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LONG-RANGE TRANSBOUNDARY AIR POLLUTION

Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission for Air Pollutants in Europe (EMEP)
(Twenty-sixth session, Geneva, 2-4 September 2002)
Working Group on Strategies and Review
(Thirty-fourth session, Geneva, 18-20 September 2002)

INTEGRATED ASSESSMENT MODELLING

Progress report prepared by the Chairman of
the Task Force on Integrated Assessment Modelling in collaboration with the secretariat

Introduction

1. This report presents progress in integrated assessment modelling and the preparation of model inputs, with a focus on particulate matter (PM) pollution and urban assessments. It includes the results of the twenty-seventh meeting of the Task Force on Integrated Assessment Modelling, held in Oslo on 13-15 May 2002. Presentations made during the meeting and reports presented can be accessed on the Internet at www.unece.org/env/tfiam.

2. Experts from the Czech Republic, Denmark, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland and the United Kingdom participated in the meeting. Representatives from the Centre for Integrated Assessment Modelling (CIAM), the Chemical Coordinating Centre (CCC), the Meteorological Synthesizing Centre-West of EMEP (MSC-W), the Coordination Center for Effects (CCE), the European Environment

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Agency (EEA), as well as from the Oil Companies' European Organization for Environment, Health and Safety (CONCAWE), the Union of the Electricity Industry (EURELECTRIC) and the World Conservation Union (IUCN), were present. Mr. Rob MAAS (Netherlands) chaired the meeting.

3. The secretariat summarized the developments under the Convention since the twenty-sixth meeting of the Task Force. It highlighted the decision taken by the Executive Body at its nineteenth session concerning the preparation for the review of the Gothenburg Protocol. It also drew attention to the new emission reporting guidelines drafted by the Task Force on Emission Inventories and Projections, which aimed at harmonizing the reporting formats with those of the United Nations Framework Convention on Climate Change. The guidelines would now cover reporting on projected activity data at five-yearly intervals. This change was intended to provide, on the one hand, the tools for better verification of emissions data and, on the other, a basis for scenario development for integrated assessment modelling.

4. The Task Force welcomed the prospect of improved data on projected activities in energy, transport and agriculture. It recognized that there was a possible area of confusion with respect to the difference between current legislation projections (CLE) and current reduction plans (CRP). The guidelines suggested that CLE should be based on national assumptions concerning projected activity levels and considering all legal regulations or other binding measures in place, while CRP should be reported taking into account a Party’s obligations under the protocols. In this context it was important to stress that CLE data should be developed from a bottom-up approach only including legal regulations concerning source-specific measures, but not legal obligations on national emission ceilings. Emission ceilings would determine CRPs.

5. Ms. B. Oudart (France) informed the Task Force about the work of the Expert Group on Techno-economic Issues. A kick-off meeting had been held in Paris on 30 April 2002. The expert group, in collaboration with the Task Force and CIAM would support the application of methodologies to derive the input data on abatement options and costs for integrated assessment modelling. The Centre Interprofessionel Technique d’Etudes de la Pollution Atmospherique (CITEPA) and the French-German Institute for Environmental Research (IFARE) would prepare an overview of existing databases and develop software tools to provide a link between national data and integrated assessment models. Information on the work of the expert group can be found at www.citepa.org/forums/egtei.

6. The Task Force stressed the importance of the work of the expert group underlining the need for data to be used for integrated assessment modelling to be ready before the end of 2003.

I. UNCERTAINTY TREATMENT IN INTEGRATED ASSESSMENT MODELLING

7. The Task Force discussed the outcome of the workshop on uncertainty treatment in integrated assessment modelling held at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg (Austria), 24-25 January 2002. It recognized that, while there was general agreement on the overall conclusions of the workshop and on its usefulness, the assessment of the degree of uncertainty differed. There were different views about the degree of sophistication in integrated assessment modelling that should be adopted in view of these uncertainties.

8. The Task Force agreed to amend the draft workshop conclusions to reflect some of the discussion on the uncertainties in energy projections. It adopted the conclusions of the workshop as amended and decided to annex them to this report.

II. EMISSION AND BASELINE SCENARIOS

9. MSC-W reported on the results of the 2001 emission-data reporting round and the results of the meeting of the Task Force on Emission Inventories and Projections held in Cordoba (Spain) on 6-8 May 2002. It informed the Task Force that a web site (available in June 2002) would give online access via the Internet to the emission database. It would be accessible via the EMEP web site (www.emep.int).

