ECLIPSE project – WP1: Emissions and Mitigation Options

Objectives

The overall goal of this work package is to develop global and regional aerosol and ozone precursors emission scenarios considering currently committed air pollution and climate policy and to determine scope for further emission reduction within the study time horizon.

The objectives are:
O1.1 – Develop updated reference emission scenario for the period 2005-2030 that will create the basis for the further modelling work
O1.2 – Assure comparability of the base year emissions with recent regional and global inventories and evaluate the reference scenario against the IPCC-RCP projections
O1.3 – Assess and update the model assumptions for current emissions in key sectors
O1.4 – Assess and update the model assumptions for emission control measures offering reduction potential beyond current commitments

WP1 contributes to the following project objectives (see section B1.1): O1, O3, O10, O11

Description of work

WP 1 will develop global and regional reference scenarios for use in WP 2, WP 3, WP 5, and WP 7. This will involve implementation of the most recent global and regional energy and agricultural projections, interpretation of current air pollution and climate policies and their implementation at a regional level, assessment and update of assumptions in the GAINS modelling framework on emission factors and reduction efficiencies, potentials and costs of mitigation measures. Special attention will be paid to reviewing the black carbon (BC) and organic carbon (OC) emission ratios for domestic biomass combustion sources. The parameterization of the model for the case-study region China will be performed in collaboration with Tsinghua University in Beijing (China). In order to achieve the above objectives, the work will be divided into the following tasks:

T1.1 – Development of the global reference emission scenario for the period 2005-2030/2050
(Responsible: IIASA, Tsinghua Univ.)
This task targets the first three objectives of WP 1, i.e., O1.1, O1.2, and O1.3.
The reference emission scenario for this project will be developed drawing on the experience of IIASA in various regional (e.g., for Europe: NECD, CAFE, CLRTAP, ECCP, Kupiainen and Klimont, 2007; for Asia: GAINS-Asia (Amann et al, 2008; Klimont et al., 2009; Wei et al., 2008)) and global (e.g., Cofala et al., 2007, Integrated Assessment of Black Carbon and tropospheric Ozone (UNEP, 2011), ACCENT (Isaksen et al., 2009)) projects where respective information on activity data, environmental

legislation, production and abatement technology characteristics, etc. have been collected and implemented in the GAINS model. Several elements of the model and implemented baselines have been reviewed by national experts and stakeholders. In this project we will draw on that experience and perform necessary updates of the activity data making use of the latest IEA energy projections (IEA, 2010) to the extent available, energy projections up to 2050 originating from the POLES model (JRC, Sevilla), long-term agricultural outlooks by FAO and environmental legislation, including climate policies. The reference emissions scenario will cover the period from 2005 to 2030 (thus, including emissions for the years 2008 and 2009 needed in WP 2 and WP 3) and will be implemented globally, distinguishing about 140 global regions; the resolution varies from provinces in large countries, e.g. China, to aggregated regions where several countries are represented, e.g., a few groups of countries in Africa.

The current legislation implementation will include assessment and update of the model assumptions on key parameters (i.e., emission factors, penetration of abatement) for key sectors in the case-study regions (Europe, Eastern-Europe and the Mediterranean, China). Key sectors include combustion of solid fuels in the residential sector for heating and cooking, transportation with specific focus on high-emitting diesel vehicles and off-road machinery, open burning of agricultural residue, and selected industrial processes in the developing world, e.g., coke ovens, brick kilns. A common feature of the above mentioned sources is that they are often characterized by a high share of BC emissions. Although the focus of the assessment will be on the non-UNFCC aerosol (BC, OC, SO2, PM2.5, NH3) and ozone precursors (NOx, NMVOC, CO, CH4), CO2 and other GHGs will be included as well. The involvement of Tsinghua University will assure that the latest results of local measurement campaigns and information on enforcement and future environmental legislation in China will be considered in the new emission scenarios. Base year emissions as well as the reference scenario will be gridded to suit the model resolution.

T1.2 – Assessment of regional emission bias in the baseline scenario and comparison with the IPCC-RCP base year and scenarios (Responsible: MET.NO, IIASA) This task addresses objective O1.2. It is expected that large regions with a significant emission bias can be identified by using global models and global-type of observational data. The baseline emission scenario will be used in forward aerosol and chemistry model simulations using the global EMEP model, and regional differences compared to observations (from WP 3) will be used to assess regional emission bias(-es). Model results from the HTAP and Aerocom database will be consulted to investigate whether any observed bias may be due to factors other than emissions (such as differences in meteorology, VOC speciation and model chemistry schemes).

A comparison of the base year emissions and the reference scenario with the peer-reviewed regional studies and the IPCC-RCP scenarios will be performed. The differences will be analysed and documented. An uncertainty estimate on individual sectors will be established based on these comparisons and the above mentioned model-observation comparisons.

T1.3 – Assessment and update of biomass burning emission ratios based on levoglucosan (Responsible: NILU, IIASA)
This task addresses objective O1.3.
Biomass combustion, including open fires (forest fires, agricultural residue burning) and small-scale combustion in the residential sector, is an important contributor to particulate matter (PM) emissions in several regions. Within the current project, emission of primary carbonaceous aerosols (black and organic carbon) is of special interest and an effort to improve emission source characterization, with respect to PM and its relative share of BC and OC, will be pursued. This task is designed to review emission ratios of the biomass burning tracer levoglucosan. This review will include emission ratios based on both emission- and ambient air samples, which can be used to calculate ambient air concentrations of PM, OC and BC from biomass burning caused by domestic heating, agricultural- and wild fires for the ECLIPSE study regions. Access to ambient air levoglucosan measurements, currently not available via databases, will be attempted and the data harmonized for the purpose of model validation.

T1.4 – Assessment and update of the model assumptions for emission control measures offering reduction potential beyond current commitments (Responsible: IIASA, Tsinghua Univ., NILU)
This task addresses objective O1.4.
The GAINS model benefits from published information on real-life performance of implemented measures and on design characteristics of measures to achieve currently discussed future emission limit values. The characteristics include control measures' reduction efficiencies, costs, and application constraints. However, most of the data has been collected in industrialized countries. Within this task, critical assessment of current model assumptions, specifically focusing on emission control measures offering potential reductions beyond current commitments will be performed considering regional differences in technology, costs, and the potential for application within the modelling horizon. Collaboration with the Chinese partner will be essential to develop a representative dataset for Asia and other developing countries and a realistic projection of future evolution of production and control technology in several countries. It is of utmost importance to include co-emitted species (e.g. OC) in the analysis and to avoid a focus on single species (e.g., BC) that, in isolation, would lead to the largest reductions in radiative forcing. Consequently, we will consider varying efficiency of reduction for specific pollutants per economic sector and region and how they depend on measures taken for other pollutants. Finally, we will consider not only technical, typically end of pipe, control measures but will discuss and implement selected non-technical measures such as elimination of the high emitting vehicles, ban of open agricultural burning and substitution of solid fuels in the residential sector.