Air pollution and Climate Change

Report from a workshop under the Swedish EU Presidency

Gothenburg, Sweden, 19-21 October 2009

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"Saltsjöbaden IV"
Workshop

Foreword

In order to evaluate the role of air pollution and air pollution control for climate policies, Swedish Environmental Protection Agency invited leading experts and scientists, senior administrators and negotiators, international organisations and industry to an international workshop in Gothenburg, Sweden, 19-21 October 2009.

The workshop was held during the Swedish EU Presidency and its aim was to provide input into international policy processes with respect to both air pollution and climate change. The more specific aim was to evaluate to what extent air pollution control is able to support intermediate climate policies over the next decades. The discussions built on recent scientific findings, conclusions from recent conferences and workshops[1] that have highlighted the issue and identified the need to improve scientific understanding, research opportunities for co-control of emissions, and assess the way in which these processes could be linked within international systems.

The Workshop was organised in close collaboration with a number of international organisations including UNFCCC, CLRTAP, US EPA, the European Commission, EEA and Global Atmospheric Pollution Forum (GAP). Important input to the workshop was obtained through the, EU Network of Excellence ACCENT and the Swedish research programmes SCARP and CLIPORE.

The workshop attracted about 200 participants from more than 30 countries representing all continents. In this report the main findings from the workshop are summarized. Further information is given at www.naturvardsverket.se/airclimconf.

In connection with the workshop, the Swedish Environmental Protection Agency highlighted the issue through publishing a book: Air Pollution and Climate; two sides of the same coin. For those wanting to get an insight to the problem, we will recommend reading this book. It can be ordered from Swedish Environmental Protection Agency to a price of 202 SEK.

We as organisers of the workshop want to thank all those who have contributed to preparation, in particular the Program Committee, speakers and workshop coordinators.

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[1] See the Global Atmospheric Pollution Conference in Stockholm 17-19 September 2008 http://www.gapforum.org/ and the Third Saltsjöbaden Conference 12-14 March 2007 http://asta.ivl.se/Workshops/Saltsjobaden3/Conclusions/Salt3_Final_conclusions_rev8juni.pdf

General conclusions

The coming period represents a key and important opportunity to link air and climate concerns, with the UNEP governing board, Arctic Council and possible conclusion of the Gothenburg Protocol revision all occurring in 2011. In light of this opportunity, the conference agreed on the following general conclusions:

1. Address under the revision of the Gothenburg Protocol the climate effects of air pollutants and the short-lived climate forcers, including BC, CO and methane.

2. Create a CLRTAP Task Force or ad hoc expert group to investigate physical and economic aspects of climate change and air quality interactions, initially urgently to inform the revision of the Gothenburg Protocol.

3. The Task Force on Reactive Nitrogen should prepare a special report on nitrogen and climate interactions.

4. CLRTAP scientists need actively contribute to IPCC-reports, including AR5, which should include air pollution impacts through the work of WG3 especially. Climate models & scenarios need to take into account the effects of ozone and nitrogen on ecosystems and their feedbacks on climate change.

5. GAP Forum, UNEP, WMO and other similar bodies should continue to build links between regional agreements and networks for air pollution and climate change to enhance exchange of knowledge and information. Such links may lead in the longer term to a framework convention for the atmosphere.

6. CLRTAP and UNEP should explore the need for developing a protocol to address background ozone on the hemispheric scale with potential participation of all countries in the Northern Hemisphere.

7. In many developing countries health and other sustainable development concerns are driving policy, and climate effects are considered a co-benefit, while in many industrialised countries climate drives policy. The CLRTAP Convention can contribute to melding these two approaches, by greatly improving its outreach, making a valuable contribution to the capacity building, science and policy know-how needs of developing countries. Regional networks need greater support.

8. Although there exists consensus on the large importance of PM-species on both health and climate change, the assessments of IGAC and UNEP will help further inform effective policy development in CLRTAP, UNFCCC and other relevant conventions. Research on the toxicity of PM-species and ozone within CLRTAP should continue.

9. A clear vision of intermediate and long term air & climate targets and measures from policymakers would aid the scientific community in structuring their research priorities. Consider the timing of targets & measures and the cumulative impact for both short- and long-lived substances.

10. Geoengineering is relevant in the cost-benefit debate. An apparent low cost opportunity to address global issues raises important questions with regard to

governance (i.e. who decides if action can or should be taken?). Create/include a global atmosphere convention as a framework for the management of the atmosphere (coherent air and climate policy).

Background

Air pollution and climate are closely interlinked. The needs and advantages of developing coordinated policies have been highlighted several times over the last 3-5years. The European Union developed in 2007 a strategy on how air pollution and climate change policies could be linked in order to reach environmental objectives in a more cost-efficient way. At the GAP Forum conference in Stockholm in September 2008, the importance of air pollutants for climate was highlighted from a development countries perspective and the conclusions clearly pointed to the advantage of coordinating efforts.

Climate change and air pollution are however given different priorities around the world. In developing countries as well as in the United States, air pollution and its threat to human health has been considered a more urgent problem while within the European Union climate change has over the last five years been put in the forefront of the overall policies within the Union.

Many main atmospheric pollutants are also important for climate. These constituents include in particular primary and secondary particles, tropospheric ozone and nitrogen compounds. The role is not always simple and there is a need to get a better understanding of the relative importance of these constituents and their sources. Particles are of particular importance, since some of them – in particular black carbon – contribute significantly to the warming of the atmosphere while others – primarily sulphate aerosols – are masking the warming effect.

Air pollution and climate change have many aspects in common. From several points of view they should be considered as one common problem;

- The atmosphere is a recipient for both atmospheric pollutants and climate gases
- Many short lived constituents normally considered as air pollutants have also significant effects on the atmosphere.
- They have to a large extent the same sources
- Control measures are interlinked and many of them will take care of both.

For climate change the global and long-term dimension has been the obvious starting point and the UNFCCC has been operating from a global perspective on climate. For air pollution international collaboration started around 1970 and control measures were developed regionally through conventions or other forms of agreements. The air pollution issue has however grown over the last 10 years and become more and more global; partly through the observations of a significant intercontinental transport of air pollution, partly through the harmonisation of emission standards. Emission standards for cars and trucks are almost identical in all industrial countries and developing economies, even if they are introduced at different times.

The main theme of the workshop was: How should air pollution policies over the next 20-30 years been developed in order meet both air pollution and climate change needs. the presentations and discussions focused on three main issues:

- The underlying science. Which are the main scientific issues to be tackled to get a sufficient scientific understanding of the short-lived components both from an air pollution and a climate perspective.
- Policies. How could combined air pollution and climate policies be developed?

- Which international platform. Should the climate negotiation system or the air pollution systems take responsibility for the development of control strategies for the short-lived radiative forcing constituents?

The workshop started with of a set of plenary sessions in order to give a background for the workshop followed of a breakout of the meeting into eight working groups. The results of the working groups were then wrapped up in a final session at which also a set of overall conclusions and recommendations were agreed. Of particular importance for the workshop was that the recommendations also should have an address tag; an organisation or a community that should take care of the recommendations. The format was similar to that of a set of three earlier workshops under the name of "Saltsjöbaden workshops"[2].

[2] www.asta.ivl.se

Report Working Group 1

Climate benefits and dis-benefits of air pollution (PM and ozone) control

Working group coordinators: Frank Raes, EC Joint Research Centre and HC Hansson, University of Stockholm

Background papers/presentations at Plenary session:

- HC Hansson, Department of Applied Environmental Science, Stockholm University, Sweden: *Particles – the dark horse in climate and air pollution policies* (pdf 417 kB)
- Joyce Penner, University of Michigan, USA: *How have atmospheric pollutants been treated within IPCC?* (pdf 778 kB)
- Sandro Fuzzi, Institute of Atmospheric Sciences and Climate, Italy: *The ACCENT Network of Excellence – contribution to policy development* (pdf 1 MB)
- Øystein Hov, met.no, Norway: *The influence of climate change on air pollution dispersion and effects* (pdf 2 MB)

Presentations in Working group:
Considering the executive capabilities of the Swedish EPA regulations about CO2 emission

Conclusions

There is a need for jointly assessing air pollution and climate change policies
Levels of particulate matter (PM) have to be reduced to protect human health. Policies are already effective in the developped world, while this is expected to be the case also in the developping world. This will have immediate (1) impacts on climate.

On the other hand, strong CO2 reductions are required, up to 90% in the developped world by 2050 compared to 1990. The needed for restructering the energy an other sectors will lead to significant reductions of air pollution aswell, with, again, impacts on climate that will materialized faster than those from CO2 reductions (1).

Policy makers need to be aware of potential short term climate effects induced by changes in air pollution, caused by the above mentiond policy acions. They need to assess possibities of avoiding or enhancing these effects by more targetted air pollution policies. In this process, they need to consider not only effects on temperature, but also effects on precipitation, melting of glaciers, etc. They further need to consider specific regions, that are particularly sensitive to the these effects (e.g. Artic, Himalaya, ...)

