ECLIPSE project – WP7: Co-benefit of Air Quality and Climate Impact Analysis and Policy Strategies

Objectives

The overall goal of this work package is to develop and assess possible effective emission abatement strategies for aerosols (including black carbon) and for the gases not included in the UNFCCC (e.g. ozone) and their corresponding precursors to mitigate climate change and to protect the quality of air. Furthermore, interactions with mitigation strategies directed at long-lived GHGs will be explored.
More specifically, this work package aims to:
O7.1 – Develop sets of promising measures that result in effective improvements for near-term climate change, long-term climate change and air quality, respectively.
O7.2 – Identify set of measures that maximize co-benefits between near-term climate change, long-term climate change and air quality, and minimize trade-offs between these objectives.
O7.3 – Validate, for key mitigation scenarios, the performance of the proposed climate metrics against the full model calculations
O7.4 – Develop robust policy conclusions about mitigation strategies that account for effects of uncertainties.
O7.5 – Explore various options for addressing short-lived components in global or regional climate policies
WP7 contributes to the following project objectives (see section B1.1): O7, O9, O10, O11

Description of work

This work package will employ the new insights generated by ECLIPSE on emissions of short-lived substances and their climate impacts to explore possible effective emission abatement strategies to mitigate climate change and to protect the quality of air. For this purpose, WP 7 will introduce new information on emissions and climate metrics into the GAINS model, which is currently used, inter alia, by the European Commission and the Convention on Long-range Transboundary Air Pollution, as a policy analysis tool for air quality and GHG mitigation measures accordingly. With these new features, GAINS will be used to explore robust mitigation strategies for Europe and China that maximize synergies between air pollution control and climate change at different time scale.

T7.1 – Implementation of new information on emission inventories for short-lived substances, climate metrics and corresponding source-receptor relationships into GAINS (responsible: IIASA)
This task will implement the relevant outcomes of other WPs into the operational version of GAINS model, so that the results of ECLIPSE could be readily used by European and Chinese decision makers for extending ongoing policy analyses on air quality towards climate forcing. Work will (i) update information on emissions and mitigation potentials for short-lived substances, and (ii) introduce the new quantifications of climate forcings developed in T4.2 in terms of GWP, GTP and the new metrics developed in WP 5. This will be done for various time horizons. Furthermore, the GAINS optimization routine will

be extended to consider constraints related to the new climate impact indicators that result from the different metrics, in addition to constraints on the various air quality impacts. This extension will enable the GAINS model to identify sets of measures that simultaneously achieve improvements for regional air quality and different climate metrics at least cost.

T7.2 – Select sets of promising of measures that achieve climate and/or air quality targets (responsible: IIASA, Tsinghua Univ.)

This task will identify sets of promising measures that achieve significant improvements for three baskets of impact indicators, i.e., for (i) near-term climate change, (ii) long-term climate change, and (iii) air quality impacts on human health and ecosystems.

Drawing on the baseline scenario developed in WP 1, the GAINS model will be used to identify sets of measures that are effective for impact categories, to estimate their costs, and estimate their co-benefits on air quality and climate change objectives. The GAINS model holds currently about 2000 concrete measures to reduce emissions of short- and long-term substances, and assesses the simultaneous impacts of these measures (i.e., co-control) on emissions of SO_2, NO_x, VOC, NH_3, BC, OC, $PM_{2.5}$, CO, CO_2, CH_4, N_2O and F-gases. The analysis will identify a subset of measures that are particularly effective in view of specific environmental targets.

The following packages of measures will be developed:

T7.2a) The top-20 measures for reducing near-term climate change.

For the key metrics for near-term climate change developed under WP 5, the 20 measures will be identified that achieve the largest global improvements for the chosen metric. Thus, the selection criterion for these sets will be their impact on metric-weighted emissions irrespective of their costs. Measures will be grouped into a) technical measures, b) non-technical measures, and c) maximum feasible technical reductions. These sets will be identified at the global level as well as for the case study regions, i.e., Europe and China. The analysis will consider uncertainties in the quantifications of the climate metrics for different gases.

T7.2b) The most cost-effective measures to limit near-term climate change.

This set of measures will consider costs of measures, and choose those measures that achieve in each region the same climate impact as the measures in T7.2a, but at least cost. This is expected to result in a larger set of measures, but will involve lower costs. For this purpose, the GAINS optimization tools will be employed, which will however limit the analysis to the case study regions Europe and China.

T7.2c) Measures to achieve long-term climate targets

This analysis will employ the 450 ppm stabilization scenario of the World Energy Outlook of the International Energy Agency and estimate its consequences on the emissions of short-lived climate forcers, on the different metrics for near-term climate change, and on air quality. This analysis will be carried out at the global scale, and measures will be explored in more detail for the case study regions Europe and China.

T7.2d) Cost-effective measures to improve air quality

Measures will be identified that achieve air quality levels that safeguard human health from exposure to $PM_{2.5}$ and ground-level ozone as well as ecosystems from acidification and eutrophication. This analysis will employ the GAINS optimization model for the case study regions Europe and China and consider the most recent air quality

policy targets. Costs and impacts on different climate metric-weighted emissions will be calculated.
This task will identify measures that make effective contributions to one of the three different impact baskets, and quantify their side-effects on the other baskets. This will highlight measures that result in win-win solutions, and measures that create trade-offs between the different policy objectives.

