Meeting report of the ad-hoc group for the modelling and assessment of contributions of climate change (MATCH) 6-7 May 2004

14 July 2004

Prepared by Simone Ullrich and Niklas Höhne

Contents

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 (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), a third expert meeting was held on the initiative of the governments of UK, Brazil and Germany. In August 2003, the UK Department for the Environments (DEFRA) commissioned Ecofys to provide administrative, secretarial and scientific assistance as 'support unit' for the process until the end of 2005.

During the third 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 6/7 May 2004 in Cologne, Germany. It was drafted by Simone Ullrich and Niklas Höhne, Ecofys, Germany and reviewed by the participants of the meeting.

The agenda of the meeting (see Annex A) consisted of three major parts. First, the Scientific Coordination Committee discussed organization aspects of MATCH. Second, authors presented the current status of the development of a first scientific paper titled: "Analysing countries' contribution to climate change: Scientific uncertainties and methodological issues", anticipated as an outcome of stream B (see report third expert meeting). Third, experts discussed themes of three additional scientific papers and the content of paper #2 that should be prepared by November 2005 in order to complete the scientific discussions under MATCH (summarized in section 3 of this report). All presentations are available on the web site www.match-info.net.

The meeting was organized by Ecofys, who had sent the invitations to the participating organizations and individuals and uploaded all information of the meeting on the MATCH website. 20 Participants attended the meeting (see Annex B).

2. ISSUES

2.1 ORGANIZATIONAL ISSUES DISCUSSED IN SCC

The Scientific Coordination Committee (SCC) met on Thursday morning and Friday lunchtime and discussed the following issues: (A) Chairmanship: Michael Prather was affirmed as chair by the members of the SCC and accepted the chairmanship. (B) Review of funding for experts from developing countries (DC): The SCC members discussed funding criteria and agreed that funding should be reserved for experts from developing countries, who are able to contribute as co-authors to drafting and the development of scientific papers. Funding will be according to UNFCCC practice and include travel and subsistence costs for those experts to attend expert meetings within the framework of MATCH.

2.2 INVOLVEMENT OF OTHER ORGANIZATIONS

Ecofys has invited a range of interested organizations to attend and observe the meeting that either participated in earlier expert meetings or whose work is linked to MATCH activities. Replies were received from WCRP and but not from IPCC, IHDP, IGBP.

WCRP replied in April and apologised for not sending a representative to the meeting. WCRP indicated that the ad-hoc group MATCH seemed to be already suitably organized and implemented at an international level, which would not require the formal involvement and support of the WCRP. Some concern was expressed regarding the need for a clear description of the uncertainties and limitations of current planned steps under MATCH; e.g. the need to fully consider aerosols, chemical feedbacks, and non-linearities to achieve scientific outputs suitable for peer review, publication and ultimately assessment, where appropriate, under IPCC, SBSTA itself, or other bodies. In general, it is felt that the current organization of the ad-hoc group MATCH should be appropriate for achieving this.

2.3 SCOPE OF MEETING AND DISCUSSION

The chair highlighted that the MATCH is a scientific group and thus aims to develop outputs that are scientifically based, defensible and inclusive, the latter referring to the involvement of all potential scientists worldwide that can contribute to the MATCH process. The group aims at producing new science that otherwise would not have been undertaken, to build new scientific synthesis and understanding relevant to the Brazil Proposal, to provide background material and information to interested stakeholders and decision makers, and to publish peer-reviewed papers in scientific journals.

The participants agreed that several scientific papers should be produced by MATCH and submitted to scientific journals for publication. Discussion during the meeting clarified that in total four scientific peer reviewed papers could be produced before the end of 2005 (see section 3 for detail on discussion of paper #1 and #2), a deadline for reporting MATCH progress to SBSTA 23.