Observations indicate that air pollution (policies) have and impact on climate
Global, hemispheric and regional temperature trends show the cooling effect of increasing pollution after world war II and the warming when air pollution was addressed in the developped world from the 80ies onwards. This cooling and warming is related to the issues of "global dimming" and "global brightening".

In order to fully explain these trends one need to consider both cooling from e.g. sulfate (SO4) and organic carbon (OC) aerosols, and warming from black carbon (BC) aerosols and tropospheric ozone.

The radiative forcing of most chemical atmospheric substances has been quantified, but ...

The IPCC 4AR has listed the global radiative forcing (i.e. the contribution to imbalance of the global radiation budget) of individual chemical compounds, including long-lived and short-lived species. These estimates mainly result from modelling studies using estimates for pre-industrial and present day emissions of these species. The uncertainty on the effects of aerosols on clouds, resulting in a large negative forcing (hence: cooling), is particularly large.

There is independent evidence from satellite observations that the anthropogenic aerosols are causing a radiative forcing of -1.2 W/m2, hence tend to cool Earth. The latter value means that in the long run (and using a climate sensitivity of 0.75 K/Wm-2) a temperature increase of 0.9 K would result, if all anthropogenic aerosols would be removed.

The IPCC 4AR shows that reducing one (set of) species will have secondary effects on the radiative forcing of other species. This is particularly the case in the NOx-VOC-O3 system. This means that it is not immediately clear whether a reduction of, e.g., an ozone precursor is a no-regret option or not. It will also depend on the sector and the regions in which such a reduction would take place (see later).

Reducing tropospheric O3 concentrations will have a cooling effect, which will be enhanced by improved CO2 uptake in the biosphere (see Working Group 2).

It is as yet unclear whether reducing BC concentrations will have a cooling effect. This is primarily due to the large uncertainty regarding the interactions of aerosols (including BC) with clouds. As mentioned before, additional climate effects, such as those on the hydrological cycle and the melting of ice, should be considered as well.

In general, there are many & large uncertainties, and the making of robust conclusions will take time. The ongoing IGAC and UNEP assessments are expected to do so in the course of 2010.

Radiative forcing created by individual sectors is more relevant for policy making than those related to single compounds

All sources/sectors emit a mix of short-lived substances, so it is not realistic to think one can control one species at the time. However the warming to cooling ratio of the emissions varies from sector to sector. Preliminary calculations show how present day emissions of short-lived species and their precursors in the power and industrial sectors lead to a negative forcing, whereas the domestic and transport sector lead to a positive forcing. Such estimates must be repeated by other groups, and, when applied to the future, they should assume the best available technologies for emission controls. In any case, there seems to exist a handle on controlling climate in the short term, by favouring controls in one sector or the other.

Obviously the importance of sectors depends strongly on where they emit. E.g., in 2000 the dominant sectors emitting BC were; in India: domestic (biofuel use), in China: industrial (small boilers) and in the Developed World; transport (diesel).

Sectors have also different effects on burdens and climate, depending on whether they emit over oceans or land, in clean or polluted regions. E.g. ships lead to more ozone per ton of NOx when emitted in the clean air over the open oceans, as compared to close to continents. Equally, sulphur emissions from ships have a stronger cooling effect over the dark ocean, than over land.

Recommendations for policy

- All chemical species that contribute to particulate matter must be further reduced, for their health impacts. At the same time, and in order to avoid fast further warming, the BC to (OC+SO4+nitrate) ratio of the overall emissions, should be reduced by selecting controls in appropriate sectors.
- In the light of the above, more emission reductions could be needed from domestic heating and cooking, and from transport.
- In addition to PM , tropospheric ozone and methane concentrations must be reduced to achieve climate neutral (or even friendly) air pollution policies, and avoid fast climatic changes.
- Now that peak ozone levels seem to be under control, by local NOx and VOC control, attention should be paid to background ozone, which becomes a significant part of the integrated ozone to which humans and ecosystems are exposed.
- Reduction of methane, to reduce in particular background ozone, is a no regret policy. It should be tackled [also] in regional air pollution policy frameworks such as CLRTAP.
- Policy actions that reduce impact on vulnerable regions should have a priority. I.e. BC reduction north of 40°N, to protect the Arctic.

Recomendations for research

- Reducing the uncertainty on aerosol forcing would help in reducing the uncertainty on the climate sensitivity. The latter prevents us form making more accurate climate productions. Especially the many effect of aerosols on the hydrological cycle need to be unravelled, better quantified and taken on board in climate models.
- More chemically resolved emission data are required for most sectors, in order to assess their impact on radiative forcing.
- The climate dis-benefit of NOx reductions is likely to be more complicated than what is mentioned by IPCC AR4. The issue must be addressed region by region and sector by sector.
- Scientists must come to a more fundamental understanding why atmospheric models do poor in representing PM, and BC in particular. One issue is the vertical distribution of air pollutants, including their exchange between the boundary layer and free troposphere. Another issue is the availability of realistic emission inventories (see above). In the latter context, inconsistencies in definitions and measurements of BC, in the emission world and the immission world must be resolved.
- In certain areas of the world (e.g. China) emissions, and the BC to (OC+SO4+nitrate) ratio of the aerosol have been changing fast. This offers a good opportunity to quantify the climate effect of such changes.

- Effects of non-linearities in the transformation of SO2 to sulphate should be considered, especially in the countries in transition, when assessing the effect of policies on aerosol burdens and their effects.

Participants

Report Working group 2

Draft conclusions and recommendations on interactions between climate change, air pollution and ecosystems.

Working group coordinators: Till Spranger, Ministry for the Environment Germany, and John Munthe, IVL Swedish Environmental Research Institute

Background presentations at Plenary sessions:

- David Fowler, CEH, United Kingdom: *How will control of ozone precursors influence air pollution and climate change?* (pdf 1 MB)
- Jan Willem Erisman, ECN, Netherlands: *Nitrogen management as an option for air pollution and climate change abatement* (pdf 2 MB)

Backgroud papers and presentations in the Working group:

- *A modelling study of Nitrogen and climate change effects on plant community composition and the underlying drivers* (pdf 6 MB) Cecilia Akselsson, Salim Belyazid
- *The nitrogen cycle and its influence on the European greenhouse gas balance* (pdf 1 MB)
- *Climate change effects on the transport and deposition of air pollution* (pdf 4 MB) Magnuz Engardt, Joakim Langner and Camilla Andersson
- *Ozone risk for vegetation in Europe under different climate change scenarios based on ozone uptake calculations* (pdf 934 kB) Jenny Klingberg, Magnuz Engardt, Johan Uddling, Per Erik Karlsson and Håkan Pleijel
- *Trophospheric ozone and climate change: impacts on vegetation* Harry Harmens & Gina Mills

Background

Air pollution and climate change interact in their effects on ecosystems.

Air pollution policies and subsequent emission control requirements under CLRTAP and EU are related to quantitative estimates of improvements of effects (effects-based approach). There is no comparable policy approach in climate change, nor does the present approach fully take into account simultaneous effects of climate change on ecosystems.

The discussions focussed on current and expected future trends in air pollution (recovery from acidification, increasing background ozone, continued nitrogen deposition), influences of a changing climate on ecosystem processes (nitrogen and carbon cycling, forest growth, vegetation composition) as well as synergies and conflicts between climate change and air pollution effects.

Conclusions

General

1. Climate change and air pollution are linked not only with respect to source oriented (emission) co-benefits and conflicts but also via their effects on ecosystems and feedbacks to climate change. The main direct bidirectional links are via tropospheric ozone and nitrogen biogeochemistry.
2. The existing CLRTAP monitoring and modelling infrastructure has been very effective in guiding air pollution abatement policy (effects-based approach). In recent

years, it has increasingly taken climate change into account; however, this has not been systematically been used to advise policy.

3. The integration of climate and air pollution science will require a new assessment of uncertainties and/or robustness in modelling tools (in climate scenarios, abatement strategies, dispersion models and ecosystem responses). The possibility of dramatic ecosystem changes cannot be excluded.

Ozone effects and climate change

1. Ozone is currently assessed to be the third most important greenhouse gas. Ecosystem feedbacks such as ozone damage to vegetation or climate influences on hydrology may both decrease carbon sequestration and reduce ozone deposition. This contributes to indirect radiative forcing, e.g. via reduced biomass accumulation and enhanced ozone concentration. Measures to reduce ozone would thus have benefits for both air pollution and climate change mitigation.
2. Stomatal ozone flux modelling allows climate change factors to be incorporated.
3. Ozone and climate change impacts on vegetation are complex :
    a. Non-linearity of interactions
    b. Scaling up from: individual to multi-component effects, plant physiological/biochemical processes to whole plant responses, plant species responses to communities to ecosystems.