10. In this reporting round, Parties were, for the first time, asked to report particulate matter (PM) emission data. Twelve Parties had reported some emission data on PM, while only some of those provided data on a sectoral or spatial disaggregation. A PM emission inventory for 1995 had been prepared under the Coordinated European Programme on Particulate Matter Emission Inventories, Projections and Guidance (CEPMEIP) and was available at www.air.sk/tno/cepmeip. This inventory was to assist Parties in preparing their inventories. The CEPMEIP inventory would also be used to fill the gaps in the data submitted by Parties for the purpose of EMEP modelling. MSC-W had started to compare the CEPMEIP data with nationally reported data and was preparing a report to the EMEP Steering Body. CIAM would also compare the data reported by Parties with its emission database and discuss any discrepancies with national focal points. Data reviewed by 2003 would provide the basis for integrated assessment modelling.

11. CIAM presented emission projections up to 2020 for the northern hemisphere. The scenario assumes the implementation of current legislation for Europe and East Asia. For North America it assumes, inter alia, the implementation of the ozone annex to the Canada/United States Air Quality Agreement. Data for China are based on the tenth

environmental six-year plan, while South Asian emissions are assumed to be uncontrolled. The analysis does not include Mexico, North Africa or Western Asia. The study concludes that traditional anthropogenic air pollutants (NO_x, CO, VOC, SO_2) are unlikely to grow in the northern hemisphere in next 20 years. Some increase in developing countries would be compensated by significant controls in industrialized countries. Air quality levels will, however, remain above the no-effect levels. While in some industrialized countries the potential for further technical controls after 2010 will be limited, developing countries have started to control mobile source emissions and sulphur from stationary sources.

12. CIAM also informed the Task Force that it had updated the emission scenario in RAINS for 1995 and 2000. These data were now based on the most recent (up to 1999) emission data and energy statistics.

13. The European Topic Centre (ETC) on Air and Climate Change reported on progress in developing a baseline scenario for EEA. A wide range of models covering the different sectors was used in the work. ETC was harmonizing the key assumptions and data used by different models. It had developed a set of five scenarios with different assumptions on climate change policies. The work would be used for a report to the Ministerial Conference in Kiev in 2003. Preliminary results indicated that structural change may especially lower emissions of the traditional pollutants in the EU accession countries. For 2010, the differences in air pollution impacts of assuming alternative climate change scenarios seemed to be limited, given the present legislation on air pollution, but cost implications might be significant.

14. The Task Force expressed its interest in the ETC work, expressing surprise over some of the preliminary cost data. It invited ETC to make available to experts future drafts of the report for the Kiev Conference to solicit comments.

15. The European Commission had issued a communication on emissions from ships. A study included data on ship emissions in ports. Over the summer a number of workshops would be held on the topic. The Task Force reiterated its intention to cover ship emission in integrated assessment modelling and invited CIAM in cooperation with MSC-W to explore the possibilities for this in view of the new data.

III. URBAN MODELLING

16. The “City-delta” project run jointly by CIAM, MSC-W, EUROTRAC2 and the European Community Joint Research Centre’s Institute for Environment and Sustainability (JRC-IES) has started its work with a meeting in February 2002. The project, coordinated by JRC-IES, covers ozone and PM (coarse and fine) and undertakes a model comparison exercise for urban/regional dispersion models to identify:

(a) Systematic differences (deltas) between rural and urban background air quality;

(b) How these deltas depend on urban emissions and other factors;

(c) How these deltas vary across cities; and

(d) How these deltas vary across models.

Seventeen modelling teams with 18 models covering eight cities (London, Paris, Marseilles, Milan, Copenhagen, Berlin, Prague and Katowice) participate in the project. The findings of the model intercomparison, i.e. the ranges of model responses towards urban and regional emission reductions, will be used in the RAINS model to link regional background concentrations to urban pollution levels and to evaluate the balance between international and local measures. The project will cover seven emission scenarios and three different abatement strategies comparing regional with urban emission controls. It will provide long-term calculations (a full year for PM, six months for O_3) at a spatial resolution within urban modelling domains of 5-10 km. The boundary conditions are provided by MSC-W or calculated by models.

17. Results are expected for the end of 2002 and their interpretation is planned for 2003. The next meeting will be held on 24-25 June 2002 at IIASA. The project web site is http://rea.ei.jrc.it/netshare/thunis/citydelta/.

18. The Task Force recognized the importance of this project for modelling the health impacts of air pollution. It noted that for the incorporation of the results, it might be important to have data on emissions in urban areas and on measures that could be applied to specifically abate these emissions. Some data may be obtained from the results of the Auto-Oil Programmes.

19. A study conducted at the Institut National de l'Environnement Industriel et des Risques (INERIS) investigated the source apportionment for PM10 concentrations in urban areas. Based on urban NO_x concentrations, as a surrogate for PM10 emissions from urban sources, and on rural SO_4 concentrations, as a surrogate for regional background PM, a model estimates the urban PM levels. The statistical model was applied to three cities in France (Paris, Caen and Clermont-Ferrand) and calibrated with local measurement data. The results indicate that both local and regional emissions are important to explain the local PM concentrations in the three cities. A surprising result was that for PM2.5 local sources tended to be more important than for PM10. Further work will be conducted to examine other cities.

