



Meeting report of the ad-hoc
group for the modelling and
assessment of contributions
to climate change (MATCH)

27 to 28 November 2006
Cologne, Germany

22 December 2006

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Contents

1 INTRODUCTION2

2 ISSUES DISCUSSED BY THE SCIENTIFIC COORDINATION COMMITTEE...2

3 OPENING OF THE MEETING3

4 MATCH RESPONSE TO AWG WORKSHOP3

5 STATUS OF PAPER #2.....4

6 UPDATES OF WORK.....5

7 DISCUSSION ON FUTURE WORK5

8 CLOSING.....6

REFERENCES7

ANNEX A: AGENDA8

ANNEX B: PARTICIPANTS OF THE MEETING.....10

ANNEX C: DRAFT WORKPLAN.....11

ANNEX D: PAPER #316

ANNEX E: PAPER #4.....20

1 INTRODUCTION

As part of the negotiations on the Kyoto Protocol, the delegation of Brazil made a proposal, in May 1997, to set differentiated emissions reduction targets for Annex I Parties of the UNFCCC according to the impact of their historic emissions on temperature rise (UNFCCC document FCCC/AGBM/1997/MISC.1/Add.3).

After two expert meetings held under the auspices of the SBSTA (28 – 30 May 2001 in Bonn, Germany; 25 - 27 September 2002 in Bracknell, UK), the SBSTA agreed that the work should be continued by the scientific community. Subsequently, further expert meetings were held on the initiative of the governments of UK, Brazil and Germany.

In August 2003, the UK Department for the Environment (DEFRA) commissioned Ecofys to provide administrative, secretarial and scientific assistance as 'support unit' for the process until the end of 2005.

During the expert meeting held in Berlin on 8/9 September 2003, draft terms of reference and a draft work plan for a process until 2005 were discussed for the now called "Ad-hoc group for the modelling and assessment of contributions to climate change (MATCH)". Participants for a scientific coordination committee were selected, which guides and coordinates the process.

This document is the report of the meeting of MATCH held on 27/28 November 2006 in Cologne, Germany. It was drafted by Niklas Höhne and Martina Jung, Ecofys, Germany [and reviewed by the participants of the meeting.]

The agenda of the meeting (Annex A) consisted of three major parts. First, a quick review of timelines, tasks, goals and long-term work plan was presented and the status quo reported. Second, the paper #2 "Attributing a fraction of climate change to a nation's historical emissions: closure and scientific uncertainty" was presented. As the third and major part, the experts discussed the way forward of the MATCH group. All presentations held during the meeting are available on file exchange of the web site www.match-info.net. 19 participants attended the meeting (Annex B).

2 ISSUES DISCUSSED BY THE SCIENTIFIC COORDINATION COMMITTEE

The members of the scientific coordination committee (SCC) Jan Fuglestvedt, Joyce Penner, Jason Lowe, Michael Prather, Maria Silvia Muylaert (for José Domingo Gonzalez Miguez) and Niklas Höhne met on Sunday (26 November) to

- Review the agenda of the MATCH meeting in the light of the recent developments
- Update the status of funding of developing country experts
- Discuss on future work
- Discuss potential changes in the composition of the SCC

3 OPENING OF THE MEETING

Joyce Penner opened the meeting as Co-Chair of the scientific coordination committee of the MATCH group. She expressed her thanks on behalf of the experts to Ecofys for hosting this meeting.

Niklas Höhne welcomed the participants on behalf of Ecofys and introduced all participants to the history of MATCH. He presented the results obtained by MATCH so far, reported on the decision on the future of MATCH taken by SBSTA in May 2006 and proposed a time line for the future work of MATCH.

Niklas Höhne also mentioned that in 18 occasions, experts from developing countries were supported with travel and subsistence costs. There is additional money for additional 1-2 expert trips available in the fund provided through the UK, German and Norwegian governments.

4 MATCH RESPONSE TO AWG WORKSHOP

The participants of MATCH had noted with great interest that the issue of historical responsibility was again discussed at the UNFCCC meetings in Nairobi, November 2006. In the workshop of the Ad hoc working group under the Kyoto Protocol, the delegation of Brazil had presented the original figures that accompanied the original Brazilian Proposal in 1997¹ (see Figure 2). Subsequently, South Africa also showed a graph with cumulative emissions developing over time.

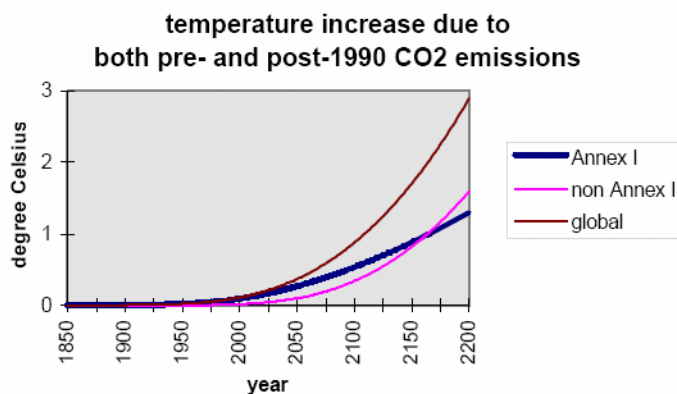


Figure 1. Contributions to temperature increase by Annex I and Non-Annex I countries as contained in the original “Brazilian proposal” of 1997 (UNFCCC 1997) and presented by Brazil at the AWG workshop in Nov 2006.

