Review of EC4MACS models

5 October 2009

Process: more feedback during the review meeting than during the internet consultation !

General conclusions

- The current EC4MACS modelling system is sufficient to describe baseline developments, but we have to be aware of possible systematic biases.
- EC4MACS-baselines are driven by extrapolations and external assumptions (SCENES, POLES, ESIM. EFMA). No feedbacks from the limited natural resources (land, freshwater at global level), limited infrastructure (road, rail, electricity grid), environmental quality; thus EC4MACS might overestimate growth, energy use, land use & emissions especially in the long term (2050).
- Transparency & communication are crucial for acceptance of EC4MACS outcomes and use in policy processes. IAM-community is invited to define what input & output data should be available. Procedure to request changes should be made clear.
- The performance of the full EC4MACS-system to analyse alternative scenarios is not tested → how to deal with new technologies (electric vehicles & heating), behavioural change, aging, dematerialisation of the economy?
- Impacts estimates depend on spatial resolution: we might underestimate effects to sensitive receptor(-areas)
- Benefits estimates should be made more robust using sensitivity analysis.

EMEP review of GAINS, September 2009

1. GAINS is based on best available science.
2. Large uncertainties in PM2.5 emissions and dispersion
   → policy advice: reduction targets, no absolute ceiling
3. Uncertainties in European background concentrations of ozone
   → sensitivity analysis
4. Ozone targets based on health protection and vegetation damage (flux approach) would extend policy attention from southern to central Europe.

5. Debate in TFIAM:

- Use of sector specific SRMs. General SRMs might overestimate local benefits of emission reductions of high stack sources.

GAINS review today

- Use of GAINS-full mode is technically possible (if required by policy makers).
- Abatement potential & costs in GAINS seem to be conservative: how to analyse premature scrapping, insulation of houses, life style changes, new technologies, economic feedbacks, GHG-emissions trading?
- How to construct 2050 figures?

- Distinguish different PM-components
- Present AP & GHG emissions results jointly.
- GAINS impact outcomes should include radiative forcing.
- Sensitivity analysis, sensitivity analysis, sensitivity analysis …

Recommendations Review March 2009

- The model doesn't yet take into account emission trading. It is recommended to add an emission trading module both for the ETS-sector within the EU and for the trading of emission credits among EU27-countries and other Annex-1 countries.
- The scenario horizon is 2030. In order to be able to explore the full potential of measures (and to avoid a lock-in of strategies that are less favorable in the long run) it is recommended to extend the time horizon to 2050.
- Cost-curves for climate mitigation options are currently published for the EU27 in total. In order to increase the transparency of the model and stimulate the use of GAINS for national policy analyses, it is recommended to also make the cost-curves available for each EU27 country separately.
- In GAINS several greenhouse gas measures (such as energy saving) appear to have negative costs when a 4% discount rate is applied. In reality these measures are not taken, because private decision takers (consumers or producers) in practice apply a higher discount rate. GAINS now enables users to apply a sensitivity analyses with a 20% discount rate used for greenhouse as mitigation options only.
- GAINS does not include behavioral changes (e.g. more use of lighter cars, more public transport, less air traveling, less international road transport, less meat consumption or less use of heating or air conditioning in buildings). The potential effects of such changes could be illustrated via sensitivity analyses, with an indication of the available instruments to implement such changes.

Review March, ctnd

- GAINS currently contains more than 300 abatement measures. Each measure can have a simultaneous effect on several pollutants. Either there is a synergetic or an antagonistic effect. For some measures these relationship need to be further explored, e.g. the relation between dietary changes for animals to reduce methane or ammonia emissions, or the effect of ethanol production on the quality of animal fodder and the emissions of NH3. For carbon capture and storage and for biofuels several options should be distinguished. The challenge is also to take into account the costs and effects of more complex system changes (such as the development of a 'supergrid' to enable better exchange of renewable electricity over Europe).
- It is recommended to add black carbon as a pollutant in GAINS, as it both influences radiative forcing and health effects.
- GAINS is able to show trade-offs and synergies between various endpoints. It is recommended to illustrate these characteristics via publications showing the relationship between radiative forcing and local health benefits, the cost-effectiveness of methane emissions in China and India for SOMO35 in Europe, and the optimal timing of abatement measures for SO2 and black carbon (using the dynamic characteristics of the ecosystem models and the climate system as well as estimated effects of climate change on vegetation). The relationship between nitrogen deposition and carbon sequestration is also a point to explore.
- The flexibility of GAINS could be increased if its dependency on PRIMES-scenarios can become somewhat less. It would be useful if GAINS could also be used for sensitivity runs on various oil prices, carbon prices or economic developments. The analysis of the possible effects of the current credit crisis offers an opportunity to introduce the non-recursive effects of a decline in production that would especially influence the older (less efficient and more polluting) capital vintages.

Conclusions EMEP-SB, september 2009

- Current status of knowledge was comprehensively covered; the review had confirmed the usefulness of the GAINS model to support the revision of the Gothenburg Protocol; and uncertainties had to be communicated clearly;
- The modelling framework had improved considerably in the past years and Parties had submitted improved input data; further work was necessary to improve PM exposure, eutrophication of selected receptors, and the links with climate change and long-term ozone exposure;
- The accuracy of the input data depended fully on the quality of data submitted by Parties; Parties should continue improving their data; and current inaccuracies in emission data would require quantitative uncertainty analyses to assess the error propagation in the GAINS model;
- Possible systematic biases required additional sensitivity analyses by the GAINS model, e.g. on background ozone boundary conditions;
- **Absolute emission ceilings for PM would be difficult to set due to current uncertainties in PM emissions but relative emission reductions would be practical at this stage;**
- Past experiences confirmed that emission reduction requirements had not been overestimated.

Review by EMEP-SB, september 2009

- CEIP and CIAM concluded that PM2.5 emission data were significantly more uncertain than the pollutants regulated by the Gothenburg Protocol. For many countries PM2.5 emission data were lacking or incomplete. However, in many cases where reported emissions exceeded the estimates by GAINS that were derived from statistical data on activity levels. The centres recommended to further analyze the substantial differences in emission factors reported by countries.
- MSC-W concluded that the nitrate chemistry and the meteorological input data had been updated with the best available scientific knowledge. These improvements had not caused systematic changes in source-receptor relationships.
- **MSC-W further noted that the model still substantially and systematically underestimated PM2.5 concentrations and secondary inorganic aerosols. Possible explanations included missing anthropogenic sources, residence time, transboundary transport lacking knowledge on biogenic production of secondary organic aerosols**.
- **TFHAP concluded that estimates of the rising background concentrations of ozone in the Northern Hemisphere showed large differences. The best estimate of 1.2 parts per billion (ppb) per decade increase is used in the GAINS model. TFHAP recommended sensitivity analyses on other values (which?). It concluded that the anthropogenic contribution to hemispheric ozone formation might be underestimated. Methane emission reductions anywhere would reduce global ozone background concentrations, and the largest cost-effective potential were in developing countries.**
- **MSC-W concluded that by including ozone flux to forests and vegetation in the GAINS would prevent a systematic policy bias. Health protection target only would not be sufficient to avoid ozone damage to vegetation and forests in the central and northern parts of Europe. Additional data for forests and soils would be needed to assess potential ozone impacts on carbon sequestration in collaboration with the Working Group on Effects**.
- TFMM concluded that models still showed a systematic underestimation of the population exposure to PM2.5. Urban emission estimates indicated differences between countries for wood burning and transport emissions. It recommended improving access to urban input data e.g. by using satellite information, model comparisons and verification with observational data.