20. Imperial College, London, examined the importance of local measures in urban areas, using the example of London, in reducing national emission and transboundary air pollution. In response to air quality objectives, particularly for NO_2 and PM10, additional abatement measures will need to be implemented in urban areas. In addition to technological improvements in vehicle emissions and some fuel switching options, there are measures to alter traffic demand, including, for example: modal switch to public transport, induced by improvements in public transport in terms of availability, time of journey, and convenience; park-and-ride schemes; car sharing and coordinated or shred delivery schemes; economic instruments and financial measures such as road user or congestion charging, parking charges or parking restrictions, limited access and pedestrian areas, and low-emission zones with restrictions on vehicles eligible to enter. As exceedance of air quality objectives is generally localized close to major roads and in limited parts of cities, emphasis is concentrated on very localized measures in hot spots. These are likely to have very modest effects on urban emissions overall, and hence make little contribution to the attainment of national emission ceilings. However, reducing of transboundary ozone levels and particulates will help attain air quality standards for NO_2 and PM10, and hence the two issues of urban air quality and transboundary air pollution need to be considered together, with a consistent approach to emission inventories.

21. The Task Force noted that several countries were reviewing NO_x emission data from heavy-duty vehicles (HDVs). Recent findings seemed to suggest that NO_x emissions from HDVs following the EURO 2 and 3 specifications were in reality higher than assumed in previous estimates.

22. The Task Force also agreed on the importance of examining the potential impact from new technologies, such as fuel cells, on emissions. This was particularly important when looking at scenarios extending up to 2020.

IV. REDUCED LIFE EXPECTANCY FROM PARTICULATE MATTER

23. CIAM presented a report on a methodology to estimate changes in statistical life expectancy due to the control of particulate matter air pollution and the first, illustrative results in using this methodology in the RAINS model. The methodology follows the recommendation of the WHO Working Group on Health Impacts made in 2001. It is also supported by the workshop under the Network of Experts on Benefits and Economic Instruments (NEBEI) on the measurement and valuation of health impacts, in London on 19-20 February 2001 (EB.AIR/WG.5/2001/4). The study was financially supported by the Netherlands and Switzerland.

24. The paper introduces a methodology to estimate reduced life expectancy due to particulate matter pollution in Europe. It combines epidemiological evidence about a systematic association between fine particulate matter (PM2.5) and increased mortality with inventories and projections of emissions of PM2.5 in Europe and calculates the implications of mortality changes due to population exposure to PM2.5 concentrations on statistical life expectancy in the various European countries. The methodology estimates PM2.5 levels for rural and urban areas with a 50 km x 50 km spatial resolution over Europe and calculates from this the exposure of population to PM2.5. For this purpose, a population database was compiled by CIAM specifying for each grid cell urban and rural population, the age structure and mortality rates. These demographic statistics have been collected for the year 2000. The development up to 2050 is extracted from the United Nations population projection.

25. The paper also presents the first results based on currently available models and data, which should be considered illustrative, showing the order of magnitude of the effects and demonstrating that, in principle, all information required for the health impact assessment is available. Further work is needed to improve emission inventories of particulate matter, to refine the Eulerian dispersion models of aerosols and validate them with more monitoring data, to improve estimates of ambient levels of particulate matter in urban air, and to obtain comprehensive advice from WHO about the use of epidemiological evidence for health impact assessment. Such improved knowledge will reduce many uncertainties of the calculations presented in this paper. However, there are other uncertainties which are not expected to disappear as a result of the improved information that is expected to become available within the next few years. For instance, there might not be complete certainty about the causal factor in particulate matter leading to increased mortality, and a range of alternative hypotheses might prevail.

26. Keeping these imperfections in mind, the preliminary results of this assessment suggest life expectancy in Europe to be significantly shortened by particulate pollution, with the present assumptions between three months in Nordic countries and more than two years in Central Europe. The 95 per cent confidence interval of these estimates, due to uncertainties in the evidential epidemiological studies, ranges between one and five months in Norway and nine months and six years in Central Europe. This situation is expected to profoundly change in the future due to the recently agreed emission controls. The Gothenburg Protocol and the National Emission Ceilings Directive of the European Union should bring significant reductions in the precursor emissions of secondary aerosols: SO_2 will be cut by 75 per cent compared to 1990, NO_x by 50 per cent and ammonia by 12 per cent. Primary emissions of PM2.5 are expected to decline by 50 per cent as a consequence of stringent controls for stationary and mobile sources. These emission controls will reduce the average loss of life expectancy in Europe to somewhat more than nine months in Europe, spreading from one month in Norway to 13.5 months in

Poland. Full application of all available technical control measures could reduce these losses by another 25 per cent.