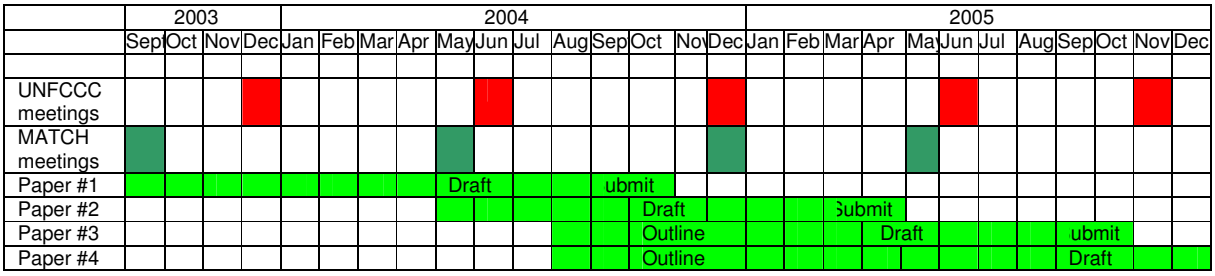
Paper #1 will look at the topic: “Analysing countries’ contribution to climate change: Scientific choices and methodological issues”. A draft of this paper was presented and discussed at this meeting (see section 3.1).

Paper #2 is anticipated to cover: “Demonstration of credible alternative scientific choices and their effect on the emissions, concentration and climate change”. For detailed discussion see section 3.2.

Paper #3 will provide a: “Formal assessment of uncertainties and clarify parameter space, that should be covered.

Paper #4 will repeat elements and attribution calculations discussed in paper #1 by including the outputs from paper #2 and paper #3.

The participants agreed on the following tentative work plan through 2005.



Paper #1 should be completed in September 2004 and submitted for peer review to journals such as Journal of Climate, Climate Research, Journal of Geophysical Research or Climatic Change. It is anticipated that the paper will become public by end of 2004 prior to COP10, although publication would depend on the conditions set out by the scientific journal. A draft version of paper #2 as well as an outline for paper #3 and paper #4 is due in October 2004 to serve as discussion material for the fifth expert meeting.

2.4 REPORTING TO THE UNFCCC

The ad-hoc group MATCH will inform the SBSTA at its 20th meeting in Bonn on the work in progress of MATCH. Michel den Elzen, Xiaosu Dai and Niklas Höhne will represent MATCH at the SBSTA side event scheduled for 21 June, 7 to 9 p.m. Niklas Höhne will present the history of the ad-hoc group, its current and anticipated activities. Michel den Elzen will inform the SBSTA about the content of paper #1. Xiaosu Dai will provide concluding remarks.

At SBSTA 23, which will take place at the end of 2005, MATCH will further inform the SBSTA.

2.5 NEXT MATCH MEETINGS

It was agreed that the next MATCH meeting should be held prior to COP10. Jose Miguez offered that Brazil could host the meeting at the University of Rio de Janeiro or in Sao Paulo in week # 49 (29 November to 3 December) preferably on 2/3 December provided that no important meeting in the week prior to COP10 are scheduled. If not held in Brazil, the meeting could be scheduled in week #47 (15 to 19 November) at a different location.

Between May 2004 and November 2005 authors of paper #1 to #4 may meet in smaller groups to focus work on the content of the papers. Date and locations were

not agreed yet but will be decided individually by the lead authors of the individual papers and the participating co-authors. The progress on the papers and the meetings will be communicated to all members of the ad-hoc group. These author groups are voluntary and self-funded except for the possible funding of DC co-authors.

2.6 FUNDING

Funding constraints of the work done by the voluntary scientific ad-hoc group MATCH remains a big issue and a potential bottleneck for slowing down the entire process of finalising paper #1 to #4 as anticipated in the work plan.

Funding is not only necessary for securing sufficient involvement of developing country experts in the process to ensure the scientific outcomes are inclusive. Developed country experts also need financial support for modelling and contributing to the development of scientific papers and clearly expressed the need during the meeting. The chair encouraged all participants to finding additional solutions and recommended to report back to the support unit (Niklas Höhne) with potential ideas of how to locate additional funding.

Ideas were expressed to bring the MATCH process to the attention of the Executive Director of UNEP to explore whether travel and other support could be provided from running programmes on climate change at UNEP.

Recently, three governments, namely UK, Norway and Germany have provided support for DC country expert participation under the condition that these experts are contributing to the development of the scientific papers. Funding is now available to support a total of 18 international travels of DC experts that meet this requirement; three experts were funded for this meeting.