Nitrogen effects and climate change

1. Nitrogen biogeochemistry is the main link between air pollution and climate change effects on ecosystems. This is not reflected in many relevant scientific and policy reports such as a recent UNEP Report on ecosystems impacts on C sequestration.
2. N inputs will foster C sequestration in ecosystems (more in trees than in soils in the medium term). This is limited by nitrogen and other nutrients, and will be sustainable only for a limited time.
3. N accumulation in non-agricultural ecosystems is reducing biodiversity, and increasing the risk of nitrate leaching and N_2O emission. There is therefore a possible conflict of interest between carbon sequestration and biodiversity protection.
4. Ammonia is the form of reactive nitrogen which is most damaging to ecosystems per unit of deposited nitrogen. This is all the more relevant because emission reduction has up to now been mostly on oxidised nitrogen.
5. N_2O is the main source of stratospheric ozone destruction. Nitrogen biogeochemistry therefore has to be taken into account in models and policies to protect the ozone layer.
6. Nitrogen has been taken up as a priority issue by the CLRTAP. The institutional recommendations of the "Saltsjöbaden 3" workshop (2007) on nitrogen have been implemented. However, the short and long term recommendations on tools, monitoring and stakeholder understanding have not been addressed adequately.

Other climate change feedbacks

1. Climate change will inevitably change the "baseline" development of ecosystems.

2. Climate change may modify air pollution effects independent of their emission abatement. One example is the mobilisation of heavy metals in ecosystems by DOC increase.

Recommendations

General

1. Links between climate change and air pollution effects necessitate formalised interactions, e.g. between CLRTAP´s WGE and IPCC´s Working Groups dealing with ecosystem effects and air pollutants including nitrogen and ozone.
   (CLRTAP EB and WGE; UNFCCC/IPCC)
2. There is an urgent need for large-scale, long-term multi-component field studies in order to further develop and evaluate models quantifying interactions between air pollution, climate change and ecosystems.
   (FP 7; other international and national research community)
3. The existing CLRTAP monitoring and modelling infrastructure should be extended to serve climate change monitoring needs. The WGE should be strengthened in the CLRTAP framework.
   (CLRTAP EB and WGE)
4. The effects-based approach to emission abatement policies needs to be extended to include effects of climate change, and may serve as a model for other regions of the world.
   (CLRTAP EB and WGE; IPCC; other regional MEAs)

Ozone effects and climate change

1. Impacts of ozone on vegetation and feedbacks to climate need to be included in global climate models to better predict consequences for C sequestration and hydrological cycles.
   (climate change, air pollution and biological systems research communities; IPCC)

Nitrogen effects and climate change

1. Climate change scenarios need to take into account nutrient (especially nitrogen) limitation of carbon sequestration, biodiversity changes and other nitrogen effects which are not directly related to CO_2.
   (climate change, air pollution and biological systems research communities; IPCC)
2. The difference in ecosystem effects of reduced vs. oxidised N has to be taken into account in air pollution and climate change abatement strategies. This means that ammonia emission reduction should be given higher priority in emission scenarios.
   (CLRTAP EB, TFIAM, WGSR and TFRN)
3. The cooperation between groups working on nitrogen effects, management and indicators and linkage to groups working on climate change should be further developed. This could be attained by proposing to IPCC a special report on nitrogen and climate change.
   (CLRTAP EB; WGE and its Task Forces, TFRN, NinE, NitroEurope; IPCC)

Other climate change feedbacks

1. Climate change induced “baseline” development of ecosystems should be taken into account when deriving effects targets.
   (research community, WGE)

2. Further improve joint efforts to understand and quantify heavy metal effects, including the global cycle of mercury and the reliability of emission inventories.
   (WGE, EMEP)
3. Uncertainties and robustness of modelling and its meaning for policy will have to be evaluated regularly when further integrating climate and air pollution science.
   (research community, all involved CLRTAP groups including TFIAM, IPCC)

Participants

Report Working group 3:

Health effects from air pollution in a changing climate

Working group coordinators: *Coordinator* Göran Pershagen, Karolinska Institutet and *Rapporteur* Tom Bellander Karolinska Institutet

Background presentation at Plenary sessions:
Bert Brunekreef, University of Utrecht, Netherlands: *Combined effects of climate change and air pollution on human health* (pdf 5 MB)

Background
Climate change may influence the health effects related to air pollution in many ways. Higher temperatures can lead to increased levels of some air pollutants, such as ozone and secondary inorganic particles. Direct interactions between air pollution and temperature may also occur, such as during heat wave related mortality episodes. Furthermore, there is evidence of interactions between traffic generated air pollution and pollen exposure in relation to allergy, particularly in children. In general, the anticipated changes in climate are mostly expected to aggravate the adverse health effects of air pollution. Thus, preventive action focusing on air pollution exposure would be expected to reduce some of the climate related health effects and vice versa.

It is also important to note that climate change and air pollution are closely connected, not only with regard to interactions in causing health effects. Some of the measures that may be taken against climate change may strongly influence air pollution levels and the other way around. For example, a greater use of solid biomass fuels in domestic heating will increase emissions of air pollutants if adequate protective technology is not applied. A change in particulate matter levels in atmosphere is expected to change its green-house properties, and in which direction may be dependent on the type of particulate matter that is affected. Health effects need to be adequately considered in prioritization of preventive measures.

The aim of this working group was to assess various aspects of the evidence regarding health effects of air pollution in relation to climate change. In addition, specific recommendations for action were proposed and research needs identified.

Conclusions

- There are important health effects, including increased mortality, already now from air pollution. Furthermore, the world population is aging and the prevalence of chronic conditions like diabetes is increasing. These groups are more susceptible to the adverse effects of both air pollution and increased temperature. There is an increasing need for strategies dealing with climate change to take into account their impact on air pollution related health effects.

- There is very strong evidence that PM is responsible for various health effects and ample evidence that primary combustion particles, including soot, are especially harmful.

- There is strong evidence that secondary particles have adverse health effects, which seems partly to be related to aging processes of sulphate particles. Reduction of secondary particles has been demonstrated to lead to health improvement.

- The serious health effects from biomass combustion emissions need to be considered. This includes not only the well known problem of biomass burning for cooking and heating, but also the biomass burning related to agricultural practices, including biofuel production.

- Many shipping lanes run close to land and shipping emissions give an important contribution to population exposure. These emissions are poorly regulated. Shipping fuels contain high levels of sulphur and metals, and are not allowed for use on land.

- The relation between acute health effects and ozone seems to be linear, which indicates that controlling peak exposure is insufficient for health protection. Controlling average exposure would be beneficial for health, vegetation and climate.

- There are several examples of complex interactions between energy conservation, air pollution and health effects. Energy conservation strategies need to be carefully evaluated with respect to their effect on the indoor environment.

- Climate change may, directly and indirectly, lead to a vast array of health effects, mostly negative. It may also modify the health effects from air pollution. The knowledge base does not allow for quantitative assessment.

Recommendations

- We recommend that IPCC and UNFCCC carefully consider the air pollution health impacts of different climate change policies.

- We recommend that air pollution regulatory agencies and other relevant bodies, e.g. CLRTAP, take into account the climate impact of different air pollution control strategies. In addition, we recommend that combustion-related primary particulate monitoring and abatement measures are developed.

- We recommend WHO to consider integrating air pollution and climate change in future recommendations to the member states, with special attention to biomass fuels.

- We recommend EU to integrate air pollution and climate into new research programs on health effects.

- We also recommend IMO to include air pollution health aspects in their work for sustainable shipping.

Research needs

- The use of different monitoring techniques for characterising primary combustion particles (including ultrafine particles and soot) for studies of health effects and risk assessment needs to be further evaluated.

- The toxicity of biomass combustion emissions needs to be further studied. Recent reports indicate that these may be more toxic that previously thought.

- There are only few studies on the health effects from nitrate and ammonium particles, and these need to be further investigated.

- There is some evidence of interaction between temperature, particles and ozone, but this needs to be further studied.

- The need and possibilities of adaptation of individuals and society to climate change should be studied, integrating consequences for air pollution related health effects.

- The health consequences of the use of new fuels in the transport sector need to be studied.

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Working Group 4

Sector control policies: energy, transport, agriculture, consumer behaviour

Working group coordinators: Simone Schucht (INERIS/France), Mark Barrett (UCL/UK), Peter Meulepas (The Flemish Government/Belgium)

Background presentations at Plenary sessions:
Markus Amann, IIASA, Austria: *Options for co-control over the next 20 years* (pdf 1 MB)

Background material and presentations in Working group:
Sector control policies -energy, transport, agriculture, consumer behaviour. Simone Schucht

- *Effects of climate policies on air polluting emissions in the Netherlands. Results of the Dutch Research Programme BOLK*. Pieter Hammingh, Koen Smekens, Robert Koelemeijer, et al.
- *Integrated implementation of air pollution and climate change policies: perspective of the power sector*. Hélène Lavray
- *Soot Free for the Climate*. Dorothee Saar
- *The effects of specific measures in the transport area on the emissions of traditional APs and GHGs*. Rafael Borge
- *Consumer behaviour and energy demand management*. Mark Barrett
- *Policies and scenarios elements on integrated measures to reduce gaseous emissions : NH3, CH4, N2O*. José Martinez

Introduction

Working Group 4 set out to discuss a) direct and indirect impacts of air pollution control policies on climate change; b) impacts of measures more specifically directed at air pollution on climate change; c) impacts of climate change policies and measures on air pollution; and to identify d) important synergetic measures and e) possibly needed further action (policies, communication, research...).

