ECLIPSE project – WP4: Climate Forcing

Objectives

The overall goal of this work package is to determine climate forcing as a function of emission sector and emission region for a comprehensive set of region/sector combinations.
In particular, this work package shall
O 4.1 – Calculate climate forcings for total global emissions for the relevant SLCFs and the forcing processes,
assess them with other published estimates and derive uncertainty ranges
O 4.2 – Exploit existing model results to calculate radiative forcing of regional emissions
O 4.3 – Establish matrix with climate forcing as a function of emitted components, source region and season

Description of work

T4.1 – Evaluation of best estimate ECLIPSE climate forcing and their uncertainty (lead by CICERO)
There is a considerable spread in the published estimates of radiative forcings (RF) and fast feedback (FF) responses for SLCF, in particular for aerosols. While the models in ECLIPSE will be validated against observations of temporal and spatial distributions of SLCF in WP 2 and 3, differences in assumptions and parameterizations of optical properties and processes and meteorological factors (e.g. surface albedo, cloud distribution, humidity) between the models lead to differences in the estimates of RF and FF. In this WP the models participating in ECLIPSE will make simulations to establish their best estimate of current RF and FF of SLCF. The causes for the differences beyond differences in concentrations will be analyzed (with input from WP 3) and the results from the ECLIPSE models will be compared against previously published results. For the direct aerosol effect and the indirect aerosol effect use of observational based estimates have provided very useful information and constraints on the radiative forcing. These observational based methods for the direct aerosol effects and indirect aerosol effects will be updated to concentrate and give constraints on BC. The work in this task will form a basis for an estimation of the uncertainties in our radiative forcing and fast feedback calculations for use in the remainder of this WP.

T4.2 – Exploiting existing model results to calculate RF of regional emissions (lead by UREAD)
During the HTAP project 16 global or hemispheric models participated in experiments where present day (2000) anthropogenic emissions in HTAP regions (North America, Europe, South Asia, and East Asia) for NOx, CO, NMVOC were perturbed by 20% individually (by region and component, i.e. 12 experiments). Archived results include ozone, and OH (methane lifetime) perturbations. Based on these results the geographical distribution of radiative forcing, and the resulting global-mean, will be calculated using off-line radiative transfer models (CICERO, UREAD), for ozone and methane, and also for our estimates of the methane-induced changes in ozone and stratospheric water vapour resulting from the OH changes. The HTAP simulations

provide a unique resource to understand the impact of differences in model formulation on RF, and its dependence on the region of emission.
Similar results from the HTAP project are also available for emissions of aerosols and aerosol precursors.
Combining these results with climatologies of clouds, humidity, surface albedo from the models in ECLIPSE
we will calculate the climate forcing (CICERO) also for regional and species specific emissions of the aerosol
species.
We will compare our RF results with more limited work which we know to be going on within HTAP.

T 4.3 – Establish matrix of climate forcing as a function of emitted components, source region and time of year (lead by METOFFICE)
Dedicated model simulation will be performed to establish a matrix with global climate forcing as function of emitted components, source region and season. The forcings will include both the radiative forcing (as defined e.g. in Forster et al., 2007) as well as the radiative effect of the fast responses. The latter covers the indirect effects of aerosols on clouds (all, not only the cloud albedo effect) and the semi-direct effect of absorbing aerosols. For ozone and aerosols we will include the indirect impact on carbon cycle through changed net primary productivity. The models that will participate are: HadGEM (at the Hadley Centre), NorESM (MET.NO), and OsloCTM2 (CICERO, with offline RF calculations). As described above the focus will be on two source regions (Europe and China), and simulations will be done for all relevant components individually (i.e. NOx, CO, VOC, SO2, BC, OC, and NH3). To account for seasonal dependence of the forcing, the simulations will be done for four seasons. The output of task 4.3 will be used to select the cases that will be the focus in the full climate response experiments in WP 6.

T 4.4 – Downscaling for Europe (lead by MET.NO)
Due to limitations in computer resources it is not possible to perform detailed calculations as in T4.2 on a country basis for Europe. However, a first order estimate of the country specific impact will be derived using the EMEP model at MET.NO to calculate changes in atmospheric burdens due to emissions from individual European countries. Based on this information the climate forcings derived in T4.2 for the whole European region will be attributed to emissions from the individual countries.