27. The Task Force welcomed the work by CIAM and agreed that the approach was useful to link the changes in air pollution to the effects' end point. Further work should include an update of the source-receptor relationships based on the Eulerian model and some estimation of the sensitivity of the results to changes in the most uncertain parameters. It would be important to determine the importance of treating morbidity effects of PM pollution in addition to the mortality impacts that were now incorporated. The Task Force would seek advice on this matter from the Task Force on Health. It would also be useful to distinguish between the benefits from reducing PM through controls of primary and secondary PM.

V. PROGRESS ON ATMOSPHERIC MODELLING OF PARTICULATE MATTER

28. MSC-W reported on progress in developing the Eulerian model. The results of a recent study conducted in collaboration with the Norwegian Institute for Air Research (NILU) and funded by the Norwegian authorities have been used to demonstrate how the Eulerian model allowed for a flexible choice of the horizontal and vertical resolution. While the Lagrangian model had come to its limits with the 150 km x 150 km grid, the Eulerian model had been used to look at very fine grid resolutions. Model calculations for Oslo were conducted at a 12.5 x 12.5 km resolution. The Eulerian model will have the potential to examine air pollution problems ranging from those on a hemispheric to those on an urban scale.

29. Another project, funded by the EC Directorate-General for Environment, focused on the study of non-linearities of Eulerian source-receptor relationships. As the dispersion of primary PM (coarse and fine) follows, in theory, linear processes, a comparison of model runs with linear estimates allows the quantification of errors due to non-linearities in the numerical advection. The results provide an effective way for model verification. Work will continue to study the model's chemical non-linearities (ozone, photo-oxidants) and non-linearities related to dynamic aerosol processes (PM). This study of the response of the model to emission changes will also contribute to the interpretation of the results from the City-delta project (see chap. III above).

30. The Task Force discussed the progress of the work on the unified Eulerian model. It welcomed the progress made and the thorough quality control in developing the model. It agreed that, from a health impact perspective, priority should be given to developing the model to allow a reliable estimate of the concentrations of PM in terms of mass. The modelling of number concentrations was not a priority from an integrated assessment modelling perspective. The Task Force suggested to MSC-W to develop, possibly together with other experts, a

detailed timetable for the further work on the Eulerian model that it could present to the EMEP Steering Body.

31. Imperial College conducted an uncertainty analysis on the impact of replacing in the Abatement Strategies Assessment Model (ASAM) the source-receptor relationships derived with the Lagrangian model with those from the Eulerian model. The calculated depositions tend to be slightly higher than those calculated with the Lagrangian model. However, the relative contributions of most countries remain fairly similar and the calculated distribution of effort in an optimized scenario does not change drastically. The most significant changes were obtained for sulphur emission reductions required. As there are not yet results for several years from the Eulerian model and the matrices were only preliminary, the conclusions have to be considered preliminary.

VI. THE USE OF RESULTS OF DYNAMIC MODELLING IN INTEGRATED ASSESSMENT MODELLING

32. CCE reported on dynamic modelling work under the Task Force on Modelling and Mapping. The work aims at developing a methodology that will allow an assessment of ecosystem recovery processes, once depositions are reduced below critical loads. A draft modelling manual has been prepared and is available on the Internet at www.rivm.nl/cce. This manual aims at assisting Parties in applying dynamic models. For those countries not using their own models, CCE has prepared a very simple dynamic model that extends the simple mass balance model for critical loads.

33. Dynamic modelling can be used in integrated assessment modelling in a variety of ways, ranging from a simple scenario analysis, over the determination of target loads using dynamic models, to the development of target load functions that could replace the present critical load function in the models. The Task Force recognized that any more complex incorporation of dynamic modelling into integrated assessment models required more work than possible in the given time frame. It might be possible to derive target loads using dynamic modelling that could assign the year of expected recovery. For this, a representative coverage of the EMEP region by dynamic modelling work was needed. This was, at present, not ensured. It would require significant effort, both by Parties to apply national models and by CCE to fill the possible gaps in the database.