Another idea was expressed that the team could make use of corporate sponsorship for financing DC experts. The team should explore opportunities with the developers of software tools, such as MathCAD, that would be willing to provide scientist with the software tool. Access to scientific and technical journals could also be provided.

2.7 IDENTIFYING ADDITIONAL EXPERTS AND AUTHORS

In order to put in place an inclusive process of preparing the scientific papers, additional authors need to be identified and invited to contribute to the content of the papers. The chair urged everybody to think about potential co-authors and to report to the support unit (Niklas Höhne) names, in particular for the development of the new papers (#2, #3 and #4).

2.8 WEBSITE / FORUM / MAILING LIST

The participants agreed that all presentations delivered during the fourth expert workshop will be downloadable from the website. Any new scientific papers on the issue are welcome to be put on the web site.

It was decided at the meeting that e-mail mailing list(s) would be more suitable to be used as information channel than the discussion forum, which is currently on www.match-info.net. Ecofys will explore if such mailing list(s) can be organised that would also allow participants and stakeholders to readily sign-on or sign-off from

such lists. If such e-mail mailing lists can be established at Ecofys, new experts and interested stakeholders should be included, as they will request to be put on the list.

3. DISCUSSION OF PAPERS

3.1 PAPER # 1: METHODOLOGICAL ISSUES

On day one of the meeting, a first draft of paper #1 ("Analysing countries' contribution to climate change: Scientific uncertainties and methodological issues") was presented and discussed, which was prepared by Michel den Elzen, Jan Fuglestvedt, Niklas Höhne, Cathy Trudinger, Ben Matthews and Bård Romstad. The draft of this paper results from activities defined in stream B of MATCH (see third expert meeting report for more details) and is available on the MATCH website.

Michel den Elzen introduced the draft paper. The central question of this paper is to assess how robustly can the existing simple climate models be used to attribute anthropogenic climate change to sources of well-mixed greenhouse gases (e.g. regions) and what effect have uncertainties in emissions, parameter choices, model formulations, as well as methodological and policy-related choices on this attribution.

He also presented the impact of choosing different timeframes on the relative attribution, e.g. setting the attribution start date, the attribution end date and the evaluation date. He further presented the impact choosing different emissions data sets for historical emissions.

The audience noted that the choice of scenarios has a policy-related component. The presenter concluded that the modelling uncertainties are rather small compared to the policy uncertainties. It was discussed whether it is necessary to use different datasets of land-use change emissions, as these are substantially different.

Niklas Höhne presented choices of climate changes indicators: radiative forcing, GWP-weighted cumulative emissions, weighted concentrations, temperature increase, integrated temperature change and sea level rise. The audience discussed, whether an additional indicator should be introduced: the equilibrium temperature rise, under the condition that elevated concentrations stay stable at current levels. It was mentioned that attention should also be paid to damage functions, which are highly non-linear.

Cathy Trudinger explained methods that can be used to attribute non-linear effects to individual causes. The marginal method, the residual method and the time-sliced method are to be further analysed in the paper. She highlighted that the choice of an attribution method has a policy-related and a scientific component. To date there is no clear consensus on which attribution method is best from the scientific point of view.

Cathy Trudinger also presented the impact of choosing different representations of the carbon cycle on the relative attribution.

Jan Fuglestvedt presented the effects of including different (greenhouse) gases and SO_2 for the attribution and also discussed the issue of ozone precursors and tropospheric oxidation capacity.

Ben Matthews Ben Matthews presented the attribution of climate change with the Java Climate Model (JCM), comparing the impact of uncertainty on relative and absolute attribution. He presented his ideas to illustrate "relative" uncertainties by using a probabilistic approach combining many sets of parameters (although this approach has not yet been applied to this type of study, paper #1). The presentation and discussion concluded that the content presented could fit better in paper #3 since one could look in more detail at implications of uncertainties on methodological choices.

A new version of paper #1 will be prepared by September 2004 and will be submitted for peer review after internal review of MATCH. The potential importance of adding more scientific contributions, including developing country co-authors, to paper #1 was discussed, and the current authors are working on this over the summer. .