Not all of these issues were finally covered in the working group at least not systematically. Presentations highlighted synergetic and antagonistic effects on air pollution and climate change of measures applicable to the sectors energy, agriculture and road transport, and of measures falling under the categories of consumer behaviour and demand management. Further presentations dealt with PM filters for all types of diesel engines, and with the EU power sector's view on integrated implementation of air pollution and climate change policies.

It was not possible to detail measures and instruments across all sectors in the brief span of this working group and accompanying report (though more details are to be found in the presentations available at www.naturvardsverket.se/airclimconf). However, during working group discussions, various participants mentioned examples of measures and policy instruments with potential synergetic effects on air pollution and climate change.

- Examples of measures: PM traps for diesel engines to reduce black carbon (also retrofit); SCR on ships (also retrofit); eating less meat; methane capture; cleaner low sulphur distillate ship fuel; off-shore electricity in ports. The importance of structural measures

was also highlighted. One example stated was that in countries where cities are still increasing, the design of cities could influence transport and the transport means needed.

- Examples of policy instruments: mandatory transport plans for cities; legislation inhibiting open burning of agricultural residues and biomass; legislation introducing black carbon emission limit values at EU level; inclusion of black carbon in the revision of the Gothenburg Protocol; legislation on standards for low emission zones in the EU; performance/emission standards for new and existing domestic boilers and stoves at national or EU level or in CLRTAP protocol technical annexes; retrofit or replacement schemes for existing domestic boilers and stoves; stricter NOx emission standards for ships; stricter regulation for wood combustion in particular from small and medium-sized plant; incentives for diesel particulate traps for road vehicles; regulation for PM trap retrofits to diesel engines at national or EU level or in technical annexes to CLRTAP protocols.

Discussions also showed that often the application of best practice measures is closely related to policy instruments in place, for example: Germany has financial support schemes for the refurbishing of buildings; in Belgium and Germany only the most energy efficient appliances can be sold; in the Netherlands tax reductions are granted for people buying a bike for work; California subsidises the retrofit of diesel engines; Switzerland has a regulation for diesel filters (retrofit) for non-road machinery and for filters on ships.

Most participants agreed that air pollution and climate change issues should not be opposed to each other. They should be considered as equally important and the emphasis should be on measures that deliver co-benefits for climate and air pollution. A closer link between science and the policy debate was thought necessary.

There was a discussion about short and long term implications. For example, air pollution control might increase fossil plant CO_2 emission in the short term, but it would decrease the relative costs of energy efficiency and renewables and so might reduce air pollution and CO_2 emission in the longer term and improve energy security. The issue was raised that regulatory stability and predictability improves the economic efficiency of investments.

No consensus was reached on the question whether indoor air pollution and people's exposure to it should be brought into discussions under CLRTAP. This would also cover the impact of energy efficiency measures in buildings (e.g. reducing ventilation) on health. Counter-arguments were, amongst others, that this would bring more different types of pollutants into play, e.g. from smoking, furniture and the issue was distant from long range transboundary air pollution.

A further question raised was whether a better or common terminology for air pollutants and green-house gases might help promote combined strategies for air quality and climate change. Should green-house gases be subsumed under the term "pollutants"?

Some sectors and activities were not covered, or at least not in a comprehensive way. Missing in the title of the working group are important sectors and emission sources such as industry, buildings and off-road sources. The presentations did not address in detail aviation, shipping, non-electricity energy supply and buildings. Given the mostly general character of conclusions and recommendations from Working Group 4, it is unlikely that they would have been altered by an inclusion of these activities.

Conclusions

- The rate and speed at which measures reducing emissions can be introduced is important. "Fast measures" increase the chances of meeting near term targets and of avoiding tipping points. Furthermore, they allow for higher cumulative impacts for both short- and long-lived substances (total emissions reduced over the number of years considered and their impacts).
- Measures affecting the activities that are at the source of emissions are likely to lead to synergetic effects for air pollution and climate change. Therefore, all categories of measures are important and should be considered: not only technology but also behavioural, demand management, energy efficiency and energy mix/structural change measures.
- Next to air pollution and climate change co-benefits also other objectives should be considered, e.g. energy security and social equity.
- Behavioural and demand management measures lead mostly to win-win situations for air pollution and climate change, energy efficiency and fuel mix & quality measures lead often to win-win situations. Such measures also serve further objectives, such as energy security.
- For reasons of economic efficiency, market based policy instruments are frequently preferred. Explicit control instruments such as regulation and planning should also be considered. They can be cost-effective and their effects are often more predictable than those of market based instruments. There may also be a conflict between the economic incentives necessary to change activities sufficiently so as to meet air pollution and climate change objectives and the politically acceptable level of prices/taxes.
- In the choice of measures, conflicts between short term requirements and long term optimality are possible. For example, changes to the energy structure may be more beneficial in the long term than the use of end-of-pipe technologies on fossil fuel based power plants. But if their investment takes too much time to meet short term environmental targets, the use of certain technologies may be necessary even if this is sub-optimal in the long term.

Recommendations

- Methodology and science:
  - There is a need for consistent, comparable and comprehensive analyses of measures. Life-cycle analyses need to cover all relevant impacts of measures and activities, no matter where in the world these occur if they are regional or global in impact (e.g. LCA of bio-fuels). *[→ Analysts]*
  - The total impact of measures in terms of net global warming needs to be assessed, i.e. positive and negative effects over different pollutants need to be added (e.g. of PM traps for diesel, SCR for ships, ...). *[→ Analysts]*
  - The speed at which measures can be implemented should be considered, in terms of both the measures' ability to meet near term targets and avoid tipping points and their cumulative impact for both short- and long-lived substances and impacts. *[→ Modelling community, policy makers]*
- Research and analysis:
  - Best practice replication is important. Best practice examples should be collated to make them known to other countries and institutions. Especially for behavioural and structural change and demand management measures there are certainly close links

between the application of measures and the instruments used to implement them. *[→ All stakeholders - countries, NGOs...]*. The possible effects of best practice if they were replicated across Europe should be modelled. *[→ NIAM?]*

- Policy:
  - More action is needed on aviation and shipping. This includes measures for existing ships, such as SCR, as well as new. For aviation behavioural change may be most important. *[→ National decision makers, regional decision makers, IMO/ICAO]*
  - In road transport there is a need for refined air pollution and green-house gas emission standards. The levels of air pollutants and green-house gases are currently independent from each other and EURO standards do not differentiate air pollution standards by car size. Air pollution and green-house gas standards should be graded by car size. *[→ EU]*

Presentations

- Introduction on Working Group 4: Sector control policies - energy, transport, agriculture, consumer behaviour (Simone Schucht, INERIS/France)
- Results of research in NL on bio-fuels for transport, biomass for stationary sources, CCS for the power sector and industry, and small scale CHP (Pieter Hammingh, PBL/NL)
- Integrated implementation of air pollution and climate change policies: perspective of the power sector (Hélène Lavray, EURELECTRIC)
- The effects of specific measures in the transport area on the emissions of traditional APs and GHGs (Rafael Borge, UPM/Spain)
- Policies and scenario elements on integrated measures to reduce gaseous emissions from agriculture (José Martinez, CEMAGREF/France)
- Consumer behaviour and energy demand management (Mark Barrett, UCL/UK)
- "Soot Free for Climate" - German NGO Campaign on Climate Impact of Black Carbon Emissions (Dorothee Saar, DUH/Germany)

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Minutes of Working Group 5

Developing Countries

Working group coordinators: Hu Tao (China) and Kevin Hicks (Global Atmospheric Pollution Forum)

Background Presentations at Plenary sessions:

- Kristin Aunan, Cicero, Norway: *Combined air pollution and climate change policies in developing countries* (pdf 1 MB)
- Mylvakanam Iyngararasan, United Nations Environment Programme (UNEP): *Interlinkages and co-control in Asia* (pdf 2 MB)

Presentations in Working groups:

- *LRTAP outreach activities* (pdf 795 kB)
- *Climate Change and Air Pollution modeling at SMHI* (pdf 2 MB)

Introduction
The working group was attended by 21 people**,** representing twelve countries from Africa, Asia, Europe, Eastern Europe, Latin America and the Caribbean and North America.

The background questions for the Working Group 5 were as follows:

1. Can air pollution impacts be a main driver for policy on climate change mitigation in developing countries?

2. Can we identify air pollution **sources/sectors** where there is a big overlap between the emission of air pollution and climate forcers in developing country regions?

3. Which **policies** are being developed or imposed which address one only or both e.g. carbon tax (broad based), FGD?

4. What **measures** make the largest contribution to climate change and air pollution – e.g. technical options such as electric vehicles or improved efficiency?