VII. TARGET VARIABLE AND OTHER POLICY-RELEVANT MODEL OUTPUT

34. The Task Force discussed options for defining target variables and other policy-relevant model output for the Gothenburg Protocol review. The Gothenburg Protocol aims at reaching critical loads and levels in the long run, while its emission ceilings were based on interim

targets for 2010. With the implementation of the Protocol more than 95 per cent of the ecosystems in Europe should be protected against acidification using the current critical load maps. Everywhere in Europe the area that is not protected would be reduced by 50 per cent compared to 1990. The excess deposition of nitrogen would be reduced by 60 per cent everywhere. In large parts of Europe this would, however, leave more than 50 per cent of the ecosystems unprotected. The model estimates that the population exposure to ozone levels exceeding 60 ppb would be reduced by 66 per cent everywhere, while the accumulated ozone exceedance over 60 ppb would not be more than 2.9 ppm-hours in four out of five years anywhere. The estimated vegetation exposure to ozone levels exceeding 40 ppb would be reduced by 33 per cent, with a maximum five-year average accumulated exceedance of 10 ppm-hours.

35. Before 2004, critical load data, land-use data, population data and the source-receptor matrix will be updated. Moreover, some Parties have agreed to reduce their national emissions further than required under the Gothenburg Protocol, or expect further reductions in emissions after 2010. The effectiveness of the Gothenburg Protocol in terms of ecosystem and population protection will be reassessed on the basis of the revised input data.

36. Several changes in the methodology are expected to change the definition of the target variables as well as the protection per centages that are equivalent to the ambition levels in the Gothenburg Protocol. Changes may include, for instance, a revision of the 40 ppb ozone level for vegetation exposure on the basis of evidence on the actual ozone uptake by plants.

37. Larger methodological changes could result from the incorporation of target loads for acidification based on the results of dynamic modelling of forest ecosystems and surface waters, and the assessment of the ecosystem protection against acidification and eutrophication for specific land habitats and aquatic ecosystems. This would mean that the ambition levels of the Gothenburg Protocol could be expressed in terms of the expected recovery period for different types of ecosystems. The ambition levels for 2015 and 2020 could also be based on desirable recovery periods and ambition levels for ecosystem protection could be specified for various ecosystems in parallel. As stated in chapter VI above, it is still uncertain whether these methodological changes are feasible within the next few years.

38. The RAINS model is now extended to incorporate the health impacts of PM. This makes it possible to assess the effectiveness of the Gothenburg Protocol in terms of population exposure and/or reduced life expectancy and to formulate policy targets for these variables. Guidance from the Task Force on Health is needed to decide whether mortality and morbidity effects are highly correlated, or whether separate target variables for mortality and morbidity are necessary.

39. In line with the objective of the Gothenburg Protocol, targets for 2015 and 2020 should be formulated to bring the protection of ecosystems and population closer to the ultimate goal of full protection. New ambition levels will be between the outcome of the current (Gothenburg Protocol) obligations and maximum feasible reduction of emissions, including structural change. The shape of the cost-effectiveness curves for the different effect categories could guide policy makers in defining new interim ambition levels.

40. Maximum feasible reductions should incorporate both technical and non-technical measures. A special sub-group of the Task Force will define the work necessary for obtaining data and reach consensus on the cost-effectiveness of non-technical measures, including the cooperation and funding that will be required. It will report orally to the EMEP Steering Body and the Working Group on Strategies and Review.

41. Non-technical measures can either be incorporated in the cost-curves or-if this is not feasible – they can be represented in alternative baseline scenarios, e.g. on climate change policies or on the reform of agricultural policies in Europe.

42. The modelling framework should not only produce 'end-point' effect variables, but also estimates for parameters such as costs and monetary benefits, emissions for each country and sector, and concentrations (e.g. of ozone, PM and NO_2). Emissions of lead and cadmium can be presented as a side effect. In a similar way, the contribution to radiative forcing and the deposition on the regional seas can be shown.

43. Once policy makers have decided on the ambition levels for 2015 and 2020, least-cost scenarios and non-optimized scenarios could help policy makers in deciding the distribution of abatement efforts over countries and sectors. The choice of such scenarios should be pragmatic and transparent.

VIII. LINKING REGIONAL INTEGRATED ASSESSMENT MODELLING AND CLIMATE CHANGE

44. CIAM presented some ideas about how air pollution modelling could be linked to climate change, including some results of a workshop by the National Aeronautics and Space Administration (NASA) on air pollution as a radiative forcing, Hawaii, United States, 29 April to 4 May 2002. One link is the recognized direct impact of air pollutants (ozone, SO_2, sulphate and nitrate aerosols, black and organic carbon) on climate change through radiative forcing. Air pollutants also have an indirect effect on radiative forcing, by influencing ozone, PM and/or hydroxyl (OH) radicals. OH radicals determine the lifetime of methane, ozone and HFCs. These effects go in different directions, either increasing or reducing radiative forcing.