The MATCH participants regretted that the official negotiation process had not taken account of its work since the proposal was made. Already in 1999, Michel den Elzen et al. showed that the cross over point of contributions by Annex I and Non-Annex I countries is between 2000 and 2060 depending on the assumptions (den Elzen et al. 1999, see Figure 2), and not in 2150. The joint MATCH paper of 2005 (den Elzen et al. 2005) and many independent analyses confirmed this result (see Figure 3).

¹ http://unfccc.int/meetings/cop_12/in-session_workshops/items/3884.php

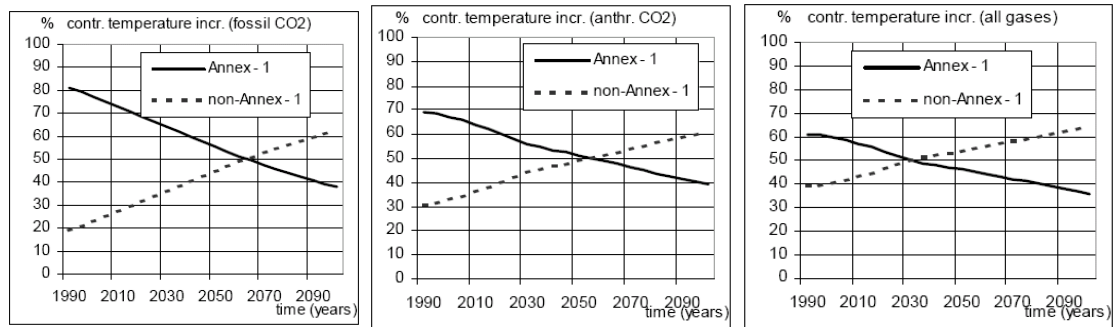


Figure 2. The contribution of Annex I and non-Annex I to global temperature increase for the IMAGE Baseline A scenario according to the meta-IMAGE model for the cases of only CO₂ emissions, all anthropogenic CO₂ emissions and all anthropogenic greenhouse gas emissions (Den Elzen et al. 1999, figure 4.3)

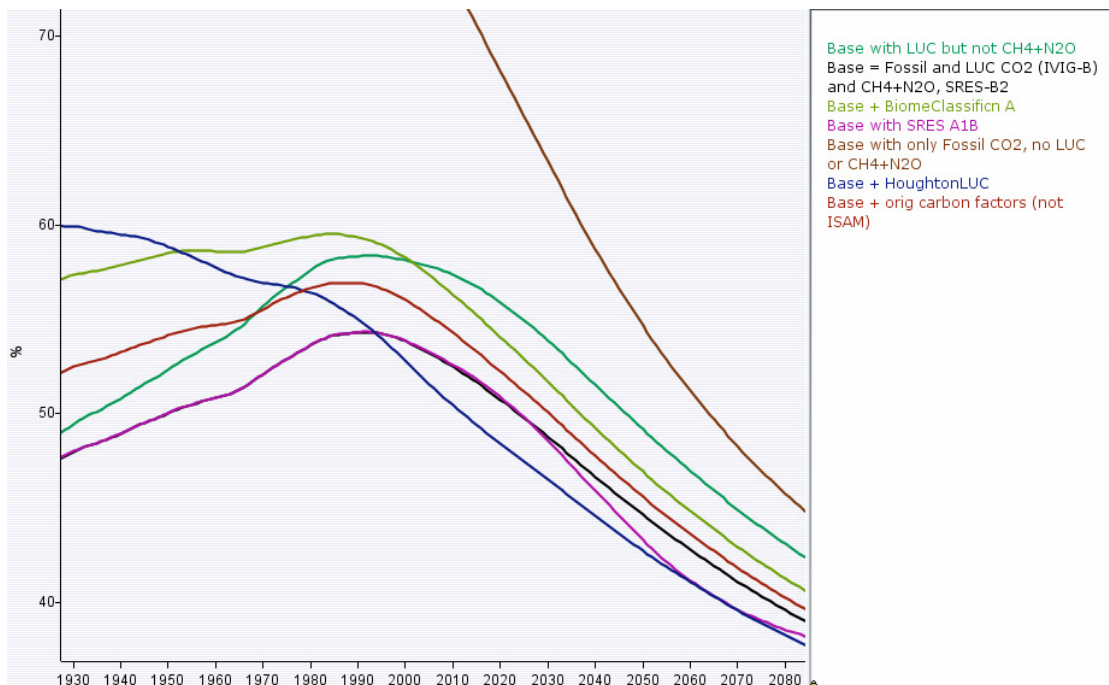


Figure 3. The fraction of global temperature rise attributed to Annex B for different assumptions (cross-over where fraction drops below 50 %)

