brazil
Atsushi Kurosawa	Institute of Applied Energy, Tokyo, Japan
Atul Jain	University of Illinois at Urbana-Champaign, USA
Bård Romstad	CICERO, Oslo, Norway
Ben Matthews	Universite Catholique de Louvain, Belgium
Benito Müller	Oxford University, UK
Brian O'Neil	IIASA, Laxenburg Austria
Christiano Pires de Campos	University of Rio de Janeiro, Brazil
Fabian Wagner	IIASA, Laxenburg, Austria
Gregory Bodeker	National Institute of Water and Atmospheric Research, Wellington, New Zealand
Helcio Blum	University of Rio de Janeiro, Brazil
Ian Enting	The University of Melbourne, Victoria, Australia
John van Aardenne	Joint Research Centre, Institute for Environment and Sustainability, Ispra, Italy
Laila Gohar	Hadley Centre for Climate Prediction and Research, Met office, Exeter, UK
Luiz Gylvan Meira Filho	University of Sao Paulo, Brazil
Luiz Pinguelli Rosa	University of Rio de Janeiro, Brazil
Malte Meinshausen	Potsdam Institute for Climate Impact Research, Germany
Maria Silvia Muylaert de Araujo	University of Rio de Janeiro, Brazil
Martina Jung	Ecofys, Germany
Mathias Friman	Linköpings University, Sweden
Michael Schlesinger	University of Illinois, Urbana, USA
Michiel Schaeffer	MNP/RIVM, Bilthoven, Netherlands
Natalia Andronova	University of Illinois, Urbana, USA
Norichika Kanie	Tokyo Institute of Technology, Japan
Peter Stott	Hadley Centre for Climate Prediction and Research, Met Office, Exeter, UK
Promode Kant	Indira Gandhi National Forest Academy, Dehradun, India
Ragnhild Bieltvedt Skeie	CICERO, Norway
Sarah Raper	University of East Anglia, Norwich, UK
Suzana Kahn Ribeiro	University of Rio De Janeiro, Brazil
Stephen W. Wood	National Institute of Water and Atmospheric Research, Wellington, New Zealand
Wandera Ogana	University of Nairobi, Kenya
Xiaosu Dai	China Meteorological Administration, Beijing, China

Scientific coordination committee	
Joyce Penner (co-chair)	University of Michigan, Ann Arbor, USA
Jan Fuglestvedt (co-chair)	CICERO, Oslo, Norway
Cathy Trudinger	CSIRO Marine and Atmospheric Research, Aspendale, Australia
Guoquan HU	China Meteorological Administration, Beijing, China
Jason Lowe	Hadley Centre for Climate Prediction and Research, Met office, Exeter, UK
José Domingos Gonzalez Miguez	Interministerial Committee on Global Climate Change, Brazil
Michael Prather	University of California at Irvine, USA
Michel den Elzen	Netherlands Environmental Assessment Agency MNP/RIVM, Bithoven, Netherlands
Murari Lal	University of South Pacific, Suva, Fiji Islands
Niklas Höhne (secretary)	Ecofys, Cologne, Germany

ANNEX B: SCIENTIFIC ARTICLES ON CONTRIBUTIONS TO CLIMATE CHANGE

Joint articles by the MATCH group:

M. den Elzen, J. Fuglestvedt, N. Höhne, C. Trudinger, J. Lowe, B. Matthews, B. Romstad, C. Pires de Campos, N. Andronova, 2005: "Analysing countries' contribution to climate change: Scientific uncertainties and methodological choices", *Environmental Science and Policy*, 8 (2005) 614–636

Michael J. Prather, Natalia Andronova, Jan S. Fuglestvedt, Niklas Höhne, Atul K. Jain, Atsushi Kurosawa, Jason A. Lowe, Joyce E. Penner, Luiz Pinguelli, Chris Pires de Campos, Sarah C.B. Raper, Ragnhild B. Skeie, Peter A. Stott, John van Ardenne, Fabian Wagner 2007: "From human activities to climate change: uncertainties in the causal chain", submitted to *Geophysical Research Letters* in November 2007

Akinori Ito, Joyce E. Penner, Michael J. Prather, Christiano Pires de Campos, Richard A. Houghton, Tomomichi Kato, Atul K. Jain, Xiaojuan Yang, George C. Hurtt, Steve Frolking, Matthew G. Fearon, Louise Parsons Chini, Audrey Wang and David T. Price: "Can we reconcile differences in estimates of carbon fluxes from land-use change and forestry for the 1990s?", submitted to *Atmospheric Chemistry and Physics Discussions* in November 2007

Niklas Höhne, Helcio Blum, Ben Mathews, Jan Fuglestvedt, Ragnhild Bieltvedt Skeie, Atsushi Kurosawa, Guoquan Hu, Jason Jowe, Laila Gohar, Ana Claudia Nioac de Salles 2007: "Contributions of individual countries' emissions to climate change and their uncertainty", submitted to *Climatic Change* in November 2007

Articles by members of the MATCH group on the topic:

Pinguelli Rosa, Luiz , Ribeiro, Suzana Kahn. "The share of responsibility between developed and developing countries in climate change, Greenhouse Gas Mitigation". In RIEMER, P.W.F., SMITH, A. Y. and THAMBIMUTHU, K.V. Proceedings from the International Energy Agency Conference on GHG, Vancouver, 1997, Pergamon Press. 1997

Pinguelli Rosa, Luiz and Ribeiro, Suzana Kahn, 2001: "The present, past, and future contributions to global warming of CO_2 emissions from fuels", *Climatic Change* 48: 289-308, 2001

M.G.J. den Elzen, and Schaeffer, M. 2002: "Responsibility for past and future global warming: Uncertainties in attributing anthropogenic climate change", *Climatic Change* 54: 29-73

M. Andronova and M. Schlesinger 2004: "Importance of Sulfate Aerosol in Evaluating the Relative Contributions of Regional Emissions to the Historical Global Temperature Change", *Adaptation and Mitigation Strategies for Global Change*, 9, 383-390

Pinguelli Rosa, Luiz , Ribeiro, Suzana Kahn , Muylaert, Maria Silvia and Campos, Christiano Pires de ., 2004: "Comments on the Brazilian Proposal and contributions to global temperature increase with different climate responses - CO_2 emissions due to fossil fuels, CO_2 emissions due to land use change", Energy Policy, Volume 32, Issue 13, September 2004, Pages 1499-1510

Muylaert, Maria Silvia, Cohen, Claude, Rosa, Luiz Pinguelli and Pereira, André Santos.. " Equity, responsibility and climate change" *Climate Research* 28 (2004) pgs. 89-92

Muylaert de Araujo, Maria Silvia, Campos, Christiano Pires de and Rosa, Luiz Pinguelli. "GHG historical contribution by sectors, sustainable development and equity" *Renewable and Sustainable Energy Reviews*. Accepted in 6 July 2005, available on line

Campos, Christiano Pires de , Muylaert, Maria Silvia and Rosa, Luiz Pinguelli. "Historical CO_2 emission and concentrations due to land use change of croplands and pastures by country", *Science of the Total Environment* 346 (2005) pgs. 149-155

Cathy Trudinger, Ian Enting, 2005: "Comparison of formalisms for attributing responsibility for climate change: Non-linearities in the Brazilian Proposal approach", *Climatic Change*, Volume 68, Issue 1 - 2, Jan 2005, Pages 67 - 99

M.G.J. Den Elzen, M. Schaeffer, Paul L. Lucas, 2005: "Differentiating Future Commitments on the Basis of Countries' Relative Historical Responsibility for Climate Change: Uncertainties in the 'Brazilian Proposal' in the Context of a Policy Implementation", *Climatic Change*, Volume 71, Issue 3, Aug 2005, Pages 277 – 301

I. G. Enting, 2005: “Automatic differentiation in the analysis of strategies for mitigation of global change” in: International Conference on Modelling and Simulation (ed. A. Zerger and R. Argent) http://www.mssanz.org.au/modsim05/papers/enting.pdf

Atsushi Kurosawa, Toshimasa Tomoda 2005: Brazilian Proposal as Greenhouse Gas Mitigation Criteria”, *Kiho Enerugi Sougou Kogaku*, vol.28 no.2, 2005

Nathan Rive, Asbjørn Torvanger, Jan S. Fuglestvedt, 2006: “Climate agreements based on responsibility for global warming: periodic updating, policy choices, and regional costs”, *Global Environmental Change*, 16 (2), p.182-194, May 2006

Niklas Höhne, Kornelis Blok, 2005: “Calculating historical contributions to climate change – discussing the ‘Brazilian Proposal’”, *Climatic Change*, Volume 71, Issue 1, Jul 2005, Pages 141 – 173

Hu, G., Dai, X., Bodeker, G., Reisinger 2006: “Numerical simulation study on the scientific and methodological aspects of the Brazilian Proposal”, *Acta Meteorologica Sinica* 19 (4), pp. 447-456

Atsushi Kurosawa, Toshimasa Tomoda 2007: “Regional Attribution to the Climate Change and Brazilian Proposal” in: Proc. Annual Meeting of Society for Environment Economics and Policy Studies, Hikone, Shiga, Japan, October 2007

Araújo, M.S.M.; Campos, C.P; Rosa, L.P. 2007: “Historical Manure Management N_2O emission and enteric fermentation CH_4 emission of domestic livestock by country”. *Climate Research*, Vol. 34: 253-258.

Araújo, M.S.M.; Silva, C.; Campos, C.P. 2007: “Land use change sector contribution to the carbon historical emissions and the sustainability case study of the Brazilian Legal Amazon”. *Renewable & Sustainable Energy Review* (accepted)

Nathan Rive, Jan S. Fuglestvedt 2007: “Introducing population-adjusted historical contributions to global warming”, *Global Environmental Change* (in press)

Benito Müller, Niklas Höhne, Christian Ellermann 2007: “Differentiating Historic Responsibility for Climate Change - Synthesis Report”, submitted to the UNFCCC

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