45. For example, increases in NO_x emissions decrease (via OH radicals) the lifetime of methane in the atmosphere and thereby cause reduced radiative forcing. At the same time, NO_x emissions produce tropospheric ozone and thus increase radiative forcing. A further pathway leads to increased nitrogen deposition, which in turn may lead, via the fertilization effect, to enhanced growth of vegetation, which, in turn, offers an increased sink for carbon. The net effect cannot yet be fully quantified.

46. Another link comes through the fact that air pollutants and greenhouse gases have common sources. Climate change measures to reduce fossil fuel combustion will have ancillary benefits for regional air pollutants. While the climate change benefits are long-term, reduced air pollution will yield benefits in the short and medium term. Ammonia abatement measures can lead to increases in N_2O, while structural measures in agriculture could reduce both regional air pollution and climate change. Methane is both an ozone precursor and a greenhouse gas; hence its abatement will have synergetic effects and some cheap abatement measures may be highly cost-effective.

47. So far, the links between climate change and air pollution have only occasionally been examined. Time is an important factor in this context. While benefits from some climate change policies on air pollution may yield short-term benefits, the lifetime of air pollutants with radiative forcing is generally shorter than that of greenhouse gases. Hence climate change benefits from reduced air pollution will come earlier than those of greenhouse gas abatement. Extending the multi-effect, multi-pollutant framework with the relevant links to climate change should give the information to assess the overall cost-effectiveness of air pollution abatement strategies.

48. The Task Force welcomed the initiative by CIAM and encouraged it to continue the work. It recognized that this work should be approached on a hemispheric scale. Further work should focus on the synergies in abatement strategies. The Task Force also recognized that science was not ready to answer all questions related to the link between regional air pollution and climate change, but much work was under way and results should be imminent. A recent EMEP workshop held in Palisades (United States), 12-15 June 2001 (EB.AIR/GE.1/2001/11, www.ciesin.columbia.edu/pph), had recognized that regional air pollution problems should now also be examined on a hemispheric scale. The work presented by CIAM should be fed into the follow-up at the EMEP workshop to be held in Bad Breisig (near Bonn, Germany) on 7-9 October 2002. The specific integrated assessment modelling questions (such as the synergies between climate measures and air pollution abatement) could be a topic of the workshop of the Task Force scheduled for the autumn of 2002.

IX. OTHER INTEGRATED ASSESSMENT MODEL ACTIVITIES

49. The Norwegian Meteorological Institute informed the Task Force about progress in the MERLIN project. The collaborative project conducted by six institutes in different European countries, coordinated by the University of Stuttgart (Germany) and funded by the European Commission's Directorate-General for Research, aims at developing an integrated assessment model for European air pollution. The model will cover regional air pollution, global warming and urban air quality. It will be able to perform cost-effectiveness and cost-benefit analyses of European abatement strategies. MERLIN is designed to link models covering emissions, atmospheric transport (using the EMEP MSC-W model), urban air quality models and a macroeconomic model. An optimization tool using an evolutionary algorithm is being developed. The Task Force invited the collaborating institutes to continue to report on progress.

50. The National Centre for Integrated Assessment of the United Kingdom at Imperial College London has developed a national model, UKIAM, to consider effective strategies for reducing acidification and eutrophication within the United Kingdom, focusing on the implementation of the emission ceilings of the Gothenburg Protocol. Further work was carried out on PM10 with a national scale model to investigate PM-reduction strategies. Work also included the revision of the ammonia abatement cost curves for the United Kingdom in view of new knowledge about ammonia emissions and consideration of geographical factors.

51. Mr. T. Pignatelli (Italy) reported on the work of the national focal point for integrated assessment. It included a techno-economic assessment, the development of emission scenarios and the preparation of the RAINS-Italy model in corporation with IIASA. A recent study compared Kyoto-Protocol implementation scenarios performed with RAINS and with an energy model (MARKAL). The objectives of the study included finding synergies between climate change and regional air pollution policies, identifying effects of a post-Kyoto energy scenario on CO_2 and SO_2 emissions and to compare the two models under similar boundary conditions. Preliminary results indicate that under a Kyoto implementation scenario the achievement of Gothenburg Protocol ceilings will be easier to achieve. While the two models are very different, there is substantial agreement between the emission scenarios calculated. The analysis proved to be very useful to test the sensitivity of the integrated assessment modelling work. Mr. J.-M. Brignon (France) presented work on black carbon (BC) and organic carbon (OC) particulate matter conducted in France. The work developed a global inventory of BC and OC PM emissions from mobile and stationary sources and biomass burning from 1950 to 1997 and projections. Global modelling covered atmospheric transport, wet and dry deposition and radiative forcing. Future work concentrating on Europe aims at including sulphate and nitrate aerosols in the work, refining the spatial resolution of the

modelling work and using the EMEP emission databases. Further work might also cover the control for PM and their impact on radiative forcing and visibility.