5. What are the **opportunities for the mitigation** of short-term forcers in developing countries e.g. black carbon, methane and tropospheric ozone?

6. **Major barriers and opportunities** to dealing with these issues in an integrated way in developing countries? [Note: there are different layers of barriers and opportunities, such as institutional, economic, technological etc.]

7. If **funds** available to improve efficiency of energy use, clean energy and renewable energy options in developing countries, how can they be used wisely?

Finally, the group considered key conclusions and recommendations to specific addressees.

Record of discussion at the workshop

1. Can air pollution impacts be a main driver for policy on climate change mitigation in developing countries?

Basically the answer is yes, but the main driver for co-control policy in developing countries is sustainable development, including abating air pollution for human health, energy security, poverty alleviation, food and water security considerations and other MDG goals. Radiative forcing considerations can be included in 'smart' policies with implication that more intensive GHG emission cuts may also be needed elsewhere.

What are the motivations for co-control?

Two main reasons were put forward:

(i) Tackling air pollution and climate change issues simultaneously (e.g. CO_2 and SO_2) can be more efficient, avoid unwanted trade-offs and be cost-effective;

(ii) By using a wider definition of co-benefits, economic development, industrial competiveness and energy security could be included leading to a stronger focus on such issues as energy efficiency and more sustainable investments.

It was noted that it is, however, often a challenge to leap-frog from traditional end of pipe technologies to clean technology and broader energy and transportation system approaches. There is a need to develop strong incentives for co-control approaches including both carrots and sticks.

Who pays for co-control?

Potential financing could include:

- International society
- National and local governments e.g. subsidy for low C and low S economy
- Private sector e.g. investing for the future

The following general points were also made by the group:

- Theory of co-control often accepted but implementation lacking;
- Air pollution is a main driver as air pollution problems are very visible for local people and authorities;
- Main climate change focus is on adaptation with the expectation that developed countries finance mitigation;
- Integration of air pollution and climate change policies in a balanced way is still a long way off, there is however large regional variation in the stage of realization of co-control/co-benefits;
- Funders do not always pay the necessary attention to the local air pollution angle;
- National policy documents are needed to support the aspiration to implement co-benefit approaches;
- Care needs to be taken to avoid creating a new 'co-benefit' group/issue that needs to be addressed by policy makers, it is better to instead join all atmospheric issues and

promote an integrated approach in the context of sustainable development, human health, food security and energy security;

- Developing countries need help to build capacity and new technologies approaches etc

Regional considerations

Each region was discussed with some particular comments on each region in addition to the general points above.

Asia

China is taking actions. As of today, 50 cities are talking about low carbon economy plans and developing co-control strategies to maximize co-benefits. Implementation is difficult because of technical and institutional barriers but cities are willing to join if resources are available.

Awareness of the two problems is important for China and the possibility of hitting 'two birds with one stone' is attractive to the Chinese Government. But, the development of industrial competiveness and energy security with particular emphasis on renewables is also important e.g. there has been a dramatic increase in wind-power and domestic solar boilers.

End of pipe technology is available in China and if no CO_2 target then rational to have first generation policies first for developing countries like developed countries did. So the key question is how developing countries can to leap-frog to more efficiency based approaches.

There is an increasing awareness in India of the air pollution and climate change problems and India is embarking on a low carbon economy but more emphasis is needed on co-benefit possibilities to policy makers, e.g. diesel engines and biomass combustion are main contributors to black carbon emissions that are linked to accelerated Himalayan glacial melt.

In SE Asia, air pollution is a serious problem and is currently attracting attention from local people and authorities. Air quality management frameworks are already being formulated in many Asian countries. Recently, climate change issues are also gaining attention but it is just beginning as many donors have funded the adaptation rather than mitigation studies. Thus, air pollution is still the entry point to co-control in SE Asia.

Latin America (LAC)

Mexico is well advanced in its approach to air pollution and climate change. It has taken steps to improve air quality and has conducted integrated assessment for an air pollution and climate action plan (three categories: adaptation, mitigation and education). Within the transport sector a system of "no driving days" has been established with an exemption for cars that are less polluting etc. Many Mexican cities interested in CDM and learning from each other's experience

Mexico a little more advanced than other Latin American countries. No regrets policy to promote social development as well as environmental benefits and potential for cooperation between countries- south –south cooperation (Mexico-Brazil-Chile to others in LAC). However, Environmental Ministries still generally lack funding and there is therefore a need to raise the level of awareness and involvement of different sectors.

Africa

Sub-Saharan Africa experiences all the classic barriers to progress on the co-control issue, such as lack of awareness, financial resources and technical and personnel capacity. The political awareness of co-benefits needs to be raised. As for other regions the entry point is air pollution rather than climate change whilst recognising the varied stages of development in the region e.g. South Africa. A major challenge is technical capacity e.g. air quality monitoring programmes often need to be built up from basics.

Most climate debate in African countries is on ecosystem impacts affecting food and water security, with air pollution more focused on urban issues and the human health effects of particulate matter emissions. There is a need to bring these two sides together.

Africa has many problems that have higher priority than air pollution and therefore sustainable development is an important entry point to convince politicians of the advantages of co-control approaches. In Africa there is a perception that tackling air quality and climate change issues are barriers to economic development and this needs to be changed by prompting greater awareness of the benefits of co-control approaches. Also, the balance between adaptation and mitigation in Africa countries needs to be better understood and communicated to policy makers.

Across Africa there are some more advanced countries but incentives are required to promote low carbon/pollution development paths. For example, African country access to CDM projects could be much improved.

Eastern Europe
There is a large variation in the capability for tackling air pollution and climate change issues. As in most regions of the world there is also a lack of interaction between government departments. Climate change issues are in the public domain but governments do not see the urgency or the need for action.

2. Can we identify air pollution sources/sectors where there is a big overlap between the emission of air pollution and climate forcers in developing country regions?

Africa:
Biomass burning –open and waste
Savanna fires
Indoor air pollution from domestic heating and cooking
Transport
Industry and Mining (Metallurgical industry)
Thermal powerplants

Asia:
Combustion, black carbon from vehicles in urban areas
Rural and urban – indoor air pollution from domestic heating and cooking
Industry – industrial estates plus small and dirty industry near residency, brick kilns
Open burning of crop residue (becomes urban pollution very easily)
Forest fires – deforestation- slash and burn (SE Asia Haze)
Europe is a source of air pollution
Land fill fires especially East Asian countries is a big seasonal source

Eastern Europe
Russia vast territory with perma frost melt and methane emissions are increasing
Transport in cities.
Industry centralised
Seasonal burning of agricultural residues
Petrochemical
More coal in future as natural gas use declines
Georgia –deforestation

Latin America
[Nat. gas use is declining]
Mobile probably the most important – biggest and highest growth
Mobile sources NOx VOCS PM- diesel BC (PM 60% OC)
Biomass burning – (i) forest fires plus agricultural burning (ii) cooking is streets – burning of garbage
Powerplants using coal (Chile coal- Mexico high sulphur oil)
Brick Kilns
LPG for home heating and cooking producing low molecular weight VOCs- from propane butane etc
Solvents
Industrial and Mining

3. Which policies are being developed or imposed which address one only or both e.g. carbon tax (broad based), FGD?

Some countries (e.g. China) are considering carbon taxes but governments are generally reluctant because of social costs. Market instruments are implemented in some countries but they are not socially acceptable in others (e.g. Chile) as there is a reluctance to link environment regulation to market forces. Market instruments have the potential to target both air pollution and short and long-lived climate forcers simultaneously e.g. fees for vehicles and subsidies on household energy and renewable energy.

CDM has the potential to address air pollution and climate change simultaneously and needs to be developed further.

4. What measures make the largest contribution to climate change and air pollution – e.g. technical options such as electric vehicles or improved efficiency?

Improved fuels and more efficient fuel use in the domestic sector, improved fuels and vehicles in the transport sector and urban planning can make a big difference: e.g. Latin America – Mexico city example, Bus Rapid Transit; ultra low sulphur fuel; more energy efficiency in domestic sectors; school bus (i.e. policy of mitigation, adaptation and education); Hongkong metro is profit making; land-use planning integration with transport sector e.g. siting of schools; laws on biofuels and renewable energy use.

Indigenous techniques
In developing countries indigenous techniques may play an important role in finding practical solutions e.g. charcoal to replace biomass burning in domestic sector; use of specific types of

biomass (e.g. just branches and crop residues etc) instead of coal in rural countries; biochar (carbon negative) use as fertilizer; gasification of waste products.

5. What are the opportunities for the mitigation of short-term forcers in developing countries e.g. black carbon, methane and tropospheric ozone?

For black carbon transportation looks to be the most promising sector for intervention. Reduced coal burning in the domestic setting could also reduce black carbon emissions as well as provide substantial health related benefits. Biomass burning a big sector but there is still uncertainty over the relative contributions of sources to black carbon and other aerosols emissions with climate warming and cooling properties respectively. However, in developing countries the main drivers of air pollution abatement are human health and food and water considerations (and not radiative forcing considerations) so the focus becomes implementing policies in a 'smart' way that maximizes air pollution and climate change co-benefits.