3.2 PAPER # 2: ALTERNATIVES FOR SCIENTIFIC CHOICES

On day two of the meeting, potential titles of paper #2 #3 and #4 were presented and paper #2 discussed in more detail.

Jason Lowe presented his current thinking on preparing paper #2 that aims at demonstrating credible alternative scientific choices and their effect on the absolute emissions, concentration and climate change thus addressing the credibility of the tools and datasets used in MATCH process. Paper #2 should bring together and list credible parameter and dataset choices based on current knowledge (e.g. emissions, concentrations, temperature and other validation data sets such as ocean heat uptake for instance), and investigate the effects of the parameter choices.

Questions this paper might try to answer can be summarized as follows:

i) What are the effects of alternative choices for emissions on absolute values?
ii) Are our emissions choices and chemistry models consistent with concentration and forcing datasets?
iii) Are the ranges of radiative forcing consistent with temperature (and ocean heat uptake) records?
iv) Can we highlight choices that are inconsistent with the data?

Jason stressed that the paper would need input on

i) Choice of parameters and datasets to test
ii) Validation data (observations, GCM results)
iii) Use of (at least one) suitable simple climate model

Michael Prather presented a first draft outline of the content of paper #2, which in general was agreed upon in principle by the participants but is likely to change during the drafting. The draft can be found in Annex C.

A first draft of the paper should be completed within the next in 6 months (draft completed by October 2004). Lead authors will be Michael Prather (responsible) and Jason Lowe. The following authors have agreed to contribute to the paper as follows:

- Climate models: Jason Lowe, Atul Jain
- Carbon cycle: Atul Jain
- Chemistry / Ozone: Michael Prather, Jan Fuglestvedt
- Aerosols: Joyce Penner, Murari Lal

- National / regional emissions: Fabian Wagner, Atsushi Kurosawa (check with UNFCCC inventories)

In order to extend participation of the development of paper #2, the team agreed to contact the following scientist to invite them into the process.

- Betts, C4MIP: to be contacted by Jason Lowe
- Experts from Tyndall: to be contacted by Rachel Warren
- Experts from Brazil: to be contacted by Maria Silvia Muylaert
- Experts from EDGAR, e.g. John van Aardenne / Jos Olivier: to be contacted by Michel den Elzen
- Experts from CDIAC, Greg Marland: contact person not yet defined
- Expert in land use change emissions: Houghton: contact person not yet defined,
- Expert on aerosol emission inventories Smith, Novakov, Tenborn, Tami Bond: to be contacted by Joyce Penner
- Expert on aerosols: Gunnar Myrhe: to be contacted by Jan Fuglestvedt
- Expert on carbon cycle Fortunat Joos: to be contacted by Rachel Warren
- Expert on simple climate models Sarah Raper: to be contacted by Jason Lowe

Ben Matthews agreed to liase with the authors of paper #2 since the work to be done can be linked into the plan for paper #3.

It was discussed whether to model according to the top down or bottom up approach. The proposed paper #2 would from a bottom up basis use atmospheric chemistry models and historical emissions to calculate the impacts, without tuning the results to observations. The top down approach would start from the observations and tune the input parameters to fit the observations. It was mentioned that most models probably combine both approaches. It was agreed that this issue should be discussed in the paper.

3.3 ADDITIONAL SCIENTIFIC PRESENTATIONS

Christiano Pires do Campos presented “System dynamics modelling of ACCC & Database analysis”. He started with a presentation of the structure of the model and summarized and analysed land use change CO_2 datasets (EDGAR, Houghton, IVIG). He used two alternative datasets for land-use change emissions, which are significantly different to that of EDGAR used in paper #1. It was agreed that the impact of different land used datasets should be further studied.

Atul Jain presented “Modelling the combined effects of CO_2 climate and land use on the Carbon Stocks of plant and soil” using the ISAM model. He derived grid based historical emissions from land use changes since 1750.