Quelle: JCM model, <http://jcm.chooseclimate.org/>

5 STATUS OF PAPER #2

Michael Prather presented the status of paper #2: "Attributing a fraction of climate change to a nation's historical emissions: closure and scientific uncertainty". The outline of the paper is as follows:

- 1 Introduction
- 2 Long-lived greenhouse gases
- 3 Short-lived greenhouse agents and other forcings
- 4 Radiative forcing and climate change
- 5 Uncertainty of impact of OECD Annex I emissions
- 6 Conclusions

The main authors of paper #2 met during the meeting and agreed on tasks and timelines. A draft of the paper would go to the 4 main authors by 1 March, to all authors by April, with the aim to submit the paper in May 2007.

6 UPDATES OF WORK

Participants of the meeting presented their new work in 5 to 10 minutes presentations. The slides are available at the file exchange at www.match-info.net.

- Ian Enting presented new insights into the use of sensitivity functions and uncertainty estimates.
- Jan Fuglestad shared his research on i) population-adjusted historical responsibility and ii) climate impact of transport systems. He concluded that population size makes a big difference in historical responsibility calculations and that in terms of current forcing since pre-industrial times, road transport is dominating due to the contributions from CO₂ and tropospheric O₃.
- Maria Silvia Muylaert held a presentation on recent publications regarding historical emissions from livestock in Brazil, impacts of the use of biomass for ferroalloy plants in Brazil, and sector-specific historical responsibility. Furthermore, she gave an overview over work in progress on a white paper by the Collaborative Program on the ethical dimension of climate change.
- Guoquan Hu presented his views on the importance of considering per capita emissions for a country like China, making reference to the concept of survival emissions. In the following, it was briefly discussed by workshop participants that survival emissions have changed over time. A range of different views were expressed regarding the concept of population-adjusted historical responsibility.
- Mathias Friman reintroduced political economic aspects into the discussion by presenting his analysis on historical responsibility in the UNFCCC negotiations.
- Niklas Höhne presented the EVOC emission dataset which combines different emission datasets (historical and future emissions and inventories) from a hierarchy of sources in order to obtain a seamless dataset from 1750 – 2100.
- Luiz Pinguelli Rosa presented a way to plot emission intensity and emission per capita over time.
- Christiano Pires de Campos shared his research on uncertainties of different datasets on land use emissions, the IVIG model land use change emissions validation, some comparisons of land use change emissions by countries, results of a method for splitting land use change emissions for big regions into countries for the past and future, concluding with two graphs of relative contributions to temperature increase and a PDF of all countries' relative contributions.
- Ben Matthews reported on the new version of the JCM model (JCM 5).

7 DISCUSSION ON FUTURE WORK

Niklas Höhne presented the proposal for the MATCH timeline until 2008 (Annex C). The workshop participants agreed that – considering the time available - anything entering the final report should be submitted for publication by October 2007.

Three proposals for papers to be elaborated within the MATCH framework were discussed among participants.

Paper #3: Update of Paper #1

The discussion focussed on which elements to include in this paper:

- finer resolution (country-level and/or sector-level)

- uncertainty estimates
- past and/or future emissions

Conclusion: It was decided to proceed with the paper and to work on it in small groups. The outcome of the groups discussion is included in Annex D. It includes lead authors, tasks and a strict timeline.

Paper #4: Historical emissions from land use

Participants noted that estimates of land use emissions varied widely. Therefore, a paper examining the reasons for these differences would be of great importance with regard to the work on historical responsibility. Although, there was interest to contribute to the paper by Christiano Pires de Campos, Silvia Muylaert, Michael Prather, Joyce Penner, Luiz Pinguelli Rosa and Martina Jung, no lead authors could be found among workshop participants. During the discussion in the break-out groups, a possible structure of the paper was elaborated (Annex E). It was decided that the participants of the break-out group on paper #4 (Michael Prather, Silvia Muylaert, Joyce Penner, Christiano de Campos, Martina Jung) would contact potential (lead) authors and conduct some further literature research on studies available on the issue.

Paper #5: Interpretation of MATCH results

A wide range of views were expressed regarding this proposal. While some argued that such a paper would be beyond the scope of the MATCH mandate or have no impact, others argued that such a paper would provide a link between the work on 'numbers' and the political process without having to be prescriptive.

It was decided that the aspects brought up in the proposal on paper 5 would be included in the final MATCH report due in October 2007 in a section on relevant aspects for future research without producing a separate MATCH paper. Interested persons could start to work independently on the issue with the option to present it at the next MATCH workshop. Some of the issues could also be mentioned in paper 3.

Further ideas:

The idea of fingerprints (detectable and attributable regional patterns of impacts) was discussed as an interesting aspect regarding historical responsibility for climate change. It was decided to keep it alive in the future discussion and mention it in the final report.