For methane there is a large potential for integrated solid waste management and - controlled land fills.

For ozone, there is the link to its precursors such as methane, carbon monoxide, nitrogen oxides and volatile organic compounds and cuts in these can be achieved in the transport sector in parallel with black carbon controls. Forest fires and open burning of crop residues and solid wastes also emit a large quantity of black carbon and ozone precursors thus co-control can be implemented for co-benefit. However, ozone control has to be implemented with great care so that unwanted trade-offs can be avoided.

6. Major barriers and opportunities to dealing with these issues in an integrated way in developing countries?

The following major barriers and opportunities were identified:

(i) Lack of awareness of potential for co-benefits e.g. perception of air quality and climate change control as a break on development. Plus, lack of awareness of opportunities e.g. CDM (which could, for example, also include black carbon and ozone forming potentials into the carbon credits);

(ii) Varying stages of development with lack of capacity building; financing and technology exchange e.g. South- South and North South;

(iii) Need for much more interaction and integration of air pollution and climate change networks and exchange of information;

(iv) There are different layers of barriers and opportunities, such as institutional, economic, technological etc which need to be considered;

(v) Politicians need to see links between air pollution and climate change issues presented as economic costs and benefits of effects on health, water and food security, to make the benefits tangible;

(vi) Regionally specific data are very important for convincing politicians and policies need to be developed according to the needs of the different regions;

(vii) There is a need for the many relevant Multi-lateral Environmental Agreements (MEAs) to communicate more with each other e.g. there are many international conventions but secretariats do not communicate enough and a mechanism is required to coordinate and communicate (capacity building and outreach);

(viii) Services and products are globalized and there should be integration at all levels of governance;

(ix) UNFCCC already linked to all developing countries and could actively seek co-control policies and put them in national communication;

(x) Renewable energy is the best technology but still expensive so economies need to make conditions favourable.

7. If funds available to improve efficiency of energy use in developing countries, how can it be used wisely?

(i) Fund can be used for improving efficiency of energy use and the development of cleaner fuels and renewable energy;

(ii) Make CDM more flexible by adding requirement that air pollution reduction potential included (e.g. include air pollutants and short-lived forcers in CDM as one of most important considerations)
plus develop other mechanisms such as nationally appropriate mitigation actions (NAMAs);

(iii) Build on best practice around the world.

Main Conclusions:

- Many sources of atmospheric emissions in developing countries emit huge amount of air pollution and climate forcing agents, both short and long-lived. Tackling air pollution and climate change issues simultaneously (e.g. CO_2 and SO_2) can be more efficient, cost-effective and avoid unwanted trade-offs;

- Co-control for co-benefit is already being practiced in some developing countries. The priority for developing countries is, however, still air pollution, health and other aspects of sustainable development, including energy security. Thus, the entry point of co-benefit for developing countries is still not climate change. Recognizing this important point would help to sustain the efforts initiated by international agencies in developing countries to obtain the co-benefits;

- Generally, the awareness of many of the major stakeholders (e.g. public, governments, donors and international organizations) on co-benefits issues needs to be raised significantly along with enhanced communication amongst the various international agreements on air pollution and climate change.

- Regionally specific data are very important for convincing politicians of the need for co-control approaches and policies need to be developed according to the needs of the different regions. Politicians need to see links between air pollution and climate

change issues presented as economic costs and benefits of the impacts on health and water and food security, to make the benefits tangible;

- There is need to promote co-control for developing countries through mechanisms that already exist such as CDM that should incorporate air pollution and other short-lived forcers. Ozone air pollution could be considered in co-benefit approaches along with black carbon as both impact of human health and climate. Ozone also affects ecosystems which can impact on crop yields and food security.

- Developing countries need to find ways to 'leap-frog' from traditional end of pipe technologies to cleaner technology and broader energy and transportation system approaches. There is a need to develop strong incentives for a co-control approach including both carrots and sticks.

Recommendations to Addressees:

- Co-control policies for air pollution and climate change can bring considerable economic benefits as well as afford protection to the climate, human population and the environment (Development organisations and National Governments);

- Local government priorities are important to drive development of co-control policies e.g. low C and low S economy (National Governments and Development organisations);

- The GAP Forum and other similar bodies should continue to build links between regional agreements and networks for air pollution and climate change to enhance exchange of knowledge and information (GAP Forum, UNEP);

- It is easier to achieve UN Millennium Development Goals if air pollution is considered in an integrated fashion, especially as air pollution issues often affect the poorest and most vulnerable members of society (UNEP, Development organisations and National Governments);

- A good governance system for Multi-lateral Environmental Agreements (MEAs), such as the climate and air pollution related conventions is needed, to enable better coordination and communication and a more integrated overall approach to make co-control approaches more achievable (UNEP and National Governments);

- The UNECE LRTAP Convention needs to greatly improve its outreach and could make a valuable contribution to capacity building and science to policy know-how needs of developing countries around the world (UNEP and National Governments);

- A financing mechanism needs to be established for the development of co-control approaches in developing countries (UNEP, Development organisations and National Governments);

- Much of funding from development organisations has shifted to climate change mitigation and adaptation, decreasing the interest in air quality. Funding should reflect the integrated nature of air pollution and climate change problems and include air

pollution as an important driver. Air quality capacity in developing countries should be strengthened. (Development organisations);

- There is a need to generate regionally specific data and knowledge on both air pollution and climate change for more effective communication with regional policy makers. There is a need for more longer-term projects that finance capacity building and technology transfer. (Development organisations, regional air pollution organisations, GAP Forum and UNEP).

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Report Working Group 6:

Which international platform? Linking air pollution control to climate change policies.

Working group coordinators: Richard Ballaman, Swiss federal Office for the Environment, Switzerland, Terry Keating, US EPA and Jan Wijmenga, Ministry of Housing, Spatial Planning and the Environment, The Netherlands

Background presentations at Plenary sessions:

- Mylvakanam Iyngararasan, United Nations Environment Programme (UNEP): *Interlinkages and co-control in Asia* (pdf 2 MB)
- Dallas Burtraw, RFF, USA: *Co-control – An American perspective* (pdf 595 kB)
- Marianne Wenning, European Commission: *Air pollution and climate change policy – A European approach* (pdf 427 kB)

Presenations in Working groups:

- *What is needed to develop a more effective global framework for integrated climate-pollution management?* (pdf 53 kB)
- *Inter Linkages and Co-Control: Asian Perspective* (pdf 2 MB)
- *Which international platform? Linking air pollution control to climate change policies* (pdf 103 kB)
- *Addressing SLCFs in UNFCCC* (pdf 514 kB)
- *Arctic Shortlived Forcer Effort: Regional Means to Global Action?* (pdf 268 kB)

Introductory Presentations

The working group began with a series of short presentations discussing the lessons that can be learned from some past, current, and proposed efforts. The presentations addressed:

- Perspectives from the Global Air Pollution Forum
- Arctic Short-Lived Forcer Effort
- Addressing Short Lived Climate Forcers (SLCFs) in UNFCCC
- Lessons from the European Nitrogen Assessment

Questions for Discussion

The co-chairs posed a series of questions for discussion that had been posted for consideration before the meeting. The questions were as follows:

- What is the likelihood of addressing the short lived climate forcing impacts of air pollution in the IPCC and UNFCCC?
    - What are the advantages and disadvantages of doing so?
    - What is coming from UNFCCC in form of air pollution abatement (e.g. ground-level ozone precursors such as methane emission reduction)?
    - What are the bottlenecks to make air pollution abatement a contribution to climate change policy more systematically?

- What other cooperative frameworks are available for addressing these issues?

Examples	Binding Agreements	Voluntary Cooperation
Global	Vienna/Montreal, Stockholm, UNEP Mercury	GAPF, IGBP/IGAC, Methane to Markets
Regional	LRTAP Convention (EMEP), Male Declaration	Arctic Council (AMAP), CAI-Asia, EANET

- What frameworks may be successful in engaging China, India, Russia, and developing countries?
    - What frameworks have been successful in changing perceptions of national self-interests and, ultimately, national policies?
- What role may existing regional institutions addressing air pollution (LRTAP Convention, Male Declaration, EANET, …) play in the future at the scientific / policy level?
    - Is there a role for linking existing efforts under a global umbrella?
    - What would such a global umbrella look like?
    - What is the role of UNEP, WMO, WHO?
    - Is there a need for an "Intergovernmental Panel on Air Quality (IPAQ)"?
- What is the role of international financing mechanisms (e.g., GEF, World Bank, regional development banks, …) in addressing these issues?
- What have we learned about these issues from the Global Air Pollution Forum?
- How to use and optimize the synergies with avoiding the trade offs by abatement strategies?