52. The Task Force welcomed the presentations on national integrated assessment modelling and encouraged the experts to continue to inform the Task Force about further progress in their work. It encouraged all national focal points to come forward with their results at its future meetings.

X. PLANNING FURTHER WORK

53. The Task Force discussed its work-plan for 2003. It recognized that the tasks foreseen in the long-term work-plan up to 2004 should be continued. This work should cover incorporating into the modelling framework: new scenarios (2004); revised cost curves (2004); urban-scale modelling and measures (2004); revised source-receptor relationship (2003); health impact indicators (2004); (dynamic) ecosystem effects (2004); as well as necessary adaptations to the optimization methodology (2003) and uncertainty analysis (2004). The Task Force agreed that the work linking air pollution and climate change should be pursued as a matter of high priority. Modelling should also be extended to cover the emission of ships (see para. 15 above). Modelling heavy metals emission could, at present, only be envisaged for cadmium and lead and only illustrate the side effects of policies in reducing the depositions of these pollutants.

54. The Task Force discussed the budget requirements of CIAM. It recognized that CIAM would receive funding worth US$ 66 000 through the EMEP Protocol via MSC-W, for temporary external assistance to MSC-W. The Executive Body had budgeted for 2002, 2003 and 2004 an additional US$ 240 000 for CIAM in its decision 2001/5 (ECE/EB.AIR/75, annex IX). Decision 2001/5 included a recommendation to Parties to contribute to the cost of core activities. However, by May 2002 not many Parties had followed that recommendation and it was uncertain whether the resources would be forthcoming as budgeted. Given, in addition, the difficult financial situation forced by IIASA, it was important that Parties continued to support the work of CIAM through special projects. It was also important that the European Commission continued to fund integrated assessment modelling work.

55. The Task Force adopted the following budget for CIAM for 2003 and tentatively for 2004:

Table. Budgeted resource requirements of CIAM covered by the Convention, 2003 and 2004 (thousands of US$)

Tasks	2003	2004
1. Dynamic modelling:		
Acid models	-	-
Cost curves	-	-
Optimization	60	-
2. Particulate matter cost curves	30	-
2020 projections and baseline emissions	60	60
Update of cost curves for other pollutants	30	60
Urban scale cost curves	-	-
3. Health impacts		
- Methodology	-	-
- Data	30	-
- Urban scale	-	30
4. Source-receptor relationships	66	-
5. Optimizations for PM and urban pollution	-	-
6. Uncertainty management	-	66
7. Scenarios	-	60
8. Public access (Internet)	-	-
Cooperation with National Focal Points	30	30
Proposed funding through EMEP and decision 2001/5	**66+240**	**66+240**

56. The next meeting of the Task Force on Integrated Assessment Modelling is tentatively scheduled for May 2003. The venue has not yet been chosen. In November 2002 a workshop will be held at CIAM at IIASA in Laxenburg (Austria) on structural measures and/or links to climate change.

Annex

UNCERTAINTY TREATMENT IN INTEGRATED ASSESSMENT MODELLING

Conclusions from a workshop held at IIASA in Laxenburg (Austria), 24-25 January 2002

Introduction

1. The workshop was attended by 75 experts from Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland, the United Kingdom, and the United States of America, as well as the UNECE secretariat, the European Community's Joint Research Centre, the World Conservation Union (IUCN), the International Union of Producers and Distributors of Electrical Energy (UNIPEDE) and the Oil Companies' European Organization for Environment, Health and Safety (CONCAWE). It was organized by the Task Force on Integrated Assessment Modelling and the EMEP Centre for Integrated Assessment Modelling (CIAM).

Background

2. Uncertainties and robustness are crucial aspects in the development and applications of integrated assessment models. Well before the next round of policy development for air pollution control in Europe under the Convention of Long-range Transboundary Air Pollution, as well as within the Clean Air for Europe (CAFE) programme of the European Commission, CIAM organized a workshop to review and discuss possible approaches to the treatment of uncertainties in integrated assessment modelling. The workshop discussed the needs and wishes of decision makers with regard to uncertainties and robustness, reviewed how uncertainties had been addressed in past work in the context of air pollution and climate assessments, and explored practical approaches to the refined treatment of uncertainties for the next round of assessments.

Some basic points

3. Six steps towards uncertainty management in an interactive learning process, with good interaction between all actors involved from science to policy, can be distinguished:

(a) Denial of uncertainties;

(b) Acknowledgement of uncertainties;

(c) Specification of types of uncertainty;

(d) Quantitative assessment of uncertainties;

(e) Specification of policy relevance;

(f) Uncertainty management.