3.4 PAPER #3 AND #4:

Detailed outlines for papers #3 and #4 as well as their schedules were not discussed at the meeting. Outlined for both papers will be prepared prior to the next expert meeting. Scientists were identified at the meeting who could possibly contribute to the papers.

For paper #3 “Formal assessment of uncertainties and clarification of parameter space to be covered”, Ben Mathews, Ian Enting and Cathy Trudinger could have a leading role in drafting an outline of this paper until the next meeting. Additional potential co-authors will be approached following the fourth expert meeting.

For paper #4 “Repeating elements and attribution calculations discussed in paper #1 by including the outputs from paper #2 and paper #3”, Niklas Höhne agreed to take the lead and will be supported by Ben Mathews in drafting an outline of the paper until the next meeting. In addition some of the experts involved in paper 1 should also contribute to paper 4. Further details will be discussed during the next months.

APPENDIX A: AGENDA

AD HOC GROUP FOR THE MODELLING AND ASSESSMENT OF CONTRIBUTIONS OF CLIMATE CHANGE (MATCH)

6-7 MAY 2004, COLOGNE GERMANY
TECHNOLOGIE PARK KÖLN, EUPENER STRAßE 161, COLOGNE, ROOM "FUTURE 1"

Day 1: Thursday, 6 May 2004

8:00 – 9:00	Chairs: Michael Prather, Niklas Höhne	Scientific Coordination Committee Meeting - Chairmanship of the SCC - Review of the agenda of the workshop in light of the preparatory work - Update on funding for developing country experts - Expansion of the SCC re emissions	1h
9:00 – 9:30	**Registration**		
9:30 – 11:00	Chair: Michael Prather	- Welcome - Quick review of timelines (SBSTA), tasks, goals of MATCH - Review of our project list & long-term work plan - News from the Scientific Coordinating Committee	1.5h
11:00	**Coffee Break**		**30'**
11:30– 13:00	Chair: Michel den Elzen	Overview, summary of draft paper on methodological issues (task #1) "Analysing countries' contribution to climate change: uncertainties and methodological issues"	1.5
13:00	**Lunch**		**1h**
14:00 –15:30	Chair: Michel den Elzen	Discussion of the draft paper on comparison of modelling results - Discussion of the outline - Discussion of the model results - Discussion of the main conclusions - Discussion of the further process - Distribution of tasks	1.5h
15:30	**Coffee Break**		**30'**
16:00– 17.30		(Continued)	1.5h
17:30	**End**		

19:00	**Dinner**	

Day 2, Friday, 7 May 2004

9.00 -11.00	Chair: Jason Lowe	Detailed outline and work plan for scientific issues (task#2)	2h
11:00	**Coffee Break**		**30'**
11:30 – 13.00		(Continued)	1.5h
13:00	**Lunch, including brief SCC meeting**		**1:00**
14:00 – 16.30	Chair: Chair of SCC	Closing Stocktaking, Work plan, SBSTA side event , Distribution of tasks until next meeting	1.5h
16:30	**End**		

APPENDIX B: LIST OF PARTICIPANTS

The following individuals attended the fourth expert meeting:

- Atsushi Kurosawa, Japan
- Atul Jain, USA
- Ben Matthews, Belgium
- Cathy Trudinger, Australia
- Christiano Pires de Campos, Brazil
- Fabian Wagner; Austria
- Gregory Bodeker, New Zealand
- Jan Fuglestvedt, Norway
- Jason Lowe, UK
- Jesper Gundermann, Denmark
- José Domingos Gonzalez Miguez, Brazil
- Joyce Penner, USA
- Maria Silvia Muylaert de Araujo, Brazil
- Martin Weiß, Germany
- Michael Prather, USA
- Michel den Elzen, The Netherlands
- Murari Lal, FIJI
- Niklas Höhne, Germany
- Rachel Warren, UK
- Simone Ullrich, Germany
- Xiaosu Dai, China

APPENDIX C: OUTLINE OF PAPER #2 (DRAFT OF 7 MAY)

MATCH Paper #2:
Identifying/Attributing a Fraction of Climate Changes with Specific Emissions: the Range in Scientific Understanding and the Propagation of Uncertainties.
(draft of 7 May 2004, prepared/revised by Michael Prather)

The goal of this paper is to define (by examples) the range in current scientific understanding in going from anthropogenic emissions to changes in atmospheric composition to simple changes in climate (T, quasi-msl=heat uptake or steric sea-level).