Conclusions from the Discussion

- Over the next two years (2010-2011), a number of international scientific assessment processes are expecting to produce conclusions and a number of relevant intergovernmental forums are scheduled to meet (including the UNEP Governing Council, the Arctic Council, the Executive Body of the LRTAP Convention, the Intergovernmental Body of the Malé Declaration, and others). This creates a window of opportunity to make significant progress in addressing the role of air pollution in near term climate forcing.

- No one international forum will be able to handle all aspects of the air pollution – climate linkage. UNFCCC and IPCC should address SLCFs, but can not be the only forums to address these issues. UNEP is a key forum for connecting to national environment ministries. WMO (GAW, WCRP) can be useful in connecting to the global science community. At the current time, we are not ready to launch a new global intergovernmental panel to address these issues.

- There is a clear need for funding specifically for developing countries for air pollution capacity building and mitigation efforts.

- Similar to the evolution of the POPs issue, the Arctic Council has begun to address the issue of SLCFs. The LRTAP Convention could take the next step in incorporating some SLCF mitigation into a binding agreement in the revision of the Gothenburg Protocol. Later, the issue may be addressed at the global level or in other regions.

- Currently, a network of regional initiatives may be more useful than a binding global agreement to address air pollution and climate change.

- As a first step, UNEP has begun the development of an assessment report addressing black carbon and tropospheric ozone to be completed by the end of 2010. This assessment provides an opportunity to coordinate existing air pollution efforts in different regions and to identify abatement measures that have benefits for air quality and climate change mitigation.

Consensus Recommendations

UNFCCC / IPCC

- The IPCC Plenary is meeting next week to discuss the content of Assessment Report 5 (AR5). National representatives should request that IPCC AR5 address air pollution – climate change linkages (especially in WG3) and the air quality community should take an active role (as authors) in the IPCC process to address these issues.
- National representatives to the UNFCCC should explore the concept of "a work programme" to address SLCFs (as proposed by Micronesia), including efforts that address the linkage between air quality and climate change.
- National representatives to the UNFCCC should support efforts to give greater weight to CDM projects that have co-benefits for reducing air pollution and allow inclusion of SLCF mitigation as appropriate National Appropriate Mitigation Actions.

Arctic Council

- Arctic Council member and observer states should support the efforts on SLCF, including the work of the SLF Task Force and AMAP, and should consider implementing mitigation actions at the national level.

UNEP / WMO

- The air quality and climate change expert communities should actively participate in the writing and review of the UNEP Black Carbon/Tropospheric Ozone Assessment. The authors should focus the assessment on identifying available solutions or mitigation options. WMO is encouraged to formally co-sponsor the Assessment. The UNEP Governing Council is requested to take note of the Assessment at its next regular session in Feb 2011 and identify future action. Countries should consider possible responses.
- National governments should support engagement of WMO and the science community to address SLCF, building upon existing global scientific frameworks.

LRTAP

- In the revision of the Gothenburg Protocol, the LRTAP Convention should consider the adoption of measures that address short-lived climate forcers and the co-benefits of air pollution control and climate change mitigation, including Black Carbon, CO, and methane. EGTEI (working with AC/SLFTF) should identify the emission reductions for soot from proposed measures to reduce fine particles. TFIAM should explore the potential benefits of simultaneously addressing Air Pollution and Climate Change using the full mode of GAINS.
- LRTAP EB should consider creating an adhoc expert group (work with EGTEI, TFIAM, TFHTAP, AC/SLFTF) to help communicate to policy makers the rationale for taking action on these issues within the LRTAP Convention to report back by Dec 2010. This expert group should be open to participation from experts outside the UNECE and should link with the UNEP Assessment process.

Other Regional Initiatives

- Other existing and emerging regional initiatives should consider appropriate mitigation actions and capacity building activities that directly address SLCFs.

National Governments

- National governments should support collaboration and communication between existing regional networks and intergovernmental agreements (in North America, Europe, and Asia), including financial support for Global Air Pollution Forum and new emerging regional networks (in Latin America and Africa). LRTAP Parties are encouraged to provide greater support for outreach efforts (capacity building, awareness), including disseminating information on SLCFs and identifying mitigation strategies appropriate for developing countries' networks.
- Given the lack of adequate funding from existing mechanisms, countries are encouraged to establish targeted funds to address SLCFs (e.g. Global Methane Fund, Global Clean Cooking Fund) and to support regional air pollution cooperation and networks (e.g., emerging networks in Latin America and Africa).

Participants

Working group 7

Costs and benefits from combined policies

Working Group Coordinators: Andew Kelly, AP EnvEcon ltd, Ireland and Julio Lumbreras, Technical University of Madrid (UPM), Spain,

Background presentations at Plenary sessions:
Markus Amann, IIASA, Austria: *Options for co-control over the next 20 years* (pdf 1 MB)

Presenations in Working group:

- *Cautionary tales on the co-benefits of VOC reductions* (pdf 591 kB)
- *Costs & benefits from combined policies* (pdf 1 MB)
- *Benefits of a joint approach of air pollution and climate change* (pdf 1 MB)

Introduction

Air pollution and climate change are intertwined at many levels. They are often driven by common sources, share reactions to specific substances and interact within the same atmosphere. Nevertheless this connection does not yet extend sufficiently into the policy arena, and in this respect there is the potential for suboptimal strategies to evolve. Implementation of the aspirational targets for climate control (the 2 degree-target) could offer considerable co-benefits for air pollution, provided that technologies that would create additional air pollution (e.g. woodstoves, 1st generation biofuels and CCS) are avoided. Similarly, transboundary air pollution control can lead to co-benefits in the context of climate ambitions. Ultimately it depends somewhat on the perspective of the policymaker and ideally this should be changed such that the perspective encompasses both areas in an integrated fashion. Such integration is important not only for fully informed decision making, but also because a failure to consider the extended implications of policy actions may lead not only to a loss of co-benefits, but additional cost from policies with damaging outcomes to one of the two fields.

Within this intertwined framework, cost benefit analysis can be a useful tool to evaluate, in a holistic manner, the valued impacts of policies and measures. However, in assessing the cost and benefits of climate and air policies together, the boundaries for considerations can be drawn quite broadly. Economic feedback mechanisms, the role of short lived climate forcers, trade-offs, co-benefits, discount rates and relative pricing are just some of the considerations that present themselves.

The manifold and urgent environmental management challenges facing the world add pressure to research and policy. The interface between these two is important, and cost benefit and related evaluation methodologies have a role to play in guiding policies. There is complexity and uncertainty, but there is pressure on decisions and actions will be taken.

In this context the principle aims of this workshop were:

- To identify the considerations of cost and benefit estimation and to move towards agreement over best practice (e.g. balancing data requirements with sufficient scope)

- To discuss specifically some of the considerations associated with modelling of costs and benefits from combined policies

The session included presentations from Kelly, Maas and Holland and a reasonable portion of time was devoted to building a discussion matrix of 'category end-points' (e.g. health, risks) – and disaggregated components related to these (e.g. vector borne diseases, PM related heath issues or fire and flood risk) that could be considerations of broad integrated CB analysis of air and climate policy outcomes.

The working group also tried to touch on the following questions:

- How to assess cost and benefits in both areas?
- How to include this into the related policy modelling processes?
- Are the boundaries wide enough for cost and benefit considerations?
- What are the barriers to implementation of seemingly CB approved options? Agency problems?

Further points or raised topics included the following. Some were linked to ultimate conclusions and recommendations to the meeting:

- The importance of integration of equity into CB frameworks
- The balance between rigorous complexity and practical simplicity in the boundaries for CB analyses.
- The potential for short-term policies to discourage long-term vision e.g. refit vs. decommission
- The importance of addressing and communicating uncertainties in research outcomes
- The relevance of economic and biogeochemical feedbacks and so forth.
- Identification of the issues with valuation of impacts/benefits for some components e.g. biodiversity
- The relevance of include indoor air quality to valuations on health – particularly in developing world.
- Examples of managing AQ in terms of longer term CC policies. Transition plans and visions.
- The importance of other evaluation mechanisms for decision makers – MCA, CGE modelling
- Importance of considering opportunity costs in decision making. Not hiding trade-offs entirely with monetary valuations. Provide detail.
- Cost-effectiveness vs. efficiency

Conclusions - Findings

- The full integrated assessment of impacts from emissions of both air pollutants and greenhouse gases is extremely challenging. CBA and other evaluation techniques can play an important role in supporting intermediate air & climate policy making.
- Health (e.g. AP related health impacts, heat stress and vector borne diseases), food risks (e.g. temperature, global dimming and ozone) and water availability (e.g. ice melting, floods and droughts) are likely to make up the greatest part of the effects within AQ and CC over the next 20 years.
- Biodiversity effects are more challenging to value in monetary terms but are an indispensable part of the framework to support decision takers.
- The choice of temporal and spatial boundaries, atmospheric and biogeochemical responses, and economic feedback mechanisms can dramatically change cost-benefit results.
- Costs from behavioural change are difficult to value. It is also complicated to know the real barriers to implementation of low cost measures (e.g. structural and behavioural).
- One way of linking air and climate policies is to focus on the short-term climate impacts from air pollutant reductions.
- Ambiguity in the presentation of results and recommendations from the science community is understandable given the complexities. However, this can limit the value of results to the policy making process.
- Clear vision of intermediate and long term air & climate targets and measures from policymakers would aid the scientific community in structuring their research priorities.
- There are specific examples of policymakers devolving some political power to scientific community in well defined areas of research (e.g. central banks, fisheries).
- Geoengineering is relevant in the cost-benefit debate. An apparent low cost opportunity to address global issues must raise important questions with regard to governance (i.e. who decides if action can or should be taken?).