4. There are different types of uncertainty. Some can be handled with statistical and other methods, others not. Many uncertainties can be reduced through further research. They result from incomplete scientific understanding of the various processes (for instance, manifested in the different predictions from different modelling systems, different meteorological models or parameterizations, different chemical mechanisms, or uncertainties in the emissions inventories). Some uncertainties are inherent and cannot be reduced. They are caused by processes that operate on space/time scales that cannot be captured by the models.

5. The workshop recognized that the assumption of a single fixed energy scenario was a source of uncertainty but that, at present, models could not capture the feedback between abatement and activity. Some concerns, however, about the robustness of least-cost solutions could be addressed by consideration of alternative projections over different time horizons.

6. A good process can help (and has helped) to deal with uncertainty: transparency, participation, and consensus-building around scenarios. Much of this was done in preparing the Gothenburg Protocol. This should serve as the basis, and as a point of reference, for further work.

The role of uncertainties in decision-making

7. For the decision-making process, good communication of uncertainties and full transparency is crucial. The process involves three distinct groups that can in turn be split into sub-groups:

(a) Scientists (applied and basic);

(b) Integrated assessment modellers;

(c) Decision makers (politicians and their representatives in negotiations), stakeholders and the public.

8. It is important to follow a systematic approach to uncertainties in order to gain confidence. Such an approach should differentiate between the reducible and the irreducible uncertainties. For the most significant sources of reducible uncertainties, it should determine by how much further scientific effort could increase the robustness of the models. For

irreducible uncertainties, the model has to make assumptions. These should be made explicit and, where they significantly influence the model outcome, alternative scenarios should be explored.

9. Simple parameters can help to present results to policy makers and the public. For example, instead of presenting expected exceedances in absolute or deterministic figures, maps can show the probability of exceedance.

10. Policy makers are aware of uncertainty. They are interested in the sources of uncertainty and whether/how they can be reduced.

11. Decision makers are looking for a rational basis for decisions, but, in the end, various driving forces often dominate specific decisions. The reliance on model results will be higher (independent of uncertainties) if model results fit the political driving forces. There is a risk that uncertainty is misused as an argument for delay, when there are opposing scientific and/or political positions.

12. Policy makers, in contrast to scientists, are not interested in the detailed statistics about uncertainties. They are interested in robust strategies. Robustness implies that strategies (control needs and priorities between countries, sectors, pollutants) do not significantly change due to changes in the uncertain model elements. Robust strategies should avoid regret investments (no-regret approach) and/or the risk of serious damage (precautionary approach). As part of such a strategy, the timing of measures may be a risk management tool. The choice of the time horizon will also influence robustness.

Uncertainties in the model chain of integrated assessment modelling

13. Good science includes a full uncertainty assessment. Such assessment is also necessary for the communication between scientists working within the Convention's framework and other scientists.

14. Scientific debate about uncertainty should lead to consensus on which uncertainties are the most important. It should flag any fundamental flaws and highlight specific points of disagreement.

15. Integrated assessment modelling should construct the model in a way to prevent the results being driven by the most uncertain elements. If this is impossible it should present different scenarios to illustrate the importance of specific uncertainties. There is a need for coordinated input on the different model elements (see further work).

16. The Regional Air Pollution Information and Simulation (RAINS) model has been expanded to examine how errors (quantified uncertainties) in the input parameters propagate through the model for ecosystem protection against acidification. One of the most important findings is that integrated assessment model results tend to be more robust than their input parameters. This is due to a compensation of statistically independent errors.

17. Some questions about the usefulness of such an approach remain:

(a) Are Parties ready to put increased effort into providing and, subsequently, agreeing upon the data needed for such an analysis?

(b) Would Parties be prepared to follow abatement strategies derived with such a method?

Further work

18. Uncertainty assessment should be conducted in each area contributing to integrated assessment modelling. This should be performed by existing bodies, where possible, or through dedicated workshops. The assessments should follow a common format to be developed by the Task Force on Integrated Assessment Modelling. The following areas have to be covered:

(a) Ecosystem effects;

(b) Health effects;

(c) Emissions;

(d) Atmospheric dispersion;

(e) Projections of activities/ sectoral scenarios;

(f) Abatement options and costs;

(g) Monetary evaluation of benefits.

The assessments should determine the types and the importance of uncertainties that are relevant for these areas. They should use existing methods, where applicable, to quantify uncertainties.

19. The Task Force on Integrated Assessment Modelling will bring the separate assessments together and show the relative importance of identified uncertainties/risks for abatement policy. Based on this overall uncertainty assessment, it should focus on:

(a) Developing a robust model structure (e.g. geographic resolution, time horizon);

(b) Formulating robust strategies (including different criteria for optimal strategies).

20. Once Parties agree to this work-plan, they should be called upon to provide:

(a) The necessary data on uncertainties for model input data;

(b) Resources for the work required at all levels.