8 CLOSING

In the closing session Joyce Penner thanked the participants for their contributions and expressed her satisfaction with the progress on the outline and attribution of assignments for paper #3 during the workshop.

Noting that there was an interest in paper 2 (land use emissions), but no lead author could be identified during the workshop, it was decided to elaborate a list of further experts in this area and invite them to contribute to the paper. Depending on the interest expressed by these further authors to take the lead it will be decided, if this paper will be able to proceed.

The next MATCH meeting was tentatively scheduled for the weeks from May 21 to 1 June was (excluding 28 May) in Norway. Jan Fuglestad kindly offered to host the meeting and will report on possible dates. The scientific coordination committee brought up the idea to have paper author meetings on the day before and/or the day after the meeting.

The MATCH meeting scheduled in September may take place in Japan. Atsushi Kurosawa kindly offered to host the meeting.

It was noted that it would be beneficial to present the result of the MATCH work to a broader audience before October 2007. The opportunity to have such a workshop back to back with the Ad-hoc Working Group and the Kyoto Protocol and the dialogue on future action under the UNFCCC was welcomed. Dates for such a meeting are not yet finalised. Niklas Höhne will keep the group informed about the progress in planning.

It was announced that Guoquan Hu would replace Xiaosu Dai in the scientific coordination committee, while it was still open who would substitute the outgoing scientific coordination committee member José Domingo Gonzalez Miguez.

Finally Joyce Penner thanked the participants for the successful meeting and Jan Fuglestvedt thanked Niklas Höhne, Martina Jung and Christian Ellermann, Ecofys, for hosting and arranging this meeting.

REFERENCES

- den Elzen, M.G.J., M.M. Berk, M. Schaeffer, O.J. Olivier, C. Hendriks and B. Metz. (1999). *The Brazilian proposal and other options for international burden sharing: an evaluation of methodological and policy aspects using the FAIR model*. No. RIVM-report 728001011. Bilthoven, the Netherlands (www.mnp.nl/en):
- den Elzen, M.G.J., J. S. Fuglestvedt, N. Höhne, C.M. Trudinger, J. Lowe, B.J.H. Matthews, B. Romstadt, C. Pires de Campos and N. Andranova. (2005). Analysing countries' contribution to climate change: Scientific uncertainties and methodological choices. *Environmental Science Policy*, 8, 614-636. http://www.sciencedirect.com/science?_ob=ArticleURL&_aset=V-WA-A-W-B-MsSAYZW-UUA-U-AACAZZUYEC-AAVEWVAZEC-EUVVVUDAW-B-U&_rdoc=1&_fmt=summary&_udi=B6VP6-4H68P03-1&_coverDate=12%2F31%2F2005&_cdi=6198&_orig=search&_st=13&_sort=d&_view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=97870dbdf722b5363079ed0417c6f74b.
- UNFCCC. (1997). FCCC/AGBM/1997/MISC.1/Add.3. Implementation of the Berlin Mandate. Additional proposals from Parties.

ANNEX A: AGENDA**AGENDA****AD HOC GROUP FOR THE MODELLING AND ASSESSMENT OF CONTRIBUTIONS OF CLIMATE CHANGE (MATCH)****27 TO 28 MARCH 2006, COLOGNE, GERMANY**

**TECHNOLOGIEPARK KÖLN,
JOSEF-LAMMERTING-ALLEE 17-19
COLOGNE, GERMANY
ROOMS: FUTURE 1 AND SUCCESS 1**

Sunday, 26 November 2006 Scientific coordination committee only (Mongos Restaurant)

18.00 – 19.00	Chair: Jan Fuglestvedt	Meeting of the scientific coordination committee	1h
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Sunday, 26 November 2006 All

19.00	Joint dinner for those in town Mongos Restaurant		
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Monday, 27 November 2006

9.00 – 10.30	Chair: Joyce Penner	- Welcome - Review of timelines (SBSTA), tasks, goals of MATCH, review of long-term work plan, update from the UNFCCC meetings in Nairobi (Niklas Höhne)	1.5h
10.30- 11.00	Chair: Joyce Penner	Short presentation and discussion on paper #2 “Attributing a fraction of climate change to a nation's historical emissions: closure and scientific uncertainty” (Michael Prather)	0.5h
11:00	Coffee Break		30'
11.30- 12.30	Chair: Joyce Penner	Short 5-10 minutes presentations of new work since the last meeting by the experts present. - Ian Enting: Sensitivity functions and uncertainty analysis - Jan Fuglestvedt: GDP and population weighted / transport / application - Ben Matthews: Calculations and plans of the Java Climate Model - Maria Silvia Muylaert: Activities at IVIG - Guoquan Hu: Calculations of historical responsibility - Mathias Friman: Historical responsibility history in climate change negotiations - Niklas Höhne: Data set on historical emissions per country - ...	1h