1. Simply put, our best models do not always match the observed climate system changes, and this represents a ??large/small uncertainty in attributing a fraction of climate changes to any specific forcing, and in turn to any specific emissions.

2. In addition, the ability to partition the emissions by nation/region is also an uncertainty – based on currently available estimates of national emissions.

3. Questions of additive / non-additive effects will need to be addressed (ref to Task #1 paper) and can include specific species or all emissions from a region. Issues of what activities/emissions can be credited or blamed are NOT a topic here.

4. We intend to synthesize the currently available range of emissions history, atmospheric composition models, radiative forcing models and climate models, and validation data. This study will identify the data and models that represent the range of current scientific understanding.

5. To start the discussion and focus on the most important anthropogenic greenhouse agents (gases and aerosols), take the TAR radiative forcing values from 1750 to 1998. The red values in the table below are highlighted as the focus elements for paper #2.

Table TAR/WGI/Ch.6. 1750 to 1998(present) RF changes

greenhouse agent	RF	uncert or range???
CO2	+1.46	+-10%
CH4	+0.48	+-10%
halocarbons	+0.34	+-10%
N2O	+0.15	+-10%
trop O3	+0.35	+-0.15
strat O3	-0.15	+-0.10
indust sulfate	-0.4	factor 2
biomass-burn	-0.2	factor 3
ff OC	-0.1	factor 3 \\
ff BC	+0.2	factor 2 //consider together
mineral dust	-0.6 to +0.4	
1st indirect	-2 to 0	(biomass and ff)
landuse(albedo)	-0.2	+-0.2
solar	*+0.3*	*+-0.2 ???*

Part 1. Relate total emissions (direct fossil-fuel & land-use change) to global atmospheric composition change (and RF).

1A. CO2 and the carbon cycle. For total CO2 emissions, we have alternative proposals for the history of emissions (ff: EDGAR/IEA, Marland; lu: EDGAR, Houghton, ?others House). For mean atmospheric CO2 we can use a single reconstruction for the past millennium (Francy, Etheridge, ...). We will use one or more C-cycle model from Task #1, and at least one 'state-of-the-art', multi-dimensional complex C-cycle models with climate feedbacks (e.g., interactive vegetation, such as the 3+ models in C4MIP). We will run the different emissions options with one or more 'standard' models to provide an 'envelope' of results for CO2 abundance (which is unlikely to match the observed history. (This avoids the problem of models tuning their choice in emissions to match observations) Add 13-CO2 record as test.

Figure. Compare different CO2 emissions (ff and lu separately) used here

Figure. CO2 observations vs. (i) range in models and (ii) range in emissions from one model.

1B. CH4. We have only one emission model (?EDGAR), but the calculation of CH4 abundance involves some atmospheric chemistry complexities. Will need to assume a parallel scenario for NOx, CO, VOC emissions (EDGAR+natural??). Have different models do their best, plus perform a separate set with one model assuming CH4 budget lifetime fixed (8.4 yr), some CH4 feedback (TAR/WGI/Ch.4); using history of NOx, CO, VOC.

Do we have natural CH4 emissions history? 13-CH4 history (ice core, emissions?)

Figure. CH4 observations vs range in models plus range in assumptions about CH4 lifetime.

[1X – Do we need to add? How important is N2O ?
ref to paper #1. – will need to wait for paper#3 (quantitative uncertainty) **]**

1C. trop O3. Have participating models calculate tropospheric O3 increases (and related RF) for attributable emissions (CH4, NOx, CO, VOC) and compare with a range of published trop O3 RF histories: TAR/WGI/Ch.6 (fig 6.8); TAR/WGI/Ch.4 back projection (w/EDGAR); Mickley et al; Wang?; Portman and Solomon; Berntsen et al., 2000; Oltmans free trop O3 25 yrs; Staehelin historical record, others? The only comparison with observed trop O3 that I would use is the recent (not the connect dots with 1900 obs. at a few stations?). ?Attribution to individual / regional emissions of CH4, NOx, CO, VOC (non-additive issues here) ?

