Working group 2:

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

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

<u>General</u>

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.

<u>Ozone effects and climate change</u>

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)