12.30 – 13.00	Chair: Jan Fuglestedt	General discussion on future work - A paper to update previous papers with detailed results on contributions to climate change including various time scales, uncertainties per region, finer resolution of sources (countries, inside countries or over sectors) and other issues. - A paper concentrating on historical emissions and uncertainties from land use change. - A paper on the ethical and equity aspects of historical responsibility (could also be included in first paper) with a qualitative discussion of the scientific and methodological choices from an equity point of view. - ...	0.5h
13.00	Lunch		1h
14.00 – 15.30	Chair: Jan Fuglestedt	General discussion on future work (continued) Setting up small groups	1.5h
15:30			30'
16:00- 17:30	Chair: Various	Discussion on future work in small groups per topic producing - list of lead authors - draft outline - time line with tasks	1.5h
17:30	End		
19:00	Dinner Malzmühle		

Tuesday, 28 November 2006

9.00 - 11.00	Chair: Jan Fuglestedt	Discussion on future work in full group - Report back from the subgroups	2h
11:00	Coffee Break		30'
11:30 – 13:00	Chair: Various	Discussion on future work in small groups per topic (continued)	1.5h
13:00	Lunch		1h
14:00 – 15:00	Chair: Joyce Penner	- Stocktaking - Work plan - Decision on next meeting - Distribution of tasks	1h
15:00	End		

Tuesday, 28 November 2006 Scientific coordination committee only

15.30 – 16.30	Chair: Jan Fuglestedt	Meeting of the scientific coordination committee	1h
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ANNEX B: PARTICIPANTS OF THE MEETING

Ana Claudia Nioac de Salles	Federal University of Rio de Janeiro, COPPE/UFRJ, Brazil
Atsushi Kurosawa	The Institute of Applied Energy, Tokyo, JAPAN
Ben Matthews	Université catholique de Louvain, Louvain la Neuve, BELGIUM
Christiano Pires de Campos	Petrobras, Brazil
Cinzia Losenno	DEFRA, Global Atmosphere Division, UK
Guoquan Hu	National Climate Center, China Meteorological Administration, China
Ian Enting	The University of Melbourne, Australia
Luiz Pinguelli Rosa	Federal University of Rio de Janeiro, COPPE/UFRJ, Brazil
Malte Meinshausen	Potsdam Institut für Klimaforschung, Germany
Maria Silvia Muylaert de Araujo	Federal University of Rio de Janeiro, COPPE/UFRJ, Brazil
Martina Jung	Ecofys Germany
Mathias Friman	University of Göteborg, SWEDEN
Norichika Kanie	Tokyo Institute of Technology, Japan
Scientific coordination committee	
Michael Prather	University of California at Irvine, USA
Jan Fuglestedt	CICERO Centre for Climate Research, Norway
Jason Lowe	Met Office Hadley Centre for Climate Prediction and Research, UK
Joyce Penner	University of Michigan, USA
Michel den Elzen	Netherlands Environmental Assessment Agency, RIVM, National Institute for Public Health and the Environment, The Netherlands
Maria Silvia Muylaert de Araujo (for José Miguez)	Federal University of Rio de Janeiro, COPPE/UFRJ, Brazil
Niklas Höhne	Ecofys Germany

ANNEX C: DRAFT WORKPLAN

Possible Workprogramme of MATCH

Niklas Höhne
Draft 22 November 2006

The objective of the paper is to stimulate a discussion prior and at the November MATCH meeting. All issues mentioned here are up for discussion, no decisions have been made on the work plan so far.

1. Timeline

The SBSTA in May 2006 agreed that the scientific community should submit its final work on contributions to climate change by 30 October 2007. This basically leaves 1 year to complete the work with the following proposed schedule:

- **MATCH Meeting** in November 2006 to plan work
- **MATCH Meeting** in May 2007 to report progress
- **MATCH Meeting** in September 2007 to finalize work
- **MATCH Workshop** in September 2007 to present MATCH work to broader audience
- Submission of the **final report** to SBSTA in October 2007
- In-session **special side event** at SBSTA 27 (December 2007) to present the work to UNFCCC delegation
- Countries submit their views on the matter by 7 March 2008
- SBSTA agreed to complete the consideration of this agenda item once the scientific work is sufficiently completed, and indicated that it would like to be able to do this finally at SBSTA 28 (June 2008) or soon after.

This following list is long and it may be overambitious to attempt to finalize all issues by October 2007. We therefore have to be very selective, focused and realistic in our choice of topics.

2. Possible paper on “contributions to climate change” as update of paper #1

Content / outline

The purpose of this paper is to present an update of paper #1. Paper #1 focussed on the effect of different scientific and methodological choices. Together with paper #2 we now have an overview, which of the choices have a large influence and which choices have a small influence. The new paper could give more numerical detail (i.e. per country and sector) for the most important choices. We would leave out the choices that do not make a large difference. The focus would therefore be on providing numerical estimates of the historical responsibility that can be used in the future. The approach is pragmatic and result-oriented as opposed to comprehensive and all encompassing. [Comment: This is a suggestion and can be discussed at the meeting.]