Recommendations

A) Cost-benefit

1. In the evaluation framework in addition to current CBA knowledge, consider (at least qualitatively) broader health effects, food risks, social migration, water availability and biodiversity. Recommendation to consider studies on value of additional information from the research community. Utilise to target research priorities.
2. As current cost benefit techniques as applied in AP policy in Europe have limitations:
    - Non-monetary metrics (e.g. biodiversity indicators, GWP) and other methodologies such as MCA can be used to supplement policy making advice

- CBA or MCA should consider temporal and spatial boundaries, atmospheric and biogeochemical responses, and economic feedback mechanisms
- For broader and longer term policy plans alternate evaluation techniques such as CGE should be used.

3. Research should focus on cost estimation and implementation of structural and behavioural measures (taxation, elasticities, barriers for their implementation, agency problems etc.)
4. CBA research should also take into account the short term climate effect of air quality policies. Currently the climate related impacts of tackling these short lived species are not captured in CBA – e.g. ambitious sulphur measures require further analysis.

B) Air-Climate linkage

5. Scientists should be more conscious of the information relevant to the policy process. Results should be accompanied by both uncertainty analysis and recommendations. These may include meaningful indicators and ideas on how to deal with uncertainty in the policy process.
6. Policymakers should support the integration of air and climate research by bridging the respective short and long term focus of policies. This includes a vision of coordinated intermediate and long term targets and measures for both air pollution and climate change.

C) Organization

7. Create/include a global atmosphere convention as a framework for the management of the atmosphere (coherent air and climate policy)
8. Incorporate CBA discussion in task forces or working groups (TFIAM/IPCC)

Partcipants

Working Group 8

How to develop optimal time-framed air pollution and climate change policies for the next decades?

Working Group Coordinators: Bill Harnett, US EPA and Martin Williams, Defra, UK

Background presentations at Plenary sessions:
Harald Dovland, Ministry of the Environment, Norway: *Air Pollution and Climate Change – Where to address particles in international environmental regimes?* (pdf 175 kB)

Presenations in Working group:

- *Policy options for HFCs and black carbon* (pdf 1 MB)
- *Air Pollution/Climate Linkages in an Atmosphere of Urgency* (pdf 1 MB)

Background
National, regional and international air pollution control efforts can play an important role in reducing climate change, including the reduction of short-term forcers such as black carbon, tropospheric ozone, hydroflurocarbons (HFCs), and methane. Such authorities face the challenge of developing additional policies to take this into account in their work, along with the trade-offs between air pollution and climate change. It also is important for these authorities to continue to recognize the importance of public health protection from air pollution effects while addressing the issue of climate change and to develop optimal strategies to address both air pollution and climate change. The co-benefits that will be achieved from a holistic policy approach will be more effective than separate policies and often can be deployed more quickly than other climate policies, and can produce a faster response from the climate system.

This working group discussed the most appropriate paths to make a critical difference and how to begin fast action. There are successful existing agreements and networks in place that can address the synergies and trade-offs of air pollution and climate change now without replacing ongoing efforts. It is necessary to take action to fill information gaps, assist developing countries, and show vision and leadership.

Conclusions
1. The efforts to proceed urgently in the UNFCCC to address CO2 should not slow down while taking steps to address the interactions between climate change and air quality. National authorities should consider CO2 abatement measures, in the short-term and long-term, which would contribute best to address air pollution.

2. More effort is needed to raise the profile of the links with air pollution within the climate change arena. Work will continue post-Copenhagen on black carbon and tropospheric ozone (e.g. UNEP Assessment, Arctic Council Task Force) as well as on HFCs (e.g. Montreal Protocol) and methane (e.g. Methane-to-Markets). It is not clear what actions will be taken based on their results.

3. The climate impact of short-lived climate forcers (SLCFs) is substantial and hence reductions in, black carbon, global ozone, methane, and HFCs would significantly mitigate near term climate change and contribute to the achievement of long-term climate targets (e.g.,

the overall global mean surface temperature increase should not exceed 2 degree Centigrade above pre-industrial levels).

4. Agreements on emission reductions of SLCFs may proceed faster at the national and regional level. In particular, agreements will go faster if existing national and regional structures are used. International coordination could also be helpful to harmonize, promote and strengthen these efforts. Additional international efforts also may be warranted.

5. Examples of existing institutional structures that can help with climate mitigation include the use of CLRTAP and the Montreal Protocol. The CLRTAP is a successful multi-national emission control instrument and could play a leading role in building regional instruments around the world. It could supplement the work already begun through its outreach activities and by the Global Atmospheric Pollution Forum.

Recommendations

1. UNEP, CLRTAP and other relevant institutions should review existing national, regional, and international air pollution control efforts to determine where they can be effectively used to help mitigate climate change. (UNEP, CLRTAP, international organizations)
2. Extend the revision of the CLRTAP Gothenburg Protocol to include consideration of the climate effects of air pollutants. This should include the control of black carbon and tropospheric ozone and its precursors. (CLRTAP)
3. Create a Task Force[3] under CLRTAP to investigate the physical and economic aspects of climate change and air quality interactions. Take note of and coordinate with the work going on under UNEP and the Arctic Council on SLCFs. Set a 1-year timeframe for the Task Force to provide the first report and recommendations to the Executive Body and the Working Group on Strategies and Review to include in the Gothenburg negotiations. Align resources within the Convention accordingly. (CLRTAP)
4. UNEP, CLRTAP, and other relevant institutions should provide outreach to developing nations either directly or through regional networks to assist in the creation of policies to address SLCFs. Investigate the potential and appropriateness of financing mechanisms for emission reductions of SLCFs. (countries, international organizations, UNEP, CLRTAP)
5. Explore the need for developing a protocol to address background ozone on the hemispheric scale with potential participation of all countries in the Northern Hemisphere. (CLRTAP, UNEP)
6. Establish stronger links between relevant bodies in the air quality and climate change areas. (CLRTAP, UNFCCC, IPCC, UNEP)
7. Take on board in the fifth assessment report an analysis of the air pollution benefits and disbenefits. (IPCC)

[3] The working group discussed several ways in which to organize the work under CLRTAP. At least one member believes it would be a better approach to have all the relevant Task Forces under CLRTAP address the issue rather than starting a new one.

Partcipants

Workshop Program

Monday 19 October

Plenary Session 1
Chair: Anna Engleryd, Sweden

- Opening speech. *Minister of Environment, Andreas Carlgren, Sweden*
- Climate and air pollution – trends and control. *Jacqueline McGlade, EEA*
- Supporting the Climate change policy system. *Harald Dovland, Ministry of the Environment, Norway*
- Particles – the dark horse in climate and air pollution policies. *HC Hansson, ITM, Sweden*
- Combined air pollution and climate change policies in developing countries. *Kristin Aunan, Cicero, Norway*
- Options for co-control over the next 20 years. *Markus Amann, IIASA, Austria*

Plenary Session 2
Chair: Peringe Grennfelt, Sweden

- How have atmospheric pollutants been treated within IPCC? *Joyce Penner, University of Michigan, US*
- How will control of ozone precursors influence air pollution and climate change? *David Fowler, CEH, United Kingdom*
- Nitrogen management as an option for air pollution and climate change abatement. *Jan Willem Erisman, ECN the Netherlands*
- Combined effects of climate change and air pollution on human health. *Bert Brunekreef, University of Utrecht, Netherlands*
- The ACCENT Network of Excellence - contribution to policy development. *Sandro Fuzzi, Institute of Atmospheric Sciences and Climate, Italy*
- The influence of climate change on air pollution dispersion and effects. *Øystein Hov, met.no, Norway*

Tuesday 20 October

Plenary Session 3
Chair: Sonja Vidic, Croatia

- Interlinkages and co-control in Asia. *Mylvakanam Iyngararasan, United Nations Environment Programme (UNEP)*
- Co-control – An American perspective. *Dallas Burtraw RFF, US*
- Air pollution and climate change policy – A European approach. *Marianne Wenning, European Commission*
- Introduction to working groups

- Working groups

Within each working group, there were short presentations. The coordinators of each group handled the program.

Wednesday 21 October

Plenary Session 4
Chair: Rob Maas, The Netherlands

- Reflections for the future. *Harald Dovland, Ministry of the Environment, Norway*
- Reports from the working groups

- Conclusions from the workshop
- Closure of the workshop

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