Figure. trop O3 RF history from this range of models and assumptions – plot observations from recent NH trends and possibly pre-ind marker from TAR.

Figure. trop O3 RF history broken into contributing emissions(stacked line) for one/two models.

1D. direct aerosols by group/species (can we treat as separable problem here?)

sulfate. We have at least 3 reconstructions of industrial SO2 emissions, and there are different values for direct RF from these emissions (depends on lifetime, size distribution, etc). Use TAR Ch.5 models to show spread in direct RF for one SO2 emission history, use the 'average' TAR model plus one of the integrated assessment models to show spread in direct RF for different emission histories. [?Observations compared as per TAR Ch.5, ?total optical depth, ?].

Figures. sulfate direct RF, include the range in the 3 emissions scenarios (one model) and also the range in models for a single emission scenario (to be established).

fossil+bio fuel OC/BC. Alternative emissions history from Novkaov (ffuel) + Ito (bfuel), and Bond (ff+bfuel). Propagate through range of TAR/Ch.5 models (assume linear). Observations compared as per TAR.

Figures. OC/BC direct RF, include the range in the emissions scenarios, possibly direct measurements (modern).

1E. indirect aerosols. Can we define an RF history for indirect effects? It will be essential for part 3. Can the D&A studies be used to infer total indirect? vs. bottom-up methodologies.

Part 2. Attribute atmospheric composition change and RF to specific regions and time periods.

2A. Regional CO2. We have regional CO2 emissions for land use from EGAR and Houghton, also the regional fossil-fuel emissions from Marland? and EDGAR. Plot the differences in these, maybe just for a few integrated time periods relevant to this study.
? Are these regional CO2 differences testable with current inversion models, obs.

2B. Other GHGases. Do we want to look at regional emissions of sum of other GHGases? Do we have any alternative viewpoints than EDGAR?

2C. Aerosols. Can we define regional emissions of aerosols/precursors ?

Part 3. Relate history of RF (anthropogenic plus solar plus volcanoes) to temperature record with climate models.

3A. Range & Evaluation of Total RF. Define several total-RF scenarios and compare them. (We must note this is admittedly a 'dumb-down' since most of these full climate model runs include the spatial pattern of forcing, not a simple RF value!). Restrict this to: our own (do we have one?); TAR/WGI/Ch.6; other recent results that include climate ensemble runs (Hansen's SI-2000 (2002); Santer (2003); others? UKMO). Note and discuss other included or not included RF (solar, volcano, strat O3, LU albedo, indirect aerosol). Analysis can examine species-specific RF and total, identify key differences.

We generate "our best range" total RF from our validated components and the range of other components used above (e.g., solar, volcano,..) This could include the integrated assessment models. This range is traceable to specific alternative views, and these alternatives can be mapped on a different T record.

Figure. Compare total RF history used in difference climate simulations and our simple model calculations. ?Do not break down by component (point to TAR/WGI/fig6.6). Put on points/bars for certain periods (e.g., 1998) where work has tried to put together a sum.

3B. Mean surface T. Map RF history onto surface T using: (i) one RF and one full climate model (with its own sensitivity) showing natural, internal variability (repeat of published data, but put all 3? together); (ii) for the 3? total RFs used in full climate models run through a simple model with ? different sensitivity parameters (e.g., 3? distinct T curves); and (iii) with our best range RF crossed with simple model range in sensitivity. Overplot the observed T record with error bars. (The AOGCM runs are credible climate responses to the RF history, and include climate variability, etc., but they are based on systematically different RF history (and of course different inherent climate sensitivity)). Use several different RF histories

propagated through simple, but non-linear climate models to address non-linearity of response (different total RF and different mix of individual components).

Figure. Observed global/hemispheric T plus ensemble runs plus our simple model runs. (may need 2+ figures)

3C. Mean sea level /ocean heat uptake ???(NB only for observed record, late 20th century)

Part 4. Non-Linear effects of regional or chemically interacting species, or regional-RF-to-climate?