Step 1:

Prepare one emission dataset for countries

- For (most important) individual countries
- For CO₂, CH₄, N₂O, (F-gases)
- For the sectors

- Energy industries and industrial processes
- Transport (?)
- Agriculture/Waste (non-CO₂)
- LUCF
- From 1750 to 2004
- For each emission estimate (per gas, sector and country) a best estimate, an upper and lower bound (using simple assumptions about the uncertainty, e.g. +/- 10% for each year in the time series based on paper #2)

Such datasets (without uncertainty) already exist: The Java Climate Model (Ben Matthews) and Ecofys (Niklas Höhne) have developed datasets on individual countries, scaling back regional data to country level.

Step 2

[One model group] [Any interested model group] calculates relative and absolute contributions to climate change in all permutations of the following:

- Indicators (2)
 - Cumulative GWP weighted emissions
 - Temperature increase in 2004
- Start dates (3)
 - 1750
 - 1900
 - 1990
 - 2050 (?)
- Sectors and gases (2)
 - All sectors and gases excluding LUCF
 - All sectors and gases including LUCF
- Emissions (3)
 - Lower bound
 - Best estimate
 - Upper bound
- Sources (192+4)
 - All separate individual countries
 - All globally aggregated sectors

Step 3:

Compilation of data in one dataset, analyse it and present it in the paper.

Responsibilities and timeline

Lead author: ...

Authors: ...

Task	Responsible	Deadline
1. Preparation of emission dataset	Niklas Höhne, ...	1. January 2007
2. Preparation of model runs	?	1. March 2007
3. Compilation of data	Niklas Höhne,...	1. April 2007
4. Writing of the paper		First draft May 2007 Final draft for submission September 2007

3. Possible paper on historical emissions and uncertainties from land use change

Content / outline

In preparing earlier papers we have learned that emissions from LUCF (historical and present) are particularly difficult to estimate. Several estimates are available and they do not necessarily correspond.

The purpose of this paper is compare all available estimates of historical and current emissions from LULUCF and derive an uncertainty range per country.

Possible sources:

- MATCH paper #1
- MATCH paper #2
- Work of Christiano comparing different datasets of LUCF emissions
- IPCC AR4
- ...

Step 1

Compilation of emission estimates from LUCF in one database

Step 2

Analysis and explanation of the differences

Step 3

Derive an indicative uncertainty range per country

Step 4

Writing of the paper

Responsibilities and timeline

Lead author: ...

Authors: ...

Task	Responsible	Deadline
1. Compilation of emission estimates	...	1. January 2007
2. Analysis and explanation of differences	...	1. March 2007
3. Derive indicative uncertainty range	...	1. April 2007
4. Writing of the paper		First draft May 2007 Final draft for submission September 2007

4. Possible paper on the ethical and equity aspects of historical responsibility

Content / outline

So far MATCH papers have only covered the quantitative aspects of historical responsibility and have not covered the interpretation of the results as in the light of equity.

Possible sources:

- White Paper on the Ethical Dimensions of Climate Change, <http://rockethics.psu.edu/climate/whitepaper-intro.htm>
- ...

A new paper could cover the following aspects:

1. Historical responsibility in general

A literature review on how historical responsibility, not only for climate change, is treated.

2. Historical responsibility on the climate negotiations

An overview of how historical responsibility has been treated in the climate negotiations (reference to agreed text of the Framework Convention and the Kyoto Protocol and related decisions)

3. Interpretation of the quantitative results

Several aspects are important to consider, when interpreting the results. The paper would describe these issues and provide recommendations, where possible, on possible interpretations. The issues include:

- *Non-linear climate system:* The climate system is not linear. For example for the saturation effect of CO₂ in the atmosphere, this means an emission today has less effect than the same amount of emissions 50 years ago. The current effect is due to earlier emissions of others. A decision to use a complex system with non-linearities and feedbacks or to use a simplified linear system is therefore not only a technical, but also a political question, which should be taken with care.
- *Technological development:* Technology develops and late emitters benefit from the technology development of early emitters. The contribution to climate change of countries that are developing later is likely to be lower than that of countries that have developed earlier. Even if a country that is today a 'developing country' will reach the same level economic development as a country that is today an 'industrialized country', the developing country's per-capita contribution to climate change will be lower than that of the industrialized country.
- *Long time scales and geographical borders:* Due to the long residence time of CO₂, time horizons in the order of 100 years are relevant for historical contributions. How can one treat the fact that geographical borders of countries change with time, including colonies?
- *Imports and exports:* Many countries, in particular developing countries, produce emission intensive commodities that are then exported to couter countries. Currently emission inventories are based on the principle that emissions are accounted where they occur, so e.g. in the steel producing not in the steel consuming country.

- *Size*: Historical responsibility could be displayed in many ways. Total contribution, related to (current or past) population or GDP. How can it be displayed in a meaningful way?

4. Conclusions

General lessons from the above.

Responsibilities and timeline

Lead author: ...

Authors: ...