T7.3 Identify strategies that maximize co-benefits and minimize trade-offs (responsible: IIASA, Tsinghua Univ., CICERO)
Task 7.2 will highlight measures that result in win-win-win solutions, and measures that create trade-offs between the different environmental policy objectives. In particular, such trade-offs are to be expected for some air quality measures that imply reductions in SO2 and OC emissions, which would cause additional warming.
It is also likely that the full application of win-win measures will not be sufficient to achieve desired levels of air quality (e.g., those explored in T7.2d), so that practical air quality policies will need to include some measures that involve possible trade-offs with (some) climate objectives (e.g., global mean temperature).
Task 7.3 will explore strategies that maximize co-benefits between the different environmental policy objectives and, if measures with trade-offs are unavoidable, minimize their negative impacts. Insight from other WPs will help to better understand the nature of potential trade-offs. The implications of accounting for effects beyond global mean forcing or temperature and differences in temporal characteristics will be explored. In practice, trade-offs could be reduced through adopting structurally different solutions. For instance, instead of compensating the warming from lower SO2 emissions through additional reductions of particulate matter emissions, a more cost-effective strategy could instead opt for higher CO2 reductions that achieve the air quality improvements of the SO2 measures and, at the same time, reduce forcing.
The GAINS optimization (for this purpose with the options for reducing long-lived GHGs) will be used to identify cost-effective strategies in Europe and China that simultaneously achieve targets on near-term climate change, long-term climate change and air quality. This optimization will use the same constraints for the climate metrics as in T7.1c, and employ air quality targets that safeguard human health from exposure to PM2.5 and ground-level ozone as well as ecosystems from acidification and eutrophication.
Analysis will compare measures emerging from such a joint analysis with those developed for individual targets in Task 7.2, and identify overlapping measures that could be robustly recommended for policy implications, and those measures that depend on particular priorities. It will also explore to what extent the identified promising measures for short-lived gases overlap with those directed at long-term climate change, i.e., whether they are complementary or a subset of conventional climate policy measures.

T 7.4 Comparison of results of simplified metrics vs full model calculations for climate impacts, for selected cases (responsible: CICERO, METOFFICE, UREAD)
As the sub-sets of measures identified in Tasks 7.2 and 7.3 will be biased towards the measures with largest (net) impacts on the selected metric, a few selected validation runs with the full GCM models will be conducted to establish the validity of the climate response suggested by the simplified metrics, both at the global and regional scales

(GCM simulations in task 6.4). While the quantification of the metrics that are used in GAINS for identifying the measures will be derived from the complex full atmospheric chemistry models, these validation runs will examine whether the simplifying steps for producing the metrics lead to serious misrepresentations of the aerosol feedbacks and the non-linear chemistry for the policy-relevant range of emission reductions. For this purpose the future emission fields of some selected key sets of measures developed under Task 7.1 and 7.2 will be calculated for all relevant components and provided to the HadGEM and NorESM models for validation runs in task 6.4. The differences between the climate response suggested by the simplified metrics and the full GCM simulations will be analysed in order to evaluate the simplified approach. The assessment of model skill carried out in WP 2 with respect to seasonal variability and emissions (also WP 1) and also in WP 3 with respect to the detailed evaluations against observations, will be used to provide an estimation of uncertainties associated with the application of metrics in GAINS.

T 7.5 Synthesis and policy implications (responsible: IIASA and CICERO, all other partners contribute)

This Task will summarize policy-relevant insights that emerge from the ECLIPSE project. Given that significant uncertainties are expected to prevail even after the project, the synthesis will focus on robust findings, identify the range within these findings are robust, and distil concrete proposals how policies could harvest the contribution of short-lived GHGs to the air quality and climate change problems; on both short and long time scales.

A critical point for assessing prevailing uncertainties are the evaluation results on emissions (WP 1), overall model capabilities (WP 2), and capacity of the models to resolve SLCF short-term variability in source and receptor regions, including long-range transport (WP 3). Where formal treatment of uncertainties is not possible, expert judgements will be made on uncertainties for the different regions and species.

The possibility of a regional approach to regulation of emissions that will account for variations in effects of emissions between regions will be assessed. We will consider the importance of location of emissions (driver region) and we will also focus on contributions to warming in a particular response region, namely the Arctic.

It will also discuss to what extent short-lived substances that are not included in the Kyoto protocol should be included into the global climate policy discussions (e.g., in the UNFCCC), or whether these could be addressed more effectively in (existing) international regional agreements on air pollution. The effects of including new perspectives and metrics explored in WP 5 will be studied. In particular, implications of using metrics that account for regional patterns and metrics using other indicators than global mean RF or temperature (based on WP 5 and WP 6) will be explored.

Furthermore, the analysis will discuss the pros and cons of treating concerns on long-term and near-term climate change in separate baskets (with different metrics), or whether a unifying metric that brings together the short- and long-term climate impacts of emissions and measures could help the policy process. This work will be carried out within the framework of international programmes such as a new IGBP initiative on Air Pollution and Climate being developed jointly with policy makers.