Task	Responsible	Deadline
1. Historical responsibility in general	...	1. January 2007
2. Historical responsibility on the climate negotiations	...	1. March 2007
3. Interpretation of the quantitative results	...	1. April 2007
4. Writing of the paper		First draft May 2007 Final draft for submission September 2007

ANNEX D: PAPER #3

Tuesday 27 November 2006 after small group discussions

Possible paper on “contributions to climate change” as update of paper #1

Content / outline

The purpose of this paper is to present an update of paper #1. Paper #1 focussed on the effect of different scientific and methodological choices. Together with paper #2 we now have an overview, which of the choices have a large influence and which choices have a small influence. The new paper could give more numerical detail (i.e. per country and sector) for the most important choices. We would leave out the choices that do not make a large difference. The focus would therefore be on providing numerical estimates of the historical responsibility that can be used in the future. The approach is pragmatic and result-oriented as opposed to comprehensive and all encompassing. [Comment: This is a suggestion and can be discussed at the meeting.]

NEW:

Finer resolution

Sectors

Uncertainty

History and future

Step 1:

Prepare one emission dataset for countries

- For all available countries
- For CO₂, CH₄, N₂O, HFCs, PFCs, SF₆
- For the sectors
 - Energy and industry (CO₂, CH₄, N₂O)
 - Agriculture/Waste (non-CO₂)
 - LUCF
- From 1750 to 2100
- Future estimates based on regional growth rates (Michel will check whether downscaling method of MNP can be used)
- For each emission estimate (per gas, sector and country) a best estimate (50th percentile), an upper and lower bound (10th and 90th percentile) using simple assumptions (per gas, sector and country, time, dataset)
 - Based on IPCC inventory guidelines as default
 - Informed by paper#2
 - Consistency
 - Increasing backwards in time
- First uncertainty rules

16th and 84th percentile (one sigma):

	CDIAC 1750 – 2003	Edgar/Hyde 1890-1990	Houghton /IVIG	IEA 1970- 2003	USEPA 1990- 2000	UNFCCC 1990 to 2004
Energy and industry CO ₂	+/-10%			+/- 10%		+/-5%
Energy and industry CH ₄ /N ₂ O		70%			+/-75%	+/-50%
Agriculture/Waste CH ₄		Factor 2			+/-50%	+/-35%
Agriculture/Waste N ₂ O		Factor 7			Factor 6	Factor 4
LUCF			See below			

Paper by Oliver/Marland on comparing CDIAC and EDGAR
LUCF: IVIG and Houghton 1750 to 2004, Max, Average, Min
Ben to provide LUCF data

As tab delimited

Country sector (energy, agri, LUCF, total) gas (CO₂, CH₄, N₂O) time (1750-2004)
uncertainty (high, best, low), scenario (A1b, A1fi, A1t, A2, B1, B2)

Step 2

Any interested model group: Ben, Jan, Niklas, Guoquan, Ian (Michel, Jason)
calculate contributions to climate change in all permutations of the following:

- Contribution (2)
 - Relative (always divide by the best value for all other countries)
 - Absolute
- Indicators (3)
 - Cumulative GWP weighted emissions (fixed Kyoto GWPs, calculated only by one group)
 - Temperature increase at end year
 - Temperature increase at 2100
- Start dates (4)
 - 1750
 - 1900
 - 1950
 - 1990
- Enddate (3) (Ben/Jan)
 - 2004
 - 2020
 - 2050
- Sectors and gases (2)
 - All sectors and gases excluding LUCF
 - All sectors and gases including LUCF
- Emissions (3) (default is that uncertainties are independent. Optional: link uncertainties to observational constraints)
 - Lower bound
 - Best estimate
 - Upper bound
- Sources (192+3) (less countries?)
 - All separate individual countries
 - All globally aggregated sectors (Ben/Jan)

Attribution method is up to modelling group. But recommended method: normalized marginal, i.e. calculate a very small perturbation and scale the output to the relative share of countries emissions for every year. Ian to clarify
 Model: take 3°C as climate sensitivity, i.e. $\lambda = dT/RF = 3K/3.71Wm^{-2}$

Whether to fix the total observed concentration is up to the modelling groups.

Reporting template: tab delimited one dimensional table

Step 3:

- Compilation of data in one dataset
- Analyse it automatic finding of interesting cases?
- Present data
 - Per capita? In histogram see Ben?
 - Uncertainty per country
 - Ratio of current emissions and historical responsibility?
 - Analysis per most interesting country?
- Write paper

	History	Future	Future/sectors
Uncertainty	Ben, Niklas, Ian, Guoquan	Ben, Guoquan	
No uncertainty	Jan, Jason	Jan, Jason	Jan?

Responsibilities and timeline

Lead author: Niklas Höhne, Ian Enting, Ben, Jan

Authors:

Interested: Ben, Chris, Ian (lead the group discussion), Atsushi, Gouquan, Jan, Ana Claudia, Jason, Malte, Niklas, Norichika, Mathias, Helcio

Task	Responsible	Deadline
Provide country template to Ben	Niklas	Now
Provide clarification email on attribution method and uncertainty analysis	Ian	Now
Provide LUCF historical and future data	Ben	Now
Provide emission data without LUCF without uncertainty	Niklas	5 December
Draft outline	Niklas, Jan, (Ian)	2. Jan
Preparation of emission dataset, prepare rules for uncertainty, liaison Paper B	Niklas Höhne, Atsushi Kurosawa, Ana	2. January 2007
Template for model outputs	Niklas Höhne	2. January 2007
Model runs	Ben, Jan, Niklas, Guoquan, Ian (Michel, Jason)	1. March 2007

Compilation of data	Niklas Höhne,...	1. April 2007
Writing of the paper	Special issues written by those that are doing the calculations Lead: Niklas, Ian, Ben, Jan	First draft May 2007 Final draft for submission September 2007

ANNEX E: PAPER #4

Paper on historical emissions from land use change (MATCH Paper #4)

Content / outline

In preparing earlier papers we have learned that emissions from LUCF (historical and present) are particularly difficult to estimate. Several estimates are available and they do not necessarily correspond.

The purpose of this paper is to compare available estimates of historical and current emissions from LULUCF and identify the reasons for the differences in estimates (see Table 1 for a list of sources of LULUCF estimates) obtained in order to derive an uncertainty range. This will be done for Annex I-R countries, a selection of countries for which data from UNFCCC reporting is available: Brazil (1990-1994), Indonesia (1994), China (1994), USA, (Canada?) as well as for global estimates. The following outline is result the discussion in the break-out group meetings and will have to be further elaborated.

Table 1: Available data sources on LULUCF emissions

UNFCCC Reporting	Inverse models LUCF	Forward models LUCF		
Annex I-R		EDGAR 2.0	Country	1990
USA		EDGAR 1.3	Region	1890/1990
Canada?		EDGAR 1.3 MATCH	Region	1890/1990
Brazil		EDGAR 3.2	Country	1990&1995
China		EDGAR 1.4	Region	1890/1990
Indonesia		EDGAR 3.2FT	Country	2000
		IVIG 01	Country	1700/1990
		IVIG32	Country	1700/2002
		CDIAC	Regions	1850/2001
		CAIT	Country	1950/2000

In a first step, potential factors responsible for the differences in estimates of LULUCF emissions are identified. These factors (characteristics and assumptions of datasets and models) will then be analysed and compared in a systematic manner. Among the factors analysed, carbon pools (above ground, below ground, soil carbon, etc.) and activities/processes/land use types (deforestation, regrowth, etc) considered in respective models and datasets will be assessed (see Table 2 and 3).

Table 2: LULUCF pools considered by different models/datasets

Carbon pools	FCCC	Edgar	Houghton (CDIAC, CAIT)	IVIG32	ISAM
Organic Soil carbon					
Above ground carbon			X	X	X
Litter					
Below ground carbon					
Below and organic			X	X	X
Global, regional?					

Table 3: Area change in ha/year for 1990s for Annex I (Brazil?, China ? etc.)

Processes/ Brazil	FCCC	Houghton (regions)	Edgar	IVIG (Hyde)	FAO	Ramakutti and F.
forest to pasture/agriculture (deforestation)	x	X	Not.applicable	x	Check (net change)	Just to agriculture
Grassland to pasture/agriculture	x	X		x		Just to agriculture
Pasture to agriculture		X		x		
Wetlands	x					
....						

Further research and input by authors will determine the final list of factors looked at, though. The year 1990/1994 will serve as a reference year since data is available for this year in all the estimates. If possible, land use changes from land use category x to land use category y, expressed in ha/year for the 1990s, and CO₂ emissions due to land use change (per category) will be extracted from the different models/datasets². Summarising this information, we will provide an overview of the estimates of yearly net emissions in the 1990s from the different models/datasets (as shown in Table 4) and derive uncertainty estimates (for the year 1990) based on the insights obtained through our analysis.

Table 4: Net CO₂ emissions in 1990s

Region/Country	FCCC	Our models	Other model (Houghton, ISAM etc.)	AR4	Uncertainty ? (our own estimate)
Annex I-R	X				
USA	X				
Brazil etc.	X				
Other regions		X	x	x	
global etc.		X	x	x	

² For this, we will have to rely on input from the authors of the models.

A final graph will then plot CO₂ emissions over time for the different models and datasets for the USA, China, Indonesia and Brazil, using our uncertainty estimates.

List of potential authors/co-authors:

Name	To be contacted by (until beginning of January)	Affiliation
Richard Houghton		Woods Hole Research Center
Omar Masera Cerruti		Centro de Investigación de Ecosistemas, Mexico
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Silvia Muylaert	-	COPPE/UFRJ, Brazil
Martina Jung		Ecofys, Germany

Timeline and further steps

- Potential authors will have to be contacted as soon as possible (latest by January)
- One or two lead authors will have to be identified
- Assignments have to be given to different authors by the end of January